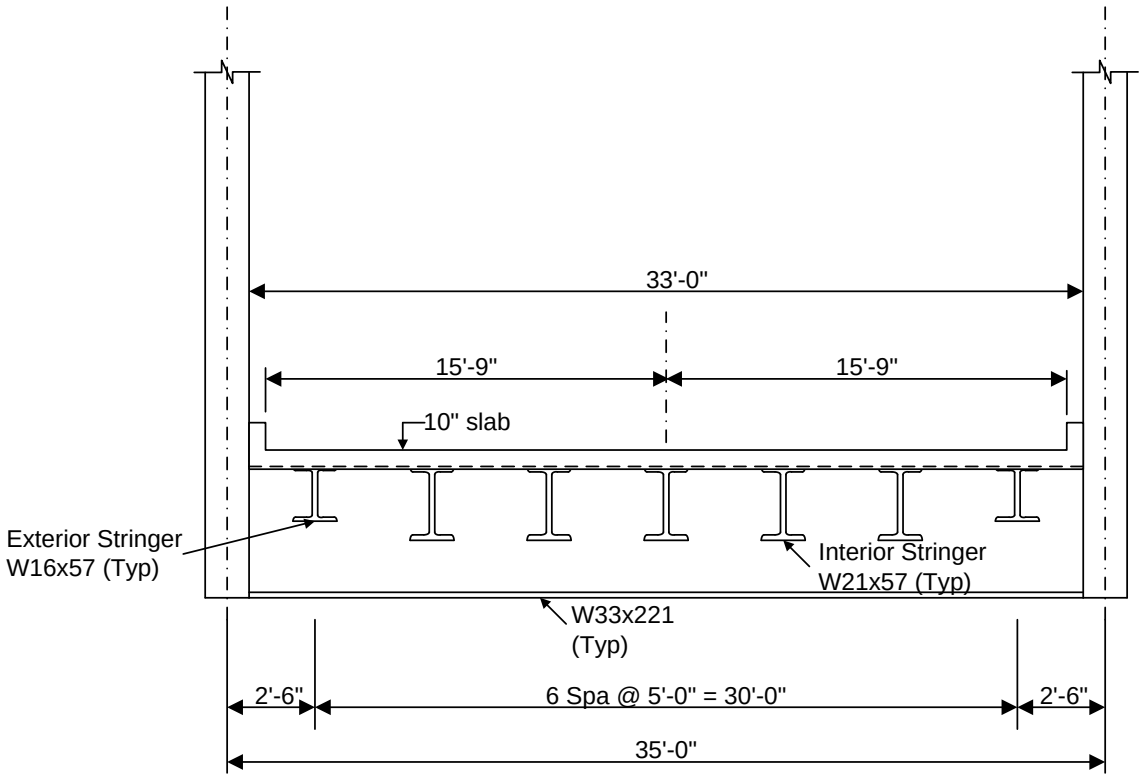
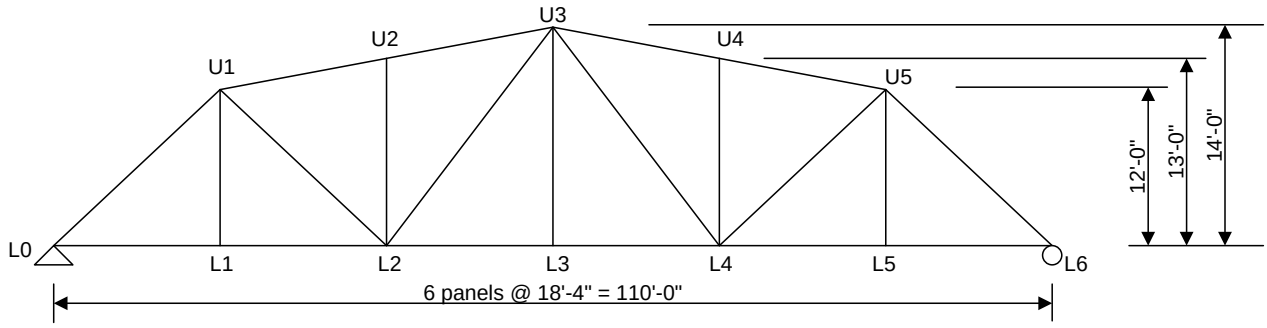
Truss Tutorial

