ADJ1 – Analysis with Adjacent Lane Routine Traffic Example

Topics Covered

- Methodology implemented for considering routine traffic in adjacent lane
- Allow distribution factors to be used to compute effects of permit loads with routine traffic
- Specify adjacent vehicle in the Analysis Settings window
- Example 1: LFR analysis and LRFR analysis using BID 10 (Example 7)
- Example 2: LFR analysis using BID 19 (TrussTrainingExample)
- Example 3: LRFD design review using BID 1 (TrainingBridge1)

Methodology implemented for considering routine traffic in adjacent lane.

The release version 7.5.0 provides users with the capability to perform the design review and rating analysis for permit vehicles with routine traffic in adjacent lanes. When an adjacent vehicle is included in the rating analysis, the live load distribution factor approach specified in LRFD Article 4.6.2.2.5 will be used to deduct the adjacent vehicle live load demand from the capacity. Capacity articles that are dependent on the load applied will use the combined force effect when determining the capacity.

LRFD Article 4.6.2.2.5:

$$G = G_P\left(\frac{g_1}{Z}\right) + G_D\left(g_m - \frac{g_1}{Z}\right)$$

G = Final force effect applied to a girder

G_P = Force effect due to overload truck

g_1 = Single lane live load distribution factor

G_D = Force effect due to design loads

g_m = Multiple lane live load distribution factor

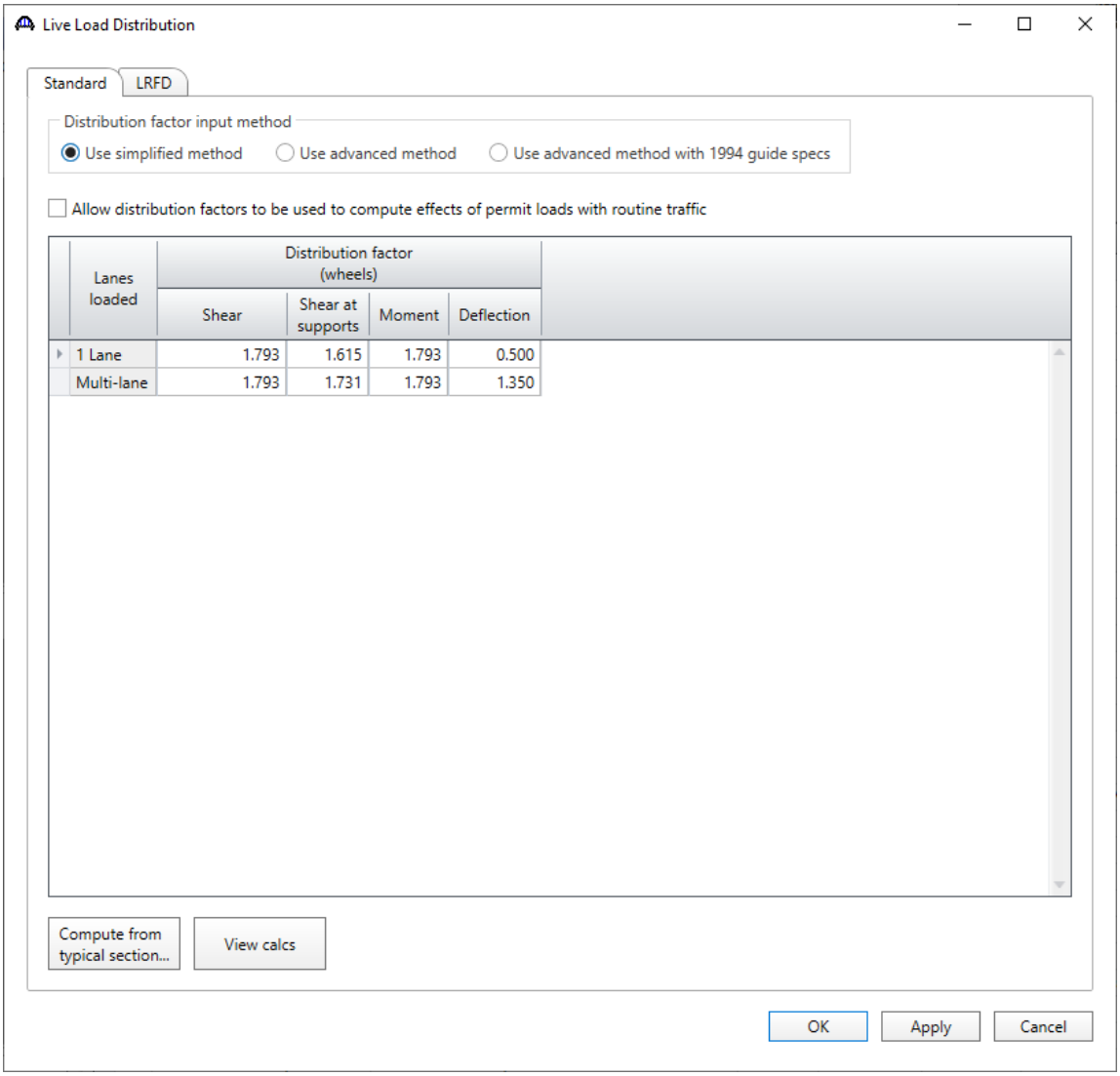
Z = A factor taken as 1.20 where the lever rule was not utilized, and 1.0 where the lever rule was used for a single lane live load distribution factor

The single lane live load distribution factor, $\mathbf{g_1}$, will be applied to the permit vehicle. The multiple lane live load distribution factor, $\mathbf{g_m}$, minus the single lane live load distribution factor, $\mathbf{g_1}$, will be applied to the adjacent vehicle. For Standard Specifications rating, the **Z** factor will be ignored.

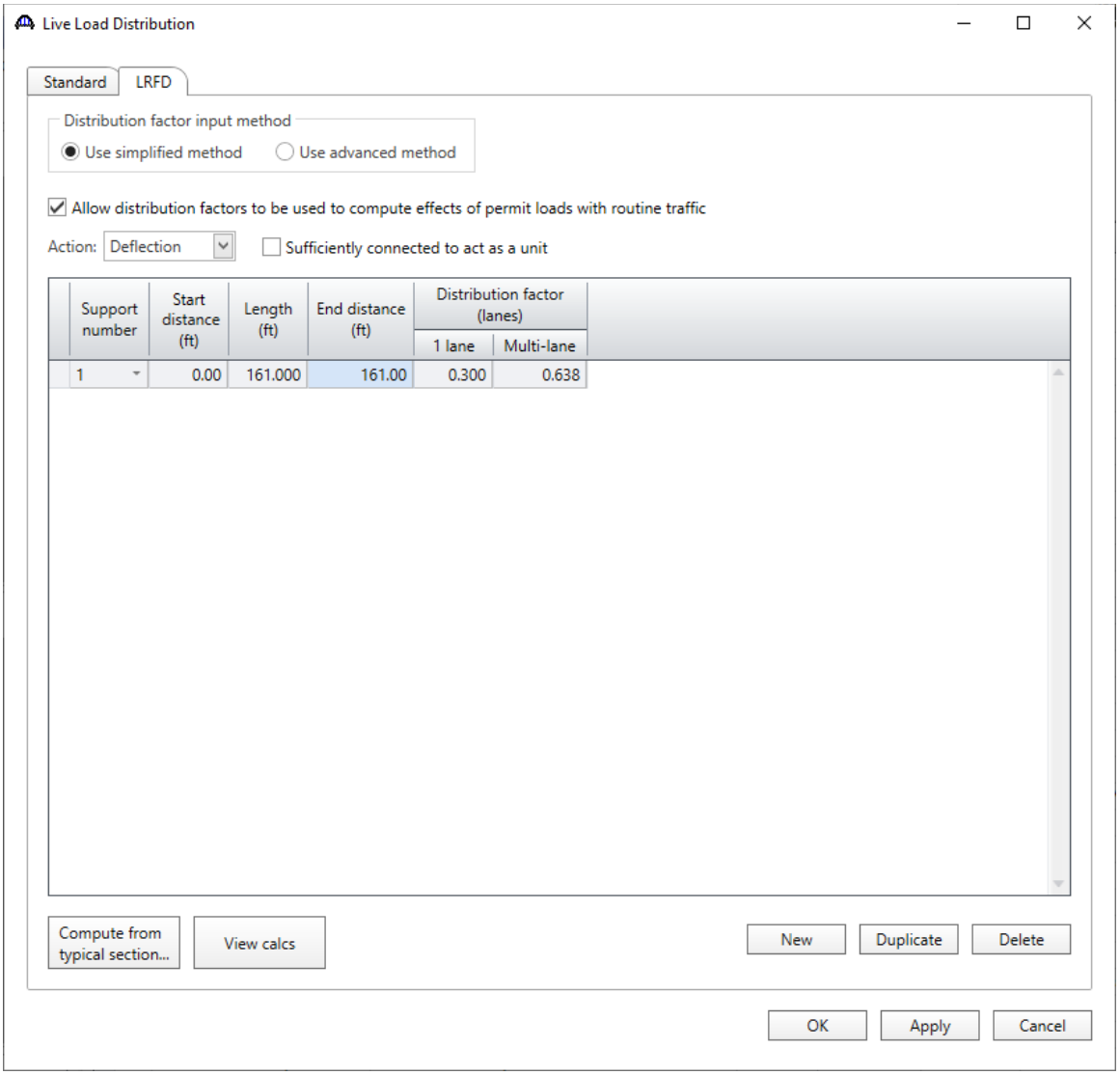
Allow distribution factors to be used to compute effects of permit loads with routine traffic.

In the **Live Load Distribution** window, the **Allow distribution factors to be used to compute effects of permit loads with routine traffic** checkbox specifies whether the live load distribution factor approach in LRFD Article 4.6.2.2.5 is allowed.

The **Standard** tab of the **Live Load Distribution** window is shown below.

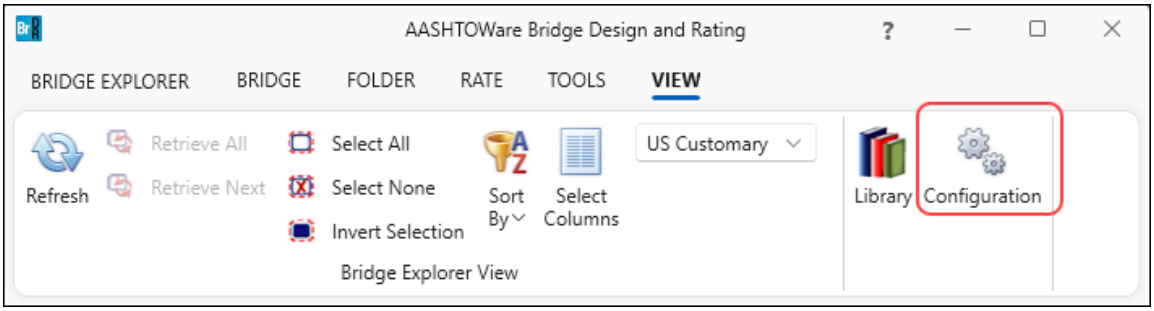


The **LRFD** tab of the **Live Load Distribution** window is shown below.

