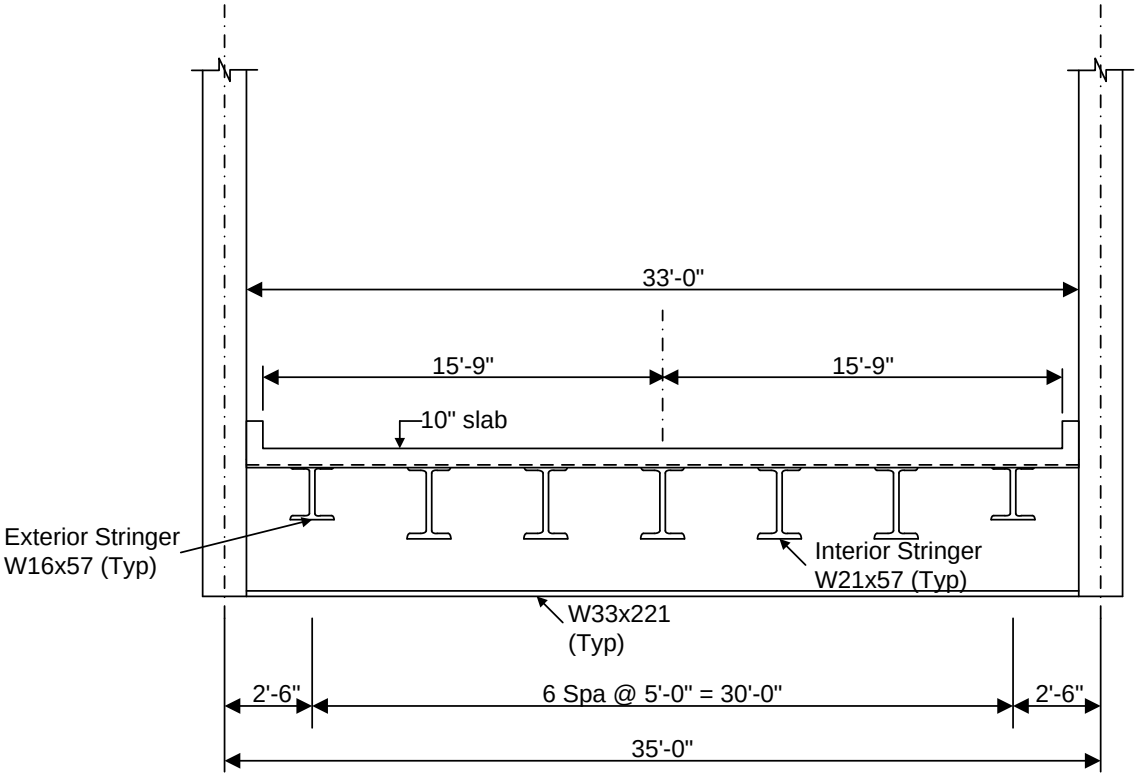
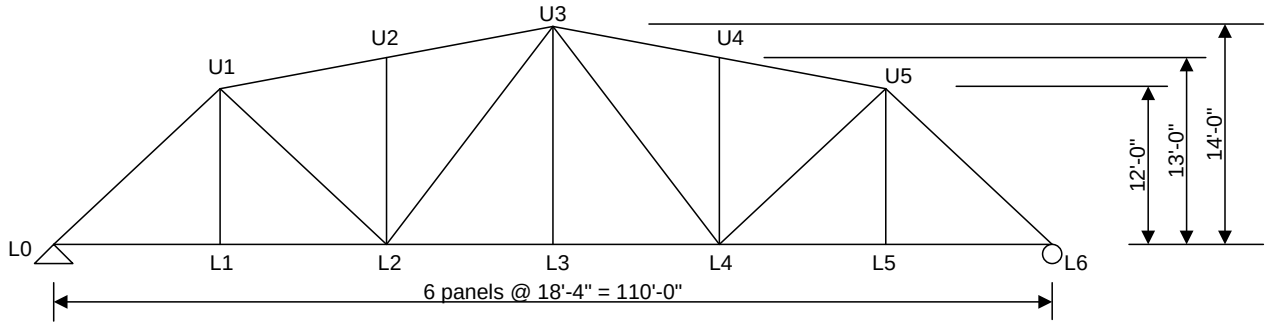
AASHTOWare BrDR 7.5.0

Truss Tutorial

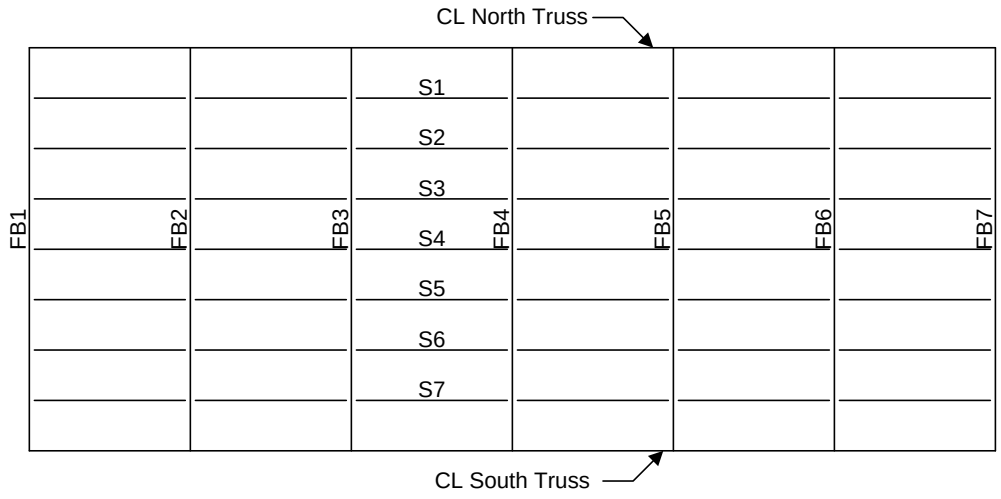
T3 – Truss Floorbeam Stringer Example



Typical Section

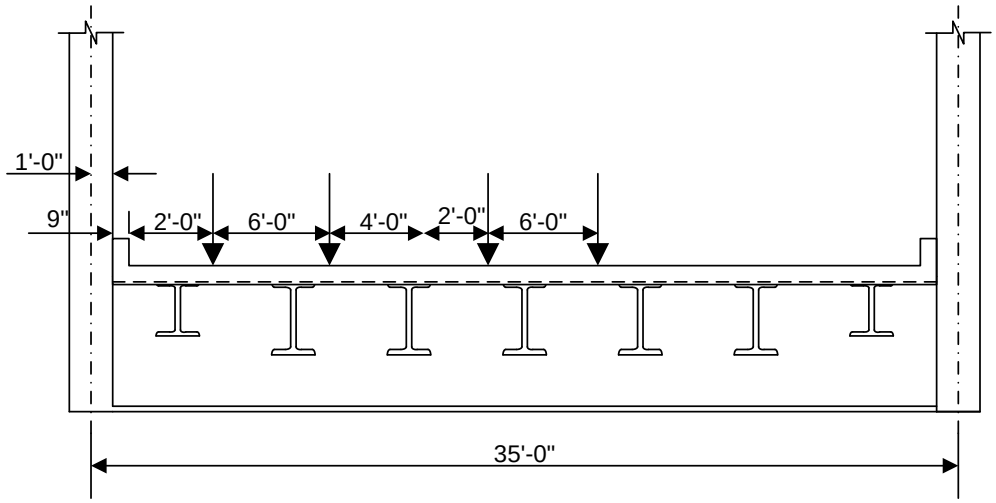


Elevation



Plan View

Truss Live Load Distribution Factors



Force

1 Lane DF = (31.25 + 25.25)/35 = 1.61 wheels

Multi Lane DF = (31.25 + 25.25 + 19.25 + 13.25)/35 = 2.54 wheels

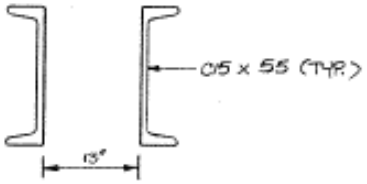
Deflection

1 Lane DF = 2 wheels/2 trusses = 1.0 wheels

Multi Lane DF = 4 wheels/2 trusses = 2.0 wheels

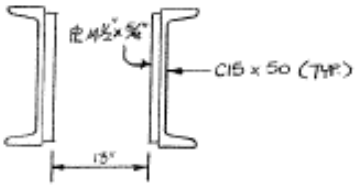
2. TRUSS MEMBERS

i. L_0L_1, L_1L_2, L_4L_5, L_5L_6



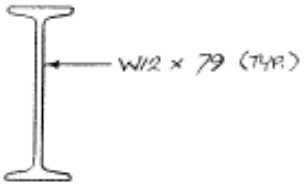
$A = 2(16.16) = 32.32\ in^2$

ii. L_2L_3, L_3L_4



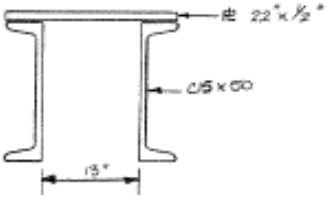
$A = 2\,[14.69 + 14\tfrac{1}{2}(\tfrac{5}{8})]$
$= 47.51\ in^2$