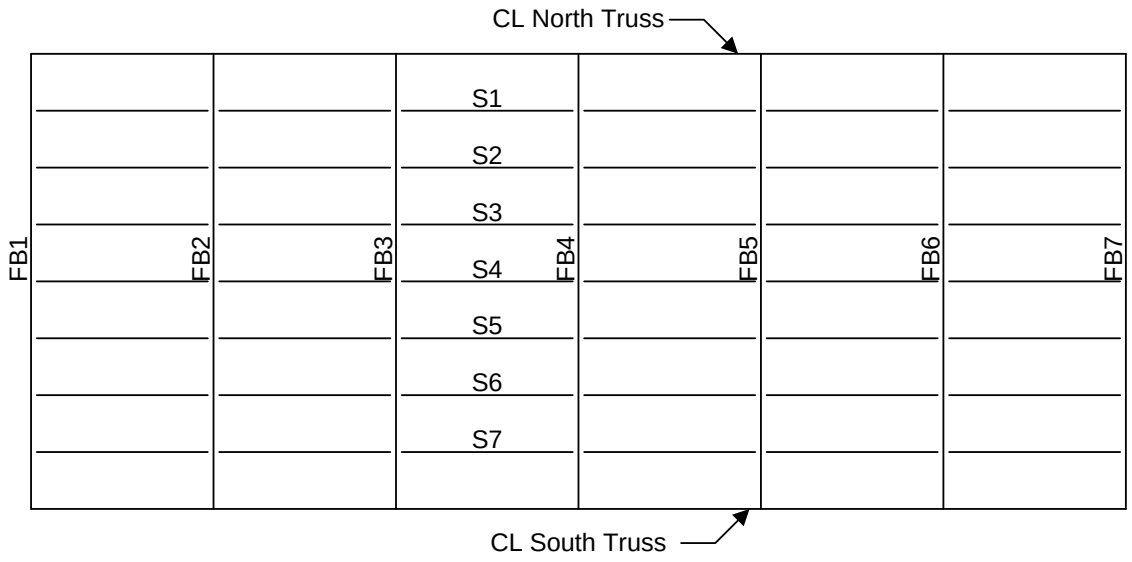
T3 – Truss Floorbeam Stringer Example



Typical Section

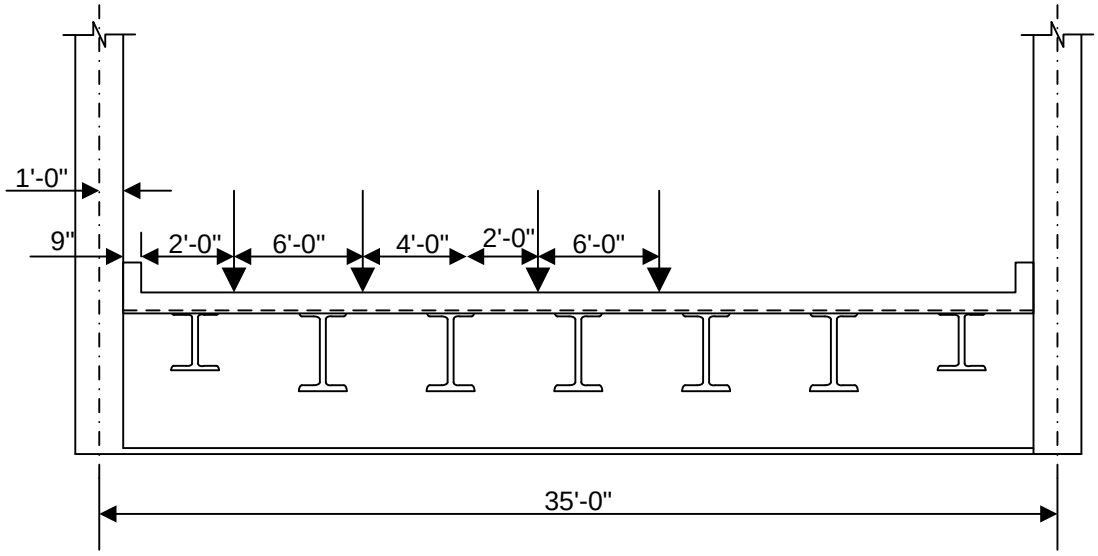


Elevation



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

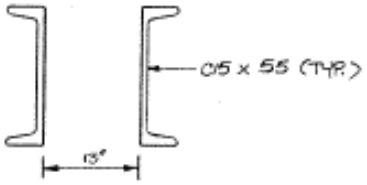
Deflection

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

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

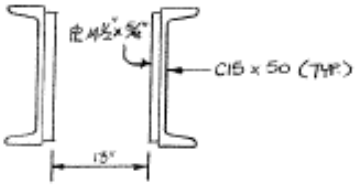
2. Truss Members

i. L_0L_1, L_1L_2, L_4L_5, L_5L_6



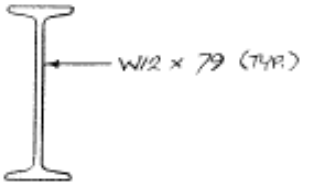
$A = 2(16.16) = 32.32\ in^2$

ii. L_2L_3, L_3L_4



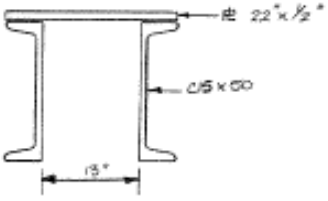
$A = 2\left[14.69 + 14\tfrac{1}{2}(\tfrac{5}{8})\right] = 47.51\ in^2$

