AASHTOWare BrDR 7.5.0

Steel Tutorial

STL3 – Steel Splice Design Review and Rating

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BrDR Tutorial

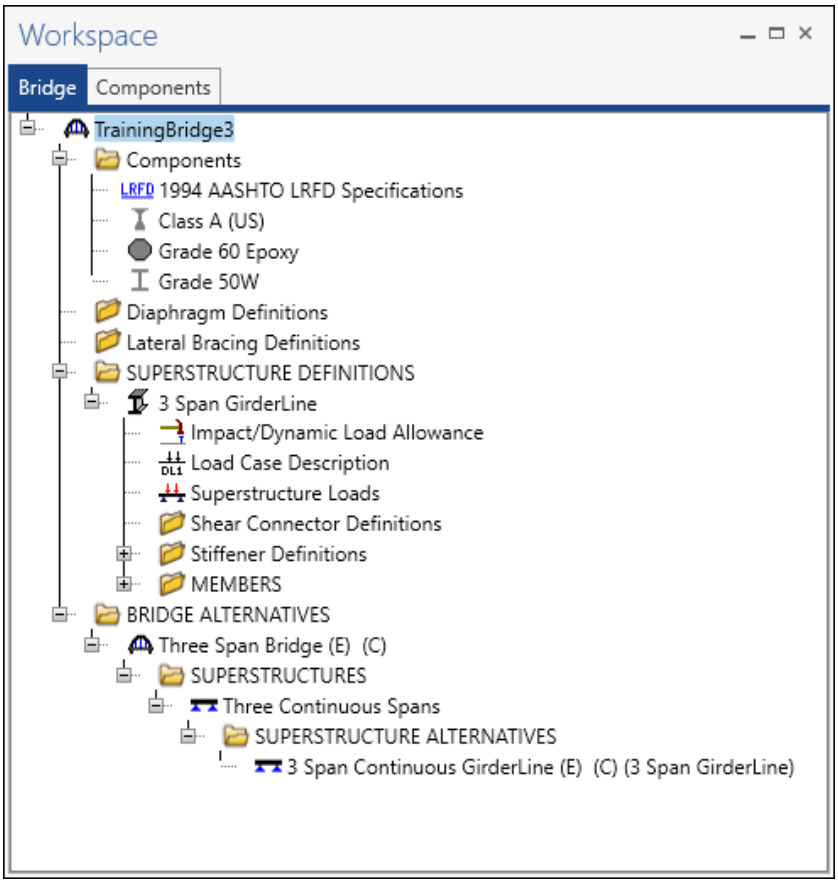
Topics Covered

- Steel splice data entry
- Splice schematic
- Splice analysis options
- LRFD analysis and results
- LRFR analysis and rating
- Using AASHTO LRFD Bridge Design Specifications, 9th Edition.
- Using Manual for Bridge Evaluation, 3rd Edition with 2023 interims.

This example describes entering a steel girder splice into BrDR and analyzing it for both LRFD and LRFR.

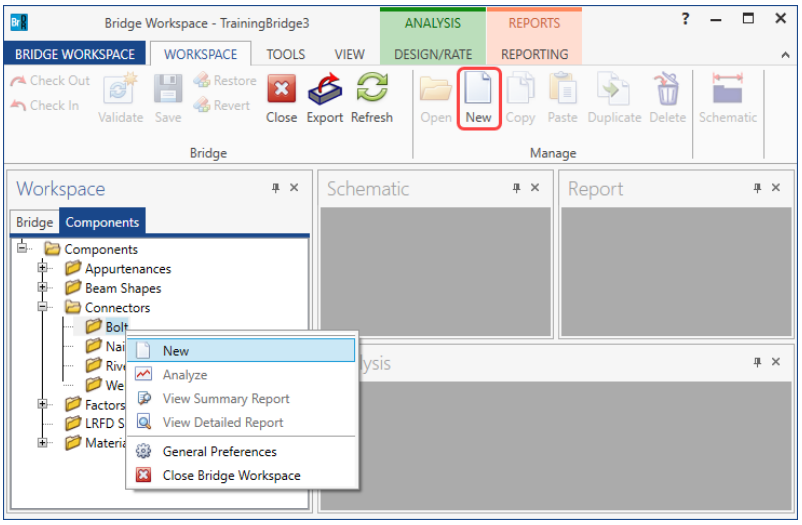
Steel splice data entry

Open bridge **BID3 – TrainingBridge3** from the sample database in the **Bridge Explorer**. The partially expanded **Bridge Workspace** tree is shown below.

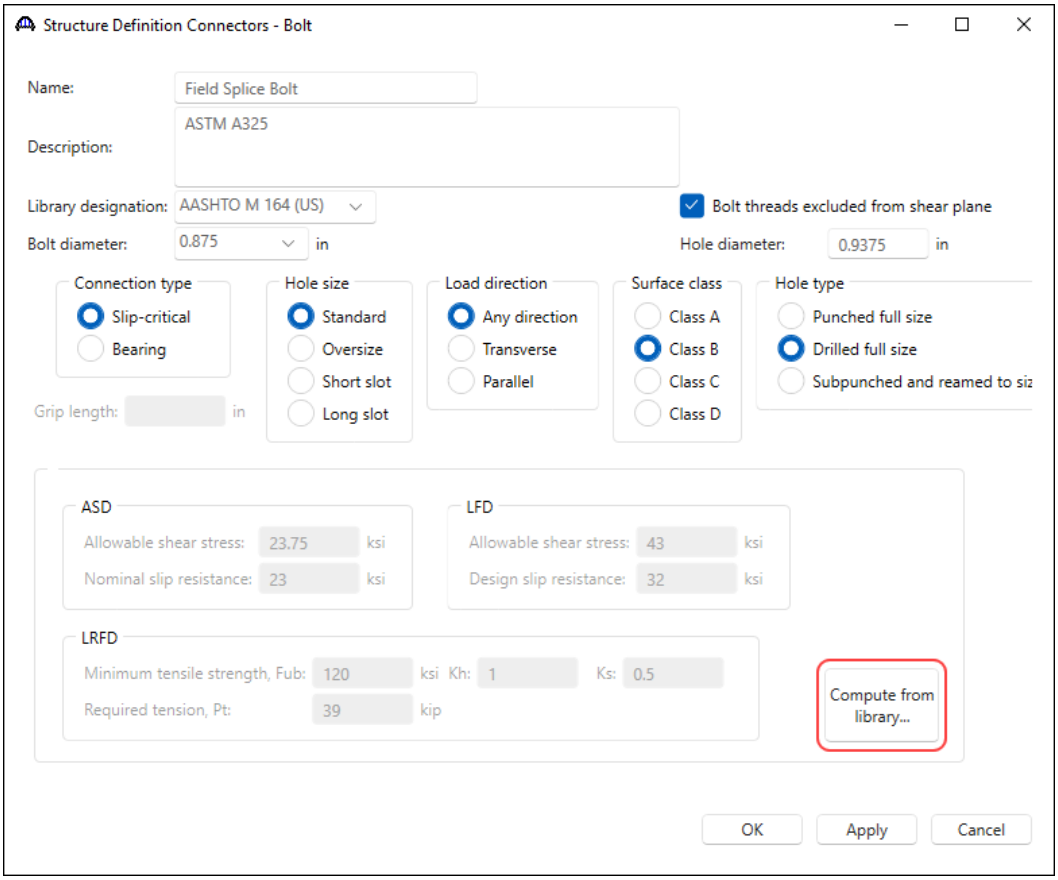


Bridge Materials - Connectors

To create a new bolt material, in the **Components** tab of the **Bridge Workspace**, expand the **Connectors** node, click on **Bolt**, and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Bolt** and select **New**). The window shown below will open.



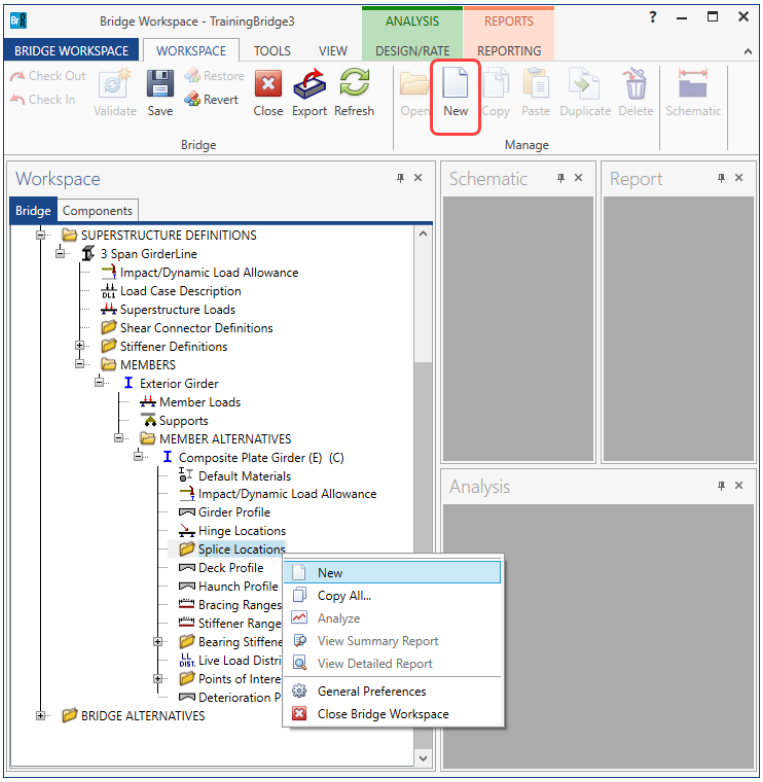
Enter the data as shown below and click the **Compute from library…** button.



