AASHTOWare BrDR 7.4.1

Steel Flange Lateral Bending Stress Tutorial

STL13 – Flange Lateral Bending Example

BrDR Training

Overview

User input flange lateral bending stresses can be defined for steel girders in girder line and girder system superstructure definitions. These lateral bending stresses are defined separately for the top and bottom flange and are used when evaluating a member for flexure using the 9th Edition AASHTO LRFD specifications. The lateral stresses must be defined at diaphragm locations. Load cases are defined specifically for the lateral bending stresses and include options for construction loads, wind loads, dead loads, live load, and proportioned loads.

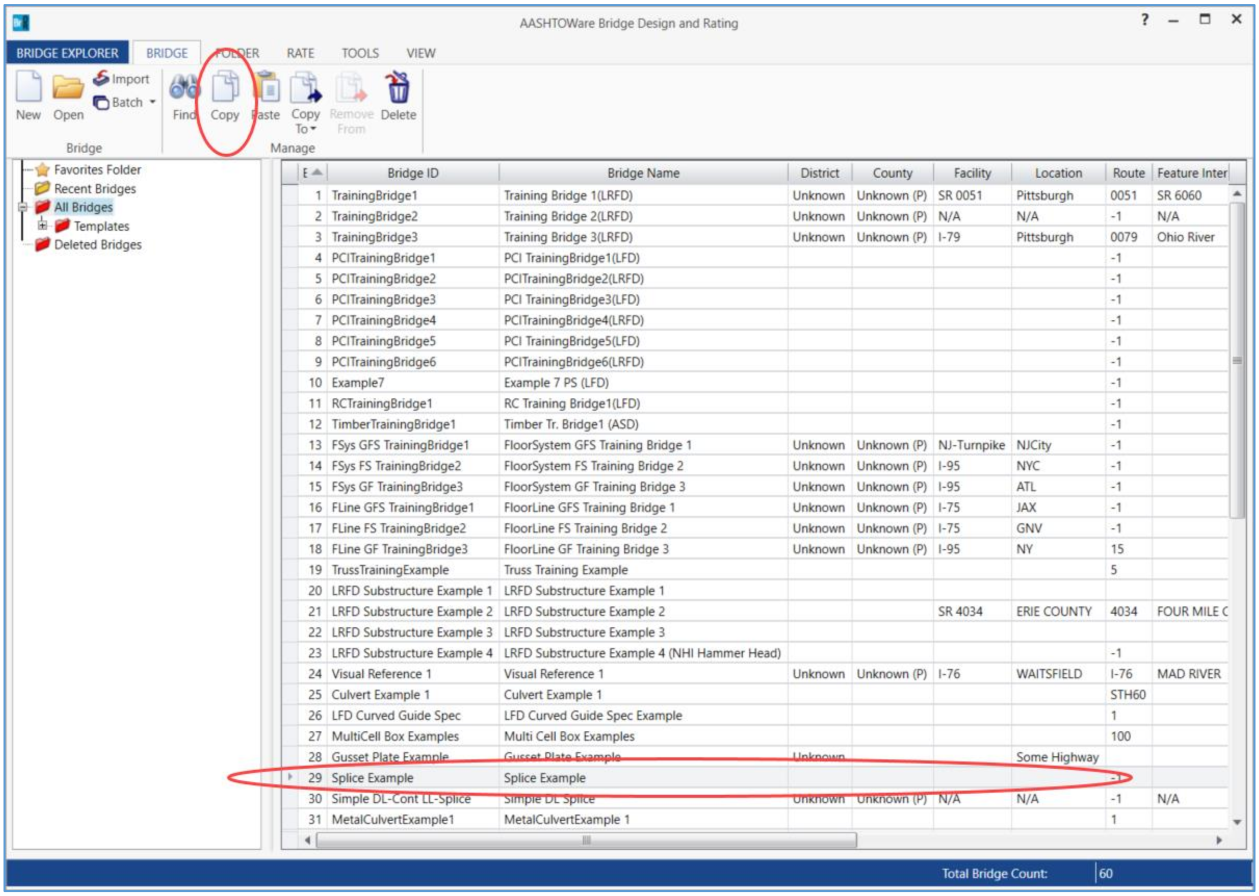
The input flange lateral bending stresses are added to any lateral bending stresses resulting from the analysis. This input can be used to:

- Approximate lateral bending stresses from skew effects while running a line girder analysis.
- Add lateral stresses from components not explicitly modeled, such as deck overhang brackets, while running a line girder or 3D analysis.
- Define temporary lateral stresses occurring during construction on the non-composite model.

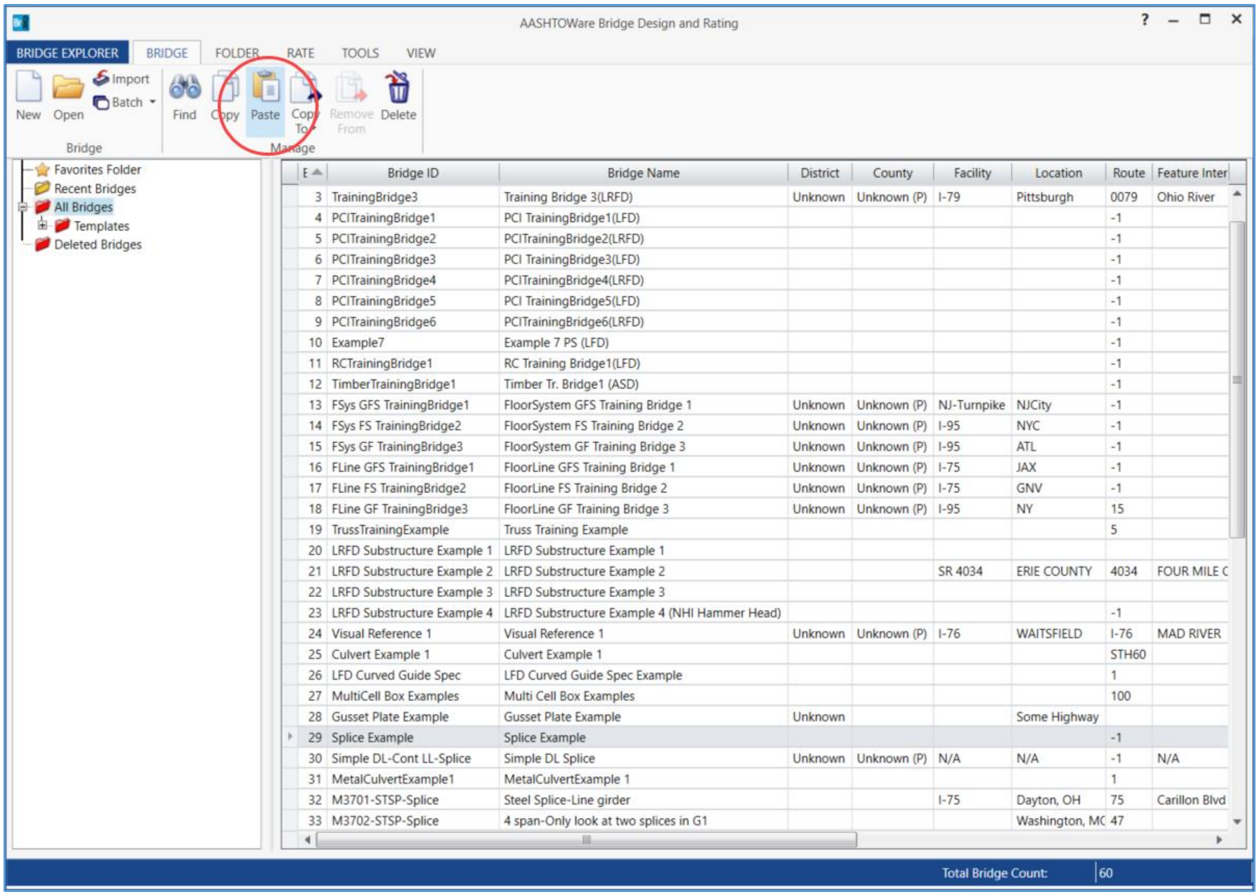
STL13 – Flange Lateral Bending Example

From the **Bridge Explorer** create a **copy** of the **Splice Example (BID 29)** bridge from the sample database.

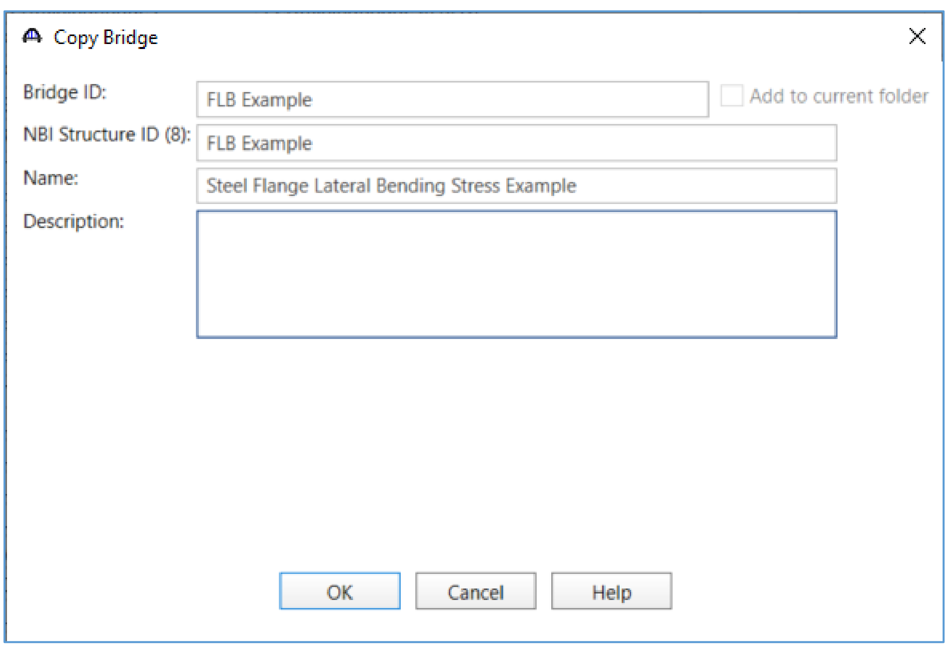
To copy the bridge, first select the **Splice Example** bridge in the bridge explorer table. Select copy in the top ribbon to copy the bridge.



