USER'S MANUAL FOR

LRFD STEEL GIRDER DESIGN AND RATING
(STLRFD)

pennsylvania
DEPARTMENT OF TRANSPORTATION

Version 2.9.0.1

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USER'S MANUAL FOR
COMPUTER PROGRAM STLRFD
LRFD STEEL GIRDER DESIGN AND RATING
VERSION 2.9.0.1

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LRFD STEEL GIRDER DESIGN AND RATING

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SUMMARY OF JUNE 1999 REVISIONS - VERSION 1.1

Since the release of STLRFD Version 1.0 some error reports and user requested enhancements have been received. This release of STLRFD Version 1.1 contains the following error corrections and enhancements:

1. The multiple presence factor is now taken into account when computing the deflection distribution factor.

2. Web thicknesses are now chosen from the tables presented with the DP1 command, rather than rounding to the nearest 1/8".

3. During the design process, the design is checked to ensure that a C' fatigue detail at the top of the bottom flange satisfies the infinite life criterion.

4. Previously, the design optimization started at the midspan point and optimized the design for all moments there. The design is now optimized for the points of maximum factored moment for strength, service, and dead loads only. In many cases, the points of maximum factored moment are different than the maximum dead load moment location.

5. Plate girders with no transitions as well as unstiffened plate girders can now be designed.

6. The design convergence criteria has been changed to compare all of the plate sizes and transitions as well as the total girder mass to ensure convergence to the exact same design as previously chosen.

7. The transverse stiffener design algorithms have been fixed so that good transverse stiffeners will be designed.

8. Limit state Service-IIB no longer includes live load for runs considering special live loads (as stated in DM-4).

9. If the number of fatigue cycles remaining is less than zero, the number is reset to zero.

10. Rating factors for noncompact, noncomposite sections are now computed properly when lateral torsional buckling governs. For this case, the tension flange is stress governed, but the compression flange is moment governed. Both ratings are now printed.

11. Sections with yield strengths over 50 ksi are treated as noncompact.

12. Analysis points located at the first transverse stiffener are now considered as part of the interior or exterior panel, based on which range, interior or exterior, has the wider spacing. This will only affect plate girders that are homogeneous.

13. Short (less than 25') spans without BRP commands have correctly defined brace points.

14. Multiple span design runs are trapped and not allowed to run.

15. Lane widths less than 3.0 meters can now be entered.

16. Recent count, previous count, and future count ADTT's on the FTL command must be greater than zero.

17. Distribution factors as per the 1998 AASHTO specifications have been implemented.

18. Built-up sections with transverse stiffeners are now analyzed as stiffened sections.

19. Version 3.2 of CBA has been implemented.

SUMMARY OF MAY 2001 REVISIONS–VERSION 1.2

Since the release of STLRFD Version 1.1, several error reports and user requested enhancements have been received. This release of STLRFD Version 1.2 contains the following error corrections and enhancements:

STLRFD Version 1.2 contains the following revisions:

1. The program now analyzes built-up sections without flange plates properly. Also, the horizontal angle legs are now considered in strength calculations and b/t ratio checks. (Requests 000/038/052)

2. Consistent criteria are now applied when determining if a given point is to be considered stiffened or not. There was a difference between the criteria on the SHEAR CAPACITY and TRANSVERSE STIFFENERS CHECK tables. (Requests 017/058)

3. Bearing stiffeners and transverse stiffeners must be defined separately; the program does not include bearing stiffeners when it checks the transverse stiffeners. The User's Manual was revised to clarify this point. (Requests 018/062)

4. When changing flange dimensions inside a varying depth web range, the web depth should not be entered; the program will automatically compute the web depth. An example was prepared for the User's Manual illustrating how to enter this situation into STLRFD. (Requests 019/059)

5. When span lengths are over 73000 mm or 240 feet, 73000 mm or 240 feet is to be used as the span length for distribution factor calculations, not the actual span of the bridge. This has been corrected. (Requests 020/031/063)

6. Small changes were done to the shear stud clearance and spacing to bring the program into compliance with the current version of BC-753M. (Requests 022)

7. The program has been modified to check the factored stress in the bottom flange to determine if a section is in positive or negative flexure. Previously, the program was using the stress in the slab, leading to contradictory results near dead load contraflexure points. (Requests 023/043)

8. User input load factors for special live load are now used. Previously, the default load factors could not be overridden. (Request 024)

9. The program now uses the load factors entered on the LDF command to determine limit state applicability for rating of special live loads. If the user does not enter an LDF command, the default limit states as defined in DM-4 are used for special live loads. (Request 025)

10. Girders with fewer than two contraflexure points per span were not handled correctly; this has been fixed. The user can also enter less than two contraflexure points per span via the ECP command. (Request 026)

11. When the user enters more than the maximum number of concentrated loads allowed, a more descriptive warning will appear. (Request 027)

12. Version 3.4 of CBA has been incorporated. (Requests 028/035/044/091)

13. The most recent version of STPOST has been incorporated for BRADD–3 compatibility. (Requests 029/072/080)

14. The code necessary for the NCHRP 12–50 project output has been incorporated. (Request 030)

15. Up to five special live load vehicles can now be analyzed and rated in a single run of the program. See the updated User's Manual pages for the new required input on the SLL and SAL commands. (Request 032) **NOTE:** this change requires that any previously existing input files using special live loads be updated because of additional input now required.

16. The PennDOT skew angle limits have been updated to match what PSLRFD uses. (Request 037)

17. The "web leg length" column of the program output now prints the values correctly. (Request 040)

18. Compression flange buckling failure codes are now only printed next to the compression flange; not both flanges. (Request 041)

19. When the LRFD compression flange buckling check fails, the program reports the stress which will cause buckling of the section as the flexural capacity of the section, and the "RESISTANCE CALCULATION" as being governed by the compression flange buckling. (Request 042)

20. The error codes and comments have been rearranged on the UNCURED SLAB WEB SPECIFICATION CHECK output report. (Request 045)

21. Stress resistances throughout the program are now limited to a maximum value equal to the yield stress of the component. (Request 046/053)

22. A more detailed sketch of the program input parameters for the CDF command has been prepared. (Request 051)

23. When the values are required for computing the flexural capacity of the section, the depth of web in compression, D_c, and the radius of gyration of the compression flange of a steel section plus one third of the web in compression about the vertical axis in the plane of the web, r_t, are reported on the “FLEXURAL CAPACITY” output reports. (Request 054)

24. The input files for STLRFD can now reside in a different directory than the executable. The working directory should be the location of the input files. (Request 055)

25. A contradiction between the SHEAR CAPACITY and the UNCURED SLAB WEB SPECIFICATION CHECK output reports has been resolved. (Request 056)

26. Several pages of the User's Manual have been revised including a new Chapter 9. (Requests 057/073/090)

27. It was found that the program was not checking the compression flange buckling criterion for the uncured slab or construction staging specification checks. This criterion has been added. (Request 064)

28. The program was not computing the total factored dead load moment correctly when computing the flexural capacity for the uncured slab or construction staging specification checks. The value now includes the proper dead load components. (Request 065)

29. On the SLL command, the program was ignoring the “PERCENT INCREASE” parameter. The program now increases all axle loads by that percentage when computing the effects due to that vehicle. (Request 066)

30. The lower limit for span length was changed to be a warning, rather than an error to allow girders with span lengths less than 5.2 m or 18 ft to run. (Request 067)

31. The extension of the Parameter Data File has been changed to PD to avoid conflicts with Adobe Acrobat files. (Request 070)

32. Additional compiler settings were activated to trap divide-by-zero errors. (Request 074)

33. The program now pauses after execution so that if the program is run via an icon on the desktop or Start menu the Command Prompt window does not close immediately after program execution. At the end of program execution, a message is printed on the screen advising the user to “Press <ENTER> to exit program.” (Request 075)

34. The User’s Manual was converted to the Microsoft Word format. (Request 077)

35. The program will now stop with an input consistency error if the user enters an effective slab thickness less than or equal to zero and requests program computed distribution factors. If the user desires an effective slab thickness less than or equal to zero, user–defined distribution factors must be used. (Request 083)

36. The importance, ductility and redundancy factors now have default values of 1.0. (Request 086)

37. An additional note has been added to the STRESS FLEXURAL CAPACITY output report to indicate that the bottom flange stress reduction due to wind effects has been subtracted from the stress resistance for the Strength-III and Strength-V limit states, when applicable. Also, codes specifying the type of stress resistance calculations have been added to the UNCURED SLAB FLANGE SPECIFICATION CHECKS and CONSTRUCTION STAGE FLANGE SPECIFICATION CHECKS output reports. (Request 092)

The following is a list of reported problems, user requests and clarifications that will be addressed in a later version of STLRFD:

1. Add options to the WIN command to allow the user to enter different conditions for the construction limit state checks. (Requests 021/047/048/050)

2. Create a “short output” option. (Requests 033/036)

3. Investigate to confirm how STLRFD checks the capacity of the girder based on the deck concrete capacity. (Request 060)

4. Investigate to determine how the program handles the location of contraflexure points when an interior span is entirely in negative bending. (Request 069)

5. Show on the output the method used to compute the distribution factors (AASHTO equations, pile load approximation, lever rule, etc.). (Request 071)

6. Add the ML-80 load to the design load options. (Request 076)

7. Allow the user to specify all intermediate web depths in a linearly varying range. (Request 078)

8. Investigate how the program computes the web compressive stress checks, and whether the web buckling stress should be reported as the web compressive stress capacity. (Request 079)

9. In the calculation of the transverse stiffener checks, take the state of flexure of the beam into account in order to interpret the location of the longitudinal stiffeners correctly. (Request 081)

10. Check the program to determine if the application of the skew correction factors considers the diaphragms properly. (Request 082)

11. Compare the program will be compared to the 2000 DM-4 and 1998 LRFD Specifications to determine what revisions are needed. After the revisions are made, the LRFD Section 6 references in the STLRFD User's Manual will be changed to match the updated number in the 1998 LRFD Specifications and 2000 DM-4. (Request 084)

12. Change the longitudinal stiffness parameter limit checks to match the April 2001 updates to DM-4 (Request 087)

13. Check the computation of the dead load flexural stress limits for the case where there are two longitudinal stiffeners. (Request 088)

14. Check the live load reactions with sidewalk. (Request 089)

15. Make the program compatible with the APRAS system. (Request 093)

16. Change the default value for the reinforcement strength to 420 MPa to reflect current practice in DM-4. (Request 094)

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SUMMARY OF JULY 2004 REVISIONS–VERSION 1.3.0.0

Since the release of STLRFD Version 1.2, several error reports and user requested enhancements have been received. This release of STLRFD Version 1.3.0.0 contains the following error corrections and enhancements:

STLRFD Version 1.3.0.0 contains the following revisions:

1. The WIN command has been replaced by two new commands, WPD and WUD, which allow the user to enter wind conditions that are different for the construction/ uncured slab limit state checks and the permanent condition limit state checks. Having two separate input commands breaks up the options for program–defined and user–defined wind conditions. The WIN command is an obsolete command that is still recognized by the program for backwards compatibility, but existing input files should be migrated to use WPD or WUD instead. (Requests 021/048/050/191/223)

2. The Department's Continuous Beam Analysis program, CBA version 3.4 is incorporated as an analysis module. (Request 035)

3. A warning is reported when the factored stress in the slab exceeds 0.85* f_c'. (Request 060)

4. The method used to compute the distribution factors (AASHTO equations, pile load approximation, lever rule, etc.) is now indicated on the output. (Request 071)

5. The ML-80 load has been added to the design load options. (Request 076)

6. The user can now enter the web depths for the intermediate ranges for linearly varying web depths. (Request 078)

7. The stress required to cause web buckling is computed and is used for web buckling check. If the web buckling controls then the corresponding stress is reported as the capacity of the section. (Request 079)

8. Longitudinally stiffened sections were incorrectly tagged with a failure code while doing transverse stiffener checks. Incorrect transverse stiffener failure tags are now eliminated by considering the state of flexure of the beam considered, while doing the transverse stiffener checks, to interpret the location of the longitudinal stiffeners correctly. (Request 081)

9. References to the LRFD Specifications and DM-4 have been updated to the sections and equations in the 1998 LRFD Specifications and 2000 DM-4. See Table 2.7-1 for a list of some Article and Equation changes that will be incorporated in a future version of STLRFD. (Request 084)

10. SI limits on the longitudinal stiffness parameter (K_g) are changed to match the April 2001 DM-4 revisions. (Request 087)

11. Dead load flexural stress limits reported were incorrect when longitudinal stiffeners were provided both at the top and the bottom. Maximum compressive stress in one flange and the corresponding stress in the other flange are used to compute Dc for the check. The final stress in the flanges is compared to the "uncured" slab stress (i.e. all slab placed at the same time). (Request 088)

12. Reactions at the supports for the cases with sidewalk were incorrectly reported. Incorrect distribution factors were used for live load reactions with sidewalks for the last support. Appropriate distribution factors are now used to compute live load reactions with sidewalks. (Request 089)

13. Explanation of computation of weighted K_g (longitudinal stiffness parameter) has been added to the chapter 3 of the user manual. (Request 090)

14. The Department's Continuous Beam Analysis program, CBA version 3.4a is incorporated as an analysis module. (Request 091)

15. The default value for the reinforcement strength is updated to 420 MPa to reflect current practice in DM-4. (Request 094)

16. Incorrect section properties were used to compute girder flexural stresses at plate transition locations and at locations where the web depth was not constant. Section properties were reported for ranges in the section property output report. The section properties are now computed to the right and left of transverse section point. The smaller moment of inertia to the left or right of the section is now used for specification checks. In a varying depth range, the section properties on each side of the transverse section point are now computed using the same web depth, but different flange plates if they happen to change at the transverse section point. The section property output report now reports the section properties at each analysis point that are used for specification checking. (Request 095)

17. The ductility factors (and the other system settings) are reported in a formatted output table. (Request 097)

18. A legend is added to the beam properties table to indicate that the properties on each row of the table are to the LEFT of the span and distance given. (Request 099)

19. Some of the locations were incorrectly identified as composite sections during construction stage computations. A computational error has been corrected while determining if an analysis point is composite for a symmetrical beam where the construction stage at the symmetrical point is not the same as the beam end point. (Request 102)

20. The program was aborting for the specific case of a noncomposite section in negative bending, where compression flange failed under buckling and the alternate formula for M_n was applicable. Modifications have been made to eliminate the program abort. (Request 106/139)

21. Section 3.8.3 (Rating Factor for Flexure-Shear Interaction) of the user manual has been updated. (Request 107)

22. The flexural stresses on the FACTORED ANALYSIS RESULTS output report are reported only for sections where flexural capacity is reported in terms of stress. For sections where flexural capacity is returned in terms of moment, " N/A* " is reported in the output with a legend explaining the reason why the stresses are not printed. (Request 108)

23. Incorrect interpretation and entry of the number of holes on SHO command were causing the program to crash. Checks are now added to let the user know when the number of holes entered in SHO command fall outside the beam dimensions. Sections 5.25 and 6.25 of the user manual have been updated to provide additional information. (Request 109/192/201)

24. STLRFD analysis point tolerances are updated to 0.1 inches and 2.54 mm to match with tolerances set in Department's Continuous Beam Analysis (CBA) program. (Request 110)

25. Multiple presence adjustment factors are applied to the factored results. (Request 111)

26. Results for SERVICE-II, SERVICE-IIA and SERVICE-IIB limits states have been removed from the "SHEAR CAPACITY" output report. (Request 112)

27. User manual section 7.1.6 has been updated to clarify the shear sign convention. (Request 113/151)

28. Designs and analysis of the fillet weld between the flange and web plates for plate girders is added. (Request 116)

29. The maximum moment and maximum shear effects were used together in all computations. Computations are now modified to use concurrent shear and moment effects for shear capacity, shear rating factors and flexure/shear interaction rating factors. (Request 118)

30. Rolled beam section properties were reported incorrectly when section losses were entered. Computation of rolled beam section properties when section losses are entered has been modified. (Request 119)

31. A separate input for impact for P82 vehicle has been added as per SOL 431-01-07. (Request 120)

32. The limitation on the number of transverse stiffener inputs has been increased from 50 to 100. (Request 121)

33. Span length limits (for spans over 240 ft long, use L = 240 ft) have been incorporated for the computation of shear distribution correction factor as per the April 2000 DM-4. (Request 123)

34. Several fixes have been made to prevent the program from crashing. (Requests 124/128/188/219/264)

35. Rating factors less than 1.0 are now flagged in the output report. (Request 129)

36. Shear connector specification checks have been updated to handle the scenarios of no contraflexure points in the interior span as well as some cases where locations of zero dead load moment are different than the user-entered contraflexure locations. (Request 130)

37. For the cases where flanges had different strengths unexpected results were observed. A correction has been made to eliminate the erroneous results for the cases where flanges have different strengths. (Request 131)

38. The SID command has been updated for APRAS requirements. The State Route field has been changed to a numeric field and the Span Identification field has been changed to an alphanumeric field. (Request 132)

39. The Department's Beam Section Properties program, BSP version 1.4 is incorporated as an analysis module. (Request 133)

40. The transverse stiffener constructability spacing requirement of 1.0D was enforced to classify the section as "stiffened" versus "unstiffened" for an exterior girder for the purpose of computing shear capacity. The enforcement has been removed and the classification now is based solely on the 1.5D criterion. A warning is generated on the TRANSVERSE STIFFENERS CHECK output report whenever the transverse stiffener spacing for an exterior girder exceeds the 1.0D constructability spacing requirement. (Request 134,149)

41. The user is not allowed to enter all the six parameters on WIN command. The user is allowed to enter specified combination of parameters on WIN command as per the user manual section 5.36. (Request 135/220)

42. The method of computing the minimum factored reactions has been revised. The factored reactions are computed by component. If a component (DC1, DC2, DW, etc.) is positive (downward), then the reaction component is multiplied by the minimum load factor and then is divided by the eta (η) factor to compute the minimum factored reaction. If the component is negative (upward), then the reaction component is multiplied by the maximum load factor and eta (η) factor to compute the minimum factored reaction. (Request 136)

43. Noncontributing axles were included for P-82 loading. Noncontributing axles are now neglected for P-82 loading. (Request 140)

44. The K_g computational procedure for both noncomposite and composite beams is made identical to ensure the noncomposite distribution factor is not less than the composite distribution factor. (Request 141)

45. Loads due to the instantaneous deck placement were used in the computations of total dead load stresses, all the time, irrespective of construction staging. Now the maximum of, the construction stage load and the instantaneous deck placement load, is used in the computation of total dead load stresses provided in the output report "RATING FACTORS - STRESS FLEXURAL CAPACITY". (Request 143)

46. A new summary output report that provides a list of specification check warnings has been added to the output. (Request 144)

47. New reaction output reports that summarize the reactions required for bearing pad, abutment and pier designs have been added to the output. (Request 145)

48. Concentrated loads at the end supports were not considered in the computations. A tolerance has been added when checking the location of concentrated dead loads so that concentrated loads at supports are no longer ignored. (Request 147)

49. For a particular case, a girder was failing the fatigue check at a point away from the location of maximum factored moment causing a specification check failure. The point of maximum fatigue range is now passed to the design routines to overcome the unwarranted specification check failure. (Request 148)

50. Deck pour and construction stage reaction output reports have been added to the output. (Request 150)

51. Modifications made to the Department's Continuous Beam Analysis (CBA) and Beam Section Properties (BSP) modules are incorporated. The modifications correct a load case problem for interpolated analysis results near points of zero moment. (Request 152)

52. Distribution factors for exterior beams for lane widths less than 12 feet were incorrectly computed. Computations of lane eccentricities used to compute distribution factors for exterior beams have been modified. (Request 153)

53. The live load distribution factor for an exterior beam was not allowed to be lower than the live load distribution factor for an interior beam. The live load distribution factor calculation for exterior girders has been revised to eliminate the requirement that the 'e' modification factor be greater than or equal to 1.0. By eliminating the restriction the live load distribution factor for an exterior girder can now be less than the live load distribution factor for an interior girder. (Request 156)

54. Bearing resistance calculations have been revised as per DM-4 revision 6.10.8.2.3. (Request 175)

55. An inconsistency when redistributing moments for the scenario where the symmetry option is specified for the girder but not for the deck pour, has been eliminated. User Manual section 6.5.8 is updated providing additional information. (Request 194)

56. The User Manual description of the CTL command, parameter 9, “ADTT for single lane”, has been updated as per AASHTO 3.6.1.4.2. (Request 198)

57. When the bearing stiffeners were entered out of order, bearing stiffeners were not displayed in locations where they were supposed to be. Bearing stiffeners are now sorted and displayed even when the bearing stiffeners are entered out of order. (Request 199)

58. SERV-IIA limit state is now checked for uplift. An uplift flag is displayed in the output report indicating no uplift is permitted under service limit state. However, uplift is allowed for strength limit states. (Request 202)

59. Under certain circumstances, incorrect fatigue resistance was reported for spans other than the span one. A tolerance has been added to correctly compute the fatigue resistance for spans other than the span one. (Request 203)

60. The upper, lower and default values of the parameters in the user manual have been updated to be consistent with the corresponding values in the program. (Request 204)

61. In Chapter 5 of the User's Manual, the ORF command parameter name LIVE LOAD RATING SUMMARY has been renamed VEHICLE RATING SUMMARY to match the program. (Request 209)

62. The parameter descriptions in several STLRFD Engineering Assistant configuration files have been updated to match the parameter descriptions in the User's Manual. (Request 210/212)

63. The program was fixed to prevent it from crashing under certain circumstances when computing the section properties for a girder in the construction condition. (Request 219)

64. A blank ARB input record is no longer added for new input files created with Engineering Assistant. (Request 234)

65. Further information has been added to the User's Manual Section 6.5.5 documenting the calculation of slab loads for girder-floorbeam-stringer systems. (Request 237)

66. An input value exceeding the upper limit of "Distance 2" on the FTG command will now result in a warning being issued and the program continuing. Previously, the program would stop with an error message. (Request 249)

67. The User's Manual has been updated to specify that the user should enter 0.0 for the Strength IP load factor on the LDF command when there is no pedestrian load present on the bridge. (Request 263)

68. Additional sketches have been added to the User's Manual for the CDF command to clarify input values for the right fascia beam. (Request 269)

69. The sketch showing the correct sign for entering section loss on the top angles of a built–up section has been revised to show that vertically down should be entered as positive. (Request 275)

The following is a list of reported problems, user requests and clarifications that will be addressed in a later version of STLRFD:

1. User request for an abbreviated output option. (Requests 033/036/190)

2. Apply a different load factor to wind on superstructure for the construction limit state. (Request 047)

3. Investigate how to calculate the effective span length for use in effective flange width calculations when an interior span is entirely in negative bending. (Request 069)

4. Incorporate Articles and Equations that have been changed in the 1998 LRFD Specifications and 2000 DM-4. See Table 2.7-1 for a full list of changes that need to be incorporated. (Requests 084, 157 to 159, 161 to 174, 178 to 187)

5. Make the program compatible with APRAS system. (Request 093)

6. Investigate how and where the program uses the “Bracing Type” parameter specified in the CDF command. (Request 098)

7. Investigate what “TOP S/R" means when the user enters 0.0 for reinforcement area and CG. (Request 100)

8. Investigate to determine if the program considers a section over the pier as noncomposite if the reinforcement over the pier is entered as zero. (Request 101/104)

9. Investigate for a specific input file why the allowable compression flange capacity at the pier is less than that at midspan despite the larger plates. (Request 103)

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10. Investigate if the program is too conservative in bearing stiffener capacity calculations. (Request 105)

11. Investigate whether STLRFD should treat the entire girder as noncompact if some sections are compact and some sections are noncompact in a given girder. (Request 114)

12. Investigate how the program handles the remaining fatigue life calculations. The program should be revised to check the permanent load stress and compare it to the live load stress. (Request 115/126/207)

13. Investigate how the program should handle hybrid girders where the web strength is greater than the flange strength. (Request 117)

14. Incorporate the TK-527 vehicle. (Request 122)

15. Allow the user to specify minimum load factors for the miscellaneous loads MC1 and MC2. (Request 127)

16. Increase the maximum number of allowable points to 60 on UDA command for camber computations. (Request 137)

17. Report flexural capacity in terms of stress at all points including sections where the flexural capacity is moment-governed for use with the splice program (SPLRFD). (Request 138)

18. Investigate to determine why sometimes asterisks are printed in the STLRFD Rating Factor output. (Request 146)

19. Investigate how the distribution factor for moment for exterior girders is computed and reported. (Request 176)

20. Remove the computed deflection distribution factor from the output if the user does not enter a deflection distribution factor. (Request 177)

21. Incorporate the web crippling check for rolled beams for the provision of bearing stiffeners. (Request 195)

22. Investigate how the web compression failure for construction stages is computed. (Request 196)

23. Incorporate the span-to-depth ratio check for design. (Request 200)

SUMMARY OF SEPTEMBER 2004 REVISIONS–VERSION 1.3.0.1

Since the release of STLRFD Version 1.3.0.0, several error reports and user requested enhancements have been received. This release of STLRFD Version 1.3.0.1 contains the following enhancement:

1. On the FTG command, fatigue detail categories BP, CP and EP, equivalent to B', C' and E', have been added to work around an issue with Engineering Dataset Manager. Because this issue only affected the Engineering Dataset Manager, this program version was only released to internal PennDOT customers. (Request 279)

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SUMMARY OF FEBRUARY 2006 REVISIONS – VERSION 1.4.0.0

Since the release of STLRFD Version 1.3.0.1, several error reports and user requested enhancements have been received. This release of STLRFD Version 1.4.0.0 contains the following revisions:

1. A new input item for field splice location (FSL command) has been added and is used to indicate that the analysis point at the splice location will always be treated as noncompact for flexural resistance calculations. (Request 114)

2. Fatigue calculations are now computed only for fatigue details that satisfy the requirement of LRFD Specifications Section 6.6.1.2.1, that is, fatigue details that incur tensile stress under the fatigue load combination, or fatigue details where compressive stress under permanent load is less than twice the fatigue live load stress. (Requests 115, 265)

3. The TK527 vehicle is now included for several live load codes, for rating, analysis and design. (Request 122)

4. The expression showing the calculation of lambda in Section 6.41 of the User's Manual has been updated to match the program. (Request 126)

5. A span-to-depth ratio check (as per DM-4 Section 2.5.2.6.3 and the LRFD Specifications Table 2.5.2.6.3-1) has been added to the design algorithm of the program. If desired, this check can be turned off via the DP2 and DRB commands. (Request 200)

6. The same procedure for calculating the fatigue stress range is now used both for fatigue resistance and estimated remaining fatigue life. (Requests 207, 255, 280)

7. The calculation of the web buckling stress now handles the case where the dead load stress is greater than the calculated stress capacity. (Request 214)

8. The brace point calculation has been modified to avoid rounding errors that could lead to a program crash. (Request 215)

9. If the depth of web in compression at the plastic moment, D_{cp}, is equal to zero and the optional Q formula is to be checked, the program has been modified to stop with an error to avoid a program crash. (Request 218)

10. The analysis point location calculation has been modified to avoid rounding errors that could lead to a program crash. (Request 222)

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11. Girder overhang checks have been added in accordance with DM-4 Article 9.7.1.5.1. Any girder overhang greater than 0.5 * girder spacing will result in a chief bridge engineer warning for both analysis and design runs of the program. A girder overhang greater than 0.625 * girder spacing will cause the program to stop with an error for design runs of the program. (Request 225)

12. The program has been modified to run as a Windows dynamic link library (DLL). (Request 228)

13. The Beam Section Properties program, BSP, version 1.5, has been incorporated into the program to compute the section properties. (Request 235)

14. The calculation of shear connector design region length now follows consistent rules for all spans. (Request 243)

15. The fatigue live load results now print correctly when the pedestrian load is entered as 0.0. (Request 250)

16. A check for built-up sections has been added to ensure that the web depth is greater than twice the vertical leg length. (Request 254)

17. Captions have been added to the images used with Engineering Assistant help. (Request 268)

18. The corner of the angle is now only counted once for calculations of moment of inertia and area of the angle when angles are used as transverse stiffeners. (Requests 270 and 271)

19. The program now takes section loss on the web into account for shear capacity and web buckling calculations. (Request 272)

20. If section hole (SHO) commands are not entered in order from left to right along the girder, the program will sort them properly. (Request 277)

21. A negative value for the distance to first hole can now be entered on the SHO command through the Engineering Assistant program. A negative value can now also be entered for the "Distance" parameter on the SLS command. (Request 278)

22. The lower limit of the dynamic load allowance and fatigue dynamic load allowance has been changed to 1.0. (Request 285)

23. The construction load path is now printed on the uncured slab and staged construction output reports. (Request 286)

24. An output report describing economic feasibility checks has been added to advise the user of economic and constructability checks that may not be satisfied by the girder. (Request 288)

25. The multiple presence adjustment factor (parameter 10 of the CTL command) is only applied to the "lever rule" and "rigid frame" methods of calculating the distribution factors. Note that the use of the multiple presence adjustment factor is no longer allowed by DM-4, so the upper and lower limits of this value have been changed to 1.0 to restrict the use of this factor. (Request 292)

26. The upper limit of concentrated loads has been changed to 30 in the User's Manual to reflect the program's capability. Also, the description of the TST command has been modified to indicate that the parameters of the command cannot be repeated. (Request 294)

27. The input line length limit has been increased to 512 characters. (Request 295)

28. The rating tonnage of SI special live load vehicles is now computed using the correct conversion factors. (Request 298)

29. The longitudinal stiffness (Kg) is now printed in the section property output tables for negative flexure. (Request 303)

30. The example input files have been modified to eliminate all input warnings. (Request 304)

31. The gross section properties now print correctly for a plate girder with section loss on a straight-line web depth variation. (Request 305)

32. An example has been added to Chapter 6 to demonstrate how the DP1 command "Weight/Mass Savings" input parameter is used by the program. (Request 306)

33. The upper limit of $b_t < 0.48 * t_p * \text{sqrt}(E/ F_y)$ has been removed from the transverse stiffener specification check calculations. (Request 309)

34. An error with reporting the gross section properties at a transition between varying-depth and constant-depth sections has been resolved. (Request 310)

35. CBA Version 3.5.0.7 has been incorporated into the program. (Request 312)

36. A new bracing command, CBR, has been added to allow the user to designate continuous bracing of the top flange for beams that are noncomposite in the final state. (Request 313)

37. The program has been modified to avoid crashes when checking if section holes are actually located on the steel section. (Request 314)

38. BSP Version 1.5.0.1 has been incorporated into the program. (Request 315)

39. When the only code check advisory on the "Web to Flange Weld Design: Weld Capacity" output report is that the designed weld size is less than the minimum, the title of the output report will now appear under "SPECIFICATION CHECK WARNINGS". (Request 316)

40. The scale tolerance has been removed from the rating tonnages computed by the program for the TK527, ML80 and special live load vehicles. (Request 318)

41. Trapezoidal loads on symmetrical girders are now mirrored properly. (Request 319)

42. The section numbering of Chapter 6 has been corrected to properly correspond with the section numbers in Chapter 5. (Request 320)

The following is a list of reported problems, user requests and clarifications that will be addressed in a later version of STLRFD:

1. User request for an abbreviated output option. (Requests 033/036/190)

2. Apply a different load factor to wind on superstructure for the construction limit state. (Request 047)

3. Investigate how to calculate the effective span length for use in effective flange width calculations when an interior span is entirely in negative bending. (Request 069)

4. Make the program compatible with APRAS system. (Request 093)

5. Investigate how and where the program uses the “Bracing Type” parameter specified in the CDF command. (Request 098)

6. Investigate for a specific input file why the allowable compression flange capacity at the pier is less than that at midspan despite the larger plates. (Request 103)

7. Investigate to determine if the program considers a section over the pier as noncomposite if the reinforcement over the pier is entered as zero. (Request 104)

8. Investigate how the program should handle hybrid girders where the web strength is greater than the flange strength. (Request 117)

9. Allow the user to specify minimum load factors for the miscellaneous loads MC1 and MC2. (Request 127)

10. Increase the maximum number of allowable points to 60 on UDA command for camber computations. (Request 137)

11. Report flexural capacity in terms of stress at all points including sections where the flexural capacity is moment-governed for use with the splice program (SPLRFD). (Request 138)

12. Investigate to determine why sometimes asterisks are printed in the STLRFD Rating Factor output. (Request 146)

13. Incorporate Articles and Equations that have been changed in the 1998 LRFD Specifications and 2000 DM-4. See Table 2.7-1 for a full list of changes that need to be incorporated. (Requests 157 to 159, 161 to 174, 178 to 187)

14. Remove the computed deflection distribution factor from the output if the user does not enter a deflection distribution factor. (Request 177)

15. Incorporate the web crippling check for rolled beams for the provision of bearing stiffeners. (Request 195)

16. Investigate how the web compression failure for construction stages is computed. (Request 196)

17. Investigate why specification checks change when a user-defined analysis point is introduced in a varying-depth section. (Request 231)

18. Investigate why specification checks are nonsymmetrical for a symmetrical, varying depth section. (Request 232)

19. Select rolled beams shallower than 18" for rolled beam design runs. (Request 236)

20. Clarify description of deflection distribution factors in User's Manual. (Request 239)

21. Allow complex geometry for varying depth sections (different adjacent parabolic sections). (Requests 240/327)

22. Investigate the application of the multiple presence factor when sidewalks are present. (Request 247)

23. Program crashes for a case where there are no dead load points of contraflexure in the end spans. (Request 293)

24. Report service limit state flexural capacities in terms of stress. (Request 296)

25. Program crashes with section loss in a varying-depth range. (Request 299/323)

26. Modify the program to compute section properties at the midpoint of each girder range to avoid problems at transitions. (Requests 321/322)

27. Add capability to specify multiple shear connector design regions with a different number of connectors per row in each region. (Request 324)

28. Modify the program to use the concurrent shear and moment from the same vehicle when analyzing a live load envelope of multiple vehicles (design live load cases D and E). (Request 325)

29. Program crashes when a transverse stiffener spacing of 0.0 is entered. (Request 326)

30. Change the upper limit on the span length (SPL) command to be a warning or Chief Bridge Engineer warning. (Request 328)

31. Increase the number of special live load axles allowed to 64. (Request 332)

32. Very large negative rating factors are calculated near hinges. (Request 333)

33. Show a specification check failure if the overhang on an exterior beam is greater than the beam depth. (Request 334)

SUMMARY OF FEBRUARY 2007 REVISIONS – VERSION 1.5.0.0

Since the release of STLRFD Version 1.4.0.0, several error reports and user requested enhancements have been received. This release of STLRFD Version 1.5.0.0 contains the following revisions:

Cross Section Property Revisions

1. The program has been enhanced to now compute section properties on both sides of the user defined analysis points using the depth of web at the user defined analysis point. Previously, for varying depth girders, the program would compute web depths at each analysis point, and use the web depth from the next analysis point to compute the section properties if it resulted in a smaller moment of inertia (Request 231).

2. The gross section property calculations have been revised to compute the actual gross section properties at the mid-length of a range. Previously the program would calculate the average of the section properties at each end of the range, which sometimes lead to incorrect results especially for varying depth girders. The net section property calculations were revised to compute the net section properties at the left and right side of a transition point and to use both the left and right section properties for all specification check calculations and report them in the output (Request 321).

Specification Related Revisions

3. For field splice locations, the program has been enhanced to report the Factored Flexural Resistance in terms of moment for the Strength-I and Strength-IP limit states because this is required input for designing or analyzing a splice with the SPLRFD program. Previously the program would report the Factored Flexural Resistance in terms of stress which required hand calculations to be done prior to running the SPLRFD program (Request 138).

4. The Service Limit State Control of Permanent Deflection output table has been revised to report the results in terms of stress. Previously, this table reported the results in terms of moment (Request 296).

5. CBA Version 3.5.0.25 has been incorporated into the program. It contains improved interpolation and extrapolation procedures for intermediate points which now provides correct results for certain input files. In addition the Fatigue Reaction Distribution Factors have now been added to the output, and the Fatigue Reactions now properly consider the skew correction factor (Requests 333, 339).

6. The program has been enhanced to check the overhang against the girder depth and provide a warning for analysis runs and an error for design runs when the overhang is greater than the girder depth as per DM-4 9.7.1.5.1P (Request 334).

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Input Revisions

7. Multiple SAL commands can now be entered for each special live load to define alarge number of axles. The number of special live load axles entered on the SAL command has been increased from 24 to 80 (Request 332).

8. The program has now been revised to allow up to 100 section holes to be entered and if the number of section holes exceeds 100 an error message is displayed and the program exits. Previously, the program would crash when this condition occurred (Request 340).

Output Revisions

9. The HL-93 Loading Code 3 displayed in the program output has been changed to "Tandem Pair + Lane Governs". Previously, HL-93 Loading Code 3 displayed "90% Tandem Pair + Lane Governs" which was inconsistent with the CBA program (Request 341).

User Manual Revisions

10. The LRFD and ML-80 Live Loading figure in Chapter 2 has been modified to reflect the correct front axle load for the ML-80 vehicle (Request 335).

Programming Revisions

11. The program has been converted to the Intel Visual Fortran compiler (Request 329).

SUMMARY OF APRIL 2008 REVISIONS - VERSION 1.6.0.0

Since the release of STLRFD Version 1.5.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 1.6.0.0 contains the following revisions and enhancements.

Input Revisions

1. An internal limit requiring all rolled beams considered for design to be greater than 18" deep has been removed (Request 236).

2. The lower limit on user-input transverse stiffener spacing has been increased to 0.65 ft (0.2 m), an approximate constructability limit. Input values less than 0.65 ft but greater than 0 ft will be flagged as warnings, but will be allowed. Users are no longer allowed to enter spacings of 0 ft (Request 326).

3. The upper limit of 500 ft (155 m) on the span length command has been changed to a Chief Bridge Engineer warning, meaning that the program will continue to run if a span length over 500 ft is entered (Request 328).

4. Loads entered by the user via the CLD (concentrated load) or DPC (deck pour concentrated) commands will no longer be mirrored for symmetrical beams if the load happens to coincide with the girder symmetry point (Request 386).

Specification Related Revisions

5. The program has been enhanced for rolled beam runs, to perform a web crippling check and a web local yielding check per DM4 6.10.8.2.1 at all concentrated load locations and at all reaction locations (Requests 195, 386).

6. The flexure/shear interaction ratings have been removed from the program since the interaction is already covered when computing shear ratings (Request 308).

7. A potential endless loop in computing the depth of web in compression has been resolved (Request 358).

8. For program runs of continuous girders, the span-to-depth checks on the ECONOMIC FEASIBILITY CHECKS output report now use the ratios for continuous spans rather than simple spans (Request 359).

9. A check of the control of deck cracking by distribution of the deck reinforcement has been added. Additional input has been added to allow the user to more completely define the deck reinforcement at interior supports (SST command) (Request 365).

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10. Both sides of field splice locations are now treated as noncompact, with flexural capacities being calculated accordingly. Previously, the left side of the splice would sometimes be incorrectly treated as compact (Request 378).

Output Revisions

11. The DEAD LOAD WEB FLEXURAL STRESS LIMITS and DEAD LOAD WEB SHEAR LIMITS output reports have been removed for composite girders since they contain information also contained on the UNCURED SLAB WEB SPECIFICATION CHECK output report. The DEAD LOAD WEB output reports have been retained for noncomposite girders since the stresses and shears on the report for noncomposite girders include live load as well. For noncomposite girders, these reports have been renamed to WEB FLEXURAL STRESS LIMITS and WEB SHEAR LIMITS (Request 291).

12. The ECONOMIC FEASIBILITY CHECKS output report no longer prints when the user turns it off via the OSC input. Previously, the report would print even when a request was made not to print it (Request 352).

13. The factored Service-II, -IIA and -IIB stresses are now printing on the FACTORED ANALYSIS RESULTS output report, and the flexural ratings are now being computed in terms of stress (Requests 354 and 370).

14. The column headings on the GROSS SECTION PROPERTIES output report have been changed to better explain the output (Request 355).

15. An extra analysis point to the right of the end of the previous span at interior supports is no longer printing. This information was redundant with the analysis at the beginning of the next span (Request 356).

16. The titles of the section property output reports that do not contain gross section properties have been updated to state that they contain net section properties (Request 357).

Live Load Distribution Factor Revisions

17. The description of how the program calculates deflection distribution factors has been clarified in the User's Manual (Request 239).

18. When computing the deflection distribution factor, the program no longer counts the pedestrian load as an additional lane when determining the multiple presence factor (Requests 247 and 366).

19. The program has been modified to correctly apply the MOMENT DF1 to negative live loads for cases where the distribution factors consider sidewalks (Request 293).

Cross Section Revisions

20. The web depth for analysis points in a varying depth range that fall entirely within a gross cross section range is now computed correctly (Request 299).

21. The program now includes the deck reinforcement when computing section properties for use with the factored shear flow calculations on the web-to-flange weld capacity output report (Request 347).

22. A program crash that occurred when a plate transition point falls immediately at a contraflexure point has been resolved (Request 360).

23. The method that the program uses internally to define analysis points to the left and right of a transition location has been modified to avoid program crashes when adjacent analysis points are too close to a transition (Requests 367, 368 and 379).

User's Manual Revisions

24. Several editorial issues with the User's Manual have been resolved (Request 336).

25. The descriptions of the right fascia on the CDF command have been corrected (Request 373).

26. The description of the concentrated load (CLD) command has been clarified with respect to when bearing stiffener checks are done at concentrated load points (Request 380).

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SUMMARY OF APRIL 2009 REVISIONS - VERSION 1.7.0.0

Since the release of STLRFD Version 1.6.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 1.7.0.0 contains the following revisions and enhancements.

Input Revisions

1. A warning has been added to the program output when the user enters negative distributed dead loads to indicate that negative values indicate an upward sense to the loads. A similar advisory has also been added to the program User's Manual (Request 343).

2. A typographical error in an error message concerning shear connectors has been corrected (Request 375).

3. A check has been added so that if the user enters 0.0 for either the thickness or width of a flange plate for built-up sections or for the cover plate of a rolled beam, the other dimension must also be entered as 0.0. The program will stop with an error so the user must enter both the width and thickness as 0.0. Previously, the program would permit one dimension to be 0.0, which could lead to a program crash (Request 385).

Specification Related Revisions

4. When designing a rolled beam, the minimum depth to overhang ratio was using an incorrect value for beam depth. The program now properly uses the actual beam depth when computing this ratio (Request 374).

5. A program crash caused by error codes on the output report for uncured slab flange checks has been resolved (Request 376).

Output Revisions

6. Input information for the SPLRFD program has been added to the end of the STLRFD output at field splice locations. This provides all of the possible SPLRFD input information in a single location (Requests 351, 372).

7. Analysis points located at the symmetry point will no longer print twice and will not have the "L" or "R" designation (Request 353).

8. Section holes will now print properly in the formatted input echo when the section hole ranges overlap with section loss ranges (Request 367)

Girder Analysis Revisions

9. CBA version 3.6.0.0 has been incorporated into the program (Requests 361).

10. A new noncomposite dead load, DC1S, has been added to allow the user to distinguish between noncomposite loads associated with the girder (DC1S) that are not computed by the program (like stiffener loads) and noncomposite loads that are not associated with the girder itself (DC1). This revision allows the user to more easily break out the components of beam camber (Request 377).

<u>Cross Section Revisions</u>

11. Consecutive ranges of increasing or decreasing girder depth can now be entered. Previously, the user had to enter an artificial range of decreasing depth after a range of increasing depth (or vice versa) to continue increasing the girder depth (Requests 240, 327).

<u>User's Manual Revisions</u>

12. The calculation of the wind load on the girder for the permanent case has been clarified in Chapter 3 (Request 381).

13. The Bureau name for program revisions has been updated on the revision request form in Chapter 9 (Request 390).

SUMMARY OF APRIL 2011 REVISIONS - VERSION 2.0.0.0

Since the release of STLRFD Version 1.7.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.0.0.0 contains the following revisions and enhancements.

Specification Related Revisions

1. The program has been updated to the 2004 LRFD Bridge Design Specifications, Third Edition and PennDOT Design Manual Part 4, September 2007 Edition (Includes Change No. 1). Exceptions to these specifications have been listed in Table 2.7-1 and Table 3.7-1 of the User's Manual (Request 384).

2. The effective slab width calculation has been updated to the 2008 AASHTO Interims Article 4.6.2.6. The ECP input command has been removed, as the effective points of contraflexure are no longer required to compute the effective slab width (Request 404).

3. The upper bound for K_g (longitudinal stiffness parameter) has been updated per 2007 DM-4 Specifications (Request 407).

4. The calculations for the hybrid factor, R_h, now use the short-term composite neutral axis when the section is in positive bending and the composite neutral axis for negative bending (Requests 423 and 429).

5. The primary design or analysis vehicle live load moments are used to determine the limits of the shear connector design regions for multi-span girders. Simple span girders will always have two shear connector design regions centered on midspan (Request 430).

6. At each analysis point, the stress in the deck reinforcement due to the fatigue load combination is used to determine the state of flexure when computing the maximum allowed pitch for the shear connectors (Request 431).

7. All analysis points within a field splice definition will be treated as noncompact (Request 450).

8. Under some circumstances, the calculation for the minimum radius of gyration of a longitudinal stiffener results in the program attempting to find the square root of a negative number. For these situations, the program now returns a large value for the required minimum radius of gyration (Request 454).

9. A cross section with holes in the tension flange (entered with the SHO command) will always be treated as noncompact for flexural resistance calculations. In addition, if the net section fracture capacity is less than the stress flexural capacity calculated by other expressions, the net section fracture capacity will be reported as the flexural capacity for the tension flange and will be used to compute the rating factor for the tension flange (Request 462).

10. If a longitudinal stiffener is entered without transverse stiffeners being defined along the length of the stiffener, a warning will appear on the LONGITUDINAL STIFFENERS CHECK (PART 1) output report stating that transverse stiffeners are required in conjunction with a longitudinal stiffener (Request 469).

11. The program now correctly computes the actual moment of inertia and radius of gyration for pairs of longitudinal stiffeners (Request 473).

Input Revisions

12. The lower limit of the DEFLECTION DF (parameter 5) on the GEO command has been increased from 0 to 0.1 (Request 406).

13. As a result of a decision by the AASHTO Subcommittee on Bridges and Structures to no longer publish SI unit specifications, the program only supports US customary (US) units. The only acceptable entry for the CTL command parameter 1, System of Units, is "US" (Request 416).

14. The lower limit of the shear connector diameter (SCS command) has been increased to 0.75". Diameters less than 0.75" will result in a warning printing in the program output (Request 439).

15. A chief bridge engineer warning will now result if the input girder has a varying-depth web or any locations where the web yield strength is greater than the flange yield strength. In addition, a warning will result if the web yield strength is less than 36 ksi or 70 percent of the flange yield strength (Request 443).

Output Revisions

16. The BEAM GEOMETRY input summary report now prints a blank for the deflection distribution factor if this parameter is to be calculated by the program (the value is left blank by the user). If the user has entered a deflection distribution factor, this value will be displayed in the BEAM GEOMETRY input summary report. The program has been modified for both pedestrian and non-pedestrian loading (Request 177).

17. Output reports now print all analysis points that contain a warning or failure, regardless of the user input for parameter 20 ("OUTPUT POINTS") on the CTL command (Request 371).

18. STLRFD will now produce PDF versions of all output in addition to the text-only files (Request 401).

19. The HL-93 LL ANALYSIS reports and all of the OVERALL REACTIONS output reports (HL-93) have been modified to now print Loading Code 4 as "4 - 90% (TRUCK PAIR + LANE) GOVERNS". Previously, Loading Code 4 printed as "4 - 90% TRUCK PAIR + LANE GOVERNS" (Request 409).

20. The DECK REINFORCEMENT AREA value on the SPLRFD INPUT INFORMATION now prints with the correct magnitude and units (Request 422).

21. The intermediate results for the compactness criteria calculations in AASHTO and DM-4 Articles 6.10.6.2.2 and 6.10.6.2.3 are included in a new output report (Request 432).

22. If the user enters a value for the centerline of exterior beam to curb that results in a de bounds violation when computing the distribution factor, a Chief Bridge Engineer warning will print, even if the cross frame or lever rule methods were used to compute the governing distribution factor (Request 437).

23. The hybrid (R_h) and load shedding (R_b) factors have been added to relevant program output reports. To make room for these values, the flange lateral capacity values have been moved to a new output report, FLANGE LATERAL CAPACITY (Request 438).

24. The depth of web in compression (D_c) has been added to the program output on the SERVICE LIMIT STATE output report (Request 441).

25. The actual wind load applied to each flange is now reported on the WIND EFFECTS and UNCURED SLAB WIND EFFECTS output reports (Request 458).

26. When appropriate, the second order lateral load stresses due to wind are now reported by the program (Request 459).

27. A program crash resulting from printing SPLRFD information for a run with only a special live load vehicle has been resolved (Request 482).

<u>Girder Analysis/Design Revisions</u>

28. The program was using the user defined minimum depth of the section for certain design run checks instead of the actual depth of the trial section. The depth has been correctly set for rolled beam and plate girder design runs of the program (Request 364).

29. For plate girders, the web depth is now correctly computed using only the depth of the web instead of the web depth minus the top and bottom flange thicknesses (Request 393).

30. The program automatically computes the number of bolt holes in the tension flange cross section for design runs containing field splices for both rolled beam (FSL command is now valid) and plate girder designs, so that the section may be appropriately designed for Net Section Fracture checks. In addition, the total length of the field splice has been incorporated into both analysis and design runs that contain a FSL command. The flexural resistance is now limited to that of a noncompact section for all points along that range as defined by parameter 3 ("FIELD SPLICE FLANGE PLATE LENGTH") of the FSL command. <u>NOTE: t</u>**<u>these changes will require revisions to all existing design and analysis input files to include valid entries for parameter 3. In addition, all existing design input files will be required to provide valid entries for parameters 4 through 7</u>** (Requests 395, 397 and 398).

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31. The program now correctly considers non-integer values for upper and lower bounds of flange width during the design process. The user must also always enter a maximum flange width for the top flange that is less than or equal to the maximum bottom flange width (Request 474).

<u>Documentation Revisions</u>

32. The User's Manual has been revised to state that the shear connector height entered on the SCS or SCC command is only compared to the effective deck thickness and a warning is printed if the connector height exceeds the effective deck thickness. No other specification checks are done with this input value (Request 440).

33. The Engineering Assistant help files for the WPD command now provide the correct help definition for the Permanent Wind Speed parameter (Request 456).

34. Section holes entered via the SHO or FSL commands are not considered when calculating the net section properties reported by the program. Sections 7.4.2 and 7.4.3 of the User's Manual have been revised to reflect this. If section holes are to be considered as part of the net section properties, they must be entered as section loss. Section 3.3.3 of the User's Manual has been updated to reflect this (Requests 460, 461 and 478).

SUMMARY OF NOVEMBER 2011 REVISIONS - VERSION 2.0.0.3

Since the release of STLRFD Version 2.0.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.0.0.3 contains the following revisions and enhancements.

Specification Related Revisions

1. The calculations of Appendix A of Chapter 6 of the LRFD Specifications have been incorporated into STLRFD (Request 463).

2. A program crash that occurs for some input files when net section fracture governs the stress flexural capacity of the section has been resolved (Request 495).

3. Distribution factors that are calculated using the lever rule will now have the appropriate multiple presence factor applied, depending on the number of traffic lanes loaded. This can also affect the fatigue vehicle distribution factors (Request 498).

4. Sections that are in negative bending and have holes in the tension flange are now properly handled as noncompact (Request 499).

User's Manual Revisions

5. A note was added to the SHO command in Chapter 5 to indicate that any sections that have section holes in the tension flange will be treated as noncompact and that Appendix A6 would never apply to those sections (Request 500).

6. Table 3.7-1 Summary of Specification Checks was modified to refer the user to the appropriate flowcharts in Appendix C6 of the LRFD Specifications (Request 502).

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SUMMARY OF AUGUST 2012 REVISIONS - VERSION 2.1.0.0

Since the release of STLRFD Version 2.0.0.3 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.1.0.0 contains the following revisions and enhancements.

Specification Related Revisions

NOTE: Unless otherwise indicated, the specification changes described below are in accordance with LRFD Specifications 5th Edition / 2012 DM-4 requirements

1. The Fatigue limit state has been split into Fatigue-I and Fatigue-II limit states (Request 507).

2. The calculations for the transverse stiffener moment of inertia have been revised and the transverse stiffener area requirements have been removed (Request 508).

3. The live load factor for Strength-IA has been changed from 1.10 to 1.35 (Request 514).

4. For design runs of the program, the input for the span-to-depth check will now default to "No", meaning that the program will not check the span-to-depth ratios of Article 2.5.2.6.3 (Request 515).

5. The program will now print warnings if the user has entered values other than 1.0 for any of the eta factors. The lower limit of 1.1 for the product of the eta factors for the fatigue limit states of nonredundant structures has been removed. The upper limit of 1.16 for the product of the eta factors for strength and service limit states remains (Request 516).

6. The values of V_o and Z_o from Table 3.8.1.1-1 for wind calculations have been updated (Request 517).

7. The constant amplitude fatigue threshold for reinforcement (Equation 5.5.3.2-1) has been revised (Request 518).

8. The horizontal fatigue shear range for transverse stiffener specification checks will now include an allowance for radial loads if the skew of the girder is less than 70 degrees (Request 520).

   NOTE: because of this, the user can now enter SKW commands in conjunction with the UDF (user defined distribution factors) commands. If existing input files using UDF commands are not revised to include SKW commands, the radial load will always be conservatively added to the horizontal fatigue shear range.

9. The bearing stiffener axial resistance calculations have been updated (Request 521).

10. The calculations of the hybrid factor, Rh, have been revised for constructability checks as well as when the yield strength of web is greater than flange yield strengths. Rh is also printed for more resistance calculation methods on the MOMENT FLEXURAL CAPACITY output report (Request 522).

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11. The shear-buckling resistance is now checked for all analysis points during the constructability checks, regardless of whether the web is stiffened or unstiffened (Request 523).

12. An additional code reference for the I_{yc} / I_y check has been added to the COMPACTNESS CRITERIA output report (Request 525).

13. An additional check of the compressive stress in the deck (0.6 * f'c) has been added to the FACTORED ANALYSIS RESULTS output report. This value will only print if it is appropriate for the given analysis point / limit state / flexure combination (Request 526).

14. The calculation of M_1 (equations A6.3.3-11, A6.3.3-12) has been revised to check if the moment variation between brace points is concave (Request 527).

15. Additional skew and diaphragm layout requirements for AASHTO Section 6 Appendix A applicability have been added **(Request 528).**

    NOTE: because of this, the user can now enter SKW commands in conjunction with the UDF (user defined distribution factors) commands. If existing input files using UDF commands are not revised to include SKW commands, no analysis points on those girders will pass applicability checks for Appendix A checks.

16. The upper limit for $\lambda_{pw(Dcp)}$ (A6.2.1-2) has been revised and situations where λ_{rw} equals $\lambda_{pw(Dc)}$ (A6.2.2-4, A6.2.2-5) are now properly handled (Request 529).

17. The St. Venant torsional constant, J, from equation A6.3.3-9 is now multiplied by 0.8 for the situation where I_{yc} / I_{yt} > 1.5 and $D/b_{fc} < 2$, $D/b_{ft} < 2$ or $b_{ft}/t_{ft} < 10$ (Request 530).

18. The AASHTO code references for several of the economic feasibility checks have been updated (Request 531).

19. If the web yield strength is greater than 120 percent of the yield strength of the weaker flange, the web yield strength will be limited to 120 percent of the strength of the weaker flange (Request 532).

20. For plate girder design runs, a warning will be issued if the yield strength of the web is not greater than 36 ksi or 70 percent of the stronger flange, and a chief bridge engineer warning will be issued if the yield strength of the web is greater than the yield strength of the weaker flange (Request 533).

21. The web specification checks of DM-4 Article 6.10.1.9.3P have been added to the program (Request 542).

22. For noncomposite sections, the value of 0.85 * f'c is no longer reported on the FACTORED ANALYSIS RESULTS output report (Request 543).

LRFD STEEL GIRDER DESIGN AND RATING

User's Manual Revisions

23. References to the User's Manual section on the economic feasibility checks (3.7.9) have been corrected elsewhere in the User's Manual as well as in the program output (Request 538).

24. A reference to the "HS20-9.0" vehicle was removed from the User's Manual Table 3.5-2 (Request 540).

Program Output Revisions

25. Input values for the new SPLRFD command ASR are provided in the SPLRFD input echo in the STLRFD output. The new SPLRFD ASR command was first available in SPLRFD version 1.4.0.0. Older versions of SPLRFD do not require the input for the ASR command (Request 536).

26. An output error that occurred for noncomposite girders on the LONGITUDINAL SLAB REINFORCEMENT AT CONTINUOUS SUPPORTS output report has been modified with a more meaningful message (Request 537).

27. The equivalent moment flexural resistances have been back-calculated and printed on the STRESS FLEXURAL CAPACITY (NONCOMPOSITE OR -FLEX OR COMPOSITE/NONCOMPACT) output report. This information has been provided for the bridge load rating table documented in DM-4 Part A Table 1.8.3-1 for noncomposite or noncompact beams (Request 539).

28. A spurious specification check failure message for a symmetrical girder has been removed (Request 546).

29. On the STRESS FLEXURAL CAPACITY output report, the flexural resistance for compression flanges will now always print as a negative value. Previously, sometimes the values would print as a positive number (Request 550).

30. A warning code has been added to the STRESS FLEXURAL CAPACITY output report to indicate when the top flange is in tension for a positive flexure condition (Request 554).

Program Input Revisions

31. The distributed DC2 load in the Example 2 input file, EX2.DAT, has been changed to 0.252 kips/ft (Request 541).

32. The TTL commands in the input files for examples 6 and 8 now reflect their status as US Units, rather than SI Units (Request 552).

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SUMMARY OF APRIL 2013 REVISIONS - VERSION 2.2.0.0

Since the release of STLRFD Version 2.1.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.2.0.0 contains the following revisions and enhancements.

Specification Related Revisions

1. The rolled beams used by the program have been revised according to the AISC Steel Construction Manual, 14th Edition, 1st printing.

   The following rolled beams were deleted from those used by the program:

   W40x321 W40x174 W40x466

   W36x848 W36x798 W36x650 W36x527 W36x439 W36x393 W36x359
   W36x328 W36x300 W36x280 W36x260 W36x245 W36x230

   W30x477

   W27x448

   W24x492 W24x408

   W14x808

   The following rolled beams were added:

   W40x397 W40x362 W40x324 W40x327 W40x294

   W36x652 W36x529 W36x487 W36x441 W36x395 W36x361 W36x330
   W36x302 W36x282 W36x262 W36x247 W36x231

   W33x387

   W30x357

   W27x336 W27x281

   W24x370 W24x306

   W21x55 W21x48

   W6x8.5

   See Section 6.22.6 of this User's Manual for a complete list of shapes included in STLRFD (Request 467).

2. When computing moment distribution factors for exterior beams, the empirical value for single lane distribution factors for interior beams will no longer be considered as one of the values to check. The single lane distribution factor for an exterior beam is always calculated with the lever rule (Request 479).

LRFD STEEL GIRDER DESIGN AND RATING

3. For plate girder design, if the minimum or maximum flange plate thicknesses are not included on the Plate Thickness Tables (Tables 5.18-1 or 5.18-2), they will be rounded up (for the minimum values) or down (for maximums) to the nearest available thicknesses on the tables. This revision was made to resolve an issue where occasionally a successful design could not be found (Request 506).

4. The calculation of D_n (used in the calculation of the hybrid factor, R_h) will now use the location of the actual elastic neutral axis, not just the location of the neutral axis of the short-term composite section (Request 534).

5. The calculation of the yield moment governed by the flexural capacity of the deck reinforcing, M_{yr}, has been corrected so that it does not appear that the flexural stresses in the flanges exceed yield under M_{yr} (Request 535).

6. When computing the rating tonnage for special live load vehicles, the program will no longer remove the scale allowance. The user enters the axle weights without the scale allowance, so it will not be removed from the total weight of the vehicle (Request 568).

7. An error in the calculation of C_b (moment gradient factor, MOMENT FLEXURAL CAPACITY output report) has been resolved (Request 561).

8. For noncomposite girders, the unfactored stresses at the top and bottom of web include live load stresses (for use with the web nominal flexural resistance from DM-4). These unfactored stresses are now calculated with the same load combination resulting in the most compressive stress in the web. Previously, these stresses could be calculated with different load combinations (for example, the top of web stress was calculated with the positive moment live load effect and the bottom of stress calculated with the negative moment live load effect) (Request 565).

9. A program crash has been resolved for the condition when the neutral axis of the composite section is in the slab (Request 573).

10. For composite sections in negative bending, Myt, the yield moment with respect to the tension flange, is now set to the minimum of My with respect to the top flange or My with respect to the deck reinforcing, as per LRFD Specifications Article D6.2.3 (Request 579).

11. The value of f_n for hybrid factor calculations (LRFD Specifications Article 6.10.1.10.1) is now set properly for the case where D_n is on the opposite side of the yielding flange (Request 580).

<u>Programming Revisions</u>

12. The program is now compiled with Intel FORTRAN Composer XE 2011, Update 9 (Request 567).

Program Output Revisions

13. For program runs that include deck pours, the calculation of the total DC1 moment appearing in the SPLRFD INPUT INFORMATION output report now properly considers the sign of the moment due to the deck pours. Previously, the program was occasionally printing an incorrect total DC1 moment when the instantaneous deck pour moment had an opposite sign than that of the cumulative deck pour moment (Request 466).

14. An incorrect warning message that occurred when the user left the cover plate yield strength blank for a rolled beam with no cover plates has been removed from the program (Request 513).

15. An error in the output report WEB SPECIFICATION CHECK that would only manifest itself when something other than 20th point output is chosen has been resolved (Request 558).

16. Service limit states will no longer print as governing shear rating factors in the RATING FACTORS - SUMMARY report (Request 559).

17. An error causing the report name RATING FACTORS - STRESS FLEXURAL CAPACITY to appear in the list of SPECIFCIATION CHECK FAILURES, when no such errors have occurred, has been resolved (Request 563).

18. An ECONOMIC FEASIBILITY CHECK failure for rolled beams with no cover plates has been resolved. Previously, a failure would be indicated on this report for the "Flange width >= 12.0" check for locations where no cover plate was defined, but the flange width of the shape selected was > 12.0" (Request 572).

19. Chief Bridge Engineer warnings will now appear in the SPECIFICATION CHECK WARNINGS output report at the end of the output file. Previously, Chief Bridge Engineer warnings did not appear and a message "No procedure defined to print MSG" would appear in the screen output whenever a Chief Bridge Engineer warning occurred (Request 575).

20. On the RATING FACTORS - SHEAR CAPACITY output report, the proper failure code for the web handling requirement (D/150 or D/300) will now print. Previously, a failure code would print, but reference the incorrect ratio (Request 582).

21. A Chief Bridge Engineer warning will now appear in the program output for girders that have varying-depth webs where the only varying-depth range is the last range along the girder. The warning was already properly printing for girders with other ranges of varying depth (Request 583).

Example File Revisions

22. Example 10 has been revised to use a rolled beam (W36x231) that is available in the AISC Steel Construction Manual, 14th Edition, 1st printing (Request 577).

LRFD STEEL GIRDER DESIGN AND RATING

Program Input Revisions

23. The program now allows the user to enter eight special live loads in a single run (increased from 5) (Request 455).

24. The user now has the option to optimize rolled beam design by depth, rather than solely by weight. This option is available on the DRB (Design Rolled Beam) command (Request 505).

25. An error for the checking of which span lengths have had values entered has been resolved. The program will now report only those spans that do not have span lengths entered (Request 510).

26. The user can no longer enter the same year for recent count and previous count or recent count and future count on the FTL (Fatigue Live) command. This revision was made to prevent the program from crashing (Request 511).

27. A error in assigning the ultimate strength of rolled beams has been resolved. With this revision the NET SECTION FRACTURE CHECK calculations will now use the correct ultimate strength value (Request 571).

28. The default value for "Live Load Code" for design runs of the program has been changed to "E" to ensure inventory rating factors for the ML-80 and TK527 vehicles > 1.0 as specified by DM-4 Sections 3.6.1.2.8P and 3.6.1.2.9P. Additionally, if the user specifies a live load code other than "E" for a design run, a warning message will appear in the program output (Request 576).

29. Additional checks were added to the FTL (Fatigue Life) command to ensure that the previous count year is less than the recent count year and that the future count year is greater than the recent count year (Request 584).

User's Manual Revisions

30. An error in the description of the SKW command has been resolved (reference to UDF has been changed to CTL) (Request 556).

31. The User's Manual was recreated to ensure that arrowheads appear correctly on the figures (Request 556).

SUMMARY OF JULY 2014 REVISIONS - VERSION 2.3.0.0

Since the release of STLRFD Version 2.2.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.3.0.0 contains the following revisions and enhancements.

Programming Revisions

1. *The method of calling the engineering program DLL from the Engineering Assistant has been changed for compatibility with EngAsst v2.5.0.0 which uses Microsoft's .NET Framework, version 4.5. Because of this, STLRFD will no longer work with EngAsst v2.4.0.6 or v2.4.0.9 unless the EngAsst "Edit / Run EXE – Command Window" option is selected. STLRFD will no longer work with EngAsst v2.4.0.0 and earlier (Request 625).*

2. The source code for CBA version 3.6.0.5 has been incorporated into STLRFD (Request 547).

3. The STLRFD program is now compiled with the Intel FORTRAN Composer XE 2013, SP1, Update 1 using Microsoft Visual Studio 2012 (Request 594).

4. The precision of a conversion factor has been increased to avoid an issue with a concentrated load placed at the last support of the girder being ignored (Request 600).

5. A program crash identified when running a rolled beam design run with concentrated loads has been resolved. This problem only occurred for a specific input file (Request 610).

Specification Related Revisions

6. When performing wind effect calculations during construction stages, the program will now include the haunch and deck thicknesses only for analysis points in the current deck pour and later stages. Previously, the program was including deck and haunch thickness for all locations for all stages (Request 483).

7. Analysis points are now placed immediately to the left and right of all bracing locations. The analysis points are then assumed to be in the bracing range on the given side of the analysis location, using the unbraced length on that side, along with the factored effects on that side. Previously, the program would only use one analysis point at a bracing location (Request 562).

8. A shear capacity check has been added to the rolled beam design algorithm to ensure that all designs will be adequate for shear resistance (Request 566).

9. The absolute value of the user input support skew angle is now used to determine the applicability of Appendix A for flexural capacity calculations and the consideration of radial fatigue shear in shear connector design. Previously, the program was not taking the absolute value of the skew angle causing the program to sometimes follow Appendix A when it should not have (Request 608).

10. When a plate or brace point transition occurs at the same location as the end of a deck pour, the analysis points immediately to the left and right will be considered in different deck pours. Previously, the program considered them to be in the same deck pour (Request 614).

11. The calculation of the depth of web in compression when both flanges have stresses of 0.0 has been set to be the depth to the neutral axis less the compression flange thickness (Request 617).

<u>Program Output Revisions</u>

12. The FATIGUE RESISTANCE output report now indicates if any of the fatigue details have finite life and warns the user that the details must be modified if this is a new bridge design (Request 480).

13. For rolled beams, the WEB CONCENTRATED LOAD CHECK output report now shows the required bearing length, N_{req}, resulting in web local yielding and web crippling resistances that are greater than the maximum factored load (Request 496).

14. The intermediate values previously printing on the MOMENT FLEXURAL CAPACITY output report have been moved to a new output report, INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY, and the depth of web in compression (D_c), and yield moments for the top and bottom flanges (M_{yt}, M_{yb}) have been added to the output report (Request 564).

15. The code checks on the WEB CONCENTRATED LOAD CHECK output report have been modified so that only code check A will result in a specification check failure (and have the name of the output report show up on the SPECIFICATION CHECK FAILURES output report at the end of the program output). All other code checks for this output report are informational, and are now treated as specification check warnings (Request 611).

16. Two new tables have been added to the output. One table named “UNFACTORED FLEXURAL STRESSES“ has been added to show the individual unfactored flexural stresses that make up the total factored stress reported by the program. The second table named “USER INPUT LATERAL STRESSES” has been added to show the individual unfactored lateral stresses that make up the total factored lateral stress (Request 612).

<u>Program Input Revisions</u>

17. The program will now stop with an error if the NUMBER OF HOLES parameter of the SHO command is entered without a corresponding HOLE SPACING. Previously, the program would keep running if a HOLE SPACING was not entered leading to erroneous results (Request 419).

18. An input parameter has been added to the ORF command to produce rating factors with and without Future Wearing Surface in a single run of the program. Previously, the user would need to run the program twice to obtain both sets of rating factors (Request 487).

LRFD STEEL GIRDER DESIGN AND RATING

19. The program has been enhanced to allow the user to enter stresses due to lateral loads for flexural resistance calculations for the girder. Either a single, constant lateral stress can be entered on the CTL command, or more detailed stresses can be entered by span on the LAS command. This enhancement has also resulted in numerous changes in the program output, usually adding new columns of data to existing output tables and moving other columns of data from existing tables to new tables. Additionally, a new example problem with lateral stresses (EX11.DAT) has been added (Requests 570, 632, 635, 637).

20. The limit on the total number of section holes entered on the SHO command has been removed. The user can enter up to 40 ranges. Each range can have up to 40 holes (Request 627).

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SUMMARY OF SEPTEMBER 2016 REVISIONS - VERSION 2.4.0.0

Since the release of STLRFD Version 2.3.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.4.0.0 contains the following revisions and enhancements.

Lateral Torsional Buckling Revisions

1. The lateral torsional buckling calculations have been revised per LRFD Specification 6.10.8.2.3 and A6.3.3 to report the smallest lateral torsional buckling resistance along an unbraced length as the resistance for all analysis locations in that unbraced length. Combined with this, STLRFD now also reports the maximum applied flexural stress in an unbraced length as the factored stress for lateral torsional buckling calculations over the entire unbraced length. Finally, STLRFD now sets C_b, the moment gradient factor, to 1.0 for unbraced lengths that are nonprismatic.

   Also, the LRFD Specifications Article 6.10.8.2.3 and Appendix A calculations are implemented for all analysis points where the Appendix A criteria are met. The rating factors (or performance ratios) are calculated for the Article 6.10.8.2.3 and Appendix A resistances, and the combination creating the larger rating factor is selected as the governing calculation for the analysis point. Appendix A calculations are only considered inside an unbraced length if the Appendix A criteria are satisfied at every analysis point in the unbraced length.

   In addition, the following revisions have been made: sections with section holes are no longer automatically treated as noncompact for the purposes of lateral torsional buckling calculations; the net section fracture resistance results are no longer reported on the STRESS FLEXURAL CAPACITY output report because they are presented on the NET SECTION FRACTURE CHECK output report; and the Appendix A criteria are now considered for the construction and uncured slab specification checks (Requests 668 and 669). Note that these changes will result in significantly lower ratings for girders that are governed by their lateral torsional buckling resistance (Requests 643, 668, 669, 700, 704, 706, 726, 727, 731, 737, 738, and 743)

2. If the calculated scaled governing Appendix A lateral torsional buckling capacity at a given analysis point is larger than the local calculated Appendix A lateral torsional buckling capacity at the analysis point, the local value will be reported as the governing capacity at the analysis point. This can occur because when the Appendix A capacity governs in a non-prismatic section, the moment capacity at the governing location is scaled by the ratio of ($S_{xc,current\ location}$) / ($S_{xc,governing}$ location) (Request 715).

3. The moments due to the beam self weight are now used to determine which end of a given unbraced length has the smaller moment. This change now allows the methodology to be consistent between the staging/uncured slab conditions and final conditions. This change was also necessary to correct the calculations for the staging/uncured slab checks for the lateral torsional buckling capacities (Request 714).

4. A change in web thickness will not cause an unbraced length to be considered nonprismatic. Changes in flange dimensions or web depth will continue to cause a section to be considered nonprismatic (Request 728).

LRFD STEEL GIRDER DESIGN AND RATING

5. LRFD Specifications Section 6 Appendix A calculations are no longer considered for the constructability checks reported in the uncured slab and staged construction output (Request 732).

6. A girder with a transition from a larger section to a smaller section in the 20% range at the end of an unbraced length with the smaller section continuing past the 20% range will have the larger section ignored so that the girder can be considered to be prismatic and have Cb > 1.0. If there are other transitions in the girder outside the 20% range, the larger section will NOT be ignored (Request 734).

7. A check has been added to the program to generate a Chief Bridge Engineer warning for bracing ranges that have analysis points in negative flexure, a varying web depth, and flange transitions further than one foot from either end of the unbraced length (Request 753).

Specification Related Revisions

8. The CONTROL OF CRACKING BY DISTRIBUTION OF REINFORCEMENT output report has been replaced with the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT output report. The information provided on the CONTROL OF CRACKING output report did not apply to the design of composite steel girders, but the input information provided for the checks was repurposed to perform slab reinforcement checks as per DM-4 Article 6.10.1.7 (Request 589 and 670).

9. When computing the value of the stress in the compression flange at the midpoint of an unbraced length, the program now interpolates the value (using a straight-line interpolation) rather than just taking the average of the values at the analysis points around it (Request 599).

10. The program can now rate an existing bridge for the Strength II and Service IIA Limit States with P-82 in one lane and PHL-93 in the other lanes in accordance with DM-4 Article 3.4.1. This is accomplished by using Live Load Code “G” for an Analysis Run (Requests 602 and 671).

11. The slab thickness is now included as part of the wind cross section for the results on the UNCURED SLAB WIND EFFECTS output report (Request 607).

12. The fatigue stress range calculations now only include live load effects, with the section properties used to compute the stresses determined based on the sign of the live load moments. Previously, unfactored dead load effects were included with the live load effects in order to determine the section properties to use in computing the stresses (Requests 621 and 672).

13. The program has been modified to use unfactored moments to compute the stress in the slab to determine which section properties to use for calculating factored flexural stresses (LRFD Specifications 6.10.1.1.1b) (Request 659).

14. It has been verified that the program already requires transverse stiffeners to be defined along the length of any longitudinal stiffeners (LRFD Specifications 6.10.11.1.1). No changes were required (Request 660).

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15. The load factors for DC, DW and LL for the construction and uncured slab limit states have been increased to 1.4 from 1.25. The load factor for the wind load for the construction and uncured slab limit states has been decreased to 1.0 from 1.25 because the construction wind pressure is now based on ASCE 7-10. In conjunction with this, the user must also enter a new wind pressure input parameter for the construction and uncured slab limit states. Previously, the user could enter a construction wind speed on the WPD command and have the program compute the corresponding wind pressure but that construction wind speed parameter is no longer supported. The user will need to review BD-620M and DM-4 C3.4.2.1 for guidance on how enter the new construction wind pressure parameter. (NOTE: All input files using the WPD command must be revised with the new construction wind pressure parameter or they will stop with an input error.) (LRFD Specifications and DM-4 Article 3.4.2.1) (Request 661)

16. It was verified that the program neglects any concrete on the tension side of the neutral axis when the neutral axis is located in the slab. The program neglects this for all limit states, not just the strength limit states (LRFD Specifications 6.10.1.1.1b) (Request 662).

17. Violations of the overhang criteria of DM-4 9.7.1.5.1P now require District Bridge Engineer approval, rather than Chief Bridge Engineer approval (Request 663).

18. Violations of the applicability limits for variables used to determine distribution factors now require District Bridge Engineer approval, rather than Chief Bridge Engineer approval (Request 664).

19. The use of hybrid sections with web yield strength greater than flange yield strength (DM-4 Article 6.10.1.3) and the use of girders with variable web depth (DM-4 Article 6.10.1.4) now require District Bridge Engineer approval, rather than Chief Bridge Engineer approval (Request 665).

20. The calculation for the constant amplitude fatigue threshold for straight reinforcement has been updated to follow the 2014 LRFD Specifications (Article 5.5.3.2) (Request 686).

<u>Program Output Revisions</u>

21. A new BRIDGE LOAD RATINGS table has been added to the program after the OVERALL RATING SUMMARY table that will report rating information similar to DM-4 Part A Table 1.8.3-1 (Requests 593 and 673).

22. The DISTRIBUTION FACTORS FOR DESIGN LIVE LOADING output report name, as well as a Chief Bridge Engineer advisory will now appear in the SPECIFICATION CHECK WARNINGS output report, even if the user has chosen to not show the DISTRIBUTION FACTOR reports in the program output (Request 606).

23. When a fatigue analysis point is defined at a transition location, the fatigue results will now print on both sides of the location, as was already being done for other specification checks (Request 609).

24. The field section length and weight have been added to the FIELD SECTIONS output report (Request 624).

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25. The page layout of the output file has been enhanced to allow for more characters per page width and more lines per page in the PDF output file. The new layout has 99 characters per page width and 83 lines per page. The Table of Contents now includes a second level which is converted to a second level of bookmarks to assist in navigating the PDF file (Requests 651, 674, and 729).

26. The FACTORED ANALYSIS RESULTS output report will now always show the factored stress in the compression flange for all locations that are in negative bending or are noncomposite in the final state (Request 703).

27. The lateral torsional buckling capacity results for the staging/uncured slab conditions have been moved to their own output report LATERAL TORSIONAL BUCKLING CAPACITY (CONSTRUCTION STAGE ii) or LATERAL TORSIONAL BUCKLING CAPACITY (UNCURED SLAB) and a report named INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (CONSTRUCTION STAGE ii) or INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (UNCURED SLAB) containing intermediate values has also been added. As a result, the output on the CONSTRUCTION STAGE ii FLANGE SPECIFICATION CHECK (PART 2) will no longer contain lateral torsional buckling capacities (Request 707).

28. The program output warning message regarding girders with web yield strengths greater than flange yield strengths now includes a DM-4 reference (DM-4 6.10.1.3) (Request 718).

29. Occasionally, an output file was found to have several pages that were showing only an output table header with no further information. The program has been revised to remove these empty table headers (Request 720).

30. The top and bottom mats of reinforcement are now checked on the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT output report. Previously, only the top mat was checked for maximum bar size and spacing (Request 721).

31. The FATIGUE STRESS RANGE LIMITS IN REINFORCING BARS calculations and output report have been removed from the program, as they do not apply to deck slabs in multigirder applications according to LRFD Specifications 5.5.3.1 (Request 722).

32. The tonnage of the P-82C load combination has been removed from the RATING FACTORS - SUMMARY and RATING FACTORS - OVERALL SUMMARY output reports because the P-82C load combination represents a combination of the P-82 and PHL-93 loadings. Also, the distribution factor for the P-82C load combination has been removed from the BRIDGE LOAD RATINGS output report because several distribution factors are used when analyzing for the P-82C load combination (Request 723).

33. The text "(NO LTB)" has been added to the titles of output reports containing flange specification checks for construction staging and uncured slab loading that do not contain lateral torsional buckling calculations (Request 736).

LRFD STEEL GIRDER DESIGN AND RATING

Program Input Revisions

34. A new program input, "DC1S Percentage" has been added to the CTL command to allow the user to specify a percentage of steel self-weight to be applied to the girder as a DC1S load. This load will be in addition to any DC1S loads specified by the user on the DLD or CLD commands (Request 591 and 675).

35. The example input files have been revised to use the PennDOT designation for skew angle (Request 634 and 676).

Program Documentation Revisions

36. Notes have been added to Chapter 2 of the STLRFD User's Manual to indicate that blast loading is not considered by STLRFD (Request 658).

37. User Manual Section 3.7.17 has been updated to document that a web depth variation anywhere in a given unbraced length causes the program to consider the entire unbraced length as having a nonprismatic member, therefore the program will always use a moment gradient factor, Cb, equal to 1.0 (Request 708).

38. The detailed descriptions of the parameters of the PLD (Pedestrian Load) command in User Manual Chapter 6 have been revised to reflect the methodology specified in DM-4 (Request 712).

39. User's Manual Section 6.7.2 has been revised to add a statement documenting that a District Bridge Engineer warning will appear in the output if the actual overhang dimension exceeds the allowable overhang shown in the DEFLECTION LIMITS FOR LIVE LOAD output table. (Request 717)

40. User Manual Section 3.7.17, Lateral Torsional Buckling Calculations, has been updated to document that the program will always include transitions that are located outside 20% of the unbraced length when the program calculates the lateral torsional buckling capacity (Request 705).

41. User Manual Section 3.7.17, Lateral Torsional Buckling Calculations, has been updated to document that the maximum factored flexural stress or moment throughout the unbraced length combined with the maximum lateral stress throughout the unbraced length are reported in the output with the lateral torsional buckling capacity that results in the larger rating factor or performance ratio at each analysis point (Request 711).

42. Assumption 13 in User Manual Section 2.7 has been revised to clarify how the program determines whether the stresses in a given section should be calculated using positive or negative flexure section properties (Request 716).

Programming Revisions

43. The method of comparing the total reinforcement areas from the SST command and the ARB/APL/ABU commands has been modified to remove a tolerance that was sometimes resulting in incorrect behavior when the reinforcement values were very close (Request 585).

44. The PDF version of the program output will now be produced if the input filename ends in a space (Request 604).

45. The comparison of the ratio $f_{mid} / f_2 > 1$ for the calculation of the moment gradient factor, C_b, has been revised to remove a tolerance from the comparison. The tolerance caused unexpected behavior when the ratio was slightly greater than 1.0 (Request 605).

46. A number of subroutines that were modified when implementing the program in BRADD have been reincorporated to the STLRFD source code (Request 656).

47. The flange to web weld size that is passed to BRADD is now set properly (Request 667).

48. Floating point underflow traps have been removed so that from runs of the program from EngAsst will be consistent with runs from the console executable (Request 681).

49. The deflections reported to BRADD had redundant values in some situations. These redundant values have been removed, and the program only reports the deflections once for each tenth point (Request 682).

50. The program is now compatible with APRAS NextGen (Request 392).

51. The deck reinforcement distribution requirements on the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT output report have been revised to make sure that 2/3 of 1% of the deck area is specified for the top layer and 1/3 of 1% of the deck area for the bottom layer (Request 730).

52. APRAS runs will no longer generate PDF output (Request 741).

53. The LRFDPAUSE and OTPTOC routines have been modified based on comments from the developers of APRAS NextGen (Request 742).

SUMMARY OF MARCH 2019 REVISIONS - VERSION 2.5.0.0

Since the release of STLRFD Version 2.4.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.5.0.0 contains the following revisions and enhancements.

<u>Programming Revisions</u>

1. The program has been revised to allow all characters in input or output file names except for the characters listed as unacceptable by Windows, \ / :* ? " < > | (Request 636).

2. The version of PennDOT's Beam Section Properties (BSP) program used by STLRFD has been updated to BSP version 2.0.2.0 (Request 642).

3. The calculation of k, the bend buckling coefficient for webs with longitudinal stiffeners, no longer uses a toleranced comparison when checking if d_s/D_c is less than 0.4, because the tolerance comparison caused the comparison to incorrectly fail when d_s/D_c was close to 0.4 (Request 772).

4. STLRFD has been revised to use Visual Studio 2017 and Intel Parallel Studio XE 2017 Fortran Update 5 for compilation and linking (Request 773).

5. A change was made in the program compilation process to place MOD files in the appropriate Debug or Release folders so that the proper version of the MOD file is used when the program is compiled (Request 792).

<u>Specification Related Revisions</u>

6. When calculating the proportions of the user input lateral stress to distribute to each component of the total lateral stress at an abutment, the program will now use the strong-axis bending stresses at an adjacent analysis point to determine the proportions. Previously, the program would report a total lateral stress of zero because there are no bending stresses at the abutments (Request 620).

7. The "Global Displacement Amplification in Narrow I-Girder Bridge Units" check from the AASHTO LRFD Specifications, 8th Edition, Section 6.10.3.4.2 has been added to STLRFD for two and three girder systems for all deck pours and the uncured slab condition. See the GLOBAL DISPLACEMENT AMPLIFICATION CHECK output reports (Requests 647 and 806).

8. If both flanges of a section are in tension, the program will now report 0.0 in as the depth of web in compression (Request 694).

9. Documentation has been added to Chapter 2 describing the limit states that are used by default when special live load is entered, and the program has been revised to include the ML-80 live load with the Strength-V limit state when analysis live load code C is used (Request 740).

10. Three vehicles specified as part of the FAST Act (EV2, EV3, and SU6TV) have been added as a live load option to the program (Analysis Live Load Code H) (Request 748).

11. A new permit design vehicle, P2016-13, has been added to several live load options for the program (Design Live Load Code F, Analysis Live Load Codes I, J, and K) (Request 749).

12. The program now reports two limit states for construction, Construction-I and Construction-II, to correctly capture the different load factors for construction loads with and without wind. Construction-I does not include effects due to wind, while Construction-II does include wind effects (Request 755).

13. When there is only a single lane of traffic on the bridge, STLRFD will now only use the single lane shear distribution factor. Previously, the program would use the maximum of the single and multiple lane shear distribution factors when calculating live load shear effects (Request 761).

14. An error that caused a designed plate girder to have a rating factor less than 1.0 has been resolved. The program was considering a section at midspan to be noncompact during design (incorrect), but compact during final analysis (correct), which led to a smaller rating factor during final analysis (Request 794).

15. Moment of inertia failures on the TRANSVERSE STIFFENERS CHECK output report will now properly cause the report title to appear on the SPECIFICATION CHECK FAILURES report at the end of the output file (Request 797).

16. The pedestrian load will now be counted as an additional design lane when determining the multiple presence factor for the deflection distribution factors with sidewalks (Request 805).

Program Output Revisions

17. The program has been revised to inform the user that section holes defined on the web are not considered when calculating section properties or any specification check calculations. This has been the case with the program, but the program now informs the user when they enter section holes that the program is not considering them (Request 689).

18. Output reports that are turned off by the user, but have errors or warnings on them will now have an asterisk (*) after the name of the report on the SPECIFICATION CHECK WARNINGS or SPECIFICATION CHECK FAILURES reports at the end of the program output. In addition, output reports with required Chief or District Bridge Engineer approvals are also indicated on the SPECIFICATION CHECK WARNINGS and FAILURES output reports (Request 698).

19. The BRIDGE LOAD RATINGS output reports now include the governing section resistance corresponding to the governing rating reported for each live load vehicle (Request 745).

LRFD STEEL GIRDER DESIGN AND RATING

20. The program output has been revised so that information about lateral capacity and deck reinforcement does not print when the FLANGE LATERAL CAPACITY and the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT output reports have been turned off (Requests 754, 759).

21. In the output reports providing SPLRFD program input, the stress capacity reported will now be the smallest stress capacity at the adjacent section, regardless of whether is causes the smallest rating factor or not. Previously in some situations, the program would report a larger stress capacity that corresponded to the lowest rating factor (Request 756).

22. An error where the reported DC1 moment in the SPLRFD INPUT INFORMATION report did not include the effects due to the concrete slab has been addressed. Previously, if the moment due to the slab was opposite in sign to the other DC1 effects, the slab moment would not be included (Request 757).

23. For limit states where rating factors are not calculated (Strength-III, Strength-IV, and Strength-V) the LATERAL TORSIONAL BUCKLING output reports will now report the combination resulting in the largest resistance / factored effect ratio as governing (Request 758).

24. The MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT output report has been revised to always print analysis points where a specification check warning has occurred for CTL / OUTPUT POINTS options 1 or 3. Previously only analysis points with a specification check failure would print for options 1 or 3 if the failure occurs at an analysis point not requested. In addition, an error was fixed where the title of the report was appearing for all live loads, not just the live load causing the specification check warning (Request 763).

25. An error has been fixed that caused the page headings to occasionally not include the current live load (Request 764).

26. The program will now correctly analyze a bearing stiffener specified at at the symmetry point of a girder with an even number of spans. An internal location assignment would previously prevent the program from printing the bearing stiffener properties for a bearing stiffener at the symmetry point (Request 765).

27. In the formatted Input Echo, the display of HAUNCH DEPTH on the DESIGN - PLATE GIRDER output report has been revised so that the user-input value is no longer divided by 12 before printing (Request 769).

28. A note has been added to the reaction summary output to remind the user that the dead load reactions at the abutments do not include any loads past the centerline of bearing (Request 774).

29. An error in calculating the total DC2 and FWS stresses for the Strength-IP limit state on the UNFACTORED FLEXURAL STRESSES output report has been fixed. Previously the the FWS stress in the top flange, and the DC2 and FWS stresses in the bottom flange were double-counting some stresses and omitting others (Request 787).

LRFD STEEL GIRDER DESIGN AND RATING

30. STLRFD now produces output that will, in conjunction with the Engineering Assistant, version 2.6.0.0 and above, allow the user to view graphs of unfactored dead and live load effects (Request 791).

31. A reaction summary report has been added to assist with the design of steel sole plates. This report includes factored as well as unfactored reactions to be used with sole plates (Request 809).

Program Input Revisions

32. STLRFD will now design bearing stiffeners and the size of the web-to-stiffener weld. Use the Bearing Stiffener Design (BSD) command to enter the design parameters (Request 588).

33. STLRFD will no longer assume brace points at 25 feet if no BRP commands are entered. The user must now always enter at least one BRP command. **NOTE: This change may require revisions to input files created for earlier versions of STLRFD** (Request 598).

34. The upper limits for year values on the FTL command have been increased from 2100 to 2200 (Request 684).

35. The upper limits for the number of trucks on the FGV command have all been increased to 300,000 to allow values that match actual PennDOT loadometer survey data ranges (Request 685).

36. A parameter has been added to the CTL command to allow the user to choose to disregard LRFD Specifications Section 6, Appendix A calculations for flexural capacity (Request 692).

37. A parameter has been added to the GEO command to allow the user to specify if the girder is in a kinked or horizontally curved bridge for the purposes of the compactness checks in the LRFD Specifications Section 6.10.6.2.2 and 6.10.6.2.3 (Request 693).

38. For input parameters that are no longer used by STLRFD, the program will generate an input warning if the user enters the value, stating that the parameter is no longer used. The documentation of the parameter in Chapter 5 has also been revised to make clear that the parameter is no longer needed or used (Request 696).

39. The BRACING TYPE parameter on the CDF command is no longer used by the program and should not be entered (Request 750).

40. Default values for the steel tensile strength on the MAT, DRB, and DP1 commands have been removed, except for the default of 58 ksi when 36 ksi is specified for the steel yield strength. **NOTE: Input files where no steel tensile strength has been entered and a steel yield strength other than 36 ksi has been entered will need to be revised to enter an steel tensile strength** (Request 751).

41. The REDUNDANT LOAD PATH parameter on the CTL command is no longer used by the program and should not be entered by users (Request 767).

LRFD STEEL GIRDER DESIGN AND RATING

42. The lower limit for the BRACE SPACING parameter on the BRP command has been changed from 0 feet to 1 foot to avoid a crash during input processing (Request 770).

43. An input parameter, AUTOMATIC BRACE POINTS AT SUPPORTS, has been added to the CTL command to allow the user to choose whether the program automatically adds brace points at supports (abutments and piers). Previously, the program would always add brace points at abutment and piers regardless of whether the BRP command defined the brace points or not (Request 796).

44. A program error was fixed that caused the program to occasionally not properly check if holes defined on the SHO command were located within the flange. The program will now stop if a hole is not located within the flange (Request 798).

45. Input value limits and default values for design runs of the program have been added to parameters four through seven of the the FSL (Field Splice Location) command. Previously, leaving these values blank could cause the program to crash (Request 806).

46. The CONSTRUCTION WIND PRESSURE parameter on the WPD and WUD commands now defaults to 0.005 ksf, and will trigger a District Bridge Engineering warning if the user enters anything other than 0.005 ksf (Request 807).

<u>Program Documentation Revisions</u>

47. The STLRFD User's Manual cover page has been revised to use the current PennDOT logo and fonts (Request 646).

48. All references to ADTT (average daily truck traffic) related to the Fatigue Life (FTL) command have been revised to read $ADTT_{sl}$ (average daily truck traffic, single lane) (Request 677).

49. The detailed description of the FGV (Fatigue Gross Vehicle) command in Chapter 6 of the STLRFD User's Manual has been revised to give more detailed information on how to input the parameters of the command (Request 680).

50. Many input commands have been revised to accurately describe how to enter multiple instances of the commands in the Engineering Assistant (EngAsst) program, and in some instances the configuration files for EngAsst have been revised to limit or change how many times a given command can be entered (Requests 683, 786).

51. The list of assumptions and limitations in Chapter 2 has been revised to remove DM-4 and LRFD Specification references. Also, the deck serviceability limitation has been removed because the deck serviceability check is now included in the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT program output (Request 746).

LRFD STEEL GIRDER DESIGN AND RATING

52. Chapter 4 of the User Manual has been revised to state the proper name for the folder containing the STLRFD installation location on the Windows start menu (Request 747).

53. For plate or built-up sections that start with a varying-depth web, Chapter 5 of the User Manual has been revised to inform the user that the first defined cross section must have a constant-depth web in order to set the web depth at support number one. This range can be very short, but it must be at the start of the girder (Request 762).

54. The contact information and revision request forms in Chapter 9 of the User's Manual have been revised (Request 804).

SUMMARY OF JULY 2020 REVISIONS - VERSION 2.6.0.0

Since the release of STLRFD Version 2.5.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.6.0.0 contains the following revisions and enhancements.

<u>Specification Related Revisions</u>

1. Uplift checks have been added to the cumulative reaction output reports for the deck pour analysis. Also, as part of this request, the Service-I limit state has been removed from the program as it does not apply to steel girders (Request 688).

2. Chief Bridge Engineer Warnings will now print in the program output for locations at the beginning or end of a web depth variation that does not have a transverse stiffener defined at the beginning or end location of the web depth variation (Request 790).

3. The program has been revised to directly use the neutral axis of the section consisting of the steel section plus slab reinforcement to calculate the depth of web in compression (D_C) for negative bending. The program previously used the factored stress in the flanges to determine D_C (Request 811).

4. The calculated lateral stress due to wind is no longer limited to the yield stress of the flange of interest. The lateral stress will be calculated and reported according to the LRFD Specifications and DM-4 (Request 815).

5. The Fatigue-I and Fatigue-II limit state load factors have been revised to 1.75 and 0.80, respectively, due to revisions in the LRFD Specifications, 8th Edition. Because of this update, the program input for Pennsylvania Traffic Factor has been removed as per the 2019 Edition of DM-4. Finally, the ADTT limits for the application of Fatigue-I versus Fatigue-II have been updated to take the number of cycles per truck passage into account. Previously, the program did not take the number of cycles per truck passage into account when applying the ADTT limits (Request 825).

6. The load factors for wind loads and the calculations for the application of wind loads have been revised to match those in the LRFD Specifications, 8th Edition and 2019 Edition of DM-4. As part of this, the WIND CONDITION and PERMANENT WIND SPEED parameters of the WIND PROGRAM DEFINED (WPD) command are no longer used by the program. The WPD command also has two new parameters, WIND EXPOSURE CATEGORY and DESIGN 3 SECOND GUST, needed by the program for the new wind load calculations (Request 826).

   <u>NOTE</u>: <u>As a result of these changes, existing input files with a WPD command will not run until the two new WPD input parameters have been entered.</u>

7. The "Cycles per Truck Passage" (LRFD Specifications Table 6.6.1.2.5-2) calculation has been revised to use the simpler set of values in the LRFD Specifications, 8th Edition. There is no longer a span length specification, and the only possible values are 1.0 or 1.5 cycles per passage (Request 827).

8. The maximum spacing of shear connectors has been increased to 48 inches, as per the LRFD Specifications, 8th Edition (Request 828).

9. Sidewalks will now be considered as an additional loaded lane for the purposes of calculating distribution factors and multiple presence factors (when applicable) (Request 831).

10. The MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT output report has been revised to check the stress in the deck assuming that the concrete is effective under negative bending for Service-II and deck pour loads, using short term “n” section properties. The deck reinforcement checks are only done for analysis points where the factored stress in the deck exceeds the factored modulus of rupture of the concrete (Request 834).

11. The methods for calculating the elastic modulus of the deck concrete and the modular ratio between the deck concrete and deck reinforcement have been revised to match the LRFD Specifications, 8th Edition, and the tables of values in the 2019 DM-4 Sections 5.4.2.1 and 5.4.2.4. Along with these changes, the SLB command has been enhanced with additional input checks, and upper and lower limits changed for consistency with the LRFD Specifications and DM-4 (Request 839).

Program Input Revisions

12. The concentrated load (CLD), distributed load (DLD), and lateral bending stress (LAS) commands have been revised to allow the user to specify noncomposite and composite utility loads (UT1 and UT2). The DW load factor is applied to both of these loads (Request 640).

13. The consistency checking of the brace point (BRP) command has been enhanced to allow the program to return error messages without crashing the program, when brace points have not been defined along the entire girder. The program will also provide more detailed information about required brace spacing, when the input brace spacing does not equally divide into the brace range length (Request 653).

14. A new input parameter, MINIMUM WEB THICKNESS, has been added to the DESIGN PLATE GIRDER, PART 2 (DP2) command. This parameter allows the user to enter a minimum web thickness to be used in the design of a plate girder (Request 655).

15. An additional input parameter, VEHICLE TYPE, has been added to the SPECIAL LIVE LOAD (SLL) command to allow the user to specify whether to apply the Design dynamic load allowance or the Permit dynamic load allowance to the specified special live load (Request 781).

16. When a bearing stiffener design is requested through use of a BEARING STIFFENER DESIGN (BSD) command, the program will now generate a separate output file with a BDH file extension (Bearing Stiffener History) that contains a description of the bearing stiffener design process and the calculations done for the design (Request 800).

17. A CLASSIFICATION STRENGTH OF BEARING STIFFENER WELD input parameter has been added to the BEARING STIFFENER (BST) command to allow the program to output the required stiffener-to-web weld size (Request 801).

18. The user can now enter the SKEW ANGLE (SKW) command along with the USER DEFINED REACTION DISTRIBUTION FACTOR (URF) command, regardless of the location of the commands in the program input file. Previously, entering the SKW command before the URF command would result in an input error. Also, the error messages that print when the user enters a COMPUTED DISTRIBUTION FACTOR (CDF) command and a USER DEFINED DISTRIBUTION FACTOR (UDF) command in the same input file have been revised to make it clearer that the user needs to enter one or the other, and not both (Request 819).

19. New input checks have been added to the ACTUAL SLAB THICKNESS and EFFECTIVE SLAB THICKNESS input parameters on the SLAB (SLB) command, to be consistent with the BD-601M, Change 2 standard. Additionally, the program can now determine a default value for ACTUAL SLAB THICKNESS if the EFFECTIVE SLAB THICKNESS has been entered. Previously the program would only calculate a default for EFFECTIVE SLAB THICKNESS if the ACTUAL SLAB THICKNESS was entered (Request 842).

20. The LOAD FACTOR (LDF) command has been revised to reflect which load factors are not used in the program. The Fatigue-I, Fatigue-II and Deflection load factors are never used for the MC1, MC2, or SLL loads. Construction-I and Construction-II load factors are not used for MC2 or SLL loads, and Strength-III and Strength-IV load factors are not used for the SLL loads. If the user enters a load factor for any of these combinations, the program will print a warning and ignore the input value (Request 846).

<u>Program Output Revisions</u>

21. The WEB-TO-FLANGE WELD DESIGN: WELD CAPACITY output report will no longer print a warning when the calculated weld size is smaller than the minimum required weld size. An additional column for designed weld size has been added to the report. This is the larger value of the calculated weld size or the minimum required weld size (Request 780).

22. The deflection distribution factor will now print as N/A on the DISTRIBUTION FACTORS FOR FATIGUE VEHICLE output report as deflection due to the fatigue is not needed or checked by the program (Request 783).

23. Some of the headings on the DESIGN - PLATE GIRDER output report have been realigned with the output and changed from abbreviations to full words to clarify the program output (Request 784).

LRFD STEEL GIRDER DESIGN AND RATING

24. Output reports not directly related to rating factor calculations will no longer print with vehicles that are included in a program run for rating purposes only. For example, for analysis live load code A, the ML-80, HS20, H20, and TK527 vehicles are rating-only vehicles and previously had output reports and specification checks included in the output, such as, TRANSVERSE STIFFENERS CHECK or WEB-TO-FLANGE WELD DESIGN which are not utilized to calculate a rating for those rating vehicles (Request 788).

25. Formatted output reports for the OUTPUT OF INPUT DATA (OIN), OUTPUT OF SECTION PROPERTIES (OSP), OUTPUT OF DESIGN TRIALS (ODG), OUTPUT OF ANALYSIS RESULTS (OAN), OUTPUT OF SPECIFICATION CHECKS (OSC), and OUTPUT OF RATING FACTORS (ORF) commands have been added to the program to allow the user to see which output reports have been turned on or off for a given run of the program (Request 793).

26. An output report (NSBA SPLICE INPUT INFORMATION) has been added to collect all STLRFD output that is available to enter on the NSBA LRFD splice design spreadsheet (Request 795).

27. An incorrect indication of a specification check failure from the REMAINING FATIGUE LIFE ESTIMATION output report for a fatigue point at midspan of a symmetrical beam has been resolved (Request 802).

28. The name of the BEARING STIFFENER CHECK output report has been changed to USER INPUT BEARING STIFFENER ANALYSIS to distinguish this output report from the BEARING STIFFENER DESIGN output report. The description of Code Check B on the USER INPUT BEARING STIFFENER ANALYSIS output report has also been revised for clarity (Request 803).

29. The DEFLECTION LIMITS FOR LIVE LOAD output report will now print only for program runs that include the PHL-93 or HL-93 live loads, as these live load combinations are the only ones that include the PennDOT or AASHTO deflection vehicles (Request 810).

30. The LOAD FACTORS AND COMBINATIONS and LIVE LOADING SUMMARY output reports have been revised to present the information in a more concise and clearer manner (Request 838).

31. The program will no longer crash when the user enters a nonzero DC1S PERCENTAGE value on the CTL command and no other distributed dead loads have been entered (Request 841).

<u>Program Documentation Revisions</u>

32. Figure 5.28-6, “Longitudinal Slab Reinforcement Location” has been revised to show the slab longitudinal reinforcement outside the transverse reinforcement as shown on BD-601M, Sheet 1, TYPICAL SLAB PANEL 2 detail. The description of the reinforcement area on the ABU, APL, and ARB commands has been revised to clarify that the reinforcement area input should only include the longitudinal reinforcement (Request 817).

33. Chapter 9 of the User's Manual has been revised to remove references to providing a program input file on a diskette. Program input files should be provided in an e-mail or as an e-mail attachment (Request 820).

34. A description of the calculations for maximum pitch of shear connectors has been added to Chapter 3 of the User's Manual (Section 3.7.21) (Request 819).

35. The name of the new DM-4 permit vehicle has been changed from "PA2016-13" to "P2016-13" in the User's Manual, configuration files, and program output (Request 836)

Programming Revisions

36. Old source code concerning the calculation of concurrent moment and shear effects when finding the critical shear combination has been removed or bypassed as concurrent moment and shear is no longer needed to calculate the shear capacity of a steel girder (Request 687).

37. The program will now generate information in the DBP.CSV file regarding the analysis points of the program. This file is not currently used by the EngAsst graphing function, but is included for completeness and possible future use (Request 799).

38. STLRFD has been revised to use Visual Studio 2019 and Intel Parallel Studio XE 2019 Fortran Update 5 for compilation and linking (Request 821).

39. A character string length in Text2PDF is now assigned properly before passing the value to a function. Previously, this value was not assigned, leading to the PDF being created with an incorrect font size which caused lines of output to wrap in the PDF file (Request 840).

40. The "/Z7" compiler flag has been added to the Fortran properties to avoid "corrupt PDB file" errors when compiling the program (Request 843).

APRAS Requests

41. For APRAS runs, the program will no longer produce any DBT, DBP, or CSV files (Request 813).

42. For APRAS runs, the program will no longer produce any screen output (Request 822).

43. For APRAS runs, the program will no longer produce an output file if the output filename is left blank. The program will now return a code of "1" for unsuccessful program runs and "0" for a successful program run (Request 837).

44. The program source code now has the option to build a 64-bit executable (EXE) and dynamic link library (DLL). The program now also has the option to create a 32-bit executable and dynamic link library that uses the Compact Visual Fortran (CVF) calling convention. Both of these revisions have been provided to support APRAS (Request 830).

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SUMMARY OF JULY 2021 REVISIONS - VERSION 2.7.0.0

Since the release of STLRFD Version 2.6.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.7.0.0 contains the following revisions and enhancements.

Specification Related Revisions

1. The shear skew correction factor (LRFD Specifications and DM-4 Section 4.6.2.2.3c) is no longer applied to shear distribution factors calculated with the rigid cross-frame equation from LRFD Specifications Section C4.6.2.2.2d. It will continue to be applied to distribution factors calculated with the expressions of LRFD Specifications Table 4.6.2.2.3b-1 at locations specified by the user on the SKW command (Request 644).

2. The Global Displacement Amplification check of the LRFD Specifications Section 6.10.3.4.2 will now be performed by default for all cross sections with two, three, or four girders (previously only two and three girder cross sections were checked). Additionally, an input has been added to the GEO command (NUMBER OF BEAMS FOR 6.10.3.4.2 CHECK) that allows the user to specify the number of beams to use for the check. This can be left blank to skip the check for cross sections with five or more girders, or the user can enter a number of beams of four or fewer to aid in phased construction calculations (Request 847).

3. The program was previously incorrectly calculating the deflection of beams that are noncomposite in the final state during the design process, leading to designed beams that occasionally failed the live load deflection criteria. The program is now calculating the deflections during the design process using appropriate section properties, leading to beam designs that satisfy the live load deflection criteria (Request 871).

Program Input Revisions

4. The program will no longer crash when user defined distribution factors (UDF command) equal to 0.0 are used for the design vehicle for girders with sidewalks. Input checks for defined hinge locations (HNG command) have also been added to prevent invalid hinge locations (Request 699).

5. If the user accidentally enters zero for SUPPORT NUMBER on the SKW command, the program will no longer crash. It will stop with an error message in the program output (Request 856).

6. Hinges cannot be defined at interior support locations. The program was revised to make sure hinges are located at least 0.01 feet away from interior support locations. Previously, the program would crash if a hinge was defined at an interior support (Request 876).

7. The program will no longer internally change the SYMMETRY parameter of the CTL command to Y for design runs of the program when the user has entered N for SYMMETRY. The user will either need to enter Y as the SYMMETRY parameter for design runs, or leave it blank and allow the program to default to Y (Request 879).

8. The OIN, OSC, ODG, OAN, OSC, and ORF commands can now be entered as blank commands (i.e. just the command name and nothing else on the line) and the program will take all defaults for the command. This will only work with the specified output commands (Request 884).

Program Documentation Revisions

9. The description of the LIVE LOAD parameter of the CTL command has been revised to clarify that only operating ratings are calculated for the P2016-13 load. The previous wording implied that inventory ratings may also be calculated for the P2016-13 load (Request 872).

Programming Revisions

10. A program crash during self-weight calculations has been resolved by internally combining adjacent ranges of self weights with identical load magnitudes (Request 867).

11. An issue with calculating the noncomposite utility (UT1) moment for the uncured slab specification checks has been resolved. Previously, the moments calculated would be cumulative over the length of the girder, making the total moments and stresses much larger than they should have been (Request 873).

SUMMARY OF FEBRUARY 2023 REVISIONS – VERSION 2.8.0.0

Since the release of STLRFD Version 2.7.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.8.0.0 contains the following revisions and enhancements.

Specification Related Revisions

1. The calculations of the LRFD Specifications, Chapter 6, Appendix D6.4 have been added to the program. For some girder configurations, Appendix D6.4 will lead to a larger lateral torsional buckling capacity (Request 648).

2. Rolled beam designs now include a check of a Category C' fatigue detail at the point of maximum fatigue moment, similar to what has previously been done for plate girders (Request 752).

3. The web concentrated load checks, previously implemented for rolled beams only, are now also applied to plate girders and built-up sections (Request 858).

4. The program has been revised to use the built-up section effective flange dimensions as described the User's Manual section 3.3.4 for the flange proportion checks on the DUCTILITY AND WEB/FLANGE PROPORTION CHECK output report (Request 865).

5. A check has been added to include a MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT warning in the Specification Check Warnings output report only when the deck stress exceeds the limits in LRFD Specifications section 6.10.1.7 (if factored stress is deck is computed) and the reinforcement entered on the ABU/ARP/APL command exceeds that entered on an SST command (Request 886).

6. The calculation of the basic development length of the slab reinforcement has been revised to the LRFD Specifications, 8th Edition method. The modified development length has been added to the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT (PART 2) output report (Requests 899, 908).

Program Input Revisions

7. Users can now input minimum load factors for Strength limit states for MC1 and MC2 loads on the LDF command. These minimum load factors are only used by the program to compute the minimum factored reaction for each limit state. If not entered by the user, the minimum load factors for MC1 and MC2 will default to 0.0. **Any input files with MC1 or MC2 loads may need to be revised to provide minimum load factors other than 0.0** (Request 127).

8. The warning message that appears when a rolled beam has been defined with a yield strength less than 36 ksi has been revised to specifically refer to the rolled beam, rather than to web and flange yield strengths (Request 645).

9. The upper limit on transverse stiffener spacing has been increased from 18 feet to 25 feet (Request 777).

LRFD STEEL GIRDER DESIGN AND RATING

10. The user now has the ability to enter a separate set of load factors via the Load Factor (LDF) command for each special live load entered by the user. The user still has the ability to enter load factors to be applied to every special live load or for all special live loads that do not have separate live load factors entered (Request 782).

11. The Sidewalk Dead Load on the PLD Command now allows negative values both in Engineering Assistant and in STLRFD without a warning message. Previously, a negative value could not be entered in Engineering Assistant (Request 860)

12. The user now has the choice of whether to perform specification checks for the uncured slab condition if they have also entered a deck pour sequence. Previously, the program would always perform the uncured slab specification checks, potentially leading to overly conservative results (Request 864).

13. The error messages regarding “Valid values” have been updated for all data types (integers, reals, and doubles) to correctly indicate that the upper and lower bound values are also acceptable input values (Request 874).

14. The stlrfd.pd file has been updated so that the default value of the parameters for the “SST” command have been changed from * to blank. This means that if an SST command is used, the user must enter a value for every parameter on the command, even if that value is 0.0 (where allowed) (Request 883).

15. Default values of 0.0 are provided for the LEFT CUTOFF POINT, RIGHT CUTOFF POINT, AND AREA OF STEEL parameters of the SST command. While these values are unrealistic, they will allow input files created with earlier versions of the program to continue to run to completion if the values had previously been left blank (Request 911)

Program Output Revisions

16. Documentation has been added to clarify the calculation of reinforcement areas from the SST command, and the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT (PART 1) output report now shows the reinforcement area calculated with both the SST inputs as well as the ABU/APL/ARB inputs. The program has also been revised to always use the information entered on the SST command for the minimum negative flexure reinforcement checks. If an SST command has not been entered for a given analysis point, then the reinforcement information on the ABU/APL/ARB command will be used. (Request 824).

17. The intermediate value of k, the bend-buckling coefficient, has been added to the SERVICE LIMIT STATE - WEB BEND-BUCKLING and UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 1) output reports (Request 852).

18. The program will print “N/A” for the unfactored flexural stresses due to pedestrian live load (PL) for limit states other than Strength-IP on the UNFACTORED FLEXURAL STRESSES output report (Request 875).

19. A typographical error (“an” rather than “a”) occurring when a real value has no default value has been resolved (Request 909).

Program Documentation Revisions

20. Section 3.7.18 of the User's Manual has been changed to clarify that the factored moment used for the GLOBAL DISPLACEMENT AMPLIFICATION CHECK is factored for the Construction-I limit state (Request 832).

21. The User's Manual and program output have been revised to make clear that when DC2, FWS, MC2, sidewalk dead load, additional FWS, or UT2 loads are entered for a beam that is noncomposite in the final state, the loads are always applied to the noncomposite, steel-only section. (Request 844).

22. Input parameters without a default value are now indicated as such in the Engineering Assistant configuration files (shown as "Default: None") (Request 848).

23. The descriptions of the Special Live Loading (SLL) and Special Axle Load (SAL) commands have been revised to make sure the user is aware that they are able to enter revised load factors for each defined special live load (Request 849).

24. Additional text has been added to the transverse stiffener (TST) and bearing stiffener (BST) commands to reiterate that the program does not consider a defined bearing stiffener to also act as a transverse stiffener. If a bearing stiffener is also to be considered as a transverse stiffener, it must be defined on both the BST and TST commands (Request 882).

25. The code reference for Wind Program Defined command has been revised to use C3.4.2.1 instead of C6.4.2.1 and Chapters 7 and 8 of the STLRFD user’s manual have also been updated with this information (Request 885).

26. The Revision Request Forms (User Manual and Word Template) no longer refer to a PennDOT fax number. (Request 894)

Programming Revisions

27. If a user enters tab or null characters on a TTL command, they will be replaced with single spaces in the program output (Request 850).

28. The tolerance for the comparison of two lengths has been changed to 0.1” from 0.05”. That is, for two lengths to be considered equal, they must be within 0.1” of each other. This will make some input values easier to make consistent (Request 851).

29. A typographical error in the program source code has been resolved that now allows the local buckling rating factors to be reported on the RATING FACTORS – MOMENT FLEXURAL CAPACITY output report and used

when determining the overall rating factors when Appendix A of Chapter 6 of the LRFD Specifications is being used. Previously, the program would report the lateral torsional buckling rating factor as governing even when the local buckling rating factor was smaller (Request 870).

30. The overall maximum number of analysis points in the program has been increased to resolve program crashes in several 18 and 20 span girder input files (Requests 880, 881).

SUMMARY OF JULY 2024 REVISIONS - VERSION 2.9.0.0

Since the release of STLRFD Version 2.8.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.9.0.0 contains the following revisions and enhancements.

Specification Related Revisions

1. **The Global Displacement Amplification Check now determines inflection points by interpolating between the nearest analysis points. Previously, a symmetrical girder could have non-symmetrical results for the Global Displacement Amplification Check. Also, the analysis points are ordered by span number and distance along the span. (Request 889)**

2. **The Global Displacement Amplification Check defaults to use a maximum of either three beams or the number of beams in the cross section. When the cross section has a minimum of four beams, the user may request that the check is made for four beams. When the total factored girder moments across the width of the unit within the span under consideration exceeds 70 percent of the elastic global lateral-torsional buckling resistance of the span a specification check failure is given. (Requests 890, 924)**

Program Input Revisions

3. **A Chief Bridge Engineer warning has been added to the input validation for floorbeam deeper than 14 ft, as per DM-4 Section 6.10.1 (Request 887).**

4. **The new Deck Overhang Loads (DOL) command allows definition of construction loads that cause flange lateral bending stresses in the exterior girder for the Uncured Slab specification checks and the deck pour construction stages specification checks. These flange lateral bending stresses are considered for Construction / Uncured Slab I and Construction / Uncured Slab II Load Combinations as defined in DM-4 Table 3.4.1.1P-1 – Load Factors and Live Load Vehicles for Steel Girders. (Request 892)**

5. **Input parameters for the Connector Height on the SCS command and the Channel Height on the SCC command are no longer used and should be entered as blank. Previously, these inputs were comparing the shear connector height to the slab thickness, but the program does not know the true haunch along the girder. (Request 893)**

Program Output Revisions

6. **The output table headings in the Specification Check Warnings list and in the Specification Check Failures list now include the page number for the warning or failure. For tables with multiple warnings or failures on multiple pages the table heading is listed twice; once for the first page with a warning or failure and once for the last page with a warning or failure. (Request 866).**

7. **A Chief Bridge Engineer warning has been added when fatigue details entered as category D, E, E', or EP for a design run (Request 888).**

Program Documentation Revisions

8. **Windows 8.1 operating system has been removed from the User's Manual as a supported operating system. (Request 916)**

Programming Revisions

9. **The program has been modified to use the depth between rivets/bolts for the web proportion check for built-up sections (Request 818).**

SUMMARY OF FEBRUARY 2025 REVISIONS - VERSION 2.9.0.1

Since the release of STLRFD Version 2.9.0.0 several revision requests and user requested enhancements have been received. This release of STLRFD Version 2.9.0.1 corrects the following known problems and provides enhancements.

Calculation Revisions

1. **Design for the Global Displacement Amplification Check now uses the number of beams for the 6.10.3.4.2 check on the GEO command instead of the total number of beams in the cross section on the CTL command when computing the Total Construction-I factored moment on all beams. Previously, using the number of beams from the CTL command could result in conservative designs or design failures. Also, the Input Summary correctly reports when the Global Displacement Amplification Check is being used as a design criterion. (Request 928)**

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1 GENERAL DESCRIPTION

1.1 PROGRAM IDENTIFICATION

Program Title: LRFD Steel Girder Design and Rating

Program Name: STLRFD

Version: 2.9.0.1

Subsystem: Superstructure

Authors: Pennsylvania Department of Transportation,
Michael Baker International and
Modjeski and Masters, Inc.

ABSTRACT:

The LRFD Steel Girder Design and Rating program (STLRFD) performs an analysis and specifications check, in accordance with the AASHTO LRFD Bridge Design Specifications and the Pennsylvania Department of Transportation Design Manual Part 4, for steel beams or girders with cast-in-place concrete slabs. The section can consist of a wide flange beam, with or without cover plates, a plate girder section, or a built-up section made of angles and plates. The section can be composite or noncomposite. Plate girder sections can be homogeneous or hybrid.

As a result of a decision by the AASHTO Subcommittee on Bridges and Structures to no longer publish System International (SI) unit specifications, the program only supports US customary (US) units.

The program can perform an analysis of a simple span and of a continuous span bridge, with or without hinges. The program uses a line girder analysis. The live load can be an LRFD loading or a user-defined loading, including a combination of truck and lane loading. The live load analysis is performed in accordance with the AASHTO LRFD Bridge Design Specifications. The user can input the deck construction staging sequence, and the program will compute the moment, shear, and reaction values for each stage.

After the analysis is performed, STLRFD checks for compliance with the AASHTO LRFD Bridge Design Specifications and the Pennsylvania Department of Transportation Design Manual Part 4. The program computes and checks specifications for shear, moment, stresses, fatigue stresses, and deflections. The program also checks specifications for shear connectors and stiffeners (transverse, longitudinal, and bearing stiffeners). Shear and flexural rating factors are also provided. For simple span bridges, the program can design wide flange beams without cover plates and plate girders.

1.2 ABBREVIATIONS

This section provides definitions of abbreviations that are commonly used throughout this User's Manual.

AASHTO	-	American Association of State Highway and Transportation Officials.
AISC	-	American Institute of Steel Construction, www.aisc.org
BSP	-	PennDOT Beam Section Properties program.
CBA	-	PennDOT Continuous Beam Analysis program.
DM-4	-	Design Manual Part 4, December 2019 Edition, published by Pennsylvania Department of Transportation. This publication can be downloaded free of charge from PennDOT's website.
LRFD Specifications	-	AASHTO LRFD Bridge Design Specifications, Eighth Edition, 2017, published by: American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, D.C. 20001
NSBA	-	National Steel Bridge Alliance
PennDOT	-	Pennsylvania Department of Transportation.
STLRFD	-	LRFD Steel Girder Design and Rating program.
SPLRFD	-	LRFD Steel Girder Splice Design and Analysis Program
US	-	Customary United States units of measurement.

2 PROGRAM DESCRIPTION

2.1 GENERAL

The purpose of this program is to provide a tool for bridge engineers to analyze and design steel girders, both noncomposite and composite (with cast-in-place concrete slabs). STLRFD performs an analysis and specifications check in accordance with the AASHTO LRFD Bridge Design Specifications and the Pennsylvania Department of Transportation Design Manual Part 4.

The analysis is based on a single girder and the fraction of the axle live loads that are carried by the girder. The user can input live load distribution factors, or the program will compute them. The cross section can consist of a wide flange beam with or without cover plates, a plate girder section, or a built-up section made of angles and plates. The section can be composite or noncomposite. Plate girder sections can be homogeneous or hybrid.

The program can perform an analysis of a simple span and of a continuous span bridge, with or without hinges. The live load can be an LRFD loading or a user-defined loading, including a combination of truck and lane loading. The live load analysis is performed in accordance with the AASHTO LRFD Bridge Design Specifications. The user can input the deck construction staging sequence, and the program will compute the moment, shear, and reaction values for each construction stage.

After the analysis is performed, the program checks for compliance with the AASHTO LRFD Bridge Design Specifications and the Pennsylvania Department of Transportation Design Manual Part 4. The program checks specifications for shear, moment, stresses, fatigue stresses, deflections, shear connectors, and stiffeners (transverse, longitudinal, and bearing stiffeners). The live load ratings are also provided.

2.2 PROGRAM FUNCTIONS

STLRFD performs the following functions:

1. Input Processing - The program prompts the user for the name of the input file and output file and then processes the input. The program checks the user-entered input values and compares them with lower and upper limits stored in the program. If the user value is less than the lower limit or greater than the upper limit, an error or warning is issued. If an error is detected, the program will stop processing; otherwise the program will continue on to the calculations of the section properties.

2. Section Properties - The program uses the PennDOT Beam Section Properties (BSP) program to compute the section properties. It computes the noncomposite section properties (steel only), the long-term composite section properties (3n section), and the short-term composite section properties (n section) for positive and negative flexure. It also computes deck construction staging section properties (n/0.70 section) for positive and negative flexure. The program considers reduction in section properties due to deterioration and/or holes.

3. Structural Analysis - The program uses the PennDOT Continuous Beam Analysis (CBA) program to compute the moments, shears, reactions, rotations, and deflections for the construction loads, permanent loads, and transient loads. For analysis, the user-input sections are used. For design, the program iterates the section dimensions until the LRFD Specifications are satisfied and an optimum design is obtained. Construction loads consist of user-input construction loads and concrete deck loads applied in stages. Permanent loads are dead loads due to the concrete deck being applied instantaneously, structural components and nonstructural attachments (DC), wearing surfaces (FWS), miscellaneous dead loads (MC1 and MC2), or utility loads (UT1 and UT2). If construction stages are input by the user, the program analyzes the girder based on each construction stage, as well as based on an instantaneous pour, and then uses the controlling analysis values. Loads applied to the section before slab placement are referred to as DC1, DC1S, MC1, or UT1 loads. Loads applied to the section after slab placement are referred to as DC2, FWS, MC2, or UT2 loads. Transient loads consist of the vehicular live load (LL) and vehicular dynamic load allowance (IM).

4. Load Combination - The program multiplies the analysis results from the permanent dead loads (DC1, DC1S, DC2, FWS, UT1, UT2, MC1, and MC2) and transient loads (LL and IM) by the load factors for the limit state under consideration. The program considers Strength I, Strength IP, Strength IA, Strength II, Strength III, Strength IV, Strength V, Service II, Service IIA, and Service IIB limit states. For each limit state, the permanent and transient loads are multiplied by the appropriate load factor as described in the LRFD Specifications. The fatigue, deflection, and construction load effects are also multiplied by the appropriate load factor. For continuous spans, the user has the option to redistribute moments when the section at the

interior support is compact. The program will redistribute the positive and negative moment values based on the LRFD Specifications; negative moments are reduced and positive moments are increased.

5. Specifications Checking - The program checks conformance to the LRFD Specifications. The specifications are checked at each analysis point for each limit state. The program checks specifications for flexure, shear, fatigue, deflection, stiffeners, and shear connectors as well as checks related to economic feasibility.

6. Live Load Ratings - The program computes the live load rating factors for flexure and shear. Flexure rating factors are computed based on either moment or stress, depending on whether the flexural capacity has been computed based on moment or stress. The program computes inventory and operating ratings for the appropriate live loadings and limit states.

7. Fatigue Life - The program computes the remaining fatigue life of the bridge. Fatigue life is computed for specified details which are input by the user.

2.3 BRIDGE TYPES FOR ANALYSIS AND RATING

This program can be used to perform an analysis of a single steel girder, such as the exterior or interior girder of a multi-girder steel bridge, the main girder or a stringer of a girder-floorbeam-stringer steel bridge, and the main girder of a girder-floorbeam steel bridge. Schematic cross sections of these bridge types are presented in Figures 1 through 3.

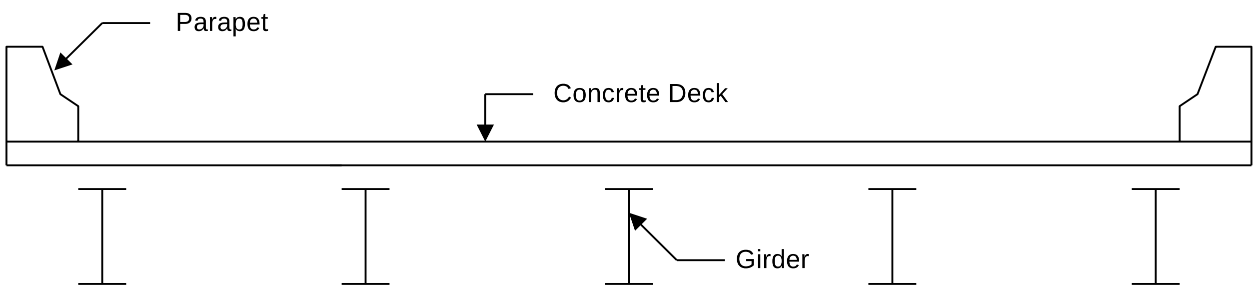


Figure 2.3-1 Schematic Cross Section of a Multi-Girder Steel Bridge

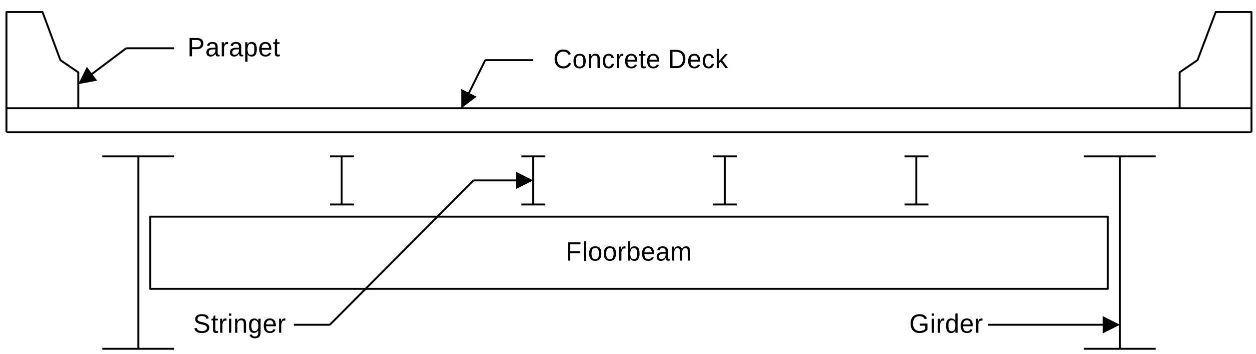


Figure 2.3-2 Schematic Cross Section of a Girder-Floorbeam-Stringer Steel Bridge

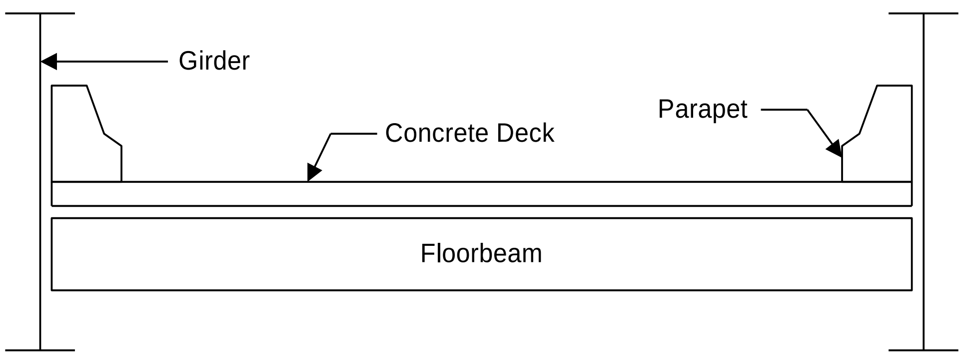


Figure 2.3-3 Schematic Cross Section of a Girder-Floorbeam Steel Bridge

The girder cross sections which can be input include user-defined rolled beams, AISC wide flange rolled beams, plate girders, and built-up girders consisting of plates and angles. The rolled beams can have a partial or full length cover plate welded to the top or bottom flange. The plate girder and built-up sections can have a constant web depth, linearly varying web depth, or parabolically varying web depth. The built-up section consists of the web plate, top flange, bottom flange, and four equal size angles. Steel girder cross sections are presented in Figure 4. The sections can be composite or noncomposite.

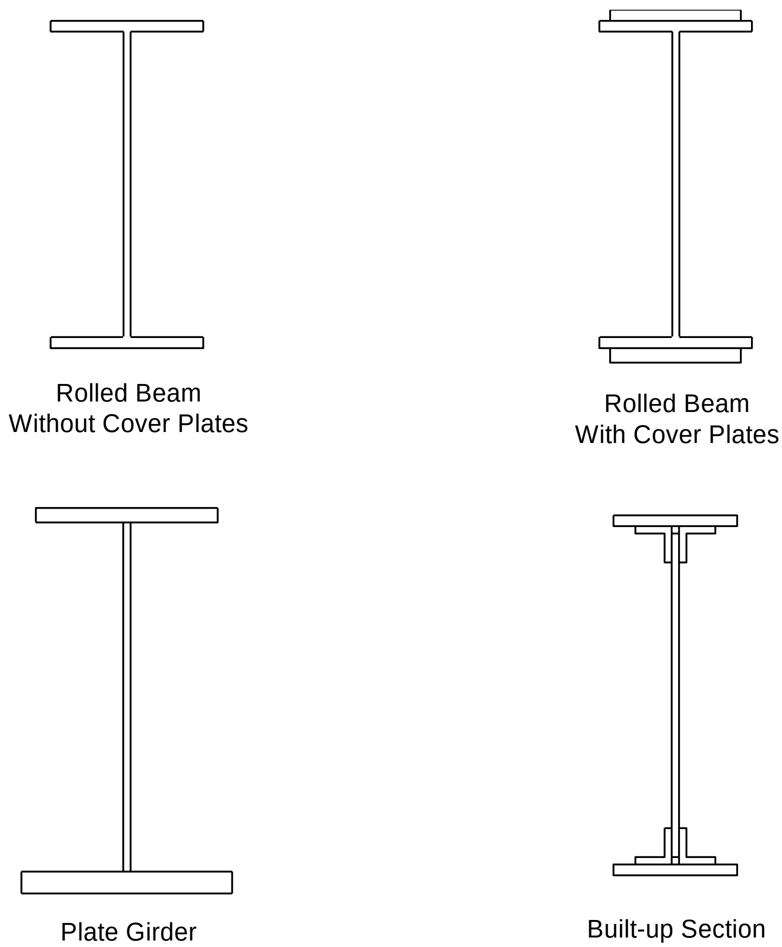


Figure 2.3-4 Steel Girder Cross Sections

The program can analyze simple spans, continuous spans, and continuous spans with hinges. It can analyze a continuous span bridge having up to twenty spans.

2.4 BRIDGE TYPES FOR DESIGN AND RATING

The program will perform an iterative design for simple span bridges. The girder cross sections which can be designed by the program are wide flange rolled beams and plate girders. For rolled beams, the program will select the beam having the least weight or depth (depending on user-input option) which satisfies the user-defined plate dimension limits. Rolled beams are designed without cover plates. For plate girders, the program uses a constant depth web plate. For both rolled beams and plate girders, the section is designed as a symmetrical girder. There is no option to design built-up sections.

For additional information concerning the design methodology for rolled beams and plate girders, see Section 3.6.

2.5 LIVE LOADINGS

The user has several live load options for performing an analysis or design. The following live loadings may be considered:

PHL-93	- PennDOT LRFD live loading
HL-93	- AASHTO LRFD live loading
P-82	- PennDOT permit live loading
ML-80	- PennDOT maximum legal live loading
TK527	- PennDOT TK527 loading
HS20	- AASHTO HS20 live loading
H20	- AASHTO H20 live loading
SLL	- User-defined special live loading
P-82C	- PennDOT permit live load, P-82, in one lane with PHL-93 in other lanes
EV2	- PennDOT single rear axle emergency vehicle
EV3	- PennDOT tandem rear axle emergency vehicle
SU6TV	- PennDOT heavy-duty tow and recovery vehicle
P2016-13	- PennDOT 13 axle permit design vehicle
P2016-13C	- P2016-13 in one lane with PHL-93 in other lanes

The HL-93 loading is the vehicular live load consisting of the design truck, design tandem, and design lane load as defined in the LRFD Specifications. The PHL-93 loading is the same as the HL-93 loading except that the axle loads on the design tandem for the PHL-93 loading are multiplied by a factor of 1.25. In addition, for negative moment between points of dead load contraflexure, the factor for the effect of two design trucks combined with the design lane load is 100% for the PHL-93 loading and 90% for the HL-93 loading. The 1.25 factor is not applied to the design tandem pair for the PHL-93 loading.

The PennDOT maximum legal live loading (ML-80) is the maximum legal truck allowed in Pennsylvania. The PennDOT permit live loading (P-82) is a notional load used to check Strength II and Service IIB limit states. The TK527 live loading is a new posting vehicle described in SOL 431-01-15. The AASHTO HS20 live loading and AASHTO H20 live loading are in accordance with the AASHTO Standard Specifications for Highway Bridges. For the special live loading (SLL), the user can input the axle loads, the axle spacings, uniform lane loading, and the corresponding load factors for each limit state.

The axle loads and axle spacings for the HL-93 and PHL-93 design truck, HL-93 design tandem, PHL-93 design tandem, HL-93 and PHL-93 design tandem pair, and ML-80 rating truck are presented in Figure 1. The P-82 permit truck, TK527 truck, HS20 truck, H20 truck, and HS20 and H20 lane loading are presented in Figure 2. The design lane load for both the HL-93 and PHL-93 loading is taken as 0.64 kips per linear foot.

The live loads to be used for an analysis or design are designated by the user by entering a live load code. The live load code is an upper case alphabetic character (A through E for design and A through G for analysis). The live load designations used for each live load code and each load case are summarized in Tables 1 and 2. The load cases are for the LRFD limit states, fatigue check, deflection check, construction check, and ratings. Separate rating tables are generated for each live load designation. Table 3 summarizes the live load used for analysis, design, rating and printing specific reaction tables that could be used for bearing, sole plate, abutment and pier designs based on live load code entered by the user.

For ML-80 and TK527 loadings, all axles are always included while for P-82 loading noncontributing axles are neglected.

EV2, EV3, and SU6TV loads are described in the FHWA FAST Act, effective December 4, 2015.

The P2016-13 permit load was developed by Penn State University in May 2016. It has 13 axles with two varying spacings following axles 7 and 10. The first varying spacing between axles 7 and 8 ranges from 30’ to 50’. The second varying spacing between axles 10 and 11 ranges from 5’ to 14’.

For the ML-80, TK527, P-82, EV2, EV3, SU6TV, and P2016-13 live loadings, only one truck unit is considered longitudinally on the structure. The program generates influence lines for deflections for each analysis point and for support reactions and rotations. The influence lines for moments and shears at analysis points are generated from the reaction influence lines. The effect of a live loading is calculated by placing the load at various locations on the influence lines. In calculating the effect of a design truck, design tandem, fatigue load, design truck pair, or design tandem pair for the LRFD loading, only the axle loads which contribute to the effect being sought are considered. The spacings between the last axles of the design truck, between the design truck pair, and between the design tandem pair are as per the LRFD Specifications.

The P-82C live loading is a combination of the P-82 live loading in one lane with PHL-93 live loading in other lanes. Similarly, the P2016-13C live loading is a combination of the P2016-13 live loading in one lane with PHL-93 live loading in other lanes. These combination loadings may be used for the rating of existing bridges with the Strength-II and Service-IIB limit states.

In place of the above live loadings, the bridge can be analyzed for several special live loadings by specifying the axle loads, axle spacings, and the uniform lane load. This can be used to analyze a permit load or to analyze more than one truck unit on the structure longitudinally, or to check the combination of a truck load and a lane load. A special live load may have up to a maximum of 80 axles.

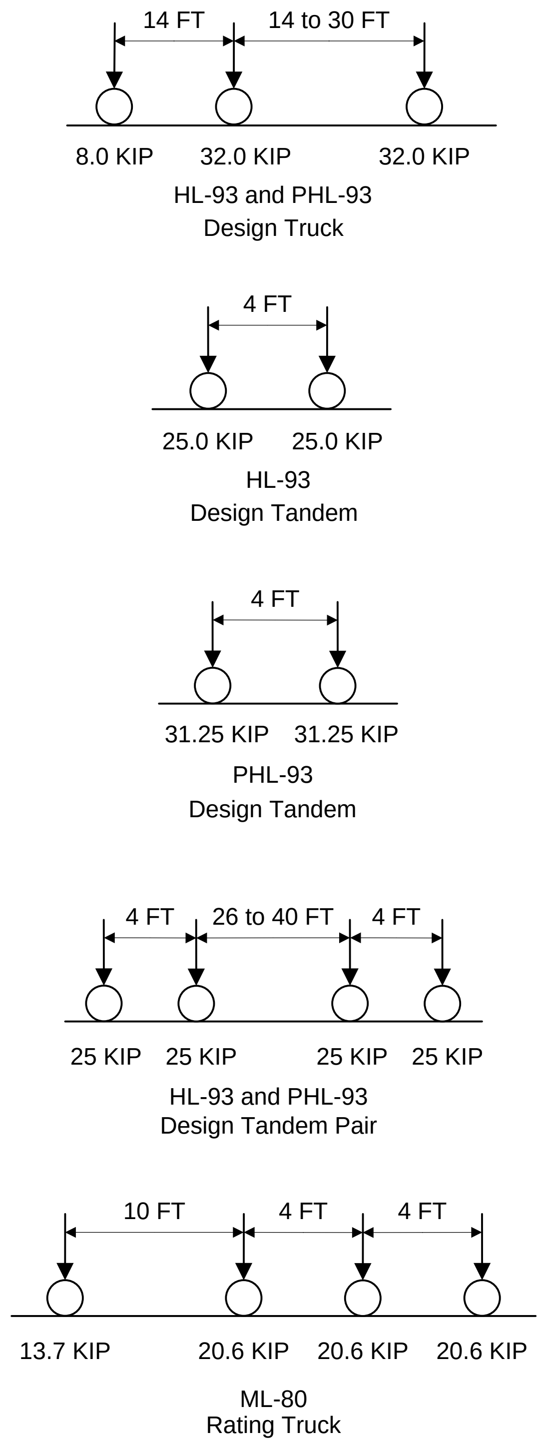
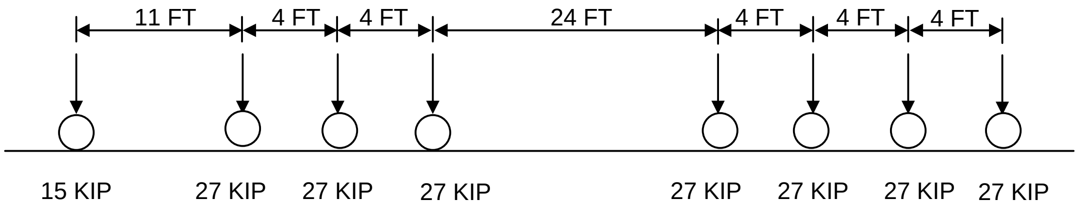
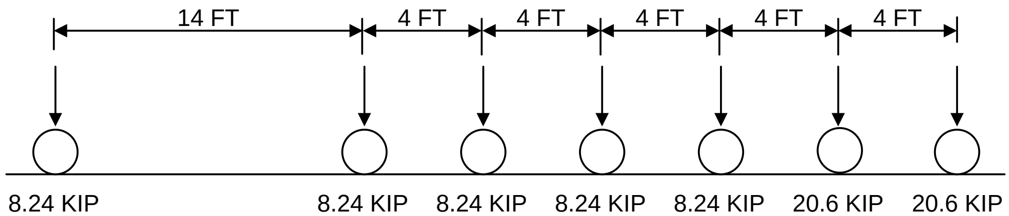


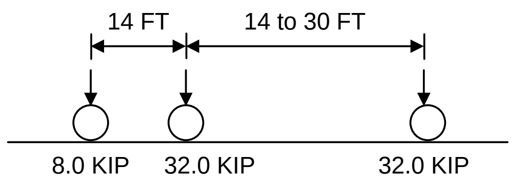
Figure 2.5-1 LRFD and ML-80 Live Loadings



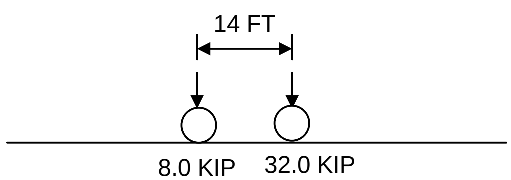
P-82 Permit Load



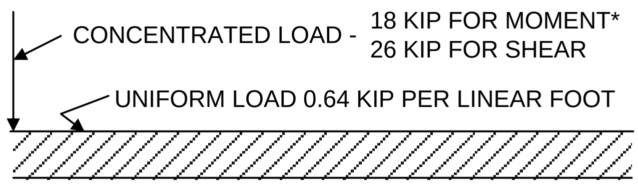
TK527 Truck



HS20 Truck



H20 Truck



HS20 and H20 Lane Load

* use two concentrated loads for negative moment

Figure 2.5-2 P-82, TK527, HS20, and H20 Live Loadings

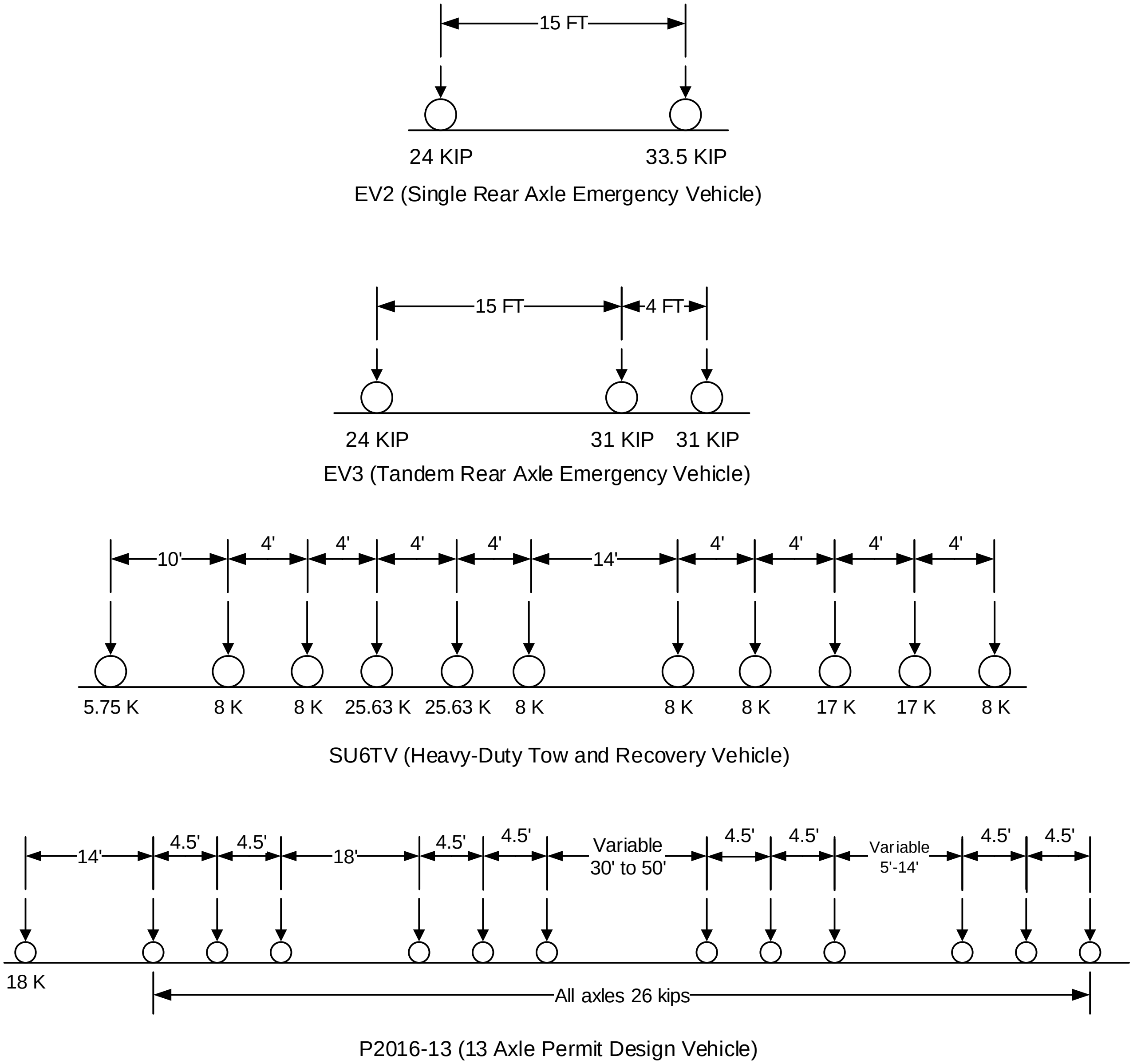


Figure 2.5-3 EV2, EV3, SU6TV, and P2016-13 Live Loadings

Table 2.5-1 Live Loadings for Design

Limit State		Live Load Code For Design[1]					
		A	B	C	D	E	F
Strength I	Design	PHL–93	HL–93	HL–93	PHL–93 / ML–80	PHL–93 / ML–80 / TK527	PHL–93 / ML–80 / TK527
	Inventory Rating	PHL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20	PHL–93 H20 HS20 ML–80 TK527	PHL–93 H20 HS20 ML–80 TK527	PHL–93 H20 HS20 ML–80 TK527
Strength IP	Design	PHL–93	HL–93	HL–93	PHL–93 / ML–80	PHL–93 / ML–80 / TK527	PHL–93 / ML–80 / TK527
	Inventory Rating	PHL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20 ML–80 TK527	HL-93	PHL–93 H20 HS20 ML–80 TK527	PHL–93 H20 HS20 ML–80 TK527	PHL–93 H20 HS20 ML–80 TK527
Strength IA	Design	PHL–93	HL–93	HL–93	PHL–93 / ML–80	PHL–93 / ML–80 / TK527	PHL–93 / ML–80 / TK527
	Operating Rating	PHL–93	HL–93	HL–93	PHL–93	PHL–93	PHL–93
Strength II	Design	P–82	P–82	none[2]	P–82	P–82	P-82 / P2016-13
	Operating Rating	P–82 H20 HS20 ML–80 TK527	P–82 H20 HS20 ML–80 TK527	H20 HS20	P–82 H20 HS20 ML–80 TK527	P–82 H20 HS20 ML–80 TK527	P-82 P2016-13 H20 HS20 ML-80 TK527
Strength III	Design	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
	No Rating						
Strength IV	Design	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
	No Rating						
Strength V	Design	PHL–93	HL–93	HL–93	PHL–93 / ML–80	PHL–93 / ML–80 / TK527	PHL–93 / ML–80 / TK527
	No Rating						

Table 2.5-1 Live Loadings for Design (continued)

Limit State		Live Load Code For Design[1]					
		A	B	C	D	E	F
Service II	Design	PHL–93	HL–93	HL–93	PHL–93 / ML–80	PHL–93 / ML–80 / TK527	PHL–93 / ML–80 / TK527
	Inventory Rating	PHL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20	PHL–93 H20 HS20 ML–80 TK527	PHL–93 ML–80 H20 HS20 TK527	PHL–93 ML–80 H20 HS20 TK527
Service IIA	Design	PHL–93	HL–93	HL–93	PHL–93 / ML–80	PHL–93 / ML–80 / TK527	PHL–93 / ML–80 / TK527
	Operating Rating	PHL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20	PHL–93 H20 HS20 ML–80 TK527	PHL–93 ML–80 H20 HS20 TK527	PHL–93 ML–80 H20 HS20 TK527
Service IIB Limit State	Design	P–82	P–82	none[2]	P–82	P–82	P-82 / P2016-13
	Operating Rating	P–82	P–82	none[2]	P–82	P–82	P-82 / P2016-13
Fatigue I Fatigue II	Design No Rating	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle
Deflection	Design No Rating	PennDOT Deflection Loading	LRFD Deflection Loading	LRFD Deflection Loading	LRFD Deflection Loading	LRFD Deflection Loading	LRFD Deflection Loading
Construction / Uncured Slab	Design No Rating	User–defined	User–defined	User–defined	User–defined	User–defined	User–defined

Notes:
1. "N/A" denotes that the specified live load designation does not apply to the limit state as specified in the LRFD Specifications.
2. "none" denotes that the specified live load designation does not apply for the live load code.

Table 2.5-2 Live Loadings for Analysis

Limit State		Live Load Code for Analysis						
		A	B	C	D	E[1]	F	G
Strength I	Inventory Rating	PHL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20	ML–80	none	SLL	TK527	PHL–93 H20 HS20 ML–80 TK527
Strength IP	Inventory Rating	PHL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20	ML–80	none	SLL	TK527	PHL–93 H20 HS20 ML–80 TK527
Strength IA	Operating Rating	PHL–93	HL–93	none	none	none	none	PHL–93
Strength II	Operating Rating	P–82 H20 HS20 ML–80 TK527	H20 HS20	ML–80	P–82	SLL	TK527	P–82C[4] H20 HS20 ML–80 TK527
Strength III	No Rating	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]
Strength IV	No Rating	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]
Strength V	No Rating	PHL–93	HL–93	ML–80	none[3]	SLL	TK527	PHL–93
Service II	Inventory Rating	PHL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20	ML–80	none[3]	SLL	TK527	PHL–93 H20 HS20 ML–80 TK527
Service IIA	Operating Rating	PHL–93 H20 HS20 ML–80 TK527	HL–93 H20 HS20	ML–80	none[3]	SLL	TK527	PHL–93 H20 HS20 ML–80 TK527
Service IIB	Operating Rating	P–82	none[3]	none[3]	P–82	SLL	none[3]	P–82C[4]
Fatigue I Fatigue II	No Rating	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle
Deflection	No Rating	PennDOT Deflection Loading	LRFD Deflection Loading	none[3]	none[3]	none[3]	none[3]	PennDOT Deflection Loading
Construction/ Uncured Slab	No Rating	User–defined	User–defined	User–defined	User–defined	User–defined	User–defined	User-defined

Table 2.5-2 Live Loadings for Analysis (Continued)

Limit State		Live Load Code for Analysis			
		H	I	J	K
Strength I	Inventory Rating	none[3]	none[3]	PHL–93 H20 HS20 ML–80 TK527	PHL–93 H20 HS20 ML–80 TK527
Strength IP	Inventory Rating	none[3]	none[3]	PHL–93 H20 HS20 ML–80 TK527	PHL–93 H20 HS20 ML–80 TK527
Strength IA	Operating Rating	none[3]	none[3]	PHL–93	PHL–93
Strength II	Operating Rating	EV2 EV3 SU6TV	P2016-13	P–82 H20 HS20 ML–80 TK527 P2016-13	P–82C[4] H20 HS20 ML–80 TK527 P2016-13C[4]
Strength III	No Rating	N/A[2]	N/A[2]	N/A[2]	N/A[2]
Strength IV	No Rating	N/A[2]	N/A[2]	N/A[2]	N/A[2]
Strength V	No Rating	none[3]	none[3]	PHL–93	PHL–93
Service II	Inventory Rating	none[3]	none[3]	PHL–93 H20 HS20 ML–80 TK527	PHL–93 H20 HS20 ML–80 TK527
Service IIA	Operating Rating	EV2 EV3 SU6TV	none[3]	PHL–93 H20 HS20 ML–80 TK527	PHL–93 H20 HS20 ML–80 TK527
Service IIB	Operating Rating	none[3]	P2016-13	P–82 P2016-13	P–82C[4] P2016-13C[4]
Fatigue I Fatigue II	No Rating	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle
Deflection	No Rating	none[3]	none[3]	PennDOT Deflection Loading	PennDOT Deflection Loading

Table 2.5-2 Live Loadings for Analysis (Continued)

Limit State		Live Load Code for Analysis			
		H	I	J	K
Construction/ Uncured Slab	No Rating	User-defined	User–defined	User–defined	User-defined

Notes:

1. The limit states denoted by SLL in this column are the limit states that include special live load by default. The user can control the limit states that apply to the special live load by using the LDF command and specifying load factors for the special live load. Strength and service limit states indicated as "No Rating" will only include special live load #1. Special live loads greater than #1 will only have ratings calculated for limit states designated as "Operating Rating" or "Inventory Rating".
2. “N/A” denotes that the specified live load designation does not apply to the limit state as specified in the LRFD Specifications.
3. "none" denotes that the specified live load designation does not apply for the live load code.
4. "P-82C" denotes P-82 in one lane and PHL-93 in other lanes.
   "P2016-13C" denotes P2016-13 in one lane and PHL-93 in other lanes.