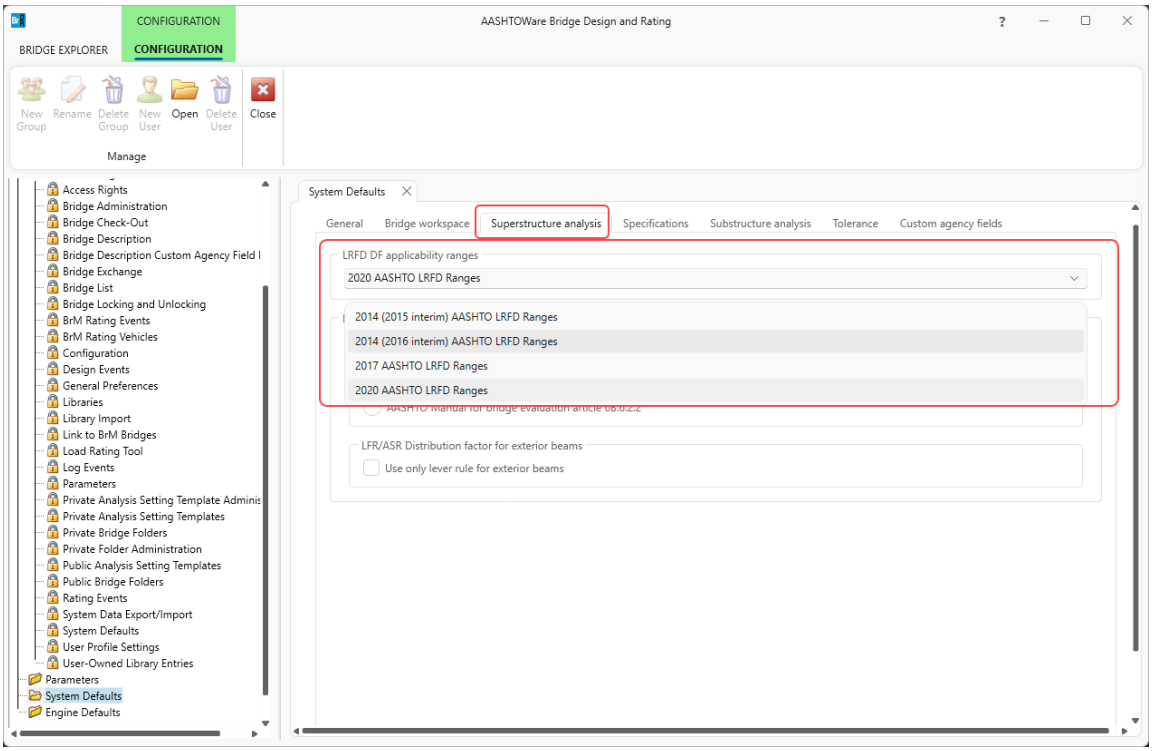


The **Compute from typical section…** button in this window will compute the live load distribution factors by checking the following two restrictions listed in LRFD Article 4.6.2.2.5:

- The lever rule has been specified for both single lane and multiple lane loadings. The **Library - LRFD DF Applicability Range Form** allows the user to define the applicability ranges using the AASHTO LRFD Specification equations for live load distribution factors when the factors are computed by BrDR. A Standard applicability range from the AASHTO LRFD Specification is delivered with BrDR and set as the default in the **System Defaults: Superstructure Analysis** window. The **Library - LRFD DF Applicability Range Form** window allows users to create an Agency applicability ranges and assign it as the default in the **System Defaults: Superstructure Analysis** window. The System Default applicability range will be used when BrDR computes the LRFD and LRFR distribution factors. To view this default range, click on the **Configuration** button from the **VIEW** ribbon of the Bridge Explorer as shown below.



The **LRFD DF applicability ranges** can be selected from the drop down menu shown below.



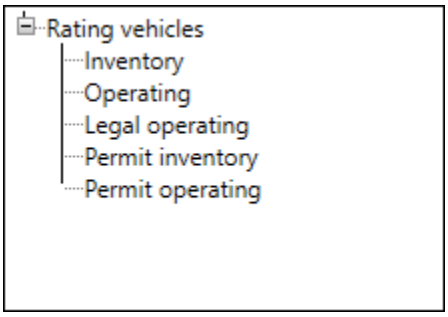
- The special requirement for exterior girders of beam-slab bridge cross-sections with diaphragms specified in Article 4.6.2.2.2d has been utilized for simplified analysis.

If the live load distribution factors are not entered, the AASHTO Engine will compute the live load distribution factors and determine whether the live load distribution factor approach for analyzing the adjacent vehicle is allowed.

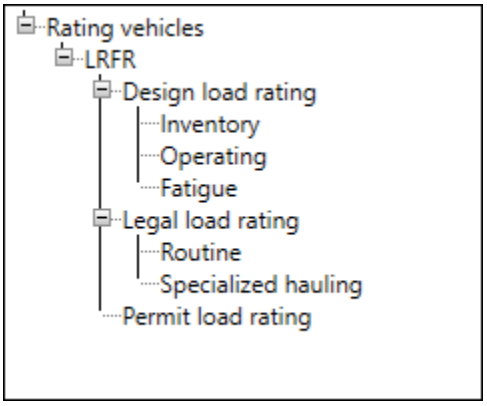
Specify adjacent vehicle in the Analysis Settings window.

In the **Analysis Settings** window, an adjacent vehicle can be specified in the **Legal operating**, **Permit inventory** and **Permit operating** categories for an **LFR** analysis. Inventory load factors are applied to the **Permit inventory** vehicles. Operating load factors are applied to the **Legal operating** and **Permit operating** vehicles. **Legal operating** analysis considers the legal train of vehicles with the adjacent vehicle requirement (MBE 6B.7.2).

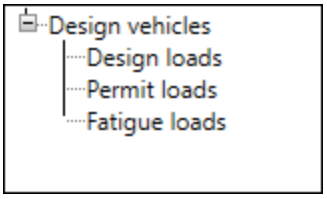
See the LFR analysis options below.



For LRFR analysis, adjacent vehicle can be specified in the **Permit load rating** category. See LRFR analysis options below:



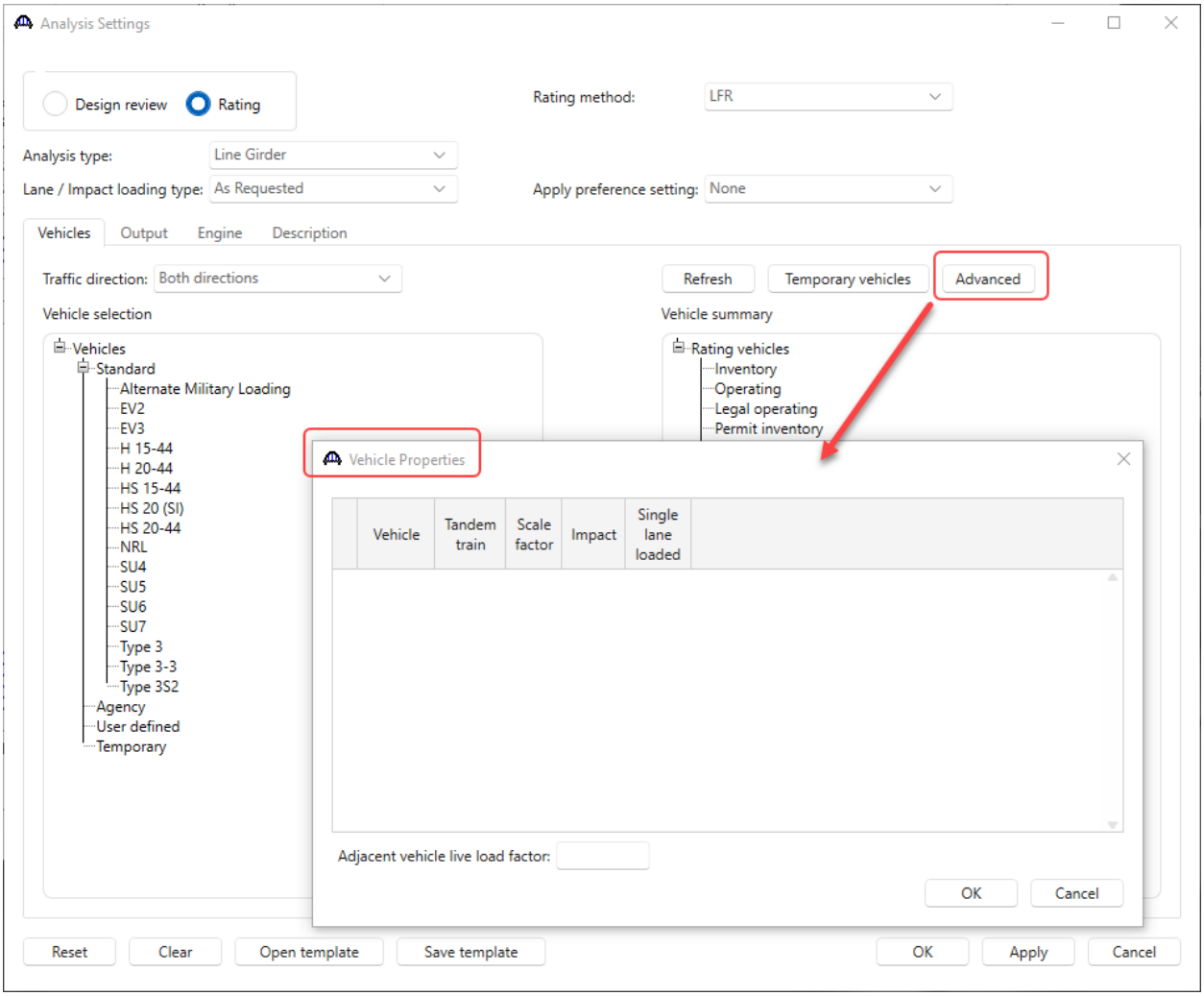
For an LRFD design review, an adjacent vehicle can be specified in the **Permit Loads** category as shown below.



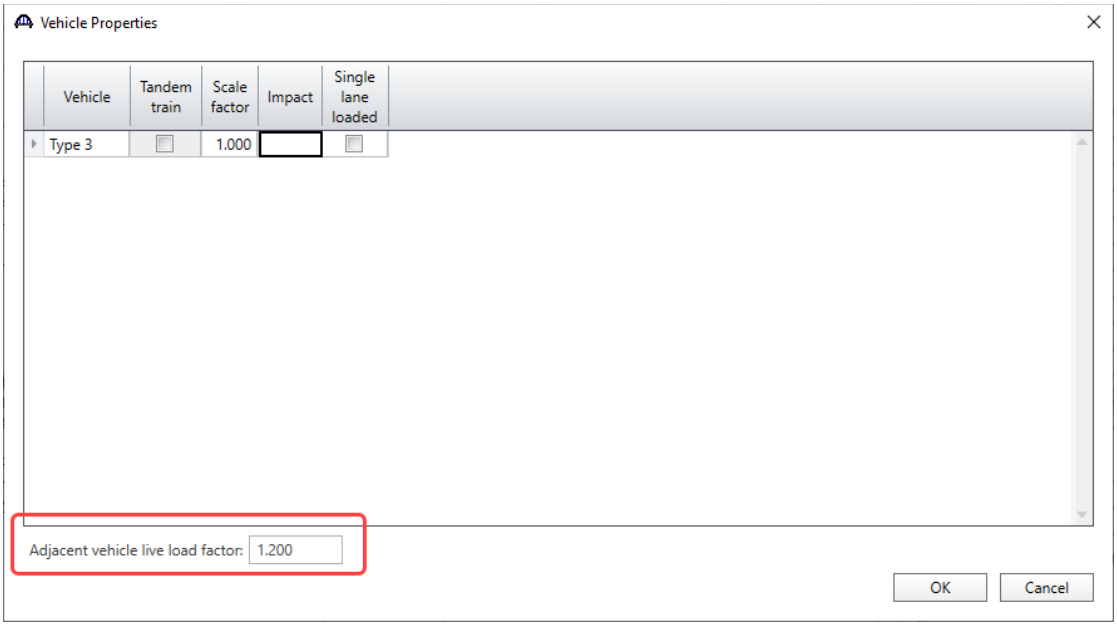
The live load factor to be applied to the adjacent vehicle is entered in the **Vehicle Properties** window. If the **Adjacent vehicle live load factor** is not entered, the adjacent vehicle will not be included in the analysis. For an LRFR analysis, the adjacent vehicle will not be considered for permits that have **Unlimited Crossing** frequency.