iii. L_1U_1, L_2U_2, L_3U_3, L_4U_4, L_5U_6



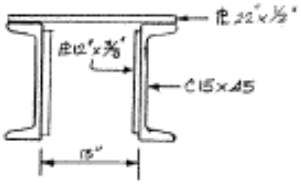
$A = 23.22\ in^2$

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



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

VI. U_1L_2, L_2U_3, U_3L_4, L_4U_5

$A = 19.1\ in^2$

BrR Training

T3 – Truss Floorbeam Stringer Example

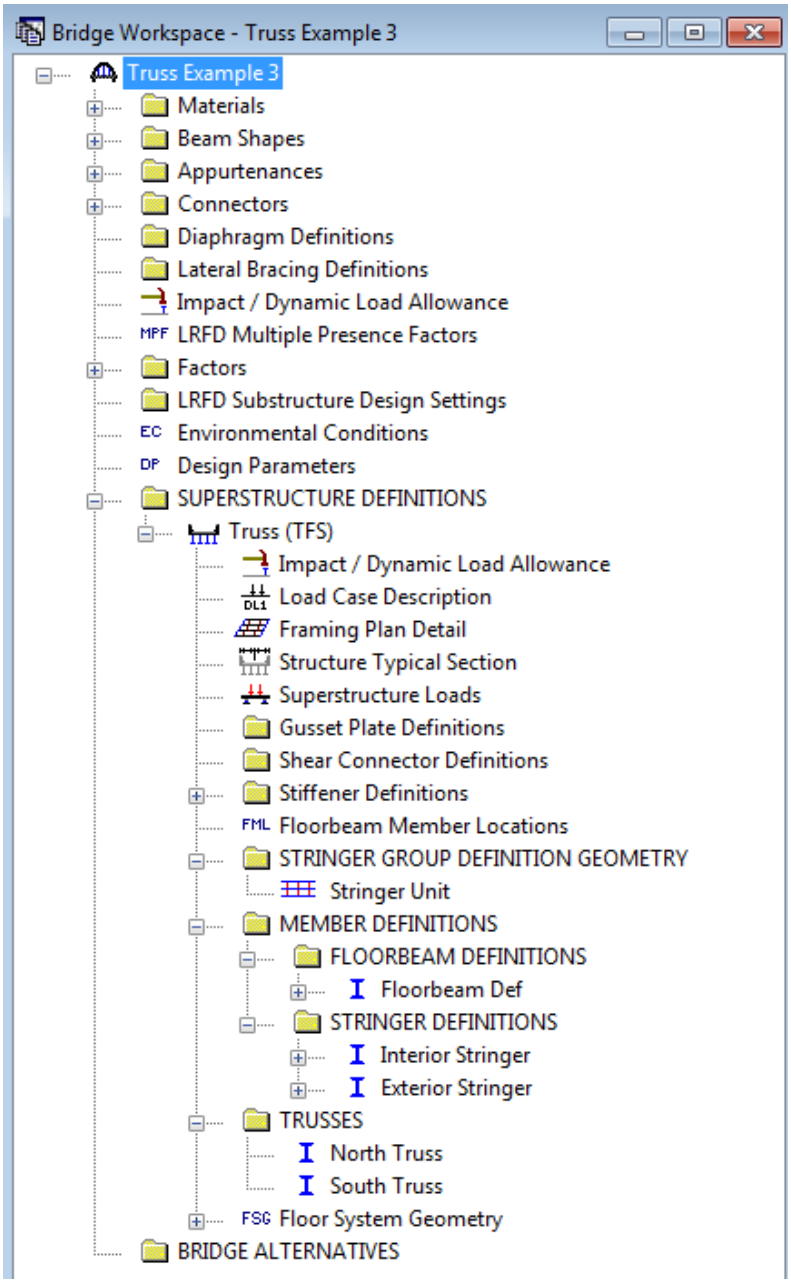
Topics covered:

- Truss description and analysis
- Truss rating results

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

This example assumes that the user is familiar with BrR and its Bridge Workspace. Therefore this example does not go into great detail explaining the Bridge Workspace and detailed entry into windows not particular to a truss.

Import the BRIDGEWare XML data file (*T3-TrussFloorbeamStringerExample.xml*) and use the "North Truss" to start off this example. The Bridge Workspace of T3 is shown below.



