USER'S MANUAL FOR

LRFD TRUSS
ANALYSIS AND RATING
(TRLRFD)

pennsylvania
DEPARTMENT OF TRANSPORTATION

Version 1.1.0.0

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USER'S MANUAL FOR
COMPUTER PROGRAM TRLRFD
LRFD TRUSS ANALYSIS AND RATING
VERSION 1.1.0.0

Prepared by:
Michael Baker International for
Pennsylvania Department of Transportation

May, 2023

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LRFD TRUSS ANALYSIS AND RATING

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SUMMARY OF MAY 2023 REVISIONS - VERSION 1.1.0.0

Since the release of TRLRFD Version 1.0.0.0 several revision requests and user requested enhancements have been received. This release of TRLRFD Version 1.1.0.0 contains the following revisions and enhancements.

Specification Related Revisions

1. **For gusset plate locations with chord members and a vertical member, but no diagonals (a "post and hanger" condition), the program was previously not checking the gusset plates at the chord locations because it was assuming that a chord splice would carry all the load from the chords. The program has been revised to check the gusset plates at the chord locations when a chord splice has not been defined at that location, or if a chord splice has been defined and is not adequate for the forces in the chords (Request 118).**

2. **Three vehicles specified as part of the FAST Act (EV2, EV3, and SU6TV) have been added as live load options to the program (Live Load Code H on the CTL command or Live Load Codes J, K, and L on the LLP command) (Request 169).**

3. **A new permit design vehicle, P2016-13, has been added to several live load options for the program (Live Load Code J on the CTL command or Live Load Codes J, K, and L on the LLP command) (Request 170).**

4. **A check for the slip resistance of the bolts in the gusset plates has been added. New input parameters for the minimum required bolt tension and the surface condition at the gusset plate have been added to calculate the slip resistance (Request 185).**

5. **The chord splice checks of LRFD Specifications Section 6.14.2.8.6 have been added to the gusset plate specification checks and the results now appear in the output (Requests 186 and 226).**

6. **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 because of the load factor changes (Request 197).**

7. **The coefficient for LRFD Specifications Equation 6.13.2.7-2 for the nominal shear resistance of bolts has been revised to 0.45, as per the LRFD Specifications 8th Edition (Request 202).**

8. **Previously, the HL-93 reactions at interior supports did not have the 90% factor applied to the lane load portion of the truck pair + lane load combination. This factor has been added, and now the PHL-93 and HL-93 interior support reactions are identical, as expected (Request 209).**

9. The program now uses the permit dynamic load allowance value in the calculations of the deflections of the P-82 vehicle as well as using the minimum (most negative) value for the controlling negative deflection. Also, the program now stops with an error if the user defines distribution factors for force and deflection on the CTL command and enters a CDF (Computed Distribution Factor) command, since entering values in both locations can be contradictory (Request 213).

10. The calculated deflections of the PHL-93 combination will now be multiplied by 1.25, in accordance with DM-4 Section 3.6.1.3.2. Previously, the program did not multiply the values by 1.25. Also, the program will now report the governing deflection vehicle combination (125% Truck Alone or 125% [25% Truck + Lane]) at each location for the deflection calculations (Request 214).

11. When applying the two tandem + live load combination for the HL-93 vehicle, the program will now make sure that the tandems are not in the same span. Previously, both tandems could be placed in the same span and a 0.9 factor was applied to both the tandems and lane load (Request 215).

<u>Program Input Revisions</u>

12. The program will now stop with an error if the end of a span does not correspond with the edge of a defined panel (Request 068).

13. The maximum number of spans has been increased to 15 (Request 069).

14. Members framing into a gusset plate that end at a middle node (rather than upper or lower node) are now included in the gusset plate analysis (Request 075).

15. A new input command, UNBRACED LENGTH (UBL), has been added to allow the user to specify different unbraced lengths for each axis (x-, y-, and z-) for calculations of elastic flexural buckling, flexural-torsional buckling, and moment magnification. The UBL command can only be used with members defined via the T## commands, not members defined with the PRP command (Request 102).

16. The upper limits for the number of trucks on the FGV command have all been increased to 300,000 to allow values that match actual PennDOT loadometer survey data ranges (Request 108).

17. The LIVE LOAD DIRECTION input parameter (CTL) command can now only be entered as B (both directions) to ensure that all vehicles will be applied to always produce the maximum live load effect (Request 151).

18. If the user does not define a DC load at an upper or lower joint supported by a vertical or diagonal member, a warning will appear in the program output. The program does not calculate self-weight due of the truss members, so the user must take this into consideration when calculating the DC loads. Also, if the user defines a DC or DW load at an upper or lower joint that is NOT supported by a vertical or diagonal member, the program will stop with an error.

The warning message for omitted DC dead loads indicates the truss analysis is not valid if loads have been omitted. The lower limit for both DC and DW dead loads is now a small positive value (0.001 kips). Previously, the DC lower limit was -500 kips and the DW lower limit was -200 kips. (Requests 152 and 234).

19. Input parameters for chord splice size have been added to the program and incorporated into the gusset plate specification check calculations (Request 153).

20. A new input command, GUSSET PLATE FILLER (GFL), has been added to allow the user to enter filler plate and connected plate areas to calculate the fastener shear resistance reduction factor from the LRFD Specifications Section 6.13.6.1.4 (Request 184).

21. 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 191).

22. A new input value has been added to the Gusset Plate (GUS) command to allow the user to input the hole diameter to use for gusset plate checks. Previously, this value was internally calculated to be equal to the fastener diameter + 1/16". The 8th Edition LRFD Specifications Table 6.13.2.4.2-1 changed the maximum standard hole size to be dependent on bolt diameter. Allowing the user to directly enter the hole diameter allows the most flexibility for design of new gusset plates, or analysis of existing gusset plates that may have nonstandard holes. The value will default to the maximum standard hole size if left blank, but the user may enter any value between the bolt diameter and the maximum standard hole size (Request 203).

23. The input parameter "Hinge At" on the CTL command has been renamed to "Pinned Support" to clarify its purpose and to distinguish it from the hinges defined on the HNG command. Also, this value will now default to joint U0 if the first panel is type 3 and remain defaulted to L0 for all other panel types (Request 210).

24. The program now requires a hinge to be located between panels when Panel Type 2 is followed by Panel Type 1. Likewise, a hinge is required between panels when Panel Type 4 is followed by Panel Type 3. Also, the Truss Dead Loads output now lists all possible joints of the truss and indicates which joints cannot be loaded (Request 199).

25. The program now allows distribution factors entered on the CTL command to be greater than 2.0 with a Warning Message. Previously, the program would stop with an error if the distribution factor entered on the CTL command was greater than 2.0 (Request 216).

26. The bolt diameter, D, on the GUS command now has an upper limit of 4.0 inches. If the user attempts to enter a value greater than 4.0 inches, the program will now stop with an error (Requests 221 and 248).

27. A warning message is now given when filler plates are specified for a member that is not present for the specified gusset plate location. Also, filler plate properties are reported in the Input Summary only for gusset plate locations with filler plates entered on the GFL command (Request 222).

28. When the distance between the first and last row of fasteners is greater than 38 inches and the member force is tensile, the shear resistance is taken as 0.83 times the original value (Request 223).

29. The program now allows distribution factors entered on the CTL command to be greater than 2.0 with a Warning Message. Previously, the program would stop with an error if the distribution factor entered on the CTL command was greater than 2.0 (Requests 216 and 230).

30. The unbraced length is limited to the member length calculated from the panel geometry. An unbraced length that exceeds the member length will result in a specification check warning (Requests 236 and 242).

31. The sum of all defined panel widths must be within 0.5" of the sum of all span lengths and the sum of all defined panel widths for a given span must be within 0.5" of the span length of that span (Request 229).

Program Output Revisions

32. For the PHL-93 and HL-93 vehicles the calculated tonnage will now be left blank on the RATING SUMMARY output report because the PHL-93 and HL-93 results are defined from multiple vehicles (Request 071).

33. Several issues regarding the calculation of Extreme Event III loads have been identified and resolved (Request 072).

34. The MEMBER FORCES AND RATINGS output reports have been revised to indicate a rating failure (RF < 1.0) with an asterisk (*) in the right-most column of the report (Request 188).

35. The Critical Rating and Rating Summary output tables now include a Rating Failure column to identify rating factors that are less than 1. (Request 228)

36. The gusset plate Input Summary now includes data past the mid-point of the truss for non-symmetrical trusses. Previously, only gusset plate input data up to the mid-point of the truss was included in the Input Summary. Also, for symmetrical trusses, if users enter data past the symmetry point, the program stops with input error messages. (Request 235)

Program Documentation Revisions

37. The detailed description of the FGV (Fatigue Gross Vehicle) command in Chapter 6 of the TRLRFD User's Manual has been revised to give more detailed information on how to input the parameters of the command (Request 111).

38. The contact information and revision request forms in Chapter 9 of the User's Manual have been revised and directions on the revision request form have been updated to request that input files be provided in an e-mail or as an e-mail attachment (Requests 193 and 195).

39. The User Manual now refers to Highway Application Division rather than Engineering Software Section (Request 220).

40. Clarifications regarding the modeling of the chord splice were added to chapter 2 and 5 of the User's Manual as well as the configuration file GCS.RTF (Request 225).

41. Chord members are assumed to be continuous at gusset plates unless Gusset Chord Splice plates are defined using the GCS command. Chord splices can only be defined at gusset plate locations (Request 227).

42. The Revision Request Forms (User Manual and Word Template) do not refer to a PennDOT fax number (Request 237).

43. Verified that the live load live results from TRLRFD differ slightly from the BAR7 live load results due to a different impact factor / dynamic load allowance. Also, emphasized in section 5.9 of the User's Manual that a series of simple span trusses must be entered in separate input files and cannot be analyzed in a single run of TRLRFD (Request 231).

44. References to the FHWA Publication FHWA-IF-09-014 and the LRFD Specifications 7th Edition in the User's Manual Section 3.12 have been removed. All gusset plate calculations in TRLRFD now use the LRFD Specifications 8th Edition (Request 243).

Programming Revisions

45. TRLRFD has been revised to use Visual Studio 2019 and Intel Parallel Studio XE 2019 Fortran Update 5 for compilation and linking (Request 196).

46. Errors with the post processing of the LLP command which resulted in live loads being placed in incorrect lanes have been resolved (Request 212).

APRAS Requests

47. The program is now compatible with APRAS NextGen (Request 042).

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1 GENERAL DESCRIPTION

1.1 PROGRAM IDENTIFICATION

Program Title:	LRFD Truss Analysis and Rating
Program Name:	TRLRFD
Version:	**1.1.0.0**
Subsystem:	Superstructure
Authors:	Pennsylvania Department of Transportation and Michael Baker International

ABSTRACT:

TRLRFD is the LRFD version of the truss analysis and rating routines found in the PennDOT computer program BAR7 (Bridge Analysis and Rating). This program has been developed by the Pennsylvania Department of Transportation to aid bridge engineers in analyzing highway truss bridges to determine load carrying capacity and to estimate fatigue life following the LRFD (Load and Resistance Factor Design) Specifications using Customary US units (ft and kips). The results of the structural analysis performed by TRLRFD can be utilized for load rating, rehabilitation, or design of a highway truss bridge. The program can analyze simple, continuous or cantilever trusses with up to **15** spans. Computed values include reactions, member axial loads, member axial resistances, stresses, deflections, rating factors, influence line ordinates and an estimated fatigue life. All truss members are analyzed and then rated for a set of standard live loadings or an inputted truck configuration using the AASHTO LRFD Bridge Design Specifications. The fatigue life analysis is performed in accordance with the Pennsylvania Department of Transportation Design Manual Part 4. TRLRFD can also analyze and rate gusset plates using the procedures described in the LRFD Specifications.

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.
DM-4	-	Pennsylvania Department of Transportation Design Manual Part 4, **December** 2019 Edition. This publication can be ordered from: Pennsylvania Department of Transportation Publication Sales P.O. Box 2028 Harrisburg, PA 17105 This publication can also be downloaded free of charge from PennDOT's website.
FHWA	-	Federal Highway Administration
LRFD Specifications	-	AASHTO LRFD Bridge Design Specifications, **8th** 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.
TRLRFD	-	LRFD Truss Analysis and Rating program.
US	-	Customary United States units of measurement.

2 PROGRAM DESCRIPTION

2.1 GENERAL

The LRFD Truss Analysis and Rating program performs the structural analysis of a truss used in a highway bridge and checks whether the truss members meet the requirements of the LRFD Bridge Design Specifications. It also calculates the rating factors for all truss members. The specification checking is performed in accordance with the AASHTO LRFD Bridge Design Specifications and the Pennsylvania Department of Transportation Design Manual Part 4.

The truss may be a simple span or a continuous span or a continuous with in span hinges (cantilever truss). A maximum of **fifteen (15)** continuous spans and a maximum of ninety-nine (99) physical panels can be analyzed. Trusses with various panel types, including counters (diagonals that can carry only tension force), can be analyzed.

The program computes member forces, support reactions, panel point deflections, rating factors and the estimated fatigue life of the truss. The applied loads (dead loads and standard live loads or a special live load) as well as the deflections due to temperature change are also calculated. The input and computed values can be printed with various output options.

2.2 PROGRAM FUNCTIONS

TRLRFD performs the following functions:

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

2. Section Properties - The program computes the section properties (steel only) for positive and negative flexure. The program considers reduction in section properties due to deterioration and/or holes.

3. Structural Analysis - The program computes the member forces, reactions and deflections for permanent loads and transient loads. Permanent loads are dead loads of structural components and nonstructural attachments (DC), and dead loads of wearing surfaces and utilities (DW). 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 (DC and DW) and transient loads (LL and IM) by the load factors for the limit state under consideration. The program considers Strength I, Strength IA, Strength II, Service II, Service IIA, Service IIB, Extreme Event III, Extreme Event IV, and Fatigue 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 load effects are also multiplied by the appropriate load factor.

5. Specifications Checking - The program checks conformance to the LRFD Specifications. The specifications are checked within each member for each limit state. The program checks specifications for axial force, combined axial force and moment and fatigue.

6. Live Load Ratings - The program computes the live load rating factors for axial force. The program computes inventory and operating ratings for the appropriate live loadings and limit states.

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

8. Gusset Plate Analysis and Rating - The program analyzes and calculates operating level ratings for gusset plates according to the Load and Resistance Factor Design Method.

2.3 LIVE LOADINGS

The user has several live load options; 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
TK527	-	PennDOT TK527 live loading
SLL	-	User-defined special live loading
EV2	**-**	**PennDOT single rear axle emergency vehicle**
EV3	**-**	**PennDOT tandem rear axle emergency vehicle**
SU6TV	**-**	**PennDOT heavy-duty tow and recovery vehicle**
P2016-13	**-**	**PennDOT 13 axle permit design vehicle**

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

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

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

The live loads to be used are designated by the user by entering a live load code. The live load code is an upper-case alphabetic character, A, B, C, D, E, F**, **G**, H, I, or J**. 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, and ratings. Separate rating tables are generated for each live load designation.

EV2, EV3, and SU6TV loads are described in the FHWA FAST Act, effective December 4, 2016.

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

The axle loads and axle spacings for the P2016-13 permit truck and the FHWA FAST Act vehicles are presented in Figure 3.

For the ML-80**,** TK527**, and P2016-13** loading, all axles are always included while for P-82 loading noncontributing axles are neglected.

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

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

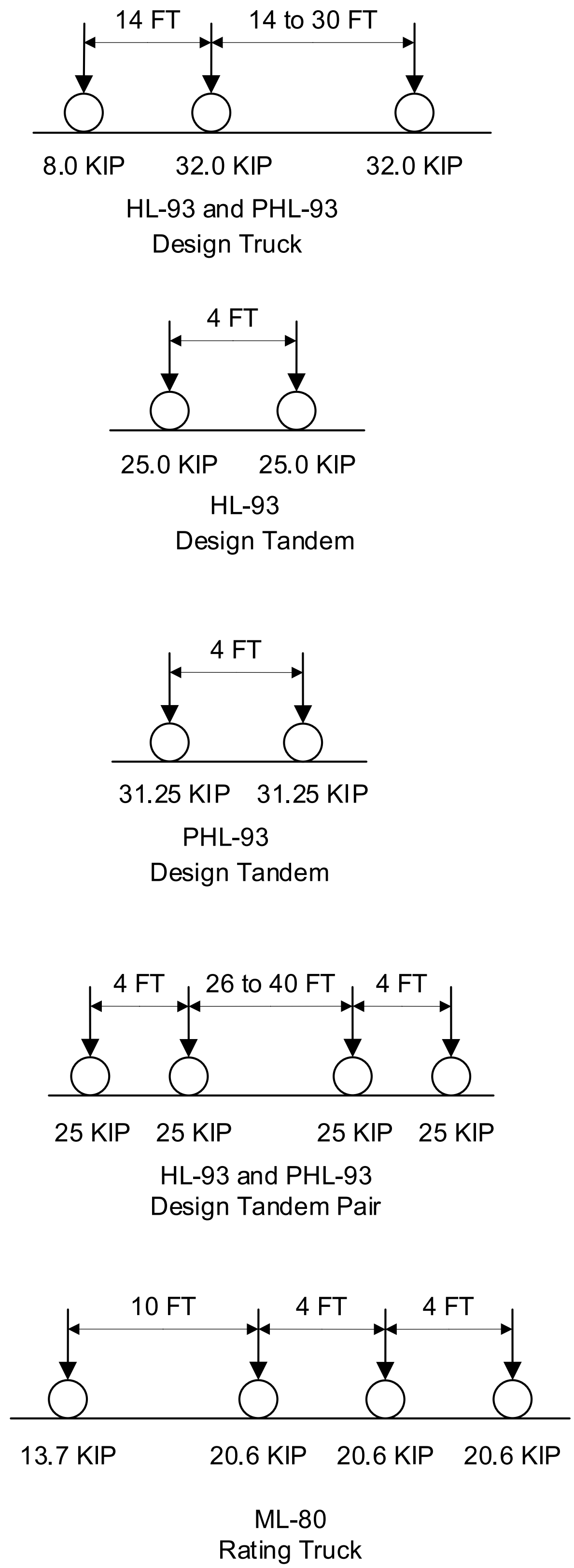
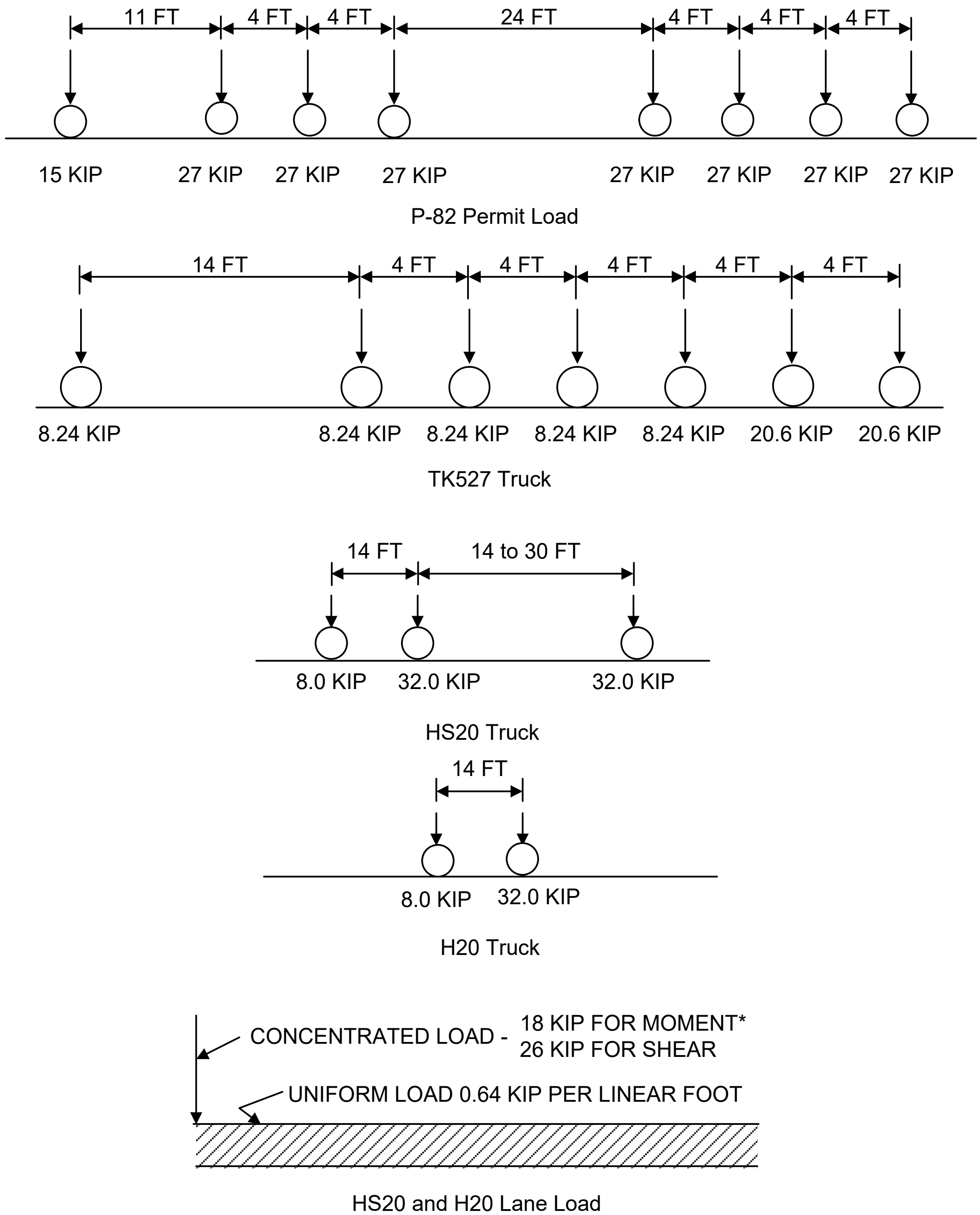
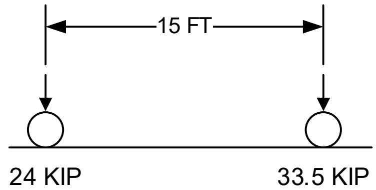


Figure 2.3-1 LRFD and ML-80 Live Loading

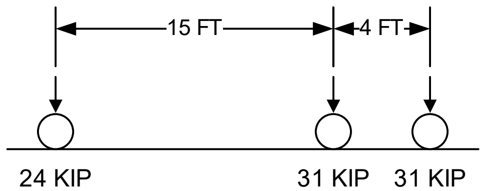


* use two concentrated loads for negative moment

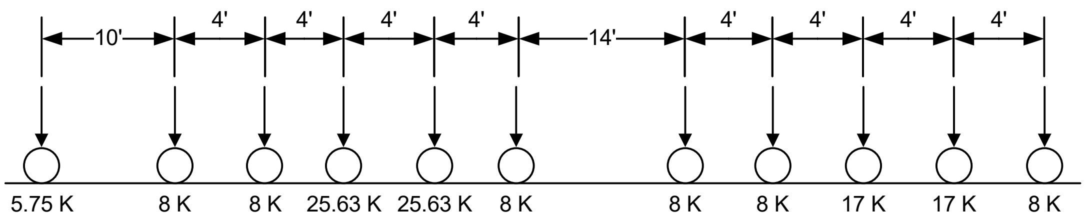
Figure 2.3-2 P-82, HS20, H20 and TK527 Live Loading



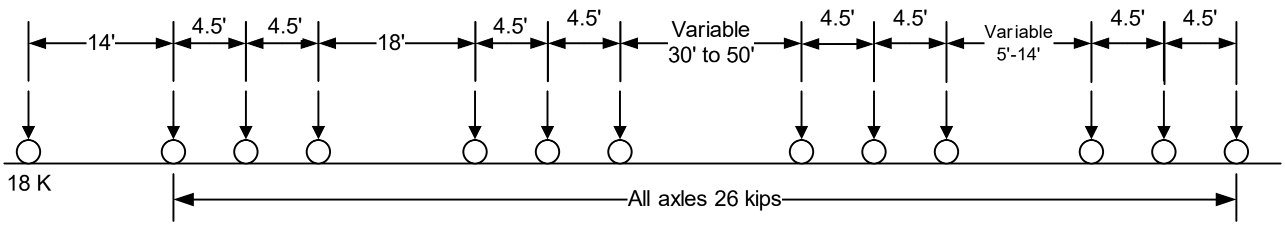
EV2 (Single Rear Axle Emergency Vehicle)



EV3 (Tandem Rear Axle Emergency Vehicle)



SU6TV (Heavy-Duty Tow and Recovery Vehicle)



P2016-13 (13 Axle Permit Design Vehicle)

Figure 2.3-3 EV2, EV3, SU6TV, and P2016-13 Live Loading

Table 2.3-1   Live Loadings

Load Case	Live Load Code						
	A	B	C	D	E	F	G
Strength I Limit State	PHL–93 H20 HS20 ML-80 TK527	HL–93 H20 HS20	ML–80	--	SLL	User-specified as appropriate	TK527
Strength IA Limit State	PHL–93	HL–93	--	--	SLL	User-specified as appropriate	--
Strength II Limit State	P-82 H20 HS20 ML-80 TK527	H20 HS20	ML–80	P–82	SLL	User-specified as appropriate	TK527
Service II Limit State	PHL–93 H20 HS20 ML-80 TK527	HL–93 H20 HS20	ML–80	--	SLL	User-specified as appropriate	TK527
Service IIA Limit State	PHL–93 H20 HS20 ML-80 TK527	HL–93 H20 HS20	ML–80	--	SLL	User-specified as appropriate	TK527
Service IIB Limit State	P-82	--	--	P–82	SLL	User-specified as appropriate	--
Fatigue	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle
Deflection	LRFD Deflection Loading	LRFD Deflection Loading	LRFD Deflection Loading	LRFD Deflection Loading	LRFD Deflection Loading	User-specified as appropriate	LRFD Deflection Loading
Ratings	PHL–93 H20 HS20 ML-80 TK527	HL–93 H20 HS20	ML–80	P-82	SLL	User-specified as appropriate	TK527

Table 2.3-1 Live Loadings (Continued)

Load Case	Live Load Code		
	H	I	J
Strength I Limit State	--	PHL–93 H20 HS20 ML-80 TK527	--
Strength IA Limit State	--	PHL–93	--
Strength II Limit State	P2016-13	P-82 P2016-13 H20 HS20 ML-80 TK527	EV2 EV3 SU6TV
Service II Limit State	--	PHL–93 H20 HS20 ML-80 TK527	--
Service IIA Limit State	--	PHL–93 H20 HS20 ML-80 TK527	--
Service IIB Limit State	P2016-13	P-82 P2016-13	EV2 EV3 SU6TV
Fatigue	Fatigue Vehicle	Fatigue Vehicle	Fatigue Vehicle
Deflection	LRFD Deflection Loading	LRFD Deflection Loading	LRFD Deflection Loading
Ratings	P2016-13	PHL–93 H20 HS20 ML-80 TK527	EV2 EV3 SU6TV

2.4 RATINGS DEFINITION

The program computes the live load rating factors for axial force for Strength I, Strength II, Service II, Service IIB, and Extreme Event III limit states. No rating factor is computed for the Extreme Event IV limit state. The live load rating factor is defined as the ratio of the live load reserve capacity divided by the factored live load effect. The live load reserve capacity is equal to the section axial capacity minus all dead load axial stresses. The program does not distinguish between inventory and operating ratings for the live loadings and limit states. 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 Strength I, Strength II, Strength IIA Service II, Service IIA, Service IIB, and Extreme Event III limit states are used for 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 3.6.

Table 2.4-1 Live Load Ratings

Live Loading	Live Load Combination							
	Str I	Str IA	Str II	Srv II	Srv IIA	Srv IIB	EE III	EE IV
PHL-93/ HL-93	R	R		R	R		R	
P-82/ **P2016-13**			R			R	R	
ML-80	R		R	R	R		R	
Special Live Load	R		R	R	R		R	
TK527	R		R	R	R		R	
EV2			**R**			**R**		
EV3			**R**			**R**		
SU6TV			**R**			**R**		
HS20	R		R	R	R		R	
H20	R		R	R	R		R	

Notes:
R - Rating is done for this live load and limit state

2.5 ASSUMPTIONS AND LIMITATIONS

Certain assumptions and limitations of the program are listed here for reference.

1. TRLRFD is not approved for final design, but can be used for preliminary member sizing.
2. Only one truss (the left side) of the bridge is analyzed in a given run. If the loads or geometry or member properties are different on both trusses of a bridge, then each truss must be analyzed separately.
3. The LRFD method is used for the analysis and rating of truss members and gusset plates.
4. Only one live loading is considered in a lane for a standard loading.
5. Extreme Event and Fatigue analysis cannot be not done for runs of the program with Loaded Lane Analysis.
6. Trusses may ONLY have vertical panel ends and vertical loads. (i.e. The x-coordinate of the top panel point must match the x-coordinate for the corresponding bottom panel point.)
7. Truss is ONLY checked for dead loads factored by minimum load factors or maximum load factors. The effect of mixing minimum and maximum DL factors is not considered.
8. Dead load distribution to the truss members is computed assuming that all dead loads are applied after erection is completed.
9. Fatigue stresses do not include additional stresses due to end connection eccentricity.
10. Fatigue is only checked in truss members subjected to a net applied tensile stress.
11. All plates/shapes within a given truss member are assumed to have the same yield strength.
12. Since sections are assumed to be homogeneous and noncomposite, the elastic neutral axis and the plastic neutral axis occur at the same location.
13. The bolt or rivet holes are only considered for the computation of net area.
14. The input deteriorations are assumed to be uniform across the entire section element.

15. For built-up sections with web plates connected to flange plate using angles, the web for computing the depth of web in compression is assumed to begin at the centerline of the outermost bolt connecting the vertical legs of the angles to the web plate. The distance from the outer edge of the vertical leg of these angles to the centerline of the outermost bolt is assumed to be 1.5 inches.

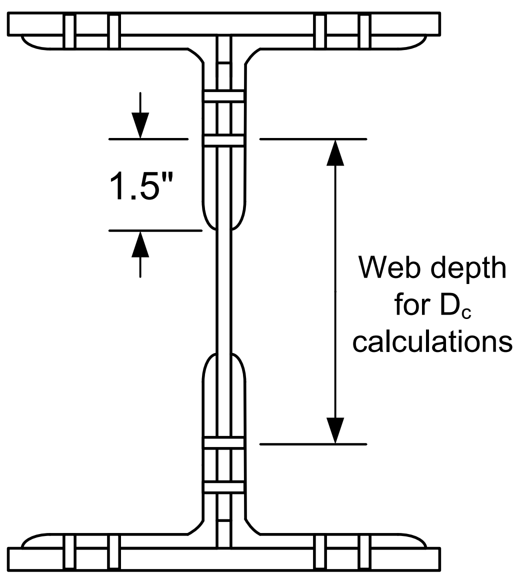


Figure 2.5-1 Dimensions for sections with angles

16. The section is broken into rectangular segments to compute section properties. This may lead to slight deviations from properties of rolled sections in the AISC Manual.

17. For gusset plate analysis, the reduction factor for shear block rupture, U_{bs}, is assumed to be 1.0 for uniform tension stress, and bolt threads are assumed to be present in the shear plane. For gusset plate analysis and tension member capacity, bolt holes are assumed to be drilled full size or subpunched and reamed to size.

18. **The information entered for the gusset plates (GUS command), member end conditions (GMB), filler plates (GFL), and chord splices (GCS) result in an idealized model of a gusset plate connection (as shown in the figures shown with those commands). The information entered on these commands is not cross-checked with the truss members entered on the T## commands and cannot be cross-checked with the generic sections entered via the PRP command to ensure that the geometries are compatible. Because of this, it is the responsibility of the engineer to ensure that the specification checks done by TRLRFD (procedure and assumptions described in section 3.12 of this User's Manual) will adequately capture the conditions of the structure being modeled.**

3 METHOD OF SOLUTION

The program analyzes the truss using the classical force and displacement method assuming the truss as a pin connected assembly with loads transmitted to the truss at the panel points. The load effects (member forces, reactions and deflections), rating factors, and the fatigue life of the truss are calculated in accordance with the applicable specifications mentioned in the Program Description.

The following sections explain the methodologies used in the program.

3.1 GEOMETRY

The geometry of the truss is defined by the user by entering the dimensions of each panel of the truss. A truss panel is defined as a group of truss members comprising of the top chord, bottom chord, upper diagonal, lower diagonal, and vertical members to the right side of the panel. Different geometry configurations of panel members are defined by panel types. From the truss geometry input the program determines the coordinates of each truss joint and the length and orientation of each truss member. The joint coordinates, member lengths and member orientations are used in calculating the member forces while analyzing each panel by the method of joints and sections.

3.2 CROSS SECTION PROPERTIES

The program computes the following elastic section properties using formulae which can be found in any structural engineering textbook: gross area, net area, moments of inertia about each axis and moment resistance about each axis.

The bolt or rivet holes are only considered for the computation of net area. Simply, the program computes:

$$A_{net} = A_g - A_{holes}$$

where: A_{net} = net area of cross section

A_g = gross area of cross section

A_{holes} = total area of holes in cross section

3.2.1 Torsional Constant for Box-shaped Sections

The torsional constant (J) for closed sections (i.e., box-shaped sections) is computed using LRFD Equation C6.12.2.2.2-3. Only the elements within the closed area are considered. In other words, all projecting elements are neglected. For the case of Section Type T12, a box section with three web plates, the center plate is also neglected for the torsional constant computation.

$$J = \frac{4A^2}{\Sigma \frac{b}{t}}$$

where: J = torsional constant

A = area enclosed within the centerlines of the plates comprising the box

b = clear distance between the main connecting elements of the box

t = thickness of the main connecting element which constitutes a side of the box. If more than one plate comprises a side, an average thickness is used.

Figure 1 illustrates how to calculate the value A for the expression above.

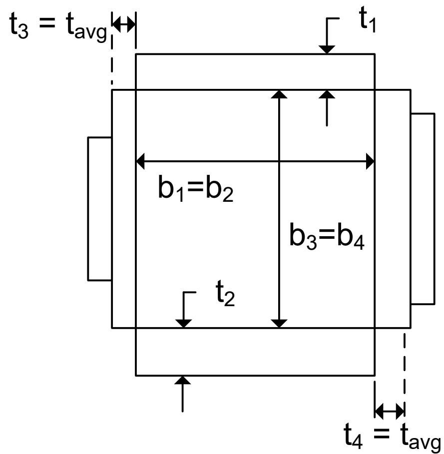


Figure 3.2-1 Torsional Constant for Box-Shaped Section

$$t_{avg} = \frac{total\ area\ of\ elements\ comprising\ a\ side}{length\ of\ the\ side}$$

$$A = \left(b_1 + \frac{t_3}{2} + \frac{t_4}{2}\right)\left(b_3 + \frac{t_1}{2} + \frac{t_2}{2}\right)$$

3.2.2 Torsional Constant for Thin-Walled Sections

The torsional constant, J, for thin-walled sections (I- or T-shaped sections or channels) is calculated according to the LRFD Specifications, Equation A6.3.3-9:

$$J = \frac{Dt_w^2}{3} + \frac{b_{fc}t_{fc}^3}{3}\left(1 - 0.63\frac{t_{fc}}{b_{fc}}\right) + \frac{b_{ft}t_{ft}^3}{3}\left(1 - 0.63\frac{t_{ft}}{b_{ft}}\right)$$

where: D = depth of web plate

t_w = thickness of web plate

b_{fc} = width of compression flange

t_{fc} = thickness of compression flange

b_{ft} = width of tension flange

t_{ft} = thickness of tension flange

Any portions of the angles or plates making up the section that appear to act as a flange will be added into the flange terms, with each piece treated as its own "flange", and each piece having a thickness equal to the total thickness at that point. For example for section T09, the top flange is broken up into five pieces, each of which is the full thickness of the flange over its entire width:

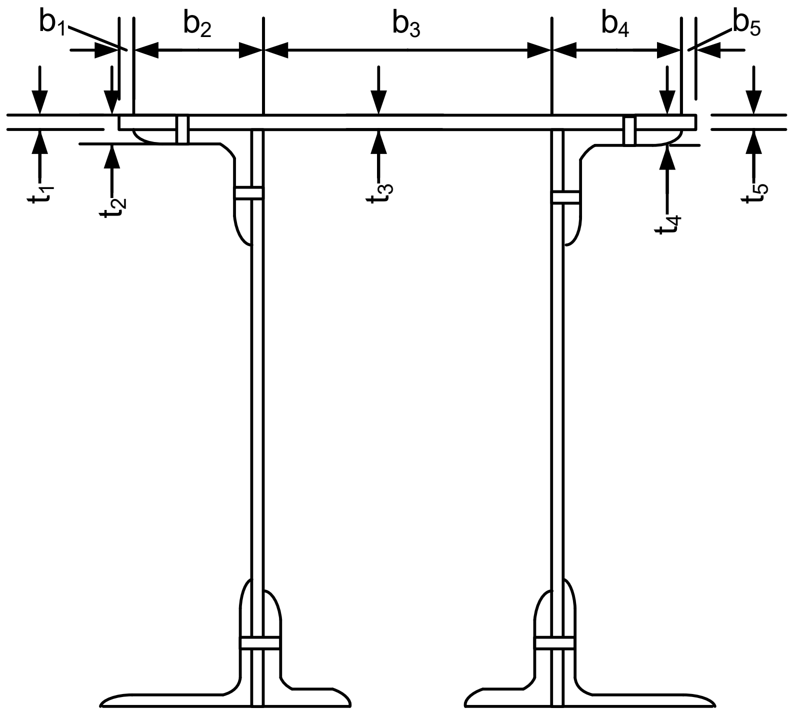


Figure 3.2-2 Top Flange Elements of Member T09

Similar logic is followed for the web and bottom flange elements, in that a given width has an assumed constant thickness over the entire width and is the full thickness at that width.

For the thin-walled sections (T09-T11 and T14-T19 in Section 5.15 of this User's Manual), the torsional constant is only used in calculating the Flexural-Torsional buckling resistance using LRFD Specifications Equation 6.9.4.1.3-5.

3.2.3 Plastic Moment

The plastic moment of the section (M_p) is calculated assuming all fibers of the section are stressed to the yield strength (F_y). Forces in the various elements of the section are calculated by multiplying the element area and the yield strength. The sum of the element forces above the neutral axis should equal the sum of element forces below the neutral axis. The plastic moment is then found by summing the first moment of all element forces about the plastic neutral axis. Refer to Figure 3.2-3.

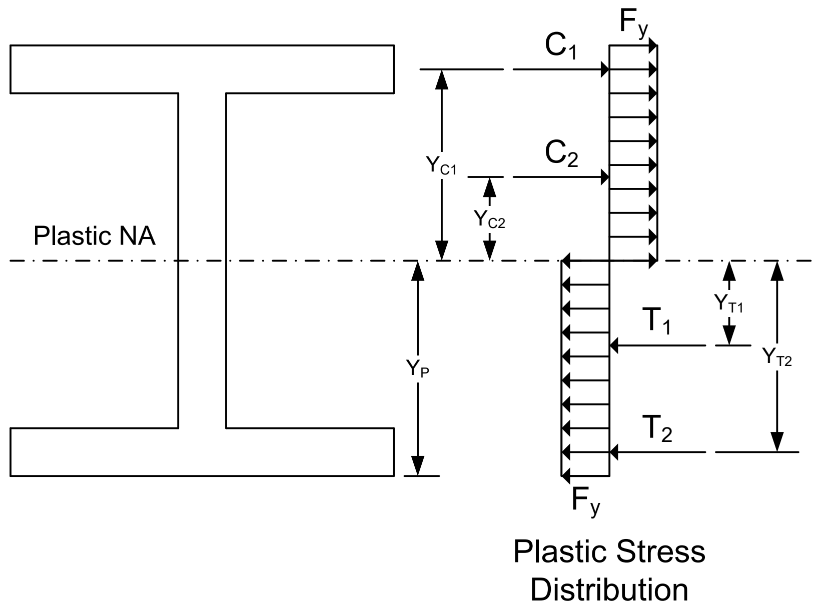


Figure 3.2-3 Plastic Moment of Homogeneous Noncomposite Section

$$M_p = C_1 Y_{C1} + C_2 Y_{C2} + T_1 Y_{T1} + T_2 Y_{T2}$$

where: M_p = plastic moment capacity

C_1 = area of top flange * F_y

C_2 = area of web above plastic NA * F_y

T_1 = area of web below plastic NA * F_y

T_2 = area of bottom flange * F_y

F_y = yield strength of steel

3.2.4 Slender Element Reduction Factor, Q

The slender element reduction factor, Q, is used in computing the nominal yield resistance of a member in compression. Calculation of the factor is based on the cross section geometry of the member. Because of this, the calculation is slightly different for each of the 19 cross sections allowed by TRLRFD. The process for computing this value for a single cross section type (T09) is described here. The process is similar for each cross section.

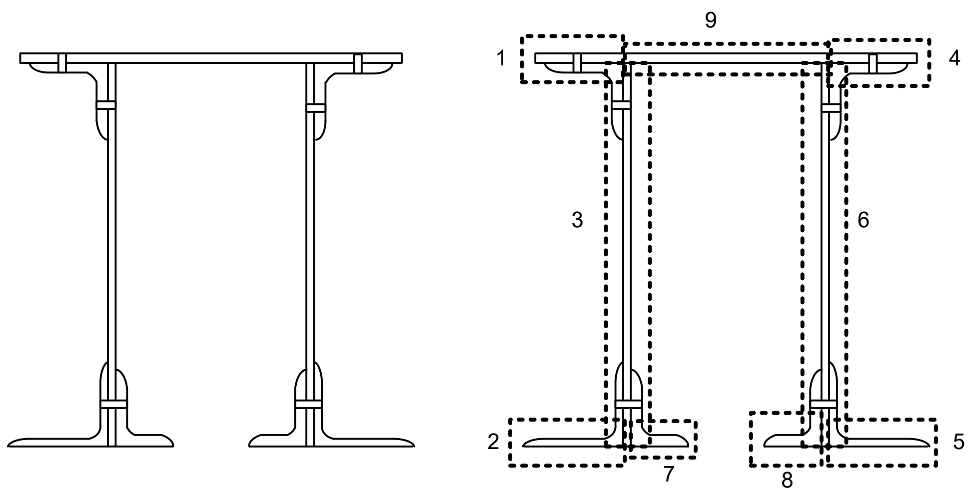


Figure 3.2-4 Cross Section T09

Q is a measure of the total slenderness of the cross section and is defined in LRFD Specifications Article 6.9.4.2. A Q of 1.0 indicates that the entire member is nonslender, so the section can reach the full yield strength of the cross section. Each element of the cross section is considered separately. For member type T09, the section is broken up into nine separate elements for the calculation of Q, as shown in Figure 4. The definition of these elements is helped by LRFD Specifications Table 6.9.4.2-1 and for T09, the elements are:

1. Top left flange
2. Bottom left flange
3. Left web
4. Top right flange
5. Bottom right flange
6. Right web
7. Bottom left inside flange
8. Bottom right inside flange
9. Top middle flange

Even though the cross section appears to be symmetrical, the user can define different section losses on each element, so each element is considered separately. Equivalent widths and thicknesses are determined for each element. For example, for element 1, the equivalent width is the larger of the dimension from the centerline of the left web to left edge of the flange plate or the length of the horizontal leg of the angle. The equivalent thickness is then determined by finding the total area of the flange plate (top plate from the centerline of left web to left edge + horizontal leg area, less any section loss) and dividing by the equivalent width. A similar procedure is followed for all nine elements.

Next, each element is classified as to whether it is stiffened or not. For the purposes of TRLRFD, an element is stiffened if it is braced on both ends. For T09, elements 3, 6, and 9 are considered stiffened. Elements 1, 2, 4, 5, 7, and 8 are considered to be flange elements. It just so happens that for this cross section, the flange elements mutually exclusive of the stiffened elements. This is not always the case.

The final value to be defined is the plate buckling coefficient for each element, also defined by LRFD Specifications Table 6.9.4.2.1-1. Elements 1, 2, 4, 5, 7, and 8 all have k = 0.45, while elements 3, 6, and 9 have k = 1.49.

After considering all of these assumptions and values, the slenderness of each element is checked based on the expressions in LRFD Specifications Article 6.9.4.2.1. For any unstiffened slender elements, then Q_s values are calculated for each slender element according to LRFD Specifications Equations 6.9.4.2.2-1 through -8. For any stiffened slender elements, Q_a values are calculated with LRFD Specifications Equations 6.9.4.2.2-9 through -11.

If all elements are nonslender, Q = 1.0. If all slender elements are unstiffened, Q = minimum Q_s value of all elements. If all slender elements are stiffened, $Q = Q_a$. If there is a mix of slender stiffened and unstiffened elements, $Q = Q_s * Q_a$, where Q_s is the smallest Q_s value of slender unstiffened elements.

3.3 STRUCTURAL ANALYSIS

Analysis of a truss is performed as a planar frame assuming the truss to be a pin connected assembly. All loads are transmitted to the truss through panel points. This section explains how the truss is analyzed for a given loading.

3.3.1 Simple Span Truss

A simple span truss is analyzed by the method of joints and sections. For this method, first the reaction due to given loads applied at the joints is calculated by taking the moment due to all loads about the right support and then dividing this moment by the truss span length. The member forces are then calculated by taking sections through each panel or around a joint and applying equilibrium equations to the isolated truss part or joint. The loading conditions considered are the input truss dead loads and a unit load applied at each joint one at a time to generate influence lines.

3.3.2 Simple Span Truss With Counters

A simple span truss with counters (diagonals that can carry only tension force) is analyzed in the same manner as the simple span truss except that when a section taken through a panel, one diagonal in the panel is first removed and the member force in the remaining diagonal is calculated applying the equilibrium equations. If the member force in the assumed diagonal is tension, then the next panel is analyzed. If the member force in the assumed diagonal is compression, then the removed diagonal is put back removing the other diagonal and member forces are calculated applying the equilibrium equations to the isolated truss part or joint. Influence lines are not generated for the truss with counters.

3.3.3 Continuous Truss

The method utilized for analysis of a continuous truss is a matrix method called the Flexibility Method. The reactions are solved by formulating as many simultaneous equations as there are supports. Two equilibrium equations are formed by setting the summation of all vertical loads to zero and the summation of moments of all loads about the left most support equal to zero. The compatibility equations are formed by setting the deflections at intermediate supports for a determinate truss (a truss with intermediate supports removed) equal to and opposite in sign of deflections due to a vertical force applied at each support equal to unknown reaction. These equations are then solved by matrix algebra. The deflections at intermediate supports for a determinate truss are calculated using the method of virtual work. A continuous truss is analyzed for the input truss dead loads and a unit load applied at each joint one at a time to generate influence lines.

3.3.4 Cantilever Truss

A cantilever truss is a continuous truss with in-span hinges. The program assumes that a cantilever truss is a statically determinate truss, i.e. the truss has as many hinges as there are redundant reactions (Number of supports = 2 + number of hinges). The reactions are solved by formulating as many simultaneous equations as there are supports. The equations are formed by:

1. Setting the sum of all vertical loads equal to zero.
2. Setting the sum of moments for all vertical loads and reactions about the left most support equal to zero.
3. Setting the moment of all loads and reactions about each hinge equal to zero.

These equations are then solved by matrix algebra. Once the reactions are known, member forces are determined by method of joints and sections.

3.4 DEAD LOAD ANALYSIS

Dead loads acting on the truss are calculated by the user and are input as joint loads. All loads are assumed to be transmitted to the truss though upper and lower panel points. A load cannot be applied at the middle joint in a subdivided panel. Dead load reactions and member forces are calculated using the methods explained under Structural Analysis.

3.5 LIVE LOAD ANALYSIS

For the purpose of live load analysis, trusses are divided into two categories. These are: A. Simple span trusses with counters, and B. Simple or continuous span trusses without counters.

A truss without counters is analyzed by the influence line method. For this, a unit vertical load is applied one at a time at each upper or lower joint, depending upon whether it is a deck truss or through truss, and the member forces are found using the method described above for the dead load analysis. When all joints are loaded, the influence lines for member forces are generated. Each influence line is then analyzed for the maximum live load effect by the method described later in this section.

Live load analysis of trusses with counters is described later in this section.

3.5.1 Live Loads

The following **groups and individual** live loads are permitted with the program. **For each of these live loads, a fatigue vehicle will automatically be included when needed for** a fatigue analysis.

3.5.1.1 PHL-93, P-82, ML-80, TK527, HS20 and H20

PHL-93 loading is the vehicular live loads consisting of the Design Truck, 1.25 times the Design Tandem, and Design Lane Load as defined in the LRFD Specifications. P-82 is the 204 kip Permit Load. ML-80 is the maximum legal load in Pennsylvania. The AASHTO HS20 live loading and AASHTO H20 live loading are in accordance with the AASHTO Standard Specifications for Highway Bridges, where an equivalent lane location (uniform load and one or two concentrated floating loads) is also considered in addition to the truck and the governing effects are stored.

3.5.1.2 HL-93, HS20 and H20

PHL-93 loading is the vehicular live loads consisting of the Design Truck, Design Tandem, and Design Lane Load as defined in the LRFD Specifications. The AASHTO HS20 live loading and AASHTO H20 live loading are in accordance with the AASHTO Standard Specifications for Highway Bridges, where an equivalent land location (uniform load and one or two concentrated floating loads) is also considered in addition to the truck and the governing effects are stored.

3.5.1.3 ML-80

ML-80 is the maximum legal load in Pennsylvania.

3.5.1.4 P-82

P-82 is the 204 kip Permit Load.

3.5.1.5 TK527

The TK527 live loading is a new posting vehicle described in DM-4 3.6.1.2.9P.

3.5.1.6 Fatigue Truck

The fatigue truck is the LRFD Design Truck without the lane load and with a 30' fixed spacing between the 32 kip axles as defined in the LRFD Specifications.

3.5.1.7 User Defined Loading

One loading can be defined by the user for each run by entering the loading parameters such as axle loads, axle spacings and uniform lane load.

3.5.1.8 P2016-13

The PennDOT Design Permit Vehicle (P2016-13) is a 165 ton, 13-axle non-notional load to check Strength II, Service IIB, Extreme Event III, and Extreme Event IV.

3.5.1.9 PHL-93, P-82, P2016-13, ML-80, TK527, HS20 and H20

PHL-93 loading is the vehicular live loads consisting of the Design Truck, 1.25 times the Design Tandem, and Design Lane Load as defined in the LRFD Specifications. P-82 is the 204 kip Permit Load. P2016-13 is the 330 kip PennDOT Design Permit Load. ML-80 is the maximum legal load in Pennsylvania. The AASHTO HS20 live loading and AASHTO H20 live loading are in accordance with the AASHTO Standard Specifications for Highway Bridges, where an equivalent lane location (uniform load and one or two concentrated floating loads) is also considered in addition to the truck and the governing effects are stored.

3.5.1.10 EV2, EV3, and SU6TV

The EV2, EV3, and SU6TV vehicles are load rating vehicles from FHWA's memo, "Load Rating for the FAST Act's Emergency Vehicles", dated November 3, 2016.

3.5.2 Truck Load Effect (Truss with counters)

For a simple span truss with counters, the actual live load is moved across the truss considering one joint at a time and trying all possible load positions to produce the maximum effect. The analysis begins with the assumption that the dead load forces are already present when the live load is applied. This is important to assure the proper action of the diagonal (counter) for a given position of the live load. For each joint, the following positions of the live load are tried. First, the axle number one is placed at the joint under consideration and all other axles are placed to the left in their respective positions. For the axles that fall between the joints, equivalent joint loads are computed assuming the panel to act as a simple span. For this position of the load, the combined factored loads (dead load plus live load plus dynamic effect) are computed. When lane load in included with a truck, three lane conditions are checked:

1. lane load across the entire truss
2. lane load from the left support to a point beyond the truck and before the next panel point.
3. lane load from the right support to a point beyond the truck and before the next panel point.

The arbitrary point between the end axle and the next panel point for lane conditions 2 and 3 is developed by iterating between tenth points along the panel and checking for effect. These lane load iterations are checked for each truck location and the absolute maximum forces are stored for each member. Next, the axle number two is placed over the joint and the procedure described above is repeated. This process is continued until the last axle is over the joint. Then the axles are placed such that the center of gravity of the load coincides with the joint and the member forces are computed again. Next, the axle loads are reversed and the whole procedure is repeated. This gives the effects of the live load moving across the bridge in the other direction. When this process is completed, the absolute maximum force is obtained for each member. The live load force is then obtained by algebraically subtracting the dead load force from the absolute maximum force.

3.5.3 Truck Load Effect (Truss without counters)

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 or P-82 vehicle for LRFD loading, the axle loads which do not contribute to the effect being sought are neglected, i.e. 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.

3.5.3.1 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 ft. For this the program starts with a design truck with 14 ft between the rear axles and analyzes the influence line as explained under Truck Load Effect. The effect of the design truck so defined is stored. Next, a new design truck is defined by adding 0.5 ft 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 ft. 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 ft.

3.5.3.2 Variable Spacing of Truck or Tandem Pair

The LRFD Specifications require that in calculating the negative moment at any section between the point of dead load contraflexure and the interior support, and in calculating the reaction at the interior support, the spacing between the two trucks of the design truck pair may vary from 50 ft 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 ft. The influence line is analyzed for so defined single truck as explained under 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 ft, 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 ft 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 varied from 26 to 40 ft. For both the truck pair and tandem pair, the vehicles are placed in adjacent spans. The vehicles are never placed in the same span.

3.5.3.3 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.

For HS20 and H20 loads, the effects of lane loading must be investigated. To find the effects of lane loading (uniform load plus one or two floating concentrated loads), 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 the 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 in the same manner. The negative load loading effect is computed in a similar manner. The governing effects are stored. The program applies Dynamic Load Allowance to the H and HS lane loading effect.

3.5.4 Member Forces Due to Positive Moment

For PHL-93 and HL-93 loads, in calculating the compressive force in top chord, tensile force in the bottom chord or any force in the diagonal, 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 under Truck Load Effect. The design truck effect is multiplied by the impact factor, then added to the design lane load effect and is stored as the combined design truck and lane load effect. Next the same procedure is repeated for the design tandem and the design lane load. The larger of these two effects is stored as the positive moment. The member force in a diagonal or a vertical, the negative reaction at an interior support, the positive and negative reaction at an exterior support are calculated in the same manner as the chord force, in calculating the negative shear and reaction due to the design lane load, the negative area of the influence line is used.

For HS20 and H20 loads, the maximum effect of the design truck is calculated by moving the load across the influence line as explained under Truck Load Effect and then the effects of lane loading must be investigated. To find the effects of lane loading (uniform load plus one floating concentrated load), the sum of all areas of the influence line are computed. Also, the absolute maximum ordinate is found. To find the lane loading effect, the sum of the areas is multiplied by the uniform load and added to the product of the maximum ordinate and the applicable (moment or shear) concentrated load in the same manner. The governing effects are stored, and the maximum of the truck or lane loading is used. The program applies Dynamic Load Allowance to the H and HS lane loading effect.

3.5.5 Member Forces due to Negative Moment

For PHL-93 and HL-93 loads, the AASHTO LRFD Specifications defines the negative moment area as the area between points of dead load contraflexure. In a truss these points are the panels that have dead load tension in the top chord and dead load compression in the bottom chord. All truss chord members in this panel range as well as the reactions at the interior piers shall be 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

Effects 1 and 2 are calculated in the same manner explained under Positive Moment due to LRFD Loading. Effects 3 and 4 are calculated as follows. The maximum effect of the design tandem pair is calculated as explained under Variable Spacing of Truck or Tandem Pair. The tension effects are checked for the top chord only and the compression effects are checked for the bottom chord only. The design tandem pair effect is multiplied by the impact factor and is added to the tension or compression design lane load effect to get Effect 3. Similarly Effect 4 is calculated using the design truck pair. The larger of Effect1, Effect 2, 100% of Effect 3 and 100% of Effect 4 is stored as the governing effect for PHL-93 moments. The larger of Effect1, Effect 2, 100% of Effect 3 and 90% of Effect 4 is stored as the governing effect for PHL-93 pier reactions. The larger of Effect 1, Effect 2, 100% of Effect 3, and 90% of Effect 4 is stored as the governing effect for HL-93 moments and pier reactions.

For HS20 and H20 loads, the maximum effect of the design truck is calculated by moving the load across the influence line as explained under Truck Load Effect and then the effects of lane loading must be investigated. To find the effects of lane loading (uniform load plus one or two floating concentrated loads), the sum of all areas of the influence line are computed. Also, the absolute maximum ordinate is found. To find the lane loading effect, the sum of the areas is multiplied by the uniform load and added to the product of the maximum ordinates and the moment concentrated load in the same manner. The governing effects are stored, and the maximum of the truck or lane loading is used. The program applies Dynamic Load Allowance to the H and HS lane loading effect.

3.5.6 Live Load Distribution

The live load distribution factor is defined as a fraction (or multiple) of the axle load that is carried by the left bridge truss. The live load distribution factors for member force, fatigue, and deflections can be determined and entered by the user. If left blank, the deflection distribution factor will default to the member force distribution factor. The live load distribution factor for truss force can be computed by the program in accordance with the LRFD Specifications "lever rule". The "lever rule" is defined as the statical summation of moments about one point to calculate the reaction at a second point. The LRFD Specifications section 4.6.2.4 states that the lever rule is applicable for the distribution of gravity loads in trusses when analyzed as planar structures. Therefore, TRLRFD uses the "lever rule" as explained below.

The distribution factor calculated for the truss is a function of the width, number and location of traffic lanes, the distance between two wheels (gage distance), the minimum distance between two passing vehicles (passing distance) and the center to center spacing of main girders or trusses. The distribution factor is computed either based on program-defined design traffic lanes, with the same live load placed in each lane (determined by the program in accordance with AASHTO Specifications) or user-defined traffic lanes, with the user choosing lane placement and which live load will appear in each lane. The live load member force used in calculating the rating based on program-defined or user-defined lanes is obtained by applying the appropriate distribution factor.

When using program-defined design traffic lanes (CTL command, live load options A, B, C, D, E, or G), the distribution factor is computed by placing the wheels within each lane in accordance with the LRFD Specifications such that the maximum reaction occurs at the left truss centerline. The reaction expressed as a fraction (or multiple) of the total number of lanes is the distribution factor. This distribution factor is then multiplied by the multiple presence factors described in the LRFD Specifications section 3.6.1.1.2, depending on the number of lanes loaded. The program repeats this process with a different number of lanes loaded and will use the largest distribution factor found.

When using user-defined design traffic lanes (CTL command, live load option F along with the LLP command), the location of each lane and the vehicle which occupies each lane is specified. The wheels are placed within each lane in accordance with the LRFD Specifications such that the maximum reaction occurs at the left truss centerline. The reaction expressed as a fraction of axles for each lane is the distribution factor for each lane. The distribution factor for each truck is the sum of the lane distribution factors which contain the same vehicle. The multiple presence factors are included in loaded lane analysis, but the program does not attempt to maximize the distribution factor by loading different numbers of lanes. For example, if the user defined four lanes, four lanes are always loaded even if loading only three of those lanes will result in a larger distribution factor.

3.6 LOAD COMBINATIONS AND STRESSES

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 IA, Strength II, Service II, Service IIA, and Service IIB limit states. The load factors used for each load type per limit state is shown in Table 1. 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 3.6-1 Load Factors

Load Combination	**Loading**						
	γ_{DC}	γ_{FWS}	γ_{LL}	γ_{PL}	γ_{SPVH}	γ_{WS}	**Live Loading**
Strength I	1.25, 0.90	1.50, 0.65	1.75	--	User Def.	--	PHL-93
Strength IA	1.25, 0.90	1.50, 0.65	1.35	--	--	--	PHL-93
Strength II	1.25, 0.90	1.50, 0.65	1.35	--	User Def.	--	Permit (P-82)
Service II	1.00	1.00	1.30	--	User Def.	--	PHL-93
Service IIA	1.00	1.00	1.00	--	User Def.	--	PHL-93
Service IIB	1.00	1.00	1.00	--	User Def.	--	Permit (P-82)
Extreme III	1.25, 0.90	--	1.30	--	User Def.	--	PHL-93 Permit (P-82)
Fatigue I	**--**	**--**	**1.75***	**--**	**--**	**--**	**HS20-30**
Fatigue II	**--**	**--**	**0.80***	**--**	**--**	**--**	**HS20-30**

***NOTE: The Fatigue II live load factor can be calculated by the program by using the FGV command. See Section 6.37 for a description of this calculation. If the FGV command is used, the Fatigue I load factor is set to 2*the calculated Fatigue-II load factor.**

3.7 MEMBER RESISTANCE

The tensile resistance of the truss member is calculated as per the LRFD Specifications Article 6.8 and the compressive resistance of the truss member is calculated as per the LRFD Specifications Article 6.9. The only flexure considered in a truss member is due to eccentricity of the end connection of the member. Flexural resistance is calculated using LRFD Specifications Articles 6.10 and 6.12, depending on the cross section shape.

3.7.1 Compressive Capacity

The compressive capacity of the section is calculated in accordance with LRFD Specifications Article 6.9.4. The elastic flexural buckling resistance is calculated for all section types. The flexural-torsional buckling resistance is also calculated for section types T09 - T11, and T14 -T19, and the minimum value of flexural buckling and flexural-torsional buckling is chosen as the governing compressive capacity of the member. When determining whether a section is doubly-symmetric or singly-symmetric, deterioration and holes are not considered. **The user can enter different unbraced lengths for elastic flexural buckling about the x- or y-axis, as well as an unbraced length for flexural-torsional buckling about the z-axis of the member (twisting) on the UNBRACED LENGTH (UBL) command.**

3.7.2 Tensile Capacity

The tensile capacity is calculated in accordance with LRFD Specifications Article 6.8. When computing the fracture capacity (LRFD Specifications Equation 6.8.2.1-2), the reduction factor to account for shear lag, U, is assumed to be 1.0 and all holes are assumed to be drilled full size or subpunched and reamed to size, so the reduction factor for holes, R_p, is assumed to also be 1.0.

3.7.3 Flexural Capacity

The flexural capacity of the section is only used in conjunction with the factored axial force and axial resistance of the section. The program does not do any checks of the flexural capacity alone, because the moment in the section is only induced by the axial forces. If there is no axial force, there is no moment.

When computing the flexural resistance, several different methods are used, depending on the cross section type (see Section 5.15 for the available cross section types).

1. For box shaped sections T01, T02, T03, T08 and T12, the expressions from the LRFD Specifications Article 6.12.2.2.2 (Box-Shaped Members) are used for bending about either the X- or Y-axis.

The flexural resistance (Mn) for a box-shaped section is calculated using the following equations according to the LRFD Specifications, Article 6.12.2.2.2. First, calculate the elastic lateral torsional buckling moment (LRFD Specifications Equation C6.12.2.2.2-1):

$$M_{CR} = \frac{\pi}{L_b}\sqrt{EI_yGJ}$$

where: M_{cr} = elastic lateral torsional buckling moment
L_b = unbraced length
E = elastic modulus
Iy = moment of inertia about an axis perpendicular to the axis of bending
G = shear modulus
= 0.385E
J = torsional constant, as defined in section 3.2.1

then the nominal flexural resistance as (LRFD Specifications Equation C6.12.2.2.2-5):

$$M_n = F_yS\left[1 - \frac{F_yS}{4M_{cr}}\right]$$

where: M_n = nominal flexural resistance
Fy = yield strength of steel
S = section modulus about the flexural axis (depends on bending axis and state of flexure. TRLRFD always calculates the resistance with respect to the compression flange)
Mcr = elastic lateral torsional buckling moment, as above

2. For I-shaped cross section types T04, T05, T06, T07, T09, T10, T11, T13, T14 and T19, the expressions from the LRFD Specifications Article 6.10.8 are used for bending about the X-axis. The following assumptions are made when using the methods of the LRFD Specifications Article 6.10.8:

    1. The cross sections are always noncomposite
    2. R_b, the load shedding factor, is calculated as specified in Article 6.10.1.10
    3. R_h, the hybrid factor, is always equal to 1.0 since the cross sections must be homogeneous
    4. C_b, the moment gradient factor, is always equal to 1.0 since moment is constant along the length of the member.

For bending about the Y-axis for types T04, T05, T06, T07, T11, T13, T14 and T19, the expressions from the LRFD Specifications Article 6.12.2.2.1 are used. For sections with compact flanges (the minimum slenderness ratio from either flange is used), the nominal flexural capacity is equal to the plastic moment capacity from C6.12.2.2.1:

$$M_p = 1.5F_yS$$

where: M_p = plastic moment capacity
F_y = steel yield strength (homogeneous sections only)
S = minimum section modulus about the bending axis (to either extreme fiber on compression or tension side)

For noncompact flanges, the flexural capacity is calculated from Equation 6.12.2.2.1-2, again with the minimum section modulus to either edge of the member.

Double web cross-section types T09 and T10 are not allowed to bend about the Y-axis.

3. For channel sections T15 and T16, the expressions from the LRFD Specifications Article 6.12.2.2.5 are used for bending about the X-axis.

   For bending about the Y-axis, the expressions from 6.12.2.2.1 are used (described above for I-shaped sections). The nominal flexural resistance for channels bending about the Y-axis is limited to 1.6 * F_y * S.

4. For tee sections T17 and T18, the expressions of the LRFD Specifications Article 6.12.2.2.4 are used for bending about the X-axis and bending about the Y-axis is not allowed.

3.7.4 Combined Flexure and Tension Force

The eccentricity is used to compute the moment induced in the member due to the tension or compression forces in the member. The member force is multiplied by the eccentricity to find a moment that is constant over the length of the member. This moment is used in conjunction with the axial forces to find the resistance of the section following the procedures defined in the LRFD Specifications Articles 6.8.2.3.

First, assume bending around one axis only and that the bending is equal to the factored tension force (P_u) multiplied by the user input eccentricity (e). Next, assume that P_u / P_r >= 0.2, and rearrange LRFD Specifications Equation 6.8.2.3-2 to solve for P_u:

$$\frac{P_u}{P_r} + \frac{8.0}{9.0}\left(\frac{M_{ux}}{M_{rx}} + \frac{M_{uy}}{M_{ry}}\right) \leq 1.0$$

substituting:

$$\frac{P_u}{P_r} + \frac{8.0}{9.0}\left(\frac{P_u e}{M_r}\right) \leq 1.0$$

rearranging:

$$P_u \leq \frac{1.0}{\left(\frac{1.0}{P_r} + \frac{8.0}{9.0}\left(\frac{e}{M_r}\right)\right)}$$

where: P_u = factored tension force in member

P_r = tensile resistance of member (without consideration of flexure, LRFD Specifications Article 6.8.2)

e = user input eccentricity of end connection

M_r = flexural resistance of member (without consideration of tension force, LRFD Specifications Article 6.10 or 6.12, depending on member shape)

The value of P_u is then divided by P_r, and if the value is less than 0.2, the procedure is repeated in a similar manner with LRFD Specifications Equation 6.8.2.3-1 to find an updated value of P_u. Whichever equation is ultimately used to compute P_u, P_u is then reported as the resistance of the section to combined tension force and flexure.

3.7.5 Combined Flexure and Compression Force

The procedure for calculating the combined flexure and compression capacity of a member is very similar to the procedure for combined flexure and tension, except that the moment in the member is magnified according to the method described in the LRFD Specifications Article 4.5.3.2.2b.

The equations in the LRFD Specifications Article 6.9.2.2 for combined axial compression and flexure are virtually the same as those used in Article 6.8.2.3, so the procedure followed in Section 3.7.4 of this manual will be used again, rearranging the equations to solve for P_u. In this case, however, the equation will be rearranged to a second order polynomial that can be solved by means of the quadratic equation, because the M_u (factored moment) term (which is replaced by P_u * e) is multiplied by a factor from Article 4.5.3.2.2b that also contains P_u.

The following assumptions are made in applying LRFD Specifications Article 4.5.3.2.2b:

1. Sidesway in the member is restricted by the truss system, so the M_{2s} value in Equation 4.5.3.2.2b-1 is zero.
2. When calculating C_m (a factor in Equation 4.5.3.2.2b-3), the moment at both ends of the member is identical, so C_m simplifies to 1.0.
3. Also in Equation 4.5.3.2.2b-3, ϕ_K is 1.0 for steel members

So, Equation 4.5.3.2.2b-3 simplifies to:

$$\delta_b = \frac{1}{1 - \frac{P_u}{P_e}}$$

and δ_b is placed into Equation 6.9.2.2-2:

$$\frac{P_u}{P_r} + \frac{8.0}{9.0}\left(\frac{\delta_b P_u e}{M_r}\right) \leq 1.0$$

after substituting and rearranging, this expression results in:

$$-\frac{1}{P_e}P_u^2 + \left(1 + \frac{8.0}{9.0}\frac{P_r e}{M_r} + \frac{P_r}{P_e}\right)P_u - P_r = 0.0$$

When this equation is solved using the quadratic formula, two possible values for P_u are found. The value that allows the ratio P_u / P_r to be less than or equal to 1.0 is the value that is used for the capacity of the section under combined compression and flexure load.