Vehicle Properties

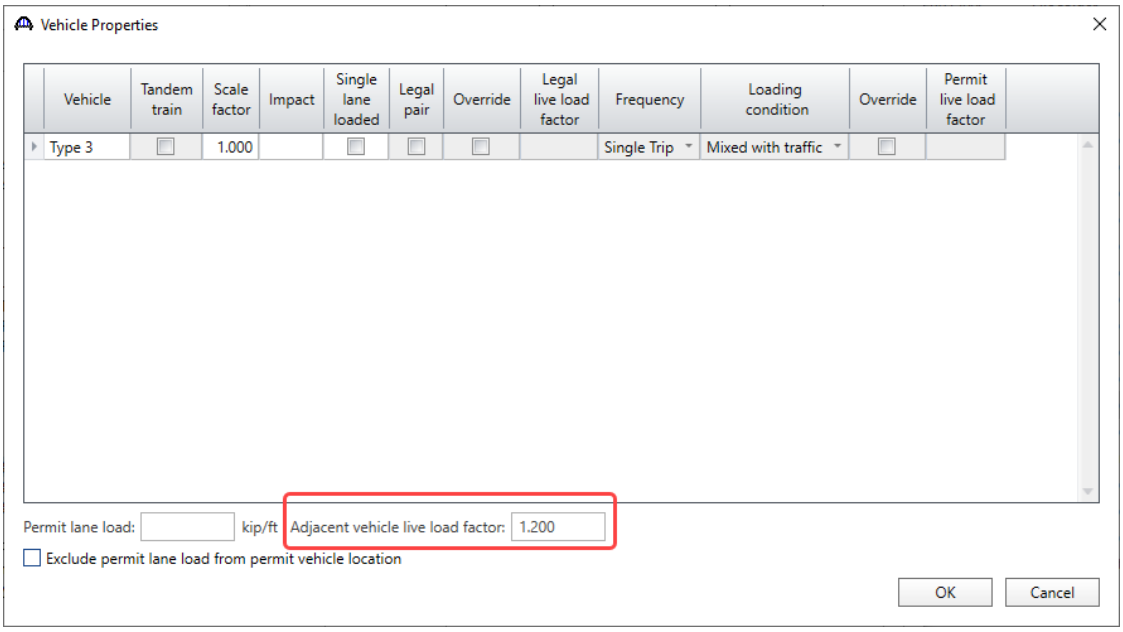
The **Vehicle Properties** window is accessible from the **Analysis Settings** window as shown below.



The **LFR Analysis** version of the **Vehicle Properties** window is shown below.

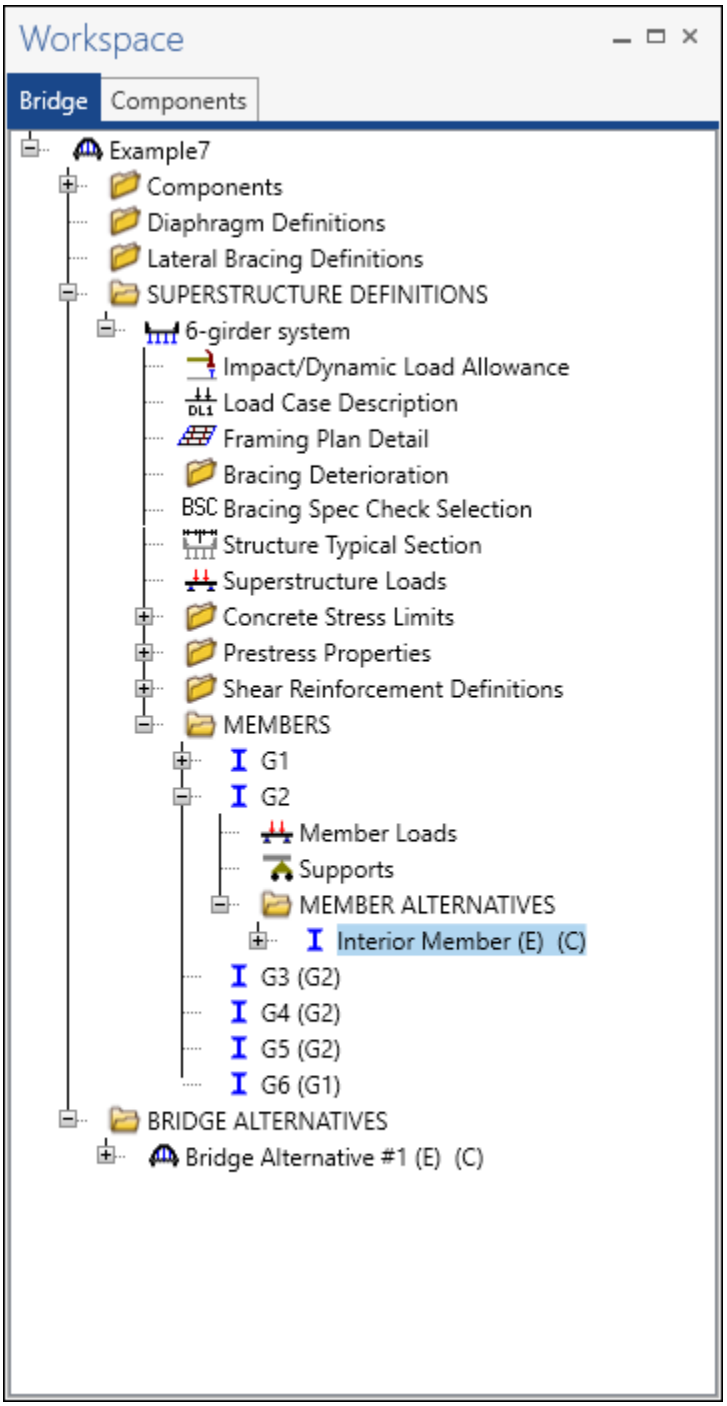


The **LRFR Analysis** version of the **Vehicle Properties** window is shown below.



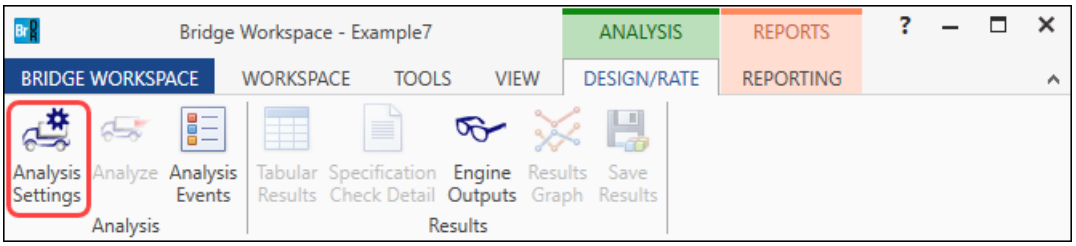
Example 1: LFR analysis and LRFR analysis using BID 10 (Example 7)

From the **Bridge Explorer**, open the bridge **BID 10 (Example7)**. Expand the **Bridge Workspace** and select member **G2**'s member alternative **Interior Member**. The **Bridge Workspace** for **BID10 (Example 7)** is shown below.

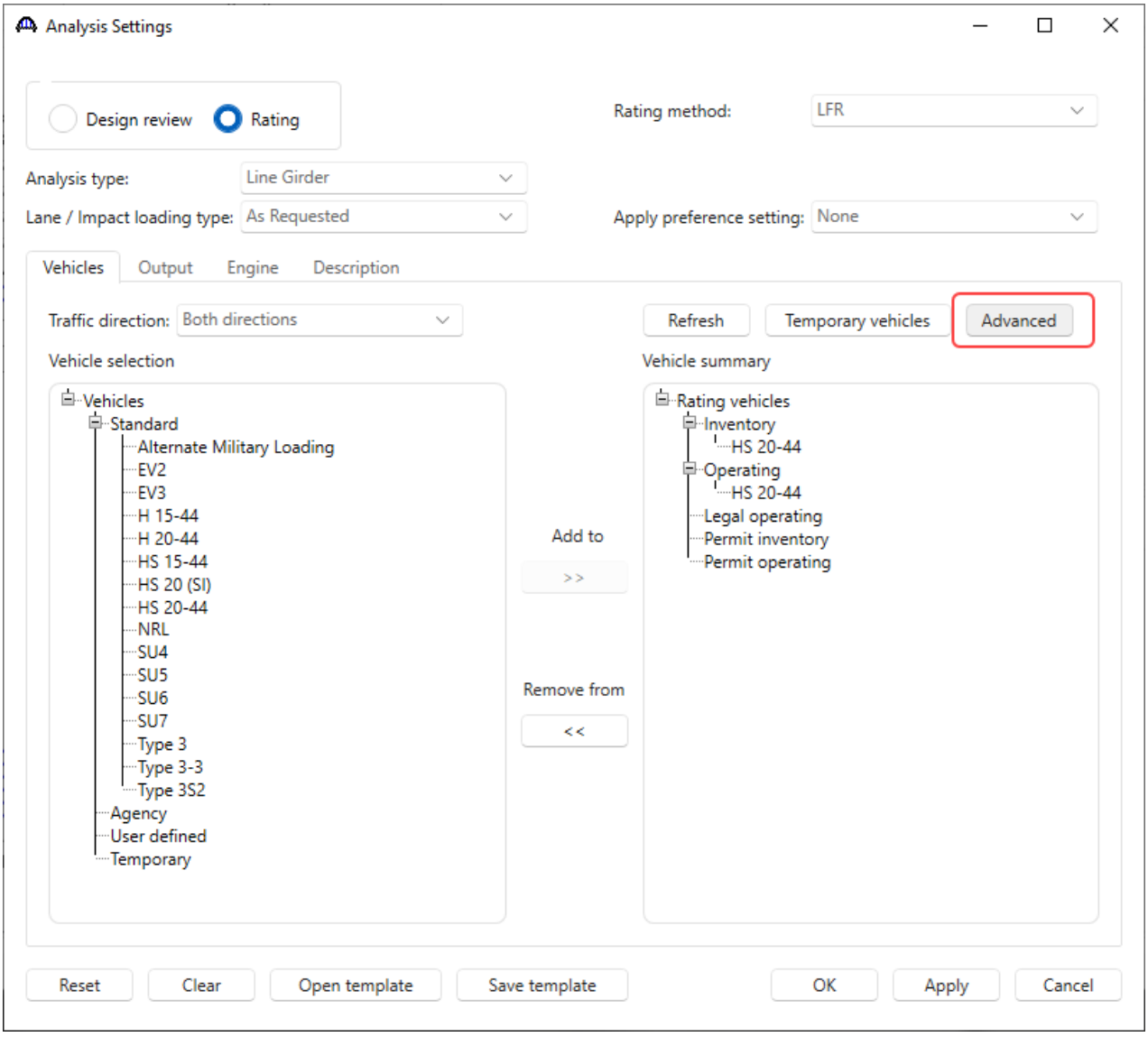


LFR analysis

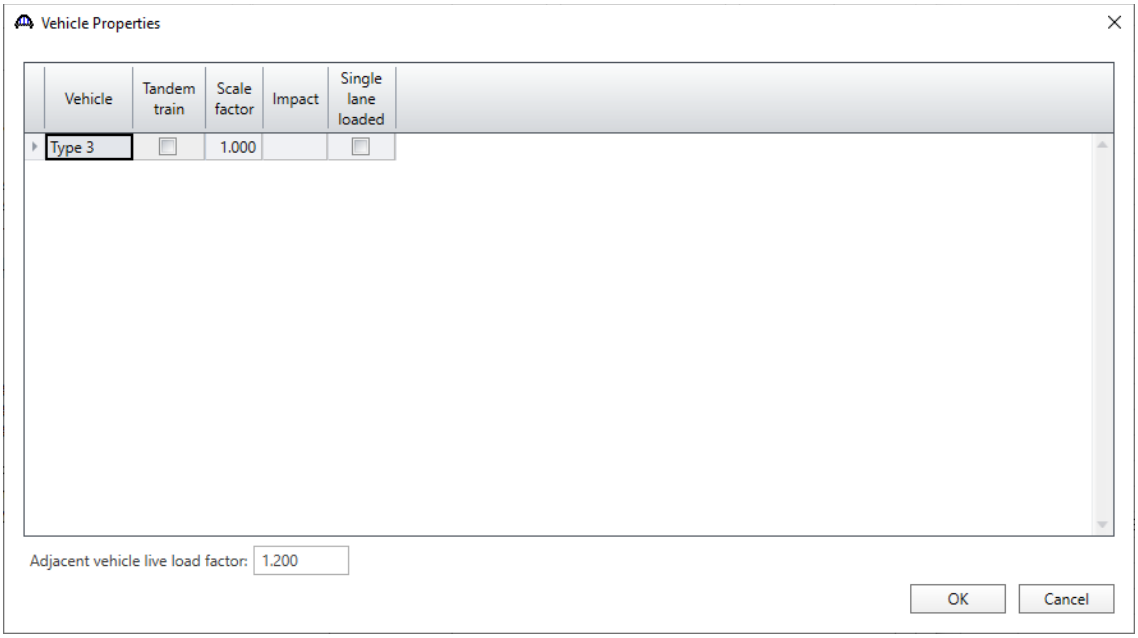
Open the **Analysis Settings** window by clicking the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon.