Table 2.5-3 Live Loadings for Reaction Tables

Design Live Load Code	Design Vehicle	Rating Vehicle	Bearing, Sole Plate, and Abutment Reaction Tables	Pier Reaction Table
A	PHL-93 & P-82	PHL-93, P-82, ML-80, HS20, H20, TK527	PHL-93	PHL-93 & P-82
B	HL-93 & P-82	HL-93, P-82, ML-80, HS20, H20, TK527	HL-93	HL-93 & P-82
C	HL-93	HL-93, HS20, H20	HL-93	HL-93
D	PHL-93/ML-80 & P-82	PHL-93, P-82, ML-80, HS20, H20, TK527	PHL-93 & ML-80	PHL-93, ML-80, & P-82
E	PHL-93 / ML-80 / TK527 & P-82	PHL-93, P-82, ML-80, HS20, H20, TK527	PHL-93, ML-80, & TK527	PHL-93, ML-80, TK527, & P-82
F	PHL-93 / ML-80 / TK527 & P-82 / P2016-13	PHL-93, P-82, ML-80, HS20, H20, TK527, P2016-13	PHL-93, ML-80, & TK527	PHL-93, ML-80, TK527, P-82, & P2016-13

Table 2.5-3 Live Loadings for Reaction Tables (Continued)

Analysis Live Load Code	Analysis Vehicle	Rating Vehicle	Bearing, Sole Plate, and Abutment Reaction Tables	Pier Reaction Table
A	PHL-93, P-82, ML-80, HS20, H20, TK527	PHL-93, P-82, ML-80, HS20, H20, TK527	PHL-93	PHL-93 & P-82
B	HL-93, HS20, H20	HL-93, HS20, H20	HL-93	HL-93
C	ML-80	ML-80	ML-80	ML-80
D	P-82	P-82	P-82	P-82
E	SLL	SLL	SLL	SLL
F	TK527	TK527	TK527	TK527
G	PHL-93, P-82C, ML-80, HS20, H20, TK527	PHL-93, P-82C, ML-80, HS20, H20, TK527	PHL-93	PHL-93 & P-82
H	EV2, EV3, SU6TV	EV2, EV3, SU6TV	EV2, EV3, SU6TV	EV2, EV3, SU6TV
I	P2016-13	P2016-13	P2016-13	P2016-13
J	PHL-93, P-82, ML-80, HS20, H20, TK527, P2016-13	PHL-93, P-82, ML-80, HS20, H20, TK527, P2016-13	PHL-93	PHL-93, P-82, & P2016-13
K	PHL-93, P-82C, ML-80, HS20, H20, TK527, P2016-13C	PHL-93, P-82C, ML-80, HS20, H20, TK527, P2016-13C	PHL-93	PHL-93 & P-82

2.6 RATINGS DEFINITION

The program computes the live load rating factors for flexure and shear for Strength I, Strength IP, Strength IA, Strength II, Service II, Service IIA, and Service IIB limit states. The live load rating factor is defined as the ratio of the live load reserve capacity divided by the factored live load effect. For sections in which the flexural reserve is based on moment, the reserve moment capacity is divided by the factored live load moment. For sections in which the flexural reserve is based on stress, the reserve stress capacity is divided by the factored live load stress. The reserve moment capacity is equal to the section moment capacity minus all dead load and pedestrian load moments. The reserve stress capacity is equal to the section stress capacity minus all dead load and pedestrian load stresses. Similarly, the reserve shear capacity is equal to the section shear capacity minus all dead load and pedestrian load shears. The program computes inventory and operating ratings for the appropriate live loadings and limit states, as presented in Table 1. The inventory rating is the load that can be carried by the structure for an indefinite period. The operating rating is the load that may produce the absolute maximum permissible stress, and it is the maximum load allowed on the structure. By specifying an input value, the program is able to generate ratings with and without Future Wearing Surface loading in a single run of the program for both design and analysis runs.

The Strength I, Strength IP, and Service II limit states are used for the inventory rating. The Strength IA, Strength II, Service IIA, and Service IIB limit states are used for the operating rating. The live load designations used for each limit state are summarized in Table 1.

The equations used for computing the rating factors are provided in Section 3.8.

Table 2.6-1 Live Load Ratings

Live Loading	Live Load Combination									
	Str I	Str IP	Str IA	Str II	Str III	Str IV	Str V	Srv II	Srv IIA	Srv IIB
PHL-93/ HL-93	—	I	O	—	—	—	—	I	O	—
P-82 / P-82C	I	—	—	O	—	—	—	—	—	O
ML-80	I	I	—	O	—	—	—	I	O	—
HS20	I	I	—	O	—	—	—	I	O	—
H20	I	I	—	O	—	—	—	I	O	—
Special Live Load	I	I	—	O	—	—	—	I	O	—
TK527	—	I	—	O	—	—	—	I	O	—
EV2	—	—	—	O	—	—	—	—	O	—
EV3	—	—	—	O	—	—	—	—	O	—
SU6TV	—	—	—	O	—	—	—	—	O	—
P2016-13 / P2016-13C							—	—	—	O

Notes:
I - Inventory
O - Operating
"P-82C" denotes P-82 in one lane and PHL-93 in other lanes
"P2016-13C" denotes P2016-13 in one lane and PHL-93 in other lanes

2.7 ASSUMPTIONS AND LIMITATIONS

The following is a list of basic assumptions and limitations for STLRFD:

1. The rolled beam dimensions used by the program are consistent with the AISC Steel Construction Manual, 14th Edition, 1st printing.

2. The steel beam section can consist of a rolled beam, with or without cover plates, a plate girder section, or a built-up section made of angles and plates.

3. The design option can be used for a rolled beam without cover plates or a plate girder section. It cannot be used for a rolled beam with cover plates or a built-up section made of angles and plates.

4. The design option can be used for single span bridges. It cannot be used for continuous span bridges.

5. For both analysis and design runs, a girder must be either composite over its entire length or noncomposite over its entire length. It cannot have portions that are composite and other portions that are noncomposite.

6. The program performs the specification check using the controlling analysis values from either the construction stages (deck pour sequencing) or the instantaneous pour. The controlling analysis values are used for load combinations with live loads.

7. The program loops through the specification check for each applicable live loading.

8. The program factors the transient loads used in the deck pour staging by using the load factors for live loads.

9. The program neglects the effects of longitudinal reinforcement in the positive moment region of a continuous composite girder. However, it assumes that the reinforcement acts compositely with the steel section in the negative moment region of a continuous composite girder.

10. The program does not redistribute the positive and negative moments from interior-pier sections in continuous span bridges as per DM-4 Section 6, Appendix B.

11. Engineering judgment is required in preparing the input and evaluating the output for a plate girder design optimization problem. The user must exercise judgment in specifying the various plate width and thickness limitations.

12. The program uses wind effects in performing the specification check for an uncured slab and for deck pour staging. The wind effects are then added to the top and bottom flange flexural stresses to achieve a total stress in each flange per LRFD Specifications Equation 6.10.3.2.1-1 and/or 6.10.3.2.2-1 where appropriate.

13. To determine if the stresses at a given section should be calculated using positive or negative flexure section properties, the program initially assumes that positive flexure section properties should be used and computes the unfactored stress in the slab using positive flexure section properties (as per LRFD Specifications Article 6.10.1.1.1b). If the unfactored stress in the top of the concrete slab is found to be compressive, then the initial assumption is correct and the factored stresses are calculated using positive flexure section properties. If, however, the unfactored stress in the top of the concrete slab is found to be tensile, then the initial assumption is not correct and STLRFD computes the factored stresses throughout the section using negative flexure section properties.

14. The program makes the following assumptions regarding the haunch:

    A. For analysis runs, the program conservatively includes the area of the top flange and cover plate in the area used to calculate the dead load due to the haunch. Therefore, the area of the top flange and cover plate is conservatively included as both steel weight (self-weight of the girder) and concrete weight (weight of the haunch). However, the user can enter a negative dead load (DC1) to eliminate the load effect of this extra area of concrete, if desired.

    B. In computing the haunch weight for both analysis and design runs, the program assumes that the haunch width is equal to the top flange width. The haunch depth used in computing the haunch weight is the inputted haunch depth.

    C. In computing the section properties for an analysis run, the program uses the haunch depth to determine the separation distance between the concrete deck and the steel girder. However, the program does not include the area of the haunch when computing the section properties. In other words, for an analysis run, the section properties are computed based on the inputted haunch depth and based on a haunch width of zero.

    D. In computing the section properties for a design run, the program assumes that the bottom of the concrete deck is located at the top of the steel girder. For a design run, the program does not use the inputted haunch depth in any way when computing the section properties. For a design run, the inputted haunch depth is used only to compute the haunch weight.

    E. To analyze a new bridge in accordance with PennDOT policy, the user should input a haunch depth equal to the top flange thickness. In addition, the user should input the assumed haunch weight as a distributed DC1 load using the DLD command.

15. The program automatically places analysis points at twentieth points of each span, at plate transition locations, at hinge locations, at deck pour locations, at bracing points, at concentrated load points, at field splice centerline locations and edge locations, and at user-defined fatigue locations. The program uses a tolerance on analysis points of 0.1 inches. That is, if two analysis points are within 0.1 inches of each other, then the program assumes that they are the same point.

16. If the user specifies the symmetry option (CTL command, parameter 7), then all input values must be specified for the first half of the bridge length only. For example, for a two-span bridge for which the symmetry option is specified, any input values at the pier must be specified at the end of the first span rather than at the beginning of the second span.

17. The program analyzes and designs typical transverse stiffeners only. The program does not analyze or design cross frame or diaphragm stiffeners.

18. The program always performs the analysis and the specification check based on the twentieth points of each span, regardless of whether these analysis points have been selected by the user to be included in the output.

19. If the user does not specify input for a particular portion of the specification check, the program will not provide output for that portion of the specification check, regardless of what output tables are requested by the user. For example, if the user requests output for stiffener checks but does not enter any stiffener input, the program will not generate output for the stiffener checks.

20. The program prints a list of all output tables for which one or more specification checks have failed. This list is printed at the end of the output, and a separate list is printed for each live loading. Therefore, a good starting point for the user is to look at this list and then refer to each output table that is included in this list to find out the specific location and nature of the specification check failure. This list may include tables that were not selected by the user to be printed. In addition, this list is based on specification checking at twentieth points and additional analysis points. Therefore, if the user chooses to have fewer analysis points printed in the output, the program may also print failure points that were not selected by the user as printable points. This is to prevent the situation where a table may be included in this list for which there appears to be no specification check warning or failure.

21. The program designs transverse stiffeners fabricated of plates only; it does not design transverse stiffeners fabricated of angles.

22. The weight of the steel is set to 490 pcf in the program.

23. The program will only consider the effects of section holes (entered using the SHO command for analysis runs or FSL command for design runs) when computing the net tension flange area, A_n, for Net Section Fracture specification checks. No other design, analysis, and specification checking processes will consider reduced section properties due to section holes. In addition, all stress calculations will be performed using the net section properties, defined as the gross section including section losses entered via the SLS command.

24. The program always assumes unshored construction.

25. Simple span girders will always have two shear connector design regions centered on midspan (one from abutment one to midspan and one from midspan to abutment two). Note that for certain span lengths, the point of maximum live load moment will not occur at midspan.

26. For shear connector pitch calculations, the radial shear force will be calculated from Equation A6.10.10.1.2-5 for all girders (interior and exterior) using a 25-kip force per Article C6.10.10.1.2. This radial shear force component is only applicable where the skew exceeds the specified value or no SKW command is entered.

27. STLRFD analyzes all girders as 2-dimensional straight girders. However, STLRFD does allow the input of lateral stresses, either as a single value (on the CTL command) or as more detailed stresses entered per span (LAS command). These stresses are user input and are added to the 2-dimensional major-axis load effects computed by the program in accordance with the LRFD Specifications. The stresses are generally from staggered diaphragms in skewed bridges. The user may obtain these stresses from a separate 3-dimensional analysis and input them to STLRFD.

28. If the neutral axis of a section falls in the concrete slab, any concrete below the neutral axis (in the tension zone) is neglected for section property calculations, for both strength and service limit states.

29. Blast loading defined in LRFD Specifications Article 3.15 is not considered by STLRFD. Blast loading is not shown in the DM-4 load factor Table 3.4.1.1P-1 for steel girders which indicates that it should not be considered, even though the AASHTO section for blast loading was not deleted in DM-4.

30. Several areas of this User's Manual refer to loads being applied to varying composite sections (3n, n, n/0.7). For girders that are noncomposite in the final state (materials defined as NONCOMPOSITE on the MAT command), all loads are applied to the steel-only section.

31. Table 1 describes LRFD Specification and DM-4 calculations that have not been implemented in the STLRFD program.

Table 2.7-1 References to Articles and Equations that are not incorporated in STLRFD

2014 AASHTO Relevant Article	Topic	Item Not Incorporated in STLRFD
3.15	Blast Loading	Blast loading is not shown in the DM-4 Load Factor table for steel girders (DM-4 Table 3.4.1.1P-1), which indicates that it should not be considered, even though DM-4 does not delete Article 3.15.
6.10.1.1.1a	Composite Sections, Stresses, Sequence of Loading	No specifications relating to shored construction have been implemented.
6.10.3.2.4	Concrete Deck	For composite sections, the longitudinal tensile stress in the concrete deck due to factored loads shall not exceed the modulus of rupture during critical stages of construction
6.10.4.2.2	Service Limit State, Flexure	No specifications relating to shored construction have been implemented.
6.10.12	Cover Plates	The provisions pertaining to cover plates have not been implemented in STLRFD

Additional assumptions and limitations, including input parameter lower limits, upper limits, and defaults, are presented with the input descriptions in Chapter 5.

3 METHOD OF SOLUTION

The primary purpose of this program is to design and rate single span steel girders and to perform an analysis and ratings for single and continuous span girders. The structural analysis and specification checking are performed in accordance with the LRFD Specifications and DM-4. This chapter provides detailed information regarding the method of solution used in the program.

In the analysis, design, and rating of a girder used for highway bridges, the following steps are generally required:

1. Calculate girder section properties.
2. Calculate dead load effects.
3. Calculate live load effects.
4. Combine dead and live load effects.
5. Calculate girder section resistance.
6. Perform specification checking.
7. Adjust girder section sizes for design.
8. Calculate ratings.

The program performs the above calculations using classical methods of structural analysis and following the specifications provided in the LRFD Specifications and DM-4. For the purpose of this program, the analysis and design runs are defined as follows.

For an analysis run, the girder sections and bridge geometry are known and the program performs all calculations mentioned above except for Step 7. For a design run, all calculations mentioned above are performed.

The following sections describe the above calculations in detail. Refer to any standard textbook on structural analysis and the appropriate sections of this manual for calculations performed in Steps 1, 2, 3, and 4. Refer to the LRFD Specifications and DM-4 for calculations performed in Steps 5 and 6. Refer to appropriate sections in this manual for calculations performed in Steps 7 and 8.

3.1 NOTATION

The following are the meanings of equation notations used in various expressions throughout this manual. Definitions of abbreviations can be found in Section 1.2.

a	=	distance along a girder from the left support of the span (ft)
b	=	effective flange (slab) width (in)
$b_{eff,ext}$	=	effective flange (slab) width for exterior girders (in)
$b_{eff,int}$	=	effective flange (slab) width for interior girders (in)
b_f	=	width of the compression flange of a steel section (in)
b_{ft}	=	maximum of the top flange or cover plate width (in)
C	=	ratio of the shear buckling stress to the shear yield strength
D	=	web depth (in)
D_c	=	depth of web in compression (in)
d	=	depth of steel section (in)
d_o	=	spacing of transverse stiffeners (in)
E	=	modulus of elasticity of steel (ksi)
E_c	=	modulus of elasticity of concrete (ksi)
E_s	=	modulus of elasticity of steel (ksi)
F_{LLr}	=	factored flexural reserve resistance for live load stress (ksi)
F_{nc}	=	nominal flexural resistance of the compression flange in terms of stress (ksi)
F_r	=	factored flexural stress resistance (ksi)
F_y	=	specified minimum yield strength of steel (ksi)
F_{yc}	=	specified minimum yield strength of a compression flange (ksi)
F_{yf}	=	specified minimum yield strength of a flange (ksi)
F_{yt}	=	specified minimum yield strength of a tension flange (ksi)
$F_{y,web}$	=	specified minimum yield strength of the web (ksi)
f_c	=	stress in a compression flange due to the factored loading (ksi)
f_{cf}	=	elastic bending stress in the compression flange due to the unfactored permanent load and twice the factored fatigue loading (ksi)
$f_{c\,max}$	=	maximum flexural stress in the compression flange based on compression flange slenderness requirements (ksi)
f_c'	=	minimum specified compressive strength of concrete (ksi)
f_{DC1}	=	maximum factored flexural stress due to permanent dead load of structural components and nonstructural attachments applied before slab placement (ksi)
f_{DC2}	=	maximum factored flexural stress due to permanent dead load of structural components and nonstructural attachments applied after slab placement (ksi)
f_{DL}	=	factored flexural stress due to dead load (ksi)
f_{DL1}	=	factored flexural stress due to dead load applied before slab placement (ksi)

f_{DL2}	=	factored flexural stress due to composite dead load applied after slab placement (ksi)
$f_{E,tg,nc}$	=	total factored stress at the top of the girder due to erection loads applied to the noncomposite section (ksi)
$f_{E,tg,tot}$	=	total factored stress at the top of the girder due to erection loads applied to the noncomposite and composite section (ksi)
$f_{E,ts}$	=	maximum factored flexural stress at the top of the slab due to erection loads (ksi)
$f_{fatigue}$	=	maximum unfactored flexural stress in the compression flange due the fatigue loading (ksi)
f_{FWS}	=	maximum factored flexural stress due to future wearing surfaces (ksi)
f_{LL}	=	maximum factored live load stress (ksi)
f_{MC1}	=	maximum factored flexural stress due to miscellaneous dead load applied before slab placement (ksi)
f_{MC2}	=	maximum factored flexural stress due to miscellaneous dead load applied after slab placement (ksi)
f_{PL}	=	factored pedestrian load stress (ksi)
f_t	=	stress in a tension flange due to the factored loading (ksi)
$f_{t\ max}$	=	maximum flexural stress in the tension flange based on the steel yield strength (ksi)
f_{ts}	=	total factored flexural stress at the top of the slab (ksi)
f_{UT1}	=	maximum factored flexural stress due to utility loads applied before slab placement (ksi)
f_{UT2}	=	maximum factored flexural stress due to utility loads applied after slab placement (ksi)
I_{beam}	=	moment of inertia of the beam only (in^4)
I_y	=	moment of inertia of a steel section about the vertical axis in the plane of its web (in^4)
I_{yc}	=	moment of inertia of a compression flange about the vertical axis in the plane of the web (in^4)
K_g	=	longitudinal stiffness parameter (in^4)
k_1	=	a coefficient related to the nominal shear resistance of interior web panels of noncompact sections
L	=	span length (ft)
L_b	=	unbraced length (in)
M_a	=	flexural moment at a distance “a” along the girder from the left support of the span (K-in)
M_{DC1}	=	maximum factored flexural moment due to permanent dead load of structural components and nonstructural attachments applied before and with slab placement (K-in)
M_{DC2}	=	maximum factored flexural moment due to permanent dead load of structural components and nonstructural attachments applied after slab placement (K-in)
M_{DL}	=	factored flexural moment due to dead load (K-in)
M_{DL1}	=	factored flexural moment due to dead load applied before and with slab placement (K-in)
M_{DL2}	=	factored flexural moment due to dead load applied after slab placement (K-in)
$M_{E,c}(i)$	=	total factored flexural moment due to erection loads applied to the composite n/0.70 section; the moment is a summation of moments from Stage 0 to the current stage; the summation is required because the load is incrementally applied per pour because the stiffness changes for each deck pour (K-in)

$M_{E,nc}(i)$	=	total factored flexural moment due to erection loads applied to the noncomposite section; the moment is a summation of moments from Stage 0 to the current stage; the summation is required because the load is incrementally applied per pour because the stiffness changes for each deck pour (K-in)
M_{FWS}	=	maximum factored flexural moment due to future wearing surfaces (K-in)
M_{LL}	=	factored live load flexural moment (K-in)
M_{LLr}	=	factored flexural reserve resistance for live load moment (K-in)
M_{MC1}	=	maximum factored flexural moment due to miscellaneous dead load applied before slab placement (K-in)
M_{MC2}	=	maximum factored flexural moment due to miscellaneous dead load applied after slab placement (K-in)
M_{PL}	=	factored pedestrian load flexural moment (K-in)
M_r	=	factored flexural moment resistance (K-in)
M_{rcf}	=	live load reserve capacity moment for the compression flange (K-in)
$M_{r\ min}$	=	minimum live load reserve capacity moment (K-in)
M_{rtf}	=	live load reserve capacity moment for the tension flange (K-in)
M_u	=	factored flexural moment (K-in)
M_{UT1}	=	maximum factored flexural moment due to utility loads applied before slab placement (K-in)
M_{UT2}	=	maximum factored flexural moment due to utility loads applied after slab placement (K-in)
M_y	=	yield moment resistance (K-in)
N	=	ratio of the modulus of elasticity of steel to that of concrete
Q	=	total factored load (moment, shear, deflection, reaction, or rotation)
q_i	=	unfactored load (moment, shear, deflection, reaction, or rotation)
R_b	=	load shedding factor (flange-stress reduction factor)
RF	=	live load rating factor
RF_M	=	live load rating factor for flexure
RF_V	=	live load rating factor for shear
R_h	=	hybrid factor (flange-stress reduction factor)
r_t	=	minimum radius of gyration of the compression flange of a steel section plus one third of the web in compression, about the vertical axis in the plane of the web between brace points (in)
$S_{bg,nc}$	=	section modulus at bottom of girder for the noncomposite section (in^3)
$S_{bg,3n}$	=	section modulus at bottom of girder for the composite 3n section (in^3)
$S_{bg,n}$	=	section modulus at bottom of girder for the composite n section (in^3)
$S_{bg,n7}$	=	section modulus at bottom of girder for the composite n/0.70 section (in^3)
S_{cDL1}	=	section modulus at the compression flange for the noncomposite section (in^3)
S_{cDL2}	=	section modulus at the compression flange for the composite 3n section (in^3)
S_{cLL}	=	section modulus at the compression flange for the composite n section (in^3)
S_{ext}	=	overhang of an exterior girder measured from the centerline of girder to the edge of the deck and along a line normal to the girder (in)

S_{int} = spacing of interior girders measured from centerline to centerline of girder and along a line normal to the girder (in)

S_{tDL1} = section modulus at the tension flange for the noncomposite section (in^3)

S_{tDL2} = section modulus at the tension flange for the composite 3n section (in^3)

$S_{tg,nc}$ = section modulus at top of girder for the noncomposite section (in^3)

$S_{tg,3n}$ = section modulus at top of girder for the composite 3n section (in^3)

$S_{tg,n}$ = section modulus at top of girder for the composite n section (in^3)

$S_{tg,n7}$ = section modulus at top of girder for the composite n/0.70 section (in^3)

S_{tLL} = section modulus at the tension flange for the composite n section (in^3)

$S_{ts,3n}$ = section modulus at top of slab for the composite 3n section (in^3)

$S_{ts,n}$ = section modulus at top of slab for the composite n section (in^3)

$S_{ts,n7}$ = section modulus at top of slab for the composite n/0.70 section (in^3)

t_f = flange thickness (in)

t_{fc} = thickness of the compression flange (in)

t_{ft} = thickness of the tension flange (in)

t_h = thickness of the haunch (in)

t_s = effective slab thickness (in)

$t_{s,avg}$ = average effective slab thickness (in)

t_w = web thickness (in)

V_{DC1} = maximum factored shear due to permanent dead load of structural components and nonstructural attachments applied before slab placement (kip)

V_{DC2} = maximum factored shear due to permanent dead load of structural components and nonstructural attachments applied after slab placement (kip)

V_{DL} = factored shear due to dead load (kip)

V_{FWS} = maximum factored shear due to future wearing surfaces (kip)

V_{LL} = factored live load shear (kip)

V_{LLr} = factored shear reserve resistance for live load (kip)

V_{MC1} = maximum factored shear due to miscellaneous dead load applied before slab placement (kip)

V_{MC2} = maximum factored shear due to miscellaneous dead load applied after slab placement (kip)

V_n = nominal shear resistance (kip)

V_p = plastic shear capacity (kip)

V_{PL} = factored pedestrian load shear (kip)

V_r = factored shear resistance (kip)

V_u = factored shear (kip)

V_{UT1} = maximum factored shear due to utility loads applied before slab placement (kip)

V_{UT2} = maximum factored shear due to utility loads applied after slab placement (kip)

w = uniform load on a member (K/ft)

w_c = density of concrete (kcf)

$Y_{bg,nc}$ = distance from neutral axis to the bottom of girder for the noncomposite section (in)

$Y_{bg,3n}$ = distance from neutral axis to the bottom of girder for the composite 3n section (in)

$Y_{bg,n}$ = distance from neutral axis to the bottom of girder for the composite n section (in)

$Y_{bg,n7}$ = distance from neutral axis to the bottom of girder for the composite n/0.70 section (in)

Y_p = distance from neutral axis to the bottom of girder for the plastic section (in)

$Y_{tg,nc}$ = distance from neutral axis to the top of girder for the noncomposite section (in)

$Y_{tg,3n}$ = distance from neutral axis to the top of girder for the composite 3n section (in)

$Y_{tg,n}$ = distance from neutral axis to the top of girder for the composite n section (in)

$Y_{tg,n7}$ = distance from neutral axis to the top of girder for the composite n/0.70 section (in)

$Y_{ts,3n}$ = distance from neutral axis to the top of slab for the composite 3n section (in)

$Y_{ts,n}$ = distance from neutral axis to the top of slab for the composite n section (in)

$Y_{ts,n7}$ = distance from neutral axis to the top of slab for the composite n/0.70 section (in)

$\Delta_{pedestrian}$ = total deflection due to pedestrian live load acting on all beams in the structure cross section (in)

$\Delta_{vehicle}$ = total deflection due to one lane of vehicular live load (in)

$\gamma_{fatigue}$ = load factor for fatigue live load

γ_i = load factor

η = load modifier

ϕ_f = resistance factor for flexure

ϕ_v = resistance factor for shear

3.2 GEOMETRY

The span lengths, bridge cross section, and other structure dimensions are input by the user. These dimensions are used to calculate the loads, distribution factors, and the structural analysis solutions. Girder cross sections are defined by their locations and dimensions. Standard AISC rolled beam dimensions are stored in the program. The user enters the beginning and end of each segment of the girder over which the cross section is either constant or varying in a given manner (i.e., parabolic or straight variation in the web depth of a haunched girder). For the purposes of analysis, design, and rating at various points of interest, an analysis point is considered at each of the following locations:

1. Each support
2. One-twentieth points of each span length
3. In-span hinge locations
4. Cross section transition points
5. Each end of a slab pour for staged construction
6. Fatigue locations
7. Bracing points
8. Field splice centerline location
9. Field splice edge locations
10. Locations of concentrated loads
11. User-defined analysis points

At cross section transition points and bracing locations, analysis points are defined immediately to the left and right in order to capture effects to the left and right of the location. For example, at a bracing location, the unbraced length and moment variation may be different on each side of an analysis point, leading to a different capacity based on the side looked at. Placing analysis points on both sides ensures that both capacities will be calculated and checked.

3.3 SECTION PROPERTIES

The program uses the routines of PennDOT's Beam Section Properties (BSP) program to compute the section properties. BSP provides the basic section properties required to analyze steel girder sections used in highway bridges. These properties include: elastic section properties, such as the moments of inertia, locations of neutral axis, section moduli, and radii of gyration; plastic section properties, such as the location of the plastic neutral axis, plastic moment capacity, and the depth of web in compression at the plastic moment; and other properties required for the LRFD Specifications checking. Elastic section properties are calculated for four values of the modular ratio (0, n, 3n, and n/0.70), for both positive and negative flexure.

The user can enter section losses using the SLS command and section holes using the SLS, SHO or FSL commands. The program will calculate gross section properties (no loss or holes taken into account), net section properties (which take only the section losses into account), and the net area of each flange for net section fracture calculations (which take both the holes and section loss into account).

The gross section properties are used for the calculations of the self-weight and the stiffness of the girder.

The net section properties are used for all specification checks and ratings except the net section fracture checks. Section holes entered using the SHO or FSL command are not considered when computing the net section properties. If a section hole is entered instead as a section loss that is the entire thickness of a plate (via the SLS command), the hole will be considered for the net section properties and will impact the specification checks and ratings.

The net area values are only used for the net section fracture specification check for analysis or design runs that include holes in the tension flange. The net area values are not available in the section properties output reports.

The program always computes the stiffness for the analysis based on the gross section dimensions. Section losses are not considered to affect the stiffness. The user must input the gross section with reduced dimensions if the user wants to reduce the stiffness resulting from section losses. The stiffness of the steel-only section is used for the dead load analysis of the self-weight of the steel girder, the concrete deck, the concrete haunch, the user-input DC1 and DC1S dead loads, and the user-input UT1 and MC1 dead loads. If the section is specified as being composite, the concrete deck is assumed to be fully effective for the entire length of the structure and the composite stiffness is used for the entire length of the structure. The short-term composite moment of inertia (n section) is used for the live load analysis, and the long-term composite moment of inertia (3n section) is used for the long-term (composite) dead load analysis. The long-term dead loads are the DC2, FWS, UT2, and MC2 loads input by the user. The stiffness is based on the positive, composite moment of inertia for both the long-term (composite) dead load analysis and the live load analysis.

For structural analysis, the program uses ranges with end points defined by each computer-generated and user-defined analysis point. The stiffness for each of these ranges is equal to the gross moments of inertia at the midpoint of the range. For sections of varying web depth, the average of the web depths at either end of the range is computed and used to compute the gross moments of inertia of the range.

The section properties used for the stiffness in the structural analysis for each load type are shown in Table 1. For construction staging, the section properties change for each pour of the sequence of pours. The construction staging is described in further detail in Section 3.4.3.

Table 3.3-1 Section Properties for Analysis

Abbreviation	Load Type	Section Properties used for	
		Composite girders[1]	Noncomposite girders[2]
DC1	Permanent load that is applied to the noncomposite section. This includes loads that are not a physical part of the girder (i.e. stay-in-place forms or haunch load corrections)	Noncomposite	Noncomposite
DC1S	Permanent load applied to the noncomposite section that is part of the girder, but is not calculated by the program (i.e. stiffeners, diaphragms or splice plates)	Noncomposite	Noncomposite
DC2	Permanent load applied after slab placement	Composite (3n)	Noncomposite
MC1	Miscellaneous permanent dead loads applied to the noncomposite section	Noncomposite	Noncomposite
UT1	Utility loads applied to the noncomposite section	Noncomposite	Noncomposite
FWS	Future wearing surface load applied after slab placement	Composite (3n)	Noncomposite
MC2	Miscellaneous permanent dead loads applied after slab placement	Composite (3n)	Noncomposite
UT2	Utility loads applied after slab placement	Composite (3n)	Noncomposite
LL	Live load of LRFD load, fatigue truck, permit truck, maximum legal loading, HS20, and H20	Composite (n)	Noncomposite
PL	Pedestrian live load	Composite (n)	Noncomposite
SLL	Special live load	Composite (n)	Noncomposite

Notes:

1 Girders that are composite in the final state

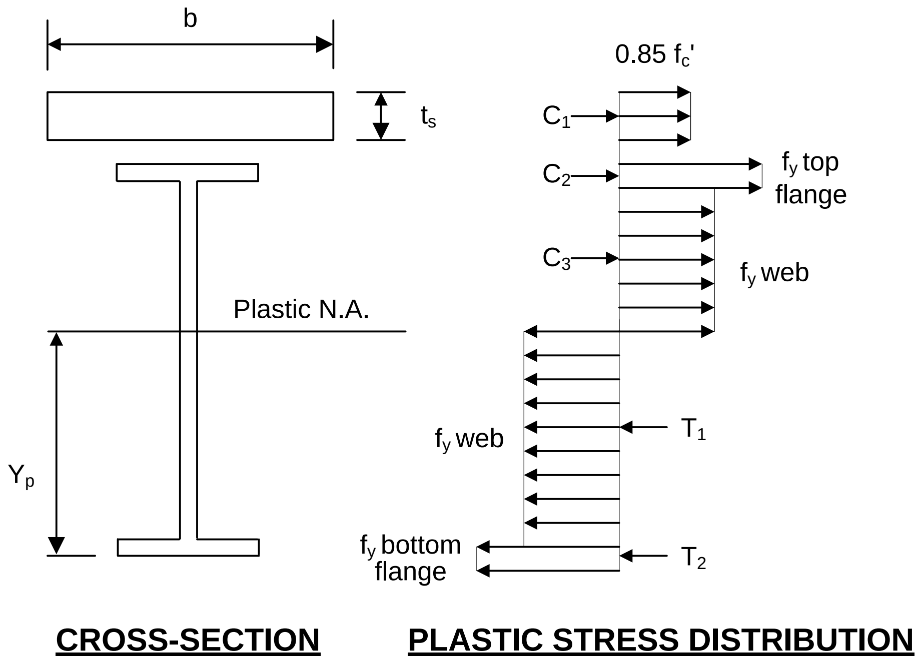
2 Girders that are noncomposite in the final state

For specification checking of composite girders, the program computes the steel-only, composite n, and composite 3n section properties for the positive flexural checks. For negative flexure, the user can input the area of longitudinal reinforcement in the deck to be used for the composite section properties. If section losses are entered, the specification module uses the section properties with losses for both the positive and negative flexural checks. The program assumes the section losses do not significantly affect the stiffness used for the analysis and does not consider section losses in performing the analysis.

The steel-only section is used for checking specifications due to noncomposite loads and for girders that are noncomposite in the final state. It is assumed that the concrete slab cannot carry any tensile stresses.

At plate transition points, field splice centerline and contraflexure points, the program computes the section properties to the right and left of the analysis point and does specification checking of each side of the analysis point; that is, specification checks are done immediately to the left and immediately to the right of each transition point, and both results are reported in the program output. In a varying depth range, the section properties on each side of the analysis point would use the same web depth, but different flange plates if they happen to change at the analysis point. The section properties listed in the STLRFD output are the section properties at each analysis point used for specification checking.

In calculating the plastic moment capacity of the steel section, the location of the plastic neutral axis is calculated by an iterative process rather than by using the formulae given in the LRFD Specifications. The iterative process is a more generalized method suitable for a symmetrical, unsymmetrical, homogeneous, or hybrid section. In this method, the location of the plastic neutral axis is first assumed to be at the mid-height of the steel section. Assuming all elements are stressed to their yield strength, forces of all elements are calculated. If there is a net axial force acting on the section, a new position of the neutral axis is assumed and the above steps are repeated until there is no net axial force acting on the section. The plastic moment capacity is then calculated by taking the first moment of all the forces about the plastic neutral axis, assuming all forces and moment arms as positive quantities, as shown in Figure 3.3-1. In calculating the plastic moment capacity of the steel section for positive moment, the forces in the longitudinal reinforcement are conservatively neglected.



C_1 = 0.85 f_c' b t_s

C_2 = (Area of top flange) (f_y top flange)

C_3= (Area of web above n.a.) (f_y web)

T_1= (Area of web below n.a.) (f_y web)

T_2= (Area of bot. flange) (f_y bot. flange)

Y_p= distance of plastic n.a. from bottom

Y_{c1}= distance of C_1 from plastic n.a.

Y_{c2}= distance of C_2 from plastic n.a.

Y_{c3}= distance of C_3 from plastic n.a.

Y_{t1}= distance of T_1 from plastic n.a.

Y_{t2}= distance of T_2 from plastic n.a.

Plastic Moment = $M_p = C_1 Y_{c1} + C_2 Y_{c2} + C_3 Y_{c3} + T_1 Y_{t1} + T_2 Y_{t2}$

Figure 3.3-1 Plastic Moment of Section

The formulae used to calculate the elastic section properties can be found in any standard textbook on structural engineering. Specific formulae used by this program are given in the following sections.

The area used in shear computations is the web area. For a plate girder or a built-up section, the web area is defined as the area of the web plate. For a rolled beam, the web area is defined as the web thickness multiplied by the web depth, where the web depth is the total beam depth minus two times the flange thickness.

The program computes and uses several section properties that are used in the LRFD Specifications and that may be new to the practicing bridge engineer. A list of some of these new section properties is presented in Table 2. Table 2 also includes the LRFD Specifications article in which the equation is presented and pertinent additional information about the section property.

Table 3.3-2 New Section Properties Used in the LRFD Specifications

Section Property Name	Section Property Notation	Reference in LRFD Specifications	Additional Information
Longitudinal stiffness parameter	K_g	Article 4.6.2.2.1	For noncomposite beams K_g is computed in the same way K_g is computed for composite beams
Effective radius of gyration for lateral torsional buckling	r_t	Article 6.10.8.2.3	Includes the effects of section loss
Hybrid factor	R_h	Article 6.10.1.10.1 Article 6.10.3.2.1	For homogeneous sections, $R_h = 1.0$ If $F_{y,web} > F_{yc}$ and $F_{y,web} > F_{yt}$, $R_h = 1.0$ If $f_c < F_{y,web}$ and $f_t < F_{y,web}$, $R_h = 1.0$
Load shedding factor	R_b	Article 6.10.1.10.2	For beams satisfying 6.10.1.10.2-1 or 6.10.1.10.2-2, or for constructability checks, $R_b = 1.0$

3.3.1 Effective Slab Width

The program computes the effective slab width in accordance with the LRFD Specifications Section 4.6.2.6. For interior beams, the effective slab width is computed as follows:

$$b_{eff,int} = S_{int}$$

For exterior beams, the effective slab width is as follows:

$$b_{eff,ext} = 0.5 * S_{int} + S_{ext}$$

3.3.2 Modular Ratio

The program computes the concrete elastic modulus, E_C, based on the concrete density for E_C (w_C) and the concrete strength input by the user (f'_C). The modular ratio, n, is then calculated as the ratio of the steel elastic modulus, E_S, to E_C.

The program input system limits the user input f'_C to be greater than or equal to 2.4 ksi and less than or equal to 15 ksi for normal weight concrete and 10 ksi for lightweight concrete. The program assumes that concrete is normal weight when it has a w_C greater than or equal to 0.135 kcf. Lightweight concrete has a w_C less than 0.135 kcf.

Several steps are followed for the determination of the concrete elastic modulus (E_c) and the modular ratio (n) used by the program. In all of these steps, E_S is assumed to be equal to 29,000 ksi.

1. DM-4 Sections 5.4.2.1 and 5.4.2.4 specify values for n and E_C based on specific f'_c and w_C values. The concrete densities are specified as either normal weight, with a density of 0.145 kcf, or lightweight, with a density of 0.110 kcf. If the user enters a w_C value of exactly 0.145 kcf or 0.110 kcf, along with an f'_C value of exactly 4.0, 3.5, 3.0, or 2.0 ksi, the E_C and n values will be set to the values shown in DM-4 Sections 5.4.2.1 and 5.4.2.4.

2. If the user enters a w_C value of exactly 0.145 kcf or 0.110 kcf, along with an f'_C value between 4.0 ksi and 2.0 ksi (and not 4.0, 3.5, 3.0, or 2.0 ksi), the E_C and n values will be interpolated between the values shown in DM-4 Sections 5.4.2.1 and 5.4.2.4. The E_C value will be rounded to the nearest 100 ksi, and n will be rounded to the nearest integer value.

3. If the user enters a w_C value of exactly 0.145 kcf, along with an f'_C value greater than 4.0 ksi and less than or equal to 10.0 ksi, the E_C value will be calculated with LRFD Specifications Equation C5.4.2.4-2:

$$E_c = 33{,}000 w_c^{1.5} \sqrt{f_c'}$$

where: E_C = Concrete elastic modulus
w_C = Concrete density for Ec
f'_C = Compressive strength of concrete

The E_C value will be rounded to the nearest 100 ksi. The rounded E_C value is then used to calculate n, which will be rounded to the nearest integer value.

4. If the user enters a w_C value of exactly 0.145 kcf, along with an f'_C value greater than 10.0 ksi, the E_C value will be calculated with LRFD Specifications Equation 5.4.2.4-1:

$$E_c = 120{,}000 K_1 w_c^{2.0} (f_c')^{0.33}$$

where:
- E_C = Concrete elastic modulus
- K_1 = Correction factor for source of aggregate. STLRFD uses a value of 1.0
- w_C = Concrete density for E_C
- f'_C = Compressive strength of concrete

The E_C value will be rounded to the nearest 100 ksi. The rounded E_C value is then used to calculate n, which will be rounded to the nearest integer value.

5. If the user enters a w_C value of exactly 0.110 kcf, along with an f'_C value greater than 4.0 ksi, the E_C value will be calculated with LRFD Specifications Equation 5.4.2.4-1, shown in step 4.

6. If the user enters a w_C value other than 0.110 kcf or 0.145 kcf, along with any f'_C value, the E_C value will be calculated with LRFD Specifications Equation 5.4.2.4-1 shown in step 4.

The user has the option to enter the elastic modulus for steel, E_S. If the user enters a value other than 29,000 ksi, the program will calculate a modular ratio using the user-input E_S and the E_C found in steps 1-5. The modular ratio is then rounded to the nearest integer.

During an erection analysis, the program divides the modular ratio by a factor of 0.70 for the portion of the deck which has hardened.

3.3.3 b/t Ratio With or Without Section Loss

For checking the b/t ratio in accordance with the LRFD Specifications, the program uses the width and thickness for the gross section for sections with no section loss. For sections with section loss, the program computes a weighted average width, b, and an effective thickness, t. Section holes entered using the SHO or FSL commands are not considered when computing the net section properties of the section and therefore do not impact the b/t ratios along the girder. If a section hole is instead entered as a section loss that is the entire thickness of a plate (via the SLS command), the hole will be considered for the net section properties of the section and will impact the appropriate b/t ratio.

Below are the equations used for computing the width to thickness ratio, b/t.

Notations:

b	=	effective width for b/t ratio
b_f	=	width of the flange
b_{f2}	=	b_f / 2
b_L	=	modified width of the plate or flange minus any end section loss based upon the left side
b_{Li}	=	width of the i'th section loss that affects the left side
b_{pl}	=	width of the plate
b_{pl2}	=	b_{pl} / 2
b_R	=	modified width of the plate or flange minus any end section loss based upon the right side
b_{Ri}	=	width of the i'th section loss that affects the right side
$NPTL_L$	=	number of partial thickness losses affecting the left side
$NPTL_R$	=	number of partial thickness losses affecting the right side
$NTTL_L$	=	number of through thickness losses affecting the left side
$NTTL_R$	=	number of through thickness losses affecting the right side
t	=	effective thickness for b/t ratio
t_f	=	thickness of the flange
t_L	=	weighted average thickness of the plate or flange based upon the left side
t_{Li}	=	thickness of the i'th section loss affecting the left side
t_{pl}	=	thickness of the plate
t_R	=	weighted average thickness of the plate or flange based upon the right side
t_{Ri}	=	thickness of the i'th section loss affecting the right side

For Plate Girders:

A cross-sectional view of the top portion of a plate girder is presented in Figure 3.3-2. This cross section shows the notations used for plate girders without section losses and for plate girders with section losses.

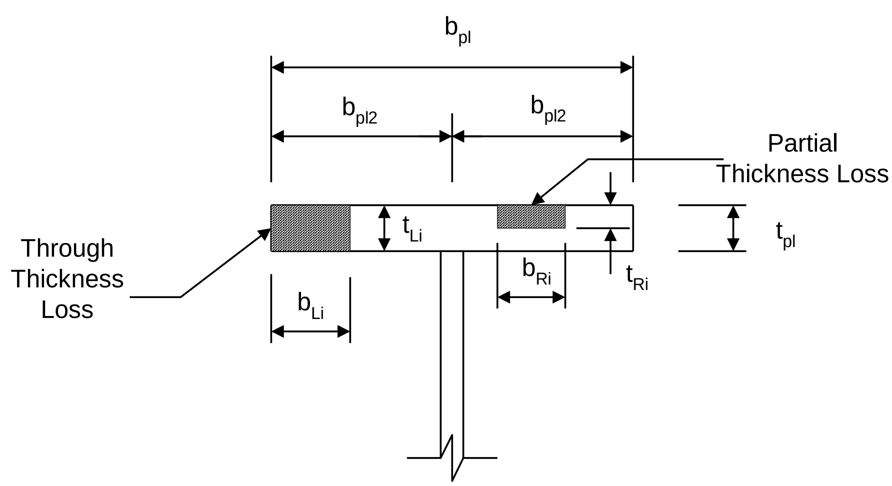


Figure 3.3-2 Cross-Sectional View of Plate Girder with Section Losses

Without Section Losses:

The program uses the width of the plate and the thickness of the plate as shown in the following equations:

$$b = b_{pl}$$
$$t = t_{pl}$$

With Section Losses:

The program uses a modified width of the plate and a weighted average thickness for each range. The modified width is the width of the plate minus any through thickness losses that occur at the end of the plate. However, the width is not reduced when the through thickness loss does not appear at the end of the plate, such as a cutout in the plate. The weighted average thickness is the area of the plate minus the area of the through thickness losses minus the area of any partial thickness losses, divided by the modified width. The width and thickness are calculated based upon the characteristics on the left and right sides of the plate. A b/t ratio is determined for each side, and the program then uses the larger of the left or right side b/t ratio.

$$b_L = 2\left(b_{pl2} - \sum_{i=1}^{NTTL_L} b_{Li} \right)$$

$$t_L = 2\,\frac{\left[b_{pl2}\, t_{pl} - \sum_{i=1}^{NTTL_L} b_{Li}\, t_{Li} - \sum_{i=1}^{NPTL_L} b_{Li}\, t_{Li} \right]}{b_L}$$

$$b_R = 2\left(b_{pl2} - \sum_{i=1}^{NTTL_R} b_{Ri} \right)$$

$$t_R = 2\,\frac{\left[b_{pl2}\, t_{pl} - \sum_{i=1}^{NTTL_R} b_{Ri}\, t_{Ri} - \sum_{i=1}^{NPTL_R} b_{Ri}\, t_{Ri} \right]}{b_R}$$

$$if\ \frac{b_L}{t_L} \le \frac{b_R}{t_R},\ then\ b = b_R,\ t = t_R$$

$$if\ \frac{b_L}{t_L} > \frac{b_R}{t_R},\ then\ b = b_L,\ t = t_L$$

For Rolled Beams:

A cross-sectional view of the top portion of a rolled beam with a cover plate is presented in Figure 3.3-4. This cross section shows the notations used for rolled beams without section losses and for rolled beams with section losses.

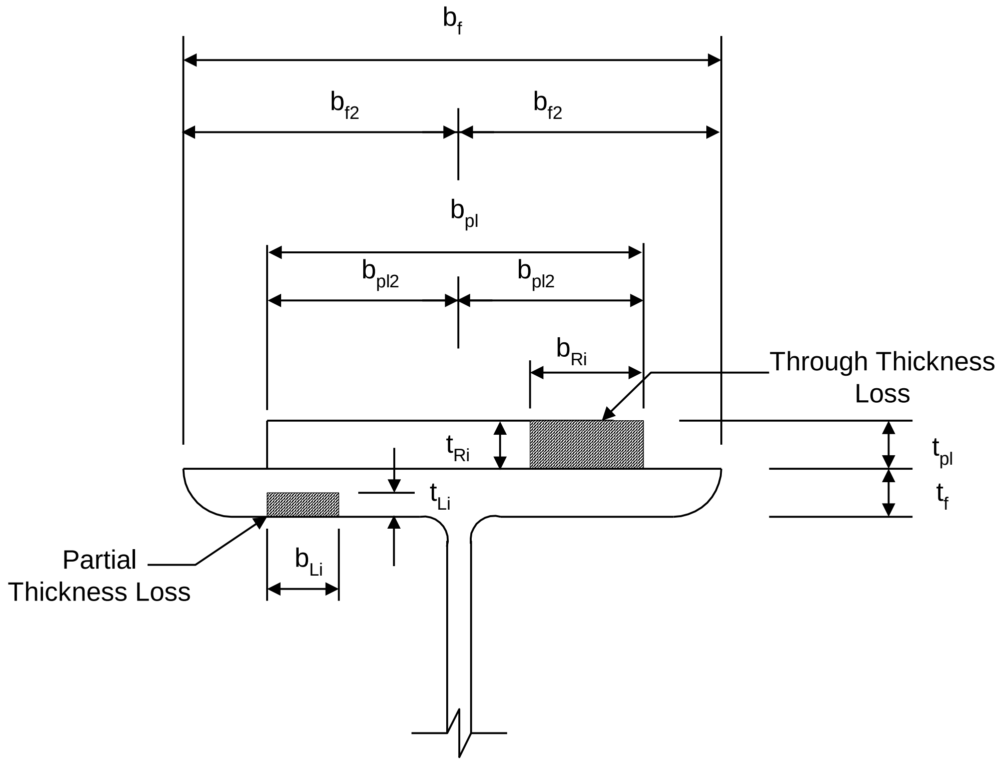


Figure 3.3-3 Cross-Sectional View of Rolled Beam with Section Losses

Without Section Losses:

The program computes the effective width as the maximum of the width of the cover plate or the width of the flange, and it computes a weighted average thickness using the flange and cover plate thicknesses, based on the following equations:

$$b = Maximum(b_f, b_{pl})$$

$$t = \frac{(b_f t_f + b_{pl} t_{pl})}{b}$$

With Section Losses:

The program uses a modified width of the cover plate or flange and a weighted average thickness for each range. The modified width is the larger of the width of the cover plate minus any through thickness losses that occur at the end of the cover plate or the width of the flange minus any through thickness losses that occur at the end of the flange. However, the width is not reduced when the through thickness loss does not appear at the end of the cover plate or flange, such as a cutout in the cover plate or a cutout in the flange. The weighted average thickness is the area of the cover plate plus the area of the flange minus any through or partial loss area of the cover plate minus any through or partial loss area of the flange, divided by the modified width. The width and thickness are calculated based upon the characteristics of the left and right sides. A b/t ratio is determined for each side, and the program then uses the larger of the left or right side b/t ratio.

$$b_L = Maximum\left[2\left(b_{f2} - \sum_{i=1}^{NTTL_L} b_{Li}\right), 2\left(b_{pl2} - \sum_{i=1}^{NTTL_L} b_{Li}\right)\right]$$

$$t_L = 2\,\frac{\left[b_{f2}\,t_f + b_{pl2}\,t_{pl} - \sum_{i=1}^{NTTL_L} b_{Li}\,t_{Li} - \sum_{i=1}^{NPTL_L} b_{Li}\,t_{Li}\right]}{b_L}$$

$$b_R = Maximum\left[2\left(b_{f2} - \sum_{i=1}^{NTTL_R} b_{Ri}\right), 2\left(b_{pl2} - \sum_{i=1}^{NTTL_R} b_{Ri}\right)\right]$$

$$t_R = 2\,\frac{\left[b_{f2}\,t_f + b_{pl2}\,t_{pl} - \sum_{i=1}^{NTTL_R} b_{Ri}\,t_{Ri} - \sum_{i=1}^{NPTL_R} b_{Ri}\,t_{Ri}\right]}{b_R}$$

$$if\ \frac{b_L}{t_L} \le \frac{b_R}{t_R},\ then\ b = b_R,\ t = t_R$$

$$if\ \frac{b_L}{t_L} > \frac{b_R}{t_R},\ then\ b = b_L,\ t = t_L$$

3.3.4 b/t and D/t Ratios for Built-Up Sections

For built-up sections, the program assumes **the edge distance (measured from centerline of hole) is equal to** 1.5 inches as presented in LRFD Specifications Article 6.13.2.6.6. It then checks **the web and**

flange proportions using LRFD Eqs. 6.10.2.1.1-1 and 6.10.2.2-1 respectively based on effective flange widths and an effective web depth**. T**he effective flange width is **computed based on Case 1, Case 2, and Case 3 below**.

For built-up sections, three **Cases are considered** for setting the flange width and thickness to check the b/t ratio. For each case two b/t ratios are **checked,** and the b and t associated with the greater ratio are used when checking the b/t ratio in the **proportions** checking routines.

Case 1: Flange plate wider than angles

In this case, the flange widths are set as the length from the vertical face of the angle to edge of the flange plate and the length from the line of bolts to the edge of the flange plate. The corresponding thicknesses are the total thickness of flange plate + angle and the thickness of the flange plate alone.

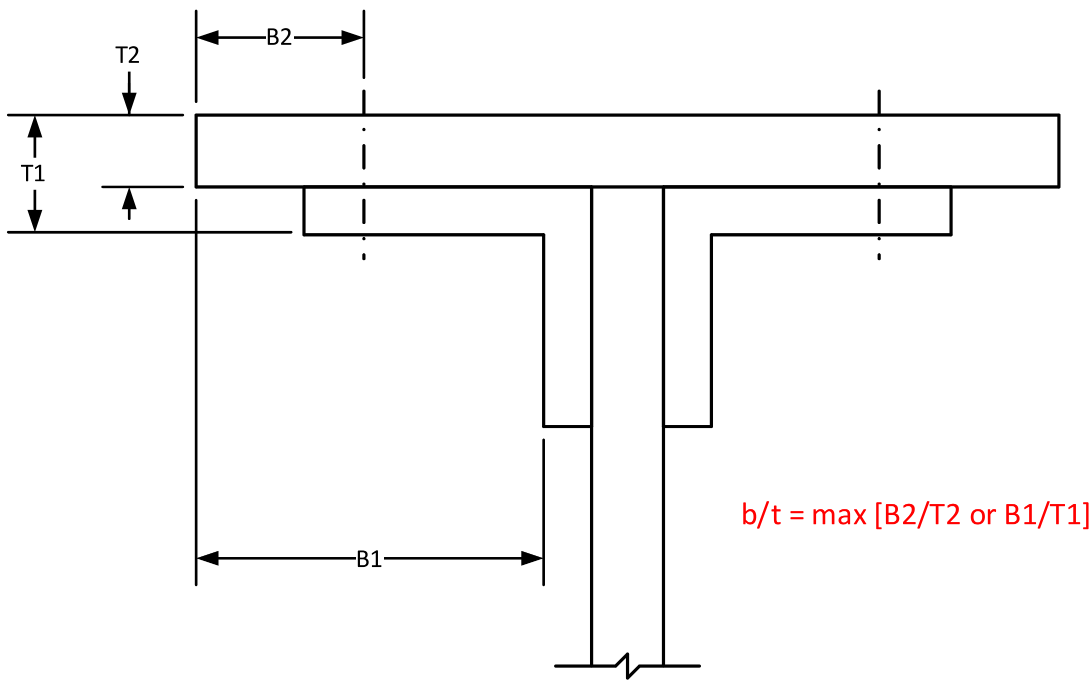


Figure 3.3-4 Flange Plate Wider Than Angles

Case 2: Flange plate narrower than angles

In this case, the distance from the face of the angle to the outer edge of the angle and the distance from the line of bolts to the outer edge of the angle are used for the widths. The corresponding thicknesses are the total thickness of the plate + the angle and just the angle thickness.

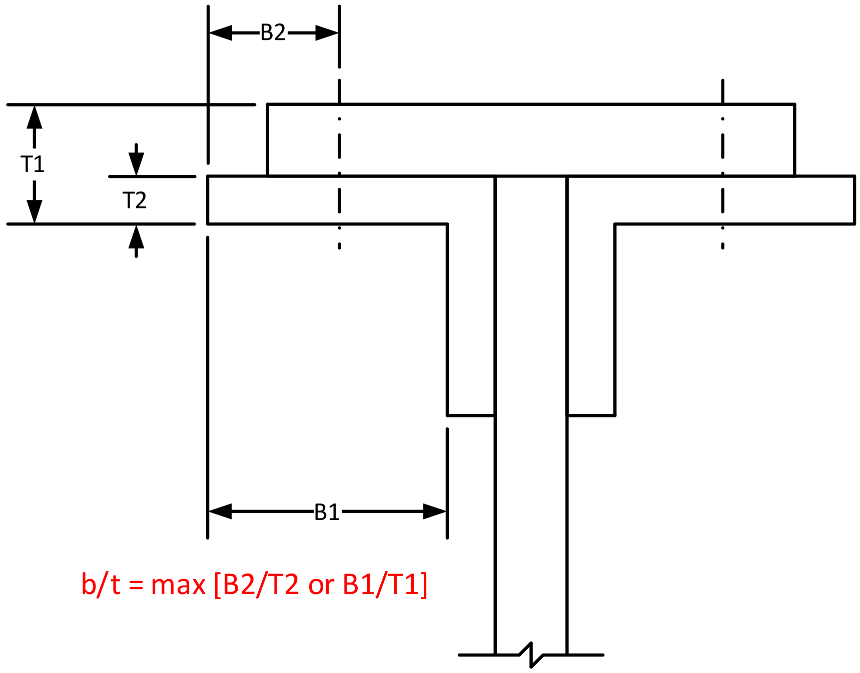


Figure 3.3-5 Flange Plate Narrower Than Angles

Case 3: No flange plate present

In this situation, set the width equal to the distance from the vertical face of the angle to the outside edge of the angle and the thickness to the thickness of the angle. In this case, there will only be one possible b/t ratio.

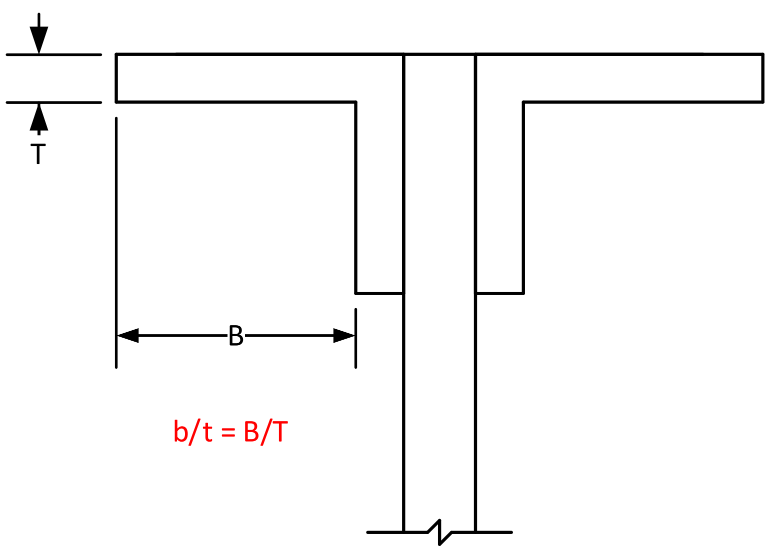


Figure 3.3-6 No Flange Plate Present

The program computes the depth of the web in compression assuming that the entire web is effective, **as computed in Section 3.3.3 above**. It then computes the effective web depth**, for checking proportions,** as follows:

$$Effective\ web\ depth = Total\ web\ depth - 2\,(Angle\ vertical\ leg - 1.5\ inches)$$

The above equations are simple approximations to account for end restraints and to provide effective dimensions for the **proportions** equations. **1.5 inches is the assumed edge distance for a 1-1/8" diameter connector from LRFD Specifications Table 6.13.2.6.6-1.**

If section loss is present on a built-up section, the program computes the b/t and D/t ratios using the effective flange widths and effective web depth, as previously described, and using the assumptions and principles for weighted section properties with section loss presented in Section 3.3.**3** for plate girders.

The equivalent flange width and **equivalent** thickness **are used for all other** specification checking apart from the **flange proportions** b/t checks. The total area of the flange plate and horizontal legs of the angles is calculated. **The equivalent flange width (A) is set as the larger of the top plate width or twice the horizontal leg length (D). The equivalent thickness is equal to the total area divided by the equivalent flange width.**

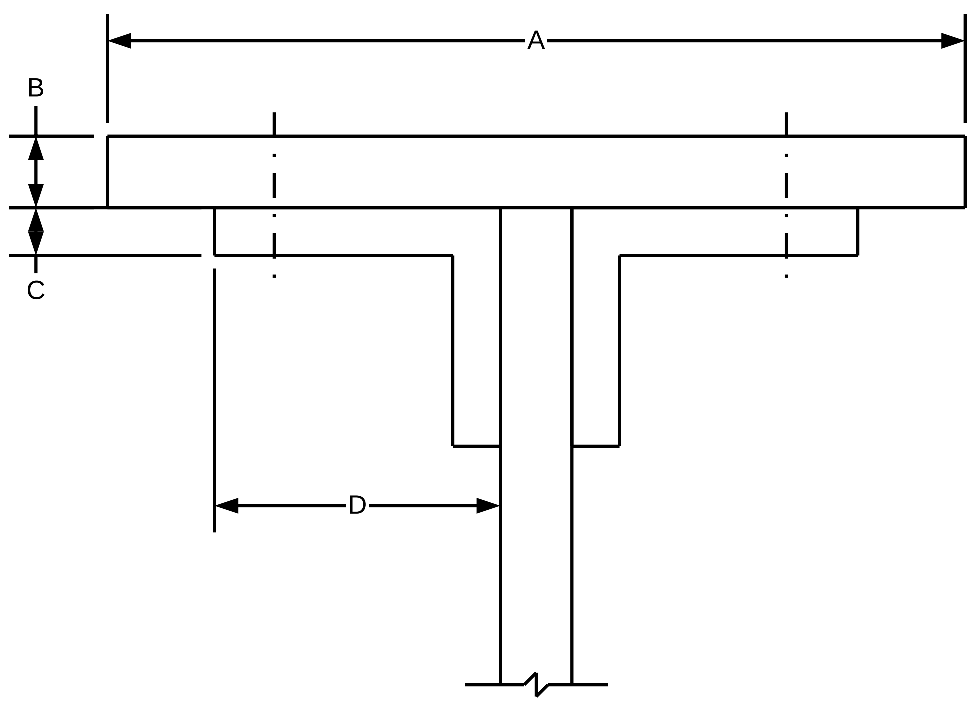


Figure 3.3-7 Dimensions **for** Equivalent Width and Thickness Calculations

$$TotalArea = A * B + 2 * D * C$$

$$EquivalentWidth = max \left| \begin{matrix} A \\ 2 * D \end{matrix} \right.$$

$$EquivalentThickness = \frac{TotalArea}{EquivalentWidth}$$

3.3.5 Web Section Loss

When section loss is present on the web, an equivalent thickness is also calculated. The area of the gross web is calculated, then the area of any section losses are deducted. This area is then divided by the full web depth to get the equivalent web thickness.

$$t_{w,eff} = \frac{Dt_w - \sum_{i=1}^{N} b_{loss,i} t_{loss,i}}{D}$$

where: $t_{w,eff}$ = effective web thickness

D = web depth

t_w = web thickness

N = number of losses on web

i = counter

$b_{loss,i}$ = width of loss i

$t_{loss,i}$ = thickness of loss i

This equivalent web thickness is then used by the specification checking routines for any calculations that involve web thickness, such as shear capacity calculations or web slenderness calculations. Note that the location of the section loss on the web is not taken into account when computing the equivalent thickness, meaning that section loss in the tensile region of the web will impact web slenderness checks.

3.4 STRUCTURAL ANALYSIS

The program uses PennDOT's Continuous Beam Analysis (CBA) program to compute the moment, shear, reaction, rotation, and deflection at each analysis point defined in Section 3.2. The program calculates these values for the following loads:

1. Self-weight of the steel girder.
2. User-input dead loads (DC1, DC2).
3. User-input miscellaneous dead loads (MC1, MC2).
4. User-input utility dead loads (UT1, UT2).
5. Noncomposite concrete deck dead load assuming the deck is poured instantaneously.
6. Each user-input deck pouring sequence.
7. User-input future wearing surface (FWS) dead loads.
8. Each live loading.

CBA analyzes the girder for a given loading condition and calculates the load effects at various analysis points. The stiffness properties used for each loading condition are described in the following sections, as well as in Section 3.3 and Table 3.3-1. CBA uses the Modified Flexibility Method for the solution of the unknown reactions for a given loading condition.

3.4.1 Modified Flexibility Method

CBA begins by dividing each span into twenty segments and setting up an analysis point at the end of each segment. If there is an in-span hinge between two analysis points, the program introduces this as an additional analysis point. The unknowns in the solution of a continuous beam are assumed to be the reactions at support points. The following conditions give a set of simultaneous equations for the solution of unknown reactions. The first condition is that the sum of reactions must be equal to the sum of applied loads. The second condition is that the sum of moments due to reactions must be equal to the sum of moments due to applied loads at the right most support. If there are in-span hinges, the next conditions are that the sum of moments due to unknown reactions at a given hinge point must be equal to the sum of moments due to applied loads at the same hinge point. The remaining conditions (if the beam is statically indeterminate) are that the deflection at each support due to applied loads is zero. The formulation of these equations and their solution by matrix algebra is the essence of the Modified Flexibility Method. The deflections and rotations are by-products of this process.

A typical loading condition is a unit load applied at an analysis point. The effects (such as reaction, rotation, deflection, etc.) are then calculated at all analysis points for this loading condition. Applying this unit load at each analysis point in succession and then calculating the effects at all analysis points produces the ordinates of an influence line for a given effect. CBA generates and stores the influence lines for support reactions, support rotations, and the deflections at analysis points. The influence lines for moments and shears at analysis points are generated from the reaction influence lines when needed for analysis of a given loading.

3.4.2 Dead Load Analysis

The dead load effect at a given analysis point is calculated by placing the loads on the appropriate influence line and then adding the effect of each load as follows. If the dead load is a series of concentrated loads, the effect is the algebraic sum of the product of the load value and the influence line ordinate value under each concentrated load. If the dead load is a uniform load, the effect is the product of the area of the influence line under the load and the intensity of the uniform load. If the dead load is trapezoidal, the effect is the summation of A_i times P_i over the length of the trapezoid, where A_i is the area of influence line between two consecutive load intensities, P_i is the average of two consecutive load intensities, and i is the segment number of the trapezoidal load. The trapezoidal load is divided into the segments that correspond to the influence line ordinates.

Permanent loads consist of the dead load of the structural components and nonstructural attachments (DC), and the dead load of the future wearing surfaces (FWS). The DC loads consist of the DC1 loads applied to the steel-only section and the DC2 loads applied to the long-term (3n) composite section. The FWS loads are also applied to the long-term (3n) composite section properties but have different load factors than the DC2 loads, as specified in the LRFD Specifications. For girders that are noncomposite in the final state, all permanent loads are applied to the steel-only section.

DC1 loads computed by the program include the self-weight of the steel girder, the concrete haunch, and the concrete deck. The user must input all other DC1 loads due to components such as stay-in-place forms, diaphragms, stiffeners, and splice plates. The program computes the uniform load due to the steel-only section based on the gross section properties (without section losses).

If the web depth varies, the program computes the beam self-weight at each computer-generated and user-defined analysis point (as specified in Section 3.2) based on the computed web depths at those points (refer to Section 6.23.10). For analysis, the program uses ranges with end points defined by each computer-generated and user-defined analysis point. The program sets the beam self-weight for each range equal to the average of the beam self-weights at each end of the range.

See Figure 3.4-1 for a typical deck cross section and haunch detail.

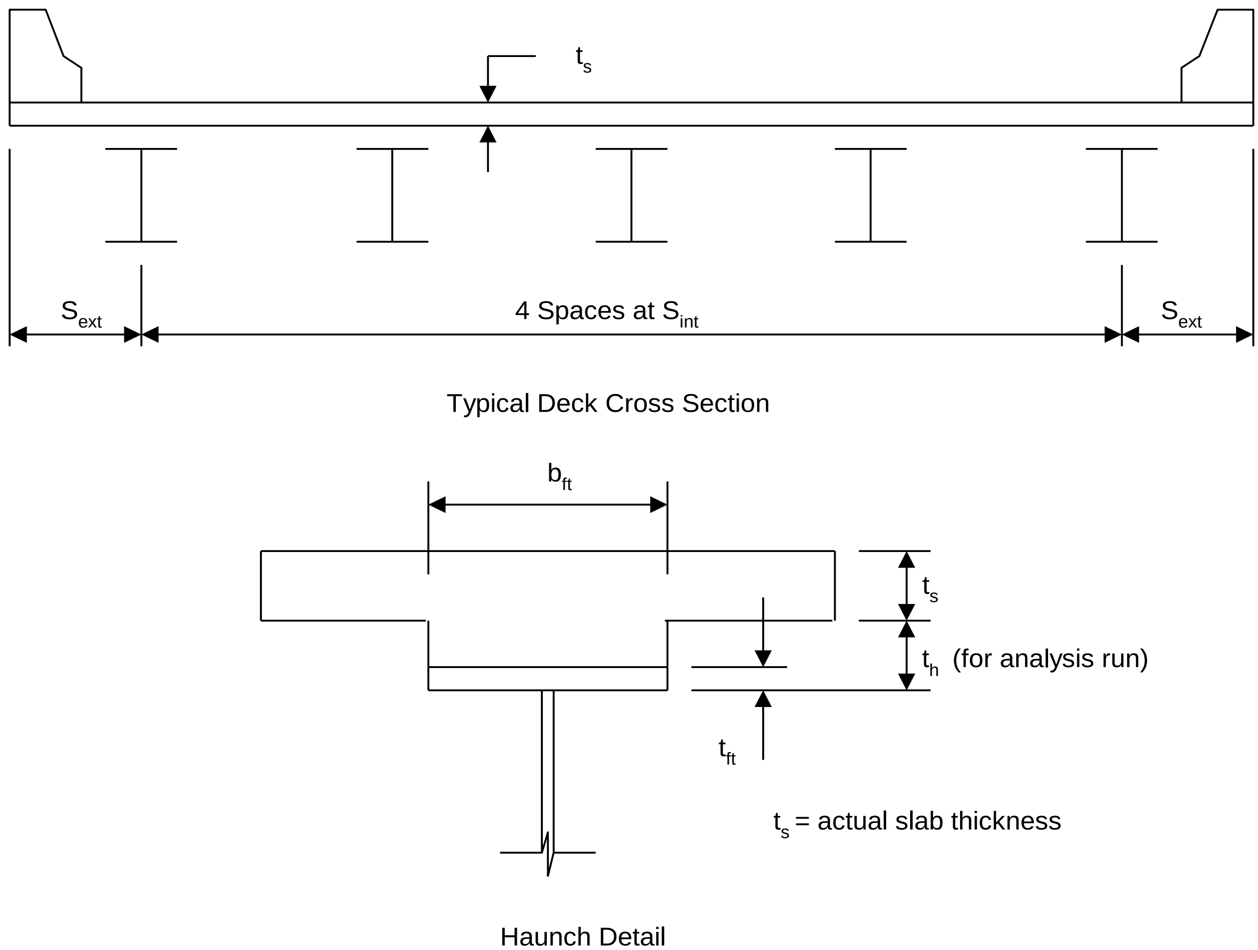


Figure 3.4-1 Typical Section and Haunch

For exterior girders, the DC1 load due to the concrete slab is:

$$DC1_{slab} = \left(s_{ext} + \frac{s_{int}}{2}\right)(t_s)(Concrete\ Density)$$

For interior girders, the DC1 load due to the concrete slab is:

$$DC1_{slab} = (s_{int})(t_s)(Concrete\ Density)$$

For an analysis run of either an interior or exterior girder, the DC1 load due to the haunch is:

$$DC1_{haunch} = \left(b_{ft}\right)(t_h)(Concrete\ Density)$$

For an analysis run, the area of the top flange and cover plate is conservatively included in the area used to calculate the load due to the haunch. Therefore, the area of the top flange and cover plate is conservatively included as both steel weight (self-weight of the girder) and concrete weight (weight of the haunch). However, the user can enter a negative dead load (DC1) to eliminate the load effect of this extra area of concrete, if desired.

For a description of the haunch for a design run, refer to Section 6.16.6.

The DC2 loads, such as parapets, are not computed by the program and must be input by the user. The DC2 input should include the loads that are distributed equally to all girders and applied to the 3n sections for composite girders. The DC1 and DC2 loads are multiplied by the same DC load factor. The FWS load consists of the future wearing surface which should be distributed equally to all girders and is applied to the 3n sections. This load must also be input by the user. The FWS loads are multiplied by the DW load factors, which are different than the DC load factors. The user input utility loads (UT1 and UT2) are also multiplied by the DW load factors. For girders that are noncomposite in the final state, the program applies DC2, FWS, and UT2 loads to the steel-only sections.

In addition to the DC1, DC1S, DC2, FWS, UT1, and UT2 loads, the user can also input two miscellaneous load types - MC1 and MC2. The miscellaneous noncomposite load (MC1) is applied to the steel-only section, and the miscellaneous permanent composite load (MC2) is applied to the composite 3n section or steel-only section for noncomposite girders. For the miscellaneous load types (MC1 and MC2), the user must input the load factors which are to be used for each load combination and each miscellaneous load type.

The program computes a separate table of moment, shear, and deflection results and a separate table of reactions for each of the following load cases:

1. DC1 loads due to the self-weight of the girder
2. DC1 loads due to the concrete slab and haunch
3. DC1 loads input by the user
4. DC1S loads input by the user
5. Total DC1 loads
6. DC2 loads input by the user
7. FWS loads input by the user
8. UT1 loads input by the user
9. UT2 loads input by the user
10. MC1 loads input by the user
11. MC2 loads input by the user

3.4.3 Construction Stage (Deck Pour Sequence) Analysis

The program can perform a construction stage analysis and a specification check for each stage (deck pour) to determine an acceptable slab placement sequence. The user inputs the location of each deck pour by entering the pour number, distance to the beginning of the slab placement, and distance to the end of the slab placement. The user can also input concentrated or distributed, permanent and temporary loads. The user enters the deck pour number, type of load (permanent or temporary), distances along the span, and the magnitude of the loads.

Permanent loads are loads that are applied during the specified deck pour and remain for all subsequent deck pours. Temporary loads are loads that are applied during the specified deck pour and are immediately removed after the concrete has hardened. The program assumes the concrete from previously poured deck pours has hardened. The concrete modulus of elasticity, for previously defined deck pour ranges, is set equal to 70 percent of the concrete modulus of elasticity at 28 days. Therefore, the program divides the modular ratio by 0.70 to compute the composite section properties of the hardened concrete used for the construction stage analysis.

The primary differences between the slab construction stage analysis and an analysis assuming the deck is placed instantaneously (uncured slab analysis) on the entire structure are:

1. For the construction stage analysis, the stiffness of the girder changes for each deck pour, which results in certain locked-in construction stresses. The stiffness is revised for each deck pour based on the deck sections that have already hardened.

2. The program uses a different unbraced length for each deck pour. The unbraced length for the noncomposite section equals the smaller of the distance between points of bracing or from a bracing point to the hardened concrete. When all of the concrete has hardened, the unbraced length is set equal to zero.

3. No moving live loads are considered during the construction stage analysis.

An example of a construction stage sequence with four stages (three deck pours) is shown in Figure 3.4-2. The numbers shown in the figure indicate the location of Deck Pours 1, 2, and 3. The program runs the analysis, load combination, and specification checking for each stage as described below:

1. In Stage 0, all of the steel is erected but no concrete is poured. The stiffness is based on the noncomposite (steel only) section properties. The load is equal to the self-weight of the beam and any additional temporary or permanent dead loads input by the user. The unbraced length is equal to the distance between bracing points as input by the user.

2. In Stage 1, the first set of deck sections are poured in Spans 1 and 2. The stiffness is still based on the noncomposite section properties for the entire structure because the concrete has not yet hardened. The load applied to Stage 1 is due to the wet concrete in the region of Deck Pour 1 only. The unbraced length is the same as for Stage 0.

3. For Stage 2, the second set of deck sections are poured at the beginning of Span 1 and at the end of Span 2. The stiffness for ranges of previously poured deck sections (Deck Pour 1) is based on the composite (n/0.70) section properties. The stiffness of the noncomposite section is used for the remainder of the structure. The load applied in Stage 2 is due to the wet concrete in the region of Deck Pour 2 only. That is, the applied load is for the pour being applied and does not include the load from the previous pour. For the range of Deck Pour 1, the unbraced length is set to zero. For all other regions, the unbraced length is equal to the smaller of the distance between points of bracing or the distance to the hardened concrete from the previous pour (Deck Pour 1).

4. For Stage 3, the final slab section is poured over the interior support. The stiffness in the region of hardened concrete from Deck Pours 1 and 2 is based on the composite (n/0.70) section properties. The noncomposite section stiffness is used in the Deck Pour 3 range. For the range of hardened concrete (Deck Pour 1 range and Deck Pour 2 range), the unbraced length is set to zero. For the Deck Pour 3 range, the unbraced length is taken as the smaller of the distance between bracing points or the distance to the hardened concrete from the previous deck pours (Deck Pours 1 and 2). The load applied in Stage 3 is due to the wet concrete in the region of Deck Pour 3 only.

For all construction stages, the actual points of contraflexure are computed by the program based on the sum of the unfactored noncomposite dead load values of DC1, DC1S, MC1, UT1, steel girder, slab and haunch only, applied instantaneously.

For each stage, the analysis results (moments and shears) from previous stages are added to the results of the current stage. The program stores the analysis results from the noncomposite and composite loads separately for each analysis point so that the appropriate section properties can be used in computing the stresses.

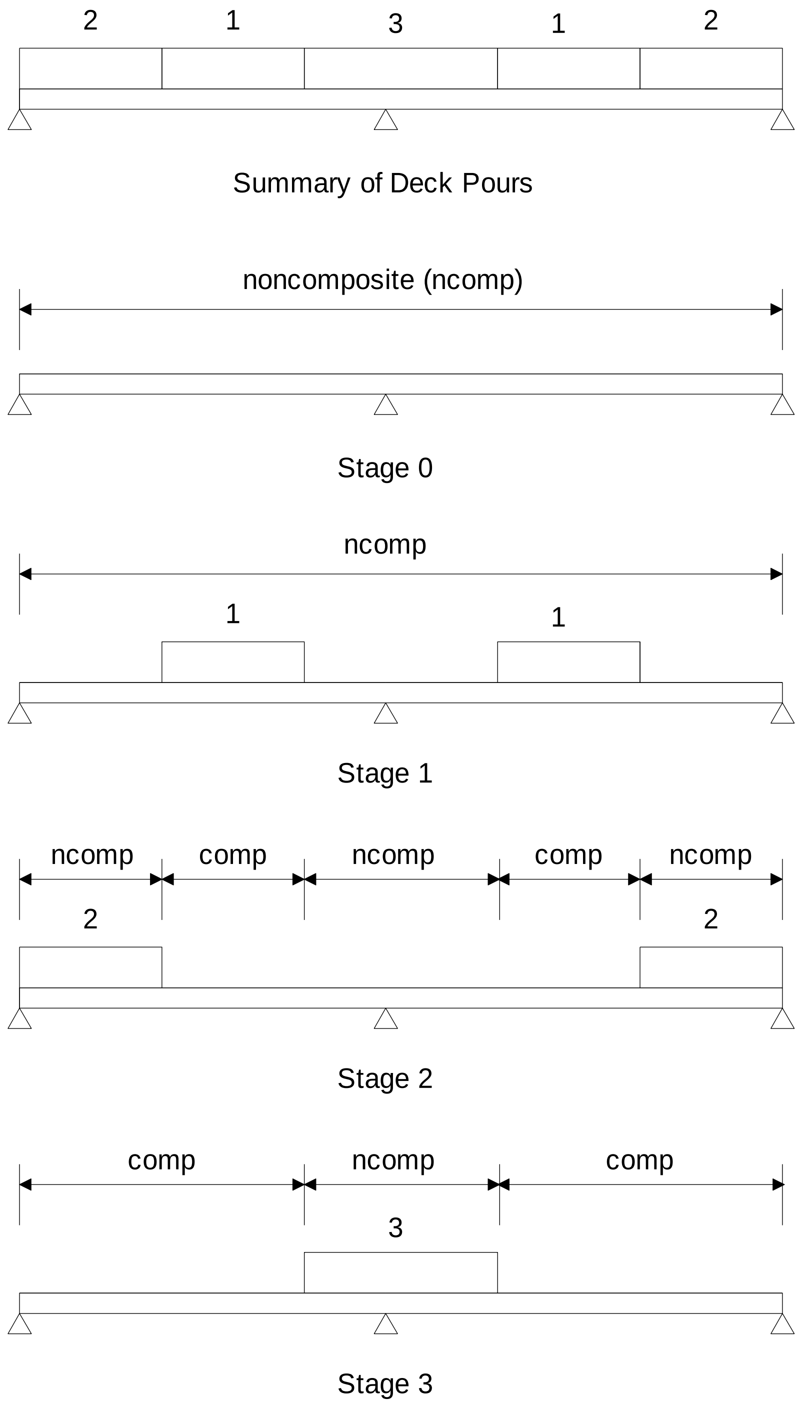


Figure 3.4-2 Construction Stages

The equation used to compute the stress in the top of the steel girder for the noncomposite regions (steel only) is:

$$f_{E,tg,nc} = \frac{\left(\sum_{i=1}^{N} M_{E,nc}(i) \right)}{S_{tg,nc}}$$

where: i = the deck pour number

N = the total number of deck pours up to and including the current deck pour

The noncomposite steel stresses become locked-in as soon as the wet concrete hardens. The stresses are locked-in for all analysis points in the region of the current deck pour. Once the concrete has hardened, the noncomposite stresses in the steel are locked-in. Loads applied after the concrete has hardened are applied to the composite section. The composite section properties for construction stages are computed based on a modular ratio equal to n/0.70. The program stores the locked-in stresses for each analysis point. The total stress at the top of the steel girder due to noncomposite and composite loads becomes:

$$f_{E,tg,tot} = \frac{\sum_{i=1}^{N} M_{E,c}(i)}{S_{tg,n7}} + f_{E,tg,nc}$$

where: i = the deck pour number

N = the total number of deck pours up to and including the current deck pour

The flexure for the noncomposite section may be different than the flexure for the composite section. This occurs when the sign of the moment applied to the noncomposite section is different than the sign of the moment applied to the composite section. This also occurs when the sign of the stress in the top flange due to the noncomposite dead loads is different than the sign of the stress in the top of the slab due to the composite dead loads. The program determines the type of flexure for the construction stage analysis using the same method as for positive and negative live load moments. Refer to Sections 2.7 (item 13) and 3.5 for a description of the method for determining the flexure type.

The program performs the specification checks using the controlling analysis values from either the construction stages (deck pour sequencing) or the instantaneous pour. The controlling value is defined as the combination of noncomposite effects with the largest magnitude. For example, in some cases, the combination of noncomposite dead loads and instantaneous slab moment will give a positive value of moment, while the combination of noncomposite dead loads and cumulative deck pour moment will be negative. The controlling value is the combination giving the largest magnitude, regardless of sign. The sign will be preserved, however, when combining the controlling value with other effects. The controlling analysis values are used for load combinations with live loads. It is possible that, for a given analysis point, the controlling moment may be based on the construction stages while the controlling shear may be based on the instantaneous pour, or vice versa. In this case, the controlling analysis values are used, even though one is based on the construction stages and another is based on the instantaneous pour.

In addition to the construction stage (deck pour sequencing) analysis, the user can also choose to have the program also perform a specification check based on an uncured slab analysis. For the uncured slab analysis, all of the steel is erected, all concrete is poured instantaneously on the entire structure, but no concrete is hardened to facilitate composite action. All noncomposite dead loads are used in the uncured slab specification check, but no composite dead loads or live loads are used in the uncured slab specification check. The unbraced lengths used for the uncured slab specification check are equal to the distance between bracing points. The program performs the following specification checks based on the uncured slab analysis: flexural capacity (in terms of stress), shear capacity, and dead load web stress limits. The program will also automatically perform an uncured slab specification check if a deck pour sequence has not been entered by the user.

3.4.4 HL-93 Loading and PHL-93 Loading

For this program, the vehicular live load consisting of the Design Truck, Design Tandem, and Design Lane Load, as defined in the LRFD Specifications, is referred to as the HL-93 loading. For the design of its bridges, PennDOT has modified the HL-93 loading, and it is referred to as the PHL-93 loading. Refer to Figures 2.5-1 and 2.5-2 for a summary of the live loads that are stored in the program. The PHL-93 loading is the same as the HL-93 loading except that the axle loads on the Design Tandem for the PHL-93 loading are multiplied by a factor of 1.25. In addition, for negative moment between points of dead load contraflexure, the factor for the effect of two design trucks combined with the design lane load is 100% for the PHL-93 loading and 90% for the HL-93 loading. The 1.25 factor is not applied to the design tandem pair for the PHL-93 loading. Refer to Table 1 for load combinations that are used to calculate various effects due to HL-93 and PHL-93 loadings. H20 and HS20 loadings are as defined in the current AASHTO Standard Specifications for Highway Bridges.

Table 3.4-1 Live Load Effects due to HL-93 and PHL-93 Loadings

Effects	Loading	Tandem + Lane	Truck + Lane	Tandem Pair + Lane	Truck Pair + Lane	Truck Alone	25% Truck + Lane
Mom +	HL-93	X	X			X	
	PHL-93	X[1]	X			X	
Mom -	HL-93			X	0.90X	X	
	PHL-93			X[1]	X	X	
End React +	HL-93	X	X			X	
	PHL-93	X[1]	X			X	
End React -	HL-93	X	X			X	
	PHL-93	X[1]	X			X	
Pier React +	HL-93			X	0.90X	X	
	PHL-93			X[1]	0.90X	X	
Pier React -	HL-93	X	X			X	
	PHL-93	X[1]	X			X	
Deflection	HL-93					X	X
	PHL-93					X	1.25X

[1] The axle loads for Design Tandem and Design Tandem Pair for PHL-93 loading are different as shown in Figure 2.5-1.

3.4.5 Truck Load Effect

The effect of a truck load is calculated by placing the load at various locations on the influence line. For this, the influence line is divided into regions of positive and negative ordinates. For each region, the location of the maximum (peak) ordinate is found. If the influence line has more than two regions, the locations of the two largest positive and the two largest negative (if they exist) peaks are stored. For each peak of the influence line, the first axle of the truck is placed over the peak and other axles that follow are placed in their respective positions. The effect of this load position is computed by multiplying the axle load with the influence line ordinate under the load.

For axle loads that fall between two known influence line ordinates, the influence line ordinate under the load is computed by straight line interpolation. The sum of the product of the axle load and influence line ordinate represents the effect of the load in that position. The effect is stored, and the load is moved such that now the second axle is placed over the peak. The effect of this load position is computed again, and it is compared with the previously stored effect. The greater of the two effects is stored again. This procedure is repeated until the last axle is placed over the peak. Next, the load is placed such that the center of gravity of the load is on the peak. This effect is calculated and saved if it is greater than the previously stored effect. The above procedure is repeated for each saved peak. The load is then reversed and the same procedure is repeated. When this process is completed, the absolute maximum positive and the absolute maximum negative truck load effects are obtained.

In calculating the effect of a Design Truck, Design Tandem, Fatigue Load, Design Truck Pair, or Design Tandem Pair for LRFD loadings, the axle loads which do not contribute to the effect being sought are neglected. That is, for a positive effect, the axles that fall on the negative region of the influence line are neglected, and for a negative effect, the axles that fall on the positive region of the influence line are neglected.

3.4.6 Variable Axle Spacing of Design Truck

The LRFD Specifications require that in calculating the effect of the design truck, the spacing between the two 32 kip axles (rear axles) may vary from 14 to 30 feet. A schematic drawing showing the variable axle spacing of the LRFD design truck is presented at the top of Figure 2.5-1.

To compute the effect of the design truck, the program starts with a design truck with 14 feet between the rear axles, and analyzes the influence line as explained in the section entitled “Truck Load Effect.” The effect of the design truck so defined is stored. Next, a new design truck is defined by adding 0.5 feet to the spacing between the rear axles. The effect of this new design truck is calculated again. The effect of the new design truck is compared with the previously stored effect, and the greater effect is stored. The above procedure is repeated until the spacing between the rear axles becomes 30 feet. The spacing between the rear axles is not varied if the lengths of the influence line regions adjacent to the region where the design truck is placed are greater than 30 feet.

3.4.7 Variable Spacing of Truck or Tandem Pair

The LRFD Specifications require that in calculating the negative moment at any section between the point of noncomposite dead load contraflexure and the interior support, and in calculating the reaction at the interior support, the spacing between the two trucks of the design truck pair may vary from 50 feet to any distance that will produce the maximum effect. For this, the program replaces the truck pair with a single truck of six axles. The first three and the last three axles of this single truck are the same as the axles of the design truck. Initially the distance between the third axle and the fourth axle is set equal to 50 feet. The influence line is analyzed for so defined single truck as explained in the section entitled “Truck Load Effect.” The effect of this load is stored. Next, the single truck is modified by increasing the distance between the third axle and the fourth axle by 0.5 feet, and its effect is calculated. The above procedure is repeated until the distance between the third axle and the fourth axle of the single truck becomes larger than the distance between two consecutive peak ordinates having the same sign. The spacing between the third axle and the fourth axle is not varied if the distance between two consecutive peak ordinates having the same sign is less than 50 feet (15 m) or if the effect being sought is a reaction at the interior support. The design tandem pair is analyzed in the same manner as the design truck pair. The single truck defined to represent a design tandem pair has four axles and the distance between the second and the third axle is varied from 26 to 40 feet.

3.4.8 Lane Load Effect

The effect of a lane load is calculated by loading the appropriate regions of the influence line with the uniform lane load. If the positive lane load effect is being sought, the sum of the positive areas of the influence line is multiplied by the value of the uniform lane load, and the result is stored as the positive lane load effect. The negative lane load effect is calculated similarly using the negative areas of the influence line. In calculating the lane load effect, the load is placed only over the positive or negative areas of the influence line.

3.4.9 Positive Moments, Shears, and End Reactions Due to HL-93 or PHL-93 Loading

In calculating the positive moment, the positive area of the influence line is multiplied by the design lane load and it is stored as the design lane load effect. Next the maximum positive effect of the design truck is calculated by moving the load across the influence line as explained in the section entitled "Truck Load Effect." The design truck effect is multiplied by the impact factor, then added to the design lane load effect and is stored as the combined design truck and lane load effect. Next the same procedure is repeated for the design tandem and the design lane load. The larger of these two effects is stored as the positive moment. The positive and negative shears at a section, the negative reaction at an interior support, the positive and negative reaction at an exterior support are calculated in the same manner as the positive moment except, in calculating the negative shear and reaction due to the design lane load, the negative area of the influence line is used.

3.4.10 Negative Moments and Pier Reactions Due to HL-93 or PHL-93 Loading

In calculating the negative moment at any section between the point of noncomposite dead load contraflexure and the interior support, and in calculating the positive reaction at the pier, the influence line is analyzed for the following conditions:

Effect 1: One design tandem plus design lane load
Effect 2: One design truck plus design lane load
Effect 3: Design tandem pair plus design lane load
Effect 4: Design truck pair plus design lane load

Schematic drawings of the design tandem and the design truck are presented in Figure 2.5-1. The design lane load consists of a uniformly distributed load (0.64 KLF) in the longitudinal direction and 10 feet in the transverse direction. The LRFD live loadings are also described in the LRFD Specifications and in DM-4.

Effects 1 and 2 are calculated in the same manner explained in the section entitled “Positive Moments, Shears, and End Reactions due to HL-93 or PHL-93 Loading.” Effects 3 and 4 are calculated as follows. The maximum effect of the design tandem pair is calculated as explained in the section entitled “Variable Spacing of Truck or Tandem Pair.” The negative area of the influence line is multiplied by the design lane load and it is stored as the design lane load effect. The design tandem pair effect is multiplied by the impact factor and is added to the design lane load effect to get Effect 3. Similarly Effect 4 is calculated using the design truck pair.

For the HL-93 loading, the larger of Effect 1, Effect 2, 100% of Effect 3, and 90% of Effect 4 is stored as the governing effect.

For the PHL-93 loading, the governing effect is computed in a similar manner except that the two-truck plus lane factor is 100% for the negative moment. Therefore, for the PHL-93 loading, the larger of Effect 1, Effect 2, 100% of Effect 3, and 100% of Effect 4 is stored as the governing effect for negative moment and the larger of Effect 1, Effect 2, 100% of Effect 3, and 90% of Effect 4 is stored as the governing effect for the positive reaction at the pier.

3.4.11 Deflections Due to HL-93 and PHL-93 Loading

The live load deflection due to the HL-93 loading is computed by analyzing the influence line for deflection for a design truck alone and a combination of 25% of the design truck and 100% of the design lane load. The larger of these two effects is stored as the live load plus impact deflection due to one lane. In calculating the above effect, the impact factor is applied to the design truck effect only. The actual live load plus impact deflection is then determined by multiplying the distribution factor for deflection and the live load plus impact deflection due to one lane calculated before.

The live load deflection due to the PHL-93 loading is computed in the same manner as the live load deflection due to the HL-93 loading except that the deflection due to HL-93 loading is multiplied by a factor of 1.25 to obtain the deflection due to the PHL-93 loading as per DM-4 Article 3.6.1.3.2.

3.4.12 Fatigue Load

The effects of a Fatigue Load are calculated in the same manner as explained in the section entitled “Truck Load Effect.” The distance between the rear axles of the Fatigue Load is kept constant at 30 feet.

3.4.13 Special Live Load

The effects of a Special Live Load are calculated in the same manner as explained in the section entitled “Truck Load Effect.” The effects of all axles are considered unless the user has specified to neglect the effects of those axles that do not produce the same effect as the effect being sought. Also, if the combined effect of a Special Lane Load and the Special Live Load is requested, the program computes these effects in a similar manner as the LRFD loading.

In calculating the effect of a Special Live Load, the effects of all axle loads are considered only if the user specifies to include the effects of all axles.

3.4.14 Influence Line Analysis for H20 and HS20 Loadings

As described earlier, the influence lines are generated for various effects at analysis points on the beam. Each influence line is then analyzed as described here to find the maximum live load effect. For this, the influence line is divided into a number of regions. Each region consists of either all positive or all negative ordinates. The area of each region, the absolute maximum (peak) ordinate in each region and its location are found. For each peak of the influence line, the following is done. First, the axle number one is placed over the peak and the other axles are placed to the left in their respective positions. The ordinates under other axles are computed by interpolation assuming a straight line variation of the influence line between two consecutive ordinates. Each axle load is then multiplied by the ordinate under it. All positive values are added and stored as a positive effect. Likewise, all negative values are added and stored as a negative effect. The absolute maximum positive effect and the absolute maximum negative effect are stored. Next, the second axle is placed over the peak and the above procedure is repeated. After the last axle is placed over the peak, the axles are then placed such that the center of gravity of the load coincides with the location of the peak. The positive and negative effects are found again and the maximum effects are stored. The axle loads are then reversed (to consider the effect of the live load moving across the bridge in the other direction) and the procedure described above is repeated. When this process is completed, the absolute maximum positive and the absolute maximum negative live load effects are obtained. These are then multiplied by the distribution factor, reduction in live load intensity factor, and impact factor to get the actual live load plus impact effects. Schematic drawings of the HS20 truck and the H20 truck are presented in Figure 2.5-2.

The procedure described above is applicable for a truck load. However, for H or HS loading, the effects of equivalent lane loading must also be investigated. To find the effects of lane loading (uniform load plus a floating concentrated load), the sum of all positive and the sum of all negative areas of the influence line are computed. Also, the absolute maximum positive ordinate and the absolute maximum negative ordinate are found. To find the positive lane loading effect, the sum of positive areas is multiplied by the uniform load and added to the product of the maximum positive ordinate and the applicable (moment or shear) concentrated load. The negative lane loading effect is found in the same manner. The governing effects are stored. A schematic drawing of the HS20 and H20 lane load is presented in Figure 2.5-2.

The above procedures are illustrated in Figure 3.4-3 and Figure 3.4-4. Figure 3.4-3 illustrates the procedure for computing the governing moment at a given analysis point ($0.4L_1$). Similarly, Figure 3.4-4 illustrates the procedure for computing the governing shear at that same analysis point.

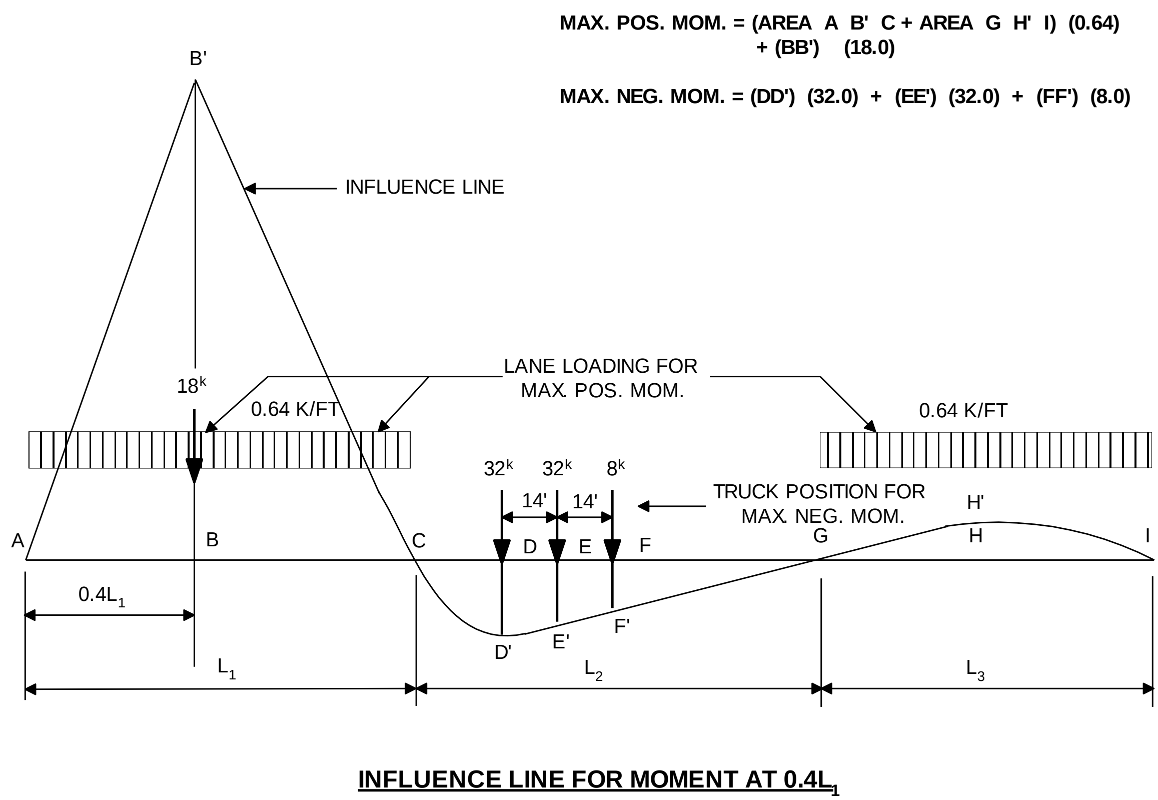
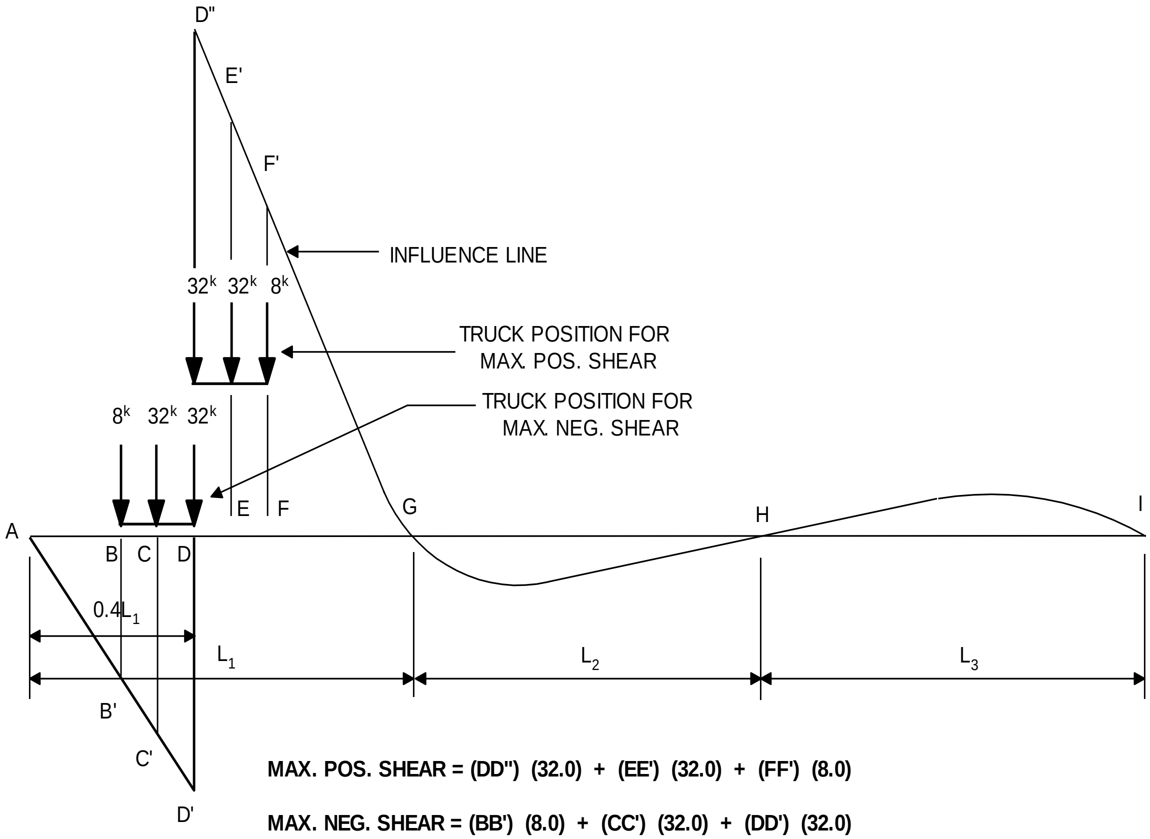


Figure 3.4-3 Moment Influence Line



INFLUENCE LINE FOR SHEAR AT $0.4L_1$

Figure 3.4-4 Shear Influence Line

3.4.15 Live Load Distribution

The live load distribution factor is defined as a fraction (or multiple) of the axle load that is carried by the steel girder. The distribution factors can be either input by the user or computed by the program. Distribution factors are used to compute live load moments, shears, reactions, and deflections.

The distribution factors for moment, shear, and reaction in a girder are a function of several variables, including the span length and the location of the analysis point. The distribution factor for deflection is a function of the number of beams and the number of lanes on the bridge.

The program computes the moment, shear, and deflection distribution factors for a design loading (with and without sidewalks) and a fatigue loading. For a design loading, the distribution factor is based on the number of loaded lanes that produces the controlling distribution factor. For bridges with sidewalks, the user enters the number of loaded lanes as if the sidewalks were not present as well as the number of loaded lanes with the sidewalks present (presumably less than or equal to the number of lanes when the sidewalks are not present). For a fatigue loading, the distribution factor is based on one lane loaded, and the resulting distribution factor is then divided by the corresponding multiple presence factor of 1.20, in accordance with LRFD Specifications Article C3.6.1.1.2. Moment and shear skew correction factors are included as appropriate. An additional computation is made for an exterior I-beam considering cross-frame or diaphragm action in accordance with LRFD Specifications Article 4.6.2.2.2d and the corresponding section of DM-4.

For the case of calculating distribution factors when sidewalks are present, the sidewalks are considered to be another loaded lane for the purpose of determining the multiple presence factor, as per LRFD Specifications Section 3.6.1.1.2. When the distribution factors are calculated using the LRFD Specifications and DM-4 Tables 4.6.2.2.2b-1, 4.6.2.2.2d-1, 4.6.2.2.3a-1, or 4.6.2.2.3b-1, the program only uses the "Two or More Design Lanes Loaded" equations when the sidewalks are present because no multiple presence factor is applied. If the distribution factors are calculated using the lever rule or the rigid cross-section approximation, the distribution factor is calculated with the user input number of loaded lanes (i.e. not including the sidewalk), but the multiple presence factor does consider an additional lane for sidewalks. For example, if the distribution factor is calculated considering two traffic lanes and a sidewalk, the multiple presence factor will be set to 0.85.

The longitudinal stiffness parameter, K_g, is used in the computation of the live load distribution factor for moment as specified in LRFD Specifications Article 4.6.2.2.2 and the corresponding section of DM-4. The equation for the longitudinal stiffness parameter is presented in LRFD Specifications Equation 4.6.2.2.1-1. A constant value of K_g equal to the weighted average of K_g is used over the entire length of the beam, from abutment to abutment. To compute this value, the K_g value for a given range is multiplied by the length of that range. This is done for each range over the entire length of the beam. These values are added together, and then divided by the total (abutment-to-abutment) length of the beam. For a noncomposite beam K_g is computed in the same way K_g is computed for composite beams.

Shear skew correction factors are computed in accordance with LRFD Specifications Article 4.6.2.2.3 and the corresponding section of DM-4. Shear skew correction factors are computed in the program as shown below:

$$Shear\ Skew\ Correction\ Factor = 1.0 + 0.20\left(\frac{12Lt_s^3}{K_g}\right)^{0.3} tan(90-\theta)$$

where: L = span length

t_s = depth of concrete slab

K_g = longitudinal stiffness parameter

θ = skew angle

Range of applicability for the span length:

$20 \text{ ft} \le L \le 500 \text{ ft}$ DM-4

If $L > 240$ ft, use $L = 240$ ft DM-4

For bridges with different skew angles at each support, the skew angle used to compute the shear skew correction factor is determined as follows:

1. For the first half of the first span, the program uses the skew angle of the first end support.
2. From the midspan of the first span to the midspan of the second span, the program uses the skew angle of the first interior support.
3. This pattern continues throughout the length of the girder, with each midspan serving as the cutoff location to determine which skew angle is used.

The usage of skew angles for the shear skew correction factors is illustrated in Figure 3.4-5.

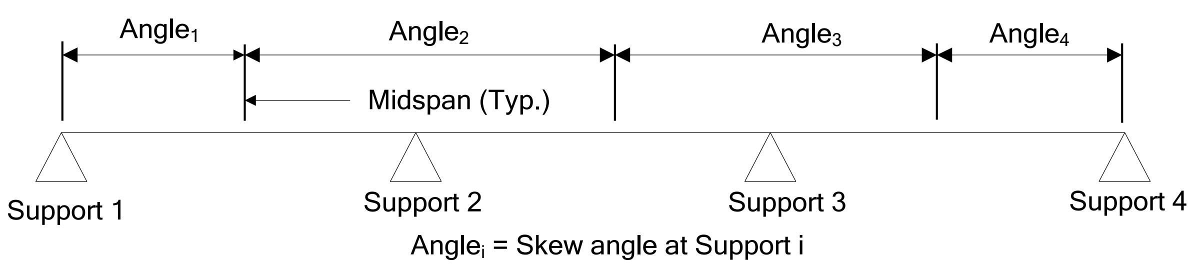


Figure 3.4-5 Usage of Skew Angles for Shear Skew Correction Factors

For steel rolled beams, plate girders, and built-up sections, the shear skew correction factors for shear force effects are applied only when each of the following four conditions are met, as illustrated in Figure 3.4-6.

1. Applied only for exterior girders.
2. Applied only where the user specifies via the SKW command. The program knows that the support is skewed, but does not not know which end is the obtuse end and which end is the acute end. It is up to the user to specify application at the obtuse corners of the structure. Obtuse is defined as exceeding 90 degrees but less than 180 degrees and is measured as shown in Figure 3.4-6 from the girder towards the C.L. of structure to the C.L. of abutment or pier.
3. Applied only from the midspan to the support.
4. Applied only to the live load distribution factors specified in LRFD Specifications Table 4.6.2.2.3b-1. The shear skew correction factor is NOT applied to live load distribution factors calculated with the rigid-cross section expression of the LRFD Specifications Section C4.6.2.2.2d.

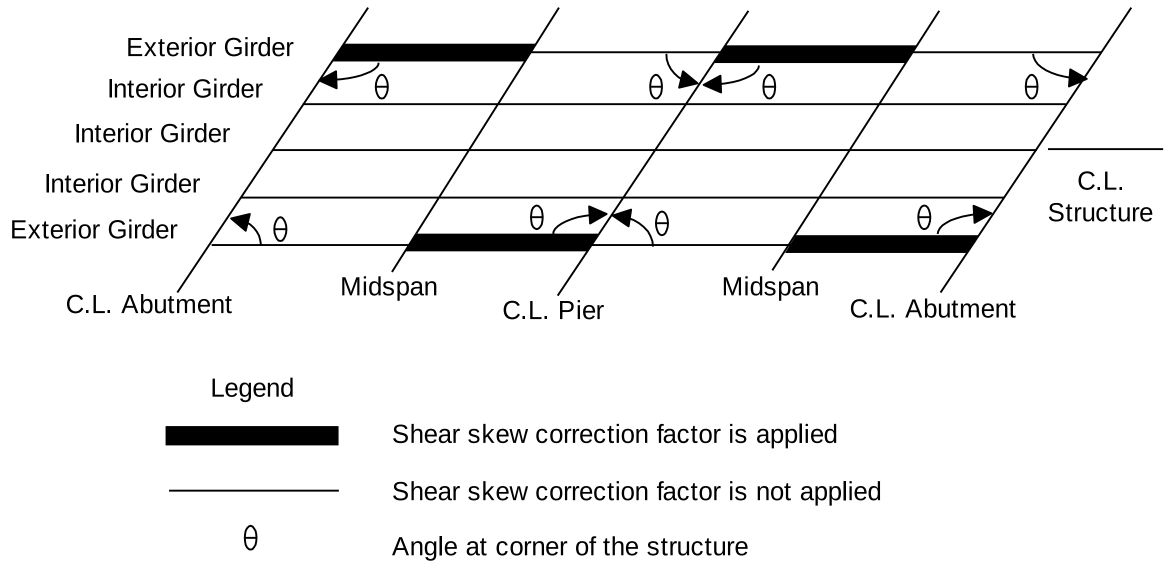


Figure 3.4-6 Application of Shear Skew Correction Factor for Shear Force Effects

In accordance with DM-4 Article C4.6.2.2.2e, a moment skew correction factor equal to 1.0 is always used. The user cannot revise this moment skew correction factor.

For steel rolled beams, plate girders, and built-up sections, the shear skew correction factors for reaction force effects are applied only when each of the following four conditions is met, as illustrated in Figure 3.4-7:

1. Applied only to exterior girders.
2. Applied only where the user specifies via the SKW command. The program knows that the support is skewed, but does not not know which end is the obtuse end and which end is the acute end. It is up to the user to specify application at the obtuse corners of the structure. Obtuse is defined as exceeding 90 degrees but less than 180 degrees and is measured as shown in Figure 3.4-7 from the girder towards the C.L. of structure to the C.L. of abutment.
3. Applied only at the abutment ends of the girders.
4. Applied only to the live load distribution factors specified in LRFD Specifications Table 4.6.2.2.3b-1. The shear skew correction factor is NOT applied to live load distribution factors calculated with the rigid-cross section expression of the LRFD Specifications Section C4.6.2.2.2d.

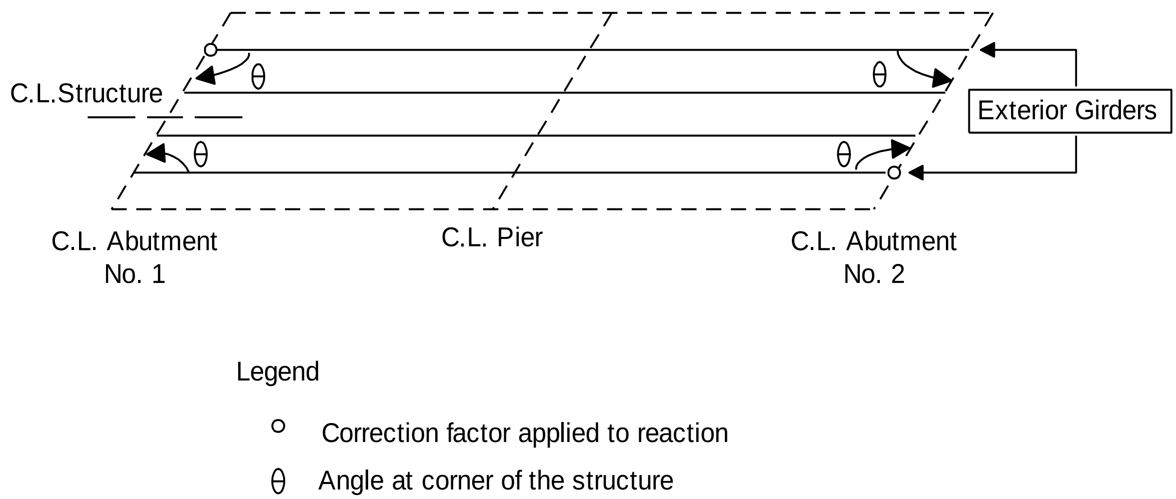


Figure 3.4-7 Application of Shear Skew Correction Factor for Reaction Force Effects

For exterior supports, the program uses the distribution factor for shear adjacent to the support as the reaction distribution factor.

Reaction Distribution Factor at the First Support:

$$Reaction\ Distribution\ Factor = DFV_1$$

Reaction Distribution Factor at the Last Support:

$$Reaction\ Distribution\ Factor = DFV_2$$

For interior supports, the program computes the reaction distribution factor using the distribution factors for shear adjacent to the support as given in the following equation:

$$Reaction\ Distribution\ Factor = \frac{1}{2}\left(\frac{DFV_1}{SCF_1} + \frac{DFV_2}{SCF_2}\right)$$

where:

DFV_1 = distribution factor for shear at the end of the span to the right of the support (includes shear skew correction factor if specified by the user and if it was not calculated with the rigid cross-section expression)

DFV_2 = distribution factor for shear at the end of the span to the left of the support (includes shear skew correction factor if specified by the user and if it was not calculated with the rigid cross-section expression)

SCF_1 = shear skew correction factor for the span to the right of the support (assumed as 1.0 if the distribution factor for shear was calculated with the rigid cross-section expression)

SCF_2 = shear skew correction factor for the span to the left of the support (assumed as 1.0 if the distribution factor for shear was calculated with the rigid cross-section expression)

When the program computes the distribution factors for shear it includes shear skew correction factors. Thus, while computing reaction distribution factors for interior supports of exterior girders, the distribution factors for shear must be divided by the shear skew correction factors to exclude skew effect from the reactions at the interior supports. If a distribution factor for shear is calculated with the rigid cross-cross section expression of LRFD Specifications Section C4.6.2.2.2d, the shear skew correction factor is not applied, so it does not need to be removed for the purpose of calculating the reaction distribution.

The program uses the lever rule to compute the moment, shear, and reaction distribution factors for a two-girder system. It also uses the lever rule to compute the moment, shear, and reaction distribution factors for an exterior girder with only one design lane loaded. As described in LRFD Specifications Article C4.6.2.2.1, “the lever rule involves summing moments about one support to find the reaction at another support by assuming that the supported component is hinged at interior supports,” in which the beams are the supports. When using the lever rule, the program also applies the appropriate multiple presence factor. For a two-girder system in which more than one design lane may be loaded, the program computes the distribution factor using the lever rule for each possible number of lanes loaded, applies the appropriate multiple presence factor to each distribution factor, and then takes the maximum as the controlling distribution factor. When the program uses the lever rule to compute the distribution factor for fatigue, the distribution factor is based on one lane loaded, and no multiple presence factor is applied, in accordance with LRFD Specifications Article C3.6.1.1.2.

For a girder-floorbeam-stringer system, the live load distribution to the girders is assumed to be similar to that of a two-girder system. The live load reactions are transferred directly to the girders, rather than being transferred from the deck to the stringers, through the floorbeam, and then to the girders. The user should enter the live load distribution factor parameters, as well as other input parameters, based on this assumption.

For additional information about distribution factors, refer to Sections 5.8, 5.9, 5.10 and 5.11. Included in Section 5.10 are two figures which illustrate the applicable range of the moment and shear distribution factors.

For specific equations used by this program to compute distribution factors, refer to LRFD Specifications Article 4.6.2.2 and the corresponding section of DM-4. Additional information concerning distribution factors for deflection is available in DM-4 Article 2.5.2.6.2, and additional information concerning multiple presence factors for live load is available in LRFD Specifications Article 3.6.1.1.2.

The P-82C and P2016-13C live loadings are a combination of the P-82 (or P2016-13) live loading in one lane with PHL-93 live loading in the other lanes as defined in DM-4 by equation 3.4.1-3P as follows:

$$FR_T = FR_{DPV}\left(\frac{g_1}{Z}\right) + FR_{PHL-93}\left(g - \frac{g_1}{Z}\right)$$

where: FR_T = total force response, moment or shear

FR_{DPV} = Design Permit Vehicle (P-82 or P2016-13) force response, moment or shear

FR_{PHL-93} = PHL-93 force response, moment or shear

g_1 = single lane distribution factor, moment or shear

g = multi-lane distribution factor, moment or shear

Z = a factor taken as 1.20 where the lever rule was not utilized and 1.0 where the lever rule was used for a single lane live load distribution factor

FR_T need not be taken greater than $FR_{DPV}(g)$.

The "Z" factor is taken as 1.20 or 1.0 and is used to remove the multiple presence factor when the approximate equations are used to compute distribution factors for a single lane. In STLRFD, single and multiple lane distribution factors are calculated specifically or user input for the P-82C or P2016-13C combinations, and are denoted as $g_{DPV,single}$ and $g_{DPV,multi}$. When computing $g_{DPV,single}$ the multiple presence factor of 1.2 is not included.

AASHTO LRFD equation 4.6.2.2.5-1 provides the same equations with different nomenclature and provides restrictions on the application of the equation. The following restrictions are applied by the program:

- The cross frame distribution factor is not considered, so $g_{DPV,single}$ and $g_{DPV,multi}$ will only ever be calculated using the AASHTO/DM-4 empirical equations or the lever rule, whichever governs.
- The equation is not allowed when both the multi-lane and the single lane distribution factors are computed using the lever rule. If both $g_{DPV,single}$ and $g_{DPV,multi}$ are governed by the lever rule, the program will stop with an error.
- The equation is not allowed when the bridge has only a single design lane. If the P-82C or P2016-13C load combination is specified for a single lane bridge, the program will stop with an error.

The equation can be rewritten using the DPV distribution factors and other program-output values as follows:

$$FR_T = FR_{DPV} + FR_{PHL-93}\left(\frac{g_{DPV,multi} - g_{DPV,single}}{g}\right) \leq FR_{DPV}\left(\frac{g}{g_{DPV,single}}\right)$$

where: FR_T = total force response, moment or shear

$g_{DPV,single}$ = single lane distribution factor for the Design Permit Vehicle combination, moment or shear, calculated subject to the restrictions of AASHTO Article 4.6.2.2.5.

$g_{PDPV,multi}$	= multi-lane distribution factor for the Design Permit Vehicle combination, moment or shear, calculated subject to the restrictions of AASHTO Article 4.6.2.2.5.
g	= multi-lane distribution factor, moment or shear, calculated without the restrictions of AASHTO Article 4.6.2.2.5.
FR_{DPV}	= Design Permit Vehicle (P-82 or P2016-13) force response, moment or shear (note that the program output for the P-82 or P2016-13 force response alone is already multiplied by $g_{DPV,single}$)
$FR_{PHL\text{-}93}$	= PHL-93 force response, moment or shear (note that the program output for the PHL-93 force response alone is already multiplied by g)

This combination loading may be used for the rating of existing bridges with the Strength II and Service IIB Limit States.

3.4.16 Dynamic Load Allowance

The dynamic load allowance (impact) is computed in accordance with LRFD Specifications Article 3.6.2 and the corresponding section of DM-4. For the fatigue limit state, the default dynamic load allowance, IM, is 15%. For P-82 and P2016-13 permit vehicles the default dynamic load allowance, IM, is 20%. For all other limit states, the default dynamic load allowance, IM, is 33%. These default dynamic load allowance values can be overridden by user input on the CTL command.

To compute the effects of dynamic load allowance only, the program multiplies the live load by (IM/100). To compute the combined effects of live load and dynamic load allowance, the program multiplies the live load by [1 + (IM/100)].

The program does not apply the dynamic load allowance to pedestrian loads or to the PHL-93 and HL-93 lane loads. However, the program does apply the dynamic load allowance to the H and HS lane loadings.

3.4.17 Pedestrian Load

The effect of a pedestrian load is calculated in the same manner as explained in the section entitled “Lane Load Effect,” except that the uniform lane load is replaced by the uniform pedestrian load.

3.4.18 Redistribution of Moments

In accordance with DM-4 Section 6, Appendix B - Moment Redistribution From Interior-Pier Sections In Continuous-Span Bridges, the redistribution of moments corresponds to inelastic design procedures and is not permitted.

3.4.19 Live Load Rotation

The live load rotations at the ends of each span are calculated by CBA by analyzing the influence lines for rotations at these points. The Distribution Factor for Moment DF1 is used to calculate the positive and negative rotations at the end support of an exterior span. The Distribution Factor for Moment DF2 is used to calculate the positive and negative rotations at an interior support. For HL93 and PHL93 loadings, the program checks all load cases that are used for calculating the live load moments.

Please note that the distribution factors used for the calculation of live load rotations may be different than the distribution factor used for the calculation of live load deflections. Also, for HL-93 and PHL-93 loadings, the program only checks Truck Alone and 25% Truck plus Lane cases for live load deflections. Thus, there may not be a correlation between the live load rotations and deflection values reported by the program.

3.4.20 Summary of Reactions

Reactions at the supports required for bearing, sole plate, abutment and pier designs are provided. Reactions, without impact but with distribution factors, are computed and provided for elastomeric bearing design. Reactions, with impact and with distribution factor, are provided for pot, disc and steel bearing design, as well as sole plate design. Reactions, without impact and without distribution factors, are provided for abutment and pier design. Reaction and rotation distribution factors used in computing the reactions and rotations are provided in sections 3.4.15 and 3.4.19 respectively.

The following procedure is used to determine the controlling live load and dead load combinations to obtain the reaction components for elastomeric, pot, steel and disc bearing design and sole plate design. The load combination that governs the elastomeric bearing design is used to obtain the reaction components for the abutment and pier designs.

For Minimum Reaction:

1. γ_{DC} * (DC1 + DC2) + γ_{MC1} * MC1 + γ_{MC2} * MC2 + γ_{DW} * (UT1 + UT2) + γ_{LL} * LL_VEHICLE
2. γ_{DC} * (DC1 + DC2) + γ_{MC1} * MC1 + γ_{MC2} * MC2 + γ_{DW} * (UT1 + UT2 + FWS) + γ_{LL} * LL_VEHICLE

Load combination from one of the above two expressions that gives the smallest algebraic reaction is used to report the minimum reactions.

For Maximum Reaction:

3. γ_{DC} * (DC1 + DC2) + γ_{MC1} * MC1 + γ_{MC2} * MC2 + γ_{DW} * (UT1 + UT2 + FWS) + γ_{LL} * LL_VEHICLE
4. γ_{DC} * (DC1 + DC2) + γ_{MC1} * MC1 + γ_{MC2} * MC2 + γ_{DW} * (UT1 + UT2) + γ_{LL} * LL_VEHICLE

Load combination from one of the above two expressions that gives the largest algebraic reaction is used to report the maximum reactions.

For Rotation:

Future wearing surface is not used in reporting the rotation. Absolute maximum of computed minimum and maximum rotations is reported for dead and live loads. Rotations are required and reported for bearing designs only.

where: γ_{DC} = Dead Load Factor

γ_{LL} = Live Load Factor

γ_{DW} = DW (Future Wearing Surface (FWS) and Utility (UT1 and UT2)) Load Factor

γ_{MC1} = Miscellaneous Noncomposite Load (MC1) Factor

γ_{MC2} = Miscellaneous Composite Load (MC2) Factor

Service-IIA load factors are used in determining controlling load combinations. Live loads used for different reaction tables are summarized in Table 2.5-3. Description of the output is provided in 7.9 and format of the output tables is provided in 7.12.

Live load and dead load reactions per girder are reported for the use in bearing and sole plate design. For abutment and pier designs dead load reactions are reported per girder while the live load reactions are reported per lane. Dead and live load reactions for pier designs shall be used appropriately by the user.

Frequently, the first interior beam may have the largest dead load reaction because of the beam spacing and loads from parapets. It is the responsibility of the user to choose the correct dead load reaction for use in the design and analysis of abutments. The user is expected to sum the dead load reactions for all the girders in the bridge cross section obtained from different runs for interior and exterior girders. The resulting value should then be divided by the skewed abutment width to obtain the total dead load reaction per unit width of the abutment for the use in abutment design.

$$RXDL_{DESIGN} = \frac{\sum_{i=1}^{N_{BEAMS}} RXDL_i}{ABW}$$

where: $RXDL_{DESIGN}$ = the dead load reaction per unit width to be used for abutment design

$RXDL_i$ = the dead load reaction for a single beam from the STLRFD output table

N_{BEAMS} = number of beams in the bridge cross section

ABW = abutment width measured along the skew

The user should multiply the live load reaction value given in the output table by the number of lanes and multiple presence factor. The resulting value should then be divided by the abutment width to obtain total live load reaction per unit width of the abutment for the use in abutment design.

$$RXLL_{DESIGN} = \frac{RXLL_{OUTPUT} * N_{LANES} * MPF}{ABW}$$

where: $RXLL_{DESIGN}$ = the live load reaction per unit width to be used for abutment design

$RXLL_{OUTPUT}$ = the live load reaction for a single lane of traffic (no impact or distribution factors) from the output table

N_{LANES} = number of lanes carried by the bridge

MPF = multiple presence factor

ABW = abutment width measured along the skew

3.5 LOAD COMBINATIONS AND STRESSES

After the effects of all loads are calculated, as described in Section 3.4, the program computes the factored moments, shears, deflections, reactions, and stresses as required by the LRFD Specifications and DM-4. In accordance with DM-4, the program computes the total factored loads using the following equation:

$$Q = \sum \left[\eta \ \gamma_i \, q_i \; or \; \frac{\gamma_i \, q_i}{\eta} \right]$$

where: Q = total factored load

η = load modifier (see Table 1)

γ_i = load factor (see Table 2)

q_i = load (unfactored analysis results)

In the above equation, when the maximum load factor is used for a given load, then $\eta \ \gamma_i \ q_i$ is used. When the minimum load factor is used with a given load, then $\gamma_i \ q_i / \eta$ is used.

The program computes the load modifier in accordance with LRFD Specifications Article 1.3.2 and the corresponding section of DM-4. The load modifier used for each load combination is summarized in Table 1.

Table 3.5-1 Load Modifier

Load Combination	Load Modifier
All Strength Limit States	η = product of inputted importance factor, ductility factor, and redundancy factor (see CTL command) Minimum η = 1.0 Maximum η = 1.16 As per PennDOT DM-4 Section 1.3.2.1, ETA factors other than 1.0 are not permitted by PennDOT.
All Service Limit States	η = 1.0
Fatigue (Redundant)	η = 1.0
Fatigue (Nonredundant)	η = 1.0
Deflection	η = product of inputted importance factor, ductility factor, and redundancy factor (see CTL command) Minimum η = 1.0 Maximum η = 1.16 As per PennDOT DM-4 Section 1.3.2.1, ETA factors other than 1.0 are not permitted by PennDOT.

Load Combination	Load Modifier
Construction/Uncured Slab	η = product of inputted importance factor, ductility factor, and redundancy factor (see CTL command) Minimum η = 1.0, Maximum η = 1.16 As per PennDOT DM-4 Section 1.3.2.1, η factors other than 1.0 are not permitted by PennDOT.

The unfactored analysis results are multiplied by the appropriate load factor. The load factor depends on the load type and the limit state, as specified in the LRFD Specifications. The program considers LRFD Strength I, Strength IP, Strength IA, Strength II, Strength III, Strength IV, Strength V, Service II, Service IIA, and Service IIB limit states. In addition, the program uses load factors for checking fatigue, deflection, and construction / uncured slab loads. The load factors used for each load type per limit state and for fatigue, deflection, and construction / uncured slab loads are shown in Table 2. When two load factors are presented, the first load factor is the maximum load factor and the second load factor is the minimum load factor.

Minimum load factors are used only in the computation of the factored reactions. For each support, the program computes the minimum factored reactions using the maximum or minimum load factor for each individual loading such that the factored downward reactions are minimized and the factored uplifts are maximized. For minimum reactions computations, if the load component is positive (downward) then the program uses $\gamma_{min}\, q_i\, /\eta$ else it uses $\eta\ \gamma_{max}\, q_i$ in computing the factored load. Then the factored minimum reaction is computed by summing up the factored loads computed as described above.

For each support, the program computes the maximum factored reactions using the maximum or minimum load factor for each individual loading such that the factored downward reactions are maximized and the factored uplifts are minimized. For maximum reaction computations, the program chooses the minimum of $\gamma_{min}\, q_i\, /\eta$ or $\eta\ \gamma_{max}\, q_i$ for each load component in computing the factored load. Then the factored maximum reaction is computed by summing up the factored loads. If the factored maximum reaction so computed is greater than zero, meaning there is no uplift, then the program repeats the process of maximum factored reaction calculation by choosing the maximum of $\gamma_{min}\, q_i\, /\eta$ or $\eta\ \gamma_{max}\, q_i$ for each load component.

With the single exception of the factored reactions, as described in the previous paragraph, the program always uses the maximum load factors.

The checks required by the LRFD Specifications are dependent on the type of flexure, either positive or negative. For example, the b/t limit is based on the compression flange, and the compression flange is dependent on the type of flexure. Positive flexure (moment) is defined as a bending condition which results in compressive stress at the top of the concrete slab for composite design or top of the steel beam for noncomposite design. A bending condition that results in tensile stress at the top of the concrete slab for composite design or top of steel beam for noncomposite design is defined as negative flexure.

Table 3.5-2 Load Factors

Load Combination	Loading							
	γ_{DC}	γ_{DW}	γ_{LL}	γ_{PL}	γ_{SPVH}	γ_{WS}	γ_{MISC}	**Design Live Loading**
Strength I	1.25, 0.90	1.50, 0.65	1.75	—	User Def.	—	User Def.	PHL–93
Strength IP	1.25, 0.90	1.50, 0.65	1.35	1.75	User Def.	—	User Def.	PHL–93
Strength IA	1.25, 0.90	1.50, 0.65	1.35	—	—	—	User Def.	PHL–93
Strength II	1.25, 0.90	1.50, 0.65	1.35	—	User Def.	—	User Def.	Permit (P–82)
Strength III	1.25, 0.90	1.50, 0.65	—	—	—	1.00	User Def.	—
Strength IV	1.50	1.50, 0.65	—	—	—	—	User Def.	—
Strength V	1.25, 0.90	1.50, 0.65	1.35	—	User Def.	1.00	User Def.	PHL–93
Service II	1.00	1.00	1.30	—	User Def.	—	User Def.	PHL–93
Service IIA	1.00	1.00	1.00	—	User Def.	—	User Def.	PHL–93
Service IIB	1.00	1.00	1.00	—	User Def.	—	User Def.	Permit (P–82)
Fatigue I	—	—	1.75	—	—	—	User Def.	HS20–30
Fatigue II	—	—	0.80	—	—	—	User Def.	HS20–30
Deflection	—	—	1.00	—	—	—	User Def.	PennDOT Defl. Trk.
Construction I/ Uncured Slab I (construction limit state without wind load applied)	1.40	1.40	1.40	—	—	—	User Def.	γ_{LL} is applied to temporary construction loads **and deck overhang live loads or finishing machine loads** (loads that are present for a given deck pour, then removed) γ_{DW} is only applied to UT1 loads. FWS loads are not considered for Construction or Uncured Slab
Construction II / Uncured Slab II (construction limit state with wind applied)	1.25	1.25	1.25	—	—	1.00	User Def.	Same as Construction I

If the moments due to all factored loads are positive, then flexure is positive. If the moments due to all factored loads are negative, then flexure is negative. However, if moments on the noncomposite section are of opposite sign as moments on the composite section, then additional investigation is required to determine the type of flexure. This can occur when the live load moment has an opposite sign than the dead load moment. It could also occur in the construction stage analysis when the composite moment and noncomposite moment have opposite signs.

At points where some moments are positive and others are negative, the program determines the type of flexure by computing the factored stress at the bottom of the bottom flange. Factored moments are used to calculate the factored stresses. However, the correct section properties to use in computing the factored stress must first be determined. This is done by computing the unfactored stress at the top of the concrete slab (as per LRFD Specifications Article 6.10.1.1.1b) according to the following equation:

$$f_{ts} = \frac{M_{DC2} + M_{FWS} + M_{MC2}}{S_{ts,3n}} + \frac{M_{LL}}{S_{ts,n}} + f_{E,ts}$$

where: $f_{E,ts}$ = the unfactored stress at the top of the slab due to the construction staging analysis.

The unfactored stress at the top of the concrete slab is first computed using section properties based on positive flexure. If the total unfactored stress at the top of the concrete slab is compressive (unfactored stress less than zero), then all of the factored stresses in the beam are computed using positive flexure section properties (including the concrete slab). If the concrete slab is in tension (unfactored stress greater than zero), the factored stresses in the beam are computed using negative flexure section properties (including the reinforcement in the slab). After computing the total factored stresses, if the bottom flange is in net tension, then the section is considered to be in positive flexure. If the bottom flange is in net compression, then the section is considered to be in negative flexure.

The live loading produces both a positive and a negative (or zero) moment at each analysis point. When combined with the dead load moment, each live load moment can produce a total factored moment that results in either positive or negative flexure. Thus, since two total factored moments are produced at each analysis point, then each analysis point can be in positive flexure only, negative flexure only, or both positive and negative flexure.

For the case in which the section can be in both positive and negative flexure, the program checks the LRFD Specifications twice for that section. The first check is for positive flexure, in which the concrete slab and the top flange of the steel beam are in compression. The second check is for negative flexure, in which the bottom flange of the steel beam is in compression.

The program checks and tags the results for uplift in “Factored Analysis Results – Reaction” tables only for Service-IIA and uplift is permitted for strength limit states.

If the stress in the slab exceeds 0.6 * f_c' (for noncompact sections in positive flexure that utilize A6.10.7.2 when calculating the flexural resistance at the strength limit state), the program identifies those locations and a failure code appears in the last column of the “Factored Analysis Results” table with a note below the table saying that the compressive stress at the top of the slab exceeds 0.6 * f_c'.

If the stress in the slab exceeds 0.85 * f_c' (for positive flexure only), the program identifies those locations and a failure code appears in the last column of the “Factored Analysis Results” table with a note below the table saying that the compressive stress at the top of slab exceeds 0.85 * f_c'.

When computing stresses for the fatigue limit states, the appropriate section properties are chosen based on the sign of the moments at the fatigue location. The unfactored stresses due to the composite dead loads are computed with the long-term composite positive section properties if the total of the composite dead load moments is positive and the composite negative section properties if the total composite dead load moment is negative. A similar method is followed for the live load stresses. For the positive fatigue live load moment, short-term composite positive section properties are used and for the negative fatigue live load, the composite negative section properties are used. For girders that are noncomposite in the final state, noncomposite section properties are used to compute stresses for all loads.

3.6 SECTION DESIGN

If the design option is selected, the program will perform an iterative design for simple span rolled beams or simple span plate girders. For rolled beams, the design is based on determining the section having the minimum weight or minimum depth (depending on user-input option) which meets the capacity requirements and inputted beam size restrictions. For plate girders, the design is based on determining the section having the minimum weight which meets the capacity requirements and inputted plate size restrictions. For plate girders and rolled beams, the capacity requirements include a check that a category C' fatigue detail at the top of the bottom flange at the location of maximum fatigue moment has an infinite fatigue life.

For either design, if one or more field splice locations are entered (via the FSL command), the program will compute the number of bolt holes and increment (if necessary) the bolt hole diameter, bolt hole spacing, and edge distances for the bottom flange according to the methods outlined in Section 3.7.13.1. These field splice properties will be recomputed for each different section tried throughout the design process. For any successful design with a defined field splice, a minimum of one row of bolt holes must fit within the flange on each side of the web. It is important to note that the program will only increase the spacing and edge distances in an effort to center and evenly distribute the bolt holes within each half of the flange per side of the web. The program will not reduce the bolt hole diameter, bolt hole spacing, or edge distances less than the user specified minimums. Therefore, if a given section with a defined field splice cannot support a minimum of one row of bolt holes, the section will be considered inadequate regardless of potentially satisfying all other specifications.

For a rolled beam design, the program begins with the beam which satisfies the user's input limitations and which is the minimum weight per unit length or shallowest actual depth. The program then performs a specification check for that beam. If the beam passes all specification checks, then that beam is selected as the optimal rolled beam. However, if the beam does not pass all specification checks, then the program performs a specification check for the beam with the next lowest weight per unit length or next shallowest actual depth. The program continues this procedure until a beam is obtained which passes all specification checks. The beam which satisfies the user's input limitations, has the lowest weight per unit length or shallowest actual depth, and passes all specification checks is selected as the optimal rolled beam.

For a plate girder design, the first step in the optimization process is to generate the initial dead load and live load moment and shear effects. In computing these effects, the initial analysis run uses a web plate depth equal to the average of the lower limit and upper limit. The web plate thickness is initially assumed to equal the initial web plate depth divided by 150, or the user-input minimum thickness value, if specified and larger than D / 150. The calculated or input thickness value is then rounded up to the closest available plate size. This provides a web thickness that satisfies the web proportions for a web without longitudinal stiffeners, as specified in LRFD Specifications Article 6.10.2.1.1 and the corresponding section of DM-4. The flange plate dimensions are initially assumed to be the average of the inputted lower and upper limits for the purpose of computing an initial girder weight. Specification checking is not performed for this initial trial run. If the user has selected predefined transition locations, then the transitions are defined at all possible transition locations. Likewise, if the user has selected user-defined transition locations, then the transitions are defined at those locations.

After the initial analysis run is completed, the maximum total factored moments and shears from all of the analysis points are found for all limit states. The maximum total factored moments may occur at different locations, depending on limit state. The member is designed for the maximum effects, regardless of where they occur. For example, the maximum dead load moment usually occurs at midspan, while the maximum factored moment including the P-82 load occurs away from midspan. The midspan section is designed for both of these occurrences. If the member contains one or more field splice locations, the member will also be designed for the maximum effects along the field splice plate using the appropriate flexural and net section fracture capacities for that section. The program then uses these moments and shears to establish the optimal girder depth and the corresponding web thickness.

The first step in establishing the optimal girder depth is to verify that a solution is possible with the given maximum plate sizes. If this check of the specifications fails, a message is printed and the run is stopped. Therefore, the user must use engineering judgment in selecting maximum plate sizes. If the maximum plate sizes result in inadequate geometry, then the section will fail the specifications check and the program will terminate.

If the maximum plate sizes produce a valid design, then the web plate depth is reset to the minimum web depth and the section is checked with the maximum flange plates. A web plate thickness is calculated such that the shear due to total factored loads is less than or equal to the factored shear resistance of the girder for unstiffened webs. The web thickness is then reduced to the next thinner available plate if the design for a stiffened web has been specified by the user (see Section 5.20, DTS command). If the user has entered a minimum web thickness (DP2 command) and the calculated web thickness is less than the input value, then the web thickness is set to the user input value rounded to the next largest available plate thickness. This section, with the given web depth, web thickness, and maximum flange plates, is checked for flexure such that the maximum total factored moment is less than or equal to the factored moment resistance.

If the section contains one or more field splices, it is also then checked at the analysis point along the field splice that produces the maximum effect for flexure with a noncompact section using the gross section properties, Net Section Fracture according to LRFD Specifications Article 6.10.1.8, and the geometric requirements for a minimum of one row of bolt holes in the flange per side of the web. The web depth is incremented by 3 inches until a valid design is found. For each web depth, the web thickness is recomputed as stated above. This establishes the minimum web depth and corresponding thickness that produces a valid design using maximum flange plates.

The second step in establishing the optimal girder depth is to start with the minimum web depth and corresponding thickness that produces a valid design to now optimize the flange plates in order to produce the minimum cross-sectional area. The available flange plate thicknesses are from 3/4 inch to 4 inches in 1/8 inch increments. The flange plate optimization process steps based on selecting option 1 for both parameters 11 and 12 of the DP2 command, Section 5.18, are as follows:

1. Starting with the maximum value of top flange width, reduce the width by 1 inch each time through this step and perform all substeps listed below until the section fails the specifications check or the minimum top flange width is used. For a top flange maximum width that is not an integer, the intermediate values are assigned as integers. These integers are determined before the iteration process as increments from the minimum width, which are then rounded down to the next whole number. The specified minimum width will be tried as entered by the user unless the section fails the specifications check.

    A. Starting with the maximum value of top flange thickness, reduce the thickness as appropriate each time through this step and perform all substeps listed below until the section fails the specifications check or the minimum top flange thickness is used.

        i. Starting with the maximum value of bottom flange width, reduce the width by 1 inch each time through this step and perform all substeps listed below until the section fails or the minimum bottom flange width is used. As with the top flange, for a bottom flange maximum width that is not an integer, the intermediate values are assigned as integers. These integers are determined before the iteration process as increments from the minimum width, which are then rounded down to the next whole number. The specified minimum width will be tried as entered by the user unless the section fails the specifications check.

            a. Starting with the maximum value of bottom flange thickness, reduce the thickness as appropriate each time through this step and perform all substeps listed below until the section fails the specifications check or the minimum bottom flange thickness is used.

                1. Calculate the total cross-sectional area of the girder section being used at this step and compare to the previous minimum cross-sectional area. Save the minimum cross-sectional area and plate sizes that produced that area.

The total number of possible girder cross sections is the product of the number of top flange plate widths times the number of top flange plate thicknesses times the number of bottom flange plate widths times the number of bottom flange plate thicknesses. Thus, even a small range of flange plate sizes can result in a large number of possible girder cross sections. For example:

Plate	Minimum	Maximum	Number of Sizes
Top Flange Width	12 inches	16 inches	@ 1 inch = 5 widths
Top Flange Thickness	1 inch	2 inches	@ 1/8 inch = 9 thicknesses
Bottom Flange Width	14 inches	20 inches	@ 1 inch = 7 widths
Bottom Flange Thickness	1 inch	2 inches	@ 1/8 inch = 9 thicknesses

Total number of possible girder cross sections = 5 x 9 x 7 x 9 = 2,835.

2. Increase the web depth by 3 inches each time through this step and perform all substeps listed below.

   A. Calculate the web plate thickness required such that the shear due to total factored loads is less than or equal to the factored shear resistance of the girder for unstiffened webs. Then the web thickness is reduced by 1/16 inch if the design for a stiffened web has been specified by the user (see Section 5.20, DTS command). This section, with the given web depth, web thickness, and maximum flange plates, is checked for flexure such that the maximum total factored moment is less than or equal to the factored moment resistance. If the section contains one or more field splices, it is also checked at the analysis point along the field splice that produces the maximum effect for flexure with a noncompact section using the gross section properties, Net Section Fracture according to LRFD Specifications Article 6.10.1.8, and the geometric requirements for a minimum of one row of bolt holes in the flange per side of the web.

3. Go back to step 1 and repeat the entire process until the maximum web depth is used.

The web depth and corresponding thickness that produces the smallest total cross-sectional area of the girder section is defined as the optimal girder depth and corresponding thickness.

Using the optimal web depth and corresponding thickness, the top and bottom flange plates are optimized based on the flange plate transition locations. The user has the option of specifying the flange plate transition locations or allowing the predefined flange plate transition locations to be used. Predefined flange plate transition locations are optimal flange plate transition locations based on the minimization of the area under a “capacity curve” which bounds the assumed parabolic moment diagram. This concept is illustrated in Figure 3.6-1, where there is a single transition between the end of the beam and midspan.

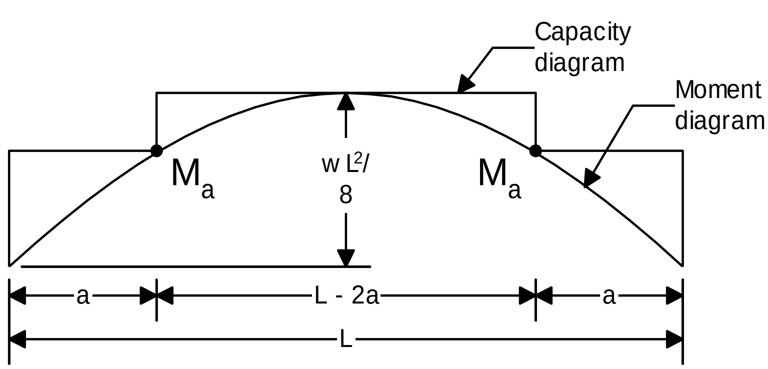


Figure 3.6-1 Derivation of Predefined Transition Locations

In Figure 1, M_a is computed as follows:

$$M_a = \frac{1}{2} wa\ (L - a)$$

The area under the capacity diagram is computed as follows:

$$Area = 2\,aM_a + (L - 2a)\,\frac{wL^2}{8}$$

Setting the differential, $\frac{d}{da}(Area) = 0,$ yields a quadratic equation having roots of a = L/6 and L/2. The root of L/6 is selected as the transition location to optimize the transition such that the area under the curve is minimized. A similar procedure can be used to determine the optimal transition points for two or more transitions per half-span. Partial differentials are taken with respect to each unknown cutoff location, resulting in “n” simultaneous non-linear equations with “n” unknowns. The optimal transition locations for 1 to 3 cutoffs per half-span are presented in Table 1.

Table 3.6-1 Predefined Flange Cutoff Transition Locations

Number of Transitions (Per Half-span)	Predefined Flange Cutoff Transition Locations		
1	0.167 L	--	--
2	0.109 L	0.239 L	--
3	0.081 L	0.172 L	0.281 L

If the user has requested predefined transitions, then the number of top and bottom flange transitions are varied from zero to the user-specified maximum. The equivalent weight of each flange is computed by including a weight penalty for each flange transition. This penalty expresses the additional fabrication cost of welding the flange plates as an equivalent amount of flange material. The user can specify the weight penalty as part of the design plate girder input using the DP1 command, parameter 6. Entering zero for the weight penalty will guarantee that the maximum number of user-requested flange transitions will be used. An example of a case where all requested transitions would not be used is if at a prior transition location the minimum plate sizes were used. If the user specifies the transition locations or if the design contains one or more field splices thus requiring an additional transition location at each field splice centerline, then the plate thicknesses are determined only at those locations, not at the predefined locations.

For the flange plate optimization, the bottom flange plate width must be equal to or larger than the top flange plate width at all flange plate transition locations and at the midspan of the girder. The flange plate optimization process consists of the following steps:

1. Starting with the minimum value of the top flange width, increase the width by 1 inch each time through this step and perform all substeps until the maximum top flange width is used. For a top flange maximum width that is not an integer, the intermediate values are assigned as integers. These integers are determined before the iteration process as increments from the minimum width, which are then rounded down to the next whole number. The specified maximum width will be tried as entered by the user.

a) Starting with the minimum value of the bottom flange width, increase the width by 1 inch each time through this step and perform all substeps until the maximum bottom flange width is used. As with the top flange, for a bottom flange maximum width that is not an integer, the intermediate values are assigned as integers. These integers are determined before the iteration process as increments from the minimum width, which are then rounded down to the next whole number. The specified maximum width will be tried as entered by the user unless the section fails the specifications check.

i. Cycle through the number of top flange plate transition locations per girder (0, 1, 2, or 3). Starting with the minimum number of transitions, increase the number of transitions by 1 each time through this step and perform all substeps until the maximum number of top flange plate transitions is used.

a. Cycle through the number of bottom flange plate transition locations per girder (0, 1, 2, or 3). Starting with the minimum number of transitions, increase the number of transitions by 1 each time through this step and perform all substeps until the maximum number of bottom flange plate transitions is used.

1. For the midspan location and each subsequent flange plate transition location, the flange plate thicknesses are optimized based on the following substeps:

A. Starting with the maximum value of the top flange thickness, reduce the thickness as appropriate each time through this step and perform all substeps until the minimum top flange thickness is used.

i. Starting with the maximum value of the bottom flange thickness, reduce the thickness as appropriate each time through this step and perform all substeps until the minimum bottom flange thickness is used.

a. Compute the total cross-sectional area of the girder at this step, including an allowance to account for the transverse stiffeners equal to the volume of a 6 inch by ½ inch stiffener divided by the minimum of either the maximum allowable stiffener spacing or the user-entered maximum stiffener spacing.

b. Compare the given total cross-sectional area to the smallest previous total cross-sectional area which passed all the specification checks. If the given total cross-sectional area is less than or equal to the smallest previous total cross-sectional area, then check the given section for flexure. If the given section passes the flexural checks and includes one or more field splice locations, the section is checked at the analysis point along the field splice that produces the maximum effect for flexure with a noncompact section using gross section properties and Net Section Fracture according to LRFD Specifications Article 6.10.1.8 at the centerline and extreme edges of the field splice. In addition, the section is also checked such that a minimum of one row of bolt holes can fit within the flange on each side of the web. If the given section passes those flexural, Net Section Fracture checks, and the bolt hole geometric requirements, or does not contain any field splice locations, determine the required transverse stiffener spacing at this section if the user has requested the design of transverse stiffeners and if an unstiffened web is not sufficient to resist the factored shear at the given section.

c. Recompute the total cross-sectional area of the given girder at this step, including the allowance to account for the transverse stiffeners based on the required transverse stiffener spacing computed in step b above. If this area is less than or equal to the smallest previous total cross-sectional area, then save the given section as the new smallest total cross-sectional area.

B. Reset the maximum value and minimum value of both the top flange thickness and the bottom flange thickness for the next transition location based on the optimal flange plates found in step A (and all substeps) above.

2. Compute the total equivalent flange volume for the given flange widths, including the total "penalty" for all flange transitions. The "penalty" for each flange transition is calculated as the Weight/Mass Savings (parameter 6, DP1 command) entered by the user divided by the weight of steel, which is set in the program as 490 pcf.

3. Compare the given total equivalent flange volume to the previously saved total equivalent flange volume. If the given total equivalent flange volume is less than the previously saved total equivalent flange volume, then compute the volume of the entire girder, including the web plate, the flange plates, and the total "penalty" for all flange transitions.

1. Design the transverse stiffeners based on the given girder section properties at each analysis point. This step is only performed if the user has requested the design of transverse stiffeners by entering a DTS command (see Section 5.20). Stiffener ranges are defined at each twentieth point of the span, beginning at the support and working toward midspan.

A. Determine the required stiffener spacing for the factored shear at the given section. The stiffener spacings are in increments of 3 inches, with the minimum stiffener spacing being 1 foot. If no stiffeners are required (that is, if the unstiffened web is sufficient to resist the factored shear), proceed to step 3 below.