Next, click **Paste** in the top ribbon to create a duplicate of the bridge.



The **Copy Bridge** window will open. Rename the bridge and select **OK** to save the bridge copy to the database.

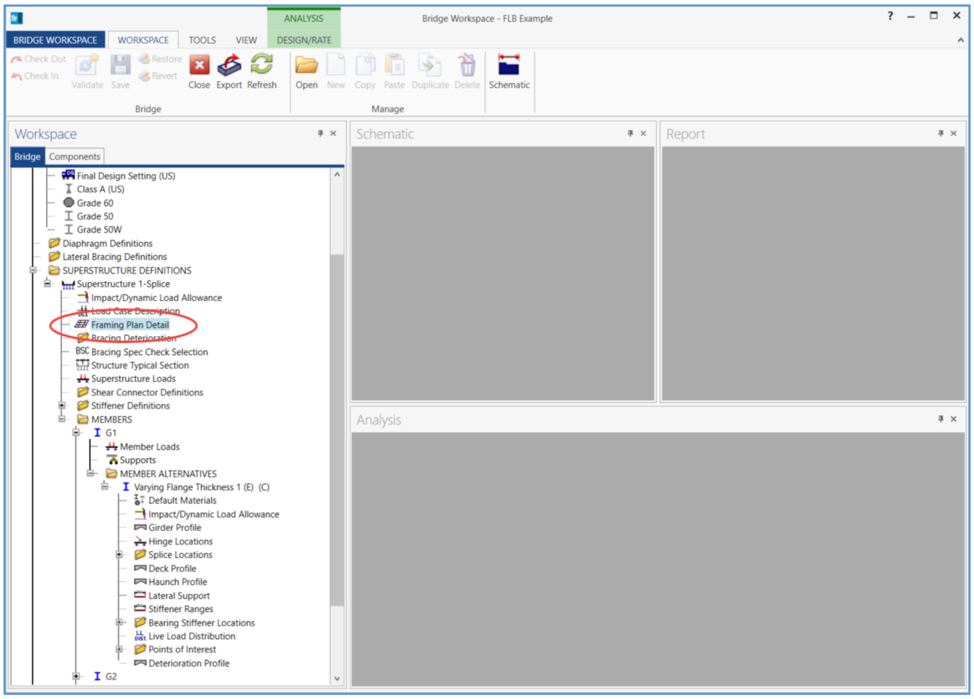


Bridge Workspace

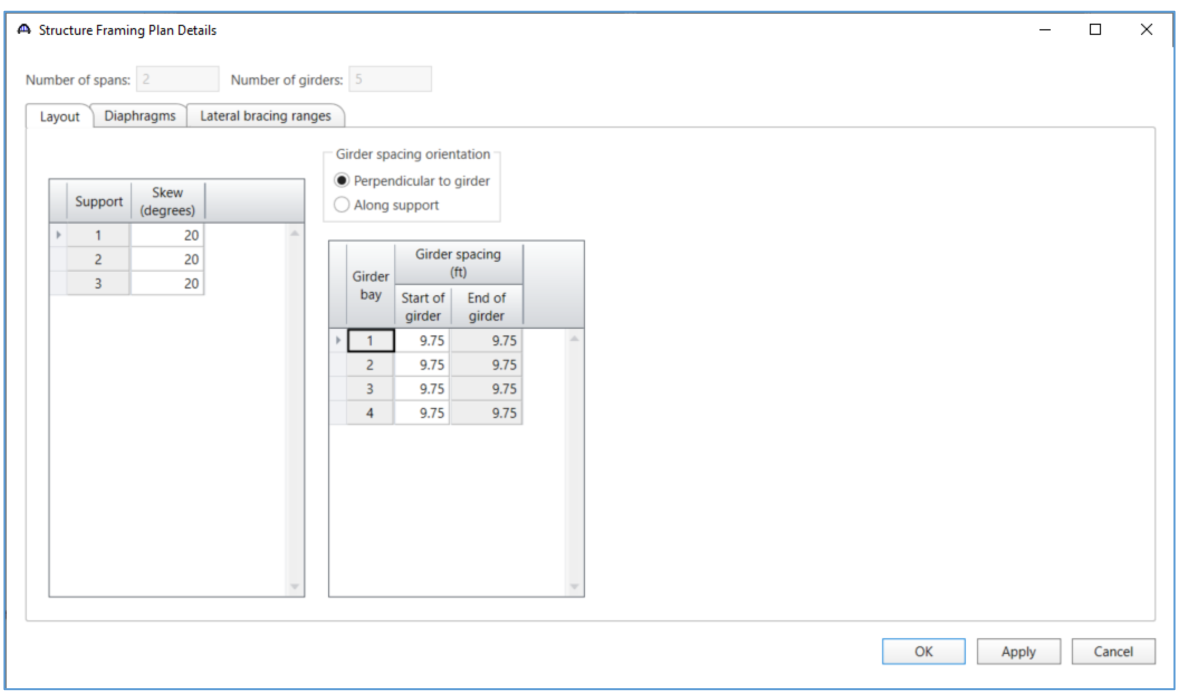
Open the newly created bridge model and expand the bridge workspace tree.

Support Skew

Update the support skew within the **Framing Plan Detail** window.



Assign a skew of 20° to each support.

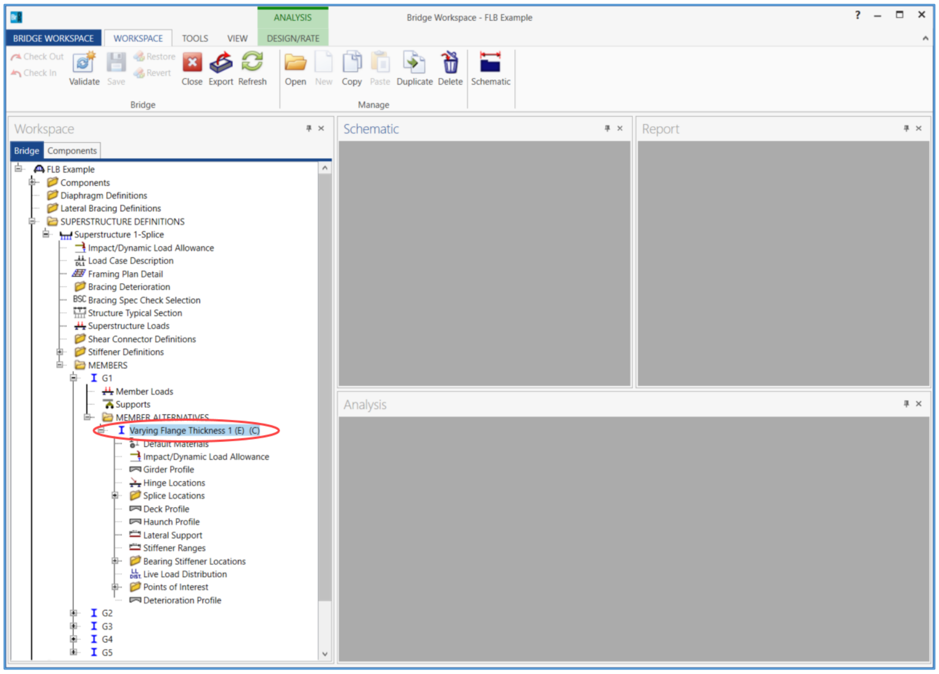


Use **OK** to save the data to memory and close the window.