iii. L_1U_1, L_2U_2, L_3U_3, L_4U_4, L_5U_6



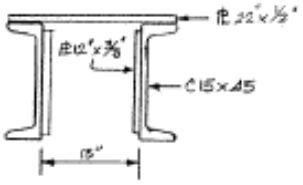
$A = 23.22\ in^2$

IV. L_0U_1, U_6L_6



$A = 2(14.69) + (22 \times \tfrac{1}{2})$
$= 40.38\ in^2$

V. U_1U_2, U_2U_3, U_5U_4, U_4U_5



$A = 2\,[13.22 + 12(\tfrac{3}{8})] + (22" \times \tfrac{1}{2}")$
$= 46.44\ in^2$

VI. U_1L_2, L_2U_3, U_3L_4, L_4U_5

$A = 19.1\ in^2$

BrDR Tutorial

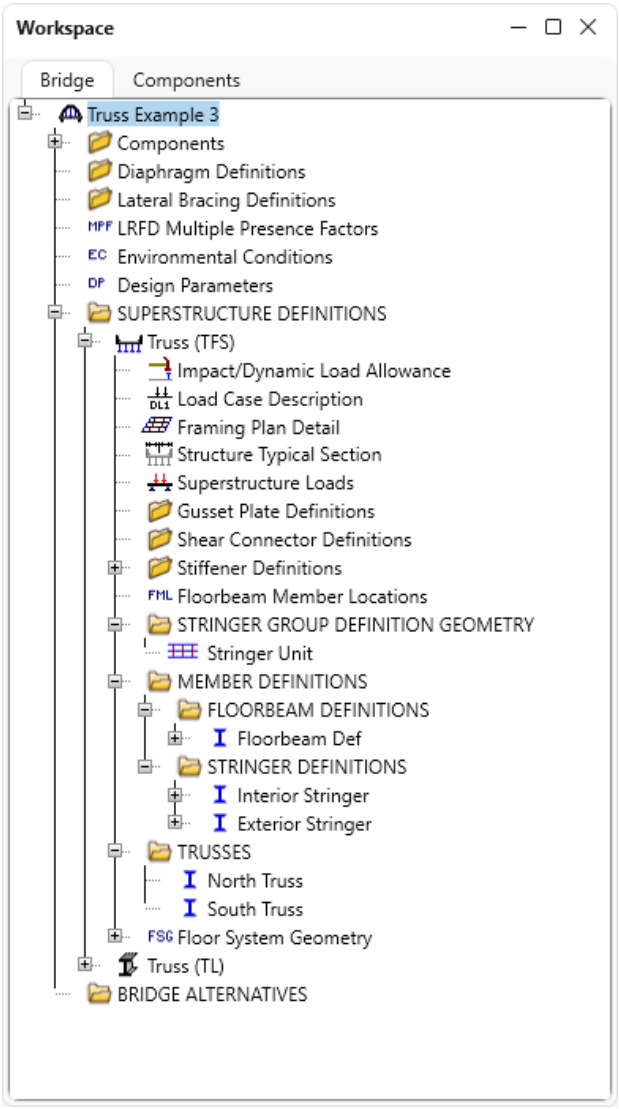
This tutorial describes entering a text description of the truss in the **BrDR Truss Command Language**, performing rating of the truss, and reviewing truss rating results.

Topics Covered

- Truss description and analysis.
- Truss rating results
- Truss line superstructures

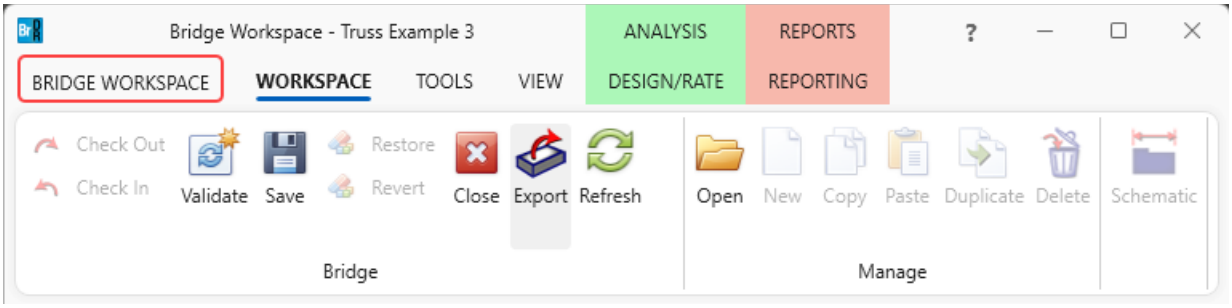
Truss description and analysis

For this example, import the BrDR XML data file – *T3-Truss-Floorbeam-Stringer.xml* and use the North Truss to get started. The partially expanded **Bridge Workspace** tree is shown below.

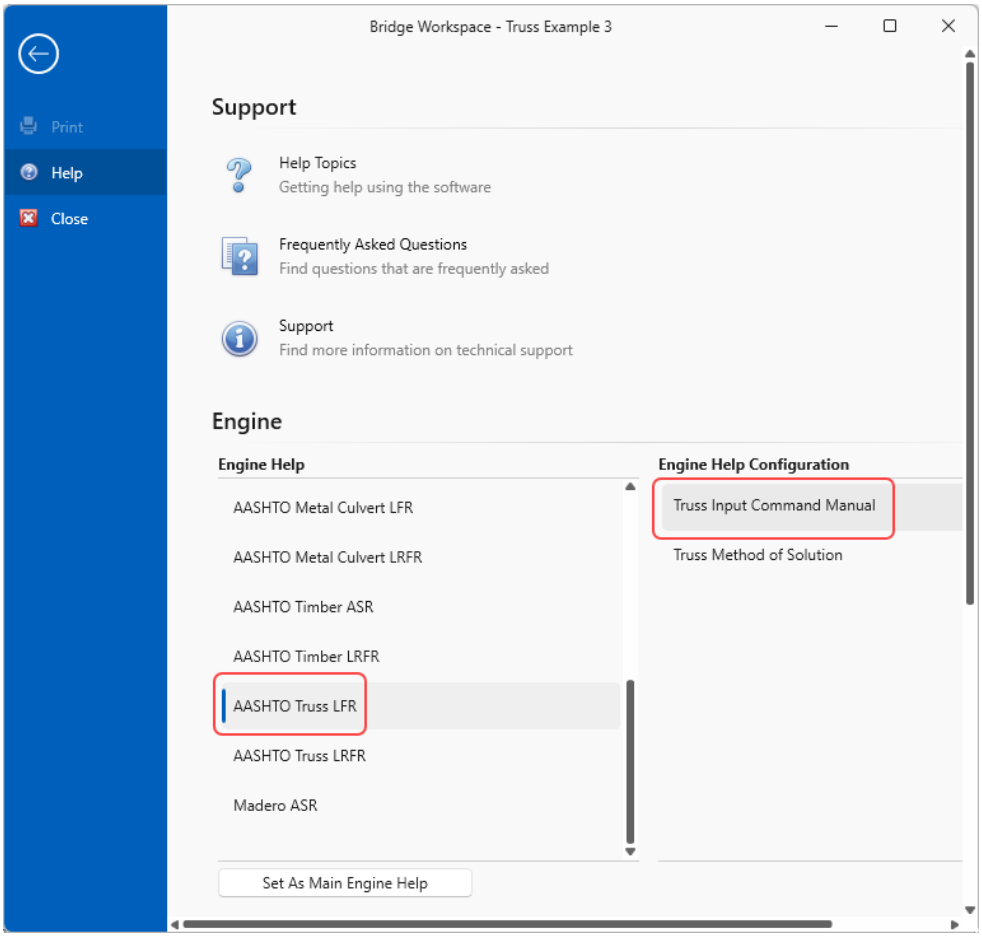


Trusses are described in BrDR by entering a text description of the truss in the BrDR Truss Command Language. This language contains commands to describe the truss geometry, members, loads, etc. The **Truss Command Language User Manual** can be accessed from the **Help** menu in BrDR as shown below.

Click on the **Bridge Workspace** ribbon to access the **Support** menu and click on the **Help** button as shown below.



In the **Engine Help** column select either **AASHTO Truss LFR** or **AASHTO Truss LRFR** to access the **Truss Input Command Manual** and **Truss Method of Solution** for the selected engine. Double-click on **Truss Input Command Manual** from the **Engine Help Configuration** column to open the truss input command manual for the selected engine as shown below.