B. Determine the required stiffener size to satisfy the specification criteria for stiffener area and moment of inertia using the stiffener having the least volume. The program starts with a 6 inch by ½ inch stiffener and increments, either up or down, the width by ½ inch. The available plate thicknesses are from ½ inch to ¾ inch in 1/16 inch increments and from 3/4 inch to 4 inches in 1/8 inch increments.

2. Compute the total equivalent weight of the given girder, including the weight of the web plate, all flange plates, all flange plate transition weight penalties, and the equivalent weight of all transverse stiffeners. The equivalent weight of all transverse stiffeners is calculated as follows:

$$W_{stiff} = \left[\sum_{n=1}^{n_{ranges}} \frac{length_{range}}{spacing_{stiffeners}} depth_{stiffener}\, thickness_{stiffener}\, width_{stiffener} \right] \frac{cost_{stiffener}}{cost_{plates}} \gamma_{steel}$$

where: $\frac{cost_{stiffener}}{cost_{plates}}$ = the Relative Cost Ratio, parameter 5, DTS command entered by the user.

$depth_{stiffener}$ = the total web depth.

3. If the total equivalent weight of the given girder is equal to the total equivalent weight of the previously saved girder, then the design optimization process has converged and the given girder is the optimum girder for this problem. If the design has not converged, then the given girder design is saved and the entire optimization process is repeated as described above, beginning by using the given girder to compute the initial analysis run in the first step to optimize the web depth.

A. If the maximum number of iterations has been reached, then the given girder will be saved and used for all subsequent calculations, such as ratings.

If no plate size limitations are input by the user, the plate girder design optimization problem may run for an excessive length of time and may not converge within the maximum number of iterations (10). The user should review the trial design output to determine if the design is oscillating between two or three different designs or if the convergence is too slow to be accomplished within the maximum number of iterations. The user can greatly reduce the run time by inputting lower and upper limits for the various plate dimensions. Generally, the run time decreases as the plate dimension limit constraints are increased. In addition, the program may generate a design which meets the requirements of the input but which may be impractical. For example, if no plate limitations are entered, the program may design a top or bottom plate measuring 4 inches by 12 inches. Although these dimensions satisfy the input requirements, such a plate size is generally not used in design. Therefore, the user must exercise engineering judgment in preparing the input and evaluating the output for a plate girder design optimization problem.

3.7 SPECIFICATIONS CHECKING

For both analysis and design runs, the program checks all analysis points for conformance with the LRFD Specifications and DM-4. The program checks all applicable specifications for flexure, shear, fatigue, deflection, stiffeners, and shear connectors. Both positive and negative flexure are considered at each analysis point, as appropriate.

The program performs the following steps at each analysis point:

1. Check the flexure type for a given load combination. The flexure type can be positive flexure, negative flexure, or positive and negative flexure.
2. Obtain the combined load effects (factored moments, shears, stresses, etc.) and appropriate section properties based on the flexure type.
3. Obtain the variables required to check the specifications, such as width and thickness of the compression flange, depth of the web in compression, and lower moment at the bracing points for checking the unbraced length.
4. Check LRFD Specifications for each limit state, as well as for uncured slab, fatigue, construction, and deflection, as summarized in Table 1.

Table 3.7-1 Summary of Specifications Checked

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Horizontal Wind Pressure (Calculation of M_w)	3.8.1	Uncured Slab Strength III Strength V Construction	N/A	
Effective Flange Width	4.6.2.6	Strength I-V Service II-IIB Fatigue Construction	N/A	
Lateral Wind Load Distribution in Multibeam Bridges (Calculation of M_w)	C4.6.2.7.1	Uncured Slab Strength III Strength V Construction	N/A	
Load-Induced Fatigue (including Fatigue Resistance and Number of Cycles per Truck Passage)	D6.6.1.2	Fatigue	N/A	Fatigue resistance applies for user-specified fatigue details; category C checked at all analysis points for design.
DM-4 PennDOT Remaining Fatigue Life Estimation		Fatigue	N/A	Applies for user-specified fatigue details when user requests a remaining fatigue life calculation at those pts.

Table 3.7-1 Summary of Specifications Checked (Continued)

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Remaining Life by Engineering Economy Equation		Fatigue	N/A	
Cumulative Fatigue Damage Factor: $\Sigma\gamma_i\phi_i^3$		Fatigue	N/A	Applicable only if truck fatigue data is available
Flange Stresses and Member Bending Moments (Calculation of f_l from M_w **or Deck Overhang lateral bending moments**)	6.10.1.6	Uncured Slab Strength III Strength V Construction	N/A	Applicable for limit states with lateral stresses due to wind moments **or deck overhang brackets**
Net Section Fracture	6.10.1.8	Uncured Slab Strength I-V Construction	Strength I-V	Applicable for sections containing holes in the tension flange. When the net section fracture capacity at a given location is less than the stress flexural capacity, the net section fracture capacity is reported as the capacity of the section
Web Bend-Buckling Resistance	6.10.1.9	Uncured Slab Service II-IIB Construction	Service II-IIB	Applies to webs with or without longitudinal stiffeners
Hybrid Factor, R_h	6.10.1.10.1 6.10.3.2.1	Uncured Slab Strength I-V Service II-IIB Construction	Strength I-II Service II-IIB	R_h is taken as 1.0 for homogeneous girders, when $F_{y,web} > F_{yc}$ and F_{yt}, and when f_c and $f_t < F_{y,web}$ during construction. For composite sections in positive flexure, D_n is determined from the short term composite neutral axis. For composite sections in negative bending, D_n is based on the composite neutral axis (including deck reinforcement).
Load Shedding Factor, R_b	6.10.1.10.2	Uncured Slab Strength I-V Construction	Strength I-II	R_b is set to 1.0 for Constructability or if 6.10.1.10.2 is satisfied
Web Proportions	6.10.2.1	Strength I-V Service II-IIB Fatigue Construction	Strength I-II Service II-IIB	Checks web proportions (D/t_w ratio) for longitudinally stiffened and unstiffened webs

Table 3.7-1 Summary of Specifications Checked (Continued)

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Flange Proportions	6.10.2.2	Strength I-V Service II-IIB Fatigue Construction	Strength I-II Service II-IIB	Checks flange proportions (flange aspect ratio, section aspect ratio, web-to-flange area ratio, and I_{yc}/I_{yt} ratio) for top and bottom flanges
Constructability, Flexure	6.10.3.1 D6.10.3.2.1 6.10.3.2.2 6.10.3.2.3	Uncured Slab Construction	N/A	A6.10.3.2.4 has <u>not</u> been implemented. Also see flowchart in Appendix C6.4.1.
Constructability, Shear	6.10.3.1 6.10.3.3	Uncured Slab Construction	N/A	Refer to A6.10.9.3 for more information. Also see flowchart in Appendix C6.4.1.
Permanent Deformations, Flexure	6.10.4.2.2	Service II-IIB	Service II-IIB	Inventory rating for Service II and operating rating for Service IIA and IIB. Also see flowchart in Appendix C6.4.2.
Fatigue	6.10.5.1	Fatigue	N/A	Also see flowchart in Appendix C6.4.3.
Special Fatigue Requirements for Webs	D6.10.5.3	Fatigue	N/A	Applicable only for stiffened interior panels of webs
Compactness for Composite Sections in Positive Flexure	6.10.6.2.2	Strength I-V	Strength I-II	Sections that satisfy 6.10.6.2.2 are treated as compact sections excluding field splices and built-up sections, and sections with holes in the tension flange, which are always considered as noncompact sections. Also see flowchart in Appendix C6.4.4.
Flexural Capacity of a Composite, Compact I-Section in Positive Flexure	6.10.7.1	Strength I-V	Strength I-II	Inventory rating for Strength I and operating rating for Strength IA and II. Also see flowchart in Appendix C6.4.5.
Flexural Capacity of a Composite, Noncompact I-Section in Positive Flexure	6.10.7.2	Strength I-V	Strength I-II	Inventory rating for Strength I and operating rating for Strength IA and II. Also see flowchart in Appendix C6.4.5.
Ductility Requirement	6.10.7.3	Strength I-V	Strength I-II	Checked for Composite Sections in Positive Flexure, Compact or Noncompact. Also see flowchart in Appendix C6.4.5.

Table 3.7-1 Summary of Specifications Checked (Continued)

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Flexural Capacity of Noncomposite Sections or Composite Sections in Negative Flexure, Compression Flanges	6.10.8.1 6.10.8.2 D6.10.8.2.3 Appendix A6	Strength I-V	Strength I-II	Inventory rating for Strength I and operating rating for Strength IA and II. Also see flowchart in Appendix C6.4.6 and Appendix C6.4.7.
Flexural Capacity of Noncomposite Sections or Composite Sections in Negative Flexure, Tension Flanges	6.10.8.1 6.10.8.3 Appendix A6	Strength I-V	Strength I-II	Inventory rating for Strength I and operating rating for Strength IA and II. Also see flowchart in Appendix C6.4.6 and Appendix C6.4.7.
Nominal (Shear) Resistance of Unstiffened Webs	D6.10.9.1 6.10.9.2	Strength I-V	Strength I-II	Inventory rating for Strength I and operating rating for Strength IA and II
Nominal (Shear) Resistance of Stiffened Webs	D6.10.9.1 6.10.9.3 D6.10.9.3.3	Uncured Slab Strength I-V Construction	Strength I-II	Also checked during Construction and Uncured Slab for stiffened webs. Inventory rating for Strength I and operating rating for Strength IA and II
Types, Stud Pitch, Transverse Spacing, Cover and Penetration	D6.10.10.1	Strength I-V Fatigue	N/A	When computing maximum pitch, the use of positive or negative bending section properties is based on the stress in the deck reinforcement under composite dead loads and fatigue live load
Shear Connectors: Fatigue Resistance	D6.10.10.2	Fatigue	N/A	
Shear Connectors: Strength Limit State Resistance	D6.10.10.4	Strength I-V	N/A	
Stiffener Design	6.10.11	Strength I-V	N/A	Transverse, longitudinal, and bearing stiffener checks
Transverse Intermediate Stiffeners	D6.10.11.1	Strength I-V	N/A	
Bearing Stiffeners	6.10.11.2	Strength I-V	N/A	
Longitudinal Stiffeners	6.10.11.3	Strength I-V	N/A	If the term "0.6 * F_{yc} / R_h * F_{ys}" in equation 6.10.11.3.3-2 is ≥ 1.0, set it to 0.99999
Yield Moment	AASHTO Appendix D6.2	Strength I-V Construction	Strength I-II Service II-IIB	For negative bending, the yield capacity of the deck reinforcement will be checked as well.

Table 3.7-1 Summary of Specifications Checked (Continued)

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Depth of the Web in Compression	AASHTO Appendix D6.3.1	Strength I-V Construction	Strength I-II Service II-IIB (when governed by web bend-buckling)	For sections in positive bending, the calculation of D_c is based upon flange flexural stresses (LRFD Specifications Equation D6.3.1-1). For sections in negative bending, D_c is based on the section consisting of the steel girder plus the longitudinal reinforcement.
Concentrated Loans Applied to Webs Without Bearing Stiffeners	AASHTO Appendix D6.5	Strength I-V Construction	Strength I-II	Checked for rolled beams only. The program assumes all plate girder and built-up sections require bearing stiffeners at concentrated load locations.

3.7.1 Cross-section Proportion Limits

In accordance with LRFD Specifications Article 6.10.2 and the corresponding section of DM-4, web and flange proportions are checked as described below:

3.7.1.1 Web Proportions

Webs are checked according to LRFD Specifications Article 6.10.2.1.1 for webs without longitudinal stiffeners and LRFD Specifications Article 6.10.2.1.2 for webs with longitudinal stiffeners. For analysis runs of the program, if these criteria cannot be satisfied, the program will continue the analysis and report a web proportions failure in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output report. For design runs of the program, if these criteria cannot be satisfied, the section will be considered inadequate and a new section will be tried.

3.7.1.2 Flange Proportions

Compression and tension flanges are checked according to LRFD Specifications Article 6.10.2.2. For analysis runs of the program, if these criteria are not satisfied, the program will continue the analysis and report a web proportions failure in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output report. For design runs of the program, if these criteria cannot be satisfied, the section will be considered inadequate and a new section will be tried.

3.7.2 Ductility Requirements

Ductility requirements are presented in LRFD Specifications Article 6.10.7.3 and the corresponding section of DM-4. For composite cross sections in positive flexure, the section must satisfy LRFD Specifications Equation 6.10.7.3-1. For analysis runs of the program, if this criterion cannot be satisfied, the program will continue the analysis and report a ductility failure in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output report. For design runs of the program, if this criterion cannot be satisfied, the section will be considered inadequate and a new section will be tried.

3.7.3 Depth of the Web in Compression (Calculation of D_c)

For the purposes of any equation (except as noted herein) requiring the depth of the web in compression, D_c, the program calculates D_c using the appropriate stresses in the compression and tension flanges for each analysis point per AASHTO Appendix D6.3.1.

3.7.4 Uplift

For each support, the program computes the minimum factored reactions using the maximum or minimum load factor for each individual loading such that the factored uplifts are maximized. Similarly, it computes the maximum factored reactions using the maximum or minimum load factor for each individual loading such that the factored uplifts are minimized.

During calculations of the maximum and minimum reactions, the total factored reactions are calculated both with and without the load due to future wearing surface (FWS). The reactions reported in the program output are the worst of these combinations, either with or without the FWS load. The worst case for minimum reaction is either the most negative (uplift) or smallest positive (downward) reaction, while the worst case for maximum reaction is the largest positive reaction or the least negative reaction.

If uplift is found to be present, based on the factored reactions for the Service-IIA limit state only, the program prints an asterisk (*) in the output table of factored reactions in the right hand column labeled "* If Uplift." If uplift occurs for Service-IIA, tie-downs, anchorages, or counterweights must be designed to resist the factored net uplift force at the Strength-I limit state, as described in DM-4 Section 14.6.1. Total reactions are printed for all limit states, but only Service-IIA is checked for uplift.

3.7.5 Pedestrian Loading

Pedestrian loading is used in the computations for limit state Strength IP only. Pedestrian loading does not affect any other limit state in any way. Pedestrian live load and vehicular live load are combined in accordance with the load factors for limit state Strength IP, as presented in Table 3.5-2.

The live load deflection check for pedestrian live load is based on the following equation:

$$\frac{L}{1000} \geq \left(\frac{\Delta_{pedestrian}}{Number\ of\ Beams} + \frac{\Delta_{vehicle}(Number\ of\ Lanes)}{Number\ of\ Beams}\right) \times MPFactor_{including\ sidewalks} \times MPAFactor$$

where: L = span length

$\Delta_{pedestrian}$ = total deflection due to pedestrian live load acting on all beams in the structure cross section

Number of Beams = total number of beams for the structure cross section

$\Delta_{vehicle}$ = total deflection due to one lane of vehicular live load

Number of Lanes = total number of lanes of vehicular live load, accounting for the presence of the sidewalks

$MPFactor_{including\ sidewalks}$ = Multiple Presence Factor as per LRFD Specifications Table 3.6.1.1.2-1 based on the number of loaded lanes counting pedestrian loads as one loaded lane

MPAFactor = Multiple Presence Adjustment Factor defined in LRFD Specifications Article C3.6.1.1.2. DM-4 deletes this portion of the article so the value is always taken as 1.0

In the above formula, the program sets the vehicular deflection distribution factor with sidewalks equal to (Number of Lanes with Sidewalks) / (Number of Beams) x Multiple Presence Factor x Multiple Presence Adjustment Factor. However, the user can enter a different vehicular deflection distribution factor with sidewalks to be used for the live load deflection check. See Section 5.7, GEO command, parameter 7.

3.7.6 Web-To-Flange Weld Design

For both design and analysis runs, the program will compute the required size of fillet weld between the web and flanges at all analysis points for all applicable limit states. For design runs, the program also reports the single acceptable size of weld for the top and bottom flanges separately. The program uses the following procedure:

1. Compute factored total shear flow, s_u, transferred through the welds to each flange:

$$s_u = \frac{V_{DC1}Q_{N/C}}{I_{N/C}} + \frac{(V_{DC2} + V_{DW})Q_{3n}}{I_{3n}} + \frac{V_{LL}Q_n}{I_n}$$

where: V_{xx} = factored shear for each load (DC1, DC2, DW, LL)

Q_{xx}	= first moment of flange area about neutral axis of the section (for composite sections, this includes the deck or reinforcement where appropriate) (N/C = noncomposite, 3n = long term composite, n = short term composite)
I_{xx}	= moment of inertia of section

2. Compute factored resistance of the weld, $R_{r,weld}$, and the connected material, $R_{r,material}$ as:

Weld (AASHTO LRFD Equation 6.13.3.2.4b-1):

$$R_{r,weld} = 0.6\varphi_{e2}F_{exx}$$

where:

ϕ_{e2}	= resistance factor for shear on throat of fillet weld (0.80)
F_{exx}	= classification strength of the weld metal

Connected Material (AASHTO LRFD Equation 6.13.5.3-2):

$$R_{r,material} = 0.58\varphi_v F_y$$

where:

ϕ_v	= resistance factor for shear in connected material (1.00)
F_y	= yield strength of connected material

3. Compute the required size of fillet weld by setting the allowable shear flow to the actual shear flow and solving for the weld size.

allowable shear flow:

$$s_r = 2R_{r,weld}\left(\frac{L_{weld}}{\sqrt{2}}\right)$$

where:

s_r	= shear flow resistance of both welds
2	= weld on both sides of the web
$R_{r,weld}$	= resistance of the weld
$\frac{L_{weld}}{\sqrt{2}}$	= effective throat of the weld, assuming two equal leg lengths (shortest distance from the joint root to the weld face).

Set:

$$s_u = s_r$$

where: s_u = factored total shear flow (from step 1)
s_r = shear flow resistance of both welds (immediately above)

After substituting and rearranging, this reduces to:

$$L_{weld} = \frac{s_u\sqrt{2}}{2R_{r,weld}}$$

4. Check required size for factored shear flow against maximum and minimum size of fillet weld. Minimum fillet weld size is based on the base metal thickness in AASHTO LRFD Table 6.13.3.4.1:

Table 3.7-2 Minimum Size of Fillet Welds

Base metal thickness of thicker part joined	Minimum size of fillet weld
T<= 3/4"	1/4”
3/4” < T	5/16”

Maximum size of fillet weld is based on the base metal thickness as specified in AASHTO LRFD Section 6.13.3.4. For material less than 0.25” thick, the maximum weld size is the thickness of the material. For material that is greater than or equal to 0.25” thick, the maximum weld size is 0.0625” less than the thickness of the material.

5. Compute shear flow resistance of the web and each flange, $s_{r,web}$, and $s_{r,flange}$:

$$s_{r,web} = R_{r,web}t_{web}$$

where: $R_{r,web}$ = resistance of the web
t_{web} = thickness of the web

$$s_{r,flange} = R_{r,flange}t_{flange}$$

where: $R_{r,flange}$ = resistance of the flange
t_{flange} = thickness of the flange

Check the resistance of the material against the factored shear flow (s_u<=$s_{r,material}$).

3.7.7 Wind Calculations

Wind load computations and applications, as used in this program, are described in LRFD Specifications Article 3.8 and the corresponding section of DM-4, and LRFD Specifications Articles 4.6.2.7, and 6.10.1.6.

The program applies the wind effects both on construction and permanent structure condition when the user chooses to include wind effects for the analysis or design. Wind loads affect limit states Strength III, Strength V, and Construction/Uncured Slab II only. For the permanent condition, the user has the option of directly entering a wind pressure or having the program compute a wind pressure based on structure height, wind exposure category condition and wind speed. For the temporary condition, the user must enter a wind pressure.

3.7.7.1 Permanent Condition

For the permanent condition, the user has the option of having STLRFD compute the wind pressure to be used in computing the wind force (using the WPD command, Section 5.36) or directly entering the wind pressure used to compute the wind force (using the WUD command, Section 5.37).

If the program is to compute the wind pressure, the LRFD Specifications Equation 3.8.1.2.1-1 is used:

$$P_Z = 2.56 \times 10^{-6} V^2 K_Z G C_D$$

where: P_Z = design wind pressure

V = design 3-second wind gust, from LRFD Specifications Table 3.8.1.1.2-1
for Strength-III, this is entered by the user and determined from the LRFD Specifications, Figure 3.8.1.1.2-1
for Strength-V, 80 mph is used

K_Z = pressure exposure and elevation coefficient
for Strength-III, calculated from LRFD Specifications Equations 3.8.1.2.1-2, -3, or -4, depending on the user-input wind exposure category
for Strength-V, use 1.0

G = gust effect factor taken as 1.0 for all limit states

C_D = drag coefficient taken as 1.3 for all limit states

The design wind pressure (either computed as described above, or user input) is then used to compute the total wind force acting on the girder:

$$W = P_z d_{total}$$

where: W = wind force acting on entire cross section

P_Z = design wind pressure

d_{total} = total depth of the cross section
= beam depth + haunch depth + slab thickness + user input additional wind cross section

The design wind pressure is then used to calculate the wind force acting on the bottom flange.

The design wind pressure (either calculated from the wind speed or entered by the user) is then used to calculate the wind force resisted by the bottom flange (wind force acting on the top flange is assumed to be resisted by the top flange acting with the deck), by using LRFD Specifications Equation C4.6.2.7.1-1.

For the permanent condition, the lateral stress due to wind is considered for the bottom flange only, as the deck is assumed to provide diaphragm action to resist the lateral wind loads for the top flange. The wind force from wind acting on the lower half of the girder only (from middepth of the beam to the bottom of the bottom flange) is computed and then used in LRFD Specifications Equations C4.6.2.7.1-2 or C4.6.2.7.1-3 to compute the wind moment for the bottom flange. The choice of equation is based on the wind condition input by the user; for a frame or truss load path wind moment is computed as per LRFD Specifications Equation C4.6.2.7.1-2 and for a flange subjected to lateral forces the wind moment is calculated as per LRFD Specifications Equation C4.6.2.7.1-3. The lateral stress is then computed from the wind moment. This is performed by dividing the computed wind moment by the section modulus about the horizontal axis of the bottom flange to obtain a first order stress. If the flange is in compression, the bottom flange is then checked to see if the first order stress should be amplified using a second order approximation, as per LRFD Specifications Equation 6.10.1.6-2. If a second order approximation is required, the lateral stress is computed per LRFD Specifications Equation 6.10.1.6-4. If a first order analysis is sufficient, the program will use the previously calculated first order lateral stress for the wind effects.

The calculated lateral stress is also applied differently to the bottom flange if the flexural capacity is moment governed or stress governed. If the section under consideration is moment governed, then the program uses a section modulus equal to M_{yt}/F_{yt}, the yield moment of the tension flange divided by the yield stress of the tension flange, as per LRFD Specifications Article 6.10.7.1, to compute an effective moment due to the lateral wind stress. If the section under consideration is stress governed, the program adds the lateral stress and flexural stress to achieve a total applied stress for the bottom flange. The total stress is then compared against the flexural resistance for the bottom flange for each analysis point.

3.7.7.2 Temporary (Construction/Uncured) Condition

For the construction and uncured slab specification checks, the user must enter the wind pressure acting on the girder. Information on determining the wind pressure for the temporary condition can be found in BD-620M and DM-4 Article C3.4.2.1.

The program does not use the user input additional cross section for the temporary state. The depth of the beam plus the haunch and deck (if present) are used to compute the wind force. For the construction checks, the cross section changes for each deck pour, and also changes depending on the current analysis point. The deck and haunch are assumed to be present for the pour in which they are placed and all pours thereafter. For the uncured slab condition, the deck and haunch are assumed to be present over the entire length of the girder.

For the construction/uncured slab condition, the lateral stress due to wind is considered for both top and bottom flanges. As per the LRFD Specifications Article 4.6.2.7.1, the wind load is distributed to the top and bottom flanges by applying the lever rule.

The wind force is computed for each flange, with corresponding wind moments resisted by each flange. The user also has the option of entering a different load path for the construction/uncured slab condition as opposed to permanent conditions. The lateral stresses are then computed from the top and bottom flange wind moments as per LRFD Specifications Article 6.10.1.6, similar to the permanent condition. Due to the stress governed flexural capacity for constructability, the lateral stresses are added to the respective flexural stresses to achieve a total stress for each flange. As with the permanent condition, the total stresses are then compared against the flexural resistances for each flange for that analysis point.

3.7.8 Deck Overhang Load Effects

The deck overhang loads are used to compute lateral bending stresses in the top and bottom flanges for exterior girders during the deck pour construction stages and the uncured slab condition. Loads applied to the deck overhang brackets induce torsion on the exterior girders, which introduces flange lateral bending stresses.

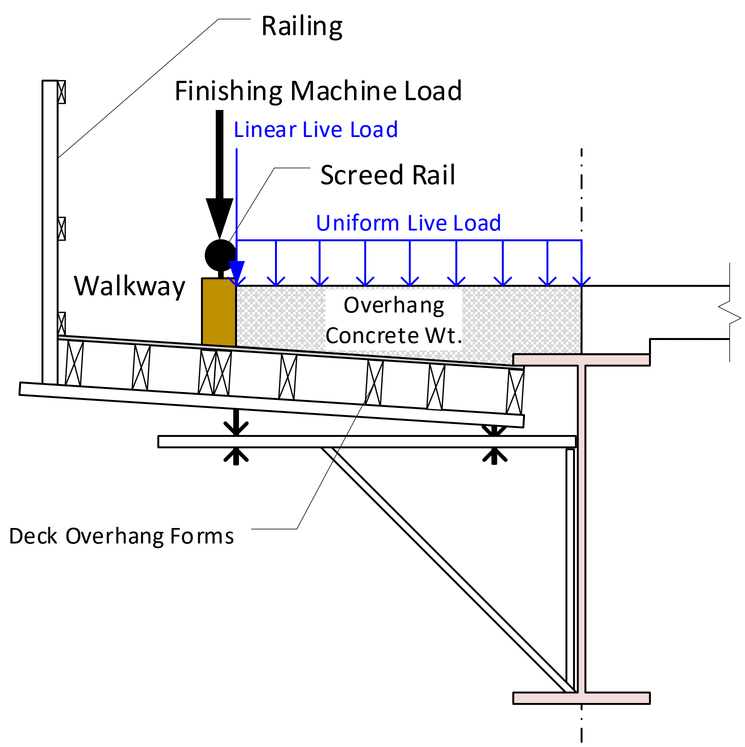


Figure 3.7-1 Typical Deck Overhang Configuration

The deck overhang bracket configuration assumed is shown in Figure 3.7-1. The brackets are typically spaced between 3 and 4 feet, but the assumption is made that the loads are uniformly distributed, except for the finishing machine. Half of the overhang weight is assumed to be carried by the exterior girder, and the remaining half is carried by the overhang brackets. The lateral force acting on the girder section due to the vertical loading is computed as follows.

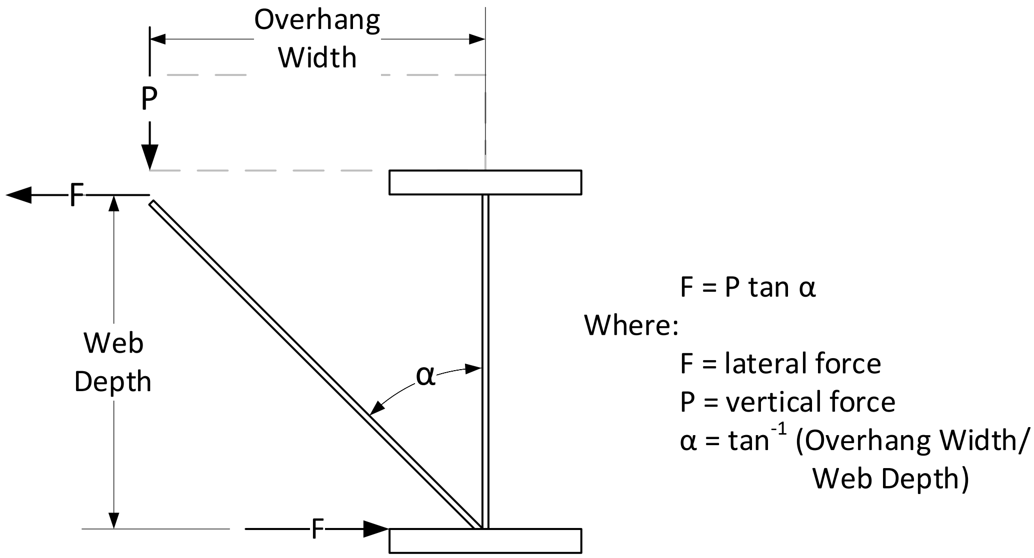


Figure 3.7-2 Idealized Free Body Diagram

The lateral bending moment for the uniformly distributed forces and concentrated forces is computed from the equations provided in Article C6.10.3.4.1. Conservatively, the maximum lateral bending moment within the unbraced length is used in the specification check for all analysis points within the unbraced length. The lateral stress is then computed from the lateral moment using the section modulus of each flange plate about the horizontal axis of the flange plate. This is a first-order lateral stress. If the flange is in compression, the flange is then checked to see if the first order stress should be amplified using a second-order approximation, as per LRFD Specifications Equation 6.10.1.6-2. The lateral stresses are added to the respective flexural stresses to achieve a total stress for each flange. The total stresses are then compared against the flexural resistances for each flange for that analysis point. Deck overhang loads affect limit states Construction/Uncured Slab I and Construction/Uncured Slab II only.

3.7.9 Specification Check Warnings and Failures

Specification warnings and check failures, for both analysis and design runs, are indicated in the output in several ways. The most common way that specification check failures are indicated is with an asterisk (*) in an output table column labeled "* If Code Failure." When this column is included in an output table, it is the rightmost column of the table. This column is commonly used to indicate that a factored load effect exceeds the factored resistance value, and both of these values are also presented in the output table.

If more than one code warning or failure is possible, this column may use letters (for example, A, B, C, and D), accompanied by a legend immediately following the table which presents a description of the specification checking failure corresponding with each letter. This column may also use two asterisks (**) if another column within that output table uses a single asterisk (*). For additional details about specification checking failure symbols and legends, refer to Chapter 7.

In addition, the program prints two separate lists of all output tables for which one or more specification checks have either generated warnings or failed. These lists are printed at the end of the output, and a separate list is printed for each live loading. Therefore, a good starting point for the user is to look at these lists and then refer to each output table that is included in this list to find out the specific location and nature of the specification check warning or failure. This list may include tables that were not selected by the user to be printed. In addition, this list is based on specification checking at twentieth points and additional analysis points. Therefore, if the user chooses to have fewer analysis points printed in the output, the program may also print failure points that were not selected by the user as printable points. This is to prevent the situation where a table may be included in this list for which there appears to be no specification check warning or failure.

3.7.10 Economic Feasibility Checks

The following checks provide a guideline for the designers regarding different economic feasibility checks. The designer should evaluate each of the following guidelines for validity as it pertains to the specific structure in question. The guidelines are based on the LRFD Specifications, DM-4, BD-613M and NSBA document G 12.1-2003 (Guidelines for Design for Constructability). These are not the only economic feasibility checks that should be done. The designer should review all references for other checks that are beyond the scope of STLRFD.

The checks are subdivided into six categories; checks that are done once for the entire girder, for each span, each girder cross section change, each transverse stiffener range, each longitudinal stiffener range and each girder field section (defined as the ranges between defined field splices). The parameters that are checked for this purpose and their guideline limits are given in Table 3.

Table 3.7-3 Economic Feasibility Checks

Parameters Checked	Guideline Criteria for Economic Feasibility Checks	References
Entire Girder		
Minimum preferred beam spacing	A minimum girder spacing of 10 ft is suggested for economical results.	DM–4 PP4.3.1(2)
Maximum beam spacing	Maximum spacing of 15 ft	DM–4 PP3.2.1
Minimum number of girders	Minimum of four girders per bridge is required.	DM–4 PP3.2.1 and DM-4 PP4.3.1(2)
User must verify availability for rolled beams	It is up to the user to determine if the rolled beam chosen by the program (design runs) or entered by the user (analysis runs) is readily available.	
Composite beam preferred	Composite design is preferred for simple span and continuous bridges. Noncomposite design may be used if it is more economical than composite design.	DM–4 PP4.3.3
Overhang	The standard form support system may be used when the deck slab overhang is less than 4'-9"	DM–4 6.10.3.2.5.2P(a2)
Actual slab thickness	The standard form support system may be used when the actual deck slab thickness is less than or equal to 10 in.	DM–4 6.10.3.2.5.2P(a3)
Spans		
Avoid haunched girders	Avoid haunched girders by using parallel flanges.	NSBA G 12.1-2003 2.3.6.2
Haunched girder span over 400 ft	Haunched girder design should not be considered for most conventional cross sections until spans exceed 400 ft.	DM–4 PP4.3.1(8)
Straight haunch preferred over curved	For haunched girders, a straight (linearly varying) taper is more cost effective.	NSBA G 12.1-2003 2.3.6.2
Span<300 ft avoid using longitudinal stiffeners	Longitudinally stiffened designs should not be considered for spans less than 300 ft.	DM–4 PP4.3.1(5)
Nominally stiffened interior girder	Interior girders are to be designed as nominally stiffened (not stiffened the full length of the girder). This check passes for girders where the transverse stiffener spacing exceeds the allowable at some point along the girder.	

Table 3.7-3 Economic Feasibility Checks (Continued)

Parameters Checked	Guideline Criteria for Economic Feasibility Checks	Reference
Spans (Continue)		
For spans > 300' lateral bracing should be provided	If a given span is greater than 300' long, lateral bracing should be provided to aid in the construction of the bridge.	BD–620M (Sept. 2010)
Use "T" load path for lateral bracing for spans > 300'	For exterior girders with spans > 300', choose "T" (truss action) as the permanent load path on the WPD or WUD input commands.	BD–620M (Sept. 2010)
For 200' <= spans <= 300', evaluate need for lateral bracing	If given span is between 200' and 300' inclusive, the designer shall evaluate the need for lateral bracing based on lateral deflection.	BD–620M (Sept. 2010)
For spans < 200' avoid lateral bracing.	Girders shall be designed so that no lateral bracing is necessary for girder spans less than 200'.	BD–620M (Sept. 2010)
Do not use "T" load path for lateral bracing for spans < 200'	For exterior girders with spans < 200', do not choose "T" (truss action) as the permanent load path on the WPD or WUD input commands.	BD–620M (Sept. 2010)
Girder Cross Section Range		
Actual slab thickness	The standard form support system may be used when the actual deck slab thickness is less than or equal to 10 in.	DM–4 6.10.3.2.5.2P(a3)
Web thickness	Web thickness should not less than 7/16”. Preferred thickness is 1/2”	NSBA G 12.1-2003 Table 1.3.A
Flange thickness	Flange thickness should not less than 3/4”.	NSBA G 12.1-2003 Table 1.3.A
Flange width	Flange width should not be less than 12”. For rolled beams, if either the wide flange section flange width or cover plate width are less than 12", a failure will be shown here.	
Change in top flange plate area at transition	Flange cross-sectional area should be reduced by no more than approximately one-half of the area of the heavier flange plate to reduce the build-up of a stress at transition.	DM–4 PP4.3.1(7a)

Table 3.7-3 Economic Feasibility Checks (Continued)

Parameters Checked	Guideline Criteria for Economic Feasibility Checks	Reference
Girder Cross Section Range		
Change in bottom flange plate area at transition	Flange cross-sectional area should be reduced by no more than approximately one-half of the area of the heavier flange plate to reduce the build-up of a stress at transition.	DM–4 PP4.3.1(7a)
Minimum girder depth-to-span ratio	The ratio of the girder depth to the span length is recommended to not be less than 0.033 for simple spans and 0.027 for continuous spans.	LRFD Specifications 2.5.2.6.3
Minimum total depth-to-span ratio	The ratio of the total depth (girder + haunch + slab) is recommended to not be less than 0.040 for simple spans and 0.032 for continuous spans.	LRFD Specifications 2.5.2.6.3
Web depth	The standard form support system may be used when the girder web depth is less than 8'-0"	DM–4 6.10.3.2.5.2P(a1)
Weight savings in top flange due to transition	700 lb of flange material should be saved to justify the introduction of a flange transition. This check passes if the weight saved over the length of the smaller plate is greater than 700 lb.	DM–4 4.3.1(7)
Weight savings in bottom flange due to transition	700 lb of flange material should be saved to justify the introduction of a flange transition. This check passes if the weight saved over the length of the smaller plate is greater than 700 lb.	DM–4 4.3.1(7)
Web depth	The standard form support system may be used when the girder web depth is less than 8'-0"	DM–4 6.10.3.2.5.2P(a1)
Weight savings in top flange due to transition	700 lb of flange material should be saved to justify the introduction of a flange transition. This check passes if the weight saved over the length of the smaller plate is greater than 700 lb.	DM–4 4.3.1(7)
Weight savings in bottom flange due to transition	700 lb of flange material should be saved to justify the introduction of a flange transition. This check passes if the weight saved over the length of the smaller plate is greater than 700 lb.	DM–4 4.3.1(7)

Table 3.7-3 Economic Feasibility Checks (Continued)

Parameters Checked	Guideline Criteria for Economic Feasibility Checks	Reference
	Transverse Stiffener Range	
Transverse stiffener thickness	Transverse stiffener thickness should not less than 7/16”. Preferred thickness is 1/2”.	NSBA G 12.1-2003 Table 1.3.A
Transverse stiffener spacing	For both exterior and interior girders, 8” or 1.5*Plate Width for welding access	NSBA G 12.1-2003 2.2.3
Transverse stiffener only on one side	Transverse stiffeners (except diaphragm connections) should be placed on only one side of the web	DM–4 PP4.3.1(3a)
Avoid same side longitudinal and transverse stiffeners	Longitudinal stiffeners used in conjunction with transverse stiffeners on longer spans with deeper webs should preferably be placed on the opposite side of the web from the transverse stiffener. This check fails for the following situations: 1. If transverse stiffeners are provided on both sides for any given range and longitudinal stiffeners are provided in the same range. 2. If longitudinal stiffeners are provided on both sides for any given range and transverse stiffeners are provided in the same range.	DM–4 PP4.3.1(3b)
Exterior girder transverse stiffener spacing	The standard form support system may be used when transverse stiffener spacing on the exterior girder does not exceed the depth of the girder.	DM–4 6.10.3.2.5.2P(a4)
	Longitudinal Stiffener Ranges	
Longitudinal stiffener thickness	Longitudinal stiffener thickness should not less than 7/16”. Preferred thickness is 1/2”.	NSBA G 12.1-2003 Table 1.3.A
	Field Sections	
Top flange width constant in field section	Keep flange widths constant within an individual shipping length.	DM–4 PP4.3.1(7)
Top flange transitions in section <= 130 ft	Use no more than three plates (two shop splices) in the top or bottom flange of field sections up to 130' long.	DM–4 PP4.3.1(6)
Bottom flange transitions in section <= 130 ft	Use no more than three plates (two shop splices) in the top or bottom flange of field sections up to 130' long.	DM–4 PP4.3.1(6)

Table 3.7-3 Economic Feasibility Checks (Continued)

Parameters Checked	Guideline Criteria for Economic Feasibility Checks	Reference
Field Sections (Continued)		
Web thickness should only vary between field sections	Designs with web thickness which varies by field section are suggested. This check fails if the web thickness varies within a field section.	DM–4 PP4.3.1(4)
Hauling permit may need to be secured	Before initiating final design using lengths greater than 70' the designer must ensure that a hauling permit can be secured for the proposed length.	DM–4 PP4.3.7
Preliminary superload permit may be required	A girder with a weight of 147 kips or greater, or a length of 144 ft or greater, will require vehicular transportation which is classified as a superload.	DM–4 PP4.3.7

3.7.11 Field Splice Locations

At user-input field splice locations, the specification checks are performed assuming that the section is always noncompact. This causes the flexural capacity calculations to be done for a noncompact section, meaning that the flexural resistance of both flanges will be limited to the yield stress of the flanges, satisfying the implications of DM-4 C6.13.6.1.4a that if the factored stress on the flanges is limited to the yield stress, fracture on the flange is theoretically prevented. For purposes of reporting the flexural capacity in the SPLRFD Input Information output report, the flexural capacity is converted into terms of moment per Section 3.7.12. This is necessary since SPLRFD only accepts flexural resistances as moment resistances while all noncompact composite sections in positive flexure, composite sections in negative flexure, and noncomposite sections are analyzed in terms of stress. The user-input field splice locations also serve to break up the girder into field sections that are then used by the economic feasibility checks to do the checks for field sections of the girder.

3.7.12 Back Calculation of Moment Flexural Capacity Given Stress Flexural Capacity

For all locations that have stress-governed flexural resistance (mostly noncompact sections), an equivalent moment-governed flexural capacity is also computed and reported. This value is used for the SPLRFD input information (as described in Section 3.7.11) and can also be used to report the "maximum factored flexural resistance" on the bridge plans as described in DM-4 PP 1.8.3.

To compute the moment flexural capacity given stress flexural capacities, the following procedure is used as follows:

1. The program first calculates the total dead load stress in each flange as a sum of the noncomposite dead load stress and composite dead load moment:

$$f_c = f_{cDL1} + \frac{M_{DL2}}{S_{lt,comp}}$$

$$f_t = f_{tDL1} + \frac{M_{DL2}}{S_{lt,tens}}$$

$$M_{tot} = M_{DL1} + M_{DL2}$$

where: f_c = total stress in compression flange due to factored dead load (taken as negative when appropriate)

f_t = total stress in tension flange due to factored dead load

M_{tot} = total moment due to factored dead load

f_{cDL1} = stress in compression flange due to factored noncomposite dead load

f_{tDL1} = stress in tension flange due to factored noncomposite dead load

M_{DL1} = total factored noncomposite dead load moment

M_{DL2} = total factored composite dead load moment

$S_{lt,comp}$ = long term section modulus, compression flange

$S_{lt,tens}$ = long term section modulus, tension flange

2. The nominal capacities of the section are then computed relative to the top and bottom flanges:

$$M_{nc} = M_{tot} + S_{st,comp}\left(F_{rc} - f_c\right)$$

$$M_{nt} = M_{tot} + S_{st,tens}\left(F_{rt} - f_t\right)$$

where: M_{nc} = nominal flexural capacity of compression flange

M_{nt} = nominal flexural capacity of tension flange

F_{rc} = flexural stress resistance of compression flange (taken as negative)

F_{rt} = flexural stress resistance of tension flange

$S_{st,comp}$ = short term section modulus, compression flange

$S_{st,tens}$ = short term section modulus, tension flange

3. For the SPLRFD output, take the flexural capacity of the section as the minimum between the nominal flexural capacity of the compression flange and the nominal flexural capacity of the tension flange:

$$M_r = \phi_f \cdot MIN(M_{nc}, M_{nt})$$

where: φ_f = resistance factor for flexure

M_r = flexural resistance of section

For the flexural capacity output, both the top and bottom flange values are reported.

3.7.13 Net Section Fracture

STLRFD only considers a reduction in cross-sectional area due to section holes when checking Net Section Fracture per LRFD Specifications Article 6.10.1.8. For analysis runs of the program, the net area used in the Net Section Fracture checks is computed from the parameters entered in the SHO command.

For design runs of the program, because the section is constantly changing throughout the design process, the net area is computed using an "adjusted diameter" and the calculated maximum number of section holes within the tension (bottom) flange. This procedure is repeated for each trial rolled beam and plate girder section according to the method outlined in Section 3.7.11.1. Please note that Section 3.7.11.1 gives the method of solving for the number of bolt holes for each side of the web. The total number of bolt holes must be multiplied by 2 to get the total number of bolt holes in the flange.

For both design and analysis runs of the program, any sections with holes in the tension flange will be classified as noncompact, so the flexural capacity will be computed as per Article 6.10.7.2 or 6.10.8 and always be reported in terms of stress. If the net section fracture capacity is less than the tension flange capacity computed in Article 6.10.7.2 or 6.10.8, the net section fracture capacity will be reported as the flexural capacity of the tension flange. This also means that when the net section fracture capacity governs, it will also be used for computing the flexure rating of the tension flange.

3.7.13.1 Calculation of Field Splice Bolt Holes for Net Section Fracture Check (for design runs only)

1. The number of bolt holes is computed from the total width of the bottom flange, thickness of the web, and minimum bolt hole spacing (supplied from the FSL input) using the following equations:

$$N_{spaces} = \frac{\left(\frac{W_{FLB} - T_{WEB}}{2}\right) - MAX(e_{in,\min}, e_{in,adjusted}) - MAX(e_{out,\min}, e_{out,adjusted})}{MAX(S_{\min}, S_{adjusted})}$$

$$N_{holes} = N_{spaces} + 1$$

where:			
	N_{spaces}	=	Number of bolt hole spaces rounded down to the nearest integer
	N_{holes}	=	Number of bolt holes
	W_{FLB}	=	Total width of the bottom flange
	T_{WEB}	=	Total thickness of the web
	$e_{in,min}$	=	User input minimum inner edge distance (web edge to centerline of last bolt hole)
	$e_{in,adjusted}$	=	Adjusted inner edge distance (web edge to centerline of last bolt hole)
	$e_{out,min}$	=	User input minimum outer edge distance (edge of bottom flange to centerline of first bolt hole)
	$e_{out,adjusted}$	=	Adjusted outer edge distance (edge of bottom flange to centerline of first bolt hole)
	S_{min}	=	User input minimum spacing between bolt hole centerlines
	$S_{adjusted}$	=	Adjusted spacing between bolt hole centerlines

a) If the number of bolts is less than the minimum of one per side of the flange, the following condition cannot be satisfied and the trial section will be considered to have failed:

$$\left(\frac{W_{FLB} - T_{WEB}}{2}\right) \geq e_{out,\min} + e_{in,\min} + S_{\min}$$

b) If the number of bolt holes is greater than or equal to one per side of the flange, the bolt hole spacing and edge distances will be adjusted until the extra distance per space, S_{extra}, is less than the distance tolerance, $D_{tolerance}$, and the extra distance, D_{extra}, is also less than the distance tolerance, $D_{tolerance}$: For configurations with only one bolt hole per side, N_{spaces}, S_{extra} and $S_{adjusted}$ are set to zero.

$$D_{extra} = \left(\frac{W_{FLB} - T_{WEB}}{2}\right) - e_{out,min} - e_{in,min} - \left(N_{spaces} \cdot S_{min}\right)$$

$$S_{extra} = \frac{D_{extra}}{N_{spaces}}$$

If $\quad S_{extra} > D_{tolerance}$

Then $\quad S_{adjusted} = MAX\left(S_{\min}, S_{adjusted}\right) + D_{tolerance}$

$$D_{extra} = D_{extra} - \left(D_{tolerance} \cdot N_{spaces}\right)$$

End

If $D_{extra} > D_{tolerance}$

Then $e_{in,adjusted} = MAX\,(e_{in,\min}, e_{in,adjusted}) + D_{tolerance}$

$$D_{extra} = D_{extra} - D_{tolerance}$$

If $D_{extra} < D_{tolerance}$

Then $e_{out,adjusted} = MAX\,(e_{out,\min}, e_{out,adjusted}) + D_{tolerance}$

$$D_{extra} = D_{extra} - D_{tolerance}$$

End

End

where: D_{extra} = Extra distance within the flange per side of the web

$D_{tolerance}$ = Tolerance for distance increment (set to 0.125")

S_{extra} = Extra distance per space within the flange, per side of the web

This process will be repeated until the program can no longer increment the bolt spacing (S_{min} or $S_{adjusted}$) or the edge distances ($e_{in,min}$ and $e_{in,adjusted}$ or $e_{out,min}$ and $e_{out,adjusted}$).

c) If the number of bolt holes per side of the web is greater than 10, the bolt hole diameter will be incremented by $D_{tolerance}$ and the adjusted bolt hole spacing, $S_{adjusted}$, will be set equal to the values supplied in the 2007 DM-4 Table C6.13.2.6.1-1. The diameter adjustment is due to a limitation of the program. For most girder designs, the program will not adjust the diameter as the number of bolt holes will typically not exceed 10 per side of the web.

If $N_{holes} > 10$

Then $H_{diameter} = H_{diameter} + D_{tolerance}$

$S_{adjusted} = S_{2007DM-4}$

End

d) If the number of holes was greater than 10, repeat the field splice bolt hole calculation procedure from Step 1.

3.7.14 Concentrated Loads at Locations Without Bearing Stiffeners

For rolled beams, plate girders, and built-up sections, at supports and concentrated load locations, STLRFD performs checks for local yielding and crippling of the web to determine if bearing stiffeners are required. These checks are performed according the requirements of the LRFD Specifications Articles D6.5.2 and D6.5.3. The program conservatively assumes that the length of bearing, N, in Equations D6.5.2-2 and D6.5.2-3 is equal to k. For a rolled beam, k is the distance from the outer face of the flange to the web toe of the fillet. For a plate girder, k is conservatively assumed to be equal to the bottom flange thickness. For a built-up section, k is conservatively assumed to be equal to the bottom flange thickness or the angle thickness if the bottom flange is not defined.

STLRFD also then calculates the required bearing length, N_{req}, to satisfy both the web local yielding and web crippling requirements. For equations D6.5.2-2 and D6.5.2-3, R_u/ϕ_b is substituted for R_n, and the equations rearranged to solve for N_{req}.

For interior-pier reactions and for concentrated loads applied at a distance from the end of the member that is greater than d:

$$N_{req} = \frac{R_u}{\varphi_b F_{yw} t_w} - 5k \quad (D6.5.2-2)$$

Otherwise:

$$N_{req} = \frac{R_u}{\varphi_b F_{yw} t_w} - 2.5k \quad (D6.5.2-3)$$

where: d = depth of the steel section

N_{req} = required length of bearing

R_u = factored concentrated load or bearing reaction

ϕ_b = resistance factor for bearing

F_{yw} = web yield strength

t_w = web thickness

k = distance from the outer face of the flange resisting the concentrated load or bearing reaction to the web toe of the fillet (for rolled beams)
bottom flange thickness (for plate girders)
bottom flange thickness or angle thickness (for built-up sections)

The same substitution is made in equations D6.5.3-2, D6.5.3-3 and D6.5.3-4. D6.5.3-2 is rearranged and solved for N_{req} directly. D6.5.3-3 is rearranged and solved for N_{req}, then N_{req}/d is checked. If N_{req}/d is greater than 0.2, then D6.5.3-4 has to be rearranged and solved for N_{req}.

For interior-pier reactions and for concentrated loads applied at a distance from the end of the member that is greater than d/2:

$$N_{req} = \left(\frac{\dfrac{R_u}{\varphi_w (0.8 t_w^2) \left(\sqrt{\dfrac{E F_{yw} t_f}{t_w}} \right)} - 1}{3 \left(\dfrac{t_w}{t_f} \right)^{1.5}} \right) d \quad (D6.5.3-2)$$

Otherwise, the program first computes N_{req} using this expression:

$$N_{req} = \left(\frac{\dfrac{R_u}{\varphi_w (0.4 t_w^2) \left(\sqrt{\dfrac{E F_{yw} t_f}{t_w}} \right)} - 1}{3 \left(\dfrac{t_w}{t_f} \right)^{1.5}} \right) d \quad (D6.5.3-3)$$

If N_{req}/d from that expression results in N_{req}/d > 0.2, N_{req} is recomputed using the following expression:

$$N_{req} = \left(\frac{\dfrac{R_u}{\varphi_w (0.4 t_w^2) \left(\sqrt{\dfrac{E F_{yw} t_f}{t_w}} \right)} - 1}{\left(\dfrac{t_w}{t_f} \right)^{1.5}} + 0.2 \right) \frac{d}{4} \quad (D6.5.3-4)$$

where: d = depth of the steel section

N_{req}	= required length of bearing
R_u	= factored concentrated load or bearing reaction
ϕ_w	= resistance factor for web crippling
E	= elastic modulus of steel
F_{yw}	= web yield strength
t_f	= thickness of the flange resisting the concentrated load or bearing reaction
t_w	= web thickness

3.7.15 Negative Flexure Concrete Deck Reinforcement Checks

For multi-span analysis problems, composite sections in negative bending with tensile stress in the slab exceeding $\varphi^* f_r$ under the Service II limit state or construction staging are checked for the minimum negative flexure concrete deck reinforcement, based on the LRFD Specifications and DM-4 Article 6.10.1.7. The modulus of rupture, fr, is calculated either as described in the LRFD Specifications Section 6.10.1.7 or 5.4.2.6, based on whether the concrete is normal-weight or lightweight. For the purposes of the modulus of rupture calculation, concrete with a "Concrete Density for Ec" entered on the SLB command greater than 135 lb/ft^3 is considered to be normal-weight. A "Concrete Density for Ec" of less than or equal to 135 lb/ft^3 is considered to be lightweight.

The tensile stress in the slab for the Service-II limit state in negative flexure is calculated using the composite section properties with the "n" modular ratio. For the staging analysis, a modular ratio of n/0.7 is used. If the tensile stress in the slab does not exceed $\varphi^* f_r$, the deck reinforcement checks are not done.

Specific reinforcement at each interior support can be entered via the SST command, with multiple reinforcement sizes and locations (top or bottom) allowed for each support (the "Specific Reinforcement Area"). If the user chooses to not enter the specific details, an area of reinforcement per unit width of deck can be entered on the ABU, APL or ARB command as appropriate (the "Deck Reinforcing Area").

If the user has entered a Specific Reinforcement Area, the total area of reinforcement steel is calculated and assumed to be evenly distributed throughout the effective slab width and concentrated at the Deck Reinforcing CG Distance, defined on the ABU, APL or ARB command. The development lengths of each bar are calculated, and if a bar is not fully developed at the current location, the area of the bar is reduced by the ratio of the location of the analysis point relative to the bar development length when calculating the total area of reinforcement.

If the user has not entered specific reinforcement details, only the total reinforcement cross-sectional area and reinforcement yield strength checks are done from DM-4 6.10.1.7.

If the Specific Reinforcement Area is used, the maximum bar size and spacing checks are done, as well as the distribution of the reinforcement between the top and bottom rows. The largest longitudinal bar is used for the allowable spacing calculations, and this largest bar is also used to calculate an equivalent top bar spacing. That is, if two different sized bars are defined for the top reinforcement at a given analysis location, the total area is found, and then using the larger of the two bars, an equivalent spacing is calculated using the following equation:

$$s_{equivalent} = \frac{A_{biggestbar} * b_{eff}}{A_{totaltop}}$$

where: $s_{equivalent}$ = equivalent bar spacing

$A_{biggestbar}$ = area of the largest top bar defined in the slab at this location

b_{eff} = effective slab width

$A_{totaltop}$ = total area of longitudinal reinforcement at this location (modified for development considerations)

When doing the reinforcement distribution check, the program will generate a code failure if the area of reinforcement at the top of the slab is less than 2/3 of 1% of the slab area or if the area of reinforcement at the bottom of the slab is less than 1/3 of 1% of the slab area.

3.7.16 Web Specification Checks

Dead load web stress and shear limits are checked in accordance with DM-4 Article 6.10.1.9.3.

For all girders, these checks appear on the UNCURED SLAB WEB SPECIFICATION CHECK output report, checking the shear and flexural stress limits using only unfactored DC1, UT1, and MC1 loads.

For girders that are noncomposite in the final state, these checks also appear on the WEB SPECIFICATION CHECKS output report. For this instance, the shear and flexural stress effects include total unfactored effects from all loads - DC1, UT1, MC1, DC2, UT2, MC2, FWS, and LL.

For program runs that include deck pours, these checks are done for the condition after each deck pour, and the results appear on the CONSTRUCTION STAGE # WEB SPECIFICATION CHECK output reports.

3.7.17 Lateral Bending Stresses

The user has the option to enter a single value for lateral bending stress (CONSTANT LATERAL BENDING STRESS on the CTL command), or components of lateral bending stress that can vary by span (LAS commands). These lateral stresses are factored and added to the major-axis bending stresses calculated by the program for flexure checks as described by the LRFD Specifications (constructability, service and strength checks) and for the calculation of flexural rating factors by the program.

For straight girders, lateral stress should only be entered for girders with skews less than 70 degrees (PennDOT designation). If the skew is greater than 45 degrees and less than 70 degrees, a constant lateral bending stress can be used. The LRFD Specifications Article C.10.1 suggests using 10 ksi for interior girders and 7.5 ksi or 2 ksi for exterior girders. For straight girders with skews less than or equal to 45 degrees, a more detailed specification of lateral stresses per span should be used.

For both methods (single value or detailed specification), the unbraced length of the compression flange will be compared to the limit described in the LRFD Specifications Article 6.10.1.6. If the unbraced length exceeds the limit, the second order amplification factor will be calculated and applied to the factored first order stress.

3.7.17.1 Constant Lateral Bending Stress

The constant lateral bending stress is broken into components corresponding to the loads acting on the girder (noncomposite dead load, composite dead load, live load, etc.) based on the fractions of the stresses from the loads acting in major-axis bending. For strength and service limit states, the stresses due to each of the unfactored major-axis loads are computed, then added together. The constant lateral load stress is then multiplied by each individual stress and divided by the total stress to determine how much of the constant lateral load stress is applied with the major-axis effects. These components are then factored with the appropriate load factors to find the total lateral bending stress acting on the section.

$$f_{total} = f_{DC1} + f_{MC1} + f_{DC2} + f_{MC2} + f_{FWS} + f_{LL}$$

$$f_{lateral,DC1} = f_{constant} * \frac{f_{DC1}}{f_{total}}$$

$$\cdots$$

$$f_{lateral,LL} = f_{constant} * \frac{f_{LL}}{f_{total}}$$

$$f_{lateral,total} = f_{lateral,DC1} * LF_{DC1} + f_{lateral,MC1} * LF_{MC1} + \ldots + f_{lateral,LL} * LF_{LL}$$

where:
- f_{total} = total unfactored major-axis bending stress
- $f_{dc1,dc2,etc}$ = unfactored major-axis bending stresses
- $f_{lateral,dc1}$ = unfactored lateral bending stress
- $f_{constant}$ = user-input constant lateral bending stress
- LF_{DC1} = load factors
- $f_{lateral,total}$ = total factored lateral bending stress

When combining the lateral stresses with the major axis stresses, the lateral stresses are assumed to have the same sense (tensile or compressive) as the major axis stresses, so the lateral stresses will always have the effect of making the major-axis stresses worse. Depending on the specification check, one-half, one-third or all of the lateral stress is added to the major-axis effects, depending on the specification being checked.

For constructability specification checks, the total constant lateral bending stress entered by the user is assumed to act along with the other noncomposite dead loads, rather than being broken up into separate components as described above for strength and service checks.

$$f_{lateral,total\ constructibility} = f_{constant} * LF_{DC1}$$

where: $f_{total,\ constructability}$ = total factored lateral bending stress for constructability checks
$f_{constant}$ = user-input constant lateral bending stress
LF_{DC1} = load factor

The constant lateral bending stress is also factored by the same load factor as other noncomposite dead loads, and is added either by a factor of one-half or full stress to the major-axis stresses, depending on the specification being checked.

The constant lateral bending stress is recommended by the LRFD Specifications in the commentary to Article 6.10.1. The Specifications suggest a value of 10.0 ksi for interior girders and 7.5 ksi for exterior girders. In certain situations, the Specifications recommend a smaller value of 2.0 ksi for exterior girders.

3.7.17.2 Detailed Lateral Bending Stresses

The detailed stresses of the LAS command are factored directly by the program since the user enters separate unfactored stresses for each load type; no further breaking down into components is necessary. For constructability checks, only the noncomposite dead loads are factored and combined with the major axis stresses in both flanges. For the permanent condition strength and service checks, the lateral stresses are combined with the major-axis bending stresses as described in the relevant articles of the LRFD Specifications (6.10.4.2.2 for service checks, 6.10.7.1.1, 6.10.7.2.1, 6.10.8.1 for strength checks, as applicable).

3.7.18 Lateral Torsional Buckling Calculations

For sections in negative bending and noncomposite sections, STLRFD calculates lateral torsional buckling capacities throughout an unbraced length using the methods of LRFD Specifications Article 6.10.8.2.3 and, if applicable, Chapter 6, Appendix A or Chapter 6, Appendix D. Additionally, the maximum factored flexural stress or moment throughout the unbraced length combined with the maximum lateral stress throughout the unbraced length (maximum flexural stress may be from a different location than the maximum lateral stress; see LRFD Specifications 6.10.1.6) will be reported with the lateral torsional buckling capacity that results in the larger rating factor or performance ratio at each analysis point.

C_b, the moment gradient factor, is set to 1.0 if the girder is not prismatic throughout the unbraced length. A girder is considered not prismatic in an unbraced length if the net moment of inertia of the noncomposite girder changes within the unbraced length due to either of the flanges changing size or if the web depth changes. If only the web thickness changes, the unbraced length is considered prismatic.

STLRFD will ignore a plate transition for the purposes of lateral torsional buckling calculations (as per LRFD Specifications 6.10.8.2.3) if the transition is ≤ 20% of the unbraced length from the brace point with the smaller moment ("20% range") and the following two conditions are met:

1. The lateral moment of inertia of each flange of the girder section inside the 20% range is greater than or equal to 50% of the lateral moment of inertia of the same flange in the section outside the 20% range.
2. The web depth of the section inside the 20% range must be equal to the web depth of the section outside the 20% range (any web depth variance disqualifies the plate transition from being ignored). (Please refer to Figure 3.7-2)

Both of these criteria must be met for the transition to be ignored, regardless of the presence of other transitions anywhere in the unbraced length. If a plate change is ignored in the first 20% of the unbraced length and there are no other plate changes in the unbraced length, then the unbraced length can be considered prismatic, and C_b may be greater than 1.0. However, if the transition in the first 20% of unbraced length is from a larger section near the brace point to a smaller section further from the brace point, it will NOT be ignored if there are any other plate changes in the unbraced length (see Figure 3.7-4).

For construction staging checks, the unbraced length of the top flange will change for subsequent construction stages because the edge of a deck pour is considered to be a brace point for the top flange only. As the unbraced length of the top flange changes, so will the 20% distance, leading to the situation that a given analysis point may fall within an unbraced length that is considered prismatic for some stages and nonprismatic for later stages.

The program determines the end of the unbraced length with the smaller moment from the moments due to the self-weight of the girder alone. For brace ranges where the self-weight moments have different signs at each end of the unbraced length, the end with the smaller moment may be different depending on whether positive flexure or negative flexure is being checked for a series of analysis points. If checking negative bending (bottom flange compression), the end with the smaller moment will be the end that is in positive bending due to beam self weight. For checking of positive bending (top flange compression), the smaller moment end is the end under negative bending. This may lead to the condition where a given unbraced length is prismatic for positive bending checks but not prismatic for negative bending checks.

If there are other plate transitions in the unbraced length outside of the 20% limit, they will always be considered for lateral torsional buckling purposes, and the unbraced length will be considered not prismatic. Applicable plate changes in the first 20% will still be ignored, however. (Please refer to Figures 3.7-1, 3.7-2, 3.7-3, and 3.7-4)

The Appendix A criteria will only be considered for analysis points in an unbraced length if all analysis points in the unbraced length satisfy the Appendix A criteria. For situations where the Appendix A criteria do not apply, the lateral torsional buckling capacity will be calculated with only the methods of LRFD Specifications Article 6.10.8.2.3. Appendix A calculations are never done for construction stage or uncured slab flexural capacity calculations.

For situations where Appendix A does apply throughout an unbraced length, lateral torsional buckling capacities will be calculated with both the Appendix A criteria and the Article 6.10.8.2.3 criteria. The capacity that results in the larger rating factor (or performance ratio for non-rating limit states) will be used as the governing capacity of the section at each analysis point.

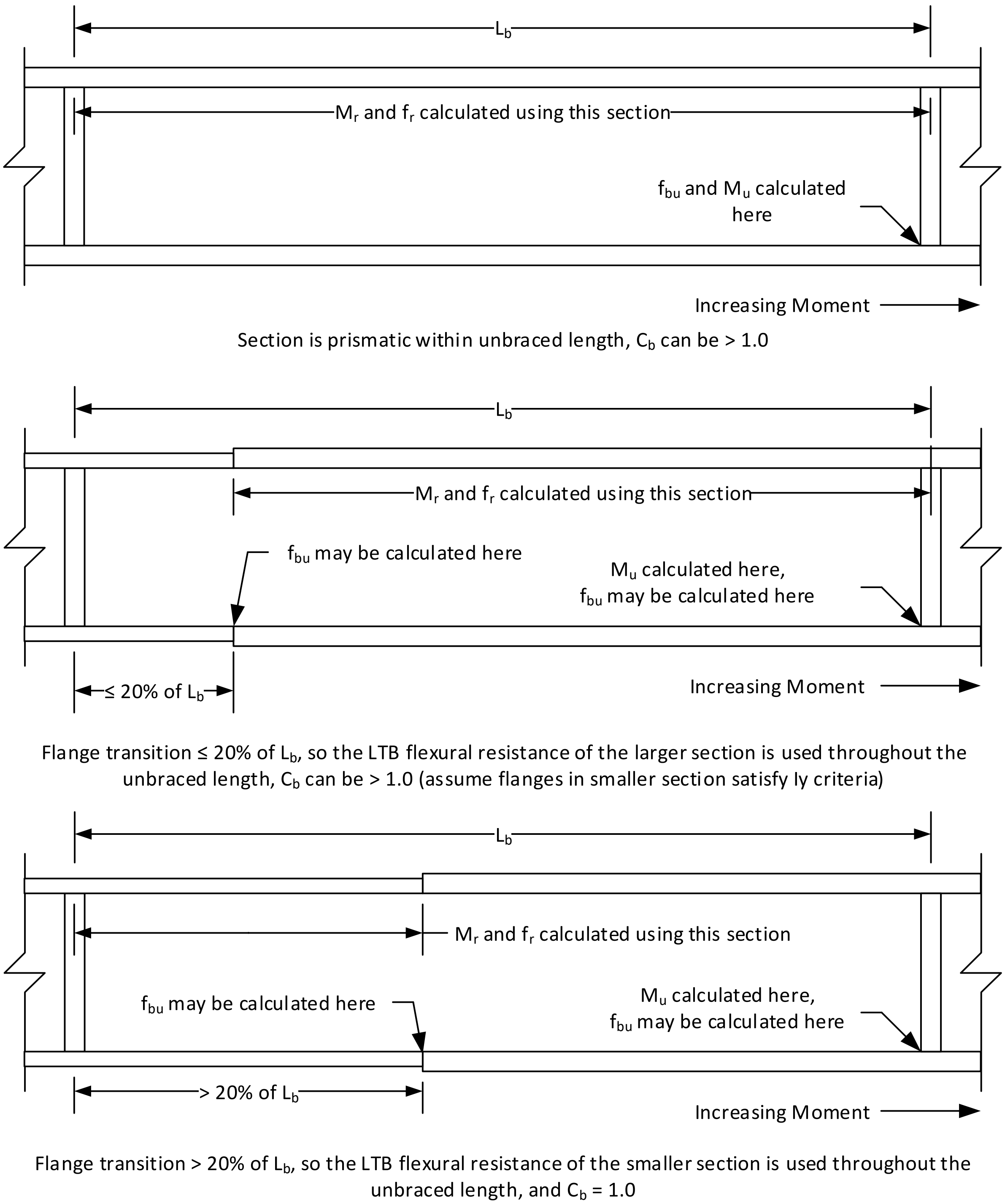
When Appendix A applies, the smallest Appendix A capacity in the unbraced length is found, then scaled to an equivalent moment flexural capacity at each analysis point by multiplying the smallest value by the ratio of the equivalent section modulus at the analysis point to the equivalent section modulus at the point of smallest flexural resistance (see the next-to-last paragraph of the LRFD Specifications Article A6.3.3). Occasionally, this scaled value will result in an Appendix A flexural capacity greater than the Appendix A flexural capacity calculated at that analysis point. When this occurs, the Appendix A flexural capacity from that analysis point will be reported as the governing Appendix A flexural capacity (NOT the scaled value).

When reporting the factored effect or calculating the rating factor for a given analysis point, the maximum effects throughout the unbraced length are used, either stress or moment. The maximum applied moment and maximum applied stress are likely to be computed at different locations in the unbraced length if the section is not prismatic in the unbraced length.

Due to the lateral torsional buckling calculations, each analysis point can have up to five flexural capacities reported:

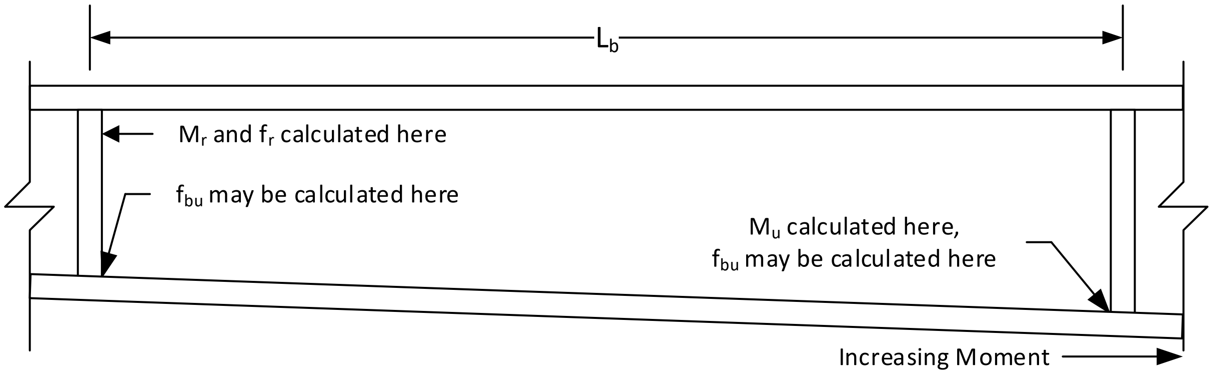
1. The local lateral torsional buckling flexural capacities calculated with the section properties at that analysis point (both 6.10.8.2.3 and Appendix A flexural capacities)
2. The governing lateral torsional buckling capacities at the analysis point (the minimum LTB capacity in the unbraced length) (both 6.10.8.2.3 and Appendix A flexural capacities)
3. The flexural capacity computed by means other than lateral torsional buckling (i.e. local buckling)

A check has been added to the program to generate a Chief Bridge Engineer warning for bracing ranges that have analysis points in negative flexure, a varying web depth, and flange transitions further than one foot from either end of the unbraced length. Girders that have this condition will still be analyzed as described in this section, but will need to obtain Chief Bridge Engineer approval for new construction.

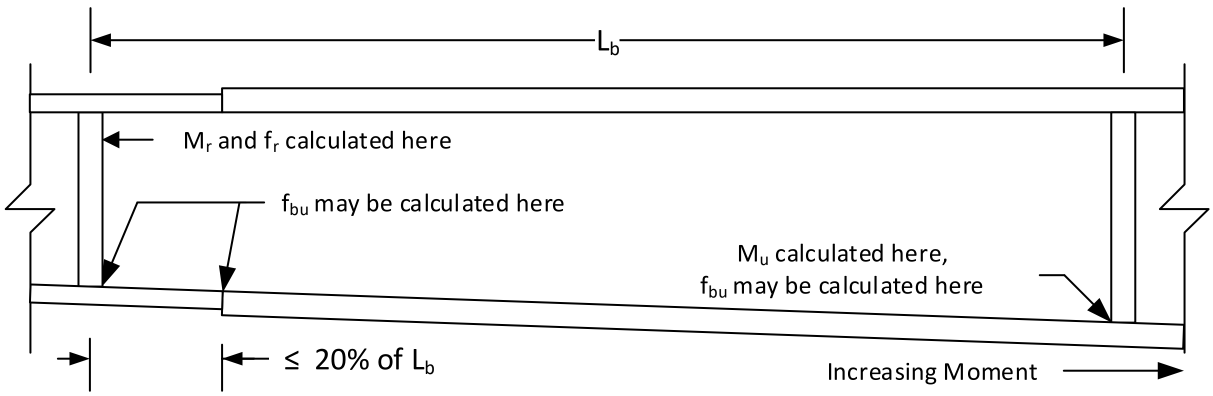


f_{bu} and M_u are defined in LRFD Specifications 6.10.1.6
LTB Flexural Resistance defined in 6.10.8.2.3 and A6.3.3

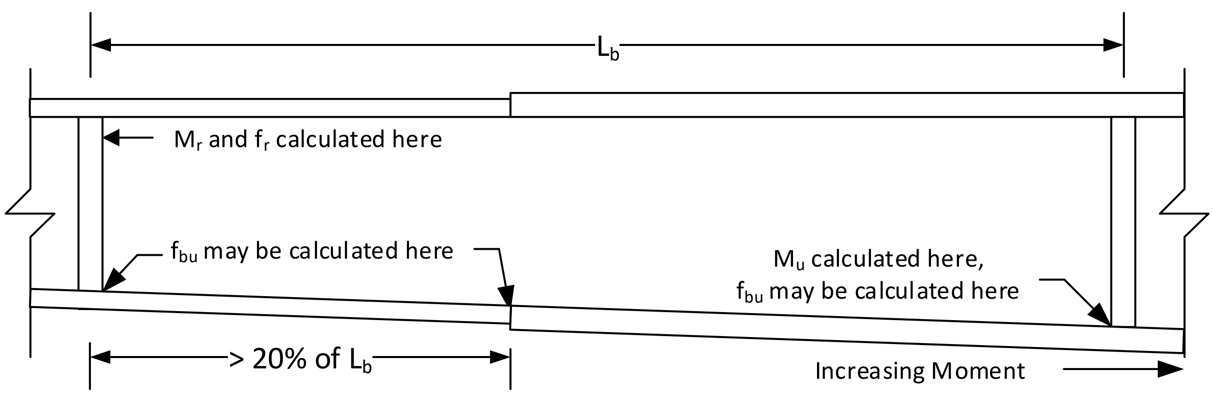
Figure 3.7-3 Lateral Torsional Buckling Example



Due to varying depth, section is not prismatic within unbraced length, C_b = 1.0



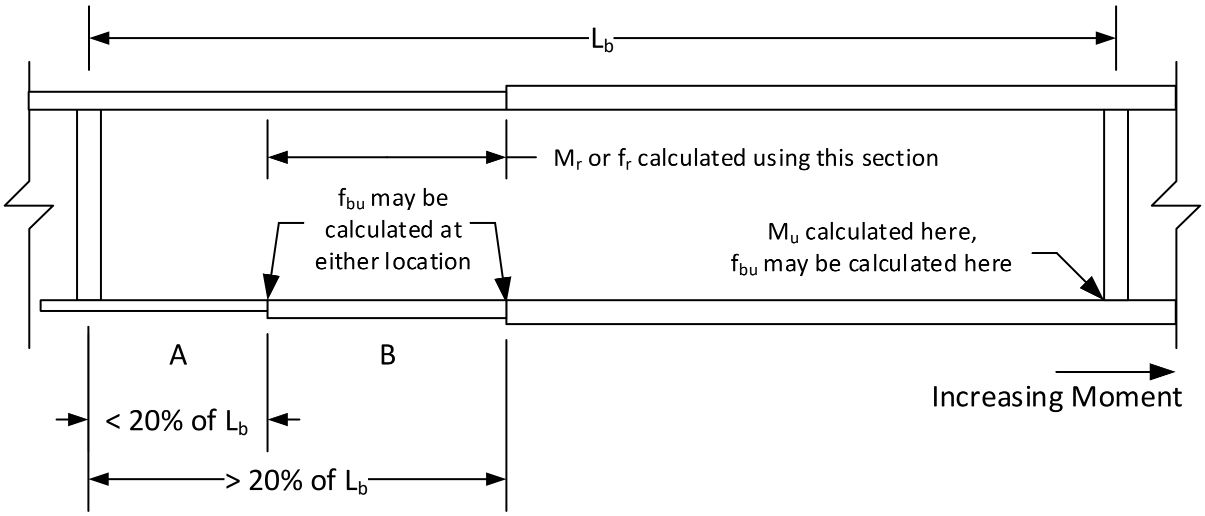
Flange transition ≤ 20% of L_b, but due to varying depth, the smaller section cannot be ignored.
Section is not prismatic within unbraced length, C_b = 1.0



Flange transition > 20% of L_b.
Section is not prismatic within unbraced length, C_b = 1.0

f_{bu} and M_u are defined in LRFD Specifications 6.10.1.6
LTB Flexural Resistance defined in 6.10.8.2.3 and A6.3.3

Figure 3.7-4 Lateral Torsional Buckling Example (Varying Depth Girder)



Section A can be ignored for the purpose of calculating M_r or f_r if the flanges meet the lateral moment of inertia requirements. Section B cannot be ignored since it extends past 20% of L_b. C_b = 1.0

f_{bu} and M_u are defined in LRFD Specifications 6.10.1.6

LTB Flexural Resistance defined in 6.10.8.2.3 and A6.3.3

Figure 3.7-5 Lateral Torsional Buckling Example (Multiple Transitions)

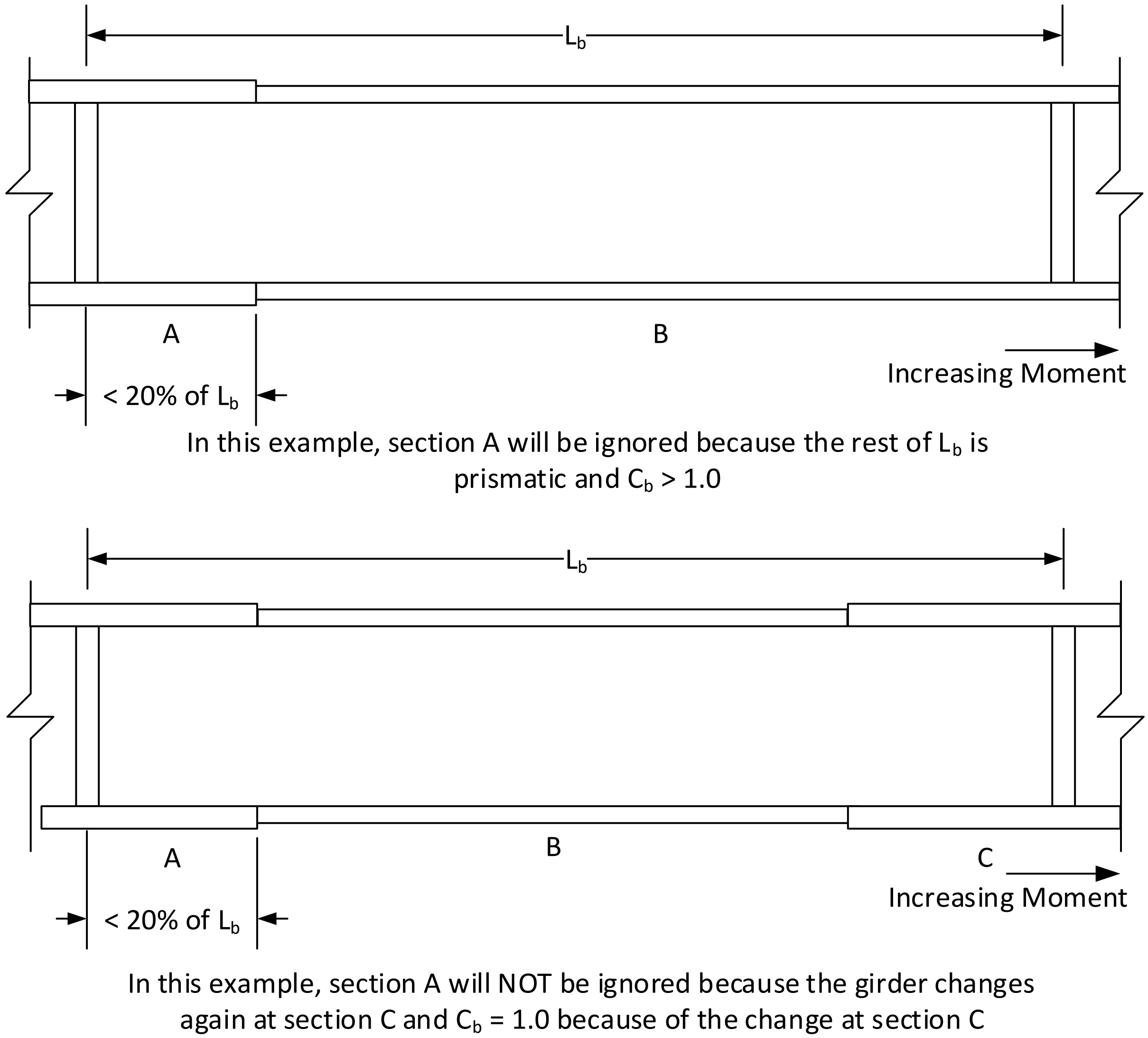


Figure 3.7-6 Lateral Torsional Buckling Example (Transition from larger to smaller section)

3.7.19 Global Displacement Amplification in Narrow I-Girder Bridge Units

For two, three, and four girder systems, the program calculates the elastic global lateral-torsional buckling resistance (M_{gs}) of each span acting as a system (LRFD Specifications Section 6.10.3.4.2), for construction stages as well as during the uncured slab check (entire slab placed simultaneously). The two, three, or four girder systems can have those number of girders in the final state or be specified as a smaller portion of a cross section with more girders in the final state. For example, a girder may be specified as part of a six girder cross section in the final state (NUMBER OF BEAMS parameter of the CTL command), but may be checked as part of a three girder cross section for the purposes of this check alone (NUMBER OF BEAMS FOR 6.10.3.4.2 CHECK on the GEO command). Specifying a smaller number of beams for this check may be desirable when analyzing a bridge for phased construction (building a portion of the final cross section first, then building the rest).

The procedure described in the LRFD Specifications 6.10.3.4.2 applies to two and three girder cross sections. However, the original research paper (Yura, et al, 2008, referenced in the LRFD Specifications) states that the simplified equation used by the LRFD Specifications may be used for two, three, or four girder sections by using the total distance between exterior girders for w_g in LRFD Specifications Equation 6.10.3.4.2-1.

To calculate the elastic global lateral-torsional buckling resistance for each span, the effective stiffness about the vertical axis (I_{eff}) and stiffness about the horizontal axis (I_x) are calculated using a weighted average of the values in the span. Separate values of each are calculated for positive and negative bending regions in each span. These regions are based on the **inflection points for the** factored total dead load moment in each span. The weighted average is calculated by finding I_{eff} and I_x at each analysis point **or inflection point**, and then multiplying it by the distance to the next analysis point **or inflection point**. These values in each region are added together, and then divided by the total length of the positive region in each span to find the weighted average value for the span. The same calculations are done for the negative region.

Because M_{gs} is assumed to be a value for the entire system (all beams) for each span, STLRFD assumes that all beams in the cross section are identical, and that the moments in each beam are identical. The maximum factored moment (positive and negative separately) in each span is multiplied by the number of beams (2, 3, or 4) and then compared to 70% of M_{gs} (either positive or negative). The maximum moment is factored for the Construction I limit state with any moment from loads designated as "Temporary" on the DECK POUR CONCENTRATED (DPC) or DECK POUR DISTRIBUTED (DPD) loads using the load factor for live loads, while moment from "Permanent" deck pour loads and other noncomposite loads use the load factor for dead loads.

If the slab in any part of a given span is being cast in the current stage, this check is not needed for subsequent stages for that span.

This check can be considered during a design run of the program by using the appropriate input parameter on the DRB or DP2 commands. However, because of the structure of the design algorithm, the designed girder may be overly conservative. The LRFD Specifications Section 6.10.3.4.2 calculation uses a weighted average of the girder stiffness over a given span. The design algorithm designs the plates at midspan and section transitions considering the conditions only at a given point, so the LRFD Specifications Section 6.10.3.4.2 calculation can only consider the lateral stiffness at that point. This can lead to a situation where the final weighted average lateral stiffness is greater than the stiffness considered at a transition point during design, meaning that smaller plates could be acceptable. The engineer must evaluate the design, possibly running the program both with the check turned on and then turned off, and revising the design as desired.

3.7.20 Bearing Stiffener Design

Bearing stiffeners are designed by the program for all girders if the BSD command is entered. The stiffeners are designed for the maximum total factored reaction (including impact and all distribution factors) from the first live load considered in a program run (designated as the "Design" combination of "Analysis and Rating" combination of the LIVE LOAD parameter of the CTL command. For special live load runs with multiple special live loads, special live load #1 is the Analysis and Rating combination). If a bearing stiffener design is done, STLRFD will also generate a bearing stiffener design history file, which shows the steps outlined below and the intermediate values calculated for each bearing stiffener location. The history file is a text file in the same directory as the input and output files, and has the extension of <input file name>.BDH (and <input file name>-BDH.PDF for the PDF version).

The following assumptions are made for the bearing stiffener design:

1. A clearance of 9 * web thickness from the end of the girder to the centerline of the first bearing stiffener plate
2. A spacing of 18 * web thickness between adjacent pairs of bearing stiffener plates
3. The stiffeners are made up of plates, not angles
4. The stiffeners are welded, not bolted

The steps of the bearing stiffener design are:

1. Find the minimum width of the bearing stiffener:

$$b_{min} = \frac{(b_{bot} - t_{web})}{2} - \frac{1"}{2}, rounded\ down\ to\ the\ nearest\ \frac{1"}{2}$$

where: b_{min} = minimum width of bearing stiffener

b_{bot} = bottom flange width

t_{web} = web thickness

2. Calculate the plate width for bearing resistance:

$$b_{bearing} = b_{min} - 1.5''$$

The 1.5 inch reduction is in accordance with BC-753M. Also, based on LRFD Specifications Article 6.10.11.2.3, the bearing area is the "area of the projecting elements of the stiffener outside of the web-to-flange fillet welds, but not beyond the edge of the flange", so for bearing, the design cannot use any material outside the flanges.

3. Projecting plate width:

$$b_{projecting} = \max\begin{bmatrix} b_{min} \\ 2'' + 5'' \end{bmatrix}$$

where: 2" + 5" = from BC-754M, Sheet 1 of 2, typical diaphragm connection plate detail, skew 90° to 70°

4. Find the required plate thickness for bearing resistance (using rearrangement of the LRFD Specification equations 6.10.11.2.3-1 and 6.10.11.2.3-2):

$$t_{bearing} = \frac{V_u}{1.4 * 2 * \phi_b b_{bearing} F_{ys}}$$

where: $t_{bearing}$ = required bearing stiffener thickness based on bearing criteria

V_u = maximum factored reaction at support

2 = stiffener plates on both sides of web

ϕ_b = resistance factor for bearing

$b_{bearing}$ = plate width for bearing resistance (step 2)

F_{ys} = yield strength of bearing stiffener plate

5. Find the required plate thickness for projecting width requirement (rearrangement of the LRFD Specifications equation 6.10.11.2.2-1):

$$t_{projecting} = \frac{b_{projecting}}{0.48\sqrt{\frac{E}{F_{ys}}}}$$

where: $t_{projecting}$ = required bearing stiffener thickness based on projecting width criteria
$b_{projecting}$ = projecting plate width (step 3)
E = elastic modulus of steel
F_{ys} = yield strength of bearing stiffener plate

6. Choose the thickness as the thicker of $t_{bearing}$ and $t_{projecting}$, and use this thickness with $b_{projecting}$ in the iterative calculation of required thickness for axial resistance. Expressions from LRFD Specifications Articles 6.9.2 and 6.9.4 are used to compute the axial resistance. The thickness of the stiffener plates is increased one thickness at a time until an acceptable axial resistance is obtained.

   If an acceptable axial resistance cannot be obtained, the program will add a pair of stiffeners and go back to step 4. STLRFD will attempt up to four pairs of stiffeners at a support or point of concentrated load.

$$t_{stf} = max\begin{bmatrix} t_{bearing} \\ t_{projecting} \end{bmatrix}$$

$$I_{stf} = n_{pair} * \frac{1}{12} t_{stf}\left(2b_{projecting} + t_{web}\right)^3$$

where: I_{stf} = moment of inertia of a group of stiffeners
n_{pair} = number of stiffener pairs
t_{stf} = governing bearing stiffener thickness
$t_{bearing}$ = required bearing stiffener thickness based on bearing criteria
$t_{projecting}$ = required bearing stiffener thickness based on projecting width criteria
I_{stf} = moment of inertia of bearing stiffener plates
$b_{projecting}$ = projecting plate width (step 3)
t_{web} = girder web thickness

A portion of the web can also be considered for axial resistance of the bearing stiffeners. Users have the option of specifying the distance from the centerline of bearing to the end of the beam (clearance) and/or the spacing from face to face of adjacent bearing stiffener pairs (spacing). If the user does not enter the clearance, the program always assumes a distance of 9 * t_{web} from the face of the stiffener to end of the beam (even if more than one pair is required). If the spacing is not entered, and STLRFD determines that more than one pair of stiffeners is necessary, the program assumes a spacing of 18 * t_{web}.

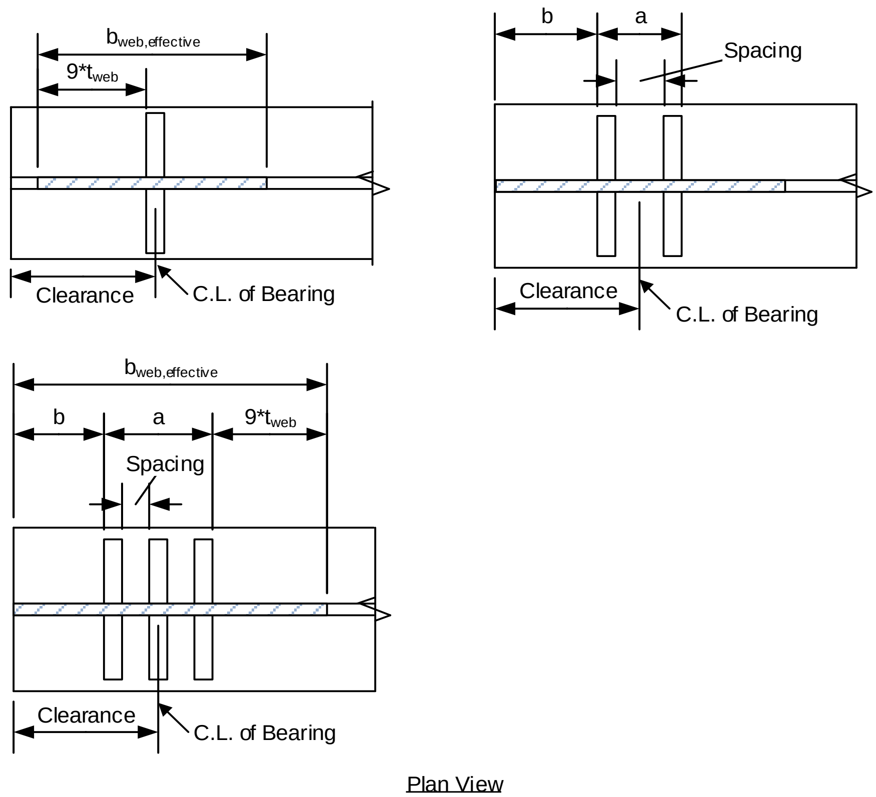


Figure 3.7-7   Bearing Stiffener Geometry

For a single pair of stiffeners at an abutment:

$$b_{web,effective} = min\begin{bmatrix} 9t_{web} + t_{stf} + 9t_{web} \\ Clearance + \dfrac{t_{stf}}{2} + 9t_{web} \end{bmatrix}$$

For multiple pairs of stiffeners at an abutment:

$$a = (n_{pair} - 1)(spacing + t_{stf}) + t_{stf}$$

$$b = Clearance - \frac{a}{2}$$

$$a' = min\begin{bmatrix} a \\ (n_{pair} - 1)(18t_{web} + t_{stf}) + t_{stf} \end{bmatrix}$$

$$b' = min\begin{bmatrix} 9t_{web} \\ b \end{bmatrix}$$

$$b_{web,effective} = b' + a'$$

For a single pair of stiffeners at a point of concentrated load or at an interior support:

$$b_{web,effective} = 9t_{web} + t_{stf} + 9t_{web}$$

For multiple pairs of stiffeners at a point of concentrated load or at an interior support:

$$b_{web,effective} = 9t_{web} + (n_{pair} - 1)(spacing + t_{stf}) + t_{stf} + 9t_{web}$$

$$A_{stf} = n_{pair} 2t_{stf} b_{projecting} + b_{web,effective} t_{web}$$

where: $b_{web,effective}$ = length of web effective in axial resistance calculations. This length of web may be neglected or reduced, based on the criteria in LRFD Specifications Section 6.10.11.2.4b.

t_{web} = girder web thickness

t_{stf} = stiffener plate thickness

Clearance = user input distance from the centerline of bearing to the end of the girder

Spacing = user input stiffener spacing from face to face of stiffeners

n_{pair} = number of stiffener pairs

a = physical length of a group of bearing stiffeners from outer face to outer face of stiffeners (shown in Figure 3.7-6)

b = physical distance from the face of the first stiffener to the end of the girder

a' = effective length of a group of bearing stiffeners from outer face to outer face of stiffeners. The spacing is limited to a maximum 18*t_{web}.

b' = effective distance from the face of the first stiffener to the end of the girder. This distance is limited to a maximum of 9*t_{web}.

A_{stf} = area of bearing stiffener and web to be used in axial resistance calculations

t_{stf} = governing bearing stiffener thickness

$b_{projecting}$ = projecting plate width (step 3)

By following this method, the designed plate size will satisfy the LRFD Specifications, as well as the BC standards.

3.7.21 Bearing Stiffener-to-Web Weld Design

Bearing stiffener-to-web welds will be based on the following procedure: Based on Note 10 of BC-753M, Sheet 1 of 2, the top and bottom flanges should be welded to the bearing stiffeners. The flange-to-bearing stiffener weld will not be designed, but will be the same size as that calculated for the bearing stiffener-to-web weld. This value will be calculated when the bearing stiffeners are designed as well as when bearing stiffener plate sizes are entered for analysis.

1. The minimum size of fillet weld is calculated using the thicker of the bearing stiffener plate thickness or web thickness at the stiffener location, as per the LRFD Specifications Table 6.13.3.4-1.

   The maximum size of fillet weld is calculated using the thinner of the bearing stiffener plate thickness or web thickness at the stiffener location, as per LRFD Specifications Section 6.13.3.4.

2. The size of the weld is also based on the minimum of the shear resistance of the weld metal (LRFD Specifications Section 6.13.3.2.4b) and shear yielding resistance of the connection element (bearing stiffener plate; LRFD Specifications Section 6.13.5.3). These resistances are calculated in terms of stress, which are then multiplied by the effective area of the weld and set equal to the reaction at the support to find the required weld thickness.

$$R_{r,weld} = 0.6\varphi_{e2}F_{exx}$$

where: $R_{r,weld}$ = shear resistance of the weld material (LRFD Specifications Equation 6.13.3.2.4b-1)

ϕ_{e2} = resistance factor of weld metal in partial penetration welds for shear parallel to axis of weld

F_{exx} = classification strength of weld metal

$$R_{r,connection} = \varphi_v 0.58F_y$$

where: $R_{r,connection}$ = shear yielding resistance of the bearing stiffener plate (LRFD Specifications Equation 6.13.5.3-1, modified to be in terms of stress for calculation of required weld size)

ϕ_v = resistance factor for shear

F_y = yield strength of bearing stiffener plate

$$R_r = min\begin{bmatrix} R_{r,weld} \\ R_{r,connection} \end{bmatrix}$$

where: R_r = governing shear resistance of the stiffener-to-web connection

The effective area is the effective weld length multiplied by the effective throat (LRFD Specifications Section 6.13.3.3.

$$throat_{effective} = \sin(45°)\, t_{weld}$$

where: $throat_{effective}$ = the effective throat of the weld; the shortest distance from the joint root to the weld face

$$L_{effective} = d - 2b_c$$

where: $L_{effective}$ = the effective length of the weld

d = depth of the stiffener, taken equal to the depth of the web

b_c = bearing clip; the distance from the edge of the flange to the start of the web weld (see Figure 3.7-5)

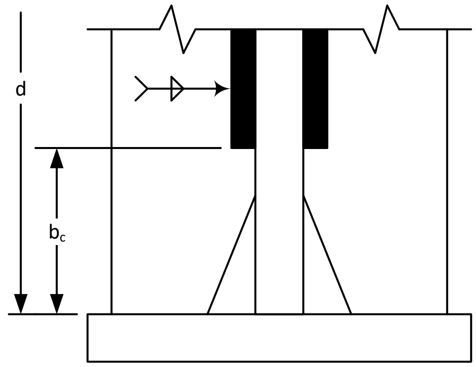


Figure 3.7-8 Bearing Clip

$$b_c = \begin{cases} 3\ 1/4", & t_{web} \le 1/2" \\ MAX(3\ 1/4", 5t_{web}), & t_{web} > 1/2" \end{cases}$$

where: b_c = bearing clip; the distance from the edge of the flange to the start of the web weld

t_{web} = web thickness

The total shear resistance of a single weld is therefore:

$$V_{r,weld} = throat_{effective} L_{effective} R_r$$

3. Find the required thickness of the fillet weld for the bearing stiffener-to-web weld design by rearranging and substituting into the final equation of step 2. Each bearing stiffener pair is assumed to have four welds; each side of the stiffener plates on both sides of the web and the applied reaction is distributed equally to each of these welds

$$t_{weld} > \frac{V_u / (4 * n_{pair})}{(d - 2b_c) R_r \sin(45°)}$$

where: t_{weld} = required weld size

V_u = total factored reaction at the support

n_{pair} = number of pairs of bearing stiffeners at the support

d = depth of the stiffener, taken equal to the depth of the web

b_c = bearing clip; the distance from the edge of the flange to the start of the web weld

R_r = governing shear resistance of the stiffener-to-web connection

Use t_{weld} fillet welds to attach the stiffeners to the web, rounded up to the nearest 1/16".

3.7.22 Maximum Pitch of Shear Connectors

The maximum pitch of the shear connectors is calculated as described in Sections 6.10.10.1.2 and 6.10.10.2 of the LRFD Specifications and DM-4. The maximum pitch shall satisfy:

$$p \le \frac{nZ_r}{V_{sr}}$$

where: p = shear connector pitch

n = number of shear connectors in a cross-section

Z_r = shear fatigue resistance of a individual shear connector (LRFD Specifications and DM-4 Section 6.10.10.2)

V_{sr} = horizontal fatigue shear range per unit length

To calculate Zr for stud shear connectors:

If the user input single lane ADTT is greater than or equal to 815 trucks per day (or 545 trucks per day if within 0.1 * span length of an interior support), the Fatigue-I load combination will be used and:

$$Z_r = 5.5d^2$$

otherwise, use the Fatigue-II load combination and:

$$Z_r = \alpha d^2$$

$$\alpha = 34.5 - 4.28 logN$$

where: Z_r = shear fatigue resistance of a individual shear connector (LRFD Specifications Section 6.10.10.2)

d = stud shear connector diameter

N = number of fatigue cycles expected over the service life of the bridge

= 365 days * 100 years * n * single lane ADTT, where n = 1.5 if the analysis point is within 0.1 * span length of an interior support, and n = 1.0 otherwise.

To calculate Z_r for channel shear connectors:

If the user input single lane ADTT is greater than or equal to 1680 trucks per day (or 1120 trucks per day if within 0.1 * span length of an interior support), the Fatigue-I load combination will be used and:

$$Z_r = 2.1w$$

otherwise, use the Fatigue-II load combination and:

$$Z_r = Bw$$

$$B = 9.37 - 1.08logN$$

where: Z_r = shear fatigue resistance of a individual shear connector (LRFD Specifications Section 6.10.10.2)

w = length of the channel measured transverse to the direction of the flange

N = number of fatigue cycles expected over the service life of the bridge

= 365 days * 100 years * n * single lane ADTT, where n = 1.5 if the analysis point is within 0.1 * span length of an interior support, and n = 1.0 otherwise.

To calculate V_{sr}:

$$V_{sr} = \sqrt{(V_{fat})^2 + (F_{fat})^2}$$

where: V_{sr} = horizontal fatigue shear range per unit length (LRFD Specifications Section 6.10.10.1.2)

V_{fat} = longitudinal fatigue shear range per unit length (LRFD Specifications Section 6.10.10.1.2, factored for the appropriate fatigue limit state, specified above)

F_{fat} = radial fatigue shear range per unit length (LRFD Specifications Equation 6.10.10.1.2-5)

when calculating F_{fat}, the program only considers LRFD Specification Equation 6.10.10.1.2-5:

$$F_{fat} = \frac{F_{rc}}{w}$$

where: F_{fat} = radial fatigue shear range per unit length

F_{rc} = net range of cross-frame or diaphragm force at the top flange. If the skew of the supports at each end of the span ≥ 70 degrees (PennDOT), F_{rc} is taken as 0.0 kips. If the skew is not entered by the user or the skew at either end < 70 degrees (PennDOT), F_{rc} is taken as 25 kips.

w = effective length of deck taken as 48 in, except at end supports where it is taken as 24 in.

As a final check, the maximum center-to-center pitch of the shear connectors calculated above shall not exceed 24 inches for girders with web depths less than 24 inches. For girders with web depths greater than or equal to 24 inches, the maximum center-to-center pitch shall not exceed 48 inches.

3.7.23 Fatigue Limit State Determination

The fatigue details are checked for either the Fatigue-I or Fatigue-II limit state, depending on the ADTT for single lane ($(ADTT)_{SL}$) entered on the CTL command (parameter 9, Section 5.5 of this Manual). These $(ADTT)_{SL}$ limits are calculated with the LRFD Specifications Equation C6.6.1.2.3-1, with a service life of 100 years, and a number of cycles per truck passage of either 1.0 or 1.5 cycles. 1.5 cycles per truck passage is used near the interior support of a continuous girder (taken as one-tenth of the span to either side of the support. 1.0 cycles per truck passage is used for simple span girders and other locations in continuous girders.

The results from the application of Equation 6.6.1.2.3-1 are rounded up to the nearest five trucks per day. The 100-year $(ADTT)_{SL}$ equivalent to infinite life used by STLRFD are shown in Table 4:

Table 3.7-4 100-year $(ADTT)_{SL}$ Equivalent to Infinite Life

Detail Category	100-year $(ADTT)_{SL}$ Equivalent to Infinite Life (trucks per day)	
	n = 1.0	n = 1.5
A	520	350
B	845	565
B'	1015	675
C	1265	845
C'	735	490
D	1840	1230
E	3465	2310
E'	6365	4245

When the user-input $(ADTT)_{SL}$ is less than or equal to the value in Table 4, the Fatigue-II load combination is used. When the $(ADTT)_{SL}$ is greater than the value in Table 4, the Fatigue-I load combination is used.

3.8 LIVE LOAD RATINGS

For both analysis and design runs, the program computes live load ratings at all analysis points. The type of rating (inventory or operating) for each live load for various load combinations is summarized in Table 2.6-1.

Load combinations of the Strength I, Strength IP, and Service II limit states are used for the computations of the inventory rating. Load combinations of the Strength IA, Strength II, Service IIA, and Service IIB limit states are used for the computations of the operating rating.

The basic equation for calculating the rating factor is:

$$Rating\ Factor = \frac{Live\ Load\ Reserve\ Capacity}{Factored\ Live\ Load\ Effect}$$

where the capacity and effect can be expressed in terms of a force (moment or shear) or stress.

Girder ratings are performed as the “reverse of design.” In other words, the same equations used to design the girder are used for live load ratings. In presenting the rating factor equations in this section, it is assumed that an analysis has been performed using the LRFD Specifications and DM-4, resulting in factored resistance values such as M_r, F_r, and V_r. The factored resistance values are determined based on each live loading and each limit state. In each of the rating factor equations, the factored dead load and pedestrian load effects are subtracted from the resistance, and the result is divided by the factored live load effect.

For the controlling rating factors for each vehicle, the program computes the rating tonnage. The rating tonnage is computed as the product of the rating factor and the corresponding vehicle weight in tons.

For both the H and HS live loadings, the controlling rating factor from either the truck loading or the lane loading is multiplied by the truck loading weight to compute the rating tonnage.

Since HL-93 and PHL-93 live loadings are based on a combination of various effects, there is no unique corresponding vehicle weight. Therefore, for HL-93 and PHL-93, no rating tonnage is computed.

The axle loads for ML-80 and TK527 vehicles include a 3% scale tolerance. When computing the rating tonnages for these vehicles, the program must remove the scale tolerance. The program divides the total of all axle loads by the scale tolerance before multiplying by the rating factor to find the rating tonnage. When specifying the special live loads, the user can enter a scale tolerance (PERCENT INCREASE entered on the SLL command) that is applied to the axle loads when performing the live load analysis. The rating tonnage for the special live loads is then computed by the multiplying the rating factor by the total tonnage of the special live load without the scale tolerance.

For a summary of the specification checks that are required for live load ratings and which limit states apply to each specification check refer to Table 3.7-1.

The rating factor at each analysis point is calculated for flexure and shear.

3.8.1 Rating Factor for Flexure

The rating factor for flexure is calculated using the following equation:

$$RF_M = \frac{M_{LLr}}{M_{LL}} \; or \; \frac{F_{LLr}}{f_{LL}}$$

where:

$$M_{LLr} = M_r - M_{DC1} - M_{DC2} - M_{FWS} - M_{MC1} - M_{MC2} - M_{UT1} - M_{UT2} - M_{PL}$$

and:

$$F_{LLr} = F_r - f_{DC1} - f_{DC2} - f_{FWS} - f_{MC1} - f_{MC2} - f_{UT1} - f_{UT2} - f_{PL}$$

The program computes the rating factor for flexure based on moments if the specification check is based on moments, and it computes the rating factor for flexure based on stresses if the specification check is based on stresses.

To compute the rating factor for flexure based on stress for composite girders, the program applies the noncomposite dead load moments to the steel-only section, it applies the composite dead load moments to the long-term (3n) composite section, and it applies the live load moments to the short-term (n) composite section. To compute the rating factor for flexure based on stress for noncomposite girders, the program applies all moments to the steel-only section.

For staged construction, M_{DC1} is the larger of the dead load moment due to the deck being poured instantaneously (uncured slab analysis) and the summation of moments for all stages, and F_{DC1} is the larger of the dead load stress due to the deck being poured instantaneously (uncured slab analysis) and the summation of stresses for all stages.

3.8.2 Rating Factor for Shear

The rating factor for shear is calculated using the following equation:

$$RF_V = \frac{V_{LLr}}{V_{LL}}$$

where:

$$V_{LLr} = V_r - V_{DC1} - V_{DC2} - V_{FWS} - V_{MC1} - V_{MC2} - V_{PL}$$

In the above shear rating factor equation, the V_{LL} corresponding to both maximum positive and maximum negative shear are used for each live loading. Rating factors are computed for both maximum positive and maximum negative live load shear values. The minimum of the rating factors computed is reported as the shear rating factor.

4 GETTING STARTED

4.1 INSTALLATION

This program is delivered via download from the Department's website. Once payment has been received by PennDOT you will receive a confirmation e-mail with instructions on how to download the software. The download file is a self-extracting installation file for the licensed PennDOT engineering software. The engineering program runs as a 32-bit application and is supported on Windows 10 operating systems (32 and 64 bit versions), and Windows 11.

Your license number, license key and registered company name, found in the e-mail received from the Department, are required to be entered when installing the program and must be entered exactly as shown in the e-mail. The license number, license key and registered company name will also be needed when requesting future versions of the program (i.e., enhancements, modifications, or error corrections), and requesting program support. A backup copy of the program download and e-mail instructions should be made and used for future installations. You may want to print the software license agreement, record the license number, license key and registered company name and keep it in a safe place.

To install the program, follow the installation instructions provided with the original e-mail from the Department.

The following files will be installed in the destination folder, which defaults to "C:\Program Files\PennDOT\STLRFD v<version number>\" for 32 bit operating systems or "C:\Program Files (x86)\PennDOT\STLRFD v<version number>\" for 64-bit operating systems:

1. STLRFD.exe, STLRFD_dll.dll - Executable program and Dynamic Link Library
2. STLRFD.pd - Parameter definition file.
3. STLRFD Users Manual.pdf - Program User's Manual (PDF Format).
4. STLRFDRevReq.dotx - Revision Request form (MS Word template).
5. GettingStarted.pdf - A document describing installation and running of the program
6. LicenseAgreement.pdf - The program license agreement
7. *.dat - Example problem input file.
8. MSVCR71.dll - Runtime Dynamic Link Library

The program example files (ex*.dat) will be installed in the program example folder, which defaults to "C:\PennDOT\STLRFD v<version number> Examples\". Users must have write access in order to run the input files from this folder.

4.2 PREPARING INPUT

The engineering program requires an ASCII input file. The input file consists of a series of command lines. Each command line defines a set of input parameters that are associated with that command. A description of the input commands can be found in Chapter 5 of the User's Manual. The input can be created using Engineering Assistant, described below, or any text editor.

4.3 ENGINEERING ASSISTANT

The Engineering Assistant (EngAsst) is a Windows application developed by the Pennsylvania Department of Transportation (PennDOT) to provide a graphical user interface (GUI) for PennDOT's engineering programs. The data for the input to the engineering program is presented in a user-friendly format, reflecting the implied structure of the data, showing each record type on a separate tab page in the display and showing each field on each record with a defining label.

With EngAsst the user can create a new input file, modify an existing input file, import input files, run the associated engineering program and view the output in a Windows environment. The help and documentation are provided, including text descriptions of each field, relevant images, and extended help text at both the record/tab level and the field level. Access to all parts of the Engineering Program User's Manual, where available, is also provided within EngAsst.

EngAsst is not included with this software. It requires a separate license that can be obtained through the Department's standard Engineering Software licensing procedures. Order forms can be obtained from program support website at http://penndot.engrprograms.com.

4.4 RUNNING THE PROGRAM WITHOUT ENGASST

The engineering programs are FORTRAN console application programs. They may be run from a command window, by double-clicking on the program icon from Windows Explorer, by selecting the shortcut from the Start menu under "PennDOT STLRFD <version number>", or by double-clicking the shortcut icon on the desktop. To run the program in a command window, the user must specify the directory in which the program has been installed or change to the directory.

The program will prompt for an input file name, and the user should then enter the appropriate input file name. The input file must be created before running the program. The program will then prompt for whether the output should be reviewed on the screen. The user should enter Y if the output is to be reviewed on the screen after execution or N if the output is not to be reviewed on the screen. The program will then prompt for the name of the output file in which the output is to be stored, and the user should then enter the desired output file name. If a file with the specified output file name already exists, the program will ask the user whether to overwrite the existing file. The user should enter Y if the existing file is to be overwritten or N if the existing file is not to be overwritten. If the user enters N to specify that the existing file is not to be overwritten, the program will prompt the user for another output file name. The program will then execute.

To cancel the program during execution, press <Ctrl C> or <Ctrl Break>, and then press <Enter>.

When the program completes execution, the user is prompted to “Press <ENTER> to exit program.” This allows the user to view the last messages written to the screen when the program was started by double-clicking on the program icon from Windows Explorer.

The user can view the *.OUT output file with a text editor and the *.PDF output file with Adobe Acrobat or any other PDF viewing program.

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5 INPUT DESCRIPTION

5.1 INPUT DATA REQUIREMENTS

Before running STLRFD, the user must create an input file. The input file consists of a series of command lines. Each command line defines a set of input parameters that are associated with that command. The program interprets each command line and checks the input parameters to insure that the input data is of the correct type and within the allowable ranges set by the program.

The syntax of a command line is given as:

```
KWD   parm1,   parm2,   ,   ,   parm5,   ,
```

where, KWD is a 3 character keyword representing a command, and
parm1, parm2.... are the parameter values associated with the KWD.

If a command line begins with an exclamation point (!), then it is treated as a comment line that is not used by the program. Comment lines can be inserted by the user to provide descriptions and clarifications. The following are two examples of a comment line:

```
!   THE FOLLOWING COMMAND LINE INCLUDES A REDUCTION IN HAUNCH WEIGHT.
!   PENNDOT SKEW ANGLE DESIGNATION IS USED IN THIS INPUT.
```

To temporarily make a command line void, the user can use an exclamation point (!) to transform the command line into a comment line. For an input line to be treated as a comment line, the exclamation point must be put in column 1 of the input line. For example, in the following case, the program will use the input data on the second line but will not use the input data on the first line:

```
!   UDF   1, D, 0.649,  , 0.815, 0.815
UDF   1, D, 0.750,  , 0.815, 0.815
```

A command line must not exceed 512 characters in length. Command lines can be continued on any number of data lines in the input file by placing a hyphen (-) at the end of each data line to be continued, and by placing any remaining parameters on the following lines starting in column 4 of each continuation line. The limit of 512 characters includes all characters and parameters on all continuation lines of a given command line. Some commands are repeatable and some commands have parameters or groups of parameters that are repeatable. When parameters are repeatable, the user has the option of repeating the parameters in a single command or repeating the command. For example, the SPL (span length) command has Span Number and Span Length as repeatable parameters. The user could enter the Span Number and Span Length three times on one command and four times on another command, or seven times on a single command.

```
SPL     1,  100,  2,  110,  3,  120
SPL     4,  130,  5,  140,  6,  150,  7,  160
```

or

```
SPL     1,  100,  2,  110,  3,  120,  4,  130,  5,  140,  6,  150,  7,  160
```

Groups of repeatable parameters, such as Span Number and Span Length, must stay together in a command line unless a continuation character (-) is used. That is, a command cannot end with a Span Number input and continue using another SPL command having the Span Length input. When a continuation character is used, the repeatable data can be separated on two lines. The program reads all continuation lines as one command. For example,

Incorrect input:

```
SPL    1, 100, 2, 110, 3
SPL    120, 4, 130, 5, 140, 6, 150, 7, 160
```

Correct input:

```
SPL    1, 100, 2, 110, 3,  -
       120, 4, 130, 5, 140, 6, 150, 7, 160
```

The first three columns of each command line are reserved for keywords that define the command type. Columns 4 through 512 are to be used to input the parameters associated with a command. One or more spaces are recommended between the keyword and the input parameters to improve readability.

The parameters associated with each command must be entered in the order they appear in the command description tables. The user must place commas to separate the parameters on the command line. Blank spaces cannot be used to separate parameters. The parameter field width is not restricted; however, the total number of characters cannot exceed 512.

The default value for a parameter is assigned by the program by placing a comma without any value for the parameter. For example, in the command syntax example shown below, the default values will be assigned to parameters parm3 and parm4.

```
KWD   parm1,   parm2,   ,   ,   parm5
```

If the user places a comma and there is no default value, the program will return an error status. If a comma is entered after the command keyword, the program will assign the default value to the first parameter. If the user does not enter all the parameters for a command, the program will assign default values for those parameters not entered. That is, the user is not required to place commas at the end of a command line. If the above example required seven parameters, parm6 and parm7 would also be assigned default values by the program.

The default values are stored in a parameter file which can be changed only by the Department's system manager. The parameter file stores the parameter description, type of data, units, upper limit, lower limit, error or warning status if the upper or lower limits are exceeded, and the default value for each parameter.

Any numerical value, within the upper and lower limits, can be entered for a parameter. The status codes, shown in parentheses below the lower and upper limits, indicate the status if an input item exceeds the lower or upper limits. The status code, (E), indicates an error. The status code, (W), indicates a warning. The status code, (C), indicates a warning that can be accepted/ignored only upon the approval of the Department's Chief Bridge Engineer, while the code (D) requires approval of the District Bridge Engineer.

In the following sections, all available commands and associated parameters are described with two tables for each command. The first table contains the keyword for a particular command along with a description of the command. The second table gives all the parameters associated with the given command, parameter description, units, limits, and default values.

The program will process all input and will check for errors and warnings. If the number of errors exceeds 25 during input processing, the program will terminate immediately. After all input is processed, the program checks if any errors were found. If an error was found, the program will terminate. If warnings are found, the program will continue to process. If the number of warnings exceeds 200 during input processing for a single run, the program will terminate immediately. The user should review all warnings in the output file to insure that the input data is correct. Warnings are an indication that the input value has exceeded normally acceptable limits for that parameter.

For parameters which are defined in ranges (such as girder sections, brace points, transverse stiffeners, and longitudinal stiffeners), the ranges cannot overlap.

5.2 ORDER OF COMMANDS

If the user wants to control the number of lines printed on a page or the number of lines to be left blank at the top of each page, the CFG (configuration) command should be the first command. The CFG command is optional and the program will use default values if the CFG command is not entered. The first required command is one or more TTL (title) commands. As many as ten TTL commands may be entered by the user. The first TTL command is printed in the header at the top of each output page. A maximum of ten TTL commands are printed on the first page of the output. The second required command after the title commands is the CTL (control) command. The CTL command includes other major control parameters such as Design/Analysis, Number of Beams, and Number of Spans.

The remaining commands can be entered in any order, provided certain required parameters for a given command have been entered previously. For example, the material properties are defined by specifying a material ID parameter in the MAT (material) command. Since the material ID parameter is used in the ARB (analysis rolled beam) command, the MAT command must precede the ARB command. The program will return an error status if a command requires data that has not been previously entered. Another example is that the SPL (span length) command must precede any commands, such as the APL, ARB, and ABU commands, which include span distance.

The user need not enter any of the output commands (OIN, OSP, ODG, OAN, OSC, and ORF commands) to produce the output tables that are designated as the default output tables. The default output tables, as presented in Sections 6.54 through 6.59, are produced if no output commands are entered.

The recommended order of the commands is shown in Table 1. The commands are shown in alphabetical order in Table 2. The section headings in these tables refer to the section number of this chapter where these commands are described. Figure 1 shows the overall view of a typical input file with these commands.

Command	Description
CFG	Configuration
TTL	Title
CTL	Control
SID	Structure Identification
GEO	Geometry
CDF	Computed Distribution Factor
UDF	User Defined Distribution Factor
URF	User Defined Reaction Factor
SKW	Skew Angle
SPL	Span Length
HNG	Hinge Location
UDA	User Defined Analysis Points
MAT	Material
DRB	Design Rolled Beam
DP1	Design Plate Girder (Part 1)
DP2	Design Plate Girder (Part 2)
DPS	Design Plate Location
DTS	Design Transverse Stiffener
URB	User Defined Rolled Beam
ARB	Analysis Rolled Beam
ABU	Analysis Built-Up
APL	Analysis Plate
SHO	Section Hole
SLS	Section Loss
SLB	Slab
SST	Slab Steel Location
DPS	Deck Pour Sequence
DPC	Deck Pour Concentrated Load
DPD	Deck Pour Distributed Load
PLD	Pedestrian Live Load
LDF	Load Factor
CLD	Concentrated Load
DLD	Distributed Load
WPD	Wind Program Defined
WUD	Wind User Defined
DOL	Deck Overhang Loads
SLL	Special Live Loading
SAL	Special Axle Load
FTL	Fatigue Life
FGV	Fatigue Gross Vehicle
FTG	Fatigue
BRP	Brace Point
CBR	Continuous Brace
TST	Transverse Stiffener
LST	Longitudinal Stiffener
BST	Bearing Stiffener
BSD	Bearing Stiffener Design
SCS	Shear Connector Stud
SCC	Shear Connector Channel
FSL	Field Splice Location
LAS	Lateral Bending Stress
OIN	Output of Input Data
OSP	Output of Section Properties
ODG	Output of Design Trials
OAN	Output of Analysis Results
OSC	Output of Specification Checking
ORF	Output of Rating Factors

Figure 5.2-1 Overall View of Input File

Table 5.2-1 Recommended Order of Commands

Keyword	Command Description	Comments	Section
CFG	Configuration	Optional for both design and analysis	5.3
TTL	Title	At least one TTL command is required for both design and analysis	5.4
CTL	Control	Required before other structure commands (other than CFG and TTL commands) for both design and analysis	5.5
SID	Structure Identification	Required only for APRAS runs	5.6
GEO	Geometry	Required for both design and analysis	5.7
CDF	Computed Distribution Factor	Required only if no UDF command for live load distribution factors is entered for both design and analysis	5.8
UDF	User Defined Distribution Factor	Required only if no CDF command for live load distribution factors is entered for both design and analysis	5.9
URF	User Defined Reaction Distribution Factor	Required only if no CDF command for live load distribution factors is entered for both design and analysis	5.10
SKW	Skew Angle	Required with CDF command for both design and analysis; a SKW command must be entered after the CDF or UDF command	5.11
SPL	Span Length	Required for both design and analysis before any commands with distance parameters	5.12
HNG	Hinge Location	Optional for analysis only; not used for design	5.13
UDA	User Defined Analysis Points	Optional for both design and analysis	5.14
MAT	Material	Required only for analysis and must be entered before ARB, ABU and APL commands; not used for design	5.15
DRB	Design Rolled Beam	Required only for design of rolled beam; not used for analysis	5.16
DP1	Design Plate Girder (Part 1)	Required only for design of plate girder; not used for analysis	5.17
DP2	Design Plate Girder (Part 2)	Required only for design of plate girder; not used for analysis	5.18
DPL	Design Plate Location	Optional; used only if CTL parameters are design and plate girder; used only for user-defined plate transition locations; not used for analysis	5.19
DTS	Design Transverse Stiffener	Required only for design with transverse stiffeners; not used for analysis	5.20
URB	User Defined Rolled Beam	Optional for analysis with ARB command; not used for design	5.21
ARB	Analysis Rolled Beam	Required only for analysis of rolled beam; not used for design	5.22
ABU	Analysis Built-Up	Required only for analysis of built-up girder section; not used for design	5.23
APL	Analysis Plate	Required only for analysis of plate girder; not used for design	5.24

Table 5.2-1 Recommended Order of Commands (Continued)

Keyword	Command Description	Comments	Section
SHO	Section Hole	Optional only for analysis; not used for design	5.25
SLS	Section Loss	Optional only for analysis; not used for design	5.26
SLB	Slab	Required for both design and analysis	5.27
SST	Slab Steel Location	Optional only for analysis; not used for design	5.28
DPS	Deck Pour Sequence	Optional for analysis only; not used for design	5.29
DPC	Deck Pour Concentrated Load	Optional for analysis only; not used for design	5.30
DPD	Deck Pour Distributed Load	Optional for analysis only; not used for design	5.31
PLD	Pedestrian Live Load	Optional for both design and analysis; required only if pedestrian loading is to be considered	5.32
LDF	Load Factor	Required for miscellaneous loads and SLL command for both design and analysis	5.33
CLD	Concentrated Load	Optional for both design and analysis	5.34
DLD	Distributed Load	Optional for both design and analysis	5.35
WPD	Wind Program Defined	This command or WUD required for both design and analysis for exterior girders only.	5.36
WUD	Wind User Defined	This command or WPD required for both design and analysis for exterior girders only.	5.37
DOL	**Deck Overhang Loads**	**Optional for both design and analysis; only for exterior girders.**	**5.38**
SLL	Special Live Loading	Required only for analysis with special live loading; not used for design	5.39
SAL	Special Axle Load	Required with SLL command only for analysis with special live loading; not used for design	5.40
FTL	Fatigue Life	Optional for both design and analysis	5.41
FGV	Fatigue Gross Vehicle	Optional for both design and analysis	5.42
FTG	Fatigue	Optional for both design and analysis	5.43
BRP	Brace Point	Optional for both design and analysis	5.44
CBR	Continuous Brace	Optional for both design and analysis	5.45
TST	Transverse Stiffener	Required only for analysis if there are transverse stiffeners; not used for design	5.46
LST	Longitudinal Stiffener	Required only for analysis if there are longitudinal stiffeners; not used for design	5.47
BST	Bearing Stiffener	Required if there are bearing stiffeners for both design and analysis	5.48
BSD	Bearing Stiffener Design	Optional for both design and analysis	5.49
SCS	Shear Connector Stud	Required for composite with stud shear connectors only for both design and analysis; for a composite girder, either SCS or SCC command must be entered	5.50

Table 5.2-1 Recommended Order of Commands (Continued)

Keyword	Command Description	Comments	Section
SCC	Shear Connector Channel	Required for composite with channel shear connectors only for analysis; for a composite girder, either SCS or SCC command must be entered	5.51
FSL	Field Splice Location	Optional for both design and analysis	5.52
LAS	Lateral Bending Stress	Optional for both design and analysis	5.53
OIN	Output of Input Data	Optional for both design and analysis	5.54
OSP	Output of Section Properties	Optional for both design and analysis	5.55
ODG	Output of Design Trials	Optional for design; not used for analysis	5.56
OAN	Output of Analysis Results	Optional for both design and analysis	5.57
OSC	Output of Specification Checking	Optional for both design and analysis	5.58
ORF	Output of Rating Factors	Optional for both design and analysis for exterior girders only	5.59

Table 5.2-2 Commands in Alphabetical Order

Keyword	Command Description	Comments	Section
ABU	Analysis Built-Up	Required only for analysis of built-up girder section; not used for design	5.23
APL	Analysis Plate	Required only for analysis of plate girder; not used for design	5.24
ARB	Analysis Rolled Beam	Required only for analysis of rolled beam; not used for design	5.22
BRP	Brace Point	Optional for both design and analysis	5.44
BSD	Bearing Stiffener Design	Optional for both design and analysis	5.49
BST	Bearing Stiffener	Required if there are bearing stiffeners for both design and analysis	5.48
CBR	Continuous Brace	Optional for both design and analysis	5.45
CDF	Computed Distribution Factor	Required only if no UDF command for live load distribution factors is entered for both design and analysis	5.8
CFG	Configuration	Optional for both design and analysis	5.3
CLD	Concentrated Load	Optional for both design and analysis	5.34
CTL	Control	Required before other structure commands (other than CFG and TTL commands) for both design and analysis	5.5
DLD	Distributed Load	Optional for both design and analysis	5.35
DOL	**Deck Overhang Loads**	**Optional for both design and analysis; only for exterior girders.**	**5.38**
DP1	Design Plate Girder (Part 1)	Required only for design of plate girder; not used for analysis	5.17
DP2	Design Plate Girder (Part 2)	Required only for design of plate girder; not used for analysis	5.18
DPC	Deck Pour Concentrated Load	Optional for analysis only; not used for design	5.30
DPD	Deck Pour Distributed Load	Optional for analysis only; not used for design	5.31
DPL	Design Plate Location	Optional; used only if CTL parameters are design and plate girder; used only for user-defined plate transition locations; not used for analysis	5.19
DPS	Deck Pour Sequence	Optional for analysis only; not used for design	5.29
DRB	Design Rolled Beam	Required only for design of rolled beam; not used for analysis	5.16
DTS	Design Transverse Stiffener	Required only for design with transverse stiffeners; not used for analysis	5.20
FGV	Fatigue Gross Vehicle	Optional for both design and analysis	5.42
FSL	Field Splice Location	Optional for both design and analysis	5.52
FTG	Fatigue	Optional for both design and analysis	5.43
FTL	Fatigue Life	Optional for both design and analysis	5.41
GEO	Geometry	Required for both design and analysis	5.7
HNG	Hinge Location	Optional for analysis only; not used for design	5.13

Table 5.2-2 Commands in Alphabetical Order (Continued)

Keyword	Command Description	Comments	Section
LAS	Lateral Bending Stress	Optional for both design and analysis	5.53
LDF	Load Factor	Required for miscellaneous loads and SLL command for both design and analysis	5.33
LST	Longitudinal Stiffener	Required only for analysis if there are longitudinal stiffeners; not used for design	5.47
MAT	Material	Required only for analysis and must be entered before ARB, ABU and APL commands; not used for design	5.15
OAN	Output of Analysis Results	Optional for both design and analysis	5.57
ODG	Output of Design Trials	Optional for design; not used for analysis	5.56
OIN	Output of Input Data	Optional for both design and analysis	5.54
ORF	Output of Rating Factors	Optional for both design and analysis	5.59
OSC	Output of Specification Checking	Optional for both design and analysis	5.58
OSP	Output of Section Properties	Optional for both design and analysis	5.55
PLD	Pedestrian Live Load	Optional for both design and analysis; required only if pedestrian loading is to be considered	5.32
SAL	Special Axle Load	Required with SLL command only for analysis with special live loading; not used for design	5.40
SCC	Shear Connector Channel	Required for composite with channel shear connectors only for analysis; for a composite girder, either SCS or SCC command must be entered	5.51
SCS	Shear Connector Stud	Required for composite with stud shear connectors only for both design and analysis; for a composite girder, either SCS or SCC command must be entered	5.50
SHO	Section Hole	Optional only for analysis; not used for design	5.25
SID	Structure Identification	Required only for APRAS runs	5.6
SKW	Skew Angle	Required with CDF command for both design and analysis; a SKW command must be entered after the CDF or UDF command	5.11
SLB	Slab	Required for both design and analysis	5.27
SLL	Special Live Loading	Required only for analysis with special live loading; not used for design	5.39
SLS	Section Loss	Optional only for analysis; not used for design	5.26
SPL	Span Length	Required for both design and analysis before any commands with distance parameters	5.12
SST	Slab Steel Location	Optional only for analysis; not used for design	5.28
TST	Transverse Stiffener	Required only for analysis if there are transverse stiffeners; not used for design	5.46
TTL	Title	At least one TTL command is required for both design and analysis	5.4
UDA	User Defined Analysis Points	Optional for both design and analysis	5.14

Table 5.2-2 Commands in Alphabetical Order (Continued)

Keyword	Command Description	Comments	Section
UDF	User Defined Distribution Factor	Required only if no CDF command for live load distribution factors is entered for both design and analysis	5.9
URB	User Defined Rolled Beam	Optional for analysis with ARB command; not used for design	5.21
URF	User Defined Reaction Distribution Factor	Required only if no CDF command for live load distribution factors is entered for both design and analysis	5.10
WPD	Wind Program Defined	This command or WUD required for both design and analysis for exterior girders only.	5.36
WUD	Wind User Defined	This command or WPD required for both design and analysis for exterior girders only.	5.37

5.3 CFG - CONFIGURATION COMMAND

KEYWORD	COMMAND DESCRIPTION
CFG	CONFIGURATION - This command is used for configuring the program output from a given PC and printer setup. Only one CFG command may be used. If this command is not entered, each parameter listed below will be automatically set to its default value.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Number of Lines Per Page	Enter the number of printable lines per output page.	--	50 (W)	83 (W)	83
2. Number of Top Blank Lines	Enter the number of lines to be left blank at the top of each output page.	--	0 (E)	5 (W)	0

5.4 TTL - TITLE COMMAND

KEYWORD	COMMAND DESCRIPTION
TTL	TITLE - As many as ten TTL commands may be entered by the user. The first TTL command is printed in the header at the top of each output page. A maximum of ten TTL commands can be entered and are printed on the first page of the output. The input file must have at least one TTL command. Any tab and null characters on the TTL commands will be replaced with single spaces.

PARAMETER	DESCRIPTION
1. Title	Enter any descriptive information about the project. Title information can be entered anywhere between Column 4 and Column 79.

5.5 CTL - CONTROL COMMAND

KEYWORD	COMMAND DESCRIPTION
CTL	CONTROL - This command is used to set the control parameters for the input. The input file must have one and only one CTL command. The CTL command must be entered before any other structure command other than the CFG and TTL commands.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. System of Units	Enter type of units: US - US customary units.	--	US (E)	--	US
2. Design/ Analysis	Enter the design/analysis option: A - Analysis of applicable loadings, specification checking, and live load ratings. D - Design and rating of simple span plate girder or simple span rolled beam for applicable loadings in accordance with the LRFD Specifications.	--	A, D (E)	--	--
3. Type of Beam	Enter the beam type: RB - Rolled beam. PG - Plate girder. BU - Built-up section consisting of a web plate, flanges, and angles.	--	RB, PG, BU (E)	--	--
4. Exterior/ Interior	Enter beam location: E - Exterior beam. I - Interior beam.	--	E, I (E)	--	--
5. Number of Beams	Enter the total number of beams for the structure cross section. For bridges built with phased construction (where one side, left or right, of the bridge is built first, then the other side), it is recommended to do at least three runs of STLRFD. One with the number of beams and geometry in the final condition, and one with the number of beams and geometry for each phase of construction so that distribution factors and the checks of the LRFD Specifications Section 6.10.3.4.2 are captured correctly.	--	2 (E)	20 (E)	--
6. Number of Spans	Enter the total number of spans for the entire structure. If the design option is chosen above, the only valid entry for the parameter is 1, because only simple span plate girders or simple span rolled beams can be designed.	--	1 (E)	20 (E)	--

5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Symmetry	Enter the symmetry option: Y - If the entire structure, including span length, section properties, and loads, is symmetrical about the center of the structure. N - If not symmetric. If DESIGN/ANALYSIS (parameter 2) is entered as D (design), this parameter must be entered as Y, or left blank in which case it will default to Y. If DESIGN/ANALYSIS is entered as A (analysis), this parameter does not have a default value.	--	Y, N (E)	--	--
8. Deck Pour Symmetry	For analysis, enter the deck pour symmetry option: Y - If the deck pours are symmetric about the center of the structure. N - If not symmetric. If Symmetry (parameter 7) is entered as ‘Y,’ then Deck Pour Symmetry (parameter 8) may be entered as ‘Y’ or ‘N.’ However, if Symmetry (parameter 7) is entered as ‘N,’ then Deck Pour Symmetry (parameter 8) is not used by the program. For design, Deck Pour Symmetry is ignored by the program since design is for simple spans only.	--	Y, N (E)	--	--
9. ADTT for Single Lane	Enter the number of trucks per day in a single lane averaged over the design life of the bridge. This value is used to compute the fatigue resistance.	--	1 (E)	10,000 (W)	--
10. Multiple Presence Adjustment Factor	Note: This parameter is no longer used and should be left blank. Current DM-4 specifications do not allow for a reduction based on the ADTT of the structure in accordance with the LRFD Specifications Article C3.6.1.1.2.	--	--	--	--

5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
11. Live Load	Enter one of the following live load options: For analysis runs, see the live load options on the next page For Design: A - PHL-93 (Design[1]); P-82 (Permit[2]); PHL-93, P-82, ML-80, HS20, H20, TK527 (Rating[3]). B - HL-93 (Design[1]); P-82 (Permit[2]); HL-93, P-82, ML-80, HS20, H20, TK527 (Rating[3]). C - HL-93 (Design[1]); HL-93, HS20, H20 (Rating[3]). D - PHL-93 and ML-80 (Design[1]); P-82 (Permit[2]) PHL-93, P-82, ML-80, HS20, H20, TK527 (Rating[3]). E - PHL-93, ML-80, and TK527 (Design[1]); P-82 (Permit[2]) PHL-93, P-82, ML-80, HS20, H20, TK527 (Rating[3]) F - PHL-93, ML-80, and TK527 (Design[1]); P-82 and P2016-13 (Permit[2]); PHL-93, P-82, ML-80, HS20, H20, TK527, P2016-13 (Rating[3]) For design runs, choose option E to ensure that the ML-80 and TK527 inventory ratings are greater than 1.0 as per DM-4 3.6.1.2.8P and 3.6.1.2.9P. To also ensure the P2016-13 Permit Vehicle operating ratings are greater than 1.0, choose option F.	--	A, B, C, D, E, F (E)	--	E (design)

Notes:

[1] Design designated vehicle(s) are used to compute factored effects and live loads for specification checks not specific to Permit vehicles. Live load effects are enveloped for multiple design vehicles.

[2] Permit designated vehicle(s) are used to compute factored effects and live loads for specification checks specific to Permit vehicles. Live load effects are enveloped for multiple permit vehicles.

[3] Rating designated vehicle(s) are used to compute rating factors. Refer to Table 2.6-1, Live Load Ratings for applicable ratings for each vehicle.

5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
11. Live Load (continued)	Enter one of the following live load options: For design runs, see the live load options on the previous page. For Analysis: A - PHL-93 (Analysis[1]) P-82 (Permit[2]) PHL-93, P-82, ML-80, HS20, H20, TK527 (Rating[3]) B - HL-93 (Analysis[1]) HL-93, HS20, H20 (Rating[3]) C - ML-80 (Analysis[1] and Rating[3]) D - P-82 (Permit[2] and Rating[3]) E - Special live loading (Analysis[1]/Permit[2] and Rating[3]). F - TK527 (Analysis[1] and Rating[3]) G - PHL-93 (Analysis[1]) P-82C (Permit[2]) PHL-93, P-82C, ML-80, HS20, H20, TK527 (Rating[3]) H - EV2 (Permit[2]) EV2, EV3, and SU6TV (Rating[3]) I - P2016-13 (Permit and Rating[3]) J - PHL-93 (Analysis[1]) P-82 (Permit[2]) PHL-93, P-82, ML-80, HS20, H20, TK527, P2016-13 (Rating[3]) K - PHL-93 (Analysis[1]) P-82C (Permit[2]) PHL-93, P-82C, ML-80, HS20, H20, TK527, P2016-13C (Rating[3]) The SLL and SAL commands must be entered when using option 'E' for Analysis. P-82C denotes P-82 in one lane and PHL-93 in the other lanes. P2016-13C denotes P2016-13 in one lane and PHL-93 in the other lanes.	--	A, B, C, D, E, F, G, H, I, J, K (E)	--	A (analysis)

Notes:

1 Analysis designated vehicle(s) are used to compute factored effects and live loads for specification checks not specific to Permit vehicles.

2 Permit designated vehicle(s) are used to compute factored effects and live loads for specification checks specific to Permit vehicles.

3 Rating designated vehicle(s) are used to compute rating factors. Refer to Table 2.6-1, Live Load Ratings for applicable ratings for each vehicle.

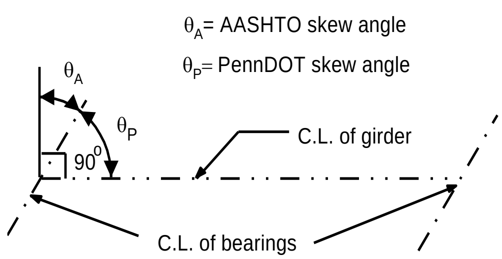
5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
12. Dynamic Load Allowance	Enter the factor by which the live load effect must be multiplied to obtain the live load plus dynamic load allowance (impact) effect.	--	1.0 (E)	2. (C)	1.33
13. Fatigue Dynamic Load Allowance	Enter the factor by which a fatigue live load effect must be multiplied to obtain the live load plus dynamic load allowance (impact) effect.	--	1.0 (E)	2. (C)	1.15
14. Pa. Traffic Factor	Note: This parameter is no longer used and should be left blank.	--	--	--	--
15. Redistrib. Negative Moments	Note: This parameter is no longer used and should be left blank. DM-4 does not allow moment redistribution.	--	--	--	--
16. Importance Factor	Enter the factor relating to the operational importance. As per DM-4 Section 1.3.3, a factor other than 1.0 is not permitted by PennDOT.	--	1.0 (E)	2.0 (W)	1.0
17. Ductility Factor	Enter the factor relating to ductility. As per DM-4 Section 1.3.4, a factor other than 1.0 is not permitted by PennDOT.	--	0.95 (E)	1.05 (W)	1.0
18. Redund. Factor	Enter the factor relating to the redundancy. As per DM-4 Section 1.3.5, a factor other than 1.0 is not permitted by PennDOT. As per DM-4 Section 1.3.2.1, the product of the Importance, Ductility, and Redundancy Factors must be 1.0. If this product exceeds 1.16, the program will reset the value of the product and provide a warning message.	--	0.95 (E)	1.05 (W)	1.0
19. Redundant Load Path	Note: This parameter is no longer used and should be left blank.	--	--	--	--
20. Output Points	Enter the output point option: 1 - If output is to be printed for tenth points, additional analysis points, user defined points, and failure points. 2 - If output is to be printed for twentieth points, additional analysis points, user defined points, and failure points. 3 - If output is to be printed for the points defined on the UDA command and failure points only.	--	1 (E)	3 (E)	2

5.5 CTL - CONTROL COMMAND (Continued)

<table>
<tr><th>PARAMETER</th><th>DESCRIPTION</th><th>UNITS</th><th>LOWER LIMIT</th><th>UPPER LIMIT</th><th>Default</th></tr>
<tr><td>21. Design Permit Vehicle Dynamic Load Allowance</td><td>Enter the factor by which the Design Permit Vehicle (P-82 or P2016-13) live load effect must be multiplied by to obtain the live load plus dynamic load allowance (impact) effect.</td><td>--</td><td>1.
(E)</td><td>2.
(C)</td><td>1.20</td></tr>
<tr><td>22. Skew Angle Designation</td><td>Enter:
A - AASHTO skew angle designation.
P - PennDOT skew angle designation.

For AASHTO, a positive skew is measured counterclockwise from a line perpendicular to the centerline of girder. For PennDOT, a positive skew is measured counterclockwise from the centerline of girder. As shown, AASHTO skew angle (θ_A) is negative and PennDOT skew angle (θ_P) is positive.



NOTE: This value is only used in conjunction with the UDF command. If the CDF command is used, this input value is ignored. When using the CDF command, define the Skew Angle Designation via that command.</td><td>--</td><td>A, P
(E)</td><td>--</td><td>P</td></tr>
</table>

5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
23. Constant Lateral Bending Stress	Enter the total unfactored lateral bending stress to be combined with stresses due to major-axis bending moments at all analysis points at all spans. For Strength and Service limit states, this value will be proportioned to dead and live load stresses in the same proportion as the major-axis bending stresses, then factored for each limit state. For constructability checks, this full value will be factored and added to the noncomposite dead loads. For effects due to staggered diaphragms, AASHTO 6.10.1 suggests using 10 ksi for interior girders and 7.5 ksi or 2 ksi for exterior girders. **This value should only be entered for straight girders with skews > 45° and < 70° (PennDOT definition).** **For straight girders with skews ≥ 70° the skew effects may be addressed by using the skew correction factors without specifically addressing the lateral bending stress effects. Therefore, this parameter should be left blank and the LAS command should not be entered.** However, if this value is entered for girders with skews ≥ 70°, a warning will be issued, but the program will continue, using this value. For straight girders with skews ≤ 45°, the lateral stresses should be entered on the LAS command. STLRFD may be used as a quality assurance check for code compliance by using the lateral bending stresses computed using an approved refined analysis. If this value and the LAS command are both entered, the program will stop with an error.	ksi	0. (E)	50. (W)	0.
24. DC1S Percentage	Enter the DC1S load to be added to the girder as a percentage of steel self-weight. This load will be in addition to any other DC1S loads entered on the DLD or CLD commands. Enter the value as a percentage, not a decimal (i.e. 5% = 5.0, not 0.05)	%	0. (E)	20. (W)	0.

5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
25. Check Appendix A	Enter: Y if the program should consider AASHTO LRFD Specifications Section 6, Appendix A calculations if the cross section meets all other criteria for applicability N if the program should never consider Section 6, Appendix A criteria even if the section meets the criteria for applicability NOTE: if Appendix A is not considered, the cross section may have a smaller calculated flexural capacity than it would if Appendix A is considered.	--	Y,N (E)	--	Y
26. Automatic Brace Points at Supports	Enter: Y if the program should automatically place flange brace points at all supports, regardless of the unbraced length entered on the BRP command N if the program should not automatically place brace points at the supports NOTE: Prior to version 2.5.0.0 of STLRFD, the program always automatically placed brace points at each support, even if a brace range was defined over a support and the brace spacing entered would result in no bracing at the support.	--	Y, N (E)	--	Y
27. Uncured Slab Checks With Deck Pours	Enter: Y if the program should do specification checks for the condition where the entire deck is placed simultaneously (uncured slab), even if a deck pour sequence has been entered with DPS commands. N if the program should not do the uncured slab checks when a deck pour sequence has been entered. If the user does not enter a deck pour sequence with DPS commands, the program will always do the uncured slab specification checks. The uncured slab checks will generally be much more conservative than an appropriate deck pour sequence. NOTE: Prior to version 2.8.0.0 of STLRFD, the program always did the uncured slab checks even if the user entered a deck pour sequence.	--	Y, N (E)	--	N

5.6 SID - STRUCTURE IDENTIFICATION COMMAND

KEYWORD	COMMAND DESCRIPTION
SID	STRUCTURE IDENTIFICATION - This command is used to pass parameters to APRAS (Automated Permit Routing Analysis System) for processing a permit load. The input file must have this command if this data file is to be processed by APRAS. This command is optional for other data files. Only one SID command can be used. Refer to PennDOT's Bridge Management System (BMS2) Coding Manual, Publication 100A for instructions on how to enter this data.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Program Identification	Enter '=STLRFD' to identify that this data file is for the LRFD Steel Girder Design and Rating program.	--	=STLRFD (E)	--	=STLRFD
2. County	Enter the county number as per PennDOT's Bridge Management System (BMS2) (the 2 digit subfield of item number 5A01).	--	1 (E)	99 (E)	--
3. State Route	Enter the state route number as per PennDOT's Bridge Management System (BMS2) (the 4 digit subfield of item number 5A01).	--	0 (E)	9999 (E)	--
4. Segment	Enter the segment number as per PennDOT's Bridge Management System (BMS2) (the 4 digit subfield of item number 5A01).	--	0 (E)	9999 (E)	--
5. Offset	Enter the offset distance as per PennDOT's Bridge Management System (BMS2) (the 4 digit subfield of item number 5A01).	--	0 (E)	9999 (E)	--
6. Span Identification	Enter the 4 digit alphanumeric Span Identification number as per PennDOT's Bridge Management System (BMS2) (item number SS01) Note: For APRAS data files, the third character must be "D" to identify STLRFD is used to analyze the span.	--	--	--	--

5.7 GEO - GEOMETRY COMMAND

KEYWORD	COMMAND DESCRIPTION
GEO	GEOMETRY - This command is used to define the beam geometry information. Only one GEO command can be used. Parameters 6 and 7 should be entered only if the run includes pedestrian loading.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Beam/ Stringer Spacing	Enter the center to center beam spacing. This value is used to compute the distribution factors, slab weight, and effective slab width. For a two-girder system, enter the stringer spacing.	ft	3. (W)	18. (W)	--
2. Deck Overhang	Enter the deck overhang measured from the centerline of exterior girder to edge of deck. This value is used to compute the slab weight and effective slab width. This input does not need to be entered for an interior beam.	ft	0. (W)	MXOH[1] (D) or (E)	--
3. Staggered Diaphragms	Enter diaphragm stagger option. This value is used for checking the maximum dead load stress per the constructability checks. This value is also used for determining the applicability of LRFD Specifications, Chapter 6, Appendix A (flexural resistances for strength limit states). Y - If diaphragms or cross frames are staggered. N - If diaphragms or cross frames are not staggered.	--	Y, N (E)	--	N
4. Number of Design Lanes	Enter the number of design lanes. This is used for computing the live load distribution factors and for performing lever rule computations. If the bridge cross section includes one or more sidewalks, this parameter is to be entered assuming that the sidewalks are not present.	--	1 (E)	8 (W)	--
5. Deflection Distribution Factor	Enter the distribution factor for live load deflection. Leave blank for the program to compute this value. If parameters 4 and 5 are both entered, the program will use the value entered in parameter 5 as the deflection distribution factor. If the bridge cross section includes one or more sidewalks, this parameter is to be entered assuming that the sidewalks are not present. The distribution factor entered should include the multiple presence factor.	--	0.1 (E)	2. (E)	--
6. Number of Design Lanes with Sidewalks	Enter the number of design lanes assuming that the sidewalks are present. This is used for computing the live load distribution factors and for performing lever rule computations. Leave blank if pedestrian loading is not included in this run.	--	1 (E)	8 (W)	--

5.7 GEO - GEOMETRY COMMAND (Continued)

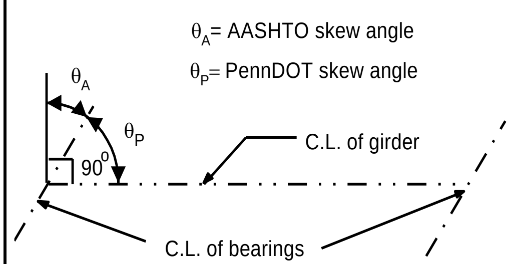
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Deflection Distribution Factor with Sidewalks	Enter the distribution factor for live load deflection assuming that the sidewalks are present. Leave blank for the program to compute this value. If parameters 6 and 7 are both entered, the program will use the value entered in parameter 7 as the deflection distribution factor with sidewalks. Leave blank if pedestrian loading is not included in this run. The distribution factor entered should include the multiple presence factor.	--	0. (E)	2. (E)	--
8. Kinked / Curved Girder	Enter whether the girder is kinked or curved or straight. This value is only used to determine the calculations to use for the flexural resistance of the girder. Y- If the beam is kinked (chorded) or horizontally curved. The flexural resistance will be calculated using the LRFD Specifications Article 6.10.7.2 for composite sections in positive flexure and Article 6.10.8 for composite sections in negative flexure and noncomposite sections. Article 6.10.7.1 and Appendix A will not be considered at all. N - If the girder is NOT kinked / curved. LRFD Specifications Article 6.10.7.1 and Appendix A will be considered if the beam satisfies the other criteria to use these calculations.	--	Y, N (E)	--	N
9. Number of Beams for 6.10.3.4.2 Check	Enter the number of beams in the cross section to consider for the Global Displacement Amplification in Narrow I-Girder Bridge Units check (LRFD Specifications 6.10.3.4.2). For phased construction, this value would be the number of beams for the current construction phase. Leave blank to omit this check for bridge cross sections with more than **three** beams. **Enter 4 to check cross sections with four beams.** This check cannot be omitted for bridge cross sections with two **or** three beams. For these sections, the value will default to the input Number of Beams. For Global Displacement Amplification calculations for systems of five or more girders, the equations of LRFD Specifications Section 6.10.3.4.2 cannot be used, so the user will need to do their own analysis if they desire to check the cross section stability.	--	2 (E)	Minimum of Number of Beams or 4 (E)	Number of Beams if **3** or fewer. No check of 6.10.3.4.2 if **four** or greater.

Notes:

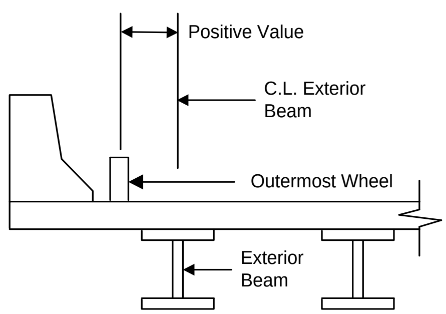
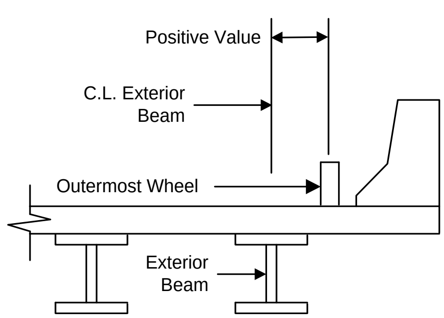
[1] Entering an overhang that exceeds 0.5 * Beam/Stringer spacing will result in a District Bridge Engineer warning for both design and analysis runs of STLRFD.
Entering an overhang that exceeds 0.625 * Beam/Stringer spacing will result in an error for design runs of STLRFD.
For a design run, entering an overhang that exceeds the maximum beam depth (for rolled beams) or the maximum web depth plus maximum flange thicknesses (for plate girders) will result in an error. For an analysis run, entering an overhang that exceeds the minimum total depth at any point along the beam will result in a District Bridge Engineer warning.

5.8 CDF - COMPUTED DISTRIBUTION FACTOR COMMAND

KEYWORD	COMMAND DESCRIPTION
CDF	COMPUTED DISTRIBUTION FACTOR - This command is used to input the required data for the program to compute the live load moment and shear distribution factors. The program will compute distribution factors assuming an equally spaced multi-girder structure or a two-girder system. Only one CDF command can be used. The user must enter a skew command (SKW) after a CDF factor command is entered. When a CDF command is entered, the user cannot input the user defined distribution factor commands (UDF). Parameters 10 through 12 should be entered only if the run includes pedestrian loading.