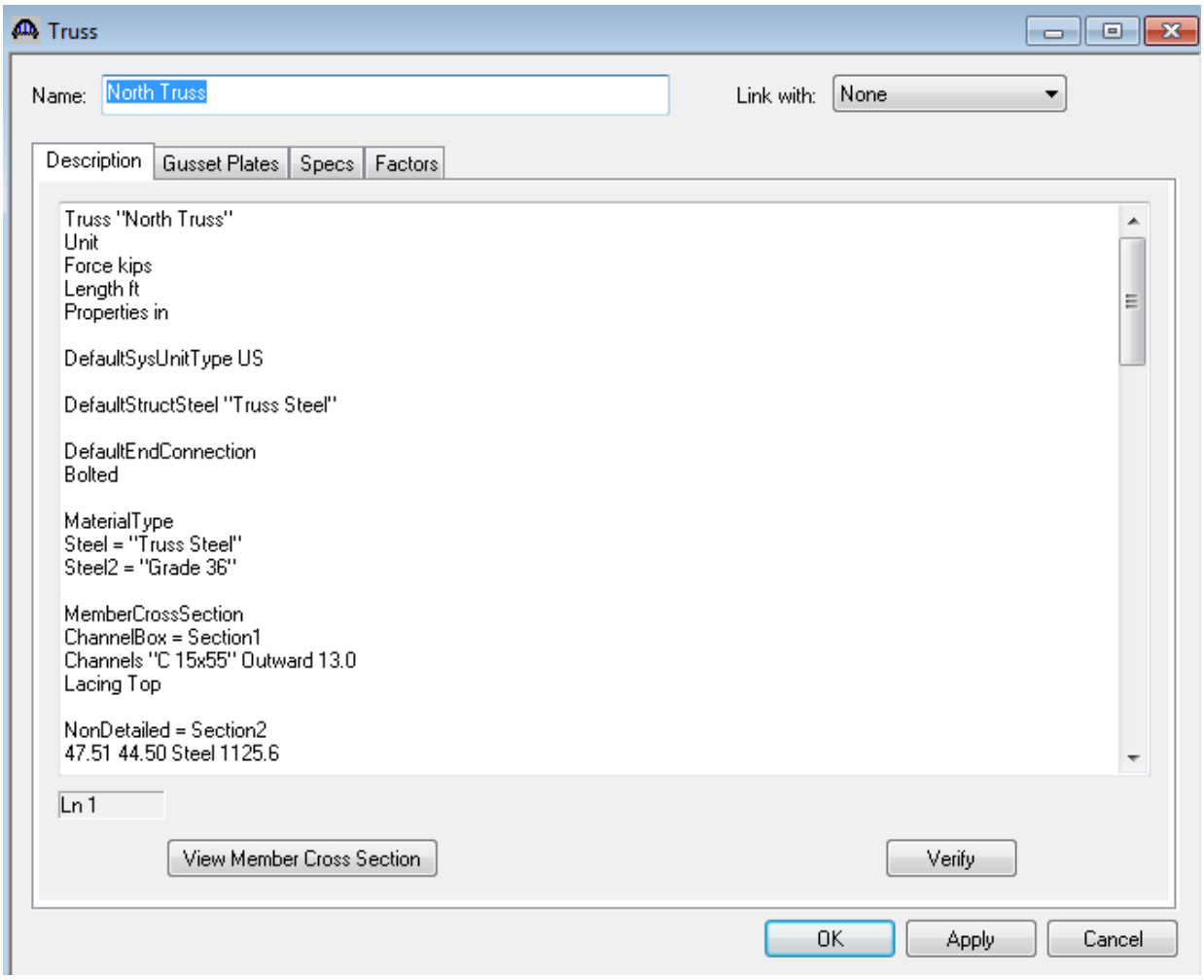
Truss Description and Analysis

Trusses are described in BrR by entering a text description of the truss in the BrR Truss Command Language. This command language contains commands to describe the truss geometry, members, loads, etc. The Truss Command Language User Manual can be accessed from the BrR Truss window's help topic.

BrR analyzes and rates trusses using the BrR Truss analysis engine. You cannot currently pick an alternate engine to perform the analysis. The BrR Truss analysis engine analyzes a finite element model of the truss and computes rating factors using the Load Factor method. The truss is analyzed for axial force only, bending due to load eccentricity is not considered.

The floor system was already entered for this example. We only need to describe truss system.

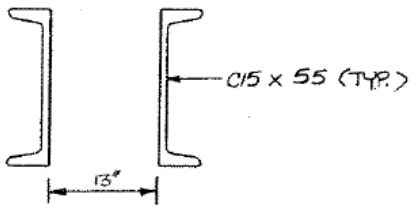
Open the ‘North Truss’ window and enter the text description shown on the next page.

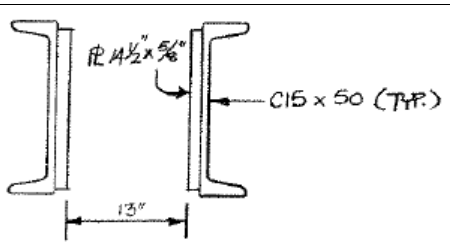
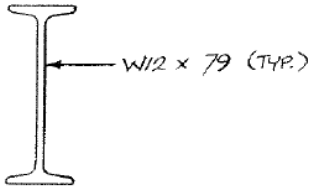
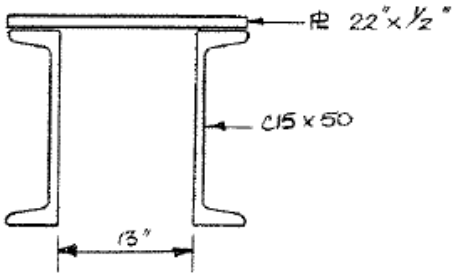
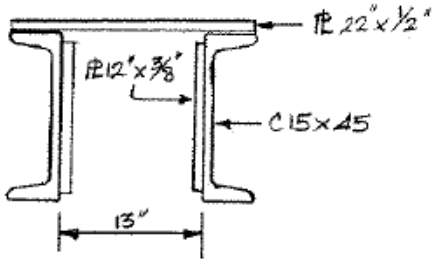


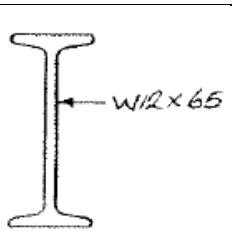
The ‘Verify’ button will read your text description of the truss and verify the syntax of the commands you have input.

The following is a copy of the truss definition described using the BrR Truss Command Language. A description of the command language and its syntax is available by opening the BrR help for the Truss window.