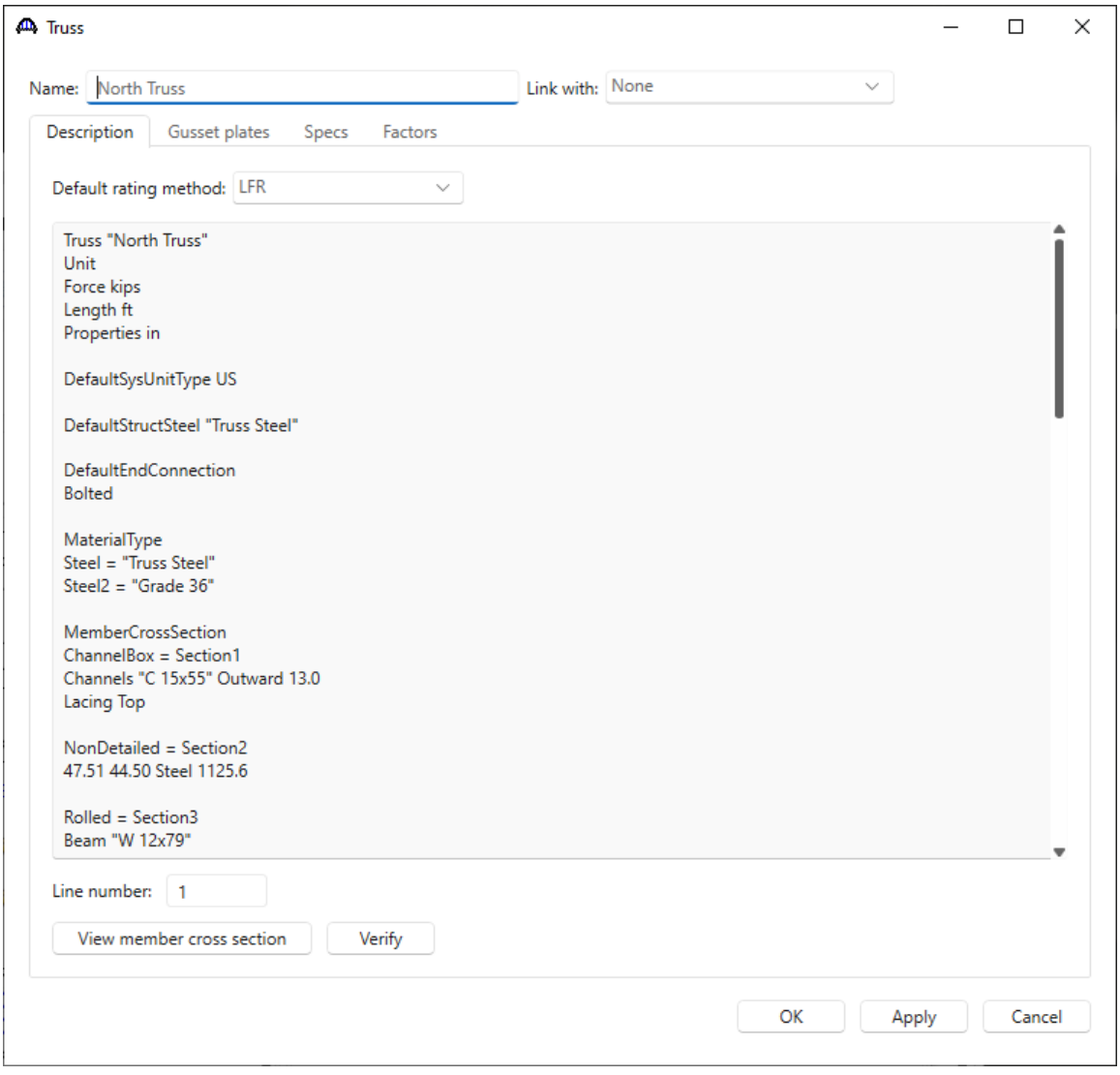


T3 – Truss Floorbeam Stringer Example

BrDR analyzes and rates trusses using the BrDR Truss analysis engine. The BrDR Truss analysis engine analyzes a finite element model of the truss and computes rating factors using the analysis method type selected (LFR or LRFR). The truss is analyzed for axial force only, bending due to load eccentricity is not considered.

Truss

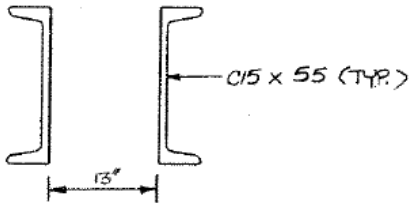
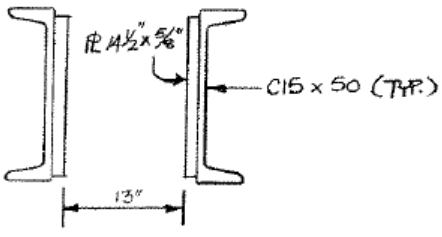
The floor system was already entered for this example. Only the truss system needs to be defined. Expand the **Trusses** node in the **Bridge Workspace** tree and double click on **North Truss** node in the **Bridge Workspace** tree to open the **Truss** window as shown below.

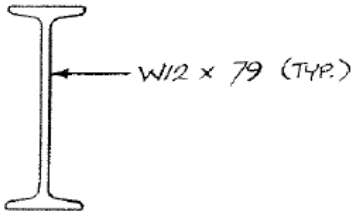
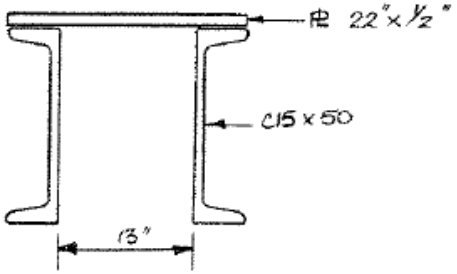
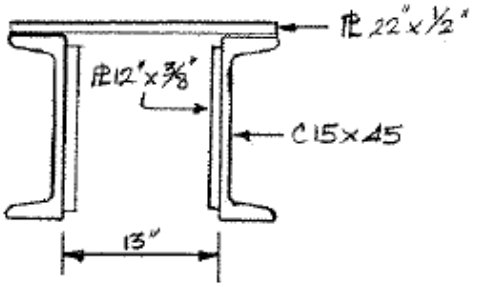
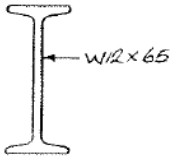


The **Verify** button will read the text description and verify the syntax of the input commands .

T3 – Truss Floorbeam Stringer Example

The following is a copy of the truss definition described using the BrDR Truss Command Language. A description of the command language and its syntax is available by opening BrDR Help for the truss window. Some of the commands are described in detail below. The name of the command is shown in bold text.

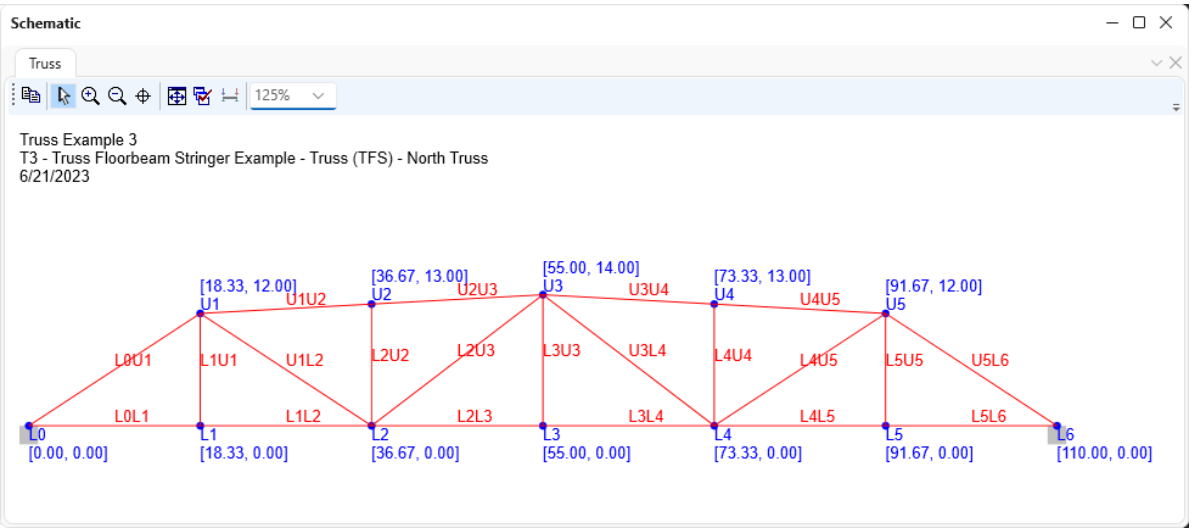
Command	**Comments**
Truss "North Truss"	
Unit Force kips Length ft Properties in	
DefaultSysUnitType US	
DefaultStructSteel "Truss Steel"	The steel material “Truss Steel” from the BrDR BWS will be used as the default steel material if steel material is not entered in later commands. The double quotations around “Truss Steel” indicate that Truss Steel is defined in the BrDR BWS.
DefaultEndConnection Bolted	Used to determine the effective length factor K
MaterialType Steel = "Truss Steel" Steel2 = "Grade 36"	Wherever ‘Steel’ appears in later commands, the properties from the ‘Truss Steel’ in the BWS will be used. This command is a shortcut way to specify a steel material. This is useful for some of the steel materials in the BrDR Library whose names are lengthy.
MemberCrossSection ChannelBox = Section1 Channels "C 15x55" Outward 13.0 Lacing Top	
NonDetailed = Section2 47.51 44.50 Steel 1125.6	