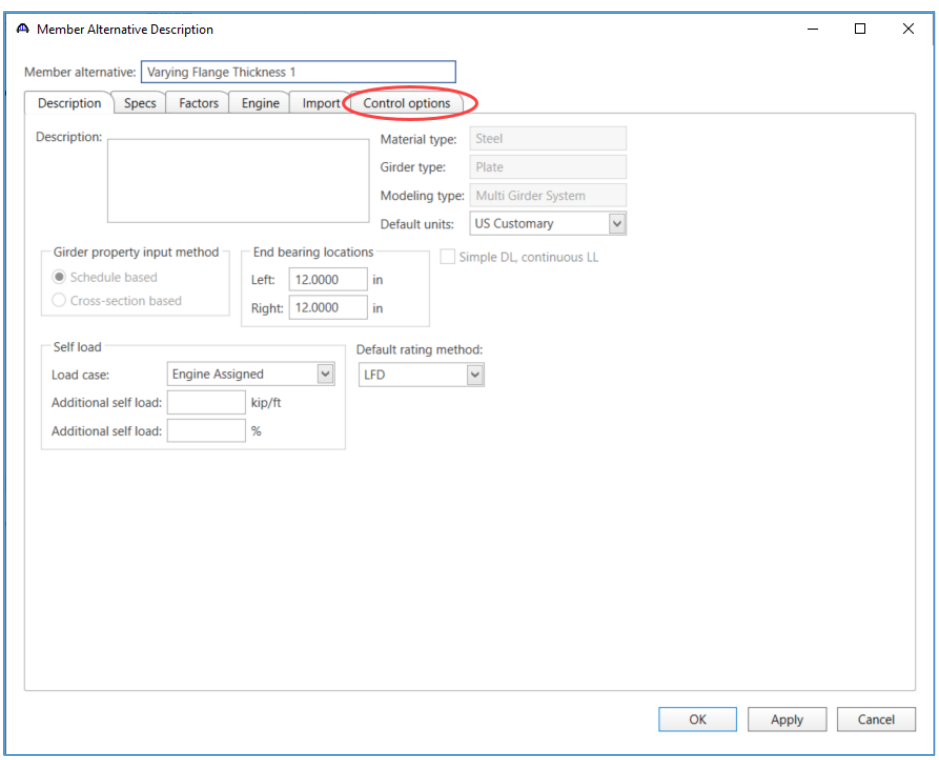
Flange Lateral Bending

Define flange lateral bending stresses for G1. Expand the **Bridge Workspace Tree** to show the *Varying Flange Thickness 1* member alternative for G1.

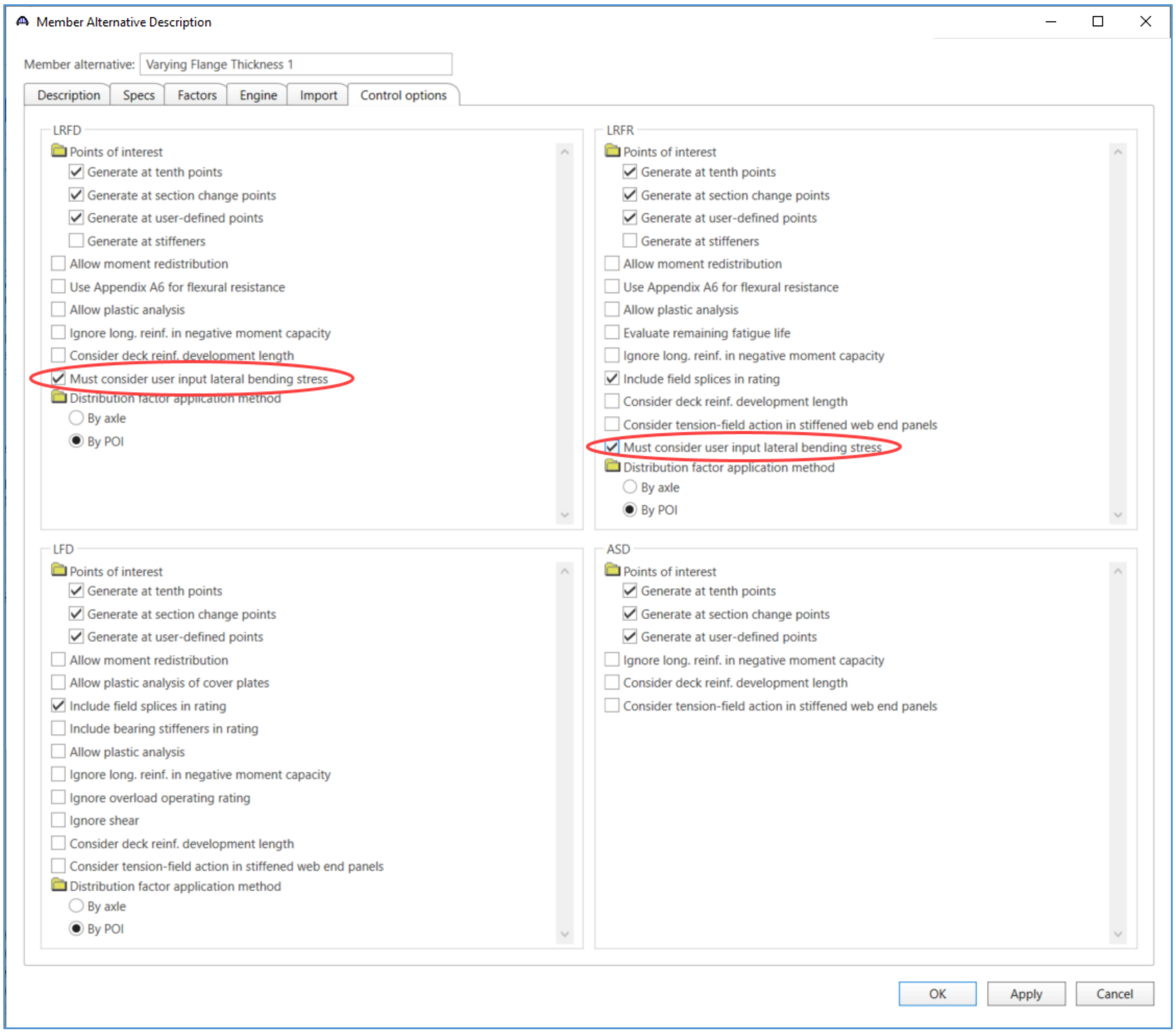
First, set the control option for the member alternative to consider user-input flange lateral bending stresses. Open the **Member Alternative** window for the *Varying Flange Thickness 1* member alternative.



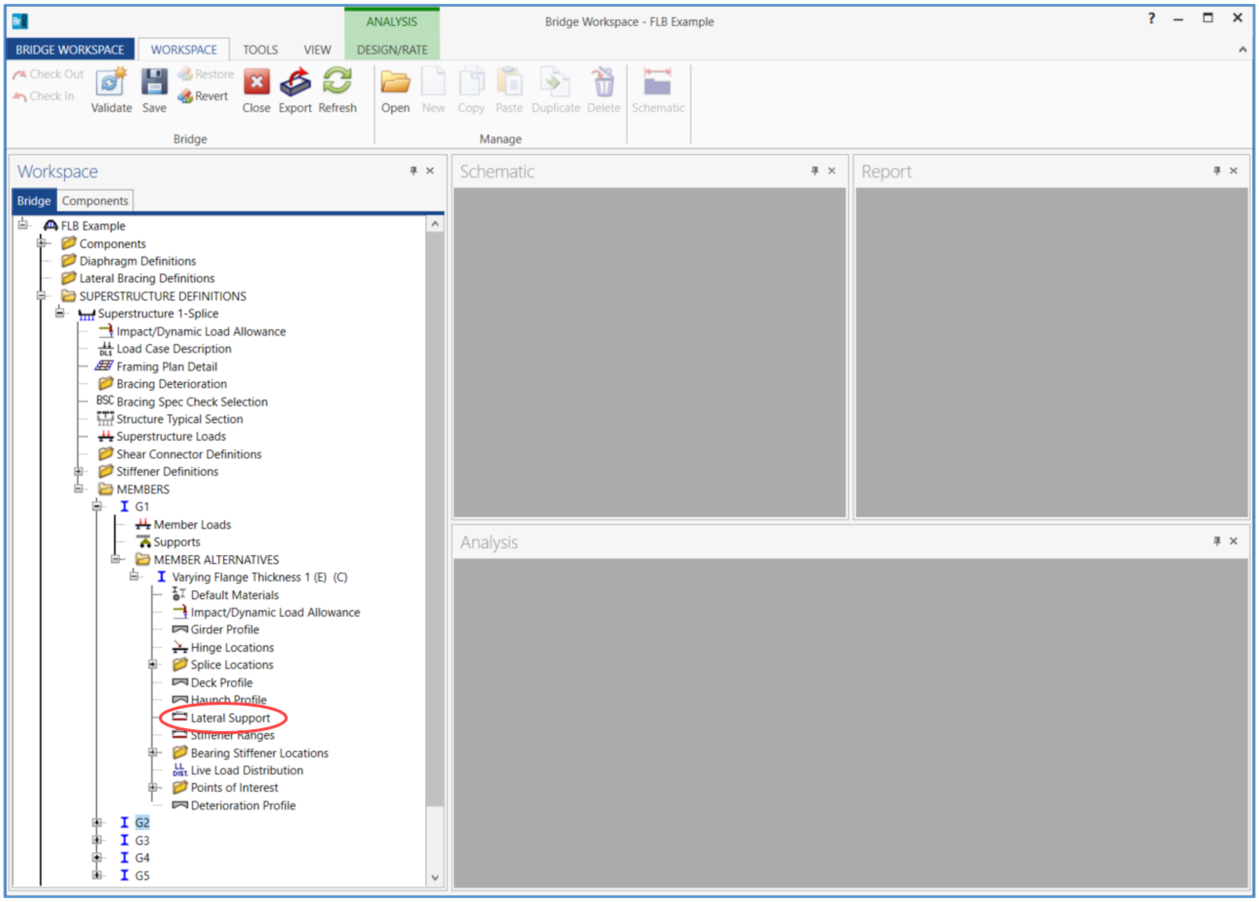
Open the **Control options** tab within the window.