Some of the commands are described in detail below. The name of the command is shown in bold text.

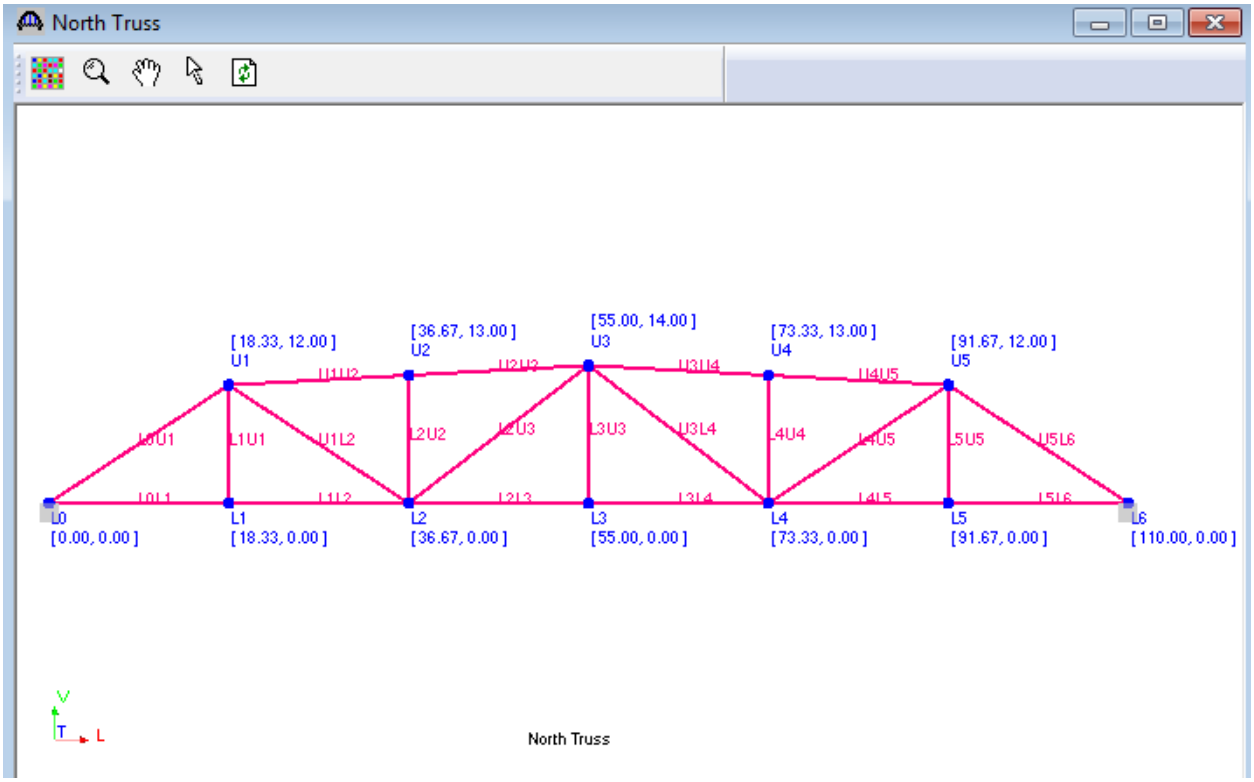
Command	**Comments**
Truss "North Truss"	
Unit Force kips Length ft Properties in	
DefaultSysUnitType US	
DefaultStructSteel "Truss Steel"	The steel material 'Truss Steel' from the BrR BWS will be used as the default steel material if you do not enter a steel material in later commands. The double quotations around "Truss Steel" indicate that Truss Steel is defined in the BrR 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 BrR 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. We only have to enter the gross, net area and the moment of inertia of the section 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.

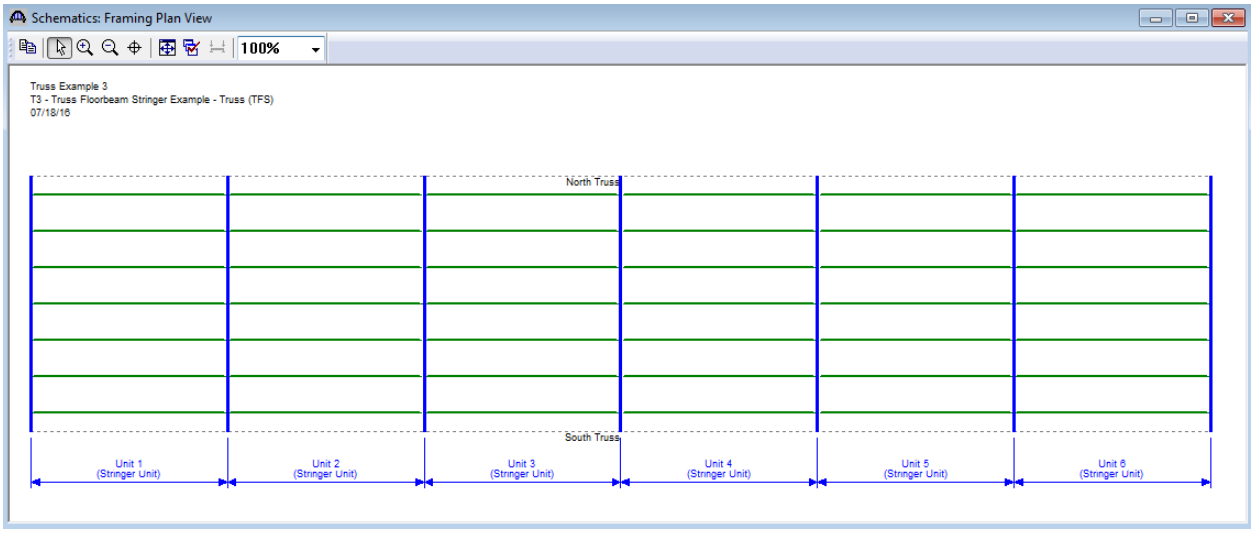
Rolled = Section6 Beam "W 12x65"	
PanelPoint L0 Lower 0.0000 0.0 L1 Lower 18.3333 0.0 L2 Lower 36.6667 0.0 L3 Lower 55.0000 0.0 L4 Lower 73.3333 0.0 L5 Lower 91.6667 0.0 L6 Lower 110.0000 0.0 U1 Upper 18.3333 12.0 U2 Upper 36.6667 13.0 U3 Upper 55.0000 14.0 U4 Upper 73.3333 13.0 U5 Upper 91.6667 12.0	
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	Members are identified by the panel points that they connect and cross sections are assigned to the members in this command.

