AASHTOWare BrDR 6.8.2

Prestress Superstructure Tutorial

PS14 – Prestressed Concrete I Beam Example

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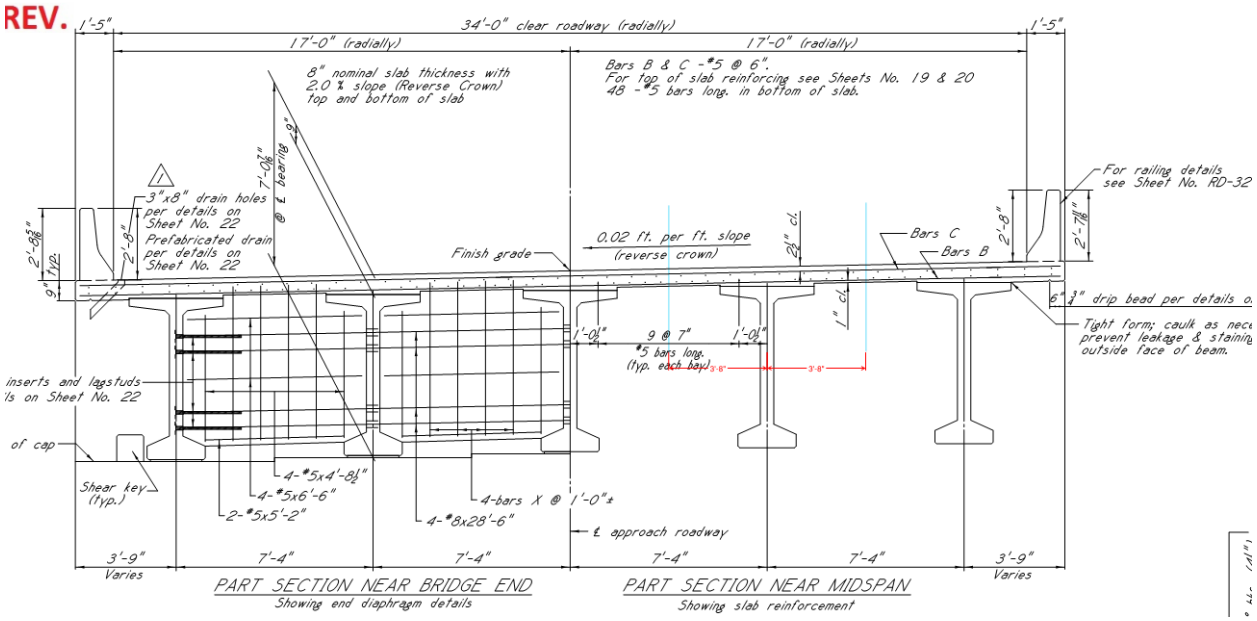
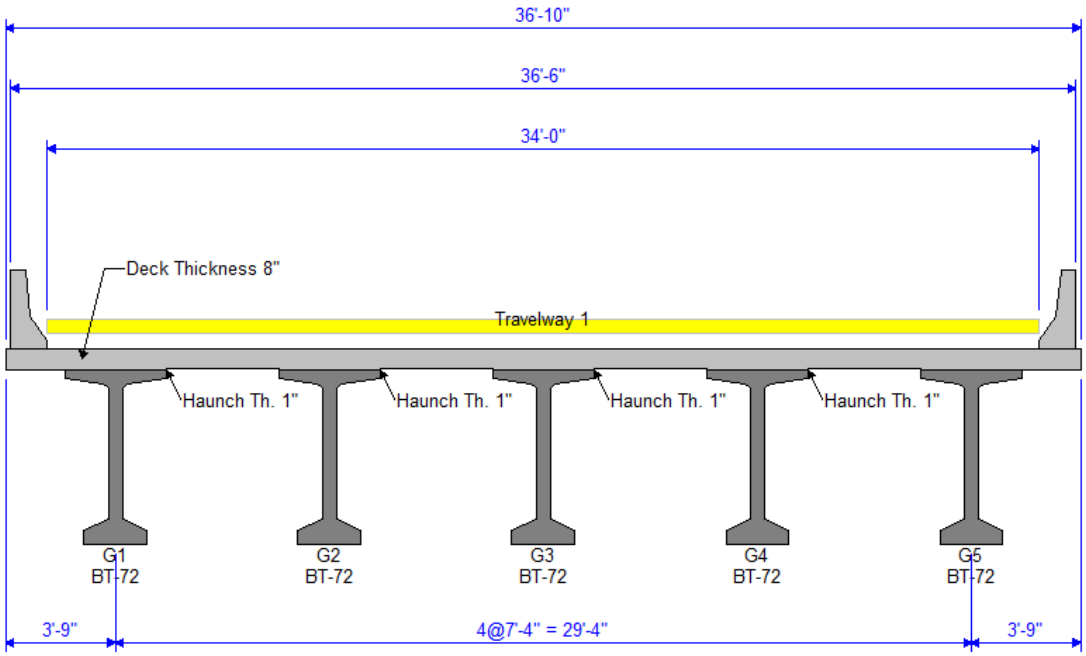
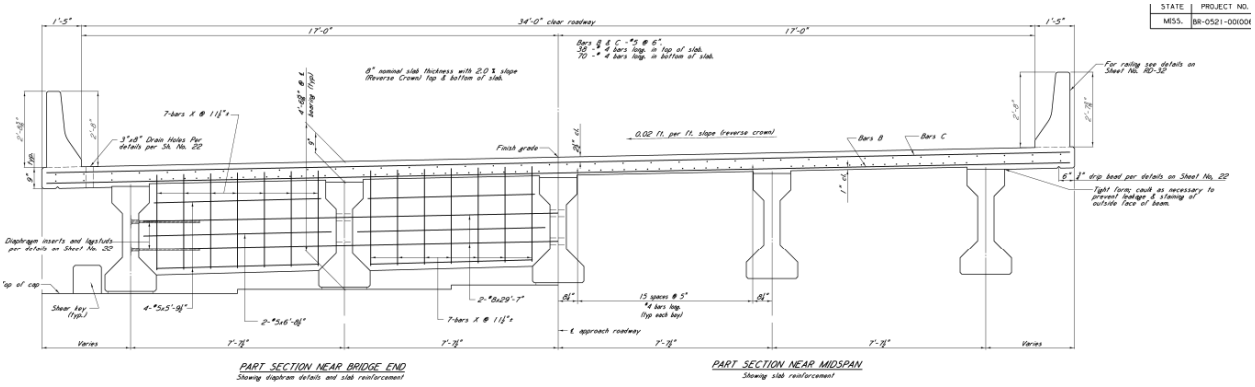
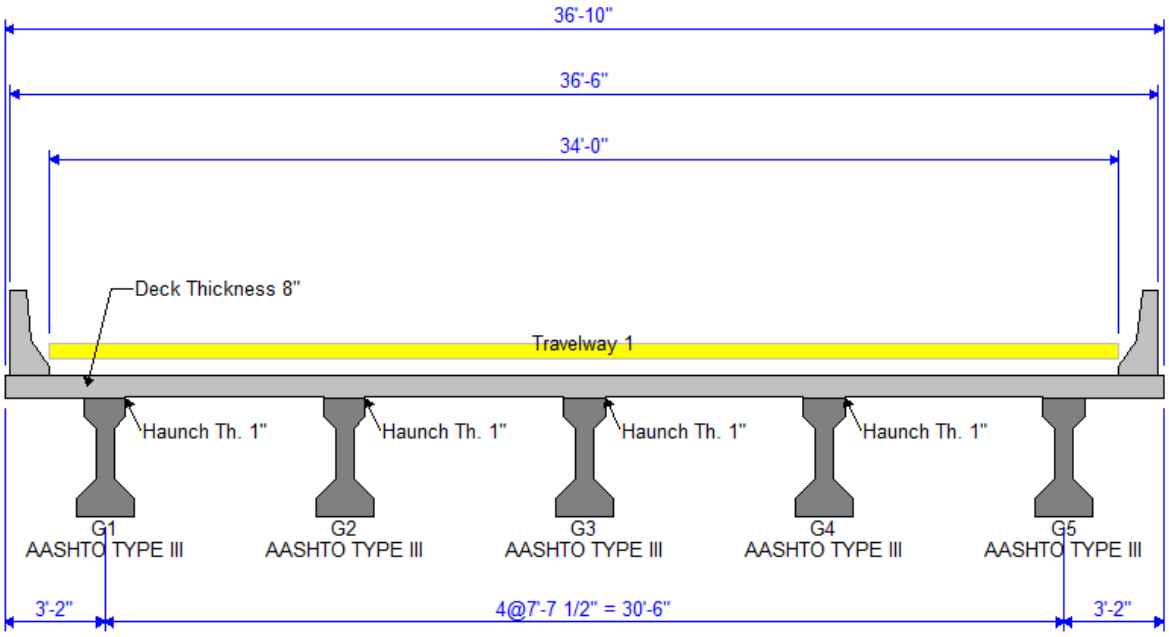
This example details the data input of a prestressed concrete I beam bridge and performing an analysis. This example is a bridge from the Mississippi DOT inventory which includes two units of SR 429, a three-span (138 ft each) continuous unit and a single 80 ft span unit.





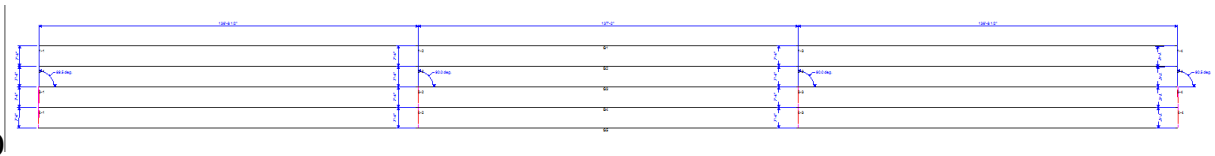
Structure Typical Section – Unit 1



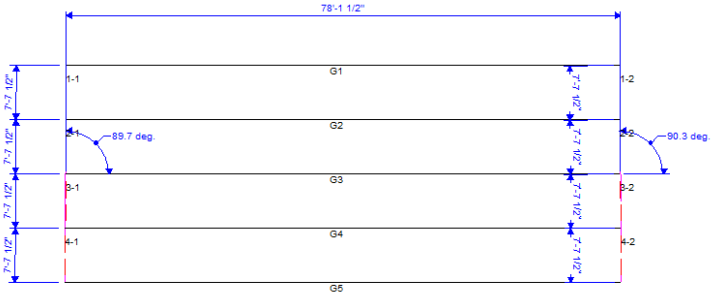


Structure Typical Section – Unit 2

(a)



(b)



Structure Framing Plan (a) Unit 1 (b) Unit 2

Topics Covered

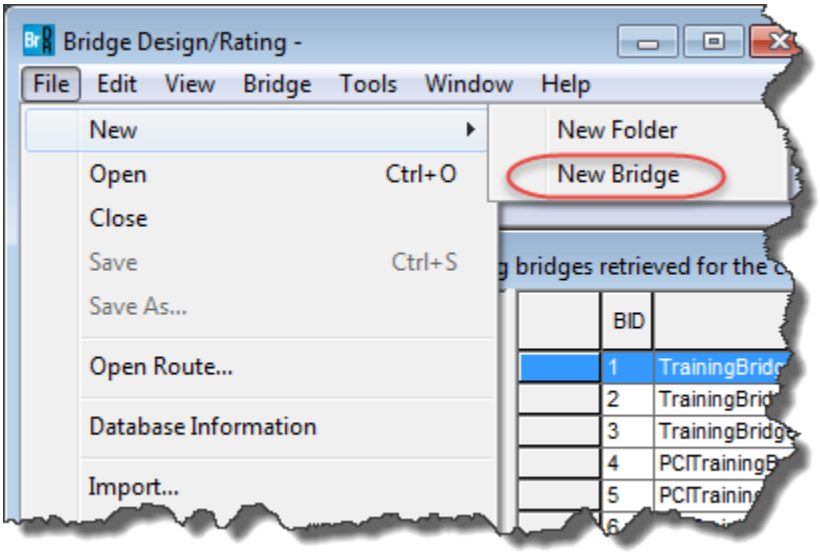
- Comments and Assumptions
- Data Entry of Prestressed concrete I beam with draped strands input as girder system.
- Prestressed multi-span modeling options
    - Multi-span continuous
    - Multi-span continuous and simple span
- Export of prestressed concrete beams to the BrDR LRFD analysis engine
- Analysis and Results

Comments and Assumptions

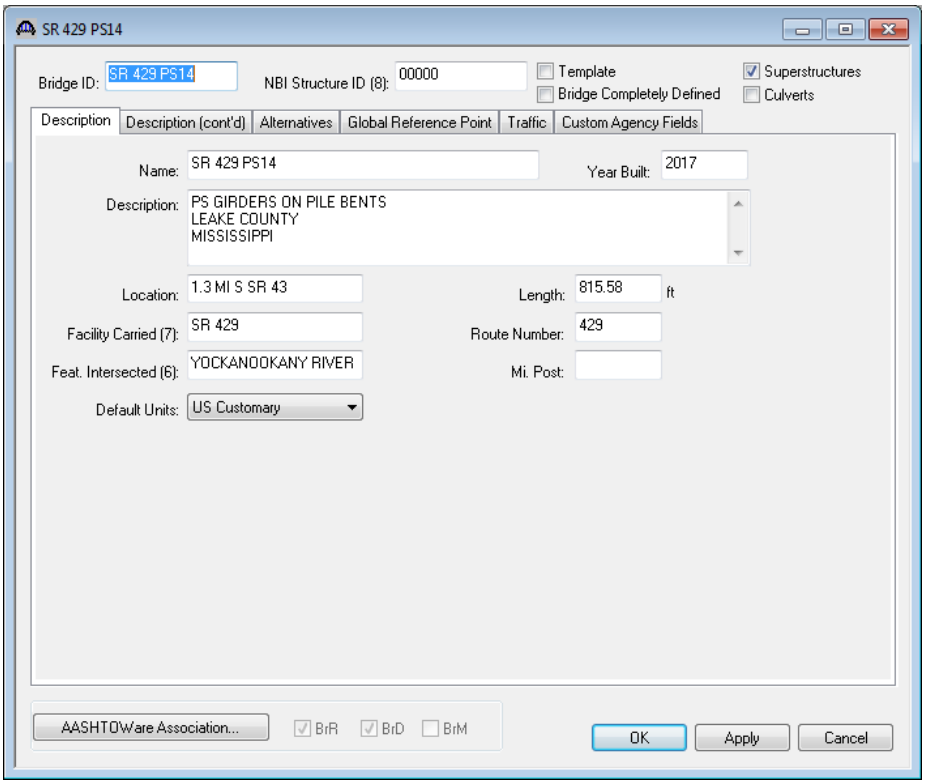
- Assume 5000 psi for the 28-day compressive concrete strength of the Type III PS Beam for the 80-foot span.
- Due to rounding on the design plans, the BrR span lengths are slightly off from the design drawings. Lengths are within 1/16".
- The plans show a discrepancy for strand type for the 138 ft beam details. The notes indicate ½" diameter 270 K-LR strands where the table and section show 0.6" diameter 270 K-LR strands so 0.6" diameter 270 K-LR strands will be used in the model.
- With larger radius, assume the overhangs as equal.
- Due to the limitations in BrR, the skew angle at Support 2 & 3 of the three-span continuous unit will be 90 degrees.
- Traffic data and design speed for LRFR analysis
    a. Assumed ADTT = 41 per NBI
- ¼" Integral Wearing Surface
- HL93 will be the vehicle used for ratings
- District, County and Owner information is not populated
- For the exterior beams, a LRFD effective width = Overhang + S/2 is used, even though the overhang is greater than S/2 (C4.6.2.6.1).