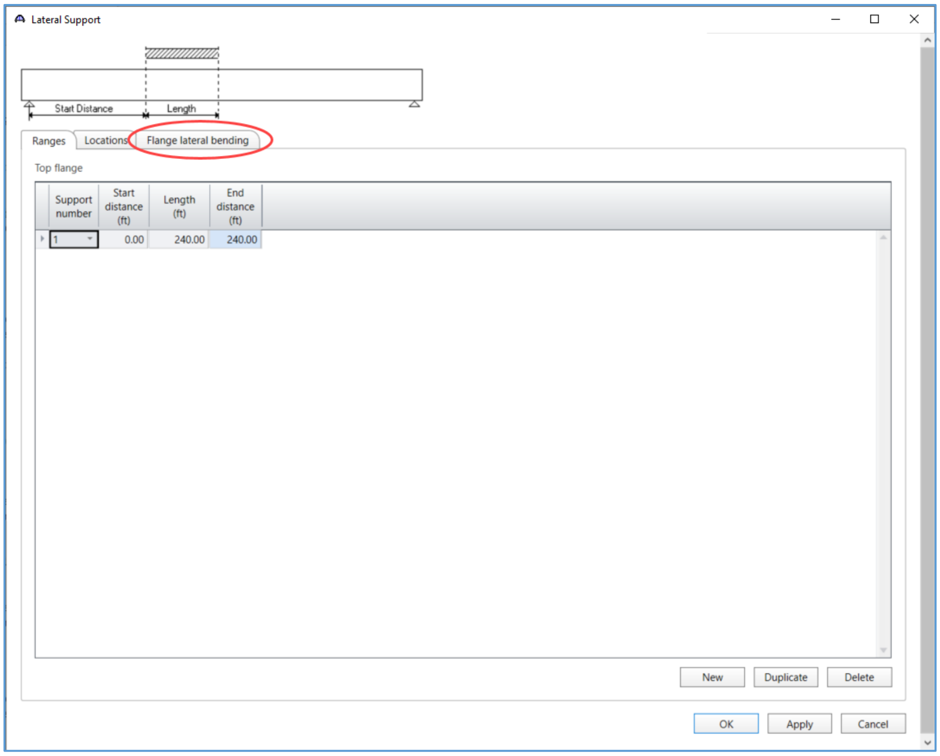
Select the checkboxes labeled *Must consider user input lateral bending stress* for both LRFD and LRFR. When this control option is selected, the analysis engine will verify that the user has input flange lateral bending stresses. If no stresses are defined, the validation will fail and the analysis will stop. When not selected, the option is interpreted to mean must NOT consider user input lateral bending stress, so any user input lateral stresses are ignored during the analysis. Select **OK** to save the control option selections to memory and close the window.

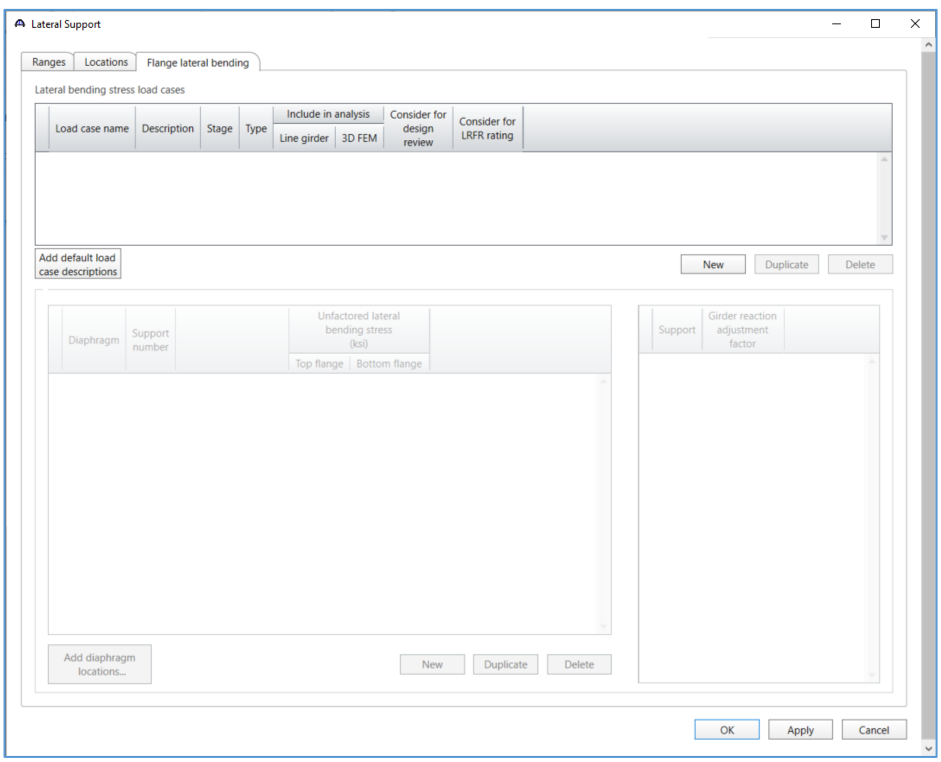


The flange lateral bending stresses are defined within the **Lateral Support** window.



Select the **Flange lateral bending** tab within the **Lateral Support** window.

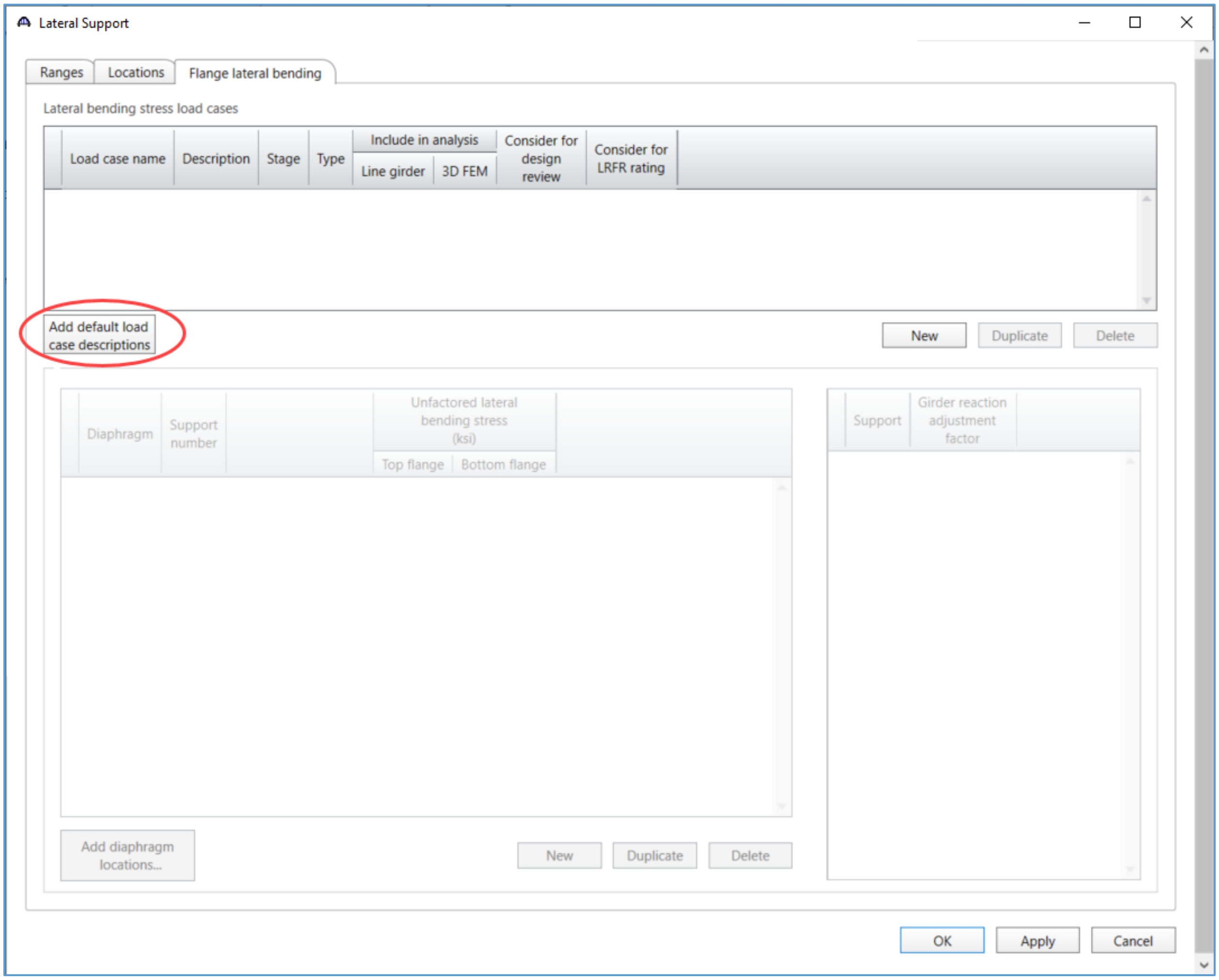




Lateral Bending Stress Load Cases

The first table in the lateral bending stress window defines the load cases for flange lateral bending stresses. These load cases are not the same as the load cases created within the **Load Case Description** window of the superstructure definition.

Use the *Add default load case descriptions* button to populate the default load cases.