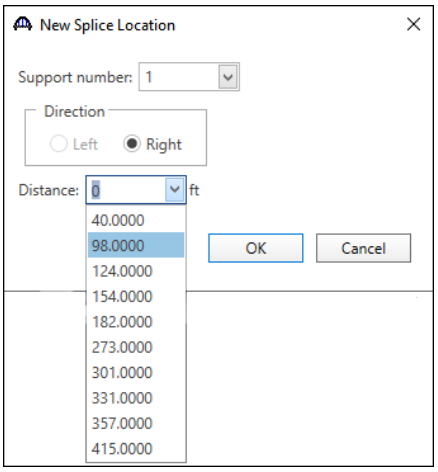
Click **OK** to apply the data and close the window.

Splice Location

Returning to the **Bridge** tab of the **Bridge Workspace**, expand the **Exterior Girder** member, **Composite Plate Girder** member alternative and select the **Splice Locations** node. Click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **Open** from the menu) to open the **New Splice Location** window as shown below.



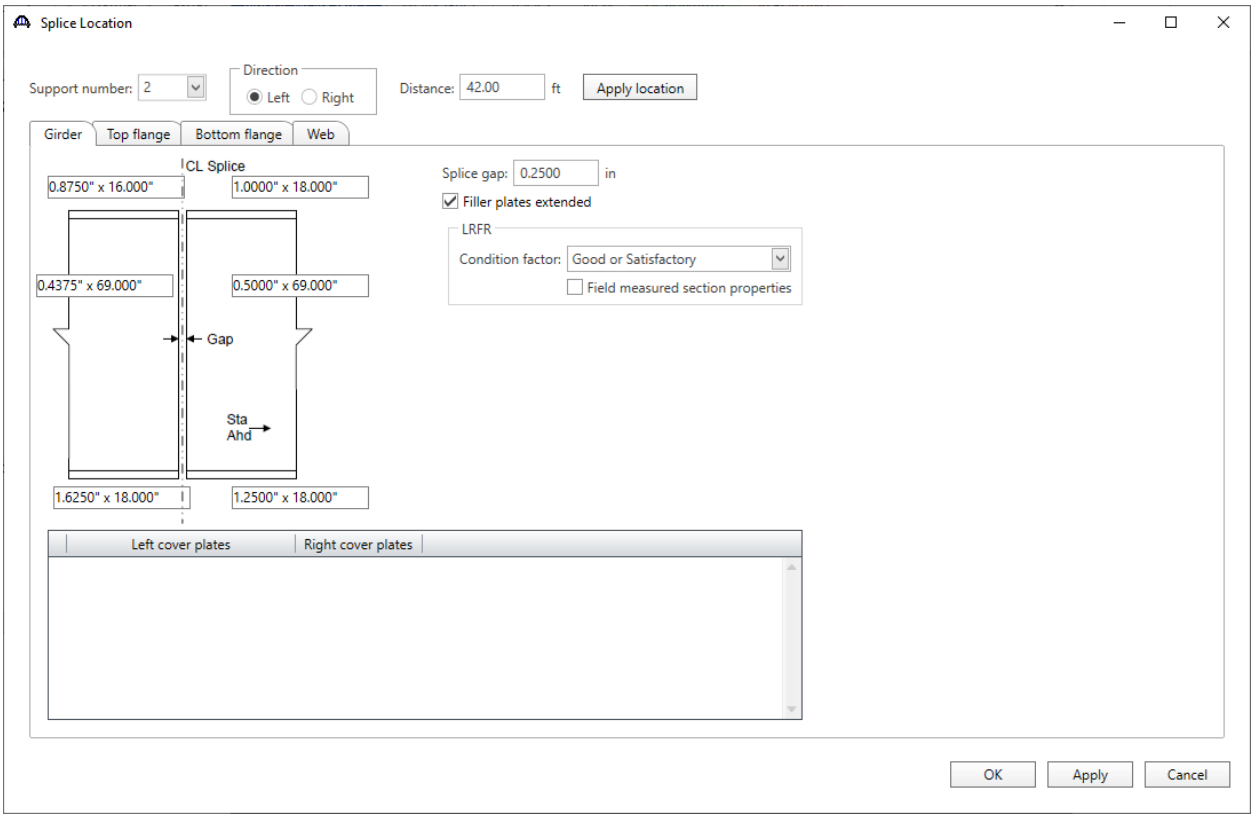
The drop down menu for **Distance** contains the locations of girder section change points (flanges and webs) that were described in the **Girder Profile** window. One of these values can be selected, or a location value can be manually entered. For this example, select 98’ from the drop down.



Click **OK** to open the **Splice Location** window as shown below.

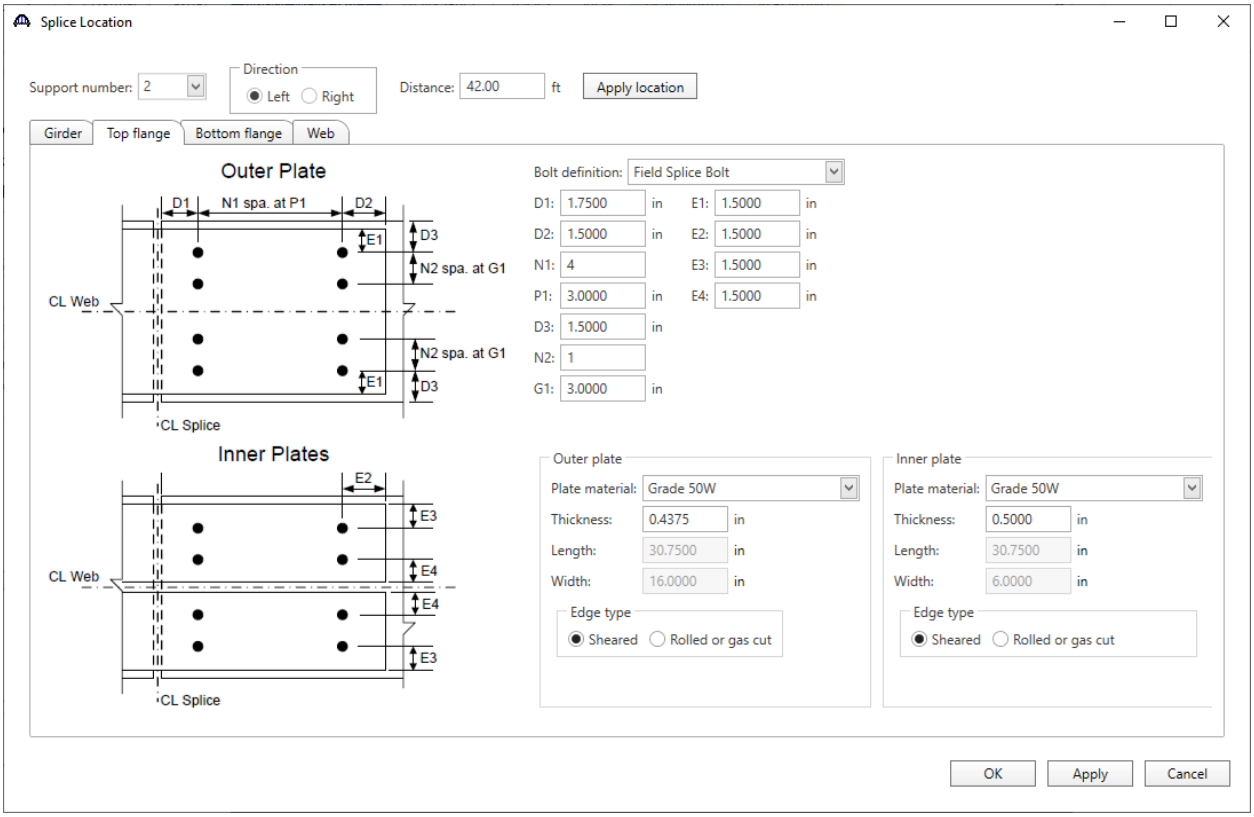
Splice Location – Girder

Enter the splice gap information as shown below and check the **Filler plate extended** checkbox, which will be disabled if the girder plate sizes don't vary on either side of the splice. The **Apply location** button updates the displayed girder plate sizes if the location changes.