Data Entry

From the Bridge Explorer, select File | New | New Bridge from the menu to create a new bridge.

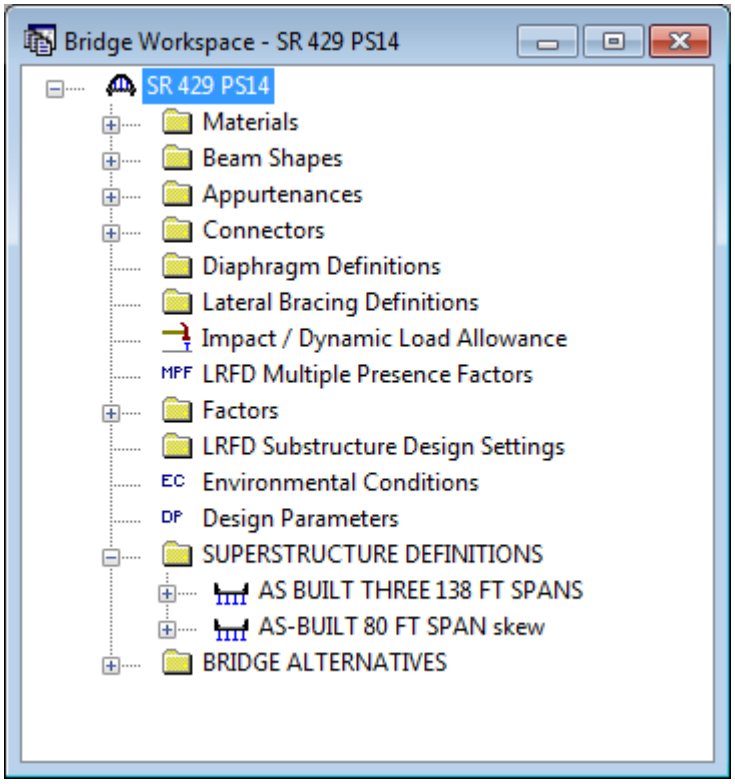


Enter the following bridge description data.

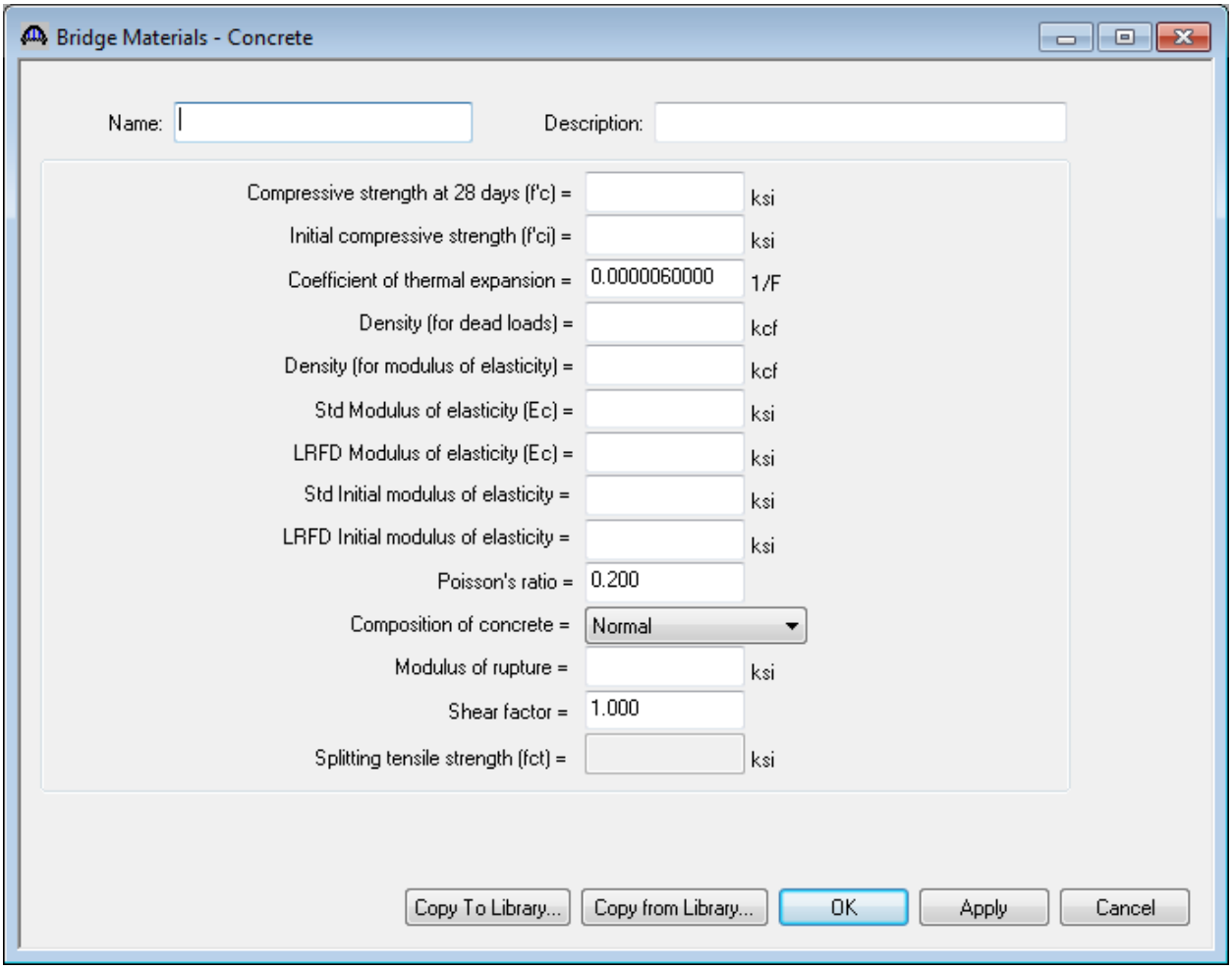


Close the window by clicking OK. This saves the data to memory and closes the window.

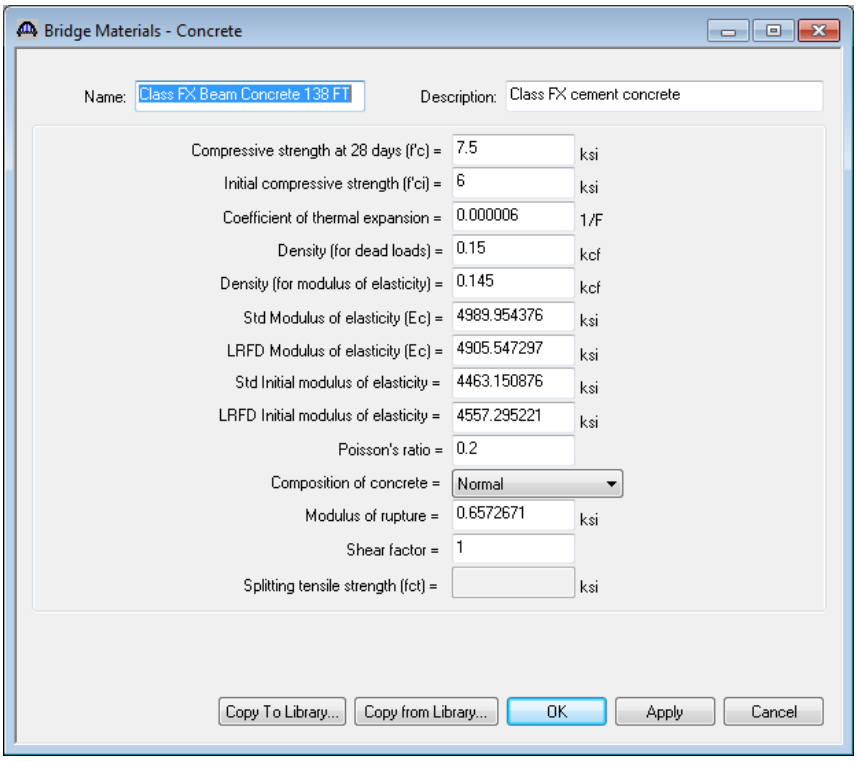
To enter the materials to be used by members of the bridge, click on the ⊞ to expand the Bridge Workspace tree for Materials. The tree with the expanded Materials branch is shown below.

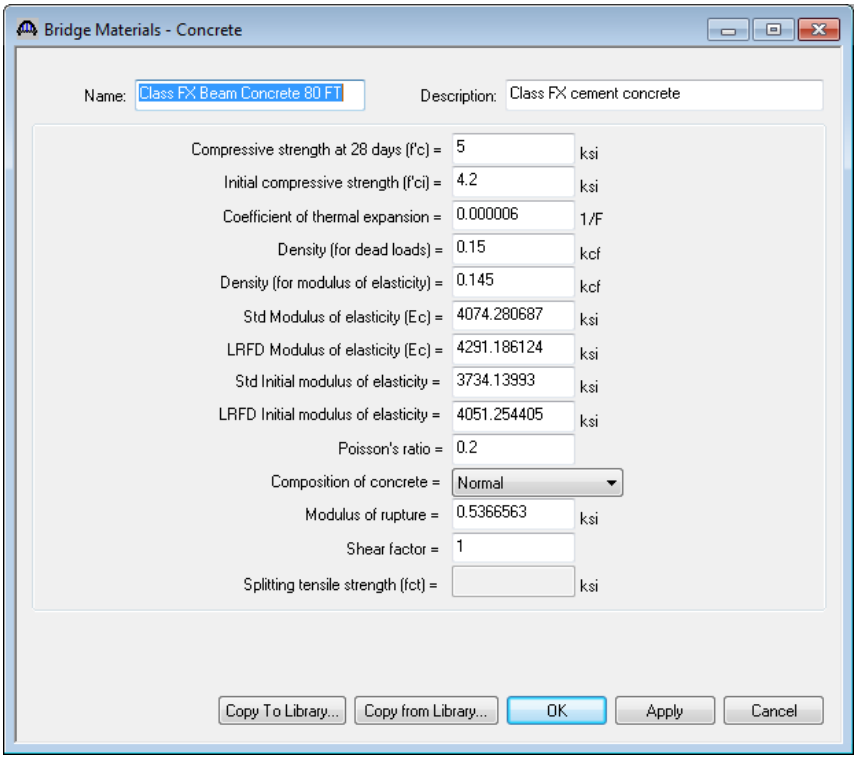


To add a concrete material for the girder, click on Concrete in the tree and select File | New from the menu (or right mouse click on Concrete and select New). The window shown below will open.



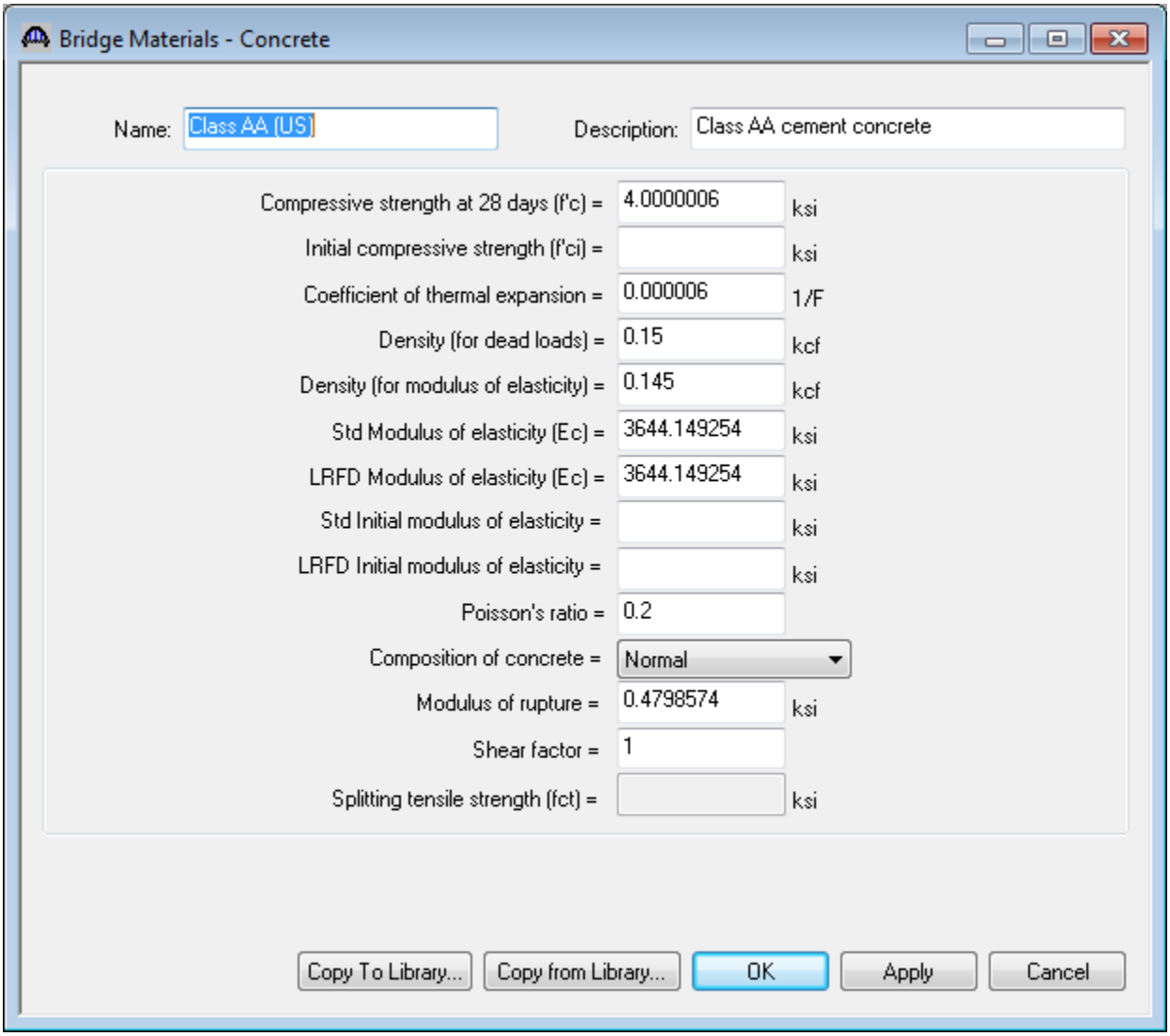
Enter the following concrete material properties for the girder concrete. The f'c and f'ci is found on the drawings or assumed.