Select the **Rating Method** as **LFR** to perform an LFR rating, add the **Type 3** vehicle to the **Permit operating** category and the **HS 20-44** vehicle as the **Adjacent Vehicle**. Click the **Advanced** button to open the **Vehicle Properties** window as shown below.

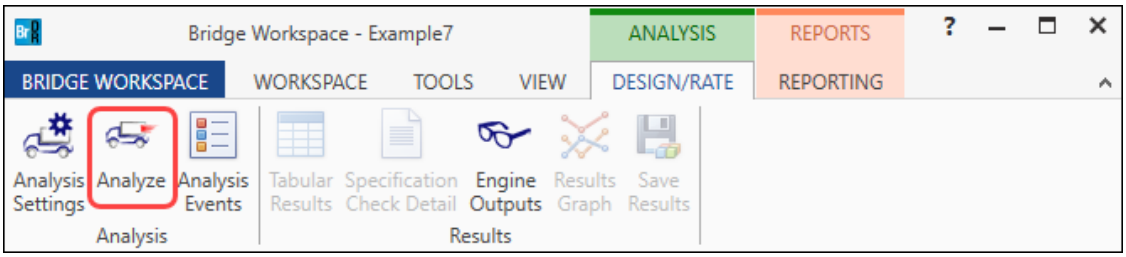


Enter **1.2** as the **Adjacent vehicle live load factor**.



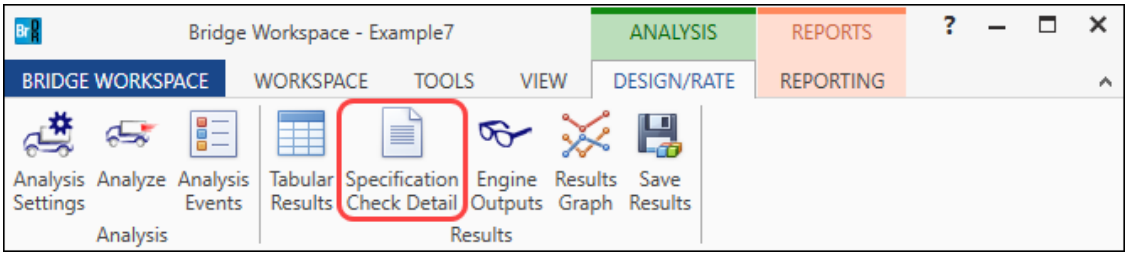
Click **OK** to save the settings and close the window.

Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.

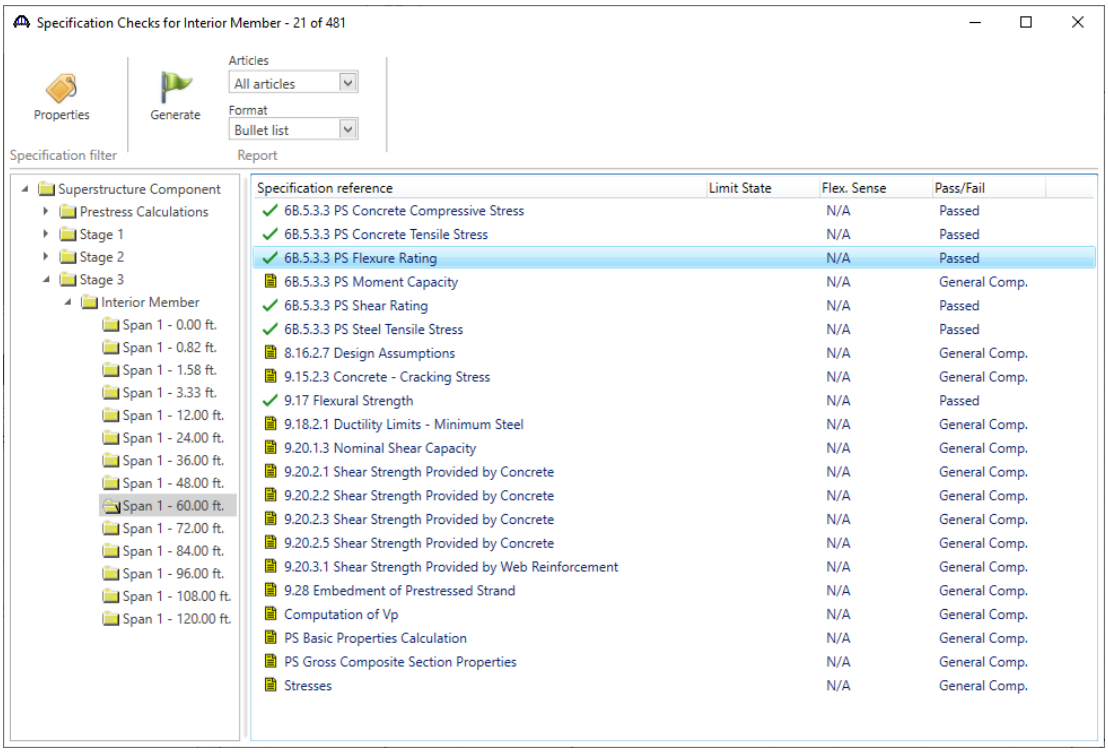


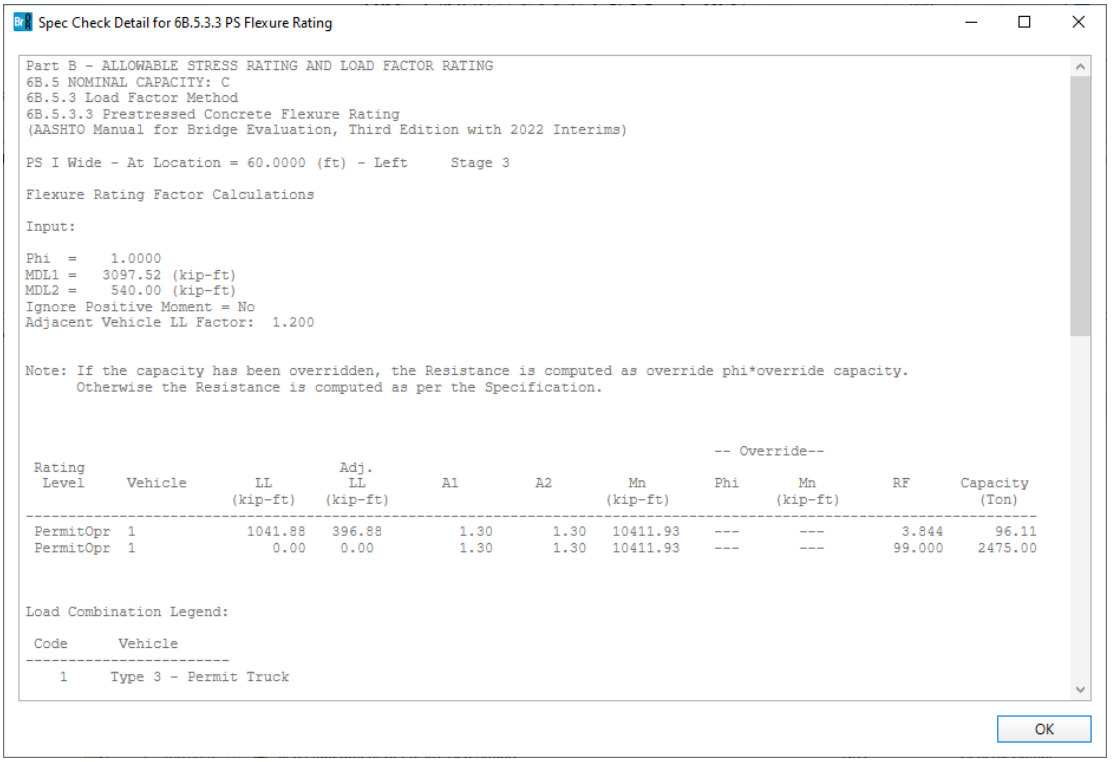
Specification Check Detail

When the rating is completed, click on the **Specification Check Detail** button on the **Results** group of the **DESIGN/RATE** ribbon to open the **Specification Checks** window.



Expand the tree and select the **Stage 3**'s **Span 1 - 60.00 ft** folder. Open the **Spec Check Detail** window for the **6B.5.3.3 PS Flexure Rating** specification reference to review the ratings.

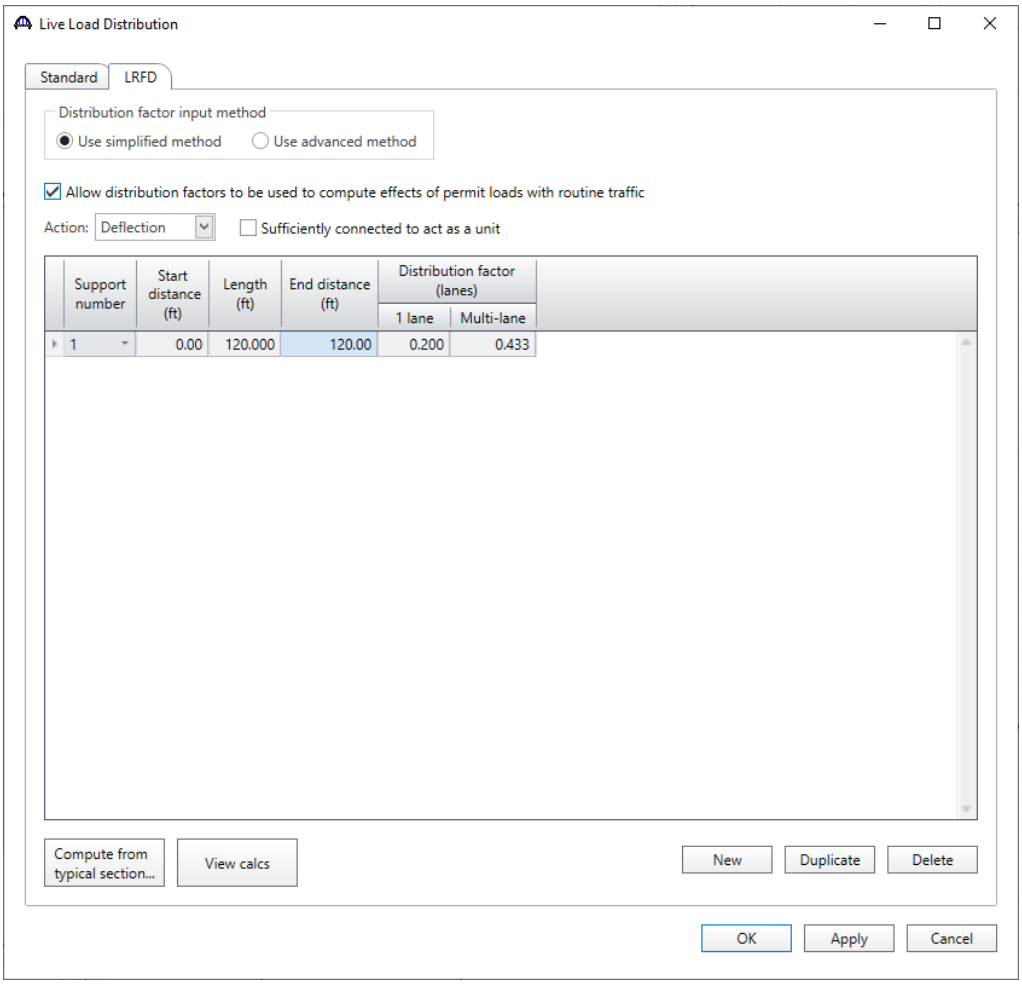




Close the **Spec Check Detail** window.

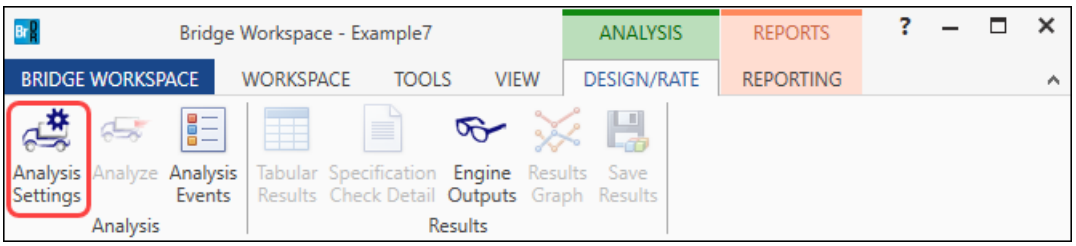
LRFR analysis:

Expand the member alternative - **Interior Member** in the **Bridge Workspace** tree. Open the **Live Load Distribution** window and select the **LRFD** tab. Select the **Allow distribution factors to be used to compute effects of permit loads with routine traffic** checkbox. Click **OK** to close the **Live Load Distribution** window.

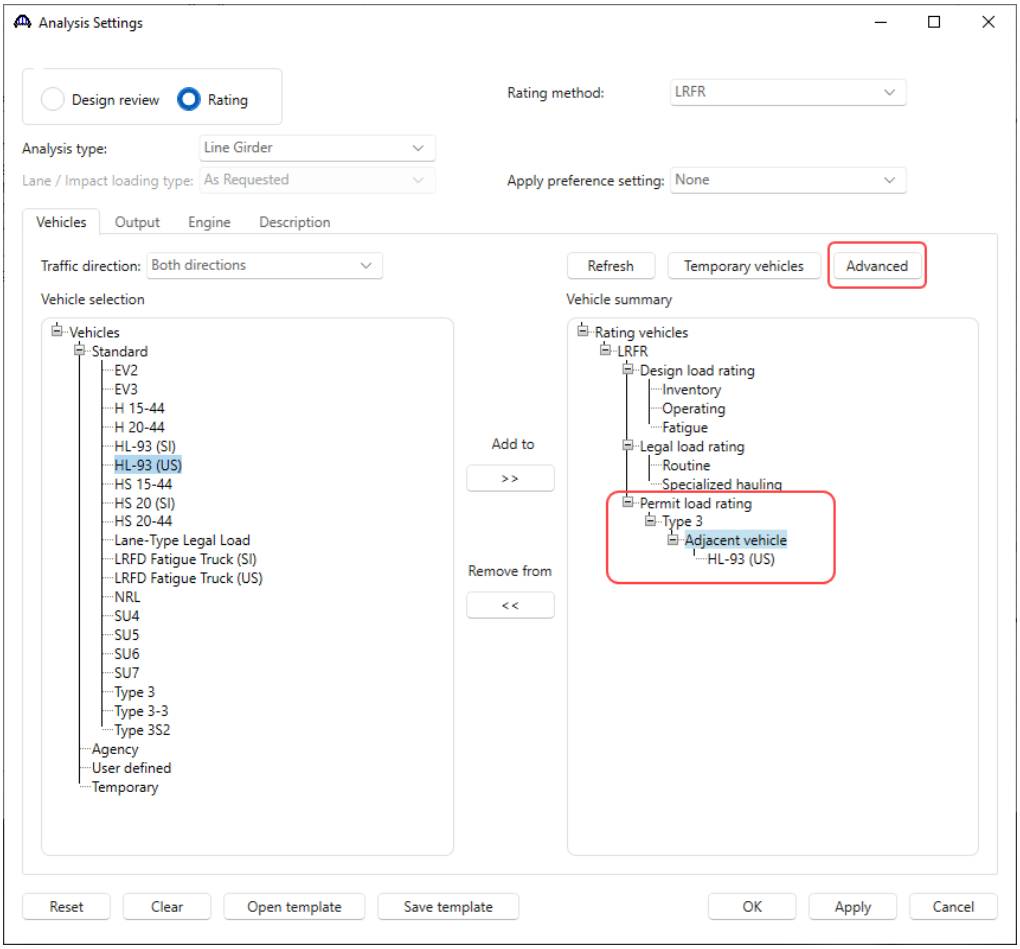


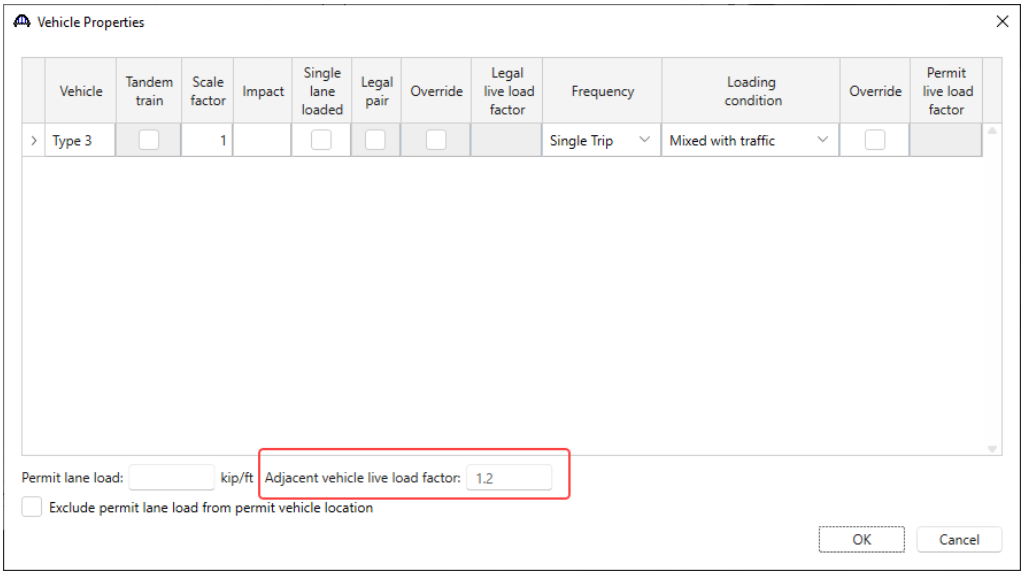
Select member **G2**'s member alternative **Interior Member** in the **Bridge Workspace** tree.

Open the **Analysis Settings** window by clicking the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon.



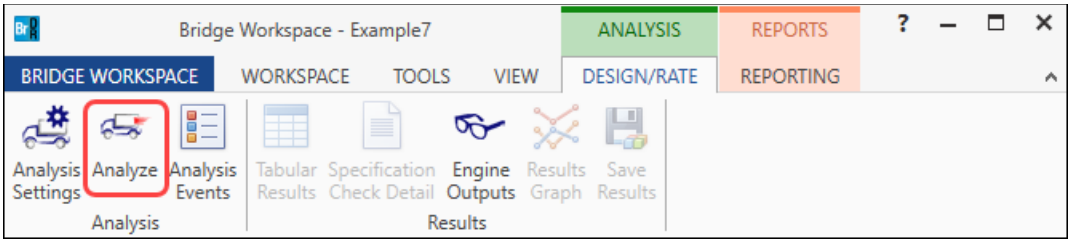
Select the **Rating Method** as **LRFR** to perform an LRFR rating, add the **Type 3** vehicle to the **Permit Load Rating** category and the **HL-93 (US)** vehicle as the **Adjacent Vehicle**. Click the **Advanced** button to open the **Vehicle Properties** window and enter **1.2** as the **Adjacent vehicle live load factor**. (see below)





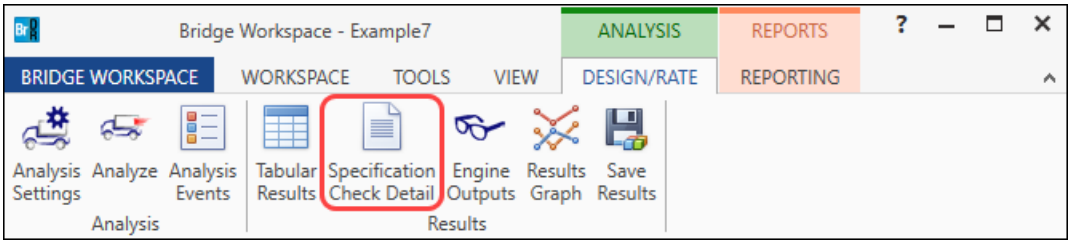
Click **OK** to save the settings and close the window.

Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.

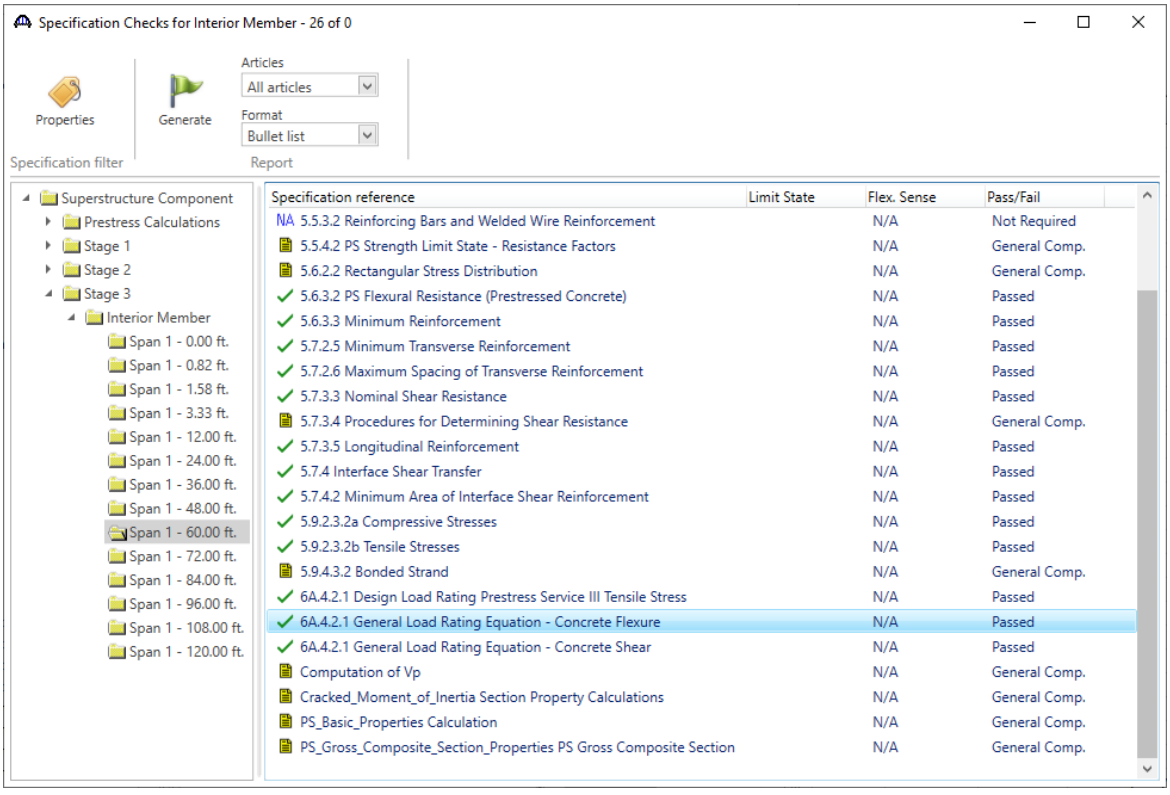


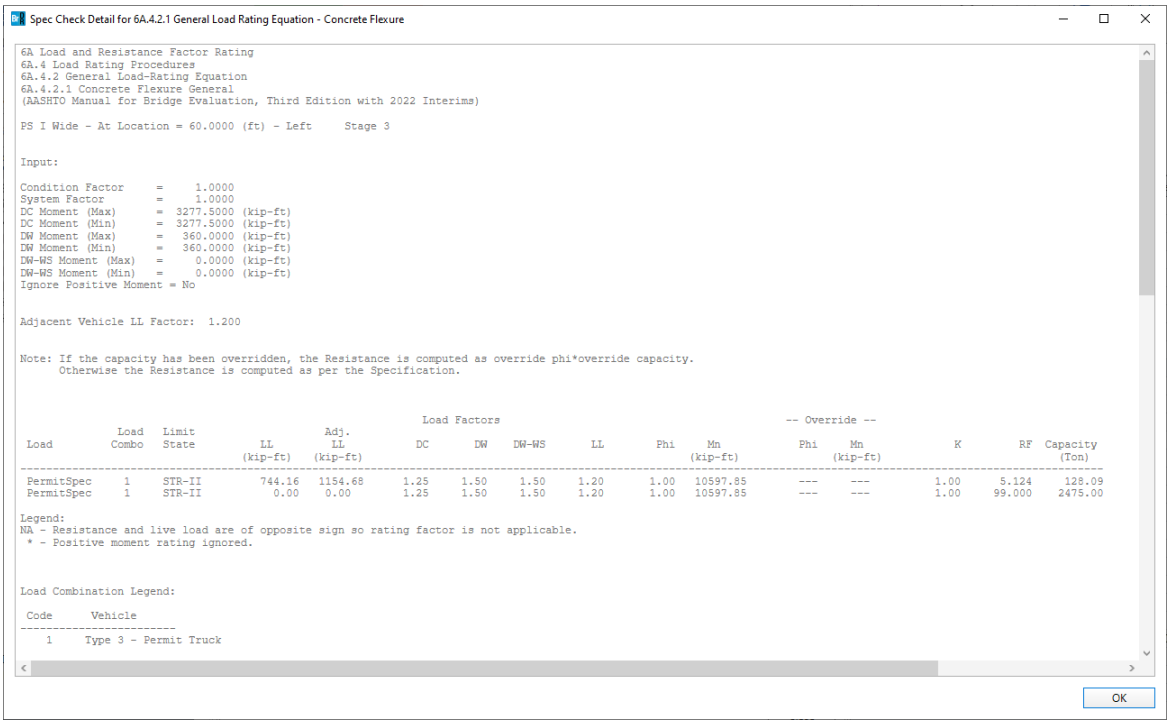
Specification Check Detail

When the rating is completed, click on the **Specification Check Detail** button on the **Results** group of the **DESIGN/RATE** ribbon to open the **Specification Checks** window.



