AASHTOWare BrR 6.8

Truss Tutorial

T5 - Truss Enhancements

BrR Training

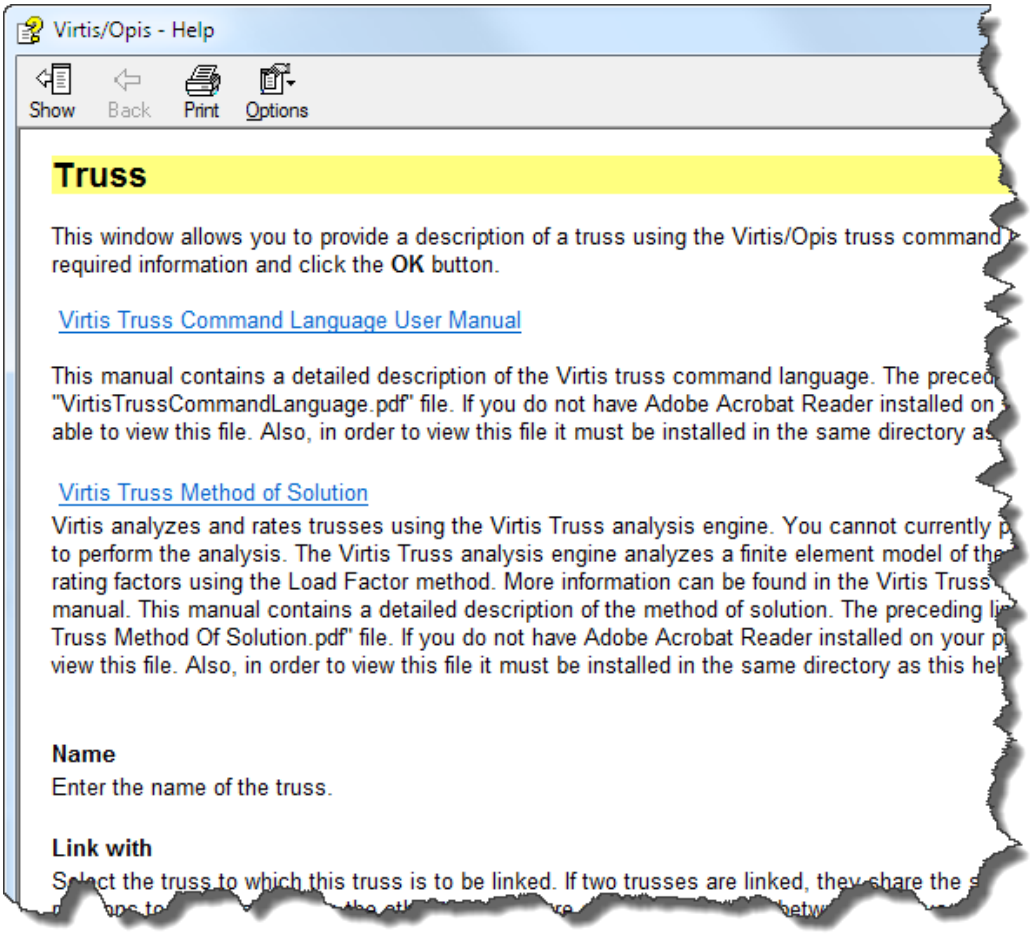
T5 –Truss Enhancements

Topics Covered

Longitudinal Truss - Counters, Member eccentricity, Suspended span and Deck-through configuration
Floor truss - Element loads and Interaction Rating for Axial and Bending

Truss Manuals

The AASHTO Truss Command Language User Manual and AASHTO Truss Method of Solution Manual can be accessed through the F1 Help of the Truss window. Please refer to these two manuals during the examples if needed. The Truss Method of Solution Manual is also available from the Help menu after the Bridge Workspace is opened.

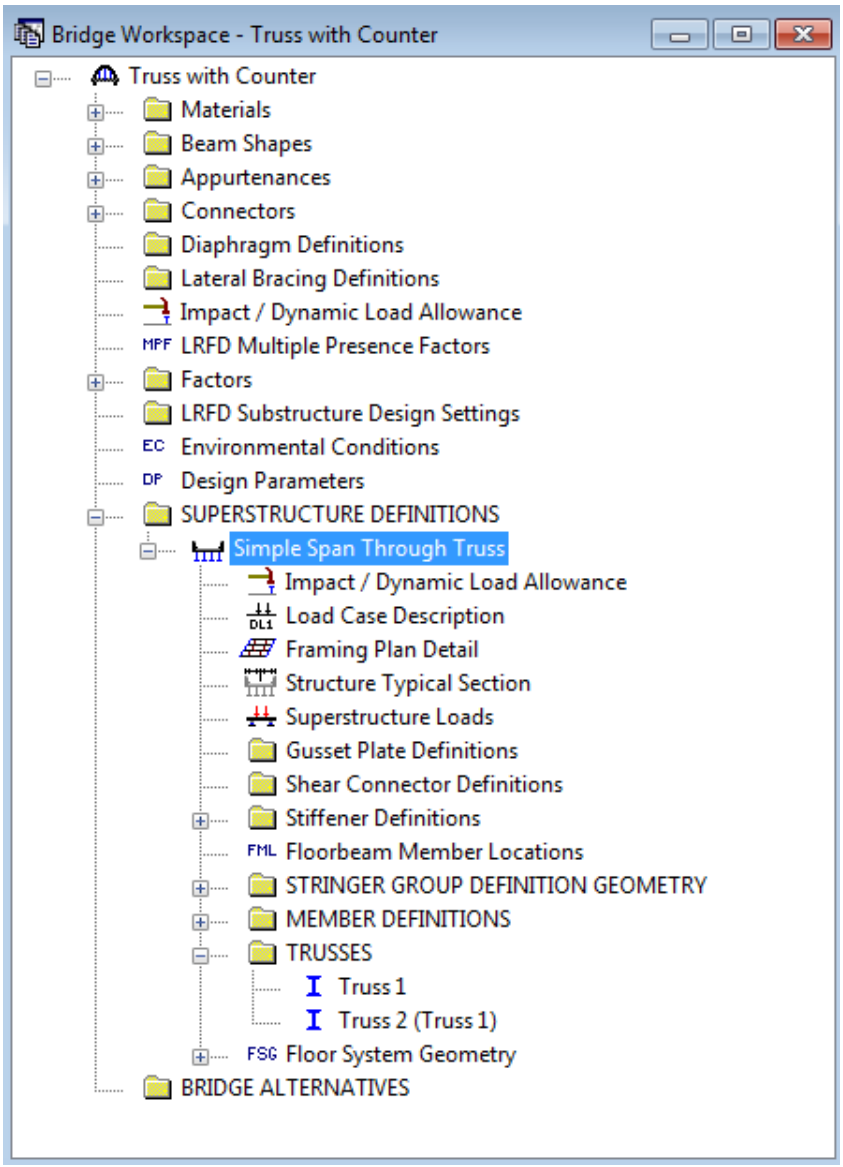


Longitudinal Truss - Counters and Member eccentricity

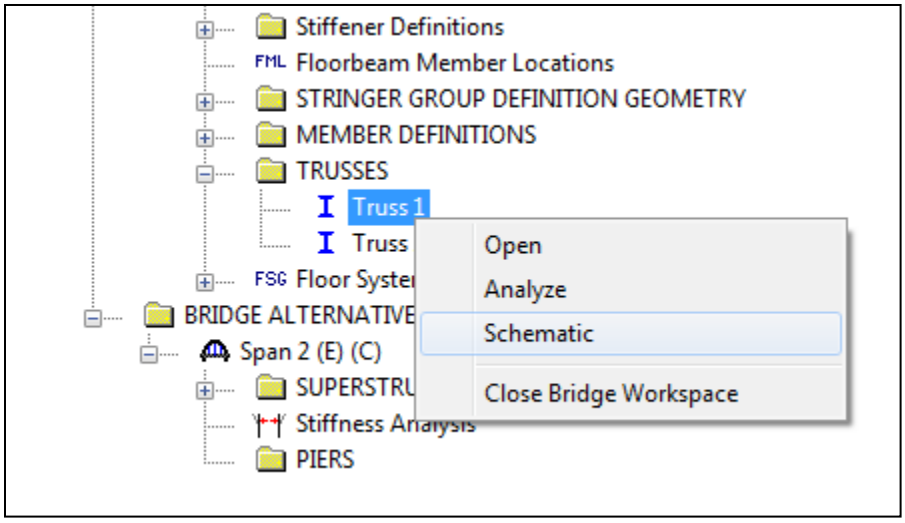
In this example, we will modify the simple span through truss in the *T5 – Truss Enhancements with Counter.xml* bridge file. We will specify counters for the diagonal members in the center panel and enter eccentricity for the upper and lower chord members in the center panel.

In the Bridge Explorer, import the *T5 - Truss Enhancements with Counter.xml* bridge file and open the Bridge Workspace. Expand the workspace tree until Truss 1 is visible.