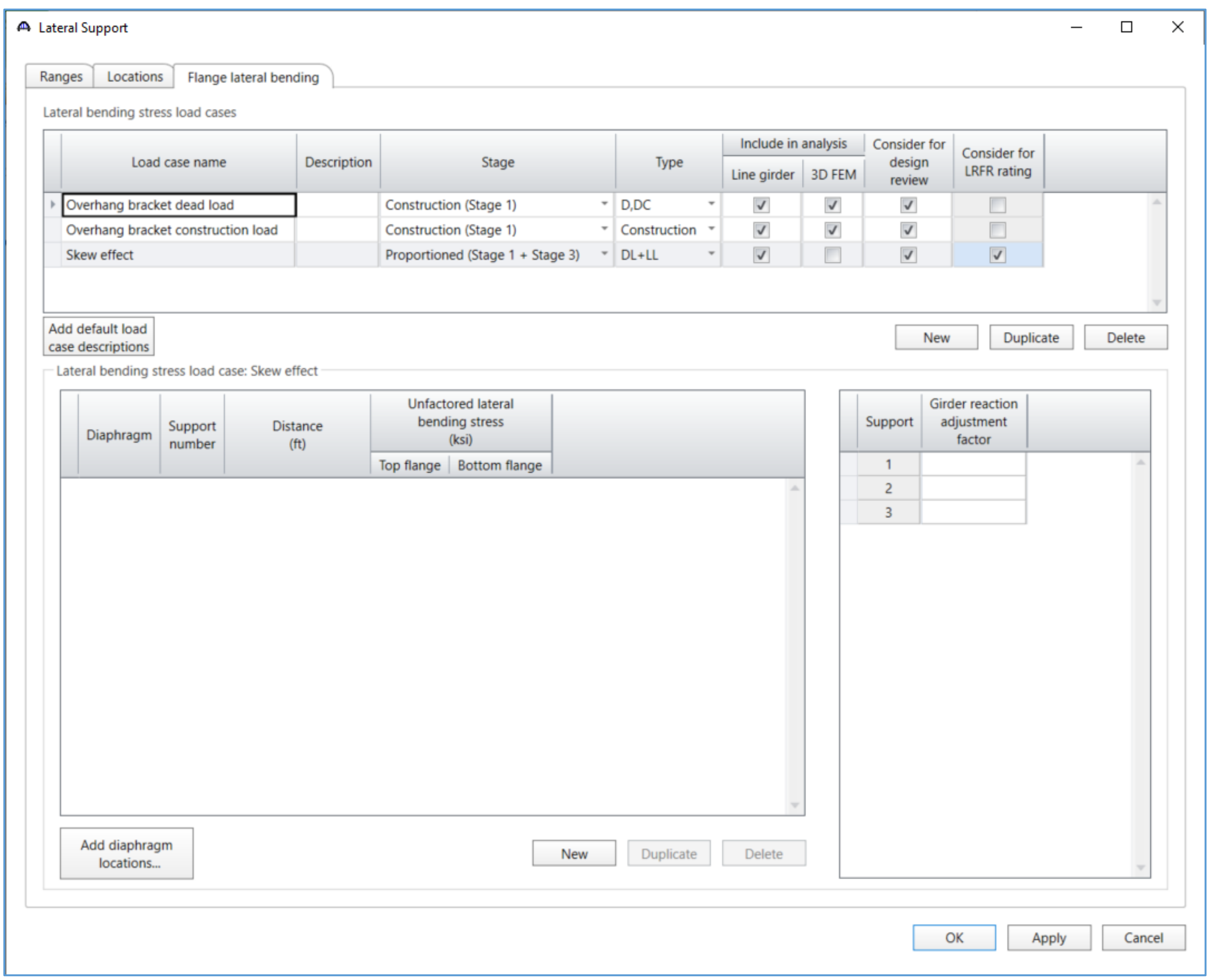
The default load cases for an exterior girder are shown below, including overhang bracket dead load, overhang construction load and skew effect. The default load cases for interior girders do not include the overhang brackets. The columns for **Stage** and **Type** include options not available for superstructure load cases.

Construction (Stage 1) loads are considered during stage 1 spec checking only, whereas *Non-composite (Stage 1)* loads are considered during stage 1 and all subsequent loading stages.

Proportioned (Stage 1 + Stage 3) loads are proportioned into dead load and live load components in the same proportion as the unfactored major axis dead load and live load moments at the section under consideration.

The load type column determines the load factors which are applied to the user-defined unfactored lateral bending stress.

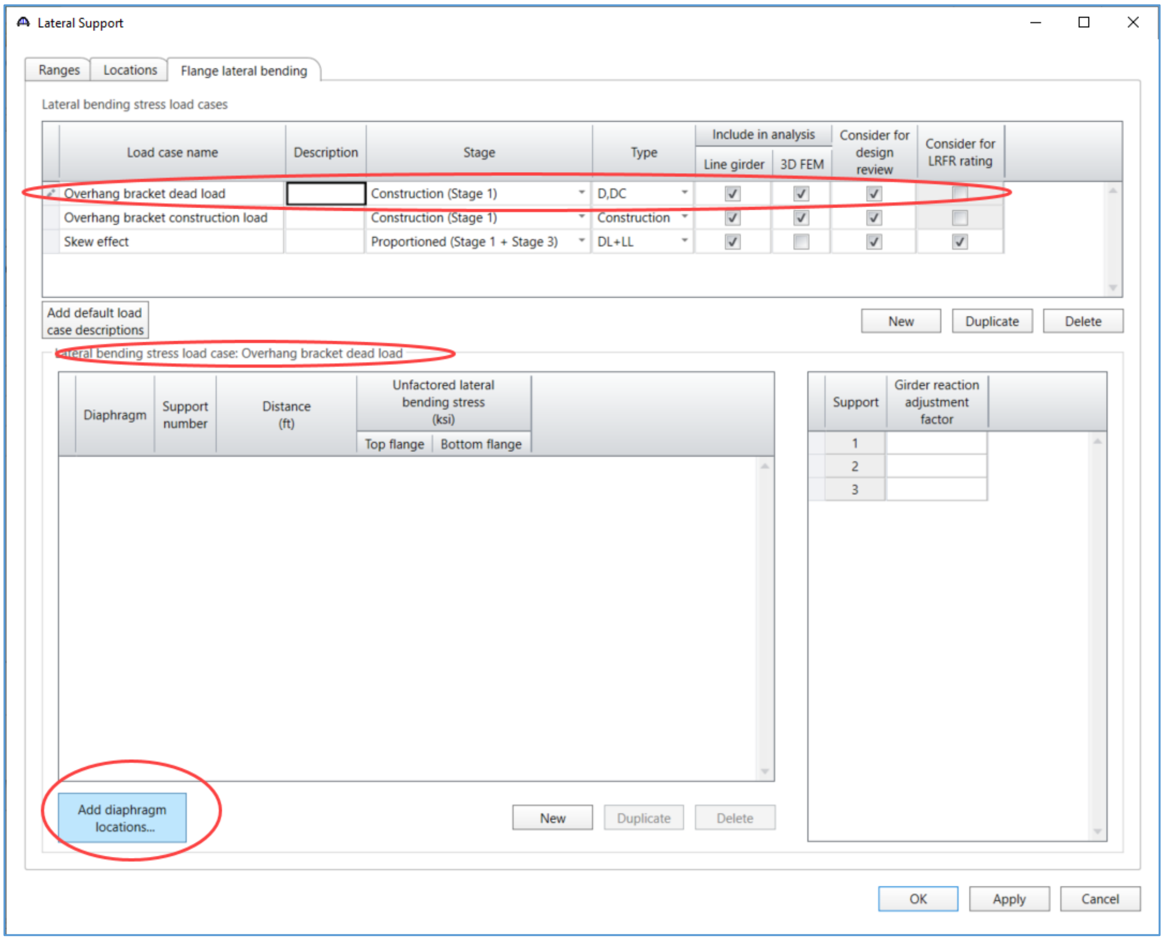
Use the provided checkboxes to indicate the analysis types for which to consider the lateral stresses.



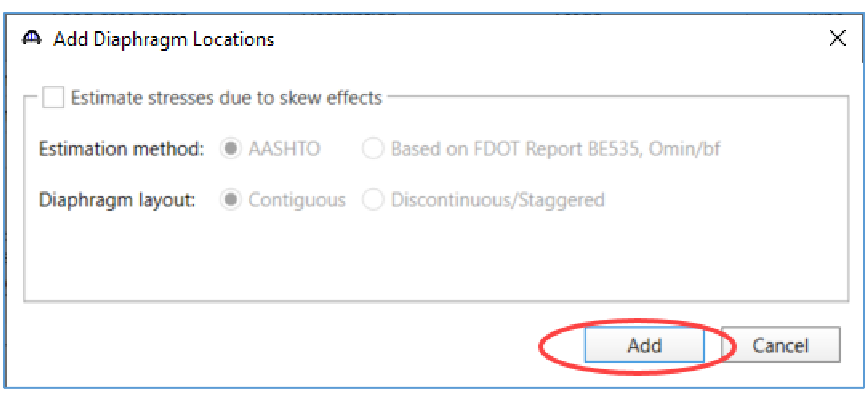
Lateral Bending Stress Load Case –Overhang bracket dead load

Compute the lateral stress transferred to the bottom flange of the exterior girder from the deck overhang brackets. Assume the brackets support the weight of the parapet.