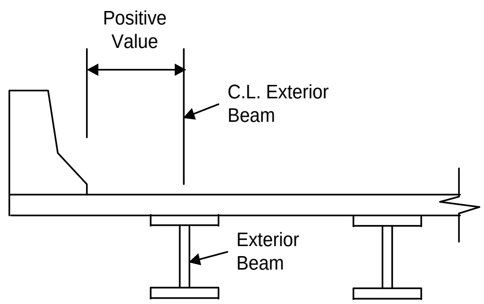
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Skew Angle Designation	Enter: A - AASHTO skew angle designation. P - PennDOT skew angle designation. For AASHTO, a positive skew is measured counterclockwise from a line perpendicular to the centerline of girder. For PennDOT, a positive skew is measured counterclockwise from the centerline of girder. As shown, AASHTO skew angle (θ_A) is negative and PennDOT skew angle (θ_P) is positive. 	--	A, P (E)	--	P
2. Bracing Type	NOTE: This parameter is no longer used and should be left blank	--	--	--	--
3. Design Lane Width	Enter the design lane width.	ft	9. (E)	15. (W)	12.0
4. Gage Distance	Enter the lateral distance between the wheels of the truck.	ft	6.0 (E)	10.0 (W)	6.0

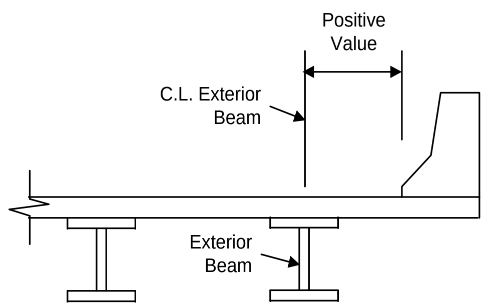
5.8 CDF - COMPUTED DISTRIBUTION FACTOR COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Passing Distance	Enter the minimum distance between adjacent wheels of passing vehicles.	ft	4.0 (E)	10.0 (W)	4.0
6. Two-Girder Spacing	Enter the center-to-center girder spacing of a two-girder system. This value is used to compute distribution factors for the girders of a two-girder system. Leave blank if bridge is not a two-girder system.	ft	10. (E)	60. (W)	--
7. Distance to Outermost Wheel	Enter the distance from the centerline of the exterior beam to the outermost wheel. This parameter is required for an exterior beam only. If the bridge cross section includes one or more sidewalks, this parameter is to be entered assuming that the sidewalks are not present. For the case shown below (left fascia beam), a positive value indicates the wheel is to the left of the centerline of the exterior beam and a negative value indicates the wheel is to the right of the centerline of the exterior beam.  For the case shown below (right fascia beam), a positive value indicates the wheel is to the right of the centerline of the exterior beam and a negative value indicates the wheel is to the left of the centerline of the exterior beam. 	ft	-10. (W)	15. (W)	--

5.8 CDF - COMPUTED DISTRIBUTION FACTOR COMMAND (Continued)

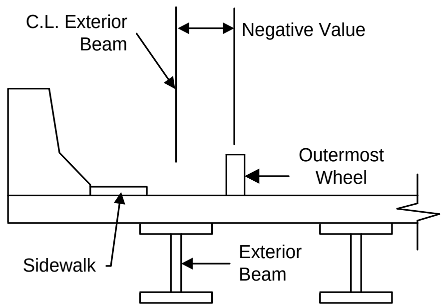
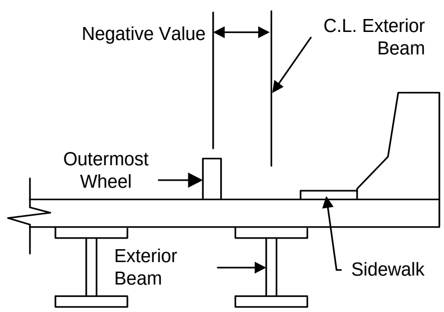
<table>
<tr><th>PARAMETER</th><th>DESCRIPTION</th><th>UNITS</th><th>LOWER LIMIT</th><th>UPPER LIMIT</th><th>Default</th></tr>
<tr>
<td>8. Centerline Exterior Beam to Curb</td>
<td>Enter the distance from the centerline of the exterior beam to the face of the curb. This parameter is required for an exterior beam only. If the bridge cross section includes one or more sidewalks, this parameter is to be entered assuming that the sidewalks are not present.

For the case shown below (left fascia beam), a positive value indicates the curb is to the left of the centerline of the exterior beam and a negative value indicates the curb is to the right of the centerline of the exterior beam.


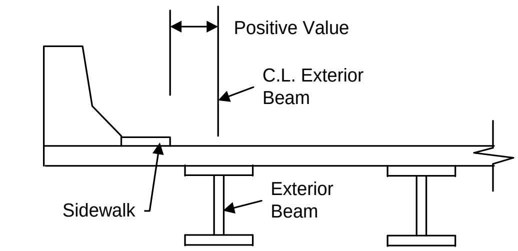
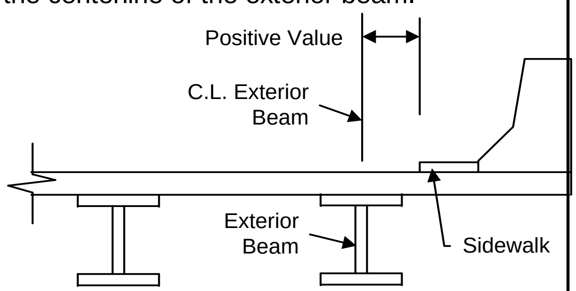
For the case shown below (right fascia beam), a positive value indicates the curb is to the right of the centerline of the exterior beam and a negative value indicates the curb is to the left of the centerline of the exterior beam.


</td>
<td>ft</td>
<td>-10.
(W)</td>
<td>10.
(W)</td>
<td>--</td>
</tr>
</table>

5.8 CDF - COMPUTED DISTRIBUTION FACTOR COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
9. Distance to Outermost Wheel with Sidewalks	Enter the distance from the centerline of the exterior beam to the outermost wheel. This parameter is required for an exterior beam only. Leave blank if pedestrian loading is not included in this run. This parameter is to be entered assuming that the sidewalks are present. For the case shown below (left fascia beam), a positive value indicates the wheel is to the left of the centerline of the exterior beam and a negative value indicates the wheel is to the right of the centerline of the exterior beam.  For the case shown below (right fascia beam), a positive value indicates the wheel is to the right of the centerline of the exterior beam and a negative value indicates the wheel is to the left of the centerline of the exterior beam. 	ft	-10. (W)	15. (W)	--

5.8 CDF - COMPUTED DISTRIBUTION FACTOR COMMAND (Continued)

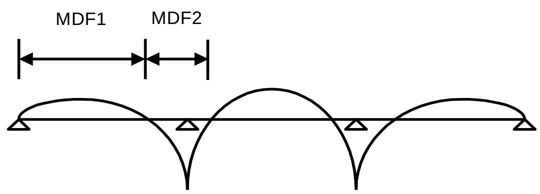
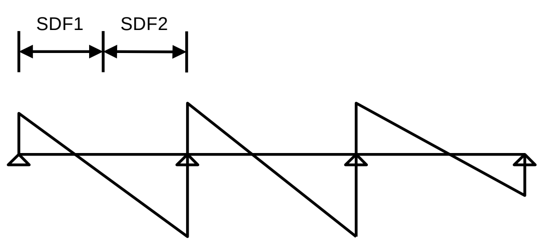
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
10. Centerline Exterior Beam to Curb with Sidewalks	Enter the distance from the centerline of the exterior beam to the face of the curb. This parameter is required for an exterior beam only. Leave blank if pedestrian loading is not included in this run. This parameter is to be entered assuming that the sidewalks are present. For the case shown below (left fascia beam), a positive value indicates the curb is to the left of the centerline of the exterior beam and a negative value indicates the curb is to the right of the centerline of the exterior beam.  For the case shown below (right fascia beam), a positive value indicates the curb is to the right of the centerline of the exterior beam and a negative value indicates the curb is to the left of the centerline of the exterior beam.  	ft	-10. (W)	10. (W)	--

5.9 UDF - USER DEFINED DISTRIBUTION FACTOR COMMAND

KEYWORD	COMMAND DESCRIPTION
UDF	USER DEFINED DISTRIBUTION FACTOR - This command is used to specify the moment and shear distribution factors. If the UDF command is not entered, the CDF command and SKW command must be entered and the program will compute the distribution factors. When the UDF command is used, all moment and shear distribution factors must be entered for each span. If the UDF command is used and pedestrian loading is not included in the run, two user defined distribution factor commands are required: one for the design vehicle (D) and one for the fatigue vehicle (F). If the UDF command is used and pedestrian loading is included in the run, three user defined distribution factor commands are required: one for the design vehicle assuming no sidewalks are present (D), one for the fatigue vehicle assuming no sidewalks are present (F), and one for the design vehicle assuming sidewalks are present (P). The parameters and the command can be repeated. A maximum of 100 sets of distribution factors (parameters 1 through 6) can be entered (25 UDF commands with four sets of distribution factors (parameters 1 through 6) on each command). User defined distribution factors must be entered in units of lane fractions and must include any skew correction factors. For a symmetrical structure, enter the distribution factors for spans up to and including the middle span. That is, for a symmetrical 5 span structure, enter the distribution factors for spans 1, 2 and 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number for which the distribution factors are to be used.	--	1 (E)	NSP[1] (E)	--
2. Distribution Factor Type	Enter the distribution factor type: D - Design live load distribution factor. F - Fatigue live load distribution factor. P - Pedestrian live load distribution factor. CS - Single lane distribution factor for the P-82C or P2016-13C combination CM - Multi-lane distribution factor for the P-82C or P2016-13C combination If pedestrian loading is included in this run, use the P indicator for design live load distribution factors assuming that the sidewalks are present and use the D indicator for design live load distribution factors assuming that the sidewalks are not present. The CS and CM distribution factors should only be entered if live load option G or K for an analysis run has been selected on the CTL command. Please see Section 3.4.15 of this manual for how the CS and CM distribution factors are used.	--	D, F, P, CS, CM (E)	--	--

5.9 UDF - USER DEFINED DISTRIBUTION FACTOR COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
3. Moment DF1	Enter the moment distribution factor to be used in calculating the live load moments in the dead load positive moment region for this span.  	--	0. (E)	2. (E)	--
4. Moment DF2	Enter the moment distribution factor to be used in calculating the live load moments in the dead load negative moment region. This distribution factor is applied to the live load moments from the computed dead load contraflexure point in this span to the contraflexure point in the next span. There is no moment DF2 factor for the last span, and therefore the user should skip this value by entering a comma.	--	0. (E)	2. (E)	--
5. Shear DF1	Enter the shear distribution factor to be used in calculating the live load shear from the left support to the midspan point for this span. Apply skew correction factor if applicable. (refer to section 6.10)  	--	0. (E)	2. (E)	--
6. Shear DF2	Enter the shear distribution factor to be used in calculating the live load shear from the midspan point to the right support for this span. Apply skew correction factor if applicable. (refer to section 6.10)	--	0. (E)	2. (E)	--

Notes:
[1] NSP is equal to the number of spans entered on the control command (CTL).

5.10 URF - USER DEFINED REACTION DISTRIBUTION FACTOR COMMAND

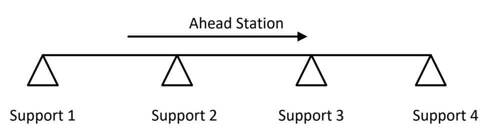
KEYWORD	COMMAND DESCRIPTION
URF	USER DEFINED REACTION DISTRIBUTION FACTOR - This command is used to specify the reaction distribution factors. This command is required if the UDF command has been entered. The URF command must be entered after the UDF command. If the URF command is used and pedestrian loading is not included in the run, two user defined distribution factor commands are required: one for the design vehicle (D) and one for the fatigue vehicle (F). If the URF command is used and pedestrian loading is included in the run, three user defined distribution factor commands are required: one for the design vehicle assuming no sidewalks are present (D), one for the fatigue vehicle assuming no sidewalks are present (F), and one for the design vehicle assuming sidewalks are present (P). The parameters and the command can be repeated. A maximum of 63 reaction distribution factors (parameters 1 through 3) can be entered (21 URF commands with three sets of reaction distribution factors (parameters 1 through 3) on each command). The URF command cannot be used with the CDF command. For a symmetrical structure, enter the supports up to and including the middle support. That is, for a symmetrical 5 span structure, enter the information for supports 1, 2 and 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Support Number	Enter the support number for which the reaction distribution factor is being defined.	--	1 (E)	NSP+1[1] (E)	--
2. Distribution Factor Type	Enter the distribution factor type: D - Design live load distribution factor. F - Fatigue live load distribution factor. P - Pedestrian live load distribution factor. If pedestrian loading is included in this run, use the P indicator for design live load distribution factors assuming that the sidewalks are present and use the D indicator for design live load distribution factors assuming that the sidewalks are not present.	--	D, F, P (E)	--	--
3. Reaction Distribution Factor	Enter the reaction distribution factor to be used in calculating the reactions. Apply skew correction factor if applicable. (refer to section 6.11)	--	0. (E)	2. (E)	--

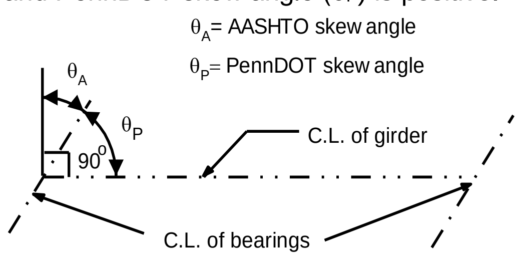
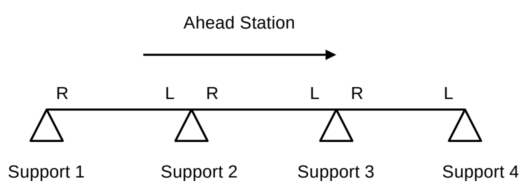
Notes:
[1] NSP is equal to the number of spans entered on the control command (CTL).

5.11 SKW - SKEW ANGLE COMMAND

KEYWORD	COMMAND DESCRIPTION
SKW	SKEW ANGLE - This command is used to specify the skew angle at the centerline of bearing for computing the shear distribution factor and the applicability of some specification checks, as described below. This command is required if the CDF command has been entered and optional if the UDF command has been entered. The SKW command must be entered after the CDF or UDF commands. The parameters and the command can be repeated for up to 21 supports (Two SKW commands with up to 15 supports on each command for a total not to exceed 21 supports). The skew angle designation, AASHTO or PennDOT, is entered on the CDF or CTL command. If the SKW command is not entered with the UDF command, the program will conservatively skip Appendix A provisions when calculating the flexural resistances for the strength limit states. Additionally, if no SKW command is entered and an SCS or SCC command is entered, the program will conservatively apply the radial fatigue shear range when determining the maximum shear connector pitch. For a symmetrical structure, enter the supports up to and including the middle support. That is, for a symmetrical 5 span structure, enter the information for supports 1, 2 and 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Support Number	Enter the support number for the skew angle being defined.  	--	1 (E)	NSP+1[1] (E)	--

5.11 SKW - SKEW ANGLE COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
2. Skew Angle	Enter the value for either the PennDOT or AASHTO skew angle based on the skew angle designation input parameter on the CDF or CTL command. For PennDOT, a positive skew is measured counterclockwise from the centerline of girder. For AASHTO, a positive skew is measured counterclockwise from a line perpendicular to the centerline of girder. As shown, AASHTO skew angle (θ_A) is negative and PennDOT skew angle (θ_P) is positive. 	deg 'P' pos. 'P' neg. 'A'	 30. (W) -90. (W) -60. (W)	 90. (W) -30. (W) 60. (W)	 --
3. Apply Skew Correction Factor	Enter: L - Shear skew correction factor is applied only to the left of the support. R - Shear skew correction factor is applied only to the right of the support. B - Shear skew correction factor is applied to both the left and right of the support. N - If an interior girder or if there is no skew or if an exterior girder is at an acute corner.  Note that this parameter is only used when the CDF command has been entered. If used in conjunction with the UDF command, the only valid entry for this parameter is "N". Shear skew correction factors can only be applied to exterior girders. For interior girders, this parameter must be entered as N.	--	L, R, B, N (E)	--	--

Notes:

[1] NSP is equal to the number of spans entered on the control command (CTL).

5.12 SPL - SPAN LENGTH COMMAND

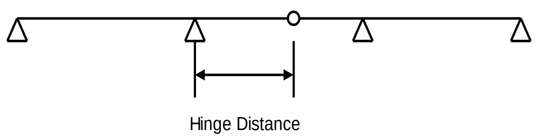
KEYWORD	COMMAND DESCRIPTION
SPL	SPAN LENGTH - This command is used to specify the length of each span. Up to 20 span lengths can be entered (Four SPL commands with five span lengths defined (parameters 1 and 2) on each command). For a symmetrical structure, enter the spans up to and including the middle span. That is, for a symmetrical 5 span structure, enter the span length for Spans 1, 2, and 3. The parameters and the command can be repeated. The maximum number of spans is 20.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number for the span length being defined.	--	1 (E)	NSP[1] (E)	--
2. Span Length	Enter the span length from C.L. of bearing to C.L. of bearing.	ft	18. (W)	500. (C)	--

Notes:
[1] NSP is equal to the number of spans entered on the control command (CTL).

5.13 HNG - HINGE LOCATION COMMAND

KEYWORD	COMMAND DESCRIPTION
HNG	HINGE LOCATION - This command is used to specify the location of hinges in a specific span. The parameters and the command can be repeated. Up to 10 HNG commands can be entered, with two hinges defined (parameters 1 and 2) on each command. The maximum number of hinges is equal to the number of spans minus one. The maximum number of hinges in the beam per interior span is equal to 2. Exterior spans can only have one hinge defined. For a symmetrical structure, enter the hinges in spans up to and including the middle span.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number of the hinge location.	--	1 (E)	NSP[1] (E)	--
2. Distance	Enter the distance of the hinge measured from the left support of the defined span.  	ft	0.01 (E)	MXSP[2]-0.01 (E)	--

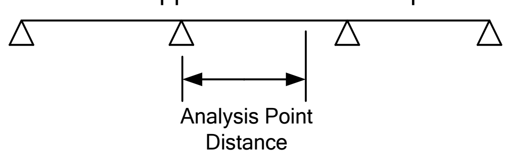
Notes:

[1] NSP is equal to the number of spans entered on the control command (CTL).

[2] MXSP is equal to the span length corresponding to the span number.

5.14 UDA - USER DEFINED ANALYSIS POINTS COMMAND

KEYWORD	COMMAND DESCRIPTION
UDA	USER DEFINED ANALYSIS POINTS - This command is used to specify the location of analysis points other than those set by the program. The program automatically places analysis points at twentieth points of each span, at plate transition locations (DPL, ABU, and APL commands), at hinge locations (HNG command), at deck pour locations (DPS command), at bracing points (BRP command), at concentrated load points (CLD command), and at user-defined fatigue locations (FTG command). The program uses a tolerance on analysis points of 0.1 inches. That is, if two analysis points are within 0.1 inches of each other, then the program assumes that they are the same point. The parameters and the command can be repeated. A maximum of 40 user defined analysis points can be entered for the entire structure (eight UDA commands with five locations defined (parameters 1 and 2) per command). For a symmetrical structure, enter the analysis points for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the analysis points for spans 1, 2 and up to the point of symmetry for span 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number of the analysis point.	--	1 (E)	NSP[1] (E)	--
2. Distance	Enter the distance of the analysis point measured from the left support of the defined span.  	ft	0. (E)	MXSP[2] (E)	--

Notes:

1 NSP is equal to the number of spans entered in the control command.

2 MXSP is equal to the span length corresponding to the span number.

5.15 MAT - MATERIAL COMMAND

KEYWORD	COMMAND DESCRIPTION
MAT	MATERIAL - This command is used to specify the material properties for an analysis problem. For analysis, the input file must have at least one material command. This command should not be entered for design. The parameters and the command can be repeated. A maximum of 20 materials (five MAT commands with four materials defined (parameters 1 through 8) per command) can be entered.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Material ID Number	Enter the material ID number associated with the following parameters.	--	1 (E)	20 (E)	--
2. Noncomposite/ Composite	Enter: N - Noncomposite. C - Composite action between the steel beam and the concrete slab. A girder must be either composite over its entire length or noncomposite over its entire length. It cannot have portions that are composite and other portions that are noncomposite.	--	N, C (E)	--	C
3. Web Yield Strength	For plate girders and built-up sections, enter the yield strength of the web plate associated with this material ID number. For rolled beams, enter the yield strength of the rolled beam associated with this material ID number. Note that entering a web yield strength greater than either flange yield strength will require District Bridge Engineer approval. The web yield strength may not exceed 120% of the lower flange yield strength and will be reduced if necessary. Also, if the yield strength of the web does not exceed the maximum of 36 ksi or 70% of the yield strength of the stronger flange, a warning will be generated. (LRFD Specifications and DM-4 Article 6.10.1.3)	ksi	30. (W)	100. (W)	36.

5.15 MAT - MATERIAL COMMAND (Continued)

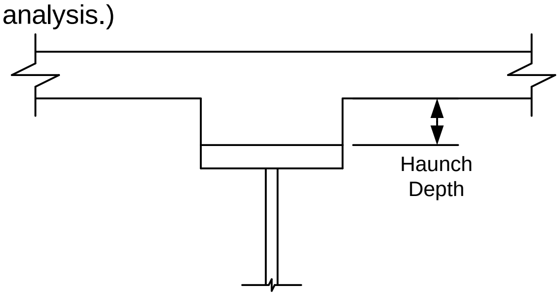
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
4. Top Flange Yield Strength	For plate girders and built-up sections, enter the yield strength of the top flange plate associated with this material ID number. For rolled beams, enter the yield strength of the top cover plate associated with this material ID number. This value must be the same value as the yield strength of the rolled beam entered for parameter 3. Leave blank if no top cover plate.	ksi	30. (W)	100. (W)	36.
5. Bottom Flange Yield Strength	For plate girders and built-up sections, enter the yield strength of the bottom flange plate associated with this material ID number. For rolled beams, enter the yield strength of the bottom cover plate associated with this material ID number. This value must be the same value as the yield strength of the rolled beam entered for parameter 3. Leave blank if no bottom cover plate.	ksi	30. (W)	100. (W)	36.
6. Classification Strength of Weld Metal	For plate girders, enter the classification strength of the weld metal used for the flange-to-web fillet weld. For rolled beams and built-up sections, leave this input blank.	ksi	30. (W)	100. (W)	70.
7. Rolled Beam Tensile Strength	For rolled beams, enter the tensile strength of the rolled beam associated with this material ID number. Leave blank if not rolled beam.	ksi	50. (W)	110. (W)	[1]
8. Top Flange Tensile Strength	For plate girders and built-up sections, enter the tensile strength of the top flange plate associated with this material ID number. Leave blank if rolled beam.	ksi	50. (W)	110. (W)	[1]
9. Bottom Flange Tensile Strength	For plate girders and built-up sections, enter the tensile strength of the bottom flange plate associated with this material ID number. Leave blank if rolled beam.	ksi	50. (W)	110. (W)	[1]

Notes:

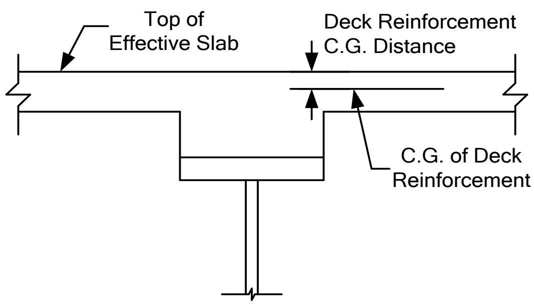
[1] Defaults to 58 ksi when the yield strength for the component is 36 ksi; otherwise no default value.

5.16 DRB - DESIGN ROLLED BEAM COMMAND

KEYWORD	COMMAND DESCRIPTION
DRB	DESIGN ROLLED BEAM - This command is used to set the design parameters to be used in designing a rolled beam. The program cannot design a built-up section or a rolled beam with cover plates. Only one DRB command can be entered. The design option is available for single spans only.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Maximum Deflection	Enter the maximum allowable live load deflection.	in	0. (E)	7.5 (W)	MXSP[1] 800
2. Maximum Deflection with Pedestrian Load	Enter the maximum allowable live load deflection with pedestrian load present. Leave blank if pedestrian load is not included in this run.	in	0. (E)	7.5 (W)	MXSP[1] 1000
3. Noncomp./ Composite	Enter: N - Noncomposite. C - Composite action between the steel beam and the concrete slab.	--	N, C (E)	--	C
4. Yield Strength	Enter the yield strength of the rolled beam.	ksi	30. (W)	100. 700. (W)	36.
5. Minimum Depth	Enter the minimum actual (not nominal) beam depth.	in	18. (W)	45. (W)	18.
6. Maximum Depth	Enter the maximum actual (not nominal) beam depth.	in	18. (W)	45. (W)	45.
7. Haunch Depth	Enter the haunch depth. The haunch depth is measured from the top of the top flange to the bottom of the deck slab. (Note that the haunch depth is entered differently for design than for analysis.)  	in	0. (E)	10. (W)	0.

5.16 DRB - DESIGN ROLLED BEAM COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
8. Deck Reinf. Area	Enter the area of reinforcement parallel to the beam per unit width of the deck to be used when computing composite section properties in the negative moment regions. For a noncomposite section, this value need not be entered.	in^2/ft	0. (E)	3. (W)	0.
9. Deck Reinf. CG Distance	Enter the distance from the center of gravity of the deck reinforcement to the top of the effective slab. For a noncomposite section, this value need not be entered.  	in	0. (E)	16. (W)	0.
10. Span-To-Depth Ratio Check	Enter 'Y' if the program is to check the span-to-depth ratio as per LRFD Specifications Table 2.5.2.6.3-1 when designing the rolled beam. Enter 'N' if the program is to ignore the check of the span-to-depth ratio.	--	Y, N (E)	--	N
11. Tensile Strength	Enter the tensile strength of the rolled beam.	ksi	50. (W)	110. (W)	2
12. Design Method	Enter W if the program is to optimize the design by weight (i.e. the lightest section that will work is chosen) or D if the program is to optimize the design by depth (i.e. the shallowest section that will work is chosen)	--	W, D (E)	--	W

5.16 DRB - DESIGN ROLLED BEAM COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
13. Section 6.10.3.4.2 Check	Enter 'Y' if the program is to check the requirements of the LRFD Specifications Section 6.10.3.4.2 - "Global Displacement Amplification in Narrow I-Girder Bridge Units" when designing the rolled beam. Enter 'N' if the program is to ignore the check of the LRFD Specifications Section 6.10.3.4.2. This parameter and the LRFD Specification requirements only apply to cross sections with two, three, or four rolled beams. This parameter will be ignored for cross sections with more than four rolled beams, unless parameter 9 of the GEO command, NUMBER OF BEAMS FOR 6.10.3.4.2 CHECK, is entered. Note that if 'N' is selected and the designed beam fails the check of the LRFD Specifications Section 6.10.3.4.2, there are other solutions described in that section to consider beyond increasing the beam stiffness.	--	Y, N (E)	--	Y

Notes:

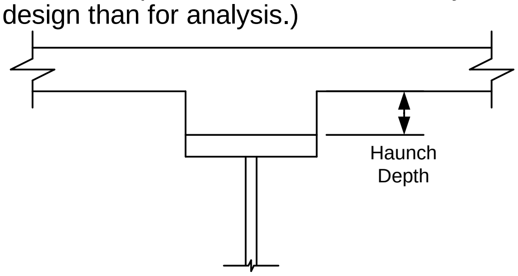
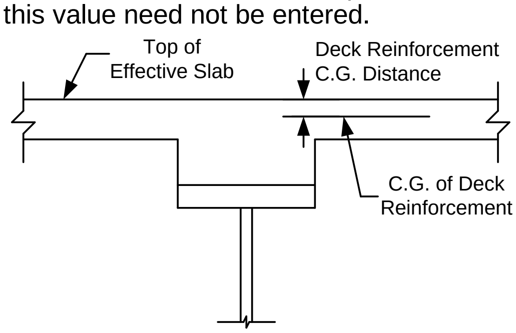
[1] MXSP is equal to the span length corresponding to the span number.
[2] Defaults to 58 ksi when the yield strength is 36 ksi; otherwise no default value.

5.17 DP1 - DESIGN PLATE GIRDER (PART 1) COMMAND

KEYWORD	COMMAND DESCRIPTION
DP1	DESIGN PLATE GIRDER (PART 1) - This command is used to set the design parameters to be used in designing a plate girder. The program cannot design a built-up section or a rolled beam with cover plates. Only one DP1 command can be entered. The design option is available for single spans only.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Transition Location Option	Enter the option for determining the plate transition locations: 1 - User-defined (if the user wants to input the plate transition locations). This option must be chosen if the user wishes to consider field splice locations in the design of the girder 2 - Predefined (if the user wants the program to use predefined plate transition locations).	--	1 (E)	2 (E)	2
2. Maximum Top Transition Cutoffs	Enter the maximum number of design transitions for the top plate of a plate girder from the centerline of bearing to midspan.	--	0 (E)	3 (E)	--
3. Maximum Bottom Transition Cutoffs	Enter the maximum number of design transitions for the bottom plate of a plate girder from the centerline of bearing to midspan.	--	0 (E)	3 (E)	--
4. Maximum Deflection	Enter the maximum allowable live load deflection.	in	0. (E)	7.5 (W)	MXSP[1] / 800
5. Maximum Deflection with Pedestrian Load	Enter the maximum allowable live load deflection with pedestrian load present. Leave blank if pedestrian load is not included in this run.	in	0. (E)	7.5 190. (W)	MXSP[1] / 1000
6. Weight/Mass Savings	Enter the weight savings required before a plate transition can occur. If the weight savings is less than this value, a transition will not be designed.	lb	0. (W)	800. (W)	800.
7. Noncomposite/ Composite	Enter: N - Noncomposite. C - Composite action between the steel beam and the concrete slab.	--	N, C (E)	--	C

5.17 DP1 - DESIGN PLATE GIRDER (PART 1) COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
8. Web Yield Strength	Enter the yield strength of the web. Note that entering a web yield strength greater than either flange yield strength will require District Bridge Engineer approval. The web yield strength may not exceed 120% of the lower flange yield strength and will be reduced if necessary. Also, if the yield strength of the web does not exceed the maximum of 36 ksi or 70% of the yield strength of the stronger flange, a warning will be generated.	ksi	30. (W)	100. (W)	36.
9. Top Flange Yield Strength	Enter the yield strength of the top flange.	ksi	30. (W)	100. (W)	36.
10. Bottom Flange Yield Strength	Enter the yield strength of the bottom flange.	ksi	30. (W)	100. (W)	36.
11. Haunch Depth	Enter the haunch depth. The haunch depth is measured from the top of the top flange to the bottom of the deck slab. (Note that the haunch depth is entered differently for design than for analysis.) 	in	0. (E)	10. (W)	0.
12. Deck Reinforcing Area	Enter the area of reinforcement parallel to the plate girder per unit width of the deck to be used when computing composite section properties in the negative moment regions. For a noncomposite section, this value need not be entered.	in^2/ft	0. (E)	3. (W)	0.
13. Deck Reinforcing CG Distance	Enter the distance from the center of gravity of the deck reinforcement to the top of the effective slab. For a noncomposite section, this value need not be entered. 	in	0. (E)	16. (W)	0.

5.17 DP1 - DESIGN PLATE GIRDER (PART 1) COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
14. Classification Strength of Weld Metal	Enter the classification strength of the weld metal used for the flange-to-web fillet weld.	ksi	30. (W)	100. (W)	70.
15. Top Flange Tensile Strength	Enter the tensile strength of the top flange.	ksi	50. (W)	110. (W)	[2]
16. Bottom Flange Tensile Strength	Enter the tensile strength of the bottom flange.	ksi	50. (W)	110. (W)	[2]

Notes:

[1] MXSP is equal to the span length corresponding to the span number.
[2] Defaults to 58 ksi when the yield strength for the component is 36 ksi; otherwise no default value.

5.18 DP2 - DESIGN PLATE GIRDER (PART 2) COMMAND

KEYWORD	COMMAND DESCRIPTION
DP2	DESIGN PLATE GIRDER (PART 2) - This command is used to set the design parameters to be used in designing a plate girder. The program cannot design a built-up section or a rolled beam with cover plates. Only one DP2 command can be entered. The design option is available for single spans only.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Minimum Web Depth	Enter the minimum web depth.	in	18. (W)	144. (W)	18.
2. Maximum Web Depth	Enter the maximum web depth.	in	18. (W)	144. (W)	144.
3. Minimum Top Plate Width	Enter the minimum width of the top plate.	in	12. (W)	50. (W)	12.
4. Maximum Top Plate Width	Enter the maximum width of the top plate. This parameter must be less than or equal to the Maximum Bottom Plate Width.	in	12. (W)	50. (W)	50.
5. Minimum Top Plate Thick.	Enter the minimum thickness of the top plate. This value should correspond to a value on the appropriate Plate Thickness Table, 1 or 2. If it does not correspond to one of those values, it will be rounded up to the nearest value on the table.	in	0.75 (W)	4. (E)	0.75
6. Maximum Top Plate Thick.	Enter the maximum thickness of the top plate. This value should correspond to a value on the appropriate Plate Thickness Table, 1 or 2. If it does not correspond to one of those values, it will be rounded down to the nearest value on the table.	in	0.75 (W)	4. (E)	4.
7. Minimum Bottom Plate Width	Enter the minimum width of the bottom plate.	in	12. (W)	50. (W)	12.
8. Maximum Bottom Plate Width	Enter the maximum width of the bottom plate. This parameter must be greater than or equal to the Maximum Top Plate Width.	in	12. (W)	50. (W)	50.

5.18 DP2 - DESIGN PLATE GIRDER (PART 2) COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
9. Minimum Bottom Plate Thick.	Enter the minimum thickness of the bottom plate. This value should correspond to a value on the appropriate Plate Thickness Table, 1 or 2. If it does not correspond to one of those values, it will be rounded up to the nearest value on the table.	in	0.75 (W)	4. (E)	0.75
10. Maximum Bottom Plate Thick.	Enter the maximum thickness of the bottom plate. This value should correspond to a value on the appropriate Plate Thickness Table, 1 or 2. If it does not correspond to one of those values, it will be rounded down to the nearest value on the table.	in	0.75 (W)	4. (E)	4.
11. Plate Thickness Table	Select which table of plate thicknesses should be used for design of the section. See Tables 1 and 2.	--	1 (E)	2 (E)	2
12. Flange Width Increment	Select '1' to increment the flange size by 1 inch or '2' to increment the flange size by 2 inches.	--	1 (E)	2 (E)	2
13. Longitudinal Stiffness Limit Check	Enter 'Y' if the program is to check the longitudinal stiffness parameter (K_g) of the steel section when designing a plate girder. Enter 'N' if the program is to ignore the check of the longitudinal stiffness parameter (K_g).	--	Y, N (E)	--	N
14. Span-To-Depth Ratio Check	Enter 'Y' if the program is to check the span-to-depth ratio as per LRFD Specifications Table 2.5.2.6.3-1 when designing the plate girder. Enter 'N' if the program is to ignore the check of the span-to-depth ratio.	--	Y, N (E)	--	N

5.18 DP2 - DESIGN PLATE GIRDER (PART 2) COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
15. Section 6.10.3.4.2 Check	Enter 'Y' if the program is to check the requirements of the LRFD Specifications Section 6.10.3.4.2 - "Global Displacement Amplification in Narrow I-Girder Bridge Units" when designing the plate girder. Enter 'N' if the program is to ignore the check of the LRFD Specifications Section 6.10.3.4.2. This parameter and the LRFD Specification requirements only apply to cross sections with two, three, or four girders. This parameter will be ignored for cross sections with more than four girders, unless parameter 9 of the GEO command, NUMBER OF BEAMS FOR 6.10.3.4.2 CHECK, is entered. Note that if 'N' is selected and the designed girder fails the check of the LRFD Specifications Section 6.10.3.4.2, there are other solutions described in that section to consider beyond increasing the girder stiffness.	--	Y, N (E)	--	Y
16. Minimum Web Thickness	Enter the minimum thickness of the web plate. This value should correspond to a value on the appropriate Plate Thickness Table, 1 or 2. If it does not correspond to one of those values, it will be rounded up to the nearest value on the table.	in	0.375 (E)	4.0 (W)	[1]

Notes:

[1] The program will default to a value of web depth / 150

Table 5.18-1 Plate Thickness Table 1

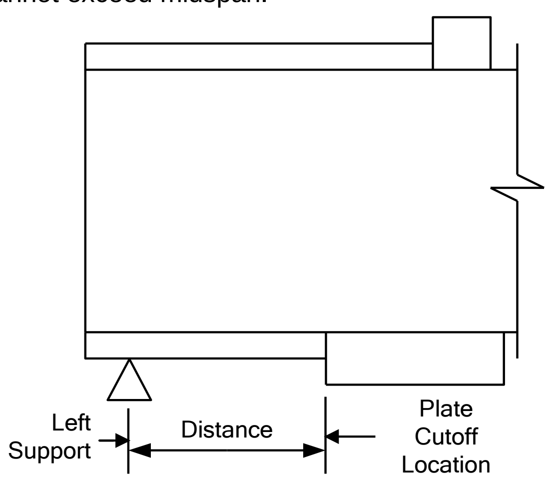
Thickness Table 1 (inches)	
0.375	2.250
0.4375	2.375
0.500	2.500
0.5625	2.625
0.625	2.750
0.6875	2.875
0.750	3.000
0.875	3.125
1.000	3.250
1.125	3.375
1.250	3.500
1.375	3.625
1.500	3.750
1.625	3.875
1.750	4.000
1.875	--
2.000	--
2.125	--

Table 5.18-2 Plate Thickness Table 2

Thickness Table 2 (inches)	
0.375	3.500
0.4375	3.750
0.500	4.000
0.5625	--
0.625	--
0.6875	--
0.750	--
1.000	--
1.250	--
1.500	--
1.750	--
2.000	--
2.250	--
2.500	--
2.750	--
3.000	--
3.250	--
--	--

5.19 DPL - DESIGN PLATE LOCATION COMMAND

KEYWORD	COMMAND DESCRIPTION
DPL	DESIGN PLATE LOCATION - This command is only used if the user wants to define the exact locations of the top and bottom plate transitions for design (as specified in parameter 1 of the DP1 command). The program will compute the required plate size for each location specified. If this command is not entered, the program will use predefined plate transition locations. The parameters and the command can be repeated. A maximum of three top plate cutoff locations and three bottom plate cutoff locations can be entered for simple spans (one DPL command with six locations defined (parameters 1 through 3) on the command). For a design plate location to also be considered a field splice, the design plate location must be entered on this command and a field splice at the same location also entered via the FSL command. If a location is only entered on a DPL command, it will be not be treated as a field splice.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number of the plate cutoff location.	--	1 (E)	NSP[1] (E)	--
2. Distance	Enter the distance along the girder measured from the left support of the defined span to the plate cutoff location. The distance entered cannot exceed midspan.  	ft	0. (E)	(½)MXSP[2] (E)	--
3. Plate	Enter: T - Top plate cutoff location. B - Bottom plate cutoff location.	--	T, B (E)	--	--

Notes:

1 NSP is equal to the number of spans entered in the control command.

2 MXSP is equal to the span length corresponding to the span number.

5.20 DTS - DESIGN TRANSVERSE STIFFENER COMMAND

KEYWORD	COMMAND DESCRIPTION
DTS	DESIGN TRANSVERSE STIFFENER - This command is used for the design of plate girders to optimize the web plate for stiffened webs. This command should not be entered for analysis. Only one DTS command can be entered.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Transverse Stiffener Type	Enter: S - Single plate transverse stiffeners. P - Pairs of plate transverse stiffeners.	--	S, P (E)	--	S
2. Minimum Stiffener Spacing	Enter the minimum stiffener spacing to be used for design.	in	12. (W)	240. (W)	--
3. Maximum Stiffener Spacing	Enter the maximum stiffener spacing to be used for design.	in	12. (W)	240. (W)	--
4. Transverse Stiffener Yield	Enter the yield strength of the transverse stiffener to be used for design.	ksi	30. (W)	50. (W)	36.
5. Relative Cost Ratio	Enter the ratio of cost of the transverse stiffener steel to the cost of the girder steel.	--	0. (E)	3. (E)	1.1

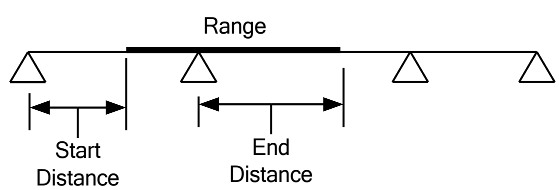
5.21 URB - USER DEFINED ROLLED BEAM COMMAND

KEYWORD	COMMAND DESCRIPTION
URB	USER DEFINED ROLLED BEAM - This command is used to input a user-defined rolled beam section. This command must come before the ARB command. If not entered, the program will use the rolled beam table. Repeat the URB command line to enter additional user-defined rolled beams. A maximum of five user-defined rolled beams (five separate URB commands) can be entered for the entire structure.

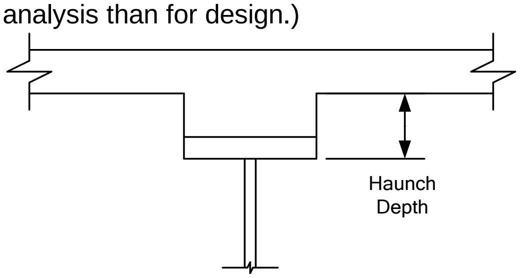
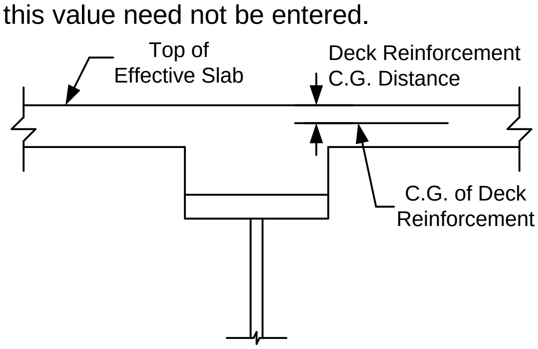
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Rolled Beam Designation	Enter the rolled beam designation, such as 'W36X300', using no spaces. This is the same designation that must be entered on the ARB command. This will override the use of the AISC designation stored in the program.	--	--	--	--
2. Nominal Depth	Enter the nominal depth of this rolled beam designation.	in	0. (E)	50. (W)	--
3. Nominal Weight/ Density	Enter the nominal weight/density to be used for computing the weight/density of the beam.	lb/ft	0. (E)	500. (W)	--
4. Moment of Inertia	Enter the moment of inertia of the rolled beam.	in^4	0. (E)	72,000. (W)	--
5. Area	Enter the area of the rolled beam.	in^2	0. (E)	250. (W)	--
6. Flange Width	Enter the flange width of the rolled beam.	in	0. (E)	50. (W)	--
7. Flange Thickness	Enter the flange thickness of the rolled beam.	in	0. (E)	2. (W)	--
8. Beam Depth	Enter the beam depth for the rolled beam.	in	0. (E)	50. (W)	--
9. Web Thickness	Enter the thickness of the web for the rolled beam.	in	0. (E)	2. (W)	--
10. Distance “k”	Enter the distance from the outer face of the flange to the web toe of the fillet.	in	0. (E)	4. (W)	--

5.22 ARB - ANALYSIS ROLLED BEAM COMMAND

KEYWORD	COMMAND DESCRIPTION
ARB	ANALYSIS ROLLED BEAM - This command is used to set the rolled beam properties for analysis. The AISC designation, cover plate dimensions, and deck reinforcement can be entered. The ARB command can be repeated. Up to 300 ARB commands can be entered. A maximum of 380 section transitions can be entered for the entire structure. This includes the section transitions defined with this command plus section transitions inserted by the program at section loss and section hole start and end locations, at field splice locations, and at all analysis points located in a region with a varying web depth. Ranges defined on this command cannot overlap with previously entered ranges. If the symmetry option is not used, the entire length of the rolled beam must be defined using one or more ARB commands. If the symmetry option is used, the first half of the entire length of the rolled beam must be defined using one or more ARB commands.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Span Number	Enter the start span number of the current range.	--	1 (E)	NSP[1] (E)	--
2. Start Distance	Enter the start distance along the girder measured from the left support of the defined span to the beginning of the current range. 	ft	0. (E)	MXSP[2] (E)	--
3. End Span Number	Enter the end span number of the current range.	--	1 (E)	NSP (E)	--
4. End Distance	Enter the end distance along the girder measured from the left support of the defined span to the end of the current range.	ft	0. (E)	MXSP (E)	--
5. Material ID Number	Enter the material ID number.	--	1 (E)	NMAT[3] (E)	--
6. Rolled Beam Designation	Enter the AISC designation for a standard AISC rolled beam stored in the program. Enter W, nominal depth, X, and nominal weight without spaces between data (for example, 'W36X300'). If a user defined rolled beam (URB) command was entered, input the same designation as entered on the URB command.	--	--	--	--

5.22 ARB - ANALYSIS ROLLED BEAM COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Top Cover Plate Width	Enter the width of the top cover plate. If the Top Cover Plate Thickness is entered as 0., this value must also be entered as 0.	in	0. (E)	50. (W)	0.
8. Top Cover Plate Thickness	Enter the thickness of the top cover plate. If the Top Cover Plate Width is entered as 0., this value must also be entered as 0.	in	0. (E)	2. (W)	0.
9. Bottom Cover Plate Width	Enter the width of the bottom cover plate. If the Bottom Cover Plate Thickness is entered as 0., this value must also be entered as 0.	in	0. (E)	50. (W)	0.
10. Bottom Cover Plate Thickness	Enter the thickness of the bottom cover plate. If the Bottom Cover Plate Width is entered as 0., this value must also be entered as 0.	in	0. (E)	2. (W)	0.
11. Haunch Depth	Enter the haunch depth. The haunch depth is measured from the top of the web (or bottom of top flange) to the bottom of the deck slab. (Note that the haunch depth is entered differently for analysis than for design.) 	in	0. (E)	10. (W)	0.
12. Deck Reinforcing Area	Enter the area of longitudinal reinforcement per unit width of the deck to be used when computing composite section properties in the negative moment regions. For a noncomposite section, this value need not be entered.	in^2/ft	0. (E)	3. (W)	0.
13. Deck Reinf. CG Distance	Enter the distance from the center of gravity of the longitudinal deck reinforcement to the top of the effective slab. For a noncomposite section, this value need not be entered. 	in	0. (E)	16. (W)	0.

Notes:

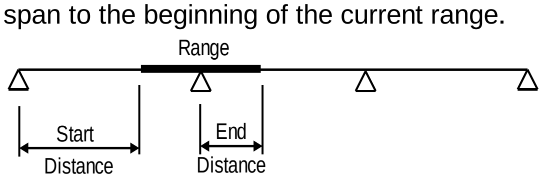
1 NSP is equal to the number of spans entered in the CTL command.

2 MXSP is equal to the span length corresponding to the span number.

3 NMAT is equal to the number of material ID numbers defined in the MAT command.

5.23 ABU - ANALYSIS BUILT-UP COMMAND

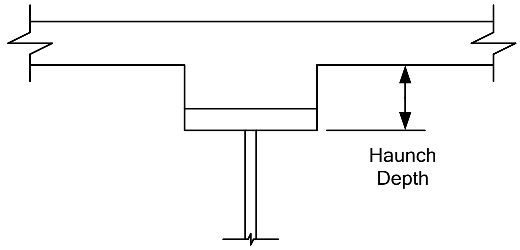
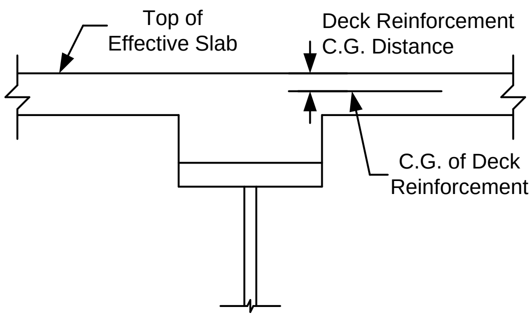
KEYWORD	COMMAND DESCRIPTION
ABU	ANALYSIS BUILT-UP - This command is used to set the parameters for the analysis of a built-up section consisting of plates and four angles. All angles are assumed to be the same size. The ABU command can be repeated. Up to 300 ABU commands can be entered. A maximum of 380 section transitions can be entered for the entire structure. This includes the section transitions defined with this command plus section transitions inserted by the program at section loss and section hole start and end locations, at field splice locations, and at all analysis points located in a region with a varying web depth. Ranges defined on this command cannot overlap with previously entered ranges. If the symmetry option is not used, the entire length of the built-up section must be defined using one or more ABU commands. If the symmetry option is used, the first half of the entire length of the built-up section must be defined using one or more ABU commands.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Span Number	Enter the start span number of the current range.	--	1 (E)	NSP[1] (E)	--
2. Start Distance	Enter the start distance along the girder measured from the left support of the defined span to the beginning of the current range.  	ft	0. (E)	MXSP[2] (E)	--
3. End Span Number	Enter the end span number of the current range.	--	1 (E)	NSP (E)	--
4. End Distance	Enter the end distance along the girder measured from the left support of the defined span to the end of the current range.	ft	0. (E)	MXSP (E)	--
5. Material ID Number	Enter the material ID number.	--	1 (E)	NMAT[3] (E)	--
6. Angle Vertical Leg	Enter the length of the vertical leg of the angle. This value must be less than half of the web depth.	in	0. (E)	9. (E)[4]	--
7. Angle Horizontal Leg	Enter the length of the horizontal leg of the angle.	in	0. (E)	9. (E)	--
8. Angle Thickness	Enter the thickness of the angle.	in	0. (E)	1.125 (E)	--

5.23 ABU - ANALYSIS BUILT-UP COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
9. Web Depth Variation	Enter type of web depth variation for the defined range: C - Constant web depth, no variation. P - Parabolic web depth variation. S - Straight line web depth variation. Note that use of a variable web depth requires District Bridge Engineer approval. (DM-4 Article 6.10.1.4) In order to establish the beginning web depth of the girder, the first girder range (at abutment one) must have a constant web depth. If the girder physically starts with a varying depth range, this range can be very short (0.1 ft), but must be constant depth. A transverse stiffener is required at each end of a web depth variation. These stiffeners may be defined with the TST command. See Figure 6.45-1 for the girder haunch stiffener detail.	--	C, P, S (E)	--	C
10. Web Depth	Enter the depth of the web at the right end of the range being defined. For a straight line web depth variation web depths between the beginning and end of straight line variation of web depth could be entered. For a parabolic web depth variation, enter only the web depth at the end of the variation. Only one depth can be entered per variation for parabolic web depth variation. This value must be greater than twice the angle vertical leg length	in	18. (W)[4]	*[5]	--
11. Web Thickness	Enter the thickness of the web along the current range.	in	0.25 (W)	2. (W)	--
12. Top Plate Width	Enter the width of the top plate. If the Top Cover Plate Thickness is entered as 0., this value must also be entered as 0.	in	0. (W)	50. (W)	--
13. Top Plate Thickness	Enter the thickness of the top plate. If the Top Cover Plate Width is entered as 0., this value must also be entered as 0.	in	0. (W)	4. (W)[5]	--
14. Bottom Plate Width	Enter the width of the bottom plate. If the Bottom Cover Plate Thickness is entered as 0., this value must also be entered as 0.	in	0. (W)	50. (W)	--
15. Bottom Plate Thickness	Enter the thickness of the bottom plate. If the Bottom Cover Plate Width is entered as 0., this value must also be entered as 0.	in	0. (W)	4. (W)[5]	--

5.23 ABU - ANALYSIS BUILT-UP COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
16. Haunch Depth	Enter the haunch depth. The haunch depth is measured from the top of the web (or bottom of top flange) to the bottom of the deck slab. 	in	0. (E)	10. (W)	0.
17. Deck Reinforcing Area	Enter the area of longitudinal reinforcement per unit width of the deck to be used when computing composite section properties in the negative moment regions. For a noncomposite section, this value need not be entered.	in^2/ft	0. (E)	3. (W)	0.
18. Deck Reinf. CG Distance	Enter the distance from the center of gravity of the longitudinal deck reinforcement to the top of the effective slab. For a noncomposite section, this value need not be entered. 	in	0. (E)	16. (W)	0.

Notes:

1 NSP is equal to the number of spans entered in the CTL command.

2 MXSP is equal to the span length corresponding to the span number.

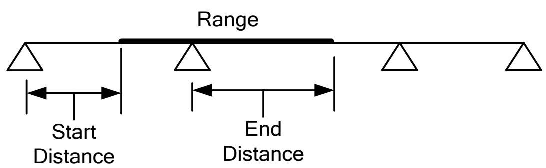
3 NMAT is equal to the number of material ID numbers defined in the MAT command.

4 If the web depth is less than twice the angle vertical leg length, the program will stop with an error.

5 Girders deeper than 14 ft. shall be designed with a horizontal field splice. The approval of the Chief Bridge Engineer shall be required when a horizontal field splice is incorporated.

5.24 APL - ANALYSIS PLATE COMMAND

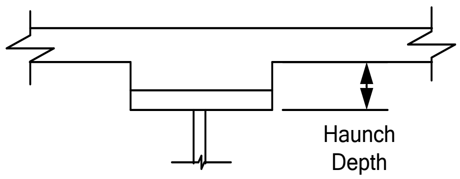
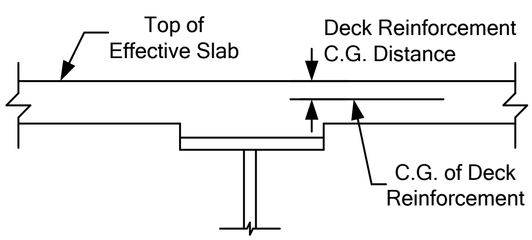
KEYWORD	COMMAND DESCRIPTION
APL	ANALYSIS PLATE - This command is used to set the analysis parameters to be used in the analysis of a plate girder. The APL command can be repeated. Up to 300 APL commands can be entered. A maximum of 380 section transitions can be entered for the entire structure. This includes the section transitions defined with this command plus section transitions inserted by the program at section loss and section hole start and end locations, at field splice locations, and at all analysis points located in a region with a varying web depth. Ranges defined on this command cannot overlap with previously entered ranges. If the symmetry option is used, the first half of the entire length of the plate girder must be defined using one or more APL commands.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Span Number	Enter the start span number of the current range.	--	1 (E)	NSP[1] (E)	--
2. Start Distance	Enter the start distance along the girder measured from the left support of the defined span to the beginning of the current range. 	ft	0. (E)	MXSP[2] (E)	--
3. End Span Number	Enter the end span number of the current range.	--	1 (E)	NSP (E)	--
4. End Distance	Enter the end distance along the girder measured from the left support of the defined span to the end of the current range.	ft	0. (E)	MXSP (E)	--
5. Material ID Number	Enter the material ID number.	--	1 (E)	NMAT[3] (E)	--

5.24 APL - ANALYSIS PLATE COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
6. Web Depth Variation	Enter type of web depth variation for the defined range: C - Constant web depth, no variation. P - Parabolic web depth variation. S - Straight line web depth variation. Note that use of a variable web depth requires District Bridge Engineer approval. (DM-4 Article 6.10.1.4) In order to establish the beginning web depth of the girder, the first girder range (at abutment one) must have a constant web depth. If the girder physically starts with a varying depth range, this range can be very short (0.1 ft), but must be constant depth. A transverse stiffener is required at each end of a web depth variation. These stiffeners may be defined with the TST command. See Figure 6.45-1 for the girder haunch stiffener detail.	--	C, P, S (E)	--	C
7. Web Depth	Enter the depth of the web at the right end of the range being defined. For a straight line web depth variation web depths between the beginning and end of straight line variation of web depth could be entered. For a parabolic web depth variation, enter only the web depth at the end of the variation. Only one depth can be entered per variation for parabolic web depth variation.	in	18. (W)	*[4]	--
8. Web Thickness	Enter the thickness of the web along the current range.	in	0.25 (W)	2. (W)	--
9. Top Plate Width	Enter the width of the top plate along the current range.	in	12. (W)	50. (W)	--
10. Top Plate Thickness	Enter the thickness of the top plate along the current range.	in	0.5 (W)	4. (W)[4]	--
11. Bottom Plate Width	Enter the width of the bottom plate along the current range.	in	12. (W)	50. (W)	--
12. Bottom Plate Thickness	Enter the thickness of the bottom plate along the current range.	in	0.5 (W)	4. (W)[4]	--

5.24 APL - ANALYSIS PLATE COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
13. Haunch Depth	Enter the haunch depth. The haunch depth is measured from the top of the web (or bottom of top flange) to the bottom of the deck slab. (Note that the haunch depth is entered differently for analysis than for design.)  	in	0. (E)	10. (W)	0.
14. Deck Reinforcing Area	Enter the area of longitudinal reinforcement per unit width of the deck to be used when computing composite section properties in the negative moment regions. For a noncomposite section, this value need not be entered.	in^2/ft	0. (E)	3. (W)	0.
15. Deck Reinf. CG Distance	Enter the distance from the center of gravity of the longitudinal deck reinforcement to the top of the effective slab. For a noncomposite section, this value need not be entered.  	in	0. (E)	16. (W)	0.

Notes:

1 NSP is equal to the number of spans entered in the CTL command.

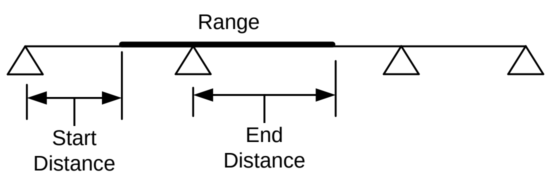
2 MXSP is equal to the span length corresponding to the span number.

3 NMAT is equal to the number of material ID numbers defined in the MAT command.

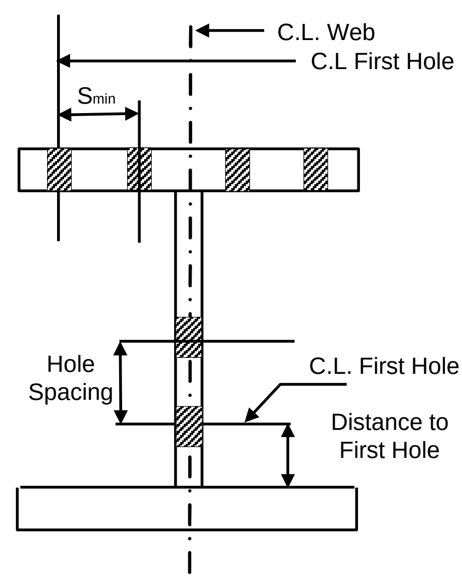
4 **Girders deeper than 14 ft. shall be designed with a horizontal field splice. The approval of the Chief Bridge Engineer shall be required when a horizontal field splice is incorporated.**

5.25 SHO - SECTION HOLE COMMAND

KEYWORD	COMMAND DESCRIPTION
SHO	SECTION HOLE - This command is used to enter the range along the beam having rivet or bolt holes in the girder cross section for a range along the girder. This command can only be entered for an analysis problem. The SHO command can be repeated. A maximum of 40 section hole ranges (40 SHO commands) can be entered for the entire structure. NOTE: Any sections with section holes in the tension flange will be considered noncompact for the purposes of flexural capacity calculations and will not satisfy the conditions for using the provisions of the LRFD Specifications, Chapter 6, Appendix A. For a symmetrical structure, enter the hole details for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the hole details for spans 1, 2 and up to the point of symmetry for span 3. Also, for a symmetrical structure, users can only enter a maximum of 20 section hole ranges.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Span Number	Enter the start span number of the current section hole range.	--	1 (E)	NSP[1] (E)	--
2. Start Distance	Enter the start distance along the girder measured from the left support of the defined span to the beginning of the section hole range.  	ft	0. (E)	MXSP[2] (E)	--
3. End Span Number	Enter the end span number of the current section hole range.	--	1 (E)	NSP (E)	--
4. End Distance	Enter the end distance along the girder measured from the left support of the defined span to the end of the current section hole range. The program will assume the cross section holes described next at every analysis point in this range.	ft	0. (E)	MXSP (E)	--
5. Location of Hole	Enter the element of the girder where the holes are located: T - Top flange and/or plates. W - Web plate. B - Bottom flange and/or plates. NOTE: Section holes in the web are ignored by STLRFD. Section holes in the web are not taken into consideration for section property or specification check calculations.	--	T, W, B (E)	--	--

5.25 SHO - SECTION HOLE COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
6. Distance to First Hole	Enter the distance to the centerline of the first hole. For top and bottom plates, this distance is measured from the centerline of the web, with right being positive. For web plates, the distance is measured from the bottom of the web. If there are holes to the left of the web, enter the distance of the left most hole with a negative value. No lower or upper limits are checked for this input parameter. Ensure that any hole does not fall outside the girder element. 	in	--	--	--
7. Diameter/ Width of Hole	Enter the diameter or width of the hole. No upper limit is checked for this input parameter.	in	0. (E)	--	--
8. Number of Holes	Enter the number of holes in this girder element. The number of holes pertains to a cross section and not along the range.	--	1 (E)	40 (E)	1
9. Hole Spacing	Enter the spacing between centers of holes for the girder element. No upper limit is checked for this input parameter. Leave blank if the number of holes equals one.	in	0. (E)	--	--

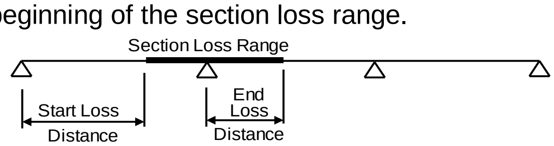
Notes:

[1] NSP is equal to the number of spans entered in the CTL command.

[2] MXSP is equal to the span length corresponding to the span number.

5.26 SLS - SECTION LOSS COMMAND

KEYWORD	COMMAND DESCRIPTION
SLS	SECTION LOSS - This command is used to define the section loss for a specific range. This command should only be entered for an analysis problem. The SLS command can be repeated. The following section loss parameters can be repeated within a command for a given range: section loss element, location, distance, width, and thickness (parameters 5 through 9). A maximum of 40 section losses can be entered for the entire structure. Up to three section losses can be defined per girder range on a single SLS command. Because of this, depending on the number of losses defined per command, from 14 to 40 SLS commands can be entered. Ranges can overlap with previously entered ranges for section holes. For the SLS command, the STLRFD program does not perform any input checks, such as whether section losses overlap or whether a particular section loss is located within a defined span length. For a symmetrical structure, enter the analysis points for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the analysis points for spans 1, 2 and up to the point of symmetry for span 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Span Number	Enter the start span number of the current section loss range.	--	1 (E)	NSP[1] (E)	--
2. Start Loss Distance	Enter the start distance along the girder measured from the left support of the defined span to the beginning of the section loss range.  	ft	0. (E)	MXSP[2] (E)	--
3. End Span Number	Enter the end span number of the current section loss range.	--	1 (E)	NSP (E)	--
4. End Loss Distance	Enter the end distance along the girder measured from the left support of the defined span to the end of the current section loss range.	ft	0. (E)	MXSP (E)	--
5. Section Loss Element	Enter the element having the section loss: TP - Top plate or cover plate. TF - Top flange of rolled beam. W - Web plate. BF - Bottom flange of rolled beam. BP - Bottom plate or cover plate. TR - Top right leg of a built-up section. TL - Top left leg of a built-up section. BR - Bottom right leg of a built-up section. BL - Bottom left leg of a built-up section.	--	TP, TF, W, BF, BP, TR, TL, BR, BL (E)	--	--

5.26 SLS - SECTION LOSS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
6. Location	Enter the location of the section loss on the specified element: T - Top of the flange or plate. B - Bottom of flange or plate. L - Left side of the web. R - Right side of the web. X - Outside surface of the horizontal leg. Y - Outside surface of the vertical leg.	--	T, B, L, R, X, Y (E)	--	--
7. Distance	Enter the distance to the center of the section loss. For top and bottom plates, this distance is measured from the centerline of the web, with right being positive. For web plates, the distance is measured from the bottom of the web. For top angles, the distance is measured from the inside corner, with right being positive and down being positive. For bottom angles, the distance is measured from the inside corner, with right being positive and up being positive. No lower or upper limits are checked for this input parameter.	in	--	--	--
8. Width	Enter the width of the section loss measured parallel to the top or bottom plates. For web loss, enter the depth of the loss.	in	0. (E)	--	--
9. Thickness	Enter the thickness of the loss.	in	0. (E)	--	--

Notes:
[1] NSP is equal to the number of spans entered in the CTL command.
[2] MXSP is equal to the span length corresponding to the span number.

5.27 SLB - SLAB COMMAND

KEYWORD	COMMAND DESCRIPTION
SLB	SLAB - This command is used to specify slab thickness and reinforcing steel. Only one SLB command can be entered.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Actual Slab Thickness	Enter the average actual slab thickness. This is the slab thickness used in calculating the slab weight. If this value is not entered and the Effective Slab Thickness was entered, the program will default this value to the Effective Slab Thickness plus ½ inch. The Actual Slab Thickness should be at least ½ inch thicker than the Effective Slab Thickness.	in	8. (W)	12. (W)	[1]
2. Effective Slab Thickness	Enter the average effective slab thickness. This is the slab thickness used in calculating the composite section properties. If this value is not entered and the Actual Slab Thickness was entered, the program will default this value to the Actual Slab Thickness minus ½ inch. The Effective Slab Thickness should be a multiple of ½ inch. The user must enter at least either the Actual Slab Thickness or Effective Slab Thickness.	in	7.5 (W)	12. (W)	[2]
3. Concrete Strength	Enter the 28-day compressive strength of the concrete slab. This value should be entered as 4 ksi, corresponding to Class AAAP concrete (BD-601M). The upper limit for this value is 15 ksi for normal weight concrete (concrete density for Ec ≥ 135 pcf) or 10 ksi for lightweight concrete (concrete density for Ec < 135 pcf).	ksi	2.4 (E)	15. or 10. (E)	4.

5.27 SLB - SLAB COMMAND (continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
4. Concrete Density for Loads	Enter the unit weight of concrete for computing dead loads due to the concrete slab and haunch. This value should be entered as 150 lb/ft^3 for normal weight concrete or as 115 lb/ft^3 for lightweight concrete. This value must be greater than or equal to the "Concrete Density for E_c" (parameter 5).	lb/ft^3	95. (E)	160. (E)	150.
5. Concrete Density for E_c	Enter the unit weight of concrete for computing the modulus of elasticity (E_c). The modulus of elasticity is used to compute the modular ratio for computing the section properties and to perform certain specification checks. This value should be entered as 145 lb/ft^3 for normal weight concrete or as 110 lb/ft^3 for lightweight concrete.	lb/ft^3	90. (E)	155. (E)	145.
6. Deck Reinforcement Strength	Enter the yield strength of the deck reinforcing steel.	ksi	30. (E)	60. (W)	60.
7. Steel Modulus of Elasticity	Enter the modulus of elasticity of the structural steel.	ksi	20,000. (E)	32,000. (E)	29,000.
8. Slab Transverse Reinforcement Bar Size	NOTE: This parameter is no longer used and should be left blank.	--	--	--	--
9. Development Length Factor for Slabs	Enter the development length factor for mild longitudinal slab reinforcement. This factor is defined as the product of the modification factors which increase ℓ_d (as presented in LRFD Specifications Article 5.10.8.2.1b) and the modification factors which decrease ℓ_d (as presented in LRFD Specifications Article 5.10.8.2.1c), divided by the concrete density modification factor. The basic development length, ℓ_{db}, is calculated by the program, and is then multiplied by this input value, as specified in LRFD Specifications Article 5.10.8.2.1.	--	0.5 (W)	2. (W)	1.

Notes:

[1] Defaults to Effective Slab Thickness + ½ inch

[2] Defaults to Actual Slab Thickness - ½ inch

5.28 SST - SLAB REINFORCEMENT LOCATION COMMAND

KEYWORD	COMMAND DESCRIPTION
SST	SLAB REINFORCEMENT LOCATION - This command is used to define the longitudinal slab reinforcement at each interior support. The user can enter up to three ranges of reinforcement for each interior support. Each support should be entered on a separate line, with up to three sets of data (a set being defined as parameters 2 through 6) defined for each support (19 SST commands with three sets of data per command). For a symmetrical structure, enter the slab reinforcement location for supports up to and including the middle support. For example, both a symmetrical 4-span structure and a symmetrical 5-span structure require data for supports 2 and 3. This information is only entered for multi-span analysis problems. NOTE: Any longitudinal slab reinforcement outside of the ranges described here must be entered using the Deck Reinforcing Area parameter of the ABU, APL, or ARB commands. In addition, any reinforcement entered here must also be entered on the ABU, APL, and ARB commands to be included in the negative bending section properties. The information entered on this command is only used to check the requirements of the LRFD Specifications and DM-4 Section 6.10.1.7, Minimum Negative Flexure Concrete Deck Reinforcement (as described in Section 3.7.15) and is not used to compute section properties.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Support Number	Enter the interior support number.	--	2 (E)	NSP[1] (E)	--
2. Bar Number	Enter the bar size number for the range (the distance from the left cutoff point to the right cutoff point)	--	3 (E)	8 (E)	--
3. Left Cutoff Point	Enter the distance from the centerline of the pier to the cutoff point left of the pier. This is the physical bar cutoff location. (See Figure 5.28-1)	ft	0. (E)	½MXSP1[2]	0.
4. Right Cutoff Point	Enter the distance from the centerline of the pier to the cutoff point right of the pier. This is the physical bar cutoff location. (See Figure 5.28-1)	ft	0. (E)	½MXSP2[3]	0.

Notes:

1 NSP is equal to the number of spans entered in the CTL command

2 MXSP1 is equal to the span length corresponding to the span to the left of the support defined

3 MXSP2 is equal to the span length corresponding to the span to the right of the support defined

5.28 **SST - SLAB REINFORCEMENT LOCATION COMMAND (Continued)**

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Area of Reinforcement	Enter the area of longitudinal slab reinforcement within the effective slab width only for the bars whose lengths are defined by the range. The area of reinforcement defined by each bar range is added together by the program to compute the total area available at any analysis point. Note: The reinforcement area used for the Article 6.10.1.7 checks at a particular analysis point is based on the maximum of either the effective area of reinforcement, entered here, or the area entered for the Deck Reinforcing Area parameter of the ABU, APL or ARB commands. The total area entered here is only available at analysis points located at least one development length (ℓ_d in Figure 5.28-1) away from the cutoff points defined in parameters 3 and 4. At analysis points between the cutoff point and one development length, a reduced area of reinforcement will be calculated, based on the development of the steel.	in^2	0. (E)	30. (W)	0.
6. Location in Slab	Enter the location of the bar in the slab: T - Top longitudinal reinforcement B - Bottom longitudinal reinforcement Longitudinal rebars in the top are considered when checking distribution requirements. (See Figure 5.28-2)	--	T,B (E)	--	T

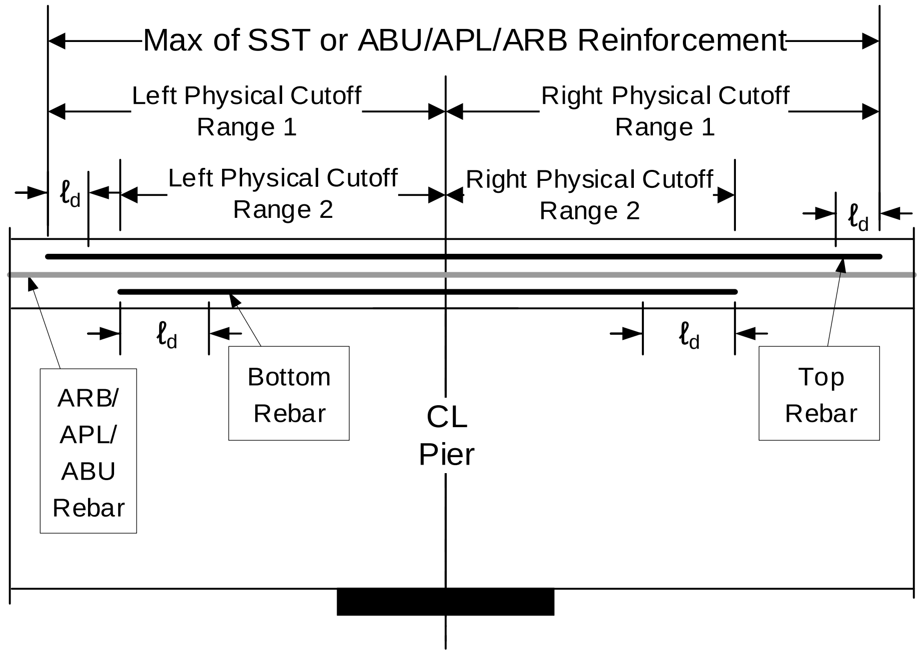


Figure 5.28-1 Definition of Left and Right Cutoff Points

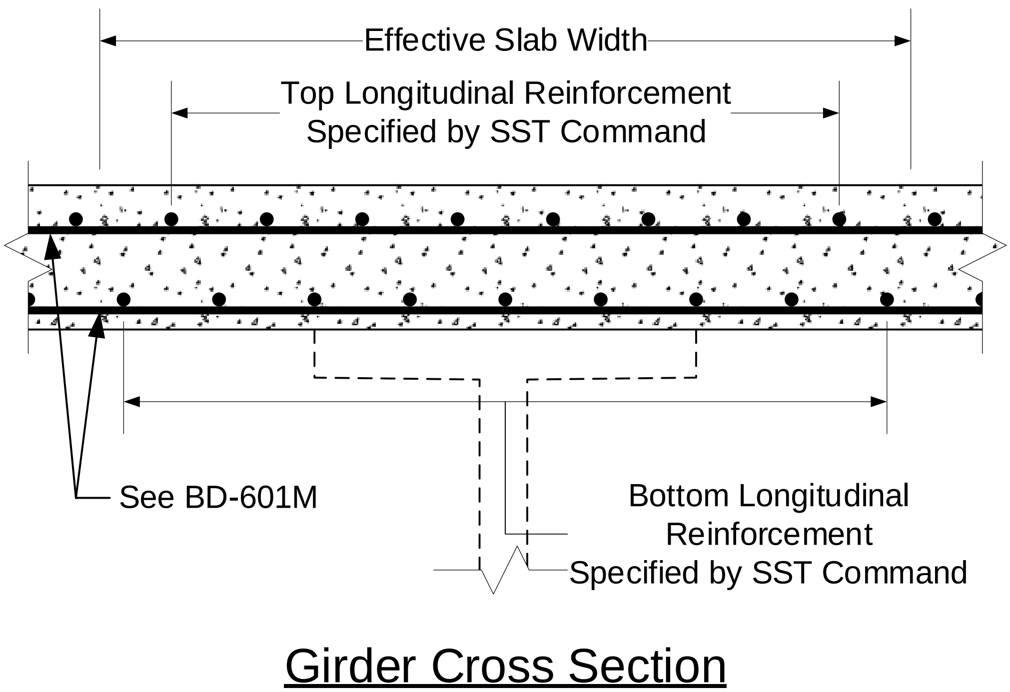
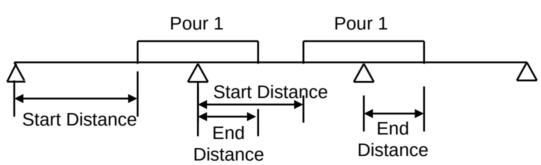


Figure 5.28-2 Longitudinal Slab Reinforcement Location

5.29 DPS - DECK POUR SEQUENCE COMMAND

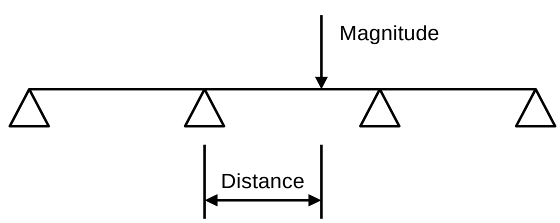
KEYWORD	COMMAND DESCRIPTION
DPS	DECK POUR SEQUENCE - This command allows the user to enter the location of each deck section to be poured at the same time. The parameters and the command can be repeated. Any number of deck pour ranges are permissible for each pour number and any number of pour numbers are permissible, with the one constraint that a maximum of 40 deck pour ranges can be entered for the entire structure (10 DPS commands with four deck pour ranges (parameters 1 through 5) per command). Deck pours must be defined sequentially, beginning with 1. This command is valid only for analysis. If deck pour symmetry on the CTL command is entered as ‘N’, then the entire length of the structure must be defined using the DPS command. If deck pour symmetry is entered as ‘Y’, then the length of the structure up to the point of symmetry must be defined using the DPS command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Pour Number	Enter the pour number for the deck sections to be poured at the same time.	--	1 (E)	40 (E)	--
2. Start Span Number	Enter the span number of the start location.	--	1 (E)	NSP[1] (E)	--
3. Start Pour Distance	Enter the start location of the pour measured from the left start span support. 	ft	0. (E)	MXSP[2] (E)	--
4. End Span Number	Enter the span number of the end location.	--	1 (E)	NSP (E)	--
5. End Pour Distance	Enter the end location of the pour measured from the left end span support.	ft	0. (E)	MXSP (E)	--

Notes:
1 NSP is equal to the number of spans entered in the CTL command.
2 MXSP is equal to the span length corresponding to the span number.

5.30 DPC - DECK POUR CONCENTRATED LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
DPC	DECK POUR CONCENTRATED LOAD - This command is used to specify additional concentrated loads in a given deck pour. The parameters and the command can be repeated. A maximum of 20 concentrated loads can be entered for the entire structure for all pours (five DPC commands with four concentrated loads (parameters 1 through 4) per command). This command is valid only for analysis. If deck pour symmetry on the CTL command is entered as 'N', then the concentrated loads for the entire length of the structure must be defined using the DPC command. If deck pour symmetry is entered as 'Y', then the concentrated loads for the length of the structure up to the point of symmetry must be defined using the DPC command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Pour Number	Enter the pour number when the load is applied.	--	1 (E)	40 (E)	--
2. Load Type	Enter: P - Permanent loads. T - Temporary loads (temporary loads are removed after the deck is hardened for the defined pour number).	--	P, T (E)	--	--
3. Span Number	Enter the span number where the concentrated load is located.	--	1 (E)	NSP[1] (E)	--
4. Distance	Enter the distance measured from the left support of the span to the concentrated load. 	ft	0. (E)	MXSP[2] (E)	--
5. Magnitude	Enter the magnitude of the concentrated load.	kip	-20. (W)	20. (W)	--

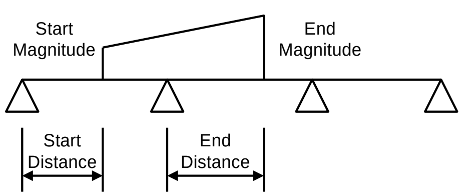
Notes:

1 NSP is equal to the number of spans entered in the CTL command.

2 MXSP is equal to the span length corresponding to the span number.

5.31 DPD - DECK POUR DISTRIBUTED LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
DPD	DECK POUR DISTRIBUTED LOAD - This command is used to specify additional distributed loads for a given deck pour. The parameters and the command can be repeated. A maximum of 20 distributed loads can be entered for the entire structure for all pours (10 DPD commands with two distributed loads (parameters 1 through 8) per command). This command is valid only for analysis. If deck pour symmetry on the CTL command is entered as 'N', then the distributed loads for the entire length of the structure must be defined using the DPD command. If deck pour symmetry is entered as 'Y', then the distributed loads for the length of the structure up to the point of symmetry must be defined using the DPD command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Pour Number	Enter the pour number when the load is applied.	--	1 (E)	40 (E)	--
2. Load Type	Enter 'P' for permanent load and 'T' for temporary load. Temporary loads are removed after the deck is hardened.	--	P, T (E)	--	--
3. Start Span Number	Enter the span number of the start location.	--	1 (E)	NSP[1] (E)	--
4. Start Distance	Enter the start location of the distributed load measured from the left support in the start span. 	ft	0. (E)	MXSP[2] (E)	--
5. End Span Number	Enter the span number of the end location.	--	1 (E)	NSP (E)	--
6. End Distance	Enter the end location of the distributed load measured from the left support in the end span.	ft	0. (E)	MXSP (E)	--
7. Start Magnitude	Enter the magnitude of the distributed load at the start distance.	kip/ft	-20. (W)	20. (W)	--
8. End Magnitude	Enter the magnitude of the distributed load at the end distance.	kip/ft	-20. (W)	20. (W)	--

Notes:

[1] NSP is equal to the number of spans entered in the CTL command.

[2] MXSP is equal to the span length corresponding to the span number.

5.32 PLD - PEDESTRIAN LIVE LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
PLD	PEDESTRIAN LIVE LOAD - This command is used to specify the pedestrian live load and associated dead loads. This command is required if pedestrian loading is to be included in the run. This command should not be used if pedestrian loading is not to be included in the run. Only one PLD command can be used.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Total Pedestrian Live Load	Enter the total pedestrian live load acting on all girders in the structure cross section.	kip/ft	0. (W)	20. (W)	--
2. Pedestrian Live Load	Enter the pedestrian live load acting on the girder being investigated only. The user must compute and enter the portion of the total pedestrian live load that acts on the girder.	kip/ft	0. (W)	20. (W)	--
3. Sidewalk Dead Load	Enter the sidewalk dead load acting on the girder being investigated only. The user must compute and enter the portion of the total sidewalk dead load that acts on the girder. The sidewalk dead load is defined as all DC2 dead load that is present when the sidewalks are present and is not present when the sidewalks are not present.	kip/ft	-20. (W)	20. (W)	--
4. Additional Future Wearing Surface Dead Load	Enter the additional future wearing surface dead load acting on the girder being investigated only. The user must compute and enter the portion of the total additional future wearing surface dead load that acts on the girder. The additional future wearing surface dead load is defined as all future wearing surface dead load that is present when the sidewalks are present and is not present when the sidewalks are not present. If the future wearing surface dead load decreases when the sidewalks are present, a negative value should be entered.	kip/ft	-20. (W)	20. (W)	--

5.33 LDF - LOAD FACTOR COMMAND

KEYWORD	COMMAND DESCRIPTION
LDF	LOAD FACTOR - This command is used to define the load factors for miscellaneous loads and special live loads. The LDF command can be repeated up to ten times; one each for MC1, MC2, and eight times for SLL loads. Load factors for other live loads, DC loads, and FWS loads are stored in the program and cannot be changed by the user. For special live loads, ratings will be computed only for limit states which are entered as nonzero on this command. If this command is not entered for a special live load, ratings will be computed only for the limit states defined for Special Vehicles on Table D3.4.1.1P-1 in DM-4. This command is required if MC1 or MC2 loads have been defined.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Load Factor Type	Enter one of the following load factor types: MC1 - Miscellaneous dead load applied before or with the deck slab. MC2 - Miscellaneous dead load applied after the deck slab. SLL - Special live load. 1 - Special live load 1 2 - Special live load 2 3 - Special live load 3 4 - Special live load 4 5 - Special live load 5 6 - Special live load 6 7 - Special live load 7 8 - Special live load 8 NOTE: Each Load Factor Type can be given only once. Load factors entered with Load Factor Type SLL will apply to any special live loads that do not have load factors entered with Load Factor Type 1 through 8.	--	MC1, MC2, SLL, 1,2,3,4,5, 6,7,8 (E)	--	--
2. Load Factor Strength I	Enter the load factor for Strength I.	--	0. (E)	2. (E)	--
3. Load Factor Strength IP	Enter the load factor for Strength IP. Enter 0.0 if pedestrian loading is not included in the run.	--	0. (E)	2. (E)	--
4. Load Factor Strength IA	Enter the load factor for Strength IA.	--	0. (E)	2. (E)	--
5. Load Factor Strength II	Enter the load factor for Strength II.	--	0. (E)	2. (E)	--

5.33 LDF - LOAD FACTOR COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
6. Load Factor Strength III	Enter the load factor for Strength III to be applied to the MC1 and MC2 loads. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	--
7. Load Factor Strength IV	Enter the load factor for Strength IV to be applied to the MC1 and MC2 loads. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	--
8. Load Factor Strength V	Enter the load factor for Strength V.	--	0. (E)	2. (E)	--
9. Load Factor Service II	Enter the load factor for Service II.	--	0. (E)	2. (E)	--
10. Load Factor Service IIA	Enter the load factor for Service IIA.	--	0. (E)	2. (E)	--
11. Load Factor Service IIB	Enter the load factor for Service IIB.	--	0. (E)	2. (E)	--
12. Load Factor Fatigue I	Note: This parameter is no longer used and should be left blank.	--	--	--	--
13. Load Factor Deflection	Note: This parameter is no longer used and should be left blank.	--	--	--	--
14. Load Factor Construction I	Enter the load factor for Construction I (no wind effects) to be applied to the MC1 load. This parameter does not apply to the MC2 or SLL loads and should be left blank.	--	0. (E)	2. (E)	--
15. Load Factor Service I	Note: This parameter is no longer used and should be left blank.	--	--	--	--
16. Load Factor Fatigue II	Note: This parameter is no longer used and should be left blank.	--	--	--	--
17. Load Factor Construction II	Enter the load factor for Construction II (includes wind effects) to be applied to the MC1 load. This parameter does not apply to the MC2 or SLL loads and should be left blank.	--	0. (E)	2. (E)	--
18. Minimum Load Factor Strength I	Enter the minimum load factor[1] for Strength I to be applied to MC1 or MC2 loads only. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	0.[2]

5.33 LDF - LOAD FACTOR COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
19. Minimum Load Factor Strength IP	Enter the minimum load factor[1] for Strength IP to be applied to MC1 or MC2 loads only. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	0.[2]
20. Minimum Load Factor Strength IA	Enter the minimum load factor[1] for Strength IA to be applied to MC1 or MC2 loads only. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	0.[2]
21. Minimum Load Factor Strength II	Enter the minimum load factor[1] for Strength II to be applied to MC1 or MC2 loads only. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	0.[2]
22. Minimum Load Factor Strength III	Enter the minimum load factor[1] for Strength III to be applied to MC1 or MC2 loads only. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	0.[2]
23. Minimum Load Factor Strength IV	Enter the minimum load factor[1] for Strength IV to be applied to MC1 or MC2 loads only. Please note that DM-4 does not define a minimum load factor for Strength IV, but the LRFD Specifications do. The program will warn the user if the minimum load factor for Strength IV does not match the maximum load factor (parameter seven), but the program will continue with the user input value. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	0.[2]
24. Minimum Load Factor Strength V	Enter the minimum load factor[1] for Strength V to be applied to MC1 or MC2 loads only. This parameter does not apply to the SLL load and should be left blank.	--	0. (E)	2. (E)	0.[2]

Notes:

1 Minimum load factors are only used for calculating total factored reactions. See User's Manual Section 3.5 for more information.

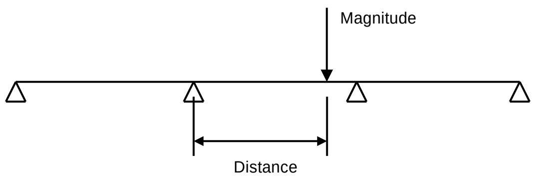
2 The default value is only used for the MC1 and MC2 loads. This parameter is not used with SLL loads.

5.34 CLD - CONCENTRATED LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
CLD	CONCENTRATED LOAD - This command is used to specify concentrated loads in a given span. The parameters and the command can be repeated. A maximum of 30 concentrated loads can be entered for the entire structure for all load types (six CLD commands with five concentrated loads (parameters 1 through 4) per command). For load types DC1, DC1S, DC2, UT1, and UT2, the default load factors are used. For MC1 and MC2, an LDF command must be entered for each miscellaneous load type. For a symmetrical structure, enter the concentrated loads for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the concentrated loads for spans 1, 2 and up to the point of symmetry for span 3. Note that at all locations of concentrated loads, STLRFD will check bearing stiffener and/or web crippling specifications. Because of this, if the concentrated load arises from a detail that does not normally require bearing stiffeners (for example, concentrated loads from cross frames), consider entering these loads as equivalent distributed loads via the DLD command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Load Type	Enter the type of load per LRFD Specifications: DC1 - Permanent load that is not part of the girder which is applied to the noncomposite section, excluding the load due to the beam, slab, and haunch, which are automatically calculated by the program. This should include loads that are not a physical part of the girder (i.e. stay-in-place forms or haunch load corrections). DC1S - Permanent load applied to the noncomposite section that is part of the girder, but is not calculated by the program (i.e. stiffeners, diaphragms or splice plates). Note: To have the program automatically compute a DC1S load as a percentage of steel self-weight, use the "DC1S Percentage" input on the CTL command. DC2 - Permanent load applied to the long-term composite (3n) section[1]. MC1 - Miscellaneous dead load applied to the noncomposite section. MC2 - Miscellaneous permanent dead load applied to the long-term composite (3n) section[1]. UT1 - Utility load applied to the noncomposite section. UT2 - Utility load applied to the composite (3n) section[1].	--	DC1, DC1S, DC2, MC1, MC2, UT1, UT2 (E)	--	--

5.34 CLD - CONCENTRATED LOAD COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
2. Span Number	Enter the span number where the concentrated load is located.	--	1 (E)	NSP[2] (E)	--
3. Distance	Enter the distance measured from the left support of the span to the concentrated load.	ft	0. (E)	MXSP[3] (E)	--
4. Magnitude	Enter the magnitude of the concentrated load acting on the beam. NOTE: a negative value for Magnitude indicates a force acting upward. 	kip	-20. (W)	20. (W)	--

Notes:

[1] For girders that are noncomposite in the final state, the DC2, MC2, and UT2 loads are applied to the steel-only section

[2] NSP is equal to the number of spans entered in the CTL command.

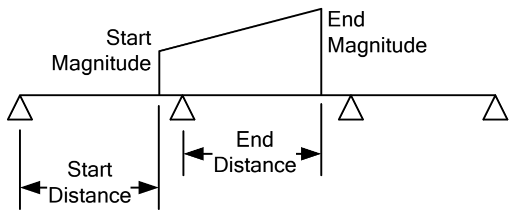
[3] MXSP is equal to the span length corresponding to the span number.

5.35 DLD - DISTRIBUTED LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
DLD	DISTRIBUTED LOAD - This command is used to specify distributed loads. A distributed load can be either a uniform or linearly varying load. The parameters and the command can be repeated. A maximum of 20 distributed loads can be entered for the entire structure for all load types (five DLD commands with four distributed loads defined (parameters 1 through 7) per command). For DC1, DC1S, DC2, UT1, UT2, and FWS, the default load factors are used. For MC1 and MC2, an LDF command must be entered for each miscellaneous load type. For a symmetrical structure, enter the distributed loads for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the distributed loads for spans 1, 2 and up to the point of symmetry for span 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Load Type	Enter the type of load per LRFD Specifications: DC1 - Permanent load that is not part of the girder which is applied to the noncomposite section, excluding the load due to the beam, slab, and haunch, which are automatically calculated by the program. This should include loads that are not a physical part of the girder (i.e. stay-in-place forms or haunch load corrections). DC1S - Permanent load applied to the noncomposite section that is part of the girder, but is not calculated by the program (i.e. stiffeners, diaphragms or splice plates). Note: To have the program automatically compute a DC1S load as a percentage of steel self-weight, use the "DC1S Percentage" input on the CTL command. DC2 - Permanent load applied to the long-term composite (3n) section[1]. FWS - Future wearing surface load applied to the long-term composite (3n) section[1]. MC1 - Miscellaneous dead load applied to the noncomposite section. MC2 - Miscellaneous permanent dead load applied to the long-term composite (3n) section[1]. UT1 - Utility load applied to the noncomposite section. UT2 - Utility load applied to the composite (3n) section[1].	--	DC1, DC1S, DC2, FWS, MC1, MC2, UT1, UT2 (E)	--	--

5.35 DLD – DISTRIBUTED LOAD COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
2. Start Span Number	Enter the span number of the start location.	--	1 (E)	NSP[2] (E)	--
3. Start Distance	Enter the start location of the distributed load measured from the left support in the start span. 	ft	0. (E)	MXSP[3] (E)	--
4. End Span Number	Enter the span number of the end location.	--	1 (E)	NSP (E)	--
5. End Distance	Enter the end location of the distributed load measured from the left support in the end span.	ft	0. (E)	MXSP (E)	--
6. Start Magnitude	Enter the magnitude of the distributed load acting on the beam at the start distance. NOTE: a negative value for magnitude indicates a force acting upward.	kip/ft	-20. (W)	20. (W)	--
7. End Magnitude	Enter the magnitude of the distributed load acting on the beam at the end distance. NOTE: a negative value for magnitude indicates a force acting upward.	kip/ft	-20. (W)	20. (W)	--

Notes:

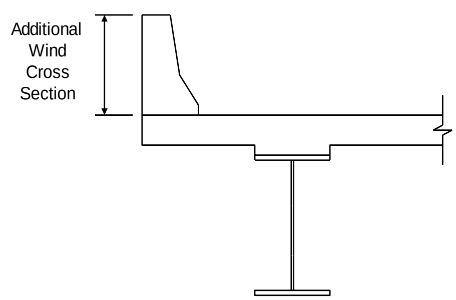
1 For girders that are noncomposite in the final state, the DC2, FWS, MC2, and UT2 loads are applied to the steel-only section

2 NSP is equal to the number of spans entered in the CTL command.

3 MXSP is equal to the span length corresponding to the span number.

5.36 WPD - WIND PROGRAM DEFINED COMMAND

KEYWORD	COMMAND DESCRIPTION
WPD	WIND PROGRAM DEFINED - This command is used to define the parameters used for computing the transverse wind load on the structure. Only one WPD or WUD command can be used. Wind pressure can be either user-defined or program-defined. To enter a program-defined wind pressure, the user must enter this command. To enter a user-defined wind pressure, the user must enter the WUD command.

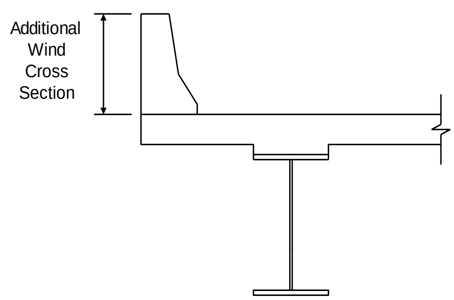
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Additional Wind Cross Section	Enter the additional section to be included in computing the wind load for strength limit states. Do not include the slab, haunch, and girder; they are included automatically by the program. Illustrated below is an example of additional wind cross section.  	in	0. (W)	120. (W)	0.
2. Construction Load Path	Enter one of the following load paths for computing the wind load on the structure in the temporary construction state: T - Truss action. F - Frame action. L - Flange subjected to lateral force.	--	T, F, L (E)	--	--
3. Construction Wind Speed	NOTE: This parameter is no longer used. Use the "Construction Wind Pressure" parameter on this command instead.	--	--	--	--
4. Permanent Load Path	Enter one of the following load paths for computing the wind load on the structure in the permanent state: T - Truss action. F - Frame action. L - Flange subjected to lateral force.	--	T, F, L (E)	--	--

5.36 WPD - WIND PROGRAM DEFINED COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Structure Height	Enter the average height of the top of the superstructure above the surrounding ground or water surface. This value corresponds to Z as used in LRFD Specifications Equations 3.8.1.2.1-2, 3.8.1.2.1-3, and 3.8.1.2.1-4.	ft	10. (W)	200. (W)	--
6. Wind Condition	NOTE: This parameter is no longer used. Use the "Wind Exposure Category" parameter on this command instead.	--	--	--	--
7. Permanent Wind Speed	NOTE: This parameter is no longer used. Use the "Design 3 Second Gust" parameter on this command instead.	--	--	--	--
8. Construction Wind Pressure	Enter the wind pressure for construction and uncured slab checks. Enter this value as 0.005 ksf unless otherwise directed by the District Bridge Engineer. This value is based on a wind speed of 30 miles per hour with exposure category C, design height of 100 ft and velocity modification factor of 0.8 (for construction duration of 1-2 years).	ksf	0. (E)	1.0 (W)	0.005
9. Wind Exposure Category	Enter the wind exposure category as described in LRFD Specifications Section 3.8.1.1.5.	--	B, C, D (E)	--	D
10. Design 3 Second Gust	Enter the design 3-second gust for use with load combination Strength-III, taken from LRFD Specifications Figure 3.8.1.1.2-1. For load combination Strength-V, the program will use 80 mph, as per LRFD Specifications Table 3.8.1.1.2-1.	mph	100. (W)	200. (W)	115.

5.37 WUD - WIND USER DEFINED COMMAND

KEYWORD	COMMAND DESCRIPTION
WUD	WIND USER DEFINED - This command is used to define the parameters used for computing the transverse wind load on the structure. Only one WPD or WUD command can be used. Wind pressure can be either user-defined or program-defined. To enter a user defined wind pressure, the user must enter this command. To enter a program-defined wind pressure, the user must enter the WPD command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Additional Wind Cross Section	Enter the additional section to be included in computing the wind load for strength limit states. Do not include the slab, haunch, and girder; they are included automatically by the program. Illustrated below is an example of additional wind cross section. 	in	0. (W)	120. (W)	0.
2. Construction Load Path	Enter one of the following load paths for computing the wind load on the structure in the temporary construction state: T - Truss action. F - Frame action. L - Flange subjected to lateral force.	--	T, F, L (E)	--	--

5.37 WUD - WIND USER DEFINED COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
3. Construction Wind Pressure	Enter the user-defined wind pressure for construction and uncured slab checks. Enter this value as 0.005 ksf unless otherwise directed by the District Bridge Engineer. This value is based on a wind speed of 30 miles per hour with exposure category C, design height of 100 ft and velocity modification factor of 0.8 (for construction duration of 1-2 years).	ksf	0. (E)	10. (W)	0.005
4. Permanent Load Path	Enter one of the following load paths for computing the wind load on the structure in the permanent state: T - Truss action. F - Frame action. L - Flange subjected to lateral force.	--	T, F, L (E)	--	--
5. Permanent Wind Pressure, Strength-III	Enter the user-defined wind pressure for the permanent state to be used with the Strength-III load combination.	ksf	0. (E)	10. (W)	--
6. Permanent Wind Pressure, Strength-V	Enter the user-defined wind pressure for the permanent state to be used with the Strength-V load combination	ksf	0. (E)	10. (W)	--

5.38 DOL – DECK OVERHANG LOADS COMMAND

KEYWORD	COMMAND DESCRIPTION
DOL	DECK OVERHANG LOADS - This command is used to define the deck overhang loads on the overhang brackets that induce torsion on the exterior girder, which introduces flange lateral bending stress. The deck overhang brackets are typically spaced between 3 and 4 feet, but the loads are assumed uniformly distributed, except for the finishing machine load. These loads are considered for load combinations CONST/Uncured Slab I and CONST/Uncured Slab II, defined in DM-4 Table 3.4.1.1P-1 – Load Factors and Live Load Vehicles for Steel Girders. The loads are used to compute lateral bending moments in the top and bottom flanges. The maximum lateral bending moment within the unbraced length is conservatively used at all analysis points along the unbraced length. The lateral bending moment is used to compute lateral bending stresses in the flanges. For the uncured slab condition, the lateral bending stresses are applied along the full girder length. For the construction staging analysis, the lateral bending stresses are applied to the analysis points corresponding to the current deck pour for the current construction stage. Only one DOL command can be used. The DOL command can be entered for exterior girders only.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Overhang Concrete wt	Enter the deck overhang weight on the overhang bracket. Refer to Figure 5.38-1.	k/ft	0. (E)	0.500 (W)	[1]
2. Overhang Form wt	Enter the weight of the overhang forms supported by the overhang brackets. Refer to Figure 5.38-1.	k/ft	0. (E)	0.100 (W)	0.040
3. Screed Rail wt	Enter the weight of the screed rail supported by the overhang brackets. Refer to Figure 5.38-1.	k/ft	0. (E)	0.150 (W)	0.085
4. Walkway Railing wt	Enter the weight of the walkway and railing supported by the overhang brackets. Refer to Figure 5.38-1.	k/ft	0. (E)	0.300 (W)	0.150
5. Finishing Machine	Enter the weight of the finishing machine supported by the overhang brackets. Refer to Figure 5.38-1.	kip	0. (E)	10.0 (W)	3.000
6. Uniform Const LL	Enter the uniform live load applied to the overhang width. One-half of this load is assumed to be carried by the overhang bracket. Refer to Figure 5.38-1.	ksf	0. (E)	0.050 (W)	0.020
7. Linear Const LL	Enter the linear live load applied at the edge of the overhang. This load is assumed to be carried by the overhang bracket. Refer to Figure 5.38-1.	k/ft	0. (E)	0.150 (W)	0.075

5.38 DOL – DECK OVERHANG LOADS COMMAND (Continued)

Notes:

[1] **Defaults to being computed from the Deck Overhang (GEO command), Actual Slab Thickness (SLB command), the Haunch Depth (APL, ABU, or ARB command) and BD-601M.**

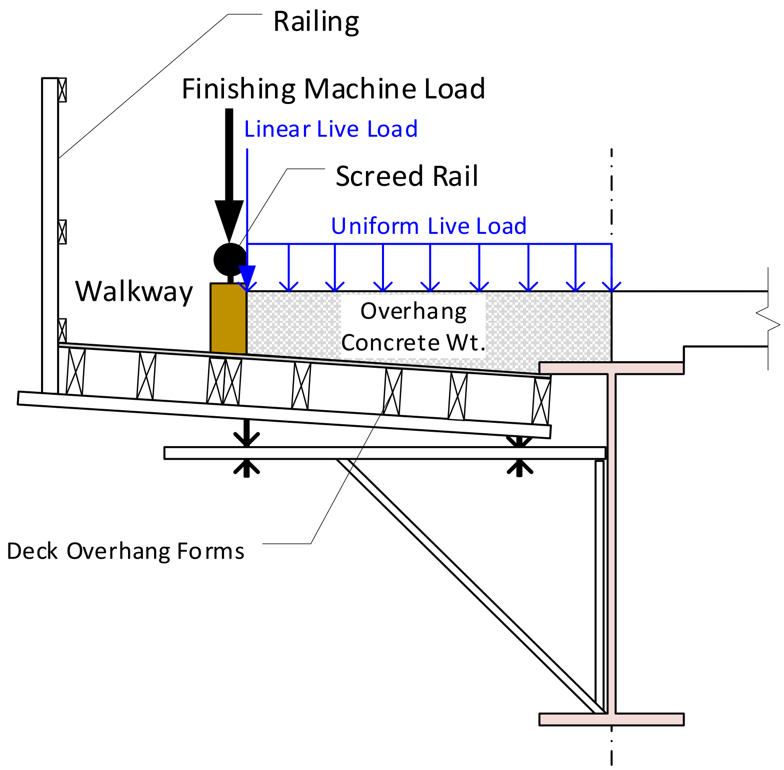


Figure 5.38-1 Definition of Deck Overhang Loads

5.39 SLL - SPECIAL LIVE LOADING COMMAND

KEYWORD	COMMAND DESCRIPTION
SLL	SPECIAL LIVE LOADING - This command must be entered when an 'E' was entered as the live load option for analysis in the CTL command. The load factors as shown on Table 3.5-2 of this manual will be applied to all special live loads. If different load factors are desired, they can be specified by using the Load Factor (LDF) command. Different load factors can be specified for each special live load. Up to eight SLL commands can be used (Eight SpecLL record sets with one SLL command in each record set).

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Special LL Number	Enter the number of the special live load being defined. Up to eight special live loads can be defined. These live loads must have continuous numbering; that is, if special live loads 1 and 3 are defined, then special live load 2 must also be defined.	--	1 (E)	8 (E)	--
2. Axle Effect	Enter: Y - If the effects of all axle loads are to be included in calculating a given live load effect. N - If the axle loads that do not contribute to the effect are to be neglected.	--	Y, N (E)	--	N
3. Lane Load	Enter a uniform lane load to be applied in combination with the special axle load (SAL) command.	kip/ft	0. (E)	1.5 (W)	0.
4. Percent Increase	Enter the percentage to increase all entered axle loads. This allows a check of permit loads for a given percentage over weight.	--	0. (E)	10. (W)	3.
5. Vehicle Type	Enter: D - If the Dynamic Load Allowance (Impact) is for Design Vehicles. P - If the Dynamic Load Allowance (Impact) is for Permit Vehicles. The Dynamic Load Allowance for Design Vehicles is specified on the CTL command as parameter 12, DYNAMIC LOAD ALLOWANCE. The Dynamic Load Allowance for Permit Vehicles is specified on the CTL command as parameter 21, DESIGN PERMIT VEHICLE DYNAMIC LOAD ALLOWANCE.	--	D, P (E)	--	D

5.40 SAL - SPECIAL AXLE LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
SAL	SPECIAL AXLE LOAD - This command must be entered when a special live loading (SLL) is entered as the live load in the CTL command. Up to eight different live loads can be defined (Eight SpecLL record sets with three SAL commands in each record set and a maximum of 24 axles per command, not to exceed 80 axles total per special live load). The parameters and the command can be repeated. A maximum of 80 axle loads and 79 spacings can be entered for each special live load. Multiple SAL commands can be entered for each live load to define large numbers of axles. Multiple SAL commands for a single special live load will be treated as cumulative; that is, if five axles are defined on the first SAL command for Special LL Number 1, and 10 axles are defined on the second SAL command for Special LL Number 1, there will be a total of 15 axles defined for Special LL Number 1. The load factors as shown on Table 3.5-2 of this manual will be applied to all special live loads. If different load factors are desired, they can be specified by using the Load Factor (LDF) command. Different load factors can be specified for each special live load.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Special LL Number	Enter the number of the special live load being defined. Up to eight special live loads can be defined. These live loads must have continuous numbering; that is, if special live loads 1 and 3 are defined, then special live load 2 must also be defined.	--	1 (E)	8 (E)	--
2. Axle Load	Enter the magnitude of the axle load.	kip	0. (E)	150. (W)	--
3. Axle Spacing	Enter the spacing from the previously-entered axle to the next axle. For example, the fourth spacing is the distance between axle 4 and axle 5. The axle spacing following the last axle load must be entered as 0.0.	ft	0. (E)	50. (W)	--

5.41 FTL - FATIGUE LIFE COMMAND

KEYWORD	COMMAND DESCRIPTION
FTL	FATIGUE LIFE - This command is used to specify the single lane ADTT data required to compute the remaining fatigue life. This command is required if the remaining life of the fatigue details specified on the FTG command is to be calculated. Only one FTL command can be used. Enter either parameters 4 and 5 or parameter 6. Similarly, enter either parameters 7 and 8 or parameter 9.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Year Built	Enter the calendar year in which the bridge was built. The program uses this value to calculate the single lane average daily (one-directional) truck traffic (($(ADTT)_{SL}$) for the year the bridge was built.	--	1900 (W)	2200 (W)	--
2. Recent Count Year	Enter a year that is the recent year for computing fatigue life.	--	1900 (W)	2200 (W)	--
3. Recent Count $(ADTT)_{SL}$	Enter the $(ADTT)_{SL}$ for the recent count year.	--	1 (E)	10,000 (W)	--
4. Previous Count Year	If an $(ADTT)_{SL}$ for a previous count is known, enter the year in which this count was taken. The previous count year must be less than the recent count year.	--	1900 (W)	2200 (W)	--
5. Previous Count $(ADTT)_{SL}$	Enter the $(ADTT)_{SL}$ for the previous count year.	--	1 (E)	10,000 (W)	--
6. Previous Growth Rate	If the rate of growth in $(ADTT)_{SL}$ for the past is known, enter the rate expressed as the percent growth; that is, 1% should be entered as 0.01.	--	0. (W)	1.0 (W)	--
7. Future Count Year	If an $(ADTT)_{SL}$ for the future can be predicted, enter the year for which the $(ADTT)_{SL}$ is predicted. The future count year must be greater than the recent count year.	--	1900 (W)	2200 (W)	--
8. Future Count $(ADTT)_{SL}$	If an $(ADTT)_{SL}$ for the future can be predicted, enter the $(ADTT)_{SL}$ for the future count year.	--	1 (E)	10,000 (W)	--
9. Future Growth Rate	If the rate of growth in $(ADTT)_{SL}$ for the future can be predicted, enter the rate expressed as the percent growth; that is, 1% should be entered as 0.01.	--	0. (W)	1.0 (W)	--

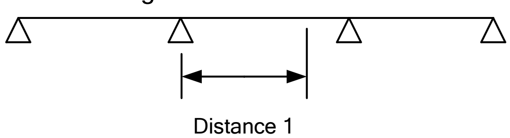
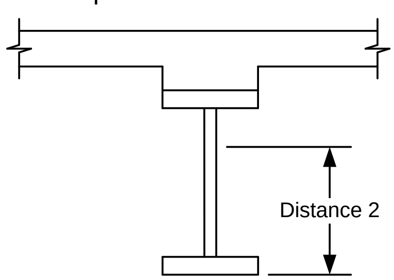
5.42 FGV - FATIGUE GROSS VEHICLE COMMAND

KEYWORD	COMMAND DESCRIPTION
FGV	FATIGUE GROSS VEHICLE - This command is used if the loadometer surveys of the gross vehicle weight distribution on the bridge are available and the gamma factor in the effective stress range equation is to be calculated. Repeat this command for each gross vehicle weight range used in the loadometer surveys. A maximum of ten sets of gross vehicle weight data can be entered (10 separate FGV commands).

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Minimum Gross Weight	Enter the minimum gross vehicle weight in this range used for the surveys. If this is the last range which includes all weights over a certain value, enter that "over value".	kip	40. (W)	300. (W)	--
2. Maximum Gross Weight	Enter the maximum gross vehicle weight in this range used for the surveys. If this is the last range which includes all weights over a certain value, enter that "over value" here also.	kip	40. (W)	300. (W)	--
3. Number of 2 Axle Trucks	Enter the number of single unit trucks with 2 axles in this range of gross vehicle weights.	--	0 (E)	300,000 (W)	--
4. Number of 3 Axle Trucks	Enter the number of single unit trucks with 3 axles in this range of gross vehicle weights.	--	0 (E)	300,000 (W)	--
5. Number of 4 Axle Trucks	Enter the number of single unit trucks with 4 axles in this range of gross vehicle weights.	--	0 (E)	300,000 (W)	--
6. Number of 3 Axle Combination Trucks	Enter the number of tractor trailer combinations with 3 axles in this range of gross vehicle weights.	--	0 (E)	300,000 (W)	--
7. Number of 4 Axle Combination Trucks	Enter the number of tractor trailer combinations with 4 axles in this range of gross vehicle weights.	--	0 (E)	300,000 (W)	--
8. Number of 5 Axle Combination Trucks	Enter the number of tractor trailer combinations with 5 or more axles in this range of gross vehicle weights.	--	0 (E)	300,000 (W)	--

5.43 FTG - FATIGUE COMMAND

KEYWORD	COMMAND DESCRIPTION
FTG	FATIGUE - This command is used to specify the location and category for checking the LRFD Specifications for fatigue. The parameters and the command can be repeated. A maximum of 40 fatigue analysis points can be entered for the entire structure (10 FTG commands with four fatigue locations defined (parameters 1 through 5) on each command). For a symmetrical structure, enter the location and category for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the location and category for spans 1, 2 and up to the point of symmetry for span 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number in which the fatigue check occurs.	--	1 (E)	NSP[1] (E)	--
2. Distance 1	Enter the distance from the left support of the span to the fatigue location. 	ft	0. (E)	MXSP[2] (E)	0.
3. Distance 2	Enter the distance from the bottom of the girder to the location along the girder where the fatigue check is to be performed. 	in	0. (E)	150. (W)	0.
4. Category	Enter the category of the fatigue check. The primes (‘) are entered using the single quote key. Note: BP, CP and EP are equivalent to B', C' and E', respectively, and should be used by users of the Engineering Dataset Manager due to a limitation in that program.	--	A, B, B', C, C', D, E, E', BP, CP, EP (E)	[3]	--
5. Fillet Weld	Enter the effective throat of the fillet weld. Enter this value if the detail is connected with a transversely loaded fillet weld where the discontinuous plate is loaded. The fillet weld is required for fatigue life estimation. Leave blank for plate girders.	in	0. (E)	10. (E)	--

5.43 FTG - FATIGUE COMMAND (Continued)

Notes:

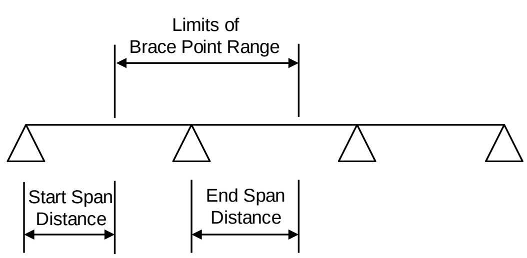
[1] NSP is equal to the number of spans entered in the CTL command.

[2] MXSP is equal to the span length corresponding to the span number.

[3] **Except for cross frame member end connections that are classified as Detail Category 7.2, details defined as Category D, E, E', or EP are considered unacceptable for new designs. Such details shall be excluded from new designs, except when approved by the Chief Bridge Engineer.**

5.44 BRP - BRACE POINT COMMAND

KEYWORD	COMMAND DESCRIPTION
BRP	BRACE POINT - This command is used to specify the lateral brace points for the girder. The parameters and the command can be repeated. A maximum of 40 bracing point ranges can be entered for the entire structure (10 BRP commands with four bracing ranges defined (parameters 1 through 5) on each command). If no bracing points are entered, the program will stop with an error. If any BRP command is entered, then the entire length of the girder must be defined using one or more BRP commands. The length of the brace point range must be equally divisible by the inputted brace spacing. However, if the symmetry option is used in the CTL command, the user may input a brace spacing that is equally divisible when the entire structure length is considered but that may not be equally divisible when the half structure length is considered. For a symmetrical structure, enter the brace points for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the brace points for spans 1, 2 and up to the point of symmetry for span 3. For a girder that is noncomposite in the final state, the top flange can be specified as continuously braced by entering the CBR command in addition to this command. Otherwise, the top flange will be considered as braced only at the locations defined by this command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Span Number	Enter the span number of the start location.	--	1 (E)	NSP[1] (E)	--
2. Start Span Distance	Enter the start location of the current brace point range measured from the left start span support.  NOTE: For the situation in the sketch above, if AUTOMATIC BRACE POINTS AT SUPPORTS on the CTL command is entered as YES, the program will consider support 2 as a brace location regardless of the value entered for BRACE SPACING. This could result in unbraced lengths immediately to the left and right of the support that are less than the BRACE SPACING.	ft	0. (E)	MXSP[2] (E)	--
3. End Span Number	Enter the span number of the end location.	--	1 (E)	NSP (E)	--

5.44 BRP - BRACE POINT COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
4. End Span Distance	Enter the end location of the current brace point range measured from the left end span support.	ft	0. (E)	MXSP (E)	--
5. Brace Spacing	Enter the brace point spacing for the given range. NOTE: For construction staging and uncured slab checks for all girders, and for girders that are noncomposite in the final state, both the top and bottom flanges are braced at these locations. To specify continuous bracing for the final state of a top flange of a girder that is noncomposite in the final state, please use the CBR command in addition to this command.	ft	1. (E)	25. (W)	--

Notes:

[1] NSP is equal to the number of spans entered in the CTL command.

[2] MXSP is equal to the span length corresponding to the span number.

5.45 CBR - CONTINUOUS BRACE COMMAND

KEYWORD	COMMAND DESCRIPTION
CBR	CONTINUOUS BRACE - This command is used to specify spans in which the top flange can be considered to be continuously braced. The parameters and the command can be repeated. A maximum of 20 continuously braced spans can be entered (Four CBR commands with five spans per command). NOTE: This command only specifies continuous bracing information for the top flange for the permanent condition. To specify bracing information for the bottom flange or noncontinuous bracing for the top flange, please use the BRP (Brace Point) command. For spans not specified on this command, the top flange bracing will be taken as that specified on the BRP command. This command only applies to girders that are specified as noncomposite on the MAT command. This command is ignored for girders that are specified as composite, since, for those girders, the top flange is always assumed to be continuously braced.

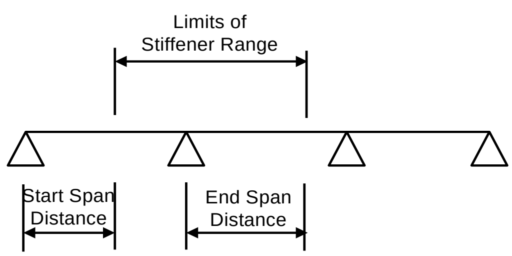
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number of the top flange assumed to be continuously braced.	--	1 (E)	NSP[1] (E)	--

Notes:

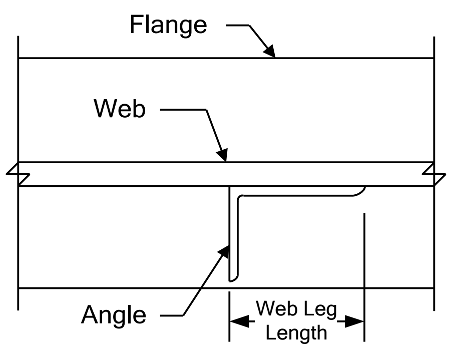
[1] NSP is equal to the number of spans entered in the CTL command.

5.46 TST - TRANSVERSE STIFFENER COMMAND

KEYWORD	COMMAND DESCRIPTION
TST	TRANSVERSE STIFFENER - This command is used to specify the transverse stiffener size and spacing for the analysis of a plate girder. The command can be repeated. A maximum of 100 stiffener ranges can be entered for the entire structure (100 TST commands). The stiffener range must be defined such that the entered stiffener spacing multiplied by an integer is equal to the length of the stiffener range, within a tolerance of 0.1 inches. A transverse stiffener is required at the termination of a web depth variation. See the detail in this manual Section 6.46 and in BC-753M. Stiffeners defined with this command are not considered to be bearing stiffeners. The information on this command is only used for shear capacity and transverse stiffener checks. In order for a transverse stiffener to be considered as a bearing stiffener, it must also be defined on the Bearing Stiffener (BST) command. For a symmetrical structure, enter the transverse stiffeners for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the transverse stiffeners for spans 1, 2 and up to the point of symmetry for span 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Span Number[1]	Enter the span number of the start location.	--	1 (E)	NSP[2] (E)	--
2. Start Span Distance	Enter the start location of the current stiffener range measured from the left start span support. 	ft	0. (E)	MXSP[3] (E)	--
3. End Span Number	Enter the span number of the end location.	--	1 (E)	NSP (E)	--
4. End Span Distance	Enter the end location of the current stiffener range measured from the left end span support.	ft	0. (E)	MXSP (E)	--
5. Single or Pair	Enter: S - If stiffener is on one side of the web only. P - If stiffeners are on both sides of the web.	--	S, P (E)	--	S
6. Stiffener Spacing	Enter the transverse stiffener spacing for the given range.	ft	0.65 (W)	25. (W)	--
7. Projected Width	Enter the width of the projecting element (length of the leg of the angle perpendicular to the web).	in	4. (W)	24. (W)	--

5.46 TST - TRANSVERSE STIFFENER COMMAND (Continued)

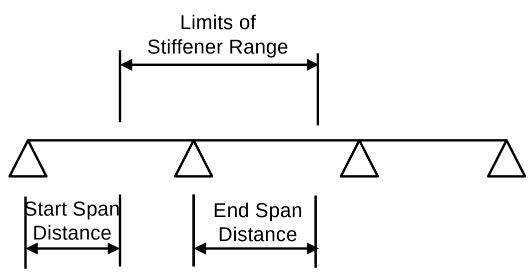
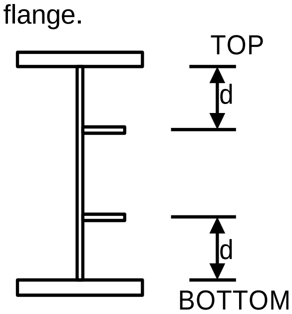
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
8. Stiffener Thickness	Enter the thickness of the transverse stiffener plate or the thickness of the angle leg.	in	0.125 (W)	3. (W)	--
9. Transv. Stiffener Yield Strength	Enter the yield strength of the transverse stiffener.	ksi	30. (W)	50. (W)	36.
10. Plate or Angle	Enter: P - If the stiffener is a plate. A - If the stiffener is an angle.	--	P, A (E)	--	P
11. Web Leg Length	Enter the length of the leg of the angle parallel to the web. Omit this value if not an angle.  Plan View	in	0. (E)	9. (W)	0.

Notes:

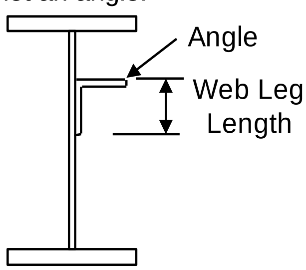
1 If a bearing stiffener is to be considered as a transverse stiffener for shear capacity calculations, it must be defined with this command
2 NSP is equal to the number of spans entered in the CTL command.
3 MXSP is equal to the span length corresponding to the span number.

5.47 LST - LONGITUDINAL STIFFENER COMMAND

KEYWORD	COMMAND DESCRIPTION
LST	LONGITUDINAL STIFFENER - This command is used to specify the longitudinal stiffener size and location for the analysis of a girder. The command can be repeated. A maximum of 40 stiffener ranges (40 LST commands) can be entered for the entire structure. For a symmetrical structure, enter the longitudinal stiffeners for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the longitudinal stiffeners for spans 1, 2 and up to the point of symmetry for span 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Span Number	Enter the span number of the start location.	--	1 (E)	NSP[1] (E)	--
2. Start Span Distance	Enter the start location of the current stiffener range measured from the left start span support. 	ft	0. (E)	MXSP[2] (E)	--
3. End Span Number	Enter the span number of the end location.	--	1 (E)	NSP (E)	--
4. End Span Distance	Enter the end location of the current stiffener range measured from the left end span support.	ft	0. (E)	MXSP (E)	--
5. Measured From Flange	Enter 'T' if the distance to the longitudinal stiffener is measured from the bottom of the top flange. Enter 'B' if the distance is measured from the top of the bottom flange. 	--	T, B (E)	--	B
6. Distance From Flange	Enter the distance from the bottom of the top flange if 'T' was entered for the previous parameter or the distance from the top of the bottom flange if 'B' was entered previously.	in	0. (E)	144. (W)	--

5.47 LST - LONGITUDINAL STIFFENER COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Single or Pair	Enter: S - Single stiffener (on one side of the web only). P - Pair of stiffeners (on both sides of the web).	--	S, P (E)	--	S
8. Projected Width	Enter the width of the projecting element (length of the horizontal leg of the angle).	in	4. (W)	24. (W)	--
9. Stiffener Thickness	Enter the thickness of the projecting element.	in	0.125 (W)	3. (W)	--
10. Longit. Stiffener Yield Strength	Enter the yield strength of the longitudinal stiffener.	ksi	30. (W)	50. . (W)	36. 250.
11. Plate or Angle	Enter: P - If the stiffener is a plate. A - If the stiffener is an angle.	--	P, A (E)	--	P
12. Web Leg Length	Enter the length of the vertical leg of the angle. Omit this value if not an angle. 	in	0. (E)	9. (W)	0.

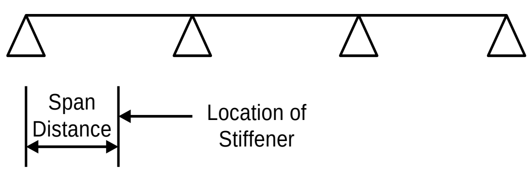
Notes:

1 NSP is equal to the number of spans entered in the CTL command.

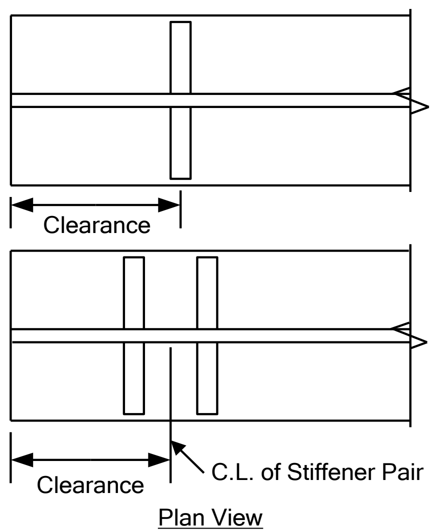
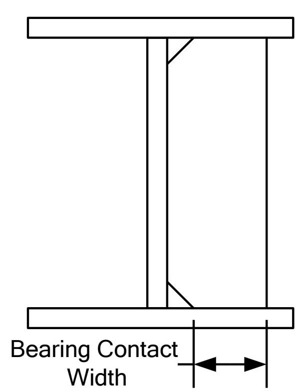
2 MXSP is equal to the span length corresponding to the span number.

5.48 BST - BEARING STIFFENER COMMAND

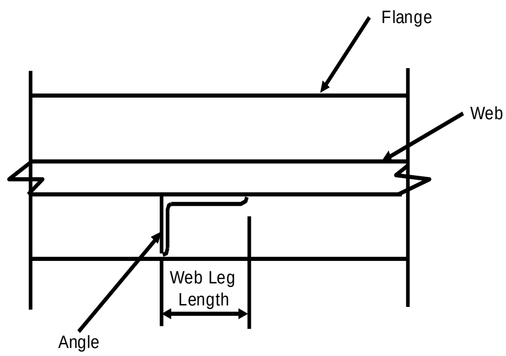
KEYWORD	COMMAND DESCRIPTION
BST	BEARING STIFFENER - This command is used to specify the bearing stiffener size and location for the analysis of a girder. The BST command can be repeated. A maximum of 41 stiffeners can be entered (41 BST commands). This maximum equals the number of supports plus the maximum number of concentrated loads. Bearing stiffeners can only be defined for points of concentrated load or at bearing locations. Stiffeners defined with this command are not considered to be transverse stiffeners. The information on this command is only used for bearing stiffener checks. In order for a bearing stiffener to be considered as a transverse stiffener, it must also be defined on the Transverse Stiffener (TST) command. For a symmetrical structure, enter the bearing stiffeners for spans up to and including the middle span up to the point of symmetry. That is, for a symmetrical 5 span structure, enter the bearing stiffeners for spans 1, 2 and up to the point of symmetry for span 3.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number in which the bearing stiffener is located.	--	1 (E)	NSP[1] (E)	--
2. Span Distance	Enter the location of the current stiffener, measured from the left span support. This distance should be entered as zero for bearing stiffeners at supports. Bearing stiffeners are also required at points of concentrated loads.  	ft	0. (E)	MXSP[2] (E)	--
3. Number of Pairs	Enter the number of pairs of bearing stiffeners at the defined support.	--	1 (E)	4 (E)	--
4. Spacing Between Pairs	Enter the distance from center to center of bearing stiffeners for pairs. Leave blank if NUMBER OF PAIRS is equal to one.	in	0. (E)	36. (W)	--

5.48 BST - BEARING STIFFENER COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Clearance	Enter the clearance from the end of the girder to the bearing stiffener. Leave blank if the bearing stiffener is not located at an abutment. 	in	0. (E)	12. (W)	--
6. Welded or Bolted	Enter: W -Welded stiffener. B - Bolted stiffener.	--	W, B (E)	--	W
7. Projected Width	Enter the width of the projecting element (length of the leg of the angle perpendicular to the web).	in	4. (W)	24. (W)	--
8. Bearing Contact Width	Enter the contact width of one stiffener between the stiffener and the flange. The bearing contact width is less than the projected width because the stiffener must be clipped to clear the web-to-flange fillet weld. 	in	3. (W)	23. (W)	--

5.48 BST - BEARING STIFFENER COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
9. Stiffener Thickness	Enter the thickness of the bearing stiffener plate or the thickness of the angle leg.	in	0.25 (W)	3. (W)	--
10. Bearing Stiffener Yield Strength	Enter the yield strength of the bearing stiffener.	ksi	30. (W)	50. (W)	36.
11. Plate or Angle	Enter: P - If the stiffeners are plates. A - If the stiffeners are angles.	--	P, A (E)	--	P
12. Web Leg Length	Enter the length of the leg of the angle parallel to the web. Omit this value if not an angle.  Plan View	in	0. (E)	9. (W)	0.
13. Classification Strength of Bearing Stiffener Weld	Enter the classification strength of the weld metal used for the calculated minimum stiffener-to-web fillet weld size.	ksi	30. (W)	100. (W)	70.

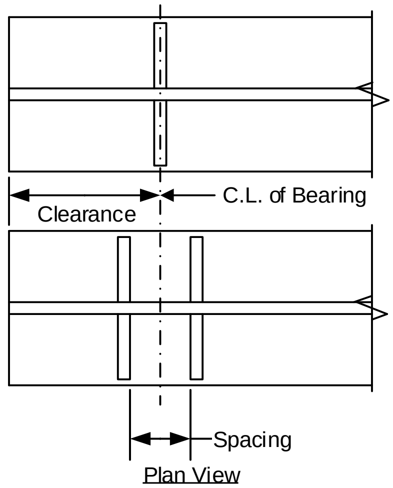
Notes:
1 NSP is equal to the number of spans entered in the CTL command.
2 MXSP is equal to the span length corresponding to the span number.

5.49 BSD - BEARING STIFFENER DESIGN COMMAND

KEYWORD	COMMAND DESCRIPTION
BSD	BEARING STIFFENER DESIGN - This command is used to specify the values necessary to design the bearing stiffeners for a girder. The BSD command cannot be repeated. NOTE: If desired, the bearing stiffener analysis command (BST) can be specified in the same input file with a BSD command. In other words, the same program run can analyze as well as design bearing stiffeners. Bearing stiffeners will be designed at points of concentrated load and bearing locations. If a BSD command is entered, the program will also generate a Bearing Stiffener Design History output file (.BDH and -BDH.PDF) that shows the process and intermediate values of the bearing stiffener design.

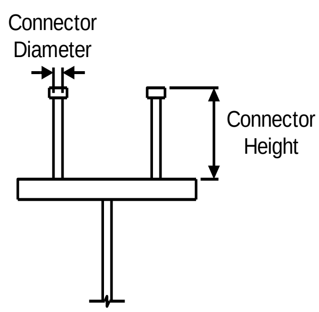
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Number of Pairs	Enter the minimum number of pairs of designed bearing stiffeners at each support. This input is provided so that if a given run of the program results in stiffeners that are thicker than desired, the number of pairs can be increased to design thinner stiffeners.	--	1 (E)	4 (E)	1
2. Bearing Stiffener Yield Strength	Enter the yield strength of the designed bearing stiffeners.	ksi	30. (W)	100. (W)	36.
3. Classification Strength of Bearing Stiffener Weld	Enter the classification strength of the weld metal used for the designed stiffener-to-web fillet weld.	ksi	30. (W)	100. (W)	70.
4. Clearance	Enter the clearance from the end of the girder to the center line of bearing. The same clearance will be used at each abutment. *If CLEARANCE is left blank, the program will assume a distance equal to 9*web thickness from the end of girder to the face of the first bearing stiffener.	in	0. (E)	12. (W)	*

5.49 BSD - BEARING STIFFENER DESIGN COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Spacing Between Pairs	Enter the distance from face to face of adjacent bearing stiffener pairs.  * if SPACING BETWEEN PAIRS is left blank, the program will assume a spacing of 18*web thickness between face of adjacent pairs of bearing stiffeners	in	0. (E)	36. (W)	*

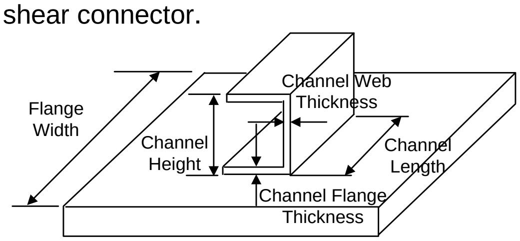
5.50 SCS - SHEAR CONNECTOR STUD COMMAND

KEYWORD	COMMAND DESCRIPTION
SCS	SHEAR CONNECTOR STUD - This command is used to specify and describe stud type shear connectors. Only one SCS command can be used. The program computes the required shear connector spacing at twentieth points. This command can only be entered if composite action is assumed between the steel beam and the concrete slab. If the beam is composite, then it is assumed to be composite over its entire length. If the beam is composite, the user must enter either the SCS or SCC command. The user cannot enter both the SCS and SCC command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Number of Connectors	Enter the number of stud type shear connectors in a transverse cross section.	--	2 (E)	5 (W)	3
2. Connector Diameter	Enter the diameter of an individual stud type shear connector. 	in	0.75 (W)	2. (W)	--
3. Connector Height	**NOTE: This parameter is no longer used and should be left blank.**	--	--	--	--
4. Connector Tensile Strength	Enter the tensile strength of the stud type shear connector.	ksi	36. (W)	70. (W)	60.

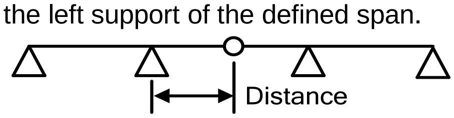
5.51 SCC - SHEAR CONNECTOR CHANNEL COMMAND

KEYWORD	COMMAND DESCRIPTION
SCC	SHEAR CONNECTOR CHANNEL - This command is used to specify and describe channel type shear connectors. Only one SCC command can be used. The program computes the required shear connector spacing at twentieth points. This command can only be entered if composite action is assumed between the steel beam and the concrete slab. If the beam is composite, then it is assumed to be composite over its entire length. If the beam is composite, the user must enter either the SCS or SCC command. The user cannot enter both the SCS and SCC command. Channel type shear connectors are to be used for analysis runs only; they cannot be used for design runs.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Channel Flange Thickness	Enter the flange thickness of the channel type shear connector. 	in	0.1 (W)	1.0 (W)	--
2. Channel Web Thickness	Enter the web thickness of the channel type shear connector.	in	0.1 (W)	1.0 (W)	--
3. Channel Length	Enter the length of the channel type shear connector, measured normal to the web of the girder.	in	2. (W)	50. (W)	--
4. Channel Height	**NOTE: This parameter is no longer used and should be left blank.**	--	--	--	--

5.52 FSL - FIELD SPLICE LOCATION COMMAND

KEYWORD	COMMAND DESCRIPTION
FSL	FIELD SPLICE LOCATION - This command is used to specify the location of field splices along the girder. The command can be repeated. The field splice locations are used for determining field sections for the economic feasibility checks, treating the sections along the field splice lengths as noncompact for flexural resistance calculations, checking field splice region for net section fracture (design runs only), and printing information for input to the SPLRFD program (in conjunction with parameter 15 of the OSC command). All parameters of the FSL command must be entered for design runs of plate girders and rolled beam girder types. Only parameters 1 through 3 should be entered for analysis runs (all beam types) of the program, since parameters 4 through 7 are not applicable and will be ignored. To consider bolt holes for an analysis run, use the SHO command. If holes are not defined along a field splice for an analysis run using the SHO command, the program will generate a warning. Holes should be defined so that the program can check net section fracture along the field splice. When entering field splice locations for plate girder design runs, the USER-DEFINED option must be used for the TRANSITION LOCATION parameter of the DP1 command, and the field splice locations must correspond to the transition locations defined on the DPL command. Each field splice location must correspond to a DPL location, but each DPL location does not have to be treated as a field splice. Sections along the length of a field splice will always be treated as noncompact. Section losses due to bolt holes along the length of a field splice will only be considered when checking the specifications for net section fracture for design runs of plate girders and rolled beams. Up to 30 field splice locations can be defined for analysis runs (30 FSL commands), while a maximum of 3 field splice locations (per half-span) (3 FSL commands) can be defined for design runs. For a symmetrical structure, enter the field splice in spans up to and including the middle span.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number of the field splice location.	--	1 (E)	NSP[1] (E)	--
2. Distance	Enter the distance of the field splice measured from the left support of the defined span.  	ft	0. (E)	MXSP[2] (E)	--

5.52 FSL - FIELD SPLICE LOCATION COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
3. Distance Between Extreme Bolt Lines	For design runs, enter the distance between the first and last bolt lines along the length of the field splice plate for the bottom flange. For analysis runs, enter the distance between the first and last bolt lines along the length of the field splice plate, as a maximum between the top flange and bottom flange field splice plates. See Figure 5.52-1.	ft	0. (E)	--	--
4. Bottom Flange Minimum Bolt Hole Diameter	Enter the minimum diameter of the bolt holes that will be used for the bottom flange field splice. This parameter is required for a design problem and will be ignored if entered during an analysis run. The default values for parameters 4-7 of this command are based on a bolt diameter of 0.875" (7/8"). The default for this parameter is a standard diameter hole from LRFD Specifications Table 6.13.2.4.2-1.	in	0.6875 (W)[3]	1.0625 (W)	0.9375
5. Bottom Flange Minimum Outer Edge Distance	Enter the minimum distance, $e_{out,min}$, from the outer edge to the center of the first bolt hole for the bottom flange field splice (Figure 5.52-2). This parameter is required for a design problem and will be ignored if entered during an analysis run. The default value is from LRFD Specifications Table 6.13.2.6.6-1, assuming "Rolled Edges of Plates or Gas Cut Edges".	in	0.875 (W)[3]	1.75 (W)	1.125
6. Bottom Flange Minimum Bolt Hole Spacing	Enter the minimum center-to-center bolt hole spacing, S_{min}, for the bottom flange field splice (Figure 5.52-2). This parameter is required for a design problem and will be ignored if entered during an analysis run. The default value is from DM-4 Table C6.13.2.6.1P-1, Preferred Bolt Spacing.	in	1.875 (W)[3]	3.5 (W)	3.0
7. Bottom Flange Minimum Inner Edge Distance	Enter the minimum distance, $e_{in,min}$, from the face of the web to the center of the last bolt hole for the bottom flange field splice (Figure 5.52-2). This parameter is required for a design problem and will be ignored if entered during an analysis run. The default value is from LRFD Specifications Table 6.13.2.6.6-1, assuming "Rolled Edges of Plates or Gas Cut Edges".	in	0.875 (W)[3]	1.75 (W)	1.125

Notes:
[1] NSP is equal to the number of spans entered on the control command (CTL).
[2] MXSP is equal to the span length corresponding to the span number.
[3] This value must be greater than zero. Entering a value less than or equal to zero will result in an error and the program will stop.

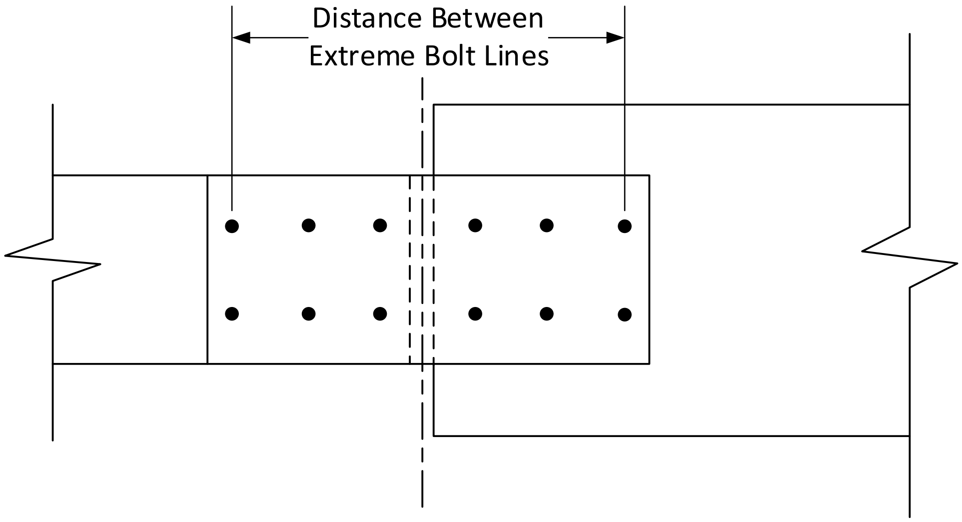


Figure 5.52-1 Plan View of Flange Splice

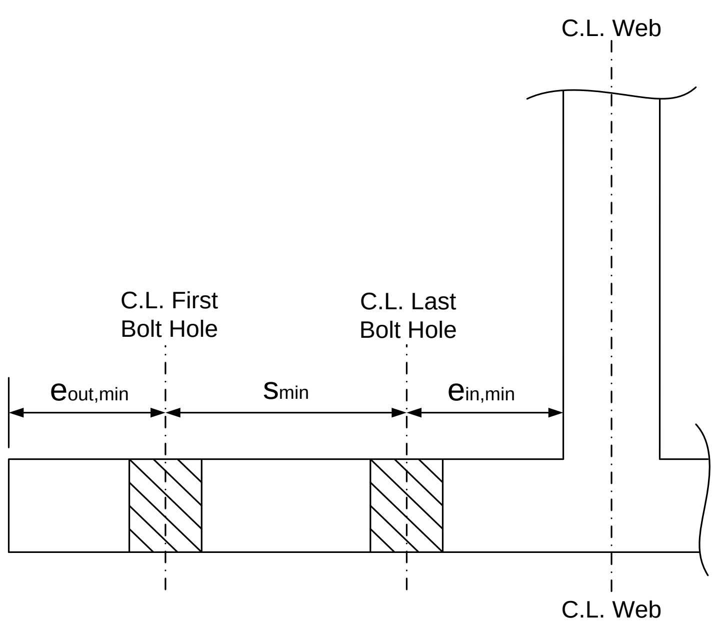


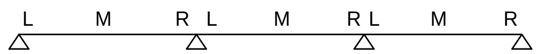
Figure 5.52-2 Bottom Flange Field Splice Parameters (Design Runs Only)

5.53 LAS - LATERAL BENDING STRESS COMMAND

KEYWORD	COMMAND DESCRIPTION
LAS	LATERAL BENDING STRESS - This command is used to specify the lateral unfactored bending stress, f_L, due to cross frames or other lateral bending or torsional effects, see LRFD Specifications Article 6.10.1.6. This command can be repeated. Exclude effects due to wind load. STLRFD internally computes the lateral loads due to wind using information from the WPD or WUD commands. Input the maximum lateral unfactored bending stresses, f_L, for each span, up to three values of f_L (left end, middle, or right end of the span). The maximum number of LAS commands that can be entered is 60. These stresses will be added to the major-axis bending stresses computed at each analysis point in the span, see LRFD Specifications Article 6.10.7. For analysis points located between the end of the span and midspan, the applied lateral bending stress will be interpolated (straight line). For straight girders, unfactored f_L should only be entered with this command for girders with skews ≤ 45° (PennDOT designation), for skews 45° < Θp < 70°, use the "Constant Lateral Bending Stress" parameter on the CTL command. For skews ≥ 70°, the skew effects may be addressed by using the skew correction factors without specifically addressing the lateral bending stress effects. STLRFD may be used as a quality assurance check for code compliance by using the lateral bending stresses computed using an approved refined analysis. For girders that are composite in the final state, the top flange lateral bending stresses may be set to zero for composite loads since the top flange is considered fully braced. If some spans have lateral stresses defined via the LAS command and others do not, the undefined spans will be considered to have lateral stresses of 0.0 over their entire length. Note that for severely skewed girders, other effects may need to be taken into account for major-axis analysis.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number for the lateral stresses being defined.	--	1 (E)	NSP[1] (E)	--

5.53 LAS - LATERAL BENDING STRESS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
2. Stress Location	Enter the location of the stresses defined by this instance of this command. Either enter L, M or R to indicate where the stress is located in the span, or enter A to indicate the stress is located at all locations in the span. L - left end of current span M - middle of current span R - right end of current span A - apply these values over the entire length of the current span  If some Stress Locations are not defined, all lateral stresses at the undefined locations will default to 0.0 ksi.	--	L, M, R, A (E)	--	A
Bottom Flange – Composite and Noncomposite Beams					
3. Unfactored DC1 stress, bottom flange	Enter the unfactored lateral stress due to all noncomposite (DC1) loads in the bottom flange.	ksi	-50. (W)	50. (W)	0.
4. Unfactored MC1 stress, bottom flange	Enter the unfactored lateral stress due to all miscellaneous MC1 loads in the bottom flange.	ksi	-50. (W)	50. (W)	0.
5. Unfactored DC2 stress, bottom flange	Enter the unfactored lateral stress due to DC2 loads in the bottom flange.	ksi	-50. (W)	50. (W)	0.
6. Unfactored FWS stress, bottom flange	Enter the unfactored lateral stress due to FWS loads in the bottom flange.	ksi	-50. (E)	50. (W)	0.
7. Unfactored MC2 stress, bottom flange	Enter the unfactored lateral stress due to all miscellaneous MC2 loads in the bottom flange.	ksi	-50. (W)	50. (W)	0.
8. Unfactored LL stress, bottom flange	Enter the unfactored lateral stress due to live loads in the bottom flange. (Do not include the stress due to the Design Permit Vehicle live load). Note that this stress will be combined with stresses due to each live load, so this value should be an "envelope" or maximum live load stress due to all of the live loads considered for this girder.	ksi	-50. (W)	50. (W)	0.

5.53 LAS - LATERAL BENDING STRESS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
9. Unfactored Design Permit Vehicle LL stress, bottom flange	Enter the unfactored lateral stress due to the Design Permit Vehicle live load in the bottom flange. Do not enter this value for runs without the Design Permit Vehicle load.	ksi	-50. (W)	50. (W)	0.
Top Flange – Composite and Noncomposite Beams					
10. Unfactored DC1 stress, top flange	Enter the unfactored lateral stress due to all noncomposite (DC1) loads in the top flange.	ksi	-50. (W)	50. (W)	0.
11. Unfactored MC1 stress, top flange	Enter the unfactored lateral stress due to all miscellaneous MC1 loads in the top flange.	ksi	-50. (W)	50. (W)	0.
Top Flange – Noncomposite Beams Only					
12. Unfactored DC2 stress, top flange	Enter the unfactored lateral stress due to DC2 loads in the top flange. NOTE: This value must only be entered for girders that are noncomposite in the final state.	ksi	-50. (W)	50. (W)	0.
13. Unfactored FWS stress, top flange	Enter the unfactored lateral stress due to FWS loads in the top flange. NOTE: This value must only be entered for girders that are noncomposite in the final state	ksi	-50. (W)	50. (W)	0.
14. Unfactored MC2 stress, top flange	Enter the unfactored lateral stress due to miscellaneous MC2 loads in the top flange. NOTE: This value must only be entered for girders that are noncomposite in the final state.	ksi	-50. (W)	50. (W)	0.
15. Unfactored LL stress, top flange	Enter the unfactored lateral stress due to live loads in the top flange. (Do not include the stress due to the Design Permit Vehicle live load). Note that this stress will be combined with stresses due to each live load, so this value should be an "envelope" or maximum live load stress due to all of the live loads considered for this girder. NOTE: This value must only be entered for girders that are noncomposite in the final state	ksi	-50. (W)	50. (W)	0.

5.53 LAS - LATERAL BENDING STRESS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
16. Unfactored Design Permit Vehicle LL stress, top flange	Enter the unfactored lateral stress due to the Design Permit Vehicle live load in the top flange. Do not enter this value for runs without the Design Permit Vehicle loads. NOTE: This value must only be entered for girders that are noncomposite in the final state	ksi	-50. (W)	50. (W)	0.
Bottom or Top Flange; State as Indicated (UT1 and UT2 loads)					
17. Unfactored UT1 stress, bottom flange	Enter the unfactored lateral stress due to UT1 utility loads in the bottom flange. Enter this value for both composite and noncomposite beams.	ksi	-50. (W)	50. (W)	0.
18. Unfactored UT2 stress, bottom flange	Enter the unfactored lateral stress due to UT2 utility loads in the bottom flange. Enter this value for both composite and noncomposite beams.	ksi	-50. (W)	50. (W)	0.
19. Unfactored UT1 stress, top flange	Enter the unfactored lateral stress due to UT1 utility loads in the top flange. Enter this value for both composite and noncomposite beams.	ksi	-50. (W)	50. (W)	0.
20 Unfactored UT2 stress, top flange	Enter the unfactored lateral stress due to UT2 utility loads in the top flange. NOTE: This value must only be entered for girders that are noncomposite in the final state	ksi	-50. (W)	50. (W)	0.

Notes:
[1] NSP is equal to the number of spans entered on the control command (CTL).

5.54 OIN - OUTPUT OF INPUT DATA COMMAND

KEYWORD	COMMAND DESCRIPTION
OIN	OUTPUT OF INPUT DATA - This command allows the user to control the output of the input data. Only one OIN command can be used.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Input File Echo	Enter: 0 - Do not print input file echo. 1 - Print input file echo.	--	0 (E)	1 (E)	0
2. Input Commands	Enter: 0 - Do not print input commands. 1 - Print input commands.	--	0 (E)	1 (E)	0
3. Input Summary	Enter: 0 - Do not print input summary. 1 - Print input summary.	--	0 (E)	1 (E)	1

5.55 OSP - OUTPUT OF SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
OSP	OUTPUT OF SECTION PROPERTIES - This command controls the section property output tables generated in the output file. Only one OSP command can be used.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Gross Section Properties	Enter: 0 - Do not print gross section properties. 1 - Print gross section properties.	--	0 (E)	1 (E)	*[1]
2. Section Properties	Enter: 0 - Do not print section properties. 1 - Print section properties.	--	0 (E)	1 (E)	*
3. Additional Section Properties	Enter: 0 - Do not print additional section properties. 1 - Print additional section properties.	--	0 (E)	1 (E)	*

Note:

[1] The default values for every parameter on this command are determined based on the type of run (analysis or design). The defaults for all output commands are detailed in Chapter 6.

5.56 ODG - OUTPUT OF DESIGN TRIALS COMMAND

KEYWORD	COMMAND DESCRIPTION
ODG	OUTPUT OF DESIGN TRIALS - This command controls the design trial output tables generated in the output file. Only one ODG command can be used. This command is to be used for a design run only.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Design Trials	Enter: 0 - Do not print the sections that were tried during the design optimization. 1 - Print the sections that were tried during the design optimization.	--	0 (E)	1 (E)	0
2. Final Design	Enter: 0 - Do not print the final designed girder. 1 - Print the final designed girder.	--	0 (E)	1 (E)	1

5.57 OAN - OUTPUT OF ANALYSIS RESULTS COMMAND

KEYWORD	COMMAND DESCRIPTION
OAN	OUTPUT OF ANALYSIS RESULTS - This command controls the analysis result output tables generated in the output file. Only one OAN command can be used.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Points of Contraflexure	Enter: 0 - Do not print the points of noncomposite dead load contraflexure. 1 - Print the points of noncomposite dead load contraflexure.	--	0 (E)	1 (E)	*1
2. Compactness Check for Redistribution	Note: This parameter is no longer used.	--	--	--	--
3. Load Modifiers	Enter: 0 - Do not print the load modifiers. 1 - Print the load modifiers.	--	0 (E)	1 (E)	*1
4. Dead Loads	Enter: 0 - Do not print the dead loads of the beam and slab. 1 - Print the dead loads of the beam and slab.	--	0 (E)	1 (E)	*1
5. Distribution Factors	Enter: 0 - Do not print the live load distribution factors. 1 - Print the live load distribution factors.	--	0 (E)	1 (E)	*1
6. Dead Load Effects	Enter: 0 - Do not print the unfactored dead load effects (moments, shears, and deflections). 1 - Print the unfactored dead load effects (moments, shears, and deflections).	--	0 (E)	1 (E)	*1
7. Dead Load Reactions	Enter: 0 - Do not print the unfactored dead load reactions. 1 - Print the unfactored dead load reactions.	--	0 (E)	1 (E)	*1
8. Staging Analysis	Enter: 0 - Do not print the unfactored deck pour analysis results (each stage and cumulative). 1 - Print the unfactored deck pour analysis results (each stage and cumulative).	--	0 (E)	1 (E)	*1

5.57 OAN - OUTPUT OF ANALYSIS RESULTS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
9. Live Load Effects	Enter: 0 - Do not print the unfactored live load effects (moments, shears, and deflections) for live loadings selected on the CTL command. 1 - Print the unfactored live load effects (moments, shears, and deflections) for live loadings selected on the CTL command.	--	0 (E)	1 (E)	*[1]
10. Live Load Reactions	Enter: 0 - Do not print the unfactored live load reactions (both with and without impact) for live loadings selected on the CTL command . 1 - Print the unfactored live load reactions (both with and without impact) for live loadings selected on the CTL command.	--	0 (E)	1 (E)	*[1]
11. HS20 Effects and Reactions	Enter: 0 - Do not print the HS20 live load effects and reactions with the output requested in parameters 9 and 10. 1 - Print the HS20 live load effects and reactions with the output requested in parameters 9 and 10.	--	0 (E)	1 (E)	*[1]
12. H20 Effects and Reactions	Enter: 0 - Do not print the H20 live load effects and reactions with the output requested in parameters 9 and 10. 1 - Print the H20 live load effects and reactions with the output requested in parameters 9 and 10.	--	0 (E)	1 (E)	*[1]
13. Fatigue Effects and Reactions	Enter: 0 - Do not print the fatigue live load effects and reactions with the output requested in parameters 9 and 10. 1 - Print the fatigue live load effects and reactions with the output requested in parameters 9 and 10.	--	0 (E)	1 (E)	*[1]
14. Factored Effects	Enter: 0 - Do not print the factored effects (moments, shears, and deflections) from the total factored loads for each applicable limit state. 1 - Print the factored effects (moments, shears, and deflections) from the total factored loads for each applicable limit state.	--	0 (E)	1 (E)	*[1]

5.57 OAN - OUTPUT OF ANALYSIS RESULTS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
15. Factored Reactions	Enter: 0 - Do not print the factored reactions from the total factored loads for each applicable limit state. 1 - Print the factored reactions from the total factored loads for each applicable limit state.	--	0 (E)	1 (E)	*[1]
16. Overall Reaction Summary	Enter: 0 - Do not print the overall reactions summary table. 1 - Print the overall reactions summary table		0 (E)	1 (E)	*[1]

Note:

[1] The default values for every parameter on this command are determined based on the type of run (analysis or design). The defaults for all output commands are detailed in Chapter 6.