U3L4 U3 L4 Section6 L4U4 L4 U4 Section3 L4U5 L4 U5 Section6 L5U5 L5 U5 Section3	
Support L0 Pinned L6 Roller	
LLDistribution OneLane 0.805 0.5 MultiLane 1.27 1.0	Lane distribution factors

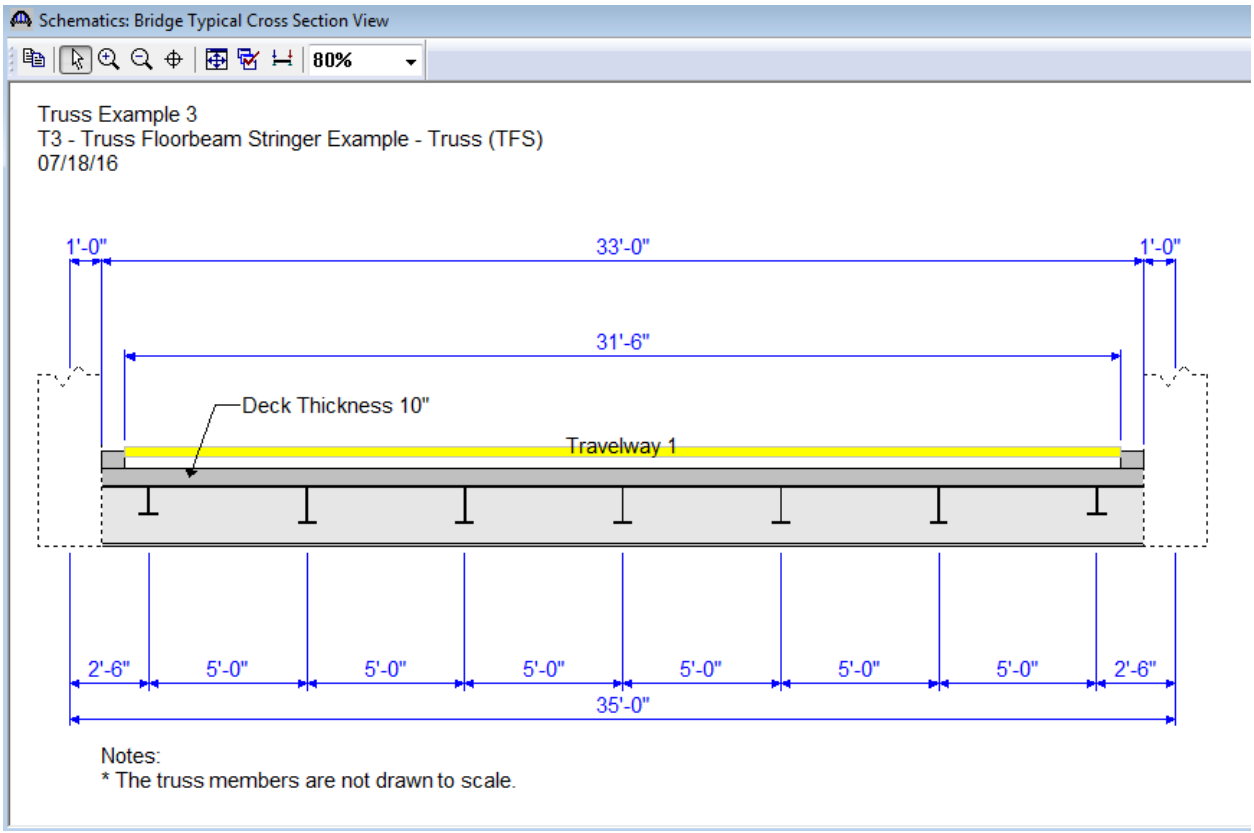
A schematic of the truss is available by selecting the ‘View schematic’ toolbar button when the truss is highlighted in the Bridge Workspace tree.



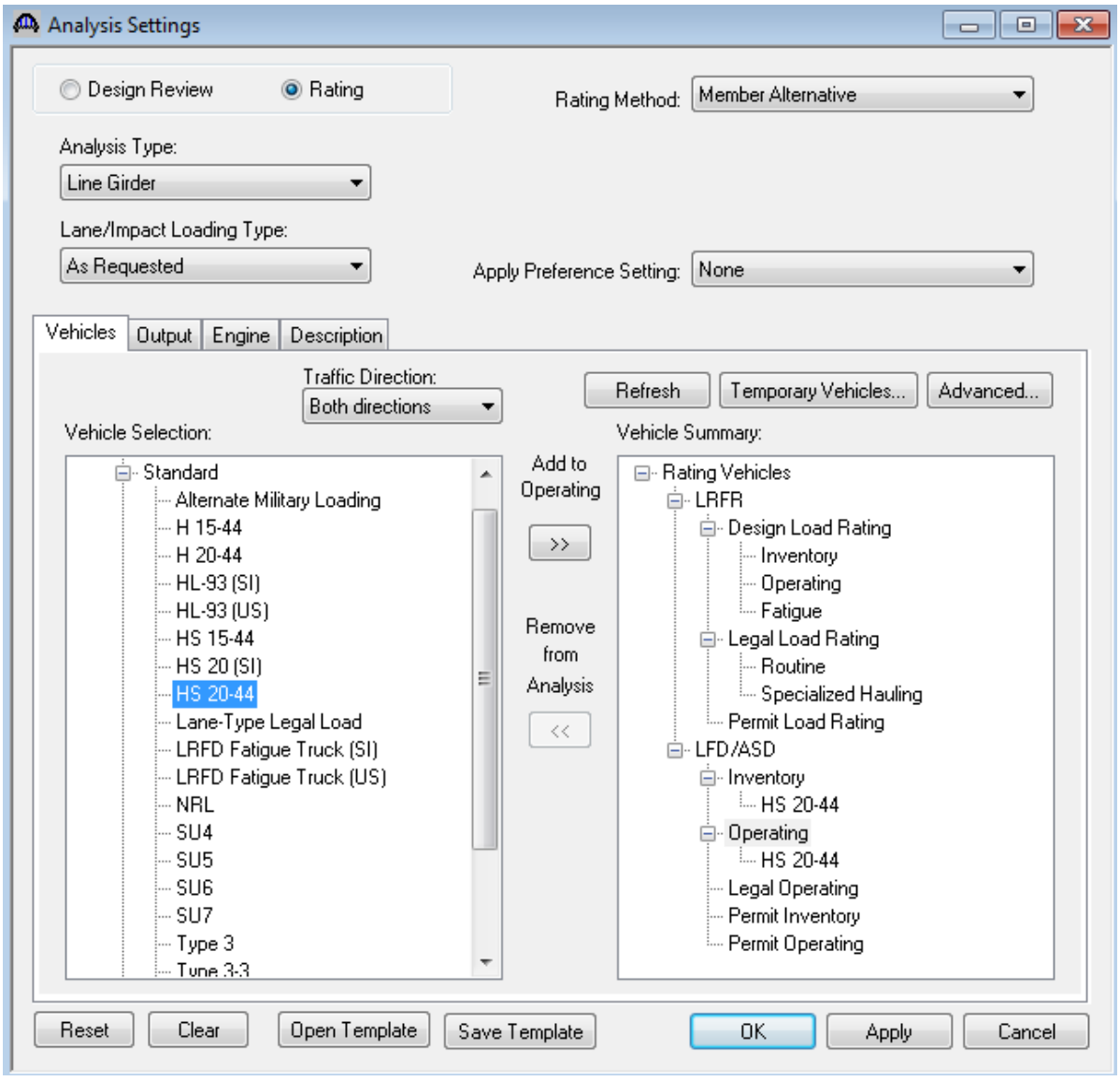
The Framing Plan Schematic now appears as follows:



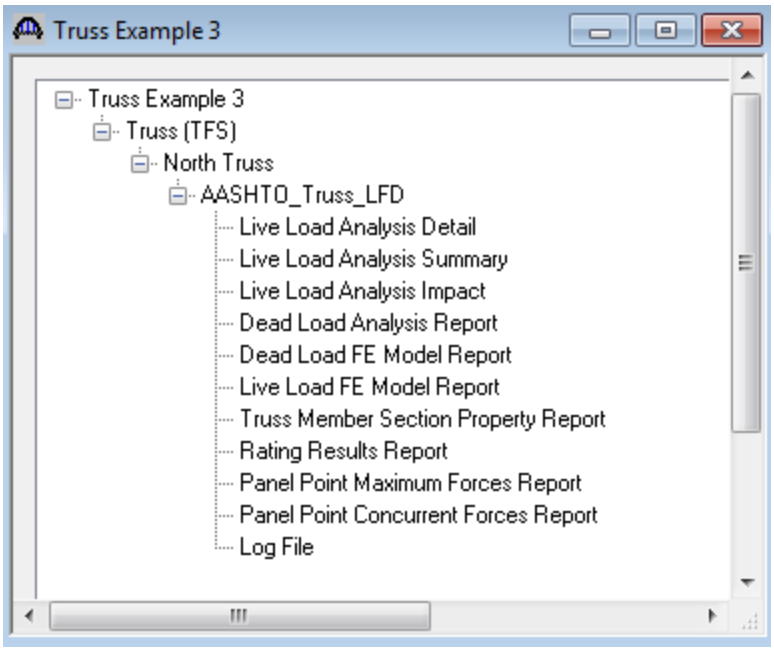
The Structure Typical Section appears as follows:



Select the HS 20 vehicle for the analysis.