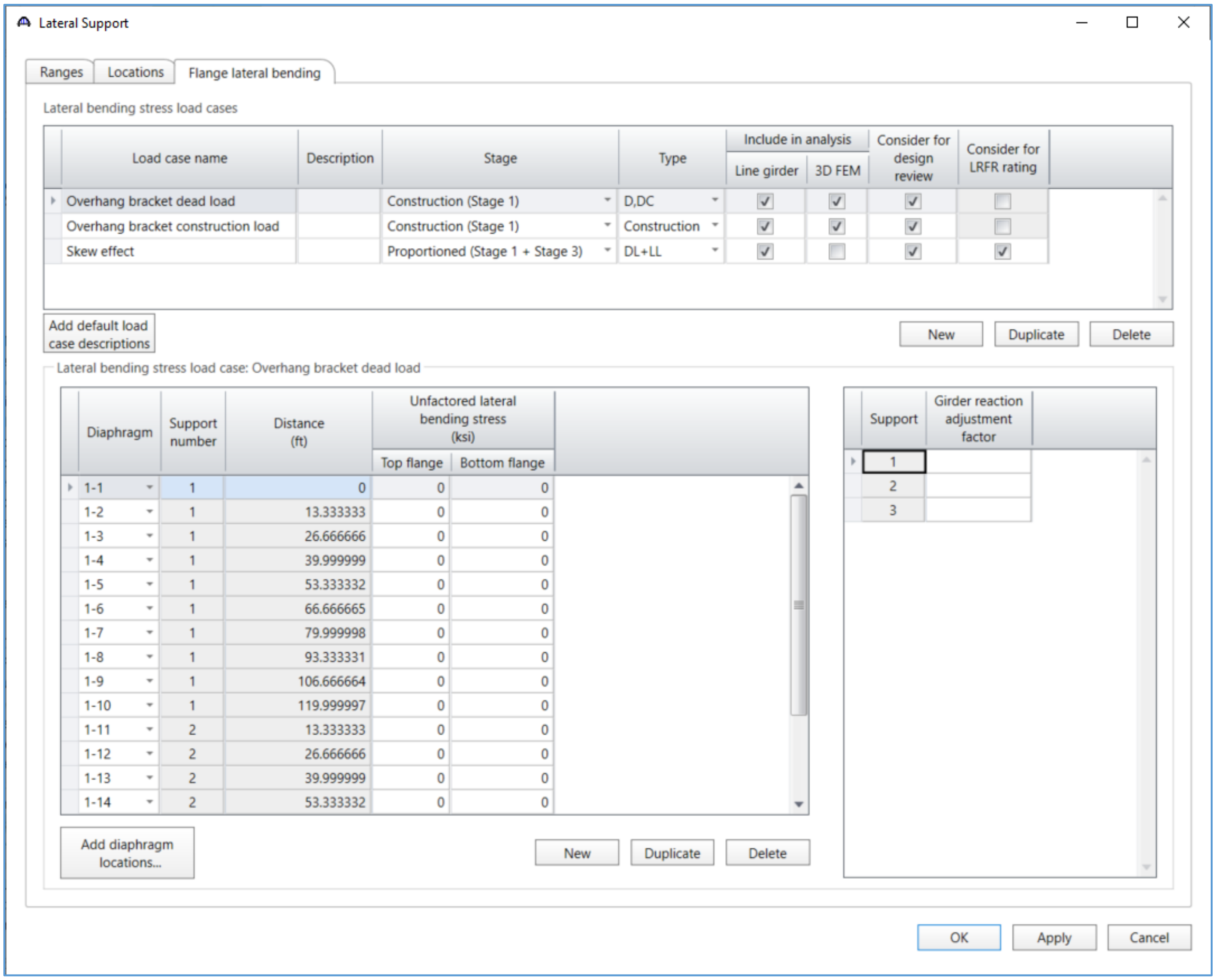
Select the first row in the **Lateral bending stress load cases** table so the bottom left table title reads: *Lateral bending stress load case: Overhang bracket dead load*. Use the *Add diaphragm locations…* button to open a diaphragm locations tool.



Select **Add** to add all diaphragm locations without estimating the skew effect stresses.



The table now includes all diaphragm locations.



From the weight of the parapet, the diaphragm spacing, structure typical section and girder profile the following stresses can be computed for the bottom flange.

Lateral bending stress load case: Overhang bracket dead load

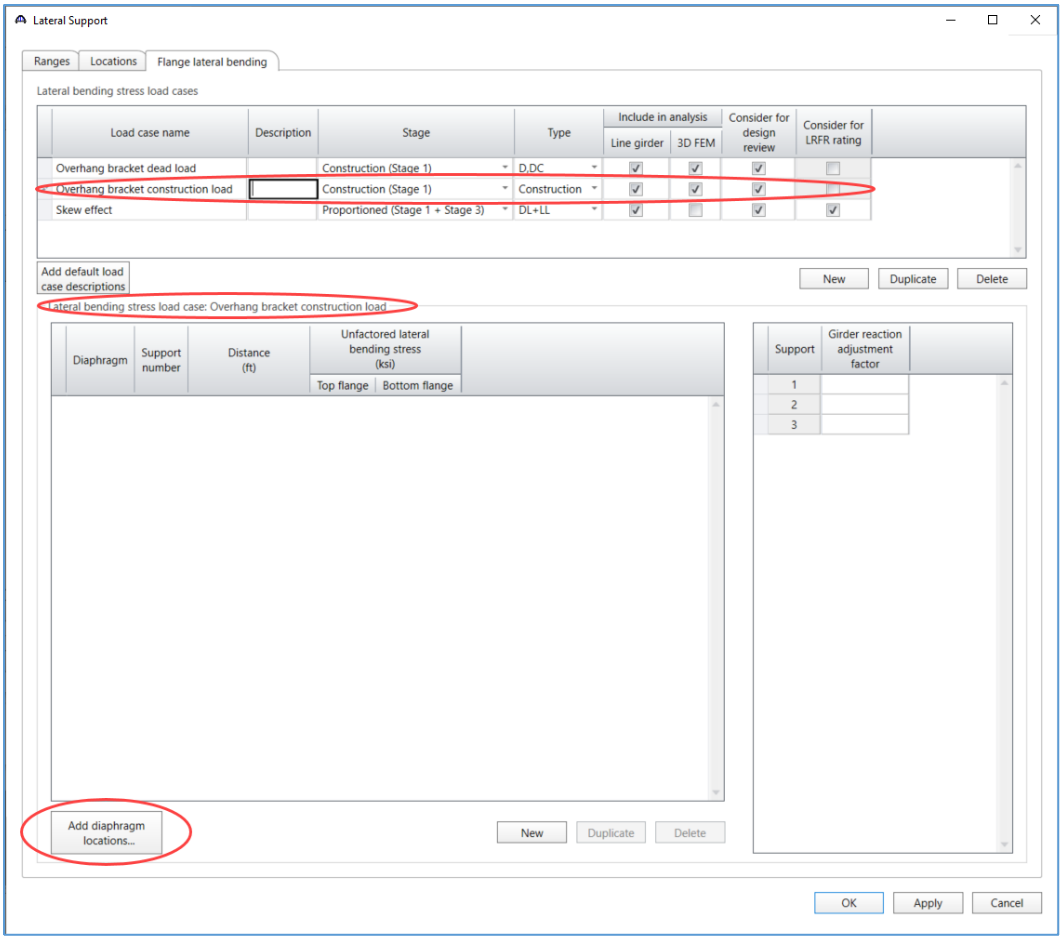
Diaphragm	Support number	Distance (ft)	Unfactored lateral bending stress (ksi)	
			Top flange	Bottom flange
1-1	1	0	0	5.85
1-2	1	13.333333	0	11.7
1-3	1	26.666666	0	11.7
1-4	1	39.999999	0	11.7
1-5	1	53.333332	0	11.7
1-6	1	66.666665	0	11.7
1-7	1	79.999998	0	11.7
1-8	1	93.333331	0	7.45
1-9	1	106.666664	0	7.45
1-10	1	119.999997	0	3.72
1-11	2	13.333333	0	7.45
1-12	2	26.666666	0	7.45
1-13	2	39.999999	0	11.7
1-14	2	53.333332	0	11.7
1-15	2	66.666665	0	11.7
1-16	2	79.999998	0	11.7
1-17	2	93.333331	0	11.7
1-18	2	106.666664	0	11.7
1-19	2	119.999997	0	5.85

Select **Apply** to save the data to memory and keep the window open.

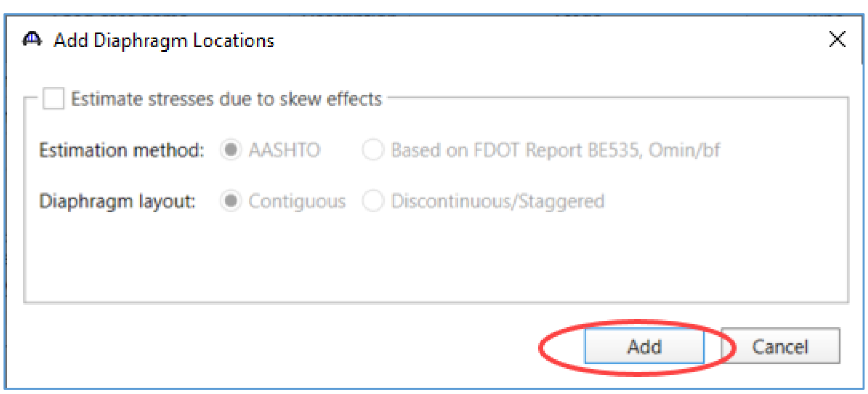
Lateral Bending Stress Load Case –Overhang bracket construction load

Compute the lateral stress transferred to the bottom flange of the exterior girder from the deck overhang brackets during construction. Assume the brackets support a 75plf load applied on the deck overhang.