	Entered as a NonDetailed section instead of describing each plate. Only the gross, net area and the moment of inertia of the section must be entered in this command.
Rolled = Section3 Beam "W 12x79"	
ChannelBox = Section4 TopFlangePlate 22.0 0.5 Steel2 Channels "C 15x50" Outward 13.0 Lacing Bottom	 The top cover plate uses 'Steel2' instead of the default steel.
ChannelBox = Section5 TopFlangePlate 22.0 0.5 LeftWebPlate 12.0 0.375 RightWebPlate 12.0 0.375 Channels "C 15x45" Outward 13.0 Connection Bolted 1.50 Lacing Bottom	 1.50 in^2 will be deducted from the gross area for the connection holes for LFR analysis.
Rolled = Section6 Beam "W 12x65"	
PanelPoint L0 Lower 0.0000 0.0 L1 Lower 18.3333 0.0 L2 Lower 36.6667 0.0 L3 Lower 55.0000 0.0	

L4 Lower 73.3333 0.0 L5 Lower 91.6667 0.0 L6 Lower 110.0000 0.0 U1 Upper 18.3333 12.0 U2 Upper 36.6667 13.0 U3 Upper 55.0000 14.0 U4 Upper 73.3333 13.0 U5 Upper 91.6667 12.0	
Member L0L1 L0 L1 Section1 L1L2 L1 L2 Section1 L2L3 L2 L3 Section2 L3L4 L3 L4 Section2 L4L5 L4 L5 Section2 L5L6 L5 L6 Section2 L0U1 L0 U1 Section4 U1U2 U1 U2 Section5 U2U3 U2 U3 Section5 U3U4 U3 U4 Section5 U4U5 U4 U5 Section5 U5L6 U5 L6 Section4 L1U1 L1 U1 Section3 U1L2 U1 L2 Section6 L2U2 L2 U2 Section3 L2U3 L2 U3 Section6 L3U3 L3 U3 Section3 U3L4 U3 L4 Section6 L4U4 L4 U4 Section3 L4U5 L4 U5 Section6 L5U5 L5 U5 Section3	Members are identified by the panel points that they connect and cross sections are assigned to the members in this command.
Support L0 Pinned L6 Roller	
LLDistribution OneLane 0.805 0.5 MultiLane 1.27 1.0	Lane distribution factors

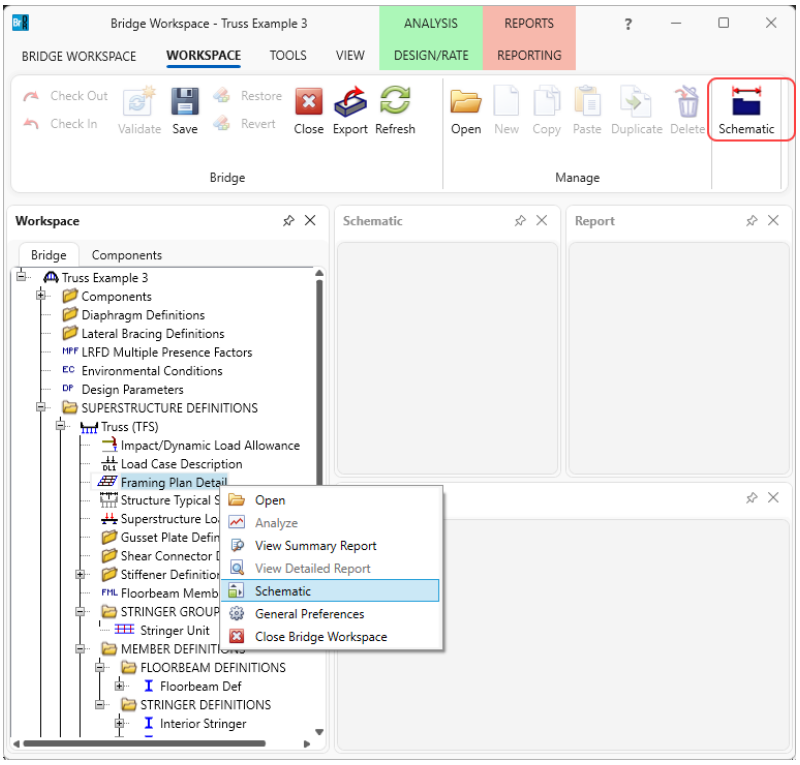
Schematic - Truss

While the **North Truss** is selected in the **Bridge Workspace** tree, open the schematic for the truss by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **North Truss** in the Bridge Workspace and select **Schematic** from the menu).

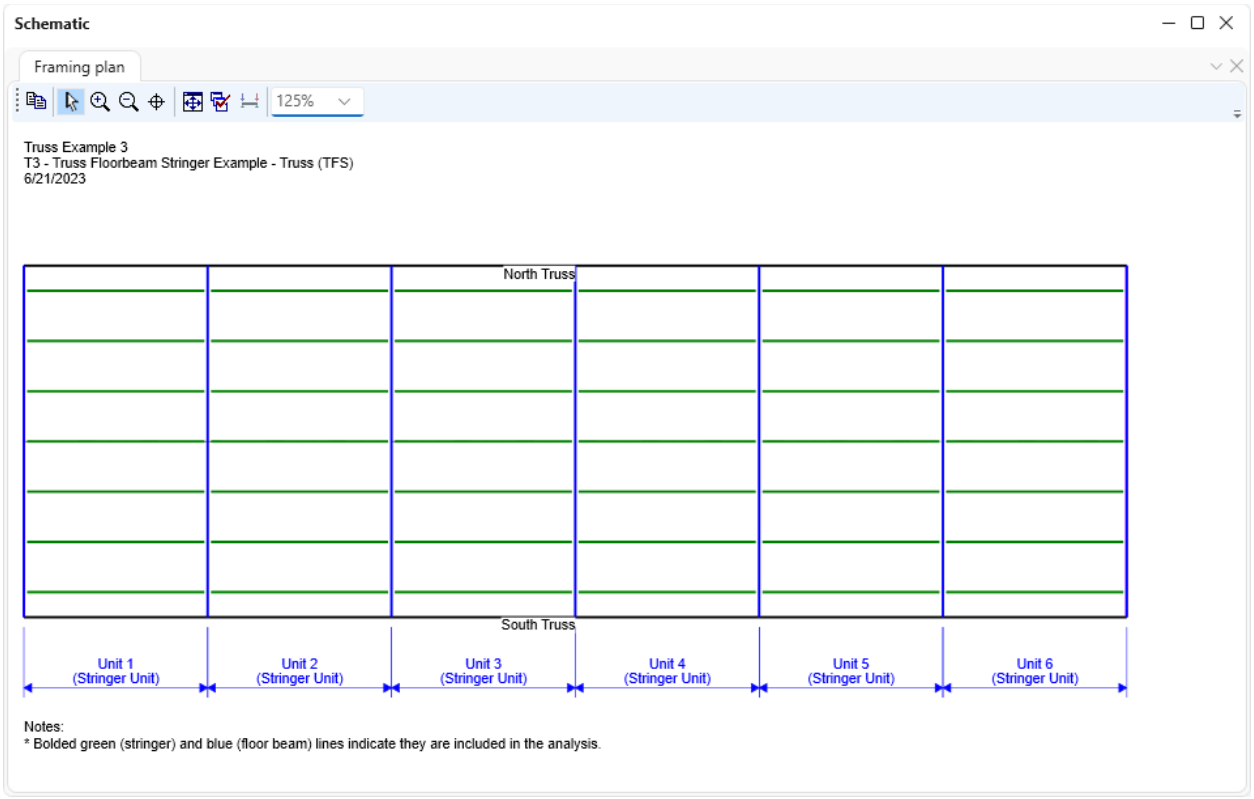


Schematic - Framing Plan Detail

While the **Framing Plan Detail** is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu).

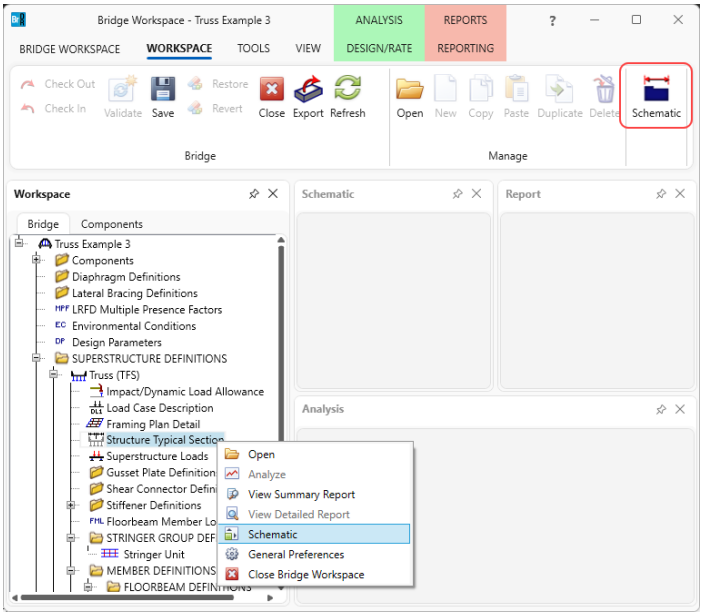


The schematic for the framing plan now appears as shown below.

