AASHTOWare BrDR 7.5.0

Floor System Tutorial

FS4 – Skewed End Panel Floor System Example

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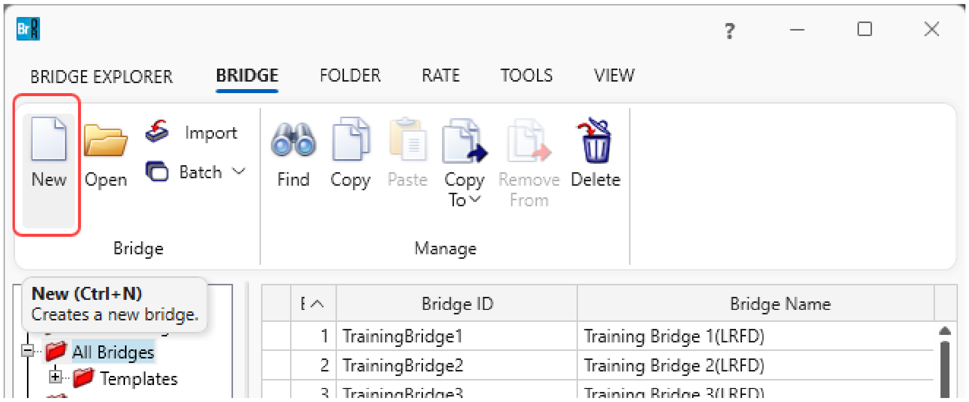
Topics Covered

- Superstructure composed of girders, floorbeams and stringers
- System Superstructure Definition
- Skewed end panels
- Mirroring stringer group definitions when they are assigned to stringer units

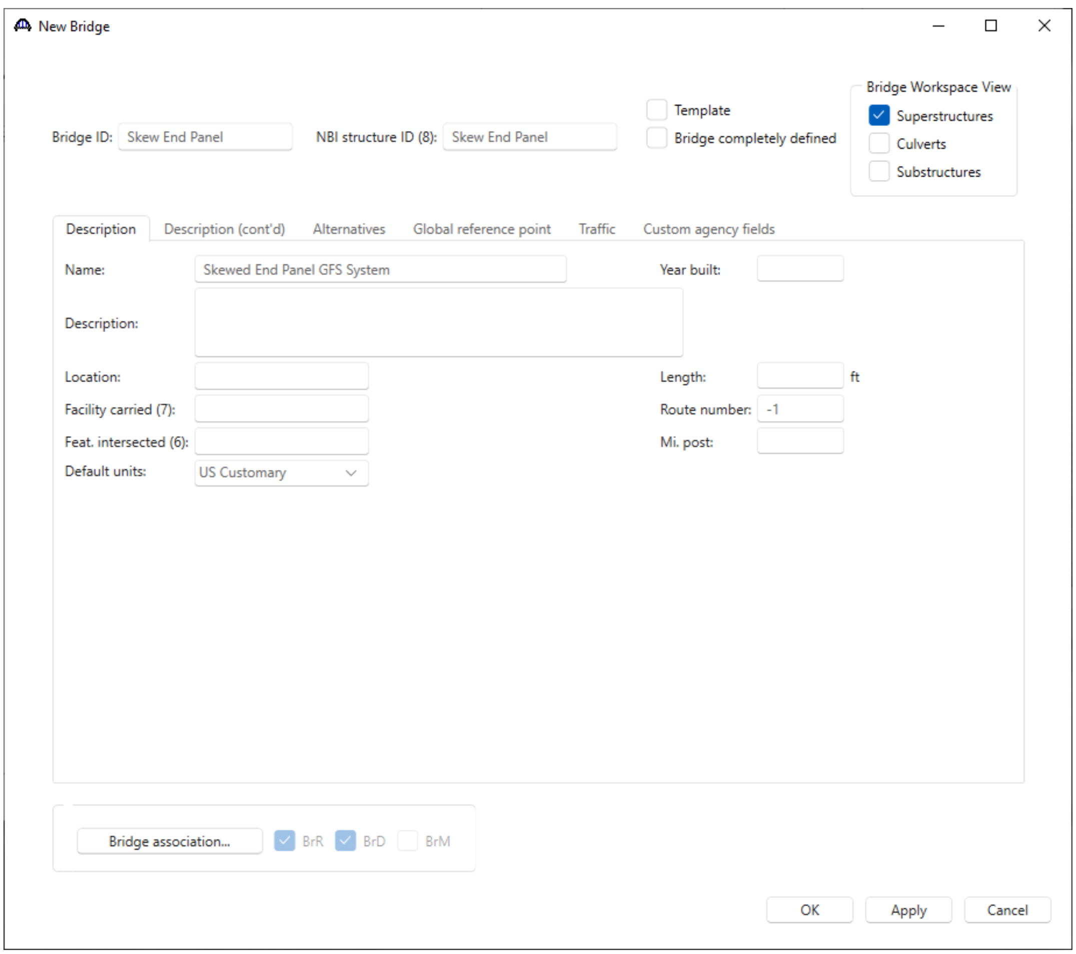
This example demonstrates entering a Girder-Floorbeam-Stringer superstructure with skewed end panels in BrDR using the system superstructure definition approach. The focus of this example is the skewed end panels and geometry of the system. This is an advanced example and it is assumed that the user is familiar with the basics of BrDR. As such, several of the details of this example such as creating bridge materials, beam shapes, etc., are not presented .

Superstructure composed of girders, floorbeams and stringers

From the **Bridge Explorer** create a **New** bridge as shown below.



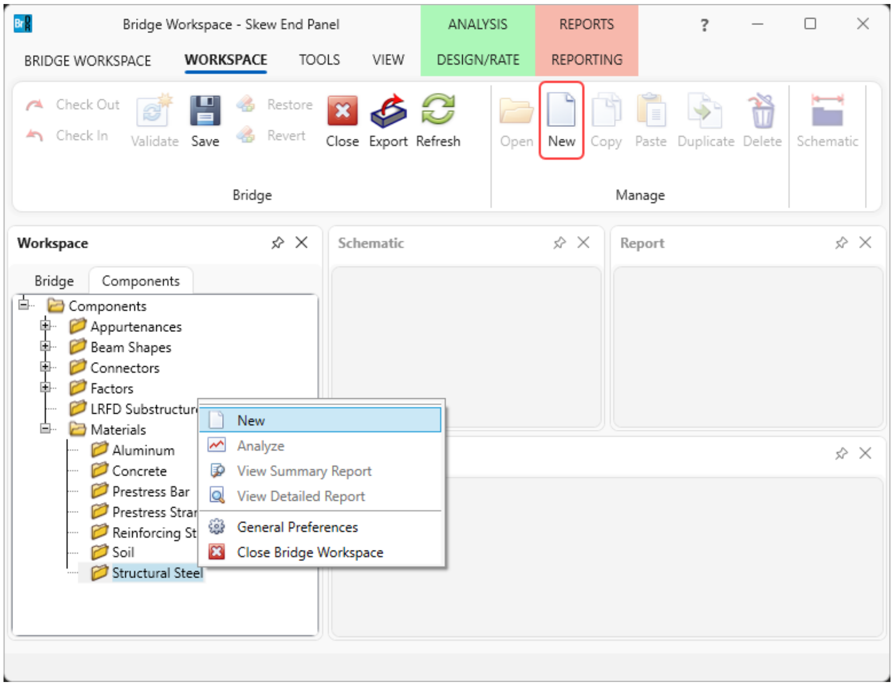
Enter the following description data.



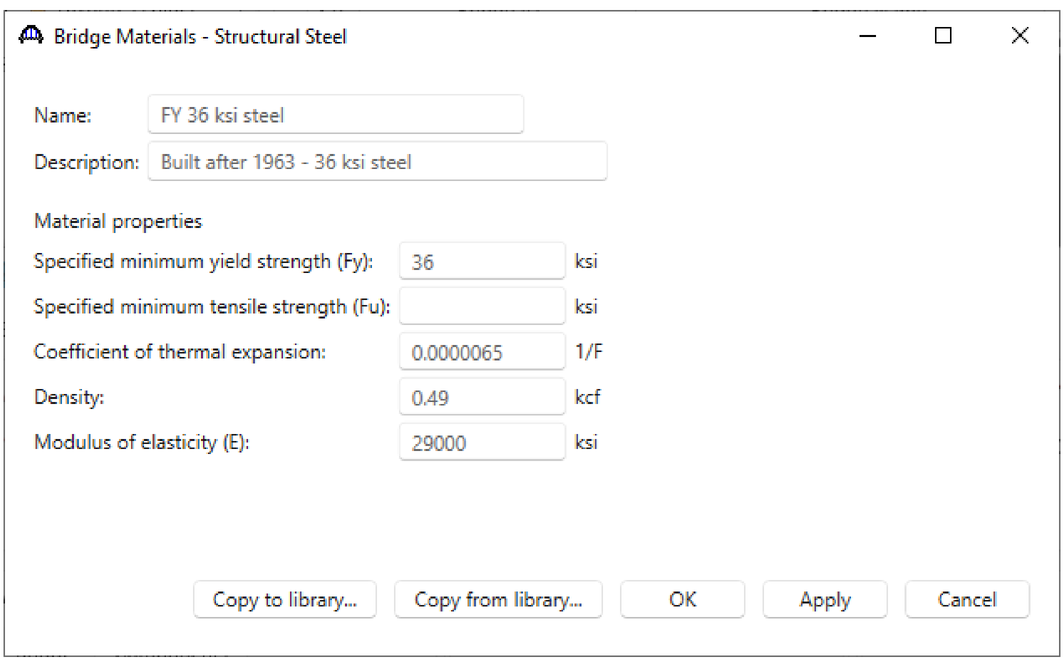
Click **OK** to apply the data and close the window.

Bridge Materials

To enter a structural steel material to be used by members of the bridge, in the **Components** tab of the **Bridge Workspace**, expand the **Materials** folder, select **Structural Steel,** and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New**, or double click) as shown below.

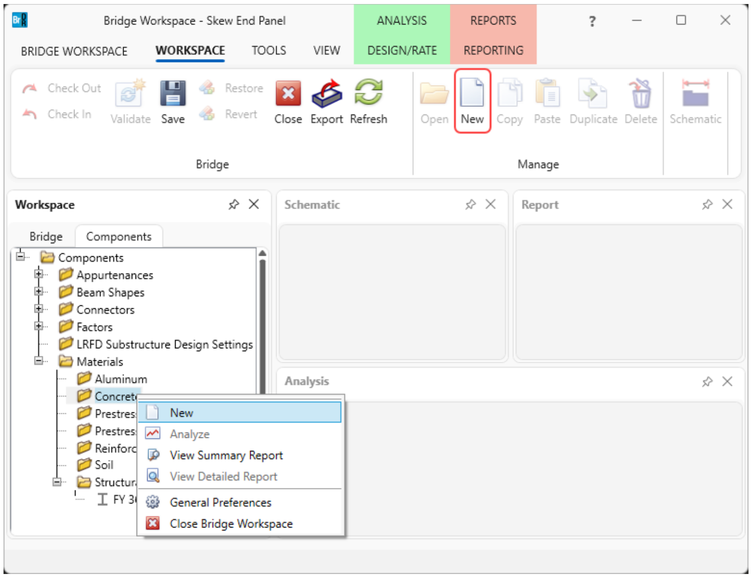


Enter data as shown below.

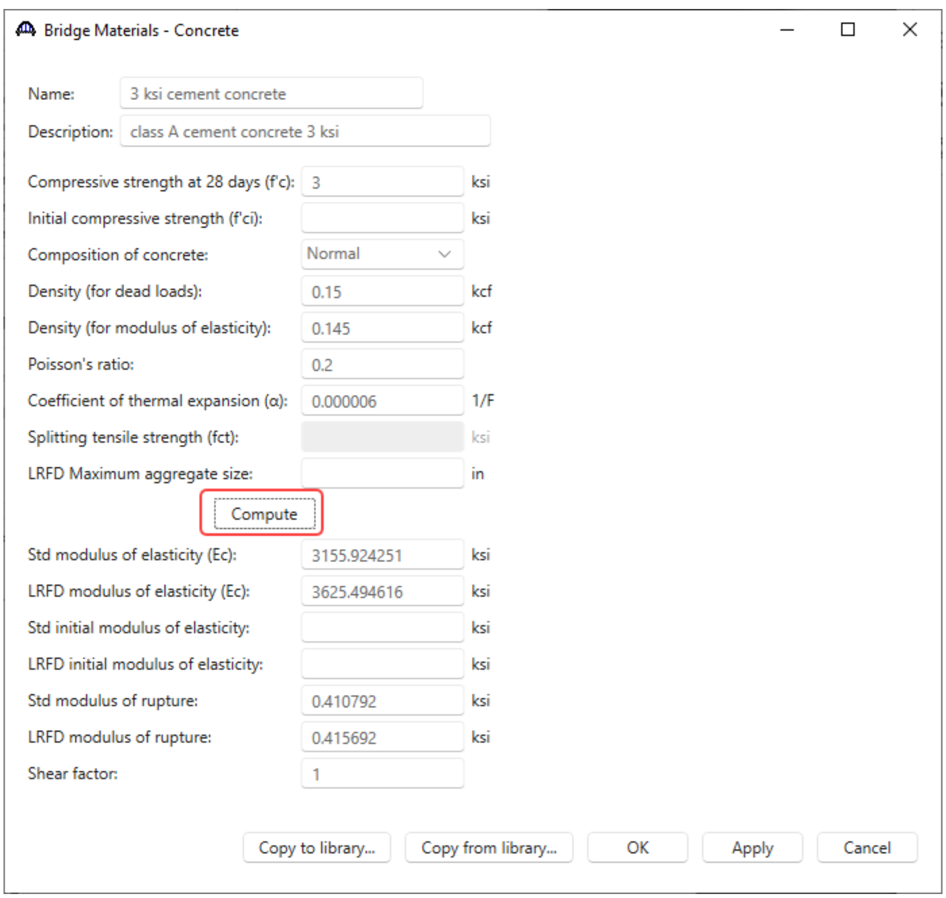


Click **OK** to apply the data and close the window.

Similarly, add the following concrete material.



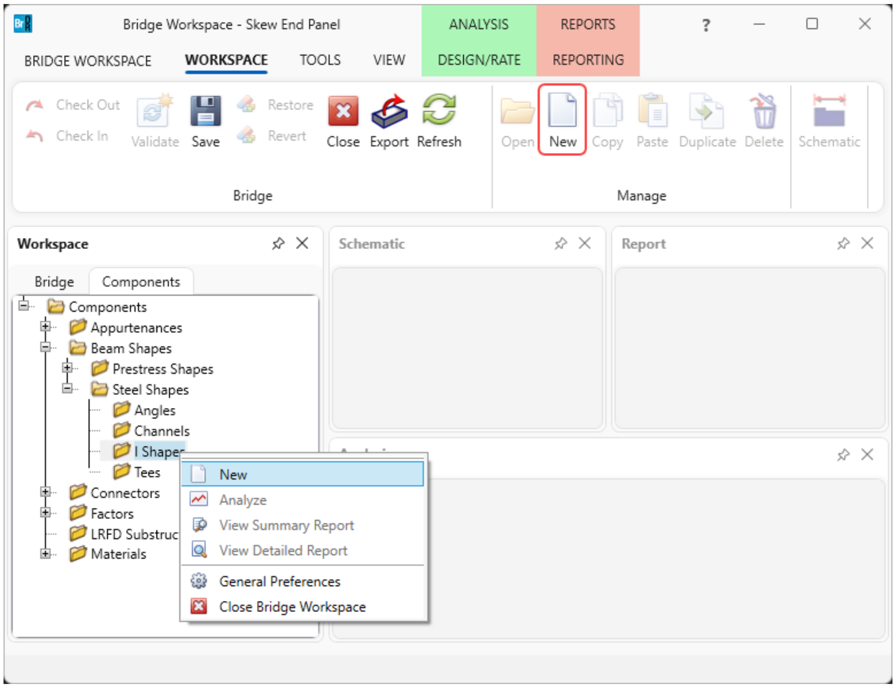
Enter the values shown above the **Compute** button and click the **Compute** button to compute the remaining values below them.



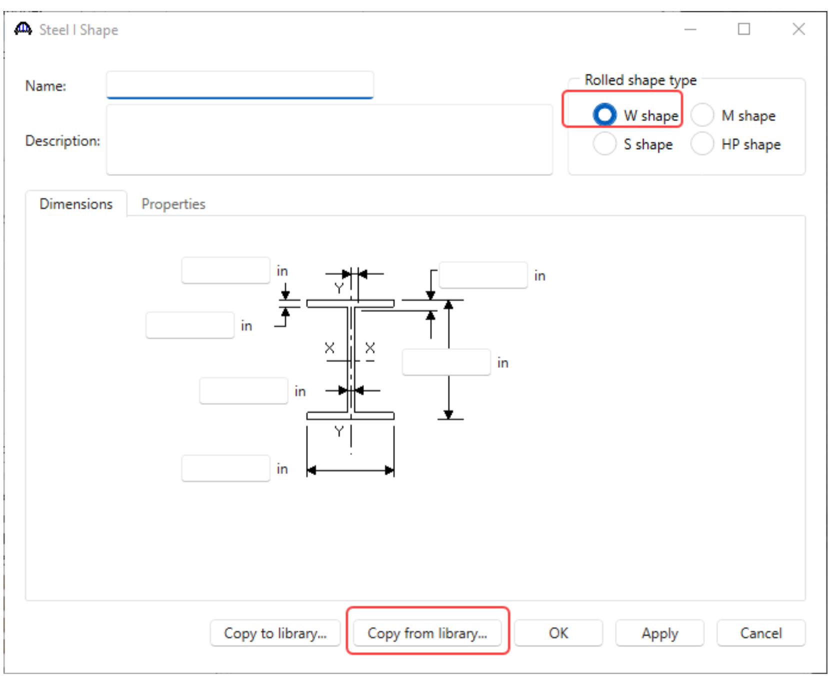
Click **OK** to apply the data and close the window.

Beam Shapes

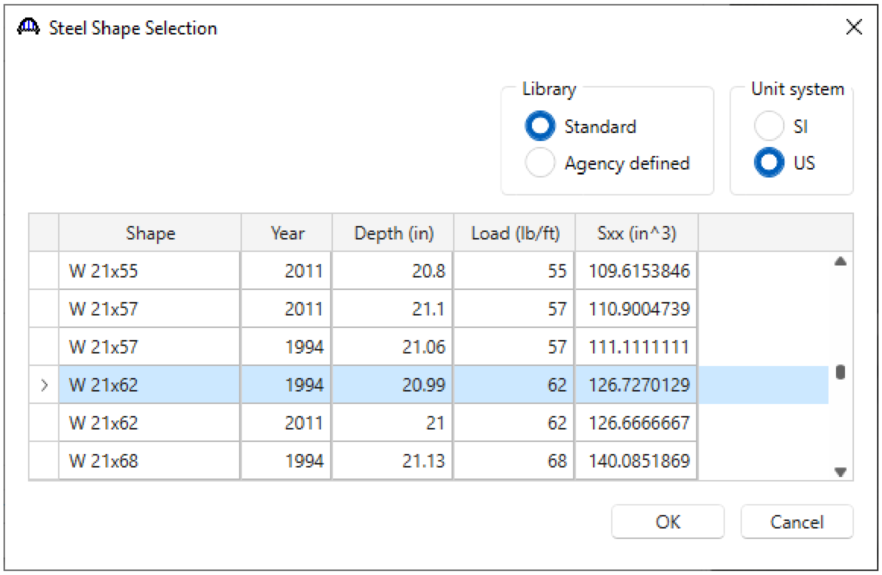
To enter a steel beam shape to be used in this bridge expand the tree labeled **Beam Shapes** and **Steel Shapes.** Click on the **I Shapes** node in the **Components** tree and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **I Shapes** and select **New** or double click on **I Shapes** in the **Components** tree).



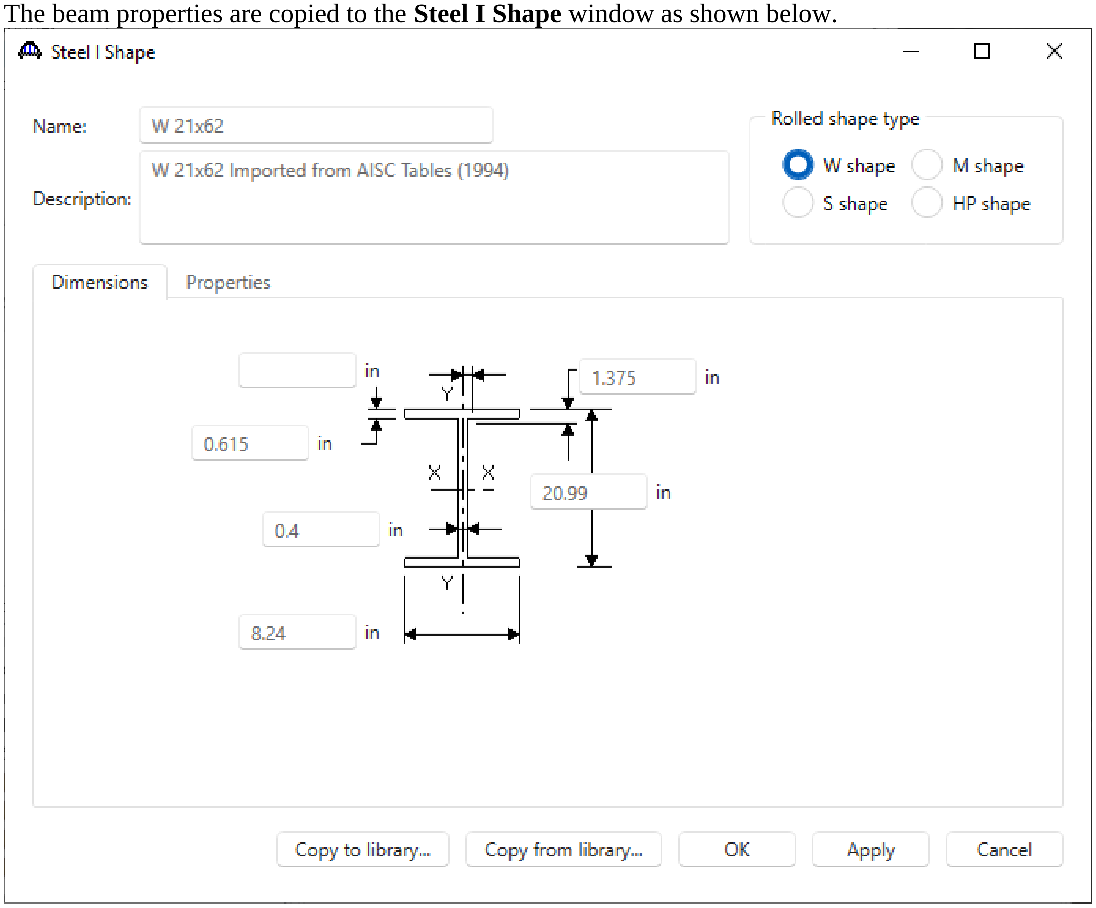
The window shown below will open. Select the **Rolled shape type** as **W shape** and click the **Copy from library…** button.



The **Steel Shape Selection** window will appear. Copy the following steel beam shape from the library to the bridge. This shape will be used for the stringers in this superstructure.



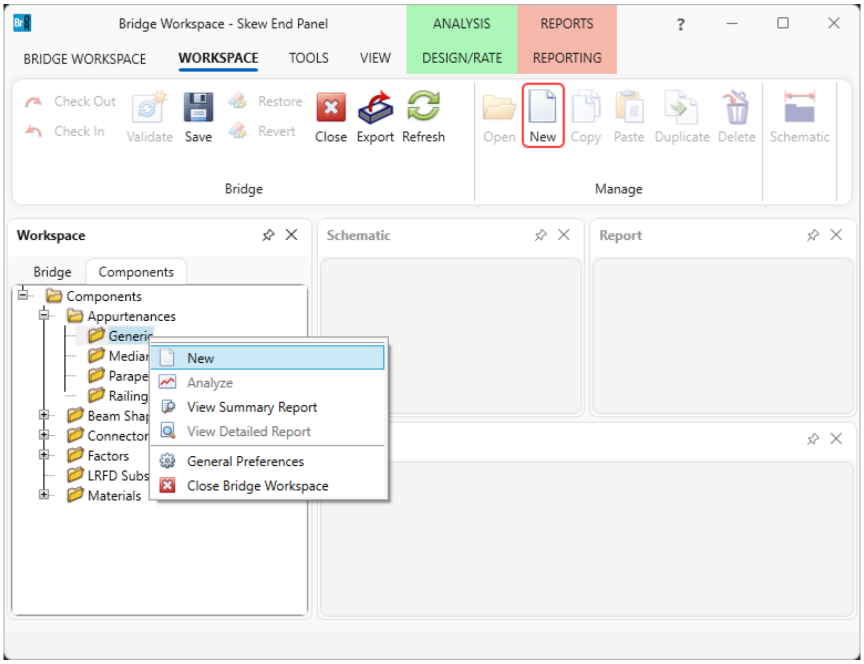
The beam properties are copied to the **Steel I Shape** window as shown below.



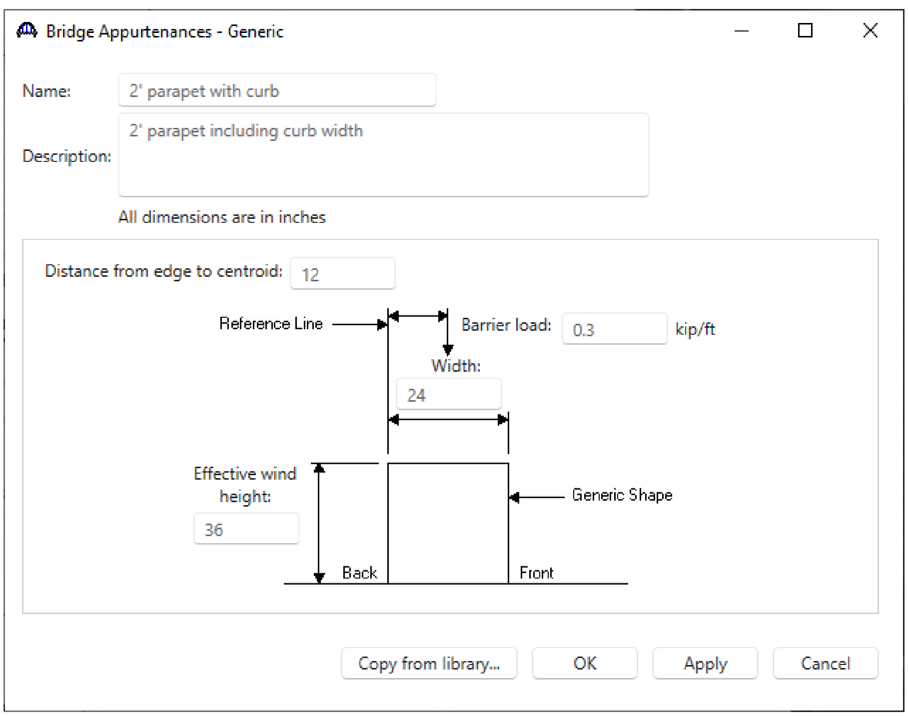
Click **OK** to apply the data and close the window.

Bridge Appurtenances - Parapet

To enter the appurtenances to be used within the bridge expand the tree branch labeled **Appurtenances**. Select **Generic** and click on **New** from the **Manage** button on the **WORKSPACE** ribbon (or double click on **Generic** in the **Components** tree).



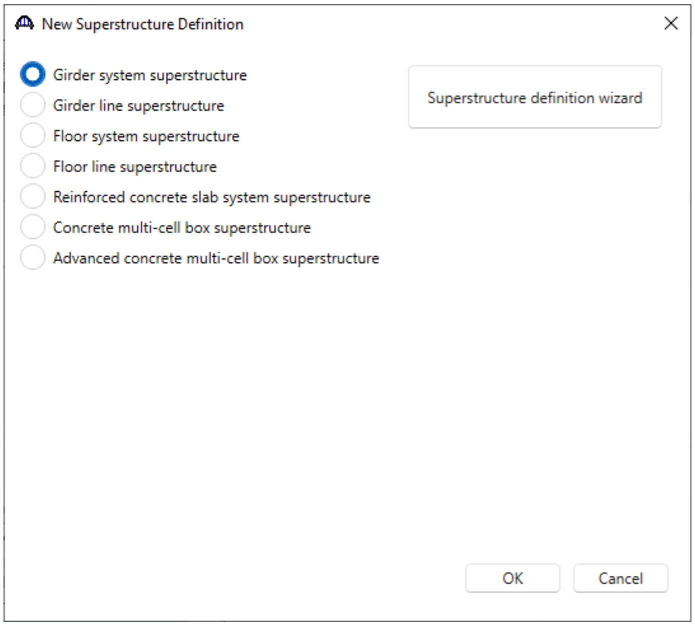
Add the following appurtenance to the bridge.



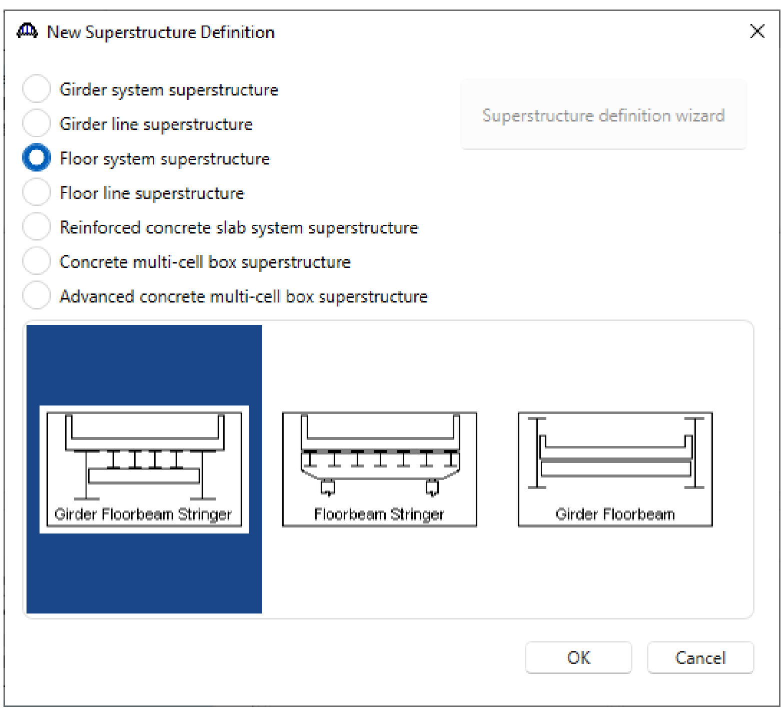
Click **OK** to apply the data and close the window.

Superstructure definition

Returning to the **Bridge** tab of the **Bridge Workspace**, double click on **SUPERSTRUCTURE DEFINITIONS** (or click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the **Manage** group of the **WORKSPACE** ribbon or right mouse click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the popup menu) to create a new structure definition. The window shown below will appear.

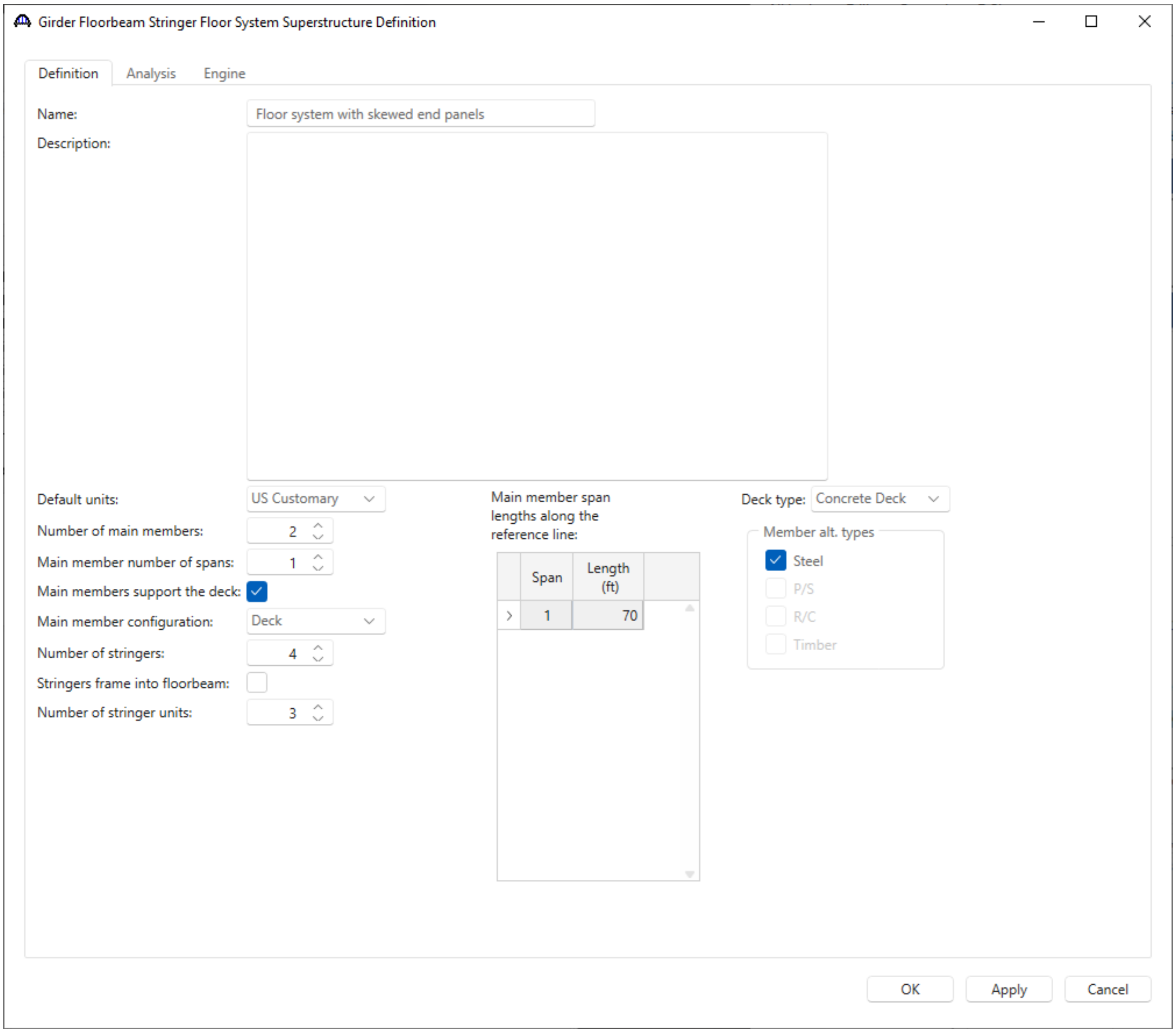


Selecting **Floor system superstructure** displays three types of floor system superstructure definitions. Select the **Girder Floorbeam Stringer** and click **OK.**

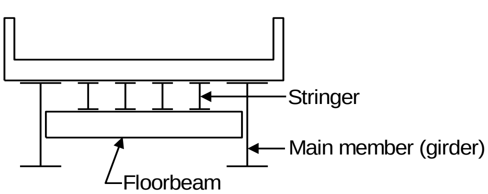


Girder Floorbeam Stringer Floor System Superstructure Definition

The **Girder Floorbeam Stringer Floor System Superstructure Definition** window will open. Enter the data as shown below.

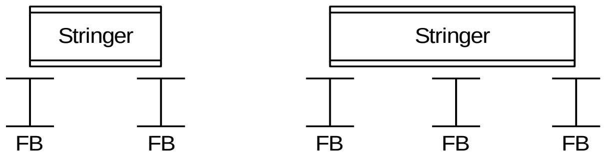


As shown by the sketch, this structure has 2 main members (girders) and 4 stringers.



FS4 – Skewed End Panel Floor System Example

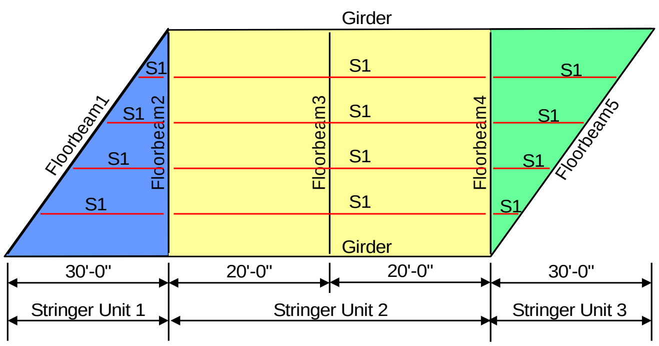
Stringer Units are the portions of the structure where the stringers are to be analyzed as structurally continuous units. In this structure, the stringers in the skewed end panels are simple span between the floorbeams and the stringers in the interior panels are 2 span continuous.



In the skewed end panels, the stringers are 1 simple span over 2 floorbeams.

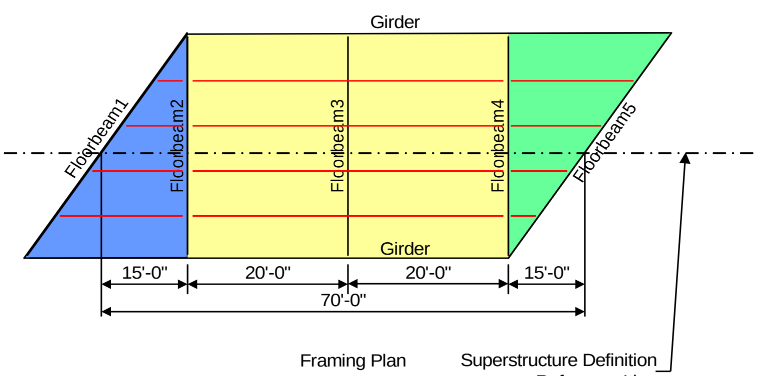
In the interior panels, the stringers are 2 continuous spans over 3 floorbeams.

This superstructure has 3 stringer units. Each stringer unit contains 4 stringer members.



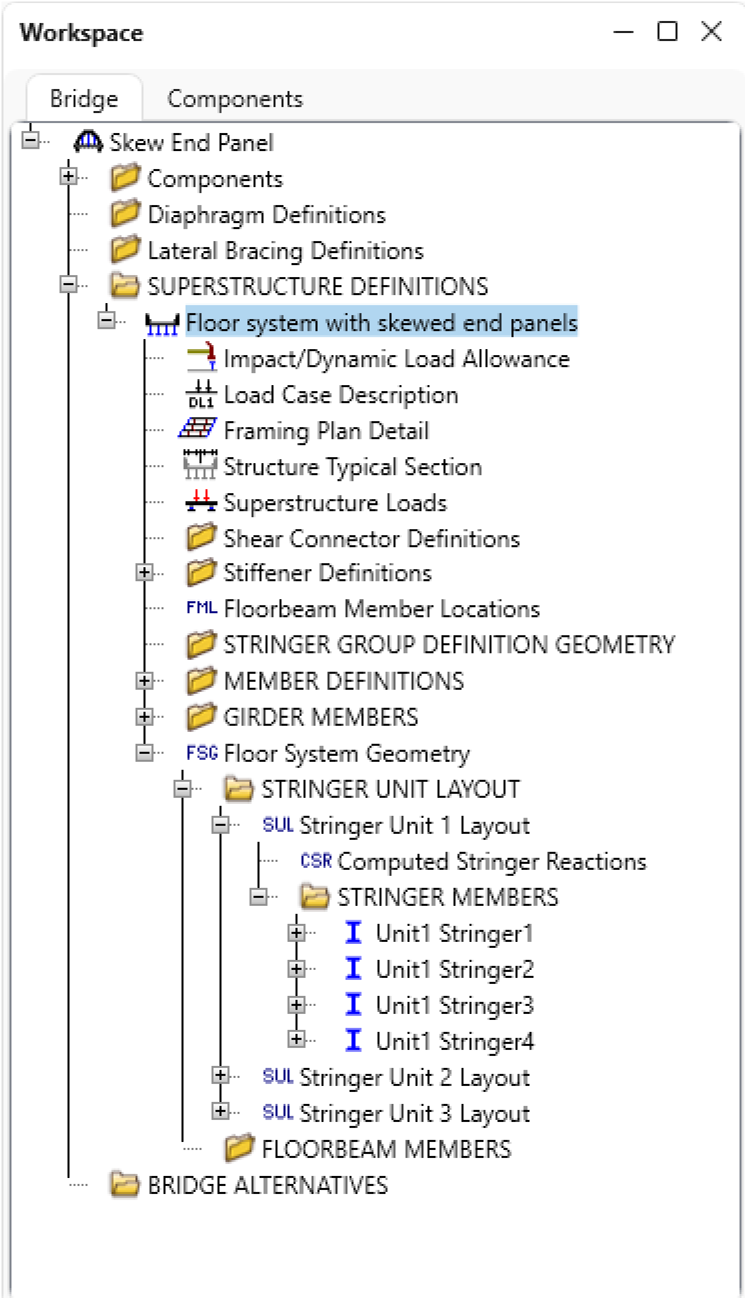
Framing Plan
(Stringers are shown in red)
There are 3 Stringer Units in this superstructure definition

The span lengths for the main members are entered along the superstructure definition reference line. In this example, the superstructure definition reference line is located in the center of the deck. It has the following dimensions. As can be seen by this example, it is important to know where the superstructure definition reference line is located within the structure typical section when the main girder supports are skewed.



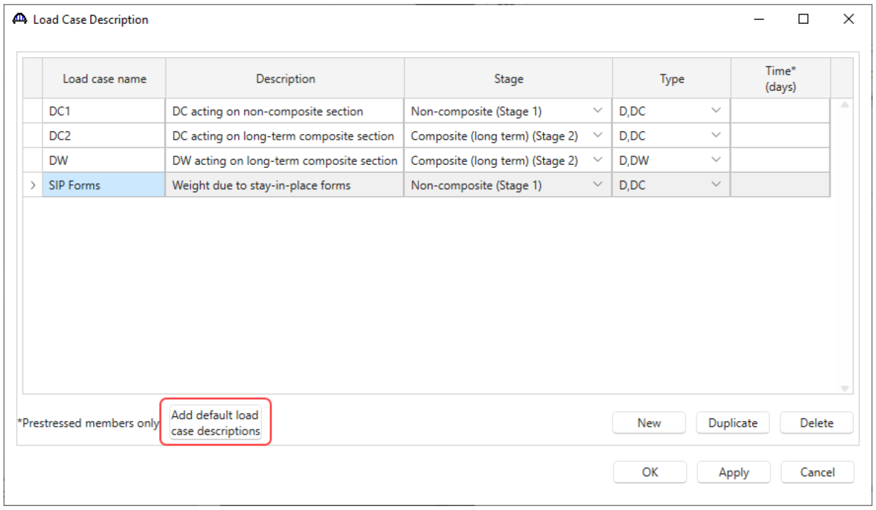
Framing Plan

The partially expanded **Bridge Workspace (BWS)** tree is shown below:



Load Case Description

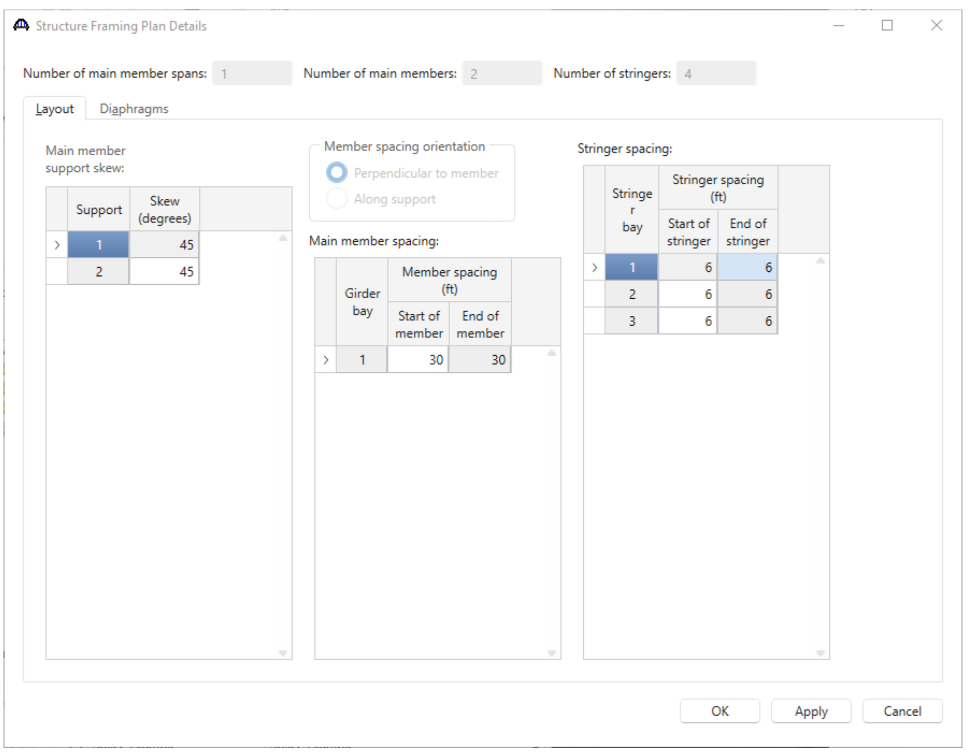
Double click on the **Load Case Description** node to define the dead load cases. Click on the **Add default load case description** button to create the following load cases.



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

Structure Framing Plan Detail – Layout

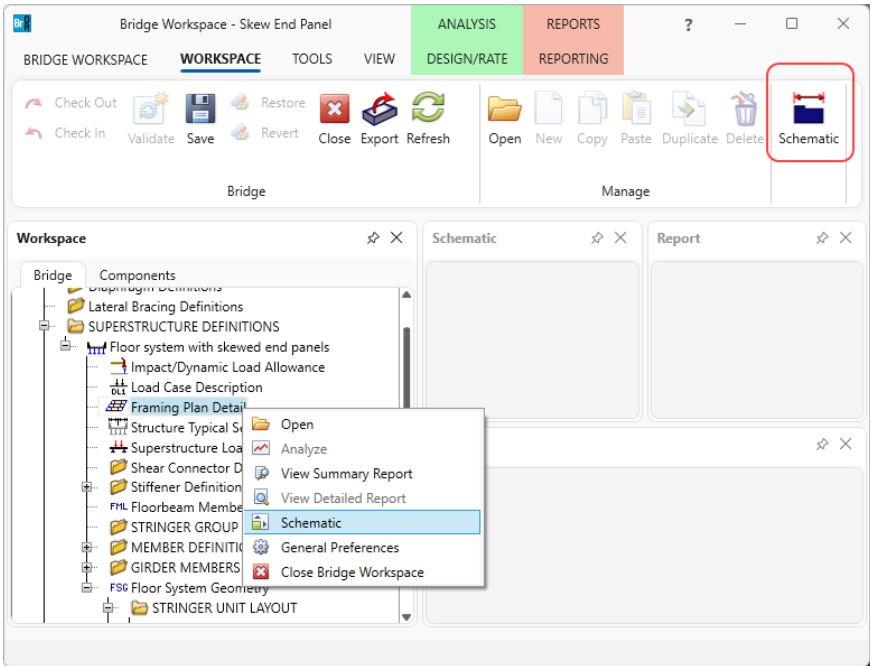
Double-click on **Framing Plan Detail** in the **Bridge Workspace** tree to describe the framing plan in the **Structure Plan Details** window. Enter the data as shown below.



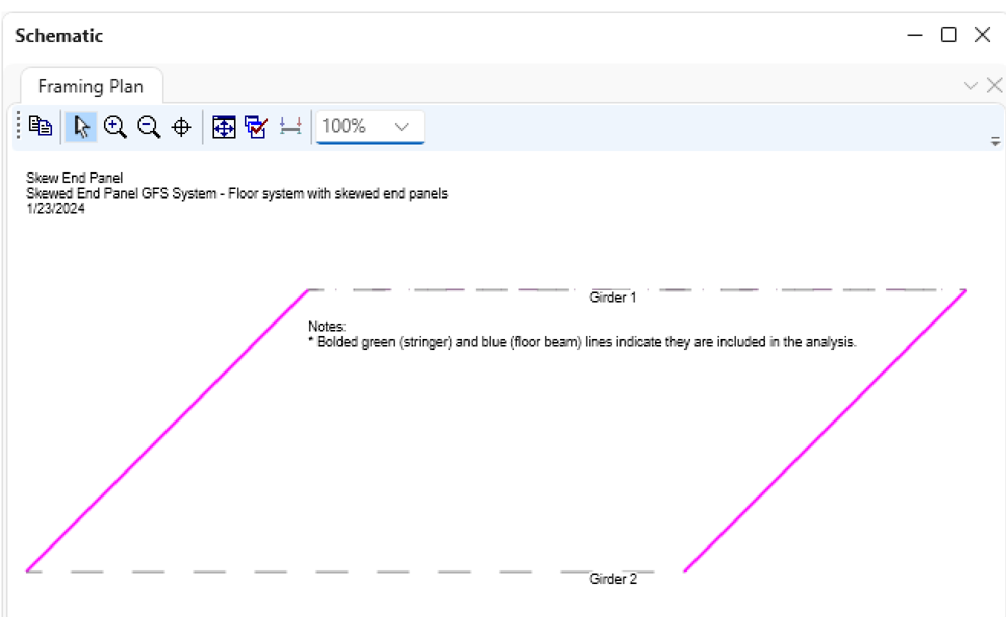
This superstructure does not have any lateral bracing between the girders no data will be entered on the **Diaphragms** tab. Click **OK** to apply the data and close the window.

Schematic – Framing Plan Detail

While the **Framing Plan Detail** node is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu). The girders appear as dashed lines because no girder member alternatives are defined yet. The stringers do not appear in the framing plan yet because the stringer members are not located along the length of the superstructure yet. The floorbeams do not appear either because information about the number of floorbeams or where they are located are not defined yet.

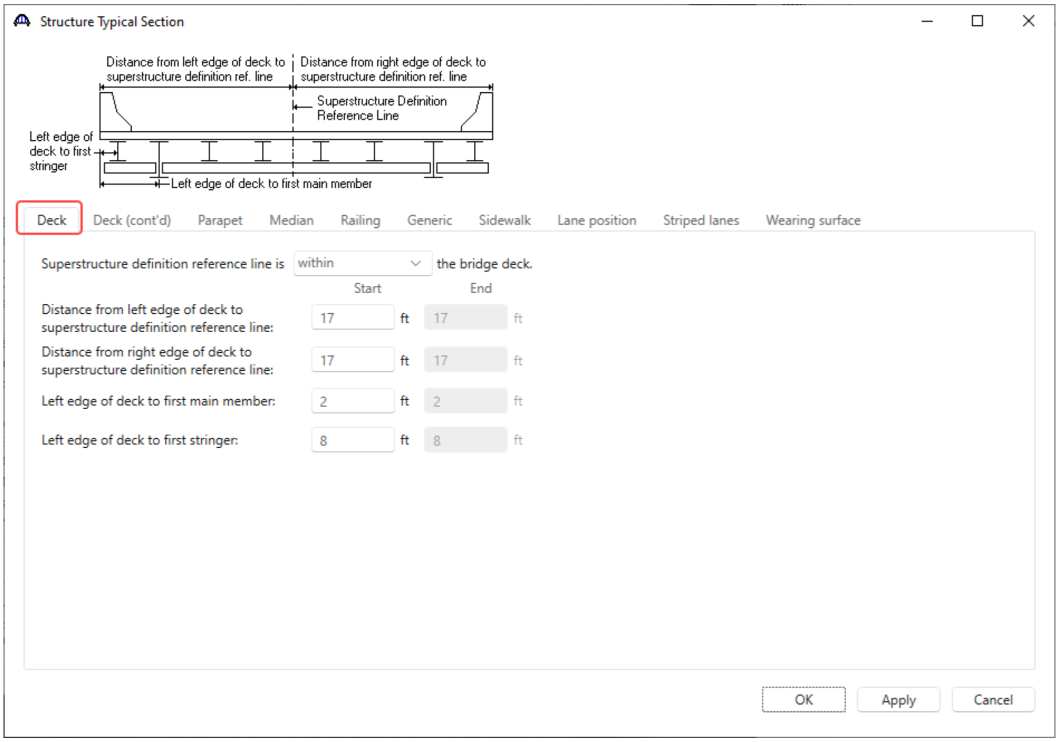


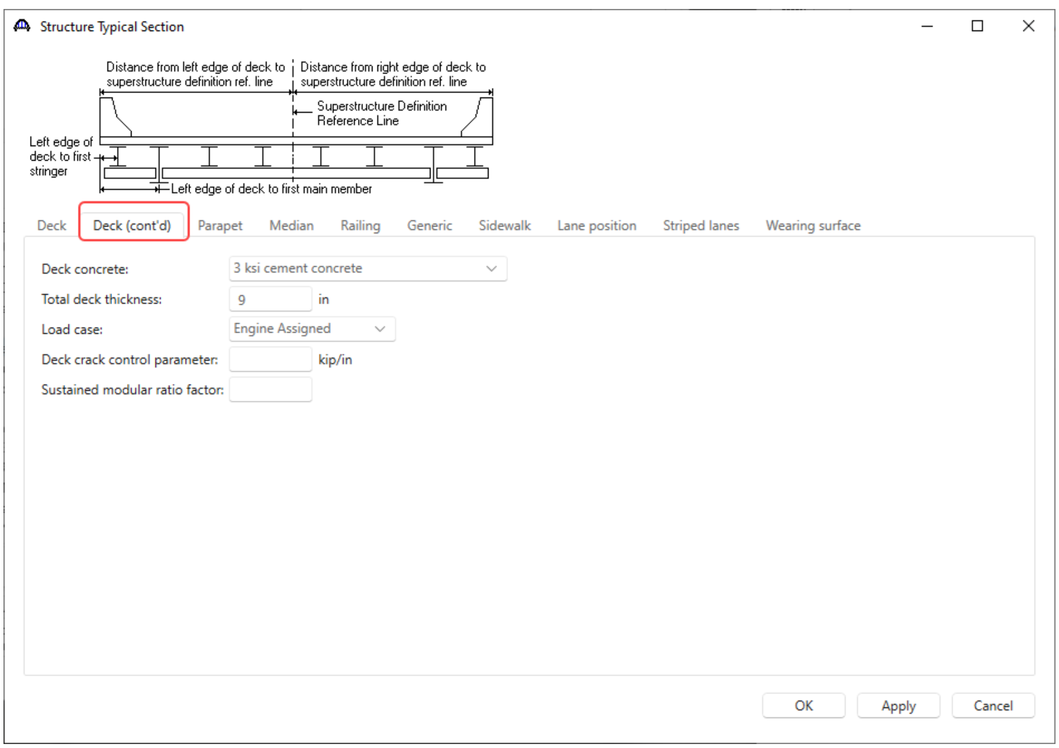
The **Structure Framing Plan Schematic** appears as follows.

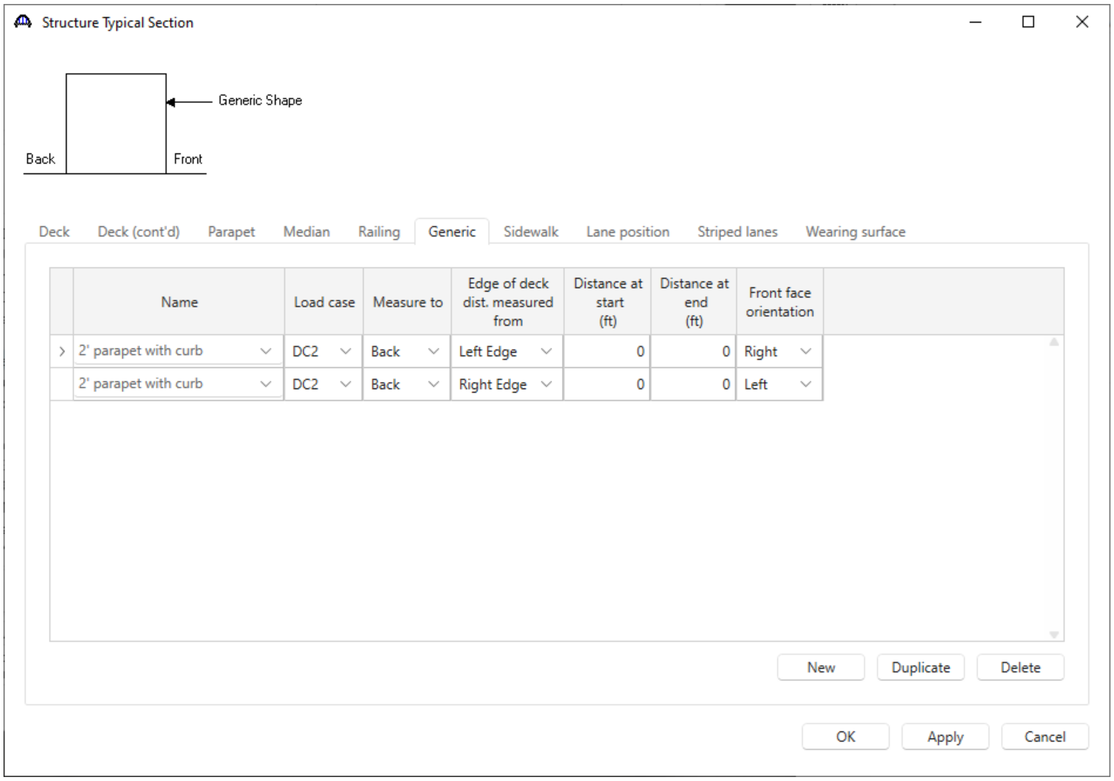


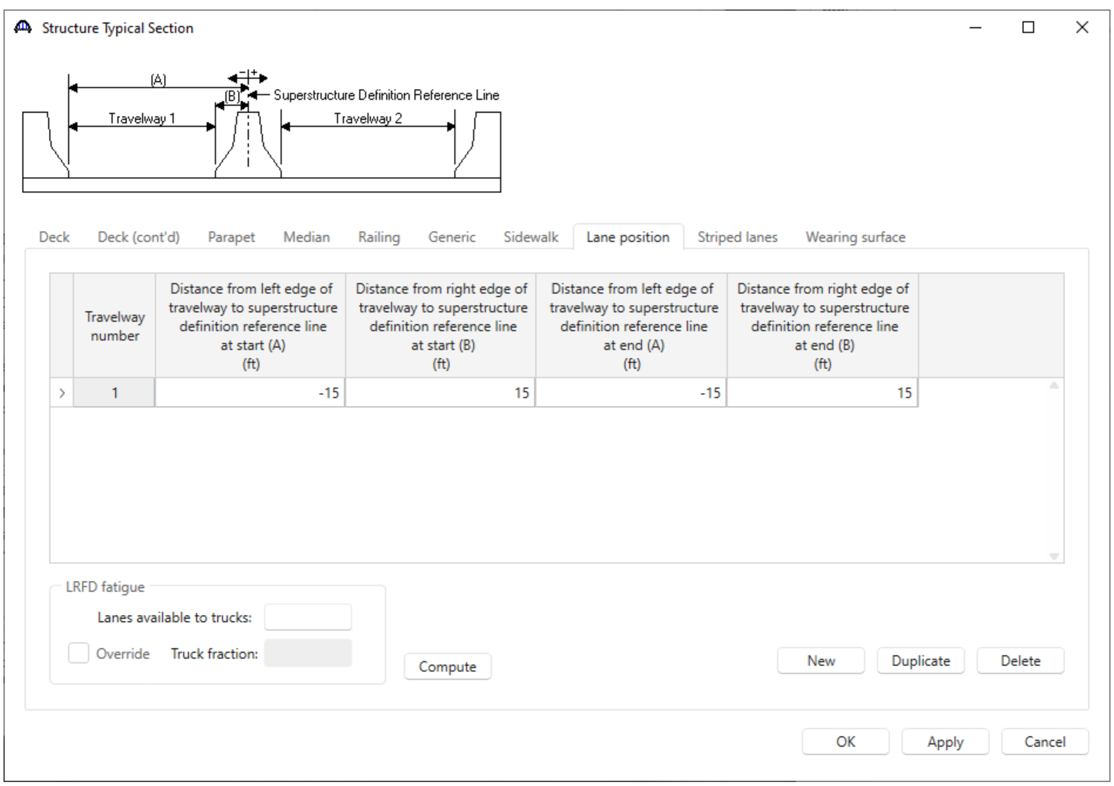
Structure Typical Section

Next define the structure typical section by double-clicking on **Structure Typical Section** node in the **Bridge Workspace** tree. Input the data describing the typical section in each of the tabs shown below.







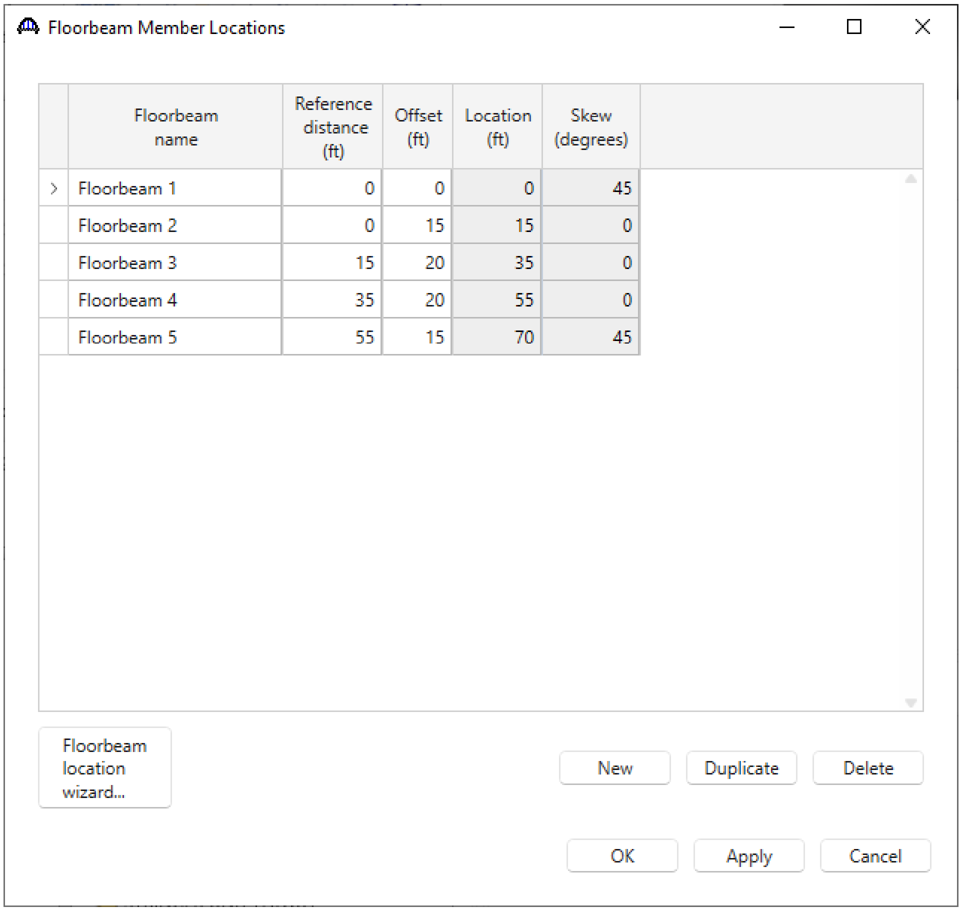


Click **OK** to apply the data and close the window.

This superstructure does not contain any transverse or bearing stiffeners so no stiffener definitions will be created.

Floorbeam Member Locations

Double click on the **Floorbeam Member Locations** node in the **Bridge Workspace** tree to open the **Floorbeam Member Locations** window and enter the data as shown below.



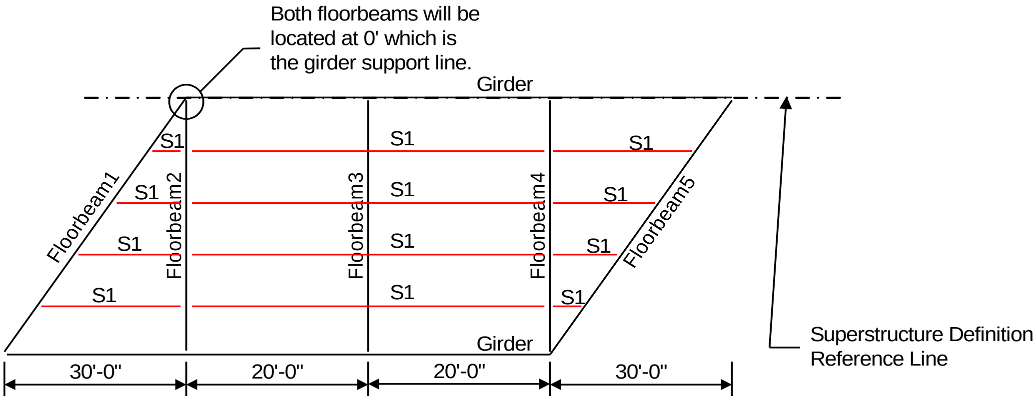
Floorbeam name	Reference distance (ft)	Offset (ft)	Location (ft)	Skew (degrees)
Floorbeam 1	0	0	0	45
Floorbeam 2	0	15	15	0
Floorbeam 3	15	20	35	0
Floorbeam 4	35	20	55	0
Floorbeam 5	55	15	70	45

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

The Skew column displays the skew angle of the floorbeam. Floorbeams that intersect the superstructure definition reference line at the same location as a support line for the main members are assumed to be at the same skew angle as the support line. Otherwise, all floorbeams are assumed to be perpendicular to the superstructure definition reference line. If this superstructure had floorbeams that were skewed and not located at a support line, floor line superstructure definition should be used to describe this superstructure.

FS4 – Skewed End Panel Floor System Example

An important item to note about a floor system with skewed support lines is that the location of the superstructure definition reference line within the structure typical section is important. Consider the following example where the superstructure definition reference line is located along the left main girder. Floorbeam 1 and 2 will both be located at 0' which is the girder support line. Therefore, both Floorbeam 1 and 2 will display the skew angle as 45 degrees. Shifting the location of the superstructure definition reference line will cause the floorbeams to have different locations and then only Floorbeam 1 will be considered to be along the girder support line and skewed.



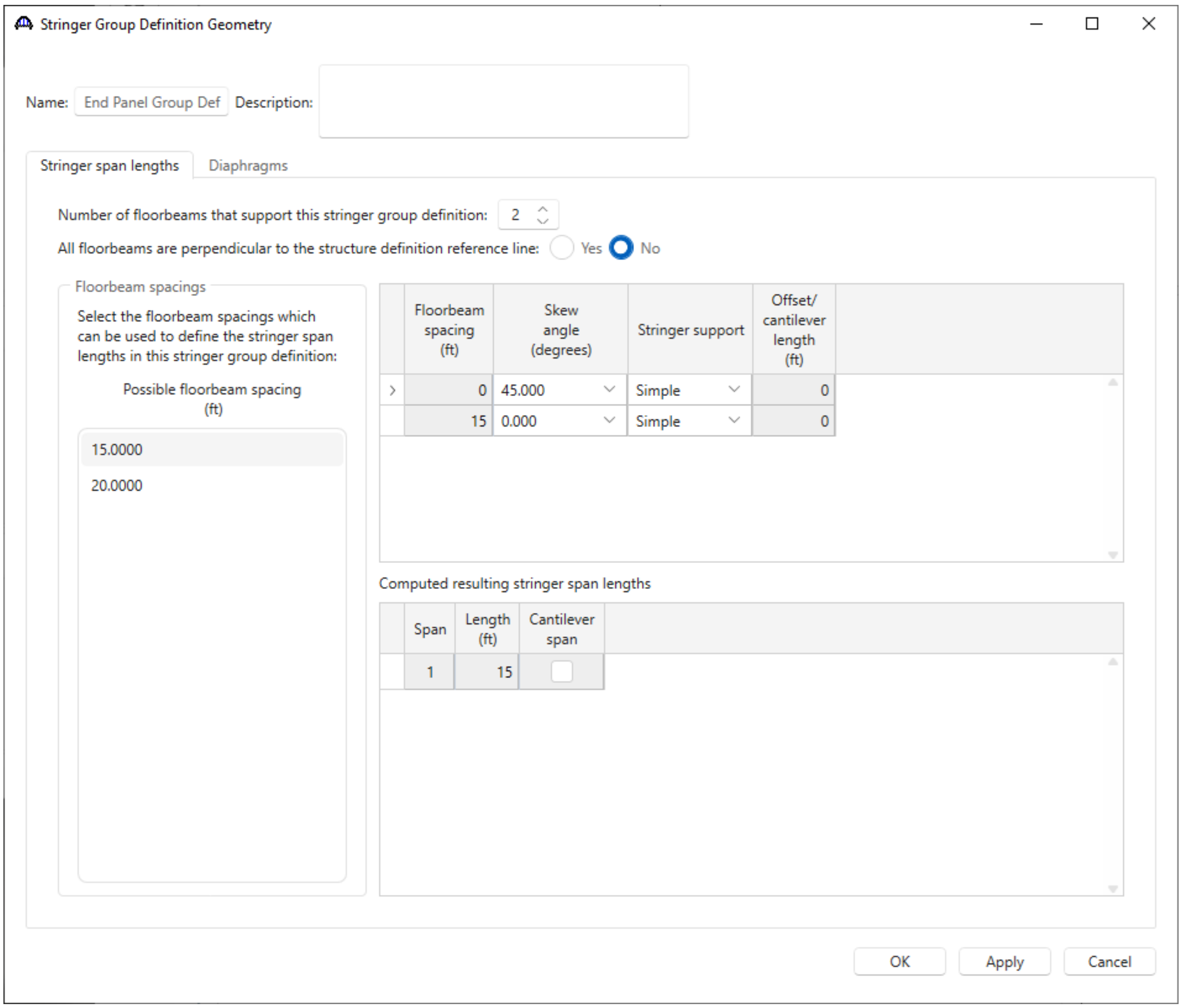
Schematic – Framing Plan Detail

While **Framing Plan Detail** is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu). The framing plan schematic will now show the floorbeam members as dashed locations. The superstructure definition reference line is now displayed in the schematic since it was located in the **Structure Typical Section** window.

STRINGER GROUP DEFINITION GEOMETRY

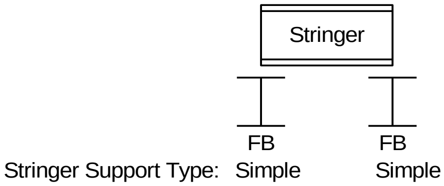
Double click on **STRINGER GROUP DEFINITION GEOMETRY** to define the geometry for a stringer group definition. A stringer group definition contains data regarding a portion of the structure where the stringers are structurally continuous. The stringers in this structure have two different types of span data. The skewed end panels are simple span, and the interior panels are 2 span continuous. 2 stringer group definitions will be created and assigned to the appropriate stringer units.

Enter the following data to describe the stringer group definition for end panels.



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

FS4 – Skewed End Panel Floor System Example

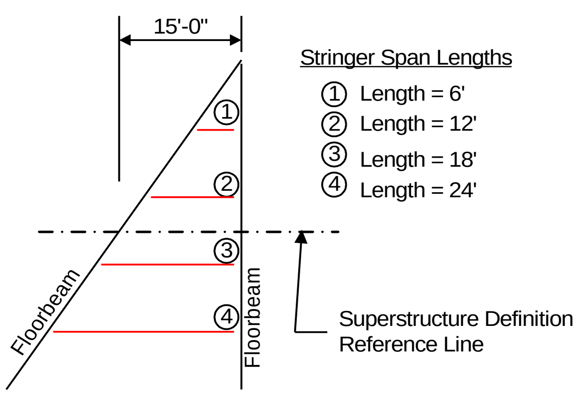


In the skewed end panels, the stringers are 1 simple span over 2 floorbeams.

The stringers in this stringer group definition are supported by 2 floorbeams. The **Floorbeam spacings** list shows all of the possible combinations of adjacent floorbeam spacings between 2 floorbeams. BrDR uses the information shown in the **Floorbeam Member Locations** window to produce this list. The spacings displayed in this list are measured along the superstructure definition reference line. Select the **15'** value in this list.

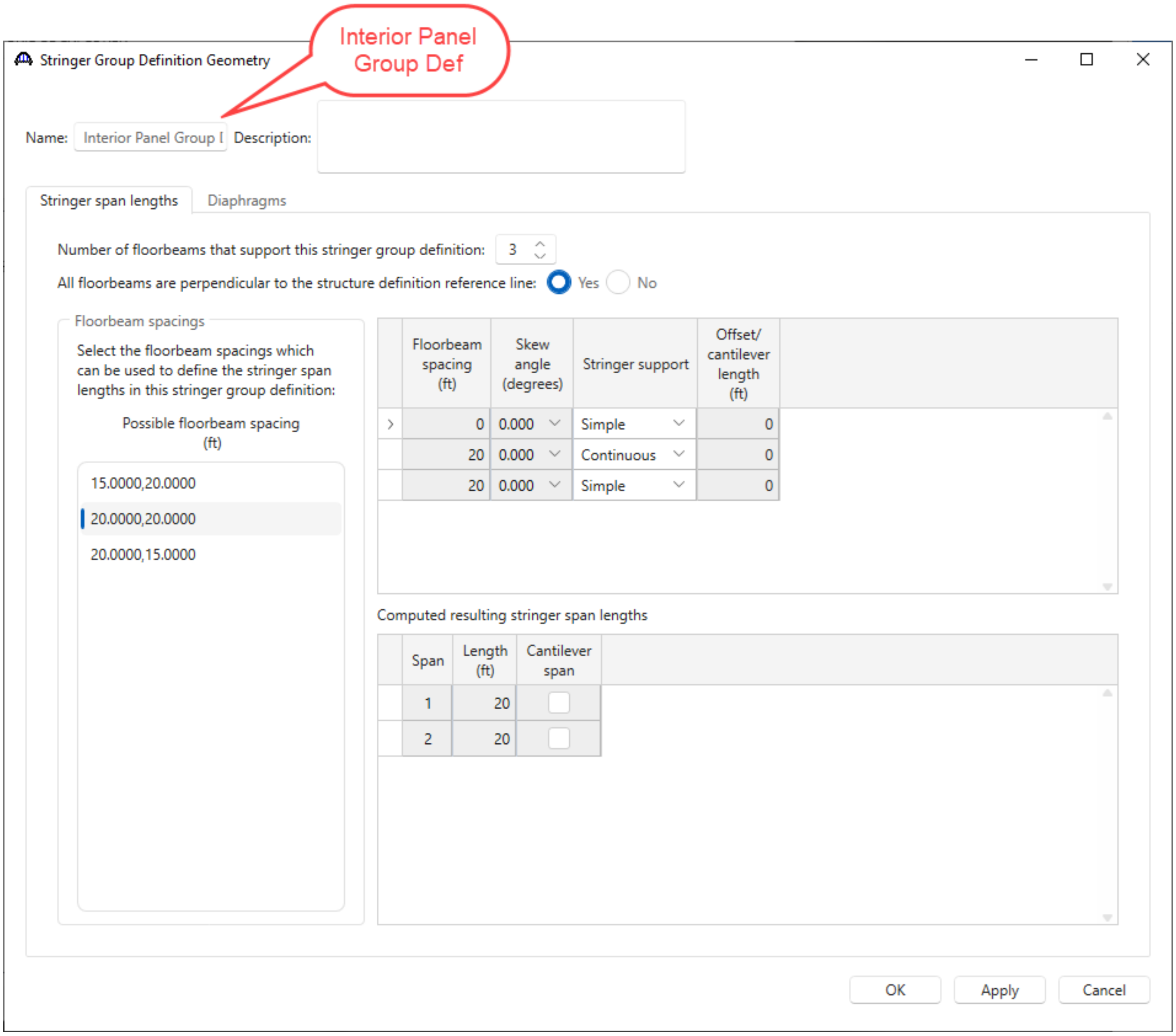
The end floorbeam is not perpendicular to the superstructure definition reference line so select **No** for that data field. It is necessary to know which floorbeams in the stringer group definition are skewed because skewed floorbeams will cause the stringer span lengths in the stringer group definition to vary. In the floorbeam spacing grid, select the skew angle of the first floorbeam as 45 degrees. When this stringer group definition is assigned to a stringer unit later in the Floor System Geometry window, BrDR will check to ensure that any floorbeams that fall along the girder support lines have the same skew as the support line. The stringer support types are **Simple** in this example.

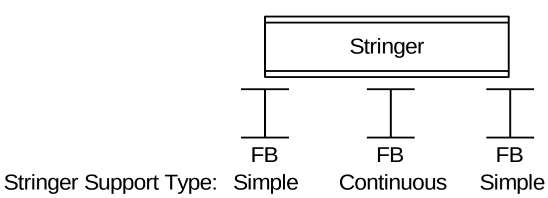
The computed resulting stringer span lengths grid displays the length of the spans measured along the superstructure definition reference line. The actual span lengths of each stringer will vary due to the skew of the first floorbeam. Based on the geometry entered on the **Structure Framing Plan Details**, **Structure Typical Section** windows and this window, BrDR will know that the span lengths of the stringers in this stringer group definition are as follows:



The stringers in this stringer group definition do not have any diaphragms so the description is complete.

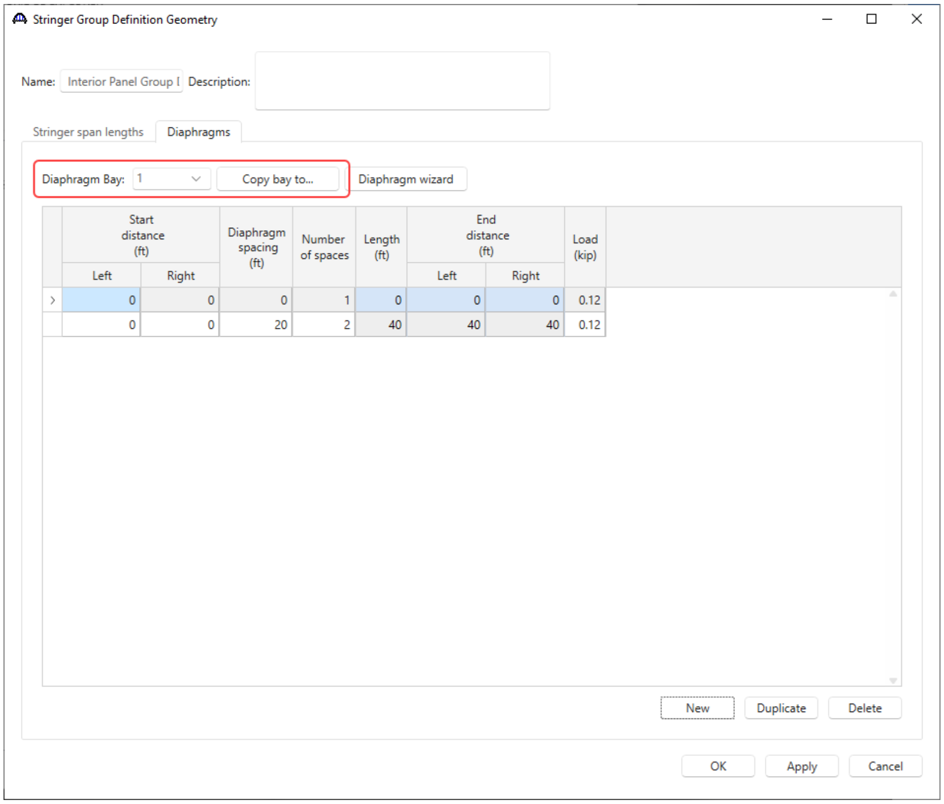
The stringer group definition that will be applied to the interior panels is defined as follows.



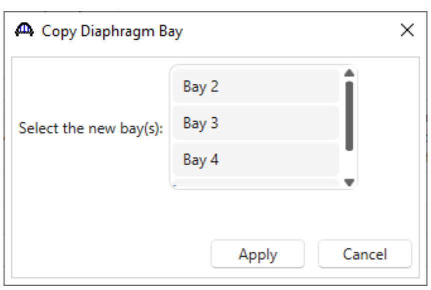


In the interior panels, the stringers are
2 continuous spans over 3 floorbeams.

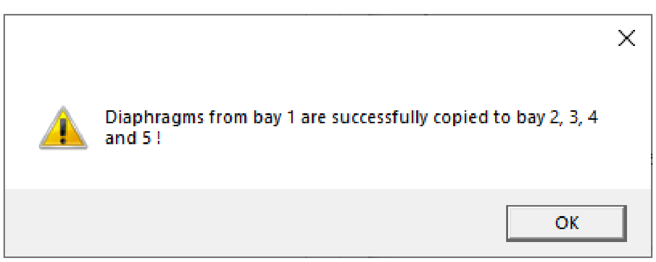
Select the **Diaphragms** tab to enter diaphragm spacing for the stringer group definition. The stringers have diaphragms at each end and one at the center of the stringer elevation. Enter the following data for **Diaphragm Bay 1** and use the **Copy bay to…** button to copy the data to the other diaphragm bays.



Click the **Copy bay to…** button to copy the diaphragms entered for Bay 1 to the other bays. The following window appears. Select all the bays by holding the **Shift** key and Click **Apply** as shown below.

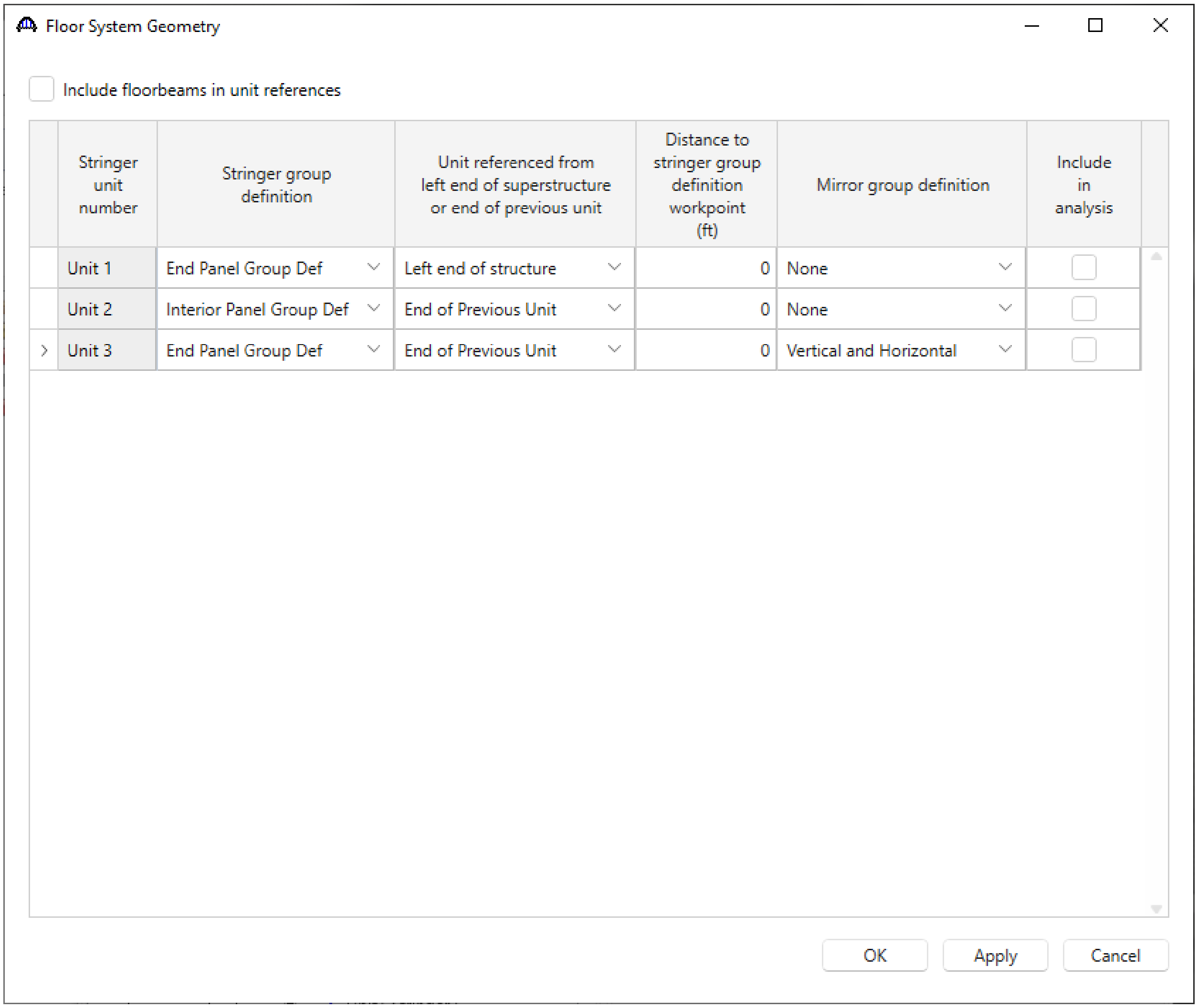


The following message appears indicating that the diaphragms have been copied. Click **OK** to close this window and update the diaphragms for each bay.



Assign Stringer Group Definitions to Stringer Units – Floor System Geometry

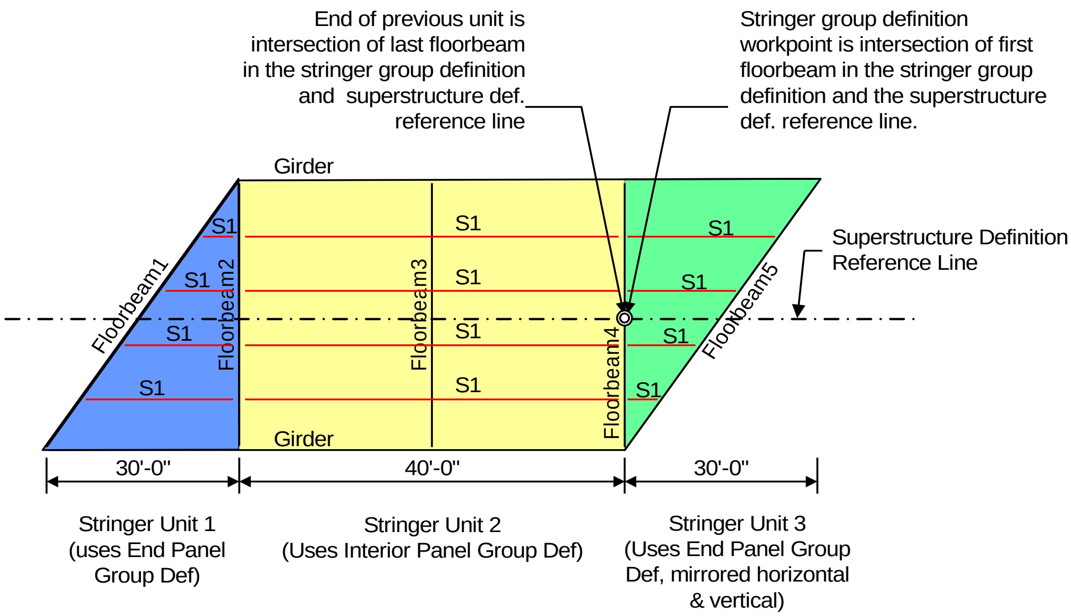
Since this example is focusing on the geometry of the system, skip over defining the floorbeam and stringer member definitions for now and open the **Floor System Geometry** window. Enter the following data to assign the stringer group definitions to the stringer units.



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

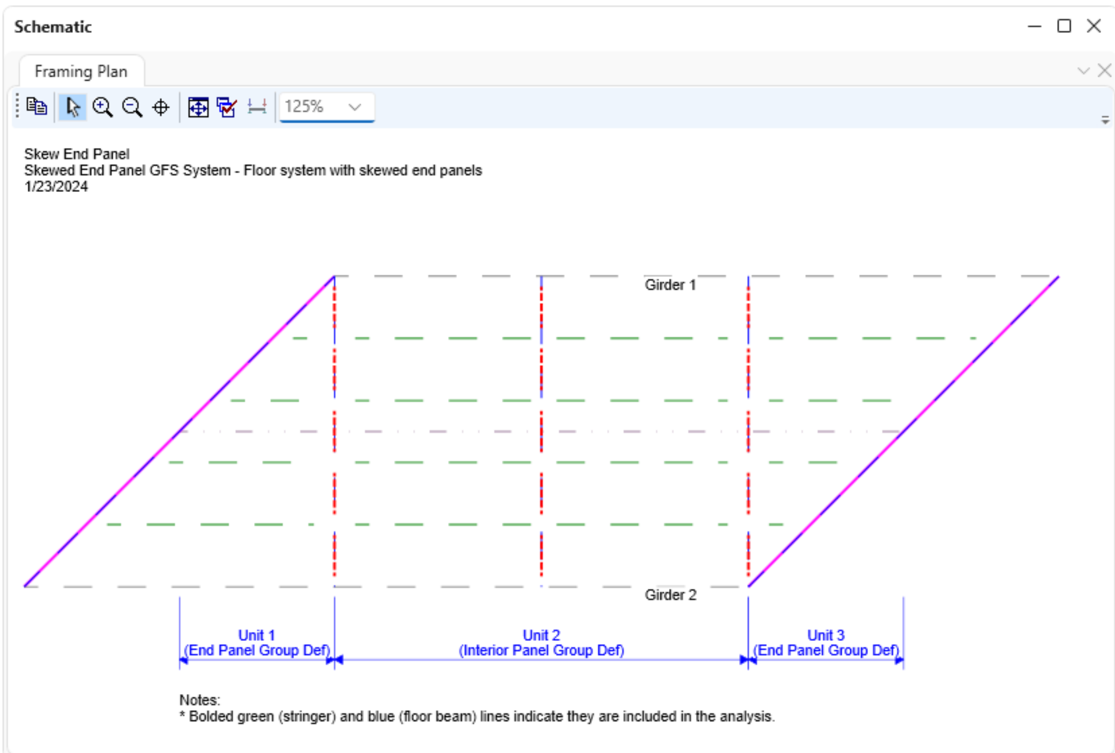
When the **End Panel Group Def** is assigned to **Stringer Unit 3**, it must be mirrored both vertically and horizontally so that the stringer members are properly located.

FS4 – Skewed End Panel Floor System Example



Schematic – Framing Plan Detail

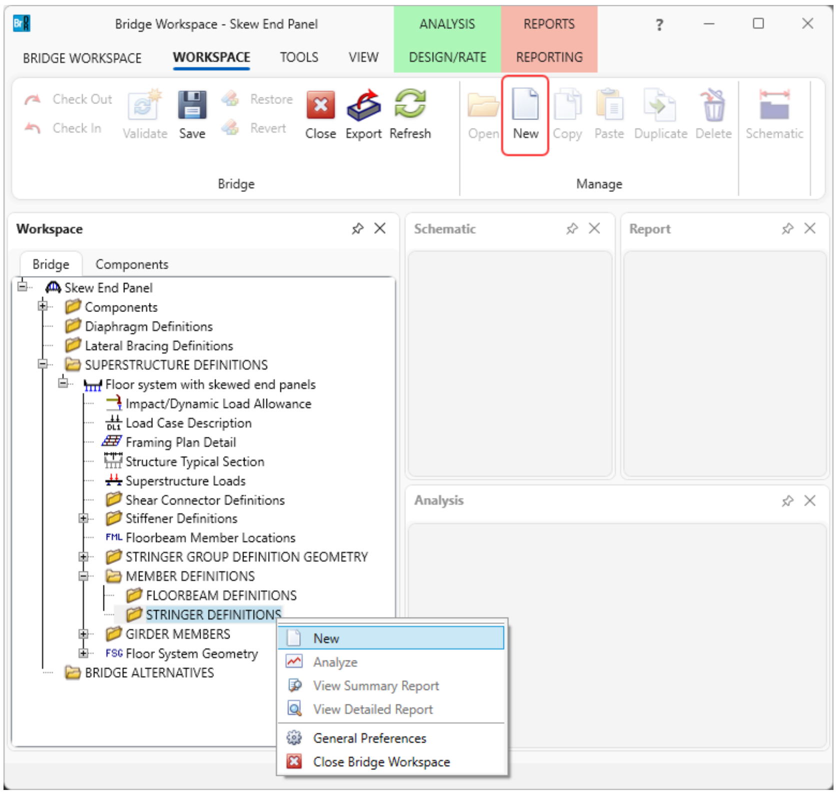
While the **Framing Plan Detail** node is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu). The **Structure Framing Plan** schematic appears as follows. The girder, floorbeam and stringer members all appear as dashed lines because the member alternatives are not defined yet for any members.



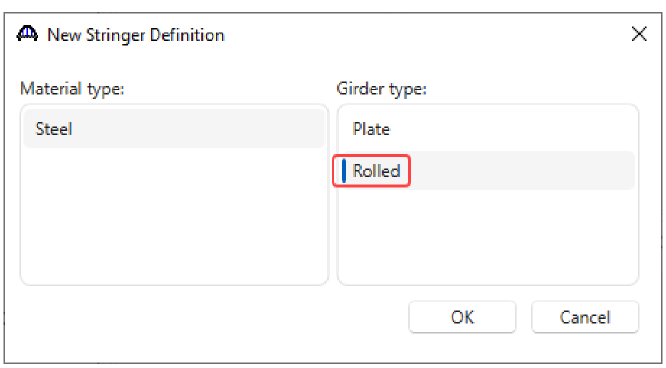
Defining Stringer Member Definitions

Create a stringer member definition for a stringer in the end panel. Since the stringer member lengths vary in this end panel, a stringer member definition will be created for each stringer member in the panel. For this example, a stringer member definition will be created that will be applied to the first stringer in the structure typical section. This stringer member has a length of 6'.

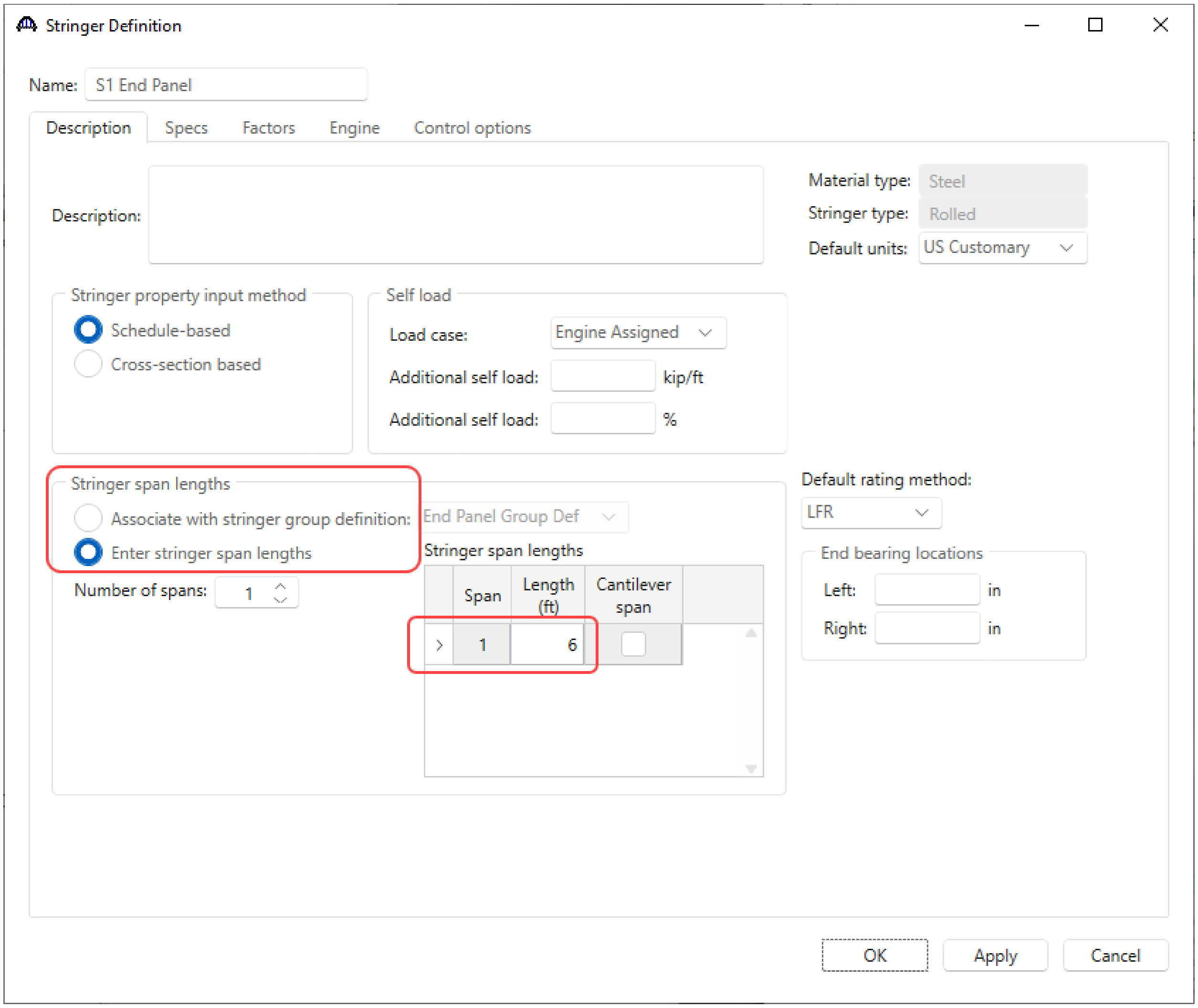
To create the stringer definition, expand the **MEMBER DEFINITION** node in the **Bridge Workspace** tree and double click on the **STRINGER DEFINITIONS** node (or select **STRINGER DEFINITIONS** and click **New** from the **Manage** group of the **WORKSPACE** ribbon). This opens the **New Stringer Definition** window as shown below.



Select **Steel** as the **Material type** and **Rolled** for **Girder type** as shown below. Click **OK**



Enter data as shown below.

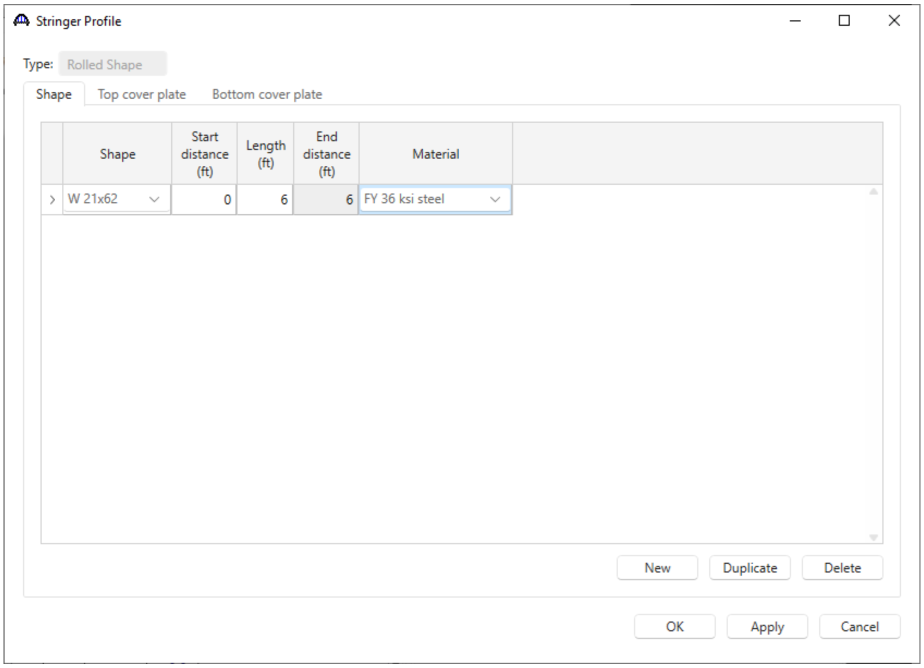


Click **OK** to apply the data and close the window.

When the stringer span lengths need to be defined, the **Associate with stringer group definition** option cannot be used. Selecting that button would mean that the stringer definition has a length equal to the stringer group definition as measured along the superstructure definition reference line. If the **Associate with stringer group definition** is selected, the stringer definition would have a length of **15'** not the **6'**. Therefore, select the **Enter stringer span lengths** button and enter the stringer span length in the grid.

Stringer Profile

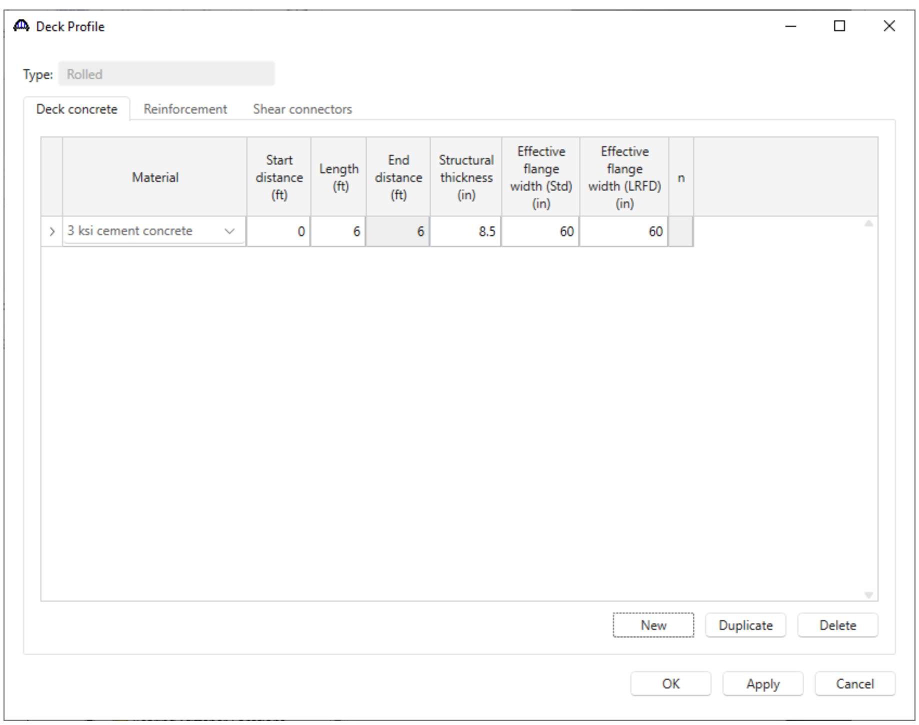
Double click on the **Stringer Profile** node and describe the stringer profile as shown below.



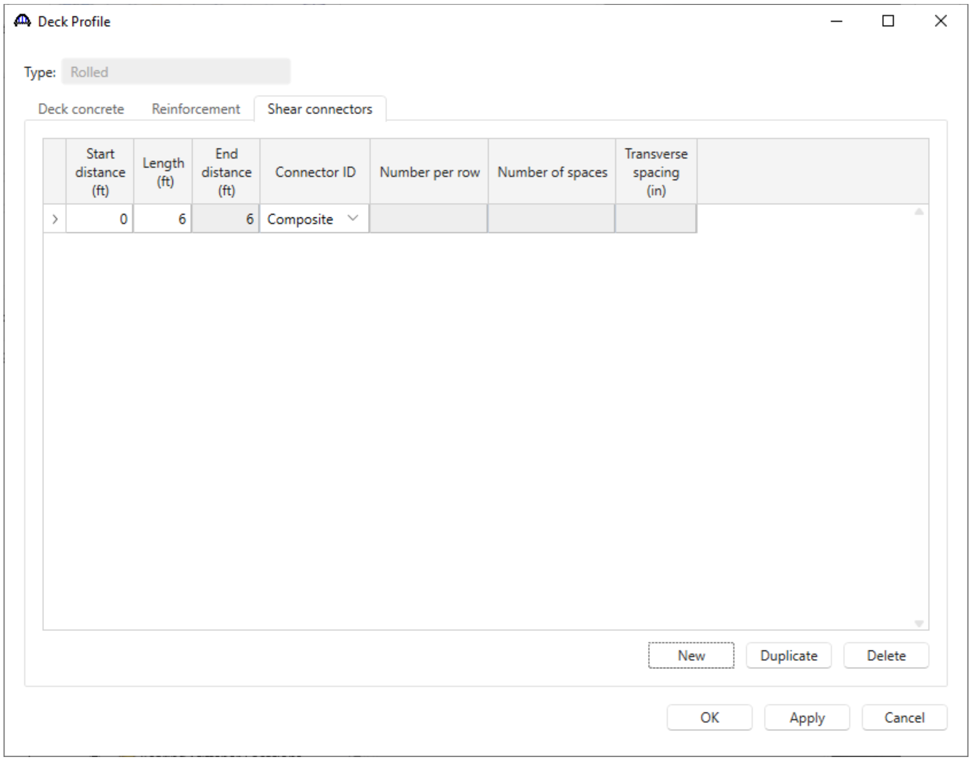
Click **OK** to apply the data and close the window.

Deck Profile

Double click on the **Deck Profile** node and enter data as shown below.



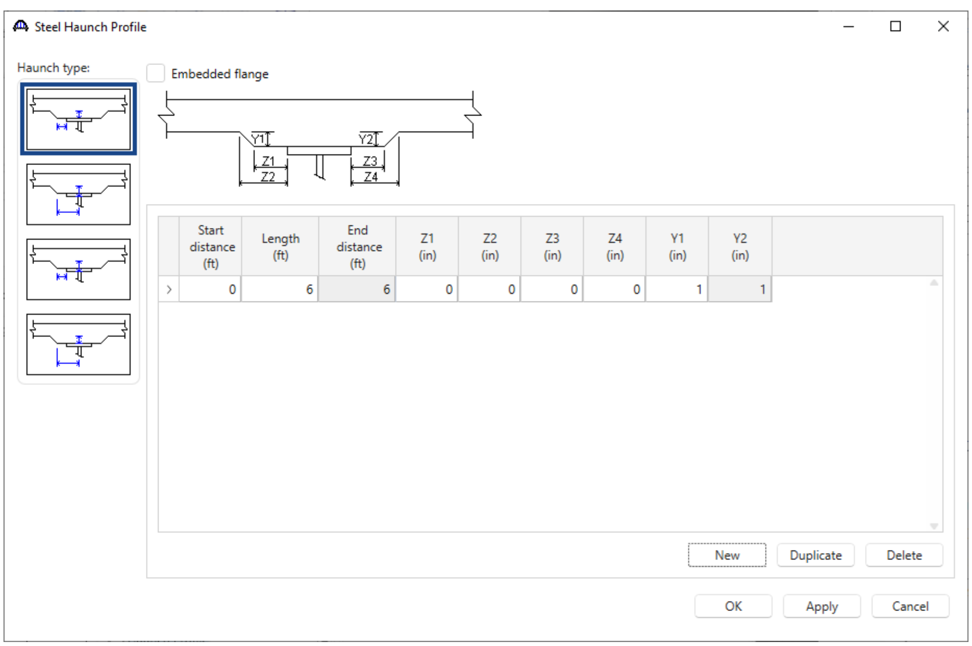
Navigate to the **Shear connectors** tab and enter the following data.



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

Haunch Profile

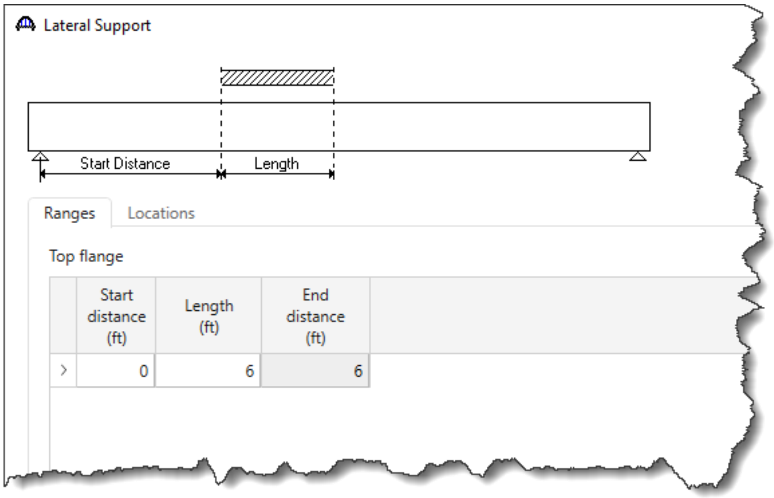
Double click on the **Haunch Profile** node and enter data as shown below.



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

Lateral Support

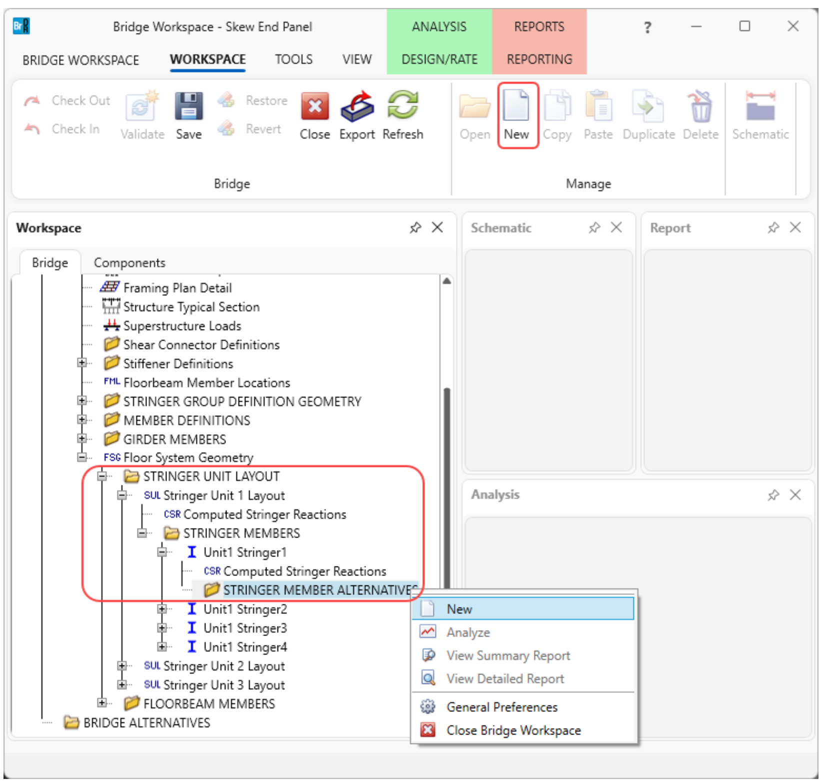
Open the **Lateral Support** window. Enter the following lateral support data for the top flange.



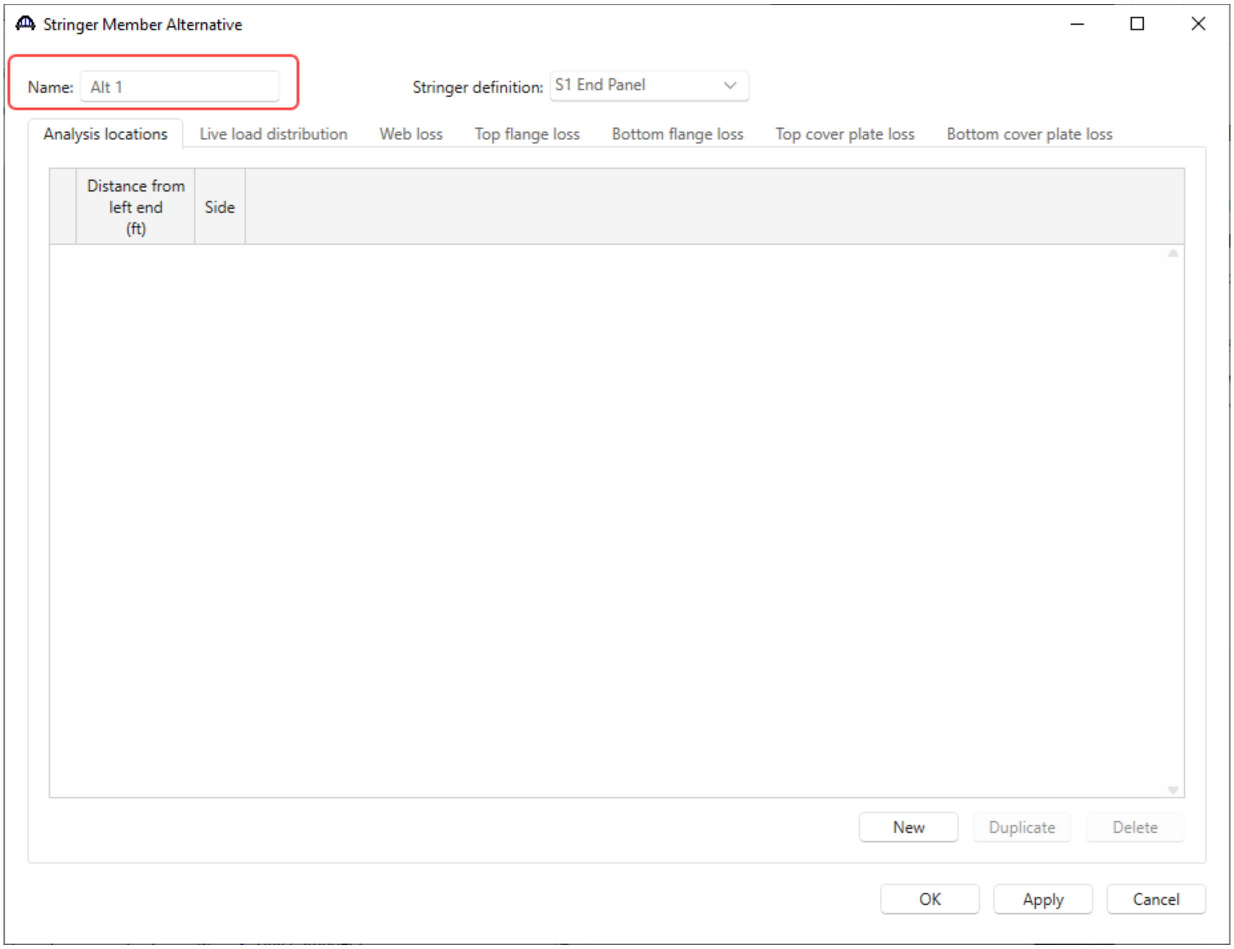
The description of the stringer member definition is complete.

Stringer Member Alternative

Now create a stringer member alternative for stringer member **Unit 1 Stringer 1** and assign this stringer definition to it. Expand the **STRINGER UNIT LAYOUT -> Stringer Unit 1 Layout -> STRINGER MEMBERS -> Unit 1 Stringer 1.** Select the **STRINGER MEMBER ALTERNATIVES** node and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New**, or double click) as shown below.



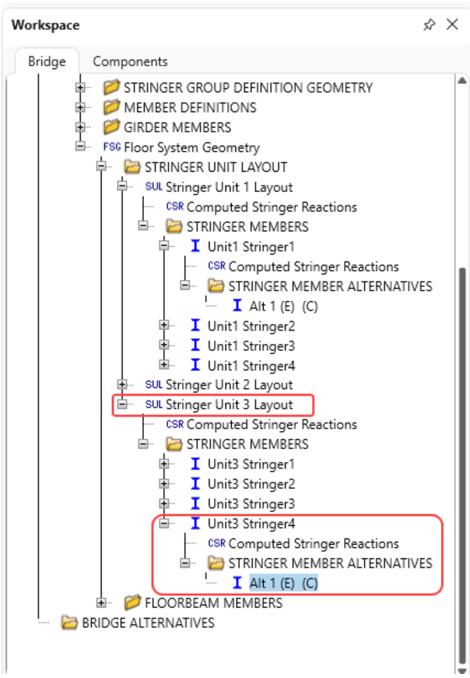
Enter the **Name** of this alternative as shown below.

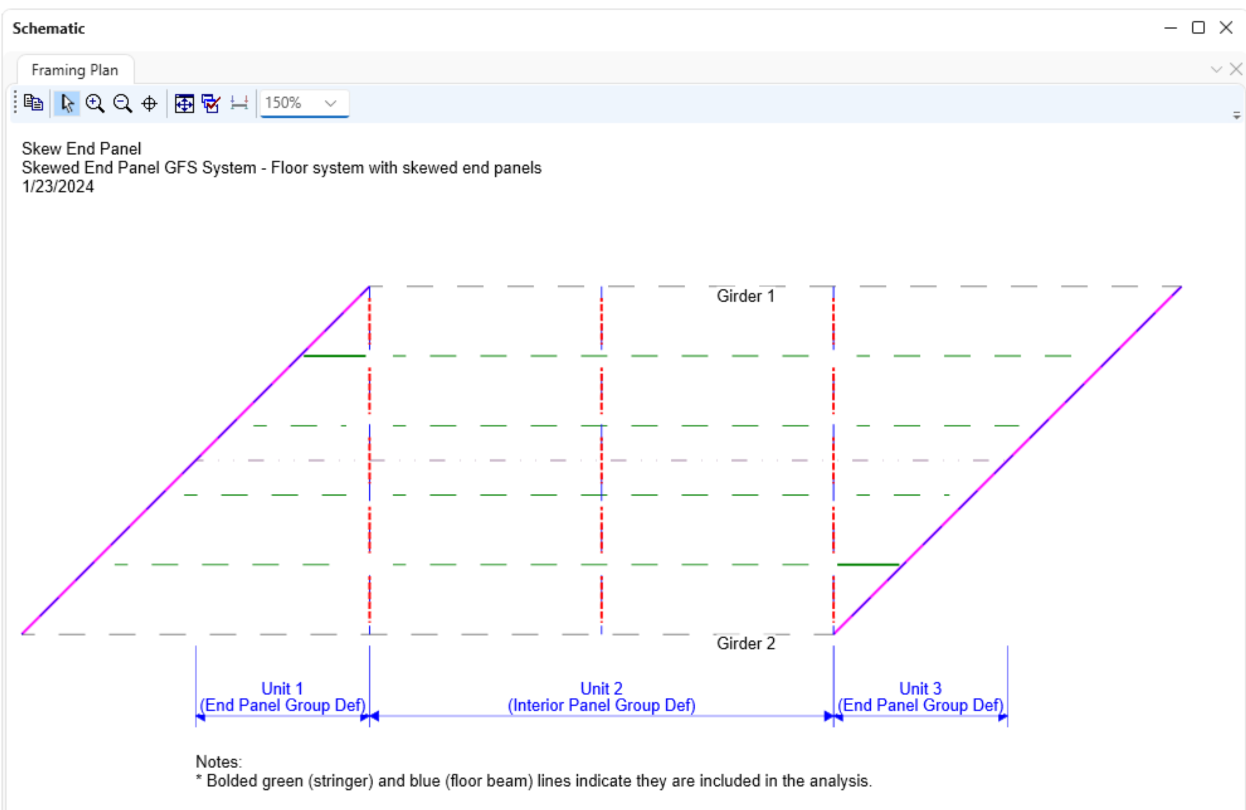


Click **OK** to create the stringer alternative and close the window.

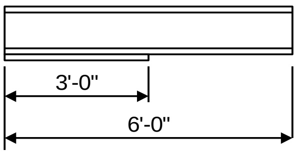
BrDR checks to ensure that the length of the stringer definition matches the length of the stringer member alternative to which you are assigning it when you hit **OK** or **Apply**.

This stringer definition can also be applied to a stringer member alternative for stringer member **Unit 3 Stringer 4** since that member is the mirror image of member **Unit 1 Stringer 1**. The following shows the **Structure Framing Plan** schematic after this stringer definition has been applied to these 2 stringer members. These 2 stringer members are displayed as solid lines since they have stringer member alternatives marked as **Existing**.



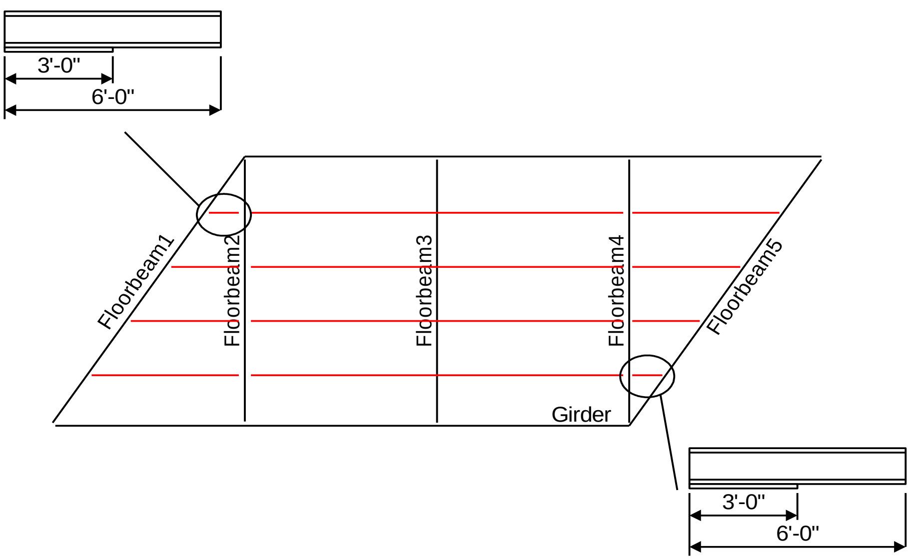


An important item to note is that a stringer member definition is not mirrored when it is assigned to a stringer member that belongs to a stringer unit where the stringer group definition is mirrored. The following sketches best explain this.

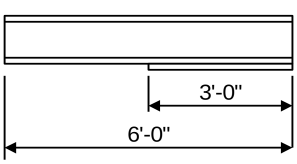


Stringer Member Definition A

Assume Stringer Member Definition A has a cover plate over the first 3' of its length. When this definition is assigned to Unit 1 Stringer 1, the cover plate is located at the left end of the member, adjacent to Floorbeam 1. When this definition is assigned to Unit 3 Stringer 4, the cover plate is still located at the left end of the member, this time adjacent to Floorbeam 4 instead of Floorbeam 5.



In order to have the BrDR model consider the cover plate at the right end of Unit 3 Stringer 4, you must create a new stringer member definition with the cover plate in that location. The following Stringer Member Definition B illustrates this.



Stringer Member Definition B

Continue with this example on your own. Create the remaining stringer and floorbeam member definitions and assign them to the member alternatives. Create girder member alternatives for the girder members and rate the member alternatives in this superstructure definition.