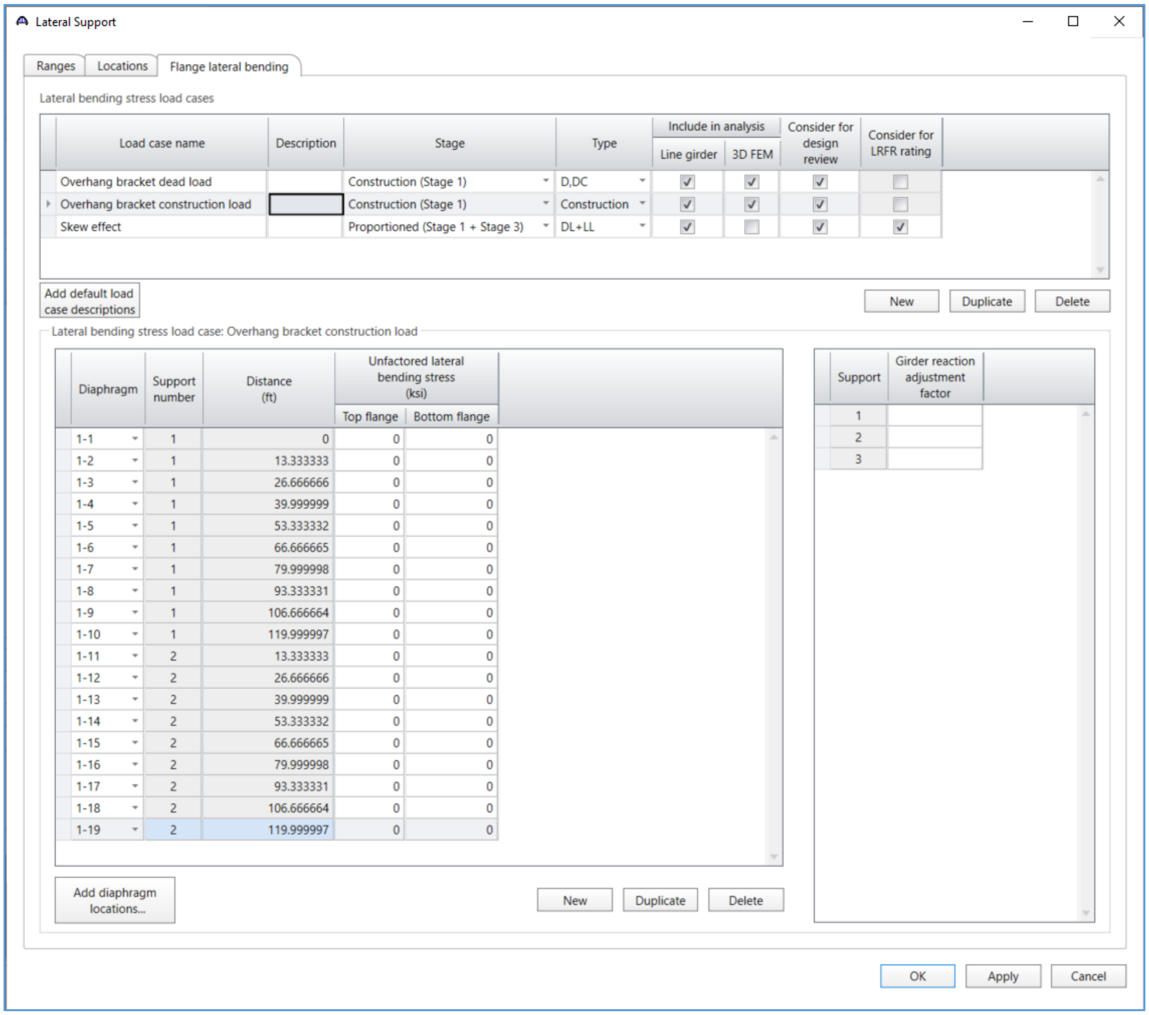
Select the second row in the **Lateral bending stress load cases** table so the bottom left table title reads: *Lateral bending stress load case: Overhang bracket construction load*. Use the *Add diaphragm locations…* button to open a diaphragm locations tool.



Select **Add** to add all diaphragm locations without estimating the skew effect stresses.



The table now includes all diaphragm locations.



From the diaphragm spacing, structure typical section and girder profile the following stresses can be computed for the bottom flange.

Lateral bending stress load case: Overhang bracket construction load

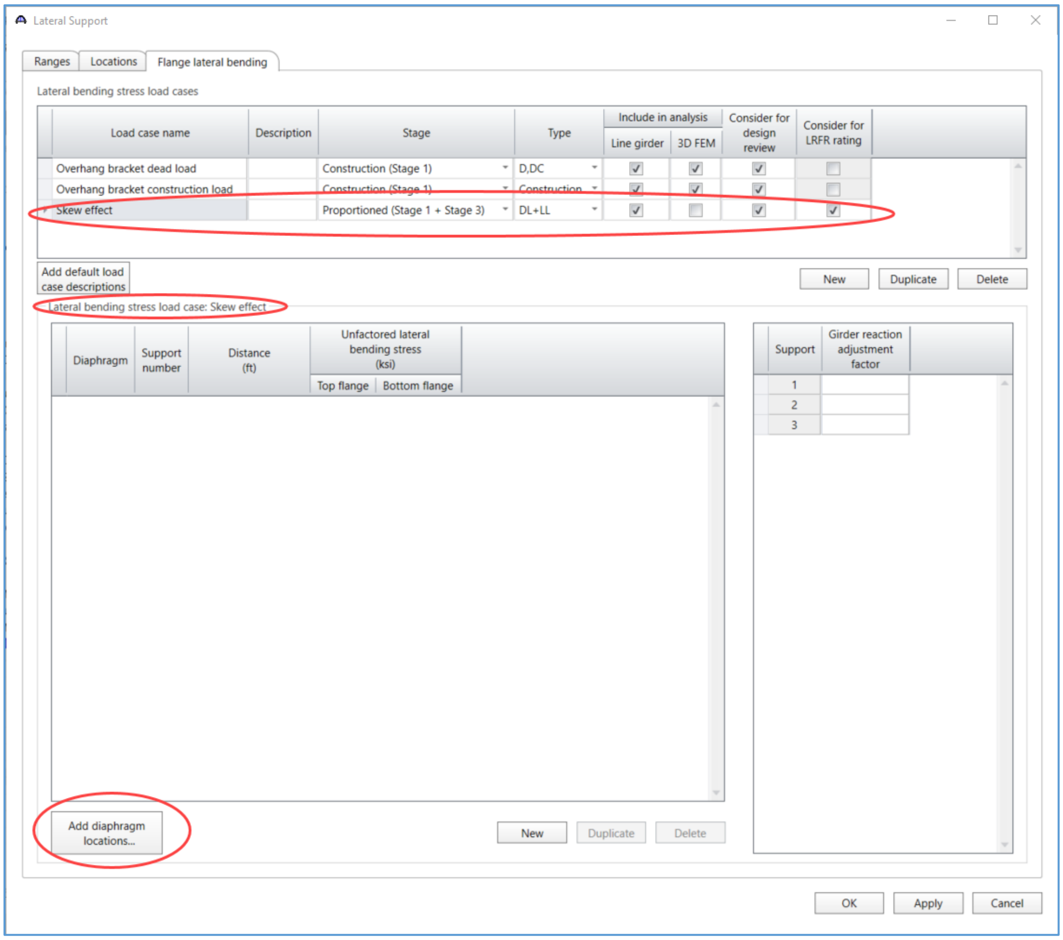
Diaphragm	Support number	Distance (ft)	Unfactored lateral bending stress (ksi)	
			Top flange	Bottom flange
1-1	1	0	0	0.83
1-2	1	13.333333	0	1.65
1-3	1	26.666666	0	1.65
1-4	1	39.999999	0	1.65
1-5	1	53.333332	0	1.65
1-6	1	66.666665	0	1.65
1-7	1	79.999998	0	1.65
1-8	1	93.333331	0	1.05
1-9	1	106.666664	0	1.05
1-10	1	119.999997	0	0.53
1-11	2	13.333333	0	1.05
1-12	2	26.666666	0	1.05
1-13	2	39.999999	0	1.65
1-14	2	53.333332	0	1.65
1-15	2	66.666665	0	1.65
1-16	2	79.999998	0	1.65
1-17	2	93.333331	0	1.65
1-18	2	106.666664	0	1.65
1-19	2	119.999997	0	0.83

Select **Apply** to save the data to memory and keep the window open.

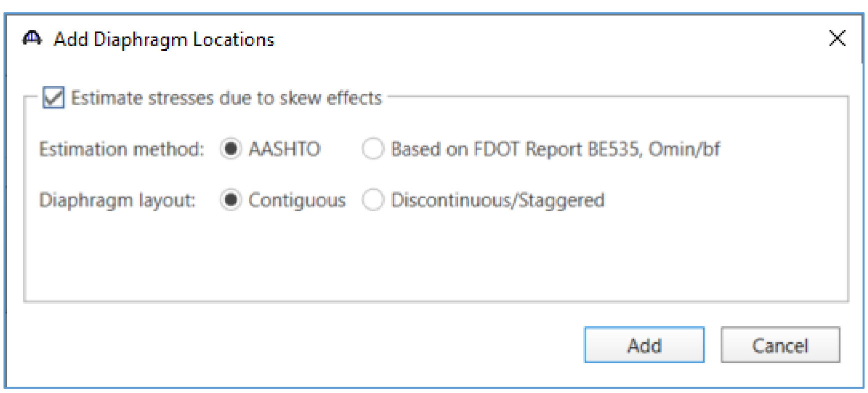
Lateral Bending Stress Load Case – Skew effect

Approximate the lateral stress transferred to the exterior girder from the skew effects as specified in the AASHTO LRFD commentary.