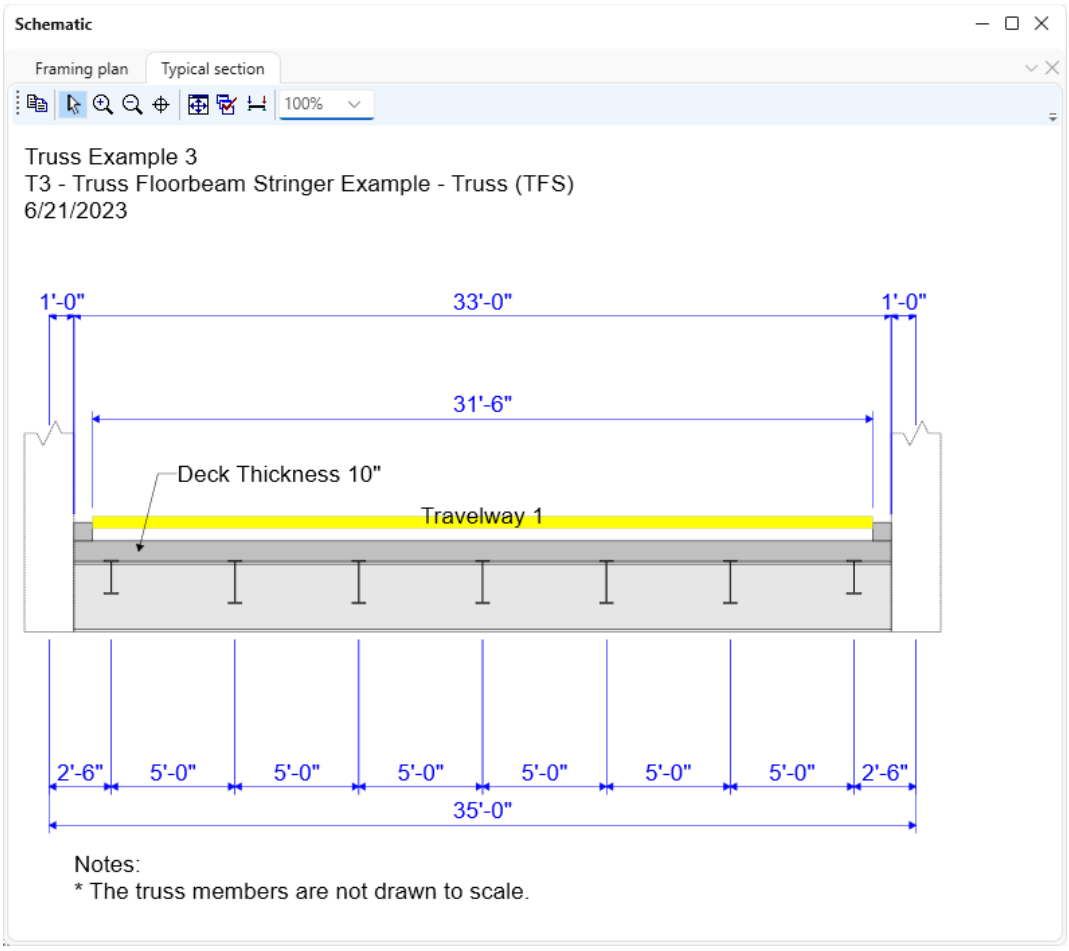


Schematic – Structure Typical Section

Similarly, while the **Structure Typical Section** is selected in the **Bridge Workspace** tree, open the schematic for the structure typical section by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Structure Typical Section** in the **Bridge Workspace** and select **Schematic** from the menu).

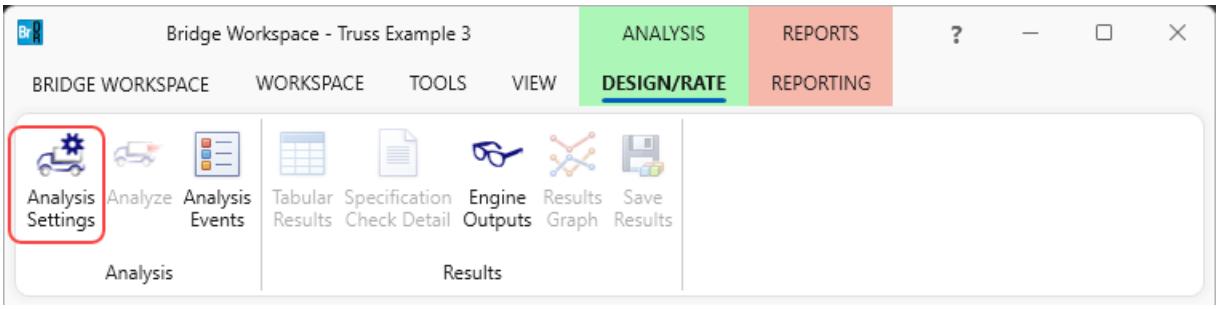


The schematic for the structure typical section now appears as shown below.

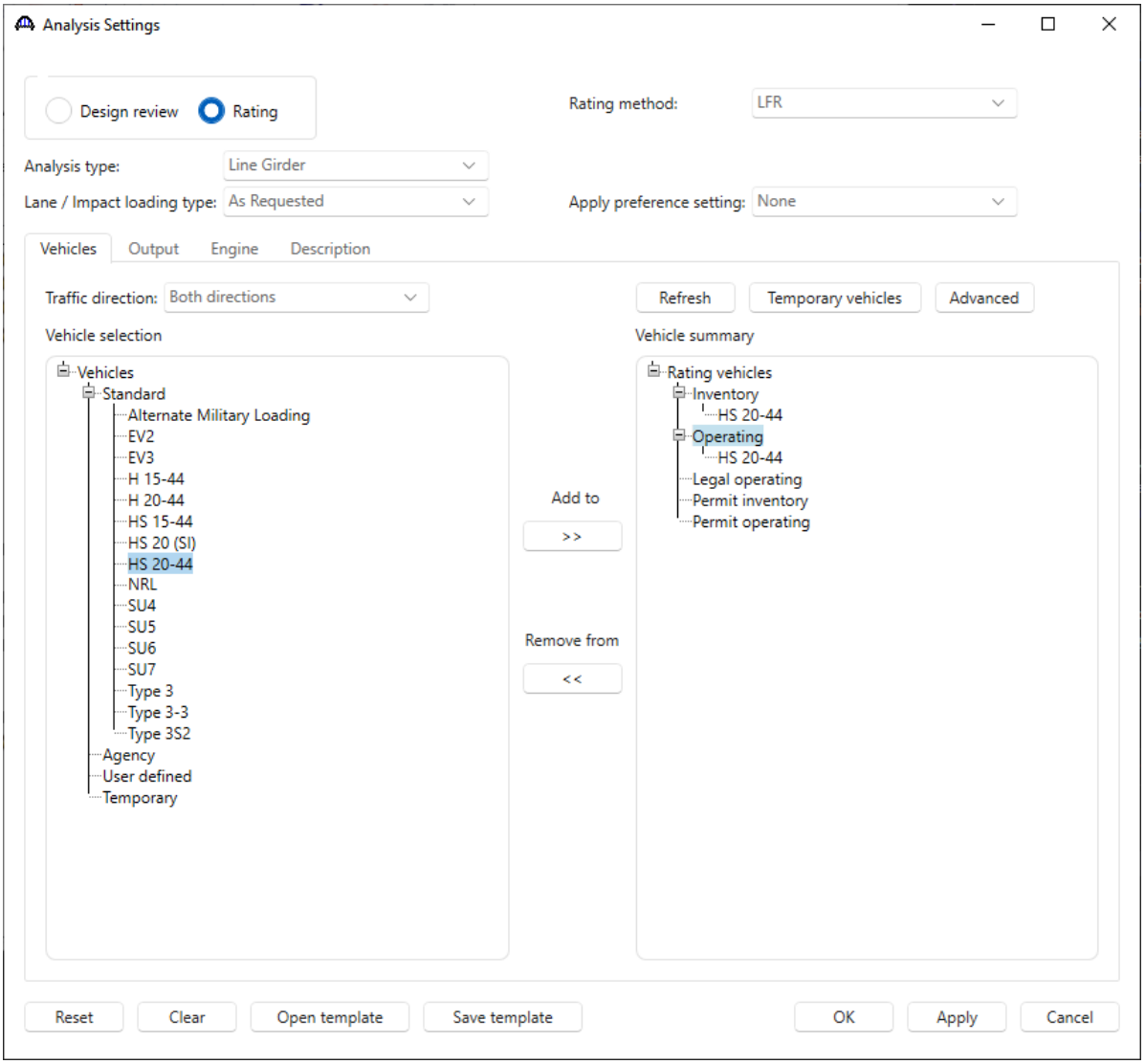


LFR Analysis

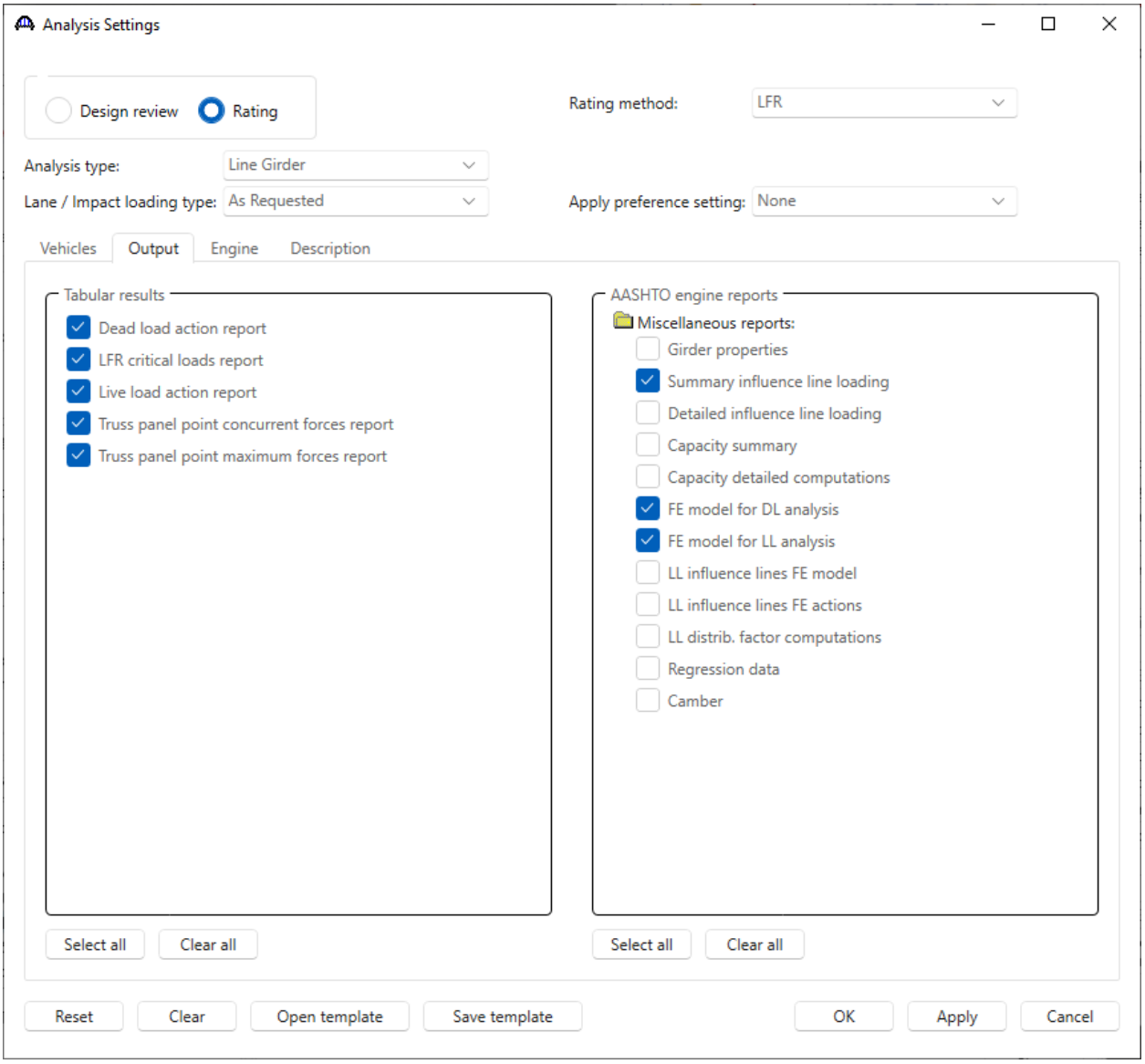
To perform a rating on the North Truss, select **North Truss** in the **Bridge Workspace** tree and click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.



Select the vehicle **HS 20-44** under **Inventory** and **Operating** as shown below.

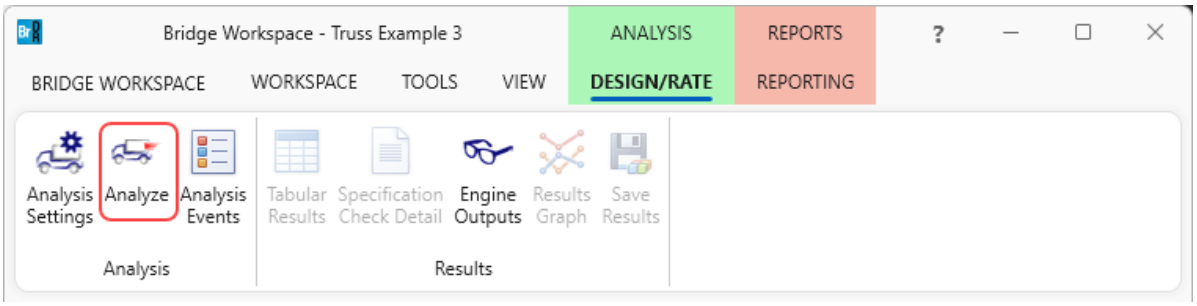


Navigate to the **Output** tab of this window and apply the following settings.



Click **OK** to apply the analysis settings and close the window.

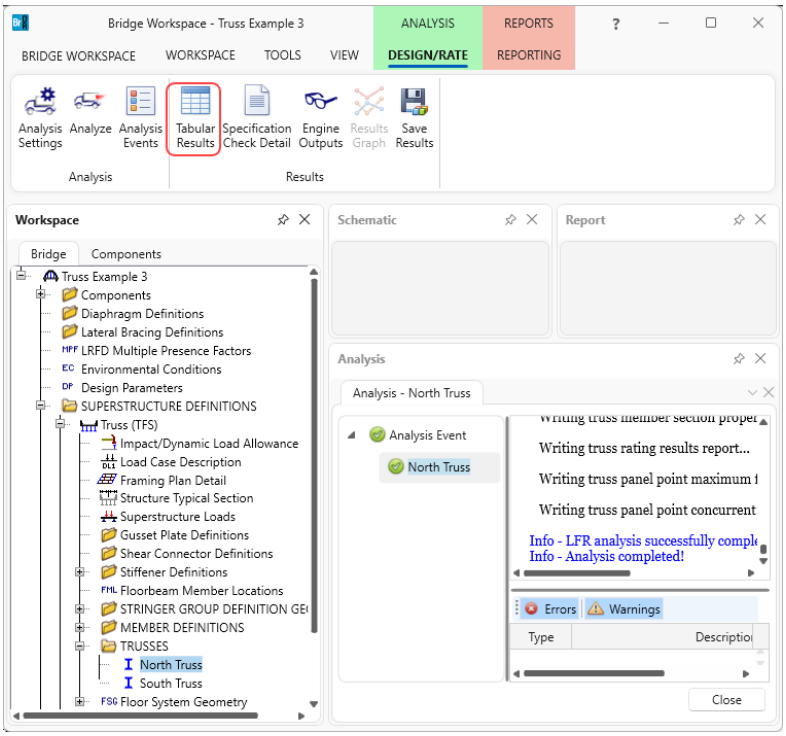
Select **North Truss** in the **Bridge Workspace** tree and click the **Analyze** button from the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



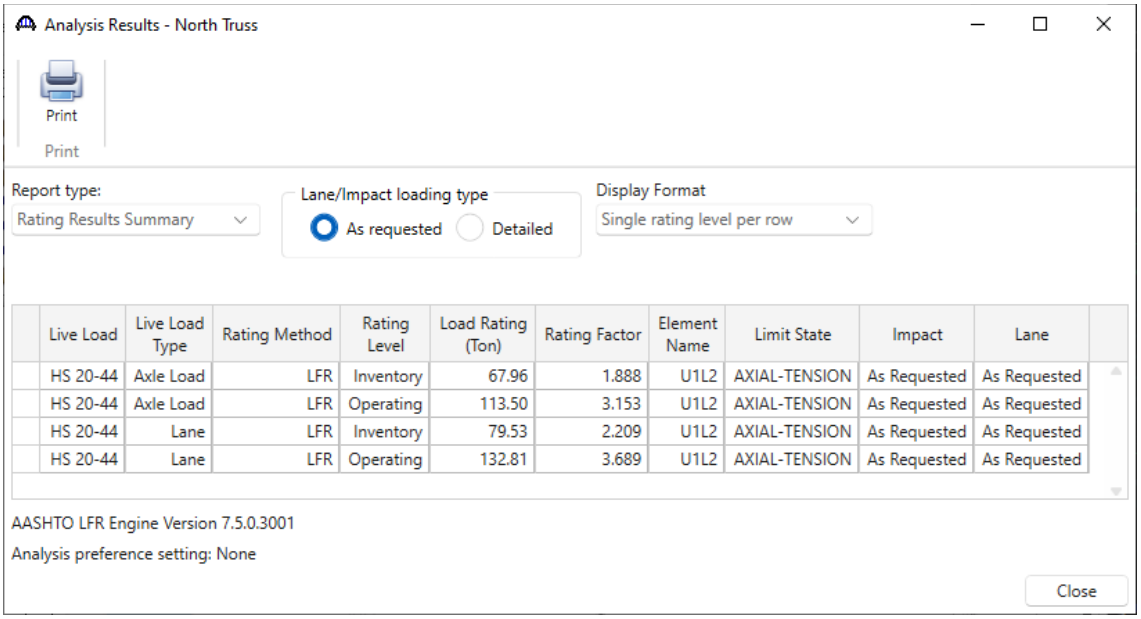
Truss rating results

Tabular Results

When the rating analysis iscompleted, results can be reviewed by selecting the **North Truss** member in the **Bridge Workspace** tree and clicking the **Tabular Results** button on the **Results** group of the ribbon.



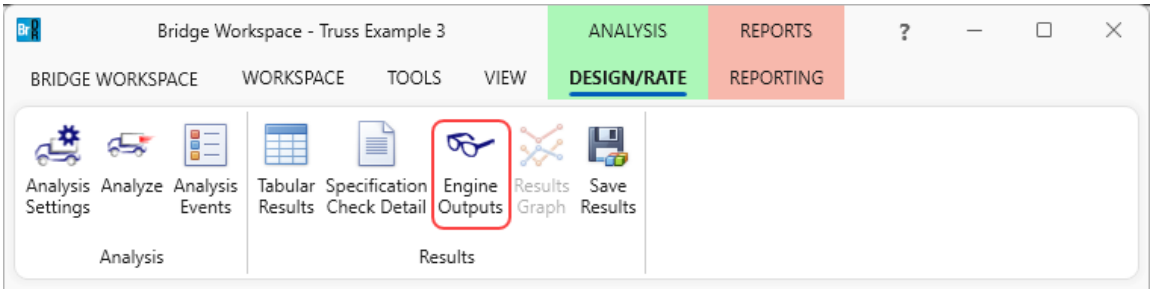
The window shown below will open.

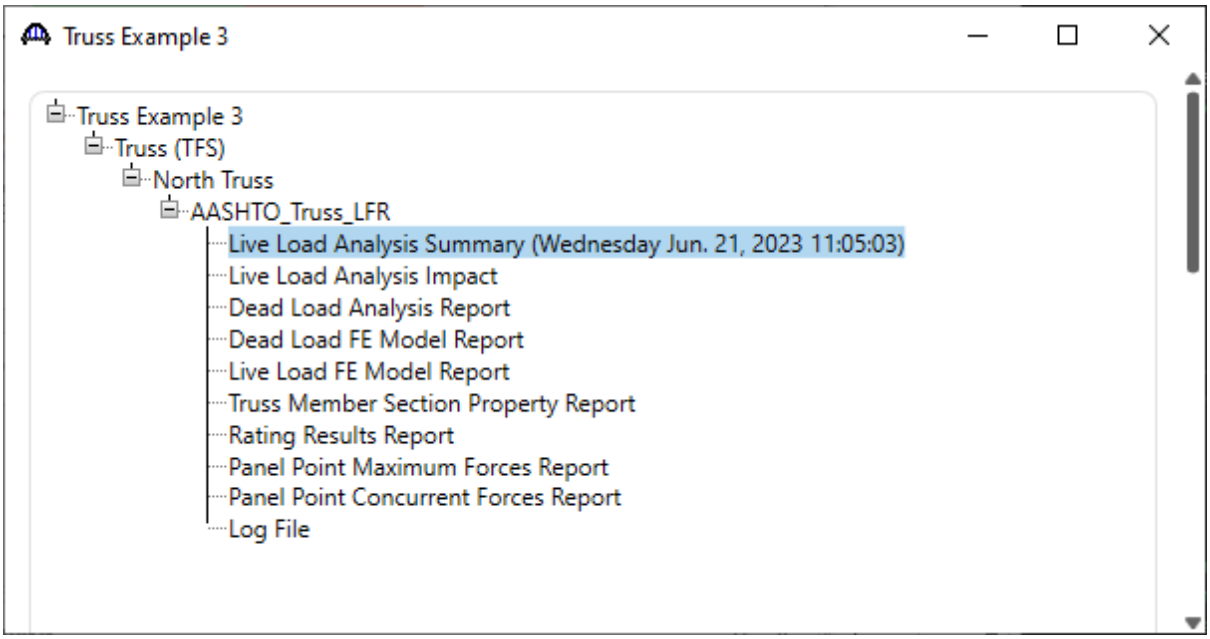


Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Element Name	Limit State	Impact	Lane
HS 20-44	Axle Load	LFR	Inventory	67.96	1.888	U1L2	AXIAL-TENSION	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	113.50	3.153	U1L2	AXIAL-TENSION	As Requested	As Requested
HS 20-44	Lane	LFR	Inventory	79.53	2.209	U1L2	AXIAL-TENSION	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	132.81	3.689	U1L2	AXIAL-TENSION	As Requested	As Requested

Engine Outputs

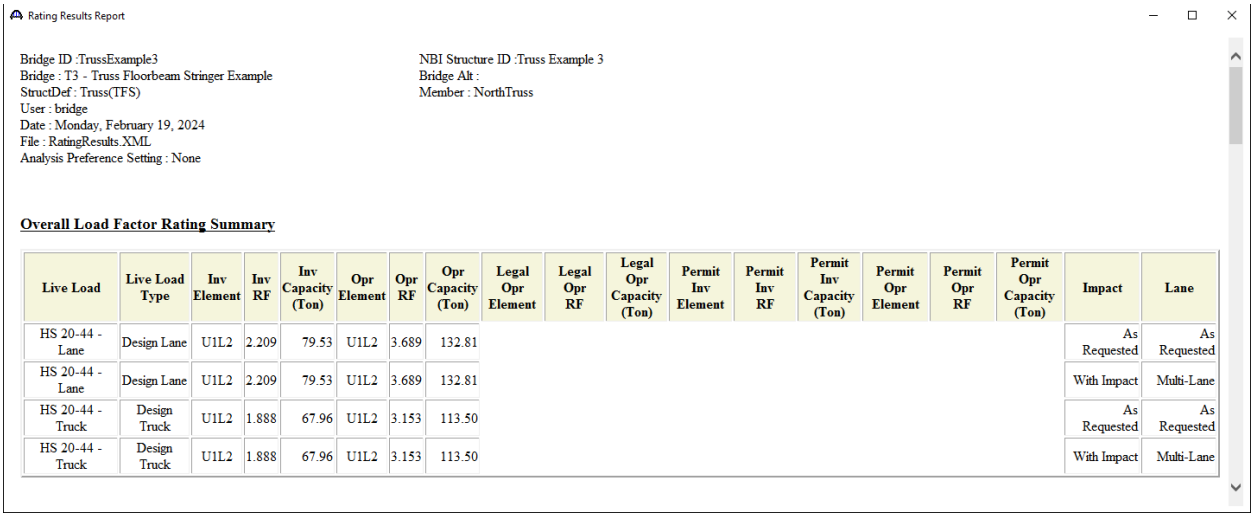
After the analysis is completed, the output files can be viewed by clicking the **Engine Outputs** button on the **Results** group of the ribbon.





- The **Live Load Analysis Summary** contains data related to the live loading of the truss influence lines.
- The **Dead Load Analysis Report** and **Dead Load FE Model Report** contain the truss finite element model and dead load analysis.
- The **Live Load FE Model Report** contains the truss finite element model for live load analysis.
- The **Truss Member Section Property Report** contains data related to the computed and user input truss member section properties.
- The **Rating Results Report** contains the rating results for the truss.
- The **Panel Point Maximum Forces Report** contains the maximum member forces due to dead load and live load for each member at each panel point.
- The **Panel Point Concurrent Forces Report** contains the concurrent member forces for each panel point's member under the critical condition.
- The **Log file** is the analysis log produced when the analysis is run. This file may contain errors and warnings that should be reviewed.

A portion of the **Rating Results Report** is shown below.



Rating Results Report

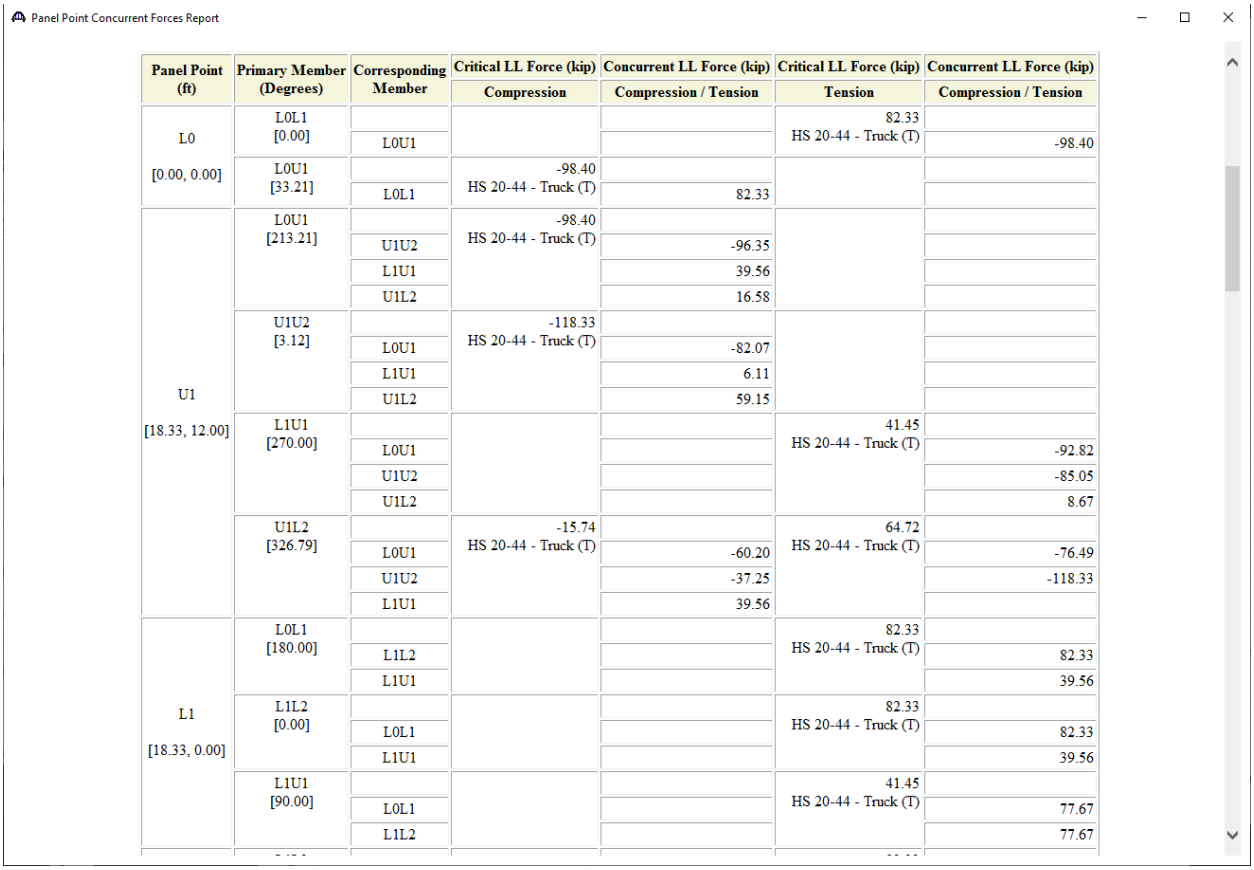
Bridge ID :TrussExample3
Bridge : T3 - Truss Floorbeam Stringer Example
StructDef : Truss(TFS)
User : bridge
Date : Monday, February 19, 2024
File : RatingResults.XML
Analysis Preference Setting : None