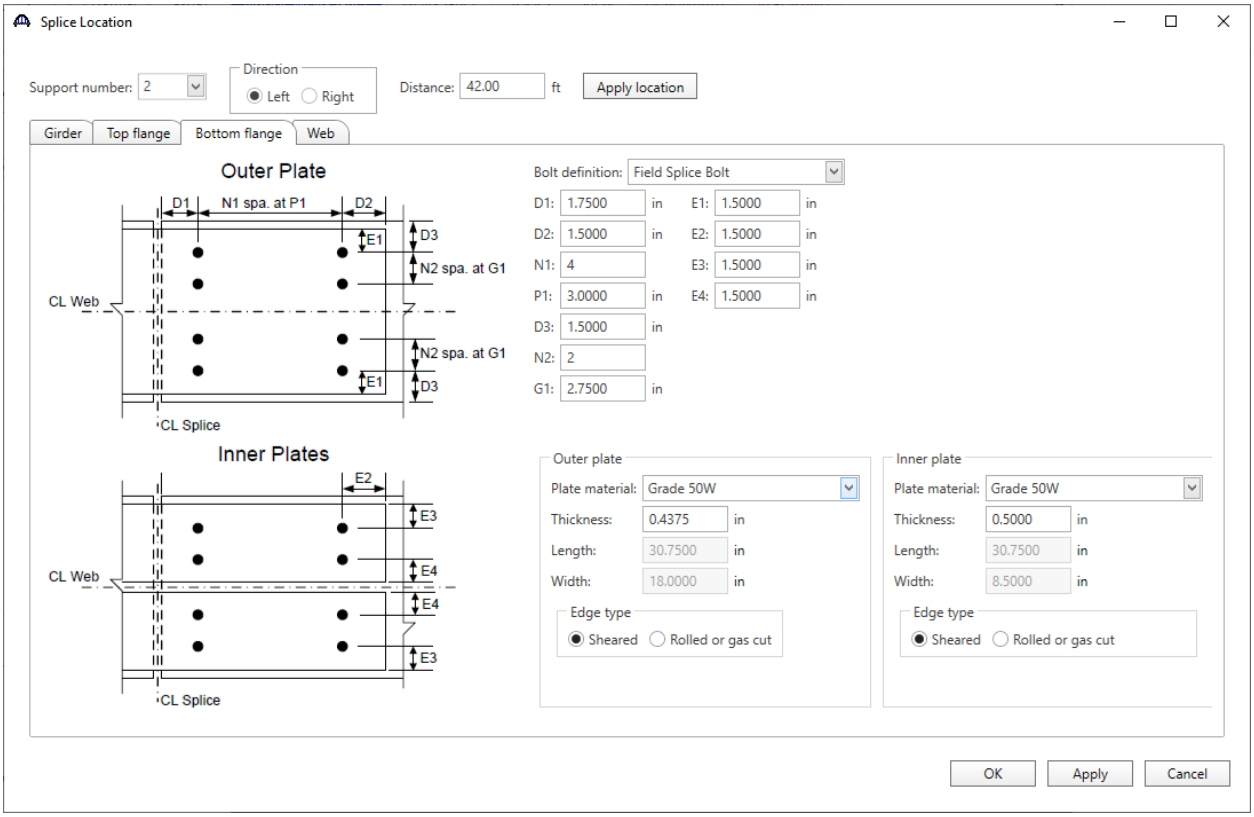
Splice Location – Top flange

Navigate to the **Top flange** tab of this window and enter the data as shown below.



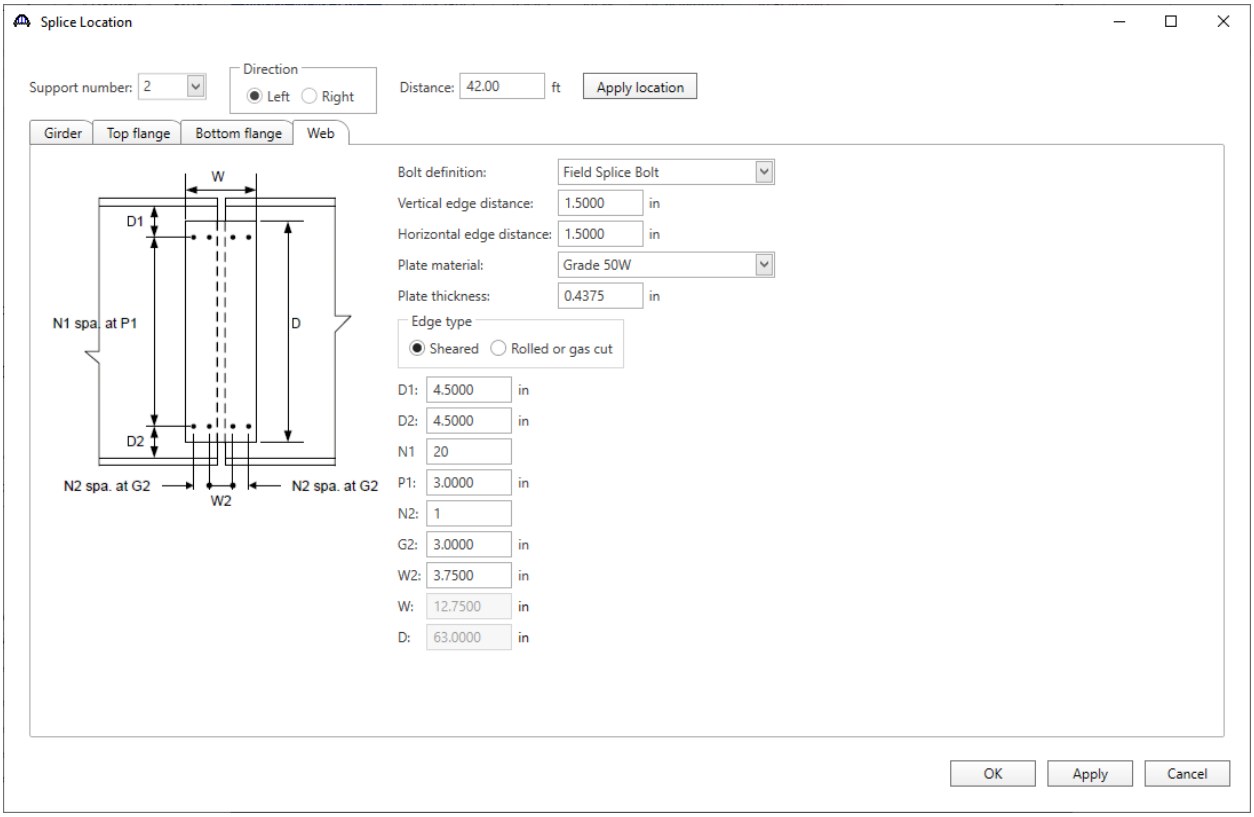
Splice Location – Bottom flange

Navigate to the **Bottom flange** tab of this window and enter the data as shown below.



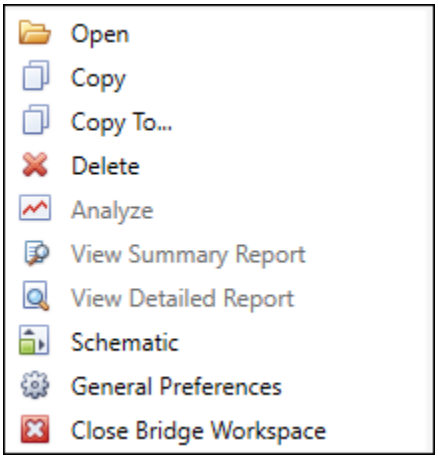
Splice Location – Web

Navigate to the **Web** tab of this window and enter the data as shown below.



Click **OK** to apply the data and close the window.

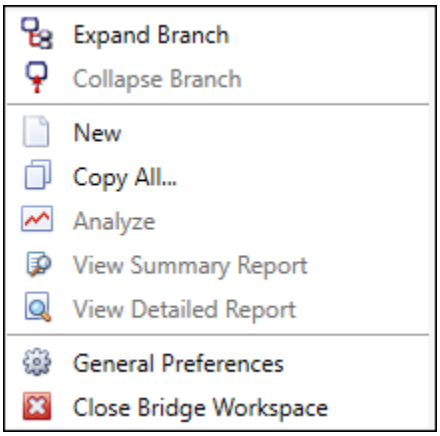
Splice – Right click menu



Copy – copy and then paste the splice to another member alternative.

Copy To… - opens a window allowing the user to pick 1 or more member alternatives to copy to.