After finding the value of P_u, the expression for δ_b is evaluated with the calculated value of P_u. The definition of δ_b in the LRFD Specifications requires δ_b to be greater than or equal to 1.0. If δ_b with the calculated value of P_u is less than 1.0, then P_u is recomputed with Equation 6.9.2.2-2. This time δ_b is 1.0, so the equation can simply be solved for P_u, rather than having to use the quadratic formula.

It is possible for a given combination of axial force, cross section properties and end eccentricity that the program will be unable to calculate a compressive resistance because δ_b is less than 1.0 when calculating P_u with the single-step adjustment and greater than 1.0 without it. If this situation occurs, TRLRFD will set the compressive capacity of the member to a very small value and print an informational code in the program output. If this occurs, the user should carefully review the program input and if all looks in order, contact the maintainers of the program.

However P_u is calculated, as with the procedure in Section 3.7.4, if P_u / P_r is less than 0.2 using Equation 6.9.2.2-1, then this procedure is followed again using Equation 6.9.2.2-1.

3.8 LIVE LOAD RATINGS

The program computes live load ratings for each member.

The load combinations of the Strength I, Strength II, Service II and Extreme Event III limit states are used for the computations of the ratings. No rating is computed for the Extreme Event IV limit state.

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 are expressed in terms of force.

Truss member ratings are performed as the "reverse of design." In other words, the same equations used to design the member 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 the factored resistance values P_r. The factored resistance value is determined based on each live loading and the applicable limit states. In each of the rating factor equations, the factored dead load effects are subtracted from the resistance, and the result is divided by the factored live load effect.

For the controlling rating factors for each vehicle, the program computes the rating tonnage as the product of the rating factor and the corresponding vehicle weight in tons.

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 vehicle includes 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.

The rating factor for each member is calculated for force only.

3.8.1 Rating Factor for Force

The rating factor for force is calculated using the following equation:

$$RF_F = \frac{P_{LLr}}{P_{LL}}$$

where: RF_F = rating factor for force

P_{LLr} = live load reserve force

$= P_r - P_{DC} - P_{DW}$

Pr	= factored force resistance of member
P_{DC}	= factored force due to DC loads
P_{DW}	= factored force due to DW loads
P_{LL}	= factored force due to live loads

For the Extreme Event III limit state, the factored resistance of the critical members is calculated using the reduced section properties entered by the user.

The rating factors are calculated for each live load specified by the user for each of the truss members. If a truss member is subjected to both tension and compression due to the passage of a live load, then two rating factors, one based on tension and one based on compression, are calculated for that member.

When LOADED LANE analysis is requested using the LLP command, the rating is based on the combination of user requested vehicles and the location of those vehicles on the structure for each limit state. The program conservatively combines all user entered live loads using the live load factors for the limit state being analyzed (i.e. PHL-93 and P-82 would be combined using STR-I live load factors).

3.9 DEFLECTIONS

The dead load deflections are computed by the unit load method. The live load deflections are computed by the influence line method. Deflections due to temperature change are computed based on the method of virtual work. The temperature range is entered on the CTL command. For these methods, refer to any standard textbook on structural engineering.

3.10 FATIGUE LIFE ESTIMATION

The program calculates the fatigue life of the members of a truss based on the criteria set forth in DM-4, Part A, Article 5.1.

The maximum factored positive (tension) axial force and the maximum factored negative (compression) axial force due to the fatigue load are calculated for each member. The algebraic difference of the maximum positive and maximum negative live load stresses is the design fatigue stress range. If the truss member is in compression due to the combination of unfactored dead load and twice the Fatigue -I factored live load tension force, the program assumes that no further fatigue analysis is required of the truss member. If, based on the single lane ADTT, the member is checked for the Fatigue-I limit state and the factored live load stress range is less than the fatigue resistance of the member, the member is assumed to have an infinite fatigue life. If the member is checked for the Fatigue-II limit state, and the factored live load stress range is less than the fatigue resistance, the member is assumed to have a finite fatigue life, but this life will be greater than the 100 year design life required by the DM-4.

If the detail does not satisfy the infinite fatigue life expressions, the fatigue life (number of fatigue cycles the detail can experience) of the detail is calculated by rearranging LRFD Specifications Equation 6.6.1.2.5-2:

$$N_{design} = \frac{A}{(\Delta f_e)^3}$$

where: N_{design} = estimated number of cycles to failure

A = detail category constant (LRFD Specifications Table 6.6.1.2.5-1)

Δf_e = factored fatigue live load stress range

The number of design cycles is then used in combination with the information entered by the user on the Fatigue Life (FTL) command to calculate the remaining fatigue life in years. The program uses the following engineering economy equations to calculate the accumulated cycles and the remaining life in years.

The program calculates the previous growth factor, $GF_{previous}$, by rearranging the following equation:

$$ADTT_{recent} = ADTT_{previous}\left(1 + GF_{previous}\right)^n$$

where: $ADTT_{recent}$ = recent count ADTT

$ADTT_{previous}$ = previous count ADTT

n = number of years between counts

= recent count year - previous count year

The above equation is not used if $GF_{previous}$ is entered by the user. This growth factor, $GF_{previous}$, is then used to approximate the ADTT for the year the structure was built as follows:

$$ADTT_{year\ built} = \frac{ADTT_{recent}}{\left(1 + GF_{previous}\right)^n}$$

where: n = number of years since construction
= recent count year - year built

The number of cycles, $N_{accumulated}$, accumulated up to the recent count year is then computed by:

$$N_{accumulated} = 365\left(ADTT_{year\ built}\right)\left[\frac{\left(1 + GF_{previous}\right)^n - 1}{GF_{previous}}\right]$$

where: n = number of years since construction
= recent count year - year built

If the estimated ADTT for a future count year, is entered, the future growth factor, GF_{future}, is calculated by:

$$ADTT_{future} = ADTT_{current}\left(1 + GF_{future}\right)^n$$

where: n = number of years between counts
= recent count year - future count year

The above equation is not used if GF_{future} is entered by the user.

The remaining life in years, R, is then calculated using the following, which is derived from the engineering economy equation for compound amount:

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

where: Δ = remaining cycles
= N_{design} - $N_{accumulated}$
λ = $(365)(ADTT_{recent})(1+GF_{future})$
ln = natural logarithm

3.11 EXTREME EVENT ANALYSIS

The program is capable of checking two additional limit states, Extreme Event III and Extreme Event IV. These limit states appear in DM-4 and not AASHTO, as they are truss specific limit states.

Extreme Event III analysis involves a critical reduction in section properties of selected members. This limit state tests the fracture of parts of built-up truss members. The member is still an active part of the truss but the section properties are reduced. For determinate structures the load remains the same but the axial resistance changes. For continuous trusses the truss stiffness may become affected which will require a reanalysis of the truss to develop the new loads which are also then checked against the new and unaffected axial resistances.

Extreme Event IV analysis involves the complete loss of a truss member due to fracture. TRLRFD does not evaluate the collapse mechanisms that occur due to such a loss. Therefore, the user must enter a member force which occurs due to the effect which is evaluated by other programs or analysis. This entered force is then checked against the calculated axial resistance.

3.12 GUSSET PLATE ANALYSIS

The program can analyze and provide operating ratings for gusset plates, based upon the PennDOT Truss Gusset Plate Analysis and Ratings spreadsheet combined with LRFD equations. Ratings are provided for shear, tension and compression, block shear, and connections.

3.12.1 Notes

The loads for analysis and rating have been factored per Strength-IA and Strength-II in accordance with DM-4 Table 3.4.1.1P-6. If the DC or DW loads have an opposite sign as the live load, the minimum load factors are used. If the DC or DW loads have the same sign as the live load, the maximum load factors are used.

When computing the net area for resistance calculations, the hole **diameter** in the gusset plate **is input by the user. If the input is left blank, the hole diameter will default to the maximum** standard size hole, as per the LRFD Specifications Table 6.13.2.4.2-1 and Article 6.8.3.

For calculations that require a measurement to the edge of the gusset plate or splice plates, an edge distance of 2 * bolt diameter is assumed. This edge distance is measured from the center of the hole closest to the edge.

For joints where only chord and vertical members are present (no diagonal members present; also called "post and hanger"), the gusset plates at the chord members will only be checked if a chord splice has not been defined (via the GCS command), or if a chord splice has been defined and has a capacity less than required (as described in section 3.12.9 of this manual). If an adequate chord splice is defined, all chord forces are assumed to be carried by the splice (not the gusset plate), so the gusset plate checks are not necessary.

3.12.2 General

F_y = specified minimum yield stress of the gusset plate material

F_u = specified minimum tensile of the gusset plate material

3.12.3 Allowable Shear

Gusset plate subjected to shear shall be investigated for two conditions: gross shear yielding and net section fracture. The shear capacity is the lesser of the two conditions, shear yielding and shear rupture. Shear yielding is calculated from the LRFD Specifications Equation 6.14.2.8.3-1 and shear rupture from Equation 6.13.5.3-2 with R_p, the reduction factor for holes assumed to be 1.0 (for holes drilled full size or subpunched and reamed to full size).

See Figures 5.41-1, 5.41-2, 5.41-3 and 5.41-4 for the sections along which shear resistance is calculated. Shear section A-A is always taken as horizontal, regardless of the angles of the chords. Because of this, only the forces from the diagonals (members 3 and 5) are considered when calculating the shear force on the section. When computing the shear resistance along sections B-B and C-C, only the holes in the vertical member (member 4) are subtracted from the gross area to find the net area. The holes in the chords are not considered.

3.12.4 Gusset Plate in Tension

Gusset plates subjected to tension shall be investigated for two conditions: yield on the gross section and fracture on the net section, as per LRFD Specifications Equations 6.8.2.1-1 and 6.8.2.1-2, with assumptions as stated in LRFD Specifications 6.13.5.2, again using a value of 1.0 for R_p. The capacity in tension will be the least of these two values. For both yielding on the gross section and fracture on the net section, **an edge distance of two times the bolt diameter and** the Whitmore method (i.e. 30° distribution) will be used to determine the "effective width" to calculate the gross area in tension (See Figure 3.12-1 at the end of this section). **Gusset plates are checked for tension at all members.**

If inside and outside chord splice plates are defined (see Figure 5.44-2), the areas of the plates are included in the gross and net area calculations at the chord members, increasing the tension capacity. If top and bottom chord splice plates are defined (see Figure 5.44-2), the tension force carried by the gusset plate and inside and outside splice plates is decreased by the ratio of the number of bolts in the gusset plate to the total number of bolts in the gusset plate and top and bottom splice plates. For the purposes of calculating the number of bolts in the top and bottom plates, bolts spaced at 3 times the bolt diameter are assumed across the plates, then rounded down to the nearest integer.

3.12.5 Gusset Plate in Compression

Gusset plates subjected to compression will be analyzed as described in the LRFD Specifications Article 6.14.2.8.4. The adequacy of the gusset plate at the end of the diagonal due to a compressive diagonal axial force will also be investigated. Buckling at the end of the compression diagonal will be the assumed failure mode in compression. Therefore, compression must be checked on the effective width line (using **an edge distance of two times the bolt diameter and** the Whitmore method, i.e. 30° distribution) at the end of the diagonal (See Figure 3.12-1 at the end of this section). Gusset plate compression is **only checked in vertical and diagonal members. Gusset plate compression is** not checked at the ends of chord members.

Because these checks are only done in vertical and diagonal members, the presence of chord splices will have no effect on these results.

3.12.6 Block Shear Rupture Capacity for Any Member Connection at a Joint

Cross-sectional elements are assumed connected to transmit the tensile force (i.e. reduction coefficient, U=1.0). For the block shear rupture planes, please refer to Figure 3.12-2 at the end of this section. The block shear resistance is calculated according to the LRFD Specifications Article 6.13.4, with U_{bs} and R_p taken as 1.0. **Block shear is only checked at members in tension. Block shear case 1 is only checked at members 1 and 2, while block shear case 2 is checked at all tension members. Block shear case 3 only includes member 3, 4 and 5. When calculating the gross area in tension for block shear cases 1 and 3, an edge distance of two times the bolt diameter is assumed.**

If chord splice plates are defined (see Figure 5.44-2), the areas of the inside and outside plates are considered for the gross and net areas in tension (not shear) for members 1 and 2, for block shear cases 1 and 2. The number of bolts in the top and bottom plates are considered to reduce the block shear force, as described in Section 3.12.4.

Block Shear Case 3

For block shear case 3, the block shear path shown in Figure 3.12-2 is checked using the forces in members 4 and 5. If member 3 is also present, the block shear path shown is mirrored about the vertical axis of the gusset plate and checked using the forces in members 3 and 4.

For the block shear case 3 path shown in Figure 3.12-2, the force in member 5 is resolved into horizontal and vertical components. The vertical component is added to the force carried by member 4. The block shear capacity calculations are done twice, once with the horizontal plane as the shear plane and the vertical plane as the tension plane, and then again with the horizontal plane as the tension plane and the vertical plane as the shear plane.

If the horizontal force is tensile and the vertical force compressive, then the resistance calculated with the horizontal plane as the shear plane is used. If the vertical force is tensile and the horizontal force compressive, then the resistance calculated with the vertical plane as the shear plane is used.

If both forces are tensile, then the resistance calculated with the plane parallel to the larger force considered the shear plane is used.

If both forces are compressive, then this block shear calculation need not be done.

After the governing force / resistance combination is found for each side (left and right) of the gusset plate, then the combination with the larger tensile force is chosen and reported as the governing block shear resistance for case 3 for the VRT-DGL location.

3.12.7 Connection Capacities

For simplicity, check the adequacy of the fasteners under the applied axial load. The member forces are assumed to be distributed equally among all fasteners.

Slip-critical connections are assumed for normal truss connection designs, however, if rivets or low-carbon steel bolts (A307) are specified on the plans, the connection is bearing-type, only high strength bolts can support the high preload necessary for slip-critical connections. In any case, bearing should always be checked in the event that the connection slips due to insufficient tension in the fasteners.

This program does not check bearing strength of the fastener.

3.12.7.1 Investigate the Fasteners in Shear

The shear resistance of the bolts is calculated as described in the LRFD Specifications Article 6.13.2.7, with the member force equally distributed to all fasteners. It is assumed that threads are included in the shear plane**. If the member force is tension and the distance between the first and last row of fasteners is greater than 38 inches, the shear resistance of the bolts is taken as 0.83 times the original value. If inside splice plates are defined (see Figure 5.44-2), an assumed number of bolts passing through both the gusset plate and inside splice plate is calculated using the following equation:**

$$n_{inside} = INT\left(\frac{\frac{L_{s4}}{2}}{L_{12} + 4d} N_{L12}\right) N_{T12}$$

where: **L_{s4}** **= length of inside splice plate**

L_{12} **= distance between the first and last fasteners along the length of member 1 or 2**

d **= fastener diameter. 4*d is the total assumed end distance at both ends of the fasteners**

N_{L12} **= number of fasteners along the length of members 1 or 2**

N_{T12} **= number of fasteners along the width of members 1 or 2**

INT **= round down to the nearest integer value**

This number of bolts is assumed to have two shear planes per bolt. Other bolts only pass through the gusset plate and only have a single shear plane per bolt. **If no splice plate is present, the bolts have only one shear plane.**

The program provides an input for the length of the outside splice plate, as well, but this plate is not considered when calculating the total number of shear planes resisting the axial force.

3.12.7.2 Investigate Bearing on the Connected Material

The hole **diameter is entered by the user, with the maximum allowed input value being the maximum hole diameter for standard sized holes (LRFD Specifications Table 6.13.2.4.2-1)**. Also, the total allowable bearing force for the connection is equal to the sum of the allowable bearing forces for the individual fasteners in the connection. Use the provisions of the LRFD Specifications 6.13.2.9, assuming that the clear end distance is not less than 2 * bolt diameter. The clear distance between bolts is calculated from user input.

3.12.7.3 Investigate Slip Resistance of the Fasteners

The slip resistance of the entire connection at each member is calculated, as described in the LRFD Specifications Section 6.13.2.8. The total number of slip planes at each member is the same as calculated for the shear resistance of the fasteners (User's Manual Section 3.12.7.1**). The slip resistance is compared to the Service-IIA or Service-IIB factored force. The exact limit state depends on the live load vehicle being checked, though the load factors are the same for both limit states. Standard size holes are assumed (K_h equal to 1.0), while the minimum required bolt tension and surface condition class are entered by the user (K_s varies based on input surface condition). The minimum required bolt tension (Pt) varies based on the bolt diameter (5/8" to 1-1/2") and bolt type (A325 or A490) (see LRFD Specifications Table 6.13.2.8-1).**

3.12.8 Unsupported Edge in Compression Adequacy Check

The length of the unsupported edge of the gusset plate is checked as described in the LRFD Specifications Article 6.14.2.8.7.

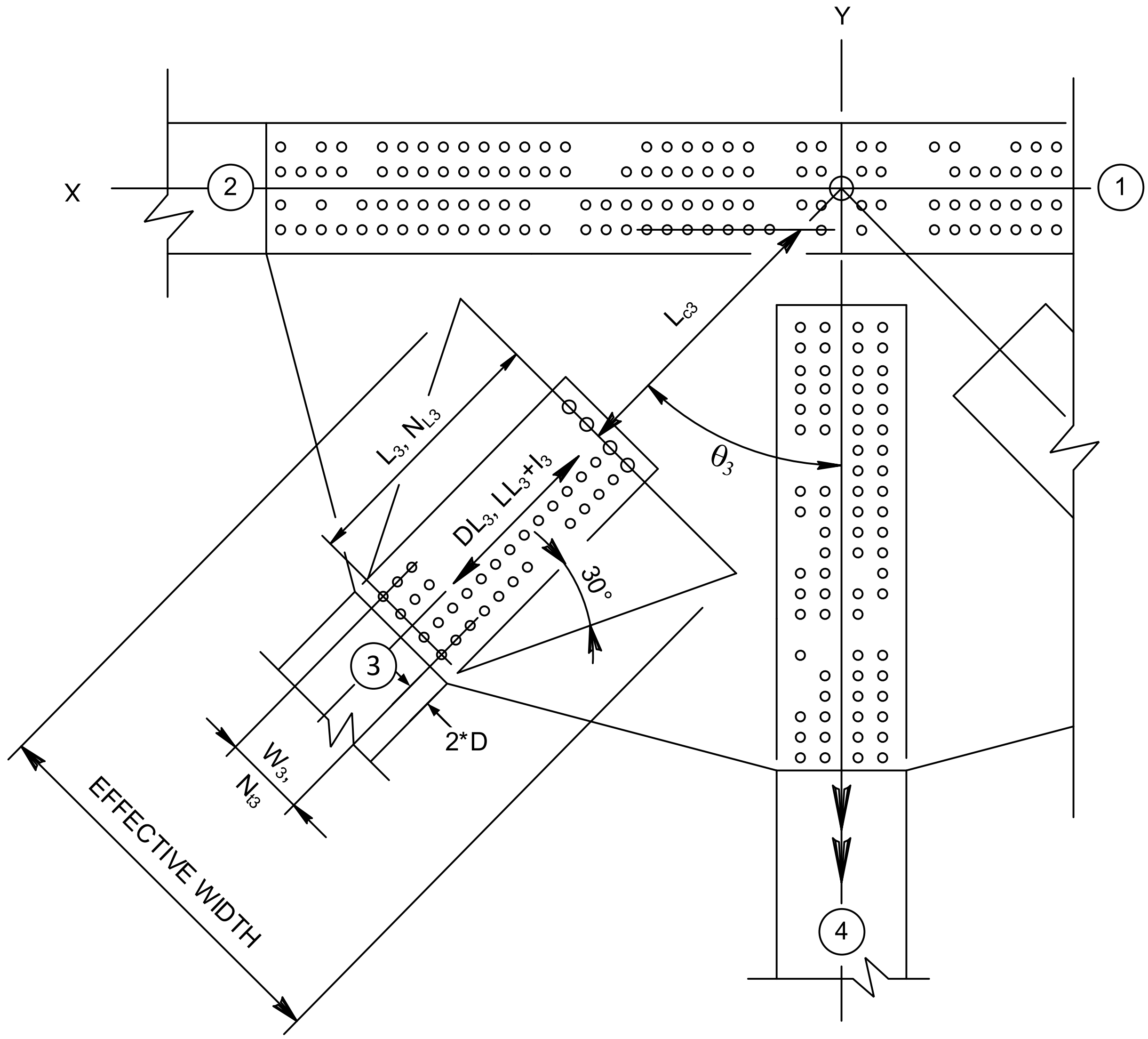


Figure 3.12-1 Gusset Plate Member Effective Width

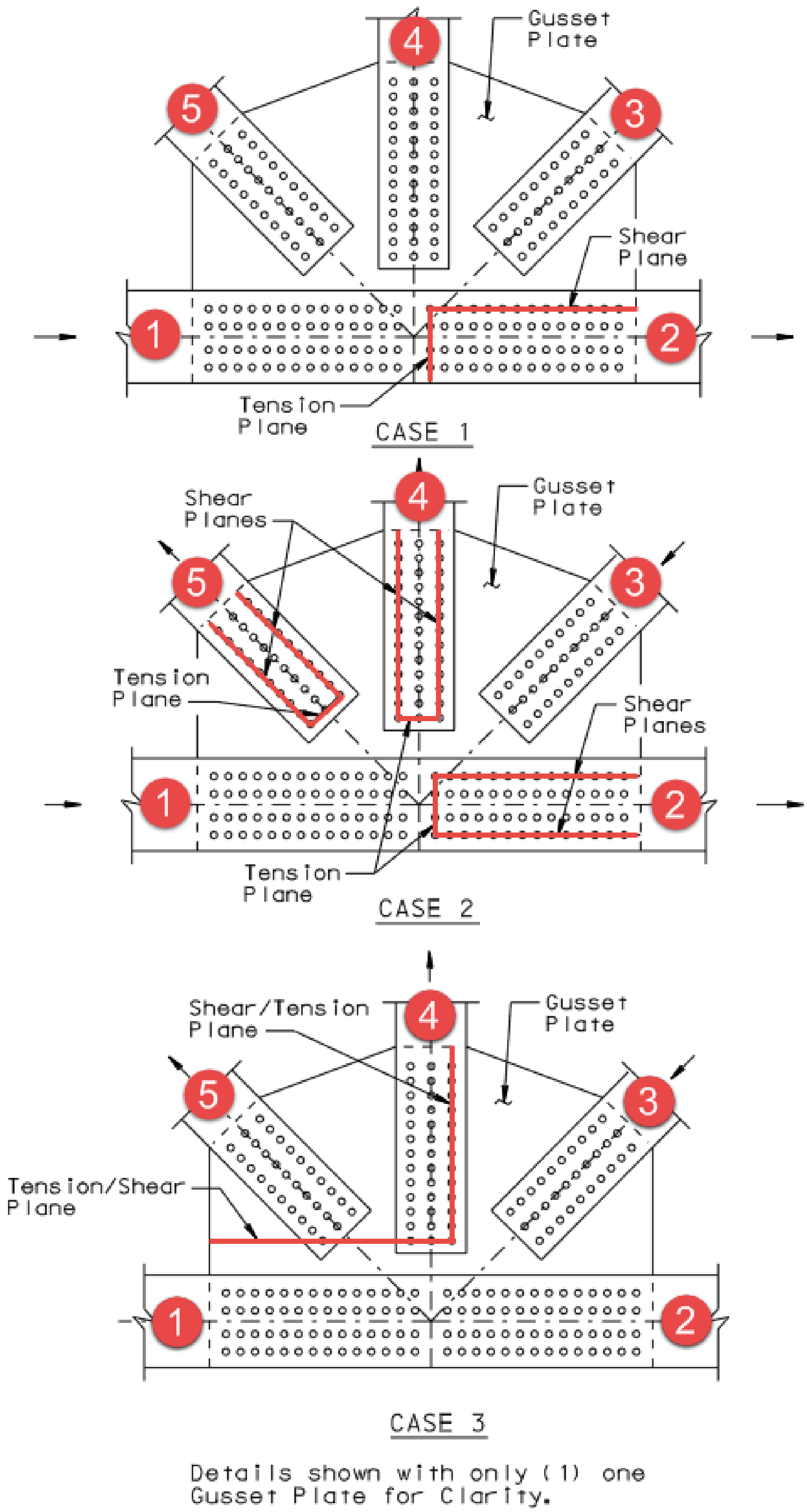


Figure 3.12-2 Gusset Plate Block Shear Cases

3.12.9 Chord Splices

When a Gusset Chord Splice (GCS) command is defined at a gusset plate location, the gusset plate and chord splice are checked as described in LRFD Specifications 6.14.2.8.6. If a chord splice is not defined at the gusset plate, then the chord is assumed to be continuous. The following assumptions are made when calculating the chord splice resistance:

1. **The two inner splice plates are the same thickness, and the two outer splice plates are the same thickness. This results in the cross section being symmetrical about the centerline vertical axis and no eccentricity about the vertical axis. Any actual differences in the inner or outer splice plates should be resolved by making conservative assumptions that maintain the vertical symmetry. These differences could be the result of unsymmetrical section loss on the plates or thicker splice plates on one side due to a floorbeam connection or a sidewalk cantilever bracket.**

2. **The widths of the inner and outer splice plates are assumed to be equal to the distance between outermost rows of fasteners (W1 and W2 on the GMB command), plus an edge distance of 2 * bolt diameter on each edge. This is consistent with other splice plate calculations. Because of this assumption, the eccentricities of the inner and outer splice plates are the same and are equal to 1/2 of their width. The edges of the inner and outer splice plates are located at the edge of the gusset plate, as shown in Figure 3. Any significant difference in the actual widths of the splice plates should be resolved by making conservative assumptions that maintain the assumed plate widths.**

3. **The horizontal components of the forces coming from the chord and diagonal members are calculated and used. The full member forces are not used (except when the chords are horizontal)**

4. **The "chord splice" checks are done for gusset plate locations with splice plates. Where splice plates are not defined, the gusset plate is not checked for the the splice plate capacity and the chord is assumed to be continuous.**

5. **The chord splice checks are done at the locations of gusset plate sections B and C, the locations of hb and hc as input by the user (see Figures 5.41-1 through 5.41-4).**

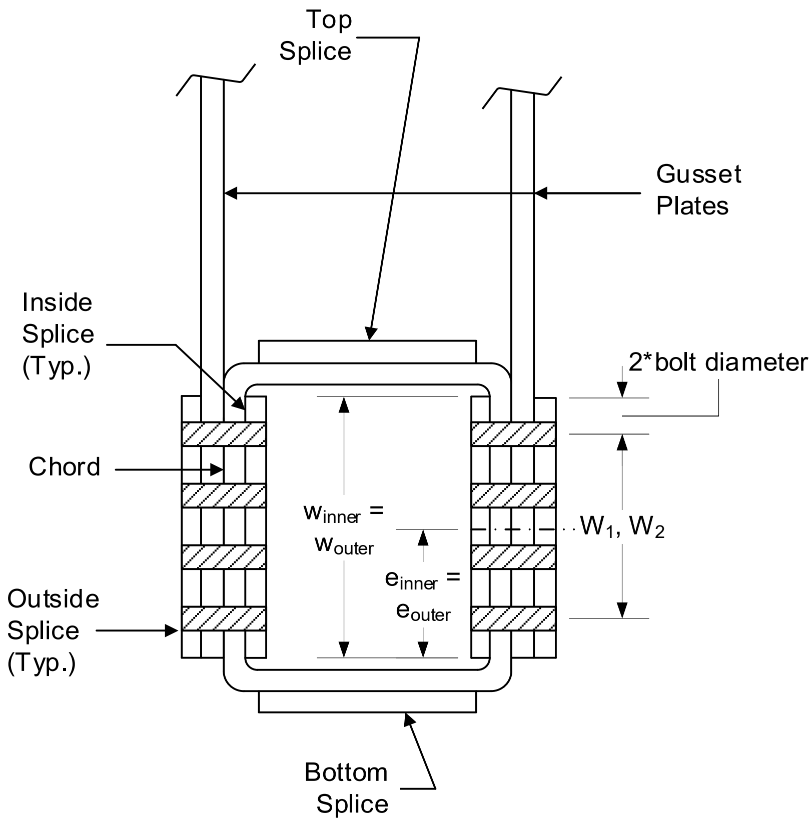


Figure 3.12-3 Inner and outer splice plate widths and eccentricities

6. **If the chord splice is in compression and the slenderness check of LRFD Specifications Equation 6.14.2.8.6-2 fails, the resistance of the splice will be reported as 0.0 because Fcr is not defined for splices that do not satisfy equation 6.14.2.8.6-2.**

7. **If a chord splice is defined at a given joint, the capacity of the chord splice alone is also calculated, using the same equations specified in the LRFD Specifications Section 6.14.2.8.6, without any contribution from the gusset plate.**

8. **TRLRFD can only analyze chord splices that are located at a joint; the centerline of the chord splice must be coincident with the truss joint. The joint must also have a defined gusset plate. Chord splices located away from a joint cannot be analyzed with TRLRFD.**

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 **8.1**, Windows 10 operating systems **(32-bit and 64-bit versions) and Windows 11**.

Your license number, license key and registered company name, found in the e-mail received from the Department, are required to be entered when installing the program and must be entered exactly as shown in the e-mail. The license number, license key and registered company name will also be needed when requesting future versions of the program (i.e., enhancements, modifications, or error corrections), and requesting program support. A backup copy of the program download and e-mail instructions should be made and used for future installations. You may want to print the software license agreement, record the license number, license key and registered company name and keep it in a safe place.

To install the program, follow the installation instructions provided with the original e-mail from the Department.

The following files will be installed in the destination folder, which defaults to "C:\Program Files\PennDOT\TRLRFD v<version number>\" or "C:\Program Files (x86)\PennDOT\TRLRFD v<version number>\" for 64-bit operating systems:

1. TRLRFD.exe, TRLRFD_dll.dll - Executable program and Dynamic Link Library
2. TRLRFD.pd - Parameter definition file.
3. TRLRFD Users Manual.pdf - Program User's Manual (PDF Format).
4. TRLRFDRevReq.dotx - Revision Request form (MS Word template).
5. GettingStarted.pdf - A document describing installation and running of the program
6. LicenseAgreement.pdf - The program license agreement
7. *.dat - Example problem input file.
8. MSVCR71.dll - Runtime Dynamic Link Library

The program example files (ex*.dat) will be installed in the program example folder, which defaults to "C:\PennDOT\TRLRFD 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

TRLRFD is a FORTRAN console application program. It 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 Programs\PennDOT TRLRFD <version number>, or by double-clicking the shortcut icon on the desktop. To run the program in a command window, the user must specify to the directory in which the program has been installed or change to the directory.

The program will prompt for an input file name, and the user should then enter the appropriate input file name. The input file must be created before running the program. The program will then prompt for whether the output should be reviewed on the screen. The user should enter Y if the output is to be reviewed on the screen after execution or N if the output is not to be reviewed on the screen. The program will then prompt for the name of the output file in which the output is to be stored, and the user should then enter the desired output file name. If a file with the specified output file name already exists, the program will ask the user whether to overwrite the existing file. The user should enter Y if the existing file is to be overwritten or N if the existing file is not to be overwritten. If the user enters N to specify that the existing file is not to be overwritten, the program will prompt the user for another output file name. The program will then execute.

To cancel the program during execution, press <Ctrl C> or <Ctrl Break>, and then press <Enter>.

When the program completes execution, the user is prompted to "Press <ENTER> to exit program." This allows the user to view the last messages written to the screen when the program was started by double-clicking on the program icon from Windows Explorer.

The user can view the *.OUT output file with a text editor and the *.PDF output file with Adobe Acrobat.

5 INPUT DESCRIPTION

5.1 INPUT DATA REQUIREMENTS

Before running TRLRFD, the user must create an input file. The input file consists of a series of command lines. Each command line defines a set of input parameters that are associated with that command. The program interprets each command line and checks the input parameters to insure that the input data is of the correct type and within the allowable ranges set by the program.

The syntax of a command line is given as:

KWD parm1, parm2, , , parm5, ,

where, KWD is a 3 character keyword representing a command, and
parm1, parm2.... are the parameter values associated with the KWD.

If a command line begins with an exclamation point (!), then it is treated as a comment line that is not used by the program. Comment lines can be inserted by the user to provide descriptions and clarifications. The following are two examples of a comment line:

! THE FOLLOWING COMMAND LINE INCLUDES A REDUCTION IN HAUNCH WEIGHT.
! PENNDOT SKEW ANGLE DESIGNATION IS USED IN THIS INPUT.

To temporarily make a command line void, the user can use an exclamation point (!) to transform the command line into a comment line. For an input line to be treated as a comment line, the exclamation point must be put in column 1 of the input line. For example, in the following case, the program will use the input data on the second line but will not use the input data on the first line:

! UDF 1, D, 0.649, , 0.815, 0.815
UDF 1, D, 0.750, , 0.815, 0.815

A command line must not exceed 512 characters in length. Command lines can be continued on any number of data lines in the input file by placing a hyphen (-) at the end of each data line to be continued, and by placing any remaining parameters on the following lines starting in column 4 of each continuation line. The limit of 512 characters includes all characters and parameters on all continuation lines of a given command line. Some commands are repeatable and some commands have parameters or groups of parameters that are repeatable. When parameters are repeatable, the user has the option of repeating the parameters in a single command or repeating the command. For example, the SPL (span length) command has Span Number and Span Length as repeatable parameters. The user could enter the Span Number and Span Length three times on one command and four times on another command, or seven times on a single command.

```
SPL      1,  100,  2,  110,  3,  120
SPL      4,  130,  5,  140,  6,  150,  7,  160
```

or

```
SPL      1,  100,  2,  110,  3,  120,  4,  130,  5,  140,  6,  150,  7,  160
```

Groups of repeatable parameters, such as Span Number and Span Length, must stay together in a command line unless a continuation character (-) is used. That is, a command cannot end with a Span Number input and continue using another SPL command having the Span Length input. When a continuation character is used, the repeatable data can be separated on two lines. The program reads all continuation lines as one command. For example,

Incorrect input:

```
SPL     1, 100, 2, 110, 3
SPL     120, 4, 130, 5, 140, 6, 150, 7, 160
```

Correct input:

```
SPL     1, 100, 2, 110, 3,  -
        120, 4, 130, 5, 140, 6, 150, 7, 160
```

The first three columns of each command line are reserved for keywords that define the command type. Columns 4 through 512 are to be used to input the parameters associated with a command. One or more spaces are recommended between the keyword and the input parameters to improve readability.

The parameters associated with each command must be entered in the order they appear in the command description tables. The user must place commas to separate the parameters on the command line. Blank spaces cannot be used to separate parameters. The parameter field width is not restricted; however, the total number of characters cannot exceed 512.

When using the Engineering Assistant (EngAsst), limits are placed on the number of times the parameters on a given command can be repeated in order to make the parameters easier to read and enter on the screen. In conjunction with this, EngAsst will also only allow the user to enter up to the total number of parameters allowed by the program, making the grouping of parameters not quite as flexible as creating an input file by hand. For example when entering the axles of a special live load vehicle, the vehicle defined can have up to 80 axles, but EngAsst limits each instance of the SAL command to 20 axles. In order to enter an 80 axle vehicle with EngAsst, the user would have to use four instances of the SAL command, but if creating the file by hand, the user can enter all 80 axles in a single instance of the SAL command, as long as the total length of the command is less than 512 characters. The hand-created file will run fine with TRLRFD, but will generate errors if read in by EngAsst. The command descriptions in this chapter will note the number of times the parameters on a given command can be repeated in order to be compatible with EngAsst.

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 girder sections, brace points, transverse stiffeners, and longitudinal stiffeners), the ranges cannot overlap.

5.2 ORDER OF COMMANDS

If the user wants to control the number of lines printed on a page or the number of lines to be left blank at the top of each page, the CFG (configuration) command should be the first command. The CFG command is optional and the program will use default values if the CFG command is not entered. The first required command is one or more TTL (title) commands. As many as ten TTL commands may be entered by the user. The first TTL command is printed in the header at the top of each output page. A maximum of ten TTL commands are printed on the first page of the output. The second required command after the title commands is the CTL (control) command. The CTL command also includes other major control parameters such as Live Load, Distribution Factors and Live Load Location.

The remaining commands can be entered in any order, provided certain required parameters for a given command have been entered previously. For example, the joint designations are defined by specifying a the truss geometry on the GEO (geometry) command. Since the joint location parameter is used on the PRP, T## AND EEV commands, the GEO command must precede the PRP, T## and EEV command\s. 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, OUT commands) to produce the output tables that are designated as the default output tables. The default output tables, as presented in Sections 6.39 through 6.40, 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.

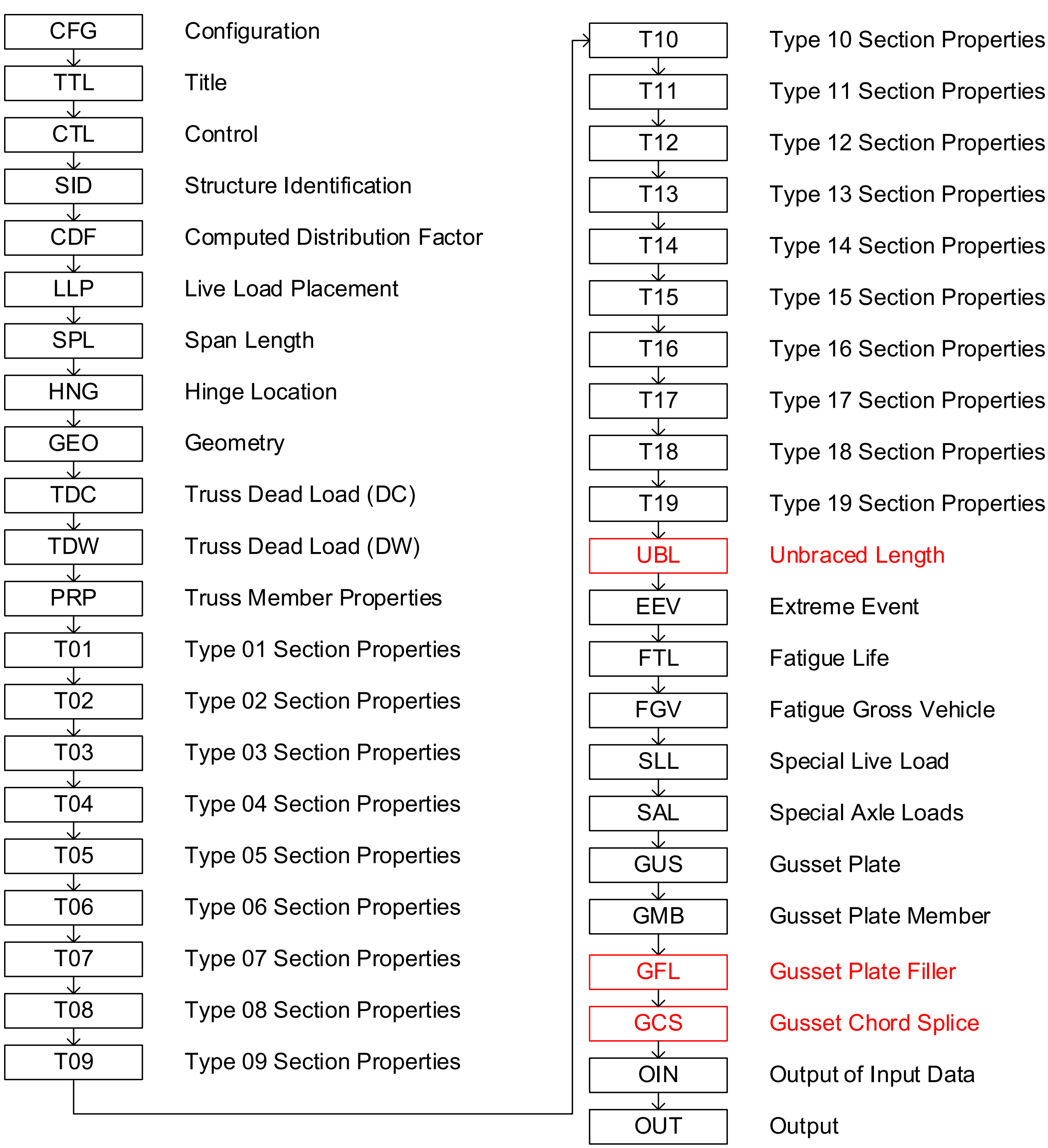


Figure 5.2-1 Overall View of Input File

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 commands (other than CFG and TTL commands)	5.5
SID	Structure Identification	Required only for APRAS runs	5.6
CDF	Computed Distribution Factor	Required to have program compute distribution factor	5.7
LLP	Live Load Placement	Optional	5.8
SPL	Span Length	Required	5.9
HNG	Hinge Location	Optional	5.10
GEO	Geometry	Required	5.11
TDC	Truss Dead Load (DC)	Optional	5.12
TDW	Truss Dead Load (DW)	Optional	5.13
PRP	Truss Member Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.14
T01	Type 01 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.16
T02	Type 02 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.17
T03	Type 03 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.18
T04	Type 04 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.19
T05	Type 05 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.20
T06	Type 06 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.21
T07	Type 07 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.22
T08	Type 08 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.23
T09	Type 09 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.24
T10	Type 10 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.25
T11	Type 11 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.26
T12	Type 12 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.27
T13	Type 13 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.28

Table 5.2-1 Recommended Order of Commands (Continued)

Keyword	Command Description	Comments	Section
T14	Type 14 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.29
T15	Type 15 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.30
T16	Type 16 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.31
T17	Type 17 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.32
T18	Type 18 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.33
T19	Type 19 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.34
UBL	**Unbraced Length**	**Optional; enter for any member defined by a T## command that is braced between the ends**	**5.35**
EEV	Extreme Event	Optional	5.36
FTL	Fatigue Life	Optional	5.37
FGV	Fatigue Gross Vehicle	Optional	5.38
SLL	Special Live Load	Optional	5.39
SAL	Special Axle Loads	Optional	5.40
GUS	Gusset Plate	Optional; Required if GMB command is entered	5.41
GMB	Gusset Plate Member	Optional; Required if GUS command is entered	5.42
GFL	**Gusset Plate Filler**	**Optional**	**5.43**
GCS	**Gusset Chord Splice**	**Optional**	**5.44**
OIN	Output of Input Data	Optional	5.45
OUT	Output	Optional	5.46

Table 5.2-2 Commands in Alphabetical Order

Keyword	Command Description	Comments	Section
CDF	Computed Distribution Factor	Required to have program compute distribution factor	5.7
CFG	Configuration	Optional	5.3
CTL	Control	Required before other commands (other than CFG and TTL commands)	5.5
EEV	Extreme Event	Optional	5.36
FGV	Fatigue Gross Vehicle	Optional	5.38
FTL	Fatigue Life	Optional	5.37
GCS	**Gusset Chord Splice**	**Optional**	**5.44**
GEO	Geometry	Required	5.11
GFL	**Gusset Plate Filler**	**Optional**	**5.43**
GMB	Gusset Plate Member	Optional; Required if GUS command is entered	5.42
GUS	Gusset Plate	Optional; Required if GMB command is entered	5.41
HNG	Hinge Location	Optional	5.10
LLP	Live Load Placement	Optional	5.8
OIN	Output of Input Data	Optional	5.45
OUT	Output	Optional	5.46
PRP	Truss Member Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.14
SID	Structure Identification	Required only for APRAS runs	5.6
SAL	Special Axle Loads	Optional	5.40
SLL	Special Live Load	Optional	5.39
SPL	Span Length	Required	5.9
T01	Type 01 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.16
T02	Type 02 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.17
T03	Type 03 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.18
T04	Type 04 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.19
T05	Type 05 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.20
T06	Type 06 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.21
T07	Type 07 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.22
T08	Type 08 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.23
T09	Type 09 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.24

Table 5.2-2 Commands in Alphabetical Order (Continued)

Keyword	Command Description	Comments	Section
T10	Type 10 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.25
T11	Type 11 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.26
T12	Type 12 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.27
T13	Type 13 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.28
T14	Type 14 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.29
T15	Type 15 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.30
T16	Type 16 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.31
T17	Type 17 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.32
T18	Type 18 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.33
T19	Type 19 Section Properties	Optional; each member must be defined either by PRP or one of the T## commands	5.34
TDC	Truss Dead Load (DC)	Optional	5.12
TDW	Truss Dead Load (DW)	Optional	5.13
TTL	Title	At least one TTL command is required	5.4
UBL	**Unbraced Length**	**Optional; enter for any member defined by a T## command that is braced between the ends**	**5.35**

5.3 CFG – CONFIGURATION COMMAND

KEYWORD	COMMAND DESCRIPTION
CFG	CONFIGURATION - This command is used for configuring the program output from a given PC and printer setup. Only one CFG command may be used. If this command is not entered, each parameter listed below will be automatically set to its default value.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Number of Lines Per Page	Enter the number of printable lines per output page.	--	50 (W)	83 (W)	83
2. Number of Top Blank Lines	Enter the number of lines to be left blank at the top of each output page	--	0 (E)	5 (W)	0

5.4 TTL – TITLE COMMAND

KEYWORD	COMMAND DESCRIPTION
TTL	TITLE - As many as ten TTL commands may be entered by the user. The first TTL command is printed in the header at the top of each output page. A maximum of ten TTL commands are printed on the first page of the output. The input file must have at least one TTL command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Title	Enter any descriptive information about the project. Title information can be entered anywhere between column 4 and column 130.	--	--	--	--

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 commands 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. Live Load	Enter one of the following live load options: A – PHL-93, P-82, ML-80, TK527, HS20 and H20 B – HL-93, HS20 and H20 C – ML-80 Loading only D – P-82 Loading only E – Special Live Loading F – Multiple Live Load Placement G – TK527 Loading Only **H – P2016-13 Loading Only** **I – PHL-93, P-82, P2016-13, ML-80, TK527, HS20 and H20** **J – EV2, EV3, and SU6TV** Note: The SLL and SAL command must be entered when using option E. The LLP command must be entered when using option F. Use option F when multiple vehicle types are to be placed on the truss.	--	A, B, C, D, E, F, G, **H, I, J** (E)	--	A
3. 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. (E)	2. (C)	1.33
4. Distribution Factor for Member Force	The user defined distribution factor to be used to calculate the live load effect. This factor is the fraction of axles that are applied. Leave blank and enter a COMPUTED DISTRIBUTION FACTOR command for the program to calculate the distribution factor	--	0. (E)	2. (**W**)	--

5.5 CTL – CONTROL COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Deflection Distribution Factor	**The user defined d**istribution factor **to be used to calculate** deflection **due to the live load. This factor is the fraction of axles that are applied.** If left blank, **and Distribution Factor for Member Force is entered,** the program will **set this value equal to the Distribution Factor for Member Force**. **Leave blank and enter a COMPUTED DISTRIBUTION FACTOR command for the program to calculate this distribution factor**	--	0. (E)	2. (**W**)	--
6. Live Load Location	Enter one of the following options: U - if live load is on the upper joints (deck truss) L - if live load is on the lower joints (through truss)	--	U, L (E)	--	L
7. End Condition	Enter one of the following options: P - for pinned end connections R - for bolted connections The program sets the K value for effective length expressions based on this value.	--	P, R (E)	--	P
8. **Pinned Support**	The joint at the support that is fixed against horizontal and vertical translation. Enter the location (U or L) and the joint number. The joint numbering starts at zero. Refer to Section 6.11 for the definition of joint designations.	--	*	*	*1
9. Temperature Change	The temperature change for which deflections are calculated and added to dead load deflections. Enter a negative value if the current temperature is less than the erection temperature. The effect of change in temperature is only considered for deflection calculations.	°F	-50. (W)	50. (W)	0.
10. End Bearing	Enter one of the following options: U - if end bearing is at upper panel joint L - if end bearing is at lower panel joint	--	U, L (E)	--	L
11. Symmetry	Enter one of the following options: Y - if the truss is symmetric about the central panel or panel point N - if the truss is not symmetric about the central panel or panel point	--	Y, N (E)	--	N

5.5 CTL – CONTROL COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
12. Live Load Direction	Enter the following option: B - move live load in both directions	--	B (E)	--	B
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)	2.0 (C)	1.15
14. **Permit** Dynamic Load Allowance	Enter the factor by which the **Design Permit Vehicles** (P-82 **and/or P2016-13)** live load effect must be multiplied by to obtain the live load plus dynamic load allowance (impact) effect.	--	1.0 (E)	2.0 (C)	1.20

Notes:

[1] **Defaults to U0 when the Panel Number one (GEO Command) is Panel Type 3, otherwise defaults to L0.**

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.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Program Identification	Enter '=TRLRFD' to identify that this data file is for the LRFD Truss Analysis and Rating program.	--	=TRLRFD (E)	--	=TRLRFD
2. County	Enter the county number as per the Bridge Management System (the 2 digit subfield of item number A01)	--	1 (E)	99 (E)	--
3. State Route	Enter the state route number as per the Bridge Management System (the 4 digit subfield of item number A01)	--	0 (E)	9999 (E)	--
4. Segment	Enter the segment number as per the Bridge Management System (the 4 digit subfield of item number A01)	--	0 (E)	9999 (E)	--
5. Offset	Enter the offset distance as per the Bridge Management System (the 4 digit subfield of item number A01)	--	0 (E)	9999 (E)	--
6. Span Identification	Enter the 4 digit alphanumeric Span Identification number as per the APRAS system.	--	--	--	--

5.7 CDF – COMPUTED DISTRIBUTION FACTOR COMMAND

KEYWORD	COMMAND DESCRIPTION
CDF	COMPUTED DISTRIBUTION FACTOR - This command is required if the user prefers to have the program calculate the distribution factor used with the live load effect. This command will override any value given for DISTRIBUTION FACTOR FOR MEMBER FORCE in the CTL command. This command cannot be repeated.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Centerline of Truss to Curb	The distance from the centerline of the truss to the inside face of curb. This value is negative if the truss is placed inside the roadway and is positive if the truss is placed outside the roadway.	ft	-50. (W)	50. (W)	
2. Truss Spacing	The distance between centerlines of the trusses.	ft	0. (E)	100. (W)	
3. Roadway Width	The width of the roadway (inside face of curb to inside face of curb)	ft	0. (E)	100. (W)	
4. Gage Distance	Enter the lateral distance between the wheels of the truck	ft	6. (E)	10. (W)	6.
5. Passing Distance	Enter the minimum distance between adjacent wheels of passing vehicles	ft	4. (E)	10. (W)	4.

5.8 LLP – LIVE LOAD PLACEMENT COMMAND

KEYWORD	COMMAND DESCRIPTION
LLP	LIVE LOAD PLACEMENT - This command allows the user to place specific live loads in specific lanes on the bridge. A maximum of six lanes can be defined. This command is optional and requires the CDF command to also be input. This command will calculate values for the truss on the left side of the structure. If the bridge has unsymmetrical lanes, the user must do another run of the program, entering these values with respect to the right side truss. The truss will always be analyzed as if all of the lanes specified by this command are loaded. In some cases, due to lane location and the application of the multiple presence factor, loading a smaller number of lanes may lead to a larger live load effect on the truss. It is recommended that the user do separate runs of the program with different numbers of loaded lanes to ensure that the worst effect is captured. This command can be repeated.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Distance	Distance from the left curb to the left edge of the lane.	ft	0. (E)	100. (W)	
2. Width	Width of the traffic lane. Minimum lane width is the vehicle gage distance plus the passing distance.	ft	9. (E)	15. (W)	12.
3. Live Load	The live load to be placed in the lane. Enter one of the following codes: A – PHL-93 B – ML-80 C – P-82 D – H20 E – HS20 F – HL-93 G – TK527 H – Special live load (also enter the SLL command) **I – P2016-13** **J – EV2** **K – EV3** **L – SU6TV**	--	A, B, C, D, E, F, G, H, **I, J, K, L** (E)	--	A

5.9 SPL – SPAN LENGTH COMMAND

KEYWORD	COMMAND DESCRIPTION
SPL	SPAN LENGTH - This command is used to set the span length. An input file must have at least one span length command and a maximum of **15**. When more than one span length command is entered, the program assumes either a cantilevered or continuous truss. **A series of simple span trusses must be analyzed in separate runs of the program, with each span considered as a separate bridge.** The parameters and the command can be repeated. For compatibility with EngAsst, enter all span lengths on a single instance of the SPL command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Length	The length of the truss span, from center-to-center of bearings.	ft	16. (E)	900. (W)	

5.10 HNG – HINGE LOCATION COMMAND

KEYWORD	COMMAND DESCRIPTION
HNG	HINGE LOCATION - This command is used to define the locations of hinges of a cantilever truss. Continuous span trusses and simple span trusses shall NOT contain this command. For cantilever trusses, the user must enter a number of hinges equal to the number of supports - 2. (See Section 3.3.4 of this manual for more information) This command is optional and can be repeated to define up to **fourteen** hinges.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Span Number	Enter the span number of the hinge.	--	1 (E)	NSP[1] (E)	--
2. Distance	The distance from the centerline of the left-most bearing of the span to the hinge.	ft	0. (E)	MXSP[2] (E)	--

Notes:
[1] NSP is equal to the number of spans entered by the SPL commands
[2] MXSP is equal to the span length corresponding to the span number

5.11 GEO – GEOMETRY COMMAND

KEYWORD	COMMAND DESCRIPTION
GEO	GEOMETRY - This command is used to define the geometry of one truss panel. If SYMMETRY is not entered as "Y" in the CTL command, then a GEO command is required for every truss panel. Refer to Figure 5.11-1 for definitions of panel geometry. This command can be repeated to define up to 100 panels (0 - 99), 99 physical panels and 1 fictitious panel (Figure 6.11-1).

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Panel Number	Enter the current panel number	--	0 (E)	99 (E)	--
2. Panel Width	Enter the width of the panel. NOTE: enter '0' if panel 0 is being defined (meaning that the truss begins with a vertical member, as shown in Figure 6.11-1). The sum of panel widths in a span must be **within 0.04167 feet (0.5") of** the span length entered on the SPL command. **The sum of panel widths over the entire length of the truss must be within 0.04167 feet (0.5") of the sum of all the span lengths.**	ft	0. (E)	100. (W)	--
3. Vertical Post	Enter one of the following options: Y - if the panel has a vertical post present on the right side N - if the panel does not have a vertical post **See Section 6.11.3 for more detailed information on how to enter this parameter.**	--	Y, N (E)	--	N
4. Right Upper Vertical Height (H1)	The length of the right upper vertical member for a subdivided member (panel types 8, 9, 10, 14) or the length of the right vertical for an undivided member (panel types 0, 1, 3, 5, 6, 7, 11, 13, 15). Corresponds to length H1 on Figure 5.11-1. H1 must be entered for the panel types listed above, even if the vertical member is not present. Leave this parameter blank for panel types 2 and 4.	ft	0. (E)	100. (W)	--
5. Right Lower Vertical Height (H2)	The length of the lower vertical member for a subdivided member (panel types 8, 9, 10, 14), corresponding to length H2 on Figure 5.11-1. H2 must be entered for the panel types listed above, even if the vertical member is not present. Leave this parameter blank for all other panel types.	ft	0. (E)	100. (W)	--

5.11 GEO – GEOMETRY COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
6. Relative Elevation of Bottom Panel Point (H3)	The elevation of the lower joint on the right hand side of the panel minus the elevation of the left-most support joint (L0 for a through truss, U0 for a deck truss). H3 is negative if the elevation of the joint under consideration is lower than the elevation of the left-most support joint.	ft	-100. (W)	100. (W)	0.
7. Panel Type	Enter the type of panel being defined (valid panel types shown in Figure 5.11-1). The dashed lines in panels 13, 14 and 15 indicate counters (diagonal members that cannot resist compression). Panel type 15 must be preceded by panel type 14. **If Panel Type 2 is followed by Panel Type 1, a hinge must be located at the common joint between panels 2 and 1. Likewise, if Panel Type 4 is followed by Panel Type 3, a hinge must be located at the common joint between panels 4 and 3. Refer to the HNG command to specify the hinge.** NOTE: If editing the input file outside of EngAsst, do not place a leading zero in front of the panel type (i.e. 01, 02). This will cause the panel type to be ignored by EngAsst and not passed to TRLRFD, leading to program errors. Enter 0 if defining panel 0.	--	0 (E)	15 (E)	--

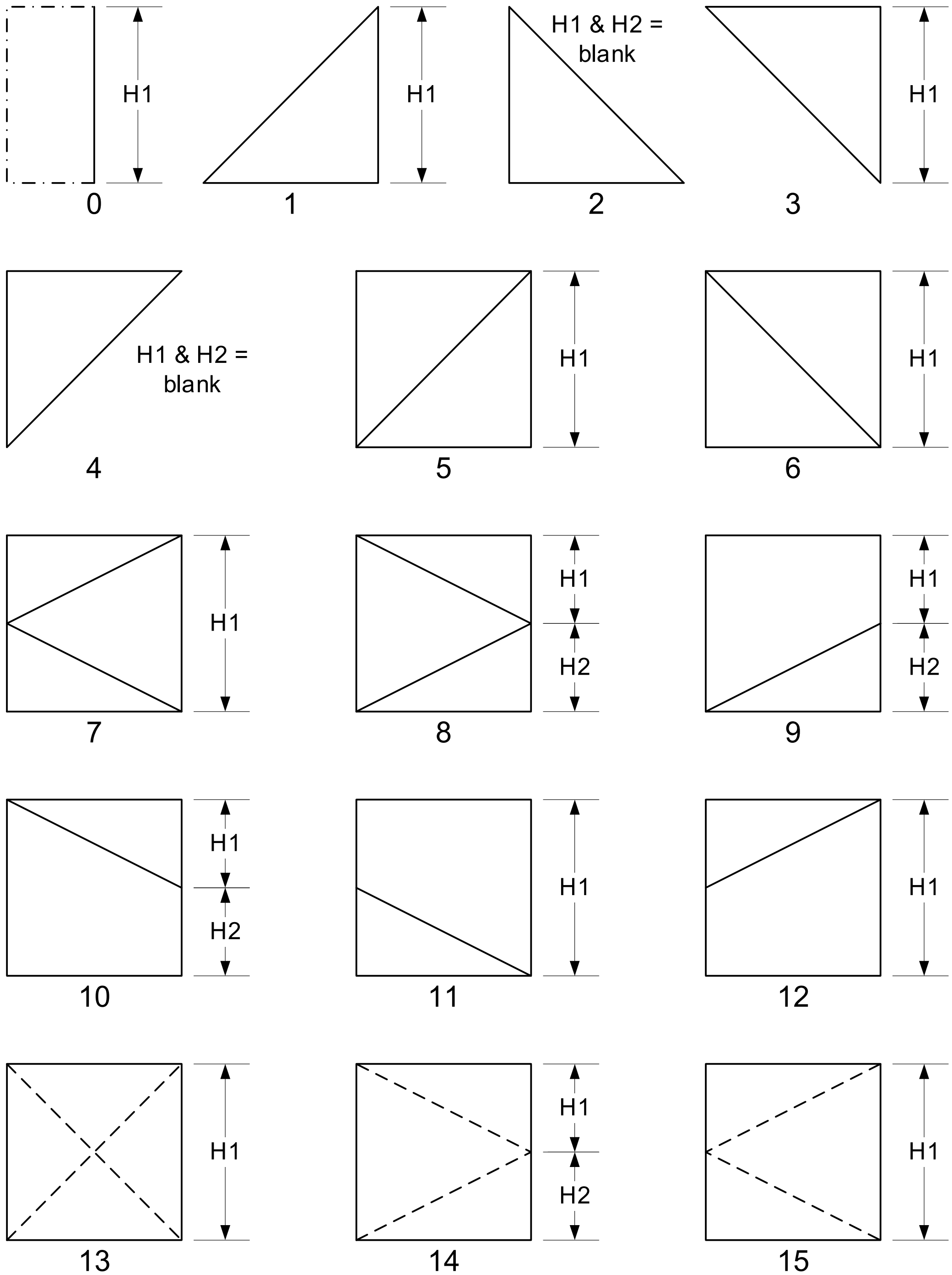


Figure 5.11-1 Truss Panel Types

5.12 TDC – TRUSS DEAD LOAD (DC) COMMAND

KEYWORD	COMMAND DESCRIPTION
TDC	TRUSS DEAD LOAD (DC) - This command is used for the input of DC (dead load of structural components and nonstructural attachments) loads acting at each joint. Dead loads shall not be entered at joints where verticals or diagonals do not exist. Dead loads cannot be applied at middle panel points. **TRLRFD does not calculate self-weight of the truss members, so the self-weight should be included with other DC loads. Because of this, a DC load should be entered at each upper and lower joint supported by vertical or diagonal members. TRLRFD also uses the DC loads to determine the dead load contraflexure points for multispan trusses.** The parameters and the command can be repeated to define up to 200 loads (only one DC load can be defined per joint). For compatibility with EngAsst, enter up to ten loads per instance of the TDC command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Location	Enter the joint designation for the load. Joints are designated by their location (U or L for Upper or Lower) followed by the joint number (L0, U13, L23, etc.). Only one DC load can be defined per joint. If a joint is entered more than once, all loads after the first load will be ignored and a warning will be generated in the output file.	--	--	--	--
2. Concentrated Load	The DC load applied at the joint described above. All dead load acting on the truss must be entered via the TDC or TDW commands. Dead loads to be entered include, but are not limited to deck weight, stringer loads, floorbeam loads, parapet, sidewalk, or median loads, diaphragms, bracing, sidewalk live load and the truss self-weight.	kip	**0.001** (W)	500. (W)	--

5.13 TDW – TRUSS DEAD LOAD (DW) COMMAND

KEYWORD	COMMAND DESCRIPTION
TDW	TRUSS DEAD LOAD (DW) - This command is used for the input of DW (dead loads of wearing surface and utilities) loads acting at each joint. Dead loads shall not be entered at joints where verticals or diagonals do not exist. Dead loads cannot be applied at middle panel points. The parameters and the command can be repeated to define up 200 loads (only one DW load can be defined per joint). For compatibility with EngAsst, enter up to ten loads per instance of the TDW command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Location	Enter the joint designation for the load. Joints are designated by their location (U or L for Upper or Lower) followed by the joint number (L0, U13, L23, etc.) Only one DW load can be defined per joint. If a joint is entered more than once, all loads after the first load will be ignored and a warning will be generated in the output file.	--	--	--	--
2. Concentrated Load	The DW load applied at the joint described above	kip	**0.001** (W)	200. (W)	--

5.14 PRP – TRUSS MEMBER PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
PRP	TRUSS MEMBER PROPERTIES - This command is used to define the structural properties of the truss members. Truss members can either be entered on the PRP command OR on one of the TYPE ## SECTION PROPERTIES commands. They cannot be entered via both commands.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.)	--	--	--	--
2. Gross Area	The gross cross-sectional area of the member. Enter the effective gross area if the member has deteriorated. This data is used in calculating the allowable tension in the member.	in^2	0.1 (W)	200. (W)	--
3. Net Area	The net cross-sectional area of the member. This data is used in calculating the allowable tension in the member. NOTE: If the input net area is greater than the input gross area, the program will stop with an error.	in^2	0.1 (W)	200 (W)	--
4. Moment of Inertia	The moment of inertia about the bending axis of the member.	in^4	0.01 (W)	30000. (W)	--
5. Yield Strength	The yield strength of the member.	ksi	26. (W)	100. (W)	36.
6. Unbraced Length	The actual unbraced length of the member, relative to the bending axis of the member. If left blank, the program will calculate this based on the geometry input. The only time that a**n unbraced** length should be entered is when the unbraced length is **different** than the **straight-line** length **between the start and end joints** compute**d** from the geometry commands. The bracing to be considered for this parameter prevents out-of-plane buckling of the member, so the relevant bracing is perpendicular to the bending axis.	ft	0. (E)	**$MbrLen^2$** (**W**)	**MbrLen**
7. Fatigue Category	Enter the category of the fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively. Leave blank if fatigue is not to be checked in this member.	--	A, B, BP, C, CP, D, E, EP	--	--

5.14 PRP – TRUSS MEMBER PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
8. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	--[1]
9. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for MOMENT RESISTANCE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
10. Moment Resistance	The moment resistance (Mr) of the current member. Leave blank if the ECCENTRICITY is entered as 0.	kip-ft	0. (E)	77000. (W)	--
11. Tensile Resistance	Enter the factored tensile resistance of the current member. Enter the resistance for tension alone. If the member is subjected to tension and flexure, the combined capacity will be calculated internally based on this value and the moment resistance entered with parameter 10. If this value is left blank, the program will compute the tensile resistance.	kips	0. (E)	15000. (W)	*
12. Compressive Resistance	Enter the factored compressive resistance of the current member. Enter the resistance for compression alone. If the member is subjected to compression and flexure, the combined capacity will be calculated internally based on this value and the moment resistance entered with parameter 10.	kips	0. (E)	15000. (W)	--

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

5.15 AVAILABLE CROSS SECTION TYPES

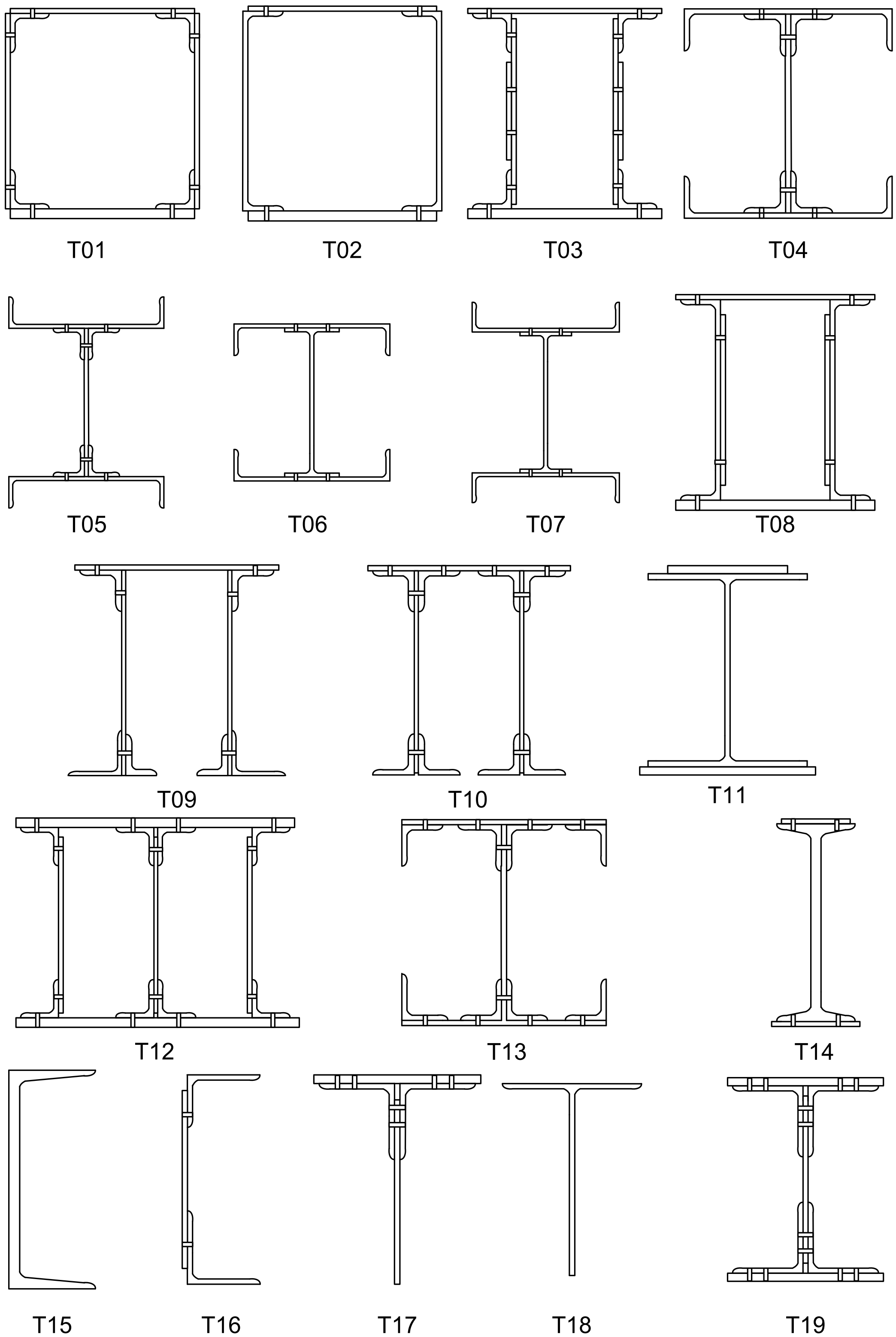


Figure 5.15-1   Available Cross Section Types

5.16 T01 – TYPE 01 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T01	TYPE 01 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 01. This command may be repeated for each member of type 01.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.16 T01 – TYPE 01 SECTION PROPERTIES COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.16-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. D	Enter the plate width corresponding to D in Figure 5.16-1.	in	0. (E)	60. (W)	--
11. TD	Enter the plate thickness corresponding to TD in Figure 5.16-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the plates defined by D and TD. The same number of holes is assumed in each plate.	--	0 (E)	10 (W)	0
13. B	Enter the plate width corresponding to B in Figure 5.16-1.	in	0. (E)	36. (W)	--
14. TBT	Enter the plate thickness corresponding to TBT in Figure 5.16-1.	in	0. (E)	2. (W)	--
15. TBB	Enter the plate thickness corresponding to TBB in Figure 5.16-1.	in	0. (E)	2. (W)	--
16. Number of holes per plate	Enter the number of bolt or rivet holes through the plates defined by B and TBT or TBB. The same number of holes is assumed in each plate.	--	0 (E)	10 (W)	0

5.16 T01 – TYPE 01 SECTION PROPERTIES COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. HT	Enter the hole width corresponding to HT in Figure 5.16-1.	in	0. (E)	24. (W)	--
18. HB	Enter the hole width corresponding to HB in Figure 5.16-1.	in	0. (E)	24. (W)	--
19. L1	Enter the horizontal leg length corresponding to L1 in Figure 5.16-1.	in	0. (E)	9. (E)	--
20. L2	Enter the vertical leg length corresponding to L2 in Figure 5.16-1.	in	0. (E)	9. (E)	--
21. TL	Enter the angle thickness corresponding to TL in Figure 5.16-1.	in	0. (E)	2. (E)	--
22. Number of Holes Per Angle	Enter the number of bolt holes in a single angle defined by L1, L2 and TL. The same number of holes will be assumed in each angle in the cross section.	--	0 (E)	10 (W)	0
DETERIORATIONS					
23. TP	Enter the deterioration on the element corresponding to TP in Figure 5.16-1.	in	0. (E)	2. (E)	0.
24. LP	Enter the deterioration on the element corresponding to LP in Figure 5.16-1.	in	0. (E)	2. (E)	0.
25. RP	Enter the deterioration on the element corresponding to RP in Figure 5.16-1.	in	0. (E)	2. (E)	0.
26. BP	Enter the deterioration on the element corresponding to BP in Figure 5.16-1.	in	0. (E)	2. (E)	0.
27. LTL	Enter the deterioration on the element corresponding to LTL in Figure 5.16-1.	in	0. (E)	2. (E)	0.
28. LTR	Enter the deterioration on the element corresponding to LTR in Figure 5.16-1.	in	0. (E)	2. (E)	0.
29. LBL	Enter the deterioration on the element corresponding to LBL in Figure 5.16-1.	in	0. (E)	2. (E)	0.
30. LBR	Enter the deterioration on the element corresponding to LBR in Figure 5.16-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

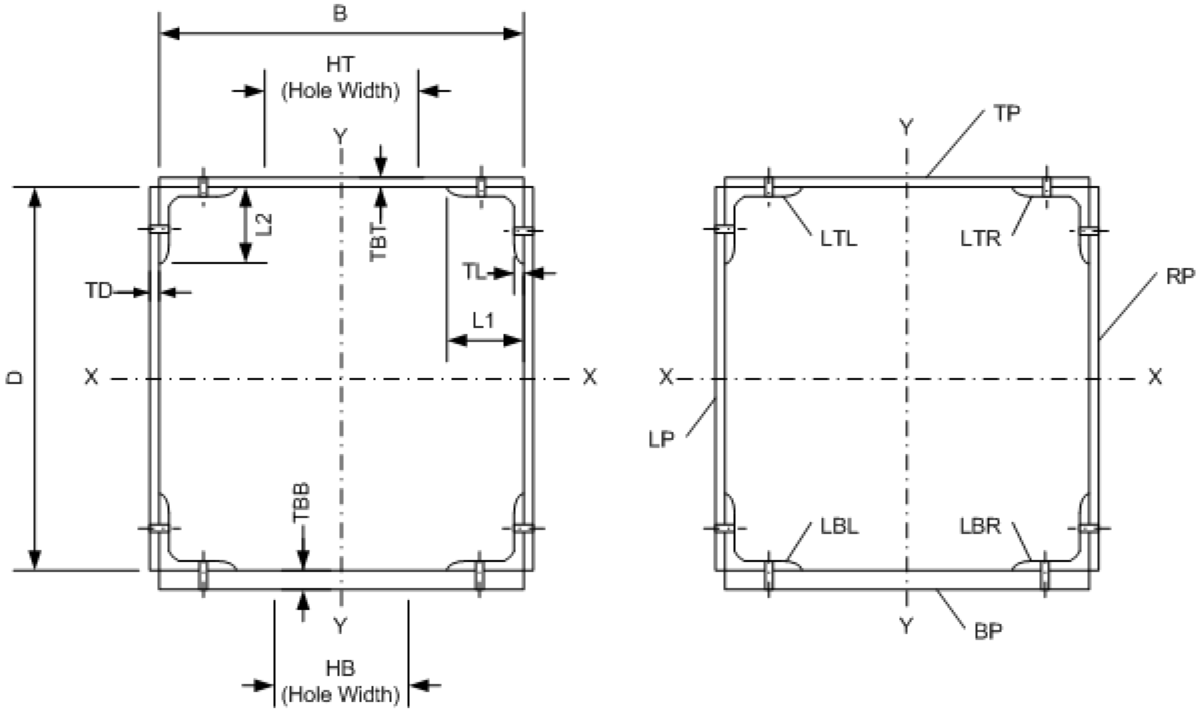


Figure 5.16-1   Section Type T01

5.17 T02 – TYPE 02 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T02	TYPE 02 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 02. This command may be repeated for each member of type 02.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.17 T02 – TYPE 02 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.17-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. B	Enter the plate width corresponding to B in Figure 5.17-1.	in	0. (E)	36. (W)	--
11. TBT	Enter the plate thickness corresponding to TBT in Figure 5.17-1.	in	0. (E)	2. (W)	--
12. TBB	Enter the plate thickness corresponding to TBB in Figure 5.17-1.	in	0. (E)	2. (W)	--
13. Number of holes per plate	Enter the number of bolt or rivet holes through the top and bottom plates defined by B and TBT or TBB. The same number of holes is assumed in each plate.	--	0 (E)	10 (W)	0
14. W	Enter the channel spacing corresponding to W in Figure 5.17-1.	in	0. (E)	24. (W)	--
15. HT	Enter the hole width corresponding to HT in Figure 5.17-1.	in	0. (E)	24. (W)	--
16. HB	Enter the hole width corresponding to HB in Figure 5.17-1.	in	0. (E)	24. (W)	--

5.17 T02 – TYPE 02 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. D	Enter the channel depth corresponding to D in Figure 5.17-1.	in	0. (E)	60. (W)	--
18. TD	Enter the channel thickness corresponding to TD in Figure 5.17-1.	in	0. (E)	2. (W)	--
19. L	Enter the horizontal leg length corresponding to L in Figure 5.17-1.	in	0. (E)	9. (E)	--
20. TL	Enter the channel flange thickness corresponding to TL in Figures 5.17-1 and 5.17-2. TRLRFD assumes a slope of 17.5% on flanges of channels. TL is the thickness at the midwidth of the flange.	in	0. (E)	2. (E)	--
21. Number of holes per flange	Enter the number of bolt or rivet holes through the channel flanges defined by L and TL. The same number of holes will be assumed in each flange.	--	0 (E)	10 (W)	0
DETERIORATION					
22. TP	Enter the deterioration on the element corresponding to TP in Figure 5.17-1.	in	0. (E)	2. (E)	0.
23. LP	Enter the deterioration on the element corresponding to LP in Figure 5.17-1.	in	0. (E)	2. (E)	0.
24. RP	Enter the deterioration on the element corresponding to RP in Figure 5.17-1.	in	0. (E)	2. (E)	0.
25. BP	Enter the deterioration on the element corresponding to BP in Figure 5.17-1.	in	0. (E)	2. (E)	0.
26. LTL	Enter the deterioration on the element corresponding to LTL in Figure 5.17-1.	in	0. (E)	2. (E)	0.
27. LTR	Enter the deterioration on the element corresponding to LTR in Figure 5.17-1.	in	0. (E)	2. (E)	0.
28. LBL	Enter the deterioration on the element corresponding to LBL in Figure 5.17-1.	in	0. (E)	2. (E)	0.
29. LBR	Enter the deterioration on the element corresponding to LBR in Figure 5.17-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.
2 **MbrLen is the member length computed from the truss geometry.**

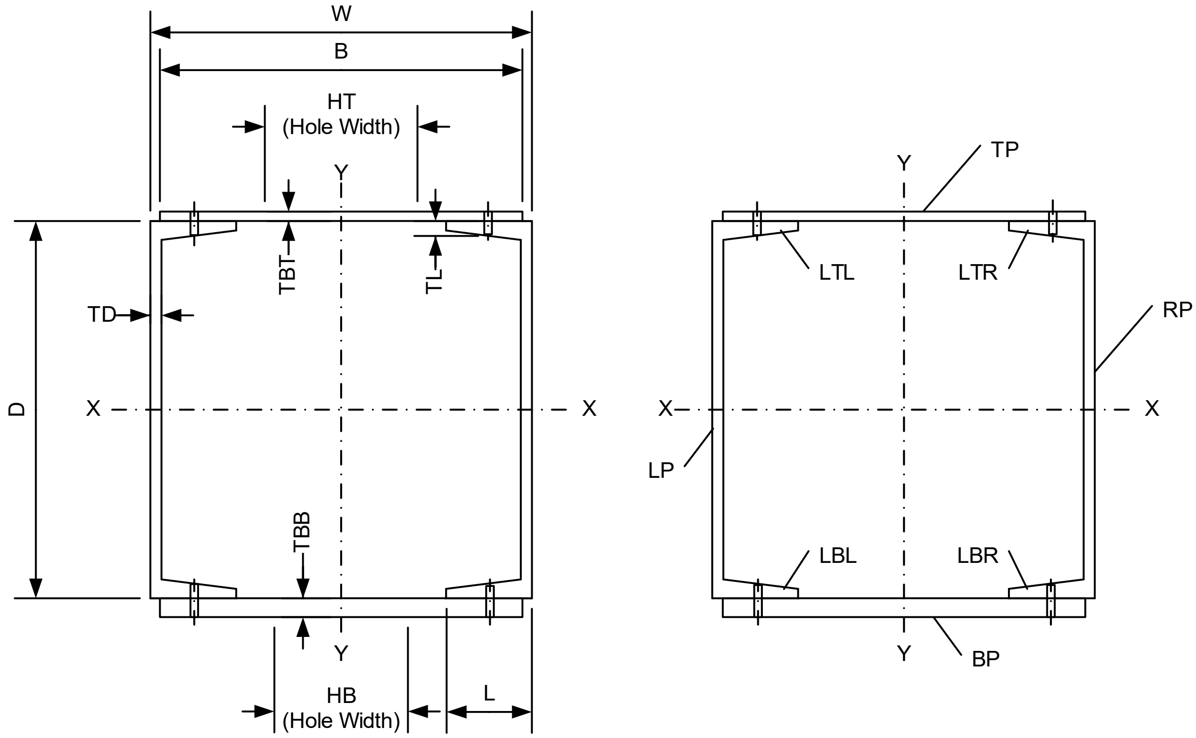


Figure 5.17-1 Section Type T02

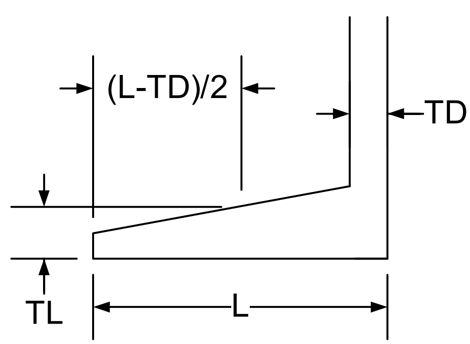


Figure 5.17-2 Dimension TL

5.18 T03 – TYPE 03 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T03	TYPE 03 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 03. This command may be repeated for each member of type 03.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.18 T03 – TYPE 03 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.18-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. D	Enter the plate width corresponding to D in Figure 5.18-1.	in	0. (E)	60. (W)	--
11. TD	Enter the plate thickness corresponding to TD in Figure 5.18-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the plates defined by D and TD. The same number of holes will also be assumed in each side plate.	--	0 (E)	10 (W)	0
13. LP	Enter the plate width corresponding to LP in Figure 5.18-1.	in	0. (E)	24. (W)	--
14. TP	Enter the plate thickness corresponding to TP in Figure 5.18-1.	in	0. (E)	2. (W)	
15. Number of holes per plate	Enter the number of bolt or rivet holes through the side plates defined by LP and TP. The same number of holes will also be assumed in each plate.	--	0 (E)	10 (W)	--
16. B	Enter the plate width corresponding to B in Figure 5.18-1.	in	0. (E)	36. (W)	--

5.18 T03 – TYPE 03 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. TBT	Enter the plate thickness corresponding to TBT in Figure 5.18-1.	in	0. (E)	2. (W)	--
18. TBB	Enter the plate thickness corresponding to TBB in Figure 5.18-1.	in	0. (E)	2. (W)	--
19. Number of holes per plate	Enter the number of bolt or rivet holes through the plates defined by B and TBT or TBB. The same number of holes is assumed in each plate.	--	0 (E)	10 (W)	0
20. W	Enter the plate spacing corresponding to W in Figure 5.18-1.	in	0. (E)	24. (W)	--
21. H	Enter the flange plate spacing corresponding to H in Figure 5.18-1.	in	0. (E)	24. (W)	--
22. HT	Enter the hole width corresponding to HT in Figure 5.18-1.	in	0. (E)	24. (W)	--
23. HB	Enter the hole width corresponding to HB in Figure 5.18-1.	in	0. (E)	24. (W)	--
24. L1	Enter the horizontal leg length corresponding to L1 in Figure 5.18-1.	in	0. (E)	9. (E)	--
25. L2	Enter the vertical leg length corresponding to L2 in Figure 5.18-1.	in	0. (E)	9. (E)	--
26. TL	Enter the angle thickness corresponding to TL in Figure 5.18-1.	in	0. (E)	2. (E)	--
27. Number of Holes Per Angle	Enter the number of bolt holes in a single angle defined by L1, L2 and TL. The same number of holes will be assumed in each angle in the cross section.	--	0 (E)	10 (W)	0
DETERIORATION					
28. TPD	Enter the deterioration on the element corresponding to TPD in Figure 5.18-1.	in	0. (E)	2. (E)	0.
29. LPD	Enter the deterioration on the element corresponding to LPD in Figure 5.18-1.	in	0. (E)	2. (E)	0.
30. RPD	Enter the deterioration on the element corresponding to RPD in Figure 5.18-1.	in	0. (E)	2. (E)	0.
31. BPD	Enter the deterioration on the element corresponding to BPD in Figure 5.18-1.	in	0. (E)	2. (E)	0.
32. LTL	Enter the deterioration on the element corresponding to LTL in Figure 5.18-1.	in	0. (E)	2. (E)	0.
33. LTR	Enter the deterioration on the element corresponding to LTR in Figure 5.18-1.	in	0. (E)	2. (E)	0.

5.18 T03 – TYPE 03 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
DETERIORATION (Continued)					
34. LBL	Enter the deterioration on the element corresponding to LBL in Figure 5.18-1.	in	0. (E)	2. (E)	0.
35. LBR	Enter the deterioration on the element corresponding to LBR in Figure 5.18-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

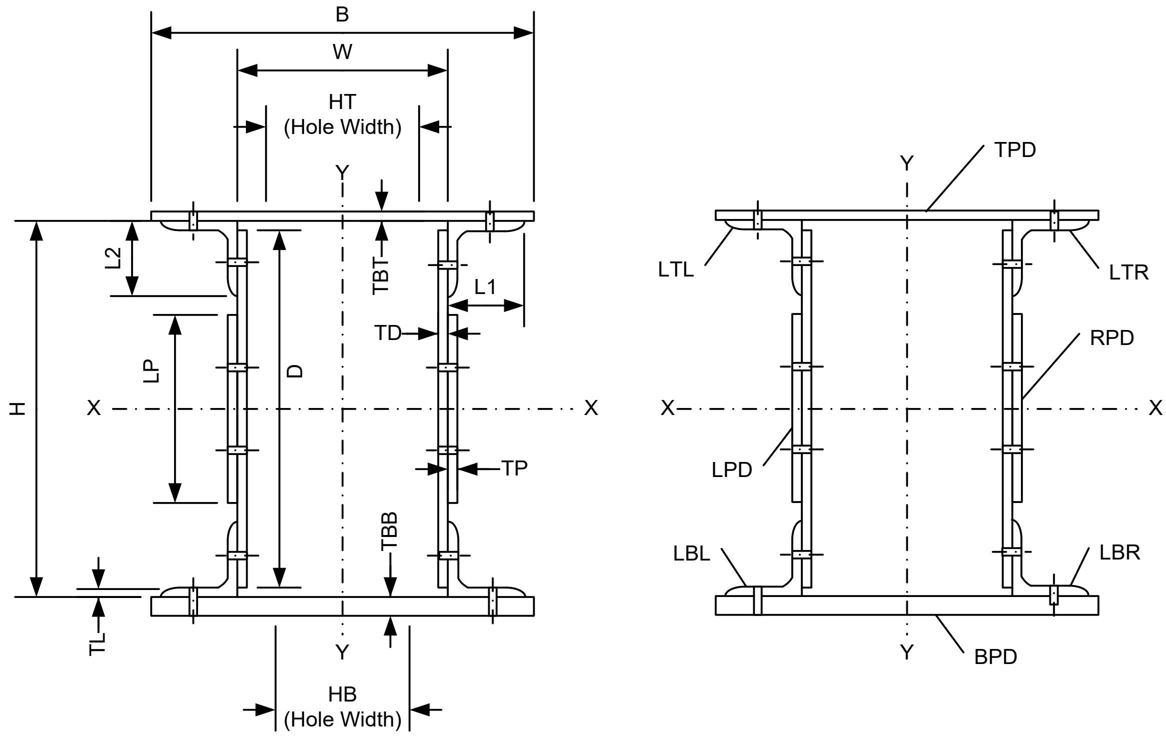


Figure 5.18-1 Section Type T03

5.19 T04 – TYPE 04 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T04	TYPE 04 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 04. This command may be repeated for each member of type 04.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.19 T04 – TYPE 04 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.19-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. D	Enter the plate width corresponding to D in Figure 5.19-1.	in	0. (E)	60. (W)	--
11. TD	Enter the plate thickness corresponding to TD in Figure 5.19-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the plate defined by D and TD.	--	0 (E)	10 (W)	0
13. B	Enter the channel depth corresponding to B in Figure 5.19-1.	in	0. (E)	36. (W)	--
14. TB	Enter the web thickness corresponding to TB in Figure 5.19-1.	in	0. (E)	2. (W)	--
15. C	Enter the channel flange width corresponding to C in Figure 5.19-1.	in	0. (E)	9. (W)	--
16. TC	Enter the channel flange thickness corresponding to TC in Figure 5.19-1 and 5.19-2. TRLRFD assumes a slope of 17.5% on flanges of channels. TC is the thickness at the midwidth of the flange.	in	0. (E)	2. (W)	--

5.19 T04 – TYPE 04 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. Number of holes per web	Enter the number of bolt or rivet holes in the webs defined by B and TB. The same number of holes will be assumed in each web.	--	0 (E)	10 (W)	0
18. L1	Enter the horizontal leg length corresponding to L1 in Figure 5.19-1.	in	0. (E)	9. (W)	--
19. L2	Enter the vertical leg length corresponding to L2 in Figure 5.19-1.	in	0. (E)	9. (W)	--
20. TL	Enter the angle thickness corresponding to TL in Figure 5.19-1.	in	0. (E)	2. (W)	--
21. Number of Holes Per Angle	Enter the number of bolt holes in a single angle defined by L1, L2 and TL. The same number of holes will be assumed in each angle in the cross section.	--	0 (E)	10 (W)	0
DETERIORATION					
22. TP	Enter the deterioration on the element corresponding to TP in Figure 5.19-1.	in	0. (E)	2. (E)	0.
23. BP	Enter the deterioration on the element corresponding to BP in Figure 5.19-1.	in	0. (E)	2. (E)	0.
24. TW	Enter the deterioration on the element corresponding to TW in Figure 5.19-1.	in	0. (E)	2. (E)	0.
25. CTL	Enter the deterioration on the element corresponding to CTL in Figure 5.19-1.	in	0. (E)	2. (E)	0.
26. CTR	Enter the deterioration on the element corresponding to CTR in Figure 5.19-1.	in	0. (E)	2. (E)	0.
27. CBL	Enter the deterioration on the element corresponding to CBL in Figure 5.19-1.	in	0. (E)	2. (E)	0.
28. CBR	Enter the deterioration on the element corresponding to CBR in Figure 5.19-1.	in	0. (E)	2. (E)	0.
29. LTL	Enter the deterioration on the element corresponding to LTL in Figure 5.19-1.	in	0. (E)	2. (E)	0.
30. LTR	Enter the deterioration on the element corresponding to LTR in Figure 5.19-1.	in	0. (E)	2. (E)	0.
31. LBL	Enter the deterioration on the element corresponding to LBL in Figure 5.19-1.	in	0. (E)	2. (E)	0.
32. LBR	Enter the deterioration on the element corresponding to LBR in Figure 5.19-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

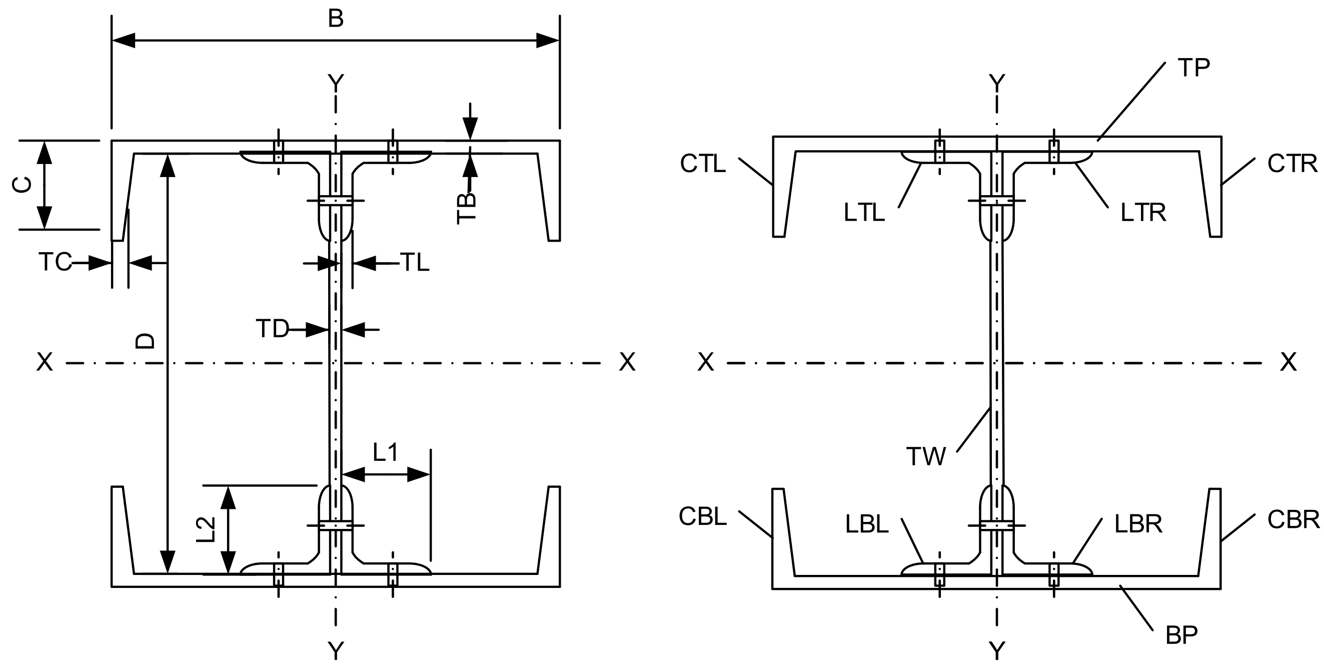


Figure 5.19-1 Section Type T04

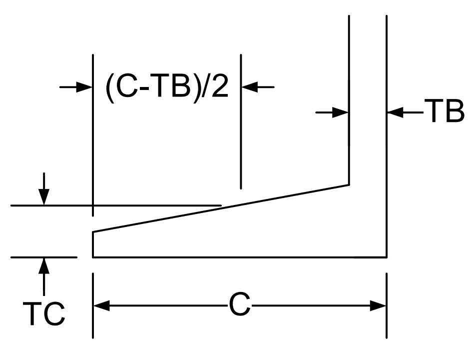


Figure 5.19-2 Dimension TC

5.20 T05 – TYPE 05 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T05	TYPE 05 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 05. This command may be repeated for each member of type 05.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.20 T05 – TYPE 05 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.20-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. D	Enter the plate width corresponding to D in Figure 5.20-1.	in	0. (E)	60. (W)	--
11. TD	Enter the plate thickness corresponding to TD in Figure 5.20-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the plate defined by D and TD.	--	0 (E)	10 (W)	0
13. B	Enter the channel depth corresponding to B in Figure 5.20-1.	in	0. (E)	36. (W)	--
14. TB	Enter the web thickness corresponding to TB in Figure 5.20-1.	in	0. (E)	2. (W)	--
15. C	Enter the channel flange width corresponding to C in Figure 5.20-1.	in	0. (E)	24. (W)	--
16. TC	Enter the channel flange thickness corresponding to TC in Figures 5.20-1 and 5.20-2. TRLRFD assumes a slope of 17.5% on flanges of channels. TC is the thickness at the midwidth of the flange.	in	0. (E)	2. (W)	--

5.20 T05 – TYPE 05 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. Number of holes per web	Enter the number of bolt or rivet holes in the webs defined by B and TB. The same number of holes will be assumed in each web	--	0 (E)	10 (W)	0
18. L1	Enter the horizontal leg length corresponding to L1 in Figure 5.20-1.	in	0. (E)	9. (W)	--
19. L2	Enter the vertical leg length corresponding to L2 in Figure 5.20-1.	in	0. (E)	9. (W)	--
20. TL	Enter the angle thickness corresponding to TL in Figure 5.20-1.	in	0. (E)	2. (W)	--
21. Number of Holes Per Angle	Enter the number of bolt holes in a single angle defined by L1, L2 and TL. The same number of holes will be assumed in each angle in the cross section.	--	0 (E)	10 (W)	0
DETERIORATION					
22. TP	Enter the deterioration on the element corresponding to TP in Figure 5.20-1.	in	0. (E)	2. (E)	0.
23. BP	Enter the deterioration on the element corresponding to BP in Figure 5.20-1.	in	0. (E)	2. (E)	0.
24. TW	Enter the deterioration on the element corresponding to TW in Figure 5.20-1.	in	0. (E)	2. (E)	0.
25. CTL	Enter the deterioration on the element corresponding to CTL in Figure 5.20-1.	in	0. (E)	2. (E)	0.
26. CTR	Enter the deterioration on the element corresponding to CTR in Figure 5.20-1.	in	0. (E)	2. (E)	0.
27. CBL	Enter the deterioration on the element corresponding to CBL in Figure 5.20-1.	in	0. (E)	2. (E)	0.
28. CBR	Enter the deterioration on the element corresponding to CBR in Figure 5.20-1.	in	0. (E)	2. (E)	0.
29. LTL	Enter the deterioration on the element corresponding to LTL in Figure 5.20-1.	in	0. (E)	2. (E)	0.
30. LTR	Enter the deterioration on the element corresponding to LTR in Figure 5.20-1.	in	0. (E)	2. (E)	0.
31. LBL	Enter the deterioration on the element corresponding to LBL in Figure 5.20-1.	in	0. (E)	2. (E)	0.
32. LBR	Enter the deterioration on the element corresponding to LBR in Figure 5.20-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

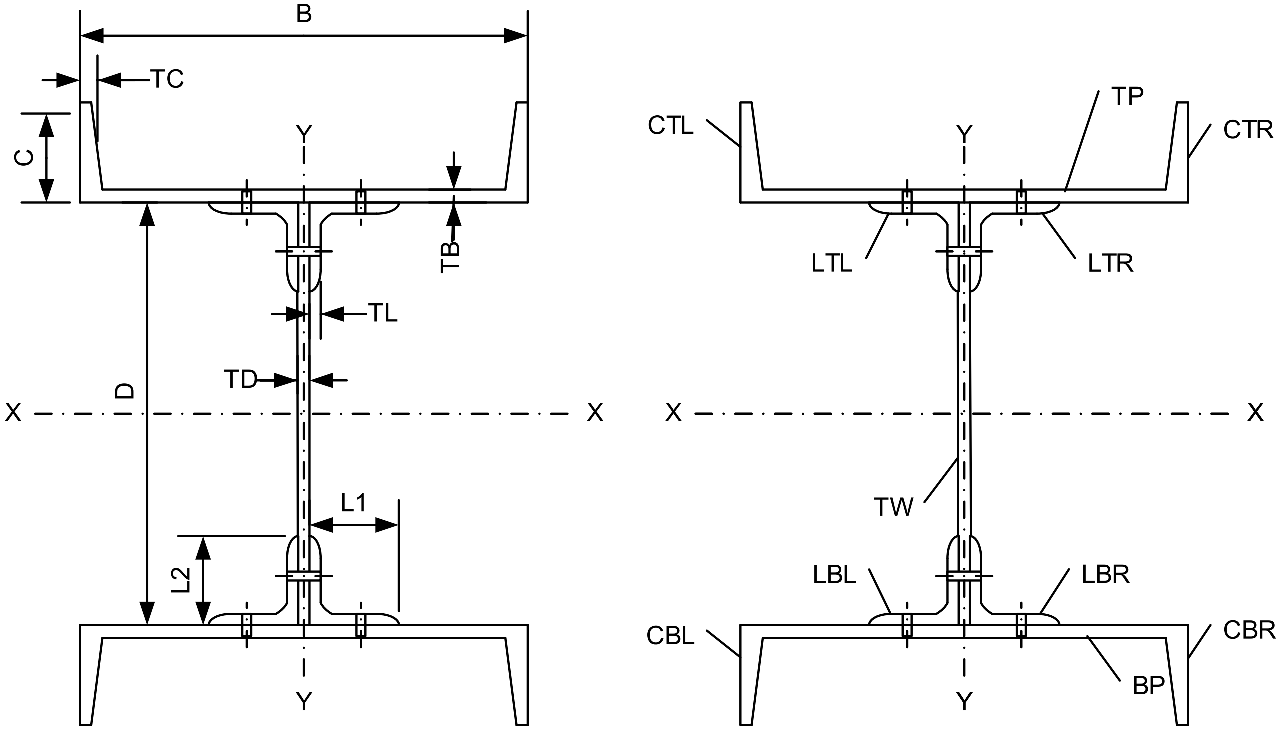


Figure 5.20-1   Section Type T05

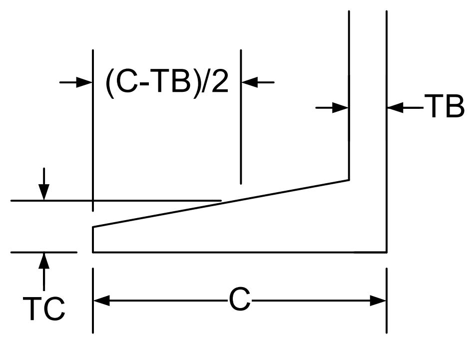


Figure 5.20-2   Dimension TC

5.21 T06 – TYPE 06 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T06	TYPE 06 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 06. This command may be repeated for each member of type 06.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.21 T06 – TYPE 06 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.21-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. B	Enter the channel depth corresponding to B in Figure 5.21-1.	in	0. (E)	36. (W)	--
11. TB	Enter the web thickness corresponding to TB in Figure 5.21-1.	in	0. (E)	2. (W)	--
12. C	Enter the channel flange width corresponding to C in Figure 5.21-1.	in	0. (E)	24. (W)	--
13. TC	Enter the channel flange thickness corresponding to TC in Figures 5.21-1 and 5.21-2. TRLRFD assumes a slope of 17.5% on flanges of channels. TC is the thickness at the midwidth of the flange.	in	0. (E)	2. (W)	--
14. Number of holes per web	Enter the number of bolt or rivet holes through the webs of the angles defined by B and TB. The same number of holes will be assumed in each web.	--	0 (E)	10 (W)	0
15. D	Enter the depth corresponding to D in Figure 5.21-1.	in	0. (E)	60. (W)	--
16. TD	Enter the web thickness corresponding to TD in Figure 5.21-1.	in	0. (E)	2. (W)	--

5.21 T06 – TYPE 06 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. F	Enter the flange width corresponding to F in Figure 5.21-1.	in	0. (E)	24. (W)	--
18. TF	Enter the flange thickness corresponding to TF in Figure 5.21-1.	in	0. (E)	2. (W)	--
19. Number of holes per flange	Enter the number of bolt or rivet holes through the flanges defined by F and TF. The same number of holes will be assumed in each flange.	--	0 (E)	10 (W)	0
DETERIORATION					
20. TP	Enter the deterioration on the element corresponding to TP in Figure 5.21-1.	in	0. (E)	2. (E)	0.
21. BP	Enter the deterioration on the element corresponding to BP in Figure 5.21-1.	in	0. (E)	2. (E)	0.
22. CTL	Enter the deterioration on the element corresponding to CTL in Figure 5.21-1.	in	0. (E)	2. (E)	0.
23. CTR	Enter the deterioration on the element corresponding to CTR in Figure 5.21-1.	in	0. (E)	2. (E)	0.
24. CBL	Enter the deterioration on the element corresponding to CBL in Figure 5.21-1.	in	0. (E)	2. (E)	0.
25. CBR	Enter the deterioration on the element corresponding to CBR in Figure 5.21-1.	in	0. (E)	2. (E)	0.
26. TFD	Enter the deterioration on the element corresponding to LTL in Figure 5.21-1.	in	0. (E)	2. (E)	0.
27. TW	Enter the deterioration on the element corresponding to LTR in Figure 5.21-1.	in	0. (E)	2. (E)	0.
28. BFD	Enter the deterioration on the element corresponding to LBL in Figure 5.21-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

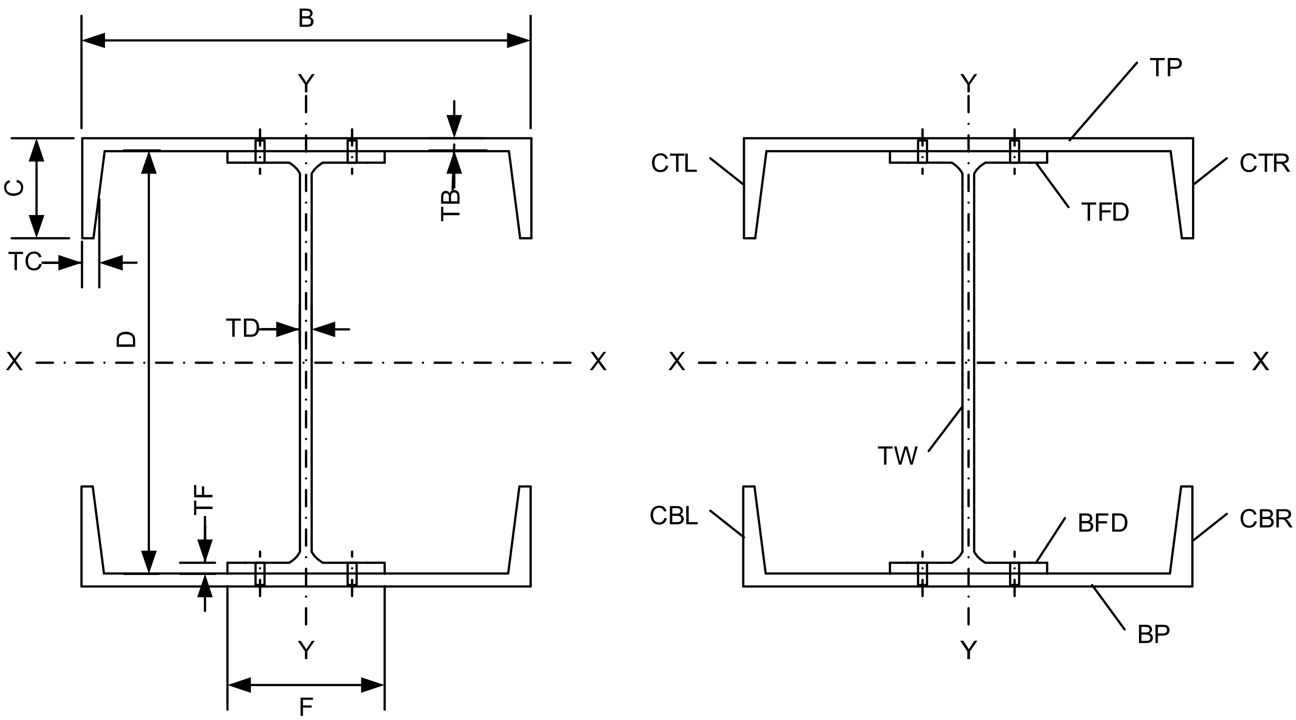


Figure 5.21-1 Section Type T06

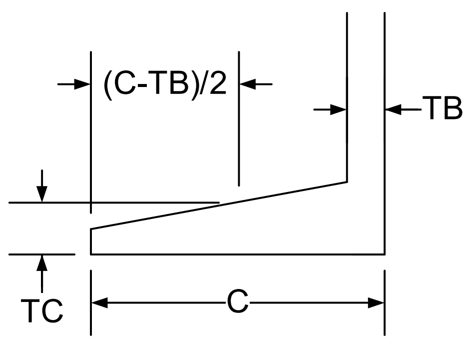


Figure 5.21-2 Dimension TC

5.22 T07 – TYPE 07 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T07	TYPE 07 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 07. This command may be repeated for each member of type 07.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen** (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.22 T07 – TYPE 07 SECTION PROPERTIES COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.22-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. B	Enter the channel depth corresponding to B in Figure 5.22-1.	in	0. (E)	36. (W)	--
11. TB	Enter the web thickness corresponding to TB in Figure 5.22-1.	in	0. (E)	2. (W)	--
12. C	Enter the channel flange width corresponding to C in Figure 5.22-1.	in	0. (E)	24. (W)	--
13. TC	Enter the channel flange thickness corresponding to TC in Figures 5.22-1 and 5.22-2. TRLRFD assumes a slope of 17.5% on flanges of channels. TC is the thickness at the midwidth of the flange.	in	0. (E)	2. (W)	--
14. Number of holes per web	Enter the number of bolt or rivet holes through the webs of the angles defined by B and TB. The same number of holes will be assumed in each web.	--	0 (E)	10 (W)	0
15. D	Enter the depth corresponding to D in Figure 5.22-1.	in	0. (E)	60. (W)	--
16. TD	Enter the web thickness corresponding to TD in Figure 5.22-1.	in	0. (E)	2. (W)	--

5.22 T07 – TYPE 07 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. F	Enter the flange width corresponding to F in Figure 5.22-1.	in	0. (E)	24. (W)	--
18. TF	Enter the flange thickness corresponding to TF in Figure 5.22-1.	in	0. (E)	2. (W)	--
19. Number of holes per flange	Enter the number of bolt or rivet holes through the flanges defined by F and TF. The same number of holes will be assumed in each flange.	--	0 (E)	10 (W)	0
DETERIORATION					
20. TP	Enter the deterioration on the element corresponding to TP in Figure 5.22-1.	in	0. (E)	2. (E)	0.
21. BP	Enter the deterioration on the element corresponding to BP in Figure 5.22-1.	in	0. (E)	2. (E)	0.
22. CTL	Enter the deterioration on the element corresponding to CTL in Figure 5.22-1.	in	0. (E)	2. (E)	0.
23. CTR	Enter the deterioration on the element corresponding to CTR in Figure 5.22-1.	in	0. (E)	2. (E)	0.
24. CBL	Enter the deterioration on the element corresponding to CBL in Figure 5.22-1.	in	0. (E)	2. (E)	0.
25. CBR	Enter the deterioration on the element corresponding to CBR in Figure 5.22-1.	in	0. (E)	2. (E)	0.
26. TFD	Enter the deterioration on the element corresponding to TFD in Figure 5.22-1.	in	0. (E)	2. (E)	0.
27. TW	Enter the deterioration on the element corresponding to TW in Figure 5.22-1.	in	0. (E)	2. (E)	0.
28. BFD	Enter the deterioration on the element corresponding to BFD in Figure 5.22-1.	in	0. (E)	2. (E)	0.

Notes:

[1] Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.
[2] **MbrLen is the member length computed from the truss geometry.**

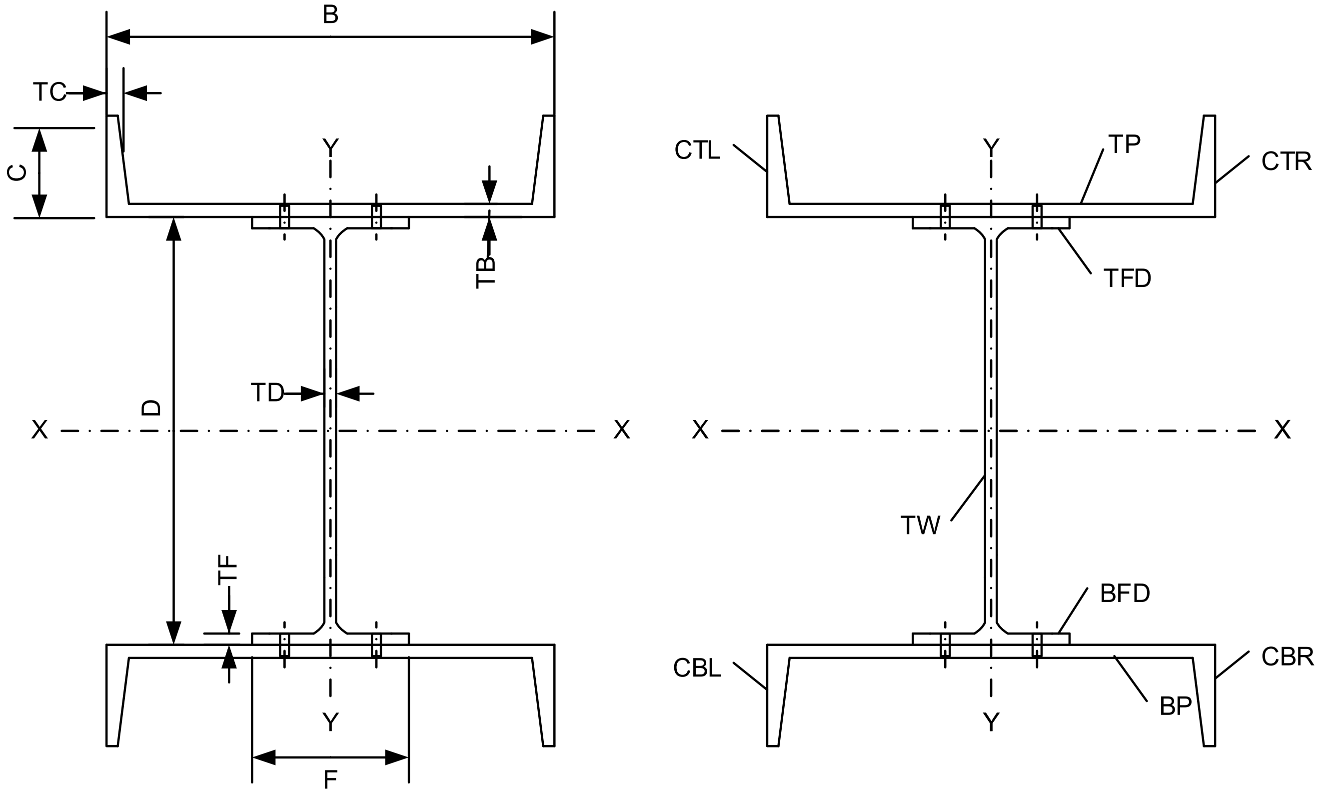


Figure 5.22-1 Section Type T07

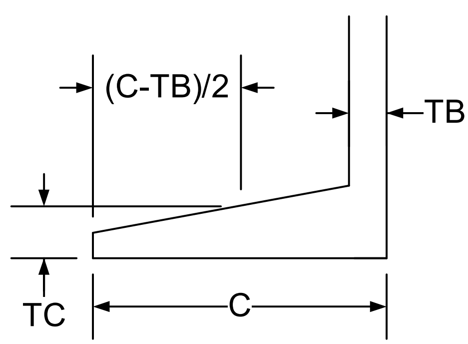


Figure 5.22-2 Dimension TC

5.23 T08 – TYPE 08 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T08	TYPE 08 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 08. This command may be repeated for each member of type 08.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.23 T08 – TYPE 08 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.23-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. P	Enter the plate width corresponding to P in Figure 5.23-1.	in	0. (E)	24. (W)	--
11. TP	Enter the plate thickness corresponding to TP in Figure 5.23-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the plates defined by P and TP. The same number of holes will be assumed in each side plate.	--	0 (E)	10 (W)	0
13. B	Enter the plate width corresponding to B in Figure 5.23-1.	in	0. (E)	36. (W)	--
14. TBT	Enter the plate thickness corresponding to TBT in Figure 5.23-1.	in	0. (E)	2. (W)	--
15. TBB	Enter the plate thickness corresponding to TBB in Figure 5.23-1.	in	0. (E)	2. (W)	--
16. Number of holes per plate	Enter the number of bolt or rivet holes through the top and bottom plates defined by B and TBT or TBB. The same number of holes is assumed in each plate.	--	0 (E)	10 (W)	0

5.23 T08 – TYPE 08 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. W	Enter the channel spacing corresponding to W in Figure 5.21-1	in	0 (E)	24 (W)	--
18. HT	Enter the hole width corresponding to HT in Figure 5.23-1.	in	0. (E)	24. (W)	--
19. HB	Enter the hole width corresponding to HB in Figure 5.23-1.	in	0. (E)	24. (W)	--
20. D	Enter the depth corresponding to D in Figure 5.23-1.	in	0. (E)	60. (W)	--
21. TD	Enter the thickness corresponding to TD in Figure 5.23-1.	in	0. (E)	2. (W)	--
22. C	Enter the channel flange width corresponding to C in Figure 5.23-1.	in	0. (E)	24. (W)	--
23. TC	Enter the channel flange thickness corresponding to TC in Figures 5.23-1 and 5.23-2. TRLRFD assumes a slope of 17.5% on flanges of channels. TC is the thickness at the midwidth of the flange.	in	0. (E)	2. (W)	--
24. Number of holes per flange	Enter the number of bolt or rivet holes through the flanges defined by C and TC. The same number of holes will be assumed in each flange.	--	0 (E)	10 (W)	0
25. Number of holes per web	Enter the number of bolt or rivet holes through the webs defined by D and TD.	--	0 (E)	10 (W)	0
DETERIORATION					
26. TPD	Enter the deterioration on the element corresponding to TP in Figure 5.23-1.	in	0. (E)	2. (E)	0.
27. LP	Enter the deterioration on the element corresponding to LP in Figure 5.23-1.	in	0. (E)	2. (E)	0.
28. RP	Enter the deterioration on the element corresponding to RP in Figure 5.23-1.	in	0. (E)	2. (E)	0.
29. BPD	Enter the deterioration on the element corresponding to BP in Figure 5.23-1.	in	0. (E)	2. (E)	0.
30. CTL	Enter the deterioration on the element corresponding to CTL in Figure 5.23-1.	in	0. (E)	2. (E)	0.
31. CTR	Enter the deterioration on the element corresponding to CTR in Figure 5.23-1.	in	0. (E)	2. (E)	0.
32. CBL	Enter the deterioration on the element corresponding to CBL in Figure 5.23-1.	in	0. (E)	2. (E)	0.
33. CBR	Enter the deterioration on the element corresponding to CBR in Figure 5.23-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.
2 **MbrLen is the member length computed from the truss geometry.**

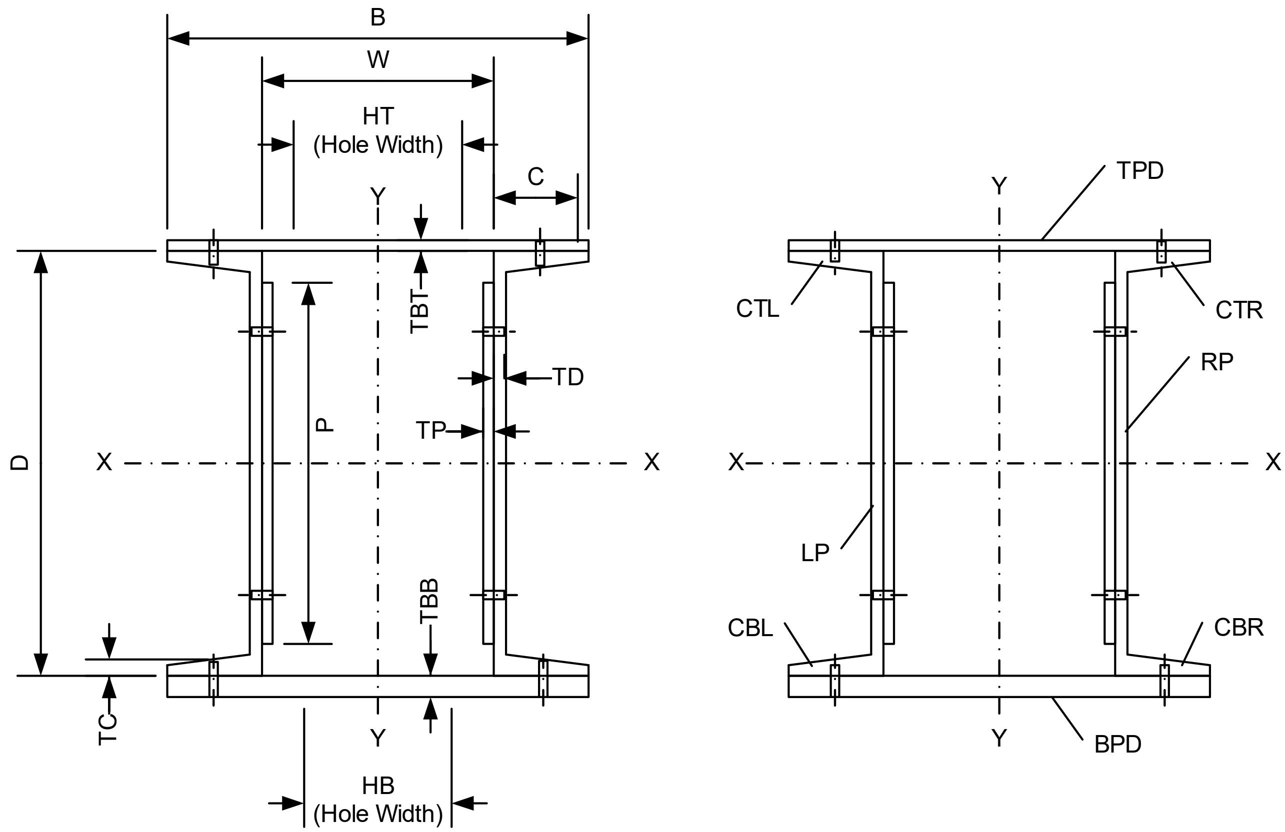


Figure 5.23-1 Section Type T08

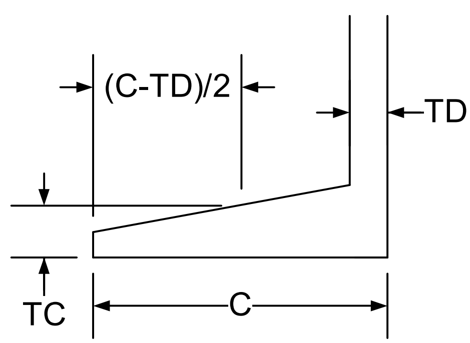


Figure 5.23-2 Dimension TC

5.24 T09 – TYPE 09 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T09	TYPE 09 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 09. This command may be repeated for each member of type 09.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.24 T09 – TYPE 09 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter X to designate the primary bending axis. The axes are shown in Figure 5.24-1. This section is not allowed to bend about the Y-axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. B	Enter the plate width corresponding to B in Figure 5.24-1.	in	0. (E)	36. (W)	--
11. TB	Enter the plate thickness corresponding to TB in Figure 5.24-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by B and TB.	--	0 (E)	10 (W)	0
13. D	Enter the plate width corresponding to D in Figure 5.24-1.	in	0. (E)	60. (W)	--
14. TD	Enter the plate thickness corresponding to TD in Figure 5.24-1.	in	0. (E)	2. (W)	--
15. Number of holes per plate	Enter the number of bolt or rivet holes through the plates defined by D and TD. The same number of holes will be assumed in each plate.	--	0 (E)	10 (W)	0
16. G	Enter the plate spacing corresponding to G in Figure 5.24-1.	in	0. (E)	24. (W)	--
17. LH1	Enter the horizontal leg length corresponding to LH1 in Figure 5.24-1.	in	0. (E)	9. (W)	--

5.24 T09 – TYPE 09 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
18. LV1	Enter the vertical leg length corresponding to LV1 in Figure 5.24-1.	in	0. (E)	9. (W)	--
19. T1	Enter the angle thickness corresponding to T1 in Figure 5.24-1.	in	0. (E)	2. (W)	--
20. Number of Holes Per Angle	Enter the number of bolt or rivet holes in the angles defined by LH1, LV1 and T1. The same number of holes will be assumed in each angle.	--	0 (E)	10 (W)	0
21. LH2	Enter the horizontal leg length corresponding to LH2 in Figure 5.24-1.	in	0. (E)	9. (W)	--
22. LV2	Enter the vertical leg length corresponding to LV2 in Figure 5.24-1.	in	0. (E)	9. (W)	--
23. T2	Enter the angle thickness corresponding to T2 in Figure 5.24-1.	in	0. (E)	2. (W)	--
24. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH2, LV2 and T2.	--	0 (E)	10 (W)	0
25. LH3	Enter the horizontal leg length corresponding to LH3 in Figure 5.24-1.	in	0. (E)	9. (W)	--
26. LV3	Enter the vertical leg length corresponding to LV3 in Figure 5.24-1.	in	0. (E)	9. (W)	--
27. T3	Enter the angle thickness corresponding to T3 in Figure 5.24-1.	in	0. (E)	2. (W)	--
28. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH3, LV3 and T3.	--	0 (E)	10 (W)	0
DETERIORATIONS					
29. TP	Enter the deterioration on the element corresponding to TP in Figure 5.24-1.	in	0. (E)	2. (E)	0.
30. LP	Enter the deterioration on the element corresponding to LP in Figure 5.24-1.	in	0. (E)	2. (E)	0.
31. RP	Enter the deterioration on the element corresponding to RP in Figure 5.24-1.	in	0. (E)	2. (E)	0.
32. LTL	Enter the deterioration on the element corresponding to LTL in Figure 5.24-1.	in	0. (E)	2. (E)	0.
33. LTR	Enter the deterioration on the element corresponding to LTR in Figure 5.24-1.	in	0. (E)	2. (E)	0.
34. LBL	Enter the deterioration on the element corresponding to LBL in Figure 5.24-1.	in	0. (E)	2. (E)	0.

5.24 T09 – TYPE 09 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
DETERIORATIONS (Continued)					
35. LBR	Enter the deterioration on the element corresponding to LBR in Figure 5.24-1.	in	0. (E)	2. (E)	0.
36. LIL	Enter the deterioration on the element corresponding to LIL in Figure 5.24-1.	in	0. (E)	2. (E)	0.
37. LIR	Enter the deterioration on the element corresponding to LIR in Figure 5.24-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.
2 **MbrLen is the member length computed from the truss geometry.**

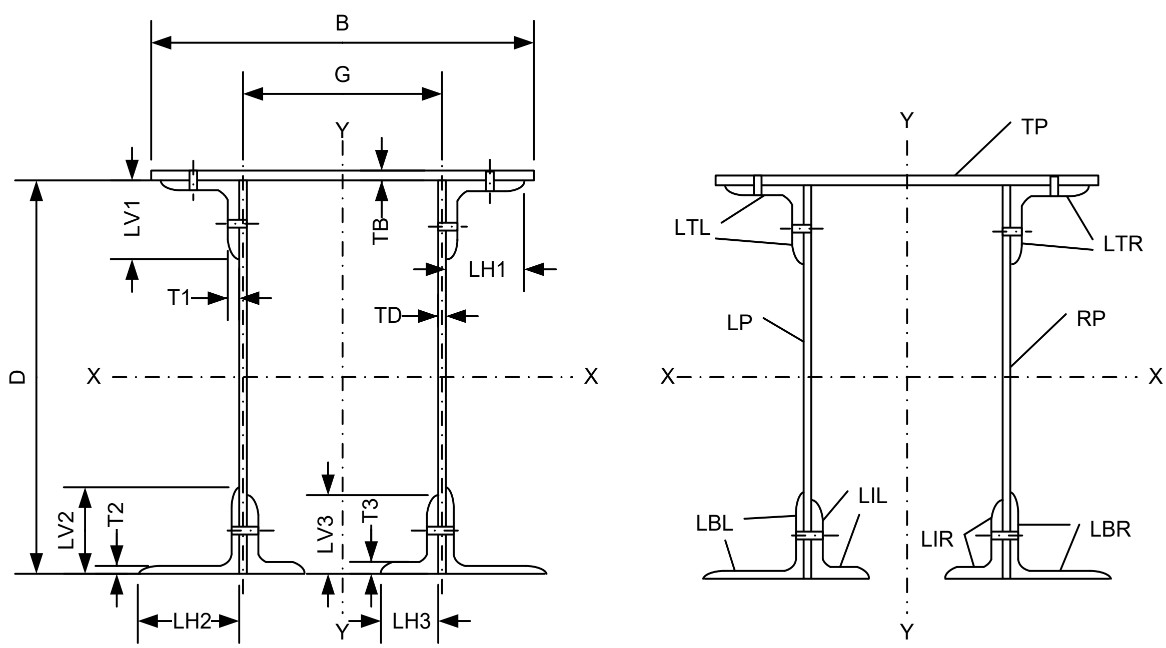


Figure 5.24-1 Section Type T09

5.25 T10 – TYPE 10 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T10	TYPE 10 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 10. This command may be repeated for each member of type 10.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen²** (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.25 T10 – TYPE 10 SECTION PROPERTIES COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter X to designate the primary bending axis. The axes are shown in Figure 5.25-1. This section is not allowed to bend about the Y-axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. B	Enter the plate width corresponding to B in Figure 5.25-1.	in	0. (E)	36. (W)	--
11. TB	Enter the plate thickness corresponding to TB in Figure 5.25-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the plate defined by B and TB.	--	0 (E)	10 (W)	0
13. D	Enter the plate width corresponding to D in Figure 5.25-1.	in	0. (E)	60. (W)	--
14. TD	Enter the plate thickness corresponding to TD in Figure 5.25-1.	in	0. (E)	2. (W)	--
15. Number of holes per plate	Enter the number of bolt or rivet holes through the plates defined by D and TD. The same number of holes will be assumed in each plate.	--	0 (E)	10 (W)	0
16. G	Enter the plate spacing corresponding to G in Figure 5.25-1.	in	0. (E)	24. (W)	--
17. LH1	Enter the horizontal leg length corresponding to LH1 in Figure 5.25-1.	in	0. (E)	9. (W)	--

5.25 T10 – TYPE 10 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
18. LV1	Enter the vertical leg length corresponding to LV1 in Figure 5.25-1.	in	0. (E)	9. (W)	--
19. T1	Enter the angle thickness corresponding to T1 in Figure 5.25-1.	in	0. (E)	2. (W)	--
20. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH1, LV1 and T1.	--	0 (E)	10 (W)	0
21. LH2	Enter the horizontal leg length corresponding to LH2 in Figure 5.25-1.	in	0. (E)	9. (W)	--
22. LV2	Enter the vertical leg length corresponding to LV2 in Figure 5.25-1.	in	0. (E)	9. (W)	--
23. T2	Enter the angle thickness corresponding to T2 in Figure 5.25-1.	in	0. (E)	2. (W)	--
24. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH2, LV2 and T2.	--	0 (E)	10 (W)	0
DETERIORATIONS					
25. TP	Enter the deterioration on the element corresponding to TP in Figure 5.25-1.	in	0. (E)	2. (E)	0.
26. LP	Enter the deterioration on the element corresponding to LP in Figure 5.25-1.	in	0. (E)	2. (E)	0.
27. RP	Enter the deterioration on the element corresponding to RP in Figure 5.25-1.	in	0. (E)	2. (E)	0.
28. TOL	Enter the deterioration on the element corresponding to TOL in Figure 5.25-1.	in	0. (E)	2. (E)	0.
29. TIL	Enter the deterioration on the element corresponding to TIL in Figure 5.25-1.	in	0. (E)	2. (E)	0.
30. TIR	Enter the deterioration on the element corresponding to TIR in Figure 5.25-1.	in	0. (E)	2. (E)	0.
31. TOR	Enter the deterioration on the element corresponding to TOR in Figure 5.25-1.	in	0. (E)	2. (E)	0.
32. BOL	Enter the deterioration on the element corresponding to BOL in Figure 5.25-1.	in	0. (E)	2. (E)	0.
33. BIL	Enter the deterioration on the element corresponding to BIL in Figure 5.25-1.	in	0. (E)	2. (E)	0.
34. BIR	Enter the deterioration on the element corresponding to BIR in Figure 5.25-1.	in	0. (E)	2. (E)	0.
35. BOR	Enter the deterioration on the element corresponding to BOR in Figure 5.25-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

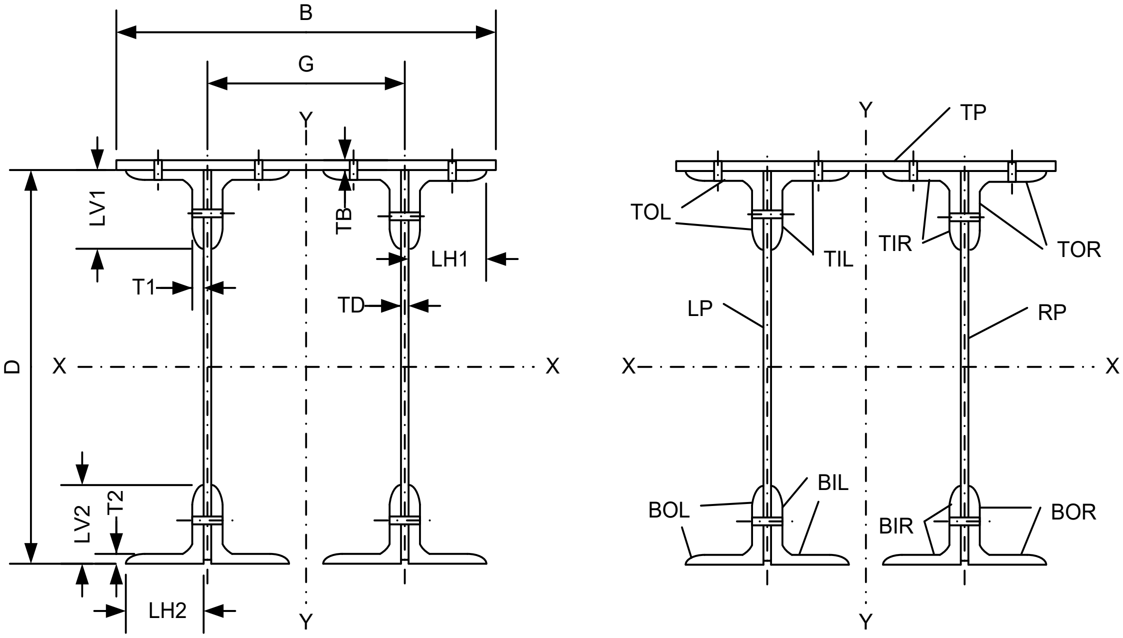


Figure 5.25-1 Section Type T10

5.26 T11 – TYPE 11 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T11	TYPE 11 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 11. This command may be repeated for each member of type 11.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.26 T11 – TYPE 11 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.26-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
8. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
9. BTP	Enter the plate width corresponding to BTP in Figure 5.26-1.	in	0. (E)	24. (W)	--
10. TTP	Enter the plate thickness corresponding to TTP in Figure 5.26-1.	in	0. (E)	2. (W)	--
11.BTF	Enter the plate width corresponding to BTF in Figure 5.26-1.	in	0. (E)	24. (W)	--
12. TTF	Enter the plate thickness corresponding to TTF in Figure 5.26-1.	in	0. (E)	2. (W)	--
13. D	Enter the plate width corresponding to D in Figure 5.26-1.	in	0. (E)	60. (W)	--
14. TW	Enter the plate thickness corresponding to TW in Figure 5.26-1.	in	0. (E)	2. (W)	--
15. BBP	Enter the plate width corresponding to BBP in Figure 5.26-1.	in	0. (E)	24. (W)	--
16. TBP	Enter the plate thickness corresponding to TBP in Figure 5.26-1.	in	0. (E)	2. (W)	--
17. BBF	Enter the plate width corresponding to BBF in Figure 5.26-1.	in	0. (E)	24. (W)	--
18. TBF	Enter the plate thickness corresponding to TBF in Figure 5.26-1.	in	0. (E)	2. (W)	--

5.26 T11 – TYPE 11 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
DETERIORATIONS					
19. TFT	Enter the deterioration on the element corresponding to TFT in Figure 5.26-1.	in	0. (E)	2. (E)	0.
20. TFB	Enter the deterioration on the element corresponding to TFB in Figure 5.26-1.	in	0. (E)	2. (E)	0.
21. WEB	Enter the deterioration on the element corresponding to WEB in Figure 5.26-1.	in	0. (E)	2. (E)	0.
22. BFT	Enter the deterioration on the element corresponding to BFT in Figure 5.26-1.	in	0. (E)	2. (E)	0.
23. BFB	Enter the deterioration on the element corresponding to BFB in Figure 5.26-1.	in	0. (E)	2. (E)	0.

Notes:

[1] Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.
[2] **MbrLen is the member length computed from the truss geometry.**

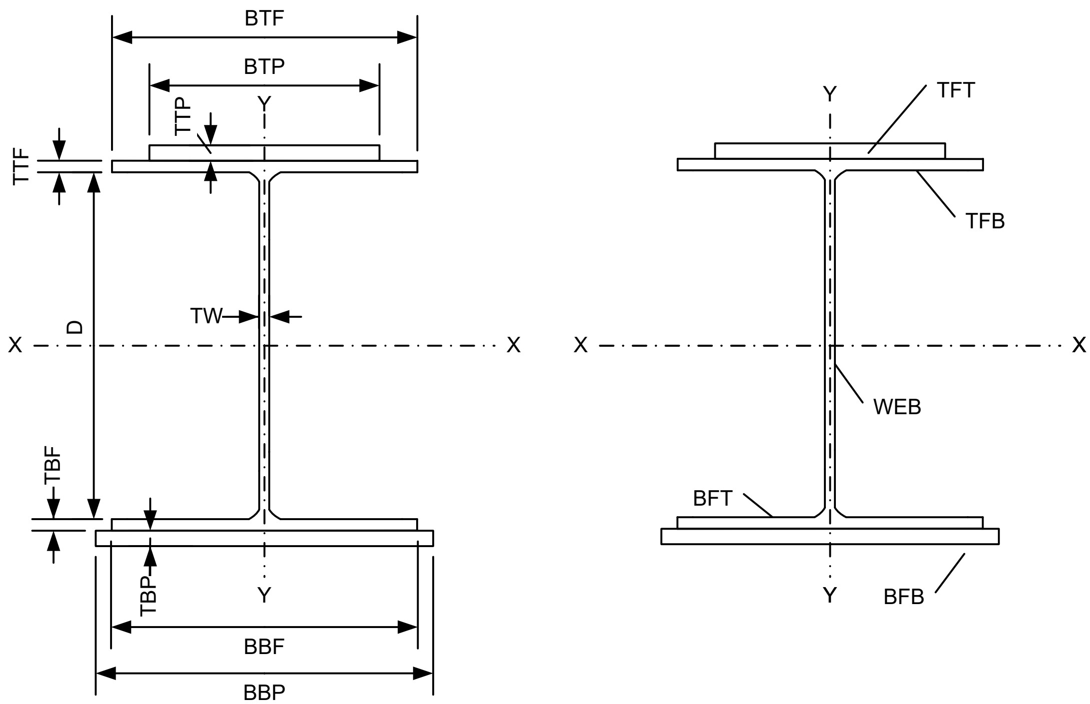


Figure 5.26-1 Section Type T11

5.27 T12 – TYPE 12 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T12	TYPE 12 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 12. This command may be repeated for each member of type 12.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.27 T12 – TYPE 12 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.27-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. B	Enter the plate width corresponding to B in Figure 5.27-1.	in	0. (E)	36. (W)	--
11. TB	Enter the plate thickness corresponding to TB in Figure 5.27-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by B and TB. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
13. D	Enter the plate width corresponding to D in Figure 5.27-1.	in	0. (E)	60. (W)	--
14. TD	Enter the plate thickness corresponding to TD in Figure 5.27-1.	in	0. (E)	2. (W)	--
15. Number of holes per plate	Enter the number of bolt or rivet holes through the plate defined by D and TD.	--	0 (E)	10 (W)	0
16. TP	Enter the plate thickness corresponding to TP in Figure 5.27-1.	in	0. (E)	2. (W)	--

5.27 T12 – TYPE 12 SECTION PROPERTIES COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by D and TP. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
18. W	Enter the web plate spacing corresponding to W in Figure 5.27-1.	in	0. (E)	24. (W)	--
19. H	Enter the flange plate spacing corresponding to H in Figure 5.27-1.	in	0. (E)	24. (W)	--
20. LH1	Enter the horizontal leg length corresponding to LH1 in Figure 5.27-1.	in	0. (E)	9. (W)	--
21. LV1	Enter the vertical leg length corresponding to LV1 in Figure 5.27-1.	in	0. (E)	9. (W)	--
22. T1	Enter the angle thickness corresponding to T1 in Figure 5.27-1.	in	0. (E)	2. (W)	--
23. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH1, LV1 and T1.	--	0 (E)	10 (W)	0
24. LH2	Enter the horizontal leg length corresponding to LH2 in Figure 5.27-1.	in	0. (E)	9. (W)	--
25. LV2	Enter the vertical leg length corresponding to LV2 in Figure 5.27-1.	in	0. (E)	9. (W)	--
26. T2	Enter the angle thickness corresponding to T2 in Figure 5.27-1.	in	0. (E)	2. (W)	--
27. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH2, LV2 and T2.	--	0 (E)	10 (W)	0
DETERIORATIONS					
28. TPD	Enter the deterioration on the element corresponding to TP in Figure 5.27-1.	in	0. (E)	2. (E)	0.
29. LP	Enter the deterioration on the element corresponding to LP in Figure 5.27-1.	in	0. (E)	2. (E)	0.
30. RP	Enter the deterioration on the element corresponding to RP in Figure 5.27-1.	in	0. (E)	2. (E)	0.
31. BPD	Enter the deterioration on the element corresponding to BP in Figure 5.27-1.	in	0. (E)	2. (E)	0.
32. LTL	Enter the deterioration on the element corresponding to LTL in Figure 5.27-1.	in	0. (E)	2. (E)	0.
33. LTR	Enter the deterioration on the element corresponding to LTR in Figure 5.27-1.	in	0. (E)	2. (E)	0.

5.27 T12 – TYPE 12 SECTION PROPERTIES COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
DETERIORATIONS (Continued)					
34. LBL	Enter the deterioration on the element corresponding to LBL in Figure 5.27-1.	in	0. (E)	2. (E)	0.
35. LBR	Enter the deterioration on the element corresponding to LBR in Figure 5.25-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

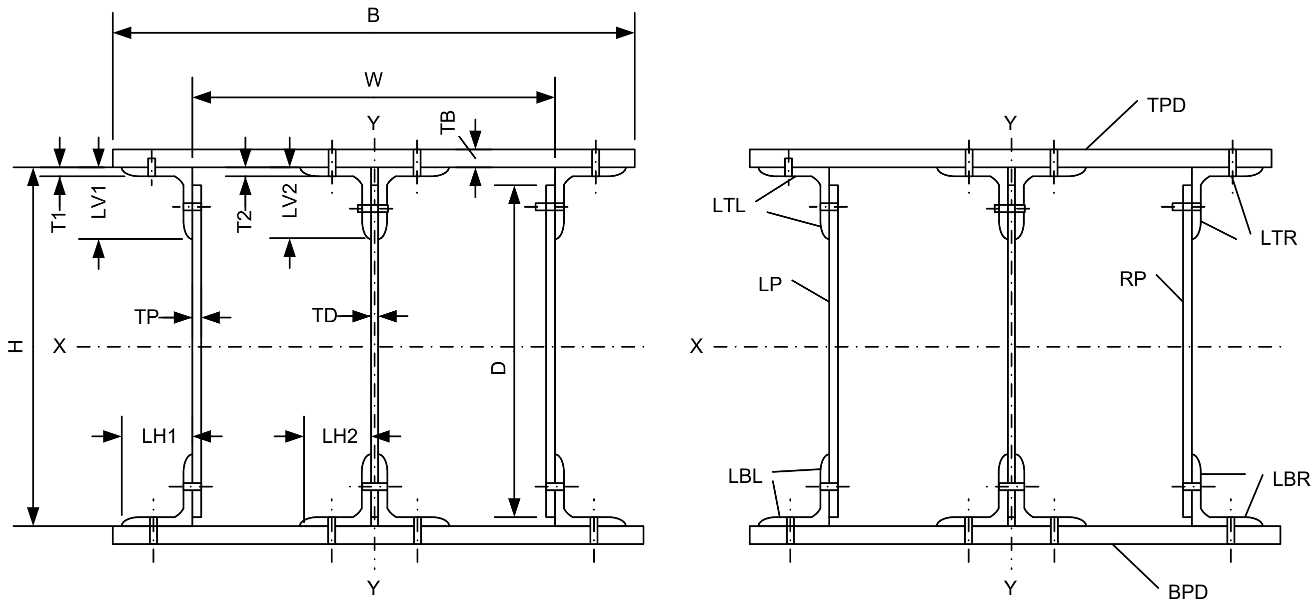


Figure 5.27-1 Section Type T12

5.28 T13 – TYPE 13 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T13	TYPE 13 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 13. This command may be repeated for each member of type 13.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about the x- and y-axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.28 T13 – TYPE 13 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.28-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. B	Enter the plate width corresponding to B in Figure 5.28-1.	in	0. (E)	36. (W)	--
11. TB	Enter the plate thickness corresponding to TB in Figure 5.28-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by D and TD. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
13. D	Enter the plate width corresponding to D in Figure 5.28-1.	in	0. (E)	60. (W)	--
14. TD	Enter the plate thickness corresponding to TD in Figure 5.28-1.	in	0. (E)	2. (W)	--
15. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by D and TD. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
16. LH1	Enter the horizontal leg length corresponding to LH1 in Figure 5.28-1.	in	0. (E)	9. (W)	--

5.28 T13 – TYPE 13 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. LV1	Enter the vertical leg length corresponding to LV1 in Figure 5.28-1.	in	0. (E)	9. (W)	--
18. T1	Enter the angle thickness corresponding to T1 in Figure 5.28-1.	in	0. (E)	2. (W)	--
19. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH1, LV1 and T1.	--	0 (E)	10 (W)	0
20. LH2	Enter the horizontal leg length corresponding to LH2 in Figure 5.28-1.	in	0. (E)	9. (W)	--
21. LV2	Enter the vertical leg length corresponding to LV2 in Figure 5.28-1.	in	0. (E)	9. (W)	--
22. T2	Enter the angle thickness corresponding to T2 in Figure 5.28-1.	in	0. (E)	2. (W)	--
23. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH2, LV2 and T2.	--	0 (E)	10 (W)	0
DETERIORATIONS					
24. TP	Enter the deterioration on the element corresponding to TP in Figure 5.28-1.	in	0. (E)	2. (E)	0.
25. WEB	Enter the deterioration on the element corresponding to WEB in Figure 5.28-1.	in	0. (E)	2. (E)	0.
26. BP	Enter the deterioration on the element corresponding to BP in Figure 5.28-1.	in	0. (E)	2. (E)	0.
27. TOL	Enter the deterioration on the element corresponding to TOL in Figure 5.28-1.	in	0. (E)	2. (E)	0.
28. TIL	Enter the deterioration on the element corresponding to TIL in Figure 5.28-1.	in	0. (E)	2. (E)	0.
29. TIR	Enter the deterioration on the element corresponding to TIR in Figure 5.28-1.	in	0. (E)	2. (E)	0.
30. TOR	Enter the deterioration on the element corresponding to TOR in Figure 5.28-1.	in	0. (E)	2. (E)	0.
31. BOL	Enter the deterioration on the element corresponding to BOL in Figure 5.28-1.	in	0. (E)	2. (E)	0.
32. BIL	Enter the deterioration on the element corresponding to BIL in Figure 5.28-1.	in	0. (E)	2. (E)	0.
33. BIR	Enter the deterioration on the element corresponding to BIR in Figure 5.28-1.	in	0. (E)	2. (E)	0.
34. BOR	Enter the deterioration on the element corresponding to BOR in Figure 5.26-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

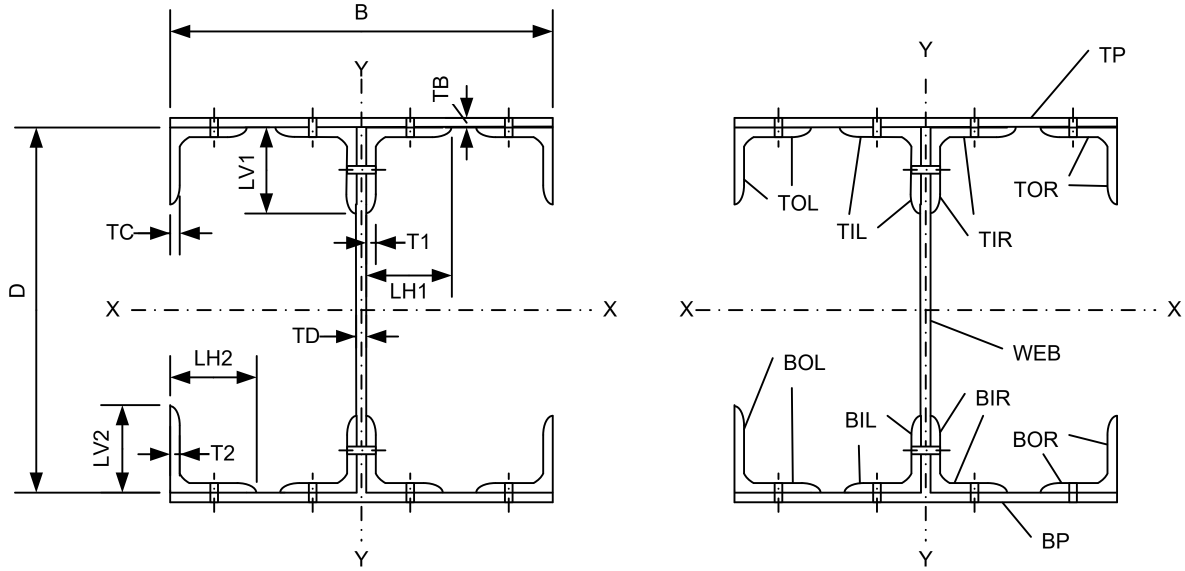


Figure 5.28-1 Section Type T13

5.29 T14 – TYPE 14 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T14	TYPE 14 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 14. NOTE: Use T14 section type for S shaped sections ONLY. This command may be repeated for each member of type 14.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.29 T14 – TYPE 14 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.29-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. BTP	Enter the plate width corresponding to BTP in Figure 5.29-1.	in	0. (E)	24. (W)	--
11. TTP	Enter the plate thickness corresponding to TTP in Figure 5.29-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by BTP and TTP. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
13. BBP	Enter the plate width corresponding to BBP in Figure 5.29-1.	in	0. (E)	24. (W)	--
14. TBP	Enter the plate thickness corresponding to TBP in Figure 5.29-1.	in	0. (E)	2. (W)	--
15. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by D and TD. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
16. D	Enter the section depth corresponding to D in Figure 5.29-1.	in	0. (E)	60. (W)	--

5.29 T14 – TYPE 14 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. TW	Enter the web thickness corresponding to TW in Figure 5.29-1.	in	0. (E)	2. (W)	--
18. B	Enter the flange width corresponding to B in Figure 5.29-1.	in	0. (E)	36. (W)	--
19. TF	Enter the flange thickness corresponding to TF in Figures 5.29-1 and 5.29-2. TRLRFD assumes a slope of 17.5% on flanges of this section. TF is the thickness at the midwidth of the flange.	in	0. (E)	2. (W)	--
20. Number of Holes per Flange	Enter the number of bolt holes in the flange defined by B and TF.	--	0 (E)	10 (W)	0
DETERIORATIONS					
21. TFT	Enter the deterioration on the element corresponding to TFT in Figure 5.29-1.	in	0. (E)	2. (E)	21. TFT
22. TFB	Enter the deterioration on the element corresponding to TFB in Figure 5.29-1.	in	0. (E)	2. (E)	22. TFB
23. WEB	Enter the deterioration on the element corresponding to WEB in Figure 5.29-1.	in	0. (E)	2. (E)	0.
24. BFT	Enter the deterioration on the element corresponding to BFT in Figure 5.29-1.	in	0. (E)	2. (E)	0.
25. BFB	Enter the deterioration on the element corresponding to BFB in Figure 5.29-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

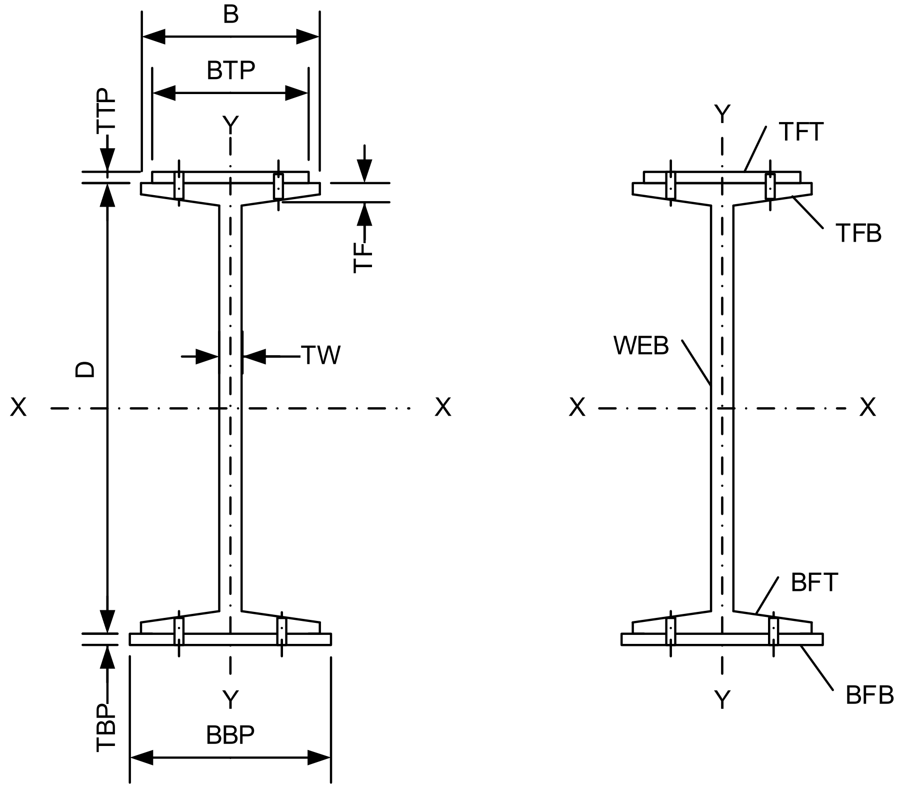


Figure 5.29-1 Section Type T14

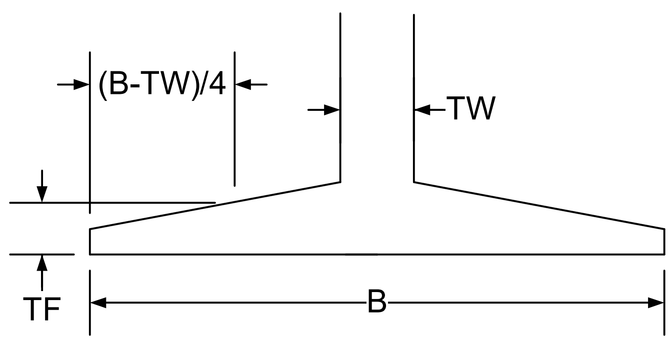


Figure 5.29-2 Dimension TF

5.30 T15 – TYPE 15 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T15	TYPE 15 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 15. This command may be repeated for each member of type 15.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen[2]** (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.30 T15 – TYPE 15 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.30-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
8. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
9. D	Enter the section depth corresponding to D in Figure 5.30-1.	in	0. (E)	60. (W)	--
10. TW	Enter the web thickness corresponding to TW in Figure 5.30-1.	in	0. (E)	2. (W)	--
11. B	Enter the flange width corresponding to B in Figure 5.30-1.	in	0. (E)	36. (W)	--
12. TF	Enter the channel flange thickness corresponding to TF in Figures 5.30-1 and 5.30-2. TRLRFD assumes a slope of 17.5% on flanges of channels. TF is the thickness at the midwidth of the flange.	in	0. (E)	2. (W)	--
DETERIORATIONS					
13. TFT	Enter the deterioration on the element corresponding to TFT in Figure 5.30-1.	in	0. (E)	2. (E)	0.
14. WEB	Enter the deterioration on the element corresponding to WEB in Figure 5.30-1.	in	0. (E)	2. (E)	0.
15. TFB	Enter the deterioration on the element corresponding to TFB in Figure 5.30-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

Notes (Continued):

2 **MbrLen is the member length computed from the truss geometry.**

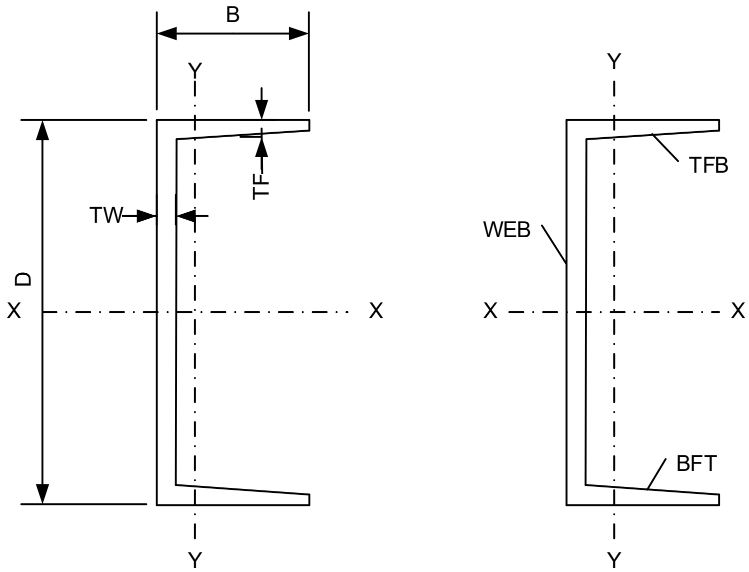


Figure 5.30-1 Section Type T15

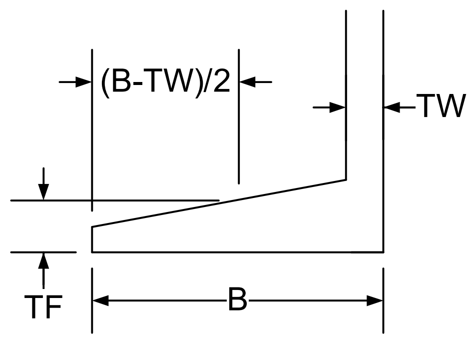


Figure 5.30-2 Dimension TF

5.31 T16 – TYPE 16 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T16	TYPE 16 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 16. This command may be repeated for each member of type 16.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.31 T16 – TYPE 16 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.31-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. D	Enter the plate width corresponding to D in Figure 5.31-1.	in	0. (E)	60. (W)	--
11. TW	Enter the plate thickness corresponding to TW in Figure 5.31-1.	in	0. (E)	2. (W)	--
12. Number of Holes per Plate	Enter the number of bolt or rivet holes in the plate defined by D and TW.	--	0 (E)	10 (W)	0
13. L1	Enter the horizontal leg length corresponding to L1 in Figure 5.31-1.	in	0. (E)	9. (W)	--
14. L2	Enter the vertical leg length corresponding to L2 in Figure 5.31-1.	in	0. (E)	9. (W)	--
15. TL	Enter the angle thickness corresponding to TL in Figure 5.31-1.	in	0. (E)	2. (W)	--
16. Number of Holes per Angle	Enter the number of bolt holes in the angle defined by L1, L2 and TL.	--	0 (E)	10 (W)	0

5.31 T16 – TYPE 16 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
DETERIORATIONS					
17. TFB	Enter the deterioration on the element corresponding to TFB in Figure 5.31-1.	in	0. (E)	2. (E)	0.
18. WEB	Enter the deterioration on the element corresponding to WEB in Figure 5.31-1.	in	0. (E)	2. (E)	0.
19. BFT	Enter the deterioration on the element corresponding to BFT in Figure 5.31-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

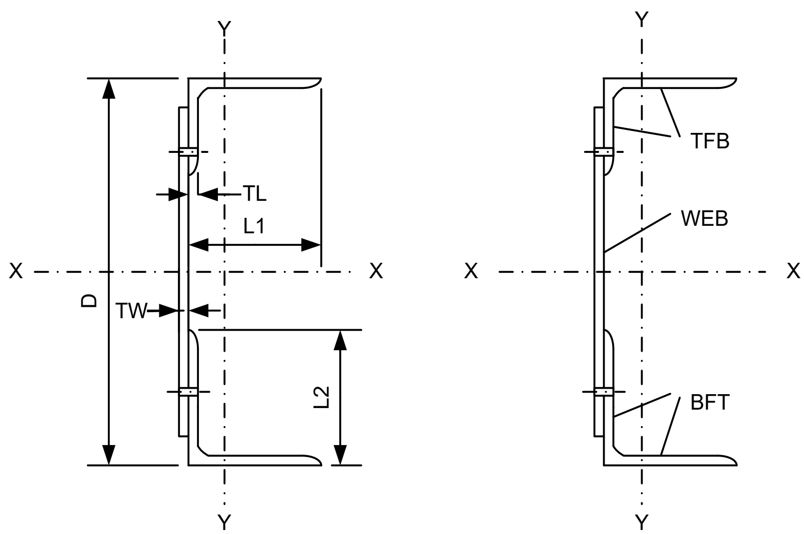


Figure 5.31-1 Section Type T16

5.32 T17 – TYPE 17 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T17	TYPE 17 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 17. This command may be repeated for each member of type 17.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen**^{2} (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.32 T17 – TYPE 17 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter X to designate the primary bending axis. The axes are shown in Figure 5.32-1. This section is not allowed to bend about the Y-axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. B	Enter the plate width corresponding to B in Figure 5.32-1.	in	0. (E)	36. (W)	--
11. TP	Enter the plate thickness corresponding to TP in Figure 5.32-1.	in	0. (E)	2. (W)	--
12. Number of Holes per Plate	Enter the number of bolt holes in the plate defined by B and TP.	--	0 (E)	10 (W)	0
13. D	Enter the plate width corresponding to D in Figure 5.32-1.	in	0. (E)	60. (W)	--
14. TW	Enter the plate thickness corresponding to TW in Figure 5.32-1.	in	0. (E)	2. (W)	--
15. Number of Holes per Plate	Enter the number of bolt holes in the plate defined by D and TW.	--	0 (E)	10 (W)	0
16. L1	Enter the horizontal leg length corresponding to L1 in Figure 5.32-1.	in	0. (E)	9. (W)	--
17. L2	Enter the vertical leg length corresponding to L2 in Figure 5.32-1.	in	0. (E)	9. (W)	--

5.32 T17 – TYPE 17 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
18. TL	Enter the angle thickness corresponding to TL in Figure 5.32-1.	in	0. (E)	2. (W)	--
19. Number of Holes per Angle	Enter the number of bolt holes in the angle defined by L1, L2 and TL.	--	0 (E)	10 (W)	0
DETERIORATIONS					
20. TFT	Enter the deterioration on the element corresponding to TFT in Figure 5.32-1.	in	0. (E)	2. (E)	0.
21. TFB	Enter the deterioration on the element corresponding to TFB in Figure 5.32-1.	in	0. (E)	2. (E)	0.
22. TFL	Enter the deterioration on the element corresponding to TFL in Figure 5.32-1.	in	0. (E)	2. (E)	0.
23. WEB	Enter the deterioration on the element corresponding to WEB in Figure 5.32-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

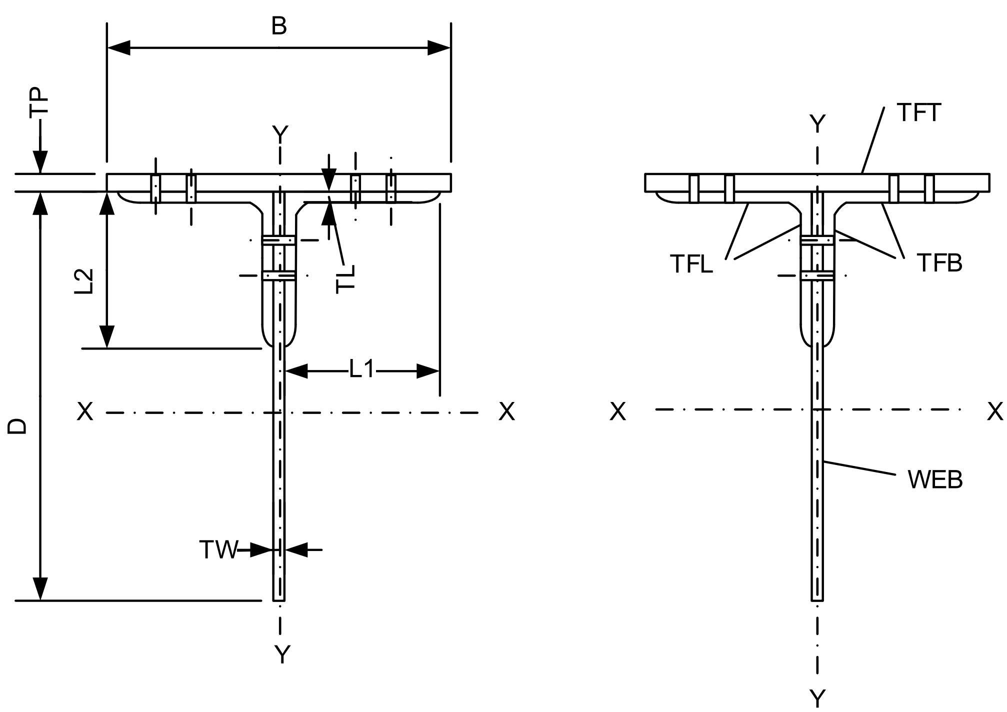


Figure 5.32-1 Section Type T17

5.33 T18 – TYPE 18 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T18	TYPE 18 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 18. This command may be repeated for each member of type 18.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.33 T18 – TYPE 18 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bending Axis	Enter X to designate the primary bending axis. The axes are shown in Figure 5.33-1. This section is not allowed to bend about the Y-axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X (E)	--	--
8. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
9. D	Enter the section depth corresponding to D in Figure 5.33-1.	in	0. (E)	60. (W)	--
10. TW	Enter the web thickness corresponding to TW in Figure 5.33-1.	in	0. (E)	2. (W)	--
11. B	Enter the flange width corresponding to B in Figure 5.33-1.	in	0. (E)	36. (W)	--
12. TF	Enter the flange thickness corresponding to TF in Figure 5.33-1.	in	0. (E)	2. (W)	--
13. TFB	Enter the deterioration on the element corresponding to TFB in Figure 5.33-1.	in	0. (E)	2. (E)	0.
14. WEB	Enter the deterioration on the element corresponding to TFB in Figure 5.33-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

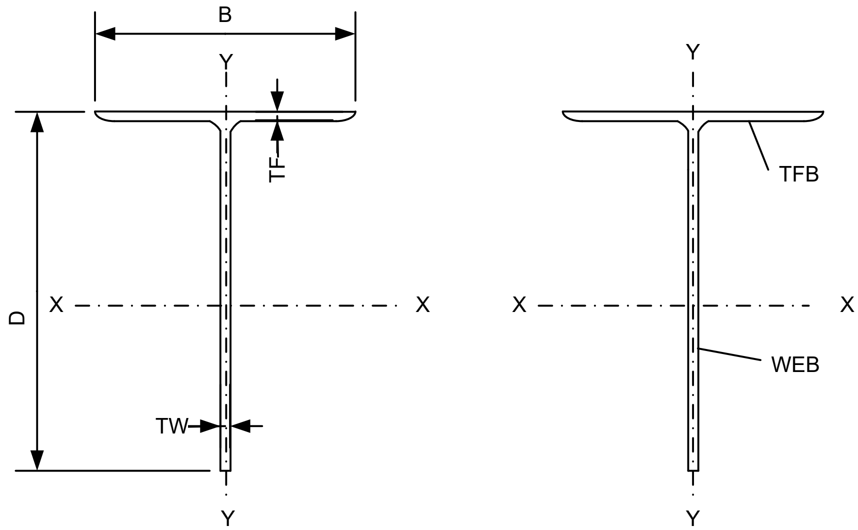


Figure 5.33-1   Section Type T18

5.34 T19 – TYPE 19 SECTION PROPERTIES COMMAND

KEYWORD	COMMAND DESCRIPTION
T19	TYPE 19 SECTION PROPERTIES - This command is used to describe the section dimensions for a truss member of type 19. This command may be repeated for each member of type 19.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
GENERAL SECTION PROPERTIES					
2. Yield Strength	Enter the yield strength of the member.	ksi	26. (W)	100. (W)	36.
3. Tensile Strength	Enter the ultimate tensile strength of the member.	ksi	50. (W)	110. (W)	*1
4. Unbraced Length	The actual, unbraced length of the member. If left blank, program will calculate from geometry input. **The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands.** **If this value is entered, the same unbraced length will be used for buckling about all three axes of the member. If a different unbraced length should be used for one or more of the axes, please leave this value blank and use the UNBRACED LENGTH (UBL) command.** **The bracing to be considered for this parameter prevents out-of-plane buckling of the member about the x- and y- axes, and prevents twisting about the z-axis.**	ft	0. (E)	**MbrLen**[2] (**W**)	**MbrLen**
5. Fatigue Category	The code that corresponds to the applicable stress category of a fatigue detail. Note: BP, CP and EP represent B', C' and E', respectively.	--	A, B, BP, C, CP, D, E, EP (E)	--	--

5.34 T19 – TYPE 19 SECTION PROPERTIES COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
GENERAL SECTION PROPERTIES (Continued)					
6. Eccentricity	The distance from the elastic neutral axis to the centerline of the end connection. If the eccentricity exists about both axes of a member, enter the larger eccentricity and the corresponding value for BENDING AXIS and FLEXURE. If the effect of eccentricity about the other axis is to be checked, rerun the program using the other values.	in	0. (E)	30. (W)	0.
7. Bolt Hole Diameter	Enter the typical bolt or rivet hole diameter. Enter a zero if the truss member contains no bolt or rivet hole.	in	0. (E)	2. (W)	0.
8. Bending Axis	Enter either X or Y to designate the desired primary bending axis. The axes are shown in Figure 5.34-1. Leave blank if eccentricity (parameter 6) is entered as zero.	--	X, Y (E)	--	--
9. Flexure	Enter P for positive flexure or N for negative flexure. Positive flexure is defined as top fiber compression for bending about the X-X axis and rightmost fiber compression for bending about the Y-Y axis. Leave blank if eccentricity (parameter 6) is entered as zero.	--	P, N (E)	--	--
MEMBER SPECIFIC PROPERTIES					
10. BTP	Enter the plate width corresponding to BTP in Figure 5.34-1.	in	0. (E)	24. (W)	--
11. TTP	Enter the plate thickness corresponding to TTP in Figure 5.34-1.	in	0. (E)	2. (W)	--
12. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by BTP and TTP. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
13. BBP	Enter the plate width corresponding to BBP in Figure 5.34-1.	in	0. (E)	24. (W)	--
14. TBP	Enter the plate thickness corresponding to TBP in Figure 5.34-1.	in	0. (E)	2. (W)	--
15. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by BBP and TBP. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
16. D	Enter the plate width corresponding to D in Figure 5.34-1.	in	0. (E)	64. (W)	--

5.34 T19 – TYPE 19 SECTION PROPERTIES COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER SPECIFIC PROPERTIES (Continued)					
17. TW	Enter the plate thickness corresponding to TD in Figure 5.34-1.	in	0. (E)	2. (W)	--
18. Number of holes per plate	Enter the number of bolt or rivet holes through the top plate defined by D and TW. The same number of holes will also be assumed in the bottom plate.	--	0 (E)	10 (W)	0
19. H	Enter the flange plate spacing corresponding to H in Figure 5.34-1.	in	0. (E)	24. (W)	--
20. LH1	Enter the horizontal leg length corresponding to LH1 in Figure 5.34-1.	in	0. (E)	9. (W)	--
21. LV1	Enter the vertical leg length corresponding to LV1 in Figure 5.34-1.	in	0. (E)	9. (W)	--
22. T1	Enter the angle thickness corresponding to T1 in Figure 5.34-1.	in	0. (E)	2. (W)	--
23. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH1, LV1 and T1.	--	0 (E)	10 (W)	0
24. LH2	Enter the horizontal leg length corresponding to LH2 in Figure 5.34-1.	in	0. (E)	9. (W)	--
25. LV2	Enter the vertical leg length corresponding to LV2 in Figure 5.34-1.	in	0. (E)	9. (W)	--
26. T2	Enter the angle thickness corresponding to T2 in Figure 5.34-1.	in	0. (E)	2. (W)	--
27. Number of Holes Per Angle	Enter the number of bolt holes in the angle defined by LH2, LV2 and T2.	--	0 (E)	10 (W)	0
DETERIORATIONS					
28. TP	Enter the deterioration on the element corresponding to TP in Figure 5.34-1.	in	0. (E)	2. (E)	0.
29. BP	Enter the deterioration on the element corresponding to BP in Figure 5.34-1.	in	0. (E)	2. (E)	0.
30. TWD	Enter the deterioration on the element corresponding to TWD in Figure 5.34-1.	in	0. (E)	2. (E)	0.
31. LTL	Enter the deterioration on the element corresponding to LTL in Figure 5.34-1.	in	0. (E)	2. (E)	0.
32. LTR	Enter the deterioration on the element corresponding to LTR in Figure 5.34-1.	in	0. (E)	2. (E)	0.

5.34 T19 – TYPE 19 SECTION PROPERTIES COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
DETERIORATIONS (Continued)					
33. LBL	Enter the deterioration on the element corresponding to LBL in Figure 5.34-1.	in	0. (E)	2. (E)	0.
34. LBR	Enter the deterioration on the element corresponding to LBR in Figure 5.34-1.	in	0. (E)	2. (E)	0.

Notes:

1 Defaults to 58 ksi when the yield strength for this member is 36 ksi; otherwise no default value.

2 **MbrLen is the member length computed from the truss geometry.**

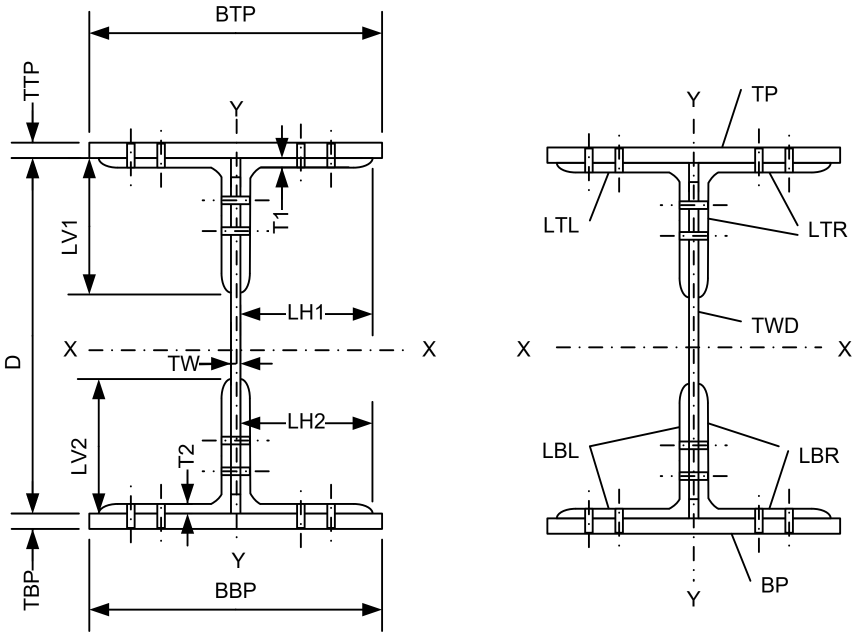


Figure 5.34-1 Section Type T19

5.35 UBL - UNBRACED LENGTH

KEYWORD	COMMAND DESCRIPTION
UBL	UNBRACED LENGTH - This command is used to define unbraced lengths for members that have bracing between their endpoints, as well as for members that have different unbraced lengths about each axis. The only time that an unbraced length should be entered is when the unbraced length is different than the straight-line length between the start and end joints computed from the geometry commands. This command can only be used with members defined with the T01-T19 commands. If this command is entered for members defined with the PRP command, the values entered on this command will be ignored. This command can be repeated.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
2. Unbraced Length L_{bx}	The unbraced length for flexural buckling about the x-axis. If this value is left blank, it will default to the member length calculated based on panel geometry.	ft	0. (E)	MbrLen (W)	Member Length
3. Unbraced Length L_{by}	The unbraced length for flexural buckling about the y-axis. If this value is left blank, it will default to the member length calculated based on panel geometry.	ft	0. (E)	MbrLen (W)	Member Length
4. Unbraced Length L_{bz}	The unbraced length for torsional buckling (twisting) about the z-axis. This value is used for calculations of flexural-torsional buckling of open singly symmetric sections such as Types 9-11 or 14-19, and cannot be entered for other member types. If this value is left blank, it will default to the member length calculated based on panel geometry.	ft	0. (E)	MbrLen (W)	Member Length

Notes:

MbrLen is the member length computed from the truss geometry.

5.36 EEV – EXTREME EVENT COMMAND

KEYWORD	COMMAND DESCRIPTION
EEV	EXTREME EVENT - This command is used to enter reduced section properties and member loadings for an extreme event analysis. Use as many EEV commands as necessary to enter all extreme event information. This command can be repeated.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Member Identification	The member is identified by the two joints where the member starts and ends (i.e. L0U2, L5M6, etc.).	--	--	--	--
2. Extreme Event Force	The user defined load in the truss member due to Extreme Event IV. Enter a negative value for compression. If this value is left blank, an Extreme Event IV analysis will not be performed. Extreme Event III only will be checked.	kip	-10000. (W)	10000. (W)	--
3. Extreme Event Gross Area	The gross cross sectional area of the member for both Extreme Event III and Extreme Event IV analysis.	in^2	0.1 (W)	200. (W)	--
4. Extreme Event Net Area	The net cross sectional area of the member for both Extreme Event III and Extreme Event IV analysis. NOTE: If the input net area is greater than the input gross area, the program will stop with an error.	in^2	0.1 (W)	200. (W)	--
5. Extreme Event Moment of Inertia	The moment of inertia about the bending axis of the member for both Extreme Event III and Extreme Event IV analysis.	in^4	0.01 (W)	30000. (W)	--
6. Extreme Event Moment Resistance	The moment resistance, Mr, of the member for both Extreme Event III and Extreme Event IV analysis. Only enter this value if a nonzero eccentricity has been input on the PRP or T## command for this member.	kip-ft	0. (E)	77000. (W)	--

5.36 EEV – EXTREME EVENT COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
7. Extreme Event Tensile Resistance	Enter the factored tensile resistance of the current member. Enter the resistance for tension alone. If the member is subjected to tension and flexure, the combined capacity will be calculated internally based on this value and the moment resistance entered with parameter 6. If this value is left blank, the program will compute the tensile resistance.	kips	0. (E)	15000. (W)	--
8. Extreme Event Compressive Resistance	Enter the factored compressive resistance of the current member. Enter the resistance for compression alone. If the member is subjected to compression and flexure, the combined capacity will be calculated internally based on this value and the moment resistance entered with parameter 6.	kips	0 (E)	15000. (W)	--

5.37 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 of the truss. Only one FTL command can be used. If parameters 6 and 7 are entered, the program will compute parameter 8, so leave it blank. Similarly, if parameters 9 and 10 are entered, leave parameter 11 blank.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Distribution Factor for Fatigue	The single vehicle distribution factor to be used for fatigue analysis.	--	0. (E)	10. (W)	--
2. PA Traffic Factor	**Note: This parameter is no longer used and should be left blank**	--	--	--	--
3. Year Built	Enter the calendar year in which the bridge was built. The program uses this value to calculate the average single lane daily (one-directional) truck traffic (ADTT) for the year the bridge was built.	--	1900 (W)	2200 (W)	--
4. Recent Count Year	Enter a year that is the recent year for computing fatigue life.	--	1900 (W)	2200 (W)	--
5. Recent Count ADTT	Enter the single lane ADTT for the recent count year.	--	1 (E)	10000 (W)	--
6. Previous Count Year	If a single lane ADTT 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)	--
7. Previous Count ADTT	Enter the single lane ADTT for the previous count year	--	1 (E)	10000 (W)	--
8. Previous Growth Rate	If the rate of growth in single lane ADTT for the past is known, enter the rate expressed as the percent growth; that is, 1% should be entered at 0.01.	--	0. (W)	1. (W)	--
9. Future Count Year	If a single lane ADTT for the future can be predicted, enter the year for which the single lane ADTT is predicted. The future count year must be greater than the recent count year.	--	1900 (W)	2200 (W)	--
10. Future Count ADTT	If a single lane ADTT for the future can be predicted, enter the single lane ADTT for the future count year.	--	1 (E)	10000 (W)	--
11. Future Growth Rate	If the rate of growth in single lane ADTT 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. (W)	--

5.38 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 **for Fatigue-II** 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.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Minimum Gross Weight	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)	300000 (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)	300000 (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)	300000 (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)	300000 (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)	300000 (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)	300000 (W)	--

5.39 SLL – SPECIAL LIVE LOAD COMMAND

KEYWORD	COMMAND DESCRIPTION
SLL	SPECIAL LIVE LOAD - This command is required when a special live load is being specified. This command may only be specified once.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. 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
2. Lane Load	Enter a uniform lane load to be applied in combination with the axle loads.	kip/ft	0. (W)	1.5 (W)	0.
3. 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.
4. Vehicle Type	**Enter:** **D - If the Dynamic Load Allowance (Impact) is for Design vehicles.** **N - If the Dynamice Load Allowance (Impact) is for Permit vehicles.** **The Dynamic Load Allowance for Design vehicles is specified on the CTL command as parameter "Dynamic Load Allowance".** **The Dynamic Load Allowance for Permit vehicles is specified on the CTL command as parameter "Permit Dynamic Load Allowance".**	**--**	**D, P** **(E)**	**--**	**D**

5.40 SAL – Special Axle Loads Command

KEYWORD	COMMAND DESCRIPTION
SAL	SPECIAL AXLE LOADS - This command is required when special live loading is requested. The parameters of this command may be repeated starting with parameter 1. For the last vehicle axle, the axle spacing can be left blank. This command is repeatable but the total number of axles must not exceed a maximum of 80 axle loads, 79 spacings. For compatibility with EngAsst, enter up to 20 axle loads per instance of the SAL command.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Axle Load	Enter the magnitude of the axle load.	kip	0. (E)	150. (W)	--
2. 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 should be entered as 0.0.	ft	0. (E)	50. (W)	--

5.41 GUS – GUSSET PLATE COMMAND

KEYWORD	COMMAND DESCRIPTION
GUS	GUSSET PLATE – This command is used to define the geometry of one gusset plate. Only one gusset plate can be defined at each upper or lower joint. This command can be repeated to define up to **200** joints, **100** upper and **100** lower.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Location	The location of the gusset plate, designated by the joint: U10, L11, etc.	--	--	--	--
2. F_y	Specified minimum yield stress of the gusset plate material.	ksi	30 (W)	100 (W)	--
3. F_u	Specified minimum tensile stress of the gusset plate material.	ksi	50 (W)	110 (W)	--[1]
4. Thickness, t	Thickness of the gusset plate on one side of the joint. If there are two gusset plates per side, then input the total thickness of the two plates on one side. (see Figure 5.41-8)	in	0.25 (W)	4 (W)	--
CROSS SECTION GEOMETRY					
5. Length, h_A	Length of the gusset plate along a horizontal cut at or near the edge of the chord (Figures 5.41-1 – 5.41-4, Section A-A). Input the length of the larger plate if two gusset plates are used per side.	in	12 (W)	200 (W)	--
6. Length, h_B	Length of the gusset plate along a vertical cut on the Section B-B side of the vertical member (Figures 5.41-1 – 5.41-4, Section B-B). Input the length of the larger plate if two gusset plates are used per side.	in	12 (W)	200 (W)	--
7. Length, h_C	Length of the gusset plate along a vertical cut on the Section C-C side of the vertical member (Figures 5.41-1 – 5.41-4, Section C-C). Input the length of the larger plate if two gusset plates are used per side.	in	12 (W)	200 (W)	--
8. Eccentricity, e_B	Distance from the line of action in the vertical member to the edge of the vertical member. Used to calculate a reduction factor on the shear force from member 1 on the vertical cut at Section B-B.	in	0 (E)	20 (W)	--

5.41 GUS – GUSSET PLATE COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
9. Eccentricity, e_C	Distance from the line of action in the vertical member to the edge of the vertical member. Used to calculate a reduction factor on the shear force from member 2 on the vertical cut at Section C-C.	in	0 (E)	20 (W)	--
10. Maximum Unsupported Edge, b	Maximum unsupported length along the edge of the gusset plate (Figures 5.41-1 through 5.40-6). For post and hanger type gusset plates, b may be taken as zero in most cases. (Figure 5.41-7).	in	0 (W)	100 (W)	--
FASTENERS					
11. Bolt Tensile Strength	Enter the specified minimum tensile strength of the bolt, as described in the LRFD Specifications Article 6.4.3.1.1. **For Grades A325 or F1852, enter 120 kips. For Grades A490 or F2280, enter 150 kips (LRFD Specifications Table 6.4.3.1.1-1).**	ksi	**50.** (W)	150 (W)	**120.**
12. **Bolt** Diameter, d	Minimum nominal diameter of the **bolts** at the joint.	in	0.25 (E)	**4.0** (E)	**0.875**
13. Minimum Required Bolt Tension	**The minimum required bolt tension, used for slip resistance calculations. For ASTM F3125 bolts, see LRFD Specifications Table 6.13.2.8-1.**	**kips**	**19. (W)**	**148. (W)**	***4**
14. Surface Condition	**The surface condition, as described in LRFD Specifications 6.13.2.8.** **A --Class A** **B --Class B** **C --Class C** **D --Class D**	**--**	**A, B, C, D**	**--**	**A**
15. Fastener Distance, L_{splice}	**Center-to-center distance between the first lines of fasteners in adjacent chords (Figure 5.41-9).** **This value is only used for the calculations of LRFD Specifications Equation 6.14.2.8.6-2.**	**in**	**0. (E)**	**24. (W)**	***5**
16. Hole Diameter	**Enter the diameter of the bolt holes at the joint.**	**in**	***2 (E)**	***3 (E)**	***6**

Notes:

1 Defaults to 58 ksi when the yield strength for this gusset plate is 36 ksi; otherwise no default value.

2 **The lower limit is equal to the fastener diameter entered as parameter 12 of this command.**

3 **The upper limit is the maximum standard hole diameter as per LRFD Specifications Table 6.13.2.4.2-1 (bolt diameter + 1/16" for bolts less than 1" in diameter, bolt diameter + 1/8" for bolts 1" or greater in diameter).**

4 **If left blank, the default minimum required bolt tension will be set equal to 0.70 * net tensile area of bolt * bolt tensile strength. The net tensile area of the bolt is calculated from Table 7-17 of the AISC Steel Construction Manual, Fifteenth Edition.**

5 **If left blank, this value will default to 2*the minimum edge distance based on bolt diameter as per LRFD Specifications Table 6.13.2.6.6-1. This is not necessarily a conservative assumption, and the user should enter this value rather than depending on the default when possible.**

6 **If left blank, this value will default to the maximum standard hole diameter as per LRFD Specifications Table 6.13.2.4.2-1.**

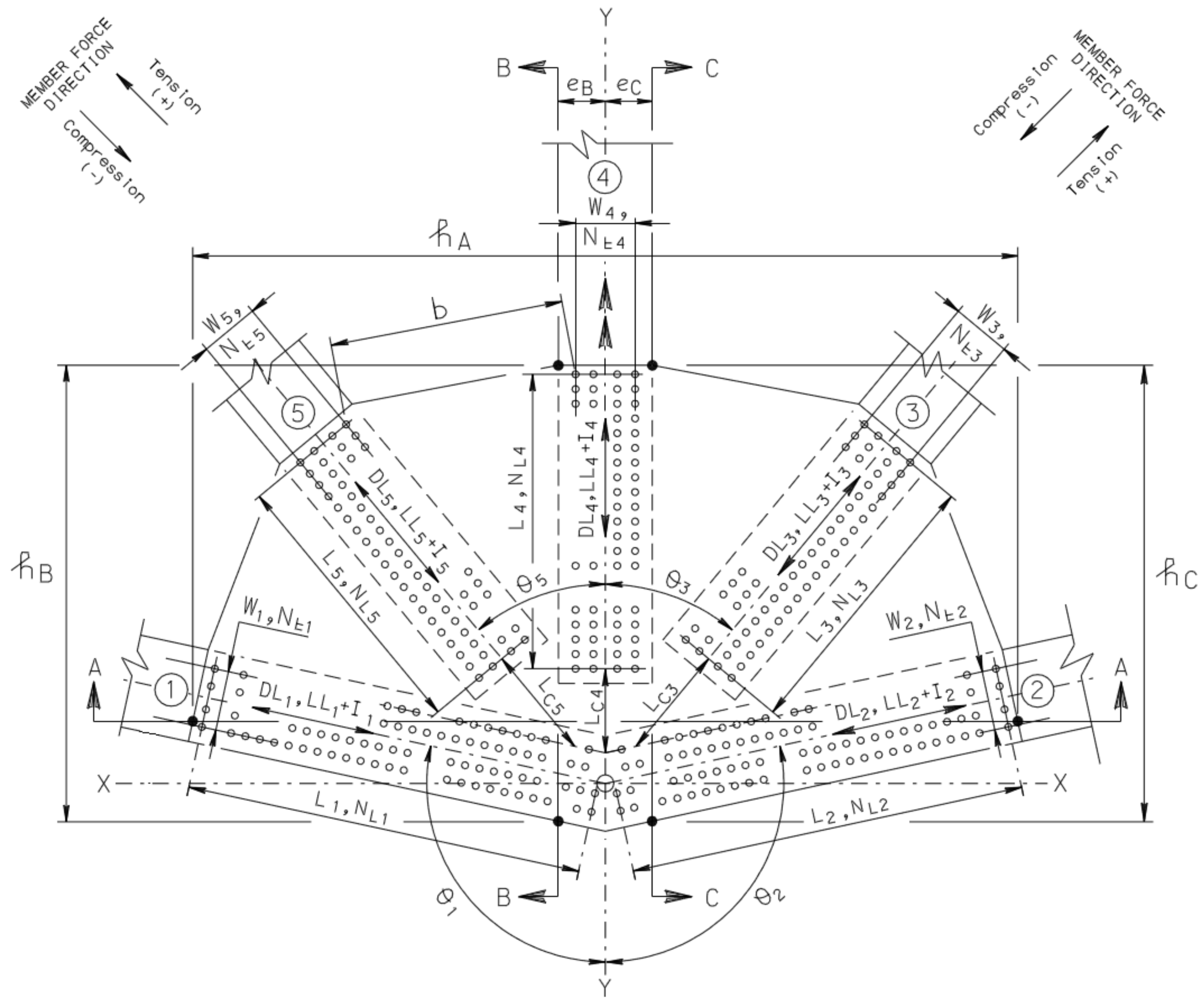


Figure 5.41-1   Gusset Plate Geometry: Angled Lower Chord

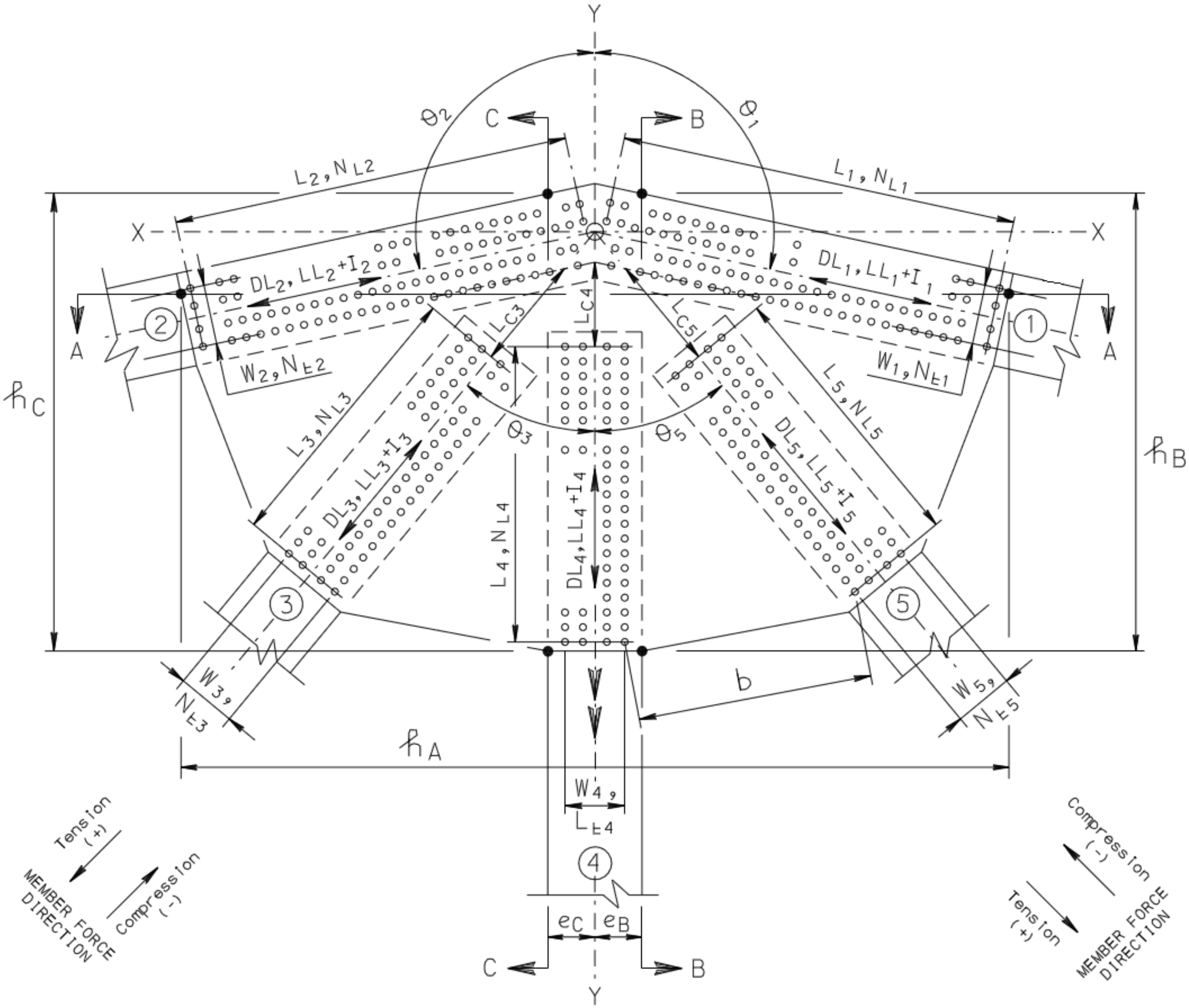


Figure 5.41-2 Gusset Plate Geometry: Angled Upper Chord

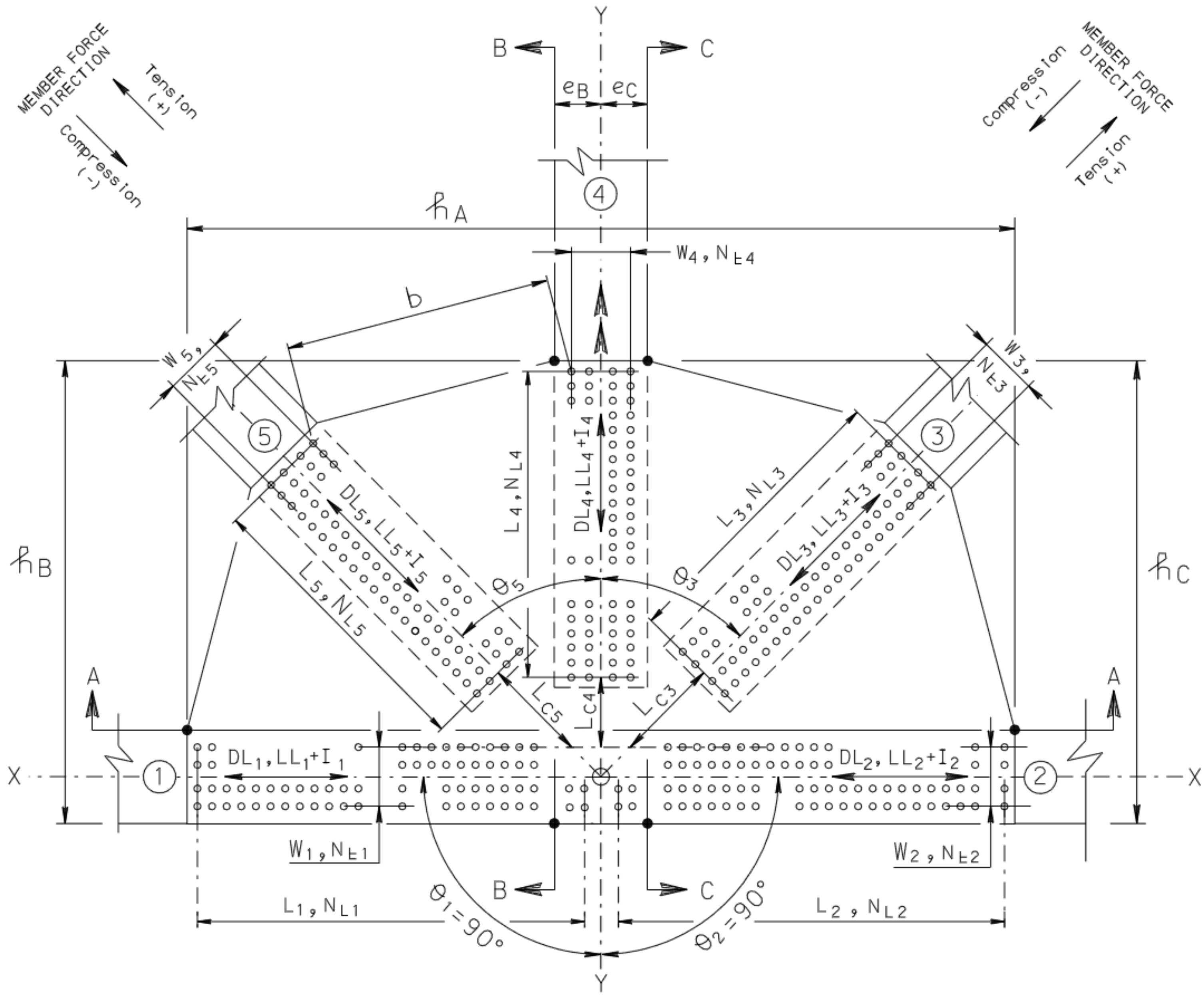


Figure 5.41-3 Gusset Plate Geometry: Horizontal Lower Chord

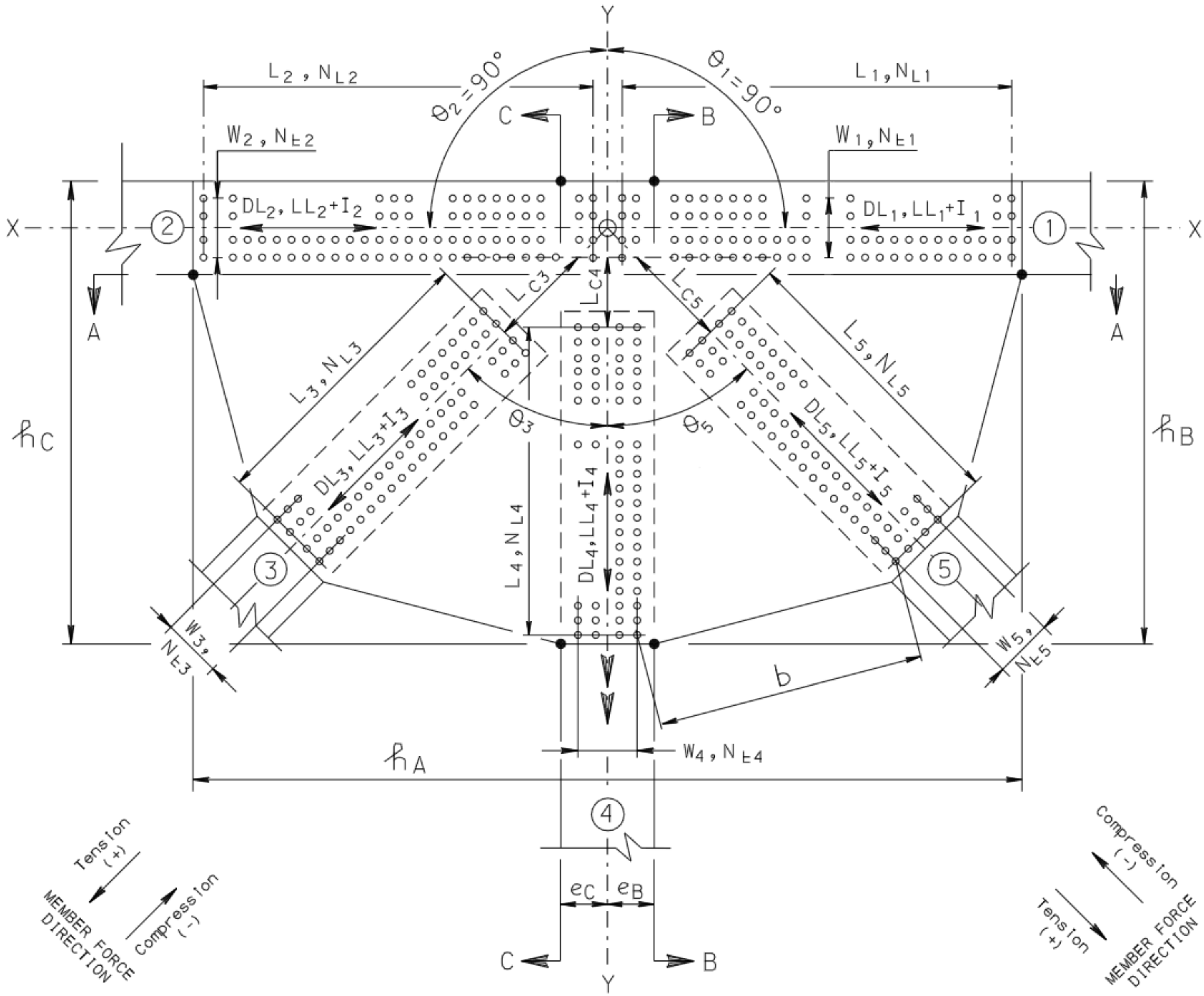


Figure 5.41-4 Gusset Plate Geometry: Horizontal Upper Chord

①	-	Left Bottom Chord
②	-	Right Bottom Chord
③	-	Right Diagonal Member
④	-	Vertical Member
⑤	-	Left Diagonal Member
e_A, e_B, e_C	-	Cross Section Eccentricity (in)
$\hbar_A$, $\hbar_B$, $\hbar_C$	-	Cross Section Length (in)
DL, LL+I	-	Member Force Load (k)
θ_1, θ_2, θ_3, θ_4	-	Member Angle (degree)
W_1, W_2, W_3, W_4, W_5	-	Length between first and last row of Fasteners in Longitudinal Direction (in).
L_{C3}, L_{C4}, L_{C5}	-	Length of the Unstiffened Vertical edge in Compression (in).
L_1, L_2, L_3, L_4, L_5	-	Length between first and last row of Fasteners in Transverse Direction (in).
b	-	Maximum Unsupported Length along the edge of Gusset Plate (in).
N_{t1}, N_{t2}, N_{t3}, N_{t4}, N_{t5}	-	Number of Fasteners in the Transverse Direction.
N_{L1}, N_{L2}, N_{L3}, N_{L4}, N_{L5}	-	Number of Fasteners in the Longitudinal Direction.

Figure 5.41-5 Legend for Figures 5.41-1 and 5.41-3

①	-	Right Top Chord
②	-	Left Top Chord
③	-	Left Diagonal Member
④	-	Vertical Member
⑤	-	Right Diagonal Member
e_A, e_B, e_C	-	Cross Section Eccentricity (in)
$\hbar_A, \hbar_B, \hbar_C$	-	Cross Section Length (in)
DL, LL+I	-	Member Force Load (k)
$\theta_1, \theta_2, \theta_3, \theta_4$	-	Member Angle (degree)
W_1, W_2, W_3, W_4, W_5	-	Length between first and last row of Fasteners in Longitudinal Direction (in).
L_{C3}, L_{C4}, L_{C5}	-	Length of the Unstiffened Vertical edge in Compression (in).
L_1, L_2, L_3, L_4, L_5	-	Length between first and last row of Fasteners in Transverse Direction (in).
b	-	Maximum Unsupported Length along the edge of Gusset Plate (in).
$N_{t1}, N_{t2}, N_{t3}, N_{t4}, N_{t5}$	-	Number of Fasteners in the Transverse Direction.
$N_{L1}, N_{L2}, N_{L3}, N_{L4}, N_{L5}$	-	Number of Fasteners in the Longitudinal Direction.

Figure 5.41-6 Legend for Figures 5.41-2 and 5.41-4

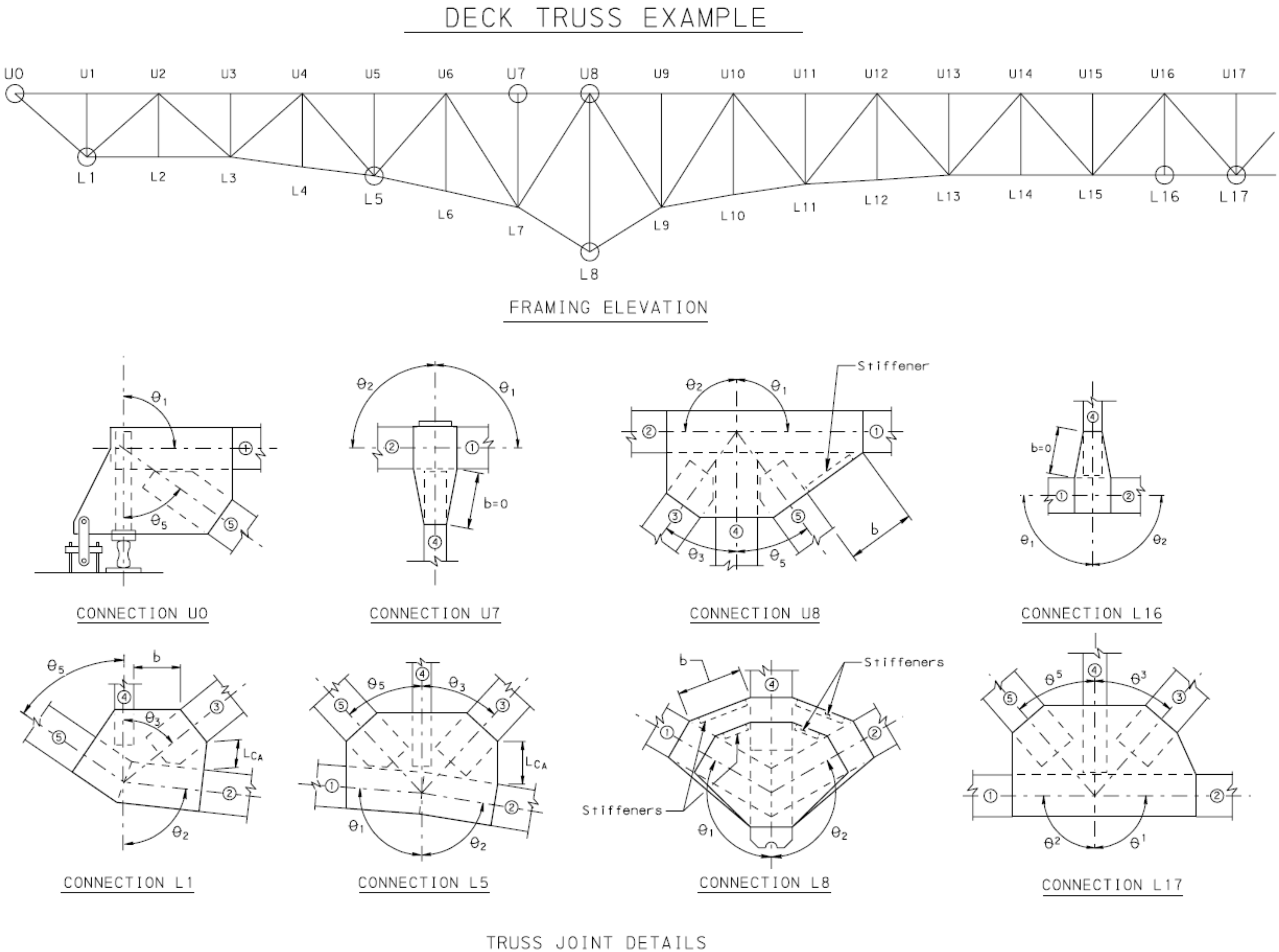


Figure 5.41-7   Deck Truss Example

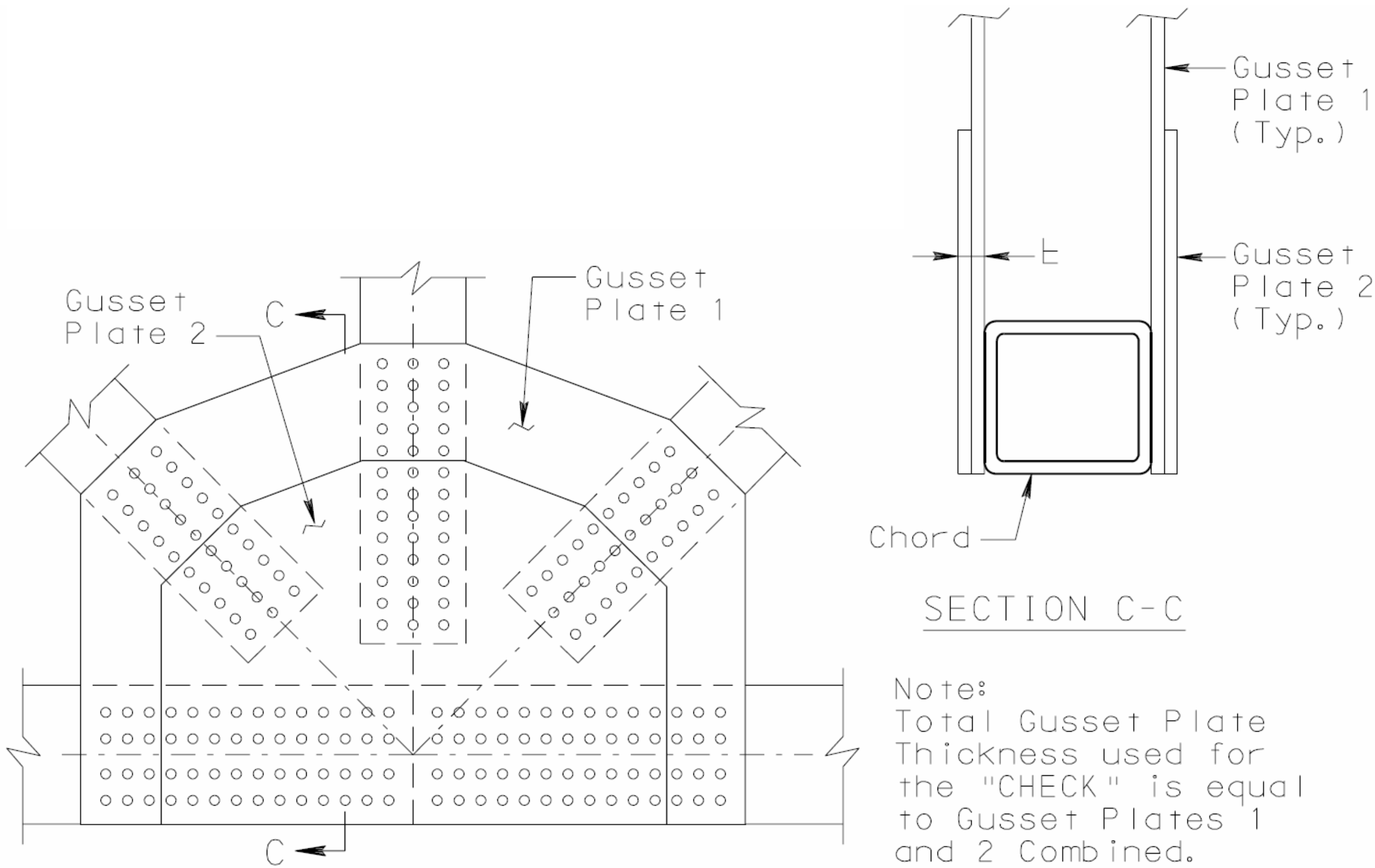


Figure 5.41-8 Double Gusset Plates on Each Side

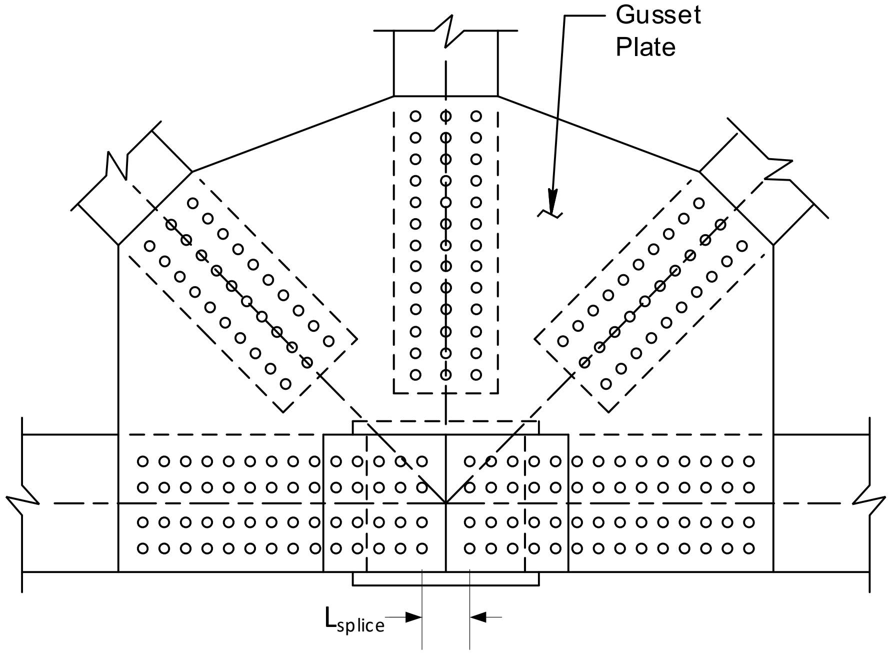


Figure 5.41-9   Example Showing L_{splice}

5.42 GMB – GUSSET PLATE MEMBER COMMAND

KEYWORD	COMMAND DESCRIPTION
GMB	GUSSET PLATE MEMBER – This command is used to input the members connected to the gusset plate. If a member is not present, leave all information for that member blank. (For example, if member 1 is not present, leave input for parameters 2-6 blank) See Figures 5.41-1 through 5.41-5 for explanations of all dimension inputs. **This command can be repeated to define members for up to 200 gusset plates and joints, 100 upper and 100 lower.**

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Location	The location of the gusset plate, designated by the joint: U10, L11, etc.	--	--	--	--
MEMBER 1 (BOTTOM/TOP CHORD)					
2. Distance, W_1	Distance between outermost rows of fasteners measured perpendicular to the line of action on member 1.	in	0 (E)	60 (W)	--
3. Distance, L_1	Distance between the first and last row of fasteners in member 1.	in	0 (E)	125 (W)	--
4. Quantity, N_{t1}	Number of fasteners across the width of member 1 (perpendicular to the line of action of the member).	--	0 (E)	20 (W)	--
5. Quantity, N_{L1}	Number of fasteners along the length of member 1 (parallel to the line of action of the member).	--	0 (E)	40 (W)	--
6. Quantity, N_{tt1}	Total number of fasteners connecting member 1 to the gusset plate	--	0 (E)	800 (W)	*
MEMBER 2 (BOTTOM/TOP CHORD)					
7. Distance, W_2	Distance between outermost rows of fasteners measured perpendicular to the line of action on member 2.	in	0 (E)	60 (W)	--
8. Distance, L_2	Distance between the first and last row of fasteners in member 2.	in	0 (E)	125 (W)	--
9. Quantity, N_{t2}	Number of fasteners across the width of member 2 (perpendicular to the line of action of the member).	--	0 (E)	20 (W)	--
10. Quantity, N_{L2}	Number of fasteners along the length of member 2 (parallel to the line of action of the member).	--	0 (E)	40 (W)	--
11. Quantity, N_{tt2}	Total number of fasteners connecting member 2 to the gusset plate	--	0 (E)	800 (W)	*

5.42 GMB – GUSSET PLATE MEMBER COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
MEMBER 3 (LEFT/RIGHT DIAGONAL)					
12. Distance, W_3	Distance between outermost rows of fasteners measured perpendicular to the line of action on member 3.	in	0 (E)	60 (W)	--
13. Distance, L_3	Distance between the first and last row of fasteners in member 3.	in	0 (E)	125 (W)	--
14. Quantity, N_{t3}	Number of fasteners across the width of member 3 (perpendicular to the line of action of the member).	--	0 (E)	20 (W)	--
15. Quantity, N_{L3}	Number of fasteners along the length of member 3 (parallel to the line of action of the member).	--	0 (E)	40 (W)	--
16. Quantity, N_{tt3}	Total number of fasteners connecting member 3 to the gusset plate	--	0 (E)	800 (W)	*
17. Length, L_{c3}	Unsupported length between the last row of fasteners for the diagonal and the first row of fasteners in the chord measured along the line of action of the diagonal.	in	0 (E)	60 (W)	--
MEMBER 4 (UP/DOWN VERTICAL)					
18. Distance, W_4	Distance between outermost rows of fasteners measured perpendicular to the line of action on member 4.	in	0 (E)	60 (W)	--
19. Distance, L_4	Distance between the first and last row of fasteners in member 4.	in	0 (E)	125 (W)	--
20. Quantity, N_{t4}	Number of fasteners across the width of member 4 (perpendicular to the line of action of the member).	--	0 (E)	20 (W)	--
21. Quantity, N_{L4}	Number of fasteners along the length of member 4 (parallel to the line of action of the member).	--	0 (E)	40 (W)	--
22. Quantity, N_{tt4}	Total number of fasteners connecting member 4 to the gusset plate	--	0 (E)	800 (W)	*
23. Length, L_{c4}	Unsupported length between the last row of fasteners for the vertical and the first row of fasteners in the chord measured along the line of action of the vertical.	in	0 (E)	60 (W)	--
MEMBER 5 (LEFT/RIGHT DIAGONAL)					
24. Distance, W_5	Distance between outermost rows of fasteners measured perpendicular to the line of action on member 5.	in	0 (E)	60 (W)	--
25. Distance, L_5	Distance between the first and last row of fasteners in member 5.	in	0 (E)	125 (W)	--

5.42 GMB – GUSSET PLATE MEMBER COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
26. Quantity, N_{t5}	Number of fasteners across the width of member 5 (perpendicular to the line of action of the member).	--	0 (E)	20 (W)	--
27. Quantity, N_{L5}	Number of fasteners along the length of member 5 (parallel to the line of action of the member).	--	0 (E)	40 (W)	--
28. Quantity, N_{tt5}	Total number of fasteners connecting member 5 to the gusset plate	--	0 (E)	800 (W)	*
29. Length, L_{c5}	Unsupported length between the last row of fasteners for the diagonal in compression and the first row of fasteners in the chord measured along the line of action of the diagonal. Leave blank if this is the tension diagonal.	in	0 (E)	60 (W)	--

Note:

[1] If left blank, $N_{tt\#}$ will default to a value of $N_{t\#}$ * $N_{L\#}$. If entered, $N_{tt\#}$ must not exceed $N_{t\#}$ * $N_{L\#}$. The program will stop and require the user to enter a value less than or equal to $N_{t\#}$ * $N_{L\#}$.

5.43 GFL – GUSSET PLATE FILLER COMMAND

KEYWORD	COMMAND DESCRIPTION
GFL	GUSSET PLATE FILLER – This command is used to input the filler plates at the members connected to the gusset plate. The input on this command is used to calculate the factored shear resistance reduction factors, R, at each member from the LRFD Specifications Section 6.13.6.1.4. This command must be included if a filler plate exists at any present member and satisfies the following criteria: • the filler plate thickness is greater than or equal to 0.25" • the filler plate does not extend past the gusset, or the filler plate extends past the gusset but is not secured by additional bolts If no filler plates are present at a gusset plate, do not enter this command for that gusset plate. If a filler plate area at a given member is entered, the connected plate area at that member must also be entered. See Figure 1 for an illustration of the filler plate and connected plate. See Figures 5.41-1 through 5.41-4 for an illustration of the location of each member.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Location	The location of the gusset plate, designated by the joint: U10, L11, etc.	--	--	--	--
2. Filler Plate Area, Member 1	Enter the total filler plate area at member 1. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--
3. Connected plate area, Member 1	Enter the area of the plate connected to the gusset plate at member 1. This value is usually not the entire area of the member; only enter the area of the plate connected to the gusset plate. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--
4. Filler Plate Area, Member 2	Enter the total filler plate area at member 2. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--

NOTE 1 – LEAVE BLANK IF THIS MEMBER IS NOT DEFINED AT THIS GUSSET PLATE, IF THERE ARE NO FILLER PLATES AT THIS MEMBER, OR IF THE FILLER PLATES ARE PRESENT AND ARE LESS THAN 0.25" THICK OR EXTEND PAST THE GUSSET PLATE AND ARE SECURED BY ADDITIONAL BOLTS.

5.43 GFL – GUSSET PLATE FILLER COMMAND (CONTINUED)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
5. Connected plate area, Member 2	Enter the area of the plate connected to the gusset plate at member 2. This value is usually not the entire area of the member; only enter the area of the plate connected to the gusset plate. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--
6. Filler Plate Area, Member 3	Enter the total filler plate area at member 3. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--
7. Connected plate area, Member 3	Enter the area of the plate connected to the gusset plate at member 3. This value is usually not the entire area of the member; only enter the area of the plate connected to the gusset plate. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--
8. Filler Plate Area, Member 4	Enter the total filler plate area at member 4. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--
9. Connected plate area, Member 4	Enter the area of the plate connected to the gusset plate at member 4. This value is usually not the entire area of the member; only enter the area of the plate connected to the gusset plate. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--
10. Filler Plate Area, Member 5	Enter the total filler plate area at member 5. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--
11. Connected plate area, Member 5	Enter the area of the plate connected to the gusset plate at member 5. This value is usually not the entire area of the member; only enter the area of the plate connected to the gusset plate. See Note 1 for when to leave this parameter blank.	in^2	0. (E)	100. (W)	--

NOTE 1 – LEAVE BLANK IF THIS MEMBER IS NOT DEFINED AT THIS GUSSET PLATE, IF THERE ARE NO FILLER PLATES AT THIS MEMBER, OR IF THE FILLER PLATES ARE PRESENT AND ARE LESS THAN 0.25" THICK OR EXTEND PAST THE GUSSET PLATE AND ARE SECURED BY ADDITIONAL BOLTS.

5.43 GFL – GUSSET PLATE FILLER COMMAND (CONTINUED)

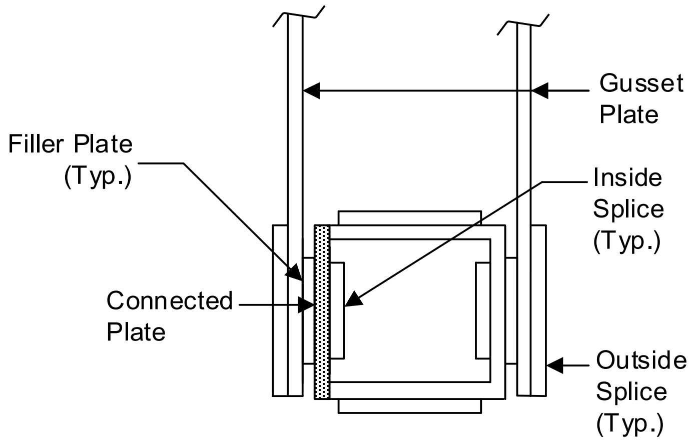


Figure 5.43-1 Filler Plate Example

5.44 GCS – GUSSET CHORD SPLICE COMMAND

KEYWORD	COMMAND DESCRIPTION
GCS	GUSSET CHORD SPLICE – This command is used to input the dimensions and locations of the chord splice plates at gusset plate locations. TRLRFD cannot analyze chord splices that are not located at gusset plate locations. If no chord splice plates are present at a gusset plate, do not enter this command for that gusset plate. See Figure 1 for an illustration of the chord splice plate dimensions and locations. TRLRFD does not do any cross-checking of the chord splice geometry entered on this command with the truss member cross sections entered on the T## commands. It is the responsibility of the engineer to ensure that the idealized geometry defined by this command will correctly model the chord splice. See Section 3.12.9 of this manual for assumptions made when calculating the chord splice resistance. This command can be repeated to define up to 200 joints, 100 upper and 100 lower.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Location	The location of the gusset plate, designated by the joint: U10, L11, etc.	--	--	--	--
2. Outside splice plate thickness, t_{s1}	Thickness of the outside splice plate, t_{s1}, on one side of the joint (see Figure 5.44-2), when present.	in	0. (E)	4. (W)	0.
3. Outside splice plate length, L_{s1}	Outside splice plate length, L_{s1}, when present (see Figure 5.44-1).	in	0. (E)	100. (W)	0.
4. Inside splice plate thickness, t_{s4}	Thickness of the Inside splice plate, t_{s4}, on one side of the joint (see Figure 5.44-2), when present.	in	0. (E)	4. (W)	0.
5. Inside splice plate length, L_{s4}	Inside splice plate length, L_{s4}, when present (see Figure 5.44-1).	in	0. (E)	100. (W)	0.
6. Top splice plate thickness, t_{s2}	Top splice plate thickness, t_{s2}, when present (see Figure 5.44-2).	in	0. (E)	4. (W)	0.
7. Top splice plate width, w_{s2}	Top splice plate width, w_{s2}, when present (see Figure 5.44-2).	in	0. (E)	36. (W)	0.
8. Top splice plate length, L_{s2}	Top splice plate length, L_{s2}, when present (see Figure 5.44-1).	in	0. (E)	100. (W)	0.

5.44 GCS – GUSSET CHORD SPLICE COMMAND (Continued)

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
9. Top splice plate eccentricity, e_{top}	Distance from the bottom of the gusset plate to the centroid of the top splice plate, e_{top} (see Figure 5.44-2).	in	0. (E)	100. (W)	0.
10. Bottom splice plate thickness, t_{s3}	Bottom splice plate thickness, t_{s3}, when present (see Figure 5.44-2).	in	0 (E)	4 (W)	0
11. Bottom splice plate width, w_{s3}	Bottom splice plate width, w_{s3}, when present (see Figure 5.44-2).	in	0. (E)	36. (W)	0.
12. Bottom splice plate length, L_{s3}	Bottom splice plate length, L_{s3}, when present (see Figure 5.44-1).	in	0. (E)	100. (W)	0.
13. Bottom splice plate eccentricity, e_{bottom}	Distance from the bottom of the gusset plate to the centroid of the bottom splice plate, e_{bottom} (see Figure 5.44-2). Enter a negative value if the bottom splice plate centroid is below the bottom of the gusset plate.	in	-100. (W)	100. (W)	0.

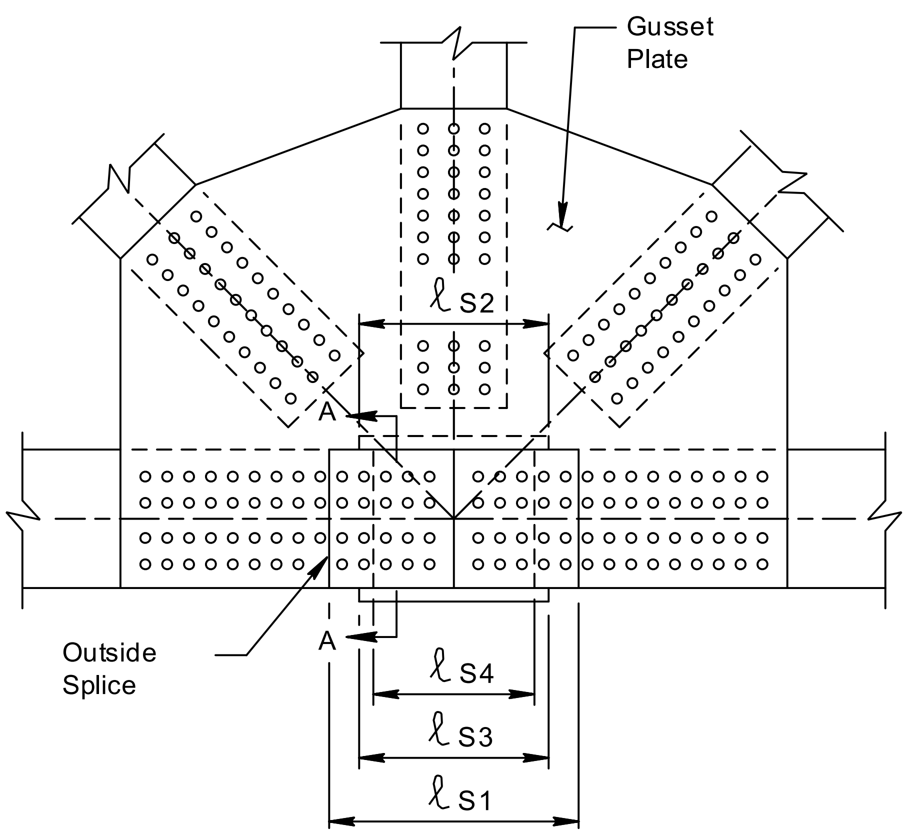


Figure 5.44-1 Splice Plate Lengths

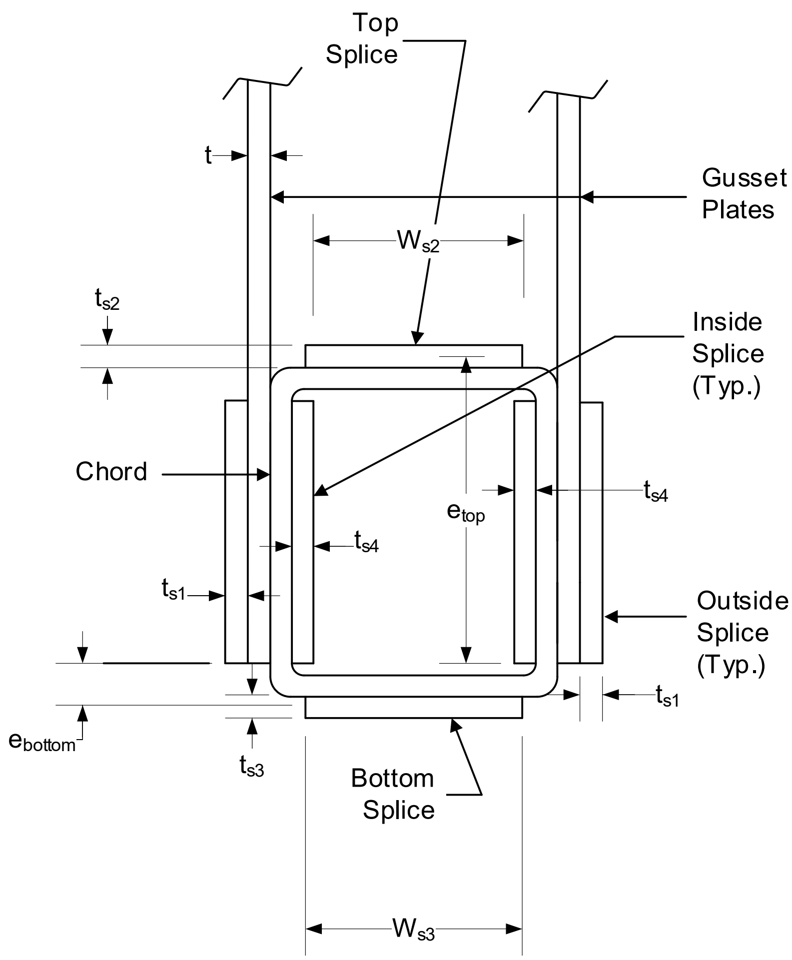


Figure 5.44-2 Splice Plate Dimensions and Locations

5.45 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

5.46 OUT – OUTPUT COMMAND

KEYWORD	COMMAND DESCRIPTION
OUT	OUTPUT - This command allows the user to control the output of all data other than the input data. Only one OUT command can be used.

PARAMETER	DESCRIPTION	UNITS	LOWER LIMIT	UPPER LIMIT	Default
1. Section Properties	Enter: 0 - Do not print the member section properties 1 - Print the member section properties	--	0 (E)	1 (E)	1
2. Analysis and Specification Checking	Enter: 0 - Do not print the member analysis and section property results 1 - Print the member analysis and section property results	--	0 (E)	1 (E)	1
3. Extreme Event Analysis	Enter: 0 - Do not print the extreme event analysis 1 - Print the extreme event analysis	--	0 (E)	1 (E)	1
4. Rating Summary	Enter: 0 - Do not print the rating summary for the truss members 1 - Print the rating summary for the truss members	--	0 (E)	1 (E)	1
5. Detailed Gusset Plate Analysis	Enter: 0 - Do not print the detailed gusset plate analysis 1 - Print the detailed gusset plate analysis	--	0 (E)	1 (E)	1
6. Gusset Plate Summary	Enter: 0 - Do not print the gusset plate summary 1 - Print the gusset plate summary	--	0 (E)	1 (E)	1
7. 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, 6.5.11 Symmetry corresponds to Section 5.5 CTL - Control Command, parameter 11. Only the commands and parameters for which detailed description is given are included in this chapter.

6.5 CTL – CONTROL COMMAND

6.5.11 Symmetry

This applies to the symmetry of a bridge about a center point for the length of the bridge. Enter "Y" if the member properties, truss geometry, truss dead loads**, and gusset plates** are symmetric about the center point (or panel) of the truss. The symmetry parameter simplifies both input as well as output. However, the user must follow these requirements:

IF THE TRUSS HAS AN ODD NUMBER OF PANELS:

The geometry command is required for all panels up to the central panel.

The dead load commands (DC and DW) require joint loads that are only on the left-hand side of the truss.

The gusset plate commands (GUS, GMB, and GCS) require gusset data that are only on the left-hand side of the truss.

The truss member properties command requires properties of all members up to and including the central panel about which the truss is symmetric.

IF THE TRUSS HAS AN EVEN NUMBER OF PANELS:

The geometry command is required for all panels up to the point of symmetry.

The dead load commands (DC and DW) require joint loads that are on the left-hand side of the truss up to and including the joint**s of symmetry**.

The gusset plate commands (GUS, GMB, and GCS) require gusset data that are on the left-hand side of the truss up to and including the joints of symmetry.

The truss member properties command requires properties of all panels up to the joint**s of symmetry**. Remember that the vertical members that form the right-hand side of the panel belong to that panel.

6.11 GEO – GEOMETRY COMMAND

The terminology used for describing the geometry of a truss is similar to that commonly used in engineering drawings. A truss consists of a number of panels (sub-frames) consisting of a top chord, bottom chord, one or two diagonals and one or two vertical members that form the right hand side of the panel (See Figure 6.11-1) Panels are numbered in a sequential order starting with 0 at the left end of a truss. A joint is designated as L0, U1, L2, M3 etc., where the letter indicates the vertical position of the joint (U for the upper joint, L for the lower joint and M for the middle joint) and the number indicates the panel containing this joint. A member within the panel is designated as U1U2, L2L3, M4M5 etc. indicating the joints it connects. The arrangement of members within a panel is designated by a panel type, as shown in Figure 5.11-1.

The geometry of a truss is defined by entering the width, height and type of each panel. If the truss has a vertical member at the left end, an imaginary panel (number 0) having zero width and height equal to length of that vertical (L0U0) member is assumed.

The geometry input for the truss in Figure 6.11-1 would be as follows:

```
GEO 0, 0, Y, 9,     0,     0
GEO 1, 6, Y, 7.5,   0,     1.5,   6
GEO 2, 6, Y, 3.375, 3.375, 2.25,  8
GEO 3, 6, Y, 6,     0,     3,    11
GEO 4, 6, Y, 3,     3,     3,     8
GEO 5, 6, Y, 6,     0,     3,    11
```

The top and bottom chords for a truss as shown in Figure 6.11-2, though commonly referred to as U1U3, U3U5, L0L2, L2L4 and L4L6, must be entered as U1U2 & U2U3, U3U4 & U4U5, L0L1 & L1L2, L2L3 & L3L4 and L4L5 & L5L6, respectively, in the Truss Member Properties input. The actual length of each member (40 ft for all top and bottom chords in this example) will be computed by the program. Dead loads may not be entered at joints U2, U4, L1, L3 and L5.

The geometry input for the truss in Figure 6.11-2 would be:

```
GEO 1, 20, N, 20, , , 1
GEO 2, 20, N, 20, , , 6
GEO 3, 20, N, 20, , , 5
GEO 4, 20, N, 20, , , 6
GEO 5, 20, N, 20, , , 5
GEO 6, 20, N, 20, , , 2
```

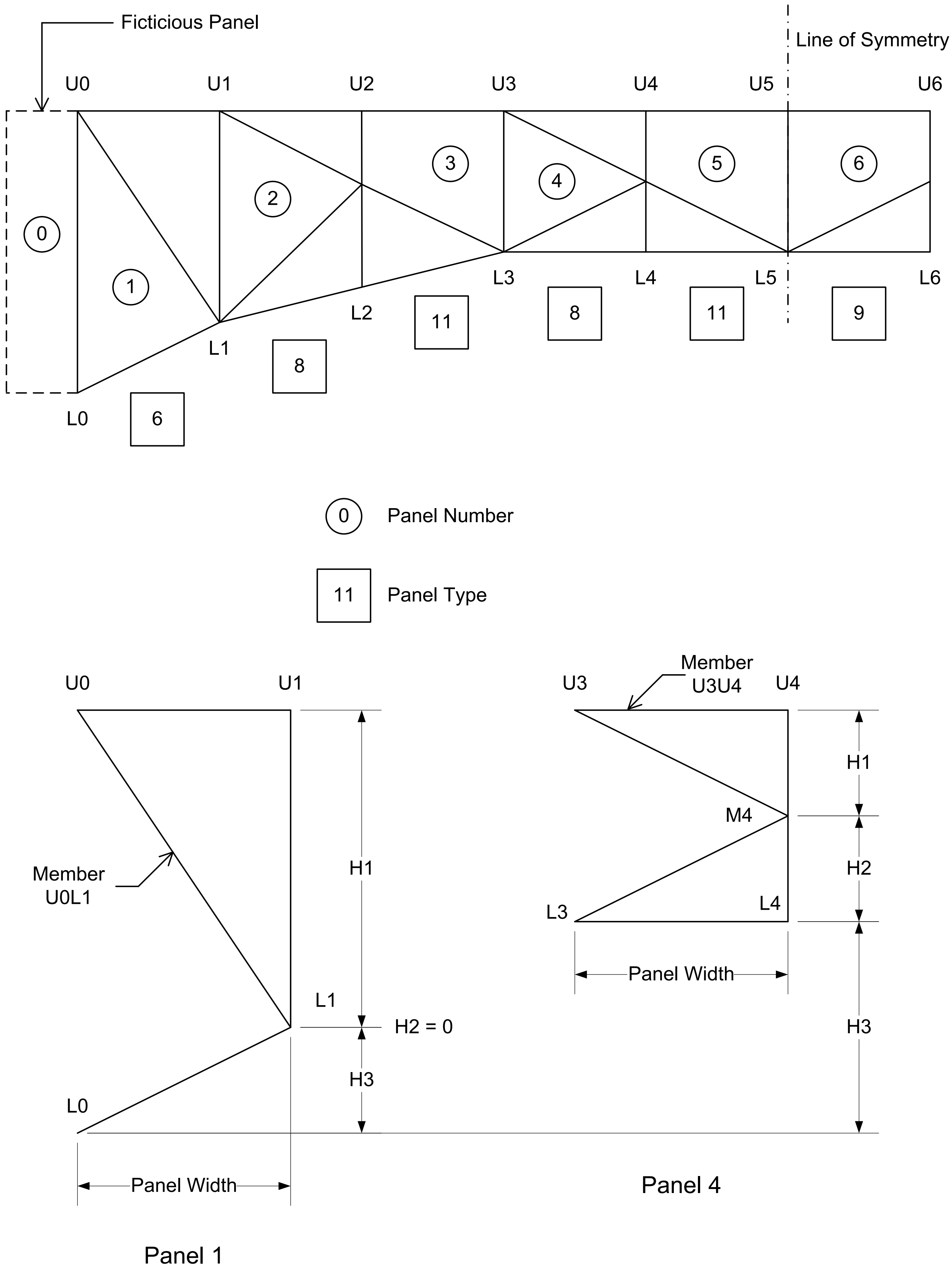


Figure 6.11-1 Truss Geometry

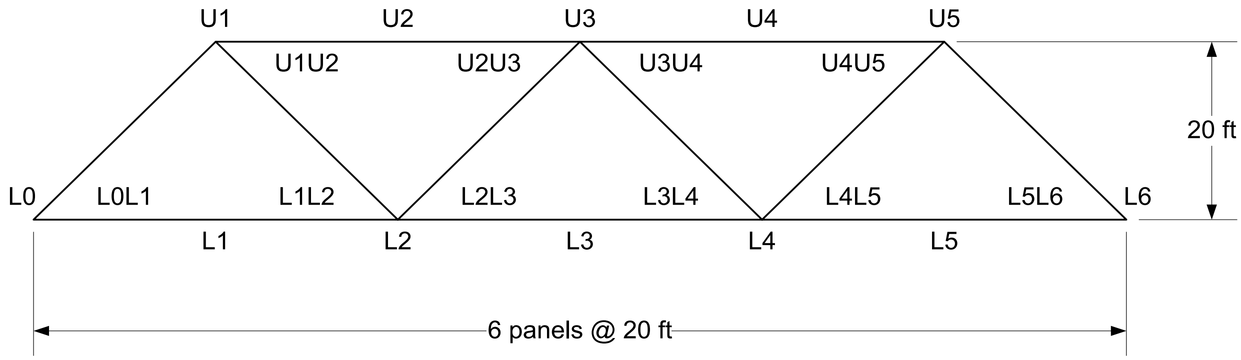


Figure 6.11-2 Chord Length Example

6.11.3 Vertical Post

Enter 'Y' for the following cases:

- For panel type 0
- For panel types 1, 3, 5, 6, 7, 11, **12,** 13 or 15 if the vertical member on the right side is present
- For panel types 8, 9, 10 and 14 of a through truss ('L' is entered for LIVE LOAD LOCATION on the CTL command) and the UPPER vertical member on the right side of the panel is present.
- For panel types 8, 9, 10 and 14 of a deck truss ('U' is entered for LIVE LOAD LOCATION on the CTL command) and the LOWER vertical member on the right side of the panel is present.

Leave blank for panel types 2 and 4

Enter 'N' for all other cases.

6.36 EEV – EXTREME EVENT COMMAND

This command is used to define the member properties for two additional limit states: Extreme Event-III and Extreme Event-IV. These limit states are intended to check:

Extreme Event-III: Truss is analyzed with specific members having reduced section properties

Extreme Event-IV: Truss member is checked for effect due to loss of a truss member. The determination of the applied load is beyond the scope of TRLRFD, therefore the load must be input by the user. If no extreme event load is input, then this limit state (Extreme Event-IV) will not be checked.

The parameters entered in the EEV command replace the normal section properties and additional analysis is performed. If the truss is indeterminate, then the truss response is reevaluated using the new stiffness. New allowables are calculated.

6.38 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 **F**atigue-**II** in the effective stress range equation is to be calculated by the program.

If the user does not enter the FGV command, then the program **sets** the gamma (γ) factor **to 0.80, as per DM-4 Table 3.4.1.1P-6.**

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 6.38-1 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 6.38-2 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 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

6.41 GUS – GUSSET PLATE COMMAND

6.41.13 Minimum Required Bolt Tension

If this value is left blank, the program will calculate a default value based on the bolt diameter and ultimate strength. From Section C6.13.2.8 of the LRFD Specifications, the minimum bolt tension values shown in Table 6.13.2.8-1 are equal to 70 percent of the tensile strength of the bolts.

$$P_t = 0.70 F_u A_n$$

where: P_t = minimum required bolt tension, kips

F_u = ultimate strength of bolt, ksi

A_n = net tensile area of bolt, in^2

The net tensile area of the bolt is calculated from Table 7-17 of the AISC Steel Construction Manual.

$$A_n = \frac{\pi}{4}\left(d - \frac{0.9743}{n}\right)^2$$

where: A_n = net tensile area of bolt, in^2

d = bolt diameter, in

n = threads per inch (from Table 7-17, based on bolt diameter)

6.45 OIN – OUTPUT OF INPUT 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 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 DATA COMPUTED DISTRIBUTION FACTOR SPAN LENGTHS (SIMPLE) SPAN LENGTHS AND HINGE LOCATIONS (CANTILEVER) SPAN LENGTHS (CONTINUOUS) LIVE LOAD PLACEMENT TRUSS GEOMETRY TRUSS DEAD LOADS TRUSS MEMBER PROPERTIES GENERAL SECTION PROPERTIES TYPE 01 SECTION PROPERTIES, PART 1 OF 2 TYPE 01 SECTION PROPERTIES, PART 2 OF 2 TYPE 02 SECTION PROPERTIES, PART 1 OF 2 TYPE 02 SECTION PROPERTIES, PART 2 OF 2 TYPE 03 SECTION PROPERTIES, PART 1 OF 3 TYPE 03 SECTION PROPERTIES, PART 2 OF 3 TYPE 03 SECTION PROPERTIES, PART 3 OF 3 TYPE 04 SECTION PROPERTIES, PART 1 OF 2 TYPE 04 SECTION PROPERTIES, PART 2 OF 2 TYPE 05 SECTION PROPERTIES, PART 1 OF 2 TYPE 05 SECTION PROPERTIES, PART 2 OF 2 TYPE 06 SECTION PROPERTIES, PART 1 OF 2 TYPE 06 SECTION PROPERTIES, PART 2 OF 2 TYPE 07 SECTION PROPERTIES, PART 1 OF 2 TYPE 07 SECTION PROPERTIES, PART 2 OF 2 TYPE 08 SECTION PROPERTIES, PART 1 OF 3 TYPE 08 SECTION PROPERTIES, PART 2 OF 3 TYPE 08 SECTION PROPERTIES, PART 3 OF 3 TYPE 09 SECTION PROPERTIES, PART 1 OF 3 TYPE 09 SECTION PROPERTIES, PART 2 OF 3 TYPE 09 SECTION PROPERTIES, PART 3 OF 3 TYPE 10 SECTION PROPERTIES, PART 1 OF 3 TYPE 10 SECTION PROPERTIES, PART 2 OF 3 TYPE 10 SECTION PROPERTIES, PART 3 OF 3 TYPE 11 SECTION PROPERTIES, PART 1 OF 2 TYPE 11 SECTION PROPERTIES, PART 2 OF 2 TYPE 12 SECTION PROPERTIES, PART 1 OF 3 TYPE 12 SECTION PROPERTIES, PART 2 OF 3 TYPE 12 SECTION PROPERTIES, PART 3 OF 3 TYPE 13 SECTION PROPERTIES, PART 1 OF 3 TYPE 13 SECTION PROPERTIES, PART 2 OF 3 TYPE 13 SECTION PROPERTIES, PART 3 OF 3 TYPE 14 SECTION PROPERTIES, PART 1 OF 2 TYPE 14 SECTION PROPERTIES, PART 2 OF 2	1

Table 6.45-1 Summary of Defaults for OIN Command (Continued)

PARAMETER	OUTPUT TABLES INCLUDED	DEFAULTS
3. Input Summary (Continued)	TYPE 15 SECTION PROPERTIES, PART 1 OF 2 TYPE 15 SECTION PROPERTIES, PART 2 OF 2 TYPE 16 SECTION PROPERTIES, PART 1 OF 2 TYPE 16 SECTION PROPERTIES, PART 2 OF 2 TYPE 17 SECTION PROPERTIES, PART 1 OF 2 TYPE 17 SECTION PROPERTIES, PART 2 OF 2 TYPE 18 SECTION PROPERTIES TYPE 19 SECTION PROPERTIES, PART 1 OF 3 TYPE 19 SECTION PROPERTIES, PART 2 OF 3 TYPE 19 SECTION PROPERTIES, PART 3 OF 3 EXTREME EVENT FATIGUE LIFE FATIGUE GROSS VEHICLE SPECIAL LIVE LOAD GUSSET PLATE GUSSET PLATE MEMBER OUTPUT	

6.46 OUT – OUTPUT COMMAND

The OUT command takes seven parameters. The output reports that print with the values of each of the parameters are shown in Table 1.

Table 6.46-1 Output Tables and OUT Input Values

PARAMETER	OUTPUT TABLES INCLUDED
1. Section Properties	MEMBER SECTION PROPERTIES
2. Analysis and Specification Checking	LIVE LOAD DISTRIBUTION FACTORS (USER DEFINED LANES) LIVE LOAD DISTRIBUTION FACTORS (PROGRAM DEFINED LANES) DEAD LOAD FORCES & AXIAL RESISTANCES PHL-93 MEMBER FORCES AND RATINGS PHL-93 TRUCK LOCATIONS FOR MAXIMUM EFFECT PHL-93 CRITICAL RATING PHL-93 SUPPORT REACTIONS PHL-93 PANEL POINT DEFLECTIONS HL-93 MEMBER FORCES AND RATINGS HL-93 TRUCK LOCATIONS FOR MAXIMUM EFFECT HL-93 CRITICAL RATING HL-93 SUPPORT REACTIONS HL-93 PANEL POINT DEFLECTIONS ML-80 MEMBER FORCES AND RATINGS ML-80 TRUCK LOCATIONS FOR MAXIMUM EFFECT ML-80 CRITICAL RATING ML-80 SUPPORT REACTIONS ML-80 PANEL POINT DEFLECTIONS P-82 MEMBER FORCES AND RATINGS P-82 TRUCK LOCATIONS FOR MAXIMUM EFFECT P-82 CRITICAL RATING P-82 SUPPORT REACTIONS P-82 PANEL POINT DEFLECTIONS TK527 MEMBER FORCES AND RATINGS TK527 TRUCK LOCATIONS FOR MAXIMUM EFFECT TK527 CRITICAL RATING TK527 SUPPORT REACTIONS TK527 PANEL POINT DEFLECTIONS HS20 MEMBER FORCES AND RATINGS HS20 TRUCK LOCATIONS FOR MAXIMUM EFFECT HS20 CRITICAL RATING HS20 SUPPORT REACTIONS HS20 PANEL POINT DEFLECTIONS H20 MEMBER FORCES AND RATINGS H20 TRUCK LOCATIONS FOR MAXIMUM EFFECT H20 CRITICAL RATING H20 SUPPORT REACTIONS H20 PANEL POINT DEFLECTIONS COMBINED LIVE LOAD MEMBER FORCES AND RATINGS COMBINED TRUCK LOCATIONS FOR MAXIMUM EFFECT COMBINED CRITICAL RATING COMBINED SUPPORT REACTIONS COMBINED PANEL POINT DEFLECTIONS FATIGUE LIFE ESTIMATION

Table 6.46-1 Output Tables and OUT Input Values (Continued)

PARAMETER	OUTPUT TABLES INCLUDED
3. Extreme Event Analysis	EXTREME EVENT III: DEAD LOAD FORCES & AXIAL RESISTANCES EXTREME EVENT III: PHL-93 MEMBER FORCES AND RATINGS EXTREME EVENT III: HL-93 MEMBER FORCES AND RATINGS EXTREME EVENT III: ML-80 MEMBER FORCES AND RATINGS EXTREME EVENT III: P-82 MEMBER FORCES AND RATINGS EXTREME EVENT III: TK527 MEMBER FORCES AND RATINGS EXTREME EVENT III: HS20 MEMBER FORCES AND RATINGS EXTREME EVENT III: H20 MEMBER FORCES AND RATINGS EXTREME EVENT IV ANALYSIS
4. Rating Summary	RATING SUMMARY
5. Detailed Gusset Plate Analysis	GUSSET PLATES: DL & LL FORCES/ANGLES - PART 1 OF 3 GUSSET PLATES: DL & LL FORCES/ANGLES - PART 2 OF 3 GUSSET PLATES: DL & LL FORCES/ANGLES - PART 3 OF 3 GUSSET PLATES: SHEAR @ SECTION A-A: LL COMPRESS GUSSET PLATES: SHEAR @ SECTION A-A: LL TENSILE GUSSET PLATES: SHEAR @ SECTION A-A: LL MATCH DL GUSSET PLATES: SHEAR @ SECTION B-B: LL COMPRESS GUSSET PLATES: SHEAR @ SECTION B-B: LL TENSILE GUSSET PLATES: SHEAR @ SECTION B-B: LL MATCH DL GUSSET PLATES: SHEAR @ SECTION C-C: LL COMPRESS GUSSET PLATES: SHEAR @ SECTION C-C: LL TENSILE GUSSET PLATES: SHEAR @ SECTION C-C: LL MATCH DL GUSSET PLATES: TENSION & COMPRESSION: LL COMPRESS GUSSET PLATES: TENSION & COMPRESSION: LL TENSILE GUSSET PLATES: BLOCK SHEAR: LL COMPRESS GUSSET PLATES: BLOCK SHEAR: LL TENSILE GUSSET PLATES: CONNECTIONS: LL COMPRESS GUSSET PLATES: CONNECTIONS: LL TENSILE
6. Gusset Plate Summary	GUSSET PLATES: SUMMARY PART 1 OF 3: LL COMPRESS GUSSET PLATES: SUMMARY PART 1 OF 3: LL TENSILE GUSSET PLATES: SUMMARY PART 2 OF 3: LL COMPRESS GUSSET PLATES: SUMMARY PART 2 OF 3: LL TENSILE GUSSET PLATES: SUMMARY PART 3 OF 3: LL COMPRESS GUSSET PLATES: SUMMARY PART 3 OF 3: LL TENSILE GUSSET PLATES: GOVERN OPERATING RATINGS: ALL CASES
7. Ratings Without Future Wearing Surface	When ratings are requested for both with FWS and without FWS, all tables included by parameters 2 through 6 are printed twice; once with FWS and once without FWS. This parameter only applies to program runs with FWS load specified.

7 OUTPUT DESCRIPTION

7.1 GENERAL OUTPUT INFORMATION

Information is provided for describing output table controls, page format, page numbering, and page header. In general, the page format is built into the program and cannot be changed by the user for either the .OUT output file or the .PDF output file. The one exception is that the user can specify the number of blank lines to be printed at the top of each page before the page header is printed. This formatting change will be reflected in both .OUT and .PDF output files accordingly.

7.1.1 Output Table Controls

The output table controls are specified using a number of input commands and parameters to control which output reports will be printed. These controls are specified using **two** different input commands, according to which kind of output they represent. The kinds of output are: input data, section properties, analysis results **and** specification checking, **extreme event analysis,** rating **summary, detailed gusset plate analysis, gusset plate summary and ratings without future wearing surface**. The commands and their defaults are discussed in Sections 6.**45 and** 6.**46**.

7.1.2 Page Format

There is a maximum of **99** columns in the output files. Column 1 ha**s** 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 **2** to column **99**. 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 Truss Analysis and Rating, Version x.x.x.x                        PAGE   3
Input File: TR1A.DAT                                        02/27/20xx  16:12:12
--------------------------------------------------------------------------------
                                BOSTON BRIDGE
                                   OUTPUT
--------------------------------------------------------------------------------
```

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
AREA	in^2
CONCENTRATED LOAD	kips
DEFLECTION	in
DEPTH	in
DISTANCE TO NEUTRAL AXIS	in
DISTRIBUTED LOAD	kip/ft
FORCE	kips
GAGE DISTANCE	ft
LANE WIDTH	ft
MODULUS OF ELASTICITY	ksi
MOMENT	kip-ft
MOMENT OF INERTIA	in^4
PASSING DISTANCE	ft
RADIUS OF GYRATION	in
RATING TONNAGE	tons
REACTION	kips
SECTION MODULUS	in^3
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 positive moment causes a compressive stress in the extreme top fiber of a flexural member.
Reaction	A reaction acting in the upward direction is positive.
Load	A load acting in the downward direction in positive.
Deflection	Downward deflection is positive. Horizontal deflection to the right is positive.
Force	A truss member force is positive if the member is in tension.
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 Truss Analysis and Rating
2. Program Name - TRLRFD
3. Version i.j.k.m - where i represents the numeric designation for major revisions and enhancements to the program, j represents less significant though still important revisions and m is used for "rapid improvement releases", or versions that fix significant issues that are important enough they cannot wait until the next j release.
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 6.40.

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 102 characters on a single line. If the input line contains more than 102 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
      LIVE LOAD                           B
      DYNAMIC LOAD ALLOWANCE           1.33            (default)
      DIST. FACTOR/ MEMBER FRCE         1.5
      DIST. FACTOR/ DEFLECTION           1.
      LIVE LOAD LOCATION                  L
      END CONDITION                       P            (default)
      PINNED SUPPORT                     L6
      TEMPERATURE CHANGE                 0.            (default)
      END BEARING                         L
      SYMMETRY                            Y
      LIVE LOAD DIRECTION                 B            (default)
      FATIGUE DYN. LOAD ALLOW.         1.15            (default)
      P-82 DYN. LOAD ALLOW.            1.20            (default)

    COMMAND:  SPL
      SPAN LENGTH                       150 ft

    COMMAND:  SPL
      SPAN LENGTH                       420 ft

    COMMAND:  SPL
      SPAN LENGTH                       150 ft

    COMMAND:  HNG
      SPAN NUMBER                         2
      DISTANCE                          150 ft
      SPAN NUMBER                         2
      DISTANCE                          270 ft
```

Figure 7.3-1 CTL, SPL and HNG 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 unbraced length of truss members. Some input is optional because it is not required for the particular problem being run. For example, the fatigue gross vehicle information is not needed unless a different load factor for the fatigue load is desired. 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 many 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 unbraced length of truss members.

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 DATA
                                        ------------
                 Dynamic     Distribution       Live
         Live    Load          Factors          Load        End      Pinned  Temperature    End
  Units  Load  Allowance   Force  Deflection  Location  Condition   Support    Change     Bearing
   US     A      1.33       1.50     1.00        L          P         L 6        0.0         L

                                  Live Load  Fatigue Dynamic   P-82 Dynamic
                        Symmetry  Direction  Load Allowance   Load Allowance
                           Y          B           1.15             1.20

                     SPAN LENGTHS AND HINGE LOCATIONS ( CANTILEVER )
                     -----------------------------------------------
       Span #            1        2        3
     Length (ft)      150.00   420.00   150.00
      Hinge #            1        2
       Span #            2        2
    Distance (ft)     300.00   420.00
```

Figure 7.3-2 CTL, SPL and HNG 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 section properties for truss stiffness and specification checking. The user can suppress all section property output by setting the ANALYSIS RESULTS parameter of the OUT command to 6.

7.4.1 Member Lengths and Unbraced Lengths

These are the member lengths calculated by the program based on panel geometry and the unbraced lengths used for specification checking either calculated by the program or entered by the user.

1. **Member ID - the member designation, denoted by the beginning and ending joints of the member.**
2. **Member Type* - the type of member entered by the user, either cross section type T01 - T19 or UD if the user defined the cross section properties with the PRP command.**
3. **Length* - the length of the member from joint to joint, as calculated by the program based on panel geometry.**
4. **Lb* - the unbraced length of a member defined via a TRUSS MEMBER PROPERTIES (PRP) command.**
5. **Lbx* - the unbraced length for buckling about the x-axis of a member defined via a T## (TYPE ## MEMBER PROPERTIES) command.**
6. **Lby* - the unbraced length for buckling about the y-axis of a member defined via a T## (TYPE ## MEMBER PROPERTIES) command.**
7. **Lbz* - the unbraced length for buckling about the z-axis of a member defined via a T## (TYPE ## MEMBER PROPERTIES) command. This value will print as N/A for members that are not checked for flexural-torsional buckling (Types 1-8, 12, and 13).**

The following note is printed under the output report:

*** Legend of General Notes:**

Type	**=**	**Defined cross section type. UD = User-defined**
Length	**=**	**Member length, determined from panel geometry**
Lb	**=**	**Unbraced length for user-defined members (PRP command)**
Lbx	**=**	**Unbraced length for buckling about the x-axis**
Lby	**=**	**Unbraced length for buckling about the y-axis**
Lbz	**=**	**Unbraced length for torsional buckling about the z-axis (twisting) N/A for closed and singly symmetrical sections, which are not checked for flexural-torsional buckling.**

Note: Lbx, Lby, and Lbz are used with members defined via T## input commands, while Lb is only used with user-defined members (PRP command)

7.4.2 Computed Member Section Properties

These are the section properties that are either entered by the user via the PRP command or computed by the program for members entered by the user on the T01 - T19 commands. The following information is reported in the MEMBER SECTION PROPERTIES output table.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Member Type* - the type of member entered by the user, either cross section type T01 - T19 or UD if the user defined the cross section properties with the PRP command.
3. Bending Axis - the primary bending axis of the member.
4. Flexure - designates if the member is in positive or negative flexure.
5. Gross Area - the gross cross-sectional area of the member. When computed by the program, this value is equal to the area of the plates, taking into account the deterioration entered by the user. This value does not include the area of any holes in the member.
6. Net Area - the net cross-sectional area of the member. When computed by the program, this value is equal to the gross area minus the area of the holes in the member.
7. Inn* - the moment of inertia of the member about the x-axis and state of flexure designated by the user for member types T01 - T19 or the moment of inertia entered by the user for member type UD. This value is calculated taking the deterioration entered by the user into account. It does not take the holes entered by the user into account.
8. Iyy* - the moment of inertia of the member about the y-axis and state of flexure designated by the user for member types T01 - T19. This value prints as "N/A" for member type UD. This value is calculated taking the deterioration entered by the user into account. It does not take the holes entered by the user into account.
9. J* - the St. Venant torsional constant of the member
10. Z* - the plastic section modulus about the bending axis of the member
11. Mr* - the moment resistance of the member, used when calculating the axial resistance of the member. This value is either computed by the program (for member types T01 - T19) or entered by the user (for member type UD).

The following note is printed below the output table:

* Legend of General Notes:

Type	=	Defined cross section type. UD = User-defined
Inn	=	Moment of inertia about horizontal axis (user-input moment of inertia for UD cross sections.)
Iyy	=	Moment of inertia about vertical axis
Lb	=	Unbraced length
J	=	St Venant torsional constant
Z	=	Plastic section modulus about bending axis

Mr = Moment resistance about bending axis. N/A indicates eccentricity is 0.0

12. Resistance Calculation** - the method used to compute the flexural resistance of the member. The methods are denoted by an alphabetic character A-U as described below.

I-sections bent about strong axis:

A. Lateral Torsional Buckling, A6.10.8.2.3-1

B. Lateral Torsional Buckling, A6.10.8.2.3-2

C. Lateral Torsional Buckling, A6.10.8.2.3-3

D. Flange Local Buckling, A6.10.8.2.2-1

E. Flange Local Buckling, A6.10.8.2.2-2

F. Tension Flange Governs, A6.10.8.3-1

Box sections:

G. Box-Shaped Member Resistance, A6.12.2.2.2-1

T-sections:

H. Section Yielding, A6.12.2.2.4-1

I. Lateral Torsional Buckling, A6.12.2.2.4-2

J. Local Buckling, A6.12.2.2.4-4

H-sections (I-sections and Channels bent about weak axis):

K. Mn = Mp, A6.12.2.2.1-1

L. Slenderness <= lambda(rf), A6.12.2.2.1-2

M. Slenderness exceeds lambda(rf), Mn = 0.0

Channels bent about strong axis:

N. Section Yielding, A6.12.2.2.5-1

O. Lateral Torsional Buckling, A6.12.2.2.5-2

P. Lateral Torsional Buckling, A6.12.2.2.5-3

User Defined sections:

U. User defined flexural resistance

7.5 ANALYSIS AND SPECIFICATION CHECKING

The analysis and specification checking output consists of the dead and live load analysis results (member forces and joint deflections) as well as the axial resistances and the rating factors for each member.

7.5.1 Live Load Distribution Factors (User Defined Lanes)

This output report will only print if the user has chosen to have the distribution factors calculated (using the CDF command) and defines the lane placement with the LLP command. The following information is reported on the LIVE LOAD DISTRIBUTION FACTORS (USER DEFINED LANES) output report.

1. Lane - the lane for which the distribution factor is being displayed
2. Live Load - the live load applied to the current lane
3. Truss Force - the distribution factor applied to the load in the current lane
4. Truss Deflection - the deflection distribution factor

7.5.2 Live Load Distribution Factors (Program Defined Lanes)

This output report will only print if the user has chosen to have the distribution factors calculated (using the CDF command) and does not define the lane placement with the LLP command. The following information is reported on the LIVE LOAD DISTRIBUTION FACTORS (PROGRAM DEFINED LANES) output report.

1. Truss Force - the distribution factor applied to the live load to determine the forces in the truss members. This value is followed by the number of lanes loaded to produce this distribution factor.
2. Truss Deflection - the deflection distribution factor. This value is followed by the number of lanes loaded to produce this distribution factor.

7.5.3 Dead Load Forces

This output report contains the dead load effects, both unfactored (Service II and Service IIB limit states) and factored (Strength I and Strength II limit states) in the members. The following information is reported on the DEAD LOAD FORCES output report:

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Dead Load Forces, Unfactored, DC - the unfactored DC load axial force
3. Dead Load Forces, Unfactored, DW - the unfactored DW load axial force
4. Dead Load Forces, Factored Minimum - the minimum factored dead load axial force.
5. Dead Load Forces, Factored Maximum - the maximum factored dead load axial force.

The following note is printed below the output table:

NOTE: Negative forces are compressive and positive forces are tensile. Dead load forces are factored using the minimum and maximum load factors for the Strength limit states. The load factors are the same for all Strength limit states.

7.5.4 Axial Resistances

This output report contains the axial resistances of the members. The following information is reported on the AXIAL RESISTANCES output report:

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Member Type* - the type of member entered by the user, either cross section type T01 - T19 or UD if the user defined the cross section properties with the PRP command.
3. Pe, FB* - the elastic critical buckling resistance, based on flexural buckling. **NOTE: The value reported is the minimum of the buckling resistance about the x- or y-axis, using the appropriate radius of gyration and unbraced length for each axis.**
4. Compression, Cw* - the warping torsional constant.
5. Compression, y0* - the distance along the y-axis between the shear center and the centroid.
6. Compression, Pe,FTB* - the elastic critical buckling resistance, based on flexural-torsional buckling.
7. Compression, Q* - the slender element reduction factor.
8. Compression, Po* - the equivalent nominal yield resistance.
9. Compression, Pr,c* - the factored resistance of the component in compression.
10. Compression, Method** - the calculation method of the factored resistance of the component in compression: pure axial or axial/moment interaction, denoted by "A" or "I" respectively.
11. Tension, Pr,t* - the factored resistance of the component in tension.
12. Tension, Method**- the calculation method of the factored axial resistance of the component in compression, pure axial or axial/moment interaction, denoted by "A" or "I" respectively. If a "Z" prints in this column, TRLRFD was unable to calculate the compressive capacity of the section because of a particular combination of axial force and end eccentricity.

The following notes are printed below the output table:

* Legend of General Notes:

Type	=	Defined cross section type. UD = User-defined
Pe,FB	=	Elastic critical buckling resistance, flexural buckling
Cw	=	Warping torsional constant
y0	=	Distance along the y-axis between the shear center and the centroid
Pe,FTB	=	Elastic critical buckling resistance, flexural-torsional buckling
Q	=	Slender element reduction factor
Po	=	Equivalent nominal yield resistance
Pr,c	=	Factored resistance of component in compression
Pr,t	=	Factored resistance of component in tension

** Legend of Axial Resistance Methods:

A. Axial Resistance Only; No Interaction

I. Moment/Axial Interaction

Z. Error in calculating axial resistance (delta(b)<1). Capacity not calculated.

7.5.5 Points of Contraflexure

This output report contains the location of the points of dead load contraflexure. This table is not displayed for simply supported trusses. The following information is reported on the POINTS OF CONTRAFLEXURE output report:

1. Span – The span number the point of contraflexure is found on.
2. Joint – The Joint ID the point of contraflexure is found on for the bottom chord.
3. Joint – The Joint ID the point of contraflexure is found on for the upper chord.

7.5.6 PHL-93 Member Forces and Ratings

This output report contains the factored dead and live load effects for each member and the rating factor resulting from those loads in the Strength I, Strength IA, Service II and Service IIA limit states.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Limit State - limit state as defined in the LRFD Specifications
3. Governing Loading - live load code which denotes the controlling truck combination for the governing live load effect (prints here for trusses with counters only). The live load codes are as follows:
   - 1 - One design truck with the effect of lane load
   - 2 - One design tandem with lane load effect
   - 3 - Two design trucks with lane load effect
   - 4 - Two design tandems with lane load effect
4. Truck Direction - direction of travel of the truck resulting in the governing live load effect (this value prints here for trusses with counters only).
5. Front Axle at - location of the front axle of the truck resulting in the governing live load effect (this value prints here for trusses with counters only).
6. Dead Load Force - the maximum factored dead load axial force.
7. Live Load + Impact Force Effects, Truck Compression - compressive live load effect with impact of the truck load alone. This value also includes the distribution factor (this does not print for trusses with counters).
8. Live Load + Impact Force Effects, Truck Tension - tensile live load effect with impact of the truck load alone. This value also includes the distribution factor (this does not print for trusses with counters).
9. Live Load + Impact Force Effects, Compression - compressive live load effect with impact of the truck load and the lane load. This value also includes the distribution factor (this value prints for truss with counters only).

10. Live Load + Impact Force Effects, Lane Compression - compressive live load effect with impact of the lane load alone. This value also includes the distribution factor (this does not print for trusses with counters).
11. Live Load + Impact Force Effects, Lane Tension - tensile live load effect with impact of the lane load alone. This value also includes the distribution factor (this does not print for trusses with counters).
12. Live Load + Impact Force Effects, Tension - tensile live load effect with impact of the truck load and the lane load. This value also includes the distribution factor (this value prints for trusses with counters only).
13. Rating Factor - minimum of the tensile or compressive rating factor. A negative rating factor indicates that the dead load force exceeds the allowable resistance for the given member.
14. Governing Combination - the load combination resulting in the governing rating factor, compression or tension, denoted by "C" or "T" respectively.
15. Lane Load Start - starting location of the lane load applied in combination with the truck (this value prints here for trusses with counters only).
16. Lane Load End - ending location of the lane load applied in combination with the truck (this value prints for trusses with counters only).
17. **Rating Failure* - an asterisk (*) will print in this column if the rating factor is less than 1.0.**

7.5.7 PHL-93 Member Forces

This output report contains the factored dead and live load effects for each member for all limit states. This report will only print when PHL-93 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Limit State - limit state as defined in the LRFD Specifications
3. Dead Load Force - the maximum factored dead load axial force.
4. Live Load + Impact Force Effects, Truck Compression - compressive live load effect with impact of the truck load alone. This value also includes the distribution factor.
5. Live Load + Impact Force Effects, Truck Tension - tensile live load effect with impact of the truck load alone. This value also includes the distribution factor.
6. Live Load + Impact Force Effects, Lane Compression - compressive live load effect with impact of the lane load alone. This value also includes the distribution factor.
7. Live Load + Impact Force Effects, Lane Tension - tensile live load effect with impact of the lane load alone. This value also includes the distribution factor.

7.5.8 PHL-93 Truck Locations for Maximum Effect

This output report contains information about the location of the live load truck inducing the compressive and tensile effects reported in the Member Forces and Ratings output report.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Tension Effects, Governing Truck - live load code which denotes the controlling truck combination for the tension effect. The live load codes are as follows:
   1 - One design truck with the effect of lane load
   2 - One design tandem with lane load effect
   3 - Two design trucks with lane load effect
   4 - Two design tandems with lane load effect
3. Tension Effects, Variable Axle Spacing - the axle spacing resulting in the reported live load effect.
4. Tension Effects, Truck Direction - direction of travel of the truck resulting in the reported live load effect.
5. Tension Effects, Front Axle - location of the front axle resulting in the reported live load effect.
6. Compression Effects, Governing Truck - live load code which denotes the controlling truck combination for the tension effect. The live load codes are the same as described in item 2.
7. Compression Effects, Variable Axle Spacing - the axle spacing resulting in the reported live load effect.
8. Compression Effects, Truck Direction - direction of travel of the truck resulting in the reported live load effect.
9. Compression Effects, Front Axle - location of the front axle resulting in the reported live load effect.

7.5.9 PHL-93 Critical Rating

This output report contains the critical (smallest) PHL-93 rating factor for each limit state applicable to the truss.

1. Limit State - limit state as defined in the LRFD Specifications
2. Member ID - the critical member designation, denoted by the beginning and ending joints of the member.
3. Member Forces, Dead Load - the factored dead load resulting in the critical rating factor
4. Member Forces, Live Load + Impact, Compression - the factored compressive live load in the critical member.
5. Member Forces, Live Load + Impact, Tension - the factored tensile live load in the critical member.
6. Factored Resistance, Compression - the compressive resistance in the critical member.
7. Factored Resistance, Tension - the tensile resistance in the critical member.
8. Rating Factor - the critical rating factor. A negative rating factor indicates that the dead load force exceeds the allowable force for the given member.
9. Tons - the rating tonnage corresponding to the critical rating factor. **(Not included for PHL-93 or HL-93)**
10. **Rating Failure* - an asterisk (*) will print in this column if the rating factor is less than 1.0.**

7.5.10 PHL-93 Support Reactions

This output report contains only the factored (Strength I and Strength IA limit states) and unfactored (Service II and Service IIA limit states) reactions to dead and live load unless PHL-93 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

1. Support - the support designation, denoted by the joint number of the support.
2. Limit State - limit state as defined in the LRFD Specifications
3. Dead Loads, Unfactored - the unfactored reaction due to all dead loads.
4. Dead Loads, Minimum Factored - the minimum factored reaction due to all dead loads.
5. Dead Loads, Maximum Factored - the maximum factored reaction due to all dead loads.
6. Factored Live Load + Dynamic Load Allowance - the factored live load + impact reaction
7. Total Factored Reaction - the maximum total factored reaction. This value is only reported for the Service-IIA or Service-IIB limit states. All other limit states will be flagged as not applicable (N/A).
8. * If Uplift - an asterisk (*) is printed in this column if uplift occurs at the specified support based on the factored analysis only for Service-IIA or Service-IIB. Uplift is checked only for Service-IIA or Service-IIB. If uplift occurs, the title of this output report will appear on the SPECIFICATION CHECK WARNINGS report at the end of the program output.

7.5.11 PHL-93 Panel Point Deflections

This output report contains the panel point deflections for load combinations with the PHL-93 live load. The sign convention for positive and negative deflection can be found in Table 7.1-2.

1. Panel Point - the support designation, denoted by the joint number of the support.
2. Dead Load + Temperature, Vertical - the vertical deflection due to dead load and temperature effects.
3. Dead Load + Temperature, Horizontal - the horizontal deflection due to dead load and temperature effects.
4. Live Load + Dynamic Effect, Vertical Positive - the positive vertical deflection due to live load + the dynamic load allowance.
5. **Live Load + Dynamic Effect, Governing Vertical Positive – the governing load code for the positive vertical deflection. (Only for PHL-93, HL-93, HS20, and H20)**
6. Live Load + Dynamic Effect, Impact Factor - the dynamic load allowance factor applied to the live load resulting in the vertical positive effect.
7. Live Load + Dynamic Effect, Vertical Negative - the negative vertical deflection due to live load + the dynamic load allowance.
8. **Live Load + Dynamic Effect, Governing Vertical Negative – the governing load code for the negative vertical deflection. (Only for PHL-93, HL-93, HS20, and H20)**
9. Live Load + Dynamic Effect, Impact Factor - the dynamic load allowance factor applied to the live load resulting in the vertical negative effect.

10. Live Load + Dynamic Effect, Horizontal Positive - the positive horizontal deflection due to live load + the dynamic load allowance.
11. **Live Load + Dynamic Effect, Governing Horizontal Positive – the governing load code for the positive horizontal deflection. (Only for PHL-93, HL-93, HS20, and H20)**
12. Live Load + Dynamic Effect, Horizontal Negative - the negative horizontal deflection due to live load + the dynamic load allowance.
13. **Live Load + Dynamic Effect, Governing Horizontal Negative – the governing load code for the negative horizontal deflection. (Only for PHL-93, HL-93, HS20, and H20)**

7.5.12 HL-93 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.6, except that the effects reported on this table come from the application of the HL-93 live loading.

7.5.13 HL-93 Member Forces

The same information is printed on this table as described in Section 7.5.7, except that the effects reported on this table come from the application of the HL-93 live loading.

7.5.14 HL-93 Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.8, except that the effects reported on this table come from the application of the HL-93 live loading.

7.5.15 HL-93 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the HL-93 live loading.

7.5.16 HL-93 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the HL-93 live loading.

7.5.17 HL-93 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the HL-93 live loading.

7.5.18 ML-80 Member Forces and Ratings

This output report contains the factored dead and live load effects for each member and the rating factor resulting from those loads.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Limit State - limit state as defined in the LRFD Specifications.
3. Truck Direction - direction of travel of the truck resulting in the governing live load effect (this value prints here for trusses with counters only).
4. Front Axle at - location of the front axle of the truck resulting in the governing live load effect (this value prints here for trusses with counters only).
5. Dead Load Force - the maximum factored dead load axial force.
6. Live Load + Impact Force Effects, Truck Compression - the factored compressive live load force in the critical member.
7. Live Load + Impact Force Effects, Truck Tension - the factored tensile live load force in the critical member.
8. Rating Factor - minimum of the tensile or compressive rating factor. A negative rating factor indicates that the dead load force exceeds the allowable force for the given member.
9. Governing Combination - the load combination resulting in the governing rating factor, compression or tension, denoted by "C" or "T" respectively.
10. **Rating Failure* - an asterisk (*) will print in this column if the rating factor is less than 1.0.**

7.5.19 ML-80 Member Forces

This output report contains the factored dead and live load effects for each member and the rating factor resulting from those loads. This report will only print when ML-80 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Limit State - limit state as defined in the LRFD Specifications.
3. Dead Load Force - the maximum factored dead load axial force.
4. Live Load + Impact Force, Compression - the factored compressive live load force in the critical member.
5. Live Load + Impact Force, Tension - the factored tensile live load force in the critical member.

7.5.20 ML-80 Truck Locations for Maximum Effect

This output report contains information about the location of the live load truck inducing the compressive and tensile effects reported in the Member Forces and Ratings output report.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.

2. Tension Effects, Variable Axle Spacing - the axle spacing resulting in the reported live load effect.
3. Tension Effects, Truck Direction - direction of travel of the truck resulting in the reported live load effect.
4. Tension Effects, Front Axle - location of the front axle resulting in the reported live load effect.
5. Compression Effects, Variable Axle Spacing - the axle spacing resulting in the reported live load effect.
6. Compression Effects, Truck Direction - direction of travel of the truck resulting in the reported live load effect.
7. Compression Effects, Front Axle - location of the front axle resulting in the reported live load effect

7.5.21 ML-80 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the ML-80 live loading.

7.5.22 ML-80 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the ML-80 live loading.

7.5.23 ML-80 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the ML-80 live loading.

7.5.24 P-82 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.18, except that the effects reported on this table come from the application of the P-82 live loading and are only applied in the Strength II and Service IIB limit states.

7.5.25 P-82 Member Forces

The same information is printed on this table as described in Section 7.5.19, except that the effects reported on this table come from the application of the P-82 live loading. This report will only print when P-82 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.26 P-82 Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.20, except that the effects reported on this table come from the application of the P-82 live loading.

7.5.27 P-82 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the P-82 live loading and are only applied in the Strength II and Service IIB limit states unless P-82 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.28 P-82 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the P-82 live loading and are only applied in the Strength II and Service IIB limit states unless P-82 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.29 P-82 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the P-82 live loading.

7.5.30 P2016-13 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.18, except that the effects reported on this table come from the application of the P2016-13 live loading and are only applied in the Strength II and Service IIB limit states.

7.5.31 P2016-13 Member Forces

The same information is printed on this table as described in Section 7.5.19, except that the effects reported on this table come from the application of the P2016-13 live loading. This report will only print when P2016-13 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.32 P2016-13 Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.20, except that the effects reported on this table come from the application of the P2016-13 live loading.

7.5.33 P2016-13 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the P2016-13 live loading and are only applied

in the Strength II and Service IIB limit states unless P2016-13 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.34 P2016-13 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the P2016-13 live loading and are only applied in the Strength II and Service IIB limit states unless P2016-13 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.35 P2016-13 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the P2016-13 live loading.

7.5.36 TK527 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.18, except that the effects reported on this table come from the application of the TK527 live loading.

7.5.37 TK527 Member Forces

The same information is printed on this table as described in Section 7.5.19, except that the effects reported on this table come from the application of the TK527 live loading.

7.5.38 TK527 Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.20, except that the effects reported on this table come from the application of the TK527 live loading.

7.5.39 TK527 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the TK527 live loading.

7.5.40 TK527 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the TK527 live loading.

7.5.41 TK527 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the TK527 live loading.

7.5.42 EV2 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.18, except that the effects reported on this table come from the application of the EV2 live loading and are only applied in the Strength II and Service IIB limit states.

7.5.43 EV2 Member Forces

The same information is printed on this table as described in Section 7.5.19, except that the effects reported on this table come from the application of the EV2 live loading. This report will only print when EV2 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.44 EV2 Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.20, except that the effects reported on this table come from the application of the EV2 live loading.

7.5.45 EV2 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the EV2 live loading and are only applied in the Strength II and Service IIB limit states unless EV2 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.46 EV2 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the EV2 live loading and are only applied in the Strength II and Service IIB limit states unless EV2 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.47 EV2 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the EV2 live loading.

7.5.48 EV3 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.18, except that the effects reported on this table come from the application of the EV3 live loading and are only applied in the Strength II and Service IIB limit states.

7.5.49 EV3 Member Forces

The same information is printed on this table as described in Section 7.5.19, except that the effects reported on this table come from the application of the EV3 live loading. This report will only print when EV3 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.50 EV3 Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.20, except that the effects reported on this table come from the application of the EV3 live loading.

7.5.51 EV3 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the EV3 live loading and are only applied in the Strength II and Service IIB limit states unless EV3 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.52 EV3 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the EV3 live loading and are only applied in the Strength II and Service IIB limit states unless EV3 is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.53 EV3 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the EV3 loading.

7.5.54 SU6TV Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.18, except that the effects reported on this table come from the application of the SU6TV live loading and are only applied in the Strength II and Service IIB limit states.

7.5.55 SU6TV Member Forces

The same information is printed on this table as described in Section 7.5.19, except that the effects reported on this table come from the application of the SU6TV live loading. This report will only print when SU6TV is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.56 SU6TV Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.20, except that the effects reported on this table come from the application of the SU6TV live loading.

7.5.57 SU6TV Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the SU6TV live loading and are only applied in the Strength II and Service IIB limit states unless SU6TV is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.58 SU6TV Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the SU6TV live loading and are only applied in the Strength II and Service IIB limit states unless SU6TV is chosen as one of the live loads on the LIVE LOAD PLACEMENT command.

7.5.59 SU6TV Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the SU6TV live loading.

7.5.60 HS20 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.18, except that the effects reported on this table come from the application of the HS20 live loading.

7.5.61 HS20 Member Forces

The same information is printed on this table as described in Section 7.5.19, except that the effects reported on this table come from the application of the HS20 live loading.

7.5.62 HS20 Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.20, except that the effects reported on this table come from the application of the HS20 live loading.

7.5.63 HS20 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the HS20 live loading.

7.5.64 HS20 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the HS20 live loading.

7.5.65 HS20 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the HS20 live loading.

7.5.66 H20 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.18, except that the effects reported on this table come from the application of the H20 live loading.

7.5.67 H20 Member Forces

The same information is printed on this table as described in Section 7.5.19, except that the effects reported on this table come from the application of the HS20 live loading.

7.5.68 H20 Truck Locations for Maximum Effect

The same information is printed on this table as described in Section 7.5.20, except that the effects reported on this table come from the application of the H20 live loading.

7.5.69 H20 Critical Rating

The same information is printed on this table as described in Section 7.5.9, except that the effects reported on this table come from the application of the H20 live loading.

7.5.70 H20 Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the application of the H20 live loading.

7.5.71 H20 Panel Point Deflections

The same information is printed on this table as described in Section 7.5.11, except that the effects reported on this table come from the application of the H20 live loading.

7.5.72 Combined Live Load Member Forces and Ratings

This output report contains the factored dead and live load effects for each member and the rating factor resulting from those loads. The live load effects reported on this table come from the combination of the live loads specified on the LIVE LOAD PLACEMENT command.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Limit State - limit state as defined in the LRFD Specifications
3. Live Load + Impact Force Effects, Truck Compression - compressive live load effect with impact of the truck load alone. This value also includes the distribution factor.
4. Live Load + Impact Force Effects, Truck Tension - tensile live load effect with impact of the truck load alone. This value also includes the distribution factor.
5. Live Load + Impact Force Effects, Lane Compression - compressive live load effect with impact of the lane load alone. This value also includes the distribution factor. This column will only print if one of the live loads specified on the LIVE LOAD PLACEMENT command has a lane load associated with it.
6. Live Load + Impact Force Effects, Lane Tension - tensile live load effect with impact of the lane load alone. This value also includes the distribution factor. This column will only print if one of the live loads specified on the LIVE LOAD PLACEMENT command has a lane load associated with it.
7. Rating Factor - minimum of the tensile or compressive rating factor. A negative rating factor indicates that the dead load force exceeds the allowable force for the given member.
8. Governing Combination - the load combination resulting in the governing rating factor, compression or tension, denoted by "C" or "T" respectively.
9. **Rating Failure* - an asterisk (*) will print in this column if the rating factor is less than 1.0.**

7.5.73 Combined Live Load Critical Rating

This output report contains the critical (smallest) combined live load rating factor for each limit state applicable to the truss. The combined live load effects reported on this table come from the combination of the live loads specified on the LIVE LOAD PLACEMENT command.

1. Limit State - limit state as defined in the LRFD Specifications
2. Member ID - the critical member designation, denoted by the beginning and ending joints of the member.
3. Member Forces, Dead Load - the factored dead load resulting in the critical rating factor
4. Member Forces, Live Load + Impact, Compression - the factored compressive live load in the critical member.
5. Member Forces, Live Load + Impact, Tension - the factored tensile live load in the critical member.
6. Factored Resistance, Compression - the compressive resistance in the critical member.
7. Factored Resistance, Tension - the tensile resistance in the critical member.
8. Rating Factor - the critical rating factor. A negative rating factor indicates that the dead load force exceeds the allowable force for the given member.
9. **Rating Failure* - an asterisk (*) will print in this column if the rating factor is less than 1.0.**

7.5.74 Combined Live Load Support Reactions

The same information is printed on this table as described in Section 7.5.10, except that the effects reported on this table come from the combination of the live loads specified on the LIVE LOAD PLACEMENT command.

7.5.75 Fatigue Life Estimation

This output report is in three parts; the first a summary of values used to calculate the values reported in the second part. The third part summarizes the critical information. The following information is reported in the first part:

1. Live Load Distribution - the distribution factor used to determine the live load effects in the current truss.
2. Pennsylvania Traffic Factor - **this value is no longer used, as per DM-4, and will print as "N/A"**
3. Past Growth Factor - if the previous growth factor is nonzero, this is the growth factor used by the program.
4. Future Growth Factor - if the future growth factor is nonzero, this is the growth factor used by the program.
5. Recent count ADTTsl - the user input recent count single lane ADTT.

The following information is reported in the second part of the output report:

1. Member - the member designation, denoted by the beginning and ending joints of the member.
2. Unfactored Dead Load Force* - the total unfactored dead load force in the member.
3. Factored Live Load Force, Maximum - the total maximum factored live load force in the member.

4. Factored Live Load Force, Minimum - the total minimum factored live load force in the member.
5. Detail Category - the fatigue detail category for the member entered by the user.
6. Fatigue Limit State* - the fatigue limit state checked for this member (either Fatigue-I or Fatigue-II).
7. Fatigue Resistance - the calculated fatigue resistance of the member.
8. Fatigue Stress Range - the factored fatigue stress range in the member.
9. Total Cycles Allowed - total number of allowed fatigue cycles for the member.
10. Remaining Years - the number of years remaining in the fatigue life of the member, calculated from the design fatigue life cycles less the already accumulated cycles.
11. Code Check** - a code failure may occur when computing the fatigue resistance or remaining fatigue life of the member. The failure is denoted by the alphabetic characters A or B as described below.

    A Fatigue stress range exceeds the fatigue resistance

    B Remaining fatigue service life is 0 years

The following information is reported in the third part of the output report:

1. Member aaaaaa is critical - the designation of the critical member, denoted by its beginning and ending joints
2. Estimated ADTTsl for iiii (year built) - the single lane ADTT of the bridge in the year that it was built, back calculated from previous growth factors and/or ADTT.
3. Design Fatigue Life (in Cycles) - the design fatigue life of the critical member.
4. Accumulated Cycles Up To iiii - the number of accumulated fatigue cycles up to the recent count year.
5. Estimated Remaining Life of the Truss is iiii Years from iiii - the number of years remaining in the fatigue life of the truss, governed by the critical member.

7.6 EXTREME EVENT ANALYSIS

The extreme event analysis output presents the effects of the extreme event analyses on the members specified by the user.

7.6.1 Extreme Event III: Dead Load Forces and Axial Resistances

This output report contains the dead load effects, both unfactored and factored in the members, as well as the axial resistances of the members For determinate structures, only the members referenced on the EEV command will appear here. For indeterminate structures, all members will appear here. The following information is reported on the EXTREME EVENT III: DEAD LOAD FORCES & AXIAL RESISTANCES output report:

1. Member ID - the member designation, denoted by the beginning and ending joints of the member.
2. Member Type - the type of member entered by the user, either cross section type T01 - T19 or UD if the user defined the cross section properties with the PRP command.
3. Dead Load Forces, Unfactored, DC - the unfactored DC dead load axial force
4. Dead Load Forces, Unfactored, DW - the unfactored DW dead load axial force
5. Dead Load Forces, Factored Minimum - the minimum factored dead load axial force.
6. Dead Load Forces, Factored Maximum - the maximum factored dead load axial force.
7. Axial Resistance, Compression - the factored resistance of the component in compression.
8. Axial Resistance, Compression Method - the calculation method of the factored axial resistance of the component in compression, pure axial or axial/moment interaction, denoted by "A" or "I" respectively.
9. Axial Resistance, Tension - the factored resistance of the component in tension.
10. Axial Resistance, Tension Method - the calculation method of the factored axial resistance of the component in tension, pure axial or axial/moment interaction, denoted by "A" or "I" respectively.

    The following notes are printed below the output table:

    Legend of Axial Resistance Methods:

    A. Axial Resistance Only; No Interaction

    I. Moment/Axial Interaction

7.6.2 Extreme Event III: PHL-93 Member Forces and Ratings

The same information is printed on this table as described in Section 7.5.6. For determinate structures, only the members referenced on the EEV command will appear here. For indeterminate structures, all members will appear here. Separate reports will be printed for the PHL-93, HL-93, ML-80, P-82, TK527, HS20, H20, special and combined live loads, depending on the live load option chosen by the user.

7.6.3 Extreme Event III: PHL-93 Critical Rating

The same information is printed on this table as described in Section 7.5.9. This report will print for indeterminate structures. Separate reports will be printed for the PHL-93, HL-93, ML-80, P-82, TK527, HS20, H20, special and combined live loads, depending on the live load option chosen by the user.

7.6.4 Extreme Event IV Analysis

Only members that have an EXTREME EVENT FORCE defined on the EEV command will appear on this table, with that force used as the applied force in the member. The following information is reported on this output table.

1. Member ID - the member designation, denoted by the beginning and ending joints of the member. Only members that have a defined EXTREME EVENT FORCE on an EEV command will appear on this output table.
2. Applied Force - the user-defined EXTREME EVENT FORCE for this member.
3. Factored Resistance - the computed axial resistance of this member, either tensile or compressive depending on the applied force.
4. Allowable / Applied Force - the ratio of the factored resistance to the applied force in the member

7.7 RATING SUMMARY

7.7.1 Rating Summary

A summary of the critical ratings for each live load vehicle. The following information is reported on this output table.

1. Load - live load designation
2. Limit State - limit state for which rating factor is reported.
3. Member - the member designation for which the rating factor is reported
4. LRFD Rating Factor - critical rating factor.
5. Tons - rating tonnage for the critical rating factor (equal to the LRFD Rating Factor * tonnage of the current live load vehicle) (this value does not print for the COMBINED LIVE LOAD case**, PHL-93, or HL-93**)
6. **Rating Failure* - an asterisk (*) will print in this column if the rating factor is less than 1.0.**

7.8 LRFD Gusset Plate Analysis And Ratings

The LRFD gusset plate analysis and ratings consist of the dead and live load analysis results (forces and moments for gusset plate sections and connected members) as well as the capacity and operating level rating of the gusset plate and connected members. The program outputs appropriate live loads defined by the user within the CTL and SLL commands as well as, when using the LLP command, a combined live load. These different live loads are indicated in each of the headings as "LL = …"

7.8.1 Gusset Plates: DL & LL Forces/Angles - Part 1, 2, and 3 of 3 (LL = …)

This output record contains the unfactored dead loads, unfactored live loads, and angles for each gusset plate member ii.

4. Plate Location - the gusset plate designation, denoted by the joint of the truss.
5. Member ID - the specific truss member that corresponds to each gusset plate member ii.
6. Dead Load Forces, DC - the dead load (DC) axial force applied to member ii.
7. Dead Load Forces, DW - the dead load (DW) axial force applied to member ii.
8. Live Load Forces, Tension - the live load tensile force applied to member ii.
9. Live Load Forces, Compression - the live load compressive force applied to member ii.
10. Angle Theta - angles measured from a vertical line at the centerline of the gusset to the line of action of the member

7.8.2 Gusset Plates: Shear At Section A-A: LL Match DL (LL = …)

This output record contains section properties, factored effects, capacity and operating level rating factor for each gusset plate. Live loads from each member have the same sign as the dead loads in each member. Section A-A is shown in Figures 5.40-1 – 5.40-4.

a. Plate Location - the gusset plate designation, denoted by the joint of the truss.
b. Section Properties, Ag - the gross cross-sectional area of Section A-A.
c. Section Properties, An - the net cross-sectional area of Section A-A.
d. Factored Shear - the maximum shear force.
e. Nominal Capacity, Minimum - the nominal shear force capacity, a minimum between P_{vg} and P_{vn}, the gross area shear force capacity and the net area shear force capacity.
f. Nominal Capacity, Governing - the governing area, gross or net (denoted by "g" or "n") from which the nominal shear force capacity is calculated.
g. Capacity Check - a check indicating if the nominal capacity is greater than the shear force. **The characters "Cs" will appear in this column if the gusset plate is located at a joint with no diagonal members, a chord splice has also been defined, and the chord splice is adequate to**

resist the forces in the chord. If all of these conditions are satisfied, the gusset plate need not be checked at the chord members.

h. Operating Level Rating - the rating factor for shear force based upon the nominal capacity, dead load, and live load results. If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column.

7.8.3 Gusset Plates: Shear At Section A-A: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.2, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force. Section A-A is shown in Figures 5.40-1 – 5.40-4.

7.8.4 Gusset Plates: Shear At Section A-A: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.2, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force. Section A-A is shown in Figures 5.40-1 – 5.40-4.

7.8.5 Gusset Plates: Shear At Section B-B: LL Match DL (LL = …)

The same information is printed on this table as described in Section 7.8.2, except that the calculations reported on this table come from section B-B. Section B-B is shown in Figures 5.40-1 – 5.40-4.

7.8.6 Gusset Plates: Shear At Section B-B: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.3, except that the calculations reported on this table come from section B-B. Section B-B is shown in Figures 5.40-1 – 5.40-4.

7.8.7 Gusset Plates: Shear At Section B-B: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.4, except that the calculations reported on this table come from section B-B. Section B-B is shown in Figures 5.40-1 – 5.40-4.

7.8.8 Gusset Plates: Shear At Section C-C: LL Match DL (LL = …)

The same information is printed on this table as described in Section 7.8.2, except that the calculations reported on this table come from section C-C. Section C-C is shown in Figures 5.40-1 – 5.40-4.

7.8.9 Gusset Plates: Shear At Section C-C: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.3, except that the calculations reported on this table come from section C-C. Section C-C is shown in Figures 5.40-1 – 5.40-4.

7.8.10 Gusset Plates: Shear At Section C-C: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.4, except that the calculations reported on this table come from section C-C. Section C-C is shown in Figures 5.40-1 – 5.40-4.

7.8.11 Gusset Plates: Tension and Compression: LL Match DL (LL = …)

This output record contains the factored effects for each member, up to five members, connected to the gusset plate the capacity at each member and the operating level rating factor resulting from these loads. Live loads from each member have the same sign as the dead loads in each member.

1. Plate Location - the gusset plate designation, denoted by the joint of the truss.
2. Member - the gusset plate member designation, as specified in Figures 5.40-1 – 5.40-4.
3. Axial Force - the maximum axial force acting upon the end of the specified gusset plate member.
4. Nominal Capacity, Minimum - the nominal axial force capacity at each member, either tension or compression.
5. Nominal Capacity, Governing - the governing area. If the governing nominal capacity is tensile, the governing area will be either gross or net area (denoted by "Tg" or "Tn") respectively. If the governing nominal capacity is compressive, the governing area will be denoted by "C". **The characters "Cs" will appear in this column if the gusset plate is located at a joint with no diagonal members, a chord splice has also been defined, and the chord splice is adequate to resist the forces in the chord. If all of these conditions are satisfied, the gusset plate need not be checked at the chord members.**
6. Capacity Check - a check indicating that the nominal capacity is greater than the axial force.
7. Operating Level, Rating - the rating factor for tension and compression of member ends based upon the nominal capacity, dead load, and live load (compression) results. If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column.
8. Operating Level, Governing - the governing axial force by which the rating was computed, either tension or compression ("T" or "C").

7.8.12 Gusset Plates: Tension and Compression: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.11, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.

7.8.13 Gusset Plates: Tension and Compression: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.11, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.

7.8.14 Gusset Plates: Block Shear: LL Match DL (LL = …)

This output record contains the factored effects for each member, up to five members, connected to the gusset plate, the capacity at each member and the resulting operating level rating factor. In addition, the combination of a vertical and diagonal member (referred to as "VRT-DGL" in the output record) and its corresponding effect and operating level rating factor is also computed by the program. Live loads from each member have the same sign as the dead loads in each member.

1. Plate Location - the gusset plate designation, denoted by the joint of the truss.
2. Member - the gusset plate member designation, as specified in Figures 5.40-1 – 5.40-4.
3. Block Shear Force - the maximum block shear force acting upon the end of the specified gusset plate member, either tensile (T) or compressive (C).
4. Nominal Capacity, Pbs - the nominal block shear capacity.
5. Nominal Capacity, Governing - the governing block shear case. For members 1 and 2, block shear case 1 ("B1") or 2 ("B2"). For members 3-5, case 2 ("B2"). For the vertical-diagonal member, block shear case 3 ("B3"). See Figure 3.11-2. **The characters "Cs" will appear in this column if the gusset plate is located at a joint with no diagonal members, a chord splice has also been defined, and the chord splice is adequate to resist the forces in the chord. If all of these conditions are satisfied, the gusset plate need not be checked at the chord members.**
6. Capacity Check - a check indicating that the nominal capacity is greater than the axial force.
7. Operating Level Rating - the rating factor for block shear based upon the nominal capacity, dead load, and live load results. If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column.

7.8.15 Gusset Plates: Block Shear: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.14, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.

7.8.16 Gusset Plates: Block Shear: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.14, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.

7.8.17 Gusset Plates: Connections **(Shear/Bearing)**: LL Match DL (LL = …)

This output record contains the factored effects for each member, up to five members, connected to the gusset plate, the capacity at each member and the operating level rating factor resulting from these loads. Live loads from each member have the same sign as the dead loads in each member.

1. Plate Location - the gusset plate designation, denoted by the joint of the truss.
2. Member - the gusset plate member designation, as specified in Figures 5.40-1 – 5.40-4.
3. Axial Force - the maximum axial force applied to the gusset plate member.
4. Nominal Capacity, Minimum (Rv, Rb) - the nominal connection capacity, a minimum between R_v (the shear capacity of all bolts or rivets) and R_b (the capacity of the connection in bearing).
5. Nominal Capacity, Governing - the governing connection type, fastener shear ("FS") or bearing on material ("MB"), by which the nominal capacity was computed. **The characters "Cs" will appear in this column if the gusset plate is located at a joint with no diagonal members, a chord splice has also been defined, and the chord splice is adequate to resist the forces in the chord. If all of these conditions are satisfied, the gusset plate need not be checked at the chord members.**
6. Capacity Check - a check indicating that the nominal capacity is greater than the axial force.
7. Operating Level, Rating - the rating factor for the gusset plate connection based upon the nominal capacity, dead load, and live load results. If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column.
8. Operating Level, Governing - the governing operating level rating type, fastener shear ("FS") or bearing on material ("MB"), by which the rating was computed.

7.8.18 Gusset Plates: Connections **(Shear/Bearing)**: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.17, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.

7.8.19 Gusset Plates: Connections **(Shear/Bearing)**: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.17, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.

7.8.20 Gusset Plates: Connections (Slip): LL Match DL (LL = …)

This output record contains the factored effects for each member, up to five members, connected to the gusset plate, the capacity at each member and the operating level rating factor resulting from these loads. Live loads from each member have the same sign as the dead loads in each member.

1. **Plate Location - the gusset plate designation, denoted by the joint of the truss.**

2. Member - the gusset plate member designation, as specified in Figures 5.40-1 – 5.40-4.
3. Axial Force - the maximum axial force applied to the gusset plate member, factored for Service-IIA or Service-IIB.
4. Slip Capacity - the nominal connection slip capacity.
5. Capacity Check - a check indicating that the nominal capacity is greater than the axial force. The characters "Cs" will appear in this column if the gusset plate is located at a joint with no diagonal members, a chord splice has also been defined, and the chord splice is adequate to resist the forces in the chord. If all of these conditions are satisfied, the gusset plate need not be checked at the chord members.
6. Operating Level, Rating - the rating factor for the gusset plate connection based upon the nominal capacity, dead load, and live load results. If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column.

7.8.21 Gusset Plates: Connections (Slip): LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.20, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.

7.8.22 Gusset Plates: Connections (Slip): LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.20, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.

7.8.23 Gusset Plates: Connections (Chord Splice): LL Match DL (LL = …)

This output record contains the factored effects for each chord member, up to two members, connected to the gusset plate, the capacity at each member, and the operating level rating factor resulting from these loads. Live loads from each member have the same sign as the dead loads in each member.

1. Plate Location - the gusset plate designation, denoted by the joint of the truss.
2. Member - the gusset plate member designation, as specified in Figures 5.40-1 – 5.40-4.
3. Axial Force - the maximum axial force applied to the gusset plate member, factored for Strength-IA or Strength-II. For member 1, this value is the total of the horizontal force components of members 1 and 5. For member 2, this value is the total of the horizontal force components of members 2 and 3.
4. Splice Only Capacity, Minimum - the governing nominal capacity of the chord splice plates alone (no gusset plate contribution)

5. **Splice Only Capacity, Governing Method - The method used to calculate the minimum capacity: gross area tension ("Tg"; LRFD Specifications Equation 6.14.2.8.6-3), net area tension ("Tn"; LRFD Specifications Equation 6.14.2.8.6-4), gross area compression ("Cg"; LRFD Specifications Equation 6.14.2.8.6-1), or compression buckling check fails ("Bu"; LRFD Specifications Equation 6.14.2.8.6-2). This value will print as "NA" if no chord splice plates have been defined at this location.**
6. **Chord Splice + Gusset: Gross Area - the total gross area of the gusset plate and chord splice plates, if present.**
7. **Chord Splice + Gusset: Gross Smod - the total gross section modulus of the gusset plate and chord splice plates, if present, measured to the outer edge of the gusset plate.**
8. **Chord Splice + Gusset: Net Area - the total net area of the gusset plate and chord splice plates, if present, less the area of all bolt holes.**
9. **Chord Splice + Gusset: Net Smod - the total gross section modulus of the gusset plate and chord splice plates, if present, less contributions of all bolt holes, measured to the outer edge of the gusset plate.**
10. **Chord Splice + Gusset: Capacity, Minimum - the governing nominal capacity of the chord splice and gusset**
11. **Chord Splice + Gusset: Capacity, Governing Method - The method used to calculate the minimum capacity: gross area tension ("Tg"; LRFD Specifications Equation 6.14.2.8.6-3), net area tension ("Tn"; LRFD Specifications Equation 6.14.2.8.6-4), gross area compression ("Cg"; LRFD Specifications Equation 6.14.2.8.6-1), or compression buckling check fails ("Bu"; LRFD Specifications Equation 6.14.2.8.6-2).**
12. **Capacity Check - a check indicating that the nominal capacity is greater than the axial force.**
13. **Operating Level, Rating - the rating factor for the gusset plate connection based upon the nominal capacity, dead load, and live load results. If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column.**

7.8.24 Gusset Plates: Connections (Chord Splice): LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.23**, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.**

7.8.25 Gusset Plates: Connections (Chord Splice): LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.23**, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.**

7.8.26 Gusset Plates: Summary Part 1 of **i**: LL Match DL (LL = …)

This output record contains the governing factored effects, capacity and operating level rating for each gusset plate for shear and tension. Live loads have the same sign as the dead loads when factoring the axial forces.

1. Plate Location - the gusset plate location designation, denoted by the joint of the truss.
2. Shear, Shear Force - the maximum shear force at Section A-A, Section B-B, or Section C-C, denoted by "A", "B", or "C" respectively. Sections A-A, B-B and C-C are shown in Figures 5.40-1 – 5.40-4.
3. Shear, Nominal Capacity - the nominal shear force capacity **at the location of maximum shear force**, a minimum between P_{vg} and P_{vn}, the gross area shear force capacity and net area shear force capacity, indicated by "g" or "n" respectively.
4. Shear, Capacity Check - a check indicating if the nominal capacity is greater than the shear force.
5. Shear, Operating Level Rating - the **minimum shear** rating factor (at Section A-A, Section B-B, or Section C-C denoted by "A", "B", or "C" respectively). Sections A-A, B-B and C-C are shown in Figures 5.40-1 – 5.40-4. If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column. **This may not be at the same location as the maximum shear force.**
6. Tension, Axial Load - the tensile axial force acting upon the **gusset plate at the location of minimum nominal tensile force capacity,** denoted **as** M.1, M.2, M.3, M.4, **or** M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4.
7. Tension, Nominal Capacity - the **minimum** nominal axial tensile force capacity of the gusset plate **at the** member denoted **as** M.1, M.2, M.3, M.4, **or** M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4.
8. Tension, Capacity Check - a check indicating that the nominal capacity is greater than the axial force.
9. Tension, Operating Level Rating – the **minimum tension** rating factor **of the gusset plate at the** member end denoted by M.1, M.2, M.3, M.4, **or** M.5 **(**for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4)**.** If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column. **This may not be at the same location as the minimum axial tensile force capacity.**

7.8.27 Gusset Plates: Summary Part 1 of **i**: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.26, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.

7.8.28 Gusset Plates: Summary Part 1 of **i**: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.26, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.

7.8.29 Gusset Plates: Summary Part 2 of **i**: LL Match DL (LL = …)

This output record contains the governing factored effects, capacity and operating level rating for each gusset plate for compression and block shear. Live loads have the same sign as the dead loads when factoring the axial forces.

1. Plate Location - the gusset plate location designation, denoted by the joint of the truss.
2. Compression, Axial Load - the compressive axial force acting upon the **gusset plate at the location of minimum nominal compressive force capacity**, denoted **as** M.1, M.2, M.3, M.4, M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4.
3. Compression, Nominal Capacity - the **minimum** nominal axial compressive force capacity of the gusset plate **at the** member denoted **as** M.1, M.2, M.3, M.4, **or** M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4.
4. Compression, Capacity Check - a check indicating if the nominal capacity is greater than the axial force.
5. Compression, Operating Level Rating – the **minimum compression** rating factor **of the gusset plate at the** member end denoted by M.1, M.2, M.3, M.4, **or** M.5 **(**for members 1 through 5 as specified in Figures 5.40-1 – 5.40-4). If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column. **This may not be at the same location as the minimum axial compressive force capacity.**
6. Block Shear, Block Shear Force - the axial force acting upon the gusset plate **at the location of minimum nominal block shear capacity** denoted **as** M.1, M.2, M.3, M.4, **or** M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4, or B.3 for block shear case 3.
7. Block Shear, Nominal Capacity - the **minimum** nominal block shear capacity of the gusset plate **at the** member **end**, denoted by M.1, M.2, M.3, M.4, **or** M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4, or B.3 for block shear case 3.
8. Block Shear, Capacity Check - a check indicating if the nominal capacity is greater than the axial force.
9. Block Shear, Operating Level Rating - the **minimum block shear** rating factor denoted by M.1, M.2, M.3, M.4, **or** M.5 **(**for members 1 through 5 as specified in Figures 5.40-1 – 5.40-4) or B.3 for block shear case 3) If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column. **This may not be at the same location as the minimum block shear capacity.**

7.8.30 Gusset Plates: Summary Part 2 of **i**: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.29, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.

7.8.31 Gusset Plates: Summary Part 2 of **i**: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.29, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.

7.8.32 Gusset Plates: Summary Part 3 of **i**: LL Match DL (LL = …)

This output record contains the governing factored effects, capacity and operating level rating for each gusset plate for connections, as well as the overall critical operating rating for each gusset plate. Live loads have the same sign as the dead loads when factoring the axial forces.

1. Plate Location - the gusset plate location designation, denoted by the joint of the truss.
2. Connections **(Shear/Bearing)**, Axial Load - the axial force acting on the connection of the gusset plate member **at the location of minimum nominal connection capacity**, denoted by M.1, M.2, M.3, M.4, M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4.
3. Connections **(Shear/Bearing)**, Nominal Capacity - the **minimum** nominal **shear or bearing** capacity of the gusset plate **connection located at** M.1, M.2, M.3, M.4, **or** M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4.
4. Connections **(Shear/Bearing)**, Capacity Check - a check indicating if the nominal capacity is greater than the axial force.
5. Connections **(Shear/Bearing)**, Operating Level Rating - the minimum **shear or bearing connection** rating factor **of the gusset plate located at** M.1, M.2, M.3, M.4, **or** M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4). If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column. **This may not be at the same location as the minimum nominal gusset plate shear or bearing connection**
6. **Connections (Slip), Axial Load - the axial force, factored for Service-IIA or Service-IIB, acting on the connection of the gusset plate member at the location of minimum nominal slip capacity denoted by M.1, M.2, M.3, M.4, or M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4.**
7. **Connections (Slip), Nominal Capacity - the minimum nominal slip capacity of the gusset plate connection at M.1, M.2, M.3, M.4, or M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4.**
8. **Connections (Slip), Capacity Check - a check indicating if the nominal capacity is greater than the axial force.**
9. **Connections (Slip), Operating Level Rating - the minimum slip rating factor of the gusset plate connections, located at M.1, M.2, M.3, M.4, or M.5 for members 1 through 5, as specified in Figures 5.40-1 – 5.40-4). If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column. This may not be at the same location as the minimum nominal slip capacity.**

7.8.33 Gusset Plates: Summary Part 3 of i: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.32, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.

7.8.34 Gusset Plates: Summary Part 3 of i: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.32, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.

7.8.35 Gusset Plates: Summary Part 4 of 4: LL Match DL (LL = …)

This output record contains the governing factored effects, capacity and operating level rating for each gusset plate where chord splices are defined, as well as the overall critical operating rating for each gusset plate. Live loads have the same sign as the dead loads when factoring the axial forces.

1. **Plate Location - the gusset plate location designation, denoted by the joint of the truss.**
2. **Connections (Chord Splice), Axial Load - the axial force acting on the combined gusset plate and chord splice at the location of minimum nominal capacity denoted as M.1 (at Section B-B) or M.2 (at Section C-C), as specified in Figures 5.40-1 – 5.40-4.**
3. **Connections (Chord Splice), Nominal Capacity - the minimum nominal combined gusset plate and chord splice capacity denoted by M.1 (at Section B-B) or M.2 (at Section C-C), as specified in Figures 5.40-1 – 5.40-4.**
4. **Connections (Chord Splice), Capacity Check - a check indicating if the nominal capacity is greater than the axial force.**
5. **Connections (Chord Splice), Operating Level Rating - the minimum rating factor for the combined gusset plate and chord splice denoted by M.1 (at Section B-B) or M.2 (at Section C-C) as specified in Figures 5.40-1 – 5.40-4). If the rating factor cannot be calculated because the live load force is equal to 0.0, +++ will print in this column. This may not be at the same location as the minimum nominal capacity.**

7.8.36 Gusset Plates: Summary Part 4 of 4: LL Compress (LL = …)

The same information is printed on this table as described in Section 7.8.35**, except that the calculations reported on this table utilize the compressive live load force instead of the matching live load force.**

7.8.37 Gusset Plates: Summary Part 4 of 4: LL Tensile (LL = …)

The same information is printed on this table as described in Section 7.8.35**, except that the calculations reported on this table utilize the tensile live load force instead of the matching live load force.**

7.8.38 Gusset Plates: Govern Operating Ratings: All Cases, LL = …

This output record contains the governing operating rating for each gusset plate and the live load condition that produces it. The record also contains the unsupported edge in compression adequacy check for each plate.

1. Plate Location - the gusset plate location designation, denoted by the joint of the truss.
2. Unsupported Edge In Compression Adequacy Check - a check indicating that the unsupported edges in compression do not require stiffeners.
3. Minimum Operating Ratings, LL Match DL - the minimum operating rating for the case where the sign of the live load matches the sign of the dead load. The check resulting in the rating is denoted by "Blks" for the block shear check, "Comp" for the compression check, "Conn" for the connection check **(shear or bearing)**, "Shea" for the shear check**,** "Tens" for the tension check**, "Slip" for the slip check, or "CSpl" for the chord splice check**.
4. Minimum Operating Ratings, LL Compressive - same as parameter 3, except that the live load for this case is always compressive.
5. Minimum Operating Ratings, LL Tensile - same as parameter 3, except that the live load for this case is always tensile.
6. Minimum Operating Ratings, Overall - the final governing operating rating for the gusset plate; the minimum of parameters 4, 5 and 6.

7.9 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=TRLRFD] [Version=x.x.x.x]
 ! ** Data Records Start Here **
 TTL Example 1
 CTL US,A,1.33,,,U,R,,,U,Y
 CDF -12,24,48
 SPL 150,300,150
 GEO 01,10.00,Y,10.00,,-10.00,3
 GEO 02,10.00,Y,10.20,,-10.20,5
 GEO 03,10.00,Y,10.40,,-10.40,6
 GEO 04,10.00,Y,10.87,,-10.87,5
 GEO 05,10.00,Y,11.63,,-11.63,6
 GEO 06,10.00,Y,12.65,,-12.65,5
. . .
```

Example of Input Commands;

```
                                                    INPUT COMMANDS
                                                    --------------

     COMMAND:  CTL
       SYSTEM OF UNITS                              US
       LIVE LOAD                                     A
       DYNAMIC LOAD ALLOWANCE                     1.33
       DIST. FACTOR/ MEMBER FRCE                     *        (computed, if necessary)
       DIST. FACTOR/ DEFLECTION                      *        (computed, if necessary)
       LIVE LOAD LOCATION                            U
       END CONDITION                                 R
       PINNED SUPPORT                                *        (computed, if necessary)
       TEMPERATURE CHANGE                           0.            (default)
       END BEARING                                   U
       SYMMETRY                                      Y
       LIVE LOAD DIRECTION                           B            (default)
       FATIGUE DYN. LOAD ALLOW.                   1.15            (default)
       PERMIT DYN. LOAD ALLOW.                    1.20            (default)

     COMMAND:  CDF
       CENTERLINE/TRUSS TO CURB                    -12 ft
       TRUSS SPACING                                24 ft
       ROADWAY WIDTH                                48 ft
       GAGE DISTANCE                                6. ft         (default)
       PASSING DISTANCE                             4. ft         (default)
```

```
COMMAND:  SPL
  SPAN LENGTH                        150 ft
  SPAN LENGTH                        300 ft
  SPAN LENGTH                        150 ft

COMMAND:  GEO
  PANEL NUMBER                        01
  PANEL WIDTH                      10.00 ft
  VERTICAL POST                        Y
  UPPER VERTICAL HEIGHT H1         10.00 ft
  LOWER VERTICAL HEIGHT H2             * ft     (computed, if necessary)
  REL ELEV BOT PANEL PT H3        -10.00 ft
  PANEL TYPE                           3

COMMAND:  GEO
  PANEL NUMBER                        02
  PANEL WIDTH                      10.00 ft
  VERTICAL POST                        Y
  UPPER VERTICAL HEIGHT H1         10.20 ft
  LOWER VERTICAL HEIGHT H2             * ft     (computed, if necessary)
  REL ELEV BOT PANEL PT H3        -10.20 ft
  PANEL TYPE                           5

COMMAND:  GEO
  PANEL NUMBER                        03
  PANEL WIDTH                      10.00 ft
  VERTICAL POST                        Y
  UPPER VERTICAL HEIGHT H1         10.40 ft
  LOWER VERTICAL HEIGHT H2             * ft     (computed, if necessary)
  REL ELEV BOT PANEL PT H3        -10.40 ft
  PANEL TYPE                           6

COMMAND:  GEO
  PANEL NUMBER                        04
  PANEL WIDTH                      10.00 ft
  VERTICAL POST                        Y
  UPPER VERTICAL HEIGHT H1         10.87 ft
  LOWER VERTICAL HEIGHT H2             * ft     (computed, if necessary)
  REL ELEV BOT PANEL PT H3        -10.87 ft
  PANEL TYPE                           5

COMMAND:  GEO
  PANEL NUMBER                        05
  PANEL WIDTH                      10.00 ft
  VERTICAL POST                        Y
  UPPER VERTICAL HEIGHT H1         11.63 ft
  LOWER VERTICAL HEIGHT H2             * ft     (computed, if necessary)
  REL ELEV BOT PANEL PT H3        -11.63 ft
  PANEL TYPE                           6

COMMAND:  GEO
  PANEL NUMBER                        06
  PANEL WIDTH                      10.00 ft
  VERTICAL POST                        Y
  UPPER VERTICAL HEIGHT H1         12.65 ft
  LOWER VERTICAL HEIGHT H2             * ft     (computed, if necessary)
  REL ELEV BOT PANEL PT H3        -12.65 ft
  PANEL TYPE                           5
```

Example of Input Summary;

```
                                          CONTROL DATA
                                          ------------
                      Dynamic     Distribution      Live
             Live       Load        Factors         Load        End       Pinned   Temperature    End
    Units    Load    Allowance   Force  Deflection  Location  Condition  Support     Change     Bearing
     aa        a       x.xx       x.xx     x.xx        a          a        aaa        x.x          a

                              Live Load  Fatigue Dynamic  Permit Dynamic
                     Symmetry Direction  Load Allowance   Load Allowance
                        a         a           x.xx             x.xx

                              COMPUTED DISTRIBUTION FACTOR
                              ----------------------------
              CL of Truss  Truss      Roadway  Gage   Pass
                to Curb    Spacing     Width   Dist   Dist
                 (ft)       (ft)       (ft)    (ft)   (ft)
                 x.xx       xx.xx      xx.xx   x.xx   x.xx

                                   LIVE LOAD PLACEMENT
                                   -------------------
      Lane #            i       i
    Distance (ft)      x.xx   xx.xx
       Width          xx.xx   xx.xx
      Live Load       aaaaa   aaaaa


                                 SPAN LENGTHS ( SIMPLE )
                                 -----------------------
      Span #            1
      Length (ft)    xxx.xx


                     SPAN LENGTHS AND HINGE LOCATIONS ( CANTILEVER )
                     -----------------------------------------------
      Span #            i       i       i
      Length (ft)    xxx.xx  xxx.xx  xxx.xx
     Hinge #            i       i
      Span #            i       i
    Distance (ft)    xxx.xx  xxx.xx


                               SPAN LENGTHS ( CONTINUOUS )
                               ---------------------------
      Span #            1       2       3
      Length (ft)    xxx.xx  xxx.xx  xxx.xx


                                     TRUSS GEOMETRY
                                     --------------
     Panel  Panel         Vertical Post      Panel
      No.   Width        H1     H2      H3    Type
             (ft)       (ft)   (ft)    (ft)
       i    xx.xx   a   xx.xx  x.xx    x.xx     i
       i    xx.xx   a   xx.xx  x.xx    x.xx     i

                                    TRUSS DEAD LOADS
                                    ----------------

        Location      aii     aii     aii     aii     aii     aii     aii
    DC Load (kip)    xx.xx   xx.xx   xx.xx   xx.xx   xx.xx   xx.xx   xx.xx
    DW Load (kip)    xx.xx   xx.xx   xx.xx   xx.xx   xx.xx   xx.xx   xx.xx
```

```
                                TRUSS MEMBER PROPERTIES (PART 1)
                                --------------------------------
Member  Gross      Net    Moment of   Yield  Unbraced  Fatigue Tensile
  ID     Area     Area     Inertia  Strength  Length  Category Strength Eccentricity
        (in^2)   (in^2)    (in^4)    (ksi)     (ft)             (ksi)       (in)
aiiaii   xx.xx    xx.xx      xxx.xx   xx.x    xx.xx       a      xx.x       x.xx

                                TRUSS MEMBER PROPERTIES (PART 2)
                                --------------------------------
Member      Moment       Tensile    Compressive
  ID     Resistance   Resistance   Resistance
          (kip-ft)      (kips)       (kips)
aiiaii    xxxxx.xx     xxxxx.xx     xxxxx.xx

                   TYPE ## GENERAL SECTION PROPERTIES
                   ----------------------------------
Member  Member   Yield    Tensile   Unbraced  Fatigue              Bolt Hole  Bending
  ID     Type   Strength  Strength   Length   Category Eccentricity  Diameter   Axis   Flexure
                 (ksi)     (ksi)      (ft)                  (in)         (in)
aiiaii    ii      xx.x       xx.x     x.xxx       a         x.xxx       x.xxx     a        a

                 TYPE 01 SECTION PROPERTIES, PART 1 OF 2
                 ---------------------------------------
Member             # Holes                    # Holes                                  # Holes
  ID     D      TD   Plate    B     TBT   TBB Side Plate  HT     HB     L1     L2     TL   Angle
       (in)   (in)          (in)   (in)  (in)            (in)   (in)   (in)   (in)   (in)
aiiaii xx.xxx x.xxx   ii   xx.xxx x.xxx x.xxx    ii     xx.xxx xx.xxx xx.xxx xx.xxx xx.xxx  ii

                 TYPE 01 SECTION PROPERTIES, PART 2 OF 2
                 ---------------------------------------
Member                D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID      TP       LP       RP       BP      LTL      LTR      LBL      LBR
        (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx

                 TYPE 02 SECTION PROPERTIES, PART 1 OF 2
                 ---------------------------------------
Member                      # Holes                                                    # Holes
  ID      B     TBT     TBB    Plate    W      HT     HB        D      TD      L       TL  Flange
        (in)   (in)    (in)           (in)    (in)   (in)     (in)    (in)    (in)    (in)
aiiaii xxx.xxx xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx xxx.xxx xxx.xxx xxx.xxx xxx.xxx xxx.xxx  ii

                 TYPE 02 SECTION PROPERTIES, PART 2 OF 2
                 ---------------------------------------
Member                D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID      TP       LP       RP       BP      LTL      LTR      LBL      LBR
        (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx

                 TYPE 03 SECTION PROPERTIES, PART 1 OF 3
                 ---------------------------------------
Member               # Holes            # Holes                        # Holes
  ID      D       TD   Plate   LP      TP   Plate    B       TBT     TBB   Plate   W       H
        (in)    (in)          (in)    (in)         (in)    (in)    (in)          (in)    (in)
aiiaii xxx.xxx xxx.xxx  ii  xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx

                 TYPE 03 SECTION PROPERTIES, PART 2 OF 3
                 ---------------------------------------
Member                                               # Holes
  ID      HT       HB       L1       L2       TL      Angle
        (in)     (in)     (in)     (in)     (in)
aiiaii   xx.xxx   xx.xxx    x.xxx    x.xxx    x.xxx      i

                 TYPE 03 SECTION PROPERTIES, PART 3 OF 3
                 ---------------------------------------
Member                D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TPD      LPD      RPD      BPD      LTL      LTR      LBL      LBR
        (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx
```

```
                  TYPE 04 SECTION PROPERTIES, PART 1 OF 2
                  ---------------------------------------
Member                # Holes                                # Holes                         # Holes
  ID      D       TD    Plate   B       TB      C        TC    Web   L1      L2      TL     Angle
        (in)    (in)          (in)    (in)    (in)     (in)         (in)    (in)    (in)
aiiaii xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx xxx.xxx   ii

                  TYPE 04 SECTION PROPERTIES, PART 2 OF 2
                  ---------------------------------------
Member               D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TP      BP      TW     CTL     CTR     CBL     CBR     LTL     LTR     LBL     LBR
        (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)
aiiaii xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx

                  TYPE 05 SECTION PROPERTIES, PART 1 OF 2
                  ---------------------------------------
Member                # Holes                                # Holes                         # Holes
  ID      D       TD    Plate   B       TB      C        TC    Web   L1      L2      TL     Angle
        (in)    (in)          (in)    (in)    (in)     (in)         (in)    (in)    (in)
aiiaii xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx xxx.xxx   ii

                  TYPE 05 SECTION PROPERTIES, PART 2 OF 2
                  ---------------------------------------
Member               D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TP      BP      TW     CTL     CTR     CBL     CBR     LTL     LTR     LBL     LBR
        (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)
aiiaii xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx

                  TYPE 06 SECTION PROPERTIES, PART 1 OF 2
                  ---------------------------------------
Member                                    # Holes                                      # Holes
  ID      B        TB       C         TC      Web      D        TD       F         TF    Flange
         (in)     (in)     (in)      (in)             (in)     (in)     (in)      (in)
aiiaii   xx.xxx    x.xxx    x.xxx    x.xxx      i     xx.xxx    x.xxx    x.xxx    x.xxx      i

                  TYPE 06 SECTION PROPERTIES, PART 2 OF 2
                  ---------------------------------------
Member                 D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TP       BP       CTL      CTR      CBL      CBR      TFD       TW      BFD
        (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx

                  TYPE 07 SECTION PROPERTIES, PART 1 OF 2
                  ---------------------------------------
Member                                    # Holes                                      # Holes
  ID      B        TB       C         TC      Web      D        TD       F         TF    Flange
         (in)     (in)     (in)      (in)             (in)     (in)     (in)      (in)
aiiaii   xx.xxx    x.xxx    x.xxx    x.xxx      i     xx.xxx    x.xxx    x.xxx    x.xxx      i

                  TYPE 07 SECTION PROPERTIES, PART 2 OF 2
                  ---------------------------------------
Member                 D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TP       BP       CTL      CTR      CBL      CBR      TFD       TW      BFD
        (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx

                  TYPE 08 SECTION PROPERTIES, PART 1 OF 3
                  ---------------------------------------
Member                    # Holes                           # Holes
  ID      P        TP      Plate     B       TBT      TBB     Plate     W        HT       HB
         (in)     (in)             (in)     (in)     (in)             (in)     (in)     (in)
aiiaii    x.xxx    x.xxx      i     xx.xxx    x.xxx    x.xxx      i      x.xxx    x.xxx    x.xxx

                  TYPE 08 SECTION PROPERTIES, PART 2 OF 3
                  ---------------------------------------
Member                                    # Holes  # Holes
  ID      D        TD       C        TC      Flange    Web
         (in)     (in)     (in)     (in)
aiiaii   xx.xxx    x.xxx    x.xxx    x.xxx      i        i
```

```
                   TYPE 08 SECTION PROPERTIES, PART 3 OF 3
                   ---------------------------------------
Member                  D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TPD       LP       RP       BPD      CTL      CTR      CBL      CBR
        (in)      (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx

                   TYPE 09 SECTION PROPERTIES, PART 1 OF 3
                   ---------------------------------------
Member                 # Holes                # Holes                                # Holes
  ID     B       TB    Plate   D       TD    Plate   G      LH1     LV1      T1    Angle
       (in)    (in)           (in)    (in)          (in)    (in)    (in)    (in)
aiiaii xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx xxx.xxx xxx.xxx    ii

                   TYPE 09 SECTION PROPERTIES, PART 2 OF 3
                   ---------------------------------------
Member                            # Holes                                # Holes
  ID     LH2      LV2       T2      Angle    LH3      LV3       T3      Angle
        (in)     (in)     (in)              (in)     (in)     (in)
aiiaii    x.xxx    x.xxx    x.xxx      i      x.xxx    x.xxx    x.xxx      i

                   TYPE 09 SECTION PROPERTIES, PART 3 OF 3
                   ---------------------------------------
Member                  D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID      TP       LP       RP       LTL      LTR      LBL      LBR      LIL      LIR
        (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx

                    TYPE 10 SECTION PROPERTIES, PART 1 OF 3
                   ---------------------------------------
Member                 # Holes                # Holes                                # Holes
  ID     B       TB    Plate   D       TD    Plate   G      LH1     LV1      T1    Angle
       (in)    (in)           (in)    (in)          (in)    (in)    (in)    (in)
aiiaii xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx   ii  xxx.xxx xxx.xxx xxx.xxx xxx.xxx   ii

                   TYPE 10 SECTION PROPERTIES, PART 2 OF 3
                   ---------------------------------------
Member                            # Holes
  ID     LH2      LV2       T2      Angle
        (in)     (in)     (in)
aiiaii    x.xxx    x.xxx    x.xxx      i
aiiaii    x.xxx    x.xxx    x.xxx      i

                   TYPE 10 SECTION PROPERTIES, PART 3 OF 3
                   ---------------------------------------
Member                D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TP      LP      RP      TOL     TIL     TIR     TOR     BOL     BIL     BIR     BOR
       (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)
aiiaii xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx

                   TYPE 11 SECTION PROPERTIES, PART 1 OF 2
                   ---------------------------------------
Member
  ID     BTP      TTP      BTF      TTF       D        TW      BBP      TBP      BBF      TBF
        (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii    x.xxx    x.xxx    x.xxx    x.xxx   xx.xxx    x.xxx    x.xxx    x.xxx    x.xxx    x.xxx

                   TYPE 11 SECTION PROPERTIES, PART 2 OF 2
                   ---------------------------------------
Member  D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TFT      TFB      WEB      BFT      BFB
        (in)     (in)     (in)     (in)     (in)
aiiaii   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx

                   TYPE 12 SECTION PROPERTIES, PART 1 OF 3
                   ---------------------------------------
Member                     # Holes                    # Holes            # Holes
  ID      B        TB      Plate     D        TD      Plate     TP      Plate     W        H
        (in)     (in)              (in)     (in)              (in)              (in)     (in)
aiiaii   xx.xxx    x.xxx      i     xx.xxx    x.xxx      i      x.xxx      i     xx.xxx   xx.xxx
```

```
                 TYPE 12 SECTION PROPERTIES, PART 2 OF 3
                 ---------------------------------------
Member                             # Holes                              # Holes
  ID     LH1      LV1      T1       Angle    LH2      LV2      T2        Angle
        (in)     (in)     (in)              (in)     (in)     (in)
aiiaii   x.xxx    x.xxx    x.xxx      i      x.xxx    x.xxx    x.xxx       i
```

```
                 TYPE 12 SECTION PROPERTIES, PART 3 OF 3
                 ---------------------------------------
Member                D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TPD      LP       RP       BPD      LTL      LTR      LBL      LBR
        (in)     (in)     (in)     (in)     (in)     (in)     (in)     (in)
aiiaii  x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx
```

```
                 TYPE 13 SECTION PROPERTIES, PART 1 OF 3
                 ---------------------------------------
Member                   # Holes                    # Holes
  ID      B        TB     Plate     D        TD      Plate
        (in)     (in)              (in)     (in)
aiiaii  xx.xxx    x.xxx     i      xx.xxx    x.xxx     i
```

```
                 TYPE 13 SECTION PROPERTIES, PART 2 OF 3
                 ---------------------------------------
Member                            # Holes                              # Holes
  ID     LH1      LV1      T1      Angle    LH2      LV2      T2        Angle
        (in)     (in)     (in)             (in)     (in)     (in)
aiiaii   x.xxx    x.xxx    x.xxx     i      x.xxx    x.xxx    x.xxx      i
```

```
                 TYPE 13 SECTION PROPERTIES, PART 3 OF 3
                 ---------------------------------------
Member                        D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TP     WEB      BP     TOL     TIL     TIR     TOR     BOL     BIL     BIR     BOR
        (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)    (in)
aiiaii xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx xx.xxxx
```

```
                 TYPE 14 SECTION PROPERTIES, PART 1 OF 2
                 ---------------------------------------
Member                  # Holes                 # Holes                                    # Holes
  ID     BTP      TTP    Plate     BBP     TBP    Plate     D        TW       B        TF    Flange
        (in)     (in)             (in)     (in)           (in)     (in)     (in)     (in)
aiiaii  xx.xxx    x.xxx    i      xx.xxx    x.xxx    i     xx.xxx    x.xxx   xx.xxx    x.xxx     i
```

```
                 TYPE 14 SECTION PROPERTIES, PART 2 OF 2
                 ---------------------------------------
Member  D  E  T  E  R  I  O  R  A  T  I  O  N  S
  ID     TFT      TFB      WEB      BFT      BFB
        (in)     (in)     (in)     (in)     (in)
aiiaii  x.xxxx   x.xxxx   x.xxxx   x.xxxx   x.xxxx
```

```
                 TYPE 15 SECTION PROPERTIES, PART 1 OF 2
                 ---------------------------------------
Member
  ID      D        TW       B        TF
        (in)     (in)     (in)     (in)
aiiaii  xx.xxx    x.xxx    x.xxx    x.xxx
```

```
                 TYPE 15 SECTION PROPERTIES, PART 2 OF 2
                 ---------------------------------------
Member     DETERIORATIONS
  ID     TFB      WEB      BFT
        (in)     (in)     (in)
aiiaii  x.xxxx   x.xxxx   x.xxxx
```

```
                 TYPE 16 SECTION PROPERTIES, PART 1 OF 2
                 ---------------------------------------
Member                   # Holes                             # Holes
  ID      D        TW     Plate     L1       L2       TL      Angle
        (in)     (in)              (in)     (in)     (in)
aiiaii  xx.xxx    x.xxx     i       x.xxx    x.xxx    x.xxx     i
```

TYPE 16 SECTION PROPERTIES, PART 2 OF 2

Member ID	DETERIORATIONS TFB (in)	WEB (in)	BFT (in)
aiiaii	x.xxxx	x.xxxx	x.xxxx

TYPE 17 SECTION PROPERTIES, PART 1 OF 2

Member ID	B (in)	TP (in)	# Holes Plate	D (in)	TW (in)	# Holes Plate	L1 (in)	L2 (in)	TL (in)	# Holes Angle
aiiaii	xx.xxx	x.xxx	i	xx.xxx	x.xxx	i	x.xxx	x.xxx	x.xxx	i

TYPE 17 SECTION PROPERTIES, PART 2 OF 2

Member ID	D E T E R I O R A T I O N S TFT (in)	TFB (in)	TFL (in)	WEB (in)
aiiaii	x.xxxx	x.xxxx	x.xxxx	x.xxxx

TYPE 18 SECTION PROPERTIES

Member ID	D (in)	TW (in)	B (in)	TF (in)	DETERIORATIONS TFB (in)	WEB (in)
aiiaii	xx.xxx	x.xxx	xx.xxx	x.xxx	x.xxx	x.xxx

TYPE 19 SECTION PROPERTIES, PART 1 OF 3

Member ID	BTP (in)	TTP (in)	# Holes Plate	BBP (in)	TBP (in)	# Holes Plate	D (in)	TW (in)	# Holes Plate
aiiaii	xx.xxx	x.xxx	i	xx.xxx	x.xxx	i	xx.xxx	x.xxx	i
aiiaii	xx.xxx	x.xxx	i	xx.xxx	x.xxx	i	xx.xxx	x.xxx	i

TYPE 19 SECTION PROPERTIES, PART 2 OF 3

Member ID	H (in)	LH1 (in)	LV1 (in)	T1 (in)	# Holes Angle	LH2 (in)	LV2 (in)	T2 (in)	# Holes Angle
aiiaii	xx.xxx	x.xxx	x.xxx	x.xxx	i	x.xxx	x.xxx	x.xxx	i
aiiaii	xx.xxx	x.xxx	x.xxx	x.xxx	i	x.xxx	x.xxx	x.xxx	i

TYPE 19 SECTION PROPERTIES, PART 3 OF 3

Member ID	D E T E R I O R A T I O N S TP (in)	BP (in)	TWD (in)	LTL (in)	LTR (in)	LBL (in)	LBR (in)
aiiaii	x.xxxx	x.xxxx	x.xxxx	x.xxxx	x.xxxx	x.xxxx	x.xxxx
aiiaii	x.xxxx	x.xxxx	x.xxxx	x.xxxx	x.xxxx	x.xxxx	x.xxxx

EXTREME EVENT

Member ID	Force (kips)	Gross Area (in^2)	Net Area (in^2)	Moment of Inertia (in^4)	Moment Resistance (kip-ft)
aiiaii	xxxx.x	xx.xx	xx.xx	xxxx.xx	x.xx
aiiaii	xxxx.x	xx.xx	xx.xx	xxxx.xx	x.xx

```
                                  FATIGUE LIFE
                                  ------------

 Distribution    PA                                         Previous                     Future
    Factor     Traffic  Year    Recent Count  Previous Count  Growth    Future Count   Growth
 For Fatigue   Factor   Built  Year    ADTT    Year     ADTT    Rate     Year     ADTT    Rate
   xx.xxx        N/A    iiii   iiii xxxxxx.   aaaa   aaaaaaa  aaaaa      aaaa  aaaaaaa   aaaaa

                              FATIGUE GROSS VEHICLE
                              ---------------------

 Gross Veh Wt  No of Single Unit Trucks  No of Tractor Trailers
    Min    Max    2 Axle  3 Axle  4 Axle  3 Axle  4 Axle  5+ Axle
  (kip)  (kip)
  xx.xx  xx.xx     iii     iii     iii     iii     iii     iii
  xx.xx  xx.xx     iii     iii     iii     iii     iii     iii

                                        SPECIAL LIVE LOAD
                                        -----------------
                          Axle       Lane      Percentage     Vehicle
                         Effect      Load       Increase       Type
                                  (kip/ft)
                            a       xx.xxx      xx.xxx          a

                                        SPECIAL AXLE LOAD
                                        -----------------

 Axle                Axle                Axle                Axle
  No.  Load    Dist  No.  Load    Dist  No.  Load    Dist  No.  Load    Dist
       kip     (ft)       kip     (ft)       kip     (ft)       kip     (ft)

   i  xx.xx  xx.xx   i  xx.xx   x.xx   i  xx.xx   x.xx   i  xx.xx   x.xx

                           GUSSET PLATE SECTION PROPERTIES PART 1 OF 2
                           -------------------------------------------
GUSSET                    C R O S S   S E C T I O N   G E O M E T R Y
  ID    FY    FU    T        HA     HB     HC    EB    EC     B
      (ksi) (ksi) (in)      (in)   (in)   (in)  (in)  (in)   (in)
 aii   xx.x  xx.x x.xxx    xx.xx  xx.xx  xx.xx xx.xx xx.xx  xx.xx

                           GUSSET PLATE SECTION PROPERTIES PART 2 OF 2
                           -------------------------------------------
                     F A S T E N E R S
GUSSET          Bolt         Surface          Hole
  ID     FUB     D     Pt   Condition Lspl  Diameter
        (ksi)  (in)  (kip)   (Class)  (in)     (in)
 aii     xxx.  x.xxx xxx.x      a     xx.xx   x.xxx

                         GUSSET PLATE MEMBER PROPERTIES PART 1 OF 2
                         ------------------------------------------
 Gusset    M  E  M  B  E  R   # 1     M  E  M  B  E  R   # 2     M   E   M   B   E   R   # 3
   ID     W1      L1     NT1   NL1    W2      L2     NT2   NL2    W3      L3     NT3   NL3   LC3
         (in)    (in)                (in)    (in)                (in)    (in)                (in)
   aii   xx.xx   xx.xx   xx.   xx.   xx.xx   xx.xx   xx.   xx.   xx.xx   xx.xx   xx.   xx.   xx.xx

                         GUSSET PLATE MEMBER PROPERTIES PART 2 OF 2
                         ------------------------------------------
 Gusset     M    E    M    B    E    R    # 4       M    E    M    B    E    R    # 5
   ID      W4       L4      NT4    NL4    LC4      W5       L5      NT5    NL5    LC5
          (in)     (in)                   (in)    (in)     (in)                   (in)
   aii   xx.xx    xx.xx    xx.    xx.    xx.xx    xx.xx    xx.xx    xx.    xx.    xx.xx
```

```
                    GUSSET PLATE FILLER PROPERTIES PART 1 OF 2
                    ------------------------------------------
                   Member #1              Member #2              Member #3
      GUSSET    Filler  Connected     Filler  Connected     Filler  Connected
        ID       Area   Plate Area     Area   Plate Area     Area   Plate Area
                (in^2)    (in^2)      (in^2)    (in^2)      (in^2)    (in^2)
        aii    xxx.xxx   xxx.xxx     xxx.xxx   xxx.xxx     xxx.xxx   xxx.xxx

                    GUSSET PLATE FILLER PROPERTIES PART 2 OF 2
                    ------------------------------------------
                              Member #4              Member #5
                 GUSSET    Filler  Connected     Filler  Connected
                   ID       Area   Plate Area     Area   Plate Area
                           (in^2)    (in^2)      (in^2)    (in^2)
                   aii    xxx.xxx   xxx.xxx     xxx.xxx   xxx.xxx
```

```
                              GUSSET PLATE CHORD SPLICE PROPERTIES
                              ------------------------------------
GUSSET     OUTSIDE PLATE        INSIDE PLATE              TOP PLATE                 BOTTOM PLATE
  ID      TS1    LS1          TS4    LS4           TS2    WS2    LS2   ETOP     TS3    WS3    LS3   EBOT
         (in)   (in)         (in)   (in)          (in)   (in)   (in)   (in)    (in)   (in)   (in)   (in)
  aii   x.xxx  xxx.x        x.xxx  xxx.x         x.xxx  xx.xx  xxx.x  xx.xx   x.xxx  xx.xx  xxx.x  xx.xx
```

```
                          OUTPUT OF INPUT
                          ---------------
                     Input       Input     Input
                   File Echo   Commands   Summary
                       i           i         i

                              OUTPUT
                              ------
 Section     Analysis and    Extreme   Rating    Detailed    Gusset    Ratings
Properties   Spec Checking    Event    Summary   Gussets     Summary   w/o FWS
    i              i            i         i         i           i         i
```

```
                         MEMBER LENGTHS AND UNBRACED LENGTHS
                         -----------------------------------
                     Member
                       ID  Type*  Length*    Lb*     Lbx*     Lby*     Lbz*
                                    (ft)     (ft)     (ft)     (ft)     (ft)
                     aiiaii aaa   xxx.xxx  xxx.xxx xxx.xxx xxx.xxx aaaaaaa

    * Legend of General Notes:
        Type = Defined cross section type. UD = User-defined
      Length = Member length, determined from panel geometry
        Lb   = Unbraced length for user-defined members (PRP command)
        Lbx  = Unbraced length for buckling about the x-axis
        Lby  = Unbraced length for buckling about the y-axis
        Lbz  = Unbraced length for torsional buckling about the z-axis (twisting)
               N/A for closed and singly symmetrical sections, which are not
               checked for flexural-torsional buckling.
      Note: Lbx, Lby, and Lbz are used with members defined via T## input commands,
            while Lb is only used with user-defined members (PRP command)
```

```
                 COMPUTED MEMBER SECTION PROPERTIES
                 ----------------------------------
    Member   Bend           A r e a                                              Resist.
     ID  Type* Axis  Flexure  Gross   Net    Inn*     Iyy*       J*       Z*     Mr*   Calc.**
                             (in^2) (in^2)  (in^4)   (in^4)    (in^4)   (in^3)  (k-ft)
  aiiaii aaa   a       a    xxxx.x xxxx.x aaaaaaaa aaaaaaaa  aaaaaaaa aaaaaaa aaaaaaa    a

        * Legend of General Notes:
           Type = Defined cross section type. UD = User-defined
           Inn  = Moment of inertia about horizontal axis (user-input moment of inertia
                  for UD cross sections.)
           Iyy  = Moment of inertia about vertical axis
           J    = St Venant torsional constant
           Z    = Plastic section modulus about bending axis
           Mr   = Moment resistance about bending axis
                  N/A indicates eccentricity is 0.0

       ** Legend of Resistance Calculation:
          I-sections bent about strong axis:
            A. Lateral Torsional Buckling, A6.10.8.2.3-1
            B. Lateral Torsional Buckling, A6.10.8.2.3-2
            C. Lateral Torsional Buckling, A6.10.8.2.3-3
            D. Flange Local Buckling, A6.10.8.2.2-1
            E. Flange Local Buckling, A6.10.8.2.2-2
            F. Tension Flange Governs, A6.10.8.3-1
          Box sections:
            G. Box-Shaped Member Resistance, A6.12.2.2.2-1
          T-sections:
            H. Section Yielding, A6.12.2.2.4-1
            I. Lateral Torsional Buckling, A6.12.2.2.4-2
            J. Local Buckling, A6.12.2.2.4-4
          H-sections (I-sections and Channels bent about weak axis):
            K. Mn = Mp, A6.12.2.2.1-1
            L. Slenderness <= lambda(rf), A6.12.2.2.1-2
            M. Slenderness exceeds lambda(rf), Mn = 0.0
          Channels bent about strong axis:
            N. Section Yielding, A6.12.2.2.5-1
            O. Lateral Torsional Buckling, A6.12.2.2.5-2
            P. Lateral Torsional Buckling, A6.12.2.2.5-3
          User Defined sections:
            U. User defined flexural resistance

              LIVE LOAD DISTRIBUTION FACTORS (USER DEFINED LANES)
              ---------------------------------------------------
                          LIVE         TRUSS     TRUSS
             LANE         LOAD         FORCE   DEFLECTION
               1      aaaaaaaaaaaa     x.xxx     x.xxx(i)
        Total Distribution Factor:     x.xxx

            LIVE LOAD DISTRIBUTION FACTORS (PROGRAM DEFINED LANES)
            ------------------------------------------------------
                            TRUSS     TRUSS
                            FORCE   DEFLECTION
                            x.xxx(i)  x.xxx(i)

                               DEAD LOAD FORCES
                               ----------------
                   DEAD LOAD FORCES
   MEMBER     U N F A C T O R E D   F A C T O R E D
     ID            DC         DW      MINIMUM  MAXIMUM
                 (kip)     (kip)      (kip)    (kip)
   aaaaaa     xxxxxxx.x xxxxxxx.x  xxxxxxx.x xxxxxxx.x

   NOTE: Negative forces are compressive and positive forces are tensile.
         Dead load forces are factored using the minimum and maximum load factors
         for the Strength limit states.
         The load factors are the same for all Strength limit states.
```

```
                              AXIAL RESISTANCES
                              -----------------
   MEMBER                          C  O  M  P  R  E  S  S  I  O  N                          TENSION
  ID  Type*  Pe,FB*      Cw*      y0*     Pe,FTB*    Q*       Po*      Pr,c* Method**  Pr,t* Method**
             (kip)     (in^6)    (in)     (kip)              (kip)      (kip)            (kip)
aaaaaa aaa xxxxxxx.x xxxxxxx.x xxxx.x  xxxxxxx.x xx.xxx xxxxxxx.x xxxxxxx.x  a    xxxxxxx.x  a

       * Legend of General Notes:
           Type = Defined cross section type. UD = User-defined
          Pe,FB = Elastic critical buckling resistance, flexural buckling. NOTE: The value
                  reported is the minimum of the buckling resistance about the x- or y-axis,
                  using the appropriate radius of gyration and unbraced length for each axis.
             Cw = Warping torsional constant
             y0 = Distance along the y-axis between the shear center and the centroid
         Pe,FTB = Elastic critical buckling resistance, flexural-torsional buckling
              Q = Slender element reduction factor
             Po = Equivalent nominal yield resistance
           Pr,c = Factored resistance of component in compression
           Pr,t = Factored resistance of component in tension

      ** Legend of Axial Resistance Methods:
            A. Axial Resistance Only; No Interaction
            I. Moment/Axial Interaction
            Z. Error in calculating axial resistance (delta(b)<1). Capacity not calculated.
```

```
                            POINTS OF CONTRAFLEXURE
                            -----------------------

                                  Dead Load
                                  Points of
                                 Contraflexure
                              Span    Joint   Joint

                                i      aaaaa   aaaaa

    * - Indicates controlling points of contraflexure
        used to determine application of negative moment
        vehicles.
```

```
                          aaaaaa MEMBER FORCES
                          ------------------
                         << LL + IM FORCE EFFECTS >>
MEMBER  LIMIT     DL      TRUCK    TRUCK
  ID    STATE    FORCE    COMP     TENS
                 (kips)   (kips)   (kips)

aiiaii  STR-1     xxx.x   xxxx.x    xxx.x
        STR-2     xxx.x   xxxx.x    xxx.x
        SRV-2     xxx.x   xxxx.x    xxx.x
       SRV-2B     xxx.x   xxxx.x    xxx.x
```

```
                     aaaaaaaa MEMBER FORCES AND RATINGS
                     ----------------------------------
                            << LL + IM FORCE EFFECTS >>
MEMBER  LIMIT      DL      TRUCK    TRUCK     LANE     LANE     RATING GOV   RATING
  ID    STATE    FORCE     COMP     TENS      COMP     TENS     FACTOR CMB  FAILURE*
                (kips)   (kips)   (kips)    (kips)   (kips)

aiiaii  STR-1   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
       STR-1A   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
        STR-2   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
        SRV-2   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
       SRV-2A   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
       SRV-2B   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a

aiiaii  STR-1   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
       STR-1A   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
        STR-2   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
        SRV-2   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
       SRV-2A   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a
       SRV-2B   xxxx.x   xxxx.x   xxxx.x   xxxx.x   xxxx.x    x.xx  a         a

NOTE: A negative rating factor indicate that the factored
      dead load force exceeds the axial resistance of the member.


                 aaaaaaaa TRUCK LOCATIONS FOR MAXIMUM EFFECT
                 -------------------------------------------
              << TENSION  EFFECTS >>          << COMP.  EFFECTS >>
MEMBER    GOV    VAR.    TRUCK    FRONT    GOV    VAR.    TRUCK    FRONT
  ID      TRK   AXL SPC  DIRECT   AXLE     TRK   AXL SPC  DIRECT   AXLE
                 ft                ft              ft                ft
aiiaii     i     xx.x    a TO a   xxx.x     i     xx.x    a TO a    xx.x
aiiaii     i     xx.x    a TO a   xxx.x     i     xx.x    a TO a    xx.x

                LRFD governing loading code legend:
                1 - One design truck + lane load
                2 - One design tandem + lane load
                3 - Two design trucks + lane load                       (For PHL-93)
                3 - 90% * Two design trucks + 90% * lane load           (For HL-93)
                4 - Two design tandems + lane load



                      aaaaaaaa CRITICAL RATING
                      ------------------------
                   MEMBER FORCES
LIMIT   MEMBER            LL + IM          RESISTANCE    RATING
STATE     ID       DL     COMP    TENS      COMP     TENS  FACTOR  TONS
                 (kip)   (kip)   (kip)     (kip)    (kip)

STR-1   aiiaii xxxxx.x xxxxx.x     x.x   xxxxx.x     xxx.x  xx.xx

STR-1A  aiiaii xxxxx.x xxxxx.x     x.x   xxxxx.x     xxx.x  xx.xx

STR-2   aiiaii xxxxx.x xxxxx.x     x.x   xxxxx.x     xxx.x  xx.xx

SRV-2   aiiaii xxxxx.x xxxxx.x     x.x   xxxxx.x     xxx.x  xx.xx

SRV-2A  aiiaii xxxxx.x xxxxx.x     x.x   xxxxx.x     xxx.x  xx.xx

SRV-2B  aiiaii xxxxx.x xxxxx.x     x.x   xxxxx.x     xxx.x  xx.xx

WARNING - The rating factor for the critical member is negative.
          This indicates that the dead load force is greater than
          the axial resistance of this member. Check input for
          geometry, dead loads and member properties for the truss.
```

```
                          aaaaaaaa SUPPORT REACTIONS
                          --------------------------
                   D E A D   L O A D S       Factored Live Load   Total
        Limit                F A C T O R E D    + Dynamic Load   Factored   * If
Support  State  Unfactored  Minimum  Maximum      Allowance      Reaction   Uplift
                  (kips)     (kips)   (kips)        (kips)        (kips)
  aaa   aaaaaa   xxxxx.x    xxxxx.x  xxxxx.x      xxxxx.x i      aaaaaaa      a

   PHL-93 (or HL-93) Loading Codes:
   1 - Truck + Lane Governs
   2 - Tandem + Lane Governs
   6 - 90%(Truck Pair + Lane) Governs
   7 - Tandem Pair + Lane Governs

   NOTE: Negative reactions indicate uplift.
         Dead load reactions are factored using the minimum and maximum load
         factors for the Strength limit states.
         The load factors are the same for all Strength limit states.
```

```
                        aaaaaaaa PANEL POINT DEFLECTIONS
                        ------------------------------
   PANEL  DEAD LOAD + TEMP          LIVE LOAD + DYNAMIC EFFECT
   POINT    VERT    HOR       VERT+  I.F.   VERT-  I.F.     HOR+    HOR-
            (in)    (in)      (in)          (in)            (in)    (in)
    aii     x.xx    x.xx      x.xx  x.xx    x.xx  x.xx      x.xx    x.xx
    aii     x.xx    x.xx      x.xx  x.xx    x.xx  x.xx      x.xx    x.xx
```

```
                                 aaaaaa PANEL POINT DEFLECTIONS
                                 ------------------------------
   PANEL  DEAD LOAD + TEMP          LIVE LOAD + DYNAMIC EFFECT
   POINT    VERT    HOR       VERT+ GOV I.F.    VERT-  GOV  I.F.     HOR+  GOV    HOR-  GOV
            (in)    (in)      (in)              (in)                 (in)         (in)
    aii     x.xx    x.xx      x.xx   a  x.xx    x.xx    a   x.xx     x.xx   a     x.xx   a

                 Governing load code legend:
                 1 - 125% Truck Alone Governs
                 2 - 125% (25% Truck + Lane) Governs
                 1 - Truck Alone Governs
                 2 - 25% Truck + Lane Governs

   NOTE: Downward deflection is positive. Horizontal deflection
         to the right is positive.
```

```
                 COMBINED LIVE LOAD MEMBER FORCES AND RATINGS
                 --------------------------------------------
                            << LL + IM FORCE EFFECTS >>
   MEMBER  LIMIT     DL      TRUCK    TRUCK    LANE     LANE    RATING GOV   RATING
     ID    STATE    FORCE    COMP     TENS     COMP     TENS    FACTOR CMB   FAILURE
                   (kips)   (kips)   (kips)   (kips)   (kips)

   aiiaii  STR-1    xxx.x   xxxx.x    xxx.x    xxx.x    xxx.x    x.xx  a        a
          STR-1A    xxx.x   xxxx.x    xxx.x    xxx.x    xxx.x    x.xx  a        a
           STR-2    xxx.x   xxxx.x    xxx.x    xxx.x    xxx.x    x.xx  a        a
           SRV-2    xxx.x   xxxx.x    xxx.x    xxx.x    xxx.x    x.xx  a        a
          SRV-2A    xxx.x   xxxx.x    xxx.x    xxx.x    xxx.x    x.xx  a        a
          SRV-2B    xxx.x   xxxx.x    xxx.x    xxx.x    xxx.x    x.xx  a        a
```

```
                      COMBINED LIVE LOAD CRITICAL RATING
                      ----------------------------------
                        MEMBER FORCES
LIMIT   MEMBER                 LL + IM          RESISTANCE    RATING
STATE     ID       DL      COMP    TENS      COMP      TENS  FACTOR
                 (kip)    (kip)   (kip)     (kip)     (kip)

STR-1   aiiaii   xxx.x  xxxx.x   xxx.x    xxxx.x     xxx.x  xx.xx

STR-1A  aiiaii   xxx.x  xxxx.x   xxx.x    xxxx.x     xxx.x  xx.xx

STR-2   aiiaii   xxx.x  xxxx.x   xxx.x    xxxx.x     xxx.x  xx.xx

SRV-2   aiiaii   xxx.x  xxxx.x   xxx.x    xxxx.x     xxx.x  xx.xx

SRV-2A  aiiaii   xxx.x  xxxx.x   xxx.x    xxxx.x     xxx.x  xx.xx

SRV-2B  aiiaii   xxx.x  xxxx.x   xxx.x    xxxx.x     xxx.x  xx.xx

WARNING - The rating factor for the critical member is negative.
          This indicates that the dead load force is greater than
          the axial resistance of this member. Check input for
          geometry, dead loads and member properties for the truss.


                     COMBINED LIVE LOAD SUPPORT REACTIONS
                     ------------------------------------
                   D E A D   L O A D S       Factored Live Load   Total
      Limit                F A C T O R E D      + Dynamic Load   Factored   * If
Support  State  Unfactored  Minimum  Maximum       Allowance      Reaction   Uplift
                  (kips)     (kips)   (kips)        (kips)         (kips)
  aaa   aaaaaaa   xxxxx.x    xxxxx.x  xxxxx.x       xxxxx.x        aaaaaaa       a

NOTE: Negative reactions indicate uplift.
      Dead load reactions are factored using the minimum and maximum load
      factors for the Strength limit states.
      The dead load factors are the same for all Strength limit states.
```

```
                          FATIGUE LIFE ESTIMATION
                          -----------------------
                 Based on AASHTO Fatigue Truck Loading

               Live load distribution : x.xxx (One lane)
                    PA traffic factor : N/A
                   Past growth factor : xx.xx %
                 Future growth factor : xx.xx %
                  Recent count ADTTsl : xxxx.

        Unfact       Factored              Fatigue        Fatigue   Total
          DL     Live Load Force   Detail   Limit   Fatg   Stress  Cycles   Remaining  Code
Member  Force*  Maximum  Minimum  Category  State* Resist  Range  Allowed    Years    Chk**
        (kips)   (kips)   (kips)                   (ksi)  (ksi)
aiiaii xxxxx.x  xxxxx.x  xxxxx.x    aa       aa     xx.xx  xx.xx  iiiiiiii    iii     aaa

Member aiiaii is critical.


Estimated ADTTsl for iiii (year built) :  xxxx

Design fatigue life (in cycles) :     xxxxxxx
Accumulated cycles up to iiii :      xxxxxxxx

The estimated remaining life of the truss is iiii YEARS FROM iiii.

      * Legend of General Notes:
         Unfact DL Force = Unfactored dead load (DC + DW) force in the member. Positive
         Unfact DL Force = Unfactored dead load (DC) force in the member. Positive
                           values indicate tension, negative values indicate compression.
                           NOTE: when comparing the dead load force to the live load force
                                 for purposes of determining whether fatigue must be checked,
                                 the live load is factored with Fatigue-I
         Fatigue Limit State = The fatigue limit state checked for this member, based on the
                               Detail Category and ADTTsl.
                                I = Fatigue-I limit state and infinite fatigue life
                               II = Fatigue-II limit state and finite fatigue life that exceeds
                                    the service life of the bridge
                               NOTE: Infinite and adequate fatigue life only occur if the
                                     Fatigue Stress Range is less than the Fatigue Resistance
     ** Legend of Code Checks:
         A. Fatigue Stress Range exceeds the Fatigue Resistance
         B. Remaining fatigue service life is 0 years

          EXTREME EVENT III: DEAD LOAD FORCES & AXIAL RESISTANCES
          -------------------------------------------------------
              D E A D    L O A D    F O R C E S
   MEMBER   U N F A C T O R E D    F A C T O R E D     A X I A L   R E S I S T A N C E
  ID  TYPE      DC         DW      MINIMUM   MAXIMUM   COMPRESSION  METHOD   TENSION  METHOD
              (kip)      (kip)      (kip)     (kip)       (kip)                (kip)
aiiaii aaa  xxxxxxx.x xxxxxxx.x  xxxxxxx.x xxxxxxx.x   xxxxxxx.x     a     xxxxxxx.x   a

Legend of Axial Resistance Methods:
      A - Axial Resistance Only; No Interaction
      I - Moment/Axial Interaction

           EXTREME EVENT III: aaaaaaaa MEMBER FORCES AND RATINGS
           -----------------------------------------------------
                           << LL + IM FORCE EFFECTS >>
MEMBER            DL      TRUCK    TRUCK    LANE     LANE    RATING       RATING
  ID            FORCE     COMP     TENS     COMP     TENS    FACTOR GOV  FAILURE*
               (kips)    (kips)   (kips)   (kips)   (kips)

aiiaii         xxxxx.x  xxxxx.x     xx.x  xxxxx.x     xx.x   xx.xx  a        a
aiiaii         xxxxx.x  xxxxx.x     xx.x  xxxxx.x     xx.x   xx.xx  a        a

NOTE: A negative rating factor indicate that the factored
      dead load force exceeds the axial resistance of the member.
```

```
                        EXTREME EVENT IV ANALYSIS
                        -------------------------
      Member      Applied    Member     Resistance /
        ID         Force   Resistance  Applied Force
                  (kips)    (kips)
      aiiaii      xxxx.x     xxxx.x        x.xxx
      aiiaii      xxxx.x     xxxx.x        x.xxx

                             RATING SUMMARY
                             --------------
                                                     Rating
   Load             Limit State           Member     Factor   Tonnage
                                                               (tons)
   aaaaaaaa         Strength-I            aiiaii     xx.xx      xx.x
                    Strength-IA           aiiaii     xx.xx      xx.x
                    Strength-II           aiiaii     xx.xx      xx.x
                    Service-II            aiiaii     xx.xx      xx.x
                    Service-IIA           aiiaii     xx.xx      xx.x
                    Service-IIB           aiiaii     xx.xx      xx.x
```

```
   GUSSET PLATES: DL & LL FORCES/ANGLES - PART 1 OF 3 (LL = aaaaaaaa)
   -------------------------------------------------------------------
      M    E    M    B    E    R        #    1      M    E    M    B    E    R        #    2
               DEAD LOAD       LIVE LOAD                        DEAD LOAD     LIVE LOAD
PL.   MEMBER     FORCES            FORCES     ANGLE  MEMBER      FORCES           FORCES      ANGLE
LOC     ID     DC        DW     TENS   COMP   THETA    ID      DC       DW    TENS    COMP    THETA
             (kip)    (kip)   (kip)  (kip)   (deg)           (kip)   (kip)   (kip)   (kip)   (deg)
aii   aiiaii aaaaaaa aaaaaaa aaaaaaa aaaaaaa aaaaa  aaaaaa aaaaaaa aaaaaaa aaaaaaa aaaaaaa aaaaa

   GUSSET PLATES: DL & LL FORCES/ANGLES - PART 2 OF 3 (LL = aaaaaaaa)
   -------------------------------------------------------------------
      M    E    M    B    E    R        #    3      M    E    M    B    E    R        #    4
               DEAD LOAD       LIVE LOAD                        DEAD LOAD     LIVE LOAD
PL.   MEMBER     FORCES            FORCES     ANGLE  MEMBER      FORCES           FORCES      ANGLE
LOC     ID     DC        DW     TENS   COMP   THETA    ID      DC       DW    TENS    COMP    THETA
             (kip)    (kip)   (kip)  (kip)   (deg)           (kip)   (kip)   (kip)   (kip)   (deg)
aii   aiiaii aaaaaaa aaaaaaa aaaaaaa aaaaaaa aaaaa  aaaaaa aaaaaaa aaaaaaa aaaaaaa aaaaaaa aaaaa

   GUSSET PLATES: DL & LL FORCES/ANGLES - PART 3 OF 3 (LL = aaaaaaaa)
   -------------------------------------------------------------------
      M    E    M    B    E    R        #    5
             DEAD LOAD       LIVE LOAD
PL.   MEMBER    FORCES           FORCES      ANGLE
LOC     ID       DC       DW     TENS   COMP   THETA
               (kip)    (kip)   (kip)  (kip)   (deg)
aii   aiiaii aaaaaaa aaaaaaa aaaaaaa aaaaaaa aaaaa
```

```
GUSSET PLATES: SHEAR @ SECTION A-A: LL SAME AS DL (LL = aaaaaaaa)
-----------------------------------------------------------------
GUSSET PLATES: SHEAR @ SECTION A-A: LL COMPRESSIVE (LL = aaaaaaaa)
------------------------------------------------------------------
  GUSSET PLATES: SHEAR @ SECTION A-A: LL TENSILE (LL = aaaaaaaa)
  --------------------------------------------------------------
GUSSET PLATES: SHEAR @ SECTION B-B: LL SAME AS DL (LL = aaaaaaaa)
-----------------------------------------------------------------
GUSSET PLATES: SHEAR @ SECTION B-B: LL COMPRESSIVE (LL = aaaaaaaa)
------------------------------------------------------------------
  GUSSET PLATES: SHEAR @ SECTION B-B: LL TENSILE (LL = aaaaaaaa)
  --------------------------------------------------------------
GUSSET PLATES: SHEAR @ SECTION C-C: LL SAME AS LL (LL = aaaaaaaa)
-----------------------------------------------------------------
GUSSET PLATES: SHEAR @ SECTION C-C: LL COMPRESSIVE (LL = aaaaaaaa)
------------------------------------------------------------------
  GUSSET PLATES: SHEAR @ SECTION C-C: LL TENSILE (LL = aaaaaaaa)
  --------------------------------------------------------------
          SECTION PROPERTIES       FACTORED   NOMINAL CAPACITY        OPERATING
PLATE  (One Side of Joint Only)      SHEAR      MIN(Pvg, Pvn)           LEVEL
LOCN.    Ag        An                FORCE        MIN     GOV*  CHECK**  RATING
       (in^2)    (in^2)              (kip)       (kip)
 aii aaaaaaaaa aaaaaaaaa           aaaaaaaaa  aaaaaaaaa  a     aa    aaaaaaaaa

      * Legend of Governing Nominal Capacity:
          g.  Gross Area (Pvg)
          n.  Net Area (Pvn)

    ** Legend of Capacity Check
         OK. Sufficient Shear Capacity
         NG. Insufficient Shear Capacity
         Cs. There are no diagonals at this location ("post and hanger" condition) and a
             chord splice has been defined at this location.  The chord splice has been
             checked and is adequate for axial loads without any contribution from the
             gusset plate.  The gusset plate will not be checked for the chord member
             at this location.

    +++ Rating factor not calculated because live load effect = 0.0
```

```
                GUSSET PLATES: TENSION & COMPRESSION: LL MATCH DL (LL = aaaaaaaa)
                -----------------------------------------------------------------
                GUSSET PLATES: TENSION & COMPRESSION: LL COMPRESS (LL = aaaaaaaa)
                -----------------------------------------------------------------
                 GUSSET PLATES: TENSION & COMPRESSION: LL TENSILE (LL = aaaaaaaa)
                 ----------------------------------------------------------------
                               NOMINAL CAPACITY           OPERATING
  PLATE                AXIAL     MIN (Pt, Pc)               LEVEL
 LOCATION   MEMBER     FORCE*      MIN  GOV**    CHECK*** RATING  GOV*
                       (kip)      (kip)
   aii        1      xxxx.xx a   xxxx.xx aa       aa      xx.xx   a
              2      xxxx.xx a   xxxx.xx aa       aa      xx.xx   a
              3      xxxx.xx a   xxxx.xx aa       aa      xx.xx   a
              4      xxxx.xx a   xxxx.xx aa       aa      xx.xx   a
              5      xxxx.xx a   xxxx.xx aa       aa      xx.xx   a

       * Legend of Governing Axial Force:
           C.  Compression
           T.  Tension
           NOTE: If a chord splice has been defined at this location (GCS command), the axial
                 force reported is the portion of the axial force carried by the gusset plate
                 and the chord splice web plates.  See Chapter 3 of the User's Manual for
                 more information.

      ** Legend of Governing Nominal Capacity:
           C.  Compression, (Pc)
           Tg. Tension, Gross Area (Pt)
           Tn. Tension, Net Area (Pt)
           Cs. There are no diagonals at this location ("post and hanger" condition) and a
               chord splice has been defined at this location.  The chord splice has been
               checked and is adequate for axial loads without any contribution from the
               gusset plate.  The gusset plate will not be checked for the chord member
               at this location.

     *** Legend of Capacity Check
           OK. Sufficient Axial Capacity
           NG. Insufficient Axial Capacity

     +++ Rating factor not calculated because live load effect = 0.0

                     GUSSET PLATES: BLOCK SHEAR: LL MATCH DL (LL = aaaaaaaa)
                     -------------------------------------------------------
                     GUSSET PLATES: BLOCK SHEAR: LL COMPRESS (LL = aaaaaaaa)
                     -------------------------------------------------------
                      GUSSET PLATES: BLOCK SHEAR: LL TENSILE (LL = aaaaaaaa)
                      ------------------------------------------------------
                        BLOCK         NOMINAL               OPERATING
  PLATE                 SHEAR         CAPACITY                LEVEL
 LOCATION   MEMBER      FORCE*       Pbs    GOV**    CHECK***  RATING
                        (kip)       (kip)
   aii        1       xxxx.xx a   xxxx.xx aa        aa       xx.xx
              2       xxxx.xx a   xxxx.xx aa        aa       xx.xx
              3       xxxx.xx a   xxxx.xx aa        aa       xx.xx
              4       xxxx.xx a   xxxx.xx aa        aa       xx.xx
              5       xxxx.xx a   xxxx.xx aa        aa       xx.xx
           VRT-DGL    xxxx.xx a   xxxx.xx aa        aa       xx.xx

       * Legend of Governing Axial Force:
           C.  Compression
           T.  Tension

      ** Legend of Governing Nominal Capacity:
           B1. Block Shear Case 1 (members 1 - 2 only)
           B2. Block Shear Case 2 (members 1 - 5 only)
           B3. Block Shear Case 3 (member VRT-DGL only)
           Cs. There are no diagonals at this location ("post and hanger" condition) and a
               chord splice has been defined at this location.  The chord splice has been
               checked and is adequate for axial loads without any contribution from the
               gusset plate.  The gusset plate will not be checked for the chord member
               at this location.
```

```
*** Legend of Capacity Check
      OK. Sufficient Block Shear Capacity
      NG. Insufficient Block Shear Capacity

+++ Rating factor not calculated because live load effect = 0.0

      GUSSET PLATES: CONNECTIONS (SHEAR/BEARING): LL MATCH DL (LL = aaaaaaaa)
      -----------------------------------------------------------------------
      GUSSET PLATES: CONNECTIONS (SHEAR/BEARING): LL COMPRESS (LL = aaaaaaaa)
      -----------------------------------------------------------------------
      GUSSET PLATES: CONNECTIONS (SHEAR/BEARING): LL TENSILE (LL = aaaaaaa)
      ---------------------------------------------------------------------
                                     NOMINAL CAPACITY          OPERATING
       PLATE              AXIAL       MIN (Rv, Rb)               LEVEL
      LOCATION   MEMBER   FORCE*        MIN   GOV**   CHECK*** RATING  GOV**
                          (kip)        (kip)
        aii         1     xxxx.xx a   xxxx.xx aa       aa     xx.xx  aa
                    2     xxxx.xx a   xxxx.xx aa       aa     xx.xx  aa
                    3     xxxx.xx a   xxxx.xx aa       aa     xx.xx  aa
                    4     xxxx.xx a   xxxx.xx aa       aa     xx.xx  aa
                    5     xxxx.xx a   xxxx.xx aa       aa     xx.xx  aa

  * Legend of Governing Axial Force:
      C.  Compression
      T.  Tension

 ** Legend of Governing Nominal Capacity:
      FS. Fastener Shear (Rv)
      MB. Bearing on Material (Rb)

*** Legend of Capacity Check
      OK. Sufficient Connection Capacity
      NG. Insufficient Connection Capacity

+++ Rating factor not calculated because live load effect = 0.0

           GUSSET PLATES: CONNECTIONS (SLIP): LL MATCH DL (LL = aaaaaaa)
           -------------------------------------------------------------
           GUSSET PLATES: CONNECTIONS (SLIP): LL COMPRESS (LL = aaaaaaa)
           -------------------------------------------------------------
           GUSSET PLATES: CONNECTIONS (SLIP): LL TENSILE (LL = aaaaaaa)
           ------------------------------------------------------------
                                                           OPERATING
           PLATE              AXIAL        SLIP              LEVEL
          LOCATION   MEMBER   FORCE*     CAPACITY   CHECK***  RATING
                              (kip)        (kip)
            U 1         1     xxxx.xx a    xxxx.xx     aa       xx.xx
                        2     xxxx.xx a    xxxx.xx     aa       xx.xx
                        3     xxxx.xx a    xxxx.xx     aa       xx.xx
                        4     xxxx.xx a    xxxx.xx     aa       xx.xx
                        5     xxxx.xx a    xxxx.xx     aa       xx.xx

  * Legend of Governing Axial Force:
      C.  Compression
      T.  Tension

 ** Legend of Governing Nominal Capacity:
      FS. Fastener Shear (Rv)
      MB. Bearing on Material (Rb)
      Cs. There are no diagonals at this location ("post and hanger" condition) and a
          chord splice has been defined at this location.  The chord splice has been
          checked and is adequate for axial loads without any contribution from the
          gusset plate.  The gusset plate will not be checked for the chord member
          at this location.

*** Legend of Capacity Check
      OK. Sufficient Connection Capacity
      NG. Insufficient Connection Capacity

+++ Rating factor not calculated because live load effect = 0.0
```

```
                GUSSET PLATES: CONNECTIONS (CHORD SPLICE): LL MATCH DL (LL = aaaaaaa)
                ---------------------------------------------------------------------
                GUSSET PLATES: CONNECTIONS (CHORD SPLICE): LL COMPRESS (LL = aaaaaaa)
                ---------------------------------------------------------------------
                 GUSSET PLATES: CONNECTIONS (CHORD SPLICE): LL TENSILE (LL = aaaaaaa)
                 --------------------------------------------------------------------

                         SPLICE ONLY     CHORD    SPLICE   +   GUSSET                  OPERATING
 PLATE          AXIAL     CAPACITY       Gross          Net         CAPACITY  CHECK    LEVEL
LOCATION MEMBER FORCE*    MIN    GOV** Area    Smod   Area    Smod   MIN  GOV**  ***    RATING  GOV**
                (kip)    (kip)       (in^2) (in^3) (in^2) (in^3)     (kip)
  aii      i  aaaaaaaaaaaaaaaaaa aa aaaaaaaaaaaaa aaaaaaaaaaaaaaaaaaaaaaaa    aa aaaaaaaaa aaa

            * Legend of Governing Axial Force:
                C.  Compression
                T.  Tension

           ** Legend of Governing Chord Splice Capacity:
                Tg. Tension, Gross Area (AASHTO LRFD Equation 6.14.2.8.6-3)
                Tn. Tension, Net Area (AASHTO LRFD Equation 6.14.2.8.6-4)
                Cg. Compression, Gross Area (AASHTO LRFD Equation 6.14.2.8.6-1)
                Bu. Compression, Buckling Check Fails (AASHTO LRFD Equation 6.14.2.8.6-2)
                NA. No chord splice defined here. Chord Splice + Gusset is gusset plate only

          *** Legend of Capacity Check
                OK. Sufficient Connection Capacity
                NG. Insufficient Connection Capacity
```

```
                 GUSSET PLATES: SUMMARY PART 1 OF i: LL MATCH DL (LL = aaaaaaaa)
                 ---------------------------------------------------------------
                 GUSSET PLATES: SUMMARY PART 1 OF i: LL COMPRESS (LL = aaaaaaaa)
                 ---------------------------------------------------------------
                  GUSSET PLATES: SUMMARY PART 1 OF i: LL TENSILE (LL = aaaaaaaa)
                  --------------------------------------------------------------
                      S  H  E  A  R                           T  E  N  S  I  O  N
                                          OPERATING                                        OPERATING
   PLATE      SHEAR     NOMINAL             LEVEL        AXIAL     NOMINAL                   LEVEL
  LOCATION    FORCE*   CAPACITY*   CHECK*** RATING*      LOAD**   CAPACITY**  CHECK*** RATING**
              (kip)     (kip)                            (kip)      (kip)
    aii     xxx.xx a   xxx.xx a    aa      xx.xx a     xxx.xx a.a  xxx.xx a.a  aa      xx.xx a.a

       * Legend of Shear Axial Load, Nominal Capacity and Operating Level Rating:
           A.   Shear @ Section A-A
           B.   Shear @ Section B-B
           C.   Shear @ Section C-C
           g.   Gross Area
           n.   Net Area

      ** Legend of Tension Axial Load, Nominal Capacity and Operating Level Rating:
           M.1. Member 1
           M.2. Member 2
           M.3. Member 3
           M.4. Member 4
           M.5. Member 5

     *** Legend of Capacity Check
           OK. Sufficient Capacity
           NG. Insufficient Capacity

     +++ Rating factor not calculated because live load effect = 0.0
```

```
                  GUSSET PLATES: SUMMARY PART 2 OF i: LL MATCH DL (LL = aaaaaaaa)
                  ---------------------------------------------------------------
                  GUSSET PLATES: SUMMARY PART 2 OF i: LL COMPRESS (LL = aaaaaaaa)
                  ---------------------------------------------------------------
                   GUSSET PLATES: SUMMARY PART 2 OF i: LL TENSILE (LL = aaaaaaaa)
                   --------------------------------------------------------------
                    C O M P R E S S I O N                  B L O C K   S H E A R
                                              OPERATING      BLOCK                            OPERATING
   PLATE       AXIAL      NOMINAL                 LEVEL      SHEAR      NOMINAL                  LEVEL
 LOCATION      LOAD*     CAPACITY*   CHECK**  RATING*        FORCE*    CAPACITY*   CHECK**  RATING*
               (kip)       (kip)                             (kip)       (kip)
    aii     xxx.xx a.a  xxx.xx a.a  aa      xx.xx a.a    xxx.xx a.a  xxx.xx a.a  aa      xx.xx a.a

         * Legend of Axial Load, Nominal Capacity and Operating Level Rating:
             M.1. Member 1
             M.2. Member 2
             M.3. Member 3
             M.4. Member 4
             M.5. Member 5
             B.3. Block Shear Case 3 (Block Shear Only)

        ** Legend of Capacity Check
             OK. Sufficient Capacity
             NG. Insufficient Capacity

       +++ Rating factor not calculated because live load effect = 0.0

                  GUSSET PLATES: SUMMARY PART 3 OF i: LL MATCH DL (LL = aaaaaaa)
                  --------------------------------------------------------------
                  GUSSET PLATES: SUMMARY PART 3 OF i: LL COMPRESS (LL = aaaaaaa)
                  --------------------------------------------------------------
                  GUSSET PLATES: SUMMARY PART 3 OF i: LL TENSILE (LL = aaaaaaa)
                  -------------------------------------------------------------
               CONNECTIONS (SHEAR/BEARING)                  CONNECTIONS (SLIP)
                                           OPERATING                                       OPERATING
   PLATE       AXIAL      NOMINAL              LEVEL       AXIAL      NOMINAL                 LEVEL
 LOCATION      LOAD*     CAPACITY*   CHECK**  RATING*      LOAD*     CAPACITY*   CHECK**  RATING*
               (kip)       (kip)                           (kip)       (kip)
    aii     xxx.xx a.a  xxx.xx a.a  aa      xx.xx a.a  xxx.xx a.a  xxx.xx a.a  aa      xx.xx a.a

         * Legend of Axial Load, Nominal Capacity and Operating Level Rating:
             M.1. Member 1
             M.2. Member 2
             M.3. Member 3
             M.4. Member 4
             M.5. Member 5

        ** Legend of Capacity Check
             OK. Sufficient Capacity
             NG. Insufficient Capacity

       +++ Rating factor not calculated because live load effect = 0.0
```

```
                    GUSSET PLATES: SUMMARY PART 4 OF 4: LL MATCH DL (LL = aaaaaaaaa)
                    ----------------------------------------------------------------
                     GUSSET PLATES: SUMMARY PART 4 OF 4: LL COMPRESS (LL = aaaaaaaa)
                     ---------------------------------------------------------------
                      GUSSET PLATES: SUMMARY PART 4 OF 4: LL TENSILE (LL = aaaaaaaa)
                      --------------------------------------------------------------
                   CONNECTIONS (CHORD SPLICE)
                                                         OPERATING
   PLATE      AXIAL      NOMINAL                           LEVEL
  LOCATION    LOAD*     CAPACITY*    CHECK**  RATING*
              (kip)        (kip)
    aii    aaaaaaaa aaa aaaaaaaa aaa  aa     aaaaaa aaa

           * Legend of Axial Load, Nominal Capacity and Operating Level Rating:
               M.1. Member 1
               M.2. Member 2
               M.3. Member 3
               M.4. Member 4
               M.5. Member 5

          ** Legend of Capacity Check
               OK. Sufficient Capacity
               NG. Insufficient Capacity

       GUSSET PLATES: GOVERN OPERATING RATINGS: ALL CASES, LL = aaaaaaaa
       -----------------------------------------------------------------
              UNSUPPORTED EDGE      M I N I M U M  O P E R A T I N G  R A T I N G S
     PLATE     IN COMPRESSION         LL            LL              LL
    LOCATION   ADEQUACY CHECK*     MATCH DL**   COMPRESSIVE**   TENSILE**     OVERALL
      aii           aa           aaaaaa aaaa   aaaaaa aaaa   aaaaaa aaaa     aaaaaa

           * Legend of Unsupported Edge In Compression Adequacy Check:
               OK. The unsupported edge does not require stiffeners
               NG. The unsupported edge requires stiffeners

          ** Legend of Minimum Operating Ratings:
               Blks. Block Shear
               Comp. Compression
               Conn. Connections
               Shea. Shear
               Tens. Tension
               Slip. Slip
               CSpl. Chord Splice

         +++ Rating factor not calculated because live load effect = 0.0
```

7.10 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 is not printed (i.e. if the user only desires rating output), the specification check is done, and if a warning occurs, the output table title will appear on this report. This table will still print, even if all other output is turned off.

A sample specification check warning table is shown in Figure 1.

```
LRFD Truss Analysis and Rating, Version 1.0.0.0                                              PAGE 33
Input File: ex1.dat                                                                09/15/2016  10:52:18
---------------------------------------------------------------------------------------------------
                                            EXAMPLE 1
                                  SUMMARY - SPECIFICATION CHECKS
---------------------------------------------------------------------------------------------------

                                   SPECIFICATION CHECK WARNINGS
                                   ----------------------------
        For the live loadings input by the user, the program encountered one or more
        specification check warnings or input 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 SUPPORT REACTIONS
     ML-80 SUPPORT REACTIONS
     P-82 SUPPORT REACTIONS
     TK527 SUPPORT REACTIONS
     HS20 SUPPORT REACTIONS
     H20 SUPPORT REACTIONS
```

Figure 7.10-1 Specification Check Warnings Page

7.11 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 is not printed (i.e. if the user only desires rating output), the specification check is done, and if a failure occurs, the output table title will appear on this report. This table will still print, even if all other output is turned off.

A sample specification check failure table is shown in Figure 1.

```
LRFD Truss Analysis and Rating, Version 1.0.0.0                                              PAGE 34
Input File: ex1.dat                                                               09/15/2016  10:52:18
----------------------------------------------------------------------------------------------------
                                           EXAMPLE 1
                              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 MEMBER FORCES AND RATINGS
     ML-80 MEMBER FORCES AND RATINGS
     P-82 MEMBER FORCES AND RATINGS
     TK527 MEMBER FORCES AND RATINGS
     HS20 MEMBER FORCES AND RATINGS
     H20 MEMBER FORCES AND RATINGS
     FATIGUE LIFE ESTIMATION
     EXTREME EVENT III: PHL-93 MEMBER FORCES AND RATINGS
     EXTREME EVENT III: ML-80 MEMBER FORCES AND RATINGS
     EXTREME EVENT III: P-82 MEMBER FORCES AND RATINGS
     EXTREME EVENT III: TK527 MEMBER FORCES AND RATINGS
     EXTREME EVENT III: HS20 MEMBER FORCES AND RATINGS
     EXTREME EVENT III: H20 MEMBER FORCES AND RATINGS
     EXTREME EVENT IV ANALYSIS
     RATING SUMMARY
```

Figure 7.11-1 Specification Check Failures Page

8 EXAMPLE PROBLEMS

8.1 EXAMPLE PROBLEMS

This chapter contains three example problems used to test this program. The following information is given: a brief narrative description of each problem, sketches which show the truss configuration, and additional assumptions required to create the input data files. The actual input data files for each example problem are listed in this manual and are included electronically along with the executable program.

8.2 EXAMPLE PROBLEM 1 – MULTI-SPAN CONTINUOUS DECK TRUSS

8.2.1 Problem Description

This is an example of a three-span continuous deck truss bridge. The truss has 60 panels and is geometrically symmetric. The span lengths are 150 feet, 300 feet, and 150 feet. Figure 1 shows a half-elevation view where the numbers in the boxes are the panel numbers corresponding to the GEO command in the input file. The bottom chord geometry follows a half-parabola and a parabola for the end and middle spans, respectively. Dimensions from the horizontal datum through the abutment bearing panel points are also shown in Figure 1.

The deck system is assumed to be a reinforced concrete slab spanning between rolled steel I-beam floorbeams attached at the top panel points. Figure 2 gives the assumed deck cross section including the design lane layout.

8.2.2 Input

The following input parameters are entered. Refer to the completed data file shown in section 8.2.4.

A. Title Command (TTL)
   "Example 1"

B. Control Command (CTL)
   1. The system of units is "US"
   2. In order to obtain ratings for multiple live loadings, "A" is selected.
   3. Impact value of 1.33 is entered.
   4. Left blank for the program to calculate the live load distribution factor.
   5. Left blank for the program to calculate the live load distribution factor.
   6. "U" is entered for bridge end bearings located at the upper panel points.
   7. "R" is entered for members connected together with bolts.
   8. **Left support is pinned. Leave** blank for default value.
   9. Temperature Change is left blank since thermal loading is not of interest in this example.
   10. End bearing is set to "U" for a deck truss.
   11. Symmetry is applicable, therefore, set to "Y".
   12. Live Load Direction can be oriented either stations ahead or back, therefore, left blank for both direction default, "B".
   13. Fatigue Dynamic Load Allowance is to be defaulted to 1.15, therefore, left blank.
   14. P**ermit** Dynamic Load Allowance is to be defaulted to 1.20, therefore, left blank.

C. Computed Distribution Factor Command (CDF)

1. The centerline of truss to inside face of curb is set to -12.00 for a truss inside the roadway a (negative) distance of 12'-0".
2. The truss spacing is set to 24.00 for a distance center-to-center of trusses of 24' 0".
3. The roadway width is set to 48.00 for four 12'-0" design lanes.
4. The gage distance is set to the default value of 6.00' when left blank.
5. The passing distance is set to the default value of 4.00' when left blank.

D. Span Length Command (SPL)

The center-to-center of bearings spans are input for the following:

Span 1, 150'-0"

Span 2, 300'-0"

Span 3, 150'-0"

E. Geometry Command (GEO)

1. Since the truss is declared symmetrical only the geometry of panels 1 through 30 is be described.
2. The first PANEL NUMBER is 1, since there is no vertical member L0U0.
3. All PANEL WIDTHS are equal to 10.00 feet. A check here shows that the sum of sixty panel widths is 600.00 feet, which equals the sum of the truss span lengths entered earlier.
4. "Y" is entered for Y OR N since a vertical is present in each panel.
5. The length of the vertical member on the right side of each panel, as tabulated on Figure 1, is entered for H1.
6. Except for panel number 15, the value of H2 is left blank for each panel because there are no joints between the upper and lower joints. For panel number 15, the value of H2 is entered as 15.00 since this is a Panel Type 8 with a distance from the bottom panel point to the center panel point of 15'-0".
7. The values of H3 are based on the H1 values since, for simplicity, the truss is assumed to be on a zero grade.
8. The PANEL TYPE is coded for each panel according to Figure 5.11-1.

F. Truss Dead Load (DC) Command (TDC)

Values for the sum of estimated truss member, gusset plates, bracing, floorbeam, and deck weights tributary to each truss connection location are entered based on values tabulated in Table 8.2-1.

G. Truss Dead Load (DW) Command (TDW)

Values for the sum of estimated deck future wearing surface weight tributary to each truss top connection location are entered based on values tabulated in Table 8.2-1.

H. Truss Member Properties Command (PRP)

1. All truss member gross properties were input for each member based upon assumed rolled member cross sections. Refer to sizes tabulated on Figure 3. For this particular example it is assumed that all member end connections are concentric; therefore, the eccentricity parameter is left blank to default to zero.

2. Member net areas are computed and input assuming deductions in cross sectional area for bolt counts consistent with the gross capacity of each truss member.
3. Member material strength values consistent with current practice are selected and entered.
4. In order to demonstrate basic fatigue design capabilities of the program, fatigue design resistance category values are input for selected members.
5. The Tensile Resistance parameter is left blank for the program to compute the values.
6. The Compressive Resistance is entered for each member.

I. Extreme Event Command (EEV)

In order to demonstrate the extreme event analysis capabilities of the program, Extreme Event III and IV data is input for selected truss members. Note, since member eccentricities are all assumed to be zero in this example, the Extreme Event Moment Resistance input is left blank.

J. Fatigue Life Command (FTL)

In order to demonstrate basic fatigue design capabilities of the program, fatigue live load data is included with assumed values. In this example, it is assumed the previous and future average daily truck traffic (ADTT) growth rates of 1% and 1.5%, respectively, are known; therefore, their values are entered directly as 0.010 and 0.015, respectively. Therefore, parameter pair 6 and 7, Previous Count Year and Previous Count ADTT, along with parameter pair 9 and 10, Future Count Year and Future Count ADTT, are left blank.

K. Output of Input Data Command (OIN)

For this example, the first and third parameters of this command are set to “1” in order to provide an echo of the input data file as well as presentation of the input in a compact, yet easily understood format with headings.

L. Output Command (OUT)

Except for those related to gusset analyses, all parameters of this command are set to “1” so the full set of output data applicable to this example may be viewed.

8.2.3 Output

Refer to section 8.2.5 for the partial output of this example problem.

A. All input values are printed for verification.

B. All computed values are printed with an appropriate heading. For details, refer to Chapter 7

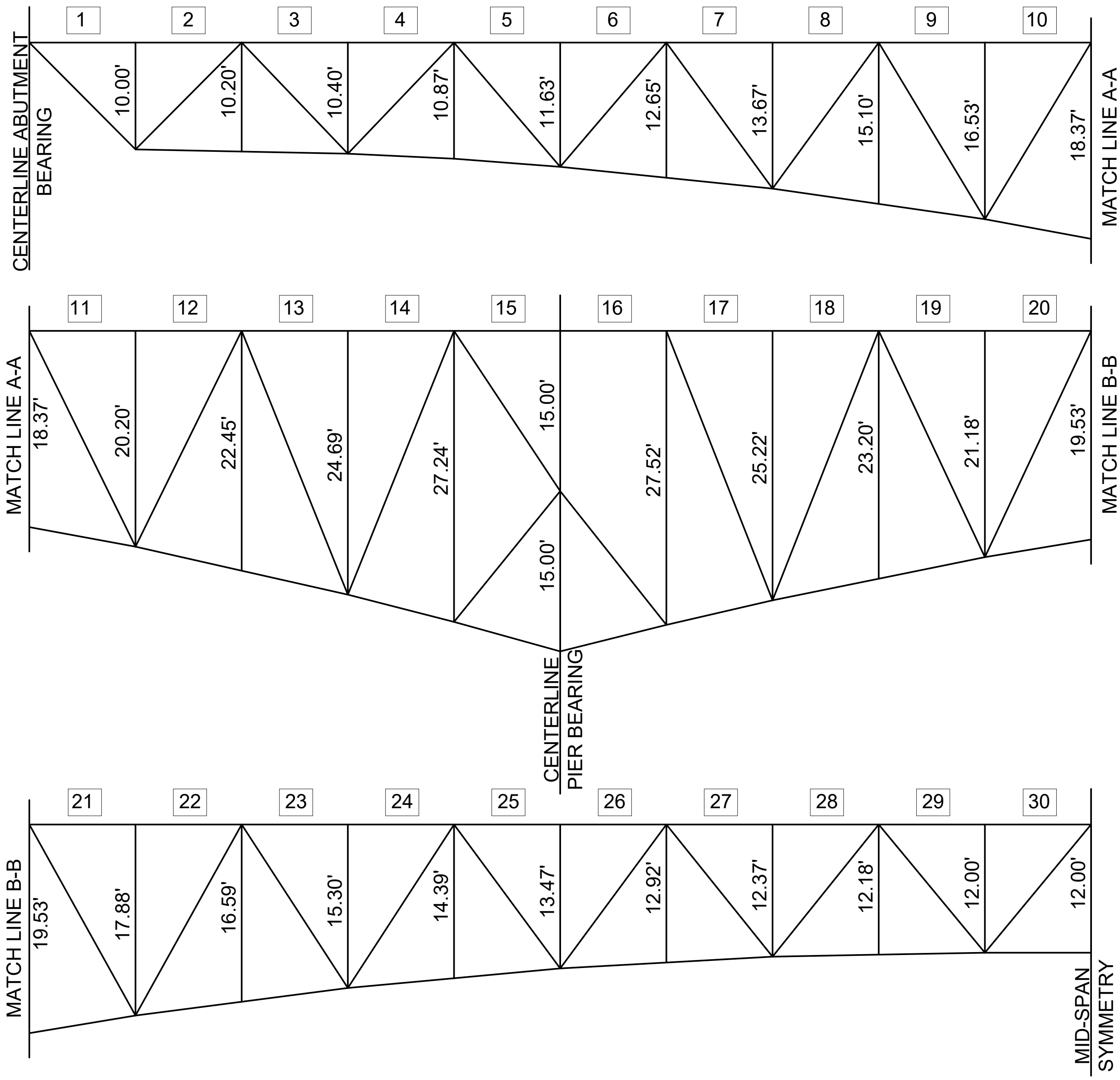


Figure 8.2-1 Example 1 Elevation

Table 8.2-1 Dead Loads

TRUSS (DC) DEAD LOADS (KIPS)					
JOINT	BOTTOM JOINT TOTAL	TOP JOINT TOTAL	JOINT	BOTTOM JOINT TOTAL	TOP JOINT TOTAL
0	--	27.44	16	7.49	60.86
1	2.09	52.88	17	10.42	56.01
2	1.11	54.39	18	2.52	60.61
3	3.31	53.34	19	6.95	54.43
4	1.33	54.95	20	1.31	57.93
5	2.98	53.59	21	5.54	53.32
6	1.14	55.22	22	1.72	58.21
7	4.07	53.70	23	7.41	54.25
8	1.73	56.80	24	3.64	63.20
9	6.09	54.53	25	11.96	56.08
10	2.45	57.99	26	5.40	68.18
11	8.16	55.31	27	15.17	57.36
12	2.99	59.69	28	6.61	71.07
13	10.81	56.04	29	15.61	57.85
14	7.64	61.25	30	5.72	59.10
15	0.00 AT BRG.	56.44			

Note: Truss (DW) dead loads are zero at bottom joints, 3.60 kips at U0, and 7.20 kips at other top joints.

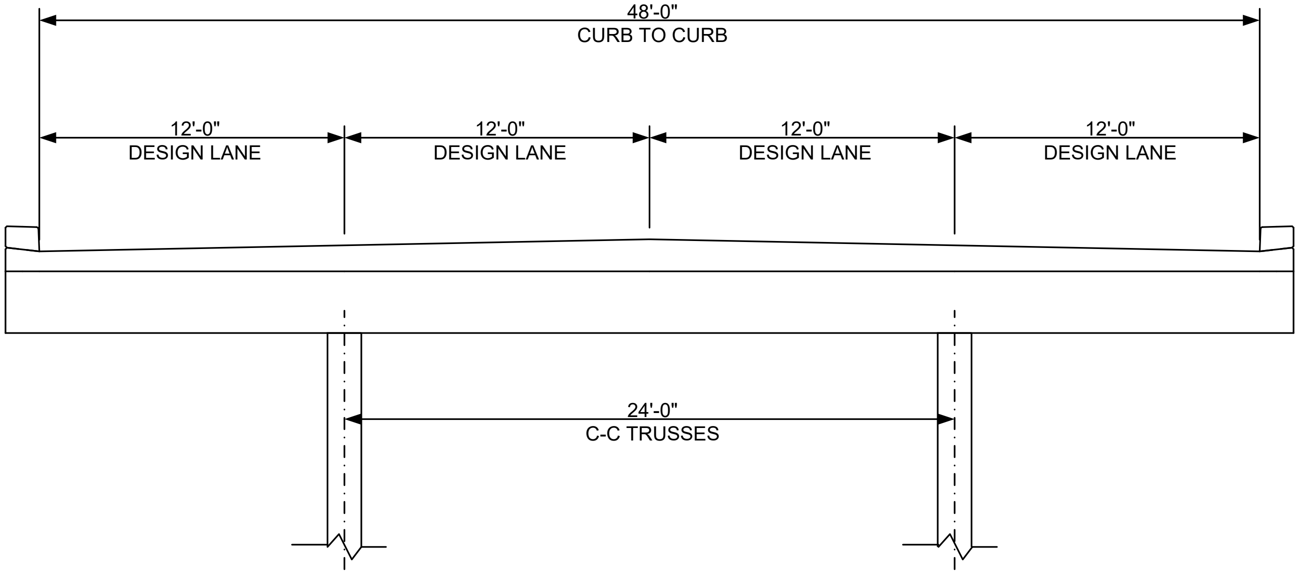
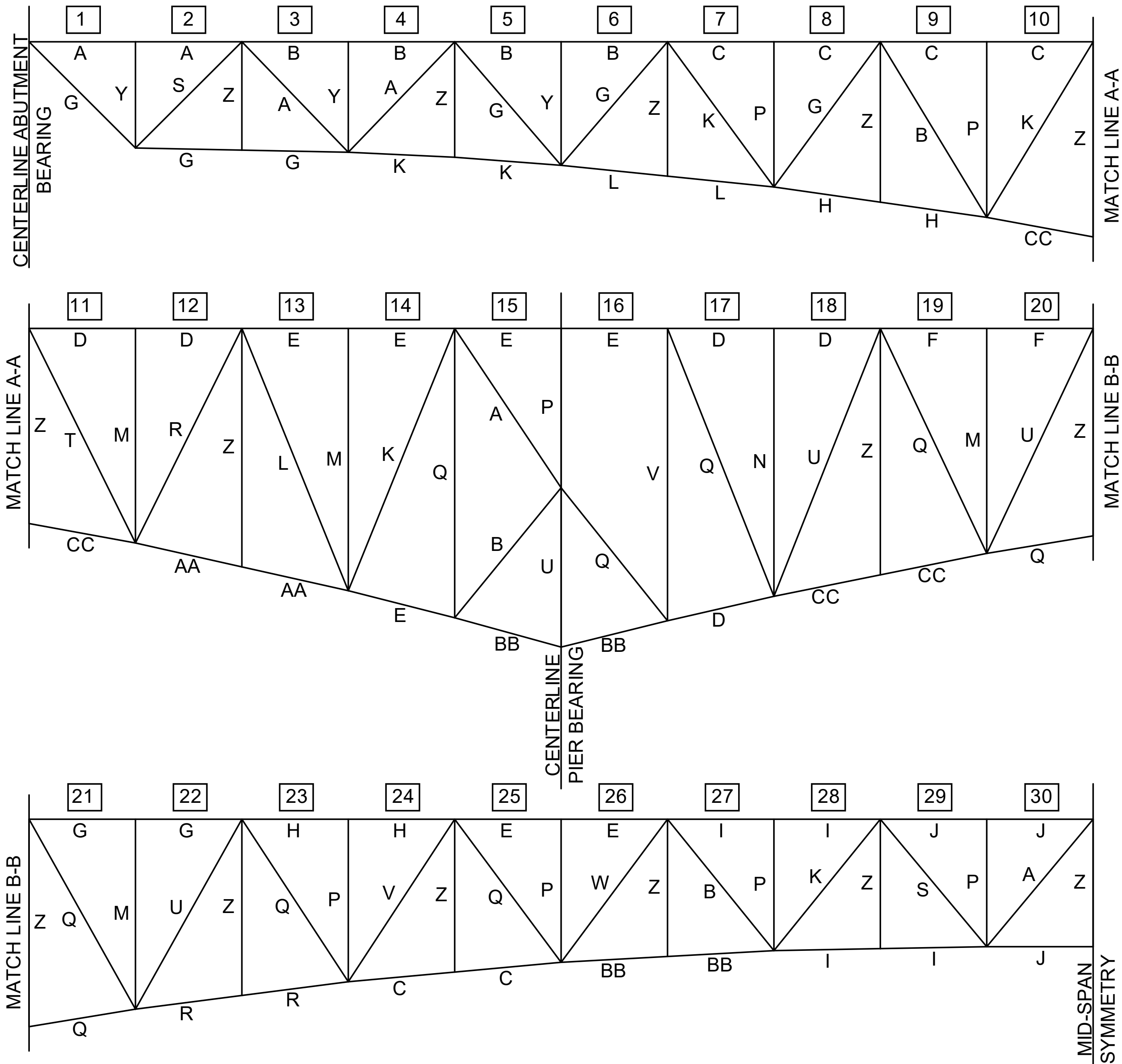


Figure 8.2-2 Typical Cross Section



A. W14x53
B. W14x99
C. W14x257
D. W14x311
E. W14x370
F. W14x211
G. W14x74
H. W14x193
I. W14x500
J. W14x550
K. W14x90
L. W14x120
M. W8x58
N. W8x67
P. W8x40
Q. W14x132
R. W14x82
S. W14x61
T. W14x109
U. W14x176
V. W14x159
W. W14x145
X. W14x43
Y. W8x31
Z. W8x24
AA. W14x283
BB. W14x398
CC. W14x233

Figure 8.2-3   Truss Member Sizes

8.2.4 Data Input File

```
!
! ** Created by EngAsst **
! EngAsst Information: [Program=TRLRFD] [Version=1.1.0.0]
! ** Data Records Start Here **
TTL Example 1
CTL US,A,1.33,,,U,R,,,U,Y
CDF -12,24,48
SPL 150,300,150
GEO 01,10.00,Y,10.00,,-10.00,3
GEO 02,10.00,Y,10.20,,-10.20,5
GEO 03,10.00,Y,10.40,,-10.40,6
GEO 04,10.00,Y,10.87,,-10.87,5
GEO 05,10.00,Y,11.63,,-11.63,6
GEO 06,10.00,Y,12.65,,-12.65,5
GEO 07,10.00,Y,13.67,,-13.67,6
GEO 08,10.00,Y,15.10,,-15.10,5
GEO 09,10.00,Y,16.53,,-16.53,6
GEO 10,10.00,Y,18.37,,-18.37,5
GEO 11,10.00,Y,20.20,,-20.20,6
GEO 12,10.00,Y,22.45,,-22.45,5
GEO 13,10.00,Y,24.69,,-24.69,6
GEO 14,10.00,Y,27.24,,-27.24,5
GEO 15,10.00,Y,15.00,15.0,-30.00,8
GEO 16,10.00,Y,27.52,,-27.52,11
GEO 17,10.00,Y,25.22,,-25.22,6
GEO 18,10.00,Y,23.20,,-23.20,5
GEO 19,10.00,Y,21.18,,-21.18,6
GEO 20,10.00,Y,19.53,,-19.53,5
GEO 21,10.00,Y,17.88,,-17.88,6
GEO 22,10.00,Y,16.59,,-16.59,5
GEO 23,10.00,Y,15.30,,-15.30,6
GEO 24,10.00,Y,14.39,,-14.39,5
GEO 25,10.00,Y,13.47,,-13.47,6
GEO 26,10.00,Y,12.92,,-12.92,5
GEO 27,10.00,Y,12.37,,-12.37,6
GEO 28,10.00,Y,12.18,,-12.18,5
GEO 29,10.00,Y,12.00,,-12.00,6
GEO 30,10.00,Y,12.00,,-12.00,5
TDC U00,23.84,U01,45.68,L01,02.09,U02,47.19,L02,1.11,U03,46.14,L03,3.31,U04,47.75,L04,1.33
TDC U05,46.39,L05,2.98,U06,48.02,L06,1.14,U07,46.50,L07,4.07,U08,49.60,L08,1.73,U09,47.33,L09,6.09
TDC U10,50.79,L10,2.45,U11,48.11,L11,8.16,U12,52.49,L12,2.99,U13,48.84,L13,10.81,U14,54.05,L14,7.64
TDC U15,49.24,L15,0.1,U16,53.66,L16,7.49,U17,48.81,L17,10.42,U18,53.41,L18,2.52,U19,47.23,L19,6.95
TDC U20,50.73,L20,1.31,U21,46.12,L21,5.54,U22,51.01,L22,1.72,U23,47.05,L23,7.41,U24,56.00,L24,3.64
TDC U25,48.88,L25,11.96,U26,60.98,L26,5.40,U27,50.16,L27,15.17,U28,63.87,L28,6.61,U29,50.65,L29,15.61
TDC U30,51.90,L30,5.72
TDW U00,3.60,U01,7.20,U02,7.20,U03,7.20,U04,7.20,U05,7.20,U06,7.20,U07,7.20,U08,7.20,U09,7.20
TDW U10,7.20,U11,7.20,U12,7.20,U13,7.20,U14,7.20,U15,7.20,U16,7.20,U17,7.20,U18,7.20,U19,7.20
TDW U20,7.20,U21,7.20,U22,7.20,U23,7.20,U24,7.20,U25,7.20,U26,7.20,U27,7.20,U28,7.20,U29,7.20
TDW U30,7.20
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PRP U01U02,015.60,011.00,0057.7,50,,,65.0,,,,598.8
PRP U02U03,029.10,022.00,0402.0,50,,,65.0,,,,1254.9
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PRP U04U05,029.10,022.00,0402.0,50,,,65.0,,,,1254.9
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PRP U07U08,075.60,047.60,1290.0,50,,B,65.0,,,,3286.8
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PRP U09U10,075.60,047.60,1290.0,50,,,65.0,,,,3286.8
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PRP U13U14,109.00,069.40,1990.0,50,,,65.0,,,,4749.6
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PRP U15U16,109.00,069.40,1990.0,50,,,65.0,,,,4749.6
PRP U16U17,091.40,057.80,1610.0,50,,,65.0,,,,3978
PRP U17U18,091.40,057.80,1610.0,50,,,65.0,,,,3978
PRP U18U19,062.00,039.00,1030.0,50,,,65.0,,,,2693
PRP U19U20,062.00,039.00,1030.0,50,,,65.0,,,,2693
PRP U20U21,021.80,017.50,0134.0,50,,,65.0,,,,891.5
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PRP U27U28,147.00,094.50,2880.0,50,,,65.0,,,,6419.4
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PRP L12U12,007.08,004.93,0018.3,50,,,65.0,,,,101.6
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PRP L17U17,019.50,014.90,0270.1,50,,,65.0,,,,383.0
PRP L18U18,007.08,004.93,0018.3,50,,,65.0,,,,95.2
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PRP L20U20,007.08,004.93,0018.3,50,,,65.0,,,,133.8
PRP L21U21,017.10,012.50,0075.1,50,,,65.0,,,,497.4
PRP L22U22,007.08,004.93,0018.3,50,,,65.0,,,,170.4
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PRP L24U24,007.08,004.93,0018.3,50,,,65.0,,,,198.9
PRP L25U25,011.70,008.51,0049.1,50,,,65.0,,,,405.1
PRP L26U26,007.08,004.93,0018.3,50,,,65.0,,,,217.9
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PRP L28U28,007.08,004.93,0018.3,50,,,65.0,,,,227.3
PRP L29U29,011.70,008.51,0049.1,50,,,65.0,,,,426.9
PRP L30U30,007.08,004.93,0018.3,50,,,65.0,,,,229.6
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PRP U02L01,017.90,013.80,0107.0,50,,,65.0,,,,661.7
PRP U02L03,015.60,011.00,0057.7,50,,,65.0,,,,504.2
PRP U04L03,015.60,011.00,0057.7,50,,,65.0,,,,504.2
PRP U04L05,021.80,017.50,0134.0,50,,,65.0,,,,783.3
PRP U06L05,021.80,017.50,0134.0,50,,,65.0,,,,783.3
PRP U06L07,026.50,021.50,0362.0,50,,,65.0,,,,1054.0
PRP U08L07,021.80,017.50,0134.0,50,,,65.0,,,,745.6
PRP U08L09,029.10,022.00,0402.0,50,,,65.0,,,,1117.2
PRP U10L09,026.50,021.50,0362.0,50,,,65.0,,,,1015.5
PRP U10L11,032.00,024.20,0447.0,50,,,65.0,,,,1162.8
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PRP U14L13,026.50,021.50,0362.0,50,,,65.0,,,,878.7
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PRP U24L25,038.80,029.40,0548.0,50,,,65.0,,,,1553.0
PRP U26L25,042.70,026.70,0677.0,50,,,65.0,,,,1731.1
PRP U26L27,029.10,022.00,0402.0,50,,,65.0,,,,1175.8
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PRP U30L29,015.60,011.00,0057.7,50,,,65.0,,,,469.1
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PRP L03L04,026.50,021.50,0362.0,50,,,65.0,,,,1142.2
PRP L04L05,026.50,021.50,0362.0,50,,,65.0,,,,1142.0
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PRP L05L06,035.30,026.70,0495.0,50,,,65.0,,,,1522.6
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PRP L07L08,056.80,035.60,0931.0,50,,,65.0,,,,2464.1
PRP L08L09,056.80,035.60,0931.0,50,,,65.0,,,,2464.1
PRP L09L10,068.50,043.10,1150.0,50,,,65.0,,,,2972.9
PRP L10L11,068.50,043.10,1150.0,50,,,65.0,,,,2972.9
PRP L11L12,083.30,052.60,1440.0,50,,,65.0,,,,3616.9
PRP L12L13,083.30,052.60,1440.0,50,,,65.0,,,,3617.0
PRP L13L14,109.00,069.40,1990.0,50,,,65.0,,,,4739.6
PRP L14L15,117.00,074.60,2170.0,50,,,65.0,,,,5088.4
PRP L15L16,117.00,074.60,2170.0,50,,,65.0,,,,5090.8
PRP L16L17,091.40,057.80,1610.0,50,,,65.0,,,,3971.0
PRP L17L18,068.50,043.10,1150.0,50,,,65.0,,,,2972.2
PRP L18L19,068.50,043.10,1150.0,50,,,65.0,,,,2972.2
PRP L19L20,038.80,029.40,0548.0,50,,,65.0,,,,1672.9
PRP L20L21,038.80,029.40,0548.0,50,,B,65.0,,,,1672.9
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PRP L22L23,024.10,018.60,0148.0,50,,,65.0,,,,983.9
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PRP L24L25,075.60,047.60,1290.0,50,,,65.0,,,,3285.8
PRP L25L26,117.00,074.60,2170.0,50,,,65.0,,,,5100.2
PRP L26L27,117.00,074.60,2170.0,50,,,65.0,,,,5100.2
PRP L27L28,147.00,094.50,2880.0,50,,,65.0,,,,6419.4
PRP L28L29,147.00,094.50,2880.0,50,,,65.0,,,,6419.4
PRP L29L30,162.00,105.00,3250.0,50,,B,65.0,,,,7079.5
EEV U14U15,2000,81.75,56.00,1990.0,,,4749.6
EEV L14L15,-2000,58.50,48.00,2170.0,,,5088.4
FTL 1,,1900,1950,600,,,0.010,,,0.015
OIN 1,0,1
OUT 1,1,1,1,0,0,1
```

8.2.5 Formatted Program Input

CONTROL DATA

Units	Live Load	Dynamic Load Allowance	Distribution Factors Force	Distribution Factors Deflection	Live Load Location	End Condition	**Pinned Support**	Temperature Change	End Bearing
US	A	1.33	0.00	0.00	U	R	**U** 0	0.0	U

Symmetry	Live Load Direction	Fatigue Dynamic Load Allowance	**Permit** Dynamic Load Allowance
Y	B	1.15	1.20

COMPUTED DISTRIBUTION FACTOR

CL of Truss to Curb (ft)	Truss Spacing (ft)	Roadway Width (ft)	Gage Dist (ft)	Pass Dist (ft)
-12.00	24.00	48.00	6.00	4.00

SPAN LENGTHS (CONTINUOUS)

Span #	1	2	3
Length (ft)	150.00	300.00	150.00

TRUSS GEOMETRY

Panel No.	Panel Width (ft)		Vertical Post H1 (ft)	Vertical Post H2 (ft)	Vertical Post H3 (ft)	Panel Type
1	10.00	Y	10.00	0.00	-10.00	3
2	10.00	Y	10.20	0.00	-10.20	5
3	10.00	Y	10.40	0.00	-10.40	6
4	10.00	Y	10.87	0.00	-10.87	5
5	10.00	Y	11.63	0.00	-11.63	6
6	10.00	Y	12.65	0.00	-12.65	5
7	10.00	Y	13.67	0.00	-13.67	6
8	10.00	Y	15.10	0.00	-15.10	5
9	10.00	Y	16.53	0.00	-16.53	6
10	10.00	Y	18.37	0.00	-18.37	5
11	10.00	Y	20.20	0.00	-20.20	6
12	10.00	Y	22.45	0.00	-22.45	5
13	10.00	Y	24.69	0.00	-24.69	6
14	10.00	Y	27.24	0.00	-27.24	5
15	10.00	Y	15.00	15.00	-30.00	8
16	10.00	Y	27.52	0.00	-27.52	11
17	10.00	Y	25.22	0.00	-25.22	6
18	10.00	Y	23.20	0.00	-23.20	5
19	10.00	Y	21.18	0.00	-21.18	6
20	10.00	Y	19.53	0.00	-19.53	5
21	10.00	Y	17.88	0.00	-17.88	6
22	10.00	Y	16.59	0.00	-16.59	5
23	10.00	Y	15.30	0.00	-15.30	6
24	10.00	Y	14.39	0.00	-14.39	5
25	10.00	Y	13.47	0.00	-13.47	6
26	10.00	Y	12.92	0.00	-12.92	5
27	10.00	Y	12.37	0.00	-12.37	6
28	10.00	Y	12.18	0.00	-12.18	5
29	10.00	Y	12.00	0.00	-12.00	6
30	10.00	Y	12.00	0.00	-12.00	5

TRUSS DEAD LOADS

Location	U 0	U 1	U 2	U 3	U 4	U 5	U 6	U 7	U 8	U 9
DC Load (kip)	23.84	45.68	47.19	46.14	47.75	46.39	48.02	46.50	49.60	47.33
DW Load (kip)	3.60	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20

Location	U10	U11	U12	U13	U14	U15	U16	U17	U18	U19
DC Load (kip)	50.79	48.11	52.49	48.84	54.05	49.24	53.66	48.81	53.41	47.23
DW Load (kip)	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20

Location	U20	U21	U22	U23	U24	U25	U26	U27	U28	U29
DC Load (kip)	50.73	46.12	51.01	47.05	56.00	48.88	60.98	50.16	63.87	50.65
DW Load (kip)	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20

Location	U30
DC Load (kip)	51.90
DW Load (kip)	7.20

Location	L 0	L 1	L 2	L 3	L 4	L 5	L 6	L 7	L 8	L 9
DC Load (kip)	-n/a-	2.09	1.11	3.31	1.33	2.98	1.14	4.07	1.73	6.09
DW Load (kip)	-n/a-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Location	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19
DC Load (kip)	2.45	8.16	2.99	10.81	7.64	0.10	7.49	10.42	2.52	6.95
DW Load (kip)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Location	L20	L21	L22	L23	L24	L25	L26	L27	L28	L29
DC Load (kip)	1.31	5.54	1.72	7.41	3.64	11.96	5.40	15.17	6.61	15.61
DW Load (kip)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Location	L30
DC Load (kip)	5.72
DW Load (kip)	0.00

Note: "-n/a-" indicates load cannot be applied to this node due to truss panel geometry.
(node not present or no vertical member defined)

TRUSS MEMBER PROPERTIES (PART 1)

Member ID	Gross Area (in^2)	Net Area (in^2)	Moment of Inertia (in^4)	Yield Strength (ksi)	Unbraced Length (ft)	Fatigue Category	Tensile Strength (ksi)	Eccentricity (in)
U 0U 1	15.60	11.00	57.70	50.0			65.0	0.00
U 1U 2	15.60	11.00	57.70	50.0			65.0	0.00
U 2U 3	29.10	22.00	402.00	50.0			65.0	0.00
U 3U 4	29.10	22.00	402.00	50.0		B	65.0	0.00
U 4U 5	29.10	22.00	402.00	50.0			65.0	0.00
U 5U 6	29.10	22.00	402.00	50.0			65.0	0.00
U 6U 7	75.60	47.60	1290.00	50.0			65.0	0.00
U 7U 8	75.60	47.60	1290.00	50.0		B	65.0	0.00
U 8U 9	75.60	47.60	1290.00	50.0			65.0	0.00
U 9U10	75.60	47.60	1290.00	50.0			65.0	0.00
U10U11	91.40	57.80	1610.00	50.0			65.0	0.00
U11U12	91.40	57.80	1610.00	50.0			65.0	0.00
U12U13	109.00	69.40	1990.00	50.0			65.0	0.00
U13U14	109.00	69.40	1990.00	50.0			65.0	0.00
U14U15	109.00	69.40	1990.00	50.0		B	65.0	0.00
U15U16	109.00	69.40	1990.00	50.0			65.0	0.00
U16U17	91.40	57.80	1610.00	50.0			65.0	0.00
U17U18	91.40	57.80	1610.00	50.0			65.0	0.00
U18U19	62.00	39.00	1030.00	50.0			65.0	0.00
U19U20	62.00	39.00	1030.00	50.0			65.0	0.00
U20U21	21.80	17.50	134.00	50.0			65.0	0.00
U21U22	21.80	17.50	134.00	50.0			65.0	0.00
U22U23	56.80	35.60	931.00	50.0			65.0	0.00
U23U24	56.80	35.60	931.00	50.0			65.0	0.00
U24U25	109.00	69.40	1990.00	50.0			65.0	0.00
U25U26	109.00	69.40	1990.00	50.0			65.0	0.00
U26U27	147.00	94.50	2880.00	50.0			65.0	0.00
U27U28	147.00	94.50	2880.00	50.0			65.0	0.00
U28U29	162.00	105.00	3250.00	50.0			65.0	0.00
U29U30	162.00	105.00	3250.00	50.0			65.0	0.00
L 1L 2	21.80	17.50	134.00	50.0			65.0	0.00

L 2L 3	21.80	17.50	134.00	50.0		65.0	0.00
L 3L 4	26.50	21.50	362.00	50.0		65.0	0.00
L 4L 5	26.50	21.50	362.00	50.0		65.0	0.00
L 5L 6	35.30	26.70	495.00	50.0		65.0	0.00
L 6L 7	35.30	26.70	495.00	50.0		65.0	0.00
L 7L 8	56.80	35.60	931.00	50.0		65.0	0.00
L 8L 9	56.80	35.60	931.00	50.0		65.0	0.00
L 9L10	68.50	43.10	1150.00	50.0		65.0	0.00
L10L11	68.50	43.10	1150.00	50.0		65.0	0.00
L11L12	83.30	52.60	1440.00	50.0		65.0	0.00
L12L13	83.30	52.60	1440.00	50.0		65.0	0.00
L13L14	109.00	69.40	1990.00	50.0		65.0	0.00
L14L15	117.00	74.60	2170.00	50.0		65.0	0.00
L15L16	117.00	74.60	2170.00	50.0		65.0	0.00
L16L17	91.40	57.80	1610.00	50.0		65.0	0.00
L17L18	68.50	43.10	1150.00	50.0		65.0	0.00
L18L19	68.50	43.10	1150.00	50.0		65.0	0.00
L19L20	38.80	29.40	548.00	50.0		65.0	0.00
L20L21	38.80	29.40	548.00	50.0	B	65.0	0.00
L21L22	24.10	18.60	148.00	50.0	B	65.0	0.00
L22L23	24.10	18.60	148.00	50.0		65.0	0.00
L23L24	75.60	47.60	1290.00	50.0		65.0	0.00
L24L25	75.60	47.60	1290.00	50.0		65.0	0.00
L25L26	117.00	74.60	2170.00	50.0		65.0	0.00
L26L27	117.00	74.60	2170.00	50.0		65.0	0.00
L27L28	147.00	94.50	2880.00	50.0		65.0	0.00
L28L29	147.00	94.50	2880.00	50.0		65.0	0.00
L29L30	162.00	105.00	3250.00	50.0	B	65.0	0.00
U 0L 1	21.80	17.50	134.00	50.0		65.0	0.00
L 1U 2	17.90	13.80	107.00	50.0		65.0	0.00
U 2L 3	15.60	11.00	57.70	50.0		65.0	0.00
L 3U 4	15.60	11.00	57.70	50.0		65.0	0.00
U 4L 5	21.80	17.50	134.00	50.0		65.0	0.00
L 5U 6	21.80	17.50	134.00	50.0		65.0	0.00
U 6L 7	26.50	21.50	362.00	50.0		65.0	0.00
L 7U 8	21.80	17.50	134.00	50.0		65.0	0.00
U 8L 9	29.10	22.00	402.00	50.0		65.0	0.00
L 9U10	26.50	21.50	362.00	50.0		65.0	0.00
U10L11	32.00	24.20	447.00	50.0		65.0	0.00
L11U12	24.10	18.60	148.00	50.0		65.0	0.00
U12L13	35.30	26.70	495.00	50.0		65.0	0.00
L13U14	26.50	21.50	362.00	50.0		65.0	0.00
U14M15	15.60	11.00	57.70	50.0		65.0	0.00
U16L17	38.80	29.40	548.00	50.0		65.0	0.00
L17U18	51.80	32.50	838.00	50.0		65.0	0.00
U18L19	38.80	29.40	548.00	50.0		65.0	0.00
L19U20	51.80	32.50	838.00	50.0		65.0	0.00
U20L21	38.80	29.40	548.00	50.0		65.0	0.00
L21U22	51.80	32.50	838.00	50.0		65.0	0.00
U22L23	38.80	29.40	548.00	50.0		65.0	0.00
L23U24	46.70	29.20	748.00	50.0		65.0	0.00
U24L25	38.80	29.40	548.00	50.0		65.0	0.00
L25U26	42.70	26.70	677.00	50.0		65.0	0.00
U26L27	29.10	22.00	402.00	50.0		65.0	0.00
L27U28	26.50	21.50	362.00	50.0		65.0	0.00
U28L29	17.90	13.80	107.00	50.0		65.0	0.00
L29U30	15.60	11.00	57.70	50.0		65.0	0.00
L14M15	29.10	22.00	402.00	50.0		65.0	0.00
M15L16	38.80	29.40	548.00	50.0		65.0	0.00
L 1U 1	9.13	6.65	37.10	50.0		65.0	0.00
L 2U 2	7.08	4.93	18.30	50.0		65.0	0.00
L 3U 3	9.13	6.65	37.10	50.0		65.0	0.00
L 4U 4	7.08	4.93	18.30	50.0		65.0	0.00
L 5U 5	9.13	6.65	37.10	50.0		65.0	0.00
L 6U 6	7.08	4.93	18.30	50.0		65.0	0.00
L 7U 7	11.70	8.51	49.10	50.0		65.0	0.00
L 8U 8	7.08	4.93	18.30	50.0		65.0	0.00
L 9U 9	11.70	8.51	49.10	50.0		65.0	0.00
L10U10	7.08	4.93	18.30	50.0		65.0	0.00
L11U11	17.10	12.50	75.10	50.0		65.0	0.00
L12U12	7.08	4.93	18.30	50.0		65.0	0.00
L13U13	17.10	12.50	75.10	50.0		65.0	0.00
L14U14	38.80	29.40	548.00	50.0		65.0	0.00
M15U15	11.70	8.51	49.10	50.0		65.0	0.00

L16U16	46.70	29.20	748.00	50.0	65.0	0.00
L17U17	19.50	14.90	270.10	50.0	65.0	0.00
L18U18	7.08	4.93	18.30	50.0	65.0	0.00
L19U19	17.10	12.50	75.10	50.0	65.0	0.00
L20U20	7.08	4.93	18.30	50.0	65.0	0.00
L21U21	17.10	12.50	75.10	50.0	65.0	0.00
L22U22	7.08	4.93	18.30	50.0	65.0	0.00
L23U23	11.70	8.51	49.10	50.0	65.0	0.00
L24U24	7.08	4.93	18.30	50.0	65.0	0.00
L25U25	11.70	8.51	49.10	50.0	65.0	0.00
L26U26	7.08	4.93	18.30	50.0	65.0	0.00
L27U27	11.70	8.51	49.10	50.0	65.0	0.00
L28U28	7.08	4.93	18.30	50.0	65.0	0.00
L29U29	11.70	8.51	49.10	50.0	65.0	0.00
L30U30	7.08	4.93	18.30	50.0	65.0	0.00
L15M15	51.80	32.50	838.00	50.0	65.0	0.00

TRUSS MEMBER PROPERTIES (PART 2)

Member ID	Moment Resistance* (kip-ft)	Tensile Resistance* (kips)	Compressive Resistance* (kips)
U 0U 1			598.80
U 1U 2			598.80
U 2U 3			1254.90
U 3U 4			1254.90
U 4U 5			1254.90
U 5U 6			1254.90
U 6U 7			3286.80
U 7U 8			3286.80
U 8U 9			3286.80
U 9U10			3286.80
U10U11			3978.00
U11U12			3978.00
U12U13			4749.60
U13U14			4749.60
U14U15			4749.60
U15U16			4749.60
U16U17			3978.00
U17U18			3978.00
U18U19			2693.00
U19U20			2693.00
U20U21			891.50
U21U22			891.50
U22U23			2465.90
U23U24			2465.90
U24U25			4749.60
U25U26			4749.60
U26U27			6419.40
U27U28			6419.40
U28U29			7079.50
U29U30			7079.50
L 1L 2			891.50
L 2L 3			891.50
L 3L 4			1142.20
L 4L 5			1142.00
L 5L 6			1522.60
L 6L 7			1522.60
L 7L 8			2464.10
L 8L 9			2464.10
L 9L10			2972.90
L10L11			2972.90
L11L12			3616.90
L12L13			3617.00
L13L14			4739.60
L14L15			5088.40
L15L16			5090.80
L16L17			3971.00
L17L18			2972.20
L18L19			2972.20
L19L20			1672.90
L20L21			1672.90
L21L22			983.90
L22L23			983.90

L23L24	3285.80
L24L25	3285.80
L25L26	5100.20
L26L27	5100.20
L27L28	6419.40
L28L29	6419.40
L29L30	7079.50
U 0L 1	810.20
L 1U 2	661.70
U 2L 3	504.20
L 3U 4	504.20
U 4L 5	783.30
L 5U 6	783.30
U 6L 7	1054.00
L 7U 8	745.60
U 8L 9	1117.20
L 9U10	1015.50
U10L11	1162.80
L11U12	666.80
U12L13	1179.70
L13U14	878.70
U14M15	418.80
U16L17	1285.20
L17U18	1783.90
U18L19	1389.50
L19U20	1909.60
U20L21	1466.10
L21U22	2001.20
U22L23	1519.30
L23U24	1859.00
U24L25	1553.00
L25U26	1731.10
U26L27	1175.80
L27U28	1069.50
U28L29	633.60
L29U30	469.10
L14M15	1177.40
M15L16	1569.00
L 1U 1	355.50
L 2U 2	251.50
L 3U 3	351.30
L 4U 4	243.50
L 5U 5	337.80
L 6U 6	221.40
L 7U 7	402.00
L 8U 8	189.70
L 9U 9	356.20
L10U10	147.90
L11U11	442.00
L12U12	101.60
L13U13	340.20
L14U14	1282.00
M15U15	381.10
L16U16	1591.40
L17U17	383.00
L18U18	95.20
L19U19	418.70
L20U20	133.80
L21U21	497.40
L22U22	170.40
L23U23	376.30
L24U24	198.90
L25U25	405.10
L26U26	217.90
L27U27	421.50
L28U28	227.30
L29U29	426.90
L30U30	229.60
L15M15	2148.00

*NOTE: A blank field indicates that the user has not input a value for this resistance.
The program can calculate tensile resistance based on other user input.

EXTREME EVENT

Member ID	Force (kips)	Gross Area (in^2)	Net Area (in^2)	Moment of Inertia (in^4)	Moment Resistance (kip-ft)	Tensile Resistance (kips)	Compressive Resistance (kips)
U14U15	2000.0	81.75	56.00	1990.00			4749.60
L14L15	-2000.0	58.50	48.00	2170.00			5088.40

FATIGUE LIFE

Distribution Factor For Fatigue	PA Traffic Factor	Year Built	Recent Year	Count ADTT	Previous Year	Count ADTT	Previous Growth Rate	Future Year	Count ADTT	Future Growth Rate
1.000	**N/A**	1900	1950	600.			0.010			0.015

OUTPUT OF INPUT

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT

Section Properties	Analysis and Spec Checking	Extreme Event	Rating Summary	Detailed Gussets	Gusset Summary	Ratings w/o FWS
1	1	1	1	0	0	1

8.3 EXAMPLE PROBLEM 2 - CAMELBACK THROUGH TRUSS

8.3.1 Problem Description

This is an example of a simple span through truss bridge. The truss has 8 panels and is geometrically symmetric. Each panel length is 24’-2 1/4” for a total span length of 193’-6”. Figure 1 shows a half-elevation view where the numbers in the boxes are the panel numbers corresponding to the GEO command in the input file. The bottom chord geometry is level for the roadway support and the top chord follows a curved geometry to create the camelback shape. Mid-length struts are shown for panels 3-6, which reduce the unsupported length of the verticals and diagonals within those panels. (Note: The struts are not input.) The deck system is assumed to be a reinforced concrete slab supported on stringers spanning between rolled steel I-beam floorbeams attached at the bottom panel points. Figure 2 gives the assumed deck cross section including the design lane layout.

8.3.2 Input

The following input parameters are entered. Refer to the completed data file shown in section 8.3.4.

A. Title Command (TTL)
   “Example 2”

B. Control Command (CTL)
   1. The system of units is “US”.
   2. In order to obtain ratings for multiple live load placement, “A” is selected.
   3. Dynamic Load Allowance is calculated by the program.
   4. Distribution factors for force and deflection are computed by the program for each lane loaded.
   5. “L” is entered for a thru truss.
   6. “R” is entered for members connected together with bolts.
   7. **Pinned support** location is set to “L0”.
   8. Temperature Change is left blank since thermal loading is not of interest in this example.
   9. End bearing is set to “L” for bearings located at the lower panel points.
   10. Symmetry is applicable, therefore, set to “Y”.
   11. Live Load Direction can be oriented either stations ahead or back, therefore, set to “B”.
   12. Fatigue Dynamic Load Allowance is to be defaulted to 1.15, therefore, left blank.
   13. P**ermit** Dynamic Load Allowance is to be defaulted to 1.20, therefore, left blank.

C. Computed Distribution Factor Command (CDF)
   1. The centerline of truss to inside face of curb is set to 1.5 for a truss outside the roadway a distance of 1’-6”.
   2. The truss spacing is set to 39.00 for a distance center-to-center of trusses of 39’ 0”.
   3. The roadway width is set to 36.00 for three design traffic lanes of 12’-0” each.
   4. The gage distance is set to the default value of 6.00’ when left blank.

5. The passing distance is set to the default value of 4.00' when left blank.

D. Span Length Command (SPL)

The center-to-center of bearings span is input as 193.50 feet.

E. Geometry Command (GEO)

1. Since the truss is declared symmetrical only the geometry of panels 1 through 4 is described.
2. The first PANEL NUMBER is 1, since there is no vertical member L0U0.
3. All PANEL WIDTHS are equal to 24.1875 feet.
4. "Y" is entered for Y OR N since a vertical is present in each panel.
5. The length of the vertical member on the right side of each panel, as shown on Figure 1, is entered for H1.
6. The values of H2 are left blank for each panel because there are no joints between the upper and lower joints. Data for the struts shown in panels 3 through 6 is not entered here.
7. The values of H3 are left blank for each panel since the bottom chord is assumed to be on a zero grade for simplicity.
8. The PANEL TYPE is coded for each panel according to Figure 5.11-1.

F. Truss Dead Load (DC) Command (TDC)

Values for the sum of estimated truss member, bracing, floorbeam, and deck system weights tributary to each truss connection location are computed and entered. Note that Truss (DW) Dead Loads are not entered for this example.

G. Truss Member Properties Command (PRP)

1. All truss member gross and net properties were input for each member. For this particular example it is assumed that all member end connections are concentric; therefore, the eccentricity parameter is left blank to default to zero.
2. The member yield strength value of 33 ksi is selected and entered.
3. The member tensile strength parameter 58 ksi is selected and entered.
4. Unbraced lengths are computed and entered for members connected to the bracing in panels 3 and 4.
5. The Tensile Resistance value is entered for each member.
6. The Compressive Resistance value is entered for each member.

H. Gusset Plate Command (GUS)

The Gusset plate parameters are defined for the gussets shown in Figures 3 through 6. Plate yield stress and tensile strength are the same as for the truss elements.

I. Gusset Plate Member Command (GMB)

Bolt layout and quantities are as shown in Figures 3 through 6.

J. Output of Input Data Command (OIN)

For this example, the first and third parameters of this command are set to "1" in order to provide an echo of the input data file as well as presentation of the input in a compact, yet easily understood format with headings.

K. Output Command (OUT)

Except for those related to extreme event analysis, all parameters of this command are set to “1” so the full set of output data applicable to this example may be viewed.

8.3.3 Output

Refer to section 8.3.5 for the partial output of this example problem.

A. All input values are printed for verification.

B. All computed values are printed with an appropriate heading. For details, refer to the section on OUTPUT DESCRIPTION in this manual.

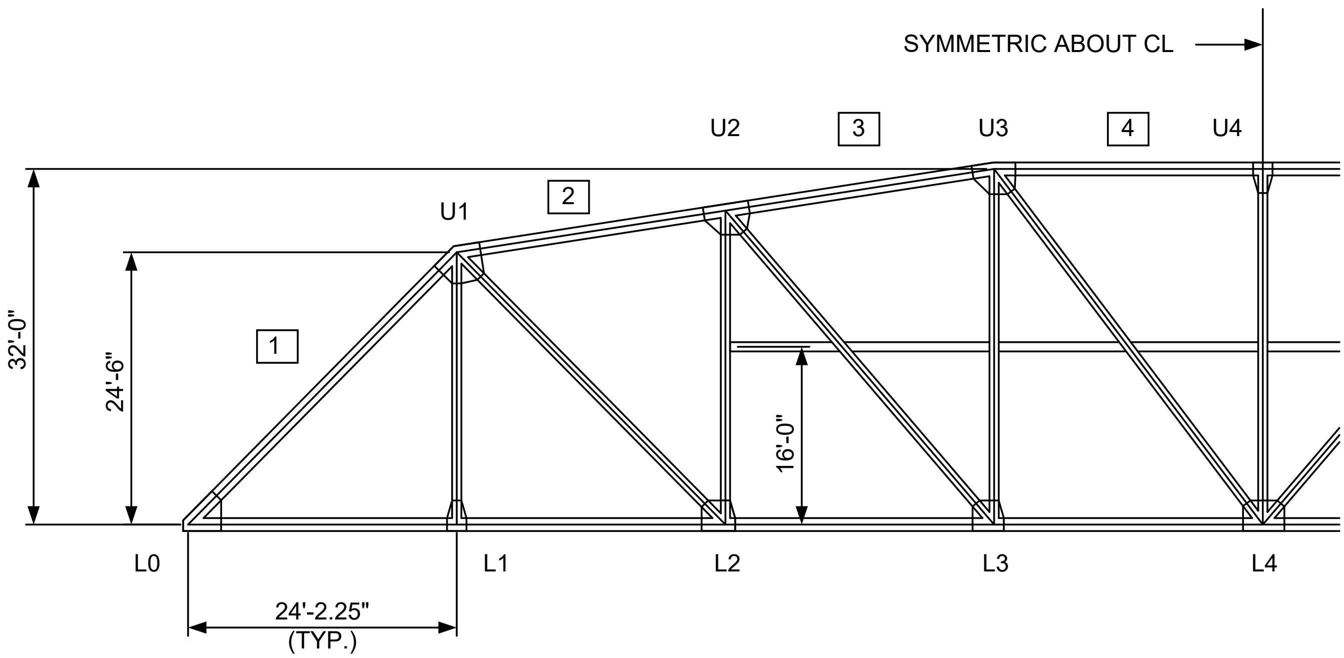

Figure 8.3-1 Example 2 Elevation

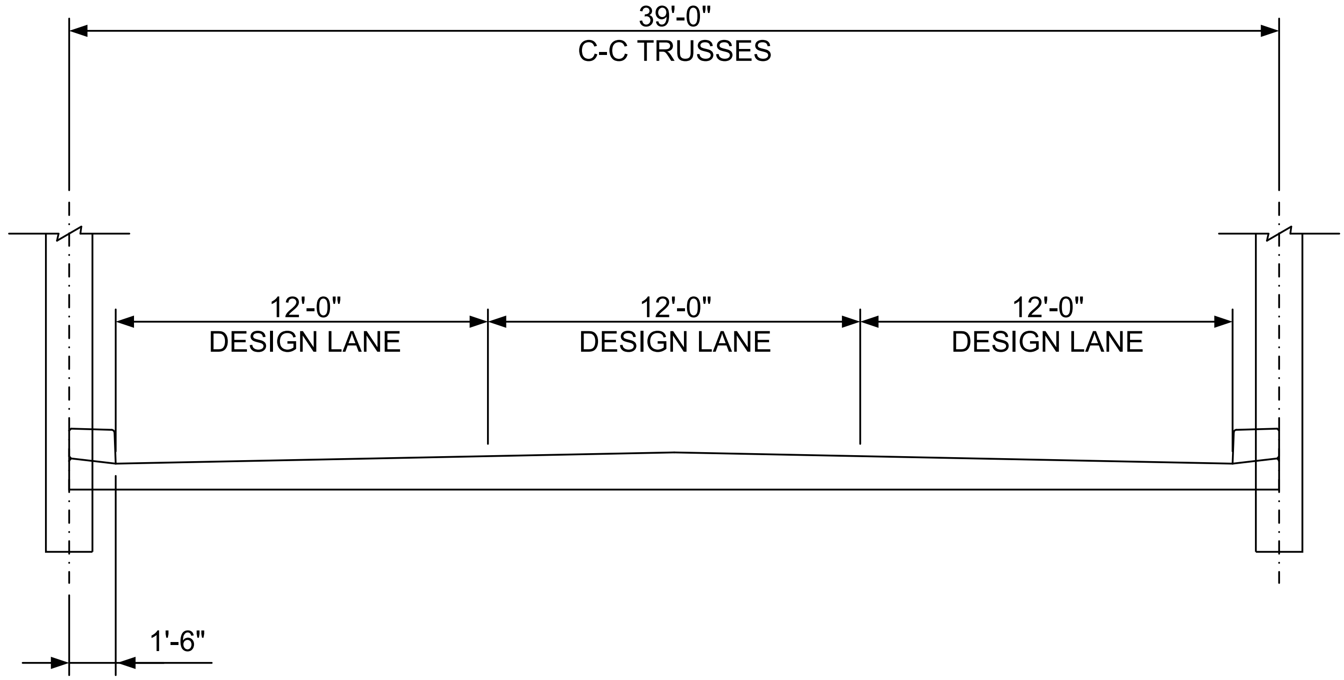

Figure 8.3-2 Typical Cross Section

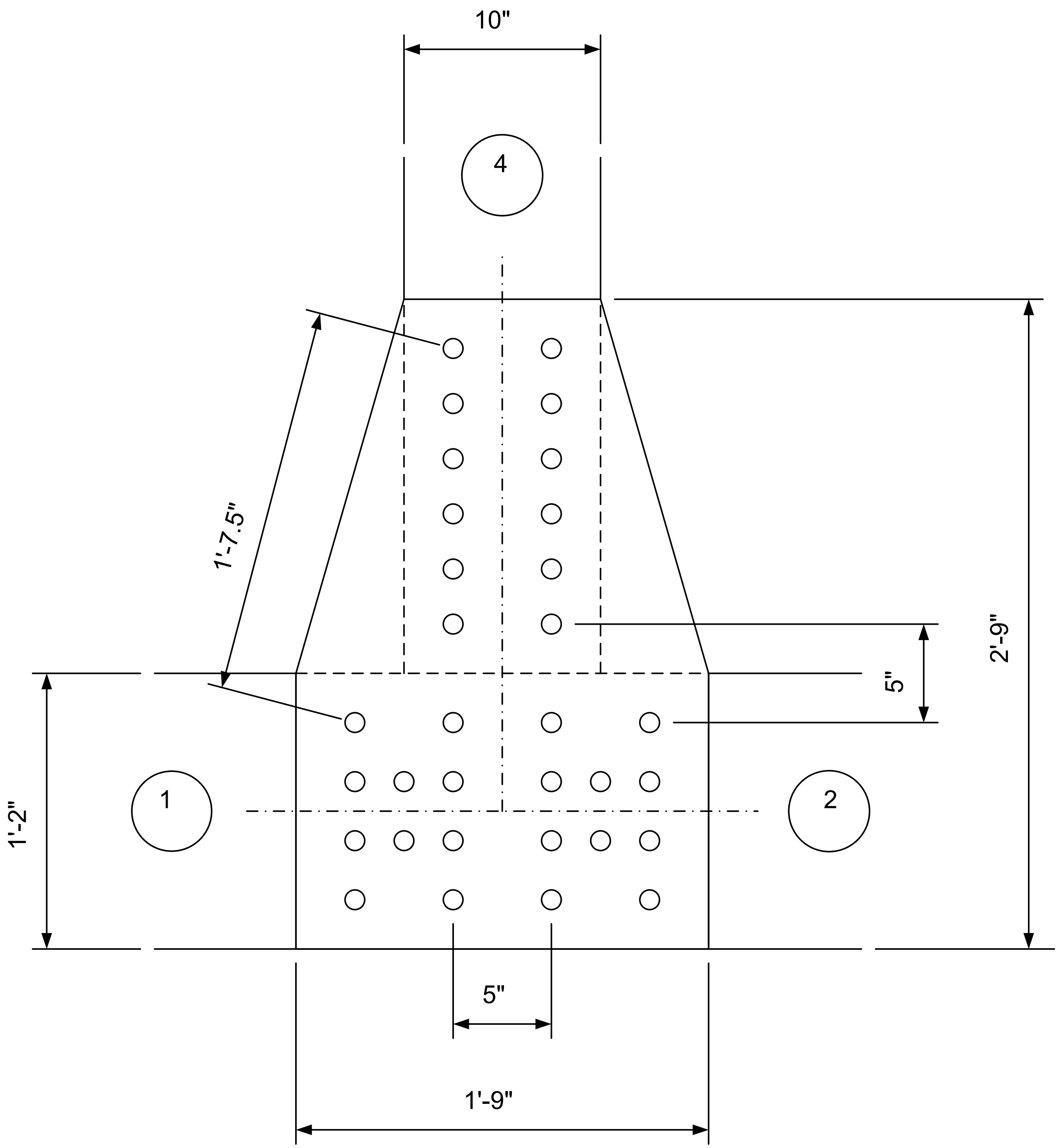

Figure 8.3-3 Gusset Plate at L1

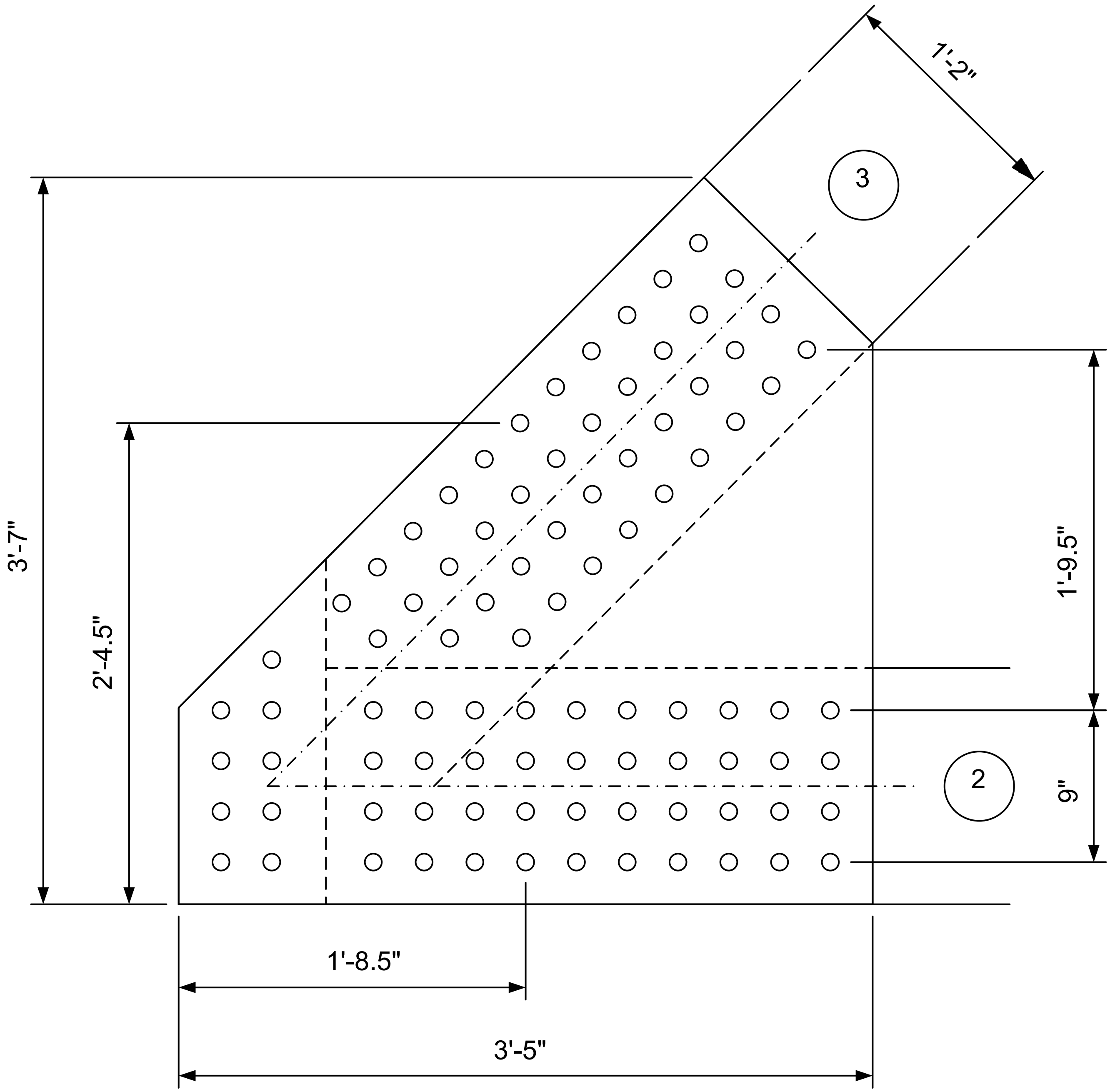

Figure 8.3-4 Gusset Plate at L0

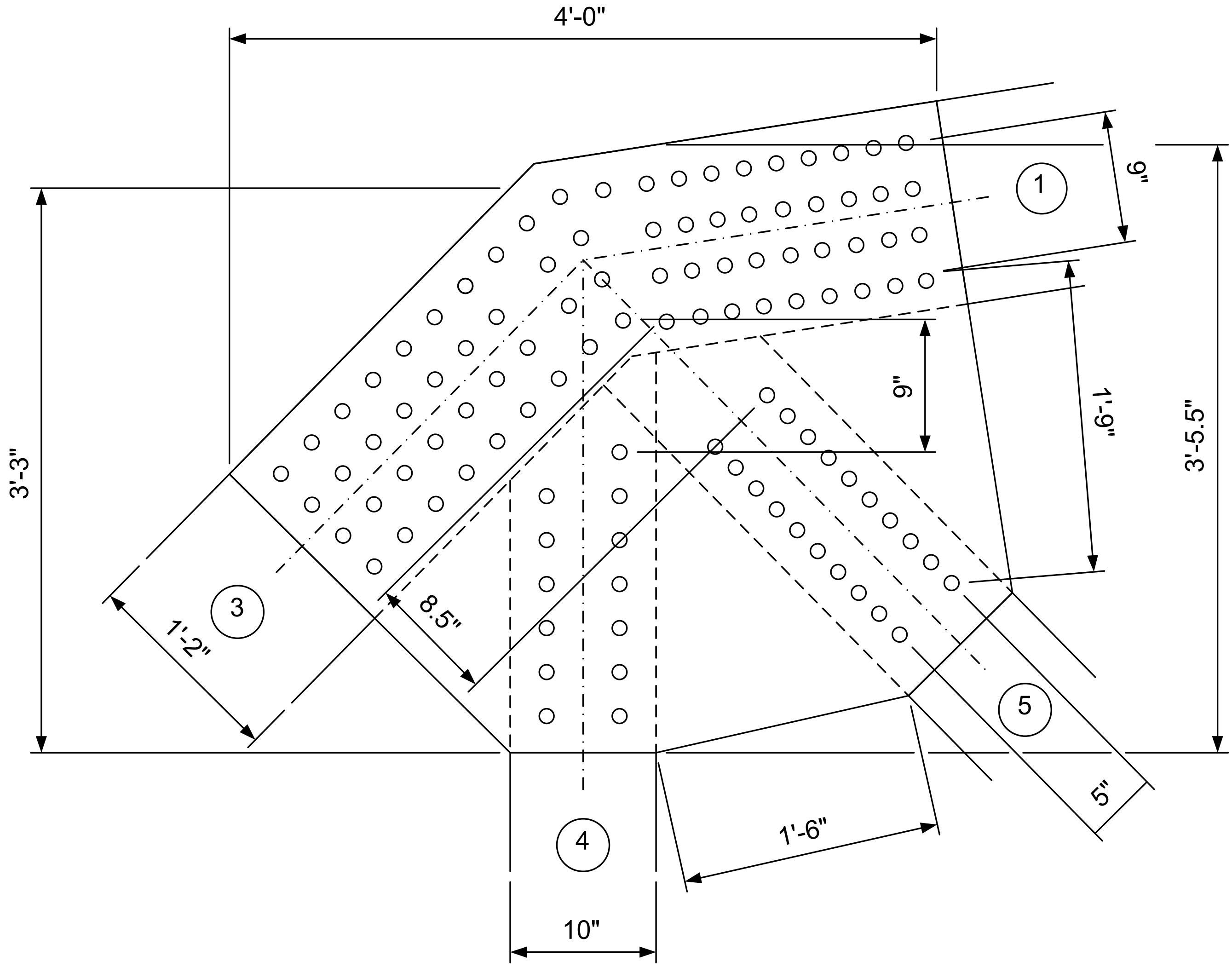

Figure 8.3-5   Gusset Plate at U1

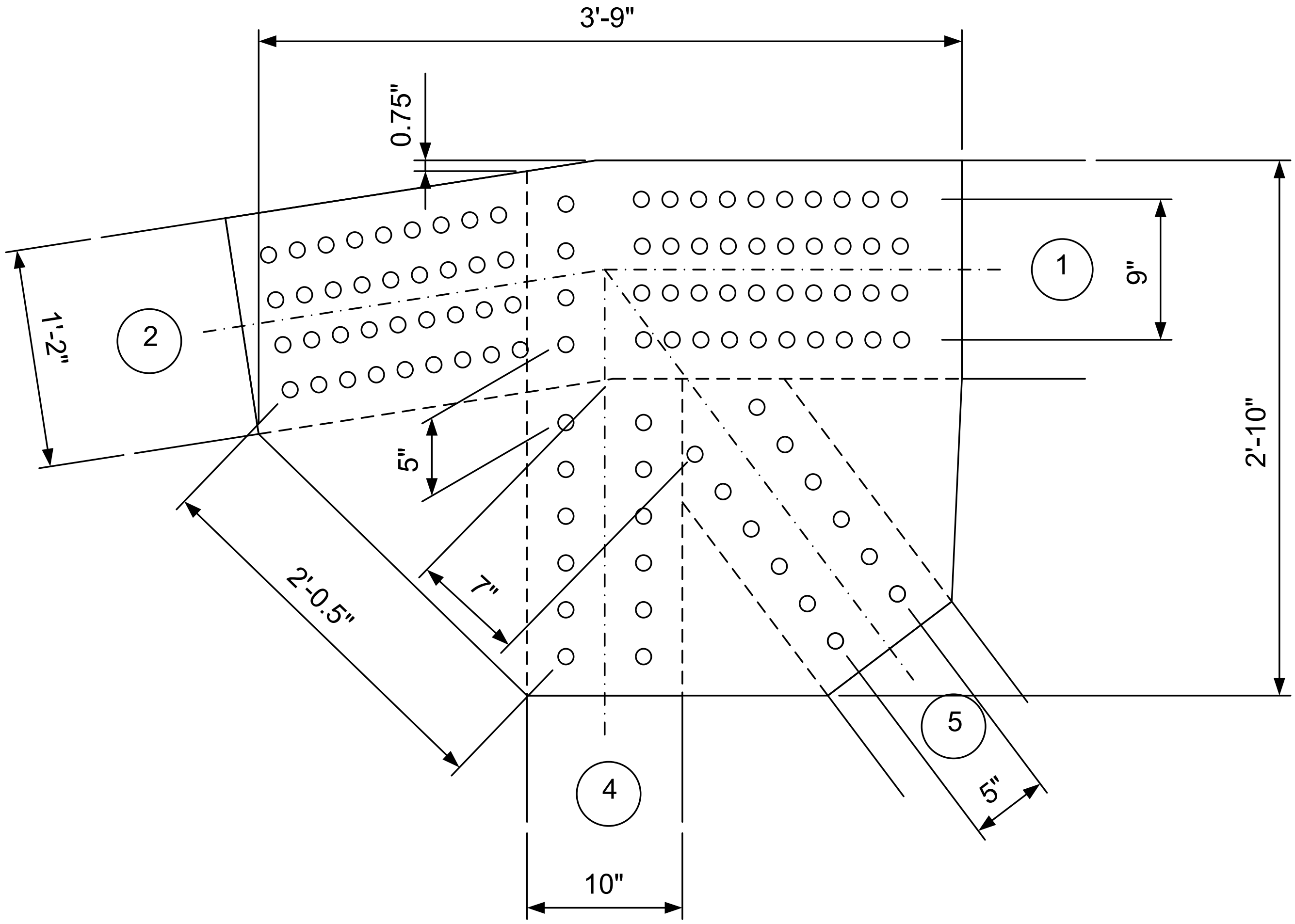

Figure 8.3-6 Gusset Plate at U3

8.3.4 Data Input File

```
!
! ** Created by EngAsst **
! EngAsst Information: [Program=TRLRFD] [Version=1.1.0.0]
! ** Data Records Start Here **
TTL Example 2
CTL US,A,,,,L,R,L0,,L,Y,B
CDF 1.50,39.00,36.00
SPL 193.5
GEO 1,24.187,Y,24.5,,,1
GEO 2,24.187,Y,28.25,,,6
GEO 3,24.187,Y,32,,,6
GEO 4,24.187,Y,32,,,6
TDC L0,31.65
TDC L1,54.01
TDC L2,56.01
TDC L3,60.18
TDC L4,60.15
TDC U1,7.49
TDC U2,8.37
TDC U3,6.68
TDC U4,9.11
```

```
PRP L0L1,25.8,21.8,814.6,33,,,58,,,882.4,772.9
PRP L1L2,25.8,21.8,814.6,33,,,58,,,882.4,772.9
PRP L2L3,37.5,31.5,1260,33,,,58,,,1282.5,1128.7
PRP L3L4,41.6,33.6,1675.7,33,,,58,,,1422.7,1267.5
PRP U1U2,36,36,822.0,33,,,58,,,1231.2,1043.8
PRP U2U3,38.5,38.5,946.7,33,,,58,,,1316.7,1125.2
PRP U3U4,41,41,1075.9,33,,,58,,,1402.2,1208.8
PRP L1U1,18.5,18.5,599.5,33,,,58,,,632.7,554.2
PRP L2U2,18.5,18.5,599.5,33,16,,58,,,632.7,579.7
PRP L3U3,12.5,12.5,244.9,33,16,,58,,,427.5,383.2
PRP L4U4,12.5,12.5,244.9,33,16,,58,,,427.5,383.2
PRP L0U1,43.5,43.5,1209.5,33,,,58,,,1487.7,1176.7
PRP L2U1,17,17,339.4,33,,,58,,,581.4,428.4
PRP L3U2,26.5,21.2,467.5,33,21.06,,58,,,906.3,771.9
PRP L4U3,26.5,21.2,467.5,33,20.06,,58,,,906.3,779.6
GUS U1,33,58,1,44,40,39,5,5,18,120,1,51,,3.0
GUS U3,33,58,1,48,34.25,34.25,5,5,25,120,1,51,,5.0
GUS L0,33,58,1,41,28,28,14,14,21.375,120,1,51,,3.0
GUS L1,33,58,0.75,21,33,33,5,5,19.5,120,1,51,,5.0
GMB U1,9,22.5,4,9,,,,,,,9,22.5,4,9,33,0,5,18,2,13,,9,5,18,2,10,,9
GMB U3,9,18,4,10,,9,19,4,10,,,,,,,,5,15,2,6,,5,5,15,2,6,,6
GMB L0,,,,,,9,27,4,10,,9,12,4,9,,0
GMB L1,9,12,4,5,16,9,12,4,5,16,,,,,,,5,15,2,6,,5
OIN 1,0,1
```

8.3.5 Formatted Program Input

CONTROL DATA

Units	Live Load	Dynamic Load Allowance	Distribution Factors Force	Distribution Factors Deflection	Live Load Location	End Condition	Pinned Support	Temperature Change	End Bearing
US	A	1.33	0.00	0.00	L	R	L 0	0.0	L

Symmetry	Live Load Direction	Fatigue Dynamic Load Allowance	Permit Dynamic Load Allowance
Y	B	1.15	1.20

COMPUTED DISTRIBUTION FACTOR

CL of Truss to Curb (ft)	Truss Spacing (ft)	Roadway Width (ft)	Gage Dist (ft)	Pass Dist (ft)
1.50	39.00	36.00	6.00	4.00

SPAN LENGTHS (SIMPLE)

Span #	1
Length (ft)	193.50

TRUSS GEOMETRY

Panel No.	Panel Width (ft)		Vertical Post H1 (ft)	H2 (ft)	H3 (ft)	Panel Type
1	24.19	Y	24.50	0.00	0.00	1
2	24.19	Y	28.25	0.00	0.00	6
3	24.19	Y	32.00	0.00	0.00	6
4	24.19	Y	32.00	0.00	0.00	6

TRUSS DEAD LOADS

Location	U 0	U 1	U 2	U 3	U 4
DC Load (kip)	-n/a-	7.49	8.37	6.68	9.11
DW Load (kip)	-n/a-	0.00	0.00	0.00	0.00

Location	L 0	L 1	L 2	L 3	L 4
DC Load (kip)	31.65	54.01	56.01	60.18	60.15
DW Load (kip)	0.00	0.00	0.00	0.00	0.00

Note: "-n/a-" indicates load cannot be applied to this node due to truss panel geometry. (node not present or no vertical member defined)

TRUSS MEMBER PROPERTIES (PART 1)

Member ID	Gross Area (in^2)	Net Area (in^2)	Moment of Inertia (in^4)	Yield Strength (ksi)	Unbraced Length (ft)	Fatigue Category	Tensile Strength (ksi)	Eccentricity (in)
U 1U 2	36.00	36.00	822.00	33.0			58.0	0.00
U 2U 3	38.50	38.50	946.70	33.0			58.0	0.00
U 3U 4	41.00	41.00	1075.90	33.0			58.0	0.00
L 0L 1	25.80	21.80	814.60	33.0			58.0	0.00
L 1L 2	25.80	21.80	814.60	33.0			58.0	0.00
L 2L 3	37.50	31.50	1260.00	33.0			58.0	0.00
L 3L 4	41.60	33.60	1675.70	33.0			58.0	0.00
L 0U 1	43.50	43.50	1209.50	33.0			58.0	0.00
U 1L 2	17.00	17.00	339.40	33.0			58.0	0.00
U 2L 3	26.50	21.20	467.50	33.0	21.06		58.0	0.00
U 3L 4	26.50	21.20	467.50	33.0	20.06		58.0	0.00
L 1U 1	18.50	18.50	599.50	33.0			58.0	0.00
L 2U 2	18.50	18.50	599.50	33.0	16.00		58.0	0.00
L 3U 3	12.50	12.50	244.90	33.0	16.00		58.0	0.00
L 4U 4	12.50	12.50	244.90	33.0	16.00		58.0	0.00

TRUSS MEMBER PROPERTIES (PART 2)

Member ID	Moment Resistance* (kip-ft)	Tensile Resistance* (kips)	Compressive Resistance* (kips)
U 1U 2		1231.20	1043.80
U 2U 3		1316.70	1125.20
U 3U 4		1402.20	1208.80
L 0L 1		882.40	772.90
L 1L 2		882.40	772.90
L 2L 3		1282.50	1128.70
L 3L 4		1422.70	1267.50
L 0U 1		1487.70	1176.70
U 1L 2		581.40	428.40
U 2L 3		906.30	771.90
U 3L 4		906.30	779.60
L 1U 1		632.70	554.20
L 2U 2		632.70	579.70
L 3U 3		427.50	383.20
L 4U 4		427.50	383.20

*NOTE: A blank field indicates that the user has not input a value for this resistance. The program can calculate tensile resistance based on other user input.

GUSSET PLATE SECTION PROPERTIES **PART 1 OF 2**

GUSSET ID	FY (ksi)	FU (ksi)	T (in)	CROSS SECTION GEOMETRY HA (in)	HB (in)	HC (in)	EB (in)	EC (in)	B (in)
U 1	33.0	58.0	1.000	44.00	40.00	39.00	5.00	5.00	18.00
U 3	33.0	58.0	1.000	48.00	34.25	34.25	5.00	5.00	25.00
L 0	33.0	58.0	1.000	41.00	28.00	28.00	14.00	14.00	21.38
L 1	33.0	58.0	0.750	21.00	33.00	33.00	5.00	5.00	19.50

GUSSET PLATE SECTION PROPERTIES **PART 2 OF 2**

GUSSET ID	FASTENERS FUB (ksi)	**Bolt** D (in)	**Pt (kip)**	**Surface Condition (Class)**	**Lspl (in)**	**Hole Diameter (in)**
U 1	**12**0.	1.000	**51.0**	**A**	**3.00**	**1.125**
U 3	**12**0.	1.000	**51.0**	**A**	**5.00**	**1.125**
L 0	**12**0.	1.000	**51.0**	**A**	**3.00**	**1.125**
L 1	**12**0.	1.000	**51.0**	**A**	**5.00**	**1.125**

GUSSET PLATE MEMBER PROPERTIES PART 1 OF 3

Gusset ID	MEMBER # 1 W1 (in)	L1 (in)	NT1	NL1	NTT1	MEMBER # 2 W2 (in)	L2 (in)	NT2	NL2	NTT2
U 1	9.00	22.50	4	9	36	0.00	0.00	0	0	0
U 3	9.00	18.00	4	10	40	9.00	19.00	4	10	40
L 0	0.00	0.00	0	0	0	9.00	27.00	4	10	40
L 1	9.00	**12**.00	4	**5**	**16**	9.00	**12**.00	4	**5**	**16**

GUSSET PLATE MEMBER PROPERTIES PART 2 OF 3

Gusset ID	MEMBER # 3 W3 (in)	L3 (in)	NT3	NL3	NTT3	LC3 (in)	MEMBER # 4 W4 (in)	L4 (in)	NT4	NL4	NTT4	LC4 (in)
U 1	9.00	22.50	4	9	33	0.00	5.00	18.00	2	13	26	9.00
U 3	0.00	0.00	0	0	0	0.00	5.00	15.00	2	6	12	5.00
L 0	9.00	12.00	4	9	36	0.00	0.00	0.00	0	0	0	0.00
L 1	0.00	0.00	0	0	0	0.00	5.00	15.00	2	6	12	5.00

GUSSET PLATE MEMBER PROPERTIES PART 3 OF 3

Gusset ID	MEMBER # 5 W5 (in)	L5 (in)	NT5	NL5	NTT5	LC5 (in)
U 1	5.00	18.00	2	10	20	9.00
U 3	5.00	15.00	2	6	12	6.00
L 0	0.00	0.00	0	0	0	0.00
L 1	0.00	0.00	0	0	0	0.00

OUTPUT OF INPUT

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT

Section Properties	Analysis and Spec Checking	Extreme Event	Rating Summary	Detailed Gussets	Gusset Summary	Ratings w/o FWS
1	1	1	1	1	1	1

8.4 EXAMPLE PROBLEM 3 – SINGLE SPAN THROUGH TRUSS WITH COUNTERS

8.4.1 Problem Description

This is an example of a single span through truss bridge. The truss has 6 panels and is geometrically symmetric. The center two panels have counter (tension only) members. Figure 1 shows an elevation view where the numbers in the boxes are the panel numbers corresponding to the GEO command in the input file.

The deck system is assumed to be timber supported by stringers. The floorbeams are attached at the bottom panel points. Figure 2 gives the assumed deck cross section including the design lane layout.

8.4.2 Input

The following input parameters are entered. Refer to the completed data file shown in section 8.4.4.

A. Title Command (TTL)
   "Example 3"

B. Control Command (CTL)
   1. The system of units is "US".
   2. In order to obtain TK527 load ratings for this example bridge, "G" is selected.
   3. Left blank for selection of the default Impact Factor of 1.33.
   4. Left blank for the program to calculate the live load distribution factor.
   5. Left blank for the program to calculate the live load distribution factor.
   6. Left blank for selection of the default "L" for a through truss.
   7. Left blank for selection of the default "P" for pin connected members.
   8. Left blank for selection of the default fixed support bearing conditions at the lower chord at support 1.
   9. Temperature Change is left blank since thermal loading is not of interest in this example.
   10. Left blank for selection of the default end bearing "L" for bearings located at the lower panel points.
   11. Symmetry is applicable, therefore, set to "Y".
   12. Live Load Direction can be oriented either stations ahead or back, therefore, left blank for both direction default "B".
   13. Fatigue Dynamic Load Allowance is to be defaulted to 1.15, therefore, left blank.
   14. P**ermit** Dynamic Load Allowance is to be defaulted to 1.20, therefore, left blank.

C. Computed Distribution Factor Command (CDF)
   1. The centerline of truss to inside face of curb is set to 1.4 for a truss outside the roadway a distance of 1'-5".
   2. The truss spacing is set to 16.00 for a distance center-to-center of trusses of 16' 0".
   3. The roadway width is set to 13.00 for a single traffic lane of 13'-0".

4. The gage distance is set to the default value of 6.00' when left blank.
5. The passing distance is set to the default value of 4.00' when left blank.

D. Span Length Command (SPL)

The center-to-center of bearings span is input as 89.10 feet since there are six equal panel lengths of 14'-10 3/16", or 14.85 feet each.

E. Geometry Command (GEO)

1. Since the truss is declared symmetrical only the geometry of panels 1, 2 and 3 are described.
2. The first PANEL NUMBER is 1, since there is no vertical member L0U0.
3. All PANEL WIDTHS are entered as 14.85.
4. "Y" is entered for Y OR N since a vertical is present in each panel.
5. The length of the vertical member on the right side of each panel of 16'-0" is entered as 16.00 feet for H1.
6. The value of H2 is left blank for each panel because there are no joints between the upper and lower joints.
7. The input parameter for H3 is left blank based on the truss panel types.
8. The PANEL TYPE is coded for each panel according to Figure 5.11-1.

F. Truss Dead Load (DC) Command (TDC)

Values for the sum of estimated truss member, bracing, floorbeam, and deck weights tributary to each truss connection location are computed and entered.

Note that Truss (DW) Dead Loads are not entered for this example.

G. Truss Member Properties Command (PRP)

Members consist of: Built up channel sections (plates attached to angles), laced angles (two angles attached by lacing), and eye bars. These members are designated on Figure 8.4-1. The member size and geometry are as follows:

Member A – Channel shape consisting of 2 angles (6x6x1) with a ½" plate for a total depth of 14".
Member B – 2 bars at 2" x 1.5"
Member C – 2 square bars at 1.5"
Member D – Channel shape consisting of 2 angles laced together (5x5x1/2) NOTE that lacing only increases compressive resistance.
Member E – 2 bars at 2" x 1"
Member F – 2" round bar

1. For truss members (except Member A), gross properties were input for each member.
2. For each of these members (except Member A) the net area equals the gross area, i.e. tension fracture is not a controlling failure mode.
3. Also, for these members (except Member A), end connections are concentric; therefore, the eccentricity and moment resistance values are left blank.

4. Member material strength values consistent with a yield strength of 36 ksi are entered.
5. The fatigue design resistance category parameters are left blank since remaining fatigue life estimates are not of interest in this example.
6. The Tensile Resistance value is computed by the program.
7. The Compressive Resistance value is entered for each member.
8. For Member A, Use Type 16 Section Properties Command (T16) – Member net areas are computed, if needed, by the program. Member end eccentricities have been computed and entered for these sections.

H. Output of Input Data Command (OIN)

For this example, the first and third parameters of this command are set to "1" in order to provide an echo of the input data file as well as presentation of the input in a compact, yet easily understood format with headings.

I. Output Command (OUT)

Except for those related to extreme event and gusset analyses, all parameters of this command are set to "1" so the full set of output data applicable to this example may be viewed.

8.4.3 Output

Refer to section 8.4.5 for the partial output of this example problem.

A. All input values are printed for verification.

B. All computed values are printed with an appropriate heading. For details, refer to the section on OUTPUT DESCRIPTION in this manual.

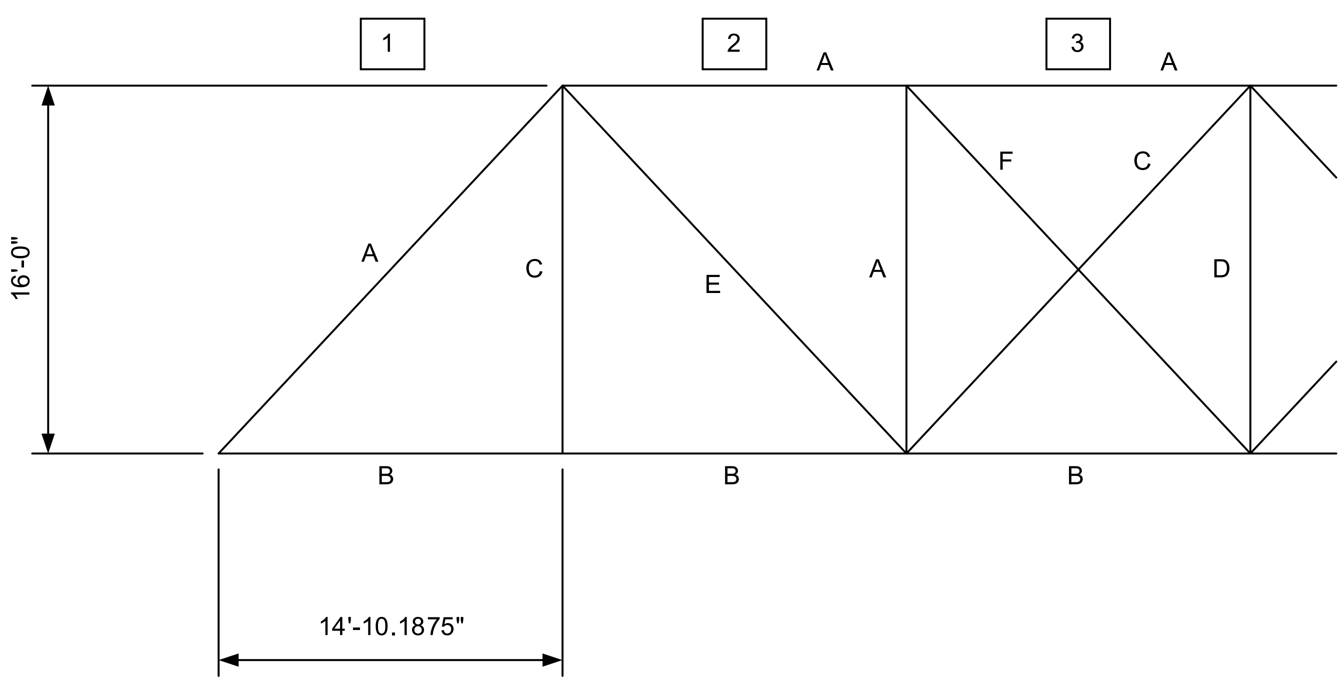

Figure 8.4-1 Example 3 Elevation

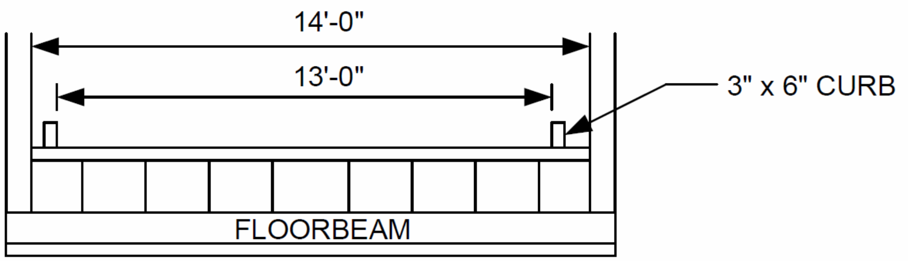

Figure 8.4-2 Typical Cross Section

8.4.4 Data Input File

```
!
! ** Created by EngAsst **
! EngAsst Information: [Program=TRLRFD] [Version=1.1.0.0]
! ** Data Records Start Here **
TTL Example 3
CTL US,G,,,,,,,,,Y
CDF 1.4,16,13
SPL 89.10
GEO 1,14.85,Y,16.00,,,1
GEO 2,14.85,Y,16.00,,,6
GEO 3,14.85,Y,16.00,,,13
TDC L00,1.53
TDC U01,1.07
TDC L01,3.25
TDC U02,0.65
TDC L02,3.25
TDC U03,0.65
TDC L03,3.25
PRP L00L01,06.00,06.00,02.00,36,,,58,,,,2.6
PRP L01L02,06.00,06.00,02.00,36,,,58,,,,2.6
PRP L02L03,06.00,06.00,02.00,36,,,58,,,,2.6
PRP L02U01,04.00,04.00,1.33,36,,,58,,,,10.4
PRP U02L03,3.141,3.141,0.785,36,,,58,,,,4.0
PRP U03L02,4.5,4.5,00.844,36,,,58,,,,0.8
PRP U01L01,4.5,4.5,00.844,36,,,58,,,,0.8
PRP U03L03,7.50,7.50,9.00,36,,,58,1.09,6.54,,90.8
T16 L00U01,36,58,,,2.12,0.50,Y,P,14,0.5,2,6,6,1.0,1,0.0,0.0,0.0
T16 U02L02,36,58,,,2.12,0.50,Y,P,14,0.5,2,6,6,1.0,1,0.0,0.0,0.0
T16 U01U02,36,58,,,2.12,0.50,Y,P,14,0.5,2,6,6,1.0,1,0.0,0.0,0.0
T16 U02U03,36,58,,,2.12,0.50,Y,P,14,0.5,2,6,6,1.0,1,0.0,0.0,0.0
OIN 1,0,1
OUT 1,1,0,1,0,0,1
```

8.4.5 Formatted Program Input

CONTROL DATA

Units	Live Load	Dynamic Load Allowance	Distribution Factors Force	Distribution Factors Deflection	Live Load Location	End Condition	**Pinned Support**	Temperature Change	End Bearing
US	G	1.33	0.00	0.00	L	P	L 0	0.0	L

Symmetry	Live Load Direction	Fatigue Dynamic Load Allowance	**Permit** Dynamic Load Allowance
Y	B	1.15	1.20

COMPUTED DISTRIBUTION FACTOR

CL of Truss to Curb (ft)	Truss Spacing (ft)	Roadway Width (ft)	Gage Dist (ft)	Pass Dist (ft)
1.40	16.00	13.00	6.00	4.00

SPAN LENGTHS (SIMPLE)

Span #	1
Length (ft)	89.10

TRUSS GEOMETRY

Panel No.	Panel Width (ft)		Vertical Post H1 (ft)	H2 (ft)	H3 (ft)	Panel Type
1	14.85	Y	16.00	0.00	0.00	1
2	14.85	Y	16.00	0.00	0.00	6
3	14.85	Y	16.00	0.00	0.00	13

TRUSS DEAD LOADS

Location	**U 0**	U 1	U 2	U 3
DC Load (kip)	**-n/a-**	1.07	0.65	0.65
DW Load (kip)	**-n/a-**	0.00	0.00	0.00

Location	L 0	L 1	L 2	L 3
DC Load (kip)	1.53	3.25	3.25	3.25
DW Load (kip)	0.00	0.00	0.00	0.00

Note: "-n/a-" indicates load cannot be applied to this node due to truss panel geometry. (node not present or no vertical member defined)

TRUSS MEMBER PROPERTIES (PART 1)

Member ID	Gross Area (in^2)	Net Area (in^2)	Moment of Inertia (in^4)	Yield Strength (ksi)	Unbraced Length (ft)	Fatigue Category	Tensile Strength (ksi)	Eccentricity (in)
L 0L 1	6.00	6.00	2.00	36.0			58.0	0.00
L 1L 2	6.00	6.00	2.00	36.0			58.0	0.00
L 2L 3	6.00	6.00	2.00	36.0			58.0	0.00
U 1L 2	4.00	4.00	1.33	36.0			58.0	0.00
L 2U 3	4.50	4.50	0.84	36.0			58.0	0.00
U 2L 3	3.14	3.14	0.79	36.0			58.0	0.00
U 1L 1	4.50	4.50	0.84	36.0			58.0	0.00
U 3L 3	7.50	7.50	9.00	36.0			58.0	1.09

TRUSS MEMBER PROPERTIES (PART 2)

Member ID	Moment Resistance* (kip-ft)	Tensile Resistance* (kips)	Compressive Resistance* (kips)
L 0L 1			2.60
L 1L 2			2.60
L 2L 3			2.60
U 1L 2			10.40
L 2U 3			0.80
U 2L 3			4.00
U 1L 1			0.80
U 3L 3	6.54		90.80

*NOTE: A blank field indicates that the user has not input a value for this resistance.
The program can calculate tensile resistance based on other user input.

TYPE ## GENERAL SECTION PROPERTIES

Member ID	Member Type	Yield Strength (ksi)	Tensile Strength (ksi)	Unbraced Length (ft)	Fatigue Category	Eccentricity (in)	Bolt Hole Diameter (in)	Bending Axis	Flexure
U 1U 2	16	36.0	58.0			2.120	0.500	Y	P
U 2U 3	16	36.0	58.0			2.120	0.500	Y	P
L 0U 1	16	36.0	58.0			2.120	0.500	Y	P
U 2L 2	16	36.0	58.0			2.120	0.500	Y	P

TYPE 16 SECTION PROPERTIES, PART 1 OF 2

Member ID	D (in)	TW (in)	# Holes Plate	L1 (in)	L2 (in)	TL (in)	# Holes Angle
U 1U 2	14.000	0.500	2	6.000	6.000	1.000	1
U 2U 3	14.000	0.500	2	6.000	6.000	1.000	1
L 0U 1	14.000	0.500	2	6.000	6.000	1.000	1
U 2L 2	14.000	0.500	2	6.000	6.000	1.000	1

TYPE 16 SECTION PROPERTIES, PART 2 OF 2

Member ID	DETERIORATIONS TFB (in)	WEB (in)	BFT (in)
U 1U 2	0.0000	0.0000	0.0000
U 2U 3	0.0000	0.0000	0.0000
L 0U 1	0.0000	0.0000	0.0000
U 2L 2	0.0000	0.0000	0.0000

OUTPUT OF INPUT

Input File Echo	Input Commands	Input Summary
1	0	1

OUTPUT

Section Properties	Analysis and Spec Checking	Extreme Event	Rating Summary	Detailed Gussets	Gusset Summary	Ratings w/o FWS
1	1	0	1	0	0	1

9 TECHNICAL QUESTIONS AND REVISION REQUEST

This chapter contains **a** reply form to make it easier for users to convey their questions, problems, or comments to the proper unit **within the Department**. General procedures for using these forms are given. Users should keep the forms in the manual as **a** master cop**y** 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 th**e** form or the information provided on th**e** 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.

Th**e** 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 th**e** form for processing.

Th**e** 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 **Highway Applications Division** via e-mail.

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TRLRFD
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, **please** 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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