NBI Structure ID :Truss Example 3
Bridge Alt :
Member : NorthTruss

Overall Load Factor Rating Summary

Live Load	Live Load Type	Inv Element	Inv RF	Inv Capacity (Ton)	Opr Element	Opr RF	Opr Capacity (Ton)	Legal Opr Element	Legal Opr RF	Legal Opr Capacity (Ton)	Permit Inv Element	Permit Inv RF	Permit Inv Capacity (Ton)	Permit Opr Element	Permit Opr RF	Permit Opr Capacity (Ton)	Impact	Lane
HS 20-44 - Lane	Design Lane	U1L2	2.209	79.53	U1L2	3.689	132.81										As Requested	As Requested
HS 20-44 - Lane	Design Lane	U1L2	2.209	79.53	U1L2	3.689	132.81										With Impact	Multi-Lane
HS 20-44 - Truck	Design Truck	U1L2	1.888	67.96	U1L2	3.153	113.50										As Requested	As Requested
HS 20-44 - Truck	Design Truck	U1L2	1.888	67.96	U1L2	3.153	113.50										With Impact	Multi-Lane

A portion of the **Panel Point Concurrent Forces Report** is shown below.

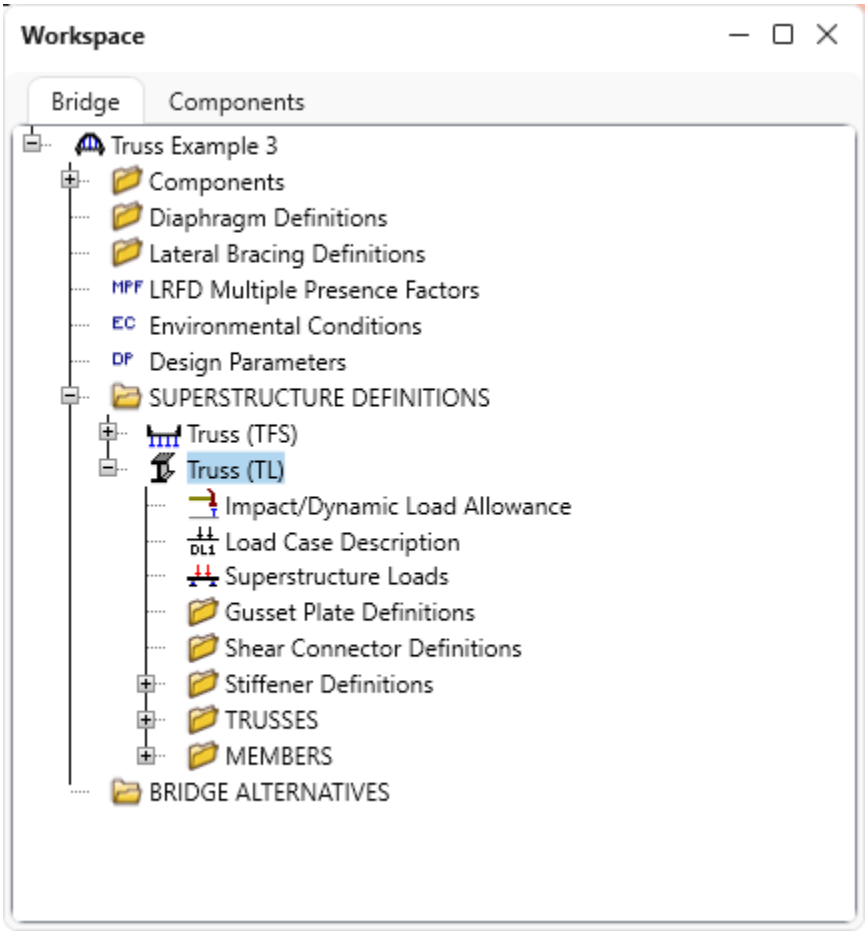


Panel Point Concurrent Forces Report

Panel Point (ft)	Primary Member (Degrees)	Corresponding Member	Critical LL Force (kip) Compression	Concurrent LL Force (kip) Compression / Tension	Critical LL Force (kip) Tension	Concurrent LL Force (kip) Compression / Tension
L0 [0.00, 0.00]	L0L1 [0.00]				82.33 HS 20-44 - Truck (T)	
		L0U1				-98.40
	L0U1 [33.21]		-98.40 HS 20-44 - Truck (T)			
		L0L1		82.33		
U1 [18.33, 12.00]	L0U1 [213.21]		-98.40 HS 20-44 - Truck (T)			
		U1U2		-96.35		
		L1U1		39.56		
		U1L2		16.58		
	U1U2 [3.12]		-118.33 HS 20-44 - Truck (T)			
		L0U1		-82.07		
		L1U1		6.11		
		U1L2		59.15		
	L1U1 [270.00]				41.45 HS 20-44 - Truck (T)	
		L0U1				-92.82
		U1U2				-85.05
		U1L2				8.67
	U1L2 [326.79]		-15.74 HS 20-44 - Truck (T)		64.72 HS 20-44 - Truck (T)	
		L0U1		-60.20		-76.49
		U1U2		-37.25		-118.33
		L1U1		39.56		
L1 [18.33, 0.00]	L0L1 [180.00]				82.33 HS 20-44 - Truck (T)	
		L1L2				82.33
		L1U1				39.56
	L1L2 [0.00]				82.33 HS 20-44 - Truck (T)	
		L0L1				82.33
		L1U1				39.56
	L1U1 [90.00]				41.45 HS 20-44 - Truck (T)	
		L0L1				77.67
		L1L2				77.67

Truss line superstructures

The **Bridge Workspace tree** for a **truss-floorbeam-stringer line** superstructure definition is shown below.



In a truss line superstructure definition, the relationship between the truss and floor system is not defined. Therefore, the floor system dead loads that act on the truss need to be entered by the user. These loads are computed as follows.

Deck Dead Load on Truss

Deck DL = 10”/12 * 33.0’ * 0.150pcf = 4.125 kip/ft

L0, L6: 18.33’/2 * 4.125 k/ft / 2 trusses = 18.90 kips

L1, L2, L3, L4, L5: 18.33’ * 4.125 k/ft / 2 trusses = 37.81 kips

Curb Dead Load on Truss

Curb DL = 85 lb/ft

L0, L6: 18.33’/2 * 0.085 k/ft * 2 curbs / 2 trusses = 0.78 kips

L1, L2, L3, L4, L5: 18.33’ * 0.085 k/ft * 2 curbs / 2 trusses = 1.56 kips

Floorbeam Dead Load on Truss

Floorbeam DL = 221 lb/ft*35 ft = 7735 lb

L0, L1, L2, L3, L4, L5, L6: 7.735 kips / 2 trusses = 3.87 kips

Stringer Dead Load on Truss

Exterior Stringer DL = 57 lb/ft

Interior Stringer DL = 57 lb/ft

L0, L6: 7 stringers * 0.057 kip/ft * 18.33'/2 / 2 trusses = 1.83 kips

L1, L2, L3, L4, L5: 7 stringers * 0.057 kip/ft * 18.33' / 2 trusses = 3.66 kips

The truss command language description for the truss line is the same as the description for the truss system with the addition of a command to describe the user computed floor system dead loads. The following is the PanelPointLoad command used to describe the floor system dead load acting on the truss. This command comes after the Support command.

PanelPointLoad

L0 DC 0.0 -25.38

L1 DC 0.0 -46.90

L2 DC 0.0 -46.90

L3 DC 0.0 -46.90

L4 DC 0.0 -46.90

L5 DC 0.0 -46.90

L6 DC 0.0 -25.38