Select the ‘North Truss’ in the BWS tree and select the ‘Analyze’ toolbar button to analyze the truss. An analysis progress dialog will appear with messages related to the analysis. After the analysis you can view the output files by selecting the ‘View latest analysis output’ toolbar button.



- The “Live Load Analysis Detail”, “Live Load Analysis Summary” and “Live Load Analysis Impact” files contain 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’ file contains the rating results for the truss.
- The “Panel Point Maximum Forces Report” file 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” file 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 output report is shown below.

Bridge ID :TrussExample3
Bridge : T3 - Truss Floorbeam Stringer Example
StructDef : Truss(TFS)
User : Bridge
Date : Monday, July 18, 2016 08:33:01
File : RatingResults.XML
Analysis Preference Setting : None

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

Overall Load Factor Rating Summary

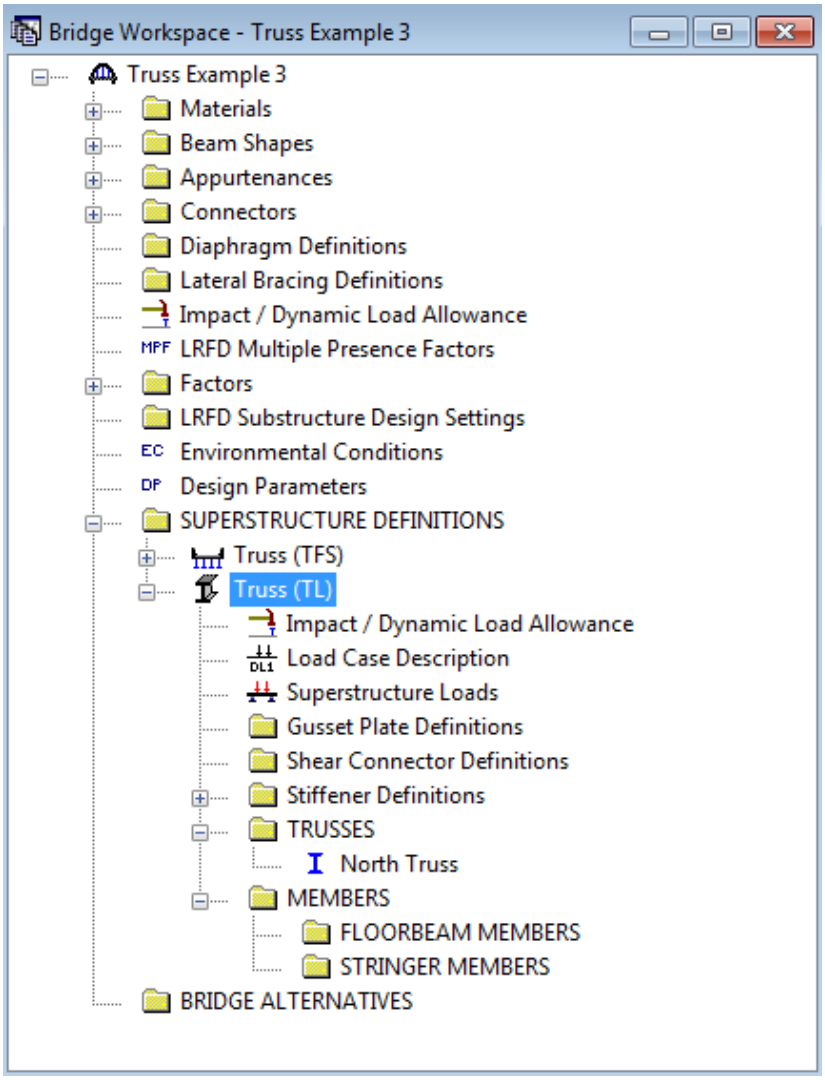
Live Load	Live Load Type	Inv Element	Inv RF	Inv Capacity (Ton)	Opr Element	Opr RF	Opr Capacity (Ton)	Legal Opr Element	Legal Opr RF	Legal Opr Capacity (Ton)	Permit Inv Element
HS 20-44 - Lane	Design Lane	U1L2	2.209	79.53	U1L2	3.689	132.81				
HS 20-44 - Lane	Design Lane	U1L2	2.209	79.53	U1L2	3.689	132.81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

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

Panel Point (ft)	Primary Member (Degrees)	Corresponding Member	Critical LL Force (kip)	Concurrent LL Force (kip)	Critical LL Force (kip)	Concurrent LL Force (kip)
			Compression	Compression / Tension	Tension	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	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

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, you must enter the floor system dead loads that act on the truss yourself. 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