5.58 OSC - OUTPUT OF SPECIFICATION CHECKING COMMAND

KEYWORD	COMMAND DESCRIPTION
OSC	OUTPUT OF SPECIFICATION CHECKING - This command controls the specification checking output tables generated in the output file. Only one OSC command can be used.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Ductility and Web/Flange Proportions	Enter: 0 - Do not print the results of the ductility and web/flange proportion specification checks. 1 - Print the results of the ductility and web/flange proportion specification checks.	--	0 (E)	1 (E)	*1
2. Wind Effects	Enter: 0 - Do not print the results of the wind effects specification checks. 1 - Print the results of the wind effects specification checks.	--	0 (E)	1 (E)	*1
3. Flexural Capacity	Enter: 0 - Do not print the results of the flexural capacity specification checks. 1 - Print the results of the flexural capacity specification checks.	--	0 (E)	1 (E)	*1
4. Shear Capacity	Enter: 0 - Do not print the results of the shear capacity specification checks. 1 - Print the results of the shear capacity specification checks.	--	0 (E)	1 (E)	*1
5. Web Checks	Enter: 0 - Do not print the results of the web specification checks. 1 - Print the results of the shear capacity specification checks. NOTE: this output will only appear for girders that are noncomposite in the final state	--	0 (E)	1 (E)	*1
6. Stiffener Checks	Enter: 0 - Do not print the results of the stiffener (transverse, longitudinal, and bearing) specification checks. 1 - Print the results of the stiffener (transverse, longitudinal, and bearing) specification checks.	--	0 (E)	1 (E)	*1

5.58 OSC - OUTPUT OF SPECIFICATION CHECKING COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Fatigue Checks	Enter: 0 - Do not print the results of the fatigue specification checks. 1 - Print the results of the fatigue specification checks.	--	0 (E)	1 (E)	*1
8. Fatigue Life Estimation	Enter: 0 - Do not print the results of the fatigue life estimation checks. 1 - Print the results of the fatigue life estimation checks.	--	0 (E)	1 (E)	*1
9. Deflection Checks	Enter: 0 - Do not print the results of the deflection specification checks. 1 - Print the results of the deflection specification checks. Deflection checks are only calculated and printed for live load codes including PHL-93 or HL-93 loads. If a live load code is specified that does not include PHL-93 or HL-93 loads, no Deflection Checks information will print, regardless of the value entered here.	--	0 (E)	1 (E)	*1
10. Shear Connector Checks	Enter: 0 - Do not print the results of the shear connector specification checks. 1 - Print the results of the shear connector specification checks.	--	0 (E)	1 (E)	*1
11. Staging/ Uncured Slab Checks	Enter: 0 - Do not print the results of the staging and uncured slab specification checks. 1 - Print the results of the staging and uncured slab specification checks.	--	0 (E)	1 (E)	*1
12. Web–to–flange Weld Design Checks	Enter: 0 - Do not print the results of the weld capacity and connected material capacity specification checks. 1 - Print the results of the weld capacity and connected material capacity specification checks.	--	0 (E)	1 (E)	*1
13. Economic Feasibility Checks	Enter: 0 - Do not print the results of the economic feasibility checks. 1 - Print the results of the economic feasibility checks	--	0 (E)	1 (E)	*1

5.58 OSC - OUTPUT OF SPECIFICATION CHECKING COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
14. Negative Moment Serviceability Checks	Enter: 0 - Do not print the results of the negative moment serviceability checks 1 - Print the results of the negative moment serviceability checks	--	0 (E)	1 (E)	*[1]
15. SPLRFD Information	Enter: 0 - Do not print the SPLRFD input information 1 - Print the SPLRFD input information. If the user has not entered a field splice location via the FSL command, no SPLRFD input information will print, regardless of the value entered here.	--	0 (E)	1 (E)	*[1]
16. NSBA Splice Information	Enter: 0 - Do not print the NSBA Splice Spreadsheet input information 1 - Print the NSBA Splice Spreadsheet input information. If the user has not entered a field splice location via the FSL command, no NSBA Splice Spreadsheet input information will print, regardless of the value entered here.	--	0 (E)	1 (E)	*[1]

Note:
[1] The default values for every parameter on this command are determined based on the type of run (analysis or design). The defaults for all output commands are detailed in Chapter 6.

5.59 ORF - OUTPUT OF RATING FACTORS COMMAND

KEYWORD	COMMAND DESCRIPTION
ORF	OUTPUT OF RATING FACTORS - This command controls the rating factor output tables generated in the output file. Only one ORF command can be used.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Vehicle Rating Summary	Enter: 0 - Do not print the rating summary for each live loading. 1 - Print the rating summary for each live loading.	--	0 (E)	1 (E)	*[1]
2. Detailed Rating Factors	Enter: 0 - Do not print the detailed ratings (flexure and shear) for each applicable point, live loading, and limit state. 1 - Print the detailed ratings (flexure and shear) for each applicable point, live loading, and limit state.	--	0 (E)	1 (E)	*[1]
3. Overall Rating Summary	Enter: 0 - Do not print the overall rating summary and bridge load ratings table. 1 - Print the overall rating summary and bridge load ratings table.	--	0 (E)	1 (E)	*[1]
4. Ratings Without Future Wearing Surface	Enter: 0 - Only print the ratings with FWS. 1 - Print the ratings both with FWS and without FWS.	--	0 (E)	1 (E)	*[1]

Note:

[1] The default values for every parameter on this command are determined based on the type of run (analysis or design). The defaults for all output commands are detailed in Chapter 6.

6 DETAILED INPUT DESCRIPTION

This chapter provides a detailed description of some of the input parameters which were described in Chapter 5, but may need further explanation or commentary. The numbering scheme used in this chapter is as follows. The section number for a command corresponds to the same section number in Chapter 5. The parameter being described is preceded by a section number, whose last extension number refers to the parameter number in the corresponding command in Chapter 5. For example, 6.16.7 Haunch Depth corresponds to Section 5.16 DRB - Design Rolled Beam Command, parameter 7. Only the commands and parameters for which detailed description is given are included in this chapter.

6.5 CTL - CONTROL COMMAND

6.5.5 Number of Beams

STLRFD uses this value for many computational purposes, and it could have slightly different meanings depending on whether the girder system being analyzed is a girder-floorbeam-stringer or girder-floorbeam system. The value is used for the following calculations:

1. Computing deflection distribution factors (# lanes/# beams)

2. Determining the pedestrian load to apply to a given beam when running CBA for deflection due to pedestrian load (Total Pedestrian Load / # beams)

3. Check applicability limits for distribution factor equations

4. Determine whether or not to use lever rule (use lever rule for two-girder systems)

5. Use for calculations of distribution factors using "Pile Action" equations for exterior beams

Three values come into consideration when entering information for girder-floorbeam-stringer and girder-floorbeam systems, the "Number of Beams', the "Beam/Stringer Spacing" on the GEO command (Section 6.7) and "Two–Girder Spacing" on the CDF command (Section 6.8). The following are recommendations on how to enter these values for various situations. When analyzing the girders of a girder-floorbeam-stringer system, enter the following:

NUMBER OF BEAMS:	the number of girders (not including stringers) in the cross section
BEAM/STRINGER SPACING:	the distance between the girder and the stringers.(Figure 1). This value will be used to compute the slab weight carried by the girder (as described in Section 6.7.1), assuming that the deck load will be shared between the edge girders and the stringers. If this is not the case, either enter this value to be the distance between the girders or enter additional noncomposite dead load due to the deck via the DLD command.
TWO-GIRDER SPACING:	the distance between the girders

When analyzing the stringers of a girder-floorbeam-stringer system, enter the following:

NUMBER OF BEAMS:	the number of stringers (not including girders) in the cross section
BEAM/STRINGER SPACING:	the distance between the stringers. (Figure 1)
TWO-GIRDER SPACING:	leave blank (not needed)

When analyzing the girders of a girder-floorbeam system, enter the following:

NUMBER OF BEAMS;	number of girders in the cross section
BEAM/STRINGER SPACING:	the distance between the girders
TWO-GIRDER SPACING:	the distance between the girders (only enter this if there are only two girders in the cross section)

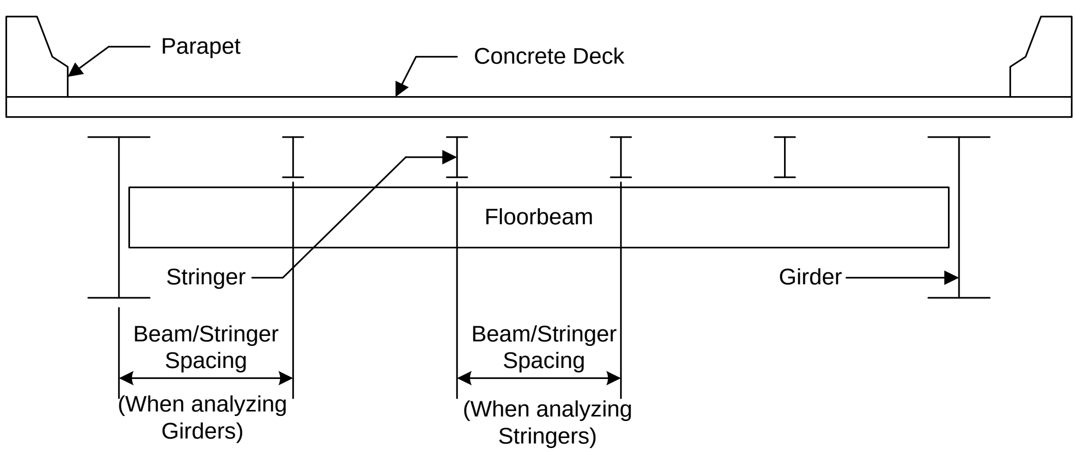


Figure 6.5-1 Beam/Stringer spacing for Girder-Floorbeam-Stringer system

6.5.7 Symmetry

If the user enters Y for this parameter, indicating that the entire structure is symmetrical, then the user must specify input for only the first half of the girder. The program will provide output for only the first half of the girder, with one exception. The single exception is that the program will provide an input summary near the beginning of the output which includes the entire length of the girder, providing the user with a check that the program has mirrored the input correctly. Although the input and the output will be for only the first half of the girder, the program will perform the analysis for the entire girder length.

Since input is specified for only the first half of the girder for a symmetrical run, maximum limits related to the allowable number of items for the entire length of the girder should be divided by 2. Examples of this include the maximum number of user defined analysis points, the maximum number of section hole ranges, and the maximum number of stiffener ranges. For these and similar maximum limits, the values presented in Chapter 5 pertain to an entire girder length. If only half the girder is to be specified in the input, then the maximum limits must be divided by 2.

If the user enters Y for this parameter, the user may enter either Y or N for parameter 8 (Deck Pour Symmetry).

6.5.8 Deck Pour Symmetry

If the user enters Y for parameter 7 (Symmetry), then the user may enter either Y or N for this parameter. However, if the user enters N for parameter 7, then the program does not use this parameter.

If parameter 7 is entered as Y and this parameter is entered as N then the girder will be treated as nonsymmetrical. This will enable the user to see potential specification check failures for the entire length of the structure caused by the unsymmetrical deck pours.

If the user enters Y for this parameter, indicating that the deck pours are symmetrical, then the user must specify deck pour related input for only the first half of the girder. The program will provide deck pour related output for only the first half of the girder, with one exception. The single exception is that the program will provide an input summary near the beginning of the output which includes the entire length of the girder, providing the user with a check that the program has mirrored the input correctly. Although the deck pour related input and output will be for only the first half of the girder, the program will perform the deck pour analysis for the entire girder length.

Since deck pour related input is specified for only the first half of the girder for a symmetrical run, maximum limits related to the allowable number of deck pour items for the entire length of the girder should be divided by 2. Examples of this include the maximum number of deck pour ranges, the maximum number of deck pour concentrated loads, and the maximum number of deck pour distributed loads. For these maximum limits, the values presented in Chapter 5 pertain to an entire girder length. If only half the girder is to be specified in the input, then the maximum limits must be divided by 2.

For a design run, the program ignores this parameter since design is for simple spans only.

6.5.11 Live Load

For design live load code D, the beam is designed for the maximum effect of either the PHL-93 or ML-80 loads for limit states Strength-I, Strength-IA, Strength-V, Service-II and Service-IIA and P-82 for limit states Strength-II and Service-IIB. The program reports both combined results for the PHL-93 and ML-80 loads as well as separate results for PHL-93 and ML-80 independently.

For design live load code E, the beam is designed for the maximum effect of the PHL-93, ML-80 or TK527 loads for limit states Strength-I, Strength-IA, Strength-V, Service-II and Service-IIA and P-82 for limit states Strength-II and Service-IIB. The program reports both combined results for the PHL-93, ML-80 and TK527 loads as well as separate results for PHL-93, ML-80 and TK527 vehicles independently.

For design live load code F, the beam is designed for the maximum effect of the PHL-93, ML-80, or TK527 loads for limit states Strength-I, Strength-IA, Strength-V, Service-II and Service-IIA and the maximum effect of the P-82 or P2016-13 for limit states Strength-II and Service-IIB. The program reports combined results for the PHL-93, ML-80, and TK527 loads, and P-82 and P2016-13 loads as well as separate results for PHL-93, ML-80, TK527, P-82, and P2016-13 vehicles independently.

6.5.20 Output Points

This parameter affects the number of points printed in the output for all output tables.

Regardless of which output point option is selected for this parameter, the program always analyzes and performs specifications checks based on twentieth points of each span length and all additional analysis points. Additional analysis points are listed in Section 3.2. The output points option selected for this parameter affects only the number of points printed in the output.

The program prints a list, at the end of the output, of all output tables for which one or more specification checks have failed. This list is based on specifications checking at twentieth points and all additional analysis points. Therefore, if the user chooses to have fewer points printed in the output, the program may also print failure points that were not selected by the user as printable points. This is to prevent the situation where a table may be included in this list for which there appears to be no specifications check warning or failure.

6.7 GEO - GEOMETRY COMMAND

6.7.1 Beam/Stringer Spacing

STLRFD uses this value for many computational purposes, and it could have slightly different meanings depending on whether the girder system being analyzed is a girder-floorbeam-stringer or a girder-floorbeam system. The value is used for the following calculations:

1. Computation of effective slab width
2. Computation of slab weight for CBA runs
3. Check of applicability limits for distribution factor calculations
4. Calculation of shear distribution factors (for systems with more than two "beams" as entered with the NUMBER OF BEAMS parameter)
5. Calculation of moment distribution factors (for systems with more than two "beams" as entered with the NUMBER OF BEAMS parameter)
6. Using the lever rule to compute the distribution factors for three or more girder systems

For recommendations on how to enter this value for girder-floorbeam-stringer and girder-floorbeam systems, see Section 6.5.5.

6.7.2 Deck Overhang

The maximum allowed overhang is determined by DM-4 9.7.1.5.1.

For both analysis and design runs, if the user enters an overhang that exceeds 0.5 * the beam/girder spacing, a District Bridge Engineer warning is issued. For design runs only, if the overhang exceeds 0.625 * the beam/girder spacing, the program will stop with an error.

In addition, for analysis runs, if the user enters an overhang which exceeds the minimum entered beam depth anywhere along the beam, a District Bridge Engineer warning is issued and the program continues. For design runs, if the user enters an overhang which exceeds the maximum possible beam depth (maximum web depth + maximum flange thicknesses for plate girders, maximum beam depth for a rolled beam), an error is issued and design stops.

For both analysis and design runs of exterior beams, the maximum allowable overhang, as per DM-4 Table 9.7.1.5.1P-1, is calculated and reported on the DEFLECTION LIMITS FOR LIVE LOAD output report. If the user enters an overhang which exceeds the deflection limits for live load, a District Bridge Engineer warning is issued and the program continues.

6.7.4 Number of Design Lanes

This parameter is to be entered assuming that sidewalks are not present. It is used in the computations for all limit states except Strength IP. The number of design lanes is based on the roadway width shown in the bottom schematic drawing of Figure 1. The user should enter the number of design lanes based on LRFD Specifications Article 3.6.1.1.1. However, roadway widths from 18 to 24 feet should have two design lanes, each equal to one-half the roadway width.

6.7.5 Deflection Distribution Factor

The deflection distribution factor is the distribution factor, in units of lane fractions, to be used in computing live load deflection in a multi-beam bridge. The program uses this parameter only to compute live load deflection. The deflection distribution factor is equal to the number of design lanes divided by the number of beams in the bridge cross section, multiplied by the appropriate multiple presence factor. If this parameter is not entered, the program computes this value as the inputted number of design lanes divided by the inputted number of beams, then multiplied by the appropriate multiple presence factor.

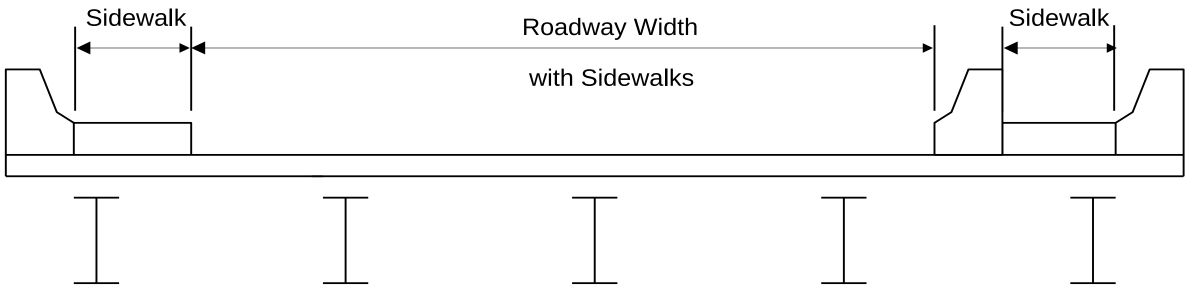
This parameter is to be entered assuming that sidewalks are not present. It is used in the computations for all limit states except Strength IP.

6.7.6 Number of Design Lanes With Sidewalks

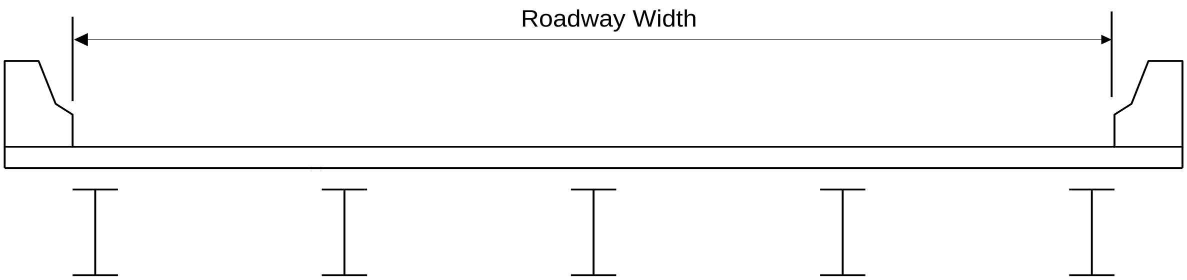
This parameter is to be entered assuming that sidewalks are present. It is used in the computations for the Strength IP limit state only. The number of design lanes with sidewalks is based on the roadway width with sidewalks shown in the top schematic drawing of Figure 1. The user should enter the number of design lanes based on LRFD Specifications Article 3.6.1.1.1. However, roadway widths from 18 to 24 feet should have two design lanes, each equal to one-half the roadway width.

6.7.7 Deflection Distribution Factor With Sidewalks

For a detailed input description of the deflection distribution factor, refer to Section 6.7.5. This parameter is to be entered assuming that sidewalks are present. It is used in the computations for the Strength IP limit state only.



Bridge Cross Section with Sidewalks



Bridge Cross Section without Sidewalks

Figure 6.7-1 Bridge Cross Sections

6.8 CDF - COMPUTED DISTRIBUTION FACTOR COMMAND

6.8.3 Design Lane Width

The design lane width is based on the design lane defined in the LRFD Specifications Article 3.6.1.2.2 and as shown in Figure 1.

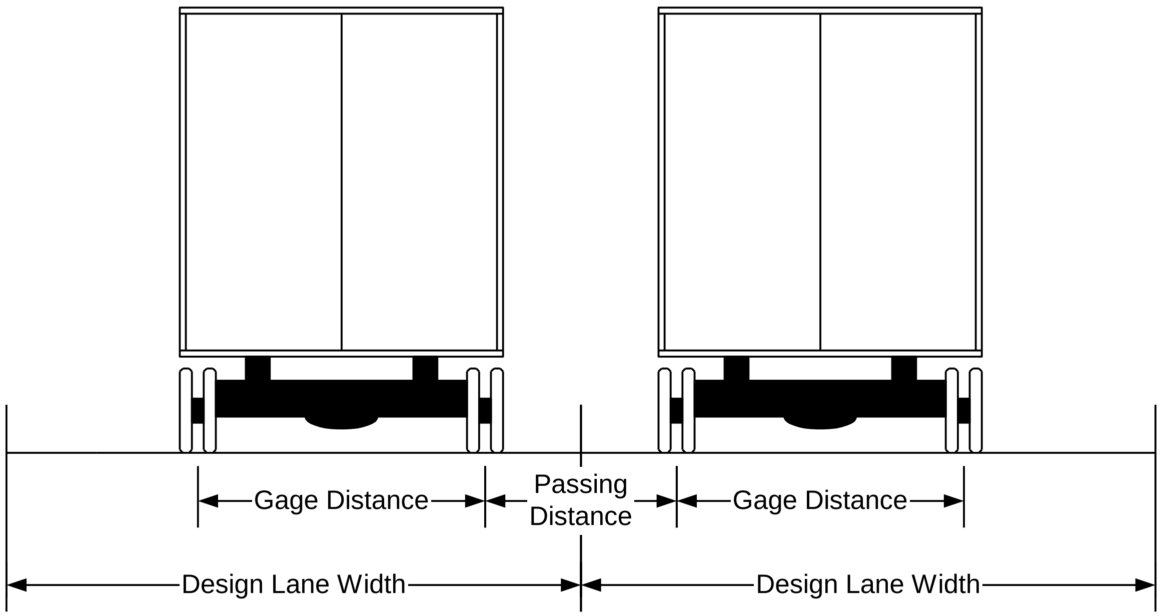


Figure 6.8-1 CDF Parameter Definitions

6.8.6 Two-Girder Spacing

STLRFD uses this value when computing the distribution factor according to the lever rule for a two girder system. For recommendations on how to enter this value for girder-floorbeam-stringer and girder-floorbeam systems, see Section 6.5.5.

6.8.7 Distance to Left Wheel

This parameter is to be entered assuming that sidewalks are not present. It is used in the computations for all limit states except Strength IP.

6.8.8 Centerline Exterior Beam to Curb

This parameter is to be entered assuming that sidewalks are not present. It is used in the computations for all limit states except Strength IP.

6.8.9 Distance to Left Wheel With Sidewalks

This parameter is to be entered assuming that sidewalks are present. It is used in the computations for the Strength IP limit state only.

6.8.10 Centerline Exterior Beam to Curb With Sidewalks

This parameter is to be entered assuming that sidewalks are present. It is used in the computations for the Strength IP limit state only.

6.9 UDF – USER DEFINED DISTRIBUTION FACTOR COMMAND

User defined distribution factors must include any skew correction factors. For a description of where the skew correction factor should be applied, refer to Section 3.4.15.

6.10 URF – USER DEFINED REACTION DISTRIBUTION FACTOR COMMAND

6.10.3 Reaction Distribution Factor

For a description of computing reaction distribution factors refer to Section 3.4.15.

6.11 SKW - SKEW ANGLE COMMAND

For a description of how the program computes the skew correction factors, refer to Section 3.4.15.

6.11.3 Apply Skew Correction Factor

For a description of where the skew correction factor should be applied, refer to Section 3.4.15 and Figure 3.4-6.

6.15 MAT - MATERIAL COMMAND

6.15.2 Noncomposite/Composite

A girder must be considered either composite over its entire length or noncomposite over its entire length. It cannot have portions that are composite and other portions that are noncomposite.

6.16 DRB - DESIGN ROLLED BEAM COMMAND

6.16.1 Maximum Deflection

If the user does not enter a value for maximum deflection, the program will default to a value of L/800, where L is the span length of the bridge.

6.16.2 Maximum Deflection With Pedestrian Load

If the user does not enter a value for maximum deflection with pedestrian load, the program will default to a value of L/1000, where L is the span length of the bridge. If this value is entered for a run that does not include pedestrian load, it will be ignored.

6.16.7 Haunch Depth

A haunch detail for a design run is presented in Figure 1. The haunch thickness is input by the user and is measured from the top of the top flange for all section types. The haunch width is assumed to be equal to the top flange width.

For a design problem, the haunch depth is used only for computing the dead load due to the haunch. For section property calculations of a design problem, the program assumes that the vertical distance from the bottom of the deck slab to the top of the top flange is zero.

To analyze a design problem solution produced by STLRFD, the user should input a haunch depth equal to the top flange thickness. In addition, the user must input a DC1 load, which sets the analysis run haunch weight equal to the design run haunch weight, using the following equation:

$$DC1_{haunch} = (\text{Top Flange Width})(\text{Design Run Haunch Depth} - \text{Top Flange Thickness})(\text{Conc. Density})$$

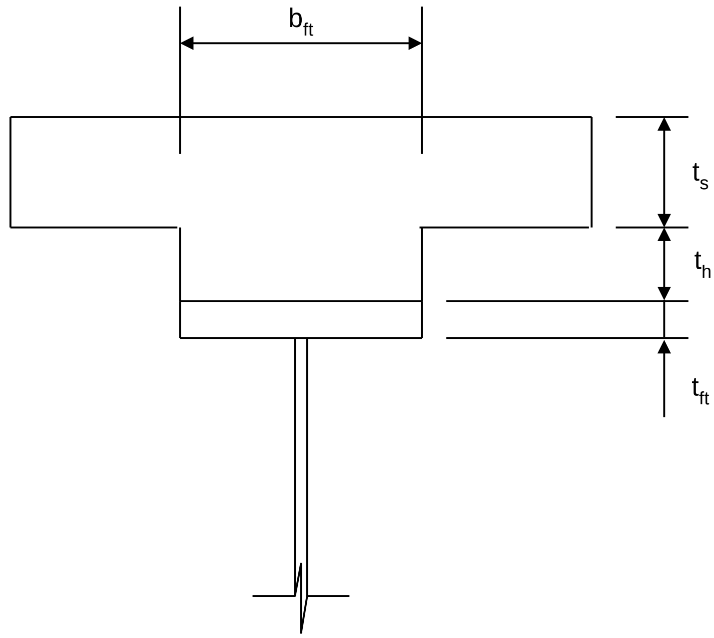


Figure 6.16-1 Haunch Detail for a Design Run

6.16.8 Deck Reinf. Area

This parameter should include the total of all layers of reinforcing steel parallel to the girder.

The value entered is multiplied by the effective slab width to compute the total area of reinforcement for the calculation of the composite girder section properties for negative flexure.

6.16.9 Deck Reinf. CG Distance

This parameter should be based on all layers of deck reinforcing steel.

6.16.10 Span-To-Depth Ratio Check

This parameter indicates whether the program is to check the span-to-depth ratio as described in the LRFD Specifications Table 2.5.2.6.3-1. For simple span beams, the overall depth of the composite I-beam (beam depth + effective slab depth) must be less than 0.040 * Span Length, while the depth of the steel section alone must be less than 0.033 * Span Length. Any sections not meeting these depth criteria will be rejected when designing the beam. If the computed minimum depth is greater than the user entered maximum depth, the program stops with an error indicating that the user should change the maximum depth.

6.17 DP1 - DESIGN PLATE GIRDER (PART 1) COMMAND

6.17.1 Transition Location Option

The user may either input user-defined plate transition locations or use the predefined plate transition locations stored in the program. For a description of the derivation of the predefined plate transition locations and a table presenting their locations, refer to Section 3.6.

For a design run, the web depth and thickness must be constant, the top plate width must be constant, and the bottom plate width must be constant. However, the top plate thickness may have as many as three transition locations per half-span. Similarly, the bottom plate thickness may have as many as three transition locations per half-span. The top plate width does not have to equal the bottom plate width.

If the user selects the user-defined option, the DPL command must be used to define the transition locations.

A plate transition detail is presented in Figure 1.

6.17.4 Maximum Deflection

If the user does not enter a value for maximum deflection, the program will default to a value of L/800, where L is the span length of the bridge.

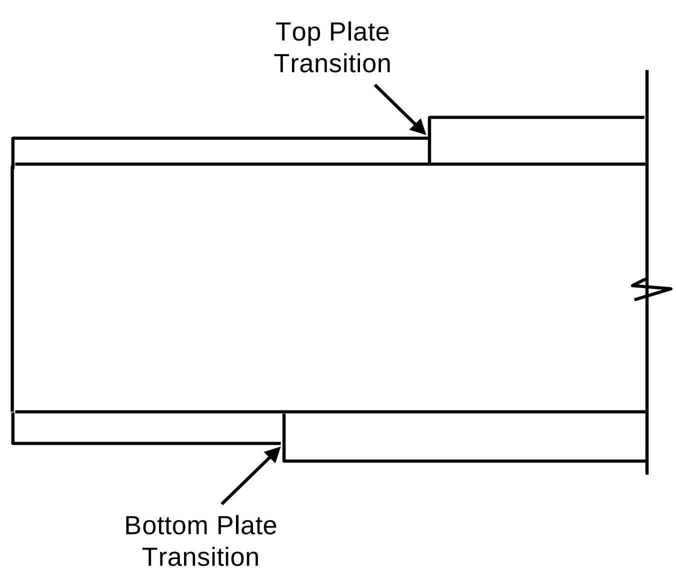


Figure 6.17-1 Plate Transition Detail

6.17.5 Maximum Deflection With Pedestrian Load

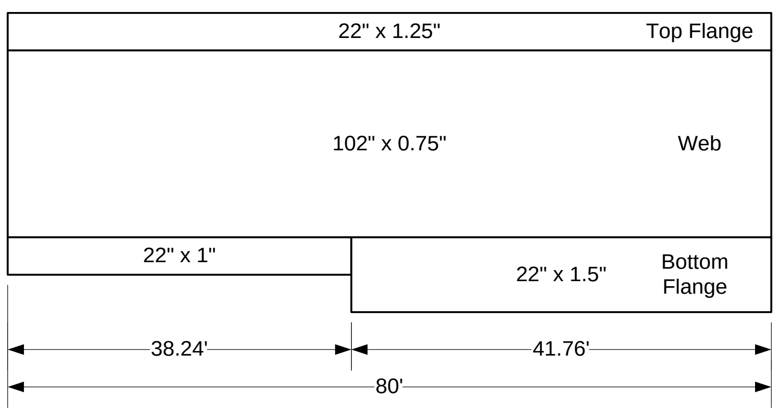
If the user does not enter a value for maximum deflection with pedestrian load, the program will default to a value of L/1000, where L is the span length of the bridge. If this value is entered for a run that does not include pedestrian load, it will be ignored.

6.17.6 Weight/Mass Savings

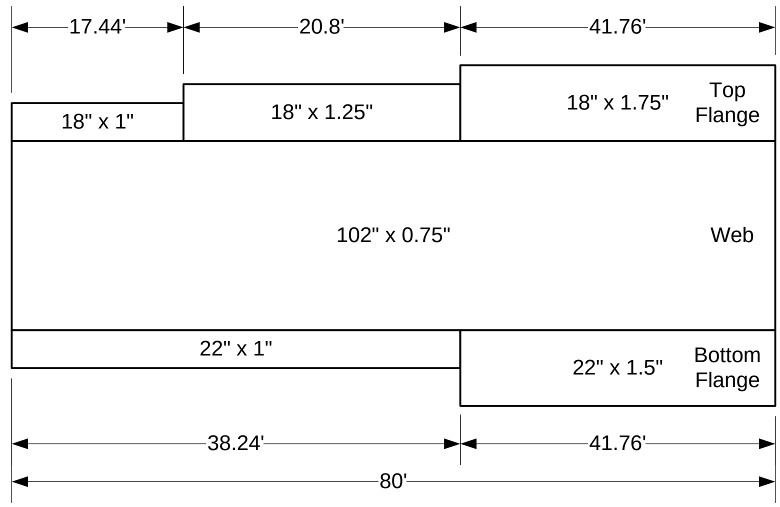
The "Weight/Mass Savings" program input is used to place a "penalty" on using too many flange size changes when designing a girder. This penalty can be thought of as taking the fabrication costs of a plate transition or girder splice into account during the design process.

The program chooses the girder with the smallest equivalent weight that passes all specification checks as the final design during the optimization process. The "Weight/Mass Savings" input value is multiplied by the number of flange size changes in a given design, then that value is added to the weight of the girder to calculate the equivalent weight of the girder. For example, consider the two girder elevations shown below (elevations are only shown to midspan since STLRFD designs only symmetrical girders):

Girder 1:



Girder 2:



Considering a "Weight/Mass Savings" entered as 0.0 lbs (effectively removing any penalty for transitions), the weight of the steel in each girder is calculated as follows:

Girder 1:

top flange volume = 22 in x 1.5 in x 80 ft = 15.28 ft^3

web volume = 102 in x 0.75 in x 80 ft = 40.8 ft^3

bottom flange volume = 22 in x 1 in x 38.24 ft + 22 in x 1.5 in x 41.76 ft = 15.54 ft^3

total girder volume = 71.49 ft^3

total girder weight = 71.49 ft^3 x 490 lb/ft^3 = 35030 lbs

Girder 2:

top flange volume = 18 inx1 inx17.44 ft + 18 inx1.25 inx20.8 ft + 18 inx1.75 inx41.76 ft

= 14.56 ft^3

web volume = 102 in x 0.75 in x 80' = 40.8 ft^3

bottom flange volume = 22 in x 1 in x 38.24 ft + 22 in x 1.5 in x 41.76 ft = 15.54 ft^3

total girder volume = 70.78 ft^3

total girder weight = 70.78 ft^3 x 490 lb/ft^3 = 34680 lbs

Based on these calculations, the program would choose Girder 2 as the more optimum girder (34680 lbs < 35030 lbs).

Now, considering a "Weight/Mass Savings" of 800 lbs, the total equivalent weights would change to:

Girder 1:

total girder weight = 35030 lbs

total transition weight = 1 transition (bottom flange) x 800 lbs = 800 lbs

total equivalent weight = 35830 lbs

Girder 2:

total girder weight = 34680 lbs

total transition weight = (2 top flange transitions + 1 bottom flange transition) x 800 lbs = 2400 lbs

total equivalent weight = 37080 lbs

Based on these calculations, girder 1 would be chosen as the more optimum girder.

This program input gives the user some ability to steer the girder optimization either towards or away from more girder transitions.

6.17.11 Haunch Depth

For a detailed input description of the haunch depth, refer to Section 6.16.7.

6.17.12 Deck Reinforcing Area

For a detailed input description of the deck reinforcing steel area, refer to Section 6.16.8.

6.17.13 Deck Reinforcing CG Distance

For a detailed input description of the deck reinforcing steel CG distance, refer to Section 6.16.9.

6.18 DP2 - DESIGN PLATE GIRDER (PART 2) COMMAND

6.18.11 Plate Thickness Table

This parameter allows the user to specify which plate thicknesses the program will consider in designing the plate girder. Tables 5.18-1 and 5.18-2 provide complete lists of plate thicknesses available for each option. Choosing option '2' reduces the number of available thicknesses approximately by half, resulting in a reduction in program run time. However by doing this, it is possible that the program will find a heavier girder than if option '1' is chosen since the program checks fewer sections.

6.18.12 Flange Width Increment

This parameter allows the user to specify the width increment the program will use in designing the plate girder. Choosing option '2' doubles the width increment. Therefore, for a flange width range of 12 inches to 16 inches, the program will only check 12, 14, and 16 inch widths, effectively reducing the number of widths tried by half. As with the flange thickness parameter, it is possible that by choosing option '2' the lightest possible girder will not be chosen.

To illustrate the potential for computation reduction, consider the following example from Section 3.6. The program is to design a girder for which the top flange width can vary from 12 inches to 16 inches, the bottom flange width from 14 inches to 20 inches, and the top and bottom flange thicknesses from 1 inch to 2 inches. These limits, along with choosing option '1' for parameters 11 and 12, give a possible 2,835 girder cross sections. Changing the flange thickness table option to '2' reduces the number of thicknesses to 5, reducing the total number of sections to 5x5x7x5=875. By changing the flange width increment option to '2', the number of sections changes to 3x9x4x9=972. Changing both the flange thickness table option and flange width increment option to '2' gives 3x5x4x5=300 possible cross sections.

For minimum flange widths that are entered as non-integer values, the intermediate flange widths are incremented from the minimum width as entered by the user and then rounded down to the next whole number. For example, if the minimum flange width is entered as 12.75" and maximum entered as 16.25" with an increment of 1", the program will try the following flange widths:

12.75" 13" 14" 15" 16" 16.25"

with an increment of 2", the program will try the following:

12.75" 14" 16" 16.25"

For a more complete explanation of non-integer flange widths and overall girder design methodology, refer to Section 3.6.

6.18.13 Longitudinal Stiffness Limit Check

When 'Y' is entered for this parameter, the program will perform a check of the longitudinal stiffness parameter, K_g, when designing a section. K_g is only used when computing the live load distribution factors and does not enter into any specification checks. Depending on the plate size restrictions and loading conditions, changing this parameter can have varying effects on the program run time. The user should review the output from runs that do not check K_g to ensure that the distribution factors and the live load effects computed from these distribution factors are computed as expected.

6.18.14 Span-To-Depth Ratio Check

This parameter indicates whether the program is to check the span-to-depth ratio as described in the LRFD Specifications Table 2.5.2.6.3-1. For simple span beams, the overall depth of the composite I-beam (beam depth + effective slab depth) must be greater than 0.040 * Span Length, while the depth of the steel section alone must be greater than 0.033 * Span Length. Any sections not meeting these depth criteria will be rejected when designing the beam. If the computed minimum depth is greater than the user entered maximum depth, the program stops with an error indicating that the user should change the maximum depth.

6.20 DTS - DESIGN TRANSVERSE STIFFENER COMMAND

6.20.5 Relative Cost Ratio

The relative cost ratio is intended to allow the user to enter a penalty for having transverse stiffeners on a girder. As stated in Section 3.6, the stiffener weight is multiplied by this ratio and then added to the girder weight to obtain a total girder weight. This relative cost ratio should include allowances for fabrication and installation of the stiffeners.

6.22 ARB - ANALYSIS ROLLED BEAM COMMAND

6.22.6 Rolled Beam Designation

The following beam designations are accepted by the program. Any rolled beams not on this list must be defined by the user via the User-defined Rolled Beam (URB) command.

W4x13						
W5x16	W5x19					
W6x8.5	W6x9	W6x12	W6x15	W6x16	W6x20	W6x25
W8x10	W8x13	W8x15	W8x18	W8x21	W8x24	W8x28
W8x31	W8x35	W8x40	W8x48	W8x58	W8x67	
W10x12	W10x15	W10x17	W10x19	W10x22	W10x26	W10x30
W10x33	W10x39	W10x45	W10x49	W10x54	W10x60	W10x68
W10x77	W10x88	W10x100	W10x112			
W12x14	W12x16	W12x19	W12x22	W12x26	W12x30	W12x35
W12x40	W12x45	W12x50	W12x53	W12x58	W12x65	W12x72
W12x79	W12x87	W12x96	W12x106	W12x120	W12x136	W12x152
W12x170	W12x190	W12x210	W12x230	W12x252	W12x279	W12x305
W12x336						
W14x22	W14x26	W14x30	W14x34	W14x38	W14x43	W14x48
W14x53	W14x61	W14x68	W14x74	W14x82	W14x90	W14x99
W14x109	W14x120	W14x132	W14x145	W14x159	W14x176	W14x193
W14x211	W14x233	W14x257	W14x283	W14x311	W14x342	W14x370
W14x398	W14x426	W14x455	W14x500	W14x550	W14x605	W14x665
W14x730						
W16x26	W16x31	W16x36	W16x40	W16x45	W16x50	W16x57
W16x67	W16x77	W16x89	W16x100			
W18x35	W18x40	W18x46	W18x50	W18x55	W18x60	W18x65
W18x71	W18x76	W18x86	W18x97	W18x106	W18x119	W18x130
W18x143	W18x158	W18x175	W18x192	W18x211	W18x234	W18x258

W18x283	W18x311					
W21x44	W21x48	W21x50	W21x55	W21x57	W21x62	W21x68
W21x73	W21x83	W21x93	W21x101	W21x111	W21x122	W21x132
W21x147	W21x166	W21x182	W21x201			
W24x55	W24x62	W24x68	W24x76	W24x84	W24x94	W24x103
W24x104	W24x117	W24x131	W24x146	W24x162	W24x176	W24x192
W24x207	W24x229	W24x250	W24x279	W24x306	W24x335	W24x370
W27x84	W27x94	W27x102	W27x114	W27x129	W27x146	W27x161
W27x178	W27x194	W27x217	W27x235	W27x258	W27x281	W27x307
W27x336	W27x368	W27x539				
W30x90	W30x99	W30x108	W30x116	W30x124	W30x132	W30x148
W30x173	W30x191	W30x211	W30x235	W30x261	W30x292	W30x326
W30x357	W30x391					
W33x118	W33x130	W33x141	W33x152	W33x169	W33x201	W33x221
W33x241	W33x263	W33x291	W33x318	W33x354	W33x387	
W36x135	W36x150	W36x160	W36x170	W36x182	W36x194	W36x210
W36x231	W36x232	W36x247	W36x256	W36x262	W36x282	W36x302
W36x330	W36x361	W36x395	W36x441	W36x487	W36x529	W36x652
W40x149	W40x167	W40x183	W40x199	W40x211	W40x215	W40x235
W40x249	W40x264	W40x277	W40x278	W40x294	W40x297	W40x324
W40x327	W40x331	W40x362	W40x372	W40x392	W40x397	W40x431
W40x503	W40x593					
W44x230	W44x262	W44x290	W44x335			

6.22.11 Haunch Depth

A haunch detail for an analysis run is presented in Figure 1. The haunch thickness is input by the user and is measured from the bottom of the top flange (top of web) for all section types. The haunch width is assumed to be equal to the top flange width. Please refer to DM-4 Articles 5.6.1 and C5.6.1 for guidance regarding haunch depth input for both new and existing beams.

For an analysis problem, the haunch depth is used to compute the section properties and dead load due to the haunch. In computing the section properties for an analysis run, the program uses the haunch depth to determine the separation distance between the concrete deck and steel girder. However, the program does not include the area of the haunch when computing the section properties. In other words, for an analysis run, the section properties are computed based on the inputted haunch depth but on a haunch width of zero.

The area of the top flange and cover plate is conservatively included as an equivalent area of concrete when calculating the dead load due to the haunch. Therefore, the area of the top flange and cover plate is conservatively considered twice, both in the steel dead load (self-weight of the girder) and the concrete dead load (weight of the haunch). However, the user can enter a negative dead load (DC1) to eliminate the dead load effect of this extra area of concrete haunch, if desired.

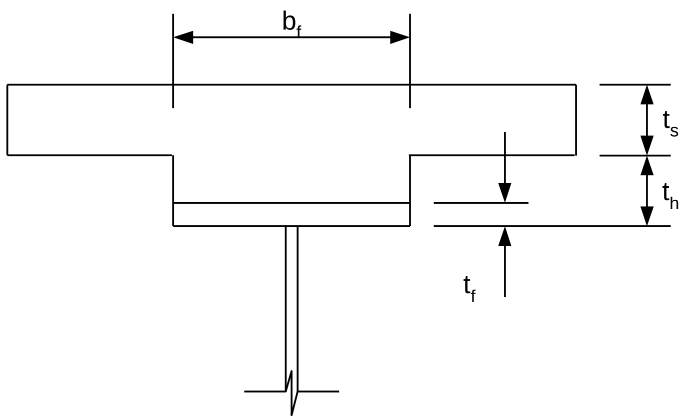


Figure 6.22-1 Haunch Detail for an Analysis Run

6.22.12 Deck Reinforcing Area

For a detailed input description of the deck reinforcing steel area, refer to Section 6.16.8.

6.22.13 Deck Reinf. CG Distance

For a detailed input description of the deck reinforcing steel CG distance, refer to Section 6.16.9.

6.23 ABU - ANALYSIS BUILT-UP COMMAND

6.23.9 Web Depth Variation

Web depth details are presented in Figure 1. Within a defined range, the web depth can either be constant with no variation, it can vary parabolically, or it can vary linearly.

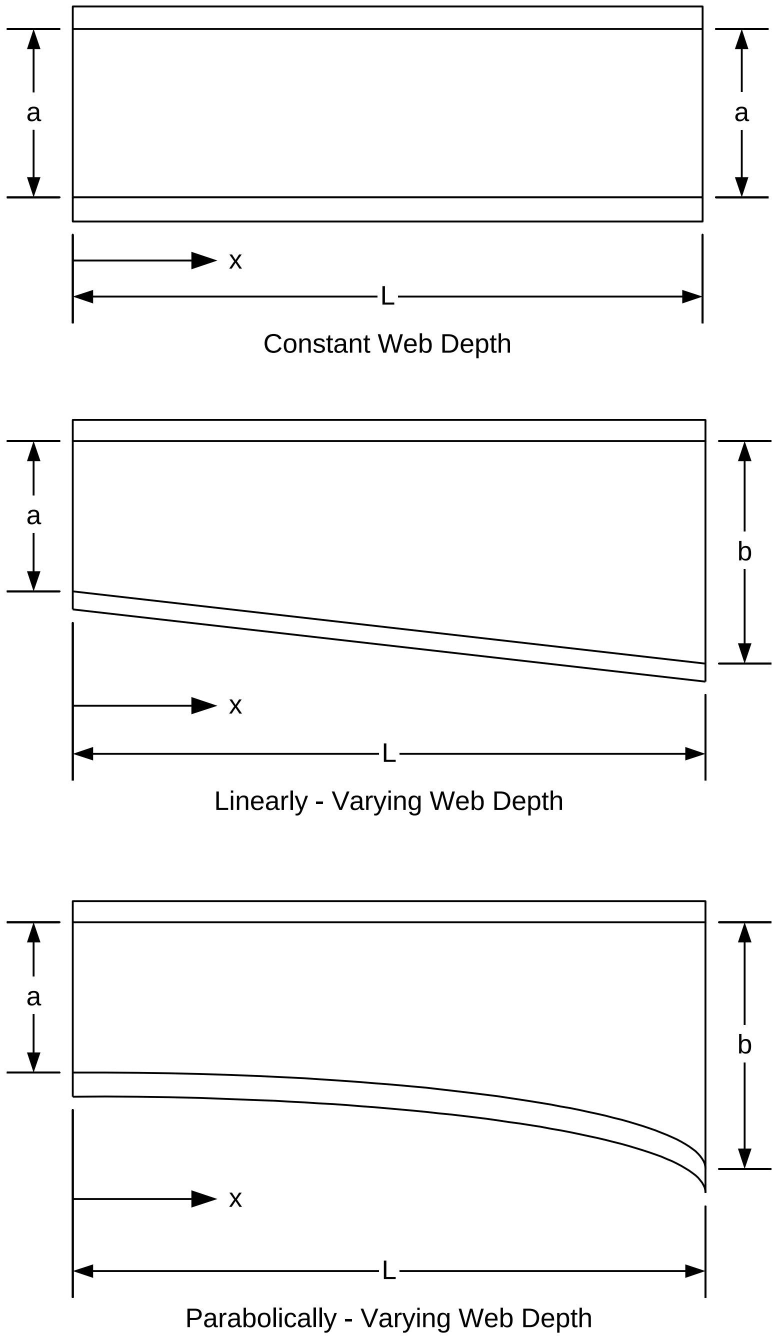


Figure 6.23-1 Web Depth Details

6.23.10 Web Depth

Web depth details are presented in Figure 1. For a constant web depth, the web depth is computed using the following equation:

$$Web\ Depth = a$$

For a linearly-varying web depth, the web depth is computed using the following equation:

$$Web\ Depth = a + \left(\frac{x}{L}\right)(b - a)$$

For a parabolically-varying web depth, the web depth is computed using the following equation:

$$Web\ Depth = a + \left(\frac{x}{L}\right)^2 (b - a)$$

If the web depth varies, the user should enter the depth of the web at the right end of the range being defined. The program will then compute the web depth at each computer-generated and user-defined analysis point (as specified in Section 3.2) based on the defined web depth variation and based on the web depths at each end of the range being defined. If the beam begins with a varying web depth, a small range (1 inch) of constant depth must first be defined, then the following range can vary in depth.

If the web depth varies, the program computes the gross moment of inertia and the beam self-weight at each computer-generated and user-defined analysis point (as specified in Section 3.2) based on the computed web depths at those points. For analysis, the program uses ranges with end points defined by each computer-generated and user-defined analysis point. The program sets the stiffness for each range equal to the average of the gross moments of inertia at each end of the range. The program sets the beam self-weight for each range equal to the average of the beam self-weights at each end of the range. For specification checking, the program uses the net section properties at each analysis point.

If the flange dimensions vary over the area where the web depth varies, the user must define separate ranges for each flange dimension variation. However, the user only need define the web depth for the range where the depth variation ends. For all other ranges contained inside the web depth variation, the depth should be left blank; the program will calculate the web depth at all relevant points. The user can also define consecutive ranges of increasing or decreasing depth if there happens to be a "kink" in the depth. The program will automatically calculate the web depth for any ranges for which web depth is not entered by the user.

Example:

Consider the linearly-varying example in Figure 2:

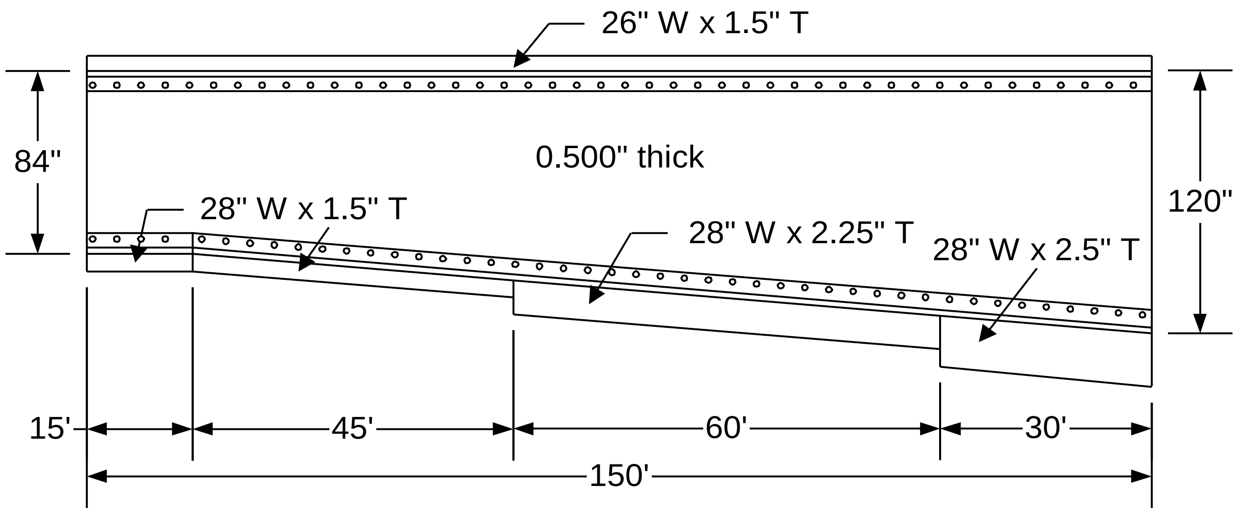


Figure 6.23-2 Linearly Varying Web Depth Example

This piece of the girder would be entered as:

```
ABU 1,   0., 1,  15., 1, 8.0, 8.0, 1.0, C,  84., 0.5, 26., 1.5, 28., 1.50, 1.5, 0.75, 4.25
ABU 1,  15., 1,  60., 1, 8.0, 8.0, 1.0, S,     , 0.5, 26., 1.5, 28., 1.50, 1.5, 0.75, 4.25
ABU 1,  60., 1, 120., 1, 8.0, 8.0, 1.0, S,     , 0.5, 26., 1.5, 28., 2.25, 1.5, 0.75, 4.25
ABU 1, 120., 1, 150., 1, 8.0, 8.0, 1.0, S, 120., 0.5, 26., 1.5, 28., 2.50, 1.5, 0.75, 4.25
```

As shown, in the linearly varying portion of the girder, the web depth is only entered for the rightmost range. However, only for linearly-varying web depths the user can enter web depths for all the ranges including the ones that are left blank as shown in the above example. The program will internally calculate the web depths for the intermediate points between 15’ and 150’. A parabolically-varying built-up section and linearly or parabolically-varying plate girder would be entered the same way.

Note that if the user enters an intermediate depth for a parabolically varying range, two different parabolically varying ranges will be defined - the program will not attempt to fit a single parabola through the depth entered by the user. See Figure 3 for an example of how the program models consecutive parabolic ranges of increasing depth versus a single parabolically varying range.

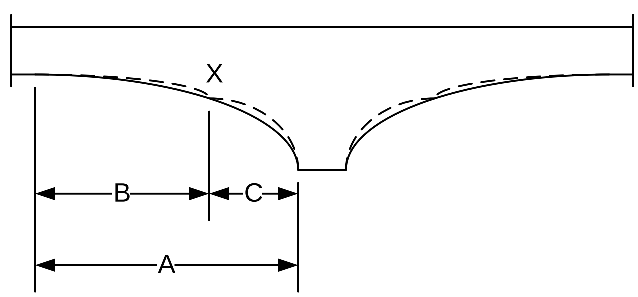


Figure 6.23-3 Parabolically Varying Web Depth Example

In the example above, region A is defined as two ABU ranges, with no web depth defined at point X:

```
ABU 1,  0.,1,115.,1,8.0,8.0,1.0,C,  84., 0.5, 26., 1.5, 28., 1.50, 1.5, 0.75, 4.25
ABU 1,115.,1,152.,1,8.0,8.0,1.0,P,     , 0.5, 26., 1.5, 28., 1.50, 1.5, 0.75, 4.25
ABU 1,152.,1,190.,1,8.0,8.0,1.0,p, 150., 0.5, 26., 1.5, 28., 2.25, 1.5, 0.75, 4.25
```

The web depth in this case is shown by the solid line.

If the user defines a specific depth at point X, there will be two different regions B and C, each defining a different parabola, as shown by the dotted lines in Figure 3:

```
ABU 1,  0.,1,115.,1,8.0,8.0,1.0,C, 84.,    0.5, 26., 1.5, 28., 1.50, 1.5, 0.75, 4.25
ABU 1,115.,1,152.,1,8.0,8.0,1.0,P,100.063, 0.5, 26., 1.5, 28., 1.50, 1.5, 0.75, 4.25
ABU 1,152.,1,190.,1,8.0,8.0,1.0,p,150.,    0.5, 26., 1.5, 28., 2.25, 1.5, 0.75, 4.25
```

6.23.16 Haunch Depth

For a detailed input description of the haunch depth, refer to Section 6.22.11.

6.23.17 Deck Reinforcing Area

For a detailed input description of the deck reinforcing steel area, refer to Section 6.16.8.

6.23.18 Deck Reinf. CG Distance

For a detailed input description of the deck reinforcing steel CG distance, refer to Section 6.16.9.

6.24 APL - ANALYSIS PLATE COMMAND

6.24.6 Web Depth Variation

For a detailed input description of the web depth variation, refer to Section 6.23.9.

6.24.7 Web Depth

For a detailed input description of the web depth, refer to Section 6.23.10.

6.24.13 Haunch Depth

For a detailed input description of the haunch depth, refer to Section 6.23.11.

6.25 SHO - SECTION HOLE COMMAND

This command allows the user to specify the presence of rivet or bolt holes in the beam. This command is only used for checking the section for Net Section Fracture. It does not affect the gross section properties. Therefore, this command does not affect the girder self-weight computations or the stiffness used in the analysis.

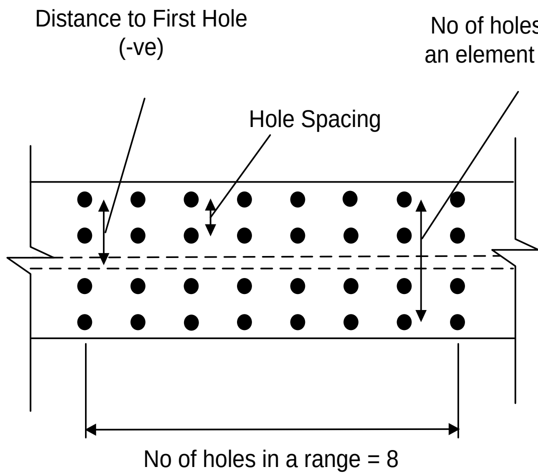


Figure 6.25-1 Top Flange Plan

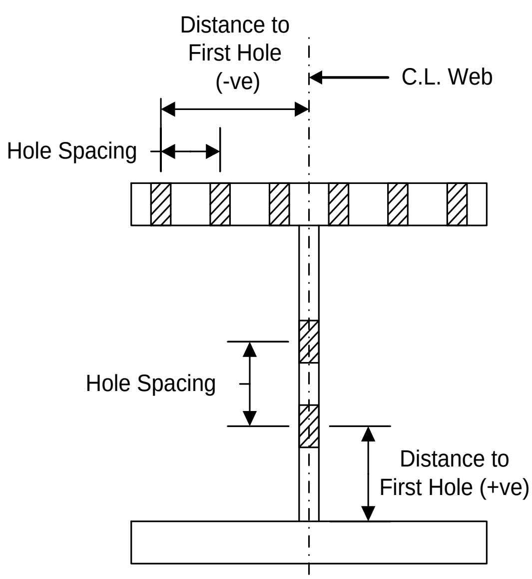


Figure 6.25-2 Cross Section

Distance to the first hole, parameter 6 on SHO command, is always measured from the centerline of the web. If the first hole lies to the right side of the centerline of the web then the parameter 6 takes a positive value. If the first hole lies to the left side of the centerline of the web then the parameter 6 takes a negative value.

Number of holes, parameter 8 on the SHO command always corresponds to number of holes at any given section of the girder element and not along the defined range.

Hole spacing, parameter 9 on SHO command is the distance between the holes measured across any given section for the given girder element.

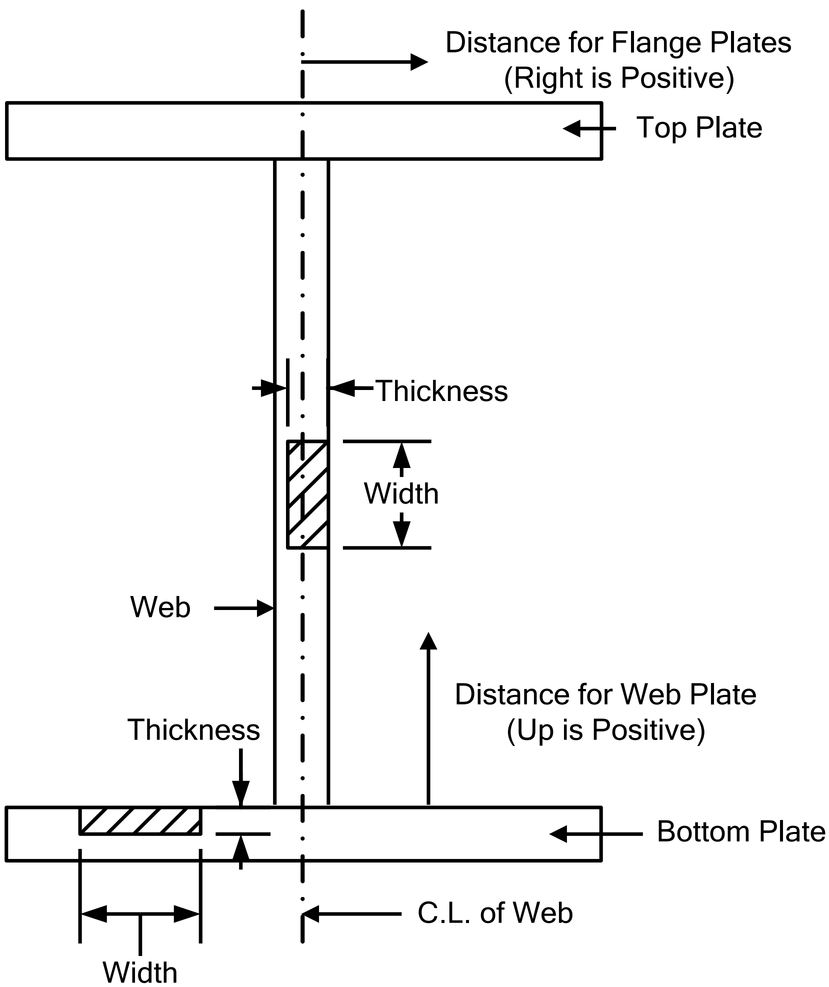
The effect of a section hole in a steel section is only considered for the Net Section Fracture checks for a section hole located within the tension flange, as per the LRFD Specifications.

6.26 SLS - SECTION LOSS COMMAND

The program uses the data on this command to compute the net section properties, which are used in specification checking and rating computations. The data on this command does not affect the girder self-weight or the gross section properties, which are used in the analysis computations.

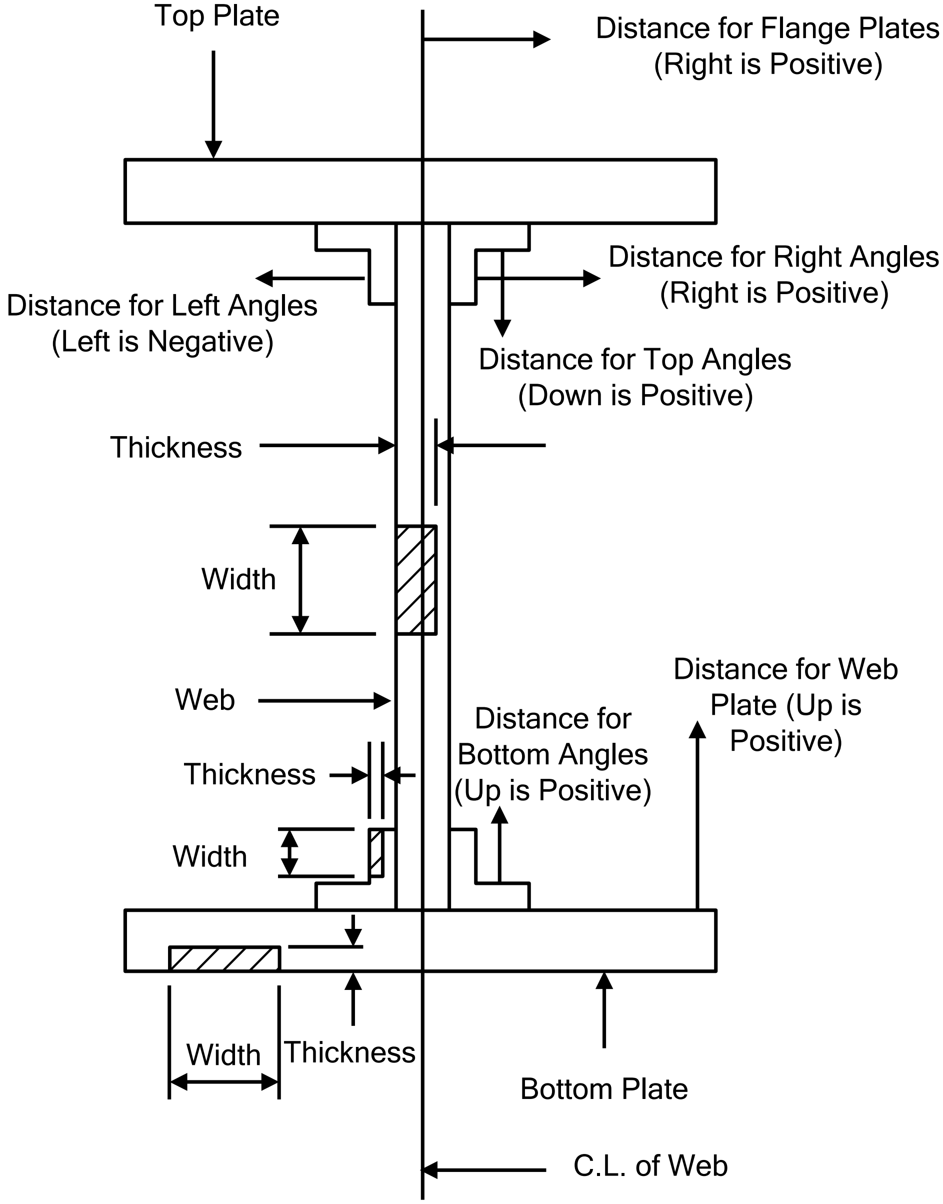
6.26.5 Section Loss Element

Schematic drawings of the section loss elements for a plate girder, built-up section, and rolled beam are presented in Figures 1 through 3, respectively.



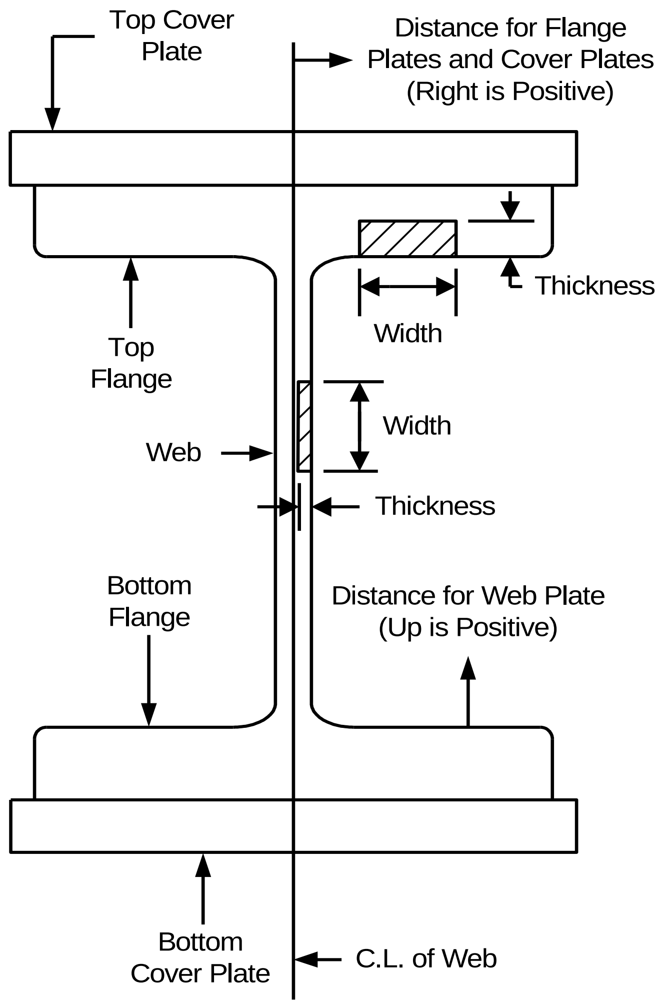
Note: Distances are measured from the origin to the center of the width of the section loss.

Figure 6.26-1 Section Loss for a Plate Girder



Note: Distances are measured from the origin to the center of the width of the section loss.

Figure 6.26-2   Section Loss for a Built-up Section



Note: Distances are measured from the origin to the center of the width of the section loss.

Figure 6.26-3 Section Loss for a Rolled Beam

6.26.7 Distance

The distance, as described in Section 5.26, is illustrated in Figures 1 through 3. The distance is measured to the center of the section loss. For top and bottom plates, the distance is measured from the centerline of the web, with right being positive. For web plates, the distance is measured from the bottom of the web, with upward being positive. For angles, the distance is measured from the inside corner of the angle, with right and upward being positive.

6.26.8 Width

The width, as described in Section 5.26, is illustrated in Figures 1 through 3. The width is measured parallel to the long dimension of the plate on which it is located. For example, for the top or bottom flange plate, the width is the horizontal dimension of the section loss. For the web plate, the width is the vertical dimension of the section loss. For the vertical leg of an angle, the width is the vertical dimension of the section loss. For the horizontal leg of an angle, the width is the horizontal dimension of the section loss.

6.26.9 Thickness

The thickness, as described in Section 5.26, is illustrated in Figures 1 through 3. The thickness is always the dimension of the section loss measured normal to the width, which is described in Section 6.26.8.

6.27 SLB - SLAB COMMAND

6.27.2 Effective Slab Thickness

The effective slab thickness is illustrated in Figure 1. If the effective slab is not input, the program computes the effective slab thickness based on the following equation:

$$t_{s,eff} = t_s - 0.5\ inches$$

where $t_{s,eff}$ is the effective slab thickness, t_s is the actual slab thickness, and 0.5 inches is the assumed integral wearing surface thickness.

The program uses the actual slab thickness in all dead load calculations. The program uses the effective slab thickness in all section property calculations.

Since integral wearing surfaces and overlays are included in the dead load calculations but generally are not included in the section property calculations, the user should subtract the thickness of integral wearing surfaces and overlays when computing the effective slab thickness.

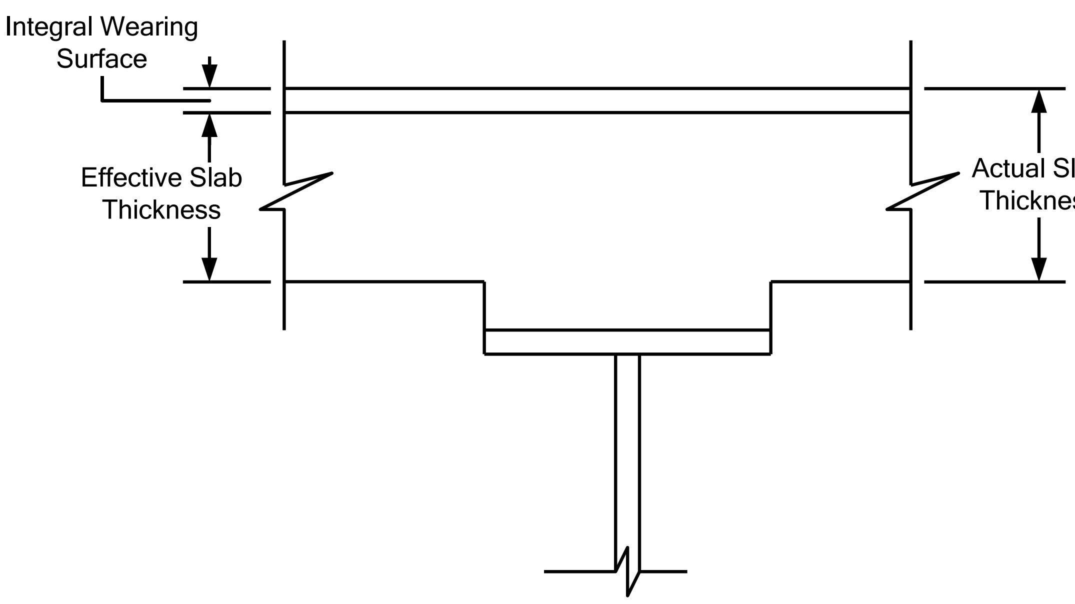


Figure 6.27-1 Effective Slab Thickness

6.27.9 Development Length Factor for Slabs

The development length factor for slabs applies to mild steel reinforcement located in the slab (both top and bottom). It is defined as the product of the modification factors which increase ℓ_d (as specified in LRFD Article 5.10.8.2.1b) and the modification factors which decrease ℓ_d (as specified in LRFD Article 5.10.8.2.1c) divided by the concrete density modification factor (as specified in LRFD Article 5.4.2.8). The development length factor for slabs is given by the following equation:

$$\text{Total Modification Factor} = \frac{\lambda_{rl} \times \lambda_{cf} \times \lambda_{rc} \times \lambda_{er}}{\lambda}$$

where: λ_{rl} = reinforcement location factor. 1.0 for slab bars.

λ_{cf} = coating factor. 1.0 for non-epoxy-coated bars, 1.5 for epoxy-coated bars with less than $3d_b$ cover or with clear spacing less than $6d_b$, 1.2 for other epoxy-coated bars. Note: the product $\lambda_{rl} \times \lambda_{cf}$ is limited to 1.7.

λ_{rc} = reinforcement confinement factor (see sample calculation below)

$0.4 \leq \lambda_{rc} \leq 1.0$

In which:

$\lambda_{rc} = \frac{d_b}{c_b + k_{tr}}$

c_b = distance from center of bar to nearest concrete surface

$k_{tr} = 40\,A_{tr}/(sn)$

k_{tr} = transverse reinforcement index

A_{tr} = total area of transverse reinforcement crossing splitting plane

s = maximum center-to-center spacing of transverse reinforcement

n = number of bars developed along plane of splitting

λ_{er} = excess reinforcement factor. This value can conservatively be taken as 1.0. The engineer can evaluate if a value less than 1.0 is appropriate. (see LRFD Specifications Article 5.10.8.2.1c)

λ = concrete density modification factor. 1.0 for normal weight concrete.

Sample calculation for λ_{rc}:

In negative moment regions the bottom longitudinal bars are located above the transverse bottom bars. The bottom transverse bar has a minimum cover of 1”. The spacing of the transverse bar varies from a maximum of 9.5” to a minimum of 5.5”. Generally, the transverse bar is a #5 bar and the longitudinal bar is a #5 bar. The plane of splitting is a vertical line from the bar to the surface of the bottom of the slab.

c_b = 1" (cover) + 5/8" (#5 transverse) + 5/8" / 2 (diameter #5 long. Bar / 2) = 1.9375"

A_{tr} = 0.31 in^2 (area of #5 transverse)

s = 9.5" (maximum transverse spacing)

n = 1

$k_{tr} = 40 \times 0.31/(9.5 \times 1) = 1.305"$

$\lambda_{rc} = \frac{0.625}{1.9375+1.305} = 0.193$ Use minimum of 0.4

The Total Modification Factor is applied directly to the basic development length, as specified in LRFD Article 5.10.8.2.1a.

6.28 SST - SLAB REINFORCEMENT LOCATION COMMAND

6.28.3 Left Cutoff Point

The left cutoff point is used to calculate the limits of the slab reinforcement. As shown in Figure 6.28-1, the left cutoff point is measured from the centerline of the pier to the physical end of the bar on the left side of the pier. Similarly, as shown in Figure 6.28-1, the development length (ℓ_d) is calculated by the program and is measured from the end of the bar towards the centerline of the pier. Therefore, the left cutoff point is required to define the location of the left end of the development length for negative bending reinforcement in the slab.

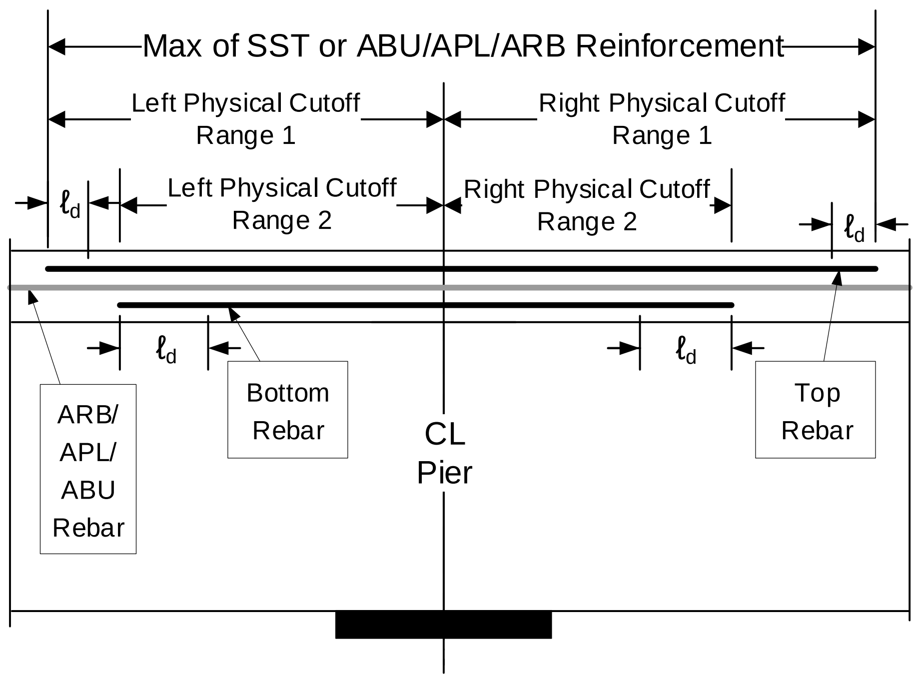


Figure 6.28-1 Definition of Left and Right Cutoff Points

6.28.4 Right Cutoff Point

The right cutoff point is used to calculate the limits of the slab reinforcement. As shown in Figure 6.28-1, the right cutoff point is measured from the centerline of the pier to the physical end of the bar on the right side of the pier. Similarly, as shown in Figure 6.28-1, the development length (ℓ_d) is calculated by the program and is measured from the end of the bar towards the centerline of the pier. Therefore, the right cutoff point is required to define the location of the end of the development length for negative bending reinforcement in the slab.

6.28.6 Location in Slab

The location of the reinforcement is considered when checking distribution requirements. At least one range of reinforcement at each interior support must be located in the top of the slab.

6.32 PLD - PEDESTRIAN LIVE LOAD COMMAND

The parameters entered on this command are used in the computations for limit state Strength IP only. They do not affect any other limit state in any way.

The program can analyze or design a cross section with a sidewalk on the left side, a sidewalk on the right side, or a sidewalk on both sides.

All values on this command are entered in units of kip/ft in the longitudinal direction. If two sidewalks are present, all values on this command should include the effects of the loads from both sidewalks.

6.32.1 Total Pedestrian Live Load

This parameter is entered in units of kip/ft acting on all girders in the structure cross section. Therefore, the user must convert the total load from ksf to kip/ft.

If two sidewalks are present, this parameter should include the effects of the loads from both sidewalks. The only difference between this parameter and parameter 2 is that this parameter is the total load acting on all girders and parameter 2 is the load acting only on the girder being investigated.

The program uses this parameter to compute the live load deflections and rotations for pedestrian live load, which is distributed equally to all girders, as described in Section 3.7.5. The program does not use this parameter for any other computations. All other pedestrian live load computations are based on the value entered in parameter 2.

6.32.2 Pedestrian Live Load

This parameter is entered in units of kip/ft acting on the girder. Therefore, the user must convert the load from ksf to kip/ft. In addition, the user must compute the portion of the total kip/ft that is carried by the girder being analyzed in accordance with the LRFD Specifications and DM-4 Article 3.5.1.1P and Article 3.6.1.6.

The only difference between this parameter and parameter 1 is that this parameter is the load acting only on the girder being investigated and parameter 1 is the total load acting on all girders.

The program uses this parameter for all pedestrian live load computations except the live load deflections and rotations for pedestrian live load, which is based on the value entered in parameter 1.

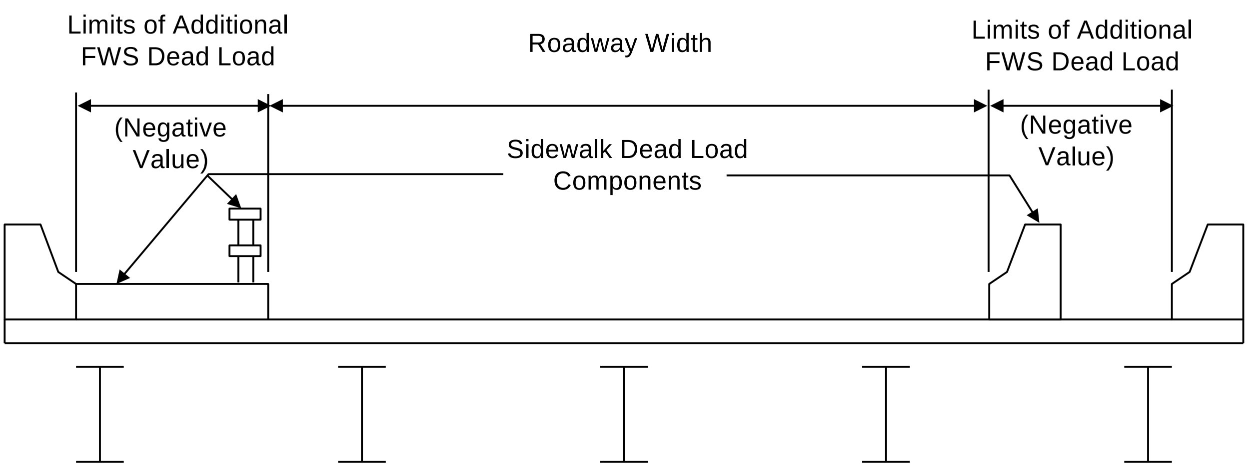
The program factors this value using the γ_{PL} load factors, as presented in Table 3.5-2.

6.32.3 Sidewalk Dead Load

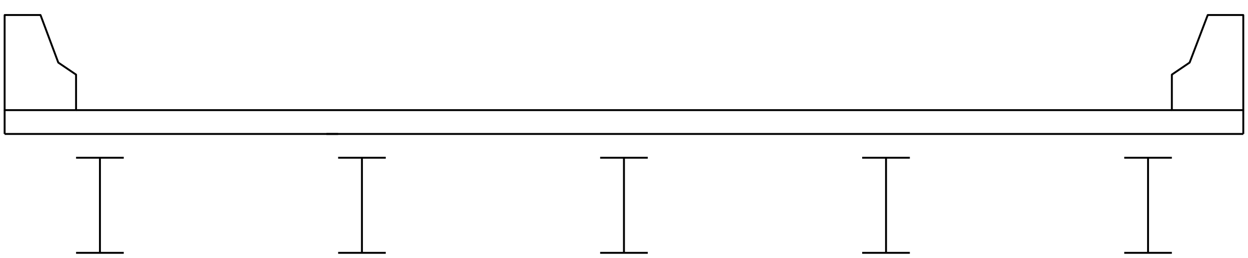
The sidewalk dead load is defined as all the DC2 dead load present when the sidewalks are present and not present when the sidewalks are not present. Therefore, the value for this parameter must include parapets or railings if they are present when the sidewalk is present and are not present when the sidewalk is not present. For the cross section illustrated in Figure 1, the sidewalk dead load includes the sidewalk and railing on the left side and the additional parapet on the right side.

This parameter is entered in units of kip/ft acting on the girder. Therefore, the user must convert the load from ksf to kip/ft . In addition, the user must compute the portion of the total kip/ft that is carried by the girder being analyzed in accordance with the LRFD Specifications and DM-4 Article 3.5.1.1P and Article 3.6.1.6.

The program factors this value using the γ_{DC} load factors, as presented in Table 3.5-2.



Bridge Cross Section with Sidewalks



Bridge Cross Section without Sidewalks

Figure 6.32-1 Sidewalk Loads

6.32.4 Additional Future Wearing Surface Dead Load

The additional future wearing surface dead load is defined as the future wearing surface dead load present when the sidewalks are present and not present when the sidewalks are not present. Since the total future wearing surface dead load usually decreases when the sidewalks are present, a negative value will usually be entered. For the cross section illustrated in Figure 1, a negative value should be entered for the additional future wearing surface dead load.

This parameter is entered in units of kip/ft acting on the girder. Therefore, the user must convert the load from ksf to kip/ft. In addition, the user must compute the portion of the total kip/ft that is carried by the girder being analyzed in accordance with the LRFD Specification and DM-4 Article 3.5.1.1P and Article 3.6.1.6.

The program factors this value using the γ_{FWS} load factors, as presented in Table 3.5-2.

6.35 DLD - DISTRIBUTED LOAD COMMAND

6.35.6 Start Magnitude

The distribution of parapet loads should be in accordance with Article D3.5.1.1P, "Application of Dead Load on Girder and Box Beam Structures".

6.35.7 End Magnitude

For information about the distribution of parapet loads, refer to Section 6.35.6.

6.36 WPD - WIND PROGRAM DEFINED

Wind load computations and applications, as used in this program, are described in LRFD Specifications Articles 3.8, 4.6.2.7, and 6.10.1.6 as well as DM-4 Articles 3.4.2.1 and 3.8.

Wind loads affect limit states Strength III, Strength V and Construction / Uncured Slab II only.

The wind load effects are computed in terms of stress using LRFD Specifications Article 6.10.1.6 and are added to the factored flexural stress to achieve a total applied stress. For situations where the flexural resistance is computed in terms of moment, the lateral stress due to wind is converted as described in Section 3.7.7. The total applied stress or moment is then used when checking the flexural resistance where appropriate.

For the Strength III and Strength V limit states, the wind load effects are applied to the bottom flange in terms of stress or moment as described in Section 3.7.7.1. The deck is assumed to provide diaphragm action against wind loads for the top flange.

For the construction and uncured slab conditions, the wind load effects are applied to the top and bottom flanges in terms of stress, as described in Section 3.7.7.2.

Based on the LRFD Specifications, wind load is required for an exterior girder only. However, the program will apply the wind load to an interior girder, as well, if the WPD or WUD commands are entered by the user.

6.36.1 Additional Wind Cross Section

The program uses the additional wind cross section to compute the wind load. Since the program automatically computes the wind load due to the wind pressure acting on the girder, haunch, and slab, these should not be included in the additional wind cross section. The additional wind cross section should include the vertical dimension of items such as parapets, sidewalks, and railings. The additional wind cross section is illustrated in a drawing in Section 5.36. The additional wind cross section is only used in computing the wind effects for the permanent state. It is not used for the construction or uncured slab specification checks.

6.36.2 Construction Load Path

Load path is used to determine which equation is to be used in computing the wind moment to be applied to the girder. This procedure, and the corresponding equations, are presented in LRFD Specifications Article C4.6.2.7.1. This input is used for construction and uncured slab specification checks only.

6.36.4 Permanent Load Path

For a detailed input description of the load path, refer to Section 6.36.2. This input is used for limit states Strength-III and Strength-V only.

6.36.5 Structure Height

As described in LRFD Specifications and DM-4 Article 3.8.1.2.1, structure height is the average height of the top of the superstructure above the surrounding ground or water surface.

For the construction and uncured slab specification checks, the wind pressure as entered by the user is used directly.

6.37 WUD - WIND USER DEFINED

For a detailed description of the application and use of the wind input, see Section 6.36.

6.37.1 Additional Wind Cross Section

For a detailed input description of the additional wind cross section, refer to Section 6.36.1.

6.37.2 Construction Load Path

For a detailed input description of the load path, refer to Section 6.36.2. This input is used for the construction and uncured slab specification checks only.

6.37.4 Permanent Load Path

For a detailed input description of the load path, refer to Section 6.36.2. This input is used for limit states Strength-III and Strength-V only.

6.41 FTL - FATIGUE LIFE

The fatigue life is computed only for fatigue locations specified in the FTG command.

The fatigue life of a girder is calculated by evaluating each fatigue prone detail specified by the user. The program calculates the design fatigue stress range and the fatigue resistance at each detail. The design fatigue stress range at a detail is calculated as follows. The maximum positive moment and the maximum negative moment at a detail are calculated by parabolic interpolation of the tenth point moments calculated earlier. The live load plus impact moment calculated for fatigue life analysis is based on AASHTO Simplified Method by placing a single fatigue vehicle in one lane. The stresses at a detail due to the dead load plus positive live load moment and due to the dead load plus negative live load moment are then calculated using appropriate section moduli. The algebraic difference of the maximum stress and the minimum stress is the design fatigue stress range.

A significant assumption made in the LRFD Specifications is that the maximum fatigue stress range that a fatigue detail will undergo is twice the factored fatigue stress range. If a fatigue detail never experiences a tensile stress (that is, if the detail always remains in compression under dead load and twice the factored fatigue live load plus impact), then the fatigue detail will have infinite life. In addition, if the factored fatigue stress range is less than one half of the constant amplitude fatigue threshold, ΔF_{TH}, the detail is said to have infinite life.

If the detail cannot be shown to have infinite life, the effective fatigue stress range and the fatigue resistance are calculated. The effective stress range is determined based on the fatigue vehicle occupying a single lane, factored by the fatigue load factor, γ. For a detail with finite life, the fatigue resistance is a function of the detail category constant, A, and the number of design cycles the fatigue detail is expected to undergo. Knowing the effective stress range and the expected $(ADTT)_{SL}$, the program can back-calculate an estimated remaining fatigue life in years. If the number of accumulated cycles exceeds the calculated fatigue life, the remaining fatigue life is set to zero cycles and zero years.

If the user wants to consider a growth factor in the average daily truck traffic, the program uses the following engineering economy equations to calculate the accumulated cycles and the remaining life in years.

If the $(ADTT)_{SL}$'s are known for two calendar years (previous count year, n_1, and recent count year, n_2), the program calculates the past growth factor, GF_1, by:

$$GF_1 = \left(\frac{(ADTT)_{SL,n_2}}{(ADTT)_{SL,n_1}}\right)^{\frac{1}{n_2-n_1}} - 1$$

where: GF_1 = Past growth factor

$(ADTT)_{SL,n2}$ = Average daily truck traffic, single lane, in the recent count year

$(ADTT)_{SL,n1}$ = Average daily truck traffic, single lane, in the previous count year

n_2 = recent count year

n_1 = previous count year

The above equation is not used if GF_1 is known (or estimated) and is entered. This growth factor, GF_1, is then used to approximate the $(ADTT)_{SL}$ for the year the structure was built as follows:

$$(ADTT)_{SL,Year\ Built} = \frac{(ADTT)_{SL,n_2}}{(1+GF_1)^n}$$

where: $(ADTT)_{SL,Year\ Built}$ = Average daily truck traffic, single lane, in the year that the bridge was built
$(ADTT)_{SL,n2}$ = Average daily truck traffic, single lane, in the recent count year
GF_1 = Past growth factor
n = n_2 - year built

The number of cycles accumulated up to the year n_2 is then computed by:

$$M = 365 * (ADTT)_{SL,Year\ Built} * \frac{(1+GF_1)^n - 1}{GF_1}$$

where: $(ADTT)_{SL,Year\ Built}$ = Average daily truck traffic, single lane, in the year that the bridge was built
GF_1 = Past growth factor
n = n_2 - year built

If the estimated $(ADTT)_{SL}$ for a future count year, n_3, is entered, the future growth factor, FG_2, is calculated by:

$$GF_2 = \left(\frac{(ADTT)_{SL,n_3}}{(ADTT)_{SL,n_2}}\right)^{\frac{1}{n_3-n_2}} - 1$$

where: GF_2 = Future growth factor
$(ADTT)_{SL,n3}$ = Average daily truck traffic, single lane, in the future count year
$(ADTT)_{SL,n2}$ = Average daily truck traffic, single lane, in the recent count year
n_3 = future count year
n_2 = recent count year

The above equation is not used if GF_2 if known (or estimated) and is entered.

The remaining life (years) is then calculated using the following, which is derived from the engineering economy equation for compound amount:

$$R = \frac{ln\left(\frac{\Delta GF_2}{\lambda} + 1\right)}{ln(GF_2 + 1)}$$

where: R = remaining years

Δ = remaining cycles

= design fatigue life - accumulated cycles

= N - M

GF_2 = future growth factor

λ = n (365) $(ADTT)_{SL,n2}$ (1 + GF_2)

n = number of cycles per vehicle passage, LRFD Specifications Table 6.6.1.2.5-2

ln = natural log

The future growth factor can be estimated and entered or can be calculated by the program if the estimated $(ADTT)_{SL}$ for the future is entered.

6.42 FGV - FATIGUE GROSS VEHICLE COMMAND

This command is used if the loadometer surveys of the gross vehicle weight distribution on the bridge are available and if the gamma (γ) factor for fatigue in the effective stress range equation is to be calculated by the program.

If the user does not enter the FGV command, then the program uses the Fatigue-II live load factor as the gamma (γ) factor.

If the FGV command is entered by the user, then the program computes the gamma factor using the parameters of the FGV command, following the procedure described in DM-4 PP 5.1.1.1.2b. The FGV command can be entered up to ten times, for different gross weight ranges each time.

Table 6.42-1 Gross Vehicle Weight Distribution by Truck Type

Gross Vehicle Weight Range		2 axle		. . .	5 axle combination	
(kips)	(kips)	(number)	(no units; ratio)		(number)	(no units; ratio)
min(i)	max(i)	$n(i,1)$	$v(i,1) = \frac{n(i,1)}{sum(1)}$		$n(i,6)$	$v(i,6) = \frac{n(i,6)}{sum(6)}$
. . .						
min(10)	max(10)	$n(10{,}1)$	$v(10{,}1) = \frac{n(10{,}1)}{sum(1)}$		$n(10{,}6)$	$v(10{,}6) = \frac{n(10{,}6)}{sum(6)}$
Sum		$sum(1) = \sum_{i=1}^{10} n(i,1)$	$\sum_{i=1}^{10} v(i,1) = 1.0$		$sum(6) = \sum_{i=1}^{10} n(i,6)$	$\sum_{i=1}^{10} v(i,6) = 1.0$
Percentage of each truck type		$percent(1) = \frac{sum(1)}{\sum_{j=1}^{6} sum(j)}$			$percent(6) = \frac{sum(6)}{\sum_{j=1}^{6} sum(j)}$	

Table 6.42-2 Cumulative Damage Factor by Truck Type

Gross Vehicle Weight Range		φ_i	2 axle	. . .	5 axle combination
(kips)	(kips)	(no units; ratio)	(no units; % * ratio)		(no units; % * ratio)
min(i)	max(i)	$\varphi_i = \frac{\frac{(Min(i) + Max(i))}{2}}{GVW_O}$	$v(i,1) * \varphi_i^3$		$v(i,6) * \varphi_i^3$
. . .					
min(10)	max(10)	$\varphi_{10} = \frac{\frac{(Min(10) + Max(10))}{2}}{GVW_O}$	$v(10{,}1) * \varphi_i^3$		$v(10{,}6) * \varphi_i^3$
Cumulative Damage Factor for each truck type			$CDF(1) = \sum_{i=1}^{10} (v(i,1) * \varphi_i^3)$		$CDF(6) = \sum_{i=1}^{10} (v(i,6) * \varphi_i^3)$

from all of this information,

$$\gamma = \left(\sum_{j=1}^{6} (percent(j) * CDF(j)) \right)^{\frac{1}{3}}$$

where: i = Current gross vehicle weight range

j = Current truck type

- j = 1: 2 Axle Trucks
- j = 2: 3 Axle Trucks
- j = 3: 4 Axle Trucks
- j = 4: 3 Axle Combination Trucks
- j = 5: 4 Axle Combination Trucks
- j = 6: 5 Axle Combination Trucks

min(i) = User input Minimum Gross Weight for gross vehicle weight range i

max(i) = User input Maximum Gross Weight for gross vehicle weight range i

n(i,j) = User input Number of Vehicles for each gross vehicle weight range (i = 1-10) of each type (j=1-6).

v(i,j) = Percentage of trucks for each gross vehicle weight range of each type (for a given truck type, the sum of v(i,type) = 1.0

sum(j) = Total number of trucks of a given type over all vehicle weight ranges

percent(j) = Total percentage of a given truck type over all gross vehicle weight ranges

GVW_o = Gross vehicle weight of the LRFD Fatigue Truck (72 kips)

ϕ_i = Ratio of average gross vehicle weight to GVW_o

CDF(j) = Cumulative damage factor for each vehicle type

γ = Fatigue-II limit state load factor

6.43 FTG - FATIGUE COMMAND

6.43.4 Category

To enter B', C', or E', the user should enter the prime (') character using the single quote key (the key next to and to the left of the <Enter> key).

6.43.5 Fillet Weld

The user should only enter this parameter to analyze a transversely loaded fillet weld where a discontinuous cover plate is loaded. This condition only exists on a rolled beam with cover plates where the weld is at the transverse end of the cover plate. For the program to analyze this correctly, the beam and detail must meet the following criteria (or the program will treat the detail as a standard fatigue detail):

1. The program must be analyzing a rolled beam with cover plates.
2. The analysis point must be located at a cover plate transition point (Distance 1 shown in Figures 1 and 2).
3. The analysis point must be located at the top or bottom of the beam (Distance 2 shown in Figures 1 and 2). (When evaluating this criterion, the analysis point is considered part of the cross-sectional range with the smaller moment of inertia, as described in Section 2.7, item 16. Therefore the beam depth is based on the depth of the section with the smaller moment of inertia.)

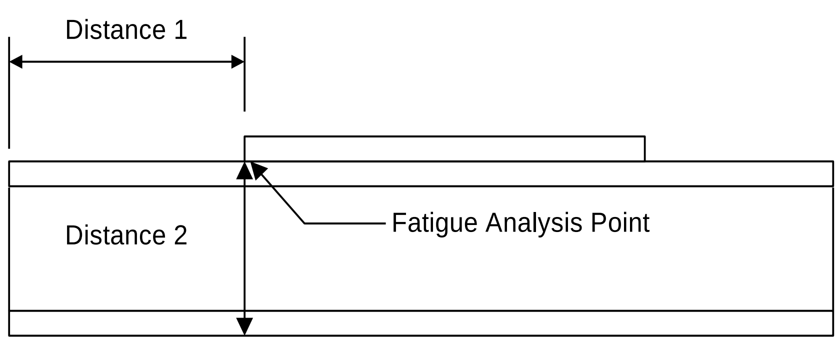


Figure 6.43-1 Fillet Weld at Top Cover Plate

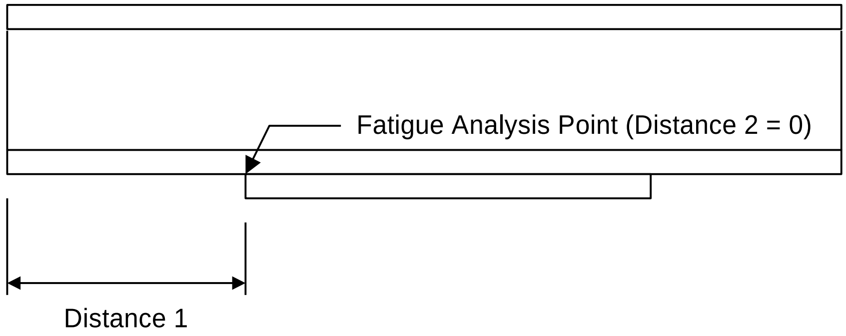


Figure 6.43-2 Fillet Weld at Bottom Cover Plate

6.44 BRP - BRACE POINT COMMAND

The program uses the data entered for this command to compute the locations of the brace points along the girder. The data entered for this command is used to compute brace points for both the bottom and top flange. The program considers the top flange to be continuously supported only if the structure is composite and only after the deck has hardened. For all other conditions, including that of a noncomposite girder, the top and bottom flanges are considered to be braced only at the brace points entered using this command. During construction staging (deck pour sequencing), the edge of the hardened deck pour serves as a brace point for the top flange only.

As an example, if the user inputs a Start Span Distance of 0 feet in Span 1, an End Span Distance of 75 feet in Span 1, and a Brace Spacing of 15 feet, then the program will place brace points at the following locations in Span 1: 0 feet, 15 feet, 30 feet, 45 feet, 60 feet, and 75 feet. These brace point locations will apply to both the bottom and top flange. The only exception to this is if the structure is composite and if the deck has hardened, in which case these brace point locations will apply only to the bottom flange and the top flange will be considered to be continuously supported.

Analysis points are placed immediately to the right and left of each each brace point. During specification checking, the program will use the unbraced length and factored moments (for lateral torsional buckling calculations) on their respective sides.

6.46 TST - TRANSVERSE STIFFENER COMMAND

This command is used to specify the transverse stiffener size and spacing for the analysis of a plate girder. The equations used in the transverse stiffener computations are presented in LRFD Specifications Articles 6.10.11.1 and in the corresponding section of DM-4.

For each stiffener range that is input by the user, the program performs the specifications checks based on the parameters (such as stiffener spacing, stiffener width, and stiffener thickness) that the user input for that range. The stiffener spacing is used to calculate the shear resistance of the girder. The stiffener width and thickness are used only for the transverse stiffener specifications checks. The transverse stiffener specifications checks do not affect the girder section analysis or design (shear resistance).

The user should define ranges such that stiffener properties remain constant throughout the range. However, the user could choose one of the following conservative approaches for ease of input data entry. For a range in which some transverse stiffeners are located on both sides of the web and others are located on only one side, the user could conservatively enter the stiffeners on one side only. For a range in which the size of the transverse stiffeners varies, the user could conservatively input the minimum stiffener size for that range.

The program does not automatically consider the lateral brace points as locations of transverse stiffeners for purposes of shear design of the girder. If the user wants the lateral brace points to also be considered as transverse stiffener locations, then these lateral brace point locations must be entered using the TST command. The BRP command is used only to define the lateral brace points of the girder.

Additionally, the program does not automatically consider bearing stiffeners defined via the BST command as acting like transverse stiffeners. If a bearing stiffener is to be considered as a transverse stiffener for shear capacity calculations, it must also be defined through the TST command.

The user does not necessarily have to define stiffener ranges over the entire girder. However, a transverse stiffener range with a length of zero cannot be entered. The program assumes that stiffeners are located at both the start and end locations of each stiffener range.

The program uses the following general assumptions in performing the transverse stiffener computations:

1. To analyze a point that is within a defined stiffener range:

   - The program uses the stiffener spacing and dimensions as defined for that range.

- If the entered stiffener spacing is greater than the maximum allowable spacing for stiffened webs (refer to LRFD Specifications Article 6.10.9 and the corresponding section of DM-4), the program calculates the shear resistance for that range as an unstiffened range.

2. To analyze a point that is not within a defined stiffener range:

   - The program computes the distance between the nearest ends of the nearest stiffener ranges on each side of the point (or, if there is no stiffener range on one or both sides of the point, the distance to the end of the girder).

   - If the distance is greater than the maximum allowable spacing for stiffened webs, the program calculates the shear resistance for that region as if it were an unstiffened range.

   - If the distance is less than or equal to the maximum allowable spacing for stiffened webs, the program calculates the shear resistance for that region as if it were a stiffened range. In this case, the program uses the stiffeners from the adjacent region with the smaller stiffener area for the transverse stiffener specification checks in that region.

3. To analyze a point that is located at the transition between two adjacent stiffener ranges:

   - If the two adjacent stiffener ranges have different stiffener spacings, the program checks that point using the larger of the two stiffener spacings.

   - The stiffener dimensions for that analysis point are taken from the range with the larger stiffener spacing.

   - In addition, if the point is located at the first or last stiffener on the beam, the point is analyzed as the appropriate panel, interior or exterior, based on which side of the stiffener has the wider spacing.

As used in this program, the region from the end of a girder to the first transverse stiffener is defined as an exterior panel. All other regions are defined as interior panels.

The program analyzes and designs typical transverse stiffeners only. Thus, the program does not analyze or design cross frame or diaphragm stiffeners. However, all cross frames and diaphragm stiffeners should be entered as transverse stiffeners for purposes of calculating the shear resistance of the girder. Therefore, the user must independently perform the specifications checks and resistance checks of cross frame and diaphragm stiffeners for the loads applied to these stiffeners.

A transverse stiffener is required at the termination of a web depth variation (see detail in Figure 1 and in BC-753M). The program will check if a stiffener has been defined at each end of a web depth variation. If a stiffener has not been defined at an end of a web depth variation, a warning will appear in the program output.

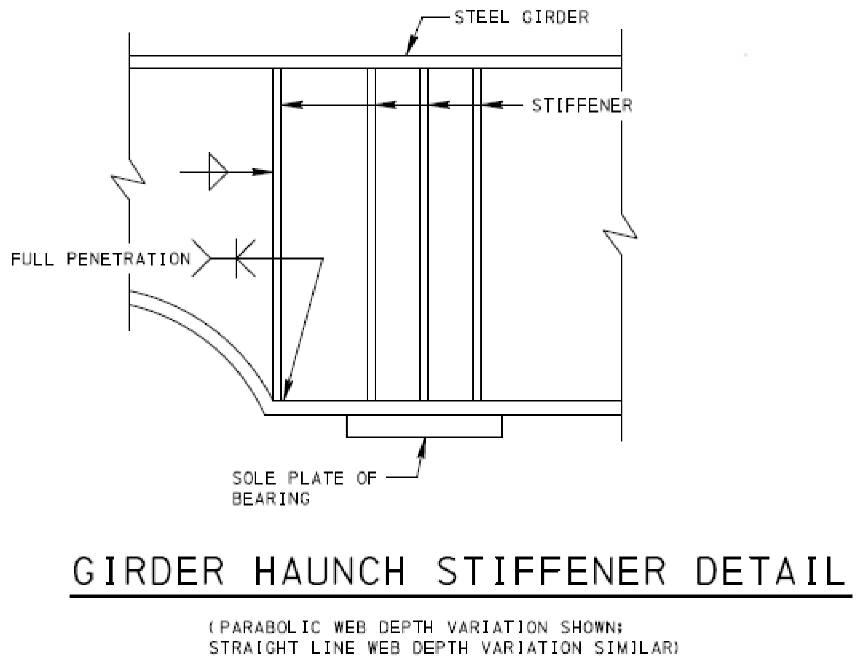


Figure 6.46-1 Girder Haunch Stiffener Detail

6.46.6 Stiffener Spacing

The stiffener spacing must be defined such that the entered stiffener spacing multiplied by an integer is equal to the length of the stiffener range, within a tolerance of 0.1 inches. If this condition is not satisfied, the program gives a descriptive error message and aborts the run.

Example:

Figure 2 shows two different ways of entering input data for transverse stiffeners along a girder, and the manner in which the program chooses stiffener spacing and stiffener size based on that input. The stiffeners are placed at various spacings with large stiffeners at four locations. The analysis points are placed to illustrate the different logic the program follows for placing the stiffeners into ranges, as well as creating new ranges.

Option A in Figure 2 defines four distinct ranges along the beam. The first range covers 4' to 32' with the small stiffeners at 4' spacing. The next range extends from 38' to 78' with two large stiffeners at 40' spacing. The third range consists of four stiffeners at 4' spacing from 80' to 92' along the girder. The final defined range is from 97' to 124' with stiffeners at 3' spacings. This leaves five undefined ranges, from 0' to 4', 32' to 38', 78' to 80', 92' to 97', and 124' to 126'.

Points B, F, and L all fall within defined ranges, using spacing and section properties as defined by rule 1 in Section 6.42.

Points A, D, H, K, and N all fall between (or outside) defined ranges, so rule 2 in Section 6.43 is followed, defining ranges from the endpoints of the girder or adjacent ranges.

Points C, E, G, J, **I**, and M all fall at ends of ranges, so rule 3 in Section 6.43 is followed, with spacings and section properties as shown in Figure 2 based on the properties of the adjacent sections.

Option B in Figure 2 changes the definitions of two of the ranges, as well as adding a fifth range. Range 1 now extends from 0' to 32', range 2 extends from 32' to 38' with large stiffeners at 6' spacing, and range 3 includes 78' to 80', again with a large stiffener. The changes have the net result of changing the section properties for points D and H because the ranges containing the points are now defined by the user to use the section properties of the larger stiffener.

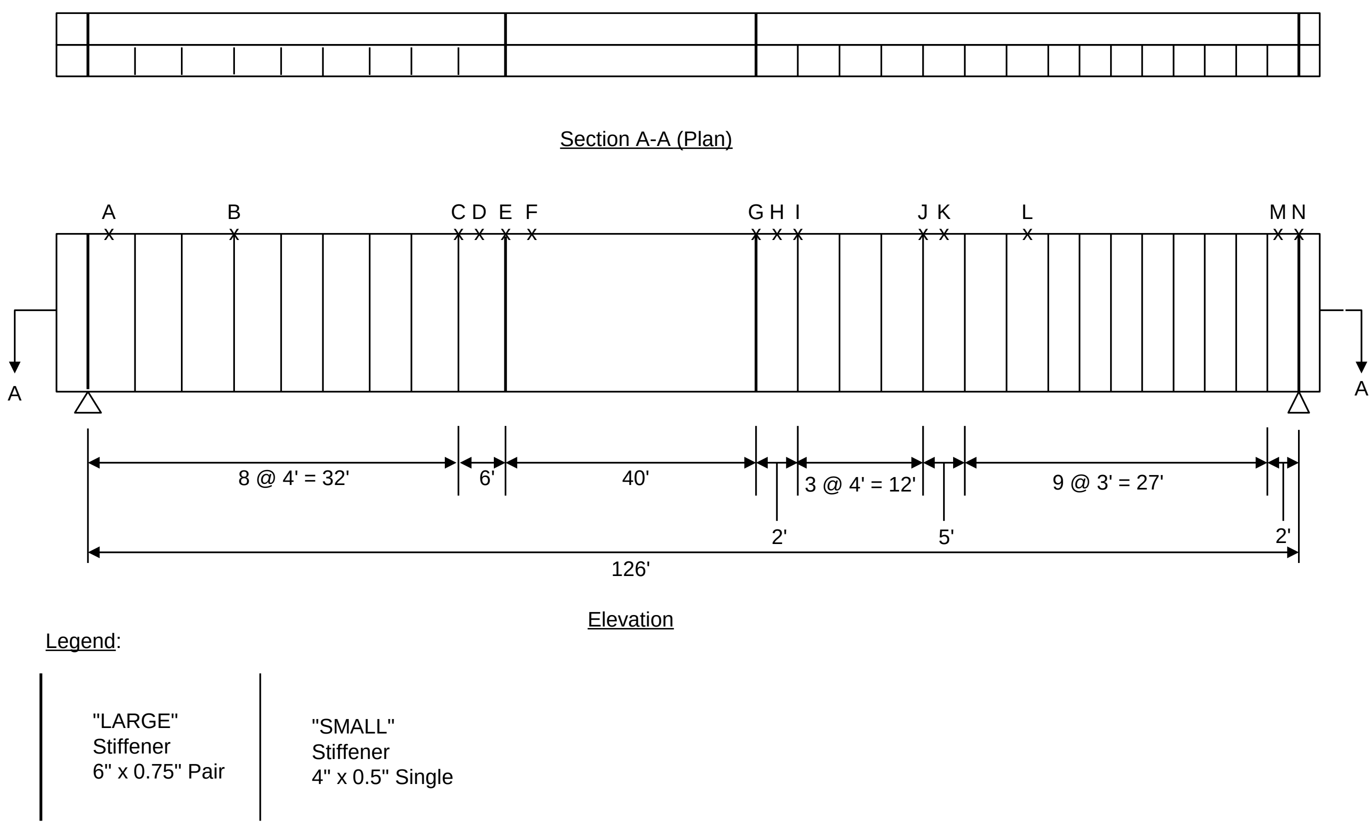


Figure 6.46-2 Transverse Stiffener Example

Option A:

```
TST     1, 4, 1, 32, S, 4, 4, 0.5, 50, P,
TST     1, 38, 1, 78, P, 40, 6, 0.75, 50, P,
TST     1, 80, 1, 92, S, 4, 4, 0.5, 50, P,
TST     1, 97, 1, 124, S, 3, 4, 0.5, 50, P,
```

Option B:

```
TST   1,0,  1,32,  S, 4, 4, 0.5, 50, P,
TST   1,32,1,38,  P, 6, 6, 0.75,50,P,
TST   1,78,1,80,  P, 2, 6, 0.75,50,P,
TST   1,80,1,92,  S, 4,4, 0.5,  50, P,
TST   1,97,1,124,S, 3,4, 0.5,  50, P,
```

Program analyzes Option A as:

Pt.	X-loc.	Spacing	Section Props. Used
A	2'	4'	Small
B	14'	4'	Small
C	32'	6'	Small
D	35'	6'	Small
E	38'	40'	Large
F	41'	40'	Large
G	78'	40'	Large
H	79'	2'	Small
I	80'	4'	Small
J	92'	5'	Small
K	95'	5'	Small
L	102'	3'	Small
M	124'	3'	Small
N	125'	2'	Small

Program analyzes Option B as:

Pt.	Spacing	Section Props. Used
A	4'	Small
B	4'	Small
C	6'	Large
D	6'	Large
E	40'	Large
F	40'	Large
G	40'	Large
H	2'	Large
I	4'	Small
J	5'	Small
K	5'	Small
L	3'	Small
M	3'	Small
N	2'	Small

Figure 6.46-2 Transverse Stiffener Example (Continued)

6.47 LST - LONGITUDINAL STIFFENER COMMAND

This command is used to specify the longitudinal stiffener size and location for the analysis of a girder. The equations used in the specifications checking of the longitudinal stiffener are presented in LRFD Specifications Article 6.10.11.3 and the corresponding section of DM-4.

For each stiffener range that is input by the user, the program performs the specifications checks based on the parameters (such as the distance from flange, projected width, and stiffener thickness) that the user input for that range. The stiffener distance from flange is used in the calculation of the flexural resistance, shear resistance, web slenderness, and dead load web stress limits. The stiffener projected width and thickness and are used only for the longitudinal stiffener specifications checks. The longitudinal stiffener specifications checks do not affect the girder section analysis.

The user does not necessarily have to define stiffener ranges over the entire girder length.

6.48 BST - BEARING STIFFENER COMMAND

This command is used to specify the bearing stiffener size and location for the analysis of a girder.

The program computes the total moment of inertia, the total area, and the radius of gyration of the bearing stiffener using the following equations:

$$I_{total} = 2n\left[\frac{b_t^3 t_p}{12}\right] + \frac{b_{web} t_w^3}{12} + 2n\left[b_t t_p\left(\left(\frac{b_t}{2}\right) + \left(\frac{t_w}{2}\right)\right)^2\right]$$

$$A_{total} = 2n\, b_t t_p + t_w b_{web}$$

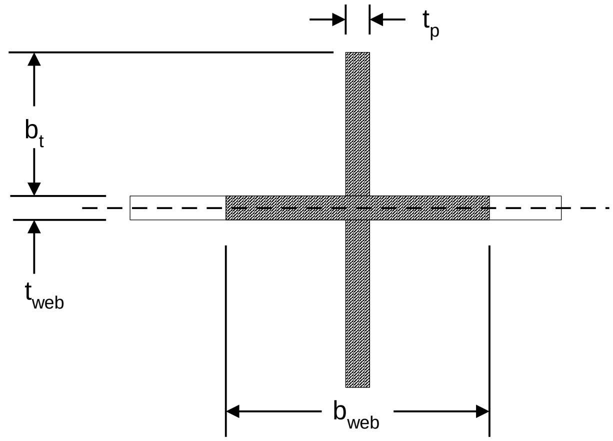
$$r_s = \sqrt{\frac{I_{total}}{A_{total}}}$$

where: n = number of bearing stiffener pairs

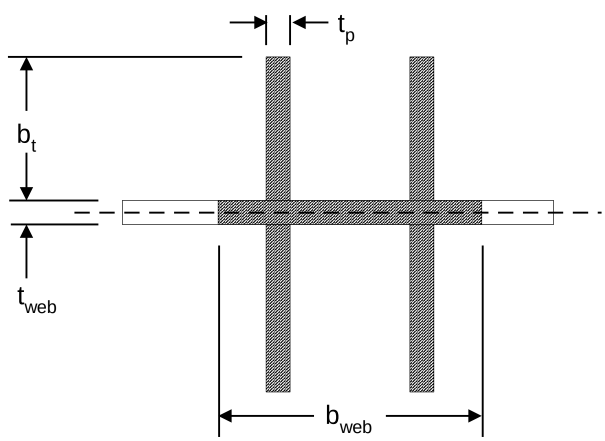
A schematic drawing of a single pair of the bearing stiffeners and groups of pairs of bearing stiffeners is presented in Figure 1.

The remaining equations used in the specifications checking of the bearing stiffener are presented in LRFD Specifications Article 6.10.11.2 and the corresponding section of DM-4.

The bearing stiffener specification checks do not affect the girder section analysis or design. In addition, bearing stiffeners defined via the BST command do not affect the shear capacity of the beam; that is, bearing stiffeners are not counted as transverse stiffeners for purposes of shear capacity and rating calculations.



Single Pair



Groups of Pairs

Figure 6.48-1   Bearing Stiffener Geometry

6.48.5   Clearance

The clearance is used to compute the effective web width for stiffener section properties in accordance with LRFD Specifications Article 6.10.11.2.4b. The clearance is to be entered from the end of the girder to the centerline of the bearing or bearing pair, measured along the girder length. This value should be entered for bearing stiffeners at abutments only; it should be left blank for all other bearing stiffener locations.

6.50 SCS - SHEAR CONNECTOR STUD COMMAND

The program performs specification checks for stud type shear connectors in accordance with LRFD Specifications Article 6.10.10.4 and the corresponding section of DM-4. For composite girders, DM-4 requires shear connectors along the entire length of the girder. Therefore, the program checks each analysis point along the entire length of the girder, including each region between points of zero moment and maximum positive or negative moment.

The stud type shear connector specifications checks do not affect the girder section analysis or design.

6.51 SCC - SHEAR CONNECTOR CHANNEL COMMAND

For channel type shear connectors, the program computes the fatigue resistance of an individual channel using Equation 10-58 in the AASHTO Standard Specifications for Highway Bridges, Fifteenth Edition, 1992, as follows:

$$Z_r = Bw$$

where B = 1.05 kips per inch, and w is the length of the channel type shear connector measured normal to the web of the girder in units of inches.

The program uses a maximum pitch of 24 inches for channel type shear connectors. In addition, the program checks cover and penetration requirements for channel type shear connectors in accordance with LRFD Specifications Article 6.10.10.1.4 and the corresponding section of DM-4 (Refer to Table 2.7-1).

The program performs all other specification checks for channel type shear connectors in accordance with LRFD Specifications Article 6.10.10.4 and the corresponding section of DM-4. For composite girders, DM-4 requires shear connectors along the entire length of the girder. Therefore, the program checks each analysis point along the entire length of the girder, including each region between points of zero moment and maximum positive or negative moment.

The channel type shear connector specifications checks do not affect the girder section analysis or design.

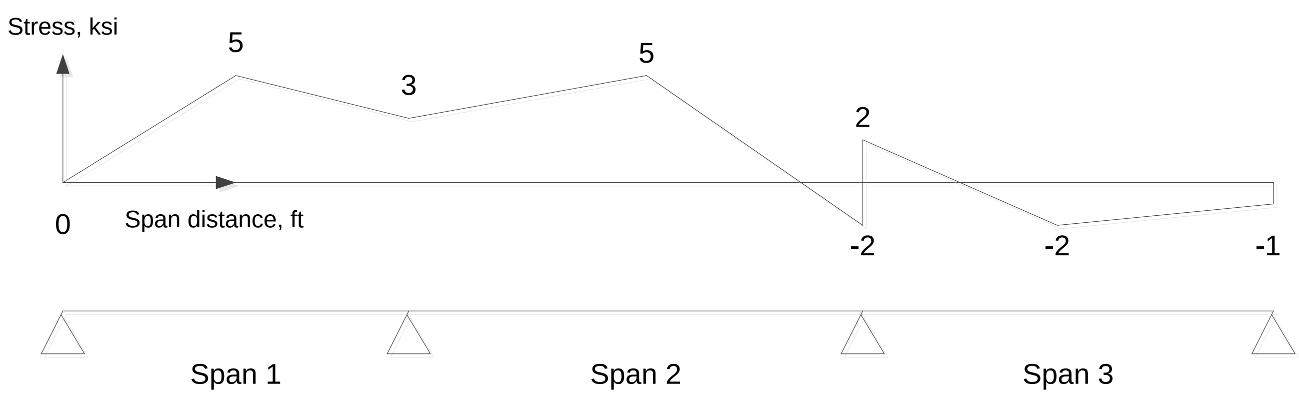
6.53 LAS - LATERAL BENDING STRESS COMMAND

The LAS command allows for the entry of lateral stresses with either positive or negative signs. The total factored lateral stress will always be added to the major-axis bending stress to increase the total stress at the section for the purposes of specification checking. The mixing of positive and negative signs along the span gives the user more control over the interpolated lateral stress values.

Consider the following input on the LAS command (the principles are the same for all lateral stresses, only the bottom flange DC1 lateral stress is shown here):

```
LAS 1, L, 0.0, ...
LAS 1, M, 5.0, ...
LAS 1, R, 3.0, ...
LAS 2, L, 3.0, ...
LAS 2, M, 5.0, ...
LAS 2, R, -2.0, ...
LAS 3, L, 2.0, ...
LAS 2, M, -2.0, ...
LAS 3, R, -1.0, ...
```

The lateral stresses that are input by the user are then interpolated by the program to determine the lateral stress to use for each analysis point, resulting in the following lateral stress diagram:



When factoring the lateral stresses, the signs of the individual lateral stresses are preserved. After combining and factoring, the absolute value of the total factored lateral stress is taken, then that lateral stress is combined with the factored major-axis bending stresses to find the largest total stress.

NOTE: The example shown in this section is provided only to illustrate how the lateral stresses are interpolated and the impact of using positive and negative values for the lateral stresses. This example is not intended to represent the actual results of a refined analysis.

6.54 OIN - OUTPUT OF INPUT DATA COMMAND

A summary of the defaults for this command is presented in Table 1. Also presented in Table 1 is a list of the output tables printed with each parameter.

Table 6.54-1 Summary of Defaults for OIN Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
1. Input File Echo	INPUT DATA FILE ECHO	0	0
2. Input Commands	COMMAND LINE INPUT	0	0
3. Input Summary	CONTROL PARAMETERS SYMMETRICAL POINT STRUCTURE IDENTIFICATION BEAM GEOMETRY COMPUTED DISTRIBUTION FACTORS SKEW ANGLES USER-DEFINED DISTRIBUTION FACTORS, DESIGN VEHICLE USER-DEFINED DISTRIBUTION FACTORS, FATIGUE VEHICLE USER-DEFINED DISTRIBUTION FACTORS, PEDESTRIAN SPAN LENGTHS HINGE LOCATIONS USER-DEFINED ANALYSIS POINTS MATERIAL PROPERTIES DESIGN - ROLLED BEAM DESIGN - PLATE GIRDER TOP PLATE DESIGN LOCATIONS BOTTOM PLATE DESIGN LOCATIONS TRANSVERSE STIFFENER DESIGN ROLLED BEAM DIMENSIONS ROLLED BEAM PROPERTIES, PART 1 OF 2 ROLLED BEAM PROPERTIES, PART 2 OF 2 BUILT-UP PROPERTIES, PART 1 OF 2 BUILT-UP PROPERTIES, PART 2 OF 2 PLATE GIRDER PROPERTIES, PART 1 OF 2 PLATE GIRDER PROPERTIES, PART 2 OF 2 SECTION HOLES SECTION LOSSES SLAB PROPERTIES DECK POUR SEQUENCE DECK POUR CONCENTRATED LOADS DECK POUR DISTRIBUTED LOADS (PERMANENT) DECK POUR DISTRIBUTED LOADS (TEMPORARY) LOAD FACTORS CONCENTRATED LOADS DISTRIBUTED LOADS (DC1) DISTRIBUTED LOADS (DC1S) DISTRIBUTED LOADS (DC2)	1	1

Table 6.54-1 Summary of Defaults for OAN Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
3. Input Summary (continued)	DISTRIBUTED LOADS (FWS) DISTRIBUTED LOADS (MC1) DISTRIBUTED LOADS (MC2) DISTRIBUTED LOADS (UT1) DISTRIBUTED LOADS (UT2) PEDESTRIAN LOAD WIND LOAD - USER ENTERED WIND PRESSURE WIND LOAD - COMPUTED WIND PRESSURE SPECIAL LIVE LOADING SPECIAL AXLE LOAD FATIGUE LIFE FATIGUE GROSS VEHICLE FATIGUE POINTS BRACE POINTS TRANSVERSE STIFFENERS LONGITUDINAL STIFFENERS BEARING STIFFENERS STUD SHEAR CONNECTORS CHANNEL SHEAR CONNECTORS FIELD SPLICE LOCATIONS SYSTEM SETTINGS		

6.55 OSP - OUTPUT OF SECTION PROPERTIES COMMAND

The defaults for this command are dependent on whether an analysis or design run is being generated. A summary of the defaults is presented in Table 1. Also presented in Table 1 is a list of the output tables printed with each parameter.

Table 6.55-1 Summary of Defaults for OSP Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
1. Gross Section Properties	GROSS SECTION PROPERTIES	0	0
2. Section Properties	SECTION PROPERTIES (NONCOMPOSITE, POSITIVE FLEXURE) SECTION PROPERTIES (COMPOSITE (3N), POSITIVE FLEXURE) SECTION PROPERTIES (COMPOSITE (N), POSITIVE FLEXURE) SECTION PROPERTIES (COMPOSITE (N/0.7), POSITIVE FLEXURE) SECTION PROPERTIES (NONCOMPOSITE, NEGATIVE FLEXURE) SECTION PROPERTIES (COMPOSITE, NEGATIVE FLEXURE)	1	1
3. Additional Section Properties	ADDITIONAL SECTION PROPERTIES (POSITIVE FLEXURE, PART 1) ADDITIONAL SECTION PROPERTIES (POSITIVE FLEXURE, PART 2) ADDITIONAL SECTION PROPERTIES (NEGATIVE FLEXURE, PART 1) ADDITIONAL SECTION PROPERTIES (NEGATIVE FLEXURE, PART 2)	1	1

6.56 ODG - OUTPUT OF DESIGN TRIALS COMMAND

This command is used only for a design run. A summary of the defaults is presented in Table 1. Also presented in Table 1 is a list of the output tables printed with each parameter.

Table 6.56-1 Summary of Defaults for ODG Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
1. Design Trials	ROLLED BEAM DESIGN TRIALS DESIGN TRIALS: FLANGE SPLICE PLATE PROPERTIES PLATE GIRDER DESIGN TRIALS TRIAL i: GIRDER DESIGN TRIAL i: FLANGE SPLICE PLATE PROPERTIES TRIAL i: TRANSVERSE STIFFENER DESIGN	Not applicable	0
2. Final Design	ROLLED BEAM FINAL DESIGN FLANGE SPLICE PLATE PROPERTIES FINAL DESIGN PLATE GIRDER FINAL DESIGN FLANGE SPLICE PLATE PROPERTIES FINAL DESIGN TRANSVERSE STIFFENERS FINAL DESIGN	Not applicable	1

6.57 OAN - OUTPUT OF ANALYSIS RESULTS COMMAND

The defaults for this command are dependent on whether an analysis or design run is being generated. A summary of the defaults is presented in Table 1. Also presented in Table 1 is a list of the output tables printed with each parameter. For parameters 9 and 10, live loadings specified on the CTL command are printed in the output. If a live loading is not specified on the CTL command, its live load effects are not printed in the output.

Table 6.57-1 Summary of Defaults for OAN Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
1. Points of Contraflexure	POINTS OF CONTRAFLEXURE	1	0
2. Compactness Check for Redistribution	COMPACTNESS CHECK FOR REDISTRIBUTION *Note, this parameter is no longer applicable. The resulting output table is no longer available.	0	0
3. Load Modifiers	LOAD FACTORS AND COMBINATIONS LIVE LOADING SUMMARY LOAD MODIFIER RESISTANCE FACTORS	1	1
4. Dead Loads	DEAD LOADS	0	1
5. Distribution Factors	DISTRIBUTION FACTORS FOR DESIGN LIVE LOADING (LANE FRACTION, INCL. SKEW) DISTRIBUTION FACTORS WITH SIDEWALKS (LANE FRACTION, INCL. SKEW) DISTRIBUTION FACTORS FOR FATIGUE VEHICLE (LANE FRACTION, INCL. SKEW) DISTRIBUTION FACTORS FOR REACTIONS DISTRIBUTION FACTORS FOR REACTIONS WITH SIDEWALKS	1	1

Table 6.57-1 Summary of Defaults for OAN Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
6. Dead Load Effects	BEAM WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) SLAB AND HAUNCH WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) PERMANENT INPUTTED DC1 ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) PERMANENT INPUTTED DC1S ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) TOTAL DC1 ANALYSIS (UNFACTORED, NONCOMPOSITE) PERMANENT INPUTTED DC2 ANALYSIS (UNFACTORED, DC2, COMPOSITE (3N) / NONCOMPOSITE[1]) FUTURE WEARING SURFACE ANALYSIS (UNFACTORED, FWS, COMPOSITE (3N) / NONCOMPOSITE[1]) UTILITY UT1 ANALYSIS (UNFACTORED, UT1, NONCOMPOSITE) UTILITY UT2 ANALYSIS (UNFACTORED, UT2, COMPOSITE (3N) / NONCOMPOSITE[1]) MISCELLANEOUS MC1 ANALYSIS (UNFACTORED, MC1, NONCOMPOSITE) MISCELLANEOUS MC2 ANALYSIS (UNFACTORED, MC2, COMPOSITE (3N) / NONCOMPOSITE[1]) SIDEWALK DEAD LOAD ANALYSIS (UNFACTORED, DC2, COMPOSITE (3N) / NONCOMPOSITE[1]) ADDITIONAL FWS ANALYSIS (UNFACTORED, FWS, COMPOSITE (3N) / NONCOMPOSITE[1])	1	1
7. Dead Load Reactions	BEAM WEIGHT ANALYSIS - REACTIONS SLAB AND HAUNCH WEIGHT ANALYSIS - REACTIONS PERMANENT INPUTTED DC1 ANALYSIS - REACTIONS PERMANENT INPUTTED DC1S ANALYSIS - REACTIONS TOTAL DC1 ANALYSIS - REACTIONS PERMANENT INPUTTED DC2 ANALYSIS - REACTIONS FUTURE WEARING SURFACE ANALYSIS - REACTIONS UTILITY UT1 ANALYSIS - REACTIONS UTILITY UT2 ANALYSIS - REACTIONS MISCELLANEOUS MC1 ANALYSIS - REACTIONS MISCELLANEOUS MC2 ANALYSIS - REACTIONS SIDEWALK DEAD LOAD ANALYSIS - REACTIONS ADDITIONAL FWS ANALYSIS - REACTIONS	0	1
8. Staging Analysis	DECK POUR ii ANALYSIS (UNFACTORED, DC1) CUMULATIVE ANALYSIS: CONSTRUCTION STAGE ii (UNFACTORED, DC1)	0	0

Notes:

[1] For girders that are composite in the final state, the load is applied to the composite section as indicated. For girders that are noncomposite in the final state, the load is applied to the noncomposite, steel-only section.

Table 6.57-1 Summary of Defaults for OAN Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
9. Live Load Effects	Different output tables will print depending on the LIVE LOAD entry on the CTL command, and whether or not sidewalks have been defined, using the PLD command. For program runs without defined sidewalks (no PLD command), the output tables: LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT) LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT) will print for: PHL-93 HL-93 P-82 ML-80 HS20 H20 SPECIAL # TK527 EV2 EV3 SU6TV P2016-13 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT) LL ANALYSIS (SHEARS, UNFACTORED, INCL. IMPACT) will print for: P-82C P2016-13C LL ANALYSIS (MOMENTS & SHEARS, UNFACTORED, INCL. IMPACT) will print for: FATIGUE	1	1

Table 6.57-1 Summary of Defaults for OAN Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS ANALYSIS RUN	DEFAULTS DESIGN RUN
9. Live Load Effects (Continued)	For program runs with defined sidewalks (PLD command supplied), the output tables: LL ANALYSIS (MOMENTS, UNF., W/O SIDEWALK, INCL. IMPACT) LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SIDEWALK, INCL. IMPACT) LL ANALYSIS (MOMENTS, UNF., W/ SIDEWALK, INCL. IMPACT) LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SIDEWALK, INCL. IMPACT) will print for: PHL-93 HL-93 P-82 ML-80 HS20 H20 SPECIAL # TK527 EV2 EV3 SU6TV P2016-13 LL ANALYSIS (MOMENTS, UNF., W/O SIDEWALK, INCL. IMPACT) LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SIDEWALK, INCL. IMPACT) will print for: P-82 P2016-13 LL ANALYSIS (MOMENTS, UNF., W/O SIDEWALK, INCL. IMPACT) LL ANALYSIS (SHEARS, UNF., W/O SIDEWALK, INCL. IMPACT) will print for: P-82C P2016-13C LL ANALYSIS (MOMENTS & SHEARS, UNF., W/O SW, INCL. IMPACT) will print for: FATIGUE LL ANALYSIS (MOMENTS, UNFACTORED) LL ANALYSIS (SHEARS, UNFACTORED) will print for: PEDESTRIAN LL ANALYSIS (DEFLECTIONS, UNFACTORED) will print for: TOTAL PEDESTRIAN		

Table 6.57-1 Summary of Defaults for OAN Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
10. Live Load Reactions	Different output tables will print depending on the LIVE LOAD entry on the CTL command, and whether or not sidewalks have been defined, using the PLD command. For program runs without defined sidewalks (no PLD command), the output tables: LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS) LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS) will print for: PHL-93 HL-93 P-82 ML-80 HS20 H20 SPECIAL # TK527 EV2 EV3 SU6TV P2016-13 FATIGUE LL ANALYSIS (ROTATIONS, W/O IMPACT OR DIST. FACTORS) will print for: PHL93 HL93 HS20 H20 SPECIAL #	0	1

Table 6.57-1 Summary of Defaults for OAN Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
10. Live Load Reactions (Continued)	For program runs with defined sidewalks (PLD command supplied), the output tables: LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS) LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS) LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS) will print for: PHL-93 HL-93 P-82 ML-80 HS20 H20 SPECIAL # TK527 EV2 EV3 SU6TV P2016-13 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS) LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS) will print for: FATIGUE LL ANALYSIS (ROTATIONS, W/O IMPACT OR DIST. FACTORS) will print for: PHL93 HL93 HS20 H20 SPECIAL #		
11. HS20 Effects and Reactions	Not applicable. (This parameter allows the user to not include HS20 live load effects and reactions with the output requested using parameters 9 and 10.)	0	0
12. H20 Effects and Reactions	Not applicable. (This parameter allows the user to not include H20 live load effects and reactions with the output requested using parameters 9 and 10.)	0	0
13. Fatigue Effects and Reactions	Not applicable. (This parameter allows the user to not include fatigue live load effects and reactions with the output requested using parameters 9 and 10.)	0	0

Table 6.57-1 Summary of Defaults for OAN Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
14. Factored Effects	UNFACTORED FLEXURAL STRESSES USER INPUT LATERAL STRESSES FACTORED ANALYSIS RESULTS FACTORED LATERAL STRESSES	1	1
15. Factored Reactions	FACTORED ANALYSIS RESULTS - REACTIONS	0	0

16. Overall Reaction Summary	SUMMARY - OVERALL REACTIONS.
	   REACTIONS & ROTATIONS PER GIRDER
	      (UNFACTORED, W/O IMPACT, W/ DISTRIBUTION)
	      FOR ELASTOMERIC BEARING PAD DESIGN.
	   REACTIONS & ROTATIONS PER GIRDER
	      (UNFACTORED, W/ IMPACT, W/ DISTRIBUTION) FOR
	      POT, STEEL OR DISC BEARING DESIGN.
	   REACTIONS PER GIRDER (UNFACTORED AND
	      FACTORED, W/ IMPACT, W/ DISTRIBUTION) FOR
	      SOLE PLATE DESIGN
	   REACTIONS (UNFACTORED) FOR ABUTMENT DESIGN.
	   REACTIONS (UNFACTORED) FOR PIER DESIGN.
		1	1

6.58 OSC - OUTPUT OF SPECIFICATION CHECKING COMMAND

The defaults for this command are dependent on whether an analysis or design run is being generated. A summary of the defaults is presented in Table 1. Also presented in Table 1 is a list of the output tables printed with each parameter.

Table 6.58-1 Summary of Defaults for OSC Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
1. Ductility and Web/Flange Proportions	DUCTILITY AND WEB/FLANGE PROPORTIONS COMPACTNESS CRITERIA	0	0
2. Wind Effects	USER-DEFINED WIND LOAD AND PRESSURE COMPUTED WIND LOAD AND PRESSURE WIND EFFECTS	0	0
3. Flexural Capacity	INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY CALCULATIONS MOMENT FLEXURAL CAPACITY (COMPOSITE, +FLEX, COMPACT OR APPENDIX A, NO LTB) STRESS FLEXURAL CAPACITY (NONCOMPOSITE OR -FLEX OR COMPOSITE/NONCOMPACT, NO LTB) INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE) FLANGE LATERAL CAPACITY NET SECTION FRACTURE CHECK SERVICE LIMIT STATE - FLEXURAL RESISTANCE SERVICE LIMIT STATE - WEB BEND-BUCKLING	1	1
4. Shear Capacity	SHEAR CAPACITY	1	1
5. Web Checks	WEB SPECIFICATION CHECK	0	0
6. Stiffener Checks	TRANSVERSE STIFFENERS CHECK LONGITUDINAL STIFFENERS CHECK (PART 1) LONGITUDINAL STIFFENERS CHECK (PART 2) USER-INPUT BEARING STIFFENER ANALYSIS WEB CONCENTRATED LOAD CHECK BEARING STIFFENER DESIGN	0	1
7. Fatigue Checks	SPECIAL FATIGUE REQUIREMENT FOR WEBS FATIGUE RESISTANCE	0	0
8. Fatigue Life Estimation	REMAINING FATIGUE LIFE ESTIMATION	1	1
9. Deflection Checks	DEFLECTION LIMITS FOR LIVE LOAD DEFLECTION LIMITS FOR DEFLECTION LOADING ONLY DEFLECTION LIMITS FOR DEFLECTION LOADING + PEDESTRIAN LIVE LOAD	0	1

Table 6.58-1 Summary of Defaults for OSC Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
10. Shear Connector Checks	SHEAR CONNECTOR DESIGN - NO. OF CONNECTORS REQUIRED SHEAR CONNECTOR DESIGN - PITCH SHEAR CONNECTOR DESIGN - SPACING, COVER, AND PENETRATION SHEAR CONNECTOR DESIGN - PITCH SHEAR CONNECTOR DESIGN - COVER AND PENETRATION	0	1
11. Staging/ Uncured Slab Checks	CONSTRUCTION STAGE ii WEB SPECIFICATION CHECK UNCURED SLAB WEB SPECIFICATION CHECK CONSTRUCTION STAGE ii FACTORED LATERAL STRESSES UNCURED SLAB FACTORED LATERAL STRESSES CONSTRUCTION STAGE ii FLANGE SPECIFICATION CHECK (NO LTB) (PART 1) CONSTRUCTION STAGE ii FLANGE SPECIFICATION CHECK (NO LTB) (PART 2) UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 1) UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 2) INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (CONSTRUCTION STAGE ii) LATERAL TORSIONAL BUCKLING CAPACITY (CONSTRUCTION STAGE ii) INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (UNCURED SLAB) LATERAL TORSIONAL BUCKLING CAPACITY (UNCURED SLAB) CONSTRUCTION STAGE ii NET SECTION FRACTURE CHECK UNCURED SLAB NET SECTION FRACTURE CHECK CONSTRUCTION STAGE ii GLOBAL DISPLACEMENT AMPLIFICATION CHECK UNCURED SLAB GLOBAL DISPLACEMENT AMPLIFICATION CHECK	0	0
12. Web–to–flange Weld Design Checks	WEB-TO-FLANGE WELD DESIGN: WELD CAPACITY WEB-TO-FLANGE WELD DESIGN: CONNECTED MATERIAL CAPACITY	0	1
13. Economic Feasibility Checks	ECONOMIC FEASIBILITY CHECKS	1	1
14. Negative Moment Serviceability Checks	LONGITUDINAL SLAB REINFORCEMENT AT CONTINUOUS SUPPORTS MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT	0	0

Table 6.58-1 Summary of Defaults for OSC Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
15. SPLRFD Information	SPLRFD INPUT INFORMATION	1	1
16. NSBA Splice Information	NSBA SPLICE INPUT INFORMATION	1	1

The program output is organized such that a set of the specification checking output is printed for each live load vehicle associated with the specified live load code entered on the CTL command. For vehicles designated as Design, Analysis, or Permit Vehicles, all specification check output reports appropriate for the given run will print with that vehicle. For vehicles designated as Rating Vehicles, only specification check reports with information needed to calculate the rating will be printed with that vehicle.

The following specification checking output reports will print with all live load vehicles, if applicable (i.e. wind load and pressure will not print if wind has not be defined for the program run):

DUCTILITY AND WEB/FLANGE PROPORTION CHECKS
COMPACTNESS CRITERIA
USER-DEFINED WIND LOAD AND PRESSURE
COMPUTED WIND LOAD AND PRESSURE
WIND EFFECTS
INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY CALCULATIONS
MOMENT FLEXURAL CAPACITY (COMPOSITE, +FLEX, COMPACT OR APPENDIX A, NO LTB)
STRESS FLEXURAL CAPACITY (NONCOMPOSITE OR -FLEX OR COMPOSITE/NONCOMPACT, NO LTB)
INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS
LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE)
FLANGE LATERAL CAPACITY
NET SECTION FRACTURE CHECK
SERVICE LIMIT STATE - FLEXURAL RESISTANCE
SERVICE LIMIT STATE - WEB BEND-BUCKLING
SHEAR CAPACITY

All other specification checking output reports will only appear once, grouped with the Analysis / Design / Permit Vehicle output.

6.59 ORF - OUTPUT OF RATING FACTORS COMMAND

The defaults for this command are dependent on whether an analysis or design run is being generated. A summary of the defaults is presented in Table 1. Also presented in Table 1 is a list of the output tables printed with each parameter.

Table 6.59-1 Summary of Defaults for ORF Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS	
		ANALYSIS RUN	DESIGN RUN
1. Vehicle Rating Summary	RATING FACTORS - SUMMARY	0	1
2. Detailed Rating Factors	RATING FACTORS - MOMENT FLEXURAL CAPACITY RATING FACTORS - STRESS FLEXURAL CAPACITY RATING FACTORS - SHEAR CAPACITY	0	0
3. Overall Rating Summary	RATING FACTORS - OVERALL SUMMARY BRIDGE LOAD RATINGS	1	1
4. Ratings Without Future Wearing Surface	When ratings are requested for both with FWS and without FWS all tables included by parameters 1 through 3 are printed twice; once with FWS and once without FWS. This parameter only applies to program runs with FWS load specified.	1	0

7 OUTPUT DESCRIPTION

7.1 GENERAL OUTPUT INFORMATION

Information is provided for describing output table controls, page format, page numbering, and page header. In general, the page format is built into the program and cannot be changed by the user for either the .OUT output file or the .PDF output file. The one exception is that the user can specify the number of blank lines to be printed at the top of each page before the page header is printed. This formatting change will be reflected in both .OUT and .PDF output files accordingly.

7.1.1 Output Table Controls

The output table controls are specified using a number of input commands and parameters to control which output reports will be printed. These controls are specified using six different input commands, according to which kind of output they represent. These six kinds of output are: input data, section properties, analysis results, design trials, specification checking, and rating factors. The commands and their defaults are discussed in Sections 6.53 through 6.58.

7.1.2 Page Format

There is a maximum of 101 columns in the output files. Columns 1, 2, 3, and 4 have been left blank to provide a margin on the left side of the page. This has been done to make the output files less dependent on the output device capabilities. The output is therefore limited to 97 characters, column 5 to column 101. The user can specify the number of lines to be left blank at the top of the page with the CFG command.

7.1.3 Page Numbering

The program assigns page numbers and determines when a new page should begin. There are certain rules built into the program to determine when a new page should begin. The program will attempt to fit up to the number of lines specified on the CFG command on each page. Internally, the program keeps track of how many lines are left on the page and adjusts according to the number of lines in the heading of the output table and a minimum number of data lines required after the heading.

7.1.4 Page Header

After the cover page, header information is printed at the top of each page. A sample header is shown in Figure 1.

```
LRFD Steel Girder Design and Rating, Version 1.0                    PAGE  29
Input File:  EX1.DAT                                       01/20/97  15:27:58
----------------------------------------------------------------------------
                                 EXAMPLE 1
                              ANALYSIS (cont.)
----------------------------------------------------------------------------
```

Figure 7.1-1 Page Header

Information printed in the header includes:

1. Program Title, Version Number - the program name and version number is located at the top left corner of the header.
2. Page Number - the page number appears at the top right corner of the header.
3. Input File - the name of the input data file used to create this output is shown at the beginning of the second line.
4. Date and Time - the date and time of the program execution for this problem is printed at the right side of the second line.
5. A separator line is printed between program specific header information and user specified header information.
6. The next header line contains the first title line input by the user via the TTL command. This should be a general descriptive line used to describe the problem to be run.
7. The next header line contains the type of output specified by the user.
8. The final header line is another separator line.

7.1.5 Units

For each value presented in the output, the corresponding units are provided. The units are presented in the column headings directly below the column description. Presented in Table 1 is a summary of the basic units of measure used by this program.

Table 7.1-1 Units

Variable	Unit of Measure (U.S. Customary Units)
AREA	in^2
BEAM DEPTH	in
BEAM SPACING	ft
BRACE SPACING	ft
CONCENTRATED LOAD	kips
DEFLECTION	in
CONCRETE DENSITY or UNIT WEIGHT	lbf/ft^3
DEPTH	in
DISTANCE ALONG SPAN	ft
DISTANCE TO NEUTRAL AXIS	in
DISTRIBUTED LOAD	kip/ft
FORCE	kips
GAGE DISTANCE	ft
LANE WIDTH	ft
LONGITUDINAL STIFFNESS PARAMETER	$10^4 in^4$
MODULUS OF ELASTICITY	ksi
MOMENT	kip-ft
MOMENT OF INERTIA	in^4
OVERHANG WIDTH	ft
PASSING DISTANCE	ft
RADIUS OF GYRATION	in
RATING TONNAGE	tons
REACTION	kips
REINFORCEMENT AREA	in^2/ft
ROTATION	radians
SECTION MODULUS	in^3
SHEAR	kips
SHEAR CONNECTOR PITCH	in
STIFFENER SPACING	in
STRESS	ksi
STRUCTURE HEIGHT	ft
THICKNESS	in
WEIGHT	lbf
WIDTH	in

7.1.6 Sign Conventions

Presented in Table 2 is a summary of the sign conventions used by this program.

Table 7.1-2 Sign Conventions

Variable	Sign Convention
MOMENT	A moment that causes a compressive stress in the extreme top fiber of the girder is positive.
REACTION	A reaction acting in the upward direction is positive.
LOAD	A load acting in the downward direction is positive.
SHEAR	A shearing force acting downward on the right face of the free body in equilibrium is positive.
DEFLECTION	A downward deflection is positive.
AXIAL FORCE	A force causing tension is positive.
STRESS	A tensile stress is positive.

7.2 COVER PAGE

The first page of the output is the cover page. The following information is shown at the top of the cover page:

1. Program Title - LRFD Steel Girder Design and Rating
2. Program Name - STLRFD
3. Version i.i.n.n - where i.i represents the numeric designation for major revisions and enhancements to the program and n.n represents the numeric designation for minor revisions.
4. Last Updated - this is the date the program was last revised.
5. Documentation - this is the date the User's Manual was last revised.
6. License Number - this is a unique number assigned to all licensees per the License Agreement.

The middle section of the cover page is reserved for the first 10 TTL commands input by the user. This information typically should describe the bridge, location, stationing, span length, type of structure, and any other information the user would need to identify the output.

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7.3 INPUT DATA

The input data consists of an echo of the input file, summary of input commands, and input summary tables. Each of these can individually be turned on or off. A summary of the output tables included is given in Section 6.53.

7.3.1 Input File Echo

The input file echo (parameter 1) is a listing of the input commands and comments as entered by the user. The user can refer to this section to trace input errors and warnings by comparing the input data to the input descriptions provided in Chapter 5. The input file can contain 512 characters in a single line, but the output is limited to 75 characters on a single line. If the input line contains more than 75 characters, the input file echo will be wrapped to the next row. Other than this limitation, the echo of the input file should appear the same as the input data file.

7.3.2 Input Commands

This section (parameter 2) is a summary that includes a detailed description of each input parameter for all input commands entered by the user. The summary of input commands is in a vertical format. Two examples of the input commands are shown in Figure 1.

The summary of input commands includes the following information:

1. Command keyword.
2. Input parameter description.
3. Value of the input parameter as entered or the default value as stored in the program. The value is displayed to the same number of significant figures as entered by the user or as stored in the input parameter file. The word (default) is placed to the right of the units when default values are used. An asterisk (*) indicates the input value is optional and was not entered.
4. Units if applicable.
5. Any warnings or errors encountered with respect to the input data.

Input values may be optional or required. Required input is input that is entered by the user or set to the default value stored in the program. Default values are indicated with the text (default) placed to the right of the units. If there is no default value stored in the program and the user does not enter a value, an error message is displayed.

```
COMMAND:  CTL
  SYSTEM OF UNITS                      US
  DESIGN/ANALYSIS                       A
  TYPE OF BEAM                         RB
  EXTERIOR/INTERIOR                     I
  NO. OF BEAMS                          4
  NO. OF SPANS                          1
  SYMMETRY                              N
  DECK POUR SYMMETRY                    N
  ADTT FOR SINGLE LANE               1700
  MULT. PRES. ADJ. FACTOR             1.0
  LIVE LOAD                             A
  DYNAMIC LOAD ALLOWANCE             1.33            (default)
  FATIGUE DYN. LOAD ALLOW.           1.15            (default)
  PA TRAFFIC FACTOR                     *        (computed, if necessary)
  REDISTRIBUTE NEG. MOMENTS             N
  IMPORTANCE FACTOR                   1.0
  DUCTILITY FACTOR                   0.95
  REDUNDANCY FACTOR                  0.95
  REDUNDANT LOAD PATH                   R
  OUTPUT POINTS                         2
  P-82 DYN. LOAD ALLOW.              1.20            (default)

COMMAND:  GEO
  BEAM/STRINGER SPACING              18.5 ft
          %WARNING - <GEO>:
              Real value out of range
              The value entered for BEAM/STRINGER SPACING is
               greater than the upper range limit.
              Value Entered: 18.5
              Valid values are between 3. and 18. inclusive
  DECK OVERHANG                       9.5 ft
  STAGGERED DIAPHRAGMS                  N
  NO. OF DESIGN LANES                   2
  DEFLECTION DF                       1.0
  SDWK NO. OF DESIGN LANES              *        (computed, if necessary)
  SDWK DEFLECTION DF                    *        (computed, if necessary)
```

Figure 7.3-1 CTL and GEO Summary of Input Commands

Optional input does not need to be entered by the user. An asterisk (*) is printed for the value indicating the input value is optional. In some cases when input is not entered, the program sets the value. An example of an optional input parameter set by the program is the effective slab thickness. Some input is optional because it is not required for the particular problem being run. For example, the girder overhang is not required for an interior girder analysis. For more information regarding specific input requirements, refer to Chapter 5.

