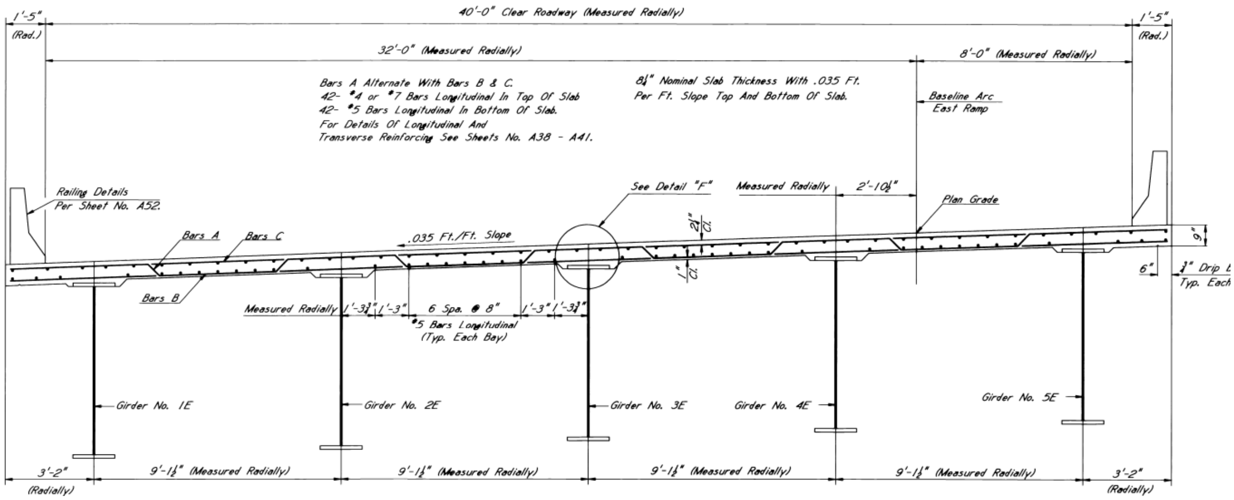
AASHTOWare BrDR 7.5.0

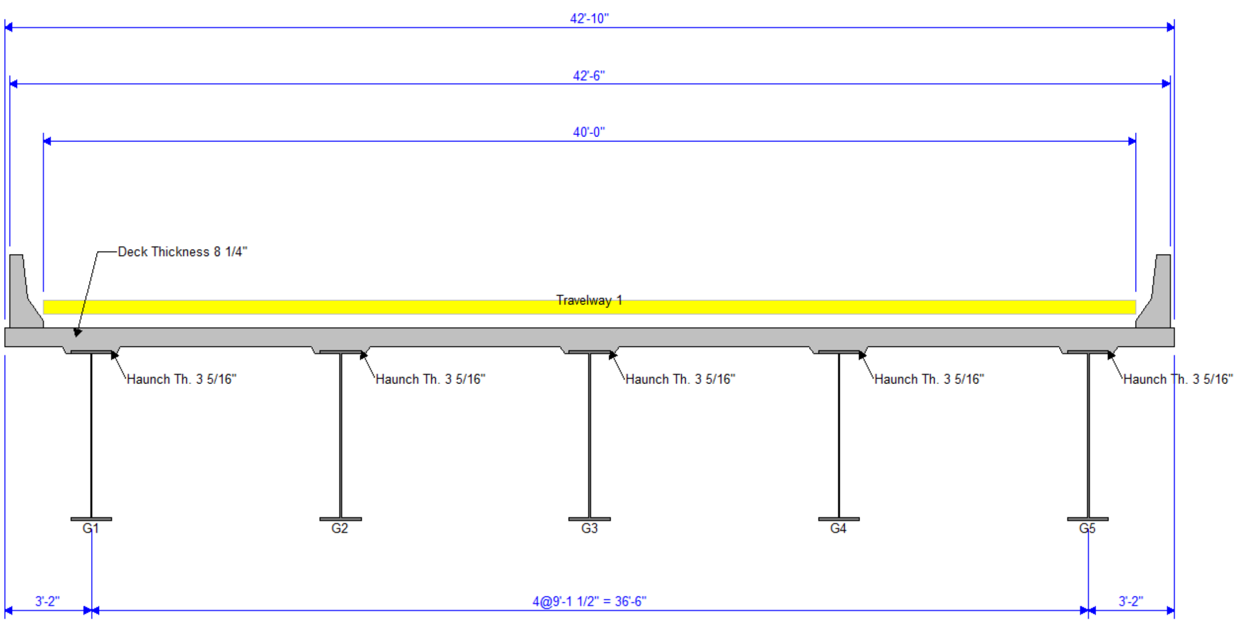
3D FEM Analysis Tutorial

3DFEM4 – Curved Steel Multi-Span 3D Example

3DFEM4 – Curved Steel I Beam Using BrDR LRFD Engine

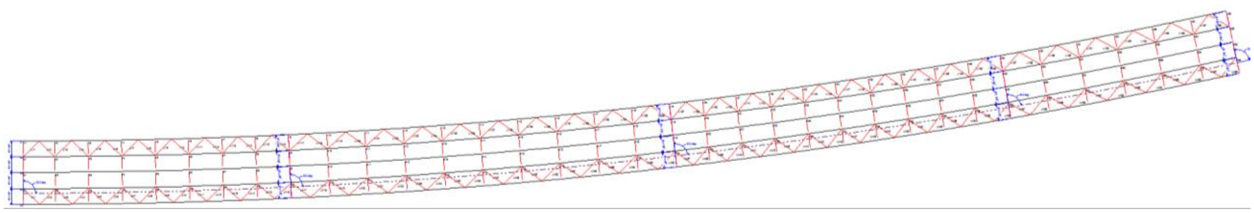
This example details the data input of a curved composite steel plate girder structure in BrDR and performing a 3D FEM analysis. This example is an I-Girder Bridge, SR 302, from the Mississippi DOT inventory.





Structure Typical Section

Member	Radius (ft)	Span 1 Length (ft)	Span 2 Length (ft)	Span 3 Length (ft)	Span 4 Length (ft)
G1	3243.7	152.33	219.95	192.21	132.51
G2	3252.9	152.76	220.57	192.75	132.89
G3	3262.0	153.19	221.19	193.29	133.26
G4	3271.1	153.61	221.81	193.83	133.63
G5	3280.2	154.04	222.42	194.37	134.01
Structure Ref.Line	3274.0	153.75	222.00	194.00	133.75



Structure Framing Plan

Topics Covered

- Comments and assumptions
- Data entry of a four-span curved steel plate girder bridge
- Diaphragm definitions
- 3D analysis settings
- 3D model
- Analysis and results

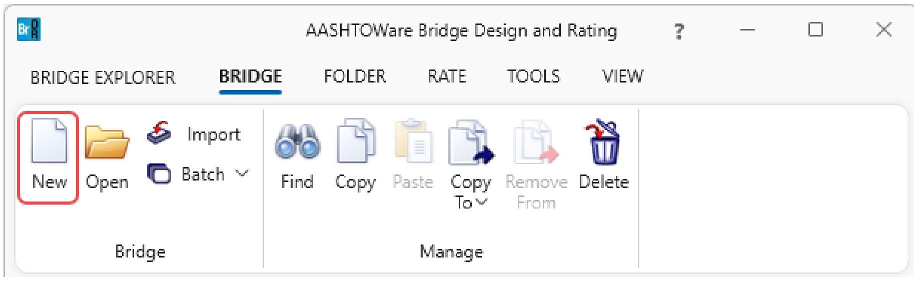
Comments and assumptions

- Per the design plans, the following material strengths were used:
  - Structural steel yield strength = 50 ksi (girders, stiffeners and splices)
  - Structural steel yield strength = 36 ksi (diaphragms)
  - Concrete compressive strength = 4.0 ksi (Class AA)
  - Reinforcing steel yield strength = 60 ksi
- District, County and Owner information is not populated
- Traffic data and design speed for LRFR analysis
  - Assumed ADTT = 1000
  - Design speed = 50 mph
- ¼" Integral Wearing Surface
- HL93 will be vehicle used for LRFR ratings and HS-20 scaled to HS-25 will be vehicle used for LFR ratings.
- An additional self-load of 0.01 kip/ft was applied to each beam/girder to account for bolts, stiffeners, diaphragm connections, etc.

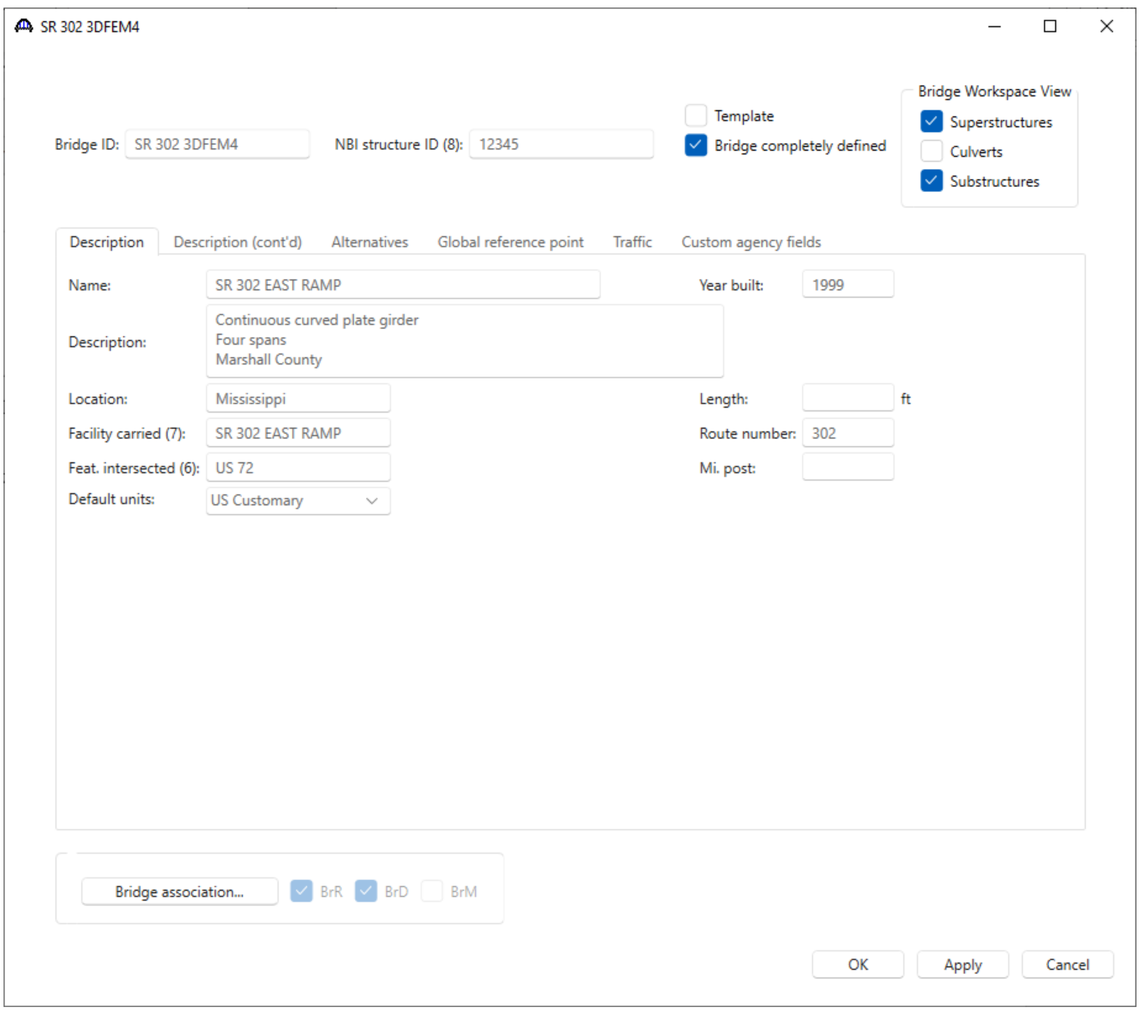
- BrDR 7.5.0 does not handle staggered bolt patterns for girder splices. Bolt patterns are entered as non-staggered.
- Splice gap = 3/8" at field splices.
- Approximate values of "Y" Distance were input for all Diaphragm Definitions.

Data entry of a four-span curved steel plate girder bridge

From the **Bridge Explorer**, create a new bridge using the **New** button from the **BRIDGE** ribbon.



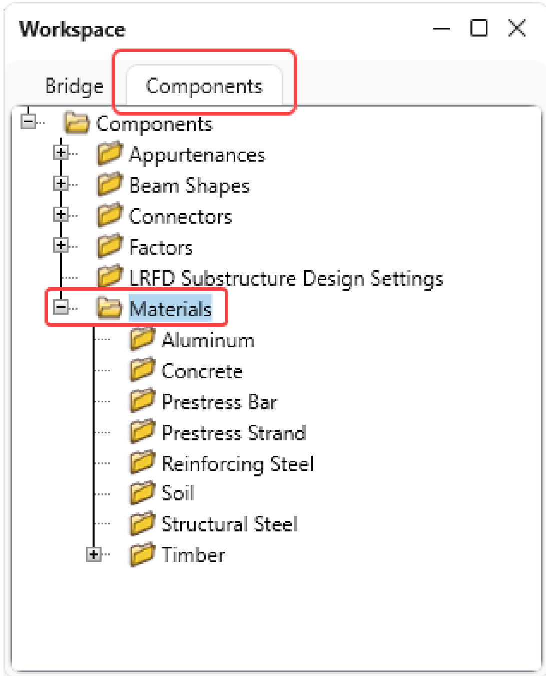
Enter the following bridge description data.



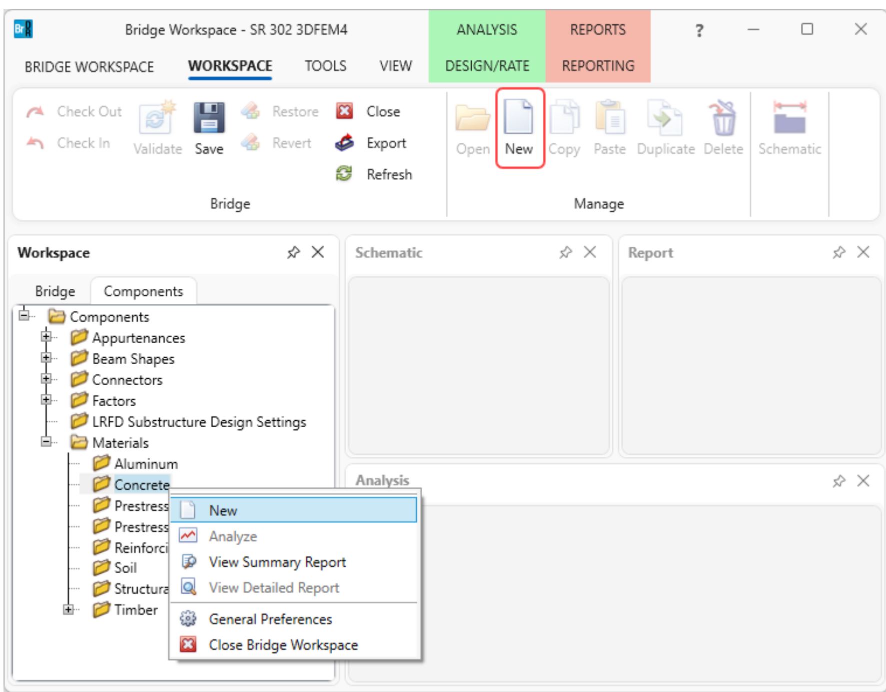
Click **OK** to apply the data and create the new bridge.

Bridge Materials – Concrete

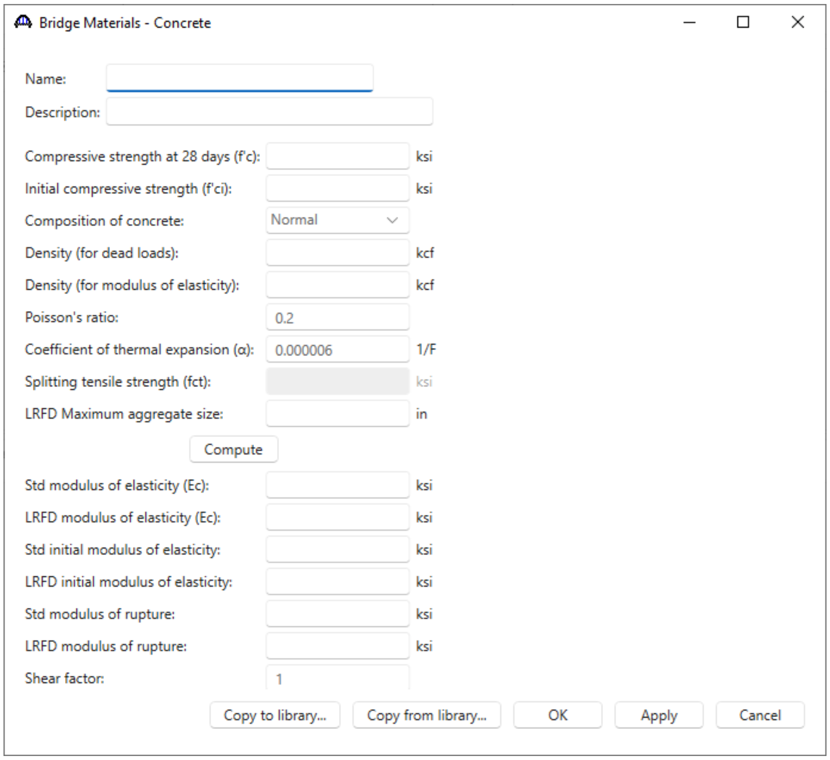
Navigate to the **Components** tab in the **Bridge Workspace** tree. Expand the **Materials** folder. The partially expanded **Bridge Workspace** tree is shown below.



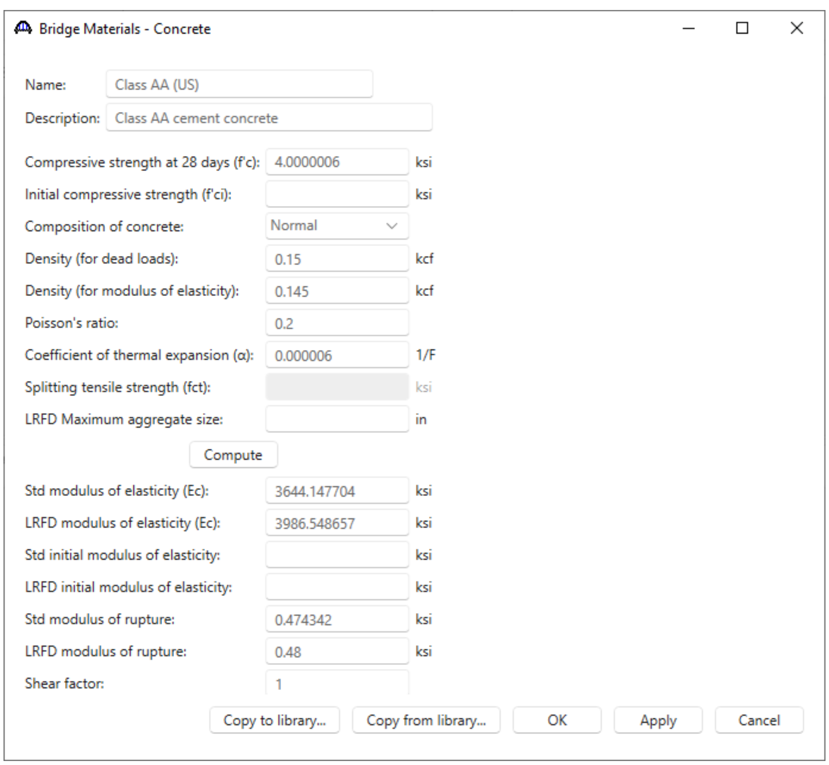
To add a concrete material for the deck, click on the **Concrete** node in the **BWS** tree and select **New** from the **WORKSPACE** ribbon (or double click on **Concrete** or right click and select **New**).



The window shown below opens.



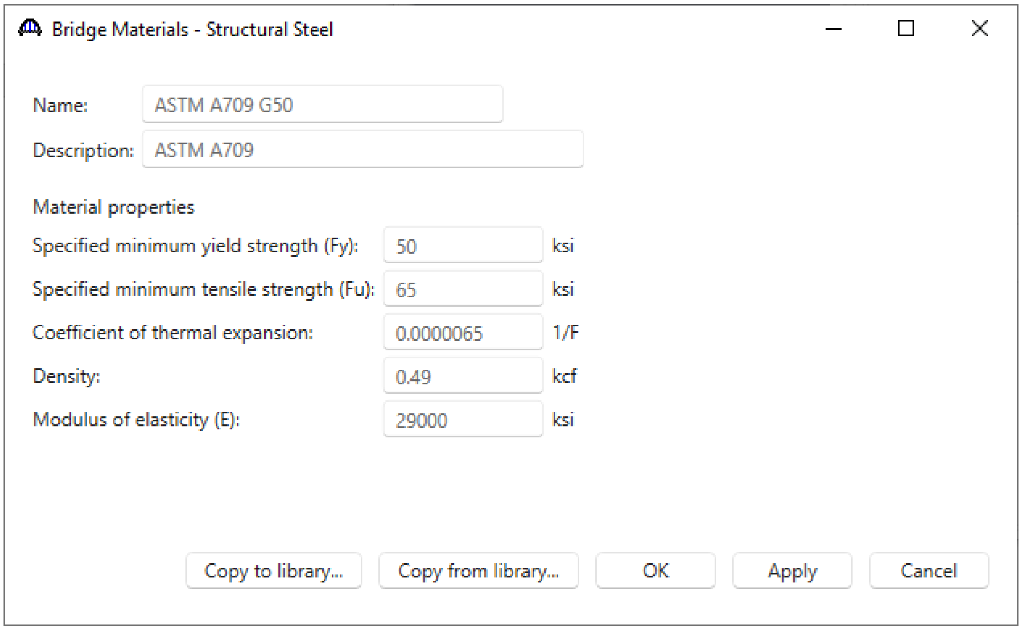
Enter data in the fields above the **Compute** button and click the **Compute** button to calculate the remaining properties. See image below.



Click **OK** to save the concrete material and close the window.

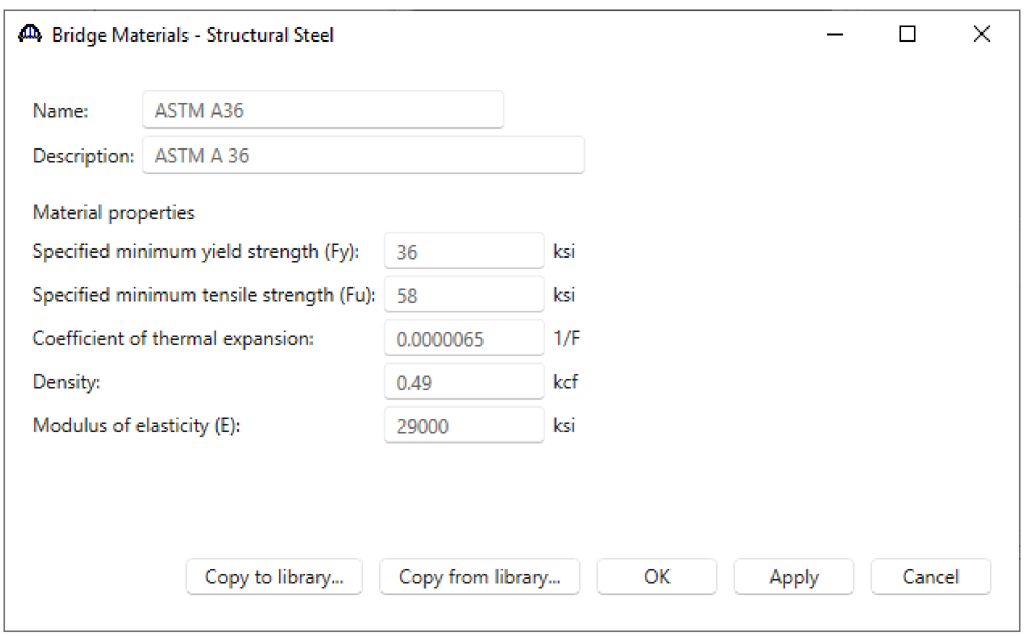
Bridge Materials – Structutral Steel

To add a structural steel material for the girder, click on **Structural Steel** in the **BWS** tree and select **New** from the **WORKSPACE** ribbon (or double click on **Structural Steel** or right click and select **New**). The window shown below opens. Enter the details shown below.



Click **OK** to save the steel material and close the window.

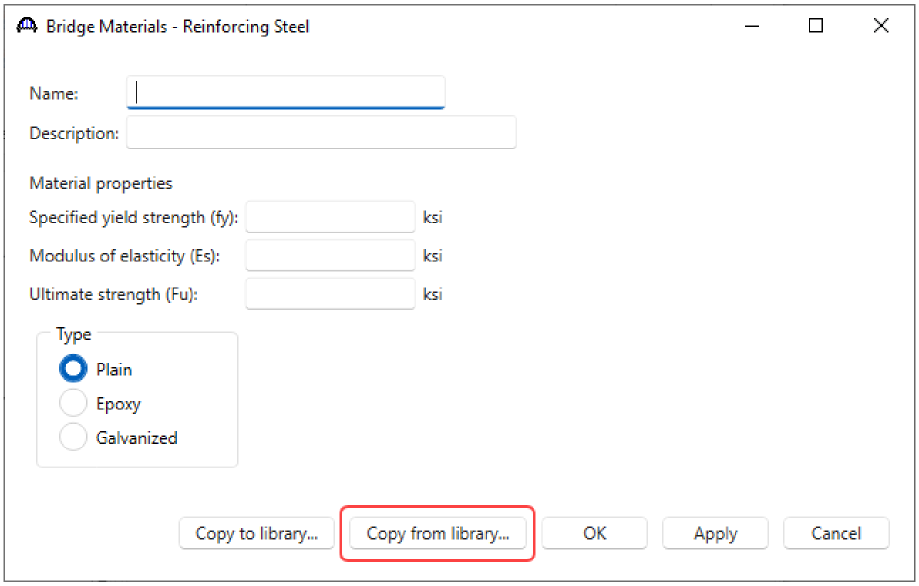
Similarly, add another structural steel material for stiffeners and diaphragms, using 36ksi strength as shown below.



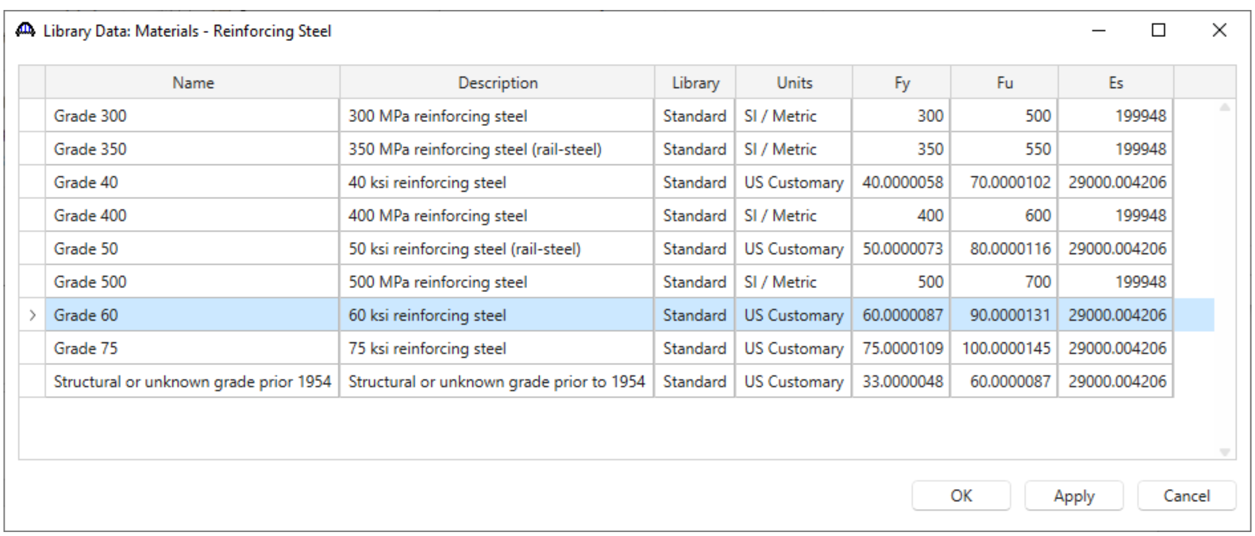
Click **OK** to save the steel material and close the window.

Bridge Materials – Reinforcing Steel

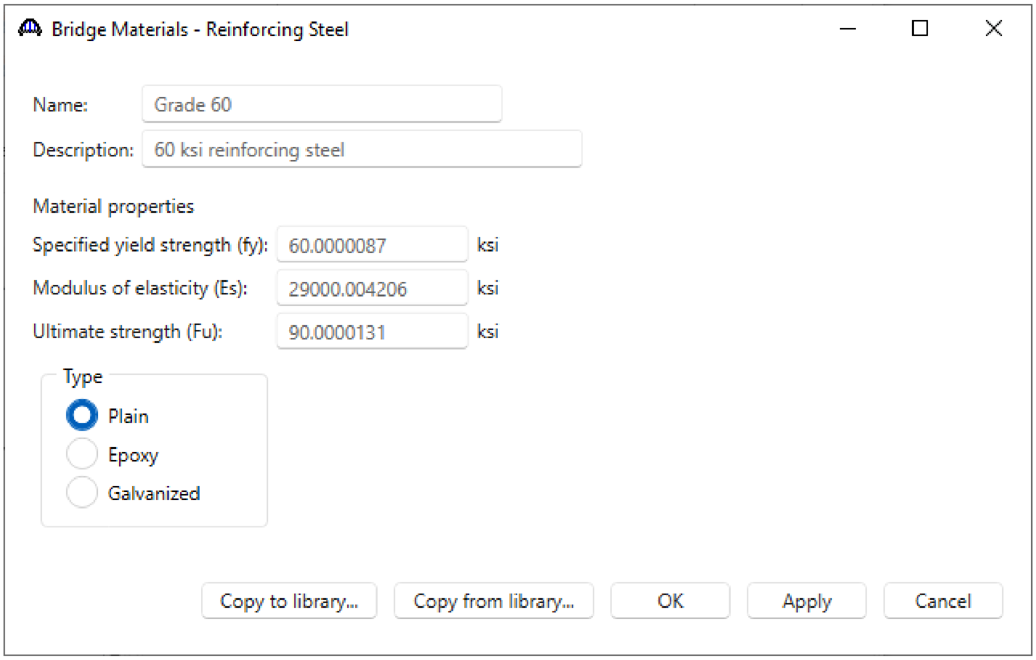
To add a reinforcing steel material for the girder, click on **Reinforcing Steel** in the **BWS** tree and select **New** from the **WORKSPACE** ribbon (or double click on **Reinforcing Steel** or right click and select **New**). The window shown below opens. Click on the **Copy from library…** button to open **the Library Data: Materials – Reinforcing Steel** window**.**



Select **Grade 60** from the window shown below and click **OK** to close this window and populate the selected steel material in the **Bridge Materials - Reinforcing Steel** window.



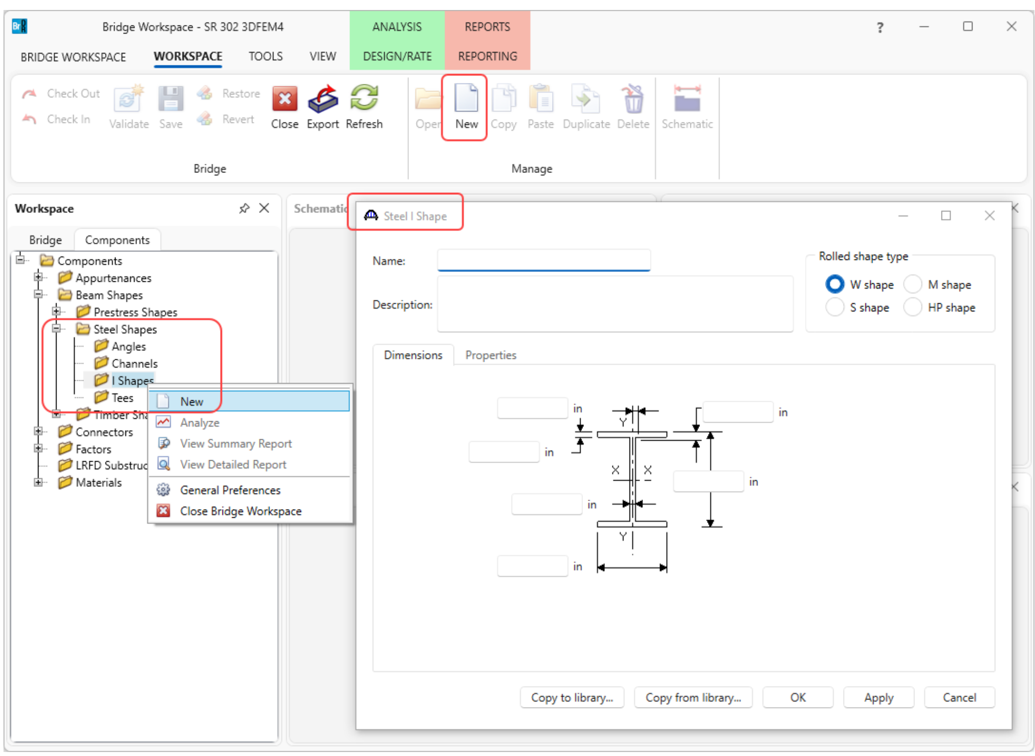
Name	Description	Library	Units	Fy	Fu	Es
Grade 300	300 MPa reinforcing steel	Standard	SI / Metric	300	500	199948
Grade 350	350 MPa reinforcing steel (rail-steel)	Standard	SI / Metric	350	550	199948
Grade 40	40 ksi reinforcing steel	Standard	US Customary	40.0000058	70.0000102	29000.004206
Grade 400	400 MPa reinforcing steel	Standard	SI / Metric	400	600	199948
Grade 50	50 ksi reinforcing steel (rail-steel)	Standard	US Customary	50.0000073	80.0000116	29000.004206
Grade 500	500 MPa reinforcing steel	Standard	SI / Metric	500	700	199948
Grade 60	60 ksi reinforcing steel	Standard	US Customary	60.0000087	90.0000131	29000.004206
Grade 75	75 ksi reinforcing steel	Standard	US Customary	75.0000109	100.0000145	29000.004206
Structural or unknown grade prior 1954	Structural or unknown grade prior to 1954	Standard	US Customary	33.0000048	60.0000087	29000.004206



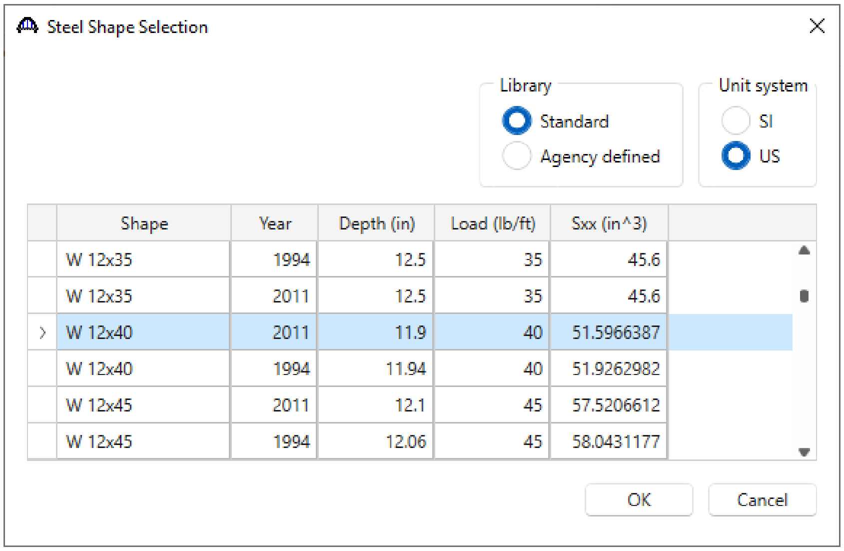
Click **OK** to save the steel material and close the window.

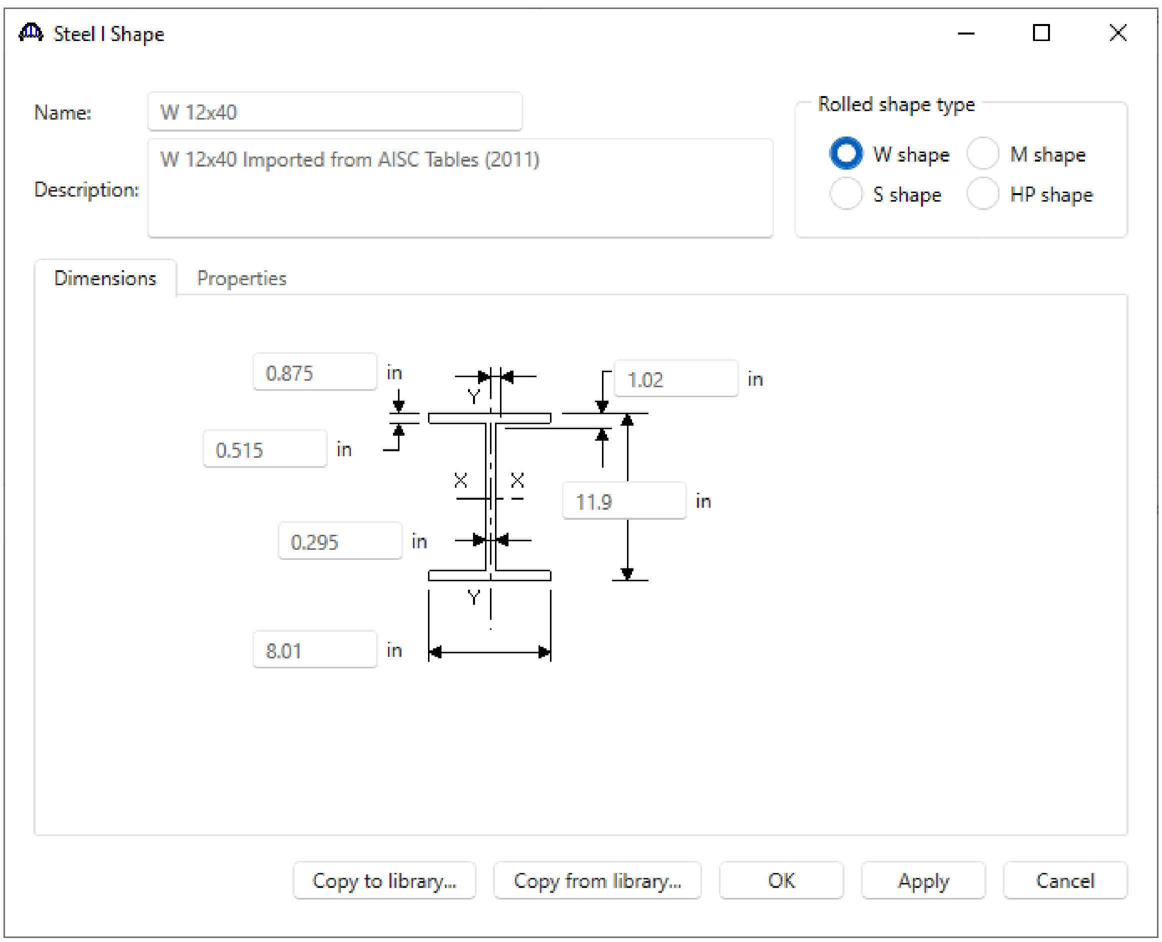
Beam Shapes – Steel I Shape

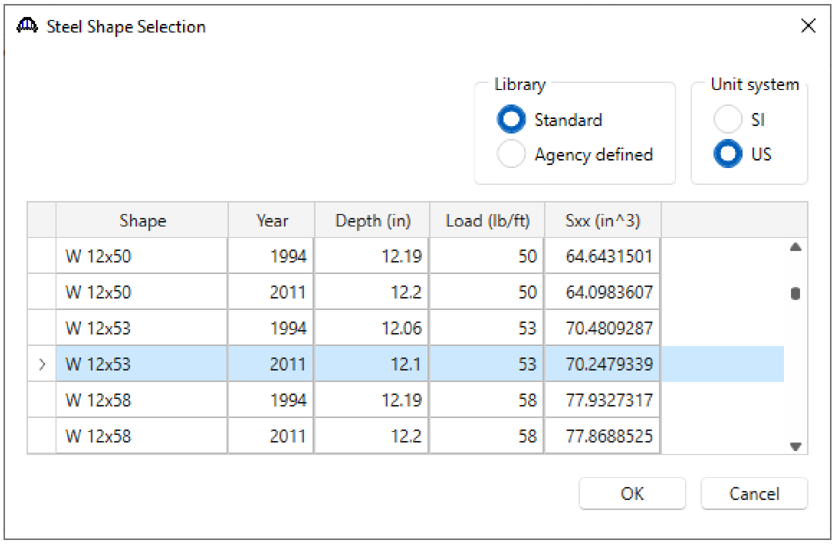
To enter a steel shape to be used in the bridge, expand the **Beam Shapes**, **Steel Shapes** nodes in the **BWS** tree and select **I Shapes**. Click on **New** from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New**, or double click) to open the **Steel I Shape** window as shown below.

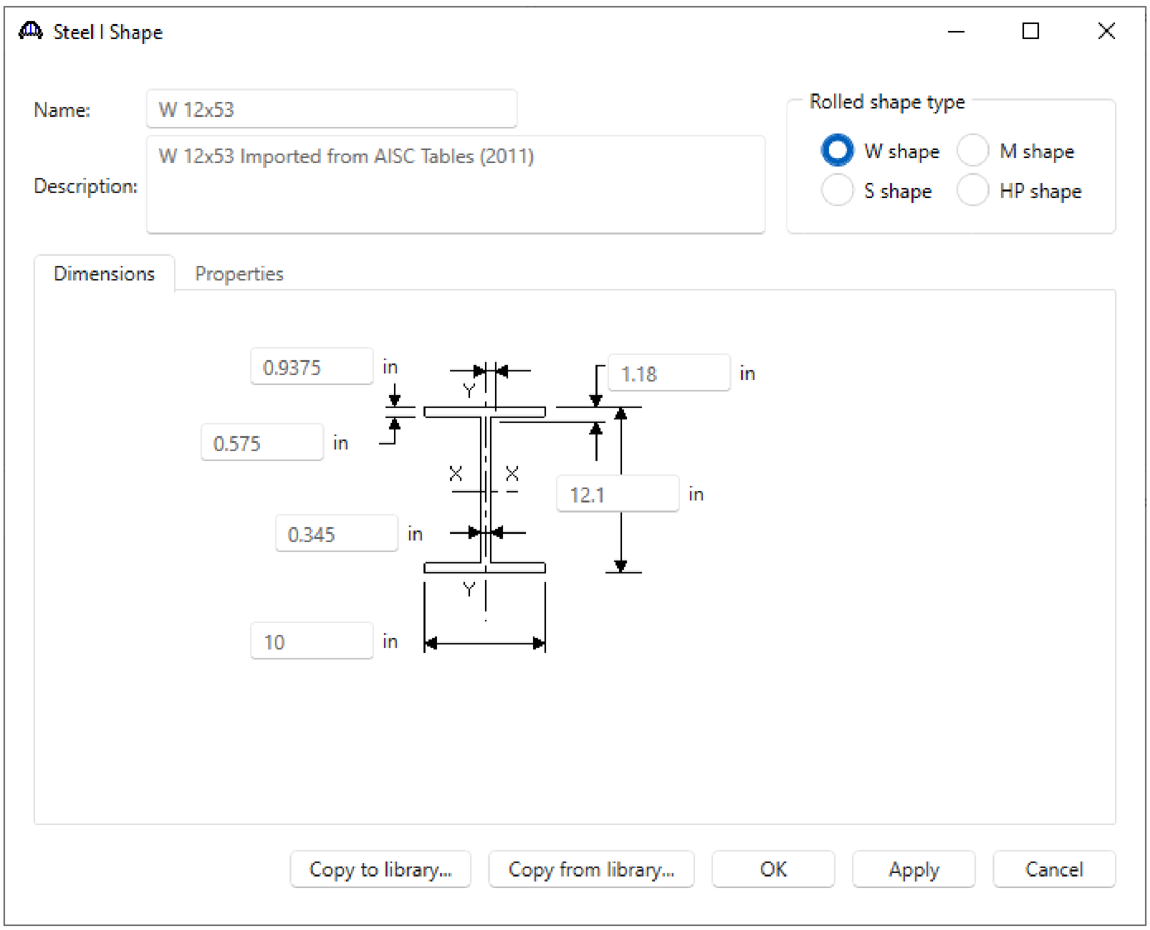


Click on the **Copy from library…** button. Select the **W12x40 (Year 2011)** from the library. Similarly add another Steel I shape, **W12x53 (Year 2011)** from the library. See images below.



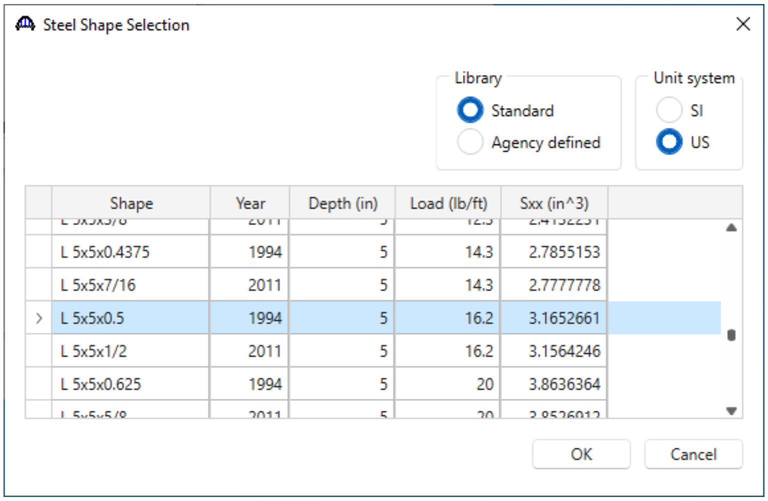


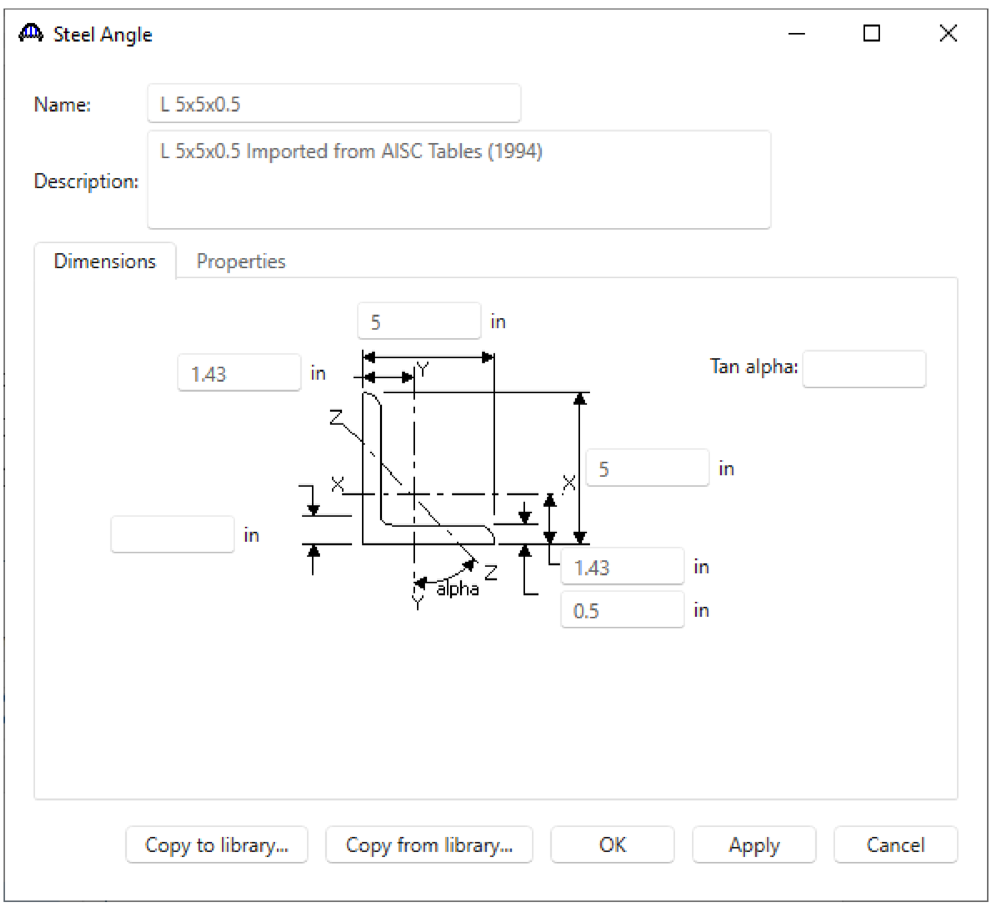

Steel Shape Selection
Library
Standard
Agency defined
Unit system
SI
US
Shape | Year | Depth (in) | Load (lb/ft) | Sxx (in^3)
W 12x50 | 1994 | 12.19 | 50 | 64.6431501
W 12x50 | 2011 | 12.2 | 50 | 64.0983607
W 12x53 | 1994 | 12.06 | 53 | 70.4809287
W 12x53 | 2011 | 12.1 | 53 | 70.2479339
W 12x58 | 1994 | 12.19 | 58 | 77.9327317
W 12x58 | 2011 | 12.2 | 58 | 77.8688525
OK
Cancel


Steel I Shape
Name:
W 12x53
Description:
W 12x53 Imported from AISC Tables (2011)
Rolled shape type
W shape
M shape
S shape
HP shape
Dimensions
Properties
0.9375 in
1.18 in
0.575 in
12.1 in
0.345 in
10 in
Y
X
X
Y
Copy to library...
Copy from library...
OK
Apply
Cancel

Beam Shapes – Steel Angles

Similar to adding steel I shapes, add the following angles to be used in the bridge. Expand the **Beam Shapes**, **Steel Shapes** nodes in the **BWS** tree and select **Angles**. Click on **New** from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New**, or double click) to open the **Steel Angle** window as shown below. Use the **Copy from library…** button and add the **L 5x5x0.5** angle.

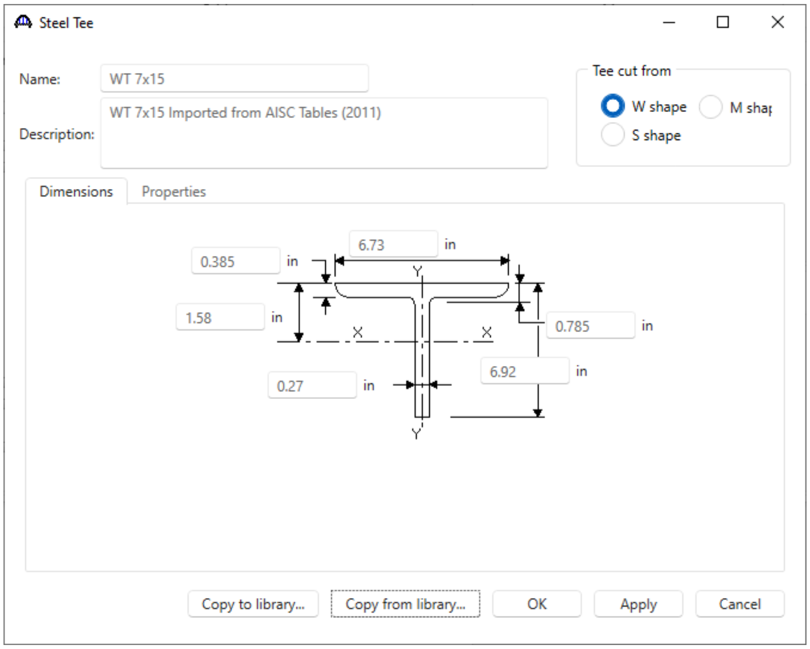




Click **OK** to save the steel angle and close the window.

Beam Shapes – Tees

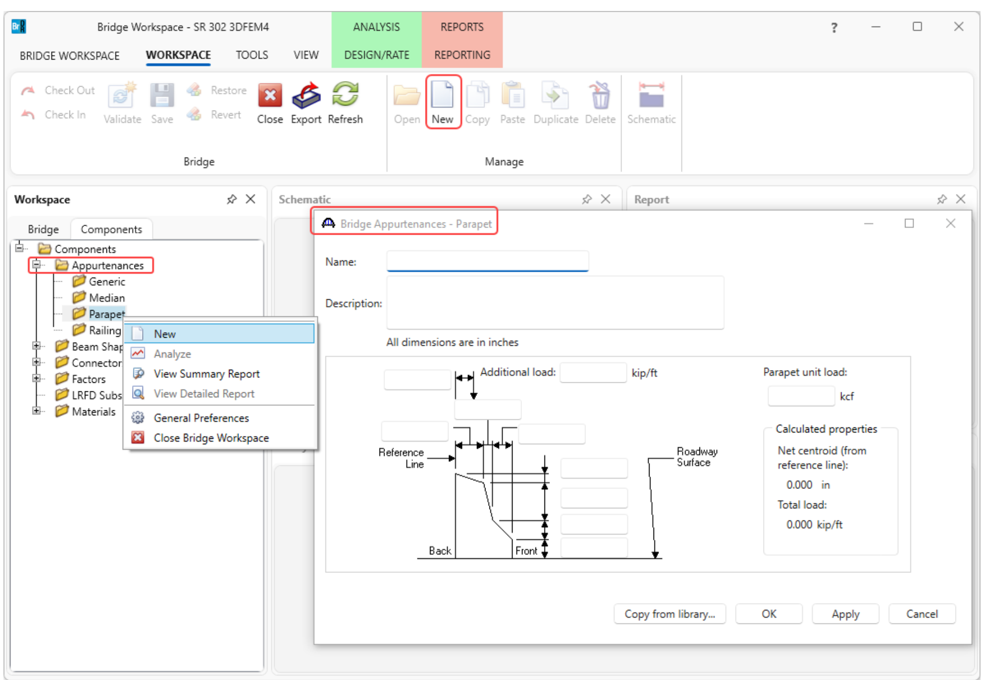
Similarly, add the following tee shape to be used in the bridge. Expand the **Beam Shapes**, **Steel Shapes** nodes in the **BWS** tree and select **Tees**. Use the **Copy from library…** button and add the **WT 7x15 (2011)** tee shape.

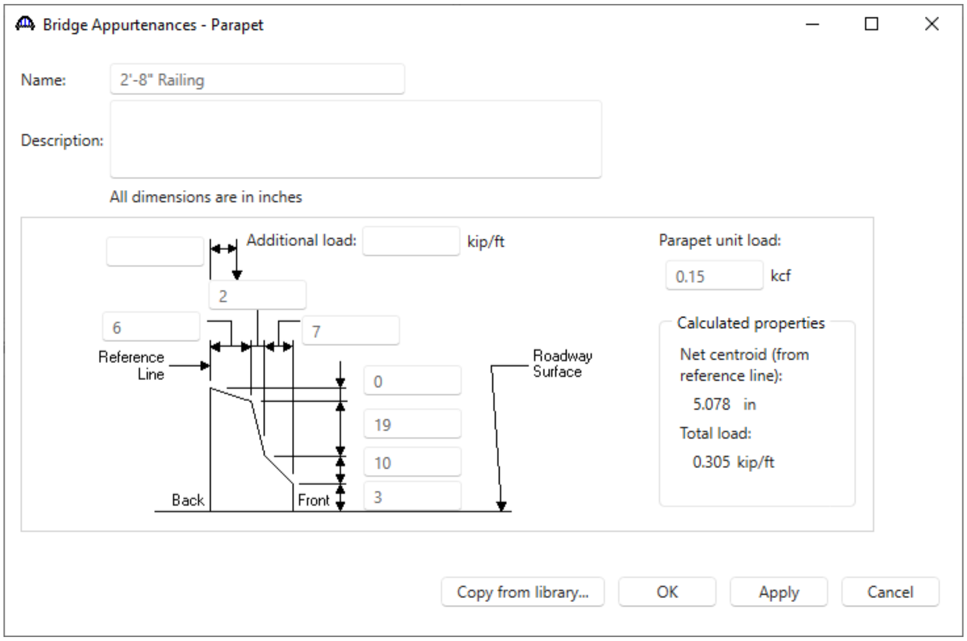


Click **OK** to add the tee shape and close the window.

Bridge Appurtenances – Parapet

To enter appurtenances to be used within the bridge, expand the node labeled **Appurtenances**. To define a parapet, double click on **Parapet** in the **BWS** tree (or right click and select **New** or select **New** from the **WORKSPACE** ribbon). The following window appears. Enter parapet dimensions as shown.

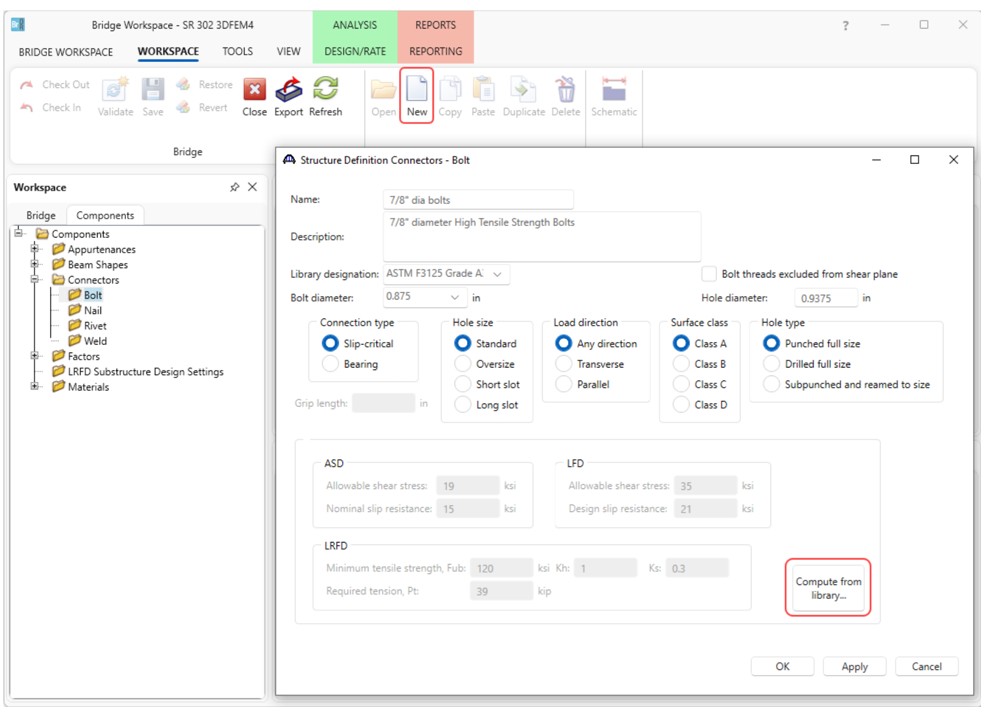




Click **OK** to save the parapet and close the window.

Connectors – Bolt Definitions

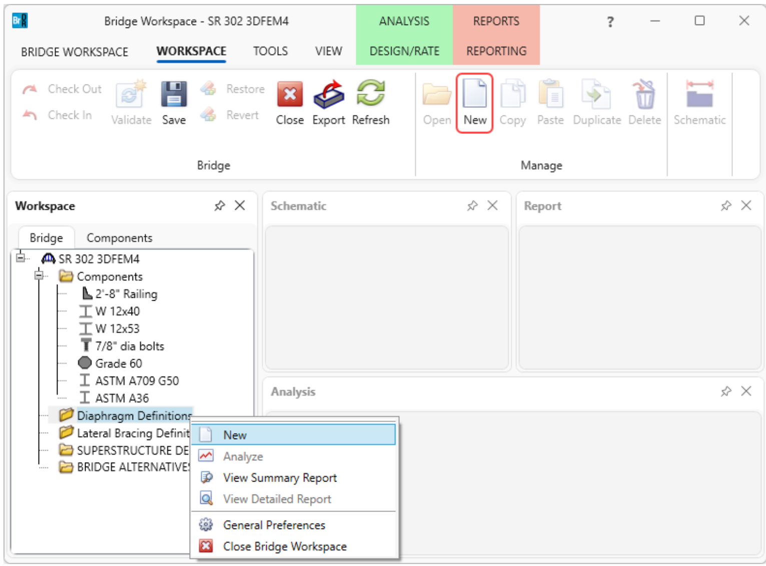
To enter a bolt definition, expand the **Connectors** node and select **Bolt**. Click **New** from the **WORKSPACE** ribbon (or right click and select **New**, or double click) to open the **Structure Definition Connectors – Bolt** window. Enter the details for a 7/8" diameter high strength bolts as shown below and click the **Compute from library…** button. Note: Select **ASTM F3125 Grade A325** from the **Library designation** menu.

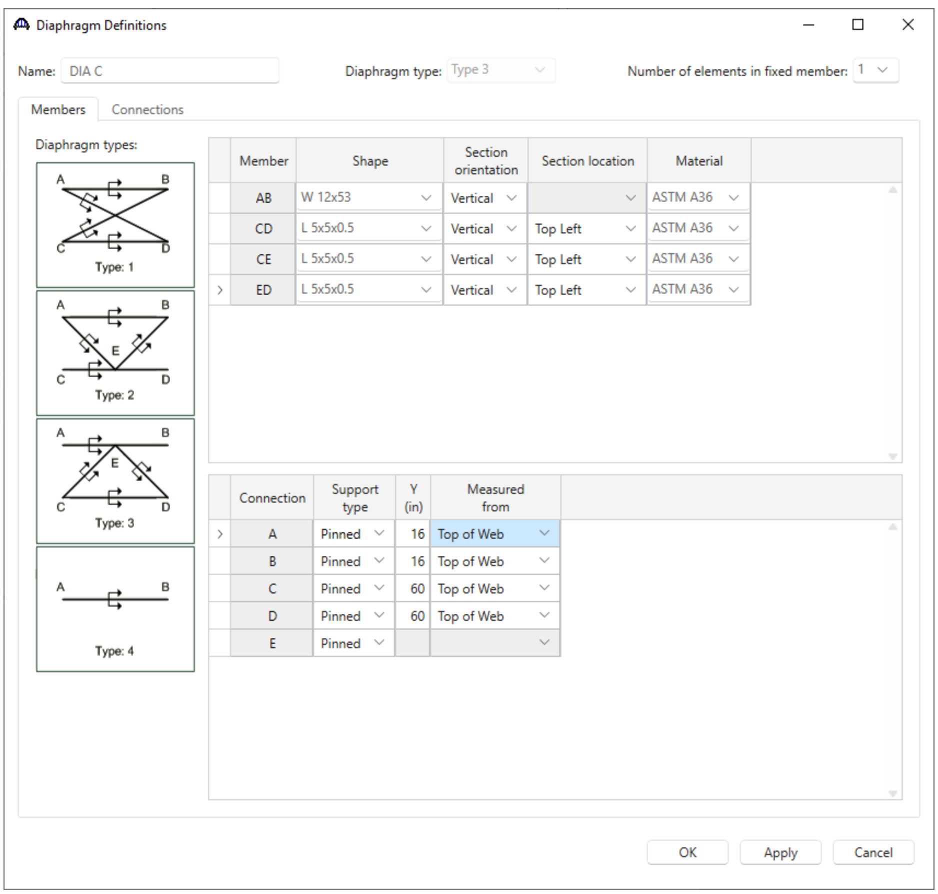


Click **OK** to save the bolt definition and close the window.

Diaphragm Definitions

Navigate back to the **Bridge** tab of the **Bridge Workspace** tree. Double click on the **Diaphragm Definitions** node (or click **New** from the **WORKSPACE** ribbon, or right click and select **New**) to add a new diaphragm definition with the input as shown below.



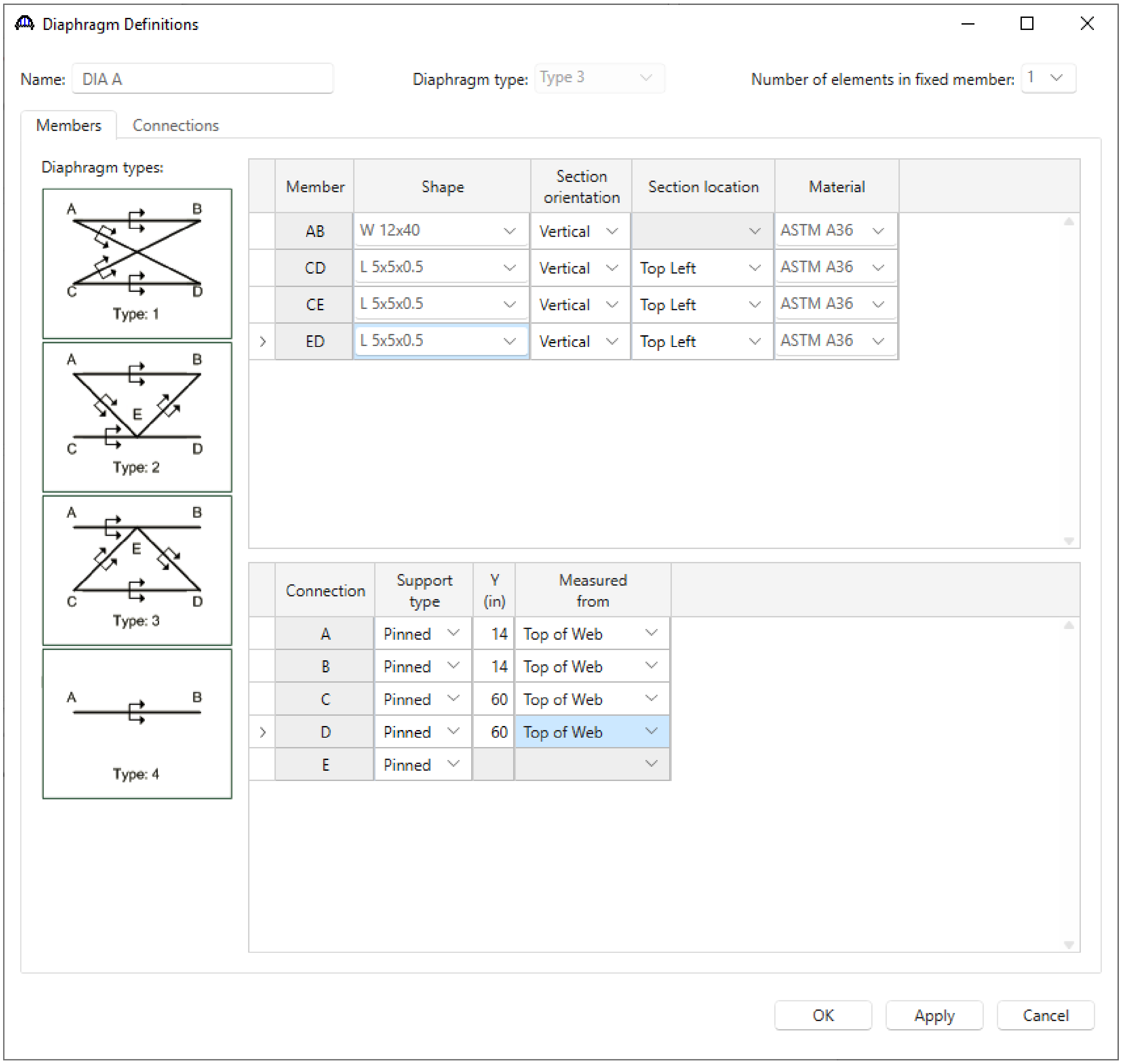


Member	Shape	Section orientation	Section location	Material
AB	W 12x53	Vertical		ASTM A36
CD	L 5x5x0.5	Vertical	Top Left	ASTM A36
CE	L 5x5x0.5	Vertical	Top Left	ASTM A36
ED	L 5x5x0.5	Vertical	Top Left	ASTM A36

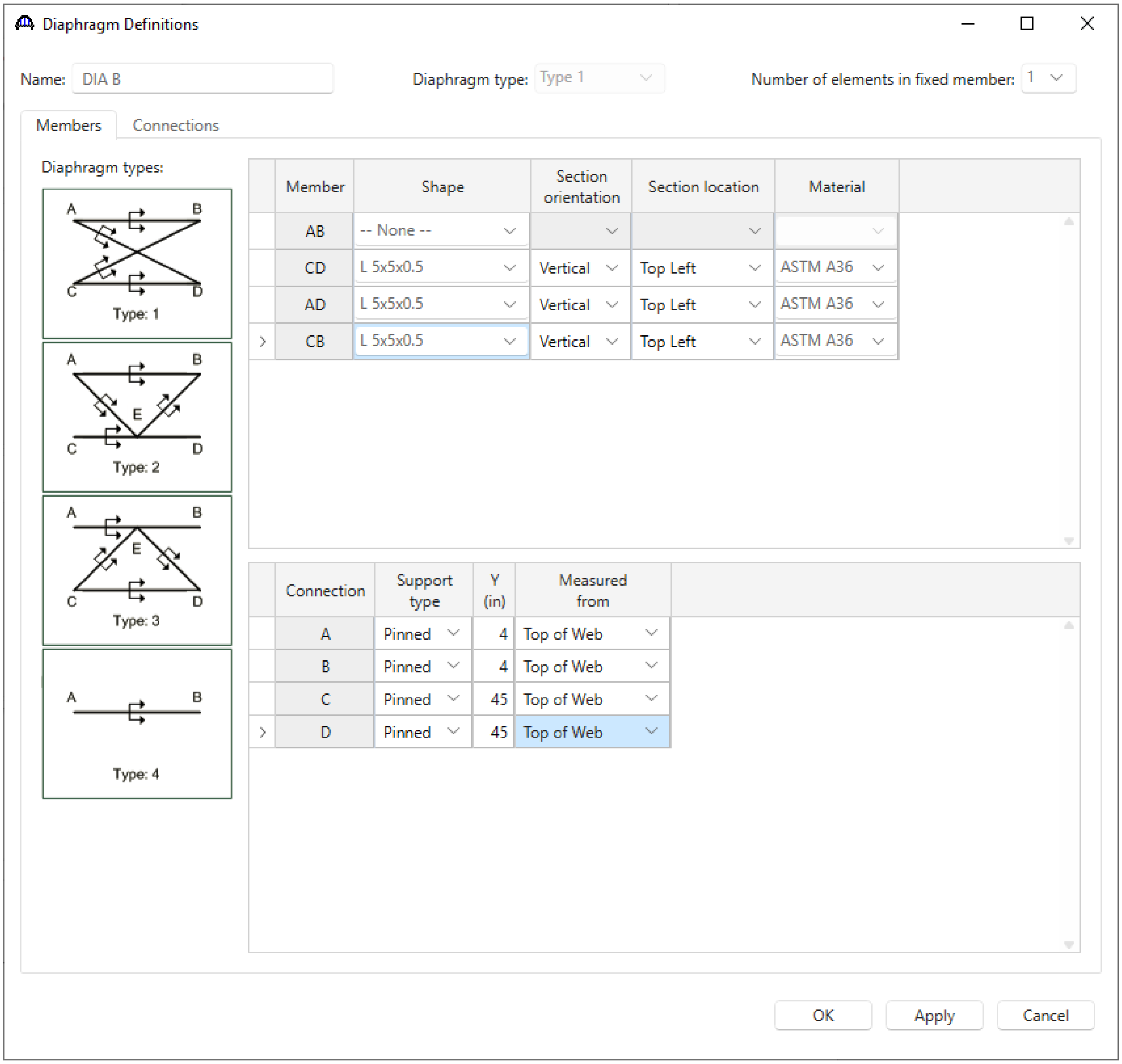
Connection	Support type	Y (in)	Measured from
A	Pinned	16	Top of Web
B	Pinned	16	Top of Web
C	Pinned	60	Top of Web
D	Pinned	60	Top of Web
E	Pinned		

Click **OK** to save the diaphragm definition and close the window.

Steel bridges may contain any of the 4 types of diaphragm definitions. Straight concrete bridges may only contain Type 4 diaphragm definitions. Similarly add 2 more diaphragm definitions – **DIA A** and **DIA B** as shown below.



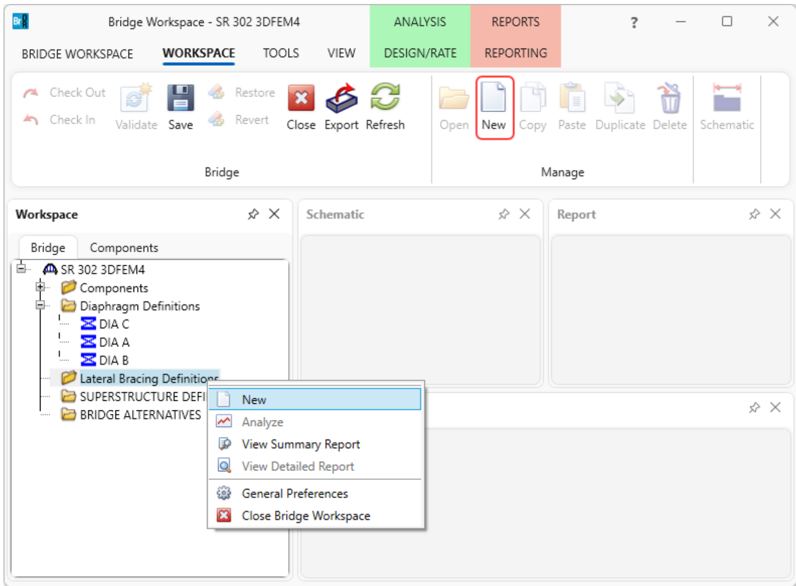
Click **OK** to save the diaphragm definition and close the window.

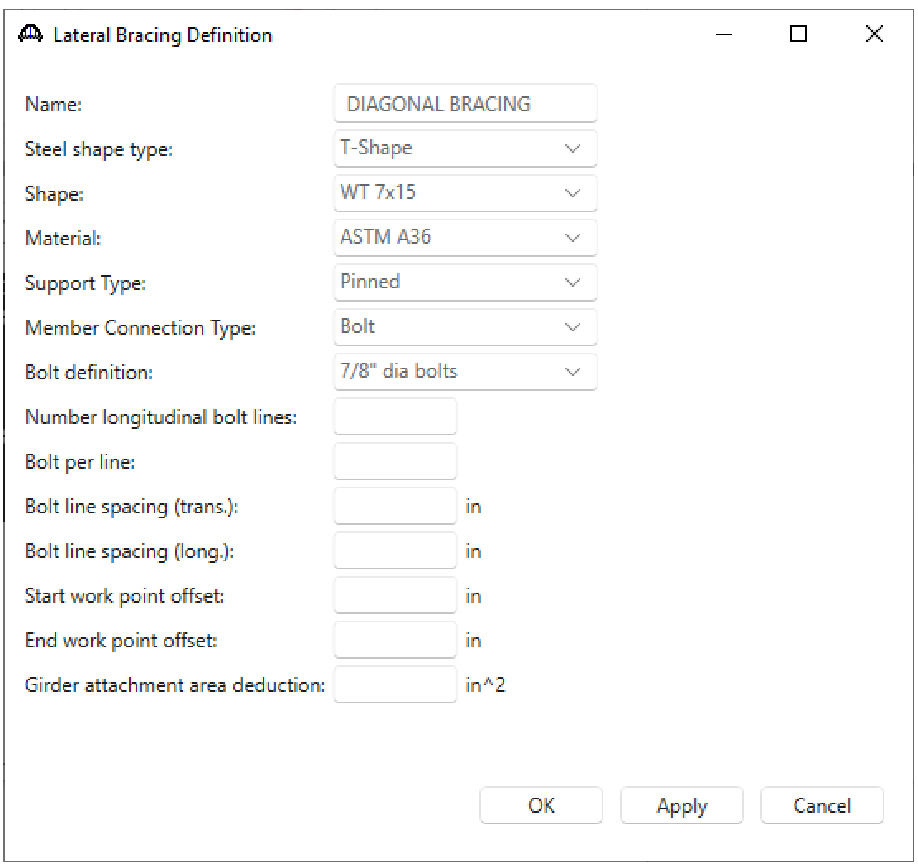


Click **OK** to save the diaphragm definition and close the window.

Lateral Bracing Definitions

To add a lateral bracing definition, double click on the **Lateral Bracing Definitions** node in the **BWS** tree. Enter data as shown below.



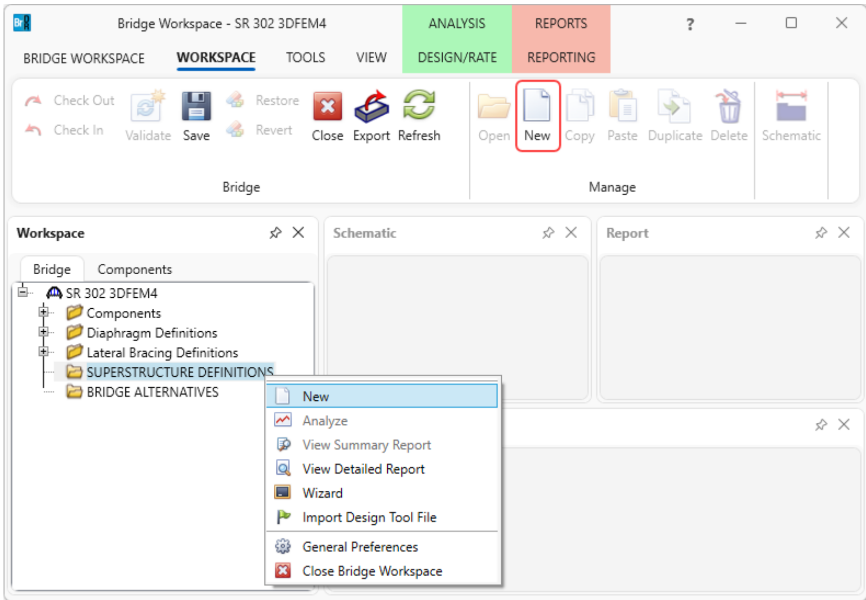


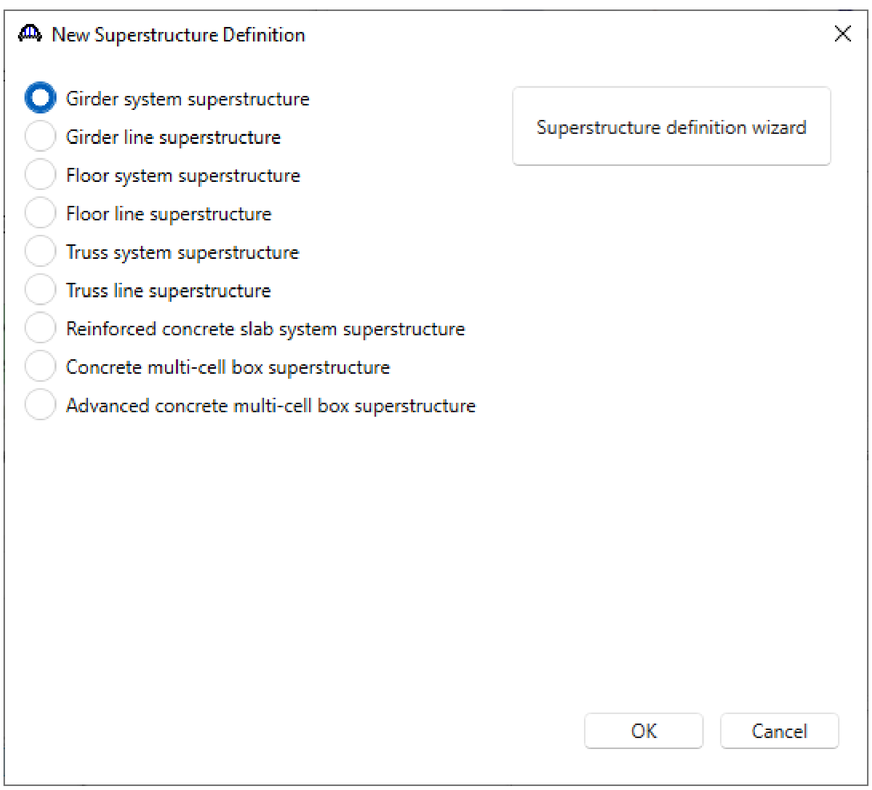
Click **OK** to apply the data and close the window.

The default LRFD dynamic load allowance and default LRFD factors will be used.

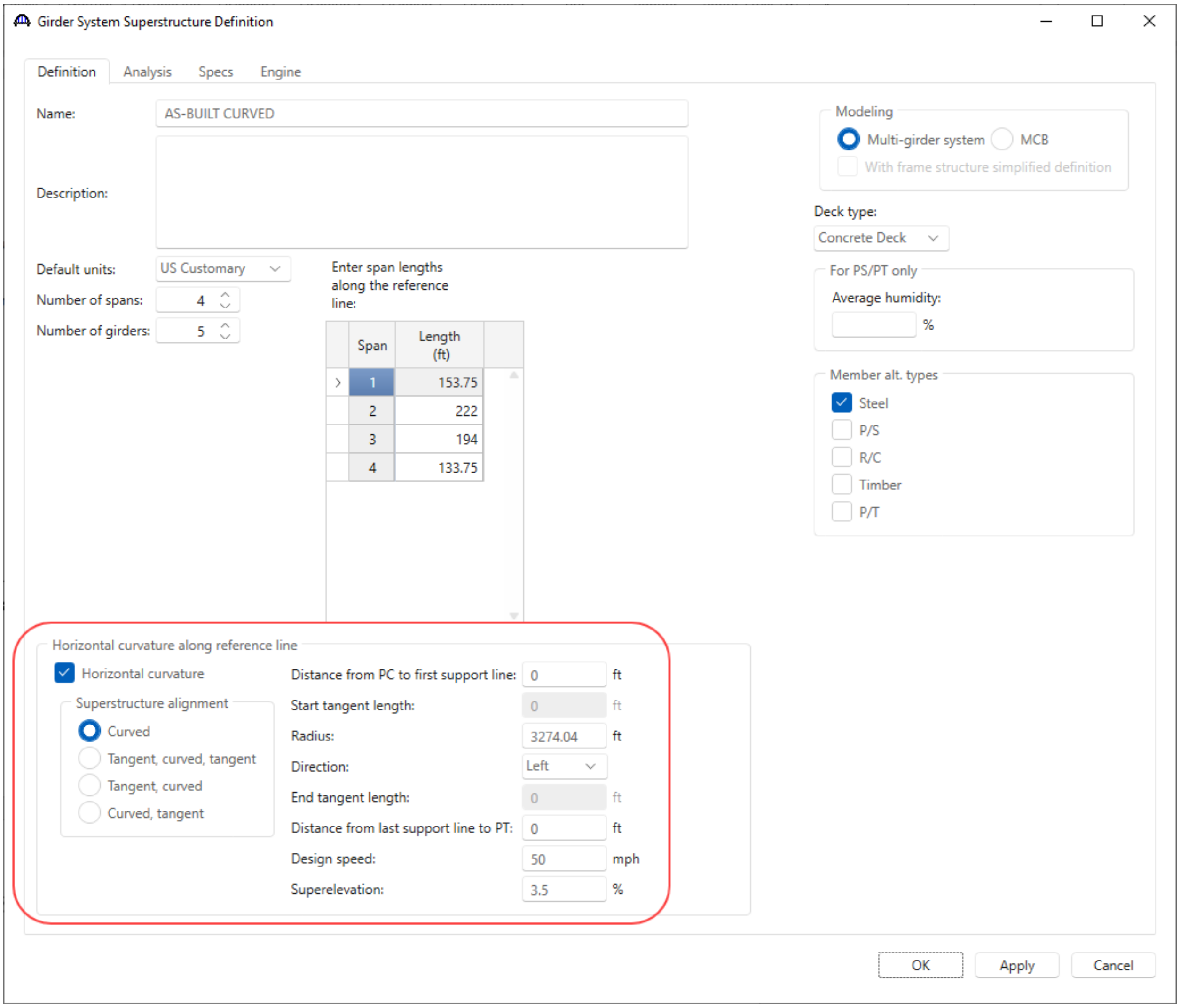
SUPERSTRUCTURE DEFINITIONS

Double click on **SUPERSTRUCTURE DEFINITIONS** (or select **SUPERSTRUCTURE DEFINITIONS** and select **New** from the **WORKSPACE** ribbon, or right click and select **New**) to create a new superstructure definition.



