USER'S MANUAL FOR

SIGN STRUCTURE ANALYSIS

(SIGN)

pennsylvania

DEPARTMENT OF TRANSPORTATION

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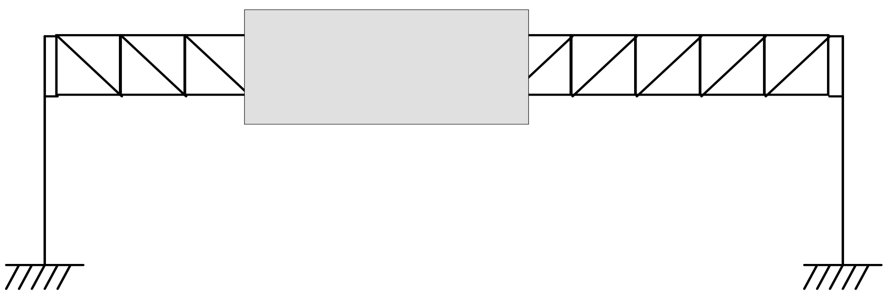
SIGN STRUCTURE ANALYSIS

(SIGN)

VERSION 1.5.0.0



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Department of Transportation

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Camp Hill, Pennsylvania

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SUMMARY OF DECEMBER 2000 REVISIONS - VERSION 1.1

SIGN Version 1.1 contains the following revisions:

1. The program has been converted to the Digital Visual Fortran Version 6.0B compiler as a Win32 application. It will run on Windows 95, Windows 98 and Windows NT Version 4.0 operating systems. It will NOT run under the DOS 6.22 or below operating systems.

2. The maximum cantilever span was increased from 40 feet to 45 feet.

3. Tapered pipe shapes can be used for post and chord members in cantilever sign structures.

4. Standard “MC” section properties can now be read from the AISC section property file.

5. The combined stress ratio equation for tension members was restored. Revisions to eliminate the AISC $f_a / F_a < 0.15$ criteria from the original code for Version 1.0 also resulted in the elimination of the combined stress ratio equation for tension members. Version 1.0 was using the compression combined stress ratio equation for tension members.

6. Specification checking for channel (MC or C) sections was added.

7. The maximum number of truss panels was increased from 30 to 100.

8. The input format for the SIGN PANEL WT field of the LOADS input line was changed from “x.ddd” to “xx.dd” allowing larger values to be entered. In addition, the maximum panel weight was increased to 100 psf. NOTE: This change will affect results for existing input files in which a value was entered for the SIGN PANEL WT.

9. The total sign weight was corrected to include the weight of the 18-inch additional length of the sign support beams below the sign panel.

10. The coupled horizontal loads applied to the top and bottom chords due to the sign attachments was corrected to include the weight of the 18 inch additional length of the sign support beams and to account for the luminaire offset.

11. The distribution of the uniform dead load due to the weight of ice on the signs and sign attachments was corrected.

12. Specification checking for four-post four-chord models has been added.

13. The distribution of the uniform horizontal wind load due to wind on the catwalk was corrected.

14. The distribution of the uniform coupled horizontal dead loads applied to the top and back chords due to ice on the catwalk was corrected.

SUMMARY OF VERSION 1.2.0.0 REVISIONS

SIGN Version 1.2.0.0 contains the following revisions:

1. Updated and expanded the local buckling criteria equations to classify components as compact, non-compact, and slender in accordance with Section 5.5 of the fourth edition 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. A new output column has been added to indicate the maximum/slender allowable limit to the COMPACT/NON-COMPACT CRITERIA TABLE.

2. Updated and expanded the allowable axial, bending, shear, and combined stresses in accordance with Sections 5.6-5.12 of the fourth edition 2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

3. The program has been modified to add provisions to calculate the number of bolts required for the alternate bolted connections joining the bracing components to the chords. A new BOLTED CONNECTIONS input card has been added and a new BOLTED CONNECTIONS output table has been added. The program will output the required number of bolts for three loading conditions: actual load in the member, average load in the member based on the actual load and the allowable load, and 75% of the allowable load in the member.

4. Fatigue loadings have been incorporated into the program. In accordance with Section 3.4, Table 3-1 and Section 11 of the fourth edition AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, the following fatigue loads were added:

    - Galloping (cantilever, centermount, tapered tube, 2 post planar and tri-chord structures only)
    - Natural Wind Gust (all structure types)
    - Truck-Induced Gust (all structure types)

5. Standard fatigue details based on the standard drawings have been incorporated for plain members, bolted connections, holes, welded connections, and attachments as per Table 11-2 of the fourth edition code.

6. Constant-amplitude fatigue thresholds were added.

7. A user-specified FATIGUE DETAILS input card has been added, and the CRITERIA input card has been modified to incorporate the "Number of Details" input field.

8. The following fatigue criteria input fields have been added to the LOADS input card: "Importance Factor Category", "Mean Wind Speed", and "Vehicle Design Speed". An input field for the "Truck-Gust Area" has been added for both the Luminaire and Catwalk sections of the LOADS input card.

9. The STRUCTURE ATTACHMENT DESCRIPTION input card was divided into the SIGN DESCRIPTION input card and the CATWALK DESCRIPTION input card. An input field for "Horizontal Projected Area" to indicate a VMS Box has been added to the SIGN DESCRIPTION input card. **As a result, input files created for SIGN v1.1 or earlier will need to be modified before running with SIGN v1.2.0.0.**

10. The following routines were added to the program to calculate and apply the fatigue loads on the members and attachments: LDGALS, LDNCAT, LDNWGM, LDNWGS, LDTRKC, LDTRKM, LDTRKS, SRTFAT, FATDES, GALLOP, NATWND, and TRUCK.

11. New FATIGUE DETAILS and FATIGUE AXIAL/MOMENT output tables have been created to display the fatigue Combined Stress Ratio and Fatigue Loads used to generate these CSR's for each valid fatigue detail.

12. Provisions were added to allow for the analysis of chord splice connections for both new and existing structures.

13. The "New or Existing Chord Splice" input field and the "Number of Splices" input field were added to the CRITERIA input card. Two new input cards, CHORD SPLICE 1 and CHORD SPLICE 2, were added to the program.

14. The CHORD SPLICE TABLE was added to the output to display the required number of bolts for the Chord Splice and the minimum required thickness of the Splice Plate.

15. Provisions were added for the analysis of the U-bolts and saddle blocks at the chord-tower seat detail.

16. The "Number of U-Bolts" input field has been added to the BOLTED CONNECTIONS input card. A SADDLE DETAIL TABLE has been added to the output.

17. The distribution of the uniform coupled horizontal dead loads applied to the top and back chords due to ice on the catwalk was corrected.

18. Revised Getxsc.for to allow the ST 3.0 x 8.625 to be located in the AISC Table.

19. Revised the number of spaces between the cross bracing in a 4-post 4-chord structure in the MG4PST routine.

20. In MGSTRT, corrected the variables TOPCRD and BOTCRD, which had been backwards.

SUMMARY OF VERSION 1.3.0.0 REVISIONS

SIGN Version 1.3.0.0 contains the following revisions and enhancements:

General Program Revisions

1. All temporary files are now deleted upon successful program runs. Previously, the program created a temporary file, FORT.28, which was not deleted. (Request 003)

2. The program will now find the "AISC" steel section properties data file in the program installation folder. Previously, the program would look for the "AISC" file in the same folder as the current input file. This became a problem when using Engineering Assistant (EngAsst) since input files can easily be created in folders other than the program installation folder. (Request 018)

3. Intermediate STOP statements were removed from the code so that there is a single termination point in the program. This will insure that program shuts down properly. (Request 031)

User Manual Revisions

4. Additional information was provided for the Sign Horizontal Projected Area input parameter description in User Manual Section 4.3 for clarification. (Request 014)

5. A discrepancy between how the program computes the Reduced Truck Gust pressure and the description of the calculation in User Manual Section 3.4.6 was corrected with a change in the User Manual. (Request 021)

6. The allowable overstress factors and load case numbers where corrected in User Manual Tables 3.4.3-1b and c. (Request 026)

7. The Single Strut Centermount description was added to User Manual Section 3.3.7. Users had question whether the single strut model was allowed by the program. (Request 027)

8. The input file preparation discussion in User Manual Section 4.0 was updated. (Request 030)

9. The span length, truss height and truss depth dimensions in User Manual Figure B1.5-1 were corrected to match the Example problem 5 input values. (Request 033)

Input Revisions

10. Fatigue Importance Factor Category 1 is now allowed for sign structure with variable message signs (VMS). Previously, Category 1 was only allowed for cantilever structures. (Request 013)

11. An input check for valid bolt diameters was added for the Chord Splice Bolt Diameter and Bolted Connection Bolt Diameter input parameters. An invalid bolt diameter would cause the program to crash while performing specification checks since data associated with the bolt diameter could not be retrieved. Bolt diameters are now chosen from a dropdown list In Engineering Assistant (EngAsst). (Request 028)

Specification Check Revisions

12. The program now uses the correct bolt diameter for chord splices Model Types 2, 3, 4 and 5. It was determined that the program was using the Model Type 1 data table for other model types when determining the chord splice bolt diameter. This could result in a program crash when bolt diameter data is not available for certain chord section diameters. (Request 015)

13. Chord splice data was added for 4" diameter pipes for Model Types 3, 4 and 5. (Request 022)

14. An input check was added to verify input pipe and tapered pipe (large end) nominal diameters are included in a list of available diameters for chord splices based on Model Type when a chord splice is entered. Previously, the program would crash if the pipe diameter was not included in the chord splice data tables. (Request 022)

15. Excessive combined stress ratios (CSR) in the Fatigue Stress Output Table are now indicated with an asterisk similar to other specification check output tables. (Request 032)

16. The Chord Splice output table is no longer printed when an angle section is used as a chord member. The program was printing the table with null values. The program currently does not perform specification checking and does not include chord splice data for angle sections. A message stating this is printed in place of the table. (Request 034)

17. Footing analysis checks have been reinstated to terminate the program when the input footing does not adequately handle all load cases to avoid a program crash. (Request 035)

Loading Revisions

18. The correct drag coefficient is now used for variable message signs (VMS) when computing normal wind load and natural wind gust fatigue load. Previously, the program was using the drag coefficient for standard sign. (Request 014)

19. Changes in SIGN v1.2.0.0 resulted in the uniform sign load not being applied to the chord/strut of the single strut centermount model and tapered tube model. The sign load is now correctly applied to these models. (Request 025)

SUMMARY OF VERSION 1.4.0.0 REVISIONS

SIGN Version 1.4.0.0 contains the following revisions and enhancements:

<u>General Program Revisions</u>

1. All real number program variables are now stored as double precision variables. This provides more accurate calculations and more consistency when comparing program results after compiler and system upgrades. Previously, the program used only used double precision for the structural analysis module. (Request 041)

2. A data overflow error when the Debug version of SIGN is run via Engineering Assistant (EngAsst) was corrected. (Request 050)

<u>User Manual Revisions</u>

3. Additional information was provided for the Sign Panel Wt input parameter description in User Manual Section 4.9 to clarify input for VMS. (Request 048)

4. A new example problem (Example Problem 6a) was added for the new VMS Cantilever model. Other example problems were revised for new input fields and to eliminate specification check errors. (Request 052)

5. A table was added in User Manual Section 4.5.2.8 to provide the stress concentration factors for standard ST sections. (Request 053)

<u>Input Revisions</u>

6. A new “Design Wind Speed” input field was added to the LOADS data line. The Design Wind Speed is used to calculate the wind load acting on the supports, signs and attachment. Previously, a wind speed of 80 mph was hardcoded in the program. The default is 80 mph. (Request 037)

7. The Engineering Assistant (EngAsst) configuration files were revised so that the Splice1 and Splice2 tabs are initially disabled, but are enabled for truss models and when a non-zero value is entered for the Number Chord Splices field. Previously, the Splice1 and Splice2 tabs were disabled for truss models and enabled for cantilever and centermount model. (Request 038)

8. The User’s Manual says that if the Right Strut Length is left blank for a centermount structure, the right strut length is assumed to be the same as the left strut length. However, leaving the Right Strut Length blank resulted in an input error stating that the

Right Strut Length is outside the range of 1' to 40' in previous versions. The right strut length is now set to the left strut length when left blank. (Revision 042)

9. A new "VMS" input field (Y/N) was added to the CRITERIA data line to indicate that the structure supports a variable message sign (VMS). The VMS designation is used to determine the appropriate Fatigue Importance Factor Category and other special design considerations for VMS structures. It is also used to differentiate between a standard cantilever model and a VMS cantilever model. Previously, the program would designate a structure as a VMS structure if at least one of the input Sign Horizontal Projected Areas was greater than zero. The default is "N". A warning message is printed if VMS is "N" and a Sign Horizontal Projected Area is greater than zero. (Request 043)

10. A default value of 2.5" was added for the Distance to Bolt Circle parameter on the Chord Splice 2 Input line for new structures ("N" entered for the New or Existing Chord Splice parameter on the Criteria line). The User's Manual states that 2.5" is the default, but previous versions only set this default for existing structures. (Request 045)

<u>Structural Analysis Revisions</u>

11. A new sign structure model was added for cantilever structures supporting a variable message sign (VMS) in accordance with the ITS-1003M Sign Standards. The VMS Cantilever is similar to the standard 2-strut cantilever with the addition of cross bracing between the struts. The VMS Cantilever model also includes a chord splice to the standard stub connection from ITS-1003M. (Request 036)

<u>Specification Check Revisions</u>

12. The equation used to compute the required number of chord splice bolts for the 75% of allowable load case for the two-post planar truss model (Model Type 2) was corrected. Previous versions required more bolts than required by the specifications. (Request 039)

13. The automatically generated fatigue check for centermount struts (Fatigue Detail #18) at the strut-to-post connection is now performed. In previous versions, the check was supposed to be done, but a coding error prevented it. (Request 044)

<u>Loading Revisions</u>

14. The sign wind loads for single strut centermount structures and the tapered tube structures were corrected. Only half the sign wind load was applied to the strut for these models in v1.3.0.0. (Request 046)

15. A maximum sign support spacing of 5’ was added for variable message signs (VMS) in accordance with the ITS-1003M Sign Standards. Previously, a maximum sign support spacing of 6’ was used for all signs. (Request 047)

16. The ice load on variable message signs (VMS) now includes ice on top and sides of the sign. The depth of the VMS is assumed to be constant and is based on the input Sign Horizontal Projected Area divided by the sign width. (Request 049)

17. The sign support dead load was added to the Load Output Table. Previously, the Load Table did not include the weight of the sign supports. (Request 051)

<u>Footing Design/Analysis Revisions</u>

18. The input top footing reinforcement cover for is now used as the side cover when calculating the footing reinforcement spacing. Previously, the top and bottom covers were inconsistently used for the side cover for separate spacing calculations. (Request 040)

SUMMARY OF VERSION 1.5.0.0 REVISIONS

SIGN Version 1.5.0.0 contains the following revisions and enhancements:

General Program Revisions

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

2. The program has been enhanced to provide a PDF output file in addition to the text output file. The PDF file makes it easier to print and paginate the program output. (Request 067)

3. The SAPV input and output files created by the program will now be uniquely named so that they will be retained and not be overwritten as in previous versions. The SAPV input file will be named "*<input filename>*_SAPV.inp". The SAPV output file will be named "*<input filename>*_SAPV.oui". Both files will be created in the same folder as the SIGN input file. (Request 068)

4. The program is now compiled with Intel Visual Fortran Composer XE version 2011.9.300 using Visual Studio 2010.

Specification Check Revisions

5. Revisions made for Request 050 in v1.4.0.0 mistakenly removed a line of code that retrieved the post yield strength for a polygonal tube. This could result an incorrect yield strength being used for the post, which could in turn result in specification check problems. This was only a problem for polygonal tubes when the post yield strength was different from the other members. The program now retrieves the correct post yield strength. (Request 054)

6. Fatigue Details #14 and #15 are now checked for all branching member section types for all truss models. Previously, details #14 and #15 were only checked for pipe sections with the slotted tube-to-gusset connection. Details #14 and #15 also include angle-to-gusset connections. (Request 055)

7. The post stress calculation at the hand hole for Fatigue Detail #20 has been corrected. Previously, the post stress based on the gross section was incorrectly added to the post stress based on the net section. (Request 056)

8. Primary (i.e., post, truss chord, chord and strut) members in compression for the load case with the worst combined stress ratio are now considered as stress reversal members if at least one load case produces tension in the member. Previously, only primary members in tension for the load case with the worst combined stress ratio were considered for stress reversal. This will increase the slenderness ratio limit for primary members in compression for the load case with the worst combined stress and subject to stress reversal. However, the upper chord members of the Two Post Planar Truss model are always considered compression members regardless of any load cases that may produce tension. (Request 062)

9. The strut-to-column pass-thru connection (fatigue detail #18) for centermount and cantilever structures was changed from category E' to category E for post members. (Request 065)

Input Revisions

10. The Section Yield Strength input check was revised to allow yield strength ranging from 35 ksi to 50 ksi. Previously, the only valid input was either 36 ksi or 50 ksi. PENNDOT's BD Standards specify that 35 ksi be used for welded and seamless pipe sections. (Request 057)

11. The Engineering Assistant (EngAsst) configuration files were revised so that the Details tab is enabled when a non-zero value is entered for the Number Details field of the Criteria tab. Previously, the Details tab remained disabled for non-zero Number Details values less than 10. (Request 059)

12. The maximum footing length was increased to 50 feet. An input check limited the Footing Length input for analysis runs to 30 feet. However, the program allows footing designs with lengths greater than 30 feet and the current PENNDOT Sign Standards include footing lengths greater than 30 feet. (Request 064)

13. The input descriptions for the hand hole, weep hole and wire outlet area were clarified removing references to the "net" area. (Request 066)

Structure Modeling Revisions

14. The orientation of the truss cross bracing was corrected for the 4-post 4-chord truss model when the first cross brace is located between the second and third truss panels from the end. (Request 063)

1.0 PROGRAM IDENTIFICATION

PROGRAM TITLE: Sign Structure Analysis

PROGRAM: SIGN

VERSION: 1.5.0.0

SUBSYSTEM: None

AUTHOR: Gannett Fleming, Inc.
under contract for
Pennsylvania Department of Transportation

ABSTRACT:

The Sign Structure program analyzes the loading conditions for seven different types of sign models using the criteria set forth in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2001 and 2006 Interims. The types of sign models available for analysis are as follows: tapered tube, two post planar truss, two post tri-chord truss, four post tri-chord truss, four post four-chord truss, cantilever and centermount structures.

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2.0 PROGRAM DESCRIPTION

The Sign Structure program analyzes seven different types of sign models including the footings. A model generator preprocessor converts user input data into a finite element model that is then analyzed using the finite element analysis core of the program. Once the analysis is complete the program performs a specification check on all members of the structure based on the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2001 and 2006 Interims. The results of the analysis and specification check including echo of user input, selected default values, member forces, cross section properties, combined stress ratios, and loadings are displayed in an output report file.

For the purpose of this manual the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2001 will be referred to as the AASHTO Sign Specifications.

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3.0 METHOD OF SOLUTION

The program uses the SAPV finite element program to obtain forces and moments and the criteria set forth in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 2001 and 2006 Interims.

The following sections explain the procedure used in various phases of the program.

3.1 NOTATIONS

The notations shown are the actual variable names used in the program Sign Structure. The purpose of this is to provide an invaluable documentation source for those who will maintain the program.

ANGCLR = Distance from the bottom chord of the truss to the top post strut (see Figure 3.3-6).

CATOFF = Catwalk offset - distance from the center of gravity of the catwalk to the center of the front chord (see Figure 3.4.1-3).

CATWT = Weight per foot of the catwalk and its attachments (see Figure 3.4.1-3).

CODIAM = Diameter of the chord.

CONOFF = Chord offset from the post.

LUMWT = Weight of a single luminaire.

NOLUM = Number of luminaires per sign (maximum of 3 per sign).

NOSUP = Number of sign supports (calculated internally).

PANOFF = Distance from the centerline of the post to the first vertical member of the truss.

PANWT = Weight per square foot of sign panel.

PDIAM = Diameter of the post for non-tapered pipes.

PLEN = Distance between the top post strut and the bottom post strut (see Figure 3.3-6).

SGNA = Area of the sign.

SGNHGT = Height of sign (see Figure 3.4.1-1).

SGNWID = Width of sign (see Figure 3.4.1-1).

SGNX = Distance of center of sign from the left post.

SGNY = Sign offset distance measured from the center of the front chord to the sign (see Figure 3.4.1-2).

SGNWGT = Weight of each sign.

STFCLR = Distance from the base of the post to the bottom post strut. This distance allows for the clearance of the stiffener (see Figure 3.3-6).

STHGT = Structure height.

STLEN = Structure length.

SUPCOV = Distance from edge of sign to the centerline of the first sign support (see Figure 3.4.1-1). The program uses 2 feet as cover.

SUPSPC = Maximum spacing of supports centerline to centerline (see Figure 3.4.1-1). The program uses a maximum spacing of 6 feet.

SUPWT = Weight of a sign support per foot.

TRDPTH = Horizontal distance between front and rear chords (see Figure 3.3-6)

TRHGT = Distance between top and bottom chord/strut (see Figures 3.3-2, 3.3-6, 3.3-9, and 3.3-10).

3.2 GENERAL

The program reads a fixed format input file supplied by the user, and from the information provided constructs a finite element model with the appropriate loadings. The program then solves the model with the finite element analysis module.

3.3 MODEL DESCRIPTION

This section describes the types of models available and description of the model built for each type. The following models are available:

1 - Tapered tube structure
2 - Two post planar truss
3 - Two post tri-chord truss
4 - Four post tri-chord truss
5 - Four post four-chord truss
6 - Cantilever structure
7 - Centermount structure

3.3.1 TAPERED TUBE STRUCTURE

The modeling of the tapered tube structure is shown in Figure 3.3-1.

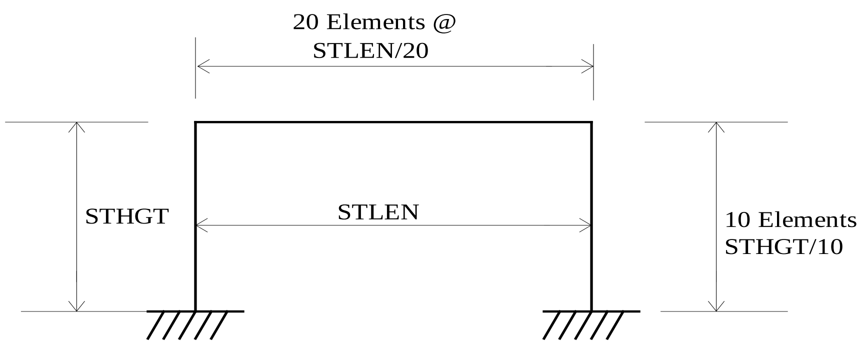


Figure 3.3-1 Tapered Tube Configuration

Each of the two posts is fixed against translation and rotation at the base, and consists of 10 equal elements that decrease in size from bottom to the top, to model the taper of the column. The horizontal chord is free to rotate at each end, and consists of 20 elements of equal length and linearly varying cross sectional properties. The structure is considered symmetric about the center of the span.

3.3.2 TWO POST PLANAR TRUSS

The two post planar truss has a truss configuration as shown below:

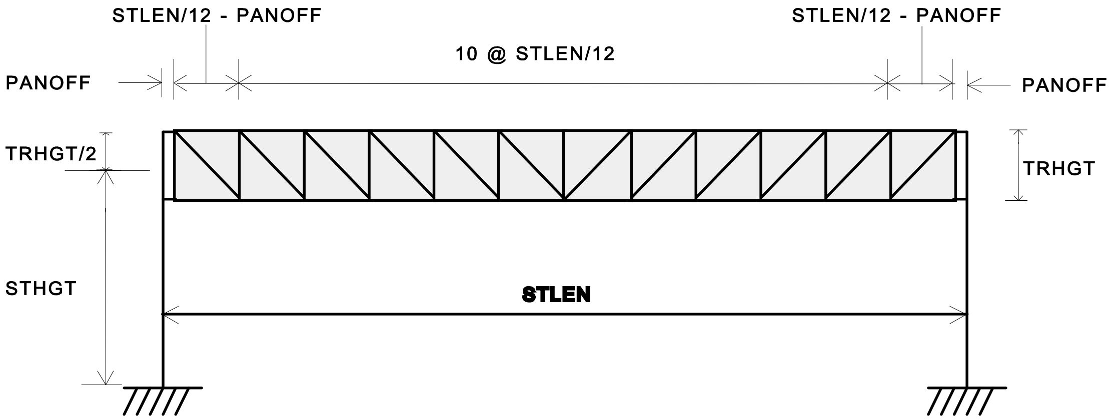
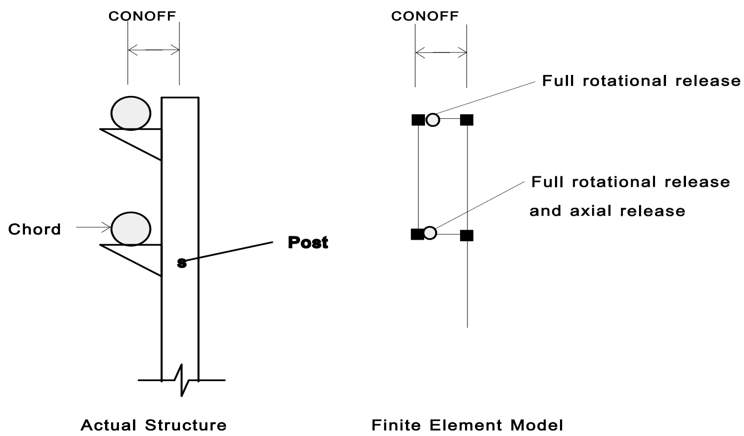


Figure 3.3-2 Two Post Planar Configuration

The model is built using space frame elements with each post composed of two elements and one element for each vertical, diagonal, and chord member in the truss. The truss itself is offset from the post by a distance equal to the sum of half the post diameter and half the chord diameter. This offset is accomplished by connecting the post to the chord using a small element (see Figure 3.3-3). The small element is rigidly connected to the post and is released for rotation in all directions at the connection with the truss. An axial release is also provided at the connection of the bottom chord of the truss and the small element (see Figure 3.3-3).



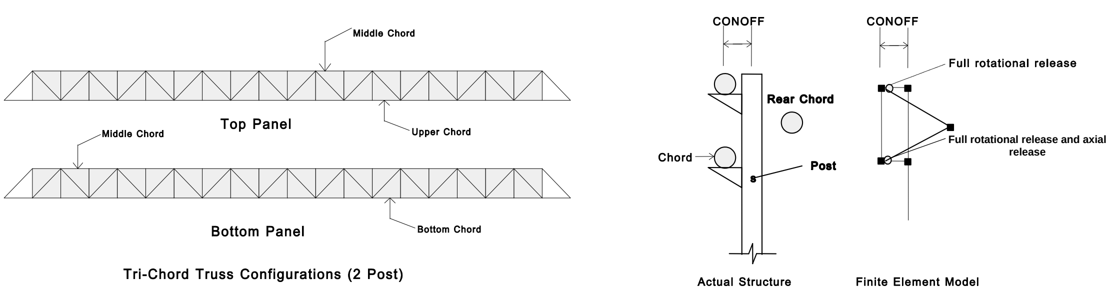
Where:

CONOFF = (CODIAM + PDIAM)/2 + 3.5"

Figure 3.3-3 Two Post Planar Detail

3.3.3 TWO POST TRI-CHORD TRUSS

The front face for the truss is similar in configuration to that of the two post planar truss, shown in Figure 3.3-2. The front panel offset from the post is the same as the two-post planar, described in Figure 3.3-3. The top and bottom truss configurations consist of diagonals and verticals with a configuration as shown in Figure 3.3-4a. The post modeling for the tri-chord two-post model is the same as that of the two post planar model. The connection of the truss to the posts is accomplished with small elements that are rigidly connected to the post and have rotational releases at the connection with the truss (see Figure 3.3-4b).



(a) **(b)**

Figure 3.3-4 Two-Post Tri-Chord Configuration

3.3.4 FOUR POST TRI-CHORD TRUSS

The truss configuration (Figure 3.3-5) is similar to that of the two-post tri-chord truss (see Figure 3.3-4) with the exception of two additional members located at the ends of the trusses. The connection of the truss to the posts is accomplished with small elements that are rigidly connected to the post and have rotational releases at the connection with the truss. The post supports may be either fixed or pinned.

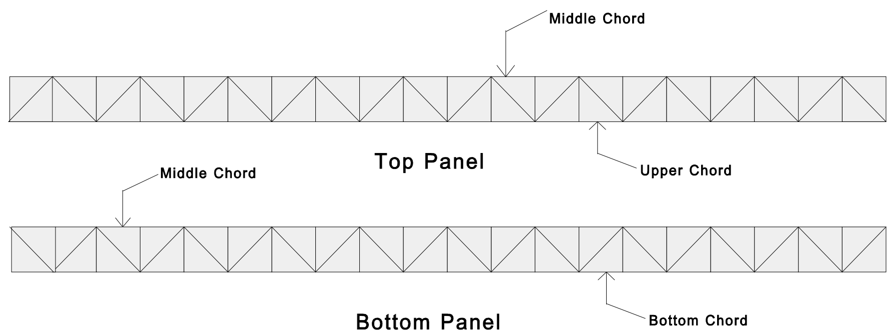


Figure 3.3-5 Four-Post Tri-Chord Configuration

The post configuration and its accompanying finite element model are shown in Figure 3.3-6. The post bracing is modeled to transfer only axial and torsion loads.

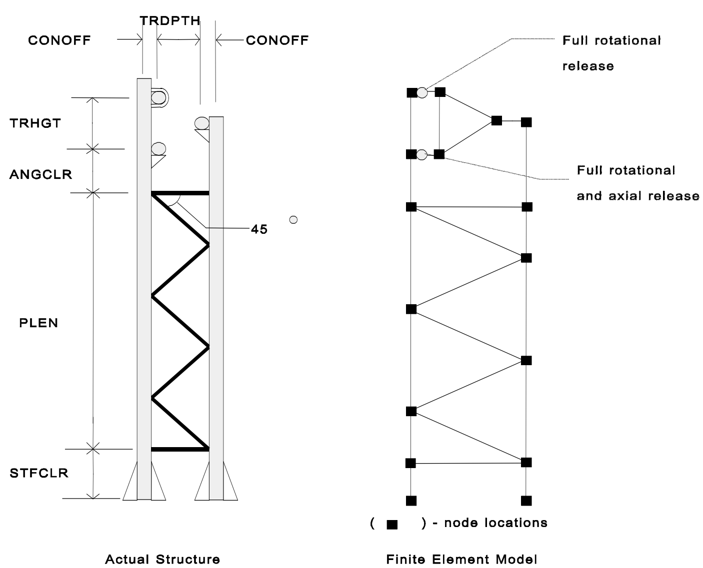
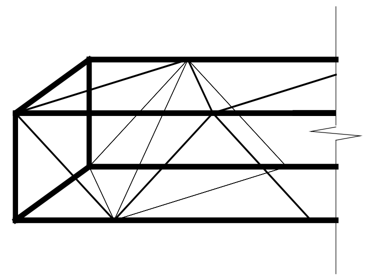


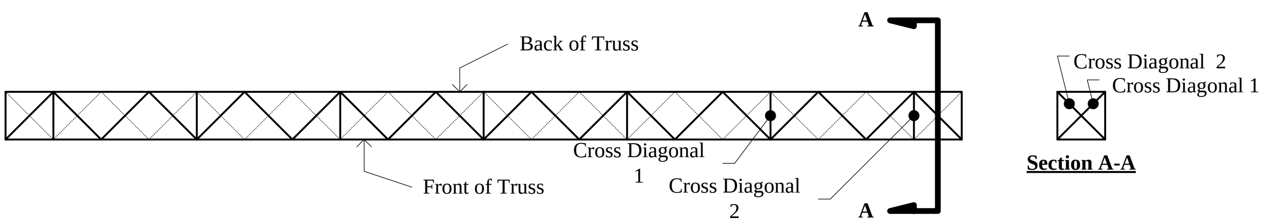
Figure 3.3-6 Four-Post Tri-Chord-Post Detail

3.3.5 FOUR POST FOUR-CHORD TRUSS

The front and rear faces of the truss are similar to that of the top and bottom panels. The top and bottom truss consist of diagonal lattice bracing as shown in Figure 3.3-7. Note that vertical members are present only at the ends of the truss.



Isometric View of 4 Chord Truss



Lattice Bracing on Top and Bottom Panels
Four-Chord Truss Model

Figure 3.3-7 Four-Chord Truss Configuration

Diagonal cross bracing from the top to bottom panel is provided at a maximum of every third panel location (see **Section A-A** in Figure 3.3-7). The connection of the truss to the posts is similar to that of the four-post tri-chord truss (see Figure 3.3-6). The post supports may be either fixed or pinned.

3.3.6 CANTILEVER STRUCTURE

The single strut cantilevered sign structure will be modeled as shown in Figure 3.3-8. The base of the structure is fixed against rotation and translation.

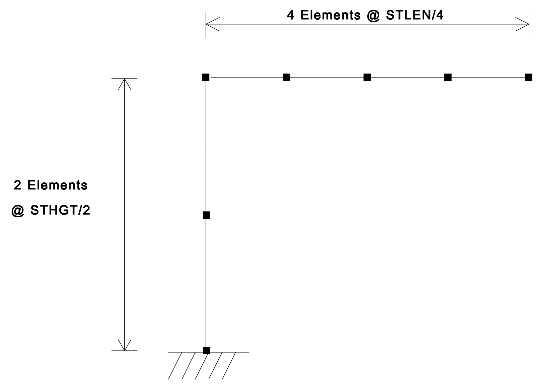


Figure 3.3-8 Single Strut Cantilever Configuration

The column and the strut are rigidly connected, with the strut consisting of four elements and the post consisting of two elements. The double strut cantilevered sign structure is modeled as shown in Figure 3.3-9. The configuration is similar to the single strut model, except an extra element is used in the column and an extra strut with four elements is placed at a distance of TRHGT below the top strut.

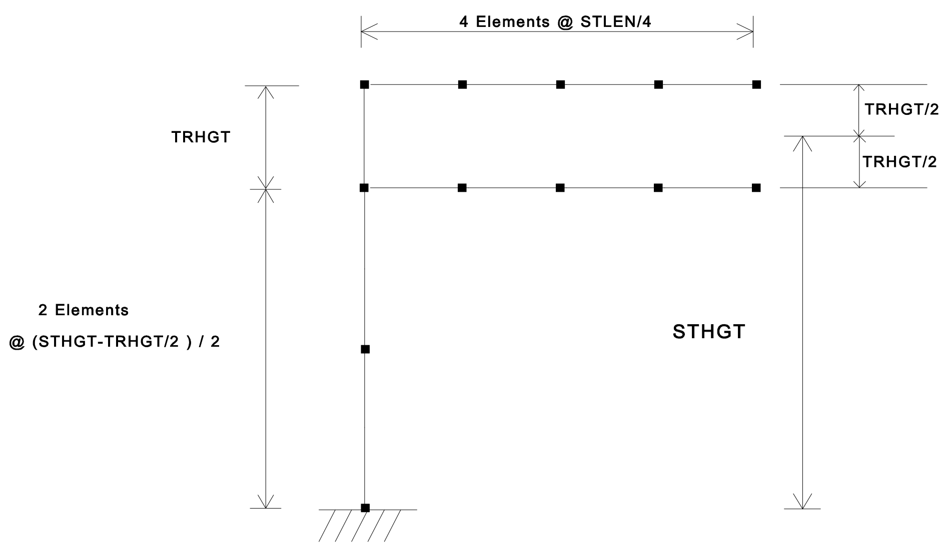


Figure 3.3-9 Double Strut Cantilever Configuration

If the cantilever structure supports a VMS, the model includes vertical and diagonal bracing between the upper and lower struts (See Figure 3.3-9a). Also, a chord splice for each strut is automatically generated at a distance of 1’-3” from the outside edge of the post.

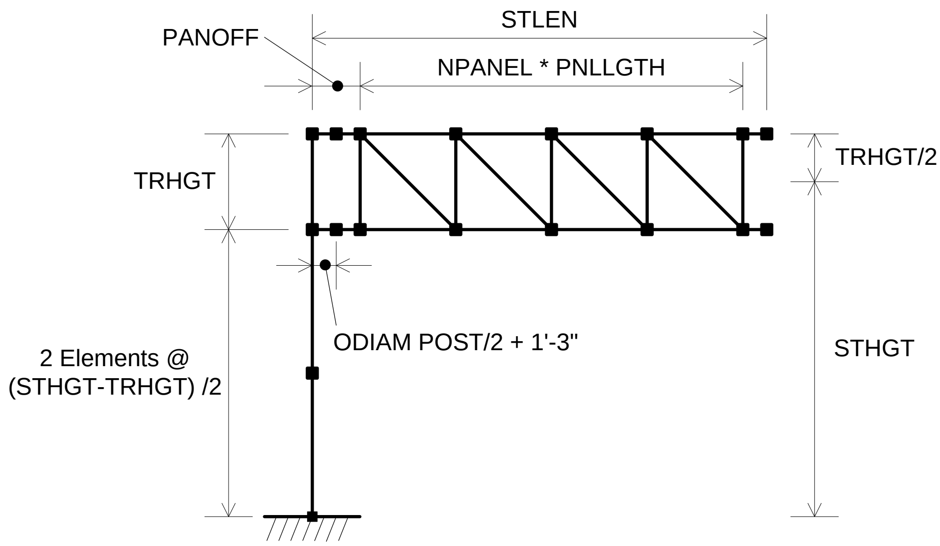


Figure 3.3-9a VMS Cantilever Configuration

3.3.7 CENTERMOUNT STRUCTURE

The centermount structures can have either one or two struts. The single strut centermount structure is fixed at the column base with the column modeled as a single element and the strut comprised of four elements (see Figure 3.3-10). The strut is modeled as a rigid connection to the column.

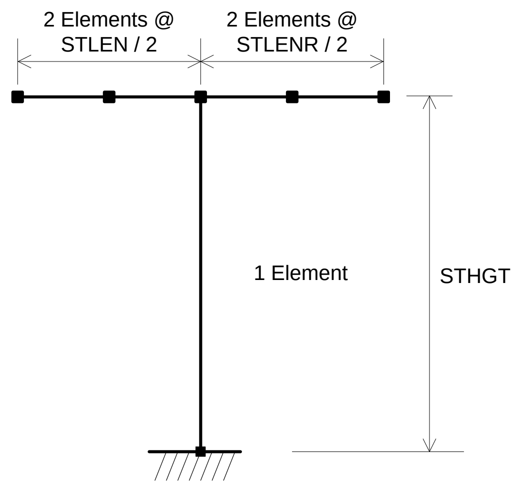


Figure 3.3-10 Single Strut Centermount Configuration

The double strut centermount structure is fixed at the column base with two elements comprising the column, and four elements comprising each of the two struts (see Figure 3.3-11). The struts are modeled as rigid connections to the column. The location of the first strut from the base will depend on the distance STHGT and the height of the sign.

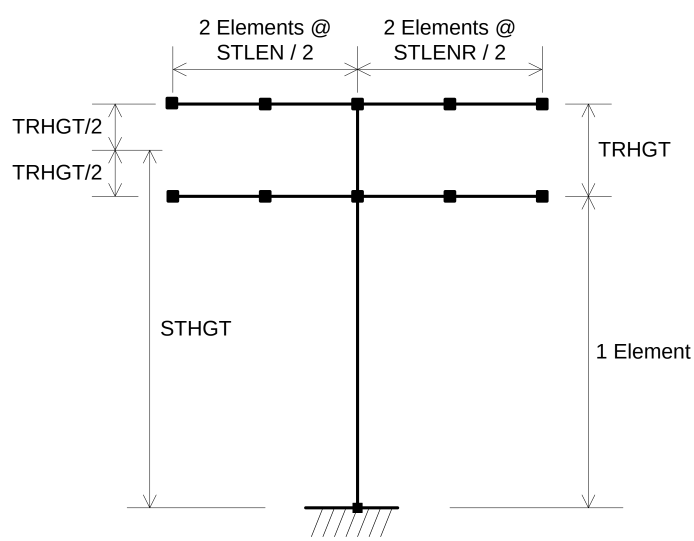


Figure 3.3-11 Double Strut Centermount Configuration

3.4 LOADING DESCRIPTION

This section describes the various loadings applied to the structure. The loadings include dead load, ice load, normal and transverse wind loads, and fatigue loads on the structure, the signs, and the structure attachments.

3.4.1 DEAD LOAD ATTACHMENTS

The dead load applied to the structure includes self-weight of the members and the weight of the sign, the sign supports, the luminaires, and the catwalk. The calculation for the total sign weight is shown below using values described in Figure 3.4.1-1.

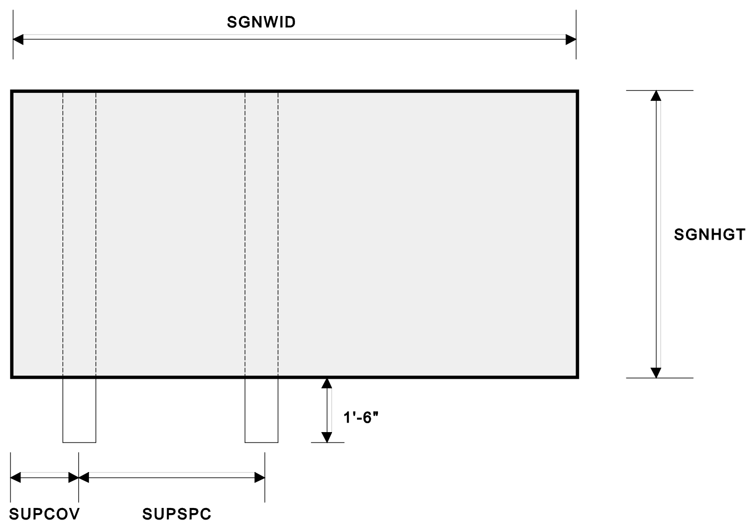
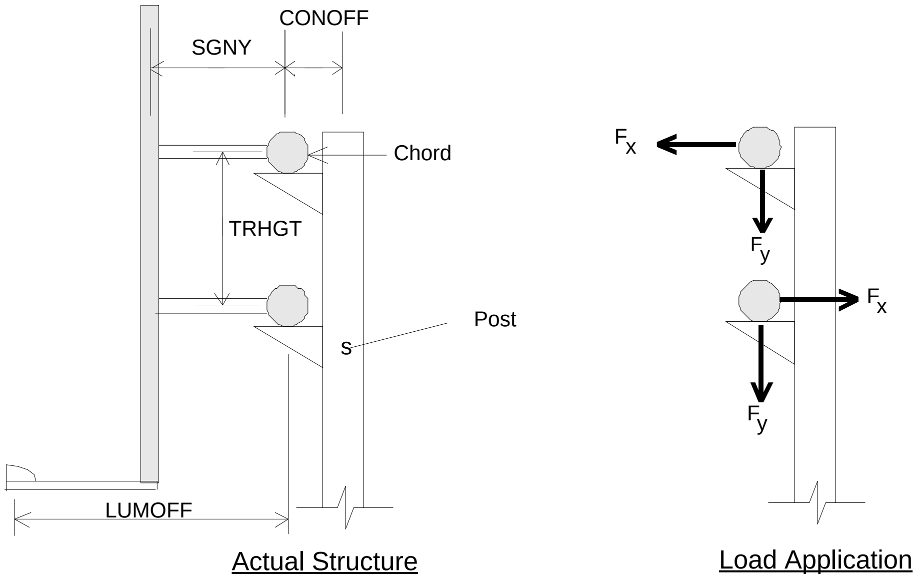


Figure 3.4.1-1 Sign Dimensions

The following equation determines the weight of each sign and its attachments:

SGNWGT = SGNA*PANWT + NOSUP*SUPWT*(SGNHGT+1'-6") + NOLUM*LUMWT

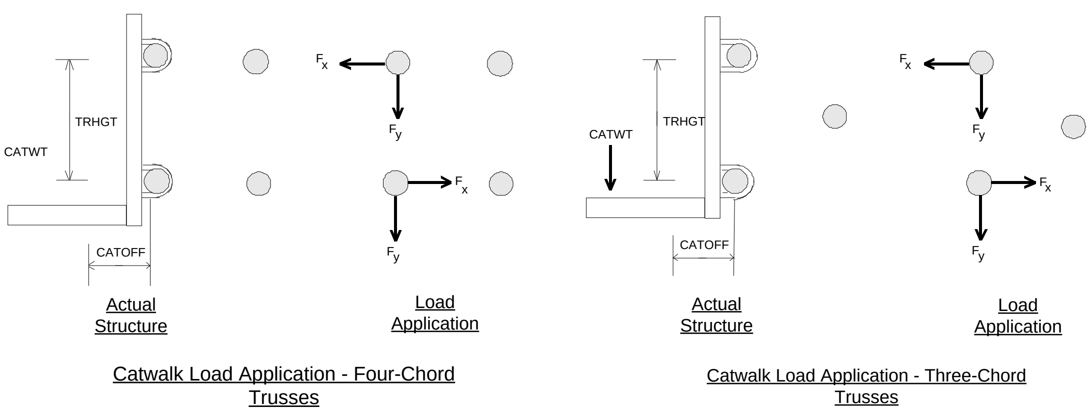
Once the total weight is computed the load is applied to the structure over the width of the sign. If the sign extends past the end of the chord/strut, the total weight of the sign is applied to the length of the sign covering the chord/strut. For two chord/strut structures (i.e., all truss type models and other models with two struts) half of the vertical load is applied to both the top and bottom chords/struts and a moment couple is applied over the two chords/struts (see Figure 3.4.1-2).



Where: F_x = [(SGNWGT * SGNY) + NOLUM * LUMWT * (LUMOFF - SGNY)] / TRHGT
F_y = SGNWGT/2

Figure 3.4.1-2 Sign Load Application

The catwalk loading for tri-chord and four-chord models distributes the load to the front upper and front lower chords (see Figure 3.4.1-3), with the actual concentrated loads distributed as uniform loads along the length of the catwalk. Catwalk loads cannot extend beyond the ends of the chords. The start and end of the catwalk is entered by the user.



Where: F_x = CATWT*CATOFF / TRHGT (for Four-Chord Trusses)
F_x = CATWT*CATOFF / (TRHGT / 2) (for Three-Chord Trusses)
F_y = CATWT/2

Figure 3.4.1-3 Catwalk Load Application

3.4.2 ICE LOAD

The sign structure computes loadings for ice on the members, ice on the signs and luminaires, and ice on the catwalk. Member ice load is computed as the input load times the surface area of the members. The ice load of the sign is computed based on only one side of the sign. For a VMS, the ice load on the top and sides is also considered. The depth of the VMS is assumed to be constant and is based on the input Sign Horizontal Projected Area divided by the sign width. The loadings are computed directly from the user input and are applied similar to the dead loads described in Section 3.4.1.

3.4.3 WIND LOAD

The wind pressure calculations for the sign structure program are based on the following equation from Appendix C, Section C.3 of the AASHTO Sign Specifications:

$$\mathbf{P = 0.00256\ (1.3\ V)^2\ C_d\ C_h}$$

Where: P = Design Wind pressure in pounds per square foot
V = Wind speed (mph)
(1.3V) = Gust speed, 30%
C_h = Coefficient for height above ground (AASHTO Table C-1)
C_d = Drag coefficient (AASHTO Table C-2)

The value for V used by the program is input by the user or defaults to 80 mph. The value for C_h is input by the user or defaults to the values shown in AASHTO Sign Specifications Table C-1 (the value used for the height 'H' is the user input value of the structure height 'STHGT'). The drag coefficient C_d is computed using AASHTO Sign Specifications Table C-2. (See Table 3.4.3-1).

Type of Member		C_d Value
Single member or Truss:		
Cylindrical		
	$Vd < 32$	1.10
	$32 < Vd < 64$	$100 / (Vd)^{1.3}$
	$Vd \geq 64$	0.45
Octagonal		1.2
Dodecagonal		
	$Vd < 32$	1.20
	$32 < Vd < 64$ and $r/2 \geq 0.125$	$9.62 / (Vd)^{0.6}$
	$32 < Vd < 64$ and $r/2 < 0.125$	1.20
	$Vd > 64$ and $r/2 \geq 0.125$	0.79
	$Vd > 64$ and $r/2 < 0.125$	1.20
Hexdecagonal		
	$Vd < 32$	1.10
	$32 < Vd < 64$ and $r \geq 0.26$	$0.55 + (64-Vd) / 58.18$
	$32 < Vd < 64$ and $0 < r < 0.26$	$1.37 + 1.08r - Vd/119 - Vdr/29.7$
	$Vd > 64$ and $r \geq 0.26$	0.55
	$Vd > 64$ and $0 < r < 0.26$	$0.83 - 1.08r$
Flat (also catwalks)		1.7
Sign Panel (by ratio of length to width)		
	$0.0 < L/W \leq 1.0$	1.12
	$1.0 < L/W \leq 2.0$	1.19
	$2.0 < L/W \leq 5.0$	1.20
	$5.0 < L/W \leq 10.0$	1.23
	$L/W > 10.0$	1.30
VMS Boxes		1.7
Luminaires (with rectangular flat side shapes)		1.2

Table 3.4.3-1

Where: L/W = maximum of SGNWID/SGNHGT or SGNHGT/SGNWID
d = Depth (diameter) of the member in feet
r = Ratio of corner radius to radius of inscribed circle for polygonal tube

3.4.4 GALLOPING FATIGUE LOAD

Galloping wind pressure is applied to the sign panel only and is applicable to the signs on cantilever, centermount, tapered tube, and tri-chord structures. In accordance with the AASHTO Sign Specification the galloping wind pressure is not applied to signs on structures with four horizontal truss chords. The galloping wind pressure is based on the following equation:

$$\mathbf{P_G = 21 * I_F}$$

Where: I_F = Importance Factor, see Section 11.6, Table 11-1 of the AASHTO Sign Specification

3.4.5 NATURAL WIND GUST FATIGUE LOAD

Natural wind gust pressure is based on the following equation:

$$\mathbf{P_{NW} = 5.2 * C_d * I_F}$$

Where: I_F = Importance Factor, see Section 11.6, Table 11-1 of the AASHTO Sign Specification

C_d = Drag coefficient (See Table 3.4.3-1)

Natural wind gust pressure is based on a yearly mean wind speed of 11.2 mph (5 m/s). For sites with higher wind speeds or locations with more detailed records, a yearly mean wind speed may be entered onto the Loads Input Card and the equation to compute the gust pressure will be adjusted as follows:

$$\mathbf{P_{NW} = 5.2 * C_d * (V^2_{mean} / 125)^2 * I_F}$$

Where: V^2_{mean} = Yearly Mean Wind Speed

3.4.6 TRUCK-INDUCED GUST FATIGUE LOAD

Truck-induced gust pressure is based on the following equation:

$$\mathbf{P_{TG} = 18.8 * C_d * I_F}$$

Where: I_F = Importance Factor, see Section 11.6, Table 11-1 of the AASHTO Sign Specifications

C_d = Drag coefficient (See Table 3.4.3-1)

Truck-induced gust pressure is applied to all members and attachments of the sign structure except for the posts and standard flat-panel signs. The program reduces the pressure applied by the truck gust dependent upon the elevation of specific members. For a structure with no catwalks or luminaries, elements between the following two elevations will have a reduced truck gust load applied to them:

Elevation 1: STHGT – ((Max(SGNHGT(j)) / 2.0) + 2.2
Elevation 2: STHGT – ((Max(SGNHGT(j)) / 2.0) + 15.3

For a structure with a catwalk and/or luminaries, elements between the following two elevations will have a reduced truck gust load applied to them:

Elevation 1: STHGT – ((Max(SGNHGT(j)) / 2.0) + 0.7
Elevation 2: STHGT – ((Max(SGNHGT(j)) / 2.0) + 13.8

To reduce the truck-induced gust pressure applied to members in between these elevations, the following equation is applied:

Reduced Truck Gust = Truck Gust * [1 – (Elevation of the member – Elevation 1) / (Elevation 2 – Elevation 1)]

For these calculations, the sign panel is assumed to be located symmetrical vertically about the mid-depth of the truss. The truck-induced gust pressure is applied only to signs that are VMS Boxes. Truck-induced pressure is based on a vehicle design speed of 65 mph (30 m/s). For locations where lower vehicle design speeds occur, a vehicle design speed may be entered onto the Loads Input Card and the equation to compute the truck-induced gust pressure will be adjusted as follows:

$$\mathbf{P_{TG} = 18.8 * C_d * (V^2_{design} / 65)^2 * I_F}$$

Where: V^2_{design} = Vehicle Design Speed

3.4.7 LOAD COMBINATIONS

The load combinations used for the program are based on the AASHTO Sign Specifications and are shown in Tables 3.4.4-1a, 3.4.4-1b, and 3.4.4-1c.

Loads	Percent of Allowable Stress
Group I – DL	100
Group II – DL + W	133(1/1.33=0.752)
Group III – DL + Ice + ½(W**)	133(1/1.33=0.752)
Group IV – Fatigue	100

** 25 psf minimum value for W

Table 3.4.3-1a

Load Case	SAPV Structure Load Case	Description	Comment
1	1M	DL structural steel only	Structural steel quantity
2	2M	DL sign panels, luminaries, catwalks	
3	3M	W on members, normal	
4	4M	W on sign panel, normal	
5	5M	W on catwalk, normal	
6	6M	W on members, transverse	
7	7M	W on sign panel, transverse	
8	8M	W on catwalk, transverse	
9	9M	ICE on members	
10	10M	ICE on sign panel	
11	11M	ICE on catwalk	
12	12M	W on members, normal	W is minimum of 25 psf
13	13M	W on sign panel, normal	“ “ “
14	14M	W on catwalk, normal	“ “ “
15	15M	W on members, transverse	“ “ “
16	16M	W on sign panel, transverse	“ “ “
17	17M	W on catwalk, transverse	“ “ “
18	18M	Pg on sign panel, vertical	
19	19M	Pnw on sign panel, normal	
20	20M	Pnw on members, normal	
21	21M	Pnw on catwalk, normal	
22	22M	Pnw on sign panel, transverse	
23	23M	Pnw on members, transverse	
24	24M	Pnw on catwalk, transverse	
25	25M	Ptg on sign panel (VMS boxes only), vertical	
26	26M	Ptg on members (no columns), vertical	
27	27M	Ptg on catwalk, vertical	

Table 3.4.3-1b

Load Case	SAPV load case	Description	Load Equation	Comments
28	1	Group I - DL only	Load 1-2 * 1.000	100% allowable
29	2	Group IIa - DL + W	Load 1-2 * 0.752 + Load 3,4,5 * 0.752 + Load 6-8 * .2(0.752)	133% allowable, +Wn, +Wt
30	3	Group IIb - DL + W	Load 1-2 * 0.752 + Load 3,4,5 * .6(0.752) + Load 6-8 * .3(0.752)	133% allowable, +Wn, +Wt
31	4	Group IIc - DL + W	Load 1-2 * 0.752 + Load 3,4,5 * 0.752 + Load 6-8 * -.2(0.752)	133% allowable, +Wn, -Wt
32	5	Group IId - DL + W	Load 1-2 * 0.752 + Load 3,4,5 * .6(0.752) + Load 6-8 * -.3(0.752)	133% allowable, +Wn, -Wt
33	6	Group IIe - DL + W	Load 1-2 * 0.752 + Load 3,4,5 * -0.752 + Load 6-8 * .2(0.752)	133% allowable, -Wn, +Wt
34	7	Group IIf - DL + W	Load 1-2 * 0.752 + Load 3,4,5 * -.6(0.752) + Load 6-8 * .3(0.752)	133% allowable, -Wn, +Wt
35	8	Group IIg - DL + W	Load 1-2 * 0.752 + Load 3,4,5 * -0.752 + Load 6-8 * -.2(0.752)	133% allowable, -Wn, -Wt
36	9	Group IIh - DL + W	Load 1-2 * 0.752 + Load 3,4,5 * -.6(0.752) + Load 6-8 * -.3(0.752)	133% allowable, -Wn, -Wt
37	10	Group IIIa-DL + ICE + .5(W)	Load 1-2 * 0.752 + Load 9-11 * 0.752 + Load 12-14 * .5(0.752) + Load 15-17 * .5(.2(0.752))	133% allowable, +Wn, +Wt
38	11	Group IIIb-DL + ICE + .5(W)	Load 1-2 * 0.752 + Load 9-11 * 0.752 + Load 12-14 * .5(.6(0.752)) + Load 15-17 * .5(.3(0.752))	133% allowable, +Wn, +Wt
39	12	Group IIIc-DL + ICE + .5(W)	Load 1-2 * 0.752 + Load 9-11 * 0.752 + Load 12-14 * .5(0.752) + Load 15-17 * -.5(.2(0.752))	133% allowable, +Wn, -Wt
40	13	Group IIId-DL + ICE + .5(W)	Load 1-2 * 0.752 + Load 9-11 * 0.752 + Load 12-14 * .5(.6(0.752)) + Load 15-17 * -.5(.3(0.752))	133% allowable, +Wn, -Wt
41	14	Group IIIe-DL + ICE + .5(W)	Load 1-2 * 0.752 + Load 9-11 * 0.752 + Load 12-14 * -.5(0.752) + Load 15-17 * .5(.2(0.752))	133% allowable, -Wn, +Wt
42	15	Group IIIf-DL + ICE + .5(W)	Load 1-2 * 0.752 + Load 9-11 * 0.752 + Load 12-14 * -.5(.6(0.752)) + Load 15-17 * .5(.3(0.752))	133% allowable, -Wn, +Wt
43	16	Group IIIg-DL + ICE + .5(W)	Load 1-2 * 0.752 + Load 9-11 * 0.752 + Load 12-14 * -.5(0.752) + Load 15-17 * -.5(.2(0.752))	133% allowable, -Wn, -Wt
44	17	Group IIIh-DL + ICE + .5(W)	Load 1-2 * 0.752 + Load 9-11 * 0.752 + Load 12-14 * -.5(.6(0.752)) + Load 15-17 * -.5(.3(0.752))	133% allowable, -Wn, -Wt
45	18	Group IVa- FATIGUE	Load 18 * 1.000	100% allowable
46	19	Group IVb- FATIGUE	Load 18 * -1.000	100% allowable
47	20	Group IVc- FATIGUE	Load 19 -21 * 1.000 + Load 22-24 * 0.200	100% allowable, +NWGn, +NWGt
48	21	Group IVd- FATIGUE	Load 19 - 21 * -1.000 + Load 22 - 24 * -0.200	100% allowable, -NWGn, -NWGt
49	22	Group IVe- FATIGUE	Load 19 - 21 * 0.600 + Load 22 - 24 * 0.300	100% allowable, +NWGn, +NWGt
50	23	Group IVf- FATIGUE	Load 19 - 21 * -0.600 + Load 22 - 24 * -0.300	100% allowable, -NWGn, -NWGt
51	24	Group IVg- FATIGUE	Load 25 - 27 * 1.000	100% allowable
52	25	Group V - DL + ICE	Load 1-2 * 1.000 + Load 9-11 * 1.000	Defl for Overhead Supports
53	26	Dead Load only	Load 1 * 1.000	Structural Steel Dead Load

Table 3.4.3-1c

3.5 ANALYSIS

Once the model has been created, the Sign Structure program generates a finite element input file, which is processed by the SAPV analysis core. The model is comprised of space frame beam elements with configurations and loadings as described in the previous sections of this chapter. A listing of the nodal geometry and element connectivity can be obtained if the user input output level is set to levels 1 or 2. The SAPV program uses the stiffness method (or matrix method) of analysis. For a more detailed description of the stiffness method, see Computer Analysis of Structural Systems by John Fleming or any other structural book related to the matrix analysis of structures.

3.6 SPECIFICATION CHECKING

The criteria used for the specification checking performed in the sign structure program are based on the tables given on the following pages. These tables show the limiting lengths of members, limiting width to thickness ratios for compression elements, slenderness ratio criteria, allowable unit stress relationship, interaction equations (combined stress ratios), and the calculation of stresses. Figures accompany the tables in order to define any length variables and stress point locations.

NOTE: Specification checking for angle and WF section types is not included in this release of the program. However, for the user's information, the specification criteria for this model are shown in the accompanying tables.

Member Stress Type	Component	Range	Comment
Tension Member	Column (Post) Truss Chord Strut Chord	$(l/r)_x$ & $(l/r)_y \le 200$	• AASHTO Sign Specification Section 1.3.2 • 1996 AASHTO Standard Specifications for Highway Bridges Section 10.7 NOTE: For centermount and cantilever structures, struts are designed based on the compression member criteria. For Two Post Planar Truss structures, upper chord members are designed based on the compression member criteria.
Tension Member	Web Vertical Front & Rear Diagonal Front & Rear Vertical Top & Bottom Diagonal Top & Bottom Vertical Tower Diagonal	$(l/r)_x$ & $(l/r)_y \le 240$	
Member Subject to a Reversal of Stress	Column (Post) Truss Chord Strut Chord	$(l/r)_x$ & $(l/r)_y \le 140$	
Compression Member	Column (Post) Truss Chord Strut Chord	$(Kl/r)_x$ & $(Kl/r)_y \le 120$	
Compression Member	Web Vertical Front & Rear Diagonal Front & Rear Vertical Top & Bottom Diagonal Top & Bottom Vertical Tower Diagonal	$(Kl/r)_x$ & $(Kl/r)_y \le 140$	

Table 3.6-1 - Limiting Lengths of Members

Structural Shape	**Shape Element**	**Width to Thickness Ratio**	Limiting Width - Thickness Ratios		
			Compact	**Non-Compact**	**Maximum (Slender)**
Round Tube	Entire Cross Section	$\frac{F_y}{E}\left[\frac{R}{t}\right]$ (1)	≤ 0.063 [Tbl. 1.4.1B(1) - 1994]	≤ 0.131	≤ 0.224
16-sided Tube	Entire Cross Section	$\frac{b}{t}$ (2)	$\leq \frac{6000}{\sqrt{Fy}}$ [Tbl 1.4.1B(1) - 1994]	$\leq \frac{6800}{\sqrt{Fy}}$	$\leq \frac{11540}{\sqrt{Fy}}$
12-sided Tube	Entire Cross Section	$\frac{b}{t}$ (2)	$\leq \frac{6000}{\sqrt{Fy}}$ [Tbl 1.4.1B(1) - 1994]	$\leq \frac{7580}{\sqrt{Fy}}$	$\leq \frac{11540}{\sqrt{Fy}}$
8-sided Tube	Entire Cross Section	$\frac{b}{t}$ (2)	$\leq \frac{6000}{\sqrt{Fy}}$ [Tbl 1.4.1B(1) - 1994]	$\leq \frac{8220}{\sqrt{Fy}}$	$\leq \frac{11540}{\sqrt{Fy}}$

(continued)

Units: pounds and inches.
R is measured to outer edge of wall.
b = the effective width of one side for polygonal tubes.

Table 3.6-2 - Limiting Width-thickness Ratios for Compression Elements

(1) Shown in same format as the 1994 Code. Current Code limits “D/t” to a percentage of “E/Fy” (see Table 5-1).
(2) Limiting values are shown in the same format as the 1994 Code. Current Code limits “b/t” to a factor multiplied by “ $\sqrt{(E/Fy)}$ ” (see Table 5.1).

Structural Shape	**Shape Element**	**Width to Thickness Ratio**	Limiting Width - Thickness Ratios		
			Compact	**Non-Compact**	**Maximum (Slender)**
WF Section	Flange	$\frac{b}{t_f}$ (1)	$\leq \frac{2050}{\sqrt{Fy}}$ [1.4.1(c)(1)(b)(i) - 1994]	$\leq \frac{3000}{\sqrt{Fy}}$ [1.4.1(c)(4) - 1994]	Not Applicable
	Web	$\frac{d}{tw}$ * (1)	For fa / Fy $\leq$ 0.16 $\leq \frac{20{,}200\,(1 - 3.74\,fa/Fy)}{\sqrt{Fy}}$ For fa / Fy > 0.16 $\leq \frac{8120}{\sqrt{Fy}}$ [1.4.1(c)(1)(b)(iv) - 1994]	$< \frac{24000}{\sqrt{Fy}}$ AISC Manual of Steel Construction, ASD, Pg. 5-36, Table B5.1.	Not Applicable
Single Angle	Leg of Angle	$\frac{b}{t}$ (1)	Not Applicable	$\leq \frac{2400}{\sqrt{Fy}}$ [1.4.1(c)(4)(a) - 1994]	Not Applicable

(continued)

* Note: For non-compact check, use h/t_w
Units: pounds and inches.

$h = d - 2t_f$
b = the width of projecting compression element ($b_f/2$ for WF).

Table 3.6-2 - Limiting Width-thickness Ratios for Compression Elements (continued)

(1) Limiting values are shown in the same format as the 1994 Code. Current Code limits the ratio to a factor multiplied by " $\sqrt{(E/Fy)}$ " (see Table 5-2).

Structural Shape	**Shape Element**	**Width to Thickness Ratio**	Limiting Width - Thickness Ratios		
			Compact	**Non-Compact**	**Maximum (Slender)**
Channel	Flange	$\frac{b}{t_f}$ (1)	$\leq \frac{2050}{\sqrt{Fy}}$ [1.4.1(c)(1)(b)(i) - 1994]	$\leq \frac{3000}{\sqrt{Fy}}$ [1.4.1(c)(4) - 1994]	Not Applicable
	Web	$\frac{d}{t_w}$ * (1)	For fa / Fy $\leq$ 0.16: Take the minimum of $\leq \frac{20{,}200\left(1-3.74\, fa/Fy\right)}{\sqrt{Fy}}$ or $\leq \frac{8120}{\sqrt{Fy}}$ For fa / Fy > 0.16 $\leq \frac{8120}{\sqrt{Fy}}$ [1.4.1(c)(1)(b)(iv)- 1994]	$< \frac{24000}{\sqrt{Fy}}$ AISC Manual of Steel Construction, ASD, Pg. 5-36, Table B5.1.	Not Applicable
WT & ST Sections	Flange	$\frac{b}{t_f}$ (1)	N/A	$\leq \frac{3000}{\sqrt{Fy}}$ [1.4.1(c)(4)(a) - 1994]	Not Applicable
	Web	$\frac{d}{t_w}$ (1)	N/A	$\leq \frac{2400}{\sqrt{Fy}}$ [1.4.1(c)(4)(a) - 1994]	Not Applicable

* Note: For non-compact check, use h/t_w
Units: pounds and inches.

$h = d - 2t_f$
b = the width of projecting compression element ($b_f/2$ for WT and ST).

<u>Table 3.6-2 - Limiting Width-thickness Ratios for Compression Elements(continued)</u>

(1) Limiting values are shown in the same format as the 1994 Code. Current Code limits the ratios to a factor multiplied by "$\sqrt{(E/Fy)}$" (see Table 5-2).