Any warnings or errors encountered while processing the input data will be reflected with the appropriate input command under the summary of input commands. If this level of input data output is turned off, the warnings will still appear, though without the added benefit of the warnings and errors being grouped with the corresponding input command. The program has almost 600 different input warning and error messages. After encountering warnings or errors, the program also prints a message to the screen advising the user to review the output file for explanations of the warnings and errors.

7.3.3 Input Summary

The input summary consists of tables that include summaries of all input parameters in horizontal tabular format. The input summary tables also include all processed input. Processed input is input that gets computed by the program based on other input items, including program set optional input values. A more complete description of all input items can be found in Chapters 5 and 6. Processed input items include the effective slab thickness, modular ratio, brace points, and the web depth for girders having a varying web depth.

For the rolled beam properties, built-up properties, and plate girder properties tables, the start and end of range points for section loss are considered end of range points and thus are included in the above listed tables. Finally, for a variable depth web, each computer-generated and user-defined analysis point (as specified in Section 3.2) is considered an end of range point and thus is included in the above listed tables.

For symmetrical runs, the input ranges are mirrored to the symmetrical side of the bridge. All ranges are sorted into the correct order.

Two examples of input summary tables are shown in Figure 2.

```
                                          CONTROL PARAMETERS
                                          ------------------
                                                                               Single   Multiple
       Design/     Type of     Exterior/  No.    No.             Deck Pour   Lane     Presence
Units  Analysis     Beam       Interior  Beams  Spans  Symmetry  Symmetry    ADTT   Adj. Factor
 US    ANALYSIS  PLATE GIRDER  INTERIOR    4      4       NO        NO       1210      N/A

                             Fatigue      PA    Redist.
Live Load  Dynamic Load  Dynamic Load  Traffic   Neg.    Impor. Duct.   Redun.  Redundant
  Code      Allowance     Allowance    Factor  Moments   Factor Factor  Factor  Load Path
   A          1.330         1.150        N/A     N/A     1.000  1.000   1.000      N/A

            Design                     Constant                        Automatic    Uncured
        Permit Vehicle                 Lateral                Check      Brace    Slab Checks
Analysis  Dynamic Load   Skew Angle   Bending      DC1S     Appendix  Points at   With Deck
 Points    Allowance    Designation    Stress   Percentage     A      Supports     Pours
                                        (ksi)
    2        1.200          N/A*        0.00       0.00       YES       YES         N/A***

      *NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR
             command, the skew angle designation is set via the CDF command.

    ***NOTE: There are no defined deck pours in this input file (DPS command).
             This value will NOT be used and all uncured slab checks will be done.

                                            BEAM GEOMETRY
                                            -------------
                                   Number                 Number                         Number of
 Beam/                               of     Deflection      of     Deflection   Kinked/  Beams for
Stringer    Deck    Staggered   Design  Distribution  Design  Distribution  Curved   6.10.3.4.2
Spacing   Overhang  Diaphragms  Lanes      Factor     Lanes      Factor     Girder     Check
  (ft)      (ft)                 (without Sidewalk)     (with Sidewalk)
  8.000     N/A        NO          2                    N/A       N/A         NO         4
```

Figure 7.3-2 CTL and GEO Input Summary Tables

The input summary tables contain the following information:

1. A description of the input data.
2. Input parameter header containing an abbreviated parameter description and units.
3. Input parameter values. The input values are shown to a fixed number of decimal places because of the tabular format. The actual input value may be rounded to fit the output format. Refer to the summary of input commands for the actual value input by the user.

7.4 SECTION PROPERTIES

The section property output consists of the gross section properties for girder stiffness, general section properties for specification checking, and additional section properties for specification checking. A summary of the output tables for each control is given in Section 6.54. The user can suppress all section property output by setting every parameter to zero.

7.4.1 Gross Section Properties

These are the section properties that are required to perform the analysis using CBA. The properties are reported for noncomposite and composite analysis. The properties are based on the gross section (no section loss or holes) for the analysis. The following information is reported in the GROSS SECTION PROPERTIES output table.

1. Start Span Number - span number corresponding to the start of the section range.
2. Start Span Distance - the distance to the start of the section range measured from the left support of the specified span number.
3. End Span Number - span number corresponding to the end of the section range.
4. End Span Distance - the distance to the end of the section range measured from the left support of the specified span number.
5. Average Section Depth – the depth of the section used for calculating the gross cross section properties. This depth is taken as the average of the depths at the start distance and the end distance.
6. Composite Status - this is the status for composite action. The possible values are noncomposite, composite 3n, composite n, and composite n/0.70 (only printed for problems with deck pour staging).
7. Beam Area - cross sectional area of the steel beam. This is used to compute the self-weight of the beam.
8. Moment of Inertia - moment of inertia about the horizontal neutral axis of the beam.
9. Distance from Neutral Axis to Bottom of Beam, y - distance from horizontal neutral axis to the bottom of the beam.

7.4.2 Net Section Properties

These are the net section properties used for checking the LRFD Specifications. Net section properties are reported for the following cases as applicable:

1. Noncomposite positive flexure
2. Composite(3n) positive flexure
3. Composite(n) positive flexure
4. Composite(n/0.7) positive flexure
5. Noncomposite negative flexure
6. Composite negative flexure

The net section properties are the same as the gross section properties if there is no section loss (deterioration). If there is section loss, the properties are based on considering the section loss. The following information is reported in the NET SECTION PROPERTIES output tables.

1. End Span Number - span number corresponding to the end of the section range.
2. End Span Distance - the distance to the end of the section range measured from the left support of the specified span number.
3. Moment of Inertia - moment of inertia about the horizontal neutral axis of the beam.
4. Distance to Neutral Axis, Bottom of Beam - distance from the horizontal neutral axis to the bottom of the beam.
5. Distance to Neutral Axis, Top of Beam - distance from the horizontal neutral axis to the top of the beam.
6. Distance to Neutral Axis, CG of Reinforcement - distance from the horizontal neutral axis to the centroid of the slab reinforcement.
7. Distance to Neutral Axis, Top of Slab - distance from the horizontal neutral axis to the top of the effective slab.
8. Section Modulus, Bottom of Beam - section modulus at the bottom of the beam.
9. Section Modulus, Top of Beam - section modulus at the top of the beam.
10. Section Modulus, CG of Reinforcement - section modulus at the centroid of the slab reinforcement.
11. Section Modulus, Top of Slab - section modulus at the top of the effective slab.

7.4.3 Additional Section Properties

These are additional section properties that are used for checking the LRFD Specifications. The properties are reported for positive and negative flexure as appropriate. The properties reported take into consideration section loss. The following information is reported in the ADDITIONAL SECTION PROPERTIES PART 1 output tables.

1. End Span Number - span number corresponding to the end of the section range.
2. End Span Distance - the distance to the end of the section range measured from the left support of the specified span number.
3. Beam Area - cross sectional area of the steel beam only, computed taking section loss into account.
4. Effective Slab Width - effective slab width for composite action.
5. Moment of Inertia, Compression Flange, Iyc - moment of inertia of the compression flange of the steel section about the vertical axis.
6. Moment of Inertia, Tension Flange, Iyt - moment of inertia of the tension flange of the steel section about the vertical axis.
7. Moment of Inertia, Y Axis, Iy - moment of inertia of the girder about the vertical axis.

8. Radius of Gyration, Steel, ry - radius of gyration of the girder about the vertical axis.
9. Radius of Gyration, Compression Flange, r' - radius of gyration of the compression flange of the steel section about the vertical axis.

The following information is reported in the ADDITIONAL SECTION PROPERTIES PART 2 output tables.

1. End Span Number - span number corresponding to the end of the section range.
2. End Span Distance - the distance to the end of the section range measured from the left support of the specified span number.
3. 1st Moment of Inertia of Transformed Section, Q - first moment of the transformed short-term (n) slab area about the neutral axis of the short-term composite section in positive bending regions, or the first moment of the area of the longitudinal reinforcement about the neutral axis of the composite section in negative bending regions.
4. Plastic Properties, N.A. to Top Slab - neutral axis to the top of the slab based on the effective slab thickness.
5. Plastic Properties, Moment, Mp - plastic moment capacity.
6. Plastic Properties, Depth of Web, Dcp - depth of web in compression at the plastic moment.
7. Distance Between Center of Gravity of Steel and Slab - distance from the center of gravity of the steel girder to the center of gravity of the slab, based on the effective slab thickness.
8. Longitudinal Stiffness Parameter - longitudinal stiffness parameter.

7.5 DESIGN TRIALS OUTPUT

A summary of the output tables for each parameter is given in Section 6.55. The user can suppress all design output by entering zero for every design output parameter. These output parameters only apply for design runs.

7.5.1 Rolled Beam Design Trials, Part 1 of 2

The following information is reported in the ROLLED BEAM DESIGN TRIALS, PART 1 OF 2 output table. These results will only print for a rolled beam design run.

1. Designation - AISC designation of the rolled beam shape checked.
2. Nominal Depth - nominal depth of the rolled beam designated above.
3. Nominal Weight - weight of the rolled beam designated above per unit length.
4. Moment of Inertia - moment of inertia of the rolled beam designated above.
5. Area - area of the rolled beam designated above.

7.5.2 Rolled Beam Design Trials, Part 2 of 2

The following information is reported in the ROLLED BEAM DESIGN TRIALS, PART 2 OF 2 output table. These results will only print for a rolled beam design run.

1. Designation - AISC designation of the rolled beam shape checked.
2. Flange Width - width of the flanges of the rolled beam designated above.
3. Flange Thickness - thickness of the flanges of the rolled beam designated above.
4. Beam Depth - total depth of the rolled beam designated above.
5. Web Thickness - web thickness of the rolled beam designated above.
6. Distance "k" - distance from the outer face of the flange to the web toe of the fillet

7.5.3 Design Trials: Flange Splice Plate Properties

The following information is reported in the DESIGN TRIALS: FLANGE SPLICE PLATE PROPERTIES output table. These results will only print for a rolled beam design run that includes field splice locations.

1a. Designation - AISC designation of the rolled beam shape checked.
1b. Span Number - span number corresponding to the location of the field splice.
2. Starting Field Splice Plate Distance - starting (left edge) distance along the span of the field splice plate.
3. Ending Field Splice Plate Distance - ending (right edge) distance along the span of the field splice plate.
4. Bolt Hole Spacing, Minimum - minimum bolt hole spacing.

5. Bolt Hole Spacing, Adjusted - adjusted bolt hole spacing computed from available flange distance.
6. Bolt Hole Diameter, Minimum - minimum bolt hole diameter.
7. Bolt Hole Diameter, Adjusted - adjusted bolt hole diameter computed from available flange distance.
8. Bolt Hole Number - the number of bolt holes per side of the flange.
9. Edge Distance, Inner (e_{in}), Minimum - minimum inner edge distance.
10. Edge Distance, Inner (e_{in}), Adjusted - adjusted inner edge distance.
11. Edge Distance, Outer (e_{out}), Minimum - minimum outer edge distance.
12. Edge Distance, Outer (e_{out}), Adjusted - adjusted outer edge distance.

7.5.4 Rolled Beam Final Design, Part 1 of 2

The same information is printed on this table as described in Section 7.5.1. The results in this table are for the final rolled beam design found by the program. These results will only print for a rolled beam design run.

7.5.5 Rolled Beam Final Design, Part 2 of 2

The same information is printed on this table as described in Section 7.5.2. The results in this table are for the final rolled beam design found by the program. These results will only print for a rolled beam design run.

Additionally, the following note will print under the table:

The final design satisfies infinite fatigue life criteria for a Category C' detail at the top of the bottom flange at the point of maximum fatigue moment. This is an indicator that any category C' details at the top of the bottom flange (such as may be encountered with the weld of a connection plate) will satisfy infinite life criteria for the designed beam.

7.5.6 Flange Splice Plate Properties Final Design

The same information is printed on this table as described in Section 7.5.3. The results in this table are for the final rolled beam design found by the program. These results will only print for a rolled beam design run that includes one or more field splices.

7.5.7 Plate Girder Design Trials

Three separate tables print for each trial under the heading of PLATE GIRDER DESIGN TRIALS. The following information is reported in the TRIAL i: GIRDER DESIGN output table. These results will only print for a plate girder design run.

1. End Span Number - span number corresponding to the end of the section range.
2. End Span Distance - the distance to the end of the section range measured from the left support of the specified span number.
3. Web Depth - depth of the web plate in the current range.
4. Web Thickness - thickness of the web plate in the current range.
5. Top Flange Width - width of the top flange in the current range.
6. Top Flange Thickness - thickness of the top flange in the current range.
7. Bottom Flange Width - width of the bottom flange in the current range.
8. Bottom Flange Thickness - thickness of the bottom flange in the current range.
9. Maximum Design Ratio - the maximum ratio obtained from the following specification checks at each analysis point:
   - Factored moment / moment resistance for all strength and service limit states
   - Dead load web stress / allowable dead load web stress
   - Uncured slab placement web stress / allowable dead load web stress
   - Uncured slab placement flange stress / allowable noncomposite flange stress
   - Live load deflection / allowable live load deflection (L/800)
   - Live load deflection with pedestrian deflection / allowable live load deflection for pedestrian cases (L/1000)

   An optimal design should have a maximum design ratio, Q_{actual} / $Q_{allowable}$, as close as possible to 1.00 without exceeding 1.00, where Q = given force effect.

The following information is reported in the TRIAL i: FLANGE SPLICE PLATE PROPERTIES output table. These results will only print for a plate girder design run that includes field splice locations.

1. Span Number - span number corresponding to the location of the field splice.
2. Starting Field Splice Plate Distance - starting (left edge) distance along the span of the field splice plate.
3. Ending Field Splice Plate Distance - ending (right edge) distance along the span of the field splice plate.
4. Bolt Hole Spacing, Minimum - minimum bolt hole spacing.
5. Bolt Hole Spacing, Adjusted - adjusted bolt hole spacing computed from available flange distance.
6. Bolt Hole Diameter, Minimum - minimum bolt hole diameter.
7. Bolt Hole Diameter, Adjusted - adjusted bolt hole diameter computed from available flange distance.
8. Bolt Hole Number - the number of bolt holes per side of the flange.
9. Edge Distance, Inner (e_{in}), Minimum - minimum inner edge distance.
10. Edge Distance, Inner (e_{in}), Adjusted - adjusted inner edge distance.
11. Edge Distance, Outer (e_{out}), Minimum - minimum outer edge distance.
12. Edge Distance, Outer (e_{out}), Adjusted - adjusted outer edge distance.

The following information is reported in the TRIAL i: TRANSVERSE STIFFENER DESIGN output table. These results will only print for a plate girder design run that includes transverse stiffener design.

1. Start Span Number - span number corresponding to the beginning of the stiffener range.
2. Start Span Distance - the distance to the beginning of the stiffener range measured from the left support of the specified span number.
3. End Span Number - span number corresponding to the end of the stiffener range.
4. End Span Distance - the distance to the end of the stiffener range measured from the left support of the specified span number.
5. Stiffener Type* - type of stiffener designed for the current range. The types are denoted by the alphabetic combinations as described below:

   S P - Single plate stiffener

   S A - Single angle stiffener

   P P - Pair of plate stiffeners

   P A - Pair of angle stiffeners
6. Stiffener Spacing - spacing of the transverse stiffeners in the current range.
7. Projecting Width - width of the stiffener as designed by the program.
8. Stiffener Thickness - thickness of the stiffener as designed by the program.
9. Yield Strength - user-defined yield strength of the transverse stiffeners.
10. Web Leg Length - length of the angle leg along the web if angle stiffeners are used.

The following data is also included at the bottom of the table:

Equivalent Weight - the weight of the entire girder (top flange, bottom flange, and web) plus the total number of flange plate transitions (both top and bottom) times the user-defined weight savings per plate transition.

7.5.8 Plate Girder Final Design

The following information is reported in the PLATE GIRDER FINAL DESIGN output table. These results will only print for a plate girder design run.

1. End Span Number - span number corresponding to the end of the section range.
2. End Span Distance - the distance to the end of the section range measured from the left support of the specified span number.
3. Web Depth - depth of the web plate in the current range.
4. Web Thickness - thickness of the web plate in the current range.
5. Top Flange Width - width of the top flange in the current range.
6. Top Flange Thickness - thickness of the top flange in the current range.
7. Bottom Flange Width - width of the bottom flange in the current range.

8. Bottom Flange Thickness - thickness of the bottom flange in the current range.
9. Maximum Design Ratio - the maximum ratio obtained from the following specification checks at each analysis point:
   - Factored moment / moment resistance for all strength and service limit states
   - Dead load web stress / allowable dead load web stress
   - Uncured slab placement web stress / allowable dead load web stress
   - Uncured slab placement flange stress / allowable noncomposite flange stress
   - Live load deflection / allowable live load deflection (L/800)
   - Live load deflection with pedestrian deflection / allowable live load deflection for pedestrian cases (L/1000)

   An optimal design should have a maximum design ratio, Q_{actual} / $Q_{allowable}$, as close as possible to 1.00 without exceeding 1.00, where Q = given force effect.

The following data is also included at the bottom of the table:

Equivalent Weight - the weight of the entire girder (top flange, bottom flange, and web) plus the total number of flange plate transitions (both top and bottom) times the user-defined weight savings per plate transition.

The program could not design a plate girder within the given user input limits to meet all LRFD requirements. Relax the design plate girder limits and rerun. - an indicator that the program ran out to the limits and was unable to design an acceptable plate girder that passed all of the requirements of the LRFD Specifications. The user should relax the limits and then rerun the program.

The maximum number of design iterations, (ii), was reached before the program could converge on a plate girder. - an indicator that the program performed as many design iterations as allowed, but still could not design an optimum girder. The user should place restrictions on the design and then rerun the program.

The program converged on a plate girder after ii trials. - an indicator that the program was able to converge on an acceptable design and the number of required trials.

The final design satisfies infinite fatigue life criteria for a Category C' detail at the top of the bottom flange at the point of maximum fatigue moment and at all flange transition points. - an indicator that any category C' details at the top of the bottom flange (such as may be encountered with the weld of a transverse stiffener) will satisfy infinite life criteria for the designed girder.

WELD SIZE:

Fillet weld size between: top flange and web: x.xxx in
bottom flange and web: x.xxx in

Provides the design weld size between top flange and web, bottom flange and web. The weld size provided here is the maximum of the computed weld size and the required minimum weld size.

7.5.9 Field Splice Plate Properties Final Design

The following information is reported in the FLANGE SPLICE PLATE PROPERTIES FINAL DESIGN output table. These results will only print for a plate girder design run that includes field splice locations.

1. Span Number - span number corresponding to the location of the field splice.
2. Starting Field Splice Plate Distance - starting (left edge) distance along the span of the field splice plate.
3. Ending Field Splice Plate Distance - ending (right edge) distance along the span of the field splice plate.
4. Bolt Hole Spacing, Minimum - minimum bolt hole spacing.
5. Bolt Hole Spacing, Adjusted - adjusted bolt hole spacing computed from available flange distance.
6. Bolt Hole Diameter, Minimum - minimum bolt hole diameter.
7. Bolt Hole Diameter, Adjusted - adjusted bolt hole diameter computed from available flange distance.
8. Bolt Hole Number - the number of bolt holes per side of the flange.
9. Edge Distance, Inner (e_{in}), Minimum - minimum inner edge distance.
10. Edge Distance, Inner (e_{in}), Adjusted - adjusted inner edge distance.
11. Edge Distance, Outer (e_{out}), Minimum - minimum outer edge distance.
12. Edge Distance, Outer (e_{out}), Adjusted - adjusted outer edge distance.

7.5.10 Transverse Stiffeners Final Design

The following information is reported in the TRANSVERSE STIFFENERS FINAL DESIGN output table. These results will only print for a plate girder design run that includes transverse stiffener design.

1. Start Span Number - span number corresponding to the beginning of the stiffener range.
2. Start Span Distance - the distance to the beginning of the stiffener range measured from the left support of the specified span number.
3. End Span Number - span number corresponding to the end of the stiffener range.
4. End Span Distance - the distance to the end of the stiffener range measured from the left support of the specified span number.
5. Stiffener Type* - type of stiffener designed for the current range. The types are denoted by the alphabetic combinations as described below:

   S P - Single plate stiffener

   S A - Single angle stiffener

   P P - Pair of plate stiffeners

   P A - Pair of angle stiffeners

6. Stiffener Spacing - spacing of the transverse stiffeners in the current range.
7. Projecting Width - width of the stiffener as designed by the program.
8. Stiffener Thickness - thickness of the stiffener as designed by the program.
9. Yield Strength - user-defined yield strength of the transverse stiffeners.
10. Web Leg Length - length of the angle leg along the web if angle stiffeners are used.

7.6 ANALYSIS RESULTS OUTPUT

A summary of the output tables for each parameter is given in Section 6.56. The user can suppress all analysis output by entering zero for every analysis output parameter. These output parameters apply for both design and analysis runs.

7.6.1 Points of Contraflexure

This table prints out the points of contraflexure. The following information is reported in the POINTS OF CONTRAFLEXURE output table.

1. Dead Load Points of Contraflexure, Span Number - the span number of the current dead load point of contraflexure.
2. Dead Load Points of Contraflexure, Distance - the location of the dead load point of contraflexure in the current span. These points are calculated by the program from the noncomposite dead loads computed by the program.
3. Code Check* - several different code checks may occur when computing the points of contraflexure. The failures are denoted by the alphabetic character A as described below

   A There is only one dead load point of contraflexure in this span. check for possible uplift condition and verify program input - the program only calculated one point of dead load contraflexure in this span. This is possible depending on the span configuration and may indicate a possible uplift condition at one or more supports. The input should be verified for correctness and completeness.

   The presence of the character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.6.2 Load Factors and Combinations

The Load Factors and Combinations table shows all of the load factors used by the program. The user can change the load factors for miscellaneous MC1 load, miscellaneous MC2 load (MC2), and the live load (LL) factors for a special live load (SLL) run of the program. The following information is reported in the LOAD FACTORS AND COMBINATIONS output table.

1. Limit State (Column Headings) - the limit state for which the load factors apply.
2. gDC Max - the maximum load factor to be applied to the girder, slab, haunch, user input DC1, and user input DC2 loads for each limit state.
3. gDC Min - the minimum load factor to applied to the girder, slab, haunch, user input DC1, and user input DC2 loads for each limit state.

4. gDW Max - the maximum load factor to be applied to future wearing surface and utility dead loads for each limit state.
5. gDW Min - the minimum load factor to be applied to future wearing surface and utility dead loads for each limit state.
6. gSWK Max - the maximum load factor to be applied to the sidewalk load for each limit state.
7. gSWK Min - the minimum load factor to be applied to the sidewalk load for each limit state.
8. gAWS Max - the maximum load factor to be applied to the additional wearing surface load for each limit state.
9. gAWS Min - the minimum load factor to be applied to the additional wearing surface load for each limit state.
10. gMC1 Max - the maximum load factor to be applied to the miscellaneous MC1 dead load for each limit state.
11. gMC1 Min - the minimum load factor to be applied to the miscellaneous MC1 dead load for each limit state.
12. gMC2 Max - the maximum load factor to be applied to the miscellaneous MC2 dead load for each limit state.
13. gMC2 Min - the minimum load factor to be applied to the miscellaneous MC2 dead load for each limit state.
14. gWS - the load factor to be applied to the wind load effects for each limit state.
15. gLL - the load factor to be applied to the vehicular live load for each limit state.
16. gPermit - the load factor to be applied to the permit live load for each limit state.
17. gRate - the load factor to be applied to the rating vehicles for each limit state
18. gPL - the load factor to be applied to pedestrian live load for each limit state.
19. gFAT - the load factor to be applied to fatigue live load for each limit state.
20. gSLL # - the load factor to be applied to special live load # for each limit state.

7.6.3 Live Loading Summary (Design/Analysis, Live Load Code: a)

This report presents the live load vehicles considered for each limit state, and identifies when an Inventory Rating, an Operating Rating, or a Specification Check is made. The following information is reported in the LIVE LOADING SUMMARY output table.

1. Limit State (Column Headings) - the limit states for which the live loadings are applicable.
2. Design/Analysis and Rating Vehicles - the following rows list the vehicles considered for Analysis or Design. For each vehicle, the limit state column indicates if an I (Inventory Rating), O (Operating Rating), SC (Specification Check), or '--' (none) applies to this vehicle and limit state combination. The limit states identified as I or O are also used for specification checks.
3. Permit and Rating Vehicles - the following rows list the vehicles considered for Permit. For each vehicle, the limit state column indicates if an I (Inventory Rating), O (Operating Rating), SC

(Specification Check), or '--' (none) applies to this vehicle and limit state combination. The limit states identified as I or O are also used for specification checks.

4. Rating Only Vehicles - the following rows list the vehicles considered for Rating. These vehicles are in addition to the vehicles listed in the previous two groups. For each vehicle, the limit state column indicates if an I (Inventory Rating), O (Operating Rating), or '--' (none) applies to this vehicle and limit state combination.
5. Fatigue - this row lists the vehicle considered for Fatigue. Only the Fatigue-I and Fatigue-II limit states apply to this vehicle and only a specification check is made.
6. Deflection - this row lists the vehicle considered for Deflection. Only the Deflection Limit State applies to this vehicle and only a specification check is made.

7.6.4 Load Modifier

The following information is reported in the LOAD MODIFIER output table.

1. Importance Factor, Ni - the importance factor of the bridge.
2. Ductility Factor, Nd - the ductility factor of the girder.
3. Redundancy Factor, Nr - the redundancy factor of the girder.
4. Calculated Ni*Nd*Nr - the cumulative eta factor found by multiplying the three other eta factors together.
5. Load Modifier Used - the actual cumulative eta factor used by the program for regular loads. This factor depends on limits imposed by DM-4 and the LRFD Specifications.
6. Fatigue Load Modifier Used - the actual cumulative eta factor used by the program for fatigue loads. This factor depends on limits imposed by DM-4 and the LRFD Specifications.

The following may print on the table:

Value of Ni*Nd*Nr = x.xxx is outside allowable bounds. Resetting load modifier to x.xxx. - this prints if the product of the factors is outside of the specified bounds. The product is reset to the bound which is exceeded.

The following may also print on the table:

As per PennDOT DM-4 Sections 1.3.2 through 1.3.5, ETA factors other than 1.0 are not permitted by PennDOT. - this prints if any of the ETA factors is not equal to 1.0.

7.6.5 Resistance Factors

The resistance factors are used by the program to modify the nominal resistances of the section. The following information is reported in the RESISTANCE FACTORS output table.

1. Flexure - resistance factor for flexure of the section.
2. Shear - resistance factor for shear on the section.
3. Axial Compression - resistance factor for compression of the section.
4. Bearing on Pins - resistance factor for bearing of the section on pins. Also used for checking the bearing resistance of the section at supports.
5. Shear Connector - resistance factor used for computing resistances of the shear connectors.

7.6.6 Dead Loads

The dead load due to the beam, slab and haunch are computed by the program. Refer to the method of solution regarding more information and equations used in computing the dead load of the slab and haunch. The following information is reported in the DEAD LOADS output table.

1. End Span Number - span number corresponding to the end of the loading region.
2. End Span Distance - distance to the end of the loading region measured from the left support of the specified span number.
3. Beam Weight - weight of the steel beam only. This includes cover plates.
4. Slab & Haunch Weight - weight due to the slab and haunch.
5. Additional DC1S - DC1S loads applied to the girder as a percentage of the girder self-weight computed using the DC1S PERCENTAGE value on the CTL command.

   The following note is printed below the output table:
   *NOTE: The values in the ADDITIONAL DC1S column are computed using the DC1S PERCENTAGE value on the CTL command and are based on the steel self weight. The values in this column do NOT include DC1S load entered on the DLD or CLD commands.

7.6.7 Distribution Factors for Design Live Loading (Lane Fraction, Including Skew)

The distribution factors for the vehicular live loads (except for the fatigue vehicle) are either entered by the user or computed by the program. These distribution factors are expressed as a fraction of a lane load and include all corrections due to the skew of the supports. The following information is reported in the DISTRIBUTION FACTORS FOR DESIGN LIVE LOADING output table.

1. Span Number - span number to which the distribution factor applies.
2. Moment DF1 - the distribution factor which applies to moment in the positive bending region of the span. For codes A or B (see next column), the value in parentheses is either "S" or "M", indicating whether the Single- or Multi-lane equations are used. For codes C or D (see next column), the value in parentheses is the number of lanes loaded to produce the controlling live load distribution factor. No value in parentheses will print if the distribution factors are user input (UDF command).

3. ** - the method used to compute the Moment DF1. The methods are denoted by an alphabetic character A-D as described below:

   A - Distribution factor calculated with moment equations from AASHTO and DM-4 Tables 4.6.2.2.2b-1 and 4.6.2.2.2d-1.

   B - Distribution factor calculated with shear equations from AASHTO and DM-4 Tables 4.6.2.2.3a-1 and 4.6.2.2.3b-1.

   C - Distribution factor calculated with the lever rule.

   D - Distribution factor calculated with the rigid cross-section approximation (AASHTO Equation C4.6.2.2.2d-1).

   This column will not print if the distribution factors are user input (UDF command).

4. Moment DF2 - the distribution factor which applies to moment in the negative bending region of the span. For codes A or B (see next column), the value in parentheses is either "S" or "M", indicating whether the Single- or Multi-lane equations are used. For codes C or D (see next column), the value in parentheses is the number of lanes loaded to produce the controlling live load distribution factor. No value in parentheses will print if the distribution factors are user input (UDF command).

5. ** - the method used to compute the Moment DF2. The methods are denoted by an alphabetic character A-D as described with column 3. This column will not print if the distribution factors are user input (UDF command).

6. Shear DF1 - the distribution factor which applies to shear at the beginning of the span. For codes A or B (see next column), the value in parentheses is either "S" or "M", indicating whether the Single- or Multi-lane equations are used. For codes C or D (see next column), the value in parentheses is the number of lanes loaded to produce the controlling live load distribution factor. No value in parentheses will print if the distribution factors are user input (UDF command).

7. ** - the method used to compute the Shear DF1. The methods are denoted by an alphabetic character A-D as described with column 3. This column will not print if the distribution factors are user input (UDF command).

8. Shear DF2 - the distribution factor which applies to shear at the end of the span. For codes A or B (see next column), the value in parentheses is either "S" or "M", indicating whether the Single- or Multi-lane equations are used. For codes C or D (see next column), the value in parentheses is the number of lanes loaded to produce the controlling live load distribution factor. No value in parentheses will print if the distribution factors are user input (UDF command).

9. ** - the method used to compute the Shear DF2. The methods are denoted by an alphabetic character A-D as described with column 3. This column will not print if the distribution factors are user input (UDF command).

10. Deflection - deflection distribution factor which applies to the span.

11. Code Check* - requirements not met which may cause bridge to require the approval of the District Bridge Engineer. The requirements are denoted by an alphabetic character A-G as described below:

    A - Beam spacing is outside the range of applicability

    B - Slab thickness is outside the range of applicability

C - Span length is outside the range of applicability

D - Number of beams is less than the lower bound of applicability

E - Longitudinal stiffness parameter is outside range of applicability

F - Skew angle is outside the range of applicability

G - Distance from exterior web to curb (de) is outside the range of applicability

The presence of any character, A-G, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

12. If the shear skew correction factors are used in computing the shear distribution factors then a note as shown below is printed in the output:

    The shear distribution factors reported include the Shear Skew Correction factors, unless they are calculated with the rigid cross-section approximation (Code D)..

7.6.8 Distribution Factors With Sidewalks (Lane Fraction, Including Skew)

The same information is printed on this table as described in Section 7.6.7, except that these distribution factors are used for the vehicular live loads when sidewalks are present (except for the fatigue vehicle). These distribution factors are either entered by the user or computed by the program. These distribution factors are expressed as a fraction of a lane load and include all corrections due to the skew of the supports. For codes A and B in columns 3, 5, 7, and 9, the value in parentheses in columns 2, 4, 6, and 8 is "M", indicating that the Multi-lane equations are used. When a sidewalk is present, only the Multi-lane equations are considered. For codes C and D, the value in parentheses is the number of lanes loaded to produce the controlling live load distribution factor, and does NOT include the sidewalk as an extra loaded lane. However, the multiple presence factor (MPF) is determined considering the sidewalk as an additional lane.

7.6.9 Distribution Factors for Fatigue Vehicle (Lane Fraction, Including Skew)

The same information is printed on this table as described in Section 7.6.7, except that these distribution factors are used for the fatigue live load. These distribution factors are either entered by the user or computed by the program. These distribution factors are expressed as a fraction of a lane load and include all corrections due to the skew of the supports.

For fatigue vehicles, the deflection distribution factor will always print as N/A on this output report because the program does not need or use a distribution factor for deflection with the fatigue vehicle.

7.6.10 Distribution Factors for P-82C Combination (Multi-Lane, Lane Fraction, Including Skew)

The same information is printed on this table as described in Section 7.6.7, except that these distribution factors are used for the PHL-93 portion of the P-82C vehicular live load. These distribution factors are either entered by the user or computed by the program. These distribution factors are expressed as a fraction of a lane load and include all corrections due to the skew of the supports.

The deflection distribution factor will always print as N/A on this output report because the program does not check deflection for this load combination.

7.6.11 Distribution Factors for P-82C Combination (Single Lane, Lane Fraction, Including Skew)

The same information is printed on this table as described in Section 7.6.7, except that these distribution factors are used for the P-82 portion of the P-82C combination. These distribution factors are either entered by the user or computed by the program. These distribution factors are expressed as a fraction of a lane load and include all corrections due to the skew of the supports.

The deflection distribution factor will always print as N/A on this output report because the program does not check deflection for this load combination.

7.6.12 Distribution Factors for P-82C and P2016-13C Combinations (Multi-Lane, Lane Fraction, Including Skew)

The same information is printed on this table as described in Section 7.6.7, except that these distribution factors are used for the PHL-93 portion of the P-82C and P2016-13C combination. These distribution factors are either entered by the user or computed by the program. These distribution factors are expressed as a fraction of a lane load and include all corrections due to the skew of the supports.

The deflection distribution factor will always print as N/A on this output report because the program does not check deflection for this load combination.

7.6.13 Distribution Factors for P-82C and P2016-13C Combinations (Single Lane, Lane Fraction, Including Skew)

The same information is printed on this table as described in Section 7.6.7, except that these distribution factors are used for the P-82 portion of the P-82C combination and the P2016-13 portion of the P2016-13C combination. These distribution factors are either entered by the user or computed by the program. These distribution factors are expressed as a fraction of a lane load and include all corrections due to the skew of the supports.

The deflection distribution factor will always print as N/A on this output report because the program does not check deflection for this load combination.

7.6.14 Shear Skew Correction Factors

Shear skew correction factors that are used in computing the shear distribution factors, when the program is requested to compute the distribution factors (CDF command), are presented in this table.

1. Span Number - span number for which the shear skew correction factor is computed.
2. LEFT – Shear skew correction factor applicable to first half of any span computed using the skew angle of the support from where that span begins.
3. RIGHT – Shear skew correction factor applicable to second half of any span computed using the skew angle of the support where that span ends.

7.6.15 Distribution Factors for Design Live Load Reactions

The vehicular live load distribution factors are computed by the program or entered by the user. The following information is reported in the DISTRIBUTION FACTORS FOR REACTIONS output table.

1. Support Number - the support for the current distribution factor.
2. Reaction Distribution Factor - the reaction distribution factor used with vehicular live loads (except the fatigue vehicle) without sidewalks.
3. Reaction Distribution Comment* - comments regarding the reaction distribution factor. The comments are denoted by an alphabetic character A-B as described below:
   - A - The distribution factor reported includes the Shear Skew Correction factor
   - B - Shear Skew Correction factor applied to abutments at both ends. Not compatible with DM-4. Refer to DM-4 Article 4.6.2.2.3C.

   The presence of any character, A-B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK WARNINGS report at the end of the program output.
4. Rotation Distribution Factor - the rotation distribution factor.

7.6.16 Distribution Factors for Reactions With Sidewalks

The same information is printed on this table as described in Section 7.6.12, except that these are vehicular live load distribution factors used when sidewalks are present. These distribution factors are computed by the program or entered by the user.

7.6.17 Distribution Factors for Fatigue Live Load Reactions

The same information is printed on this table as described in Section 7.6.12, except that these are vehicular live load distribution factors used when the fatigue vehicle is present. These distribution factors are computed by the program or entered by the user.

7.6.18 Beam Weight Analysis (Unfactored, DC1, Noncomposite)

The program computes the beam weight according to the cross section area of the beam that is entered into the program. The following information is reported in the BEAM WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) output table.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Moment - moment due only to the steel beam.
4. Shear - shear value due only to the steel beam weight.
5. Deflection - deflection due only to the steel beam weight.

7.6.19 Beam Weight Analysis - Reactions

The following information is reported in the BEAM WEIGHT ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the steel beam weight only.
3. Rotation - rotation at support due to the steel beam weight only.

7.6.20 Slab and Haunch Weight Analysis (Unfactored, DC1, Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of the slab and haunch weight.

7.6.21 Slab and Haunch Weight Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of the slab and haunch weight.

7.6.22 Permanent Inputted DC1 Analysis (Unfactored, DC1, Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of permanent noncomposite load that is not part of the girder, excluding the load due to the beam, slab, and haunch, which are automatically calculated by the program. This includes loads that are not a physical part of the girder (i.e. stay-in-place forms or haunch load corrections). These loads are entered by the user as DC1 loads.

7.6.23 Permanent Inputted DC1 Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of permanent noncomposite load that is not part of the girder, excluding the load due to the beam, slab, and haunch, which are automatically calculated by the program. This includes loads that are not a physical part of the girder (i.e. stay-in-place forms or haunch load corrections). These loads are entered by the user as DC1 loads.

7.6.24 Permanent DC1S Analysis (Unfactored, DC1, Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of permanent noncomposite load that is part of the girder, but is not calculated by the program (i.e. stiffeners, diaphragms, splice plates). These loads are entered by the user as DC1S loads.

7.6.25 Permanent DC1S Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of permanent noncomposite load that is part of the girder, but is not calculated by the program (i.e. stiffeners, diaphragms, splice plates). These loads are entered by the user as DC1S loads.

7.6.26 Total DC1 Analysis (Unfactored, Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table are a combination of all of the above DC1 loads (beam self-weight, slab and haunch weight, and permanent DC1).

7.6.27 Total DC1 Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table are a combination of all of the above DC1 loads (beam self-weight, slab and haunch weight, and permanent DC1).

7.6.28 Permanent Inputted DC2 Analysis (Unfactored, DC2, Composite(3n)/Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of the permanent inputted DC2 loads, and the section stiffness indicator will change based on whether the girder is composite or noncomposite in the final state.

7.6.29 Permanent Inputted DC2 Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of the permanent inputted DC2 loads.

7.6.30 Future Wearing Surface Analysis (Unfactored, FWS, Composite(3n)/Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of the future wearing surface loads, and the section stiffness indicator will change based on whether the girder is composite or noncomposite in the final state.

7.6.31 Future Wearing Surface Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of the future wearing surface loads.

7.6.32 Utility UT1 Analysis (Unfactored, UT1, Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of the utility UT1 loads.

7.6.33 Utility UT1 Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of the utility UT1 loads.

7.6.34 Utility UT2 Analysis (Unfactored, UT2, Composite(3n)/Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of the composite utility loads, and the section stiffness indicator will change based on whether the girder is composite or noncomposite in the final state.

7.6.35 Utility UT2 Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of the utility UT1 loads.

7.6.36 Miscellaneous MC1 Analysis (Unfactored, MC1, Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of the miscellaneous noncomposite loads.

7.6.37 Miscellaneous MC1 Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of the miscellaneous MC1 loads.

7.6.38 Miscellaneous MC2 Analysis (Unfactored, MC2, Composite(3n)/Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of the miscellaneous composite loads, and the section stiffness indicator will change based on whether the girder is composite or noncomposite in the final state.

7.6.39 Miscellaneous MC2 Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of the miscellaneous MC2 loads.

7.6.40 Sidewalk Dead Load Analysis (Unfactored, DC2, Composite(3n)/Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table come from the application of the sidewalk dead load, and the section stiffness indicator will change based on whether the girder is composite or noncomposite in the final state.

7.6.41 Sidewalk Dead Load Analysis - Reactions

The same information is printed on this table as described in Section 7.6.19, except that the effects reported on this table come from the application of the sidewalk dead load.

7.6.42 Additional Future Wearing Surface Analysis (Unfactored, FWS, Composite(3n)/Noncomposite)

The same information is printed on this table as described in Section 7.6.18, except that the effects reported on this table are from the additional future wearing surface load, and the section stiffness indicator will change based on whether the girder is composite or noncomposite in the final state.

7.6.43 Additional Future Wearing Surface Analysis - Reactions

The same information is printed on this table as described in Section 7.6.16, except that the effects reported on this table are from the additional future wearing surface load.

7.6.44 Deck Pour ii Analysis (Unfactored, DC1)

There are several output tables generated for the slab and haunch weight analysis for each deck pour for a girder with a deck pour sequence analysis. These output reports give the results from each deck pour, individually. The following information is reported in the DECK POUR ii ANALYSIS (UNFACTORED, DC1) output table.

1. Span Number - span where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Composite - a flag indicating the composite state of the section. A ‘Y’ indicates that the section is already composite (the deck in the section was placed in a previous pour), while an ‘N’ indicates that the section is not yet composite. Once the concrete has hardened (a section with a ‘Y’ indicator), the section is assumed to act compositely between the concrete and steel girder for all subsequent pours, using section properties based on the modular ratio (n / 0.7).
4. Permanent Loads Moment - the moment due to the slab and haunch from the wet concrete as well as any permanent loads defined by the DPC or DPD commands for the specific deck pour only.
5. Permanent Loads Shear - the shear due to the slab and haunch from the wet concrete as well as any permanent loads defined by the DPC or DPD commands for the specific deck pour only.
6. Permanent Loads Deflection - the deflection due to the slab and haunch from the wet concrete as well as any permanent loads defined by the DPC or DPD commands for the specific deck pour only.
7. Temporary Loads Moment - the moment due to any temporary loads defined by the DPC or DPD commands for the specific deck pour only.
8. Temporary Loads Shear - the shear due to any temporary loads defined by the DPC or DPD commands for the specific deck pour only.
9. Temporary Loads Deflection - the deflection due to any temporary loads defined by the DPC or DPD commands for the specific deck pour only.

7.6.45 Deck Pour ii Analysis - Reactions

These output report tables give the reaction results from each deck pour, individually. The following information is reported in the DECK POUR ii ANALYSIS - REACTIONS output table.

1. Support Number – Support where the reaction is computed.
2. Permanent Loads Reaction – the reaction due to the slab and haunch from the wet concrete as well as any permanent loads defined by the DPC or DPD commands for the specific deck pour only.
3. Permanent Loads Rotation – the rotation due to the slab and haunch from the wet concrete as well as any permanent loads defined by the DPC or DPD commands for the specific deck pour only.
4. Temporary Loads Reaction – the reaction due to any temporary loads defined by the DPC or DPD commands for the specific deck pour only.

5. Temporary Loads Rotation – the rotation due to any temporary loads defined by the DPC or DPD commands for the specific deck pour only.

7.6.46 Cumulative Analysis: Construction Stage ii (Unfactored, DC1)

These output report tables give the cumulative effects of the deck pours for a girder with a deck pour sequence analysis. These results include the total effects (moment, shear, deflection) on the girder due to dead loads before any deck pours have occurred (Stage 0; see Section 3.4.3 for explanation of Stage 0). The following information is reported on the CUMULATIVE ANALYSIS: CONSTRUCTION STAGE ii (UNFACTORED, DC1) output table.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Current Pour - whether the analysis point is part of the current pour or not.
4. Noncomposite Moment - cumulative moment acting on the noncomposite section, up to and including the current deck pour.
5. Composite Moment - cumulative moment acting on the composite (n/0.7) section, up to and including the current deck pour.
6. Total Moment - Total moment acting on the section, equal to the noncomposite plus composite moment, up to and including the current deck pour.
7. Shear - cumulative shear acting on the section, equal to the noncomposite plus composite shear, up to and including the current deck pour.
8. Deflection - cumulative deflection of the section, equal to the noncomposite plus composite deflection, up to and including the current deck pour.

7.6.47 Cumulative Analysis: Construction Stage ii - Reactions

These output report tables give the cumulative effects of the deck pours for a girder with a deck pour sequence analysis. These results include the total effects on the girder due to dead loads before any deck pours have occurred (Stage 0; see Section 3.4.3 for explanation of Stage 0). The following information is reported on the CUMULATIVE ANALYSIS: CONSTRUCTION STAGE ii - REACTIONS output table.

1. Support Number – Support where the reaction is computed.
2. Reaction – cumulative reaction at a support equal to the noncomposite plus composite reaction, up to and including the current deck pour.
3. Rotation – cumulative rotation at a support equal to the noncomposite plus composite reaction, up to and including the current deck pour.
4. * If Uplift - an asterisk (*) is printed in this column if uplift occurs at the specified support based on the cumulative effects at the current construction stage. If uplift occurs, the following note will appear under the output report:

"NOTE: Uplift has been detected for this stage at the indicated support. See DM-4 C6.10.3.2.5.1P for information on how to address uplift during construction."

If uplift occurs, the title of this output report will appear on the SPECIFICATION CHECK WARNINGS report at the end of the program output.

7.6.48 PHL-93 LL Analysis (Moments, Unfactored, Including Impact)

The following live load analysis tables only print the live loading results corresponding to the live load code entered on the CTL input card. If a live loading does not apply to a given run of the program, the analysis tables for that live loading are not printed.

The following information is reported in the PHL-93 LL ANALYSIS (MOMENTS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the PHL-93 live loading as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Positive Moment - maximum positive moment due to the live load.
4. Maximum Positive Moment LC - Live load code which denotes the controlling LRFD live load condition for maximum positive moment. The live load codes are as follows:

   1 - tandem + lane governs

   2 - truck + lane governs

   3 - tandem pair + lane governs

   4 - truck pair + lane governs

   5 - truck alone governs

   6 - 25% truck + lane governs

   7 - 90% (truck pair + lane governs)
5. Maximum Negative Moment - maximum negative moment due to the live.
6. Maximum Negative Moment LC - LRFD live load code which denotes the controlling LRFD live load condition for maximum negative moment. Codes are as denoted above.

7.6.49 PHL-93 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The following information is reported in the PHL-93 LL ANALYSIS (SHEARS AND DEFLECTIONS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the PHL-93 live loading as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Shear Positive - maximum positive shear due to the live load.

4. Maximum Shear Positive LC - LRFD live load code which denotes the controlling live load condition for maximum positive shear. The live load codes are as follows:
   1 - tandem + lane governs
   2 - truck + lane governs
   3 - tandem pair + lane governs
   4 - truck pair + lane governs
   5 - truck alone governs
   6 - 25% truck + lane governs
   7 - 90% (truck pair + lane governs)
5. Maximum Shear Negative - maximum negative shear due to the live load.
6. Maximum Shear Negative LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum negative shear.
7. Maximum Deflection - maximum live load deflection.
8. Maximum Deflection LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum live load deflection.

7.6.50 PHL-93 LL Analysis (Reactions, Including Impact and Distribution Factors)

The following information is reported in the PHL-93 LL ANALYSIS (REACTIONS, INCLUDING IMPACT AND DISTRIBUTION FACTORS) output table. These results are for the PHL-93 live loading as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Support Number - support number for which the results are printed.
2. Maximum Reaction - maximum reaction from the live load.
3. Maximum Reaction LC - LRFD live load code which denotes the controlling LRFD live load condition for the maximum reaction. The live load codes are as follows:
   1 - tandem + lane governs
   2 - truck + lane governs
   3 - tandem pair + lane governs
   4 - truck pair + lane governs
   5 - truck alone governs
   6 - 25% truck + lane governs
   7 - 90% (truck pair + lane governs)
4. Minimum Reaction - minimum reaction from the live load.
5. Minimum Reaction LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for the minimum reaction.
6. Maximum Rotation - maximum rotation at the support from the live load.
7. Maximum Rotation LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum rotation.

8. Minimum Rotation - minimum rotation at the support from the live load.
9. Minimum Rotation LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for minimum rotation.

7.6.51 PHL-93 LL Analysis (Reactions, Without Impact or Distribution Factors)

The following information is reported in the PHL-93 LL ANALYSIS (REACTIONS, WITHOUT IMPACT OR DISTRIBUTION FACTORS) output table. These results are for the PHL-93 live loading as indicated in the title of the table. The results do not include impact or distribution factors.

1. Support Number - support number for which the results are printed.
2. Maximum Vehicle - maximum reaction from the PHL-93 vehicle.
3. Minimum Vehicle - minimum reaction from the PHL-93 vehicle.
4. Maximum Lane - maximum reaction from the PHL-93 lane live load.
5. Minimum Lane - minimum reaction from the PHL-93 lane live load.

The maximum and minimum reactions for PHL-93 vehicle and PHL-93 lane live load are based on the maximum and minimum reactions and maximum and minimum reaction LC as specified in Section 7.6.40.

7.6.52 HL-93 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the effects reported on this table come from the application of the HL-93 live loading and that the live load codes are as follows:

1 - tandem + lane governs
2 - truck + lane governs
3 - tandem pair + lane governs
4 - 90% (truck pair + lane) governs
5 - truck alone governs
6 - 25% truck + lane governs

7.6.53 HL-93 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the effects reported on this table come from the application of the HL-93 live loading and that the live load codes are as follows:

1 - tandem + lane governs
2 - truck + lane governs
3 - tandem pair + lane governs
4 - 90% (truck pair + lane) governs
5 - truck alone governs
6 - 25% truck + lane governs

7.6.54 HL-93 LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the effects reported on this table come from the application of the HL-93 live loading and that the live load codes are as follows:

1 - tandem + lane governs
2 - truck + lane governs
3 - tandem pair + lane governs
4 - 90% (truck pair + lane) governs
5 - truck alone governs
6 - 25% truck + lane governs

7.6.55 HL-93 LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.51, except that the effects reported on this table come from the application of the HL-93 live loading.

The maximum and minimum reactions for HL-93 vehicle and HL-93 lane live load are based on the maximum and minimum reactions and maximum and minimum LC as specified in Section 7.6.44.

7.6.56 P-82 LL Analysis (Moments, Unfactored, Including Impact)

The following information is reported in the P-82 LL ANALYSIS (MOMENTS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the P-82 live load as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Positive Moment - maximum positive moment due to the live load.
4. Simultaneous Shear - the shear at this location when the live load is located to produce the maximum positive moment.
5. Maximum Negative Moment - maximum negative moment due to the live load.
6. Simultaneous Shear - the shear at this location when the live load is located to produce the maximum negative moment.

7.6.57 P-82 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The following information is reported in the P-82 LL ANALYSIS (SHEARS AND DEFLECTIONS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the P-82 live load as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Shear Positive - maximum positive shear due to the live load.
4. Simultaneous Moment - the moment at this location when the live load is located to produce the maximum positive shear.
5. Maximum Shear Negative - maximum negative shear due to the live load.
6. Simultaneous Moment - the moment at this location when the live load is located to produce the maximum negative shear.
7. Maximum Deflection - maximum live load deflection.

7.6.58 P-82 LL Analysis (Reactions, Including Impact and Distribution Factors)

The following information is reported in the P-82 LL ANALYSIS (REACTIONS, INCLUDING IMPACT AND DISTRIBUTION FACTORS) output table. These results are for the P-82 live load as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Support Number - support number for which the results are printed.
2. Maximum Reaction - maximum reaction from the live load.
3. Minimum Reaction - minimum reaction from the live load.
4. Maximum Rotation - maximum rotation at the support from the live load.
5. Minimum Rotation - minimum rotation at the support from the live load.

7.6.59 P-82 LL Analysis (Reactions, Without Impact or Distribution Factors)

The following information is reported in the P-82 LL ANALYSIS (REACTIONS, WITHOUT IMPACT OR DISTRIBUTION FACTORS) output table. These results are for the P-82 live load as indicated in the title of the table. The results do not include impact or distribution factors.

1. Support Number - support number for which the results are printed.
2. Maximum Truck - maximum reaction from the P-82 truck live load.
3. Minimum Truck - minimum reaction from the P-82 truck live load.
4. Maximum Rotation - maximum rotation from the P-82 truck live load.
5. Minimum Rotation - minimum rotation from the P-82 truck live load.

7.6.60 P-82C LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of the P-82C live load.

7.6.61 P-82C LL Analysis (Shears, Unfactored, Including Impact)

The following information is reported in the P-82C LL ANALYSIS (SHEARS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the P-82C live load as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Shear Positive - maximum positive shear due to the live load.
4. Simultaneous Moment - the moment at this location when the live load is located to produce the maximum positive shear.
5. Maximum Shear Negative - maximum negative shear due to the live load.
6. Simultaneous Moment - the moment at this location when the live load is located to produce the maximum negative shear.

7.6.62 ML-80 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of an ML-80 live load.

7.6.63 ML-80 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.57. The effects for this table come from the application of an ML-80 live load.

7.6.64 ML-80 LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58. The effects for this table come from the application of an ML-80 live load.

7.6.65 ML-80 LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.59. The effects for this table come from the application of an ML-80 live load.

7.6.66 HS20 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the effects reported on this table come from the application of the HS20 live loading and that the live load codes are as follows:

L - lane load governs

<no character> - truck load governs

7.6.67 HS20 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the effects reported on this table come from the application of the HS20 live loading and that the live load codes are as follows:

L - lane load governs

<no character> -truck load governs

7.6.68 HS20 LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the effects reported on this table come from the application of the HS20 live loading and that the live load codes are as follows:

L - lane load governs

<no character> - truck load governs

7.6.69 HS20 LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.51, except that the effects reported on this table come from the application of the HL-93 live loading.

7.6.70 H20 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.48. The effects for this table come from the application of an H20 live load.

7.6.71 H20 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.49. The effects for this table come from the application of an H20 live load.

7.6.72 H20 LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50. The effects for this table come from the application of an H20 live load.

7.6.73 H20 LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.51. The effects for this table come from the application of an H20 live load.

7.6.74 Special ## LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of a special live load, and the ## in the title will be replaced with the appropriate special live load number (1-5).

7.6.75 Special ## LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.57. The effects for this table come from the application of a special live load, and the ## in the title will be replaced with the appropriate special live load number (1-5).

7.6.76 Special ## LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58. The effects for this table come from the application of a special live load, and the ## in the title will be replaced with the appropriate special live load number (1-5).

7.6.77 Special ## LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.59, in addition to maximum and minimum reactions from lane live load. The effects for this table come from the application of a special live load, and the ## in the title will be replaced with the appropriate special live load number (1-5).

7.6.78 TK527 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of a TK527 live load.

7.6.79 TK527 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.57. The effects for this table come from the application of a TK527 live load.

7.6.80 TK527 LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58. The effects for this table come from the application of a TK527 live load.

7.6.81 TK527 LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.59. The effects for this table come from the application of a TK527 live load.

7.6.82 EV2 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of an EV2 live load.

7.6.83 EV2 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.57. The effects for this table come from the application of an EV2 live load.

7.6.84 EV2 LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58. The effects for this table come from the application of a EV2 live load.

7.6.85 EV2 LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.59. The effects for this table come from the application of a EV2 live load.

7.6.86 EV3 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of an EV3 live load.

7.6.87 EV3 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.57. The effects for this table come from the application of an EV3 live load.

7.6.88 EV3 LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58. The effects for this table come from the application of a EV3 live load.

7.6.89 EV3 LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.59. The effects for this table come from the application of a EV3 live load.

7.6.90 SU6TV LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of an SU6TV live load.

7.6.91 SU6TV LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.57. The effects for this table come from the application of an SU6TV live load.

7.6.92 SU6TV LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58. The effects for this table come from the application of a SU6TV live load.

7.6.93 SU6TV LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.59. The effects for this table come from the application of a SU6TV live load.

7.6.94 P2016-13 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of an P2016-13 live load.

7.6.95 P2016-13 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.57. The effects for this table come from the application of an P2016-13 live load.

7.6.96 P2016-13 LL Analysis (Reactions, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58. The effects for this table come from the application of a P2016-13 live load.

7.6.97 P2016-13 LL Analysis (Reactions, Without Impact or Distribution Factors)

The same information is printed on this table as described in Section 7.6.59. The effects for this table come from the application of a P2016-13 live load.

7.6.98 P2016-13C LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.56. The effects for this table come from the application of an P2016-13C live load.

7.6.99 P2016-13C LL Analysis (Shears, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.6.61. The effects for this table come from the application of an P2016-13C live load.

7.6.100 Fatigue LL Analysis (Moments & Shears, Unfactored, Including Impact)

The following information is reported in the FATIGUE LL ANALYSIS (MOMENTS & SHEARS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the fatigue live load as indicated in the title of the table. They are unfactored and include impact and distribution factors.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Moment Positive - maximum positive moment due to the live load.
4. Maximum Moment Negative - maximum negative moment due to the live load.
5. Maximum Shear Positive - maximum positive shear due to the live load.
6. Maximum Shear Negative - maximum negative shear due to the live load.

7.6.101 Fatigue LL Analysis (Reactions, Including Impact and Distribution Factors)

The following information is reported in the FATIGUE LL ANALYSIS (REACTIONS, INCLUDING IMPACT AND DISTRIBUTION FACTORS) output table. These results are for the fatigue live load as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Support Number - support number for which the results are printed.
2. Maximum Reaction - maximum reaction from the live load.
3. Minimum Reaction - minimum reaction from the live load.
4. Maximum Rotation - maximum rotation at the support from the live load.
5. Minimum Rotation - minimum rotation at the support from the live load.

7.6.102 Fatigue LL Analysis (Reactions, Without Impact or Distribution Factors)

The following information is reported in the FATIGUE LL ANALYSIS (REACTIONS, WITHOUT IMPACT OR DISTRIBUTION FACTORS) output table. These results are for the fatigue live load as indicated in the title of the table. The results do not included impact or distribution factors.

1. Support Number - support number for which the results are printed.
2. Maximum Truck - maximum reaction from the fatigue truck live load.
3. Minimum Truck - minimum reaction from the fatigue truck live load.

7.6.103 PHL-93 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The following tables replace the live load analysis tables described above when the program run includes pedestrian loadings.

The same information is printed on this table as described in Section 7.6.48, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the PHL-93 load.

7.6.104 PHL-93 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the PHL-93 load.

7.6.105 PHL-93 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the PHL-93 load.

7.6.106 PHL-93 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the PHL-93 load.

7.6.107 PHL-93 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the PHL-93 load.

7.6.108 PHL-93 LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the PHL-93 load.

7.6.109 HL-93 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the HL-93 load.

7.6.110 HL-93 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the HL-93 load.

7.6.111 HL-93 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the HL-93 load.

7.6.112 HL-93 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the HL-93 load.

7.6.113 HL-93 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the HL-93 load.

7.6.114 HL-93 LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the HL-93 load.

7.6.115 P-82 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the P-82 load.

7.6.116 P-82 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the P-82 load.

7.6.117 P-82 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the P-82 load.

7.6.118 P-82C LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the P-82C load.

7.6.119 P-82C LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the P-82C load.

7.6.120 ML-80 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the ML-80 load.

7.6.121 ML-80 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the ML-80 load.

7.6.122 ML-80 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the ML-80 load.

7.6.123 ML-80 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the ML-80 load.

7.6.124 ML-80 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the ML-80 load.

7.6.125 ML-80 LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the ML-80 load.

7.6.126 HS20 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the HS20 load.

7.6.127 HS20 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the HS20 load.

7.6.128 HS20 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the HS20 load.

7.6.129 HS20 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the HS20 load.

7.6.130 HS20 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the HS20 load.

7.6.131 HS20 LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the HS20 load.

7.6.132 H20 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the H20 load.

7.6.133 H20 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the H20 load.

7.6.134 H20 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the H20 load.

7.6.135 H20 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.48, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the H20 load.

7.6.136 H20 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.49, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the H20 load.

7.6.137 H20 LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.50, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the H20 load.

7.6.138 Special ## LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of a special live load.

7.6.139 Special ## LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of a special live load.

7.6.140 Special ## LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of a special live load.

7.6.141 Special ## LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of a special live load.

7.6.142 Special ## LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of a special live load.

7.6.143 Special ## LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of a special live load.

7.6.144 TK527 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the TK527 load.

7.6.145 TK527 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the TK527 load.

7.6.146 TK527 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the TK527 load.

7.6.147 TK527 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the TK527 load.

7.6.148 TK527 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the TK527 load.

7.6.149 TK527 LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of the TK527 load.

7.6.150 EV2 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of an EV2 live load.

7.6.151 EV2 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of an EV2 live load.

7.6.152 EV2 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of a EV2 live load.

7.6.153 EV3 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of an EV3 live load.

7.6.154 EV3 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of an EV3 live load.

7.6.155 EV3 LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of a EV3 live load.

7.6.156 SU6TV LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of an SU6TV live load.

7.6.157 SU6TV LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of an SU6TV live load.

7.6.158 SU6TV LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of a SU6TV live load.

7.6.159 SU6TV LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of an SU6TV live load.

7.6.160 SU6TV LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.57, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of an SU6TV live load.

7.6.161 SU6TV LL Analysis (Reactions, With Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.58, except that the live load effects are generated using the distribution factors that do include sidewalks. The effects for this table come from the application of a SU6TV live load.

7.6.162 P2016-13 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of an P2016-13 live load.

7.6.163 P2016-13 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.51, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of an P2016-13 live load.

7.6.164 P2016-13 LL Analysis (Reactions, Without Sidewalk, Including Impact and Distribution Factors)

The same information is printed on this table as described in Section 7.6.52, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of the P2016-13 load.

7.6.165 P2016-13C LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.56, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of an P2016-13C live load.

7.6.166 P2016-13C LL Analysis (Shears, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.6.55, except that the live load effects are generated using the distribution factors that do not include sidewalks. The effects for this table come from the application of an P2016-13C live load.

7.6.167 Pedestrian LL Analysis (Moments, Unfactored)

The same information is printed on this table as described in Section 7.6.56, except that the effects for this table come from the application of the pedestrian live load.

7.6.168 Pedestrian LL Analysis (Shears, Unfactored)

The following information is reported in the PEDESTRIAN LL ANALYSIS (SHEARS, UNFACTORED) output table. These results are for the Pedestrian live loading as indicated in the title of the table. The results are unfactored.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Shear Positive - maximum positive shear due to the live load.
4. Maximum Shear Negative - maximum negative shear due to the live load.

7.6.169 Pedestrian LL Analysis (Reactions)

The following information is reported in the PEDESTRIAN LL ANALYSIS (REACTIONS) output table. These results are for the Pedestrian live loading as indicated in the title of the table. The results are unfactored.

1. Support Number - support number for which the results are printed.
2. Maximum Reaction - maximum reaction from the live load.
3. Minimum Reaction - minimum reaction from the live load.
4. Maximum Rotation - maximum rotation at the support from the live load.
5. Minimum Rotation - minimum rotation at the support from the live load.

7.6.170 Total Pedestrian LL Analysis (Deflections, Unfactored)

The following information is reported in the PEDESTRIAN LL ANALYSIS (DEFLECTIONS, UNFACTORED) output table. These results are for the Pedestrian live loading as indicated in the title of the table. The results are unfactored.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Deflection - maximum deflection due to the live load.

7.6.171 Unfactored Flexural Stresses

The following information is reported in the UNFACTORED FLEXURAL STRESSES output table. These results are the unfactored individual stresses at the extreme fibers of each flange. Results are reported for every limit state despite these being unfactored values because the section properties used to compute the stresses may vary depending on the total factored effects on the section.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure.
6. Total DC1, Instantaneous* - the total stress in the flange due to the instantaneous placement of the concrete slab along with all other DC1 loads.
7. Total DC1, Deck Pour* - the total stress in the flange due to the cumulative effects of the deck pours along with all other DC1 loads.
8. MC1 - the stress in the flange due to the miscellaneous MC1 loads.
9. UT1 - the stress in the flange due to the utility UT1 loads

10. DC2 - the stress in the flange due to the DC2 loads.
11. FWS - the stress in the flange due to the FWS loads.
12. MC2 - the stress in the flange due to the miscellaneous MC2 loads.
13. UT2 - the stress in the flange due to the utility UT2 loads.
14. LL - the stress in the flange due to the current live load applicable to this limit state.
15. PL - the stress in the flange due to the pedestrian live load for Strength-IP limit state.

The following note will print under this output table:

* Legend of General Notes:

TOTAL DC1 INST = the total DC1 stress assuming instantaneous placement of the deck slab and haunch

TOTAL DC1 DECK POUR = the total DC1 stress at the end of the deck pour analysis. When computing the total factored stress, STLRFD uses the total DC1 stress (either instantaneous or deck pour) that causes the largest stress in the flanges.

7.6.172 User Input Lateral Stresses

The following information is reported in the USER INPUT LATERAL STRESSES output table. This table will not print if the user has not entered any lateral stresses for this girder.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Unfactored Lateral Stresses, DC1 - the unfactored DC1 lateral stress in the flange.
6. Unfactored Lateral Stresses, MC1 - the unfactored miscellaneous MC1 lateral stress in the flange.
7. Unfactored Lateral Stresses, UT1 - the unfactored utility UT1 stress in the flange.
8. Unfactored Lateral Stresses, DC2 - the unfactored DC2 lateral stress in the flange.
9. Unfactored Lateral Stresses, FWS - the unfactored FWS lateral stress in the flange.
10. Unfactored Lateral Stresses, MC2 - the unfactored miscellaneous MC2 lateral stress in the flange.
11. Unfactored Lateral Stresses, UT2 - the unfactored utility UT2 stress in the flange.
12. Unfactored Lateral Stresses, LL - the unfactored live load lateral stress in the flange.
13. Total User Input 1st Order Lateral Stress, Unfactored - the total unfactored lateral stress in the flange, not considering 2nd order effects.
14. Total User Input 1st Order Lateral Stress, Factored - the total factored lateral stress in the flange, not considering 2nd order effects.

7.6.173 Factored Analysis Results

The following information is reported in the FACTORED ANALYSIS RESULTS output table. These results are for the total (dead plus live load) factored results for each limit state.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Flexure - positive or negative flexure indicator which is set to 'POS.' for positive flexure and 'NEG.' for negative flexure.
5. Maximum Moment - maximum factored moment (largest absolute value).
6. Maximum Shear - maximum factored shear (largest absolute value).
7. Flexural Stress*, Bottom Beam - total factored flexural stress at the bottom of the steel beam.
8. Flexural Stress*, Top Beam - total factored flexural stress at the top of the steel beam.
9. Flexural Stress*, Top Slab/Reinforcement - total factored flexural stress at the top of the effective thickness of the concrete for positive flexure for all limit states. For negative flexure, the total factored stress at the centroid of the slab reinforcement for limit states other than Service-II. For Service-II negative flexure, the stresses are calculated assuming that the concrete deck is effective with n section properties for all composite loads.
10. Compression Limits*, 0.6*f'c - compressive stress in the slab limit of 0.6*f'c according to A6.10.7.2. This limit is only applicable for noncompact sections in positive flexure that utilize A6.10.7.2 when calculating the flexural resistance at the strength limit state.
11. Compression Limits*, 0.85*f'c - compressive stress in the slab limit of 0.85*f'c. This limit is only applicable for composite sections in positive flexure.

The following note is printed below the output table:

* Legend of General Notes:

N/A*	=	Since the flexural capacity at this analysis point, limit state, flexure state and flange is moment governed, the total factored flexural stress is not used for any specification checks and there is not applicable.
N/A**	=	This check is not required or not applicable at this analysis point, limit state, and flexure state.
Top S/R	=	For all limit states for positive flexure, the values in this column are stresses calculated to the top of the slab effective thickness. For all limit states for negative flexure (except SERV-II), the values in this column are stresses calculated to the cg of the reinforcement.
&	=	For SERV-II negative flexure, this value is calculated to the top of the slab effective thickness using "n" section properties, assuming the slab to be effective. (values calculated this way are indicated with "&")

12. Code Check** - two different code failures may occur when checking the compressive stress in the slab. These failures are denoted by alphabetic characters A-B as described below. A single analysis point can have multiple failures.

    A Compressive stress at the top of the slab exceeds 0.6*f'c (A6.10.7.2)

    B Compressive stress at the top of the slab exceeds 0.85*f'c

    The presence of any character, A-B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.6.174 Factored Analysis Results - Reactions

The following information is reported in the FACTORED ANALYSIS RESULTS - REACTIONS output table. These results are for the total (dead plus live load) factored results for each limit state.

1. Support Number - support number for which the results are printed.
2. Limit State - limit state as defined in the LRFD Specifications.
3. Maximum Reaction - maximum reaction from the factored analysis results.
4. ** - indicates whether the Maximum Reaction includes effects from FWS or not. F indicates that FWS effects are included, N indicates that FWS effects are not included.
5. Minimum Reaction - minimum reaction from the factored analysis results.
6. ** - indicates whether the Minimum Reaction includes effects from FWS or not. F indicates that FWS effects are included, N indicates that FWS effects are not included.
7. Maximum Rotation - maximum rotation at the support from the factored analysis results.
8. Minimum Rotation - minimum rotation at the support from the factored analysis results.
9. * If Uplift - an asterisk (*) is printed in this column if uplift occurs at the specified support based on the factored analysis results only for Service IIA. Uplift is checked only for Service IIA. All other limit states will be flagged as not applicable (N/A).

    If Service IIA has uplift, and Strength I has uplift, then the uplift code for Strength I will be left blank instead of N/A since if uplift does exist under Service IIA, the tie down or counterweight is to be sized from Strength I uplift value. If Service IIA has uplift and Strength I has no uplift, then the uplift code for Strength I will be listed as N/A. If Service IIA has no uplift then all uplift codes will be listed as N/A except Service IIA which will be left blank. If uplift occurs under Service-IIA, the following note will print under the report:

    "NOTE: Uplift is occurring for the Service-IIA Limit State at the indicated support. If possible, revise span and/or skew such that no uplift occurs. If this is not possible, tie-downs, anchorages, or counterweights must be designed to resist the factored net uplift force at the Strength-I Limit State. (see DM-4 14.6.1)

    If uplift occurs, the title of this output report will appear on the SPECIFICATION CHECK WARNINGS report at the end of the program output.

7.6.175 Factored Lateral Stresses

The following information is reported in the FACTORED LATERAL STRESSES output table.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set equal to 'TOP' for the top flange or 'BOT' for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Flexure - positive or negative flexure indicator which is set to 'POS.' for positive flexure and 'NEG.' for negative flexure.
6. Intermediate Calculations, rt* - effective radius of gyration for lateral torsional buckling.
7. Intermediate Calculations, Lp* - limiting unbraced length to achieve the nominal flexural resistance $R_{pc}M_{yc}$ under uniform bending
8. Intermediate Calculations, Cb* - moment gradient modifier
9. Intermediate Calculations, Rb* - web load shedding factor
10. Wind, 1st Order - first order lateral bending stress due to wind loads
11. Wind, 2nd Order - second order lateral bending stress due to wind loads (second order stress computed as per A6.10.1.6)
12. User Input, 1st Order - first order lateral bending stress due to user input lateral stresses
13. User Input, 2nd Order - second order lateral bending stress due to user input lateral stresses (second order stress computed as per A6.10.1.6)

The following note is printed below the output table:

* Legend of General Notes:

rt	= Effective radius of gyration for lateral torsional buckling (A6.10.8.2.3-9)
Lp	= Unbraced length for nominal flexural resistance (6.10.8.2.3-4)
Cb	= Moment gradient modifier (A6.10.8.2.3)
Rb	= Web load shedding factor (A6.10.1.10.2)
N/A*	= This value is not applicable for this limit state
N/A**	= This second order stress is not applicable at this analysis point, limit state and flexure state
N/A***	= No user-input lateral stress has been entered

If no wind loads or user-input lateral loads are entered, the title of the output table prints, followed by the message:

"This output report is not applicable because no lateral loads (wind or user input lateral loads) have been entered."

If wind loads have been entered, but no user-input lateral loads are entered, the following message prints for live load vehicles after the first vehicle:

"This output report is not applicable because wind loads do not apply to this vehicle."

7.7 SPECIFICATION CHECKING OUTPUT

A summary of the output tables for each parameter is given in Section 6.57. The user can suppress all specification checking output by entering zero for every specification check output parameter. This output applies to both design and analysis runs of the program.

7.7.1 Ductility and Web/Flange Proportion Checks

The following information is reported in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output table.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure.
4. Web Proportion, Longitudinal Stiffeners (Y/N) - indicates 'Y' if the section is longitudinally stiffened and 'N' if the section is not longitudinally stiffened.
5. Web Proportion, D/tw, Check 1* - the ratio of the web depth to the web thickness. This ratio must be less than or equal to 150 for unstiffened webs and less than or equal to 300 for stiffened webs, as per the LRFD Specifications.
6. Flange Proportions, Top Flange, Check 2* - the ratio of the top flange width to twice the top flange thickness. This ratio must be less than or equal to 12.0, as per the LRFD Specifications.
7. Flange Proportions, Top Flange, Check 3* - the ratio of the web depth to the top flange width. This ratio must be less than or equal to 6.0, as per the LRFD Specifications.
8. Flange Proportions, Top Flange, Check 4* - the ratio of the top flange thickness to the web thickness. This ratio must be greater than or equal to 1.1, as per the LRFD Specifications.
9. Flange Proportions, Bottom Flange, Check 2* - the ratio of the bottom flange width to twice the bottom flange thickness. This ratio must be less than or equal to 12.0, as per the LRFD Specifications.
10. Flange Proportions, Bottom Flange, Check 3* - the ratio web depth to the bottom flange width. This ratio must be less than or equal to 6.0, as per the LRFD Specifications.
11. Flange Proportions, Bottom Flange, Check 4* - the ratio of the bottom flange thickness to the web thickness. This ratio must be greater than or equal to 1.1, as per the LRFD Specifications.
12. Flange Proportions, Iyc/Iyt, Check 5* - the ratio of the moment of inertia of the compression flange about the vertical axis of the girder to the moment of inertia of the tension flange about the vertical axis of the girder. This ratio must be between 0.1 and 10, as per the LRFD Specifications.
13. Ductility, Check 6* - the ratio of the distance from the top of the concrete deck to the neutral axis of the composite section at the plastic moment to the total depth of the composite section. This ratio must be between less than or equal to 0.42, as per the LRFD Specifications. This ratio is only applicable for compact/noncompact composite sections in positive flexure.

    The following note is printed below the output table:

* Legend of Abbreviated Proportion Checks:

Chk1:	D/tw <= 150 (unstiffened), D/tw <= 300 (stiffened), A6.10.2.1	
Chk2:	bf / 2tf <= 12.0,	A6.10.2.2-1
Chk3:	D/bf <= 6.0,	A6.10.2.2-2
Chk4:	tf/tw >= 1.1,	A6.10.2.2-3
Chk5:	0.1 <= Iyc/Iyt <= 10.0,	A6.10.2.2-4
Chk6:	Dp/Dt <= 0.42 (composite, + flex only)	A6.10.7.3-1

14. Code Check** - several different code failures may occur when checking the ductility and web/flange proportions. These failures are denoted by alphabetic characters A-I as described below. A single analysis point can have multiple failures.

A Web slenderness (D/tw) greater than 150, A6.10.2.1.1-1

B Web slenderness (D/tw) greater than 300 for longitudinally stiffened webs, A6.10.2.1.2-1.

C Top flange aspect ratio (bf/2tf) greater than 12.0, A6.10.2.2-1.

D Top flange-web aspect ratio (D/bf) greater than 6.0, A6.10.2.2-2.

E Top flange thickness to web thickness less than 1.1, A6.10.2.2-3

F Bottom flange aspect ratio (bf/2tf) greater than 12.0, A6.10.2.2-1.

G Bottom flange-web aspect ratio (D/bf) greater than 6.0, A6.10.2.2-2.

H Bottom flange thickness to web thickness less than 1.1, A6.10.2.2-3

I Flange Iyc/Iyt ratio not within boundaries 0.1 and 10, A6.10.2.2-4

J Ductility requirement fails, Dp/Dt greater than 0.42, A6.10.7.3-1

The presence of any character, A-J, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.2 Compactness Criteria

The following information is reported in the COMPACTNESS CRITERIA output table.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure.
5. Fy, top - yield stress of the top flange
6. Fy, bottom - yield stress of the bottom flange
7. AASHTO 6.10.6.2.2, D / tw - value of the ratio D/tw used in AASHTO Article 6.10.6.2.2
8. AASHTO 6.10.6.2.2, 2 * Dcp / tw - value of the ratio 2 * Dcp /t used in AASHTO Article 6.10.6.2.2

9. AASHTO 6.10.6.2.2, 3.76 * sqrt(E / Fyc) - value of the ratio 3.76 * sqrt(E / Fyc) used in AASHTO Article 6.10.6.2.2
10. AASHTO 6.10.6.2.3, 2 * Dcp / tw - value of the ratio 2 * Dcp / tw used in AASHTO Article 6.10.6.2.3 and Appendix A6.1
11. AASHTO 6.10.6.2.3, 5.7 * sqrt(E / Fyc) - value of the ratio 5.7 * sqrt(E / Fyc) used in AASHTO Article 6.10.6.2.3 and Appendix A6.1
12. AASHTO 6.10.6.2.3, Iyc / Iyt - value of the ratio used in AASHTO Article 6.10.6.2.3 and Appendix A6.1
13. Criteria Not Met** - compactness requirements not met for the given section. The comments are denoted by the alphabetic characters A-H as described below.

    A Fy,top or Fy,bot > 70 ksi (A6.10.6.2.2, A6.10.6.2.3)

    B D/tw > 150 (A6.10.6.2.2, A6.10.2.1.1)

    C Web slenderness limit not satisfied (A6.10.6.2.2-1)

    D Web noncompact slenderness limit not satisfied (A6.10.6.2.3-1)

    E Iyc / Iyt < 0.3 (A6.10.6.2.3-2, App A A6.1-2)

    F Built-up sections are always noncompact

    G Field splice locations are always noncompact

    H Locations with holes in the tension flange are always noncompact

    I Kinked or curved girders are always noncompact

    The presence of any character, A-I, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK WARNINGS report at the end of the program output.

7.7.3 User-Defined Wind Load and Pressure

The following information is reported in the USER-DEFINED WIND LOAD AND PRESSURE output table. This table will only be printed for user-defined wind pressures.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Total Depth - total cross section of the girder exposed to wind, including girder depth, haunch depth, slab depth, and any additional cross section entered by the user.
4. Strength-III Wind Pressure - the unfactored wind pressure entered by the user for use with the Strength III limit state.
5. Strength-III Wind Load - the unfactored wind load induced by the Strength III wind pressure, reported in units of force per unit length.
6. Strength-V Wind Pressure - the unfactored wind pressure entered by the user for use with the Strength V limit state.

7. Strength-V Wind Load - the unfactored wind load induced by the Strength V wind pressure, reported in units of force per unit length.

7.7.4 Computed Wind Load and Pressure

The following information in reported in the COMPUTED WIND LOAD AND PRESSURE output table. This table will only be printed if the user wants the program to compute the wind pressures and loads on the structure.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Total Depth - total cross section of the girder exposed to wind, including girder depth, haunch depth, slab depth, and any additional cross section entered by the user.
4. Strength-III Kz - the pressure exposure and elevation coefficient calculated for use with the calculations for the Strength-III wind pressure.
5. Strength-III Wind Pressure - the unfactored wind pressure induced on the structure for the Strength III limit state as calculated from the conditions entered by the user.
6. Strength-III Wind Load - the unfactored wind load induced by the calculated Strength III wind pressure reported above, reported in units of force per unit length.
7. Strength-V Wind Pressure - the unfactored wind pressure induced on the structure for the Strength V limit state as calculated from the conditions entered by the user.
8. Strength-V Wind Load - the unfactored wind load induced by the calculated Strength V wind pressure reported above, reported in units of force per unit length.

7.7.5 Wind Effects

The following information is reported in the WIND EFFECTS output table.

1. Permanent Load Path – load paths for computing the wind load:
   T-Truss action.
   F-Frame action.
   L-Flange subjected to lateral force.
2. Span Number - span number where the analysis point is located.
3. Distance - distance to the analysis point measured from the left support of the specified span number.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure.
6. Top Flange, Factored Wind Force, W – represents the total factored wind load resisted by the top flange. If 'N/A' prints in this column, the deck is assumed to provide horizontal diaphragm action.

7. Top Flange, Factored Wind Moment, Mwt* - maximum lateral moment in the top flange due to the factored wind loading. If 'N/A' prints in this column, the deck is assumed to provide horizontal diaphragm action.
8. Top Flange, Lateral Bending Stress, fl, 1st Order* - the first order bending stress at the edges of the top flange due to the factored wind loading. If 'N/A' prints in this column, the deck is assumed to provide horizontal diaphragm action.
9. Top Flange, Lateral Bending Stress, fl, 2nd Order* - the second order bending stress at the edges of the top flange due to amplifying the first order stress. If 'N/A' prints in this column, either the deck is assumed to provide horizontal diaphragm action (in which case, Mwt and fl, 1st order would also print 'N/A') or the section satisfies the unbraced length requirements of DM-4 Article 6.10.1.6.
10. Bottom Flange, Factored Wind Force, W – represents the total factored wind load resisted by the top flange.
11. Bottom Flange, Factored Wind Moment, Mwb - maximum lateral moment in the bottom flange due to the factored wind loading.
12. Bottom Flange, Lateral Bending Stress, fl, 1st Order - the first order bending stress at the edges of the bottom flange due to the factored wind loading.
13. Bottom Flange, Lateral Bending Stress, fl, 2nd Order* - the second order bending stress at the edges of the bottom flange due to amplifying the first order stress. If 'N/A' prints in this column, the section satisfies the unbraced length requirements of DM-4 Article 6.10.1.6.

7.7.6 Intermediate Values for Moment Flexural Capacity Calculations

The following information is reported in the INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY CALCULATIONS output table. This table prints for points where the flexural capacity is returned in terms of moment.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
5. Dp* - distance from top of concrete deck to neutral axis of composite section at the plastic moment.
6. Dt* - total depth of the composite section
7. Rh* - hybrid factor
8. Rpc* - web plastification factor for the compression flange.
9. Rpt* - web plastification factor for the tension flange.
10. Myt - yield moment with respect to the top flange, per Appendix D6.2
11. Myb - yield moment with respect to the bottom flange, per Appendix D6.2

The following note is printed below the output table:

* Legend of General Notes:

Dp = Distance from top of concrete deck to neutral axis of the composite section at the plastic moment (A6.10.7.1.2)

Dt = Total depth of the composite section (A6.10.7.1.2)

Rh = Hybrid factor (A6.10.1.10.1)

Rpc = Web plastification factor for the compression flange (App A 6.2.1-4 or A6.2.2-4)

Rpc = Web plastification factor for the tension flange (App A 6.2.1-5 or A6.2.2-5)

Dc = Total depth of the web in compression, per Appendix D6.3.1

Myt = Yield moment to the top flange, per Appendix D6.2

Myb = Yield moment of the bottom flange, per Appendix D6.2

12. Resistance Calculations** - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character A-H as described below.

    Compact Section:

    A Dp <= 0.1*Dt, Mn calculated using A6.10.7.1.2-1

    B Dp > 0.1*Dt, Mn calculated using A6.10.7.1.2-2

    C Continuous span, Mn calculated using A6.10.7.1.2-3

    Appendix A:

    D Discretely braced compression flange, local buckling governs (Appendix A A6.3.2-1)

    E Discretely braced compression flange, local buckling governs (Appendix A A6.3.2-2)

    F Discretely braced tension flange governs (Appendix A A6.1.2)

    G Continuously braced compression flange governs (Appendix A A6.1.3)

    H Continuously braced tension flange governs (Appendix A A6.1.4)

7.7.7 Moment Flexural Capacity (Composite, +Flex, Compact or Appendix A, No Lateral Torsional Buckling)

The following information is reported in the MOMENT FLEXURAL CAPACITY (COMPOSITE, +FLEX, COMPACT OR APPENDIX A, NO LTB) output table. This table prints for points where the flexural capacity is returned in terms of moment. The moments are factored for each limit state.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
5. Flexural Resistance, Mr - the moment flexural resistance, based on calculations other than lateral torsional buckling

6. Factored Flexural + Lateral Moment, M+* - total factored moment, flexural plus lateral due to wind, for the given limit state and state of flexure.

The following note is printed below the output table:

* Legend of General Notes:

NOTE: Intermediate values have been moved to a separate output report, INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY CALCULATIONS

M+ = Mu + (1/3)*fl*Sxt, total factored flexural + lateral moment due to wind or user input effects, A6.10.7.1.1-1

w = Value for M+ includes lateral load effects

7. Resistance Calculation** - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character A-H as described below.

   Compact Section:

   A Dp <= 0.1*Dt, Mn calculated using A6.10.7.1.2-1

   B Dp > 0.1*Dt, Mn calculated using A6.10.7.1.2-2

   C Continuous span, Mn calculated using A6.10.7.1.2-3

   Appendix A:

   D Discretely braced compression flange, local buckling governs (Appendix A 6.3.2)

   E Discretely braced compression flange, lateral torsional buckling governs (Appendix A 6.3.3)

   F Discretely braced tension flange governs (Appendix A 6.1.2)

   G Continuously braced compression flange governs (Appendix A 6.1.3)

   H Continuously braced tension flange governs (Appendix A 6.1.4)

8. Code Check*** - a code failure may occur when computing the resistance of the section. The failures are denoted by the alphabetic character A as described below.

   A Insufficient flexural resistance - the flexural resistance is less than the factored flexural + lateral moment (Mr<M+).

   The presence of a character in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.8 Stress Flexural Capacity (Noncomposite or -Flex or Composite/Noncompact, no Lateral Torsional Buckling)

The following information is reported in the STRESS FLEXURAL CAPACITY (NONCOMPOSITE OR -FLEX OR COMPOSITE/NONCOMPACT, NO LTB) output table. This table prints for points where the flexural capacity is returned in terms of stress in the flanges. The moments are factored for each limit state.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.

5. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
6. Intermediate Calculations, Rh* - hybrid factor
7. Intermediate Calculations, Rb* - load shedding factor
8. Flexural Resistance, Mr(e) - equivalent moment resistance, back-calculated from stress flexural resistance.
9. Flexural Resistance, Fr - stress flexural resistance, without consideration of lateral torsional buckling.
10. Factored Flexural + Lateral Stress, F+* - total factored stress, flexural + lateral due to wind and/or user input lateral effects, for the given limit state and state of flexure.
11. Resistance Calculations** - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character A-H as described below.

    Composite Section in Positive Flexure, Noncompact Section:

    A Compression flange governs, Fr calculated using A6.10.7.2.2-1

    B Tension flange governs, Fr calculated using A6.10.7.2.2-2

    Composite Section in Negative Flexure or Noncomposite Section:

    C Compression flange governs, Fr calculated using A6.10.8.1.3-1

    D Compression flange governs, Fr calculated using flange local buckling, A6.10.8.2.2-1

    E Compression flange governs, Fr calculated using flange local buckling, A6.10.8.2.2-2

    F Tension flange governs, Fr calculated using A6.10.8.1.3-1

    G Tension flange governs, Fr calculated using A6.10.8.3-1

    H SKW has not been entered. Appendix A provisions has been skipped but may be applicable
12. Code Check*** - a code failure may occur when computing the resistance of the section. The failure is denoted by the alphabetic character A as described below.

    A Insufficient flexural resistance - the flexural resistance is less than the factored flexural + lateral stress (Fr<F+).

    B Based on the total stress in the bottom flange, this section is analyzed for positive flexure, so the top flange capacity is based on compression. However, the total factored stress (F+) in the top flange is tensile. The user should verify the acceptability of the section by comparing the top flange stress (F+) to the flexural resistance (Fr) of the top flange in negative flexure.

    The presence of the character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.9 Intermediate Values for Lateral Torsional Buckling Calculations

The following information is reported in the INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS output table. This table prints for points where the flexural capacity may be governed by lateral torsional buckling. Please see Section 3.7.18 of this User's Manual for a discussion on the STLRFD implementation of the lateral torsional buckling calculations.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Flexure - positive or negative flexure indicator which is set to ‘P’ for positive flexure and ‘N’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
5. rt* - effective radius of gyration for lateral torsional buckling (Equations 6.10.8.2.3-9 or A6.3.3-10)
6. Rh* - hybrid factor (Article 6.10.1.10.1)
7. Rb* - load shedding factor (Article 6.10.1.10.2)
8. Dc* - depth of web in compression (Article D6.3.1)
9. Lp* - limiting unbraced length to achieve the nominal flexural resistance of RbRhFyc under uniform bending (Equations 6.10.8.2.3-4 or A6.3.3-4)
10. 6.10.8.2.3, Lr* - limiting unbraced length to achieve the onset of nominal yielding in either flange under uniform bending with consideration of compression-flange residual stress effects (Equation 6.10.8.2.3-5). This value is for use with Article 6.10.8.2.3.
11. 6.10.8.2.3, Cb* - moment gradient factor (Equation 6.10.8.2.3-6 or 6.10.8.2.3-7). This value is for use with Article 6.10.8.2.3.
12. Appendix A, Lr* - limiting unbraced length to achieve the onset of nominal yielding in either flange under uniform bending with consideration of compression-flange residual stress effects (Equation A6.3.3-5). This value is for use with Appendix A.
13. Appendix A, Cb* - moment gradient factor (Equation A6.3.3-6 or A6.3.3-7). This value is for use with Appendix A.
14. Appendix A, Myc* - yield moment with respect to the compression flange (Article D6.2). This value is for use with Appendix A
15. Appendix A, Rpc* - web plastification factor for the compression flange (Article A6.2.1 or A6.2.2). This value is for use with Appendix A.

7.7.10 Lateral Torsional Buckling Capacity (Noncomposite or Negative Flexure)

The following information is reported in the LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE) output table. This table prints for points where the flexural capacity may be governed by lateral torsional buckling. The moments and stresses are factored for each limit state. Please see Section 3.7.18 of this User's Manual for a discussion on the STLRFD implementation of the lateral torsional buckling calculations.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set to 'TOP' for the top flange or 'BOT' for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Flexure - positive or negative flexure indicator which is set to 'P' for positive flexure and 'N' for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
6. 6.10.8.2.3 Flexural Resistance, Local Fr - stress flexural resistance, using the method of Article 6.10.8.2.3. This resistance is calculated using the section properties at the current analysis location.
7. * - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character A-C, I, or J as described below.
   - A Fr calculated using AASHTO Equation 6.10.8.2.3-1
   - B Fr calculated using AASHTO Equation 6.10.8.2.3-2
   - C Fr calculated using AASHTO Equation 6.10.8.2.3-3
   - I Fr calculated using AASHTO Equation D6.4.1-2
   - J Fr calculated using AASHTO Equation D6.4.1-4
8. 6.10.8.2.3 Flexural Resistance, Governing Mr(e) - equivalent moment resistance, back-calculated from the governing stress flexural resistance.
9. 6.10.8.2.3 Flexural Resistance, Governing Fr - stress flexural resistance, using the method of Article 6.10.8.2.3. For unbraced lengths that are nonprismatic (after any eligible transitions have been ignored in the 20% region), this resistance is the minimum flexural resistance in the unbraced length containing the current analysis location. For prismatic unbraced lengths (after any eligible transitions have been ignored in the 20% region), this resistance is the same as the local resistance.
10. * - the method used to compute the governing flexural resistance of the section. The methods are denoted by an alphabetic character A-C as described above.
11. Appendix A Flexural Resistance, Local Mr - stress flexural resistance, using the method of Appendix A. This resistance is calculated using the section properties at the current analysis location and will print as N/A if Appendix A does not apply.
12. * - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character D-H, K, or L as described below.
   - D Mr calculated using AASHTO Equation A6.3.3-1

E Mr calculated using AASHTO Equation A6.3.3-2

F Mr calculated using AASHTO Equation A6.3.3-3

G. Girder skew angle has not been entered. Appendix A provisions have not been checked, but may be applicable

H Appendix A provisions are not applicable at this location

K Mr calculated using AASHTO Equation D6.4.2-2

L Mr calculated using AASHTO Equation D6.4.2-4

13. Appendix A Flexural Resistance, Governing Mr - stress flexural resistance, using the method of Appendix A. For unbraced lengths that are nonprismatic (after any eligible transitions have been ignored in the 20% region), this resistance is the minimum flexural resistance in the unbraced length containing the current analysis location. For prismatic unbraced lengths (after any eligible transitions have been ignored in the 20% region), this resistance is the same as the local resistance. This value will print as N/A if Appendix A does not apply.
14. Factored Effects Flexural + Lateral Stress, F+** - total factored stress, flexural + lateral due to wind and/or user input lateral effects, for the given limit state and state of flexure. This value is the maximum factored stress in the current unbraced length. This value will print as N/A if the Appendix A capacity governs.
15. Factored Effects Flexural + Lateral Moment, M+** - total factored moment flexural + lateral due to wind and/or user input lateral effects, for the given limit state and state of flexure. This value is the maximum factored moment in the current unbraced length. This value will print as N/A if the Article 6.10.8.2.3 capacity governs.
16. Code Check*** - a code failure may occur when computing the resistance of the section. The failure is denoted by the alphabetic characters A or B as described below.

A Insufficient flexural resistance - the flexural resistance is less than the factored flexural + lateral effect.

B Based on the total stress in the bottom flange, this section is analyzed for positive flexure, so the top flange capacity is based on compression. However, the total factored stress (F+) in the top flange is tensile. The user should verify the acceptability of the section by comparing the top flange stress (F+) to the flexural resistance (Fr) of the top flange in negative flexure.

C The unbraced range containing this analysis point varies in depth and has a flange transition more than one foot away from the ends of the unbraced range.

The presence of the character A or B in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output. The presence of the character C in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK WARNINGS report at the end of the program output, and a Chief Bridge Engineer warning message printing along with the code check legend.

7.7.11 Flange Lateral Capacity

The following information is reported in the FLANGE LATERAL CAPACITY output table.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set to 'TOP' for the top flange or 'BOT' for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications
5. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
6. Lateral Resistance, 0.6*Fyf* - lateral stress resistance, computed as 0.60*yield stress of the top or bottom flange.

   The following note is printed below the output table:

   * Legend of General Notes:

   Fyf = Yield stress of flange

   NOTE: Lateral stress check is not applicable to the top flange because the deck is assumed to provide the horizontal diaphragm action for wind loads, whether the girder is composite or noncomposite in the final state.
7. Factored Lateral Stress, fl - bending stress at the edges of the top or bottom flange due to factored wind loading.
8. Code Check*** - requirements not med for the flange lateral capacity check. The failure is denoted by the alphabetic character A as described below.

   A Insufficient flange lateral resistance - the lateral resistance of the flange is less than the factored lateral stress.

   The presence of the character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.12 Net Section Fracture Check

The following information is reported in the NET SECTION FRACTURE CHECK output table. This check is only printed at points where it is required; analysis points that include section holes in the tension flange. The moments are factored for each limit state.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.

5. Flange Area Ratio, An/Ag - the ratio of the net area (defined as the gross area including all section losses and section holes) to the gross area
6. Tensile Strength - the tensile strength of the tension flange
7. Yield Strength - the yield strength of the tension flange
8. Net Section Fracture Resistance, Fr - net section fracture resistance
9. Factored Flexural Stress, ft - maximum factored stress at the analysis point for the given limit state and flange.
10. Code Check* - requirements not met for the net section fracture specification check. The failure is denoted by the alphabetic character A as described below.

    A Flange fails net section fracture check, A6.10.1.8-1

    The presence of a character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.13 Service Limit State - Flexural Resistance

The following information is reported in the SERVICE LIMIT STATE - FLEXURAL RESISTANCE output table. The moments are factored for each limit state.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set to 'TOP' for the top flange or 'BOT' for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Flexure - positive or negative flexure indicator which is set to 'POS.' for positive flexure and 'NEG.' for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
6. Intermediate Calculation, Rh* - hybrid factor

    The following information will print below this output table:

    Rh = Hybrid factor

    Mr(e) = Flexural resistance in terms of moment, back-calculated from the stress flexural resistance, Fr
7. Flexural Resistance, Mr(e) - equivalent moment resistance, back-calculated from stress flexural resistance
8. Flexural Resistance, Fr - flexural resistance.
9. Factored Flexural Stress, Fu* - maximum factored stress at the analysis point for the given limit state and state of flexure.

    The following information will print below this output table:

    Fu = For bottom flanges of composite sections or both flanges of noncomposite sections, this value includes lateral stresses when input by the user (A6.10.4.2.2)

10. Resistance Calculations** - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character A-D as described below.

    A Composite, top flange, Fr calculated using A6.10.4.2.2-1

    B Composite, bottom flange, Fr calculated using A6.10.4.2.2-2

    C Noncomposite, Fr calculated using A6.10.4.2.2-3

11. Code Check*** - a code failure may occur when computing the resistance of the section. The failure is denoted by the alphabetic character A as described below.

    A Insufficient flexural resistance - the flexural resistance is less than the factored stress (Fr < Fu).

    The presence of the character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.14 Service Limit State - Web Bend-Buckling

The following information is reported in the SERVICE LIMIT STATE - WEB BEND-BUCKLING output table. The moments are factored for each limit state.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
6. Intermediate Calculations, Dc* - depth of web in compression
7. Intermediate Calculations, Rh* - hybrid factor
8. Intermediate Calculations, k* – bend-buckling coefficient.
9. Flexural Resistance, Mr(e)* - equivalent moment resistance, back-calculated from stress flexural resistance
10. Flexural Resistance, Fcrw* - flexural resistance.
11. Factored Flexural Stress, fc* - maximum factored stress at the analysis point for the given limit state and state of flexure.

    The following information will print below this output table:

    * Legend of Intermediate Calculations:

    Dc = Depth of web in compression

    Rh = Hybrid factor

    k = Bend-buckling coefficient, LRFD Specifications 6.10.1.9.2. Web bend-buckling checks only apply to compression flanges; tension flanges are identified as N/A.

Mr(e) = Flexural resistance in terms of moment, back-calculated from the stress flexural resistance, Fcrw

Fcrw = Nominal bend-buckling resistance, LRFD Specifications 6.10.4.2.2-4

fc = Compression flange stress calculated without flange lateral bending

N/A = This check is not required for composite sections in positive flexure in which the web satisfies the requirement of LRFD Specifications Article 6.10.2.1.1

12. Code Check** - a code failure may occur when computing the resistance of the section. The failure is denoted by the alphabetic character A as described below.

    A Insufficient flexural resistance - the flexural resistance is less than the factored stress (Fcrw < Fu).

    The presence of the character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.15 Shear Capacity

The following information is reported in the SHEAR CAPACITY output table. The shear values are factored for each limit state.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Factored Shear Resistance, Vr - factored shear resistance.
5. Maximum Factored Shear, Vu - maximum factored shear at the analysis point for the given limit state.
6. Stiffened/Unstiffened - indicator which is set to ‘S’ for a web with transverse stiffeners which meet the spacing requirements for a stiffened web, or set to ‘U’ for a web without transverse stiffeners or stiffeners which do not meet the spacing requirements.
7. Code Check* - requirements not met for the shear resistance of the section. The failures are denoted by an alphabetic character A-B as described below. A single section can have multiple failures.

    A Insufficient shear resistance - The factored shear resistance is less than the factored shear (Vr < Vu).

    B D/tw has exceeded limit of 150 for unstiffened webs - The depth/thickness ratio of the unstiffened web exceeds the web proportion requirement of the LRFD Specifications. Consider revising the web depth and/or web thickness of the section, or adding transverse stiffeners to the web.

    C D/tw has exceeded limit of 300 for stiffened webs - The depth/thickness ratio of the stiffened web exceeds the web proportion requirement of the LRFD Specifications. Consider revising the web depth and/or web thickness of the section.

The presence of any character, A-C, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.16 Web Specification Check

The following information is reported in the WEB SPECIFICATION CHECK output table. This table is printed only for girders that are noncomposite in the final state.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Gamma -slenderness value calculated as per DM-4 Equation 6.10.1.9.3P-2
4. Shear Force in Web, Vr - shear resistance of the web
5. Shear Force in Web, 4*V - 4 * the total unfactored shear force
6. Compressive Stress in Web, fcw - compressive bending stress limit, calculated as per DM-4 Equation 6.10.1.9.3P-1
7. Compressive Stress in Web, fu - total unfactored compressive bending stress in web
8. Code Check - requirements not met for web specification checks. The failures are denoted by the alphabetic characters A or B as described below. A single section can have multiple failures.
   - A Slenderness check fails and Vr < 4*V - the web slenderness (gamma) is less than the limit of 2.5, so 4*shear is checked and exceeds the shear resistance
   - B Insufficient web stress capacity (fcw < fu) - total unfactored compressive stress in web exceeds the compressive bending stress limit

   The presence of any character, A-B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.17 Transverse Stiffeners Check

The following information is reported in the TRANSVERSE STIFFENERS CHECK output table. This table is printed only for points within a transversely stiffened range.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Spacing, Maximum - maximum allowed stiffener spacing as per the LRFD Specifications.
4. Spacing, Actual - actual spacing of the stiffeners, as entered by the user.
5. Width, Minimum - minimum allowable width of the transverse stiffener to be effective, as per the LRFD Specifications.
6. Width, Maximum - maximum allowable width of the transverse stiffener to limit local buckling, as per the LRFD Specifications.

7. Width, Actual - actual width of the transverse stiffeners as entered by the user.
8. Moment of Inertia, Minimum - minimum allowable moment of inertia of the transverse stiffeners as per the LRFD Specifications.
9. Moment of Inertia, Governing Limit State - limit state corresponding to the governing minimum moment of inertia. This value will only print if the minimum moment of inertia is calculated with LRFD Specifications Equation 6.10.11.1.3-9. Otherwise this value will print as "n/a".
10. Moment of Inertia, Actual - actual moment of inertia, as calculated from user-entered information.
11. Code Check* - requirements not met for transverse stiffeners. The failures are denoted by the alphabetic characters A-F as described below. A single section can have multiple failures.

    A Stiffener spacing greater than maximum allowed; check SHEAR CAPACITY output report to determine if an unstiffened web will be sufficient - fails if the user-entered stiffener spacing is greater than the maximum allowable. However, an unstiffened web may be sufficient for the shear at this point. Check the SHEAR CAPACITY output report to see if the section is adequate.

    B Projecting width less than minimum required - fails if the user-entered stiffener width is less than the minimum required.

    C Projecting width greater than maximum allowed - fails if the user-entered stiffener width is greater than the maximum allowed.

    D Transverse stiffeners not needed at this location; unstiffened web is sufficient - this message prints if the program has determined that this section need not be stiffened for a design plate girder problem.

    E Since the transverse stiffener spacing exceeds the depth of the girder, conventional deck slab overhang forms are not permitted and the provision of DM-4 Section 6.10.3.2.5.2P(b) must be complied with.

    F Moment of inertia less than minimum required - fails if the user-defined stiffener actual moment of inertia is less than the minimum required.

    The presence of the characters, A or E, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK WARNINGS report at the end of the program output.

    The presence of any character, B-D or F, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.18 Longitudinal Stiffeners Check (Part 1)

The following information is reported in the LONGITUDINAL STIFFENERS CHECK (PART 1) output table. This table is printed only for points within a longitudinally stiffened range.

1. Span Number - span number where the analysis point is located.

2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
4. Maximum Width - maximum allowable width of the longitudinal stiffener to limit local buckling, as per the LRFD Specifications.
5. Actual Width - actual width of the longitudinal stiffener as entered by the user.
6. Minimum Moment of Inertia - minimum allowable moment of inertia of the longitudinal stiffener as per the LRFD Specifications. If no transverse stiffeners are present with this longitudinal stiffener, this value will print as N/A.
7. Actual Moment of Inertia - actual moment of inertia, as calculated from user-entered information. If no transverse stiffeners are present with this longitudinal stiffener, this value will print as N/A.
8. Code Failure* - requirements not met for longitudinal stiffeners. The failures are denoted by the alphabetic characters A-C as described below. A single section can have multiple failures.

   A Projecting width greater than maximum allowed - fails if the user-entered width is greater than the maximum allowable.

   B Moment of inertia less than minimum required - fails if the user-defined stiffener actual moment of inertia is less than the minimum required.

   C No transverse stiffeners defined here. Transverse stiffeners are required when longitudinal stiffeners are present.

   The presence of any character, A-C, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.19 Longitudinal Stiffeners Check (Part 2)

The following information is reported in the LONGITUDINAL STIFFENERS CHECK (PART 2) output table. This table is printed only for points within a longitudinally stiffened range.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
4. Distance from the Flange** - location of the stiffener relative to the flange. This value is followed by the alphabetic characters ‘B’ or ‘T’ as described below.

   T Distance is measured from top flange

   B Distance is measured from bottom flange

5. Minimum Radius of Gyration - minimum allowable radius of gyration of the longitudinal stiffener as per the LRFD Specifications. If no transverse stiffeners are present with this longitudinal stiffener, this value will print as N/A.
6. Actual Radius of Gyration - actual radius of gyration, as calculated from user-entered information. If no transverse stiffeners are present with this longitudinal stiffener, this value will print as N/A.
7. Code Failure* - requirement not met for longitudinal stiffeners. The failure is denoted by the alphabetic characters A-B as described below.
   - A Radius of gyration less than minimum required - fails if the user-defined actual radius of gyration is less than the minimum required.
   - B No transverse stiffeners defined here. Transverse stiffeners are required when longitudinal stiffeners are present.

   The presence of any character, A-B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.20 User-Input Bearing Stiffener Analysis

The following information is reported in the USER-INPUT BEARING STIFFENER ANALYSIS output table. This table will print where bearing stiffeners are required, or other points where the user has defined bearing stiffeners. Please note: if the user has not defined a bearing stiffener at a concentrated load location on a rolled beam, but the web at the concentrated load location passes the criteria of the WEB CONCENTRATED LOAD CHECK output table, the location will NOT appear on this output table.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Width - allowable maximum width of the bearing stiffener as per the LRFD Specifications.
4. Stiffener Width - actual width of the bearing stiffener.
5. Bearing Resistance - maximum resistance of the bearing stiffener in bearing.
6. Axial Resistance - maximum axial resistance of the bearing stiffener.
7. Maximum Factored Reaction - maximum factored reaction at the bearing location.
8. Stiffener / Web Weld Size Design - the required weld size based on the factored shear and weld metal resistance. If the calculated required value is less than the minimum allowed weld size, the design value is set to the minimum allowed weld size.
9. Stiffener / Web Weld Size Minimum - the minimum allowed weld size, based on the thicknesses of the web and stiffener plates.
10. Stiffener / Web Weld Size Maximum - the maximum allowed weld size, based on the thicknesses of the web and stiffener plates.
11. Code Check* - requirements not met for bearing stiffeners. The failures are denoted by the alphabetic characters A-E as described below.

A Projecting stiffener width greater than maximum allowed - fails if the user-entered width is less than the maximum allowed.

B Provided resistance less than maximum factored reaction - fails if the maximum reaction is less than the bearing or axial resistance provided.

C Bearing stiffener is required at this location - a bearing stiffener is required, but has not been defined by the user at this location.

D Bearing stiffener was defined at this location but is not required - a bearing stiffener is not required at this location, but one was defined by the user.

E The calculated required weld size is greater than the maximum allowed weld size (AASHTO LRFD Specifications 6.13.3.4). Review stiffener and web thicknesses. The maximum weld size, which is solely dependent on the thicknesses of the plates being joined, is less than the weld size calculated from applied loads and weld material strength.

The presence of any character, A-E, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.21 Web Concentrated Load Check

The following information is reported in the WEB CONCENTRATED LOAD CHECK output table. This table will print for rolled beams, plate girders, and built-up sections where bearing stiffeners are required, or other points where the user has defined bearing stiffeners.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Distance, k* - distance from the outer face of the flange to the web toe of the fillet (for rolled beams)
   bottom flange thickness (for plate girders)
   bottom flange thickness or angle thickness (for built-up sections)
4. Bearing Length, N* - length of bearing, N, as defined in the LRFD Specifications. STLRFD sets this value equal to k for the purposes of these calculations.
5. Web Local Yielding Resistance - web local yielding resistance, as defined in LRFD Specifications.
6. Web Crippling Resistance - web crippling resistance, as defined LRFD Specifications.
7. Maximum Factored Load - maximum factored concentrated load at this location
8. Required Bearing Length, Nreq* -required bearing length calculated by STLRFD so that web local yielding and web crippling requirements are met. This value is followed by a character denoting which condition governs its calculation. The character Y indicates that it is governed by web local yielding, while the character C indicates web crippling.

The following note is printed below the output table:

* Legend of General Notes:

k = Distance from the outer face of the flange resisting the reaction to the web toe of the fillet (for rolled beams)
Bottom flange thickness (for plate girders)
Bottom flange thickness or angle thickness (for built-up sections)

N = Bearing length used by the program to compute the web local yielding and crippling resistances (assumed equal to k)

Nreq = Required bearing length resulting in web local yielding and web crippling capacities greater than or equal to the maximum factored load (LRFD Specifications D6.5.2, denoted by Y, and D6.5.3, denoted by C)

9. Code Check* - requirements not met for web yielding or crippling. The failures are denoted by the alphabetic characters A-D as described below.

   A The resistance provided without a bearing stiffener is less than the maximum factored load. A bearing stiffener is required at this location. The minimum of the web local yielding resistance and the web crippling resistance is less than the factored concentrated load at this location, and no bearing stiffener has been defined here.

   B The resistance provided without a bearing stiffener is less than the maximum factored load. A bearing stiffener is required here, and the user has defined one at this location. Please see the USER-INPUT BEARING STIFFENER ANALYSIS output report to verify that the bearing stiffener is adequate. The minimum of the web local yielding resistance and the web crippling resistance is less than the factored concentrated load at this location, and a bearing stiffener has been defined here.

   C A bearing stiffener was defined at this location but is not required - since the resistance of the web is greater than the factored concentrated load, a bearing stiffener is not required at this location

   D A noncomposite (DC1, UT1, or MC1) concentrated load has been defined for this location. The user must review LRFD Specifications Appendix D6.5.1 for important information regarding concentrated loads applied directly to the steel section.

   The presence of the character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output. The presence of any of the other characters, B-D, will result in this output report appearing on the SPECIFICATION CHECK WARNINGS report at the end of the program output.

7.7.22 Bearing Stiffener Design

The following information is reported in the BEARING STIFFENER DESIGN output table. This information will only be printed if bearing stiffener design is requested with the BSD input command.

1. Span Number - span number where the analysis point is located.

2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. # Pair - the number of pairs of stiffeners required at this location. A single pair consists of two bearing stiffener plates, one on each side of the web.
4. Spacing - the spacing between pairs used by the program during the bearing stiffener design. If SPACING BETWEEN PAIRS is not input on the BSD command, the default spacing between stiffener pairs will be 18*web thickness.
5. Clearance - the distance from the centerline of bearing to the end of the girder used by the program during the bearing stiffener design. If CLEARANCE is not input on the BSD command, the default distance from the end of the beam to the first stiffener will be 9*web thickness.
6. Stiffener Width - the full width of the designed bearing stiffener; used for axial resistance calculations.
7. Stiffener Effective Width - the effective width of the designed bearing stiffener; used for bearing resistance calculations.
8. Stiffener Thickness - the thickness of the designed bearings stiffener plates.
9. Weld - the required size of the designed bearing stiffener-to-web weld.
10. Resistance Bearing - the bearing resistance of the designed bearing stiffener.
11. Resistance Axial - the axial resistance of the designed bearing stiffener
12. Maximum Factored Reaction - the maximum factored reaction at this location.
13. Code Check** - indications if a bearing stiffener cannot be designed at this location. The design failures are indicated by the alphabetic characters A-C as described below.
    - A Bearing stiffener design cannot be found with the maximum number of pairs and maximum thickness.
    - B Bearing stiffener design cannot be found because of stiffener pair spacing and clearance restrictions.
    - C The calculated required weld size is greater than the maximum allowed weld size (AASHTO LRFD Specifications 6.13.3.4). Review stiffener and web thicknesses as well as the bearing stiffener design history file for more information about maximum and minimum weld sizes ("<filename>.BDH" or "<filename>-BDH.PDF" in the same directory as this output file). The maximum weld size, which is solely dependent on the thicknesses of the plates being joined, is less than the weld size calculated from applied loads and weld material strength.

7.7.23 Web-To-Flange Weld Design: Weld Capacity

The following information is reported in the WEB–TO–FLANGE WELD DESIGN: WELD CAPACITY output table. This information will only be printed for plate girders.

1. Span Number - span number where the analysis point is located
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Flange - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.

5. Flexure - positive or negative flexure indicator which is set to 'POS.' for positive flexure and 'NEG.' for negative flexure. For sections that can be in both positive and negative flexure, only the governing case (case with the greater shear flow) is reported.
6. Weld Metal Resistance, Rr, weld - the resistance of the weld metal.
7. Factored Shear Flow**, su - the total factored shear flow at the transition between web and flange. The following note is printed below the table:

   NOTE: FACTORED SHEAR FLOW is the total shear flow between the web and the flange. The calculated weld size is based on 1/2 of the total factored shear flow
8. Weld Size, Calculated - the required weld size based on the factored shear flow and weld metal resistance.
9. Weld Size, Minimum - the minimum allowed weld size based on the thicker piece joined.
10. Weld Size, Maximum - the maximum allowed weld size based on the thinner piece joined.
11. Weld Size, Designed - the designed weld size for this analysis location. This value is the larger of the Weld Size, Calculated and the Weld Size, Minimum.
11. Code Check* - requirements not met for the designed weld size. The comments are denoted by the alphabetic character A as described below.

   A Calculated weld size is larger than maximum allowed; adjust girder section properties.

   The presence of the character, A, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.24 Web-To-Flange Weld Design: Connected Material Capacity

The following information is reported in the WEB–TO–FLANGE: CONNECTED MATERIAL CAPACITY output table. This information will only be printed for plate girders. All analysis points are printed for design runs, while only the controlling point is printed for analysis runs.

1. Span Number - span number where the analysis point is located
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Flange - flange location indicator set to 'TOP' for the top flange or 'BOT' for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Flexure - positive or negative flexure indicator which is set to 'POS.' for positive flexure and 'NEG.' for negative flexure. For sections that can be in both positive and negative flexure, only the governing case (case with the greater shear flow) is reported.
6. Connected Metal Resistance, Web, sr, web - the resistance of the web metal
7. Connected Metal Resistance, Flange, sr, flange - the resistance of the flange metal
8. Factored Shear Flow***, su - the total factored shear flow at the transition between web and flange. The following note is printed below the output table:

   ***NOTE: FACTORED SHEAR FLOW is the total shear flow between the web and the flange.

9. Performance Ratio** - the maximum ratio of su/sr,web and su/sr,flange. The following note is printed below the output table:

   For Analysis:

   ***NOTE: PERFORMANCE RATIO is the maximum ratio of su/sr, web and su/sr, flange. [The loading combination specified here results in the maximum performance ratio along the entire girder.]

   For Design:

   ***NOTE: PERFORMANCE RATIO is the maximum ratio of su/sr, web and su/sr, flange.

10. Code Check* - requirements not met for the connected metal. The comments are denoted by the alphabetic characters A-B as described below.

    A Web metal resistance less than factored shear flow

    B Flange metal resistance less than factored shear flow

    The presence of any character, A-B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.25 Longitudinal Slab Reinforcement at Continuous Supports

The following information is reported in the LONGITUDINAL SLAB REINFORCEMENT AT CONTINUOUS SUPPORTS output table. This table is only printed if the user enters any instances of the SST command.

1. Support Number - support number for which the slab reinforcement is defined.
2. Bar Number - bar designation for longitudinal bar at this support
3. Left Cutoff - location of the physical left end of this longitudinal bar.
4. As/Effective Slab Width - total area of reinforcement within the effective slab width
5. As/Unit Slab Width - total area of reinforcement divided by the effective slab width to get an area per unit width
6. Location in Slab - location of reinforcement; T for top of slab, B for bottom of slab

7.7.26 Minimum Negative Flexure Concrete Deck Reinforcement (Part 1)

The following information is reported in the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT (PART 1) output table.

1. Span Number – span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. phi*fr - the modulus of rupture of the deck concrete multiplied by a phi factor of 0.9. The specification checks of this output report are only done when the negative bending tensile stress in the deck under the Service-II limit state or construction staging analysis exceeds phi*fr.

4. Service-II Stress - the stress in the slab under the Service-II limit state. If the current analysis point is not in negative flexure for the Service-II limit state, this value will print as "n/a(1)*".
5. Construction Stress - the maximum tensile stress in the slab during construction staging analysis. If the current analysis point is not in negative flexure for any construction stages or staging analysis has not been entered for this girder, this value will print as "n/a(2)*".
6. Construction Stage - the stage in which the maximum construction staging stress occurs. If the current analysis point is not in negative flexure for any construction stages or staging analysis has not been entered for this girder, this value will be blank.
7. Total Area: Slab Reinforcement ABU/APL/ARB* - the total longitudinal slab reinforcement at the specified location, based on input on the ABU/APL/ARB command (as appropriate for the current beam type).
8. Total Area: Slab Reinforcement SST* - the total longitudinal slab reinforcement at the specified location based on input on the SST command; the area will include reductions for development length for locations within the development length of the rebar. If the maximum deck stress in columns 4 and 5 does not exceed the limit in column 3, this column and all following will replaced with "Not Applicable (3)" because the checks are not necessary.
9. Total Area: Slab* - the cross-sectional area of the slab, based on the actual thickness of the slab, not the effective thickness.
10. Percent Area* - the percentage of the slab area occupied by the reinforcement area.
11. Yield Strength - the yield strength of the deck reinforcement.

The following note is printed below the output table:

* Legend of General Notes (all checks done as per DM-4 Article 6.10.1.7):

phi*fr: phi of 0.9 * modulus of rupture of the concrete fr calculated for normal-weight concrete using AASHTO 6.10.1.7

Total Area Slab Reinforcement ABU/APL/ARB: Area of longitudinal slab reinforcement defined with ABU/APL/ARB commands

Total Area Slab Reinforcement SST: Total area of all longitudinal slab reinforcement defined with SST commands. Total area is reduced before bars are fully developed.

Total Area Slab: Total cross sectional area of the slab, using the total slab depth

Percent Area: The percentage of the slab total area occupied by the SST slab reinforcement. If the SST slab reinforcement is not defined, then the ABU/APL/ARB slab reinforcement is used.

(1) The point is not in negative flexure for the Service-II limit state.

(2) The point is not in negative flexure for construction staging, construction staging has not been entered for this girder, or deck is never in tension for construction.

(3) The tensile stress in the deck does not exceed phi*modulus of rupture for the Service-II limit state or construction stages, so the deck reinforcement checks need not be done.

(4) The slab reinforcement has not been defined with an SST command at this location.

12. Code Check** - requirements not met for the concrete deck reinforcement. The failures are denoted by an alphabetic character A-F as described below. A single section can have multiple failures.

    A Slab reinforcement is less than 1% of the total cross-sectional area of the slab

    B Slab reinforcement yield strength < 60 ksi

    C. The area of reinforcing defined on the APL command is greater than that defined on the SST command. The program will use the SST values, but the input should be reviewed.

    The presence of the characters, A or B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output. If the character C appears in this column, the title of the output report will appear on the SPECIFICATION CHECK WARNINGS report at the end of the program output.

7.7.27 Minimum Negative Flexure Concrete Deck Reinforcement (Part 2)

The following information is reported in the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT (PART 2) output table.

1. Span Number – span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Maximum Bar Size, Top* - the maximum bar size in the top layer of reinforcement at this location. If the reinforcement has not been entered on the SST command, the maximum bar size will be unknown. If the maximum deck stress in columns 4 and 5 on the MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT (PART 1) output report does not exceed the limit in column 3 on the same report, this column and all following will replaced with "Not Applicable (3)" because the checks are not necessary.
4. Maximum Bar Size, Bottom* - the maximum bar size in the bottom layer of reinforcement at this location. If the reinforcement has not been entered on the SST command, the maximum bar size will be unknown.
5. Maximum Bar Spacing, Top* - the maximum bar spacing in the top layer at this location. If the reinforcement has not been entered on the SST command, the maximum bar spacing will be unknown.
6. Maximum Bar Spacing, Bottom* - the maximum bar spacing in the bottom layer at this location. If the reinforcement has not been entered on the SST command, the maximum bar spacing will be unknown.
7. Maximum Bar Development Length, Top* - the modified development length of the largest bar at the top of the slab
8. Maximum Bar Development Length, Bottom* - the modified development length of the largest bar at the bottom of the slab
9. Reinforcement Area Top, Required* - the required area of reinforcement required at the top of the slab, equal to 2/3 of 1% of the slab area.

10. Reinforcement Area Top, Actual* - the area of reinforcement provided at the top of the slab. If the reinforcement at this location is not fully developed, the area reported will be less than that input. If the reinforcement has not been entered on the SST command, the top bar layer area will be unknown.
11. Reinforcement Area Bottom, Required* - the required area of reinforcement required at the bottom of the slab, equal to 1/3 of 1% of the slab area.
12. Reinforcement Area Bottom, Actual* - the actual area of reinforcement provided at the bottom of the slab. If the reinforcement at this location is not fully developed, the area reported will be less than that input. If the reinforcement has not been entered on the SST command, the top bar layer area will be unknown.

The following note is printed below the output table:

* Legend of General Notes (all checks done as per DM-4 Article 6.10.1.7):

Maximum Bar Size: The largest bar size of the top and bottom layers

Maximum Bar Spacing: The largest bar spacing of the top and bottom layers

Maximum Bar Development Length: The modified development length of the largest bar in each of the top and bottom layers

Reinforcement Area Required: The required area of reinforcement in the top or bottom of the slab. At least 2/3 of 1% of the slab area is required in the top and at least 1/3 of 1% of the slab area is required in the bottom.

Reinforcement Area Actual: The area of reinforcement in the top or bottom of the slab. If the reinforcement at this location is not fully developed, the area reported will be less than the input area.

(3) The tensile stress in the deck does not exceed phi*modulus of rupture for the Service-II limit state or construction stages, so the deck reinforcement checks need not be done.

11. Code Check** - requirements not met for the concrete deck reinforcement. The failures are denoted by an alphabetic character A-F as described below. A single section can have multiple failures.

A Slab reinforcement spacing > 12"

B Maximum bar size > #6

C The top layer has less reinforcement than required

D The bottom layer has less reinforcement than required

The presence of any character, A-D, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

If the reinforcement is not entered using the SST command at a given location, "Unknown***" will print in the "Maximum Bar" and "Reinforcement Area Actual" columns and will result in the title of the output report appearing on the SPECIFICATION CHECK WARNINGS report at the end of the program output, and the following message below the output table:

*** The Deck Reinforcing Area entered via the APL command is greater than the total area entered on the SST command (or the SST command is omitted for this location). Because of this, the bar size, spacing and location are unknown.
For analysis locations where the reinforcing entered on the SST command is not fully developed, a reduced area is calculated. Be sure to specify a cutoff location such that the developed SST area is greater than the area entered via the APL command. If the SST area is not greater than the APL area, the title of this output report will appear on the SPECIFICATION CHECK WARNINGS report.

7.7.28 Special Fatigue Requirement for Webs

The following information is reported in the SPECIAL FATIGUE REQUIREMENT FOR WEBS output table. This check is only printed at points where it is required; analysis points that are located within interior panels of webs with transverse stiffeners, with or without longitudinal stiffeners. If no applicable points exist for a given run (no interior panels are considered stiffened by STLRFD), the table will not print. The live load stresses are factored based on the fatigue limit state (as described below).

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Allowable, Vcr - maximum allowable shear stress (shear-buckling resistance). This value will print as ‘N/A’ for points that have unstiffened webs or are located within exterior panels.
4. Actual, Vu - actual elastic shear in the web due to unfactored permanent load and twice the factored fatigue loading. This value will print as ‘N/A’ for unstiffened webs or exterior panels.
5. Comment* - comments on the web fatigue shear stress check. The comments are denoted by the alphabetic characters A-C as described below. A single section can have multiple comments.
   - A Code check: Vu > Allowable, Vcr - A code failure occurs if the actual shear stress is greater than the allowable shear stress.
   - B Unstiffened web or exterior panel - this check is not required if the web is unstiffened or the panel is an exterior panel (the shear force is already limited by other means).

   The presence of the character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.29 Fatigue Resistance

The following information is reported in the FATIGUE RESISTANCE output table. The stresses are factored based on the fatigue limit state. This table only applies when the user enters an FTG command to check fatigue for a specific detail.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Distance From Bottom - distance measured from the bottom of the girder.
4. Detail Category - category of the detail as specified in the LRFD Specifications.
5. Fatigue Limit State - the fatigue limit state used for the fatigue resistance check.
6. Stresses, Dead*** - the total, unfactored dead load stress at the fatigue detail.
7. Stresses, Positive Live*** - the factored live load stress due to the positive fatigue live load moment at the fatigue detail.
8. Stresses, Negative Live*** - the factored live load stress due to the negative fatigue live load moment at the fatigue detail.

   The following note is printed below the output table:

   *** The dead load stress is unfactored, and is the total of all dead load stresses at the fatigue detail. The live load stress is factored for the limit state shown in the Fatigue Limit State column.
9. Fatigue Resistance - factored fatigue resistance at the specified location.
10. Fatigue Stress Range - factored fatigue stress range at the specified location.
11. Fillet Weld - effective throat measurement of a transversely loaded fillet weld between two plates where the discontinuous plate is loaded. This value will only print if it is valid and is needed for the calculation at this section.
12. Code Checks* - requirements not met for fatigue resistance. The failure is denoted by the alphabetic character A or B as described below.

    A Insufficient fatigue resistance - fails if the allowable fatigue stress range is less than the actual fatigue stress range.

    B User entered effective throat of fillet weld where there is no transversely loaded fillet weld with discontinuous cover plate loaded. Analyzing as standard fatigue detail. - fails if the user enters an effective throat of fillet weld dimension where one is not required.

    The presence of any character, A-B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.30 Remaining Fatigue Life Estimation

The following information is reported in the REMAINING FATIGUE LIFE ESTIMATION output table. This table prints only when FTG and FTL commands are entered.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Distance From Bottom - distance measured from the bottom of the girder.
4. Total Cycles - total number of fatigue cycles allowed over the life of the detail.

5. Accumulated Cycles to Date - estimated number of cycles that the detail has seen.
6. Remaining Cycles - estimated number of cycles left in the life of the detail.
   If the number of remaining cycles is less than or equal to zero, the title of this output report will appear on the SPECIFICATION CHECK FAILURES report at the end of the program output.
7. Number of Years Remaining - estimated number of years remaining in the life of the detail based on the average daily truck traffic carried by the structure.

7.7.31 Deflection Limits for Live Load

The following information is reported in the DEFLECTION LIMITS FOR LIVE LOAD output table.

1. Span Number - span number where the analysis point is located.
2. Location of Maximum Deflection - distance to the analysis point having the maximum live load deflection measured from the left support of the specified span number.
3. Deflection Allowable - maximum allowable live load deflection.
4. Deflection Actual - actual live load deflection.
5. Overhang Allowable - maximum allowable overhang. "N/A" will print in this column for program runs for interior beams.
6. Overhang Actual - actual overhang entered by the user. "N/A" will print in this column for program runs for interior beams.
7. Code Check* - requirements not met for live load deflection limits. The failure is denoted by the alphabetic characters A, B or C as described below.
   - A Maximum deflection exceeds allowable - fails if the allowable deflection is less than the actual live load deflection.
   - B Deck overhang exceeds minimum beam depth - fails if the user input overhang exceeds the limit
   - C Deck overhang exceeds maximum allowable due to deflections - fails if the user input overhang exceeds the limit calculated as per DM–4 Table 9.7.1.5.1P–1.

   The presence of a characters A, B or C in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.32 Deflection Limits for Deflection Loading Only

The same information is printed on this table as described in Section 7.7.23, except that this table prints instead of the DEFLECTION LIMITS FOR LIVE LOAD output table for program runs that include sidewalk loads.

7.7.33 Deflection Limits for Deflection Loading Plus Pedestrian Live Load

The same information is printed on this table as described in Section 7.7.23, except this table includes effects from the pedestrian live load as well as the deflection loading. This table only prints for runs that include sidewalk loads.

7.7.34 Shear Connector Design - Number of Connectors Required

The following information is reported in the SHEAR CONNECTOR DESIGN - NO. OF CONNECTORS REQUIRED output table.

1. Design Region - the design region is based on the maximum live load moment locations and interior supports. Each design region is defined by the LRFD Specifications Article 6.10.10 and is consecutively numbered.
2. Start Span Number - span number of the left end of the design region.
3. Start Span Distance - distance to the left end of the design region measured from the left support of the specified span number.
4. End Span Number - span number of the right end of the design region.
5. End Span Distance - distance to the right end of the design region measured from the left support of the specified span number.
6. Horizontal Shear, P - total factored shear force that the shear connectors need to carry.
7. Factored Resistance, Q(r) - total factored resistance of the shear connectors.
8. Number of Connectors Required - total number of shear connectors required for the specified design region.

7.7.35 Shear Connector Design - Pitch

The following information is reported in the SHEAR CONNECTOR DESIGN - PITCH output table. Two mutually exclusive output tables may be printed here: one for stud shear connectors and one for channel shear connectors.

The following information is printed for stud shear connectors:

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Connectors Per Row, Maximum - maximum number of connectors per row.
4. Connectors Per Row, Actual - actual number of connectors per row inputted.
5. Pitch Required, Minimum - minimum required pitch for shear connectors.
6. Pitch Required, Maximum - maximum required pitch for shear connectors.

7. Pitch Based on Number of Connectors Required - pitch based on the required number of connectors (that is, (total length of design region)/((number of connectors required/actual number of connectors per row) - 1)).
8. Actual Pitch - actual pitch to be used out of the three spacing values above.
9. Code Check* - requirements not met for shear connector spacing. The failures are denoted by the alphabetic characters A-C as described below.
   - A Actual pitch is less than the minimum pitch required - the actual pitch recommended is less than the minimum pitch allowed; change geometry of shear connectors.
   - B Maximum allowable pitch is less than minimum allowable pitch. Increase number of connectors in cross section. - the maximum allowable pitch is less than minimum allowable.
   - C Actual number of connectors greater than maximum allowed - the actual number of connectors in each cross section is greater than the maximum allowed in the cross section, due to spacing requirements.

   The presence of any character, A-C, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

The following information is printed for channel shear connectors:

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Pitch Required, Minimum - minimum required pitch for shear connectors.
4. Pitch Required, Maximum - maximum required pitch for shear connectors.
5. Pitch Based on Number Required - pitch based on the required number of connectors (that is, (total length of region)/(number of connectors required - 1)).
6. Actual Pitch - actual pitch to be used out of the three spacing values above.
7. Code Check* - requirements not met for shear connector spacing. The failures are denoted by the alphabetic characters A-B as described below.
   - A Actual pitch is less than the minimum pitch required - the actual pitch recommended is less than the minimum pitch allowed; change geometry of shear connectors.
   - B Maximum allowable pitch is less than minimum allowable pitch. Increase the length of the connector in a cross section. - the maximum allowable pitch is less than minimum allowable.

   The presence of any character, A-B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

For either stud or channel shear connectors, if no SKW command has been entered, the program will assume a conservative calculation when computing the maximum shear connector pitch by including the radial fatigue shear range component per A6.10.10.1.2. A warning will appear at the end of the output file and the following information will be printed below the SHEAR CONNECTOR DESIGN - PITCH header to indicate that the radial fatigue shear range component has been applied due to an SKW command not entered:

SKW command not entered, radial fatigue shear range conservatively applied.

7.7.36 Shear Connector Design - Spacing, Cover, and Penetration

The following information is reported in the SHEAR CONNECTOR DESIGN - SPACING, COVER, AND PENETRATION output table. This table only prints for runs that include stud shear connectors.

1. Minimum Transverse Spacing, Center to Center - minimum allowable transverse center to center spacing of the shear connectors in a row.
2. Minimum Transverse Spacing, Center to Edge - minimum allowable distance from the center of the shear connector to the edge of the flange.
3. Minimum Cover - minimum cover from the top of the shear connector to the top of the effective slab.
4. Minimum Penetration into Slab above Haunch - minimum distance from the bottom of the slab to the top of the shear connector.

7.7.37 Shear Connector Design - Cover and Penetration

The following information is reported in the SHEAR CONNECTOR DESIGN - COVER AND PENETRATION output table. This table only prints for runs that include channel shear connectors.

1. Minimum Cover - minimum cover from the top of the shear connector to the top of the effective slab.
2. Minimum Penetration into Slab above Haunch - minimum distance from the bottom of the slab to the top of the shear connector.

7.7.38 Construction Stage ii and Uncured Slab Web Specification Checks

The following information is reported on the CONSTRUCTION STAGE ii WEB SPECIFICATION CHECK and UNCURED SLAB WEB SPECIFICATION CHECK output tables. The CONSTRUCTION STAGE output tables are only generated for program runs which include construction stage analysis. The UNCURED SLAB output tables will be generated for every run of the program.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Gamma -slenderness value calculated as per DM-4 Equation 6.10.1.9.3P-2
4. Shear Force in Web, Vr - shear resistance of the web
5. Shear Force in Web, 4*Vdl - 4 * the unfactored DC1 shear force

6. Shear Force in Web, Vu - actual factored shear force in the web, including only staging loads (no vehicular live loads).
7. Compressive Stress in Web, fcw - compressive bending stress limit, calculated as per DM-4 Equation 6.10.1.9.3P-1
8. Compressive Stress in Web, fu - total unfactored compressive bending stress in web
9. Code Check - requirements not met for web specification checks. The failures are denoted by the alphabetic characters A or B as described below. A single section can have multiple failures.
   - A Slenderness check fails and Vr < 4*V - the web slenderness (gamma) is less than the limit of 2.5, so 4*shear is checked and exceeds the shear resistance
   - B Insufficient web stress capacity (fcw < fu) - total unfactored compressive stress in web exceeds the compressive bending stress limit

   The presence of any character, A-B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.39 Construction Stage ii and Uncured Slab Wind Effects

The following information is reported on the CONSTRUCTION STAGE ii WIND EFFECTS and UNCURED SLAB WIND EFFECTS output tables. The CONSTRUCTION STAGE output tables are only generated for program runs which include construction stage analysis. The UNCURED SLAB output tables will be generated for every run of the program. These tables are generated only if the wind load is specified and the user defined wind velocity is greater than 0.

1. Construction Load Path – load paths for computing the wind load on the structure in the temporary construction stage:
   - T - Truss action.
   - F - Frame action.
   - L - Flange subjected to lateral force.
2. Span Number - span number where the analysis point is located.
3. Distance - distance to the analysis point measured from the left support of the specified span number.
4. Total Depth – Total depth for wind cross section includes beam depth, haunch thickness and slab thickness.
5. Wind Pressure - Wind pressure applied per cross sectional area to compute the wind loads.
6. Top Flange, Factored Wind Force, W – represents the total factored wind load resisted by the top flange.
7. Top Flange, Factored Wind Moment, Mwt – Wind moment resisted by the top flange.
8. Top Flange, Lateral Bending Stress, fl, 1st Order - First order lateral bending stress computed from the top flange wind moment, Mwt

9. Top Flange, Lateral Bending Stress, fl, 2nd Order* - Second order lateral bending stress computed from amplifying the first order stress. If 'N/A' prints in this column, the section satisfies the unbraced length requirements of DM-4 Article 6.10.1.6.
10. Bottom Flange, Factored Wind Force, W– represents the total factored wind load resisted by the bottom flange.
11. Bottom Flange, Factored Wind Moment, Mwb - Wind moment resisted by the bottom flange.
12. Bottom Flange, Lateral Bending Stress, fl, 1st Order - First order lateral bending stress computed from the bottom flange wind moment, Mwb.
13. Bottom Flange, Lateral Bending Stress, fl, 2nd Order* - Second order lateral bending stress computed from amplifying the first order stress. If 'N/A' prints in this column, the section satisfies the unbraced length requirements of DM-4 Article 6.10.1.6.

7.7.40 Construction Stage ii and Uncured Slab Factored Lateral Stresses

The following information is reported in the CONSTRUCTION STAGE ii FACTORED LATERAL STRESSES and UNCURED SLAB FACTORED LATERAL STRESSES output tables. The CONSTRUCTION STAGE output tables are only generated for program runs which include construction stage analysis. The UNCURED SLAB output tables will be generated for every run of the program.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set equal to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
4. Intermediate Calculations, rt* - effective radius of gyration for lateral torsional buckling.
5. Intermediate Calculations, Lp* - limiting unbraced length to achieve the nominal flexural resistance $R_{pc}M_{yc}$ under uniform bending
6. Intermediate Calculations, Cb* - moment gradient modifier
7. Intermediate Calculations, Rb* - web load shedding factor
8. Wind, 1st Order - first order lateral bending stress due to wind loads
9. Wind, 2nd Order - second order lateral bending stress due to wind loads (second order stress computed as per A6.10.1.6)
10. User Input, 1st Order - first order lateral bending stress due to user input lateral stresses
11. User Input, 2nd Order - second order lateral bending stress due to user input lateral stresses (second order stress computed as per A6.10.1.6)

The following note is printed below the output table:

* Legend of General Notes:

rt = Effective radius of gyration for lateral torsional buckling (A6.10.8.2.3-9)

Lp = Unbraced length for nominal flexural resistance (6.10.8.2.3-4)

Cb = Moment gradient modifier (A6.10.8.2.3)

Rb = Web load shedding factor (A6.10.1.10.2)

N/A* = This value is not applicable for this limit state

N/A** = This second order stress is not applicable at this analysis point, limit state and flexure state

N/A*** = No user-input lateral stress has been entered

If no wind loads or user-input lateral loads are entered, the title of the output table prints, followed by the message:

"This output report is not applicable because no lateral loads (wind or user input lateral loads) have been entered."

7.7.41 Construction Stage ii and Uncured Slab Flange Specification Check (No Lateral Torsional Buckling) (Part 1)

The following information is reported in the CONSTRUCTION STAGE ii FLANGE SPECIFICATION CHECK (NO LTB) (PART 1) and UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 1) output table. The CONSTRUCTION STAGE output tables are only generated for program runs which include construction stage analysis. The UNCURED SLAB output tables will be generated for every run of the program.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Hybrid Factor, Rh - the hybrid factor
4. Top/Bottom - flange location indicator set equal to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
5. Flange Nominal Yielding, Flexural + Lateral Allowable Stress - maximum allowable flexural plus lateral stress in the flange for flange nominal yielding criteria.
6. Flange Nominal Yielding, Flexural + Lateral, Actual Stress* - actual factored flexural plus lateral stress due to wind effects in the flange.
7. Web Bend Buckling*, Coefficient k – bend-buckling coefficient. Web bend-buckling checks only apply to compression flanges; tension flanges are identified as N/A.
8. Web Bend Buckling*, Flexural Stress Only, Allowable Stress - maximum allowable flexural stress in the flange for web bend buckling criteria.
9. Web Bend Buckling*, Flexural Stress Only, Actual Stress* - actual factored flexural stress in the flange.

The following notes are printed below the output table:

Legend of General Notes:

Actual Stresses are obtained using the appropriate factors for the construction limit state

Web bend-buckling checks only apply to compression flanges, tension flange are identified as N/A

10. Code Check** - requirements not met for staging flange specification checks. The failures are denoted by the alphabetic characters A-B as described below.

    A Flange fails nominal yielding check, A6.10.3.2.1-1, A6.10.3.2.2-1, or A6.10.3.2.3-1

    B Compression flange fail bend-buckling check, A6.10.3.2.1-3

    The presence of any character, A or B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.42 Construction Stage ii and Uncured Slab Flange Specification Check (No Lateral Torsional Buckling) (Part 2)

The following information is reported in the CONSTRUCTION STAGE ii FLANGE SPECIFICATION CHECK (NO LTB) (PART 2) and UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 2) output table. The CONSTRUCTION STAGE output tables are only generated for program runs which include construction stage analysis with an unbraced compression flange. The UNCURED SLAB output tables will be generated for every run of the program that includes a discretely braced compression flange.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Unbraced Length - maximum unbraced length measured between bracing points or to the point of where the deck has hardened.
4. Top/Bottom - compression flange location indicator set equal to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
5. Load Shedding Factor, Rb - the load shedding factor of the compression flange
6. Compression Flange Flexural Resistance (6.10.3.2.1-2), Flexural + Lateral Stresses, Allowable Stress - maximum allowable flexural plus lateral stress in the compression flange for flexural resistance criteria.
7. Compression Flange Flexural Resistance (6.10.3.2.1-2), Flexural + Lateral Stresses, Actual Stress* - actual factored flexural plus lateral stress in the compression flange.
8. Compression Flange Flexural Resistance (6.10.3.2.1-2), Flexural + Lateral Stresses, Resistance Calculation** - the method of calculating the flexural resistance for the compression flange, denoted by the alphabetic characters A-G as described below.

    A Compression flange is continuously braced, flexural resistance and lateral bending checks do not apply

    LRFD Specifications Article 6.10.8.2.2 (Flange Local Buckling)

    B Flange local buckling governs, AASHTO Equation 6.10.8.2.2-1

    C Flange local buckling governs, AASHTO Equation 6.10.8.2.2-2

    Other Notes

D Lateral stresses due to wind and/or user input effects apply to discretely braced flanges and have been included in the Actual Stress column

9. Compression Flange Flexural Resistance (6.10.1.6-1), Lateral Only, Allowable Stress - maximum allowable lateral stress in the compression flange for flexural resistance criteria.
10. Compression Flange Flexural Resistance (6.10.1.6-1), Lateral Only, Actual Stress* - actual factored lateral stress effects in the compression flange.

    The following note is printed below the output table:

    * Legend of General Notes:

        Actual Stresses are obtained using the appropriate factors for the construction limit state
11. Code Check*** - requirements not met for staging flange specification checks. The failures are denoted by the alphabetic characters A-B as described below.

    A Compression flange fails flexural resistance check, A6.10.3.2.1-2

    B Compression flange fails lateral bending check, A6.10.1.6-1

    The presence of any character, A or B, in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.43 Intermediate Values for Lateral Torsional Buckling Calculations (Construction Stage ii and Uncured Slab)

The following information is reported in the INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (CONSTRUCTION STAGE ii) and INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (UNCURED SLAB) output table. The CONSTRUCTION STAGE output tables are only generated for program runs which include construction stage analysis with an unbraced compression flange. The UNCURED SLAB output tables will be generated for every run of the program that includes a discretely braced compression flange. This table prints for points where the flexural capacity may be governed by lateral torsional buckling. Please see Section 3.7.18 of this User's Manual for a discussion on the STLRFD implementation of the lateral torsional buckling calculations.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - compression flange location indicator set equal to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
4. Flexure - positive or negative flexure indicator which is set to ‘P’ for positive flexure and ‘N’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
5. rt* - effective radius of gyration for lateral torsional buckling (Equation 6.10.8.2.3-9)
6. Rh* - hybrid factor (Article 6.10.1.10.1)
7. Rb* - load shedding factor (Article 6.10.1.10.2)

8. Dc* - depth of web in compression (Article D6.3.1)
9. Lp* - limiting unbraced length to achieve the nominal flexural resistance of RbRhFyc under uniform bending (Equation 6.10.8.2.3-4)
10. 6.10.8.2.3, Lr* - limiting unbraced length to achieve the onset of nominal yielding in either flange under uniform bending with consideration of compression-flange residual stress effects (Equation 6.10.8.2.3-5).
11. 6.10.8.2.3, Cb* - moment gradient factor (Equations 6.10.8.2.3-6 or 6.10.8.2.3-7).

7.7.44 Lateral Torsional Buckling Capacity (Construction Stage ii and Uncured Slab)

The following information is reported in the LATERAL TORSIONAL BUCKLING CAPACITY (CONSTRUCTION STAGE ii) and LATERAL TORSIONAL BUCKLING CAPACITY (UNCURED SLAB) output table. The CONSTRUCTION STAGE output tables are only generated for program runs which include construction stage analysis with an unbraced compression flange. The UNCURED SLAB output tables will be generated for every run of the program that includes a discretely braced compression flange. This table prints for points where the flexural capacity may be governed by lateral torsional buckling. The stresses are factored for the construction limit state. Please see Section 3.7.18 of this User's Manual for a discussion on the STLRFD implementation of the lateral torsional buckling calculations.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Top/Bottom - flange location indicator set to 'TOP' for the top flange or 'BOT' for the bottom flange.
4. Flexure - positive or negative flexure indicator which is set to 'P' for positive flexure and 'N' for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
5. 6.10.8.2.3 Flexural Resistance, Local Fr - stress flexural resistance, using the method of Article 6.10.8.2.3. This resistance is calculated using the section properties at the current analysis location.
6. * - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character A-E as described below.
   - A Fr calculated using AASHTO Equation 6.10.8.2.3-1
   - B Fr calculated using AASHTO Equation 6.10.8.2.3-2
   - C Fr calculated using AASHTO Equation 6.10.8.2.3-3
   - D Fr calculated using AASHTO Equation D6.4.1-2
   - E Fr calculated using AASHTO Equation D6.4.1-4
7. 6.10.8.2.3 Flexural Resistance, Governing Fr - stress flexural resistance, using the method of Article 6.10.8.2.3. For unbraced lengths that are nonprismatic (after any eligible transitions have been ignored in the 20% region), this resistance is the minimum flexural resistance in the unbraced length containing the current analysis location. For prismatic unbraced lengths (after any eligible transitions have been ignored in the 20% region), this resistance is the same as the local resistance.

8. * - the method used to compute the governing flexural resistance of the section. The methods are denoted by an alphabetic character A-C as described above.
9. Factored Effects Flexural + Lateral Stress, F+** - total factored stress, flexural + 1/3 * lateral due to wind and/or user input lateral effects This value is the maximum factored stress in the current unbraced length.
10. Code Check*** - a code failure may occur when computing the resistance of the section. The failure is denoted by the alphabetic characters A or B as described below.
    - A Insufficient flexural resistance - the flexural resistance is less than the factored flexural + lateral effect.
    - B Based on the total stress in the bottom flange, this section is analyzed for positive flexure, so the top flange capacity is based on compression. However, the total factored stress (F+) in the top flange is tensile. The user should verify the acceptability of the section by comparing the top flange stress (F+) to the flexural resistance (Fr) of the top flange in negative flexure.

    The presence of the character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.45 Construction Stage ii and Uncured Slab Net Section Fracture Check

The following information is reported in the CONSTRUCTION STAGE ii NET SECTION FRACTURE CHECK and UNCURED SLAB NET SECTION FRACTURE CHECK output table. This check is only printed at points where it is required; analysis points that include section holes in the tension flange. The CONSTRUCTION STAGE output tables are only generated for program runs which include construction stage analysis. The UNCURED SLAB output tables will be generated for every run of the program.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
5. Flange Area Ratio, An/Ag - the ratio of the net area (defined as the gross area including all section losses and section holes) to the gross area
6. Tensile Strength - the tensile strength of the tension flange
7. Yield Strength - the yield strength of the tension flange
8. Net Section Fracture Resistance, Fr - net section fracture resistance
9. Factored Flexural Stress, ft - maximum factored stress at the analysis point for the given limit state and flange.
10. Code Check* - requirements not met for the net section fracture specification check. The failure is denoted by the alphabetic character A as described below.
    - A Flange fails net section fracture check, A6.10.1.8-1

The presence of a character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.7.46 Construction Stage ii and Uncured Slab Global Displacement Amplification Check

The following information is reported in the CONSTRUCTION STAGE ii GLOBAL DISPLACEMENT AMPLIFICATION CHECK and UNCURED SLAB GLOBAL DISPLACEMENT AMPLIFICATION CHECK output table. The CONSTRUCTION STAGE output tables are generated for program runs which include construction stage analysis with two**,** three**, or four** girder systems. The UNCURED SLAB output tables will be generated for every run of the program with two**,** three**, or four** girder systems. If a hardened composite deck is present anywhere a span (i.e. cast in a previous stage), no values will print for that span.

1. Span Number - span number of interest.
2. Distance - distance to the location of maximum factored moment measured from the left support of the specified span number.
3. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for spans that are in both positive and negative flexure.
4. Number of Beams - the assumed number of beams in the cross section used for this specification check. This value is either user input (two, three, or four beams for cross sections with any number of beams), or equal to the number of beams in the cross section (default for cross sections with two **or** three beams).
5. Ieff* - effective noncomposite moment of inertia about the vertical centroidal axis of a single girder within the span under consideration used in calculating the elastic global lateral-torsional buckling resistance of the span. This value is the weighted average of the value over the positive or negative portion of the span.
6. Ix* - noncomposite moment of inertia about the horizontal centroidal axis of a single girder within the span under consideration. This value is the weighted average of the value over the positive or negative portion of the span.
7. Mgs* - the elastic global lateral-torsional buckling resistance of the span acting as a system.
8. Mu* - the largest total factored girder moment during the deck placement within the span under consideration. Separate checks are done for positive and negative bending for each span.
9. 0.7*Mgs* - 70% of the elastic global lateral-torsional buckling resistance. The total factored moment, Mu, of all beams must not exceed 70% of Mgs.
10. Mu* (all beams) - the largest total factored girder moment multiplied by the number of beams in the cross section (two or three). This value is compared to 0.7 * Mgs.
11. Code Check** - requirements not met for the global displacement amplification check. A **failure** is denoted by the alphabetic character A, while an advisory about the applicability of this check is denoted by the alphabetic character B.

A - Insufficient flexural resistance (Mu (all beams) > 0.70*Mgs) **has been determined using the conservative equation in** LRFD Specifications Section 6.10.3.4.2**. P**otential solutions to consider beyond increasing the section stiffness **are other analysis methods such as an eigenvalue buckling analysis or a global second-order load-deflection analysis to determine the system response.**

B - The girder contains lateral bracing from a hardened composite deck somewhere within the span, so this check is not necessary.

The presence of a character A in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK **FAILURES** report at the end of the program output.

7.8 RATING FACTORS OUTPUT

A summary of the output tables for each parameter is given in Section 6.58. The user can suppress all rating output by entering zero for every rating factor output parameter. This output applies to both design and analysis runs of the program. The page heading indicates whether or not Future Wearing Surface load is included in the ratings.

7.8.1 Rating Factors - Summary

The following information is reported in the RATING FACTORS - SUMMARY output table.

1. Basis of Rating - basis of the ratings: flexure, shear or controlling rating.
2. T/B - the governing flange for the flexure rating. A ‘T’ appears for the top flange and a ‘B’ appears for the bottom flange.
3. Rating Factor - minimum rating factor for the given basis of rating.
4. Rating Tonnage - the equivalent tonnage for the given rating factor. A tonnage will not print for the PHL-93, HL-93 or P-82C loading combinations, since each of these are a combination of several live loads. For the P-82C combination, see DM-4 Article 3.4.1 for more information.
5. Span Number - span number of the controlling rating.
6. Distance - distance to the analysis point of the controlling rating measured from the left support of the specified span number.
7. Limit State - limit state of the governing rating factor as defined in the LRFD Specifications.

7.8.2 Rating Factors - Moment Flexural Capacity

The following information is reported in the RATING FACTORS - MOMENT FLEXURAL CAPACITY output table. This table will only print for points for which the flexural capacity is reported in terms of moment.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
5. Resisting Moment, Mr - factored flexural resistance.
6. Total DL Moment - total factored dead load moment (noncomposite + composite dead loads). For program runs that include sidewalk and pedestrian loads, the pedestrian live load is included as part of the total dead load moment for the Strength-IP limit state.
7. Total LL Moment - total factored live load moment.

8. Rating Factor - Moment flexural capacity rating factor. An asterisk (*) following the rating factor indicates that the rating is governed by lateral torsional buckling capacity. The total DL and LL moments are from the maximum effect in the current unbraced length.
9. Rating Failures** - several different code failures are reported that do not directly impact the rating factors. These failures are denoted by alphabetic characters A-D as described below. A single section can have multiple failures.
   - A Section fails web proportion check - the section has exceeded the allowable D/tw ratio of 150 for unstiffened webs or 300 for stiffened webs, as per LRFD Specifications Article 6.10.2.1. The web proportion check can be found in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output table.
   - B Section fails one or more flange proportion checks - the section has failed one or more flange proportion checks, as per LRFD Specifications Article 6.10.2.2. The flange proportions checks can be found in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output table.
   - C Section fails ductility check - the section has exceeded the ductility check for composite sections in positive flexure, as per LRFD Specifications Article 6.10.7.3. The ductility check can be found in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output table.
   - D Rating factor less than 1.0 - If the rating factor at any given section is less than 1.0, then the program flags the section to let the user know that the rating factor computed is less than 1.0.

   The presence of any character A-D in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.8.3 Rating Factors - Stress Flexural Capacity

The following information is reported in the RATING FACTORS - STRESS FLEXURAL CAPACITY output table. This table will only print for points for which the flexural capacity is reported in terms of stress.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Flange - flange indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
4. Limit State - limit state as defined in the LRFD Specifications.
5. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure. Both positive and negative results are reported for sections that can be in both positive and negative flexure.
6. Resisting Stress, Fr - factored flexural resistance in terms of stress.
7. Total DL Stress - total factored dead load stress (noncomposite + composite dead loads). For program runs that include sidewalk and pedestrian loads, the pedestrian live load is included as part of the total dead load stress for the Strength-IP limit state.
8. Total LL Stress - total factored live load stress.

9. Rating Factor - Stress flexural capacity rating factor. An asterisk (*) following the rating factor indicates that the rating is governed by lateral torsional buckling capacity. The total DL and LL moments are from the maximum effect in the current unbraced length. A plus sign (+) following the rating factor indicates that net section fracture governs and a hash sign (#) indicates web-bend buckling. For net section fracture and web bend-buckling, the DL and LL effects do not include lateral effects, as per the LRFD Specification.
10. Rating Failures** - several different code failures are reported that do not directly impact the rating factor. These failures are denoted by alphabetic characters A-D as described below. A single section can have multiple failures.
    - A Section fails web proportion check - the section has exceeded the allowable D/tw ratio of 150 for unstiffened webs or 300 for stiffened webs, as per LRFD Specifications Article 6.10.2.1. The web proportion check can be found in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output table.
    - B Section fails one or more flange proportion checks - the section has failed one or more flange proportion checks, as per LRFD Specifications Article 6.10.2.2. The flange checks can be found in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output table.
    - C Section fails ductility check - the section has exceeded the ductility check for composite sections in positive flexure, as per LRFD Specifications Article 6.10.7.3. The ductility check can be found in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output table.
    - D Rating factor less than 1.0 - If the rating factor at any given section is less than 1.0, then the program flags the section to let the user know that the rating factor computed is less than 1.0.

    The presence of any character A-D in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.8.4 Rating Factors - Shear Capacity

The following information is reported in the RATING FACTORS - SHEAR CAPACITY output table.

1. Span Number - span number where the analysis point is located.
2. Distance - distance to the analysis point measured from the left support of the specified span number.
3. Limit State - limit state as defined in the LRFD Specifications.
4. Shear - positive or negative shear indicator which is set to ‘POS.’ for positive shear and ‘NEG.’ for negative shear. Only the governing rating (of positive shear or negative shear) will print for a given point and limit state.
5. Resisting Shear, Vr - factored shear resistance.
6. Total DL Shear - total factored dead load shear (noncomposite + composite dead loads). For program runs that include sidewalk and pedestrian loads, the pedestrian live load is included as part of the total dead load shear for the Strength-IP limit state.

7. Total LL Shear - total factored live load shear.
8. Rating Factor - Shear rating factor.
9. Rating Failure* - a code failure is reported that does not directly impact the rating factor. This failure is denoted by the alphabetic character A-C as described below.
   - A D/tw has exceeded limit of 150 for unstiffened webs - The depth/thickness ratio of the unstiffened web exceeds the web proportion requirement of the LRFD Specifications. Consider revising the web depth and/or web thickness of the section, or adding transverse stiffeners to the web.
   - B D/tw has exceeded limit of 300 for stiffened webs - The depth/thickness ratio of the stiffened web exceeds the web proportion requirement of the LRFD Specifications. Consider revising the web depth and/or web thickness of the section.
   - C Rating factor less than 1.0 - If the rating factor at any given section is less than 1.0, then the program flags the section to let the user know that the rating factor computed is less than 1.0.

   The presence of any character A-C in this column in the program output will result in the title of this output report appearing on the SPECIFICATION CHECK FAILURES report at the end of the program output.

7.8.5 Rating Factors - Overall Summary

The following information is reported in the RATING FACTORS - OVERALL SUMMARY output table.

1. Governs - basis of the governing (minimum) rating: flexure or shear.
2. T/B - the governing flange for flexure ratings. A ‘T’ appears for the top flange and a ‘B’ appears for the bottom flange.
3. Rating Factor - minimum rating factor.
4. Rating Tonnage - the equivalent tonnage to the rating factor. A tonnage will not print for the PHL-93, HL-93 or P-82C loading combinations, since each of these are a combination of several live loads. For the P-82C combination, see DM-4 Article 3.4.1 for more information.
5. Span Number - span number of the controlling rating.
6. Distance - distance to the analysis point of the controlling rating measured from the left support of the specified span number.
7. Limit State - limit state of the governing rating as defined in the LRFD Specifications.

7.8.6 Bridge Load Ratings

This table presents inventory and operating ratings for each span of the bridge and for each rating vehicle considered in a format that is consistent with DM-4 Part A Table 1.8.3-1. The following information is presented in this table:

1. Span ii - the span number for the rating summary

2. Beam Type and Size: - the web depth (for plate girders and built-up sections) or beam designation (rolled beams) at the left end of the span
3. INVENTORY RATING Distribution Factor - the live load distribution factor for each vehicle
4. INVENTORY RATING Location (ft) - the distance from the left centerline of bearing in feet to the location of the specified rating
5. INVENTORY RATING Resistance - the section resistance (flexure or shear) at the location of the rating factor
6. INVENTORY RATING Limit State - the limit state corresponding to the given rating
7. INVENTORY RATING RF - the rating factor value with either "M" or "S" to identify whether moment ("M") or shear ("S") controls
8. OPERATING RATING Distribution Factor - the live load distribution factor for each vehicle. A distribution factor will not print for the P-82C loading combination, since several distribution factors are used in the calculation of the P-82C effects. See DM-4 Equation 3.4.1-3P for more information.
9. OPERATING RATING Location (ft) - the distance from the left centerline of bearing in feet to the location of the specified rating
10. OPERATING RATING Resistance - the section resistance (flexure or shear) at the location of the rating factor
11. OPERATING RATING Limit State - the limit state corresponding to the given rating
12. OPERATING RATING RF - the rating factor value with either "M" or "S" to identify whether moment ("M") or shear ("S") controls
13. Maximum Factored Flexural Resistance (kip-ft) - the maximum moment capacity in the given span
14. Span Length(ft) - the span length measured from the left centerline of bearing (abutment or pier) to the right centerline of bearing (abutment or pier)
15. Location (ft) - the distance from the left centerline of bearing to the location of the maximum factored flexural resistance
16. Maximum Factored Shear Resistance (kips) - the maximum shear capacity in the given span
17. Location (ft) - the distance from the left centerline of bearing to the location of the maximum factored shear resistance

7.9 SUMMARY - OVERALL REACTIONS TABLES

A list of the overall reaction output tables printed by default is given in Section 6.56. The user can suppress all of the overall reaction table outputs by entering zero on the OAN command for the overall reaction summary parameter. The output applies to both design and analysis runs of the program. Tables listed from 7.9.1 to 7.9.8 are printed under the above title. The tables provide reaction values that could be used as an input for bearing, abutment and pier designs.

7.9.1 Reactions & Rotations Per Girder (Unfactored , w/o Impact, w/ Distribution) for Elastomeric Bearing Pad Design

All the reaction values provided in this table are per girder. Live load reaction and rotation values provided in this table are computed as follows:

Vehicle reaction (without impact and without distribution factor) is summed with the lane reaction (without impact and without distribution factor). The resulting value is multiplied by reaction distribution factor (refer to section 3.4.15 for reaction distribution factor computation) to obtain the final reaction value provided in the table.

The absolute maximum of minimum and maximum rotation for the given live load is multiplied by rotation distribution factor (refer to section 3.4.19 for rotation distribution factor computation) to obtain the final rotation provided in the table. Both dead load and live load reactions are provided in one table.

The following information is reported in the REACTIONS & ROTATIONS PER GIRDER (UNFACTORED, W/O IMPACT, W/ DISTRIBUTION) FOR ELASTOMERIC BEARING PAD DESIGN output table.

1. Support No. - Support number of the reported reaction location.
2. Lists load types such as Dead Load (DC1, MC1, UT1, DC2, MC2, UT2, FWS) and LL (Live Load Vehicle). The dead load reactions at the abutments do not include any loads past the centerline of bearing. To include these loads, specify them using the CLD (Concentrated Load) command.
3. Minimum Reaction - Minimum reaction value for the given load type.
5. Minimum Reaction LC – Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for minimum reaction. The live load codes are as follows:
   1 - tandem + lane governs
   2 - truck + lane governs
   3 - tandem pair + lane governs
   4 - truck pair + lane governs (PHL-93 only)
   4 - 90% (truck pair + lane) governs (HL-93 only)
   5 - truck alone governs
   6 - 25% truck + lane governs

7 - 90% (truck pair + lane governs)

5. Maximum Reaction - Maximum reaction value for the given load type.
6. Maximum Reaction LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for maximum reaction. Codes are as denoted above.
7. Live Load Rotation - Rotation for live loads only. Lists absolute maximum of minimum and maximum rotations for the given live load. Rotation is about an axis normal to the centerline of the beam.
8. Live Load Rotation LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for absolute maximum rotation.

7.9.2 Reactions Per Girder (Unfactored and Factored, w/ Impact, w/ Distribution) for Sole Plate Design

All the reaction values provided in this table are per girder. Both dead load and live load reactions are provided in one table. The following information is reported in the REACTIONS PER GIRDER (UNFACTORED AND FACTORED, W/ IMPACT, W/ DISTRIBUTION) FOR SOLE PLATE DESIGN output table.

1. Support No. - Support number of the reported reaction location.
2. Lists load types such as Dead Load (DC1, MC1, UT1, DC2, MC2, UT2, FWS) and LL (Live Load Vehicle). The dead load reactions at the abutments do not include any loads past the centerline of bearing. To include these loads, specify them using the CLD (Concentrated Load) command. Total factored reactions are provided for Strength-I and Service-II limit states.
3. Minimum Reaction - Minimum reaction value for the given load type.
4. Minimum Reaction LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for minimum reaction. The live load codes are as follows:

   1 - tandem + lane governs

   2 - truck + lane governs

   3 - tandem pair + lane governs

   4 - truck pair + lane governs (PHL-93 only)

   4 - 90% (truck pair + lane) governs (HL-93 only)

   5 - truck alone governs

   6 - 25% truck + lane governs

   7 - 90% (truck pair + lane governs)
5. Maximum Reaction - Maximum reaction value for the given load type.
6. Maximum Reaction LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for maximum reaction. Codes are as denoted above.

7.9.3 Reactions & Rotations Per Girder (Unfactored , w/ Impact, w/ Distribution) for Pot, Steel or Disc Bearing Design

All the reaction values provided in this table are per girder. Both dead load and live load reactions are provided in one table. The following information is reported in the REACTIONS & ROTATIONS PER GIRDER (UNFACTORED, W/ IMPACT, W/ DISTRIBUTION) FOR POT, STEEL OR DISC BEARING DESIGN output table.

1. Support No. - Support number of the reported reaction location.
2. Lists load types such as Dead Load (DC1, MC1, UT1, DC2, MC2, UT2, FWS) and LL (Live Load Vehicle). The dead load reactions at the abutments do not include any loads past the centerline of bearing. To include these loads, specify them using the CLD (Concentrated Load) command.
3. Minimum Reaction - Minimum reaction value for the given load type.
4. Minimum Reaction LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for minimum reaction. The live load codes are as follows:
   1 - tandem + lane governs
   2 - truck + lane governs
   3 - tandem pair + lane governs
   4 - truck pair + lane governs (PHL-93 only)
   4 - 90% (truck pair + lane) governs (HL-93 only)
   5 - truck alone governs
   6 - 25% truck + lane governs
   7 - 90% (truck pair + lane governs)
5. Maximum Reaction - Maximum reaction value for the given load type.
6. Maximum Reaction LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for maximum reaction. Codes are as denoted above.
7. Rotation - Rotation for both dead loads and live loads are listed. Lists absolute maximum of minimum and maximum rotations for the given load. Future wearing surface is not considered for rotation. Rotation is about an axis normal to the centerline of the beam.
8. Live Load Rotation LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for absolute maximum rotation.

7.9.4 Reactions (Unfactored) for Abutment Design

The following two tables, 7.9.4.1 and 7.9.4.2, are summarized for the abutment design under the title REACTIONS (UNFACTORED) FOR ABUTMENT DESIGN. Dead load and live load reactions are provided in two different tables. These values are to be used only if the end supports are abutments. Do not use these values for the pier design at a discontinuous superstructure.

7.9.4.1 DL Reactions (Unfactored) per Girder

All the reaction values provided in this table are per girder. The user is expected to sum the reactions from each girder obtained from different runs for interior and exterior girders. The resulting value should then be divided by the skewed abutment width to obtain total dead load reaction per unit width of the abutment for the use in abutment design (refer to section 3.4.20). The dead load reactions at the abutments do not include any loads past the centerline of bearing. To include these loads, specify them using the CLD (Concentrated Load) command.

The following information is reported in the DL REACTIONS (UNFACTORED) PER GIRDER output table.

1. Support No. - Support number of the reported reaction location.
2. Lists dead load types (DC1, MC1, UT1, DC2, MC2, UT2, FWS).
3. Minimum Reaction - Minimum reaction value for the given load type.
4. Maximum Reaction - Maximum reaction value for the given load type.

7.9.4.2 LL Reactions per Lane (Unfactored, w/o Impact)

The user should multiply the reaction value given in the output table by the number of lanes and multiple presence factor. The resulting value should then be divided by the abutment width to obtain total live load reaction per unit width of the abutment for the use in abutment design (refer to section 3.4.20).

Minimum and maximum reaction values listed under this table is the summation of vehicle and lane reactions.

The following information is reported in the LL REACTIONS PER LANE (UNFACTORED, W/O IMPACT) output table.

1. Support No. - Support number of the reported reaction location.
2. Lists live load run for the reported reaction.
3. Minimum Reaction - Minimum reaction value for the given load type.
4. Minimum Reaction LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for minimum reaction. The live load codes are as follows:
   1 - tandem + lane governs
   2 - truck + lane governs
   3 - tandem pair + lane governs
   4 - truck pair + lane governs (PHL-93 only)
   4 - 90% (truck pair + lane) governs (HL-93 only)
   5 - truck alone governs
   6 - 25% truck + lane governs

7 - 90% (truck pair + lane governs)

5. Maximum Reaction - Maximum reaction value for the given load type.
6. Maximum Reaction LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for maximum reaction. Codes are as denoted above.

7.9.5 Reactions (Unfactored) for Pier Design

The following two tables 7.9.5.1 and 7.9.5.2 are summarized for the pier design under the title REACTIONS (UNFACTORED) FOR PIER DESIGN. Dead load and live load reactions are provided in two different tables.

7.9.5.1 DL Reactions (Unfactored) per Girder

The following information is reported in the DL REACTIONS (UNFACTORED) PER GIRDER output table. The dead load reactions at the abutments do not include any loads past the centerline of bearing. To include these loads, specify them using the CLD (Concentrated Load) command.

1. Support No. - Support number of the reported reaction location.
2. Lists dead load types (DC1, MC1, UT1, DC2, MC2, UT2, FWS).
3. Minimum Reaction - Minimum reaction value for the given load type.
4. Maximum Reaction - Maximum reaction value for the given load type.

7.9.5.2 LL Reactions per Lane (Unfactored, w/o Impact)

The following information is reported in the LL REACTIONS PER LANE (UNFACTORED, W/O IMPACT) output table.

1. Support No. - Support number of the reported reaction location.
2. Lists live load run for the reported reaction.
3. Minimum Reaction Vehicle - Minimum vehicle reaction value for the given LL. Note that impact must be added for pier cap design.
4. Minimum Reaction Vehicle LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for minimum vehicle reaction. The live load codes are as follows:

   1 - tandem + lane governs

   2 - truck + lane governs

   3 - tandem pair + lane governs

   4 - truck pair + lane governs (PHL-93 only)

   4 - 90% (truck pair + lane) governs (HL-93 only)

   5 - truck alone governs

   6 - 25% truck + lane governs

7 - 90% (truck pair + lane governs)

5. Minimum Reaction Lane - Minimum lane reaction value for the given LL.
6. Minimum Reaction Lane LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for minimum lane reaction. Codes are as denoted above.
7. Maximum Reaction Vehicle - Maximum vehicle reaction value for the given LL. Note that impact must be added for pier cap design.
8. Maximum Reaction Vehicle LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for maximum vehicle reaction. Codes are as denoted above.
9. Maximum Reaction Lane - Maximum lane reaction value for the given LL.
10. Maximum Reaction Lane LC - Live load code (for PHL-93 and HL-93 only) which denotes the controlling LRFD live load condition for maximum lane reaction. Codes are as denoted above.

7.10 ECONOMIC FEASIBILITY CHECKS

The following output reports give information about economic feasibility checks that are done by STLRFD. The field section output describes the field sections that are considered by the field section feasibility checks

7.10.1 Field Sections

The following information is reported in the FIELD SECTIONS output table.

1. Field Section Number - The identifying number for the field section which is used on the ECONOMIC FEASIBILITY CHECKS output table.
2. Start Span Number - span number corresponding to the beginning of the field section
3. Start Distance - the distance to the beginning of the field section measured from the left support of the specified span number
4. End Span Number - span number corresponding to the end of the field section
5. End Distance - the distance to the end of the field section measured from the left support of the specified span number.
6. Field Section Length - the total length of the field section
7. Field Section Weight - the total weight of the field section

7.10.2 Economic Feasibility Checks

The economic feasibility check output table summarizes the economic feasibility checks performed by the program. The output table serves as a guideline for the designer regarding different economic feasibility checks. The designer should evaluate each of the guidelines provided in the output table for validity as it pertains to the specific structure in question. The guidelines are based on the LRFD Specifications, DM-4 and NSBA document G 12.1-2003. In addition to the checks provided in the output table the designer should review the LRFD Specifications, DM-4 and the NSBA document for other checks that are beyond the scope of STLRFD. See section 3.7.10 for full descriptions of the economic feasibility checks done. During the design of a beam the program performs the economic feasibility checks at the end of the design and the program does not revise the design for the failed economic feasibility checks.

7.11 SPLRFD AND NSBA SPLICE INPUT INFORMATION

This output gives information for SPLRFD input files or the NSBA Splice Spreadsheet that is available from STLRFD. This input is reported at each field splice location input on the Field Splice Location (FSL) input command. When certain parameters on a given command or input field are not available, "Not available" will print immediately after the parameter name. If no parameters on a given command or group of input fields are available, the command or input field group name will print, followed by "Not available".

7.12 FORMATTED OUTPUT TABLES

The following pages contain the format (i.e. the title, output parameters, units, field width and decimal locations, and legends) for each output table described in this chapter, in the order listed in this chapter. On each table, the character "a" represents a character value for that column, and the number of "a" characters shows the number of characters possible there. The character "i" represents an integer value for that column, and the character "x" represents a real value for that column, with the decimal location indicated. The output available for every run of the program may not include all of the output tables shown. Depending on such items as the live loadings, type of run, specifications checked, and output commands and parameters chosen, the program will print different combinations of these output reports.

7.12.1 Input Data

Example of Input File Echo:

```
                                  ex1.dat
                                  -------
TTL   EXAMPLE 1
TTL
TTL   SIMPLE SPAN - COMPOSITE ROLLED BEAM SECTION
TTL   WITH COVER PLATES
TTL
TTL   US UNITS
!
CTL   US, A, RB, I, 4, 1, N, N, 1700, 1.0, A, , , 1.3,N, 1.0, 0.95, 0.95,-
    R, 2
!
GEO   8.0, , N, 2, ,
!
UDF   1, D, 0.649, , 0.815, 0.815
UDF   1, F, 0.476, , 0.567, 0.567
! URF added on 7/14/03 required with UDF
URF   1, D, 0.815
URF   2, D, 0.815
URF   1, F, 0.567
URF   2, F, 0.567
!
SPL   1, 65.0
!
MAT   1, C, 50.0, 50.0, 50.0
!
ARB   1,   0.0, 1, 22.75, 1, W33X141, , ,     ,     , 0.96, , 0.00
ARB   1, 22.75, 1, 42.25, 1, W33X141, , , 14.0, 0.75, 0.96, , 0.00
ARB   1, 42.25, 1, 65.00, 1, W33X141, , ,     ,     , 0.96, , 0.00
!
SLB   9.0,  , 4.0, , , ,
!
DLD   DC1, 1, 0.0, 1, 65.0, 0.120, 0.120
DLD   DC2, 1, 0.0, 1, 65.0, 0.253, 0.253
DLD   FWS, 1, 0.0, 1, 65.0, 0.214, 0.214
!
WIN   , 32.0, F, 100., S, 100., 100., F
```

```
!
FTL   1969, 1995, 2000, 1978, 1675, , 2005, 2230,
!
FTG   1, 42.25, 0.0, E, 0.0
!
BRP   1, 0.0, 1, 65.0, 21.6667
!
SCS   2, 0.875, 4.0, 60.0
!
SP2   N
!
OIN   1, 1, 1
OSP   1, 1, 1
OAN   1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
OSC   1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1
ORF   1, 1, 1
```

Example of Input Commands:

```
                              INPUT COMMANDS
                              --------------

 COMMAND:  CTL
   SYSTEM OF UNITS                  US
   DESIGN/ANALYSIS                   A
   TYPE OF BEAM                     RB
   EXTERIOR/INTERIOR                 I
   NO. OF BEAMS                      4
   NO. OF SPANS                      1
   SYMMETRY                          N
   DECK POUR SYMMETRY                N
   ADTT FOR SINGLE LANE           1700
   MULT. PRES. ADJ. FACTOR         1.0
   LIVE LOAD                         A
   DYNAMIC LOAD ALLOWANCE         1.33              (default)
   FATIGUE DYN. LOAD ALLOW.       1.15              (default)
   PA TRAFFIC FACTOR                 *        (computed, if necessary)
   REDISTRIBUTE NEG. MOMENTS         N
   IMPORTANCE FACTOR               1.0
   DUCTILITY FACTOR               0.95
   REDUNDANCY FACTOR              0.95
   REDUNDANT LOAD PATH               R
   OUTPUT POINTS                     2
   P-82 DYN. LOAD ALLOW.          1.20              (default)
   SKEW ANGLE DESIGNATION            P              (default)
   CONSTANT LATERAL STRESS          0. ksi          (default)
   DC1S PERCENTAGE                  0.              (default)
   CHECK APPENDIX A                  Y              (default)
   AUTO BRACE AT SUPPORTS            Y              (default)
   UNCURED SLAB CHECKS W DPS         N              (default)

 COMMAND:  GEO
   BEAM/STRINGER SPACING           8.0 ft
   DECK OVERHANG                     * ft     (computed, if necessary)
   STAGGERED DIAPHRAGMS              N
   NO. OF DESIGN LANES               2
   DEFLECTION DF                     *        (computed, if necessary)
   SDWK NO. OF DESIGN LANES          *        (computed, if necessary)
   SDWK DEFLECTION DF                *        (computed, if necessary)
```

```
  KINKED/CURVED GIRDER                    N             (default)
  NO. BEAMS FOR 6.10.3.4.2                *        (computed, if necessary)

COMMAND:  UDF
  SPAN NUMBER                             1
  DISTRIBUTION FACTOR TYPE                D
  MOMENT DF1                          0.649
  MOMENT DF2                              *        (computed, if necessary)
  SHEAR DF1                           0.815
  SHEAR DF2                           0.815

COMMAND:  UDF
  SPAN NUMBER                             1
  DISTRIBUTION FACTOR TYPE                F
  MOMENT DF1                          0.476
  MOMENT DF2                              *        (computed, if necessary)
  SHEAR DF1                           0.567
  SHEAR DF2                           0.567

COMMAND:  URF
  SUPPORT NUMBER                          1
  DISTRIBUTION FACTOR TYPE                D
  REACTION DF                         0.815

COMMAND:  URF
  SUPPORT NUMBER                          2
  DISTRIBUTION FACTOR TYPE                D
  REACTION DF                         0.815

COMMAND:  URF
  SUPPORT NUMBER                          1
  DISTRIBUTION FACTOR TYPE                F
  REACTION DF                         0.567

COMMAND:  URF
  SUPPORT NUMBER                          2
  DISTRIBUTION FACTOR TYPE                F
  REACTION DF                         0.567
```

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
aa	aaaaaaaa	aaaaaaaaaaaa	aaaaaaaa	ii	ii	aaa	aaa	iiiii	aaa

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
a	x.xxx	x.xxx	aaa	aaa	x.xxx	x.xxx	x.xxx	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
ii	xx.xxx	aaaa	aaaaaa	xx.xx	aaa	aaa	aaaaaa

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

**NOTE: Detailed lateral stresses have been defined via the LAS command. This value will NOT be used.

***NOTE: There are no defined deck pours in this input file (DPS command). This value will NOT be used and all uncured slab checks will be done.

***NOTE: This value is not used for design runs. Uncured slab checks are always done for design runs.

SYMMETRICAL POINT

Span No.	Span Dist. (ft)
ii	xxx.xxx

STRUCTURE IDENTIFICATION

Program Identification	County	State Route	Segment	Offset	Span Identification
aaaaaaaaa	ii	iiii	iiii	iiii	aaaa

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
aaaaaa	aaaaaa	aaa	aaa	aaaaa	aaa	aaaaa	aaa	i

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
aaaaaaa	N/A	xxx.xxx	xxx.xxx	xxx.xxx	aaaaaaa

Distance to Outermost Wheel (ft) (without Sidewalk)	Centerline Exterior Beam to Curb (ft) (without Sidewalk)	Distance to Outermost Wheel (ft) (with Sidewalk)	Centerline Exterior Beam to Curb (ft) (with Sidewalk)
aaaaaaa	aaaaaaa	aaaaaaa	aaaaaaa

USER-DEFINED DISTRIBUTION FACTORS, DESIGN VEHICLE

USER-DEFINED DISTRIBUTION FACTORS, FATIGUE VEHICLE

USER-DEFINED DISTRIBUTION FACTORS, P-82C, SINGLE LANE

USER-DEFINED DISTRIBUTION FACTORS, P-82C, MULTI-LANE

	Moment		Shear	
Span No.	DF1	DF2	DF1	DF2
ii	x.xxx	x.xxx	x.xxx	x.xxx

USER-DEFINED REACTION DISTRIBUTION FACTORS, DESIGN VEHICLE

USER-DEFINED REACTION DISTRIBUTION FACTORS, FATIGUE VEHICLE

USER-DEFINED REACTION DISTRIBUTION FACTORS, PEDESTRIAN

Support No.	Reaction DF
ii	x.xxx

SKEW ANGLES

Support	ii	ii	ii	ii	ii	ii	ii
Angle (deg)	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx
Apply skew	a	a	a	a	a	a	a

SPAN LENGTHS

Span No.	ii	ii	ii	ii	ii	ii	ii
Length (ft)	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

HINGE LOCATIONS

Span No.	ii	ii	ii	ii	ii	ii	ii
Distance (ft)	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

USER-DEFINED ANALYSIS POINTS

Span No.	ii	ii	ii	ii	ii	ii	ii
Distance (ft)	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Rolled Beam Fy (ksi)	Rolled Beam Fu (ksi)	Cover Plate Top Fy (ksi)	Cover Plate Bottom Fy (ksi)
ii	aaaaaaaaaaaa	xxx.x	xxx.x	xxx.x	xxx.x

Matl. ID No.	Noncomposite/ Composite	Web Fy (ksi)	Flange Plate Top Fy (ksi)	Flange Plate Bottom Fy (ksi)	Flange Plate Top Fu (ksi)	Flange Plate Bottom Fu (ksi)	Classification Strength of Weld Metal (ksi)
ii	aaaaaaaaaaaa	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x

DESIGN - ROLLED BEAM

Max. Defl. (in)	Max. Defl. w/Ped. (in)	Noncomposite/ Composite	Rolled Beam Fy (ksi)	Rolled Beam Fu (ksi)	Beam Depth Minimum (in)	Beam Depth Maximum (in)	Haunch Depth (in)
xx.xx	aaaaa	aaaaaaaaaaaa	xxx.xx	xxx.xx	xxx.xx	xxx.xx	xxx.xx

Reinforcement Area (in^2/ft)	Reinforcement C.G. Distance (in)	Span-to-Depth Check	Design Method	Section 6.10.3.4.2 Check
xxx.xx	xx.xx	aaa	aaaaaa	aaa

DESIGN - PLATE GIRDER

Location Location Option	No. Top Top Trans.	No. Bottom Bottom Trans.	Max. Max. Defl. (in)	Max. Defl. Defl. w/Ped. (in)	Mass Weight Savings (lbf)	Noncomposite/ Noncomposite/ Composite
aaaaaaaaaa	ii	ii	xx.xx	aaaaa	xxx.xxx	aaaaaaaaaaaa

Web Fy (ksi)	Top Flange Fy (ksi)	Bottom Flange Fy (ksi)	Top Flange Fu (ksi)	Bottom Flange Fu (ksi)	Haunch Depth (in)	Reinforcement Area (in^2/ft)	Reinforcement C.G. Distance (in)	Minimum Depth (in)	Maximum Depth (in)
xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	x.xxx	x.xxx	x.xxx	xxx.xxx	xxx.xxx

Top Plate Width Min. (in)	Top Plate Width Max. (in)	Top Plate Thickness Min. (in)	Top Plate Thickness Max. (in)	Bottom Plate Width Min. (in)	Bottom Plate Width Max. (in)	Bottom Plate Thickness Min. (in)	Bottom Plate Thickness Max. (in)
xxx.xxx	xxx.xxx	xxx.xxxx	xxx.xxxx	xxx.xxx	xxx.xxx	xxx.xxxx	xxx.xxxx

Classification Strength of Weld Metal (ksi)	Plate Thickness Table	Flange Width Increment	Longitudinal Stiffness Limit Check	Span-to-depth Check	Section 6.10.3.4.2 Check	Minimum Web Thickness (in)
xxx.xx	i	i	aaa	aaa	aaa	aaaaaaa

*NOTE: A MINIMUM WEB THICKNESS was not entered by the user. The program will set the minimum web thickness to D/150, rounded up to the nearest available plate size.

TOP PLATE DESIGN LOCATIONS

BOTTOM PLATE DESIGN LOCATIONS

Span No.	ii	ii	ii	ii	ii	ii	ii
Distance (ft)	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

TRANSVERSE STIFFENER DESIGN

Stiff. Type	Min. Spacing (in)	Max. Spacing (in)	Yield Strength (ksi)	Cost Ratio
aaaaaa	xxx.xxx	xxx.xxx	xxx.xxx	x.xxx

```
                    ROLLED BEAM DIMENSIONS, PART 1 of 2
                    -----------------------------------
                         Nominal   Nominal   Moment of
          Designation     Depth    Weight     Inertia    Area
                          (in)    (lbm/ft)    (in^4)    (in^2)
          aaaaaaaaa      iiii      iiii    xxxxxx.      xxx.xx

                    ROLLED BEAM DIMENSIONS, PART 2 of 2
                    -----------------------------------
                    Flange    Flange     Beam       Web      Distance
     Designation    Width    Thickness   Depth   Thickness     “k”
                    (in)       (in)      (in)      (in)       (in)
     aaaaaaaaa    xx.xxx   xx.xxxx    xx.xxx   xx.xxxx    xx.xxxx

                     ROLLED BEAM PROPERTIES, PART 1 of 2
                     -----------------------------------
                     L H
End   End     Matl.  O O    Rolled        Top Cover          Bottom Cover
Span  Span     ID    S L     Beam           Plate               Plate
 No.  Dist.*   No.   S E   Designat.    Width    Thick.      Width    Thick.
      (ft)                              (in)      (in)        (in)      (in)
 ii  xxx.xxx   ii    a a   aaaaaaaaa   xx.xxxx  xx.xxxx     xx.xxxx  xx.xxxx

                     ROLLED BEAM PROPERTIES, PART 2 of 2
                     -----------------------------------
                 End    End                 Deck     Reinf.
                 Span   Span     Haunch    Reinf.     C.G.
                  No.   Dist.*    Depth     Area      Dist.
                        (ft)      (in)    (in^2/ft)   (in)
                  ii   xxx.xxx   xxx.xxx   xxx.xxx   xxx.xxx

       * The properties given on each line of this table are for the range
         of the beam to the LEFT of the span and the distance given.

                      BUILT-UP PROPERTIES, PART 1 of 2
                      --------------------------------
                     L H V
End   End     Matl.  O O A    Angle    Angle
Span  Span     ID    S L R    Vert.    Hort.    Angle       Web      Web
 No.  Dist.*   No.   S E Y     Leg      Leg     Thick.     Depth    Thick.
      (ft)                    (in)     (in)     (in)       (in)     (in)
 ii  xxx.xxx   ii    a a a  xxx.xxx  xxx.xxx  xx.xxxx    xxx.xxx  xxx.xxx

                      BUILT-UP PROPERTIES, PART 2 of 2
                      --------------------------------
End   End                                                     Deck     Reinf.
Span  Span       Top Plate       Bottom Plate     Haunch    Reinf.     C.G.
 No.  Dist.*  Width     Thick.   Width     Thick.  Depth     Area      Dist.
      (ft)    (in)      (in)     (in)      (in)    (in)   (in^2/ft)   (in)
ii  xxx.xxx  xx.xxxx  xx.xxxx  xx.xxxx  xx.xxxx  xxx.xxx  xxx.xxx  xxx.xxx

       * The properties given on each line of this table are for the range
         of the beam to the LEFT of the span and the distance given.
```

```
                      PLATE GIRDER PROPERTIES, PART 1 of 2
                      ------------------------------------
                     L H V
End   End   Matl. O O A                        Top              Bottom
Span  Span   ID   S L R    Web    Web         Plate              Plate
 No.  Dist.* No.  S E Y   Depth  Thick.    Width   Thick.    Width   Thick.
       (ft)                (in)   (in)      (in)     (in)     (in)     (in)
ii  xxx.xxx  ii   a a a xxx.xxx  xx.xxx  xx.xxxx  xx.xxxx  xx.xxxx  xx.xxxx

                      PLATE GIRDER PROPERTIES, PART 2 of 2
                      ------------------------------------
                  End    End                Deck     Reinf.
                  Span   Span     Haunch    Reinf.    C.G.
                   No.   Dist.*   Depth     Area      Dist.
                          (ft)     (in)    (in^2/ft)   (in)
                   ii   xxx.xxx   xxx.xxx   xxx.xxx   xxx.xxx

         * The properties given on each line of this table are for the range
           of the beam to the LEFT of the span and the distance given.

                                  SECTION HOLES
                                  -------------
Start  Start   End    End      Type    Distance    Width    No.
Span   Span    Span   Span      of      to 1st      of      of      Hole
 No.   Dist.    No.   Dist.    Hole      Hole      Holes   Holes   Spacing
        (ft)           (ft)               (in)      (in)              (in)
ii   xxx.xxx   ii   xxx.xxx  aaaaaaa   xxx.xxx   xxx.xxx    ii    aaaaaaa
                             aaaaaaa   xxxxxx.   xxxxxx.    ii    xxxxxx.
                             aaaaaaa   xxx.xxx   xxx.xxx    ii    xxx.xxx

                                 SECTION LOSSES
                                 --------------
Start Start  End   End
Span  Span   Span  Span
 No.  Dist.   No.  Dist.    Loss Type    Location  Distance  Width    Thick.
       (ft)         (ft)                             (in)     (in)     (in)
ii  xxx.xxx  ii  xxx.xxx  aaaaaaaaaaaaaa  aaaaaa  xxx.xxx  xxx.xxx  xx.xxxx
                          aaaaaaaaaaaaaa  aaaaaa  xxx.xxx  xxx.xxx  xx.xxxx
```

```
                                     SLAB PROPERTIES
                                     ---------------
                                                     Deck                 Transv   Development
  Slab Thickness    Concrete    Concrete Density   Reinforcement  Steel   Reinf   Length Factor
Actual  Effective   Strength     Loads      Ec       Strength       E      Size     for Slabs
 (in)     (in)        (ksi)   (lbf/ft^3) (lbf/ft^3)    (ksi)       (ksi)
 xx.xxx   xx.xxx     xx.xxx     xxx.xx     xxx.xx     xxxxx.     xxxxxx.   N/A       x.xxx

                                CALCULATED SLAB PROPERTIES
                                --------------------------
                                    Concrete    Modular
                                       E        Ratio, n
                                     (ksi)
                                    xxxxxx.        xx.
```

```
                              DECK POUR SEQUENCE
                              ------------------
                           Start  Start   End    End
                   Pour    Span   Span    Span   Span
                    No.     No.   Dist.    No.   Dist.
                                   (ft)           (ft)
                    ii     ii   xxx.xxx   ii   xxx.xxx
```

```
                     DECK POUR CONCENTRATED LOADS
                     ----------------------------
                  Span   Span
                   No.   Dist.   Temporary  Permanent
                          (ft)     (kips)    (kips)
                   ii  xxx.xxx   xxx.xxx    xxx.xxx

                DECK POUR DISTRIBUTED LOADS (Permanent)
                ---------------------------------------
              Start  Start   End    End
        Pour  Span   Span    Span   Span     Begin       End
         No.   No.   Dist.    No.   Dist.     Mag.       Mag.
                      (ft)          (ft)   (kips/ft) (kips/ft)
         ii    ii  xxx.xxx   ii   xxx.xxx   xxx.xxx   xxx.xxx

                DECK POUR DISTRIBUTED LOADS (Temporary)
                ---------------------------------------
                      (ft)          (ft)   (kips/ft) (kips/ft)
         ii    ii  xxx.xxx   ii   xxx.xxx   xxx.xxx   xxx.xxx

                LATERAL BENDING STRESSES (BOTTOM FLANGE)
                ----------------------------------------
                  LATERAL BENDING STRESSES (TOP FLANGE)
                  -------------------------------------
Span
 No.  Location   DC1    MC1    DC2    FWS    MC2    LL     DPV    UT1    UT2
                (ksi)  (ksi)  (ksi)  (ksi)  (ksi)  (ksi)  (ksi)  (ksi)  (ksi)
 ii  aaaaaaaaa xxx.xx xxx.xx xxx.xx xxx.xx xxx.xx xxx.xx xxx.xx xxx.xx xxx.xx

                             LOAD FACTORS
                             ------------
 Load
Factor
 Type    STR-I    STR-IP    STR-IA    STR-II    STR-III    STR-IV    STR-V
  aaa    x.xxx    x.xxx     x.xxx     x.xxx      aaaaa     aaaaa     x.xxx

 Load
Factor
 Type  SERV-II  SERV-IIA  SERV-IIB  FATG-I  DEFL  CONST-I  SERV-I  FATG-II  CONST-II
  aaa   x.xxx    x.xxx     x.xxx      N/A   N/A    aaaaa     N/A     N/A     aaaaa

 Load
Factor  Minimum  Minimum  Minimum  Minimum  Minimum  Minimum  Minimum
 Type    STR-I   STR-IP   STR-IA   STR-II   STR-III  STR-IV   STR-V
  aaa    aaaaa    aaaaa    aaaaa    aaaaa    aaaaa    aaaaa    aaaaa

                          CONCENTRATED LOADS
                          ------------------
Span  Span
 No.  Dist.    DC1      DC1S     DC2      MC1      MC2      UT1      UT2
       (ft)   (kips)   (kips)   (kips)   (kips)   (kips)   (kips)   (kips)
 ii  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx
```

DISTRIBUTED LOADS (DC1)

DISTRIBUTED LOADS (DC1S)

DISTRIBUTED LOADS (DC2)

DISTRIBUTED LOADS (FWS)

DISTRIBUTED LOADS (MC1)

DISTRIBUTED LOADS (MC2)

DISTRIBUTED LOADS (UT1)

DISTRIBUTED LOADS (UT2)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
ii	xxx.xxx	ii	xxx.xxx	xxx.xxx	xxx.xxx

PEDESTRIAN LOAD

Total Pedestrian Live Load (kips/ft)	Pedestrian Live Load (kips/ft)	Sidewalk Dead Load (kips/ft)	Addl. FWS Dead Load (kips/ft)
xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

WIND PROGRAM DEFINED

Additional Wind Cross Section (in)	Construction Load Path	Construction Wind Speed (mph)	Permanent Load Path	Permanent Structure Height (ft)	Permanent Wind Cond	Wind Speed (mph)	Construction Wind Pressure (ksf)	Wind Exposure Category
xxx.xxx	a	N/A*	a	xxx.xxx	N/A	xxx.xxx	x.xxxx	a

NOTE: STLRFD no longer takes the CONSTRUCTION WIND SPEED as program input. Please enter the CONSTRUCTION WIND PRESSURE instead. See BD-620M and DM-4 C3.4.2.1 for information on how to calculate the CONSTRUCTION WIND PRESSURE.

WIND USER DEFINED

Additional Wind Cross Section (in)	Construction Load Path	Construction Wind Pressure (ksf)	Permanent Load Path	Permanent Wind Pressure Str-III (ksf)	Permanent Wind Pressure Str-V (ksf)
xxx.xxx	a	xxx.xxx	a	xxx.xxx	xxx.xxx

DECK OVERHANG LOADS

Overhang Concrete (k/ft)	**Overhang Forms (k/ft)**	**Screed Rail (k/ft)**	**Walkway & Railing (k/ft)**	**Finishing Machine (kips)**	**Uniform CLL (ksf)**	**Linear CLL (k/ft)**
x.xxxx	**x.xxxx**	**x.xxxx**	**x.xxxx**	**xx.xxx**	**x.xxxx**	**x.xxxx**

SPECIAL LIVE LOADING

LL No.	Axle Effect	Lane Load (kip/ft)	Percentage Increase	Vehicle Type
a	aaa	xxx.xxx	xx.xxx	a

```
                            SPECIAL AXLE LOAD
                            -----------------
  LL   Axle             Axle             Axle             Axle
  No.  Load   Spacing   Load   Spacing   Load   Spacing   Load   Spacing
       (kip)   (ft)     (kip)   (ft)     (kip)   (ft)     (kip)   (ft)
   a  xxx.xxx xxx.xxx  xxx.xxx xxx.xxx  xxx.xxx xxx.xxx  xxx.xxx xxx.xxx

                              FATIGUE LIFE
                              ------------
                                             Previous                     Future
         Year    Recent Count    Previous Count   Growth    Future Count    Growth
         Built  Year   (ADTT)sl  Year   (ADTT)sl   Rate     Year  (ADTT)sl   Rate
         iiii   iiii    iiiii    aaaa    aaaaa     aaaaa    aaaa   aaaaa     aaaaa

                          FATIGUE GROSS VEHICLE
                          ---------------------
     Gross          No. of   No. of   No. of      Combination Trucks
     Weight         2 Axle   3 Axle   4 Axle     No. of   No. of   No. of
  Min.      Max.    Trucks   Trucks   Trucks     3 Axle   4 Axle   5 Axle
 (kip)     (kip)
 xxx.xx   xxxx.x     iiiii    iiiii    iiiii      iiiii    iiiii    iiiii

                             FATIGUE POINTS
                             --------------
               Span    Span                           Fillet
                No.    Dist.     Distance  Category    Weld
                        (ft)       (in)                (in)
                ii    xxx.xxx   xxx.xxx      aa      aaaaaaa

                              BRACE POINTS
                              ------------
               Start   Start    End     End
               Span    Span     Span    Span        Brace
                No.    Dist.    No.     Dist.      Spacing
                        (ft)             (ft)        (ft)
                ii    xxx.xxx    ii    xxx.xxx     xxx.xxx

                          TRANSVERSE STIFFENERS
                          ---------------------
Start Start   End   End                                                  Web
Span  Span    Span  Span   Stiff.  Stiff.    Proj.    Stiff.    Yield    Leg
 No.  Dist.   No.   Dist.  Type*   Spacing   Width    Thick.   Strength  Length
       (ft)          (ft)           (in)      (in)     (in)     (ksi)     (in)
ii  xxx.xxx  ii  xxx.xxx  a  a   xxxx.xx   xxx.xxx  xxx.xxx  xxx.xxx  aaaaaaa
```

```
                      LONGITUDINAL STIFFENERS
                      -----------------------
Start Start  End   End          Dist.                                       Web
Span  Span   Span  Span  Stiff.  from      Proj.   Stiff.   Yield     Leg
 No.  Dist.   No.  Dist. Type*  Flange**   Width   Thick.    Str.    Length
      (ft)         (ft)          (in)      (in)    (in)     (ksi)     (in)
ii  xxx.xxx  ii  xxx.xxx  a a  xxx.xxx a  xxx.xxx  xxx.xxx  xxx.xx  aaaaaaa

      * Legend of Stiffener Types:
         S P  Single plate stiffener
         S A  Single angle stiffener
         P P  Pair of plate stiffeners
         P A  Pair of angle stiffeners

     ** Legend of Stiffener Locations:
         T    Distance is measured from top flange
         B    Distance is measured from bottom flange
```

```
                              BEARING STIFFENERS
                              ------------------
                                       Number  Spacing
            Span   Span   Stiffener     of     Between                 Projecting
             No.   Dist.    Type*      Pairs    Pairs    Clearance       Width
                   (ft)                          (in)      (in)          (in)
             ii   xxx.xxx    a a        ii      aaaaaa    aaaaaa        xx.xxx

                        Bearing                           Web      Classification
        Span    Span    Contact  Stiffener   Yield        Leg       Strength of
         No.    Dist.    Width   Thickness  Strength    Length   Web-Stiffener Weld
                 (ft)    (in)       (in)      (ksi)       (in)          (ksi)
         ii   xxx.xxx   xx.xxx     xx.xxx    xx.xxx     aaaaaa          xx.x

             * Legend of Stiffener Types:
                W P  Welded plate stiffener
                W A  Welded angle stiffener
                B P  Bolted plate stiffener
                B A  Bolted angle stiffener
```

```
                          BEARING STIFFENER DESIGN
                          ------------------------
         Minimum   Stiffener     Classification              Spacing
          Number     Yield         Strength of               Between
         of Pairs  Strength    Web-Stiffener Weld  Clearance   Pairs
                     (ksi)           (ksi)           (in)      (in)
            i        xxx.x           xxx.x          aaaaaa    aaaaaa

    * NOTE: If the CLEARANCE is left blank, the program will assume a clearance of
            9*web thickness from the end of the beam to the face of the first bearing
            stiffener during design. If SPACING BETWEEN PAIRS is left blank, the
            program will assume a clear distance of 18*web thickness from face to
            face of adjacent stiffener pairs.
```

```
                     STUD SHEAR CONNECTORS
                     ---------------------
             No. of                               Tensile
           Connectors    Diameter     Height     Strength
                           (in)        (in)        (ksi)
               ii         xx.xxx       N/A        xxx.xxx
```

```
                           FIELD SPLICE LOCATIONS
                           ----------------------
                         Distance
                         Between     Minimum     Minimum      Minimum     Minimum
    Span                 Extreme    Bolt Hole  Outer Edge   Bolt Hole  Inner Edge
     No.    Distance   Bolt Lines   Diameter    Distance     Spacing    Distance
              (ft)        (ft)        (in)        (in)         (in)        (in)
     ii     xxx.xxx      xx.xxx      x.xxx       x.xxx        x.xxx       x.xxx
```

```
                    CHANNEL SHEAR CONNECTORS
                    ------------------------
 Channel Flange    Channel Web    Channel    Channel
  Thickness         Thickness     Length     Height
     (in)              (in)        (in)       (in)
    xx.xxx            xx.xxx      xx.xxx      N/A

                    OUTPUT OF INPUT DATA
                    --------------------
                 Input      Input      Input
               File Echo  Commands   Summary
                   i          i          i

                OUTPUT OF SECTION PROPERTIES
                ----------------------------
             Gross                      Additional
            Section       Section        Section
           Properties    Properties     Properties
               i             i              i

                  OUTPUT OF DESIGN TRIALS
                  -----------------------
                    Design     Final
                    Trials     Design
                      i          i

                          OUTPUT OF ANALYSIS RESULTS
                          --------------------------
                Compactness                                         Dead       Dead
  Points of      Check For       Load      Dead   Distribution      Load       Load     Staging
Contraflexure  Redistribution  Modifiers   Loads    Factors        Effects   Reactions  Analysis
      i             n/a            i         i         i              i          i         i

    Live      Live        HS20         H20        Fatigue                             Overall
    Load      Load     Effects and  Effects and  Effects and  Factored   Factored     Reaction
  Effects   Reactions   Reactions    Reactions    Reactions    Effects   Reactions    Summary
     i          i           i            i            i           i          i           i

                       OUTPUT OF SPECIFICATION CHECKING
                       --------------------------------
Ductility and                                                             Fatigue
 Web/Flange    Wind     Flexural    Shear      Web    Stiffener  Fatigue    Life      Deflection
 Proportions  Effects   Capacity   Capacity   Checks   Checks    Checks  Estimation     Checks
      i          i          i          i         i        i         i         i            i

      Shear      Staging /      Web-to-       Economic    Negative Moment
    Connector   Uncured Slab   Flange Weld   Feasibility   Serviceability      SPLRFD
     Checks       Checks      Design Checks    Checks         Checks         Information
        i            i              i             i              i                 i

                    OUTPUT OF RATING FACTORS
                    ------------------------
         Vehicle   Detailed   Overall   Ratings Without
         Rating     Rating    Rating    Future Wearing
         Summary    Factors   Summary       Surface
            i          i         i             i
```

```
                    SYSTEM SETTINGS
                    ---------------
                  Steel     Construction
                 Weight     Modular Ratio
               (lbf/ft^3)
                xxx.xx        xx.xxx
```

7.12.2 Section Properties

```
                                GROSS SECTION PROPERTIES
                                ------------------------
     Start          End         Average
   Span          Span           Section           Composite       Beam       Moment of
    No. Dist.     No. Dist.      Depth              Status        Area        Inertia
        (ft)          (ft)        (in)                           (in^2)       (in^4)
    ii xxx.xxx    ii xxx.xxx    ii xxx.xxx     Noncomposite     xxxx.xx     xxxxxxx.
                                               Comp.(3n=aa)                 xxxxxxx.
                                               Comp.(n=aa)                  xxxxxxx.
                                               Comp.(n/0.7=aa)              xxxxxxx.

             NET SECTION PROPERTIES (NONCOMPOSITE, POSITIVE FLEXURE)
             -------------------------------------------------------
            NET SECTION PROPERTIES (COMPOSITE(3n), POSITIVE FLEXURE)
            --------------------------------------------------------
             NET SECTION PROPERTIES (COMPOSITE(n), POSITIVE FLEXURE)
             -------------------------------------------------------
           NET SECTION PROPERTIES (COMPOSITE(n/0.7), POSITIVE FLEXURE)
           -----------------------------------------------------------
             NET SECTION PROPERTIES (NONCOMPOSITE, NEGATIVE FLEXURE)
             -------------------------------------------------------
              NET SECTION PROPERTIES (COMPOSITE, NEGATIVE FLEXURE)
              ----------------------------------------------------
                             Distance to Neutral Axis              Section Modulus
Span          Moment of   Bot.of  Top of  CG of   Top of    Bot.of   Top of   CG of  Top of
 No.  Dist.    Inertia     Beam    Beam   Reinf.   Slab      Beam     Beam    Reinf.  Slab
      (ft)     (in^4)      (in)    (in)    (in)    (in)     (in^3)   (in^3)   (in^3) (in^3)
 ii xxx.xxxa xxxxxxx.  xxx.xxx xxx.xxx xxx.xxx xxx.xxx   xxxxxxx. xxxxxxx. xxxxxxx. xxxxxxx.
 ii xxx.xxxa xxxxxxx.  xxx.xxx xxx.xxx xxx.xxx aaaaaaa   xxxxxxx. xxxxxxx. xxxxxxx. aaaaaaaa
 ii xxx.xxxa xxxxxxx.  xxx.xxx xxx.xxx aaaaaaa aaaaaaa   xxxxxxx. xxxxxxx. aaaaaaaa aaaaaaaa

            ADDITIONAL SECTION PROPERTIES (POSITIVE FLEXURE, PART 1)
            --------------------------------------------------------
            ADDITIONAL SECTION PROPERTIES (NEGATIVE FLEXURE, PART 1)
            --------------------------------------------------------
                                                                           Radius of
                          Effect.        Moment of Inertia                  Gyration
 Span           Beam       Slab     C.Flange   T.Flange   Y Axis       Steel   C.Flange
  No.   Dist.   Area       Width      Iyc        Iyt        Iy           ry       r'
        (ft)   (in^2)      (in)     (in^4)     (in^4)     (in^4)        (in)     (in)
  ii  xxx.xxx   xxx.xx   xxx.xxx    xxxxxx.    xxxxxx.    xxxxxxx.     xx.xxx   xx.xxx
```

```
          ADDITIONAL SECTION PROPERTIES (POSITIVE FLEXURE, PART 2)
          --------------------------------------------------------
          ADDITIONAL SECTION PROPERTIES (NEGATIVE FLEXURE, PART 2)
          --------------------------------------------------------
              1st M of I       Plastic Properties      Dist. Bet.  Longitud.
 Span         of Transf'd  N.A. to   Moment  Depth of  C.G. Steel   Stiff.
 No.   Dist.  Section, Q   Top Slab    Mp    Web, Dcp   & Slab    Parameter
       (ft)     (in^3)      (in)     (k-ft)    (in)      (in)     (10^4in^4)
 ii  xxx.xxxR  xxxxxx.     xxx.xxx xxxxxx.x   xxx.xxx    xxx.xx     xxxx.xx
 ii  xxx.xxx     N/A         N/A    xxxxx.x   xxx.xxx     N/A       xxxx.xx
```

7.12.3 Design Trials Output

```
                   ROLLED BEAM DESIGN TRIALS, PART 1 of 2
                   --------------------------------------
                   ROLLED BEAM FINAL DESIGN, PART 1 of 2
                   -------------------------------------
                           Nominal   Nominal   Moment of
             Designation    Depth    Weight     Inertia    Area
                            (in)    (lbm/ft)    (in^4)    (in^2)
              aaaaaaaaa    iiii      iiii      xxxxxxx.   xxx.xx

                   ROLLED BEAM DESIGN TRIALS, PART 2 of 2
                   --------------------------------------
                   ROLLED BEAM FINAL DESIGN, PART 2 of 2
                   -------------------------------------
                      Flange    Flange     Beam       Web      Distance
        Designation   Width    Thickness   Depth   Thickness     "k"
                       (in)       (in)      (in)      (in)       (in)
         aaaaaaaaa    xx.xxx   xx.xxxx    xx.xxx   xx.xxxx     xx.xxxx

                 DESIGN TRIALS: FLANGE SPLICE PLATE PROPERTIES
                 ---------------------------------------------
                  FLANGE SPLICE PLATE PROPERTIES FINAL DESIGN
                  -------------------------------------------
 Desig/  Strt   End    Bolt Hole    Bolt Hole   Bolt  E D G E  D I S T A N C E
 Span    FSPL   FSPL   Spacing      Diameter    Hole  Inner(ein)   Outer(eout)
 Number  Dist   Dist   Min.  Adj.   Min.  Adj.  No.   Min.  Adj.    Min.  Adj.
         (ft)   (ft)   (in)  (in)   (in)  (in)        (in)  (in)    (in)  (in)
 aaaaaaa
   i   xxx.xx xxx.xx  Insufficient flange width for field splice bolt holes.
 aaaaaaa
   i   xxx.xx xxx.xx  x.xxx x.xxx x.xxx x.xxx   i   x.xxx x.xxx  x.xxx x.xxx

     NOTES: The number of bolt holes reflects one side of the flange.
            Inner edge distances are measured from the web face outward.
            Outer edge distances are measured from the flange edge inward.

          The final design satisfies infinite fatigue life criteria
          for a Category C' detail at the top of the bottom flange
          at the point of maximum fatigue moment.
```

```
                         PLATE GIRDER DESIGN TRIALS
                         --------------------------
                           TRIAL i: GIRDER DESIGN
                           ----------------------
End   End                           Top      Top    Bottom   Bottom    Max.
Span  Span     Web      Web    Flange   Flange   Flange   Flange   Design
 No.  Dist.   Depth    Thick    Width    Thick    Width    Thick    Ratio
      (ft)     (in)     (in)    (in)     (in)     (in)     (in)
 ii  xxx.xxx  xxx.xxx  xx.xxxx  xx.xxxx  xx.xxxx  xx.xxxx  xx.xxxx  x.xxxxx

                     TRIAL i: FLANGE SPLICE PLATE PROPERTIES
                     ---------------------------------------
  Span  Strt    End    Bolt Hole    Bolt Hole  Bolt  E D G E  D I S T A N C E
  No.,  FSPL    FSPL   Spacing      Diameter   Hole  Inner(ein)    Outer(eout)
  Loc.  Dist    Dist   Min.  Adj.   Min.  Adj.  No.  Min.  Adj.    Min.  Adj.
        (ft)    (ft)   (in)  (in)   (in)  (in)       (in)  (in)    (in)  (in)
   i   xxx.xx xxx.xx  Insufficient flange width for field splice bolt holes.
   i   xxx.xx  xxx.xx  x.xxx x.xxx x.xxx x.xxx   i   x.xxx x.xxx  x.xxx x.xxx

      NOTES: The number of bolt holes reflects one side of the flange.
             Inner edge distances are measured from the web face outward.
             Outer edge distances are measured from the flange edge inward.

                    TRIAL i: TRANSVERSE STIFFENER DESIGN
                    ------------------------------------
Start Start  End   End                                                   Web
Span  Span   Span  Span  Stiff.  Stiff.   Proj.   Stiff.    Yield     Leg
 No.  Dist.  No.  Dist. Type*  Spacing   Width   Thick.   Strength  Length
      (ft)        (ft)           (in)     (in)     (in)     (ksi)     (in)
ii  xxx.xxx  ii  xxx.xxx  a  a  xxxx.xx  xxx.xxx  xxx.xxx  xxx.xxx  aaaaaaa

      * Legend of Stiffener Types:
         S P  Single plate stiffener
         S A  Single angle stiffener
         P P  Pair of plate stiffeners
         P A  Pair of angle stiffeners

                                      Equivalent Weight (lbs)    xxxxxxx.

                          PLATE GIRDER FINAL DESIGN
                          -------------------------
End   End                           Top      Top    Bottom   Bottom    Max.
Span  Span     Web      Web    Flange   Flange   Flange   Flange   Design
 No.  Dist.   Depth    Thick    Width    Thick    Width    Thick    Ratio
      (ft)     (in)     (in)    (in)     (in)     (in)     (in)
 ii  xxx.xxx  xxx.xxx  xx.xxxx  xx.xxxx  xx.xxxx  xx.xxxx  xx.xxxx  x.xxxxx

    WELD SIZE:
    Fillet weld size between: top flange and web: x.xxx in
                              bottom flange and web: x.xxx in
```

```
                     FLANGE SPLICE PLATE PROPERTIES FINAL DESIGN
                     -------------------------------------------
       Strt    End    Bolt Hole    Bolt Hole  Bolt  E D G E  D I S T A N C E
  Span FSPL    FSPL   Spacing      Diameter   Hole  Inner(ein)    Outer(eout)
  No.  Dist    Dist   Min.  Adj.   Min.  Adj.  No.  Min.  Adj.    Min.  Adj.
       (ft)    (ft)   (in)  (in)   (in)  (in)       (in)  (in)    (in)  (in)
   i  xxx.xx  xxx.xx  x.xxx x.xxx x.xxx x.xxx   i   x.xxx x.xxx  x.xxx x.xxx

        NOTES: The number of bolt holes reflects one side of the flange.
               Inner edge distances are measured from the web face outward.
               Outer edge distances are measured from the flange edge inward.

                       TRANSVERSE STIFFENERS FINAL DESIGN
                       ----------------------------------
 Start Start  End   End                                                Web
 Span  Span   Span  Span  Stiff.  Stiff.   Proj.   Stiff.    Yield     Leg
  No.  Dist.   No.  Dist. Type*  Spacing   Width   Thick.   Strength  Length
       (ft)         (ft)          (in)     (in)     (in)     (ksi)     (in)
 ii  xxx.xxx  ii  xxx.xxx  a  a  xxxx.xx  xxx.xxx  xxx.xxx  xxx.xxx  aaaaaaa

       * Legend of Stiffener Types:
          S P  Single plate stiffener
          S A  Single angle stiffener
          P P  Pair of plate stiffeners
          P A  Pair of angle stiffeners

                                            Equivalent Weight (lbs)    xxxxxxx.

          The program could not design a plate girder within the
            given user input limits to meet all LRFD requirements.
          Relax the design plate girder limits and rerun.

         The maximum number of design iterations, (ii), was reached
           before the program could converge on a plate girder.

           The program converged on a plate girder after ii trials.

           The final design satisfies infinite fatigue life criteria
           for a Category C' detail at the top of the bottom flange
           at the point of maximum fatigue moment and at all
           flange transition points.
```

7.12.4 Analysis Results Output

```
                             POINTS OF CONTRAFLEXURE
                             -----------------------
                               Dead Load
                               Points of        Code
                             Contraflexure     Check*
                             Span
                              No.   Dist.
                                    (ft)
                              ii  xxx.xxx

    * Legend of Code Checks:
       A.  There is only one dead load point of contraflexure in this span.
           Check for possible uplift condition and verify program input
```

LOAD FACTORS AND COMBINATIONS

		LIMIT STATE														
gamma		STR I	STR IP	STR IA	STR II	STR III	STR IV	STR V	SRV II	SRV IIA	SRV IIB	FAT I	FAT II	DEFL	CON I	CON II
gDC	Max	1.25	1.25	1.25	1.25	1.25	1.50	1.25	1.00	1.00	1.00	--	--	--	1.40	1.25
	Min	0.90	0.90	0.90	0.90	0.90	1.50	0.90	--	--	--	--	--	--	--	--
gDW	Max	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.00	1.00	1.00	--	--	--	1.40	1.25
	Min	0.65	0.65	0.65	0.65	0.65	0.65	0.65	--	--	--	--	--	--	--	--
gSWK	Max	--	1.25	--	--	--	--	--	--	--	--	--	--	--	--	--
	Min	--	0.90	--	--	--	--	--	--	--	--	--	--	--	--	--
gAWS	Max	--	1.50	--	--	--	--	--	--	--	--	--	--	--	--	--
	Min	--	0.65	--	--	--	--	--	--	--	--	--	--	--	--	--
gMC1	Max	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	--	--	--	x.xx	x.xx
	Min	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	--	--	--	--	--	--	--	--
gMC2	Max	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	--	--	--	--	--
	Min	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	--	--	--	--	--	--	--	--
gWS		--	--	--	--	1.00	--	1.00	--	--	--	--	--	--	--	1.00
gLL		1.75	1.35	1.35	1.35	--	--	1.35	1.30	1.00	1.00	--	--	1.00	1.40	1.25
gPermit		--	--	--	1.35	--	--	--	--	--	1.00	--	--	--	--	--
gRate		1.75	1.35	1.35	1.35	--	--	--	1.30	1.00	1.00	--	--	--	--	--
gPL		--	1.75	--	--	--	--	--	--	--	--	--	--	--	--	--
gFAT		--	--	--	--	--	--	--	--	--	--	1.75	0.80	--	--	--
gSLL		x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	x.xx	--	--	--	--	--

NOTE: "gDC" applies to DC1, DC1S, and DC2
"gDW" applies to FWS, UT1, and UT2

LIVE LOADING SUMMARY (aaaaaa, Live Load Code: a)

	LIMIT STATE														
Live Load Vehicles	STR I	STR IP	STR IA	STR II	STR III	STR IV	STR V	SRV II	SRV IIA	SRV IIB	FAT I	FAT II	DEFL	CON I	CON II
Design and Rating Vehicles															
aaaaaaaa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	--	--
Permit and Rating Vehicles															
aaaaaaaa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	--	--
Rating Only Vehicles															
aaaaaaaa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	aa	--	--
Fatigue															
HS20-30	--	--	--	--	--	--	--	--	--	--	SC	SC	--	--	--
Deflection															
aaaaaaaa	--	--	--	--	--	--	--	--	--	--	--	--	SC	--	--

Note: Rating Applicability: I = Inventory, O = Operating
SC = Specification Check Only, No Rating

LOAD MODIFIER

Importance Factor Ni	Ductility Factor Nd	Redundancy Factor Nr	Calculated Ni*Nd*Nr	Load Modifier Used	Fatigue Load Modifier Used
x.xx	x.xx	x.xx	x.xxx	x.xxx	x.xxx

Value of Ni*Nd*Nr = x.xxx is outside allowable bounds.
Resetting load modifier to x.xxx.

As per PennDOT DM-4 Sections 1.3.2 through 1.3.5,
ETA factors other than 1.0 are not permitted by PennDOT.

```
                          RESISTANCE FACTORS
                          ------------------
                                 Axial        Bearing      Shear
     Flexure     Shear     Compression    on Pins     Connector
      x.xx        x.xx         x.xx         x.xx         x.xx

                              DEAD LOADS
                              ----------
          End          End           Beam          Slab &       Additional
       Span No.    Span Dist.       Weight     Haunch Weight      DC1S*
                      (ft)        (kips/ft)      (kips/ft)      (kips/ft)
          ii        xxx.xxx        xxx.xxx        xxx.xxx        xxx.xxx

*NOTE: The values in the ADDITIONAL DC1S column are computed using the DC1S
       PERCENTAGE value on the CTL command and are based on the steel self
       weight. The values in this column do NOT include DC1S load entered on
       the DLD or CLD commands.
```

```
                          LOADS ON OVERHANG BRACKETS
                          --------------------------
                           Overhang    Construction     Construction Live Load
   End        End          Concrete     Dead Load     Concentrated   Distributed
 Span No.  Span Dist.       Weight       Weight          Weight        Weight
                             (DC)         (CDL)          (CLLp)        (CLLu)
              (ft)        (kips/ft)    (kips/ft)        (kips)       (kips/ft)
   ii       xxx.xxx        x.xxxx       x.xxxx          xx.xxx        x.xxxx
```

```
 DISTRIBUTION FACTORS FOR DESIGN LIVE LOADING (LANE FRACTION, INCL. SKEW)
 ------------------------------------------------------------------------
               M o m e n t            S h e a r                      Code
 Span No.   DF1   **    DF2   **    DF1   **    DF2   **  Deflection    Check*
    ii    x.xxx(a) a  aaaaa(a) a  x.xxx(a) a  x.xxx(a) a    x.xxx    aaaaaaaaaaaaa

** Legend of Distribution Factor Calculations:
   A - Distribution factor calculated with moment equations from AASHTO and DM-4 Tables
       4.6.2.2.2b-1 and 4.6.2.2.2d-1.
   B - Distribution factor calculated with shear equations from AASHTO and DM-4 Tables
       4.6.2.2.3a-1 and 4.6.2.2.3b-1.
   C - Distribution factor calculated with the lever rule.
   D - Distribution factor calculated with the rigid cross-section approximation (AASHTO
       Equation C4.6.2.2.2d-1).

NOTE: For codes A and B, the value in parentheses is either "S" or "M", indicating
      whether the Single- or Multi-lane equations are used.

      For codes C and D, the value in parentheses is the number of lanes loaded
      to produce the controlling live load distribution factor.

      The shear distribution factors reported include the Shear Skew Correction factors,
      unless they are calculated with the rigid cross-section approximation (Code D).
```

```
     DISTRIBUTION FACTORS WITH SIDEWALKS (LANE FRACTION, INCL. SKEW)
     ---------------------------------------------------------------
               M o m e n t            S h e a r                      Code
 Span No.   DF1   **    DF2   **    DF1   **    DF2   **  Deflection    Check*
    ii    x.xxx(a) a  aaaaa(a) a  x.xxx(a) a  x.xxx(a) a    x.xxx    aaaaaaaaaaaaa

** Legend of Distribution Factor Calculations:
   A - Distribution factor calculated with moment equations from AASHTO and DM-4 Tables
       4.6.2.2.2b-1 and 4.6.2.2.2d-1.
   B - Distribution factor calculated with shear equations from AASHTO and DM-4 Tables
       4.6.2.2.3a-1 and 4.6.2.2.3b-1.
   C - Distribution factor calculated with the lever rule.
   D - Distribution factor calculated with the rigid cross-section approximation (AASHTO
       Equation C4.6.2.2.2d-1).
```

```
NOTE: For codes A and B, the value in parentheses is "M", indicating that the Multi-
      lane equations are used. When a sidewalk is present, only the Multi-lane
      equations are considered.

      For codes C and D, the value in parentheses is the number of lanes loaded to
      produce the controlling live load distribution factor, and does NOT include the
      sidewalk as an extra loaded lane.  However, the multiple presence factor (MPF)
      is determined considering the sidewalk as an additional lane.

      The shear distribution factors reported include the Shear Skew Correction factors,
      unless they are calculated with the rigid cross-section approximation (Code D).

            DISTRIBUTION FACTORS FOR FATIGUE VEHICLE (LANE FRACTION, INCL. SKEW)
            --------------------------------------------------------------------
                         M o m e n t            S h e a r                       Code
          Span No.   DF1   **    DF2   **    DF1   **    DF2   **  Deflection    Check*
             ii    x.xxx(a) a  aaaaa(a) a  x.xxx(a) a  x.xxx(a) a     N/A   aaaaaaaaaaaaa

** Legend of Distribution Factor Calculations:
   A - Distribution factor calculated with moment equations from AASHTO and DM-4 Tables
       4.6.2.2.2b-1 and 4.6.2.2.2d-1.
   B - Distribution factor calculated with shear equations from AASHTO and DM-4 Tables
       4.6.2.2.3a-1 and 4.6.2.2.3b-1.
   C - Distribution factor calculated with the lever rule.
   D - Distribution factor calculated with the rigid cross-section approximation (AASHTO
       Equation C4.6.2.2.2d-1).

NOTE: For codes A and B, the value in parentheses is either "S" or "M", indicating
      whether the Single- or Multi-lane equations are used.

      For codes C and D, the value in parentheses is the number of lanes loaded
      to produce the controlling live load distribution factor.

      The shear distribution factors reported include the Shear Skew Correction factors,
      unless they are calculated with the rigid cross-section approximation (Code D).

   DISTRIBUTION FACTORS FOR P-82C COMBINATION (MULTI-LANE, LANE FRACTION, INCLUDING SKEW)
   --------------------------------------------------------------------------------------
                DISTRIBUTION FACTORS FOR P-82C AND PA2013-16C COMBINATIONS
                       (MULTI-LANE, LANE FRACTION, INCLUDING SKEW)
                ----------------------------------------------------------
                         M o m e n t            S h e a r                       Code
          Span No.   DF1   **    DF2   **    DF1   **    DF2   **  Deflection    Check*
             ii    x.xxx(a) a  aaaaa(a) a  x.xxx(a) a  x.xxx(a) a     N/A   aaaaaaaaaaaaa

** Legend of Distribution Factor Calculations:
   A - Distribution factor calculated with moment equations from AASHTO and DM-4 Tables
       4.6.2.2.2b-1 and 4.6.2.2.2d-1.
   B - Distribution factor calculated with shear equations from AASHTO and DM-4 Tables
       4.6.2.2.3a-1 and 4.6.2.2.3b-1.
   C - Distribution factor calculated with the lever rule.
   D - Distribution factor calculated with the rigid cross-section approximation (AASHTO
       Equation C4.6.2.2.2d-1).

NOTE: For codes A and B, the value in parentheses is either "S" or "M", indicating
      whether the Single- or Multi-lane equations are used.

      For codes C and D, the value in parentheses is the number of lanes loaded
      to produce the controlling live load distribution factor.

      The shear distribution factors reported include the Shear Skew Correction factors,
      unless they are calculated with the rigid cross-section approximation (Code D).

NOTE: The DISTRIBUTION FACTORS FOR P-82C COMBINATION (MULTI-LANE) are used as the
      "g" value in DM-4 Equation 3.4.1-3P when computing the combined live load
      effects of the P-82 vehicle in one lane and the PHL-93 vehicle in all
      other lanes.
```

```
DISTRIBUTION FACTORS FOR P-82C COMBINATION (SINGLE LANE, LANE FRACTION, INCLUDING SKEW)
---------------------------------------------------------------------------------------
               DISTRIBUTION FACTORS FOR P-82C AND PA2013-16C COMBINATIONS
                      (SINGLE-LANE, LANE FRACTION, INCLUDING SKEW)
               ----------------------------------------------------------
                       M o m e n t            S h e a r                         Code
        Span No.   DF1   **    DF2   **    DF1   **    DF2   **  Deflection    Check*
           ii    x.xxx(a) a  aaaaa(a) a  x.xxx(a) a  x.xxx(a) a     N/A   aaaaaaaaaaaaa

** Legend of Distribution Factor Calculations:
   A - Distribution factor calculated with moment equations from AASHTO and DM-4 Tables
       4.6.2.2.2b-1 and 4.6.2.2.2d-1.
   B - Distribution factor calculated with shear equations from AASHTO and DM-4 Tables
       4.6.2.2.3a-1 and 4.6.2.2.3b-1.
   C - Distribution factor calculated with the lever rule.
   D - Distribution factor calculated with the rigid cross-section approximation (AASHTO
       Equation C4.6.2.2.2d-1).

NOTE: For codes A and B, the value in parentheses is either "S" or "M", indicating
      whether the Single- or Multi-lane equations are used.

      For codes C and D, the value in parentheses is the number of lanes loaded
      to produce the controlling live load distribution factor.

      The shear distribution factors reported include the Shear Skew Correction factors,
      unless they are calculated with the rigid cross-section approximation (Code D).

NOTE: The DISTRIBUTION FACTORS FOR P-82C COMBINATION (SINGLE LANE) are used as the
      "g1/Z" value in DM-4 Equation 3.4.1-3P when computing the combined live load
      effects of the P-82 vehicle in one lane and the PHL-93 vehicle in all other
      lanes. The values printed here do NOT include any multiple presence factor.

* Legend of code checks:
     A. Beam spacing is outside the range of applicability
     B. Slab thickness is outside the range of applicability
     C. Span length is outside the range of applicability
     D. Number of beams is less than the lower bound of applicability
     E. Longitudinal stiffness parameter is outside range of applicability
     F. Skew angle is outside the range of applicability
     G. Distance from exterior web to curb (de) is outside
        the range of applicability
```

```
                  SHEAR SKEW CORRECTION FACTORS
                  -----------------------------
                   Span No.  LEFT      RIGHT
                      ii     x.xxx     x.xxx

         DISTRIBUTION FACTORS FOR DESIGN LIVE LOAD REACTIONS
         ---------------------------------------------------
          DISTRIBUTION FACTORS FOR REACTIONS WITH SIDEWALKS
          -------------------------------------------------
         DISTRIBUTION FACTORS FOR FATIGUE LIVE LOAD REACTIONS
         ----------------------------------------------------
                        c Reaction            Rotation
             Support   Distribution         Distribution
               No.        Factor  Comment*      Factor
               ii         x.xxx    aaa          x.xxx

 *  Legend of Comments:
    A. The distribution factor reported includes the Shear Skew
       Correction factor.
    B. Shear Skew Correction factor applied to abutments at both ends.
       Not compatible with DM-4. Refer to DM-4 Article 4.6.2.2.3C.
```

```
      BEAM WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE)
      ----------------------------------------------------
SLAB AND HAUNCH WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE)
---------------------------------------------------------------
PERMANENT INPUTTED DC1 ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE)
---------------------------------------------------------------
    PERMANENT DC1S ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE)
    -------------------------------------------------------
         TOTAL DC1 ANALYSIS (UNFACTORED, NONCOMPOSITE)
         ---------------------------------------------
PERMANENT INPUTTED DC2 ANALYSIS (UNFACTORED, DC2, COMPOSITE(3N))
----------------------------------------------------------------
PERMANENT INPUTTED DC2 ANALYSIS (UNFACTORED, DC2, NONCOMPOSITE)
---------------------------------------------------------------
FUTURE WEARING SURFACE ANALYSIS (UNFACTORED, FWS, COMPOSITE(3N))
----------------------------------------------------------------
FUTURE WEARING SURFACE ANALYSIS (UNFACTORED, FWS, NONCOMPOSITE)
---------------------------------------------------------------
    UTILITY UT1 ANALYSIS (UNFACTORED, UT1, NONCOMPOSITE)
    ----------------------------------------------------
      UTILITY UT2 ANALYSIS (UNFACTORED, UT2, COMPOSITE(3N))
      -----------------------------------------------------
      UTILITY UT2 ANALYSIS (UNFACTORED, UT2, NONCOMPOSITE)
      ----------------------------------------------------
  MISCELLANEOUS MC1 ANALYSIS (UNFACTORED, MC1, NONCOMPOSITE)
  ----------------------------------------------------------
  MISCELLANEOUS MC2 ANALYSIS (UNFACTORED, MC2, COMPOSITE(3N)
  ----------------------------------------------------------
  MISCELLANEOUS MC2 ANALYSIS (UNFACTORED, MC2, NONCOMPOSITE)
  ----------------------------------------------------------
  SIDEWALK DEAD LOAD ANALYSIS (UNFACTORED, DC2, COMPOSITE(3N))
  ------------------------------------------------------------
  SIDEWALK DEAD LOAD ANALYSIS (UNFACTORED, DC2, NONCOMPOSITE)
  -----------------------------------------------------------
    ADDITIONAL FWS ANALYSIS (UNFACTORED, FWS, COMPOSITE(3N))
    --------------------------------------------------------
    ADDITIONAL FWS ANALYSIS (UNFACTORED, FWS, NONCOMPOSITE)
    -------------------------------------------------------
  Span
   No.     Dist.      Moment     Shear     Deflect.
            (ft)      (k-ft)     (kips)     (in)
   ii     xxx.xxx   xxxxxx.x    xxxx.xx    xxx.xxx
```

```
                     BEAM WEIGHT ANALYSIS - REACTIONS
                     --------------------------------
                SLAB AND HAUNCH WEIGHT ANALYSIS - REACTIONS
                -------------------------------------------
                PERMANENT INPUTTED DC1 ANALYSIS - REACTIONS
                -------------------------------------------
                    PERMANENT DC1S ANALYSIS - REACTIONS
                    -----------------------------------
                      TOTAL DC1 ANALYSIS - REACTIONS
                      ------------------------------
                PERMANENT INPUTTED DC2 ANALYSIS - REACTIONS
                -------------------------------------------
                FUTURE WEARING SURFACE ANALYSIS - REACTIONS
                -------------------------------------------
                      UTILITY UT1 ANALYSIS - REACTIONS
                      --------------------------------
                      UTILITY UT2 ANALYSIS - REACTIONS
                      --------------------------------
                   MISCELLANEOUS MC1 ANALYSIS - REACTIONS
                   ---------------------------------------
                   MISCELLANEOUS MC2 ANALYSIS - REACTIONS
                   --------------------------------------
                  SIDEWALK DEAD LOAD ANALYSIS - REACTIONS
                  ---------------------------------------
                    ADDITIONAL FWS ANALYSIS - REACTIONS
                    -----------------------------------
                  Support No.     Reaction       Rotation
                                   (kips)       (radians)
                     ii            xxxx.xx      xx.xxxxxx

                    N/A because user-defined load = 0.0
```

```
                          DECK POUR ii ANALYSIS (UNFACTORED, DC1)
                          ---------------------------------------
  Span                               Permanent Loads                Temporary Loads
   No.    Dist.   Composite   Moment    Shear  Deflection    Moment    Shear  Deflection
          (ft)     (Y/N)      (k-ft)   (kips)     (in)       (k-ft)   (kips)     (in)
   ii   xxx.xxxa     a     xxxxxx.x xxxxx.xx  xxx.xxx    xxxxxx.x xxxxx.xx  xxx.xxx
```

```
                       DECK POUR ii ANALYSIS - REACTIONS
                       ---------------------------------
             Support    Permanent Loads      Temporary Loads
             Number   Reaction   Rotation  Reaction   Rotation
                       (kips)   (radians)   (kips)    (radians)
                ii    xxxx.xx  xx.xxxxxx   xxxx.xx   xx.xxxxxx
```

```
        CUMULATIVE ANALYSIS: CONSTRUCTION STAGE ii (UNFACTORED, DC1)
        ------------------------------------------------------------
Span          Current   Noncomp.     Comp.     Total
 No.   Dist.    Pour     Moment     Moment    Moment      Shear     Deflect.
       (ft)    (Y/N)     (k-ft)     (k-ft)    (k-ft)      (kips)      (in)
 ii   xxx.xxx    a xxxxxxxxxx.x xxxxxxxx.x xxxxxxx.x xxxxxxx.xx    xx.xxx
```

```
CUMULATIVE ANALYSIS: CONSTRUCTION STAGE ii - REACTIONS
-------------------------------------------------------
           Support No.     Reaction      Rotation   * If Uplift
                            (kips)      (radians)
                ii          xxx.xx      xx.xxxxxx        a

  NOTE: Uplift has been detected for this stage at the indicated support.
        See DM-4 C6.10.3.2.5.1P for information on how to address uplift
        during construction.

 PHL-93 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
 ------------------------------------------------------
  HL-93 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
  -----------------------------------------------------
  HS20 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
  ----------------------------------------------------
   H20 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
   ---------------------------------------------------
PHL-93 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
--------------------------------------------------------
 PHL-93 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
 -------------------------------------------------------
 HL-93 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
 -------------------------------------------------------
 HL-93 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
 ------------------------------------------------------
 HS20 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
 ------------------------------------------------------
  HS20 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
  -----------------------------------------------------
  H20 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
  -----------------------------------------------------
   H20 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
   ----------------------------------------------------
Span         Maximum Positive  Simult   Maximum Negative  Simult
 No.  Dist.    Moment    LC    Shear      Moment    LC    Shear
      (ft)     (k-ft)          (kips)     (k-ft)          (kips)
 ii xxx.xxx   xxxxxx.x    i  xxxxx.xx   xxxxxx.x    i  xxxxx.xx
```

```
PHL-93 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
 ----------------------------------------------------------------
  HL-93 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
  ---------------------------------------------------------------
  HS20 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
  --------------------------------------------------------------
   H20 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
   -------------------------------------------------------------
PHL-93 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
------------------------------------------------------------------
 PHL-93 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
 -----------------------------------------------------------------
 HL-93 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
 -----------------------------------------------------------------
 HL-93 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
 ----------------------------------------------------------------
 HS20 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
 ----------------------------------------------------------------
  HS20 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
  ---------------------------------------------------------------
  H20 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
  ---------------------------------------------------------------
   H20 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
   --------------------------------------------------------------
  Span          Maximum Shear Simult  Maximum Shear  Simult   Maximum
   No.  Dist.     Positive    Moment    Negative     Moment   Deflect.
        (ft)       (kips)     (k-ft)     (kips)      (k-ft)     (in)
   ii  xxx.xxx   xxxxx.xx   xxxxxx.x   xxxxx.xx    xxxxxx.x    xx.xxx


   PHL-93 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
   ------------------------------------------------------------
    HL-93 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
    -----------------------------------------------------------
    HS20 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
    ----------------------------------------------------------
     H20 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
     ---------------------------------------------------------
PHL-93 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
------------------------------------------------------------------
 PHL-93 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
 -----------------------------------------------------------------
 HL-93 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
 -----------------------------------------------------------------
 HL-93 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
 ----------------------------------------------------------------
 HS20 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
 ----------------------------------------------------------------
  HS20 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
  ---------------------------------------------------------------
  H20 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
  ---------------------------------------------------------------
   H20 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
   --------------------------------------------------------------
Support      Maximum         Minimum          Maximum         Minimum
  No.      Reaction  LC    Reaction  LC    Rotation  LC    Rotation  LC
            (kips)          (kips)         (radians)       (radians)
  ii       xxxxx.xx   a    xxxxx.xx   a    xx.xxxxxx  a    xx.xxxxxx  a
```

```
PHL-93 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
-----------------------------------------------------------
HL-93 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
----------------------------------------------------------
 HS20 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
 ---------------------------------------------------------
 H20 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
 --------------------------------------------------------
Support    Maximum      Minimum      Maximum      Minimum
  No.      Vehicle      Vehicle       Lane         Lane
            (kips)       (kips)      (kips)       (kips)
  ii       xxxxx.xx     xxxxx.xx     xxxxx.xx     xxxxx.xx
```

```
LC (PHL-93 Loading Codes):
1 - Tandem + Lane Governs
2 - Truck  + Lane Governs
3 - Tandem Pair + Lane Governs
4 - Truck Pair + Lane Governs
5 - Truck Alone Governs
6 - 25% Truck + Lane Governs
7 - 90% (Truck Pair + Lane Governs)

LC (HL-93 Loading Codes):
1 - Tandem + Lane Governs
2 - Truck  + Lane Governs
3 - Tandem Pair + Lane Governs
4 - 90% (Truck Pair + Lane) Governs
5 - Truck Alone Governs
6 - 25% Truck + Lane Governs

LC (Standard H20 or HS20 Loading Codes):
L - Lane Load Governs
```

```
             P-82 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
             ----------------------------------------------------
             P-82C LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
                 (P-82 in one lane with PHL-93 in other lanes)
             -----------------------------------------------------
             ML-80 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
             -----------------------------------------------------
          SPECIAL ## LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
          ---------------------------------------------------------
             TK527 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
             -----------------------------------------------------
              EV2 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
              ---------------------------------------------------
              EV3 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
              ---------------------------------------------------
            SU6TV LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
            -----------------------------------------------------
          P2016-13 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
          --------------------------------------------------------
            P-82 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
            ------------------------------------------------------
            P-82C LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
                 (P-82 in one lane with PHL-93 in other lanes)
            -------------------------------------------------------
            ML-80 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
            -------------------------------------------------------
            ML-80 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
            ------------------------------------------------------
           SPECIAL LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
           ---------------------------------------------------------
           SPECIAL LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
           --------------------------------------------------------
            TK527 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
            -------------------------------------------------------
            TK527 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
            ------------------------------------------------------
             EV2 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
             -----------------------------------------------------
             EV2 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
             ----------------------------------------------------
             EV3 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
             -----------------------------------------------------
             EV3 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
             ----------------------------------------------------
            SU6TV LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
            -------------------------------------------------------
            SU6TV LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
            ------------------------------------------------------
          P2016-13 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
          ----------------------------------------------------------
          P2016-13C LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
               (P2016-13 in one lane with PHL-93 in other lanes)
          -----------------------------------------------------------
                  PEDESTRIAN LL ANALYSIS (MOMENTS, UNFACTORED)
                  --------------------------------------------
    Span         Maximum Positive  Simult    Maximum Negative  Simult
     No.  Dist.       Moment       Shear          Moment        Shear
          (ft)        (k-ft)       (kips)         (k-ft)       (kips)
     ii xxx.xxx      xxxxxx.x    xxxxx.xx       xxxxxx.x    xxxxx.xx
```

```
        P-82 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
        --------------------------------------------------------------
        ML-80 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
        ---------------------------------------------------------------
     SPECIAL ## LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
     --------------------------------------------------------------------
       TK527 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
       ---------------------------------------------------------------
        EV2 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
        -------------------------------------------------------------
        EV3 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
        -------------------------------------------------------------
       SU6TV LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
       ---------------------------------------------------------------
     P2016-13 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
     ------------------------------------------------------------------
       P-82 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
       ----------------------------------------------------------------
       ML-80 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
       -----------------------------------------------------------------
       ML-80 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
       ----------------------------------------------------------------
    SPECIAL ## LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
    ----------------------------------------------------------------------
    SPECIAL ## LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
    ---------------------------------------------------------------------
       TK527 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
       -----------------------------------------------------------------
       TK527 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
       ----------------------------------------------------------------
     EV2 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, W/O SW, INCL. IMPACT)
     ---------------------------------------------------------------------
     EV2 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, W/ SW, INCL. IMPACT)
     --------------------------------------------------------------------
     EV3 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, W/O SW, INCL. IMPACT)
     ---------------------------------------------------------------------
     EV3 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, W/ SW, INCL. IMPACT)
     --------------------------------------------------------------------
    SU6TV LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, W/O SW, INCL. IMPACT)
    -----------------------------------------------------------------------
    SU6TV LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, W/ SW, INCL. IMPACT)
    ----------------------------------------------------------------------
  P2016-13 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, W/O SW, INCL. IMPACT)
  --------------------------------------------------------------------------
               Span            Maximum Shear        Maximum
                No.  Dist.     Positive  Negative     Deflect.
                     (ft)       (kips)    (kips)        (in)
                ii  xxx.xxx    xxxx.xx   xxxx.xx      xxx.xxx
```

```
     P-82C LL ANALYSIS (SHEARS, UNFACTORED, INCLUDING IMPACT)
          (P-82 in one lane with PHL-93 in other lanes)
     --------------------------------------------------------
     P2016-13C LL ANALYSIS (SHEARS, UNFACTORED, INCLUDING IMPACT)
           (P2016-13 in one lane with PHL-93 in other lanes)
     ------------------------------------------------------------
Span          Maximum Shear Simult  Maximum Shear  Simult
 No.  Dist.     Positive    Moment    Negative     Moment
      (ft)       (kips)     (k-ft)     (kips)      (k-ft)
 ii  xxx.xxxa   xxxx.xx   xxxxxx.x    xxxx.xx    xxxxxx.x
```

```
          P-82 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
          ----------------------------------------------------------
          ML-80 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
          -----------------------------------------------------------
       SPECIAL ## LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
       ----------------------------------------------------------------
          TK527 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
          -----------------------------------------------------------
          EV2 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
          ---------------------------------------------------------
          EV3 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
          ---------------------------------------------------------
         SU6TV LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
         -----------------------------------------------------------
       P2016-13 LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
       --------------------------------------------------------------
       P-82 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
       ----------------------------------------------------------------
       ML-80 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
       -----------------------------------------------------------------
       ML-80 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
       ----------------------------------------------------------------
    SPECIAL ## LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
    ----------------------------------------------------------------------
    SPECIAL ## LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
    ---------------------------------------------------------------------
       TK527 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
       -----------------------------------------------------------------
       TK527 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
       ----------------------------------------------------------------
       EV2 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
       ---------------------------------------------------------------
       EV2 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
       --------------------------------------------------------------
       EV3 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
       ---------------------------------------------------------------
       EV3 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
       --------------------------------------------------------------
     SU6TV LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
     -----------------------------------------------------------------
     SU6TV LL ANALYSIS (REACTIONS, W/ SW, INCL. IMP. & DIST. FACTORS)
     ----------------------------------------------------------------
    P2016-13 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMP. & DIST. FACTORS)
    --------------------------------------------------------------------
                     PEDESTRIAN LL ANALYSIS (REACTIONS)
                     ----------------------------------
        Support     Maximum      Minimum       Maximum      Minimum
          No.       Reaction     Reaction      Rotation     Rotation
                     (kips)       (kips)      (radians)    (radians)
          ii        xxxxx.xx     xxxxx.xx     xx.xxxxxx    xx.xxxxxx
```

```
     P-82 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
     ---------------------------------------------------------
    ML-80 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
    ----------------------------------------------------------
 SPECIAL ## LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
 ---------------------------------------------------------------
    TK527 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
    ----------------------------------------------------------
     EV2 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
     --------------------------------------------------------
     EV3 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
     --------------------------------------------------------
    SU6TV LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
    ----------------------------------------------------------
  P2016-13 LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
  -------------------------------------------------------------
     Support    Maximum      Minimum      Maximum     Minimum
       No.       Truck        Truck       Rotation    Rotation
                 (kips)       (kips)     (radians)   (radians)
       ii       xxxxx.xx     xxxxx.xx   xx.xxxxxx   xx.xxxxxx

 FATIGUE LL ANALYSIS (MOMENTS & SHEARS, UNFACTORED, INCL. IMPACT)
 ----------------------------------------------------------------
    Span              Maximum Moment          Maximum Shear
     No.  Dist.     Positive  Negative      Positive  Negative
          (ft)       (k-ft)    (k-ft)        (kips)    (kips)
     ii  xxx.xxx    xxxxxx.x  xxxxxx.x      xxxxx.xx  xxxxx.xx

   FATIGUE LL ANALYSIS (REACTIONS, INCL. IMPACT & DIST. FACTORS)
   -------------------------------------------------------------
  Support     Maximum      Minimum       Maximum      Minimum
    No.       Reaction     Reaction      Rotation     Rotation
               (kips)       (kips)      (radians)    (radians)
    ii        xxxxx.xx     xxxxx.xx     xx.xxxxxx    xx.xxxxxx

   FATIGUE LL ANALYSIS (REACTIONS, W/O IMPACT OR DIST. FACTORS)
   ------------------------------------------------------------
                Support    Maximum      Minimum
                  No.       Truck        Truck
                            (kips)       (kips)
                  ii       xxxxx.xx     xxxxx.xx

            PEDESTRIAN LL ANALYSIS (SHEARS, UNFACTORED)
            -------------------------------------------
                Span              Maximum Shear
                 No.  Dist.     Positive  Negative
                      (ft)       (kips)    (kips)
                 ii  xxx.xxx    xxxx.xx   xxxx.xx

      TOTAL PEDESTRIAN LL ANALYSIS (DEFLECTIONS, UNFACTORED)
      ------------------------------------------------------
                     Span            Maximum
                      No.  Dist.     Deflect.
                           (ft)       (in)
                      ii  xxx.xxx    xxx.xxx
```

```
                       UNFACTORED FLEXURAL STRESSES
                       ----------------------------
                                 Total DC1
Span              Limit                Deck
 No.  Dist.  T/B  State    Flex. Inst*  Pour*  MC1   UT1   DC2   FWS   MC2   UT2   LL    PL
      (ft)                       (ksi)  (ksi) (ksi) (ksi) (ksi) (ksi) (ksi) (ksi) (ksi) (ksi)
 ii xxx.xxxa aaa aaaaaaaa aaaa xxxx.x aaaaaaxxxx.xxxxx.xxxxx.xxxxx.xxxxx.xxxxx.xaaaaaaaaaaaaa
                 aaaaaaaa aaaa xxxx.x aaaaaaxxxx.xxxxx.xxxxx.xxxxx.xxxxx.xxxxx.xaaaaaaaaaaaaa

      * Legend of General Notes:
         TOTAL DC1 INST      = the total DC1 stress assuming instantaneous placement of
                               the deck slab and haunch
         TOTAL DC1 DECK POUR = the total DC1 stress at the end of the deck pour analysis.
         When computing the total factored stress, STLRFD uses the total DC1 stress
         (either instantaneous or deck pour) that causes the largest stress in the flanges.

                                USER INPUT LATERAL STRESSES
                                ---------------------------
                                                                       Total User Input
                                                                          1st Order
Span              Limit         Unfactored Lateral Stresses               Lateral Stress
 No. Dist.   T/B  State    DC1   MC1   UT1   DC2   FWS   MC2   UT2   LL   Unfactored  Factored
     (ft)                 (ksi) (ksi) (ksi) (ksi) (ksi) (ksi) (ksi) (ksi)   (ksi)      (ksi)
 ii xxx.xxxa aaa aaaaaaaa xxxx.xxxxx.xxxxx.xxxxx.xxxxx.xxxxx.xxxxx.xxxxx.x   xxxx.x     xxxx.x
                 aaaaaaaa xxxx.xxxxx.xxxxx.xxxxx.xxxxx.xxxxx.xxxxx.xxxxx.x   xxxx.x     xxxx.x

                                 FACTORED ANALYSIS RESULTS
                                 -------------------------
Span         Limit             Max.      Max.        Flexural Stress*      Compress. Limits*  Code
 No.  Dist.  State   Flex.    Moment    Shear    Bot. Bm. Top Bm.  Top S/R  0.6*f'c  0.85*f'c  Chk**
      (ft)                    (k-ft)    (kips)    (ksi)    (ksi)    (ksi)    (ksi)     (ksi)
 ii xxx.xxxa aaaaaaaa aaaa xxxxxxx.x xxxxx.xx aaaaaaaaaaaaaaaaaaaaxxxxx.xxa aaaaaaa  aaaaaaa     aaa
             aaaaaaaa aaaa xxxxxxx.x xxxxx.xx aaaaaaaaaaaaaaaaaaaaxxxxx.xxa aaaaaaa  aaaaaaa     aaa
             aaaaaaaa aaaa xxxxxxx.x xxxxx.xx aaaaaaaaaaaaaaaaaaaaxxxxx.xxa aaaaaaa  aaaaaaa     aaa

      * Legend of General Notes:
         N/A*  = Since the flexural capacity at this analysis point, limit state,
                 flexure state and flange is moment-governed, the total factored
                 flexural stress is not used for any specification checks and
                 therefore is not applicable.
         N/A** = This check is not required or not applicable at this analysis
                 point, limit state, and flexure state.
       Top S/R = For all limit states for positive flexure, the values in this column are stresses
                 calculated to the top of the slab effective thickness.
                 For all limit states for negative flexure (except SERV-II), the values in this
                 column are stresses calculated to the cg of the reinforcement.
             & = For SERV-II negative flexure, this value is calculated to the top of the slab
                 effective thickness using "n" section properties, assuming the slab
                 to be effective. (values calculated this way are indicated with "&")

     ** Legend of Code Check:
         A. Compressive stress at the top of the slab exceeds 0.6*f'c (A6.10.7.2)
         B. Compressive stress at the top of the slab exceeds 0.85*f'c
```

```
                    FACTORED ANALYSIS RESULTS - REACTIONS
                    -------------------------------------
Support    Limit       Maximum     Minimum     Maximum     Minimum    * If
  No.      State       Reaction ** Reaction ** Rotation    Rotation  Uplift
                        (kips)      (kips)    (radians)   (radians)
  ii      aaaaaaaa    xxxxx.xx a  xxxxx.xx a xx.xxxxxx   xx.xxxxxx    n/a
          aaaaaaaa    xxxxx.xx a  xxxxxx.x a xx.xxxxxx   xx.xxxxxx    n/a
          SERV-IIA    xxxxx.xx a  xxxxx.xx a xx.xxxxxx   xx.xxxxxx    a

      ** Legend of General Notes:
         F = Indicates that the reaction includes effects from FWS load
         N = Indicates that the reaction does not include effects from FWS load

     NOTE: Uplift is occurring for the Service-IIA Limit State at the indicated
           support.  If possible, revise span and/or skew such that no uplift
           occurs.  If this is not possible, tie-downs, anchorages, or
           counterweights must be designed to resist the factored net uplift
           force at the Strength-I Limit State. (see DM-4 14.6.1)
```

```
                            FACTORED LATERAL STRESSES
                            -------------------------
                                                          Wind          User Input
Span             Limit          Intermediate Values     1st      2nd      1st      2nd
 No.  Dist.  T/B  State   Flex.  rt*   Lp*   Cb*   Rb*   Order    Order    Order    Order
      (ft)                      (in)  (ft)               (ksi)    (ksi)    (ksi)    (ksi)
 ii xxx.xxxa aaa aaaaaaaa aaaa xxx.x xxx.x xx.xx xx.xx  aaaaaaa  aaaaaaa  aaaaaaa  aaaaaa
             aaa aaaaaaaa aaaa xxx.x xxx.x xx.xx xx.xx  aaaaaaa  aaaaaaa  aaaaaaa  aaaaaa

      * Legend of General Notes:
         rt = Effective radius of gyration for lateral torsional buckling (A6.10.8.2.3-9)
         Lp = Unbraced length for nominal flexural resistance (A6.10.8.2.3-4)
         Cb = Moment gradient modifier (A6.10.8.2.3)
         Rb = Web load shedding factor (A6.10.1.10.2)
         N/A*   = This value is not applicable for this limit state
         N/A**  = This second order stress is not applicable at this analysis
                  point, limit state, and flexure state
         N/A*** = No user-input lateral stress has been entered
```

7.12.5 Specification Checking Output

```
                   DUCTILITY AND WEB/FLANGE PROPORTION CHECKS
                   ------------------------------------------
               Web Proportion    F L A N G E   P R O P O R T I O N S
Spn             Long. D/tw      Top Flange      Bottom Flange    Iyc/Iyt  Duct.      Code
No.  Dist. Flex. Stff. Chk1*  Chk2* Chk3* Chk4* Chk2* Chk3* Chk4*  Chk5*   Chk6*     Check**
     (ft)
ii xxx.xxx  aaaa   a   xxx.x  xx.x  xx.x  xx.x  xx.x  xx.x  xx.x  xxx.xxx  aaaa aaaaaaaaaaaaaa
ii xxx.xxx  aaaa   a   xxx.x  xx.x  xx.x  xx.x  xx.x  xx.x  xx.x  xxx.xxx  aaaa aaaaaaaaaaaaaa
  *  Legend of Abbreviated Proportion Checks:
     Chk1:  D/tw <= 150 (unstiffened), D/tw <= 300 (stiffened), A6.10.2.1
     Chk2:  bf / 2tf <= 12.0,              A6.10.2.2-1
     Chk3:  D/bf <= 6.0,                   A6.10.2.2-2
     Chk4:  tf/tw >= 1.1,                  A6.10.2.2-3
     Chk5:  0.1 <= Iyc/Iyt <= 10.0,        A6.10.2.2-4
     Chk6:  Dp/Dt <= 0.42 (composite only) A6.10.7.3-1

  ** Legend of Code Checks:
     A. Web slenderness (D/tw) greater than 150 (A6.10.2.1.1-1)
     B. Web slenderness (D/tw) greater than 300 for longitudinally
         stiffened webs (A6.10.2.1.2-1)
     C. Top flange aspect ratio (bf/2tf) greater than 12.0, A6.10.2.2-1
     D. Top flange-web aspect ratio (D/bf) greater than 6.0, A6.10.2.2-2
     E. Top flange thickness to web thickness less than 1.1, A6.10.2.2-3
```

```
     F. Bottom flange aspect ratio (bf/2tf) greater than 12.0, A6.10.2.2-1
     G. Bottom flange-web aspect ratio (D/bf) greater than 6.0, A6.10.2.2-2
     H. Bottom flange thickness to web thickness less than 1.1, A6.10.2.2-3
     I. Flange Iyc/Iyt ratio not within boundaries 0.1 and 10, A6.10.2.2-4
     J. Ductility requirement fails, Dp/Dt greater than 0.42, A6.10.7.3-1
```

```
                          COMPACTNESS CRITERIA
                          --------------------
                                       AASHTO 6.10.6.2.2       AASHTO 6.10.6.2.3
Span         Limit         Fy,   Fy,         2*Dcp/    3.76*      2*Dc/    5.7*      Iyc/  Criteria
 No.  Dist.  State  Flex.  top   bot   D/tw    tw   sqrt(E/Fyc)    tw   sqrt(E/Fyc) Iyt    Not Met**
      (ft)                (ksi) (ksi)
 ii xxx.xxxa aaaaaaa aaaa xxx.x xxx.xaaaaaaa aaaaaaa aaaaaaa   aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaaaa

      ** Legend of Criteria Not Met:
        A. Fy,top or Fy,bot > 70 ksi (A6.10.6.2.2, A6.10.6.2.3)
        B. D/tw > 150 (A6.10.6.2.2, A6.10.2.1.1)
        C. Web slenderness limit not satisfied (A6.10.6.2.2-1)
        D. Web noncompact slenderness limit not satisfied (A6.10.6.2.3-1)
        E. Iyc / Iyt < 0.3 (App A A6.1-2)
        F. Built-up sections are always noncompact
        G. Field splice locations are always noncompact
        H. Locations with holes in the tension flange are always noncompact
        I. Kinked or curved girders are always noncompact
```

```
                        USER-DEFINED WIND LOAD AND PRESSURE
                        -----------------------------------
                                     Strength-III*       Strength-V*
                Span           Total     Wind     Wind     Wind     Wind
                 No.    Dist.  Depth   Pressure   Load   Pressure   Load
                        (ft)    (ft)     (ksf)    (klf)    (ksf)    (klf)
                 ii   xxx.xxxa  xxx.xx  xx.xxx   xx.xxx   xx.xxx   xx.xxx

  * The wind pressures and loads reported here are unfactored.  Different wind speeds are
    used for the calculation of wind pressures for Strength-III and Strength-V, as per
    LRFD Specifications Table 3.8.1.1.2-1.
```

```
                          COMPUTED WIND LOAD AND PRESSURE
                          -------------------------------
                                      Strength-III*          Strength-V*
            Span           Total               Wind     Wind     Wind     Wind
             No.    Dist.  Depth    Kz**  Pressure   Load   Pressure   Load
                    (ft)    (ft)              (ksf)    (klf)    (ksf)    (klf)
             ii   xxx.xxxa xxx.xx  x.xxx   xx.xxx   xx.xxx   xx.xxx   xx.xxx

  * The wind pressures and loads reported here are unfactored.  Different wind speeds are
    used for the calculation of wind pressures for Strength-III and Strength-V, as per
    LRFD Specifications Table 3.8.1.1.2-1.

  ** Kz is the pressure exposure and elevation coefficient from the LRFD Specifications,
     section 3.8.1.2.1, used with Strength-III.  For Strength-V, Kz is taken equal to 1.0.
```

```
                                          WIND EFFECTS
                                          ------------
                          Permanent Load Path = a = aaaaaaaaaaaa
                                     T O P   F L A N G E         B O T T O M   F L A N G E
                                  Factored    Lateral Bending     Factored    Lateral Bending
                               Wind    Wind     Stress, fl     Wind     Wind     Stress, fl
Span           Limit           Force   Moment   1st     2nd    Force    Moment   1st     2nd
 No.   Dist.   State   Flex.    W*      Mwt*   Order*  Order*    W       Mwb    Order   Order*
       (ft)                   (k/ft)  (k-ft)  (ksi)   (ksi)   (k/ft)  (k-ft)  (ksi)   (ksi)
 ii  xxx.xxxa aaaaaaaa  aaaa  aaaaaaa aaaaaaa aaaaaaa aaaaaaa  xxx.xxx  xxxx.xx xxxx.xx aaaaaaa

      * Legend of General Notes:')
         N/A = If this appears in the "Factored Wind Moment" or "1st Order" columns,')
               the deck is assumed to provide horizontal diaphragm action, so the')
               lateral stress does not apply.')
               If this appears in the "2nd Order" column (and not in the "1st Order" column')
               at the same time), the analysis location satisfies the unbraced length ')
               requirements of D6.10.1.6.')

              N/A because user-defined wind pressure = 0.0
```

```
                  INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY CALCULATIONS
                  -------------------------------------------------------------
Span         Limit                                                                Resist.
 No.  Dist.  State  Flex.   Dp*   Dt*  Rh*   Rpc*  Rpt*  Dc*     Myt      Myb    Calc.**
      (ft)                 (in)  (in)                   (in)   (kip-ft)  (kip-ft)
 ii xxx.xxxa aaaaaaa aaaa aaaaa aaaaa x.xxx aaaaa aaaaa aaaaa xxxxxxx.x xxxxxxx.x   a

    * Legend of General Notes:
       Dp = Distance from top of concrete deck to neutral axis of the composite section at the
            plastic moment (A6.10.7.1.2)
       Dt = Total depth of the composite section (A6.10.7.1.2)
       Rh = Hybrid factor (A6.10.1.10.1)
      Rpc = Web plastification factor for the compression flange (App A A6.2.1-4 or A6.2.2-4)
      Rpt = Web plastification factor for the tension flange (App A A6.2.1-5 or A6.2.2-5)
       Dc = Total depth of the web in compression, per Appendix D6.3.1
      Myt = Yield moment to the top flange, per Appendix D6.2
      Myb = Yield moment to the bottom flange, per Appendix D6.2

   ** Legend of Resistance Calculation:
      Compact Section:
        A. Dp <= 0.1*Dt, Mn calculated using A6.10.7.1.2-1
        B. Dp >  0.1*Dt, Mn calculated using A6.10.7.1.2-2
        C. Continuous span, Mn calculated using A6.10.7.1.2-3
      Appendix A:
        D. Discretely braced compression flange, local buckling governs (App A A6.3.2-1)
        E. Discretely braced compression flange, local buckling governs (App A A6.3.2-2)
        F. Discretely braced tension flange governs (App A A6.1.2)
        G. Continuously braced compression flange governs (App A A6.1.3)
        H. Continuously braced tension flange governs (App A A6.1.4)

                MOMENT FLEXURAL CAPACITY (COMPOSITE, +FLEX, COMPACT OR APPENDIX A)
                -----------------------------------------------------------------
                                      Factored           LTB    Gov LTB  Factored
                             Flexural Flex+Lat         Flexural Flexural Flex+Lat
   Span         Limit        Resist.   Moment  Resist. Resist.  Resist.   Moment  Resist.  Code
    No.  Dist.  State  Flex.    Mr       M+*   Calc.**    Mr       Mr       M+*   Calc.** Chk***
         (ft)                 (k-ft)   (k-ft)           (k-ft)   (k-ft)   (k-ft)
   ii xxx.xxxa aaaaaaa aaaa xxxxxx.x xxxxxx.xa   a    aaaaaaaa aaaaaaaa aaaaaaaaa   a      a

        * Legend of General Notes:
           NOTE: Intermediate values have been moved to a separate output report,
                 INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY CALCULATIONS
           M+  = Mu + (1/3)*fl*Sxt, total factored flexural + lateral moment due to
                 wind or user input effects
           w   = Value for M+ includes lateral load effects

       ** Legend of Resistance Calculation:
          Compact Section:
            A. Dp <= 0.1*Dt, Mn calculated using A6.10.7.1.2-1
            B. Dp >  0.1*Dt, Mn calculated using A6.10.7.1.2-2
            C. Continuous span, Mn calculated using A6.10.7.1.2-3
          Appendix A:
            D. Discretely braced compression flange, local buckling governs (App A 6.3.2)
            E. Discretely braced compression flange, lateral tors buckling governs (App A 6.3.3)
            F. Discretely braced tension flange governs (App A 6.1.2)
            G. Continuously braced compression flange governs (App A 6.1.3)
            H. Continuously braced tension flange governs (App A 6.1.4)
          Lateral Torsional Buckling Equivalent Moment Resistance:
            I. Mr(equivalent) calculated using lateral torsional buckling, A6.10.8.2.3-1
            J. Mr(equivalent) calculated using lateral torsional buckling, A6.10.8.2.3-2
            K. Mr(equivalent) calculated using lateral torsional buckling, A6.10.8.2.3-3

      *** Legend of Code Check:
           A. Insufficient flexural resistance
```

```
        STRESS FLEXURAL CAPACITY (NONCOMPOSITE OR -FLEX OR COMPOSITE/NONCOMPACT, NO LTB)
        --------------------------------------------------------------------------------
                                                                    Factored
                                                                    Flexural
                                           Intermediate     Flexural   +Lateral  Resistance  Code
  Span              Limit                  Calculations    Resistance   Stress   Calculation Check
   No. Dist.   T/B  State  Flex.    Rh*    Rb*    Mr(e)*   Fr      F+*        **        ***
       (ft)                                               (kip-ft) (ksi)  (ksi)
   ii xxx.xxxa aaa aaaaaaa aaaa   aaaaa  aaaaa aaaaaaaaa xxxx.x xxxx.xa     aaa      aaa

   * Legend of General Notes:
        Rh = Hybrid factor
        Rb = Load shedding factor (only applies to compression flange)
     Mr(e) = Flexural resistance in terms of moment, back-calculated from
             from the stress flexural resistance, Fr
        F+ = fbu + (1/3)*fl, total factored flexural + lateral stress
             due to wind (per A6.10.7.2.1-2, A6.10.8.1.1-1, or
             A6.10.8.1.2-1) and/or user input lateral effects
         w = Value for F+ includes lateral load effects

  ** Legend of Resistance Calculation:
     Composite Section in Positive Flexure, Noncompact Section:
       A. Compression flange governs, Fr calculated using A6.10.7.2.2-1
       B. Tension flange governs, Fr calculated using A6.10.7.2.2-2
     Composite Section in Negative Flexure or Noncomposite Section:
       C. Compression flange governs, Fr calculated using A6.10.8.1.3-1
       D. Compression flange governs, Fr calculated using FLB, A6.10.8.2.2-1
       E. Compression flange governs, Fr calculated using FLB, A6.10.8.2.2-2
       F. Tension flange governs, Fr calculated using A6.10.8.1.3-1
       G. Tension flange governs, Fr calculated using A6.10.8.3-1
       H. Girder skew angle has not been entered. Appendix A provisions have not been checked,
          but may be applicable.

 *** Legend of Code Check:
     A. Insufficient flexural resistance
     B. Based on the total stress in the bottom flange, this section is analyzed for positive
        flexure, so the top flange capacity is based on compression. However, the total
        factored stress (F+) in the top flange is tensile. The user should verify the
        acceptability of the section by comparing the top flange stress (F+) to the flexural
        resistance (Fr) of the top flange in negative flexure.
```

```
                INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS
                ---------------------------------------------------------------
Span             Limit                                  6.10.8.2.3        Appendix A
 No. Dist.   T/B  State Flx  rt*  Rh*   Rb*    Dc*   Lp*   Lr*  Cb*     Lr*   Cb*    Myc*    Rpc*
     (ft)                   (in)              (in)  (ft)  (ft)          (ft)        (kip-ft)
 ii xxx.xxxa aaa aaaaaaa a xxx.x x.xxx x.xxx xxx.x xx.xx xx.xx x.xxx  aaaaa aaaaa aaaaaaaaa aaaaa

      * Legend of General Notes:
        Values that are the same for Article 6.10.8.2.3 and Appendix A
           rt = Effective radius of gyration for lateral torsional buckling
                (Equations 6.10.8.2.3-9 or A6.3.3-10)
           Rh = Hybrid factor (Article 6.10.1.10.1)
           Rb = Load shedding factor (Article 6.10.1.10.2)
           Dc = Depth of the web in compression (Article D6.3.1)
           Lp = Limiting unbraced length to achieve the nominal flexural resistance of RbRhFyc
                under uniform bending (Equations 6.10.8.2.3-4 or A6.3.3-4)
        Values that are different for Article 6.10.8.2.3 and Appendix A
           Lr = Limiting unbraced length to achieve the onset of nominal yielding in either
                flange under uniform bending with consideration of compression-flange residual
                stress effects (Equations 6.10.8.2.3-5 or A6.3.3-5)
           Cb = Moment gradient modifier
                (Equations 6.10.8.2.3-6, 6.10.8.2.3-7, A6.3.3-6, or A6.3.3-7)
        Values that are specific to Appendix A
          Myc = Yield moment with respect to the compression flange (Article D6.2)
          Rpc = Web plastification factor for the compression flange
                (Article A6.2.1 or A6.2.2)
```

```
              LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE)
              ----------------------------------------------------------------------
                                  6.10.8.2.3               Appendix A        Factored Effects Code
                              Flexural Resistance      Flexural Resistance   Flexural+Lateral Chk
Span             Limit      Local       Governing        Local    Governing   Stress   Moment  ***
No. Dist.   T/B  State  Flx  Fr   *   Mr(e)**  Fr   *     Mr    *    Mr    *   F+**     M+**
    (ft)                    (ksi)   (kip-ft)  (ksi)   (kip-ft)   (kip-ft)    (ksi)   (kip-ft)
ii xxx.xxxa aaa aaaaaaa  a aaaaaa a aaaaaaaa aaaaaa a aaaaaaaa a aaaaaaaa a aaaaaaa aaaaaaaaa aaa

    * Legend of Resistance Calculation:
      LRFD Specifications Article 6.10.8.2.3
        A. Fr calculated using AASHTO Equation 6.10.8.2.3-1
        B. Fr calculated using AASHTO Equation 6.10.8.2.3-2
        C. Fr calculated using AASHTO Equation 6.10.8.2.3-3
      LRFD Specifications Chapter 6, Appendix A
        D. Mr calculated using AASHTO Equation A6.3.3-1
        E. Mr calculated using AASHTO Equation A6.3.3-2
        F. Mr calculated using AASHTO Equation A6.3.3-3
        G. Girder skew angle has not been entered. Appendix A provisions have not been checked,
           but may be applicable
        H. Appendix A provisions are not applicable at this location
      LRFD Specifications Chapter 6, Appendix D
        I. Fr calculated using AASHTO Equation D6.4.1-2
        J. Fr calculated using AASHTO Equation D6.4.1-4
        K. Mr calculated using AASHTO Equation D6.4.2-2
        L. Mr calculated using AASHTO Equation D6.4.2-4

   ** Legend of General Notes:
      Mr(e) = Flexural resistance in terms of moment, back-calculated from
              from the stress flexural resistance, Fr
         F+ = fbu + (1/3)*fl, total factored flexural + lateral stress due to wind (per
              A6.10.7.2.1-2, A6.10.8.1.1-1, or A6.10.8.1.2-1) and/or user input lateral effects
              If F+ prints as N/A, Appendix A calculations govern the LTB capacity
         M+ = Mu + (1/3)*fl*Sxt, total factored flexural + lateral moment due to wind or user
              input effects, A6.10.7.1.1-1
              If M+ prints as N/A, 6.10.8.2.3 calculations govern the LTB capacity
          w = Value for F+ or M+ includes lateral load effects

  *** Legend of Code Check:
      A. Insufficient flexural resistance
      B. Based on the total stress in the bottom flange, this section is analyzed for positive
         flexure, so the top flange capacity is based on compression. However, the total
         factored stress (F+) in the top flange is tensile. The user should verify the
         acceptability of the section by comparing the top flange stress (F+) to the flexural
         resistance (Fr) of the top flange in negative flexure.
      C. The unbraced range containing this analysis point varies in depth and has a flange
         transition more than one foot away from the ends of the unbraced range.
             %WARNING: **THIS MUST BE APPROVED BY CHIEF BRIDGE ENGINEER**

                           NET SECTION FRACTURE CHECK
                           --------------------------
                                   Flange                          Net Section   Factored
                                   Area     Tensile     Yield      Fracture      Flexural
   Span           Limit            Ratio    Strength   Strength    Resistance    Stress      Code
    No.   Dist.   State      T/B   An/Ag      Fu         Fyt          Fr           ft        Check*
          (ft)                              (ksi)       (ksi)       (ksi)        (ksi)
    ii  xxx.xxxa  aaaaaaa    aaa   x.xxx    xxx.xx     xxx.xx      xxx.xx       xxx.xx        a
                  aaaaaaa    aaa   x.xxx    xxx.xx     xxx.xx      xxx.xx       xxx.xx        a

      ** Legend of Code Checks:
          A. Flange fails net section fracture check, A6.10.1.8-1
```

```
                SERVICE LIMIT STATE - FLEXURAL RESISTANCE
                -----------------------------------------
                                                            Factored
                                       Intermediate    Flexural   Flexural
Span                 Limit             Calculation    Resistance   Stress   Resist.  Code
 No.   Dist.   T/B   State     Flex.       Rh*         Mr(e)*    Fr     Fu*     Calc.** Check***
       (ft)                                          (kip-ft)  (ksi)   (ksi)
 ii  xxx.xxxa  aaa  aaaaaaaa  aaaa     x.xxx       aaaaaaaa xxxx.x  xxxx.x      a        a

      * Legend of General Notes:
         Rh    = Hybrid factor
         Mr(e) = Flexural resistance in terms of moment, back-calculated
                 from the stress flexural resistance, Fr
         Fu    = For bottom flanges of composite sections or both flanges
                 of noncomposite sections, this value includes lateral
                 stresses when input by the user (A6.10.4.2.2)

     ** Legend of Resistance Calculation:
         A. Composite, top flange, Fr calculated using A6.10.4.2.2-1
         B. Composite, bottom flange, Fr calculated using A6.10.4.2.2-2
         C. Noncomposite, Fr calculated using A6.10.4.2.2-3

    *** Legend of Code Check:
         A. Insufficient flexural resistance
```

```
                SERVICE LIMIT STATE - WEB BEND-BUCKLING
                ---------------------------------------
                                                               Factored
                                   Intermediate      Flexural   Flexural
Span                Limit           Calculations     Resistance   Stress    Code
 No.   Dist.  T/B   State     Flex.   Dc*    Rh*     Mr(e)*  Fcrw*    fc*     Check**
       (ft)                          (in)           (kip-ft)  (ksi)   (ksi)
 ii  xxx.xxxa aaa  aaaaaaaa   aaaa  aaaaaa aaaaaa aaaaaaaa aaaaaa  aaaaaa      a

      * Legend of Intermediate Calculations:
         Dc = Depth of web in compression
         Rh = Hybrid factor
         Mr(e) = Flexural resistance in terms of moment, back-calculated from
                 from the stress flexural resistance, Fcrw
         Fcrw = Nominal bend-buckling resistance, LRFD Specifications 6.10.4.2.2-4
         fc = Compression-flange stress calculated without flange lateral bending
         N/A = This check is not required for composite sections in positive
               flexure in which the web satisfies the requirement of LRFD
               Specifications Article 6.10.2.1.1

     ** Legend of Code Check:
         A. Insufficient bend-buckling resistance
```

```
                          SHEAR CAPACITY
                          --------------
                        Factored   Maximum
                         Shear     Factored
Span           Limit   Resistance   Shear    Stiffened/     Code
 No.   Dist.   State       Vr        Vu      Unstiffened   Check*
       (ft)              (kips)    (kips)
 ii  xxx.xxxL aaaaaaaa  xxxxx.xx  xxxxx.xx       a           aaa
 ii  xxx.xxxR aaaaaaaa  xxxxx.xx  xxxxx.xx       a           aaa
              aaaaaaaa  xxxxx.xx  xxxxx.xx       a           aaa

    * Legend of Code Checks:
        A. Insufficient shear resistance
        B. D/tw has exceeded limit of 150 for unstiffened webs
        C. D/tw has exceeded limit of 300 for stiffened webs
```

```
                                 WEB SPECIFICATION CHECK
                                 -----------------------
                                                         Compressive Stress
   Span                Shear Force in Web                      in Web          Code
    No.  Dist.   Gamma*   Vr*     4*V*                      fcw*     fu*      Check**
         (ft)            (kips)   (kips)                   (ksi)    (ksi)
    Ii xxx.xxxa  xxx.x aaaaaaaa aaaaaaaa                 xxxx.xx  xxxx.xx     aaaaa

       * Legend of General Notes:
          Gamma = ( 5.4 * E ) / ( fcw * ( Dc / tw )**2 ) (DM-4 6.10.1.9.3P-2)
          The two following values will print as N/A if Gamma is greater than 2.5:
          Vr    = shear resistance of web (A6.10.9)
          4*V   = 4 * unfactored shear (DM-4 6.10.1.9.3P)
          fcw   = web compressive bending stress limit (DM-4 6.10.1.9.3P-1)
          fu    = unfactored compressive bending stress in web (DM-4 6.10.1.9.3P)

          NOTE: For composite sections, the unfactored shear and compressive
                bending stress include effects due to noncomposite dead loads only.
                For noncomposite sections, the unfactored shear and bending

       **  Legend of Code Checks:
           A.  Slenderness check fails and Vr < 4*V
           B.  Insufficient web stress capacity (fcw < fu)
```

```
                            TRANSVERSE STIFFENERS CHECK
                            ---------------------------
  Span            S p a c i n g       W i d t h          Moment of Inertia        Code
   No.   Dist.   Maximum   Actual   Min    Max   Actual  Minimum  Gov LS*  Actual   Check**
         (ft)      (ft)     (ft)    (in)   (in)   (in)    (in^4)           (in^4)
   ii  xxx.xxxa  xxx.xxx  xxx.xxx  xxx.xx xxx.xx xxx.xx  xxxx.xx  aaaaaaa xxxx.xx   aaaaaaa
   ii  xxx.xxxa  <TRANSVERSE STIFFENERS NOT NEEDED HERE>                            aaaaaaa
   ii  xxx.xxxa  xxx.xxx  xxx.xxx  <UNSTIFFENED REGION>                             aaaaaaa

       * NOTE:
           If "n/a" appears in this column, it indicates that the calculation of the
           minimum moment of inertia was NOT governed by AASHTO LRFD Equation
           6.10.11.1.3-9. If a limit state designation appears, equation 6.10.11.1.3-9
           governs and the factored shear for the designated limit state was used.

      ** Legend of Code Checks:
           A. Stiffener spacing greater than maximum allowed; check
              SHEAR CAPACITY output report to determine if an
              unstiffened web will be sufficient
           B. Projecting width less than minimum required
           C. Projecting width greater than maximum allowed
           D. Transverse stiffeners not needed at this location;
              unstiffened web is sufficient
           E. Since the transverse stiffener spacing exceeds the
              depth of the girder, conventional deck slab overhang
              forms are not permitted and the provisions of DM-4
              Section 6.10.3.2.5.2P(b) must be complied with
           F. Moment of inertia less than minimum required
```

```
                    LONGITUDINAL STIFFENERS CHECK (PART 1)
                    --------------------------------------
      Span                    Max   Actual    Minimum     Actual       Code
       No.   Dist.   Flex.   Width   Width    M of I      M of I      Check*
             (ft)             (in)    (in)    (in^4)      (in^4)
        ii  xxx.xxxa   aaaa   xx.xxx  xx.xxx  aaaaaaaa    aaaaaaaa       aaa

          * Legend of Code Checks:
              A. Projecting width greater than maximum allowed
              B. Moment of inertia less than minimum required
              C. No transverse stiffeners defined here. Transverse
                 stiffeners are required when longitudinal stiffeners
                 are present.

                    LONGITUDINAL STIFFENERS CHECK (PART 2)
                    --------------------------------------
                             Distance     Minimum     Actual
        Span                 From the    Radius of  Radius of      Code
         No.   Dist.   Flex.  Flange**     Gyration   Gyration      Check*
               (ft)             (in)        (in)       (in)
          ii   xxx.xxxa  aaaa   xxx.xxx  a  aaaaaaaa   aaaaaaaa         a

          * Legend of Code Checks:
              A. Radius of gyration less than minimum required
              B. No transverse stiffeners defined here. Transverse
                 stiffeners are required when longitudinal stiffeners
                 are present.

         ** Legend of Stiffener Locations:
              T  Distance is measured from top flange
              B  Distance is measured from bottom flange
```

```
                      USER-INPUT BEARING STIFFENER ANALYSIS
                      -------------------------------------
                                                    Maximum     Stiffener / Web
Span           Maximum  Stiff.   Bearing     Axial     Factored        Weld Size        Code
 No.  Dist.     Width   Width   Resistance  Resistance  Reaction   Desn** Min    Max   Check*
      (ft)      (in)     (in)     (kips)      (kips)     (kips)     (in)   (in)   (in)
 ii  xxx.xxx   xx.xxx   xx.xxx   xxxxx.xx    xxxxx.xx   xxxxx.xx  x.xxxx x.xxxx x.xxxx  aaa
 ii  xxx.xxx     <NO BEARING STIFFENER DEFINED HERE>    xxxxx.xx                       aaa
 ii  xxx.xxx     <BEARING STIFFENER DEFINED BUT NOT NEEDED>                            aaa

      *  Legend of Code Checks:
         A. Projecting stiffener width greater than maximum allowed
         B. Provided resistance less than maximum factored reaction
         C. Bearing stiffener is required at this location
         D. Bearing stiffener was defined at this location but is not required
         E. The calculated required weld size is greater than the maximum allowed
            weld size (A6.13.3.4).  Review stiffener and web plate thicknesses.

      ** NOTE: WELD SIZE DESIGN is the designed weld size and is the larger
               of the calculated weld size and the minimum weld size.
```

```
                                   WEB CONCENTRATED LOAD CHECK
                                   ---------------------------
                                                                          Required
                        Bearing  Web Local      Web      Maximum   Bearing
Span          Distance  Length    Yielding    Crippling  Factored   Length     Code
 No.  Dist.      k*        N*    Resistance  Resistance    Load     Nreq*    Check**
      (ft)     (in)      (in)      (kips)      (kips)     (kips)    (in)
 ii xxx.xxx  xx.xxxx   xx.xxxx   xxxxx.xx    xxxxx.xx   xxxxx.xx  xx.xxxx a    aaa

      *  Legend of General Notes:
         k    = Distance from the outer face of the flange resisting the reaction
                to the web toe of the fillet (for rolled beams)
                Bottom flange thickness (for plate girders)
                Bottom flange thickness or angle thickness (for built-up sections)
         N    = Bearing length used by the program to compute the web local yielding
                and crippling resistances (assumed equal to k)
         Nreq = Required bearing length resulting in web local yielding and web
                crippling capacities greater than or equal to the maximum factored load
                (LRFD Specifications D6.5.2, denoted by Y, and D6.5.3, denoted by C)

     **  Legend of Code Checks:
         A. The resistance provided without a bearing stiffener is less than
            the maximum factored load. A bearing stiffener is required at
            this location.
         B. The resistance provided without a bearing stiffener is less than
            the maximum factored load.  A bearing stiffener is required here, and
            the user has defined one at this location.
            Please see the USER-INPUT BEARING STIFFENER ANALYSIS output report to
            verify that the bearing stiffener is adequate.
         C. A bearing stiffener was defined at this location but is
            not required.
         D. A noncomposite (DC1, MC1, or UT1) concentrated load has been defined for
            this location. The user must review LRFD Specifications Section
            CD6.5.1 for important information regarding concentrated loads
            applied directly to the steel section.
```

```
                                    BEARING STIFFENER DESIGN
                                    ------------------------
Span           #                    Stiffener                Resistance    Max. Fct.  Code
 No.  Dist.   Pair* Spc*  Clr* Width EWid* Thick    Weld* Bearing   Axial  Reaction  Check**
      (ft)          (in)  (in)  (in)  (in)   (in)    (in)   (kips)  (kips)   (kips)
 ii   xxx.xxx   i   xx.xx aaaaa xx.x  xx.x  x.xxxx  x.xxxx xxxxx.xx xxxxx.xx xxxxx.xx   aaa

 * Legend of General Notes:
  # Pair = Number of pairs of stiffeners required at this location
     Spc = When more than one pair of stiffeners is required, this is the spacing between
           pairs used by the program
     Clr = Clearance from centerline of bearing to the end of the beam at the abutments
           used by the program to calculate the bearing and axial resistance of the
           stiffeners.
    EWid = Effective width used for bearing resistance calculations
    Weld = The required size of the weld between the bearing stiffener and the web
    NOTE: The program designs welded plate bearing stiffeners (not bolted or angles).
          If CLEARANCE is not input on the BSD command, the default distance from the end
           of the beam to the first stiffener will be 9*web thickness.
          If SPACING BETWEEN PAIRS is not input on the BSD command, the default spacing
           between stiffener pairs will be 18*web thickness.
          Both defaults allow the program to consider the maximum contribution of the web.
          A more detailed history of the bearing stiffener and weld design can be found
           in "<filename>.BDH" or "<filename>-BDH.PDF" in the same directory as the
           program output file.

      **  Legend of Code Checks:
         A. Bearing design cannot be found with maximum number of stiffener pairs
            and maximum thickness
         B. Bearing design cannot be found because of pair spacing and clearance restrictions
         C. The calculated required weld size is greater than the maximum allowed weld size
            (A6.13.3.4).  Review stiffener and web plate thicknesses as well as the bearing
            stiffener design history file for more information about maximum and minimum weld
            sizes ("<filename>.BDH" or "<filename>-BDH.PDF" in the same directory as this
            output file).
```

```
                                 WEB-TO-FLANGE WELD DESIGN: WELD CAPACITY
                                 ----------------------------------------
                                        Weld   Factored
                                        Metal   Shear
   Span               Limit            Resist.  Flow**          Weld Size              Code
    No.  Dist. Flange  State   Flex. Rr,weld    su     Calc.  Min.   Max.  Design**  Check*
         (ft)                         (ksi)  (kip/in)  (in)   (in)   (in)   (in)
    ii xxx.xxxa aaa   aaaaaaa  aaaa xxxx.xx xxxx.xx  x.xxx  x.xxx  x.xxx  x.xxx        a
                aaa   aaaaaaa  aaaa xxxx.xx xxxx.xx  x.xxx  x.xxx  x.xxx  x.xxx        a

         *  Legend of Code Check:
            A. Calculated weld size is larger than maximum allowed; adjust
               girder section properties

        ** NOTE: FACTORED SHEAR FLOW is the total shear flow between the web
                 and the flange. The calculated weld size is based on 1/2 of
                 the total factored shear flow.
                 WELD SIZE DESIGN is the designed weld size and is the larger
                 of the calculated weld size and the minimum weld size.

            WEB-TO-FLANGE WELD DESIGN: CONNECTED MATERIAL CAPACITY
            ------------------------------------------------------
                                  Connected Metal  Factored
                                    Resistance      Shear
   Span              Limit          Web     Flange   Flow*** Perf.   Code
    No.  Dist. Flange State Flex.  sr,web  sr,flange  su    Ratio**  Check*
         (ft)                     (kip/in) (kip/in) (kip/in)
    ii xxx.xxxa aaa  aaaaaaa aaaa  xxxx.xx   xxxx.xx  xxxx.xx  xx.xx    aaa
                aaa  aaaaaaa aaaa  xxxx.xx   xxxx.xx  xxxx.xx  xx.xx    aaa

         *  Legend of Code Checks:
            A. Web metal resistance less than factored shear flow
            B. Flange metal resistance less than factored shear flow

        ** NOTE: PERFORMANCE RATIO is the maximum ratio of su/sr,web and
                 su/sr,flange [The loading combination specified here results
                 in the maximum performance ratio along the entire girder.]
        ** NOTE: PERFORMANCE RATIO is the maximum ratio of su/sr,web and
                 su/sr,flange

       *** NOTE: FACTORED SHEAR FLOW is the total shear flow between the web
                 and the flange.

            LONGITUDINAL SLAB REINFORCEMENT AT CONTINUOUS SUPPORTS
            ------------------------------------------------------
       Support  Bar    Left     Right     As/Eff.      As/Unit    Location
         No.    No.   Cutoff   Cutoff   Slab Width   Slab Width   In Slab
                       (ft)     (ft)      (in^2)      (in^2/ft)
         ii     ii   xxx.xxx  xxx.xxx   xxxx.xx       xxxx.xx        a
```

```
                  MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT (PART 1)
                  -------------------------------------------------------------
                                                               T o t a l   A r e a
 Span                   Serv-II   Construction    Slab Reinf.          Percent  Yield     Code
  No. Distance  phi*fr* Stress   Stress  Stage    aaa*    SST*   Slab*   Area*  Strength  Check**
       (ft)      (ksi)  (ksi)     (ksi)          (in^2)  (in^2)  (in^2)   (%)     (ksi)
  ii  xxx.xxxa  xx.xxx  xx.xxx  xx.xxx    ii    xxxx.xx xxxx.xx xxxx.xx  xxx.x   xxx.xx  aaaaaaaaaa
  ii  xxx.xxxa  xx.xxx  n/a(1)* xx.xxx    ii    xxxx.xx xxxx.xx xxxx.xx  xxx.x   xxx.xx  aaaaaaaaaa
  ii  xxx.xxxa  xx.xxx  xx.xxx  n/a(2)*         xxxx.xx xxxx.xx xxxx.xx  xxx.x   xxx.xx  aaaaaaaaaa
  ii  xxx.xxxa  xx.xxx  xx.xxx  xx.xxx    ii     N o t    A p p l i c a b l e (3)*

      * Legend of General Notes (all checks done as per DM-4 Article 6.10.1.7):
         phi * fr: phi of 0.9 * modulus of rupture of the concrete
                   fr calculated for normal-weight concrete using AASHTO 6.10.1.7
         Total Area Slab Reinforcement aaa: Area of longitudinal slab reinforcement
                                            defined with aaa commands
         Total Area Slab Reinforcement SST: Total area of all longitudinal slab reinforcement
                                            defined with SST commands.  Total area is reduced
                                            before bars are fully developed.
         Total Area Slab: Total cross sectional area of the slab, using the total slab depth
         Percent Area: The percentage of the slab total area occupied by the SST slab reinforcement.
                       If the SST slab reinforcement is not defined, then the aaa slab reinforcement
                       is used.
     (1) The point is not in negative flexure for the Service-II limit state.
     (2) The point is not in negative flexure for construction staging, construction staging
            has not been entered for this girder, or deck is never in tension for construction.
     (3) The tensile stress in the deck does not exceed phi*modulus of rupture for the Service-II
            limit state or construction stages, so the deck reinforcement checks need not be done.
     (4) The slab reinforcement has not been defined with an SST command at this location.

     ** Legend of Code Checks:
         A. Slab reinforcement is less than 1% of the total cross-sectional area of the slab
         B. Slab reinforcement yield strength < 60 ksi
         C. The area of reinforcing defined on the APL command is greater than that defined on
            the SST command.  The program will use the SST values, but the input should be reviewed.

                  MINIMUM NEGATIVE FLEXURE CONCRETE DECK REINFORCEMENT (PART 2)
                  -------------------------------------------------------------
                                Maximum Bar             Reinforcement Area
           Span            Size*  Spacing*  Dev Length*     Top        Bottom    Code
            No. Distance   T  B   T     B     T     B   Req'd* Act* Req'd* Act* Check**
                  (ft)           (in)  (in)  (in)  (in) (in^2)(in^2)(in^2)(in^2)
            ii  xxx.xxxa  ii ii xx.xx xx.xx xxx.x xxx.x xxx.x xxx.x xxx.x xxx.x aaaaaaaaaa
            ii  xxx.xxxa                N o t    A p p l i c a b l e (3)*

      * Legend of General Notes (all checks done as per DM-4 Article 6.10.1.7):
         Maximum Bar Size: The largest bar size of the top and bottom layers
         Maximum Bar Spacing: The largest bar spacing of the top and bottom layers
         Maximum Bar Development Length: The modified development length of the largest bar
            in each of the top and bottom layers
         Reinforcement Area Required: The required area of reinforcement in the top or bottom
            of the slab. At least 2/3 of 1% of the slab area is required in the top and at least
            1/3 of 1% of the slab area is required in the bottom.
         Reinforcement Area Actual: The actual area of reinforcement in the top or bottom of the slab.
            If the bars at this location are not fully developed, the area reported will be
            less than the input area.
     (3) The tensile stress in the deck does not exceed phi*modulus of rupture for the Service-II
            limit state or construction stages, so the deck reinforcement checks need not be done.

     ** Legend of Code Checks:
         A. Slab reinforcement spacing > 12"
         B. Maximum bar size > #6
         C. The top layer has less reinforcement than required
         D. The bottom layer has less reinforcement than required

    *** The Deck Reinforcing Area entered via the APL command is greater than the total area
        entered on the SST command (or the SST command is omitted for this location). Because
        of this, the bar size, spacing and location are unknown.
        For analysis locations where the reinforcing entered on the SST command is not fully
         developed, a reduced area is calculated.  Be sure to specify a cutoff location such
         that the developed SST area is greater than the area entered via the APL command.
        If the SST area is not greater than the APL area, the title of this output report
         will appear on the SPECIFICATION CHECK WARNINGS report.
```

```
                    SPECIAL FATIGUE REQUIREMENT FOR WEBS
                    ------------------------------------
           Span               Allowable      Actual
            No.     Dist.        Vcr           Vu       Comment*
                    (ft)       (kips)        (kips)
            ii     xxx.xxxa   aaaaaaa       aaaaaaa       aaaa

            *  Legend of Comments:
               A.  Code check:  Vu > Allowable, Vcr
               B.  Unstiffened web or exterior panel

                    Not applicable due to unstiffened web
```

```
                                      FATIGUE RESISTANCE
                                      ------------------
            Distance          Fatigue       Stresses***                   Fatigue
Span          From    Detail  Limit          Positive Negative  Fatigue    Stress   Fillet  Code
 No.  Dist.   Bottom Category State   Dead    Live     Live   Resistance  Range    Weld   Check*
      (ft)     (in)                  (ksi)   (ksi)    (ksi)     (ksi)     (ksi)    (in)
 ii  xxx.xxxa xxx.xx    aa      aa   xxx.xx  xxx.xx   xxx.xx    xxx.xx    xxx.xx  aaaaaaa   aaa

       * Legend of Code Checks:
           A. Insufficient fatigue resistance
           B. User entered effective throat of fillet weld where there
              is no transversely loaded fillet weld with discontinuous
              cover plate loaded. Analyzing as standard fatigue detail.

       ** Fatigue resistance is not calculated at this point because
          the unfactored permanent load stress is compressive and
          greater than the maximum live load tensile stress caused by
          the Fatigue I load combination (LRFD 6.6.1.2.1).

       *** The dead load stress is unfactored, and is the total of all dead load stresses
           at the fatigue detail. The live load stress is factored for the limit state
           shown in the Fatigue Limit State column.
```

```
                    REMAINING FATIGUE LIFE ESTIMATION
                    ---------------------------------
                                    Accumulated                Number of
   Span          Dist.From    Total      Cycles     Remaining     Years
    No.   Dist.   Bottom      Cycles     To Date      Cycles     Remaining
          (ft)    (in)
    ii  xxx.xxxa xxx.xxx   iiiiiiiii   iiiiiiiii   iiiiiiiii     iiii
    ii  xxx.xxx  xxx.xxx                                        INFINITE

           Unable to calculate, an FTL command was not entered
         Fatigue life not calculated; No fatigue points to check
```

```
                     DEFLECTION LIMITS FOR LIVE LOAD
                     -------------------------------
              DEFLECTION LIMITS FOR DEFLECTION LOADING ONLY
              ---------------------------------------------
     DEFLECTION LIMITS FOR DEFLECTION LOADING + PEDESTRIAN LIVE LOAD
     ---------------------------------------------------------------
    Span Location of Max.  Deflection        Overhang       Min. Bm.  Code
     No.   Deflection   Allow   Actual    Allow   Actual       Depth  Check*
                (ft)     (in)    (in)     (in)    (in)          (in)
     ii      xxx.xxxa  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx    xxx.xxx  aaaa
     ii      xxx.xxxa  xxx.xxx  xxx.xxx    N/A      N/A      xxx.xxx  aaaa

    * Legend of Code Checks:
        A. Maximum deflection exceeds allowable
        B. Deck overhang exceeds minimum beam depth
        C. Deck overhang exceeds maximum allowable due to deflections
           (See DM-4 Table 9.7.1.5.1P-1)

               SHEAR CONNECTOR DESIGN - NO. OF CONNECTORS REQUIRED
               ---------------------------------------------------
          Start   Start   End     End    Horizontal    Factored    No. of
 Design   Span    Span    Span    Span     Shear      Resistance    Conn.
 Region   No.     Dist.   No.     Dist.      P            Q(r)     Required
                  (ft)            (ft)     (kips)       (kips)
   ii      ii   xxx.xxx    ii   xxx.xxx   xxxx.xx      xxxx.xx      iiiii

                     SHEAR CONNECTOR DESIGN - PITCH
                     ------------------------------
SKW command not entered, radial fatigue shear range conservatively applied.

                 Connectors      Pitch     Pitch Based
  Span             Per Row      Required   on No. Conn. Actual     Code
   No.   Dist.   Max. Actual   Min.    Max.   Required   Pitch     Check*
         (ft)                  (in)    (in)     (in)      (in)
   ii  xxx.xxxa  ii    ii      xxx.x  xxx.x    xxx.x     xxx.x     aaaaa

 *  Legend of Code Checks:
    A.  Actual pitch is less than the minimum pitch required
    B.  Maximum allowable pitch is less than minimum allowable pitch.
        Increase number of connectors in cross section.
        Increase the length of the connector in a cross section.
    C.  Actual number of connectors greater than maximum allowed

            SHEAR CONNECTOR DESIGN - SPACING, COVER, AND PENETRATION
            --------------------------------------------------------
            Minimum Transverse Spacing                Min. Penetration
             Center to      Center to       Minimum      into Slab
               Center          Edge          Cover     above Haunch
                (in)           (in)          (in)          (in)
               xxx.x          xxx.x         xxx.x         xxx.x
```

```
                    SHEAR CONNECTOR DESIGN - PITCH
                    ------------------------------
                       Pitch     Pitch Based
      Span            Required    on Number    Actual     Code
       No.   Dist.   Min.    Max.  Required     Pitch     Check*
             (ft)    (in)    (in)    (in)       (in)
       ii   xxx.xxx  xxx.x   xxx.x   xxx.x      xxx.x      aaa

 *  Legend of Code Checks:
    A.  Actual pitch is less than the minimum pitch required
    B.  Maximum allowable pitch is less than minimum allowable pitch.
        Increase number of connectors in cross section.
        Increase the length of the connector in a cross section.

            SHEAR CONNECTOR DESIGN - COVER AND PENETRATION
            ----------------------------------------------
                             Min. Penetration
                  Minimum       into Slab
                   Cover       above Haunch
                   (in)            (in)
                   xxx.x           xxx.x

             CONSTRUCTION STAGE ii WEB SPECIFICATION CHECK
             ---------------------------------------------
                 UNCURED SLAB WEB SPECIFICATION CHECK
                 ------------------------------------
                                                   Compressive Stress
Span                Shear Force in Web                   in Web          Code
 No.  Dist.   Gamma*   Vr*    4*Vdl*     Vu*        fcw*     fu*      Check**
      (ft)           (kips)   (kips)   (kips)      (ksi)    (ksi)
 ii xxx.xxxa  xxx.x xxxxx.xx aaaaaaaa xxxxx.xx    xxxx.xx  xxxx.xx     aaaaa

      * Legend of General Notes:
         Gamma = ( 5.4 * E ) / ( fcw * ( Dc / tw )**2 ) (DM-4 6.10.1.9.3P-2)
         Vr    = phi(v) * Vcr (A6.10.3.3-1)
         4*Vdl = 4 * unfactored dead load shear (DM-4 6.10.1.9.3P)
                 (will print as N/A if Gamma is greater than 2.5)
         Vu    = factored construction/uncured slab shear (A6.10.3.3-1)
         fcw   = web compressive bending stress limit (DM-4 6.10.1.9.3P-1)
         fu    = compressive bending stress in web due to unfactored dead
                 load and construction loads (DM-4 6.10.1.9.3P)

     **  Legend of Code Checks:
         A.  Insufficient shear resistance (Vr < Vu)
         B.  Slenderness check fails and Vr < 4*Vdl
         C.  Insufficient web stress capacity (fcw < fu)
```

CONSTRUCTION STAGE ii WIND EFFECTS

UNCURED SLAB WIND EFFECTS

Construction Load Path = a = aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa

Span No.	Dist. (ft)	Total Depth (ft)	Wind Pressure (ksf)	TOP FLANGE Factored Wind Force W (k/ft)	TOP FLANGE Factored Wind Moment Mwt (k-ft)	TOP FLANGE Lateral Bending Stress, fl 1st Order (ksi)	TOP FLANGE Lateral Bending Stress, fl 2nd Order* (ksi)	BOTTOM FLANGE Factored Wind Force W (k/ft)	BOTTOM FLANGE Factored Wind Moment Mwb (k-ft)	BOTTOM FLANGE Lateral Bending Stress, fl 1st Order (ksi)	BOTTOM FLANGE Lateral Bending Stress, fl 2nd Order* (ksi)
ii	xxx.xxxa	xxx.x	x.xxxx	xxx.xxx	xxxx.xx	xxx.xxx	aaaaaaa	xxx.xxx	xxxx.xx	xxx.xxx	aaaaaaa

* NOTE: If "N/A" appears in this column, the analysis location satisfies the unbraced length requirements of A6.10.1.6.

CONSTRUCTION STAGE ii DECK OVERHANG EFFECTS

UNCURED SLAB DECK OVERHANG EFFECTS

Span No.	Dist. (ft)	Limit State	Lateral Force Uniform Load Flu (k/ft)	Lateral Force Point Load Flp (kip)	Lateral Moment Uniform Load Mlu (k-ft)	Lateral Moment Point Load Mlp (k-ft)	Total Lateral Bending Stress Top Flange 1st Order (ksi)	Total Lateral Bending Stress Top Flange 2nd Order* (ksi)	Total Lateral Bending Stress Bottom Flange 1st Order (ksi)	Total Lateral Bending Stress Bottom Flange 2nd Order* (ksi)
ii	xxx.xxx	aaaaaaaa	x.xxxxx	xx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	aaaaaaa	xxx.xxx	aaaaaaa

*** NOTE: If "N/A" appears in this column, the analysis location satisfies the unbraced length requirements of A6.10.1.6.**

CONSTRUCTION STAGE ii FACTORED LATERAL STRESSES

UNCURED SLAB FACTORED LATERAL STRESSES

Span No.	Dist. (ft)	T/B	Intermediate Values rt* (in)	Lp* (ft)	Cb*	Rb*	Wind 1st Order (ksi)	Wind 2nd Order (ksi)	User Input 1st Order (ksi)	User Input 2nd Order (ksi)
ii	xxx.xxxa	aaa	aaaaa	aaaaa	aaaaa	aaaaa	aaaaaaa	aaaaaaa	aaaaaaa	aaaaaaa

* Legend of General Notes:
rt = Effective radius of gyration for lateral torsional buckling (A6.10.8.2.3-9)
Lp = Unbraced length for nominal flexural resistance (A6.10.8.2.3-4)
Cb = Moment gradient modifier (A6.10.8.2.3)
Rb = Web load shedding factor (A6.10.1.10.2)
N/A* = This value is not applicable for this limit state
N/A** = This second order stress is not applicable at this analysis point, limit state, and flexure state
N/A*** = No user-input lateral stress has been entered

CONSTRUCTION STAGE ii FLANGE SPECIFICATION CHECK (NO LTB)(PART 1)

UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 1)

Span No.	Dist. (ft)	Hybrid Factor Rh	T/B	Flange Nominal Yielding Flexural + Lateral Allowable Stress (ksi)	Flange Nominal Yielding Flexural + Lateral Actual Stress* (ksi)	Web Bend Buckling* Coefficient k*	Web Bend Buckling* Flexural Stress Only Allowable Stress (ksi)	Web Bend Buckling* Flexural Stress Only Actual Stress* (ksi)	Code Check**
ii	xxx.xxxa	x.xxx	aaa	aaaaaaa	aaaaaaa i	aaaaaaa	aaaaaaa	aaaaaaa	aaaa

```
     * Legend of General Notes:
      1 or 2 = Indicates the governing loading combination
               1: load combination does not include wind and uses load factors of 1.4 for DC loads
               2: load combination includes wind and uses load factors of 1.25 for DC loads and
                  1.0 for wind loads
      k = Bend-buckling coefficient
          Web bend-buckling checks only apply to compression flanges; tension flanges
           are identified as N/A
```

```
            CONSTRUCTION STAGE ii FLANGE SPECIFICATION CHECK (NO LTB) (PART 2)
            ------------------------------------------------------------------
                  UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 2)
                  --------------------------------------------------------
                                         Compression Flange Flexural Resistance
                            Load           (6.10.3.2.1-2)           (6.10.1.6-1)
                          Shedding   Flexural + Lateral Stresses     Lateral Only
 Span         Unbraced     Factor   Allowable  Actual    Resist.  Allowable  Actual    Code
  No.  Dist.   Length   T/B   Rb       Stress   Stress*  Calc.**    Stress   Stress*  Check***
       (ft)     (ft)                   (ksi)     (ksi)               (ksi)     (ksi)
  ii xxx.xxxa  xxx.xx   aaa   x.xxx   xxxx.xx   xxxx.xx i  aaaaa    xxxx.xx   xxxx.xx   aaaa

     * Legend of General Notes:
      1 or 2 = Indicates the governing loading combination
               1: load combination does not include wind and uses load factors of 1.4 for DC loads
               2: load combination includes wind and uses load factors of 1.25 for DC loads and
                  1.0 for wind loads

    ** Legend of Resistance Calculation:
         A. Compression flange is continuously braced, flexural resistance and lateral bending
            checks do not apply
       LRFD Specifications Article 6.10.8.2.2 (Flange Local Buckling)
         B. Flange local buckling governs, AASHTO Equation 6.10.8.2.2-1
         C. Flange local buckling governs, AASHTO Equation 6.10.8.2.2-2
       Other Notes
         D. Lateral stresses due to wind and/or user input effects apply to discretely braced
            flanges and have been included in the Actual Stress column

   *** Legend of Code Checks:
         A.  Compression flange fails flexural resistance check, A6.10.3.2.1-2
         B.  Compression flange fails lateral bending check, A6.10.1.6-1

                 Not applicable due to lack of an unbraced compression flange
```

```
       INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (CONSTRUCTION STAGE ##)
       ---------------------------------------------------------------------------------------
           INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (UNCURED SLAB)
           ------------------------------------------------------------------------------
Span                                                     6.10.8.2.3
 No. Dist.   T/B        Flx  rt*  Rh*   Rb*    Dc*   Lp*   Lr*  Cb*
     (ft)                    (in)              (in)  (ft)  (ft)
 ii xxx.xxxa aaa         a xxx.x x.xxx x.xxx xxx.x xx.xx xx.xx x.xxx

       * Legend of General Notes:
            rt = Effective radius of gyration for lateral torsional buckling
                 (Equation 6.10.8.2.3-9)
            Rh = Hybrid factor (Article 6.10.1.10.1)
            Rb = Load shedding factor (Article 6.10.1.10.2)
            Dc = Depth of the web in compression (Article D6.3.1)
            Lp = Limiting unbraced length to achieve the nominal flexural resistance of RbRhFyc
                 under uniform bending (Equation 6.10.8.2.3-4)
            Lr = Limiting unbraced length to achieve the onset of nominal yielding in either
                 flange under uniform bending with consideration of compression-flange residual
                 stress effects (Equation 6.10.8.2.3-5)
            Cb = Moment gradient modifier
                 (Equations 6.10.8.2.3-6 or 6.10.8.2.3-7)
```

```
                   LATERAL TORSIONAL BUCKLING CAPACITY (CONSTRUCTION STAGE ##)
                   -----------------------------------------------------------
                       LATERAL TORSIONAL BUCKLING CAPACITY (UNCURED SLAB)
                       -------------------------------------------------
                                 6.10.8.2.3                              Factored Effects Code
                             Flexural Resistance                         Flexural+Lateral Chk
Span                       Local       Governing                         Stress           ***
No. Dist.   T/B        Flx  Fr   *           Fr   *                       F+**
    (ft)                   (ksi)            (ksi)                        (ksi)
ii xxx.xxxa aaa         a aaaaaa a         aaaaaa a                     aaaaaaa          aaa

    * Legend of Resistance Calculation:
      LRFD Specifications Article 6.10.8.2.3
        A. Fr calculated using AASHTO Equation 6.10.8.2.3-1
        B. Fr calculated using AASHTO Equation 6.10.8.2.3-2
        C. Fr calculated using AASHTO Equation 6.10.8.2.3-3
      LRFD Specifications Chapter 6, Appendix D
        D. Fr calculated using AASHTO Equation D6.4.1-2
        E. Fr calculated using AASHTO Equation D6.4.1-4

   ** Legend of General Notes:
         F+ = fbu + (1/3)*fl, total factored flexural + lateral stress due to wind (per
              A6.10.3.2.1-2) and/or user input lateral effects.
          w = Value for F+ includes lateral load effects

  *** Legend of Code Check:
      A. Insufficient flexural resistance
      B. Based on the total stress in the bottom flange, this section is analyzed for positive
         flexure, so the top flange capacity is based on compression. However, the total
         factored stress (F+) in the top flange is tensile. The user should verify the
         acceptability of the section by comparing the top flange stress (F+) to the flexural
         resistance (Fr) of the top flange in negative flexure.
```

```
                    CONSTRUCTION STAGE ii NET SECTION FRACTURE CHECK
                    ------------------------------------------------
                          UNCURED SLAB NET SECTION FRACTURE CHECK
                          ---------------------------------------
                                Flange                           Net Section   Factored
                                Area     Tensile     Yield       Fracture      Flexural
      Span           Limit              Ratio    Strength    Strength    Resistance    Stress       Code
       No.   Dist.   State     T/B    An/Ag       Fu          Fyt          Fr           ft        Check*
            (ft)                                (ksi)       (ksi)        (ksi)        (ksi)
       ii  xxx.xxxa  aaaaaaaa  aaa  xxx.xxx     xxx.xx      xxx.xx       xxx.xx       xxx.xx        a

        * Legend of Code Check:
           A. Flange fails net section fracture check, A6.10.1.8-1

                           Not applicable due to absence of section holes
```

```
                  CONSTRUCTION STAGE ii GLOBAL DISPLACEMENT AMPLIFICATION CHECK
                  -------------------------------------------------------------
                      UNCURED SLAB GLOBAL DISPLACEMENT AMPLIFICATION CHECK
                      ----------------------------------------------------

                This check defaults to the Number of Beams for two and three girder systems.
                For four girder systems the user must enter 4 to have the Global
                Dislacement Amplification Check made. (LRFD Specifications 6.10.3.4.2)

 Span                                                                     Mu*      Code
  No.   Dist.  Flex.   Ieff*     Ix*       Mgs*        Mu*     0.7*Mgs*  (all beams) Check**
        (ft)          (in^4)   (in^4)    (kip-ft)    (kip-ft)   (kip-ft)    (kip-ft)
  ii  xxx.xxxa  aaaa xxxxxxx. xxxxxxx. xxxxxxxx.x xxxxxxxx.x xxxxxxxx.x  xxxxxxxx.x     a

       * Legend of General Notes:
           Ieff = Effective noncomposite moment of inertia about the vertical centroidal
                  axis of a single girder (Equations 6.10.3.4.2-2 and 6.10.3.4.2-3)
             Ix = Noncomposite moment of inertia about the horizontal centroidal axis
                  of a single girder
                  NOTE: both Ieff and Ix are calculated as a weighted average over the positive
                        or negative bending region within the span under consideration
            Mgs = Elastic global lateral-torsional buckling resistance of the span acting as a
                  system (Equation 6.10.3.4.2-1)
             Mu = Total factored moment in a single girder
       0.70*Mgs = The limit on the sum of total factored girder moments (Article 6.10.3.4.2)
  Mu (all beams) = Mu * number of beams in the cross-section. The same moment is assumed
                  in each beam in the cross-section.

    ** Legend of Code Check:
       A. Insufficient flexural resistance (Mu (all beams)>0.70*Mgs)
          Please review LRFD Specifications Section 6.10.3.4.2 for potential solutions
          to consider beyond increasing the section stiffness.
       B. The girder contains lateral bracing from a hardened composite deck somewhere
          within the span, so this check is not necessary.
```

7.12.6 Rating Factors Output

```
                              RATING FACTORS - SUMMARY
                              ------------------------
               Basis of          Rating   Rating    Span               Limit
                Rating      T/B  Factor   Tonnage    No.    Dist.      State
                                          (tons)             (ft)
    PHL-93
    ------
    PHL-93/ML-80
    ------------
    HL-93
    -----
    P-82
    ----
    P-82C
    -----
    ML-80
    -----
    HS20
    ----
    H20
    ---
    TK527
    -----
    SPECIAL ##
    ----------
    Inventory  Flexure       a   xxx.xxx             ii    xxx.xxxL   aaaaaaaa
    Inventory  Flexure       a   xxx.xxx  xxxxx.x    ii    xxx.xxxR   aaaaaaaa
    Operating  Flexure       a   xxx.xxx             ii    xxx.xxx    aaaaaaaa
    Operating  Flexure       a   xxx.xxx  xxxxx.x    ii    xxx.xxx    aaaaaaaa
               Shear             xxx.xxx             ii    xxx.xxx    aaaaaaaa
               Shear             xxx.xxx  xxxxx.x    ii    xxx.xxx    aaaaaaaa
               Controlling       xxx.xxx             ii    xxx.xxx    aaaaaaaa
               Controlling       xxx.xxx  xxxxx.x    ii    xxx.xxx    aaaaaaaa
    Inventory  Not Applicable
    Operating  Not Applicable
```

```
                      RATING FACTORS - MOMENT FLEXURAL CAPACITY
                      -----------------------------------------
                                    Resist.  Total    Total
      Span           Limit          Moment    DL       LL     Rating  Rating
      Span           Limit          Moment    DL***    LL     Rating  Rating
       No.  Dist.    State   Flex.    Mr     Moment   Moment  Factor Failures**
            (ft)                    (k-ft)  (k-ft)   (k-ft)
      ii  xxx.xxxa aaaaaaaa  aaaa  xxxxxx.  xxxxxx.  xxxxxx.  xxx.xxxa aaaaa
                   aaaaaaaa  aaaa  xxxxxx.  xxxxxx.  xxxxxx.  xxx.xxxa aaaaa
```

* An asterisk following the rating factor indicates that the rating is governed by lateral torsional buckling.

** Legend of Rating Failures:
- A. Section fails Iyc/Iy range check
- B. Rating factor is less than 1.0

*** For Strength-IP limit state, pedestrian live load is included as part of Total DL Moment.

```
                    RATING FACTORS - STRESS FLEXURAL CAPACITY
                    -----------------------------------------
                                      Resist. Total   Total
Span              Limit               Stress    DL      LL    Rating  Rating
Span              Limit               Stress   DL***    LL    Rating  Rating
 No.  Dist.  Flng  State    Flex.      Fr    Stress  Stress  Factor Failures**
      (ft)                            (ksi)   (ksi)   (ksi)
ii  xxx.xxxa aaa  aaaaaaaa  aaaa   xxxx.x  xxxx.x  xxxx.x  xxx.xxxa aaaaa
             aaa  aaaaaaaa  aaaa   xxxx.x  xxxx.x  xxxx.x  xxx.xxxa aaaaa
                  aaaaaaaa  aaaa   xxxx.x  xxxx.x  xxxx.x  xxx.xxxa aaaaa

    * An asterisk following the rating factor indicates that the rating is governed by
      lateral torsional buckling (AASHTO 6.10.8.2.3).

    + An plus sign following the rating factor indicates that the rating is governed by
      net section fracture (AASHTO 6.10.1.8).

    # An hash sign following the rating factor indicates that the rating is governed by
      web bend-buckling (AASHTO 6.10.4.2.2-4).

     ** Legend of Rating Failures:
         A. Section fails Iyc/Iy range check
         B. Rating factor is less than 1.0

     *** For Strength-IP limit state, pedestrian live load
           is included as part of Total DL Stress.

                         RATING FACTORS - SHEAR CAPACITY
                         -------------------------------
                               Resist.    Total     Total
Span          Limit             Shear       DL        LL     Rating  Rating
Span          Limit             Shear      DL**       LL     Rating  Rating
 No.  Dist.   State   Shear      Vr       Shear     Shear    Factor Failure*
       (ft)                    (kips)    (kips)    (kips)
 ii  xxx.xxxa aaaaaaaa aaaa xxxxx.xx  xxxxx.xx  xxxxx.xx xxxx.xxx    a
              aaaaaaaa aaaa xxxxx.xx  xxxxx.xx  xxxxx.xx xxxx.xxx    a

      * Legend of Rating Failure:
          A. D/tw has exceeded limit of 150 for unstiffened webs
          B. D/tw has exceeded limit of 300 for stiffened webs
          C. Rating factor is less than 1.0

     ** For Strength-IP limit state, pedestrian live load
           is included as part of Total DL Shear.
```

7.12.7 Summary – Overall Reactions Tables

```
REACTIONS & ROTATIONS PER GIRDER (UNFACTORED, W/O IMPACT, W/ DISTRIBUTION)
                    FOR ELASTOMERIC BEARING PAD DESIGN
--------------------------------------------------------------------------
    Support                   Minimum          Maximum         Live Load
      No.                  Reaction  LC     Reaction  LC     Rotation  LC
                             (kips)           (kips)        (radians)

      1     Total aaa     xxxxxxx.x       xxxxxxx.x
            Total aaa     xxxxxxx.x       xxxxxxx.x
            FWS                           xxxxxxx.x
            --------------------------------------------------------------
            Total DL      xxxxxxx.x       xxxxxxx.x
            LL (aaaaaa)   xxxxxxx.x       xxxxxxx.x    a    x.xxxxxx   a

      NOTE: Rotation is about an axis normal to the centerline of the beam.
            The rotation value given is the larger of the positive
            rotation and absolute value of the negative rotation due
            to live load.
            The dead load reactions at the abutments do not include any loads
            past the centerline of bearing. To include these loads, the user
            may specify them using the CLD (Concentrated Load) command.
```

```
   REACTIONS PER GIRDER (UNFACTORED AND FACTORED, W/ IMPACT, W/ DISTRIBUTION)
                          FOR SOLE PLATE DESIGN
   ---------------------------------------------------------------------
    Support                               Minimum         Maximum
      No.                              Reaction  LC    Reaction  LC
                                        (kips)          (kips)
      1     Total aaa                xxxxxx.xx       xxxxx.xx
            Total aaa                xxxxxx.xx       xxxxx.xx
            FWS                      xxxxxx.xx       xxxxx.xx
            --------------------------------------------------------------
            Total DL                  xxxxx.xx       xxxxx.xx
            Unfactored LL (aaaaaaaaaa)xxxxx.xx       xxxxx.xx
            Total STR-I (aaaaaaaaaa)  xxxxx.xx       xxxxx.xx
            Total SERV-II (aaaaaaaaaa)xxxxx.xx       xxxxx.xx

      Note: The dead load reactions at the abutments do not include any loads
            past the centerline of bearing. To include these loads, the user
            may specify them using the CLD (Concentrated Load) command.
```

```
REACTIONS & ROTATIONS PER GIRDER (UNFACTORED, W/ IMPACT, W/ DISTRIBUTION)
                  FOR POT, STEEL OR DISC BEARING DESIGN
-------------------------------------------------------------------------
   Support                   Minimum         Maximum
     No.                   Reaction  LC    Reaction  LC    Rotation  LC
                             (kips)          (kips)       (radians)

     ii     Total aaa     xxxxxx.xx       xxxxxx.xx       xx.xxxxxx
            Total aaa     xxxxxx.xx       xxxxxx.xx       xx.xxxxxx
            FWS           xxxxxx.xx       xxxxxx.xx
            -------------------------------------------------------------
            Total DL      xxxxxx.xx       xxxxxx.xx       xx.xxxxxx

            LL(aaaaa)     xxxxxx.xx  xx   xxxxxx.xx  xx   xx.xxxxxx  xx

     Note: Rotation is about an axis normal to the centerline of the beam.
           The dead load reactions at the abutments do not include any loads
           past the centerline of bearing. To include these loads, the user
           may specify them using the CLD (Concentrated Load) command.

               REACTIONS (UNFACTORED) FOR ABUTMENT DESIGN
               ------------------------------------------

                  DL REACTIONS (UNFACTORED) PER GIRDER
                  ------------------------------------
              Support               Minimum      Maximum
                No.                 Reaction     Reaction
                                     (kips)       (kips)
                ii    Total aaa     xxxxxx.xx    xxxxxx.xx
                      Total aaa     xxxxxx.xx    xxxxxx.xx
                      FWS           xxxxxx.xx    xxxxxx.xx
                      --------------------------------------
                      Total DL      xxxxxx.xx    xxxxxx.xx

             LL REACTIONS PER LANE (UNFACTORED, W/O IMPACT)
             ----------------------------------------------
          Support                  Minimum          Maximum
            No.                 Reaction  LC     Reaction  LC
                                 (kips)           (kips)
            ii    aaaaa        xxxxxx.xx  xx    xxxxxx.xx  xx

     Note: These values are to be used only if the end supports are
           abutments. Do not use these values for the pier design at a
           discontinuous superstructure.
           The dead load reactions at the abutments do not include any loads
           past the centerline of bearing. To include these loads, the user
           may specify them using the CLD (Concentrated Load) command.
```

```
                REACTIONS (UNFACTORED) FOR PIER DESIGN
                --------------------------------------

                 DL REACTIONS (UNFACTORED) PER GIRDER
                 ------------------------------------
             Support                 Minimum      Maximum
               No.                   Reaction     Reaction
                                      (kips)       (kips)
               ii    Total aaa      xxxxxx.xx    xxxxxx.xx
                     Total aaa      xxxxxx.xx    xxxxxx.xx
                     FWS            xxxxxx.xx    xxxxxx.xx
                     --------------------------------------
                     Total DL       xxxxxx.xx    xxxxxx.xx


            LL REACTIONS PER LANE (UNFACTORED, W/O IMPACT)
            ----------------------------------------------
Support               Minimum Reaction                Maximum Reaction
  No.           Vehicle  LC     Lane    LC      Vehicle  LC     Lane    LC
                (kips)         (kips)           (kips)         (kips)
  ii    aaaaa  xxxxxx.xx  xx  xxxxxx.xx  xx    xxxxxx.xx  xx  xxxxxx.xx  xx
        P-82   xxxxxx.xx                       xxxxxx.xx

      Note: Impact must be added for pier cap design
            The dead load reactions at the abutments do not include any loads
            past the centerline of bearing. To include these loads, the user
            may specify them using the CLD (Concentrated Load) command.

      LC (PHL-93 Loading Codes):
      1 - Tandem + Lane Governs
      2 - Truck + Lane Governs
      3 - Tandem Pair + Lane Governs
      4 - Truck Pair + Lane Governs
      5 - Truck Alone Governs
      6 - 25% Truck + Lane Governs
      7 - 90% (Truck Pair + Lane) Governs

      LC (HL-93 Loading Codes):
      1 - Tandem + Lane Governs
      2 - Truck + Lane Governs
      3 - Tandem Pair + Lane Governs
      4 – 90% (Truck Pair + Lane) Governs
      5 - Truck Alone Governs
      6 - 25% Truck + Lane Governs
```

```
                  RATING FACTORS - OVERALL SUMMARY
                  --------------------------------
                                    Rating    Rating   Span               Limit
             Governs     T/B   Factor    Tonnage   No.     Dist.     State
                                              (tons)              (ft)
PHL-93
------
PHL-93/ML-80
------------
HL-93
-----
P-82
----
P-82C
-----
ML-80
-----
HS20
----
H20
---
Inventory  aaaaaaaaaaaaaaa   xxx.xxx            ii    xxx.xxx   aaaaaaaa
Operating  aaaaaaaaaaaaaaa   xxx.xxx            ii    xxx.xxx   aaaaaaaa
Inventory  aaaaaaaaaaaaaaa   xxx.xxx  xxxxx.x   ii    xxx.xxx   aaaaaaaa
Operating  aaaaaaaaaaaaaaa   xxx.xxx  xxxxx.x   ii    xxx.xxx   aaaaaaaa
Inventory  Not Applicable
Operating  Not Applicable
```

```
                              BRIDGE LOAD RATINGS W/ FWS
                              --------------------------
                              BRIDGE LOAD RATINGS W/O FWS
                              ---------------------------

Span  ii                   STEEL PLATE GIRDER xxx. inches
                      aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa
INVENTORY  Dist. Fact.     x.xxx      x.xxx      x.xxx      x.xxx      x.xxx      x.xxx
RATING     Loc. (ft)   xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa
(IR)       Resistance  aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa
           Limit State aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa
           RF            xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa

Span  ii                   STEEL PLATE GIRDER xxx. inches
                      aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa
OPERATING  Dist. Fact.     x.xxx      x.xxx      x.xxx      x.xxx      x.xxx      x.xxx
RATING     Loc. (ft)   xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa
(IR)       Resistance  aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa
           Limit State aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa
           RF            xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa


Maximum Factored Flexural Resistance (kip-ft) xxxxxx.xx   Span Length(ft) = xxx.xx
Location (ft)                                xxxxxxxxxxa

Maximum Factored Shear Resistance (kips)      xxxxxx.xx
Location (ft)                                xxxxxxxxxxa

NOTES:
GIVEN DISTRIBUTION FACTOR IS THE VEHICULAR LIVE LOAD DISTRIBUTION FACTOR
USED TO PRODUCE THE GIVEN RATING.  FOR THE STR-IP LIMIT STATE, THE VEHICULAR
LIVE LOAD DISTRIBUTION FACTOR ACCOUNTS FOR THE PRESENCE OF PEDESTRIAN
LOADS, IF APPLICABLE.

THE LIVE LOAD EFFECTS OF THE P-82C COMBINATION USE SEVERAL DIFFERENT LIVE LOAD
DISTRIBUTION FACTORS. AS SUCH, A SINGLE DISTRIBUTION FACTOR CANNOT BE REPORTED
HERE. PLEASE SEE THE "DISTRIBUTION FACTORS FOR P-82C COMBINATION" OUTPUT REPORTS
FOR THE RELEVANT DISTRIBUTION FACTORS AND DM-4 EQUATION 3.4.1-3P FOR HOW THEY
ARE COMBINED.

ALL RATINGS ARE BASED ON THE INCLUSION OF THE DESIGN FUTURE WEARING SURFACE.

SYMBOL DESIGNATION FOR RATING FACTORS:
M - MOMENT RATING FACTOR CONTROLS
S - SHEAR RATING FACTOR CONTROLS

                                    FIELD SECTIONS
                                    --------------
                 Field        Start            End
                Section   Span            Span             Field Section
                  No.      No.   Dist.     No.   Dist.    Length     Weight
                                 (ft)            (ft)      (ft)      (kips)
                  ii       ii   xxx.xxx    ii   xxx.xxx xxxxx.xxx xxxxx.xxx
```

7.12.8 Economic Feasibility Checks

```
                          ECONOMIC FEASIBILITY CHECKS
                          ---------------------------
The following provides a guideline for the designer regarding different
economic feasibility checks. The designer should evaluate each of the
following guidelines for validity as it pertains to the specific structure
in question. The guidelines are based on the LRFD Specifications, DM-4 and
NSBA document G 12.1-2003. These are not the only economic feasibility
checks that should be done. The designer should review the LRFD
Specifications, DM-4 and the NSBA document for other checks that are
beyond the scope of STLRFD. See section 3.7.9 of the STLRFD User's Manual
for full descriptions of the economic checks done.

NOTE: At least one economic feasibility check has failed
NOTE: All economic feasibility checks have passed

                                                                     Pass
                                                 Actual   Limiting   /Fail
Criterion                                        Value    Condition  /Note
---------------------------------------------------------------------------
ENTIRE GIRDER
-------------
Minimum preferred beam spacing (aa)                    >= xx.xxx      aaaa
  Entire girder                                 xx.xxx
Maximum beam spacing (aa)                              <= xx.xxx      aaaa
Minimum girders                                        >= x           aaaa
Composite beam preferred                                              aaaa
User must verify availability for rolled beams                        aaaa
Overhang (aa)                                          <= xx.xxx      aaaa
Actual slab thickness (aa)                             <= xx.xxx      aaaa

SPANS
-----
Avoid haunched girders                                                aaaa
Haunched girder spans should be over xxx aa                           aaaa
Straight haunch preferred over curved                                 aaaa
Span < xxx aa avoid using longitudinal stiffeners                     aaaa
Nominally stiffened interior girder                                   aaaa
For spans > xxx aa lateral bracing should be provided
  Use "T" load path for lateral bracing for spans > xxx               aaaa
For xxx aa <= spans <= xxx aa evaluate need for lateral bracing
For spans < xxx aa avoid lateral bracing
  Do not use "T" load path for lateral bracing for spans < xxx aa     aaaa

GIRDER CROSS SECTION RANGES
---------------------------
Web thickness (aa) (Prefer >= x.x)                     >= xx.xxx      aaaa
Flange thickness (aa)                                  >= xx.xxx      aaaa
Flange width (aa)                                      >= xx.xxx      aaaa
Change in top flange plate area at transition (%)      <= xx.xxx      aaaa
Change in bottom flange plate area at transition (%)   <= xx.xxx      aaaa
Minimum girder depth-to-span ratio                     >= xx.xxx      aaaa
Minimum total depth-to-span ratio                      >= xx.xxx      aaaa
Web depth (aa)                                          < xx.xxx      aaaa
Weight savings in top flange due to transition (aa)    >=xxx.xxx      aaaa
Weight savings in bottom flange due to transition (aa) >=xxx.xxx      aaaa
```

```
TRANSVERSE STIFFENER RANGES
---------------------------
Transverse stiffener thickness (aa) (Prefer >= x.x)    >= xx.xxx      aaaa
Transverse stiffener spacing (aa)                      >=8 or 1.5*w   aaaa
Transverse stiffener only on one side                                 aaaa
Avoid same side transverse and longitudinal stiffeners                aaaa
Exterior girder transverse stiffener spacing           <=D            aaaa

LONGITUDINAL STIFFENER RANGES
-----------------------------
Longitudinal stiffener thickness (aa) (Prefer >= x.x)  >= xx.xxx      aaaa

FIELD SECTIONS
--------------
Top flange width constant in field section                            aaaa
Top flange transitions in section <= xxx aa            <=2            aaaa
Bottom flange transitions in section <= xxx aa         <=2            aaaa
Web thickness should only vary between field sections                 aaaa
Hauling permit may need to be secured (aa)              > xx.xxx      aaaa
  Field Section 1
Prelim. superload permit appl. may be required (aa)    >=xxx.xxx      aaaa
  Field Section 1
Prelim. superload permit appl. may be required (aaaa)  >=xxx.xxx      aaaa
```

7.12.9 SPLRFD and NSBA Splice Input Information

```
                         SPLRFD INPUT INFORMATION
                         ------------------------

SPLICE LOCATION: Span ii, xxx.xxx aa
------------------------------------

COMMAND:  CFG
   Not available

COMMAND:  TTL
   Not available

COMMAND:  CTL
   SYSTEM OF UNITS                      aa
   COMPOSITE/NONCOMPOSITE                a
   DES./ANAL. WEB SPL. PLATE  Not available
   DES./ANAL. WEB SPL. BOLTS  Not available
   THREAD OF WEB BOLT IN SHR  Not available
   INCR. PLATE/BOLT WEB SPL   Not available
   DES./ANAL. TOP FSPL. PL.   Not available
   DES./ANAL. TOP FSPL. BOLT  Not available
   THREAD OF TOP FSPL. BOLT   Not available
   INCR. PL./BOLT TOP FSPL.   Not available
   DES./ANAL. BOT FSPL. PL.   Not available
   DES./ANAL. BOT FSPL. BOLT  Not available
   THREAD OF BOT FSPL. BOLT   Not available
   INCR. PL./BOLT BOT FSPL.   Not available
   TOP FSPL. CONFIGURATION    Not available
   BOT FSPL. CONFIGURATION    Not available
   STAG./NON-STAG. TOP FLNG.  Not available
   STAG./NON-STAG. BOT FLNG.  Not available
   BOLT CONNECTION TYPE       Not available
   CHECK PLATE FATIGUE        Not available
   PEDESTRIAN LOADING                    a

COMMAND:  DDL
   DC1 MOMENT                     xxxxxxx.x aaaaaa
   DC2 MOMENT                     xxxxxxx.x aaaaaa
   FWS MOMENT                     xxxxxxx.x aaaaaa
   DC1 SHEAR                      xxxxxx.xx aaaaaa
   DC2 SHEAR                      xxxxxx.xx aaaaaa
   FWS SHEAR                      xxxxxx.xx aaaaaa

COMMAND:  DLL
   TYPE OF LIVE LOAD                      a (aaaaaaaa)
   LIVE LOAD NUMBER                       i
   POSITIVE MOMENT                xxxxxxx.x aaaaaa
   NEGATIVE MOMENT                xxxxxxx.x aaaaaa
   POSITIVE SHEAR                 xxxxxx.xx aaaaaa
   NEGATIVE SHEAR                 xxxxxx.xx aaaaaa

COMMAND:  MAT
   Not available
```

```
COMMAND:  GAS
   LEFT/RIGHT                             a
   WEB YIELD STRENGTH             xxxxxxx.x aaaaaa
   WEB TENSILE STRENGTH       Not available
   WEB THICKNESS                xxxxxxx.xxx aaaaaa
   WEB DEPTH                    xxxxxxx.xxx aaaaaa
   TOP FLANGE YIELD STRENGTH      xxxxxxx.x aaaaaa
   TOP FLANGE TENSILE STR.        xxxxxxx.x aaaaaa
   TOP FLANGE WIDTH           Not available*
   TOP FLANGE THICKNESS       Not available*
   BOT. FLANGE YIELD STR.         xxxxxxx.x aaaaaa
   BOT. FLANGE TENSILE STR.       xxxxxxx.x aaaaaa
   TOP FLANGE WIDTH             xxxxxxx.xxx aaaaaa
   TOP FLANGE THICKNESS         xxxxxxx.xxx aaaaaa
   POS. FACT. FLEX. RESIST.       xxxxxxx.x aaaaaa
   NEG. FACT. FLEX. RESIST.       xxxxxxx.x aaaaaa
   FACTORED SHEAR RESIST.         xxxxxx.xx aaaaaa
   WEB EDGE TYPE              Not available
   TOP FLANGE EDGE TYPE       Not available
   BOT. FLANGE EDGE TYPE      Not available

   *NOTE: For rolled beams with cover plates, it is the responsibility
          of the engineer to determine the proper values for flange
          width and thickness for use in SPLRFD.

COMMAND:  ASR
   LEFT/RIGHT                             a
   TOP STR-I POS FLEX FR               xx.x aaa
   TOP STR-I NEG FLEX FR               xx.x aaa
   TOP STR-IP POS FLEX FR              xx.x aaa
   TOP STR-IP NEG FLEX FR              xx.x aaa
   TOP STR-II POS FLEX FR              xx.x aaa
   TOP STR-II NEG FLEX FR              xx.x aaa
   BOT STR-I POS FLEX FR               xx.x aaa
   BOT STR-I NEG FLEX FR               xx.x aaa
   BOT STR-IP POS FLEX FR              xx.x aaa
   BOT STR-IP NEG FLEX FR              xx.x aaa
   BOT STR-II POS FLEX FR              xx.x aaa
   BOT STR-II NEG FLEX FR              xx.x aaa
   STR-I POS FLEX RH                    x.xxx
   STR-I NEG FLEX RH                    x.xxx
   STR-IP POS FLEX RH                   x.xxx
   STR-IP NEG FLEX RH                   x.xxx
   STR-II POS FLEX RH                   x.xxx
   STR-II NEG FLEX RH                   x.xxx
   SERV-II POS FLEX RH                  x.xxx
   SERV-II NEG FLEX RH                  x.xxx
   SERV-IIB POS FLEX RH                 x.xxx
   SERV-IIB NEG FLEX RH                 x.xxx

COMMAND:  SLB (left)
COMMAND:  SLB (right)
   EFFECTIVE SLAB THICKNESS     xxxxxxx.xxx aaaaaa
   EFFECTIVE SLAB WIDTH         xxxxxxx.xxx aaaaaa
   HAUNCH DEPTH                 xxxxxxx.xxx aaaaaa
   DECK REINFORCEMENT AREA      xxxxxxx.xxx aaaaaa
   DECK REINFORCEMENT CGS       xxxxxxx.xxx aaaaaa
   STEEL TO CONC. MOD. RATIO    xxxxxxx.xxx
```

```
COMMAND:  WSB
   Not available

COMMAND:  WBP
   Not available

COMMAND:  WSP
   Not available

COMMAND:  FSB
   Not available

COMMAND:  FSP
   Not available

COMMAND:  DRI
   STRENGTH DUCTIL. FACTOR             x.xxx
   STRENGTH REDUND. FACTOR             x.xxx
   STRENGTH IMPORT. FACTOR             x.xxx

COMMAND:  MIS
   SURFACE                     Not available
   WEB HOLE SIZE FACTOR        Not available
   WEB NOM. FAT. RES.          Not available
   TOP FLNG. NOM. FAT. RES.    Not available
   BOT. FLNG. NOM. FAT. RES.   Not available
   PENN. TRAFFIC FACTOR                x.xxx
   MIN. WEB BOLT TENSION       Not available
   MIN. TOP FLG. BOLT TENS.    Not available
   MIN. BOT. FLG. BOLT TENS.   Not available
   TOP FLG. HOLE SIZE FACTOR   Not available
   BOT FLG. HOLE SIZE FACTOR   Not available

COMMAND:  OIN
   Not available

COMMAND:  OSP
   Not available

COMMAND:  OCN
   Not available

COMMAND:  OAN
   Not available

COMMAND:  OSC
   Not available
```

```
                              NSBA SPLICE INPUT INFORMATION
                              -----------------------------

                           SPLICE LOCATION: Span ii, xxx.xxx ft
                           ------------------------------------
Unfactored Loads - Splice Centerline
------------------------------------
                                          Moment (kip*ft)  Shear (kip)
   Noncomposite Dead Load (DC1)              xxxxxxx.x       xxxxxx.xx
   Superimposed Composite Dead Load (DC2)    xxxxxxx.x       xxxxxx.xx
   Sidewalk Dead Load (DC2)                  xxxxxxx.x       xxxxxx.xx
   Future Wearing Surface (DW)               xxxxxxx.x       xxxxxx.xx
   Additional Future Wearing Surface (DW)    xxxxxxx.x       xxxxxx.xx
   Positive Live Load plus Impact            xxxxxxx.x       xxxxxx.xx aaaaaaaaaaaaaaaaaaaa
                                             xxxxxxx.x       xxxxxx.xx aaaaaaaaaaaaaaaaaaaa
   Negative Live Load plus Impact            xxxxxxx.x       xxxxxx.xx aaaaaaaaaaaaaaaaaaaa
                                             xxxxxxx.x       xxxxxx.xx aaaaaaaaaaaaaaaaaaaa
   Deck Casting (Cumulative)                 xxxxxxx.x       xxxxxx.xx Deck Pour ii

   NOTES:
     DC1 effects include unfactored effects from beam weight, deck and haunch weight,
       and user input DC1, DC1S, MC1, and UT1 loads.
     DC2 effects include unfactored effects from user input DC2, MC2, and UT2 loads.
       DW effects are from user input FWS only
     Deck Casting values are cumulative and include all DC1 effects, permanent deck pour
       effects up to and including the current deck pour, and temporary effects from
       current deck pour.

Girder Properties
-----------------
                                               Left      Right
   Top Flange Material (Fy, ksi)            xxxxxxx.x  xxxxxxx.x
   Top Flange Thickness (in)                xxxxx.xxx  xxxxx.xxx
   Top Flange Width (in)                    xxxxx.xxx  xxxxx.xxx

   Web Material (Fy, ksi)                   xxxxxxx.x  xxxxxxx.x
   Web Thickness (in)                       xxxxx.xxx  xxxxx.xxx
   Web Depth (in)                           xxxxx.xxx  xxxxx.xxx

   Bottom Flange Material (Fy, ksi)         xxxxxxx.x  xxxxxxx.x
   Bottom Flange Thickness (in)             xxxxx.xxx  xxxxx.xxx
   Bottom Flange Width (in)                 xxxxx.xxx  xxxxx.xxx

Haunch Properties
-----------------
   Haunch (in)                              xxxxx.xxx

   NOTES:
     Haunch is measured from top of web to bottom of slab.
     The value reported here is the largest of the top flange thickness (either left or
     right side) or the haunch input by the user.

Splice Plate Properties
-----------------------
   Not available

Bolt Properties
---------------
   Not available

Concrete Deck Properties
------------------------
   Composite                                Composite
   Thickness (effective, in)                xxxxx.xxx
```

```
Spacing and Clearance Values
----------------------------
   Bolt Spacing                              Not available
   Edge Distance - Flange (in)               Not available
   End Distance - Flange (in)                Not available
   Edge Distance - Web (in)                  Not available
   End Distance - Web (in)                   Not available
   Web Weld Size (in)                        xxxxx.xxx
   Web Weld Clearance (in)                   Not available
   Web Gap (in)                              Not available
   Entering & Tightening Clearance (in)      Not available

Miscellaneous Properties
------------------------
   Splice Plate Hole Method                  Not available
   Transverse stiffener spacing (do)(ft)     xxxxx.xxx
```

7.13 SPECIFICATION CHECK WARNINGS

This output table gives a summary of the titles of all output tables which contain a specification check warning. Even if a specification checking output table and/or an analysis point is not printed (i.e., if the user only desires output at 10th points or user-defined points only), the specification check is done, and if a warning occurs, the output table title will appear on this report **with a page number if the table is printed or N/P if the table is Not Printed. If this table has multiple warnings on multiple output pages, the output table title will appear twice, once with the first page having a warning and once with the last page having a warning**. This table prints for both design and analysis runs, and will still print, even if all other output is turned off.

The warnings are broken up according to live load vehicles. Warnings on tables which are live load independent (such as staging checks or shear connector checks) will be reported under the design vehicle warnings. A sample specification check warning table is shown in Figure 1.

```
LRFD Steel Girder Design and Rating, Version x.x.x.x                                     PAGE 224
Input File: STER019.DAT                                                          dd/mm/yyyy  08:23:16
---------------------------------------------------------------------------------------------------
            DETERMINE DEAD LOAD CAMBER BASED ON 114 INCH WEB DEPTH WITH END SPAN TAPER
                                  SUMMARY - SPECIFICATION CHECKS
---------------------------------------------------------------------------------------------------

                                   SPECIFICATION CHECK WARNINGS
                                   ----------------------------
        For the live loadings input by the user, the program encountered one or
        more specification check warnings. Specification check warnings indicate
        conditions that do not fail a specification check, but may need to be
        reviewed by the user. The following is a list of output table headings,
        listed separately for each live loading for which warnings have occurred.
        The page number is the output page number with the warning. If a table has
        multiple warnings, the second table heading is the last page with a warning.
        It should be noted that the program does not perform specification checking
        corresponding to commands that have not been input by the user.


PHL-93/P-82                                                                                    Page
-----------                                                                                    ----
*FACTORED ANALYSIS RESULTS - REACTIONS.......................................................  N/P
 COMPACTNESS CRITERIA........................................................................  497
 COMPACTNESS CRITERIA........................................................................  530

ML-80
-----
 COMPACTNESS CRITERIA........................................................................ 1292
 COMPACTNESS CRITERIA........................................................................ 1306

HS20
----
 COMPACTNESS CRITERIA........................................................................ 1588
 COMPACTNESS CRITERIA........................................................................ 1602

H20
---
 COMPACTNESS CRITERIA........................................................................ 1887
 COMPACTNESS CRITERIA........................................................................ 1901


    * - An asterisk indicates the table was not printed
```

Figure 7.13-1 Specification Check Warnings Page

7.14 SPECIFICATION CHECK FAILURES

This output table gives a summary of the titles of all output tables which contain a specification check failure. Even if a specification checking output table and/or an analysis point is not printed (i.e., if the user only desires output at 10th points or user-defined points only), the specification check is done, and if a failure occurs, the output table title will appear on this report **with a page number if the table is printed or N/P if the table is Not Printed. If this table has multiple failures on multiple output pages, the output table title will appear twice, once with the first page having a failure and once with the last page having a failure**. This table prints for both design and analysis runs, and will still print, even if all other output is turned off.

The failures are broken up according to live load vehicles. Failures on tables which are live load independent (such as staging checks or shear connector checks) will be reported under the design vehicle failures. A sample specification check failure table is shown in Figure 1.

```
LRFD Steel Girder Design and Rating, Version x.x.x.x                                    PAGE 225
Input File: STER019.DAT                                                       dd/mm/yyyy  08:23:16
--------------------------------------------------------------------------------------------------
            DETERMINE DEAD LOAD CAMBER BASED ON 114 INCH WEB DEPTH WITH END SPAN TAPE
                              SUMMARY - SPECIFICATION CHECKS (cont.)
--------------------------------------------------------------------------------------------------

                                   SPECIFICATION CHECK FAILURES
                                   ----------------------------
        For the live loadings input by the user, the program encountered one or
        more specification check failures. The following is a list of output table
        headings, listed separately for each live loading for which failures have
        occurred. The page number is the output page number with the failure. If a
        table has multiple failures, the second table heading is the last page with
        a failure. It should be noted that the program does not perform specification
        checking corresponding to commands that have not been input by the user.


PHL-93/P-82                                                                                  Page
-----------                                                                                  ----
 USER-INPUT BEARING STIFFENER ANALYSIS.........................................................  61
 LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE).....................  166
 LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE).....................  169
*REMAINING FATIGUE LIFE ESTIMATION.........................................................  N/P
 SHEAR CONNECTOR DESIGN - PITCH


ML-80
-----
 LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE).....................  342


HS20
----
 LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE).....................  441


H20
---
 LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE).....................  537



    * - An asterisk indicates the table was not printed
```

Figure 7.14-1 Specification Check Failures Page

7.15 BEARING STIFFENER DESIGN HISTORY FILE

This output file (named <output file name>.BDH) and the equivalent PDF output (named <output file name>-BDH.PDF) are automatically created for runs of the program that include a BSD (Bearing Stiffener Design) input command. This file has limited formatting and is intended only as a troubleshooting aid for the design of the stiffeners. As such, this file is not intended to become part of the final design calculations.

Partial BDH file sample output:

```
 ==================================================
 ==================================================
 BEGIN Bearing Stiffener Design at
Span 1 Location =    0.000  ft

 Max reaction, Vu =    397.1120      kips
     Fy,stiffener =    50.00000      ksi


 1. Minimum width of bearing stiffener
      bbot =        18.00 (in)
      tweb =       0.6875 (in)
      bmin = (bbot - tweb)/2  - 0.5 =         8.00 (in) (rounded down)

 2. Plate width for bearing resistance
      bbearing = bmin - 1.5" (BC-753M)=        6.50 (in)

 3. Projecting plate width
                   +-                    +-
                   | bmin                |        8.00
       bproj =  max | 2" +  5" (BC-754M) |        7.00 =         8.00 (in)
                   +-                    +-

 4. Bearing Resistance (A6.10.11.2.3)
       Vu   =       397.11 (kips)
       Phib =         1.00
       Fys  =        50.00 (ksi)
       npair =   1
      tbearing = Vu/(1.4 * 2 * Phib * bbearing * Fys * npair) =         0.44 (in)
```

8 EXAMPLE PROBLEMS

8.1 EXAMPLE PROBLEMS

This chapter contains the example problems used to test and verify this program. Table 1 shows the example problem matrix, which lists each example problem and the key input items used to differentiate the problems. For each example problem, the following information is given: a brief narrative description of the problem; sketches which show the deck cross section and span configuration; the input items from the example problem matrix; and additional assumptions and input items required to create the input data file. The actual input data file for each example problem is not listed in this manual but is included electronically along with the executable program.

Table 8.1-1   Example Problem Matrix

	Example Problem				
Input Item	**1**	**2**	**3**	**4**	**5**
Number of Spans	1	2	2	4	4
Span Lengths	65'	190' 190'	190' 190'	100' 120' 120' 100'	100' 120' 120' 100'
System of Units	US	US	US	US	US
Number of Deck Pours	N/A	3	N/A	N/A	N/A
Type of Beam	RB	PG	Built-up	PG	PG
Design/Analysis Indicator	A	A	A	A	A
Concrete Strength f_c'	4000 psi	4000 psi	4000 psi	4000 psi	4000 psi
Web Steel Strength F_{yw}	50 ksi	36 ksi	36 ksi	36 ksi	36 ksi
Flange Steel Strength F_{yw}	50 ksi	50 ksi	36 ksi	50 ksi	50 ksi
Cover Plates	Y	N/A	N/A	N/A	N/A
Composite/ Noncomposite	C	C	N	C	C
Slab Thickness S_t	9"	9"	9"	9-1/2"	9-1/2"
Effective Slab Thickness	8-1/2"	8-1/2"	9"	9"	9"
Girder Spacing	8'	8'	12'	12'	12'
Interior/Exterior Girder	I	I	E	I	I
Deck Overhang	N/A	N/A	3'-6"	N/A	N/A
Skew Angle	90°	60°	-80°	-80°	-80°
Live Load Type	LRFD	LRFD	SPECIAL VEHICLE	LRFD	LRFD
ADTT	MED	HIGH	LOW	HIGH	HIGH
Shear Connector	YES	YES	NO	YES	YES
Transverse Stiffener	NO	NO	NO	YES	YES
Longitudinal Stiffener	NO	NO	NO	YES	YES
Symmetry Option	NO	NO	NO	YES	NO
Wind Effects	NO	NO	YES	NO	NO
Fatigue Life Estimation	YES	NO	NO	NO	NO
Section Losses	NO	NO	NO	NO	NO
Fatigue Check, Reinforcement Bars	YES	YES	YES	YES	YES
Pedestrian Live Load	NO	NO	NO	NO	NO
Ratings	YES	YES	YES	YES	YES
Lateral Stresses	NO	NO	NO	NO	NO

Table 8.1-1 Example Problem Matrix (Continued)

	Example Problem					
Input Item	**6**	**7**	**8**	**9**	**10**	**11**
Number of Spans	3	6	1	1	2	3
Span Lengths	115' 165' 130'	122' 154' 154' (Symm.)	65'	160'	80' 80'	115' 165' 130'
System of Units	US	US	US	US	US	US
Number of Deck Pours	3	N/A	N/A	N/A	N/A	3
Type of Beam	PG	PG	RB	PG	RB	PG
Design/Analysis Indicator	A	A	D	D	A	A
Concrete Strength f_c'	4000 psi	4000 psi	4000 psi	4000 psi	4000 psi	4000 psi
Web Steel Strength F_{yw}	50 ksi	36 ksi	50 ksi	50 ksi	50 ksi	50 ksi
Flange Steel Strength F_{yw}	50 ksi	36 ksi	50 ksi	50 ksi	50 ksi	50 ksi
Cover Plates	N/A	N/A	N/A	N/A	N/A	N/A
Composite/ Noncomposite	C	C	C	C	C	C
Slab Thickness S_t	10"	9"	9"	10"	8-1/2"	10"
Effective Slab Thickness	9-1/2"	8-1/2"	8-1/2"	9-1/2"	8"	9-1/2"
Girder Spacing	15'	18'	8'	15'	8'	15'
Interior/Exterior Girder	E	E	I	I	I	E
Deck Overhang	5'	9'	N/A	4'-0"	N/A	5'
Skew Angle	90°	90°	-80°	-60°	-80°	-45°
Live Load Type	LRFD	LRFD	LRFD	LRFD	LRFD	LRFD
ADTT	HIGH	750	HIGH	HIGH	HIGH	HIGH
Shear Connector	YES	YES	YES	YES	YES	YES
Transverse Stiffener	YES	YES	NO	YES	NO	YES
Longitudinal Stiffener	NO	YES	NO	NO	NO	NO
Symmetry Option	NO	YES	YES	YES	NO	NO
Wind Effects	YES	YES	NO	NO	NO	YES
Fatigue Life Estimation	NO	NO	NO	NO	NO	NO
Section Losses	NO	YES	NO	NO	NO	NO
Fatigue Check, Reinforcement Bars	YES	YES	YES	YES	YES	YES
Pedestrian Live Load	NO	NO	NO	NO	YES	NO
Ratings	YES	YES	YES	YES	YES	YES
Lateral Stresses	NO	NO	NO	NO	NO	YES

8.2 EXAMPLE 1

Example 1 is a 65' simple span rolled beam analysis example. The rolled beam is an AISC standard W33x141 section having a 3/4"x14" bottom cover plate over midspan. The example assumes an interior beam with composite construction. A PHL-93 live loading is assumed with medium average daily truck traffic.

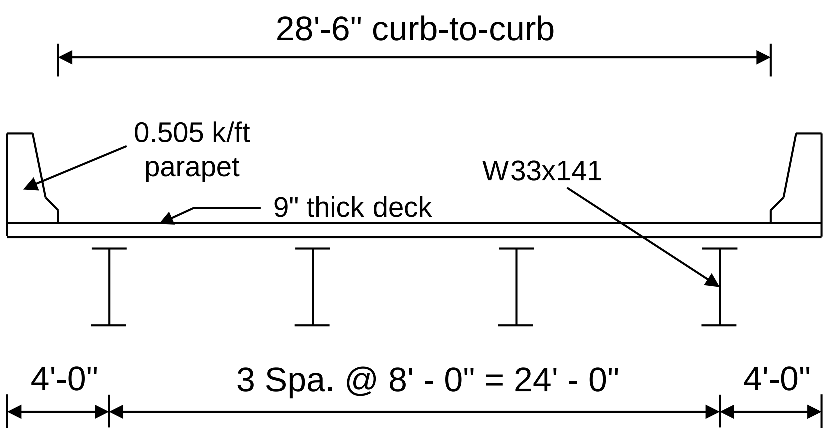

Figure 8.2-1 Example 1 Cross Section

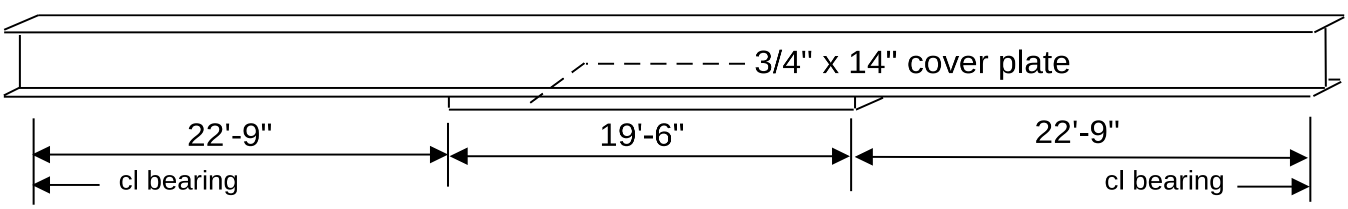

Figure 8.2-2 Example 1 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	ROLLED BEAM	INTERIOR	4	1	NO	NO	1700	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
A	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	N/A***

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

***NOTE: There are no defined deck pours in this input file (DPS command). This value will NOT be used and all uncured slab checks will be done.

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
8.000	N/A	NO	2		N/A	N/A	NO	4

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
N/A	N/A	N/A	N/A

SKEW ANGLES

Support	1	2
Angle (deg)	90.000	90.000
Apply skew	N	N

SPAN LENGTHS

Span No.	1
Length (ft)	65.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Rolled Beam Fy (ksi)	Rolled Beam Fu (ksi)	Cover Plate Top Fy (ksi)	Cover Plate Bottom Fy (ksi)
1	COMPOSITE	50.0	70.0	50.0	50.0

ROLLED BEAM DIMENSIONS, PART 1 of 2

Designation	Nominal Depth (in)	Nominal Weight (lbm/ft)	Moment of Inertia (in^4)	Area (in^2)
W33X141	33	141	7450.	41.50

ROLLED BEAM DIMENSIONS, PART 2 of 2

Designation	Flange Width (in)	Flange Thickness (in)	Beam Depth (in)	Web Thickness (in)	Distance "k" (in)
W33X141	11.500	0.9600	33.300	0.6050	1.6600

ROLLED BEAM PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	Rolled Beam Designat.	Top Cover Plate Width (in)	Top Cover Plate Thick. (in)	Bottom Cover Plate Width (in)	Bottom Cover Plate Thick. (in)
1	22.750	1			W 33x 141	0.0000	0.0000	0.0000	0.0000
1	42.250	1			W 33x 141	0.0000	0.0000	14.0000	0.7500
1	65.000	1			W 33x 141	0.0000	0.0000	0.0000	0.0000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

ROLLED BEAM PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
1	22.750	0.960	0.000	0.000
1	42.250	0.960	0.000	0.000
1	65.000	0.960	0.000	0.000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Loads (lbf/ft^3)	Concrete Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
9.000	8.500	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DISTRIBUTED LOADS (DC1)

Start Span No.	Span Dist. (ft)	End Span No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	65.000	0.120	0.120

DISTRIBUTED LOADS (DC2)

Start Span No.	Span Dist. (ft)	End Span No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	65.000	0.253	0.253

DISTRIBUTED LOADS (FWS)

Start Span No.	Span Dist. (ft)	End Span No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	65.000	0.214	0.214

FATIGUE LIFE

Year Built	Recent Count Year	Recent Count (ADTT)sl	Previous Count Year	Previous Count (ADTT)sl	Previous Growth Rate	Future Count Year	Future Count (ADTT)sl	Future Growth Rate
1969	1995	2000	1978	1675	0.010	2005	2230	0.011

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	42.250	0.000	E	0.000

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	1	65.000	21.667

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.3 EXAMPLE 2

Example 2 consists of a two-span continuous plate girder analysis example. The spans are identical, each with a length of 190' and four different cross-section types. The plate girder is an interior beam having a PennDOT skew angle of 60°. The example assumes composite construction with three deck pouring stages and checks fatigue stresses in the reinforcing steel. A PHL-93 live loading is assumed with high average daily truck traffic. Flexure and shear rating factors are also computed for this problem.

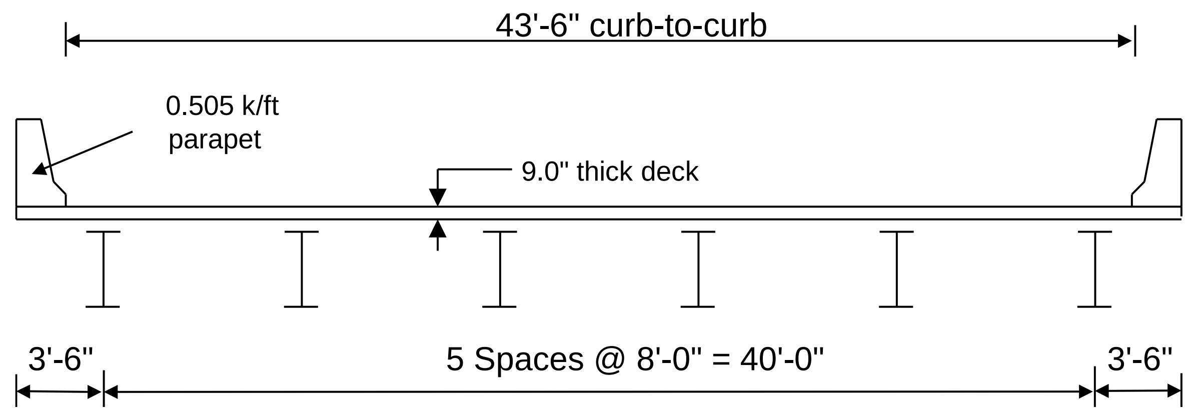

Figure 8.3-1 Example 2 Cross Section

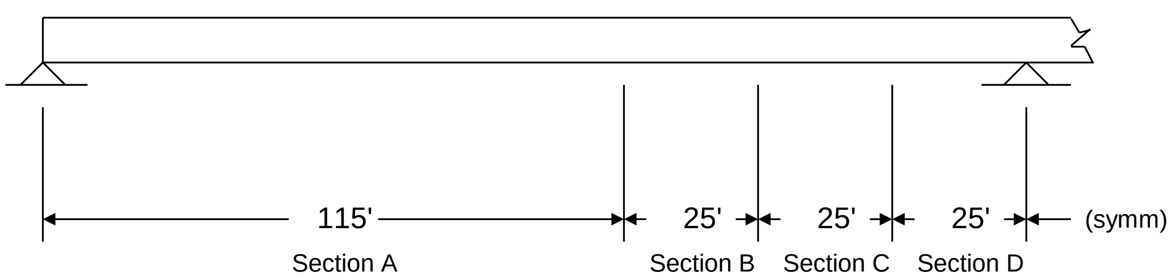

Figure 8.3-2 Example 2 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	PLATE GIRDER	INTERIOR	6	2	NO	NO	2338	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
A	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	NO

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
8.000	N/A	NO	3		N/A	N/A	NO	N/A

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
N/A	N/A	N/A	N/A

SKEW ANGLES

Support	1	2	3
Angle (deg)	60.000	60.000	60.000
Apply skew	N	N	N

SPAN LENGTHS

Span No.	1	2
Length (ft)	190.000	190.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Web Fy (ksi)	Flange Top Fy (ksi)	Flange Bottom Fy (ksi)	Plate Top Fu (ksi)	Plate Bottom Fu (ksi)	Classification Strength of Weld Metal (ksi)
1	COMPOSITE	36.0	50.0	50.0	70.0	70.0	70.0

PLATE GIRDER PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	VARY	Web Depth (in)	Web Thick. (in)	Top Plate Width (in)	Top Plate Thick. (in)	Bottom Plate Width (in)	Bottom Plate Thick. (in)
1	115.000	1				84.000	0.688	18.0000	0.7500	18.0000	2.0000
1	140.000	1				84.000	0.688	18.0000	1.3750	18.0000	1.2500
1	165.000	1				84.000	0.688	24.0000	1.3750	24.0000	1.2500
1	190.000	1				84.000	0.688	24.0000	2.0000	24.0000	2.0000
2	25.000	1				84.000	0.688	24.0000	2.0000	24.0000	2.0000
2	50.000	1				84.000	0.688	24.0000	1.3750	24.0000	1.2500
2	75.000	1				84.000	0.688	18.0000	1.3750	18.0000	1.2500
2	190.000	1				84.000	0.688	18.0000	0.7500	18.0000	2.0000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

PLATE GIRDER PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
1	115.000	3.250	0.775	4.250
1	140.000	3.875	0.775	4.250
1	165.000	3.875	0.775	4.250
1	190.000	4.500	0.775	4.250
2	25.000	4.500	0.775	4.250
2	50.000	3.875	0.775	4.250
2	75.000	3.875	0.775	4.250
2	190.000	3.250	0.775	4.250

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Density Loads (lbf/ft^3)	Concrete Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
9.000	8.500	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DECK POUR SEQUENCE

Pour No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)
2	1	0.000	1	70.000
1	1	70.000	1	140.000
3	1	140.000	2	50.000
1	2	50.000	2	120.000
2	2	120.000	2	190.000

DISTRIBUTED LOADS (DC1)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	190.000	0.130	0.130

DISTRIBUTED LOADS (DC2)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	190.000	0.252	0.252

DISTRIBUTED LOADS (FWS)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	190.000	0.218	0.218

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	165.000	0.000	C	0.000

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	2	190.000	19.000

BEARING STIFFENERS

Span No.	Span Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
1	0.000	W P	1	n/a	6.188	8.000
1	190.000	W P	1	n/a	n/a	11.000
2	190.000	W P	1	n/a	6.188	8.000

Span No.	Span Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	Classification Strength of Web-Stiffener Weld (ksi)
1	0.000	6.500	0.750	50.000	n/a	70.0
1	190.000	9.500	1.000	50.000	n/a	70.0
2	190.000	6.500	0.750	50.000	n/a	70.0

* Legend of Stiffener Types:
- W P Welded plate stiffener
- W A Welded angle stiffener
- B P Bolted plate stiffener
- B A Bolted angle stiffener

BEARING STIFFENER DESIGN

Minimum Number of Pairs	Stiffener Yield Strength (ksi)	Classification Strength of Web-Stiffener Weld (ksi)	Clearance (in)	Spacing Between Pairs (in)
1	50.0	70.0	6.188	*

* NOTE: If the CLEARANCE is left blank, the program will assume a clearance of 9*web thickness from the end of the beam to the face of the first bearing stiffener during design. If SPACING BETWEEN PAIRS is left blank, the program will assume a clear distance of 18*web thickness from face to face of adjacent stiffener pairs.

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.4 EXAMPLE 3

Example 3 is a two-span continuous built-up girder analysis example. The spans are identical, each with a length of 190' and 2 different cross-section types. The plate girder is an exterior beam having a PennDOT skew angle of −80°. The example assumes non composite construction. A special live load is assumed (ML-80 loading entered as a special load for this example) with low average daily truck traffic.

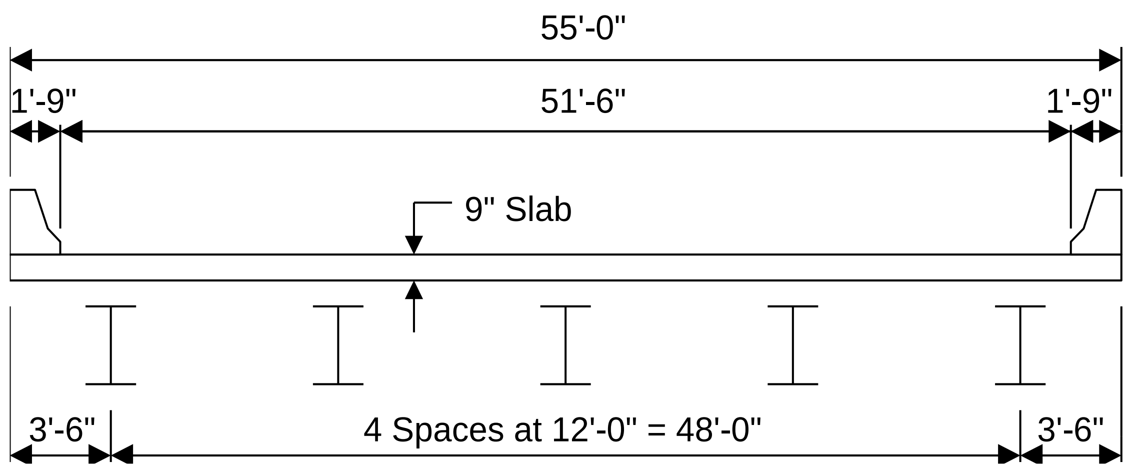

Figure 8.4-1 Example 3 Cross Section

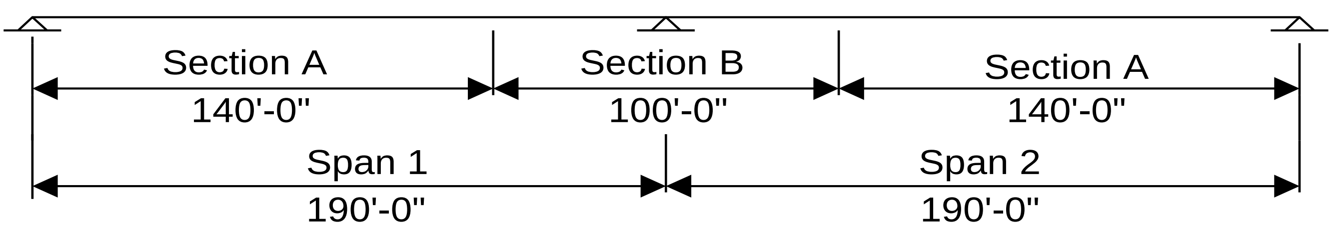

Figure 8.4-2 Example 3 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	BUILT-UP	EXTERIOR	5	2	NO	NO	800	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
E	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	N/A***

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

***NOTE: There are no defined deck pours in this input file (DPS command). This value will NOT be used and all uncured slab checks will be done.

STRUCTURE IDENTIFICATION

Program Identification	County	State Route	Segment	Offset	Span Identification
=STLRFD	12	3456	7890	1234	5678

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
12.000	3.500	NO	4	0.800	N/A	N/A	NO	N/A

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	48.000

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
-0.250	1.750	N/A	N/A

SKEW ANGLES

Support	1	2	3
Angle (deg)	-80.000	-80.000	-80.000
Apply skew	R	B	L

SPAN LENGTHS

Span No.	1	2
Length (ft)	190.000	190.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Web Fy (ksi)	Flange Top Fy (ksi)	Flange Bottom Fy (ksi)	Plate Top Fu (ksi)	Plate Bottom Fu (ksi)
1	NONCOMPOSITE	36.0	36.0	36.0	58.0	58.0

BUILT-UP PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	VARY	Angle Vert. Leg (in)	Angle Hort. Leg (in)	Angle Thick. (in)	Web Depth (in)	Web Thick. (in)
1	140.000	1				8.000	8.000	1.0000	84.000	0.688
2	50.000	1				8.000	8.000	1.0000	84.000	0.688
2	190.000	1				8.000	8.000	1.0000	84.000	0.688

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

BUILT-UP PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Top Plate Width (in)	Top Plate Thick. (in)	Bottom Plate Width (in)	Bottom Plate Thick. (in)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
1	140.000	24.0000	1.5000	24.0000	1.5000	1.500	0.000	0.000
2	50.000	24.0000	2.5000	24.0000	2.5000	2.500	0.000	0.000
2	190.000	24.0000	1.5000	24.0000	1.5000	1.500	0.000	0.000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Density Loads (lbf/ft^3)	Concrete Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
9.000	8.500	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DISTRIBUTED LOADS (DC1)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	190.000	0.158	0.158

DISTRIBUTED LOADS (DC2)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	190.000	0.202	0.202

DISTRIBUTED LOADS (FWS)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	190.000	0.309	0.309

WIND PROGRAM DEFINED

Additional Wind Cross Section (in)	Construction Load Path	Construction Wind Speed (mph)	Permanent Load Path	Permanent Structure Height (ft)	Permanent Wind Cond	Permanent Wind Speed (mph)	Construction Wind Pressure (ksf)	Wind Exposure Category	Design 3 Second Gust (mph)
36.000	F	N/A*	F	25.000	N/A	N/A	0.0050	D	115.000

NOTE: STLRFD no longer takes the CONSTRUCTION WIND SPEED as program input. Please enter the CONSTRUCTION WIND PRESSURE instead. See BD-620M and DM-4 C3.4.2.1 for information on how to calculate the CONSTRUCTION WIND PRESSURE.

SPECIAL LIVE LOADING

LL No.	Axle Effect	Lane Load (kip/ft)	Percentage Increase	Vehicle Type
1	Y	0.000	3.000	D

SPECIAL AXLE LOAD

LL No.	Axle Load (kip)	Spacing (ft)	Axle Load (kip)	Spacing (ft)	Axle Load (kip)	Spacing (ft)	Axle Load (kip)	Spacing (ft)
1	13.680	10.000	20.600	4.000	20.600	4.000	20.600	0.000

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	142.500	0.000	D	0.000

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	2	190.000	19.000

BEARING STIFFENERS

Span No.	Span Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
1	0.000	W P	1	n/a	6.188	7.000
1	190.000	W P	1	n/a	n/a	7.000
2	190.000	W P	1	n/a	6.188	7.000

Span No.	Span Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	Classification Strength of Web-Stiffener Weld (ksi)
1	0.000	6.000	0.875	36.000	n/a	70.0
1	190.000	6.000	0.875	36.000	n/a	70.0
2	190.000	6.000	0.875	36.000	n/a	70.0

* Legend of Stiffener Types:
- W P Welded plate stiffener
- W A Welded angle stiffener
- B P Bolted plate stiffener
- B A Bolted angle stiffener

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

```
    SYSTEM SETTINGS
    ---------------
  Steel     Construction
 Weight     Modular Ratio
(lbf/ft^3)
 490.00        11.000
```

8.5 EXAMPLE 4

Example 4 is a four-span continuous plate girder analysis example. The two outer spans each measure 100', while the two inner spans measure 120' each. The plate girder is an interior beam having a PennDOT skew angle of −80°. The example uses composite construction. A PHL-93 live loading is assumed with high average daily truck traffic. Longitudinal and transverse stiffeners are also assumed on this example. A fatigue life estimate of the fatigue details is done as is a fatigue check on the reinforcing steel. This example is identical to Example 5 except that this problem uses the symmetry option; therefore, only two spans are entered.

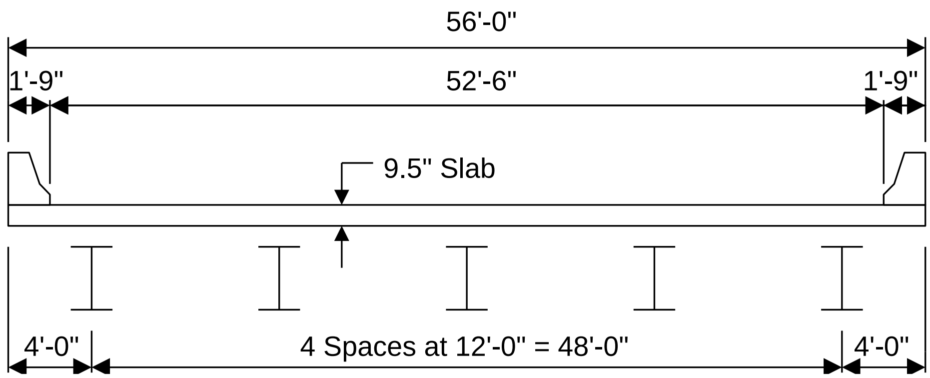

Figure 8.5-1 Example 4 Cross Section

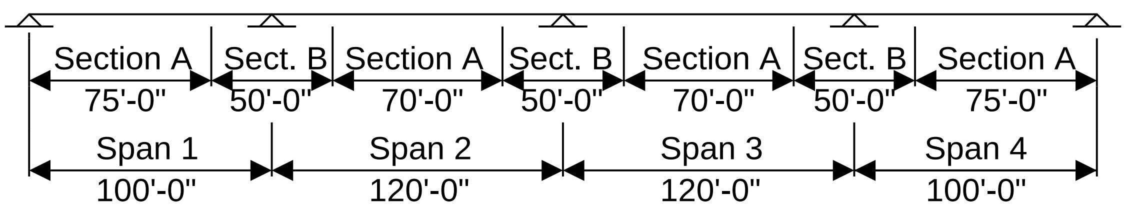

Figure 8.5-2 Example 4 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	PLATE GIRDER	INTERIOR	5	4	YES	NO	2975	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
A	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	N/A***

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

***NOTE: There are no defined deck pours in this input file (DPS command). This value will NOT be used and all uncured slab checks will be done.

SYMMETRICAL POINT

Span No.	Span Dist. (ft)
2	120.000

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
12.000	N/A	YES	4		N/A	N/A	NO	N/A

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
N/A	N/A	N/A	N/A

SKEW ANGLES

Support	1	2	3	4	5
Angle (deg)	-80.000	-80.000	-80.000	-80.000	-80.000
Apply skew	N	N	N	N	N

SPAN LENGTHS

Span No.	1	2	3	4
Length (ft)	100.000	120.000	120.000	100.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Web Fy (ksi)	Flange Top Fy (ksi)	Flange Bottom Fy (ksi)	Plate Top Fu (ksi)	Plate Bottom Fu (ksi)	Classification Strength of Weld Metal (ksi)
1	COMPOSITE	36.0	50.0	50.0	70.0	70.0	70.0

PLATE GIRDER PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	VARY	Web Depth (in)	Web Thick. (in)	Top Plate Width (in)	Top Plate Thick. (in)	Bottom Plate Width (in)	Bottom Plate Thick. (in)
1	75.000	1				66.000	0.625	16.0000	0.7500	16.0000	2.0000
2	25.000	1				66.000	0.625	20.0000	1.7500	20.0000	2.5000
2	95.000	1				66.000	0.625	16.0000	0.7500	16.0000	2.0000
2	120.000	1				66.000	0.625	20.0000	1.7500	20.0000	2.5000
3	25.000	1				66.000	0.625	20.0000	1.7500	20.0000	2.5000
3	95.000	1				66.000	0.625	16.0000	0.7500	16.0000	2.0000
4	25.000	1				66.000	0.625	20.0000	1.7500	20.0000	2.5000
4	100.000	1				66.000	0.625	16.0000	0.7500	16.0000	2.0000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

PLATE GIRDER PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
1	75.000	0.750	0.775	4.500
2	25.000	1.750	0.775	4.500
2	95.000	0.750	0.775	4.500
2	120.000	1.750	0.775	4.500
3	25.000	1.750	0.775	4.500
3	95.000	0.750	0.775	4.500
4	25.000	1.750	0.775	4.500
4	100.000	0.750	0.775	4.500

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Loads (lbf/ft^3)	Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
9.500	9.000	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DISTRIBUTED LOADS (DC1)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	120.000	0.195	0.195
3	0.000	4	100.000	0.195	0.195

DISTRIBUTED LOADS (DC2)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	120.000	0.202	0.202
3	0.000	4	100.000	0.202	0.202

DISTRIBUTED LOADS (FWS)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	2	120.000	0.315	0.315
3	0.000	4	100.000	0.315	0.315

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	40.000	0.000	C	0.000
4	60.000	0.000	C	0.000

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	2	120.000	20.000
3	0.000	4	100.000	20.000

TRANSVERSE STIFFENERS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Stiff. Type*	Stiff. Spacing (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Strength (ksi)	Web Leg Length (in)
1	0.000	1	4.000	P P	24.00	6.000	0.750	36.000	
1	4.000	1	9.250	P P	63.00	6.000	0.750	36.000	
1	9.250	1	100.000	P P	99.00	6.000	0.750	36.000	
2	0.000	2	57.750	P P	99.00	6.000	0.750	36.000	
2	57.750	2	62.250	P P	54.00	6.000	0.750	36.000	
2	62.250	2	120.000	P P	99.00	6.000	0.750	36.000	
3	0.000	3	57.750	P P	99.00	6.000	0.750	36.000	
3	57.750	3	62.250	P P	54.00	6.000	0.750	36.000	
3	62.250	4	0.000	P P	99.00	6.000	0.750	36.000	
4	0.000	4	90.750	P P	99.00	6.000	0.750	36.000	
4	90.750	4	96.000	P P	63.00	6.000	0.750	36.000	
4	96.000	4	100.000	P P	24.00	6.000	0.750	36.000	

* Legend of Stiffener Types:
- S P Single plate stiffener
- S A Single angle stiffener
- P P Pair of plate stiffeners
- P A Pair of angle stiffeners

LONGITUDINAL STIFFENERS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Stiff. Type*	Dist. from Flange** (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Str. (ksi)	Web Leg Length (in)
1	91.750	2	8.250	S P	12.150 B	5.250	0.500	36.00	
2	111.750	2	120.000	S P	12.150 B	5.250	0.500	36.00	
3	0.000	3	8.250	S P	12.150 B	5.250	0.500	36.00	
3	111.750	4	8.250	S P	12.150 B	5.250	0.500	36.00	

* Legend of Stiffener Types:
- S P Single plate stiffener
- S A Single angle stiffener
- P P Pair of plate stiffeners
- P A Pair of angle stiffeners

** Legend of Stiffener Locations:
- T Distance is measured from top flange
- B Distance is measured from bottom flange

BEARING STIFFENERS

Span No.	Span Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
1	0.000	W P	1	n/a	5.625	7.000
1	100.000	W P	1	n/a	n/a	7.000
2	120.000	W P	1	n/a	n/a	7.000
3	0.000	W P	1	n/a	n/a	7.000
4	0.000	W P	1	n/a	n/a	7.000
4	100.000	W P	1	n/a	5.625	7.000

Span No.	Span Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	Classification Strength of Web-Stiffener Weld (ksi)
1	0.000	6.000	1.250	36.000	n/a	70.0
1	100.000	6.000	1.250	36.000	n/a	70.0
2	120.000	6.000	1.250	36.000	n/a	70.0
3	0.000	6.000	1.250	36.000	n/a	70.0
4	0.000	6.000	1.250	36.000	n/a	70.0
4	100.000	6.000	1.250	36.000	n/a	70.0

* Legend of Stiffener Types:
W P Welded plate stiffener
W A Welded angle stiffener
B P Bolted plate stiffener
B A Bolted angle stiffener

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.6 EXAMPLE 5

Example 5 is a four-span continuous plate girder analysis example. The two outer spans each measure 100', while the two inner spans measure 120' each. This plate girder is an interior beam having a PennDOT skew angle of −80° using composite construction. A PHL-93 live loading is assumed with high average daily truck traffic. Longitudinal and transverse stiffeners are also assumed on this example. A fatigue life estimate of the fatigue details is done, as is a fatigue check on the reinforcing steel. This example is identical to Example 4 except that this problem does not use the symmetry option, so all four spans must be entered.

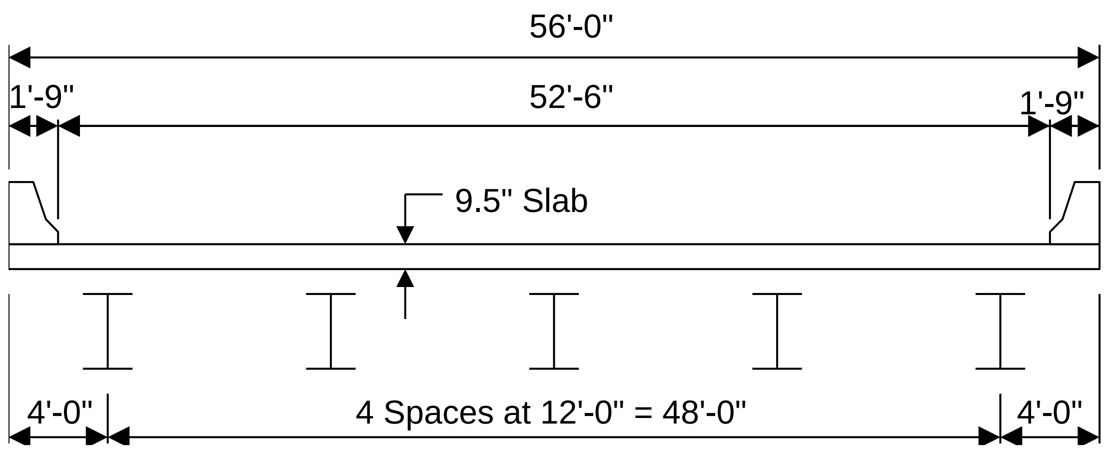

Figure 8.6-1 Example 5 Cross Section

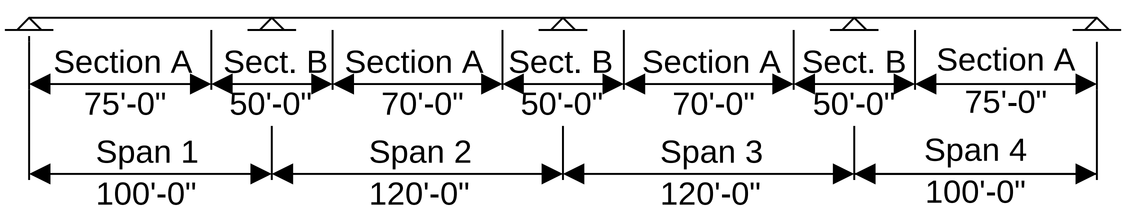

Figure 8.6-2 Example 5 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	PLATE GIRDER	INTERIOR	5	4	NO	NO	2975	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
A	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	N/A***

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

***NOTE: There are no defined deck pours in this input file (DPS command). This value will NOT be used and all uncured slab checks will be done.

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
12.000	N/A	YES	4		N/A	N/A	NO	N/A

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
N/A	N/A	N/A	N/A

SKEW ANGLES

Support	1	2	3	4	5
Angle (deg)	-80.000	-80.000	-80.000	-80.000	-80.000
Apply skew	N	N	N	N	N

SPAN LENGTHS

Span No.	1	2	3	4
Length (ft)	100.000	120.000	120.000	100.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Web Fy (ksi)	Flange Top Fy (ksi)	Flange Bottom Fy (ksi)	Plate Top Fu (ksi)	Plate Bottom Fu (ksi)	Classification Strength of Weld Metal (ksi)
1	COMPOSITE	36.0	50.0	50.0	70.0	70.0	70.0

PLATE GIRDER PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	VARY	Web Depth (in)	Web Thick. (in)	Top Plate Width (in)	Top Plate Thick. (in)	Bottom Plate Width (in)	Bottom Plate Thick. (in)
1	75.000	1				66.000	0.625	16.0000	0.7500	16.0000	2.0000
2	25.000	1				66.000	0.625	20.0000	1.7500	20.0000	2.5000
2	95.000	1				66.000	0.625	16.0000	0.7500	16.0000	2.0000
3	25.000	1				66.000	0.625	20.0000	1.7500	20.0000	2.5000
3	95.000	1				66.000	0.625	16.0000	0.7500	16.0000	2.0000
4	25.000	1				66.000	0.625	20.0000	1.7500	20.0000	2.5000
4	100.000	1				66.000	0.625	16.0000	0.7500	16.0000	2.0000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

PLATE GIRDER PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
1	75.000	0.750	0.775	4.500
2	25.000	1.750	0.775	4.500
2	95.000	0.750	0.775	4.500
3	25.000	1.750	0.775	4.500
3	95.000	0.750	0.775	4.500
4	25.000	1.750	0.775	4.500
4	100.000	0.750	0.775	4.500

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Loads (lbf/ft^3)	Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
9.500	9.000	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DISTRIBUTED LOADS (DC1)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	4	100.000	0.195	0.195

DISTRIBUTED LOADS (DC2)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	4	100.000	0.202	0.202

DISTRIBUTED LOADS (FWS)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	4	100.000	0.315	0.315

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	40.000	0.000	C	0.000

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	4	100.000	20.000

TRANSVERSE STIFFENERS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Stiff. Type*	Stiff. Spacing (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Strength (ksi)	Web Leg Length (in)
1	0.000	1	4.000	P P	24.00	6.000	0.750	36.000	
1	4.000	1	9.250	P P	63.00	6.000	0.750	36.000	
1	9.250	1	100.000	P P	99.00	6.000	0.750	36.000	
2	0.000	2	57.750	P P	99.00	6.000	0.750	36.000	
2	57.750	2	62.250	P P	54.00	6.000	0.750	36.000	
2	62.250	2	120.000	P P	99.00	6.000	0.750	36.000	
3	0.000	3	57.750	P P	99.00	6.000	0.750	36.000	
3	57.750	3	62.250	P P	54.00	6.000	0.750	36.000	
3	62.250	3	120.000	P P	99.00	6.000	0.750	36.000	
4	0.000	4	90.750	P P	99.00	6.000	0.750	36.000	
4	90.750	4	96.000	P P	63.00	6.000	0.750	36.000	
4	96.000	4	100.000	P P	24.00	6.000	0.750	36.000	

* Legend of Stiffener Types:
- S P Single plate stiffener
- S A Single angle stiffener
- P P Pair of plate stiffeners
- P A Pair of angle stiffeners

LONGITUDINAL STIFFENERS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Stiff. Type*	Dist. from Flange** (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Str. (ksi)	Web Leg Length (in)
1	91.750	2	8.250	S P	12.150 B	5.250	0.500	36.00	
2	111.750	3	8.250	S P	12.150 B	5.250	0.500	36.00	
3	111.750	4	8.250	S P	12.150 B	5.250	0.500	36.00	

* Legend of Stiffener Types:
- S P Single plate stiffener
- S A Single angle stiffener
- P P Pair of plate stiffeners
- P A Pair of angle stiffeners

** Legend of Stiffener Locations:
- T Distance is measured from top flange
- B Distance is measured from bottom flange

BEARING STIFFENERS

Span No.	Span Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
1	0.000	W P	1	n/a	5.625	7.000
1	100.000	W P	1	n/a	n/a	7.000
2	120.000	W P	1	n/a	n/a	7.000
3	120.000	W P	1	n/a	n/a	7.000
4	100.000	W P	1	n/a	5.625	7.000

Span No.	Span Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	Classification Strength of Web-Stiffener Weld (ksi)
1	0.000	6.000	1.250	36.000	n/a	70.0
1	100.000	6.000	1.250	36.000	n/a	70.0
2	120.000	6.000	1.250	36.000	n/a	70.0
3	120.000	6.000	1.250	36.000	n/a	70.0
4	100.000	6.000	1.250	36.000	n/a	70.0

* Legend of Stiffener Types:
- W P Welded plate stiffener
- W A Welded angle stiffener
- B P Bolted plate stiffener
- B A Bolted angle stiffener

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.7 EXAMPLE 6

Example 6 is a three-span continuous plate girder analysis example. The three spans are unequal with lengths of 115, 165 and 130 ft. The plate girder is an exterior beam with composite construction and three separate deck pouring stages. A PHL-93 live loading is assumed with high average daily truck traffic. Use of transverse stiffeners is also assumed, and a fatigue check of the reinforcing steel is done.

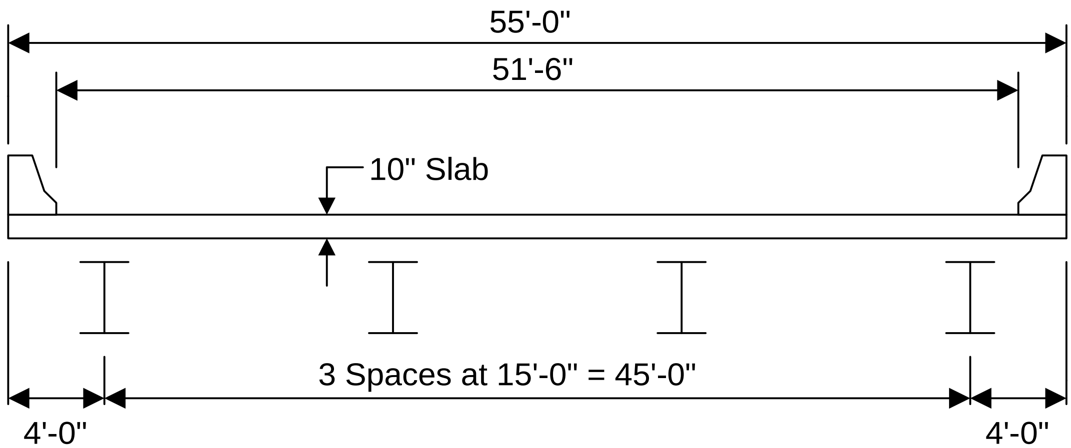

Figure 8.7-1 Example 6 Cross Section

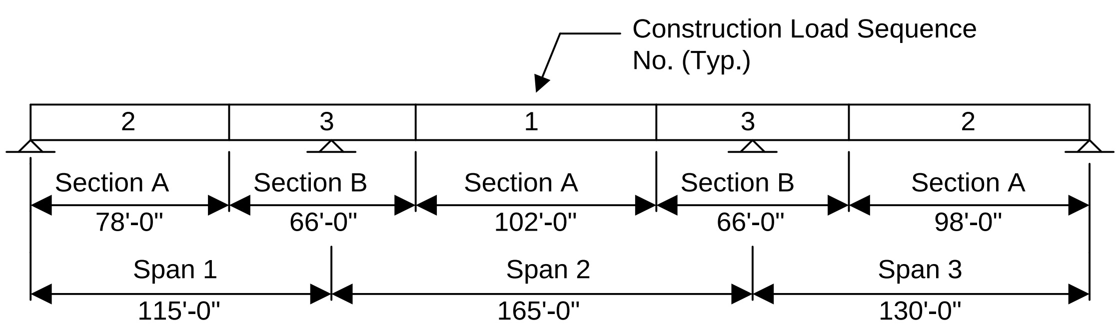

Figure 8.7-2 Example 6 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	PLATE GIRDER	EXTERIOR	4	3	NO	NO	2800	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
A	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	NO

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
15.000	5.000	YES	4		N/A	N/A	NO	4

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
1.250	3.250	N/A	N/A

SKEW ANGLES

Support	1	2	3	4
Angle (deg)	90.000	90.000	90.000	90.000
Apply skew	N	N	N	N

SPAN LENGTHS

Span No.	1	2	3
Length (ft)	115.000	165.000	130.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Web Fy (ksi)	Flange Top Fy (ksi)	Flange Bottom Fy (ksi)	Plate Top Fu (ksi)	Plate Bottom Fu (ksi)	Classification Strength of Weld Metal (ksi)
1	COMPOSITE	50.0	50.0	50.0	70.0	70.0	70.0

PLATE GIRDER PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	VARY	Web Depth (in)	Web Thick. (in)	Top Plate Width (in)	Top Plate Thick. (in)	Bottom Plate Width (in)	Bottom Plate Thick. (in)
1	78.000	1				90.000	0.875	18.0000	1.0000	18.0000	2.0000
2	30.000	1				90.000	0.875	24.0000	3.0000	24.0000	3.0000
2	130.000	1				90.000	0.875	18.0000	1.0000	18.0000	2.0000
3	33.000	1				90.000	0.875	24.0000	3.0000	24.0000	3.0000
3	130.000	1				90.000	0.875	18.0000	1.0000	18.0000	2.0000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

PLATE GIRDER PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
1	78.000	1.000	0.780	4.750
2	30.000	3.000	0.780	4.750
2	130.000	1.000	0.780	4.750
3	33.000	3.000	0.780	4.750
3	130.000	1.000	0.780	4.750

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Loads (lbf/ft^3)	Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
10.000	9.500	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DECK POUR SEQUENCE

Pour No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)
2	1	0.000	1	78.000
3	1	78.000	2	30.000
1	2	30.000	2	130.000
3	2	130.000	3	33.000
2	3	33.000	3	130.000

DECK POUR CONCENTRATED LOADS

Span No.	Span Dist. (ft)	Temporary (kips)	Permanent (kips)
2	33.000	18.000	0.000
3	33.000	0.000	5.620

DISTRIBUTED LOADS (DC1)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	130.000	0.203	0.203

DISTRIBUTED LOADS (DC2)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	130.000	0.253	0.253

DISTRIBUTED LOADS (FWS)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	130.000	0.387	0.387

WIND PROGRAM DEFINED

Additional Wind Cross Section (in)	Construction Load Path	Construction Wind Speed (mph)	Load Path	Permanent Structure Height (ft)	Permanent Wind Cond	Wind Speed (mph)	Construction Wind Pressure (ksf)	Wind Exposure Category	Design 3 Second Gust (mph)
12.000	L	N/A*	F	148.000	N/A	N/A	0.0050	D	115.000

NOTE: STLRFD no longer takes the CONSTRUCTION WIND SPEED as program input. Please enter the CONSTRUCTION WIND PRESSURE instead. See BD-620M and DM-4 C3.4.2.1 for information on how to calculate the CONSTRUCTION WIND PRESSURE.

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	78.000	0.000	B	0.000
2	30.000	0.000	B	0.000
2	130.000	0.000	B	0.000
3	33.000	0.000	B	0.000
2	165.000	96.000	C	0.000

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	3	120.000	16.000

TRANSVERSE STIFFENERS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Stiff. Type*	Stiff. Spacing (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Strength (ksi)	Web Leg Length (in)
1	0.000	1	6.000	P P	36.00	8.000	0.750	50.000	
1	6.000	1	111.000	P P	90.00	8.000	0.750	50.000	
2	0.000	2	164.000	P P	48.00	8.000	0.750	50.000	
3	0.000	3	60.000	P P	45.00	8.000	0.750	50.000	
3	60.000	3	127.500	P P	90.00	8.000	0.750	50.000	
3	127.500	3	130.000	P P	30.00	8.000	1.125	50.000	

* Legend of Stiffener Types:
- S P Single plate stiffener
- S A Single angle stiffener
- P P Pair of plate stiffeners
- P A Pair of angle stiffeners

BEARING STIFFENERS

Span No.	Span Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
1	0.000	W P	1	n/a	7.750	10.000
1	115.000	W P	1	n/a	n/a	10.000
2	165.000	W P	1	n/a	n/a	10.000
3	130.000	W P	1	n/a	7.750	10.000

Span No.	Span Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	Classification Strength of Web-Stiffener Weld (ksi)
1	0.000	8.830	1.125	50.000	n/a	70.0
1	115.000	8.830	1.125	50.000	n/a	70.0
2	165.000	8.830	1.125	50.000	n/a	70.0
3	130.000	8.830	1.125	50.000	n/a	70.0

* Legend of Stiffener Types:
- W P Welded plate stiffener
- W A Welded angle stiffener
- B P Bolted plate stiffener
- B A Bolted angle stiffener

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.8 EXAMPLE 7

Example 7 is a six-span continuous plate girder analysis example. The spans are 122', 154', 154', 154', 154', and 122' (symmetric). The plate girder is an exterior beam with parabolic depth variations near the supports and uses composite construction. A PHL-93 live loading is assumed with average daily truck traffic of 750. Longitudinal and transverse stiffeners are also assumed on this example. Two areas of section losses are also taken into account.

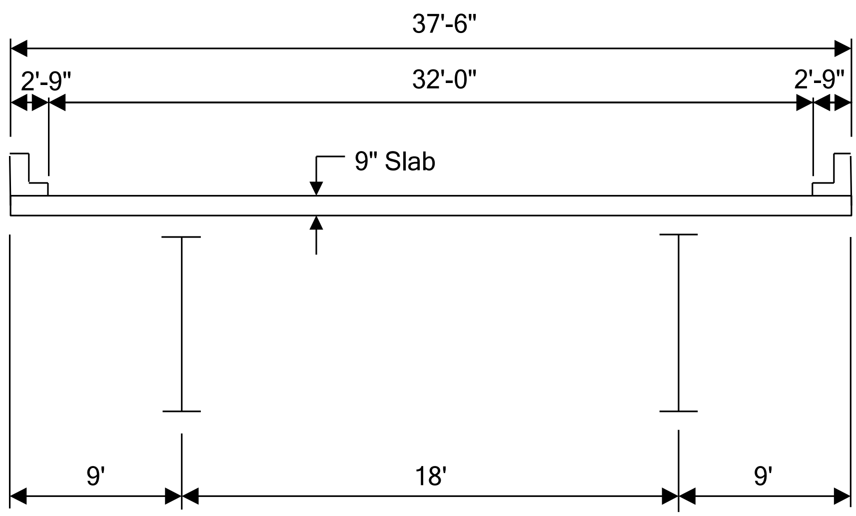

Figure 8.8-1 Example 7 Cross Section

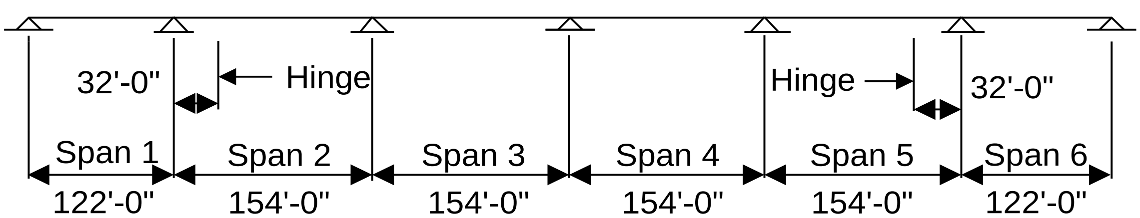

Figure 8.8-2 Example 7 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	PLATE GIRDER	EXTERIOR	2	6	YES	NO	750	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
A	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	N/A***

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

***NOTE: There are no defined deck pours in this input file (DPS command). This value will NOT be used and all uncured slab checks will be done.

SYMMETRICAL POINT

Span No.	Span Dist. (ft)
3	154.000

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
18.000	9.000	NO	2	1.000	N/A	N/A	NO	2

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	18.500

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
4.750	6.750	N/A	N/A

SKEW ANGLES

Support	1	2	3	4	5	6	7
Angle (deg)	90.000	90.000	90.000	90.000	90.000	90.000	90.000
Apply skew	N	N	N	N	N	N	N

SPAN LENGTHS

Span No.	1	2	3	4	5	6
Length (ft)	122.000	154.000	154.000	154.000	154.000	122.000

HINGE LOCATIONS

Span No.	2	5
Distance (ft)	32.000	122.000

USER-DEFINED ANALYSIS POINTS

Span No.	2	6
Distance (ft)	0.000	0.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Web Fy (ksi)	Flange Plate Top Fy (ksi)	Flange Plate Bottom Fy (ksi)	Flange Plate Top Fu (ksi)	Flange Plate Bottom Fu (ksi)	Classification Strength of Weld Metal (ksi)
1	COMPOSITE	36.0	36.0	36.0	58.0	58.0	70.0

PLATE GIRDER PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	VARY	Web Depth (in)	Web Thick. (in)	Top Plate Width (in)	Top Plate Thick. (in)	Bottom Plate Width (in)	Bottom Plate Thick. (in)
1	22.000	1				108.000	0.438	18.0000	1.1250	18.0000	1.1250
1	50.000	1				108.000	0.438	18.0000	1.6250	18.0000	1.6250
1	81.000	1	L			108.000	0.438	18.0000	1.6250	18.0000	1.6250
1	85.400	1	L		P	108.415	0.438	18.0000	1.6250	18.0000	1.6250
1	86.000	1			P	108.535	0.438	18.0000	1.6250	18.0000	1.6250
1	91.500	1			P	110.361	0.438	18.0000	1.6250	18.0000	1.6250
1	97.600	1			P	113.901	0.438	18.0000	1.6250	18.0000	1.6250
1	103.500	1			P	118.842	0.438	18.0000	1.6250	18.0000	1.6250
1	103.700	1			P	119.035	0.562	18.0000	1.6250	18.0000	1.6250
1	104.000	1			P	119.329	0.562	18.0000	1.6250	18.0000	1.6250
1	109.800	1			P	125.763	0.562	18.0000	1.6250	18.0000	1.6250
1	115.900	1			P	134.085	0.562	18.0000	1.6250	18.0000	1.6250
1	122.000	1			P	144.000	0.562	18.0000	1.6250	18.0000	1.6250
2	0.100	1	L		P	143.825	0.562	18.0000	1.6250	18.0000	1.6250
2	4.000	1	L		P	137.318	0.562	18.0000	1.6250	18.0000	1.6250
2	7.700	1	L		P	131.748	0.562	18.0000	1.6250	18.0000	1.6250
2	15.400	1			P	122.035	0.562	18.0000	1.6250	18.0000	1.6250
2	18.000	1			P	119.329	0.562	18.0000	1.6250	18.0000	1.6250
2	23.100	1			P	114.862	0.562	16.0000	0.7500	16.0000	0.7500
2	30.800	1			P	110.228	0.562	16.0000	0.7500	16.0000	0.7500
2	32.000	1			P	109.735	0.562	16.0000	0.7500	16.0000	0.7500
2	36.000	1			P	108.535	0.562	16.0000	0.7500	16.0000	0.7500
2	38.500	1			P	108.134	0.562	16.0000	0.7500	16.0000	0.7500
2	41.000	1			P	108.000	0.562	16.0000	0.7500	16.0000	0.7500
2	47.000	1				108.000	0.438	16.0000	0.7500	16.0000	0.7500
2	108.000	1				108.000	0.438	16.0000	1.3750	16.0000	1.3750
2	113.000	1				108.000	0.438	16.0000	0.7500	16.0000	0.7500
2	115.500	1			P	108.134	0.438	16.0000	0.7500	16.0000	0.7500
2	118.000	1			P	108.535	0.438	16.0000	0.7500	16.0000	0.7500
2	123.200	1			P	110.228	0.438	16.0000	0.7500	16.0000	0.7500
2	128.500	1			P	113.145	0.438	16.0000	0.7500	16.0000	0.7500
2	130.900	1			P	114.862	0.438	18.0000	1.8750	18.0000	1.8750
2	135.500	1			P	118.842	0.438	18.0000	1.8750	18.0000	1.8750
2	136.000	1			P	119.329	0.625	18.0000	1.8750	18.0000	1.8750
2	138.600	1			P	122.035	0.625	18.0000	1.8750	18.0000	1.8750

2	146.300	1	P	131.748	0.625	18.0000	1.8750	18.0000	1.8750
2	154.000	1	P	144.000	0.625	18.0000	1.8750	18.0000	1.8750
3	7.700	1	P	131.748	0.625	18.0000	1.8750	18.0000	1.8750
3	15.400	1	P	122.035	0.625	18.0000	1.8750	18.0000	1.8750
3	18.000	1	P	119.329	0.625	18.0000	1.8750	18.0000	1.8750
3	20.000	1	P	117.444	0.625	18.0000	1.8750	18.0000	1.8750
3	23.100	1	P	114.862	0.438	18.0000	1.8750	18.0000	1.8750
3	25.000	1	P	113.482	0.438	18.0000	1.8750	18.0000	1.8750
3	30.800	1	P	110.228	0.438	16.0000	0.7500	16.0000	0.7500
3	36.000	1	P	108.535	0.438	16.0000	0.7500	16.0000	0.7500
3	38.500	1	P	108.134	0.438	16.0000	0.7500	16.0000	0.7500
3	41.000	1	P	108.000	0.438	16.0000	0.7500	16.0000	0.7500
3	52.500	1		108.000	0.438	16.0000	0.7500	16.0000	0.7500
3	91.000	1		108.000	0.438	16.0000	1.2500	16.0000	1.2500
3	113.000	1		108.000	0.438	16.0000	0.7500	16.0000	0.7500
3	115.500	1	P	108.134	0.438	16.0000	0.7500	16.0000	0.7500
3	118.000	1	P	108.535	0.438	16.0000	0.7500	16.0000	0.7500
3	123.200	1	P	110.228	0.438	16.0000	0.7500	16.0000	0.7500
3	129.500	1	P	113.830	0.438	16.0000	0.7500	16.0000	0.7500
3	130.900	1	P	114.862	0.438	18.0000	1.8750	18.0000	1.8750
3	134.000	1	P	117.444	0.438	18.0000	1.8750	18.0000	1.8750
3	136.000	1	P	119.329	0.625	18.0000	1.8750	18.0000	1.8750
3	138.600	1	P	122.035	0.625	18.0000	1.8750	18.0000	1.8750
3	146.300	1	P	131.748	0.625	18.0000	1.8750	18.0000	1.8750
3	154.000	1	P	144.000	0.625	18.0000	1.8750	18.0000	1.8750
4	7.700	1	P	131.748	0.625	18.0000	1.8750	18.0000	1.8750
4	15.400	1	P	122.035	0.625	18.0000	1.8750	18.0000	1.8750
4	18.000	1	P	119.329	0.625	18.0000	1.8750	18.0000	1.8750
4	20.000	1	P	117.444	0.625	18.0000	1.8750	18.0000	1.8750
4	23.100	1	P	114.862	0.438	18.0000	1.8750	18.0000	1.8750
4	24.500	1	P	113.830	0.438	18.0000	1.8750	18.0000	1.8750
4	30.800	1	P	110.228	0.438	16.0000	0.7500	16.0000	0.7500
4	36.000	1	P	108.535	0.438	16.0000	0.7500	16.0000	0.7500
4	38.500	1	P	108.134	0.438	16.0000	0.7500	16.0000	0.7500
4	41.000	1	P	108.000	0.438	16.0000	0.7500	16.0000	0.7500
4	63.000	1		108.000	0.438	16.0000	0.7500	16.0000	0.7500
4	101.500	1		108.000	0.438	16.0000	1.2500	16.0000	1.2500
4	113.000	1		108.000	0.438	16.0000	0.7500	16.0000	0.7500
4	115.500	1	P	108.134	0.438	16.0000	0.7500	16.0000	0.7500
4	118.000	1	P	108.535	0.438	16.0000	0.7500	16.0000	0.7500
4	123.200	1	P	110.228	0.438	16.0000	0.7500	16.0000	0.7500
4	129.000	1	P	113.482	0.438	16.0000	0.7500	16.0000	0.7500
4	130.900	1	P	114.862	0.438	18.0000	1.8750	18.0000	1.8750
4	134.000	1	P	117.444	0.438	18.0000	1.8750	18.0000	1.8750
4	136.000	1	P	119.329	0.625	18.0000	1.8750	18.0000	1.8750
4	138.600	1	P	122.035	0.625	18.0000	1.8750	18.0000	1.8750
4	146.300	1	P	131.748	0.625	18.0000	1.8750	18.0000	1.8750
5	0.000	1	P	144.000	0.625	18.0000	1.8750	18.0000	1.8750
5	7.700	1	P	131.748	0.625	18.0000	1.8750	18.0000	1.8750
5	15.400	1	P	122.035	0.625	18.0000	1.8750	18.0000	1.8750
5	18.000	1	P	119.329	0.625	18.0000	1.8750	18.0000	1.8750
5	18.500	1	P	118.842	0.625	18.0000	1.8750	18.0000	1.8750
5	23.100	1	P	114.862	0.438	18.0000	1.8750	18.0000	1.8750
5	25.500	1	P	113.145	0.438	18.0000	1.8750	18.0000	1.8750
5	30.800	1	P	110.228	0.438	16.0000	0.7500	16.0000	0.7500
5	36.000	1	P	108.535	0.438	16.0000	0.7500	16.0000	0.7500
5	38.500	1	P	108.134	0.438	16.0000	0.7500	16.0000	0.7500
5	41.000	1	P	108.000	0.438	16.0000	0.7500	16.0000	0.7500
5	46.000	1		108.000	0.438	16.0000	0.7500	16.0000	0.7500
5	107.000	1		108.000	0.438	16.0000	1.3750	16.0000	1.3750

5	113.000	1			108.000	0.438	16.0000	0.7500	16.0000	0.7500
5	115.500	1		P	108.134	0.562	16.0000	0.7500	16.0000	0.7500
5	118.000	1		P	108.535	0.562	16.0000	0.7500	16.0000	0.7500
5	122.000	1		P	109.735	0.562	16.0000	0.7500	16.0000	0.7500
5	123.200	1		P	110.228	0.562	16.0000	0.7500	16.0000	0.7500
5	130.900	1		P	114.862	0.562	16.0000	0.7500	16.0000	0.7500
5	136.000	1		P	119.329	0.562	16.0000	0.7500	16.0000	0.7500
5	138.600	1		P	122.035	0.562	18.0000	1.6250	18.0000	1.6250
5	146.300	1		P	131.748	0.562	18.0000	1.6250	18.0000	1.6250
5	150.000	1	L	P	137.318	0.562	18.0000	1.6250	18.0000	1.6250
5	153.900	1	L	P	143.825	0.562	18.0000	1.6250	18.0000	1.6250
6	0.000	1	L	P	144.000	0.562	18.0000	1.6250	18.0000	1.6250
6	6.100	1		P	134.085	0.562	18.0000	1.6250	18.0000	1.6250
6	12.200	1		P	125.763	0.562	18.0000	1.6250	18.0000	1.6250
6	18.000	1		P	119.329	0.562	18.0000	1.6250	18.0000	1.6250
6	18.300	1		P	119.035	0.562	18.0000	1.6250	18.0000	1.6250
6	18.500	1		P	118.842	0.562	18.0000	1.6250	18.0000	1.6250
6	24.400	1		P	113.901	0.438	18.0000	1.6250	18.0000	1.6250
6	30.500	1		P	110.361	0.438	18.0000	1.6250	18.0000	1.6250
6	36.000	1		P	108.535	0.438	18.0000	1.6250	18.0000	1.6250
6	36.600	1		P	108.415	0.438	18.0000	1.6250	18.0000	1.6250
6	41.000	1	L	P	108.000	0.438	18.0000	1.6250	18.0000	1.6250
6	72.000	1	L		108.000	0.438	18.0000	1.6250	18.0000	1.6250
6	100.000	1			108.000	0.438	18.0000	1.6250	18.0000	1.6250
6	122.000	1			108.000	0.438	18.0000	1.1250	18.0000	1.1250

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

PLATE GIRDER PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
1	22.000	1.125	0.750	4.250
1	50.000	1.625	0.750	4.250
1	81.000	1.625	0.750	4.250
1	85.400	1.625	0.750	4.250
1	86.000	1.625	0.750	4.250
1	91.500	1.625	0.750	4.250
1	97.600	1.625	0.750	4.250
1	103.500	1.625	0.750	4.250
1	103.700	1.625	0.750	4.250
1	104.000	1.625	0.750	4.250
1	109.800	1.625	0.750	4.250
1	115.900	1.625	0.750	4.250
1	122.000	1.625	0.750	4.250
2	0.100	1.625	0.750	4.250
2	4.000	1.625	0.750	4.250
2	7.700	1.625	0.750	4.250
2	15.400	1.625	0.750	4.250
2	18.000	1.625	0.750	4.250
2	23.100	0.750	0.750	4.250
2	30.800	0.750	0.750	4.250
2	32.000	0.750	0.750	4.250
2	36.000	0.750	0.750	4.250
2	38.500	0.750	0.750	4.250
2	41.000	0.750	0.750	4.250
2	47.000	0.750	0.750	4.250

2	108.000	1.375	0.750	4.250
2	113.000	0.750	0.750	4.250
2	115.500	0.750	0.750	4.250
2	118.000	0.750	0.750	4.250
2	123.200	0.750	0.750	4.250
2	128.500	0.750	0.750	4.250
2	130.900	1.875	0.750	4.250
2	135.500	1.875	0.750	4.250
2	136.000	1.875	0.750	4.250
2	138.600	1.875	0.750	4.250
2	146.300	1.875	0.750	4.250
2	154.000	1.875	0.750	4.250
3	7.700	1.875	0.750	4.250
3	15.400	1.875	0.750	4.250
3	18.000	1.875	0.750	4.250
3	20.000	1.875	0.750	4.250
3	23.100	1.875	0.750	4.250
3	25.000	1.875	0.750	4.250
3	30.800	0.750	0.750	4.250
3	36.000	0.750	0.750	4.250
3	38.500	0.750	0.750	4.250
3	41.000	0.750	0.750	4.250
3	52.500	0.750	0.750	4.250
3	91.000	1.250	0.750	4.250
3	113.000	0.750	0.750	4.250
3	115.500	0.750	0.750	4.250
3	118.000	0.750	0.750	4.250
3	123.200	0.750	0.750	4.250
3	129.500	0.750	0.750	4.250
3	130.900	1.875	0.750	4.250
3	134.000	1.875	0.750	4.250
3	136.000	1.875	0.750	4.250
3	138.600	1.875	0.750	4.250
3	146.300	1.875	0.750	4.250
3	154.000	1.875	0.750	4.250
4	7.700	1.875	0.750	4.250
4	15.400	1.875	0.750	4.250
4	18.000	1.875	0.750	4.250
4	20.000	1.875	0.750	4.250
4	23.100	1.875	0.750	4.250
4	24.500	1.875	0.750	4.250
4	30.800	0.750	0.750	4.250
4	36.000	0.750	0.750	4.250
4	38.500	0.750	0.750	4.250
4	41.000	0.750	0.750	4.250
4	63.000	0.750	0.750	4.250
4	101.500	1.250	0.750	4.250
4	113.000	0.750	0.750	4.250
4	115.500	0.750	0.750	4.250
4	118.000	0.750	0.750	4.250
4	123.200	0.750	0.750	4.250
4	129.000	0.750	0.750	4.250
4	130.900	1.875	0.750	4.250
4	134.000	1.875	0.750	4.250
4	136.000	1.875	0.750	4.250
4	138.600	1.875	0.750	4.250
4	146.300	1.875	0.750	4.250
5	0.000	1.875	0.750	4.250
5	7.700	1.875	0.750	4.250
5	15.400	1.875	0.750	4.250

5	18.000	1.875	0.750	4.250
5	18.500	1.875	0.750	4.250
5	23.100	1.875	0.750	4.250
5	25.500	1.875	0.750	4.250
5	30.800	0.750	0.750	4.250
5	36.000	0.750	0.750	4.250
5	38.500	0.750	0.750	4.250
5	41.000	0.750	0.750	4.250
5	46.000	0.750	0.750	4.250
5	107.000	1.375	0.750	4.250
5	113.000	0.750	0.750	4.250
5	115.500	0.750	0.750	4.250
5	118.000	0.750	0.750	4.250
5	122.000	0.750	0.750	4.250
5	123.200	0.750	0.750	4.250
5	130.900	0.750	0.750	4.250
5	136.000	0.750	0.750	4.250
5	138.600	1.625	0.750	4.250
5	146.300	1.625	0.750	4.250
5	150.000	1.625	0.750	4.250
5	153.900	1.625	0.750	4.250
6	0.000	1.625	0.750	4.250
6	6.100	1.625	0.750	4.250
6	12.200	1.625	0.750	4.250
6	18.000	1.625	0.750	4.250
6	18.300	1.625	0.750	4.250
6	18.500	1.625	0.750	4.250
6	24.400	1.625	0.750	4.250
6	30.500	1.625	0.750	4.250
6	36.000	1.625	0.750	4.250
6	36.600	1.625	0.750	4.250
6	41.000	1.625	0.750	4.250
6	72.000	1.625	0.750	4.250
6	100.000	1.625	0.750	4.250
6	122.000	1.125	0.750	4.250

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SECTION LOSSES

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Loss Type	Location	Distance (in)	Width (in)	Thick. (in)
1	50.000	1	81.000	Bottom Plate	Bottom	0.000	18.000	0.5000
1	81.000	1	85.400	Bottom Plate	Bottom	0.000	18.000	0.5000
2	0.000	2	0.100	Web	Right	6.000	12.000	0.2500
2	0.100	2	4.000	Web	Right	6.000	12.000	0.2500
2	4.000	2	7.700	Web	Right	6.000	12.000	0.2500
5	146.300	5	150.000	Web	Right	6.000	12.000	0.2500
5	150.000	5	153.900	Web	Right	6.000	12.000	0.2500
5	153.900	6	0.000	Web	Right	6.000	12.000	0.2500
6	36.600	6	41.000	Bottom Plate	Bottom	0.000	18.000	0.5000
6	41.000	6	72.000	Bottom Plate	Bottom	0.000	18.000	0.5000

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Loads (lbf/ft^3)	Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
9.000	8.500	4.000	150.00	145.00	50.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DISTRIBUTED LOADS (DC1)

Start Span No.	Dist. (ft)	End Span No.	Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	154.000	0.296	0.296
4	0.000	6	122.000	0.296	0.296

DISTRIBUTED LOADS (DC2)

Start Span No.	Dist. (ft)	End Span No.	Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	154.000	0.586	0.586
4	0.000	6	122.000	0.586	0.586

DISTRIBUTED LOADS (FWS)

Start Span No.	Dist. (ft)	End Span No.	Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	154.000	0.480	0.480
4	0.000	6	122.000	0.480	0.480

WIND PROGRAM DEFINED

Additional Wind Cross Section (in)	Construction Load Path	Construction Wind Speed (mph)	Permanent Load Path	Permanent Structure Height (ft)	Permanent Wind Cond	Permanent Wind Speed (mph)	Construction Wind Pressure (ksf)	Wind Exposure Category	Design 3 Second Gust (mph)
36.000	F	N/A*	F	25.000	N/A	N/A	0.0050	D	115.000

NOTE: STLRFD no longer takes the CONSTRUCTION WIND SPEED as program input. Please enter the CONSTRUCTION WIND PRESSURE instead. See BD-620M and DM-4 C3.4.2.1 for information on how to calculate the CONSTRUCTION WIND PRESSURE.

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	54.900	1.625	B	0.000
6	67.100	1.625	B	0.000

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	1	14.000	14.000
1	14.000	1	122.000	18.000
2	0.000	2	72.000	18.000
2	72.000	2	82.000	10.000
2	82.000	2	154.000	18.000
3	0.000	3	72.000	18.000
3	72.000	3	82.000	10.000
3	82.000	3	154.000	18.000
4	0.000	4	72.000	18.000
4	72.000	4	82.000	10.000
4	82.000	5	0.000	18.000
5	0.000	5	72.000	18.000
5	72.000	5	82.000	10.000
5	82.000	6	0.000	18.000
6	0.000	6	108.000	18.000
6	108.000	6	122.000	14.000

TRANSVERSE STIFFENERS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Stiff. Type*	Stiff. Spacing (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Strength (ksi)	Web Leg Length (in)
1	0.000	1	4.500	P P	54.00	9.000	0.750	36.000	
1	4.500	1	14.000	P P	57.00	9.000	0.750	36.000	
1	14.000	1	122.000	P P	108.00	9.000	0.750	36.000	
2	0.000	2	72.000	P P	108.00	9.000	0.875	36.000	
2	72.000	2	82.000	P P	60.00	9.000	0.750	36.000	
2	82.000	2	154.000	P P	108.00	9.000	0.750	36.000	
3	0.000	3	72.000	P P	108.00	9.000	0.750	36.000	
3	72.000	3	82.000	P P	60.00	9.000	0.750	36.000	
3	82.000	3	154.000	P P	108.00	9.000	0.750	36.000	
4	0.000	4	72.000	P P	108.00	9.000	0.750	36.000	
4	72.000	4	82.000	P P	60.00	9.000	0.750	36.000	
4	82.000	5	0.000	P P	108.00	9.000	0.750	36.000	
5	0.000	5	72.000	P P	108.00	9.000	0.750	36.000	
5	72.000	5	82.000	P P	60.00	9.000	0.750	36.000	
5	82.000	6	0.000	P P	108.00	9.000	0.875	36.000	
6	0.000	6	108.000	P P	108.00	9.000	0.750	36.000	
6	108.000	6	117.500	P P	57.00	9.000	0.750	36.000	
6	117.500	6	122.000	P P	54.00	9.000	0.750	36.000	

* Legend of Stiffener Types:
- S P Single plate stiffener
- S A Single angle stiffener
- P P Pair of plate stiffeners
- P A Pair of angle stiffeners

LONGITUDINAL STIFFENERS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Stiff. Type*	Dist. from Flange** (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Str. (ksi)	Web Leg Length (in)
1	113.000	2	9.000	S P	30.450 B	7.000	0.625	36.00	
2	145.000	3	9.000	S P	30.450 B	7.000	0.625	36.00	
3	145.000	3	154.000	S P	30.450 B	7.000	0.625	36.00	
4	0.000	4	9.000	S P	30.450 B	7.000	0.625	36.00	
4	145.000	5	9.000	S P	30.450 B	7.000	0.625	36.00	
5	145.000	6	9.000	S P	30.450 B	7.000	0.625	36.00	

* Legend of Stiffener Types:
- S P Single plate stiffener
- S A Single angle stiffener
- P P Pair of plate stiffeners
- P A Pair of angle stiffeners

** Legend of Stiffener Locations:
- T   Distance is measured from top flange
- B   Distance is measured from bottom flange

BEARING STIFFENERS

Span No.	Span Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
1	0.000	W P	1	n/a	5.063	7.000
1	122.000	W P	1	n/a	n/a	7.000
2	154.000	W P	1	n/a	n/a	7.000
3	154.000	W P	1	n/a	n/a	7.000
4	0.000	W P	1	n/a	n/a	7.000
5	0.000	W P	1	n/a	n/a	7.000
6	0.000	W P	1	n/a	n/a	7.000
6	122.000	W P	1	n/a	5.063	7.000

Span No.	Span Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	Classification Strength of Web-Stiffener Weld (ksi)
1	0.000	6.000	1.250	36.000	n/a	70.0
1	122.000	6.000	1.250	36.000	n/a	70.0
2	154.000	6.000	1.250	36.000	n/a	70.0
3	154.000	6.000	1.250	36.000	n/a	70.0
4	0.000	6.000	1.250	36.000	n/a	70.0
5	0.000	6.000	1.250	36.000	n/a	70.0
6	0.000	6.000	1.250	36.000	n/a	70.0
6	122.000	6.000	1.250	36.000	n/a	70.0

* Legend of Stiffener Types:
- W P Welded plate stiffener
- W A Welded angle stiffener
- B P Bolted plate stiffener
- B A Bolted angle stiffener

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.9 EXAMPLE 8

Example 8 is a simple span continuous rolled beam optimization example. The span is 65 ft long for an interior rolled beam. The example assumes composite construction with a PennDOT skew angle of −80°. A PHL-93 live loading is assumed with high average daily truck traffic.

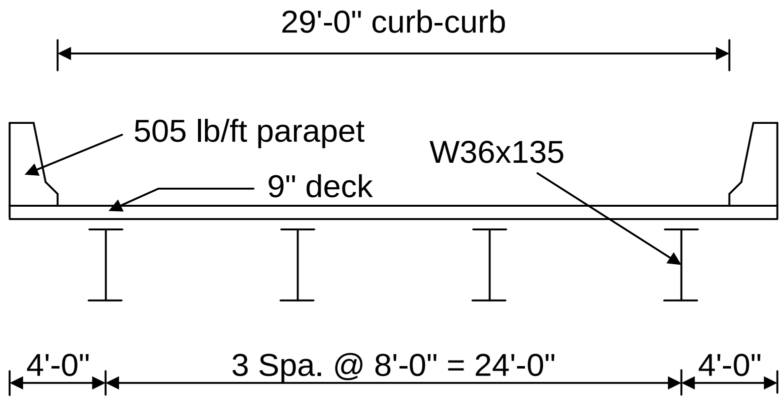

Figure 8.9-1 Example 8 Cross Section

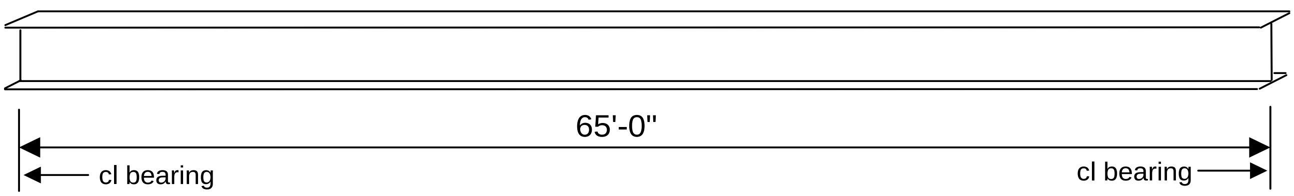

Figure 8.9-2 Example 8 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	DESIGN	ROLLED BEAM	INTERIOR	4	1	YES		3400	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
E	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	N/A***

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

***NOTE: This value is not used for design runs. Uncured slab checks are always done for design runs.

SYMMETRICAL POINT

Span No.	Span Dist. (ft)
1	32.500

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
8.000	N/A	NO	2		N/A	N/A	NO	4

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
N/A	N/A	N/A	N/A

SKEW ANGLES

Support	1	2
Angle (deg)	-80.000	-80.000
Apply skew	N	N

SPAN LENGTHS

Span No.	1
Length (ft)	65.000

DESIGN - ROLLED BEAM

Max. Defl. (in)	Max. Defl. w/Ped. (in)	Noncomposite/ Composite	Rolled Beam Fy (ksi)	Rolled Beam Fu (ksi)	Beam Depth Minimum (in)	Beam Depth Maximum (in)	Haunch Depth (in)
1.00		COMPOSITE	50.00	70.00	18.00	45.00	0.00

Reinforcement Area (in^2/ft)	Reinforcement C.G. Distance (in)	Span-to-Depth Check	Design Method	Section 6.10.3.4.2 Check
0.000	0.00	NO	WEIGHT	N/A

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Loads (lbf/ft^3)	Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
9.000	8.500	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DISTRIBUTED LOADS (DC1)

Start Span No.	Start Dist. (ft)	End Span No.	End Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	32.500	0.120	0.120
1	32.500	1	65.000	0.120	0.120

DISTRIBUTED LOADS (DC2)

Start Span No.	Start Dist. (ft)	End Span No.	End Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	32.500	0.253	0.253
1	32.500	1	65.000	0.253	0.253

DISTRIBUTED LOADS (FWS)

Start Span No.	Start Dist. (ft)	End Span No.	End Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	32.500	0.219	0.219
1	32.500	1	65.000	0.219	0.219

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	1	65.000	21.667

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF DESIGN TRIALS

Design Trials	Final Design
1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	0

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.10 EXAMPLE 9

Example 9 is a simple span plate girder optimization example. The span is a 160' interior plate girder. The example uses composite construction, a PennDOT skew angle of −60°, and transverse stiffeners. A PHL-93 live loading is assumed with high average daily truck traffic.

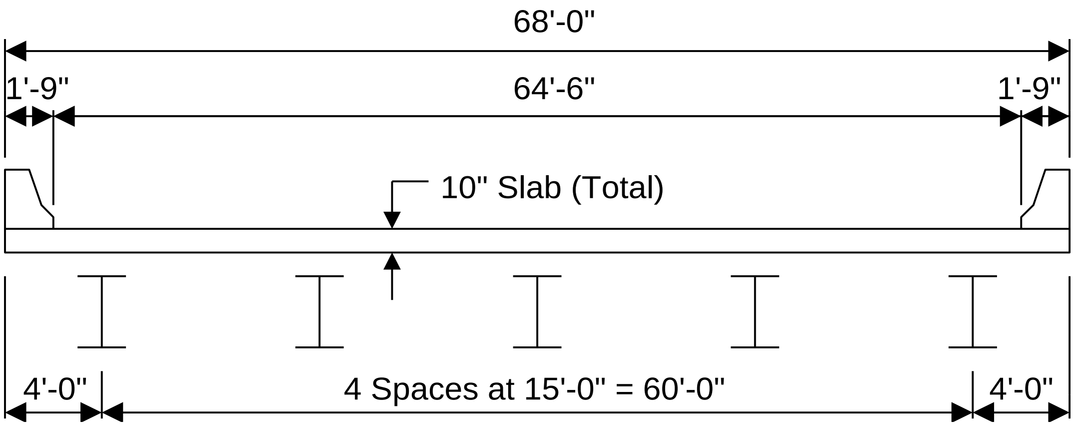

Figure 8.10-1 Example 9 Cross Section

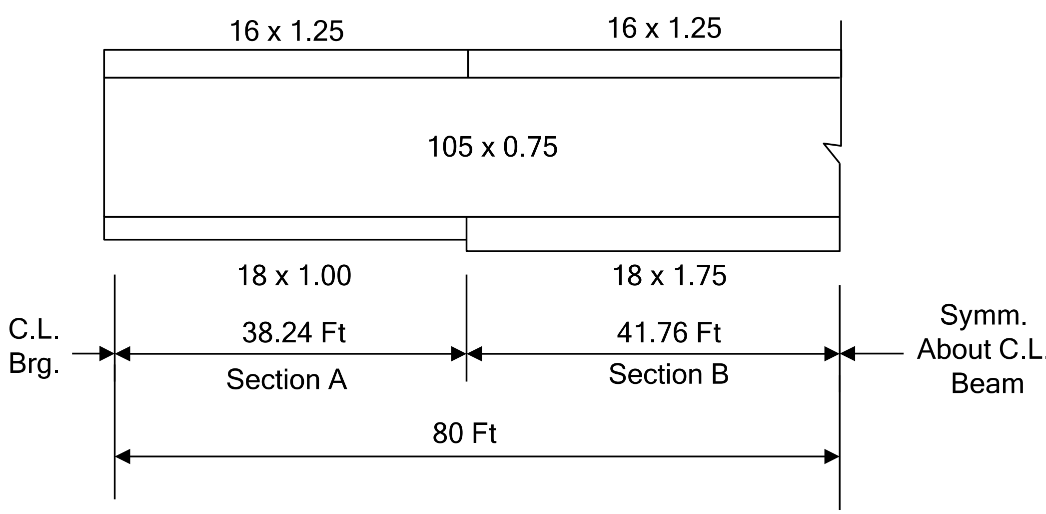

Figure 8.10-2 Example 9 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	DESIGN	PLATE GIRDER	INTERIOR	5	1	YES		4000	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
E	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	N/A***

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

***NOTE: This value is not used for design runs. Uncured slab checks are always done for design runs.

SYMMETRICAL POINT

Span No.	Span Dist. (ft)
1	80.000

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
15.000	N/A	NO	5	0.800	N/A	N/A	NO	N/A

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

Distance to Outermost Wheel (ft) (without Sidewalk)	Centerline Exterior Beam to Curb (ft) (without Sidewalk)	Distance to Outermost Wheel (ft) (with Sidewalk)	Centerline Exterior Beam to Curb (ft) (with Sidewalk)
N/A	N/A	N/A	N/A

SKEW ANGLES

Support	1	2
Angle (deg)	-60.000	-60.000
Apply skew	N	N

SPAN LENGTHS

Span No.	1
Length (ft)	160.000

DESIGN - PLATE GIRDER

Location Option	No. Top Trans.	No. Bottom Trans.	Max. Defl. (in)	Max. Defl. w/Ped. (in)	Weight Savings (lbf)	Noncomposite/ Composite
PREDEFINED	2	2	2.40		800.000	COMPOSITE

Web Fy (ksi)	Top Flange Fy (ksi)	Bottom Flange Fy (ksi)	Top Flange Fu (ksi)	Bottom Flange Fu (ksi)	Haunch Depth (in)	Reinforcement Area (in^2/ft)	Reinforcement C.G. Distance (in)	Minimum Depth (in)	Maximum Depth (in)
50.000	50.000	50.000	70.000	70.000	0.000	0.775	4.750	18.000	144.000

Top Plate Width Min. (in)	Top Plate Width Max. (in)	Top Plate Thickness Min. (in)	Top Plate Thickness Max. (in)	Bottom Plate Width Min. (in)	Bottom Plate Width Max. (in)	Bottom Plate Thickness Min. (in)	Bottom Plate Thickness Max. (in)
12.000	50.000	0.7500	4.0000	12.000	50.000	0.7500	4.0000

Classification Strength of Weld Metal (ksi)	Plate Thickness Table	Flange Width Increment	Longitudinal Stiffness Limit Check	Span-to-depth Check	Section 6.10.3.4.2 Check	Minimum Web Thickness (in)
70.00	2	2	NO	NO	N/A	N/A*

*NOTE: A MINIMUM WEB THICKNESS was not entered by the user. The program will set the minimum web thickness to D/150, rounded up to the nearest available plate size.

TRANSVERSE STIFFENER DESIGN

Stiff. Type	Min. Spacing (in)	Max. Spacing (in)	Yield Strength (ksi)	Cost Ratio
SINGLE	12.000	240.000	36.000	1.100

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Loads (lbf/ft^3)	Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
10.000	9.500	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DISTRIBUTED LOADS (DC1)

Start Span No.	Start Dist. (ft)	End Span No.	End Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	80.000	0.240	0.240
1	80.000	1	160.000	0.240	0.240

DISTRIBUTED LOADS (DC2)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	80.000	0.202	0.202
1	80.000	1	160.000	0.202	0.202

DISTRIBUTED LOADS (FWS)

Start No.	Span Dist. (ft)	End No.	Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	80.000	0.387	0.387
1	80.000	1	160.000	0.387	0.387

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	1	160.000	20.000

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF DESIGN TRIALS

Design Trials	Final Design
1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	0

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.11 EXAMPLE 10

Example 10 is a two-span continuous beam analysis example. Both spans are 80' long, and the beam is an interior beam. The example uses composite construction with a PennDOT skew angle of −80°. A PHL-93 live loading is assumed with high average daily truck traffic. A fatigue check of the reinforcing steel is done, pedestrian loads are included, and flexure and shear ratings are done.

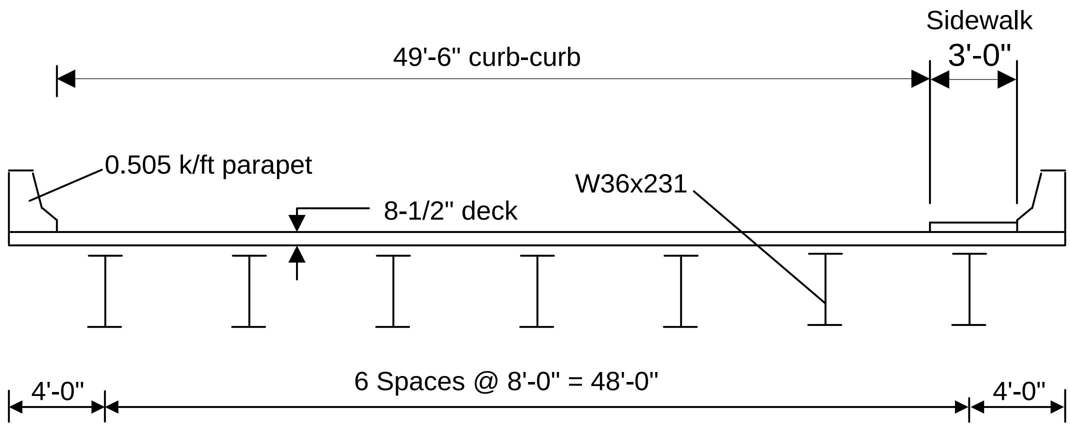

Figure 8.11-1 Example 10 Cross Section

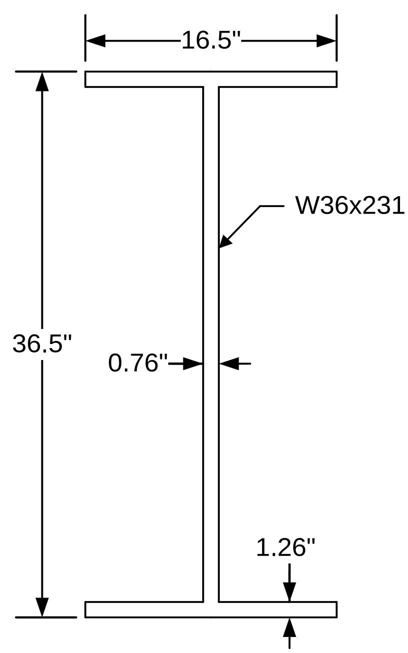

Figure 8.11-2 Example 10 Beam Dimensions

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	ROLLED BEAM	INTERIOR	7	2	NO	NO	3000	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
A	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	0.00	0.00	YES	YES	N/A***

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

***NOTE: There are no defined deck pours in this input file (DPS command). This value will NOT be used and all uncured slab checks will be done.

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
8.000	N/A	NO	4		4		NO	N/A

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
N/A	N/A	N/A	N/A

SKEW ANGLES

Support	1	2	3
Angle (deg)	-80.000	-80.000	-80.000
Apply skew	N	N	N

SPAN LENGTHS

Span No.	1	2
Length (ft)	80.000	80.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Rolled Beam Fy (ksi)	Rolled Beam Fu (ksi)	Cover Plate Top Fy (ksi)	Cover Plate Bottom Fy (ksi)
1	COMPOSITE	50.0	70.0	50.0	50.0

ROLLED BEAM DIMENSIONS, PART 1 of 2

Designation	Nominal Depth (in)	Nominal Weight (lbm/ft)	Moment of Inertia (in^4)	Area (in^2)
W36X231	36	231	15600.	68.20

ROLLED BEAM DIMENSIONS, PART 2 of 2

Designation	Flange Width (in)	Flange Thickness (in)	Beam Depth (in)	Web Thickness (in)	Distance "k" (in)
W36X231	16.500	1.2600	36.500	0.7600	2.2100

ROLLED BEAM PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	Rolled Beam Designat.	Top Cover Plate Width (in)	Top Cover Plate Thick. (in)	Bottom Cover Plate Width (in)	Bottom Cover Plate Thick. (in)
2	80.000	1			W 36x 231	0.0000	0.0000	0.0000	0.0000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

ROLLED BEAM PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
2	80.000	2.760	0.775	4.250

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Density Loads (lbf/ft^3)	Concrete Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
8.500	8.000	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DISTRIBUTED LOADS (DC1)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	80.000	0.130	0.130
2	0.000	2	80.000	0.130	0.130

DISTRIBUTED LOADS (DC2)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	80.000	0.144	0.144
2	0.000	2	80.000	0.144	0.144

DISTRIBUTED LOADS (FWS)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	1	80.000	0.225	0.225
2	0.000	2	80.000	0.225	0.225

PEDESTRIAN LOAD

Total Pedestrian Live Load (kips/ft)	Pedestrian Live Load (kips/ft)	Sidewalk Dead Load (kips/ft)	Addl. FWS Dead Load (kips/ft)
0.700	0.100	0.032	-0.013

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	32.000	0.000	A	
1	80.000	35.900	A	

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	2	80.000	16.000

BEARING STIFFENERS

Span No.	Span Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
1	0.000	W P	1	n/a	7.000	7.855
1	80.000	W P	1	n/a	n/a	7.855
2	80.000	W P	1	n/a	7.000	7.855

Span No.	Span Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	Classification Strength of Web-Stiffener Weld (ksi)
1	0.000	6.355	0.812	50.000	n/a	70.0
1	80.000	6.355	0.812	50.000	n/a	70.0
2	80.000	6.355	0.812	50.000	n/a	70.0

* Legend of Stiffener Types:
- W P Welded plate stiffener
- W A Welded angle stiffener
- B P Bolted plate stiffener
- B A Bolted angle stiffener

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
2	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

8.12 EXAMPLE 11

Example 11 is a three-span continuous plate girder analysis example. The three spans are unequal with lengths of 115, 165 and 130 ft. The plate girder is an exterior beam with composite construction and three separate deck pouring stages. A PHL-93 live loading is assumed with high average daily truck traffic. Use of transverse stiffeners is also assumed, and a fatigue check of the reinforcing steel is done. Lateral stresses are also included for each span.

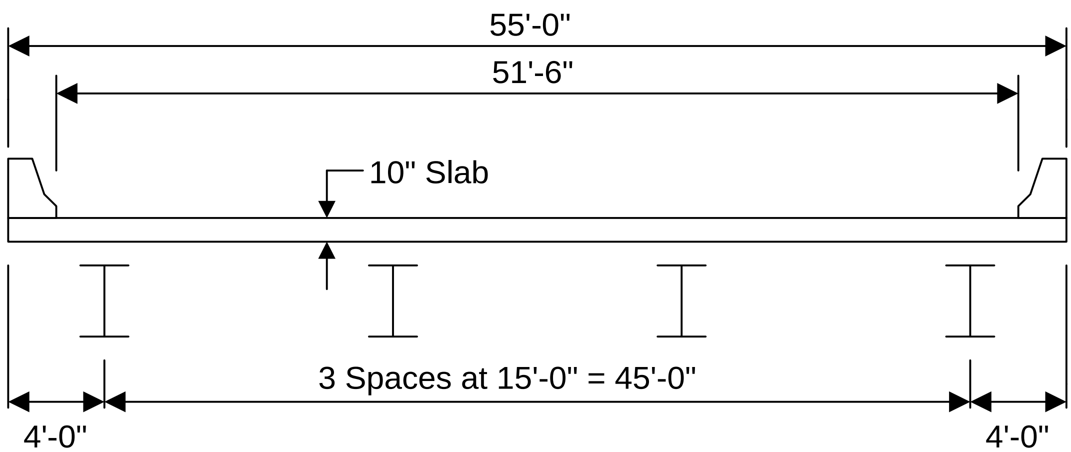

Figure 8.12-1 Example 11 Cross Section

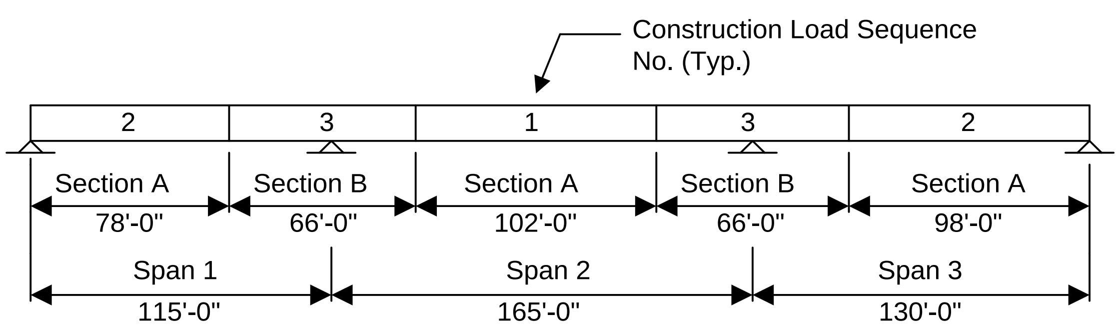

Figure 8.12-2 Example 11 Elevation

CONTROL PARAMETERS

Units	Design/ Analysis	Type of Beam	Exterior/ Interior	No. Beams	No. Spans	Symmetry	Deck Pour Symmetry	Single Lane ADTT	Multiple Presence Adj. Factor
US	ANALYSIS	PLATE GIRDER	EXTERIOR	4	3	NO	NO	2800	N/A

Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor	Redist. Neg. Moments	Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path
A	1.330	1.150	N/A	N/A	1.000	1.000	1.000	N/A

Analysis Points	Design Permit Vehicle Dynamic Load Allowance	Skew Angle Designation	Constant Lateral Bending Stress (ksi)	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports	Uncured Slab Checks With Deck Pours
2	1.200	N/A*	N/A**	0.00	YES	YES	NO

*NOTE: Since this input file uses the COMPUTED DISTRIBUTION FACTOR command, the skew angle designation is set via the CDF command.

**NOTE: Detailed lateral stresses have been defined via the LAS command. This value will NOT be used.

BEAM GEOMETRY

Beam/ Stringer Spacing (ft)	Deck Overhang (ft)	Staggered Diaphragms	Number of Design Lanes (without Sidewalk)	Deflection Distribution Factor (without Sidewalk)	Number of Design Lanes (with Sidewalk)	Deflection Distribution Factor (with Sidewalk)	Kinked/ Curved Girder	Number of Beams for 6.10.3.4.2 Check
15.000	5.000	YES	4		N/A	N/A	NO	4

COMPUTED DISTRIBUTION FACTORS

Skew Angle Designation	Brace Type	Design Lane Width (ft)	Gage Distance (ft)	Passing Distance (ft)	Two Girder Spacing (ft)
PennDOT	N/A	12.000	6.000	4.000	N/A

(without Sidewalk) Distance to Outermost Wheel (ft)	(without Sidewalk) Centerline Exterior Beam to Curb (ft)	(with Sidewalk) Distance to Outermost Wheel (ft)	(with Sidewalk) Centerline Exterior Beam to Curb (ft)
1.250	3.250	N/A	N/A

SKEW ANGLES

Support	1	2	3	4
Angle (deg)	-45.000	-45.000	-45.000	-45.000
Apply skew	R	R	R	N

SPAN LENGTHS

Span No.	1	2	3
Length (ft)	115.000	165.000	130.000

MATERIAL PROPERTIES

Matl. ID No.	Noncomposite/ Composite	Web Fy (ksi)	Flange Top Fy (ksi)	Flange Bottom Fy (ksi)	Plate Top Fu (ksi)	Plate Bottom Fu (ksi)	Classification Strength of Weld Metal (ksi)
1	COMPOSITE	50.0	50.0	50.0	70.0	70.0	70.0

PLATE GIRDER PROPERTIES, PART 1 of 2

End Span No.	End Span Dist.* (ft)	Matl. ID No.	LOSS	HOLE	VARY	Web Depth (in)	Web Thick. (in)	Top Plate Width (in)	Top Plate Thick. (in)	Bottom Plate Width (in)	Bottom Plate Thick. (in)
1	78.000	1				90.000	0.875	18.0000	1.0000	18.0000	2.0000
2	30.000	1				90.000	0.875	24.0000	3.0000	24.0000	3.0000
2	130.000	1				90.000	0.875	18.0000	1.0000	18.0000	2.0000
3	33.000	1				90.000	0.875	24.0000	3.0000	24.0000	3.0000
3	130.000	1				90.000	0.875	18.0000	1.0000	18.0000	2.0000

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

PLATE GIRDER PROPERTIES, PART 2 of 2

End Span No.	End Span Dist.* (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
1	78.000	1.000	0.780	4.750
2	30.000	3.000	0.780	4.750
2	130.000	1.000	0.780	4.750
3	33.000	3.000	0.780	4.750
3	130.000	1.000	0.780	4.750

* The properties given on each line of this table are for the range of the beam to the LEFT of the span and the distance given.

SLAB PROPERTIES

Slab Thickness Actual (in)	Slab Thickness Effective (in)	Concrete Strength (ksi)	Concrete Loads (lbf/ft^3)	Density Ec (lbf/ft^3)	Deck Reinforcement Strength (ksi)	Steel E (ksi)	Transv Reinf Size	Development Length Factor for Slabs
10.000	9.500	4.000	150.00	145.00	60.	29000.	N/A	1.000

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

DECK POUR SEQUENCE

Pour No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)
2	1	0.000	1	78.000
3	1	78.000	2	30.000
1	2	30.000	2	130.000
3	2	130.000	3	33.000
2	3	33.000	3	130.000

DECK POUR CONCENTRATED LOADS

Span No.	Span Dist. (ft)	Temporary (kips)	Permanent (kips)
2	33.000	18.000	0.000
3	33.000	0.000	5.620

LATERAL BENDING STRESSES (BOTTOM FLANGE)

Span No.	Location	DC1 (ksi)	MC1 (ksi)	DC2 (ksi)	FWS (ksi)	MC2 (ksi)	LL (ksi)	DPV (ksi)	UT1 (ksi)	UT2 (ksi)
1	Left End	1.40	0.00	0.30	0.25	0.00	2.90	3.50	0.00	0.00
	Midspan	-1.00	0.00	-0.20	-0.10	0.00	-2.00	-2.50	0.00	0.00
	Right End	1.40	0.00	0.30	0.25	0.00	2.90	3.50	0.00	0.00
2	Left End	1.60	0.00	0.10	0.15	0.00	1.30	1.80	0.00	0.00
	Midspan	-1.30	0.00	-0.10	-0.10	0.00	-0.80	-1.20	0.00	0.00
	Right End	1.60	0.00	0.10	0.15	0.00	1.30	1.80	0.00	0.00
3	Left End	1.40	0.00	0.30	0.25	0.00	2.90	3.50	0.00	0.00
	Midspan	-1.00	0.00	-0.10	-0.10	0.00	-1.50	-2.50	0.00	0.00
	Right End	1.40	0.00	0.30	0.25	0.00	2.90	3.50	0.00	0.00

LATERAL BENDING STRESSES (TOP FLANGE)

Span No.	Location	DC1 (ksi)	MC1 (ksi)	DC2 (ksi)	FWS (ksi)	MC2 (ksi)	LL (ksi)	DPV (ksi)	UT1 (ksi)	UT2 (ksi)
1	Left End	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Midspan	-0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Right End	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Left End	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Midspan	-0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Right End	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Left End	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Midspan	-0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Right End	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DISTRIBUTED LOADS (DC1)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	130.000	0.203	0.203

DISTRIBUTED LOADS (DC2)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	130.000	0.253	0.253

DISTRIBUTED LOADS (FWS)

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Magnitude (kips/ft)	End Magnitude (kips/ft)
1	0.000	3	130.000	0.387	0.387

WIND PROGRAM DEFINED

Additional Wind Cross Section (in)	Construction Load Path	Construction Wind Speed (mph)	Permanent Load Path	Permanent Structure Height (ft)	Permanent Wind Cond	Permanent Wind Speed (mph)	Construction Wind Pressure (ksf)	Wind Exposure Category	Design 3 Second Gust (mph)
12.000	L	N/A*	F	148.000	N/A	N/A	0.0050	D	115.000

NOTE: STLRFD no longer takes the CONSTRUCTION WIND SPEED as program input. Please enter the CONSTRUCTION WIND PRESSURE instead. See BD-620M and DM-4 C3.4.2.1 for information on how to calculate the CONSTRUCTION WIND PRESSURE.

FATIGUE POINTS

Span No.	Span Dist. (ft)	Distance (in)	Category	Fillet Weld (in)
1	78.000	0.000	B	0.000
2	30.000	0.000	B	0.000
2	130.000	0.000	B	0.000
3	33.000	0.000	B	0.000
2	165.000	96.000	C	0.000

BRACE POINTS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Brace Spacing (ft)
1	0.000	3	120.000	16.000

TRANSVERSE STIFFENERS

Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Stiff. Type*	Stiff. Spacing (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Strength (ksi)	Web Leg Length (in)
1	0.000	1	6.000	P P	36.00	8.000	0.750	50.000	
1	6.000	1	111.000	P P	90.00	8.000	0.750	50.000	
2	0.000	2	164.000	P P	48.00	8.000	0.750	50.000	
3	0.000	3	60.000	P P	45.00	8.000	0.750	50.000	
3	60.000	3	127.500	P P	90.00	8.000	0.750	50.000	
3	127.500	3	130.000	P P	30.00	8.000	1.125	50.000	

* Legend of Stiffener Types:
- S P Single plate stiffener
- S A Single angle stiffener
- P P Pair of plate stiffeners
- P A Pair of angle stiffeners

BEARING STIFFENERS

Span No.	Span Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
1	0.000	W P	1	n/a	7.750	10.000
1	115.000	W P	1	n/a	n/a	10.000
2	165.000	W P	1	n/a	n/a	10.000
3	130.000	W P	1	n/a	7.750	10.000

Span No.	Span Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	Classification Strength of Web-Stiffener Weld (ksi)
1	0.000	8.830	1.125	50.000	n/a	70.0
1	115.000	8.830	1.125	50.000	n/a	70.0
2	165.000	8.830	1.125	50.000	n/a	70.0
3	130.000	8.830	1.125	50.000	n/a	70.0

* Legend of Stiffener Types:
- W P Welded plate stiffener
- W A Welded angle stiffener
- B P Bolted plate stiffener
- B A Bolted angle stiffener

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
4	0.875	**N/A**	60.000

OUTPUT OF INPUT DATA

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT OF SECTION PROPERTIES

Gross Section Properties	Section Properties	Additional Section Properties
1	1	1

OUTPUT OF ANALYSIS RESULTS

Points of Contraflexure	Compactness Check For Redistribution	Load Modifiers	Dead Loads	Distribution Factors	Dead Load Effects	Dead Load Reactions	Staging Analysis
1	n/a	1	1	1	1	1	1

Live Load Effects	Live Load Reactions	HS20 Effects and Reactions	H20 Effects and Reactions	Fatigue Effects and Reactions	Factored Effects	Factored Reactions	Overall Reaction Summary
1	1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Wind Effects	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1	1

Shear Connector Checks	Staging / Uncured Slab Checks	Web-to-Flange Weld Design Checks	Economic Feasibility Checks	Negative Moment Serviceability Checks	SPLRFD Information	NSBA Splice Information
1	1	1	1	1	1	1

OUTPUT OF RATING FACTORS

Vehicle Rating Summary	Detailed Rating Factors	Overall Rating Summary	Ratings Without Future Wearing Surface
1	1	1	1

SYSTEM SETTINGS

Steel Weight (lbf/ft^3)	Construction Modular Ratio
490.00	11.000

9 TECHNICAL QUESTIONS AND REVISION REQUESTS

This chapter contains a reply form to make it easier for users to convey their questions, problems or comments to the proper unit within the Department. General procedures for using these forms are given. Users should keep the forms in the manual as a master copy which can be reproduced as needed. It is also included as a Word template as part of the program installation.

Technical questions related to the interpretations of the design specifications as implemented in this program, why certain assumptions are made, applicability and limitations of this program, and other questions not related to the operation of this program can be directed to the appropriate person in PennDOT using the form or the information provided on the form. Please review the information provided in this User's Manual and the references given in Chapter 1 before submitting this form for processing or calling for assistance.

The form can also be used to report suspected program malfunctions that may require revisions to the program or to request revisions that may be required due to changes in specifications and for the enhancement of the program. Unexpected or incorrect output, rejection of input data, endless program cycling, and program crashes are examples of program malfunctions. Users are requested to review their input data and the program User's Manual before submitting the form for processing.

The form may also be used to submit suggestions for improving the User's Manual for this program. Suggestions might include typographical error correction, clarification of confusing sections, expansion of certain sections, changes in format, and the inclusion of additional information, diagrams, or examples.

The completed form should be sent to the Highway Applications Division via e-mail.

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STLRFD
TECHNICAL QUESTION / REVISION REQUEST

This form is to be used to report suspected program malfunctions, or to request revisions to the program or its documentation. Users are requested to review their input data and the program User's Manual before submitting this form.

CONTACT PERSON: ________________________________ DATE: ____________________
ORGANIZATION: ________________________________ PHONE: ____________________
E-MAIL ADDRESS: ________________________________ PROGRAM VERSION: _________

Define your problem and attach samples and/or documentation you feel would be helpful in correcting the problem. If the input data is more than 4 or 5 lines, Licensees should provide the input data file as an e-mail attachment. If you require more space, use additional 8½ x 11 sheets of plain paper.

FORWARD COMPLETED FORM TO: Pennsylvania Office of Administration
Infrastructure and Economic Development
Bureau of Solutions Management
Highway Applications Division
E-MAIL: PenndotBisEngineer@pa.gov
PHONE: (717) 783-8822

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