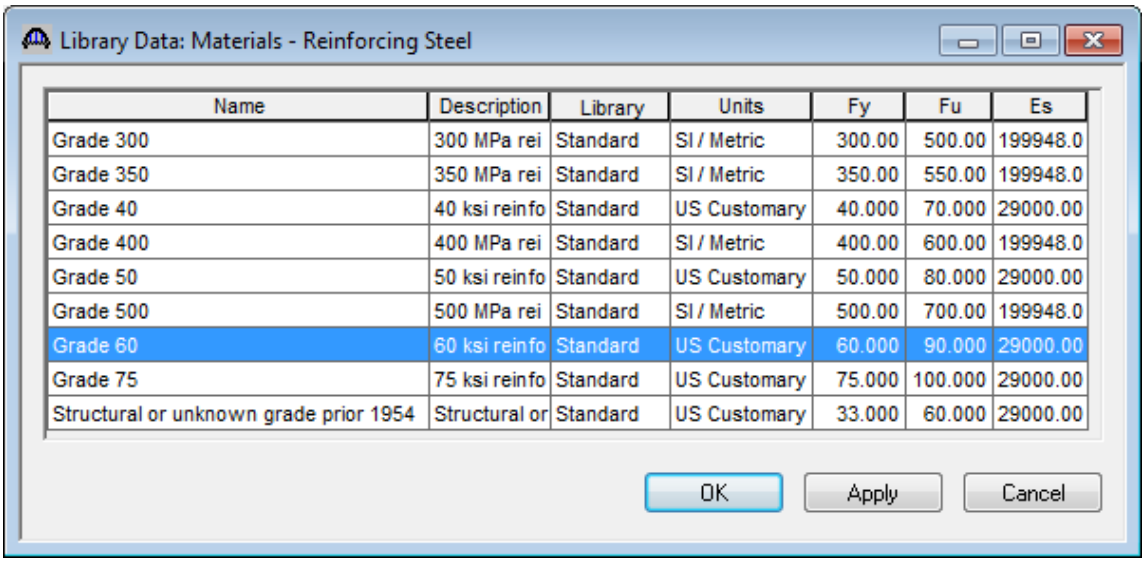
Click OK to save the data to memory and close the window.

Enter the following concrete material properties for the deck concrete or use Class A from library and change name to Class AA.

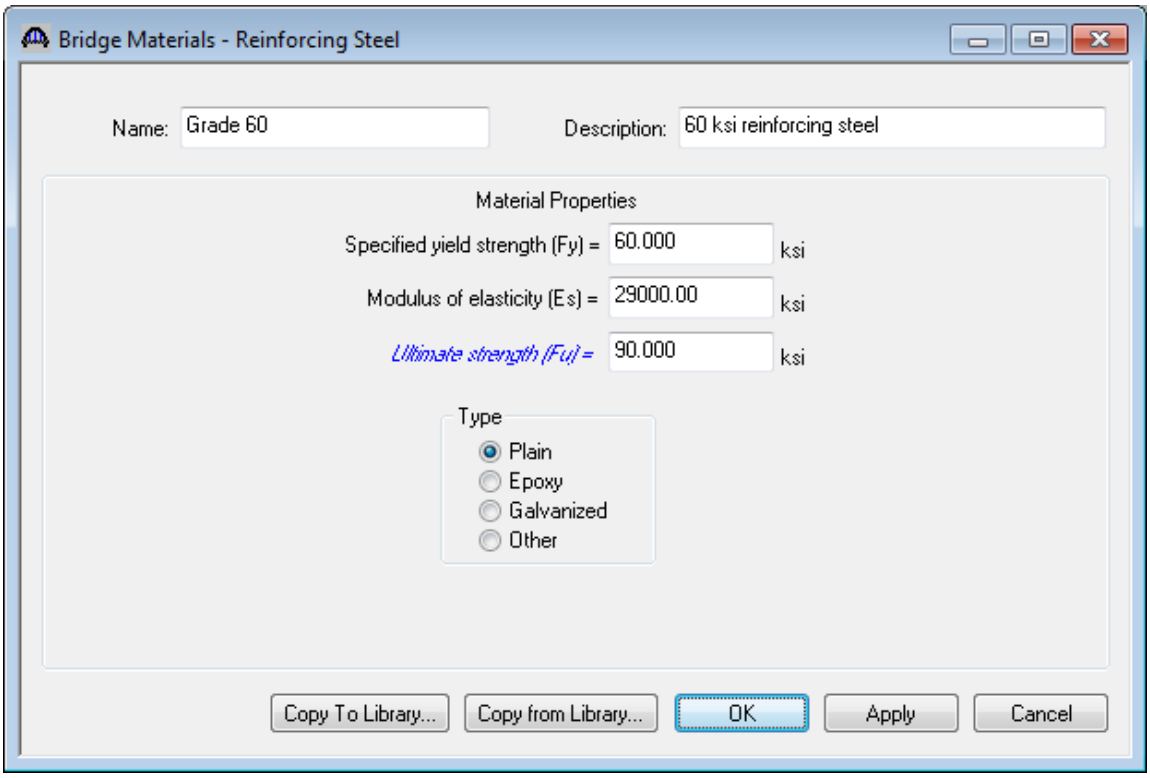


Click OK to save the data to memory and close the window.

To add reinforcement material, click on Reinforcing Steel in the tree and select File | New from the menu (or right mouse click on Reinforcing Steel and select New). Click on the Copy from Library button to open the Reinforcing Steel Materials Library Data window.



Select the Grade 60 material and click OK. The selected material properties are copied to the Bridge Materials - Reinforcing Steel window.



Close the window by clicking OK. This saves the data to memory and closes the window.

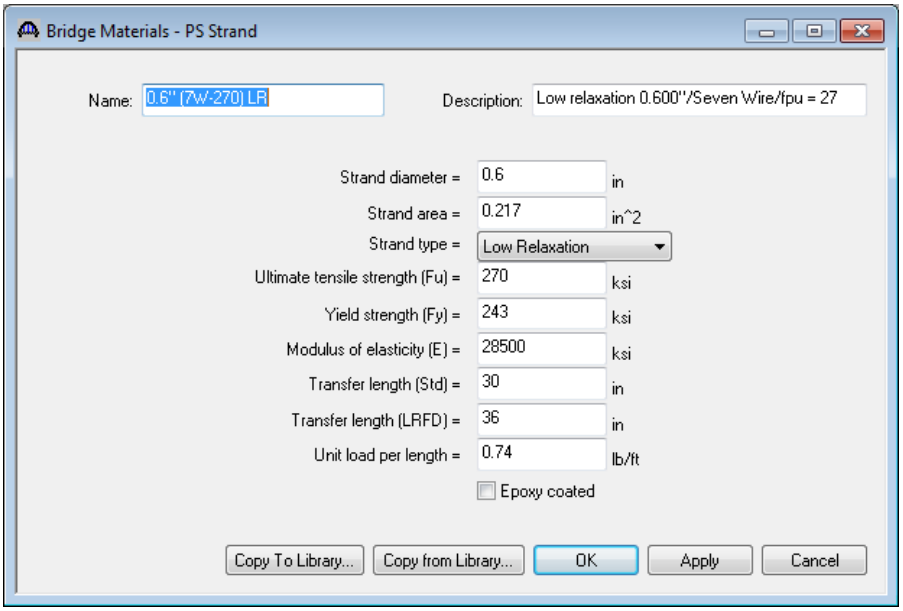
Add prestress strand using the same Copy from Library technique. The window will look like as shown below.

LR indicates low-relaxation strands

PRESTRESS REQUIREMENTS

For deflection diagram, see Misc. Span Details per Sheet No. 22

Strand type	Minimum breaking strength lbs/strand	Initial tension lbs/strand	Required number and location of strands: Total number strands	Straight strands: Number strands	Straight strands: Centroid (in.)	Draped strands: Number strands	Draped strands: Centroid (in.) ℄ span	Draped strands: Centroid (in.) Beam end	Centroid for total number of strands (in.): At ℄ span	Centroid for total number of strands (in.): At beam end	Distance from ℄ span to hold-down point	Camber limits	Deflection diagram: A	B	C	Minimum concrete strength at time of release (psi)
0.6"ø270 K-LR	45,000	△43,940	36	26	4.19	10	6.50	65.00	4.83	21.08	14'-0"	0 to 5½"	5/16"	2 3/8"	2 1/2"	6000

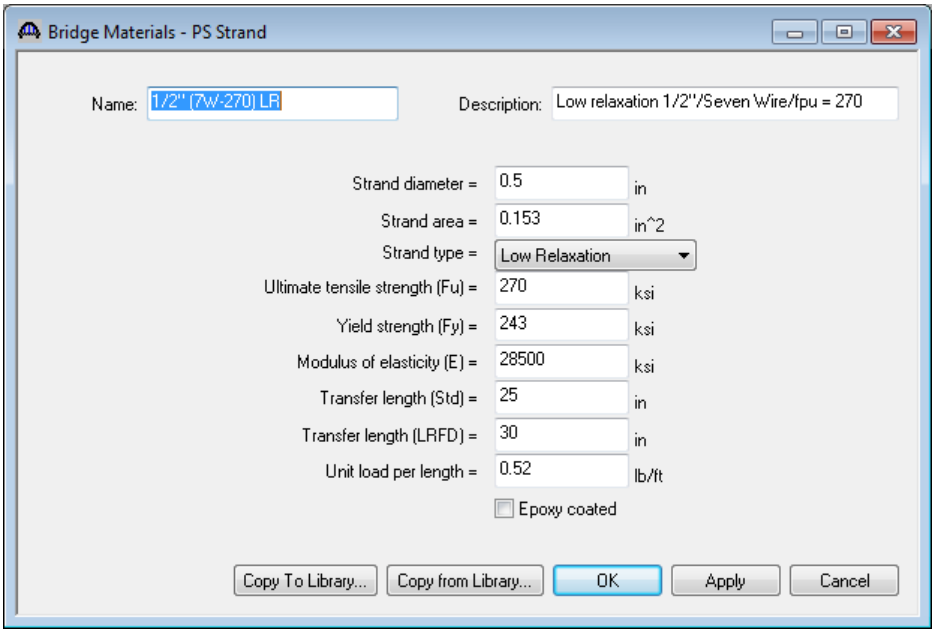


LR indicates low-relaxation strands

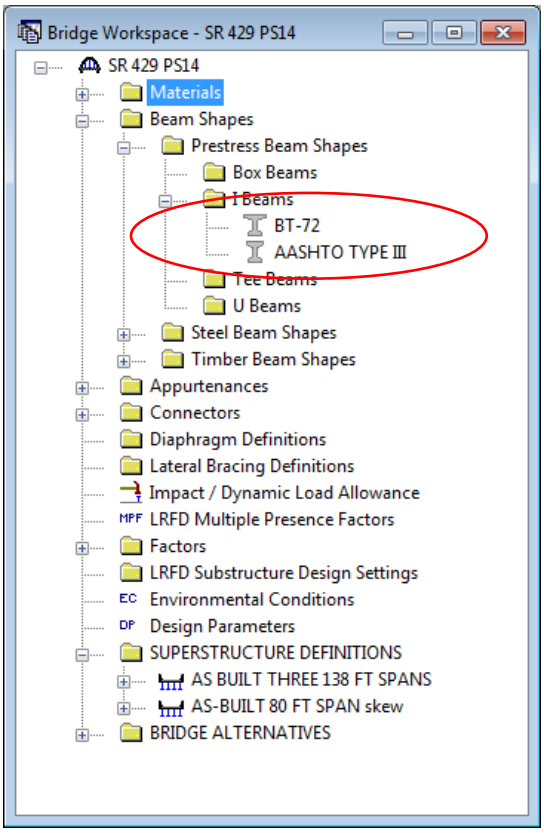
PRESTRESS REQUIREMENTS

For deflection diagram, see Misc. Span Details per Sheet No. 22

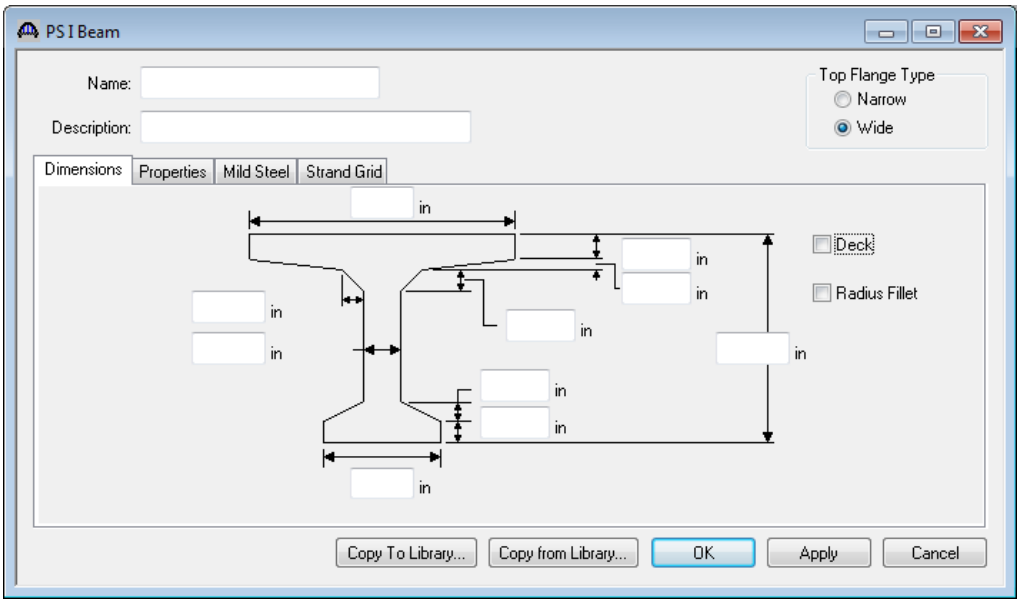
Strand type	Minimum breaking strength lbs/strand	Initial tension lbs/strand	Required number and location of strands: Total number strands	Straight strands: Number strands	Straight strands: Centroid (in.)	Draped strands: Number strands	Draped strands: Centroid (in.) ℄ span	Draped strands: Centroid (in.) Beam end	Centroid for total number of strands (in.): At ℄ span	Centroid for total number of strands (in.): At beam end	Distance from ℄ span to hold-down point	Camber limits	Deflection diagram: A	B	C	Minimum concrete strength at time of release (psi)
1"ø270 K-LR	41,300	30,980	26	20	4.10	6	4.50	40.00	4.19	12.38	8'-0"	0 to 2¾"	1/8"	1 5/16"	3/16"	4200