Structure Type	Component	K	Length	Radius of Gyration	Figure
Centermount	Column (Post)	2.0	L_c	r_{min}	See Figure 3.6-1
	Strut	1.0	L_s	r_{min}	
Cantilever	Column (Post)	2.0	L_c	r_{min}	See Figure 3.6-2
	Strut	1.0	L_s	r_{min}	
2 Post Planar	Column (Post)	2.0	L_c	r_{min}	See Figure 3.6-3
	Chord	1.0	l_s	r_x *	
		0.696 **	L_s	r_y *	
	Web	0.75	l_w	r_{min}	
	Vertical	0.75	l_v	r_{min}	
Tapered Tube	Column (Post)	See Footnote	L_c	$r_{min\ @\ base}$	See Figure 3.6-4
	Chord	See Footnote	L_s	$r_{min\ @\ center}$	
2 Post Tri-Chord	Column (Post)	2.0	L_c	r_{min}	See Figure 3.6-5
	Chord	1.0	l_s	r_{min}	
	Vertical	0.75	l_v	r_{min}	
	Diagonal	0.75	l_w	r_{min}	
4 Post Tri-Chord	Column (Post)	1.0	l_c	r_x *	See Figure 3.6-6
		2.0	L_c	r_y *	
	Chord	1.0	l_s	r_{min}	
	Vertical	0.75	l_v	r_{min}	
	Diagonal	0.75	l_w	r_{min}	
	Tower Diagonal	0.75	l_d	r_{min}	

(continued)

*   Based on orientation of member.
** See "Theory of Elastic Stability" by Timoshenko and Gere, 1961, Page 111, Table 2-9.

Table 3.6-3 - Slenderness Ratio Criteria

Structure Type	Component	K	Length	Radius of Gyration	Figure
4 Post 4 Chord	Column (Post)	1.0	l_c	r_x *	See Figure 3.6-7
		2.0	L_c	r_y *	
	Chord	1.0	l_s	r_{min}	
	Front & Rear Diagonal	0.75	l_f	r_{min}	
	Front & Rear Vertical	0.75	l_v	r_{min}	
	Top & Bottom Diagonal	0.75	l_t	r_{min}	
	Top & Bottom Diagonal	0.75	l_{vt}	r_{min}	
	Tower Diagonal	0.75	l_d	r_{min}	

* Based on orientation of member.

Table 3.6-3 - Slenderness Ratio Criteria (continued)

FOOTNOTE:
Effective length factors, K, for tapered columns and tapered chords are calculated from Equation 2-53, page 128, "Theory of Elastic Stability" by Timoshenko and Gere, 2nd Edition, 1961. Calulating critical stress and solving for K yields:

$$K = \sqrt{\frac{\pi^2}{m}}$$

From Tables 2-12 and 2-13, equations are developed.

From Table 2-12, $m = 2.4775\ X^{\mathbf{0.3113}}$ (POSTS).

From Table 2-13, $m = 9.91059\ X^{\mathbf{0.31195}}$ (CHORDS).

Where: $X = \frac{I_1}{I_2}$

Therefore,

For Posts: $K = 1.9959\left(\frac{I_1}{I_2}\right)^{0.1556}$ where $I_1 = I_{top}$ and $I_2 = I_{base}$.

For Chords: $K = 0.9979\left(\frac{I_1}{I_2}\right)^{0.15598}$ where $I_1 = I_{end}$ and $I_2 = I_{center}$.

Stress Type	Program Equation ID	Equation	Range	Comments
Axial F_a	Tensile A_1	$0.60\ F_y$	Welded Connections	Sign Specification Section 5.9
	Tensile A_2	Minimum of: 0.50 Fu * Ae * Ag or $0.60\ F_y$	Bolted Connections	Sign Specification Section 5.9
	Compression A_3	$\frac{0.52\pi^2 E}{(KL/r)^2}$	$\frac{KL}{r} \geq \sqrt{\frac{2\pi^2 E}{F_y}} = C_c$	Sign Specification Section 5.10
	A_4	$\frac{\left[\left(1-(KL/r)^2\right)/\left(2C_c^2\right)\right]F_y}{\frac{5}{3}+\frac{3(KL/r)}{8C_c}-\frac{(KL/r)^3}{8(C_c^3)}}$	$\frac{KL}{r} < C_c$	Sign Specification Section 5.10
Shear F_v	V_1	$0.33\ F_y$	$\frac{Fy}{E}\left(\frac{R}{t}\right)^{3/2} \leq 0.44$ (1)	Round Tubes, Sign Specification Section 1.4.1(C)(2) And Table 1.4.1B(1) - 1994

(continued on next page)

Table 3.6-4 - Allowable Unit Stress Relationship

(1) Shown in same format as the 1994 Code. Current Code limits "D/t" instead (see Eq. 5-11).

Stress Type	Program Equation ID	Equation	Range	Comments
Shear F_v	V_2	$0.143\,E\left(\frac{t}{R}\right)^{3/2}$ (2)	$\frac{F_y}{E}\left(\frac{R}{t}\right)^{3/2} > 0.44$ (1)	Round Tubes, Sign Specification Table 1.4.1B(1) - 1994
	V_3	$0.33\ F_y$	$\frac{h}{t_W} \le \frac{12000}{\sqrt{Fy}}$ (2)	I-shaped Sections and Channels, Sign Specification Sect. 5.11.3
	V_4	$0.33\ F_y$	$\frac{b}{t} \le \frac{12000}{\sqrt{Fy}}$ (2)	Polygonal Tubes, Sign Specification Table 1.4.1B(1) - 1994
	V_5	$\frac{47.52 \times 10^6}{\left(\frac{b}{t}\right)^2}$	$\frac{b}{t} > \frac{12000}{\sqrt{F_y}}$ (2)	Polygonal Tubes, Sign Specification Table 1.4.1B(1) - 1994
Bending F_b	B_1	$0.66\ F_y$	$\frac{Fy}{E}\left(\frac{R}{t}\right) \le 0.063$ (1)	Round Compact Tubes, Sign Specification Table 1.4.1B(1) - 1994

(continued on next page)

Table 3.6-4 - Allowable Unit Stress Relationship (continued)

(1) Shown in same format as the 1994 Code. Current code limits “D/t” instead (see Eq. 5-12).

(2) Shown in same format as the 1994 Code.

Stress Type	Program Equation ID	Equation	Range	Comments
Bending F_b	B_2	$\left[0.39 + 0.017\left(\frac{E}{F_y}\right)\left(\frac{t}{R}\right)\right]F_y$ (1)	$0.063 < \frac{Fy}{E}\left(\frac{R}{t}\right) \le 0.224$ (1)	Round Non-compact or Slender Tubes, Sign Specification Table 5-3
	B_3	$0.60\ F_y$	$L \le \frac{2400\ b}{\sqrt{F_y}}$ (1)	Compact W Sections, Sign Specification Section 1.4.1(C)(1)(b) - 1994
	B_4	Larger of following: $F_b = \left[\frac{2}{3} - \frac{F_y\ (L/r_t)^2}{1530 \times 10^6}\right]F_y$ $F_b = \frac{12 \times 10^6}{L\,d/A_f}$ (1)	$\frac{L}{r_t} \ge \sqrt{\frac{102 \times 10^6}{F_y}}$ $\frac{L}{r_t} \le \sqrt{\frac{510 \times 10^6}{F_y}}$ (1)	Non-compact W Sections, Sign Specification Section 1.4.1(C)(1)(c) - 1994 C_b taken as unity
	B_5	Larger of following $F_b = \frac{170 \times 10^6}{(L/r_t)^2} \le 0.60\ F_y$ $F_b = \frac{12 \times 10^6}{L\,d/A_f} \le 0.60\ F_y$ (1)	$\frac{L}{rt} > \sqrt{\frac{510 \times 10^6}{Fy}}$ (1)	Non-compact W Sections, Sign Specification Section 1.4.1(C)(1)(c) - 1994 C_b taken as unity

(continued on next page)

Table 3.6-4 - Allowable Unit Stress Relationship (continued)

(1) Shown in same format as the 1994 Code.

Stress Type	Program Equation ID	Equation	Range	Comments
Bending F_b	B_6	$0.60F_y$	$Mx = 0.0$ And $L \le \frac{2400b}{\sqrt{Fy}}$ (1)	Channel Sections loaded through shear center, with adequate lateral support. Sign Specification Section 5.7.1.2
	B_7	$F_b = \frac{12 \times 10^6}{L\,d / A_f} \le 0.60\,F_y$ (1)	$L > \frac{2400b}{\sqrt{Fy}}$ (1)	Channel Sections with inadequate lateral support. Sign Specification Section 5.7.1.2 C_b taken as unity
	B_8	FLANGE Use Eqn. B_5 and B_6. WEB $F_b = 21{,}560 - 17.4\,(d/t)^2$ $F_b = 0.60\,F_y$	Same as B_5 and B_6.	ST, WT Sections with inadequate lateral support For Web, see U.S. Steel Design Manual, 1981, Pg. 71, Eqn. 4.4
	B_9	FLANGE $0.60F_y$ WEB $F_b = 21{,}560 - 17.4\,(d/t)^2$ F_b □= $0.60F_y$	$L \le \frac{2400b}{\sqrt{Fy}}$	ST, WT Sections with adequate lateral support For Web, see U.S. Steel Design Manual, 1981, Pg. 71, Eqn. 4.4
	B_{10}	Hexdecagonal $0.66\,F_y$ Dodecagonal $0.65\,F_y$ Octagonal $0.64\,F_y$	$\frac{b}{t} \le \frac{6000}{\sqrt{Fy}}$ (1)	Compact Polygonal Tubes, Sign Specification Table 5-3
	B_{11}	$0.964\,F_y \left[1 - \left(0.3014/\sqrt{\frac{E}{F_y}}\right)\left(\frac{b}{t}\right)\right]$	$\frac{6000}{\sqrt{Fy}} < \frac{b}{t} \le \frac{8200}{\sqrt{Fy}}$ (1)	Non-compact Octagonal Tubes, Sign Specification Table 5-3

(continued on next page)

Table 3.6-4 - Allowable Unit Stress Relationship (continued)

(1) Shown in same format as the 1994 Code.

Stress Type	Program Equation ID	Equation	Range	Comments
Bending F_b	B_{12}	$1.152\,Fy\left[1-\left(0.39/\sqrt{\frac{E}{F_y}}\right)\left(\frac{b}{t}\right)\right]$	$\frac{6000}{\sqrt{Fy}} < \frac{b}{t} \le \frac{7600}{\sqrt{Fy}}$ (1)	Non-compact Dodecagonal Tubes, Sign Specification Table 5-3
	B_{13}	$1.709\,Fy\left[1-\left(0.55/\sqrt{\frac{E}{F_y}}\right)\left(\frac{b}{t}\right)\right]$	$\frac{6000}{\sqrt{Fy}} < \frac{b}{t} \le \frac{6800}{\sqrt{Fy}}$ (1)	Non-compact Hexdecagonal Tubes, Sign Specification Table 5-3
	B_{14}	Hexdecagonal $0.74\,Fy\left[1-\left(0.2333/\sqrt{\frac{E}{F_y}}\right)\left(\frac{b}{t}\right)\right]$ Dodecagonal $0.75\,Fy\left[1-\left(0.2197/\sqrt{\frac{E}{F_y}}\right)\left(\frac{b}{t}\right)\right]$ Octagonal $0.74\,Fy\left[1-\left(0.1941/\sqrt{\frac{E}{F_y}}\right)\left(\frac{b}{t}\right)\right]$	Hexdecagonal $\frac{6800}{\sqrt{Fy}} < \frac{b}{t} \le \frac{11500}{\sqrt{F_y}}$ Dodecagonal $\frac{7600}{\sqrt{Fy}} < \frac{b}{t} \le \frac{11500}{\sqrt{F_y}}$ Octagonal $\frac{8200}{\sqrt{Fy}} < \frac{b}{t} \le \frac{11500}{\sqrt{F_y}}$ (1)	Slender Polygonal Tubes, Sign Specification Table 5-3

***** The allowable bending stress for polygonal tubes shall not exceed the allowable stress for round tubes of equivalent radius.

Table 3.6-4 - Allowable Unit Stress Relationship (continued)

(1) Shown in same format as the 1994 Code.

Stress Type	Equation ID	Combined Stress Ratio based on Allowable Unit Stress Relationship	Range	Comment
Compression	I_1	The greater of: $\frac{f_a}{F_a}+\frac{f_b}{\left(1-\frac{f_a}{\frac{12\pi^2 E}{23(kL/r)^2}}\right)F_b}+\left(\frac{f_v}{F_v}\right)^2$ And $\frac{f_a}{0.6F_a}+\frac{f_b}{C_A F_b}+\left(\frac{f_v}{F_v}\right)^2$	$\frac{fa}{Fa} < -0.15$	Sign Specification Section 5.12.2 Amplification Coeff. for cantilever and centermount post: $C_A = 1-\left[\frac{P_T+0.38D_P}{\frac{2.46EI_B}{L^2}}\right] \leq 1.0$ Otherwise, $C_A = 1.0$
	I_2	$\left\|\frac{f_a}{F_a}\right\|+\left\|\frac{f_b}{C_A F_b}\right\|+\left(\frac{f_v}{F_v}\right)^2$	$\frac{fa}{Fa} \geq -0.15$	
Tension	I_3	$\frac{f_a}{0.6F_t}+\frac{f_b}{F_b}+\left(\frac{f_v}{F_v}\right)^2$	Truss members in tension and cantilevered horizontal supports. Also, for members having no axial load and members in axial tension, combined with other effects.	Sign Specification Eq. 5-16. The amplification term, C_A, has been eliminated, since it does not apply to tension.
	I_4	$\frac{f_a+\sqrt{f_{bx}^2+f_{by}^2}}{F_{sr}}$ for round sections $\frac{f_a+f_{bx}+\left\|f_{by}\right\|}{F_{sr}}$ for ST's and WT's	F_{sr} = Fatigue Allowable Stress Range, Table 11-3	Fatigue Stress Combined Stress Ratio
Tension or Compression	I_5	$\left\|\frac{fa}{Fa}\right\|+\frac{\sigma max}{Fb}+\left(\frac{fv}{Fv}\right)^2$	End connections of Tri-chord and 4-chord trusses	Saddle Detail CSR, σ_{max} is stress due to circumferential bending.

Table 3.6-5 - Interaction Equations

Structural Shape	Figure	Point	f_a * Axial Stress	v_b Beam Shear Stress	v_t Torsion Shear Stress	f_v Shear Stress	f_b Bending Stress	Comment
Round Tube	See Figure 3.6-8	1	$\pm\frac{P}{A}$	$\frac{2\sqrt{V_y^2+V_x^2}}{A}$	$\left\lvert\frac{T\,r}{2I}\right\rvert$	$v_b + v_t$	$\frac{-r\sqrt{M_y^2+M_x^2}}{I}$	A & I are from AISC Tables; 2I = J r = radius (diameter/2)
		2					$\frac{-r\sqrt{M_y^2+M_x^2}}{I}$	
Polygonal Tube	See Figure 3.6-12	1	$\pm\frac{P}{A}$	**	**	$v_b + v_t$	**	** See Sign Specification Commentary Section 1.3.1
		2						
WF Section	See Figure 3.6-9	1	$\pm\frac{P}{A}$	$\left\lvert\frac{V_x}{2\,b_f\,t_f}\right\rvert$	$\left\lvert\frac{T\,t_f}{J}\right\rvert$	$v_b + v_t$	$-\frac{M_y}{S_y}-\frac{M_x}{S_x}$	A, b_f, t_f, y, d, t_w, S_y, S_x & J from AISC Tables
		2					$+\frac{M_y}{S_y}-\frac{M_x}{S_x}$	
		3					$-\frac{M_y}{S_y}+\frac{M_x}{S_x}$	
		4					$+\frac{M_y}{S_y}+\frac{M_x}{S_x}$	
		5		$\left\lvert\frac{V_y}{d\,t_w}\right\rvert$ & $\left\lvert\frac{V_x}{b_f\,t_f}\right\rvert$	$\left\lvert\frac{T\,\delta\,t_f}{J}\right\rvert$	$\sqrt{(v_{bx}+v_t)^2+v_{by}^2}$	$-\frac{M_x}{S_x}$	
		6					$+\frac{M_x}{S_x}$	

(continued)

δ is the stress concentration factor for WF sections from the "U.S. Steel Design Manual", pp. 161-162.

* The negative sign applies to the **i** side axial load, positive sign applies to the **j** side. Do not apply the sign notation to the axial load in the bending term; use the actual number from SAP.

** Reference AASHTO Sign Structure Specification Commentary Section 1.3.1 for polygonal tube stress equations.

<u>Table 3.6-6 - Calculation of Stresses</u>

Structural Shape	Figure	Point	f_a * Axial Stress	v_b Beam Shear Stress	v_t Torsion Shear Stress	f_v Shear Stress	f_b Bending Stress	Comment
Channel	See Figure 3.6-10	1	$\pm \frac{P}{A}$	$\left\lvert \frac{V_y}{d\,t_w} \right\rvert \;\&\; \left\lvert \frac{V_x}{2\,b_f\,t_f} \right\rvert$	$\frac{\delta\left(\lvert T \rvert + \lvert V_y e_o \rvert\right) t_f}{J}$	$\sqrt{\left(v_{by}+v_t\right)^2+\left(v_{bx}+v_t\right)^2}$	$-\frac{M_y}{S_{y_1}} - \frac{M_x}{S_x}$	A, t_f, J, x, e_o, b_f, d, t_w, I_y, S_x & S_{y2} from AISC Tables $S_{y_1} = \frac{I_y}{x}$
		2		$\left\lvert \frac{V_x}{2\,b_f\,t_f} \right\rvert$	$\frac{\left(\lvert T \rvert + \lvert V_y e_o \rvert\right) t_f}{J}$	$v_{bx} + v_t$	$+\frac{M_y}{S_{y_2}} - \frac{M_x}{S_x}$	
		3		$\left\lvert \frac{V_y}{d\,t_w} \right\rvert \;\&\; \left\lvert \frac{V_x}{2\,b_f\,t_f} \right\rvert$	$\frac{\delta\left(\lvert T \rvert + \lvert V_y e_o \rvert\right) t_f}{J}$	$\sqrt{\left(v_{by}+v_t\right)^2+\left(v_{bx}+v_t\right)^2}$	$-\frac{M_y}{S_{y_1}} + \frac{M_x}{S_x}$	
		4		$\left\lvert \frac{V_x}{2\,b_f\,t_f} \right\rvert$	$\frac{\left(\lvert T \rvert + \lvert V_y e_o \rvert\right) t_f}{J}$	$v_{bx} + v_t$	$+\frac{M_y}{S_y} + \frac{M_x}{S_x}$	
ST and WT Sections	See Figure 3.6-11	1	$\pm \frac{P}{A}$	$\left\lvert \frac{V_x}{b_f\,t_f} \right\rvert$	$\left\lvert \frac{T\,t_f}{J} \right\rvert$	$v_{bx} + v_t$	$-\frac{M_y}{S_y} - \frac{M_x}{S_{x_1}}$	A, t_f, J, y, b_f, d, t_w, I_x, S_y & S_{x2} from AISC Tables $S_{x_1} = \frac{I_x}{y}$
		2					$+\frac{M_y}{S_y} - \frac{M_x}{S_{x_1}}$	
		3		$\left\lvert \frac{V_y}{d\,t_w} \right\rvert \;\&\; \left\lvert \frac{V_x}{b_f\,t_f} \right\rvert$	$\left\lvert \frac{T\,\delta\,t_f}{J} \right\rvert$	$\sqrt{\left(v_{by}+v_t\right)^2+\left(v_{bx}+v_t\right)^2}$	$-\frac{M_x}{S_{x_1}}$	
		4		$\left\lvert \frac{V_y}{d\,t_w} \right\rvert$	$\left\lvert \frac{T\,t_w}{J} \right\rvert$	$v_{by} + v_t$	$+\frac{M_x}{S_{x_2}}$	

δ is the stress concentration factor for ST and WT flanged sections from the "U.S. Steel Design Manual", pp. 161-162.

δ is the stress concentration factor for channel sections from page 2.10-8 of the "Design of Welded Structures", by Omar W. Blodgett.

* The negative sign applies to the **i** side axial load, positive sign applies to the **j** side. Do not apply the sign notation to the axial load in the bending term; use the actual number from SAP.

Table 3.6-6 - Calculation of Stresses (continued)