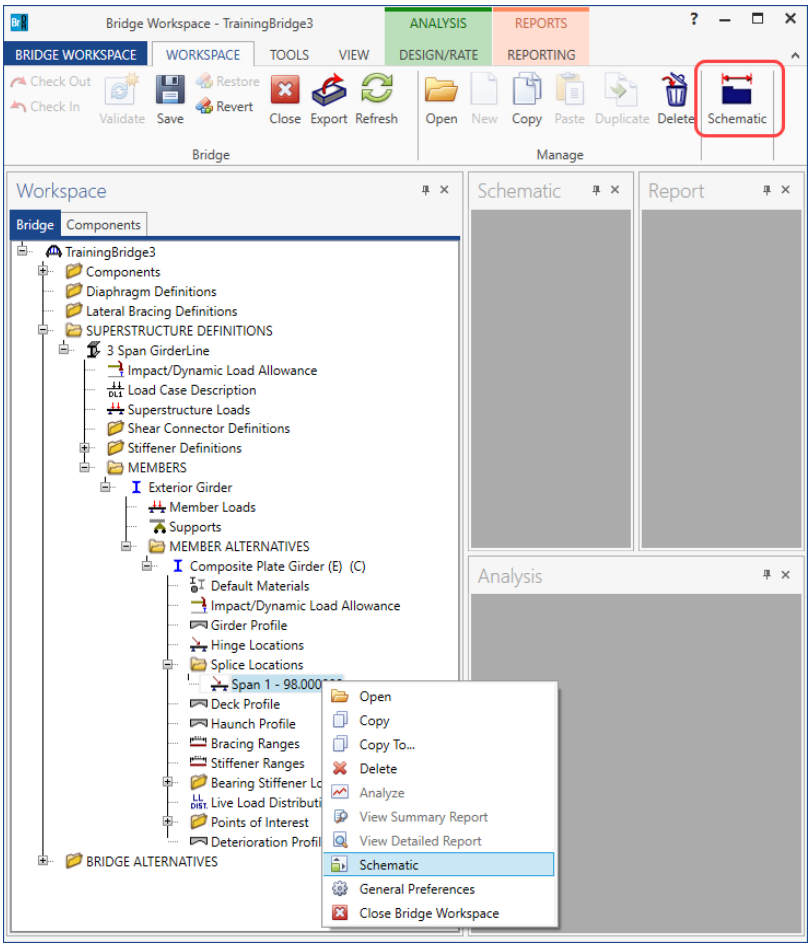
Splice Locations – Right click menu



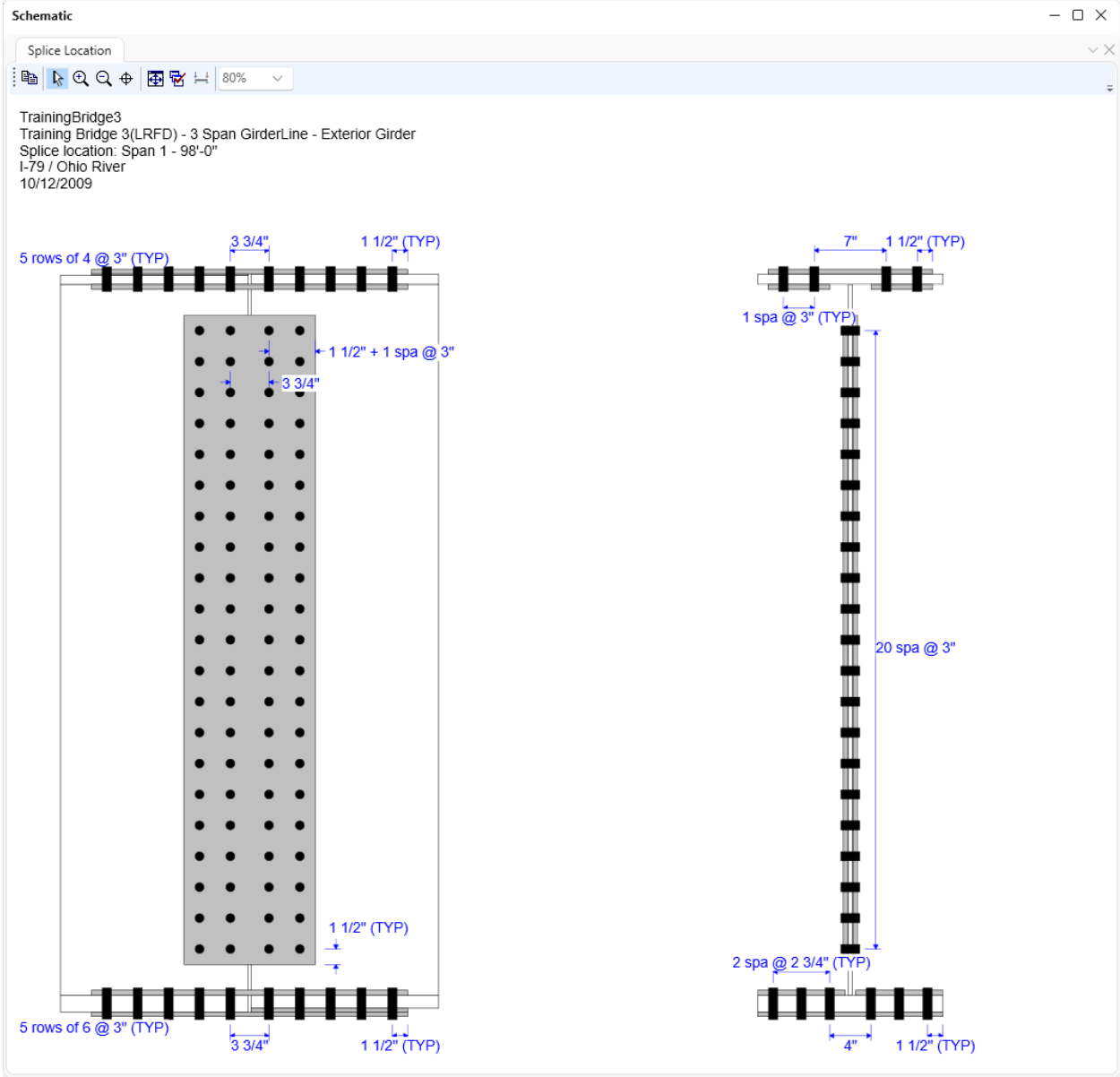
Copy All… - opens a window allowing the user to pick one or more member alternatives to copy all the splices in the member alternative to.

Splice - Schematic

Select the splice **Span 1 – 98.000000** in the **Bridge Worksapce** tree and click on the **Schematic** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **Schematic** from the menu) as shown below.



The following schematic is displayed.



Splice Analysis Options

Analyze a single splice.

Select a **Splice Location** in the **Bridge Workspace** tree and click the **Analyze** button from the **Analysis** group of the **DESIGN/RATE** ribbon. The girder DL and LL analysis will run. Specification checks will be performed at points required for the splice location, the splice itself, and stress calculations at adjacent brace points. For LRFR or LFR, the spec checks will include the splice rating articles.

Analyze a girder that contains a splice.

LRFD Design Review.

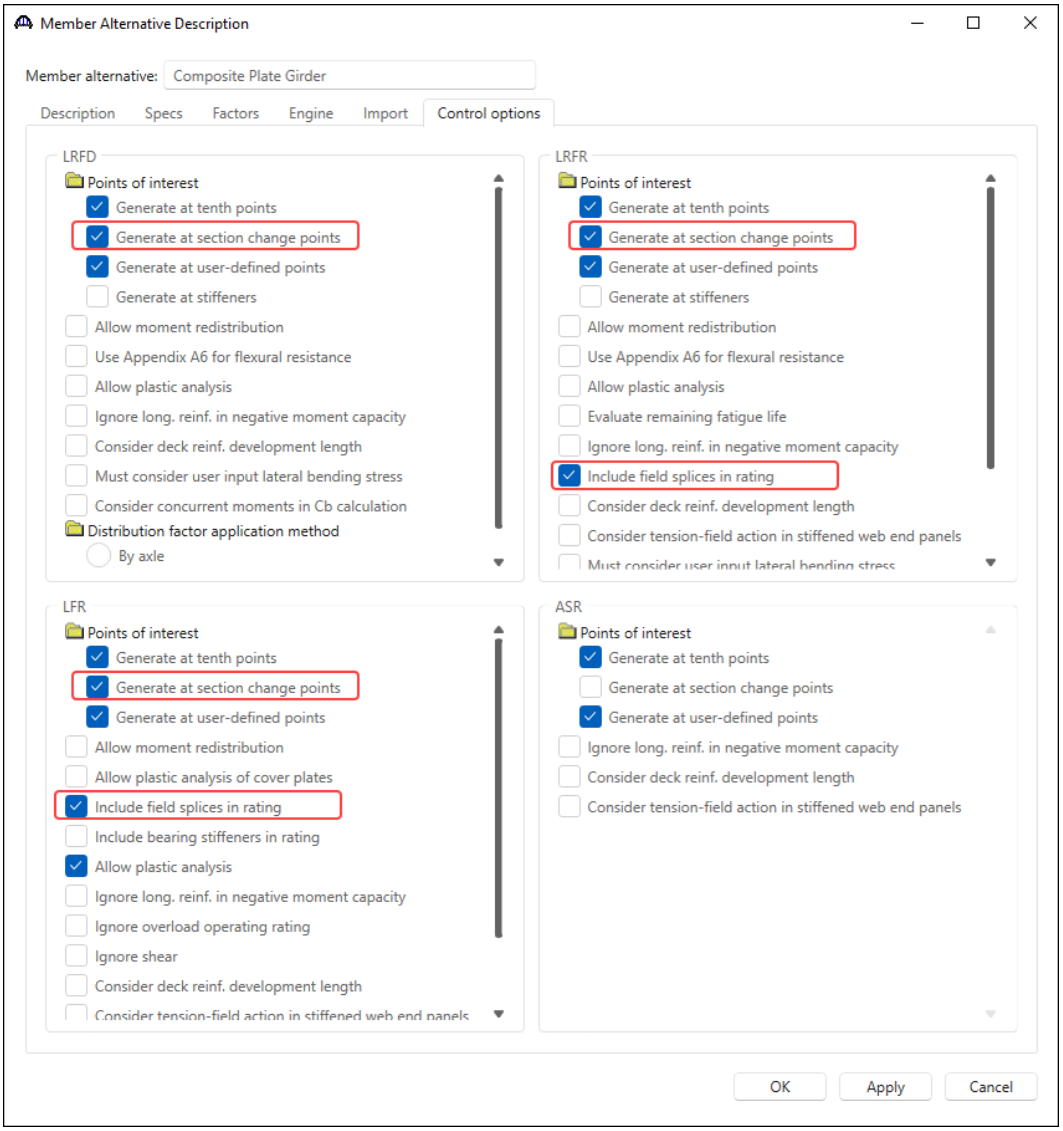
Select **Generate at section change points** under **LRFD** in the **Control options** tab of the **Member Alternative Description** window for a member alternative to have spec checking occur at the splice location. Splice specification articles will be processed in addition to the regular steel girder specification articles.

LRFR/LFR Rating

Select **Generate at section change points** under **LRFR** and **LFR** to have specification checking occur at the splice location. Splice specification articles will be processed in addition to the regular steel specification girder articles. Also select **Include splices in rating** to have the splice rating articles processed as well.

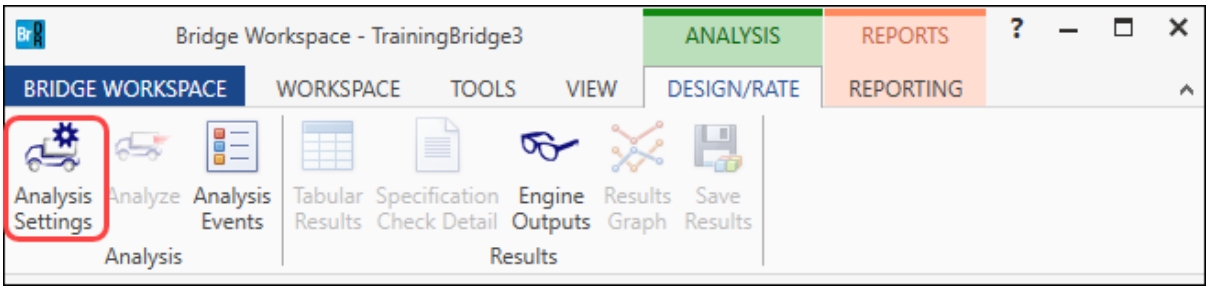
Select only **Include splices in rating** to have the splice specification articles and splice rating specification articles processed at the splice locations in addition to the regular steel girder specification articles.

*(See the image below for **Member Alternative Description – Control options** settings)*

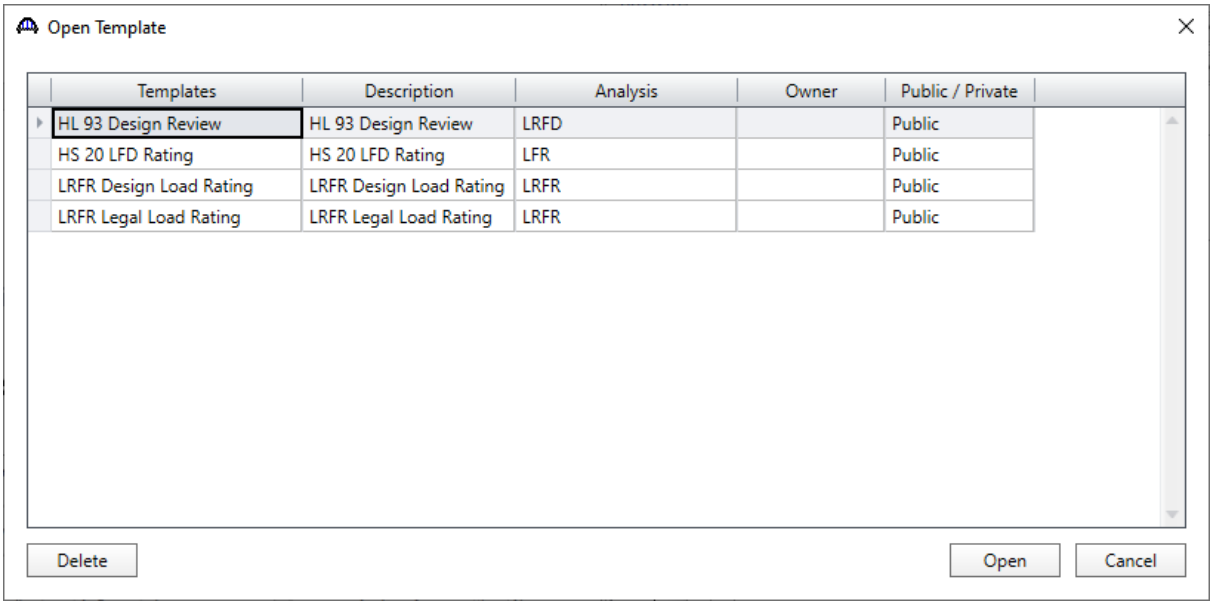

Member Alternative Description
Member alternative: Composite Plate Girder
Description
Specs
Factors
Engine
Import
Control options
LRFD
Points of interest
Generate at tenth points
Generate at section change points
Generate at user-defined points
Generate at stiffeners
Allow moment redistribution
Use Appendix A6 for flexural resistance
Allow plastic analysis
Ignore long. reinf. in negative moment capacity
Consider deck reinf. development length
Must consider user input lateral bending stress
Consider concurrent moments in Cb calculation
Distribution factor application method
By axle
LRFR
Points of interest
Generate at tenth points
Generate at section change points
Generate at user-defined points
Generate at stiffeners
Allow moment redistribution
Use Appendix A6 for flexural resistance
Allow plastic analysis
Evaluate remaining fatigue life
Ignore long. reinf. in negative moment capacity
Include field splices in rating
Consider deck reinf. development length
Consider tension-field action in stiffened web end panels
LFR
Points of interest
Generate at tenth points
Generate at section change points
Generate at user-defined points
Allow moment redistribution
Allow plastic analysis of cover plates
Include field splices in rating
Include bearing stiffeners in rating
Allow plastic analysis
Ignore long. reinf. in negative moment capacity
Ignore overload operating rating
Ignore shear
Consider deck reinf. development length
ASR
Points of interest
Generate at tenth points
Generate at section change points
Generate at user-defined points
Ignore long. reinf. in negative moment capacity
Consider deck reinf. development length
Consider tension-field action in stiffened web end panels
OK
Apply
Cancel

LRFD Design Review

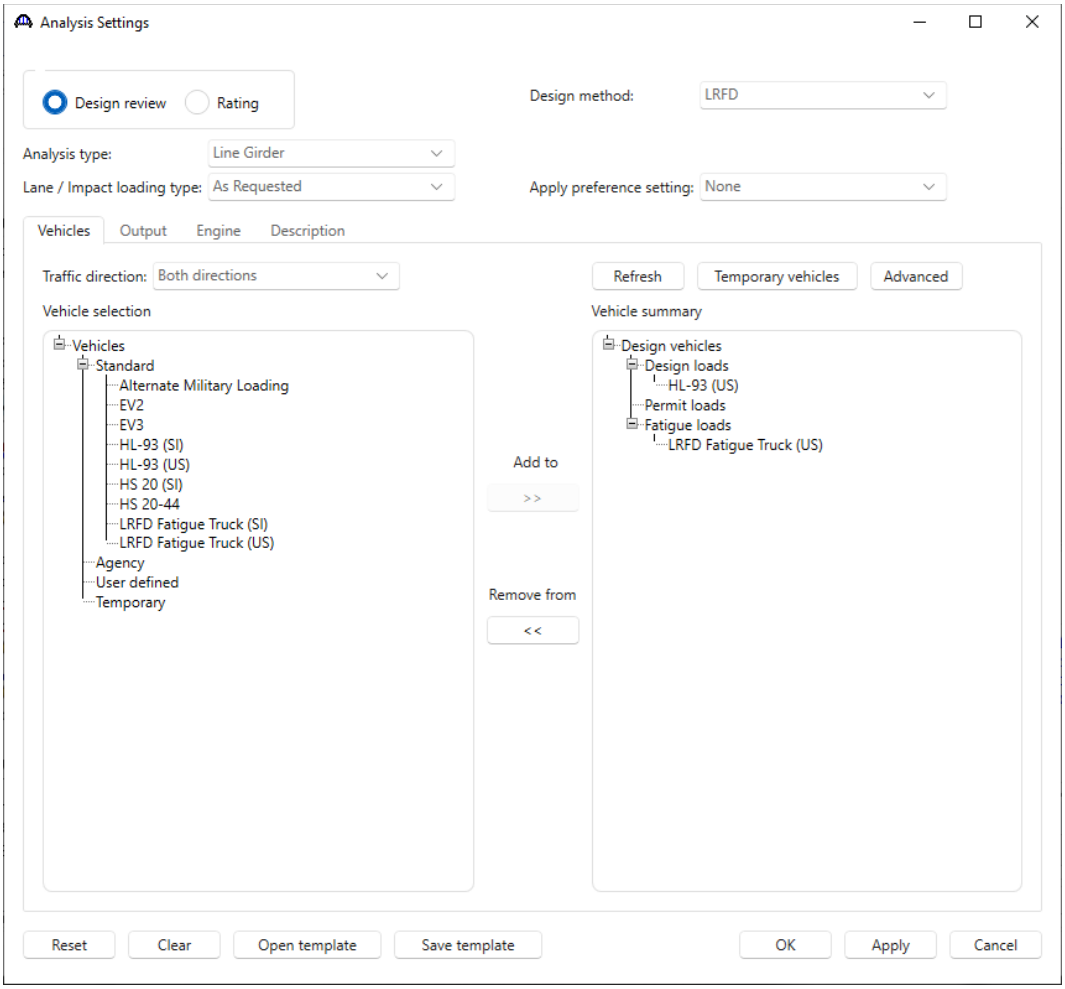
To perform an LRFD design review, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.



Click the **Open Template button** and select the **HL 93 Design Review** to be used in the design review and click **Open**.



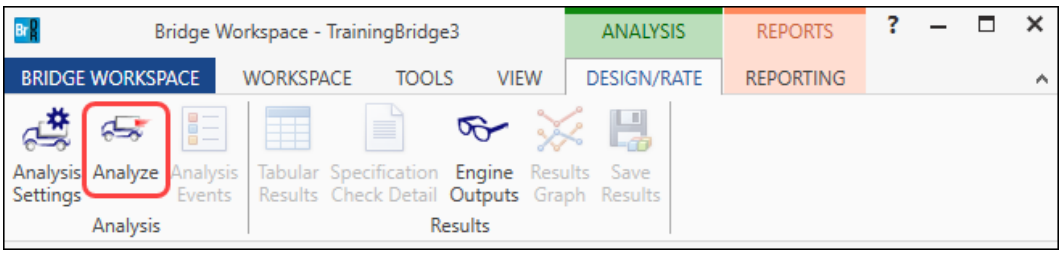
The **Analysis Settings** window will be populated as shown below.



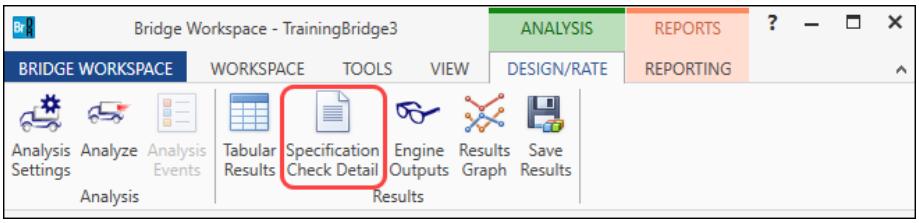
Click **OK** to apply the data and close the window.

Specification Check Detail

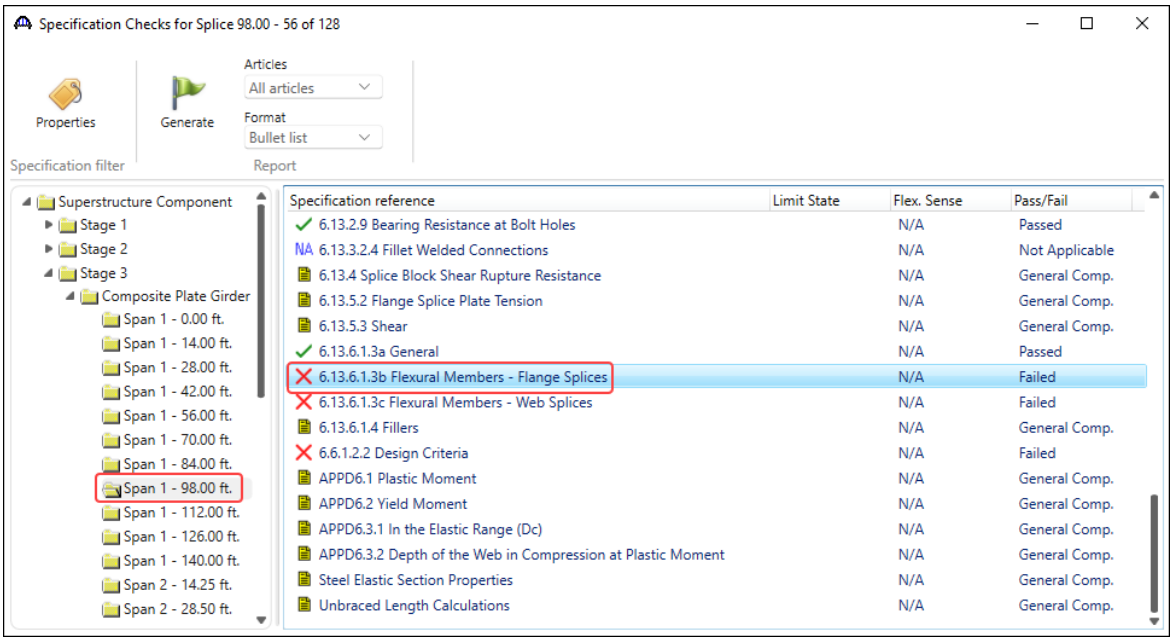
Select the splice **Span 1 – 98.00** in the **Bridge Workspace** tree and click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating. This will begin an analysis and specification check of the points required for the splice, the splice location (98.00 ft) itself and typically the brace points on the left and right side of the splice location (84.00 ft and 112.00 ft).



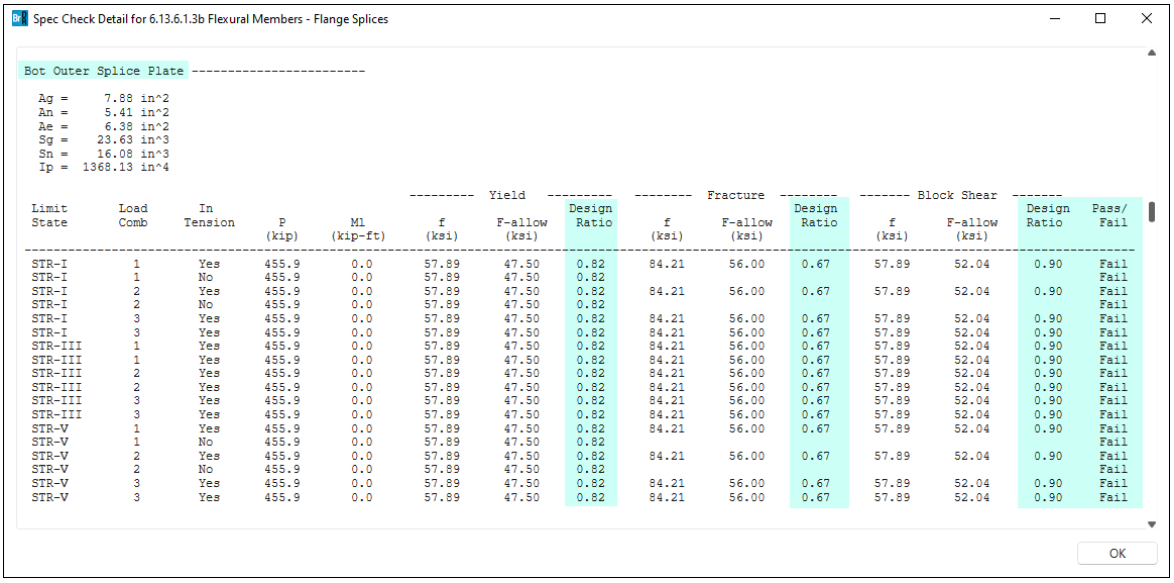
The specification checks for the splice can be viewed by clicking the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon.



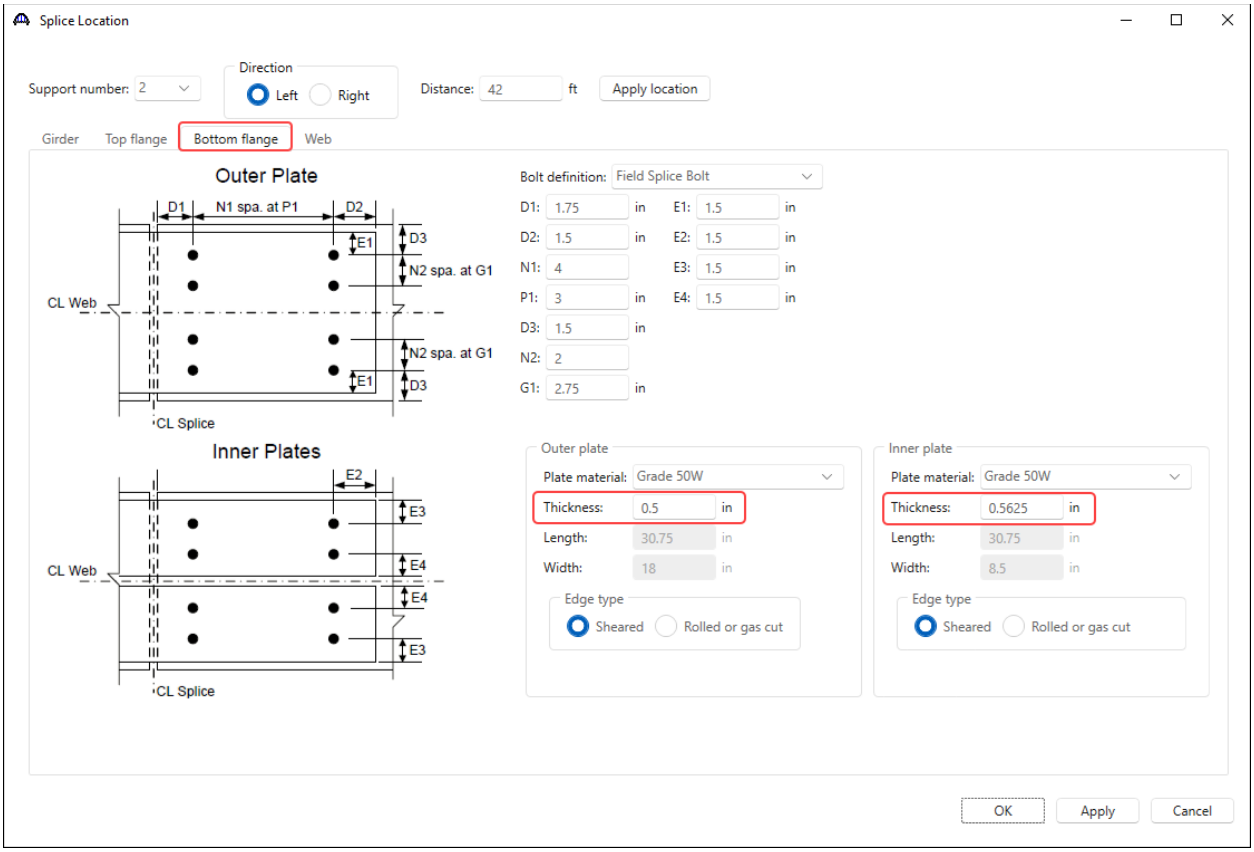
Double click on the **6.13.6.1.3b Flexural Members – Flange Splices** article for **Stage 3** at **Span 1 – 98.00 ft**.



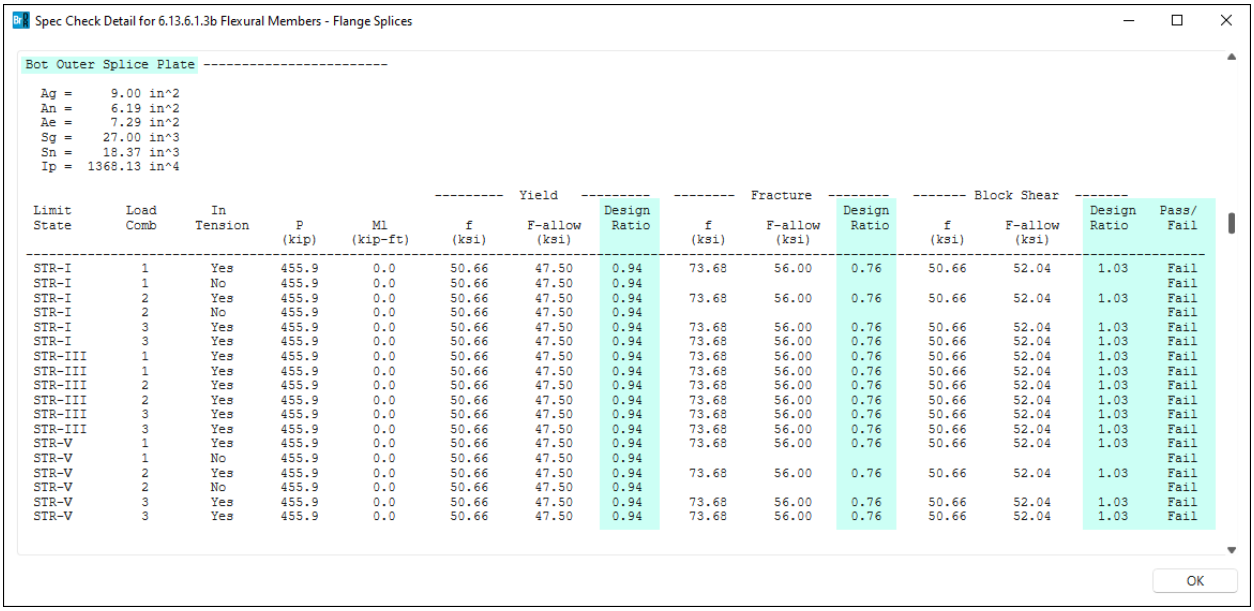
Review the splice specification article. Article 6.13.6.1.3b fails for the bottom flange splice plates.



Revise the bottom flange splice plate as follows in the **Splice location** window.



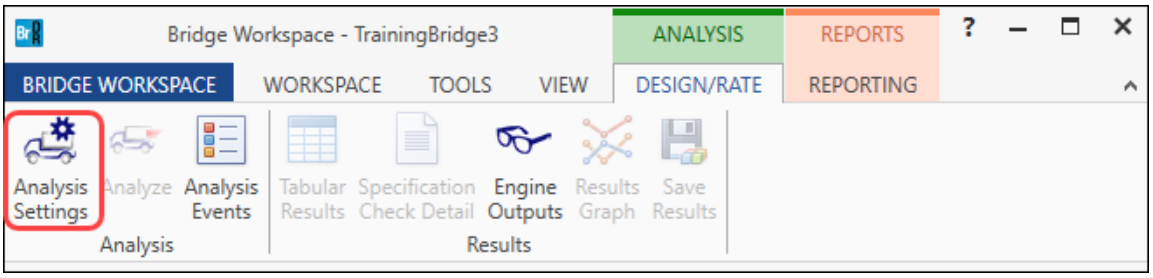
Rerun the LRFD design review on the splice plate. Once the analysis is complete, open the same specification article and review the results. Take note of the change in design ratios as shown below.



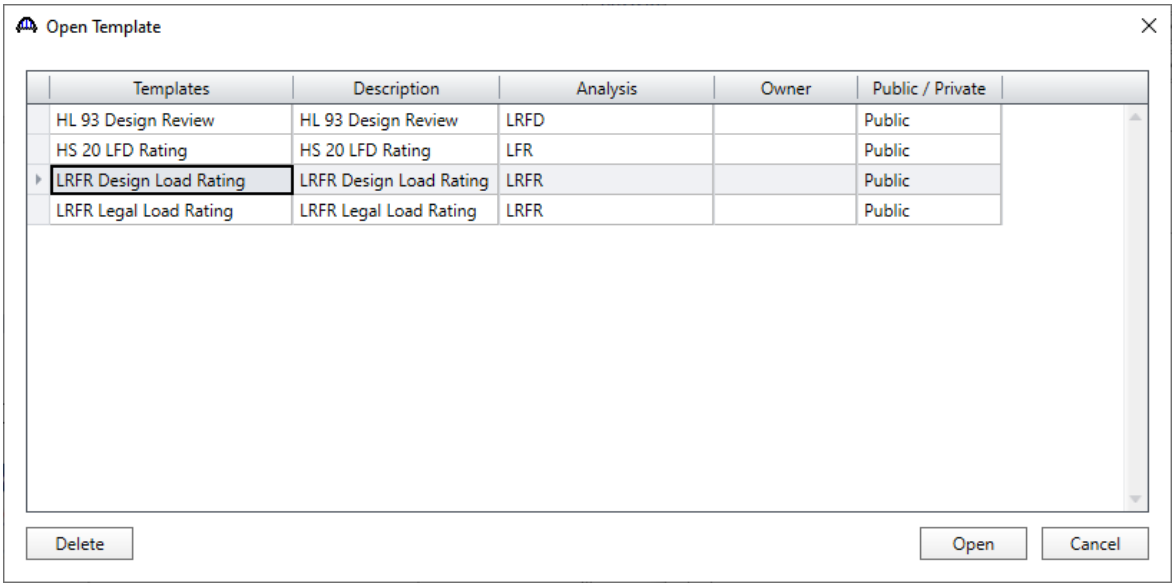
Limit State	Load Comb	In Tension	P (kip)	M1 (kip-ft)	Yield f (ksi)	Yield F-allow (ksi)	Yield Design Ratio	Fracture f (ksi)	Fracture F-allow (ksi)	Fracture Design Ratio	Block Shear f (ksi)	Block Shear F-allow (ksi)	Block Shear Design Ratio	Pass/ Fail
STR-I	1	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-I	1	No	455.9	0.0	50.66	47.50	0.94							Fail
STR-I	2	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-I	2	No	455.9	0.0	50.66	47.50	0.94							Fail
STR-I	3	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-I	3	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-III	1	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-III	1	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-III	2	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-III	2	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-III	3	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-III	3	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-V	1	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-V	1	No	455.9	0.0	50.66	47.50	0.94							Fail
STR-V	2	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-V	2	No	455.9	0.0	50.66	47.50	0.94							Fail
STR-V	3	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail
STR-V	3	Yes	455.9	0.0	50.66	47.50	0.94	73.68	56.00	0.76	50.66	52.04	1.03	Fail