Expand the tree and select the **Stage 3**'s **Span 1 - 60.00 ft** folder. Open the **Spec Check Detail** window for the **6A.4.2.1 General Load Rating Equation – Concrete Flexure** specification reference to review the ratings.

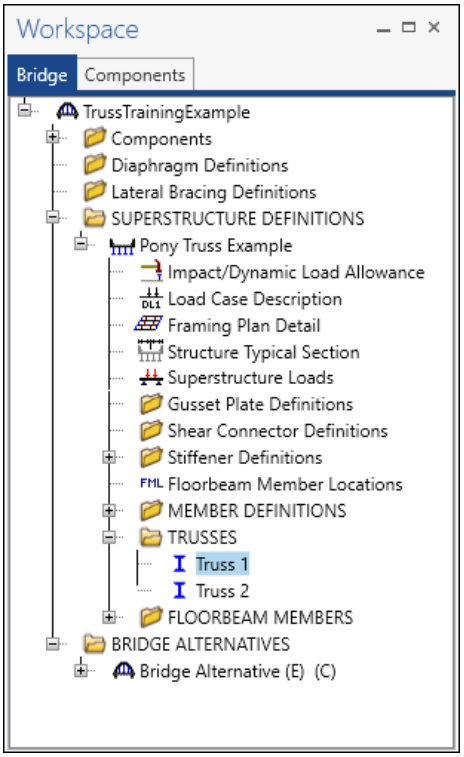




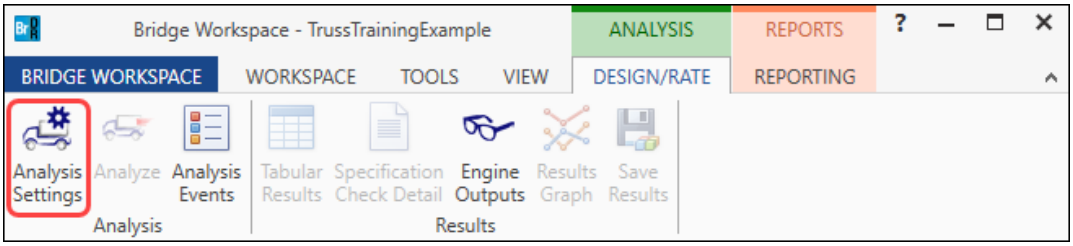
Close the **Spec Check Detail** window.

Example 2: LFR analysis using BID 19 (TrussTrainingExample)

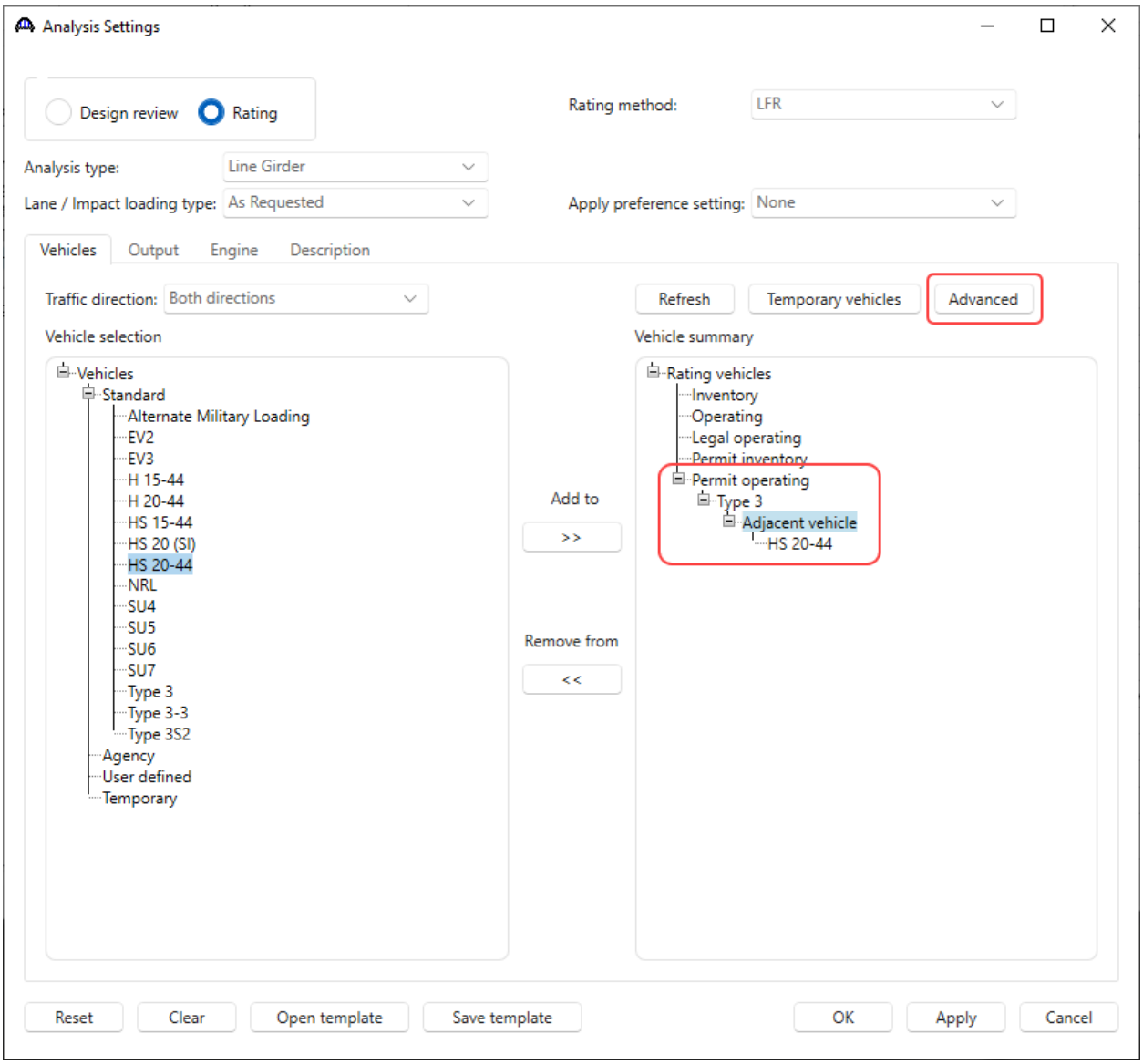
From the **Bridge Explorer**, open the **Bridge Workspace** for **BID 19 (TrussTrainingExample).** Expand the **Bridge Workspace** and select **Truss 1** as shown below.



Open the **Analysis Settings** window by clicking the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon.

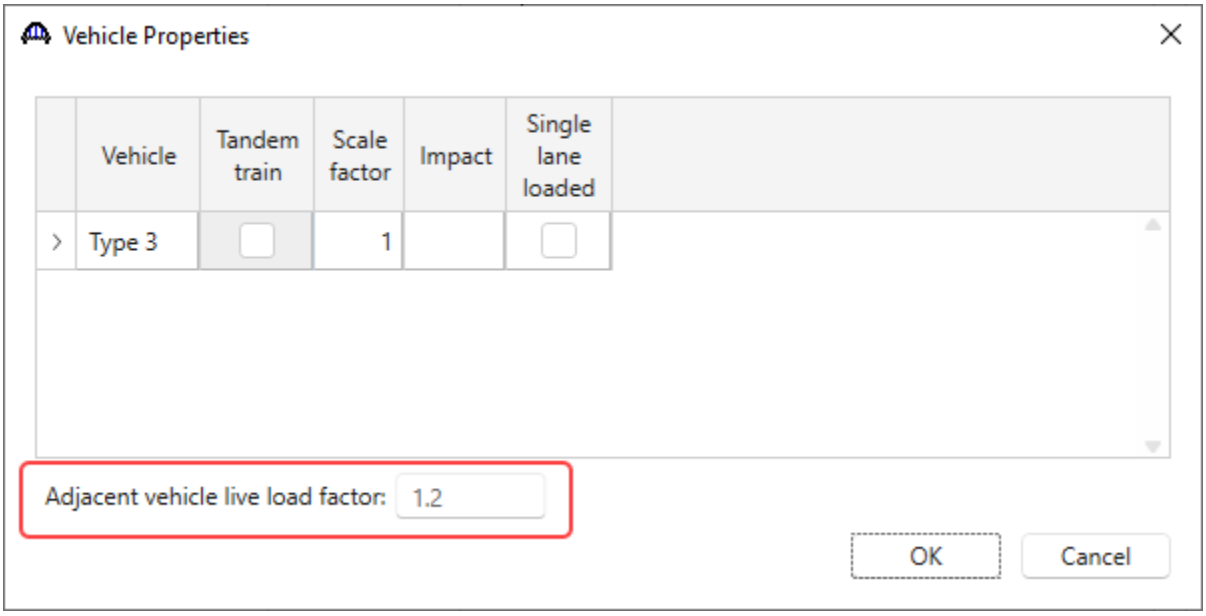


Select the **Rating Method** as **LFR** to perform an LFR rating, add the **Type 3** vehicle to the **Permit operating** category and the **HS 20-44** vehicle as the **Adjacent Vehicle**. Click the **Advanced** button to open the **Vehicle Properties** window as shown below.



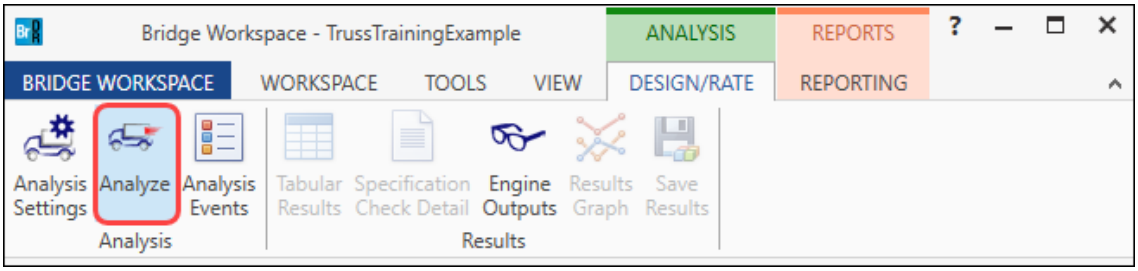
Vehicle Properties

Enter **1.2** as the **Adjacent vehicle live load factor**.