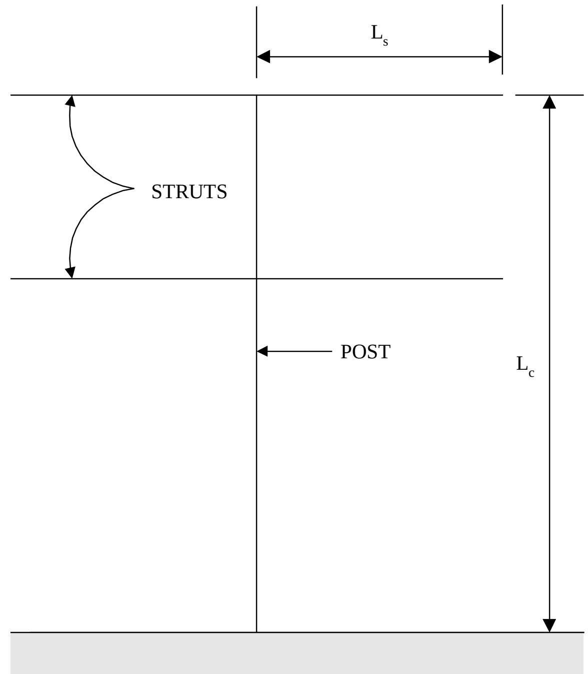


Figure 3.6-1 Centermount

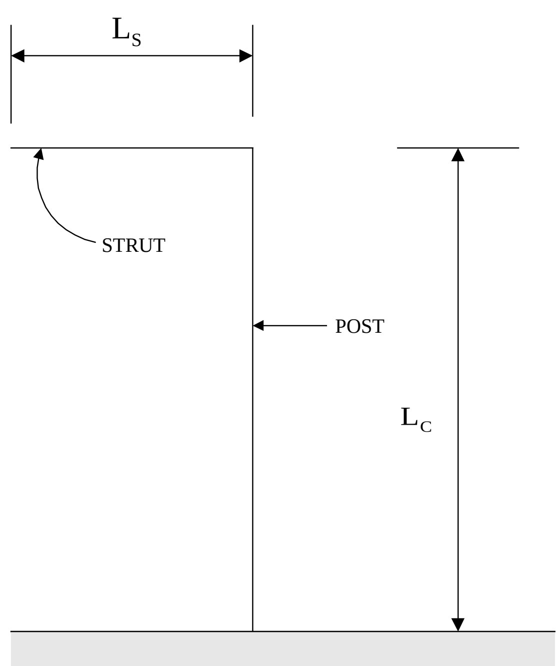


Figure 3.6-2 Cantilever

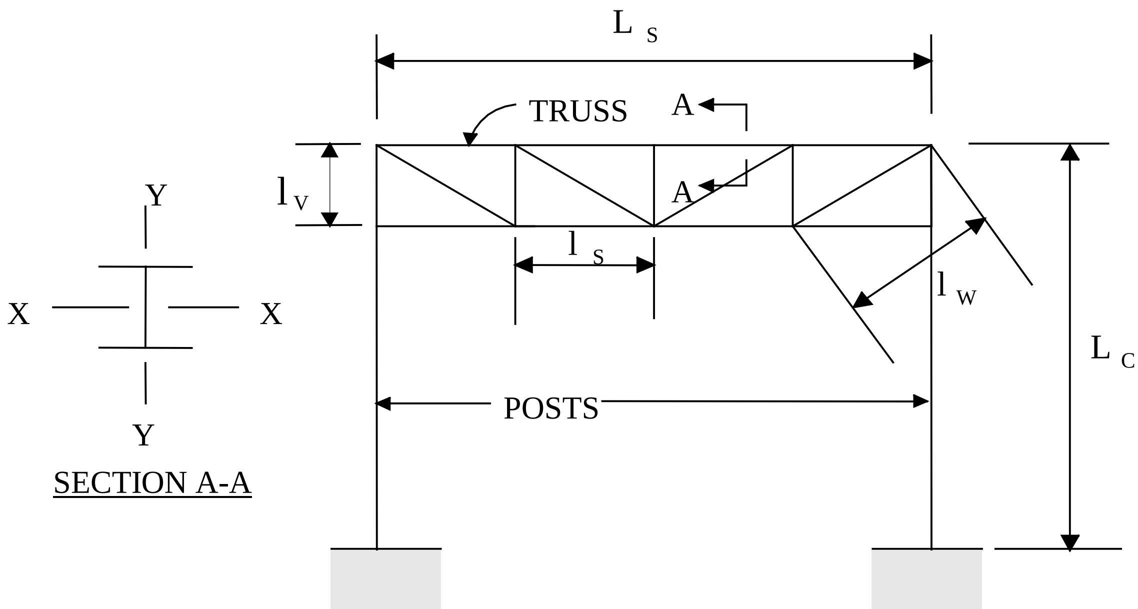


Figure 3.6-3 Two-Post Planar

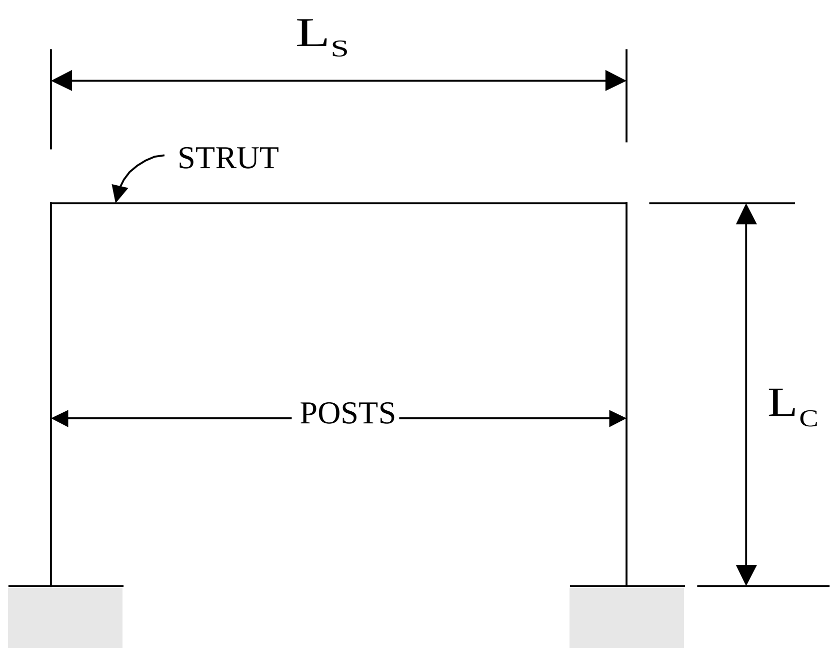


Figure 3.6-4 Tapered Tube

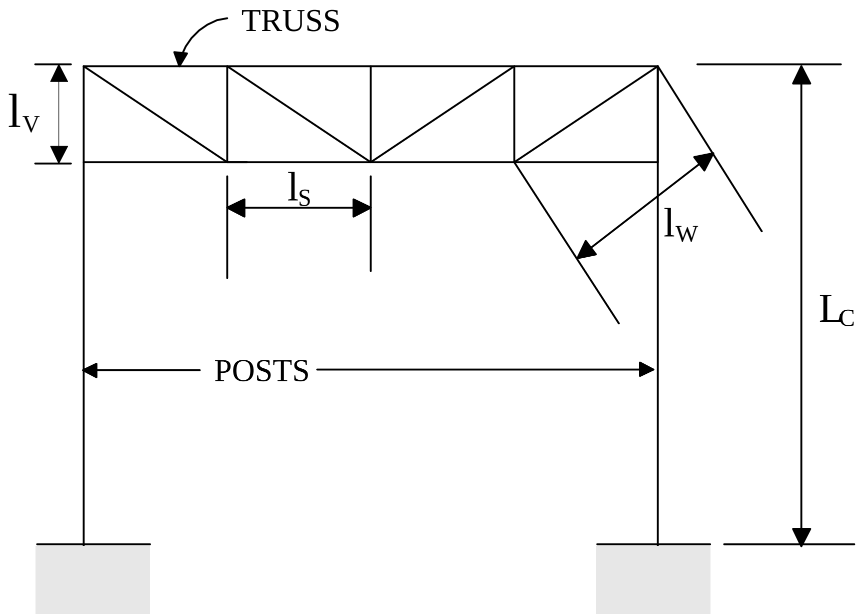


Figure 3.6-5 Two-Post Tri-Chord

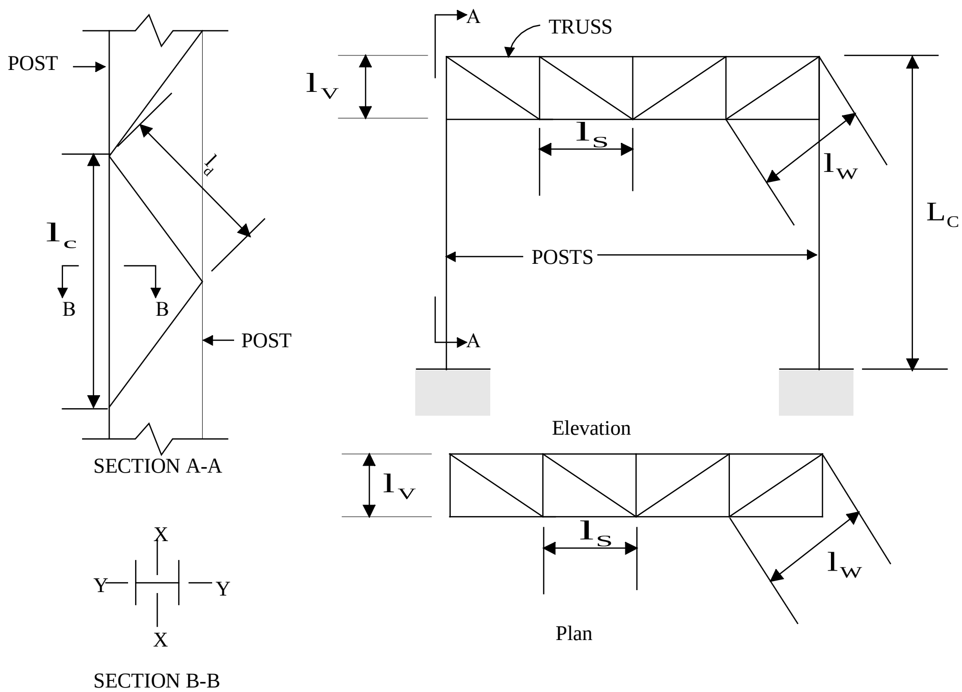


Figure 3.6-6 Four-Post Tri-Chord

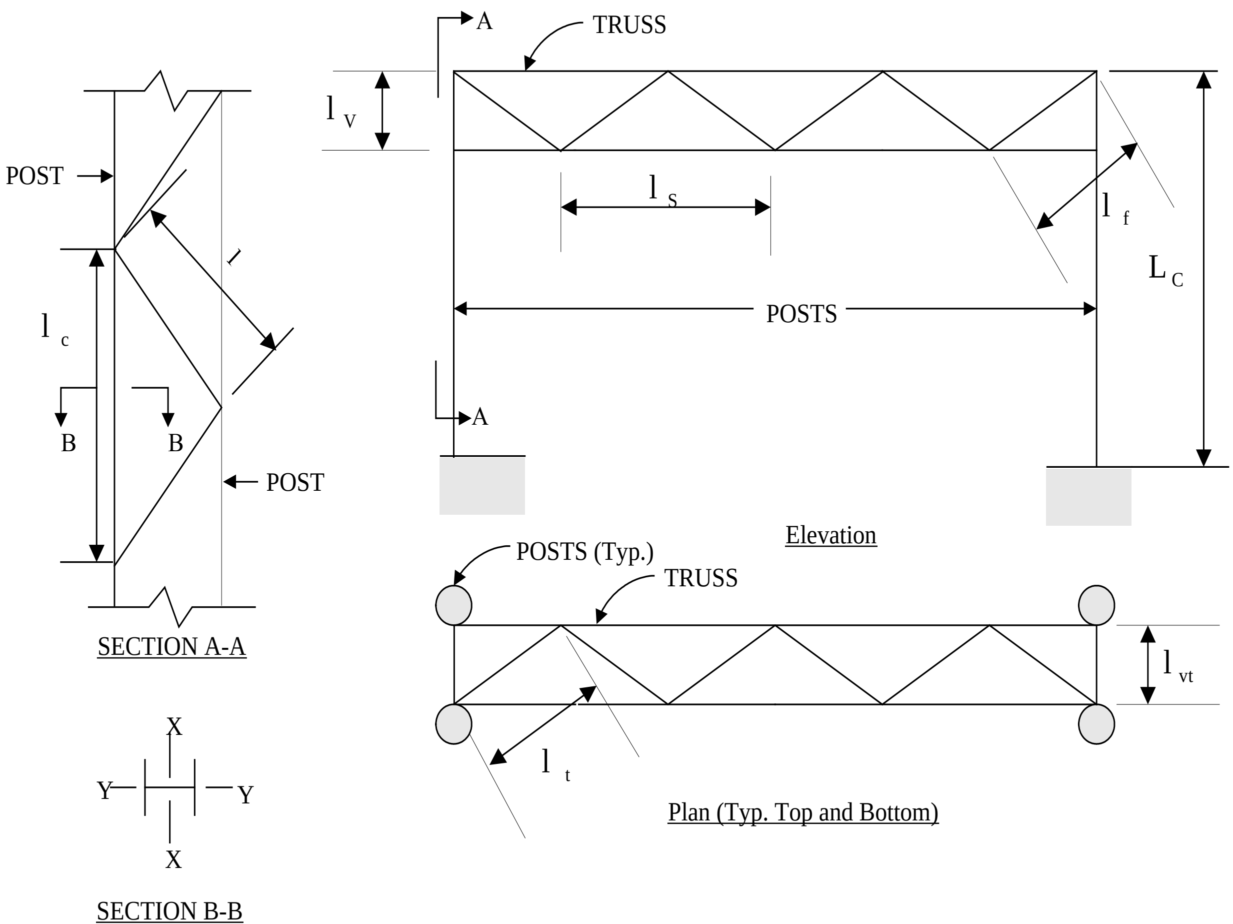


Figure 3.6-7 Four-Post Four-Chord

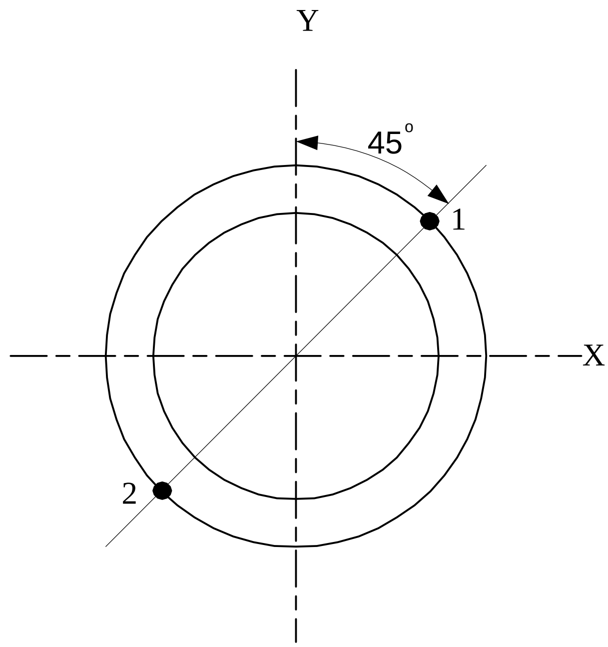


Figure 3.6-8 Round Tube Stress Point Locations

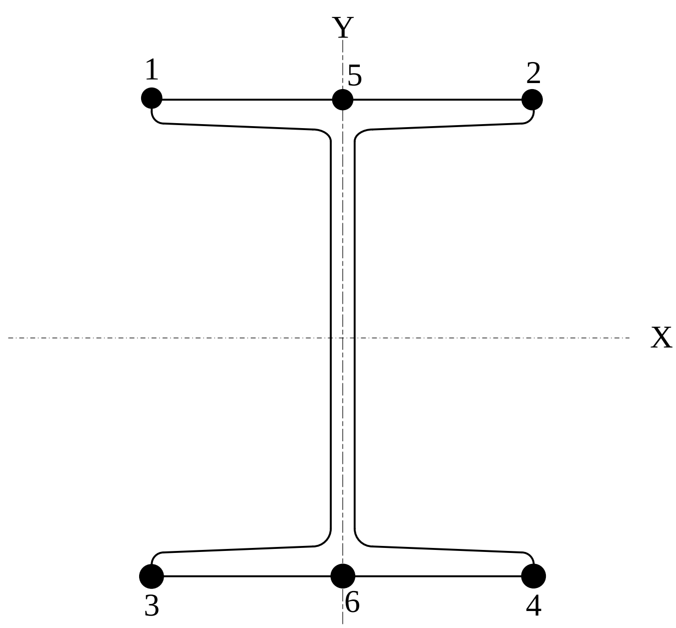


Figure 3.6-9 W Section Stress Point Locations

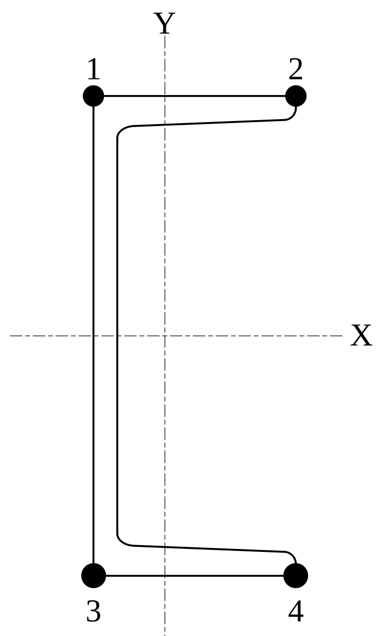


Figure 3.6-10 Channel Stress Point Locations

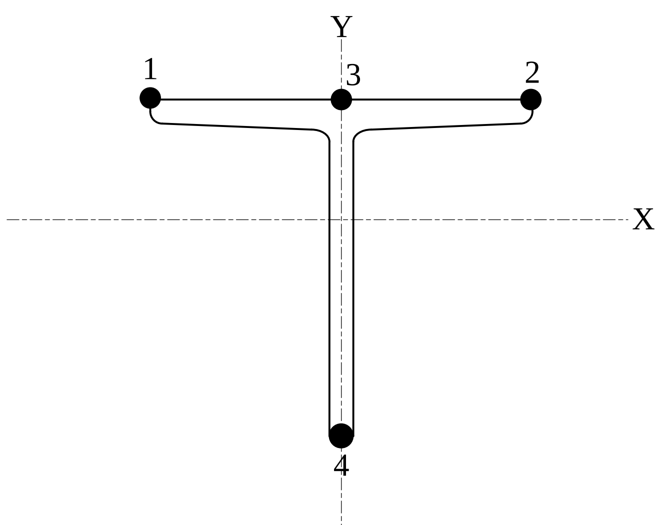


Figure 3.6-11 WT and ST Section Stress Point Locations

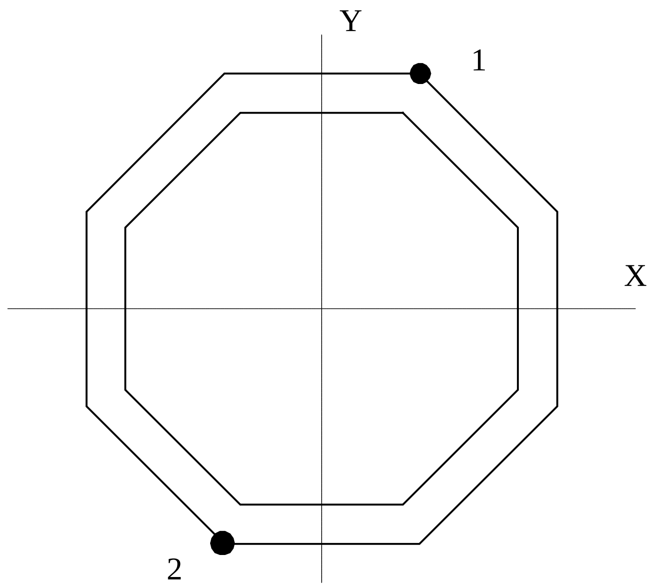


Figure 3.6-12 Polygonal Tube Section Stress Point Locations

3.7 FOOTING DESIGN

The footing program designs or checks spread footings using the 1989 *AASHTO Standard Specifications for Highway Bridges* with interims up to and including 1989 and the *PennDOT Design Manual 4*. Factored load cases are input from the preprocessor and the footing design is checked against each load case. When a load case violates any related design criteria, the footing size is increased to satisfy the subject criteria. The program then begins the check for every load case again. After a complete pass is successful, the program then designs the steel and computes the quantities.

Axial loads, horizontal shears, and biaxial bending moments are applied at the footing centroid. In the case of a four-post sign structure, only one footing supports both posts at each end of the structure. Thus, the double reaction is converted into an eccentric load with a given moment arm. Only one footing is designed for both posts. The footing is assumed infinitely rigid and the footing pressures are calculated from the static equations of equilibrium. The program considers uplift, calculates a line of zero pressure (neutral axis) and the percentage of total area of footing that is in uplift. The minimum bearing area for the footing is 95%.

The program requires a minimal amount of input data to design a footing. Items such as footing size, and rebar size are designed, yet the option exists such that an engineer can input these quantities if no design requirements are violated using the input values. The program has a design/analyze switch such that an engineer can perform a code check for a user-defined footing. Input items that are required for design besides the different load cases are: Pedestal size, Minimum and maximum footing depth, Footing material properties, soil data and Fill material height.

In the design mode, the program will increment the footing thickness by 3" increments if any shear requirements are violated. The footing width is incremented by 1, 2, or 4 foot increments depending on the code violation and the severity of the violation. The footing length is also incremented by 1, 2, or 4 foot increments depending on the code violation and the severity of the violation. The incrementing is based on violations of shear and overturning in the respective directions. The minimum footing size is 2 feet greater than the pedestal size. The program checks every standard rebar size from No. 3 to No. 11 and then uses the smallest bars with a resultant spacing of 6" or greater.

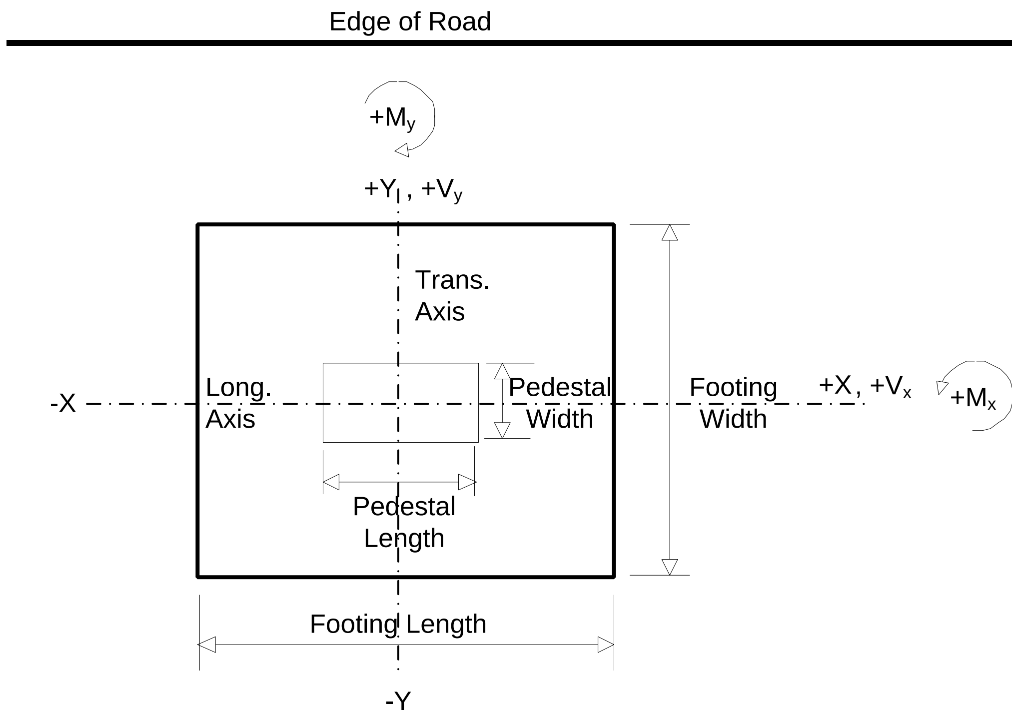


Figure 3.7-1 Footing Sign Convention

3.8 PROGRAM ASSUMPTIONS

The following assumptions are made by the Sign Structure Program:

- Default yield strength of all sign structure steel is 36 ksi.

4.0 INPUT DATA REQUIREMENTS

The input form shown on the following pages (Figure 4.0-1) has been provided to facilitate data preparation for execution of this program. All input fields are fixed format. The implied decimal point location for each data field is as shown on the input form. To override the fixed format, data can be entered with a decimal point as part of the data field. Examples of completed input files are shown in Appendix B. Refer to Figures 3.3-1 through 3.3-10 and the example problems in Appendix B for more information related to specific structure types. The units for dimensions and loads are documented for each input item. In general, dimensions and distances are in feet except as noted, and loads are in pounds except as noted.

PREPARING INPUT

The program requires an ASCII input file. The input file consists of a series of data lines. Each data line consists of a number of fixed length data fields. The input can be created using Engineering Assistant, described below, or any text editor.

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 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.

RUNNING THE PROGRAM WITHOUT ENGINEERING ASSISTANT

SIGN 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 Program\PennDOT, or by double-clicking the shortcut icon on the desktop. To run the program in a command window, the user must specify the directory in which the program has been installed or change to the directory.

The program will first 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. Next, 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 gives the option of overwriting the existing file or entering a new output file output file name. If no output file name is entered, a default output file will be used. The program will then execute.

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

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 from within EngAsst or with a text editor, and the *.PDF output file with Adobe Acrobat.

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PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 1 of 5

PROBLEM IDENTIFCATION
*
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11

PREPARED BY .... DATE ...../...../..... SHEET .....OF.....

Figure 4.0-1 Input Form

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Form 2 of 5

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION					SECTION Fy	PANEL NUMBER
		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5		
1	7	10	16	22	28	34	40	42

PREPARED BY .... DATE ...../...../..... SHEET .....OF.....

Figure 4.0-1 Input Form (continued)

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PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 3 of 5

BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES			LUMINAIRE					CATWALK				IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
			SIGN 1	SIGN 2	SIGN 3	OFFSET	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA				
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71

PREPARED BY .... DATE ...../...../..... SHEET .....OF.....

Figure 4.0-1 Input Form (continued)

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SIGN STRUCTURE ANALYSIS

Form 4 of 5

FATIGUE DETAILS

DETAIL NUMBER	FATIGUE CATEGORY	WEEP HOLE AREA	WIRE OUTLET AREA	HAND HOLE AREA	C/P/B TYPE
1	3	5	11	17	23

PREPARED BY .... DATE ...../...../..... SHEET .....OF.....

Figure 4.0-1 Input Form (continued)

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SIGN STRUCTURE ANALYSIS

Form 5 of 5

FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL			FOOTING			
							HEIGHT	LENGTH	WIDTH	MIN THK	MAX THK	WIDTH	LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP				BOTTOM			
			LONG BAR		TRANS BAR		LONG BAR		TRANS BAR	
			SIZE	SPACING	SIZE	SPACING	SIZE	SPACING	SIZE	SPACING
1	3	7	11	13	17	19	23	25	29	31

PREPARED BY .... DATE ...../...../..... SHEET .....OF.....

Figure 4.0-1 Input Form (continued)

4.1 PROBLEM IDENTIFICATION

Any number of lines may be used to enter user comments for problem identification. The first column of each line must contain an asterisk (*) to indicate that this is a user comment. These comment lines may be placed anywhere within the input data; up to three comment lines at the beginning of the input file will be printed on the output for identification.

4.2 CRITERIA

This input line defines the criteria required for modeling the sign structure.

MODEL TYPE (MODTYP)

A numeric value indicating the type of sign model to be run. The following is a description of the valid model types. (Refer to Figures 3.3-1 through 3.3-10 for an example of the model types).

1 - Tapered tube structure
2 - Two post planar truss
3 - Two post tri-chord truss
4 - Four post tri-chord truss
5 - Four post four-chord truss
6 - Cantilever structure
7 - Centermount structure

STRUCT HEIGHT (STHGT)

Enter the distance from the top of the post base plate to the center of gravity of the horizontal structure (truss or strut) in feet (see Figure 4.2.2). The valid range for this value is between 6 and 35 feet.

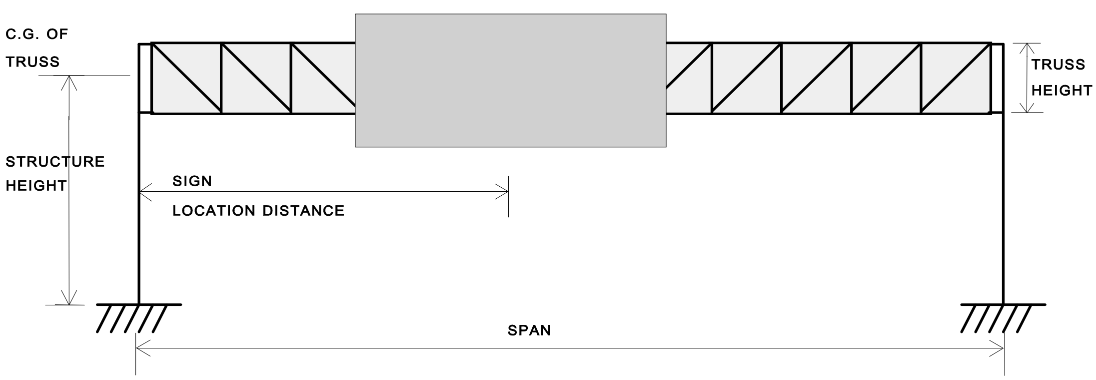


Figure 4.2.2 Truss Sign Structure Geometry

SPAN / CANT LENGTH (STLEN)

Enter the span length or the cantilever arm length in feet. For models 1-5 (i.e. models with end supports), the length is the distance between the centerlines of the supports. For model 6 (cantilevered structures) and model 7 (centermount structures), the length represents the length of the cantilever measured from the centerline of the support (Figure 3.3-8 and Figure 3.3-9). The valid range for a tapered tube structure, a two post planar truss or a two-post tri-chord truss is between 30 and 100 feet. The valid range for a four-post tri-chord or a four post four-chord truss is between 50 and 240 feet. The valid range for a cantilever structure is between 4 and 45 feet. The valid range for a centermount structure is between 1 and 40 feet.

NUMBER SIGNS (NSIGN)

Enter the number of signs to hang on the structure (minimum of 1 and a maximum of 3).

NUMBER PANELS (NPANEL)

Enter this value to define the number of truss panels. This value has a maximum of 100 and must be a multiple of 2. Leave blank for tapered tube, non-VMS cantilever and centermount structures. For cantilevers structures supporting a VMS, an odd number is panels can be entered.

TRUSS / STRUT HEIGHT (TRHGT)

Enter the truss height in feet or enter the distance in feet between struts for a two strut centermount or cantilever structure. This value is used for all trusses, two-strut centermount structures, and two-strut cantilever structures. The valid range for trusses is between 2 and 20 feet. The valid range for struts is between 0 and 12 feet. Leave blank for tapered tube and single strut structures. The default for this value is based on the model type, shown in Table 4.2.1.

Model Type	Height*
Two-post planar	$\frac{L}{12}$
Tri-chord	$\frac{L}{23}$
Four-chord	$\frac{L}{(\text{NUMBER OF PANELS})}$
Two Strut Cantilever	NONE
Two Strut Centermount	NONE

* Rounded to the next highest 3"

Table 4.2.1 Truss or Two Strut Default Heights

TRUSS DEPTH (TRDPTH)

Enter the truss depth in feet for tri-chord and four-chord trusses (see Figure 3.3-6). The valid range is between 2 and 20 feet. If no value is entered, the tri-chord truss default depth is based on the truss height and the assumption that the chords form an equilateral triangle. For the four-chord truss, the default depth is equal to the truss height.

HEIGHT FACTOR (CH)

Enter the coefficient of height (Ch) for the sign structure. This value is used to compute the wind load. The valid range for Ch is between 0.5 and 2.0. If the value is not entered, the program will use the structure height to determine the default value of Ch based on Appendix C Table C-1 of the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals" (2001).

POST FIXITY (FIXITY)

Enter the fixity of the post for a four-post sign as 'P' for pinned supports or 'F' for fixed supports. If this value is not entered, the program will default to fixed supports. This option is only valid for four-post models.

NUMBER X-SECT (NUMXSI)

Enter the number of cross section definition cards that are supplied to define the structure. Cross section definition input lines are described in Section 4.4. Refer to Table 4.4.1 for the cross sections required for each model type. The minimum number of cross sections is two and the maximum number is 30.

NEW OR EXISTING CHORD SPLICE (NORE)

This variable determines if your structure is a new or existing structure for the chord splice analysis. Enter "N" for a new structure or "E" for an existing structure. If the program will be performing an analysis of a new structure, the number of chord splices entered into the variable NUMSPL, below, must equal the maximum number of splices as listed in Table 4.2.2. If the program is to perform an analysis of an existing structure, the number of splices must be within the range listed in Table 4.2.2 for the structure length (STLEN) of your model type (MODTYP). For Non-VMS Cantilever and Centermount structures (MODTYP = 6 or 7), this input should be left blank, as these structures cannot contain a chord splice. This parameter is required for VMS Cantilever structures for the automatically generated chord splice at the stub-truss connection.

MODEL TYPE	SPAN LENGTH	ANALYSIS OF A NEW STRUCTURE: Allowable Number of Chord Splices	ANALYSIS OF AN EXISTING STRUCTURE: Allowable Number of Chord Splices
1	All Span Lengths	1	1
2	STLEN<=30’	0	0
	30’<STLEN<=60’	1	1
	60’<STLEN	2	1 or 2
3	All Span Lengths	2	1 or 2
4	STLEN<=100’	2	1 or 2
	100’<STLEN<=160’	3	1 – 3
	160’<STLEN<=200’	4	1 - 4
	200’<STLEN	6	1 - 6
5	STLEN<=120’	2	1 or 2
	120’<STLEN	4	1 - 4
6	N/A	N/A	N/A
7 (Non-VMS)	N/A	N/A	N/A
7 (with VMS)	All Span Lengths	1	1

Table 4.2.2 Number of Splices Criteria Table

NUMBER OF CHORD SPLICES (NUMSPL)

Enter the number of chord splices per chord. This represents the number of Chord Splice 1 input cards supplied for the program. If this input is left blank or if the user inputs a value of zero, then the program will assume that there are no chord splices and the user should not enter lines for the Chord Splice Input Cards (4.7 and 4.8). Instead, the user should input the Loads Card (4.9) directly after the Bolted Connections Card (4.6). If a structure is Model Type 1 (tapered tube), the user can enter 0, 1 or leave NUMSPL blank. The program will always create exactly one chord splice for tapered tube structures and it will be located at midspan.

When NUMSPL > 0, the program assumes that each chord will contain the same number of splices and they will be at the same locations on each chord. The valid number of chord splices is based on model type and span length. Cantilever and Centermount models (Model Types 6 and 7, respectively) cannot have chord splices, so NUMSPL should be “0” or left blank. See Table 4.2.2 for the valid range for the other Model Types.

NUMBER OF FATIGUE DETAILS (NUMDET)

Enter the number of fatigue details. The program will automatically calculate certain fatigue details based on the Model Type of the structure. The number input for NUMDET represents the number of additional details that the user wants the program to calculate. These details can be details that the program does not normally calculate for a given model type or any of the optional details from Table 4.2.3. NUMDET represents the number of fatigue detail cards that will be supplied for the program to analyze. The maximum is 20. If this input is left blank or if the user inputs a value of zero, then the program will assume that the user doesn't want the program to calculate any additional fatigue details. If this is the case, the user should not enter lines for the Fatigue Details Input Card (4.10). Instead, the user should input the Footing Card (4.11) directly after the Loads Card (4.9).

OPTIONAL FATIGUE DETAILS	DESCRIPTION
3	High-Strength Bolted Connection, Net Section
8	Column and/or Chord/Strut Seam Welds
7	Weepholes, Bottom of Columns
7	Unreinforced Handholes, Bottom of Columns
7	Wire Outlet Holes, Top of Columns
12	Chord splice, chord member
12	Column-to-base PL connection
19	Tube-to-Tube, Angle, or WT/ST Welded Connections
20	Column-to-Base PL Stiffener Connection
20	Reinforced Handholes, Bottom of Columns

Table 4.2.3 User-Input Fatigue Details

MODEL TYPE	DETAIL NUMBERS AND DESCRIPTIONS
Cantilever/Centermount	**#11:** Column-to-base PL connection, category E **#18:** Strut-to-column pass-thru connection, post members, category E **#18:** Strut-to-column pass-thru connection, chord members, category E'
Cantilever w/ VMS	**# 5:** Chord splice, bolts, category D **#11:** Column-to-base PL connection, category E **#18:** Strut-to-column pass-thru connection, post members, category E **#18:** Strut-to-column pass-thru connection, chord members, category E' **#14:** Slotted tube-to-gusset connection, branching member, category E **#15:** Slotted tube-to-gusset connection, branching member, category E' **#21:** Weld termination at ends of chord splice longitudinal stiffeners, category E'
Tapered Tube	**# 5:** Chord splice, bolts, category D **#11:** Chord splice, chord member, category E **#11:** Column-to-base PL connection, category E
2-Post Planar Truss 2-Post Tri-Chord Truss 4-Post Tri-Chord Truss	**# 5:** Chord splice, bolts, category D **#11:** Chord splice, chord member, category E **#11:** Column-to-base PL connection, category E **#14:** Slotted tube-to-gusset or angle-to-gusset connection, branching member, category E **#15:** Slotted tube-to-gusset or angle-to-gusset connection, branching member, category E' **#19:** Tube-to-tube, angle-to-tube or plate-to-tube connection, branching member, category E
4-Post 4-Chord Truss	**# 5:** Chord splice, bolts, category D **#11:** Chord splice, chord member, category E **#11:** Column-to-base PL connection, category E **#14:** Slotted tube-to-gusset or angle-to-gusset connection, branching member, category E **#15:** Slotted tube-to-gusset or angle-to-gusset connection, branching member, category E'

Table 4.2.4 Automatically Generated Fatigue Details, by Model Type

OUTPUT (OUTPUT)

Enter the level of output. A value from 0-2 can be entered to control the level of output.

0 = Worst combined stress ratio (CSR) for each type of cross section.
1 = Worst CSR for each finite element (worst i or j node).
2 = CSR values for all i and j nodes.

In addition to the worst combined stress ratios printed for each element, a geometry report listing all finite element node and element information will be printed for output levels 1 and 2.

RIGHT STRUT (Centermount Only) (STLENR)

The entry of this value in feet is optional and applies **ONLY** to centermount models. The value is entered for a structure with different strut lengths on either side of the post. The valid range is between 1 and 40 feet. If this value is not entered, the strut lengths are assumed equal.

VMS

Variable Message Sign (VMS) indicator. Enter “Y” if the sign structure supports at least one variable message sign. Enter “N” or leave blank if there are no variable message signs.

PANEL LENGTH (VMS Cantilever Only) (PNLLGTH)

Enter the panel length in feet for the truss panels of a cantilever VMS structure. The Panel Length must be entered for cantilever structures with VMS. The typical maximum panel length is 6 feet. Leave blank for all other structure types and cantilever structures with flat signs.

4.3 SIGN DESCRIPTION

The following input line describes the signs that are attached to the structure.

One group of the following sign geometry entries should be entered for each sign (minimum of 1, maximum of 3). The number of signs is set by **NUMBER SIGNS** (Section 4.2 Criteria).

SIGN (j) HEIGHT (SGNHGT(j))

Enter the height of the sign in feet. The valid range for this value is between 1 and 25 feet. Also the sign height must be greater than the value entered for the **TRUSS / STRUT HEIGHT** (Section 4.2 Criteria).

SIGN (j) AREA (SGNA(j))

Enter the area of the sign in square feet. Refer to PennDOT Standard Drawing BD-641M (Sheet 2 of 11) to compute the design sign area.

SIGN (j) LOCAT (SGNX(j))

Enter the distance from the center of the left column to the center of the sign in feet. For centermounts, enter the distance from the end of the left horizontal strut to the center of the sign in feet. The valid range for this value is between 1 foot and the value entered for **SPAN / CANT LENGTH** (Section 4.2 Criteria).

SIGN (j) OFFSET (SGNY(j))

Enter the distance from the center of gravity of the sign to the centerline of the front chord or horizontal strut member. The valid range for this value is between 0 and 10 feet.

SIGN (j) HORIZONTAL PROJECTED AREA (HAREA(j))

Enter the horizontal projected area for the sign in square feet. The horizontal projected area is defined as the exposed horizontal surface of the sign, in other words, the sign width times the sign thickness. Entering the horizontal projected area for a sign indicates that the sign is a VMS (variable message) box. The horizontal area is used to calculate fatigue loadings on the VMS box. This field should be left blank for standard signs.

4.4 CATWALK DESCRIPTION

The following input line describes the catwalk of the structure. Catwalk loads are not computed for tapered tube, cantilever, centermount or planar truss structures. Therefore, do not enter any of the following catwalk values for these types of structures.

CATWALK LOCAT (CATLOC)

Enter the start location of the catwalk from the left post in feet. The valid range for this value is between zero feet and the value entered for **SPAN / CANT LENGTH** (Section 4.2 Criteria).

CATWALK LENGTH (CATLEN)

Enter the length of the catwalk in feet. The valid range for this value is between 5 feet and the value entered for **SPAN / CANT LENGTH** (Section 4.2 Criteria).

CATWALK OFFSET (CATOFF)

Enter the distance from the catwalk to the centerline of the front chord in feet. The valid range for this value is between 0 and 10 feet.

4.5 CROSS SECTION DEFINITION

This type of input line is used to fully define the cross section geometry of the structure. Each input line is separated into three groups: the first group is a descriptor to indicate the member type (e.g. FVERT for a front truss vertical member). The second group is a description of the cross section; this includes the **SECTION TYPE** of section and fields 1 through 3 to describe the physical dimensions. The third group represents the location of cross section transition by panel number for chord members only. There must be one and only one input line for each type of member in the sign structure, except for section transitions for chord members. Chords are the only members that can be transitioned by the user. Posts for tapered tube structures only are varied linearly from the bottom to the top of the post; however, this is accomplished by the user entering a single tapered post (**TP**) type member, which requires a diameter for the start and the end of the post. Intermediate post sections for tapered tubes are calculated at tenth points by the program.

4.5.1 STRUCTURAL MEMBER TYPE

SECTION LOCATION (IXSIID(i))

Enter one of the following identifiers to describe the structure location being defined. The entry can appear anywhere in the field (i.e. It does not have to be right or left justified).

Cross Section	Model(s)	Description	Default (If applicable)
POST	All Types	Sign post	
PXBRAC	4-Post Truss	Cross bracing between posts	
CHORD	All Trusses	Chord section	
CHORD	Tapered tube, Cantilever, Centermount	Horizontal strut member	
RVERT	4-Chord Truss	Vert. member of the rear face	
FVERT	All Trusses, VMS Cantilever	Vert. member of the front face	
FDIAG	All Trusses, VMS Cantilever	Diag. member of the front face	
RDIAG	4-Chord Truss	Diag. member of the rear face	Same as FDIAG
TVERT	3, 4-Chord Truss	Vert. member of the top face	
TDIAG	3, 4-Chord Truss	Diag. member of the top face	
BVERT	3, 4-Chord Truss	Vert. member of the bottom face	Same as TVERT
BDIAG	3, 4-Chord Truss	Diag. member of the bottom face	Same as TDIAG
TXBRAC	4-Chord Truss	Truss cross bracing member	

Table 4.5.1 Cross Sections

4.5.2 SECTION DESCRIPTION

(XSITYP(i), XSIDES(1-5,i))

The input required following the section type differs for each section, with a maximum of five data fields required. The following sections describe the input for each cross section type. Enter one of the following section types for each section location. The entry can appear anywhere in the field (i.e. It does not have to be right or left justified).

SECTION TYPE (XSITYP(i))

Enter the type of section from the following list:

- P - Round pipe sections
- P8 - Octagonal pipe sections
- P12 - Dodecagonal pipe sections
- P16 - Hexdecagonal pipe sections
- C - Standard channel sections
- MC - Miscellaneous channels
- TP - Tapered round pipe sections
- T8 - Tapered octagonal pipe sections
- T12 - Tapered dodecagonal pipe sections
- T16 - Tapered hexdecagonal pipe sections
- WF - Wide flange sections
- WT - WT sections
- ST - ST sections
- L - Angle sections

Table 4.5.2-1 shows the valid section types for each model.

Cross Section	Tapered Tube	Two Post Planar	Two Post Tri-Chord	Four Post Tri-Chord	Four Post Four-Chord	Cantilever	Centermount
POST	T	P	P	P	P, WF	P, T	P
PXBRAC	n/a	n/a	n/a	*	*	n/a	n/a
CHORD	T	P	P	P	L, P	P, T	P
RVERT	n/a	n/a	n/a	n/a	*	n/a	n/a
FVERT	n/a	*	*	*	*	n/a	*
FDIAG	n/a	*	*	*	*	n/a	*
RDIAG	n/a	n/a	n/a	n/a	*	n/a	n/a
TVERT	n/a	n/a	n/a	*	*	n/a	n/a
TDIAG	n/a	n/a	n/a	*	*	n/a	n/a
BVERT	n/a	n/a	n/a	*	*	n/a	n/a
BDIAG	n/a	n/a	n/a	*	*	n/a	n/a
TXBRAC	n/a	n/a	n/a	n/a	*	n/a	n/a

* Any section but WF or T

Where: P = any pipe shape
T = any tapered pipe shape

Table 4.5.2-1 Valid Section Types

Model Type	Valid Nominal Pipe and Tapered Diameters for Chord Members
Tapered Tube	8”, 10”, 11”, 12’, 13”, 14”, 15”, 16”, 17”, 18”, 19”, 20”, 21”, 22”, 23”, 24”, 25”
Two Post Planar	6”, 8”, 10”, 12’, 14”, 16”, 18”, 20”, 22”, 24”, 26”
VMS Cantilever	4”, 5”, 6”, 8”, 10”, 12’, 14”, 16”, 18”, 20”, 24”, 26”
Two Post Tri-Chord	4”, 5”, 6”, 8”, 10”, 12’, 14”, 16”, 18”, 20”, 24”, 26”
Four Post Tri-Chord	4”, 5”, 6”, 8”, 10”, 12’, 14”, 16”, 18”, 20”, 24”, 26”
Four Post Four-Chord	4”, 5”, 6”, 8”, 10”, 12’, 14”, 16”, 18”, 20”, 24”, 26”

Table 4.5.2-2 Valid Nominal Pipe and Tapered Pipe Diameters for Chord Section

4.5.2.1 ROUND PIPE SECTION TYPE
(Ex. P 12.0 0.375 0 0 0)

FIELD 1 - ACTUAL OUTSIDE DIAM

Enter the actual outside diameter of the pipe in inches. Value must be greater than 0.0. See Table 4.5.2-2 for valid nominal diameters (integer portion of actual outside diameter) for chord sections.

FIELD 2 – THICKNESS

Enter the actual wall thickness in inches. Value must be greater than 0.0 and cannot exceed the outside radius of the pipe.

No input is required in FIELDS 3, 4 and 5.

4.5.2.2 POLYGONAL PIPE SECTION TYPES (P8, P12, P16)
(Ex. P8 12.0 0.375 0.30 0 0)

FIELD 1 – DEPTH

Enter the distance between the outside surfaces of parallel faces of the pipe in inches as shown in Figure 4.5-1. Value must be greater than 0.0. See Table 4.5.2-2 for valid nominal diameters (integer portion of actual outside diameter) for chord sections.

FIELD 2 – THICKNESS

Enter the actual wall thickness in inches. Value must be greater than 0.0 and cannot exceed the depth of the pipe.

FIELD 3 - CORNER RADIUS RATIO

Enter the ratio (**r**) of the corner radius to the radius of an inscribed circle on the polygonal shape as described in AASHTO Sign Specification Table 3-6. The value of r must be greater than 0.0 and less than 1.0.

No input is required in FIELDS 4 and 5.

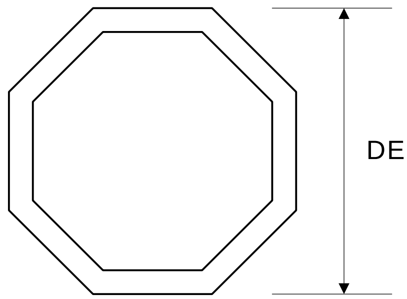


Figure 4.5-1 Depth Dimension of Polygonal Pipe

4.5.2.3 CHANNEL SECTION TYPES (C, MC)

(Ex. C 8.0 11.5 1.0 0 0 or MC 12.0 50.0 1.1 0 0)

The channel sections must be valid standard (C) channels or valid miscellaneous (MC) channels from the "AISC Manual of Steel Construction."

FIELD 1 – DEPTH

Enter the nominal depth of the channel in inches.

FIELD 2 – WEIGHT

Enter the nominal weight of the channel in pounds/foot.

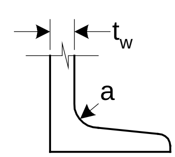
FIELD 3 - STRESS CONCENTRATION FACTOR

Enter the appropriate stress concentration factor (δ) for the channel section using the following equation (from page 2.10-8 of "Design of Welded Structures" by Omar W. Blodgett). The value must be greater than or equal to 1.0, but less than 1.5.

$$\delta = 1 + \frac{t_w}{4\,a}$$

Where: a = Inside corner radius.

t_w = Channel web thickness.



No input is required in FIELDS 4 and 5.

4.5.2.4 TAPERED ROUND PIPE SECTION TYPE

(Ex. TP 16.0 0.375 12.0 0 0)

FIELD 1 - ACTUAL OUTSIDE DIAM LARGE

Enter the outside diameter of the pipe for the large end in inches. The value must be greater than 0.0. See Table 4.5.2-2 for valid nominal diameters (integer portion of actual outside diameter) for chord sections.

FIELD 2 – THICKNESS

Enter the actual thickness of the pipe in inches. The value must be greater than 0.0 and cannot exceed the actual outside diameter of the small end.

FIELD 3 - ACTUAL OUTSIDE DIAM SMALL

Enter the outside diameter of the pipe for the small end in inches. The value must be greater than 0.0 and cannot exceed the outside diameter of the large end.

No input is required in FIELDS 4 and 5.

4.5.2.5 TAPERED POLYGONAL PIPE SECTION TYPES (T8, T12, T16)

(Ex. T12 16.0 0.375 12.0 0.30 0.25)

FIELD 1 - DEPTH LARGE END

Enter the distance between the outside surfaces of parallel faces of the large end of the pipe in inches as shown in Figure 4.5-1. Value must be greater than 0.0. See Table 4.5.2-2 for valid nominal diameters (integer portion of actual outside diameter for chord sections).

FIELD 2 – THICKNESS

Enter the actual wall thickness in inches. Value must be greater than 0.0 and cannot exceed the depth of the pipe.

FIELD 3 - DEPTH SMALL END

Enter the distance between the outside surfaces of parallel faces of the small end of the pipe in inches as shown in Figure 4.5-1. Value must be greater than 0.0.

FIELD 4 - CORNER RADIUS RATIO LARGE END

Enter the ratio (**r**) for the large end of the corner radius to the radius of an inscribed circle on the polygonal shape as described in AASHTO Sign Specification Table 3-6. The value of r must be greater than 0.0 and less than 1.0.

FIELD 5 - CORNER RADIUS RATIO SMALL END

Enter the ratio (**r**) for the small end of the corner radius to the radius of an inscribed circle on the polygonal shape as described in AASHTO Sign Specification Table 3-6. The value of r must be greater than 0.0 and less than 1.0.

4.5.2.6 WIDE FLANGE SECTION TYPE

(Ex. WF 30.0 116.0 0 0 0)

The section entered must be a valid wide flange section from the "AISC Manual of Steel Construction."

FIELD 1 – DEPTH

Enter the nominal depth of the beam in inches.

FIELD 2 – WEIGHT

Enter the nominal weight of the beam in pounds/foot.

FIELD 3 - STRESS CONCENTRATION FACTOR

Not applicable. No specification checking performed.

No input is required in FIELDS 4 and 5.

4.5.2.7 WT SECTION TYPE

(Ex. WT 12.0 81.0 1.20 0 0)

The section entered must be a valid WT section from the "AISC Manual of Steel Construction."

FIELD 1 – DEPTH

Enter the nominal depth of the WT member in inches.

FIELD 2 – WEIGHT

Enter the nominal weight of the WT member in pounds/foot.

FIELD 3 - STRESS CONCENTRATION FACTOR

Enter the appropriate stress concentration factor (**δ**) from the figures in the "U.S. Steel Design Manual", pp. 161-162. The value must be greater than or equal to 1.0, but less than 1.5.

No input is required in FIELDS 4 and 5.

4.5.2.8 ST SECTION TYPE

(Ex. ST 10.0 33.0 1.20 0 0)

The section entered must be a valid ST section from the "AISC Manual of Steel Construction."

FIELD 1 – DEPTH

Enter the nominal depth of the ST member in inches.

FIELD 2 – WEIGHT

Enter the nominal weight of the ST member in pounds/foot.

FIELD 3 - STRESS CONCENTRATION FACTOR

Enter the appropriate stress concentration factor (**δ**) from the figures in the "U.S. Steel Design Manual", pp. 161-162. See Table 4.5.2-3 for approximate stress concentration factors for ST shapes. The value must be greater than or equal to 0.9, but less than 1.4.

Designation	t_w	R	t_f	Thickness Ratio t_w / t_f	Ratio R / t_f	Approximate Stress Coefficient
ST 10 x 48	0.800	0.70	1.1875	0.6737	0.5895	1.12
ST 10 x 43	0.660	0.70	1.1875	0.5558	0.5895	1.09
ST 9 x 35	0.711	0.56	0.9375	0.7584	0.5973	1.15
ST 9 x 27.35	0.691	0.56	0.9375	0.7371	0.5973	1.15
ST 7.5 x 25	0.550	0.51	0.8125	0.6769	0.6277	1.13
ST 7.5 x 21.45	0.410	0.51	0.8125	0.5046	0.6277	1.08
ST 6 x 25	0.687	0.56	0.8750	0.7851	0.6400	1.17
ST 6 x 20.4	0.462	0.56	0.8750	0.5280	0.6400	1.09
ST 6 x 17.5	0.428	0.45	0.7500	0.5707	0.6000	1.10
ST 6 x 15.9	0.350	0.45	0.7500	0.4667	0.6000	1.07
ST 5 x 17.5	0.594	0.41	0.6875	0.8640	0.5964	1.18
ST 5 x 12.7	0.310	0.41	0.6875	0.4509	0.5964	1.06
ST 4 x 11.5	0.441	0.37	0.5625	0.7840	0.6578	1.17
ST 4 x 9.2	0.270	0.37	0.5625	0.4800	0.6578	1.08
ST 3 x 8.625	0.465	0.33	0.5000	0.9300	0.6600	1.23
ST 3 x 6.25	0.230	0.33	0.5000	0.4600	0.6600	1.07
ST 2.5 x 5	0.210	0.31	0.4375	0.4800	0.7086	1.09
ST 2 x 4.75	0.326	0.29	0.3750	0.8693	0.7733	1.22
ST 2 x 3.85	0.190	0.29	0.3750	0.5067	0.7733	1.10
ST 1.5 x 3.75	0.349	0.27	0.3750	0.9307	0.7200	1.24
ST 1.5 x 2.85	0.170	0.27	0.3750	0.4533	0.7200	1.08

Note: The term t_f in the "U.S. Steel Design Manual" is the thickness of the flange at the root of the fillet connecting the flange to the web. The values for R and t_f are taken from Catalog S-58, published by Bethlehem Steel Company, for "American Standard Beams".

Table 4.5.2-3 Approximate Stress Concentration Factors for ST shapes

No input is required in FIELDS 4 and 5.

4.5.2.9 ANGLE SECTION TYPE

(Ex. L 3.5 0.25 0 0 0)

The section entered must be a valid equal leg angle section from the "AISC Manual of Steel Construction."

FIELD 1 – LEG

Enter the width of the equal leg angle in inches.

FIELD 2 – THICKNESS

Enter the thickness of the equal leg angle in inches.

No input is required in FIELDS 3, 4 and 5.

4.5.3 CROSS SECTION YIELD STRENGTH

This entry allows user to specify different yield strengths for different cross sections.

SECTION Fy (XSIDES(6,i))

Enter the section yield strength in ksi. Value must be within the range of 35 ksi to 50 ksi.

4.5.4 CHORD CROSS SECTION TRANSITION

This entry applies only to chord members for truss type models. If this entry is left blank for chord members, the program will assume the chord cross section is prismatic.

PANEL NUMBER (IXSIPN(i))

Enter the last panel number from the left post that the cross-section is used as a chord member. Up to eight sections may be entered to fully define the chord cross-section. The section is stepped at the panel point. Only one chord is defined to represent all chords of the truss (i.e. all chords will have the same cross section transitions). If multiple sections are required to define a chord, the chord section commands should be entered sequentially and should not be separated by other cross section commands. For a sample of a chord with a changing cross section, see Example 3 in Appendix B.

4.6 BOLTED CONNECTIONS

When the structure does not contain bolted connections, the bolted connections input card should be left blank.

BOLT DIAMETER (BD)

If a bolt diameter is entered, the program will assume that the program has bolted, instead of welded, connections. Bolted connections are valid only for model types 2, 3, 4, and 5. If no bolt diameter is entered, then the rest of the bolted connections card must be left blank and the program will assume welded connections. Valid bolt diameters are: 0.500", 0.625", 0.750", 0.875", 1.000", 1.125", 1.250", 1.375" and 1.500".

NUMBER OF BOLT ROWS (BR)

If a bolt diameter is entered, then the user must enter the number of bolt rows for the connection. The program assumes that all bolted connections will contain the same number of bolt rows, regardless of the number of bolts required for each connection. Valid range for bolt rows is 1 – 4.

CONNECTION PLATE 1 WIDTH (CP1W)

If Connection Plate 1 Width (CP1W) is entered, the program will assume that the bolted connections in the program are connection plate connections, as opposed to member-to-member connections. If CP1W is not entered, the program assumes member-to-member connections. If CP1W is entered, then the next input item, CP1T, must also be entered. Connection Plate 1 is the front face/rear face connection plate, meaning that it is for members connected to the truss chord gusset plate via the web of the member. Members with this type of connection are FVERT, FDIAG, RVERT, and RDIAG.

CONNECTION PLATE 1 THICKNESS (CP1T)

If a CP1W is entered, then the user must enter the Connection Plate 1 Thickness (CP1T). This thickness cannot be less than 0.5".

CONNECTION PLATE 2 WIDTH (CP2W)

Connection Plate 2 Width (CP2W) is entered for Model Type 3, 4, and 5 members with flange connections. Members with flange connections are TVERT, TDIAG, BVERT, BDIAG, PXBRAC, and TXBRAC. Connection Plate 2 inputs cannot be used with Model Types 1, 2, 6, and 7. If CP2W is entered, then the next input item, CP2T, must also be entered

CONNECTION PLATE 2 THICKNESS (CP2T)

If a CP2W is entered, then the user must enter the Connection Plate 2 (Top/Bottom Face) Thickness (CP2T). This thickness cannot be less than 0.5”.

NUMBER OF U-BOLTS (NUBOLTS)

The number of U-bolts input by the user is used in the saddle detail module. The program assumes that U-bolts are A449 H.S. The minimum number of U-bolts required is one. The assumed bolt diameter is 1”.

4.7 CHORD SPLICE 1

This input card is valid only for Model Types 2, 3, 4 and 5, and should be entered when the number of splices (from the Criteria Card) is greater than zero. Model Type 1 structures all contain exactly one chord splice and it is always located at half the structure length (STLEN/2). Model Type 6 (with VMS) structures also contain one chord splice located 1'-3" from the outside edge of the post in accordance with the ITS-1003M standards. Therefore, for Model Type 1 and Model Type 6 (with VMS), the Chord Splice 1 input card is not needed and should not be entered. The first chord splice input card contains a user-defined identifier for each chord splice and its corresponding distance along the chord. It is assumed that for models with more than one chord, the splices will be located at the same point on each chord. Therefore, the user should not enter an input line for each chord splice on the model. Instead, the program will apply all of the splices entered to each chord. The number of lines entered for the Chord Splice 1 input card should be the same as the number entered for NUMSPL in Section 4.2 (Criteria Card) and corresponds to Table 4.2.2.

SPLICE(j) NAME (SPLICE(j))

The Splice Name is a character input that will be used to identify each splice location. The user can input any combination of letters or numbers for this identifier.

SPLICE(j) PANEL NUMBER (PANNUM(j))

The Splice Panel Number designates the panel number where the splice occurs. The splice is at the right edge of the panel.

4.8 CHORD SPLICE 2

The second chord splice input card is valid for Model Types 1, 2, 3, 4, 5 and 6 (with VMS), and is a single line that will apply to all of the lines entered for the Chord Splice 1 input card. If the Chord Splice 1 input card is not needed, then the Chord Splice 2 input card should not be included (with the exception of Model Type 1 and Model Type 6 (with VMS), which always require a Chord Splice 2 input card). The chord splice 2 input card is required for Model Type 1 and Model Type 6 (with VMS) because both models always have one chord splice. Enter the last two parameters (SPLBLT and SPLTHK) if this run is for an analysis of an existing structure (NORE from the Criteria Card = E).

CHORD SPLICE BOLT DIAMETER (SPLBD)

Enter the Bolt Diameter for Chord Splices in inches. Valid bolt diameters are: 0.500", 0.625", 0.750", 0.875", 1.000", 1.125", 1.250", 1.375" and 1.500". This parameter must always be entered for this card to be valid.

DISTANCE TO BOLT CIRCLE (BCDIST)

Enter the Distance to the Bolt Circle in inches. This distance is measured from the outside face of the chord to the centerline of the bolt circle. The distance must be greater than 2.25". The default value is 2.5".

NUMBER OF BOLTS (SPLBLT)

Enter the Number of Bolts to be analyzed for the chord splice locations. The minimum allowed is four.

SPLICE PLATE THICKNESS (SPLTHK)

Enter the Splice Plate Thickness in inches.

4.9 LOADS

SIGN SUPP BEAM WT (SUPWT)

Enter the weight in lbs/ft of a one-foot section of the sign support beam. The sign support beams are attached vertically to the sign structure, at a spacing not to exceed 6'-0" (5’-0" for VMS), and the sign panels are attached to them. The sign support beam size will vary depending on the height of the sign. The valid range for this value is between 1 and 100 lbs/ft. If left blank, the program will use the following defaults shown in Table 4.5.1.

Distance top chord to top of sign	Beam Size
0'-0" to 5'-6"	W6x15.5
5'-6"+ to 6'-6"	W6x20.0
6'-6"+ to 7'-6"	W6x25.0
7'-6"+ to 8'-6"	W8x28.0
8'-6"+ to 9'-6"	W8x31.0

Table 4.9.1 Sign Support Beam Weight Table

See **Section 3.4.1 Dead Load Attachments** for the description of the support weight calculation.

SIGN PANEL WT (PANWT)

Enter the weight of the sign panel in pounds per square foot. The valid range for this value is between 1 and 40 psf. If left blank the program will default to 2.848 psf, which is the weight of a 12" extruded aluminum channel sign panel. For a VMS, enter the total sign weight divided by the area of the vertical face (Sign Height x Sign Width) of the VMS.

ICE LOAD (ICELOD)

Enter the weight of the ice load expressed in pounds per square foot. The valid range for this value is between 1 and 10 psf. If left blank the program will default to 3.0 psf.

NUMBER OF LUMINAIRES (NOLUM(3))

Enter the number of luminaires attached to each sign panel (Maximum of 3 sign panels). The number for each sign panel must be entered separately. Enter -1 to have the program compute the number of luminaires automatically at a maximum spacing of 12' along the width of each sign.

LUMINAIRE OFFSET (LUMOFF)

Enter the distance from the center of gravity of the luminaire and its support members, to the centerline of the front chord/strut, in feet. The valid range for this value is between 0 and 100 feet.

LUMINAIRE WEIGHT (LUMWT)

Enter the weight of one luminaire and its support members in pounds. The value will be used for the luminaire weight for all sign panels. The valid range for this value is between 0 and 1000 lbs.

LUMIN NORMAL AREA (LAREAN)

Enter the cross-sectional area, in square feet, of one luminaire and its support members to be used in computing the wind load normal to the sign structure. The valid range for this value is between 0 and 10 ft^2.

LUMIN ICE AREA (LAREAI)

Enter the total surface area, in square feet, of one luminaire and its support members to be used in computing the ice load. The valid range for this value is between 0 and 100 ft^2.

LUMIN TRUCK-GUST AREA (TGLAREA)

Enter the truck-gust surface area, in square feet, of one luminaire and its support members to be used in computing the ice load. The valid range for this value is between 0 and 3 ft^2.

CATWALK WEIGHT (CATWT)

Enter the dead load weight of the catwalk in pounds per linear foot. The valid range for this value is between 0 and 500 lbs/ft. Leave blank if no catwalk location distance was input. Do not enter this value for tapered tube, cantilever, centermount, or planar truss structures, since catwalk loadings are not computed for these sign structure types.

CATWALK NORMAL AREA (AREAN)

Enter the cross-sectional area, in square feet per foot of catwalk, of the catwalk to be used in computing the wind load normal to the sign structure. The valid range for this value is between 0 and 10 ft^2/ft. Leave blank if no catwalk location distance was input. Do not enter this value for tapered tube, cantilever, centermount, or planar truss structures, since catwalk loadings are not computed for these sign structure types.

CATWALK ICE AREA (AREAI)

Enter the total surface area, in square feet per foot of catwalk, of the catwalk and luminaires to be used in computing the ice load. The valid range for this value is between 0 and 100 ft^2/ft. Leave blank if no catwalk location distance was input. Do not enter this value for tapered tube, cantilever, centermount, or planar truss structures, since catwalk loadings are not computed for these sign structure types.

CATWALK TRUCK-GUST AREA (TGCAREA)

Enter the truck-gust surface area, in square feet per foot of the catwalk. The valid range for this value is between 0 and 3 ft^2/ft. Leave blank if no catwalk location distance was input. Do not enter this value for tapered tube, cantilever, centermount, or planar truss structures, since catwalk loadings are not computed for these model types.

IMPORTANCE FACTOR CATEGORY (IFCTOR)

The importance factor accounts for the degree of hazard to traffic and damage to property and is applied to the fatigue loadings to adjust the structural reliability. Enter the Importance Factor Category (from Table 9.2) number (1, 2, or 3). The program will then reference this number to apply the correct importance factor to the fatigue loadings. Importance Factor Category 1 is valid only for Model Type 6 (Cantilever) and structures with variable message signs (VMS). Importance Factor Categories 2 and 3 may be used for any Model Type.

Importance Factor Category	Galloping Wind Gust	Natural Wind Gust	Truck-induced Gust
1	1.0	1.0	1.0
2	0.65	0.75	0.89
3	0.31	0.49	0.77

Table 4.9.2 – Importance Factor Categories

Importance Factor Category Descriptions:

1: Critical sign structures installed on major highways.

2: Other sign structures installed on major highways and all sign structures installed on secondary highways.

3: Sign structures installed at all other locations.

YEARLY MEAN WIND SPEED (MWIND)

Enter the Yearly Mean Wind Speed in mph. This speed is used to calculate the fatigue due to natural wind gusts. The default value is 11.2 mph.

VEHICLE DESIGN SPEED (VDESPD)

Enter the Vehicle Design Speed in mph. This speed is used to calculate the fatigue due to truck-induced gusts. The default value is 65.0 mph.

DESIGN WIND SPEED (DWIND)

Enter the Design Wind Speed in mph. This speed is used to calculate the wind loads acting on the supports, signs and attachments. The default value is 80.0 mph.

4.10 FATIGUE DETAILS

The Fatigue Details input card is needed only when the number of fatigue details (from the Criteria Card) is greater than zero. This card allows the user to input fatigue details that aren't automatically computed by the program. It also allows the user to enter fatigue details that the program automatically computes, but with a different allowable stress category. To change the default values, enter a full line on the Fatigue Details card for the detail that you want to change and include all the information that is needed for that detail. The program will use the line that the user inputs instead of the default values that it would normally use.

DETAIL(j) NUMBER (DETNUM(j))

For each line of the Fatigue Details Input Card, enter a detail number for a detail that you want the program to analyze. Valid user-input details are listed in Table 4.2.3.

ALLOWABLE FATIGUE STRESS CATEGORY (FATCAT(j))

Enter the allowable fatigue stress category. Valid categories are listed on Table 4.10-1. The Constant-Amplitude Fatigue Thresholds that correspond to the Fatigue Stress Categories are used to compute the Fatigue Combined Stress Ratio.

ALLOWABLE FATIGUE STRESS CATEGORY	CONSTANT-AMPLITUDE FATIGUE THRESHOLD (ksi)
A	24
B	16
B'	12
C	10
D	7
E	4.5
E'	2.6
ET	1.2

Table 4.10-1 Table of Fatigue Allowable Stresses

WEEP HOLE AREA (AEWEEP(j))

When detail number 7 is entered, the user can input a weep hole area. Enter the cross-sectional area of the weep hole (the post wall thickness times the width of the opening) in square inches.

WIRE OUTLET AREA (AEWIRE(j))

When detail number 7 is entered, the user can input a wire outlet area. Enter the cross-sectional area of the wire outlet (the post wall thickness times the width of the opening) in square inches.

HAND HOLE AREA (AEWEEP(j))

When detail number 7 is entered, the user can input an unreinforced hand hole area. When detail number 20 is entered, the user must input a reinforced hand hole area. Enter the cross-sectional area of the hand hole (the post wall thickness times the width of the opening) in square inches.

CHORD/POST/BRANCH (CPBTYP(j))

Enter “C”, “P”, or “B” to designate a chord, post, or branching member when a single detail can apply to more than one of these member types. CPBTYP needs to be input for Detail 8 (can apply to chords or posts). This variable will cause output level 0 to print out a separate line for each CPBTYP listed for each detail.

4.11 FOOTING

A OR D (AORD)

Enter "A" for a footing analysis or "D" for a footing design problem. Refer to METHOD OF SOLUTION for what the program will do for a given type of problem. If left blank the program will run a footing design problem. The entry can appear anywhere in the field.

BEARING PRESSURE (PRESS)

Enter the allowable soil pressure in kips per square foot. The valid range for this value is between 0 and 50 ksf. If left blank, the program uses a value of 3.0 ksf.

CONC F'C (FPC)

Enter the compressive strength of concrete for the foundation in psi. The valid range for this value is between 1000 and 9000 psi. If left blank, the program defaults to 3000 psi.

CONCRETE DENSITY (CDENS)

Enter the density of concrete, in pcf. The valid range for this value is between 50 and 500 pcf. If left blank, the program will default to 150 pcf.

FILL DENSITY (FDENS)

Enter the density of the fill material, in pcf. The valid range for this value is between 50 and 500 pcf. If left blank, the program will default to 100 pcf.

COEFF FRICTION (FRICT)

Enter the coefficient of friction of the foundation material. The normal range for this data varies from 0.33 for silty clay, to 0.60 for gravel or sand, to 0.99 for rock. Refer to the tables given in DM-4 for this value based on the given type of soil. The value is used to compute the horizontal sliding resistance of the footing. The valid range for this value is between 0.1 and 1.0. If left blank, the program defaults to 0.25.

FILL HEIGHT (FILLHT)

Enter the average height of fill material over the top of the footing in feet. The valid range for this value is between 1 and 30 feet.

PEDESTAL HEIGHT (PEDHGT)

Enter the height of the pedestal, in feet, as the distance from the top of the footing to the top of the base plate. This value must be entered for both footing analysis and design problems and cannot be zero. The valid range for this value is between 1 and 30 feet. (The actual pedestal height is to the bottom of the grout. The height to the top of the base plate is used to account for the grout thickness and base plate thickness.)

PEDESTAL LENGTH (PEDWID)

Enter the length of the pedestal, in feet. The pedestal length is that side of the pedestal measured parallel to the roadway. This value must be entered for both footing analysis and design problems, and cannot be zero. The valid range for this value is between 0.5 and 25 feet.

PEDESTAL WIDTH (PEDLEN)

Enter the width of the pedestal, in feet. The pedestal width is that side of the pedestal measured normal to the roadway. This value must be entered for both footing analysis and design problems, and cannot be zero. The valid range for this value is between 0.5 and 25 feet.

FOOTING MIN THK (FMINTH)

Enter the actual footing thickness for a footing analysis problem, or the minimum footing thickness for a footing design problem, in feet. The valid range for this value is between 2 and 20 feet. For a footing design problem, if this is left blank, the program will default to a 2.0 foot footing thickness.

FOOTING MAX THK (FMAXTH)

This item is ignored for a footing analysis problem. For a footing design problem, enter the maximum footing thickness in feet. This value must be greater than the value of the **FOOTING MIN THK** but less than or equal to 20 feet. If left blank, the program will default to a 5-foot footing thickness.

FOOTING WIDTH (FTGWID)

Enter the actual footing width for a footing analysis problem, or the minimum footing width for a footing design problem, in feet. The footing width is that side of the footing measured normal to the roadway. The valid range for this value is between 2.5 and 20 feet. For a footing design problem, if this value is left blank, the program will default to a value equal to the pedestal width plus 2.0 feet, rounded up to the nearest foot.

FOOTING LENGTH (FTGLEN)

Enter the actual footing length for a footing analysis problem, or the minimum footing length for a footing design problem, in feet. The footing length is that side of the footing measured parallel to the roadway. The valid range for this value is between 2.5 and 50 feet. For a footing design problem, if this value is left blank, the program will default to a value equal to the pedestal depth plus 2.0 feet, rounded up to the nearest foot.

4.12 REBAR

REBAR GRADE (FY)

Enter the reinforcement grade. Enter "40", "50" or "60". If left blank, the program defaults to grade 60.

COVER TOP (TLONG)

Enter the clear distance from the top of the footing to the first mat of reinforcement. The valid range for this value is between 1 and 9 inches. If left blank, the program defaults to 3.0 inches. The top cover is also used for the side cover when calculating bar spacing.

COVER BOTTOM (BLONG)

Enter the clear distance from the bottom of the footing to the first mat of reinforcement. The valid range for this value is between 1 and 9 inches. If left blank, the program defaults to 4.0 inches.

TOP LONG REBAR SIZE (TLSIZE)

For a footing analysis problem, enter the rebar size, as a number between 4 and 11, for the top longitudinal reinforcement. Leave blank for a footing design problem.

TOP LONG REBAR SPACING (TLSPAC)

For a footing analysis problem, enter the rebar spacing for the top longitudinal reinforcement. Valid spacings range from 6 to 18 inches. Leave blank for a footing design problem.

TOP TRANS REBAR SIZE (TTSIZE)

For a footing analysis problem, enter the rebar size, as a number between 4 and 11, for the top transverse reinforcement. Leave blank for a footing design problem.

TOP TRANS REBAR SPACING (TTSPAC)

For a footing analysis problem, enter the rebar spacing for the top transverse reinforcement. Valid spacings range from 6 to 18 inches. Leave blank for a footing design problem.

BOTTOM LONG REBAR SIZE (BLSIZE)

For a footing analysis problem, enter the rebar size, as a number between 4 and 11, for the bottom longitudinal reinforcement. Leave blank for a footing design problem.

BOTTOM LONG REBAR SPACING (BLSPAC)

For a footing analysis problem, enter the rebar spacing for the bottom longitudinal reinforcement. Valid spacing ranges from 6 to 18 inches. Leave blank for a footing design problem.

BOTTOM TRANS REBAR SIZE (BTSIZE)

For a footing analysis problem, enter the rebar size, as a number between 4 and 11, for the bottom transverse reinforcement. Leave blank for a footing design problem.

BOTTOM TRANS REBAR SPACING (BTSPAC)

For a footing analysis problem, enter the rebar spacing for the bottom transverse reinforcement. Valid spacing ranges from 6 to 18 inches. Leave blank for a footing design problem.

5.0 DESCRIPTION OF OUTPUT

The level of output for the Sign Structure program can be controlled by the user by entering a different value for the 'level of output' variable on the input criteria card (see page 51). The printed output consists of a repeat of all the input values exactly as read by the program, error messages, default values used by the program and the following computed values. Only the output applicable to a given type of problem is printed.

5.1 INPUT ECHO

An input echo section is provided for each input line provided by the user, namely the Criteria, Sign Description, Catwalk Description, Cross Section Definition, Bolted Connections, Chord Splice One, Chord Splice Two, Loads, Fatigue Details, Footing, and Rebar cards. Input items that are not entered by the user and have some default value assigned by the program are listed in the Default Values section of the output.

5.2 NODE OUTPUT

For output levels 1 and 2, a report indicating the model node geometry is provided. These coordinates are the values for the finite element model used by the analysis core of the program.

NODE NUMBER

The node identification number.

COORDINATES X, Y, Z

The location of the node in space in feet.

5.3 ELEMENT OUTPUT

For output levels 1 and 2, a report indicating the model element connectivity is provided. These coordinates are the values for the finite element model used by the analysis core of the program.

ELEMENT NUMBER

The member number.

TYPE

Describes the location within the sign structure as described in Table 5.3-1.

Type	Model(s)	Description
POST	All Types	Sign post
PXBRAC	4-Post Truss	Cross bracing between posts
FUCORD	All Types	Front upper chord for all trusses and upper strut for centermount, cantilever, and tapered tube models
FLCORD	All Trusses, 2-strut cantilever, 2-strut centermount	Front lower chord for all trusses and lower strut for 2-strut centermount and 2-strut cantilever models.
RUCORD	4-Chord Trusses	Rear upper chord for 4 chord trusses.
RLCORD	3, 4-Chord Trusses	Rear chord for 3 chord trusses and rear lower chord for 4 chord trusses.
RVERT	4-Chord Truss	Vertical member of the rear face
FVERT	All Trusses	Vertical member of the front face
FDIAG	All Trusses	Diagonal member of the front face
RDIAG	4-Chord Truss	Diagonal member of the rear face
TVERT	3, 4-Chord Truss	Vertical member of the top face
TDIAG	3, 4-Chord Truss	Diagonal member of the top face
BVERT	3, 4-Chord Truss	Vertical member of the bottom face
BDIAG	3, 4-Chord Truss	Diagonal member of the bottom face
TXBRAC	4-Chord Truss	Truss cross bracing member
CONECT[1]	All Trusses	Connection elements between the post and trusses.

Table 5.3-1

[1] Connection elements are rigid connections between the post and chords. Because they are used only to model the offset connection between the post and the chord, specification checking is not provided for these elements.

INODE, JNODE

Indicates the node numbers representing the element connectivity (see Figure 5.3-1).

KNODE

The location of the k-node orients the member in space (see Figure 5.3-1).

IREL, JREL

Indicates the global member releases at the end of each member (see Figure 5.3-1). A “0” indicates that the direction is fixed while a “1” indicates the direction is released.

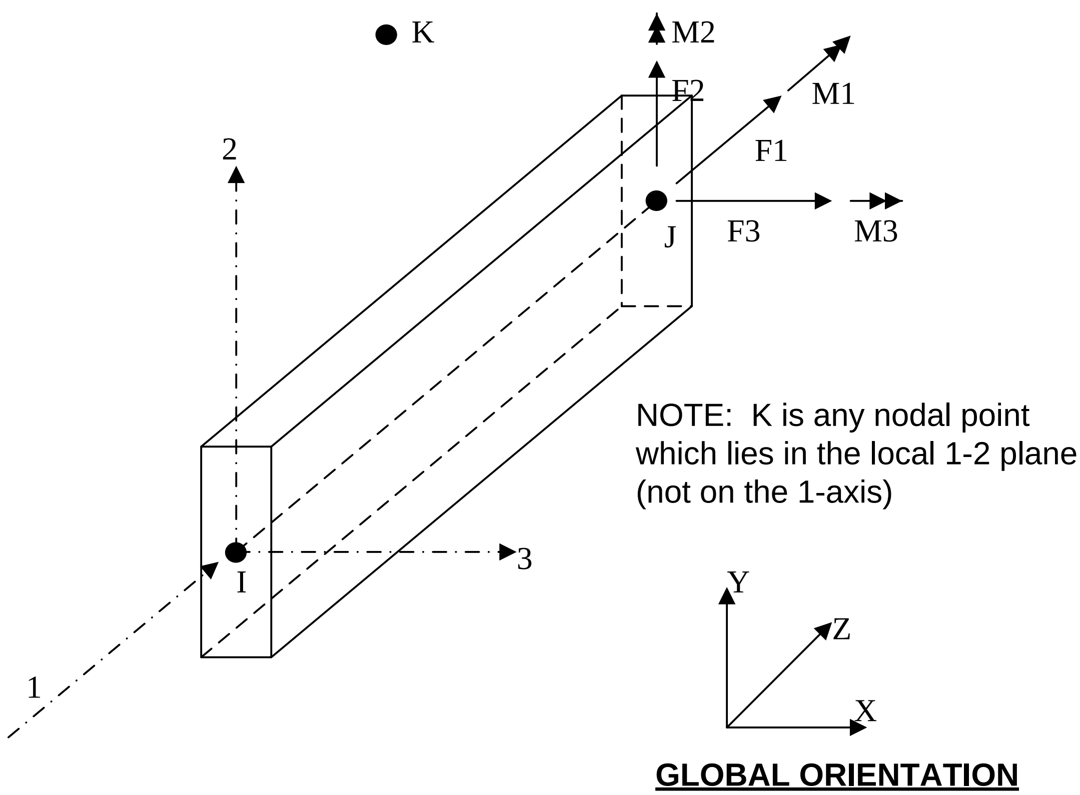


Figure 5.3-1 Local Member Orientation

5.4 SAPV FINITE ELEMENT OUTPUT

The detailed results from the SAPV finite element analysis are stored in an output file named "*<input filename>*_SAPV.oui". The information provided in the SAPV output is in a general finite element form. **For a description of the general SAPV finite element output, see Appendix A.**

5.5 CROSS SECTION OUTPUT

The cross section output lists all cross section information for the user input sections and lists the intermediate sections generated by the program for the tapered tube model. The values for pipes are computed in the program. The values for all other cross sections are retrieved from a cross section table corresponding to the "AISC Manual of Steel Construction".

LOCAT

The location (either member or attachment) that the load is applied.

X-SECT NO.

Cross-section identification number. This number is assigned by the program and referenced in other output reports.

Sect Type

Cross section type as defined by the user (see Section 4.4.2 Cross Section Description).

D

Depth of the member in inches.

T

Web thickness for WF, WT, ST and channel sections, pipe wall thickness, or angle leg thickness in inches.

B

Flange width or angle width in inches. Length of one side of a polygonal pipe in inches. Value is reported 0.0 for other sections.

Tf

Thickness of the flange for WF, WT, ST, channel, and angle sections in inches. Value is reported as 0.0 for other sections.

Ax

Cross sectional area in $inch^2$.

Perim

Outside perimeter of the cross section in inches (used for ice loading).

J

Torsional moment of inertia in $inch^4$.

Rt/Rz

For WF, WT, and ST sections, the value is Rt, which is defined as the radius of gyration of a section comprising the compression flange plus 1/3 of the compression web area, taken about an axis in the plane of the web. For angle sections, the value is Rz, which is defined as the radius of gyration about the principal axis. For all other sections, the value is set to 0.0.

Ix

Moment of inertia about the X-X (see Figure 5.5-1) axis in $inch^4$.

Iy

Moment of inertia about the X-X (see Figure 5.5-1) axis in $inch^4$.

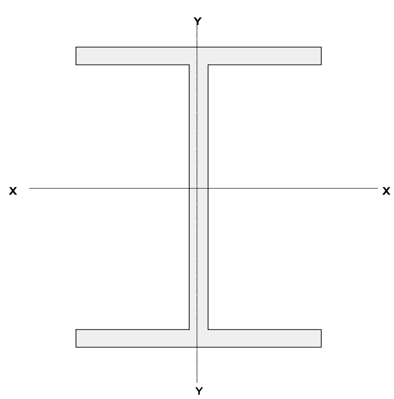


Figure 5.5-1 Member Axis

Sx/top

Section modulus to the top of the section about the X-X axis in $inch^3$.

Sx/bot

Section modulus to the bottom of the section about the X-X axis in $inch^3$.

Sy/Lt

Section modulus to the bottom of the section about the Y-Y axis for the left part of the section in $inch^3$.

Sy/Rt

Section modulus to the bottom of the section about the Y-Y axis for the right part of the section in $inch^3$.

Rx

Radius of gyration about the X-X axis in inches.

Ry

Radius of gyration about the Y-Y axis in inches.

5.6 LOADS OUTPUT

The following values are listed in the Sign Structure LOAD TABLE. For a description of how these loads are computed, see Chapter 3.

LOCAT

The location (either member or attachment) at which the load is applied.

X-SECT NOS.

Starting and ending cross-section identifications for the member. These numbers refer to the cross section identification numbers provided in the **CROSS SECTION OUTPUT**.

DL

Self weight load in pounds per foot of the member or attachment.

ICE

Ice load in pounds per foot of the member or attachment.

NORM WIND

Normal wind load in pounds per square foot on the member or attachment.

WN

Wind normal to the sign panel in pounds per foot.

WN"

Wind normal to sign structure panel in pounds per square foot used for Load Group III. Minimum value is 25 psf.

GLP

Galloping wind load in pounds per foot on the sign.

NAT

Natural wind gust load normal to the sign panel in pounds per foot.

TRUCK

Truck-induced gust load in pounds per foot.

CENTERMOUNT TORQUE

For centermount structures the torque applied to the structure is listed in inch kips.

5.7 LOAD CASE TABLE

This table lists the AASHTO sign structure load combination table (see AASHTO Sign Specs 1.2.6).

LOAD CASE

Load id number used as a reference in subsequent tables listing forces and moments.

ALLOW

Percentage of allowable stress.

GROUP

AASHTO Load group (see AASHTO Sign Spec. 1.2.6).

DL, ICE, Wn, Wt, Wn", Wt", Wg, Wnw, Wnwt, Wtg

Load combinations for each type of loading on the sign structure where:

DL	=	Dead Load
Ice	=	Ice Load
Wn	=	Wind Load normal to sign panel
Wt	=	Wind Load transverse to sign panel[2]
Wn"	=	Wind Load normal to sign panel for Group III (25 psf minimum)
Wt"	=	Wind Load transverse to sign panel for Group III (25 psf minimum)[2]
Wg	=	Galloping Wind Load
Wnw	=	Natural Wind Gust Load normal to sign panel
Wnwt	=	Natural Wind Gust Load transverse to sign panel [2]
Wtg	=	Truck-induced Gust Load

[2]Transverse wind loadings (Wt, Wt") have the same magnitude and are applied at the same locations as the normal wind loadings (Wn, Wn") but are applied in the transverse direction. Because the magnitudes for the transverse values are the same as the normal, they are not reported in the LOAD TABLE.

5.8 COMPACT CRITERIA TABLE

This table lists the compact/non-compact criteria for each cross section used in the model.

LOCAT

The cross section member location.

X-SEC NO.

The cross section identification number. This number refers to the cross section identification number provided in the **CROSS SECTION OUTPUT**.

DIST

Location of the member in feet. For chord members this is the distance along the chord from the centerline of the left post (see Figure 5.8-1). Truss vertical and diagonal member distances are measured by panel increments (i.e. the panel in which the member is contained). Distances for posts are measured from the support upward as shown in Figure 5.8-1. Distance for struts/chords on centermount sign structures is measured from the left most end of the strut (see Figure 5.8-1). The DIST value is listed only for output level 0.

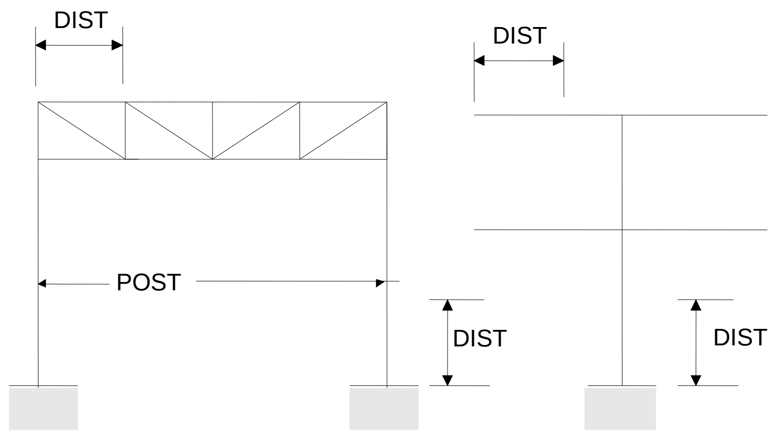


Figure 5.8-1 DIST Location

MEM

This value lists the finite element member number. The value is listed only for output levels 1 and 2.

NODE

This value lists the finite element node number that corresponds to this member. For output level 1 the worst result of the two element nodes is displayed. For output level 2 both node results are displayed. The NODE value is listed only for output levels 1 and 2.

CATEGORY

Lists whether the section is COMPACT or NON-COMPACT.

SECT TYPE

List the cross section type (see **Section 4.4.2 Cross Section Description**).

CRITERIA

Lists the equation used to compute the actual compactness ratio for this cross section. This value is compared with the allowable values to determine if the section is compact or non-compact. For a description of the equations, see **Section 3.6 Specification Checking**.

ACTUAL VALUE

Displays the compactness ratio for this cross section.

ALLOW COMPACT VALUE

The allowable compactness value. If the actual value is less than the allowable, the section is compact.

ALLOW NON-COMPACT VALUE

The allowable non-compactness value. If the actual value exceeds the allowable compactness value but is less than the allowable non-compactness value, the section is non-compact. If the actual value exceeds the allowable non-compactness value then the section is undefined and the allowable stress equations do not apply to this section.

ALLOW SLENDER VALUE

The allowable slenderness value (not related to 5.9 Slenderness Table). If the actual value exceeds the allowable non-compactness value but is less than the maximum allowable value, the section is slender. If the actual value exceeds the allowable slenderness value then the section is undefined and the allowable stress equations do not apply to this section.

5.9 SLENDERNESS TABLE

This table lists the slenderness values for each member type. For information about the computation of these values, see Chapter 3.

LOCATION

The cross section member location.

X-SEC NO

The cross section identification number. This number refers to the cross section identification number provided in the **CROSS SECTION OUTPUT**.

DIST

Location of the member in feet. For chord members this is the distance along the chord from the centerline of the left post (see Figure 5.8-1). Truss vertical and diagonal member distances are measured by panel increments (i.e. the panel in which the member is contained). Distances for posts are measured from the support upward as shown in Figure 5.8-1. Distance for struts/chords on centermount sign structures is measured from the left most end of the strut (see Figure 5.8-1). The DIST value is listed only for output level 0.

MEM

This value lists the finite element member number. The value is listed only for output levels 1 and 2.

NODE

This value lists the finite element node number that corresponds to this member. For output level 1, the worst result of the two element nodes is displayed. For output level 2, both node results are displayed. The NODE value is listed only for output levels 1 and 2.

K

The value for the ratio of effective column length to unbraced length.

L

The length of the member in feet.

R

Radius of gyration of the member in inches.

ACTUAL KL/R

Computed value for KL/R for the member. If this exceeds the allowable KL/R value the program will place an asterisk next to the value.

ALLOW KL/R

Allowable value for KL/R for the member. The allowable KL/R value is based on Section 10.7 of the *AASHTO Standard Specifications for Highway Bridges (1985, interim 1989)* as summarized in Table 1, **Section 3.6 Specification Checking**.

MEMBER CATEGORY

Describes whether the member is in tension or compression.

5.10 BOLTED CONNECTIONS TABLE

This table lists the number of bolts required for each member with bolted connections. The table is only printed if the model contains bolted connections. Chords, posts, and round or multi-sided pipes cannot have bolted connections. Below the table, the program will always print the following error message:

> "The value indicated does not account for an increased force due to the eccentricity of the bolt pattern relative to the neutral axis on the member. The user must either account for this increased force or detail the bolted connection so that the center of gravity (c.g.) of the bolt pattern and the neutral axis of the member coincide (produce no eccentric)."

This message is printed because the bolt pattern is not known. Since the minimum number of bolts is two, it would be conservative to increase the shear/slip force assuming only two bolts resist the Mx moment for FVERT and FDIAG members. An additional increase in the shear/slip force occurs due to the eccentricity of the bolt group relative to the neutral axis of the member. This increase in force can only be determined with a known bolt pattern. Because each fabricator details this connection differently, the increase in force cannot be accounted for accurately. Therefore, this shear/slip force will not be calculated by the program. The designer/fabricator should however be required to verify that this increase in force will not overstress the bolts. The force is calculated as follows:

$$M_{(A_x)} = A_x * e$$

Where Ax is actual Axial Load in the member and e is the eccentricity of the bolt group relative to the neutral axis of the member.

$$V_{(A_x)} = M_{(A_x)} * \frac{d}{E * d^2}$$

Where d is the distance to the bolt under consideration and $E * d^2$ is the summation of all distances squared.

LOCATION

The cross section member location.

X-SEC NO

The cross section identification number. This number refers to the cross section identification number provided in the **CROSS SECTION OUTPUT**.

DIST

Location of the member in feet. . For chord members this is the distance along the chord from the centerline of the left post (see Figure 5.8-1). Truss vertical and diagonal member distances are measured by panel increments (i.e. the panel in which the member is contained). Distances for posts are measured from the support upward as shown in Figure 5.8-1. Distance for struts/chords on centermount sign structures is measured from the left most end of the strut (see Figure 5.8-1). The DIST value is listed only for output level 0.

MEM

This value lists the finite element member number. The value is listed only for output levels 1 and 2.

NODE

This value lists the finite element node number that corresponds to this member. For output level 1, the worst result of the two element nodes is displayed. For output level 2, both node results are displayed. The NODE value is listed only for output levels 1 and 2.

Fa TYPE

Stress category for each bolted member (Compression or Tension).

Fu

Ultimate strength. The program calculates Ultimate strength based on the yield strength. Fu is 58 ksi for Fy = 36ksi. Fu is 65 ksi for Fy = 50 ksi.

ACT LD (kips)

The actual load in kips for the member.

ALL LD (kips)

The allowable load in kips for the member.

BLT REQ ACT LD

Number of Bolts Required for the Actual Load.

BLT REQ AVG LD

Number of Bolts Required for the Average Load. Average load is calculated by dividing the sum of the Actual and Allowable Load by two.

BLT REQ 75% ALL

Number of Bolts Required for 75% of the Allowable Load.

5.11 CHORD SPLICE TABLE

The chord splice table output depends on whether the chord splice module is conducting an analysis of a new structure or an analysis of an existing structure. If the number of bolts and the splice plate thickness are input on the Chord Splice 2 input card, the chord splice module will analyze an existing structure and go into analyze mode. In analyze mode, the table will print the splice name, chord designation, the input number of bolts (from the Chord Splice 2 input card), the actual tension per bolt, the applied tension check, the combined tension and shear check, the minimum required thickness of plate, the user specified plate thickness, and the thickness check. If the two inputs are left blank, the chord splice module will design a new chord splice and go into design mode. In design mode, the program will print the splice name, the chord designation, the required minimum number of bolts for the actual load, average load, and 75% of the allowable load, the combined tension and shear check, and the minimum required thickness of the splice plate for the actual load, average load, and 75% capacity. To calculate the required splice plate thickness, the program checks each specified splice location for the following two conditions:

1) <u>"Cantilever" type bending</u>: It is assumed that the flange of the splice plate will act as a cantilever beam, subject to bending caused by a "P" force in the bolt.
2) <u>"Span" type bending</u>: It is assumed that the splice plate will be subjected to bending moments resulting from simple span bending due to the "P" force in two adjacent bolts.

For each of these two bending conditions, the bolts in the connection plate are subjected to applied static tension as a result of direct axial tension and tension resulting from bending moments in the chords. Therefore, the required thickness of the splice plate is calculated using a "P" force equal to the allowable bolt tension, since this is the maximum applied tension that the bolts can carry.

SPLICE NAME

The user-defined splice identifier (from the Chord Splice One input card).

CHORD DESIGNATION

The chord type: FUCORD = front upper chord, FLCORD = front lower chord, RUCORD = rear upper chord, and RLCORD = rear lower chord.

REQUIRED MINIMUM NUMBER OF BOLTS ACT LOAD

The Required Number of Bolts for the Actual Load. This is only printed on the design mode table.

REQUIRED MINIMUM NUMBER OF BOLTS AVERAGE LOAD

The Required Number of Bolts for the Average Load (based on the average of the Actual Load and the Allowable Load). This is only printed on the design mode table.

REQUIRED MINIMUM NUMBER OF BOLTS 75% ALL LOAD

The Required Number of Bolts for 75% of the Allowable Load. This is only printed on the design mode table.

INPUT NUMBER OF BOLTS

This is the same value that was input into the Chord Splice 2 input card for an analysis mode run and is output only on the analysis of an existing structure table.

ACTUAL BOLT TENSION STRESS

This is the actual static tension per bolt and is output on the existing structure table.

APPLIED TENSION CHECK

When the user-input number of splice bolts is greater than or equal to the minimum required number of bolts for the actual load, this value is "OK". Otherwise, it is no good, "NG". This check is for analysis of existing structures only.

COMBINED TENSION AND SHEAR CHECK

The Combined Tension and Shear Check is actually a series of checks that the element must pass to receive an "OK". If, at any point, the element fails a check, the value will be printed as "NG". For an existing structure, if the element failed the Applied Tension Check (above), the Combined Tension and Shear Check will not be performed and the value for this column will be printed as "—". Table 5.11.1 shows how the tension and shear is calculated for this check. First, the actual splice bolt shear is checked against the allowable splice bolt shear 1. If the actual is greater than the allowable, the check is "NG". Next, the shear ratio is calculated. If this ratio is less than 0.33, the check is "OK". Then, the allowable chord splice tension 2 is calculated and compared with the allowable chord splice tension 1. If the tension 2 is greater than the tension 1, the check is "OK". Finally, if the actual shear is less than the allowable tension, the check is "OK". Otherwise, the check is "NG".

TENSION/STRESS PARAMETER NAME	FORMULA
Actual Splice Bolt Shear Stress	$SPLFV = \dfrac{\sqrt{V_x^2 + V_y^2}}{\text{total area of bolts}} + \left\lvert \dfrac{\text{torsional moment about z - axis}}{\text{total area of bolts * radius}} \right\rvert$
Allowable Splice Bolt Shear Stress #1	D_{max} = Maximum number of bolts per quadrant of the bolt circle. Sum of D_{max} = the D_{max} value for all quadrants combined. Fs = nominal slip resistance per unit of bolt area (from AASHTO Table 10.32.3C) due to galvanized slip surface. For splice bolt diameter <= 1", it is 15. For diameters > 1", it is 0.875* 15. ft = actual static tension per bolt. For new splices, it is 0.9 * allowable static tension per bolt. For existing splices, it is $\left\lvert \dfrac{Ax}{\text{total area of bolts}} \right\rvert + \dfrac{D_{max} * \sqrt{M_x^2 + M_y^2}}{\text{total area of bolts * sum of } D_{max}}$ Fu = Ultimate strength (from AASHTO Table 10.32.3.3.3). For splice bolt diameter <= 1", it is 120. Otherwise, it is 105. $SPLFFV1 = Fs * (1 - \dfrac{1.88 * ft}{Fu})$
Allowable Splice Bolt Shear Stress #2	If the bolt nominal diameter <= 1" then SPLFFV2 = 19.0 * 1.25 If the bolt nominal diameter > 1" then SPLFFV2 = 0.875 * 19.0 * 1.25
Shear Ratio	$FVOFFV = \dfrac{\text{Actual Splice Bolt Shear Stress}}{\text{Allowable Splice Bolt Shear Stress \#2}}$

Allowable Chord Splice Tension #1	If the splice bolt diameter <= 1" then
	FFT1 = 38.0
	
	If the splice bolt diameter > 1" then
	FFT1 = 0.875 * 38.0

Allowable Chord Splice Tension #2	1^{st} eqn. = $FFT1 * \sqrt{1 - \left(\dfrac{SPLFV}{SPLFFV2}\right)^2}$ 2^{nd} eqn. = $\sqrt{(SPLFFV2^2 - SPLFV^2)/0.36}$ FFT2 = minimum of 1^{st} eqn. and 2^{nd} eqn.

Table 5.11.1 – Tension and Shear Check Equations

MINIMUM REQUIRED THICKNESS OF SPLICE PLATE DUE TO ACTUAL LOADS
MINIMUM REQUIRED THICKNESS OF SPLICE PLATE DUE TO AVERAGE LOADS
MINIMUM REQUIRED THICKNESS OF SPLICE PLATE DUE TO 75% CAPACITY

For analysis of a new structure, the minimum required thickness of the splice plate due to the three load conditions is printed in inches.

REQUIRED THICKNESS OF SPLICE PLATE

For analysis of an existing structure, the required splice plate thickness, based on span- and cantilever-type bending is printed in inches.

SPLICE PLATE THICKNESS

For an existing structure, this column will echo the user-input splice plate thickness from the Chord Splice 2 input card.

THICKNESS CHECK

For existing structures only, this check indicates if the user-input splice plate thickness is greater than the required thickness of splice plate calculated by the program. If the user-input thickness is greater, the table will display “OK”. Otherwise, the table will display “NG”.

5.12 MOMENT/TORSION TABLE

This table lists the moments and torsion values for each member. For output level 0 the case corresponding to the worst combined stress ratio (CSR) value for each member type is listed. For output level 1, the worst case for each element (i.e. the worst i or j node) in the model is listed. For output level 2, all values for each end of each element are listed.

LOCATION

The cross section member location.

X-SEC NO

The cross section identification number. This number refers to the cross section identification number provided in the **CROSS SECTION OUTPUT**.

DIST

Location of the member in feet. For chord members this is the distance along the chord from the centerline of the left post (see Figure 5.8-1). Truss vertical and diagonal member distances are measured by panel increments (i.e. the panel in which the member is contained). Distances for posts are measured from the support upward as shown in Figure 5.8-1. Distance for struts/chords on centermount sign structures is measured from the left most end of the strut (see Figure 5.8-1). The DIST value is listed only for output level 0.

MEM

This value lists the finite element member number. The value is listed only for output levels 1 and 2.

NODE

This value lists the finite element node number that corresponds to this member. For output level 1, the worst result of the two element nodes is displayed. For output level 2, both node results are displayed. The NODE value is listed only for output levels 1 and 2.

LOAD CASE

This number refers to the load case id listed in the load combination table. See section 5.4.

MX

Moment about the member x-axis in inch-kips (see Figure 5.12-1).

MY

Moment about the member y-axis in inch-kips (see Figure 5.12-1).

TZ

Torsion about the member z-axis in inch-kips (see Figure 5.12-1).

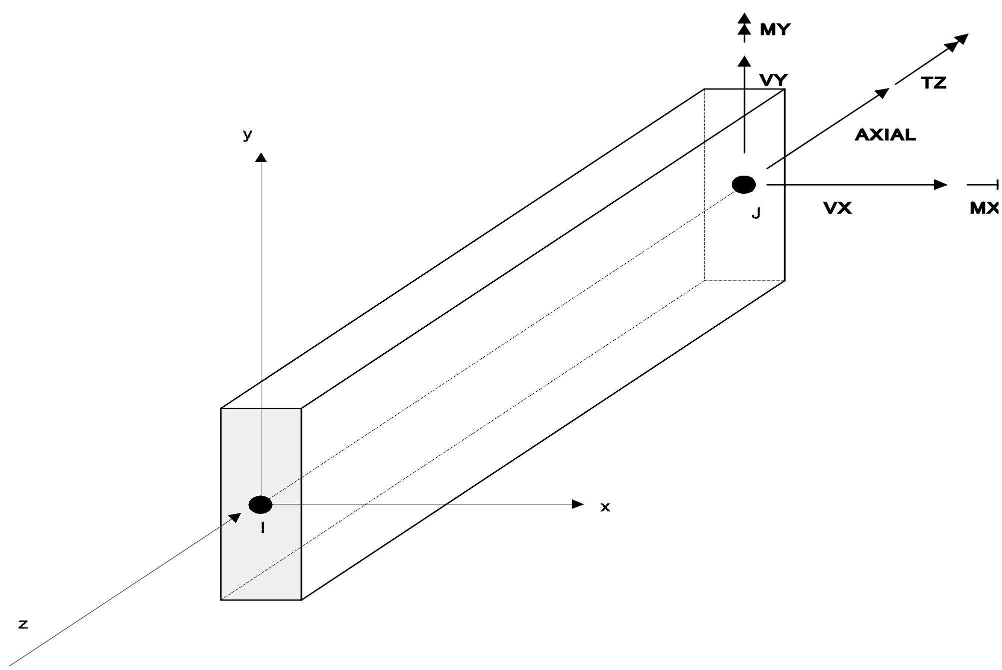


Figure 5.12-1 Local Member Orientation

5.13 SHEAR / AXIAL TABLE

This table lists the shear and axial values for each member. For output level 0, the case corresponding to the worst combined stress ratio (CSR) value for each member type is listed. For output level 1, the worst case for each element (i.e. the worst i or j node) in the model is listed. For output level 2, all values for each end of each element are listed.

LOCATION

The cross section member location.

X-SEC NO

The cross section identification number. This number refers to the cross section identification number provided in the **CROSS SECTION OUTPUT**.

DIST

Location of the member in feet. For chord members this is the distance along the chord from the centerline of the left post (see Figure 5.8-1). Truss vertical and diagonal member distances are measured by panel increments (i.e., the panel in which the member is contained). Distances for posts are measured from the support upward as shown in Figure 5.8-1. Distance for struts/chords on centermount sign structures is measured from the left most end of the strut (see Figure 5.8-1). The DIST value is listed only for output level 0.

MEM

This value lists the finite element member number. The value is listed only for output levels 1 and 2.

NODE

This value lists the finite element node number that corresponds to this member. For output level 1, the worst result of the two element nodes is displayed. For output level 2, both node results are displayed. The NODE value is listed only for output levels 1 and 2.

LOAD CASE

This number refers to the load case id listed in the load combination table. See **Section 5.7 LOAD CASE TABLE.**

VY

Shear on the member y-axis in kips (see Figure 5.13-1).

VX

Shear on the member x-axis in kips (see Figure 5.13-1).

AXIAL

Member axial load in kips (see Figure 5.13-1).

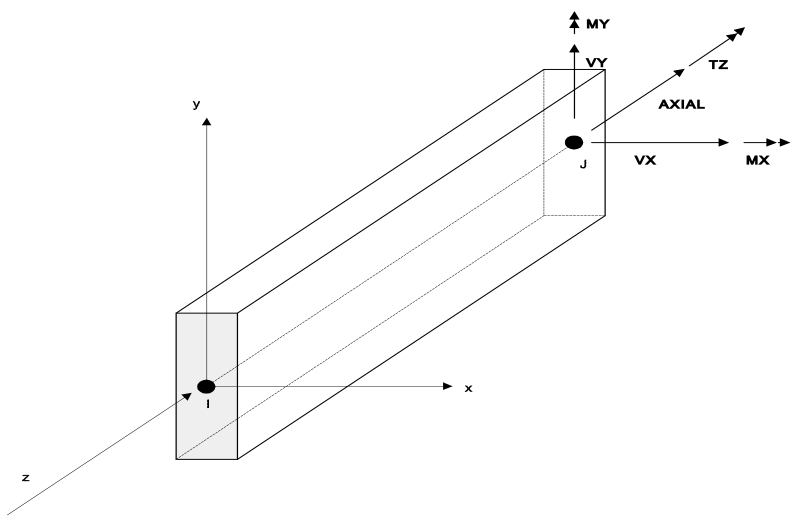


Figure 5.13-1 Local Member Orientation

5.14 ALLOWABLE STRESS TABLE

This table lists the allowable stress values for each member. For output level 0, the case corresponding to the worst combined stress ratio (CSR) value for each member type is listed. For output level 1, the worst case for each element (i.e. the worst i or j node) in the model is listed. For output level 2, all values for each end of each element are listed.

LOCATION

The cross section member location.

X-SEC NO

The cross section identification number. This number refers to the cross section identification number provided in the **CROSS SECTION OUTPUT**.

DIST

Location of the member in feet. For chord members this is the distance along the chord from the centerline of the left post (see Figure 5.8-1). Truss vertical and diagonal member distances are measured by panel increments (i.e. the panel in which the member is contained). Distances for posts are measured from the support upward as shown in Figure 5.8-1. Distance for struts/chords on centermount sign structures is measured from the left most end of the strut (see Figure 5.8-1). The DIST value is listed only for output level 0.

MEM

This value lists the finite element member number. The value is listed only for output levels 1 and 2.

NODE

This value lists the finite element node number that corresponds to this member. For output level 1, the worst result of the two element nodes is displayed. For output level 2, both node results are displayed. The NODE value is listed only for output levels 1 and 2.

LOAD CASE

This number refers to the load case id listed in the load combination table. See **Section 5.7 LOAD CASE TABLE**.

Fa

Allowable unit stress for members in axial compression (ksi).

Fb

Allowable unit bending stress for each member (ksi).

Fv

Allowable unit shear stress for each member (ksi).

5.15 STRESS TABLE

This table lists the actual stress values and the combined stress ratio (CSR) for each member. For output level 0, the case corresponding to the worst CSR value for each member type is listed. For output level 1, the worst case for each element (i.e., the worst i or j node) in the model is listed. For output level 2, all values for each end of each element are listed.

LOCATION

The cross section member location.

X-SEC NO

The cross section identification number. This number refers to the cross section identification number provided in the **CROSS SECTION OUTPUT**.

DIST

Location of the member in feet. For chord members this is the distance along the chord from the centerline of the left post (see Figure 5.8-1). Truss vertical and diagonal member distances are measured by panel increments (i.e., the panel in which the member is contained). Distances for posts are measured from the support upward as shown in Figure 5.8-1. Distance for struts/chords on centermount sign structures is measured from the left most end of the strut (see Figure 5.8-1). The DIST value is listed only for output level 0.

MEM

This value lists the finite element member number. The value is listed only for output levels 1 and 2.

NODE

This value lists the finite element node number that corresponds to this member. For output level 1, the worst result of the two element nodes is displayed. For output level 2, both node results are displayed. The NODE value is listed only for output levels 1 and 2.

LOAD CASE

This number refers to the load case id listed in the load combination table. See **Section 5.7 LOAD CASE TABLE**.

fa

Calculated axial compressive stress for each (ksi).

fbx

Calculated bending stress about the member X-axis (ksi).

fby

Calculated bending stress about the member Y-axis (ksi).

fv

Calculated stress due to shear and/or torsion for each member (ksi).

CSR

Combined stress ratio for each member. See Table 5 in Section 3.6 for the equations used to compute the CSR values.

5.16 FATIGUE MOMENT/AXIAL TABLE

This table lists the fatigue moments and axial force values for members whose fatigue loads are printed in the fatigue stress table (5.17). For output level 0 this table will print the controlling member for each fatigue detail automatically generated by the program and for each detail input by the user. Output level 1 is similar to level 0, the difference being that for level 1 the program will output each controlling member type (POST, FVERT, FUCHORD, etc.) for each detail automatically generated by the program and for each detail input by the user. For output level 2, the worst case for each node in the model applicable to each detail is listed for each fatigue load case that is applied to it for which the CSR is greater than 0.0.

DETAIL NUMBER

The detail number from the fatigue details input card is printed.

FATIGUE ALLOWABLE STRESS CATEGORY

This echoes the category from the fatigue details input card.

CHORD/POST/BRANCH MEMBER

This echoes the member type from the fatigue details input card, where applicable.

LOCATION

The cross section member location.

X-SEC NO

The cross section identification number. This number refers to the cross section identification number provided in the **CROSS SECTION OUTPUT**.

MEMBER

The finite element member number.

NODE

The finite element node number that corresponds to the current member.

LOAD CASE

This number refers to the load case id listed in the load combination table. See **Section 5.7 LOAD CASE TABLE**.

AXIAL

Member axial load in kips.

MX

Moment about the member x-axis in inch-kips.

MY

Moment about the member y-axis in inch-kips.

5.17 FATIGUE STRESS TABLE

This table lists the fatigue stress values and the fatigue combined stress ratio (CSR). For output level 0, the controlling member for each automatically generated fatigue detail and each user-input fatigue detail are printed out. For output 1, the case corresponding to the worst CSR value for each section type for both automatically generated and user-input fatigue details is printed. For output level 2, the worst case for each node in the model applicable to each detail and for each fatigue load case is listed.

DETAIL NUMBER

The detail number from the fatigue details input card is printed.

FATIGUE ALLOWABLE STRESS CATEGORY

This echoes the category from the fatigue details input card.

CHORD/POST/BRANCH MEMBER

This echoes the member type from the fatigue details input card.

LOCATION

The cross section member location.

MEMBER

This value lists the finite element member number.

NODE

This value lists the finite element node number that corresponds to this member.

LOAD CASE

This number refers to the load case id listed in the load combination table. See **Section 5.7 LOAD CASE TABLE**.

fa

Calculated axial compressive fatigue stress for each (ksi).

fbx

Calculated bending fatigue stress about the member X-axis (ksi).

fby

Calculated bending fatigue stress about the member Y-axis (ksi).

CSR

Combined fatigue stress ratio for each member. See Table 5 in Section 3.6 for the equations used to compute the CSR values.

5.18 SADDLE DETAIL DESIGN TABLE

This table lists the saddle detail stresses at both ends of the applicable chords. The purpose of this table is to determine if the “ideal height” of the saddle (determined by geometric constraints) is adequate for the reaction from the chord. Also, the shear and frictional resistance of the system due to U-bolt tension will be checked to determine if the input number of U-bolts will be adequate for a given bolt diameter.

The program makes several assumptions:

1. U-bolts are to be A325 H.S. Although it is noted in the current Standard Drawings that the U-bolts are to be A325, it is highly unlikely that this is the case, since the A325 specification deals with headed bolts, which of course a U-bolt is not. It is more likely that these bolts are A449, which has the same tensile strength and othe characteristics as A325. Therefore, the minimum fastener tension requirements used are okay.
2. The default bolt diameter is 1”.
3. Width (thickness) of the saddle plate is 4”, by default.
4. Shelf (top flats) length is 3”.
5. Saddle height at center is 1”.
6. Minimum number of U-bolts required is one. (Two legs per saddle block)
7. Allowable bolt shear is determined assuming the threads are excluded from the shear plane. Fv = 19*1.25 = 23.75 ksi, based on Table 10.32.3B of AASHTO Bridge Specifications.
8. If more than one U-bolt is required, the number of saddle blocks required will be the same.
9. The bearing length of the pipe on the saddle will be limited to 0.33 * (circumference of pipe), which is the length of arc subtended by Beta Angle = 120 degrees (upper limit for optimum saddle angle).
10. The force used to calculate bearing at the pipe/saddle interface will include the effects of the minimum required tension in the U-bolt, 51k * 2 = 102k (See AASHTO Div.II, Table 11.5A).
11. No bending of the U-bolt is considered.
12. Saddle is made of A36 steel.
13. “Ideal Height” assumes U-bolt is centered on 3” shelf.

LOCATION

The cross section member location. For this table, the member location will always be a chord location, because the saddle detail design is applicable only for chords. The program will specify which chord is analyzed on each line of the table: FUCORD = front upper chord, FLCORD = front lower chord, RUCORD = rear upper chord, RLCORD = rear lower chord.

MEMBER

This value lists the finite element member number.

NODE

This value lists the finite element node number that corresponds to this member.

LOAD CASE

This number refers to the load case id listed in the load combination table. See **Section 5.7 LOAD CASE TABLE**. This load case is the load case that causes the CSR value to be printed in the CSR column of the table.

NUMBER OF U-BOLTS REQUIRED

This is an echo of the NUBOLTS input value from the Bolted Connections Input Card.

REQUIRED MINIMUM Tmin

This is the minimum required U-bolt tension per leg.

$$T_{min} = \left[\left| \frac{A_x}{0.3} \right| - V_y \right] / 2 * n$$

Where: Ax = Axial Force

Vy = Shear along y-axis

n = Number of U-bolts

If the minimum tension is due to a load case other than the one printed in the load case column (above), an addition sign (+) will be placed next to the value to indicate the inconsistency.

BETA ANGLE

Angle, in degrees, between the saddle block and the center of the pipe. The optimum saddle angle is between 90 and 120 degrees. This is applicable only for chords that have a diameter of 10” or greater.

SADDLE HEIGHT

Height, in inches, of the saddle block. Height = 1 + 2R * $\sin^2$(Beta Angle/4), where R = outside radius of the pipe.

SADDLE LENGTH

Length, in inches, of the saddle block. Length = 2*(R – 1) + 6 (for 1” bolt), where R = outside radius of the pipe.

CHORD fa

Actual axial stress, in ksi, of the specified chord.

CHORD fb

Actual bending stress, in ksi, of the specified chord.

CHORD fv

Actual shear stress, in ksi, of the specified chord.

CSR

Combined saddle stress ratio for each member. This CSR value is based on the load case listed in the Load Case column of this Saddle Table. See Table 5 in Section 3.6 for the equations used to compute the CSR values.

U-BOLT fv

Actual shear stress, in ksi, of the U-bolt. U-bolt fv = $\frac{\sqrt{V_x{}^2 + A_x{}^2}}{2 * n * A_b}$, where Ab = Bolt Area. If this fv is based on a different load case than the one displayed, a number sign (#) will be displayed next to the value.

U-BOLT Fv

Allowable shear stress, in ksi, of the U-bolt. U-bolt Fv = $23.75 * \left[\pi(1.0)^2/4\right]/Ab$, where Ab = Bolt Area.

5.19 CANTILEVER / CENTERMOUNT DEFLECTION TABLE

This table is provided for cantilever and centermount models. It lists the allowable and actual angular rotations based on the AASHTO Sign Specifications 1.9.1(B).

5.20 TRUSS / TAPERED TUBE DEFLECTION TABLE

This table is provided for trusses and tapered tube models. It lists the actual and allowable vertical chord deflections. This table is not printed for centermount and cantilever models.

5.21 VERTICAL CAMBER TABLE

This table lists deflections for the total vertical camber of the lower chord for truss type models and tapered tube models, and the end of the strut for cantilever and centermount models. This table also lists the maximum horizontal post deflection for cantilever and centermount models.

5.22 QUANTITY TABLE

This table is lists the total steel quantity in pounds for the structural steel.

5.23 FOOTING OUTPUT

5.23.1 LONG OUTPUT

Selecting output levels 1 and 2 produces five additional pages in front of the standard output. The first two pages print the results of the rebar checking used to design the rebar. After the footing has been sized for the given load cases, the program checks every rebar size. This feature gives the engineer the opportunity to change bar sizes and spacing within the footing. The third page of the footing output prints the respective factored load cases, the soil pressures, and the ratios of actual/allowable for bearing capacity, sliding and overturning. In addition, the uplift conditions are output for the load cases that produce uplift. This page also includes the weights of the footing, overburden and pedestal along with a schematic of the footing and the corner pressures due to the governing load case. The fourth and fifth pages print the results for the rebar analysis using the design bars. The results of the checking of minimum steel are included with the governing analysis check printed at the page bottoms.

5.23.2 STANDARD OUTPUT

The remainder of the output is always printed:

FINAL RESULTS FOR FOOTING DESIGN

Footing length, width and depth (as required by design or as per input if analysis checks are satisfied).

SPREAD FOOTING STRESS RESULTS

Governing soil stresses (maximum and minimum) and the governing safety factors for sliding as well as overturning.

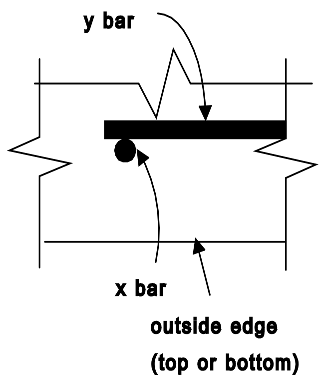
SHEAR RESULTS

Each governing load case is listed for one-way shear in each direction and the load case, which governs punching shear (VP). The Shear capacities, the effective depths used to calculate the capacities, the actual shears, and the ratios of actual / allowable shears are listed.

FLEXURE RESULTS

Each bar (top x direction, top y direction, bottom x direction, and bottom y direction) is listed along with the governing load cases, the effective depths, applied governing moments, required bar spacing, total required steel area, and the total bars required for the design bar size.

NOTE: Effective depths are calculated using the actual cover and the actual "overall" diameters of the bar as per the <u>CRSI Manual of Standard Practice</u>[3] Chapter 6 (Recommended Industry practice for Detailing Reinforcing Material). The x bars are assumed to be placed closest to the outside edge with the y bars place on top of the x bars as show in Figure 5.18.2-1.



<u>Figure 5.18.2-1 Footing Rebar Location</u>

FOOTING REINFORCEMENT REQUIREMENTS

The total bar lengths for all bars and respective weights are given in this section.

EXCAVATION AND CONCRETE QUANTITIES

The required excavation for the input cover, the required backfill, and the total volume of concrete along with the total weight of the footing steel are listed in this section.

[3]<u>CRSI Manual of Standard Practice</u>, First Printing, January 1986, p 6-2 Section D

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6.0 ERROR MESSAGES

The program prints an error message upon encountering a detectable input error. These messages are self-explanatory. The program checks all input values and lists all error messages for a single input line before terminating. The engineer should correct input errors and resubmit the job for execution.

For the model generation, the program will print an error message if the structure is found to be inadequate in any way. These messages are also self-explanatory. If an error is found during the model and load generation, the program will terminate before attempting to perform the finite element analysis.

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7.0 TECHNICAL QUESTIONS AND REVISION REQUESTS

This chapter contains reply forms 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 master copies, which can be reproduced as needed. They are also included as a Word template on the disk that has been provided for the program.

7.1 TECHNICAL QUESTIONS

Technical questions related to the interpretations of the design specifications as implemented in this program, why certain assumptions are made, applicability and limitations of this program, and other questions not related to the operation of this program can be directed to the appropriate person in PennDOT using this form or the information provided on this form. Please review the information provided in this User's Manual and the references given in Chapter 1 before submitting this form for processing or calling for assistance. The completed form should be sent to the Bridge Quality Assurance Division (see form for complete address).

7.2 REVISION REQUESTS

This form is to be used to report suspected program malfunctions that may require revisions to the program. It can also be used to request revisions that may be required due to changes in specifications and for the enhancement of the program. Unexpected or incorrect output, rejection of input data, endless program cycling, and program abortion are examples of program malfunctions. Users are requested to review their input data and the program User's Manual before submitting this form for processing.

This form may also be used to submit suggestions for improving the User's Manual for this program. Suggestions might include typographical error correction, clarification of confusing sections, expansion of certain sections, changes in format, and the inclusion of additional information, diagrams, or examples.

The completed form should be sent to the Engineering Unit via mail, fax, or e-mail.

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SIGN
TECHNICAL QUESTIONS

This form is to be used to ask questions on technical issues related to this engineering program. Questions on the interpretations of the design specifications as implemented in this program, why certain assumptions are made by the program and other questions not related to the operation of this program may be submitted using this form or by calling the telephone number listed in this form. Users are requested to read the User's Manual, LFD Specifications and DM-4 before submitting this form or calling to ask questions.

CONTACT PERSON: ____ DATE: ____________________
ORGANIZATION: ____ PHONE: ____________________
E-MAIL ADDRESS: ____ FAX: ____________________
PROGRAM VERSION: _________

Clearly state your question(s) and attach documentation you feel would be helpful in answering your question(s). If you require more space, use additional 8½ x 11 sheets of plain paper.

FORWARD COMPLETED FORM TO: Pennsylvania Dept. of Transportation
Bridge Design and Technology Division
Commonwealth Keystone Building, 7th Floor
400 North Street
Harrisburg, PA 17120-0094
PHONE: (717) 787-2881
FAX: (717) 787-2882

FOR DEPARTMENT USE ONLY

RECEIVED BY: ________________ ASSIGNED TO: ____________________ DATE: ______________

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SIGN
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: ______________________ FAX: ____________
PROGRAM VERSION: _________

Define your problem and attach samples and/or documentation you feel would be helpful in correcting the problem. If the input data is more than 4 or 5 lines, Licensees should provide the input data file on a diskette. If you require more space, use additional 8½ x 11 sheets of plain paper.

FORWARD COMPLETED FORM TO: Pennsylvania Department of Transportation
Bureau of Business Solutions and Services
Engineering Software Section
Commonwealth Keystone Building, 5th Floor
400 North Street
Harrisburg, PA 17120-0041
PHONE: (717) 783-8822
FAX: (717) 705-5529
E-MAIL: penndotbisengineer@pa.gov

FOR DEPARTMENT USE ONLY
RECEIVED BY: _________________ ASSIGNED TO: ____________________ DATE: ______________

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Appendix A: SAPV Output Description

This appendix is a description of the SAPV finite element output that accompanies each program runs. Each execution of the program creates a SAPV input file (*<input filename>*_SAPV.inp) and a SAPV output file (*<input filename>*_SAPV.oui). **NOTE: Some of the SAPV reports require 132 columns. When using model 5 always print the output using the appropriate 132 column printing option. This option varies dependent on the printer or operating system.**

A1.1 NODAL POINT INPUT DATA

This section describes all of the node information. Nodes are generated internally within the program.

NODE NUMBER

Node identification number.

BOUNDARY CONDITION CODES (X, Y, Z, XX, YY, ZZ)

Fixity of the node for translation and rotation (X, Y, Z represent translation and XX, YY, ZZ represent rotation). If the value is “1”, the node is fixed against movement in that global direction. If the value is “0”, the node is free to move in that global direction.

NODAL POINT COORDINATES (X, Y, Z)

The X, Y, Z nodal coordinates represent the global location of the node. The values shown are in inches. The origin for this model is located at the base of the front left post.

T

This value is not used.

A1.2 MATERIAL PROPERTIES

This section describes all of the material information. Only one material type is used by the sign structure program.

MATERIAL NUMBER

Material identification number. This value is always “1”.

YOUNG'S MODULUS

Modulus of elasticity of the material. This value is set equal to 29000 ksi.

POISSON'S RATIO

Poisson's ration of the material. This value is set equal to 0.3.

MASS DENSITY

VALUES NOT USED BY THIS APPLICATION.

WEIGHT DENSITY

VALUES NOT USED BY THIS APPLICATION. Self-weight of all members is entered as an applied uniform load.

A1.3 BEAM GEOMETRIC PROPERTIES

This section describes all section property information for all members.

SECTION NUMBER

Cross-section identification number.

AXIAL AREA A(1)

Cross sectional area in $inch^2$.

SHEAR AREA A(2)

Shear area associated with the forces in the local 2 direction in $inch^2$ (see Figure A1.3-1). This area is for shear deformation effects. For pipes, this value is set to (AXIAL AREA/1.6667). For other sections, this value is set to the (DEPTH OF THE WEB * THICKNESS OF THE WEB).

SHEAR AREA A(3)

Shear area associated with the forces in the local 3 direction in $inch^2$ (see Figure A1.3-1). This area is for shear deformation effects. For pipes, this value is set to (AXIAL AREA/1.6667). For other sections, this value is set to the (DEPTH OF THE FLANGES * THICKNESS OF THE FLANGES).

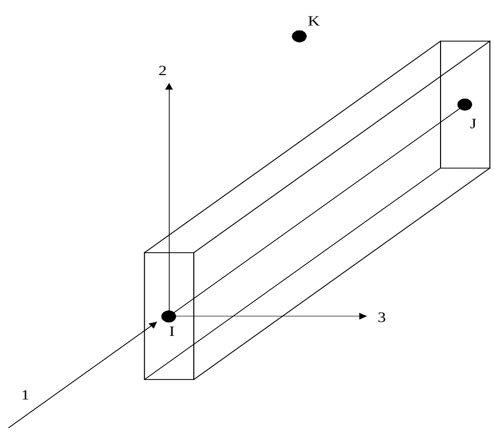

Figure A1.3-1 Local Element Axis

TORSION J(1)

Torsional moment in $inch^3$.

INERTIA I(2)

Moment of inertia about the local 2 axis in $inch^4$.

INERTIA I(3)

Moment of inertia about the local 3 axis in $inch^4$.

SECTION MODULUS S(2), S(3)

These values represent the section moduli of the cross section. Since SAPV is not used to compute stresses, **these values are not entered and are thus always 0.0**.

A1.4 MEMBER LOADS

This section describes the member load identifications. The loads described in this section are referenced by their **ID** in the **3D BEAM ELEMENT DATA** discussed in the next section.

ID

Member load identification number.

ORNT

Orientation of the member load:

0 - Load is in the global direction.

1 - Load is in the local direction.

DIR

This value represents the force or moment and its direction. See Figure A1.4-1.

1 - FX-force in the x direction.

2 - FY-force in the y direction.

3 - FZ-force in the z direction.

4 - MX-moment in the x direction.

5 - MY-moment in the y direction.

6 - MZ-moment in the z direction.

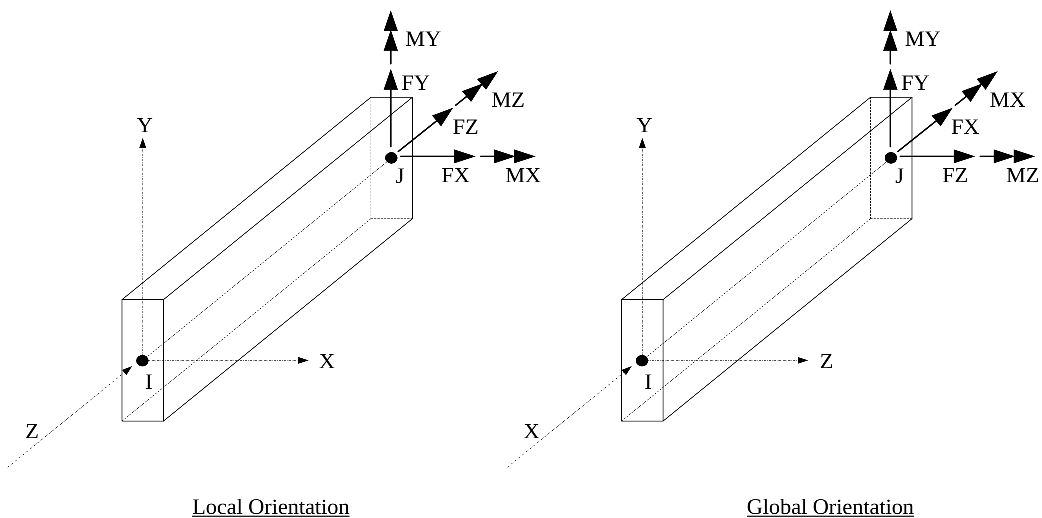

Figure A1.4-1 Force Orientation

TYPE

This value represents the type of load. The following are the possible types:

1 - Concentrated load.

2 - Uniform load.

3 - Linearly varying uniform load.

P1 (W1)

The magnitude of the load at the starting point for uniform and linearly varying uniform loads in kips/in. See Figure A1.4-2. For concentrated loads, the magnitude of the load in kips. See Figure A1.4-3.

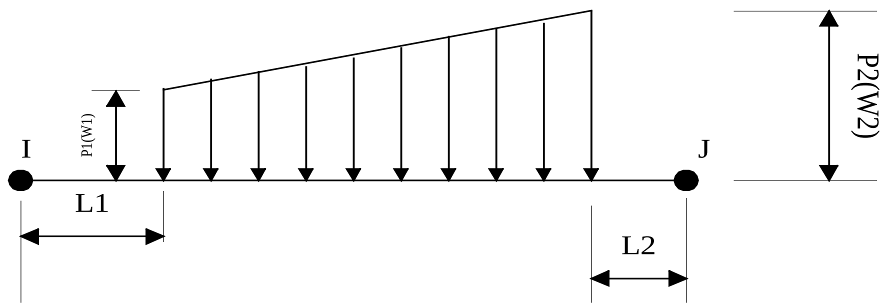

Figure A1.4-2 Member Load Location for Uniform/Linear Loads

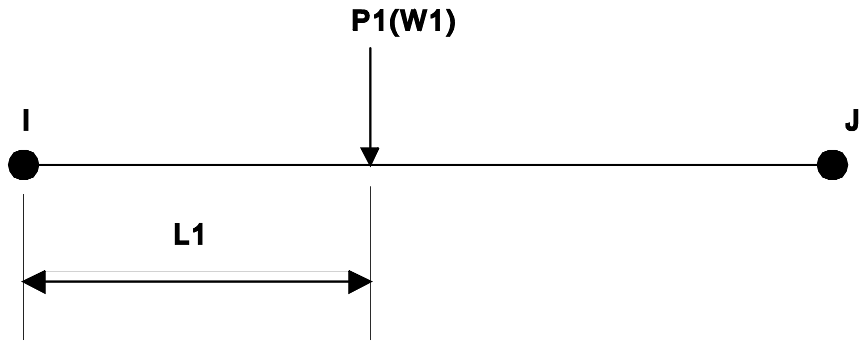

Figure A1.4-3 Member Load Location for Concentrated Loads

P2 (W2)

The magnitude of the load at the ending point for uniform and linearly varying uniform loads in kips/in. See Figure A1.4-2. For concentrated loads, this value is ignored.

L1

For uniform and linearly varying uniform loads, the starting point location of the load along the member measured from the I node as a ratio of the member length. See Figure A1.4-2. For concentrated loads this is the distance from the I node as a ratio of the member length to the concentrated load. See Figure 1.4-3.

L2

For uniform and linearly varying uniform loads, the ending point location of the load along the member measured from the J node as a ratio of the member length. See Figure A1.4-2. For concentrated loads, this value is ignored.

DESCRIPTION

Brief description of the type of load. Internally assigned by the program.

A1.5 3/D BEAM ELEMENT DATA

This section describes the member connectivity and member load information.

BEAM NUMBER

Member identification number.

NODE I

Starting node number of the member (see Figure A1.5-1).

NODE J

Ending node number of the member (see Figure A1.5-1).

NODE K

Node number defining the orientation of the member in space (see Figure A1.5-1).

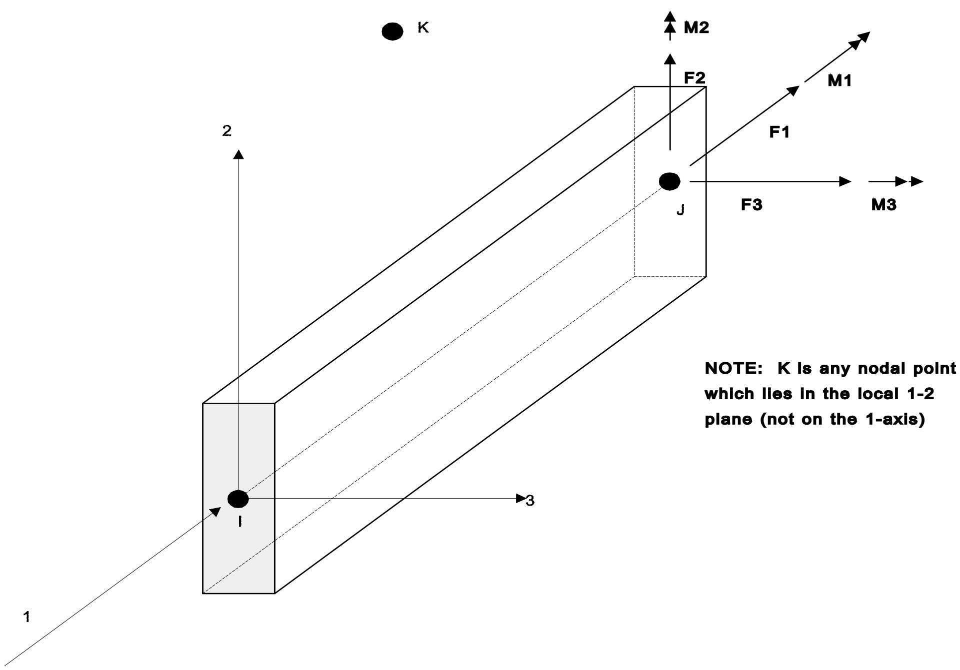

Figure A1.5-1 Local Member Axes

MATERIAL NUMBER

Material identification number. Always equal to “1”.

SECTION NUMBER

Section identification number.

ELEMENT END LOADS

NOT USED BY THIS APPLICATION.

END CODES (I, J)

Element releases at the I and J nodes. Each end of the element is represented by a field width that is six characters wide representing translational and rotational releases in the global X, Y, and Z directions (see Figure A1.5-1), respectively (i.e., column 1 of the field represents FX, column 2 FY, column 3 FZ, column 4 MX, column 5 MY, and column 6 MZ). A blank or zero in a column indicates that element is fixed in that direction; a zero represents the element is released in that direction.

MEMB LOAD

Number of member loads on this element.

BAND

NOT USED IN THIS APPLICATION.

MEMBER LOAD CASE (line item output)

The structure load case which to apply the given load id (see **Section A1.6 Structure Loads** for a definition of structure load case).

LOAD ID (line item output)

Load identification number. This number refers to **ID** defined in **Section A1.4 Member Loads**.

A1.6 STRUCTURE LOADS

This section describes the structure load case multiplication factors. *Structure load cases* are load definitions that can be combined in part or in whole with other structure load cases to form a single *load case*. In other words, a *load case* is defined as a combination of *structure load cases.* The total number of *structure load cases* applied to any sign structure is 27 (For a full listing of the *structure load cases* used for the sign structure program, see Table 3.4.3-1b).

STRUCTURE LOAD CASE

Structure load case number from 1M to 27M.

ELEMENT LOAD MULTIPLIERS

Load factor applied to each *structure load case* to form a *load case*. The load case identification number shown under the **ELEMENT LOAD MULTIPLIER** heading is the id number that is referenced in the **DISPLACEMENTS/ROTATIONS OF UNRESTAINED NODES** report (see Section A1.7) and in the **BEAM ELEMENTS FORCES AND MOMENTS** report (see Section A1.8). For a full listing of the load cases and their load factors, see the load equations in Table 3.4.3-1c.

A1.7 DISPLACEMENT/ROTATIONS OF UNRESTRAINED NODES

This section describes the output for the global nodal displacements.

LOAD CASE

At the beginning of each new set of displacements is a load case id number. The makeup of this load case is defined in **Section A1.6 STRUCTURE LOADS**.

NODE NUMBER

Node identification number.

TRANSLATION (X, Y, Z)

Translation of the node in the global direction measured from the original node location in inches.

ROTATION (X, Y, Z)

Global rotation of the node measured in radians.

A1.8 BEAM ELEMENT FORCES AND MOMENTS

This section describes the local member forces and moments. The forces described in the section are represented if Figure A1.8-1.

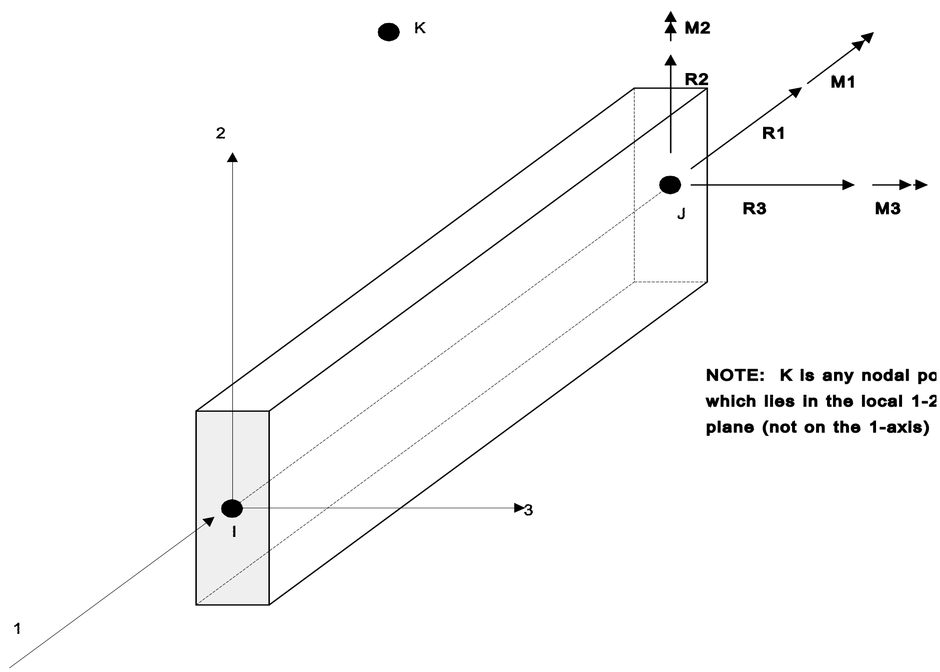

Figure A1.8-1 Local Member Forces

BEAM NO.

Member identification number.

LOAD NO.

Load case identification number. The makeup of this load case is defined in **Section A1.6 STRUCTURE LOADS**.

AXIAL R1

Member axial force in the 1-axis direction in kips. See Figure A1.8-1.

SHEAR R2

Shear force in the 2-axis direction in kips. See Figure A1.8-1.

SHEAR R3

Shear force in the 3-axis direction in kips. See Figure A1.8-1.

TORSION M1

Torsion about the 1-axis in kip-in. See Figure A1.8-1.

BENDING M2

Bending moment about the 2-axis in kip-in. See Figure A1.8-1.

BENDING M3

Bending moment about the 3-axis in kip-in. See Figure A1.8-1.

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Appendix B: EXAMPLE PROBLEMS

The following pages provide a description of the 8 example problems, one for each model type, along with prepared input forms. Prepared input files for each example are provided in the installation folder, and can be run to view output.

B1.1 EXAMPLE 1

Example 1 is a tapered tube structure with a height of 12.0 feet and a span length of 30.0 feet as shown in Figure B1.1-1 below.

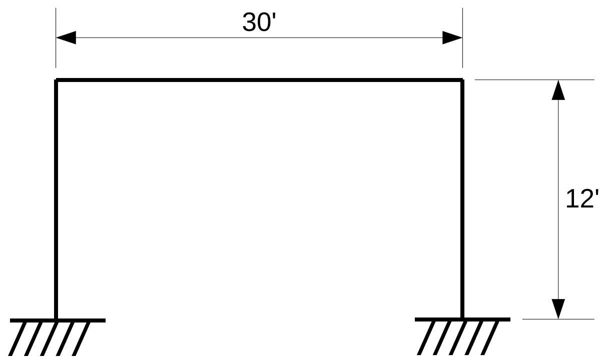

Figure B1.1-1 Example 1 Sketch

Completed input forms for this example are shown on the following pages.

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

Form 1 of 5

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

PROBLEM IDENTIFICATION

* EXAMPLE 1 - TAPERED TUBE
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53
1	1200	3000	1		000	000	110		2	N	1		0			

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71
1850	1750	1260	1 . 497											

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11

PREPARED BY ....RFY.............................. DATE ..10/23/13.. SHEET .1..OF.5..

Figure B1.1-2 Example 1 Input

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

Form 2 of 5

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION					SECTION Fy	PANEL NUMBER
		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5		
1	7	10	16	22	28	34	40	42
POST	TP	9.00	0..3750	7.32			36	
CHORD	TP	12.00	0..3750	9.90			36	

PREPARED BY RFY DATE 10/23/13 SHEET 2 OF 5

Figure B1.1-2 Example 1 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 3 of 5

BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13
0.875	2.500		

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES: SIGN 1	NUMBER OF LUMINAIRES: SIGN 2	NUMBER OF LUMINAIRES: SIGN 3	LUMINAIRE: OFFSET	LUMINAIRE: WEIGHT	LUMINAIRE: NORMAL AREA	LUMINAIRE: ICE AREA	LUMINAIRE: TRUCK-GUST AREA	CATWALK: WEIGHT	CATWALK: NORMAL AREA	CATWALK: ICE AREA	CATWALK: TRUCK-GUST AREA	IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71
310			-1			3.02	40000	9.917	5500						2			

PREPARED BY ......RFY.................................. DATE 10/23/13. SHEET 3..OF 5...

Figure B1.1-2 Example 1 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 4 of 5

FATIGUE DETAILS

DETAIL NUMBER	FATIGUE CATEGORY	WEEP HOLE AREA	WIRE OUTLET AREA	HAND HOLE AREA	C/P/B TYPE
1	3	5	11	17	23

PREPARED BY ....REY........................... DATE 10./23./13. SHEET 4...OF5...

Figure B1.1-2 Example 1 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 5 of 5

FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL HEIGHT	PEDESTAL LENGTH	PEDESTAL WIDTH	FOOTING MIN THK	FOOTING MAX THK	FOOTING WIDTH	FOOTING LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59
D	3.00				0.25	10.00	11.00	2.17	2.17	2.00		0.00	0.00

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP LONG BAR SIZE	TOP LONG BAR SPACING	TOP TRANS BAR SIZE	TOP TRANS BAR SPACING	BOTTOM LONG BAR SIZE	BOTTOM LONG BAR SPACING	BOTTOM TRANS BAR SIZE	BOTTOM TRANS BAR SPACING
1	3	7	11	13	17	19	23	25	29	31

PREPARED BY ....RFY........ DATE 10/23/13 SHEET 5 OF 5

Figure B1.1-2 Example 1 Input (continued)

B1.2 EXAMPLE 2

Example 2 is a two post planar structure with a height of 12.0 feet and a span length of 30.0 feet as shown in Figure B1.2-1 below.

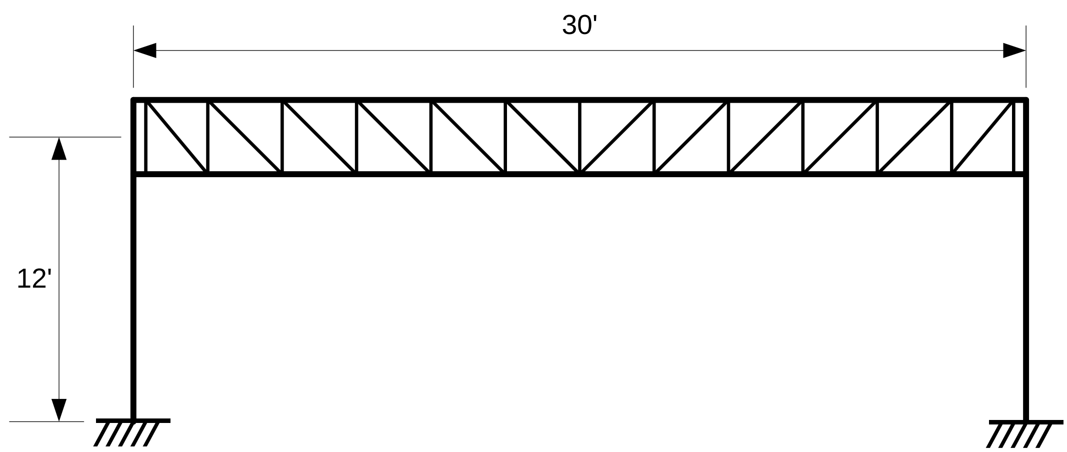

Figure B1.2-1 Example 2 Sketch

Completed input forms for this example are shown on the following pages.