LRFR Analysis

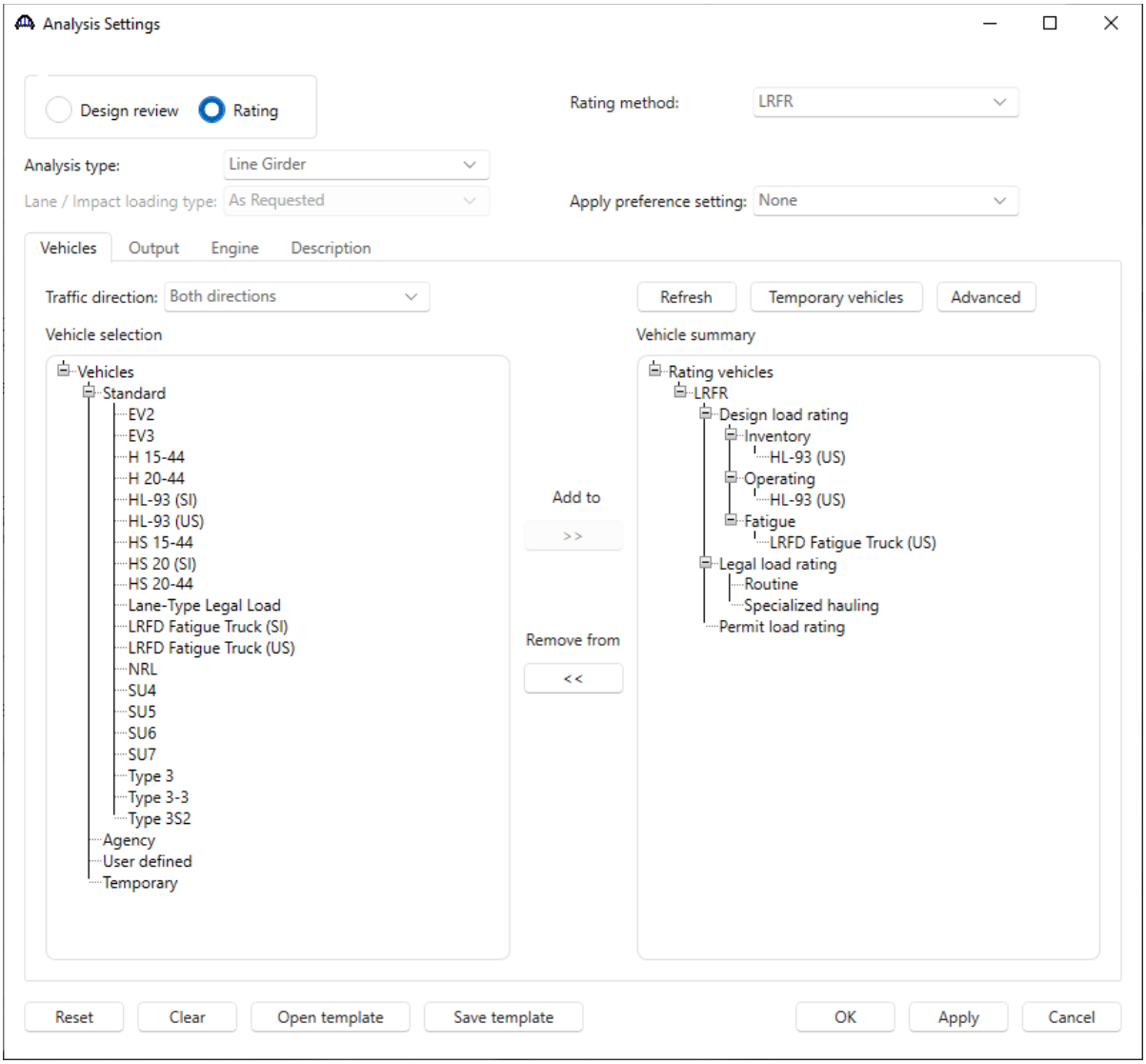
Splices can be rated for either LRFR or LFR. To perform an **LRFR** rating, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.



Click the **Open Template button** and select the template **LRFR Design Load Rating** and click **Open**.



The **Analysis Settings** window will be updated as shown below.

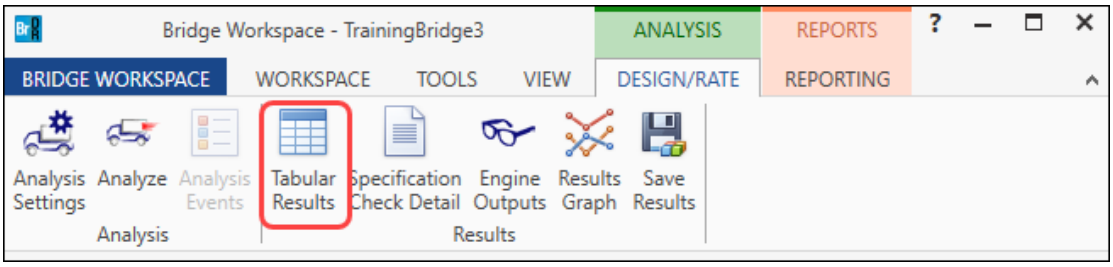


Click **OK** to apply the analysis settings and close the window.

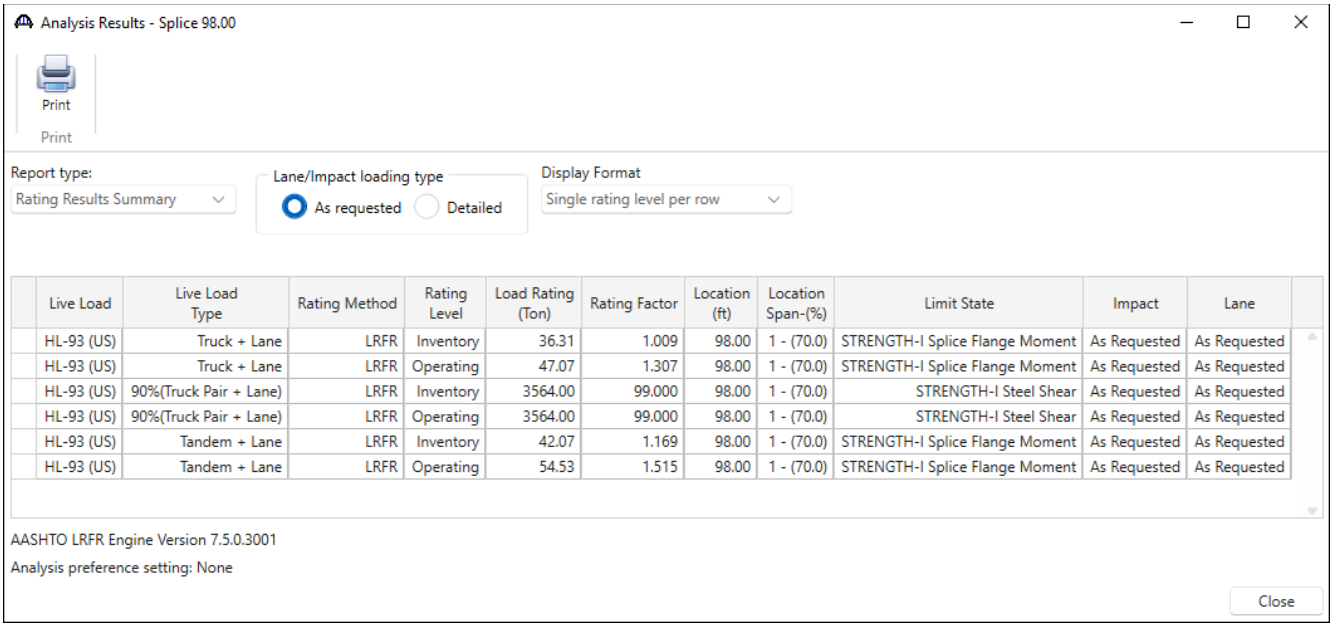
Tabular Results

Select the splice **Span 1 – 98.00** in the **Bridge Workspace** tree and click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.

When the rating analysis is finished, results can be reviewed by clicking the **Tabular Results** button on the **Results** group of the ribbon. The **Tabular Results** window shows the controlling rating factors at this location. For this example, some ratings are controlled by the splice, and some are controlled by the steel girder.



The window shown below will open.



Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HL-93 (US)	Truck + Lane	LRFR	Inventory	36.31	1.009	98.00	1 - (70.0)	STRENGTH-I Splice Flange Moment	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	47.07	1.307	98.00	1 - (70.0)	STRENGTH-I Splice Flange Moment	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	3564.00	99.000	98.00	1 - (70.0)	STRENGTH-I Steel Shear	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	3564.00	99.000	98.00	1 - (70.0)	STRENGTH-I Steel Shear	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	42.07	1.169	98.00	1 - (70.0)	STRENGTH-I Splice Flange Moment	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	54.53	1.515	98.00	1 - (70.0)	STRENGTH-I Splice Flange Moment	As Requested	As Requested