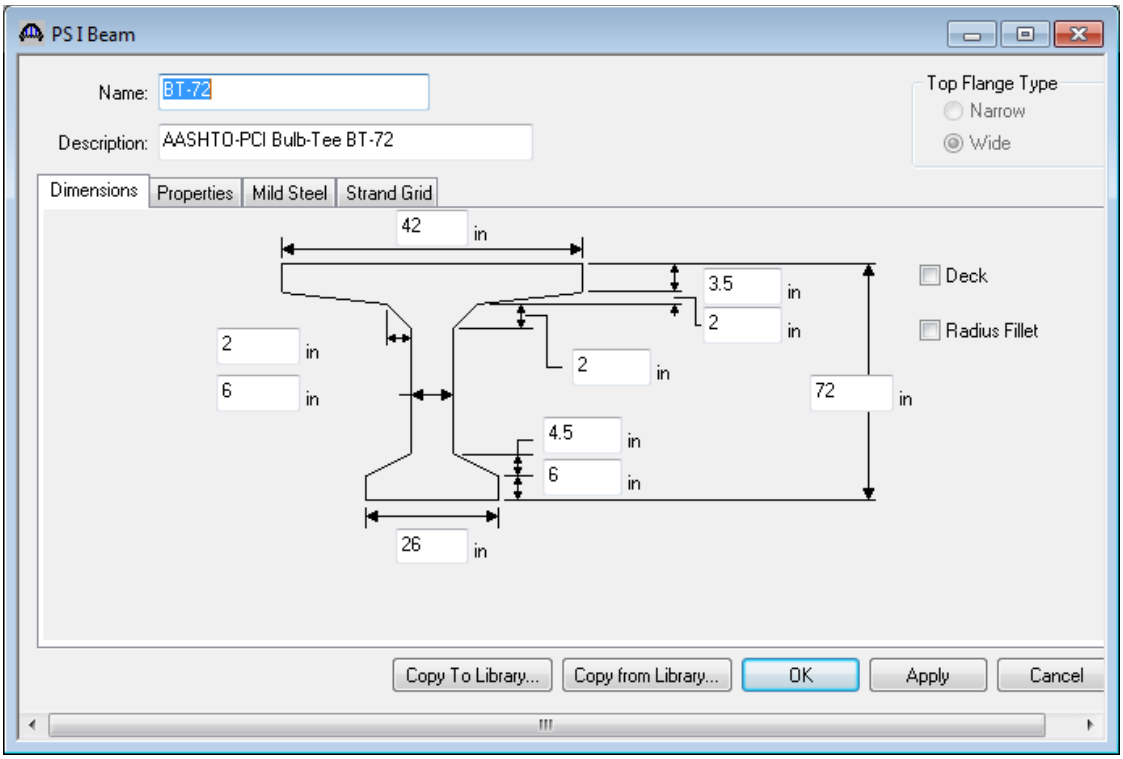
To enter a prestress beam shape to be used in this bridge, expand the tree labeled Beam Shapes as shown below.

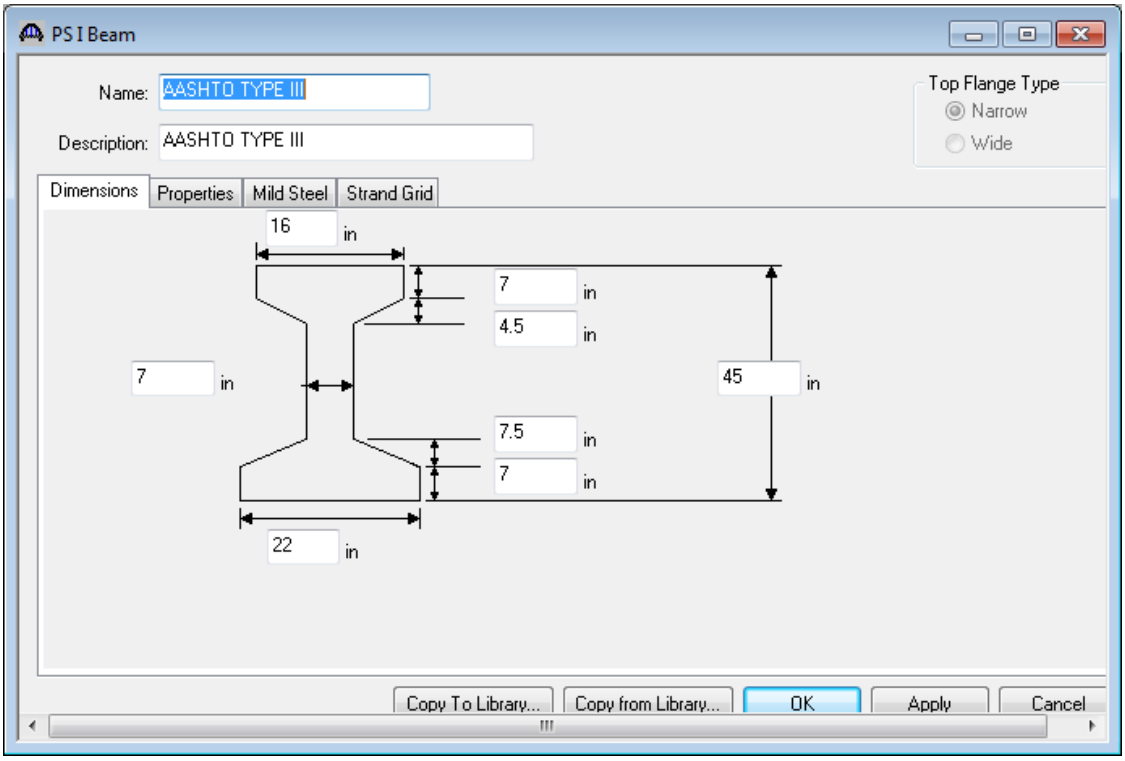


Click on I Beams in the tree and select File | New from the menu (or double-click on I Beams in the tree). The window shown below will open.

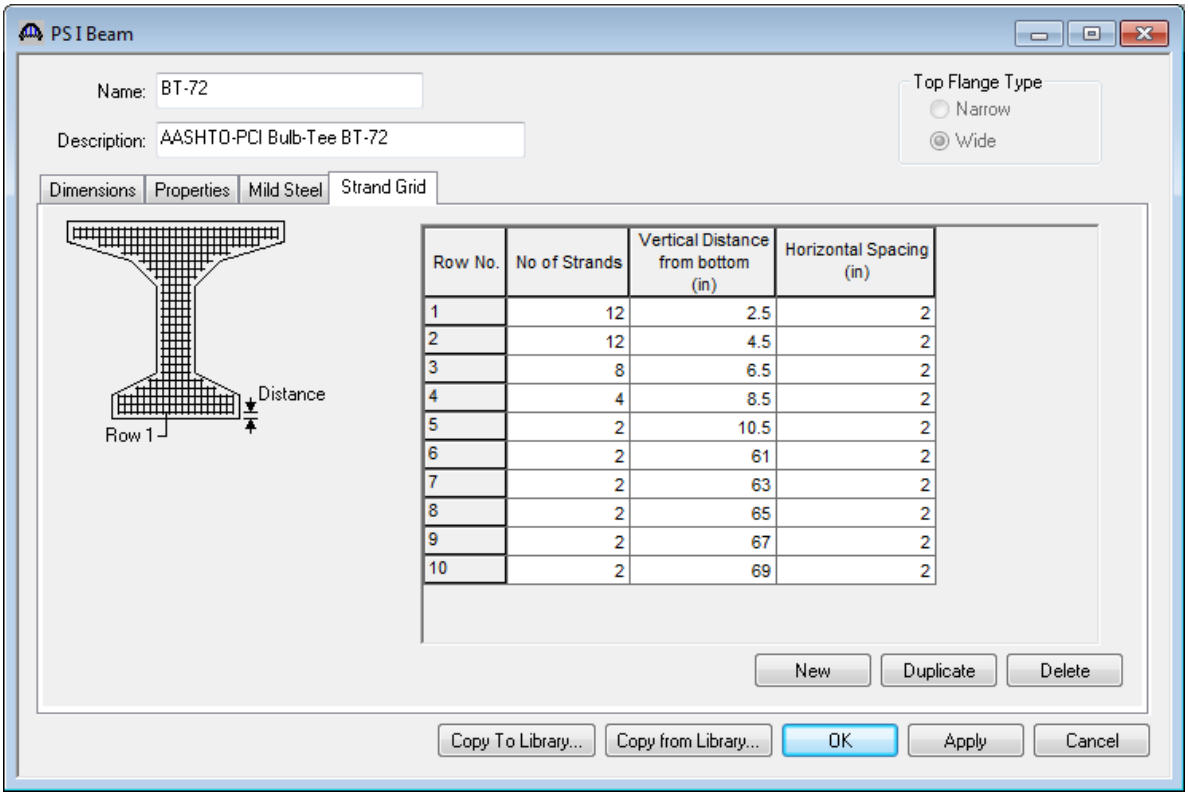


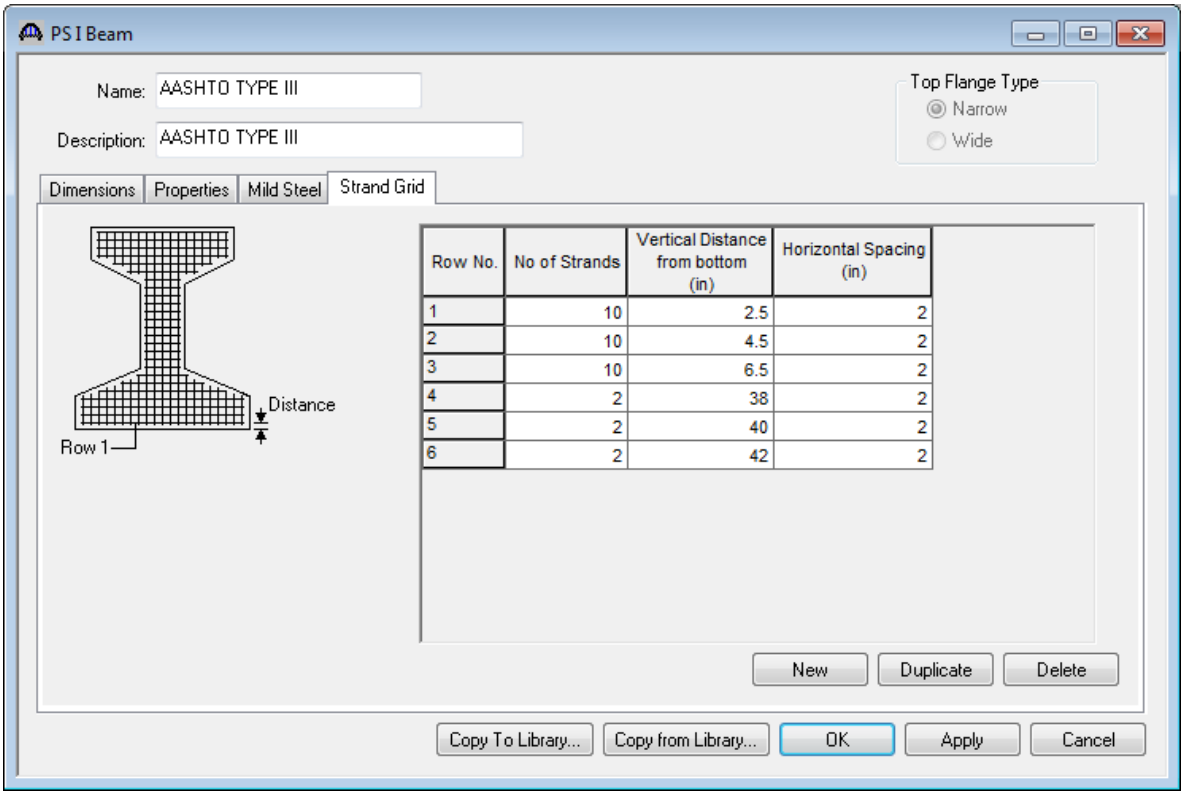
Click on the Copy from Library button. Select BT-72 (AASHTO-PCI-Bulb-Tee BT-72) in the PS I Beam Shapes Library Data window and the AASHTO Type III beam or enter the data manually and click OK. The beam properties are copied to the PS I Beam window as shown below.



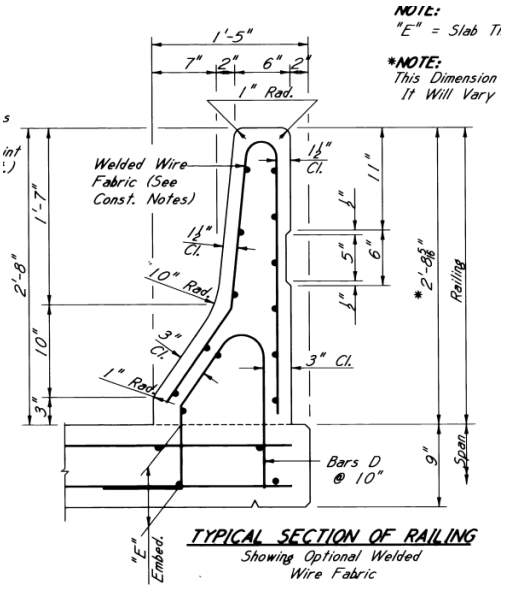


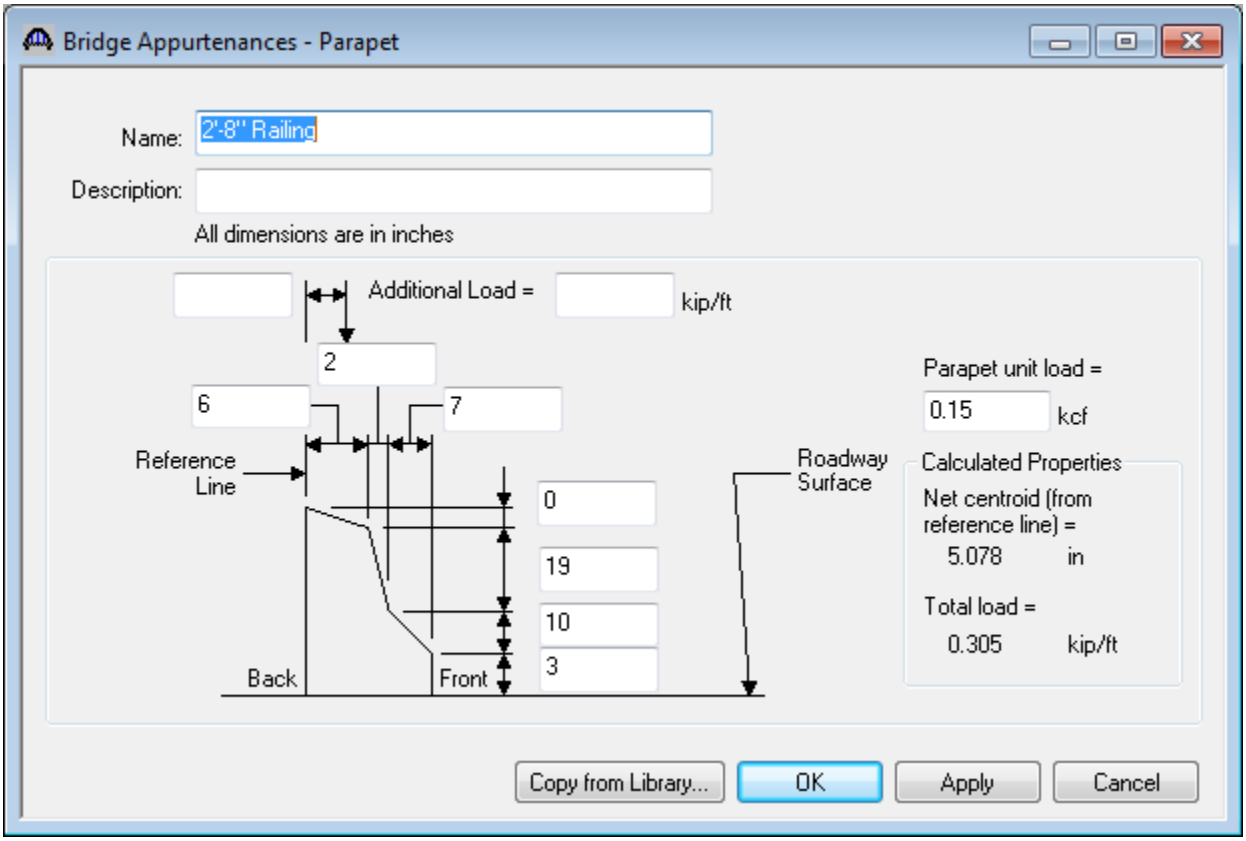
Click OK to save the data to memory and close the window. We will now edit the Strand Grid. Delete the existing grid and enter the following data.





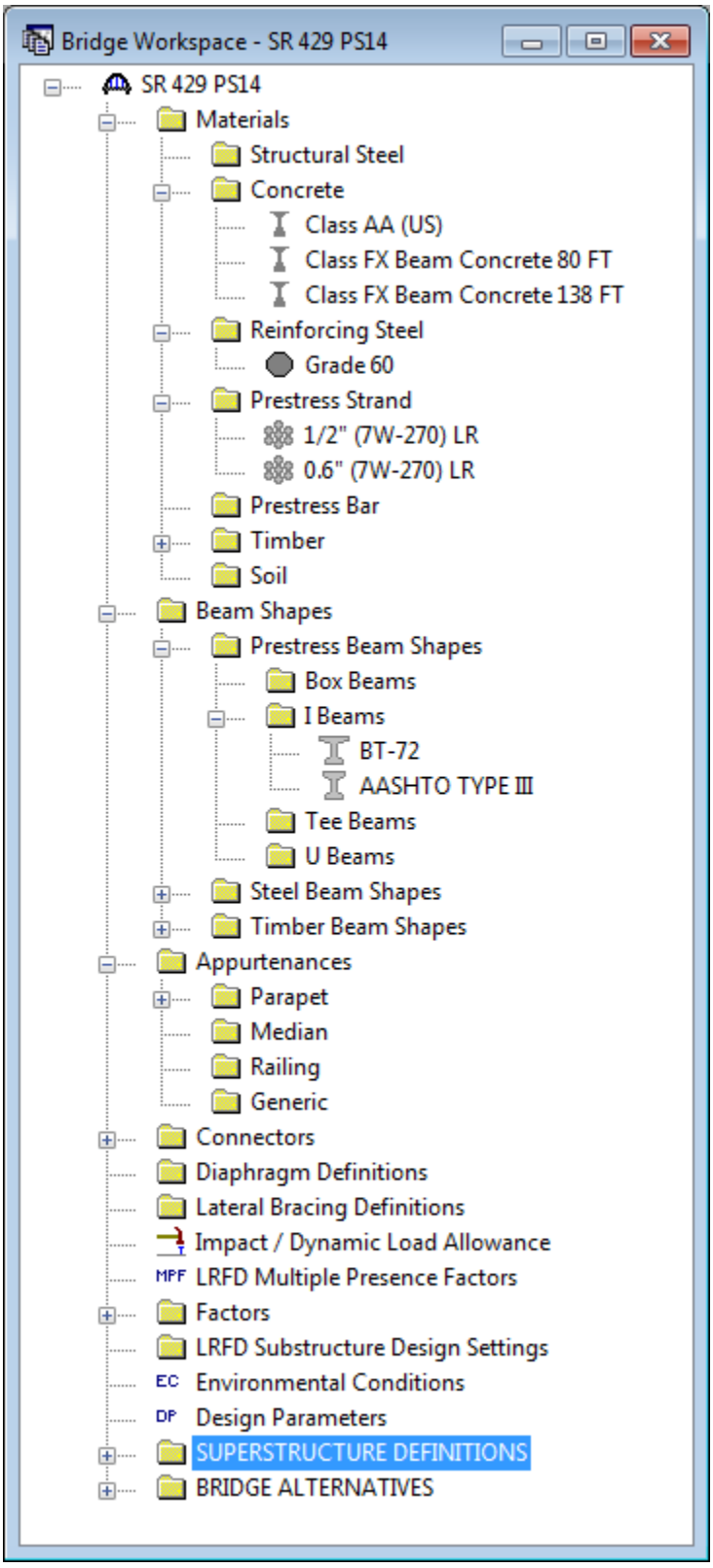
To enter the appurtenances to be used within the bridge, expand the tree branch labeled Appurtenances. To define a parapet, double-click on Parapet in the tree and enter the parapet dimensions as shown below. Click OK to save the data to memory and close the window.



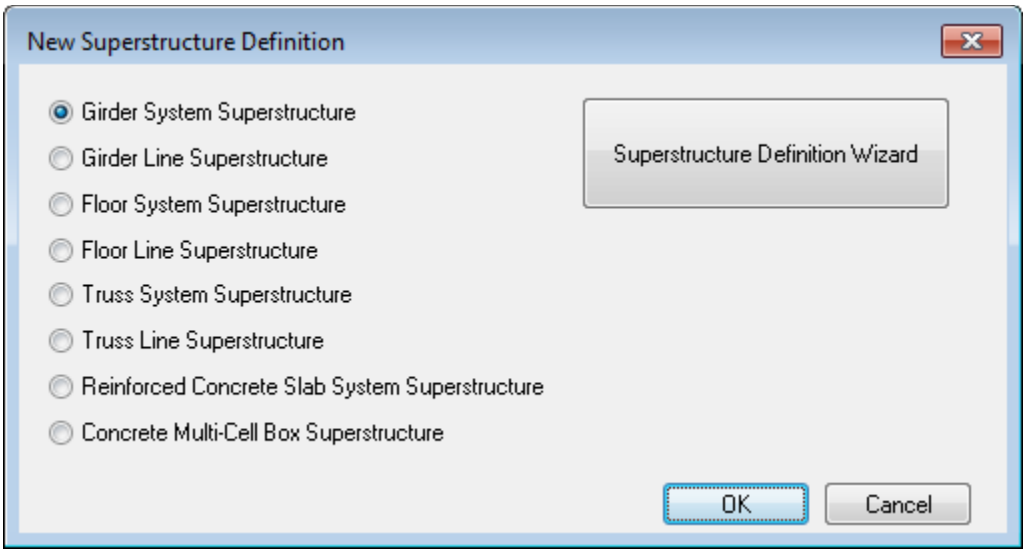


The default LRFD dynamic load allowance and default LRFD factors will be used so we will skip to Superstructure Definition.

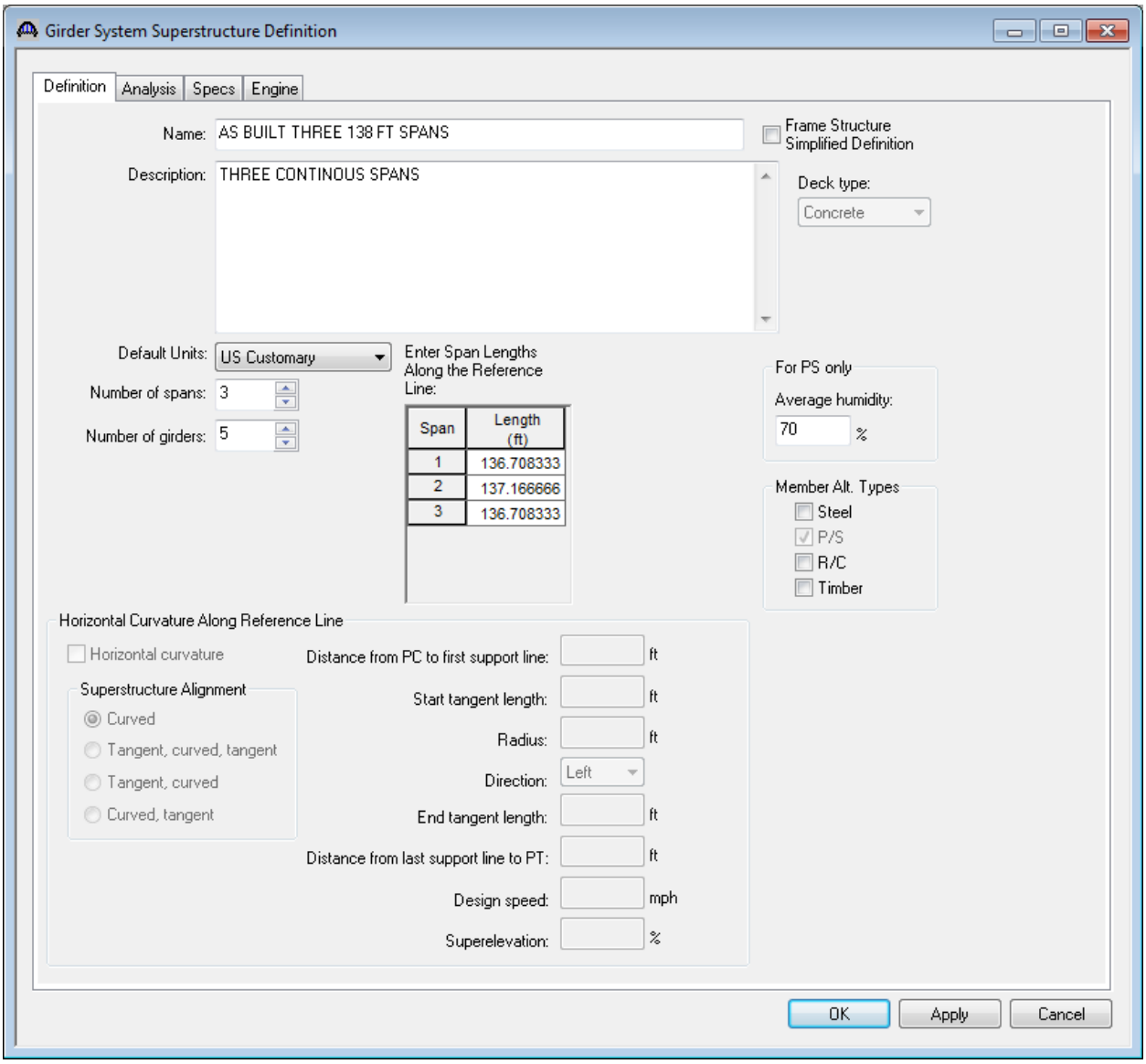
Now the Bridge workspace is as shown below.



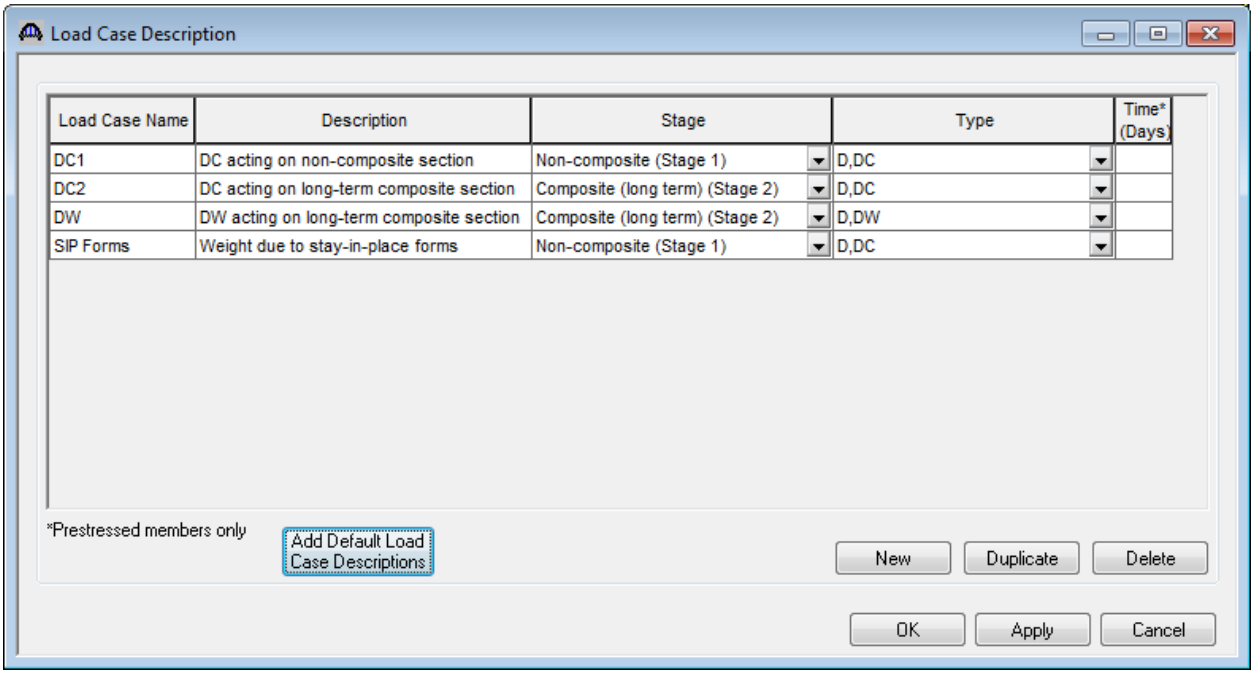
Double-click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and select File | New from the menu or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the popup menu) to create a new superstructure definition. The following dialog will open.



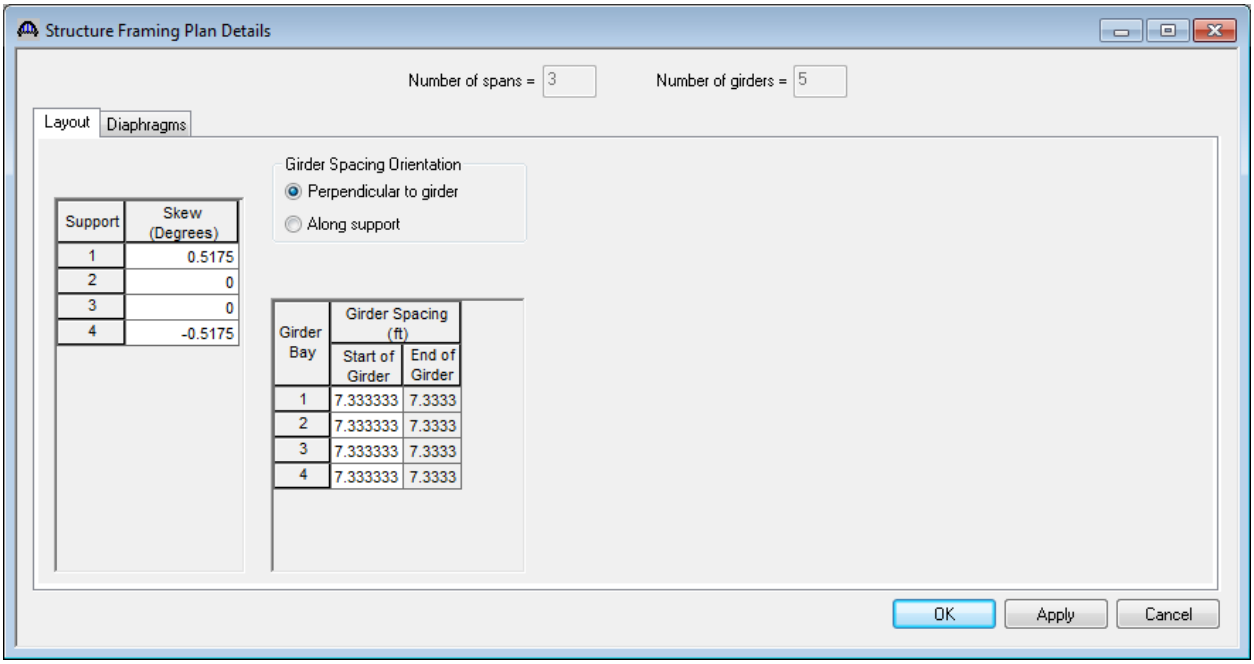
Select Girder System and the Structure Definition window will open. Enter the appropriate data as shown below:



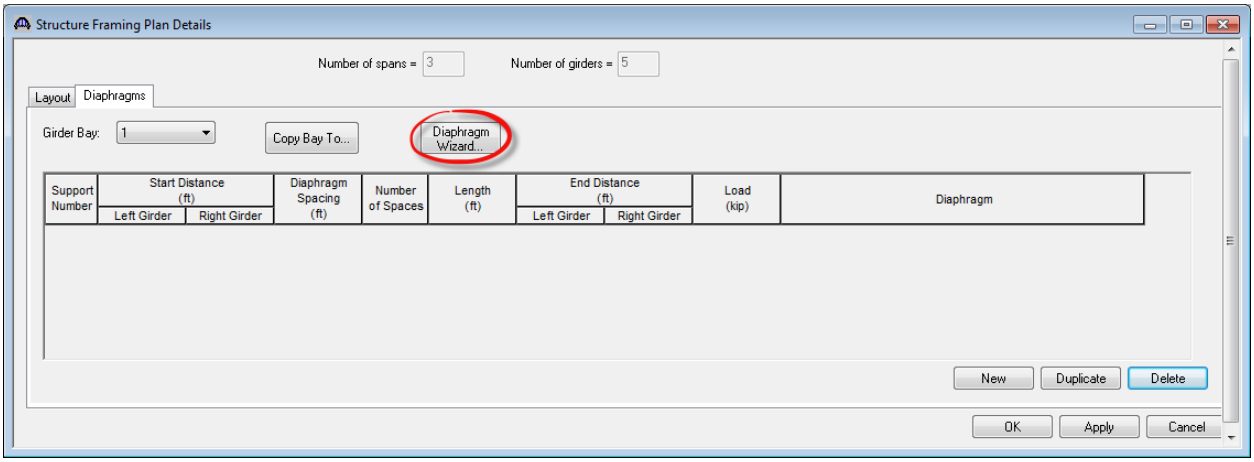
Click Load Case Description to define the dead load cases. Use the "Add Default…" button to create the following load cases.



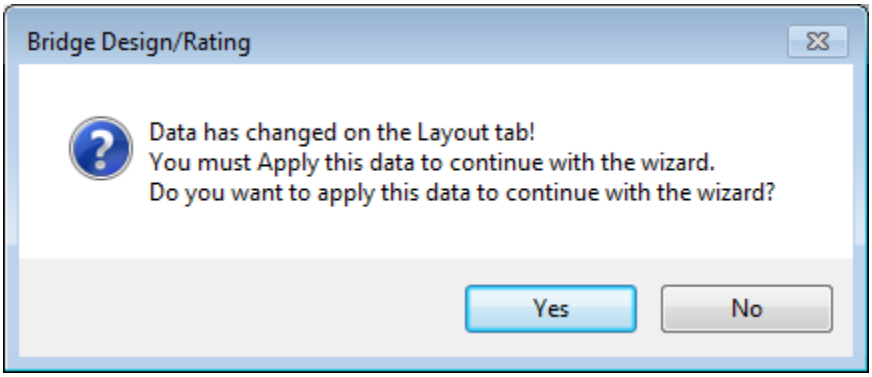
Double-click on Framing Plan Detail to describe the framing plan. Enter the appropriate data as shown below. In this example we are entering all data to 4 significant digits so enter the 7'-4" spacing as 7.3333.



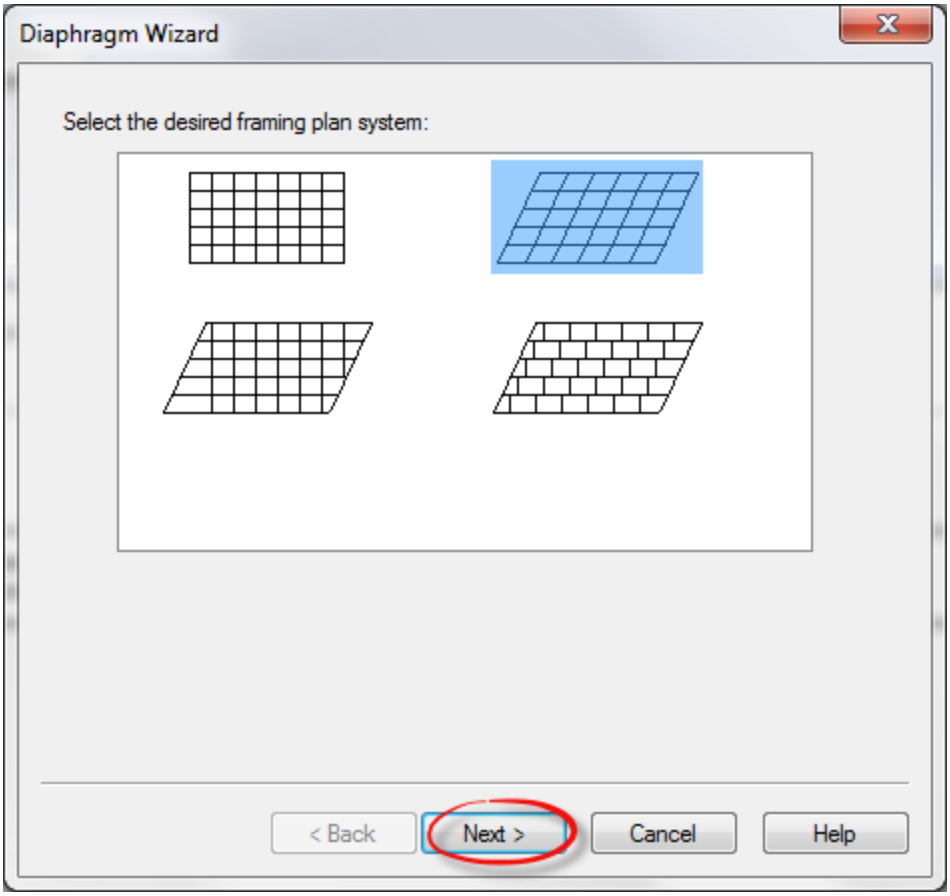
Switch to the Diaphragms tab and use the Wizard to enter diaphragm spacing.



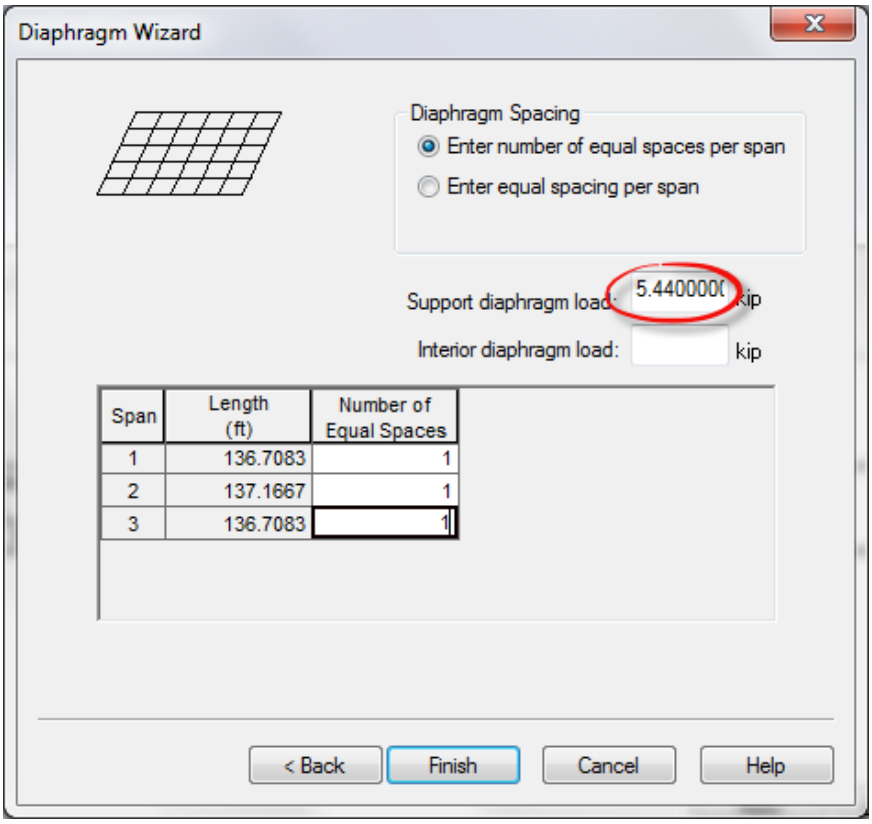
Click on “Diaphragm Wizard” button; The following dialog will appear. Click ‘Yes’ to continue.



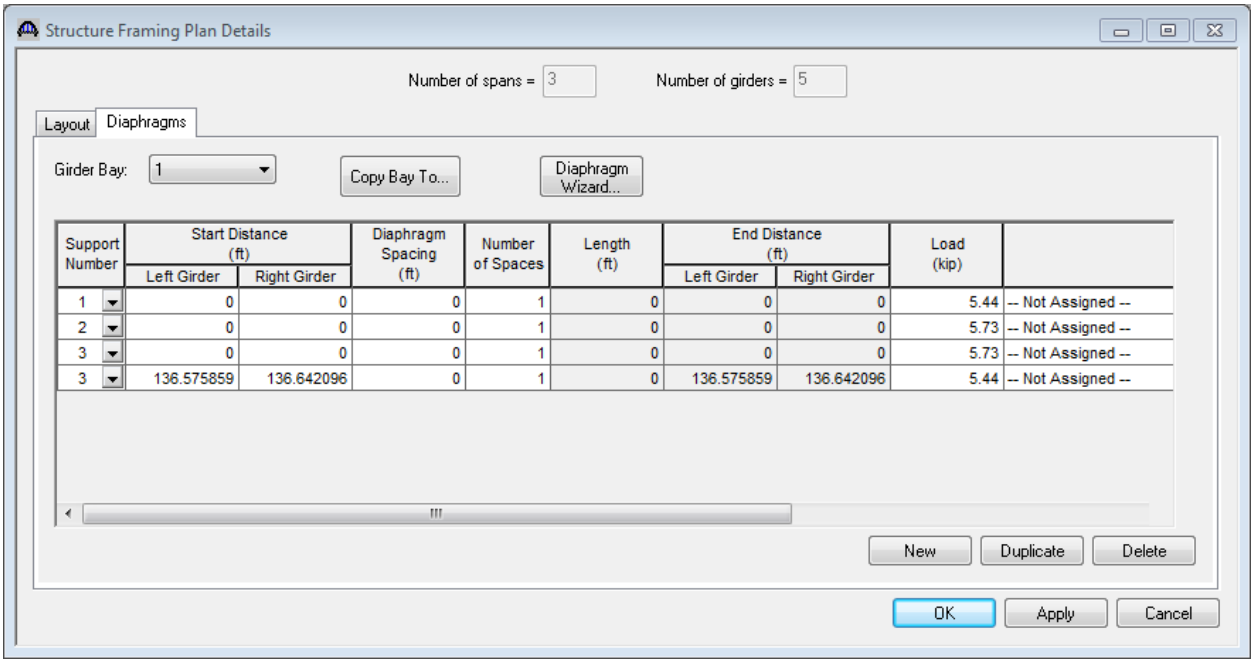
Click ‘Next’ to advance the Wizard.

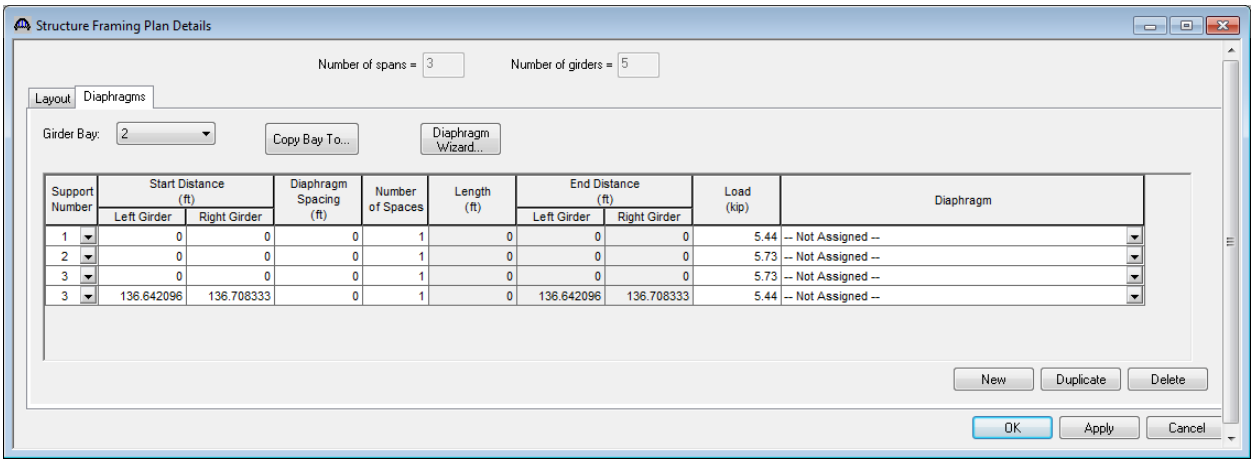


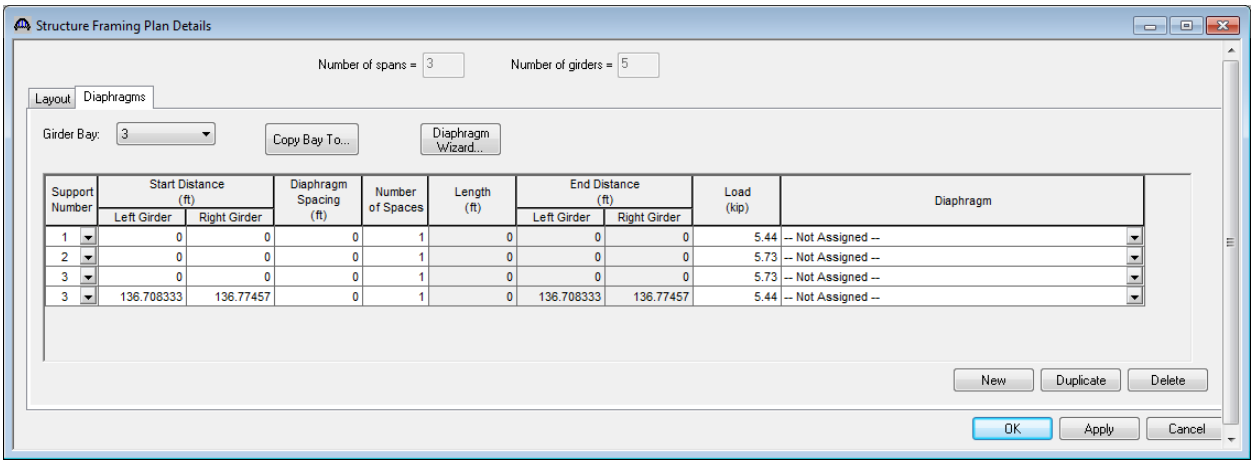
Enter the following data in the wizard and click ‘Finish’. Modifications will need made to update interior supports with different load.

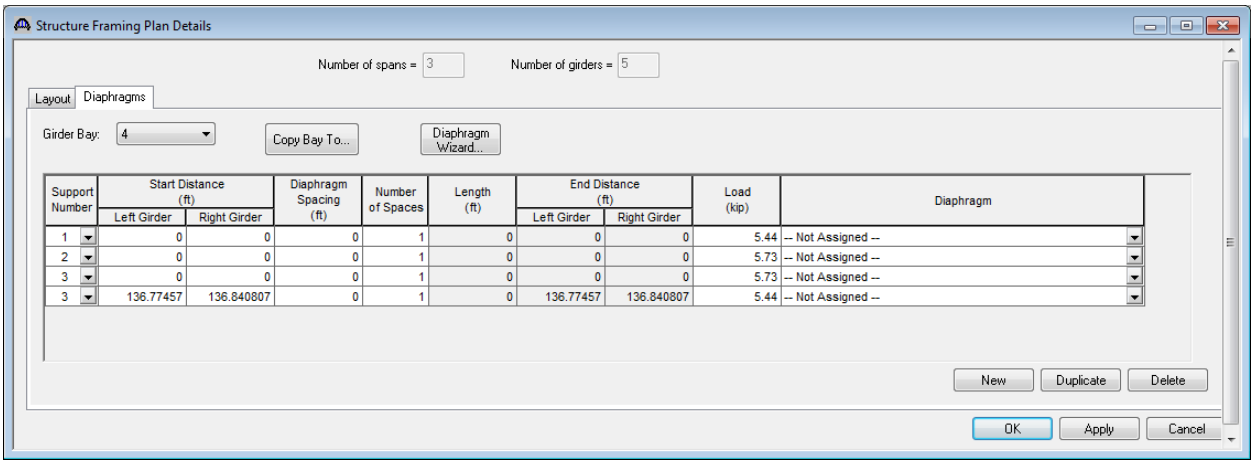


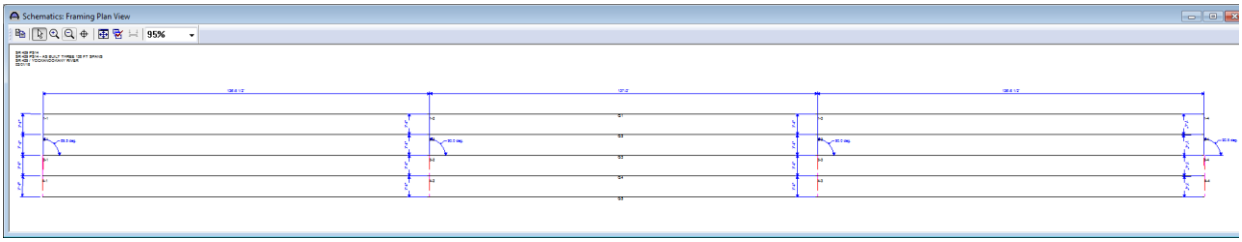
The following data appears in the Framing Plan Details window and the Framing Plan Schematic is shown below.




Structure Framing Plan Details
Number of spans = 3
Number of girders = 5
Layout
Diaphragms
Girder Bay: 2
Copy Bay To...
Diaphragm Wizard...
Support Number
Start Distance (ft)
Left Girder
Right Girder
Diaphragm Spacing (ft)
Number of Spaces
Length (ft)
End Distance (ft)
Left Girder
Right Girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.44 -- Not Assigned --
2 0 0 0 1 0 0 0 5.73 -- Not Assigned --
3 0 0 0 1 0 0 0 5.73 -- Not Assigned --
3 136.642096 136.708333 0 1 0 136.642096 136.708333 5.44 -- Not Assigned --
New
Duplicate
Delete
OK
Apply
Cancel

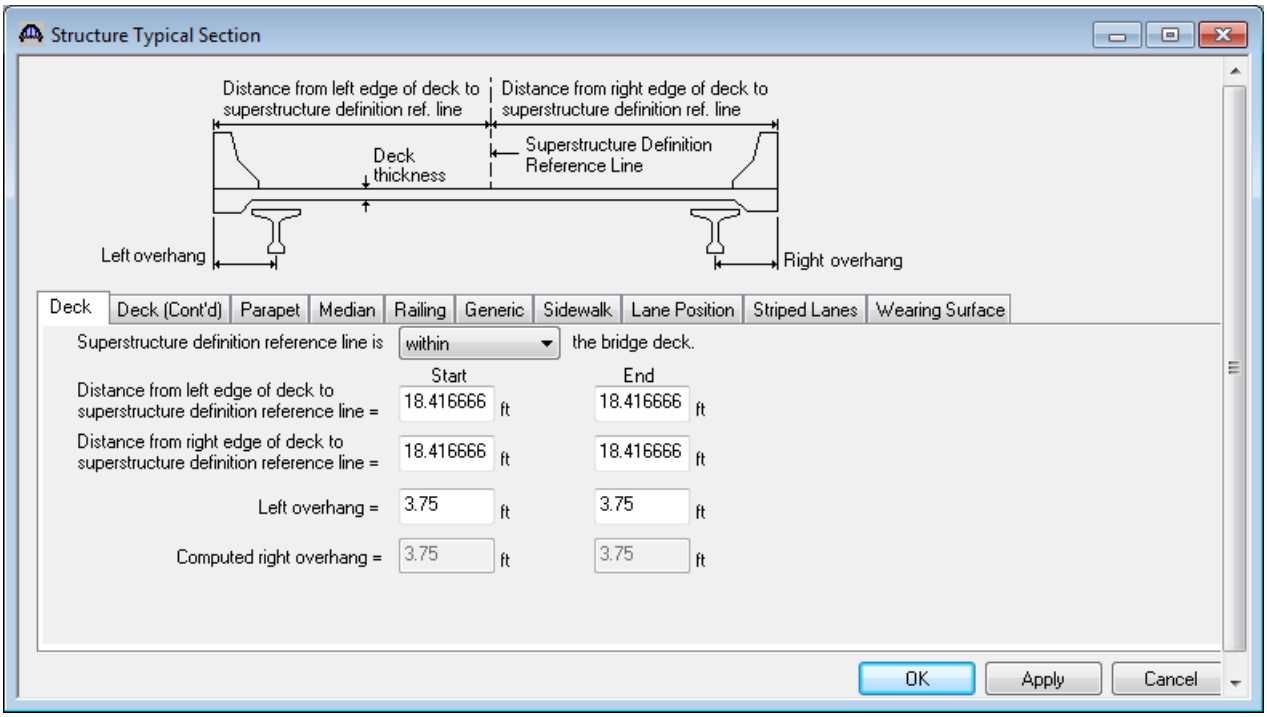

Structure Framing Plan Details
Number of spans = 3
Number of girders = 5
Layout
Diaphragms
Girder Bay: 3
Copy Bay To...
Diaphragm Wizard...
Support Number
Start Distance (ft)
Left Girder
Right Girder
Diaphragm Spacing (ft)
Number of Spaces
Length (ft)
End Distance (ft)
Left Girder
Right Girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.44 -- Not Assigned --
2 0 0 0 1 0 0 0 5.73 -- Not Assigned --
3 0 0 0 1 0 0 0 5.73 -- Not Assigned --
3 136.708333 136.77457 0 1 0 136.708333 136.77457 5.44 -- Not Assigned --
New
Duplicate
Delete
OK
Apply
Cancel


Structure Framing Plan Details
Number of spans = 3
Number of girders = 5
Layout
Diaphragms
Girder Bay: 4
Copy Bay To...
Diaphragm Wizard...
Support Number
Start Distance (ft)
Left Girder
Right Girder
Diaphragm Spacing (ft)
Number of Spaces
Length (ft)
End Distance (ft)
Left Girder
Right Girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.44 -- Not Assigned --
2 0 0 0 1 0 0 0 5.73 -- Not Assigned --
3 0 0 0 1 0 0 0 5.73 -- Not Assigned --
3 136.77457 136.840807 0 1 0 136.77457 136.840807 5.44 -- Not Assigned --
New
Duplicate
Delete
OK
Apply
Cancel