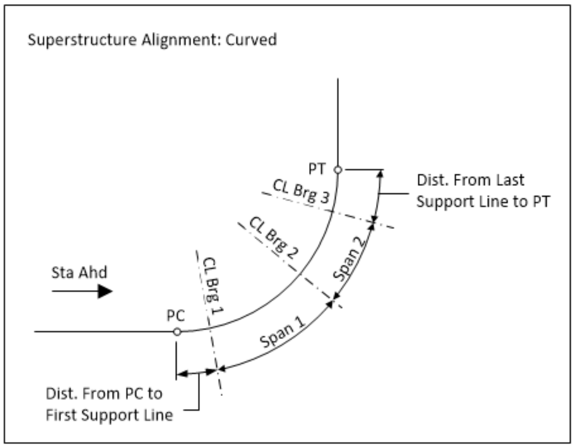


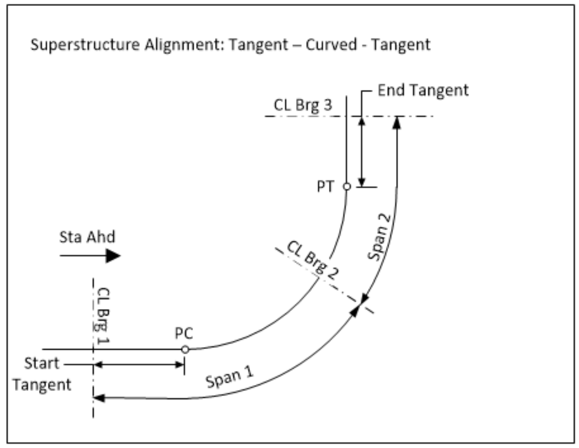
Select **Girder system superstructure** and the **Girder System Superstructure Definition** window appears. Enter the data as shown below.

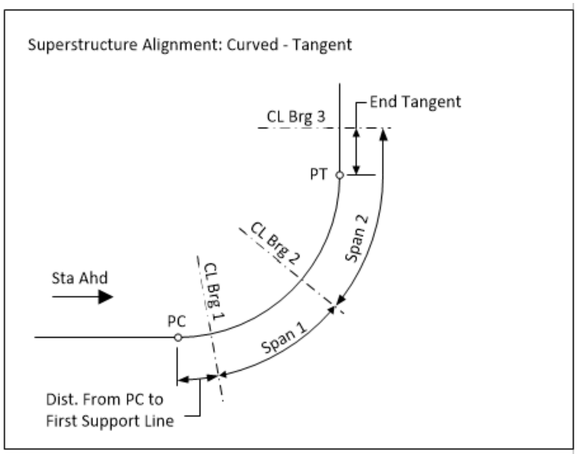


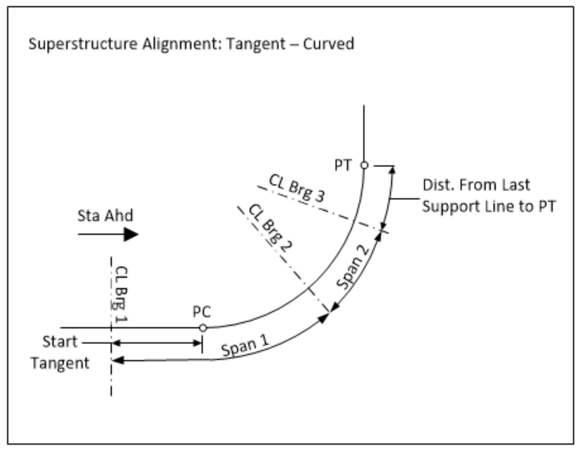
The **Design speed** and **Superelevation** are used to compute the centrifugal force effects on the truck live load. The high side of the roadway is assumed to be at the outside of the curve.

The following types of horizontal alignments are supported.







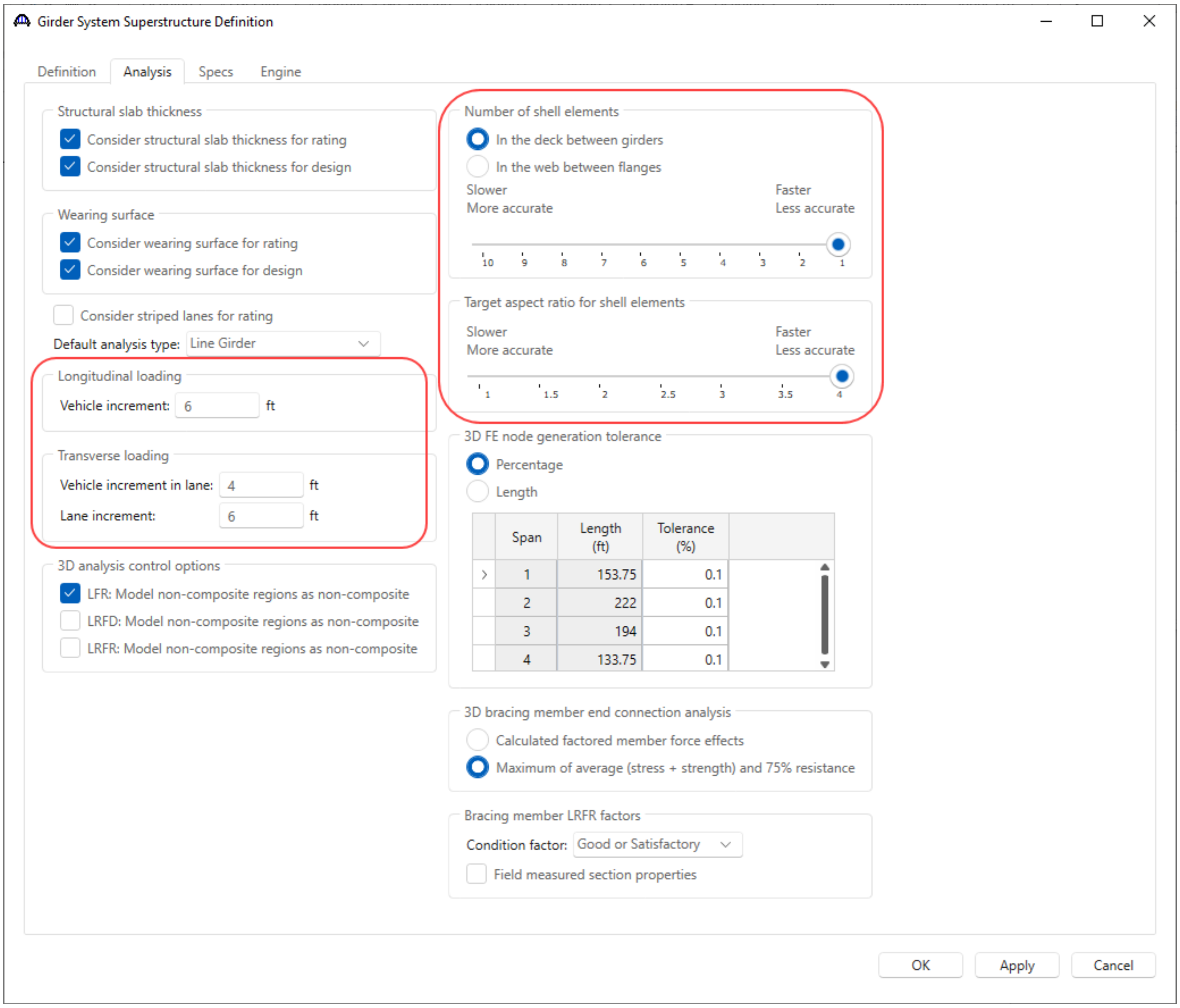


The **Distance from PC to first support line** and **Distance from last support line to PT** are necessary to determine the member lengths when the first or last support line is skewed.

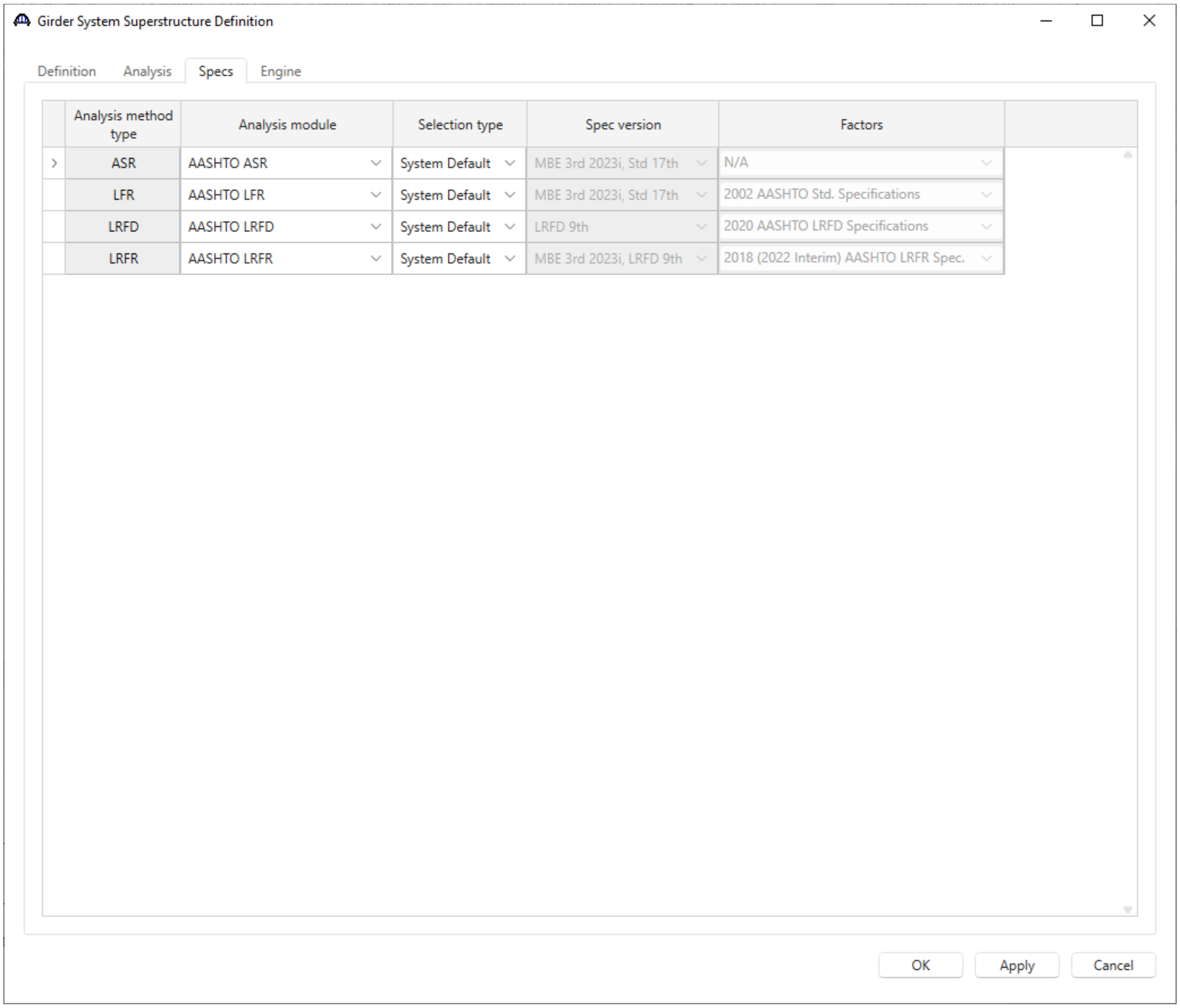
If the member starts before the defined PC location, that portion of the member is assumed to be tangent to the curve at the defined PC location.

If the member ends after the defined PT location, that portion of the member is assumed to be tangent to the curve at the defined PT location.

Navigate to the **Analysis** tab of this window. This tab contains the following settings to control the 3D analysis. Enter the information as shown below.



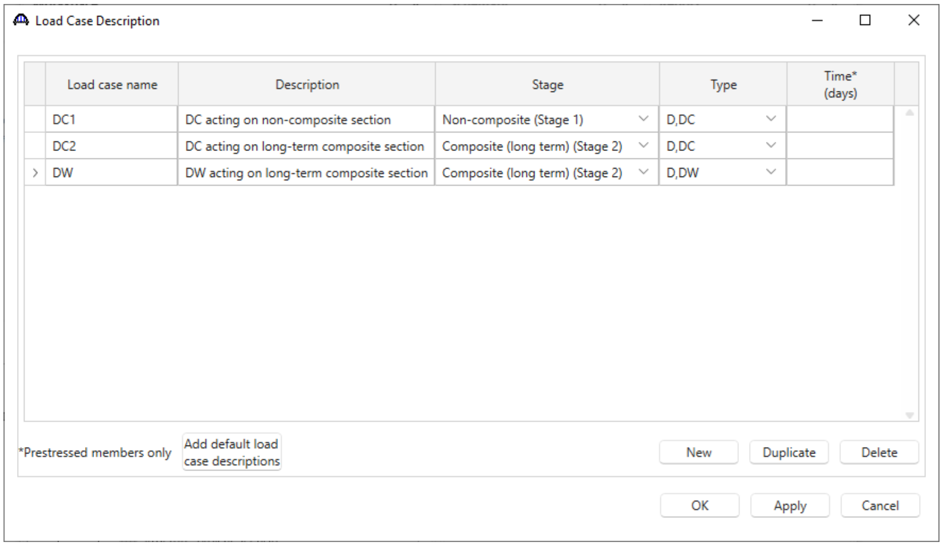
Navigate to the **Specs** tab of this window. The analysis of all member alternatives in the superstructure definition will use the following engine and specification set this tab. An exception to this is LFR rating of curved systems. The LFR rating is performed in accordance with the “AASHTO Guide Specifications for Horizontally Curved Steel Girder Highway Bridges 2003”. Note: ASR is not available for horizontally curved girders.



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

Load Case Description

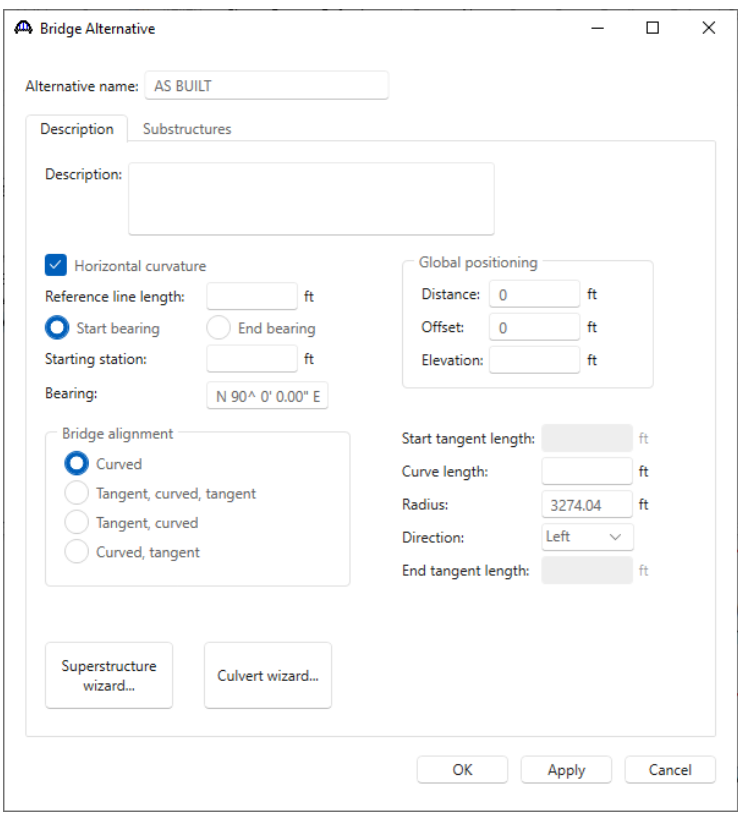
Double click on **Load Case Description** node in the **Bridge Workspace** tree and enter the following load cases.



Click OK to apply the data and close the window.

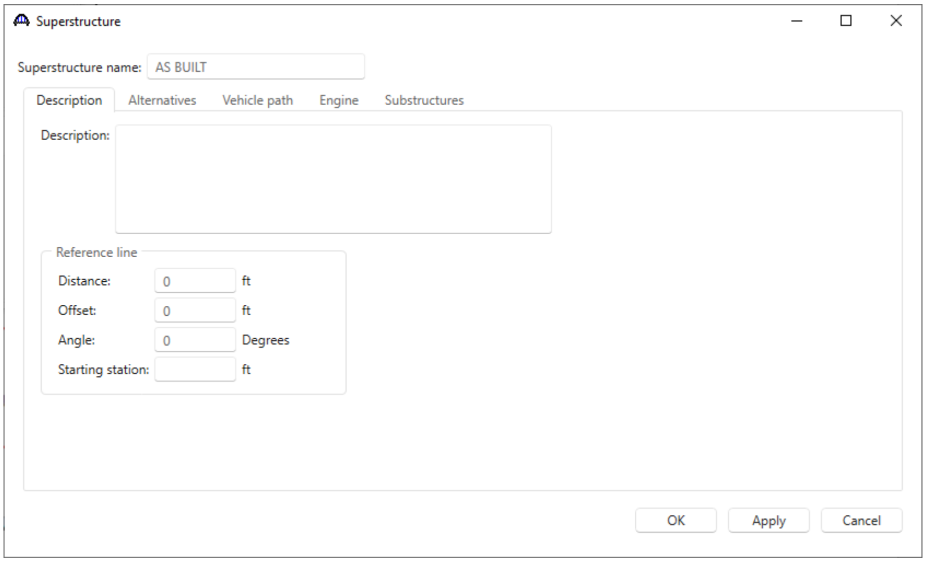
Bridge Alternatives

Double click on the **Bridge Alternatives** node in the **BWS** tree. Enter the data as shown below.



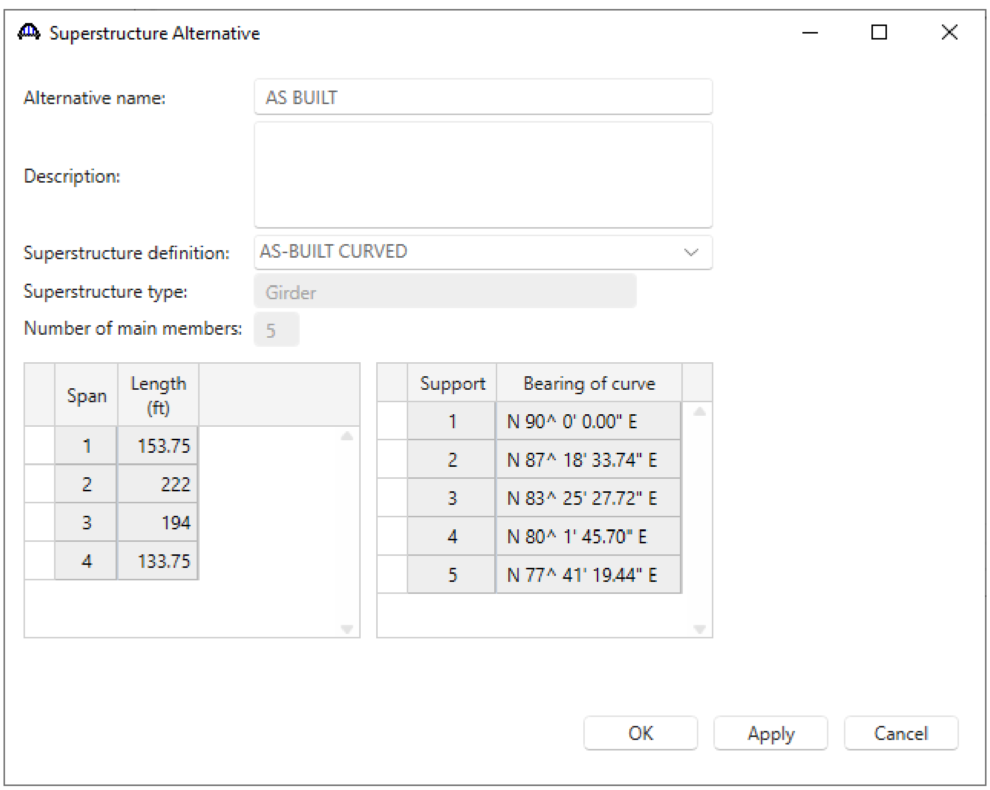
Click **OK** to apply the data and close the window.

Expand the newly added bridge alternative – **AS BUILT** and double click on **SUPERSTRUCTURES** node in the tree. Enter data as shown below.



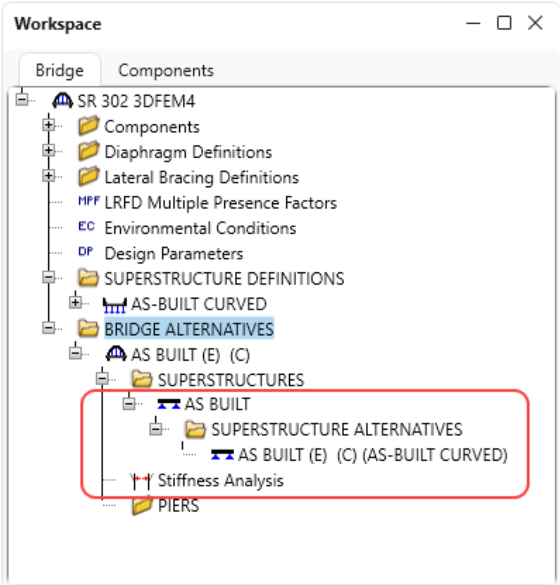
Click **OK** to apply the data and close the window.

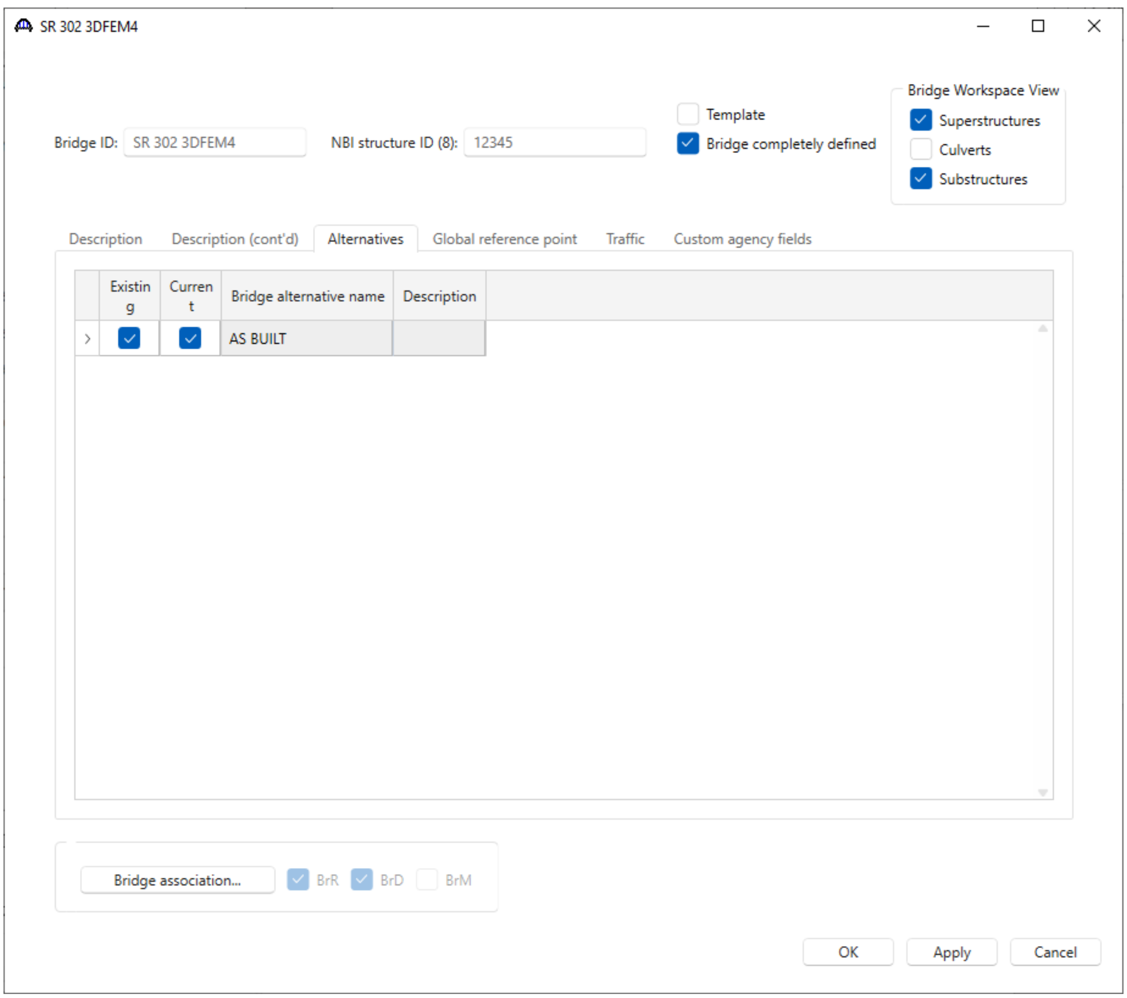
Expand the newly added superstructure definition, double click on **SUPERSTRUCTURE ALTENRATIVES**. Enter the data as shown below.



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

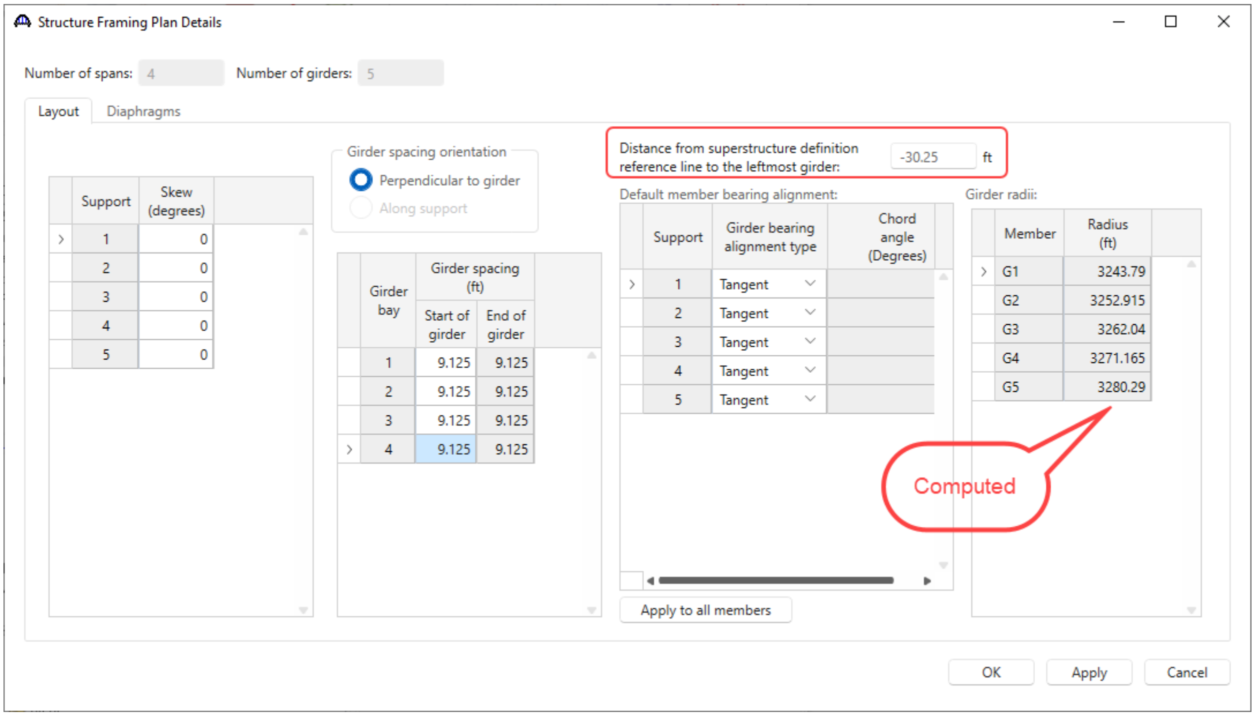
The partially expanded **BWS** tree is shown below.





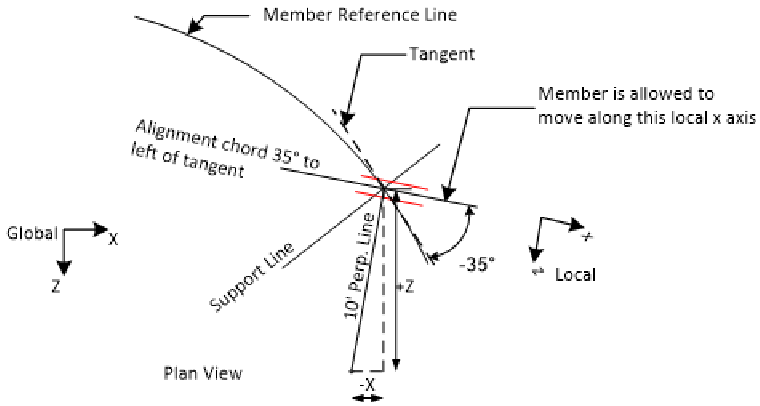
Framing Plan Detail

Navigate back to the Superstructure definition – **AS BUILT CURVED.** Expand this node, and double click on the **Framing Plan Detail** node to open the **Structure Framing Plan Details** window. The **Layout** tab of this window shows how the girders are located in the structure typical section. The following options are available for curved girder systems to locate the leftmost girder relative to the superstructure definition reference line. Enter a negative value if the leftmost girder is to the left of the superstructure definition reference line. This along with the entered girder spacing determines the computed radii of the girders.



Bearings are oriented in a local coordinate system at each member support in curved girder systems. The user may enter default values for the orientation of the member support constraints on this window and then apply them to all members. This is a shortcut feature to allow for ease of data entry. The constraints can be modified on the member **Support** window as necessary. The constraint settings on this window are not used in the analysis, the constraint settings on the member **Support** window are used instead.

Select **Tangent** if the local x axis for bearing alignment is parallel to the tangent of the member reference line at the support. Select **Chord** if the local x axis for the bearing alignment is parallel to a specified chord angle from the tangent of the member reference line at the support. The following sketch shows an example of defining a bearing alignment along a chord.



Navigate to the **Diaphragms** tab of this window to see how diaphragm definitions are assigned to the framing plan. The weight of the diaphragms will be computed by the software and applied to the 3D model.

Diaphragms in curved girder systems can be located by one of 3 methods:

- entering the spacing along both girders of the bay
- entering the spacing along the left girder of the bay
- entering the spacing along the right girder of the bay

The spacing reference type **Both** must be used when the diaphragms are not radial to either girder. This spacing reference type may also be used when the diaphragms are radial as shown in this example.

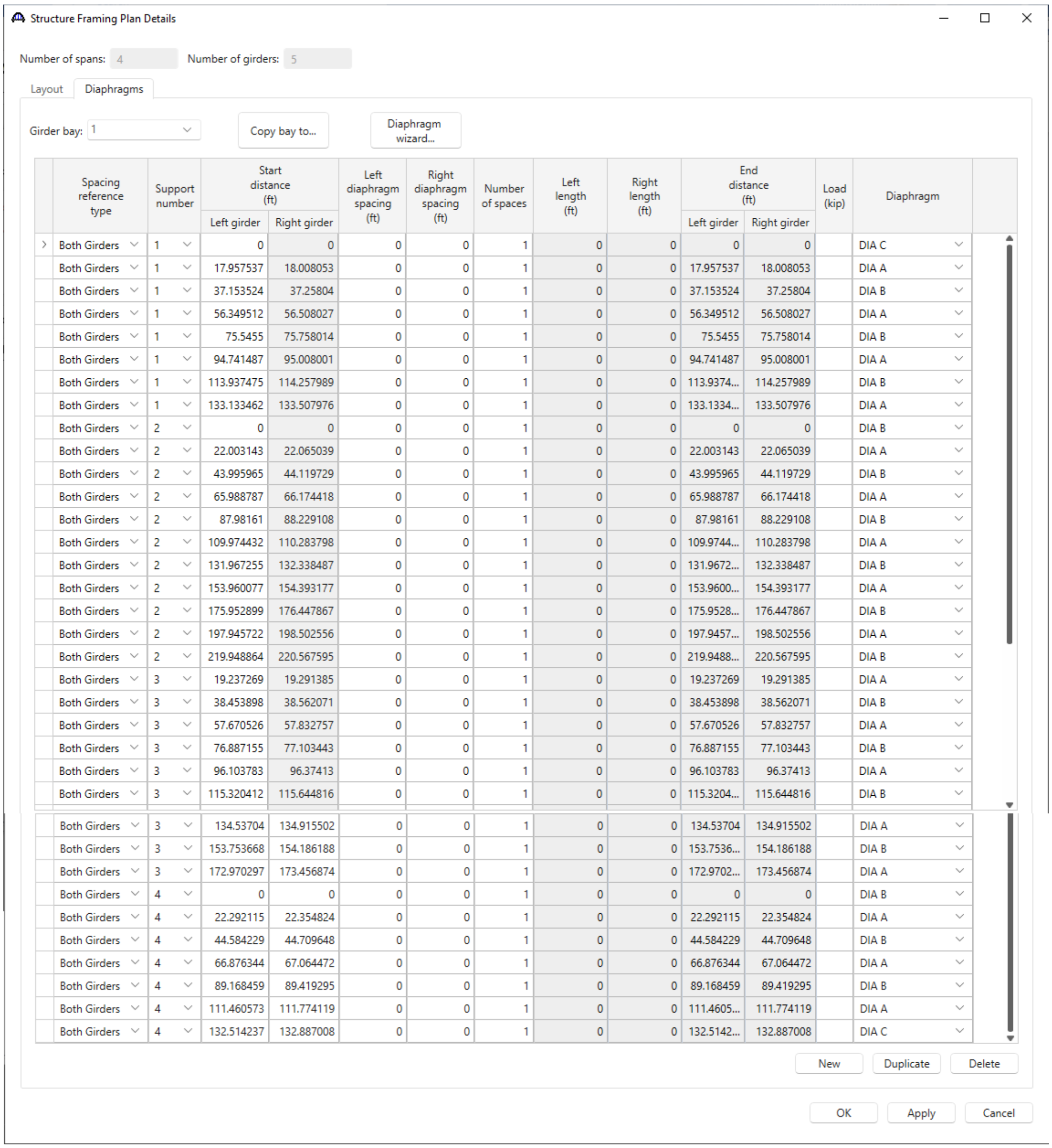
If the diaphragms are located by entering the spacing along the left or right girder of the bay, the resulting diaphragm location on the alternate girder will be computed by the program by casting a line perpendicular to the tangent of the specified girder at each spacing interval.

Enter the following data for each girder bay. These values can be copied from the provided spreadsheet with this tutorial to save time. To copy from spreadsheet, follow these steps:

1. Open the given **3DFEM4-Diaphragms.xslx** file in Microsoft Excel. Data for each bay is provided in separate sheets named after the bay numbers. For bay 1, navigate to sheet **Bay 1**.
2. Use the keyboard shortcut Ctrl+A to select all cells and use Ctrl+C to copy to the clipboard.
3. Navigate back to **BrDR** -> **Structure Framing Plan Details** window -> **Diaphragms** tab -> **Girder bay 1.** Use Ctrl+V to paste the clipboard items in this window. Repeat the process for each girder bay.

Each girder bay with completed data entry is shown below.

Bay 1



Structure Framing Plan Details

Number of spans: 4 Number of girders: 5

Layout | Diaphragms

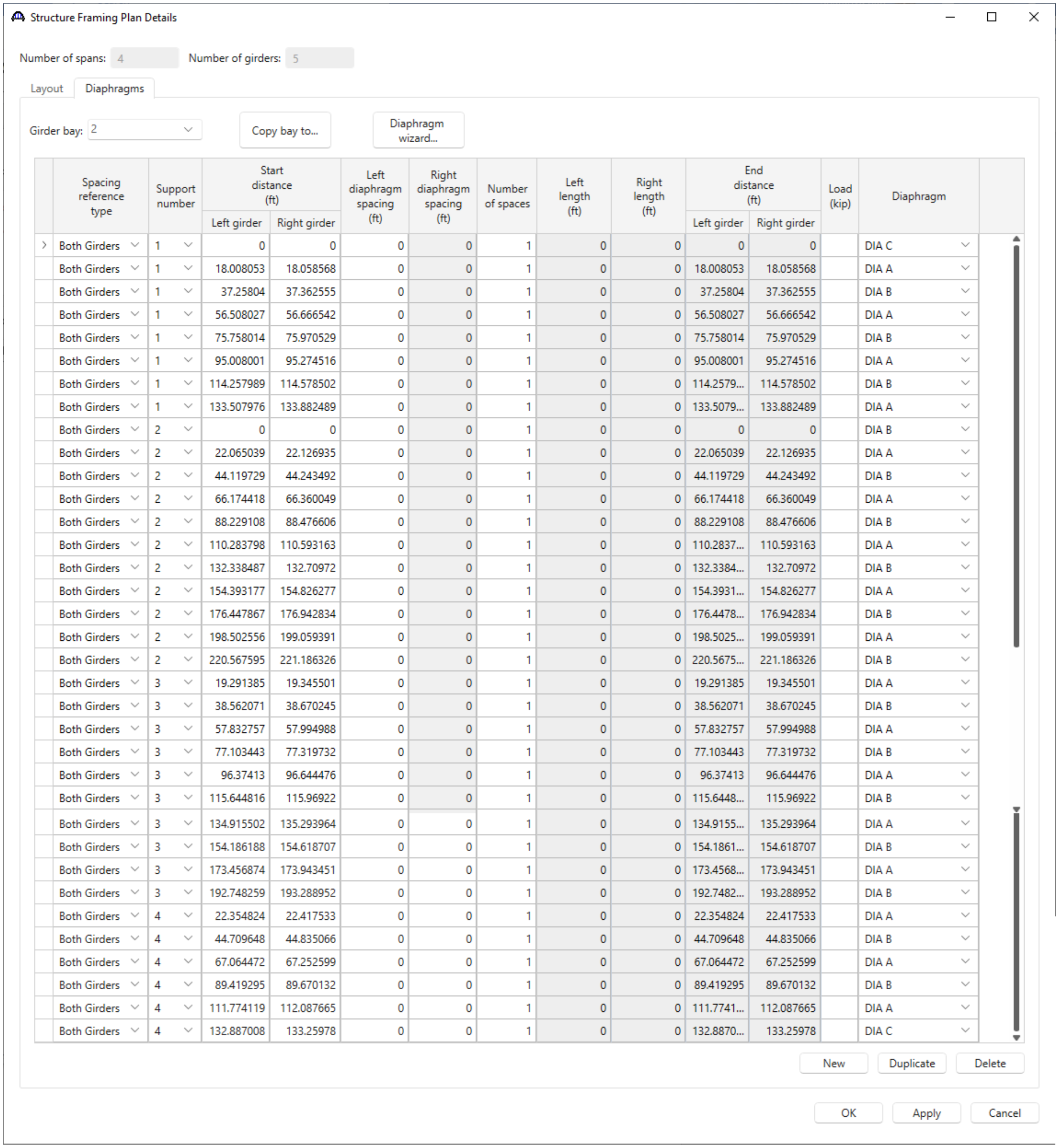
Girder bay: 1 | Copy bay to... | Diaphragm wizard...

Spacing reference type	Support number	Start distance (ft) Left girder	Start distance (ft) Right girder	Left diaphragm spacing (ft)	Right diaphragm spacing (ft)	Number of spaces	Left length (ft)	Right length (ft)	End distance (ft) Left girder	End distance (ft) Right girder	Load (kip)	Diaphragm
Both Girders	1	0	0	0	0	1	0	0	0	0		DIA C
Both Girders	1	17.957537	18.008053	0	0	1	0	0	17.957537	18.008053		DIA A
Both Girders	1	37.153524	37.25804	0	0	1	0	0	37.153524	37.25804		DIA B
Both Girders	1	56.349512	56.508027	0	0	1	0	0	56.349512	56.508027		DIA A
Both Girders	1	75.5455	75.758014	0	0	1	0	0	75.5455	75.758014		DIA B
Both Girders	1	94.741487	95.008001	0	0	1	0	0	94.741487	95.008001		DIA A
Both Girders	1	113.937475	114.257989	0	0	1	0	0	113.9374...	114.257989		DIA B
Both Girders	1	133.133462	133.507976	0	0	1	0	0	133.1334...	133.507976		DIA A
Both Girders	2	0	0	0	0	1	0	0	0	0		DIA B
Both Girders	2	22.003143	22.065039	0	0	1	0	0	22.003143	22.065039		DIA A
Both Girders	2	43.995965	44.119729	0	0	1	0	0	43.995965	44.119729		DIA B
Both Girders	2	65.988787	66.174418	0	0	1	0	0	65.988787	66.174418		DIA A
Both Girders	2	87.98161	88.229108	0	0	1	0	0	87.98161	88.229108		DIA B
Both Girders	2	109.974432	110.283798	0	0	1	0	0	109.9744...	110.283798		DIA A
Both Girders	2	131.967255	132.338487	0	0	1	0	0	131.9672...	132.338487		DIA B
Both Girders	2	153.960077	154.393177	0	0	1	0	0	153.9600...	154.393177		DIA A
Both Girders	2	175.952899	176.447867	0	0	1	0	0	175.9528...	176.447867		DIA B
Both Girders	2	197.945722	198.502556	0	0	1	0	0	197.9457...	198.502556		DIA A
Both Girders	2	219.948864	220.567595	0	0	1	0	0	219.9488...	220.567595		DIA B
Both Girders	3	19.237269	19.291385	0	0	1	0	0	19.237269	19.291385		DIA A
Both Girders	3	38.453898	38.562071	0	0	1	0	0	38.453898	38.562071		DIA B
Both Girders	3	57.670526	57.832757	0	0	1	0	0	57.670526	57.832757		DIA A
Both Girders	3	76.887155	77.103443	0	0	1	0	0	76.887155	77.103443		DIA B
Both Girders	3	96.103783	96.37413	0	0	1	0	0	96.103783	96.37413		DIA A
Both Girders	3	115.320412	115.644816	0	0	1	0	0	115.3204...	115.644816		DIA B
Both Girders	3	134.53704	134.915502	0	0	1	0	0	134.53704	134.915502		DIA A
Both Girders	3	153.753668	154.186188	0	0	1	0	0	153.7536...	154.186188		DIA B
Both Girders	3	172.970297	173.456874	0	0	1	0	0	172.9702...	173.456874		DIA A
Both Girders	4	0	0	0	0	1	0	0	0	0		DIA B
Both Girders	4	22.292115	22.354824	0	0	1	0	0	22.292115	22.354824		DIA A
Both Girders	4	44.584229	44.709648	0	0	1	0	0	44.584229	44.709648		DIA B
Both Girders	4	66.876344	67.064472	0	0	1	0	0	66.876344	67.064472		DIA A
Both Girders	4	89.168459	89.419295	0	0	1	0	0	89.168459	89.419295		DIA B
Both Girders	4	111.460573	111.774119	0	0	1	0	0	111.4605...	111.774119		DIA A
Both Girders	4	132.514237	132.887008	0	0	1	0	0	132.5142...	132.887008		DIA C

New | Duplicate | Delete

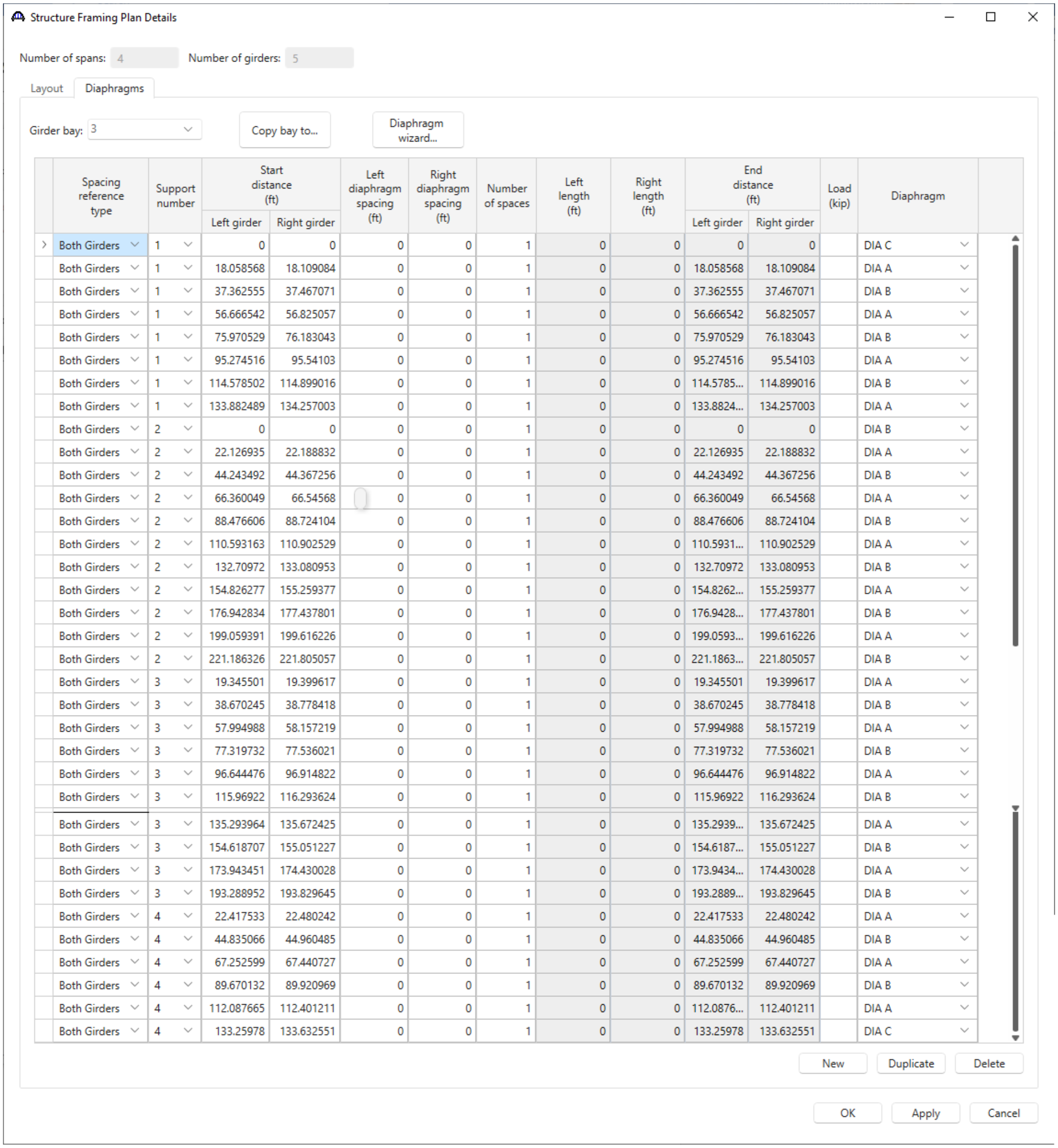
OK | Apply | Cancel

Bay 2



Spacing reference type	Support number	Start distance (ft) Left girder	Start distance (ft) Right girder	Left diaphragm spacing (ft)	Right diaphragm spacing (ft)	Number of spaces	Left length (ft)	Right length (ft)	End distance (ft) Left girder	End distance (ft) Right girder	Load (kip)	Diaphragm
Both Girders	1	0	0	0	0	1	0	0	0	0		DIA C
Both Girders	1	18.008053	18.058568	0	0	1	0	0	18.008053	18.058568		DIA A
Both Girders	1	37.25804	37.362555	0	0	1	0	0	37.25804	37.362555		DIA B
Both Girders	1	56.508027	56.666542	0	0	1	0	0	56.508027	56.666542		DIA A
Both Girders	1	75.758014	75.970529	0	0	1	0	0	75.758014	75.970529		DIA B
Both Girders	1	95.008001	95.274516	0	0	1	0	0	95.008001	95.274516		DIA A
Both Girders	1	114.257989	114.578502	0	0	1	0	0	114.2579...	114.578502		DIA B
Both Girders	1	133.507976	133.882489	0	0	1	0	0	133.5079...	133.882489		DIA A
Both Girders	2	0	0	0	0	1	0	0	0	0		DIA B
Both Girders	2	22.065039	22.126935	0	0	1	0	0	22.065039	22.126935		DIA A
Both Girders	2	44.119729	44.243492	0	0	1	0	0	44.119729	44.243492		DIA B
Both Girders	2	66.174418	66.360049	0	0	1	0	0	66.174418	66.360049		DIA A
Both Girders	2	88.229108	88.476606	0	0	1	0	0	88.229108	88.476606		DIA B
Both Girders	2	110.283798	110.593163	0	0	1	0	0	110.2837...	110.593163		DIA A
Both Girders	2	132.338487	132.70972	0	0	1	0	0	132.3384...	132.70972		DIA B
Both Girders	2	154.393177	154.826277	0	0	1	0	0	154.3931...	154.826277		DIA A
Both Girders	2	176.447867	176.942834	0	0	1	0	0	176.4478...	176.942834		DIA B
Both Girders	2	198.502556	199.059391	0	0	1	0	0	198.5025...	199.059391		DIA A
Both Girders	2	220.567595	221.186326	0	0	1	0	0	220.5675...	221.186326		DIA B
Both Girders	3	19.291385	19.345501	0	0	1	0	0	19.291385	19.345501		DIA A
Both Girders	3	38.562071	38.670245	0	0	1	0	0	38.562071	38.670245		DIA B
Both Girders	3	57.832757	57.994988	0	0	1	0	0	57.832757	57.994988		DIA A
Both Girders	3	77.103443	77.319732	0	0	1	0	0	77.103443	77.319732		DIA B
Both Girders	3	96.37413	96.644476	0	0	1	0	0	96.37413	96.644476		DIA A
Both Girders	3	115.644816	115.96922	0	0	1	0	0	115.6448...	115.96922		DIA B
Both Girders	3	134.915502	135.293964	0	0	1	0	0	134.9155...	135.293964		DIA A
Both Girders	3	154.186188	154.618707	0	0	1	0	0	154.1861...	154.618707		DIA B
Both Girders	3	173.456874	173.943451	0	0	1	0	0	173.4568...	173.943451		DIA A
Both Girders	3	192.748259	193.288952	0	0	1	0	0	192.7482...	193.288952		DIA B
Both Girders	4	22.354824	22.417533	0	0	1	0	0	22.354824	22.417533		DIA A
Both Girders	4	44.709648	44.835066	0	0	1	0	0	44.709648	44.835066		DIA B
Both Girders	4	67.064472	67.252599	0	0	1	0	0	67.064472	67.252599		DIA A
Both Girders	4	89.419295	89.670132	0	0	1	0	0	89.419295	89.670132		DIA B
Both Girders	4	111.774119	112.087665	0	0	1	0	0	111.7741...	112.087665		DIA A
Both Girders	4	132.887008	133.25978	0	0	1	0	0	132.8870...	133.25978		DIA C

Bay 3



Structure Framing Plan Details

Number of spans: 4 Number of girders: 5

Layout | Diaphragms

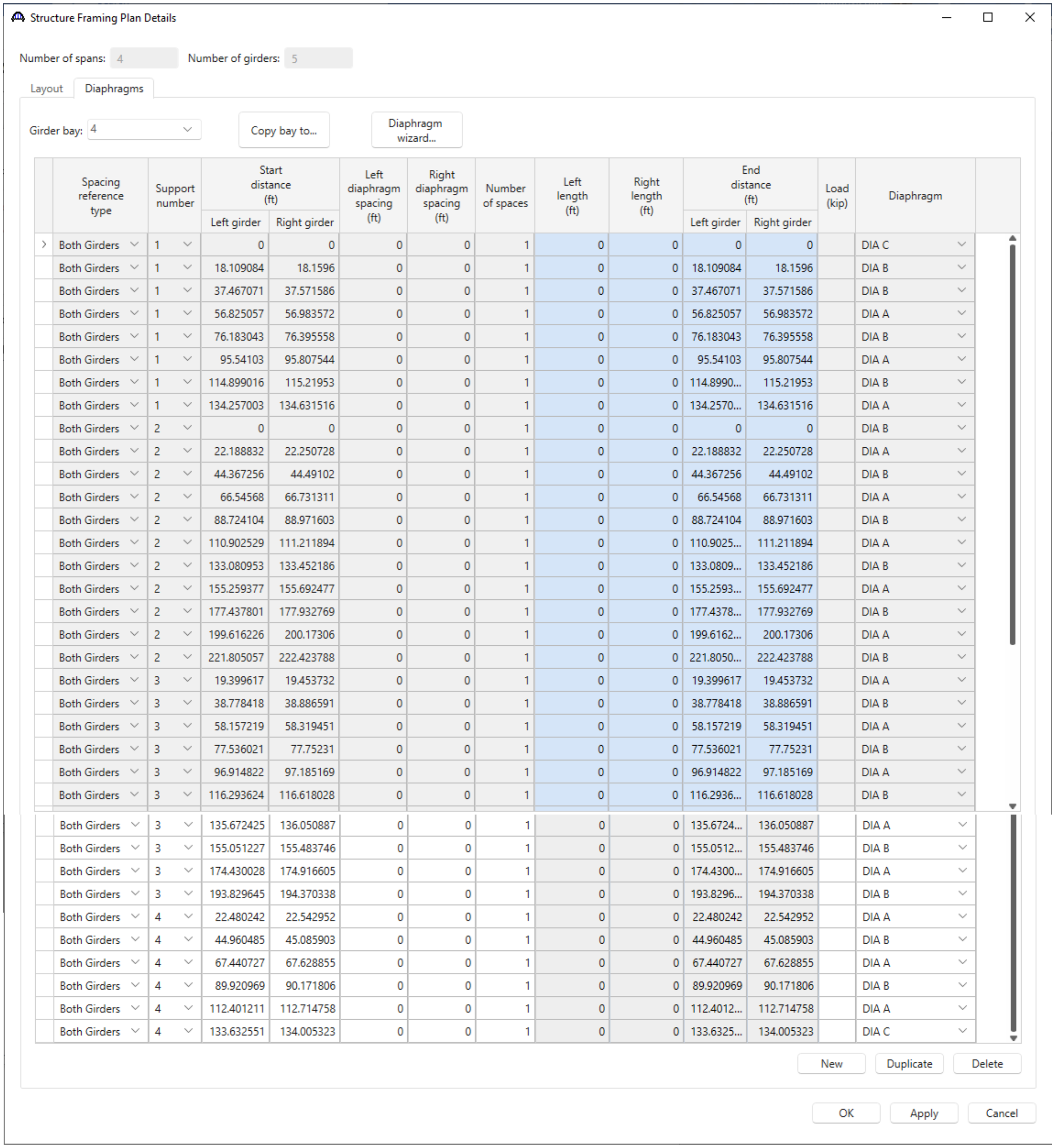
Girder bay: 3 | Copy bay to... | Diaphragm wizard...

Spacing reference type	Support number	Start distance (ft) Left girder	Start distance (ft) Right girder	Left diaphragm spacing (ft)	Right diaphragm spacing (ft)	Number of spaces	Left length (ft)	Right length (ft)	End distance (ft) Left girder	End distance (ft) Right girder	Load (kip)	Diaphragm
Both Girders	1	0	0	0	0	1	0	0	0	0		DIA C
Both Girders	1	18.058568	18.109084	0	0	1	0	0	18.058568	18.109084		DIA A
Both Girders	1	37.362555	37.467071	0	0	1	0	0	37.362555	37.467071		DIA B
Both Girders	1	56.666542	56.825057	0	0	1	0	0	56.666542	56.825057		DIA A
Both Girders	1	75.970529	76.183043	0	0	1	0	0	75.970529	76.183043		DIA B
Both Girders	1	95.274516	95.54103	0	0	1	0	0	95.274516	95.54103		DIA A
Both Girders	1	114.578502	114.899016	0	0	1	0	0	114.5785...	114.899016		DIA B
Both Girders	1	133.882489	134.257003	0	0	1	0	0	133.8824...	134.257003		DIA A
Both Girders	2	0	0	0	0	1	0	0	0	0		DIA B
Both Girders	2	22.126935	22.188832	0	0	1	0	0	22.126935	22.188832		DIA A
Both Girders	2	44.243492	44.367256	0	0	1	0	0	44.243492	44.367256		DIA B
Both Girders	2	66.360049	66.54568	0	0	1	0	0	66.360049	66.54568		DIA A
Both Girders	2	88.476606	88.724104	0	0	1	0	0	88.476606	88.724104		DIA B
Both Girders	2	110.593163	110.902529	0	0	1	0	0	110.5931...	110.902529		DIA A
Both Girders	2	132.70972	133.080953	0	0	1	0	0	132.70972	133.080953		DIA B
Both Girders	2	154.826277	155.259377	0	0	1	0	0	154.8262...	155.259377		DIA A
Both Girders	2	176.942834	177.437801	0	0	1	0	0	176.9428...	177.437801		DIA B
Both Girders	2	199.059391	199.616226	0	0	1	0	0	199.0593...	199.616226		DIA A
Both Girders	2	221.186326	221.805057	0	0	1	0	0	221.1863...	221.805057		DIA B
Both Girders	3	19.345501	19.399617	0	0	1	0	0	19.345501	19.399617		DIA A
Both Girders	3	38.670245	38.778418	0	0	1	0	0	38.670245	38.778418		DIA B
Both Girders	3	57.994988	58.157219	0	0	1	0	0	57.994988	58.157219		DIA A
Both Girders	3	77.319732	77.536021	0	0	1	0	0	77.319732	77.536021		DIA B
Both Girders	3	96.644476	96.914822	0	0	1	0	0	96.644476	96.914822		DIA A
Both Girders	3	115.96922	116.293624	0	0	1	0	0	115.96922	116.293624		DIA B
Both Girders	3	135.293964	135.672425	0	0	1	0	0	135.2939...	135.672425		DIA A
Both Girders	3	154.618707	155.051227	0	0	1	0	0	154.6187...	155.051227		DIA B
Both Girders	3	173.943451	174.430028	0	0	1	0	0	173.9434...	174.430028		DIA A
Both Girders	3	193.288952	193.829645	0	0	1	0	0	193.2889...	193.829645		DIA B
Both Girders	4	22.417533	22.480242	0	0	1	0	0	22.417533	22.480242		DIA A
Both Girders	4	44.835066	44.960485	0	0	1	0	0	44.835066	44.960485		DIA B
Both Girders	4	67.252599	67.440727	0	0	1	0	0	67.252599	67.440727		DIA A
Both Girders	4	89.670132	89.920969	0	0	1	0	0	89.670132	89.920969		DIA B
Both Girders	4	112.087665	112.401211	0	0	1	0	0	112.0876...	112.401211		DIA A
Both Girders	4	133.25978	133.632551	0	0	1	0	0	133.25978	133.632551		DIA C

New | Duplicate | Delete

OK | Apply | Cancel

Bay 4

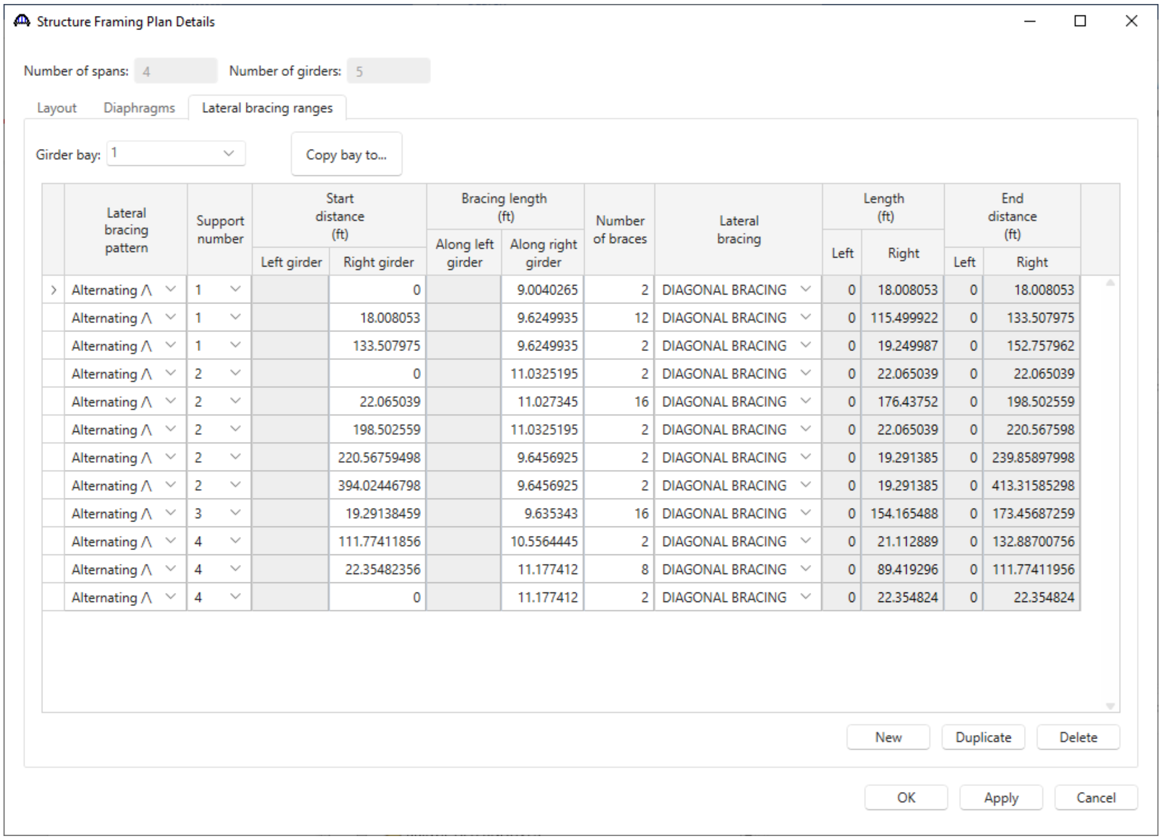


Spacing reference type	Support number	Start distance (ft) Left girder	Start distance (ft) Right girder	Left diaphragm spacing (ft)	Right diaphragm spacing (ft)	Number of spaces	Left length (ft)	Right length (ft)	End distance (ft) Left girder	End distance (ft) Right girder	Load (kip)	Diaphragm
Both Girders	1	0	0	0	0	1	0	0	0	0		DIA C
Both Girders	1	18.109084	18.1596	0	0	1	0	0	18.109084	18.1596		DIA B
Both Girders	1	37.467071	37.571586	0	0	1	0	0	37.467071	37.571586		DIA B
Both Girders	1	56.825057	56.983572	0	0	1	0	0	56.825057	56.983572		DIA A
Both Girders	1	76.183043	76.395558	0	0	1	0	0	76.183043	76.395558		DIA B
Both Girders	1	95.54103	95.807544	0	0	1	0	0	95.54103	95.807544		DIA A
Both Girders	1	114.899016	115.21953	0	0	1	0	0	114.8990...	115.21953		DIA B
Both Girders	1	134.257003	134.631516	0	0	1	0	0	134.2570...	134.631516		DIA A
Both Girders	2	0	0	0	0	1	0	0	0	0		DIA B
Both Girders	2	22.188832	22.250728	0	0	1	0	0	22.188832	22.250728		DIA A
Both Girders	2	44.367256	44.49102	0	0	1	0	0	44.367256	44.49102		DIA B
Both Girders	2	66.54568	66.731311	0	0	1	0	0	66.54568	66.731311		DIA A
Both Girders	2	88.724104	88.971603	0	0	1	0	0	88.724104	88.971603		DIA B
Both Girders	2	110.902529	111.211894	0	0	1	0	0	110.9025...	111.211894		DIA A
Both Girders	2	133.080953	133.452186	0	0	1	0	0	133.0809...	133.452186		DIA B
Both Girders	2	155.259377	155.692477	0	0	1	0	0	155.2593...	155.692477		DIA A
Both Girders	2	177.437801	177.932769	0	0	1	0	0	177.4378...	177.932769		DIA B
Both Girders	2	199.616226	200.17306	0	0	1	0	0	199.6162...	200.17306		DIA A
Both Girders	2	221.805057	222.423788	0	0	1	0	0	221.8050...	222.423788		DIA B
Both Girders	3	19.399617	19.453732	0	0	1	0	0	19.399617	19.453732		DIA A
Both Girders	3	38.778418	38.886591	0	0	1	0	0	38.778418	38.886591		DIA B
Both Girders	3	58.157219	58.319451	0	0	1	0	0	58.157219	58.319451		DIA A
Both Girders	3	77.536021	77.75231	0	0	1	0	0	77.536021	77.75231		DIA B
Both Girders	3	96.914822	97.185169	0	0	1	0	0	96.914822	97.185169		DIA A
Both Girders	3	116.293624	116.618028	0	0	1	0	0	116.2936...	116.618028		DIA B
Both Girders	3	135.672425	136.050887	0	0	1	0	0	135.6724...	136.050887		DIA A
Both Girders	3	155.051227	155.483746	0	0	1	0	0	155.0512...	155.483746		DIA B
Both Girders	3	174.430028	174.916605	0	0	1	0	0	174.4300...	174.916605		DIA A
Both Girders	3	193.829645	194.370338	0	0	1	0	0	193.8296...	194.370338		DIA B
Both Girders	4	22.480242	22.542952	0	0	1	0	0	22.480242	22.542952		DIA A
Both Girders	4	44.960485	45.085903	0	0	1	0	0	44.960485	45.085903		DIA B
Both Girders	4	67.440727	67.628855	0	0	1	0	0	67.440727	67.628855		DIA A
Both Girders	4	89.920969	90.171806	0	0	1	0	0	89.920969	90.171806		DIA B
Both Girders	4	112.401211	112.714758	0	0	1	0	0	112.4012...	112.714758		DIA A
Both Girders	4	133.632551	134.005323	0	0	1	0	0	133.6325...	134.005323		DIA C

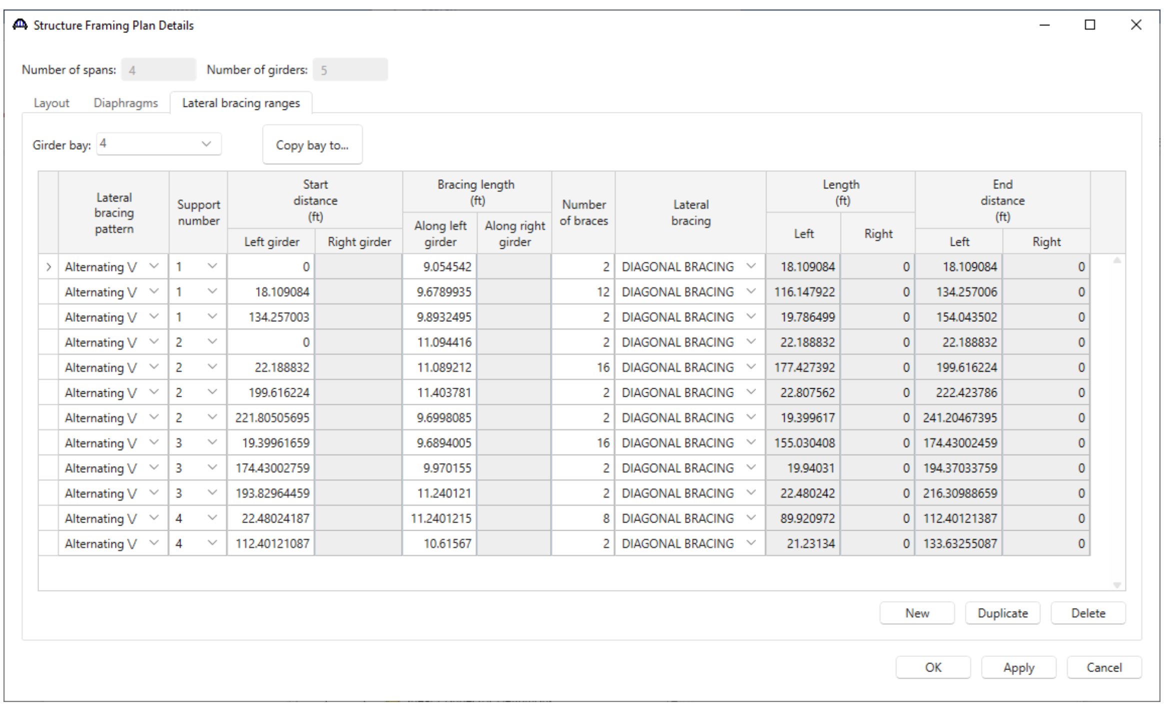
Click **Apply** to apply the diaphragm definition and keep the window open.

A wizard is also available to create the diaphragm locations for the user.

Navigate to the **Lateral bracing ranges** tab of this window to see how lateral bracing definitions are assigned to the framing plan. Values can be copied from the provided spreadsheet for girder bay 1 and girder bay 4. See images below.



Lateral bracing pattern	Support number	Start distance (ft)		Bracing length (ft)		Number of braces	Lateral bracing	Length (ft)		End distance (ft)	
		Left girder	Right girder	Along left girder	Along right girder			Left	Right	Left	Right
Alternating Λ	1		0		9.0040265	2	DIAGONAL BRACING	0	18.008053	0	18.008053
Alternating Λ	1		18.008053		9.6249935	12	DIAGONAL BRACING	0	115.499922	0	133.507975
Alternating Λ	1		133.507975		9.6249935	2	DIAGONAL BRACING	0	19.249987	0	152.757962
Alternating Λ	2		0		11.0325195	2	DIAGONAL BRACING	0	22.065039	0	22.065039
Alternating Λ	2		22.065039		11.027345	16	DIAGONAL BRACING	0	176.43752	0	198.502559
Alternating Λ	2		198.502559		11.0325195	2	DIAGONAL BRACING	0	22.065039	0	220.567598
Alternating Λ	2		220.56759498		9.6456925	2	DIAGONAL BRACING	0	19.291385	0	239.85897998
Alternating Λ	2		394.02446798		9.6456925	2	DIAGONAL BRACING	0	19.291385	0	413.31585298
Alternating Λ	3		19.29138459		9.635343	16	DIAGONAL BRACING	0	154.165488	0	173.45687259
Alternating Λ	4		111.77411856		10.5564445	2	DIAGONAL BRACING	0	21.112889	0	132.88700756
Alternating Λ	4		22.35482356		11.177412	8	DIAGONAL BRACING	0	89.419296	0	111.77411956
Alternating Λ	4		0		11.177412	2	DIAGONAL BRACING	0	22.354824	0	22.354824

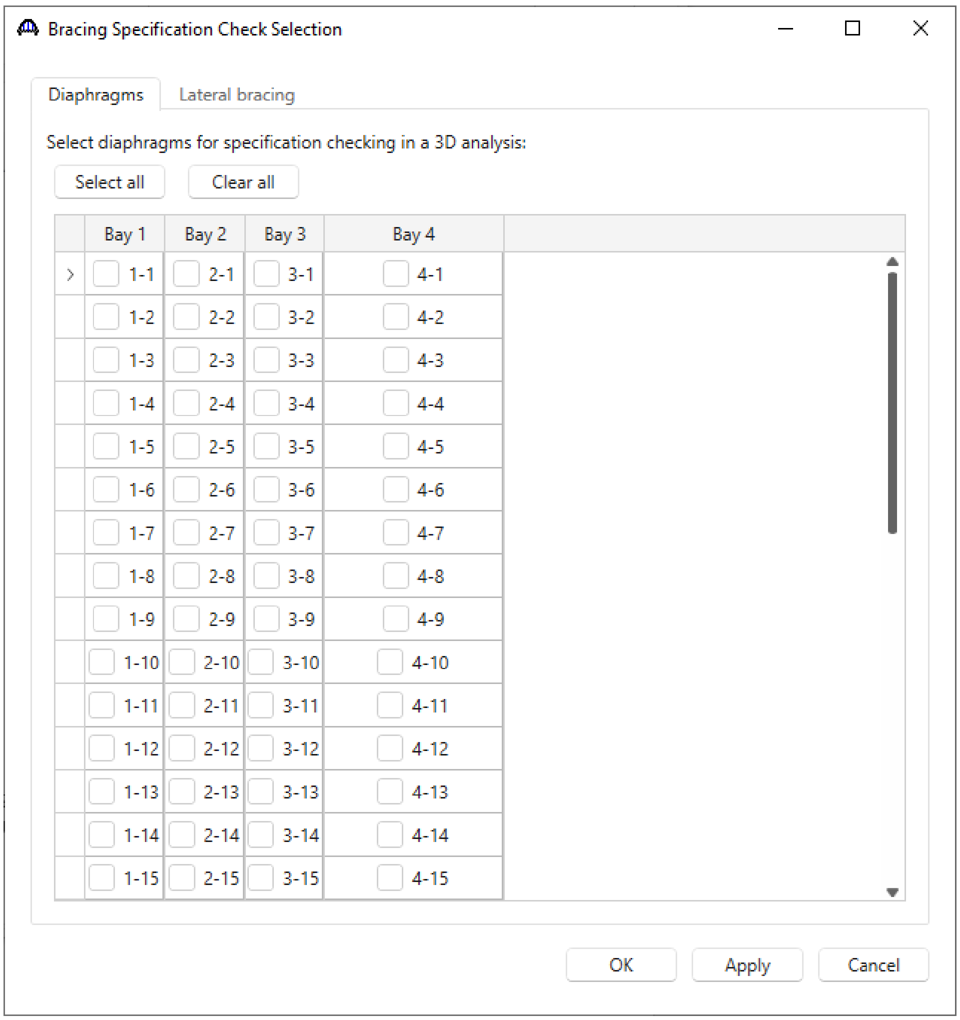


Lateral bracing pattern	Support number	Start distance (ft)		Bracing length (ft)		Number of braces	Lateral bracing	Length (ft)		End distance (ft)	
		Left girder	Right girder	Along left girder	Along right girder			Left	Right	Left	Right
Alternating V	1	0		9.054542		2	DIAGONAL BRACING	18.109084	0	18.109084	0
Alternating V	1	18.109084		9.6789935		12	DIAGONAL BRACING	116.147922	0	134.257006	0
Alternating V	1	134.257003		9.8932495		2	DIAGONAL BRACING	19.786499	0	154.043502	0
Alternating V	2	0		11.094416		2	DIAGONAL BRACING	22.188832	0	22.188832	0
Alternating V	2	22.188832		11.089212		16	DIAGONAL BRACING	177.427392	0	199.616224	0
Alternating V	2	199.616224		11.403781		2	DIAGONAL BRACING	22.807562	0	222.423786	0
Alternating V	2	221.80505695		9.6998085		2	DIAGONAL BRACING	19.399617	0	241.20467395	0
Alternating V	3	19.39961659		9.6894005		16	DIAGONAL BRACING	155.030408	0	174.43002459	0
Alternating V	3	174.43002759		9.970155		2	DIAGONAL BRACING	19.94031	0	194.37033759	0
Alternating V	3	193.82964459		11.240121		2	DIAGONAL BRACING	22.480242	0	216.30988659	0
Alternating V	4	22.48024187		11.2401215		8	DIAGONAL BRACING	89.920972	0	112.40121387	0
Alternating V	4	112.40121087		10.61567		2	DIAGONAL BRACING	21.23134	0	133.63255087	0

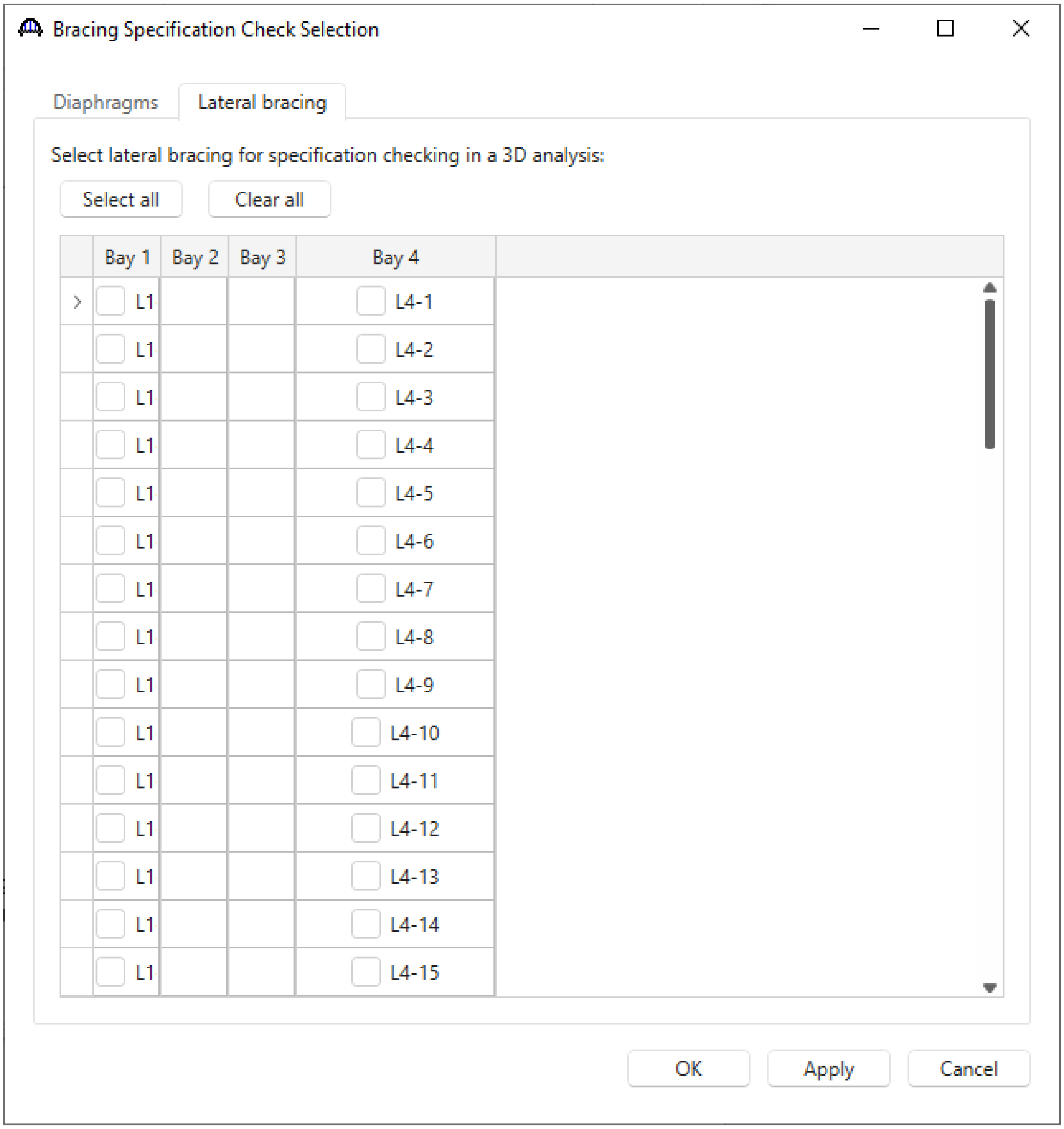
Click **OK** to apply the data and close the window.

Bracing Spec Check Selection

Double click on the **Bracing spec check selection** node in the BWS tree. This window is used to identify which diaphragms should be loaded for live load (for both straight and curved girder systems). This window contains a listing of each diaphragm location in the superstructure definition. The first number is the bay number, and the second number is the numerical id of the diaphragm starting with 1 for the diaphragm at the start of the bay. Selecting a diaphragm in this window will result in influence surfaces for the diaphragm members being generated and then loaded with the live load. BrDR will also perform a specification check on each checked diaphragm. Including more diaphragms for specification checking in a 3D analysis can greatly affect the run time and amount of memory needed for the analysis. Note that the diaphragms are always included in the FE model. This checkbox only controls if the diaphragm members are loaded for live load and specification checking.



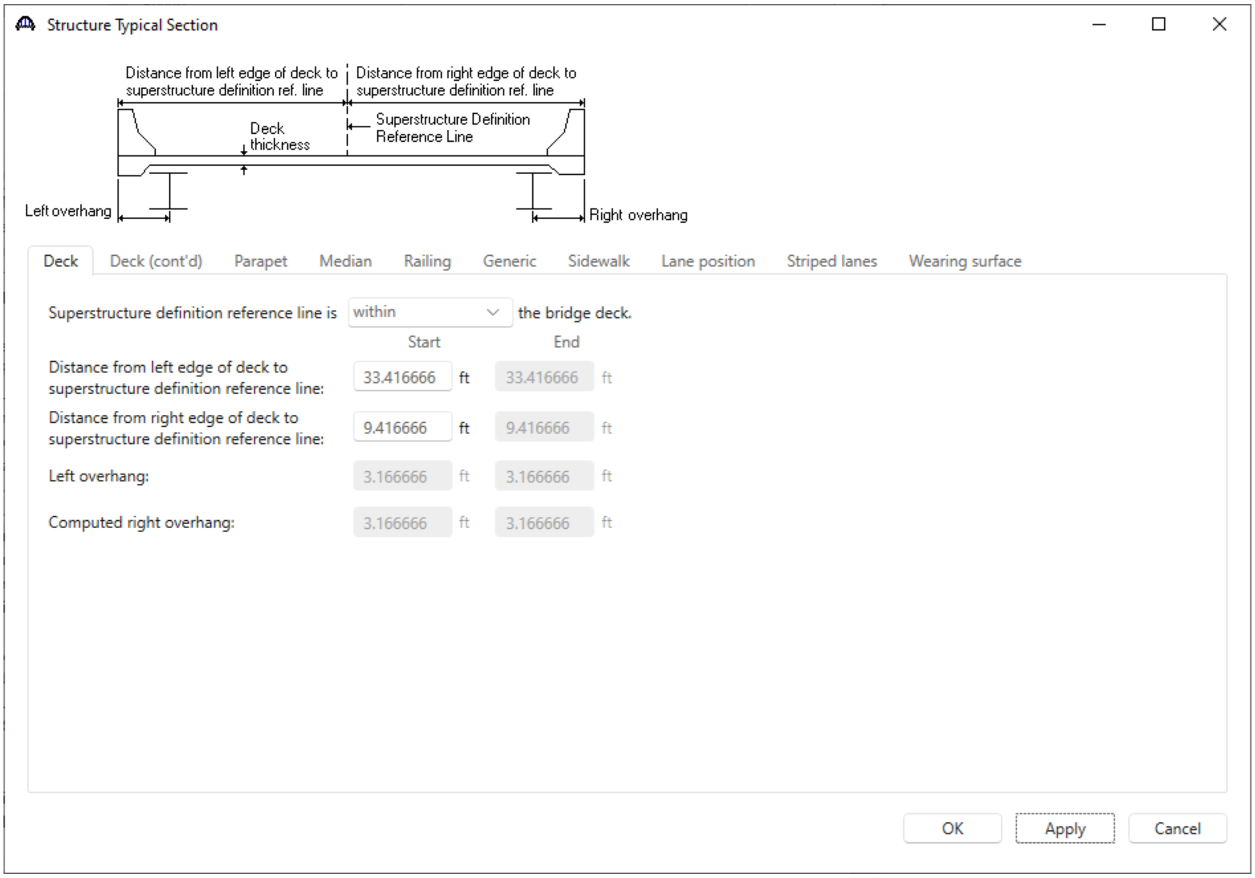
Similarly, the same can be done with the lateral bracing in the **Lateral bracing** tab of this window as shown below.



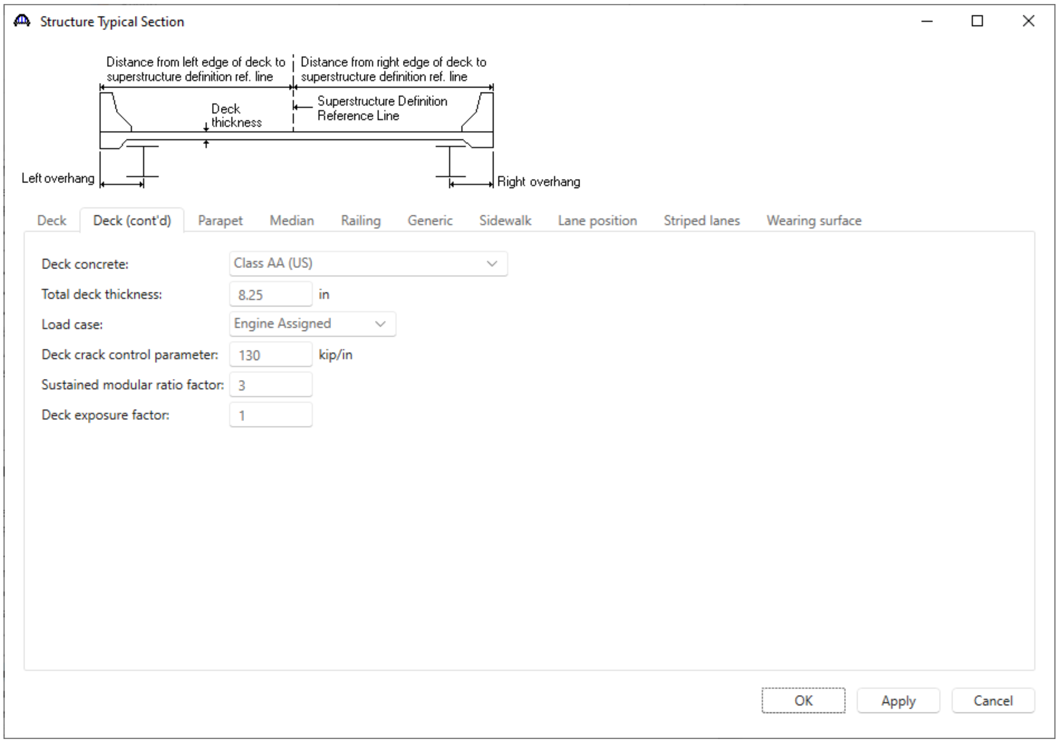
Click **OK** to apply the data and close the window.

Structure Typical Section

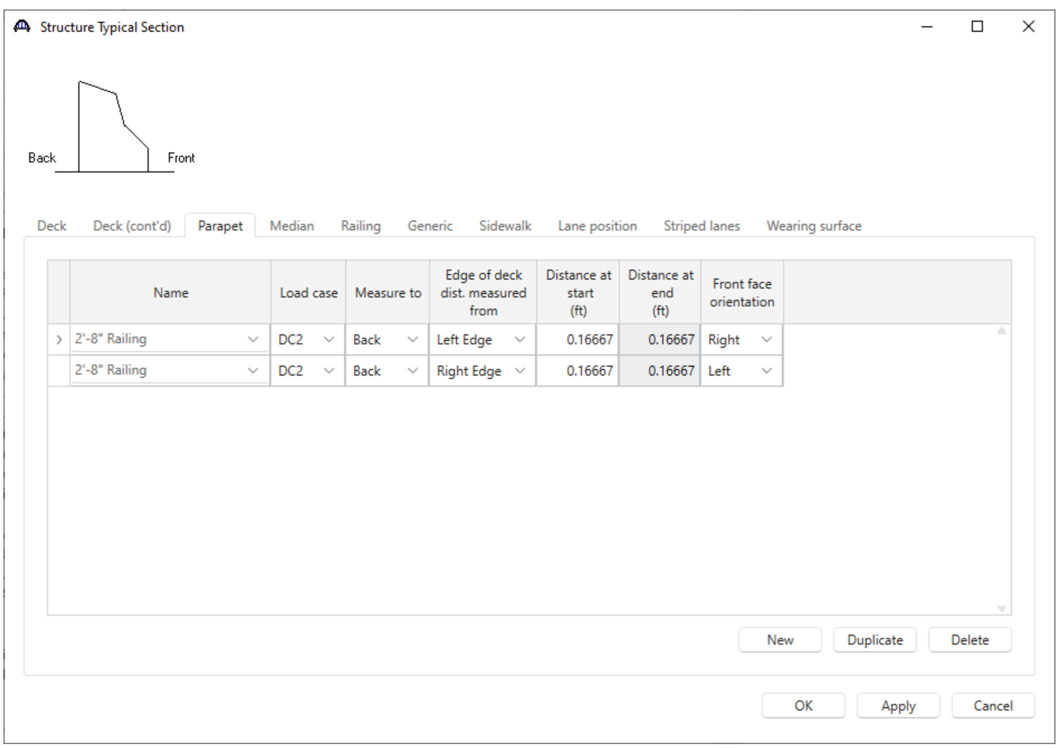
Double click on the **Structure Typical Section** node in the **BWS tree** to open the **Structure Typical Section** window. This window contains the following options for curved girder systems. The width of the deck must be constant along the length of the structure. The overhangs are computed based on the distance from the superstructure definition reference line to the leftmost girder and girder spacing entered on the **Framing Plan Detail** window and the deck width entered here.



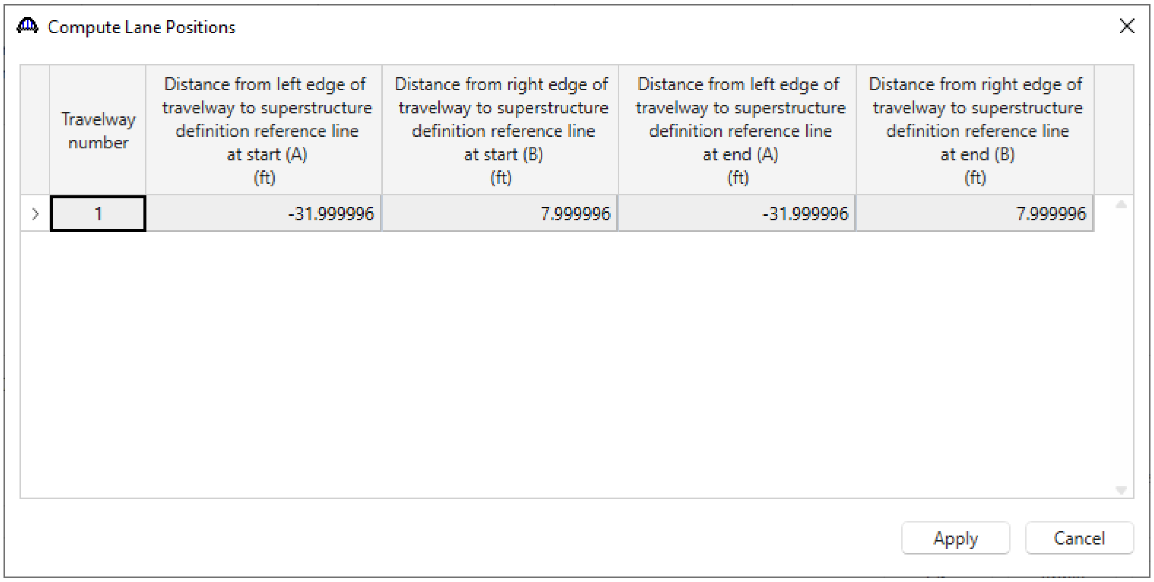
Navigate to the **Deck (Cont'd)** tab of this window and enter the information related to the deck concrete and thickness as shown below.

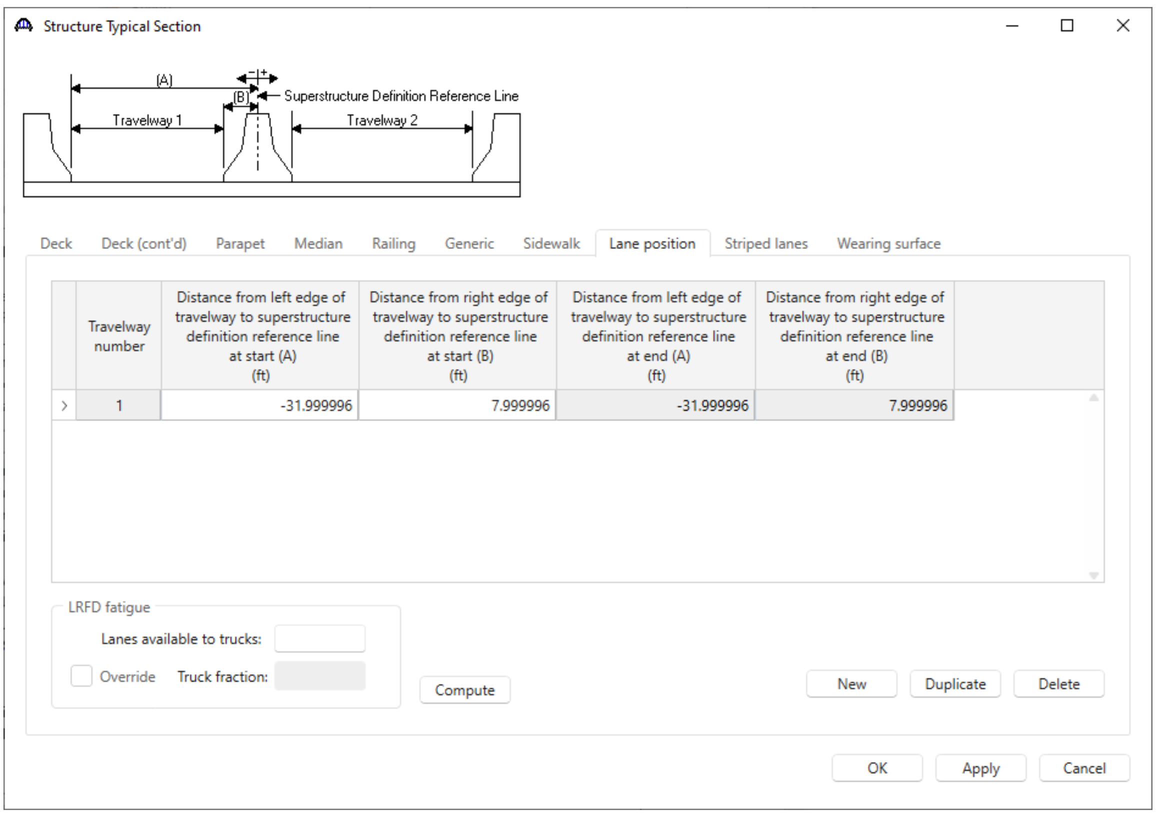


Switch to the **Parapets** tab and enter the following parapet information.



Navigate to the **Lane position** tab of this window. Use the **Compute** button to have BrDR compute the lane positions. These lane positions are used to compute the LRFD live load distribution factors.



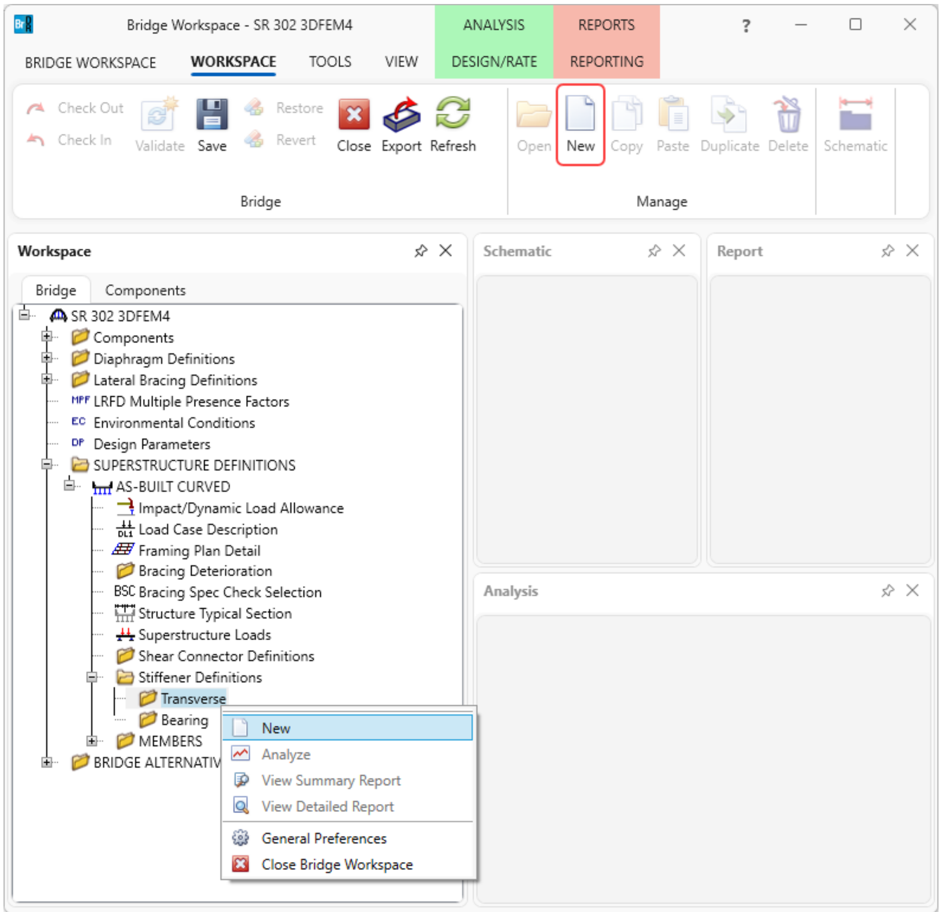


Click **OK** to apply the data and close the window.

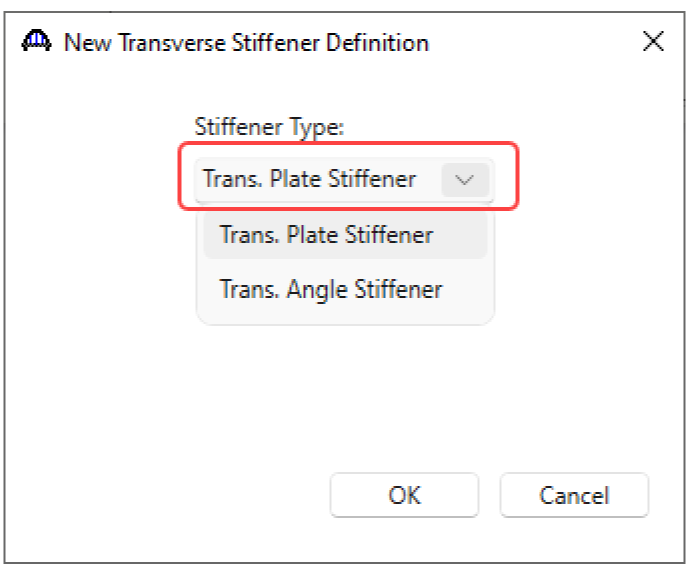
The next step is to add transverse and bearing stiffeners.

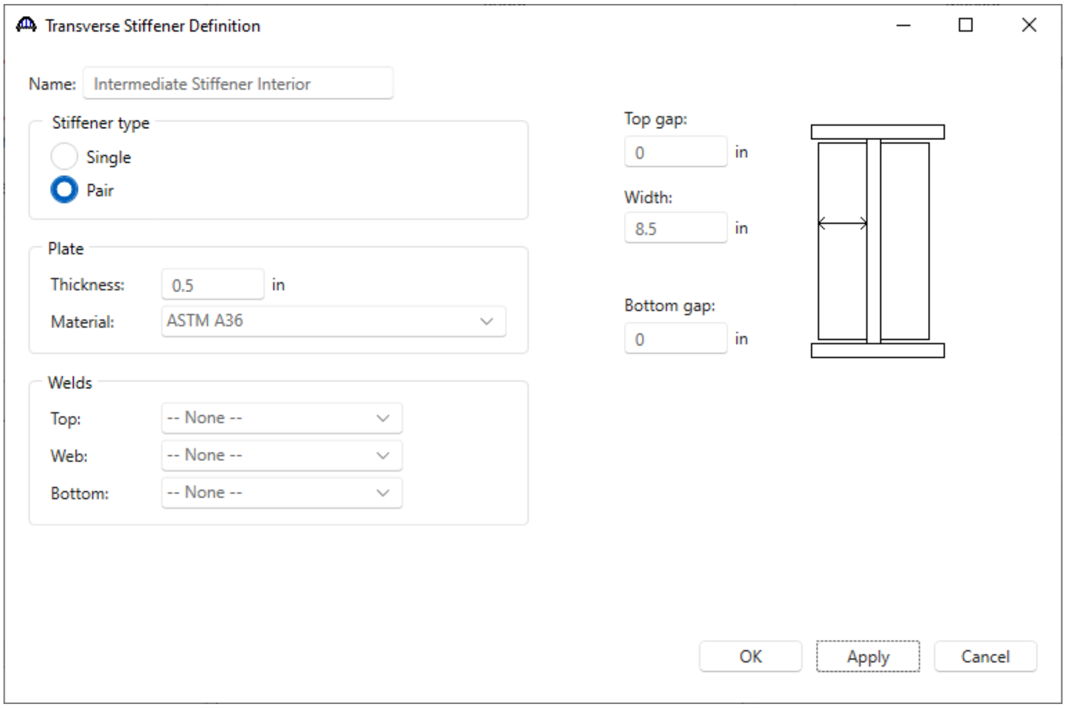
Transverse Stiffeners

To add transverse stiffeners, expand the **Stiffener Definitions** node in the **BWS** tree. Click on **Transverse** and select **New** from the **WORKSPACE** ribbon (or right click and select **New**, or double click) as shown below.



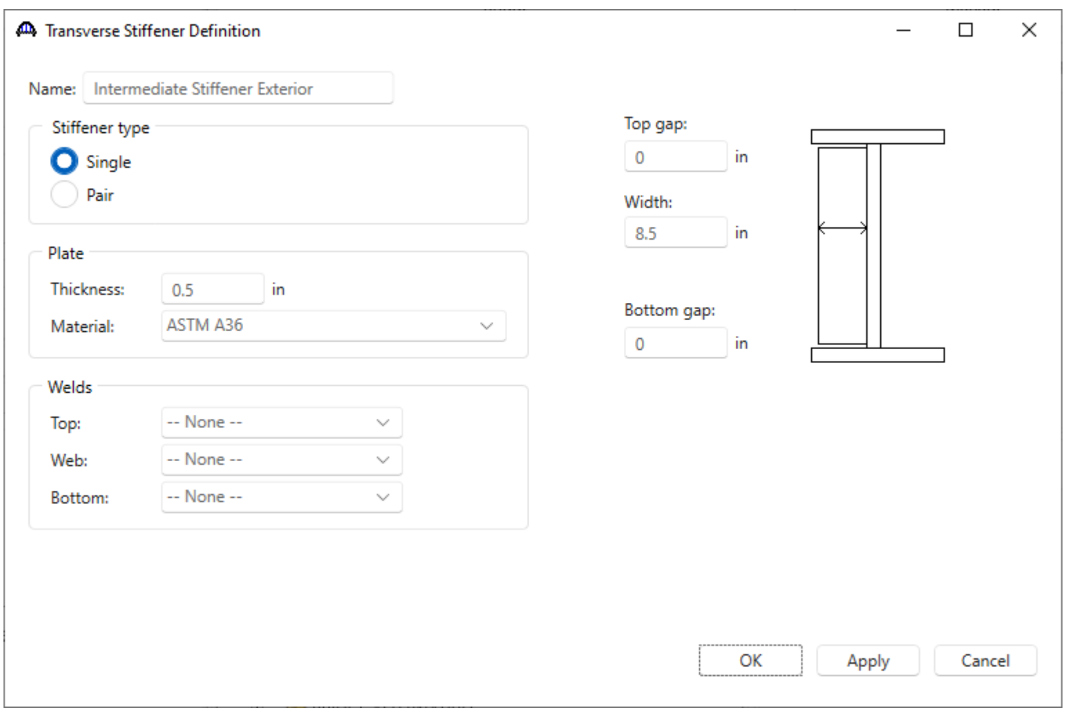
Select **Trans. Plate Stiffener** from the **Stiffener Type** menu.





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

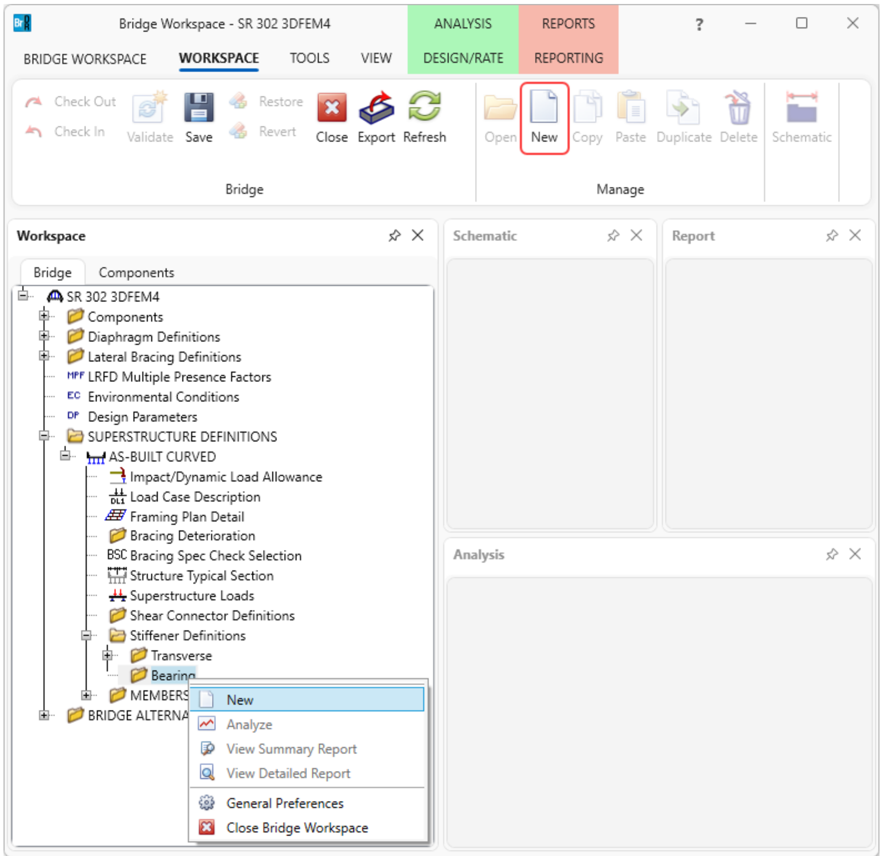
Similarly add another stiffener definition as shown below.



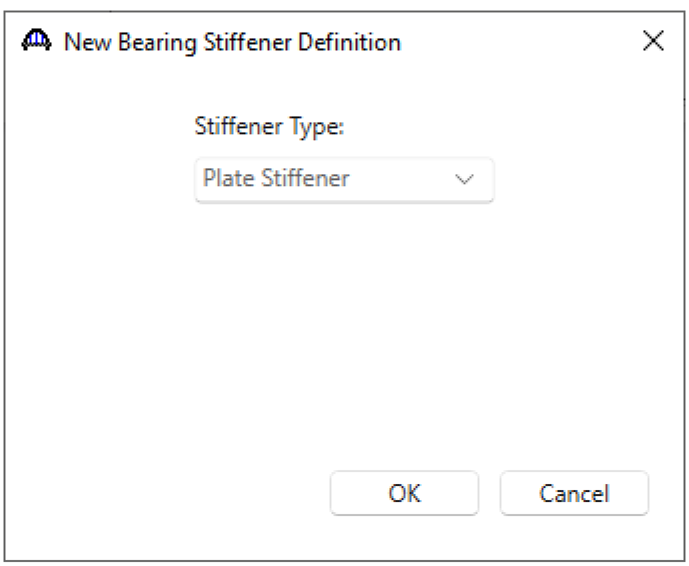
Click **OK** to apply the data and close the window.

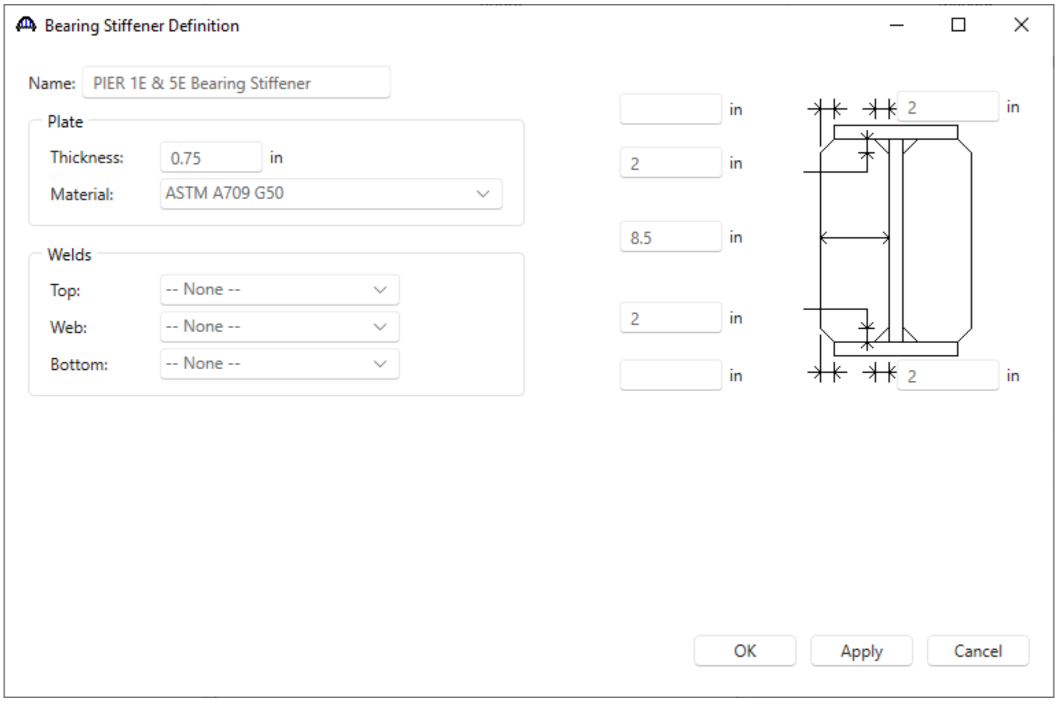
Bearing Stiffener

To add bearing stiffeners, expand the **Stiffener Definitions** node in the **BWS** tree. Click on the **Bearing** node and select **New** from the **WORKSPACE** ribbon (or right click and select **New**, or double click) as shown below.



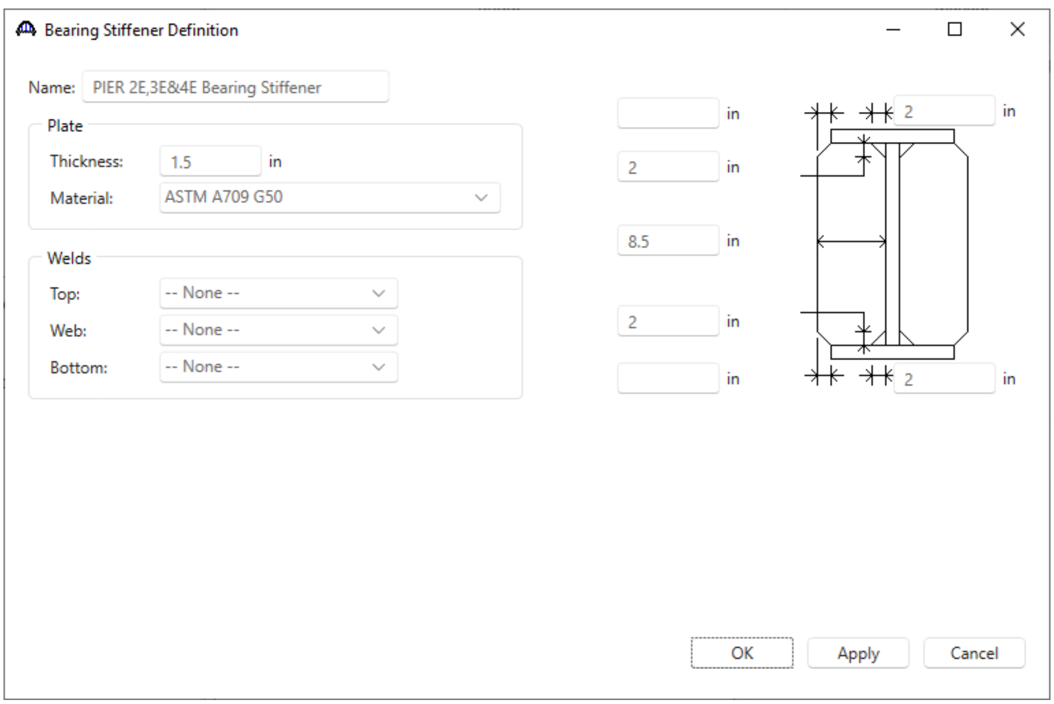
Select **Plate Stiffener** from the **Stiffener Type** menu.





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

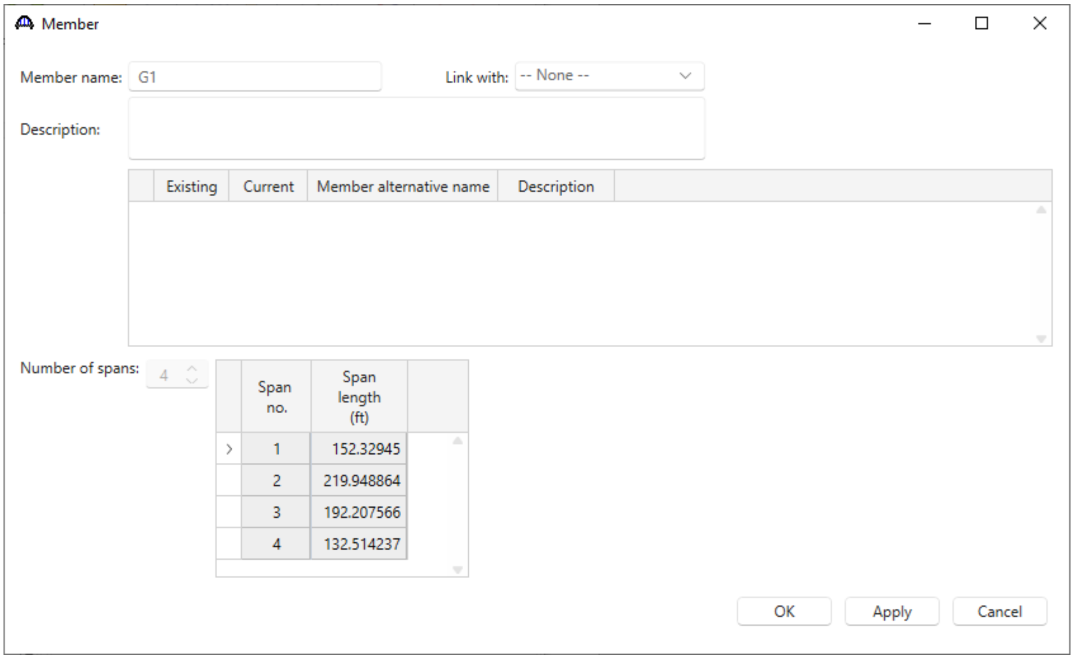
Similarly add another stiffener definition as shown below.



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

Member

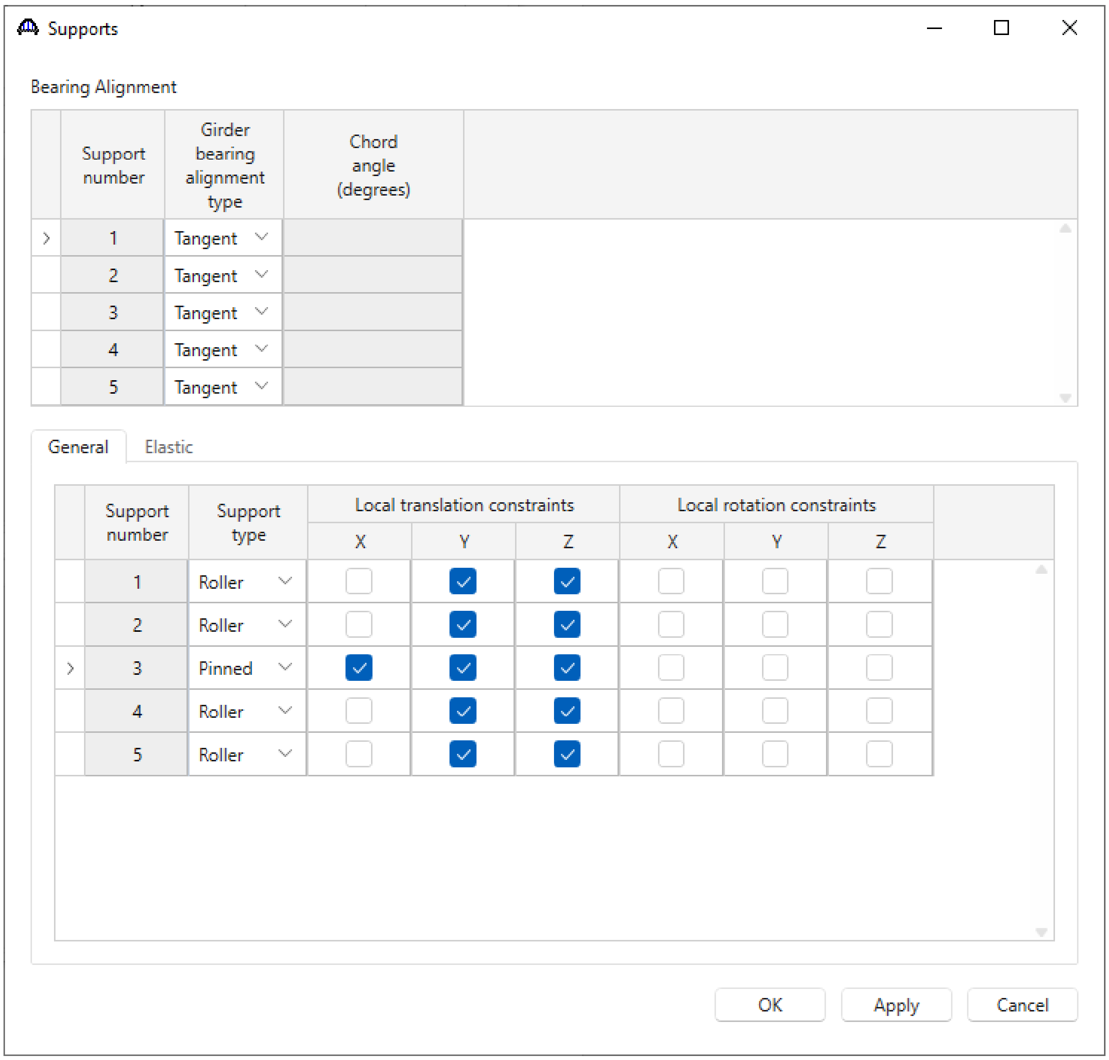
Expand the **Members** node in the **BWS** tree and double click on **G1** to open the **Member** window. This window shows the data that was generated when the structure definition was created. No changes are required in this window. The first Member Alternative created will automatically be assigned as the **Existing** and **Current** Member alternative for this Member.



Click **Cancel** to close the window.

Supports

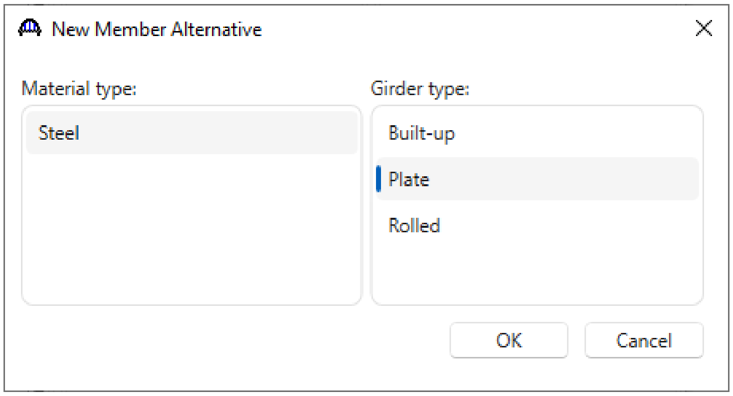
Expand the **G1** node and double click on **Supports** to open the **Supports** window for member **G1** to see how bearings can be oriented for curved girder systems. For curved girder systems bearings are oriented in a local coordinate system at each member support. Select **Tangent** if the local x axis for the bearing alignment is parallel to the tangent of the member reference line at the support. Select **Chord** if the local x axis for the bearing alignment is parallel to a specified chord angle from the tangent of the member reference line at the support.

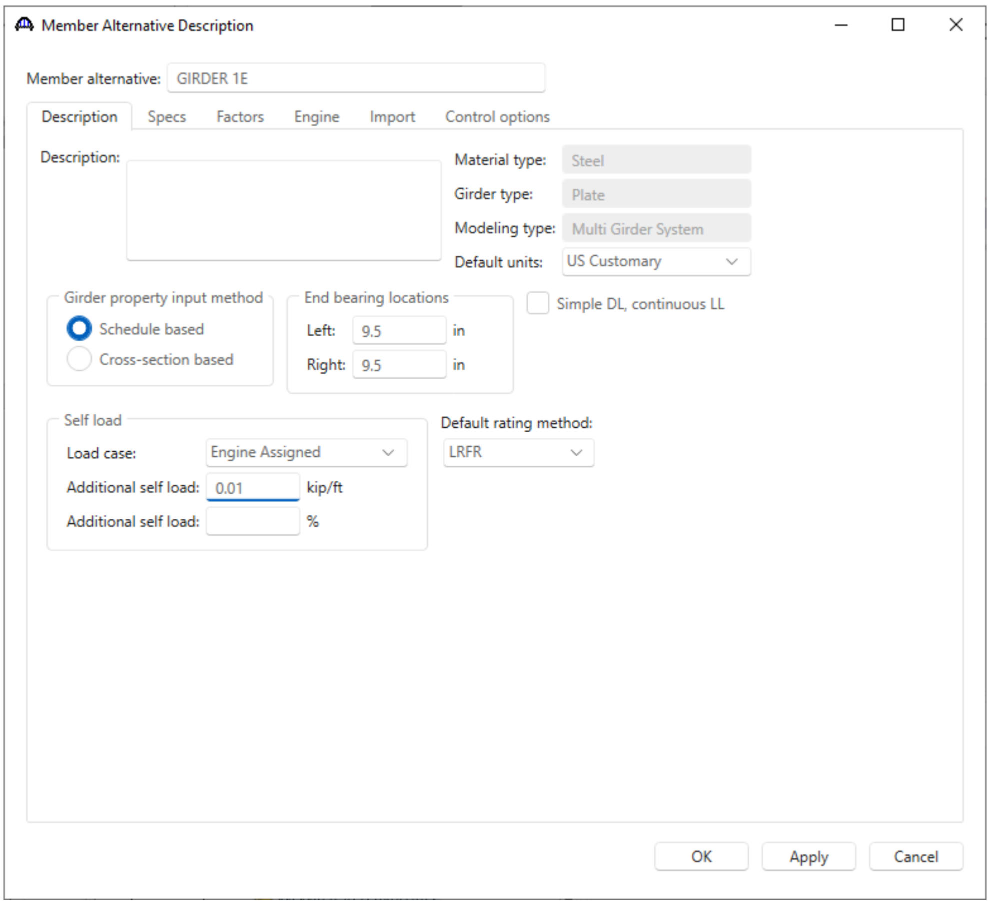


Click **OK** to apply the data and close the window.

Member Alternative

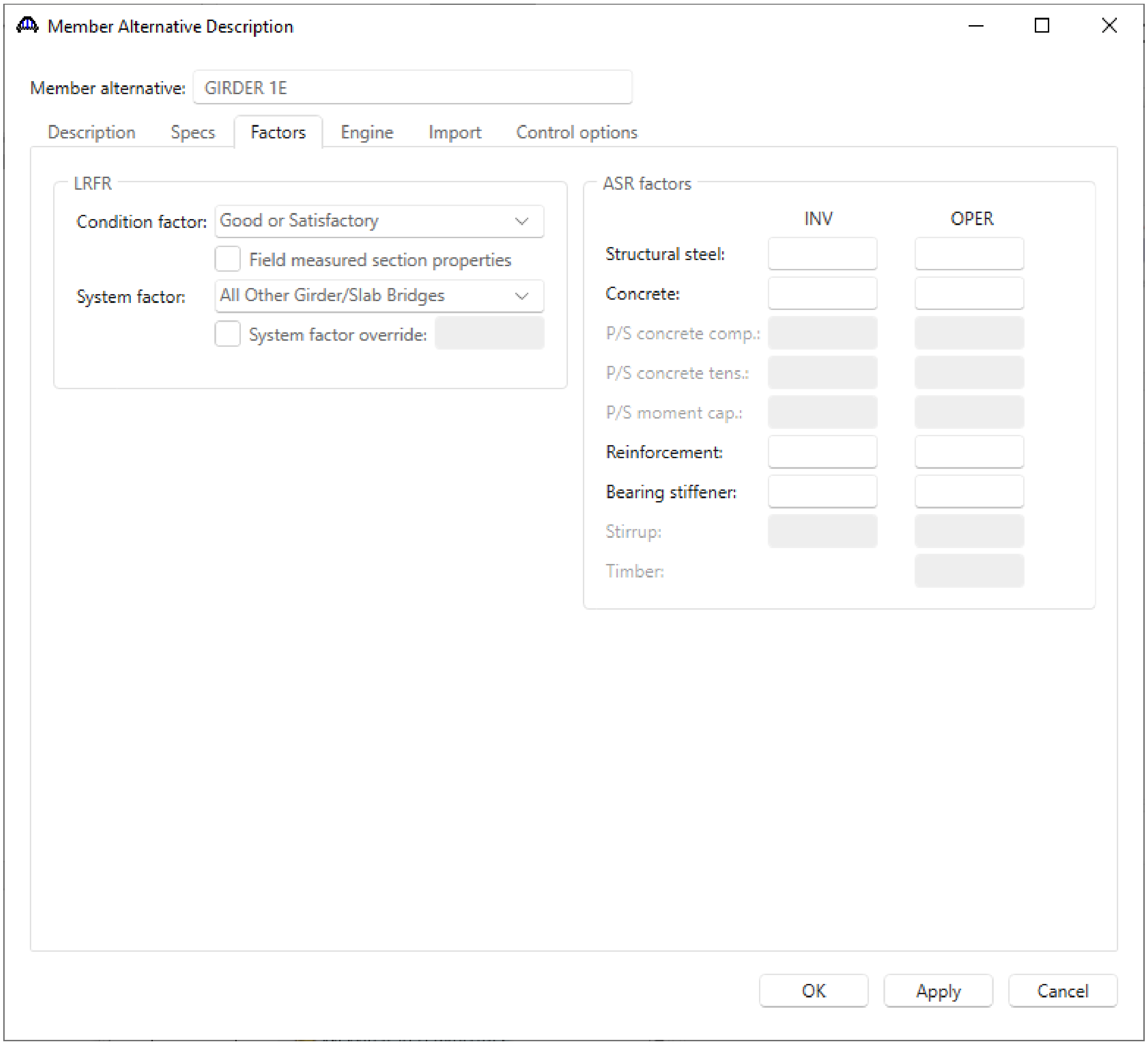
Double click on the **Member Alternatives** node for member **G1** in the **BWS** tree to create a new alternative. The **New Member Alternative** window shown below will open. Select **Steel Material type** and **Plate** for **Girder type** and click **OK**.

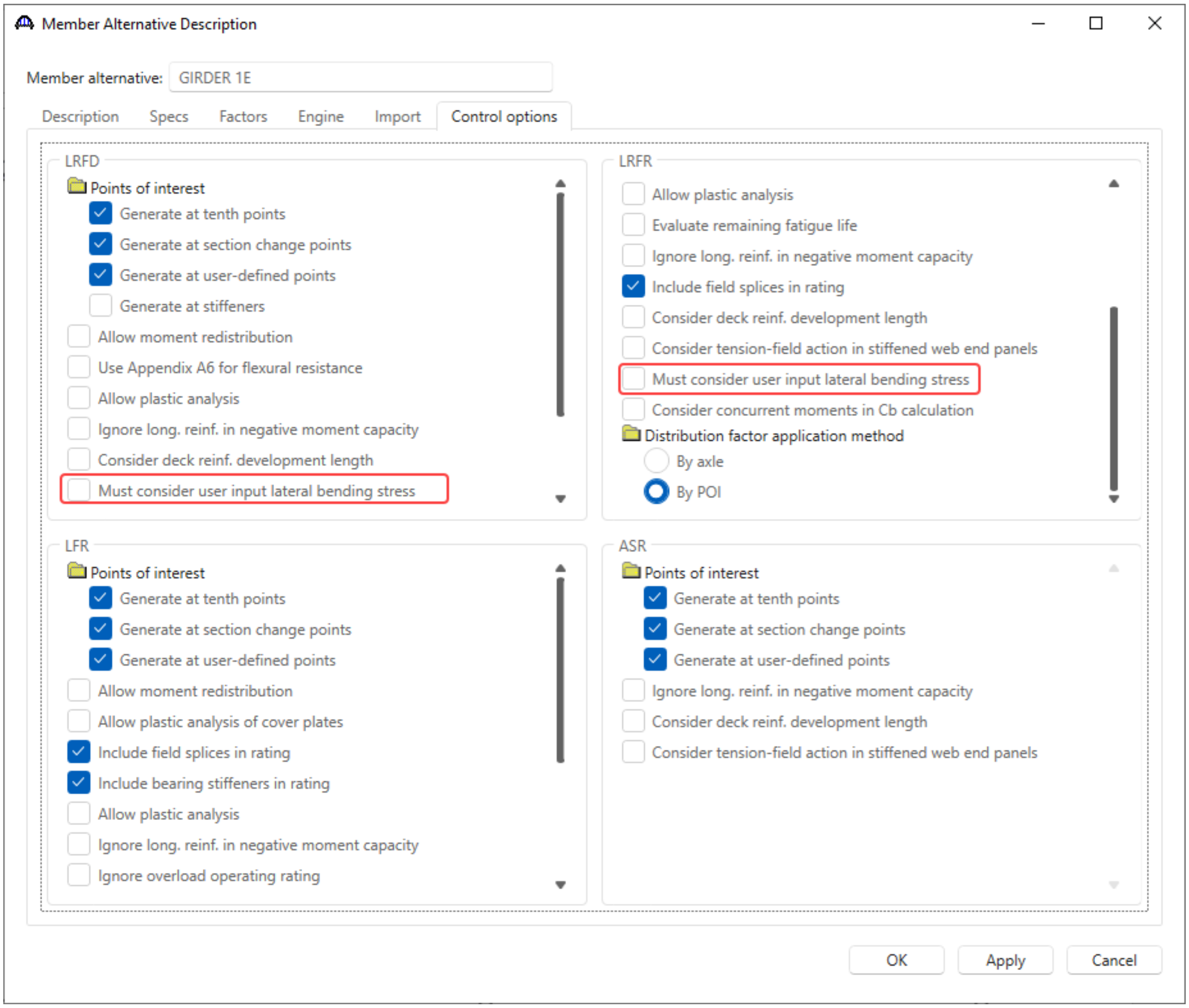




Click **Apply** the save the data and not close the window.

Navigate to the **Factors** tab. The condition and system factors can be updated on this tab if an inspection report is available, and the user can check specific control options from the **Control options** tab in this window. Make sure to uncheck the checkbox – **Must consider user input lateral bending stress** checkbox under LRFD and LRFR. Enter the data as shown below.



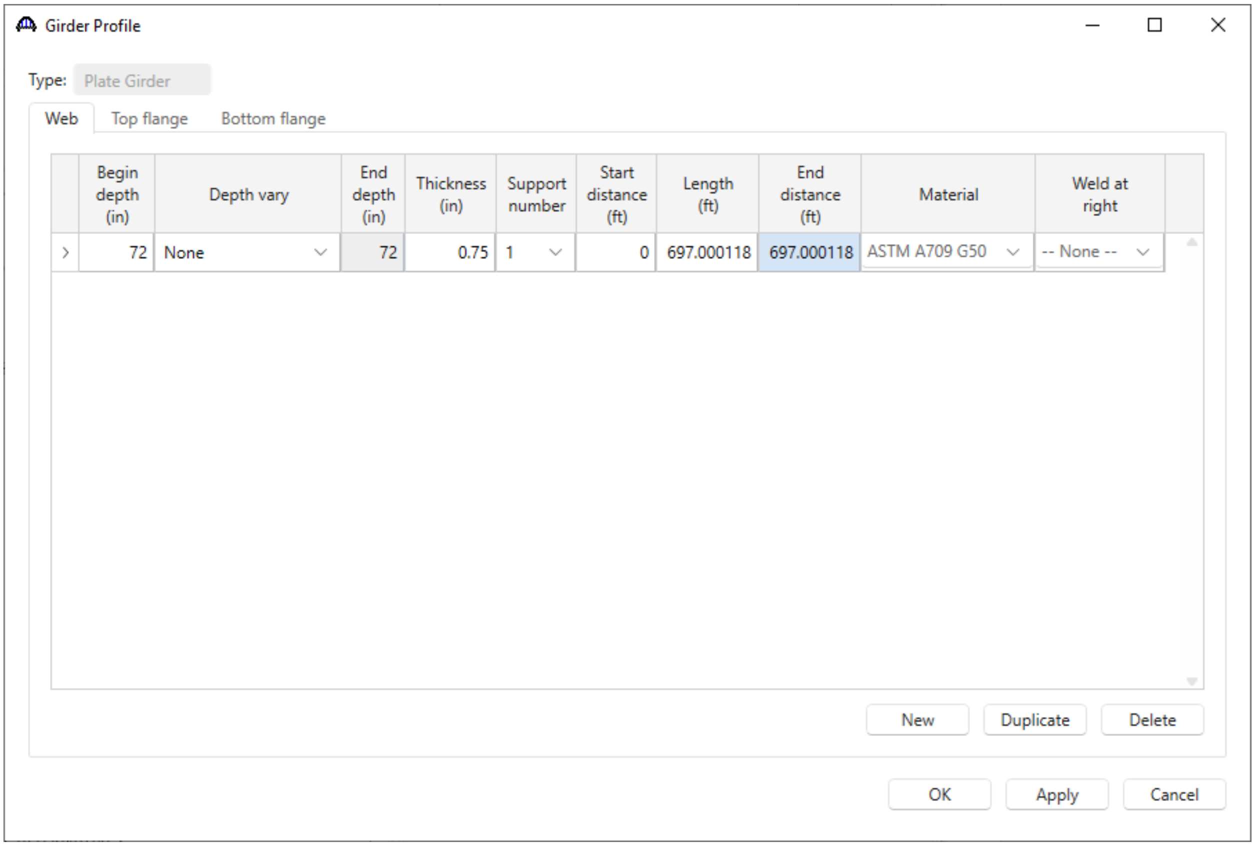


Click **OK** to apply the data and close the window.

Girder Profile

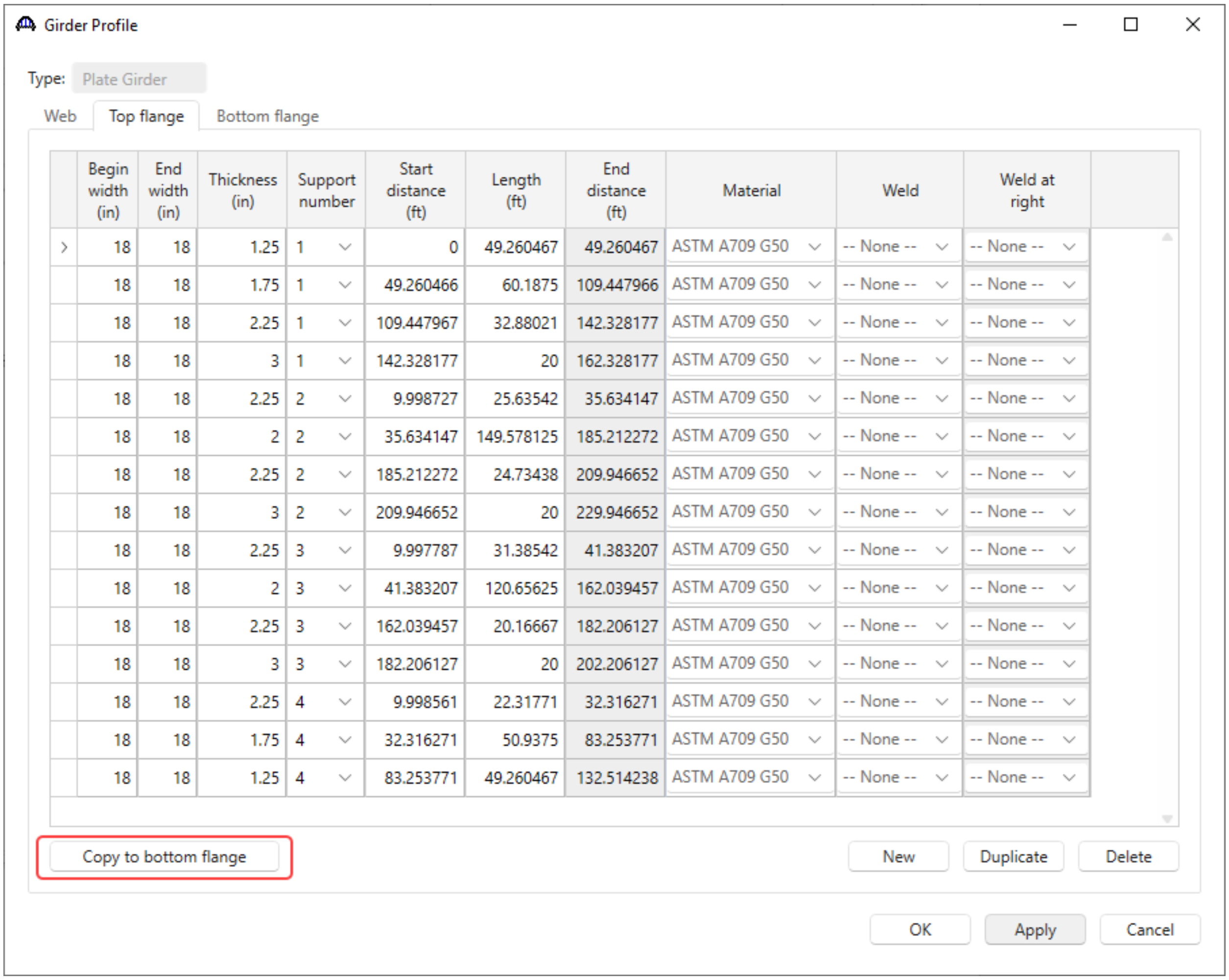
Expand the newly added member alternative node and double click on the **Girder Profile** node. Enter the following data in each of its tabs. Since top and bottom flange are the same, the **Copy** feature can be used to save time.

Web



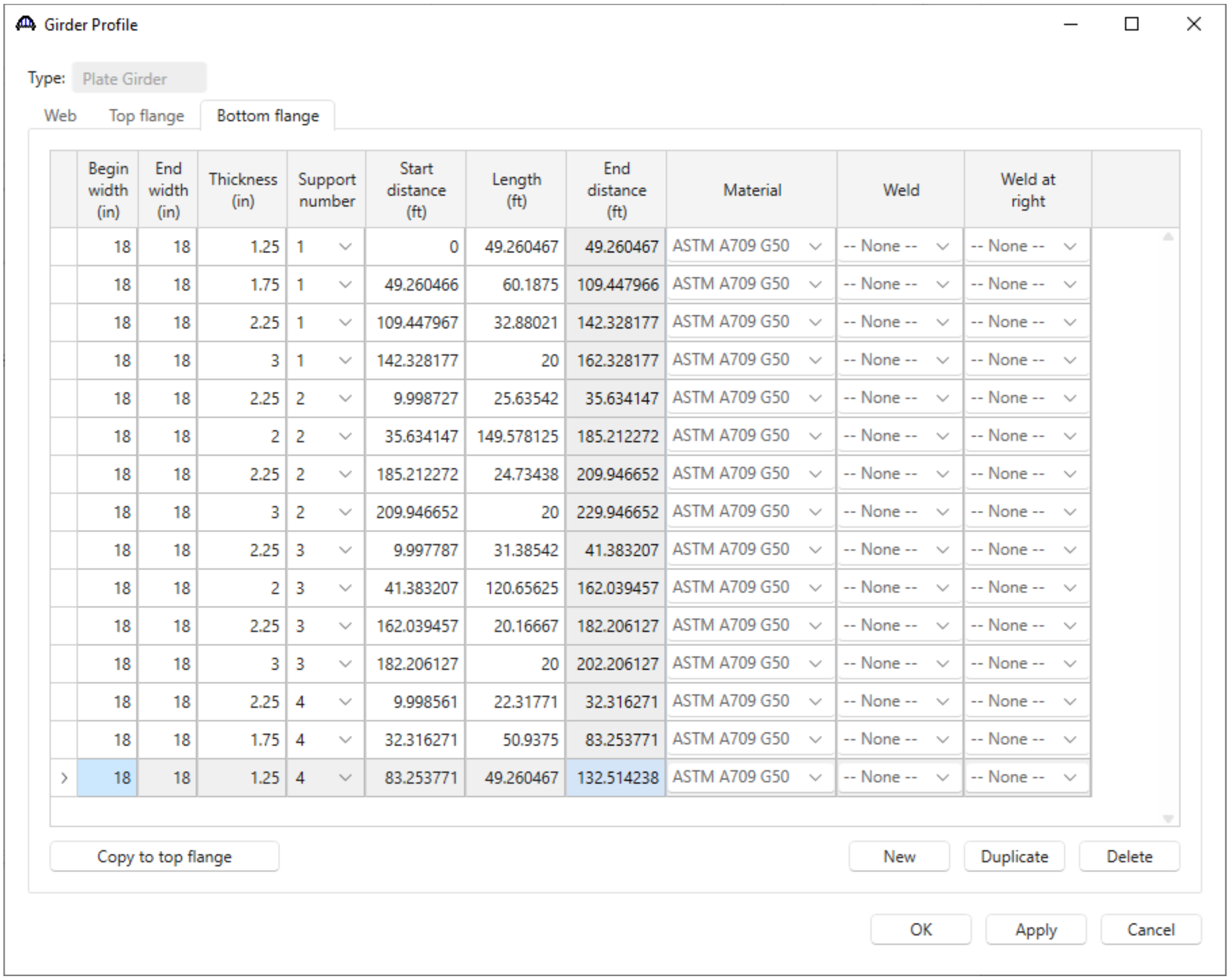
Top flange

Navigate to the **Top flange** tab and enter the following data. Once entered click **Apply** and then click on the **Copy to bottom flange** button to copy the same rows to the **Bottom flange** tab of this window.



Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.260467	49.260467	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.260466	60.1875	109.447966	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	109.447967	32.88021	142.328177	ASTM A709 G50	-- None --	-- None --
18	18	3	1	142.328177	20	162.328177	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	9.998727	25.63542	35.634147	ASTM A709 G50	-- None --	-- None --
18	18	2	2	35.634147	149.578125	185.212272	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	185.212272	24.73438	209.946652	ASTM A709 G50	-- None --	-- None --
18	18	3	2	209.946652	20	229.946652	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	9.997787	31.38542	41.383207	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.383207	120.65625	162.039457	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	162.039457	20.16667	182.206127	ASTM A709 G50	-- None --	-- None --
18	18	3	3	182.206127	20	202.206127	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	9.998561	22.31771	32.316271	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.316271	50.9375	83.253771	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	83.253771	49.260467	132.514238	ASTM A709 G50	-- None --	-- None --

Bottom flange

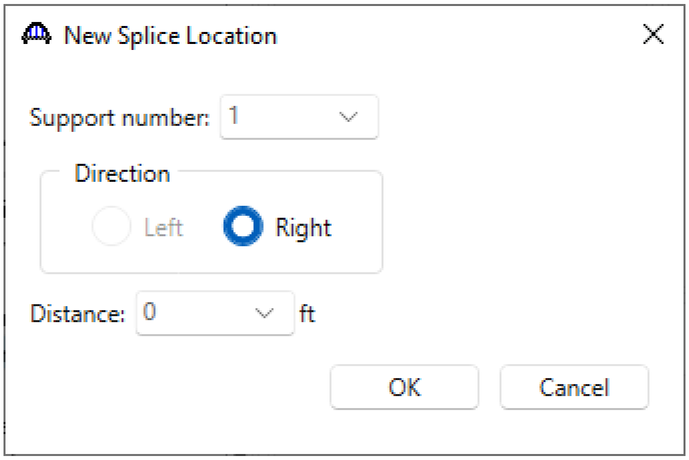


Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.260467	49.260467	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.260466	60.1875	109.447966	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	109.447967	32.88021	142.328177	ASTM A709 G50	-- None --	-- None --
18	18	3	1	142.328177	20	162.328177	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	9.998727	25.63542	35.634147	ASTM A709 G50	-- None --	-- None --
18	18	2	2	35.634147	149.578125	185.212272	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	185.212272	24.73438	209.946652	ASTM A709 G50	-- None --	-- None --
18	18	3	2	209.946652	20	229.946652	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	9.997787	31.38542	41.383207	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.383207	120.65625	162.039457	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	162.039457	20.16667	182.206127	ASTM A709 G50	-- None --	-- None --
18	18	3	3	182.206127	20	202.206127	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	9.998561	22.31771	32.316271	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.316271	50.9375	83.253771	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	83.253771	49.260467	132.514238	ASTM A709 G50	-- None --	-- None --

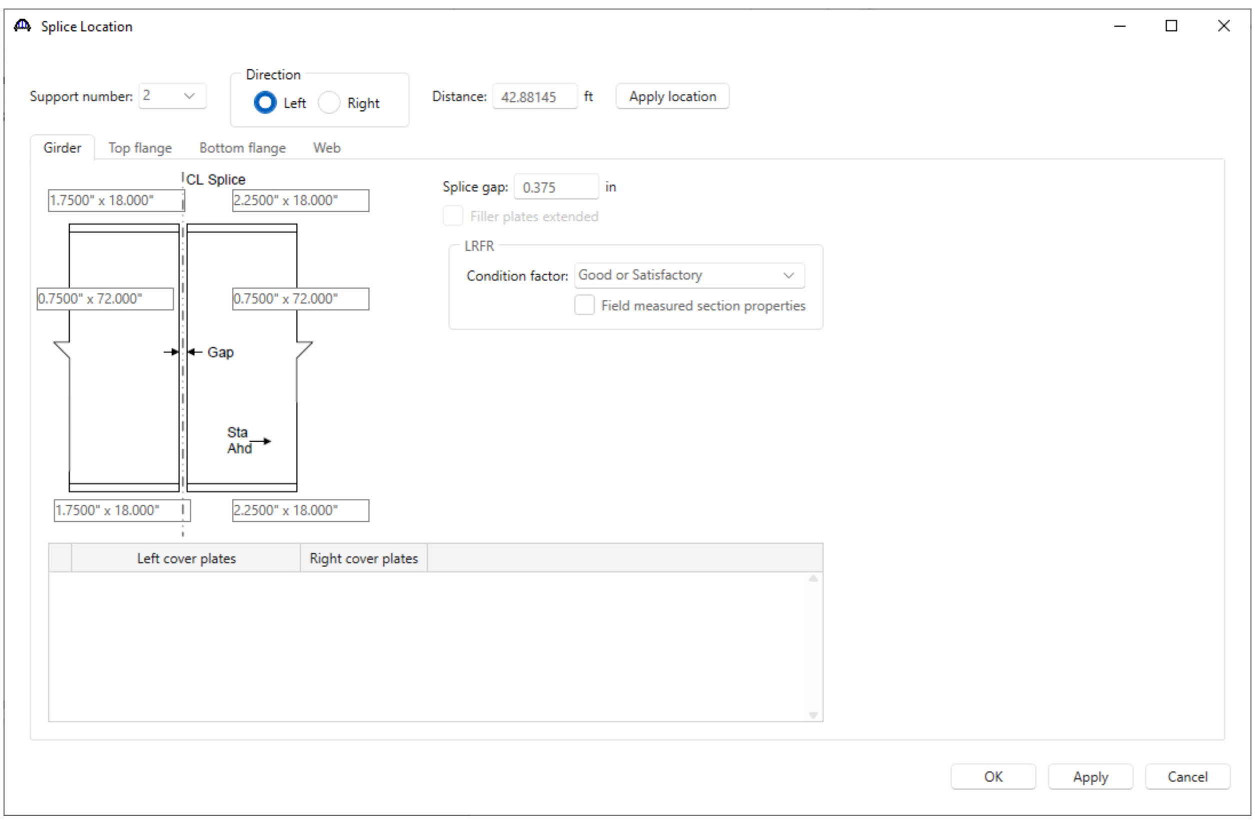
Click **OK** to apply the data and close the window.

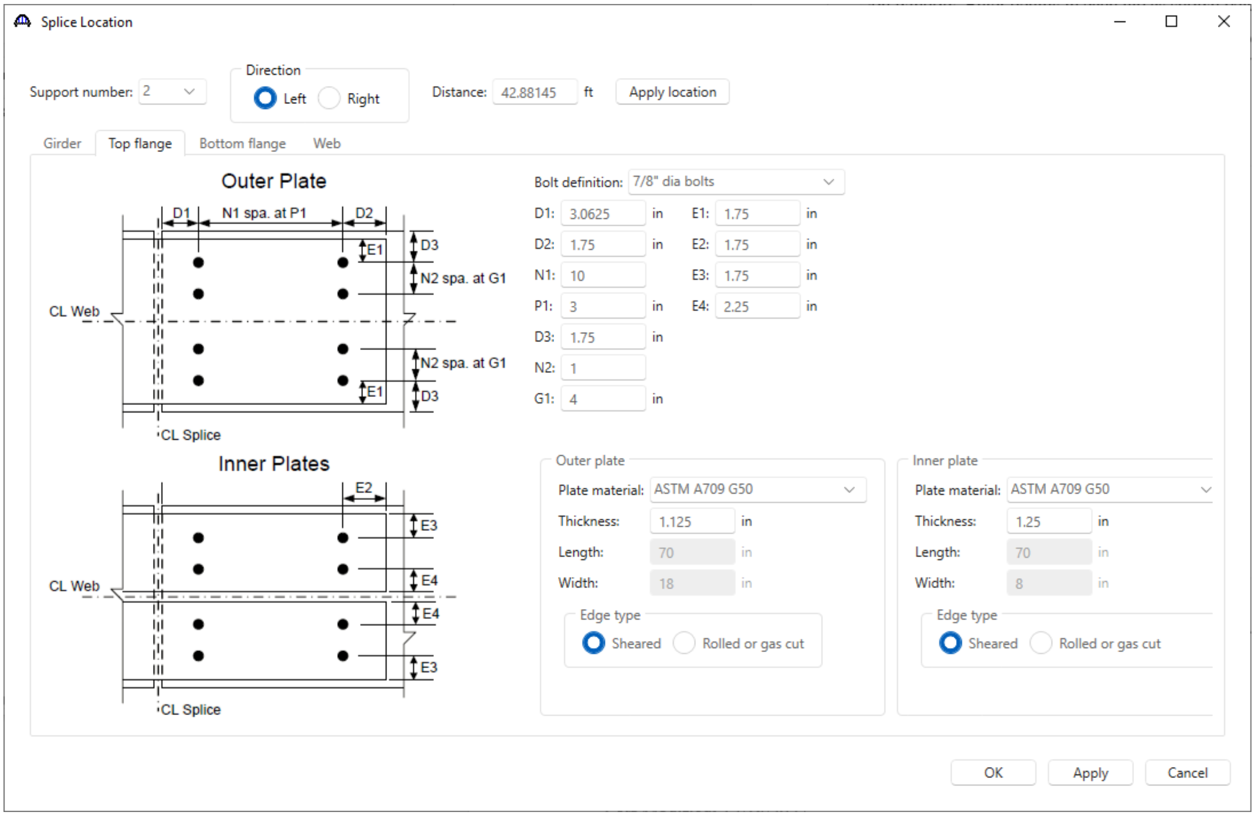
Splice Locations

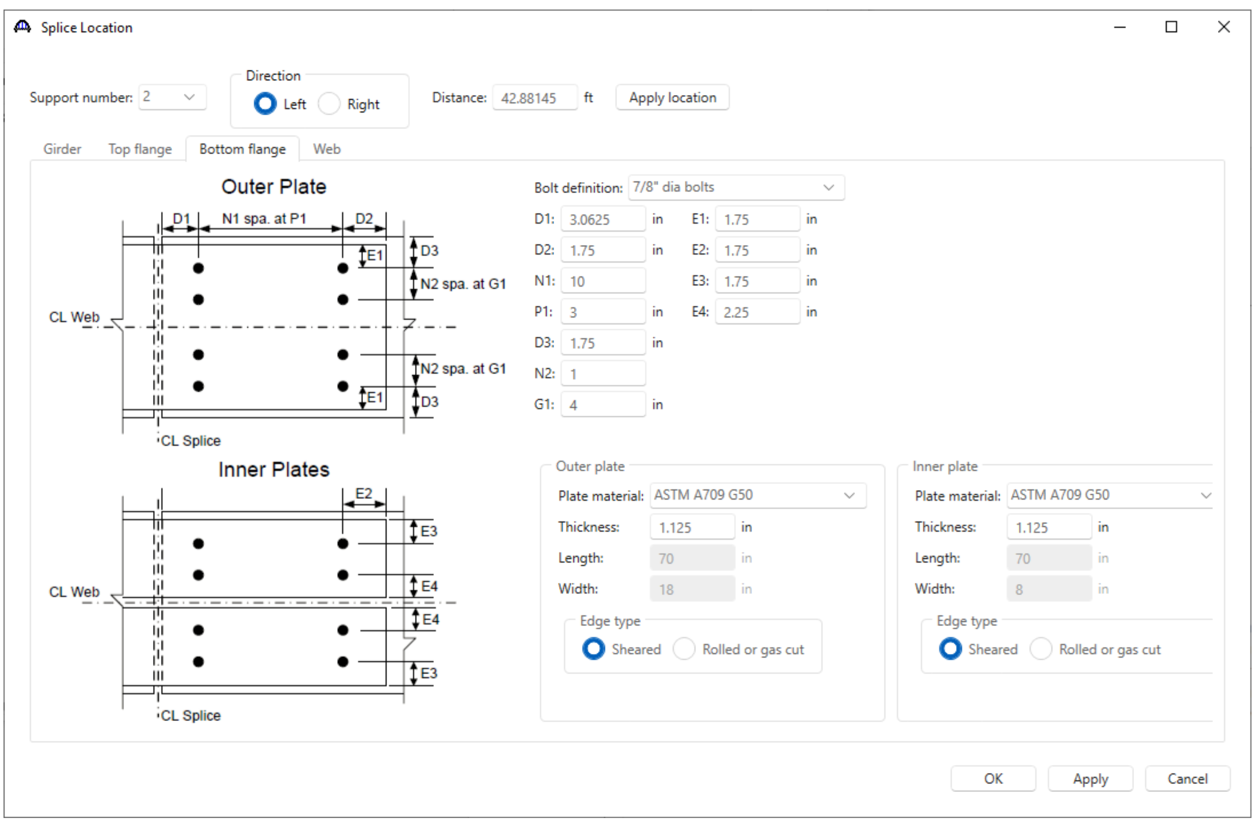
Define splice locations for GIRDER 1E by double clicking on the **Splice Locations** node in the **BWS** tree. This opens the **New Splice Location** window. Define splice locations as shown below. The splices are the same for all locations and all girders.

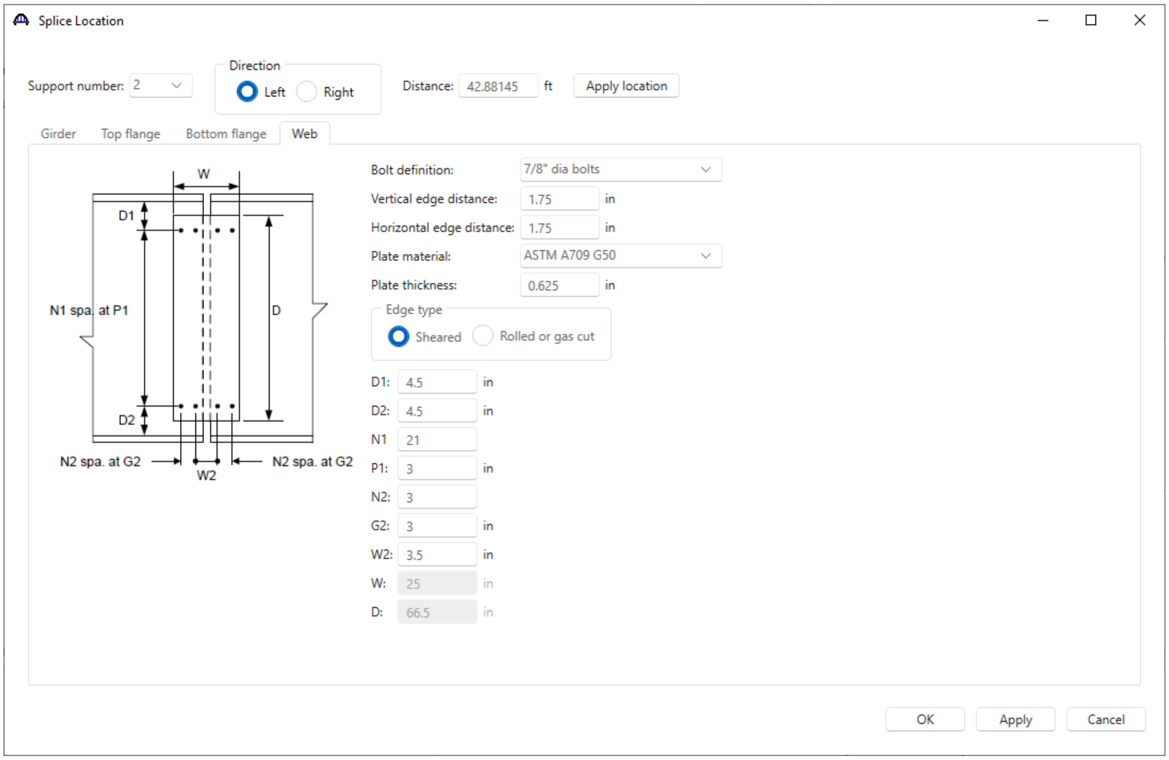


Click **OK** to open the Splice Location window. Enter details as shown below and click **Apply location**. Also enter details in each tab as shown below.



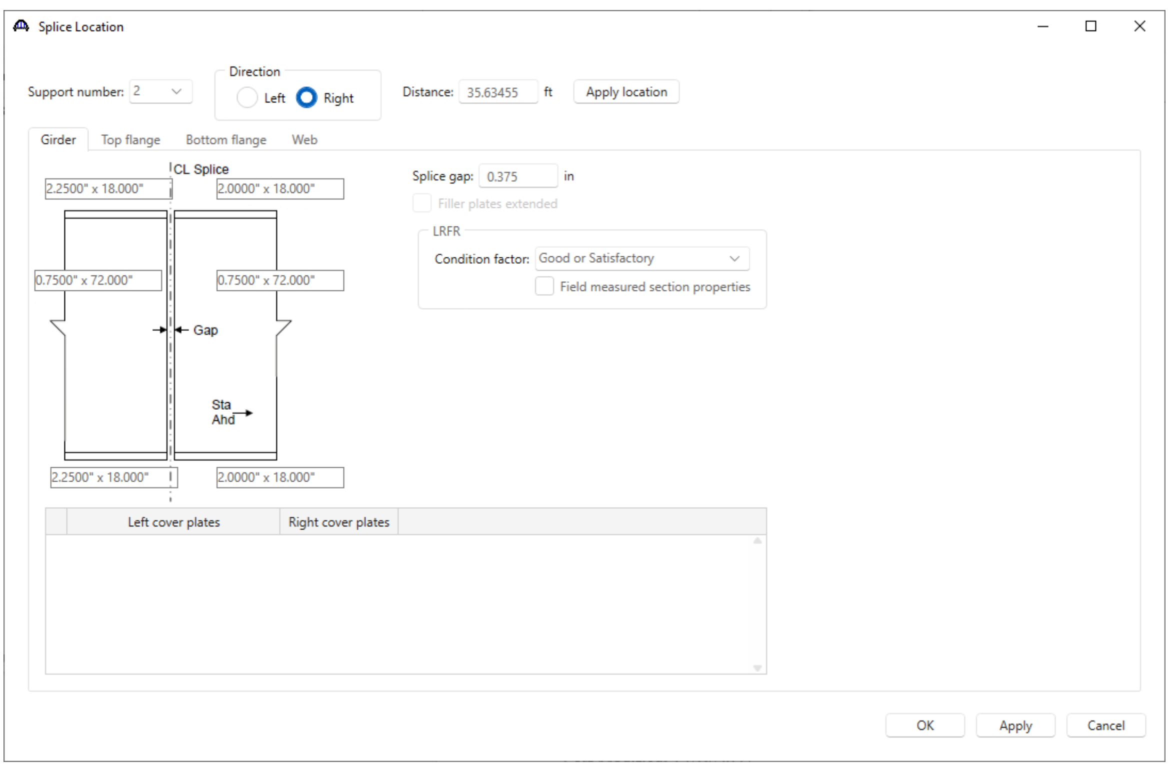

Splice Location
Support number: 2
Direction
Left
Right
Distance: 42.88145 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
Inner Plates
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
D2: 1.75 in
N1: 10
P1: 3 in
D3: 1.75 in
N2: 1
G1: 4 in
E1: 1.75 in
E2: 1.75 in
E3: 1.75 in
E4: 2.25 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.25 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

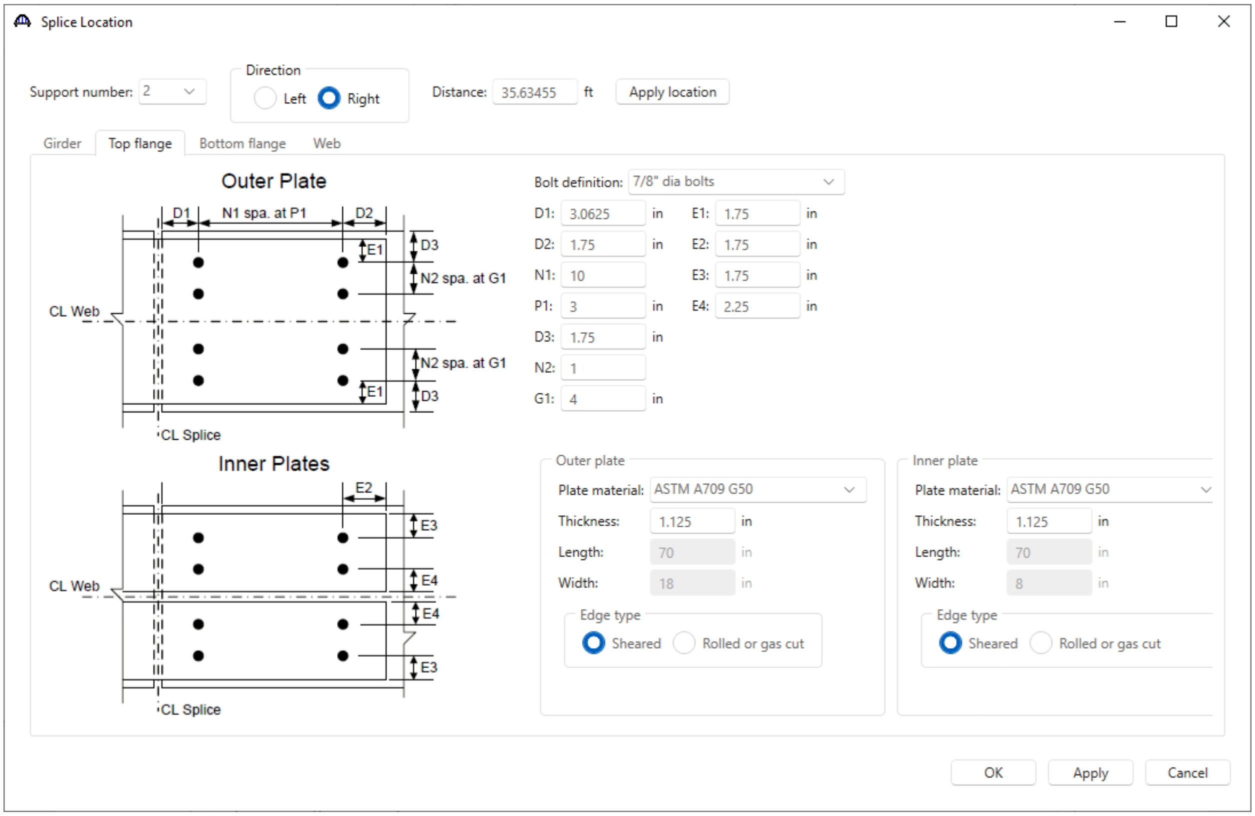

Splice Location
Support number: 2
Direction
Left
Right
Distance: 42.88145 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
Inner Plates
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
D2: 1.75 in
N1: 10
P1: 3 in
D3: 1.75 in
N2: 1
G1: 4 in
E1: 1.75 in
E2: 1.75 in
E3: 1.75 in
E4: 2.25 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

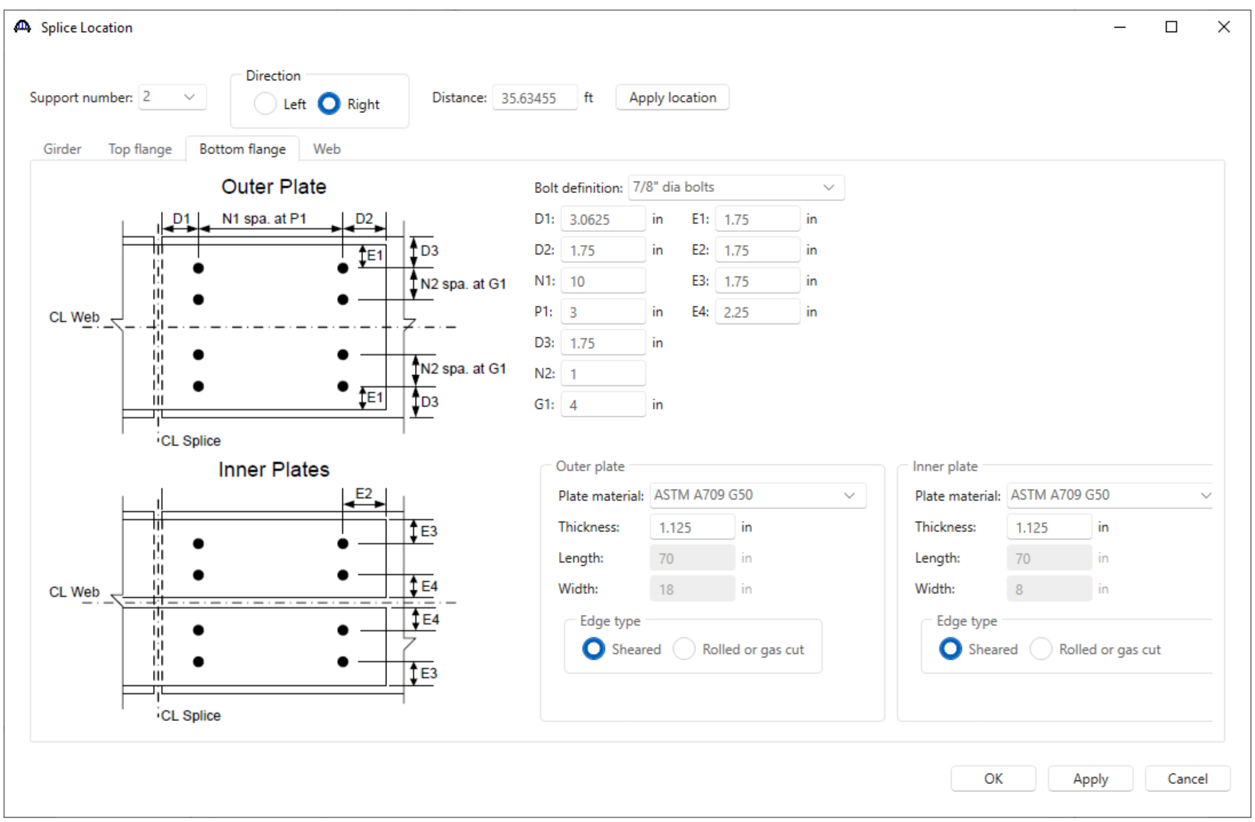


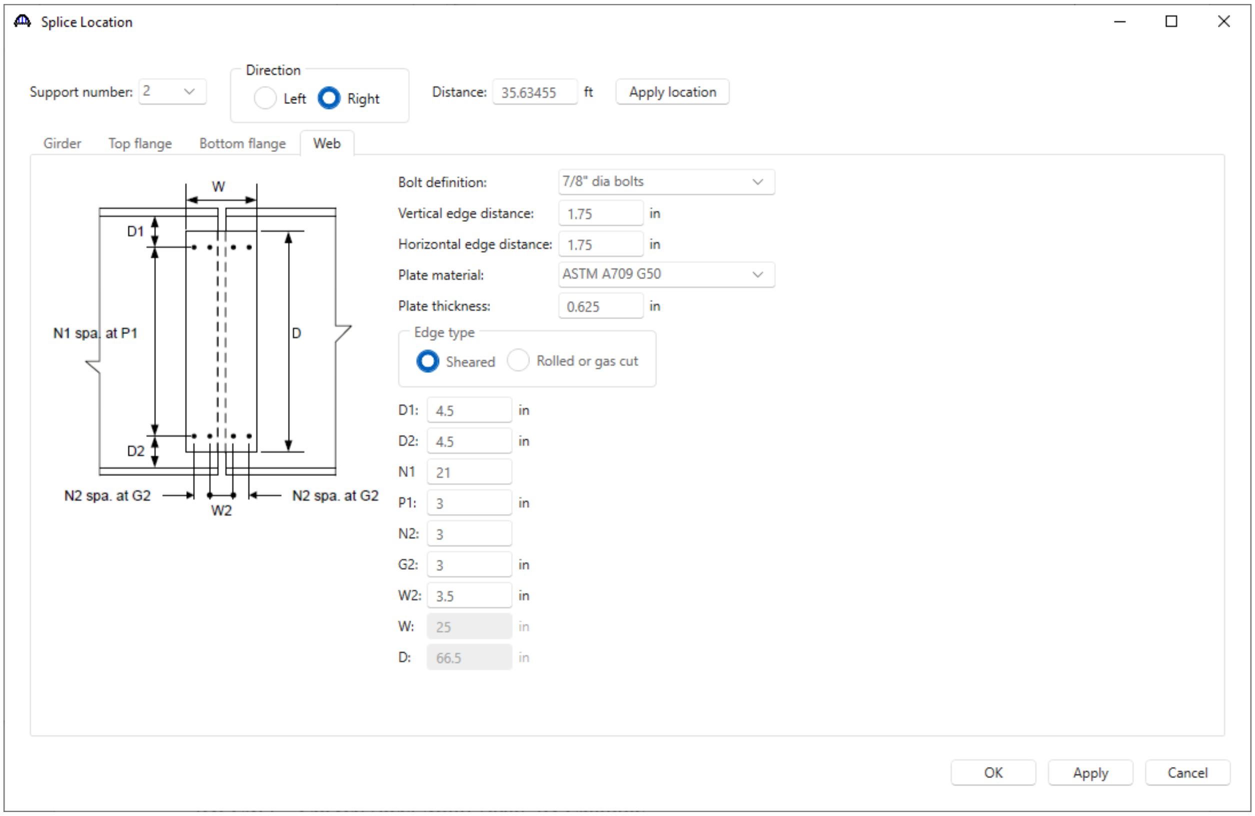
Add the following splice locations in similar manner.

Splice 2

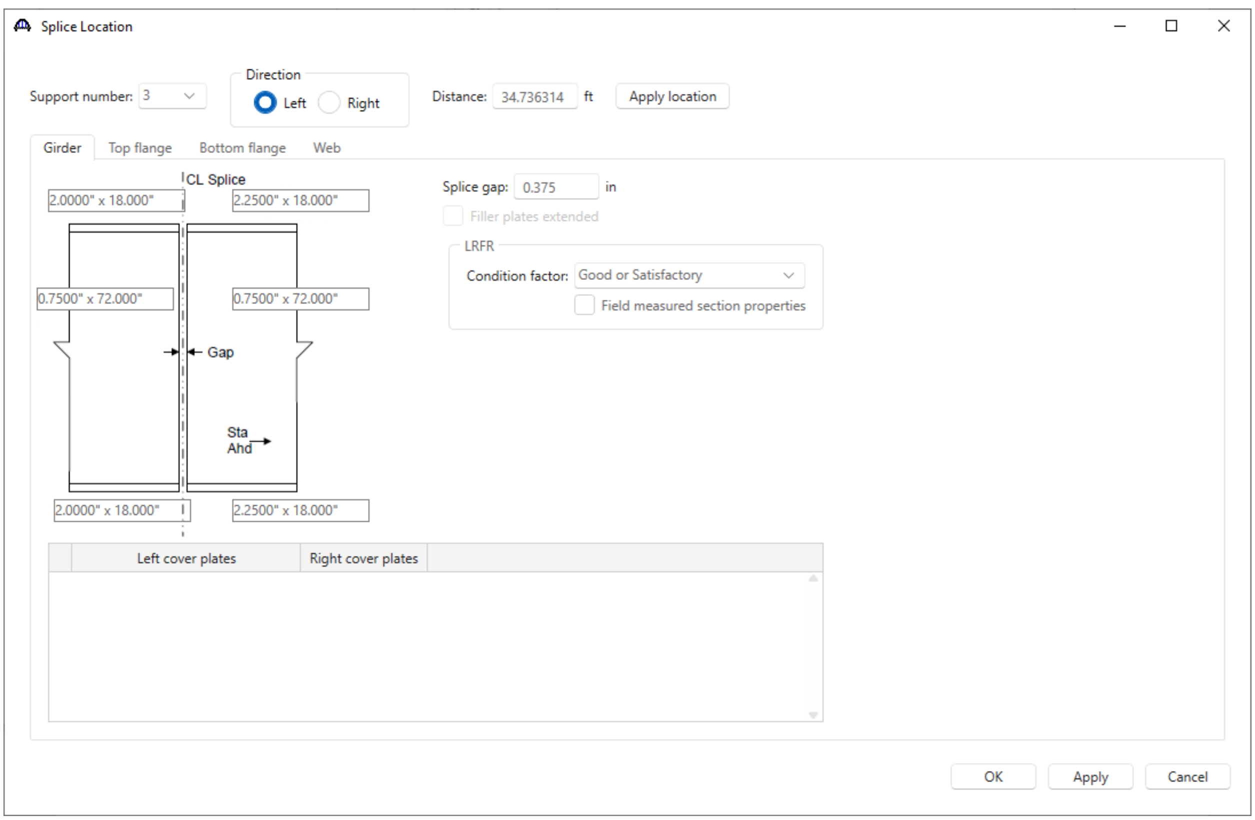


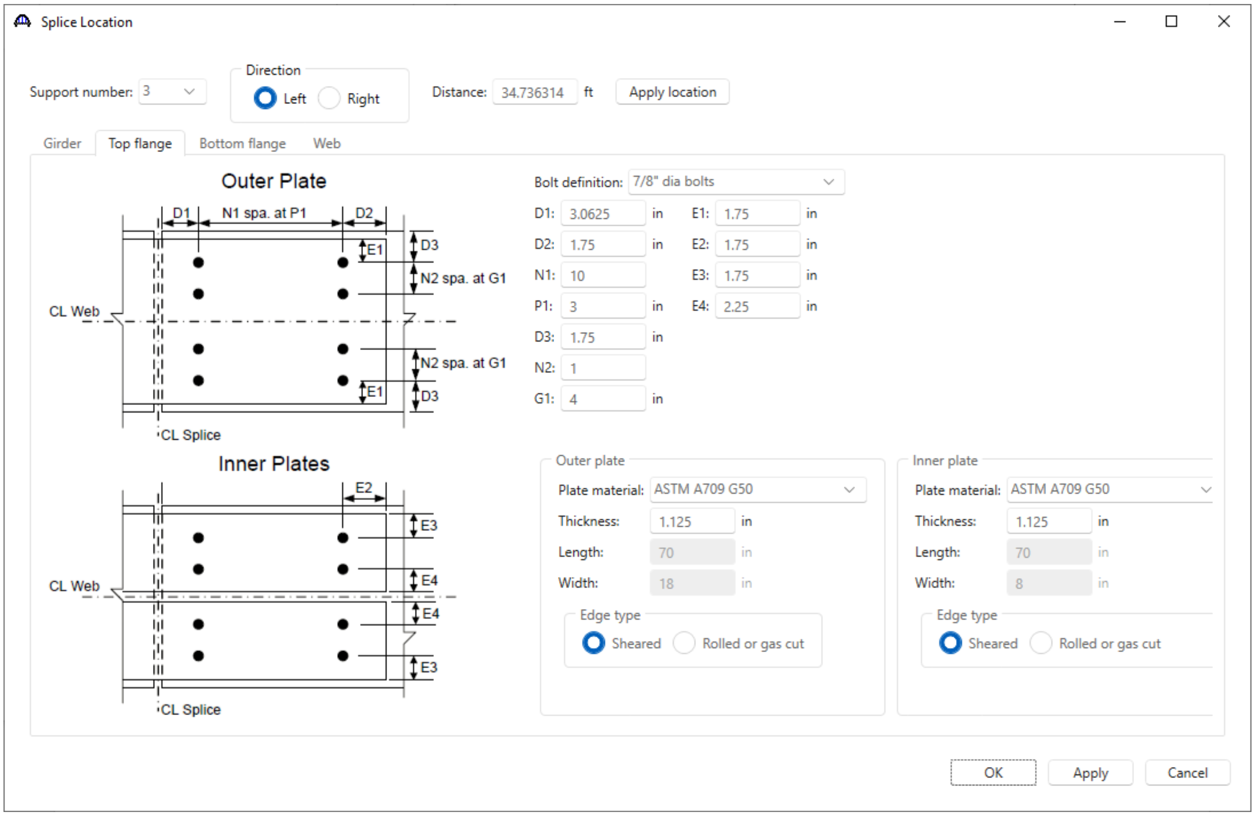

Splice Location
Support number: 2
Direction
Left
Right
Distance: 35.63455 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
D2: 1.75 in
N1: 10
P1: 3 in
D3: 1.75 in
N2: 1
G1: 4 in
E1: 1.75 in
E2: 1.75 in
E3: 1.75 in
E4: 2.25 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

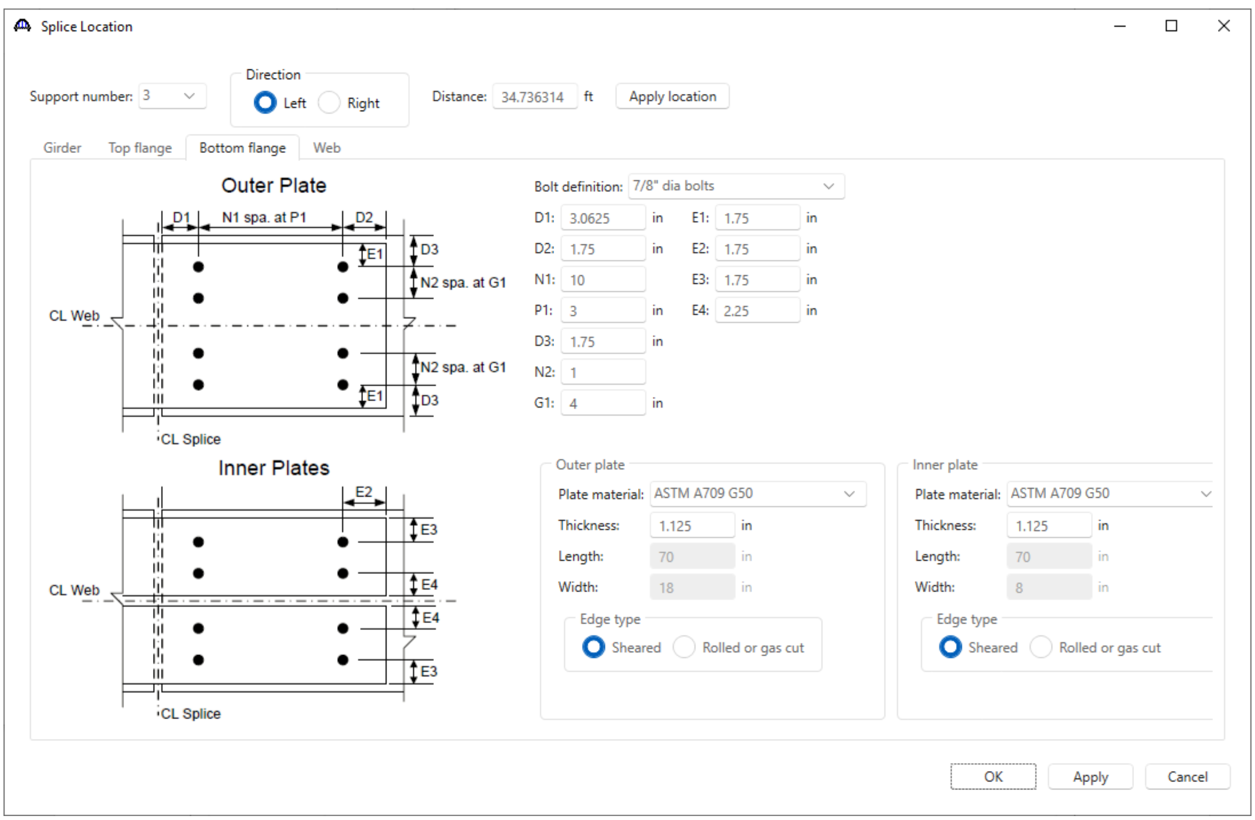

Splice Location
Support number: 2
Direction
Left
Right
Distance: 35.63455 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
D2: 1.75 in
N1: 10
P1: 3 in
D3: 1.75 in
N2: 1
G1: 4 in
E1: 1.75 in
E2: 1.75 in
E3: 1.75 in
E4: 2.25 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

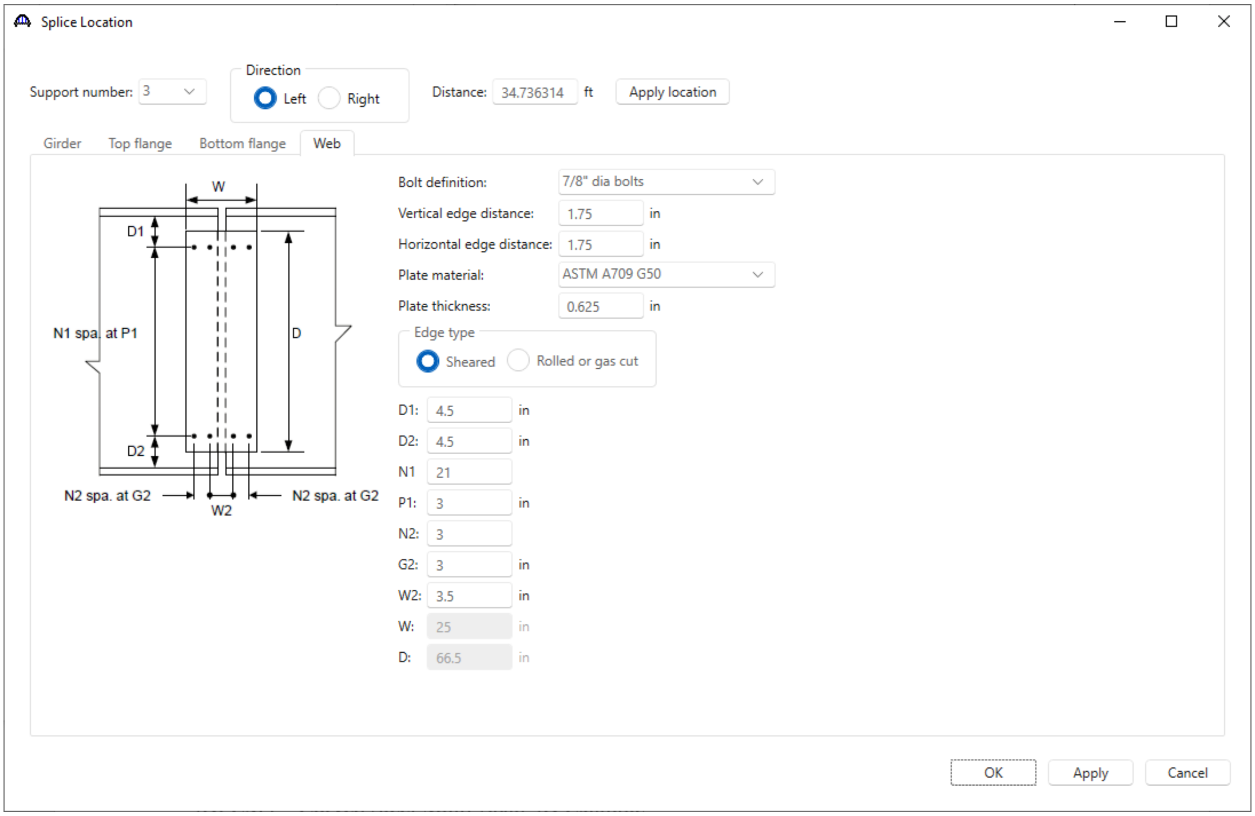

Splice Location
Support number: 2
Direction
Left
Right
Distance: 35.63455 ft
Apply location
Girder
Top flange
Bottom flange
Web
W
D1
N1 spa. at P1
D
D2
N2 spa. at G2
W2
N2 spa. at G2
Bolt definition: 7/8" dia bolts
Vertical edge distance: 1.75 in
Horizontal edge distance: 1.75 in
Plate material: ASTM A709 G50
Plate thickness: 0.625 in
Edge type
Sheared
Rolled or gas cut
D1: 4.5 in
D2: 4.5 in
N1 21
P1: 3 in
N2: 3
G2: 3 in
W2: 3.5 in
W: 25 in
D: 66.5 in
OK
Apply
Cancel

Splice 3

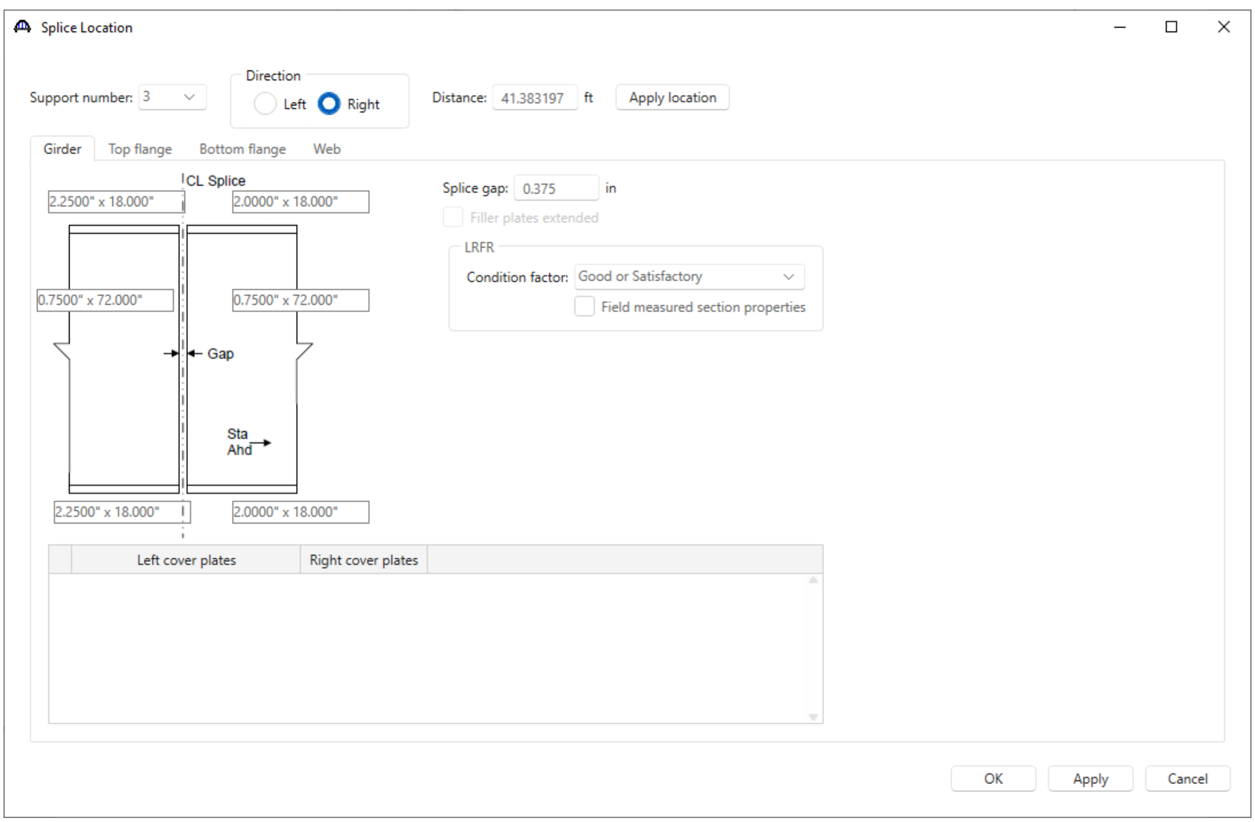

Splice Location
Support number: 3
Direction
Left
Right
Distance: 34.736314 ft
Apply location
Girder
Top flange
Bottom flange
Web
CL Splice
2.0000" x 18.000"
2.2500" x 18.000"
0.7500" x 72.000"
0.7500" x 72.000"
Gap
Sta Ahd
2.0000" x 18.000"
2.2500" x 18.000"
Splice gap: 0.375 in
Filler plates extended
LRFR
Condition factor: Good or Satisfactory
Field measured section properties
Left cover plates
Right cover plates
OK
Apply
Cancel

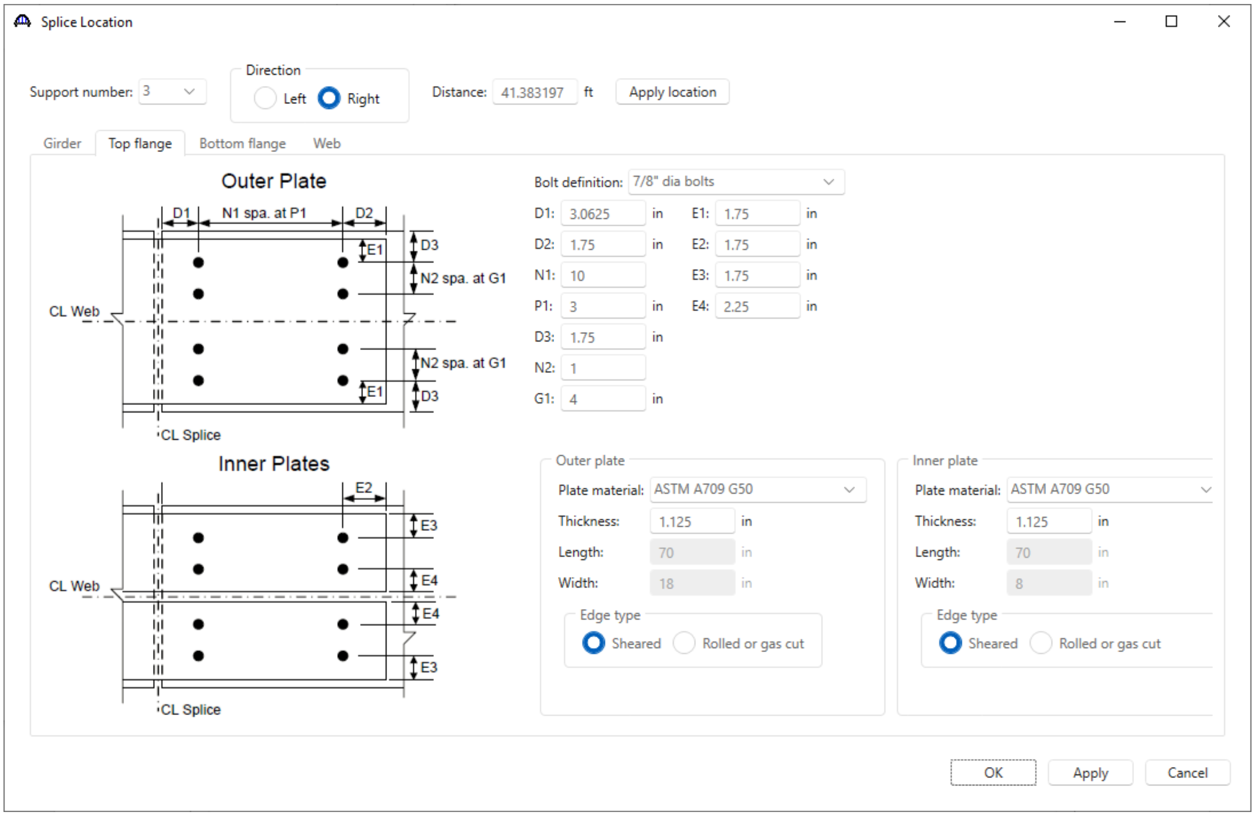

Splice Location
Support number: 3
Direction
Left
Right
Distance: 34.736314 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
E1: 1.75 in
D2: 1.75 in
E2: 1.75 in
N1: 10
E3: 1.75 in
P1: 3 in
E4: 2.25 in
D3: 1.75 in
N2: 1
G1: 4 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

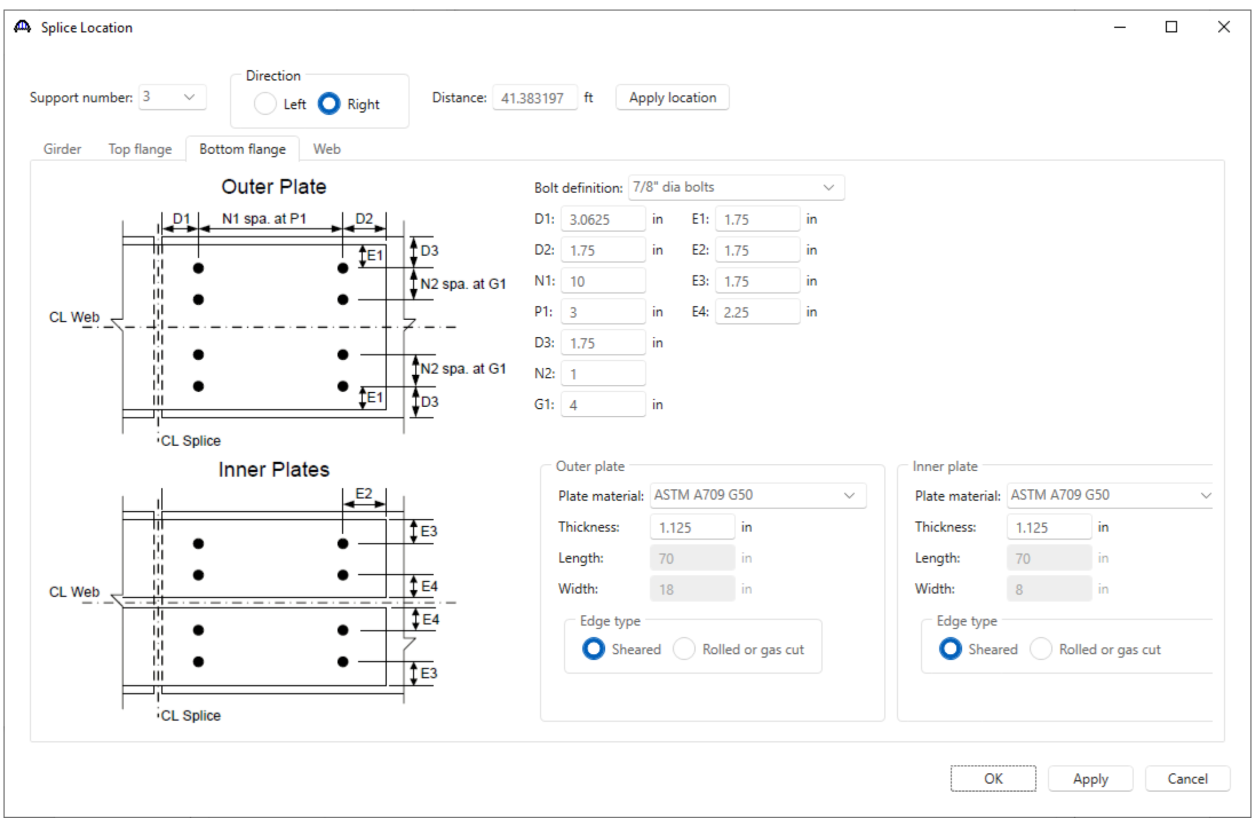

Splice Location
Support number: 3
Direction
Left
Right
Distance: 34.736314 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
E1: 1.75 in
D2: 1.75 in
E2: 1.75 in
N1: 10
E3: 1.75 in
P1: 3 in
E4: 2.25 in
D3: 1.75 in
N2: 1
G1: 4 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

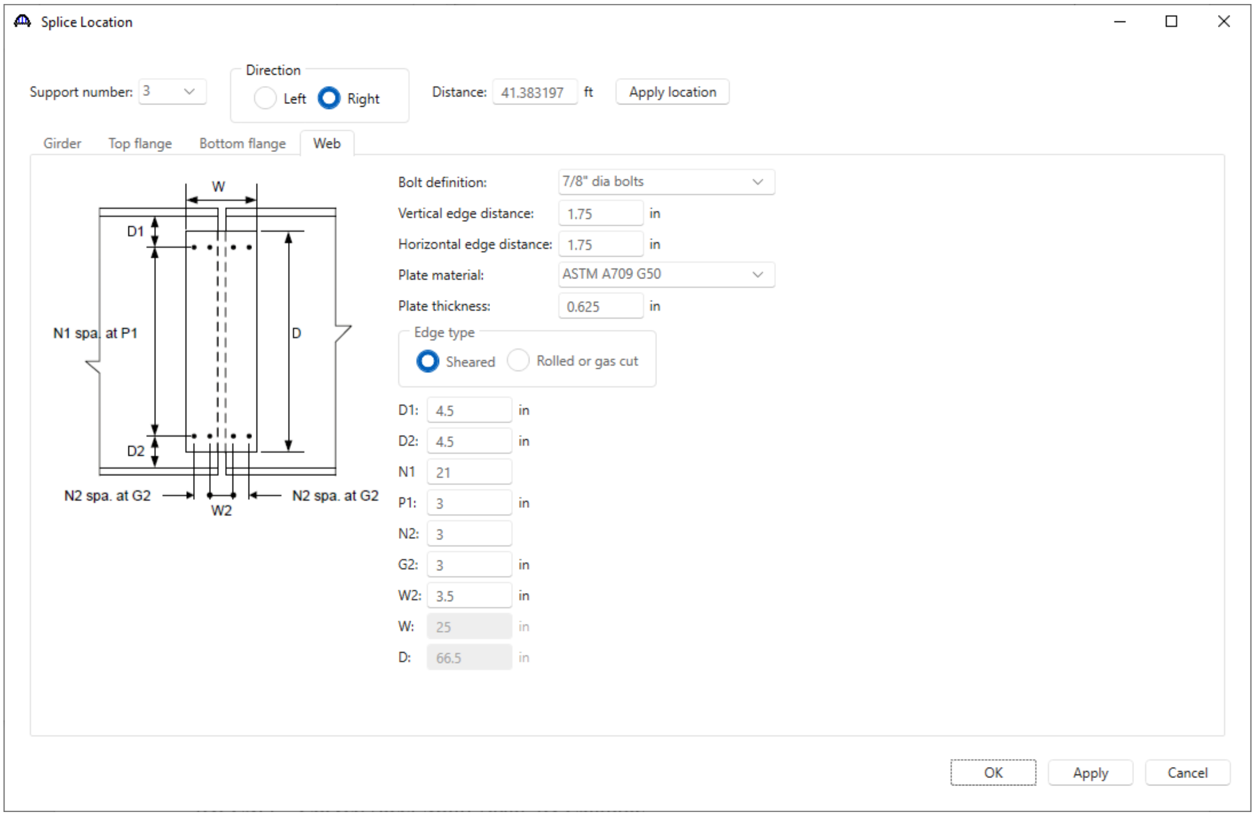

Splice Location
Support number: 3
Direction
Left
Right
Distance: 34.736314 ft
Apply location
Girder
Top flange
Bottom flange
Web
Bolt definition: 7/8" dia bolts
Vertical edge distance: 1.75 in
Horizontal edge distance: 1.75 in
Plate material: ASTM A709 G50
Plate thickness: 0.625 in
Edge type
Sheared
Rolled or gas cut
D1: 4.5 in
D2: 4.5 in
N1 21
P1: 3 in
N2: 3
G2: 3 in
W2: 3.5 in
W: 25 in
D: 66.5 in
W
D1
N1 spa. at P1
D
D2
N2 spa. at G2
W2
N2 spa. at G2
OK
Apply
Cancel

Splice 4

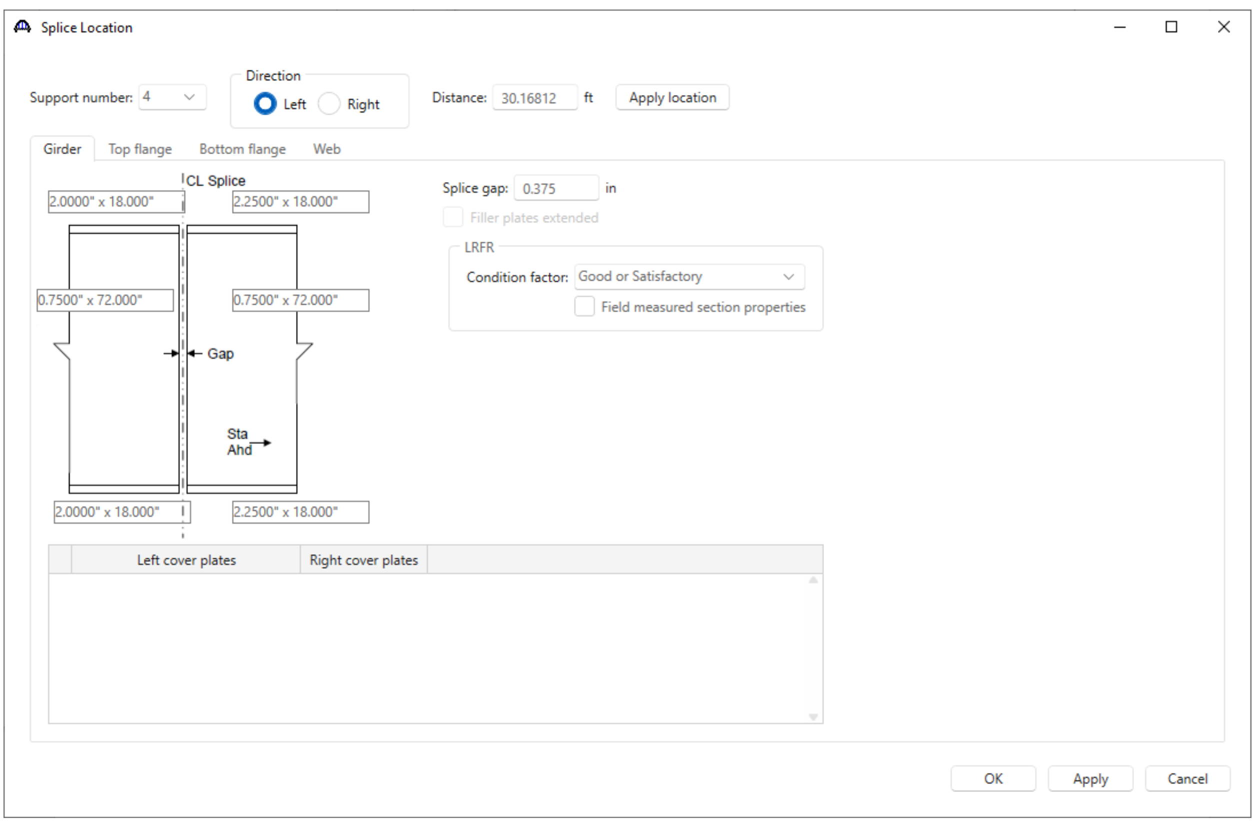

Splice Location
Support number: 3
Direction
Left
Right
Distance: 41.383197 ft
Apply location
Girder
Top flange
Bottom flange
Web
CL Splice
2.2500" x 18.000"
2.0000" x 18.000"
0.7500" x 72.000"
0.7500" x 72.000"
Gap
Sta Ahd
2.2500" x 18.000"
2.0000" x 18.000"
Splice gap: 0.375 in
Filler plates extended
LRFR
Condition factor: Good or Satisfactory
Field measured section properties
Left cover plates
Right cover plates
OK
Apply
Cancel

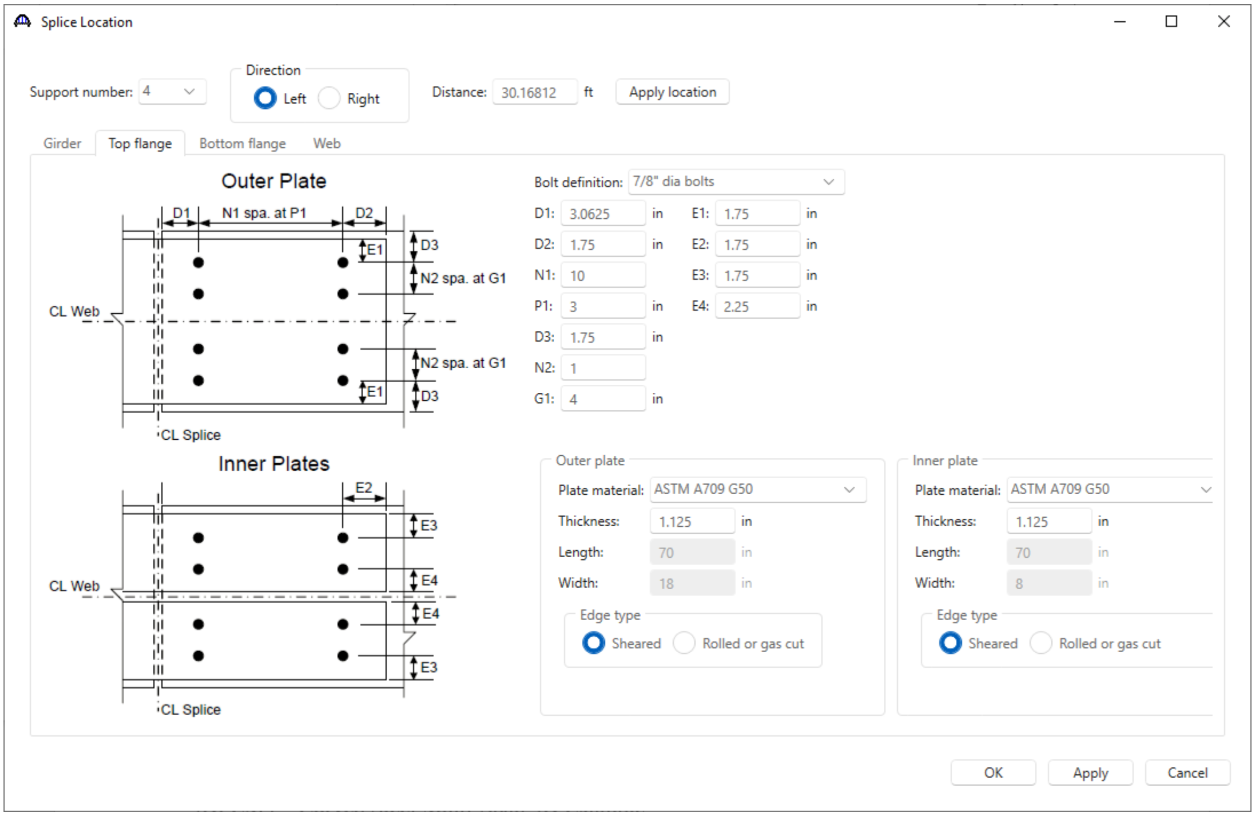

Splice Location
Support number: 3
Direction
Left
Right
Distance: 41.383197 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
D2: 1.75 in
N1: 10
P1: 3 in
D3: 1.75 in
N2: 1
G1: 4 in
E1: 1.75 in
E2: 1.75 in
E3: 1.75 in
E4: 2.25 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

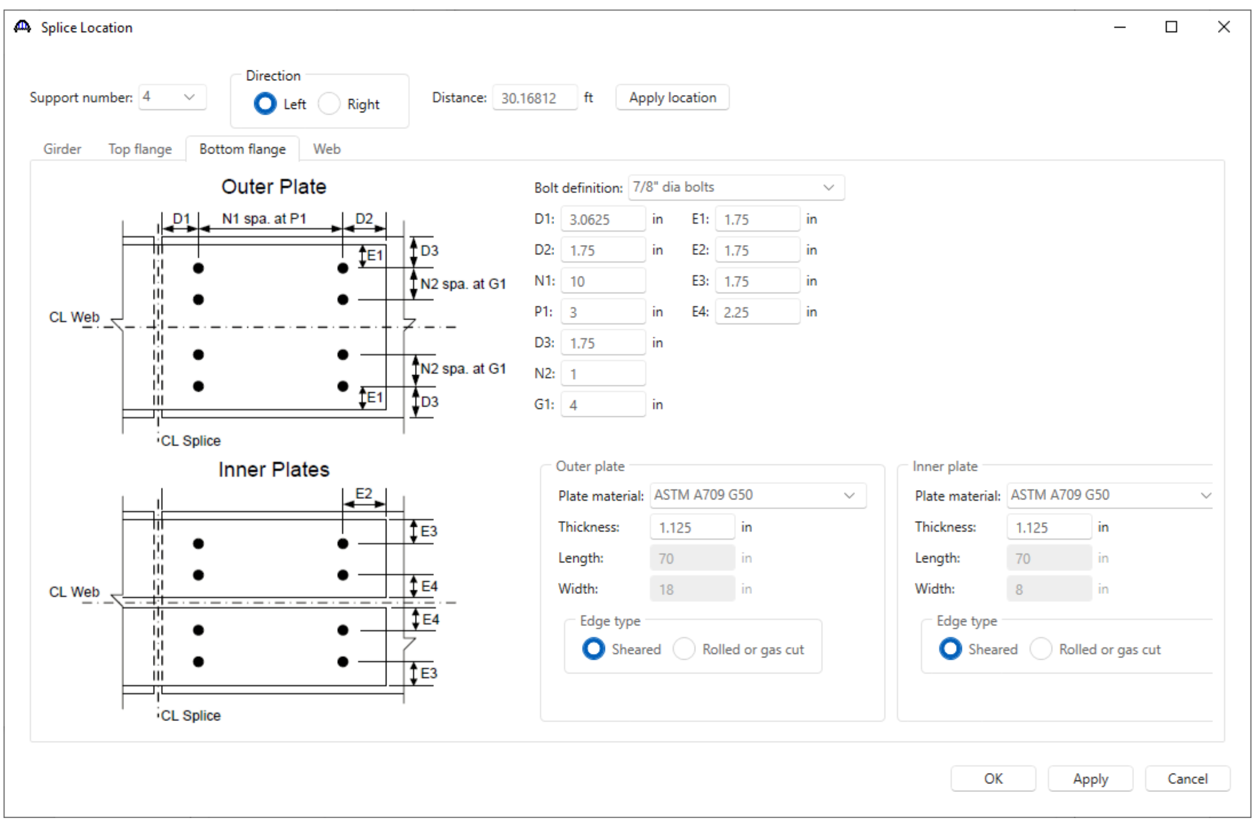

Splice Location
Support number: 3
Direction
Left
Right
Distance: 41.383197 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
D2: 1.75 in
N1: 10
P1: 3 in
D3: 1.75 in
N2: 1
G1: 4 in
E1: 1.75 in
E2: 1.75 in
E3: 1.75 in
E4: 2.25 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

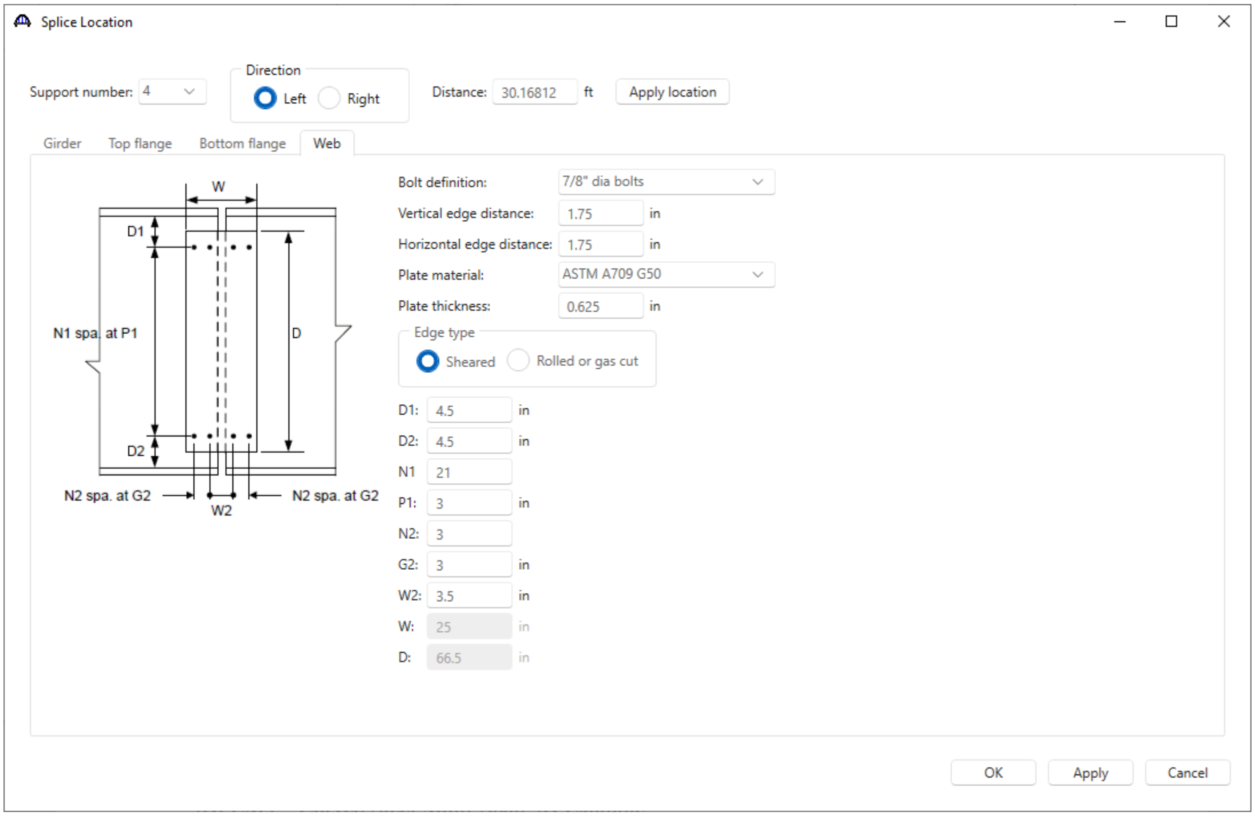

Splice Location
Support number: 3
Direction
Left
Right
Distance: 41.383197 ft
Apply location
Girder
Top flange
Bottom flange
Web
Bolt definition: 7/8" dia bolts
Vertical edge distance: 1.75 in
Horizontal edge distance: 1.75 in
Plate material: ASTM A709 G50
Plate thickness: 0.625 in
Edge type
Sheared
Rolled or gas cut
D1: 4.5 in
D2: 4.5 in
N1 21
P1: 3 in
N2: 3
G2: 3 in
W2: 3.5 in
W: 25 in
D: 66.5 in
W
D1
N1 spa. at P1
D
D2
N2 spa. at G2
W2
N2 spa. at G2
OK
Apply
Cancel

Splice 5

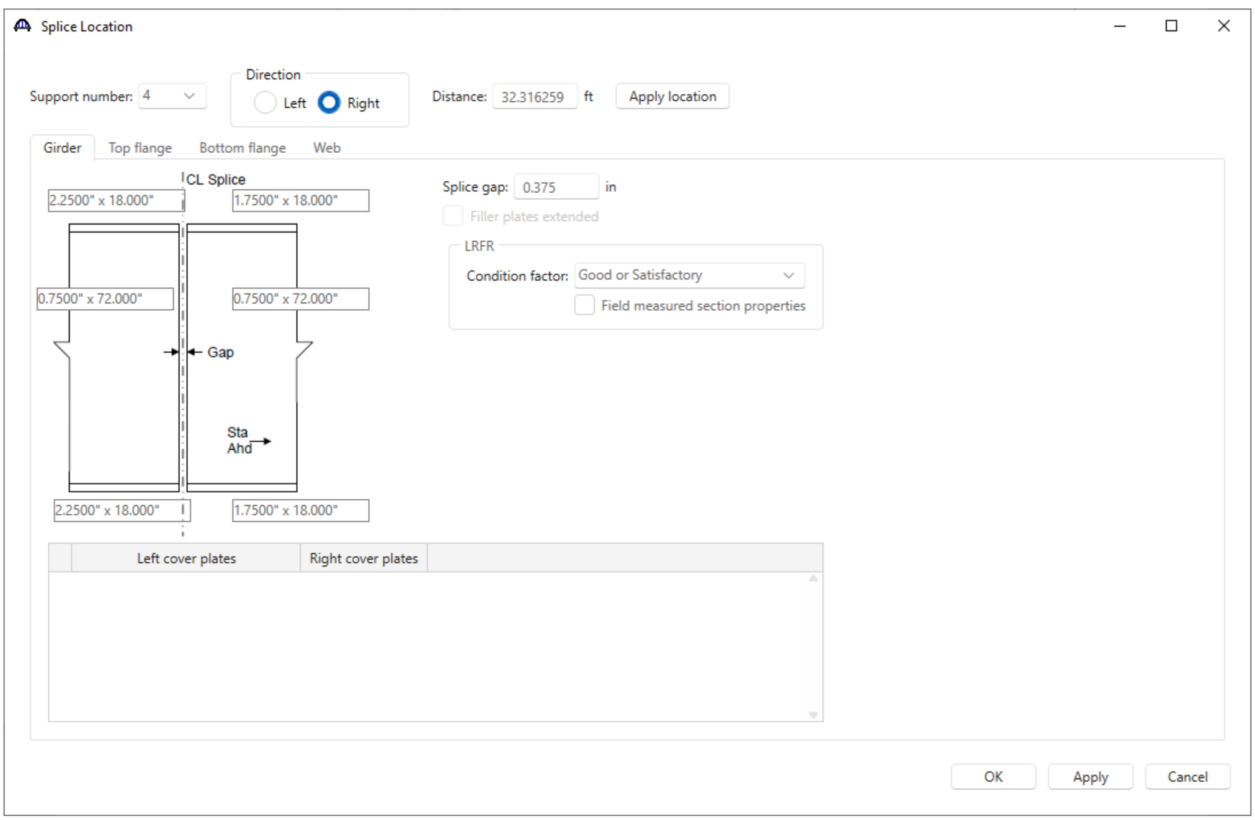

Splice Location
Support number: 4
Direction
Left
Right
Distance: 30.16812 ft
Apply location
Girder
Top flange
Bottom flange
Web
CL Splice
2.0000" x 18.000"
2.2500" x 18.000"
0.7500" x 72.000"
0.7500" x 72.000"
Gap
Sta Ahd
2.0000" x 18.000"
2.2500" x 18.000"
Splice gap: 0.375 in
Filler plates extended
LRFR
Condition factor: Good or Satisfactory
Field measured section properties
Left cover plates
Right cover plates
OK
Apply
Cancel

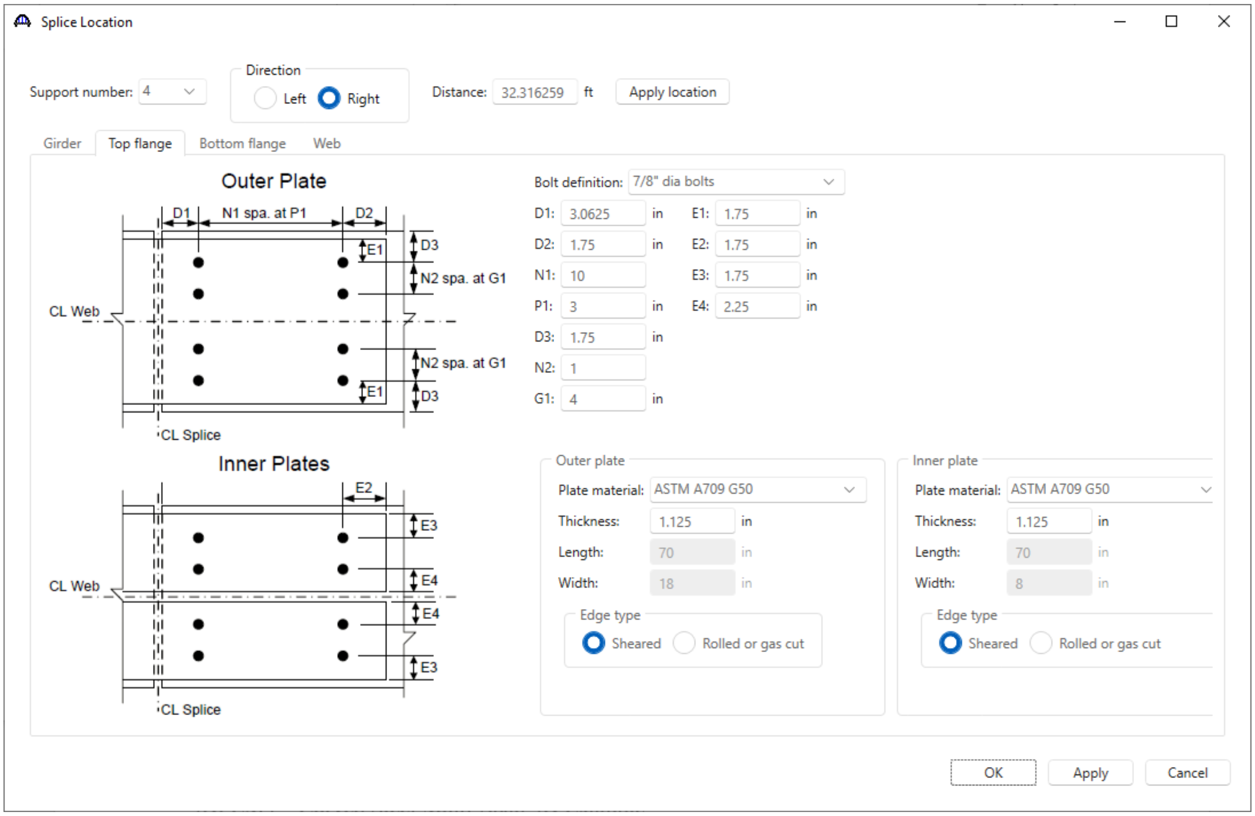

Splice Location
Support number: 4
Direction
Left
Right
Distance: 30.16812 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
D2: 1.75 in
N1: 10
P1: 3 in
D3: 1.75 in
N2: 1
G1: 4 in
E1: 1.75 in
E2: 1.75 in
E3: 1.75 in
E4: 2.25 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

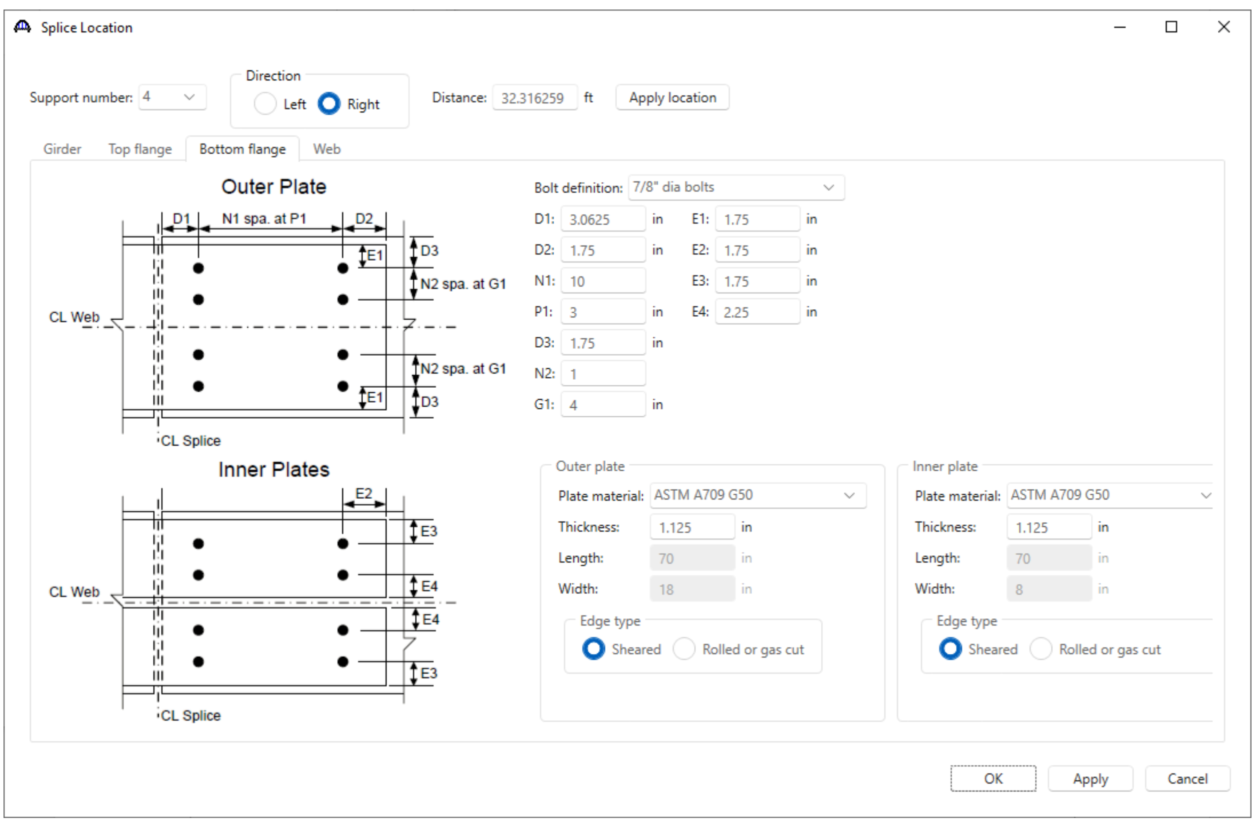

Splice Location
Support number: 4
Direction
Left
Right
Distance: 30.16812 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
D2: 1.75 in
N1: 10
P1: 3 in
D3: 1.75 in
N2: 1
G1: 4 in
E1: 1.75 in
E2: 1.75 in
E3: 1.75 in
E4: 2.25 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

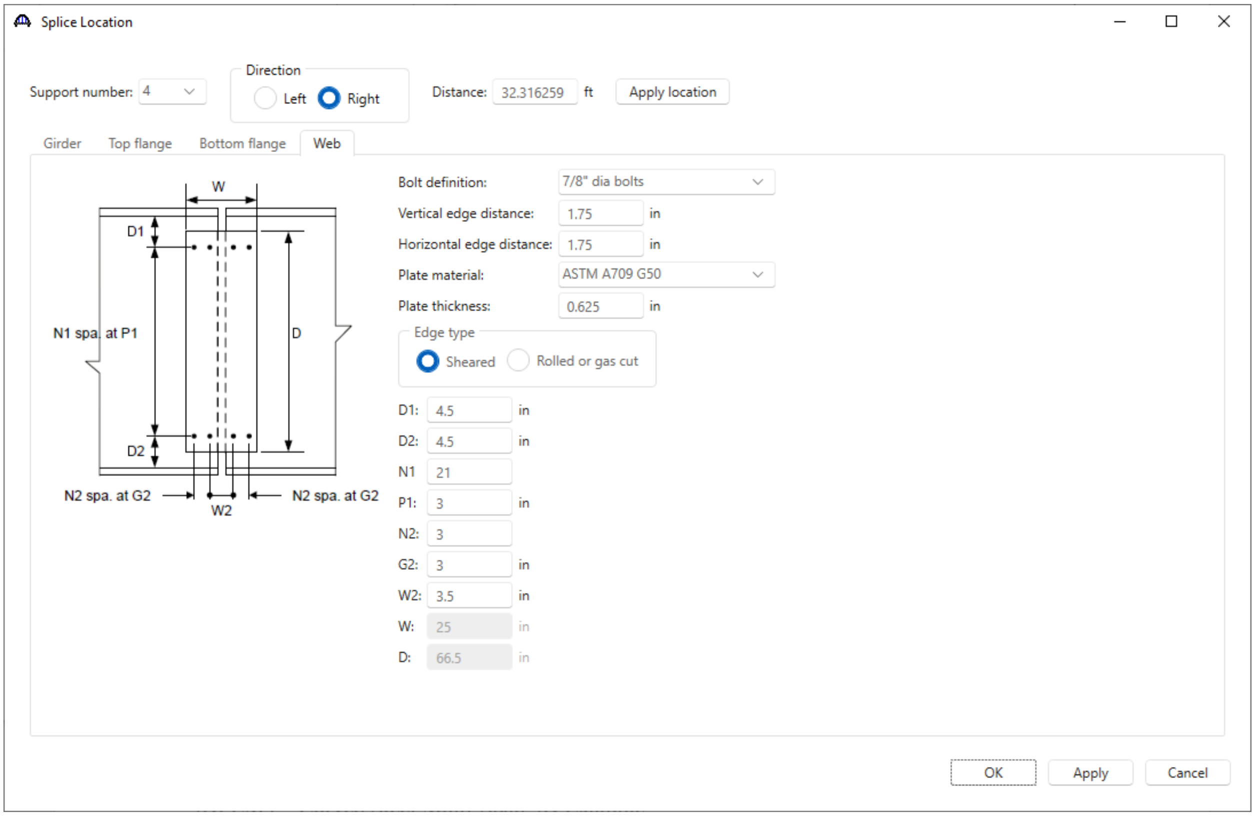

Splice Location
Support number: 4
Direction
Left
Right
Distance: 30.16812 ft
Apply location
Girder
Top flange
Bottom flange
Web
W
D1
N1 spa. at P1
D
D2
N2 spa. at G2
W2
N2 spa. at G2
Bolt definition: 7/8" dia bolts
Vertical edge distance: 1.75 in
Horizontal edge distance: 1.75 in
Plate material: ASTM A709 G50
Plate thickness: 0.625 in
Edge type
Sheared
Rolled or gas cut
D1: 4.5 in
D2: 4.5 in
N1 21
P1: 3 in
N2: 3
G2: 3 in
W2: 3.5 in
W: 25 in
D: 66.5 in
OK
Apply
Cancel

Splice 6

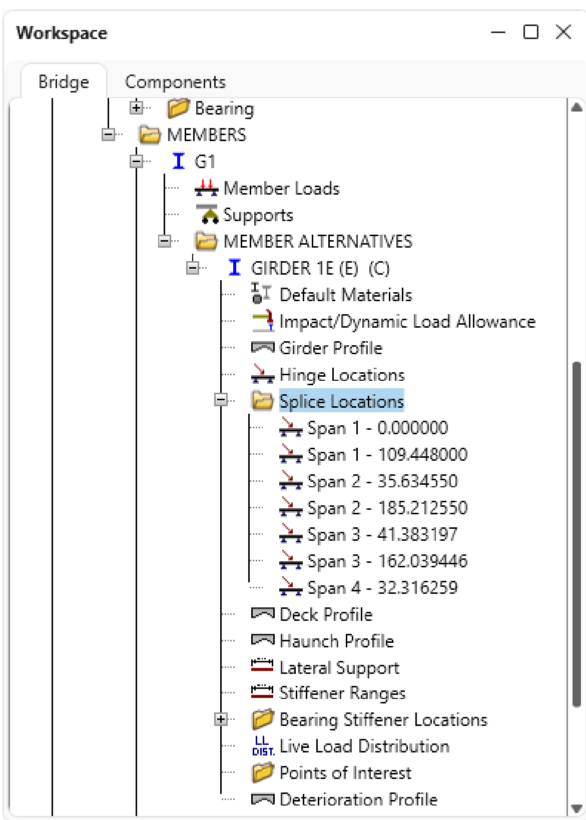

Splice Location
Support number: 4
Direction
Left
Right
Distance: 32.316259 ft
Apply location
Girder
Top flange
Bottom flange
Web
CL Splice
2.2500" x 18.000"
1.7500" x 18.000"
0.7500" x 72.000"
0.7500" x 72.000"
Gap
Sta
Ahd
2.2500" x 18.000"
1.7500" x 18.000"
Splice gap: 0.375 in
Filler plates extended
LRFR
Condition factor: Good or Satisfactory
Field measured section properties
Left cover plates
Right cover plates
OK
Apply
Cancel


Splice Location
Support number: 4
Direction
Left
Right
Distance: 32.316259 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
E1: 1.75 in
D2: 1.75 in
E2: 1.75 in
N1: 10
E3: 1.75 in
P1: 3 in
E4: 2.25 in
D3: 1.75 in
N2: 1
G1: 4 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel


Splice Location
Support number: 4
Direction
Left
Right
Distance: 32.316259 ft
Apply location
Girder
Top flange
Bottom flange
Web
Outer Plate
D1
N1 spa. at P1
D2
E1
D3
N2 spa. at G1
CL Web
CL Splice
Inner Plates
E2
E3
E4
Bolt definition: 7/8" dia bolts
D1: 3.0625 in
E1: 1.75 in
D2: 1.75 in
E2: 1.75 in
N1: 10
E3: 1.75 in
P1: 3 in
E4: 2.25 in
D3: 1.75 in
N2: 1
G1: 4 in
Outer plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 18 in
Edge type
Sheared
Rolled or gas cut
Inner plate
Plate material: ASTM A709 G50
Thickness: 1.125 in
Length: 70 in
Width: 8 in
Edge type
Sheared
Rolled or gas cut
OK
Apply
Cancel

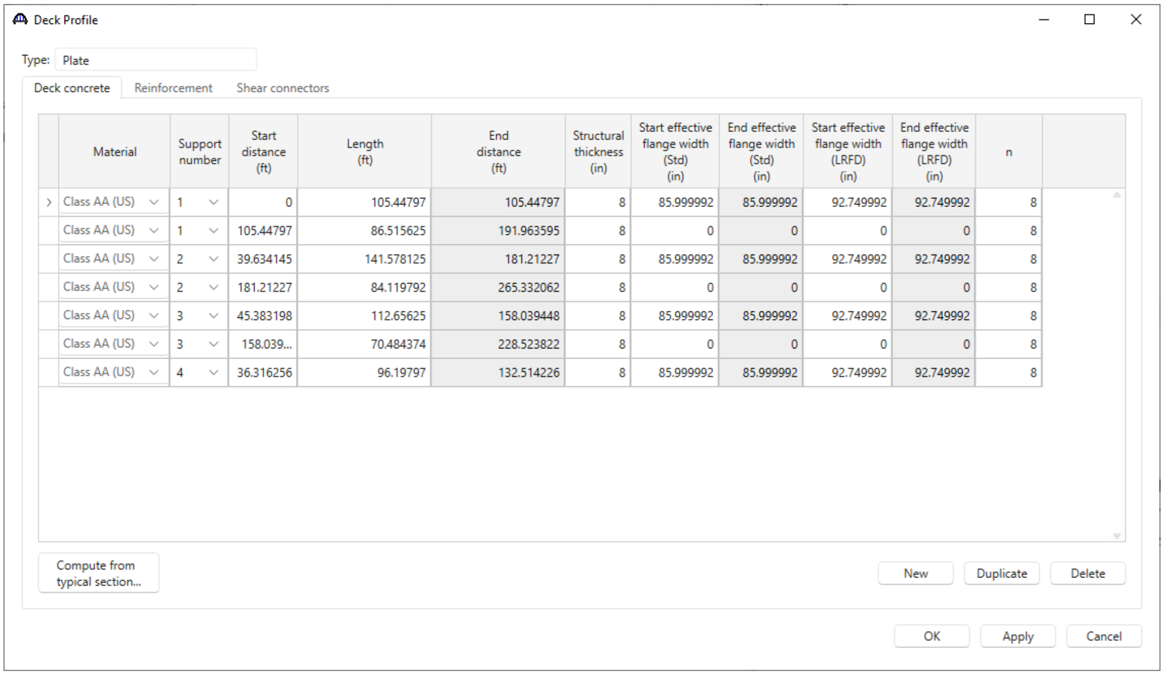


The added splice locations are shown below.



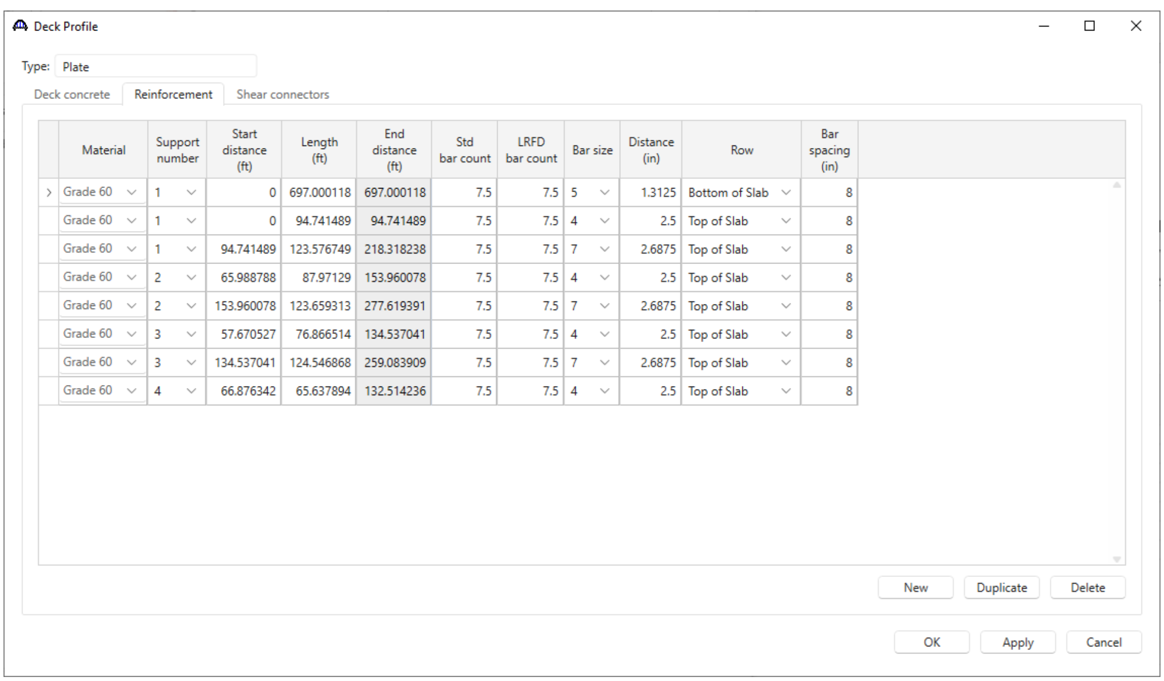
Deck Profile

Double click on the **Deck Profile** node in the **BWS** tree and enter the data describing the structural properties of the deck. Clicking on the **Compute from typical section…** button computes the effective flange widths populate automatically. For this example, enter the details as shown below. The **Structural thickness** has ¼' deducted from the **Total deck thickness** (as entered in the **Structure Typical Section** window -> **Deck (cont'd)** tab) to account for an integral wearing surface.



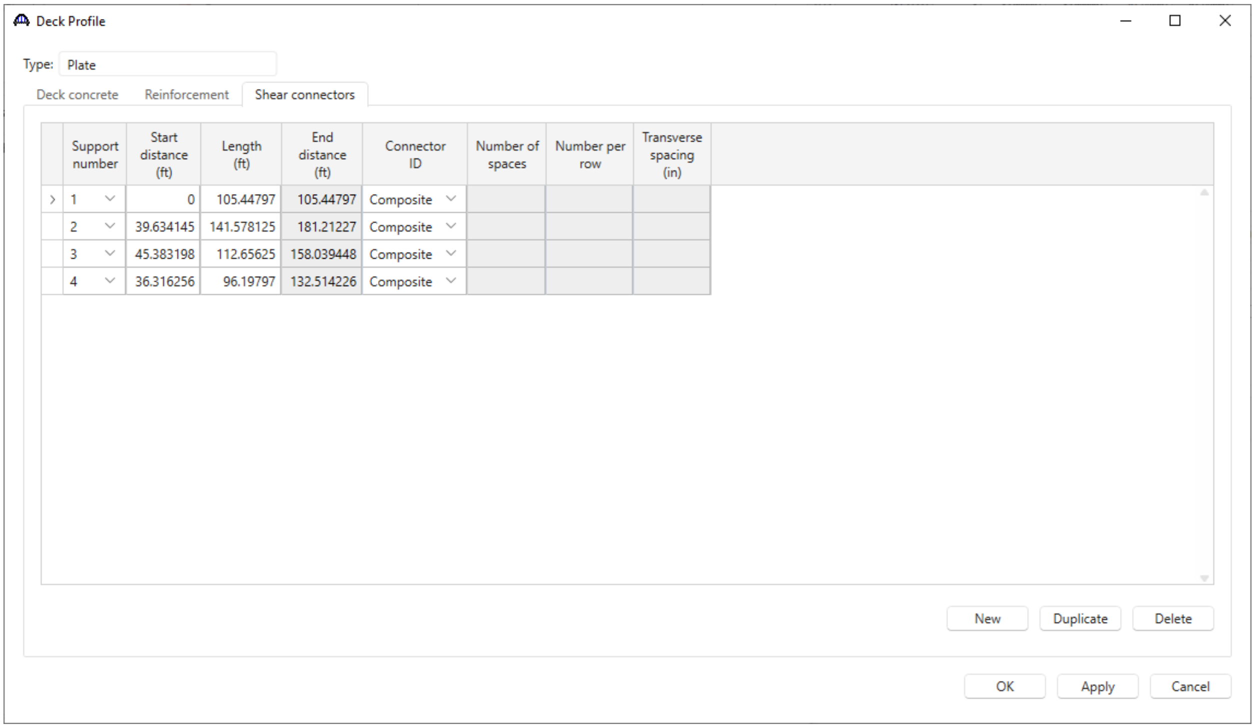
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	105.44797	105.44797	8	85.999992	85.999992	92.749992	92.749992	8
Class AA (US)	1	105.44797	86.515625	191.963595	8	0	0	0	0	8
Class AA (US)	2	39.634145	141.578125	181.21227	8	85.999992	85.999992	92.749992	92.749992	8
Class AA (US)	2	181.21227	84.119792	265.332062	8	0	0	0	0	8
Class AA (US)	3	45.383198	112.65625	158.039448	8	85.999992	85.999992	92.749992	92.749992	8
Class AA (US)	3	158.039...	70.484374	228.523822	8	0	0	0	0	8
Class AA (US)	4	36.316256	96.19797	132.514226	8	85.999992	85.999992	92.749992	92.749992	8

The reinforcement is defined on the **Reinforcement** tab of this window. Enter data as shown below.



Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	0	697.000118	697.000118	7.5	7.5	5	1.3125	Bottom of Slab	8
Grade 60	1	0	94.741489	94.741489	7.5	7.5	4	2.5	Top of Slab	8
Grade 60	1	94.741489	123.576749	218.318238	7.5	7.5	7	2.6875	Top of Slab	8
Grade 60	2	65.988788	87.97129	153.960078	7.5	7.5	4	2.5	Top of Slab	8
Grade 60	2	153.960078	123.659313	277.619391	7.5	7.5	7	2.6875	Top of Slab	8
Grade 60	3	57.670527	76.866514	134.537041	7.5	7.5	4	2.5	Top of Slab	8
Grade 60	3	134.537041	124.546868	259.083909	7.5	7.5	7	2.6875	Top of Slab	8
Grade 60	4	66.876342	65.637894	132.514236	7.5	7.5	4	2.5	Top of Slab	8

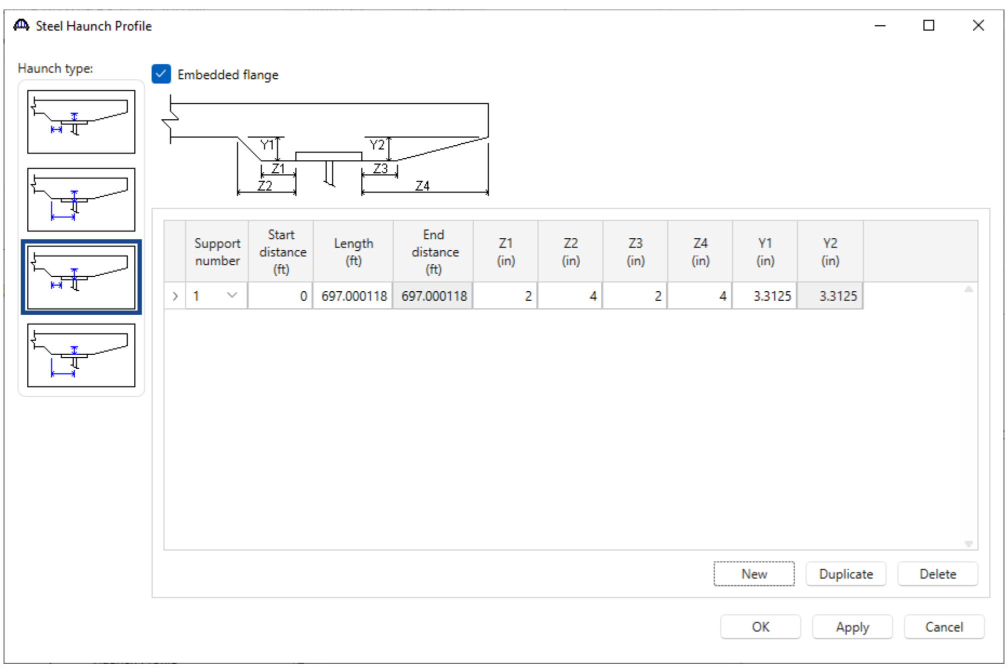
The **Shear connectors** tab of this window indicates if the bridge is composite. Enter the data as shown below.



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

Haunch Profile

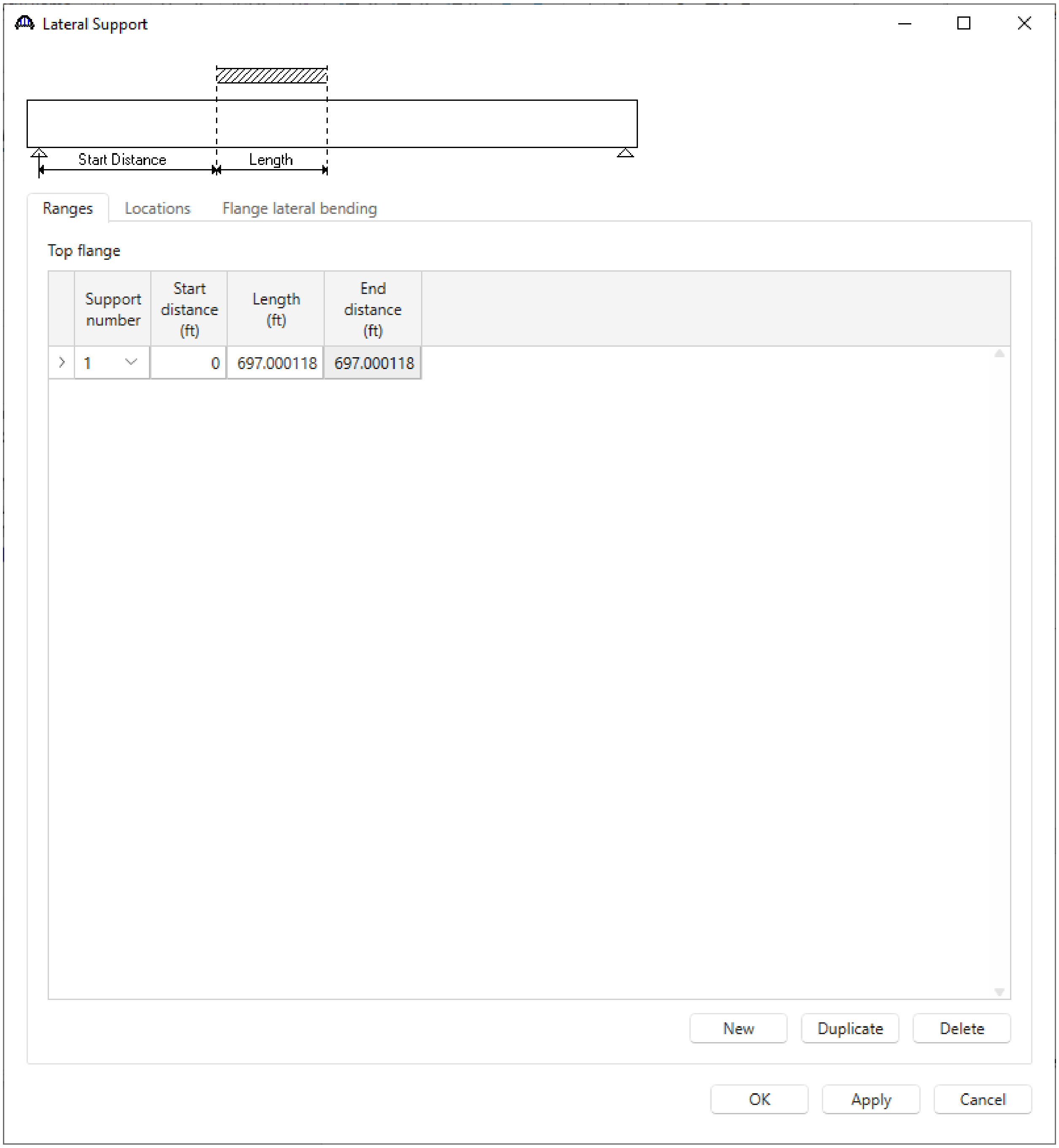
Double click on the **Haunch Profile** node from the BWS tree. The length can be found in the **Member** window. Enter the data as shown below.



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

Lateral Support

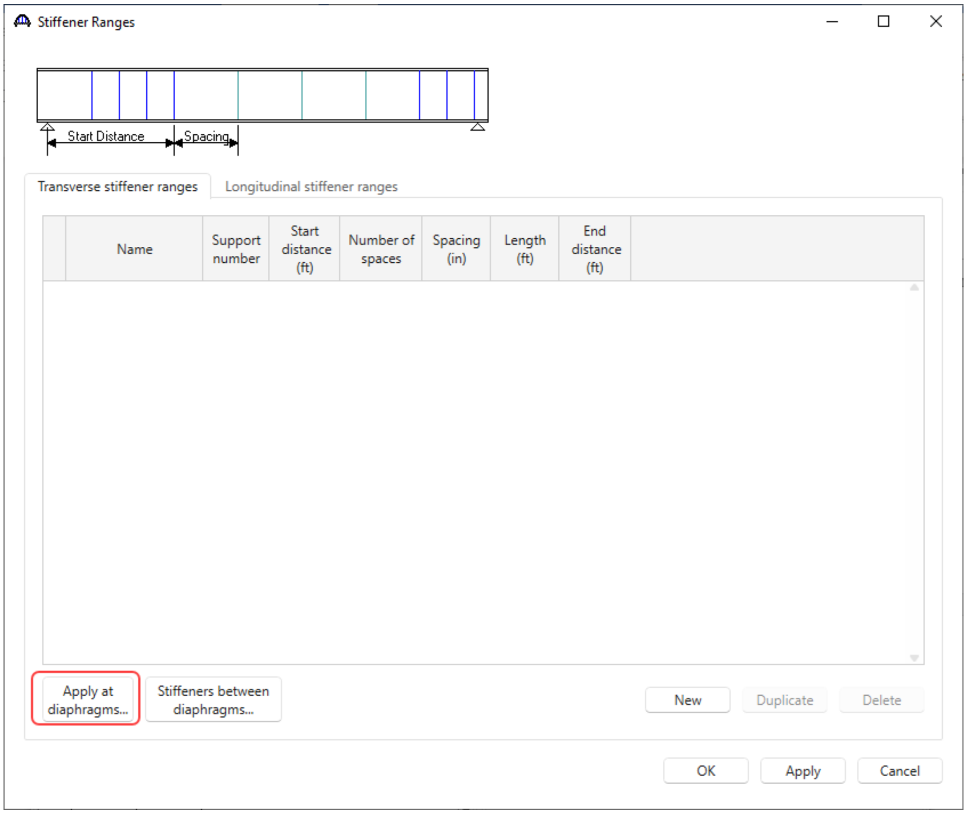
Double click on the **Lateral Support** node in the **BWS** tree to open the window. Enter the data as shown below.



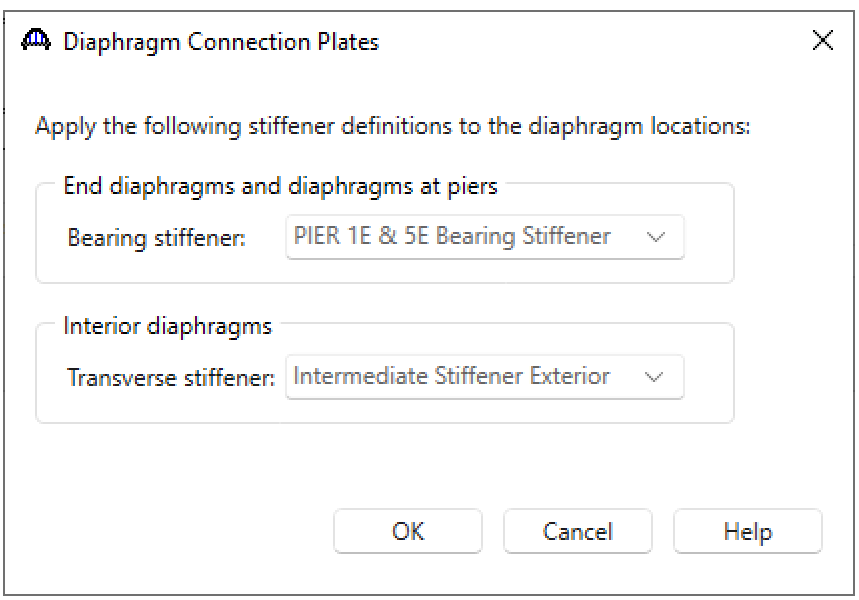
Click **OK** to apply the data and close the window.

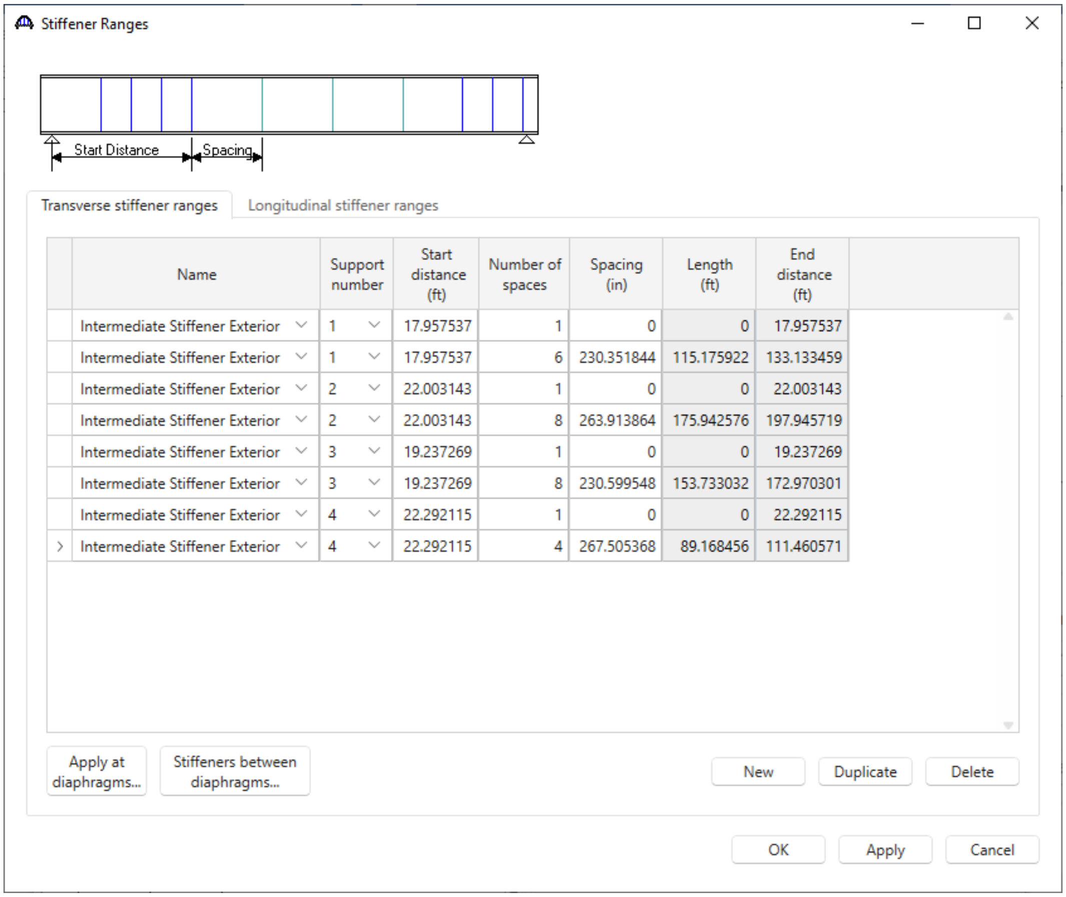
Stiffener Ranges

Double click on the **Stiffener Ranges** node in the **BWS** to open the window shown below. Click on the **Apply at diaphragms…** button.



Make the following selections and click **OK** to apply the data and close the window.

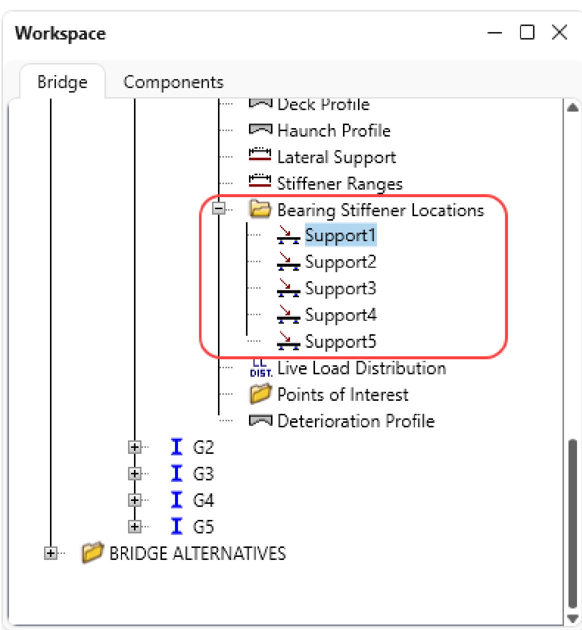




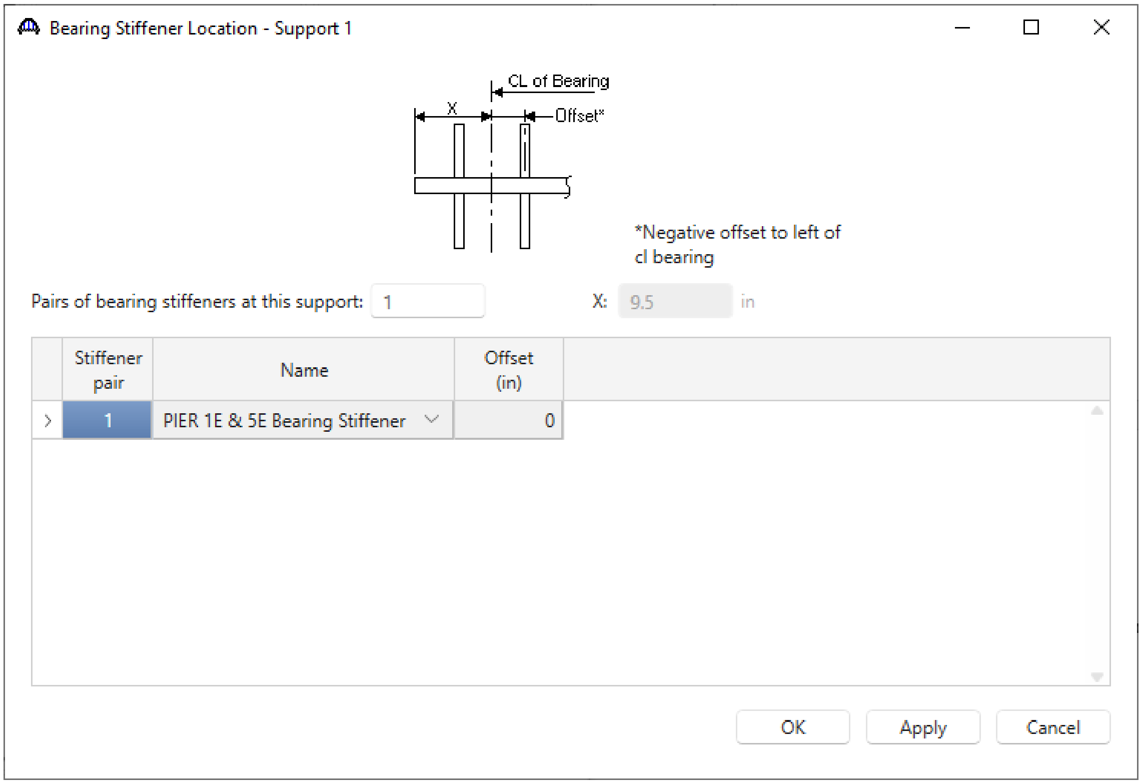
Click **OK** to apply the data and close the window.

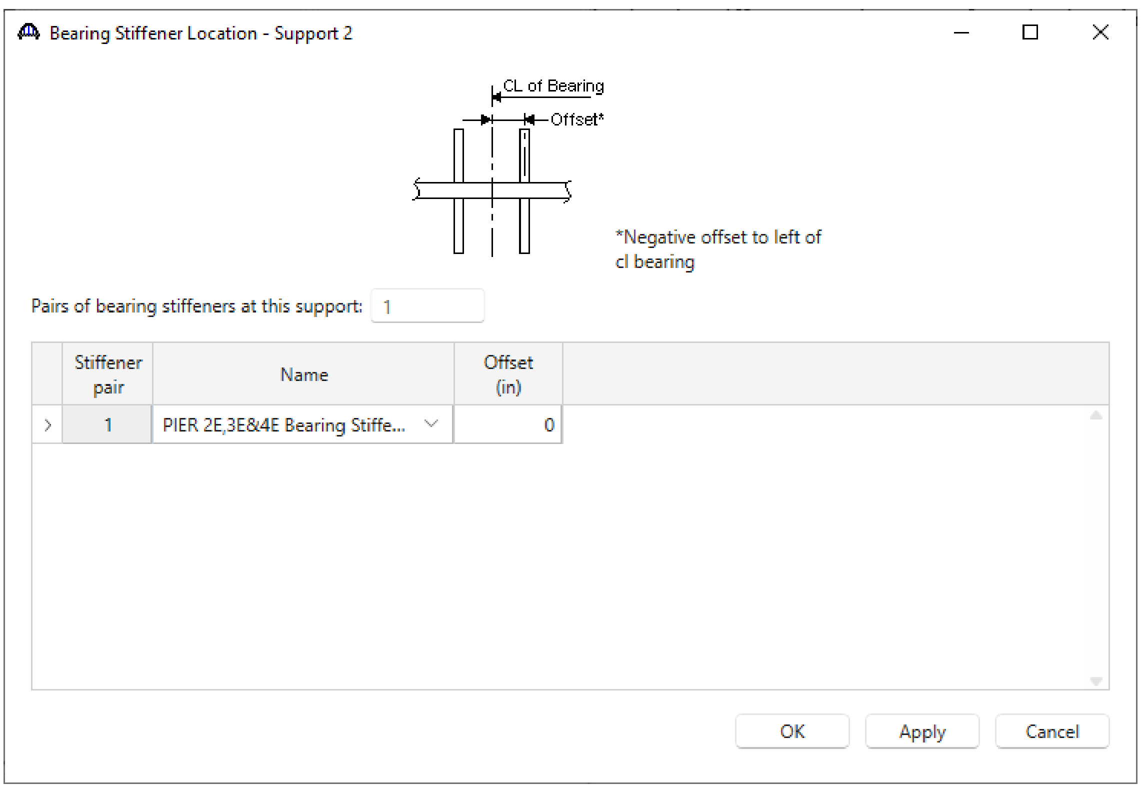
Bearing Stiffener Locations

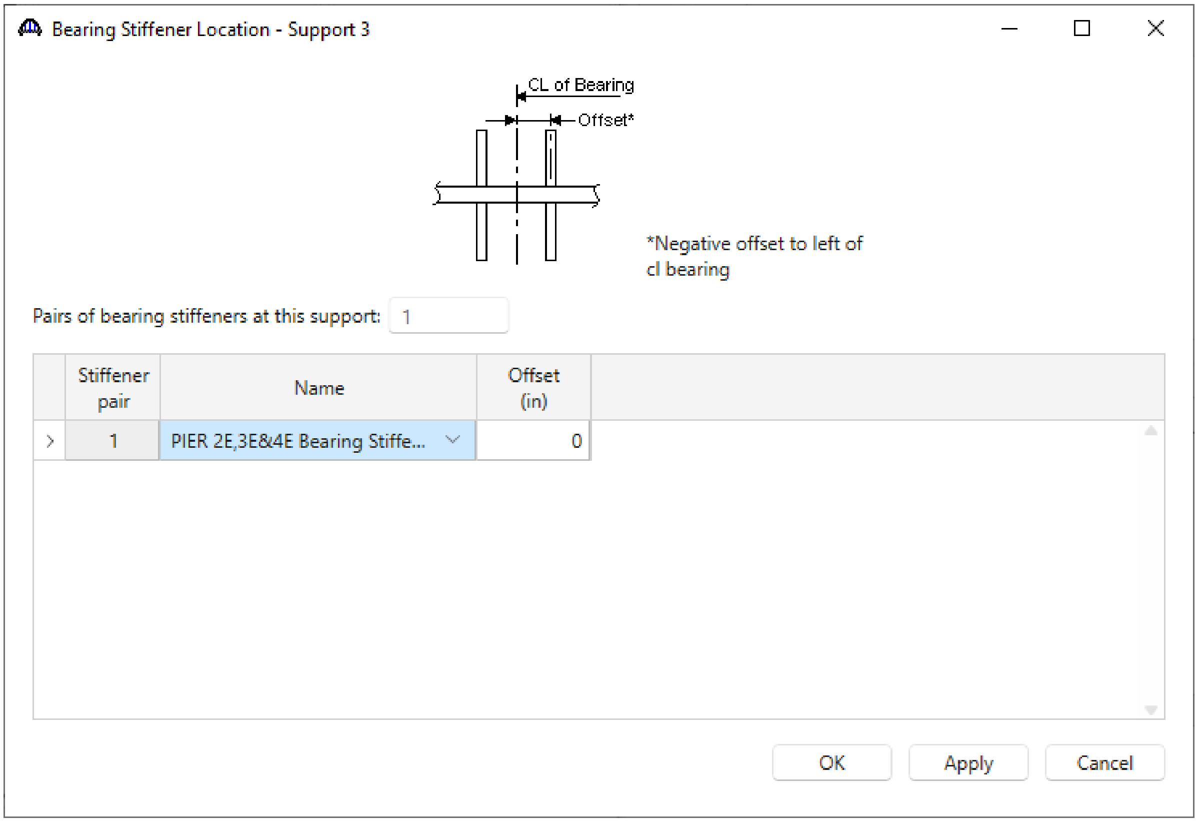
Expand the **Bearing Stiffener Locations** node and double click on **Support 1** as shown below.

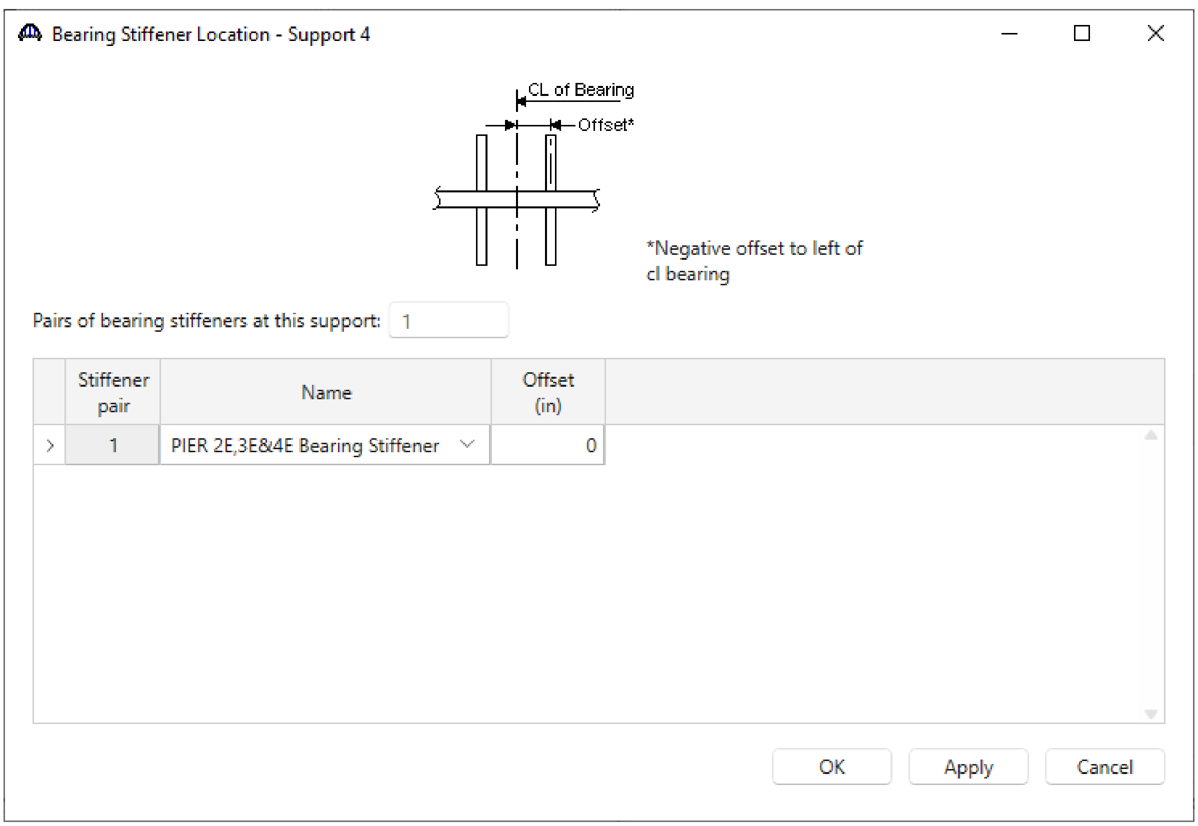


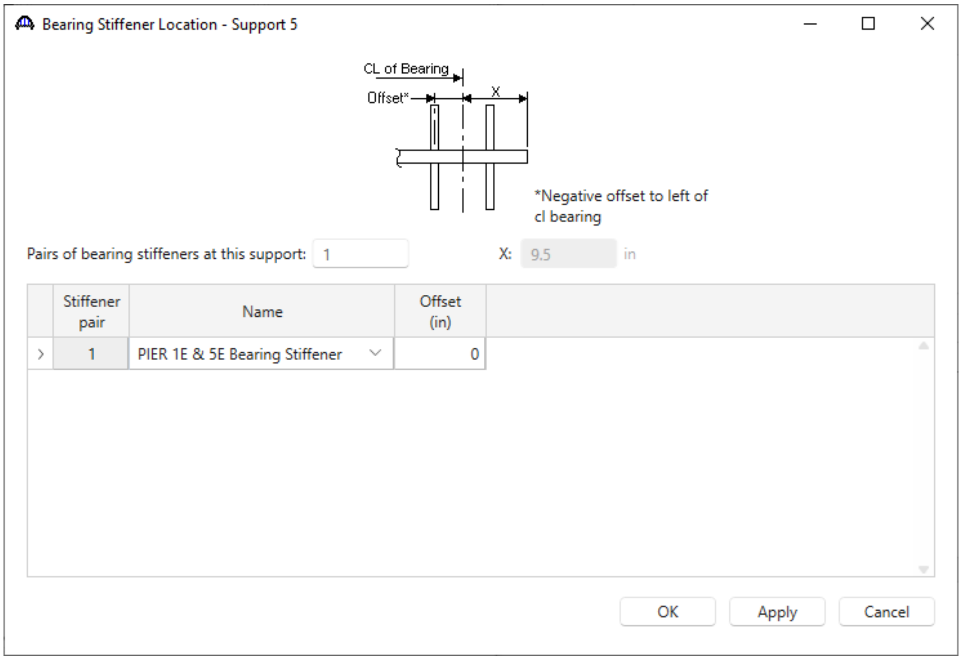
The bearing stiffeners are defined by selecting the stiffener at each support from the drop down menu. See images below for bearing stiffener locations at each support.





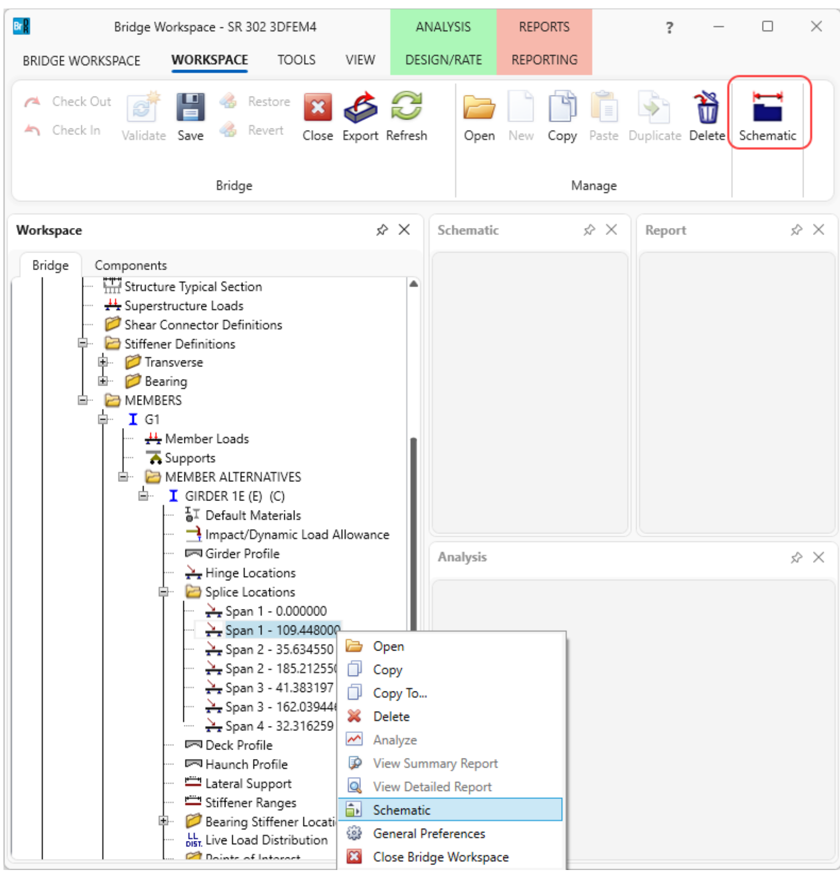

Bearing Stiffener Location - Support 3
CL of Bearing
Offset*
*Negative offset to left of cl bearing
Pairs of bearing stiffeners at this support: 1
Stiffener pair
Name
Offset (in)
1
PIER 2E,3E&4E Bearing Stiffe...
0
OK
Apply
Cancel

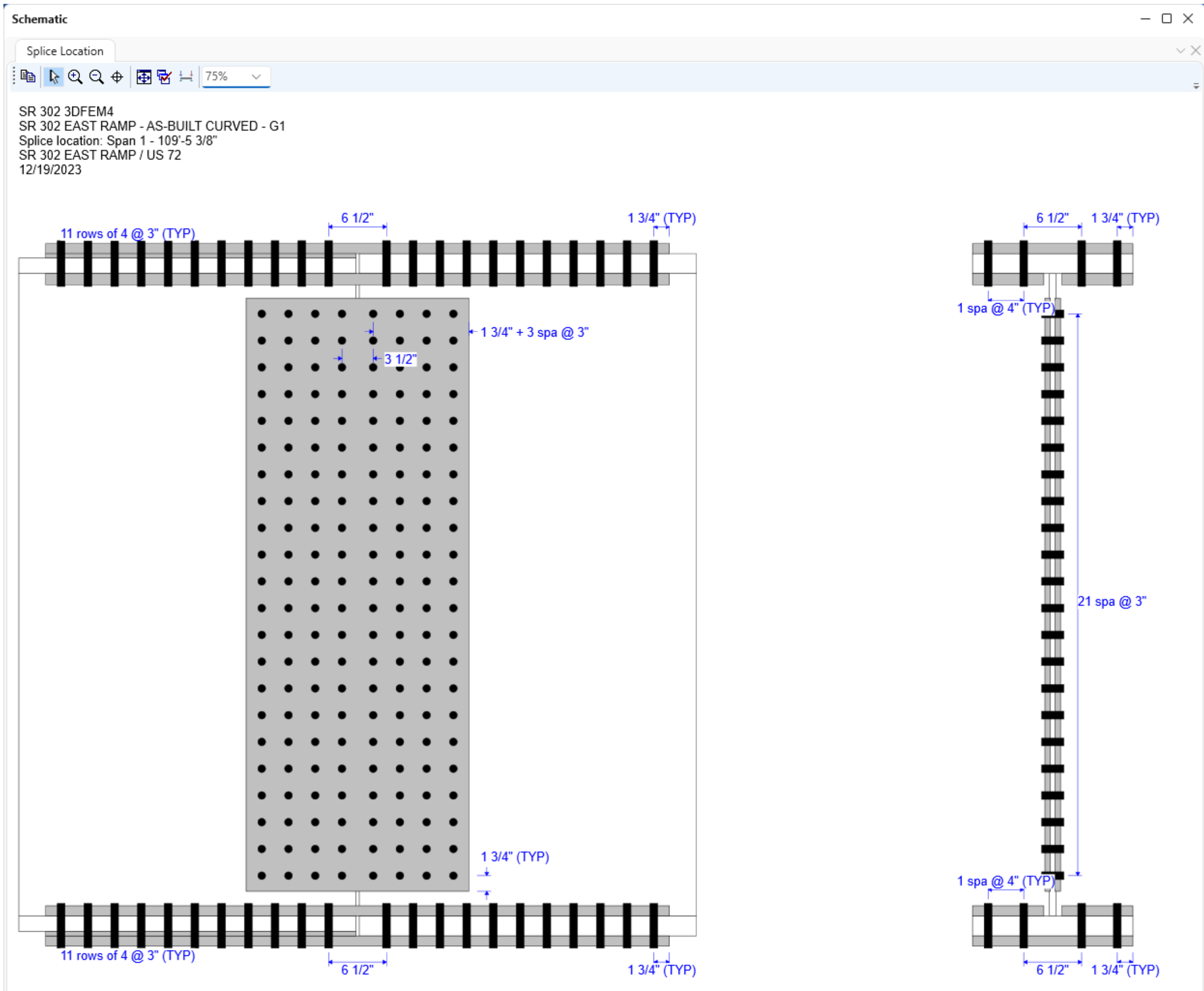

Bearing Stiffener Location - Support 4
CL of Bearing
Offset*
*Negative offset to left of cl bearing
Pairs of bearing stiffeners at this support: 1
Stiffener pair
Name
Offset (in)
1
PIER 2E,3E&4E Bearing Stiffener
0
OK
Apply
Cancel



Schematic – Splice Location

With Splice Location **Span 1 – 109.448000** selected in the **BWS** tree, click on the **Schematic** button from the **WORKSPACE** ribbon (or right click and select **Schematic**) to view the splice schematic as shown below.



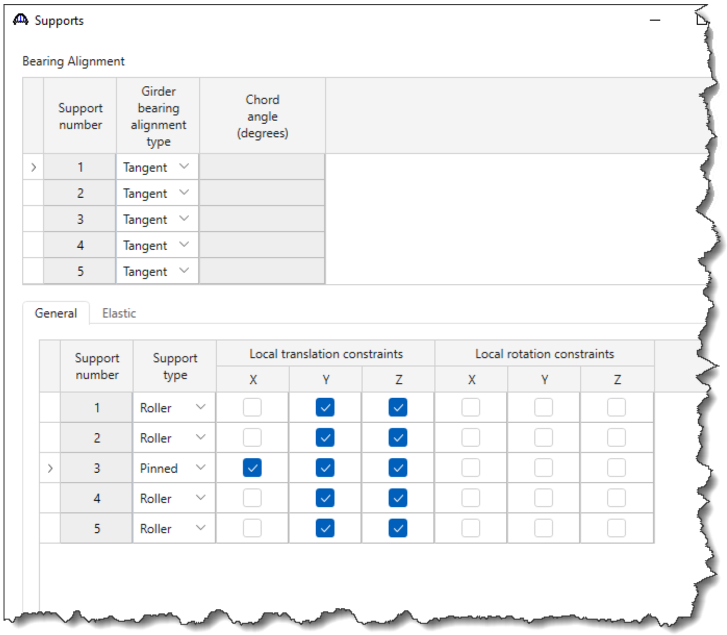


The description for **Girder 1** for this superstructure definition is complete. **Girder 2** through **Girder 5** are similar. The information is provided below. The girder flanges and web sizes are the same as **Girder 1**. The length will need to be updated for the haunches and lateral support. The stiffeners will need to be generated at the diaphragm locations.

TABLE OF DIMENSIONS											
Girder	"A"	"B"	"C"	"D"	"E"	"F"	"G"	"H"	"I"	"J"	"K"
1E	153'-6 13/16"	219'-11 3/8"	192'-2 1/2"	133'-9 1/16"	60'-2 1/4"	78'-6 3/16"	149'-6 15/16"	76'-1 7/16"	120'-7 7/8"	62'-5 13/16"	50'-11 1/4"
2E	154'-0"	220'-6 13/16"	192'-9"	134'-1 9/16"	60'-6"	78'-8 13/16"	150'-0"	76'-4"	121'-0"	62'-7 15/16"	51'-2 5/8"
3E	154'-5 3/16"	221'-2 1/4"	193'-3 7/16"	134'-6 1/16"	60'-9 3/4"	78'-11 7/16"	150'-5 1/16"	76'-6 9/16"	121'-4 1/16"	62'-10"	51'-6 1/16"
4E	154'-10 3/8"	221'-9 11/16"	193'-9 15/16"	134'-10 9/16"	61'-1 1/2"	79'-2 1/16"	150'-10 1/8"	76'-8 9/16"	121'-8 1/16"	63'-0 1/8"	51'-10 1/8"
5E	155'-3 9/16"	222'-5 1/16"	194'-4 7/16"	135'-3 1/16"	61'-5 1/4"	79'-4 11/16"	151'-3 3/16"	76'-11 11/16"	122'-0 3/16"	63'-2 1/4"	52'-0 7/8"

The following are all of the steps needed to define members alternatives for members G2 through G5.

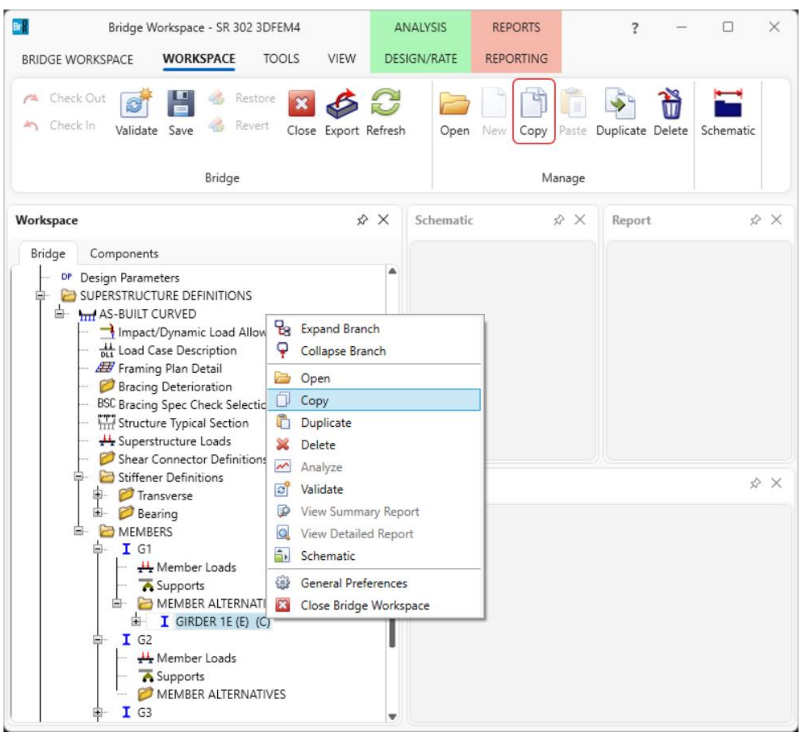
Member G2



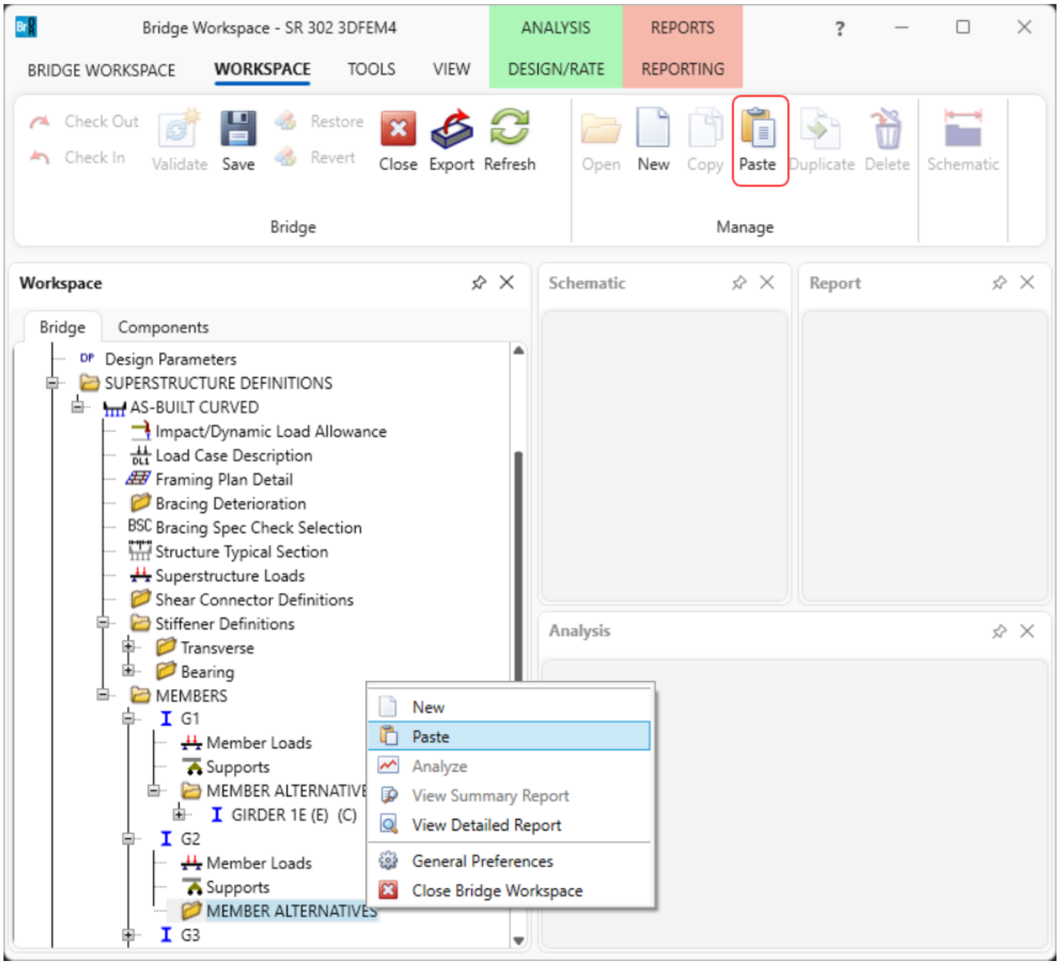
Copy and Paster Member Alternative

An easier/quicker way to enter these member alternatives is to copy the member alternative entered for member G1 and make changes to selected windows for each member alternative based on the bridge details given.

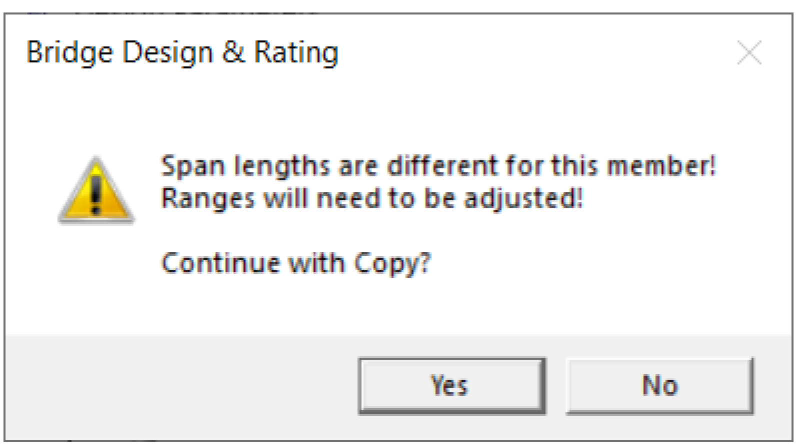
To copy, first select the **GIRDER 1E** member alternative for member **G1** and click on the **Copy** button from the **WORKSPACE** ribbon, or right click and select **Copy** as shown below.



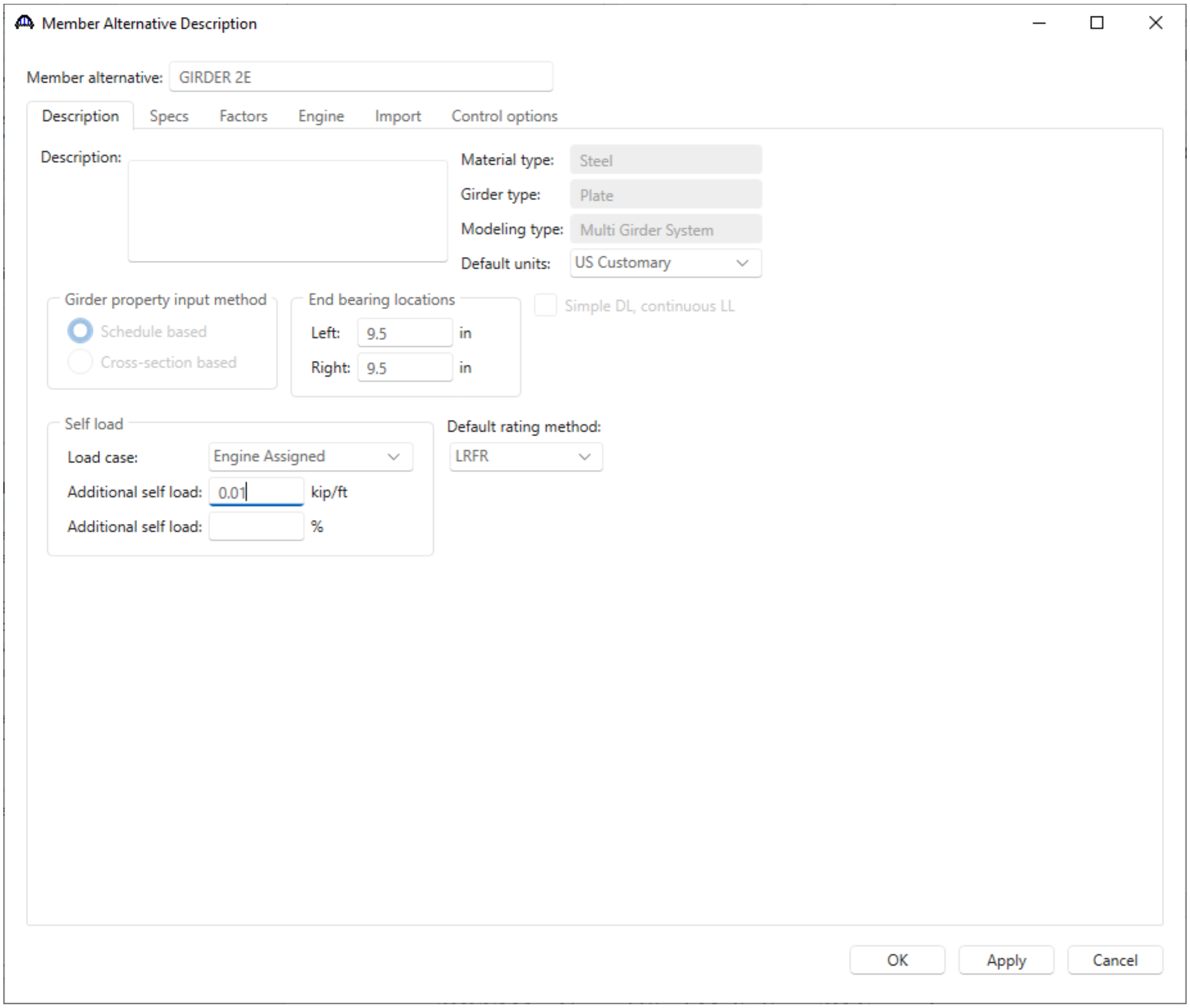
Now, select the node **MEMBER ALTERNATIVES** under member **G2** and click the **Paste** button from the **WORKSPACE** ribbon or right click and select **Paste** as shown below.



The following warning message shows up indicating that the span lengths are different. Click Yes to continue.

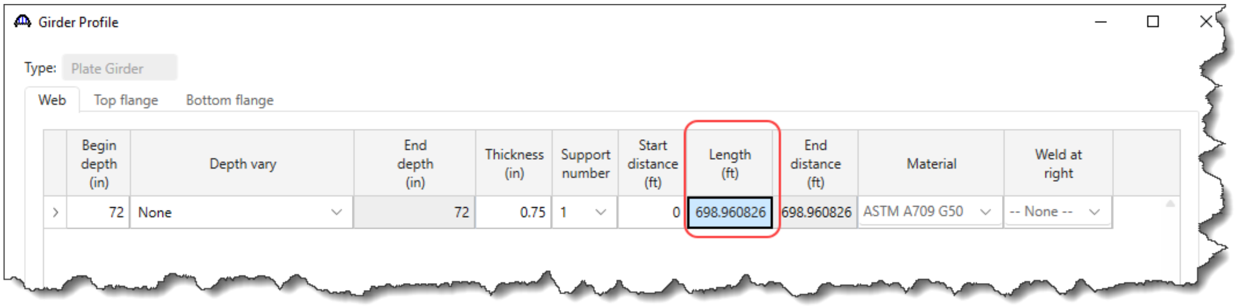


The copied member alternative is shown below. Rename the copied member alternative as shown below. Double click on the newly copied member alternative for member **G2** to open the **Member Alternative Description** window and rename it as shown below. Also uncheck the **Must consider user input lateral bending stress** checkbox in the **Control options** tab as shown for member **G1.**



Now visit the following windows for this member alternative and make the necessary changes as shown below.

Girder Profile – Web

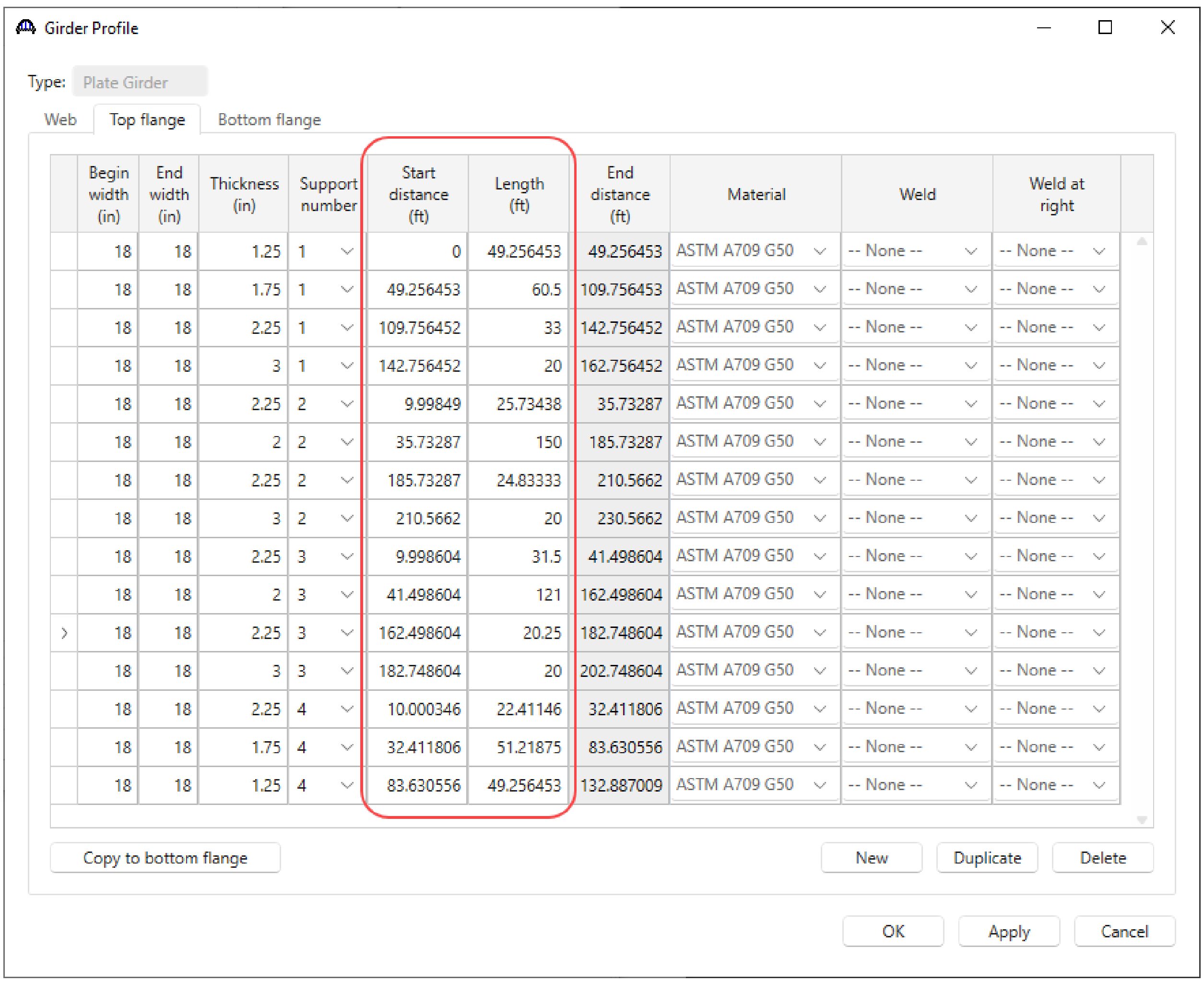

Girder Profile

Type: Plate Girder

Web | Top flange | Bottom flange

Begin depth (in)	Depth vary	End depth (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld at right
72	None	72	0.75	1	0	698.960826	698.960826	ASTM A709 G50	-- None --

Girder Profile – Top flange


Girder Profile

Type: Plate Girder

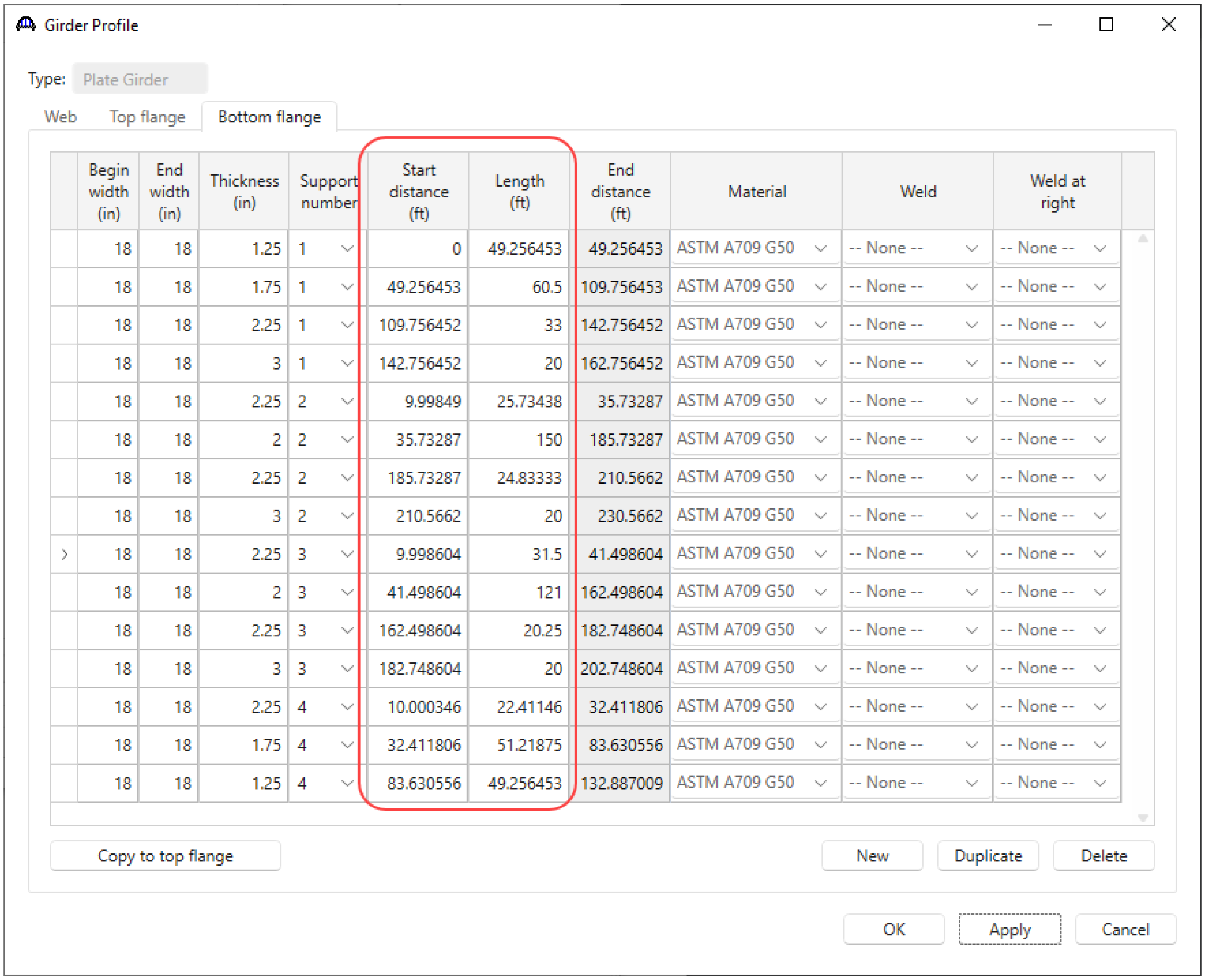
Web | Top flange | Bottom flange

Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.256453	49.256453	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.256453	60.5	109.756453	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	109.756452	33	142.756452	ASTM A709 G50	-- None --	-- None --
18	18	3	1	142.756452	20	162.756452	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	9.99849	25.73438	35.73287	ASTM A709 G50	-- None --	-- None --
18	18	2	2	35.73287	150	185.73287	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	185.73287	24.83333	210.5662	ASTM A709 G50	-- None --	-- None --
18	18	3	2	210.5662	20	230.5662	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	9.998604	31.5	41.498604	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.498604	121	162.498604	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	162.498604	20.25	182.748604	ASTM A709 G50	-- None --	-- None --
18	18	3	3	182.748604	20	202.748604	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	10.000346	22.41146	32.411806	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.411806	51.21875	83.630556	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	83.630556	49.256453	132.887009	ASTM A709 G50	-- None --	-- None --

Copy to bottom flange | New | Duplicate | Delete

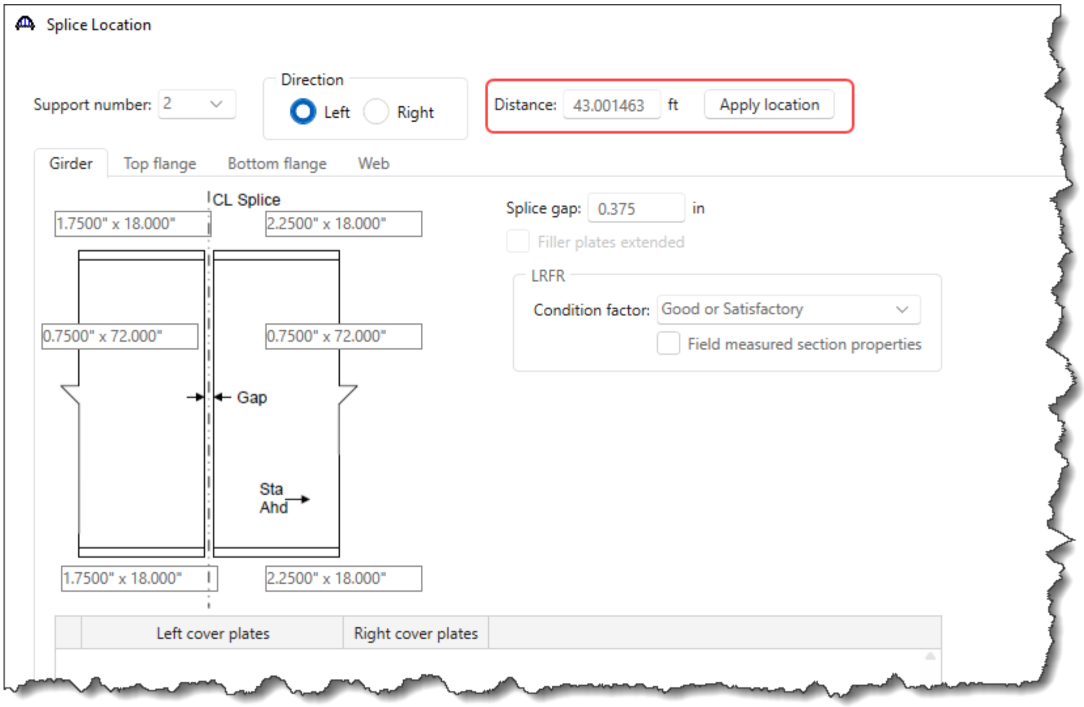
OK | Apply | Cancel

Girder Profile – Bottom flange

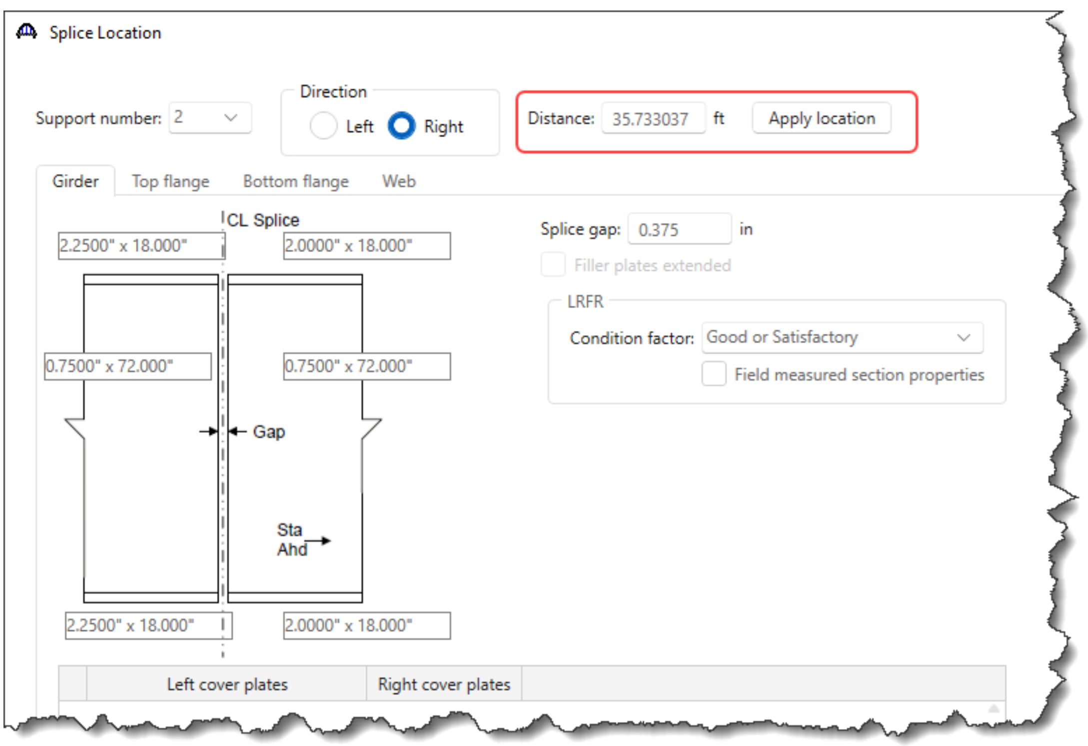


Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.256453	49.256453	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.256453	60.5	109.756453	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	109.756452	33	142.756452	ASTM A709 G50	-- None --	-- None --
18	18	3	1	142.756452	20	162.756452	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	9.99849	25.73438	35.73287	ASTM A709 G50	-- None --	-- None --
18	18	2	2	35.73287	150	185.73287	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	185.73287	24.83333	210.5662	ASTM A709 G50	-- None --	-- None --
18	18	3	2	210.5662	20	230.5662	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	9.998604	31.5	41.498604	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.498604	121	162.498604	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	162.498604	20.25	182.748604	ASTM A709 G50	-- None --	-- None --
18	18	3	3	182.748604	20	202.748604	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	10.000346	22.41146	32.411806	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.411806	51.21875	83.630556	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	83.630556	49.256453	132.887009	ASTM A709 G50	-- None --	-- None --

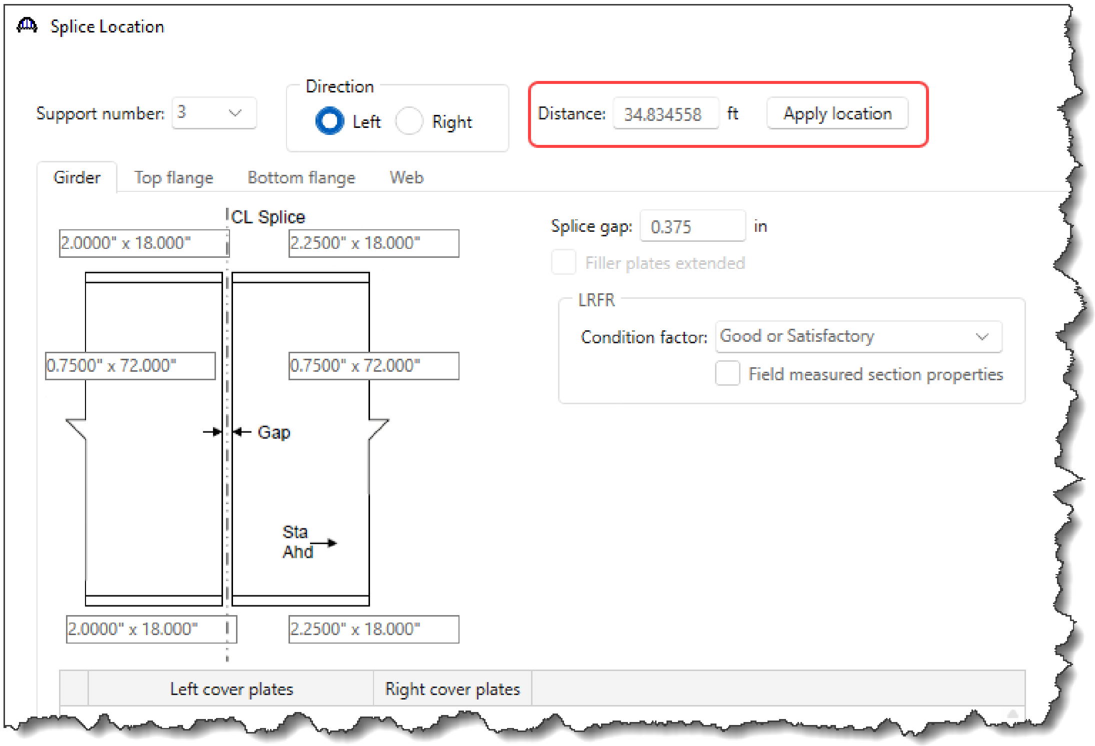
Splice Location 1



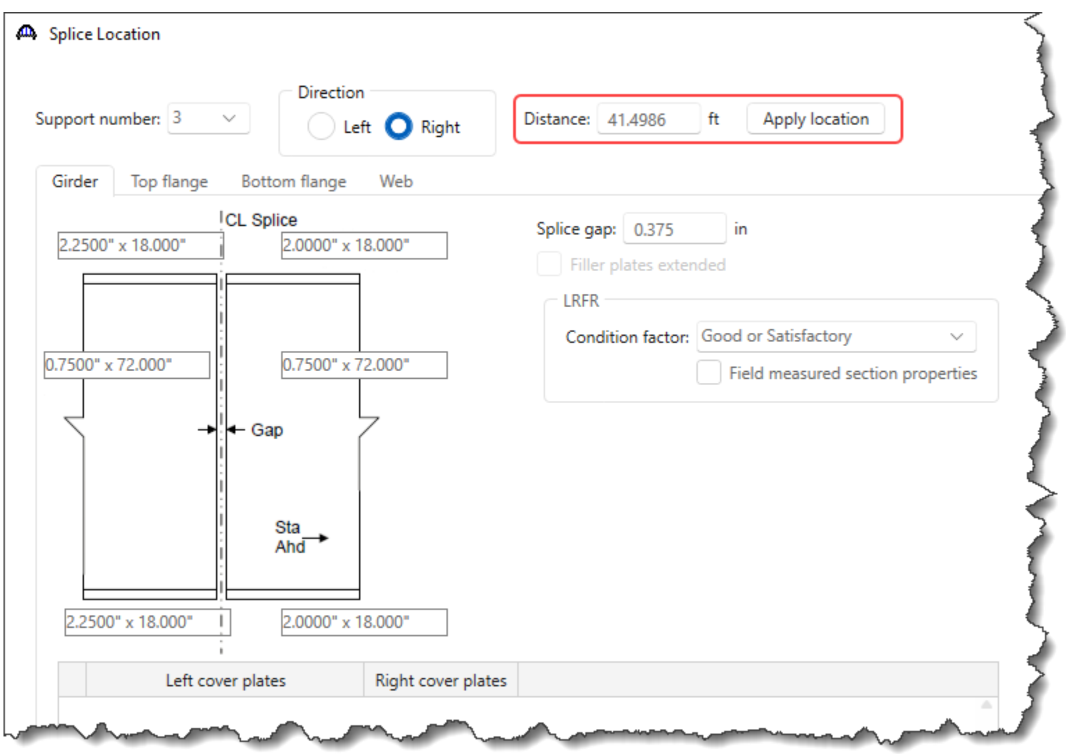
Splice Location 2



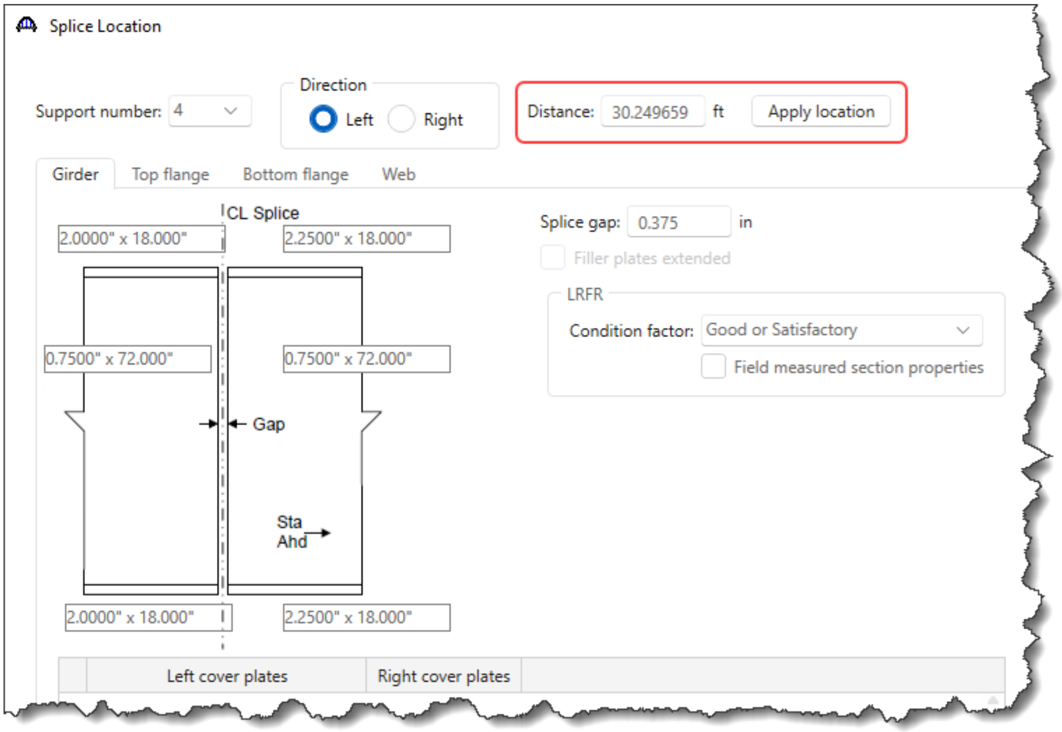
Splice Location 3



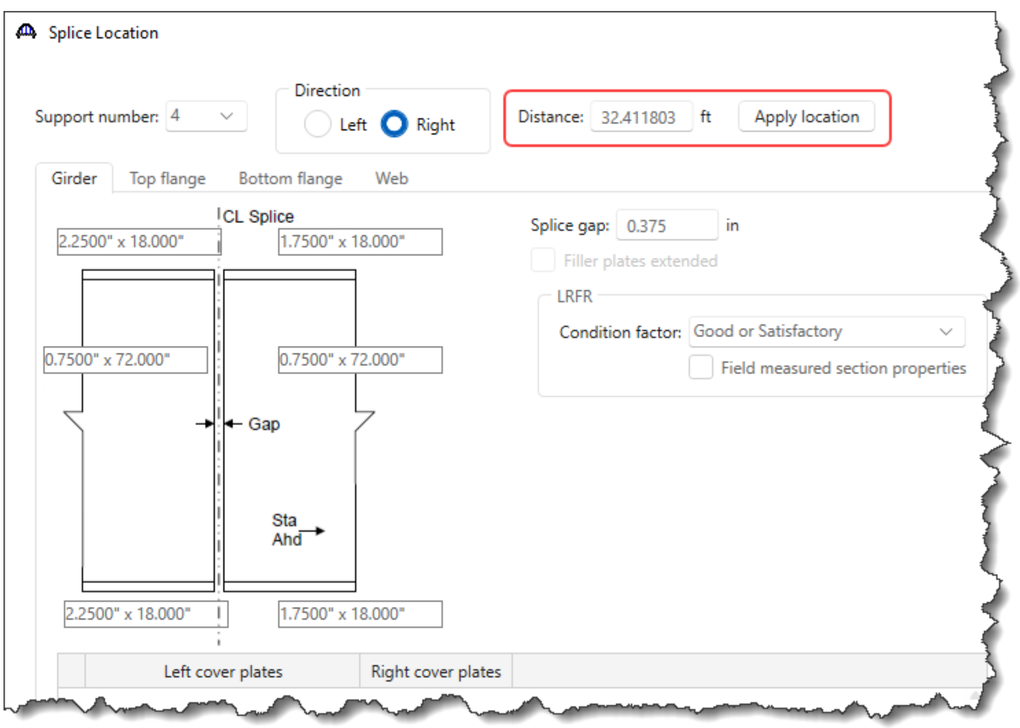
Splice Location 4



Splice Location 5



Splice Location 6



Deck Profile – Deck concrete

Deck Profile

Type: Plate

Deck concrete | Reinforcement | Shear connectors

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	105.75645	105.75645	8	96	96	109.5	109.5	8
Class AA (US)	1	105.75645	86.734375	192.490825	8	0	0	0	0	8
Class AA (US)	2	39.732862	142	181.732862	8	96	96	109.5	109.5	8
Class AA (US)	2	181.732862	84.333333	266.066195	8	0	0	0	0	8
Class AA (US)	3	45.4986	113	158.4986	8	96	96	109.5	109.5	8
Class AA (US)	3	158.4986	70.661459	229.160059	8	0	0	0	0	8
Class AA (US)	4	36.4118	96.4752	132.887	8	96	96	109.5	109.5	8
Class AA (US)	4	132.887	9E-06	132.887009	8	0	0	0	0	8

Deck Profile – Reinforcement

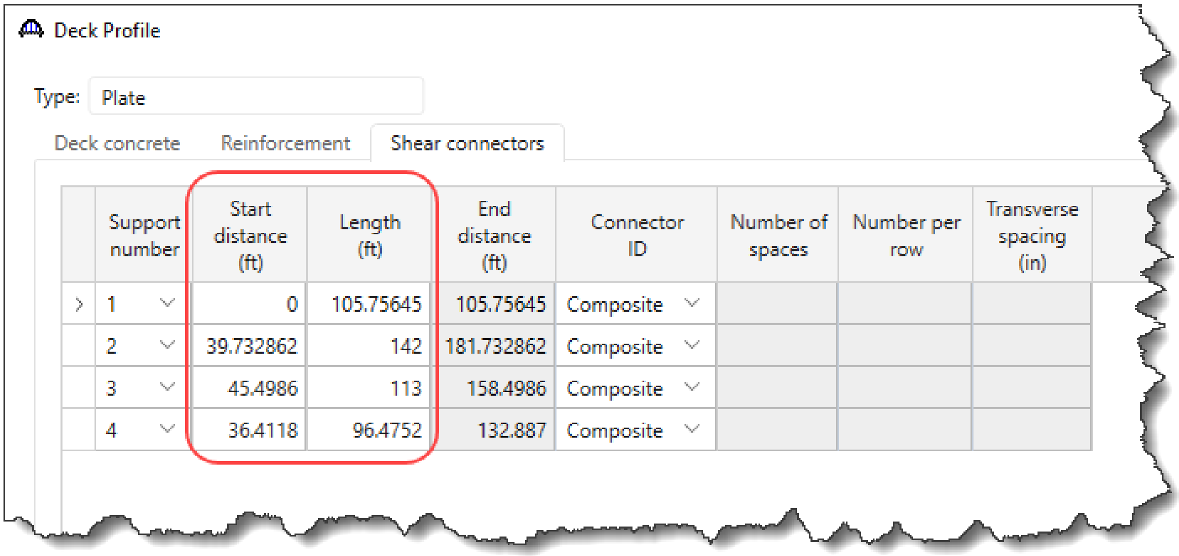
Deck Profile

Type: Plate

Deck concrete | Reinforcement | Shear connectors

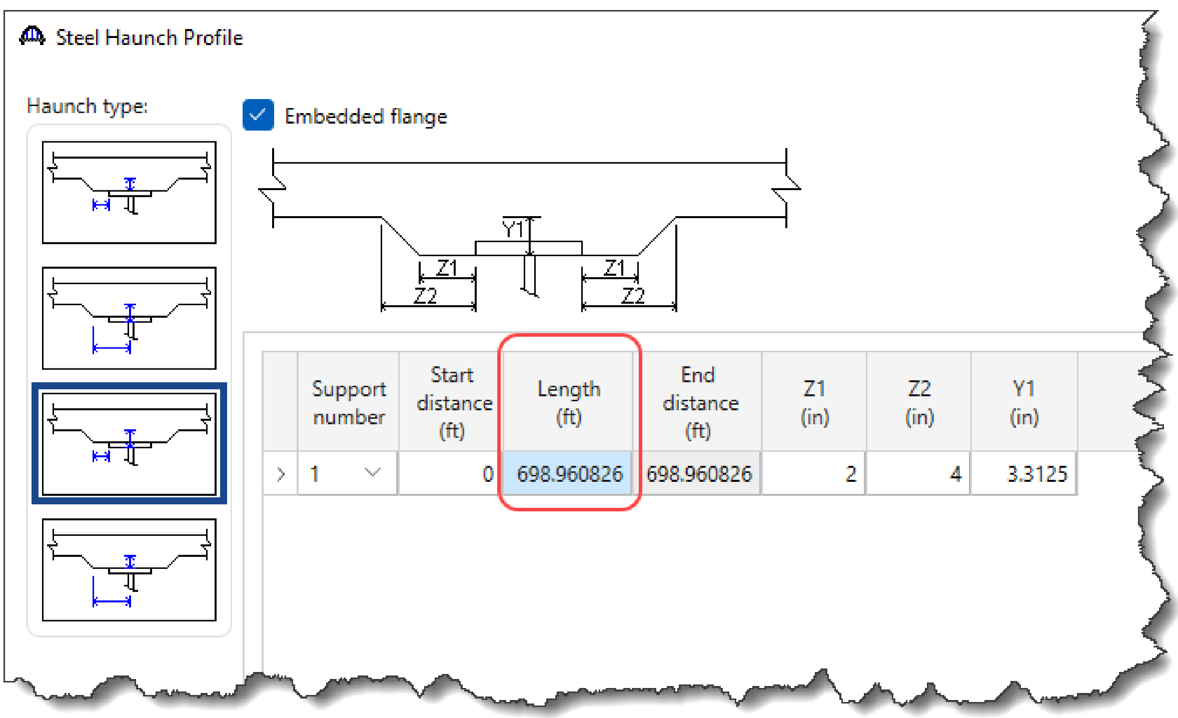
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	0	95.008001	95.008001	9	9	4	2.5	Top of Slab	8
Grade 60	1	0	698.960826	698.960826	9	9	5	1.3125	Bottom of Slab	8
Grade 60	1	95.008001	123.92438	218.932381	9	9	7	2.6875	Top of Slab	8
Grade 60	2	66.174418	88.218758	154.393176	9	9	4	2.5	Top of Slab	8
Grade 60	2	154.393176	124.007176	278.400352	9	9	7	2.6875	Top of Slab	8
Grade 60	3	57.832757	77.082744	134.915501	9	9	4	2.5	Top of Slab	8
Grade 60	3	134.915501	124.897231	259.812732	9	9	7	2.6875	Top of Slab	8
Grade 60	4	67.064473	65.822537	132.88701	9	9	4	2.5	Top of Slab	8

Deck Profile – Shear connectors



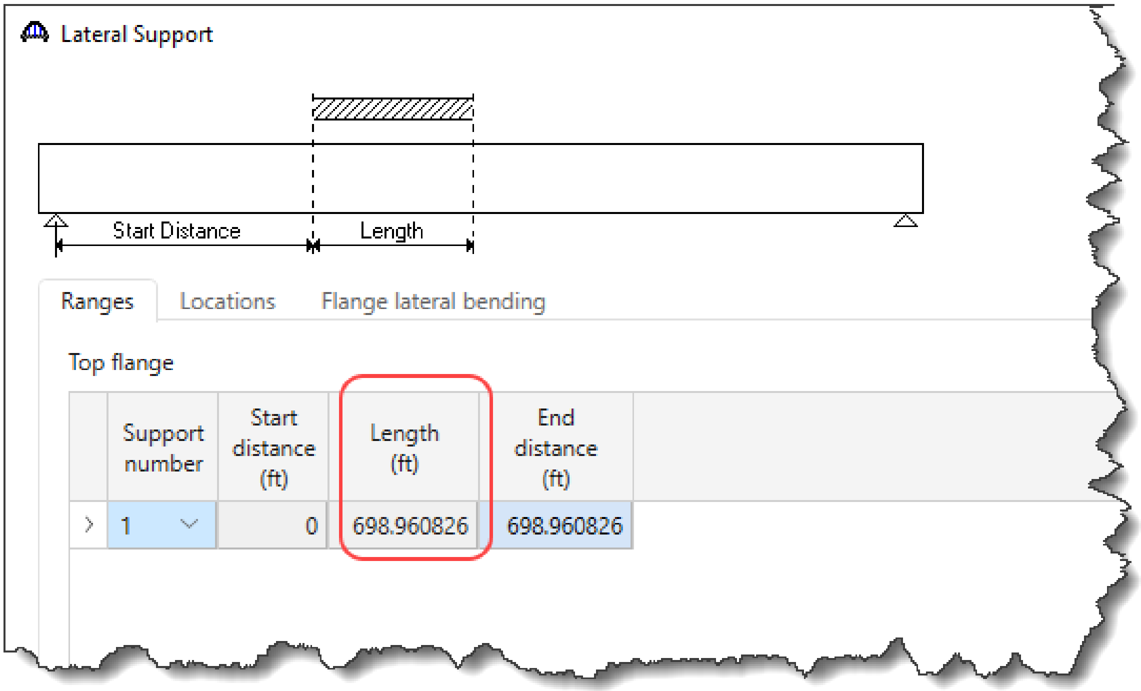
Support number	Start distance (ft)	Length (ft)	End distance (ft)	Connector ID	Number of spaces	Number per row	Transverse spacing (in)
1	0	105.75645	105.75645	Composite			
2	39.732862	142	181.732862	Composite			
3	45.4986	113	158.4986	Composite			
4	36.4118	96.4752	132.887	Composite			

Haunch Profile



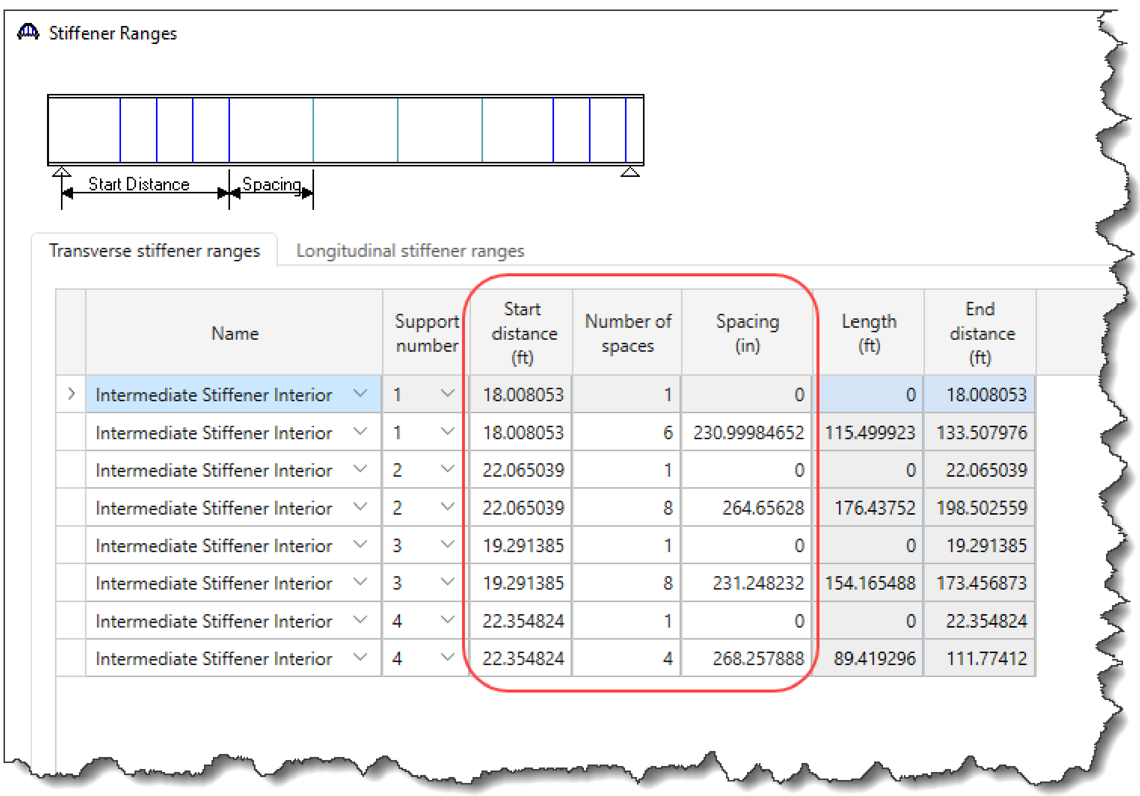
Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)
1	0	698.960826	698.960826	2	4	3.3125

Lateral Support



	Support number	Start distance (ft)	Length (ft)	End distance (ft)
>	1	0	698.960826	698.960826

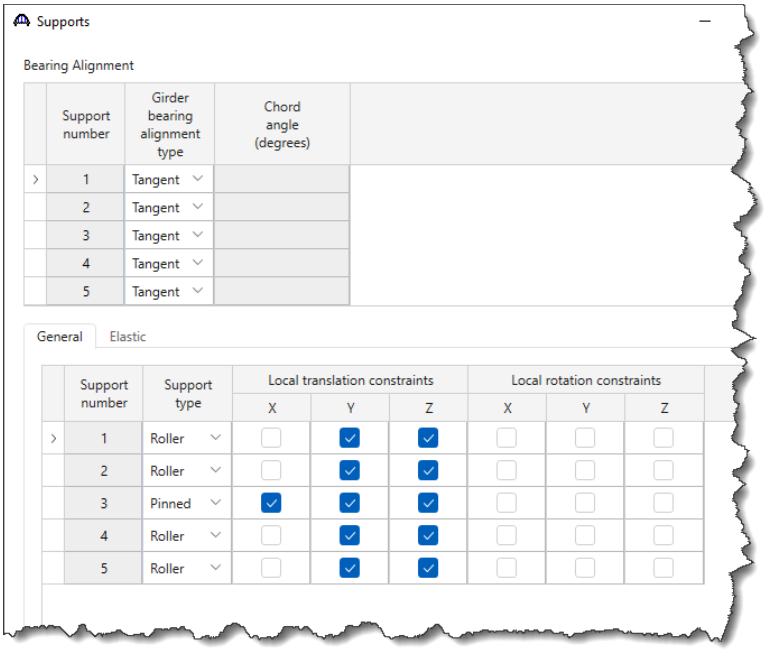
Stiffener Ranges



	Name	Support number	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
>	Intermediate Stiffener Interior	1	18.008053	1	0	0	18.008053
	Intermediate Stiffener Interior	1	18.008053	6	230.99984652	115.499923	133.507976
	Intermediate Stiffener Interior	2	22.065039	1	0	0	22.065039
	Intermediate Stiffener Interior	2	22.065039	8	264.65628	176.43752	198.502559
	Intermediate Stiffener Interior	3	19.291385	1	0	0	19.291385
	Intermediate Stiffener Interior	3	19.291385	8	231.248232	154.165488	173.456873
	Intermediate Stiffener Interior	4	22.354824	1	0	0	22.354824
	Intermediate Stiffener Interior	4	22.354824	4	268.257888	89.419296	111.77412

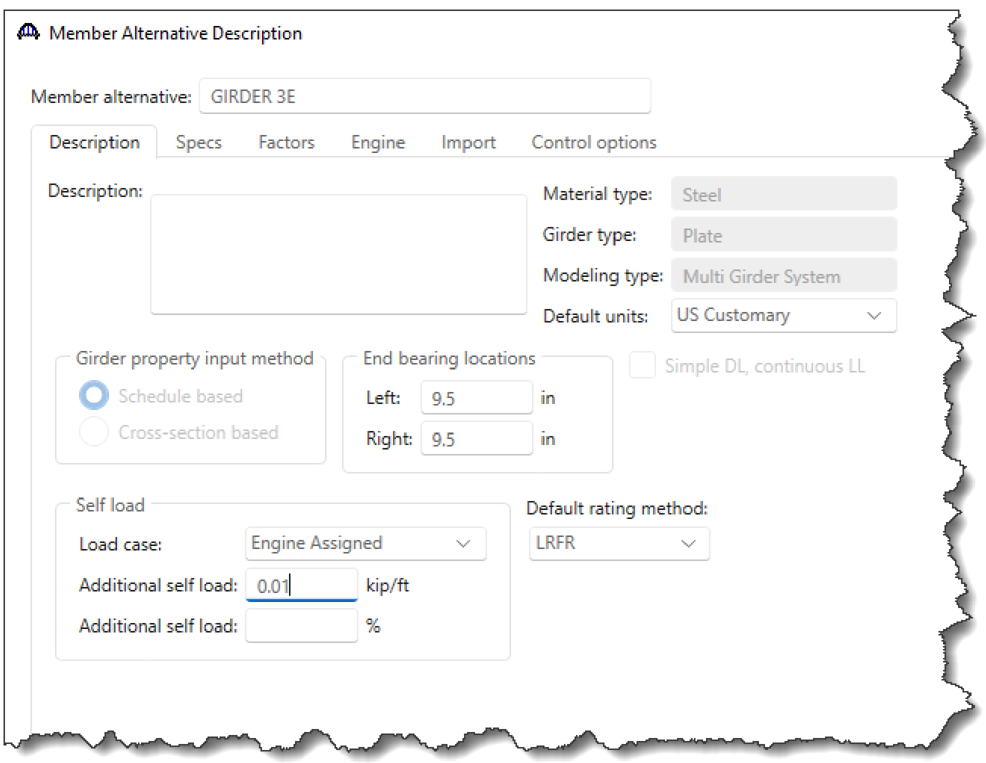
Member G3

Supports



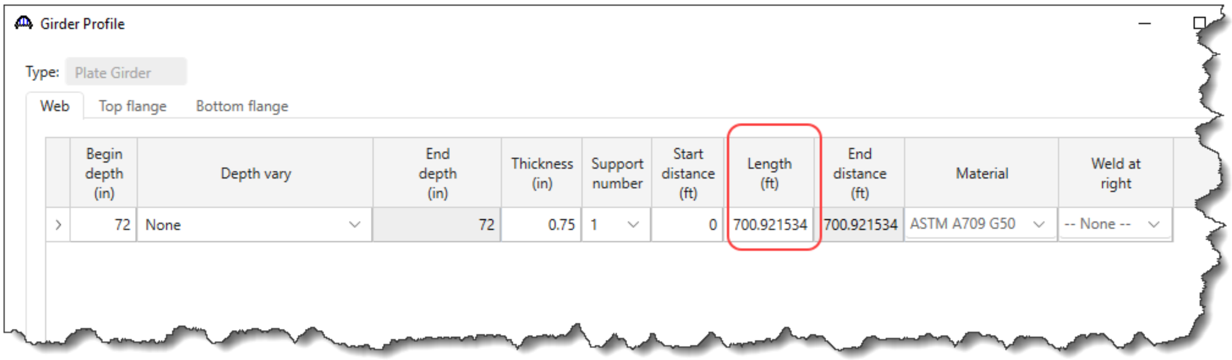
Member Alternative Description

Use the Copy and Paste method discussed in the last section to copy member alternative from member G1 to G3. Rename the member alternative for member G3 as shown below.

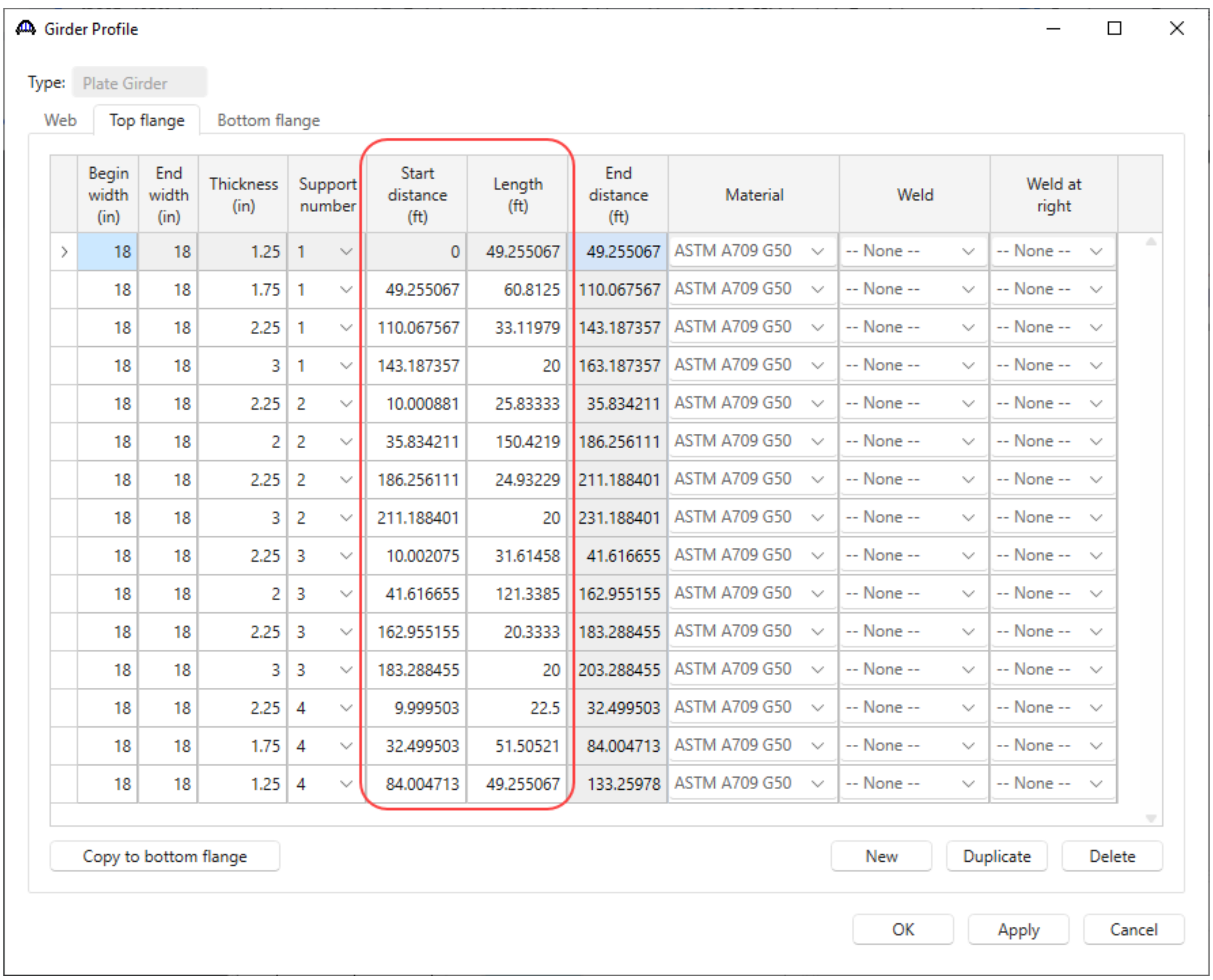


Now visit the following windows for this member alternative and make the necessary changes as shown below similar to the changes made for G2.

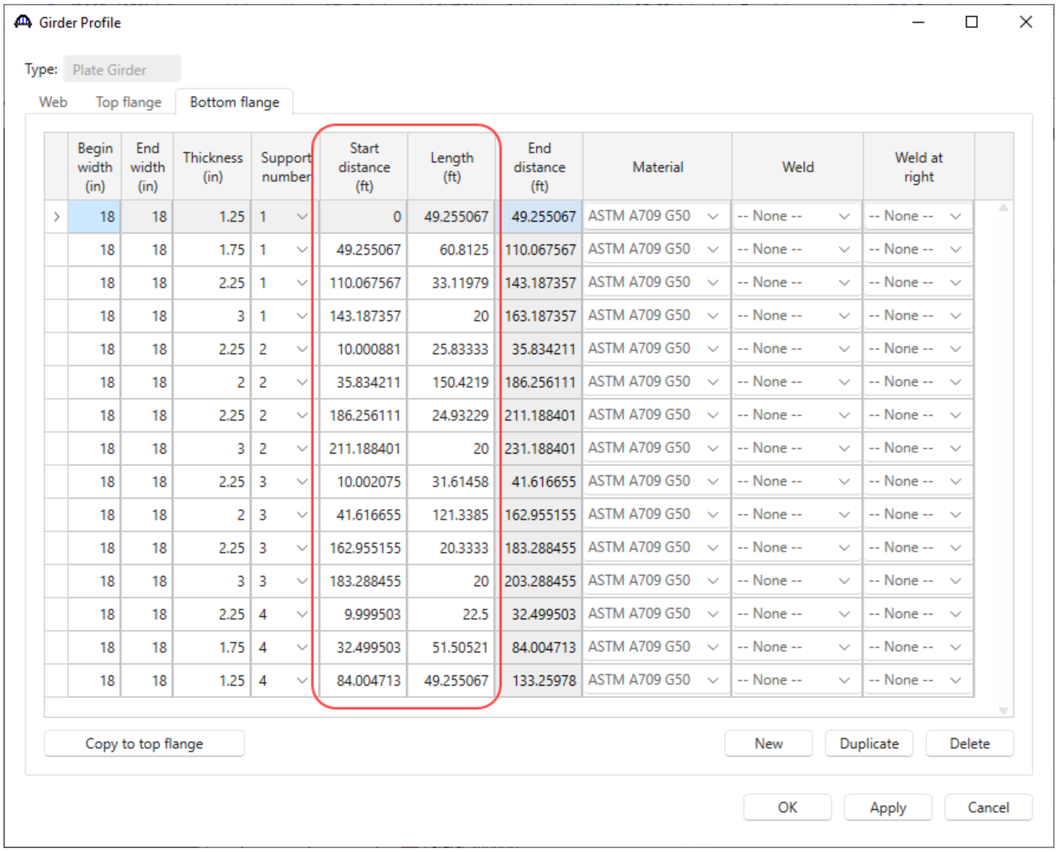
Girder Profile – Web



Girder Profile – Top flange

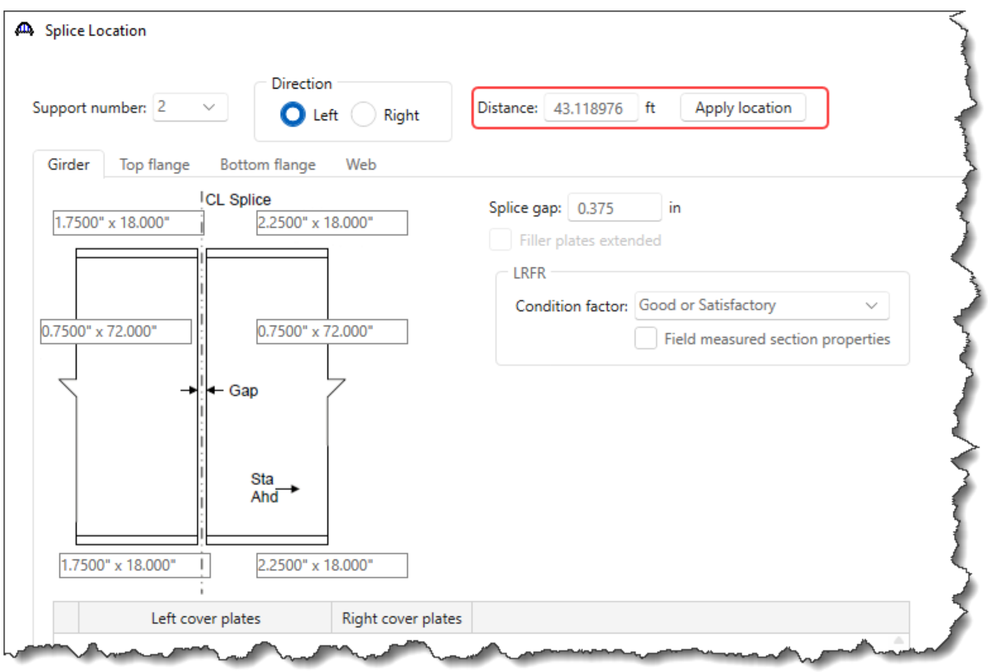


Girder Profile – Bottom flange

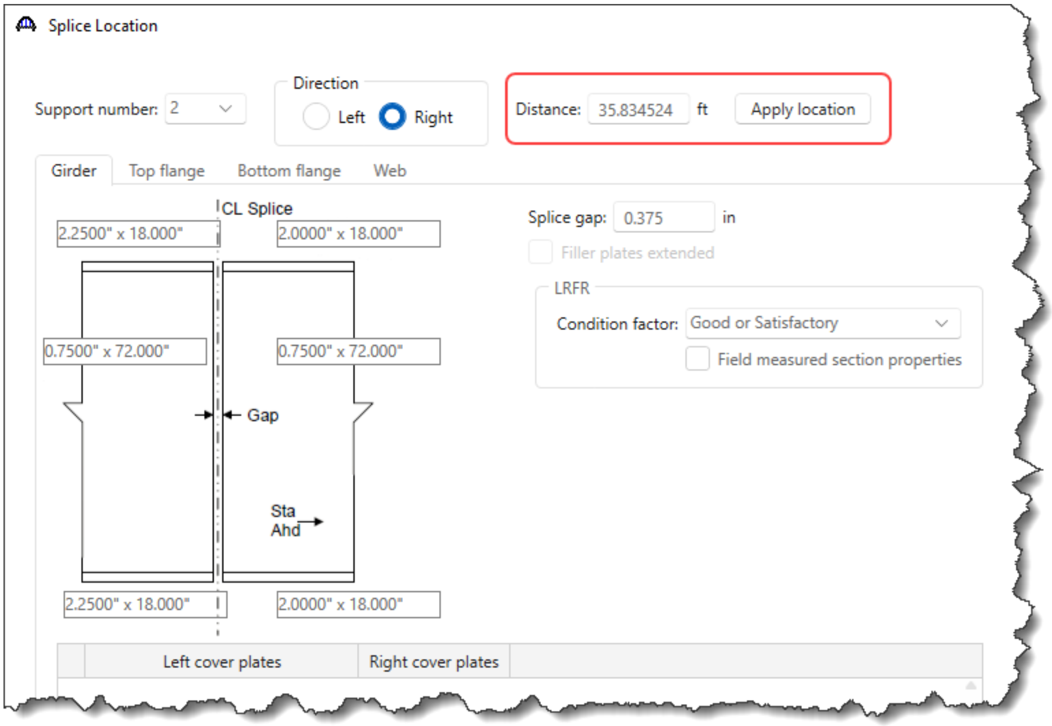


Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.255067	49.255067	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.255067	60.8125	110.067567	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	110.067567	33.11979	143.187357	ASTM A709 G50	-- None --	-- None --
18	18	3	1	143.187357	20	163.187357	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	10.000881	25.83333	35.834211	ASTM A709 G50	-- None --	-- None --
18	18	2	2	35.834211	150.4219	186.256111	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	186.256111	24.93229	211.188401	ASTM A709 G50	-- None --	-- None --
18	18	3	2	211.188401	20	231.188401	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	10.002075	31.61458	41.616655	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.616655	121.3385	162.955155	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	162.955155	20.3333	183.288455	ASTM A709 G50	-- None --	-- None --
18	18	3	3	183.288455	20	203.288455	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	9.999503	22.5	32.499503	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.499503	51.50521	84.004713	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	84.004713	49.255067	133.25978	ASTM A709 G50	-- None --	-- None --

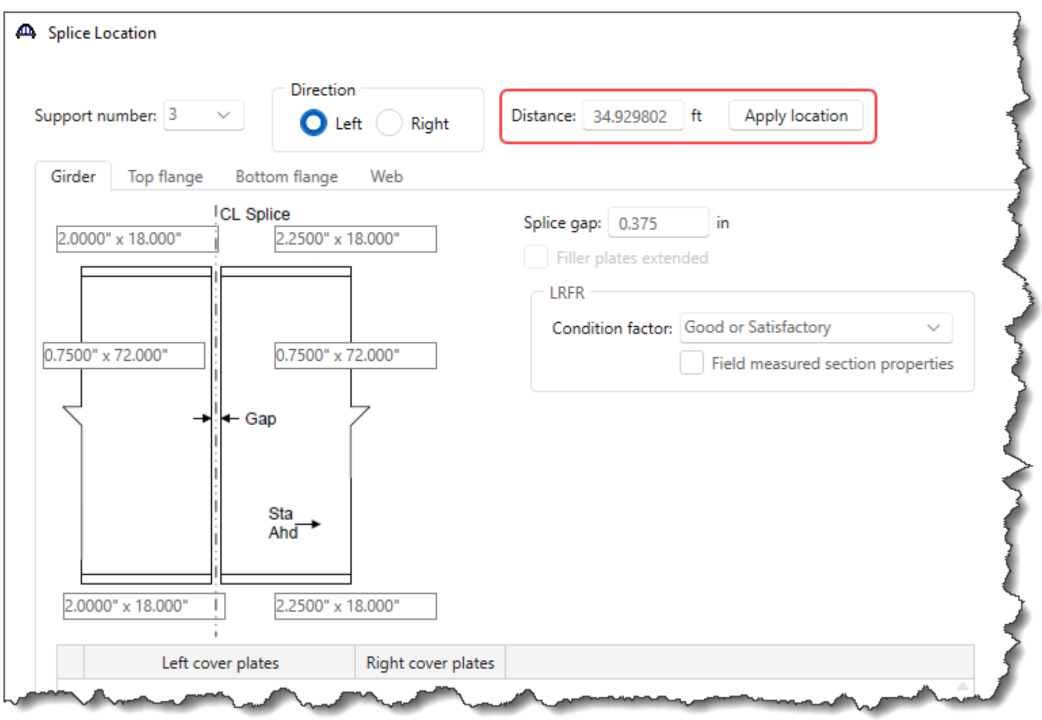
Splice Location 1



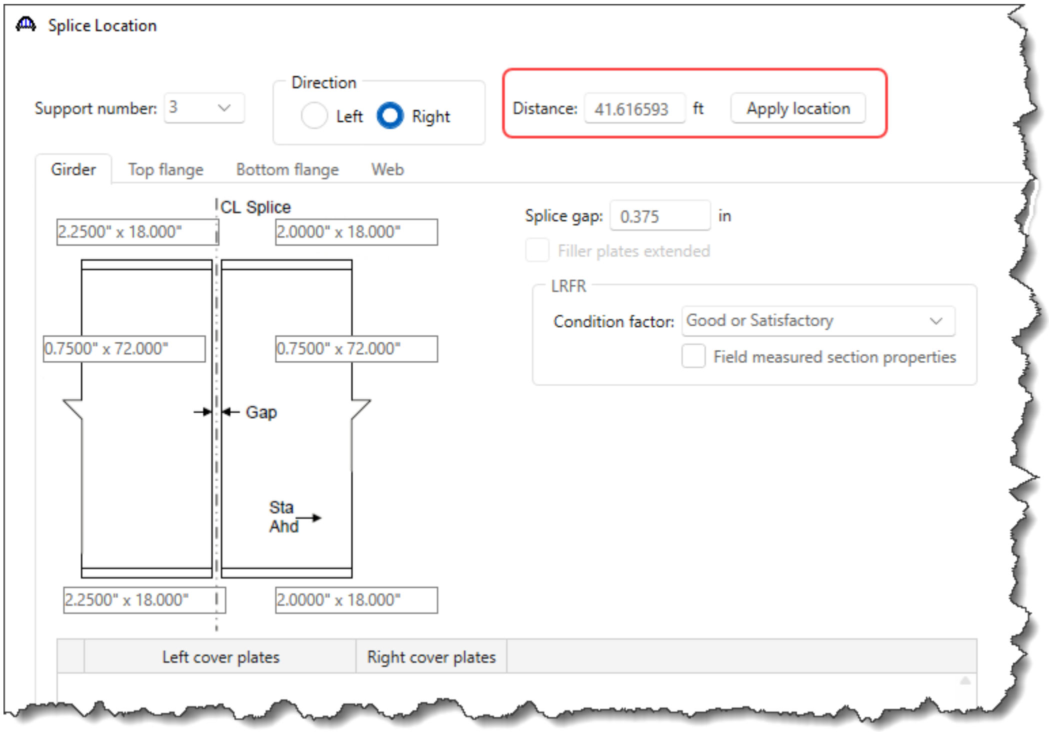
Splice Location 2



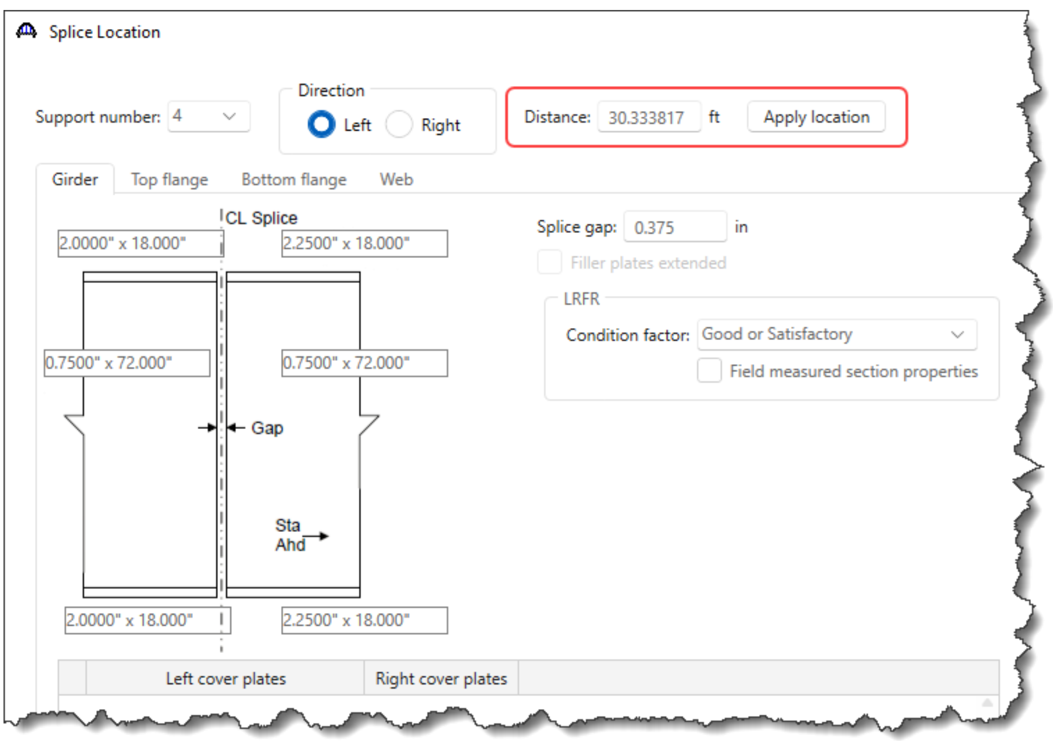
Splice Location 3



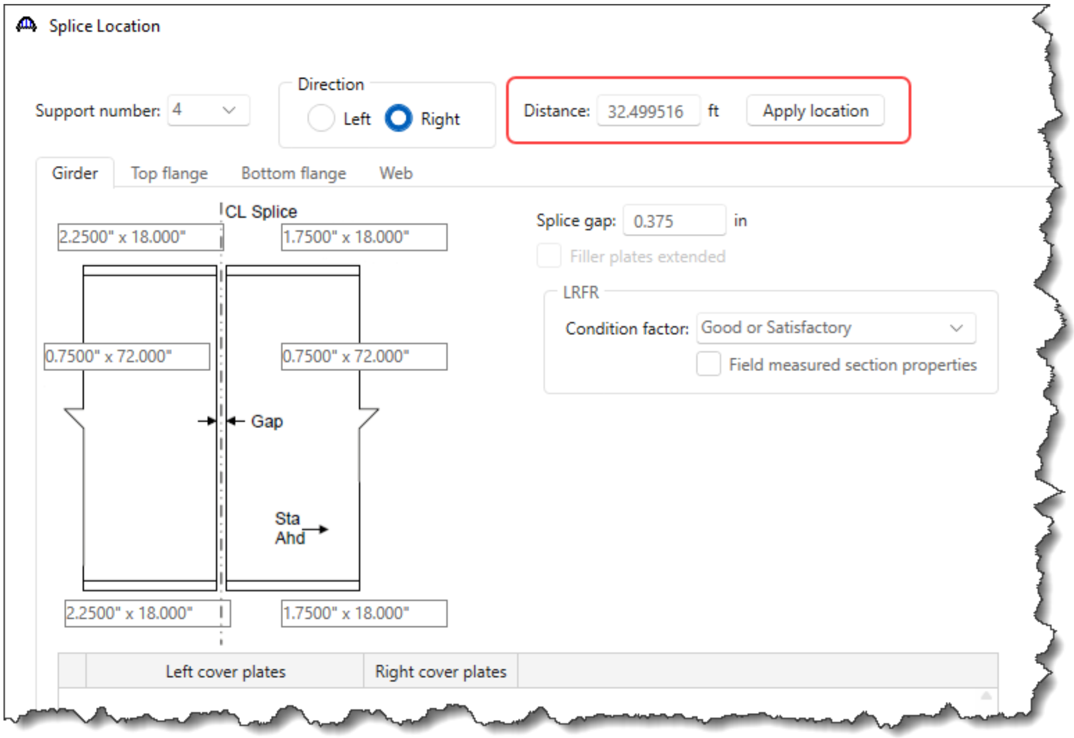
Splice Location 4



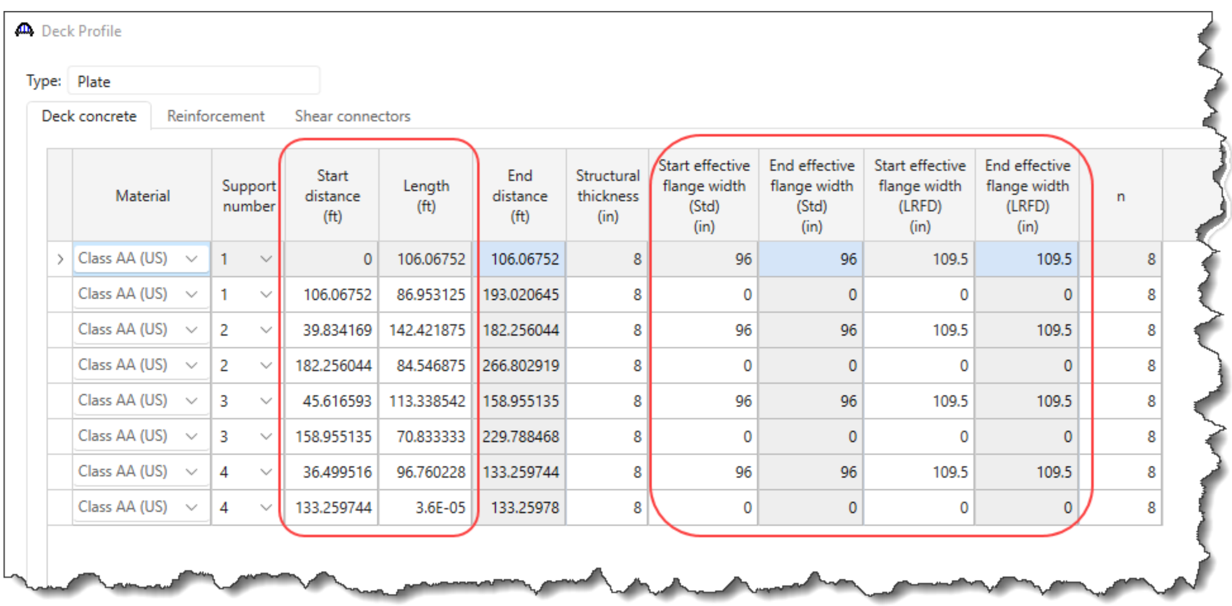
Splice Location 5



Splice Location 6

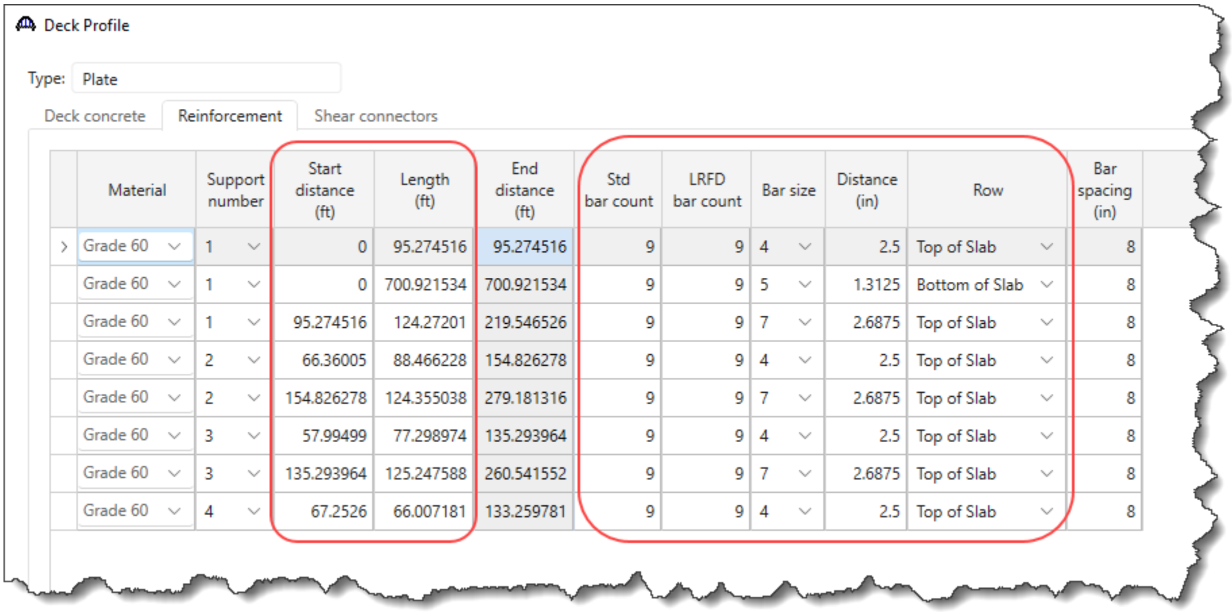


Deck Profile – Deck concrete



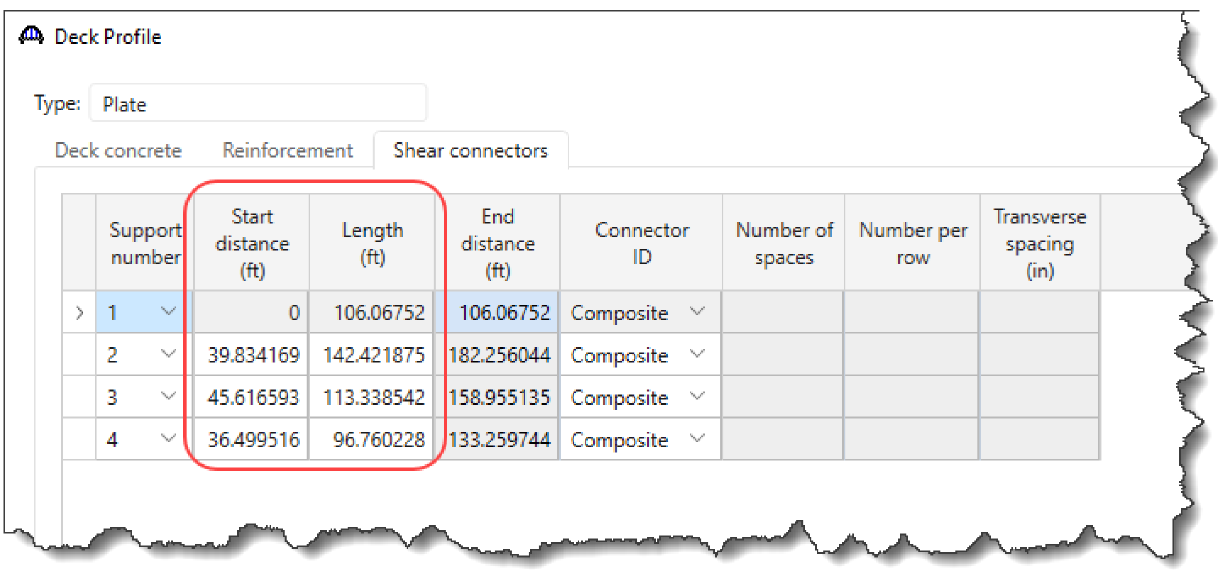
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	106.06752	106.06752	8	96	96	109.5	109.5	8
Class AA (US)	1	106.06752	86.953125	193.020645	8	0	0	0	0	8
Class AA (US)	2	39.834169	142.421875	182.256044	8	96	96	109.5	109.5	8
Class AA (US)	2	182.256044	84.546875	266.802919	8	0	0	0	0	8
Class AA (US)	3	45.616593	113.338542	158.955135	8	96	96	109.5	109.5	8
Class AA (US)	3	158.955135	70.833333	229.788468	8	0	0	0	0	8
Class AA (US)	4	36.499516	96.760228	133.259744	8	96	96	109.5	109.5	8
Class AA (US)	4	133.259744	3.6E-05	133.25978	8	0	0	0	0	8

Deck Profile – Reinforcement



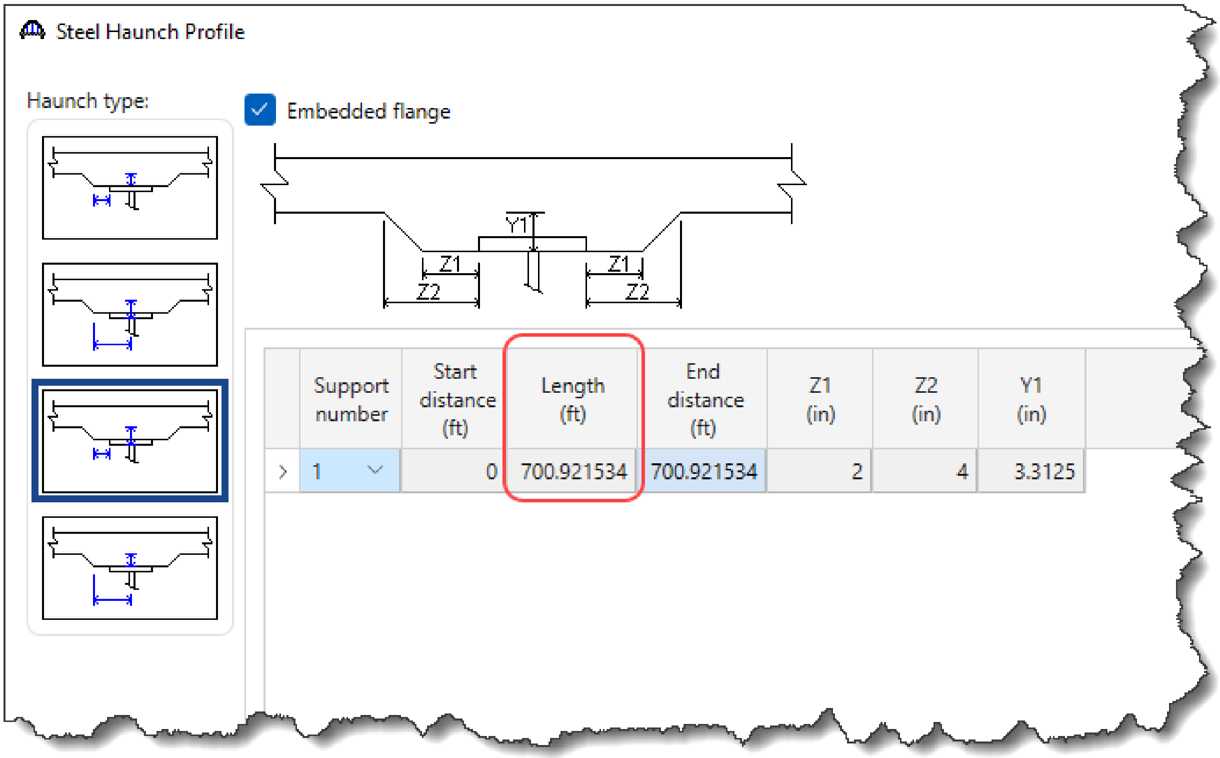
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	0	95.274516	95.274516	9	9	4	2.5	Top of Slab	8
Grade 60	1	0	700.921534	700.921534	9	9	5	1.3125	Bottom of Slab	8
Grade 60	1	95.274516	124.27201	219.546526	9	9	7	2.6875	Top of Slab	8
Grade 60	2	66.36005	88.466228	154.826278	9	9	4	2.5	Top of Slab	8
Grade 60	2	154.826278	124.355038	279.181316	9	9	7	2.6875	Top of Slab	8
Grade 60	3	57.99499	77.298974	135.293964	9	9	4	2.5	Top of Slab	8
Grade 60	3	135.293964	125.247588	260.541552	9	9	7	2.6875	Top of Slab	8
Grade 60	4	67.2526	66.007181	133.259781	9	9	4	2.5	Top of Slab	8

Deck Profile – Shear connectors

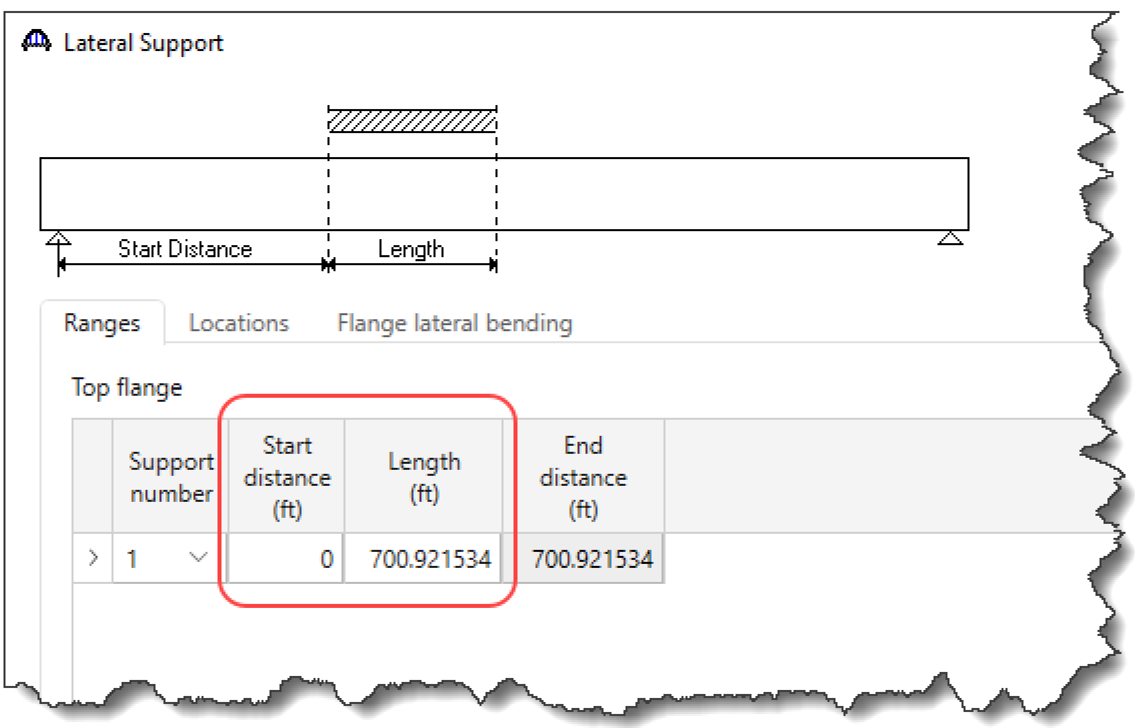


Support number	Start distance (ft)	Length (ft)	End distance (ft)	Connector ID	Number of spaces	Number per row	Transverse spacing (in)
1	0	106.06752	106.06752	Composite			
2	39.834169	142.421875	182.256044	Composite			
3	45.616593	113.338542	158.955135	Composite			
4	36.499516	96.760228	133.259744	Composite			

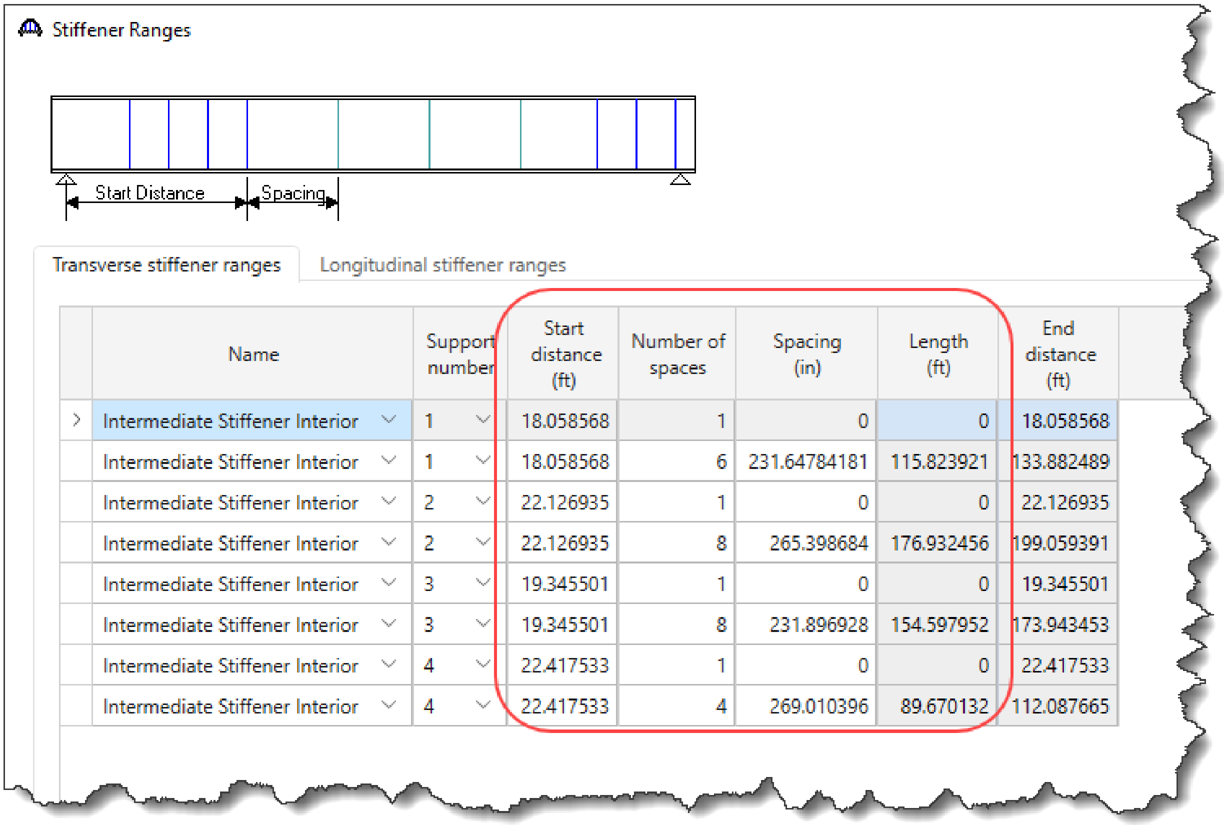
Haunch Profile



Lateral Support



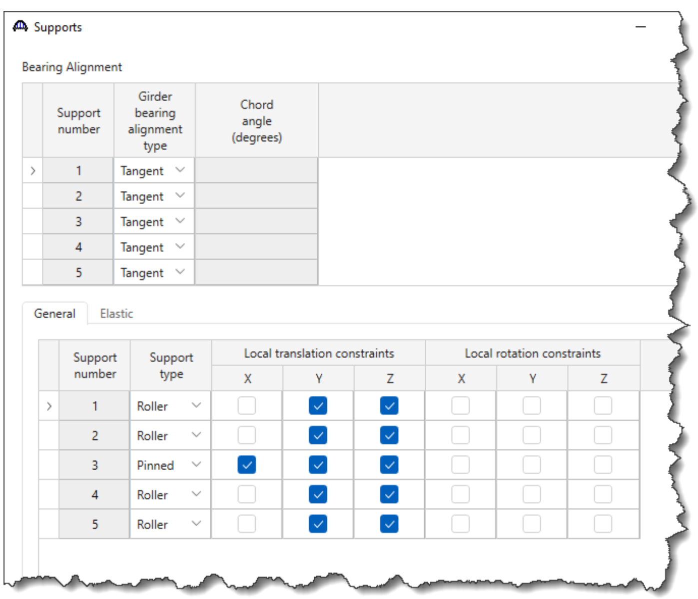
Stiffener Ranges



Name	Support number	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
Intermediate Stiffener Interior	1	18.058568	1	0	0	18.058568
Intermediate Stiffener Interior	1	18.058568	6	231.64784181	115.823921	133.882489
Intermediate Stiffener Interior	2	22.126935	1	0	0	22.126935
Intermediate Stiffener Interior	2	22.126935	8	265.398684	176.932456	199.059391
Intermediate Stiffener Interior	3	19.345501	1	0	0	19.345501
Intermediate Stiffener Interior	3	19.345501	8	231.896928	154.597952	173.943453
Intermediate Stiffener Interior	4	22.417533	1	0	0	22.417533
Intermediate Stiffener Interior	4	22.417533	4	269.010396	89.670132	112.087665

Member G4

Supports

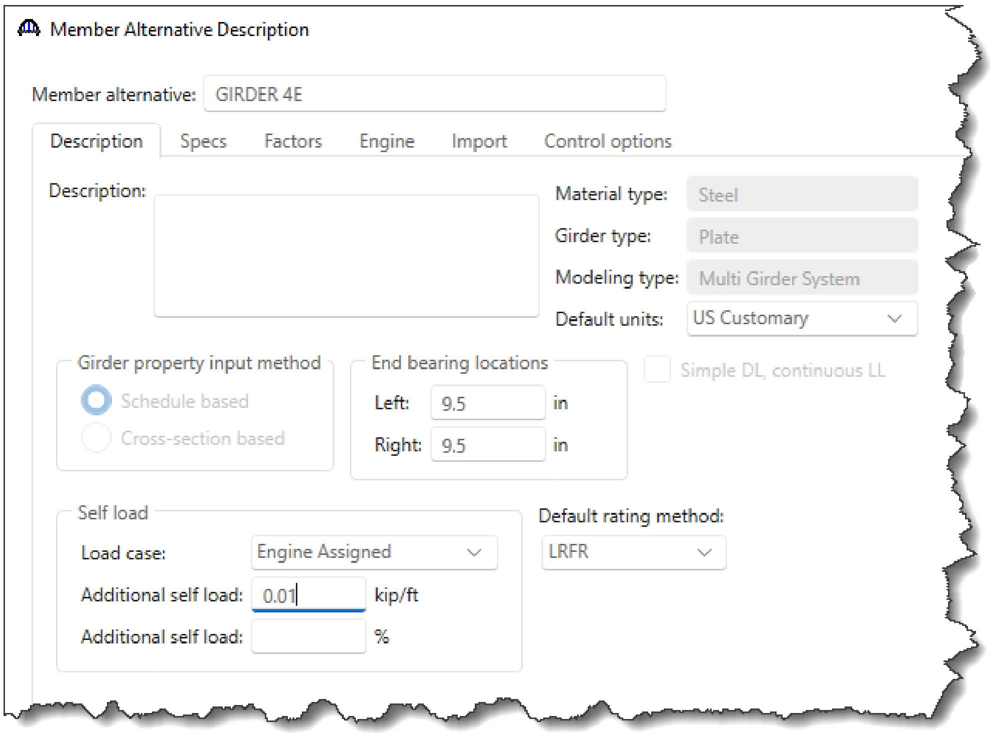


Support number	Girder bearing alignment type	Chord angle (degrees)
1	Tangent	
2	Tangent	
3	Tangent	
4	Tangent	
5	Tangent	

Support number	Support type	Local translation constraints X	Y	Z	Local rotation constraints X	Y	Z
1	Roller	☐	☑	☑	☐	☐	☐
2	Roller	☐	☑	☑	☐	☐	☐
3	Pinned	☑	☑	☑	☐	☐	☐
4	Roller	☐	☑	☑	☐	☐	☐
5	Roller	☐	☑	☑	☐	☐	☐

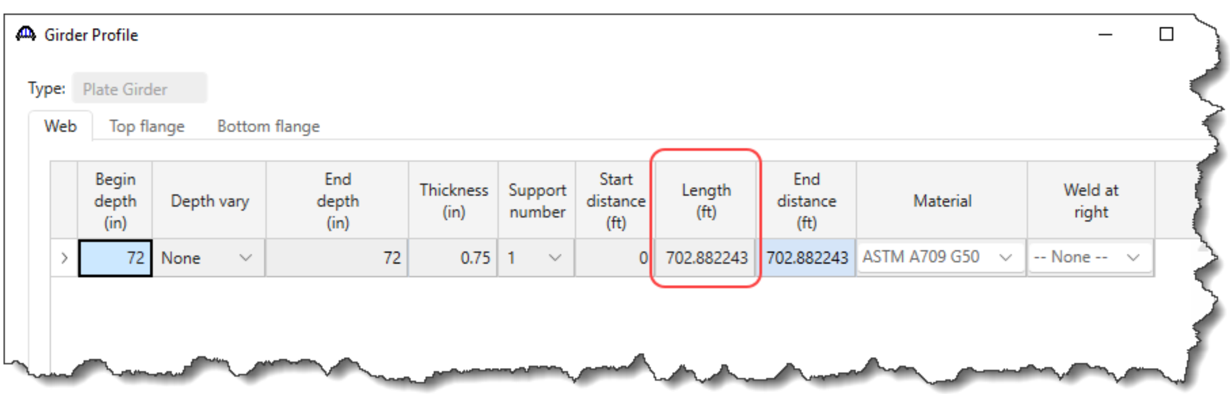
Member Alternative Description

Use the Copy and Paste method discussed in the last section to copy member alternative from member G1 to G4 and rename it as shown below. Also uncheck the **Must consider user input lateral bending stress** checkbox in **Control options** tab as shown for member **G1.**

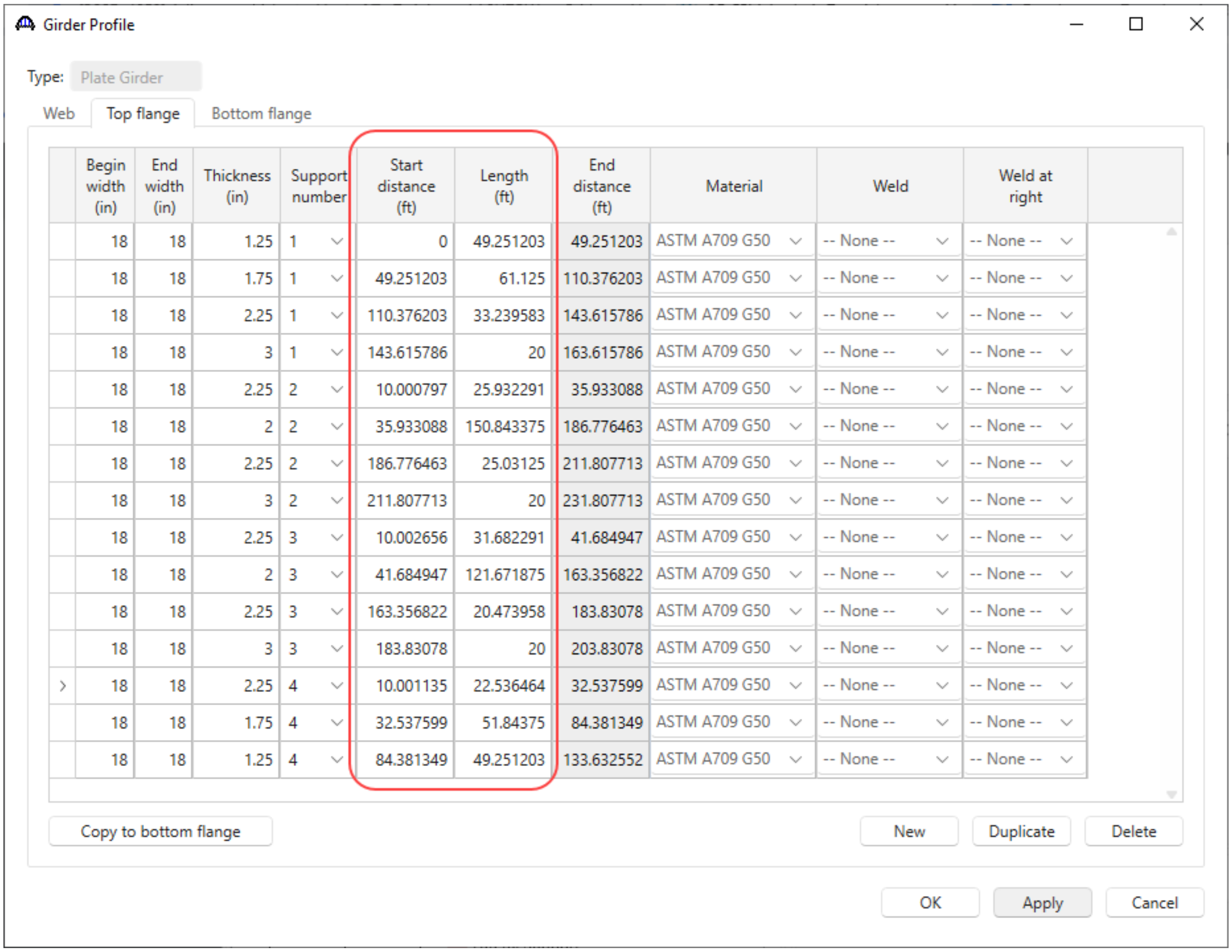


Now visit the following windows for this member alternative and make the necessary changes as shown below similar to the changes made for G2.

Girder Profile – Web

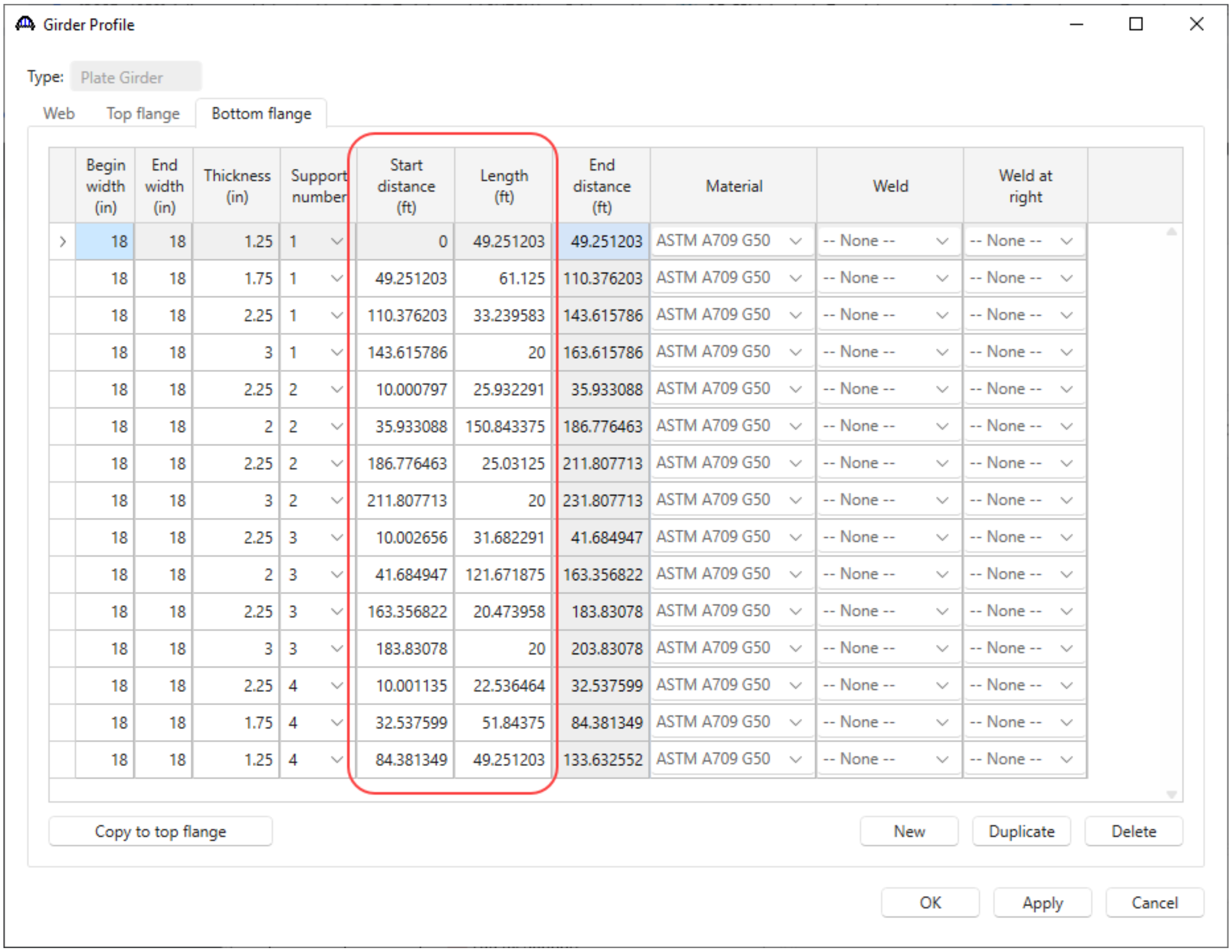


Girder Profile – Top flange



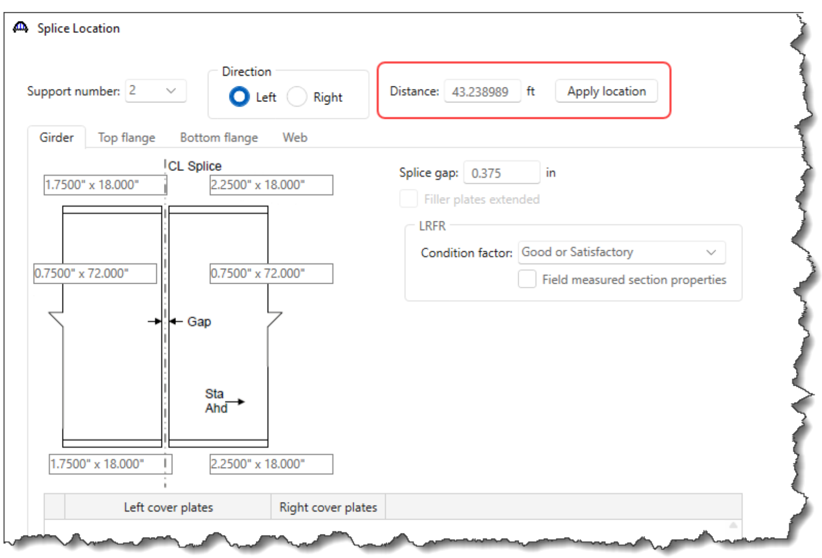
Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.251203	49.251203	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.251203	61.125	110.376203	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	110.376203	33.239583	143.615786	ASTM A709 G50	-- None --	-- None --
18	18	3	1	143.615786	20	163.615786	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	10.000797	25.932291	35.933088	ASTM A709 G50	-- None --	-- None --
18	18	2	2	35.933088	150.843375	186.776463	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	186.776463	25.03125	211.807713	ASTM A709 G50	-- None --	-- None --
18	18	3	2	211.807713	20	231.807713	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	10.002656	31.682291	41.684947	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.684947	121.671875	163.356822	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	163.356822	20.473958	183.83078	ASTM A709 G50	-- None --	-- None --
18	18	3	3	183.83078	20	203.83078	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	10.001135	22.536464	32.537599	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.537599	51.84375	84.381349	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	84.381349	49.251203	133.632552	ASTM A709 G50	-- None --	-- None --

Girder Profile – Bottom flange

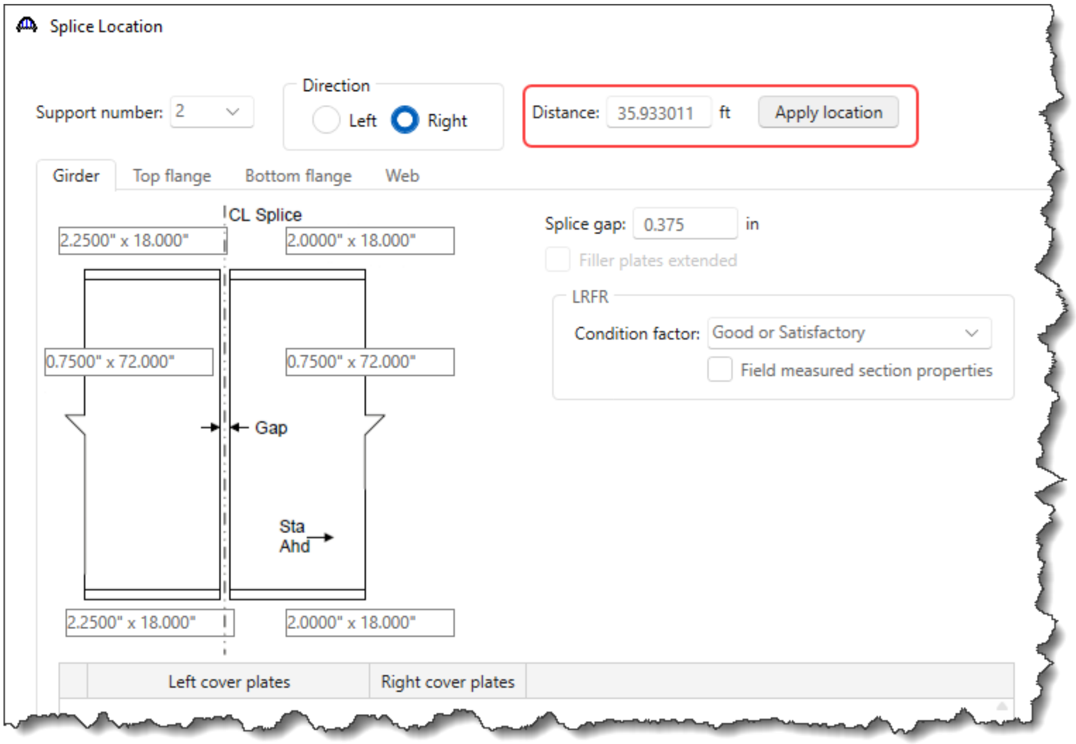


Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.251203	49.251203	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.251203	61.125	110.376203	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	110.376203	33.239583	143.615786	ASTM A709 G50	-- None --	-- None --
18	18	3	1	143.615786	20	163.615786	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	10.000797	25.932291	35.933088	ASTM A709 G50	-- None --	-- None --
18	18	2	2	35.933088	150.843375	186.776463	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	186.776463	25.03125	211.807713	ASTM A709 G50	-- None --	-- None --
18	18	3	2	211.807713	20	231.807713	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	10.002656	31.682291	41.684947	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.684947	121.671875	163.356822	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	163.356822	20.473958	183.83078	ASTM A709 G50	-- None --	-- None --
18	18	3	3	183.83078	20	203.83078	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	10.001135	22.536464	32.537599	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.537599	51.84375	84.381349	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	84.381349	49.251203	133.632552	ASTM A709 G50	-- None --	-- None --

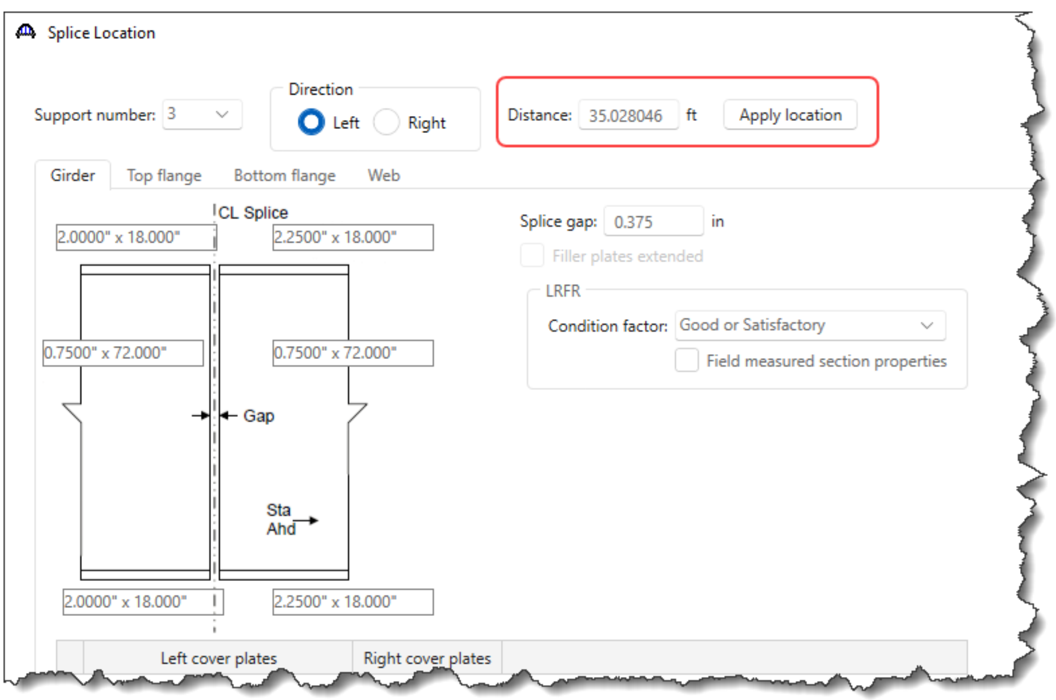
Splice Location 1



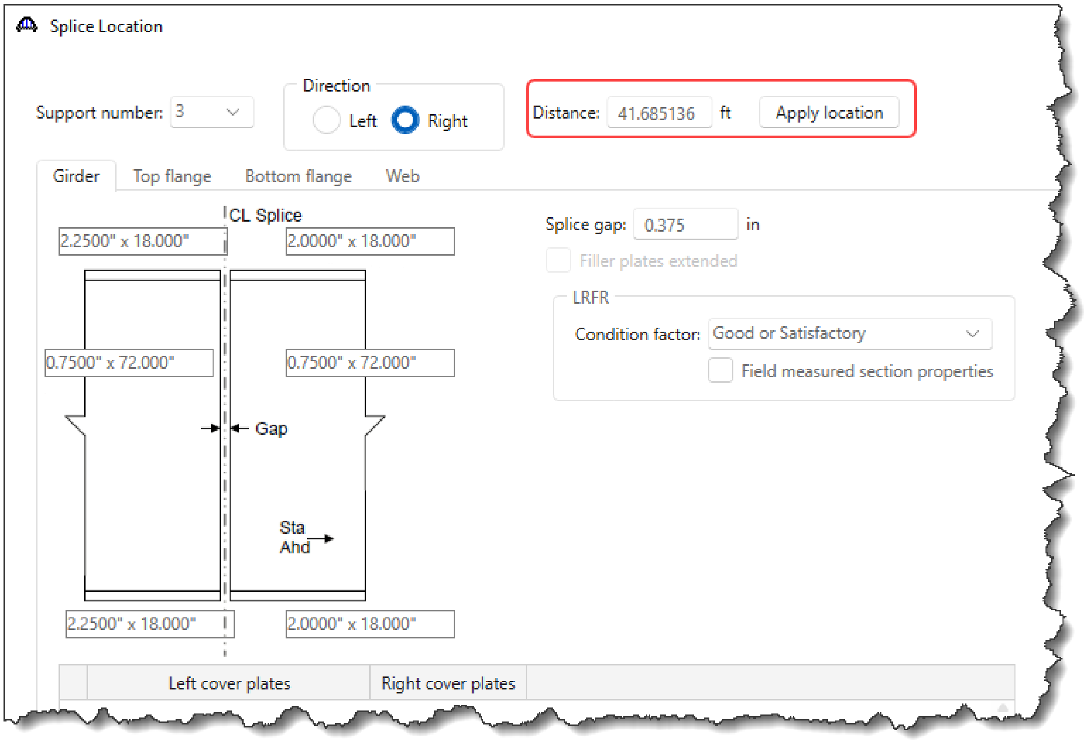
Splice Location 2



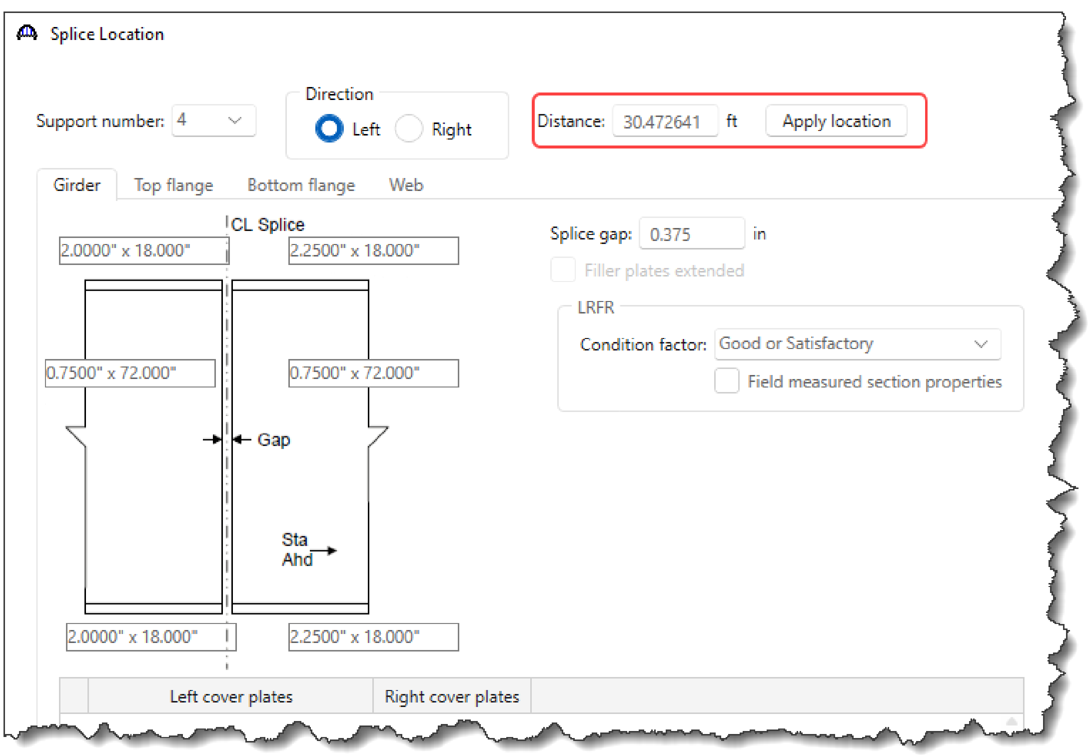
Splice Location 3



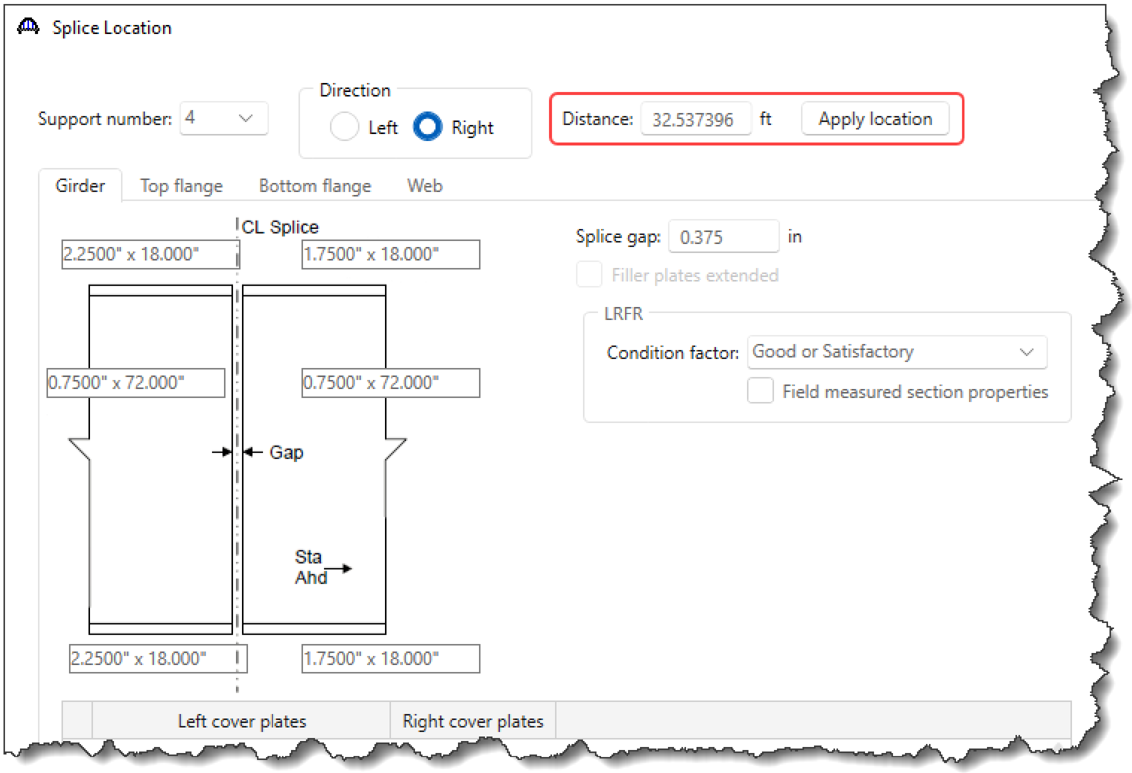
Splice Location 4



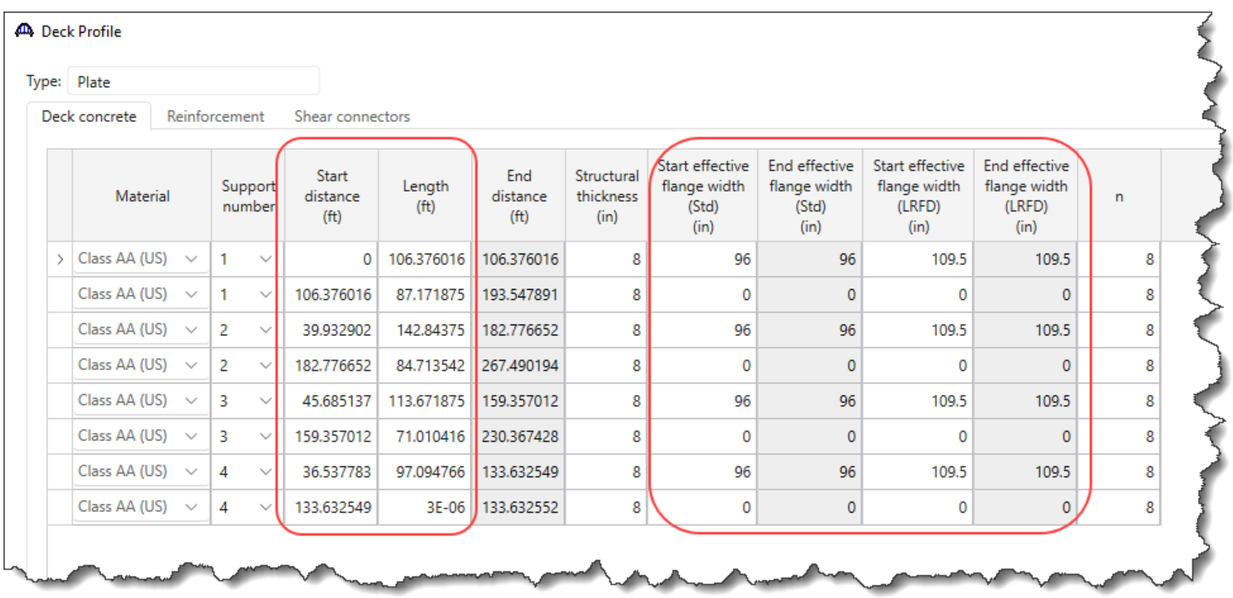
Splice Location 5



Splice Location 6

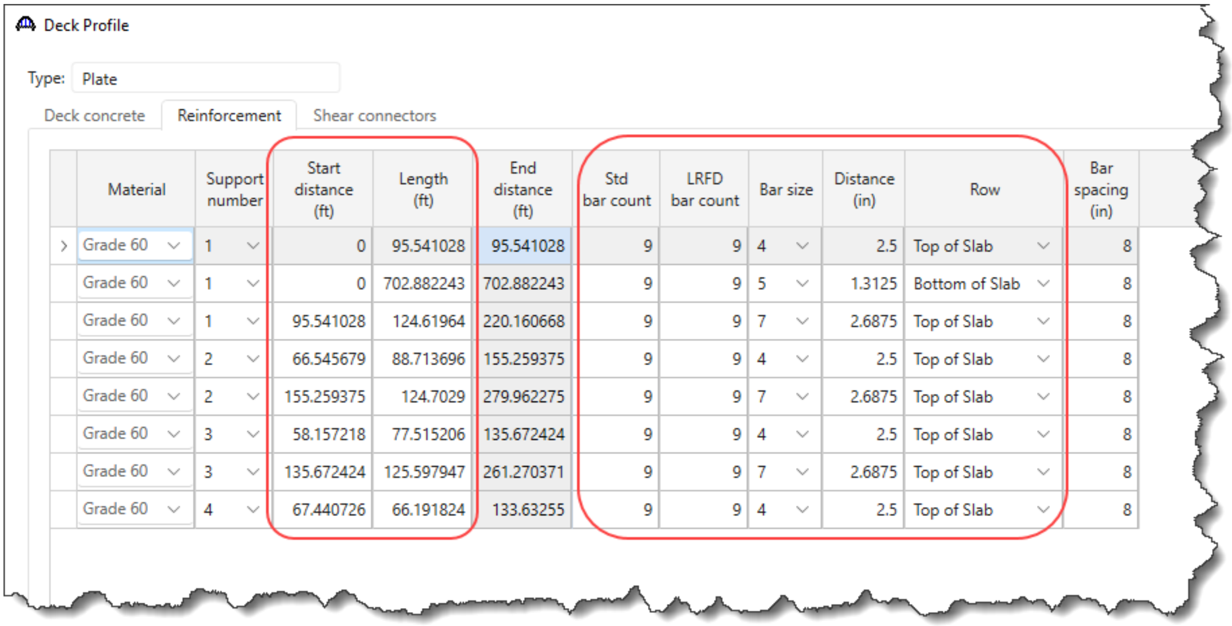


Deck Profile – Deck concrete



Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	106.376016	106.376016	8	96	96	109.5	109.5	8
Class AA (US)	1	106.376016	87.171875	193.547891	8	0	0	0	0	8
Class AA (US)	2	39.932902	142.84375	182.776652	8	96	96	109.5	109.5	8
Class AA (US)	2	182.776652	84.713542	267.490194	8	0	0	0	0	8
Class AA (US)	3	45.685137	113.671875	159.357012	8	96	96	109.5	109.5	8
Class AA (US)	3	159.357012	71.010416	230.367428	8	0	0	0	0	8
Class AA (US)	4	36.537783	97.094766	133.632549	8	96	96	109.5	109.5	8
Class AA (US)	4	133.632549	3E-06	133.632552	8	0	0	0	0	8

Deck Profile – Reinforcement

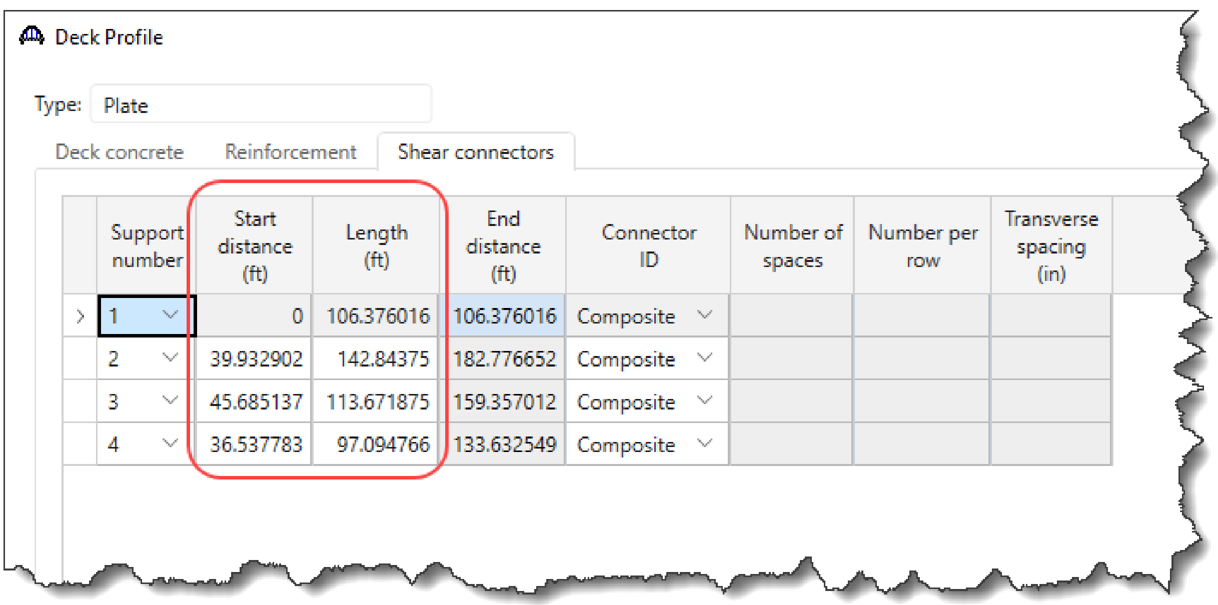

Deck Profile

Type: Plate

Deck concrete | Reinforcement | Shear connectors

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	0	95.541028	95.541028	9	9	4	2.5	Top of Slab	8
Grade 60	1	0	702.882243	702.882243	9	9	5	1.3125	Bottom of Slab	8
Grade 60	1	95.541028	124.61964	220.160668	9	9	7	2.6875	Top of Slab	8
Grade 60	2	66.545679	88.713696	155.259375	9	9	4	2.5	Top of Slab	8
Grade 60	2	155.259375	124.7029	279.962275	9	9	7	2.6875	Top of Slab	8
Grade 60	3	58.157218	77.515206	135.672424	9	9	4	2.5	Top of Slab	8
Grade 60	3	135.672424	125.597947	261.270371	9	9	7	2.6875	Top of Slab	8
Grade 60	4	67.440726	66.191824	133.63255	9	9	4	2.5	Top of Slab	8

Deck Profile – Shear connectors

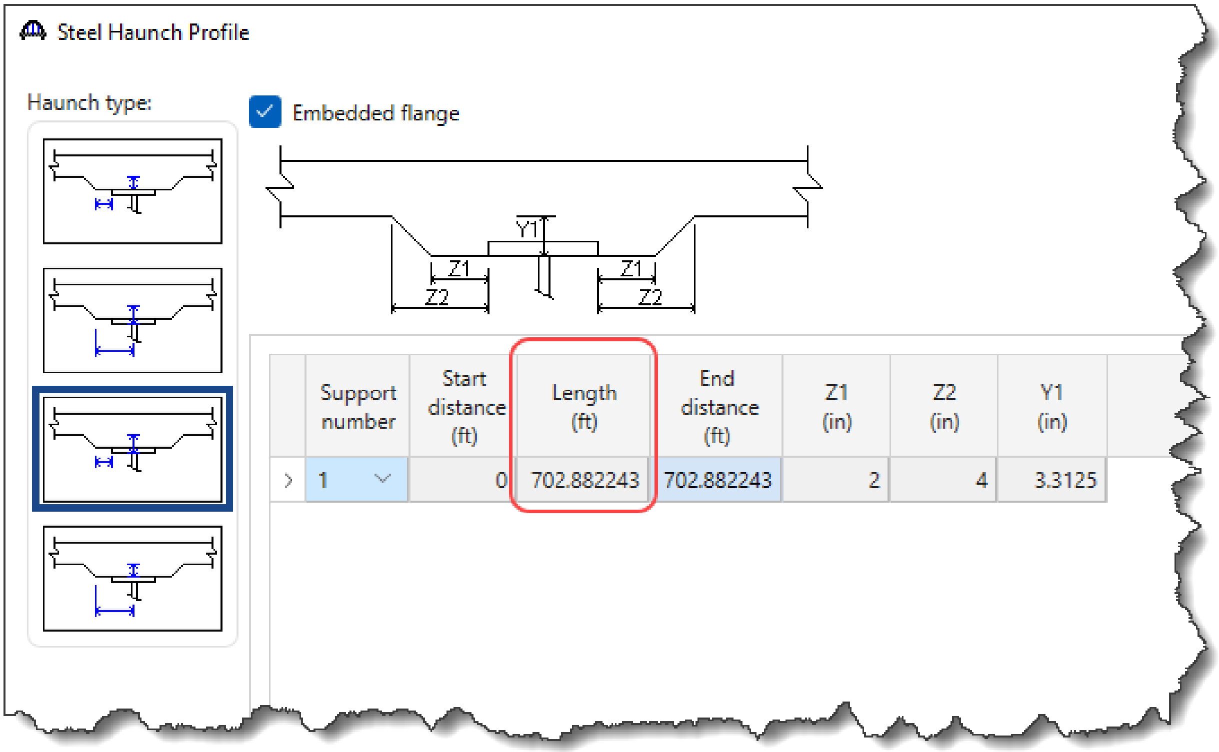

Deck Profile

Type: Plate

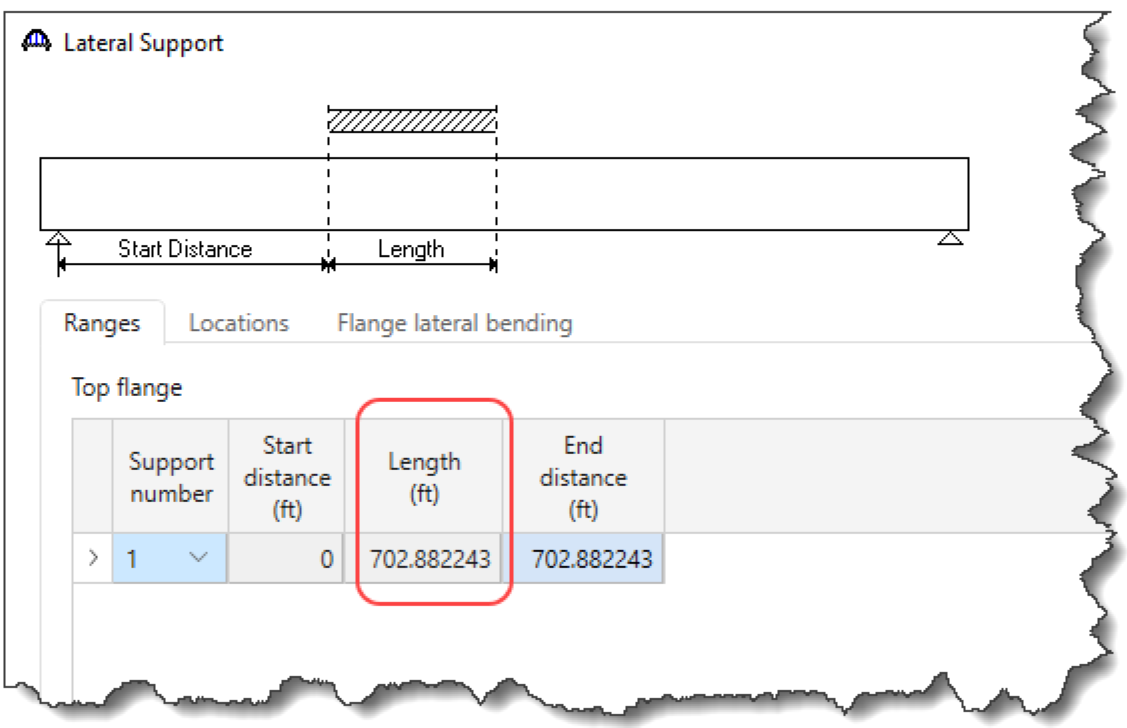
Deck concrete | Reinforcement | Shear connectors

Support number	Start distance (ft)	Length (ft)	End distance (ft)	Connector ID	Number of spaces	Number per row	Transverse spacing (in)
1	0	106.376016	106.376016	Composite			
2	39.932902	142.84375	182.776652	Composite			
3	45.685137	113.671875	159.357012	Composite			
4	36.537783	97.094766	133.632549	Composite			

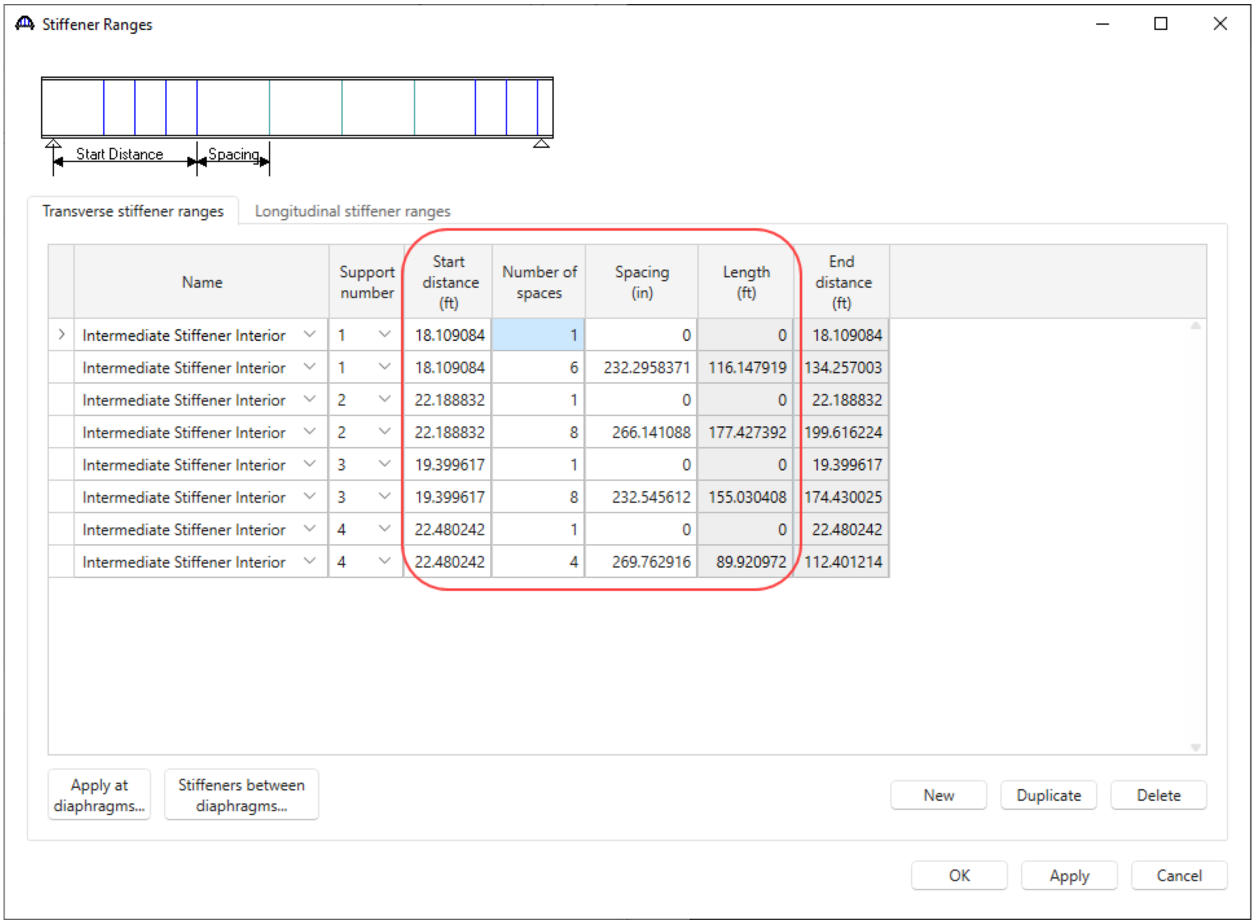
Haunch Profile



Lateral Support



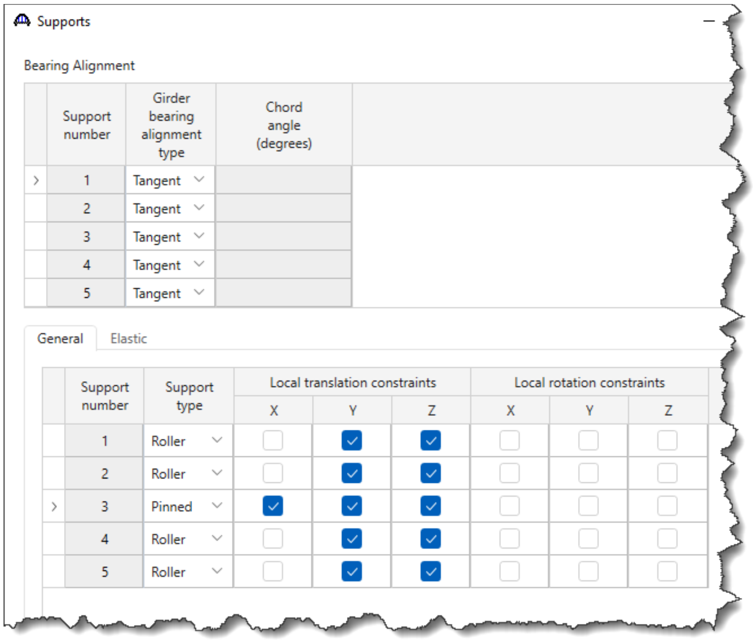
Stiffener Ranges



Name	Support number	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
Intermediate Stiffener Interior	1	18.109084	1	0	0	18.109084
Intermediate Stiffener Interior	1	18.109084	6	232.2958371	116.147919	134.257003
Intermediate Stiffener Interior	2	22.188832	1	0	0	22.188832
Intermediate Stiffener Interior	2	22.188832	8	266.141088	177.427392	199.616224
Intermediate Stiffener Interior	3	19.399617	1	0	0	19.399617
Intermediate Stiffener Interior	3	19.399617	8	232.545612	155.030408	174.430025
Intermediate Stiffener Interior	4	22.480242	1	0	0	22.480242
Intermediate Stiffener Interior	4	22.480242	4	269.762916	89.920972	112.401214

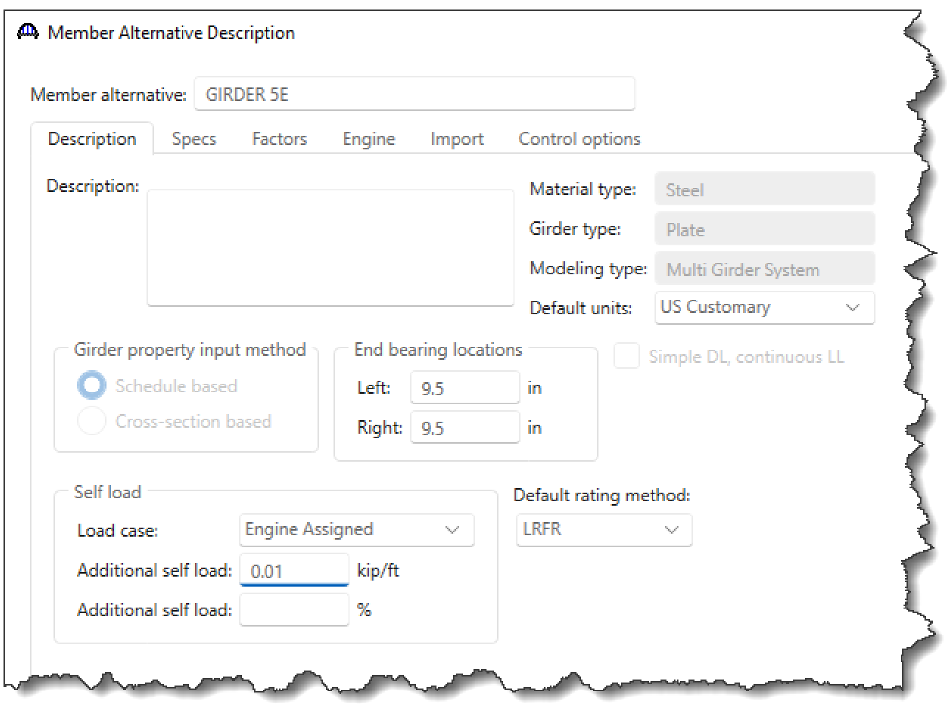
Member G5

Supports



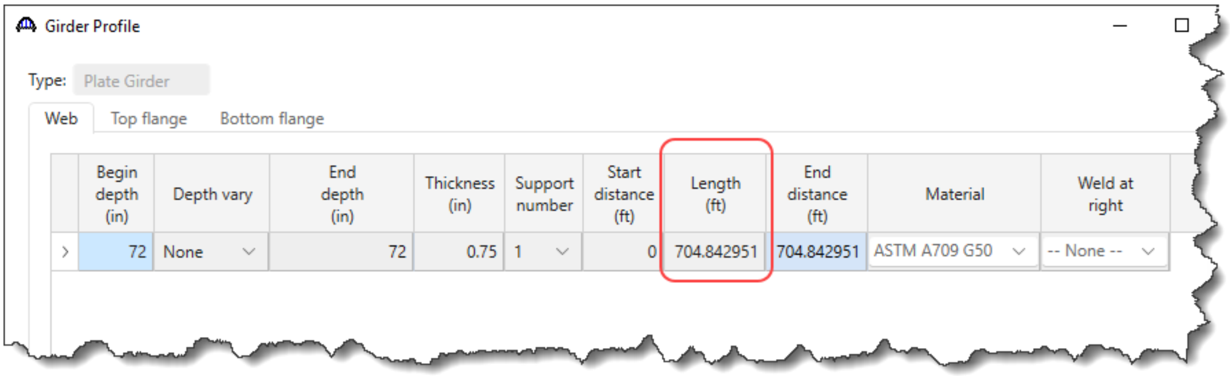
Member Alternative Description

Use the Copy and Paste method discussed in the last section to copy member alternative from member G1 to G5 rename it as shown below. Also uncheck the **Must consider user input lateral bending stress** checkbox in **Control options** tab as shown for member **G1.**



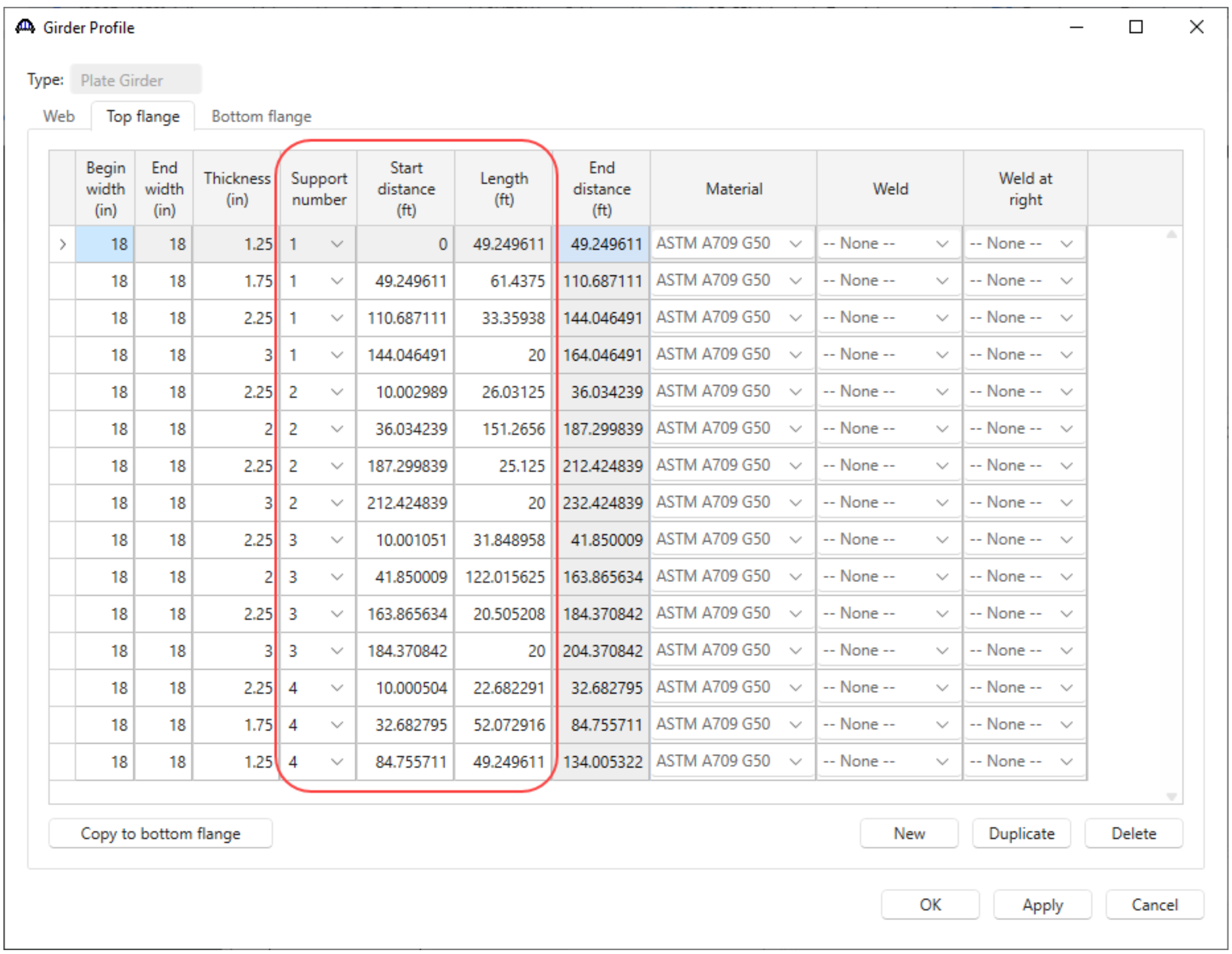
Now visit the following windows for this member alternative and make the necessary changes as shown below similar to the changes made for G2.

Girder Profile – Web



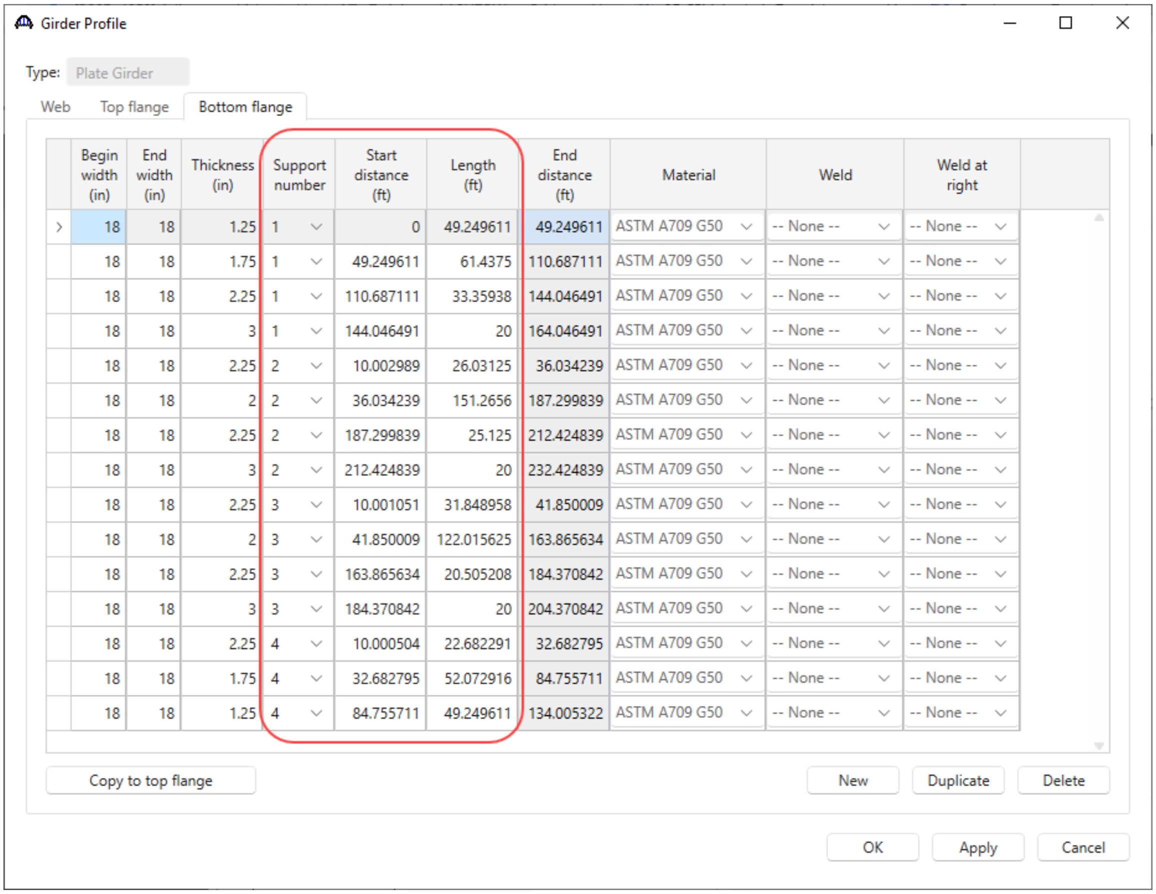
Begin depth (in)	Depth vary	End depth (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld at right
72	None	72	0.75	1	0	704.842951	704.842951	ASTM A709 G50	-- None --

Girder Profile – Top flange



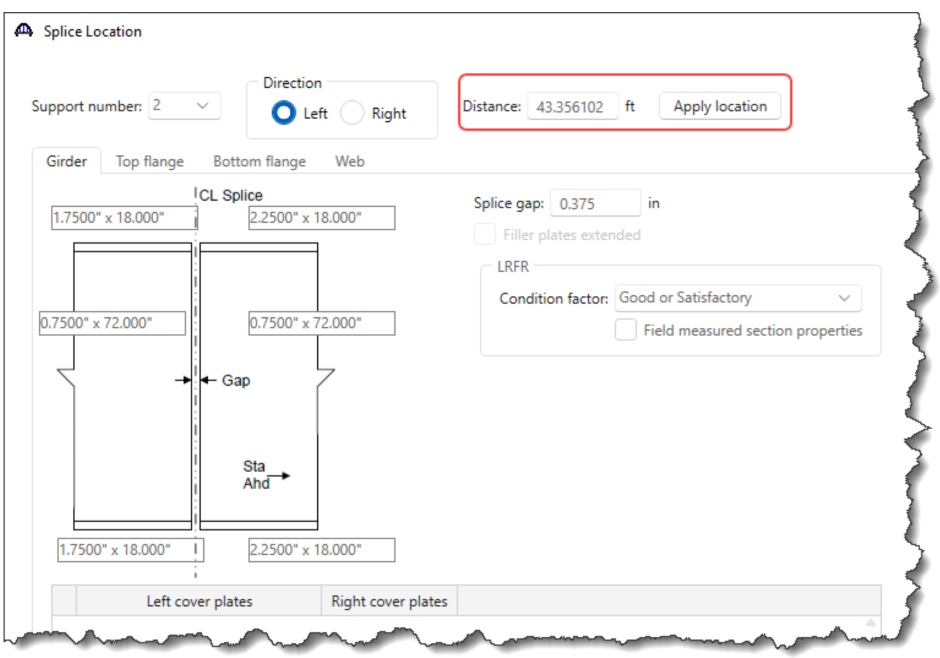
Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.249611	49.249611	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.249611	61.4375	110.687111	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	110.687111	33.35938	144.046491	ASTM A709 G50	-- None --	-- None --
18	18	3	1	144.046491	20	164.046491	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	10.002989	26.03125	36.034239	ASTM A709 G50	-- None --	-- None --
18	18	2	2	36.034239	151.2656	187.299839	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	187.299839	25.125	212.424839	ASTM A709 G50	-- None --	-- None --
18	18	3	2	212.424839	20	232.424839	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	10.001051	31.848958	41.850009	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.850009	122.015625	163.865634	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	163.865634	20.505208	184.370842	ASTM A709 G50	-- None --	-- None --
18	18	3	3	184.370842	20	204.370842	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	10.000504	22.682291	32.682795	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.682795	52.072916	84.755711	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	84.755711	49.249611	134.005322	ASTM A709 G50	-- None --	-- None --

Girder Profile – Bottom flange

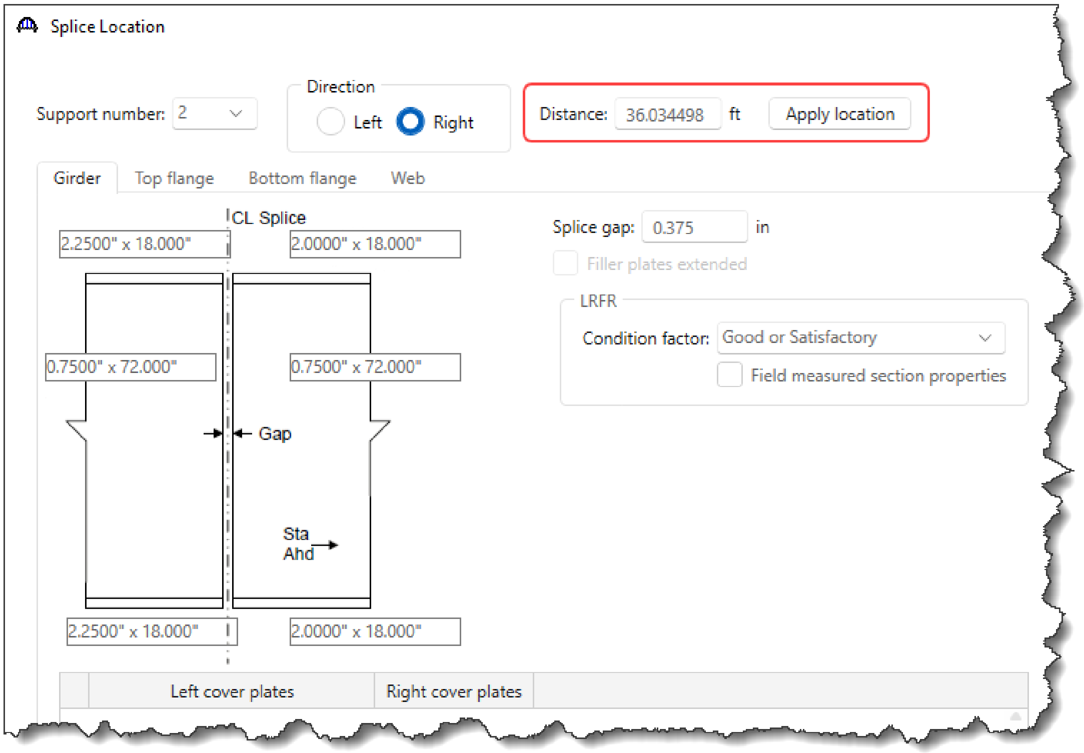


Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right
18	18	1.25	1	0	49.249611	49.249611	ASTM A709 G50	-- None --	-- None --
18	18	1.75	1	49.249611	61.4375	110.687111	ASTM A709 G50	-- None --	-- None --
18	18	2.25	1	110.687111	33.35938	144.046491	ASTM A709 G50	-- None --	-- None --
18	18	3	1	144.046491	20	164.046491	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	10.002989	26.03125	36.034239	ASTM A709 G50	-- None --	-- None --
18	18	2	2	36.034239	151.2656	187.299839	ASTM A709 G50	-- None --	-- None --
18	18	2.25	2	187.299839	25.125	212.424839	ASTM A709 G50	-- None --	-- None --
18	18	3	2	212.424839	20	232.424839	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	10.001051	31.848958	41.850009	ASTM A709 G50	-- None --	-- None --
18	18	2	3	41.850009	122.015625	163.865634	ASTM A709 G50	-- None --	-- None --
18	18	2.25	3	163.865634	20.505208	184.370842	ASTM A709 G50	-- None --	-- None --
18	18	3	3	184.370842	20	204.370842	ASTM A709 G50	-- None --	-- None --
18	18	2.25	4	10.000504	22.682291	32.682795	ASTM A709 G50	-- None --	-- None --
18	18	1.75	4	32.682795	52.072916	84.755711	ASTM A709 G50	-- None --	-- None --
18	18	1.25	4	84.755711	49.249611	134.005322	ASTM A709 G50	-- None --	-- None --

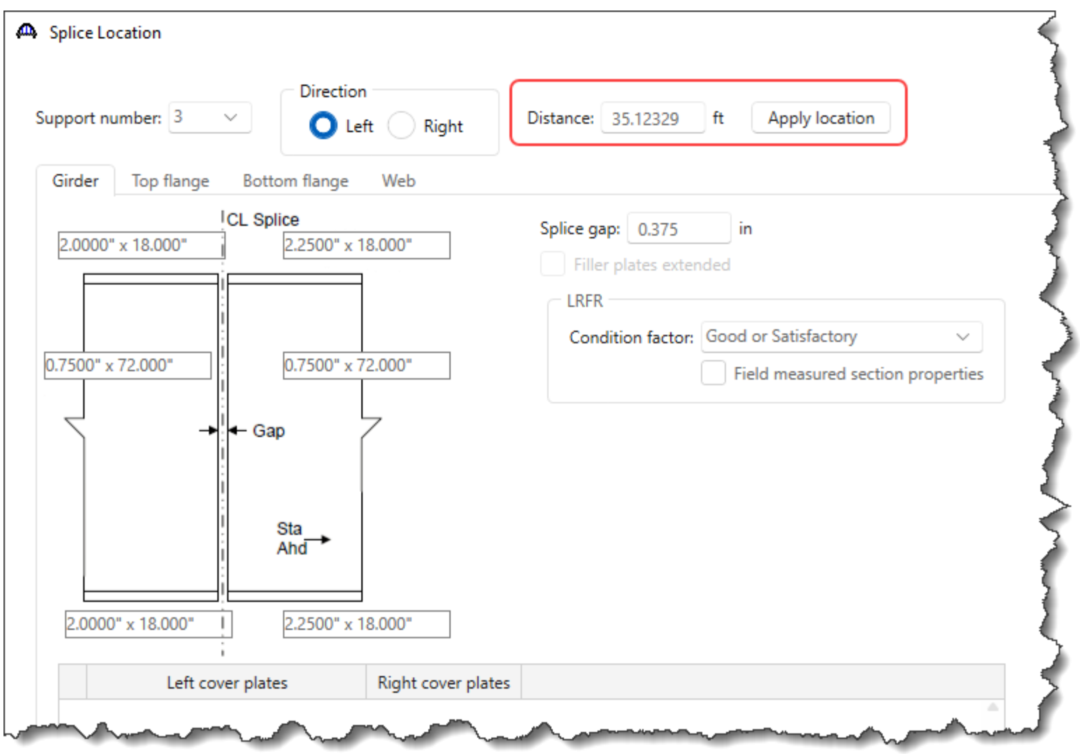
Splice Location 1



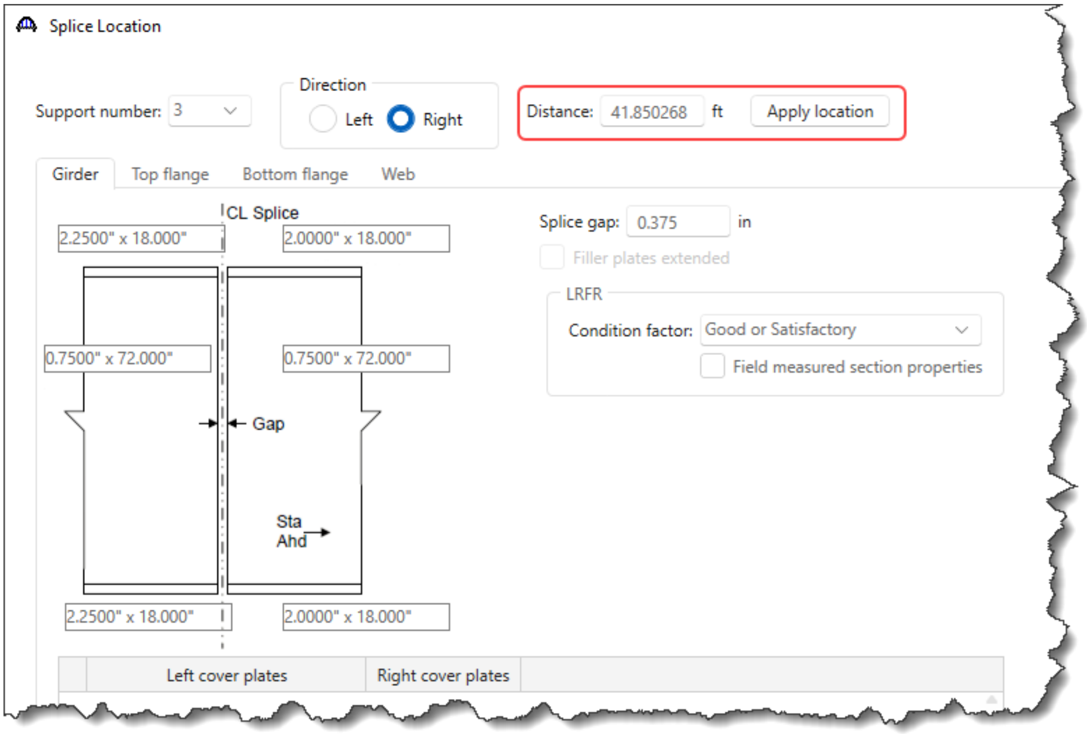
Splice Location 2



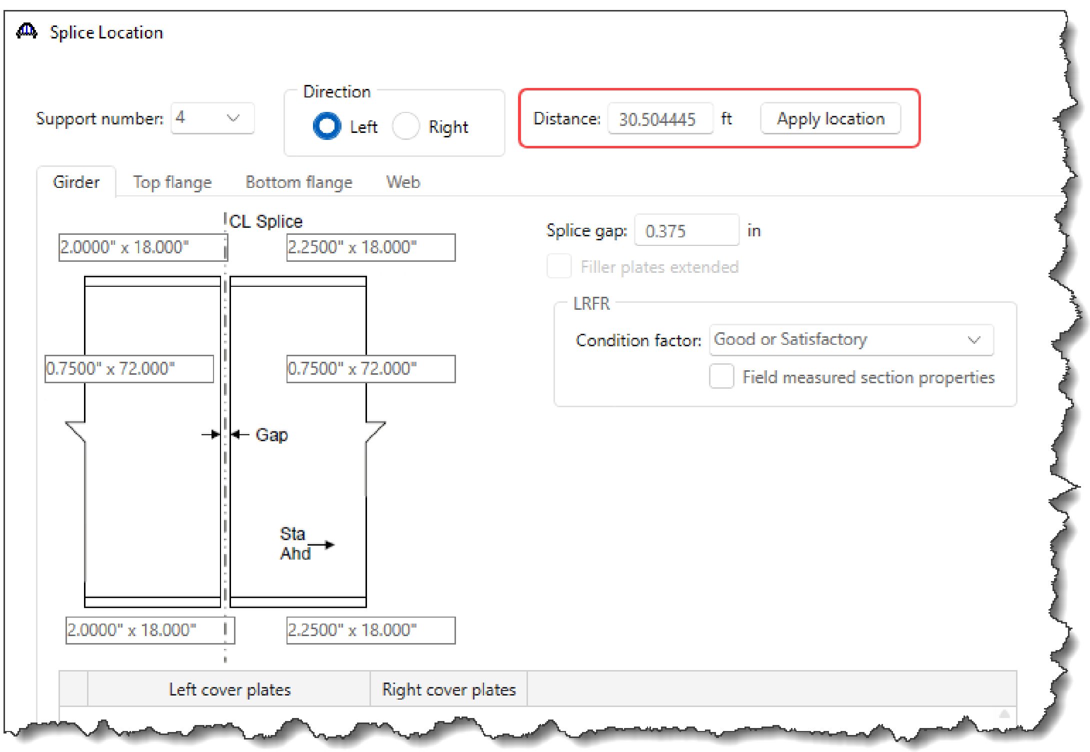
Splice Location 3



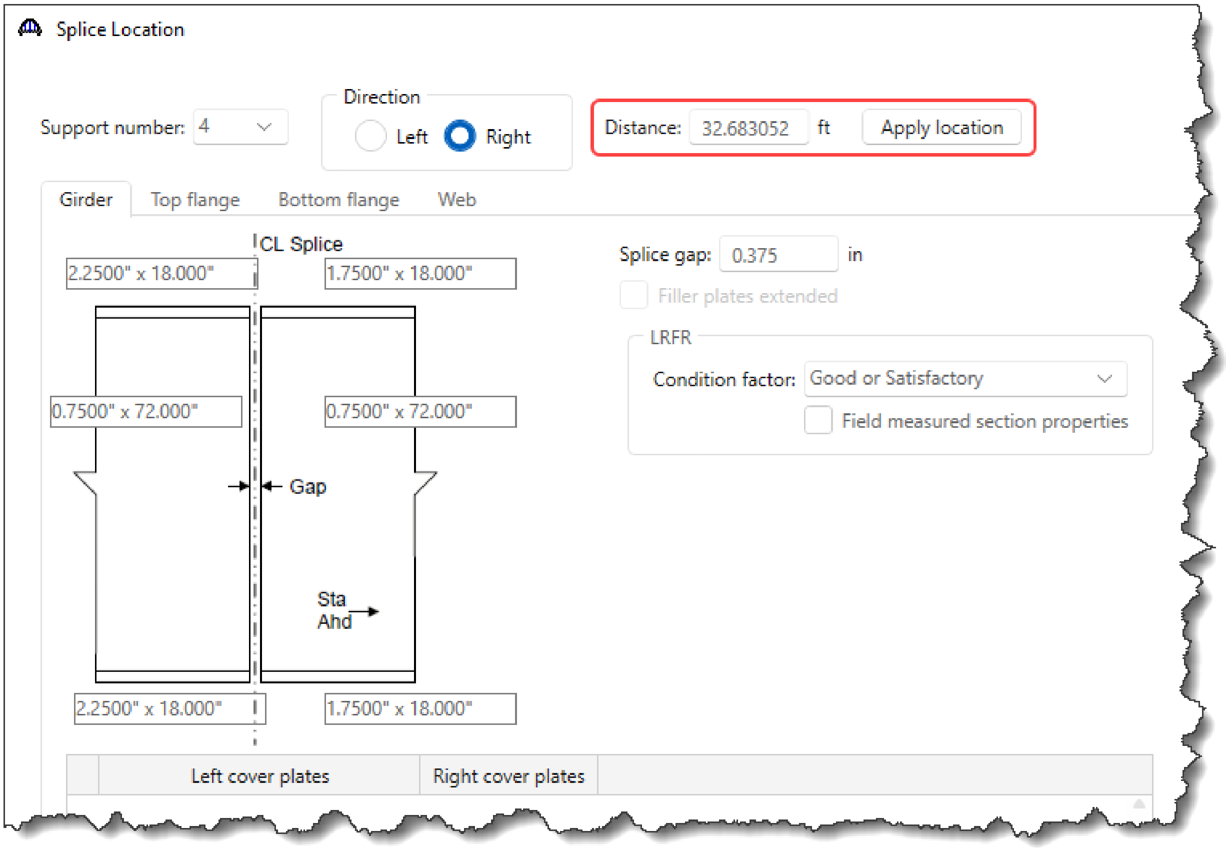
Splice Location 4



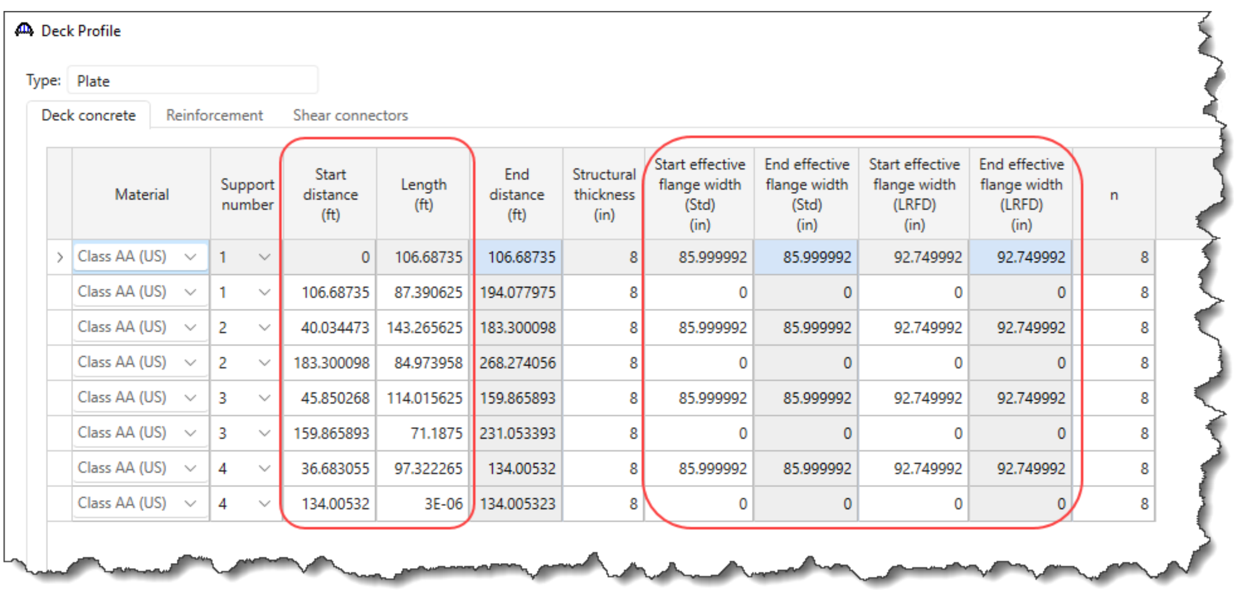
Splice Location 5



Splice Location 6

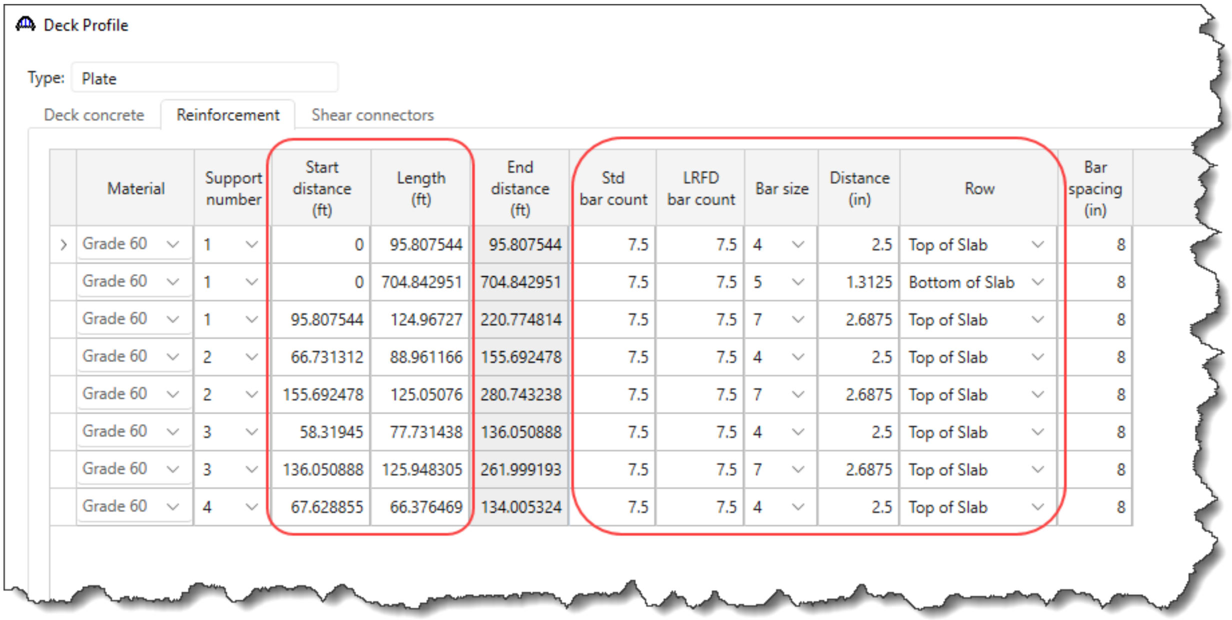


Deck Profile – Deck concrete



Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	106.68735	106.68735	8	85.999992	85.999992	92.749992	92.749992	8
Class AA (US)	1	106.68735	87.390625	194.077975	8	0	0	0	0	8
Class AA (US)	2	40.034473	143.265625	183.300098	8	85.999992	85.999992	92.749992	92.749992	8
Class AA (US)	2	183.300098	84.973958	268.274056	8	0	0	0	0	8
Class AA (US)	3	45.850268	114.015625	159.865893	8	85.999992	85.999992	92.749992	92.749992	8
Class AA (US)	3	159.865893	71.1875	231.053393	8	0	0	0	0	8
Class AA (US)	4	36.683055	97.322265	134.00532	8	85.999992	85.999992	92.749992	92.749992	8
Class AA (US)	4	134.00532	3E-06	134.005323	8	0	0	0	0	8

Deck Profile – Reinforcement



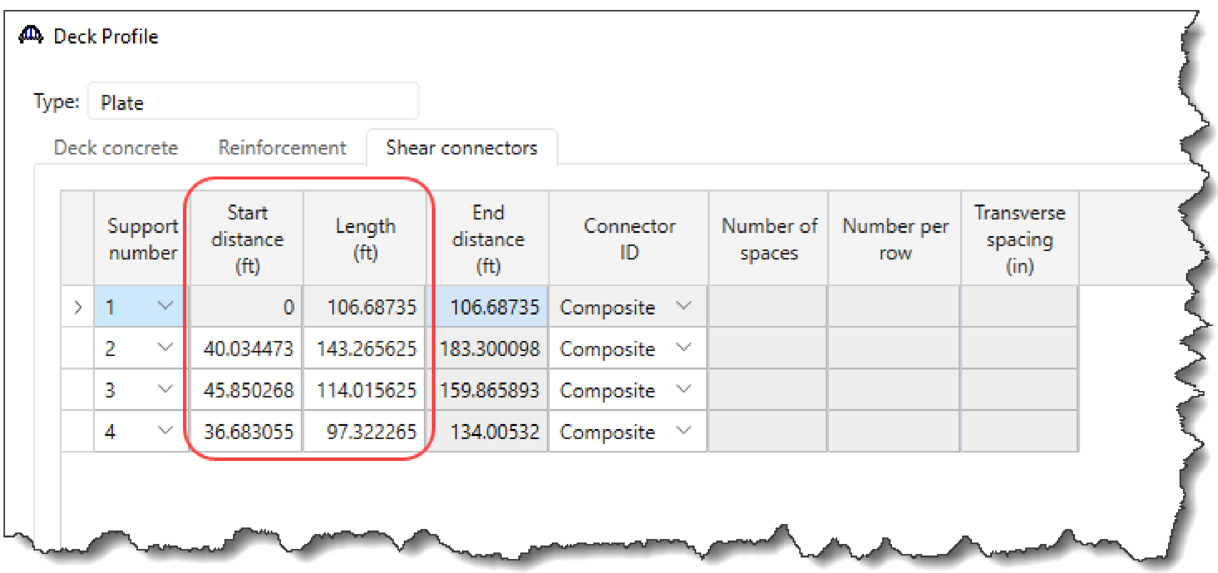
Deck Profile

Type: Plate

Deck concrete | Reinforcement | Shear connectors

	Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
>	Grade 60	1	0	95.807544	95.807544	7.5	7.5	4	2.5	Top of Slab	8
	Grade 60	1	0	704.842951	704.842951	7.5	7.5	5	1.3125	Bottom of Slab	8
	Grade 60	1	95.807544	124.96727	220.774814	7.5	7.5	7	2.6875	Top of Slab	8
	Grade 60	2	66.731312	88.961166	155.692478	7.5	7.5	4	2.5	Top of Slab	8
	Grade 60	2	155.692478	125.05076	280.743238	7.5	7.5	7	2.6875	Top of Slab	8
	Grade 60	3	58.31945	77.731438	136.050888	7.5	7.5	4	2.5	Top of Slab	8
	Grade 60	3	136.050888	125.948305	261.999193	7.5	7.5	7	2.6875	Top of Slab	8
	Grade 60	4	67.628855	66.376469	134.005324	7.5	7.5	4	2.5	Top of Slab	8

Deck Profile – Shear connectors



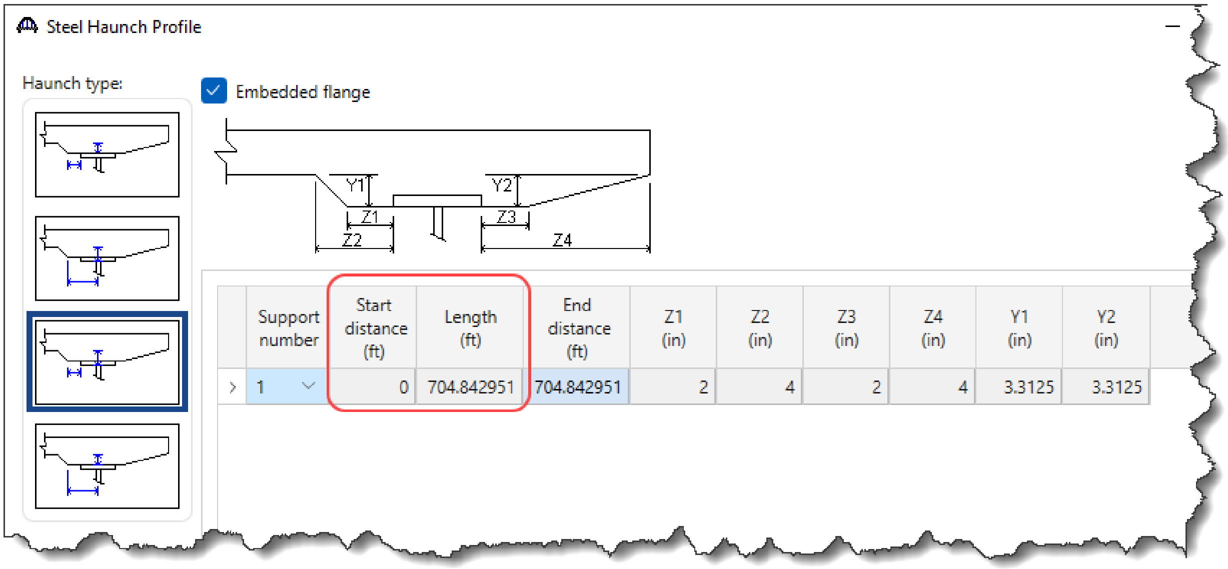
Deck Profile

Type: Plate

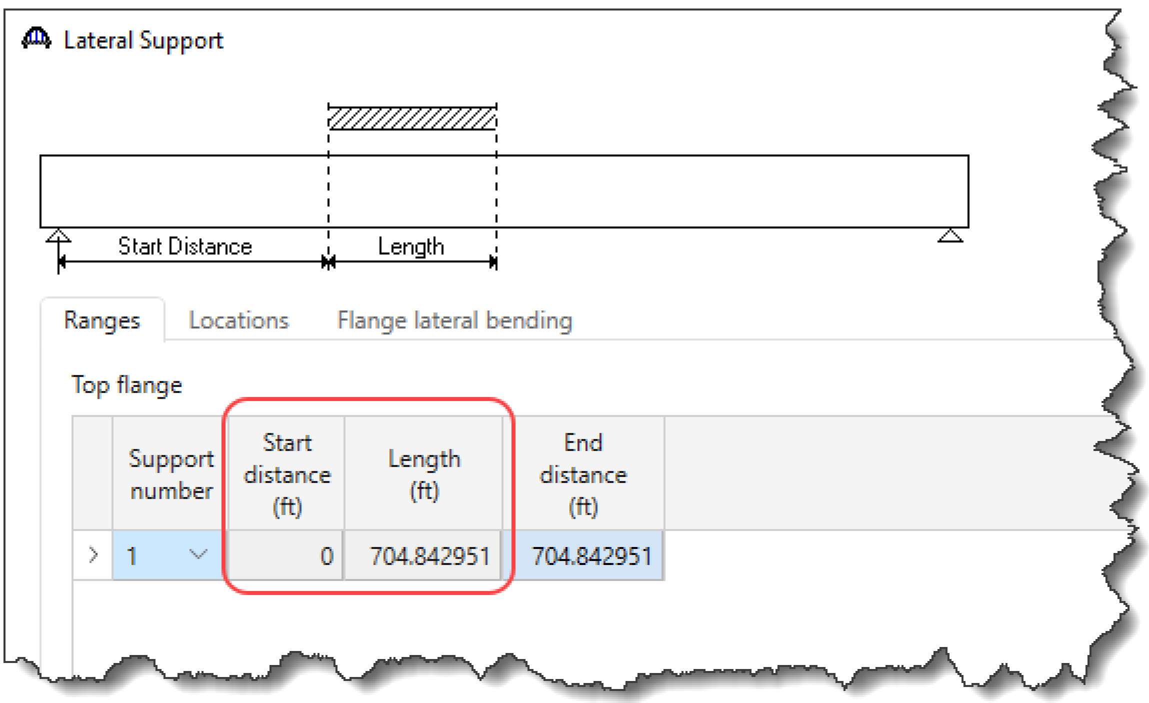
Deck concrete | Reinforcement | Shear connectors

	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Connector ID	Number of spaces	Number per row	Transverse spacing (in)
>	1	0	106.68735	106.68735	Composite			
	2	40.034473	143.265625	183.300098	Composite			
	3	45.850268	114.015625	159.865893	Composite			
	4	36.683055	97.322265	134.00532	Composite			

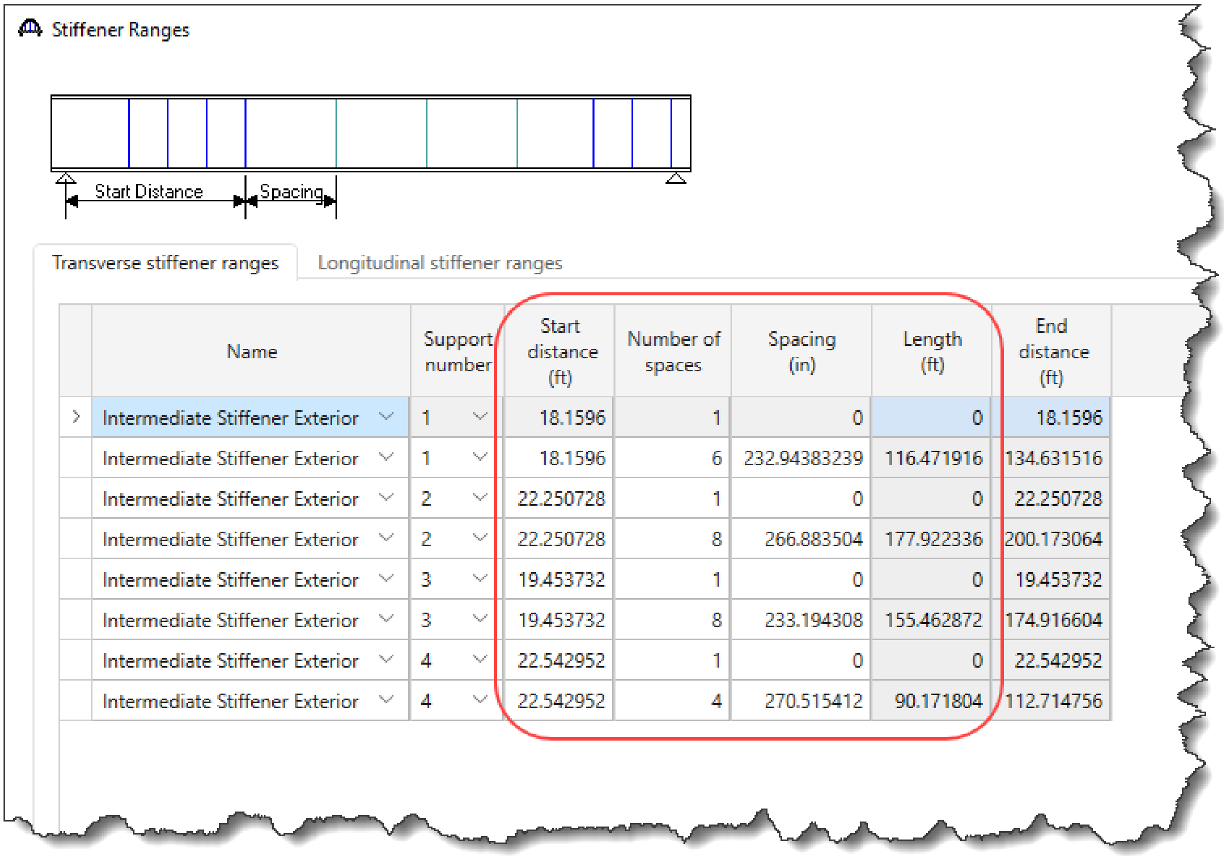
Haunch Profile



Lateral Support



Stiffener Ranges



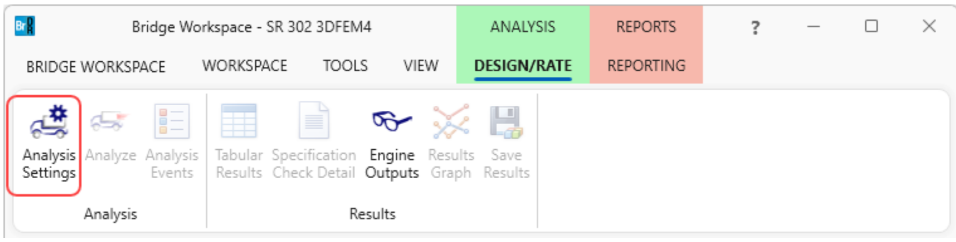
Name	Support number	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
Intermediate Stiffener Exterior	1	18.1596	1	0	0	18.1596
Intermediate Stiffener Exterior	1	18.1596	6	232.94383239	116.471916	134.631516
Intermediate Stiffener Exterior	2	22.250728	1	0	0	22.250728
Intermediate Stiffener Exterior	2	22.250728	8	266.883504	177.922336	200.173064
Intermediate Stiffener Exterior	3	19.453732	1	0	0	19.453732
Intermediate Stiffener Exterior	3	19.453732	8	233.194308	155.462872	174.916604
Intermediate Stiffener Exterior	4	22.542952	1	0	0	22.542952
Intermediate Stiffener Exterior	4	22.542952	4	270.515412	90.171804	112.714756

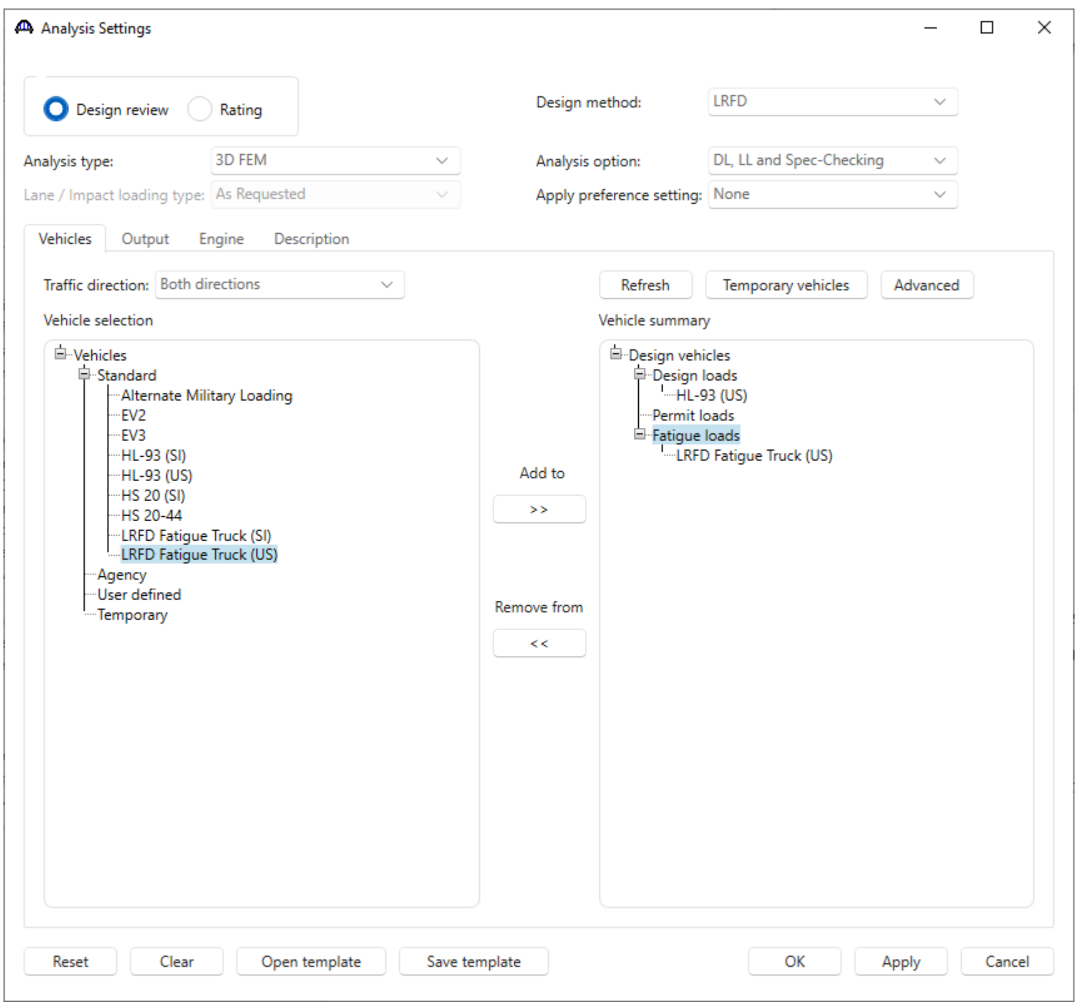
3D Analysis Settings

It is not recommended that users launch an analysis in training due to the large number of degrees of freedom in this example. The analysis runtime will require a 64 bit PC and adequate memory that is likely not available on attendee laptops.

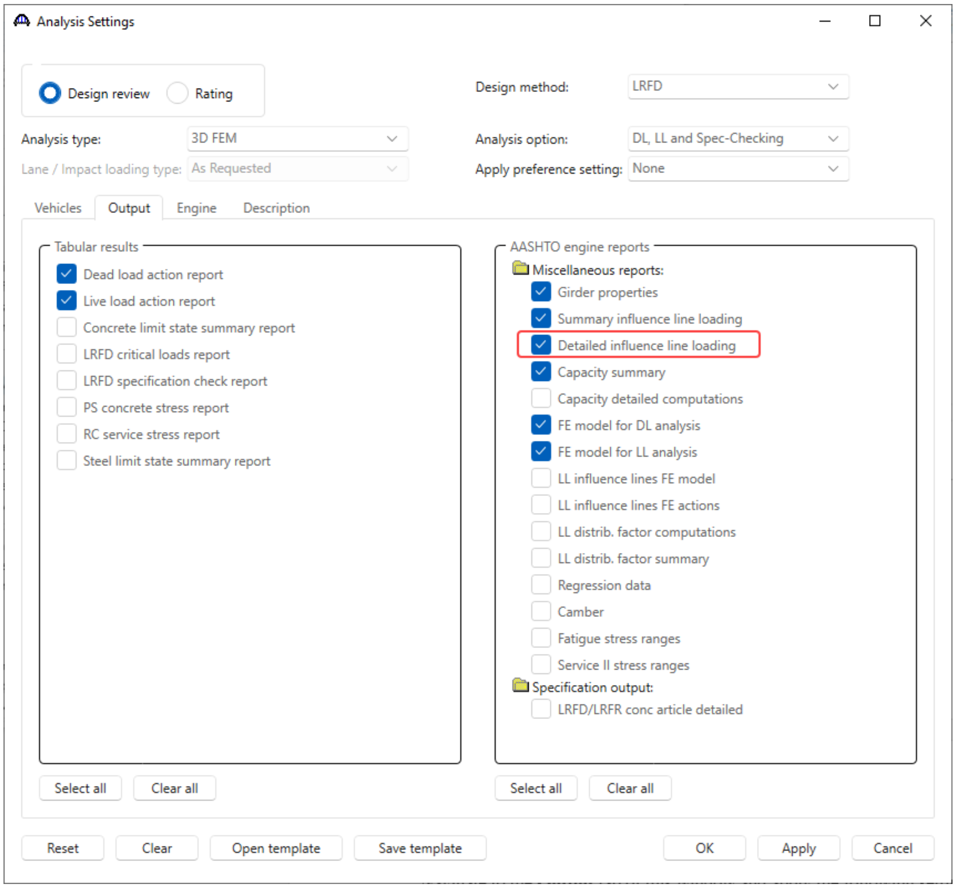
LRFD Design Review

To perform a 3D LRFD design review on the superstructure, from the **Analysis** group of the **DESIGN/RATE** ribbon, click on the **Analysis Settings** button to open the window shown below. Apply the following selections for an HL93 Design review.



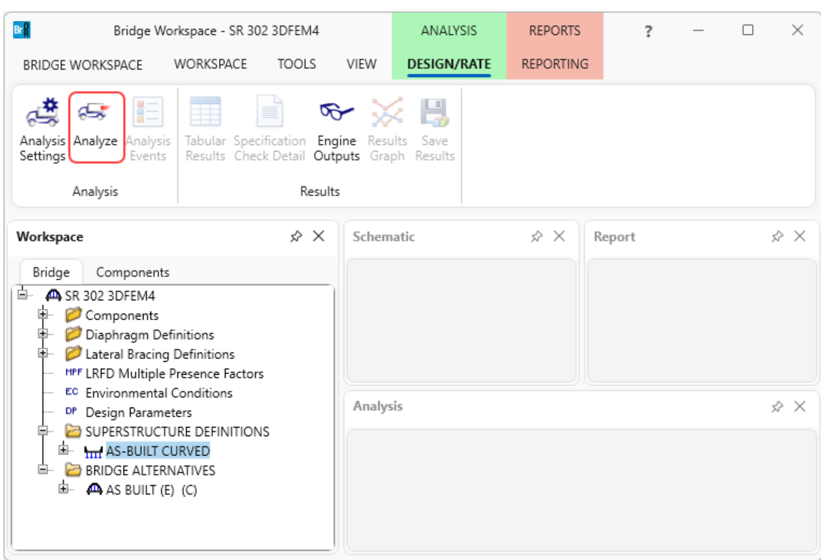


Navigate to the **Output** tab of this window and apply the following settings. Make sure to check the **Detailed influence line loading** checkbox to view the centrifugal force calculations.



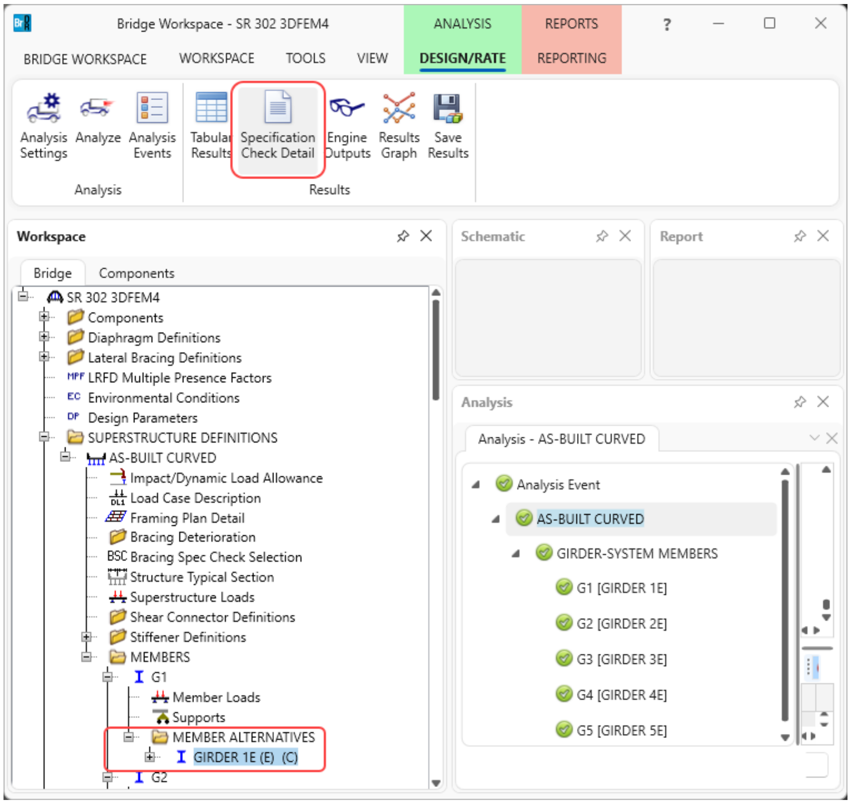
Click **OK** to apply the settings and close the window.

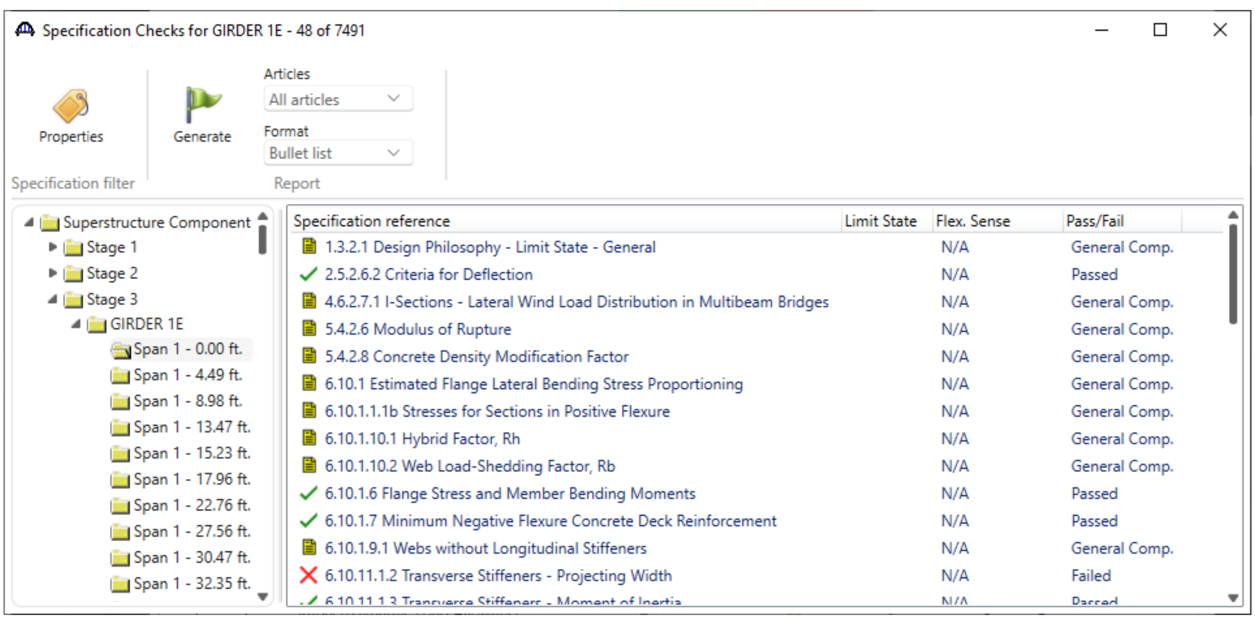
With the **AS-BUILT CURVED** superstructure definition selected on the **BWS** tree, click the **Analysis** button from the Analysis group of the **DESIGN/RATE** ribbon.



Specification Check Detail - LRFD Design Review

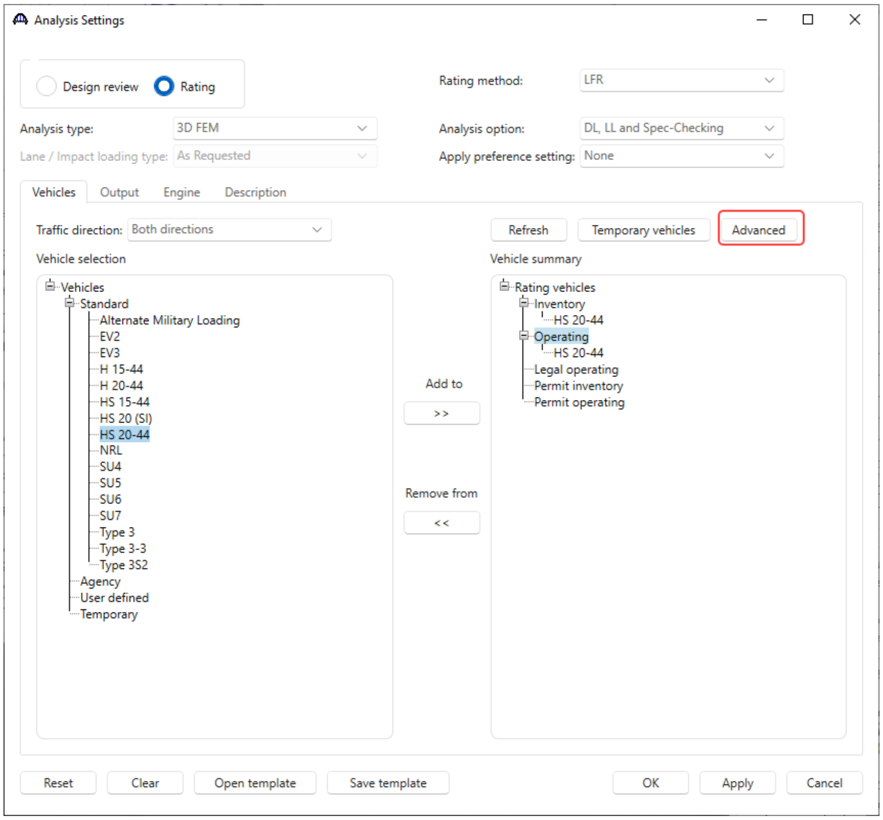
Select the member alternative **GIRDER 1E** of member **G1** and click on the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon to view all the spec check articles for this alternative.



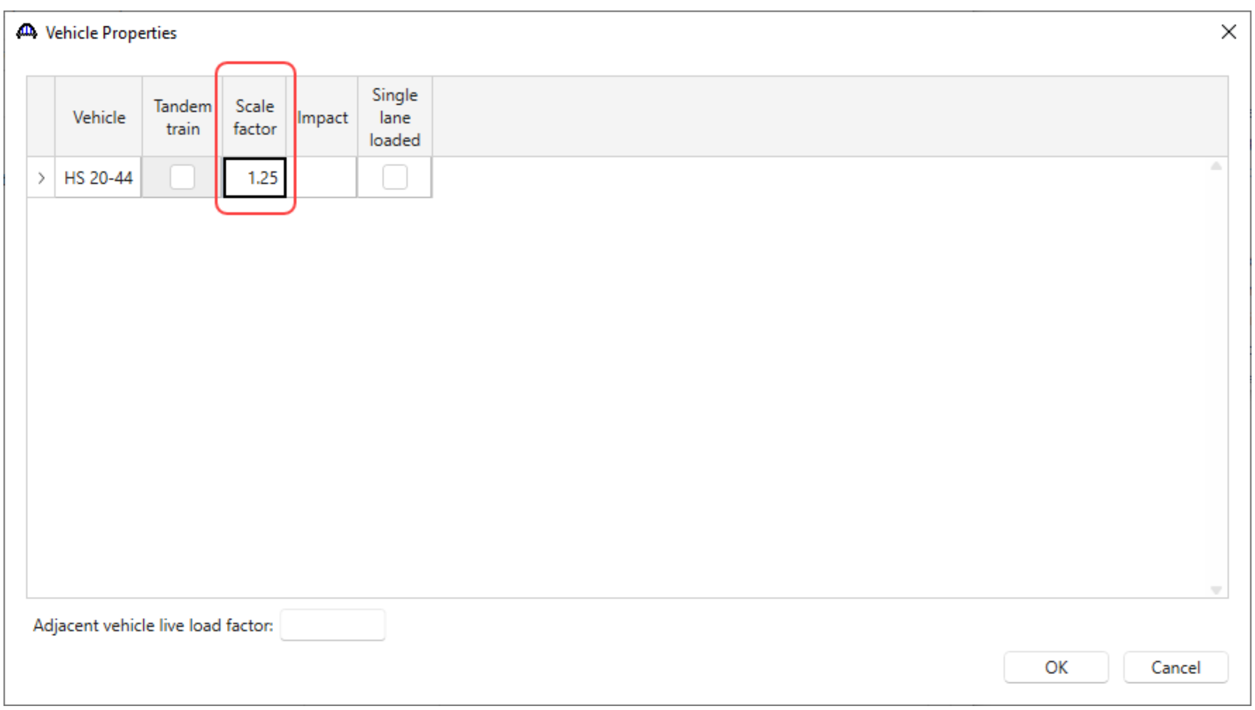


LFR Rating

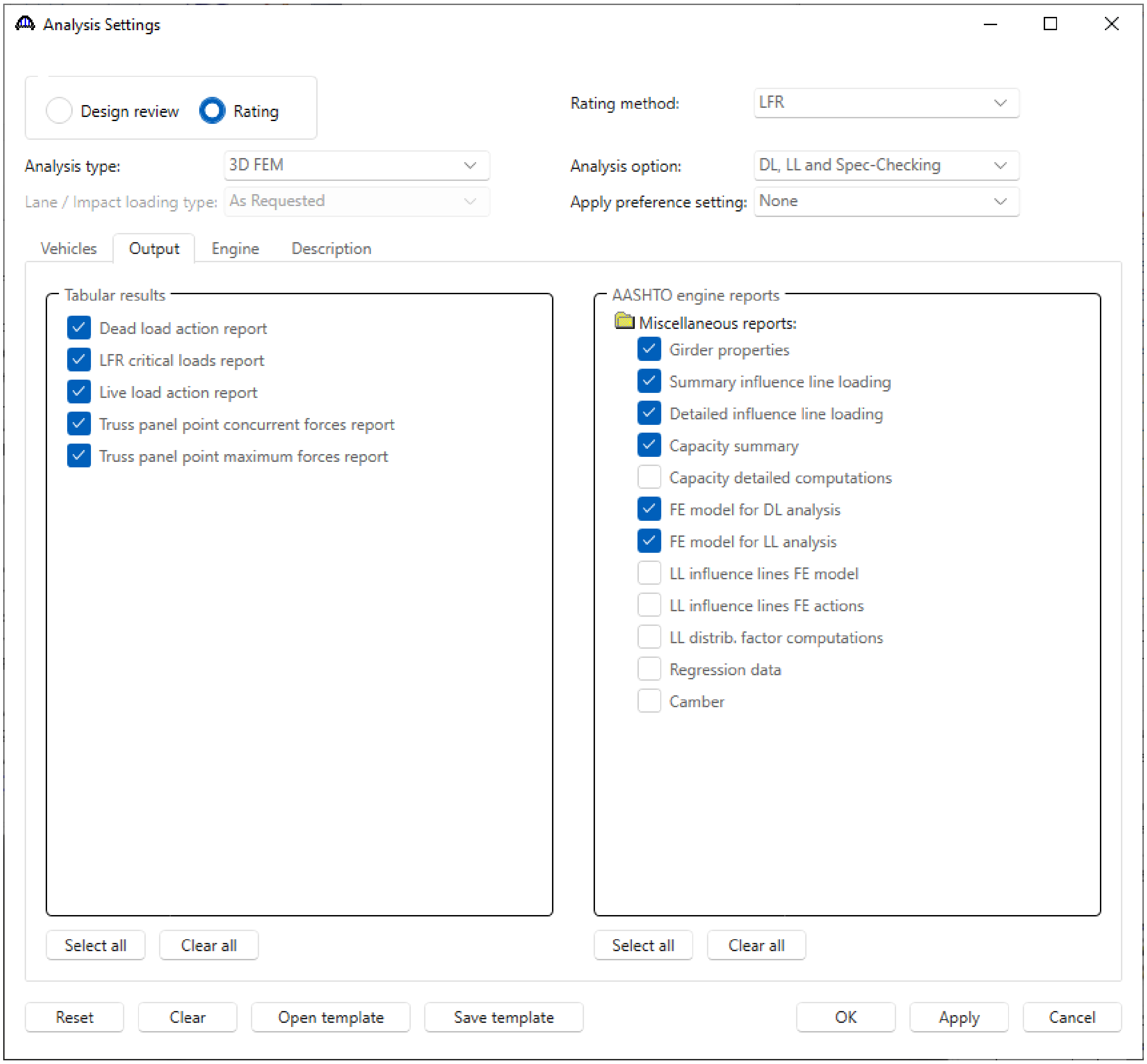
In the **Analysis Settings** window select the following vehicles and settings for an LFR rating.



The example in the AASHTO Guide Specification is for an HS25 loading. To produce this loading, enter a scale factor of 1.25 in the **Vehicle Properties** window as shown below.



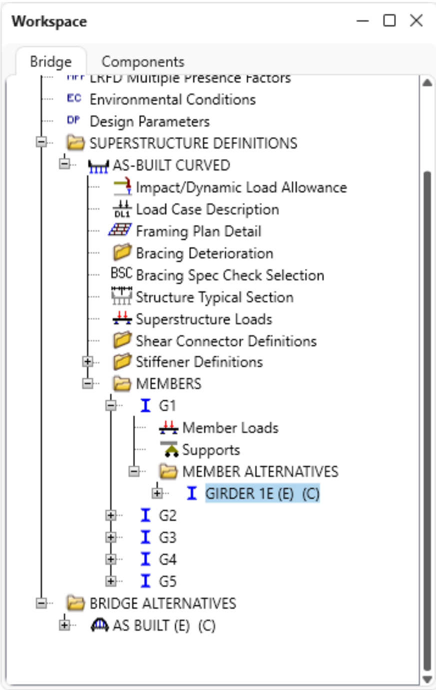
Navigate to the **Output** tab and check the checkboxes shown below to generate detailed reports. Be sure to check the **Detailed influence line loading** to be able to view the centrifugal force calculations.



This example shows the results from a 3D LFD rating. It is not recommended that users launch an analysis in training due to the large number of degrees of freedom in this example The analysis runtime will require a 64 bit PC and adequate memory that is likely not available on attendee laptops.

The software develops the 3D model using the member alternative marked as **Existing** for each member. If the member does not have a member alternative marked as **Existing** and only has 1 member alternative, that member alternative is used for the 3D model. If the member has no member alternative marked as **Existing** and more than 1 member alternative, the analysis will not be performed.

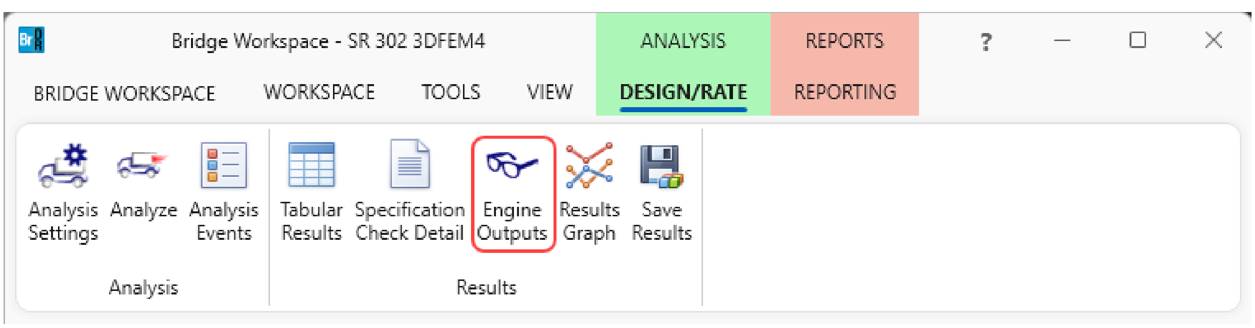
When the analysis is launched for the superstructure definition, spec checking and rating is only performed for the member alternatives marked as **Existing**. When the analysis is launched for a single member alternative (as shown below), the spec checking and rating will only be performed for that member alternative.

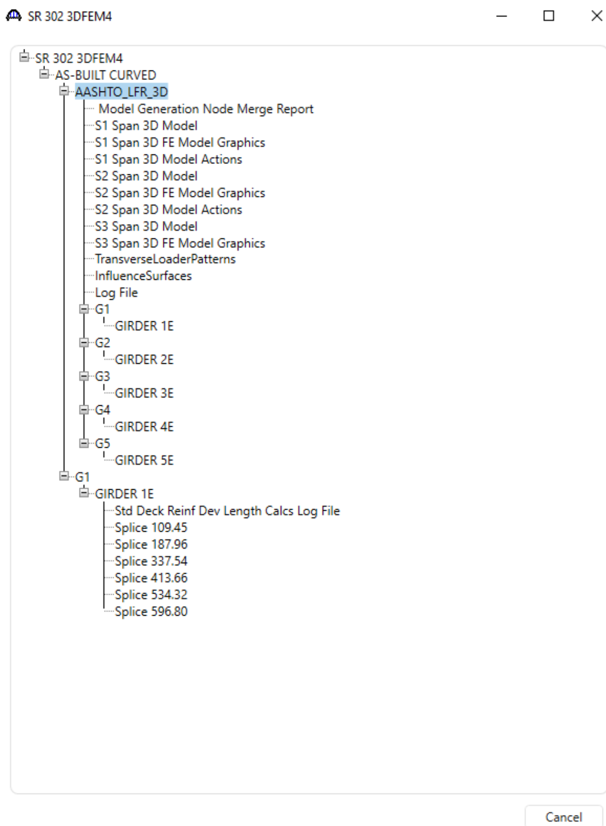


A feature for both straight and curved girder system FE analysis is the ability to reuse existing FEA results. The program will generate new dead load and live load influence surface FE models and compare the models to previous models. If the models compare exactly then the FEA results will be reused. The live load will be applied to the previous influence surfaces. This leads to a greatly reduced runtime on successive runs.

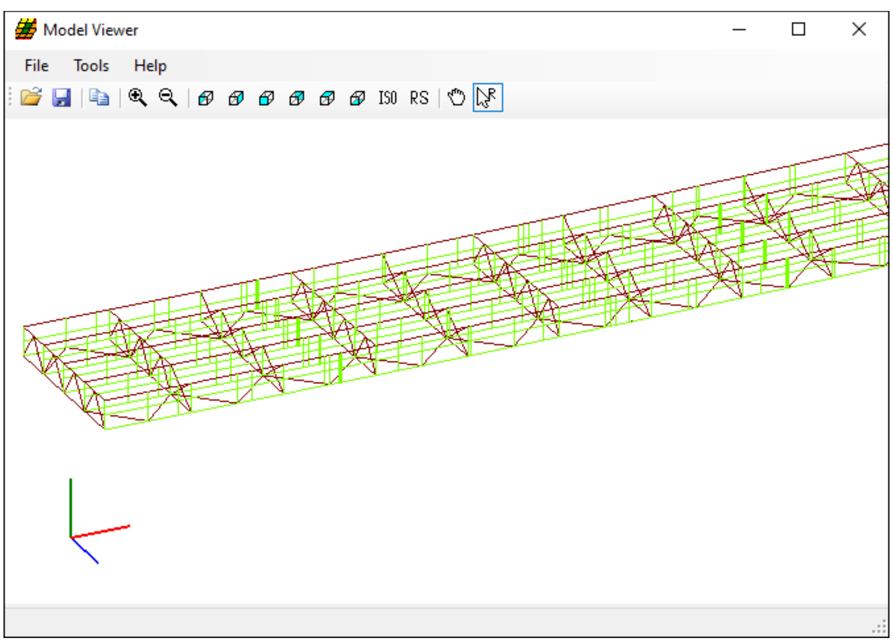
Engine Outputs – LFR Rating

Select the **GIRDER 1E** member alternative for member **G1** and click the **Engine Outputs** button on the **Results** group of the **DESIGN/RATE** ribbon. The following shows the output files created by the 3D LFR rating.



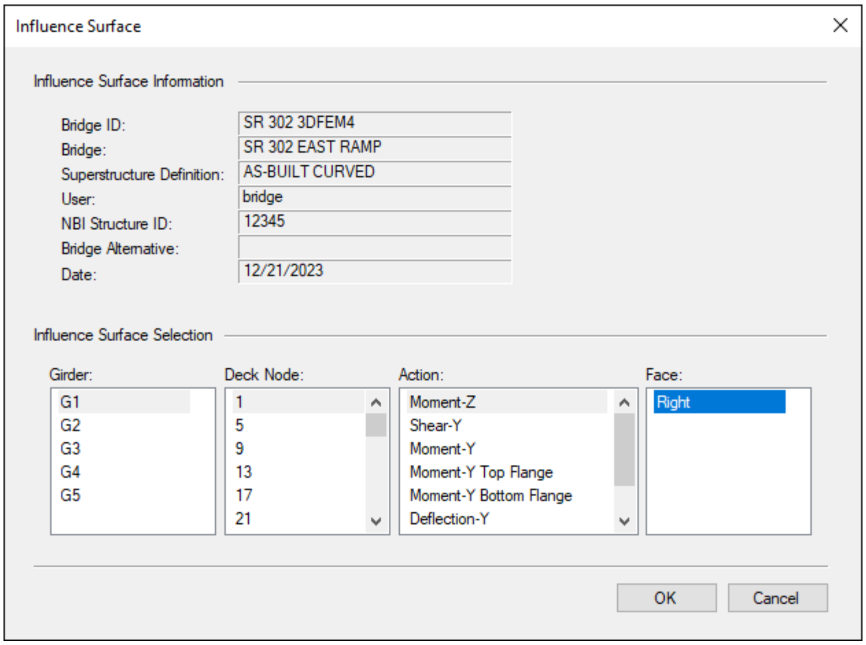


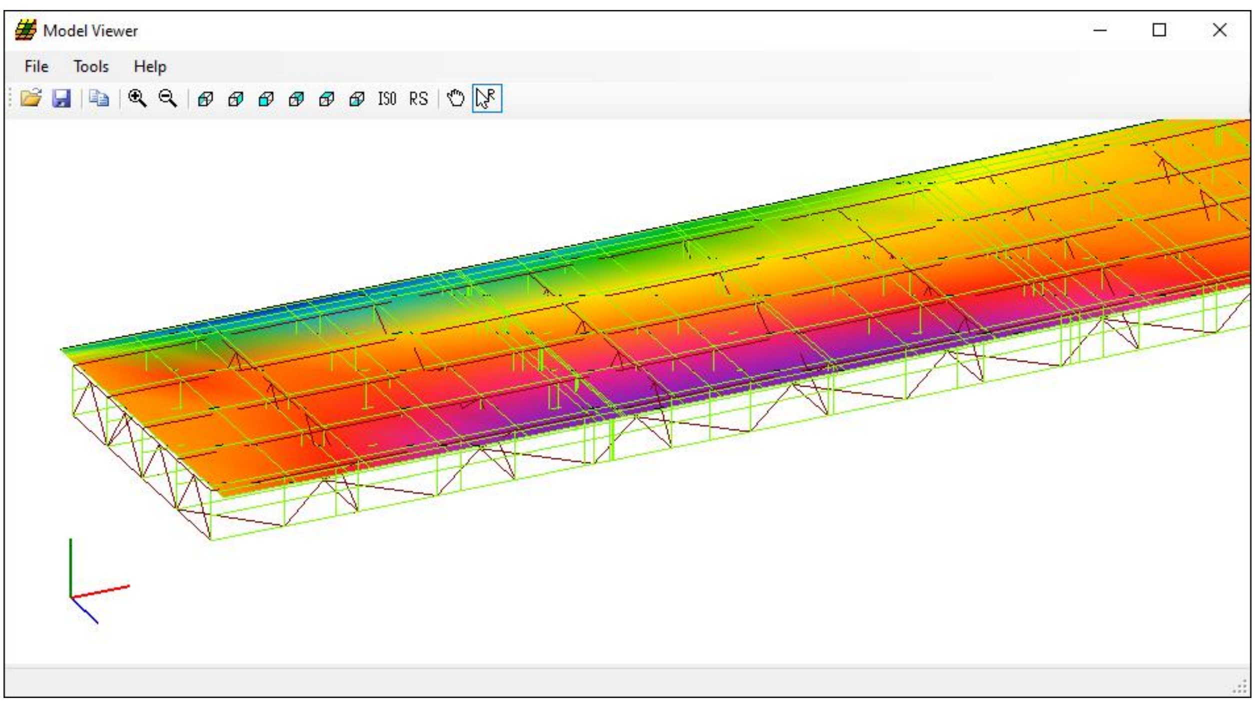
The **3D Model** files list the data for the models including nodes, members, properties, and loads. The **3D Model Actions** files list the FE results (reactions, element actions, displacements) for the models. The **Model Graphics** files can be opened to graphically view the FE models. The following shows the graphics for the **Stage 1** model which contains the steel beams and diaphragms.



Node and element numbers can be turned on from the **Tools** menu. The mouse controls manipulation of the view. Zoom by rolling the mouse wheel. Translate by pushing down the mouse wheel. Rotate by pushing down the left mouse button.

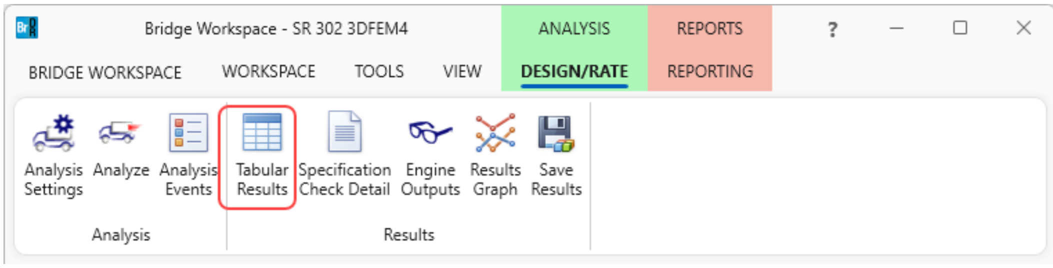
The generated influence surfaces for the unit live loading can be viewed by selecting the **Stage 3** Graphics model and then selecting **File** -> **Open** -> **Influence Surfaces.sur**. This opens the **Influence Surface** window as shown below. An influence surface for viewing can be chosen by selecting **Tools** -> **Change Influence Surface** and then selecting desired actions.

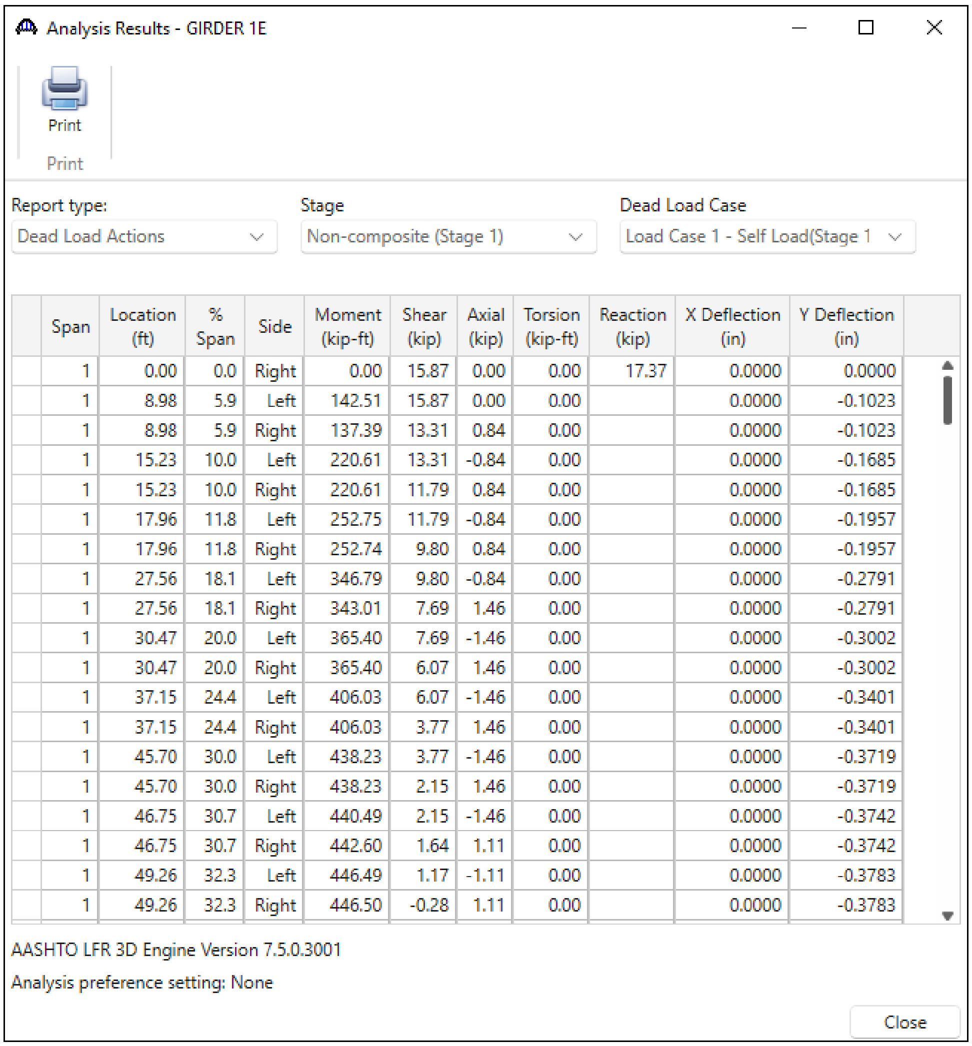




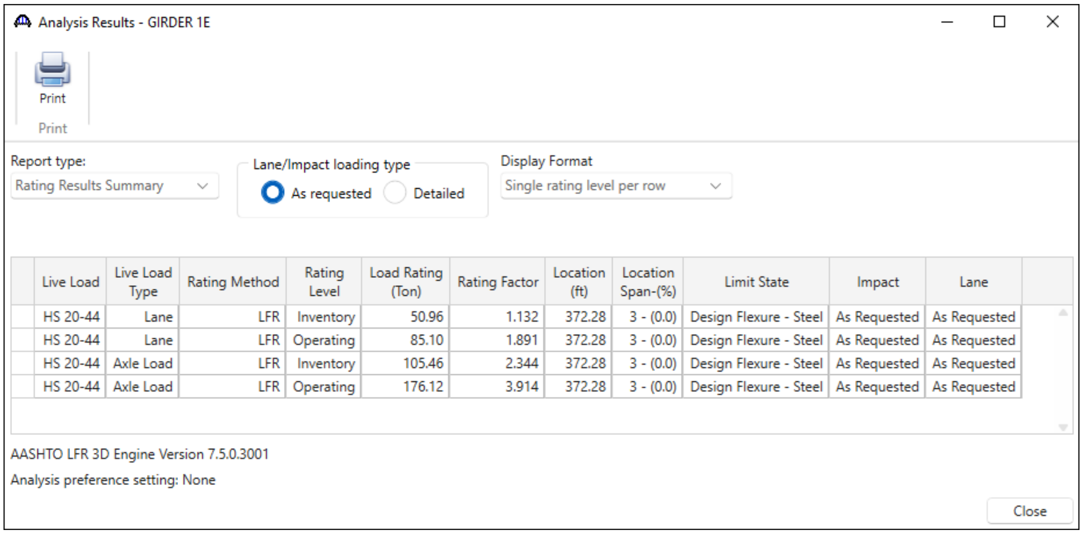
Tabular Results – LFR Rating

From the **Results** group of the **DESIGN/RATE** ribbon, click on **Tabular Results** to view the LFR rating results for member alternative **GIRDER 1E** as shown below.



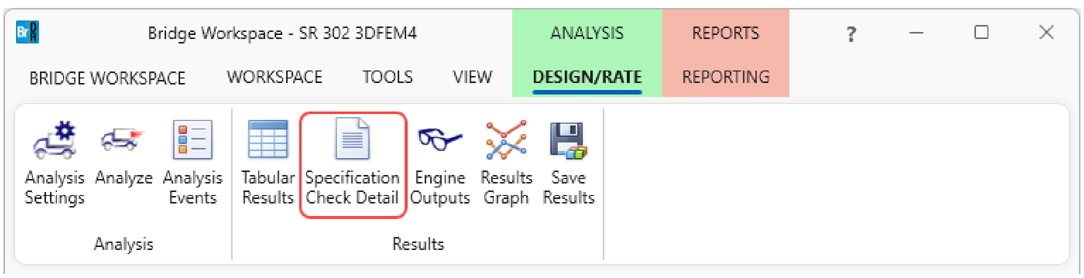


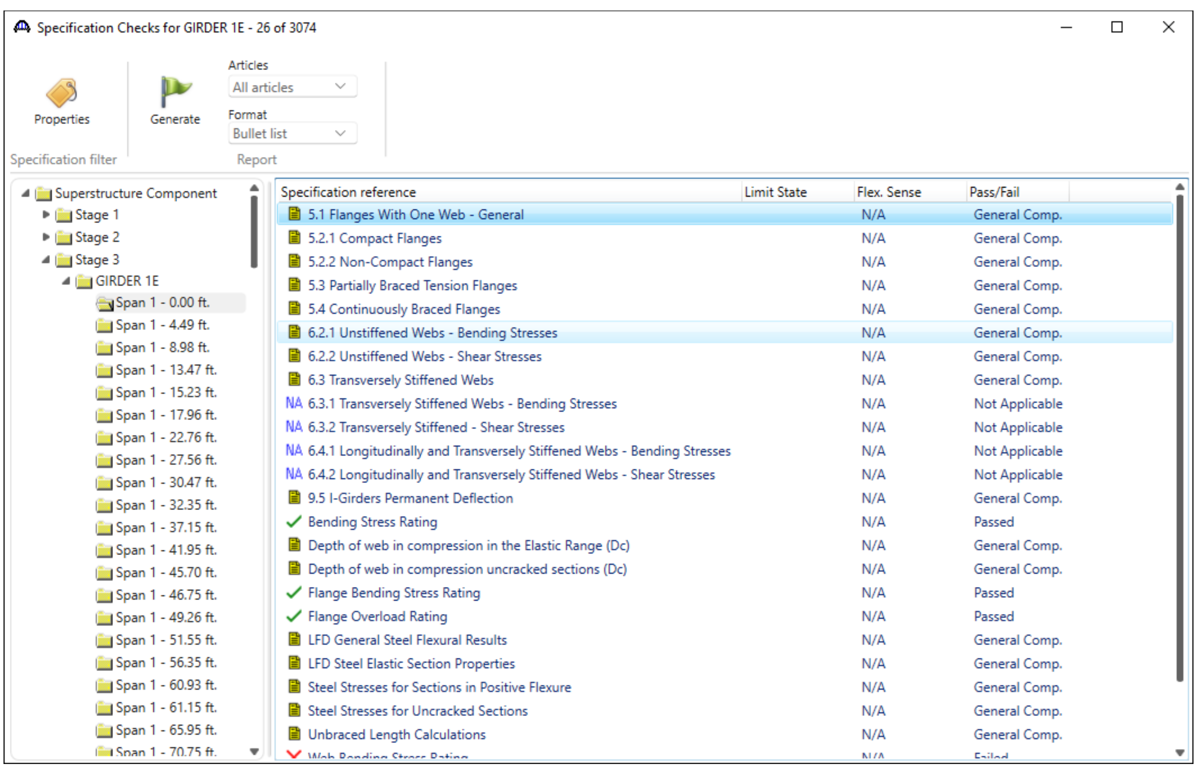
Span	Location (ft)	% Span	Side	Moment (kip-ft)	Shear (kip)	Axial (kip)	Torsion (kip-ft)	Reaction (kip)	X Deflection (in)	Y Deflection (in)
1	0.00	0.0	Right	0.00	15.87	0.00	0.00	17.37	0.0000	0.0000
1	8.98	5.9	Left	142.51	15.87	0.00	0.00		0.0000	-0.1023
1	8.98	5.9	Right	137.39	13.31	0.84	0.00		0.0000	-0.1023
1	15.23	10.0	Left	220.61	13.31	-0.84	0.00		0.0000	-0.1685
1	15.23	10.0	Right	220.61	11.79	0.84	0.00		0.0000	-0.1685
1	17.96	11.8	Left	252.75	11.79	-0.84	0.00		0.0000	-0.1957
1	17.96	11.8	Right	252.74	9.80	0.84	0.00		0.0000	-0.1957
1	27.56	18.1	Left	346.79	9.80	-0.84	0.00		0.0000	-0.2791
1	27.56	18.1	Right	343.01	7.69	1.46	0.00		0.0000	-0.2791
1	30.47	20.0	Left	365.40	7.69	-1.46	0.00		0.0000	-0.3002
1	30.47	20.0	Right	365.40	6.07	1.46	0.00		0.0000	-0.3002
1	37.15	24.4	Left	406.03	6.07	-1.46	0.00		0.0000	-0.3401
1	37.15	24.4	Right	406.03	3.77	1.46	0.00		0.0000	-0.3401
1	45.70	30.0	Left	438.23	3.77	-1.46	0.00		0.0000	-0.3719
1	45.70	30.0	Right	438.23	2.15	1.46	0.00		0.0000	-0.3719
1	46.75	30.7	Left	440.49	2.15	-1.46	0.00		0.0000	-0.3742
1	46.75	30.7	Right	442.60	1.64	1.11	0.00		0.0000	-0.3742
1	49.26	32.3	Left	446.49	1.17	-1.11	0.00		0.0000	-0.3783
1	49.26	32.3	Right	446.50	-0.28	1.11	0.00		0.0000	-0.3783



Specification Check Detail – LFR Rating

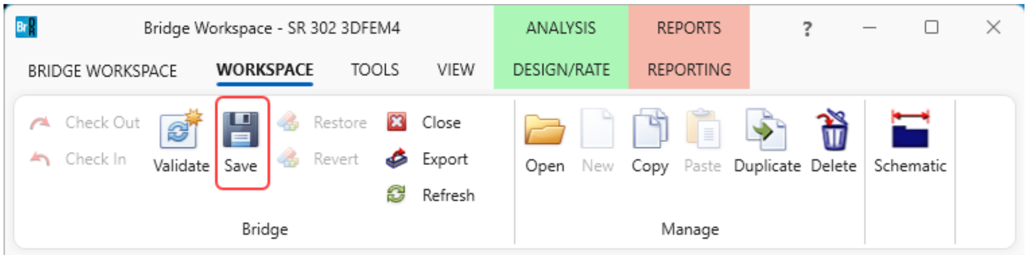
From the **Results** group of the **DESIGN/RATE** ribbon, click on **Specification Check Detail** to view the LFR spec check results for member alternative **GIRDER 1E** as shown below.



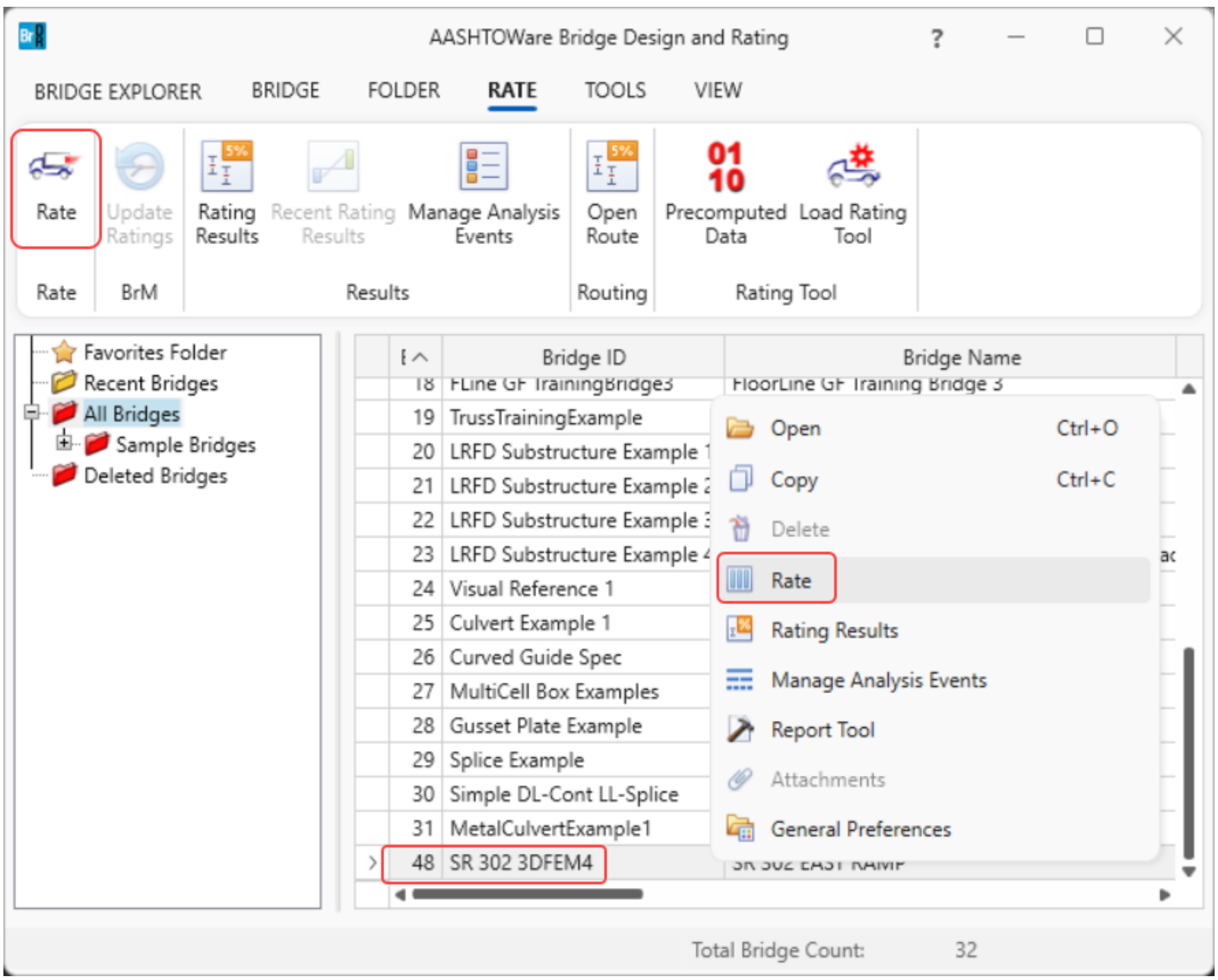


LFR Rating from Bridge Explorer

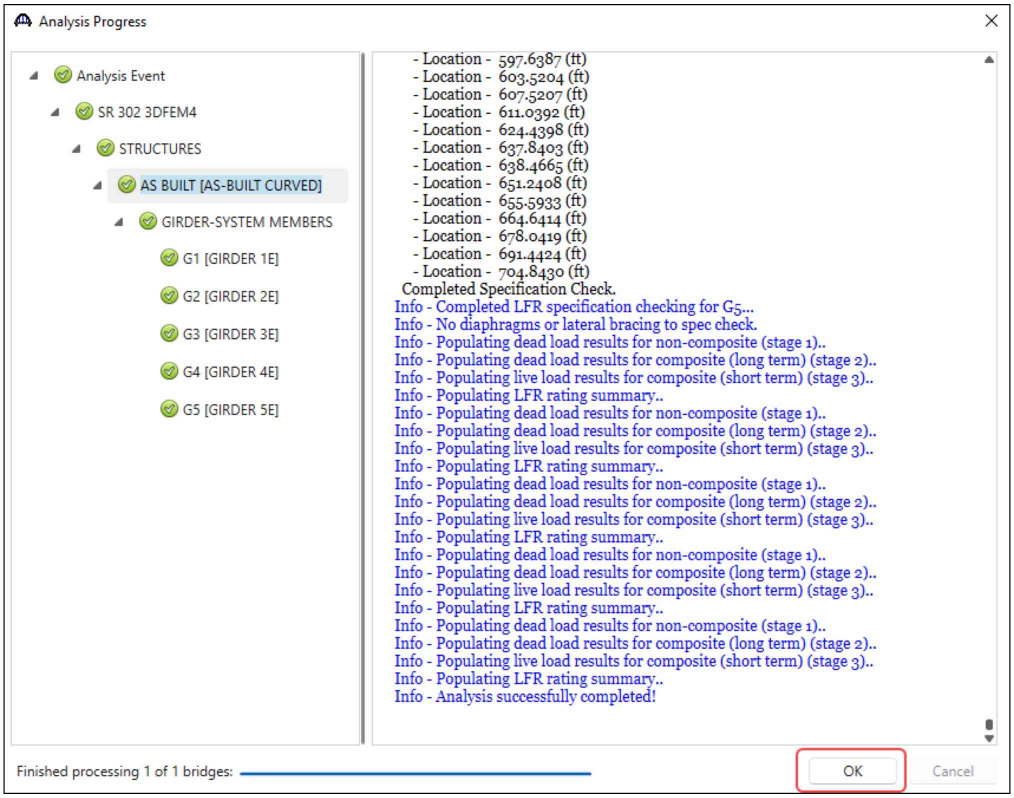
Rating of a bridge can be performed from the **Bridge Explorer** as well. To do this, first the newly created bridge description needs to be saved. Click on the **Save** button from the **WORKSPACE** ribbon to save the bridge to the database.



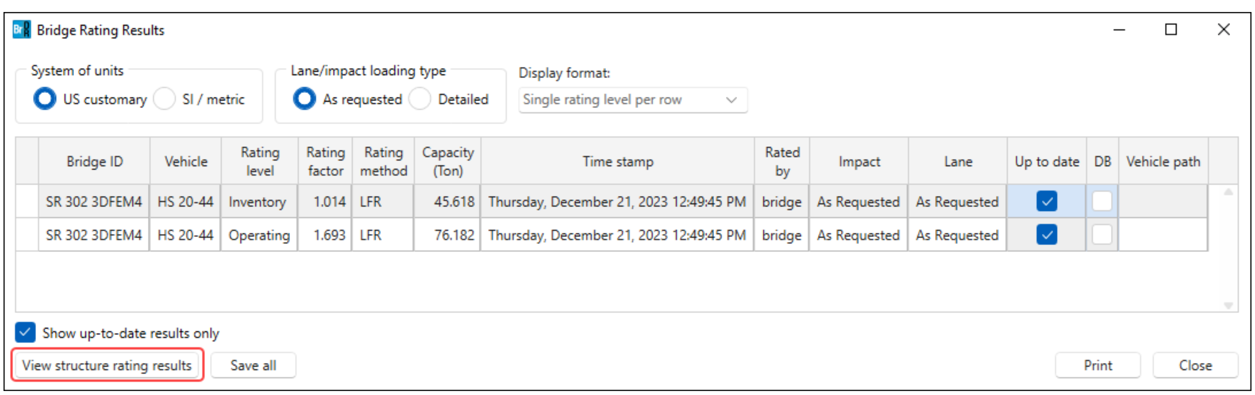
Now from the **Bridge Explorer**, select the bridge, and click on the **Rate** button from the **RATE** ribbon (or right click and select **Rate**) as shown below.



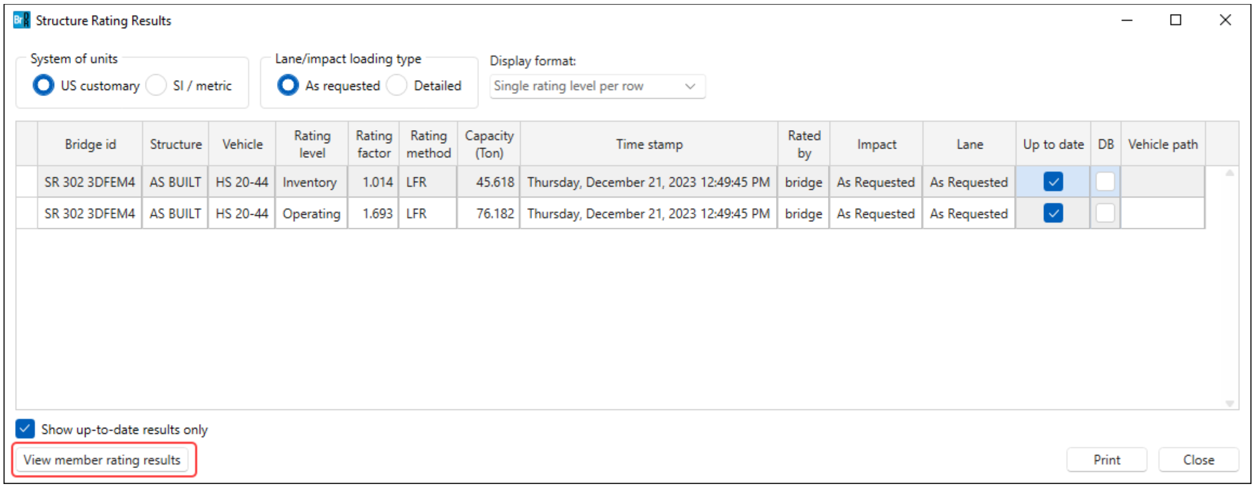
This opens the **Analysis Settings** window. Apply the same settings as discussed in the LFR analysis section of this tutorial and click **OK** to initiate the rating process. This opens the **Analysis Progress** window listing details of the ongoing analysis. Once the analysis is complete, review this window for any warnings, or error messages and click **OK** to close the window.



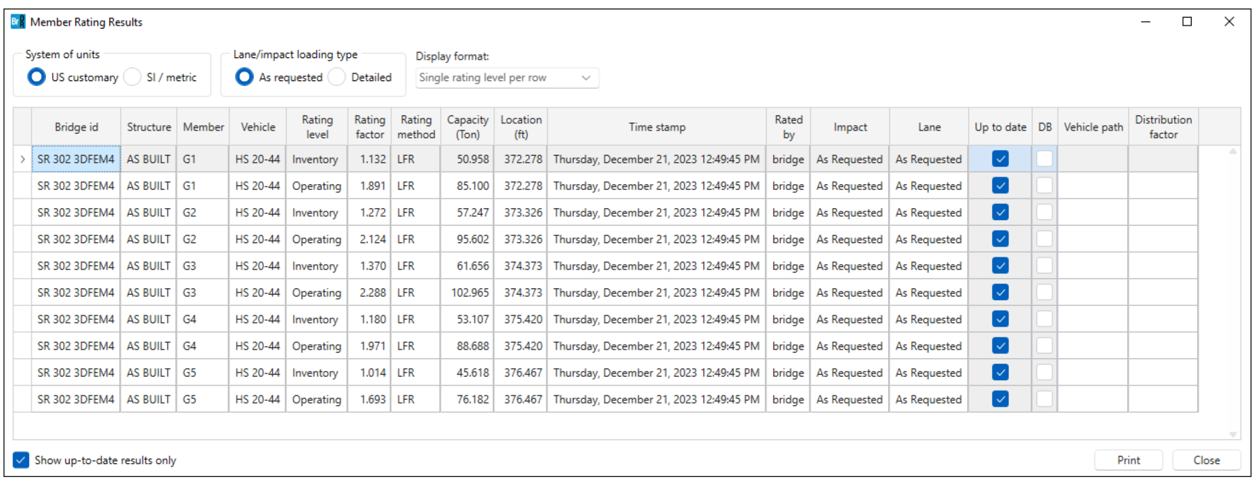
Clicking **OK** on the window shown above closes the **Analysis Progress** window and opens the **Bridge Rating Results** window. Alternatively, this window can be opened by clicking on the **Rating Results** button from the **Results** group of the **RATE** ribbon or right clicking and selecting **Rating Results**



The 3D LFR results of the HS25 ratings are shown for all girders when run using the bridge explorer. Click on the **View structure rating results** button in this window to view the results per structure in the Structure Rating Results window. In this window, click on the **View member rating results** button to view rating factors per member. (See images below).

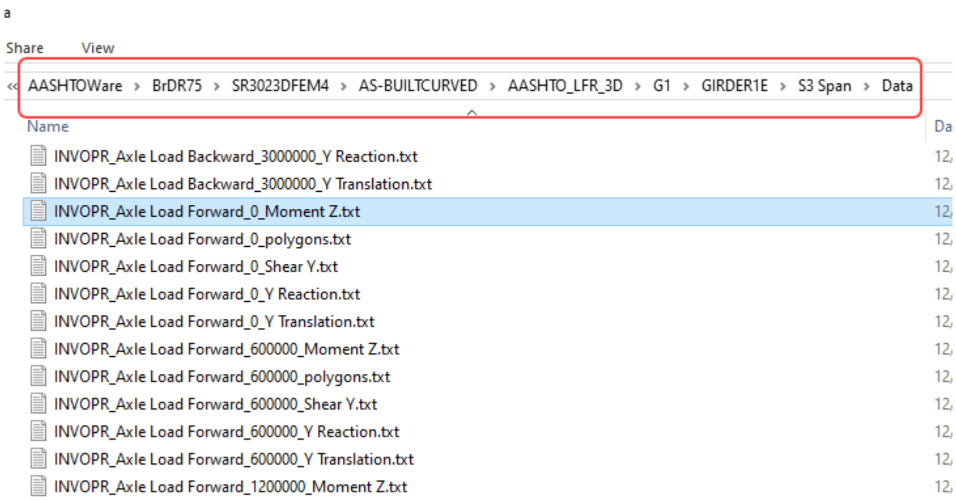


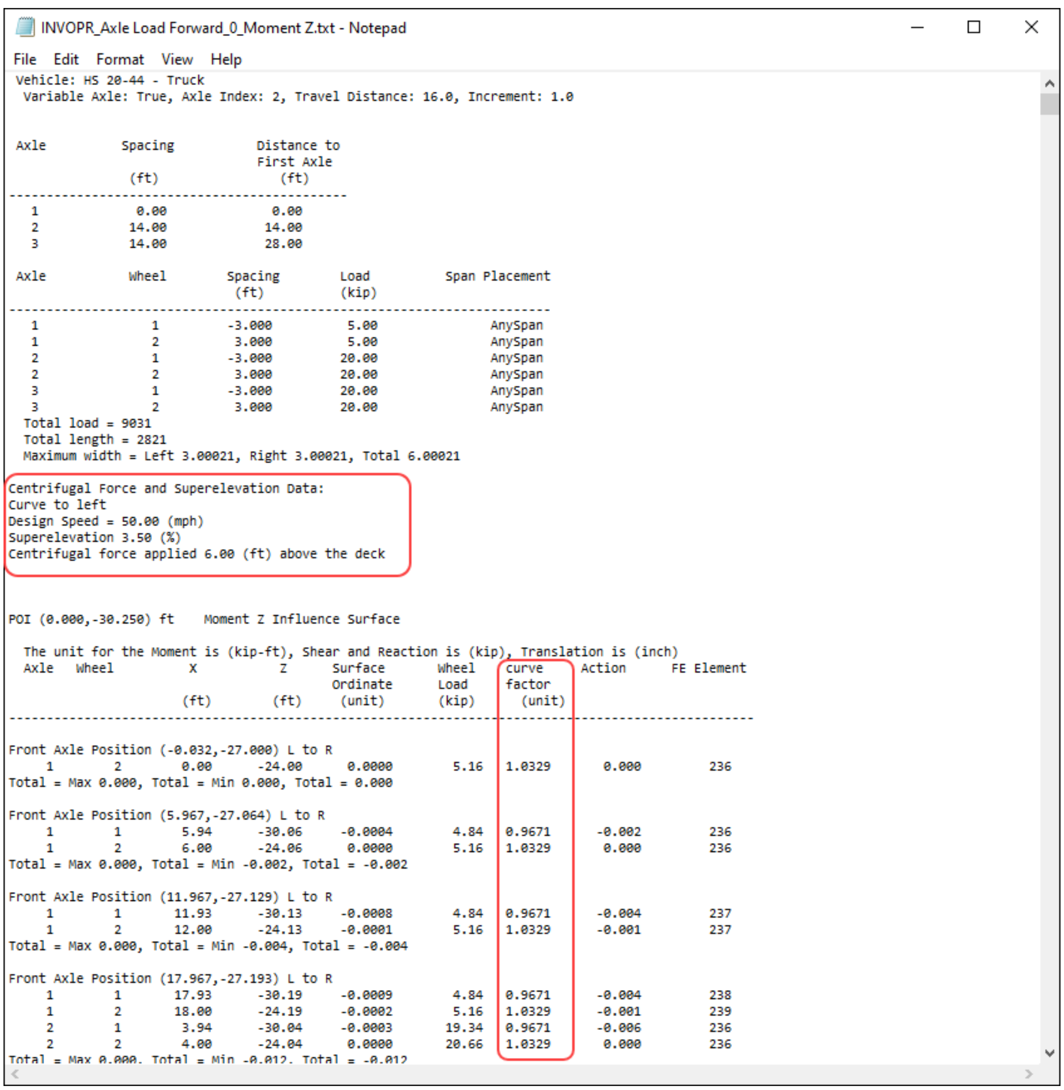
Bridge id	Structure	Vehicle	Rating level	Rating factor	Rating method	Capacity (Ton)	Time stamp	Rated by	Impact	Lane	Up to date	DB	Vehicle path
SR 302 3DFEM4	AS BUILT	HS 20-44	Inventory	1.014	LFR	45.618	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested			
SR 302 3DFEM4	AS BUILT	HS 20-44	Operating	1.693	LFR	76.182	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested			



Bridge id	Structure	Member	Vehicle	Rating level	Rating factor	Rating method	Capacity (Ton)	Location (ft)	Time stamp	Rated by	Impact	Lane	Up to date	DB	Vehicle path	Distribution factor
SR 302 3DFEM4	AS BUILT	G1	HS 20-44	Inventory	1.132	LFR	50.958	372.278	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G1	HS 20-44	Operating	1.891	LFR	85.100	372.278	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G2	HS 20-44	Inventory	1.272	LFR	57.247	373.326	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G2	HS 20-44	Operating	2.124	LFR	95.602	373.326	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G3	HS 20-44	Inventory	1.370	LFR	61.656	374.373	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G3	HS 20-44	Operating	2.288	LFR	102.965	374.373	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G4	HS 20-44	Inventory	1.180	LFR	53.107	375.420	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G4	HS 20-44	Operating	1.971	LFR	88.688	375.420	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G5	HS 20-44	Inventory	1.014	LFR	45.618	376.467	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				
SR 302 3DFEM4	AS BUILT	G5	HS 20-44	Operating	1.693	LFR	76.182	376.467	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested				

The centrifugal force effect calculations can be found in the detailed influence surface loading files found in the following folder (of the Documents folder).





INVOPR_Axle Load Forward_0_Moment Z.txt - Notepad

File Edit Format View Help

```
Vehicle: HS 20-44 - Truck
 Variable Axle: True, Axle Index: 2, Travel Distance: 16.0, Increment: 1.0


 Axle          Spacing           Distance to
                                 First Axle
                (ft)               (ft)
---------------------------------------------
  1             0.00               0.00
  2            14.00              14.00
  3            14.00              28.00

 Axle           Wheel        Spacing        Load          Span Placement
                              (ft)          (kip)
-----------------------------------------------------------------------
  1               1          -3.000         5.00               AnySpan
  1               2           3.000         5.00               AnySpan
  2               1          -3.000        20.00               AnySpan
  2               2           3.000        20.00               AnySpan
  3               1          -3.000        20.00               AnySpan
  3               2           3.000        20.00               AnySpan
  Total load = 9031
  Total length = 2821
  Maximum width = Left 3.00021, Right 3.00021, Total 6.00021

Centrifugal Force and Superelevation Data:
Curve to left
Design Speed = 50.00 (mph)
Superelevation 3.50 (%)
Centrifugal force applied 6.00 (ft) above the deck


POI (0.000,-30.250) ft     Moment Z Influence Surface

  The unit for the Moment is (kip-ft), Shear and Reaction is (kip), Translation is (inch)
  Axle   Wheel          X           Z         Surface      Wheel    curve    Action      FE Element
                                              Ordinate     Load     factor
                       (ft)        (ft)        (unit)      (kip)     (unit)
-------------------------------------------------------------------------------------------------------

Front Axle Position (-0.032,-27.000) L to R
     1        2        0.00       -24.00      0.0000        5.16   1.0329      0.000         236
Total = Max 0.000, Total = Min 0.000, Total = 0.000

Front Axle Position (5.967,-27.064) L to R
     1        1        5.94       -30.06     -0.0004        4.84   0.9671     -0.002         236
     1        2        6.00       -24.06      0.0000        5.16   1.0329      0.000         236
Total = Max 0.000, Total = Min -0.002, Total = -0.002

Front Axle Position (11.967,-27.129) L to R
     1        1       11.93       -30.13     -0.0008        4.84   0.9671     -0.004         237
     1        2       12.00       -24.13     -0.0001        5.16   1.0329     -0.001         237
Total = Max 0.000, Total = Min -0.004, Total = -0.004

Front Axle Position (17.967,-27.193) L to R
     1        1       17.93       -30.19     -0.0009        4.84   0.9671     -0.004         238
     1        2       18.00       -24.19     -0.0002        5.16   1.0329     -0.001         239
     2        1        3.94       -30.04     -0.0003       19.34   0.9671     -0.006         236
     2        2        4.00       -24.04      0.0000       20.66   1.0329      0.000         236
Total = Max 0.000, Total = Min -0.012, Total = -0.012
```

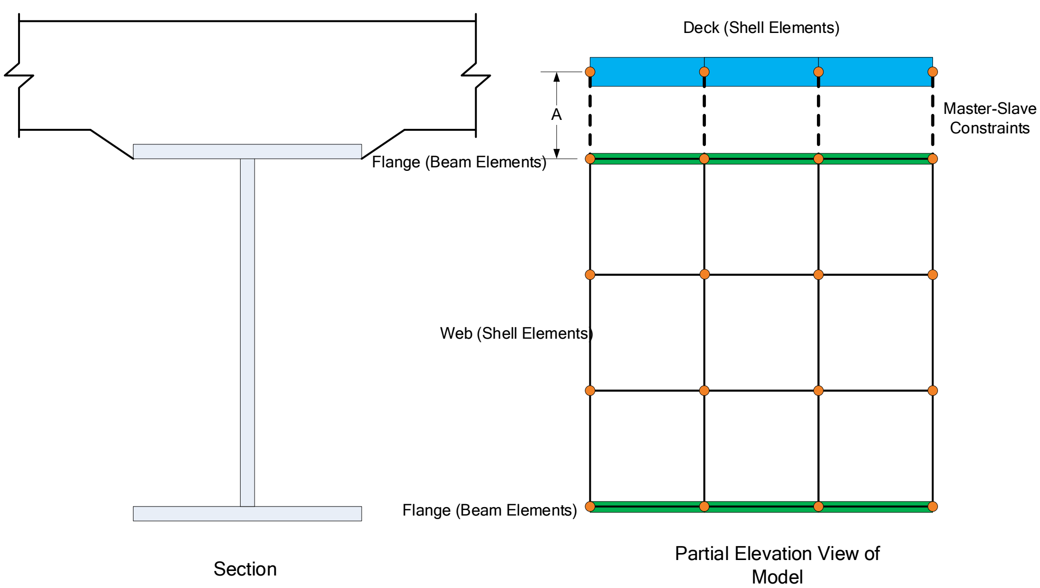
3D Model

The modeling techniques used are the result of a survey of researchers and practitioners and review of several software packages.

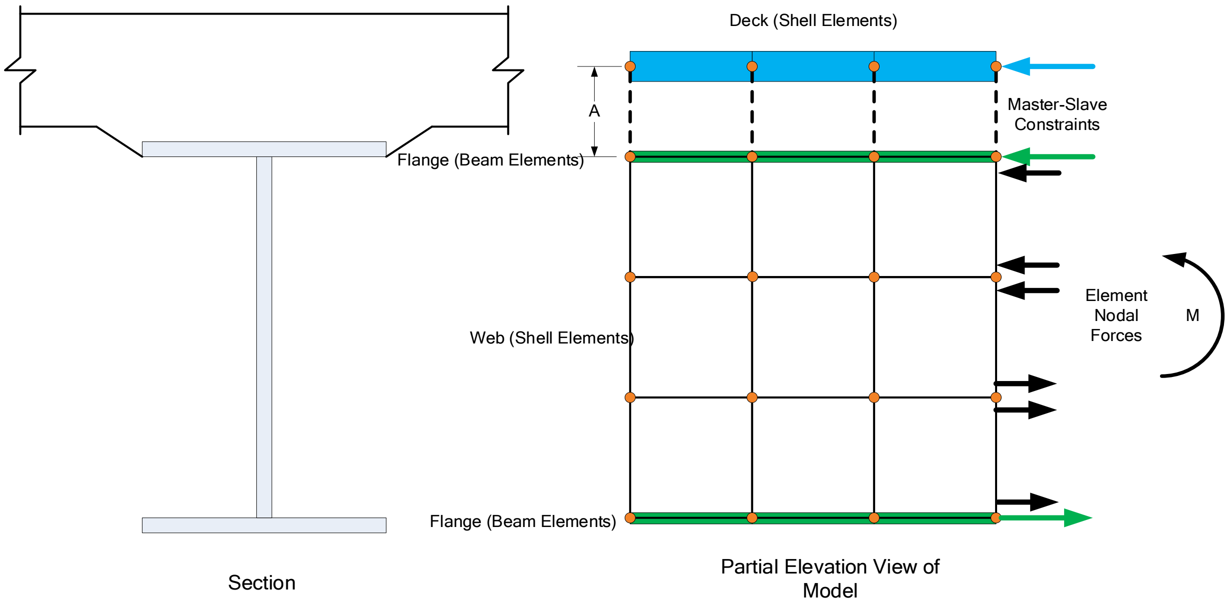
Steel Members

The model for a girder system structure with steel girders is comprised of the following:

- Shell elements for the deck
- Beam elements for the top and bottom flanges.
- Shell elements for the web. Web shell elements are divided into equal segments for web shells. The shell nodes may be adjusted to match diaphragm connections.
- For curved structures, curvature is represented by straight elements with small kinks at node points instead of curved elements.
- Master-slave constraints that connect the top flange to middle of deck. The distance ‘A’ as shown in figure below is measured from the center of the deck to the center of gravity of the top flange (including cover plates) at the start of G1. The same value is used everywhere for all girders to maintain horizontal elements.



The moment at a beam cross section is calculated by solving the equilibrium equations at that section. This moment is then used in the specification check articles in the same way that it would for a line girder analysis.



Mesh Generation

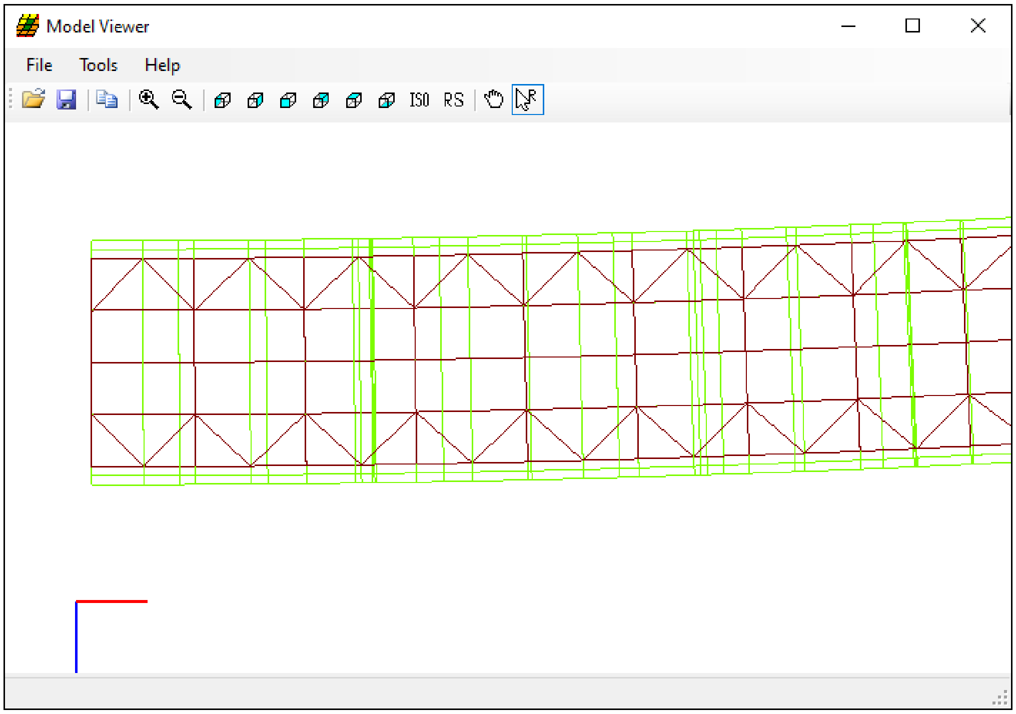
The FE model created by BrDR will contain nodes at the following locations.

- Cross section property change points
- Span tenth points
- Support locations
- Diaphragm locations
- User defined points of interest

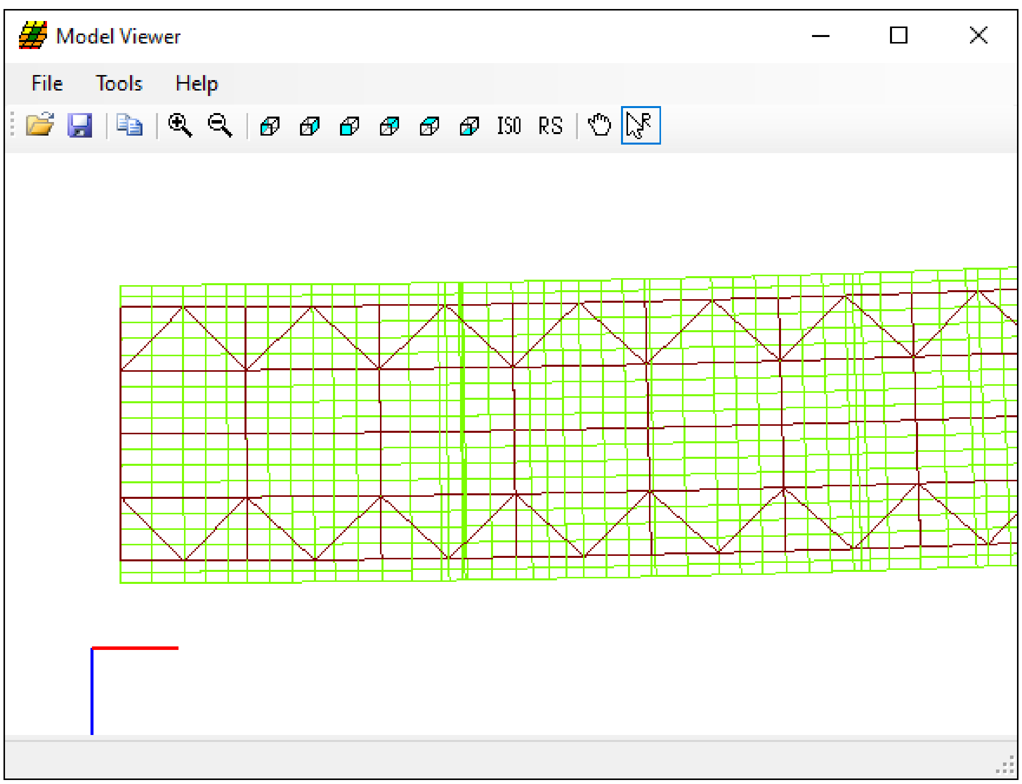
The user controls the mesh generation by the controls previously shown on the **Superstructure Definition: Analysis** tab. The software creates the mesh following the number of elements selected between beams or within the web of a steel beam and the target aspect ratio entered by the user. The presence of nodes at the locations listed above may result in some elements falling outside the target aspect ratio.

The following plan views show how the mesh for this example can be controlled by the user.

1 shell between beams, target aspect ratio = 4

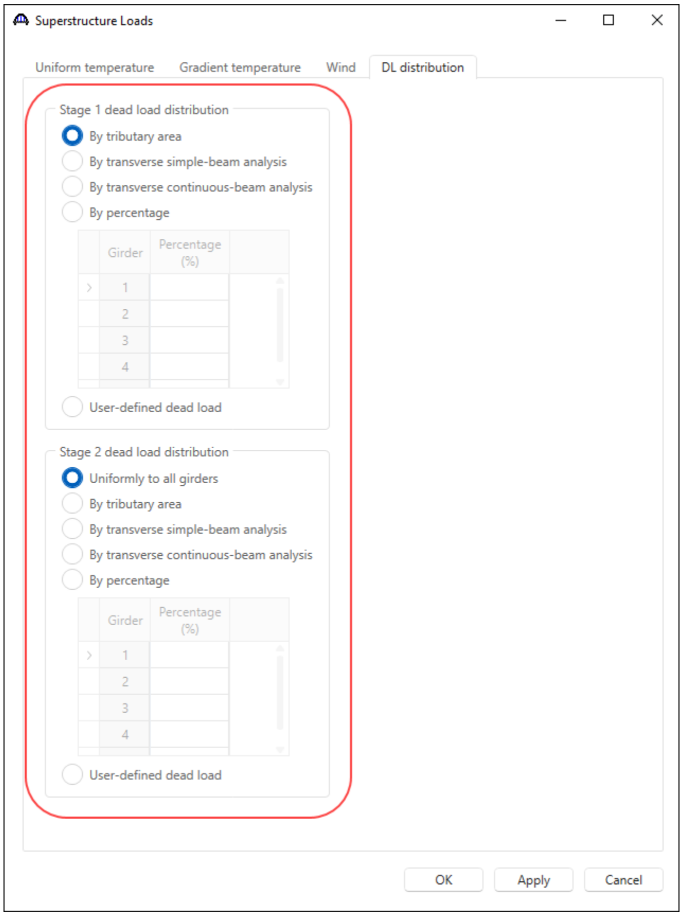


4 shells between beams, target aspect ratio = 2



Loading

The program computes all the dead loads acting on the beam including the self-weight of the beam, user defined appurtenances on the structure typical section, wearing surfaces, diaphragms, and user defined member loads. Composite dead loads are applied directly to the deck shells in the 3D model in their actual location. They are not distributed to the girders based on the choices available in the **Superstructure Loads** window as they are for a 2D line girder analysis.



The Stage 3 FE model is loaded with unit loads at each deck node within the travelway to generate influence surfaces for the beam. Lane positions and combinations are determined based on the travelway, and the transverse loading parameters set by the user on the **Superstructure Definition: Analysis Settings** tab. The influence surfaces are then loaded with the selected vehicles to find the maximum live load effects.

Analysis and Results

LFR (HS-20 scaled to HS-25)

Bridge Rating Results

System of units: US customary / SI / metric

Lane/impact loading type: As requested / Detailed

Display format: Single rating level per row

Bridge ID	Vehicle	Rating level	Rating factor	Rating method	Capacity (Ton)	Time stamp	Rated by	Impact	Lane	Up to date	DB	Vehicle path
SR 302 3DFEM4	HS 20-44	Inventory	1.014	LFR	45.618	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested	☑	☐	
SR 302 3DFEM4	HS 20-44	Operating	1.693	LFR	76.182	Thursday, December 21, 2023 12:49:45 PM	bridge	As Requested	As Requested	☑	☐	

☑ Show up-to-date results only

View structure rating results | Save all | Print | Close

Girder 1E

Analysis Results - GIRDER 1E

Print

Report type: Rating Results Summary

Lane/Impact loading type: As requested / Detailed

Display Format: Single rating level per row

Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Lane	LFR	Inventory	50.96	1.132	372.28	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	85.10	1.891	372.28	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Inventory	105.46	2.344	372.28	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	176.12	3.914	372.28	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested

AASHTO LFR 3D Engine Version 7.5.0.3001

Analysis preference setting: None

Close

Girder 2E

Analysis Results - GIRDER 2E

Print

Report type: Rating Results Summary

Lane/Impact loading type: As requested / Detailed

Display Format: Single rating level per row

Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Lane	LFR	Inventory	57.25	1.272	373.33	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	95.60	2.124	373.33	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Inventory	114.16	2.537	373.33	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	190.63	4.236	49.26	1 - (32.2)	Design Flexure - Steel	As Requested	As Requested

AASHTO LFR 3D Engine Version 7.5.0.3001

Analysis preference setting: None

Close

Girder 3E

Analysis Results - GIRDER 3E

Print

Print

Report type: Rating Results Summary

Lane/Impact loading type: As requested / Detailed

Display Format: Single rating level per row

Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Lane	LFR	Inventory	61.66	1.370	374.37	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	102.96	2.288	374.37	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Inventory	119.14	2.648	49.26	1 - (32.2)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	198.75	4.417	49.26	1 - (32.2)	Design Flexure - Steel	As Requested	As Requested

AASHTO LFR 3D Engine Version 7.5.0.3001

Analysis preference setting: None

Close

Girder 4E

Analysis Results - GIRDER 4E

Print

Print

Report type: Rating Results Summary

Lane/Impact loading type: As requested / Detailed

Display Format: Single rating level per row

Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Lane	LFR	Inventory	53.11	1.180	375.42	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	88.69	1.971	375.42	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Inventory	105.68	2.348	375.42	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	176.48	3.922	375.42	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested

AASHTO LFR 3D Engine Version 7.5.0.3001

Analysis preference setting: None

Close

Girder 5E

Analysis Results - GIRDER 5E

Print

Print

Report type: Rating Results Summary

Lane/Impact loading type: As requested / Detailed

Display Format: Single rating level per row

Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Lane	LFR	Inventory	45.62	1.014	376.47	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	76.18	1.693	376.47	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Inventory	94.57	2.101	376.47	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	157.93	3.509	376.47	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested

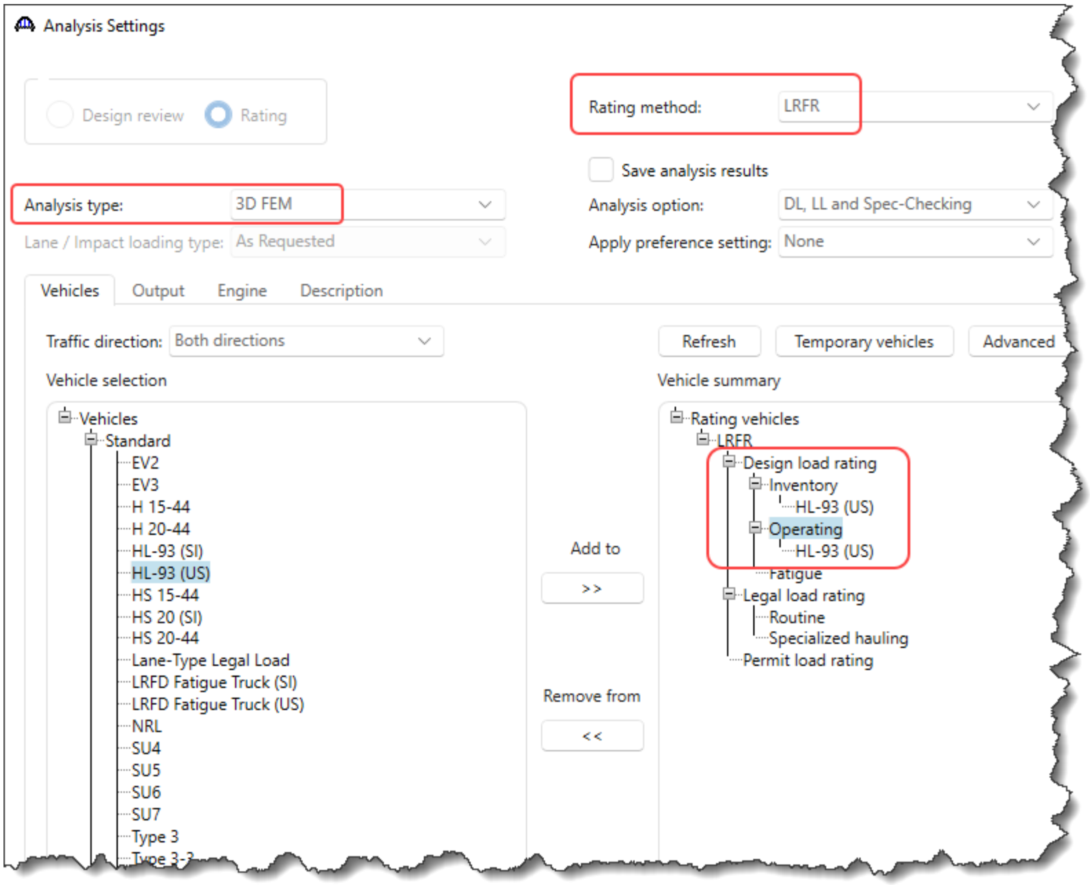
AASHTO LFR 3D Engine Version 7.5.0.3001

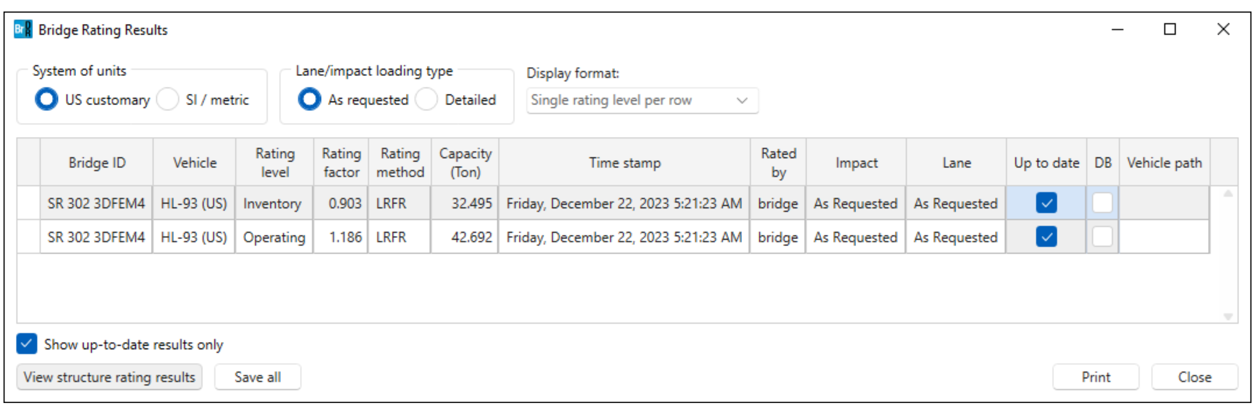
Analysis preference setting: None

Close

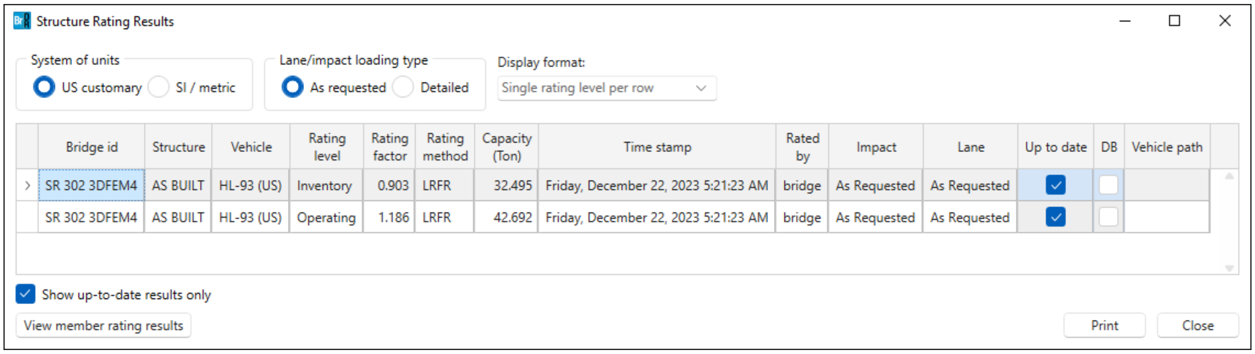
LRFR (HL-93)

Run an LRFR 3D analysis with HL-93 (US) vehicle in Inventory and Operating from the Bridge Explorer. Below are the results for this analysis.





Bridge ID	Vehicle	Rating level	Rating factor	Rating method	Capacity (Ton)	Time stamp	Rated by	Impact	Lane	Up to date	DB	Vehicle path
SR 302 3DFEM4	HL-93 (US)	Inventory	0.903	LRFR	32.495	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐	
SR 302 3DFEM4	HL-93 (US)	Operating	1.186	LRFR	42.692	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐	



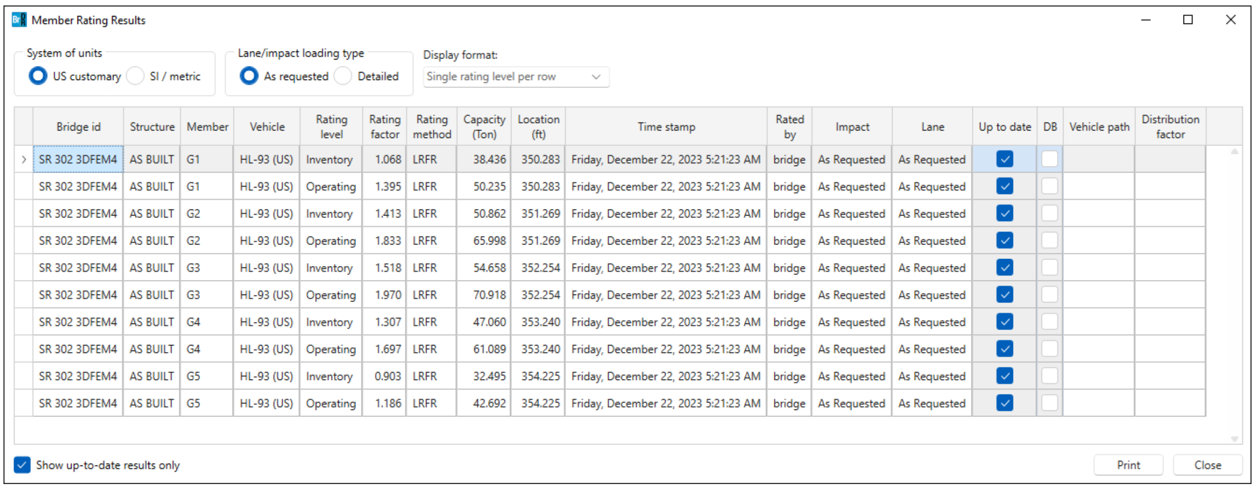
Structure Rating Results

System of units: US customary / SI / metric — Lane/impact loading type: As requested / Detailed — Display format: Single rating level per row

Bridge id	Structure	Vehicle	Rating level	Rating factor	Rating method	Capacity (Ton)	Time stamp	Rated by	Impact	Lane	Up to date	DB	Vehicle path
SR 302 3DFEM4	AS BUILT	HL-93 (US)	Inventory	0.903	LRFR	32.495	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐	
SR 302 3DFEM4	AS BUILT	HL-93 (US)	Operating	1.186	LRFR	42.692	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐	

☑ Show up-to-date results only

View member rating results — Print — Close



Member Rating Results

System of units: US customary / SI / metric — Lane/impact loading type: As requested / Detailed — Display format: Single rating level per row

Bridge id	Structure	Member	Vehicle	Rating level	Rating factor	Rating method	Capacity (Ton)	Location (ft)	Time stamp	Rated by	Impact	Lane	Up to date	DB	Vehicle path	Distribution factor
SR 302 3DFEM4	AS BUILT	G1	HL-93 (US)	Inventory	1.068	LRFR	38.436	350.283	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G1	HL-93 (US)	Operating	1.395	LRFR	50.235	350.283	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G2	HL-93 (US)	Inventory	1.413	LRFR	50.862	351.269	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G2	HL-93 (US)	Operating	1.833	LRFR	65.998	351.269	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G3	HL-93 (US)	Inventory	1.518	LRFR	54.658	352.254	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G3	HL-93 (US)	Operating	1.970	LRFR	70.918	352.254	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G4	HL-93 (US)	Inventory	1.307	LRFR	47.060	353.240	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G4	HL-93 (US)	Operating	1.697	LRFR	61.089	353.240	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G5	HL-93 (US)	Inventory	0.903	LRFR	32.495	354.225	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		
SR 302 3DFEM4	AS BUILT	G5	HL-93 (US)	Operating	1.186	LRFR	42.692	354.225	Friday, December 22, 2023 5:21:23 AM	bridge	As Requested	As Requested	☑	☐		

☑ Show up-to-date results only

Print — Close