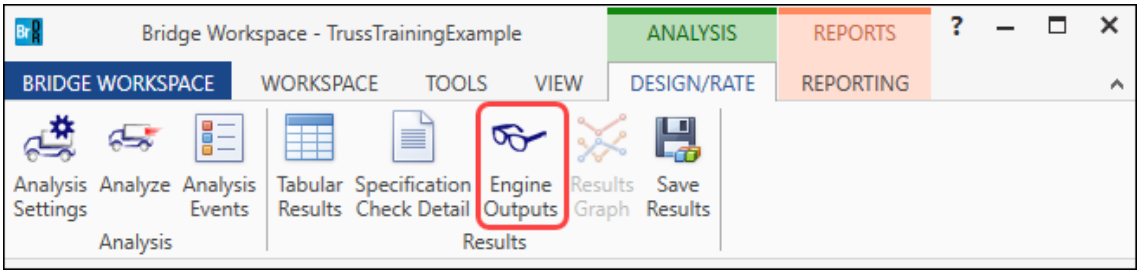
Click **OK** to save the analysis settings and close the window.

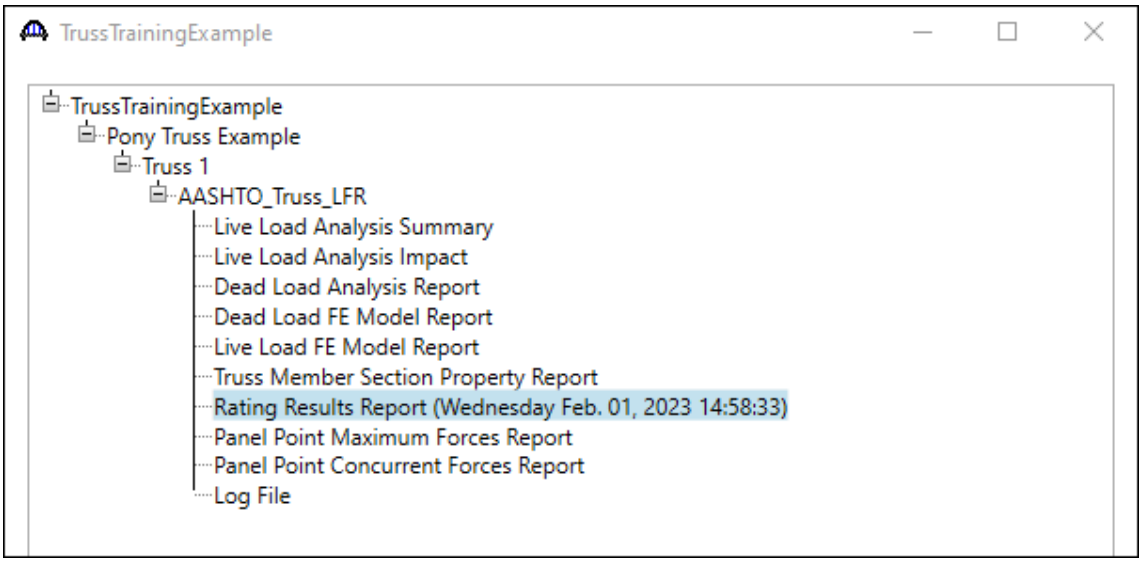
Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



Engine Outputs

When the rating is completed, click on the **Engine Outputs** button on the **Results** group of the **DESIGN/RATE** ribbon to open the **Engine Outputs** window as shown below.





Open the **Rating Results Report** to review the ratings. (See below)

Bridge ID :TrussTrainingExample
Bridge : Truss Training Example
StructDef : PonyTrussExample
User : bridge
Date : Wednesday, February 1, 2023
File : RatingResults.XML
Analysis Preference Setting : None

NBI Structure ID :TrussTrainingEx
Bridge Alt :
Member : Truss1

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
Type 3 - Truck	Permit Truck													U5U7	1.227	30.69	As Requested	As Requested
Type 3 - Truck	Permit Truck													U5U7	1.227	30.69	With Impact	Multi-Lane

Live Load: Type 3 - Truck (Permit Truck)

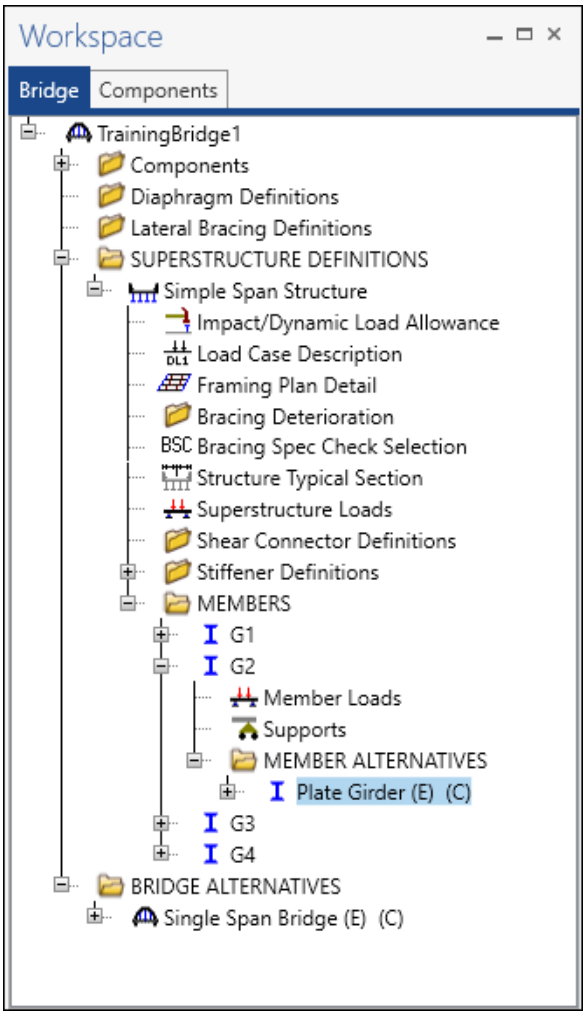
Detailed Truss Member Rating Results

LL Scale Factor = 1.00
Adjacent Vehicle LL Factor = 1.20
Operating:
A1 = 1.30, A2 = 1.30
Note: Rating factor is outputted as 99.00 when it is greater than 99

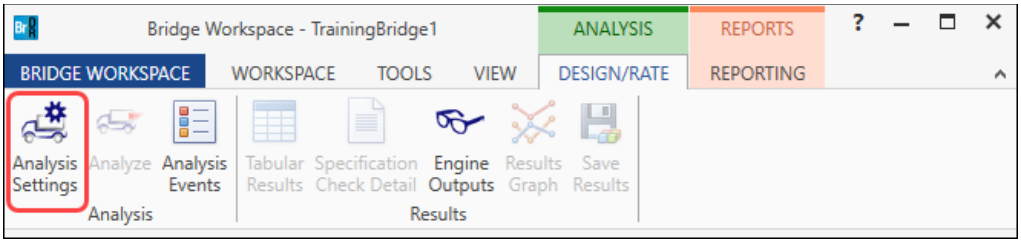
Member	Truss Element	DL Force (kip)	LL Force				Capacity		Adj Veh Demand		One Lane LLDF	Multi Lane LLDF	Inv RF	Opr RF	Legal Opr RF	Permit Inv RF	Permit Opr RF
			Comp. (kip)	IF	Tens. (kip)	IF	Comp. (kip)	Tens. (kip)	Comp. (kip)	Tens. (kip)							
L0L1	Lower-Chord	98.06			41.62	1.21		597.60		58.69		1.075					8.938
L1L2	Lower-Chord	98.06			41.62	1.21		597.60		58.69		1.075					8.938
L2L3	Lower-Chord	180.64			74.53	1.21		978.00		104.40		1.075					7.829
L3L4	Lower-Chord	180.64			74.53	1.21		978.00		104.40		1.075					7.829
L4L5	Lower-Chord	201.13			81.40	1.21		1113.00		113.33		1.075					8.244
L5L6	Lower-Chord	201.13			81.40	1.21		1113.00		113.33		1.075					8.244
L6L7	Lower-Chord	180.86			74.53	1.21		978.00		104.40		1.075					7.826
L7L8	Lower-Chord	180.86			74.53	1.21		978.00		104.40		1.075					7.826
L8L9	Lower-Chord	98.26			41.62	1.21		597.60		58.69		1.075					8.933
L9L10	Lower-Chord	98.26			41.62	1.21		597.60		58.69		1.075					8.933
U1U3	Upper-Chord	-154.87	-65.04	1.21			-431.11		-91.46			1.075					2.418

Example 3: LRFD design review using BID 1 (TrainingBridge1)

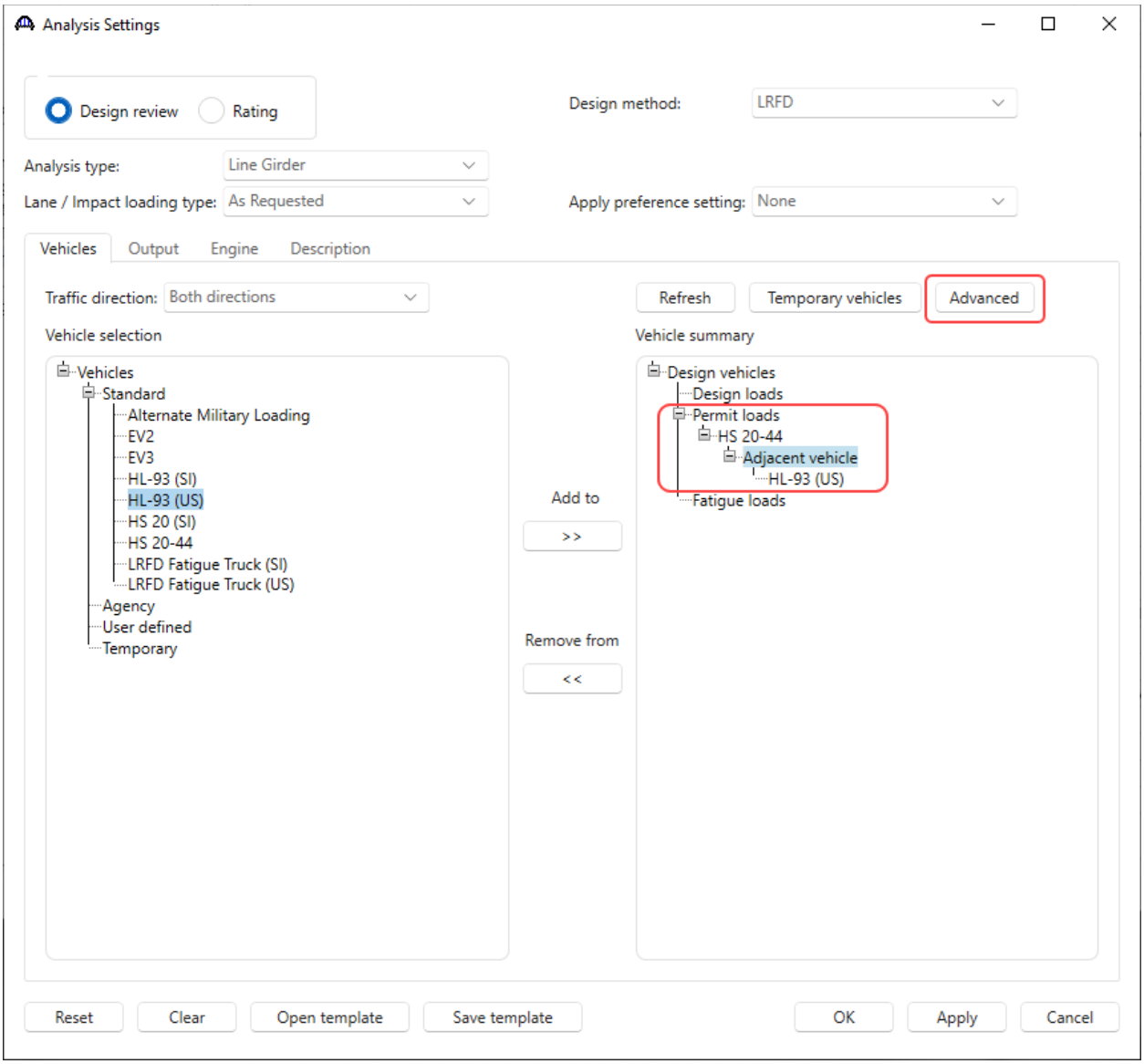
From the **Bridge Explorer**, open the **Bridge Workspace** for **BID 1 (TrainingBridge1)**. Expand the **Bridge Workspace** and select member **G2**'s member alternative **Plate Girder**.



Open the **Analysis Settings** window by clicking the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon.

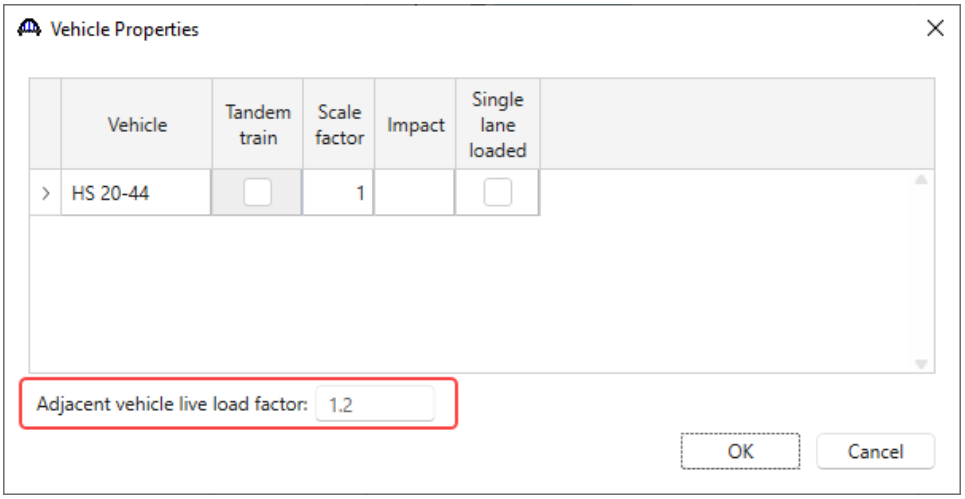


Select the **Design review** button. **LRFD** is selected as the **Design method**. Add the **HS 20-44 3** vehicle to the **Permit Loads** category and the **HL-93 (US)** vehicle as the **Adjacent Vehicle**. Click the **Advanced** button to open the **Vehicle Properties** window.



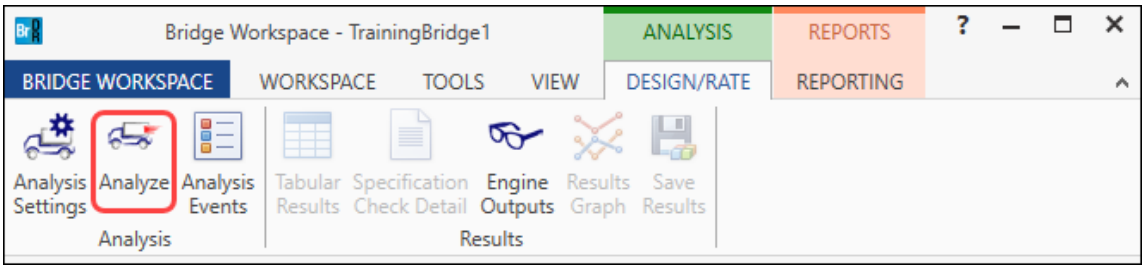
Vehicle Properties

Enter **1.2** as the **Adjacent vehicle live load factor**.



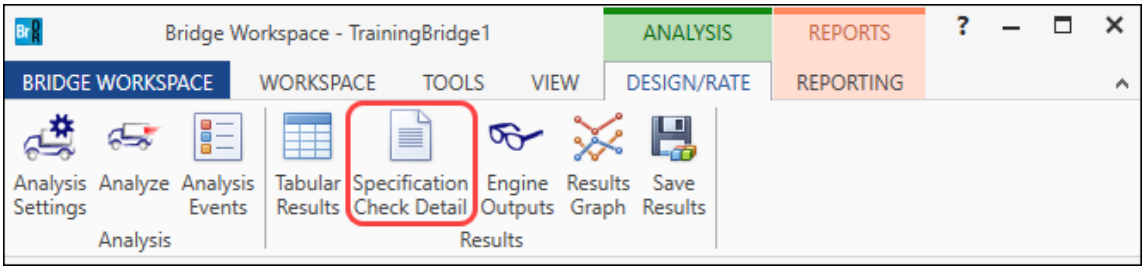
Click **OK** to save the analysis settings and close the window.

Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the design review.

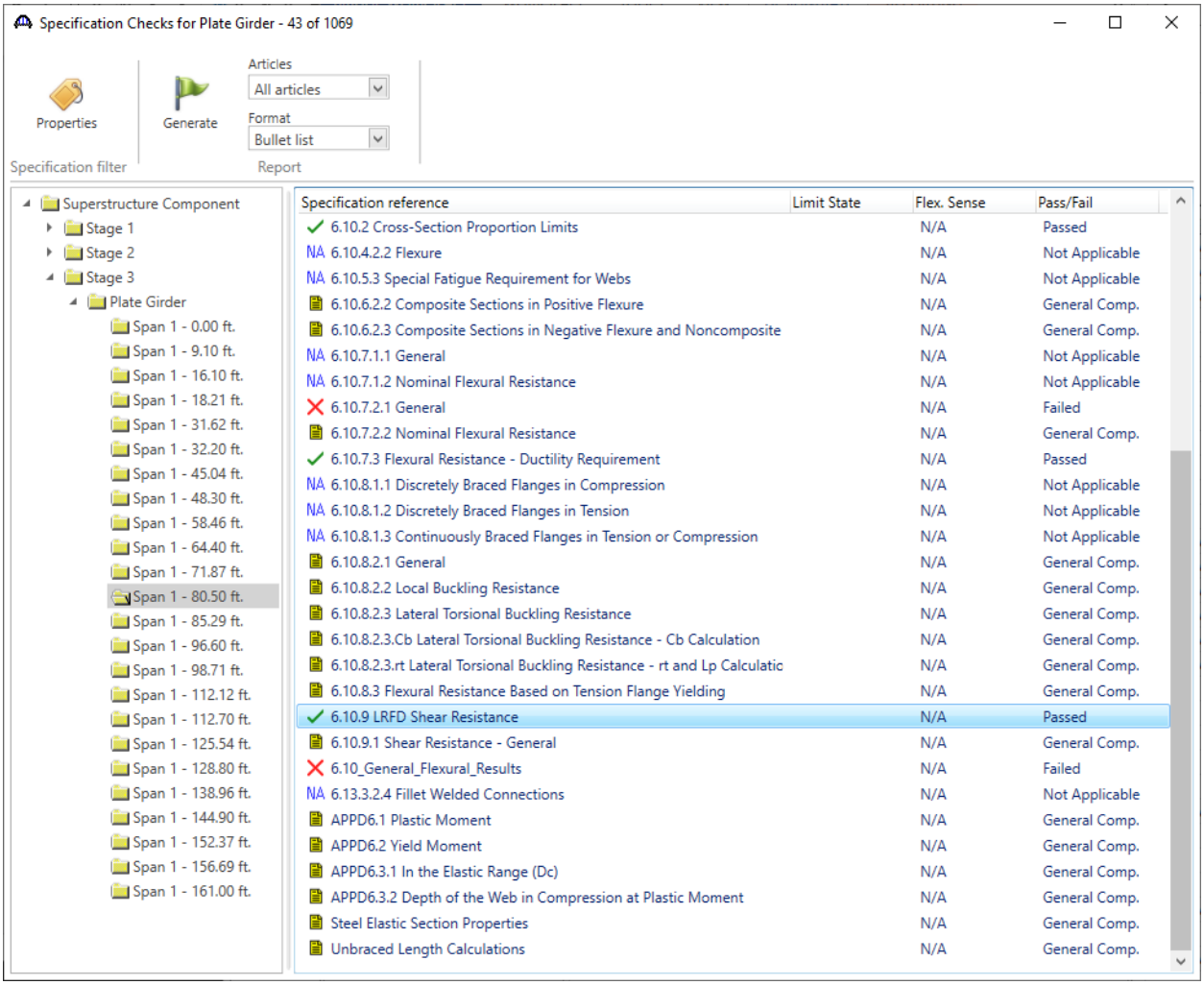


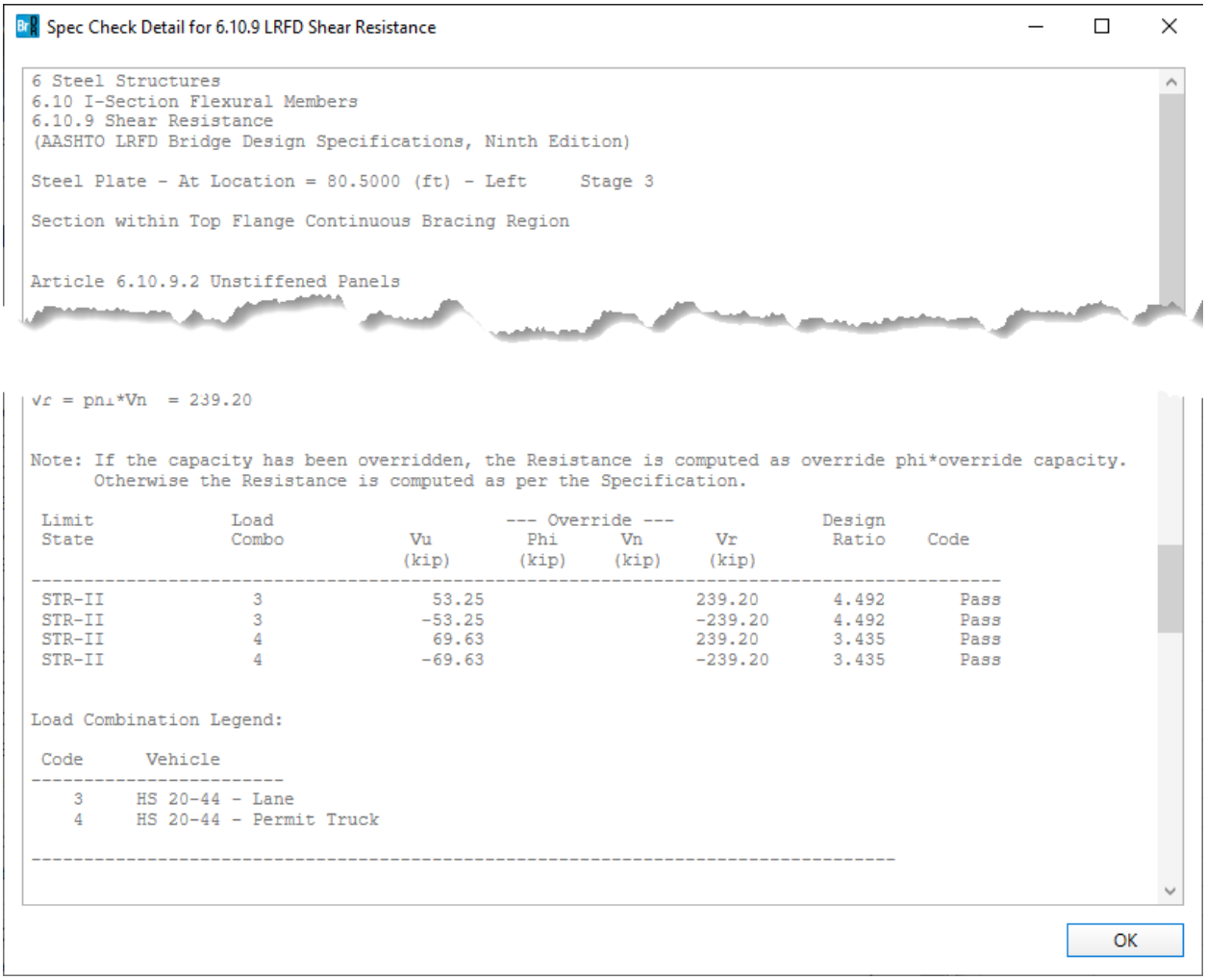
Specification Check Detail

When the design review is finished, click on the **Specification Check Detail** button on the **Results** group of the **DESIGN/RATE** ribbon to open the **Specification Checks** window.



Expand the tree and select the **Stage 3**'s **Span 1 – 80.50 ft** folder. Open the **Spec Check Detail** window for the **6.10.9 Shear Resistance** specification reference to review the article.





Close the **Spec Check Detail** window. Perform another **LRFD Design Review** without the adjacent vehicle and review the **6.10.9 Shear Resistance** specification reference for comparison.