Select the third row in the **Lateral bending stress load cases** table so the bottom left table title reads: *Lateral bending stress load case: Skew effect*. Use the *Add diaphragm locations…* button to open a diaphragm locations tool.



Select **Add** to approximate lateral stresses all diaphragm locations using the AASHTO commentary.



The table now includes approximate lateral stresses at all diaphragm locations.

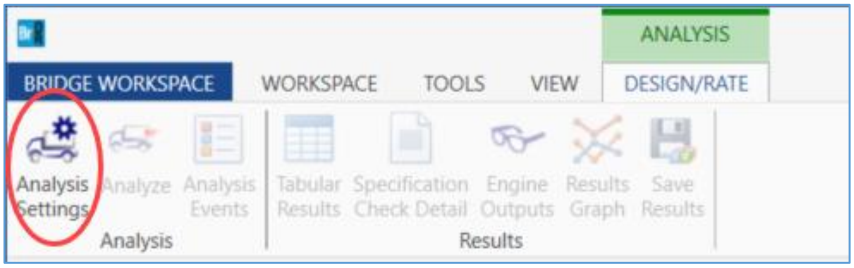
Lateral bending stress load case: Skew effect

Diaphragm	Support number	Distance (ft)	Unfactored lateral bending stress (ksi)	
			Top flange	Bottom flange
1-1	1	0	7.5	7.5
1-2	1	13.333333	7.5	7.5
1-3	1	26.666666	0	0
1-4	1	39.999999	0	0
1-5	1	53.333332	0	0
1-6	1	66.666665	0	0
1-7	1	79.999998	0	0
1-8	1	93.333331	0	0
1-9	1	106.666664	7.5	7.5
1-10	1	119.999997	7.5	7.5
1-11	2	13.333333	7.5	7.5
1-12	2	26.666666	0	0
1-13	2	39.999999	0	0
1-14	2	53.333332	0	0
1-15	2	66.666665	0	0
1-16	2	79.999998	0	0
1-17	2	93.333331	0	0
1-18	2	106.666664	7.5	7.5
1-19	2	119.999997	7.5	7.5

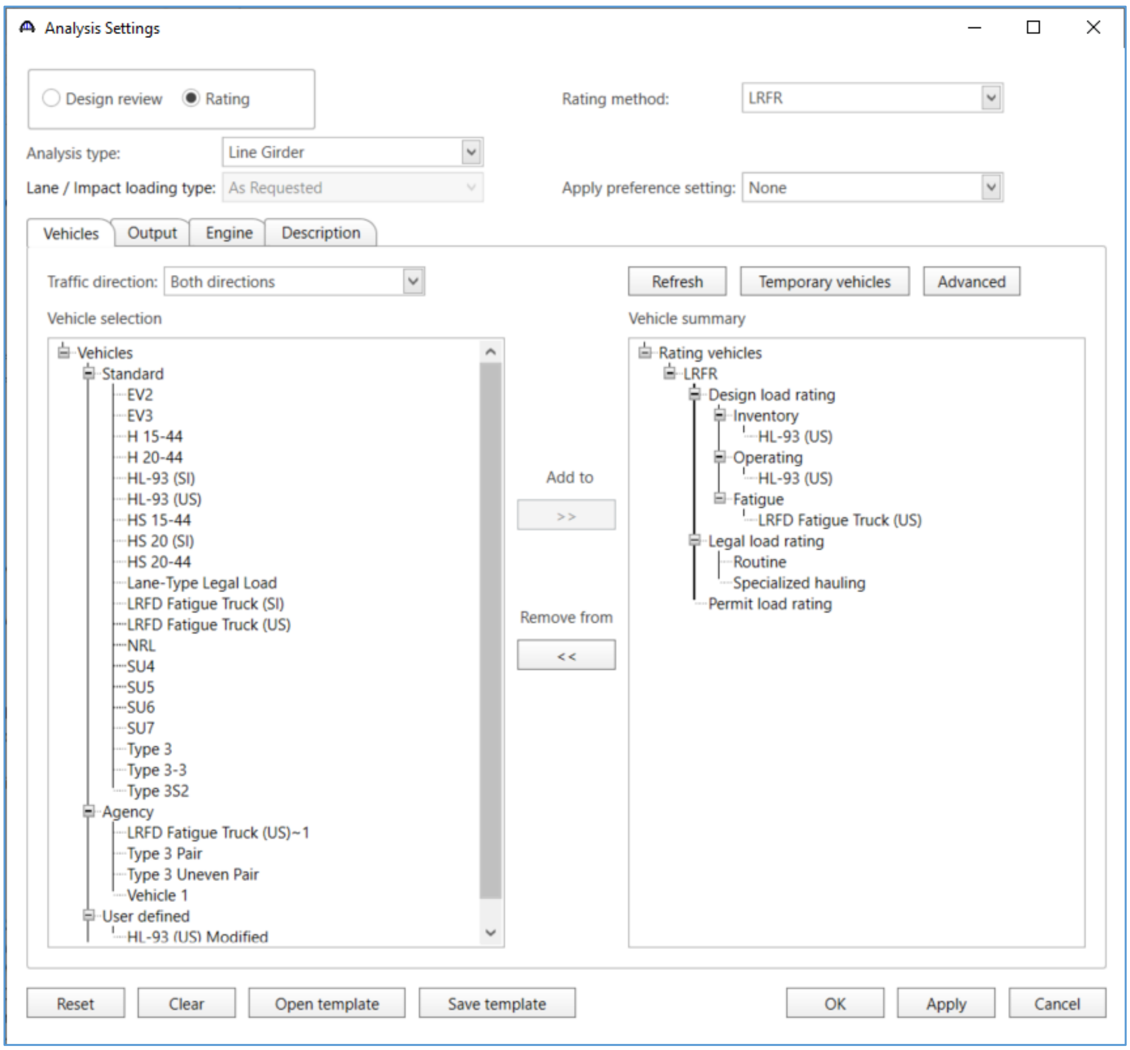
Select **OK** to save the data to memory and close the window.

LRFR Rating

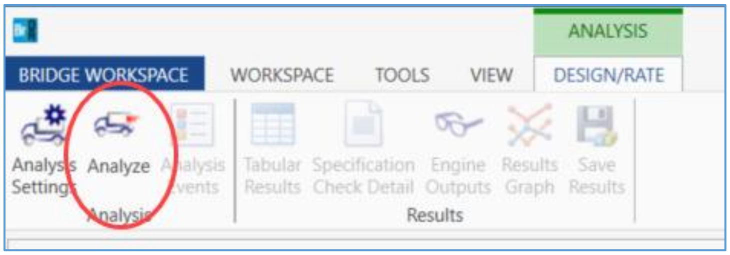
To perform an **LRFR** rating, click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon which opens the **Analysis Settings** window.



Select the vehicles to be used in the rating as shown below and click **OK**.

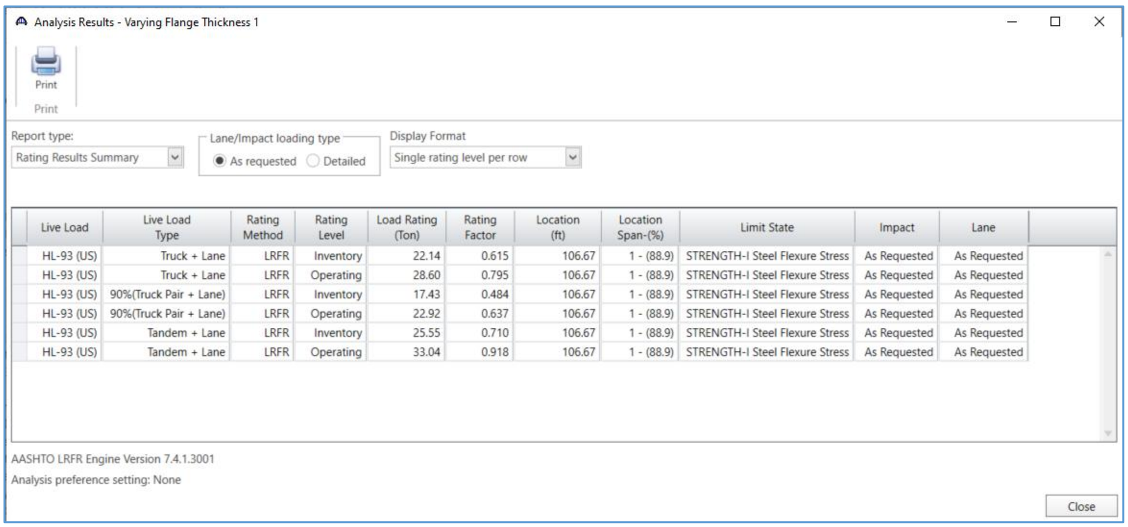


Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



Tabular Results

When the rating is finished results can be reviewed by clicking the **Tabular Results** button on the **Results** group of the **DESIGN/RATE** ribbon. 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	22.14	0.615	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	28.60	0.795	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	17.43	0.484	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	22.92	0.637	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	25.55	0.710	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	33.04	0.918	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested