USER'S MANUAL FOR

LRFD FLOORBEAM ANALYSIS AND RATING (FBLRFD)

pennsylvania

DEPARTMENT OF TRANSPORTATION

Version 1.8.0.0

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USER'S MANUAL FOR
COMPUTER PROGRAM FBLRFD
LRFD FLOORBEAM ANALYSIS AND RATING
VERSION 1.8.0.0

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LRFD FLOORBEAM ANALYSIS AND RATING

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SUMMARY OF APRIL 2007 REVISIONS - VERSION 1.1.0.0

Since the release of FBLRFD Version 1.0a several revision requests and user requested enhancements have been received. This release of FBLRFD Version 1.1.0.0 corrects the following known problems and provides enhancements.

Input Revisions

1. 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 004)
   NOTE: this change requires that any previously existing input files using special live loads be updated because of additional input now required.

2. The default reinforcement grade has been changed to 420 MPa for SI units. (Request 015)

3. Short spans (less than 25') without BRP commands now have correctly defined brace points. (Request 035)

4. Recent count, previous count, and future count ADTTs on the FTL command must now be greater than zero. (Request 036)

5. User input load factors for special live load are now used. Previously, the default load factors could not be overridden. (Request 045)

6. 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 058)

7. 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 046)

8. When the user enters more than the maximum number of concentrated loads allowed, a more descriptive warning will now appear. (Request 047)

9. The lower limit for span length has been 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 059)

10. Fatigue points can now be defined on the left overhang and the allowable number of fatigue points has been increased to 30. (Request 072, 075, 139)

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11. The "Distance", "Location", and "Width" parameters of the SLS command are now correctly read by the input processor. (Requests 118, 134, 136)

12. Successive girder ranges of straight-line increasing web depth can now be entered. (Request 120)

13. The program will no longer crash when 18 stringers are entered. (Request 129)

14. The lower limit for transverse stiffener spacing has been changed to 0.2 m (0.65 ft), an approximate constructability limit, and has been changed to generate a warning if this limit is violated. (Request 247)

15. The maximum length of a command line has been increased from 256 characters to 512 characters. (Request 249)

16. The program has been modified to complete processing of an entire input command before halting for errors. (Request 254)

17. The number of allowed concentrated loads has been increased to 200 from 50. An input check has also been added which will inform the user if the number of user entered concentrated loads on a floorbeam will exceed the maximum limit the program can handle. In addition the Future Wearing Surface load has been added to the "Floorbeam Concentrated Loads Output" Table. (Request 255)

18. The stringer symmetry function of the program has been corrected to allow correct symmetry when a stringer is placed at the center of the floorbeam. Previously this would cause the program to crash. (Request 264)

<u>Output Revisions</u>

19. The "web leg length" column of the transverse stiffener program output now prints the values correctly. (Request 049)

20. When the LRFD compression flange buckling check fails, the program will now report 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 050, 056)

21. The error codes and comments have been rearranged on the UNCURED SLAB WEB SPECIFICATION CHECK output report. (Request 051)

22. 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 069)

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23. When the values D_c and r_t are required for computing the flexural capacity of the section, they are now reported on the "FLEXURAL CAPACITY" output reports. The r' value in the Additional Section Properties Table has been changed to r_t to be consistent with the 1998 AASHTO notation. (Request 053, 257)

Distribution Factor Revisions

24. The US Units distribution factor for floorbeams less than 6 feet apart has been corrected. (Request 030)

Live Load Reaction Revisions

25. The program has been modified so impact is now applied to the live load reactions when floorbeam spacing is less than 6 feet (1.8 meters). (Request 256)

26. The program has been modified so the percent increase for Special Live Loads is now applied when the floorbeam spacing is less than 6 feet (1.8 meters). (Request 261)

27. The program has been modified so impact is now applied to the live load reactions when floorbeam spacing is less than 6 feet (1.8 meters). (Request 256)

28. The program has been modified so the percent increase for Special Live Loads is now applied when the floorbeam spacing is less than 6 feet (1.8 meters). (Request 261)

Rating Factor Revisions

29. Corrections have been made to the shear rating factor calculations. (Requests 032)

Transverse Stiffener Revisions

30. When the first defined transverse stiffener range does not start at the left end of the floorbeam, the program will now run to completion. (Requests 013, 054, 124)

31. Built-up sections with transverse stiffeners are now analyzed as stiffened sections. (Requests 031, 038, 125)

32. A column has been added to the transverse stiffener check output reports to indicate whether the section should be treated as stiffened or unstiffened, based on the stiffener spacing. (Request 037)

33. Consistent criteria are now applied when determining if a given point is to be considered stiffened or not. Previously, there was a difference between the criteria on the SHEAR CAPACITY and TRANSVERSE STIFFENERS CHECK tables. (Requests 040, 146)

34. Transverse stiffeners can now be defined on the left overhang of the floorbeam. (Request 132)

LRFD FLOORBEAM ANALYSIS AND RATING

Section Property Revisions

35. The program will now run to completion and process section holes correctly. (Request 014)

36. 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. (Request 034)

Flexural Capacity Revisions

37. 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. The User's Manual has been modified to describe the use of the bottom flange stress when determining moment direction in floorbeams. Previously the program was using the stress in the top slab. (Requests 044, 259)

38. Stress resistances throughout the program are now limited to a maximum value equal to the yield stress of the component. (Request 052)

39. 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 057)

40. The case of a noncomposite section in negative bending where the alternate formula for Mn applies will no longer cause an abnormal termination of the program. (Request 082)

Shear Revisions

41. Small changes have been made to the shear stud clearance and spacing calculations to bring the program into compliance with the current version of BC-753M. (Request 043)

Fatigue Revisions

42. If the fatigue life remaining calculations indicate a negative fatigue life, the fatigue life is now reported as 0 years. (Request 070)

User Manual Revisions

43. Chapter 9 of the User's Manual has been updated with new contact information. (Request 007)

44. The User's Manual has been clarified to indicate that bearing stiffeners are not considered along with the transverse stiffeners when performing transverse stiffener checks. (Request 041)

45. The User's Manual has been clarified and an example added concerning entry of variable-depth webs. (Request 042)

46. The User's Manual and EngAsst configuration files have been updated to reflect that FWS and PFWS are acceptable load codes for the FCL (floorbeam concentrated load) command. (Request 243)

47. The User’s Manual has been changed to reflect the programs capability of accepting 200 floorbeam cross section ranges versus the 40 that were previously indicated. (Request 260)

Engineering Assistant Revisions

48. Negative values can now be entered for the FCL command through Engineering Assistant. (Request 126)

49. The program has been updated for the FCL, SCL, FDL and SDL commands to allow more combinations of number loads and number of commands when run using Engineering Assistant. (Request 135)

Programming Revisions

50. The program input file can now be located in a different directory than the program executable. (Request 008)

51. CBA Version 3.5.0.7 has been incorporated into the program. (Requests 003, 005, 016, 238)

52. The program is now compatible with APRAS. (Request 066)

53. The example input files have been modified to eliminate all input warnings. (Request 148)

54. The program has been converted to the Intel Visual Fortran Compiler Version 9.1.034. (Request 262)

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SUMMARY OF APRIL 2009 REVISIONS - VERSION 1.2.0.0

Since the release of FBLRFD Version 1.1.0.0 several revision requests and user requested enhancements have been received. This release of FBLRFD Version 1.2.0.0 contains the following revisions and enhancements.

Users Manual Revisions

1. The User's Manual has been updated for issues with the sign convention for shear results and the loads included for composite beams when doing the dead load web checks (Request 195).

2. Information has been added to the User's Manual Section 6.16.8 to describe how to enter the web depth for a floorbeam that begins with a varying web depth (Request 220).

3. 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 a positive value (Request 221).

4. A DM-4 reference about the entry of the haunch depth has been added to the User's Manual Section 6.15.9 (Request 237).

5. The User's Manual Figure 2.4-1 sketch of the axle loads for the ML-80 vehicle has been updated to show a first axle of 13.68 kips (Request 252).

Input Revision

6. An input check has been added to the program to ensure that the web depth of a built-up section must be larger than twice the vertical leg length of the angles. This was done to avoid a possible endless loop in calculation of the plastic moment capacity of the section (Requests 130 and 211).

7. The program was revised so the number of points of contraflexure will always be set to two, to ensure that the effective slab width is computed properly (Request 144).

8. The program will now accept up to 80 axles for special live loads (Requests 147, 232 and 250).

9. A negative value for the distance to the first hole can now be entered on the SHO command through EngAsst. A negative value can also be entered for the distance parameter on the SLS command (Request 222).

10. 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 (Request 223).

11. The lower limit of the dynamic load allowance and fatigue dynamic load allowance has been changed to 1.0 (Requests 227 and 241).

12. The value of the multiple presence factor adjustment has been set equal to 1.0 for all runs of the program (Request 251).

13. Previously, incorrect interpretation and entry of the number of holes on SHO command could lead to program crashes. Checks have now been added to let the user know when the number of holes entered in SHO command fall outside the beam dimensions (Request 268).

Specification Related Revisions

14. Design and analysis of the fillet weld between the flange and web plates for plate girder floorbeams has been added to the program (Request 092, 214). **NOTE: Because of the addition of a new parameter on the MAT command, input files that have more than one set of MAT parameters on a single line will need to be modified.**

15. Previously, the maximum moment and maximum shear effects were used together in all computations. Computations have now been revised to use concurrent shear and moment effects for shear capacity and shear rating factors (Requests 094, 186).

16. A precision problem with the calculation of points of contraflexure has been resolved. Previously, for certain input files the program would stop prematurely (Request 122).

17. DM-4 equation 6.10.11.2.3-2 for bearing stiffener capacity has been incorporated into the program (Request 163).

18. The program now takes section loss on the web into account when performing the shear capacity and web buckling calculations (Request 219).

19. The flexure/shear interaction ratings have been removed from the program since the interaction is already covered when computing shear ratings (Request 277).

Output Revisions

20. A new summary output report that provides a list of specification check warnings has been added to the output (Requests 110, 215, 216).

21. The specification check failure field width has been increased in the SHEAR CONNECTOR DESIGN - PITCH output report (Request 218).

22. The longitudinal stiffness (Kg) is now printed in the section property output tables for the negative flexure condition (Request 275).

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Girder Analysis Revisions

23. CBA version 3.6.0.0 has been incorporated into the program (Requests 151, 267).

24. A problem error that considered a point at the end of one span to be different than a point at the beginning of the next span has been corrected. Previously, this problem could cause stringer distributed loads to be incorrectly applied (Request 142).

Cross Section Revisions

25. The section properties are now computed to the left and right of each transition point and are reported at each analysis point (Request 067).

26. The calculation of the moment of inertia for transverse stiffeners constructed with angles has been fixed to avoid double-counting the intersection of the legs as well as using the correct leg lengths (Request 140).

27. The calculation of the area of transverse stiffeners constructed with angles has been modified to avoid double-counting of the intersection of the legs as well as properly multiplying by the angle thickness (Request 141).

28. BSP version 1.5.0.0 has been incorporated into the program (Requests 151, 202).

29. The web depth for an analysis point in a varying depth range that falls entirely within a gross cross section range is now computed correctly. Previously, for certain input files, the program would compute incorrect web depths which could cause the program to stop prematurely (Request 236).

30. The gross section properties are now computed at the midpoint of each range and used for structural analysis of the floorbeam. Specification checking is now done for both the left and right of each cross-section transition point, using the appropriate section properties for each side (Requests 199, 200, 276).

Programming Revisions

31. The program will now print (unlicensed) in the program output when the program has not had a valid license number assigned (Request 198).

32. The program has been updated to use the FORTRAN compiler version 10.1.013. This revision includes increasing the "Fixed Form Line Length" to 132 characters (Request 273).

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Rating Revisions

33. The rating tonnage of SI special live load vehicles is now computed using the correct conversion factors (Request 235).

34. The scale tolerance has been removed from the rating tonnages computed by the program for the ML80 and special live load vehicles (Request 239).

SUMMARY OF MAY 2011 REVISIONS - VERSION 1.3.0.0

Since the release of FBLRFD Version 1.2.0.0 several revision requests and user requested enhancements have been received. This release of FBLRFD Version 1.3.0.0 contains the following revisions and enhancements.

Specification Related Revisions

1. 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. In addition, the flexural ratings for service limit states are now computed in terms of stress (Request 233).

2. The effective slab width calculation has been updated to the 2008 AASHTO Interims Article 4.6.2.6.5. (Request 279).

Input Revisions

3. A separate input parameter for the dynamic load allowance applied to the P-82 vehicle is now available on the CTL command (Request 073).

4. The TK527 vehicle is now included for several live load codes for analysis and rating (Request 097).

5. 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 283).

6. The input consistency checking now allows the user to enter a sidewalk on only side of the bridge. However, if the user enters a distance to one side of the sidewalk, they must enter the distances to both sides of he same sidewalk. For example, if a user enters LEFT SIDEWALK LEFT EDGE (parameter 9 on the GEO command), they must also enter LEFT SIDEWALK RIGHT EDGE (parameter 10). Parameter 10 cannot be left blank (Request 123).

7. If a floorbeam has no overhangs, it must be entered with the TYPE OF SUPPORT (CTL command) set to type "S", simple span with or without applied moments at the ends and no overhangs (Request 131).

8. Trapezoidal distributed loads are now mirrored correctly for symmetrical floorbeams (Request 240).

9. If a floorbeam has overhangs, it now must be entered with the TYPE OF SUPPORT set to "C" or "O" (Request 269).

LRFD FLOORBEAM ANALYSIS AND RATING

10. The Engineering Assistant configuration files have been modified to only allow a single bearing stiffener location to be defined per BST record, and the number of BST records that can be defined has been revised from 41 to 42. Previously, two bearing stiffener locations could be entered per record, but FBLRFD could only accept one location per record (Request 289).

Output Revisions

11. Pedestrian live load effects will no longer print for a sidewalk if no pedestrian live load is defined on the sidewalk (Request 074).

12. FBLRFD will now produce PDF versions of all output in addition to the text-only files (Request 278).

13. If the governing rating location is on the left overhang, the governing ratings will now print on the RATING FACTORS - SUMMARY output reports. Previously, governing ratings that occurred at a negative distance (left of the left support) would not print in the program output (Request 281).

Girder Analysis/Design Revisions

14. The definition of analysis points has been changed to use a fraction of the span length, rather than adding a fixed value on to each analysis point. This helps to avoid rounding issues in the definition of the analysis points (Request 121).

15. The brace point calculation has been modified to avoid rounding errors that could lead to a program crash (Request 192).

16. If, due to floorbeam geometry, there are no points of dead load contraflexure on the floorbeam, the program will now define effective points of contraflexure at the mid-length of the floorbeam, if the user has not entered them via the ECP command. These effective points of contraflexure are only used to define the shear connector design ranges (Request 265).

Documentation Revisions

17. The User's Manual has been revised for the Stringer Dead Load (SDL) command to reflect that FBLRFD will allow up to 100 stringer dead loads to be defined and that all parameters must be repeated when repeating the command (Request 119).

18. An additional footnote has been added to the "Range" shown in the figure for Parameter 1 of the APL command. The footnote defines the minimum range distance between a floorbeam section change (Request 291).

19. User Manual Section 6.5.5 has been added to show examples of the bridge cross section for each of the CTL command, Type of Support, S, C and O (Request 293).

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Programming Revisions

20. The program has been updated to work with Visual Studio 2008 and Intel Fortran version 11.1.067 (Request 287).

21. The program has been revised for a situation where multiple rolled beams (of different sizes) would cause the program to terminate without a successful analysis (Request 293).

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SUMMARY OF MAY 2013 REVISIONS - VERSION 1.4.0.0

Since the release of FBLRFD Version 1.3.0.0 several revision requests and user requested enhancements have been received. This release of FBLRFD Version 1.4.0.0 contains the following revisions and enhancements.

Specification Related Revisions

1. The program has been revised to use the LRFD Specifications 5th Edition and 2012 DM-4 (Requests 270, 302, 303, 305, 313, 314, 315).

2. The rolled beams used by the program have been revised according to the AISC Steel Construction Manual, 14th Edition, 1st printing (Request 290).

   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						

3. A program crash that was occurring when the floorbeam starts at a support with partial fixity has been resolved (Request 308).

LRFD FLOORBEAM ANALYSIS AND RATING

4. If the deck is supported directly by floorbeams and the floorbeam spacing is less than or equal to 6 feet, the live load reaction on the floorbeam will be determined using the heaviest axle of the live load vehicle, rather than always using 32 kips (Request 310).

5. 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 317).

6. 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 318).

7. 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 297).

Output Related Revisions

8. A typographical error has been corrected in an error message produced when defining shear connectors for a noncomposite floorbeam (Request 307).

9. 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 319).

Documentation Revisions

10. A reference to AASHTO Article 6.10.7.2 has been added to the User's Manual, as has a complete listing of rolled beams available to the program (Request 316).

SUMMARY OF JUNE 2015 REVISIONS - VERSION 1.5.0.0

Since the release of FBLRFD Version 1.4.0.0 several revision requests and user requested enhancements have been received. This release of FBLRFD Version 1.5.0.0 contains the following revisions and enhancements.

General Programing Revisions

1. ***The method of calling the engineering program DLL from 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, FBLRFD 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. FBLRFD will no longer work with EngAsst v2.4.0.0 and earlier (Request 322).***

2. The Department's Continuous Beam Analysis program, CBA Version 3.6.0.5, has been incorporated into the program (Request 306).

3. The program is now compiled with Intel Visual Fortran Composer XE version 2011.9.300 using Visual Studio 2010 (Request 321).

4. An error with reporting the gross section properties at a transition between varying-depth and constant-depth sections have been resolved (Request 326).

5. 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 366).

6. 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 370).

7. A tolerance has been applied to avoid an issue with the program ignoring a concentrated load placed on a stringer framing into a floorbeam that is at the last support of the stringer (Requests 379, 386).

8. The program now stops execution on the rare occurrence of a floating point error. Previously, on the rare occurrence of a floating point error the program would continue execution, which would result in the program calculating incorrect results and sometimes stopping execution later in the program with a different error (Request 393).

LRFD FLOORBEAM ANALYSIS AND RATING

Program Input Revisions

9. 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 stage (Request 327).

10. A new noncomposite dead load, DC1S, has been added to allow the user to distinguish between noncomposite loads associated with the floorbeam/stringer (DC1S) that are not computed by the program (like stiffeners 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 349).

11. The description of the Floorbeam Concentrated Load (FCL) command has been clarified with respect to when bearing stiffener checks are done at concentrated load points (Request 350).

12. A check has been added so that if a user enters 0.0 for 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. If only one dimension has been entered as 0.0, the program will stop with an error. Previously, the program would permit one dimension to be 0.0, which could lead to a program crash (Request 351).

13. 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 message printed in the program output (Request 356).

14. Loads entered by the user via the Floorbeam Concentrated Load (FCL command) will no longer be mirrored for symmetrical beams if the load coincides with the floorbeam symmetry point (Request 352).

15. The Previous Count Year must be less than the Recent Count Year and the Future Count Year must be greater than the Recent Count Year on the FTL (Fatigue Live) command. This revision was made to prevent the program from crashing (Request 362, 372).

16. The limit on the total number of section holes entered on the SHO command has been increased. The user can now enter up to 40 ranges and each range can have up to 40 holes. If a user enters a value greater than one for "Number of Holes" on the SHO command, they must also enter a value for "Hole Spacing" (Requests 337, 355, 388).

Program Output Revisions

17. For symmetrical floorbeams; only a single analysis point will now print at the symmetrical point; live load results will now be symmetric; stringer dead loads can no longer be entered on stringers past the symmetry point, and results for analysis location past they symmetry point will no longer print (Requests 311, 342).

18. A new rating table has been added to the program after the OVERALL RATING SUMMARY table that will report rating information in a table similar to DM-4 Part A Table 1.8.3-1 (Requests 320, 397).

LRFD FLOORBEAM ANALYSIS AND RATING

19. The formatted Input table that is printed to the output file for the FGV command has been revised to prevent formatting errors (Request 334).

20. The HL-93 Loading Code 3 legend description displayed in the program output has been corrected to be "TANDEM PAIR + LANE GOVERNS". Previously, HL93 Loading Code 3 displayed "90% TANDEM PAIR + LANE GOVERNS" which was inconsistent with the CBA program (Request 338).

21. 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 been added to the program User's Manual (Request 339).

22. Output reports now print all analysis points that contain a warning or failure regardless of the user input for parameter 19 ("OUTPUT POINTS") on the CTL command (Request 346).

23. The HL-93 LL ANALYSIS reports and all of the OVERALL REACTIONS output reports for HL-93 have been modified to now print Loading Code 4 legend description as "90% (TRUCK PAIR + LANE) GOVERNS". Previously, Loading Code 4 legend printed as "90% TRUCK PAIR + LANE GOVERNS" (Request 354).

24. 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 (Requests 361, 384).

25. 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 (Requests 368, 385).

26. 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 371).

27. If a fatigue analysis point is placed at an analysis point that produces result immediately to the left and right of the analysis point, the fatigue results will now be calculated on both sides of the fatigue analysis point (Request 381).

28. 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 382).

29. A new output 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 (Requests 383, 389).

LRFD FLOORBEAM ANALYSIS AND RATING

30. 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 102 characters per page width and 83 lines per page (Request 392).

User's Manual Revisions

31. Additional information has been added to the User Manual Chapter 7 description of the Bearing Stiffener Check output report to clarify when concentrated load locations are included in this output report (Request 352).

32. The User’s Manual has been revised to state that; the shear connector height entered on the SCS and SCC command is only compared to the effective deck thickness; a warning is printed if the connector height exceeds the effective deck thickness; and that no other specification checks are done with the shear connector height input value (Request 357).

33. The User’s Manual has been revised to remove a reference to section holes in Section 7.4.2 and 7.4.3 which cover net section properties as the FBLRFD program does not consider section holes when computing net section properties (Request 358).

Specification Checking Revisions

34. The calculation of the stress in the compression flange at the midpoint of an unbraced length is now calculated by straight-line interpolation of the values at the two nearest analysis points, rather than taking the average of the two values (Requests 378, 399).

35. The determination of fmid/f2 > 1.0 in the calculation of the moment gradient factor, Cb, is now done correctly and the calculated value of Cb has been included in a new output report INTERMEDIATE VALUES FOR STRESS FLEXURAL CAPACITY CALCULATIONS. This new output report includes values that were previously included on the STRESS FLEXURAL CAPACITY output report (Request 380).

SUMMARY OF NOVEMBER 2017 REVISIONS - VERSION 1.6.0.0

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

General Programming Revisions

1. FBLRFD 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 (Requests 086, 436).

2. 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 corrected (Request 095).

3. The BSP source code used by FBLRFD has been updated to BSP version 2.0.2.0 (from 2.0.0.2) (Request 394).

4. The list of invalid characters for input file names has been reduced to \ / : * ? " < > |. The previous list also included characters that were actually acceptable for Windows file names (Request 400).

5. Changes how the compiler handles floating point values have been made to ensure similar program results when running FBLRFD from a command prompt as well as from EngAsst (Request 405)

6. The program is now compiled with Intel Parallel Studio XE 2017 Update 5 using Visual Studio 2017 (Request 434).

Lateral Torsional Buckling Revisions

7. 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, FBLRFD 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, FBLRFD 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.

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 (Sxc,current location) / (Sxc,governing location).

The moments due to the beam self-weight are now used in order 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.

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.

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

A floorbeam 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 floorbeam can be considered to be prismatic and have Cb > 1.0. If there are other transitions in the floorbeam outside the 20% range, the larger section will NOT be ignored.

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 403). **Note that these changes will result in significantly lower ratings for floorbeams that are governed by their lateral torsional buckling resistance.**

<u>Program Input Revisions</u>

8. 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 180)

9. The program will now stop with an error if the maximum number of loads allowed are exceeded for the commands: FCL (20 loads), FDL (50 loads), SCL (100 loads), or SDL (100 loads). Previously, the program would generate a warning that the rest of the input line would be ignored, but continue with execution. Also, the User's Manual descriptions for the TST and LST command now state that the parameters for those commands cannot be repeated in a single instance of the command. (Request 231, 437)

10. 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 floorbeam 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 375).

11. The User's Manual and configuration files for the Engineering Assistant have been revised to consistently describe how many instances of each command are allowed, and how to define these instances (Request 416).

12. Documentation of the values on the FGV command has been added to Section 6.33 of the User's Manual (Request 417).

13. The upper limits on year values have been increased on the FTL command (Request 418).

14. The upper limits on the number of trucks on the FGV command have been increased (Request 419).

15. Subscripts for values on the SLS command are now properly assigned so that the varying web depth is correctly calculated (Request 420).

16. Information on the SLS and SHO commands is now mirrored properly for symmetrical floorbeams (Requests 424, 438).

17. The FDL and SDL commands will now allow negative values for load magnitudes when entering these values through EngAsst. FBLRFD has always allowed negative values for these magnitudes, but they could not be entered through EngAsst (Request 446).

Program Output Revisions

18. A warning has been added to the program output to advise the user that section holes defined on the web of a cross section are always ignored, and will not affect program output (Request 421).

User's Manual Revisions

19. The parameter descriptions in several FBLRFD Engineering Assistant configuration files have been updated to match the parameter descriptions in the User's Manual. (Request 188)

20. Notes have been added to Chapter 2 of the FBLRFD User's Manual to indicate that blast loading is not considered by FBLRFD (Request 407).

21. References to "ADTT" on the FTL command have been changed to "$(ADTT)_{SL}$" (Request 413).

22. On the SAL command, the description has been modified to let the user know that the axle spacing following the last axle must be entered as 0.0 (Request 415).

23. The description of the folder structure on the Start Menu has been modified in Chapter 4 to correctly reflect the program installation (Request 425).

Specification Checking Revisions

24. 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 107)
25. 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 (Requests 376, 409).
26. 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 (Request 387).
27. For floorbeams that are entirely in negative bending, the shear connector design ranges will be broken up at the location of the smallest magnitude negative moment (rather than looking for the maximum positive moment) (Request 390).
28. 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 408).
29. 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 (Request 410).
30. 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 411).
31. 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 412).
32. 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 431).

SUMMARY OF OCTOBER 2020 REVISIONS - VERSION 1.7.0.0

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

<u>Specification Related Revisions</u>

1. The calculations of the LRFD Specifications, Section 6, Appendix D have been added to the program. For some girder configurations, Appendix D will lead to a larger lateral torsional buckling capacity (Request 404).

2. Three vehicles specified as part of the FAST Act (EV2, EV3, and SU6TV) have been added as a live load option to the program (Live Load Code H) (Request 426).

3. Rating factors governed by lateral torsional buckling for live load placement runs (Live Load Code F) will now include the live load effects for the non-rating vehicle as part of the dead load effects, as defined in the User's Manual Live Load Ratings section (Request 428).

4. 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 (DC) for negative bending. The program previously used the factored stress in the flanges to determine DC (Requests 435, 475).

5. 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 451).

6. 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 as required by the GIRDER HAUNCH STIFFENER DETAIL shown in BC-753M (Requests 467, 508).

7. Moment of inertia check 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 470).

8. 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 480).

LRFD FLOORBEAM ANALYSIS AND RATING

9. 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 482).

10. The maximum spacing of shear connectors has been increased to 48 inches, as per the LRFD Specifications, 8th Edition (Request 483).

11. Sidewalks will now be considered as an additional loaded lane for the purposes of calculating distribution factors and multiple presence factors (when applicable) (Request 484).

12. 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 487).

13. An error in the calculation of moment and shear effects from a sidewalk live load applied outboard of the outermost stringer has been resolved. Previously, the concurrent effects were occasionally larger than the reported maximum effects (Request 445).

Program Input Revisions

14. The error messages regarding the limits of the floorbeam overhang distance with respect to the deck edge limits have been revised to more clearly indicate that the floorbeam cannot extend past the deck edges. The User's Manual and configuration files have also been revised to make this clear (Request 127).

15. Rules have been defined for use with the Engineering Assistant program to enable and disable FBLRFD input tabs based on program input (for example, the rolled beam and built up section commands are disabled if the user chooses plate girder for the floorbeam type on the CTL command) (Request 266).

16. 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 406).

17. New input checks were added to the BEARING STIFFENER (BST) command. The user no longer has to enter SPACING BETWEEN PAIRS when only one pair is present, and CLEARANCE is only required at the actual ends of the floorbeam, not at supports, for all floorbeam types (Request 440).

18. 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 443).

19. 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 one set of 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 444).

20. 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 449).

21. The upper limit on transverse stiffener spacing has been increased from 18 feet to 25 feet (Request 462).

22. 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. Previously, the program would always add brace points at supports regardless of whether the BRP command defined the brace points or not (Request 469).

23. 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 471).

24. New input checks have been added to the ACTUAL SLAB THICKNESS and EFFECTIVE SLAB THICKNESS input parameters on the SLAB (SLB) command, in order 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 488).

25. 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 load factors are not used for MC2 or 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 494).

26. An input check has been added to prevent users from entering Live Load Definition (LLD) or Live Load Assignment (LLA) commands if a Live Load option other than F (Multiple Live Load Placement) has been specified on the CTL command (Request 505).

<u>Program Output Revisions</u>

27. 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 441).

LRFD FLOORBEAM ANALYSIS AND RATING

28. 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 454).

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 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 465).

30. The name of the BEARING STIFFENER CHECK output report has been changed to USER INPUT BEARING STIFFENER ANALYSIS. The description of Code Check B on the USER INPUT BEARING STIFFENER ANALYSIS output report has also been revised for clarity (Request 473).

31. 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 474).

32. 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 493).

33. Some pagination issues (some pages overflowing onto the following page, some pages not filled as much as they could be) have been resolved for the output of example problems 1 and 3 (Request 511).

Program Documentation Revisions

34. A new section (3.4.7) was added to the User's Manual describing how the loading effects are calculated for a Multiple Live Load placement run of the program (Live Load code F on the CTL command) (Request 429).

35. The contact information and revision request form in Chapter 9 of the User's Manual have been revised (Requests 448 and 477).

36. 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 entered at the start of the floorbeam (Request 459).

Programming Revisions

37. The calculation of k, the bend buckling coefficient for webs with longitudinal stiffeners, no longer uses a tolerance comparison when checking if ds/Dc is less than 0.4, because the tolerance comparison caused the comparison to incorrectly fail when ds/Dc was close to 0.4 (Request 461).

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38. FBLRFD has been revised to use Microsoft Visual Studio 2019 and Intel Parallel Studio XE 2019 Fortran Update 5 for compilation and linking (Request 478).

39. The PennDOT BEAM SECTION PROPERTIES (BSP) program version 2.0.2.0, and the CONTINUOUS BEAM ANALYSIS (CBA) program version 3.7.0.0 have been incorporated into FBLRFD (Request 486).

40. Some variables related to the factored uncured slab lateral torsional buckling stress were added to a common block to ensure they retain their value across subroutines (Request 490).

APRAS Requests

41. The program is now compatible with APRAS NextGen (Request 274).

42. APRAS runs will no longer generate a PDF output file (Request 455).

43. 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 479).

SUMMARY OF DECEMBER 2023 REVISIONS - VERSION 1.8.0.0

Since the release of FBLRFD Version 1.7.0.0, several revision requests and user requested enhancements have been received. This release of FBLRFD Version 1.8.0.0 contains the following revisions and enhancements.

Program Input Revisions

1. **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 100).**

2. **The number of special live loads available in a single run has been increased from five to eight (Request 288).**

3. **The floorbeam concentrated loads (FCL), stringer concentrated loads (SCL), floorbeam distributed loads (FDL), and stringer distributed loads (SDL) commands have been revised to allow the user to specify non-composite and composite utility loads (UT1 and UT2). The DW load factor is applied to all these loads (Request 402).**

4. **The average of the floorbeam spacing has been reimplemented in the program as an absolute upper bound on the effective slab width, and the method used for calculating the effective slab width has been added to the ADDITIONAL SECTION PROPERTIES tables (Request 432).**

5. **On the MAT command, if the tensile strength is left blank, the program will attempt to set a default value of tensile strength based on the input yield strength. If the input yield strength is shown on Table 6.4.1-1 in the LRFD Specifications the program will set the tensile strength equal to the value shown on the table. If the input yield strength is not shown on the table, the program will stop with an error and the user must enter the tensile strength. If the input yield strength is greater than the input tensile strength, the tensile strength will be set to be equal to the yield strength (Request 457).**

6. **The lower limit of brace spacing (BRP command) has been increased to 1 foot. As a result, if the user enters a brace spacing of zero, the program will stop with an input error and stop rather than crashing (Request 460).**

7. **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 vehicle is rating-only vehicle and previously had output reports and specification checks included in the output such as WEB SPECIFICATION CHECK which are not utilized to calculate a rating for the rating vehicles (Request 466).**

8. Formatted output reports for the OUTPUT OF INPUT DATA (OIN), OUTPUT OF SECTION PROPERTIES (OSP), 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 users to see which output reports have been turned on or off for a given run of the program (Request 468).

9. The section resistance corresponding to the controlling rating (Flexure or Shear) has been added as a new line on the BRIDGE LOAD RATINGS output report (Request 489).

10. An input for the classification strength of the weld metal has been added to the BST command for the weld size calculation for Bearing Stiffener analysis. (Request 492).

11. The User's Manual and program output have been revised to make clear that when DC2, FWS, MC2, sidewalk dead load, or additional FWS loads are entered for a beam that is non-composite in the final state, the loads are always applied to the non-composite, steel-only section. (Request 495).

12. Input parameters without a default value are now indicated as such in the Engineering Assistant configuration files (shown as "Default: None"). For the parameters that have a default value in UM and the FBLRFD.PD but not in the configuration files, the default values have been added to the configuration files. The mismatched default values have been updated in either the UM or the FBLRFD.PD to maintain consistency (Request 497).

13. The legend for bend-buckling coefficient has been added to the UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 1) output report and updated on the SERVICE LIMIT STATE - WEB BEND-BUCKLING output report (Request 500).

14. The web concentrated load checks, previously implemented for rolled beams only, are now also applied to plate girders and built-up sections (Request 502).

15. The program has been modified to use the depth between rivets/bolts for the web proportion check (Request 503).

16. The program has been revised to print the proper column headings for the DEAD LOADS output when the DEAD LOADS output extends to more than one page. Previously the column headings would be incorrect for floorbeams with stringers when the report extended to more than one page (Request 506).

17. The program has been revised to use the built-up section effective flange dimensions described in the User’s Manual section 3.3.4 for the flange proportion checks on the DUCTILITY AND WEB/FLANGE PROPORTION CHECK output report (Request 513).

18. A program crash during self-weight calculations has been resolved by internally combining adjacent ranges of self-weights with identical load magnitudes (Request 514).

19. **A typographical error in the program source code has been resolved that now allows the minimum rating factors to be reported on the RATING FACTORS – MOMENT FLEXURAL CAPACITY table. An error in calculating rating factors due to net section fraction has been fixed for the RATING FACTORS – STRESS FLEXURAL CAPACITY table. (Request 515).**

20. **The program will print "N/A" for the unfactored flexural stresses due to pedestrian live load (PL) for limit states other than Strength-IP (Request 517).**

21. **The OAN, OIN, ORF, OSC, and OSP 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 (Requests 501 and 519).**

22. **A Chief Bridge Engineer warning has been added to the input validation for floorbeams deeper than 14 ft, as per DM-4 Section 6.10.1. (Request 520).**

23. **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 (Requests 100, 533).**

24. **The number of special live loads available in a single run has been increased from five to eight (Requests 288, 534).**

25. **The lower limit of brace spacing (BRP command) has been increased to 0.05 feet. As a result, if the user enters a brace spacing of zero, the program will stop with an input error and stop rather than crashing (Requests 460, 535).**

26. **On the MAT command, if the tensile strength is left blank, the program will set a default value of tensile strength based on the input yield strength. If the input yield strength is shown on Table 6.4.1-1 in the LRFD Specifications or on Table 6A.6.2.1-1 in the Manual for Bridge Evaluation, the program will set the tensile strength equal to the value shown on the table, otherwise the tensile strength will be set based on the values in the Table 5.13-1 of the User's Manual. If the input yield strength is greater than the input tensile strength, the tensile strength will be set to be equal to the yield strength. (Requests 457, 536).**

27. **The program has been revised to use the built-up section effective flange dimensions described in the User's Manual section 3.3.5 for the flange proportion checks on the DUCTILITY AND WEB/FLANGE PROPORTION CHECK output report. Section 3.3.5 of the User's Manual has been revised to clarify that the "b" dimensions are computed from the edge of bolt or rivet holes. (Request 513, 537)**

28. The program now runs to completion for Multiple Live Load Placement runs that include the PHL-93 vehicle with a Special Live Load vehicle. Previously, Multiple Live Load Placement runs with PHL-93 and Special Live Load vehicles resulted in a program crash. (Request 538)

Program Output Revisions

29. An output switch that provides the load ratings with and without FWS has been added to command ORF (Request 296).

Program Documentation Revisions

30. There are 5 parameters that are no longer used by the program. The User's Manual, config files, the PD file, and some source codes for the parameters have been updated for FBREV480 and FBREV494, so that the users are informed that these parameters are no longer used. (Request 453).

31. 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 498).

32. Additional text has been added to the transverse stiffener (TST) and bearing stiffener (BST) commands in the EngAsst configuration files and FBLRFD User's Manual 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 518).

33. The FAX number from Chapter 9 of the User's Manual and the revision request form has been removed as it is no longer monitored (Request 521).

34. Windows 8.1 operating system has been removed from the User's Manual as a supported operating system. (Request 532).

User's Manual Revisions

35. The program has been revised to use the built-up section effective flange dimensions described in the User's Manual section 3.3.5 for the flange proportion checks on the DUCTILITY AND WEB/FLANGE PROPORTION CHECK output report. Section 3.3.5 of the User's Manual has been revised to clarify that the edge distances are measured from the center of the holes. (Requests 513, 537, 540)

Requests Do Not Need Revision

36. **This request is a duplicate of FBREV519. The OAN, OIN, ORF, OSC, and OSP 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 501).**

Requests on Hold

37. **A request regarding adding reaction summary tables is on hold because it is not clear that which reactions tables are helpful for engineers when they analyze and design floorbeams (Request 111).**

38. **A request regarding generating data for DBP.CSV database file is on hold because FBREV447 is not done. We will revisit this request when FBREV447 is done (Request 472).**

39. **A request regarding not producing DBT and CSV files for APRAS runs is on hold because FBREV447 is not done. We will revisit this request when FBREV447 is done and the FBLRFD program generates the DBT and CSV output files. We will need to make sure the DBT and CSV files are not created for APRAS runs (Request 476).**

1 GENERAL DESCRIPTION

1.1 PROGRAM IDENTIFICATION

Program Title:	LRFD Floorbeam Analysis and Rating
Program Name:	FBLRFD
Version:	1.8.0.0
Subsystem:	Superstructure
Authors:	Pennsylvania Department of Transportation, Michael Baker International and Modjeski and Masters, Inc.

ABSTRACT:

The LRFD Floorbeam Analysis and Rating program (FBLRFD) 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 floorbeams of a two girder system bridge 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 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: (1) a simple span with or without applied moments at the ends and with no overhangs, (2) a floorbeam with cantilever overhangs continuous over the supports, and (3) a simple span with or without applied moments at the ends and with fixed end cantilevers at one or both ends of the span. 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 program does not design a floorbeam.

After the analysis is performed, FBLRFD 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.

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.
FBLRFD	-	LRFD Floorbeam Analysis and Rating program.
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
PennDOT	-	Pennsylvania Department of Transportation.
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 rate steel floorbeams, both noncomposite and composite. FBLRFD 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 floorbeam floor system can consist of: (1) a deck supported by floorbeams and stringers or (2) a deck supported by floorbeams only, without stringers. The analysis is based on a single floorbeam and the fraction of the axle live loads that are transferred from the deck or stringers to the floorbeam. The user can define the location of each traffic lane or allow the program to generate the number and placement of the traffic lanes. The floorbeam 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: (1) a simple span floorbeam with or without applied moments at the ends and with no overhangs, (2) a floorbeam with cantilever overhangs continuous over the supports, and (3) a simple span floorbeam with or without applied moments at the ends and with fixed end cantilevers at one or both ends of the span. 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.

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

FBLRFD 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-entered 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. The program considers reduction in section properties due to deterioration. Section holes are considered for net section fracture specification checks only.

3. Structural Analysis - The program uses the PennDOT Continuous Beam Analysis (CBA) program to compute the moments, shears, reactions, rotations, and deflections for the permanent loads and influence lines for transient loads. Permanent loads are **dead** loads due to the concrete deck, dead loads of structural components and nonstructural attachments (DC), dead loads of wearing surfaces (FWS), **miscellaneous dead loads (MC1 and MC2), or utility loads (UT1 and UT2).** DC loads applied to the section **before slab placement** are referred to as DC1 or DC1S loads, and DC loads applied to the section **after slab placement** are referred to as DC2 loads. Miscellaneous loads which act on the section **before slab placement** are referred to as MC1 loads, and miscellaneous loads which act on the section **after slab placement** are referred to as MC2 loads. **Utility loads which act on the section before slab placement are referred to as UT1 loads, and utility loads which act on the section after slab placement are referred to as UT2 loads.** In addition, permanent loads applied to the section **before slab placement** only when the sidewalks are present is referred to as PDC2 loads, and future wearing surface load applied to the section **after slab placement** only when the sidewalks are present is referred to as PFWS 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, MC1, MC2, **UT1, UT2,** PDC2, **and** PFWS) 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, 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 and deflection load effects are also multiplied by the appropriate load factors.

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.

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 floorbeam. Fatigue life is computed for specified details which are input by the user.

8. **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.**

2.3 FLOORBEAM TYPES AND SECTIONS

This program can be used to perform an analysis of a single steel floorbeam, such as the floorbeam of a girder-floorbeam-stringer steel bridge and the floorbeam of a girder-floorbeam steel bridge. Schematic cross sections of these bridge types are presented in Figures 1 and 2.

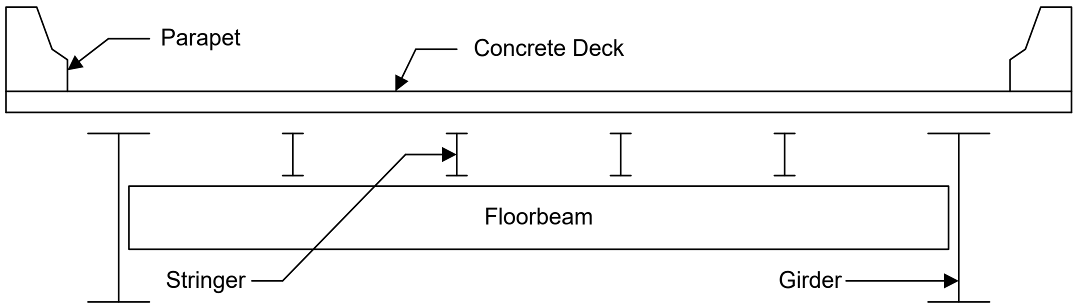


Figure 2.3-1 Schematic Cross Section of a Girder-Floorbeam-Stringer Steel Bridge

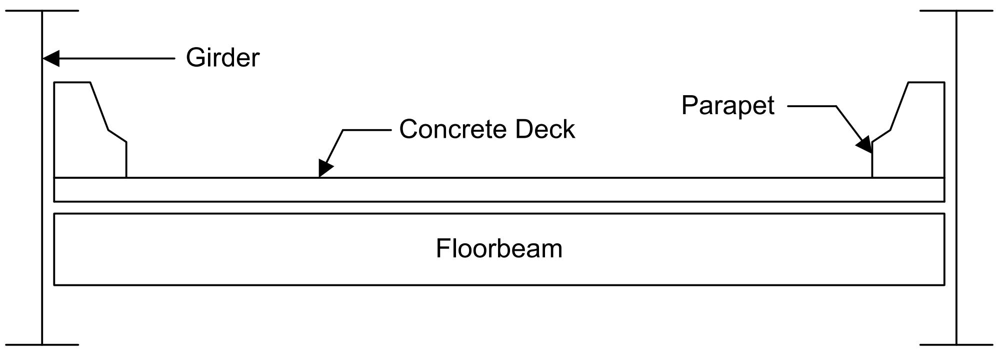


Figure 2.3-2 Schematic Cross Section of a Girder-Floorbeam Steel Bridge

The floorbeam cross sections which can be input include user-defined rolled beams, AISC wide flange rolled beams, plate girders, and built-up sections 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 floorbeam cross sections are presented in Figure 3. The sections can be composite or noncomposite.

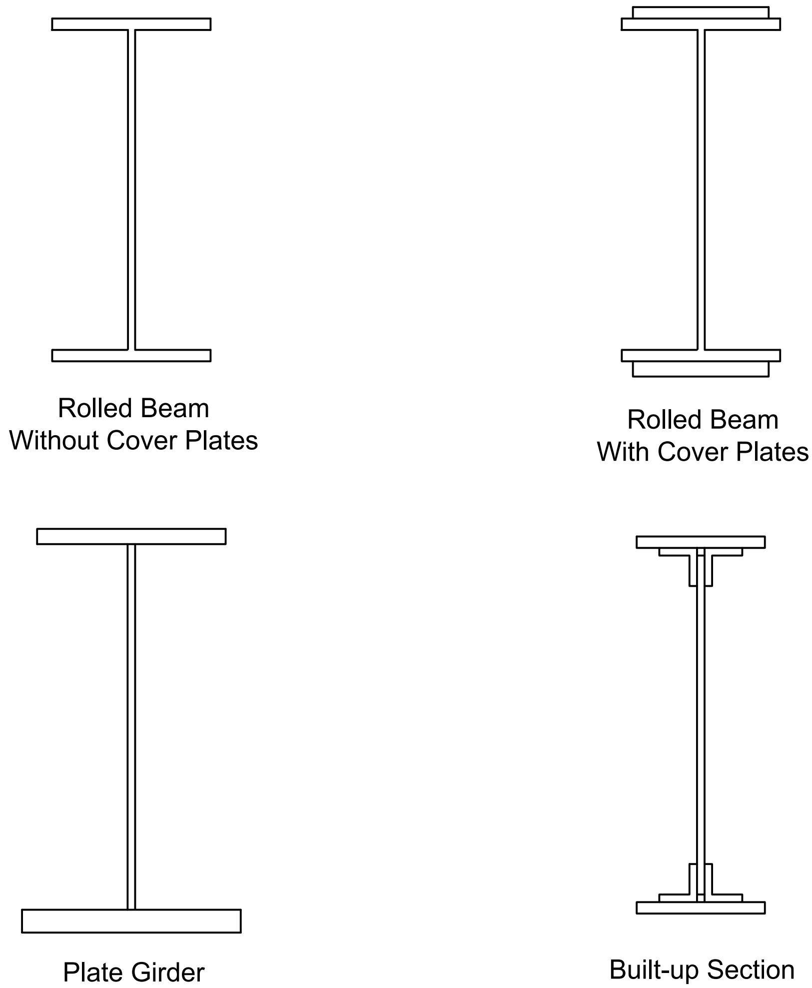


Figure 2.3-3 Steel Floorbeam Cross Sections

The program can analyze: (1) a simple span with or without applied moments at the ends and with no overhangs, (2) a floorbeam with cantilever overhangs continuous over the supports, and (3) a simple span with or without applied moments at the ends and with fixed end cantilevers at one or both ends of the span. These floorbeam support types are presented in Figure 4, in the order listed above.

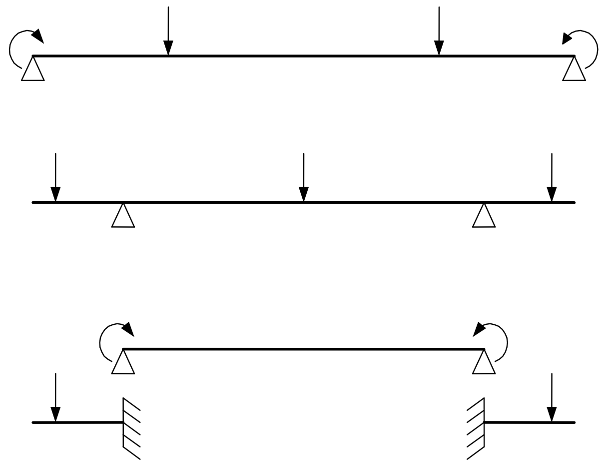


Figure 2.3-4 Floorbeam Support Types

2.4 LIVE LOADINGS

The user has several live load options for performing an analysis. 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
HS20	-	AASHTO HS20 live loading
H20	-	AASHTO H20 live loading
SLL	-	User-defined special live loading
TK527	-	PennDOT TK527 live loading
EV2	-	PennDOT single rear axle emergency vehicle
EV3	-	PennDOT tandem rear axle emergency vehicle
SU6TV	-	PennDOT heavy-duty tow and recovery vehicle

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 reaction on the interior floorbeams only, the factor for the effect of two design trucks and design lane load is 100% for the PHL-93 loading and 90% for the HL-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 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, 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, with EV2, EV3, and SU6TV in Figure 3. 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 are designated by the user by entering a live load code. The live load code is an upper case alphabetic character (A through G). The live load designations used for each live load code and each load case are summarized in Table 1. The load cases are for the LRFD limit states, fatigue check, deflection check, and ratings. Separate rating tables are generated for each live load designation.

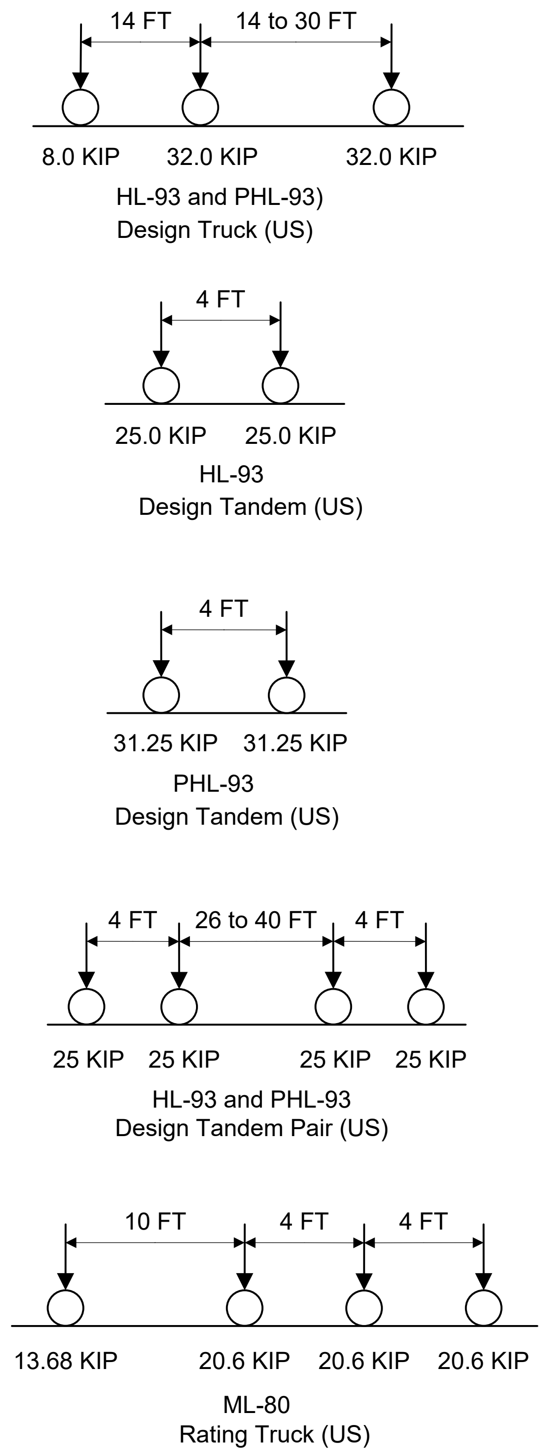


Figure 2.4-1 LRFD and ML-80 Live Loading

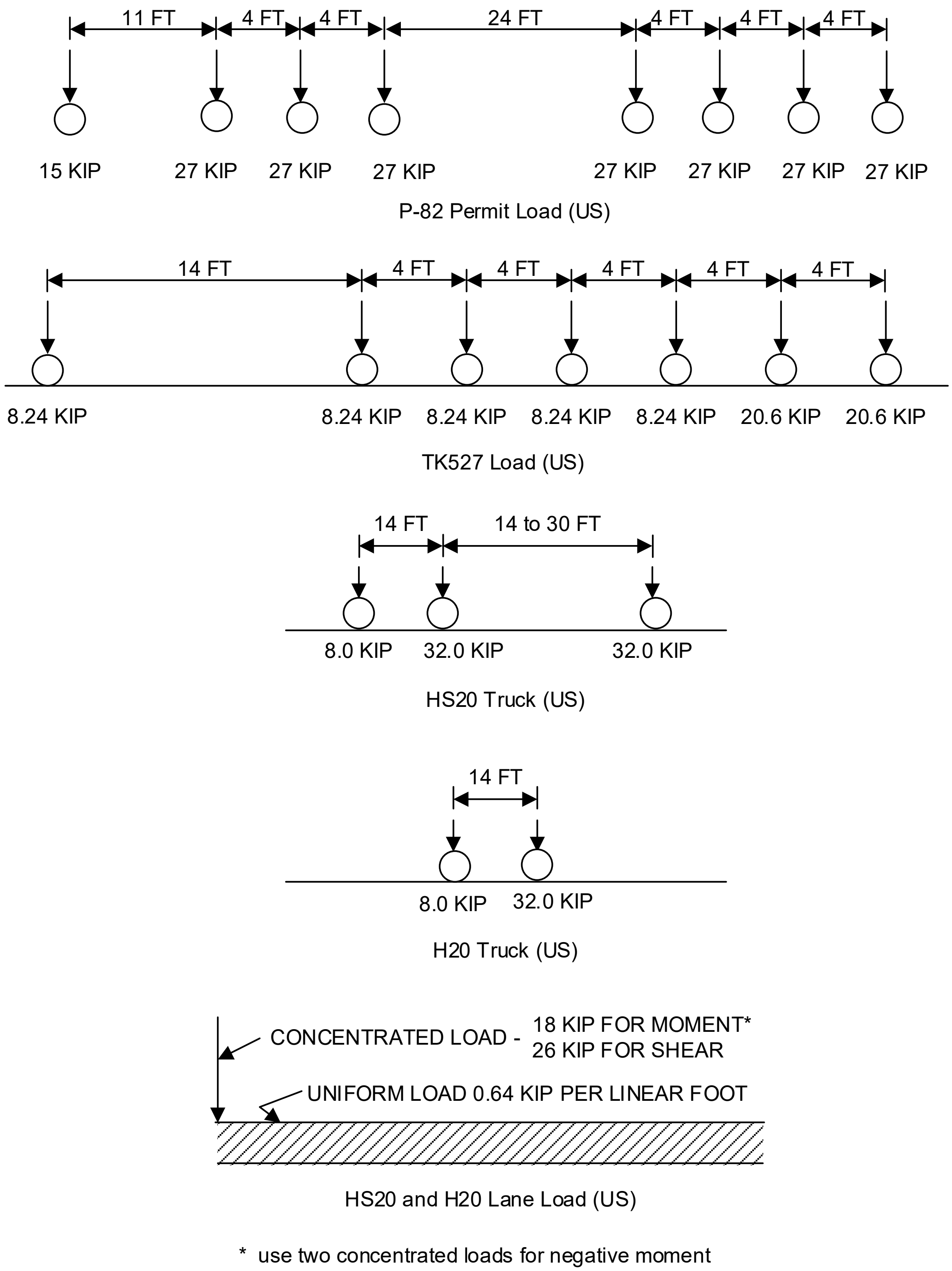


Figure 2.4-2 P-82, TK527, HS20, and H20 Live Loading

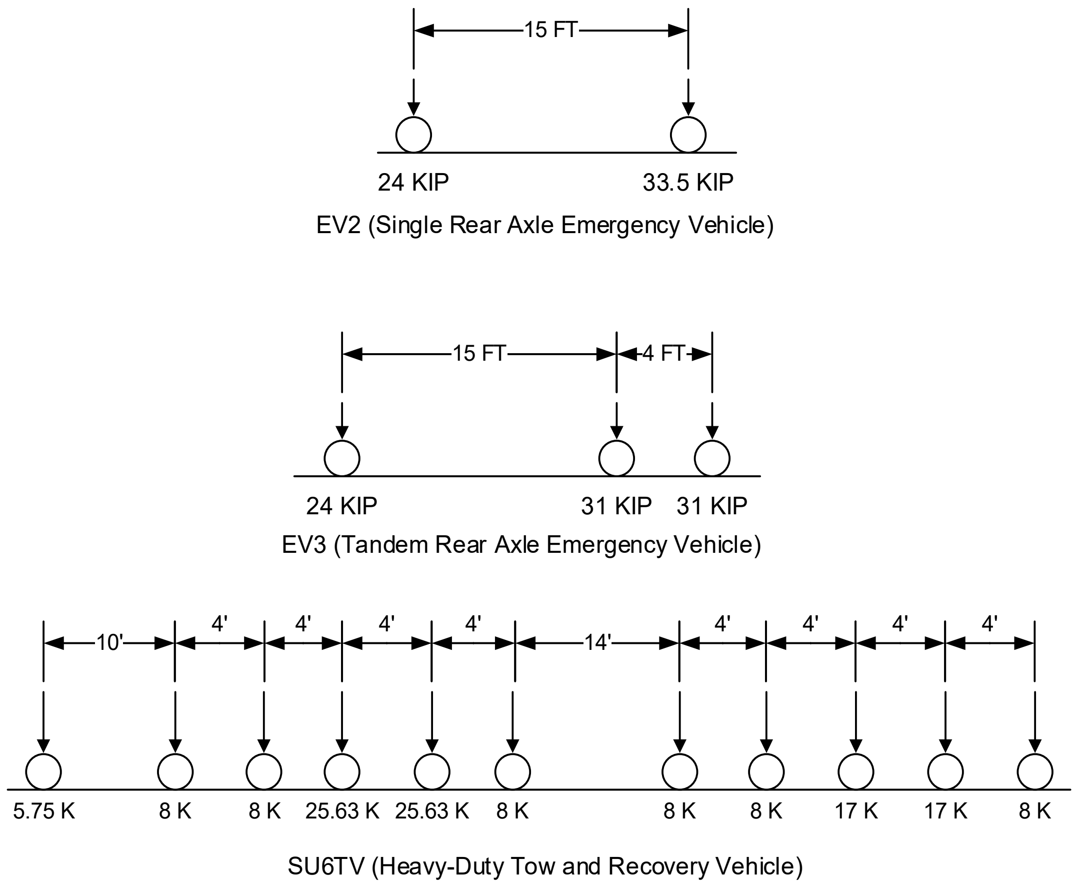


Figure 2.4-3 EV2, EV3, and SU6TV Live Loading

Table 2.4-1 Live Loadings

Load Case	Live Load Code							
	A	B	C	D	E[2]	F	G	H
Strength I Limit State	PHL-93 H20 HS20 ML-80 TK527	HL-93 H20 HS20	ML-80	none	SLL	User-specified	TK527	none[1]
Strength IP Limit State	PHL-93 H20 HS20 ML-80 TK527	HL-93 H20 HS20	ML-80	none	SLL	User-specified	TK527	none[1]
Strength IA Limit State	PHL-93	HL-93	none	none	none	User-specified	none	none[1]
Strength II Limit State	P-82 H20 HS20 ML-80 TK527	H20 HS20	ML-80	P-82	SLL	User-specified	TK527	EV2 EV3 SU6TV
Service II Limit State	PHL-93 H20 HS20 ML-80 TK527	HL-93 H20 HS20	ML-80	none	SLL	User-specified	TK527	none[1]
Service IIA Limit State	PHL-93 H20 HS20 ML-80 TK527	HL-93 H20 HS20	ML-80	none	SLL	User-specified	TK527	EV2 EV3 SU6TV
Service IIB Limit State	P-82	none	none	P-82	none	User-specified	none	none[1]
Fatigue I Limit State Fatigue II Limit State	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle
Deflection	PennDOT Deflection Loading	LRFD Deflection Loading	none	none	none	User-specified	none	none[1]
Ratings	PHL-93 P-82 H20 HS20 ML-80 TK527	HL-93 H20 HS20	ML-80	P-82	SLL	User-specified	TK527	EV2 EV3 SU6TV

Notes:
1. "none" denotes that the specified live load designation does not apply for the live load code.
2. The limit state applicability shown here for special live load runs are the default limit states. The user can change the applicable limit states by entering load factors for special live loads on the LDF command.

For the ML-80, TK527, P-82, EV2, EV3, and SU6TV live loadings when computing reactions on the floorbeam, only one truck unit is considered longitudinally on the structure. In calculating the reaction 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.

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

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 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.

In locating the live loadings along the length of the floorbeam, two options are available to the user. The user can define the location of each traffic lane or allow the program to generate the number and placement of the traffic lanes. In addition, the user can place specific live loads in specific lanes on the bridge.

2.5 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 factored dead load and pedestrian load moments. The reserve stress capacity is equal to the section stress capacity minus factored dead load and pedestrian load stresses. Similarly, the reserve shear capacity is equal to the section shear capacity minus factored dead load and pedestrian load shears. **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.**

The program allows the user to place specific live loads in specific lanes on the bridge. If more than one live load type is placed on the floorbeam, the user must specify the live load type for which ratings are desired. If more than one type of live loadings are entered by the user, the live loading for which ratings are not requested is treated as a permanent load in the calculation of the rating factor. That is, it is subtracted from the reserve capacity in the numerator of the rating factor equation. The factored live load effect in the denominator is based only on the live load type for which ratings are desired.

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 of time. The operating rating is the load that may produce the absolute maximum permissible stress, and it is the maximum load allowed on the structure.

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 2.5-1 Live Load Ratings

Live Loading	Live Load Combination						
	Strength I	**Strength IP**	**Strength IA**	**Strength II**	**Service II**	**Service IIA**	**Service IIB**
PHL-93/ HL-93	I	I	O	--	I	O	--
P-82	--	--	--	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	I	--	O	I	O	--
EV2	--	--	--	O	--	O	--
EV3	--	--	--	O	--	O	--
SU6TV	--	--	--	O	--	O	--

Notes:

I - Inventory

O - Operating

2.6 ASSUMPTIONS AND LIMITATIONS

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

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

2. The steel floorbeam 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. A floorbeam 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.

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

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

6. 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 FBLRFD computes the factored stresses throughout the section using negative flexure section properties.

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

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

D. 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 FDL command.

8. The program automatically places analysis points at twentieth points of each floorbeam between supports, at tenth points on the overhangs, at plate transition locations, at bracing points, at concentrated load points, at stringer locations and at user-defined fatigue locations. The program uses a tolerance on analysis points of 0.05 inches. That is, if two analysis points are within 0.05 inches of each other, then the program assumes that they are the same point.

9. For analysis locations directly at transitions between section ranges, specification checks are done immediately to the left and to the right of the transition.

10. For a floorbeam to qualify as a symmetric beam (CTL command, SYMMETRY parameter), all input values for the floorbeam must be symmetric and they must be entered for the first half of the floorbeam length only.

11. The program computes the effective points of contraflexure based on a uniform dead load placed over the length of the floorbeam in the noncomposite state. The composite dead load analysis results and the live load analysis results do not affect the effective points of contraflexure. The effective points of contraflexure are only used to define shear connector design regions. If the span configuration of the floorbeam is such that no dead load contraflexure points exist, the shear connector design regions will be defined from the support to the midlength of the floorbeam, assuming negative flexure in all design regions.

12. The program does not perform a serviceability check on the deck reinforcing steel.

13. The program always performs the analysis and the specification check based on the twentieth points between floorbeam supports and based on tenth points on the floorbeam overhangs, regardless of whether these analysis points have been selected by the user to be included in the output.

14. 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.

15. 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, when in fact the specification check warning or failure is for an analysis point that was not selected by the user to be printed.

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

17. The program will only consider the effects of section holes (entered using the SHO command) when computing the net tension flange area, An, 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.

18. The program always assumes unshored construction.

19. 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.

20. Blast loading defined in LRFD Specifications Article 3.15 is not considered by FBLRFD. Blast loading is not shown in the DM-4 load factor Table 3.4.1.1P-5 for steel floorbeams which indicates that it should not be considered, even though the AASHTO section for blast loading was not deleted in DM-4.

21. 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.

22. All references to articles and equations in this manual refer to articles and equations in the AASHTO LRFD Bridge Design Specifications, Seventh Edition, 2014 or PennDOT Design Manual Part 4, April 2015 Edition. However, not all of the calculations inside the FBLRFD program have been updated to conform to these specifications. Table 1 describes the calculations that have not yet been updated to the 2014 LRFD Specifications or 2015 DM-4 in the FBLRFD program. Unless otherwise specified, the FBLRFD calculations conform to the 2014 AASHTO LRFD Bridge Design Specifications both in the manual and in the program.

Table 2.6-1 References to Articles and Equations that are yet to be incorporated in FBLRFD

2014 AASHTO Relevant Article	Topic	Change Not Incorporated in FBLRFD
3.15	Blast Loading	Blast loading is not shown in the DM-4 Load Factor table for steel floorbeams (DM-4 Table 3.4.1.1P-5), 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.
6.10.1.7	Minimum Negative Flexure Concrete Deck Reinforcement	Wherever the longitudinal tensile stress in the concrete deck due to either the factored construction loads or Load Combination Service II exceeds the modulus of rupture, the total cross-sectional area of the longitudinal reinforcement shall not be less than 1 percent of the total cross-sectional area of the deck.
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
6.10.4.2.1	Service Limit State, General	No checks relating to Article 6.10.1.7 have been implemented.
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 FBLRFD
Appendix D6.4	Lateral Torsional Buckling Equations for C_b > 1.0	The program does not consider developing the maximum flexural resistance through the provisions of Appendix D6.4.
Appendix D6.5	Web Crippling and Web Local Yielding	Web Local Yielding (D6.5.2) and Web Crippling (D6.5.3) checks at all concentrated load locations and reactions for plate girders and built-up sections have not been added.

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 analyze and rate steel floorbeams. 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 and rating of a floorbeam used for highway bridges, the following steps are generally required:

1. Calculate floorbeam section properties.
2. Calculate dead load effects.
3. Calculate live load effects.
4. Combine dead and live load effects.
5. Calculate floorbeam section resistance.
6. Perform specification checking.
7. 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 floorbeam sections and bridge geometry are known, and the program performs all calculations mentioned above.

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 Step 7.

Chapter 3 Method of Solution

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 floorbeams (in)
$b_{eff,int}$	=	effective flange (slab) width for interior floorbeams (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 dead load **applied after slab placement** (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 non-compact sections

L = span length (ft)

L_b = unbraced length (in)

L_{eff} = effective span length used in computing the effective flange (slab) width and taken as the actual span length for simply supported spans and the distance between points of noncomposite permanent load inflection for continuous spans (ft)

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_{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 = shear interaction factor

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 floorbeam for the noncomposite section (in^3)

$S_{bg,3n}$ = section modulus at bottom of floorbeam for the composite 3n section (in^3)

$S_{bg,n}$ = section modulus at bottom of floorbeam for the composite n 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_{int} = spacing of interior floorbeams measured from centerline to centerline of floorbeam and along a line normal to the floorbeam (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 floorbeam for the noncomposite section (in^3)

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

$S_{tg,n}$ = section modulus at top of floorbeam for the composite n 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)

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 floorbeam for the noncomposite section (in)

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

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

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

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

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

$Y_{tg,n}$ = distance from neutral axis to the top of floorbeam for the composite n 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)

$\Delta_{pedestrian}$ = total deflection due to pedestrian live load (in)

$\Delta_{vehicle}$ = total deflection due to 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 and the structural analysis solutions. Floorbeam 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 floorbeam 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 floorbeam). For the purposes of analysis 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 the span length between supports and tenth points on the overhangs
3. Cross section transition points
4. Fatigue locations
5. Bracing points
6. Locations of concentrated loads
7. User-defined analysis points
8. Stringer locations

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 and floorbeam 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 three values of the modular ratio (0, n, and 3n), for both positive and negative flexure.

The user can enter section losses using the SLS command and section holes using the SLS or SHO 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 floorbeam.

The net section properties are used for all specification checks and ratings except the net section fracture checks. Section holes entered using the SHO 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 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 floorbeam, 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 floorbeam and the composite stiffness is used for the entire length of the floorbeam. 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 example, DC1 loads are applied to the noncomposite steel-only section and DC2 loads are applied to the composite 3n section.

Table 3.3-1 Section Properties for Analysis

Abbreviation	Load Type	Section Properties	
		Composite girders[1]	**Noncomposite girders[2]**
DC1 DC1S	Dead loads of structural components and nonstructural attachments	**Noncomposite**	Noncomposite
DC2	Dead loads of structural components and nonstructural attachments	**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 (3n)**	**Noncomposite**
PL	Pedestrian live load	**Composite (3n)**	**Noncomposite**
SLL	Special live load	**Composite (3n)**	**Noncomposite**

Notes:

[1] **Girders that are composite in the final state**

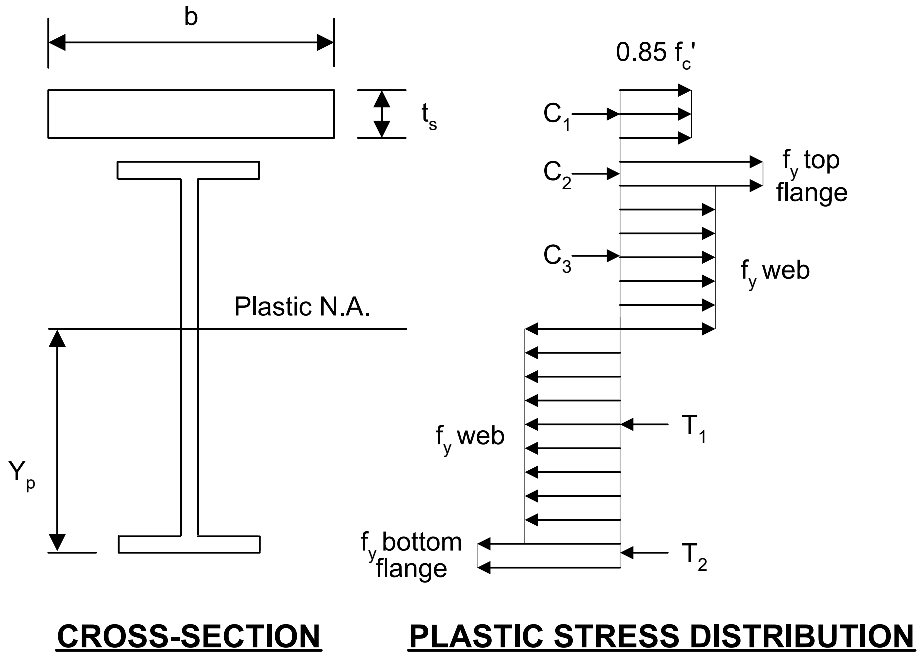
[2] **Girders that are noncomposite in the final state**

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 transverse 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.

The program computes the section properties to the right and left of every transition point and does specification checking at both locations. 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 property output reports 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 1. In calculating the plastic moment capacity of the steel section for positive moment, the forces in the transverse 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, $K_g = I_{beam}$
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 constructablity checks, $R_b = 1.0$

3.3.1 Effective Span Length

The effective span lengths are defined in accordance with Article 4.6.2.6.5 of the LRFD Specifications. For overhangs, the effective span length is two times the length of the cantilever. For other locations, the effective span length is the distance between the supports.

3.3.2 Effective Slab Width

The program computes the effective slab width in accordance with Article 4.6.2.6.5 of the LRFD Specifications. For interior floorbeams, the effective slab width is the minimum of three terms, as follows:

$$b_{eff,int} = minimum\left(\left(2 * \frac{1}{10} L_{eff}\right), \left(2 * 6t_{s,eff}\right), S\right)$$

where:

$b_{eff,int}$ = effective slab width for an interior floorbeam

L_{eff} = effective span length (defined in section 3.3.1)

$t_{s,eff}$ = effective slab thickness

S = floorbeam spacing. For interior floorbeams, this is equal to the average of the spacings on either side of the floorbeam of interest.

Exterior floorbeams are assumed to have a slab on one side of the web only, so the effective slab width is as follows:

$$b_{eff,int} = minimum\left(\frac{1}{10}L_{eff}, 6t_{s,eff}, \frac{1}{2}S\right)$$

where:

$b_{eff,int}$ = effective slab width for an exterior floorbeam

L_{eff} = effective span length (defined in section 3.3.1)

$t_{s,eff}$ = effective slab thickness

S = floorbeam spacing. For exterior floorbeams, this is equal to the distance from the floorbeam of interest to the first interior floorbeam.

3.3.3 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.

3.3.4 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 command 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. This cross section shows the notations used for plate girders without section losses and for plate girders with section losses.

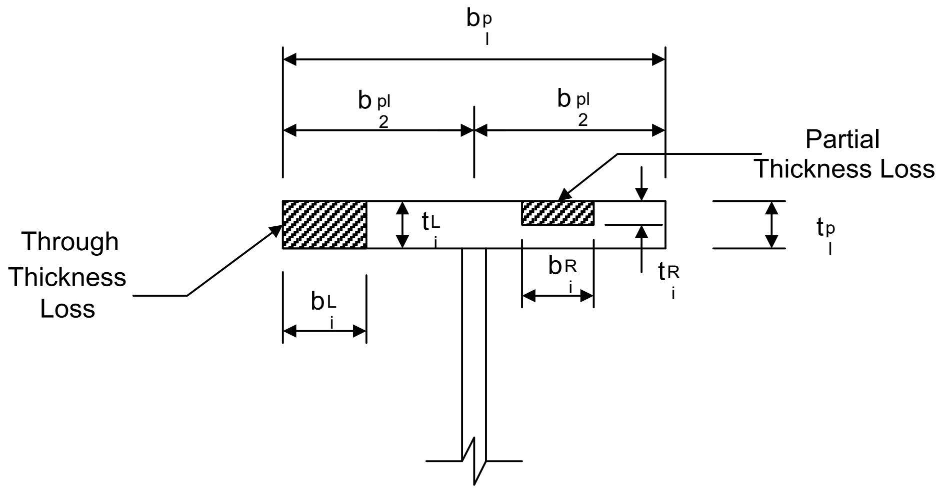


Figure 3.3-3 Cross-Sectional View of Plate Girder with Section Losses

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.

$$b_L = 2\left(b_{pl\,2} - \sum_{i=1}^{NTTL_L} b_{Li} \right)$$

$$t_L = 2\,\frac{\left[b_{pl\,2}\, t_{pl} - \sum_{i=1}^{NTTL_L} b_{Li}\, t_{Li} - \sum_{i=1}^{NPTL_L} b_{Li}\, t_{Li} \right]}{b_L}$$

$$b_R = 2\left(b_{pl2} - \sum_{i=1}^{NTTL_R} b_{Ri}\right)$$

$$t_R = 2\,\frac{\left[b_{pl2}\,t_{pl} - \sum_{i=1}^{NTTL_R} b_{Ri}\,t_{Ri} - \sum_{i=1}^{NPTL_R} b_{Ri}\,t_{Ri}\right]}{b_R}$$

$$if\ \frac{b_L}{t_L} \le \frac{b_R}{t_R},\ then\ b = b_R,\ t = t_R$$

$$if\ \frac{b_L}{t_L} > \frac{b_R}{t_R},\ then\ b = b_L,\ t = t_L$$

For Rolled Beams:

A cross-sectional view of the top portion of a rolled beam with a cover plate is presented in Figure 4. This cross section shows the notations used for rolled beams without section losses and for rolled beams with section losses.

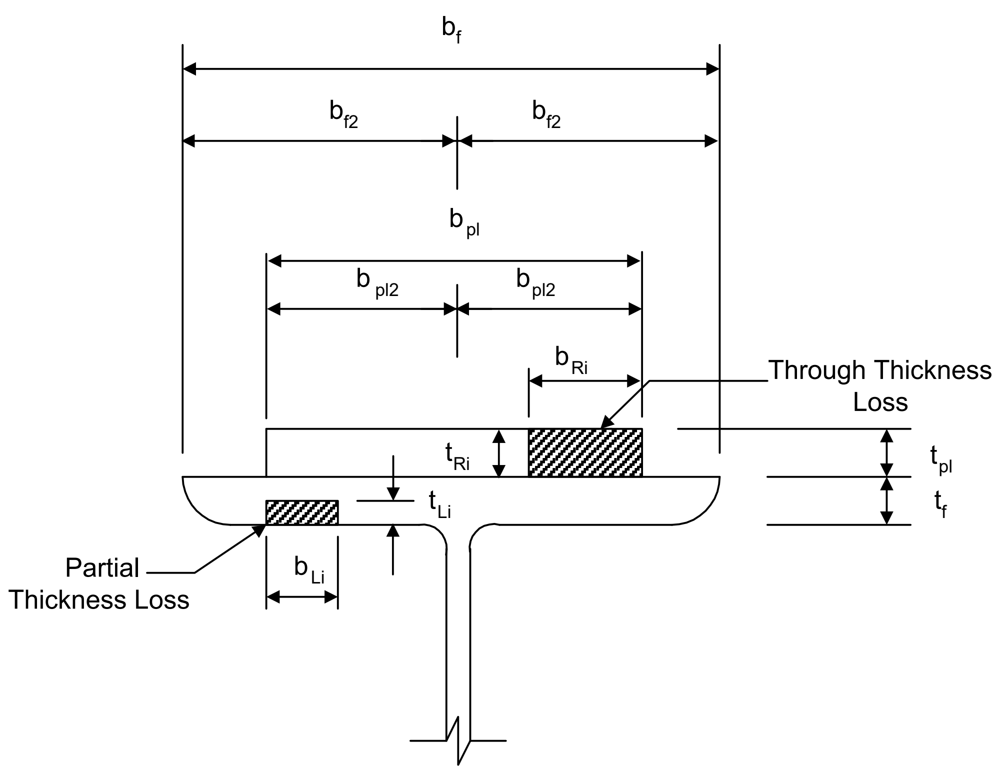


Figure 3.3-4 Cross-Sectional View of Rolled Beam with Section Losses

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.

$$b_L = Maximum\left[\,2\,(b_{f2} - \sum_{i=1}^{NTTL_L} b_{Li})\,,\, 2\,(b_{pl2} - \sum_{i=1}^{NTTL_L} b_{Li})\,\right]$$

$$t_L = 2\,\frac{\left[\,b_{f2}\, t_f + b_{pl2}\, t_{pl} - \sum_{i=1}^{NTTL_L} b_{Li}\, t_{Li} - \sum_{i=1}^{NPTL_L} b_{Li}\, t_{Li}\,\right]}{b_L}$$

$$b_R = Maximum\left[\,2\,(b_{f2} - \sum_{i=1}^{NTTL_R} b_{Ri})\,,\, 2\,(b_{pl2} - \sum_{i=1}^{NTTL_R} b_{Ri})\,\right]$$

$$t_R = 2\,\frac{\left[\,b_{f2}\, t_f + b_{pl2}\, t_{pl} - \sum_{i=1}^{NTTL_R} b_{Ri}\, t_{Ri} - \sum_{i=1}^{NPTL_R} b_{Ri}\, t_{Ri}\,\right]}{b_R}$$

$$if\ \frac{b_L}{t_L} \leq \frac{b_R}{t_R}\,,\ then\ b = b_R\,,\ t = t_R$$

$$if\ \frac{b_L}{t_L} > \frac{b_R}{t_R},\ then\ \ b = b_L\ , t = t_L$$

3.3.5 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 **the first two** case**s** two b/t ratios are checked and the b and t associated with the greater ratio **is** used when checking the b/t ratio in the **proportions** checking routines. **Only a single b/t ratio is checked for the third case (no flange plate).**

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**, B1,** and the length from the **center** of **the holes** to the edge of the flange plate, **B2**. The corresponding thicknesses are the total thickness of flange plate + angle**, T1,** and the thickness of the flange plate alone**, T2**.

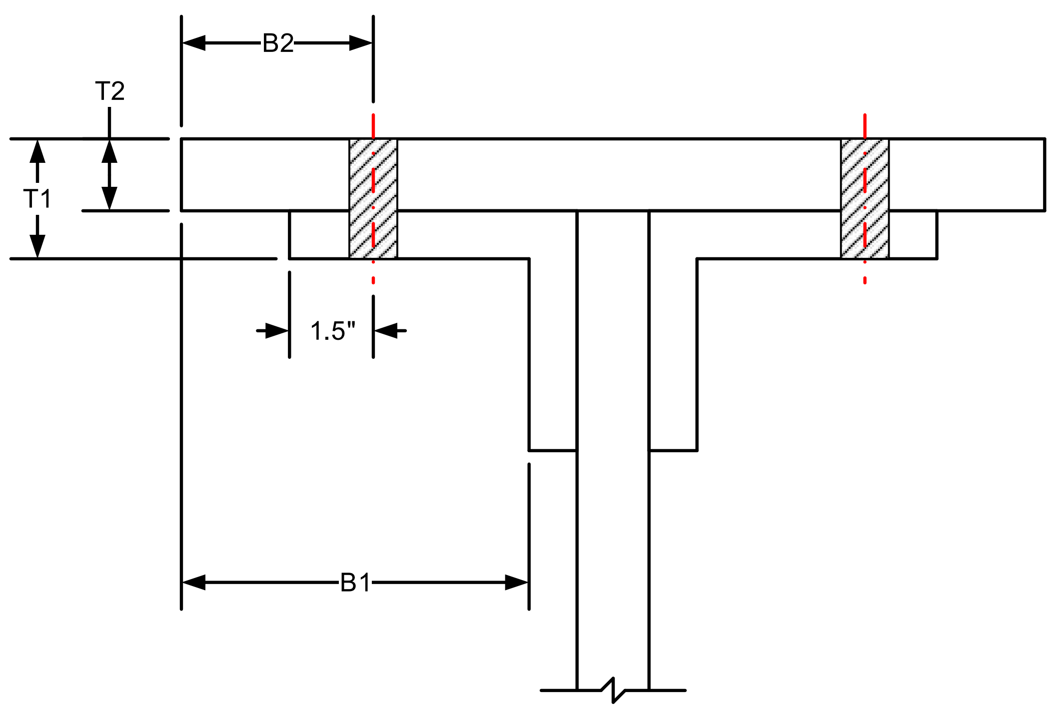


Figure 3.3-5 Flange Plate Wider Than Angles

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, **B1,** and the distance from the **center** of **the holes** to the outer edge of the angle, **B2,** are used for the widths. The corresponding thicknesses are the total thickness of the plate + the angle, **T1,** and just the angle thickness, **T2**.

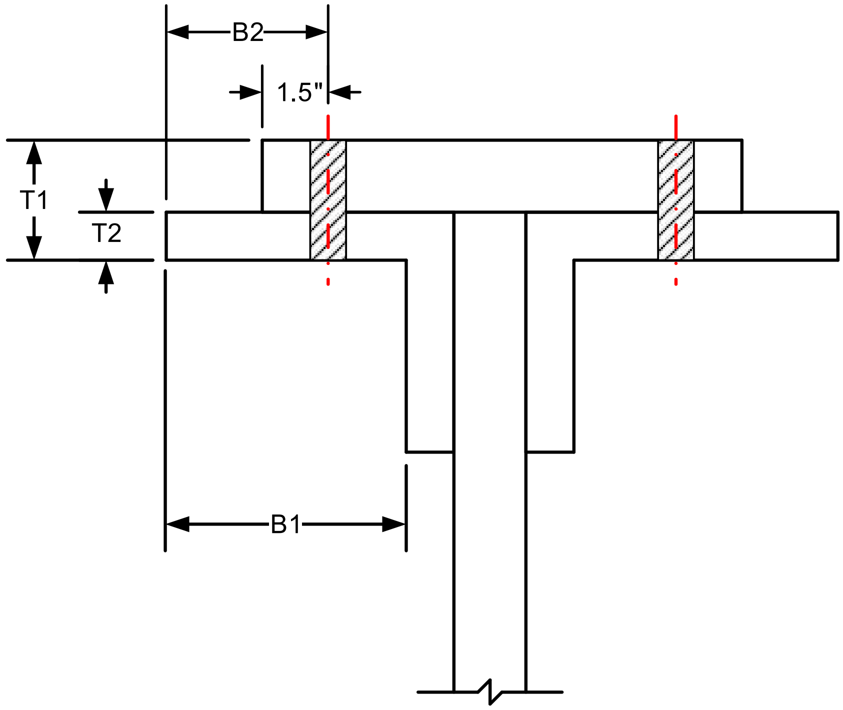


Figure 3.3-6 Flange Plate Narrower Than Angles

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, **B,** and the thickness to the thickness of the angle, **T**. In this case, there will only be one possible b/t ratio.

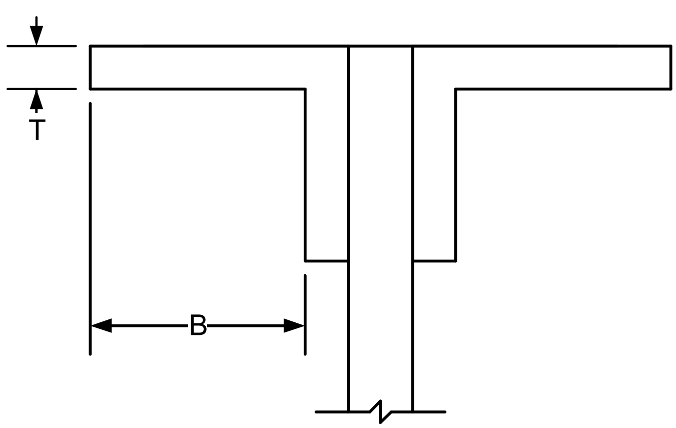


Figure 3.3-7 No Flange Plate Present

The program computes the depth of the web in compression assuming that the entire web is effective. 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 3.3.4 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.**

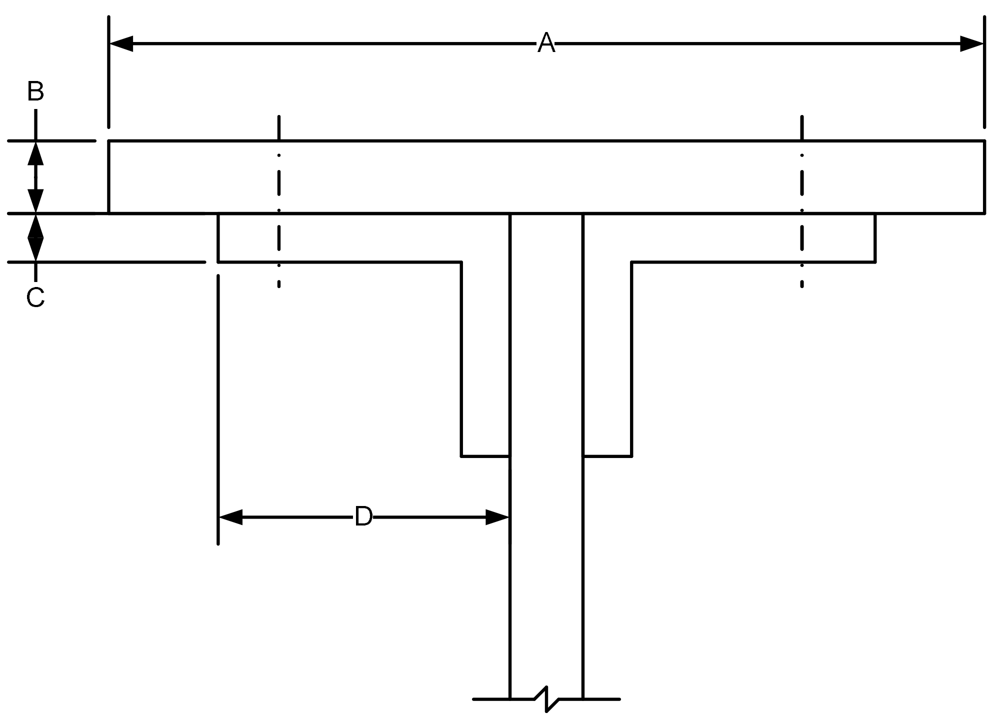


Figure 3.3-8 Dimensions for Equivalent Width and Thickness Calculations

$$TotalArea = A * B + 2 * D * C$$

$$EquivalentWidth = max\begin{vmatrix} A \\ 2 * D \end{vmatrix}$$

$$EquivalentThickness = \frac{TotalArea}{EquivalentWidth}$$

3.3.6 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

FBLRFD uses PennDOT's Continuous Beam Analysis (CBA) program to compute the moment, shear, reaction, rotation, and deflection as specified for the following load conditions and locations. CBA can perform a structural analysis of a longitudinal beam (such as stringer) and a transverse beam (such as floorbeam).

When stringers frame into the floorbeam, the following loads are applied to each stringer. CBA is used to find the reaction from the stringer to be applied to floorbeam for each of the following:

1. Inputted noncomposite DC1 dead loads.
2. Inputted noncomposite DC1S dead loads
3. Inputted miscellaneous noncomposite MC1 dead loads.
4. **Inputted noncomposite utility dead loads (UT1).**
5. Inputted DC2 dead loads.
6. Inputted future wearing surface FWS dead loads.
7. Inputted miscellaneous permanent MC2 dead loads.
8. **Inputted utility dead loads (UT2).**

These reactions are then placed as concentrated loads on the floorbeam and are included as part of the appropriate loads below.

For all floorbeams, CBA is used to compute moment, shear, deflection, reaction and rotation at each analysis point defined in Section 3.2 for:

1. Self-weight of the steel floorbeam.
2. Inputted noncomposite DC1 dead loads.
3. Inputted noncomposite DC1S dead loads
4. Inputted miscellaneous noncomposite MC1 dead loads.
5. **Inputted noncomposite utility dead loads (UT1)**
6. Noncomposite concrete deck dead load assuming the deck is poured instantaneously.
7. Inputted DC2 dead loads.
8. Inputted future wearing surface FWS dead loads.
9. Inputted miscellaneous permanent MC2 dead loads.
10. **Inputted utility dead loads (UT2)**
11. Influence lines.

CBA is also used to compute the reaction on the floorbeam from one traffic lane of each live loading.

CBA analyzes the floorbeam for a given loading condition and calculates the load effects at various analysis points, as explained in Section 3.4.1. 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.

3.4.1 Floorbeam Analysis by CBA

CBA can analyze three types of floorbeams: a simple span floorbeam supported on ends; a cantilever floorbeam continuous over one or two supports; a floorbeam simply supported between two main girders and one or two overhangs which are fixed at the girder and free at the other ends. All three floorbeam types described above are assumed to be statically determinate. The floorbeam between girders can also be assumed to be partially fixed at its ends.

The floorbeam is analyzed as follows. First the reactions at the supports due to a given load are determined by statics. The moments and shears at analysis points are then determined assuming a free body taking a section at the analysis point. Once the moments are calculated at all analysis points, the M/EI value is calculated at each analysis point., where M is the moment acting at the analysis point and EI is the product of the modulus of elasticity (E) and the moment if inertia (I) at the section. The M/EI is then applied as a loading on a conjugate beam of the actual structure. The moments and shears at analysis points in the conjugate beam due to the M/EI loading are then computed using the principles of statics. The moment at a section in the conjugate beam due to the M/EI loading is equal to the deflection at that section of the actual beam. The shear at a section in the conjugate beam due to the M/EI loading is equal to the rotation of the section of the actual beam.

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 effect at all analysis points produces the coordinates of an influence line for a given effect. These influence lines are then used to calculate the effect of a given dead load.

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 floorbeam, the concrete haunch over the floorbeam, and the concrete deck if no stringers are present. DC1S loads are permanent loads applied to the noncomposite section that are part of the floorbeam but not calculated by the program (i.e., stiffeners, splice plates). If stringers are present, the user must enter the deck load as a distributed load on each stringer. The user must input all other DC1 and DC1S loads due to components such as stay-in-place forms, diaphragms, stiffeners, and splice plates, as well as the self-weight and haunch weight of stringers, if present. The program computes the uniform load of the floorbeam 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 6.16.7). 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 1 for a typical deck cross section detail. For stringers framing into the floorbeam, the program considers only their location and continuity over the floorbeam. Therefore, the user must enter the self-weight, haunch weight, and deck weight manually as noncomposite stringer dead loads.

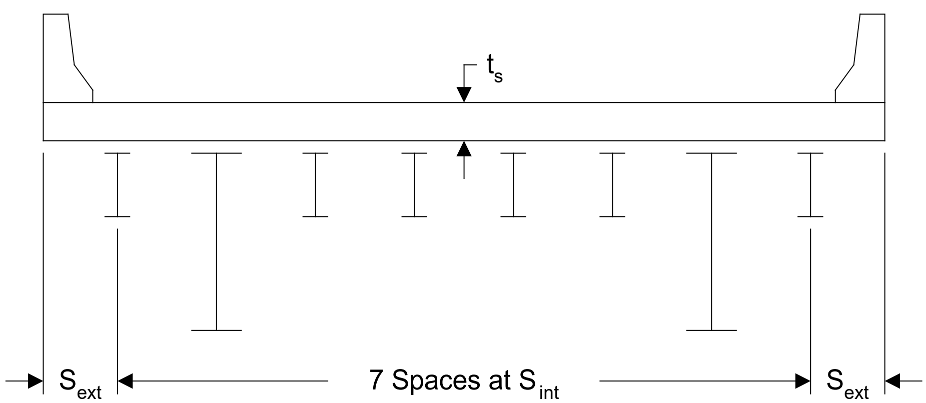


Figure 3.4-1 Typical Deck Cross Section

See Figure 2 for a typical girder-floorbeam bridge section and floorbeam haunch detail. This model is used to compute the load acting on each floorbeam due to the concrete deck when no stringers are present, and the haunch load for all floorbeams.

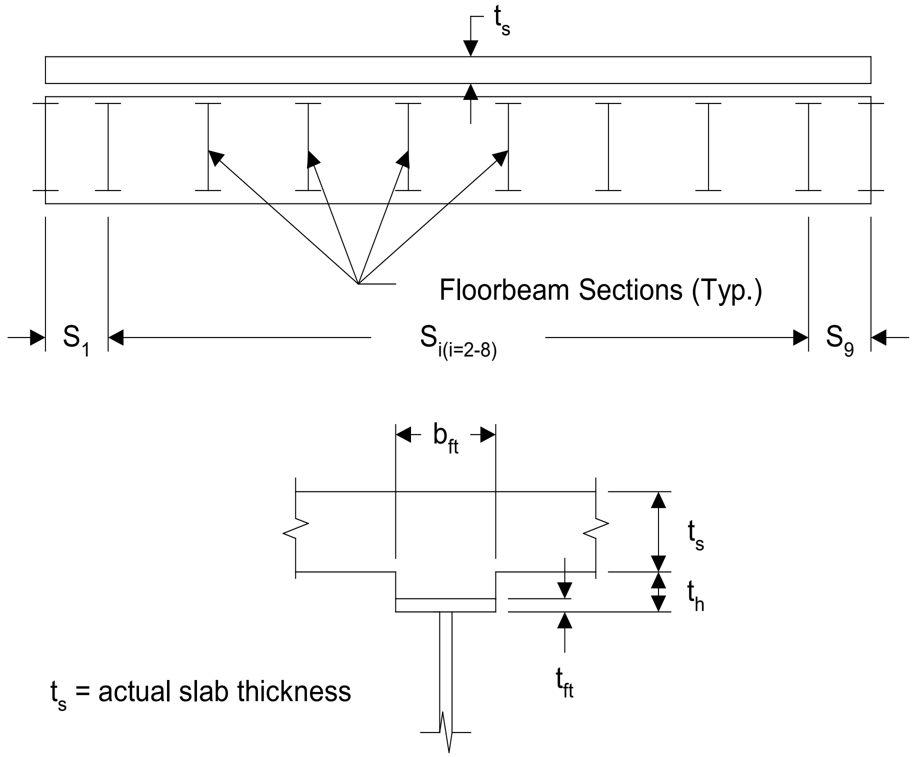


Figure 3.4-2 Typical Floorbeam Section and Haunch

For exterior floorbeams without stringers, the DC1 load due to the concrete slab is:

$$DC1_{slab} = \left(\frac{S_1}{2}\right)(t_s)\,(Concrete\ Density)$$

For interior floorbeams without stringers, the DC1 load due to the concrete slab is:

$$DC1_{slab} = \left(\frac{S_i + S_{i-1}}{2}\right)(t_s)\,(Concrete\ Density)$$

Where: i = number of the floorbeam currently being analyzed

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 floorbeam) 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.

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 floorbeams. 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 applied DC2, FWS, and UT2 loads to the steel-only sections.**

In addition to the DC1, 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 floorbeam
2. DC1 loads due to the concrete slab and haunch
3. DC1S loads due to noncomposite floorbeam loads such as stiffeners and splice plates
4. DC1 loads due to noncomposite stringer loads and loads input by the user
5. DC1S loads due to noncomposite stringer loads such as stiffeners and splice plates
6. Total DC1 loads
7. DC2 loads input by the user
8. FWS loads input by the user
9. **UT1 loads input by the user**
10. **UT2 loads input by the user**
11. MC1 loads input by the user
12. MC2 loads input by the user

3.4.3 Uncured Slab Analysis

The program performs 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.

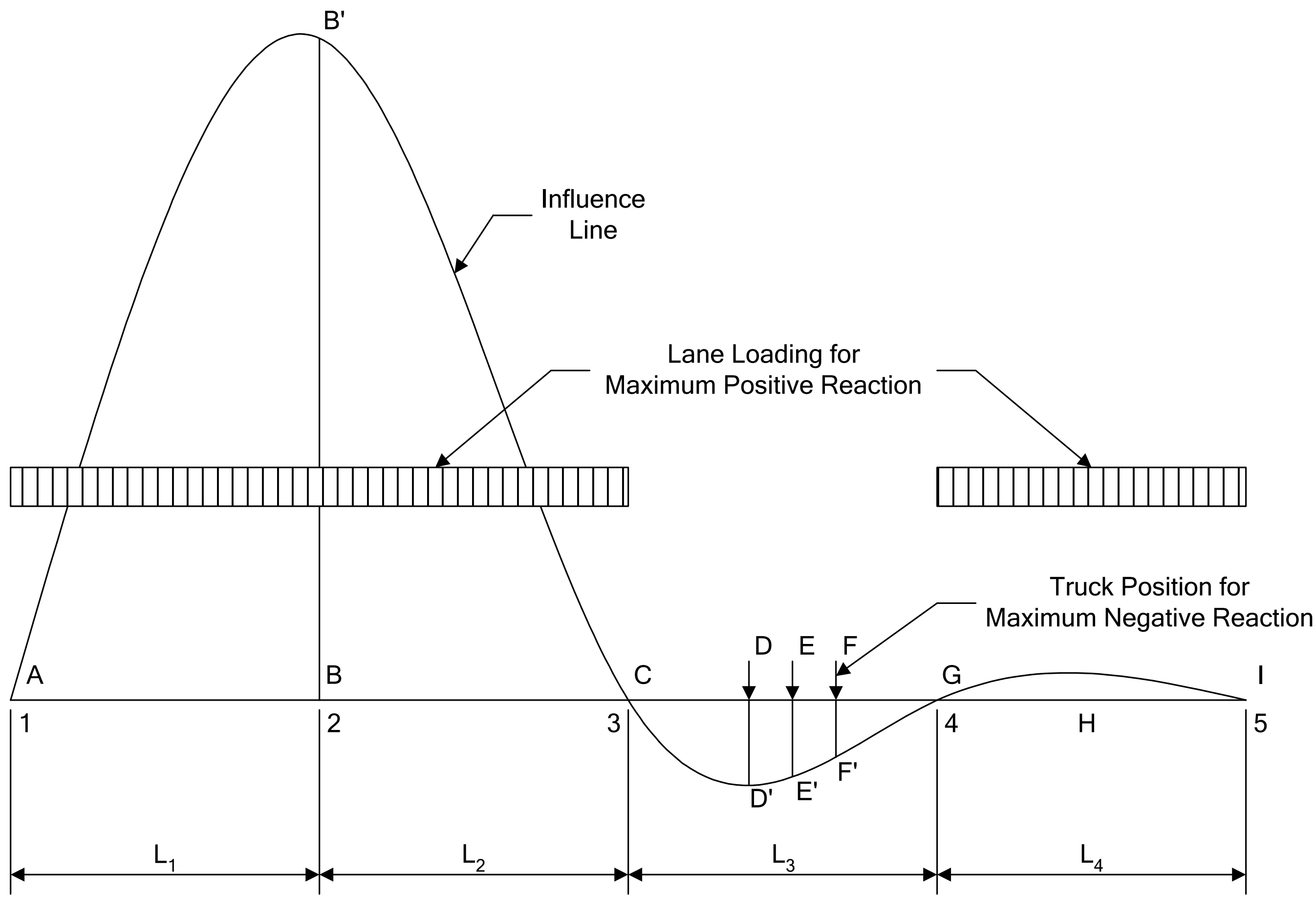


Figure 3.4-3 Influence Line for Reaction at Floorbeam 2

3.4.4 Live Load Reactions on Floorbeam

Live load reactions on the floorbeam can be determined by three different methods. If the deck is supported directly by the floorbeams and the floorbeam spacing is less than or equal to 6 feet (LRFD Specifications Table 4.6.2.2.2f-1), a distribution factor is computed based on the spacing of the floorbeams. The distribution factor is then multiplied by the heaviest axle of the live load vehicle to find the total reaction of one traffic lane on the floorbeam. If the floorbeam spacing exceeds the requirements on LRFD Specifications Table 4.6.2.2.2f-1, the total reaction is computed by CBA.

If stringers are present, a CBA run is performed assuming a stringer having as many spans as floorbeam spacings entered by the user. When entering the floorbeam spacings, the user also enters a code to designate whether the stringers are continuous over the floorbeams. For each support where the stringers are non continuous, a hinge is entered into CBA. If the stringers are continuous, it is possible to have a small uplift reaction at the floorbeam of interest (for example, in Figure 3.4-3, the truck load positioned at points D, E, and F will cause an uplift reaction at floorbeam 2). Simplifying assumptions of a constant moment of inertia in the longitudinal direction and a live load distribution factor of 1.00 are also made. The lane and truck loads are treated equivalently, with the reaction ultimately assumed to come through two lines of wheels placed a gage distance apart.

3.4.4.1 HL-93 Loading and PHL-93 Loading

For the purpose of 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 analysis of its bridges, PennDOT has modified the HL-93 loading, and it is referred to as the PHL-93 loading. Refer to Figures 2.4-1 and 2.4-2 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 reaction at the interior supports only, the factor for the effect of two design trucks and design lane load is 100% for the PHL-93 loading and 90% for the HL-93 loading. H20 and HS20 loadings are as defined in the current AASHTO Standard Specifications for Highway Bridges.

3.4.4.2 Truck Load Effect

To find the maximum and minimum reactions due to a single lane, 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.

3.4.4.3 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 2.4-1.

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.

3.4.4.4 Variable Spacing of Truck or Tandem Pair

The LRFD Specifications require that 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 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.

3.4.4.5 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.

3.4.4.6 End Reactions due to HL-93 or PHL-93 Loading

In calculating the positive end reaction, 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 end reaction. The negative reactions at the interior and exterior supports are calculated in the same manner as the positive end reaction except that the negative area of the influence line is used.

3.4.4.7 Interior Reactions due to HL-93 or PHL-93 Loading

In calculating the positive interior reactions, 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 2.4-1. 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 "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 both the PHL-93 and HL-93 loadings, the larger of Effect 1, Effect 2, 100% of Effect 3, and 90% of Effect 4 is stored as the governing effect.

3.4.4.8 Reactions Used to Compute Deflection due to HL-93 and PHL-93 Loading

Separate reactions are computed in order to find the deflection due to the HL-93 loading. These reactions are 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 live load reactions used to compute 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.

3.4.4.9 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.

3.4.4.10 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.

3.4.4.11 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. Schematic drawings of the HS20 truck and the H20 truck are presented in Figure 2.4-2.

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 2.4-2.

Figure 3 illustrates the procedure for computing the governing reaction at a given analysis point (Floorbeam 2).

3.4.4.12 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 dynamic load allowance, IM, is 15%. For all other limit states, the dynamic load allowance, IM, is 33%.

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.

3.4.4.13 Live Load Distribution

After finding the single lane reaction, the program then computes the influence lines for the floorbeam. CBA is also used for this, returning influence lines for moment, shear, deflection, reaction and rotation at all analysis points. These influence lines are then loaded with the wheel loads found for each live load vehicle.

When user-defined lanes are used, the number and location of the traffic lanes are fixed. The only variation is the location of the wheel loads within the lanes. The user enters the gage distance between the wheels, the passing distance between trucks, and the left and right edge of each lane. The user-defined lanes are located across the floorbeam, then a wheel is placed one-half the passing distance from the left edge of the first lane. The second wheel is placed a gage distance to the right of this wheel. With the wheels in this location, all effects are computed from this lane by finding the influence value at each wheel location for each analysis point defined in Section 3.2. The two influence values (one for each wheel location) are summed. These values (a value each for moment, shear, and deflection are found, and possibly a value for reaction and rotation, depending on the analysis point) are stored for each point. After computing these values, the wheel loads are moved 3 inches to the right. If the right wheel is still more than one-half the passing distance from the right edge of the lane, all influence values are computed with the wheels in the new location. The current influence values are compared to the earlier maximum and minimum influence values. If the current values are greater than the maximum or less than the minimum, they are stored. This process of moving the wheels and computing influence values is repeated until the right wheel is less than one-half the passing distance from the right edge of the lane. Figure 4 presents a schematic of wheel positions.

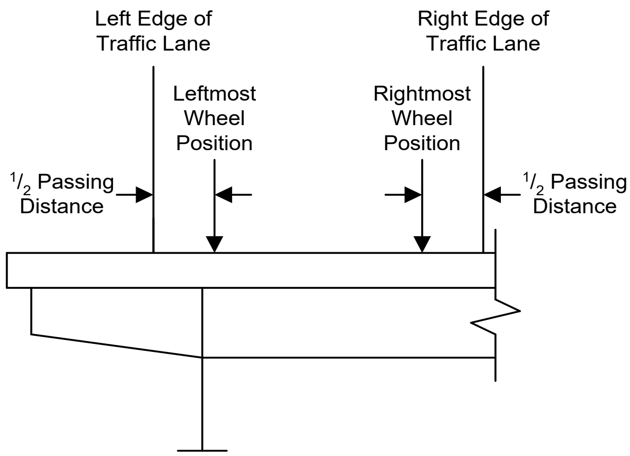


Figure 3.4-4 Wheel Positions

After reaching the rightmost wheel position, the maximum and minimum vehicle influence values are known for the current lane. Wheels are then placed in every other lane in turn, following the above process to find the maximum and minimum values for each lane. After doing this for each lane, the maximum and minimum values for each lane are sorted from maximum to minimum. Starting with the maximum value, the influence value is multiplied by the lane reaction and by the multiple presence factor appropriate to the number of lanes being loaded. One lane is added at a time in an attempt to find the maximum and minimum moment, shear, deflection, reaction and rotation values due to the current vehicle. These values are computed for every analysis point along the floorbeam. If the effects are being calculated with one or two sidewalks present, the sidewalks are considered to be a loaded lane for the purposes of calculating the multiple presence factor. That is, if there are three traffic lanes loaded plus two sidewalks, an MPF of 0.65 is used (four lanes or more MPF). It does not matter if there are one or two sidewalks; only one lane is added.

If program-defined lanes are being used, the above process is changed slightly. Before placing the wheels in a lane, the lanes must be defined. As in the program-defined lanes, the user defines the gage distance and passing distance, but in this case also defines the left and right edges of the roadway and the lane width to be used. In the first iteration, a lane is placed against the left roadway edge. The right edge of this lane is placed a lane width to the right of the left edge. The left edge of the next lane is placed at the same location as the right edge of the current lane. This process is repeated until the right edge of a lane is less than a lane width from the right roadway edge. Figure 5 illustrates the placement of program-defined lanes.

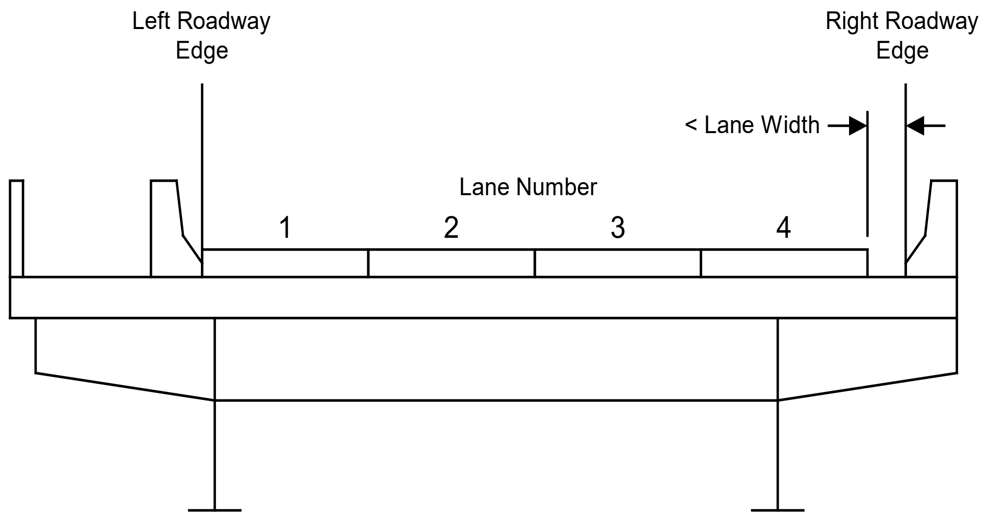
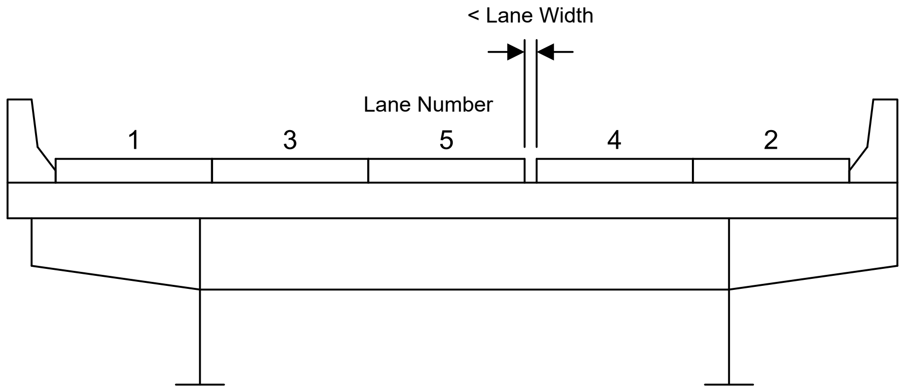


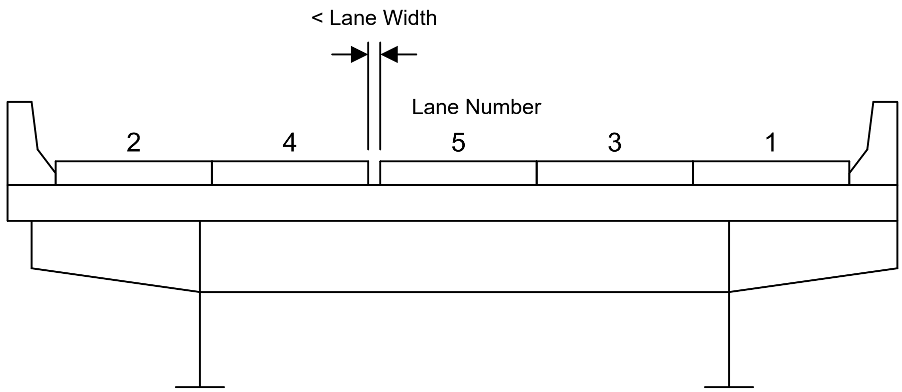
Figure 3.4-5 Placement of Program-Defined Lanes

No lanes can be used that are narrower than a lane width. Once the lanes are defined, the wheel movements described above are used to find the minimum and maximum influence values. After finding the maximum and minimum influence values for this lane configuration, the actual effects are found as above, sorting the values and then loading the lanes one by one. In this case, though, after the maximum and minimum values are found for one configuration of lanes, additional configurations must be investigated. The program moves the leftmost point of the first lane 3 inches to the right, and repeats the whole process of lane definition and wheel placement. The leftmost point movement is repeated until the leftmost point of the first lane is less than a lane width from the right edge of the roadway. The final two iterations shown in Figure 3.4-6 load the floorbeam from the outside in. The next-to-last iteration places the left edge of the first lane against the left roadway edge while the right edge of the second lane is placed against the right roadway edge. This alternating procedure is followed until the space remaining in the center of the floorbeam is less than a lane width. The last iteration follows a similar procedure, except that the first lane is placed against the right curb, with the others placed in an alternating fashion. At this point, the iterations are completed.

The purpose of the moving of lanes and wheels is to maximize and minimize the influence values. When no stringers are present on the floorbeam, the computation of the influence values for each location is done by interpolating the influence values between known values. In Figure 7, the total influence value at A due to the two wheels is the sum of the influence lines under the wheels.

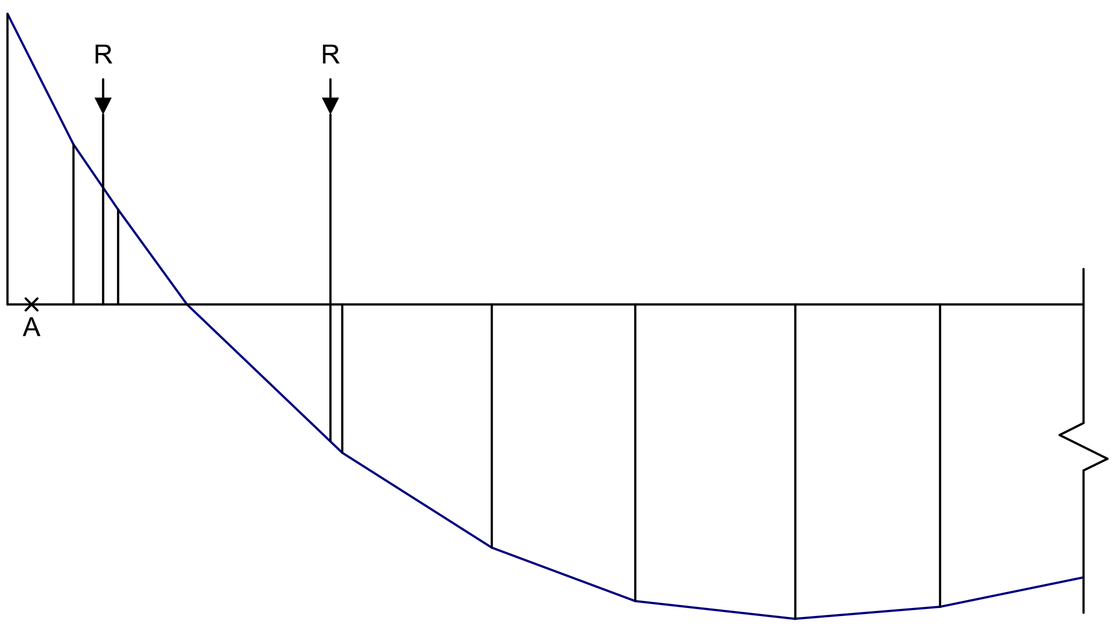


Next-to-last Lane Placement Iteration



Last Lane Placement Iteration

Figure 3.4-6 Next-to-Last and Last Iterations



INFLUENCE LINE FOR DEFLECTION AT A

Figure 3.4-7 Application of Wheel Loads Without Stringers

When stringers are present, however, all of the live loads will be transferred to the floorbeam through the stringers. In this case, the values are not simply interpolated. Each wheel falls between two stringers and is transferred to each stringer assuming a simply supported condition between stringers. This load is then transferred to the floorbeam through the stringer points. Figure 8 illustrates the load transfer process.

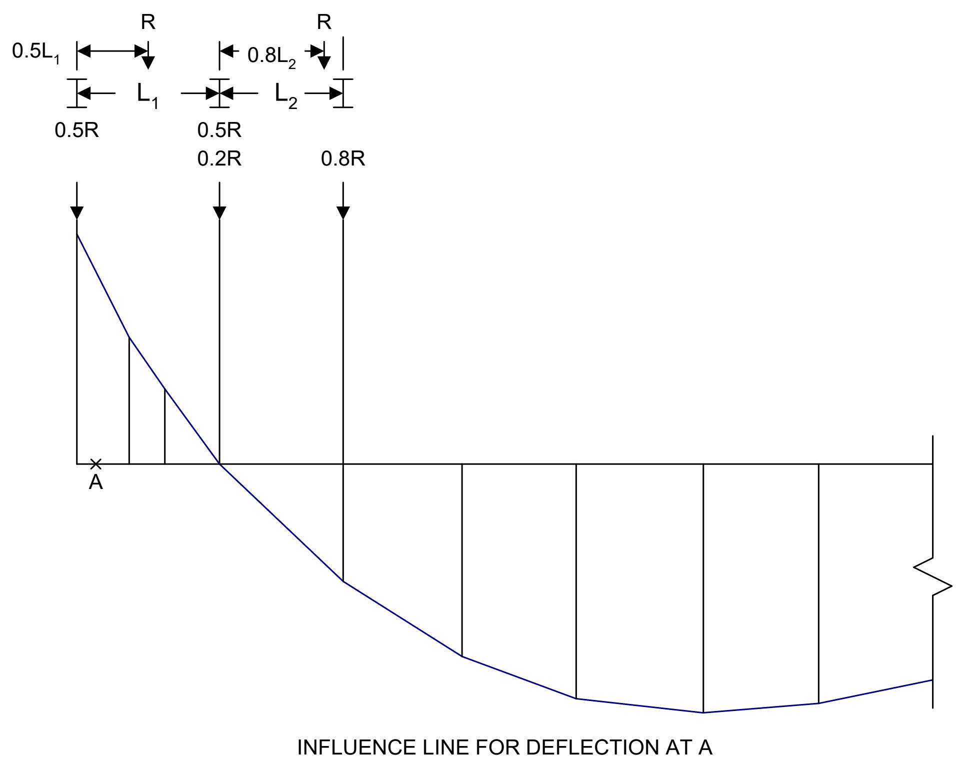


Figure 3.4-8 Application of Wheel Loads With Stringers

For most live loading cases, the processes above are usually used to load every lane with the same live load at the same time. That is, when analyzing for PHL-93 loading, each lane will either be empty or contain a PHL-93 load. The program also has the capability to describe two different loads that can be placed simultaneously in different lanes. However, this feature can only handle up to two different loads and can only be used with user-defined lanes, since it becomes a complicated issue to describe lane numbers for program-defined lanes. In this case, the user also has the ability to choose for which vehicle the floorbeam will be rated and the ability to define a single multiple presence factor to use in conjunction with these loads.

3.4.5 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, and the pedestrian load is applied to a set of influence lines along the floorbeam, not along a longitudinal beam. The same rules with regard to stringers are also followed for pedestrian load; that is, the pedestrian load is transferred to the floorbeam through the stringers.

3.4.6 Partial Fixity of Floorbeam Connections

The program also has the ability to model partially fixed connections between the floorbeam and the supports, by allowing the user to enter a percent fixity for each support for dead load and live load separately. This capability is available by specifying the floorbeam as either simply supported between the supports without overhangs, or simply supported between the supports with overhangs fixed at the supports. The percent fixity refers to a percentage of the maximum moment induced by the wheel and lane placement for each point along the floorbeam.

For dead load moments, the process for computing the fixed-end moment effects is straightforward. The maximum moment due to the dead load is found; then the appropriate percentage of this moment is applied to each simple support of the floorbeam. The floorbeam is then analyzed as a simply supported beam with applied end moments that are a percentage of the maximum moment in the beam and the moment, shear, deflection, reaction, and rotation at each analysis point are calculated. These effects are then added to the effects computed by assuming the floorbeam to be simply supported between the support points.

For live loads, the process is more involved. At each analysis point, the moment is maximized by placing the wheel loads as described above. By maximizing the moment at each point independently, the potential exists for a different wheel configuration to induce the maximum moment at each point. Once a maximum value is found for each analysis point, the program computes the moment at each analysis point along the floorbeam for that wheel placement and stores the maximum moment along the floorbeam due to this wheel placement as the "relative maximum" moment for each analysis point. Figure 9 shows the difference between the absolute maximum moment and the relative maximum associated with a given analysis point.

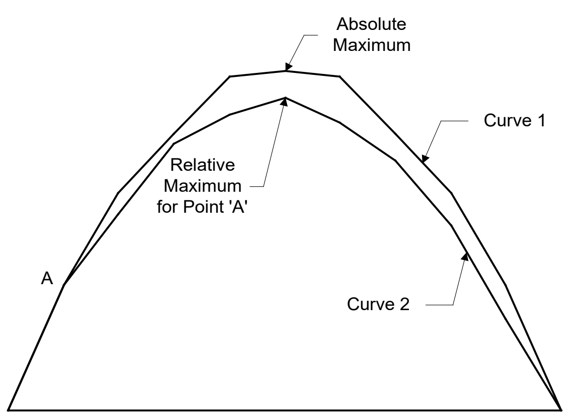


Figure 3.4-9 Absolute and Relative Maximum Moments

In Figure 9, Curve 1 is the absolute maximum moment for each analysis point; the program computed the data points for this curve by following the method of moving lanes and loads as described above. Curve 2 is the moment diagram induced by the wheel placement that induced the moment at Point A. After computing the relative maximum for each point, the fixed end moment effect is computed for each analysis point by placing a percentage of this moment at either end of the floorbeam and finding the effects at the analysis point of interest. Each of the fixed end effects is then added to the simply supported effects.

The partial fixity effects are computed for all load-induced effects, including movement, shear, deflection, rotation, and reaction.

3.4.7 Multiple Live Load Placement

The program allows the user to choose the "Multiple Live Load Placement" option on the CTL command for the "Live Load" parameter. This allows the user to choose two different vehicles and have the user specify the lanes where they are to be placed. This function can only be used with user-defined lanes (UDL command), and only two different vehicles can be used.

The program will find the maximum positive moment, negative moment, shear, and deflection at each analysis point by moving the vehicles inside the lanes, choosing which lanes to load to maximize the effects, and applying multiple presence factors depending on the number of lanes loaded. The program will report separate effects from each live load, as well as a total live load effect. The separate load effects reported will always add up to the total live load effect; the separate live loads are not maximized independently of the total effect. Occasionally, this may result in results that do not appear to be correct at a first look.

For example, a situation was found with a floorbeam with an overhang long enough to carry two lanes of traffic, with the live load effects applied through stringers. The user chose to place a P-82 load in the outermost lane, and a PHL-93 vehicle in the other lanes. For some analysis locations, the single P-82 load with the single lane multiple presence factor of 1.2 resulted in larger negative moments than the P-82 lane combined with the PHL-93 load with the two lane multiple presence factor of 1.0. However, at the same time, the shear from the two loads was greater with two lanes than the single lane of P-82, resulting in a situation where the program reports negative moments of zero for the PHL-93 load, but nonzero shear results for the same vehicle. This is because the effects are maximized independently.

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:

$$Q = \Sigma \left[\eta_i \gamma_i q_i \; or \; \frac{\gamma_i q_i}{\eta_i} \right]$$

where:	Q	=	total factored load
	η_i	=	load modifier (see Table 1)
	γ_i	=	load factor (see Table 2)
	q_i	=	load (unfactored analysis results)

The above equation, when the maximum load factor is used for a given load, then $\eta_i \gamma_i q_i$ is used. When the minimum load factor is used with a given load, then $\gamma_i q_i / \eta_i$ 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, η 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, η factors other than 1.0 are not permitted by PennDOT.
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, Service II, Service IIA, and Service IIB limit states. In addition, the program uses load factors for checking fatigue, deflection, and uncured slab loads. The load factors used for each load type per limit state and for fatigue, deflection, and 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.

Table 3.5-2 Load Factors

Load Combination	Loading						
	γ_{DC}	γ_{DW}	γ_{LL}	γ_{PL}	γ_{SPVH}	γ_{MISC}	**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)
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.
Uncured Slab	1.40	--	--	--	--	User Def.	No DW or live loads are considered for the Uncured Slab check.

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 factored reaction computations for Strength limit states, if the dead 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 dead load reaction, where q_i is the unfactored dead load component reaction. The factored minimum reaction is computed by summing the factored loads computed as described above.

For maximum factored reaction computations for Strength limit states, if the dead load component is positive (downward) then the program uses $\eta\ \gamma_{max}\ q_i$, else it uses $\gamma_{min}\ q_i\ /\ \eta$, in computing the factored dead load reaction, where q_i is the dead load component reaction. The factored maximum reaction is computed by summing the factored loads computed as described above.

With the exception of the factored reactions, as described in the previous paragraphs, 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 analysis or top of the steel floorbeam for noncomposite analysis. A bending condition that results in tensile stress at the top of the concrete slab for composite analysis or top of steel floorbeam for noncomposite analysis is defined as negative flexure.

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.

At points where some moments are positive and others are negative, the program determines the type of flexure by computing the factored stress in 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:

$$f_{ts} = \frac{M_{DC2} + M_{FWS} + M_{MC2}}{S_{ts,3n}} + \frac{M_{LL}}{S_{ts,n}}$$

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 or equal to 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 floorbeam is in compression. The second check is for negative flexure, in which the bottom flange of the steel floorbeam is in compression.

The program checks and tags the results for uplift in “Factored Analysis Results – Reaction” tables only for Service-IIA. 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.

Fatigue will be considered when the unfactored loads produce a tension stress. At locations where the unfactored dead loads produce compression stress, fatigue will be considered only if the compressive stress is less than the maximum live load tensile stress caused by the Fatigue-I limit state, as per LRFD Specifications Article 6.6.1.2.1.

3.6 SPECIFICATIONS CHECKING

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, and deflection, as summarized in Table 1.

Table 3.6-1 Summary of Specifications Checked

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Effective Flange Width	4.6.2.6.5	Strength I-II Service II-IIB Fatigue	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
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 points
Remaining Life by Engineering Economy Equation		Fatigue	N/A	
Cumulative Fatigue Damage Factor: $\Sigma\gamma_i\varphi_i^3$		Fatigue	N/A	Applicable only if truck fatigue data is available
Net Section Fracture	6.10.1.8	Uncured Slab Strength I-II	Strength I-II	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 Strength I-II	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-II Service II-IIB	Strength I-II Service II-IIB	Applies for hybrid floorbeams only; R_h is taken as 1.0 for homogeneous floorbeams, when $F_{y,web} > F_{yc}$ and F_{yt}, and when f_c and $f_t < F_{y,web}$ during construction. For all sections, D_n is determined from the factored stresses in the flanges.

Table 3.6-1 Summary of Specifications Checked (continued)

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Load Shedding Factor, R_b	6.10.1.10.2	Uncured Slab Strength I-II	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-II Service II-IIB Fatigue	Strength I-II Service II-IIB	Checks web proportions (D/t_w ratio) for longitudinally stiffened and unstiffened webs
Flange Proportions	6.10.2.2	Strength I-II Service II-IIB Fatigue	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	N/A	A6.10.3.2.4 has not 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-II	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-II	Strength I-II	Inventory rating for Strength I and operating rating for Strength IA and II. Also see flowchart in Appendix C6.4.5.

Table 3.6-1 Summary of Specifications Checked (continued)

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Flexural Capacity of a Composite, Noncompact I-Section in Positive Flexure	6.10.7.2	Strength I-II	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-II	Strength I-II	Checked for Composite Sections in Positive Flexure, Compact or Noncompact. Also see flowchart in Appendix C6.4.5.
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-II	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-II	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-II	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-II	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-II 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-II	N/A	
Transverse Intermediate Stiffeners	D6.10.11.1	Strength I-II	N/A	
Bearing Stiffeners	6.10.11.2	Strength I-II	N/A	

Table 3.6-1 Summary of Specifications Checked (continued)

Specification Description	LRFD Specifications or DM-4 Article	Limit State Applicability for		Remarks
		Specification Checking	Ratings	
Longitudinal Stiffeners	6.10.11.3	Strength I-II	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-II Uncured Slab	Strength I-II Service II-IIB	For negative bending, the yield capacity of the deck reinforcement will be checked as well.
Depth of the Web in Compression	AASHTO Appendix D6.3.1	Strength I-II Uncured Slab	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, Dc is based on the section consisting of the steel girder plus the longitudinal reinforcement.
Concentrated Loads Applied to Webs Without Bearing Stiffeners	AASHTO Appendix D6.5	Strength I-II	N/A	Checked for rolled beams only. The program assumes all plate girder and built-up sections require bearing stiffeners at concentrated load locations.

3.6.1 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:

3.6.1.1 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.

3.6.1.2 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.

3.6.2 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.

3.6.3 Ductility Requirements

Ductility requirements are presented in LRFD Specifications Article 6.10.7.3 and the corresponding section of DM-4. For compact composite cross sections in positive flexure, the section must satisfy LRFD Specifications Equation 6.10.7.3-1.

3.6.4 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.

If uplift is found to be present, based on the factored reactions, 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.**

3.6.5 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 between floorbeam supports is based on the following equation:

$$\frac{L}{1000} \geq \Delta_{pedestrian} + \Delta_{vehicle}$$

Where: L = span length

$\Delta_{pedestrian}$ = total deflection due to pedestrian live load

$\Delta_{vehicle}$ = total deflection due to vehicular live load

3.6.6 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, DC1S, 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):

$$R_{r,weld} = 0.6\phi_{e2}F_{exx}$$

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):

$$R_{r,material} = 0.58\phi_v F_y$$

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 3.6-2 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 ($s_u <= s_{r,material}$).

3.6.7 Specification Check Warnings and Failures

Specification check warnings and failures 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 failures. 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 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 between the supports, tenth points on the overhangs, 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, when in fact the specification check warning or failure is for an analysis point that was not selected by the user to be printed.

3.6.8 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 can 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:

$$f_c = f_{cDL1} - 1 \cdot (M_{DL2}) \cdot (S_{lt,comp})$$

$$f_t = f_{tDL1} + (M_{DL2}) \cdot (S_{lt,tens})$$

$$M_{tot} = M_{DL1} + M_{DL2}$$

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:

$$M_{nc} = M_{tot} + \left(F_{rc} - |f_c|\right) \cdot (S_{st,comp})$$

$$M_{nt} = M_{tot} + \left(F_{rt} - f_t\right) \cdot (S_{st,tens})$$

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. 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

3.6.9 Net Section Fracture

The program 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. The net area used in the Net Section Fracture checks is computed from the parameters entered in the SHO command.

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.

3.6.10 Concentrated Loads at Locations Without Bearing Stiffeners

For rolled beam**s, plate girders, and built-up sections,** at supports and concentrated load locations, the program 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.**

FBLRFD 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 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:

$$N_{req} = \left(\frac{\frac{R_u}{\varphi_w(0.4t_w^2)\left(\sqrt{\frac{EF_{yw}t_f}{t_w}}\right)} - 1}{3\left(\frac{t_w}{t_f}\right)^{1.5}} \right) d \quad (D6.5.3-3)$$

If N_{req}/d from that expression results in $N_{req}/d > 0.2$, N_{req} is recomputed using the following expression:

$$N_{req} = \left(\frac{\frac{R_u}{\varphi_w(0.4t_w^2)\left(\sqrt{\frac{EF_{yw}t_f}{t_w}}\right)} - 1}{\left(\frac{t_w}{t_f}\right)^{1.5}} + 0.2 \right) \frac{d}{4} \quad (D6.5.3-4)$$

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

3.6.11 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, DC1S 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, DC1S, MC1, DC2, MC2, DW and LL.

3.6.12 Lateral Torsional Buckling Calculations

For sections in negative bending and noncomposite sections, FBLRFD calculates lateral torsional buckling capacities throughout an unbraced length using the methods of LRFD Specifications Article 6.10.8.2.3 and, if applicable, Section 6, Appendix A, and Section 6, Appendix D. Additionally, the maximum factored flexural stress or moment throughout the unbraced length 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.

FBLRFD 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 floorbeam 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.

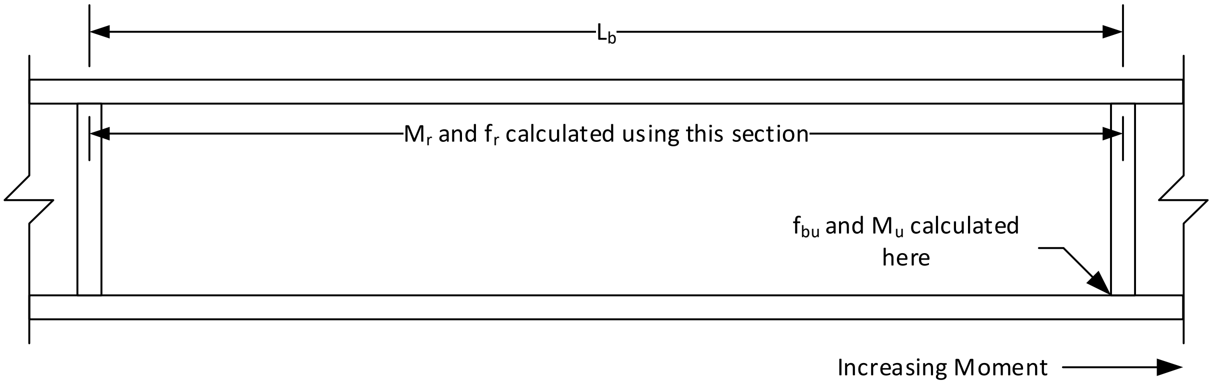
When Appendix A applies, the smallest Appendix A capacity in the unbraced length is found, then scaled to an equivalent moment flexural capacity at each analysis point by multiplying the smallest value by the ratio of the equivalent section modulus at the analysis point to the equivalent section modulus 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.

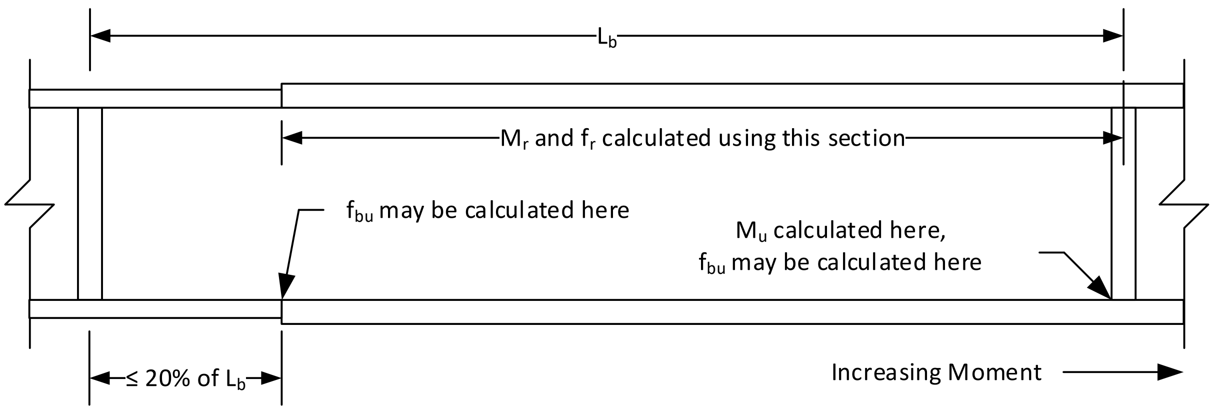
Due to the lateral torsional buckling calculations, each analysis point can have up to five flexural capacities reported:

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)

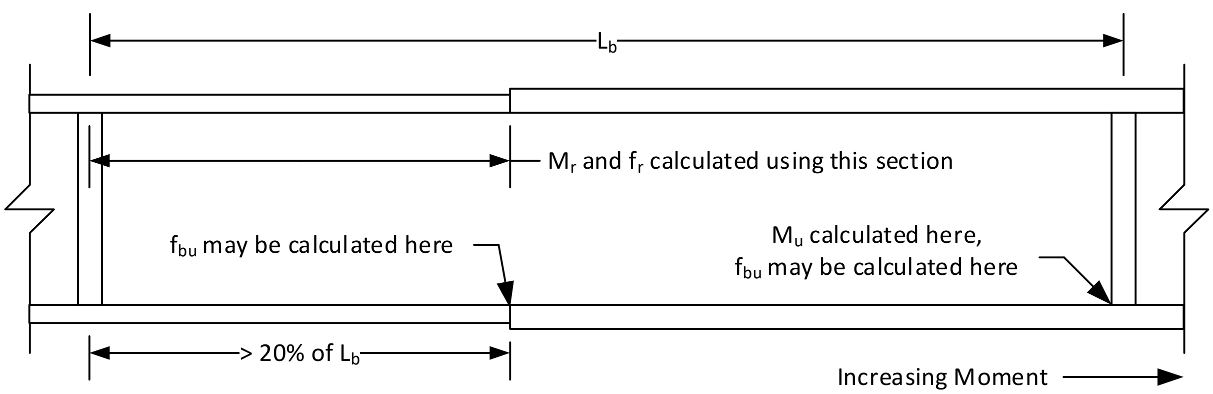
A check has been added to the program to generate a Chief Bridge Engineer warning for bracing ranges that have analysis points in negative flexure, a varying web depth, and flange transitions further than one foot from either end of the unbraced length. Floorbeams that have this condition will still be analyzed as described in this section, but will need to obtain Chief Bridge Engineer approval for new construction.



Section is prismatic within unbraced length, C_b can be > 1.0



Flange transition ≤ 20% of L_b, so the LTB flexural resistance of the larger section is used throughout the unbraced length, C_b can be > 1.0 (assume flanges in smaller section satisfy Iy criteria)



Flange transition > 20% of L_b, so the LTB flexural resistance of the smaller section is used throughout the unbraced length, and 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 3.6-1 Lateral Torsional Buckling Example

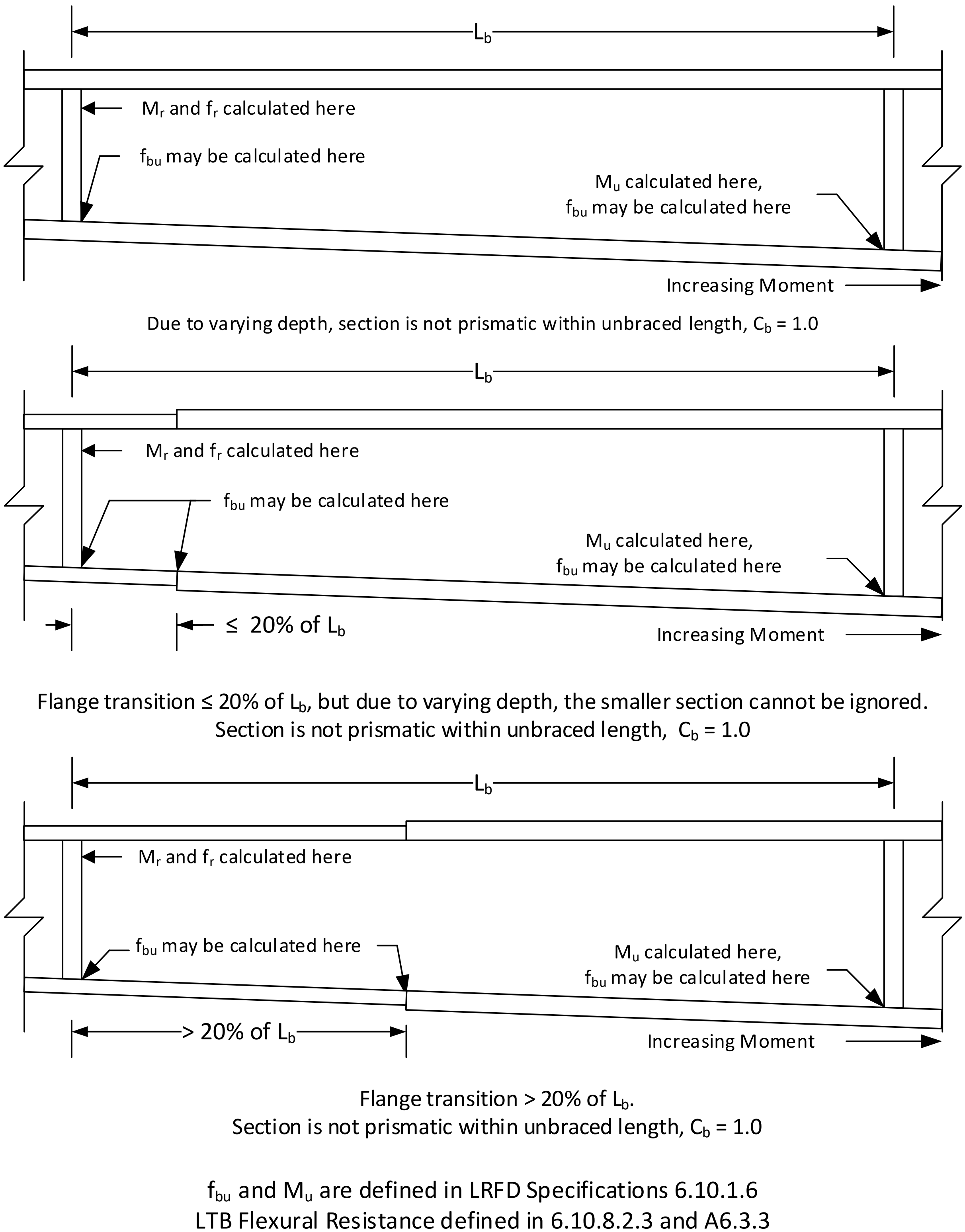
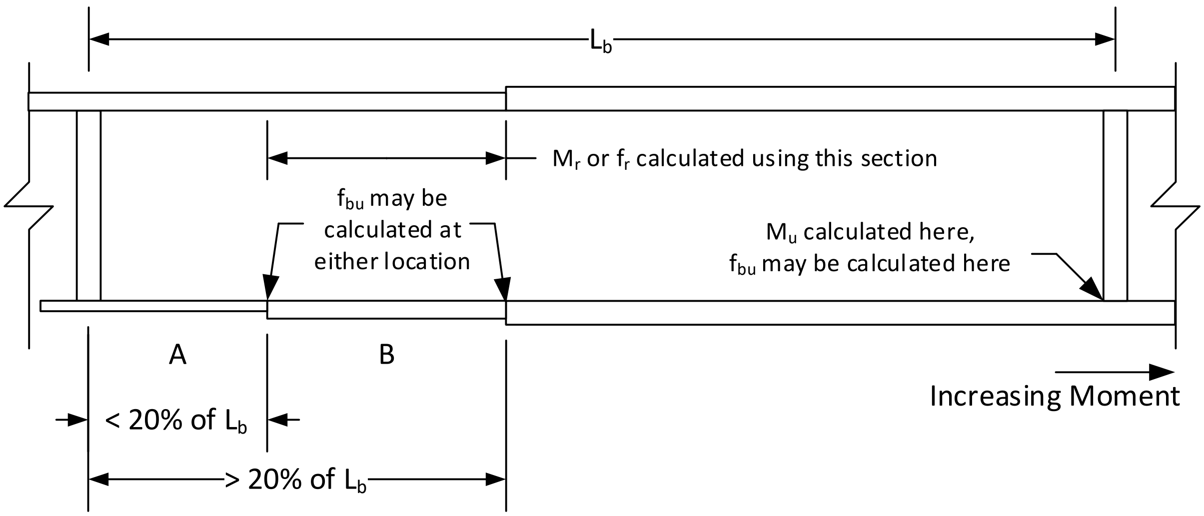


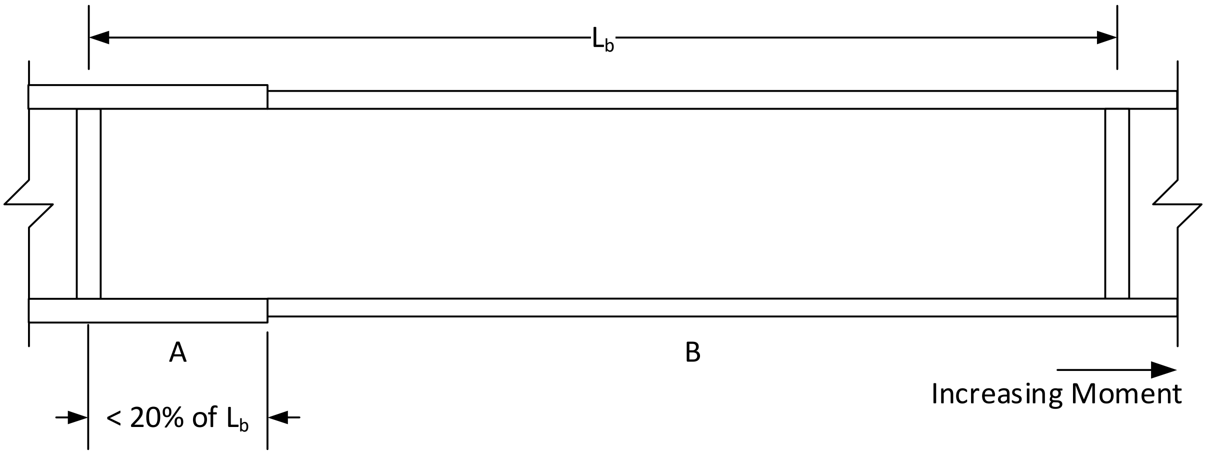
Figure 3.6-2 Lateral Torsional Buckling Example (Varying Depth Girder)



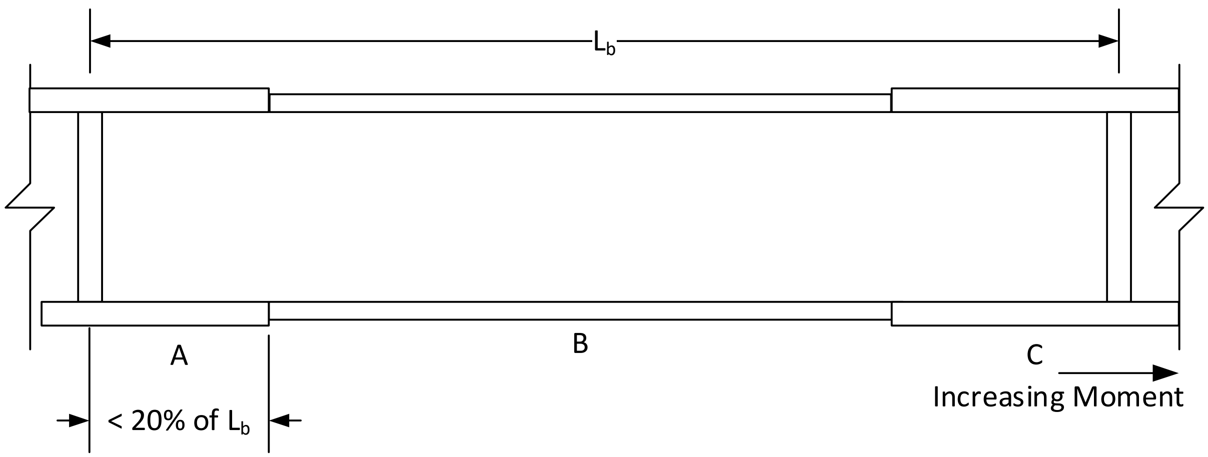
Section A can be ignored for the purpose of calculating M_r or f_r if the flanges meet the lateral moment of inertia requirements. Section B cannot be ignored since it extends past 20% of L_b. $C_b = 1.0$

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 3.6-3 Lateral Torsional Buckling Example (Multiple Transitions)



In this example, section A will be ignored because the rest of L_b is prismatic and C_b > 1.0



In this example, section A will NOT be ignored because the girder changes again at section C and C_b = 1.0 because of the change at section C

Figure 3.6-4 Lateral Torsional Buckling Example (Transition from larger to smaller section)

3.6.13 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:

$$p \leq \frac{nZ_r}{V_{sr}}$$

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 and the average floorbeam spacing is greater than 20 feet, or 410 trucks per day and the average floorbeam spacing is less than or equal to 20 feet, the Fatigue-I load combination will be used and:

$$Z_r = 5.5d^2$$

otherwise, use the Fatigue-II load combination and:

$$Z_r = \alpha d^2$$

$$\alpha = 34.5 - 4.28logN$$

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 = 2.0 if the average floorbeam spacing is less than or equal to 20 feet, 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 and the average floorbeam spacing is greater than 20 feet, or 840 trucks per day and the floorbeam spacing is less than or equal to 20 feet, 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, n = 2.0 if the average floorbeam spacing is less than or equal to 20 feet, and n = 1.0 otherwise.

To calculate V_{sr}:

$$V_{sr} = \sqrt{\left(V_{fat}\right)^2 + \left(F_{fat}\right)^2}$$

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) (NOTE: radial fatigue shear range is assumed to be zero for floorbeams)

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.

3.6.14 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 2.0 cycles. 1.0 cycles per truck passage is used when the floorbeam spacing is greater than 20 feet, while 2.0 cycles per truck passage is used when the floorbeam spacing is less than or equal to 20 feet.

The results from the application of Equation C6.6.1.2.3-1 are rounded up to the nearest five trucks per day. The 100-year $(ADTT)_{SL}$ equivalent to infinite life used by FBLRFD are shown in Table 3:

Table 3.6-3 100-year $(ADTT)_{SL}$ Equivalent to Infinite Life

Detail Category	100-year $(ADTT)_{SL}$ Equivalent to Infinite Life (trucks per day)	
	n = 1.0	n = 2.0
A	520	260
B	845	425
B'	1015	510
C	1265	635
C'	735	370
D	1840	920
E	3465	1735
E'	6365	3185

When the user-input $(ADTT)_{SL}$ is less than or equal to the value in Table 3, the Fatigue-II load combination is used. When the $(ADTT)_{SL}$ is greater than the value in Table 3, the Fatigue-I load combination is used.

3.7 LIVE LOAD RATINGS

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 2.5-1.

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.

Floorbeam ratings are performed as the "reverse of analysis." In other words, the same equations used for analysis and specification checking 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 to calculate the live load reserve capacity, and then it is divided by the factored live load effect to calculate the rating factor.

For the controlling rating factors for each vehicle, the program computes the rating tonnage. 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 the ML-80 and TK527 vehicles include a 3% scale tolerance, while the axle loads for special live loads include a scale tolerance input by the user (PERCENT INCREASE entered on the SLL command). 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.

For a summary of the specification checks that are required for live load ratings, as well as which limit states apply to each specification check, refer to Table 3.6-1.

The rating factor at each analysis point is calculated for flexure and shear.

3.7.1 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:

$$M_{LLr} = M_r - M_{DC1} - M_{DC1S} - M_{DC2} - M_{FWS} - M_{MC1} - M_{MC2} - M_{PL}$$

and

$$F_{LLr} = F_r - f_{DC1} - f_{DC1S} - f_{DC2} - f_{FWS} - f_{MC1} - f_{MC2} - f_{PL}$$

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 floorbeams, 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 floorbeams, the program applies all moments to the steel-only section.

3.7.2 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} values 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.

3.7.3 Rating Factors When Using Live Load Placement Commands

Within the program, the user has the ability to place different live loads exclusively in specific user-defined lanes. With this option, the user also chooses the vehicle for which the ratings are to be performed. The vehicle chosen by the user will be treated as the factored live load in all of the expressions given above for flexure, shear, and flexure-shear interaction ratings. In these cases, the live load not chosen by the user will be treated as part of the permanent load on the bridge, similar to how the pedestrian load is treated in the above expressions.

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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 **(32 and 64 bit versions) and Windows 11** operating systems.

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 program destination folder, which defaults to "C:\Program Files\PennDOT\FBLRFD v<version number>\" or "C:\Program Files (x86)\PennDOT\FBLRFD v<version number>\" for 64-bit operating systems:

1. FBLRFD.exe, FBLRFD_dll.dll - Executable program and Dynamic Link Library.
2. FBLRFD.pd - Parameter definition file.
3. FBLRFD Users Manual.pdf - Program User's Manual (PDF Format).
4. FblrfdRevReq.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. 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\FBLRFD 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 FBLRFD <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 (for those programs that produce it) with Adobe Acrobat.

5 INPUT DESCRIPTION

5.1 INPUT DATA REQUIREMENTS

Before running FBLRFD, 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:

```
!  CFG  60, 0
CFG 65, 0
```

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 UDL (user defined lanes) command has Lane Number, Centerline Left Support to Left Edge of Lane, and Centerline Left Support to Right Edge of Lane as repeatable parameters. The user could enter the Lane Number, Centerline Left Support to Left Edge of Lane, and Centerline Left Support to Right Edge of Lane three times on one command and two times on another command, or five times on a single command.

```
UDL N, 1, -9.833, 1.167, 2, 2.50, 13.50, 3, 18.00, 29.00
UDL N, 4, 32.00, 43.00, 5, 46.00, 57.00
```

or

```
UDL N, 1, -9.833, 1.167, 2, 2.50, 13.50, 3, 18.00, 29.00, 4, 32.00, 43.00, 5, 46.00, 57.00
```

Groups of repeatable parameters, such as Lane Number, Centerline Left Support to Left Edge of Lane, and Centerline Left Support to Right Edge of Lane, must stay together in a command line unless a continuation character (-) is used. That is, a command cannot end with a Lane Number input and continue using another UDL command having the Centerline Left Support to Left Edge of Lane 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:

```
UDL N, 1, -9.833, 1.167, 2, 2.50, 13.50, 3
UDL N, 18.00, 29.00, 4, 32.00, 43.00, 5, 46.00, 57.00
```

Correct input:

```
UDL N, 1, -9.833, 1.167, 2, 2.50, 13.50, 3, 18.00, -
29.00, 4, 32.00, 43.00, 5, 46.00, 57.00
```

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.

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 floorbeam 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 major control parameters such as Type of Floorbeam, Type of Support, and Framing Type.

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.

The user need not enter any of the output commands (OIN, OSP, 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 6.41 through 6.45, 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.

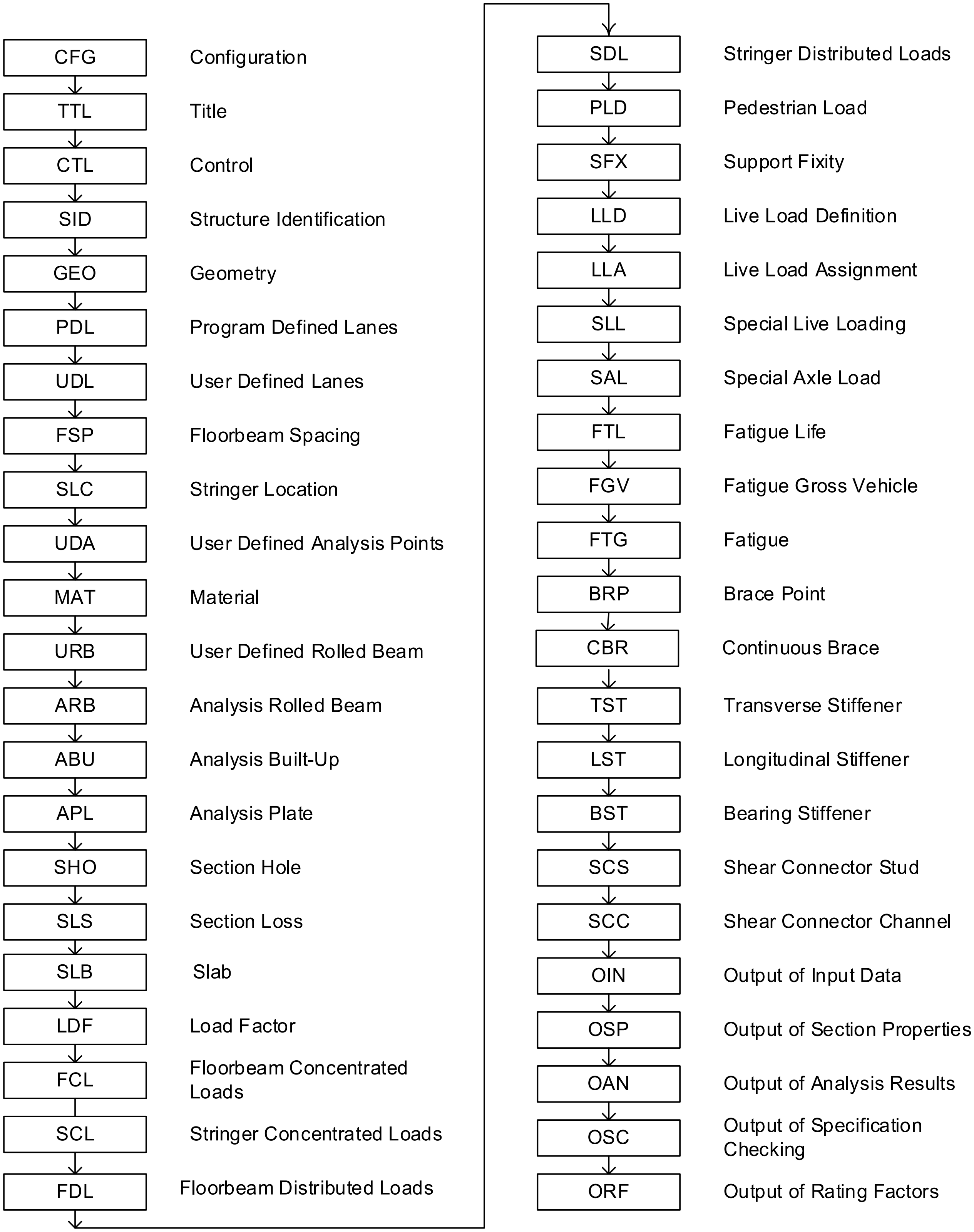


Figure 5.2-1 Overall View of Input File

Table 5.2-1 Recommended Order of Commands

Keyword	Command Description	Comments	Section
CFG	Configuration	Optional	5.3
TTL	Title	At least one TTL command is required	5.4
CTL	Control	Required before other structure commands (other than CFG and TTL commands)	5.5
SID	Structure Identification	Required only for APRAS runs	5.6
GEO	Geometry	Required before any commands with distance parameters	5.7
PDL	Program Defined Lanes	Required only for program defined lanes	5.8
UDL	User Defined Lanes	Required only for user defined lanes	5.9
FSP	Floorbeam Spacing	Required	5.10
SLC	Stringer Location	Required only if stringers are present	5.11
UDA	User Defined Analysis Points	Optional	5.12
MAT	Material	Required and must be entered before ARB, ABU and APL commands	5.13
URB	User Defined Rolled Beam	Optional for analysis with ARB command	5.14
ARB	Analysis Rolled Beam	Required only for rolled floorbeams	5.15
ABU	Analysis Built-Up	Required only for built-up floorbeams	5.16
APL	Analysis Plate	Required only for welded plate floorbeams	5.17
SHO	Section Hole	Optional	5.18
SLS	Section Loss	Optional	5.19
SLB	Slab	Required	5.20
LDF	Load Factor	Required for miscellaneous loads	5.21
FCL	Floorbeam Concentrated Loads	Optional	5.22
SCL	Stringer Concentrated Loads	Optional	5.23
FDL	Floorbeam Distributed Loads	Optional	5.24
SDL	Stringer Distributed Loads	Optional	5.25
PLD	Pedestrian Load	Required for floorbeams with sidewalks	5.26
SFX	Support Fixity	Optional	5.27
LLD	Live Load Definition	Required only with multiple live load placement option	5.28
LLA	Live Load Assignment	Required only with multiple live load placement option	5.29
SLL	Special Live Loading	Required only for special live loading	5.30
SAL	Special Axle Load	Required with SLL command only	5.31

Table 5.2-1   Recommended Order of Commands (continued)

Keyword	Command Description	Comments	Section
FTL	Fatigue Life	Required when remaining fatigue life estimation is desired	5.32
FGV	Fatigue Gross Vehicle	Optional	5.33
FTG	Fatigue Location	Optional	5.34
BRP	Brace Point	Optional	5.35
CBR	Continuous Brace	Optional	5.36
TST	Transverse Stiffener	Required only if there are transverse stiffeners	5.37
LST	Longitudinal Stiffener	Required only if there are longitudinal stiffeners	5.38
BST	Bearing Stiffener	Required only if there are bearing stiffeners	5.39
SCS	Shear Connector Stud	Required for composite with stud shear connectors; for a composite girder, either SCS or SCC command must be entered	5.40
SCC	Shear Connector Channel	Required for composite with channel shear connectors; for a composite girder, either SCS or SCC command must be entered	5.41
OIN	Output of Input Data	Optional	5.42
OSP	Output of Section Properties	Optional	5.43
OAN	Output of Analysis Results	Optional	5.44
OSC	Output of Specification Checking	Optional	5.45
ORF	Output of Rating Factors	Optional	5.46

Table 5.2-2 Commands in Alphabetical Order

Keyword	Command Description	Comments	Section
ABU	Analysis Built-Up	Required only for built-up floorbeams	5.16
APL	Analysis Plate	Required only for welded plate floorbeams	5.17
ARB	Analysis Rolled Beam	Required only for rolled floorbeams	5.15
BRP	Brace Point	Optional	5.35
BST	Bearing Stiffener	Required only if there are bearing stiffeners	5.39
CBR	Continuous Brace	Optional	5.36
CFG	Configuration	Optional	5.3
CTL	Control	Required before other structure commands (other than CFG and TTL commands)	5.5
FCL	Floorbeam Concentrated Loads	Optional	5.22
FDL	Floorbeam Distributed Loads	Optional	5.24
FGV	Fatigue Gross Vehicle	Optional	5.33
FSP	Floorbeam Spacing	Required	5.10
FTG	Fatigue Location	Optional	5.34
FTL	Fatigue Life	Required when remaining fatigue life estimation is desired	5.32
GEO	Geometry	Required before any commands with distance parameters	5.7
LDF	Load Factor	Required for miscellaneous loads and SLL command	5.21
LLA	Live Load Assignment	Required only with multiple live load placement option	5.29
LLD	Live Load Definition	Required only with multiple live load placement option	5.28
LST	Longitudinal Stiffener	Required only if there are longitudinal stiffeners	5.37
MAT	Material	Required and must be entered before ARB, ABU and APL commands	5.13
OAN	Output of Analysis Results	Optional	5.44
OIN	Output of Input Data	Optional	5.42
ORF	Output of Rating Factors	Optional	5.46
OSC	Output of Specification Checking	Optional	5.45
OSP	Output of Section Properties	Optional	5.43
PDL	Program Defined Lanes	Required only for program defined lanes	5.8
PLD	Pedestrian Load	Required for floorbeams with sidewalks	5.26
SAL	Special Axle Load	Required with SLL command only	5.31
SCC	Shear Connector Channel	Required for composite with channel shear connectors; for a composite girder, either SCS or SCC command must be entered	5.41

Table 5.2-2 Commands in Alphabetical Order (continued)

Keyword	Command Description	Comments	Section
SCL	Stringer Concentrated Loads	Optional	5.23
SCS	Shear Connector Stud	Required for composite with stud shear connectors; for a composite girder, either SCS or SCC command must be entered	5.40
SDL	Stringer Distributed Loads	Optional	5.24
SFX	Support Fixity	Optional	5.25
SHO	Section Hole	Optional	5.18
SID	Structure Identification	Required only for APRAS runs	5.6
SLB	Slab	Required	5.20
SLC	Stringer Location	Required only if stringers are present	5.11
SLL	Special Live Loading	Required only for special live loading	5.30
SLS	Section Loss	Optional	5.19
TST	Transverse Stiffener	Required only if there are transverse stiffeners	5.37
TTL	Title	At least one TTL command is required	5.4
UDA	User Defined Analysis Points	Optional	5.12
UDL	User Defined Lanes	Required only for user defined lanes	5.9
URB	User Defined Rolled Beam	Optional for analysis with ARB command	5.14

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 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

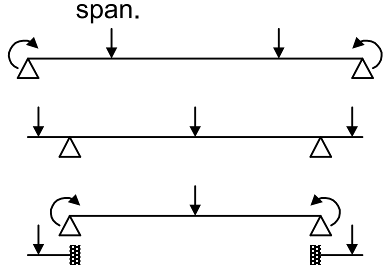
5.4 TTL - TITLE COMMAND

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.

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. Total Number of Floorbeams	Enter the total number of floorbeams on the bridge. This number is used to check the input of the FSP command as well as determining the reactions on the floorbeam.	--	1 (E)	21 (E)	--
3. Floorbeam Number to Analyzed	Enter the number of the floorbeam to be analyzed. This number should correspond to numbers assigned on the FSP command. Only one floorbeam can be analyzed per run of the program.	--	1 (E)	NFLB (E)	--
4. Type of Floorbeam	Enter the type of floorbeam section: RB - Rolled beam. PG - Plate girder. BU - Built-up section consisting of a web plate, flanges, and angles.	--	RB, PG, BU (E)	--	--
5. Type of Support	Enter the type of connection between the floorbeam and the main girder or truss: S - Simple span with or without applied moments at the ends and no overhangs. C - Floorbeam with cantilever overhangs continuous over supports. O - Simple span with or without applied moments at ends and fixed end cantilevers at one or both ends of the span.  Type S Type C Type O NOTE: If the floorbeam has no overhangs (see GEO command), this parameter must be entered as S. If the floorbeam does have overhangs, this parameter must be C or O.	--	S, C, O (E)	--	--

5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
6. Framing Type	Enter the framing type: S - If the deck is supported by floorbeams and stringers. User must also enter SLC command. N - If the deck is supported by floorbeams and there are no stringers.	--	S, N (E)	--	--
7. Number of Stringers	Enter the number of stringer lines framing into the floorbeam. Leave blank if there are no stringers.	--	1 (E)	20 (E)	--
8. Symmetry	Enter: Y - If the floorbeam and overhangs are symmetric about the bridge centerline including length, section properties, and dead loads. N - If not symmetric.	--	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 Factor Adjust.	Leave blank or enter 1.0 for the multiple presence adjustment factor. 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. (This input item was retained for compatibility with existing input files.)	--	1.0 (E)	1.0 (E)	1.0
11. Live Load	Enter one of the following live load options for analysis and rating: A - PHL-93, P-82, ML-80, HS20, H20, TK527. B - HL-93, HS20, H20. C - ML-80. D - P-82. E - Special live loading. F - Multiple Live Load Placement. G - TK527 H - EV2, EV3, and SU6TV The SLL and SAL commands must be entered when using option E. The LLD and LLA commands must be entered when using option F. Use option F when multiple vehicle types are to be placed on the floorbeam concurrently. Option F can only be used with user-defined traffic lanes. Use the UDL command with option F.	--	A, B, C, D, E, F, G (E)	--	A
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

5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
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. Import. Factor	Enter the factor relating to the operational importance as per DM-4. As per DM-4 Section 1.3.5, a factor other than 1.0 is not permitted by PennDOT.	--	1.0 (E)	2.0 (W)	1.0
16. Ductility Factor	Enter the factor relating to ductility as per DM-4. As per DM-4 Section 1.3.3, a factor other than 1.0 is not permitted by PennDOT.	--	0.95 (E)	1.05 (W)	1.0
17. Redund. Factor	Enter the factor relating to the redundancy as per DM-4. As per DM-4 Section 1.3.4, 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
18. Redundant Load Path	NOTE: This parameter is no longer used and should be left blank.	--	--	--	--
19. Output Points	Enter the output point option: 1 - If output is to be printed for tenth points (fifth points on overhang), additional analysis points, user defined points, and failure points. 2 - If output is to be printed for twentieth points (tenth points on overhangs), 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
20. Design Permit Vehicle Dynamic Load Allowance	Enter the factor by which the Design Permit Vehicle (P-82 or Special Live Load) live load effect must be multiplied to obtain the live load plus dynamic load allowance (impact) effect.	--	1. (E)	2. (C)	1.20

5.5 CTL - CONTROL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
21. DC1S Percentage	Enter the DC1S load to be added to the floorbeam as a percentage of steel self-weight. This load will be in addition to any other DC1S loads entered on the FDL or FCL commands. Enter the value as a percentage, not a decimal (i.e. 5% = 5.0, not 0.05)	%	0. (E)	20. (W)	0.
22. 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
23. 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 1.7.0.0 of FBLRFD, 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

5.6 SID - STRUCTURE IDENTIFICATION COMMAND

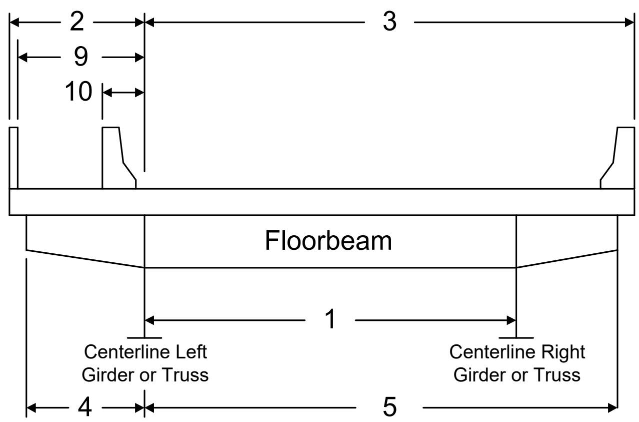
KEYWORD	COMMAND DESCRIPTION
SID	STRUCTURE IDENTIFICATION - This command is used to pass parameters to APRAS (Automated Permit Routing Analysis System) for processing a permit load. The input file must have this command if this data file is to be processed by APRAS. This command is optional for other 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 '=FBLRFD' to identify that this data file is for the LRFD Floorbeam Analysis and Rating program.	--	=FBLRFD (E)	--	--
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 "G" to identify FBLRFD 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 9 through 12 should be entered only if the run includes pedestrian loading.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Centerline Left Support to Centerline Right Support	Enter the distance from the centerline of the left support to the centerline of the right support. The numbers in the drawing below correspond to the parameter numbers of this command.	ft	10. (E)	100. (W)	--



PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
2. Centerline Left Support to Left Deck Edge	Enter the distance from the centerline of the left support to the left edge of the deck. Distances to the left of the left support should be entered as negative values.	ft	-MXLOV[1] (W)	0. (W)	0.
3. Centerline Left Support to Right Deck Edge	Enter the distance from the centerline of the left support to the right edge of the deck. Leave blank if the SYMMETRY parameter has been entered as Y.	ft	SUPDT[2] (W)	MXROV[3] (W)	--
4. Centerline Left Support to Left Overhang End	Enter the distance from the centerline of the left support to the left floorbeam overhang end. Distances to the left of the left support should be entered as negative values. Leave blank if there is no left overhang. NOTE: If there is no overhang on the left or right, the TYPE OF SUPPORT on the CTL command must be S. If there is an overhang on the left or right, the TYPE OF SUPPORT must be C or O.	ft	-MXLDK[4] (E)	0. (E)	--

5.7 GEO - GEOMETRY COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Centerline Left Support to Right Overhang End	Enter the distance from the centerline of the left support to the right floorbeam overhang end. Leave blank if there is no right overhang, or if the SYMMETRY parameter has been entered as Y. NOTE: If there is no overhang on the left or right, the TYPE OF SUPPORT on the CTL command must be S. If there is an overhang on the left or right, the TYPE OF SUPPORT must be C or O.	ft	SUPDT[2] (E)	MXRDK[5] (E)	--
6. Gage Distance	Enter the lateral distance between the wheels of the truck.	ft	4. (W)	10. (W)	6.
7. Passing Distance	Enter the minimum distance between adjacent wheels of passing vehicles.	ft	4. (W)	10. (W)	4.
8. Staggered Diaphragms	Enter the 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
9. Left Sidewalk Left Edge	Enter the distance from the centerline of the left support to the left edge of the left sidewalk. If a sidewalk is present on the left, both this value and the next one must be entered. Leave blank if there is no left sidewalk. Distances to the left of the left support should be entered as negative values.	ft	MXLDK[4] (W)	MXRDK[5] (W)	--
10. Left Sidewalk Right Edge	Enter the distance from the centerline of the left support to the right edge of the left sidewalk. If a sidewalk is present on the left, both this value and the previous one must be entered. Leave blank if there is no left sidewalk. Distances to the left of the left support should be entered as negative values.	ft	MXLDK[4] (W)	MXRDK[5] (W)	--

5.7 GEO - GEOMETRY COMMAND (Continued)

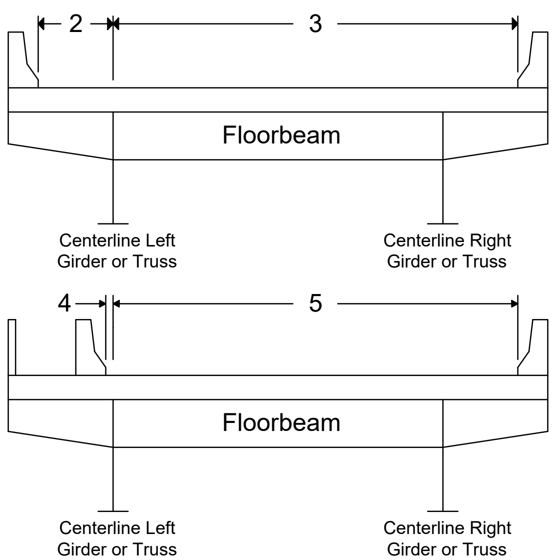
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
11. Right Sidewalk Left Edge	Enter the distance from the centerline of the left support to the left edge of the right sidewalk. Leave blank if there is no right sidewalk or if the SYMMETRY parameter has been entered as Y. If a sidewalk is present on the right (and the girder is not entered as symmetrical), both this value and the next one must be entered.	ft	0. (E)	MXRDK[5] (W)	--
12. Right Sidewalk Right Edge	Enter the distance measured from the centerline of the left support to the right edge of the right sidewalk. Leave blank if there is no right sidewalk or if the SYMMETRY parameter has a value of Y. If a sidewalk is present on the right (and the girder is not entered as symmetrical), both this value and the next one must be entered.	ft	0. (E)	MXRDK[5] (W)	--

Notes:

1 MXLOV is equal to one-half of the distance between the supports.
2 SUPDT is equal to the distance between the supports.
3 MXROV is equal to one and one-half times the distance between the supports.
4 MXLDK is the maximum length (negative) from the centerline of the left support to the left edge of the deck.
5 MXRDK is the maximum length from the centerline of the left support to the right edge of the deck.

5.8 PDL - PROGRAM DEFINED LANES COMMAND

KEYWORD	COMMAND DESCRIPTION
PDL	PROGRAM DEFINED LANES - This command is used to provide the deck geometry information needed for the program to generate the number and placement of the traffic lanes. Only one PDL command can be used. This command cannot be used with the UDL command. This command cannot be used if option F has been specified for the live load option on the CTL command. Parameters 4 and 5 should be entered only if the run includes pedestrian loading.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Lane Width	Enter the lane width.	ft	9. (W)	15. (W)	12.0
2. Centerline Left Support to Left Curb	Enter the distance from the centerline of the left support to the roadway left curb. A positive value indicates that this curb is to the right of the centerline of the left support and a negative value indicates that this curb is to the left of the centerline of the left support. If the bridge cross section includes a left sidewalk, this parameter is to be entered assuming that the sidewalk is not present.  The numbers in the drawing below correspond to the parameter numbers of this command.	ft	MXLDK[1] (E)	MXRDK[2] (E)	--

5.8 PDL - PROGRAM DEFINED LANES COMMAND (Continued)

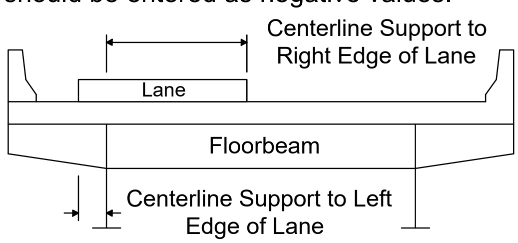
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
3. Centerline Left Support to Right Curb	Enter the distance from the centerline of the left support to the roadway right curb. If the bridge cross section includes a right sidewalk, this parameter is to be entered assuming that the sidewalk is not present.	ft	MXLDK[1] (E)	MXRDK[2] (E)	--
4. Centerline Left Support to Left Curb with Sidewalks	Enter the distance from the centerline of the left support to the roadway left curb. A positive value indicates that this curb is to the right of the centerline of the support and a negative value indicates that this curb is to the left of the centerline of the left support. This parameter must be entered if one or two sidewalks have been defined on the GEO command. Leave blank if no sidewalks have been defined. This parameter is to be entered assuming that the sidewalks are present.	ft	MXLDK[1] (E)	MXRDK[2] (E)	--
5. Centerline Left Support to Right Curb with Sidewalks.	Enter the distance from the centerline of the left support to the roadway right curb. This parameter must be entered if one or two sidewalks have been defined on the GEO command. Leave blank if no sidewalks have been defined. This parameter is to be entered assuming that the sidewalks are present.	ft	MXLDK[1] (E)	MXRDK[2] (E)	--

Notes:

[1] MXLDK is the maximum length (negative) from the centerline of the left support to the left edge of the deck.
[2] MXRDK is the maximum length from the centerline of the left support to the right edge of the deck.

5.9 UDL - USER DEFINED LANES COMMAND

KEYWORD	COMMAND DESCRIPTION
UDL	USER DEFINED LANES - This command is used to provide the information needed to explicitly place the fixed traffic lanes. This command cannot be used with the PDL command. This command can be entered twice (once defining lanes with sidewalks, once without), with a maximum of eight lanes on each command.

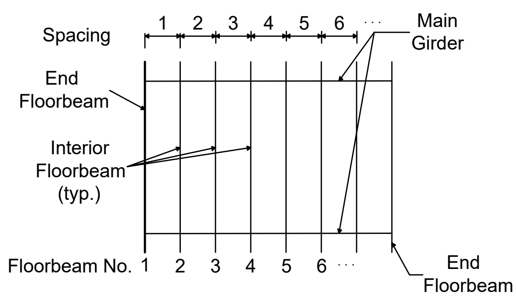
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. With Sidewalk	Enter Y if the lanes to follow are being defined as if there were 1 or 2 sidewalks on the bridge. Otherwise, enter N.	--	Y, N (E)	--	--
2. Lane Number	Enter the current lane number.	--	1 (E)	8 (W)	--
3. Centerline Left Support to Left Edge of Lane	Enter the distance measured from the centerline of the left support to the left edge of the lane. Distances to the left of the left support should be entered as negative values.  	ft	MXLDK[1] (E)	MXRDK[2] (E)	--
4. Centerline Left Support to Right Edge of Lane	Enter the distance measured from the centerline of the left support to the right edge of the lane. Distances to the left of the left support should be entered as negative values.	ft	MXLDK[1] (E)	MXRDK[2] (E)	--

Notes:

[1] MXLDK is the maximum length (negative) from the centerline of the left support to the left edge of the deck.
[2] MXRDK is the maximum length from the centerline of the left support to the right edge of the deck.

5.10 FSP - FLOORBEAM SPACING COMMAND

KEYWORD	COMMAND DESCRIPTION
FSP	FLOORBEAM SPACING - This command is used to define the spacing between floorbeams and the continuity of the stringers at the floorbeam designated by parameter 1. At least one FSP command is required. The parameters and the command are to be repeated for each floorbeam. Enter a number of floorbeam spacings equal to the Number of Floorbeams (CTL command) - 1. Up to six spacings can be entered per FSP command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Floorbeam Number	Enter the floorbeam number. Do not enter this command for the last floorbeam.	--	1 (E)	NFB[1] (E)	--
2. Floorbeam Spacing	Enter the spacing from this floorbeam to the next floorbeam. For example, the fourth spacing is the distance between floorbeam 4 and floorbeam 5. 	ft	3. (W)	50. (W)	--
3. Stringers Simple or Continuous	Enter Y if the stringers are continuous over or frame into this floorbeam. Enter N if the stringers are simply supported. Stringers framing into an end floorbeam will be treated as simply supported at that floorbeam. Leave blank if there are no stringers.	--	Y, N (E)	--	--

Notes:

[1] NFB is the number of floorbeams entered on the CTL command.

5.11 SLC - STRINGER LOCATION COMMAND

KEYWORD	COMMAND DESCRIPTION
SLC	STRINGER LOCATION - This command is used to locate the stringers along the floorbeam. At least one SLC command is required if stringers are present. The parameters and the command can be repeated. Enter a number of stringer locations equal to the Number of Stringers (CTL command). Up to 10 stringer locations can be entered per command.

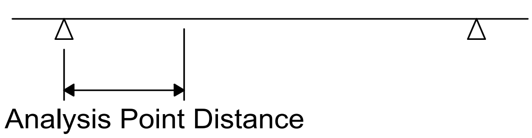
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Stringer Number	Enter the stringer number.	--	1 (E)	NST[1] (E)	--
2. Location	Enter the location of the stringer, measured from the centerline of the left support. Distances to the left of the left support should be entered as negative values.	ft	MXLFL[2] (E)	MXRFL[3] (E)	--

Notes:

[1] NST is the number of stringers entered on the CTL command.
[2] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[3] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.12 UDA - USER DEFINED ANALYSIS POINTS COMMAND

KEYWORD	COMMAND DESCRIPTION
UDA	USER DEFINED ANALYSIS POINTS - This command is used to specify the locations of analysis points other than those set by the program. The program automatically places analysis points at twentieth points of each floorbeam (tenth points on the overhangs), at plate transition locations (ABU and APL commands), at bracing points (BRP command), at concentrated load points (FCL command), at stringer locations (SSC 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 30 user defined analysis points can be entered for the entire floorbeam. Up to 10 locations can be entered per UDA command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Location	Enter the distance of the point from the centerline of the left support. Distances to the left of the left support should be entered as negative values. 	--	MXLFL[1] (E)	MXRFL[2] (E)	--

Notes:

[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.13 MAT - MATERIAL COMMAND

KEYWORD	COMMAND DESCRIPTION
MAT	MATERIAL - This command is used to specify the material properties of a floorbeam. At least one material command is required. The parameters and the command can be repeated. A maximum of 20 materials (five MAT commands with four materials defined per command) can be entered.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Material ID Number	Enter the material identification number associated with the following parameters.	--	1 (E)	20 (E)	--
2. Noncomposite/ Composite	Enter: N - Noncomposite. C - Composite action between the floorbeam and the concrete slab. A floorbeam 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 welded plate and built-up floorbeams, 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.
4. Top Flange Yield Strength	For welded plate and built-up floorbeams, 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.

5.13 MAT - MATERIAL COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Bottom Flange Yield Strength	For welded plate and built-up floorbeams, 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. If left blank for rolled beams, the program will assume a tensile strength according to Table 5.13-1. Leave blank if not rolled beam.	ksi	52. (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. If left blank for plate girders or built-up sections, the program will assume a tensile strength according to Table 5.13-1. Leave blank if rolled beam.	ksi	52. (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. If left blank for plate girders or built-up sections, the program will assume a tensile strength according to Table 5.13-1. Leave blank if rolled beam.	ksi	52. (W)	110. (W)	[1]

Notes:

[1] If left blank, the program will default to a value corresponding to the yield strength as per Table 5.13-1 **(these values are based on LRFD Specifications Table 6.4.1-1 and MBE Table 6A.6.2.1-1).**

If the user input tensile strength is less than the user input yield strength, the tensile strength is set to the value of the yield strength.

5.13 MAT - MATERIAL COMMAND (Continued)

Table 5.13-1 **Default** Tensile Strength **based on entered Yield Strength**

YIELD STRENGTH (Fy, ksi)	TENSILE STRENGTH (Fu, ksi)
Fy < 26	Fu = Fy
Fy < 30	Fu = 52
Fy < 33	Fu = 60
Fy < 36	Fu = 66
Fy < 50	Fu = 58
Fy < 70	Fu = 65
Fy < 90	Fu = 85
Fy < 100	Fu = 100
Fy < 110	Fu = 110
Fy >= 110	Fu = Fy

Table 5.13-2 Yield and Tensile Strengths (MBE Table 6A.6.2.1-1)

YIELD STRENGTH (Fy, ksi)	TENSILE STRENGTH (Fu, ksi)
26	52
30	60
33	66

Table 5.13-3 Yield and Tensile Strengths (AASHTO Table 6.4.1-1)

YIELD STRENGTH (Fy, ksi)	TENSILE STRENGTH (Fu, ksi)
36	58
50	65
70	85
90	100
100	110

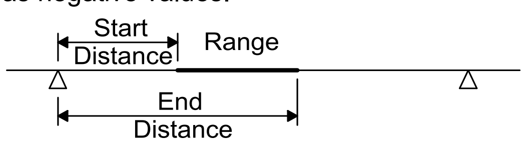
5.14 URB - USER DEFINED ROLLED BEAM COMMAND

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 AISC rolled beam tables that are stored in the program for the designation entered in the ARB command. 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 floorbeam.

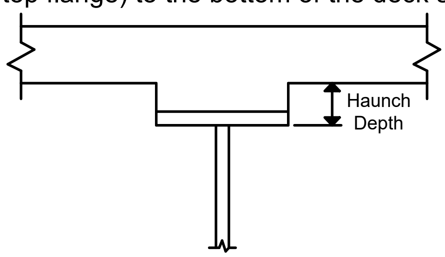
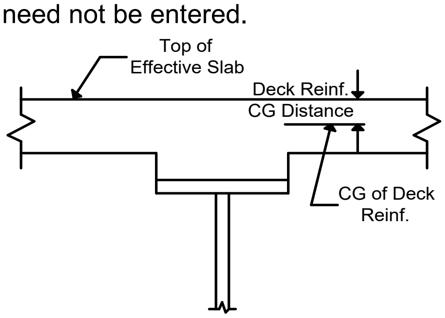
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Rolled Beam Designation	Enter the rolled beam designation, such as 'W36X300', using no spaces. This is the same designation that must be entered on the ARB command. This will override the use of the AISC designation stored in the program.	--	--	--	--
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)	--

5.15 ARB - ANALYSIS ROLLED BEAM COMMAND

KEYWORD	COMMAND DESCRIPTION
ARB	ANALYSIS ROLLED BEAM - This command is used to define the ranges of section properties for rolled beam floorbeams. The AISC designation, cover plate dimensions, and deck reinforcement can be entered. The ARB command can be repeated. A maximum of 200 section transitions (200 ARB commands) can be entered for the entire floorbeam. This includes user-defined section ranges plus the section ranges automatically computed by the program. The program computes a section range for section loss, section holes, twentieth points in the regions between the supports where the web depth varies, and tenth points in the regions outside the supports where the web depth varies. Ranges 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 Distance	Enter the start distance along the floorbeam measured from the centerline of the left support to the beginning of the current range. Distances to the left of the left support should be entered as negative values.  	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
2. End Distance	Enter the end distance along the floorbeam measured from the centerline of the left support of the floorbeam to the end of the current range. Distances to the left of the left support should be entered as negative values.	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
3. Material ID Number	Enter the material ID number.	--	1 (E)	NMAT[3] (E)	--
4. 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. 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.

5.15 ARB - ANALYSIS ROLLED BEAM COMMAND (Continued)

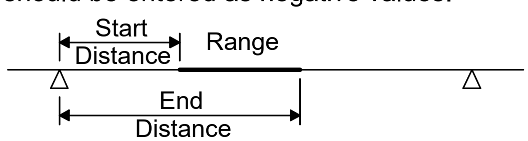
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
6. Top Cover Plate Thickness	Enter the thickness of the top cover plate. If the top cover plate width is entered as 0., this value must also be entered as 0.	in	0. (E)	2. (W)	0.
7. Bottom Cover Plate Width	Enter the width of the bottom cover 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.
8. 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.
9. 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.
10. Deck Transverse Reinforcement Area	Enter the area of reinforcement parallel to the floorbeam 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.
11. 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.

Notes:

[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.
[3] NMAT is equal to the number of material ID numbers defined in the MAT command.

5.16 ABU - ANALYSIS BUILT-UP COMMAND

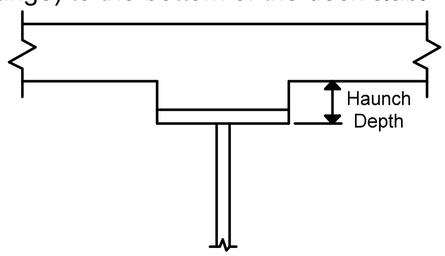
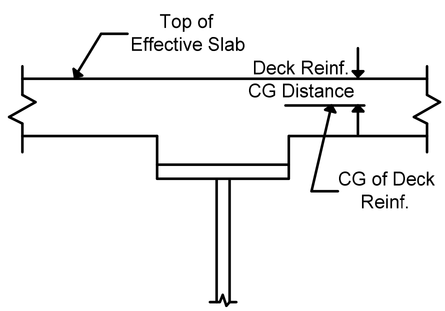
KEYWORD	COMMAND DESCRIPTION
ABU	ANALYSIS BUILT-UP - This command is used to define the ranges of section properties for a built-up floorbeam consisting of plates and four angles. All angles are assumed to be the same size. The ABU command can be repeated. A maximum of 200 section transitions (200 ABU commands) can be entered for the entire floorbeam. This includes user defined section ranges plus the section ranges automatically computed by the program. The program computes a section range for section loss, section holes, twentieth points in the regions between the supports where the web depth varies, and tenth points in the regions outside the supports where the web depth varies. Ranges 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 Distance	Enter the start distance along the floorbeam measured from the centerline of the left support of the floorbeam to the beginning of the current range. Distances to the left of the left support should be entered as negative values. 	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
2. End Distance	Enter the end distance along the floorbeam measured from the left support of the floorbeam to the end of the current range. Distances to the left of the left support should be entered as negative values.	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
3. Material ID Number	Enter the material ID number.	--	1 (E)	NMAT[3] (E)	--
4. 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]	--
5. Angle Horizontal Leg	Enter the length of the horizontal leg of the angle.	in	0. (E)	9. (E)	--
6. Angle Thickness	Enter the thickness of the angle.	in	0. (E)	1.125 30. (E)	--

5.16 ABU - ANALYSIS BUILT-UP COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. 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 floorbeam, the first floorbeam range (at the left end) 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 6.37-1.	--	C, P, S (E)	--	C
8. Web Depth	Enter the depth of the web at the right end of the range being defined. For a web depth variation, enter only the web depth at the end of the variation. Only one depth can be entered per variation. NOTE: If the beam begins with a varying web depth, a small range (0.1 ft long) of constant depth must first be defined, then the following range can vary in depth. This value must be greater than twice the angle vertical leg length.	in	18. (W)[4]	*[5]	--
9. Web Thickness	Enter the thickness of the web along the current range.	in	0.25 (W)	2. (W)	--
10. 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	12. (W)	50. (W)	--
11. 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	0.50 (W)	4. (W)[5]	--
12. 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	12. (W)	50. (W)	--
13. 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	0.50 (W)	4. (W)[5]	--

5.16 ABU - ANALYSIS BUILT-UP COMMAND (Continued)

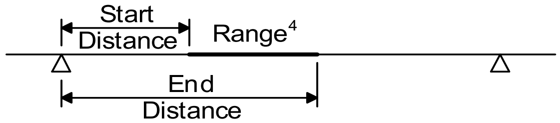
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
14. Haunch Depth	Enter the haunch depth. The haunch depth is measured from the top of the web (or bottom of top flange) to the bottom of the deck slab. 	in	0. (E)	10. (W)	0.
15. Deck Transverse Reinforcing Area	Enter the area of reinforcement parallel to the built-up floorbeam 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.
16. 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.

Notes:

[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.
[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] Beams 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.

5.17 APL - ANALYSIS PLATE COMMAND

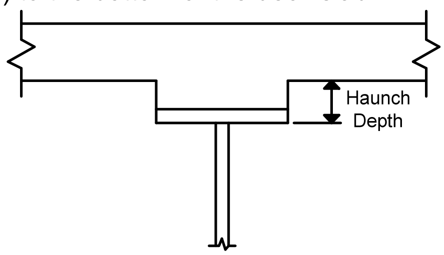
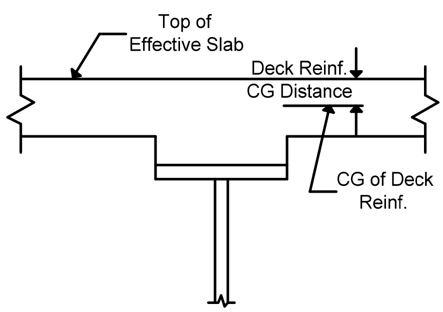
KEYWORD	COMMAND DESCRIPTION
APL	ANALYSIS PLATE - This command is used to define the ranges of section properties for a welded plate floorbeam. The APL command can be repeated. A maximum of 200 section transitions (200 APL commands) can be entered for the entire structure. This includes user-defined section ranges plus the section ranges automatically computed by the program. The program computes a section range for section loss, section holes, twentieth points in the regions between the supports where the web depth varies, and tenth points in the regions outside the supports where the web depth varies. Ranges cannot overlap with previously entered ranges. If the symmetry option is not used, the entire length of the welded plate floorbeam must be defined using one or more APL commands. If the symmetry option is used, the first half of the entire length of the welded plate floorbeam must be defined using one or more APL commands.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Distance	Enter the start distance along the floorbeam measured from the centerline of the left support of the floorbeam to the beginning of the current range. Distances to the left of the left support should be entered as negative values.  	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
2. End Distance	Enter the end distance along the floorbeam measured from the centerline of the left support to the end of the current range.	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
3. Material ID Number	Enter the material identification number.	--	1 (E)	NMAT[3] (E)	--

5.17 APL - ANALYSIS PLATE COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
4. 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 floorbeam, the first floorbeam range (at the left end) 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 6.37-1.**	--	C, P, S (E)	--	C
5. Web Depth	Enter the depth of the web at the right end of the range being defined. For a web depth variation, enter only the web depth at the end of the variation. Only one depth can be entered per variation. NOTE: If the beam begins with a varying web depth, a small range (0.1 ft long) of constant depth must first be defined, then the following range can vary in depth.	in	18. (W)	*5	--
6. Web Thickness	Enter the thickness of the web along the current range.	in	0.25 (W)	2. (W)	--
7. Top Plate Width	Enter the width of the top plate along the current range.	in	12. (W)	50. (W)	--
8. Top Plate Thickness	Enter the thickness of the top plate along the current range.	in	0.5 (W)	4. (W)[5]	--
9. Bottom Plate Width	Enter the width of the bottom plate along the current range.	in	12. (W)	50. (W)	--
10. Bottom Plate Thickness	Enter the thickness of the bottom plate along the current range.	in	0.5 (W)	4. (W)[5]	--

5.17 APL - ANALYSIS PLATE COMMAND (Continued)

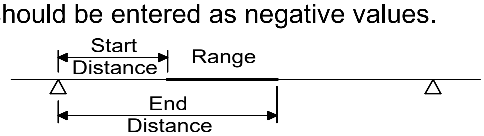
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
11. Haunch Depth	Enter the haunch depth. The haunch depth is measured from the top of the web (or bottom of top flange) to the bottom of the deck slab. 	in	0. (E)	10. (W)	0.
12. Deck Transverse Reinforce-ment Area	Enter the area of reinforcement parallel to the welded plate floorbeam 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 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:

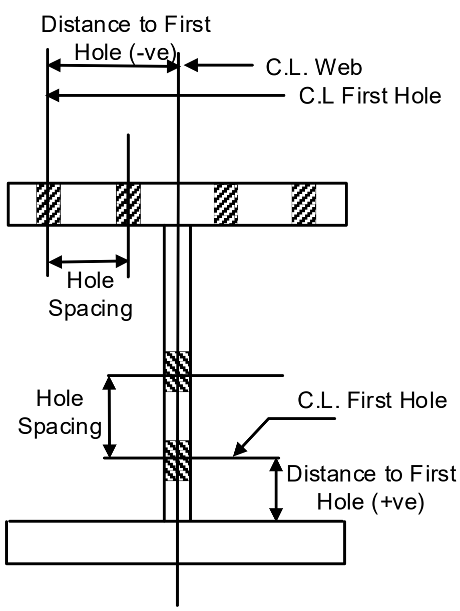
[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.
[3] NMAT is equal to the number of material ID numbers defined in the MAT command.
[4] The minimum range distance between floorbeam section change is 0.02084 foot.
[5] Beams 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.

5.18 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. The SHO command can be repeated. A maximum of 40 section hole ranges (40 SHO commands) can be entered for the entire floorbeam. 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. The effect of a section hole in a steel section is only considered for the Net Section Fracture checks for a section hole located in the tension flange, as per the LRFD Specifications. For a symmetrical floorbeam, enter the hole details up to the point of symmetry. For a symmetrical floorbeam, users can only enter a maximum of 20 section hole ranges.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Distance	Enter the start distance along the floorbeam measured from centerline of the left support to the centerline of the first hole in the range. Distances to the left of the left support should be entered as negative values. 	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
2. End Distance	Enter the end distance along the floorbeam measured from the centerline of the left support to the centerline of the last hole in the range. Distances to the left of the left support should be entered as negative values.	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
3. Location of Hole	Enter the hole location: T - Top flange and/or plates. W - Web plate. B - Bottom flange and/or plates. NOTE: Section holes in the web are ignored by FBLRFD. Section holes in the web are not taken into consideration for section property or specification check calculations.	--	T, W, B (E)	--	--

5.18 SHO - SECTION HOLE COMMAND (Continued)

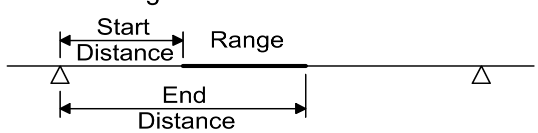
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
4. Distance to First Hole	Enter the distance to the centerline of the first hole. For top and bottom plates, this distance is measured from the centerline of the web, with right being positive. For web plates, the distance is measured from the bottom of the web. If there are holes to the left of the web, enter the distance of the leftmost 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	--	--	--
5. Diameter/ Width of Hole	Enter the diameter or width of the hole. No upper limit is checked for this input parameter.	in	0. (E)	--	--
6. Number of Holes	Enter the number of holes in the girder element. The number of holes pertains to a cross section and not along the range.	--	1 (E)	40 (E)	1
7. 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] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.19 SLS - SECTION LOSS COMMAND

KEYWORD	COMMAND DESCRIPTION
SLS	SECTION LOSS - This command is used to define the section loss for a specific range. 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. 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. Ranges can overlap with previously entered ranges for section holes. For the SLS command, the FBLRFD program does not perform any input checks, such as whether section losses overlap or whether a particular section loss is located on the floorbeam.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Loss Distance	Enter the start distance along the floorbeam measured from the centerline of the left support to the beginning of the section loss range. Distances to the left of the left support should be entered as negative values. 	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
2. End Loss Distance	Enter the end distance along the floorbeam measured from the centerline of the left support to the end of the current section loss range. Distances to the left of the left support should be entered as negative values.	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
3. 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. These elements should be defined as if looking right from the left end of the floorbeam.	--	TP, TF, W, BF, BP, TR, TL, BR, BL (E)	--	--

5.19 SLS - SECTION LOSS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
4. 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. These elements should be defined as if looking right from the left end of the floorbeam.	--	T, B, L, R, X, Y (E)	--	--
5. 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	--	--	--
6. 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)	--	--
7. Thickness	Enter the thickness of the loss.	in	0. (E)	--	--

Notes:

[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.20 SLB - SLAB COMMAND

KEYWORD	COMMAND DESCRIPTION
SLB	SLAB - This command is used to specify the slab and reinforcement properties. 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 $E_C \geq 135$ pcf) or 10 ksi for lightweight concrete (concrete density for $E_C < 135$ pcf).	ksi	2.4 (E)	15. or 10. (E)	4.

5.20 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/ft3 for normal weight concrete or as 115 lb/ft3 for lightweight concrete. This value must be greater than or equal to the "Concrete Density for E_C" (parameter 5).	lb/ft^3	95. (W)	160. (W)	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. (W)	155. (W)	145.
6. Deck Transverse Reinforcement Strength	Enter the yield strength of the transverse 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.

Notes:
[1] Defaults to Effective Slab Thickness + ½ inch
[2] Defaults to Actual Slab Thickness - ½ inch

5.21 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 and 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-5 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 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. Leave blank 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)	--
6. Load Factor Service II	Enter the load factor for Service II.	--	0. (E)	2. (E)	--

5.21 LDF - LOAD FACTOR COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Load Factor Service IIA	Enter the load factor for Service IIA.	--	0. (E)	2. (E)	--
8. Load Factor Service IIB	Enter the load factor for Service IIB.	--	0. (E)	2. (E)	--
9. Load Factor Fatigue I	Note: This parameter is no longer used and should be left blank.	--	--	--	--
10. Load Factor Deflection	Note: This parameter is no longer used and should be left blank.	--	--	--	--
11. Load Factor Construction	Enter the load factor for Construction 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)	--
12. Load Factor Fatigue II	Note: This parameter is no longer used and should be left blank.	--	--	--	--
13. 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]**
14. 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]**
15. 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]**
16. 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]**

Notes:

[1] **Minimum load factors are only used for calculating total factored reactions. See User's Manual Section 3.5 for more information.**

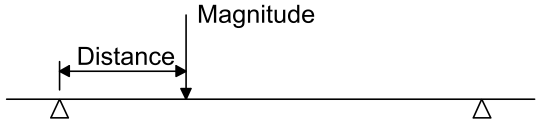
[2] **The default value is only used for the MC1 and MC2 loads. This parameter is not used with SLL loads.**

5.22 FCL - FLOORBEAM CONCENTRATED LOADS COMMAND

KEYWORD	COMMAND DESCRIPTION
FCL	FLOORBEAM CONCENTRATED LOADS - This command is used to specify concentrated loads acting on a floorbeam. A maximum of 20 concentrated loads can be entered per run (four FCL commands with five loads on each). For load types DC1, DC1S, DC2, FWS, PDC2, PFWS, **UT1, and UT2**, the load factors are stored in the program and cannot be changed by the user. For MC1 and MC2, an LDF command must be entered for each miscellaneous load type. For a symmetrical structure, enter the concentrated loads up to and including the point of symmetry. Note that at all locations of concentrated loads, FBLRFD will check bearing stiffener and/or web crippling specifications. Because of this, if the concentrated load does not normally require bearing stiffeners (for example, concentrated loads from cross frames), consider entering these loads as equivalent distributed loads via the FDL command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Load Type	Enter the type of load per LRFD Specifications: DC1 - Permanent load applied to the noncomposite section, excluding the load due to the beam, slab, and haunch. This should include loads that are not a physical part of the floorbeam (i.e., stay-in-place forms, haunch load corrections) DC1S - Permanent load applied to the noncomposite section that is part of the floorbeam, but is not calculated by the program (i.e., stiffeners, 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 **before or with the deck slab.** MC2 - Miscellaneous permanent dead load **applied after the deck slab[1].** (input parameter description continued on next page)	--	DC1, DC1S, DC2, FWS, MC1, MC2, PDC2, PFWS, **UT1, UT2** (E)	--	--

5.22 FCL - FLOORBEAM CONCENTRATED LOADS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Load Type (continued)	PDC2 - Additional permanent load applied to the long-term composite (3n) section[1]. PFWS - Additional future wearing surface load applied to the long-term composite (3n) section[1]. **UT1 - Utility load applied to the non-composite section.** **UT2 - Utility load applied to the composite (3n) section[1].** Both the PDC2 and PFWS loads are present when the sidewalks are present and are not present when the sidewalks are not present				
2. Distance	Enter the distance measured from the centerline of the left support to the concentrated load. 	ft	MXLFL[2] (E)	MXRFL[3] (E)	--
3. Magnitude	Enter the magnitude of the concentrated load acting on the floorbeam. A positive value represents a load acting downwards. NOTE: A negative value for magnitude indicates a force acting upward.	kip	-20. (W)	20. (W)	--

Notes:

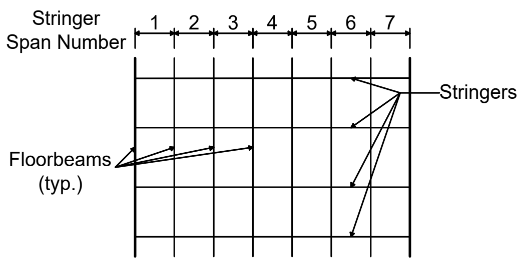
[1] **For girders that are noncomposite in the final state, the DC2, FWS, MC2, PDC2, PFWS, and UT2 loads are applied to the steel-only section.**
[2] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[3] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.23 SCL - STRINGER CONCENTRATED LOADS COMMAND

KEYWORD	COMMAND DESCRIPTION
SCL	STRINGER CONCENTRATED LOADS - This command is used to specify concentrated loads on a stringer. A maximum of 100 concentrated loads can be entered per run (25 SCL commands with four loads defined on each command). For load type DC1, DC1S, DC2, **UT1, and UT2**, the load factors are stored in the program and cannot be changed by the user. For MC1 and MC2, an LDF command must be entered for each miscellaneous load type. Do not enter this command for stringers past the symmetry point of a symmetrical floorbeam. Loads are transferred to the floorbeams via the stringer location points.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Stringer Number	Enter the stringer number. This stringer number should correspond to the stringer numbers entered on the SSC command.	--	1 (E)	NST[1] (E)	--
2. Load Type	Enter the type of load per LRFD Specifications: DC1 - Permanent load applied to the noncomposite section (including the load due to the beam which is not calculated internally by the program). This should also include loads that are not a physical part of the stringer (i.e., stay-in-place forms, haunch load corrections) DC1S - Permanent load applied to the noncomposite section that is part of the stringer (i.e., stiffeners, splice plates) DC2 - Permanent load applied to the long-term composite (3n) section[2]. MC1 - Miscellaneous dead load applied **before or with the deck slab.** MC2 - Miscellaneous permanent dead load applied **after the deck slab[2].** PDC2 - Additional permanent load applied to the long-term composite (3n) section. This dead load is present when the sidewalks are present and is not present when the sidewalks are not present[2]. **UT1 - Utility load applied to the non-composite section.** **UT2 - Utility load applied to the composite (3n) section[2].**	--	DC1, DC1S, DC2, MC1, MC2, PDC2, **UT1,** **UT2** (E)	--	--

5.23 SCL - STRINGER CONCENTRATED LOADS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
3. Span Number	Enter the stringer span number where the concentrated load is located. 	--	1 (W)	NFB-1[3] (W)	--
4. Distance	Enter the distance measured from the centerline of the left support of the stringer span to the concentrated load.	ft	0. (E)	MXSP[4] (E)	--
5. Magnitude	Enter the magnitude of the concentrated load acting on the stringer. A positive value represents a load acting downwards. NOTE: A negative value for magnitude indicates a force acting upward.	kip	-20. (W)	20. (W)	--

Notes:

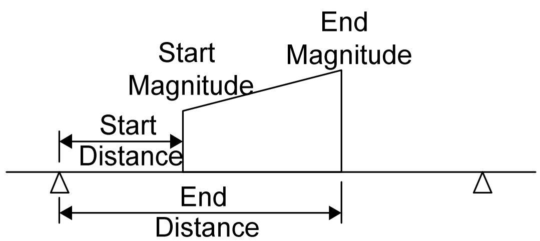
1 NST is the number of stringers.
2 **For girders that are noncomposite in the final state, the DC2, MC2, PDC2, and UT2 loads are applied to the steel-only section.**
3 NFB is the number of floorbeams on the bridge.
4 MXSP is the floorbeam spacing of the span.

5.24 FDL - FLOORBEAM DISTRIBUTED LOADS COMMAND

KEYWORD	COMMAND DESCRIPTION
FDL	FLOORBEAM DISTRIBUTED LOADS - This command is used to specify distributed loads on a floorbeam. A distributed load can be either a uniform or linearly varying load. The parameters and command can be repeated. A maximum of 50 distributed loads can be entered per run for all load types. (25 FDL commands with two distributed loads defined per command) For load types DC1, DC1S, DC2, FWS, PDC2, PFWS, **UT1, and UT2**, the load factors are stored within the program and cannot be changed by the user. For MC1 and MC2, an LDF command must be entered for each miscellaneous load type.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Load Type	Enter the type of load per LRFD Specifications: DC1 - Permanent load applied to the noncomposite section, excluding the load due to the beam, slab, and haunch. This should include loads that are not a physical part of the floorbeam (i.e., stay-in-place forms, haunch load corrections) DC1S - Permanent load applied to the noncomposite section that is part of the floorbeam, but is not calculated by the program (i.e., stiffeners, 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 **before or with the deck slab.** MC2 - Miscellaneous permanent dead load applied **after the deck slab[1].** (input parameter description continued on next page)	--	DC1, DC1S, DC2, FWS, MC1, MC2, PDC2, PFWS, **UT1, UT2** (E)	--	--

5.24 FDL - FLOORBEAM DISTRIBUTED LOADS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Load Type (continued)	PDC2 - Additional permanent load applied to the long-term composite (3n) section. This dead load is applicable when the sidewalks are present and is not applicable when the sidewalks are not present[1]. PFWS - Additional future wearing surface load applied to the long-term composite (3n) section. This dead load is applicable when the sidewalks are present and is not applicable when the sidewalks are not present. Typically, this value is negative since FWS dead load usually decreases when sidewalks are present[1]. **UT1 - Utility load applied to the non-composite section.** **UT2 - Utility load applied to the composite (3n) section[1].**				
2. Start Distance	Enter the distance from the centerline of the left support to the start location of the distributed load. Distances to the left of the left support should be entered as negative values.  	--	MXLFL[2] (E)	MXRFL[3] (E)	--
3. End Distance	Enter the distance from the centerline of the left support to the end location of the distributed load. Distances to the left of the left support should be entered as negative values.	ft	MXLFL[2] (E)	MXRFL[3] (E)	--
4. Start Magnitude	Enter the magnitude of the distributed load acting on the floorbeam at the start distance. A positive value represents a load acting downwards. NOTE: A negative value for magnitude indicates a force acting upward.	kip/ft	-20. (W)	20. (W)	--
5. End Magnitude	Enter the magnitude of the distributed load acting on the floor beam at the end distance. A positive value represents a load acting downwards. NOTE: A negative value for magnitude indicates a force acting upward.	kip/ft	-20. (W)	20. (W)	--

5.24 FDL - FLOORBEAM DISTRIBUTED LOADS COMMAND (Continued)

Notes:

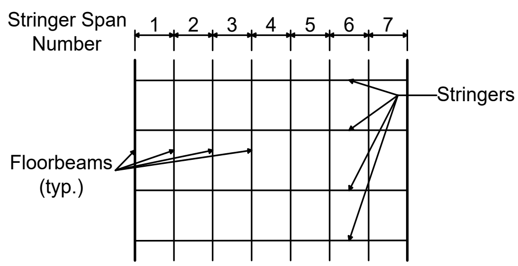
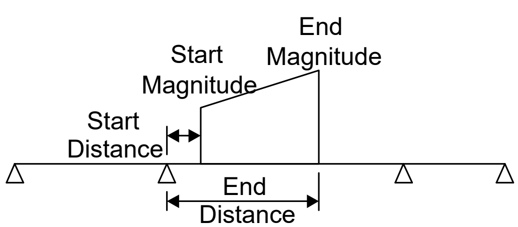
[1] **For girders that are noncomposite in the final state, the DC2, FWS, MC2, PDC2, PFWS, and UT2 loads are applied to the steel-only section.**
[2] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[3] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.25 SDL - STRINGER DISTRIBUTED LOADS COMMAND

KEYWORD	COMMAND DESCRIPTION
SDL	STRINGER DISTRIBUTED LOADS - This command is used to specify distributed loads on a stringer. A distributed load can be either a uniform or linearly varying load. The parameters and the command can be repeated. A maximum of 100 distributed loads can be entered per run for all load types. (50 SDL commands with two distributed loads defined per command) For load types DC1, DC1S, DC2, FWS, PDC2, PFWS, **UT1, and UT2** the load factors are stored within the program and cannot be changed by the user. For MC1 and MC2, an LDF command must be entered for each miscellaneous load type. Do not enter this command for stringers past the symmetry point of a symmetrical floorbeam.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Stringer Number	Enter the stringer number. This stringer number should correspond to the stringer numbers entered on the SSC command.	--	1 (E)	NST[1] (E)	--
2. Load Type	Enter the type of load per LRFD Specifications: DC1 - Permanent load applied to the noncomposite section (including the load due to the beam, which is not calculated internally by the program). This should also include loads that are not a physical part of the stringer (i.e., stay-in-place forms, haunch load corrections) DC1S - Permanent load applied to the noncomposite section that is part of the stringer (i.e., stiffeners, splice plates) DC2 - Permanent load applied to the long-term composite (3n) section[2]. FWS - Future wearing surface load applied to the long-term composite (3n) section[2]. MC1 - Miscellaneous dead load applied to **before or with the deck slab.** MC2 - Miscellaneous permanent dead load applied **after the deck slab[2].** (input parameter description continued on next page)	--	DC1, DC1S, DC2, FWS, MC1, MC2, PDC2, PFWS, **UT1,** **UT2** (E)	--	--

5.25 SDL - STRINGER DISTRIBUTED LOADS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
2. Load Type (continued)	PDC2 - Additional permanent load applied to the long-term composite (3n) section. This dead load is present when the sidewalks are present and is not present when the sidewalks are not present[2]. PFWS - Additional future wearing surface load applied to the long-term composite (3n) section. This dead load is present when the sidewalks are present and is not present when the sidewalks are not present. Typically, this value is negative since FWS dead load usually decreases when sidewalks are present[2]. **UT1 - Utility load applied to the non-composite section.** **UT2 - Utility load applied to the composite (3n) section[2].**	--		--	--
3. Start Stringer Span Number	Enter the stringer span number of the start location.  	--	1 (W)	NFB-1[3] (W)	--
4. Start Distance	Enter the distance from the centerline of the left support of the stringer span to the start location of the distributed load.  	ft	0. (E)	MXSP[4] (E)	--
5. End Stringer Span Number	Enter the stringer span number of the end location.	--	1 (W)	NFB-1[3] (W)	--
6. End Distance	Enter the distance from the centerline of the left support of the stringer span to the end location of the distributed load.	ft	0. (E)	MXSP[4] (E)	--

5.25 SDL - STRINGER DISTRIBUTED LOADS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Start Magnitude	Enter the magnitude of the distributed load acting on the stringer at the start distance. A positive value represents a load acting downwards. NOTE: A negative value for magnitude indicates a force acting upward.	kip/ft	-20. (W)	20. (W)	--
8. End Magnitude	Enter the magnitude of the distributed load acting on the stringer at the end distance. A positive value represents a load acting downwards. NOTE: A negative value for magnitude indicates a force acting upward.	kip/ft	-20. (W)	20. (W)	--

Notes:

[1] NST is the number of stringers.
[2] **For girders that are noncomposite in the final state, the DC2, FWS, MC2, PDC2, PFWS, and UT2 loads are applied to the steel-only section.**
[3] NFB is the number of floorbeams on the bridge.
[4] MXSP is the floorbeam spacing of the span.

5.26 PLD - PEDESTRIAN LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
PLD	PEDESTRIAN LOAD - This command is used to specify the pedestrian load to be used for analyzing the sidewalk areas. This command should only be entered if sidewalk locations were entered on the GEO command. Different loads for left and right sidewalks may be entered. Only one PLD command can be entered.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Left Sidewalk Pedestrian Live Load	Enter the uniform load to be used to compute the effects due to pedestrian live load. A positive value represents a load acting downwards.	ksf	-0.1 (W)	0.1 (W)	0.075
2. Right Sidewalk Pedestrian Live Load	Enter the uniform load to be used to compute the effects due to pedestrian live load. A positive value represents a load acting downwards. **Leave blank if the Symmetry parameter has been entered as 'Y'**	ksf	-0.1 (W)	0.1 (W)	*1

Notes:

[1] This value will default to 0.075 when the parameter "Symmetry" in the CTL command is set to "N"; otherwise, the value will be set to the same value as the left sidewalk pedestrian live load.

5.27 SFX - SUPPORT FIXITY COMMAND

KEYWORD	COMMAND DESCRIPTION
SFX	SUPPORT FIXITY - This command is used to specify the amount of maximum simple span moment to be applied at the supports of a floorbeam to model the partial fixity at the supports. This command should only be entered for support types S and O on the CTL command. This command is used to simulate partial fixity of the floorbeam supports. Only one SFX command can be entered.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Left Support DL Moment Percentage	Enter the percentage of the maximum simple span dead load moment to be applied at the left support. This percentage will be applied to all dead load moments (DC1, DC1S, DC2, FWS, MC1, MC2, PDC2, PFWS, **UT1, UT2**).	--	0. (E)	100. (E)	--
2. Right Support DL Moment Percentage	Enter the percentage of the maximum simple span dead load moment to be applied at the right support. This percentage will be applied to all dead load moments (DC1, DC1S, DC2, FWS, MC1, MC2, PDC2, PFWS, **UT1, UT2**).	--	0. (E)	100. (E)	--
3. Left Support LL+I Moment Percentage	Enter the percentage of the maximum simple span live load + impact moment to be applied at the left support. This percentage will be applied to all live load moments.	--	0. (E)	100. (E)	*1
4. Right Support LL+I Moment Percentage	Enter the percentage of the maximum simple span live load + impact moment to be applied at the right support. This percentage will be applied to all live load moments.	--	0. (E)	100. (E)	*1

Notes:

[1] If this value is not entered, it will default to the same value as the dead load moment percentage for the appropriate support.

5.28 LLD - LIVE LOAD DEFINITION COMMAND

KEYWORD	COMMAND DESCRIPTION
LLD	LIVE LOAD DEFINITION - This command allows the user to define live loads to place in specific lanes on the bridge. This command must be used when an 'F' was entered as the live load option on the CTL command, and cannot be used with any other live load options. The lane assignments are made with the LLA command. This command cannot be used with the PDL command. Only one LLD command can be entered.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Live Load Type 1	Enter the live load to be placed in all lanes designated for Live Load Type 1, as defined on the LLA command: A - PHL-93. B - ML-80. C - P-82. D - H20. E - HS20. F - HL-93. G - Special live load vehicle #1. H - Special live load vehicle #2. I - TK527 J - EV2 K - EV3 L - SU6TV To use a special live load vehicle, the special live load (SLL) and special axle load (SAL) commands must be entered.		A, B, C, D, E, F, G, H, I, J, K, L (E)	--	A
2. Live Load Type 2	Enter the live load to be placed in all lanes designated for Live Load Type 2, as defined on the LLA command: A - PHL-93. B - ML-80. C - P-82. D - H20. E - HS20. F - HL-93. G - Special live load vehicle #1. H - Special live load vehicle #2. I - TK527 J - EV2 K - EV3 L - SU6TV To use a special live load vehicle, the special live load (SLL) and special axle load (SAL) commands must be entered. This live load must be different than Live Load Type 1.	--	A, B, C, D, E, F, G, H, I, J, K, L (E)	--	B

5.28 LLD - LIVE LOAD DEFINITION COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
3. Ratings Desired	Enter the rating option: 1 - If ratings are desired for Live Load Type 1. 2 - If ratings are desired for Live Load Type 2. The Live Load Type for which ratings are not desired is treated as a permanent load in the calculation of the rating factor.	--	1, 2 (E)	--	1
4. Multiple Presence Factor	Enter the factor by which the combined effect of all loads should be multiplied. If this value is not entered, the program will compute the factor as per LRFD Specifications.	--	0.65 (W)	1.20 (W)	--

5.29 LLA - LIVE LOAD ASSIGNMENT COMMAND

KEYWORD	COMMAND DESCRIPTION
LLA	LIVE LOAD ASSIGNMENT - This command allows the user to assign the live loads designated on the LLD command to specific lanes. This command must only be entered when an 'F' was entered as the live load option on the CTL command**, and cannot be used with any other live load options.** If pedestrian loading is not included in the run, one live load assignment command is required, with parameter 1 set to N. If pedestrian loading is included in this run, two live load assignment commands are required: one with parameter 1 set to Y, and another with parameter 1 set to N. The command can be entered a maximum of two times (once for the "with sidewalk" case, once without). For each LLA command, parameters 2 and 3 (lane number and live load type) may be repeated for up to 8 lanes. This command cannot be used with the PDL (program-defined lanes) command. If a lane is not entered on this command, it will default to no live load in that lane.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. With Sidewalks	Enter the sidewalk code: Y - If the lanes to follow are being defined as if there were 1 or 2 sidewalks on the bridge. N - If the lanes to follow are being defined as if there were no sidewalks on the bridge.	--	Y, N (E)	--	--
2. Lane Number	Enter the lane number in which to place the live load specified in parameter 3. If using user-defined lanes, this number should correspond to the lane number entered on the UDL command.	--	1 (E)	8 (E)	--
3. Live Load Type	Enter the live load type for the lane number entered in parameter 2. A value of N indicates that no live load is to be placed in this lane.	--	1, 2, N (E)	--	N

5.30 SLL - SPECIAL LIVE LOADING COMMAND

KEYWORD	COMMAND DESCRIPTION
SLL	SPECIAL LIVE LOADING - This command must be entered if an 'E' was entered as the live load option for analysis in the CTL command or if an 'F' was entered on the CTL command and 'G' or 'H' are entered as either of the live loads on the LLD 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.** The command can be repeated up to **eight** times (defining **eight** different special live loads) if 'E' is entered as the live load option for analysis or up to two times if 'G' or 'H' are entered as either of the live loads on the LLD command.

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. NOTE: If live load code F is entered on the CTL command, only up to two special live loads can 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. The force effects from this lane load are not subject to a dynamic load allowance.	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.

5.30 SLL - SPECIAL LIVE LOADING COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
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 20, DESIGN PERMIT VEHICLE DYNAMIC LOAD ALLOWANCE.	--	D, P (E)	--	D

5.31 SAL - SPECIAL AXLE LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
SAL	SPECIAL AXLE LOAD - This command must be entered when an 'E' was entered as the live load option for analysis in the CTL command or if an 'F' is entered on the CTL command and 'G' or 'H' entered as either of the loads on the LLD command. The command can be repeated up to **eight** times (defining **eight** different special live loads) if ‘E’ is entered as the live load option for analysis or up to two times if ‘G’ or ‘H’ are entered as either of the live loads on the LLD command. A maximum of 80 axle loads and 80 spacings can be entered. The final axle spacing of any vehicle must be entered as 0.0. **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 number; that is, if special live loads 1 and 3 are defined, then special live load 2 must also be defined. NOTE: If live load code F is entered on the CTL command, only up to two special live loads can 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)	--

5.32 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 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)	--

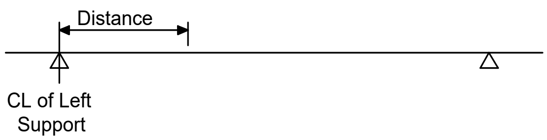
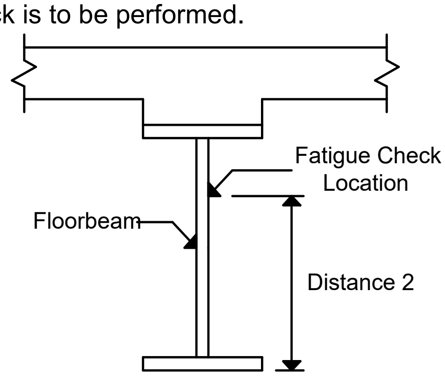
5.33 FGV - FATIGUE GROSS VEHICLE COMMAND

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)	--

5.34 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 30 fatigue analysis points (Six FTG commands with five fatigue locations each) can be entered for the entire floorbeam.

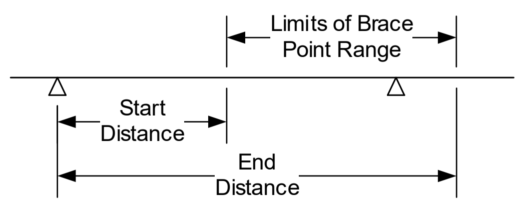
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Distance 1	Enter the distance from the centerline of the left support to the fatigue location. Distances to the left of the left support should be entered as negative values.  	ft	MXLFL[1] (E)	MXRFL[2] (E)	0.
2. Distance 2	Enter the distance from the bottom of the floorbeam to the location where the fatigue check is to be performed.  	in	0. (E)	150. (W)	0.
3. 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',BP, C, C', CP, D, E, E', EP (E)	--	--
4. 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 welded plate floorbeams.	in	0. (E)	10. (E)	--

Notes:

[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.35 BRP - BRACE POINT COMMAND

KEYWORD	COMMAND DESCRIPTION
BRP	BRACE POINT - This command is used to specify the lateral brace points for the floorbeam. The parameters and the command can be repeated. A maximum of 40 bracing point ranges can be entered for the entire floorbeam (10 BRP commands with four bracing point ranges each). If no bracing points are entered, the program assumes brace points only at the floorbeam supports. If any BRP command is entered, then the entire length of the floorbeam 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 floorbeam length is considered but that may not be equally divisible when the half floorbeam length is considered. For a floorbeam 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 braced only at the locations defined by this command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Distance	Enter the distance from the centerline of the left support to the start location of the current brace point range. Distances to the left of the left support should be entered as negative values.  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	MXLFL[1] (E)	MXRFL[2] (E)	--
2. End Distance	Enter the distance from the centerline of the left support to the end location of the current brace point range.	ft	MXLFL[1] (E)	MXRFL[2] (E)	--

5.35 BRP - BRACE POINT COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
3. Brace Spacing	Enter the brace point spacing for the given range. NOTE: For uncured slab checks for all floorbeams, and for floorbeams 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 floorbeam that is noncomposite in the final state, please use the CBR command in addition to this command.	ft	**0.05** (E)	25. (W)	--

Notes:
[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

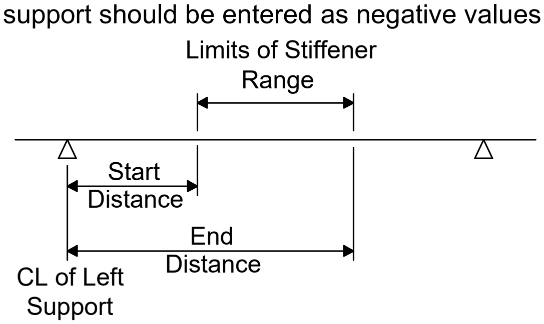
5.36 CBR - CONTINUOUS BRACE COMMAND

KEYWORD	COMMAND DESCRIPTION
CBR	CONTINUOUS BRACE - This command is used to specify if the top flange of a floorbeam can be considered continuously braced. The parameter and the command can only be specified once. 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 non-continuous bracing for the top flange, use the BRP (Brace Point) command. This command only applies to floorbeams that are specified noncomposite on the MAT command. This command is ignored for floorbeams specified as composite, since for those floorbeams, the top flange is always assumed to be continuously braced.

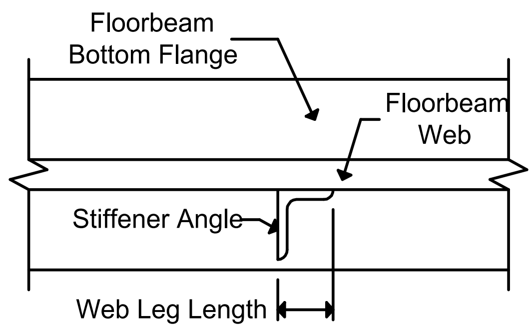
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Continuously Braced Top Flange	Enter “Y” if the top flange of the noncomposite floor beam is to be considered continuously braced in the permanent state. Enter “N” if the top flange of the noncomposite floorbeam is to be considered discretely braced in the permanent state. Enter the BRP command to define the flange brace locations.	--	Y, N (E)	--	N

5.37 TST - TRANSVERSE STIFFENER COMMAND

KEYWORD	COMMAND DESCRIPTION
TST	TRANSVERSE STIFFENER - This command is used to specify the transverse stiffener size and spacing for a welded plate floorbeam. The command can be repeated. A maximum of 20 stiffener ranges can be entered for the entire floorbeam (20 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 0.05 inches. A transverse stiffener is required at the termination of a web depth variation. See the detail in this manual Section 6.37 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.** The program does not 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.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Distance	Enter the distance from the centerline of the left support to the start location of the current stiffener range. Distances to the left of the left support should be entered as negative values.  	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
2. End Distance	Enter the distance from the centerline of the left support to the end location of the current stiffener range.	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
3. 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
4. Stiffener Spacing	Enter the transverse stiffener spacing for the given range.	ft	0.65 (W)	25. (W)	--

5.37 TST - TRANSVERSE STIFFENER COMMAND (Continued)

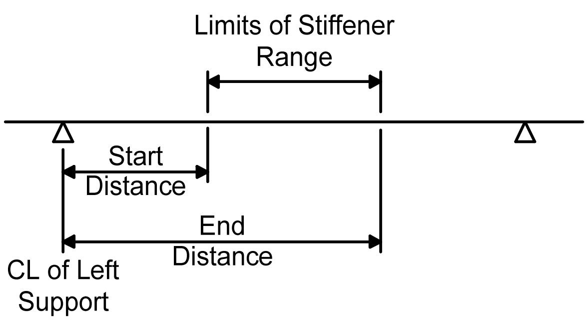
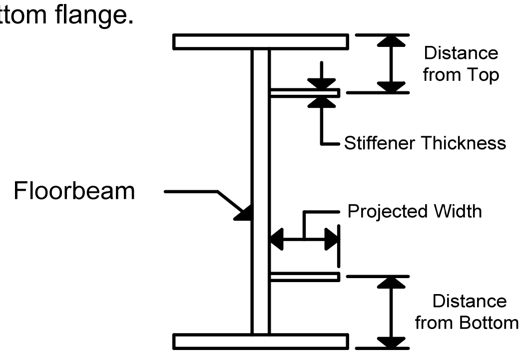
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Projected Width	Enter the width of the projecting element (length of the leg of the angle perpendicular to the web).	in	4. (W)	24. (W)	--
6. Stiffener Thickness	Enter the thickness of the transverse stiffener plate or the thickness of the angle leg.	in	0.125 (W)	3. (W)	--
7. Transv. Stiffener Yield Strength	Enter the yield strength of the transverse stiffener.	ksi	30. (W)	50. (W)	36.
8. Plate or Angle	Enter: P - If the stiffener is a plate. A - If the stiffener is an angle.	--	P, A (E)	--	P
9. Web Leg Length	Enter the length of the leg of the angle parallel to the web. Omit this value if stiffener is not an angle.  Plan View	in	0. (E)	9. (W)	0.

Notes:

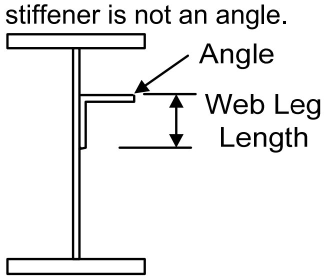
[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.38 LST - LONGITUDINAL STIFFENER COMMAND

KEYWORD	COMMAND DESCRIPTION
LST	LONGITUDINAL STIFFENER - This command is used to specify the longitudinal stiffener size and location. The command can be repeated. A maximum of 20 stiffener ranges (20 LST commands) can be entered for the entire floorbeam.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Start Distance	Enter the distance from the centerline of the left support to the start location. Distances to the left of the left support should be entered as negative values.  	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
2. End Distance	Enter the distance from the centerline of the left support to the end location of the current stiffener range. Distances to the left of the left support should be entered as negative values.	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
3. 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
4. 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)	--

5.38 LST - LONGITUDINAL STIFFENER COMMAND (Continued)

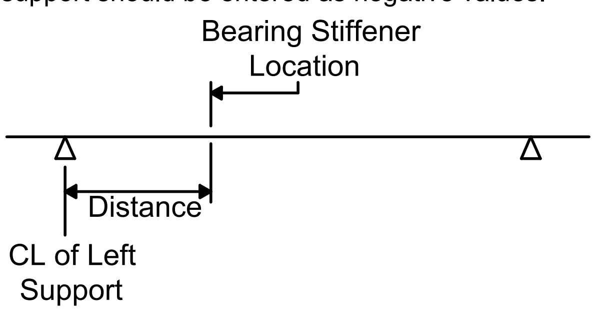
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Single or Pair	Enter: S - Single stiffener (on one side of the web only). P - Pair of stiffeners (on both sides of the web).	--	S, P (E)	--	S
6. Projected Width	Enter the width of the projecting element (length of the horizontal leg of the angle).	in	4. (W)	24. (W)	--
7. Stiffener Thickness	Enter the thickness of the projecting element.	in	0.125 (W)	3. (W)	--
8. Longit. Stiffener Yield Strength	Enter the yield strength of the longitudinal stiffener.	ksi	30. (W)	50. (W)	36.
9. Plate or Angle	Enter: P - If the stiffener is a plate. A - If the stiffener is an angle.	--	P, A (E)	--	P
10. Web Leg Length	Enter the length of the vertical leg of the angle. Omit this value if stiffener is not an angle.  	in	0. (E)	9. (W)	0.

Notes:

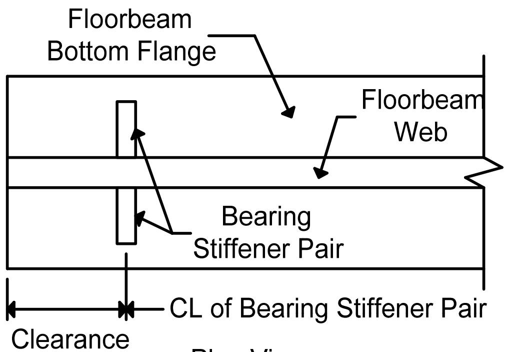
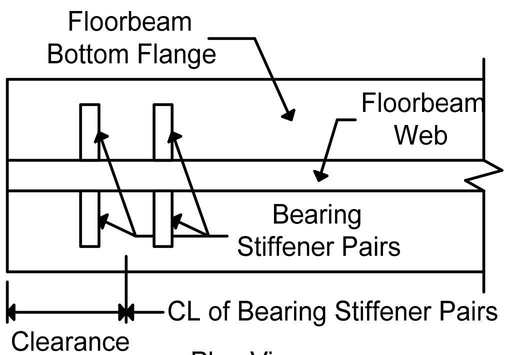
[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.
[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

5.39 BST - BEARING STIFFENER COMMAND

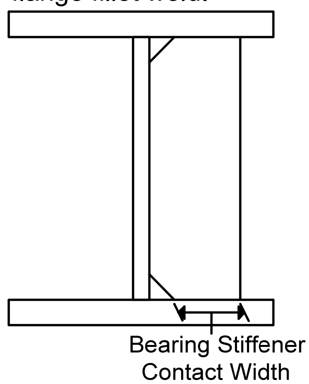
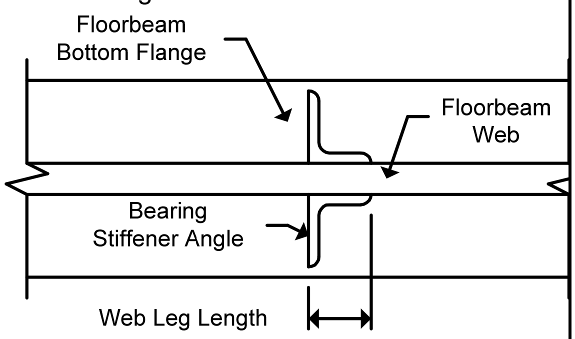
KEYWORD	COMMAND DESCRIPTION
BST	BEARING STIFFENER - This command is used to specify the bearing stiffener size and location. The BST command can be repeated. A maximum of 42 stiffener locations can be entered (42 BST commands). This maximum equals the number of supports plus the maximum number of concentrated loads plus the maximum number of stringer 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.** Bearing stiffener locations can only be defined for points of concentrated load or at bearing locations.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Distance	Enter the distance from the centerline of the left support to the location of the current bearing stiffener. This distance should be entered as zero for bearing stiffener pairs at the left support. Bearing stiffeners are also required at points of concentrated loads. Distances to the left of the left support should be entered as negative values.  	ft	MXLFL[1] (E)	MXRFL[2] (E)	--
2. Number of Pairs	Enter the number of bearing stiffener pairs at the defined support.	--	1 (E)	4 (E)	--
3. Spacing Between Pairs	Enter the distance center to center between bearing stiffener pairs. Leave blank if NUMBER OF PAIRS is equal to one.	in	0. (E)	36. (W)	--

5.39 BST - BEARING STIFFENER COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
4. Clearance	Enter the distance from the end of the floorbeam to the centerline of the bearing stiffener pairs.  Plan View  Plan View For floorbeams with a TYPE OF SUPPORT (CTL command) of C (continuous) or O (simply supported with fixed overhangs), enter this value only for bearing stiffeners located at the ends of the overhangs. For floorbeams with a TYPE OF SUPPORT of S (simply supported, no overhangs), enter this value only for bearing stiffeners located at the support locations. Leave blank if the bearing stiffener is not located at the ends of the floorbeam.	in	0. (E)	12. (W)	[3]
5. Welded or Bolted	Enter: W - Welded stiffener. B - Bolted stiffener.	--	W, B (E)	--	W
6. 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)	--

5.39 BST - BEARING STIFFENER COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Bearing Contact Width	Enter the contact width of one stiffener between the stiffener and the flange. The bearing contact width is less than the stiffener projecting width because the stiffener must be clipped to clear the web-to-flange fillet weld. 	in	3. (W)	23. (W)	--
8. Stiffener Thickness	Enter the thickness of the bearing stiffener plate or bearing stiffener angle leg.	in	0.25 (W)	3. (W)	--
9. Bearing Stiffener Yield Strength	Enter the yield strength of the bearing stiffener.	ksi	30. (W)	50. (W)	36.
10. Plate or Angle	Enter: P - If the stiffeners are plates. A - If the stiffeners are angles.	--	P, A (E)	--	P
11. Web Leg Length	Enter the length of the leg of the stiffener angle parallel to the web. Omit this value if the stiffener is not an angle.  Plan View	in	0. (E)	9. (W)	0.
12. 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.**

5.39 BST - BEARING STIFFENER COMMAND (Continued)

Notes:

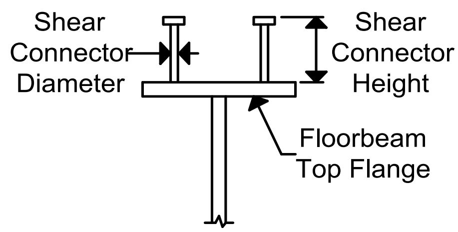
[1] MXLFL is the maximum length (negative) of the left cantilever of the floorbeam.

[2] MXRFL is the center-to-center girder or truss spacing plus the right cantilever length.

[3] CLEARANCE will default to 0.0 inches for bearing stiffeners at the ends of the floorbeam. This value is not used for bearing stiffeners located anywhere else on the floorbeam, so there is no default for those locations.

5.40 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 floorbeam and the concrete slab. If the floorbeam is composite, then it is assumed to be composite over its entire length. If the floorbeam is composite, the user must enter either the SCS or SCC command. The user cannot enter both the SCS and SCC command.

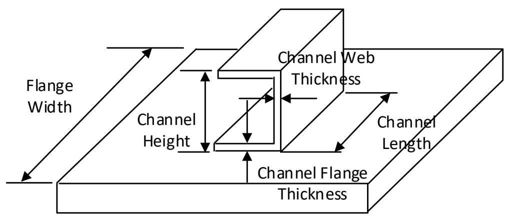
PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Number of Connectors	Enter the number of stud type shear connectors in a transverse cross section.	--	2 (E)	5 (W)	3
2. Connector Diameter	Enter the diameter of an individual stud type shear connector.  Transverse Cross Section	in	0.75 (W)	MXHT[1] (W)	--
3. Connector Height	Enter the height of the stud type shear connector. NOTE: if this value exceeds the effective deck thickness (entered on the SLB command), the program will stop with an error. The connector height is not used for any other checks.	in	4. (W)	14. (W)	--
4. Connector Tensile Strength	Enter the tensile strength of the stud type shear connector.	ksi	36. (W)	60. (W)	36.

Notes:

[1] MXHT is equal to the smallest value of the (effective slab thickness + haunch thickness - top flange thickness) over the entire length of the floorbeam.

5.41 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 floorbeam and the concrete slab. If the floorbeam is composite, then it is assumed to be composite over its entire length. If the floorbeam 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. 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 floorbeam.	in	2. (W)	50. (W)	--
4. Channel Height	Enter the height of the channel type shear connector. NOTE: if this value exceeds the effective deck thickness (entered on the SLB command), the program will stop with an error. The connector height is not used for any other checks.	in	4. (W)	MXHT[1] (W)	--

Notes:

[1] MXHT is equal to the smallest value of the (effective slab thickness + haunch thickness - top flange thickness) over the entire length of the floorbeam.

5.42 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

5.43 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)	0
2. Section Properties	Enter: 0 - Do not print section properties. 1 - Print section properties.	--	0 (E)	1 (E)	1
3. Additional Section Properties	Enter: 0 - Do not print additional section properties. 1 - Print additional section properties.	--	0 (E)	1 (E)	1

5.44 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 non-composite dead load contraflexure. 1 - Print the points of noncomposite dead load contraflexure.	--	0 (E)	1 (E)	1
2. Load Modifiers	Enter: 0 - Do not print the load modifiers. 1 - Print the load modifiers.	--	0 (E)	1 (E)	1
3. 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)	0
4. 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
5. Dead Load Reactions	Enter: 0 - Do not print the unfactored dead load reactions. 1 - Print the unfactored dead load reactions.	--	0 (E)	1 (E)	0
6. Influence Lines	Enter: 0 - Do not print the influence lines for moment, shear, deflection, reaction, and rotation. 1 - Print the influence lines for moment, shear, deflection, reaction, and rotation.	--	0 (E)	1 (E)	0
7. 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

5.44 OAN - OUTPUT OF ANALYSIS RESULTS COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
8. 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)	0
9. HS20 Effects and Reactions	Enter: 0 - Do not print the HS20 live load effects and reactions with the output requested in parameters 7 and 8. 1 - Print the HS20 live load effects and reactions with the output requested in parameters 7 and 8.	--	0 (E)	1 (E)	0
10. H20 Effects and Reactions	Enter: 0 - Do not print the H20 live load effects and reactions with the output requested in parameters 7 and 8. 1 - Print the H20 live load effects and reactions with the output requested in parameters 7 and 8.	--	0 (E)	1 (E)	0
11. Fatigue Effects and Reactions	Enter: 0 - Do not print the fatigue live load effects and reactions with the output requested in parameters 7 and 8. 1 - Print the fatigue live load effects and reactions with the output requested in parameters 7 and 8.	--	0 (E)	1 (E)	0
12. 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
13. 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)	0

5.45 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)	0
2. 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
3. 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
4. Web Checks	Enter: 0 - Do not print the results of the web specification checks. 1 - Print the results of the web specification checks. NOTE: this output will only appear for floorbeams that are noncomposite in the final state	--	0 (E)	1 (E)	0
5. 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)	0
6. 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)	0
7. 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

5.45 OSC - OUTPUT OF SPECIFICATION CHECKING COMMAND (continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
8. 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)	0
9. 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)	0
10. Uncured Slab Checks	Enter: 0 - Do not print the results of the uncured slab specification checks. 1 - Print the results of the uncured slab specification checks.	--	0 (E)	1 (E)	0
11. 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)	0

5.46 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)	0
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)	0
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**

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, 6.15.9 Haunch Depth corresponds to Section 5.15 ARB - Analysis Rolled Beam Command, parameter 9. Only the commands and parameters for which detailed description is given are included in this chapter.

6.5 CTL - CONTROL COMMAND

6.5.5 Type of Support

The following figures represent each of the three types of support that can be entered.

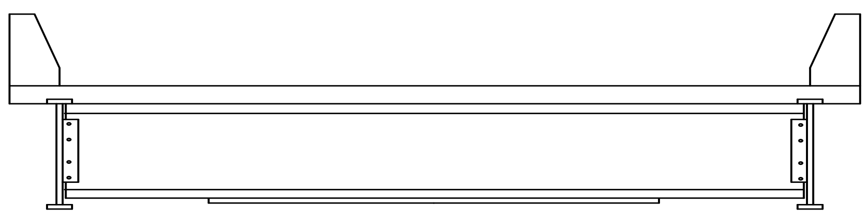


Figure 6.5-1 Simple Span (Type S)

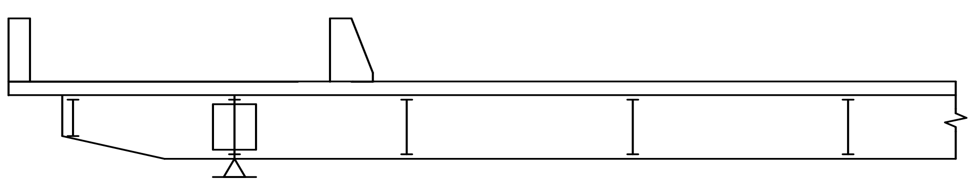


Figure 6.5-2 Continuous Span (Type C)

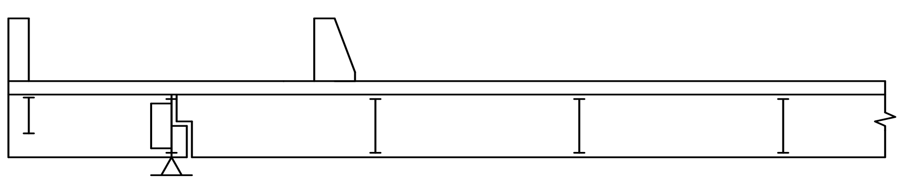


Figure 6.5-3 Simple Span with Fixed End Cantilevers (Type O)

6.5.8 Symmetry

If the user enters Y for this parameter, indicating that the entire floorbeam is symmetrical, then the user must specify input for only the first half of the floorbeam. The program will provide output for only the first half of the floorbeam, 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 floorbeam, 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 floorbeam, the program will perform the analysis for the entire floorbeam length.

Since input is specified for only the first half of the floorbeam for a symmetrical run, maximum limits related to the allowable number of items for the entire length of the floorbeam 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 floorbeam length. If only half the floorbeam is to be specified in the input, then the maximum limits must be divided by 2.

6.5.11 Live Load

For live load options 'A' through 'E' and 'G', the analysis for each live load vehicle is performed separately. That live load vehicle is placed in as many traffic lanes as necessary to produce the controlling effect at each analysis point. The analysis, specification checking, and rating factor modules give output considering each live load independently.

This procedure is changed for live load option F. Live load option F is used in conjunction with the User Defined Lanes (UDL), Live Load Definition (LLD), and Live Load Assignment (LLA) commands to define two different live loads that can be placed on the floorbeam at the same time in specific traffic lanes. Live load option F cannot be used with the Program Defined Lanes (PDL) command because the live loads must be placed in specific traffic lanes by the LLA command.

6.5.19 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 between the floorbeam supports, tenth points on the floorbeam overhangs, 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 between the floorbeam supports, tenth points on the floorbeam overhangs, 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.

6.8 PDL - PROGRAM DEFINED LANES COMMAND

6.8.2 Centerline Left Support to Left Curb

(Refer to Section 6.8.3)

6.8.3 Centerline Left Support to Right Curb

These parameters are to be entered assuming that sidewalks are not present. They are used in placement and boundaries of traffic lanes for all limit states except Strength IP.

6.8.4 Centerline Left Support to Left Curb with Sidewalks

(Refer to Section 6.8.5)

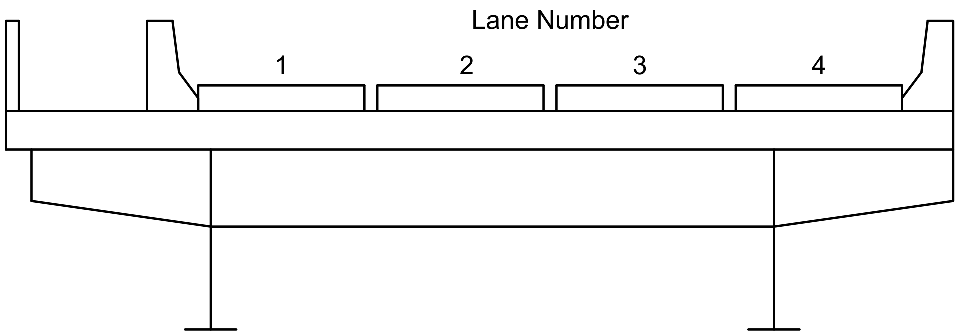
6.8.5 Centerline Left Support to Right Curb with Sidewalks

These parameters are to be entered assuming that sidewalks are present. They are used in placement and boundaries of traffic lanes for the Strength IP limit state only.

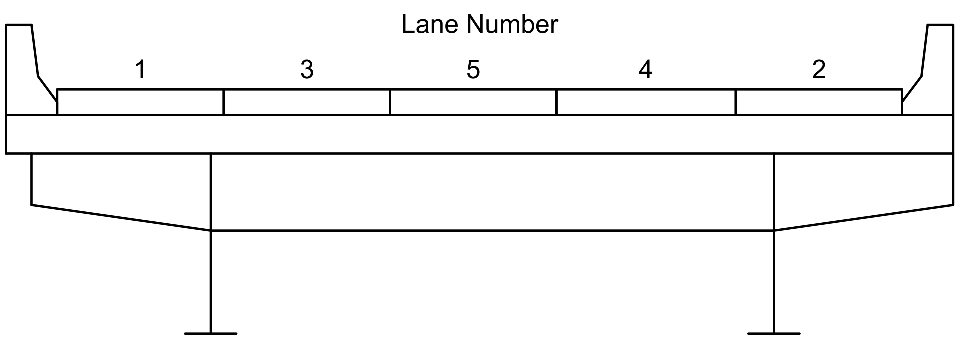
6.9 UDL - USER DEFINED LANES COMMAND

6.9.1 With Sidewalk

This flag designates if the lane definitions to follow are for traffic lanes defined with or without sidewalks present on the bridge. The lane definitions without sidewalks are used to place live loads for all limit states except Strength IP, while the definitions with sidewalks are used to place live loads for Strength IP. Figure 1 shows the difference between the two definitions. For either of the two cases shown in Figure 1, the traffic lanes may be defined as adjacent to each other or with gaps between each lane.



User-Defined Traffic Lanes with Sidewalks



User-Defined Traffic Lanes without Sidewalks

Figure 6.9-1 Lane Definitions

6.9.2 Lane Number

As shown in Figure 1, the lanes do not have to be defined in order from left to right along the floorbeam.

6.13 MAT - MATERIAL COMMAND

6.13.2 Noncomposite/Composite

A floorbeam 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.

6.15 ARB - ANALYSIS ROLLED BEAM COMMAND

6.15.4 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			

6.15.9 Haunch Depth

A haunch detail 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 6.10.1.5 and C6.10.1.5 for guidance regarding haunch depth input for both new and existing beams.

The haunch depth is used to compute the section properties and dead load due to the haunch. In computing the section properties, the program uses the haunch depth to determine the separation distance between the concrete deck and steel floorbeam. However, the program does not include the area of the haunch when computing the section properties. In other words, 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 floorbeam) 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.

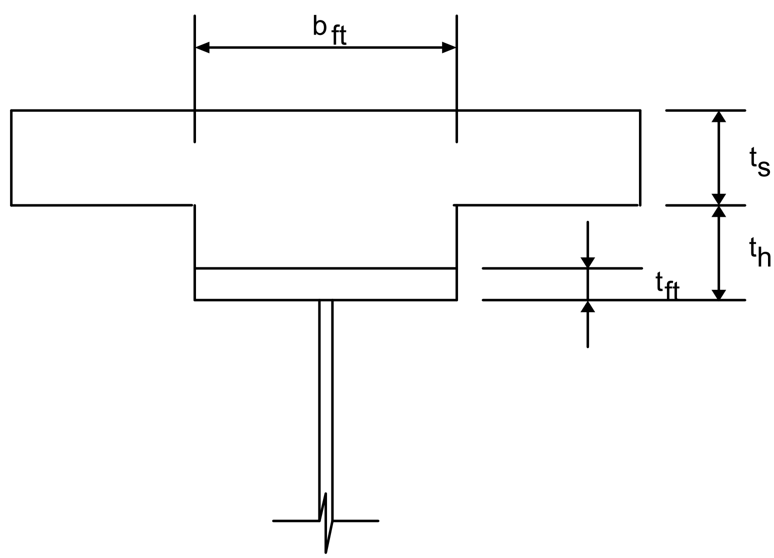


Figure 6.15-1 Haunch Detail

6.15.10 Deck Transverse Reinforcement Area

This parameter includes the total of all layers of reinforcing steel parallel to the floorbeam.

The value entered is multiplied by the effective slab width to compute the total area of reinforcement for the calculation of the composite floorbeam section properties for negative flexure.

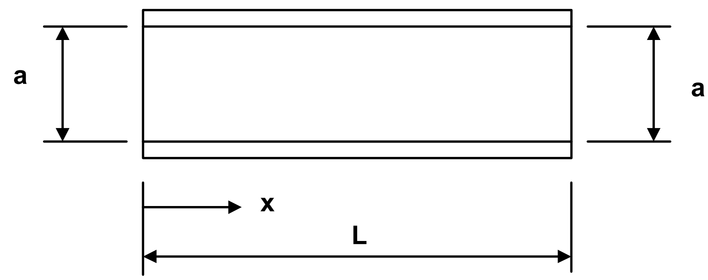
6.15.11 Deck Reinforcement CG Distance

This parameter is the distance from the location of the centroid of all layers of transverse deck reinforcing steel to the top of the deck.

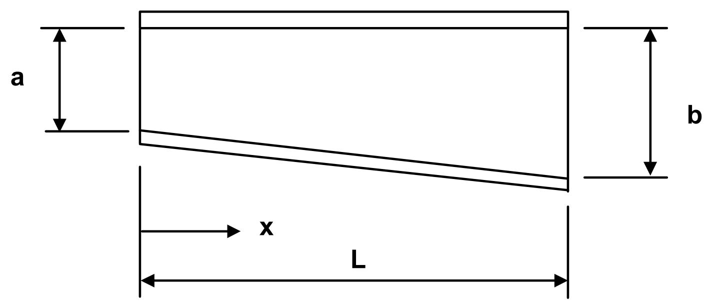
6.16 ABU - ANALYSIS BUILT-UP COMMAND

6.16.7 Web Depth Variation

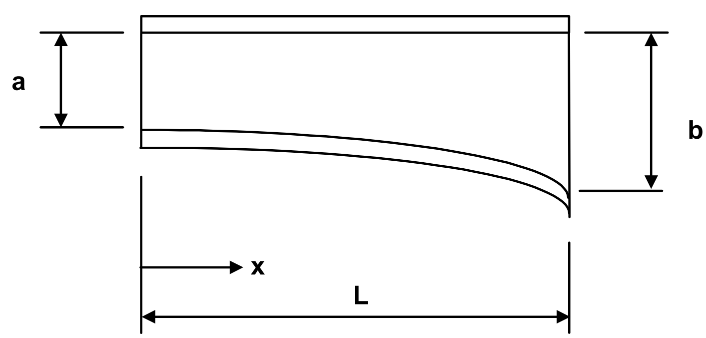
Web depth details are presented in Figure 1. Within a defined range, the web depth can either be constant with no variation, it can vary parabolically, or it can vary linearly.



Constant Web Depth



Linearly - Varying Web Depth



Parabolically - Varying Web Depth

Figure 6.16-1 Web Depth Details

6.16.8 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 floorbeam 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. 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 floorbeam self-weight for each range equal to the average of the floorbeam 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.

Example:

Consider the linearly-varying example in figure 2:

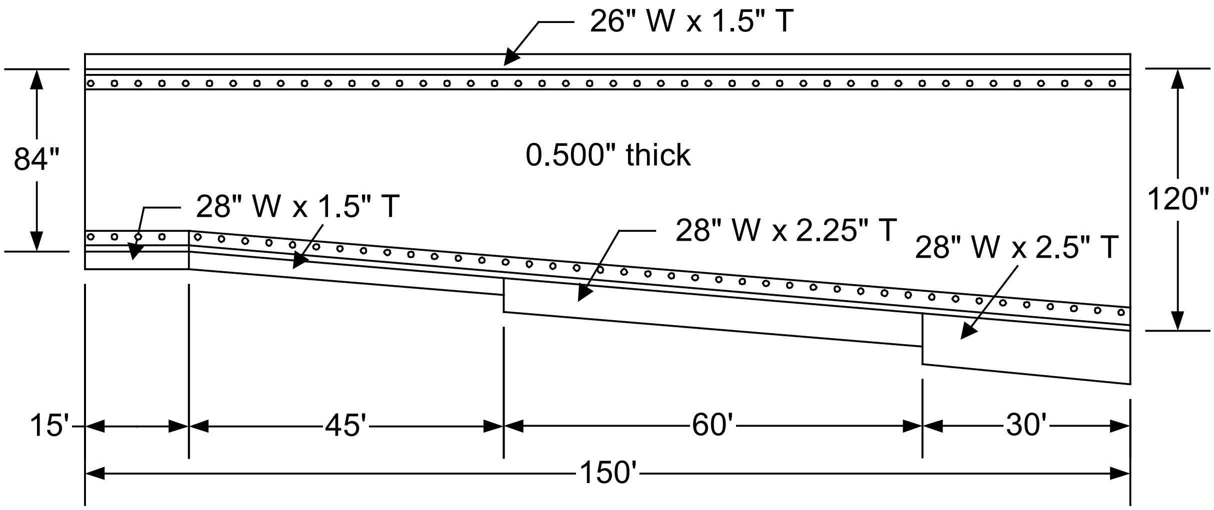


Figure 6.16-2 Linearly Varying Web Depth Example

This piece of the girder would be entered as:

```
ABU   0.,  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  15.,  60., 1, 8.0, 8.0, 1.0, S,     , 0.5, 26., 1.5, 28., 1.50, 1.5, 0.75, 4.25
ABU  60., 120., 1, 8.0, 8.0, 1.0, S,     , 0.5, 26., 1.5, 28., 2.25, 1.5, 0.75, 4.25
ABU 120., 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. 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.

6.16.14 Haunch Depth

For a detailed input description of the haunch depth, refer to Section 6.15.9.

6.16.15 Deck Transverse Reinforcing Area

For a detailed input description of the deck reinforcing steel area, refer to Section 6.15.10.

6.16.16 Deck Reinforcement CG Distance

For a detailed input description of the deck reinforcing steel CG distance, refer to Section 6.15.11.

6.17 APL - ANALYSIS PLATE COMMAND

6.17.4 Web Depth Variation

For a detailed input description of the web depth variation, refer to Section 6.16.7.

6.17.5 Web Depth

For a detailed input description of the web depth, refer to Section 6.16.8.

6.17.11 Haunch Depth

For a detailed input description of the haunch depth, refer to Section 6.15.9.

6.17.12 Deck Transverse Reinforcing Area

For a detailed input description of the deck reinforcing steel area, refer to Section 6.15.10.

6.17.13 Deck Reinforcement CG Distance

For a detailed input description of the deck reinforcing steel CG distance, refer to Section 6.15.11.

6.18 SHO - SECTION HOLE COMMAND

6.18.6 Number of Holes

The number of holes is counted across the cross section, not along the range, as shown in Figures 1 and 2.

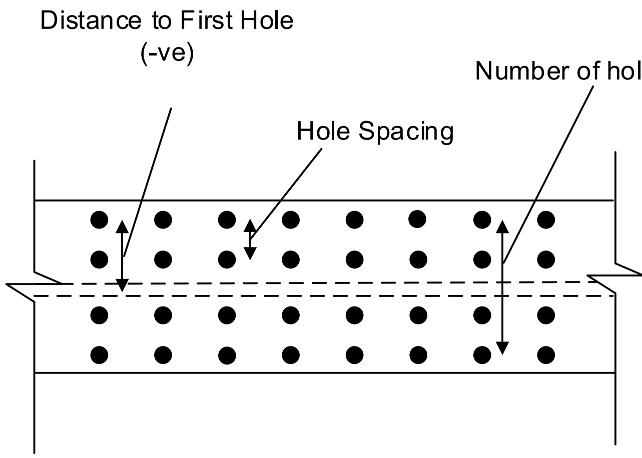


Figure 6.18-1 Number of Holes: Flange Plan View

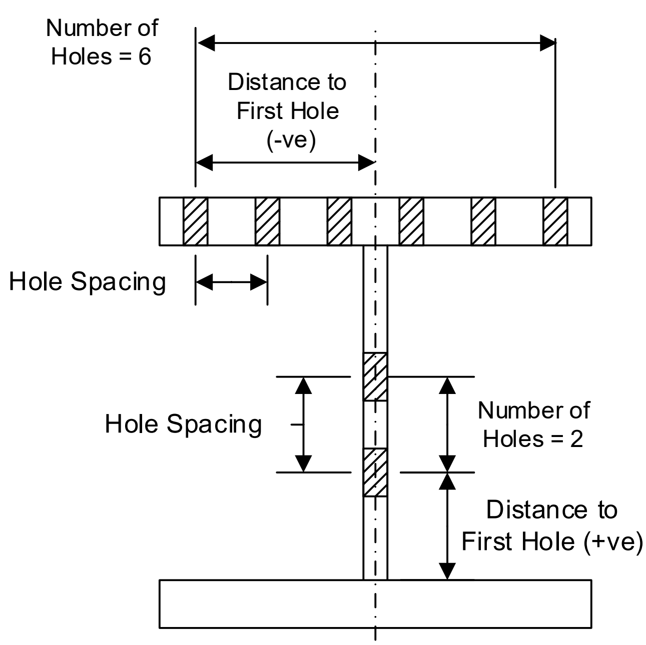


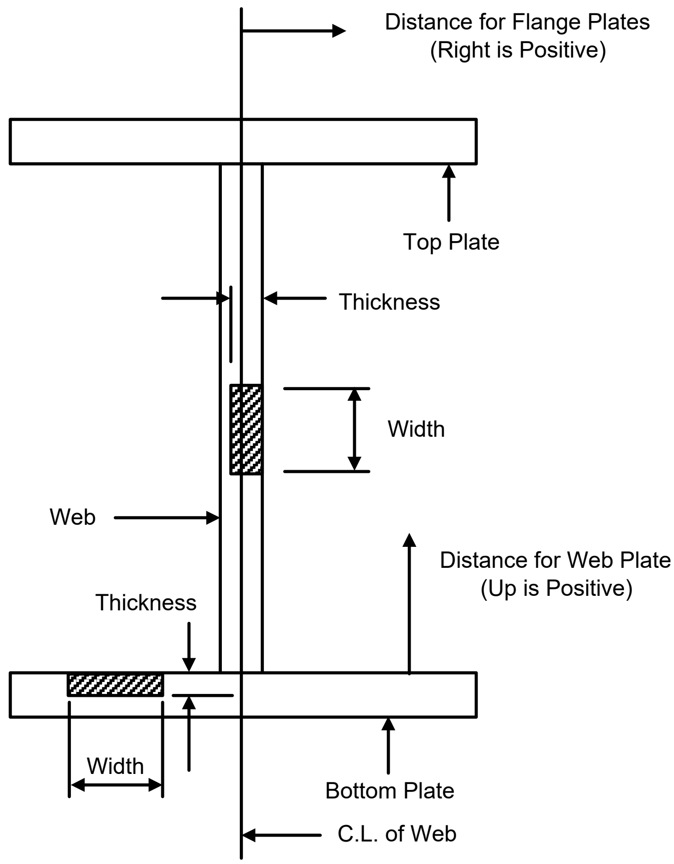
Figure 6.18-2 Number of Holes: Cross Section View

6.19 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 floorbeam self-weight or the gross section properties, which are used in the analysis computations.

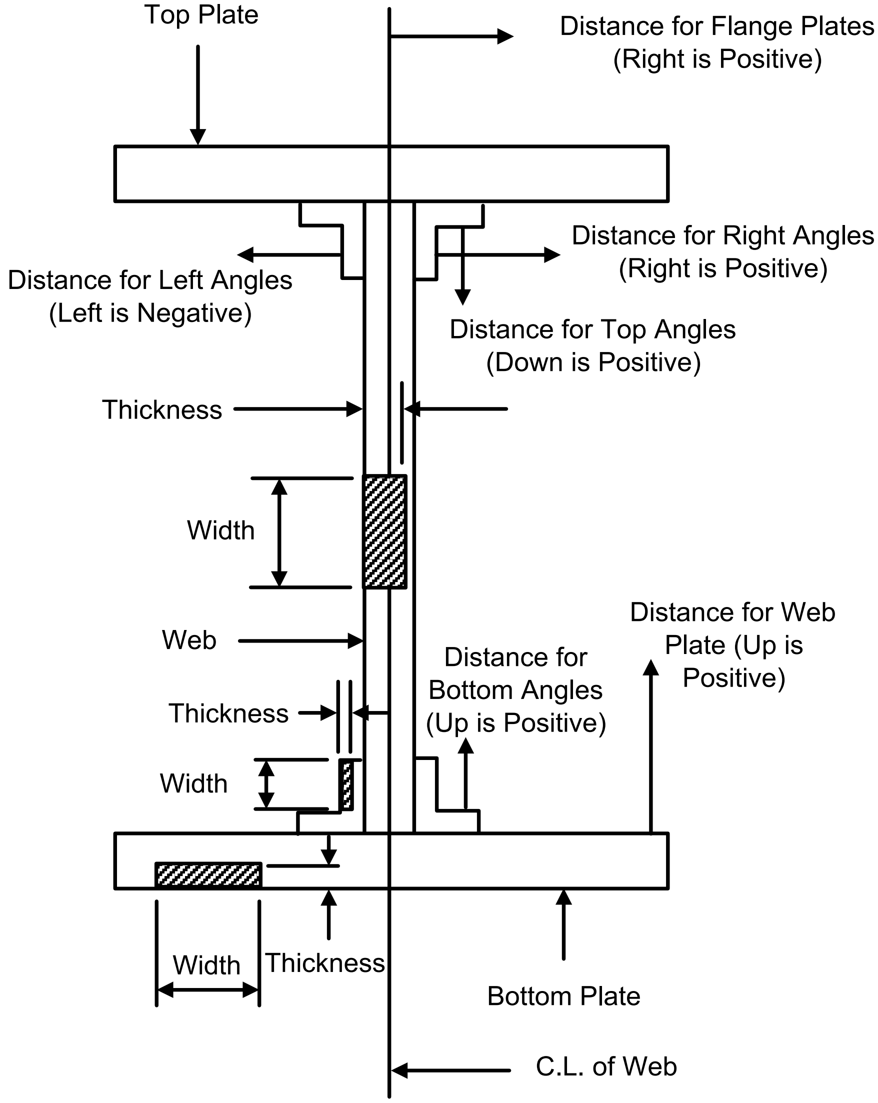
6.19.3 Section Loss Element

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.



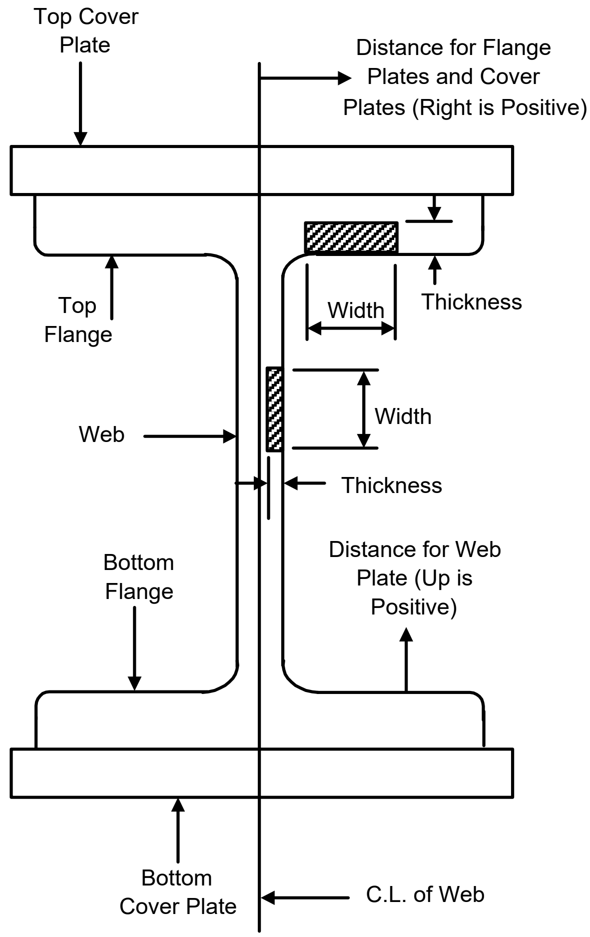
Note: Distances are measured from the origin to the center of the width of the section loss.

Figure 6.19-1 Section Loss for a Plate Girder



Note: Distances are measured from the origin to the center of the width of the section loss.

Figure 6.19-2 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 6.19-3   Section Loss for a Rolled Beam

6.19.5   Distance

The distance, as described in Section 5.19, 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.

6.19.6   Width

The width, as described in Section 5.19, 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.

6.19.7 Thickness

The thickness, as described in Section 5.19, 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 6.19.6.

6.20 SLB - SLAB COMMAND

6.20.2 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:

$$t_{s,eff} = t_x - 0.5\ inches$$

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.

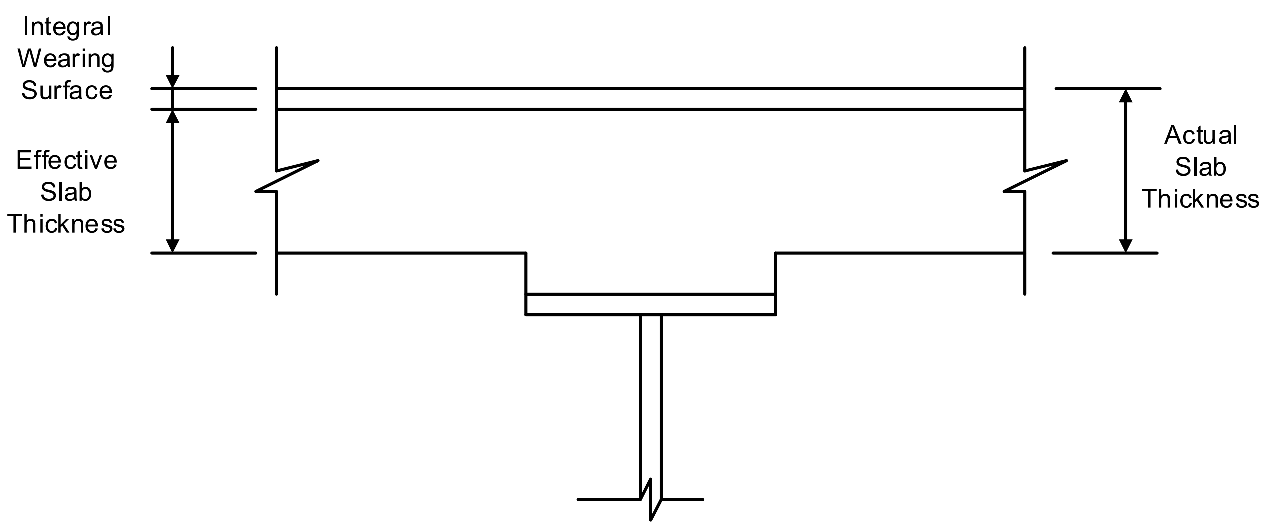


Figure 6.20-1 Effective Slab Thickness

6.22 FCL - FLOORBEAM CONCENTRATED LOAD COMMAND

6.22.1 Load Type

The pedestrian DC2 (PDC2) 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 PDC2 dead load includes the sidewalk and railing on the left side and the additional parapet on the right side. The railing and parapet should be entered as floorbeam concentrated loads if stringers are not present, while the sidewalk should be entered as a floorbeam distributed load, again if no stringers are present. If stringers are present, all three loads should be entered as PDC2 stringer distributed loads.

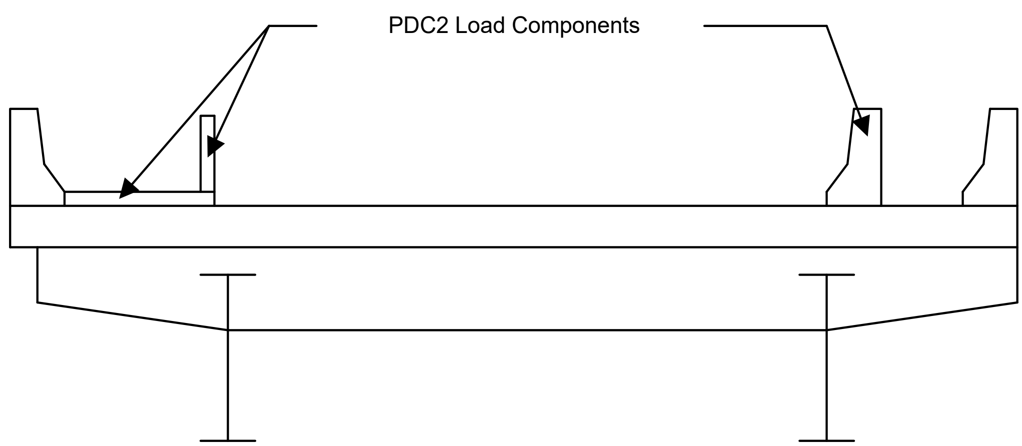


Figure 6.22-1 PDC2 Load Components

This parameter is entered in units of kips acting on the floorbeam. Therefore, the user must convert the load from ksf to kips. In addition, the user must compute the portion of the total kips that is carried by the floorbeam being analyzed using the lever rule.

The program factors this value using the γ_{DC} load factors, as presented in Table 3.5-2.

The additional future wearing surface dead (PFWS) 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 2, a negative value should be entered for the additional future wearing surface dead load.

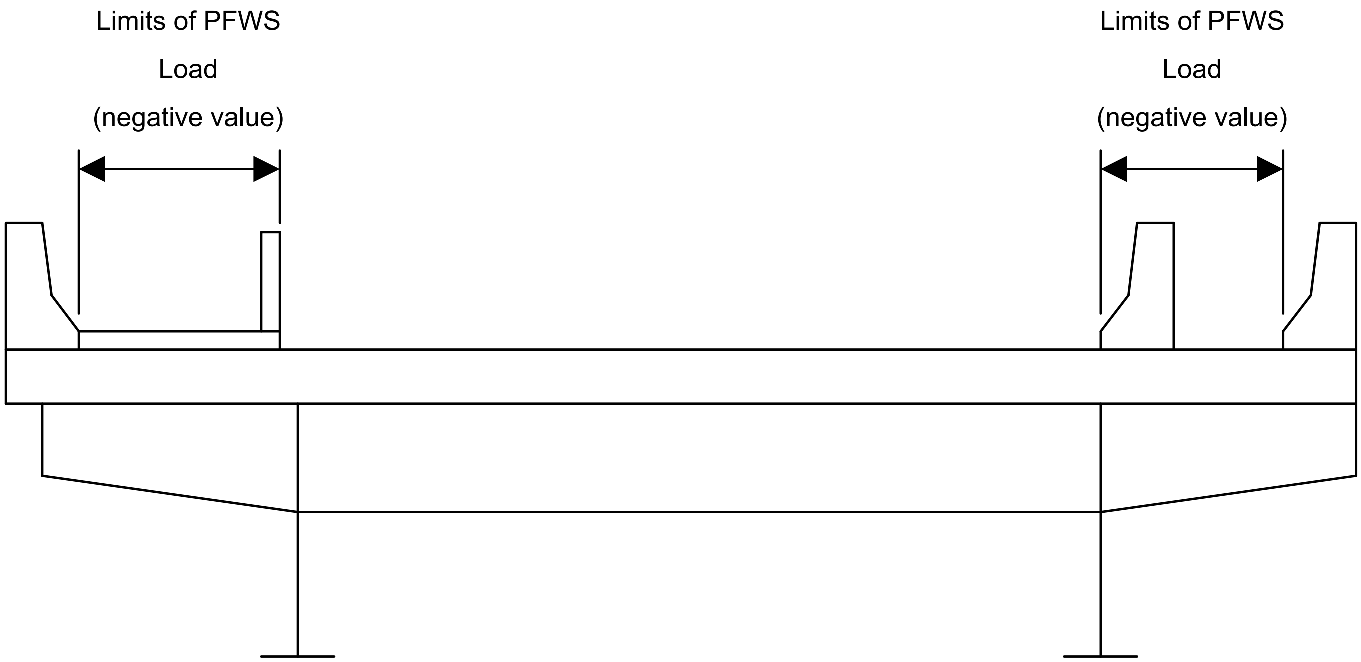


Figure 6.22-2 Pedestrian FWS Load Components

This parameter is entered in units of kip/ft acting on the floorbeam. 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 floorbeam being analyzed using the lever rule.

The program factors this value using the γ_{FWS} load factors, as presented in Table 3.5-2.

6.22.3 Magnitude

The distribution of parapet loads should be in accordance with DM-4 Section D3.5.1.1P, "Application of Dead Load on Girder and Box Beam Structures".

6.23 SCL - STRINGER CONCENTRATED LOADS COMMAND

6.23.2 Load Type

For information about pedestrian DC2 (PDC2) loads, refer to Section 6.22.1.

6.24 FDL - FLOORBEAM DISTRIBUTED LOADS COMMAND

6.24.1 Load Type

For information about pedestrian DC2 (PDC2) and pedestrian FWS (PFWS) loads, refer to Section 6.22.1.

6.25 SDL - STRINGER DISTRIBUTED LOADS COMMAND

6.25.2 Load Type

For information about pedestrian DC2 (PDC2) and pedestrian FWS (PFWS) loads, refer to Section 6.22.1.

6.26 PLD - PEDESTRIAN 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 a cross section with a sidewalk on the left side, a sidewalk on the right side, or a sidewalk on both sides.

6.26.1 Left Sidewalk Pedestrian Live Load

6.26.2 Right Sidewalk Pedestrian Live Load

This parameter is entered in units of ksf acting over the width of the sidewalk. The program internally computes the load acting on the floorbeam based on the sidewalk boundaries entered on the GEO command.

The program factors this value using the γ_{PL} load factors, as presented in Table 3.5-2.

6.27 SFX - SUPPORT FIXITY COMMAND

This command allows the user to specify the percentage of simple span moment to be applied at the supports of a simply supported beam in order to approximate a floorbeam with some fixity at the supports. Separate inputs are provided for each support, as well as for dead load versus live load plus impact. The program first computes the effects (moment, shear, deflection, etc.) due to the loads as if the beam were simply supported. A representative moment diagram is shown in Figure 1.

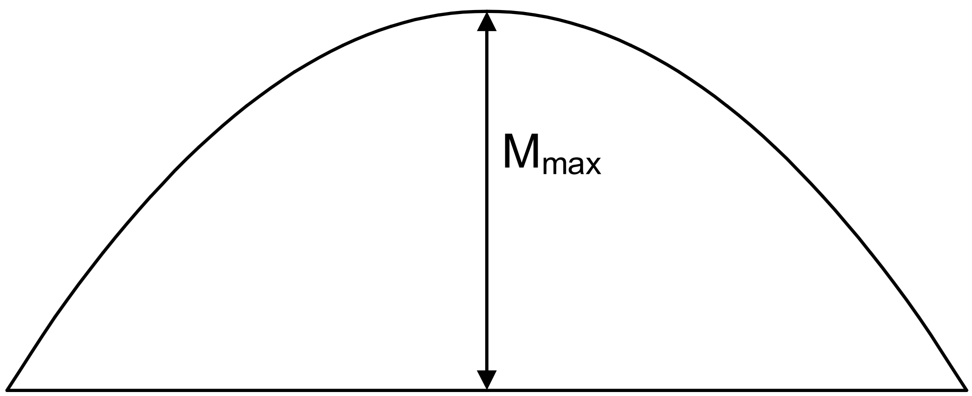


Figure 6.27-1 Simple Span Relative Maximum Live Load Moment Diagram

The program then finds the relative maximum moment for each analysis point, and then computes the appropriate percentage of that moment to be applied to the analysis point, as defined in this command. The relative maximum moment is the maximum moment induced in the floorbeam by the wheel locations inducing the maximum moment at a given analysis point. Each analysis point has a corresponding relative maximum moment value. The beam is then analyzed as a simply supported beam with applied end moments. These end moments are applied such that the sense of flexure is opposite that of the simple span moments. For example, in Figure 1, the extreme bottom fiber of the floorbeam is in tension. If the user enters 30% for the left support and 50% for the right support, the extreme top fiber of the floorbeam would be in tension and the applied end moment diagram would be as shown in Figure 2.

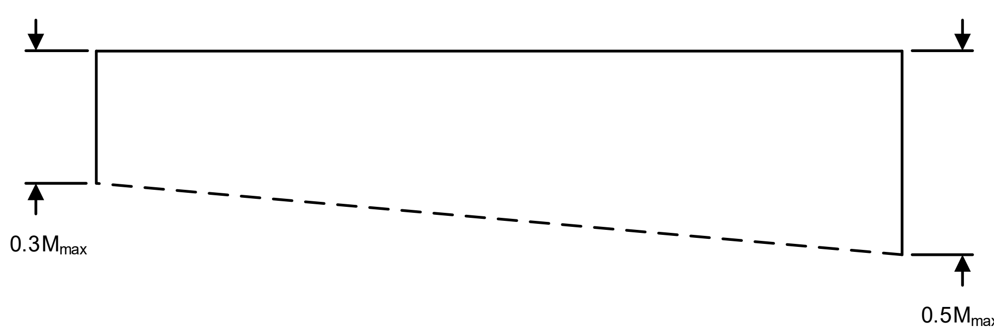


Figure 6.27-2 Applied End Moment Diagram

The effects induced by these end moments are then superimposed on the simple span effects. For example, the total moment diagram would be as shown in Figure 3.

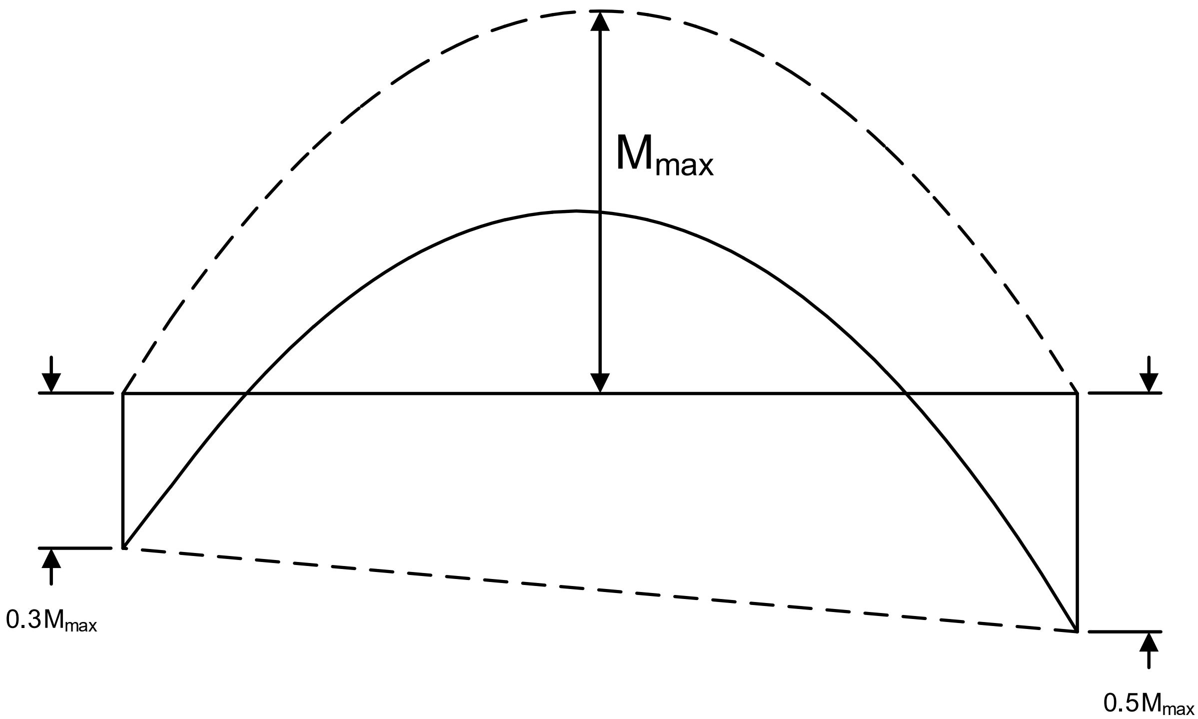


Figure 6.27-3 Actual Moment Diagram

6.27.3 Left Support LL+I Moment Percentage

This percentage is used to define the fixity of the left support. This percentage is also applied to the pedestrian live load effects. However, impact is not included with the pedestrian live load effects, so no impact moment will be added to the pedestrian fixed end moments.

6.27.4 Right Support LL+I Moment Percentage

This percentage is used to define the fixity of the right support. This percentage is also applied to the pedestrian live load effects. However, impact is not included with the pedestrian live load effects, so no impact moment will be added to the pedestrian fixed end moments.

6.28 LLD - LIVE LOAD DEFINITION COMMAND

This command, coupled with the Live Load Assignment (LLA) command, is used to define different live loads to be simultaneously placed in specific lanes along the floorbeam. This command could be used when attempting to rate the floorbeam for a specific permit loading, while concurrently allowing other live loads in the other lanes. The command also allows the option of leaving specific lanes free of live load vehicles to allow the rating of the floorbeam for a single live load in a single lane.

6.28.1 Live Load Type 1

6.28.2 Live Load Type 2

When a special live load vehicle is desired in one or more of the user-defined lanes, it should be specified as one of these parameters. The Special Live Load (SLL) and Special Axle Load (SAL) commands must also be entered, in order to define the special live load vehicle. However, only one special live load vehicle may be defined; different special live load vehicles cannot be defined for each Live Load Type parameter.

6.28.3 Ratings Desired

This parameter allows the user to choose the vehicle for which the program will compute ratings. The effect from the vehicle not chosen will be assumed as part of the permanent load and will be removed from the load resistance before dividing by the live load effect. For example, if ratings for Live Load Type 2 are desired, the expression for the moment rating will be as follows:

$$Rating\ Factor = \frac{M_r - M_{DC1} - M_{DC1S} - M_{DC2} - M_{FWS} - M_{LL1}}{M_{LL2}}$$

In addition, rating factors will only be calculated for the limit states corresponding to the given live load type. For example, in the case above, if P-82 is Live Load Type 2, ratings will only be calculated for limit states Strength II and Service IIB.

6.32 FTL - FATIGUE LIFE COMMAND

The fatigue life is computed only for fatigue locations specified in the FTG command.

The fatigue life of a floorbeam is calculated by evaluating each fatigue prone detail specified by the user. The program calculates the actual fatigue stress range and the fatigue resistance at each detail. The actual 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 between the tenth/twentieth point moments calculated earlier. The live load plus impact moment calculated for fatigue life analysis is based on the 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 actual 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 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 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 is 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:

$$R = \frac{ln\left(\frac{\Delta GF_2}{\lambda} + 1\right)}{ln(1+GF_2)}$$

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.

6.33 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 FGV command is not entered by the user, 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 6.33-1 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 6.33-2 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 CombinationTrucks

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

6.34 FTG - FATIGUE COMMAND

6.34.3 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).

6.34.4 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 2.6, item 9. Therefore the beam depth is based on the depth of the section with the smaller moment of inertia.)

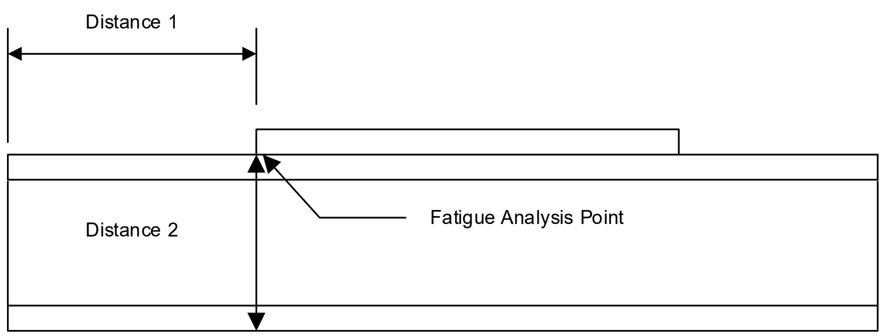


Figure 6.34-1 Fillet Weld at Top Cover Plate

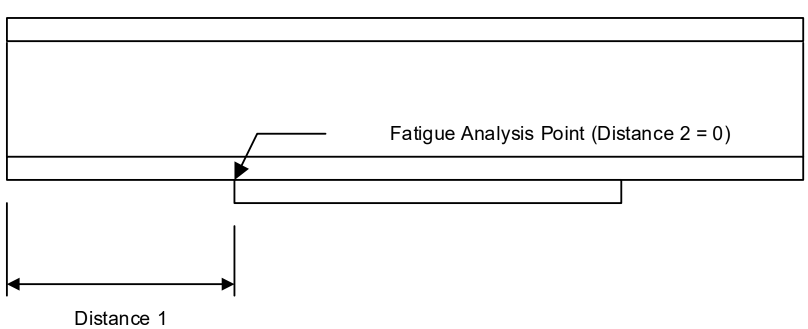


Figure 6.34-2 Fillet Weld at Bottom Cover Plate

6.35 BRP - BRACE POINT COMMAND

The program uses the data entered for this command to compute the locations of the brace points along the floorbeam. 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 floorbeam is composite and only after the deck has hardened. For all other conditions, including that of a noncomposite floorbeam, the top and bottom flanges are considered to be braced only at the brace points entered using this command.

As an example, if the user inputs a Start Distance of 0 feet, an End Distance of 75 feet, and a Brace Spacing of 15 feet, then the program will place brace points at the following locations: 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 floorbeam 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.

6.37 TST - TRANSVERSE STIFFENER COMMAND

This command is used to specify the transverse stiffener size and spacing for a plate girder. The equations used in the transverse stiffener computations are presented in LRFD Specifications Article 6.10.11.1 and in the corresponding sections 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 floorbeam. The stiffener width and thickness are used only for the transverse stiffener specifications checks. The transverse stiffener specifications checks do not affect the floorbeam section analysis (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. Also, if alternating stiffeners are used, enter the stiffeners as single stiffeners and the spacing as the spacing between adjacent alternating stiffeners.

The program does not automatically consider the lateral brace points as locations of transverse stiffeners for purposes of shear analysis of the floorbeam. 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 floorbeam.

The program does not 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 floorbeam. 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 floorbeam).

   - 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.

As used in this program, the region from the end of a floorbeam to the first transverse stiffener is defined as an exterior panel. All other regions are defined as interior panels.

The program analyzes typical transverse stiffeners only. Thus, the program cannot analyze 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 floorbeam. 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 Chief Bridge Engineer warning will appear in the program output.

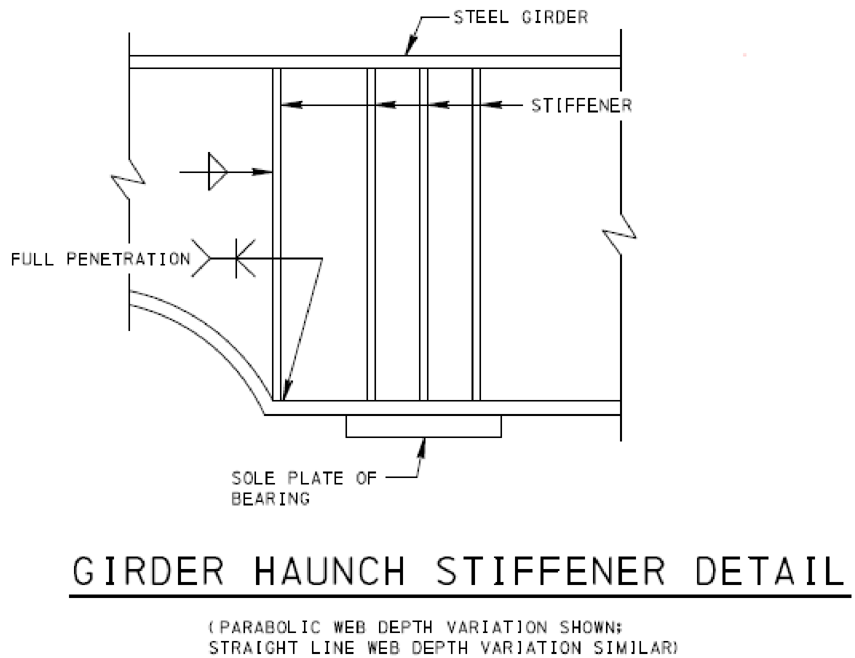


Figure 6.37-1 Girder Haunch Stiffener Detail

6.37.4 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 0.05 inches. If this condition is not satisfied, the program gives a descriptive error message and aborts the run.

Example:

Figure 1 shows two different ways of entering input data for transverse stiffeners along a floorbeam, 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 1 defines four distinct ranges along the floorbeam. 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 floorbeam. 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 6.37.

Points A, D, H, K, and N all fall between (or outside) defined ranges, so rule 2 in Section 6.37 is followed, defining ranges from the endpoints of the floorbeam or adjacent ranges.

Points C, E, G, J, I, and M all fall at ends of ranges, so rule 3 in Section 6.37 is followed, with spacings and section properties as shown in Figure 1 based on the properties of the adjacent sections.

Option B in Figure 1 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.

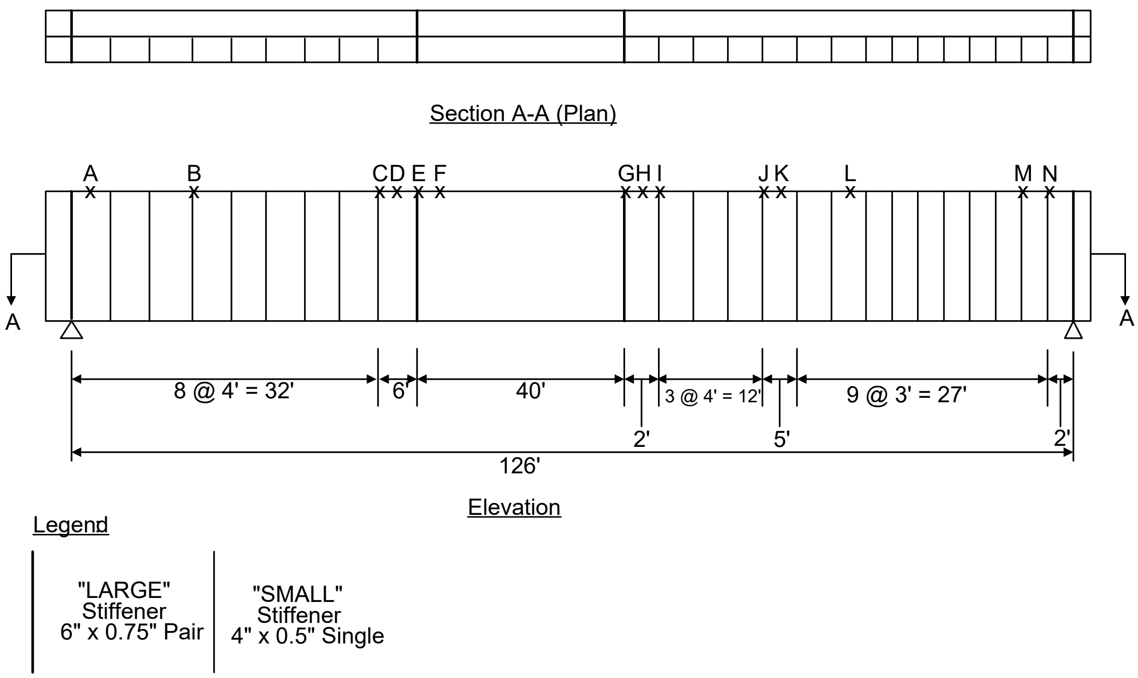


Figure 6.37-2 Transverse Stiffener Example

Option A:

TST 4, 32, S, 4, 4, 0.5, 50, P,
TST 38, 78, P, 40, 6, 0.75, 50, P,
TST 80, 92, S, 4, 4, 0.5, 50, P,
TST 97, 124, S, 3, 4, 0.5, 50, P,

Option B:

TST 0, 32, S, 4, 4, 0.5, 50, P,
TST 32, 38, P, 6, 6, 0.75,50,P,
TST 78, 80, P, 2, 6, 0.75,50,P,
TST 80, 92, S, 4,4, 0.5, 50, P,
TST 97, 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	12'	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 6.37-2 Transverse Stiffener Example (continued)

6.38 LST - LONGITUDINAL STIFFENER COMMAND

This command is used to specify the longitudinal stiffener size and location. 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 are used only for the longitudinal stiffener specifications checks. The longitudinal stiffener specifications checks do not affect the floorbeam section analysis.

The user does not necessarily have to define stiffener ranges over the entire floorbeam length.

6.39 BST - BEARING STIFFENER COMMAND

This command is used to specify the bearing stiffener size and location.

The program computes the total moment of inertia, the total area, and the radius of gyration of the bearing stiffener using the following equations:

$$I_{total} = 2n\left[\frac{b_t^3 t_p}{12}\right] + \frac{b_{web} t_w^3}{12} + 2n\left[b_t t_p\left(\frac{b_t}{2} + \frac{t_w}{2}\right)^2\right]$$

$$A_{total} = 2nb_t t_p + t_w b_{web}$$

$$r_s = \sqrt{\frac{I_{total}}{A_{total}}}$$

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 floorbeam section analysis.

It should be noted that bearing stiffeners are required only for certain floorbeams. This criteria is based on the type of connection between the floorbeam and its supporting structure.

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.

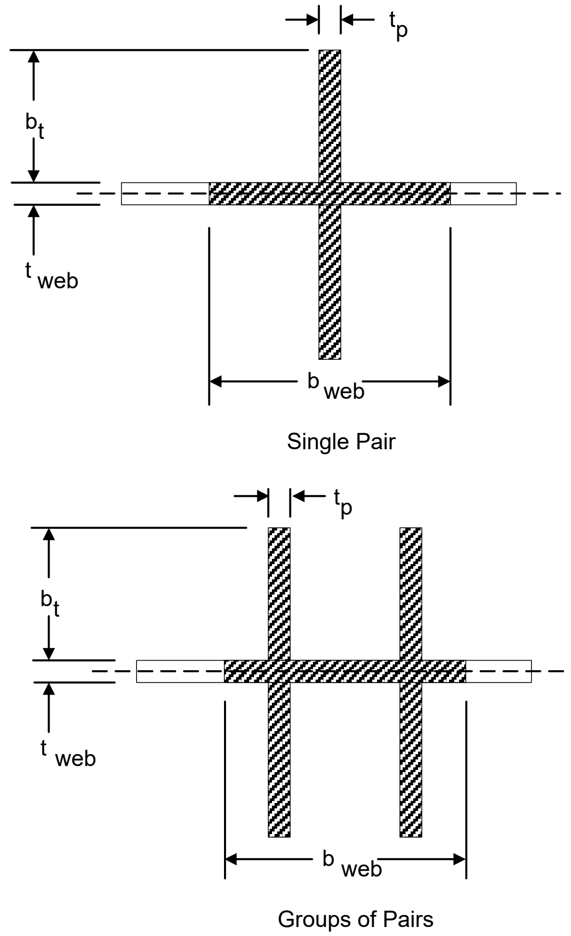


Figure 6.39-1 Bearing Stiffener Geometry

6.39.4 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 floorbeam to the centerline of the bearing or bearing pair, measured along the floorbeam length.

6.40 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 floorbeams, DM-4 requires shear connectors along the entire length of the floorbeam. Therefore, the program checks each analysis point along the entire length of the floorbeam, 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 floorbeam section analysis.

6.41 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 floorbeam 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.

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 floorbeams, DM-4 requires shear connectors along the entire length of the floorbeam. Therefore, the program checks each analysis point along the entire length of the floorbeam, 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 floorbeam section analysis.

6.42 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 6.42-1 Summary of Defaults for OIN Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
1. Input File Echo	INPUT DATA FILE ECHO	0
2. Input Commands	COMMAND LINE INPUT	0
3. Input Summary	CONTROL PARAMETERS SYMMETRICAL POINT STRUCTURE IDENTIFICATION FLOORBEAM GEOMETRY PROGRAM DEFINED LANES USER-DEFINED LANES (WITHOUT SIDEWALK) USER-DEFINED LANES (WITH SIDEWALK) FLOORBEAM SPACING STRINGER LOCATION USER-DEFINED ANALYSIS POINTS MATERIAL PROPERTIES 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 LOAD FACTORS FLOORBEAM CONCENTRATED LOADS STRINGER CONCENTRATED LOADS FLOORBEAM DISTRIBUTED LOADS (DC1) FLOORBEAM DISTRIBUTED LOADS (DC1S) FLOORBEAM DISTRIBUTED LOADS (DC2) FLOORBEAM DISTRIBUTED LOADS (FWS) FLOORBEAM DISTRIBUTED LOADS (MC1) FLOORBEAM DISTRIBUTED LOADS (MC2) FLOORBEAM DISTRIBUTED LOADS (PDC2) FLOORBEAM DISTRIBUTED LOADS (PFWS) **FLOORBEAM DISTRIBUTED LOADS (UT1)** **FLOORBEAM DISTRIBUTED LOADS (UT2)** STRINGER DISTRIBUTED LOADS (DC1) STRINGER DISTRIBUTED LOADS (DC1S) STRINGER DISTRIBUTED LOADS (DC2) STRINGER DISTRIBUTED LOADS (FWS) STRINGER DISTRIBUTED LOADS (MC1) STRINGER DISTRIBUTED LOADS (MC2) STRINGER DISTRIBUTED LOADS (PDC2) STRINGER DISTRIBUTED LOADS (PFWS)	1

Table 6.42-1   Summary of Defaults for OIN Command (continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
3. Input Summary (continued)	**STRINGER DISTRIBUTED LOADS (UT1)** **STRINGER DISTRIBUTED LOADS (UT2)** PEDESTRIAN LOADS APPLIED MOMENTS LIVE LOAD PLACEMENT LANE ASSIGNMENTS (WITHOUT SIDEWALKS) LANE ASSIGNMENTS (WITH SIDEWALKS) 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	1

6.43 OSP - OUTPUT OF SECTION PROPERTIES 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 6.43-1 Summary of Defaults for OSP Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
1. Gross Section Properties	GROSS SECTION PROPERTIES	0
2. Section Properties	SECTION PROPERTIES (NONCOMPOSITE, POSITIVE FLEXURE) SECTION PROPERTIES (COMPOSITE (3N), POSITIVE FLEXURE) SECTION PROPERTIES (COMPOSITE (N), POSITIVE FLEXURE) SECTION PROPERTIES (NONCOMPOSITE, NEGATIVE FLEXURE) SECTION PROPERTIES (COMPOSITE, NEGATIVE FLEXURE)	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

6.44 OAN - OUTPUT OF ANALYSIS RESULTS 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. For parameters 7 and 8, 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 6.44-1 Summary of Defaults for OAN Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
1. Points of Contraflexure	POINTS OF CONTRAFLEXURE	1
2. Load Modifiers	LOAD FACTORS AND COMBINATIONS LIVE LOADING SUMMARY LOAD MODIFIER RESISTANCE FACTORS	1
3. Dead Loads	DEAD LOADS STRINGER DEAD LOAD REACTIONS	0
4. Dead Load Effects	BEAM WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) SLAB AND HAUNCH WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) HAUNCH WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) PERMANENT INPUTTED DC1 ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) PERMANENT INPUTTED DC1 ANALYSIS (UNFACTORED, DC1S, 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]**)** MISC**ELLANEOUS MC1** ANALYSIS (UNFACTORED, MC1, NONCOMPOSITE) MISC**ELLANEOUS MC2** ANALYSIS (UNFACTORED, MC2, COMPOSITE (3N) **/ NONCOMPOSITE**[1]) ADDITIONAL DC2 ANALYSIS (UNFACTORED, DC2, COMPOSITE (3N) **/ NONCOMPOSITE**[1]) ADDITIONAL FWS ANALYSIS (UNFACTORED, FWS, COMPOSITE (3N) **/ NONCOMPOSITE**[1])	1

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 6.44-1 Summary of Defaults for OAN Command (continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
5. Dead Load Reactions	BEAM WEIGHT ANALYSIS - REACTIONS SLAB AND HAUNCH WEIGHT ANALYSIS - REACTIONS 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** MISC**ELLANEOUS MC1** ANALYSIS - REACTIONS MISC**ELLANEOUS MC2** ANALYSIS - REACTIONS ADDITIONAL DC2 ANALYSIS - REACTIONS ADDITIONAL FWS ANALYSIS - REACTIONS	0
6. Influence Lines	MOMENT INFLUENCE LINES FOR FLOORBEAM (1 KIP UNIT LOAD) SHEAR INFLUENCE LINES FOR FLOORBEAM (1 KIP UNIT LOAD) DEFLECTION INFLUENCE LINES FOR FLOORBEAM (10 KIP UNIT LOAD) REACTION INFLUENCE LINES FOR FLOORBEAM (1 KIP UNIT LOAD) ROTATION INFLUENCE LINES FOR FLOORBEAM (1000 KIP UNIT LOAD)	1
7. 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 TK527 SPECIAL # TOT VEHICLE EV2 EV3 SU6TV the tables: LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT) LL ANALYSIS (SHEARS, UNFACTORED, INCL. IMPACT) will print for: FATIGUE	1

Table 6.44-1 Summary of Defaults for OAN Command (continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
7. 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 ML-80 HS20 H20 TK527 SPECIAL # TOT VEHICLE EV2 EV3 SU6TV the tables: LL ANALYSIS (MOMENTS, UNF., W/O SIDEWALK, INCL. IMPACT) LL ANALYSIS (SHEARS, UNFACTORED, W/O SIDEWALK, INCL. IMPACT) will print for: P-82 FATIGUE the tables: LL ANALYSIS (MOMENTS, UNFACTORED) LL ANALYSIS (SHEARS & DEFLECTIONS, UNFACTORED) will print for: LEFT SW PED LL RIGHT SW PED LL	1

Table 6.44-1 Summary of Defaults for OAN Command (continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
8. 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) will print for: PHL-93 HL-93 P-82 ML-80 HS20 H20 TK527 SPECIAL # TOT VEHICLE EV2 EV3 SU6TV FATIGUE For program runs with defined sidewalks (PLD command supplied), the output tables: LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT) LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT) will print for: PHL-93 HL-93 ML-80 HS20 H20 TK527 SPECIAL # TOT VEHICLE EV2 EV3 SU6TV the table: LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT) will print for: P-82 FATIGUE the table: PED LL ANALYSIS (REACTIONS) will print for: LEFT SW RIGHT SW	0

Table 6.44-1 Summary of Defaults for OAN Command (continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
9. 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 7 and 8.)	0
10. 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 7 and 8.)	0
11. 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 7 and 8.)	0
12. Factored Effects	UNFACTORED FLEXURAL STRESSES FACTORED ANALYSIS RESULTS	1
13. Factored Reactions	FACTORED ANALYSIS RESULTS - REACTIONS	0

6.45 OSC - OUTPUT OF SPECIFICATION CHECKING 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 6.45-1 Summary of Defaults for OSC Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
1. Ductility and Web/Flange Proportions	DUCTILITY AND WEB/FLANGE PROPORTION CHECKS COMPACTNESS CRITERIA	0
2. 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) NET SECTION FRACTURE CHECK SERVICE LIMIT STATE - FLEXURAL RESISTANCE SERVICE LIMIT STATE - WEB BEND-BUCKLING	1
3. Shear Capacity	SHEAR CAPACITY	1
4. Web Checks	WEB SPECIFICATION CHECK	0
5. Stiffener Checks	TRANSVERSE STIFFENERS CHECK LONGITUDINAL STIFFENERS CHECK (PART 1) LONGITUDINAL STIFFENERS CHECK (PART 2) USER-INPUT BEARING STIFFENER ANALYSIS WEB CONCENTRATED LOAD CHECK	0
6. Fatigue Checks	SPECIAL FATIGUE REQUIREMENT FOR WEBS FATIGUE RESISTANCE	0
7. Fatigue Life Estimation	REMAINING FATIGUE LIFE ESTIMATION	1
8. Deflection Checks	DEFLECTION LIMITS FOR LIVE LOAD DEFLECTION LIMITS FOR DEFLECTION LOADING ONLY DEFLECTION LIMITS FOR DEFLECTION LOADING + PEDESTRIAN LIVE LOAD	0
9. 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

Table 6.45-1 Summary of Defaults for OSC Command (continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
10. Uncured Slab Checks	UNCURED SLAB WEB SPECIFICATION CHECK 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 (UNCURED SLAB) LATERAL TORSIONAL BUCKLING CAPACITY (UNCURED SLAB) UNCURED SLAB NET SECTION FRACTURE CHECK	0
11. Web-to-flange Weld Design Checks	WEB-TO-FLANGE WELD DESIGN: WELD CAPACITY WEB-TO-FLANGE WELD DESIGN: CONNECTED MATERIAL CAPACITY	0

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 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., net section fracture is not checked if section holes are not defined for the program run):

DUCTILITY AND WEB/FLANGE PROPORTION CHECKS
COMPACTNESS CRITERIA
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)
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 / Permit Vehicle output.

6.46 ORF - OUTPUT OF RATING FACTORS 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 6.46-1 Summary of Defaults for ORF Command

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
1. Vehicle Rating Summary	RATING FACTORS - SUMMARY	0
2. Detailed Rating Factors	RATING FACTORS - MOMENT FLEXURAL CAPACITY RATING FACTORS - STRESS FLEXURAL CAPACITY RATING FACTORS - SHEAR CAPACITY	0
3. Overall Rating Summary	RATING FACTORS - OVERALL SUMMARY BRIDGE LOAD RATINGS	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**

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 the .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 five different input commands, according to which kind of output they represent. These five kinds of output are: input data, section properties, analysis results, specification checking, and rating factors. The commands and their defaults are discussed in Sections 6.42 through 6.46.

7.1.2 Page Format

There is a maximum of 102 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 98 characters, column 5 to column 102. 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 Floorbeam Analysis and Rating, Version 1.5.0.0                                        PAGE 27
Input File: EX1.DAT                                                             06/23/2015  15:55:34
----------------------------------------------------------------------------------------------------
                                         FBLRFD 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	$10^4 in^4$
MASS	N/A
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 HEIGHT	in
SHEAR CONNECTOR PITCH	in
STIFFENER SPACING	in
STRESS	ksi
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 Floorbeam Analysis and Rating
2. Program Name - FBLRFD
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 6.42.

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
  NO. OF FLOORBEAMS                     5
  FLOORBEAM NUMBER                      2
  TYPE OF FLOORBEAM                    PG
  TYPE OF SUPPORT                       C
  FRAMING TYPE                          S
  NO. OF STRINGERS                     10
  SYMMETRY                              N
  ADTT FOR SINGLE LANE               4000
  MULT. PRES. FACTOR ADJ.             1.0
  LIVE LOAD                             A
  DYNAMIC LOAD ALLOWANCE             1.33            (default)
  FATIGUE DYN. LOAD ALLOW.           1.15            (default)
  PA TRAFFIC FACTOR                     *        (computed, if necessary)
  IMPORTANCE FACTOR                   1.0
  DUCTILITY FACTOR                    1.0
  REDUNDANCY FACTOR                   1.0
  REDUNDANT LOAD PATH                   R
  OUTPUT POINTS                         1
  DPV DYN. LOAD ALLOW.               1.20            (default)
  DC1S PERCENTAGE                      0.            (default)
  CHECK APPENDIX A                      Y            (default)
  AUTO BRACE AT SUPPORTS                Y            (default)

COMMAND:  GEO
  CL LFT SUP CL RGT SUP              67.0 ft
  CL LFT SUP LFT DECK EDGE          -45.0 ft
          %WARNING - <GEO>:
              Real value out of range.
              The value entered for CL LFT SUP LFT DECK EDGE is
               less than the lower range limit.
              Value entered: -45.
              Valid values are between -33.5 and 0.
  CL LFT SUP RGT DECK EDGE          77.33 ft
  CL LFT SUP LFT OVHG END           -7.83 ft
  CL LFT SUP RGT OVHG END           74.83 ft
  GAGE DISTANCE                        6. ft         (default)
```

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 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 effective points of contraflexure are considered end of range points and therefore are included in these tables whether or not the section varies at these points. Also, 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

Units	Number of Floorbeams	Floorbeam Number	Type of Floorbeam	Type of Support	Framing Type	No. of Stringers
US	5	2	PLATE GIRDER	CONTIN	STRINGR	10

Symmetry	Lane Defin.	Single Lane ADTT	Multiple Presence Factor Adj.	Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor
NO	USER	4000	1.000	A	1.330	1.150	N/A

Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path	Analysis Points	Design Permit Vehicle Dynamic Load Allowance	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports
1.000	1.000	1.000	N/A	2	1.200	0.00	YES	YES

FLOORBEAM GEOMETRY

Centerline of Left Support to								
Right Support (ft)	Deck Edge Left (ft)	Deck Edge Right (ft)	Overhang End Left (ft)	Overhang End Right (ft)	Gage Distance (ft)	Passing Distance (ft)	Staggered Diaphragms
67.000	-7.330	77.330	-7.830	74.830	6.000	4.000	NO

Centerline of Left Support to			
Left Sidewalk Edge Left (ft)	Left Sidewalk Edge Right (ft)	Right Sidewalk Edge Left (ft)	Right Sidewalk Edge Right (ft)
-10.330	5.000	62.000	77.330

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 6.43. 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. End Span Distance - the distance to the end of the section range measured from the left support of the floorbeam.
2. Composite Status - this is the status for composite action. The possible values are noncomposite, composite 3n, and composite n.
3. Beam Area - cross sectional area of the steel beam. This is used to compute the self weight of the beam.
4. Moment of Inertia - moment of inertia about the horizontal neutral axis of the beam.
5. 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 general 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. Noncomposite negative flexure
5. 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 SECTION PROPERTIES output tables.

1. End Span Distance - the distance to the end of the section range measured from the left support of the floorbeam.
2. Moment of Inertia - moment of inertia about the horizontal neutral axis of the beam.
3. Distance to Neutral Axis, Bottom of Beam - distance from the horizontal neutral axis to the bottom of the beam.
4. Distance to Neutral Axis, Top of Beam - distance from the horizontal neutral axis to the top of the beam.
5. Distance to Neutral Axis CG of Reinforcement - distance from the horizontal neutral axis to the centroid of the slab reinforcement.
6. Distance to Neutral Axis, Top of Slab - distance from the horizontal neutral axis to the top of the effective slab.
7. Section Modulus, Bottom of Beam - section modulus at the bottom of the beam.
8. Section Modulus, Top of Beam - section modulus at the top of the beam.
9. Section Modulus, CG of Reinforcement - section modulus at the centroid of the slab reinforcement.
10. Section Modulus, Top of Slab - section modulus at the top of the effective slab.

7.4.3 Additional Section Properties

These are additional section net 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 Distance - the distance to the end of the section range measured from the left support of the floorbeam.
2. Beam Area - cross sectional area of the steel beam only, computed taking section loss into account.
3. Effective Slab Width - effective slab width for composite action.
4. **Effective Slab Calculation Type – the calculation method for effective slab width.**
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 Distance - the distance to the end of the section range measured from the left support of the floorbeam.
2. 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.
3. Plastic Properties, N.A. to Top Slab - neutral axis to the top of the slab based on the effective slab thickness.
4. Plastic Properties, Moment, Mp - plastic moment capacity.
5. Plastic Properties, Depth of Web, Dcp - depth of web in compression at the plastic moment.
6. 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.
7. Longitudinal Stiffness Parameter - longitudinal stiffness parameter.

7.5 ANALYSIS RESULTS OUTPUT

A summary of the output tables for each parameter is given in Section 6.44. The user can suppress all analysis output by entering zero for every analysis output parameter.

7.5.1 Points of Contraflexure

This table prints out the points of contraflexure used by the program to compute the effective slab width, the actual points of contraflexure and the difference between them as a percentage of the span length. The following information is reported in the POINTS OF CONTRAFLEXURE output table.

1. 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.
2. 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.

7.5.2 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 (MC1), 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. gLL - the load factor to be applied to the vehicular live load for each limit state.
15. gPermit - the load factor to be applied to the permit live load for each limit state.
16. gRate - the load factor to be applied to the rating vehicles for each limit state
17. gPL - the load factor to be applied to pedestrian live load for each limit state.
18. gFAT - the load factor to be applied to fatigue live load for each limit state.
19. gSLL 1 - the load factor to be applied to special live load 1 for each limit state.
20. gSLL 2 - the load factor to be applied to special live load 2 for each limit state.
21. gSLL 3 - the load factor to be applied to special live load 3 for each limit state.
22. gSLL 4 - the load factor to be applied to special live load 4 for each limit state.
23. gSLL 5 - the load factor to be applied to special live load 5 for each limit state.
24. **gSLL 6 - the load factor to be applied to special live load 6 for each limit state.**
25. **gSLL 7 - the load factor to be applied to special live load 7 for each limit state.**
26. **gSLL 8 - the load factor to be applied to special live load 8 for each limit state.**

7.5.3 Live Loading Summary (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.

7.5.4 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.

7.5.5 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.
6. Shear on Fillet Weld Throat - resistance factor used for computing resistances of the web to flange weld
7. Web Crippling - resistance factor used for computing the web crippling capacity

7.5.6 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 Distance - distance to the end of the loading region measured from the left support of the floorbeam.
2. Beam Weight - weight of the steel beam only. This includes cover plates.
3. Slab & Haunch Weight - weight due to the slab and haunch. If the floorbeam has stringers framing into it, this column only includes the weight due to the haunch over the floorbeam.
4. Additional DC1S - DC1S loads applied to the girder as a percentage of the floorbeam 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 FDL or FCL commands.

7.5.7 Stringer Dead Load Reactions

The dead loads acting on the stringers are entered by the user and are transferred to the floorbeam through the reactions from the stringers. The following information is reported in the STRINGER DEAD LOAD REACTIONS output table.

1. Stringer Number - the number of the stringer for which the reactions are being reported.
2. Stringer Distance - the location of the stringer for which the reactions are being reported, measured from the left support of the floorbeam.
3. DC1 - reaction on the floorbeam from this stringer due to noncomposite dead load.
4. DC1S - reaction on the floorbeam from this stringer due to noncomposite dead load.

5. DC2 - reaction on the floorbeam from this stringer due to dead load **before slab placement**.
6. FWS - reaction on the floorbeam from this stringer due to future wearing surface load.
7. **UT1 - reaction on the floorbeam from this stringer due to utility UT1 load.**
8. **UT2 - reaction on the floorbeam from this stringer due to utility UT2 load.**
9. MC1 - reaction on the floorbeam from this stringer due to miscellaneous **MC1** load.
10. MC2 - reaction on the floorbeam from this stringer due to miscellaneous **MC2** load.
11. PDC2 - reaction on the floorbeam from this stringer due to additional dead load that is present only when sidewalks are present.
12. PFWS - reaction on the floorbeam from this stringer due to additional future wearing surface load that is present only when sidewalks are present.

7.5.8 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due only to the steel beam weight.
3. Shear - shear value due only to the steel beam weight.
4. Deflection - deflection due only to the steel beam weight.

7.5.9 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.

7.5.10 Slab and Haunch Weight Analysis (Unfactored, DC1, Noncomposite)

The following information is reported in the SLAB AND HAUNCH WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due only to the slab and haunch weight.
3. Shear - shear value due only to the slab and haunch weight.
4. Deflection - deflection due only to the slab and haunch weight.

7.5.11 Slab and Haunch Weight Analysis - Reactions

The following information is reported in the SLAB AND HAUNCH WEIGHT ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to slab and haunch weight only.
3. Rotation - rotation at support due to slab and haunch weight only.

7.5.12 Haunch Weight Analysis (Unfactored, DC1, Noncomposite

The following information is reported in the HAUNCH WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due only to the haunch weight.
3. Shear - shear value due only to the haunch weight.
4. Deflection - deflection due only to the haunch weight.

7.5.13 Haunch Weight Analysis - Reactions

The following information is reported in the HAUNCH WEIGHT ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to haunch weight only.
3. Rotation - rotation at support due to haunch weight only.

7.5.14 Permanent Inputted DC1 Analysis (Unfactored, DC1, Noncomposite)

Permanent inputted DL (DC1) refers to all noncomposite dead load that is not included in the beam self weight or the slab or haunch weight. The following information is reported in the PERMANENT INPUTTED DC1 ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment due to the DC1 loads input by the user.
3. Shear - shear value due to the DC1 loads input by the user.
4. Deflection - deflection due to the DC1 loads input by the user.

7.5.15 Permanent DC1S Analysis (Unfactored, DC1S, Noncomposite)

The same information is printed on this table as described in section 7.5.14, except that the effects reported on this table come from the application of permanent noncomposite load that is part of the floorbeam, but is not calculated by the program (i.e. stiffeners, diaphragms, splice plates). These loads are entered by the user as DC1S loads, or calculated as a percentage of the beam self-weight.

7.5.16 Permanent Inputted DC1 Analysis - Reactions

The following information is reported in the PERMANENT INPUTTED DC1 ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to permanent inputted DC1 only.
3. Rotation - rotation at support due to permanent inputted DC1 only.

7.5.17 Permanent DC1S Analysis - Reactions

The same information is printed on this table as described in section 7.5.16, except that the effects reported on this table come from the application of permanent noncomposite load that is part of the floorbeam, but is not calculated by the program (i.e. stiffeners, diaphragms, splice plates). These loads are entered by the user as DC1S loads, or calculated as a percentage of the beam self-weight.

7.5.18 Total DC1 Analysis (Unfactored, Noncomposite)

The program combines all of the above (beam self-weight, slab and haunch weight, and permanent DC1 and DC1S) and generates the total DC1 analysis. The following information is reported in the TOTAL DC1 ANALYSIS output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - total moment due to all DC1 loads.
3. Shear - total shear due to all DC1 loads.
4. Deflection - total deflection due to all DC1 loads.

7.5.19 Total DC1 Analysis - Reactions

The following information is reported in the TOTAL DC1 ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the total DC1 load.

3. Rotation - rotation at support due to the total DC1 load.

7.5.20 Permanent Inputted DC2 Analysis (Unfactored, DC2, Composite(3n) **/Noncomposite)**

The following information is reported in the PERMANENT INPUTTED DC2 ANALYSIS (UNFACTORED, DC2, COMPOSITE(3N) **/ NONCOMPOSITE**) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due to the DC2 loads input by the user.
3. Shear - shear value due to the DC2 loads input by the user.
4. Deflection - deflection due to the DC2 loads input by the user.

7.5.21 Permanent Inputted DC2 Analysis - Reactions

The following information is reported in the PERMANENT INPUTTED DC2 ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the DC2 load.
3. Rotation - rotation at support due to the DC2 load.

7.5.22 Future Wearing Surface Analysis (Unfactored, FWS, Composite(3n) **/ Noncomposite**)

The following information is reported in the FUTURE WEARING SURFACE ANALYSIS (UNFACTORED, FWS, COMPOSITE(3N) **/ NONCOMPOSITE**) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due to the FWS loads input by the user.
3. Shear - shear value due to the FWS loads input by the user.
4. Deflection - deflection due to the FWS loads input by the user.

7.5.23 Future Wearing Surface Analysis - Reactions

The following information is reported in the FUTURE WEARING SURFACE ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the FWS load.
3. Rotation - rotation at support due to the FWS load.

7.5.24 Utility UT1 Analysis (Unfactored, UT1, Noncomposite)

The following information is reported in the UTILITY UT1 ANALYSIS (UNFACTORED, UT1, NONCOMPOSITE) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due to the UT1 loads input by the user.
3. Shear - shear value due to the UT1 loads input by the user.
4. Deflection - deflection due to the UT1 loads input by the user.

7.5.25 Utility UT1 Analysis - Reactions

The following information is reported in the UTILITY UT1 ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the UT1 load.
3. Rotation - rotation at support due to the UT1 load.

7.5.26 Utility UT2 Analysis (Unfactored, UT2, Composite(3n) / Noncomposite)

The following information is reported in the UTILITY UT2 ANALYSIS (UNFACTORED, UT2, COMPOSITE(3N) / NONCOMPOSITE) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due to the UT2 loads input by the user.
3. Shear - shear value due to the UT2 loads input by the user.
4. Deflection - deflection due to the UT2 loads input by the user.

7.5.27 Utility UT2 Analysis - Reactions

The following information is reported in the UTILITY UT2 ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the UT2 load.
3. Rotation - rotation at support due to the UT2 load.

7.5.28 Miscellaneous **MC1** Analysis (Unfactored, MC1, Noncomposite)

The following information is reported in the MISCELLANEOUS MC1 ANALYSIS (UNFACTORED, MC1, NONCOMPOSITE **/ COMPOSITE**) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due to the MC1 loads input by the user.
3. Shear - shear value due to the MC1 loads input by the user.
4. Deflection - deflection due to the MC1 loads input by the user.

7.5.29 Miscellaneous **MC1** Analysis - Reactions

The following information is reported in the MISCELLANEOUS MC1 ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the MC1 load.
3. Rotation - rotation at support due to the MC1 load.

7.5.30 Miscellaneous **MC2** Analysis (Unfactored, MC2, Composite(3n) **/ Noncomposite**)

The following information is reported in the MISCELLANEOUS **MC2** ANALYSIS (UNFACTORED, MC2, COMPOSITE(3N) **/ NONCOMPOSITE**) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due to the MC2 loads input by the user.
3. Shear - shear value due to the MC2 loads input by the user.
4. Deflection - deflection due to the MC2 loads input by the user.

7.5.31 Miscellaneous **MC2** Analysis - Reactions

The following information is reported in the MISCELLANEOUS MC2 ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the MC2 load.
3. Rotation - rotation at support due to the MC2 load.

7.5.32 Additional DC2 Analysis (Unfactored, DC2, Composite(3n) **/ Noncomposite**)

Additional DC2 load refers to all composite dead load that is present only when sidewalks are included on the bridge, and is only used in computing effects for limit state Strength-IP. The following information is reported in the ADDITIONAL DC2 ANALYSIS (UNFACTORED, DC2, COMPOSITE(3N) **/ NONCOMPOSITE**) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.

2. Moment - moment value due to the additional DC2 dead loads input by the user.
3. Shear - shear value due to the additional DC2 loads input by the user.
4. Deflection - deflection due to the additional DC2 loads input by the user.

7.5.33 Additional DC2 Analysis - Reactions

The following information is reported in the ADDITIONAL DC2 ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the DC2 load.
3. Rotation - rotation at support due to the DC2 load.

7.5.34 Additional Future Wearing Surface Analysis (Unfactored, FWS, Composite(3n) **/ Noncomposite**)

Additional FWS load refers to all future wearing surface dead load that is present only when sidewalks are included on the bridge, and is only used in computing effects for limit state Strength-IP. The following information is reported in the ADDITIONAL FUTURE WEARING SURFACE ANALYSIS (UNFACTORED, FWS, COMPOSITE(3N) **/ NONCOMPOSITE**) output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Moment - moment value due to the additional FWS loads input by the user.
3. Shear - shear value due to the additional FWS loads input by the user.
4. Deflection - deflection due to the additional FWS loads input by the user.

7.5.35 Additional Future Wearing Surface Analysis - Reactions

The following information is reported in the ADDITIONAL FUTURE WEARING SURFACE ANALYSIS - REACTIONS output table.

1. Support Number - support number for the reaction.
2. Reaction - reaction due to the additional FWS load.
3. Rotation - rotation at support due to the additional FWS load.

7.5.36 Moment Influence Lines for Floorbeam

These influence lines are produced by moving a 1 kip unit load along the floorbeam and finding the moment at each analysis point. The following information is reported in the MOMENT INFLUENCE LINES FOR FLOORBEAM output table.

1. Load Location: Distance - distance measured from the left support of the floorbeam at which the load is placed.
2. Influence Value for Analysis Point - each column represents the influence line for the given analysis point.

7.5.37 Shear Influence Lines for Floorbeam

These influence lines are produced by moving a 1 kip unit load along the floorbeam and finding the shear at each analysis point. The following information is reported in the SHEAR INFLUENCE LINES FOR FLOORBEAM output table.

1. Load Location: Distance - distance measured from the left support of the floorbeam at which the load is placed.
2. Influence Value for Analysis Point - each column represents the influence line for the given analysis

7.5.38 Deflection Influence Lines for Floorbeam

These influence lines are produced by moving a 10 kip unit load along the floorbeam and finding the deflection at each analysis point. The following information is reported in the DEFLECTION INFLUENCE LINES FOR FLOORBEAM output table.

1. Load Location: Distance - distance measured from the left support of the floorbeam at which the load is placed.
2. Influence Value for Analysis Point - each column represents the influence line for the given analysis point.

7.5.39 Reaction Influence Lines for Floorbeam

These influence lines are produced by moving a 1 kip unit load along the floorbeam and finding the reaction at each support. The following information is reported in the REACTION INFLUENCE LINES FOR FLOORBEAM output table.

1. Load Location: Distance - distance measured from the left support of the floorbeam at which the load is placed.
2. Influence Value for Analysis Point - each column represents the influence line for the given analysis point.

7.5.40 Rotation Influence Lines for Floorbeam

These influence lines are produced by moving a 1000 kip unit load along the floorbeam and finding the rotation at each support. The following information is reported in the ROTATION INFLUENCE LINES FOR FLOORBEAM output table.

1. Load Location: Distance - distance measured from the left support of the floorbeam at which the load is placed.
2. Influence Value for Analysis Point - each column represents the influence line for the given

7.5.41 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.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Positive Moment - maximum positive moment due to the live load.
3. 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
4. Maximum Negative Moment - maximum negative moment due to the live load.
5. 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.
6. Maximum Relative Moment Distance - distance to the location of the maximum positive moment due the wheel placement inducing the maximum positive moment at the current analysis point.
7. Maximum Relative Moment Positive - maximum positive moment due to the wheel placement inducing the maximum positive moment at the current analysis point.
8. Maximum Relative Moment Distance -distance to the location of the maximum negative moment due the wheel placement inducing the maximum negative moment at the current analysis point.

9. Maximum Relative Moment Negative - maximum negative moment due to the wheel placement inducing the maximum negative moment at the current analysis point.

7.5.42 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Shear Positive - maximum positive shear due to the live load.
3. 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
4. Maximum Shear Negative - maximum negative shear due to the live load.
5. Maximum Shear Negative LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum negative shear.
6. Maximum Deflection Positive - maximum positive (downward) live load deflection.
7. Maximum Deflection Positive LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum positive live load deflection.
8. Maximum Deflection Negative - maximum negative (upward) live load deflection.
9. Maximum Deflection Negative LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum negative live load deflection.

7.5.43 PHL-93 LL Analysis (Reactions, Including Impact)

The following information is reported in the PHL-93 LL ANALYSIS (REACTIONS, 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.

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.

7.5.44 HL-93 LL Analysis (Moments, Unfactored, Including Impact)

The following information is reported in the HL-93 LL ANALYSIS (MOMENTS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the HL-93 live loading as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Positive Moment - initial maximum positive moment due to the live load.
3. 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 - 90% (truck pair + lane) governs

   5 - truck alone governs

   6 - 25% truck + lane governs
4. Maximum Negative Moment - initial maximum negative moment due to the live load.
5. 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.
6. Maximum Relative Moment Distance - distance to the location of the maximum positive moment due the wheel placement inducing the maximum positive moment at the current analysis point.

7. Maximum Relative Moment Positive - maximum positive moment due to the wheel placement inducing the maximum positive moment at the current analysis point.
8. Maximum Relative Moment Distance -distance to the location of the maximum negative moment due the wheel placement inducing the maximum negative moment at the current analysis point.
9. Maximum Relative Moment Negative - maximum negative moment due to the wheel placement inducing the maximum negative moment at the current analysis point.

7.5.45 HL-93 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The following information is reported in the HL-93 LL ANALYSIS (SHEARS AND DEFLECTIONS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the HL-93 live loading as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Shear Positive - maximum positive shear due to the live load.
3. 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 - 90% (truck pair + lane) governs
   5 - truck alone governs
   6 - 25% truck + lane governs
4. Maximum Shear Negative - maximum negative shear due to the live load.
5. Maximum Shear Negative LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum negative shear.
6. Maximum Deflection Positive - maximum positive (downward) live load deflection.
7. Maximum Deflection Positive LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum positive live load deflection.
8. Maximum Deflection Negative - maximum negative (upward) live load deflection.
9. Maximum Deflection Negative LC - LRFD live load code (as above) which denotes the controlling LRFD live load condition for maximum negative live load deflection.

7.5.46 HL-93 LL Analysis (Reactions, Including Impact)

The following information is reported in the HL-93 LL ANALYSIS (REACTIONS, INCLUDING IMPACT) output table. These results are for the HL-93 live loading as indicated in the title of the table. The results are unfactored and include impact.

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 - 90% (truck pair + lane) governs
   5 - truck alone governs
   6 - 25% truck + 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.

7.5.47 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.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Positive Moment - maximum positive moment due to the live load.
3. Maximum Negative Moment - maximum negative moment due to the live load.
4. Maximum Relative Moment Distance - distance to the location of the maximum positive moment due the wheel placement inducing the maximum positive moment at the current analysis point.
5. Maximum Relative Moment Positive - maximum positive moment due to the wheel placement inducing the maximum positive moment at the current analysis point.
6. Maximum Relative Moment Distance -distance to the location of the maximum negative moment due the wheel placement inducing the maximum negative moment at the current analysis point.
7. Maximum Relative Moment Negative - maximum negative moment due to the wheel placement

7.5.48 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.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Shear Positive - maximum positive shear due to the live load.
3. Maximum Shear Negative - maximum negative shear due to the live load.
4. Maximum Deflection Positive - maximum positive (downward) deflection due to the live load.
5. Maximum Deflection Negative - maximum negative (upward) deflection due to the live load.

7.5.49 P-82 LL Analysis (Reactions, Including Impact)

The following information is reported in the P-82 LL ANALYSIS (REACTIONS, 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.

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.

7.5.50 ML-80 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the application of an ML-80 live load.

7.5.51 ML-80 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.48. The effects for this table come from the application of an ML-80 live load.

7.5.52 ML-80 LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the application of an ML-80 live load.

7.5.53 HS20 LL Analysis (Moments, Unfactored, Including Impact)

The following information is reported in the HS20 LL ANALYSIS (MOMENTS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the HS20 live loading as indicated in the title of the table. The results are unfactored and include impact.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Positive Moment - maximum positive moment due to the live load.
3. Maximum Positive Moment LC - Live load code which denotes the controlling condition for maximum positive moment. The live load codes are as follows:
   L - lane load governs
   <no character> - truck load governs
4. Maximum Negative Moment - maximum negative moment due to the live load.
5. Maximum Negative Moment LC - Live load code which denotes the controlling condition for maximum negative moment. Codes are as denoted above.
6. Maximum Relative Moment Distance - distance to the location of the maximum positive moment due the wheel placement inducing the maximum positive moment at the current analysis point.
7. Maximum Relative Moment Positive - maximum positive moment due to the wheel placement inducing the maximum positive moment at the current analysis point.
8. Maximum Relative Moment Distance -distance to the location of the maximum negative moment due the wheel placement inducing the maximum negative moment at the current analysis point.
9. Maximum Relative Moment Negative - maximum negative moment due to the wheel placement inducing the maximum negative moment at the current analysis point.

7.5.54 HS20 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The following information is reported in the HS20 LL ANALYSIS (SHEARS AND DEFLECTIONS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the HS20 live loading as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Shear Positive - maximum positive shear due to the live load.
3. Maximum Shear Positive LC - Live load code which denotes the controlling condition for maximum positive shear. The live load codes are as follows:
   L - lane load governs
   <no character> -truck load governs
4. Maximum Shear Negative - maximum negative shear due to the live load.
5. Maximum Shear Negative LC - Live load code (as above) which denotes the controlling condition for maximum negative shear.
6. Maximum Deflection Positive - maximum positive (downward) deflection due to the live load.

7. Maximum Deflection Positive LC - Live load code (as above) which denotes the controlling condition for maximum positive live load deflection.
8. Maximum Deflection Negative - maximum negative (upward) deflection due to the live load.
9. Maximum Deflection Negative LC - Live load code (as above) which denotes the controlling condition for maximum negative live load deflection.

7.5.55 HS20 LL Analysis (Reactions, Including Impact)

The following information is reported in the HS20 LL ANALYSIS (REACTIONS, INCLUDING IMPACT) output table. These results are for the HS20 live loading as indicated in the title of the table. The results are unfactored and include impact.

1. Support Number - support number for which the results are printed.
2. Maximum Reaction - maximum reaction from the live load.
3. Maximum Reaction LC - Live load code which denotes the controlling condition for the maximum reaction. The live load codes are as follows:
   L - lane load governs
   <no character> - truck load governs
4. Minimum Reaction - minimum reaction from the live load.
5. Minimum Reaction LC - Live load code (as above) which denotes the controlling condition for the minimum reaction.
6. Maximum Rotation - maximum rotation at the support from the live load.
7. Maximum Rotation LC - Live load code (as above) which denotes the controlling condition for maximum rotation.
8. Minimum Rotation - minimum rotation at the support from the live load.
9. Minimum Rotation LC - Live load code (as above) which denotes the controlling condition for minimum rotation.

7.5.56 H20 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.53. The effects for this table come from the application of an H20 live load.

7.5.57 H20 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.54. The effects for this table come from the application of an H20 live load.

7.5.58 H20 LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.55. The effects for this table come from the application of an H20 live load.

7.5.59 Special LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the application of a special live load.

7.5.60 Special LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.48. The effects for this table come from the application of a special live load.

7.5.61 Special LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the application of a special live load.

7.5.62 TK527 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the application of a TK527 live load.

7.5.63 TK527 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.48. The effects for this table come from the application of a TK527 live load.

7.5.64 TK527 LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the application of a TK527 live load.

7.5.65 EV2 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the application of an EV2 live load.

7.5.66 EV2 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.48. The effects for this table come from the application of an EV2 live load.

7.5.67 EV2 LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the application of an EV2 live load.

7.5.68 EV3 LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the application of an EV3 live load.

7.5.69 EV3 LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.48. The effects for this table come from the application of an EV3 live load.

7.5.70 EV3 LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the application of an EV3 live load.

7.5.71 SU6TV LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the application of an SU6TV live load.

7.5.72 SU6TV LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.48. The effects for this table come from the application of an SU6TV live load.

7.5.73 SU6TV LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the application of an SU6TV live load.

7.5.74 Total Vehicle LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.75 Total Vehicle LL Analysis (Shears and Deflections, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.48. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.76 Total Vehicle LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.77 Fatigue LL Analysis (Moments, Unfactored, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the application of a fatigue live load.

7.5.78 Fatigue LL Analysis (Shears, Unfactored, Including Impact)

The following information is reported in the FATIGUE LL ANALYSIS (SHEARS, UNFACTORED, INCLUDING IMPACT) output table. These results are for the fatigue live loading as indicated in the title of the table. The results are unfactored and include impact and distribution factors.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Shear Positive - maximum positive shear due to the live load.
3. Maximum Shear Negative - maximum negative shear due to the live load.

7.5.79 Fatigue LL Analysis (Reactions, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the application of a fatigue live load.

7.5.80 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 7.5.41, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the PHL-93 load.

7.5.81 PHL-93 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.42, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the PHL-93 load.

7.5.82 PHL-93 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.43, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the PHL-93 load.

7.5.83 PHL-93 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.41, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the PHL-93 load.

7.5.84 PHL-93 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.42, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the PHL-93 load.

7.5.85 PHL-93 LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.43, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the PHL-93 load.

7.5.86 HL-93 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.44, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the HL-93 load.

7.5.87 HL-93 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.45, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the HL-93 load.

7.5.88 HL-93 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.46, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the HL-93 load.

7.5.89 HL-93 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.44, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the HL-93 load.

7.5.90 HL-93 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.45, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the HL-93 load.

7.5.91 HL-93 LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.46, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the HL-93 load.

7.5.92 P-82 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the P-82 load.

7.5.93 P-82 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the P-82 load.

7.5.94 P-82 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the P-82 load.

7.5.95 ML-80 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the ML-93 load.

7.5.96 ML-80 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the ML-80 load.

7.5.97 ML-80 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the ML-80 load.

7.5.98 ML-80 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the ML-80 load.

7.5.99 ML-80 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the ML-80 load.

7.5.100 ML-80 LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the ML-80 load.

7.5.101 HS20 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.53, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the HS20 load.

7.5.102 HS20 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.54, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the HS20 load.

7.5.103 HS20 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.55, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the HS20 load.

7.5.104 HS20 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.53, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the HS20 load.

7.5.105 HS20 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.54, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the HS20 load.

7.5.106 HS20 LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.55, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the HS20 load.

7.5.107 H20 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.53, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the H20 load.

7.5.108 H20 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.54, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the H20 load.

7.5.109 H20 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.55, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of the H20 load.

7.5.110 H20 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.53, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the H20 load.

7.5.111 H20 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.54, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the H20 load.

7.5.112 H20 LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.55, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of the H20 load.

7.5.113 Special LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of a special live load.

7.5.114 Special LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of a special live load.

7.5.115 Special LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of a special live load.

7.5.116 Special LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of a special live load.

7.5.117 Special LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of a special live load.

7.5.118 Special LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of a special live load.

7.5.119 TK527 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of a TK527 live load.

7.5.120 TK527 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of a TK527 live load.

7.5.121 TK527 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of a TK527 live load.

7.5.122 TK527 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of a TK527 live load.

7.5.123 TK527 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of a TK527 live load.

7.5.124 TK527 LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of a TK527 live load.

7.5.125 EV2 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an EV2 live load.

7.5.126 EV2 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an EV2 live load.

7.5.127 EV2 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an EV2 live load.

7.5.128 EV2 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an EV2 live load.

7.5.129 EV2 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an EV2 live load.

7.5.130 EV2 LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an EV2 live load.

7.5.131 EV3 LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an EV3 live load.

7.5.132 EV3 LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an EV3 live load.

7.5.133 EV3 LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an EV3 live load.

7.5.134 EV3 LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an EV3 live load.

7.5.135 EV3 LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an EV3 live load.

7.5.136 EV3 LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an EV3 live load.

7.5.137 SU6TV LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an SU6TV live load.

7.5.138 SU6TV LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an SU6TV live load.

7.5.139 SU6TV LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the application of an SU6TV live load.

7.5.140 SU6TV LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an SU6TV live load.

7.5.141 SU6TV LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an SU6TV live load.

7.5.142 SU6TV LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the application of an SU6TV live load.

7.5.143 Total Vehicle LL Analysis (Moments, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.144 Total Vehicle LL Analysis (Shears and Deflections, Unfactored, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.145 Total Vehicle LL Analysis (Reactions, Without Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined without sidewalks. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.146 Total Vehicle LL Analysis (Moments, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.47, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.147 Total Vehicle LL Analysis (Shears and Deflections, Unfactored, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.48, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.148 Total Vehicle LL Analysis (Reactions, With Sidewalk, Including Impact)

The same information is printed on this table as described in Section 7.5.49, except that the live load effects are generated using traffic lanes that were defined with sidewalks. The effects for this table come from the total of the two vehicles defined on the live load definition and live load assignment commands.

7.5.149 Left Sidewalk Pedestrian LL Analysis (Moments, Unfactored)

The following information is reported in the LEFT SIDEWALK PEDESTRIAN LL ANALYSIS (MOMENTS, UNFACTORED) output table. These results are for the left sidewalk pedestrian live load as indicated in the title of the table. The results are unfactored. These results are obtained by only loading the portions of the sidewalk width that contribute to the desired effect.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Positive Moment - maximum positive moment due to the live load.
3. Maximum Negative Moment - maximum negative moment due to the live load.
4. Maximum Relative Moment Distance - distance to the location of the maximum positive moment due the wheel placement inducing the maximum positive moment at the current analysis point.
5. Maximum Relative Moment Positive - maximum positive moment due to the wheel placement inducing the maximum positive moment at the current analysis point.
6. Maximum Relative Moment Distance -distance to the location of the maximum negative moment due the wheel placement inducing the maximum negative moment at the current analysis point.
7. Maximum Relative Moment Negative - maximum negative moment due to the wheel placement inducing the maximum negative moment at the current analysis point.

7.5.150 Left Sidewalk Pedestrian LL Analysis (Shears and Deflections, Unfactored)

The following information is reported in the LEFT SIDEWALK PEDESTRIAN LL ANALYSIS (SHEARS AND DEFLECTIONS, UNFACTORED) output table. These results are for the left sidewalk pedestian live load as indicated in the title of the table. The results are unfactored. These results are obtained by only loading the portions of the sidewalk that contribute to the desired effect.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Shear Positive - maximum positive shear due to the live load.
3. Maximum Shear Negative - maximum negative shear due to the live load.
4. Maximum Deflection Positive - maximum positive (downward) deflection due to the live load.
5. Maximum Deflection Negative - maximum negative (upward) deflection due to the live load.

7.5.151 Left Sidewalk Pedestrian LL Analysis (Reactions)

The following information is reported in the LEFT SIDEWALK PEDESTRIAN LL ANALYSIS (REACTIONS) output table. These results are for the left sidewalk pedestrian live load as indicated in the title of the table. The results are unfactored. These results are obtained by only loading the portions of the sidewalk width that contribute to the desired effect.

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.

7.5.152 Right Sidewalk Pedestrian LL Analysis (Moments, Unfactored)

The same information is printed on this table as described in Section 7.5.149. These effects for this table come from the pedestrian live loading on the right sidewalk.

7.5.153 Right Sidewalk Pedestrian LL Analysis (Shears and Deflections, Unfactored)

The same information is printed on this table as described in Section 7.5.150. These effects for this table come from the pedestrian live loading on the right sidewalk.

7.5.154 Right Sidewalk Pedestrian LL Analysis (Reactions)

The same information is printed on this table as described in Section 7.5.151. These effects for this table come from the pedestrian live loading on the right sidewalk.

7.5.155 Fatigue LL Analysis (Moments, Unfactored, Without Sidewalks, Including Impact)

The same information is printed on this table as described in Section 7.5.47. The effects for this table come from the application of a fatigue live load.

7.5.156 Fatigue LL Analysis (Shears, Unfactored, Without Sidewalks, Including Impact)

The same information is printed on this table as described in Section 7.5.48. The effects for this table come from the application of a fatigue live load.

7.5.157 Fatigue LL Analysis (Reactions, Without Sidewalks, Including Impact)

The same information is printed on this table as described in Section 7.5.49. The effects for this table come from the application of a fatigue live load.

7.5.158 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Top/Bottom - flange location set to 'TOP' for the top flange or 'BOT' for the bottom flange
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. DC1 - the stress in the flange due to the DC1 loads.
6. MC1 - the stress in the flange due to miscellaneous **MC1** loads.
7. **UT1 - the stress in the flange due to utility UT1 loads.**
8. DC2 - the stress in the flange due to the DC2 loads.
9. FWS - the stress in the flange due to the FWS loads.
10. MC2 - the stress in the flange due to miscellaneous **MC2** loads.
11. **UT2 - the stress in the flange due to utility UT2 loads.**
12. LL - The stress in the flange due to the current live load applicable to this limit state.
13. PL - the stress in the flange due to the pedestrian live load **for Strength-IP limit state.**

7.5.159 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Limit State - limit state as defined in the LRFD Specifications.
3. Flexure - positive or negative flexure indicator which is set to POS. for positive flexure and NEG. for negative flexure.
4. Maximum Moment - maximum factored moment (largest absolute value).
5. Maximum Shear - maximum factored shear (largest absolute value).
6. Flexural Stress*, Bottom Beam - total factored flexural stress at the bottom of the steel beam.
7. Flexural Stress*, Top Beam - total factored flexural stress at the top of the steel beam.
8. Flexural Stress*, Top Slab/Reinforcement - total factored flexural stress at the top of the effective thickness of the concrete for positive flexure or at the centroid of the slab reinforcement for negative flexure.
9. 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.
10. 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.

11. 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.

7.5.160 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. Minimum Reaction - minimum reaction from the factored analysis results.
5. Maximum Rotation - maximum rotation at the support from the factored analysis results.
6. Minimum Rotation - minimum rotation at the support from the factored analysis results.
7. * If Uplift - an asterisk (*) is printed in this column if uplift occurs at the specified support based on the factored analysis results.

7.6 SPECIFICATION CHECKING OUTPUT

A summary of the output tables for each parameter is given in Section 6.45. The user can suppress all specification checking output by entering zero for every specification check output parameter.

7.6.1 Ductility and Web/Flange Proportion Checks

The following information is reported in the DUCTILITY AND WEB/FLANGE PROPORTION CHECKS output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam
2. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure.
3. Web Proportion, Longitudinal Stiffeners (Y/N) - indicates 'Y' if the section is longitudinally stiffened and 'N' if the section is not longitudinally stiffened.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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

13. 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.

7.6.2 Compactness Criteria

The following information is reported in the COMPACTNESS CRITERIA output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Limit State - limit state as defined in the LRFD Specifications.
3. Flexure - positive or negative flexure indicator which is set to ‘POS.’ for positive flexure and ‘NEG.’ for negative flexure.
4. Fy, top - yield stress of the top flange
5. Fy, bottom - yield stress of the bottom flange
6. AASHTO 6.10.6.2.2, D / tw - value of the ratio D/tw used in AASHTO Article 6.10.6.2.2
7. 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
8. 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
9. AASHTO 6.10.6.2.3, 2 * Dc / tw - value of the ratio 2 * Dc / tw used in AASHTO Article 6.10.6.2.3 and Appendix A6.1

10. 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
11. 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
12. 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

    The presence of any character, A-H, 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.

7.6.3 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. Distance - distance to the analysis point measured from the left support of the specified span number.
2. Limit State - limit state as defined in the LRFD Specifications.
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. Dp* - distance from top of concrete deck to neutral axis of composite section at the plastic moment (Article 6.10.7.1.2).
5. Dt* - total depth of the composite section (Article 6.10.7.1.2)
6. Rh* - hybrid factor (Article 6.10.1.10.1)
7. Rpc* - web plastification factor for the compression flange (Article A6.2.1 or A6.2.2)
8. Rpt* - web plastification factor for the tension flange (Article A6.2.1 or A6.2.2)
9. Dc* - depth of web in compression (Article D6.3.1)
10. Myt* - yield moment with respect to the top flange (Article D6.2)
11. Myb* - yield moment with respect to the bottom flange (Article 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)

7.6.4 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Limit State - limit state as defined in the LRFD Specifications.
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. Flexural Resistance, Mr - the moment flexural resistance, based on calculations other than lateral torsional buckling.
5. Factored Moment, Mu - total factored moment for the given limit state and state of flexure.
6. 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. Code Check*** - a code failure may occur when computing the resistance of the section. The failure is are denoted by the alphabetic character A as described below.
   - A Insufficient flexural resistance - the factored flexural resistance is less than the factored flexural moment (Mr<Mu).

   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.

7.6.5 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Flange - flange location indicator set to TOP for the top flange or BOT for the bottom flange.
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. Intermediate Calculations, Rh* - hybrid factor
6. Intermediate Calculations, Rb* - load shedding factor (only applies to compression flange)
7. Flexural Resistance, Mr(e)* - equivalent moment resistance, back-calculated from stress flexural resistance.
8. Flexural Resistance, Fr - stress flexural resistance, without consideration of lateral torsional buckling.
9. Factored Flexural Stress, Fu - total factored stress in the flange for the given limit state and state of flexure.
10. Resistance Calculation** - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character A-G 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 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

11. Code Check*** - several different code failures may occur when computing the resistance of the section. The failures are denoted by alphabetic characters A-B as described below. A single section can have multiple failures.
    - A Insufficient flexural resistance - the factored flexural resistance is less than the factored flexural moment (Fr<Fu).
    - 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 (Fu) in the top flange is tensile. The user should verify the acceptability of the section by comparing the top flange stress (Fu) 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.

7.6.6 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 3.6.12 of this User's Manual for a discussion on the FBLRFD implementation of the lateral torsional buckling calculations.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Top/Bottom - flange location indicator set to TOP for the top flange or BOT for the bottom flange.
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 A6.10.8.2.3-6 or A6.10.8.2.3-7). 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.

7.6.7 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 3.6.12 of this User's Manual for a discussion on the FBLRFD implementation of the lateral torsional buckling calculations.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
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. 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-C, H, or I 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
   - H Fr calculated using AASHTO Equation D6.4.1-2
   - I Fr calculated using AASHTO Equation D6.4.1-2
7. 6.10.8.2.3 Flexural Resistance, Governing Mr(e) - equivalent moment resistance, back-calculated from the governing stress flexural resistance.
8. 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.

9. * - 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.
10. 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.
11. * - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character D-G, J, or K 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 Appendix A provisions are not applicable at this location
    - J Mr calculated using AASHTO Equation A6.4.2-2
    - K Mr calculated using AASHTO Equation A6.4.2-4
12. 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.
13. Factored Flexural Effects, Stress, F+** - total factored flexural stress, 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.
14. Factored Flexural Effects, Moment, M+** - total factored moment, 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.
15. 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.

7.6.8 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Limit State - limit state as defined in the LRFD Specifications.
3. Top/Bottom - flange location indicator set to 'TOP' for the top flange or 'BOT' for the bottom flange.
4. 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
5. Tensile Strength - the tensile strength of the tension flange
6. Yield Strength - the yield strength of the tension flange
7. Net Section Fracture Resistance, Fr - net section fracture resistance
8. Factored Flexural Stress, ft - maximum factored stress at the analysis point for the given limit state and flange.
9. 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.

7.6.9 Service Limit State - Flexural Resistance

The following information is reported in the SERVICE LIMIT STATE - FLEXURAL RESISTANCE output table. The stresses are factored for each limit state.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Top/Bottom - flange location indicator set to TOP for the top flange or BOT for the bottom flange.
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. Intermediate Calculations, Rh* - hybrid factor

6. Flexural Resistance, Mr(e) - equivalent moment resistance, back-calculated from stress flexural resistance, Fr
7. Flexural Resistance, Fr - flexural resistance.
8. Factored Flexural Moment, Fu - maximum factored flexural stress at the analysis point for the limit state and state of flexure.
9. Resistance Calculations** - the method used to compute the flexural resistance of the section. The methods are denoted by an alphabetic character A-C 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
10. 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.

7.6.10 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
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. Intermediate Calculations, Dc* - depth of web in compression
6. Intermediate Calculations, Rh* - hybrid factor
7. Intermediate Calculations, k* - bend-buckling coefficient
8. Flexural Resistance, Mr(e)* - equivalent moment resistance, back-calculated from stress flexural resistance
9. Flexural Resistance, Fcrw* - flexural resistance.
10. 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

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

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 (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.

7.6.11 Shear Capacity

The following information is reported in the SHEAR CAPACITY output table. The shear values are factored for each limit state.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Limit State - limit state as defined in the LRFD Specifications.
3. Factored Shear Resistance, Vr - factored shear resistance.
4. Maximum Factored Shear, Vu - maximum factored shear at the analysis point for the given limit state.
5. 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.
6. 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.

7.6.12 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Gamma - slenderness value calculated as per DM-4 Equation 6.10.1.9.3P-2
3. Shear Force in Web, Vr - shear resistance of the web
4. Shear Force in Web, 4*V - 4 * the total unfactored shear force
5. Compressive Stress in Web, fcw - compressive bending stress limit, calculated as per DM-4 Equation 6.10.1.9.3P-1
6. Compressive Stress in Web, fu - total unfactored compressive bending stress in web
7. 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 Insufficent 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.

7.6.13 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.

Distance - distance to the analysis point measured from the left support of the floorbeam.
Spacing, Maximum - maximum allowed stiffener spacing as per the LRFD Specifications.
Spacing, Actual - actual spacing of the stiffeners, as entered by the user.
Width, Minimum - minimum allowable width of the transverse stiffener to be effective, as per the LRFD Specifications.
Width, Maximum - maximum allowable width of the transverse stiffener to limit local buckling, as per the LRFD Specifications.
Width, Actual - actual width of the transverse stiffeners as entered by the user.

Moment of Inertia, Minimum - minimum allowable moment of inertia of the transverse stiffeners as per the LRFD Specifications.

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 6.10.11.1.3-7. Otherwise this value will print as "n/a".

Moment of Inertia, Actual - actual moment of inertia, as calculated from user-entered information.

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 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 character A 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 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.

7.6.14 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.

Distance - distance to the analysis point measured from the left support of the floorbeam.

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.

Maximum Width - maximum allowable width of the longitudinal stiffener to limit local buckling, as per the LRFD Specifications.

Actual Width - actual width of the longitudinal stiffener as entered by the user.

Minimum Moment of Inertia - minimum allowable moment of inertia of the longitudinal stiffener as per the LRFD Specifications.

Actual Moment of Inertia - actual moment of inertia, as calculated from user-entered information.

Code Check* - requirements not met for longitudinal stiffeners. The failures are denoted by the alphabetic characters A-B 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.

7.6.15 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. 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.
3. 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
4. Minimum Radius of Gyration - minimum allowable radius of gyration of the longitudinal stiffener as per the LRFD Specifications.
5. Actual Radius of Gyration - actual radius of gyration, as calculated from user-entered information.
6. Code Check* - requirement not met for longitudinal stiffeners. The failure is denoted by the alphabetic character A as described below.
   - A Radius of gyration less than minimum required - fails if the user-defined stiffener 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.

7.6.16 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Maximum Width - allowable maximum width of the bearing stiffener as per the LRFD Specifications.
3. Stiffener Width - actual width of the bearing stiffener.
4. Bearing Resistance - maximum resistance of the bearing stiffener in bearing.
5. Axial Resistance - maximum axial resistance of the bearing stiffener.
6. Maximum Factored Reaction - maximum factored reaction at the bearing location.
7. **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.**
8. **Stiffener / Web Weld Size Minimum - the minimum allowed weld size, based on the thicknesses of the web and stiffener plates.**
9. **Stiffener / Web Weld Size Maximum - the maximum allowed weld size, based on the thicknesses of the web and stiffener plates.**
10. Code Check* - requirements not met for bearing stiffeners. The failures are denoted by the alphabetic characters A-D 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 6.13.34). 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.

7.6.17 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Distance, k* - distance from the outer face of the flange to the web toe of the fillet **(for rolled beam)**
   bottom flange thickness (for plate girders)
   bottom flange thickness or angle thickness (for built-up sections)
3. Bearing Length, N* - length of bearing, N, as defined in the LRFD Specifications. FBLRFD sets this value equal to k for the purposes of these calculations.
4. Web Local Yielding Resistance - web local yielding resistance, as defined in LRFD Specifications.
5. Web Crippling Resistance - web crippling resistance, as defined LRFD Specifications.
6. Maximum Factored Load - maximum factored concentrated load at this location
7. 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 beam)**
Bottom flange thickness (for plate girder)
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)

8. 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 maximum factored load. A bearing stiffener has been defined here. A bearing stiffener is required here, and the user has defined one at this location. Please see the USER-DEFINED BEARING STIFFENER ANALYSIS output report to verify that the defined 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.

7.6.18 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Flange - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
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. For sections that can be in both positive and negative flexure, only the governing case (case with the greater shear flow) is reported.
5. Weld Metal Resistance, Rr, weld - the resistance of the weld metal.
6. 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

7. Weld Size, Calculated - the required weld size based on the factored shear flow and weld metal resistance.
8. Weld Size, Minimum - the minimum allowed weld size based on the thicker piece joined.
9. Weld Size, Maximum - the maximum allowed weld size based on the thinner piece joined.
10. Weld Size, Design - the designed weld size for this analysis location. This value is the larger of the Weld Size, Calculated and the Weld Size, Minimum.
11. Criteria Not Met* - requirements not met for the designed weld size. The comments are denoted by the alphabetic characters 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.

7.6.19 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, and only the controlling point will print.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Flange - flange location indicator set to 'TOP' for the top flange or 'BOT' for the bottom flange.
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. For sections that can be in both positive and negative flexure, only the governing case (case with the greater shear flow) is reported.
5. Connected Metal Resistance, Web, sr, web - the resistance of the web metal
6. Connected Metal Resistance, Flange, sr, flange - the resistance of the flange 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 output table:

    ***NOTE: FACTORED SHEAR FLOW is the total shear flow between the web and the flange.
8. Performance Ratio** - the maximum ratio of su/sr,web and su/sr,flange. The following note is printed below the output table:

    ***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.
9. 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 factore shear flow

7.6.20 Special Fatigue Requirements for Webs

The following information is reported in the SPECIAL FATIGUE REQUIREMENTS 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 FBLRFD), the table will not print. The live load stresses are factored based on the fatigue limit state (as described below).

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Allowable, Vcr - maximum allowable shear (shear-buckling resistance). This value will print as 'N/A' for points that have unstiffened webs or are located within exterior panels.
3. 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 external panels.
4. Comment* - comments on the special fatigue requirement for webs. The comments are denoted by the alphabetic characters A-B as described below. A single section can have multiple comments.
   - A Code check: Vu > Allowable, Vcr - A code failure occurs if the actual shear force is greater than the allowable shear force.
   - 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).

7.6.21 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Distance From Bottom - distance measured from the bottom of the girder.
3. Detail Category - category of the detail as specified in the LRFD Specifications.
4. Fatigue Limit State - the fatigue limit state used for the fatigue resistance check.
5. Stresses, Dead*** - the total, unfactored dead load stress at the fatigue detail.
6. Stresses, Positive Live*** - the factored live load stress due to the positive fatigue live load moment at the fatigue detail.
7. 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.
8. Fatigue Resistance - factored fatigue resistance at the specified location.
9. Fatigue Stress Range - actual factored fatigue stress range at the specified location.

10. 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.
11. 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.

7.6.22 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Distance From Bottom - distance measured from the bottom of the girder.
3. Total Cycles - total number of fatigue cycles allowed over the life of the detail.
4. Accumulated Cycles to Date - estimated number of cycles that the detail has seen.
5. Remaining Cycles - estimated number of cycles left in the life of the detail.
6. 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.

7.6.23 Deflection Limits for Live Load

The following information is reported in the DEFLECTION LIMITS FOR LIVE LOAD output table.

1. Location of Maximum Deflection - distance to the analysis point having the maximum live load deflection measured from the left support of the floorbeam.
2. Allowable Deflection - maximum allowable live load deflection.
3. Actual Deflection - actual live load deflection.
4. Code Check* - requirements not met for live load deflection limits. The failure is denoted by the alphabetic character A as described below.
    - A Maximum deflection exceeds allowable - fails if the allowable deflection is less than the actual live load deflection.

7.6.24 Deflection Limits for Deflection Loading Only

The following information is reported in the DEFLECTION LIMITS FOR DEFLECTION LOADING ONLY output table. This table prints instead of the DEFLECTION LIMITS FOR LIVE LOAD output table for program runs that include sidewalk loads.

1. Location of Maximum Deflection - distance to the analysis point having the maximum live load deflection measured from the left support of the floorbeam.
2. Allowable Deflection - maximum allowable live load deflection.
3. Actual Deflection - actual live load deflection.
4. Code Check* - requirements not met for live load deflection limits. The failure is denoted by the alphabetic character A as described below.
   A Maximum deflection exceeds allowable - fails if the allowable deflection is less than the actual live load deflection.

7.6.25 Deflection Limits for Deflection Loading plus Pedestrian Live Load

The following information is reported in the DEFLECTION LIMITS FOR DEFLECTION LOADING PLUS PEDESTRIAN LIVE LOAD output table. This table only prints for runs that include sidewalk loads.

1. Location of Maximum Deflection - distance to the analysis point having the maximum live load deflection measured from the left support of the floorbeam.
2. Allowable Deflection - maximum allowable live load deflection.
3. Actual Deflection - actual live load deflection.
4. Code Check* - requirements not met for live load deflection limits. The failure is denoted by the alphabetic character A as described below.
   A Maximum deflection exceeds allowable - fails if the allowable deflection is less than the actual live load deflection.

7.6.26 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 points of contraflexure. Each design region is consecutively numbered.
2. Start Distance - distance to the left end of the design region measured from the left support of the floorbeam.
3. End Distance - distance to the right end of the design region measured from the left support of the floorbeam.

4. Horizontal Shear, P - total factored horizontal shear force that the shear connectors need to carry.
5. Factored Resistance, Q(r) - total factored resistance of the shear connectors.
6. Number of Connectors Required - total number of shear connectors required for the specified design region.

7.6.27 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Connectors Per Row, Maximum - maximum number of connectors per row.
3. Connectors Per Row, Actual - actual number of connectors per row inputted.
4. Pitch Required, Minimum - minimum required pitch for shear connectors.
5. Pitch Required, Maximum - maximum required pitch for shear connectors.
6. Fatigue LS - the fatigue limit state used to calculate the maximum required pitch.
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 following information is printed for channel shear connectors:

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Pitch Required, Minimum - minimum required pitch for shear connectors.
3. Pitch Required, Maximum - maximum required pitch for shear connectors.
4. Fatigue LS - the fatigue limit state used to calculate the maximum required pitch.

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.

7.6.28 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.

7.6.29 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.

7.6.30 Uncured Slab Web Specification Check

The following information is reported on the UNCURED SLAB WEB SPECIFICATION CHECK output table. The UNCURED SLAB output tables will be generated for every run of the program.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Gamma -slenderness value calculated as per DM-4 Equation 6.10.1.9.3P-2.
3. Shear Force in Web, Vr - shear resistance of the web.

4. Shear Force in Web, 4*Vdl - 4 * the unfactored DC1 shear force.
5. Shear Force in Web, Vu - actual factored shear force in the web, including only the uncured slab loads (no vehicular live loads). This value will print as N/A for unstiffened ranges.
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 Insufficent 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.

7.6.31 Uncured Slab Flange Specification Check (No Lateral Torsional Buckling) (Part 1)

The following information is reported in the UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 1) output table. The UNCURED SLAB output tables will be generated for every run of the program.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Hybrid Factor, Rh - the hybrid factor
3. Flange - flange location indicator set equal to TOP for the top flange or BOT for the bottom flange.
4. Flange Nominal Yielding, Allowable Stress - maximum allowable flexural stress in the flange for flange nominal yielding criteria.
5. Flange Nominal Yielding, Actual Stress* - actual factored flexural stress in the flange.
6. Web Bend Buckling*, Coefficient k - bend-buckling coefficient, k.
7. Web Bend Buckling*, Allowable Stress - maximum allowable flexural stress in the flange for web bend buckling criteria.
8. Web Bend Buckling*, Actual Stress* - actual factored flexural stress in the 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

   Web bend-buckling checks only apply to compression flanges, tension flanges are identified as N/A
9. 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

7.6.32 Uncured Slab Flange Specification Check (No Lateral Torsional Buckling) (Part 2)

The following information is reported in the UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 2) output table. The UNCURED SLAB output tables will be generated for every run of the program that includes a discretely braced compression flange.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Unbraced Length - maximum unbraced length measured between bracing points or to the point of where the deck has hardened.
3. Top/Bottom - compression flange location indicator set equal to 'TOP' for the top flange or 'BOT' for the bottom flange.
4. Load Shedding Factor, Rb - the load shedding factor of the compression flange
5. Compression Flange Flexural Resistance (6.10.3.2.1-2), Flexural Stress, Allowable Stress - maximum allowable flexural stress in the compression flange for flexural resistance criteria.
6. Compression Flange Flexural Resistance (6.10.3.2.1-2), Flexural Stress, Actual Stress* - actual factored flexural stress 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
7. Compression Flange Flexural Resistance (6.10.3.2.1-2), Flexural Stress, Resistance Calculation** - the method of calculating the flexural resistance for the compression flange, denoted by the alphabetic characters A-C as described below.
   A Compression flange is continuously braced, flexural resistance checks do not apply
   LRFD Specifications Article 6.10.8.2.2 (Flange Local Buckling)
   B Compression flange is discretely braced, local flange buckling governs allowable stress
   C Compression flange is discretely braced, lateral torsional buckling governs allowable stress
8. 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.

7.6.33 Intermediate Values for Lateral Torsional Buckling Calculations (Uncured Slab)

The following information is reported in the INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (UNCURED SLAB) output table. 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 3.6.122 of this User's Manual for a discussion on the FBLRFD implementation of the lateral torsional buckling calculations.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Top/Bottom - compression flange location indicator set equal to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
3. 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.
4. rt* - effective radius of gyration for lateral torsional buckling (Equation 6.10.8.2.3-9)
5. Rh* - hybrid factor (Article 6.10.1.10.1)
6. Rb* - load shedding factor (Article 6.10.1.10.2)
7. Dc* - depth of web in compression (Article D6.3.1)
8. Lp* - limiting unbraced length to achieve the nominal flexural resistance of RbRhFyc under uniform bending (Equation 6.10.8.2.3-4)
9. 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).
10. 6.10.8.2.3, Cb* - moment gradient factor (Equations 6.10.8.2.3-6 or 6.10.8.2.3-7).

7.6.34 Lateral Torsional Buckling Capacity (Uncured Slab)

The following information is reported in the LATERAL TORSIONAL BUCKLING CAPACITY (UNCURED SLAB) output table. 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 3.6.122 of this User's Manual for a discussion on the FBLRFD implementation of the lateral torsional buckling calculations.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
3. 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.
4. 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.
5. * - 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

6. 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.
7. * - 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.
8. Factored Flexural Stress, Fu - total factored stress. This value is the maximum factored stress in the current unbraced length.
9. 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.

7.6.35 Uncured Slab Net Section Fracture Check

The following information is reported in the 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 UNCURED SLAB output tables will be generated for every run of the program.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Top/Bottom - flange location indicator set to ‘TOP’ for the top flange or ‘BOT’ for the bottom flange.
3. 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
4. Tensile Strength - the tensile strength of the tension flange
5. Yield Strength - the yield strength of the tension flange
6. Net Section Fracture Resistance, Fr - net section fracture resistance
7. Factored Flexural Stress, ft - maximum factored stress at the analysis point for the given limit state and flange.

8. 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 RATING FACTORS OUTPUT

A summary of the output tables for each parameter is given in Section 6.46. The user can suppress all rating output by entering zero for every rating factor output parameter. **The page heading indicates whether or not Future Wearing Surface load is included in the ratings.**

7.7.1 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.
5. Distance - distance to the analysis point of the controlling rating measured from the left support of the floorbeam.
6. Limit State - limit state of the governing rating factor as defined in the LRFD Specifications.

7.7.2 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Limit State - limit state as defined in the LRFD Specifications.
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. Resisting Moment, Mr - factored flexural resistance.
5. 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.
6. Total LL Moment - total factored live load moment.
7. 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.
8. 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.

7.7.3 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. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Flange - flange indicator set to TOP for the top flange or BOT for the bottom flange.
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 Stress, Fr - factored flexural resistance in terms of stress.
6. 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.
7. Total LL Stress - total factored live load stress.
8. 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.

9. Rating Failures* - several different code failures are reported that do not directly impact the rating factor. These failures are denoted by alphabetic characters A- 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.

7.7.4 Rating Factors - Shear Capacity

The following information is reported in the RATING FACTORS - SHEAR CAPACITY output table.

1. Distance - distance to the analysis point measured from the left support of the floorbeam.
2. Limit State - limit state as defined in the LRFD Specifications.
3. 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.
4. Resisting Shear, Vr - factored shear resistance.
5. 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.
6. Total LL Shear - total factored live load shear.
7. Rating Factor - Shear rating factor.
8. Rating Failure* - a code failure is reported that does not directly impact the rating factor. This failure is denoted by the alphabetic character A 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.

7.7.5 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.
5. Distance - distance to the analysis point of the controlling rating measured from the left support of the floorbeam.
7. Limit State - limit state of the governing rating as defined in the LRFD Specifications.

7.7.6 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. Floorbeam ii - the number of the current floorbeam
2. Beam Type and Size: - the web depth (for plate girders and built-up sections) or beam designation (rolled beams) at the left support of the floorbeam
3. INVENTORY RATING Location (ft) - the distance from the left support centerline of bearing in feet to the location of the specified rating
4. INVENTORY RATING Limit State - the limit state corresponding to the given rating
5. **INVENTORY RATING Resistance – the section resistance (flexure or shear) at the location of the rating factor**
6. INVENTORY RATING RF - the rating factor value with either "M" or "S" to identify whether moment ("M") or shear ("S") controls
7. OPERATING RATING Location (ft) - the distance from the left support centerline of bearing in feet to the location of the specified rating

8. OPERATING RATING Limit State - the limit state corresponding to the given rating
9. **OPERATING RATING Resistance – the section resistance (flexure or shear) at the location of the rating factor**
10. OPERATING RATING RF - the rating factor value with either "M" or "S" to identify whether moment ("M") or shear ("S") controls
11. Maximum Factored Flexural Resistance (kip-ft) - the maximum moment capacity in the floorbeam
12. Span Length(ft) - the total length of the floorbeam (including overhangs)
13. Location (ft) - the distance from the left support centerline of bearing to the location of the maximum factored flexural resistance
14. Maximum Factored Shear Resistance (kips) - the maximum shear capacity in the given floorbeam
15. Location (ft) - the distance from the left support centerline of bearing to the location of the maximum factored shear resistance.

7.8 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.

Example of Input File Echo:

```
                                                 EXAMPLE.DAT
                                                 -----------
 !
 ! ** Created by EngAsst **
 ! EngAsst Information: [Program=FBLRFD] [Version=1.6.0.0]
 ! ** Data Records Start Here **
 TTL FBLRFD EXAMPLE 2
 TTL
 TTL SIMPLY SUPPORTED - NONCOMPOSITE ROLLED BEAM SECTION
 TTL WITH COVER PLATES
 TTL
 TTL US UNITS
 TTL
 CTL US,5,3,RB,S,N,,N,4250,,E,1.33,1.15,1.2,,,,R,2
 GEO 25,-1.5,26.5,,,6.0,4.0,N
 PDL 12.0,0.0,25.0
 FSP 1,10.0
. . .
```

Example of Input Commands:

```
                                                INPUT COMMANDS
                                                --------------

     COMMAND:  CTL
       SYSTEM OF UNITS                          US
       NO. OF FLOORBEAMS                         5
       FLOORBEAM NUMBER                          2
       TYPE OF FLOORBEAM                        PG
       TYPE OF SUPPORT                           C
       FRAMING TYPE                              N
       NO. OF STRINGERS                          *        (computed, if necessary)
       SYMMETRY                                  N
       ADTT FOR SINGLE LANE                   1700
       MULT. PRES. FACTOR ADJ.                 1.0
       LIVE LOAD                                 A
       DYNAMIC LOAD ALLOWANCE                 1.33            (default)
       FATIGUE DYN. LOAD ALLOW.               1.15            (default)
       PA TRAFFIC FACTOR                         *        (computed, if necessary)
       IMPORTANCE FACTOR                       1.0
       DUCTILITY FACTOR                       1.00
       REDUNDANCY FACTOR                      1.00
       REDUNDANT LOAD PATH                       R
       OUTPUT POINTS                             2
       P-82 DYN. LOAD ALLOW.                  1.20            (default)

     COMMAND:  GEO
       CL LFT SUP CL RGT SUP                  67.0 ft
       CL LFT SUP LFT DECK EDGE             -10.33 ft
       CL LFT SUP RGT DECK EDGE              77.33 ft
       CL LFT SUP LFT OVHG END               -7.83 ft
       CL LFT SUP RGT OVHG END               74.83 ft
       GAGE DISTANCE                            6. ft         (default)
       PASSING DISTANCE                         4. ft         (default)
       STAGGERED DIAPHRAGMS                      N
```

CONTROL PARAMETERS

Units	Number of Floorbeams	Floorbeam Number	Type of Floorbeam	Type of Support	Framing Type	No. of Stringers
aa	ii	ii	aaaaaaaaaaaa	aaaaaa	aaaaaaa	ii

Symmetry	Lane Defin.	Single Lane ADTT	Multiple Presence Factor Adj.	Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor
aaa	aaaa	iiii	x.xxx	a	x.xxx	x.xxx	N/A

Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path	Analysis Points	Design Permit Vehicle Dynamic Load Allowance	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports
x.xxx	x.xxx	x.xxx	aaa	ii	x.xxx	xx.xx	aaa	aaa

SYMMETRICAL POINT

Span Dist. (ft)
xxx.xxx

STRUCTURE IDENTIFICATION

Program Identification	County	State Route	Segment	Offset	Span Identification
aaaaaaaaa	ii	aaaa	iiii	iiii	iiii

FLOORBEAM GEOMETRY

	Centerline of Left Support to						
Right Support (ft)	Deck Edge Left (ft)	Deck Edge Right (ft)	Overhang End Left (ft)	Overhang End Right (ft)	Gage Distance (ft)	Passing Distance (ft)	Staggered Diaphragms
xx.xxx	xxx.xxx	xxx.xxx	aaaaaaa	aaaaaaa	xxx.xxx	xxx.xxx	aaa

Centerline of Left Support to			
Left Sidewalk Edge Left (ft)	Left Sidewalk Edge Right (ft)	Right Sidewalk Edge Left (ft)	Right Sidewalk Edge Right (ft)
aaaaaaa	aaaaaaa	aaaaaaa	aaaaaaa

PROGRAM DEFINED LANES

Lane Width (ft)	(without Sidewalk) Centerline Girder to Left Curb (ft)	(without Sidewalk) Centerline Girder to Right Curb (ft)	(with Sidewalk) Centerline Girder to Left Curb (ft)	(with Sidewalk) Centerline Girder to Right Curb (ft)
xxx.xxx	xxx.xxx	xxx.xxx	aaaaaaa	aaaaaaa

```
                   USER-DEFINED LANES (WITHOUT SIDEWALK)
                   -------------------------------------
Lane No.           ii       ii       ii       ii       ii       ii       ii
Lft Edge      xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx
Rgt Edge      xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx


                    USER-DEFINED LANES (WITH SIDEWALK)
                    ----------------------------------
Lane No.           ii       ii       ii       ii       ii       ii       ii
Lft Edge      xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx
Rgt Edge      xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx

                             FLOORBEAM SPACING
                             -----------------
Flrbm No.          ii       ii       ii       ii       ii       ii       ii
Spacing       xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx
Contin Str          a        a        a        a        a        a        a

                             STRINGER LOCATION
                             -----------------
Strgr No.          ii       ii       ii       ii       ii       ii       ii
Location      xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx

                       USER-DEFINED ANALYSIS POINTS
                       ----------------------------
Distance      xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx

                            MATERIAL PROPERTIES
                            -------------------
             Matl.                                   Cover Plate
              ID   Noncomposite/    Rolled Beam      Top     Bottom
              No.    Composite        Fy     Fu       Fy        Fy
                                    (ksi)   (ksi)   (ksi)     (ksi)
              ii    aaaaaaaaaaaa   xxx.x   xxx.x    xxx.x     xxx.x

 Matl.                             F l a n g e   P l a t e      Classification
  ID    Noncomposite/   Web      Top   Bottom     Top   Bottom    Strength of
  No.    Composite       Fy       Fy     Fy        Fu     Fu      Weld Metal
                        (ksi)    (ksi)  (ksi)     (ksi)  (ksi)      (ksi)
  ii     aaaaaaaaaaaa   xxx.x    xxx.x  xxx.x     xxx.x  xxx.x      xxx.x

                    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
                 Matl. O O    Rolled        Top Cover        Bottom Cover
 Start     End    ID   S L     Beam           Plate              Plate
 Dist.    Dist.  No.   S E   Designat.    Width    Thick.   Width    Thick.
 (ft)     (ft)                             (in)      (in)    (in)      (in)
xxx.xxx  xxx.xxx ii    a a   aaaaaaaaa   xx.xxxx  xx.xxxx  xx.xxxx  xx.xxxx

                    ROLLED BEAM PROPERTIES, PART 2 of 2
                    -----------------------------------
                                          Deck     Reinf.
               Start     End     Haunch   Reinf.    C.G.
               Dist.    Dist.     Depth    Area     Dist.
               (ft)     (ft)      (in)   (in^2/ft)   (in)
              xxx.xxx  xxx.xxx   xxx.xxx  xxx.xxx   xxx.xxx

                     BUILT-UP PROPERTIES, PART 1 of 2
                     --------------------------------
                        L H V
                   Matl. O O A    Angle    Angle
 Start     End      ID   S L R    Vert.    Hort.    Angle     Web      Web
 Dist.    Dist.     No.  S E Y     Leg      Leg     Thick.   Depth    Thick.
 (ft)     (ft)                     (in)     (in)     (in)    (in)     (in)
xxx.xxx  xxx.xxx    ii   a a a   xxx.xxx  xxx.xxx  xx.xxxx  xxx.xxx  xxx.xxx

                     BUILT-UP PROPERTIES, PART 2 of 2
                     --------------------------------
                                                               Deck     Reinf.
Start     End      Top Plate       Bottom Plate    Haunch    Reinf.     C.G.
Dist.    Dist.   Width   Thick.   Width   Thick.   Depth      Area      Dist.
(ft)     (ft)    (in)     (in)    (in)     (in)     (in)   (in^2/ft)    (in)
xx.xxx xxx.xxx  xx.xxxx xx.xxxx  xx.xxxx xx.xxxx  xxx.xxx  xxx.xxx   xxx.xxx

                   PLATE GIRDER PROPERTIES, PART 1 of 2
                   ------------------------------------
                     L H V
                Matl. O O A                     Top              Bottom
Start    End     ID   S L R  Web     Web       Plate              Plate
Dist.   Dist.    No.  S E Y Depth  Thick.   Width    Thick.   Width   Thick.
(ft)    (ft)                 (in)   (in)    (in)      (in)     (in)    (in)
xx.xxx 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

Start Dist. (ft)	End Dist. (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

SECTION HOLES

Start Dist. (ft)	End Dist. (ft)	Type of Hole	Distance to 1st Hole (in)	Width of Holes (in)	No. of Holes	Hole Spacing (in)
xxx.xxx	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 Dist. (ft)	End Dist. (ft)	Loss Type	Location	Distance (in)	Width (in)	Thick. (in)
xxx.xxx	xxx.xxx	aaaaaaaaaaaaaa	aaaaaa	xxx.xxx	xxx.xxx	xx.xxxx
		aaaaaaaaaaaaaa	aaaaaa	xxxxxx.	xxxxxx.	xxxxxx.
		aaaaaaaaaaaaaa	aaaaaa	xxx.xxx	xxx.xxx	xx.xxxx

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)
xx.xxx	xx.xxx	xx.xxx	xxx.xx	xxx.xx	xxxxx.	xxxxxxx.

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
xxxxx.	xxx.

LOAD FACTORS

Load Factor Type	STR-I	STR-IP	STR-IA	STR-II
aaa	x.xxx	x.xxx	x.xxx	x.xxx

Load Factor Type	SERV-II	SERV-IIA	SERV-IIB	FATG-I	DEFL	CONST	FATG-II
aaa	x.xxx	x.xxx	x.xxx	aaaaa	aaaaa	aaaaa	aaaaa

Load Factor Type	**Minimum STR-I**	**Minimum STR-IP**	**Minimum STR-IA**	**Minimum STR-II**
aaa	**x.xxx**	**x.xxx**	**x.xxx**	**x.xxx**

```
                    FLOORBEAM CONCENTRATED LOADS, PART 1 of 2
                    -----------------------------------------
 Dist.     DC1      DC1S      DC2      MC1      MC2      PDC2     PFWS      FWS
 (ft)    (kips)    (kips)   (kips)   (kips)   (kips)   (kips)   (kips)   (kips)
xxx.xxx xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx

                    FLOORBEAM CONCENTRATED LOADS, PART 2 of 2
                    -----------------------------------------
 Dist.     UT1      UT2
 (ft)    (kips)    (kips)
xxx.xxx xxx.xx   xxx.xx

                     STRINGER CONCENTRATED LOADS, PART 1 of 2
                     ----------------------------------------
Strgr.  Span
 No.     No.   Dist.     DC1      DC1S      DC2      MC1      MC2      PDC2
               (ft)    (kips)   (kips)   (kips)   (kips)   (kips)   (kips)
  ii     ii   xxx.xxx xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx

                     STRINGER CONCENTRATED LOADS, PART 2 of 2
                     ----------------------------------------
Strgr.  Span
 No.     No.   Dist.     UT1      UT2
               (ft)    (kips)   (kips)
  ii     ii   xxx.xxx xxx.xxx  xxx.xxx

              FLOORBEAM DISTRIBUTED LOADS (DC1)
              ---------------------------------
         Start      End       Start      End
         Dist.      Dist.     Mag.       Mag.
         (ft)       (ft)    (kips/ft)  (kips/ft)
        xxx.xxx    xxx.xxx   xxx.xxx    xxx.xxx

              FLOORBEAM DISTRIBUTED LOADS (DC1S)
              ----------------------------------
         Start      End       Start      End
         Dist.      Dist.     Mag.       Mag.
         (ft)       (ft)    (kips/ft)  (kips/ft)
        xxx.xxx    xxx.xxx   xxx.xxx    xxx.xxx

              FLOORBEAM DISTRIBUTED LOADS (DC2)
              ---------------------------------
         Start      End       Start      End
         Dist.      Dist.     Mag.       Mag.
         (ft)       (ft)    (kips/ft)  (kips/ft)
        xxx.xxx    xxx.xxx   xxx.xxx    xxx.xxx

              FLOORBEAM DISTRIBUTED LOADS (FWS)
              ---------------------------------
         Start      End       Start      End
         Dist.      Dist.     Mag.       Mag.
         (ft)       (ft)    (kips/ft)  (kips/ft)
        xxx.xxx    xxx.xxx   xxx.xxx    xxx.xxx

              FLOORBEAM DISTRIBUTED LOADS (MC1)
              ---------------------------------
         Start      End       Start      End
         Dist.      Dist.     Mag.       Mag.
         (ft)       (ft)    (kips/ft)  (kips/ft)
        xxx.xxx    xxx.xxx   xxx.xxx    xxx.xxx
```

FLOORBEAM DISTRIBUTED LOADS (MC2)

Start Dist. (ft)	End Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

FLOORBEAM DISTRIBUTED LOADS (PDC2)

Start Dist. (ft)	End Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

FLOORBEAM DISTRIBUTED LOADS (PFWS)

Start Dist. (ft)	End Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

FLOORBEAM DISTRIBUTED LOADS (UT1)

Start Dist. (ft)	**End Dist. (ft)**	**Start Mag. (kips/ft)**	**End Mag. (kips/ft)**
xxx.xxx	**xxx.xxx**	**xxx.xxx**	**xxx.xxx**

FLOORBEAM DISTRIBUTED LOADS (UT2)

Start Dist. (ft)	**End Dist. (ft)**	**Start Mag. (kips/ft)**	**End Mag. (kips/ft)**
xxx.xxx	**xxx.xxx**	**xxx.xxx**	**xxx.xxx**

STRINGER DISTRIBUTED LOADS (DC1)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
ii	ii	xxx.xxx	ii	xxx.xxx	xxx.xxx	xxx.xxx

STRINGER DISTRIBUTED LOADS (DC1S)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
ii	ii	xxx.xxx	ii	xxx.xxx	xxx.xxx	xxx.xxx

STRINGER DISTRIBUTED LOADS (DC2)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
ii	ii	xxx.xxx	ii	xxx.xxx	xxx.xxx	xxx.xxx

```
                    STRINGER DISTRIBUTED LOADS (FWS)
                    --------------------------------
       Start  Start   End    End
Strgr. Span   Span    Span   Span        Start      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

                    STRINGER DISTRIBUTED LOADS (MC1)
                    --------------------------------
       Start  Start   End    End
Strgr. Span   Span    Span   Span        Start      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

                    STRINGER DISTRIBUTED LOADS (MC2)
                    --------------------------------
       Start  Start   End    End
Strgr. Span   Span    Span   Span        Start      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

                    STRINGER DISTRIBUTED LOADS (PDC2)
                    ---------------------------------
       Start  Start   End    End
Strgr. Span   Span    Span   Span        Start      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

                    STRINGER DISTRIBUTED LOADS (PFWS)
                    ---------------------------------
       Start  Start   End    End
Strgr. Span   Span    Span   Span        Start      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

                    STRINGER DISTRIBUTED LOADS (UT1)
                    --------------------------------
       Start  Start   End    End
Strgr. Span   Span    Span   Span        Start      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

                    STRINGER DISTRIBUTED LOADS (UT2)
                    --------------------------------
       Start  Start   End    End
Strgr. Span   Span    Span   Span        Start      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
```

```
                         PEDESTRIAN LOADS
                         ----------------
                   Left Sidewalk  Right Sidewalk
                    Pedestrian      Pedestrian
                    Live Load       Live Load
                      (ksf)           (ksf)
                      x.xxx           x.xxx

                          SUPPORT FIXITIES
                          ----------------
                                DL         LL
                   Support   Moment %   Moment %
                    LEFT      xxx.xx     xxx.xx
                    RIGHT     xxx.xx     xxx.xx

                        LIVE LOAD DEFINITION
                        --------------------
            Live Load  Live Load    Ratings   Mult Pres
             Type 1     Type 2      Desired    Factor
             aaaaaa     aaaaaa         i       xxx.xxx

             LIVE LOAD ASSIGNMENTS (WITHOUT SIDEWALKS)
             -----------------------------------------
Lane No.        ii       ii       ii       ii       ii       ii       ii
LL Type       aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaa

              LIVE LOAD ASSIGNMENTS (WITH SIDEWALKS)
              --------------------------------------
Lane No.        ii       ii       ii       ii       ii       ii       ii
LL Type       aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaa  aaaaaaa
```

SPECIAL LIVE LOADING

LL No.	Axle Effect	Lane Load (kip/ft)	Percentage Increase	Vehicle Type
i	a	xxx.xxx	xx.xxx	a

SPECIAL AXLE LOAD

Axle Load (kip)	Spacing (ft)	Axle Load (kip)	Spacing (ft)	Axle Load (kip)	Spacing (ft)	Axle Load (kip)	Spacing (ft)
xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx	xxx.xxx

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
iiii	iiii	aaaaa	aaaa	aaaaa	aaaaa	aaaa	aaaaa	aaaaa

FATIGUE GROSS VEHICLE

Gross Weight Min. (kip)	Gross Weight Max. (kip)	No. of 2 Axle Trucks	No. of 3 Axle Trucks	No. of 4 Axle Trucks	Combination Trucks No. of 3 Axle	Combination Trucks No. of 4 Axle	Combination Trucks No. of 5 Axle
xxx.xx	xxxx.x	iiiii	iiiii	iiiii	iiiii	iiiii	iiiii

FATIGUE POINTS

Dist. 1 (ft)	Dist. 2 (in)	Category	Fillet Weld (in)
xxx.xxx	xxx.xxx	aa	aaaaaaa

BRACE POINTS

Start Dist. (ft)	End Dist. (ft)	Brace Spacing (ft)
xxx.xxx	xxx.xxx	xxx.xxx

CONTINUOUS BRACE

Continuously Braced Top Flange
a

```
                        TRANSVERSE STIFFENERS
                        ---------------------
                                                                      Web
  Start     End     Stiff.  Stiff.    Proj.    Stiff.    Yield       Leg
  Dist.     Dist.   Type*   Spacing   Width    Thick.   Strength   Length
   (ft)      (ft)             (in)     (in)     (in)     (ksi)      (in)
 xxx.xxx   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

                       LONGITUDINAL STIFFENERS
                       -----------------------
                              Dist.                                   Web
  Start     End     Stiff.   from       Proj.    Stiff.   Yield       Leg
  Dist.     Dist.   Type*   Flange**    Width    Thick.    Str.     Length
   (ft)      (ft)            (in)        (in)     (in)    (ksi)      (in)
 xxx.xxx   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
                    Stiffener   of     Between                Projecting
             Dist.    Type*    Pairs    Pairs    Clearance       Width
             (ft)                        (in)       (in)          (in)
            xxx.xxx    a a       ii     xx.xxx     xx.xxx        x.xxx
            xxx.xxx    a a       ii      n/a        n/a          x.xxx

                    Bearing                            Web      Classification
                    Contact  Stiffener   Yield         Leg       Strength of
            Dist.    Width   Thickness  Strength     Length   Web-Stiffener Weld
             (ft)     (in)      (in)      (ksi)        (in)          (ksi)
            xxx.xxx  xx.xxx    xx.xxx    xx.xxx      xxx.xx          xxx.x
            xxx.xxx  xx.xxx    xx.xxx    xx.xxx      aaaaaa          xxx.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

                        STUD SHEAR CONNECTORS
                        ---------------------
              No. of                                 Tensile
            Connectors    Diameter     Height       Strength
                            (in)        (in)         (ksi)
                ii         xx.xxx      xx.xxx       xxx.xxx
```

```
                    CHANNEL SHEAR CONNECTORS
                    ------------------------
Channel Flange    Channel Web    Channel    Channel
  Thickness        Thickness      Length     Height
     (in)             (in)         (in)       (in)
    xx.xxx           xx.xxx       xx.xxx     xx.xxx

                         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 ANALYSIS RESULTS
                      --------------------------
                                  Dead       Dead
  Points of       Load      Dead      Load       Load       Influence
Contraflexure   Modifiers   Loads    Effects   Reactions     Lines
      i             i         i         i          i            i

  Live       Live         HS20          H20         Fatigue
  Load       Load     Effects and  Effects and  Effects and  Factored   Factored
 Effects   Reactions   Reactions    Reactions    Reactions    Effects   Reactions
    i          i           i            i            i           i          i

                   OUTPUT OF SPECIFICATION CHECKING
                   --------------------------------
Ductility and                                                          Fatigue
 Web/Flange    Flexural    Shear     Web    Stiffener   Fatigue          Life        Deflection
 Proportions   Capacity   Capacity  Checks   Checks     Checks       Estimation       Checks
      i            i          i        i        i           i             i              i

   Shear                       Web-to-
 Connector   Uncured Slab    Flange Weld
   Checks       Checks      Design Checks
      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       Include Flange
    Weight     Modular Ratio     in Haunch Weight
  (lbf/ft^3)
    xxx.xx        xx.xxx               aaa
```

```
                          GROSS SECTION PROPERTIES
                          ------------------------
   End         Composite       Beam      Moment of   Dist. from N.A. to
  Dist.         Status         Area      Inertia     Bottom of Beam, y
  (ft)                        (in^2)     (in^4)            (in)
 xxx.xxx   Noncomposite      xxxx.xx    xxxxxxx.          xxx.xxx
           Comp.(3n=aa)      xxxx.xx    xxxxxxx.          xxx.xxx
           Comp.(n=aa)       xxxx.xx    xxxxxxx.          xxx.xxx

            NET SECTION PROPERTIES (NONCOMPOSITE, POSITIVE FLEXURE)
            -------------------------------------------------------
            NET SECTION PROPERTIES (COMPOSITE(3n), POSITIVE FLEXURE)
            --------------------------------------------------------
            NET SECTION PROPERTIES (COMPOSITE(n), POSITIVE FLEXURE)
            -------------------------------------------------------
            NET SECTION PROPERTIES (NONCOMPOSITE, NEGATIVE FLEXURE)
            -------------------------------------------------------
              NET SECTION PROPERTIES (COMPOSITE, NEGATIVE FLEXURE)
              ----------------------------------------------------

                         Distance to Neutral Axis              Section Modulus
          Moment of  Bot.of  Top of  CG of   Top of     Bot.of   Top of   CG of  Top of
  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)
 xxx.xxx  xxxxxxx.  xxx.xxx xxx.xxx xxx.xxx xxx.xxx    xxxxxx.  xxxxxx.  xxxxxx. xxxxx.

        ADDITIONAL SECTION PROPERTIES (POSITIVE FLEXURE, PART 1)
        --------------------------------------------------------
        ADDITIONAL SECTION PROPERTIES (NEGATIVE FLEXURE, PART 1)
        --------------------------------------------------------
                                                                      Radius of
                      Effect.   Effect.        Moment of Inertia       Gyration
             Beam      Slab    Slab Calc  C.Flange  T.Flange  Y Axis    Steel  C.Flange
  Dist.      Area      Width     Type       Iyc       Iyt       Iy       ry       r'
  (ft)      (in^2)     (in)               (in^4)    (in^4)    (in^4)    (in)     (in)
 xxx.xxx    xxx.xx    xxx.xxx      i      xxxxxxx.  xxxxxxx. xxxxxxx. xxx.xxx  xxx.xxx

        ADDITIONAL SECTION PROPERTIES (POSITIVE FLEXURE, PART 2)
        --------------------------------------------------------
        ADDITIONAL SECTION PROPERTIES (NEGATIVE FLEXURE, PART 2)
        --------------------------------------------------------
           1st M of I       Plastic Properties      Dist. Bet.  Longitud.
  End     of Transf'd  N.A. to   Moment  Depth of  C.G. Steel    Stiff.
 Dist.    Section, Q   Top Slab    Mp    Web, Dcp   & Slab     Parameter
 (ft)       (in^3)       (in)    (k-ft)    (in)      (in)     (10^4in^4)
xxx.xxx    xxxxxx.     xxx.xxx  xxxxx.x  xxx.xxx    xxx.xx     xxxx.xx
xxx.xxx      N/A         N/A    xxxxx.x  xxx.xxx     N/A       xxxx.xx

                          POINTS OF CONTRAFLEXURE
                          -----------------------
                           Dead Load
                           Points of       Code
                          Contraflexure    Check*
                               Dist.
                               (ft)
                              xxx.xxx        a
```

```
                         LOAD FACTORS AND COMBINATIONS
                         -----------------------------
                             L I M I T    S T A T E
            STR  STR  STR   STR   SRV   SRV   SRV   FAT   FAT
 gamma       I    IP   IA    II    II   IIA   IIB    I     II   DEFL  CON
gDC   Max  1.25 1.25 1.25  1.25  1.00  1.00  1.00   --    --    --   1.40
      Min  0.90 0.90 0.90  0.90   --    --    --    --    --    --    --
gDW   Max  1.50 1.50 1.50  1.50  1.00  1.00  1.00   --    --    --   1.40
      Min  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
      Min  x.xx x.xx x.xx  x.xx   --    --    --    --    --    --    --
gMC2 Max   x.xx x.xx x.xx  x.xx  x.xx  x.xx  x.xx   --    --    --    --
      Min  x.xx x.xx x.xx  x.xx   --    --    --    --    --    --    --
gLL        1.75 1.35 1.35  1.35  1.30  1.00  1.00   --    --   1.00  1.40
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 1     x.xx x.xx x.xx  x.xx  x.xx  x.xx  x.xx   --    --    --    --
gSLL 2     x.xx x.xx x.xx  x.xx  x.xx  x.xx  x.xx   --    --    --    --
gSLL 3     x.xx x.xx x.xx  x.xx  x.xx  x.xx  x.xx   --    --    --    --
gSLL 4     x.xx x.xx x.xx  x.xx  x.xx  x.xx  x.xx   --    --    --    --
gSLL 5     x.xx x.xx x.xx  x.xx  x.xx  x.xx  x.xx   --    --    --    --
gSLL 6     x.xx x.xx x.xx  x.xx  x.xx  x.xx  x.xx   --    --    --    --
gSLL 7     x.xx x.xx x.xx  x.xx  x.xx  x.xx  x.xx   --    --    --    --
gSLL 8     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 (Analysis, Live Load Code: F)
            --------------------------------------------------
 Live                                    L I M I T     S T A T E
 Load       STR  STR  STR   STR   SRV   SRV   SRV   FAT   FAT
 Vehicles    I    IP   IA    II    II   IIA   IIB    I     II   DEFL  CON

Analysis and Rating Vehicles
aaaaaaaaaa aa   aa   aa    aa    aa    aa    aa    aa    aa    --    --

Permit and Rating Vehicles
aaaaaaaaaa aa   aa   aa    aa    aa    aa    aa    aa    aa    --    --

Rating Only Vehicles
aaaaaaaaaa aa   aa   aa    aa    aa    aa    aa    aa    aa    --    --

Fatigue
HS20-30     --   --   --    --    --    --    --    SC    SC    --    --

Deflection
aaaaaaaaaa --   --   --    --    --    --    --    --    --    SC    --

 Note:  Rating Applicability: I = Inventory, O = Operating
        SC = Specification Check Only, No Rating
```

```
                              LOAD MODIFIER
                              -------------
                                                                Fatigue
   Importance  Ductility  Redundancy                    Load      Load
     Factor      Factor     Factor    Calculated   Modifier  Modifier
       Ni          Nd         Nr       Ni*Nd*Nr       Used      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.


                          RESISTANCE FACTORS
                          ------------------
                                                         Shear
                      Axial      Bearing     Shear     on Fillet     Web
 Flexure   Shear   Compression   on Pins   Connector  Weld Throat  Crippling
  x.xx      x.xx      x.xx        x.xx       x.xx        x.xx        x.xx

                                       DEAD LOADS
                                       ----------
                      End          Beam          Slab &       Additional
                  Span Dist.      Weight     Haunch Weight      DC1S*
                     (ft)       (kips/ft)      (kips/ft)      (kips/ft)
                    xxx.xxx       xxx.xxx       xxx.xxx        xxx.xxx

                      End          Beam                       Additional
                  Span Dist.      Weight     Haunch Weight      DC1S*
                     (ft)       (kips/ft)      (kips/ft)      (kips/ft)
                    xxx.xxx       xxx.xxx       xxx.xxx        xxx.xxx

                    STRINGER DEAD LOAD REACTIONS, PART 1 of 2
                    -----------------------------------------
  Stringer
 No.  Dist.      DC1     DC1S      DC2      FWS      MC1      MC2     PDC2     PFWS
      (ft)     (kips)   (kips)   (kips)   (kips)   (kips)   (kips)   (kips)   (kips)
 ii  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx  xxx.xxx

                    STRINGER DEAD LOAD REACTIONS, PART 2 of 2
                    -----------------------------------------
  Stringer
 No.  Dist.      UT1      UT2
      (ft)     (kips)   (kips)
 ii  xxx.xxx  xxx.xxx  xxx.xxx

          BEAM WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE)
          ----------------------------------------------------
                Dist.        Moment      Shear      Deflect.
                (ft)         (k-ft)     (kips)       (in)
               xxx.xxx     xxxxxx.x    xxxx.xx     xxx.xxx

                    BEAM WEIGHT ANALYSIS - REACTIONS
                    --------------------------------
                  Support No.      Reaction        Rotation
                                    (kips)        (radians)
                     ii            xxxx.xx        xx.xxxxxx

       SLAB AND HAUNCH WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE)
       ---------------------------------------------------------------
                Dist.        Moment      Shear      Deflect.
                (ft)         (k-ft)     (kips)       (in)
```

```
                xxx.xxx    xxxxxx.x    xxxx.xx    xxx.xxx


               SLAB AND HAUNCH WEIGHT ANALYSIS - REACTIONS

                -------------------------------------------
                  Support No.     Reaction       Rotation
                                   (kips)       (radians)
                     ii            xxxx.xx      xx.xxxxxx

           HAUNCH WEIGHT ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE)
           ------------------------------------------------------
                 Dist.       Moment     Shear     Deflect.
                  (ft)        (k-ft)     (kips)     (in)
                xxx.xxx    xxxxxx.x    xxxx.xx    xxx.xxx

                    HAUNCH WEIGHT ANALYSIS - REACTIONS
                    ----------------------------------
                  Support No.     Reaction       Rotation
                                   (kips)       (radians)
                     ii            xxxx.xx      xx.xxxxxx

       PERMANENT INPUTTED DC1 ANALYSIS (UNFACTORED, DC1, NONCOMPOSITE)
       ---------------------------------------------------------------
                 Dist.       Moment     Shear     Deflect.
                  (ft)        (k-ft)     (kips)     (in)
                xxx.xxx    xxxxxx.x    xxxx.xx    xxx.xxx

          PERMANENT DC1S ANALYSIS (UNFACTORED, DC1S, NONCOMPOSITE)
          --------------------------------------------------------
                 Dist.       Moment     Shear     Deflect.
                  (ft)        (k-ft)     (kips)     (in)
                xxx.xxx    xxxxxx.x    xxxx.xx    xxx.xxx

                 PERMANENT INPUTTED DC1 ANALYSIS - REACTIONS
                -------------------------------------------
                  Support No.     Reaction       Rotation
                                   (kips)       (radians)
                     ii            xxxx.xx      xx.xxxxxx

                    PERMANENT DC1S ANALYSIS - REACTIONS
                    -----------------------------------
                  Support No.     Reaction       Rotation
                                   (kips)       (radians)
                     ii            xxxx.xx      xx.xxxxxx

               TOTAL DC1 ANALYSIS (UNFACTORED, NONCOMPOSITE)
                ---------------------------------------------
                 Dist.       Moment     Shear     Deflect.
                  (ft)        (k-ft)     (kips)     (in)
                xxx.xxx    xxxxxx.x    xxxx.xx    xxx.xxx

                      TOTAL DC1 ANALYSIS - REACTIONS
                      ------------------------------
                  Support No.     Reaction       Rotation
                                   (kips)       (radians)
                     ii            xxxx.xx      xx.xxxxxx
```

```
PERMANENT INPUTTED DC2 ANALYSIS (UNFACTORED, DC2, COMPOSITE(3N))
----------------------------------------------------------------
            Dist.        Moment      Shear      Deflect.
            (ft)         (k-ft)      (kips)      (in)
           xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

PERMANENT INPUTTED DC2 ANALYSIS (UNFACTORED, DC2, NONCOMPOSITE)
---------------------------------------------------------------
            Dist.        Moment      Shear      Deflect.
            (ft)         (k-ft)      (kips)      (in)
           xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

           PERMANENT INPUTTED DC2 ANALYSIS - REACTIONS
           -------------------------------------------
             Support No.      Reaction        Rotation
                               (kips)        (radians)
                ii            xxxx.xx       xx.xxxxxx

FUTURE WEARING SURFACE ANALYSIS (UNFACTORED, FWS, COMPOSITE(3N))
----------------------------------------------------------------
            Dist.        Moment      Shear      Deflect.
            (ft)         (k-ft)      (kips)      (in)
           xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

FUTURE WEARING SURFACE ANALYSIS (UNFACTORED, FWS, NONCOMPOSITE)
---------------------------------------------------------------
            Dist.        Moment      Shear      Deflect.
            (ft)         (k-ft)      (kips)      (in)
           xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

           FUTURE WEARING SURFACE ANALYSIS - REACTIONS
           -------------------------------------------
             Support No.      Reaction        Rotation
                               (kips)        (radians)
                ii            xxxx.xx       xx.xxxxxx

       UTILITY UT1 ANALYSIS (UNFACTORED, UT1, NONCOMPOSITE)
       ----------------------------------------------------
            Dist.        Moment      Shear      Deflect.
            (ft)         (k-ft)      (kips)      (in)
           xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

                 UTILITY UT1 ANALYSIS - REACTIONS
                 --------------------------------
             Support No.      Reaction        Rotation
                               (kips)        (radians)
                ii            xxxx.xx       xx.xxxxxx

       UTILITY UT2 ANALYSIS (UNFACTORED, UT2, COMPOSITE(3N))
       -----------------------------------------------------
            Dist.        Moment      Shear      Deflect.
            (ft)         (k-ft)      (kips)      (in)
           xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

       UTILITY UT2 ANALYSIS (UNFACTORED, UT2, NONCOMPOSITE)
       ----------------------------------------------------
            Dist.        Moment      Shear      Deflect.
            (ft)         (k-ft)      (kips)      (in)
           xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx
```

```
             UTILITY UT2 ANALYSIS - REACTIONS
             --------------------------------
         Support No.      Reaction        Rotation
                           (kips)        (radians)
            ii            xxxx.xx       xx.xxxxxx

MISCELLANEOUS MC1 ANALYSIS (UNFACTORED, MC1, NONCOMPOSITE)
----------------------------------------------------------
         Dist.        Moment      Shear      Deflect.
          (ft)         (k-ft)     (kips)      (in)
        xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

         MISC. NONCOMPOSITE ANALYSIS - REACTIONS
         ---------------------------------------
         Support No.      Reaction        Rotation
                           (kips)        (radians)
            ii            xxxx.xx       xx.xxxxxx

 MISCELLANEOUS MC2 ANALYSIS (UNFACTORED, MC2, COMPOSITE(3N))
 -----------------------------------------------------------
         Dist.        Moment      Shear      Deflect.
          (ft)         (k-ft)     (kips)      (in)
        xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

 MISCELLANEOUS MC2 ANALYSIS (UNFACTORED, MC2, NONCOMPOSITE)
 ----------------------------------------------------------
         Dist.        Moment      Shear      Deflect.
          (ft)         (k-ft)     (kips)      (in)
        xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

          MISCELLANEOUS MC2 ANALYSIS - REACTIONS
          --------------------------------------
         Support No.      Reaction        Rotation
                           (kips)        (radians)
            ii            xxxx.xx       xx.xxxxxx

 ADDITIONAL DC2 ANALYSIS (UNFACTORED, DC2, COMPOSITE(3N))
 --------------------------------------------------------
         Dist.        Moment      Shear      Deflect.
          (ft)         (k-ft)     (kips)      (in)
        xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

 ADDITIONAL DC2 ANALYSIS (UNFACTORED, DC2, NONCOMPOSITE)
 -------------------------------------------------------
         Dist.        Moment      Shear      Deflect.
          (ft)         (k-ft)     (kips)      (in)
        xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx

           ADDITIONAL DC2 ANALYSIS - REACTIONS
           -----------------------------------
         Support No.      Reaction        Rotation
                           (kips)        (radians)
            ii            xxxx.xx       xx.xxxxxx
```

```
          ADDITIONAL FWS ANALYSIS (UNFACTORED, FWS, COMPOSITE(3N))
          --------------------------------------------------------
                  Dist.        Moment      Shear      Deflect.
                  (ft)         (k-ft)      (kips)      (in)
                 xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx
```

ADDITIONAL FWS ANALYSIS (UNFACTORED, FWS, NONCOMPOSITE)

```
          -------------------------------------------------------
                  Dist.        Moment      Shear      Deflect.
                  (ft)         (k-ft)      (kips)      (in)
                 xxx.xxx     xxxxxx.x     xxxx.xx     xxx.xxx
```

```
                     ADDITIONAL FWS ANALYSIS - REACTIONS
                     -----------------------------------
                   Support No.      Reaction        Rotation
                                     (kips)        (radians)
                      ii            xxxx.xx       xx.xxxxxx

                     N/A because user-defined load = 0.0

           MOMENT INFLUENCE LINES FOR FLOORBEAM (1 KIP UNIT LOAD)
           ------------------------------------------------------
    Load
    Location:   Influence Value For Analysis Point (ft):
     Dist.      xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx
     (ft)        (kip-ft)   (kip-ft)   (kip-ft)   (kip-ft)   (kip-ft)   (kip-ft)
    xxx.xxx     xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx

            SHEAR INFLUENCE LINES FOR FLOORBEAM (1 KIP UNIT LOAD)
            -----------------------------------------------------
    Load
    Location:   Influence Value For Analysis Point (ft):
     Dist.      xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx
     (ft)         (kip)      (kip)      (kip)      (kip)      (kip)      (kip)
    xxx.xxx     xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx

         DEFLECTION INFLUENCE LINES FOR FLOORBEAM (10 KIP UNIT LOAD)
         -----------------------------------------------------------
    Load
    Location:   Influence Value For Analysis Point (ft):
     Dist.      xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx
     (ft)          (in)       (in)       (in)       (in)       (in)       (in)
    xxx.xxx     xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx

          REACTION INFLUENCE LINES FOR FLOORBEAM (1 KIP UNIT LOAD)
          --------------------------------------------------------
    Load
    Location:   Influence Value For Analysis Point (ft):
     (ft)         (kip)      (kip)      (kip)      (kip)      (kip)      (kip)
     Dist.      xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx    xxx.xxx

         ROTATION INFLUENCE LINES FOR FLOORBEAM (1000 KIP UNIT LOAD)
         -----------------------------------------------------------
    Load
    Location:   Influence Value For Analysis Point (ft):
     (ft)       (radians)  (radians)  (radians)  (radians)  (radians)  (radians)
    xxx.xxx     xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx   xxx.xxxx
```

```
         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)
          ----------------------------------------------------
                Maximum Moment            Maximum Relative Moment
 Dist.   Positive  LC   Negative  LC   Dist.   Positive   Dist.   Negative
 (ft)     (k-ft)         (k-ft)        (ft)     (k-ft)    (ft)     (k-ft)
xxx.xxx  xxxxxx.x   a   xxxxxx.x   a  xxx.xxx  xxxxxx.x  xxx.xxx  xxxxxx.x
```

```
    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)
     --------------------------------------------------------------
                  Maximum Shear             Maximum Deflection
 Dist.    Positive  LC    Negative  LC     Positive  LC  Negative  LC
 (ft)      (kips)          (kips)            (in)          (in)
xxx.xxx   xxxx.xx    a    xxxx.xx    a      xxx.xxx   a  xxx.xxx   a
```

```
                   PHL-93 LL ANALYSIS (REACTIONS, INCL. IMPACT)
                   --------------------------------------------
                    HL-93 LL ANALYSIS (REACTIONS, INCL. IMPACT)
                    -------------------------------------------
                     H20 LL ANALYSIS (REACTIONS, INCL. IMPACT)
                     -----------------------------------------
               PHL-93 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
               ----------------------------------------------------
                PHL-93 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
                ---------------------------------------------------
               HL-93 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
               ---------------------------------------------------
                HL-93 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
                --------------------------------------------------
               HS20 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
               --------------------------------------------------
                HS20 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
                -------------------------------------------------
               H20 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
               -------------------------------------------------
                H20 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
                ------------------------------------------------
     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

      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)
          ----------------------------------------------------
         ML-80 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
         -----------------------------------------------------
         TK527 LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
         -----------------------------------------------------
        SPECIAL 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)
         -----------------------------------------------------
      TOT VEHICLE LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
      -----------------------------------------------------------
        FATIGUE LL ANALYSIS (MOMENTS, UNFACTORED, INCL. IMPACT)
        -------------------------------------------------------
        P-82 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
        ------------------------------------------------------
        P-82 LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
        -----------------------------------------------------
        ML-90 LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
        -------------------------------------------------------
        ML-80 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)
        ------------------------------------------------------
       SPECIAL LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
       ---------------------------------------------------------
       SPECIAL 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)
        ------------------------------------------------------
     TOT VEHICLE LL ANALYSIS (MOMENTS, UNF., W/O SW, INCL. IMPACT)
     -------------------------------------------------------------
     TOT VEHICLE LL ANALYSIS (MOMENTS, UNF., W/ SW, INCL. IMPACT)
     ------------------------------------------------------------
             LEFT SW PED LL ANALYSIS (MOMENTS, UNFACTORED)
             ---------------------------------------------
             RIGHT SW PED LL ANALYSIS (MOMENTS, UNFACTORED)
             ----------------------------------------------
             Maximum Moment            Maximum Relative Moment
  Dist.   Positive   Negative     Dist.   Positive   Dist.   Negative
  (ft)     (k-ft)     (k-ft)      (ft)     (k-ft)    (ft)     (k-ft)
 xxx.xxx  xxxxxx.x   xxxxxx.x    xxx.xxx  xxxxxx.x  xxx.xxx  xxxxxx.x
```

```
        P-82 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
        --------------------------------------------------------------
        ML-80 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
        ---------------------------------------------------------------
        TK527 LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
        ---------------------------------------------------------------
       SPECIAL 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)
       ---------------------------------------------------------------
     TOT VEHICLE LL ANALYSIS (SHEARS & DEFLECT., UNFACTORED, INCL. IMPACT)
     ---------------------------------------------------------------------
            FATIGUE LL ANALYSIS (SHEARS, UNFACTORED, INCL. IMPACT)
            ------------------------------------------------------
       P-82 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
       ----------------------------------------------------------------
       P-82 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ 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)
       ----------------------------------------------------------------
       TK527 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
       -----------------------------------------------------------------
       TK527 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)
      ------------------------------------------------------------------
        EV2 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
        ---------------------------------------------------------------
        EV2 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
        --------------------------------------------------------------
        EV3 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
        ---------------------------------------------------------------
        EV3 LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
        --------------------------------------------------------------
       SU6TV LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
       -----------------------------------------------------------------
       SU6TV LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
       ----------------------------------------------------------------
    TOT VEHICLE LL ANALYSIS (SHEARS & DEFLECT., UNF., W/O SW, INCL. IMPACT)
    -----------------------------------------------------------------------
    TOT VEHICLE LL ANALYSIS (SHEARS & DEFLECT., UNF., W/ SW, INCL. IMPACT)
    ----------------------------------------------------------------------
          LEFT SW PED LL ANALYSIS (SHEARS & DEFLECTIONS, UNFACTORED)
          ----------------------------------------------------------
          RIGHT SW PED LL ANALYSIS (SHEARS & DEFLECTIONS, UNFACTORED)
          -----------------------------------------------------------
               Maximum Moment              Maximum Relative Moment
      Dist.   Positive   Negative     Dist.   Positive   Dist.   Negative
      (ft)     (k-ft)     (k-ft)      (ft)     (k-ft)    (ft)     (k-ft)
     xxx.xxx  xxxxxx.x   xxxxxx.x    xxx.xxx  xxxxxx.x  xxx.xxx  xxxxxx.x
```

```
                P-82 LL ANALYSIS (REACTIONS, INCL. IMPACT)
                ------------------------------------------
                ML-80 LL ANALYSIS (REACTIONS, INCL. IMPACT)
                -------------------------------------------
                TK527 LL ANALYSIS (REACTIONS, INCL. IMPACT)
                -------------------------------------------
               SPECIAL LL ANALYSIS (REACTIONS, INCL. IMPACT)
               ---------------------------------------------
                 EV2 LL ANALYSIS (REACTIONS, INCL. IMPACT)
                 -----------------------------------------
                 EV3 LL ANALYSIS (REACTIONS, INCL. IMPACT)
                 -----------------------------------------
                SU6TV LL ANALYSIS (REACTIONS, INCL. IMPACT)
                -------------------------------------------
             TOT VEHICLE LL ANALYSIS (REACTIONS, INCL. IMPACT)
             -------------------------------------------------
               FATIGUE LL ANALYSIS (REACTIONS, INCL. IMPACT)
               ---------------------------------------------
            P-82 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
            --------------------------------------------------
            P-82 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
            -------------------------------------------------
            ML-80 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
            ---------------------------------------------------
            ML-80 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
            --------------------------------------------------
            TK527 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
            ---------------------------------------------------
            TK527 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
            --------------------------------------------------
          SPECIAL LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
          -----------------------------------------------------
          SPECIAL LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
          ----------------------------------------------------
            EV2 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
            -------------------------------------------------
            EV2 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
            ------------------------------------------------
            EV3 LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
            -------------------------------------------------
            EV3 LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
            ------------------------------------------------
           SU6TV LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
           ---------------------------------------------------
           SU6TV LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
           --------------------------------------------------
        TOT VEHICLE LL ANALYSIS (REACTIONS, W/O SW, INCL. IMPACT)
        ---------------------------------------------------------
        TOT VEHICLE LL ANALYSIS (REACTIONS, W/ SW, INCL. IMPACT)
        --------------------------------------------------------
                     LEFT SW PED LL ANALYSIS (REACTIONS)
                     -----------------------------------
                     RIGHT SW PED 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
```

```
                         UNFACTORED FLEXURAL STRESSES
                         ----------------------------
              Limit
  Dist.  T/B  State     Flex. DC1    MC1    UT1    DC2   FWS    MC2    UT2    LL     PL
  (ft)                       (ksi)  (ksi)  (ksi)  (ksi) (ksi)  (ksi)  (ksi)  (ksi) (ksi)
xxx.xxxa aaa aaaaaaaa aaaaxxxx.x xxxx.x xxxx.x xxxx.x xxxx.x xxxx.x xxxx.x xxxx.x aaaaaa
```

```
                         FACTORED ANALYSIS RESULTS
                         -------------------------
       Limit            Max.      Max.        Flexural Stress*      Compress. Limits*  Code
  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)
xxx.xxxa aaaaaaaa aaaa xxxxxxx.x xxxxx.xx aaaaaaaaaaaaaaaaaaaaxxxxx.xx  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.
```

```
                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    xxxxx.xx   xx.xxxxxx   xx.xxxxxx     a
         aaaaaaaa    xxxxx.xx    xxxxx.xx   xx.xxxxxx   xx.xxxxxx     a
```

```
             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
              Long. D/tw      Top Flange      Bottom Flange    Iyc/Iyt  Duct.      Code
  Dist. Flex. Stff. Chk1*  Chk2* Chk3* Chk4* Chk2* Chk3* Chk4*  Chk5*   Chk6*     Check**
  (ft)
xxx.xxx  aaaa   a   xxx.x  xx.x  xx.x  xx.x  xx.x  xx.x  xx.x  xxx.xxx  aaaa aaaaaaaaaaaaaa
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
         Limit           Fy,    Fy,          2*Dcp/    3.76*      2*Dc/     5.7*      Iyc/  Criteria
  Dist.  State  Flex.   top    bot    D/tw    tw    sqrt(E/Fyc)    tw    sqrt(E/Fyc)  Iyt   Not Met**
  (ft)                 (ksi)  (ksi)
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

           INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY CALCULATIONS
           -------------------------------------------------------------
      Limit                                                                     Resist.
 Dist.  State  Flex.   Dp*   Dt*  Rh*   Rpc*  Rpt*  Dc*     Myt       Myb    Calc.**
 (ft)                 (in)  (in)                   (in)   (kip-ft)  (kip-ft)
xxx.xxxa aaaaaaa aaaa aaaaa aaaaa aaaaa aaaaa aaaaa aaaaa  xxxxxx.x xxxxxx.x    a

    * Legend of General Notes:
       Dp  = Distance from top of concrete deck to neutral axis
             of the composite section at the plastic moment
       Dt  = Total depth of the composite section
       Rh  = Hybrid factor (not used with A6.10.7.1.2-1 or A6.10.7.1.2-2)
       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, NO LTB)
       --------------------------------------------------------------------------
                          Flexural     Flexural  Resistance  Code
         Limit           Resistance     Moment   Calculation Check
  Dist.  State  Flex.       Mr           Mu*        **        ***
  (ft)                   (kip-ft)     (kip-ft)
xxx.xxxa aaaaaaa aaaa   xxxxxx.x     xxxxxx.x      a         a

    * Legend of General Notes:
       NOTE: Intermediate values have been moved to a separate output report,
             INTERMEDIATE VALUES FOR MOMENT FLEXURAL CAPACITY CALCULATIONS

   ** 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)

  *** Legend of Code Check:
      A. Insufficient flexural resistance
```

```
              INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS
              ---------------------------------------------------------------
               Limit                                  6.10.8.2.3         Appendix A
  Dist.   T/B  State Flx  rt*  Rh*   Rb*    Dc*   Lp*   Lr*  Cb*     Lr*  Cb*    Myc*    Rpc*
  (ft)                   (in)              (in)  (ft)  (ft)         (ft)        (kip-ft)
 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 A6.10.8.2.3-6, A6.10.8.2.3-7, 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     Code
                           Flexural Resistance      Flexural Resistance   Flexural Effects Chk
              Limit      Local       Governing       Local    Governing   Stress   Moment  ***
 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)
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. Appendix A provisions are not applicable at this location
    LRFD Specifications Chapter 6, Appendix D
      H. Fr calculated using AASHTO Equation D6.4.1-2
      I. Fr calculated using AASHTO Equation D6.4.1-4
      J. Mr calculated using AASHTO Equation D6.4.2-2
      K. 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, total factored flexural stress
            If F+ prints as N/A, Appendix A calculations govern the LTB capacity
       M+ = Mu, total factored flexural moment
            If M+ prints as N/A, 6.10.8.2.3 calculations govern the LTB capacity

*** 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.
```

```
   STRESS FLEXURAL CAPACITY (NONCOMPOSITE OR -FLEX OR COMPOSITE/NONCOMPACT, NO LTB)
   ---------------------------------------------------------------------------------
                                                         Factored
                          Intermediate     Flexural   Flexural  Resistance  Code
             Limit        Calculations    Resistance   Stress   Calculation Check
  Dist.   T/B  State  Flex.   Rh*    Rb*    Mr(e)*   Fr      F+*        **       ***
  (ft)                                   (kip-ft) (ksi)  (ksi)
 xxx.xxxa aaa aaaaaa  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

 ** 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

*** 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 (Fu) in the top flange is tensile. The user should verify the
        acceptability of the section by comparing the top flange stress (Fu) to the flexural
        resistance (Fr) of the top flange in negative flexure.

                   NET SECTION FRACTURE CHECK
                   --------------------------
                           Flange                         Net Section   Factored
                           Area     Tensile    Yield      Fracture      Flexural
          Limit            Ratio    Strength   Strength   Resistance    Stress      Code
    Dist.   State     T/B    An/Ag     Fu        Fyt        Fr           ft         Check*
    (ft)                              (ksi)     (ksi)      (ksi)        (ksi)
  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
              Limit           Calculation     Resistance   Stress   Resist.  Code
    Dist.   T/B   State    Flex.      Rh*       Mr(e)*    Fr      Fu      Calc.** Check***
    (ft)                                       (kip-ft)  (ksi)   (ksi)
  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
              from the stress flexural resistance, Fr

  ** 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
      D. Fr calculated as nominal bend-buckling resistance, A6.10.4.2.2-4

 *** Legend of Code Check:
      A. Insufficient flexural resistance
```

```
                       SERVICE LIMIT STATE - WEB BEND-BUCKLING
                       ---------------------------------------
                                                                   Factored
                                         Intermediate      Flexural   Flexural
                     Limit               Calculations      Resistance    Stress    Code
     Dist.    T/B    State     Flex.      Dc*    Rh*      Mr(e)*  Fcrw*    fc*     Check**
     (ft)                                 (in)           (kip-ft)  (ksi)   (ksi)
   xxx.xxxa  aaa   aaaaaaaa    aaaa   aaaaaa aaaaaa aaaaaaaa xxxx.x  xxxx.x      a

                       SERVICE LIMIT STATE - WEB BEND-BUCKLING
                       ---------------------------------------
                                                                          Factored
                                             Intermediate         Flexural    Flexural
                     Limit                   Calculations         Resistance    Stress    Code
     Dist.    T/B    State     Flex.      Dc*    Rh*      k*      Mr(e)*  Fcrw*     fc*    Check**
     (ft)                                 (in)                   (kip-ft)  (ksi)    (ksi)
  xxx.xxxa   aaa   aaaaaaaa    aaaa   aaaaaa aaaaaa aaaaaa  aaaaaaaa xxxx.x  xxxx.x      a

  * Legend of Intermediate Calculations:
     Dc = Depth of web in compression
     Rh = Hybrid factor
     k = Bend-buckling coefficient
         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
             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
               Limit   Resistance    Shear    Stiffened/     Code
      Dist.    State       Vr         Vu      Unstiffened   Check*
      (ft)               (kips)     (kips)
    xxx.xxx  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
              Shear Force in Web                       in Web          Code
  Dist.   Gamma*   Vr*     4*V*                    fcw*     fu*      Check**
  (ft)            (kips)   (kips)                  (ksi)    (ksi)
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
                    ---------------------------
          S p a c i n g       W i d t h         Moment of Inertia       Code
  Dist.   Maximum   Actual   Min    Max   Actual  Minimum  Gov LS*  Actual   Check**
  (ft)      (ft)    (ft)     (in)   (in)   (in)    (in^4)           (in^4)
xxx.xxxa  xxx.xxx  xxx.xxx  xxx.xx xxx.xx xxx.xx  xxxx.xx  aaaaaaa xxxx.xx   aaaaaaa
xxx.xxxa  <TRANSVERSE STIFFENERS NOT NEEDED HERE>                            aaaaaaa
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
    6.10.11.1.3-7. If a limit state designation appears, equation 6.10.11.1.3-7
    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. Moment of inertia less than minimum required
```

```
            LONGITUDINAL STIFFENERS CHECK (PART 1)
            --------------------------------------
                    Max   Actual    Minimum     Actual      Code
  Dist.    Flex.   Width   Width    M of I      M of I     Check*
  (ft)              (in)    (in)    (in^4)      (in^4)
 xxx.xxx    aaaa   xx.xxx  xx.xxx   aaaaaaa     aaaaaaa      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
                         From the    Radius of  Radius of      Code
        Dist.   Flex.    Flange**     Gyration   Gyration      Check*
        (ft)               (in)                    (in)
       xxx.xxx   aaaa    xxx.xxx  a    xx.xxx      xx.xxx        aaa

    * 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
           Maximum  Stiff.   Bearing     Axial          Factored      Weld Size          Code
 Dist.      Width   Width   Resistance  Resistance      Reaction   Desn** Min    Max     Check*
 (ft)       (in)    (in)     (kips)      (kips)          (kips)    (in)   (in)   (in)
xxx.xxx   xx.xxx   xx.xxx   xxxxx.xx    xxxxx.xx        xxxxx.xx  x.xxxx x.xxxx x.xxxx   aaa
xxx.xxx     <NO BEARING STIFFENER DEFINED HERE>         xxxxx.xx  x.xxxx x.xxxx x.xxxx   aaa
xxx.xxx     <BEARING STIFFENER DEFINED BUT NOT NEEDED>            x.xxxx x.xxxx x.xxxx   aaa

 *  Legend of Code Checks:
    A. Projecting stiffener width greater than maximum allowed
    B. Provided resistance less than maximum factored reaction
    C. Bearing stiffener may be required at this location,
       depending on the connection between the floorbeam and
       the supporting structure.
    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
           Distance  Length    Yielding    Crippling   Factored   Length     Code
  Dist.       k*        N*    Resistance  Resistance     Load      Nreq*    Check**
  (ft)       (in)      (in)     (kips)      (kips)      (kips)     (in)
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 beam)
             Bottom flange thickness (for plate girder)
             Bottom flange thickness or angle thickness (for built-up section)
      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 defined bearing stiffener is adequate.
      C. A bearing stiffener was defined at this location but is
         not required.
      D. A noncomposite (DC1, UT1, or MC1) 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.
```

```
                    WEB-TO-FLANGE WELD DESIGN: WELD CAPACITY
                    ----------------------------------------
                               Weld  Factored
                              Metal   Shear
               Limit         Resist.  Flow**          Weld Size              Code
  Dist. Flange  State  Flex. Rr,weld    su     Calc.  Min.   Max.  Design**  Check*
  (ft)                        (ksi)  (kip/in)  (in)   (in)   (in)   (in)
xxx.xxx  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
             Limit          Web     Flange   Flow*** Perf.   Code
  Dist. Flange State Flex.  sr,web  sr,flange  su    Ratio**  Check*
  (ft)                     (kip/in)  (kip/in) (kip/in)
xxx.xxx  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: FACTORED SHEAR FLOW is the total shear flow between the web
           and the flange.
```

```
               SPECIAL FATIGUE REQUIREMENT FOR WEBS
               ------------------------------------
                         Allowable      Actual
               Dist.        Vcr           Vu       Comment*
               (ft)       (kips)       (kips)
              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
         From    Detail  Limit         Positive Negative  Fatigue   Stress   Fillet  Code
 Dist.   Bottom Category State   Dead    Live     Live  Resistance  Range    Weld  Check*
 (ft)     (in)                  (ksi)   (ksi)    (ksi)    (ksi)     (ksi)    (in)
xxx.xxxa xxx.xxx   aa      ii    xxx.xx   xxx.xx   xxx.xx   xxx.xx    xxx.xx  aaaaaa   aaa
xxx.xxxa xxx.xxx   aa      ii    xxx.xx   xxx.xx   xxx.xx   <NOT APPLICABLE>**

   * 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
         Dist.From    Total      Cycles     Remaining    Years
  Dist.   Bottom      Cycles    To Date      Cycles    Remaining
  (ft)    (in)
 xxx.xxx  xxx.xxx   iiiiiiiii  iiiiiiiii   iiiiiiiii     iiii
 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
 --------------------------------------------------------------
         Location of Max.   Allowable    Actual       Code
            Deflection     Deflection  Deflection    Check*
               (ft)           (in)        (in)
              xxx.xxx        xxx.xxx     xxx.xxx        a

   * Legend of Code Check:
       A. Maximum deflection exceeds allowable
```

```
          SHEAR CONNECTOR DESIGN - NO. OF CONNECTORS REQUIRED
          ---------------------------------------------------
                              Horizontal    Factored    No. of
  Design    Start      End      Shear      Resistance    Conn.
  Region    Dist.     Dist.       P           Q(r)      Required
             (ft)      (ft)     (kips)       (kips)
    ii     xxx.xxx   xxx.xxx   xxxx.xx      xxxx.xx      iiiii
```

```
                         SHEAR CONNECTOR DESIGN - PITCH
                         ------------------------------
          Connectors      Pitch              Pitch Based
           Per Row       Required    Fatigue  on No. Conn. Actual      Code
   Dist.  Max. Actual   Min.    Max.    LS      Required   Pitch      Check*
   (ft)                 (in)    (in)              (in)      (in)
 xxx.xxx   ii    ii     xxx.x  xxx.x    aa        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.
   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
                         Required    Fatigue  on No. Conn. Actual      Code
   Dist.                Min.    Max.    LS      Required   Pitch      Check*
   (ft)                 (in)    (in)              (in)      (in)
 xxx.xxx                xxx.x  xxx.x    aa        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 the length of the connector in a cross section.
```

```
      SHEAR CONNECTOR DESIGN - SPACING, COVER, AND PENETRATION
      --------------------------------------------------------
                            Min. Penetration
                 Minimum       into Slab
                  Cover      above Haunch
                  (in)           (in)
                  xxx.x          xxx.x
```

```
                    UNCURED SLAB WEB SPECIFICATION CHECK
                    ------------------------------------
                                                         Compressive Stress
                      Shear Force in Web                       in Web          Code
  Dist.    Gamma*    Vr*      4*Vdl*      Vu*           fcw*      fu*       Check**
  (ft)                (kips)    (kips)    (kips)        (ksi)     (ksi)
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)
```

```
                  UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 1)
                  -----------------------------------------------------------
           Hybrid         Flange Nominal Yielding          Web Bend Buckling*
           Factor           Allowable    Actual     Coefficient  Allowable  Actual     Code
  Dist.      Rh      T/B      Stress     Stress*         k*        Stress   Stress*  Check**
  (ft)                         (ksi)      (ksi)                     (ksi)    (ksi)
xxx.xxxa  x.xxx     aaa    xxxx.xx    xxxx.xx        xxxx.xx   xxxx.xx  xxxx.xx     aaaa

  * Legend of General Notes:
     Actual Stresses are obtained using the appropriate factors for the
      construction limit state
     k = Bend-buckling coefficient
         Web bend-buckling checks only apply to compression flanges; tension flanges
           are identified as N/A

 ** Legend of Resistance Calculation:
     A.  Compression flange is braced, flexural resistance and
           lateral bending checks do not apply
     B.  Compression flange is unbraced, local
           flange buckling governs Fr
     C.  Compression flange is unbraced, lateral
           torsional buckling governs Fr

*** 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
```

```
                  UNCURED SLAB FLANGE SPECIFICATION CHECK (NO LTB) (PART 2)
                  ---------------------------------------------------------
                                    Compression Flange Flexural Resistance
                              Load           (6.10.3.2.1-2)
                            Shedding       Flexural Stresses
              Unbraced       Factor   Allowable  Actual    Resist.    Code
       Dist.   Length   T/B    Rb       Stress   Stress*   Calc.**  Check***
       (ft)     (ft)                    (ksi)     (ksi)
     xxx.xxxa  xxx.xx   aaa   x.xxx    aaaaaa    aaaaaa      aaa     aaaa

       * Legend of General Notes:
          Actual Stresses are obtained using the appropriate factors for the construction
           limit state

  ** Legend of Resistance Calculation:
        A. Compression flange is continuously braced, flexural resistance
           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

      ***  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

        INTERMEDIATE VALUES FOR LATERAL TORSIONAL BUCKLING CALCULATIONS (UNCURED SLAB)
        ------------------------------------------------------------------------------
                                                     6.10.8.2.3
   Dist.   T/B        Flx  rt*  Rh*   Rb*    Dc*   Lp*   Lr*  Cb*
   (ft)                   (in)              (in)  (ft)  (ft)
 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 (UNCURED SLAB)
                    --------------------------------------------------
                              6.10.8.2.3                                  Factored
                          Flexural Resistance                             Flexural          Code
                        Local       Governing                              Stress           Chk
 Dist.   T/B        Flx  Fr   *          Fr   *                             Fu              ***
 (ft)                   (ksi)           (ksi)                              (ksi)
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 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.
```

```
                 UNCURED SLAB NET SECTION FRACTURE CHECK
                 ---------------------------------------
                     Flange                          Net Section   Factored
                     Area     Tensile     Yield      Fracture      Flexural
                     Ratio    Strength    Strength   Resistance    Stress      Code
      Dist.   T/B    An/Ag      Fu          Fyt         Fr           ft        Check*
      (ft)                     (ksi)       (ksi)       (ksi)        (ksi)
    xxx.xxxa  aaa    xx.xx    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
```

```
                          RATING FACTORS - SUMMARY
                          ------------------------
            Basis of          Rating   Rating                       Limit
             Rating     T/B   Factor   Tonnage          Dist.       State
                                       (tons)            (ft)
PHL-93
------
HL-93
-----
P-82
----
Inventory  Flexure     a     xxx.xxx                   xxx.xxx    aaaaaaaa
Inventory  Flexure     a     xxx.xxx  xxxxx.x          xxx.xxx    aaaaaaaa
Operating  Flexure     a     xxx.xxx                   xxx.xxx    aaaaaaaa
Operating  Flexure     a     xxx.xxx  xxxxx.x          xxx.xxx    aaaaaaaa
           Shear             xxx.xxx                   xxx.xxx    aaaaaaaa
           Shear             xxx.xxx  xxxxx.x          xxx.xxx    aaaaaaaa
           Controlling       xxx.xxx                   xxx.xxx    aaaaaaaa
           Controlling       xxx.xxx  xxxxx.x          xxx.xxx    aaaaaaaa
Inventory  Not Applicable
Operating  Not Applicable
```

```
                 RATING FACTORS - MOMENT FLEXURAL CAPACITY
                 -----------------------------------------
                              Resist.  Total    Total
              Limit           Moment     DL       LL     Rating  Rating
              Limit           Moment    DL***     LL     Rating  Rating
      Dist.   State   Flex.     Mr     Moment   Moment   Factor Failures**
       (ft)                    (k-ft)  (k-ft)   (k-ft)
    xxx.xxx  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 web proportion check
     B. Section fails one or more flange proportion checks
     C. Section fails ductility check
     D. Rating factor is less than 1.0

 *** For Strength-IP limit state, live load is included as part
     of the Total DL Moment.
```

```
                 RATING FACTORS - STRESS FLEXURAL CAPACITY
                 ------------------------------------------
                                 Resist. Total   Total
                 Limit           Stress   DL***    LL    Rating  Rating
    Dist.  Flng  State     Flex.   Fr     Stress  Stress  Factor Failures**
     (ft)                         (ksi)   (ksi)   (ksi)
  xxx.xxxa aaa  aaaaaaaa  aaaa   xxxx.x  xxxx.x xxxx.x xxxxx.xxxa aaaaa
```

```
* An asterisk following the rating factor indicates that the rating is governed by
  lateral torsional buckling (AASHTO 6.10.8.2.3).
+ A plus sign following the rating factor indicates that the rating is governed by
  net section fracture (AASHTO 6.10.1.8).
# A 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 web proportion check
     B. Section fails one or more flange proportion checks
     C. Section fails ductility check
     D. Rating factor is less than 1.0

 *** For Strength-IP limit state, live load is included as part of
       the Total DL Stress.
```

```
                        RATING FACTORS - SHEAR CAPACITY
                        --------------------------------
                              Resist.    Total     Total
           Limit               Shear      DL        LL      Rating  Rating
           Limit               Shear      DL**      LL      Rating  Rating
  Dist.    State   Shear        Vr       Shear     Shear    Factor Failure*
   (ft)                       (kips)     (kips)    (kips)
 xxx.xxx  aaaaaaaa aaaa xxxxx.xx  xxxxx.xx  xxxxx.xx  xxx.xxx    a
          aaaaaaaa aaaa xxxxx.xx  xxxxx.xx  xxxxx.xx  xxx.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, live load
       is included as part of Total DL Shear.

                      RATING FACTORS - OVERALL SUMMARY
                       --------------------------------
                               Rating    Rating                  Limit
            Governs       T/B  Factor    Tonnage         Dist.     State
                                          (tons)          (ft)
PHL-93
------
HL-93
-----
P-82
----
ML-80
-----
HS20
----
H20
---
TK527
-----
EV2
---
EV3
---
SU6TV
-----

TOT VEHICLE
-----------
Inventory  aaaaaaaaaaaaaaa   xxx.xxx                  xxx.xxx   aaaaaaaa
Operating  aaaaaaaaaaaaaaa   xxx.xxx                  xxx.xxx   aaaaaaaa
Inventory  aaaaaaaaaaaaaaa   xxx.xxx  xxxx.x          xxx.xxx   aaaaaaaa
Operating  aaaaaaaaaaaaaaa   xxx.xxx  xxxx.x          xxx.xxx   aaaaaaaa
Inventory  Not Applicable
Operating  Not Applicable
```

```
                                   BRIDGE LOAD RATINGS
                                   -------------------

Floorbeam  ii                Beam Type and Size: STEEL PLATE GIRDER xxx. inches
                      aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa
INVENTORY  Loc. (ft)   xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa
RATING     Limit State aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa
(IR)       Resistance  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa
           RF            xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa    xxx.xxa

Floorbeam  ii                Beam Type and Size: STEEL PLATE GIRDER xxx. inches
                      aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa aaaaaaaaaa
OPERATING  Loc. (ft)   xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa xxxxx.xxxa
RATING     Limit State aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa  aaaaaaaaa
(OR)       Resistance  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)                                 xxxxxx.xxa

Maximum Factored Shear Resistance (kips)     xxxxxxx.xx
Location (ft)                                xxxxxxx.xxa

NOTES:
FOR FLOORBEAMS, DISTRIBUTION FACTORS ARE NOT USED TO DETERMINE THE LIVE LOAD
EFFECTS. THE VEHICULAR LOADS ARE MOVED TRANSVERSELY ACROSS THE FLOORBEAM TO
OBTAIN THE MAXIMUM EFFECTS.
THE SPAN LENGTH, FOR FLOORBEAMS, IS REPORTED AS THE TOTAL LENGTH OF THE
FLOORBEAM, INCLUDING LEFT AND RIGHT OVERHANGS, IF APPLICABLE.

SYMBOL DESIGNATION FOR RATING FACTORS:
M - MOMENT RATING FACTOR CONTROLS
S - SHEAR RATING FACTOR CONTROLS
```

7.9 SPECIFICATION CHECK WARNINGS

This output table gives a summary of the titles of all of the 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. This table prints 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 uncured slab checks or shear connector checks) will be reported under the analysis vehicle failures. A sample specification check failure table is shown in Figure 1.

```
 LRFD Floorbeam Analysis and Rating, Version 1.7.0.0                                          PAGE 4
 Input File: FBREV285A.dat                                                         04/02/2020  10:27:10
 ---------------------------------------------------------------------------------------------------
                                        S-9530 FLR BM RATING
                                   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. 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
 -----------
  %WARNING: **THIS MUST BE APPROVED BY DISTRICT BRIDGE ENGINEER** on Page 2
  LOAD MODIFIER
 *FACTORED ANALYSIS RESULTS - REACTIONS
 *LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE)(CHIEF BRIDGE ENGINEER)


 ML-80
 -----
  LOAD MODIFIER
 *FACTORED ANALYSIS RESULTS - REACTIONS
 *LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE)(CHIEF BRIDGE ENGINEER)

. . .

TK527
 -----
  LOAD MODIFIER
 *FACTORED ANALYSIS RESULTS - REACTIONS
 *LATERAL TORSIONAL BUCKLING CAPACITY (NONCOMPOSITE OR NEGATIVE FLEXURE)(CHIEF BRIDGE ENGINEER)



     * - An asterisk indicates the table was not printed
```

Figure 7.9-1 Specification Check Warnings Page

7.10 SPECIFICATION CHECK FAILURES

This output table gives a summary of the titles of all of the 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. This table prints 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 uncured slab checks or shear connector checks) will be reported under the analysis vehicle failures. A sample specification check failure table is shown in Figure 1.

```
 LRFD Floorbeam Analysis and Rating, Version 1.7.0.0                                         PAGE 5
 Input File: FBREV285A.dat                                                      04/02/2020  10:27:10
 ---------------------------------------------------------------------------------------------------
                                       S-9530 FLR BM RATING
                              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. 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
 -----------
 *DUCTILITY AND WEB/FLANGE PROPORTION CHECKS
 *LONGITUDINAL STIFFENERS CHECK (PART 1)
 *LONGITUDINAL STIFFENERS CHECK (PART 2)
 *BEARING STIFFENER CHECK
  RATING FACTORS - MOMENT FLEXURAL CAPACITY
  RATING FACTORS - STRESS FLEXURAL CAPACITY


 ML-80
 -----
 *DUCTILITY AND WEB/FLANGE PROPORTION CHECKS
 *LONGITUDINAL STIFFENERS CHECK (PART 1)
 *LONGITUDINAL STIFFENERS CHECK (PART 2)
 *BEARING STIFFENER CHECK
  RATING FACTORS - MOMENT FLEXURAL CAPACITY
  RATING FACTORS - STRESS FLEXURAL CAPACITY

. . .

TK527
 -----
 *DUCTILITY AND WEB/FLANGE PROPORTION CHECKS
 *LONGITUDINAL STIFFENERS CHECK (PART 1)
 *LONGITUDINAL STIFFENERS CHECK (PART 2)
 *BEARING STIFFENER CHECK
  RATING FACTORS - MOMENT FLEXURAL CAPACITY
  RATING FACTORS - STRESS FLEXURAL CAPACITY


     * - An asterisk indicates the table was not printed
```

Figure 7.10-1 Specification Check Failures Page

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; a sketch which shows the floorbeam 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**
System of Units	US	US	US
Number of Floorbeams	5	5	5
Floorbeam to be Analyzed	2	3	2
Support Distance	67'	25'	70'
Left Overhang	7'-10"	0'	8'
Right Overhang	7'-10"	0'	8'
Floorbeam Spacing	45'	10', 16', 16', 10'	45'
Stringers	Y	N	Y
Type of Floorbeam	PG	RB	PG
Support Type	C	S	O
User/Program Defined Lanes	User	Program	User
Concrete Strength f'_c	3500 psi	4000 psi	3500 psi
Web Steel Strength F_{yw}	36 ksi	50 ksi	36 ksi
Flange Steel Strength F_{yw}	50 ksi	50 ksi	50 ksi
Cover Plates	N/A	Y	N/A
Composite/ Noncomposite	C	N	C
Slab Thickness S_t	9"	9.5"	9"
Effective Slab Thickness	8-1/2"	8.5"	8-1/2"
Live Load Type	LRFD	SPECIAL VEHICLE	P-82 in two lanes and HL-93 in other lanes
ADTT	5000	5000	3000
Transverse Stiffener	NO	NO	NO
Symmetry Option	NO	NO	NO
Fatigue Life Estimation	YES	YES	YES
Section Losses	NO	NO	NO

8.2 EXAMPLE 1

Example 1 is a plate girder floorbeam example having a support distance of 67' and two overhangs of 7'-10" each. The example assumes an interior floorbeam with composite construction. A PHL-93 live loading is assumed with single lane average daily truck traffic of 5000 vehicles. The floorbeam is continuous over its supports and has stringers framing into it.

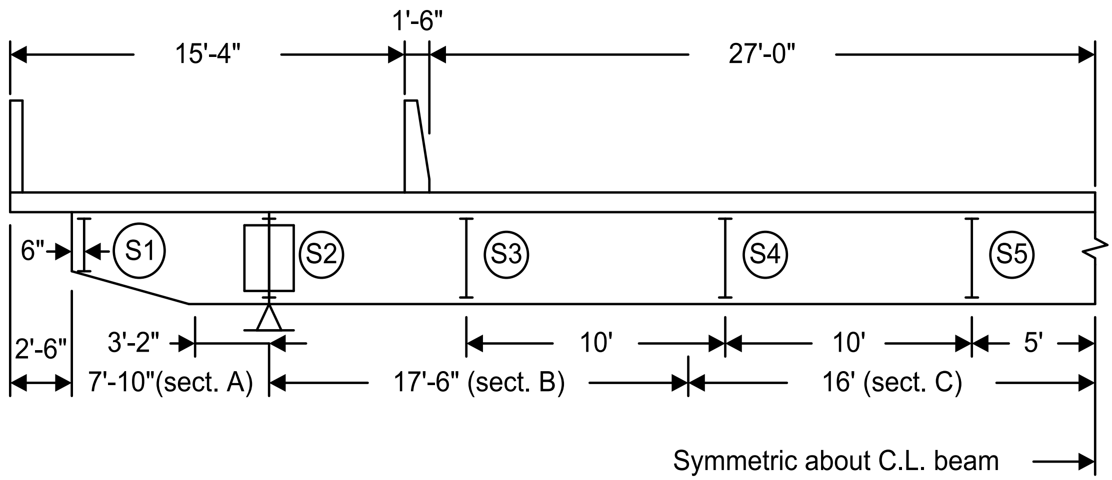

Figure 8.2-1 Example 1 Configuration

CONTROL PARAMETERS

Units	Number of Floorbeams	Floorbeam Number	Type of Floorbeam	Type of Support	Framing Type	No. of Stringers
US	5	2	PLATE GIRDER	CONTIN	STRINGR	10

Symmetry	Lane Defin.	Single Lane ADTT	Multiple Presence Factor Adj.	Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor
NO	USER	4000	1.000	A	1.330	1.150	N/A

Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path	Analysis Points	Design Permit Vehicle Dynamic Load Allowance	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports
1.000	1.000	1.000	N/A	2	1.200	0.00	YES	YES

FLOORBEAM GEOMETRY

Centerline of Left Support to							
Right Support (ft)	Deck Edge Left (ft)	Deck Edge Right (ft)	Overhang End Left (ft)	Overhang End Right (ft)	Gage Distance (ft)	Passing Distance (ft)	Staggered Diaphragms
67.000	-10.330	77.330	-7.830	74.830	6.000	4.000	NO

Centerline of Left Support to			
Left Sidewalk Edge Left (ft)	Left Sidewalk Edge Right (ft)	Right Sidewalk Edge Left (ft)	Right Sidewalk Edge Right (ft)
-10.330	5.000	62.000	77.330

USER-DEFINED LANES (WITHOUT SIDEWALK)

Lane No.	1	2	3	4	5	6
Lft Edge (ft)	-9.833	2.500	18.000	32.000	46.000	60.000
Rgt Edge (ft)	1.167	13.500	29.000	43.000	57.000	71.000

USER-DEFINED LANES (WITH SIDEWALK)

Lane No.	1	2	3	4
Lft Edge (ft)	10.170	21.170	32.170	43.170
Rgt Edge (ft)	21.170	32.170	43.170	54.170

FLOORBEAM SPACING

Flrbm No.	1	2	3	4
Spacing (ft)	45.000	45.000	45.000	45.000
Contin Str	Y	Y	Y	Y

STRINGER LOCATION

Strgr No.	1	2	3	4	5	6	7
Location (ft)	-7.330	0.000	8.500	18.500	28.500	38.500	48.500

Strgr No.	8	9	10
Location (ft)	58.500	67.000	74.330

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	**65.0**	**65.0**	70.0

PLATE GIRDER PROPERTIES, PART 1 of 2

Start Dist. (ft)	End 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)
-7.833	-7.750	1				27.000	0.562	14.0000	0.7500	14.0000	1.0000
-7.750	-7.330	1			S	29.199	0.562	14.0000	0.7500	14.0000	1.0000
-7.330	-7.047	1			S	30.681	0.562	14.0000	0.7500	14.0000	1.0000
-7.047	-6.264	1			S	34.782	0.562	14.0000	0.7500	14.0000	1.0000
-6.264	-5.481	1			S	38.882	0.562	14.0000	0.7500	14.0000	1.0000
-5.481	-4.698	1			S	42.983	0.562	14.0000	0.7500	14.0000	1.0000
-4.698	-3.915	1			S	47.083	0.562	14.0000	0.7500	14.0000	1.0000
-3.915	-3.167	1			S	51.000	0.562	14.0000	0.7500	14.0000	1.0000
-3.167	0.000	1				51.000	0.562	14.0000	0.7500	14.0000	1.0000
0.000	17.500	1				51.000	0.812	18.0000	2.0000	27.0000	2.5000
17.500	49.500	1				51.000	0.812	18.0000	2.5000	27.0000	3.0000
49.500	67.000	1				51.000	0.812	18.0000	2.0000	27.0000	2.5000
67.000	70.167	1				51.000	0.562	14.0000	0.7500	14.0000	1.0000
70.167	70.915	1			S	47.083	0.562	14.0000	0.7500	14.0000	1.0000
70.915	71.698	1			S	42.983	0.562	14.0000	0.7500	14.0000	1.0000
71.698	72.481	1			S	38.882	0.562	14.0000	0.7500	14.0000	1.0000
72.481	73.264	1			S	34.782	0.562	14.0000	0.7500	14.0000	1.0000
73.264	74.047	1			S	30.681	0.562	14.0000	0.7500	14.0000	1.0000
74.047	74.330	1			S	29.199	0.562	14.0000	0.7500	14.0000	1.0000
74.330	74.750	1			S	27.000	0.562	14.0000	0.7500	14.0000	1.0000
74.750	74.833	1				27.000	0.562	14.0000	0.7500	14.0000	1.0000

PLATE GIRDER PROPERTIES, PART 2 of 2

Start Dist. (ft)	End Dist. (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
-7.833	-7.750	2.500	0.775	4.500
-7.750	-7.330	2.500	0.775	4.500
-7.330	-7.047	2.500	0.775	4.500
-7.047	-6.264	2.500	0.775	4.500
-6.264	-5.481	2.500	0.775	4.500
-5.481	-4.698	2.500	0.775	4.500
-4.698	-3.915	2.500	0.775	4.500
-3.915	-3.167	2.500	0.775	4.500
-3.167	0.000	2.500	0.775	4.500
0.000	17.500	2.500	0.775	4.500
17.500	49.500	2.500	0.775	4.500
49.500	67.000	2.500	0.775	4.500
67.000	70.167	2.500	0.775	4.500
70.167	70.915	2.500	0.775	4.500
70.915	71.698	2.500	0.775	4.500
71.698	72.481	2.500	0.775	4.500
72.481	73.264	2.500	0.775	4.500
73.264	74.047	2.500	0.775	4.500
74.047	74.330	2.500	0.775	4.500
74.330	74.750	2.500	0.775	4.500
74.750	74.833	2.500	0.775	4.500

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)
9.000	8.500	4.000	150.00	145.00	60.	29000.

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

STRINGER DISTRIBUTED LOADS (DC1)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	0.964	0.964
2	1	0.000	4	45.000	1.198	1.198
3	1	0.000	4	45.000	1.364	1.364
4	1	0.000	4	45.000	1.463	1.463
5	1	0.000	4	45.000	1.463	1.463
6	1	0.000	4	45.000	1.463	1.463
7	1	0.000	4	45.000	1.463	1.463
8	1	0.000	4	45.000	1.364	1.364
9	1	0.000	4	45.000	1.198	1.198
10	1	0.000	4	45.000	0.964	0.964

STRINGER DISTRIBUTED LOADS (DC2)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	0.075	0.075
2	1	0.000	4	45.000	0.328	0.328
3	1	0.000	4	45.000	0.253	0.253
4	1	0.000	4	45.000	0.000	0.000
5	1	0.000	4	45.000	0.000	0.000
6	1	0.000	4	45.000	0.000	0.000
7	1	0.000	4	45.000	0.000	0.000
8	1	0.000	4	45.000	0.253	0.253
9	1	0.000	4	45.000	0.328	0.328
10	1	0.000	4	45.000	0.075	0.075

STRINGER DISTRIBUTED LOADS (FWS)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	0.333	0.333
2	1	0.000	4	45.000	0.333	0.333
3	1	0.000	4	45.000	0.463	0.463
4	1	0.000	4	45.000	0.500	0.500
5	1	0.000	4	45.000	0.500	0.500
6	1	0.000	4	45.000	0.500	0.500
7	1	0.000	4	45.000	0.500	0.500
8	1	0.000	4	45.000	0.463	0.463
9	1	0.000	4	45.000	0.333	0.333
10	1	0.000	4	45.000	0.333	0.333

STRINGER DISTRIBUTED LOADS (PDC2)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	0.192	0.192
2	1	0.000	4	45.000	0.191	0.191
3	1	0.000	4	45.000	0.000	0.000
4	1	0.000	4	45.000	0.000	0.000
5	1	0.000	4	45.000	0.000	0.000
6	1	0.000	4	45.000	0.000	0.000
7	1	0.000	4	45.000	0.000	0.000
8	1	0.000	4	45.000	0.000	0.000
9	1	0.000	4	45.000	0.191	0.191
10	1	0.000	4	45.000	0.192	0.192

STRINGER DISTRIBUTED LOADS (PFWS)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	-0.333	-0.333
2	1	0.000	4	45.000	-0.333	-0.333
3	1	0.000	4	45.000	-0.067	-0.067
4	1	0.000	4	45.000	0.000	0.000
5	1	0.000	4	45.000	0.000	0.000
6	1	0.000	4	45.000	0.000	0.000
7	1	0.000	4	45.000	0.000	0.000
8	1	0.000	4	45.000	-0.067	-0.067
9	1	0.000	4	45.000	-0.333	-0.333
10	1	0.000	4	45.000	-0.333	-0.333

PEDESTRIAN LOADS

Left Sidewalk Pedestrian Live Load (ksf)	Right Sidewalk Pedestrian Live Load (ksf)
0.075	0.075

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
1960	1985	5000			0.010			0.010

FATIGUE POINTS

Dist. 1 (ft)	Dist. 2 (in)	Category	Fillet Weld (in)
33.500	3.000	B	

BRACE POINTS

Start Dist. (ft)	End Dist. (ft)	Brace Spacing (ft)
-7.830	-7.330	0.500
-7.330	0.000	7.330
0.000	8.500	8.500
8.500	58.500	10.000
58.500	67.000	8.500
67.000	74.330	7.330
74.330	74.830	0.500

TRANSVERSE STIFFENERS

Start Dist. (ft)	End Dist. (ft)	Stiff. Type*	Stiff. Spacing (in)	Proj. Width (in)	Stiff. Thick. (in)	Yield Strength (ksi)	Web Leg Length (in)
-7.750	-3.167	S P	27.48	7.000	0.500	36.000	
-3.167	0.000	S P	38.00	7.000	0.500	36.000	
0.000	67.000	S P	73.09	7.000	0.500	36.000	
67.000	70.167	S P	38.00	7.000	0.500	36.000	
70.167	74.750	S P	27.48	7.000	0.500	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

BEARING STIFFENERS

Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
0.000	W P	2	6.000	n/a	6.750
67.000	W P	2	6.000	n/a	6.750

Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	**Classification Strength of Web-Stiffener Weld (ksi)**
0.000	6.500	0.750	50.000	n/a	**70.0**
67.000	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

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
4	0.875	7.000	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	Load Modifiers	Dead Loads	Dead Load Effects	Dead Load Reactions	Influence Lines
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
1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1

Shear Connector Checks	Uncured Slab Checks	Web-to-Flange Weld Design Checks
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	Include Flange in Haunch Weight
490.00	11.000	YES

8.3 EXAMPLE 2

Example 2 is a rolled beam floorbeam example having a support distance of 25' with no overhangs. The example assumes an interior floorbeam with noncomposite construction. A special live loading is assumed with average daily truck traffic of 5000 vehicles. The floorbeam is simply supported with no stringers framing into it.

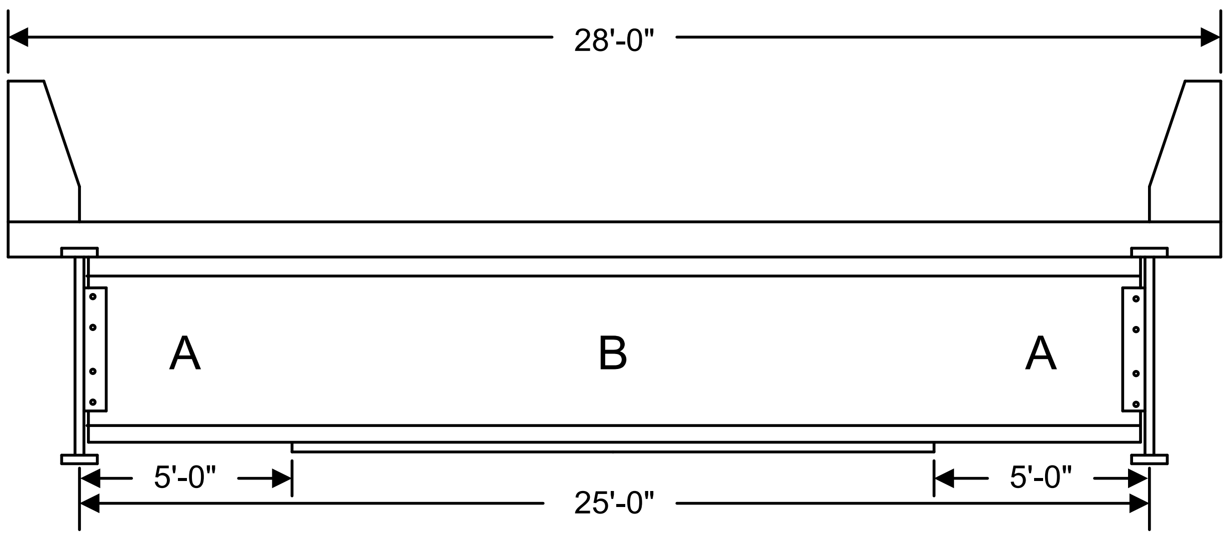

Figure 8.3-1 Example 2 Cross Section

CONTROL PARAMETERS

Units	Number of Floorbeams	Floorbeam Number	Type of Floorbeam	Type of Support	Framing Type	No. of Stringers
US	5	3	ROLLED BEAM	SIMPLE	NO STR	0

Symmetry	Lane Defin.	Single Lane ADTT	Multiple Presence Factor Adj.	Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor
NO	PROG	4250	1.000	E	1.330	1.150	N/A

Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path	Analysis Points	Design Permit Vehicle Dynamic Load Allowance	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports
1.000	1.000	1.000	N/A	2	1.200	0.00	YES	YES

FLOORBEAM GEOMETRY

Right Support (ft)	Centerline of Left Support to Deck Edge Left (ft)	Deck Edge Right (ft)	Overhang End Left (ft)	Overhang End Right (ft)	Gage Distance (ft)	Passing Distance (ft)	Staggered Diaphragms
25.000	-1.500	26.500			6.000	4.000	NO

PROGRAM DEFINED LANES

Lane Width (ft)	(without Sidewalk) Centerline Girder to Left Curb (ft)	(without Sidewalk) Right Curb (ft)	(with Sidewalk) Centerline Girder to Left Curb (ft)	(with Sidewalk) Right Curb (ft)
12.000	0.000	25.000		

FLOORBEAM SPACING

Flrbm No.	1	2	3	4
Spacing (ft)	10.000	16.000	16.000	10.000
Contin Str	N	N	N	N

USER-DEFINED ANALYSIS POINTS

Distance (ft)	0.000	2.500	5.000	7.500	10.000	12.500

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	NONCOMPOSITE	50.0	**65**.0	36.0	36.0
2	NONCOMPOSITE	50.0	**65**.0	36.0	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)
W24X68	24	68	1830.	20.10

ROLLED BEAM DIMENSIONS, PART 2 of 2

Designation	Flange Width (in)	Flange Thickness (in)	Beam Depth (in)	Web Thickness (in)	Distance "k" (in)
W24X68	8.970	0.5850	23.700	0.4150	1.0900

ROLLED BEAM PROPERTIES, PART 1 of 2

Start Dist. (ft)	End 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)
0.000	5.000	1			W 24x 68	0.0000	0.0000	0.0000	0.0000
5.000	20.000	2			W 24x 68	0.0000	0.0000	10.0000	0.7500
20.000	25.000	1			W 24x 68	0.0000	0.0000	0.0000	0.0000

ROLLED BEAM PROPERTIES, PART 2 of 2

Start Dist. (ft)	End Dist. (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
0.000	5.000	0.000	0.000	0.000
5.000	20.000	0.000	0.000	0.000
20.000	25.000	0.000	0.000	0.000

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)
9.500	8.500	4.000	150.00	145.00	60.	29000.

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

FLOORBEAM DISTRIBUTED LOADS (DC1)

Start Dist. (ft)	End Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
0.000	25.000	0.240	0.240

FLOORBEAM DISTRIBUTED LOADS (FWS)

Start Dist. (ft)	End Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
0.000	25.000	0.810	0.810

SUPPORT FIXITIES

Support	DL Moment %	LL Moment %
LEFT	30.00	30.00
RIGHT	50.00	50.00

SPECIAL LIVE LOADING

LL No.	Axle Effect	Lane Load (kip/ft)	Percentage Increase	Vehicle Type
1	N	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	10.000	11.000	15.750	4.000	15.750	22.000	15.750	4.000
	15.750	0.000						

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
1990	2001	5000			0.080			0.150

FATIGUE POINTS

Dist. 1 (ft)	Dist. 2 (in)	Category	Fillet Weld (in)
5.000	0.000	B	

BRACE POINTS

Start Dist. (ft)	End Dist. (ft)	Brace Spacing (ft)
0.000	25.000	12.500

BEARING STIFFENERS

Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
0.000	W P	1	n/a	4.000	4.000
25.000	W P	1	n/a	4.000	4.000

Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	**Classification Strength of Web-Stiffener Weld (ksi)**
0.000	3.500	0.500	50.000	n/a	**70.0**
25.000	3.500	0.500	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

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	Load Modifiers	Dead Loads	Dead Load Effects	Dead Load Reactions	Influence Lines
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
1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1

Shear Connector Checks	Uncured Slab Checks	Web-to-Flange Weld Design Checks
1	1	1

```
                                    OUTPUT OF RATING FACTORS
                                    ------------------------
                            Vehicle  Detailed  Overall  Ratings Without
                            Rating    Rating    Rating  Future Wearing
                            Summary  Factors  Summary      Surface
                               1         1        1            1

                                 SYSTEM SETTINGS
                                 ---------------
      Steel       Construction       Include Flange
      Weight     Modular Ratio     in Haunch Weight
    (lbf/ft^3)
     490.00         11.000               YES
```

8.4 EXAMPLE 3

Example 3 is a plate girder floorbeam example having a support distance of 70 ft with two overhangs of 8 ft each. The example assumes an interior floorbeam with composite construction. An average daily truck traffic of 5000 vehicles is assumed. The floorbeam is simply supported between the supports and has fixed overhangs and stringers framing into it. Simultaneous live load placement of P-82 and HL-93 is used in this example.

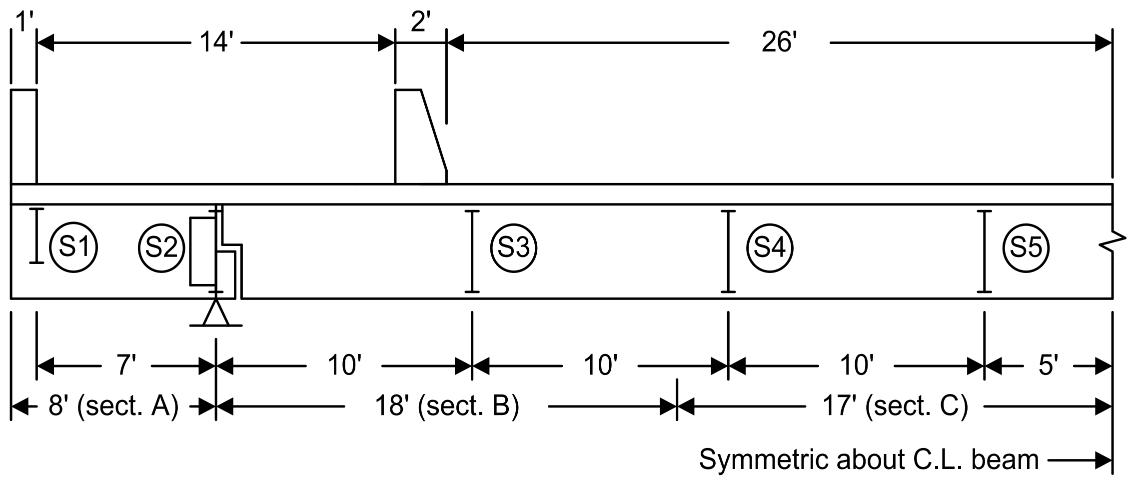

Figure 8.4-1 Example 3 Cross Section

CONTROL PARAMETERS

Units	Number of Floorbeams	Floorbeam Number	Type of Floorbeam	Type of Support	Framing Type	No. of Stringers
US	5	2	PLATE GIRDER	OVHNG	STRINGR	10

Symmetry	Lane Defin.	Single Lane ADTT	Multiple Presence Factor Adj.	Live Load Code	Dynamic Load Allowance	Fatigue Dynamic Load Allowance	PA Traffic Factor
NO	USER	3000	1.000	F	1.330	1.150	N/A

Impor. Factor	Duct. Factor	Redun. Factor	Redundant Load Path	Analysis Points	Design Permit Vehicle Dynamic Load Allowance	DC1S Percentage	Check Appendix A	Automatic Brace Points at Supports
1.000	1.000	1.000	N/A	2	1.200	0.00	YES	YES

FLOORBEAM GEOMETRY

	Centerline of Left Support to						
Right Support (ft)	Deck Edge Left (ft)	Deck Edge Right (ft)	Overhang End Left (ft)	Overhang End Right (ft)	Gage Distance (ft)	Passing Distance (ft)	Staggered Diaphragms
70.000	-8.000	78.000	-8.000	78.000	7.000	6.000	NO

Centerline of Left Support to			
Left Sidewalk Edge Left (ft)	Left Sidewalk Edge Right (ft)	Right Sidewalk Edge Left (ft)	Right Sidewalk Edge Right (ft)
-7.000	7.000	63.000	77.000

USER-DEFINED LANES (WITHOUT SIDEWALK)

Lane No.	1	2	3	4	5	6
Lft Edge (ft)	-7.000	7.000	21.000	35.000	49.000	63.000
Rgt Edge (ft)	7.000	21.000	35.000	49.000	63.000	77.000

USER-DEFINED LANES (WITH SIDEWALK)

Lane No.	1	2	3
Lft Edge (ft)	9.000	28.000	49.000
Rgt Edge (ft)	23.000	42.000	63.000

FLOORBEAM SPACING

Flrbm No.	1	2	3	4
Spacing (ft)	45.000	45.000	45.000	45.000
Contin Str	Y	Y	Y	Y

STRINGER LOCATION

Strgr No.	1	2	3	4	5	6	7
Location (ft)	-7.000	0.000	10.000	20.000	30.000	40.000	50.000

Strgr No.	8	9	10
Location (ft)	60.000	70.000	77.000

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	65.0	65.0	70.0
2	COMPOSITE	50.0	50.0	50.0	65.0	65.0	70.0

PLATE GIRDER PROPERTIES, PART 1 of 2

Start Dist. (ft)	End 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)
-8.000	0.000	1				55.000	0.562	14.0000	0.7500	14.0000	1.0000
0.000	18.000	2				55.000	0.812	18.0000	2.0000	27.0000	2.5000
18.000	52.000	1				55.000	0.812	20.0000	2.5000	27.0000	3.0000
52.000	70.000	2				55.000	0.812	18.0000	2.0000	27.0000	2.5000
70.000	78.000	1				55.000	0.562	14.0000	0.7500	14.0000	1.0000

PLATE GIRDER PROPERTIES, PART 2 of 2

Start Dist. (ft)	End Dist. (ft)	Haunch Depth (in)	Deck Reinf. Area (in^2/ft)	Reinf. C.G. Dist. (in)
-8.000	0.000	0.000	0.775	3.500
0.000	18.000	0.000	0.775	3.500
18.000	52.000	0.000	0.775	3.500
52.000	70.000	0.000	0.775	3.500
70.000	78.000	0.000	0.775	3.500

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)
9.000	8.500	4.000	150.00	145.00	60.	29000.

CALCULATED SLAB PROPERTIES

Concrete E (ksi)	Modular Ratio, n
3600.	8.

STRINGER DISTRIBUTED LOADS (DC1)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	0.688	0.688
2	1	0.000	4	45.000	1.272	1.272
3	1	0.000	4	45.000	1.448	1.448
4	1	0.000	4	45.000	1.463	1.463
5	1	0.000	4	45.000	1.463	1.463
10	1	0.000	4	45.000	0.688	0.688
9	1	0.000	4	45.000	1.272	1.272
8	1	0.000	4	45.000	1.448	1.448
7	1	0.000	4	45.000	1.463	1.463
6	1	0.000	4	45.000	1.463	1.463

STRINGER DISTRIBUTED LOADS (DC2)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	0.075	0.075
2	1	0.000	4	45.000	0.328	0.328
3	1	0.000	4	45.000	0.253	0.253
4	1	0.000	4	45.000	0.000	0.000
5	1	0.000	4	45.000	0.000	0.000
10	1	0.000	4	45.000	0.075	0.075
9	1	0.000	4	45.000	0.328	0.328
8	1	0.000	4	45.000	0.253	0.253
7	1	0.000	4	45.000	0.000	0.000
6	1	0.000	4	45.000	0.000	0.000

STRINGER DISTRIBUTED LOADS (FWS)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	0.225	0.225
2	1	0.000	4	45.000	0.225	0.225
3	1	0.000	4	45.000	0.500	0.500
4	1	0.000	4	45.000	0.500	0.500
5	1	0.000	4	45.000	0.500	0.500
10	1	0.000	4	45.000	0.225	0.225
9	1	0.000	4	45.000	0.225	0.225
8	1	0.000	4	45.000	0.500	0.500
7	1	0.000	4	45.000	0.500	0.500
6	1	0.000	4	45.000	0.500	0.500

STRINGER DISTRIBUTED LOADS (PDC2)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	0.175	0.175
2	1	0.000	4	45.000	0.175	0.175
3	1	0.000	4	45.000	0.000	0.000
4	1	0.000	4	45.000	0.000	0.000
5	1	0.000	4	45.000	0.000	0.000
10	1	0.000	4	45.000	0.175	0.175
9	1	0.000	4	45.000	0.175	0.175
8	1	0.000	4	45.000	0.000	0.000
7	1	0.000	4	45.000	0.000	0.000
6	1	0.000	4	45.000	0.000	0.000

STRINGER DISTRIBUTED LOADS (PFWS)

Strgr. No.	Start Span No.	Start Span Dist. (ft)	End Span No.	End Span Dist. (ft)	Start Mag. (kips/ft)	End Mag. (kips/ft)
1	1	0.000	4	45.000	-0.225	-0.225
2	1	0.000	4	45.000	-0.225	-0.225
3	1	0.000	4	45.000	-0.067	-0.067
4	1	0.000	4	45.000	0.000	0.000
5	1	0.000	4	45.000	0.000	0.000
10	1	0.000	4	45.000	-0.225	-0.225
9	1	0.000	4	45.000	-0.225	-0.225
8	1	0.000	4	45.000	-0.067	-0.067
7	1	0.000	4	45.000	0.000	0.000
6	1	0.000	4	45.000	0.000	0.000

PEDESTRIAN LOADS

Left Sidewalk Pedestrian Live Load (ksf)	Right Sidewalk Pedestrian Live Load (ksf)
0.075	0.075

LIVE LOAD DEFINITION

Live Load Type 1	Live Load Type 2	Ratings Desired	Mult Pres Factor
P-82	HL-93	1	1.000

LIVE LOAD ASSIGNMENTS (WITHOUT SIDEWALKS)

Lane No.	1	2	3	4	5	6
LL Type	P-82	HL-93	HL-93	HL-93	HL-93	P-82

LIVE LOAD ASSIGNMENTS (WITH SIDEWALKS)

Lane No.	1	2	3
LL Type	P-82	HL-93	P-82

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
1960	1985	5000			0.010			0.010

FATIGUE POINTS

Dist. 1 (ft)	Dist. 2 (in)	Category	Fillet Weld (in)
35.000	47.500	C	

BRACE POINTS

Start Dist. (ft)	End Dist. (ft)	Brace Spacing (ft)
-8.000	-7.000	1.000
-7.000	0.000	7.000
0.000	70.000	10.000
70.000	77.000	7.000
77.000	78.000	1.000

BEARING STIFFENERS

Dist. (ft)	Stiffener Type*	Number of Pairs	Spacing Between Pairs (in)	Clearance (in)	Projecting Width (in)
0.000	W P	2	6.000	n/a	8.500
70.000	W P	2	8.000	n/a	8.500

Dist. (ft)	Bearing Contact Width (in)	Stiffener Thickness (in)	Yield Strength (ksi)	Web Leg Length (in)	**Classification Strength of Web-Stiffener Weld (ksi)**
0.000	8.250	0.750	50.000	n/a	**70.0**
70.000	8.250	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

STUD SHEAR CONNECTORS

No. of Connectors	Diameter (in)	Height (in)	Tensile Strength (ksi)
4	0.875	7.000	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	Load Modifiers	Dead Loads	Dead Load Effects	Dead Load Reactions	Influence Lines
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
1	1	1	1	1	1	1

OUTPUT OF SPECIFICATION CHECKING

Ductility and Web/Flange Proportions	Flexural Capacity	Shear Capacity	Web Checks	Stiffener Checks	Fatigue Checks	Fatigue Life Estimation	Deflection Checks
1	1	1	1	1	1	1	1

Shear Connector Checks	Uncured Slab Checks	Web-to-Flange Weld Design Checks
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	Include Flange in Haunch Weight
490.00	11.000	YES

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9 TECHNICAL QUESTIONS AND REVISION REQUESTS

This chapter contains a reply forms to make it easier for users to convey their questions, problems, or comments to the proper unit witin the Department. General procedures for using this form are given. Users should keep the form 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 this form or the information provided on this 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.

This 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 abortion are examples of program malfunctions. Users are requested to review their input data and the program User’s Manual before submitting this form for processing.

This 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 Engineering Software Section via fax or e-mail.

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FBLRFD

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

FOR DEPARTMENT USE ONLY

RECEIVED BY: ______________ ASSIGNED TO: ________________ DATE: ____________

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