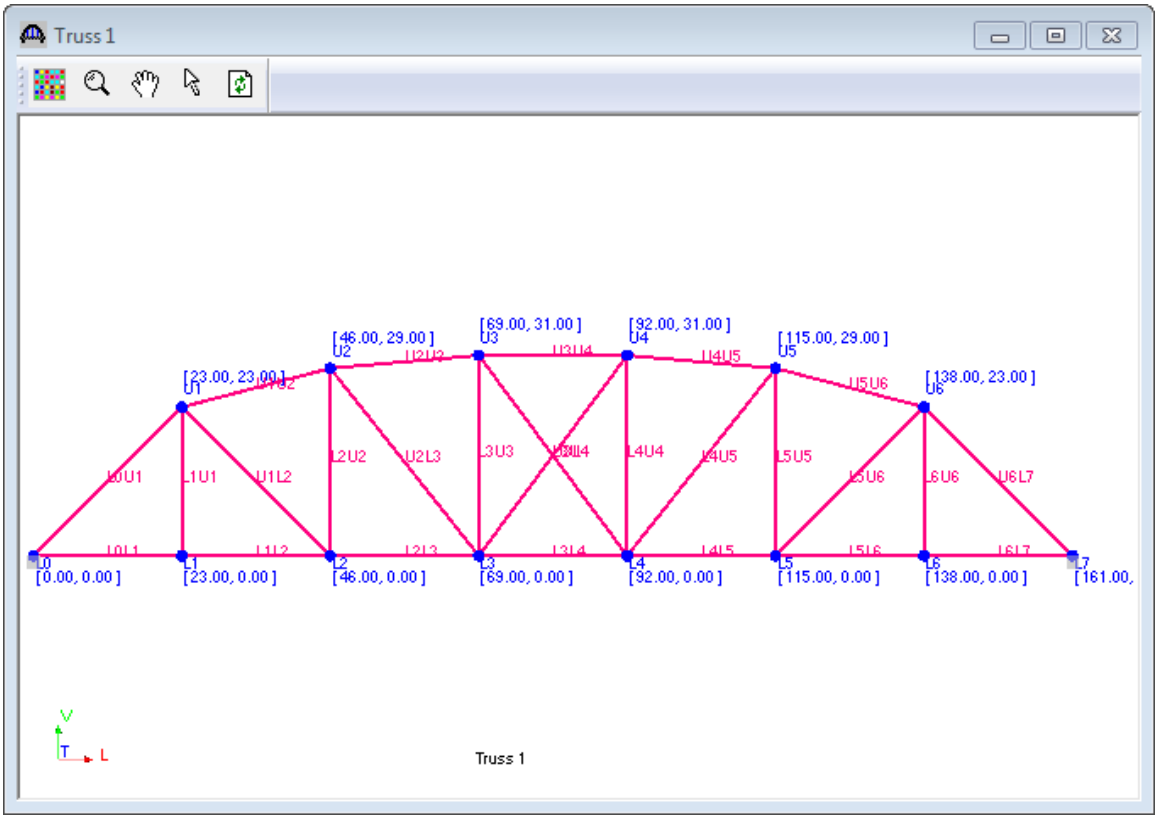
The Bridge Workspace of the Truss with Counter is shown below.



Next right-click Truss 1 in the tree and select Schematic.



The truss schematic is shown below. We are going to specify counters for the diagonal members in the center panel (U3L4 and L3U4) and enter eccentricity for the upper and lower chord members (U3U4 and L3L4) in the center panel.



Counter is tension-only member and is specified using the Member command. To specify a member is a counter, enter the word **Counter** after the cross section name of that member. The word **Counter** is an optional entry in the Member command. All tension-only members in a truss should be specified as **Counter.**

6.12 Member Command

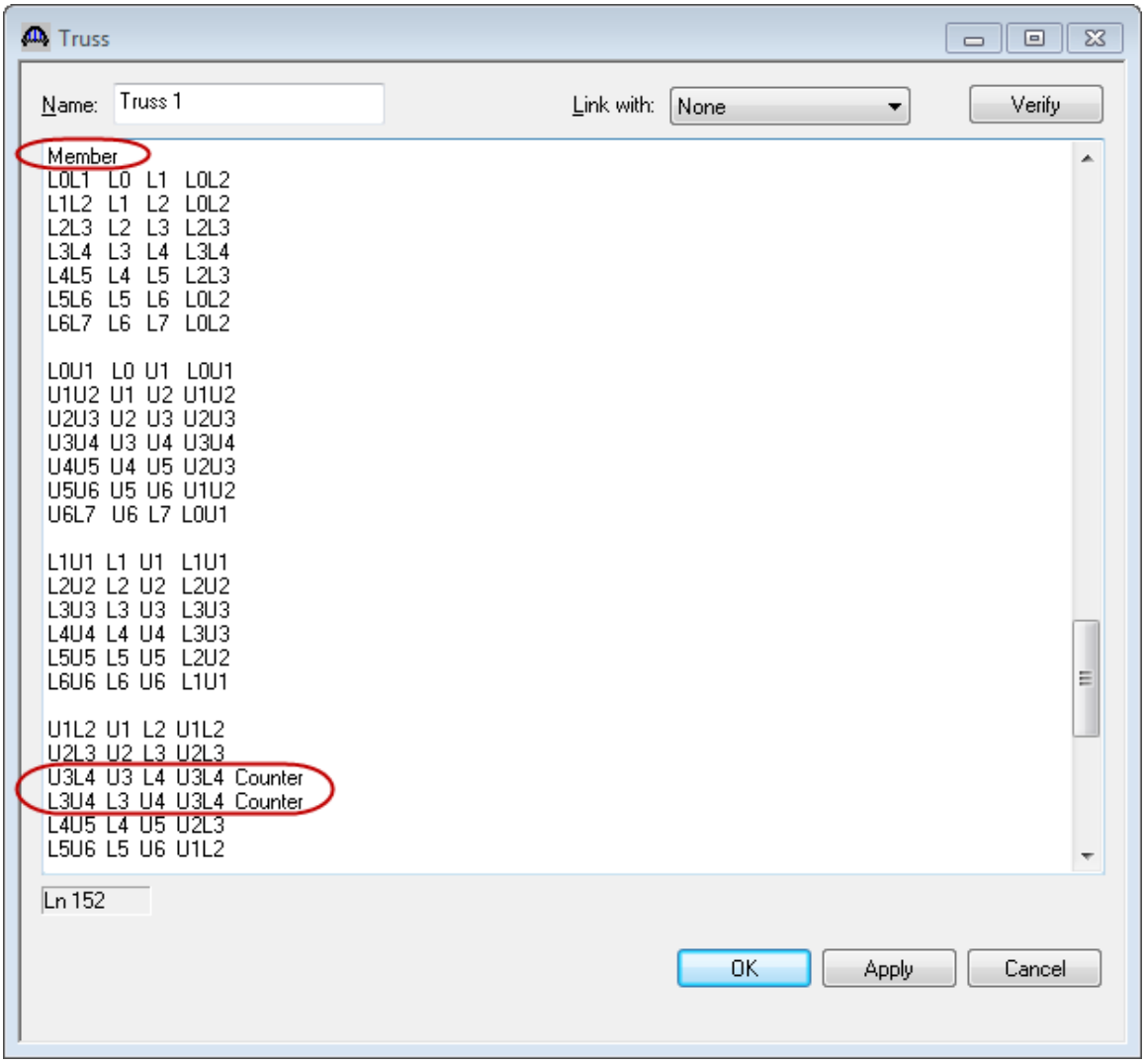
Use this command to describe the truss member connectivity, end connection type , cross section type , k values, unbraced lengths and whether or not a member is a counter.

	Command
Command	**Member** (<member_name> <panel_point_name> <panel_point_name><cross_section_name> <counter><end_connection_type‡><member_k_value‡><z_unbraced_length‡> <y_unbraced_length‡>)*
Description	<member_name> = Enter your choice of name for member. <panel_point_name> = Enter panel point name from records in command 11. <panel_point_name>= Enter panel point name from records in command 11. <cross_section_name> = Choose among the cross section declared in command 9. <counter> = **Counter** <end_connection_type> = **Pinned** | **Riveted** | **Bolted** | **Welded** | **UserDefined** <member_k_value> = Enter k value. <z_unbraced_length> = Enter z unbraced length value. <y_unbraced_length> = Enter y unbraced length value.

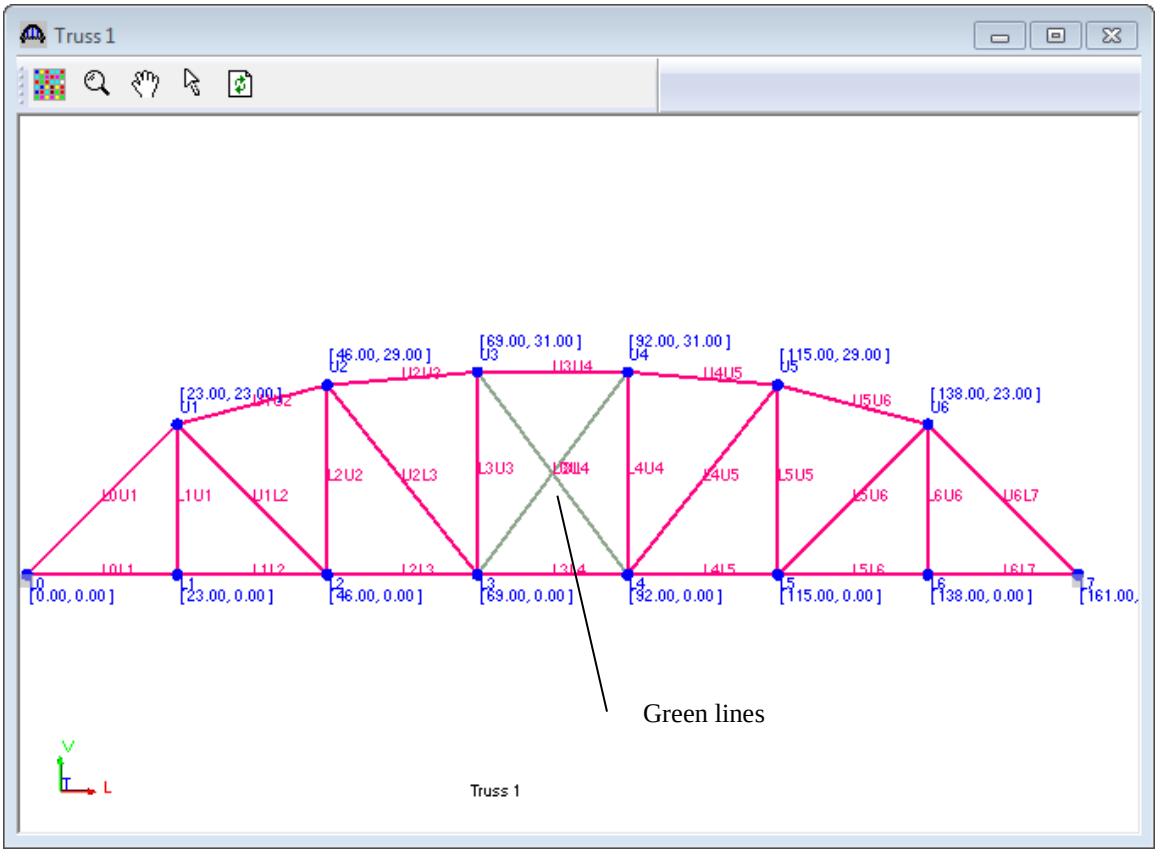
Double-click Truss 1 in the tree to open the Truss window. Scroll down to the Member command and enter the word **Counter** for U3L4 and L3U4. Click OK to save the changes to the memory and close the window.

Counters introduce nonlinearity since the structural model changes as the live load moves across the truss. The analysis cannot use superposition of DL and LL or influence lines for computing LL effects. As a result, it is necessary to move the live load vehicle across the truss and generate a load case for each vehicle position. Each load case must include the factored dead load and the factored live load for a vehicle position.

The nonlinear analysis iterates for a solution for each load case by removing counters that are in compression and including counters that are in tension for the combined factored DL + LL load case. The results of the nonlinear analysis are scanned to determine the critical loading for each truss element. Another factored DL-only analysis is necessary for use in the rating equation. The factored LL for the rating equation is computed by subtracting the factored DL for each truss element from the critical loading for the element.



Right-click Truss 1 in the tree and select Schematic. The truss schematic is shown below. The counters in the center panel (U3L4 and L3U4) are colored in green and all other members are colored in red.



In-plane member eccentricity at connection is entered using the MemberEccen command. The MemberEccen command is an optional command entered after the Member command.

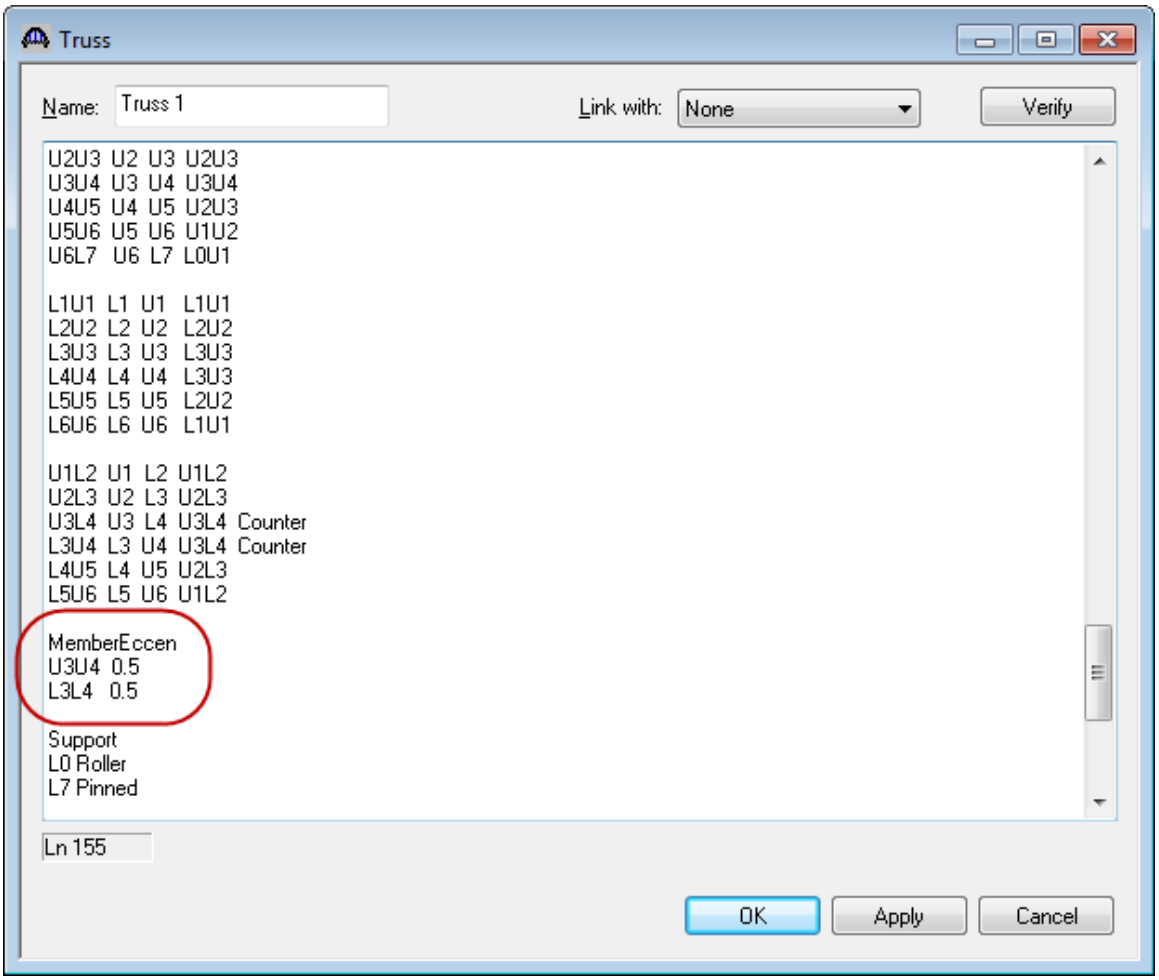
6.13 MemberEccen Command

Use this command to describe the eccentricity of truss members. The eccentricity of a truss member is in the truss main plane. No out-of-plane eccentricity will be considered.

	Command
Command	**MemberEccen** (<member_name> <eccentricity>)*
Description	<member_name> = Enter the name of an eccentric member. < eccentricity > = Enter the eccentricity. **Note**: 1. The unit of eccentricity is the same as that specified by **Properties** command.

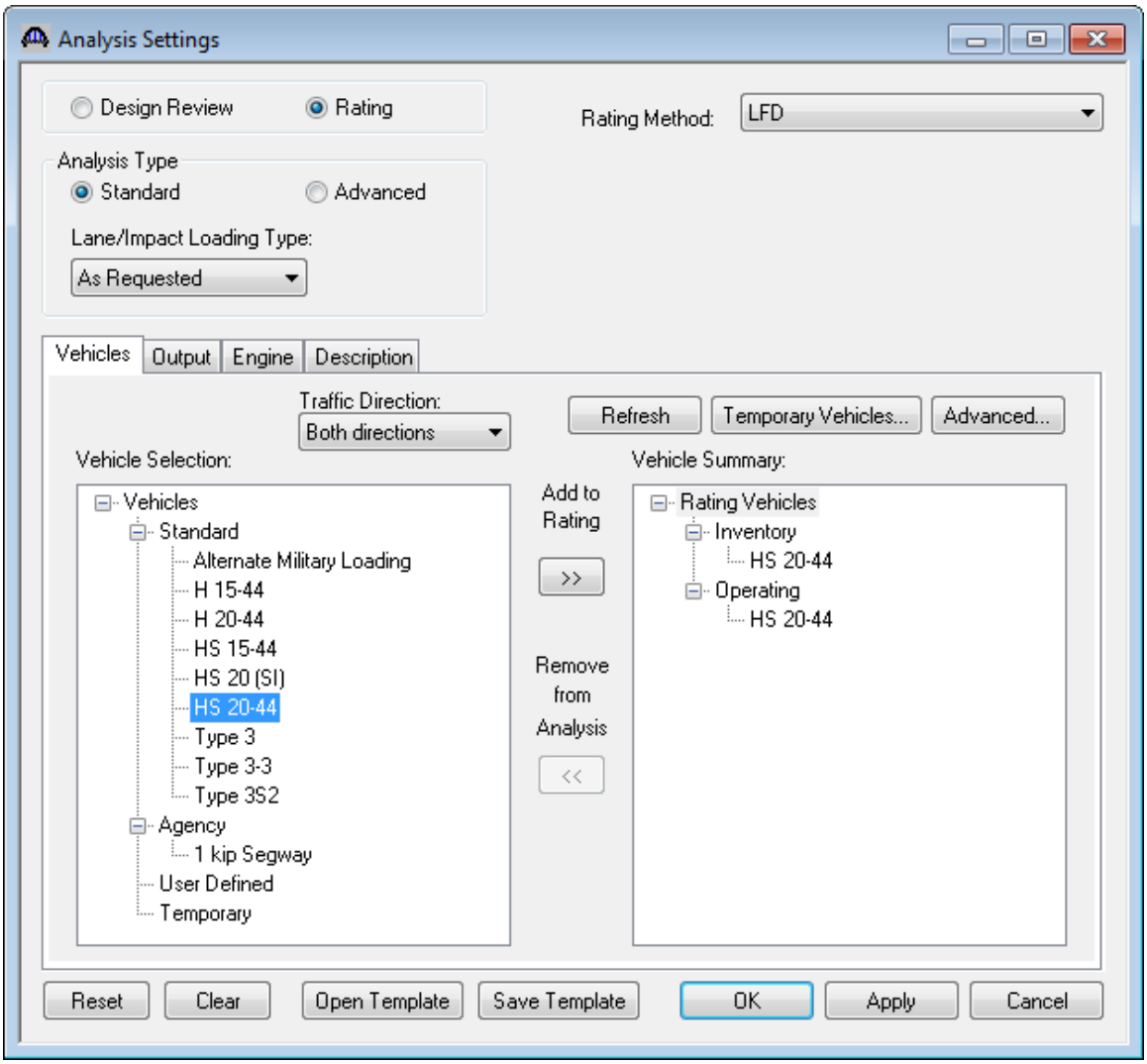
Double-click Truss 1 in the tree to open the Truss window. Scroll down to after the Member command and before the Support command. Enter 0.5 in eccentricity for U3U4 and L3L4. Click OK to save the changes to the memory and close the window.

The eccentricity is only applied to the rating by considering the axial force in the member to be acting at the user-specified eccentricity thus causing a moment M = P x e about the axis perpendicular to the plane of the truss. The eccentricity is not considered in the structural analysis and secondary effects are not considered. Load ratings for eccentric members of a longitudinal truss are computed using the Secant Formula Method in the Load and Resistance Factor Rating method.

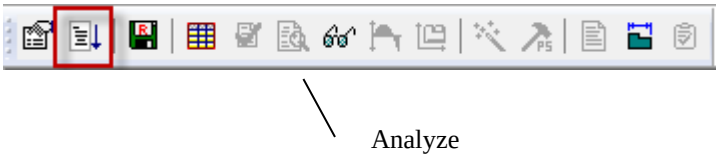


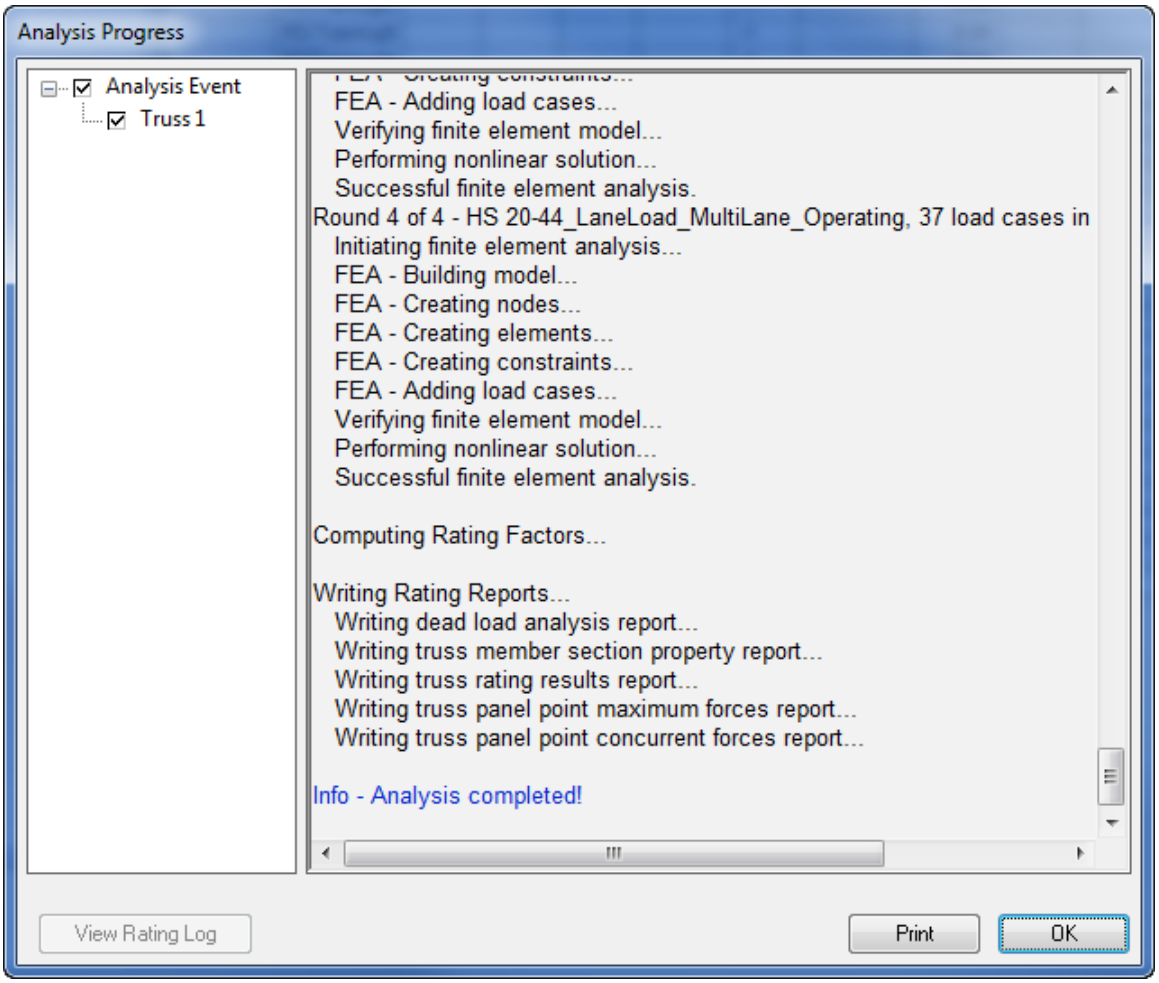
Click View Analysis Settings in the Bridge Workspace toolbar to open the Analysis Settings window. Select HS 20-44 as the vehicle to be used in the rating. Click OK to save the analysis settings to memory.

View Analysis Settings



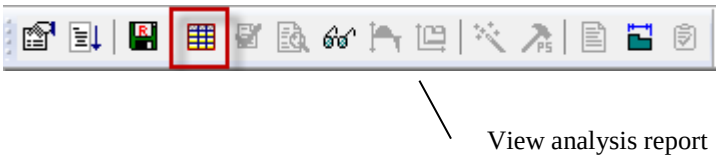
Select Truss 1 in the tree. Click Analyze in the Bridge Workspace toolbar to start the analysis. The Analysis Progress window will open.



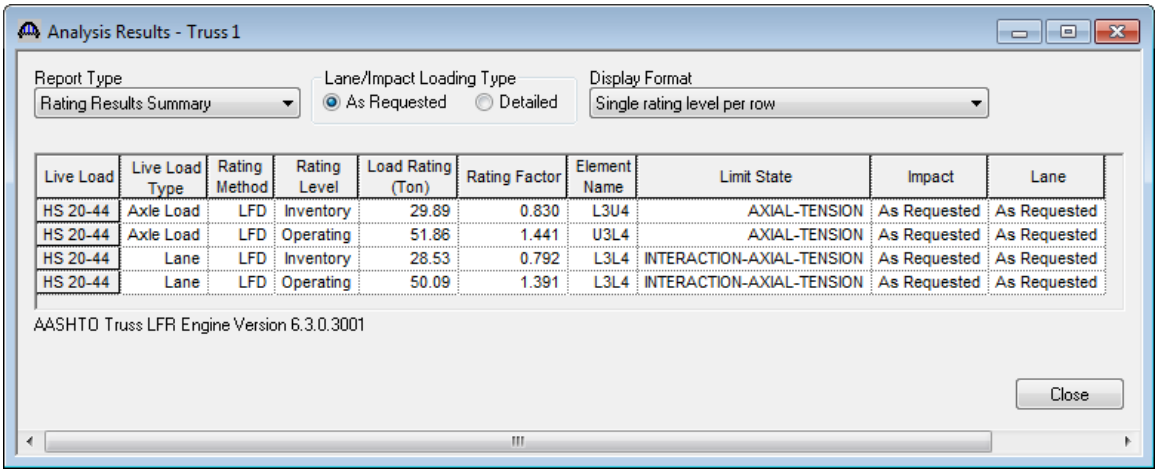


The Analysis Progress window indicates the analysis is successfully completed. Scroll up to the Live Load Analysis in the progress. The HS 20-44 vehicle is analyzed for the truck component and the lane component. Each vehicle component is analyzed four times, each time is a combination of one lane/multi-lane loaded and inventory/operating rating. Click OK to close the Analysis Progress window.

Click View analysis report in the Bridge Workspace toolbar to open the Analysis Results window.



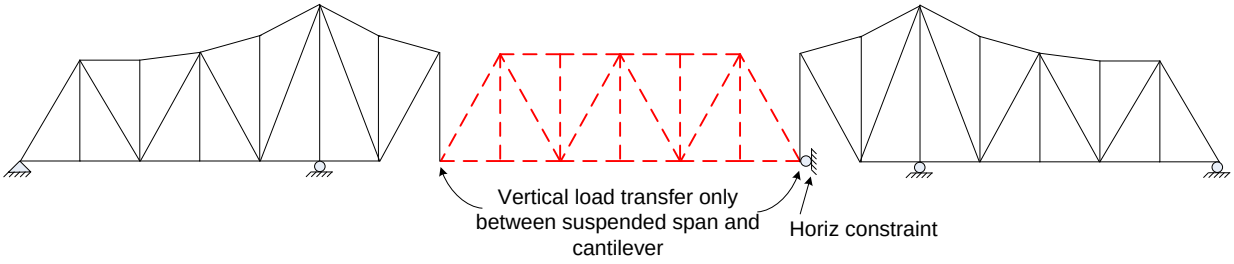
The Rating Results Summary of Truss 1 is shown below.



Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Element Name	Limit State	Impact	Lane
HS 20-44	Axle Load	LFD	Inventory	29.89	0.830	L3U4	AXIAL-TENSION	As Requested	As Requested
HS 20-44	Axle Load	LFD	Operating	51.86	1.441	U3L4	AXIAL-TENSION	As Requested	As Requested
HS 20-44	Lane	LFD	Inventory	28.53	0.792	L3L4	INTERACTION-AXIAL-TENSION	As Requested	As Requested
HS 20-44	Lane	LFD	Operating	50.09	1.391	L3L4	INTERACTION-AXIAL-TENSION	As Requested	As Requested

Longitudinal Truss - Suspended span

In this example, we will model a truss bridge with a suspended span. The following shows the model with two anchor and cantilever spans and a suspended span (dashed lines). It shows two top chord and two bottom chord elements are removed from the model and a horizontal constraint is provided to eliminate instability in the model. No horizontal forces are transferred between the suspended span and the cantilevers.



Description of example truss bridge (*T5 - Truss Enhancements Suspended Truss Bridge.xml* bridge file)

1. Figure 1 shows the schematic of the example truss bridge. The span layout is 110 ft, 154 ft and 110 ft. The suspended span length is 88 ft.