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
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APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 1 of 5

PROBLEM IDENTIFICATION

* EXAMPLE 2 - 2-POST PLANAR TRUSS
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53
2	12.00	30.00	1	12	0.00	0.00	1.10		4	N			0	.		.

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71
18.50	100.0	12.60	1.15	.	.	.	.	.	.	.	.	.	.	.

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11
.	.	.

PREPARED BY ....RFY.............................. DATE .04/08/09. SHEET .1..OF.5..

Figure B1.2-2 Example 2 Input

Form 2 of 5

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION					SECTION Fy	PANEL NUMBER
		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5		
1	7	10	16	22	28	34	40	42
POST	P	8..625	0..322				36	
CHORD	P	6..625	028				36	
FVERT	P	2..375	0..2180				36	
FDIAG	P	2..375	0..1540				36	

PREPARED BY ....RFY....................................... DATE 04/08/09. SHEET .2..OF.5...

Figure B1.2-2 Example 2 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 3 of 5

BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES			LUMINAIRE					CATWALK				IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
			SIGN 1	SIGN 2	SIGN 3	OFFSET	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA				
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71
3 1 0			- 0 1			2 . . 6 7	4 0 0 0 0	9 . . 9 1 7	5 5 0 0						3			

PREPARED BY ......RFY.............................. DATE 04/08/09. SHEET 3..OF 5..

Figure B1.2-2 Example 2 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

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SIGN STRUCTURE ANALYSIS

Form 4 of 5

FATIGUE DETAILS

DETAIL NUMBER	FATIGUE CATEGORY	WEEP HOLE AREA	WIRE OUTLET AREA	HAND HOLE AREA	C/P/B TYPE
1	3	5	11	17	23

PREPARED BY ....RFY..

DATE ..04/..08/..09.

SHEET ..4...OF..5..

Figure B1.2-2 Example 2 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
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PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 5 of 5

FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL			FOOTING			
							HEIGHT	LENGTH	WIDTH	MIN THK	MAX THK	WIDTH	LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59
D	3.00				0.25	10.00	11.00	1.83	1.83	2.00	.	0.00	0.00

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP				BOTTOM			
			LONG BAR		TRANS BAR		LONG BAR		TRANS BAR	
			SIZE	SPACING	SIZE	SPACING	SIZE	SPACING	SIZE	SPACING
1	3	7	11	13	17	19	23	25	29	31
	.	.		.		.		.		.

PREPARED BY ....RFY..........................

DATE 04./08./09

SHEET .5..OF.5..

Figure B1.2-2 Example 2 Input (continued)

B1.3 EXAMPLE 3

Example 3 is a two-post tri-chord structure with a height of 12.0 feet and a span length of 60.0 feet as shown in Figure B1.3-1 below.

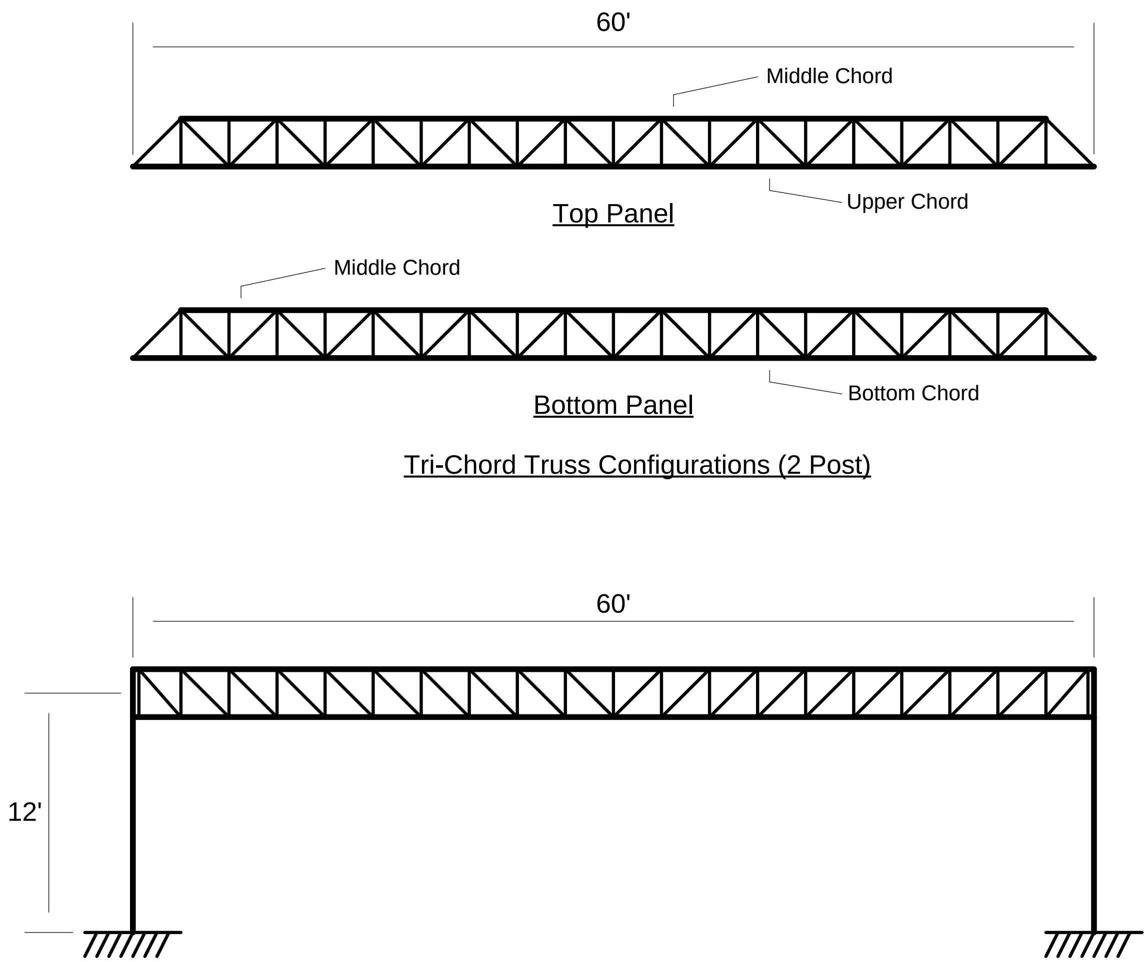

Figure B1.3-1 Example 3 Sketch

Completed input forms for this example are shown on the following pages.

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 1 of 5

PROBLEM IDENTIFICATION

* EXAMPLE 3 - 2-POST TRI-CHORD
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53
3	12.00	60.00	1	20	0.00	0.00	1.10		10	N	2		0	.		.

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71
18.50	125.0	34.80	1.23	.	.	.	.	.	.	.	.	.	.	.

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11
0.00	38.18	2.20

PREPARED BY ....RFY.............................. DATE .04/08/09.. SHEET .1..OF.5..

Figure B1.3-2 Example 3 Input

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

Form 2 of 5

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	SECTION Fy	PANEL NUMBER
1	7	10	16	22	28	34	40	42
POST	P	1075	0..500				36	
CHORD	P	5..563	0..258				36	007
CHORD	P	5..563	0..258				36	013
CHORD	P	5..563	0..258				36	020
FVERT	ST	150	375	100			36	
TVERT	ST	150	375	100			36	
BVERT	ST	150	375	100			36	
FDIAG	ST	150	375	100			36	
TDIAG	ST	150	375	100			36	
BDIAG	ST	150	375	100			36	

PREPARED BY ....RFY.................................. DATE .04/08/09. SHEET .2..OF.5...

Figure B1.3-2 Example 3 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 3 of 5

BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3
1	07
2	13

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13
0875	2500		

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES			LUMINAIRE					CATWALK				IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
			SIGN 1	SIGN 2	SIGN 3	OFFSET	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA				
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71
310			-01			2.73	40000	9..917	5500		497	0..994	861		3			

PREPARED BY ......RFY.................................. DATE 04/08/09. SHEET 3..OF 5..

Figure B1.3-2 Example 3 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
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APRIL 2009

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SIGN STRUCTURE ANALYSIS

Form 4 of 5

FATIGUE DETAILS

DETAIL NUMBER	FATIGUE CATEGORY	WEEP HOLE AREA	WIRE OUTLET AREA	HAND HOLE AREA	C/P/B TYPE
1	3	5	11	17	23

PREPARED BY ....RFY........................

DATE ..04./..08./09.

SHEET ..4..OF..5..

Figure B1.3-2 Example 3 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 5 of 5

FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL HEIGHT	PEDESTAL LENGTH	PEDESTAL WIDTH	FOOTING MIN THK	FOOTING MAX THK	FOOTING WIDTH	FOOTING LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59
D	3.00				0.25	10.00	11.00	2.17	2.17	2.00	.	0.00	0.00

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP LONG BAR SIZE	TOP LONG BAR SPACING	TOP TRANS BAR SIZE	TOP TRANS BAR SPACING	BOTTOM LONG BAR SIZE	BOTTOM LONG BAR SPACING	BOTTOM TRANS BAR SIZE	BOTTOM TRANS BAR SPACING
1	3	7	11	13	17	19	23	25	29	31
	.	.		.		.		.		.

PREPARED BY ....RFY..................................

DATE 04./08./09

SHEET ..5..OF..5..

Figure B1.3-2 Example 3 Input (continued)

B1.4 EXAMPLE 4

Example 4 is a four-post tri-chord structure with a height of 12.0 feet and a span length of 60.0 feet as shown in Figure B1.4-1 below.

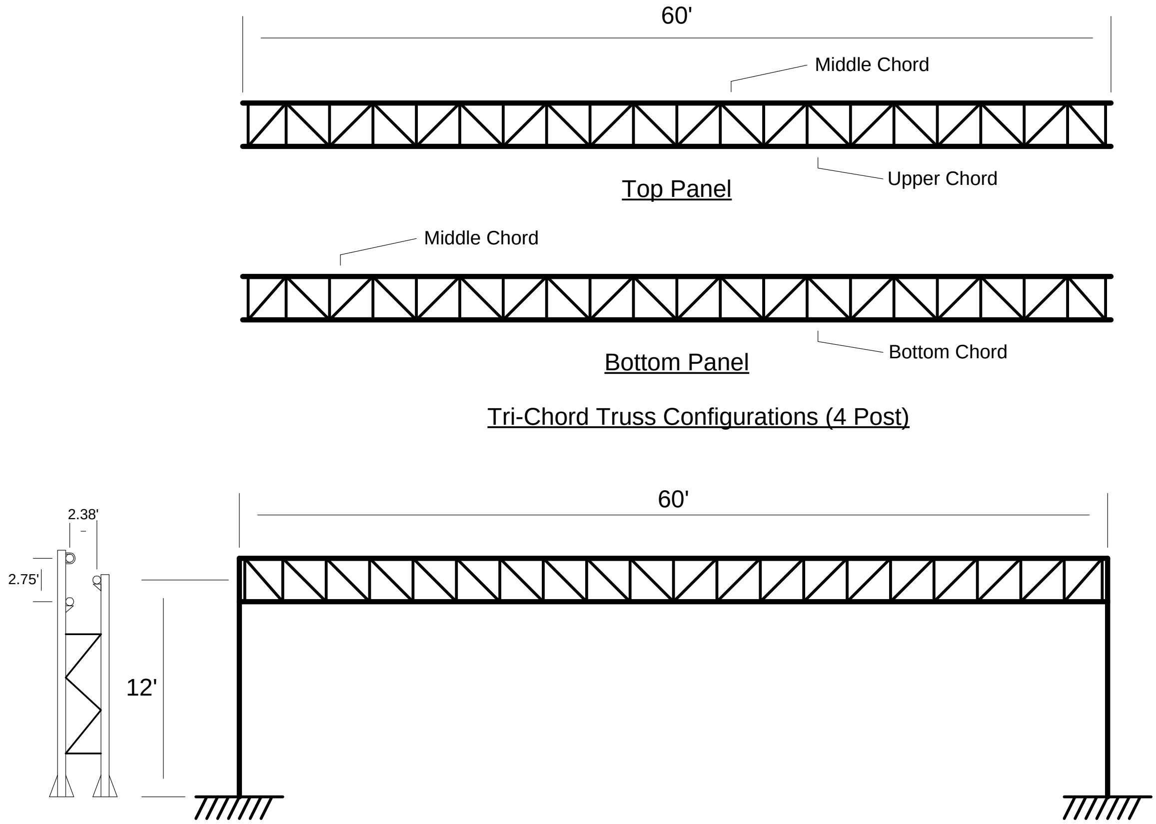

Figure B1.4-1 Example 4 Sketch

Completed input forms for this example are shown on the following pages.

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
APRIL 2009

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 1 of 5

PROBLEM IDENTIFICATION
* EXAMPLE 4 - 4-POST TRI-CHORD
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53
4	1200	6000	1	20	000	000	110		11	N	2		0			

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71
1850	1250	3480	123											

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11
000	3818	220

PREPARED BY ....RFY............................ DATE .04/08/09. SHEET .1..OF.5..

Figure B1.4-2 Example 4 Input

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
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SIGN STRUCTURE ANALYSIS

Form 2 of 5

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION					SECTION Fy	PANEL NUMBER
		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5		
1	7	10	16	22	28	34	40	42
POST	P	8.75	0.322	.	.	.	36	
CHORD	P	5.563	0.258	.	.	.	36	007
CHORD	P	5.563	0.258	.	.	.	36	013
CHORD	P	5.563	0.258	.	.	.	36	020
PXBRAC	ST	20.0	47.5	10.0	.	.	36	
FVERT	ST	15.0	37.5	10.0	.	.	36	
TVERT	ST	15.0	28.5	10.0	.	.	36	
BVERT	ST	15.0	28.5	10.0	.	.	36	
FDIAG	ST	15.0	28.5	10.0	.	.	36	
TDIAG	ST	15.0	28.5	10.0	.	.	36	
BDIAG	ST	15.0	28.5	10.0	.	.	36	

PREPARED BY RFY DATE 04/08/09 SHEET 2 OF 5

Figure B1.4-2 Example 4 Input (continued)

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SIGN STRUCTURE ANALYSIS

Form 3 of 5

BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3
1	0 7
2	1 3

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13
0.875	2.500		

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES			LUMINAIRE					CATWALK				IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
			SIGN 1	SIGN 2	SIGN 3	OFFSET	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA				
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71
31.0			-01			2 . 7.3	400.00	9 . 9.17	55.00		49.7	0 . 9.94	8.61		3			

PREPARED BY ......REY.............................. DATE 04/08/09. SHEET .3..OF.5..

Figure B1.4-2 Example 4 Input (continued)

Form 4 of 5

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
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SIGN STRUCTURE ANALYSIS

SHEET 4 OF 5

FATIGUE DETAILS

DETAIL NUMBER (1)	FATIGUE CATEGORY (3)	WEEP HOLE AREA (5)	WIRE OUTLET AREA (11)	HAND HOLE AREA (17)	C/P/B TYPE (23)

PREPARED BY RFY DATE 04/08/09

Figure B1.4-2 Example 4 Input (continued)

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
BUREAU OF INFORMATION SYSTEMS
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PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 5 of 5

FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL			FOOTING			
							HEIGHT	LENGTH	WIDTH	MIN THK	MAX THK	WIDTH	LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59
D	3.00				0.25	10.00	11.00	7.67	2.50	2.00	.	0.00	0.00

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP				BOTTOM			
			LONG BAR		TRANS BAR		LONG BAR		TRANS BAR	
			SIZE	SPACING	SIZE	SPACING	SIZE	SPACING	SIZE	SPACING
1	3	7	11	13	17	19	23	25	29	31
	.	.		.		.		.		.

PREPARED BY ....RFY.........................

DATE 04 / 08 / 09

SHEET .5..OF..5..

Figure B1.4-2 Example 4 Input (continued)

B1.5 EXAMPLE 5

Example 5 is a four post four-chord structure with a height of 12.0 feet and a span length of 100.0 feet as shown in Figure B1.5-1 below.

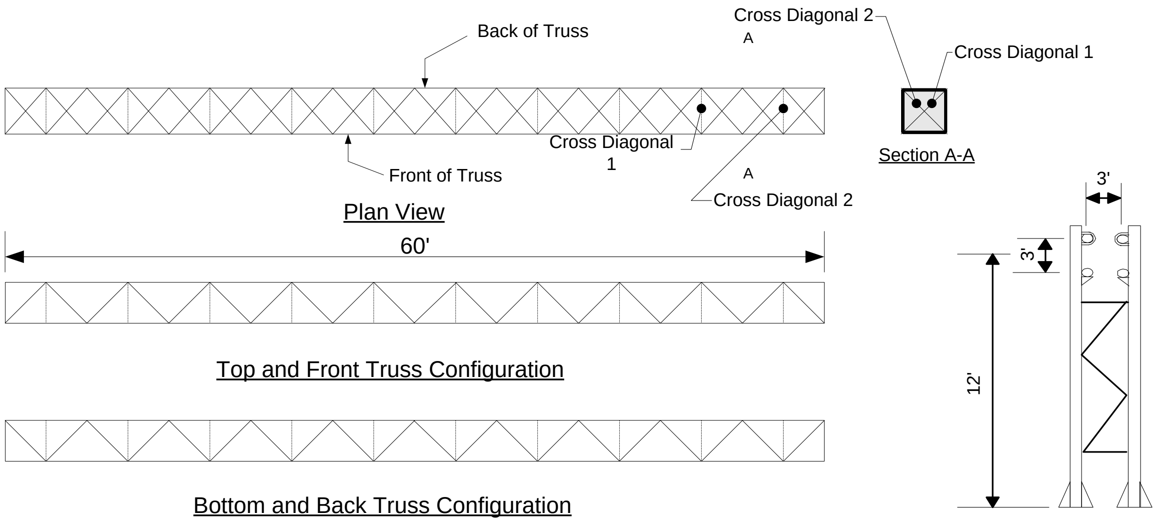

Figure B1.5-1 Example 5 Sketch

Completed input forms for this example are shown on the following pages.

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
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SIGN STRUCTURE ANALYSIS

Form 1 of 5

PROBLEM IDENTIFICATION
* EXAMPLE 5 - 4-POST 4-CHORD
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53
5	1200	10000	1	26	400	000	110		14	N	2		0			

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71
1850	2000	5800	1.141											

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11
000	6741	2.604

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DATE 04/08/09

SHEET 1 OF 5

Figure B1.5-2 Example 5 Input

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
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Form 2 of 5

PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION					SECTION Fy	PANEL NUMBER
		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5		
1	7	10	16	22	28	34	40	42
POST	P	10.75	0.365				36	
CHORD	P	6.625	0.280				36	008
CHORD	P	6.625	0.280				36	018
CHORD	P	6.625	0.280				36	026
PXBRAC	ST	2.00	3.85	1.00			36	
FVERT	P	2.875	0.203				36	
TVERT	P	2.875	0.203				36	
BVERT	P	2.875	0.203				36	
RVERT	P	2.875	0.203				36	
FDIAG	P	2.875	0.203				36	
TDIAG	P	2.875	0.203				36	
BDIAG	P	2.875	0.203				36	
RDIAG	P	2.875	0.203				36	
TXBRAC	P	2.875	0.203				36	

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Figure B1.5-2 Example 5 Input (continued)

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SIGN STRUCTURE ANALYSIS

BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3
1	08
2	18

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13
0875	2500		

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES: SIGN 1	NUMBER OF LUMINAIRES: SIGN 2	NUMBER OF LUMINAIRES: SIGN 3	LUMINAIRE: OFFSET	LUMINAIRE: WEIGHT	LUMINAIRE: NORMAL AREA	LUMINAIRE: ICE AREA	LUMINAIRE: TRUCK-GUST AREA	CATWALK: WEIGHT	CATWALK: NORMAL AREA	CATWALK: ICE AREA	CATWALK: TRUCK-GUST AREA	IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71
250			-01			7 . 06	40000	9 . 917	5500		545	115	1471	059	2			

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Figure B1.5-2 Example 5 Input (continued)

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SIGN STRUCTURE ANALYSIS

FATIGUE DETAILS

DETAIL NUMBER	FATIGUE CATEGORY	WEEP HOLE AREA	WIRE OUTLET AREA	HAND HOLE AREA	C/P/B TYPE
1	3	5	11	17	23

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Figure B1.5-2 Example 5 Input (continued)

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SIGN STRUCTURE ANALYSIS

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FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL HEIGHT	PEDESTAL LENGTH	PEDESTAL WIDTH	FOOTING MIN THK	FOOTING MAX THK	FOOTING WIDTH	FOOTING LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59
D	3.00				0.25	10.00	11.00	9.75	2.75	2.00		0.00	0.00

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP LONG BAR SIZE	TOP LONG BAR SPACING	TOP TRANS BAR SIZE	TOP TRANS BAR SPACING	BOTTOM LONG BAR SIZE	BOTTOM LONG BAR SPACING	BOTTOM TRANS BAR SIZE	BOTTOM TRANS BAR SPACING
1	3	7	11	13	17	19	23	25	29	31

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DATE 04 / 08 / 09

SHEET .5..OF..5..

Figure B1.5-2 Example 5 Input (continued)

B1.6 EXAMPLE 6

Example 6 is a cantilever structure with a height of 12.0 feet and a cantilever length of 8'-2" as shown in Figure B1.6-1 below.

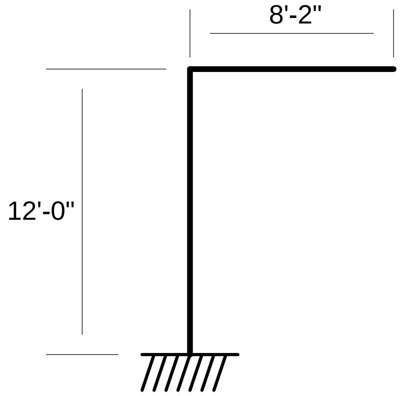

Figure B1.6-1 Example 6 Sketch

Completed input forms for this example are shown on the following pages.

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PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

Form 1 of 5

PROBLEM IDENTIFICATION

* EXAMPLE 6 - CANTILEVER
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53
6	1 2 0 0	8 . 1 6 7	1		0 0 0	0 0 0	1 1 0		2				0			

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71
1 2 0 0	1 0 0 0	4 0 0	1 3 6											

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11

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Figure B1.6-2 Example 6 Input

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PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION					SECTION Fy	PANEL NUMBER
		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5		
1	7	10	16	22	28	34	40	42
POST	P	1075	0..365				36	
CHORD	P	6..625	0..365				36	

PREPARED BY RFY DATE 04/08/09 SHEET 2 OF 5

Figure B1.6-2 Example 6 Input (continued)

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SIGN STRUCTURE ANALYSIS

Form 3 of 5

BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES			LUMINAIRE					CATWALK				IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
			SIGN 1	SIGN 2	SIGN 3	OFFSET	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA				
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71
310			-01			2.88	40000	9.917	5500						2			

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Figure B1.6-2 Example 6 Input (continued)

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SIGN STRUCTURE ANALYSIS

FATIGUE DETAILS

DETAIL NUMBER	FATIGUE CATEGORY	WEEP HOLE AREA	WIRE OUTLET AREA	HAND HOLE AREA	C/P/B TYPE
1	3	5	11	17	23

PREPARED BY ....RFY.......................... DATE .04/.08/.09. SHEET .4..OF.5..

Figure B1.6-2 Example 6 Input (continued)

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SIGN STRUCTURE ANALYSIS

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FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL			FOOTING			
							HEIGHT	LENGTH	WIDTH	MIN THK	MAX THK	WIDTH	LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59
D	3.00				0.25	10.00	11.00	2.17	2.17	2.00	.	0.00	0.00

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP				BOTTOM			
			LONG BAR		TRANS BAR		LONG BAR		TRANS BAR	
			SIZE	SPACING	SIZE	SPACING	SIZE	SPACING	SIZE	SPACING
1	3	7	11	13	17	19	23	25	29	31
	.	.		.		.		.		.

PREPARED BY ....RFY..........

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Figure B1.6-2 Example 6 Input (continued)

B1.6a EXAMPLE 6a

Example 6a is a cantilever structure supporting a variable message sign (VMS). The structure height is 20’-6” with a cantilever length of 8'-2" as shown in Figure B1.6a-1 below.

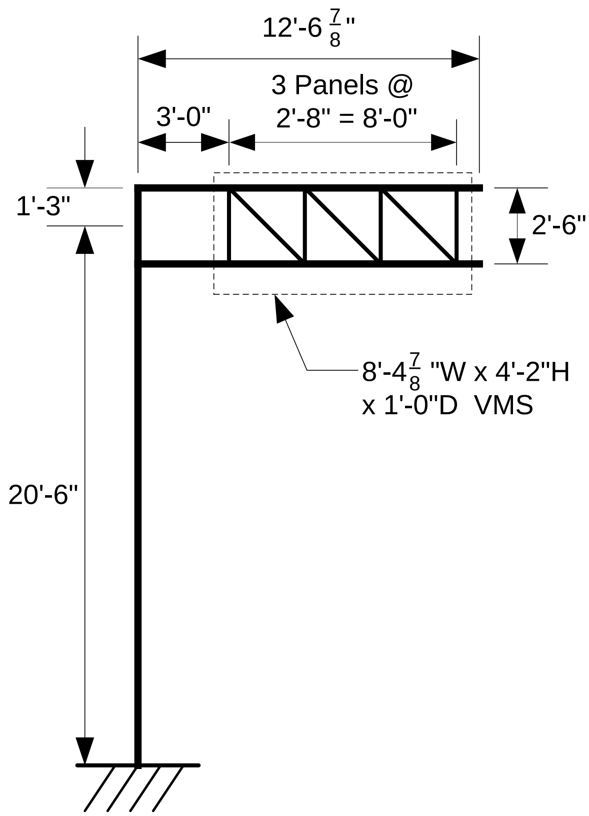

Figure B1.6a-1 Example 6a Sketch

Completed input forms for this example are shown on the following pages.

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SIGN STRUCTURE ANALYSIS

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PROBLEM IDENTIFICATION

* EXAMPLE 6A - VMS CANTILEVER
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53
6	2050	1257	1	3	250				4	E		010	0		Y	2667

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71
4..167	35..03	767	1..508	8..406										

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11

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Figure B1.6a-2 Example 6 Input

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SIGN STRUCTURE ANALYSIS

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION					SECTION Fy	PANEL NUMBER
		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5		
1	7	10	16	22	28	34	40	42
POST	P	1600	0.375				36	
CHORD	P	6.625	0.280				36	
FVERT	P	2.375	0.218				36	
FDIAG	P	2.375	0.154				36	

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Figure B1.6a-2 Example 6 Input (continued)

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SIGN STRUCTURE ANALYSIS

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BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13
0.875	2.687	08	2.000

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES			LUMINAIRE					CATWALK				IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
			SIGN 1	SIGN 2	SIGN 3	OFFSET	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA				
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71
15.0	31.40														1			

PREPARED BY ......RFY.............................. DATE 04/08/09. SHEET 3..OF 5..

Figure B1.6a-2 Example 6 Input (continued)

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SIGN STRUCTURE ANALYSIS

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FATIGUE DETAILS

DETAIL NUMBER	FATIGUE CATEGORY	WEEP HOLE AREA	WIRE OUTLET AREA	HAND HOLE AREA	C/P/B TYPE
1	3	5	11	17	23
20	E			1.125	P

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Figure B1.6a-2 Example 6 Input (continued)

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SIGN STRUCTURE ANALYSIS

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FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL			FOOTING			
							HEIGHT	LENGTH	WIDTH	MIN THK	MAX THK	WIDTH	LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59
D						3.00	02.00	2.50	2.50				

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP				BOTTOM			
			LONG BAR		TRANS BAR		LONG BAR		TRANS BAR	
			SIZE	SPACING	SIZE	SPACING	SIZE	SPACING	SIZE	SPACING
1	3	7	11	13	17	19	23	25	29	31

PREPARED BY ....RFY..........................

DATE 04./08./09

SHEET .5..OF.5..

Figure B1.6a-2 Example 6 Input (continued)

B1.7 EXAMPLE 7

Example 7 is a centermount structure with a height of 12.0 feet and a cantilever length of 6.0 feet on each side as shown in Figure B1.7-1 below.

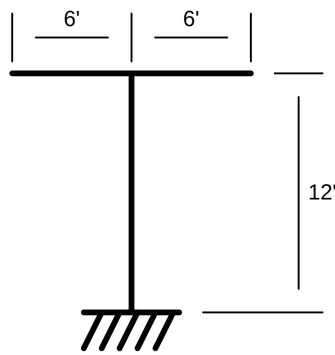

Figure B1.7-1 Example 7 Sketch

Completed input forms for this example are shown on the following pages.

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BUREAU OF INFORMATION SYSTEMS
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PROGRAM P4367030
SIGN STRUCTURE ANALYSIS

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PROBLEM IDENTIFICATION

* EXAMPLE 7 - CENTERMOUNT
*
*

CRITERIA

MODEL TYPE	STRUCTURE HEIGHT	SPAN LENGTH	NUMBER SIGNS	NUMBER PANELS	TRUSS HEIGHT	TRUSS DEPTH	HEIGHT FACTOR	POST FIXITY	NUMBER X-SECTIONS	N or E	SPLICES	NUMEER OF DETAILS	OUTPUT	RIGHT STRUT	VMS	PANEL LENGTH
1	2	8	15	18	21	27	33	37	38	41	42	43	45	46	52	53
7	1200	600	1		000	000	110		2				0	600		

SIGN DESCRIPTION

SIGN 1					SIGN 2					SIGN 3				
HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA	HEIGHT	AREA	LOCATION	OFFSET	HORIZ PROJ AREA
1	6	11	16	21	26	31	36	41	46	51	56	61	66	71
833	1000	600	0127											

CATWALK DESCRIPTION

CATWALK		
LOCATION	LENGTH	OFFSET
1	6	11

PREPARED BY ......RFY..............................

DATE .04/08/09.

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Figure B1.7-2 Example 7 Input

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SIGN STRUCTURE ANALYSIS

CROSS SECTION DEFINITION

SECTION LOCATION	SECTION TYPE	SECTION DESCRIPTION					SECTION Fy	PANEL NUMBER
		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5		
1	7	10	16	22	28	34	40	42
POST	P	10.75	0..3.65	.	.	.	36	
CHORD	P	4.50	0..2.37	.	.	.	36	
		.	.	.	.	.		
		.	.	.	.	.		
		.	.	.	.	.		
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		.	.	.	.	.		
		.	.	.	.	.		

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Figure B1.7-2 Example 7 Input (continued)

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SIGN STRUCTURE ANALYSIS

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BOLTED CONNECTIONS

BOLT DIAMETER	BLT ROWS WEB	CONNECTION PLATE 1 WIDTH	CONNECTION PLATE 1 THICKNESS	BLT ROWS FLNG	CONNECTION PLATE 2 WIDTH	CONNECTION PLATE 2 THICKNESS	No. U BLTS
1	6	7	13	19	20	26	32

CHORD SPLICE ONE

SPLICE NAME	PANEL No.
1	3

CHORD SPLICE TWO

CHORD SPLICE BOLT DIAMETER	DISTANCE TO BOLT CIRCLE	No. OF BOLTS	SPLICE PLATE THICKNESS
1	6	11	13

LOADS

SIGN SUPP BEAM WT	SIGN PANEL WT	ICE LOAD	NUMBER OF LUMINAIRES			LUMINAIRE					CATWALK				IF CATGY	MEAN WIND SPEED	VEHICLE DESIGN SPEED	DESIGN WIND SPEED
			SIGN 1	SIGN 2	SIGN 3	OFFSET	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA	WEIGHT	NORMAL AREA	ICE AREA	TRUCK-GUST AREA				
1	5	9	12	15		21	25	30	35	40	44	48	53	58	62	63	67	71
310			-01			2..79	40000	9..917	5500						2			

PREPARED BY ......RFY...............................

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Figure B1.7-2 Example 7 Input (continued)

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SIGN STRUCTURE ANALYSIS

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FATIGUE DETAILS

DETAIL NUMBER	FATIGUE CATEGORY	WEEP HOLE AREA	WIRE OUTLET AREA	HAND HOLE AREA	C/P/B TYPE
1	3	5	11	17	23

PREPARED BY RFY DATE 04/08/09 SHEET 4 OF 5

Figure B1.7-2 Example 7 Input (continued)

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SIGN STRUCTURE ANALYSIS

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FOOTING

A or D	BEARING PRESSURE	CONC F'c	CONCRETE DENSITY	FILL DENSITY	COEFF FRICTION	FILL HEIGHT	PEDESTAL HEIGHT	PEDESTAL LENGTH	PEDESTAL WIDTH	FOOTING MIN THK	FOOTING MAX THK	FOOTING WIDTH	FOOTING LENGTH
1	2	7	12	16	20	24	29	34	39	44	49	54	59
D	30.0				0.25	10.00	11.00	2.17	2.17	2.00	.	0.00	0.00

REBAR

REBAR GRADE	COVER TOP	COVER BOTTOM	TOP LONG BAR SIZE	TOP LONG BAR SPACING	TOP TRANS BAR SIZE	TOP TRANS BAR SPACING	BOTTOM LONG BAR SIZE	BOTTOM LONG BAR SPACING	BOTTOM TRANS BAR SIZE	BOTTOM TRANS BAR SPACING
1	3	7	11	13	17	19	23	25	29	31
	.	.		.		.		.		.

PREPARED BY ......REY...... DATE 04 / 08 / 09 SHEET 5 OF 5

Figure B1.7-2 Example 7 Input (continued)

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