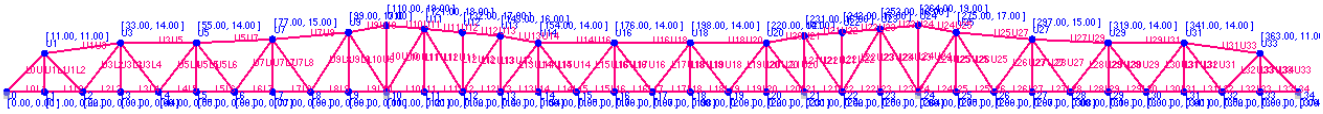


Figure 1

2. Figure 2 shows the schematic of the suspended span, which is from member L13U13 to L21U21.

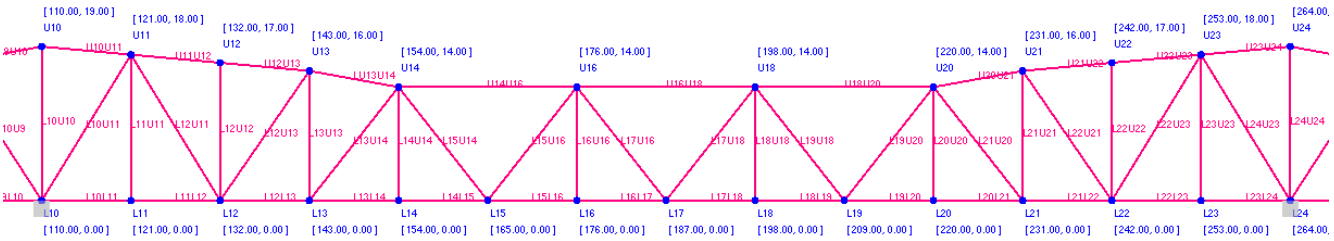


Figure 2

3. The suspended span is supported by the tension members L13U13 and L21U21. Chord members L12L13, U13U14, L21L22 and U20U21 are built as false member to release axial displacements for simulating hinges.

Steps to model the suspended span (Follow the steps with the *T5 - Truss Enhancements Suspended Truss Bridge.xml* bridge file)

1. Remove the false members L12L13, U13U14, L21L22 and U20U21 from the model.

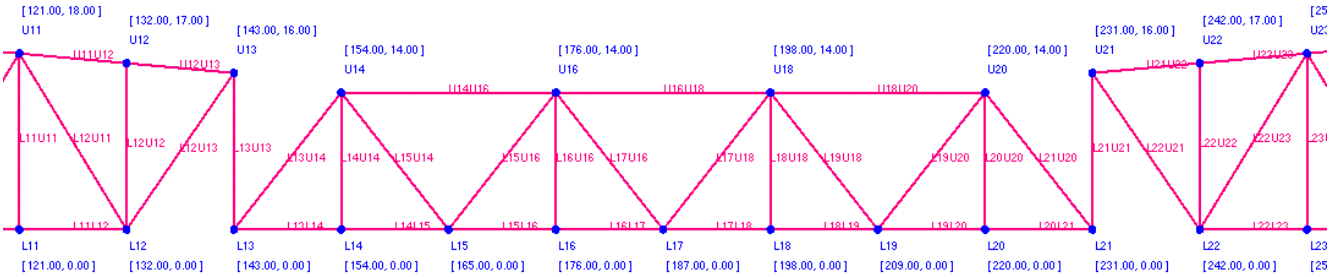


Figure 3

2. Use the Support Command to set left and right anchor spans as simple support spans.

   Support
   L0 Pinned
   L10 Roller
   L24 Roller
   L34 Pinned

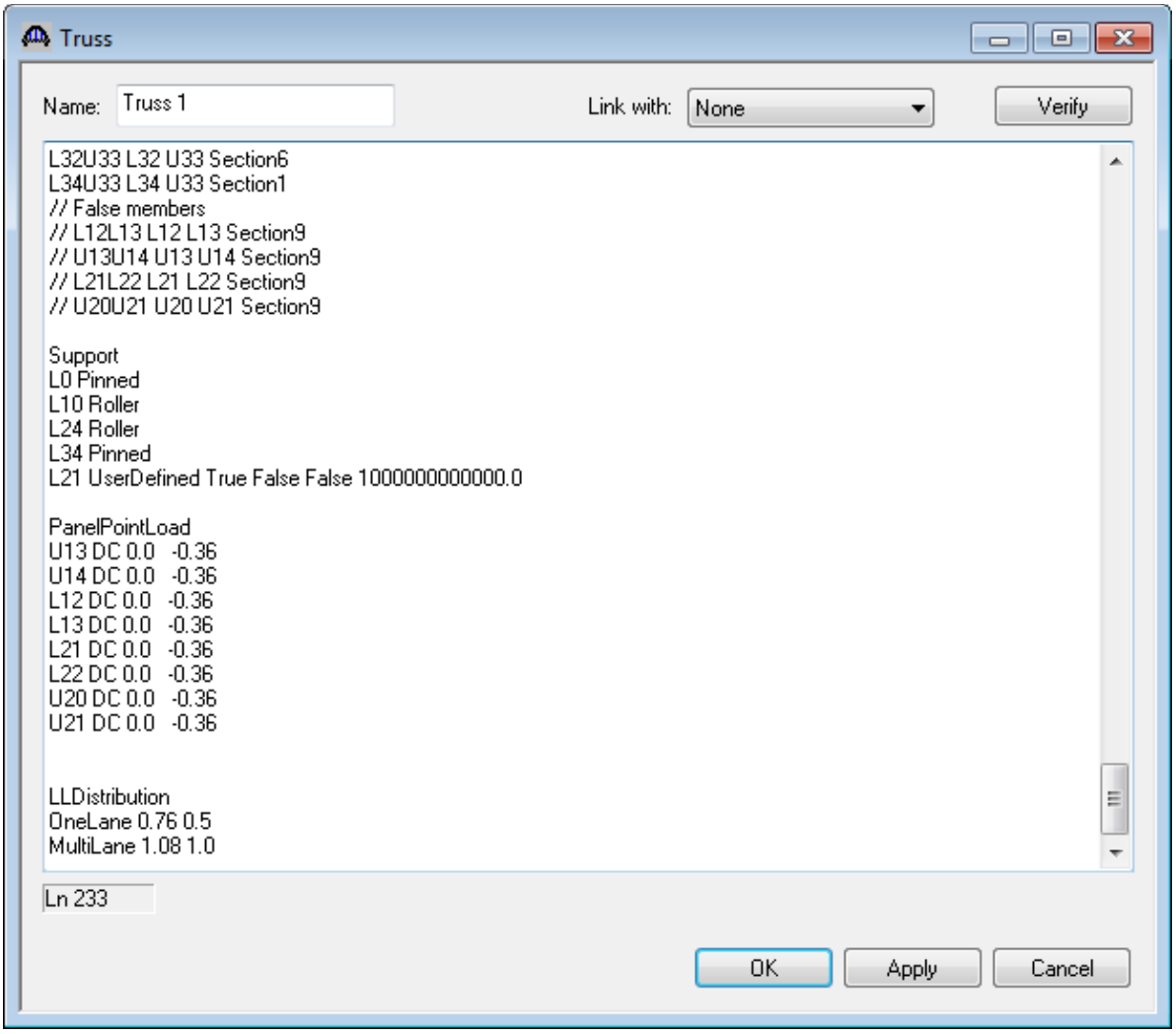
3. Use the UserDefined Support Command to add the horizontal restraint at L21 for providing horizontal stability to the suspended span. L13U13 and L21U21 will provide vertical support to the suspended span.

   Support
   L0 Pinned
   L10 Roller
   L24 Roller
   L34 Pinned
   L21 UserDefined True False False 1000000000000.0

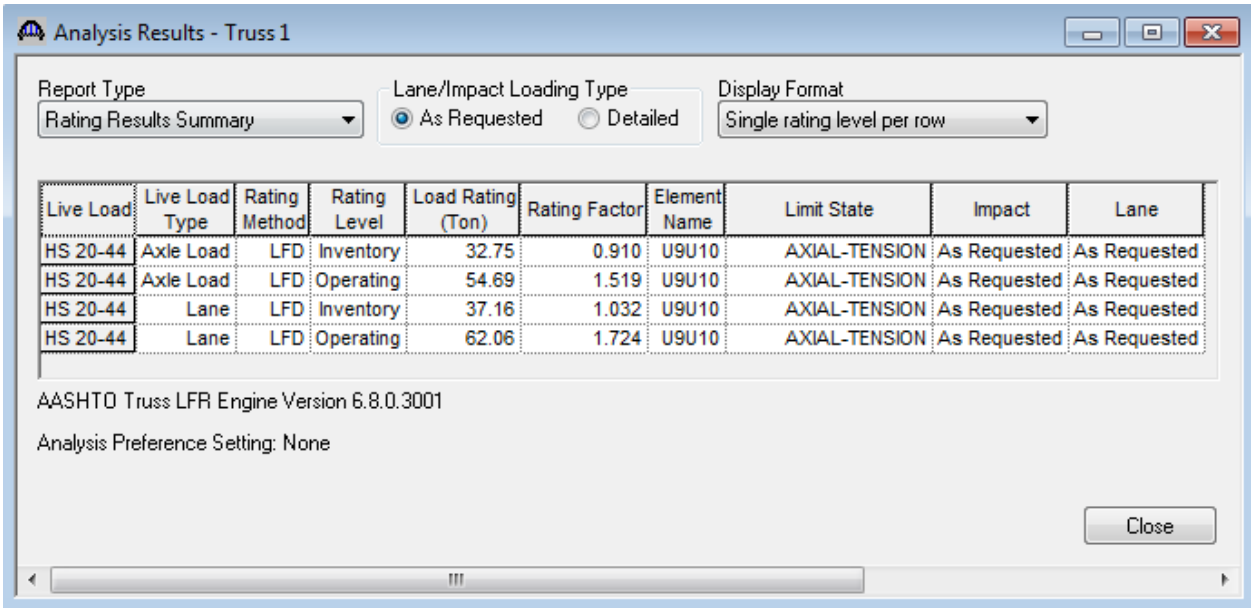
4. Use the PanelPointLoad command to add the self-weight of the false members into the model. The vertical load -0.36 kips is half of the self-weight of the false member.

   PanelPointLoad
   U13 DC 0.0 -0.36
   U14 DC 0.0 -0.36
   L12 DC 0.0 -0.36
   L13 DC 0.0 -0.36

L21	DC	0.0	-0.36
L22	DC	0.0	-0.36
U20	DC	0.0	-0.36
U21	DC	0.0	-0.36



The Rating Results Summary of Truss 1 for an HS 20-44 vehicle is shown below.

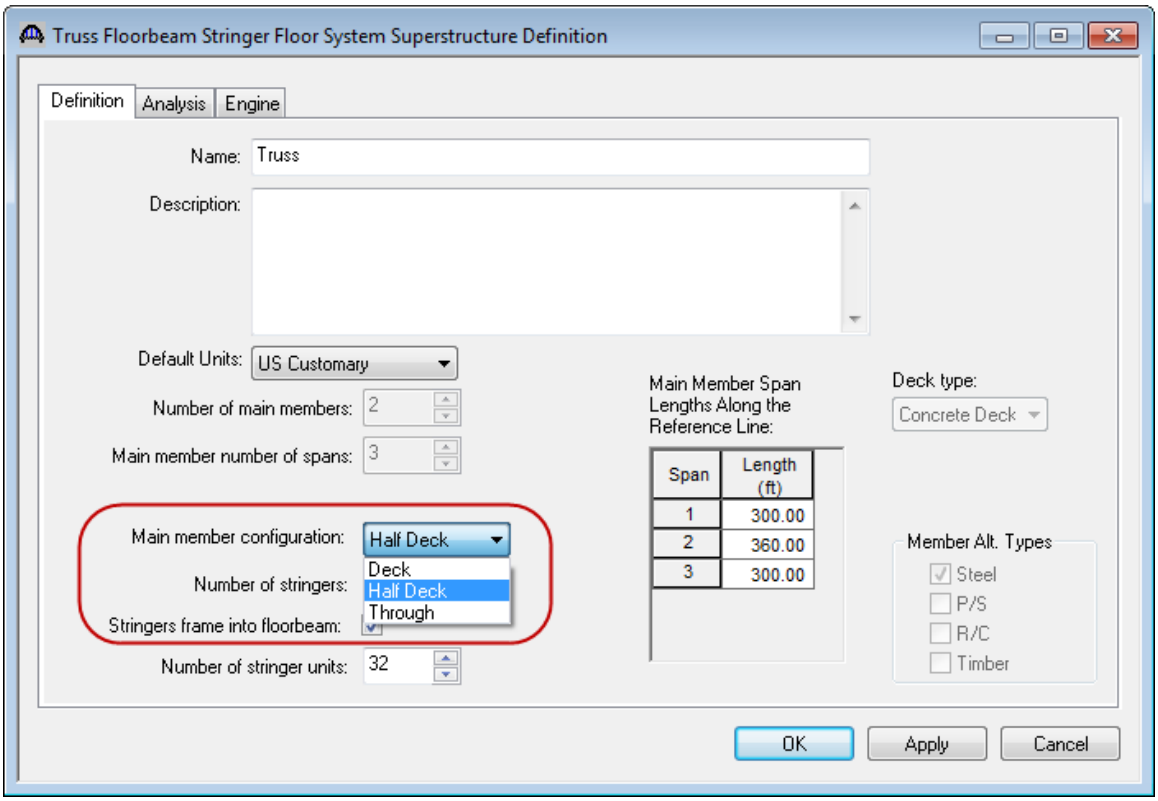


Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Element Name	Limit State	Impact	Lane
HS 20-44	Axle Load	LFD	Inventory	32.75	0.910	U9U10	AXIAL-TENSION	As Requested	As Requested
HS 20-44	Axle Load	LFD	Operating	54.69	1.519	U9U10	AXIAL-TENSION	As Requested	As Requested
HS 20-44	Lane	LFD	Inventory	37.16	1.032	U9U10	AXIAL-TENSION	As Requested	As Requested
HS 20-44	Lane	LFD	Operating	62.06	1.724	U9U10	AXIAL-TENSION	As Requested	As Requested

Longitudinal Truss - Deck-through configuration

In this example, we will go through the windows for modeling a truss with the deck-through configuration instead of the deck or through configuration.

In the Floor System Superstructure Definition window, the Half Deck selection in "Main member configuration" is used to indicate the truss has a deck-through configuration.



When Half Deck is selected in "Main member configuration", the HalfDeckLineLocations command is used to describe the panel points at the deck line locations.

6.15 HalfDeckLineLocations

Use this command to describe the panel points at the deck line locations for a deck-through truss configuration.

	Command
Command	**HalfDeckLineLocations** (<panel_point_name>)*
Description	<panel_point_name> = Enter panel point name from PanelPoint command which describes the deck line locations.

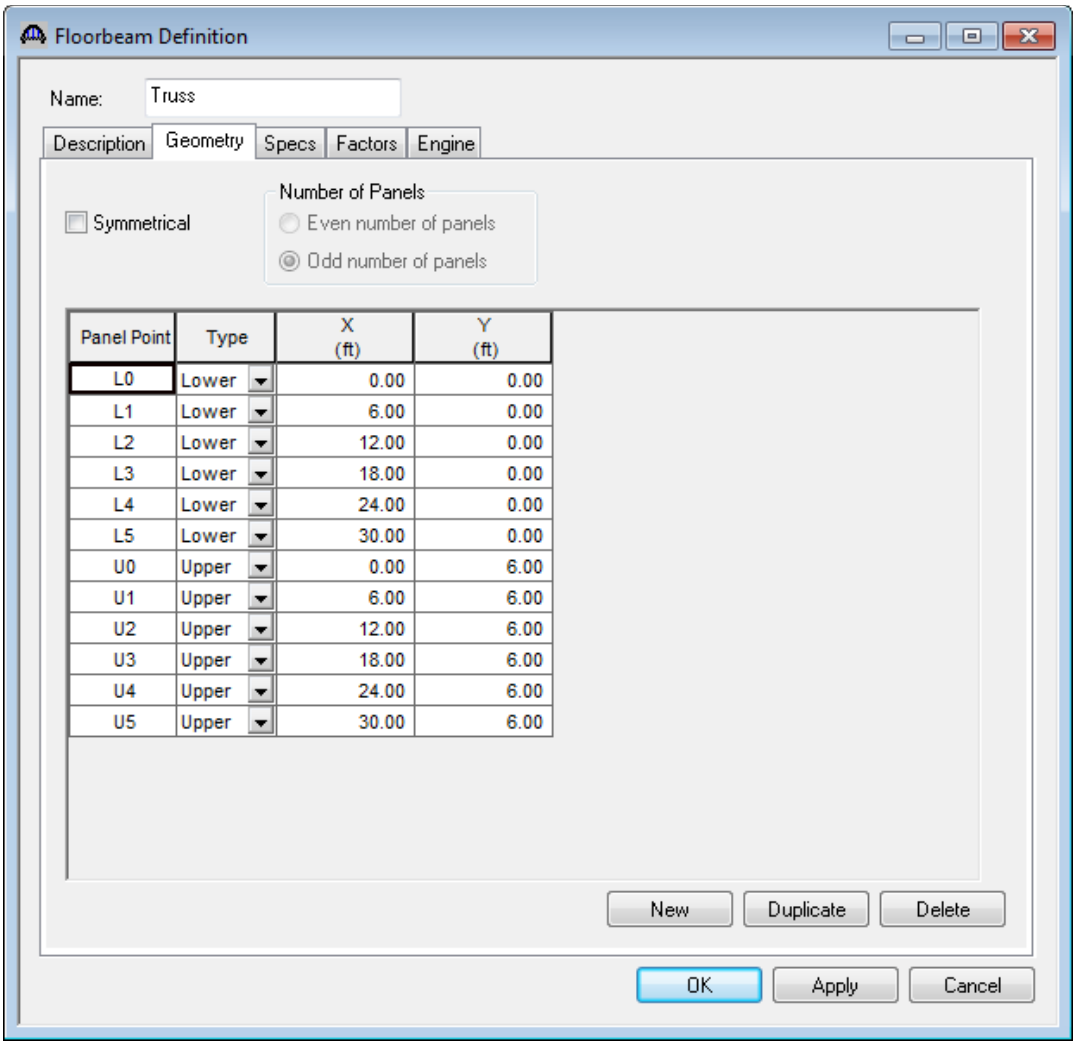
Floor truss - Element loads and Interaction Rating for Axial and Bending

In this example, we will go through the windows for modeling a floor truss using beam finite element instead of truss finite element. Import the T5 – Truss Enhancements with Floorbeams bridge file.

Modeling the truss members using beam elements are required when the stringers are located between panel points or member loads are applied between panel points.

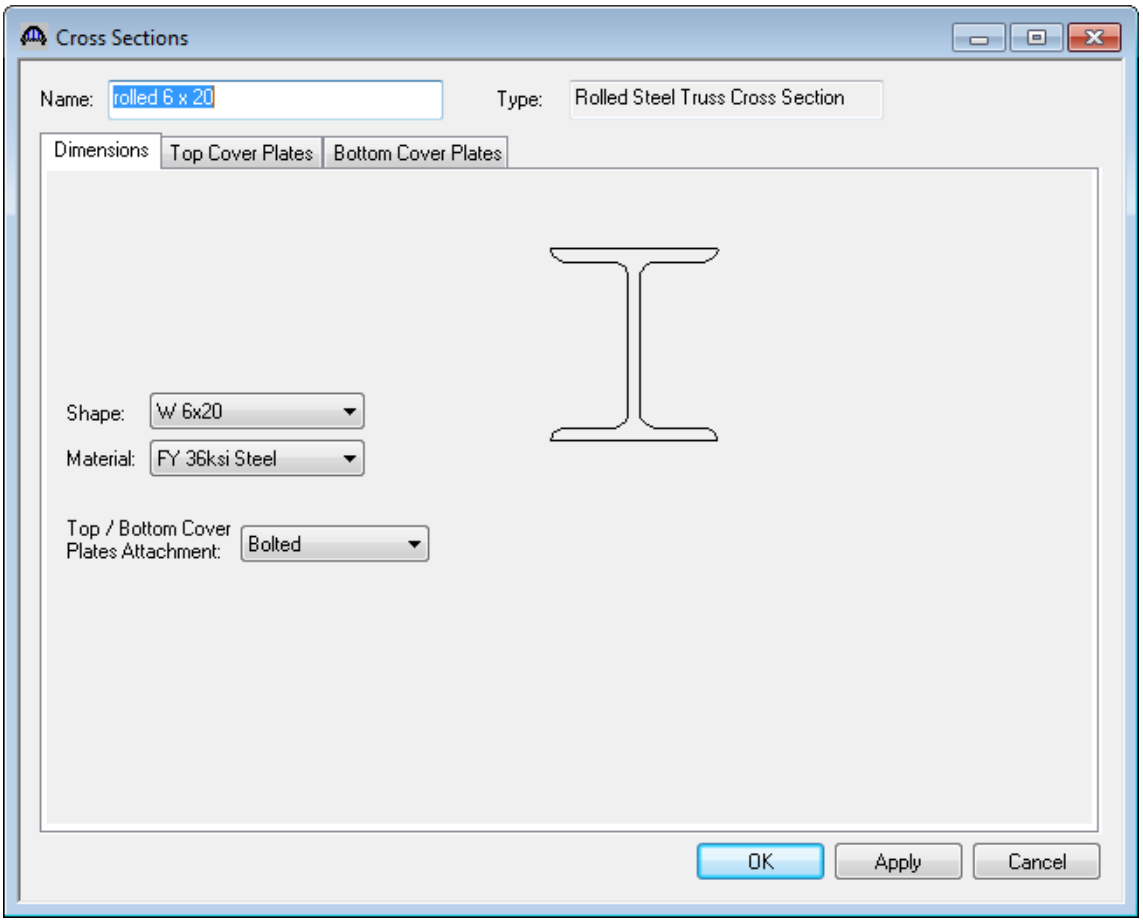
Open the SUPERSTRUCTURE DEFINITIONS / Floor System GFS with Deck / MEMBER DEFINITIONS / FLOORBEAM DEFINITIONS / Truss

Then open the Geometry tab:

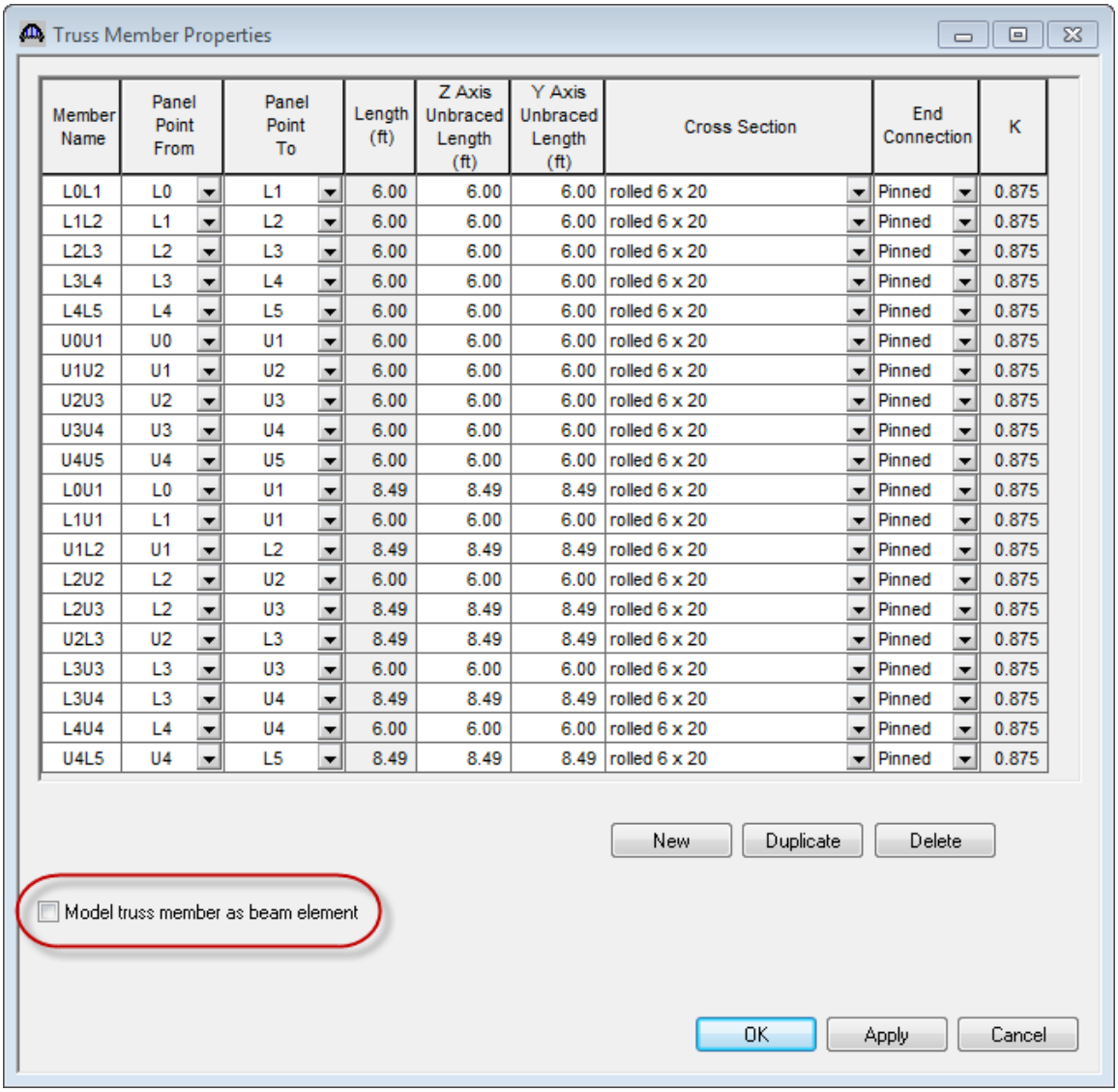


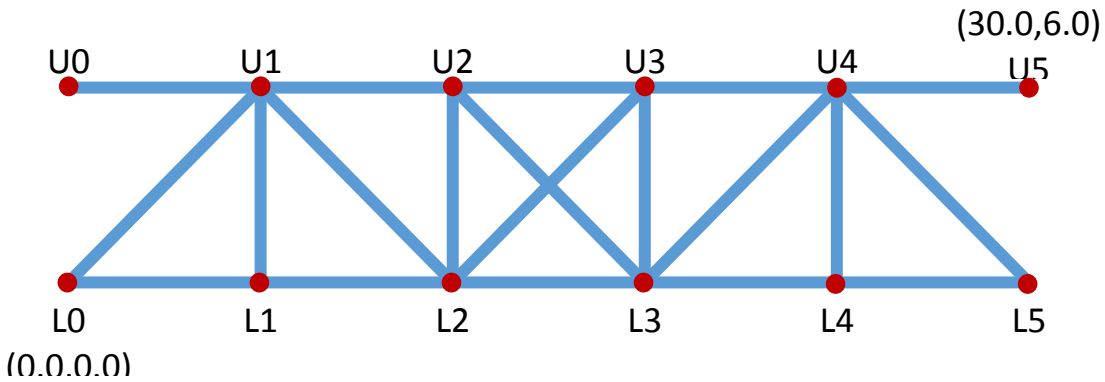
This is the definitions of the nodes for which the truss is defined.

Under Truss, open the Truss Member Cross Sections \ rolled 6 x 20 definition. This is the steel section used for the floor beam truss.

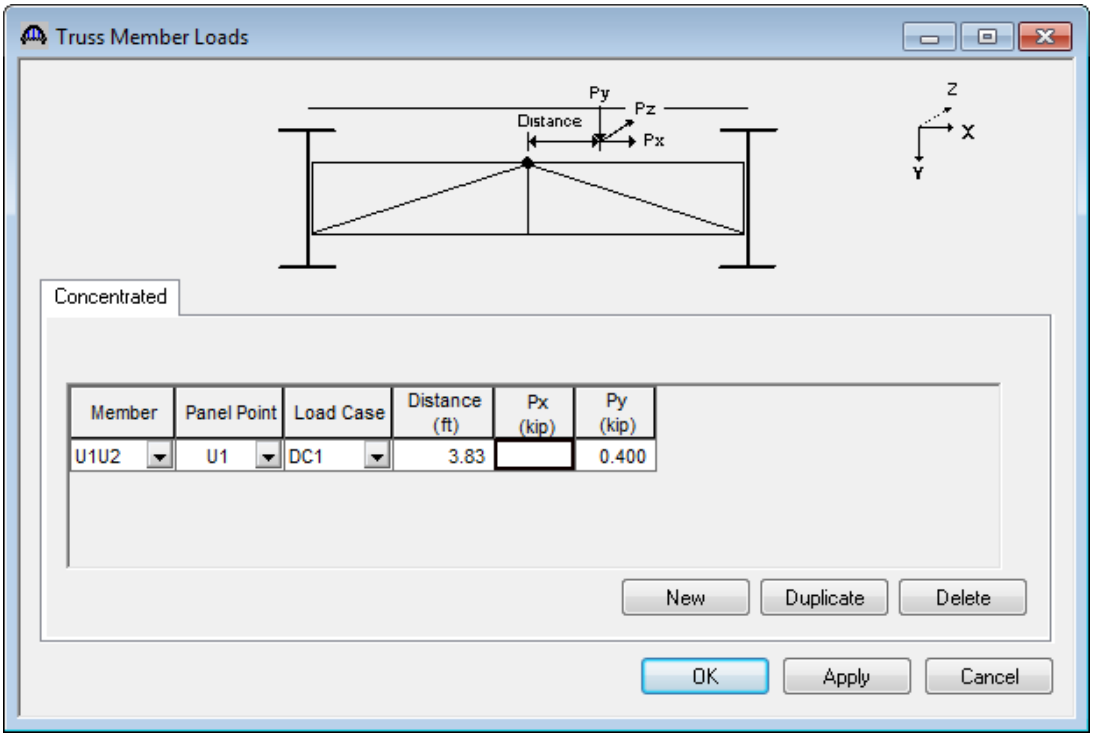


In the Truss Member Properties window, the "Model truss member as beam element" selection is used to indicate whether to use truss or beam elements in the finite element model.



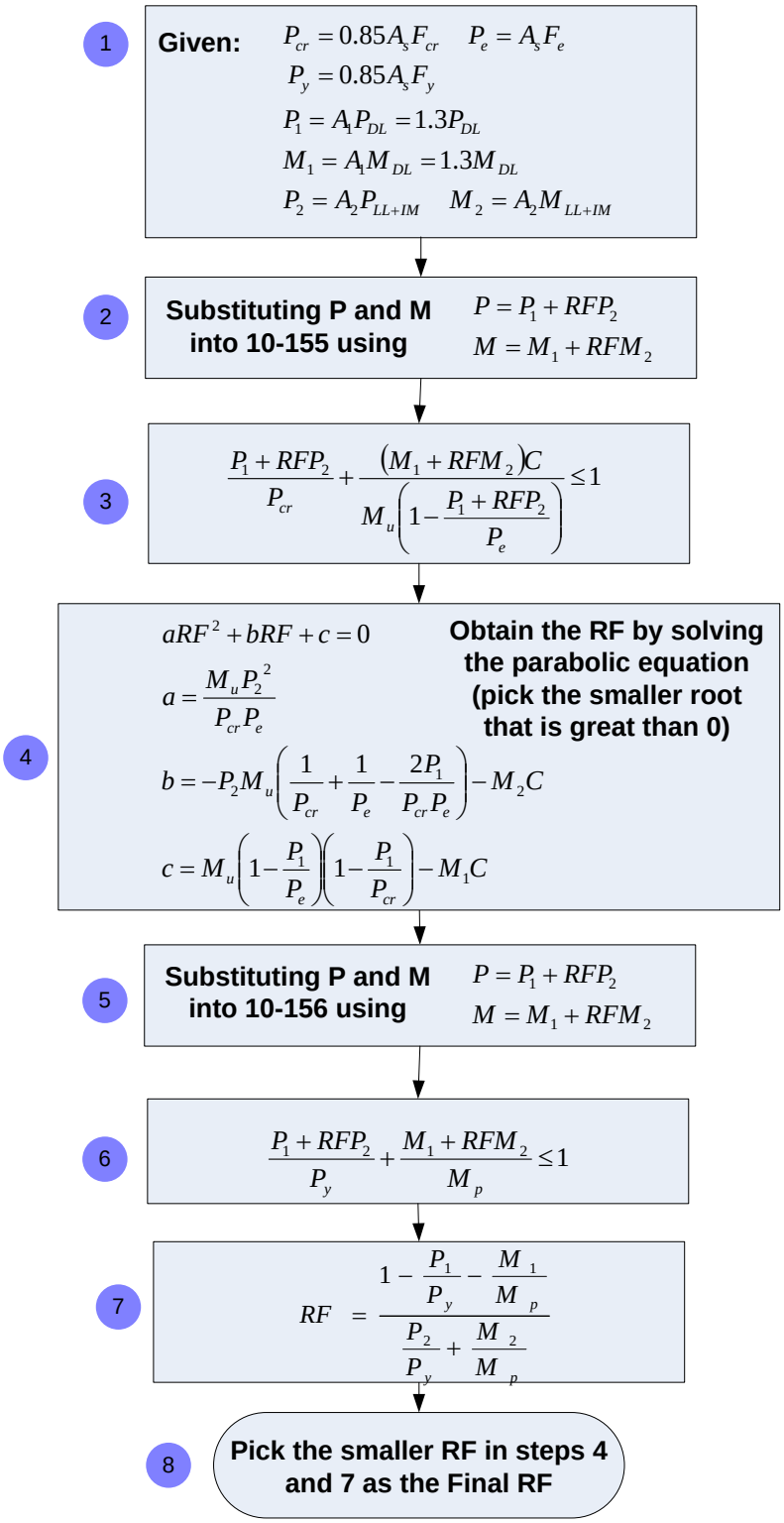


"Model truss member as beam element" is selected, the Truss Member loads window will allow you to enter member load at a distance from a panel point. For now, we will not add this load.



When a floor truss is modeled using truss elements, live load analysis is performed by loading transverse load combinations on influence lines through stringer reactions. When it is modeled using beam elements, all transverse load combinations are analyzed as individual load cases, and the maximum and minimum forces are obtained by scanning the results of these individual load cases.

The Inventory and Operating rating factors are computed using the following flow chart. Please refer to the Truss Method of Solution Manual for the descriptions of the notations.

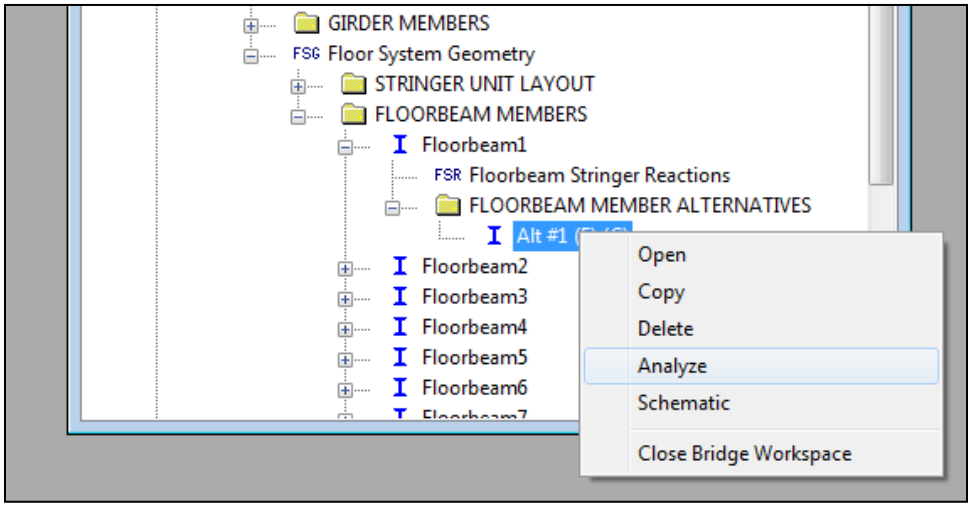


Floor truss - Spec Check Details

BrR includes the ability to view truss member specific specifications checks. Analyze the floor truss from before with LFD and the AASHTO HS-20 design truck.

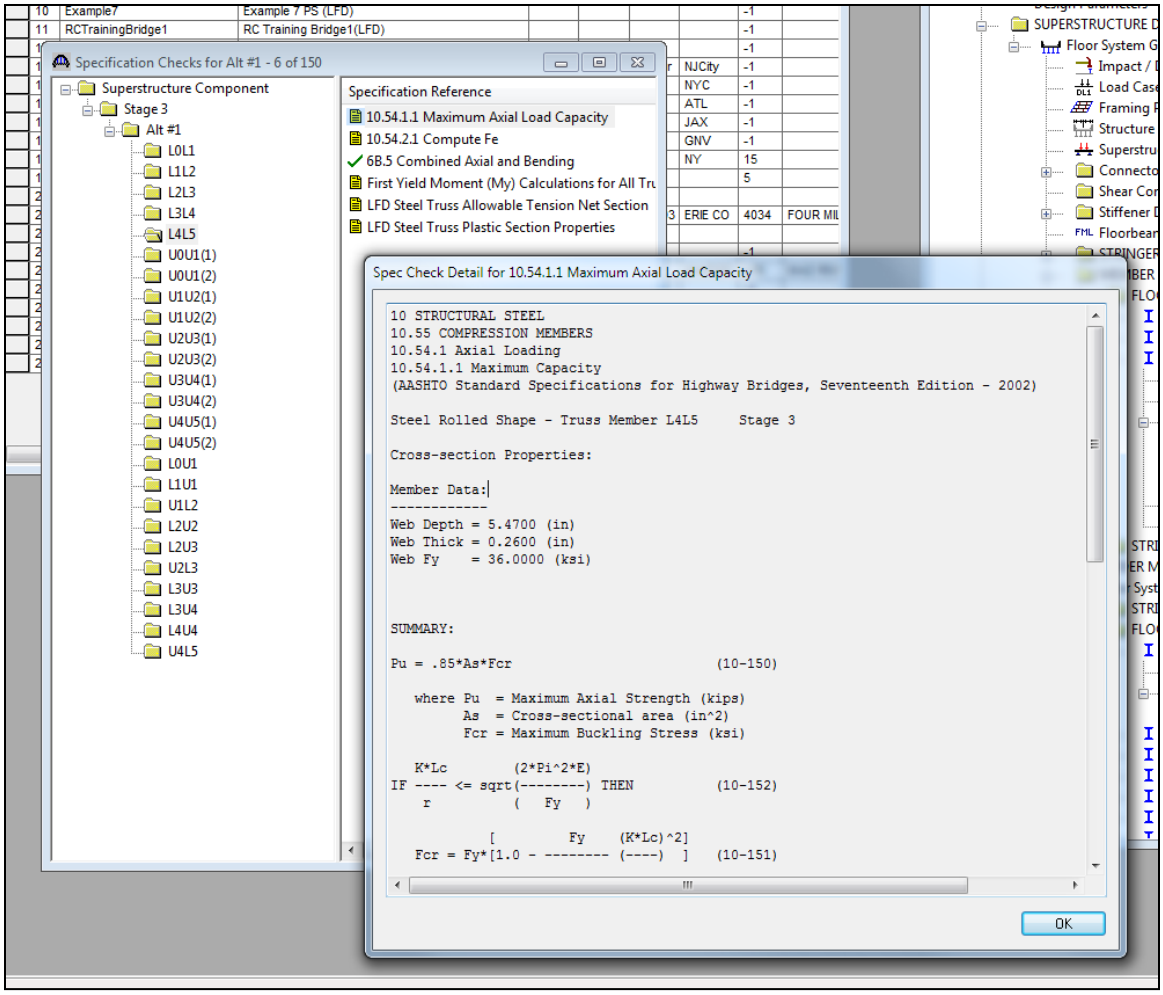
Open Floor System Geometry / FLOORBEAM MEMBERS / Floorbeam1 / FLOORBEAM MEMBER ALTERNATIVES / Alt #1

Right-click on the definition title in the tree and select Analyze.



Page through the other available specifications.

Click on the spec check button.



Floor truss – Boundary Conditions

Before BrR/BrD version 6.3, the supports at the four corners of a truss floorbeam was modeled as pinned supports. After version 6.3, the software provides a pinned support at a corner where a diagonal member points to with roller supports at the other three corners. This feature is non-modifiable. In a future version, the user will be able to select the desired support conditions for the four corners.