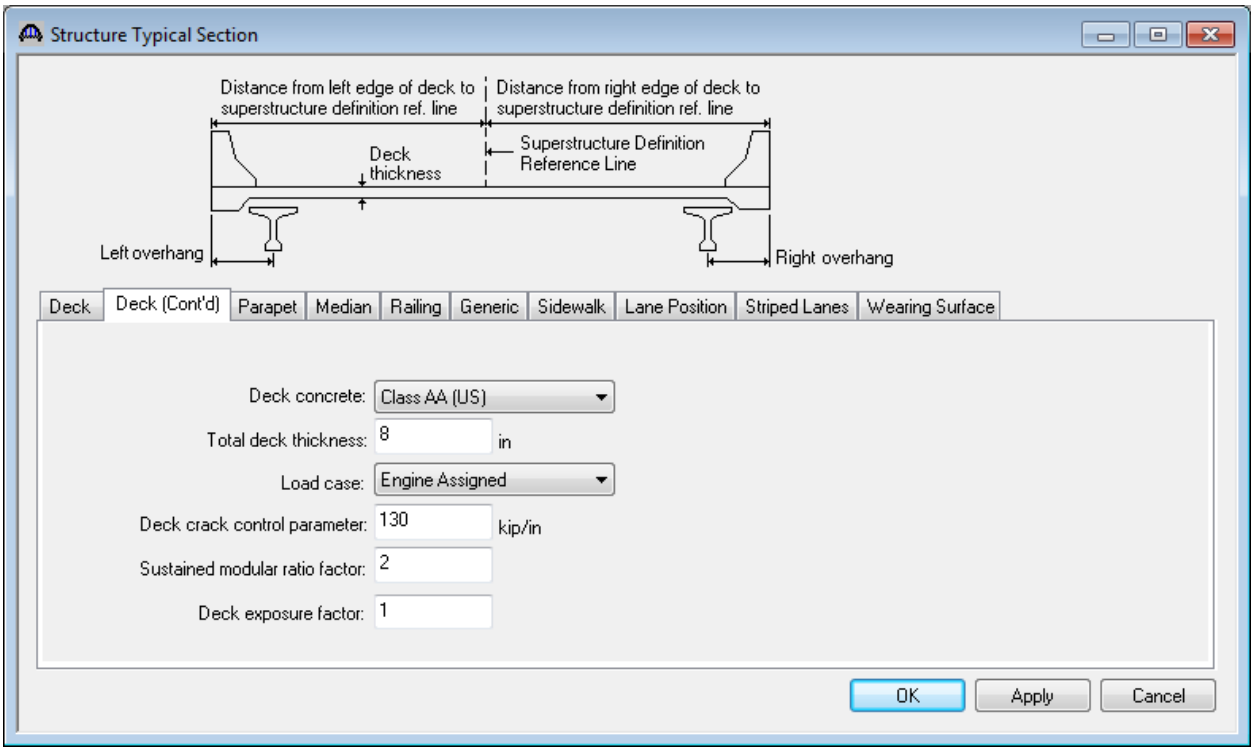

Schematics: Framing Plan View
95%

Next define the structure typical section by double-clicking on Structure Typical Section in the Bridge Workspace tree. Input the data describing the typical section as shown below. This screen initially shows steel girders as the default girder type until the member alternatives are defined.

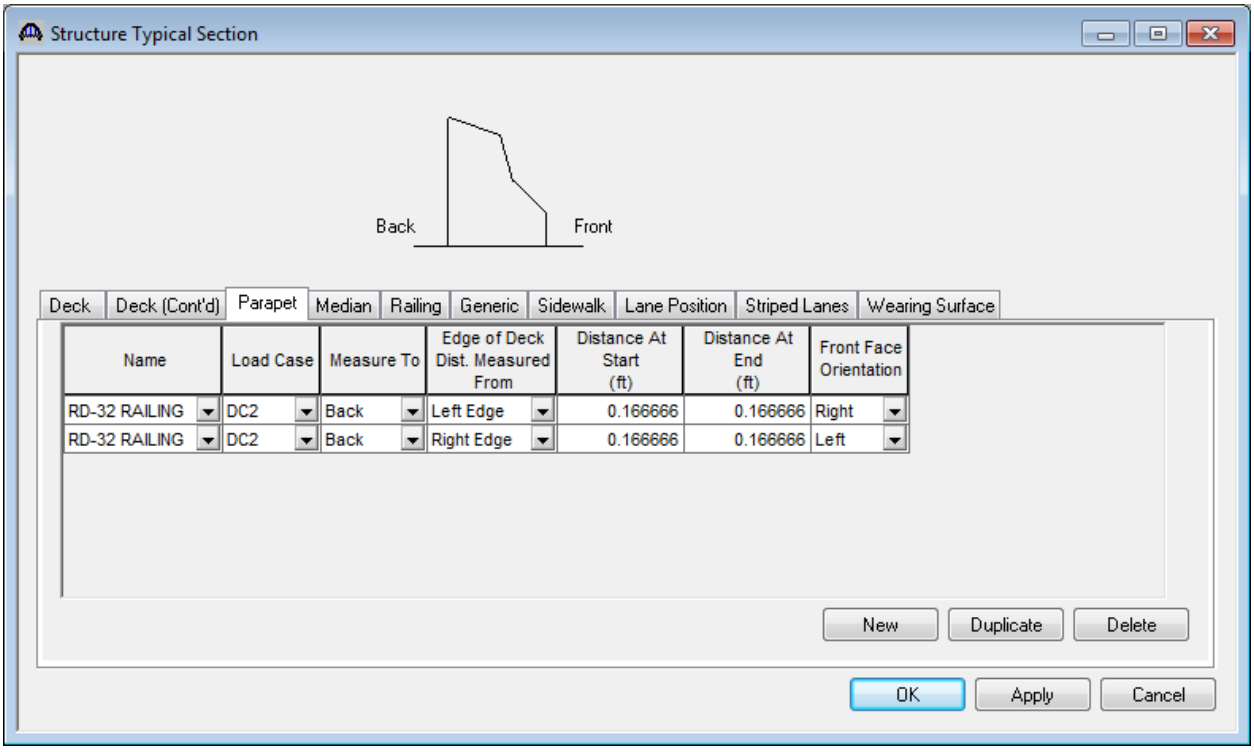
Basic deck geometry:



The Deck (cont'd) tab is used to enter information about the deck concrete and thickness.

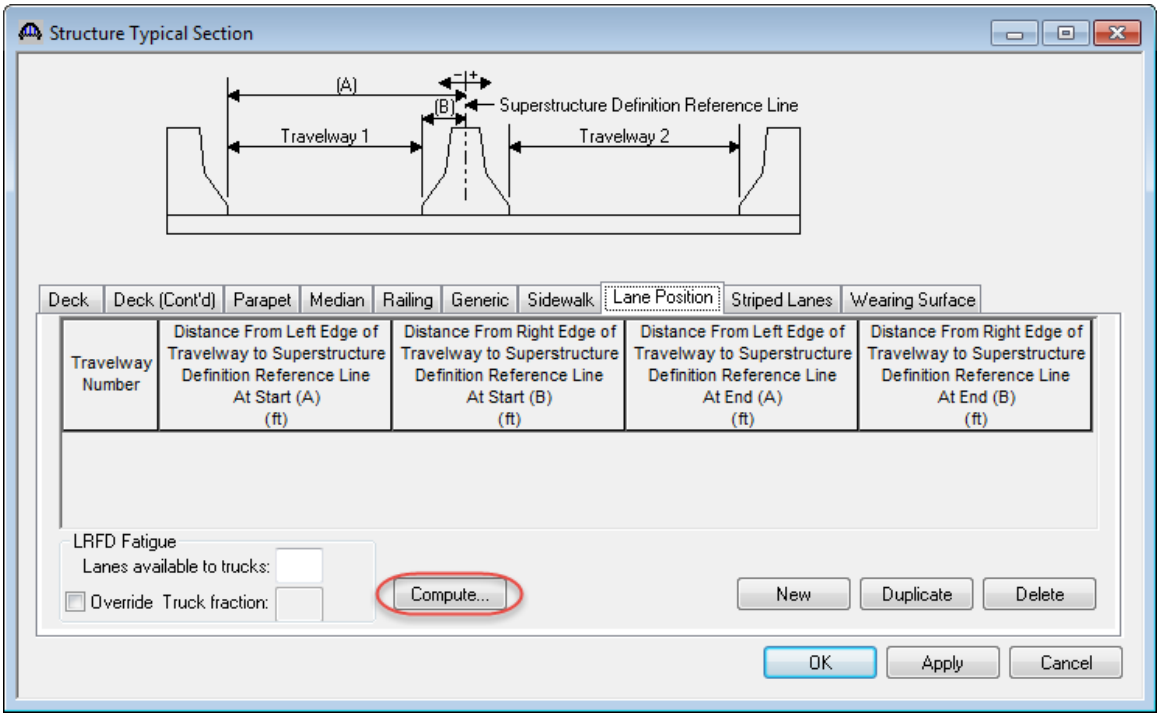


Enter the following parapets:

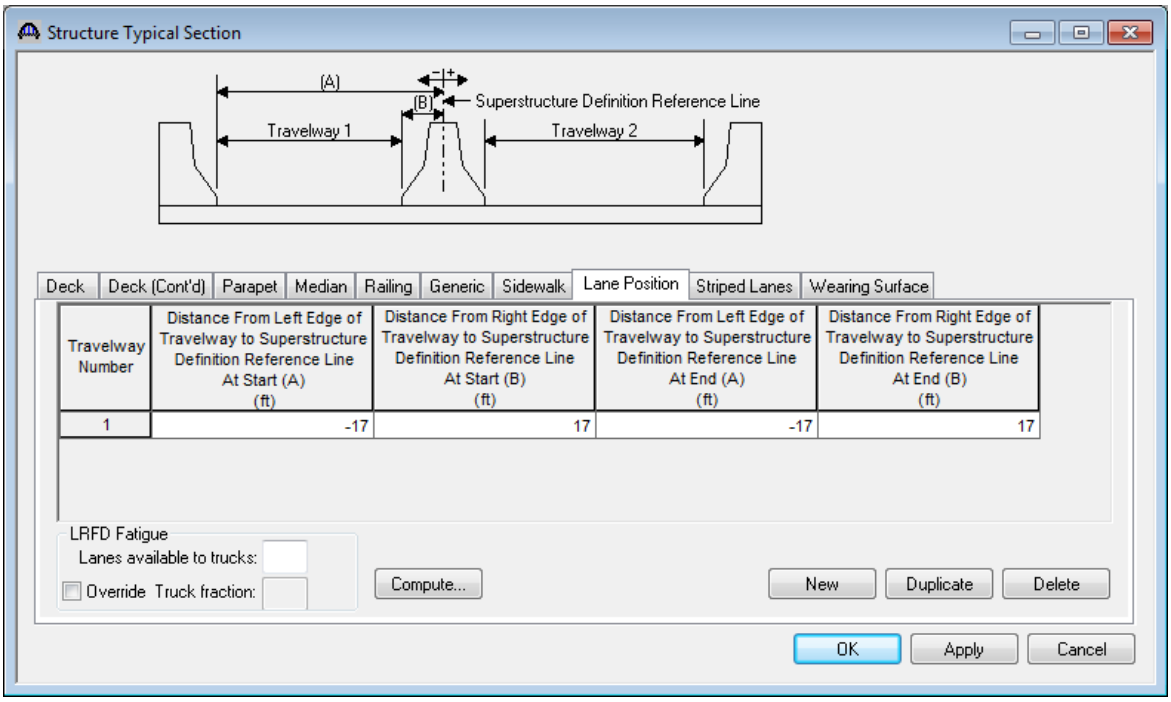


Lane Positions:

Use the ‘Compute’ button to have BrD compute the lane positions for you. These lane positions are used by BrD to compute the LRFD live load distribution factors.

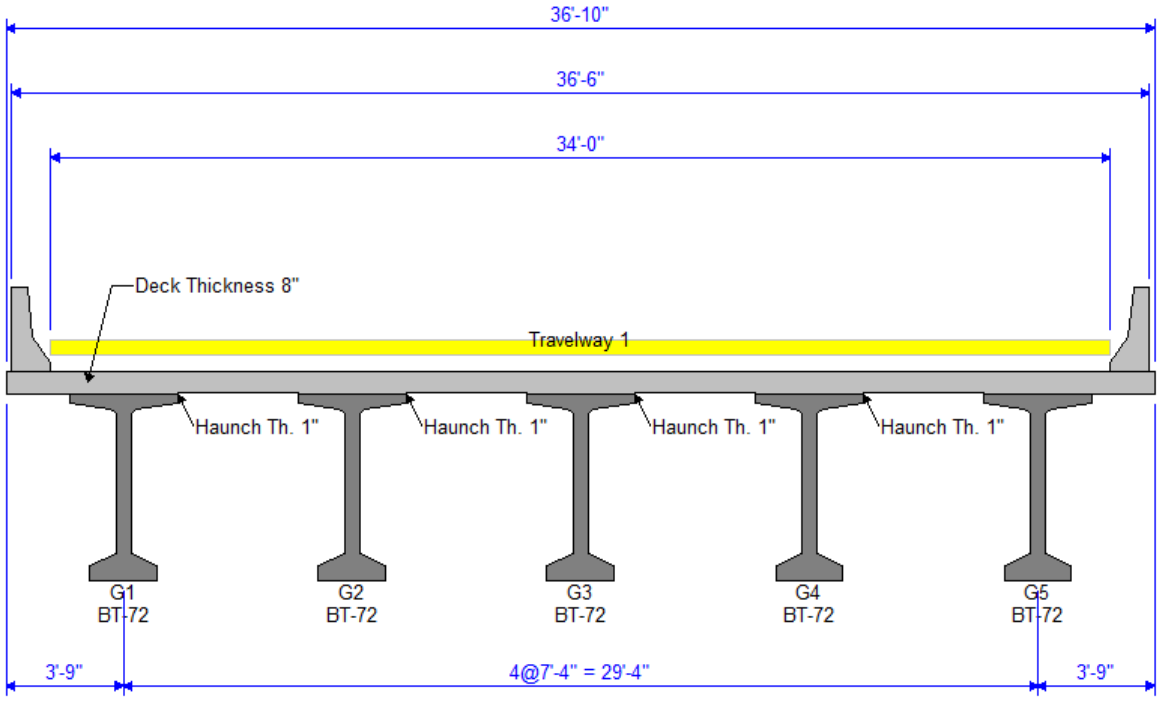


The computed values are shown below.

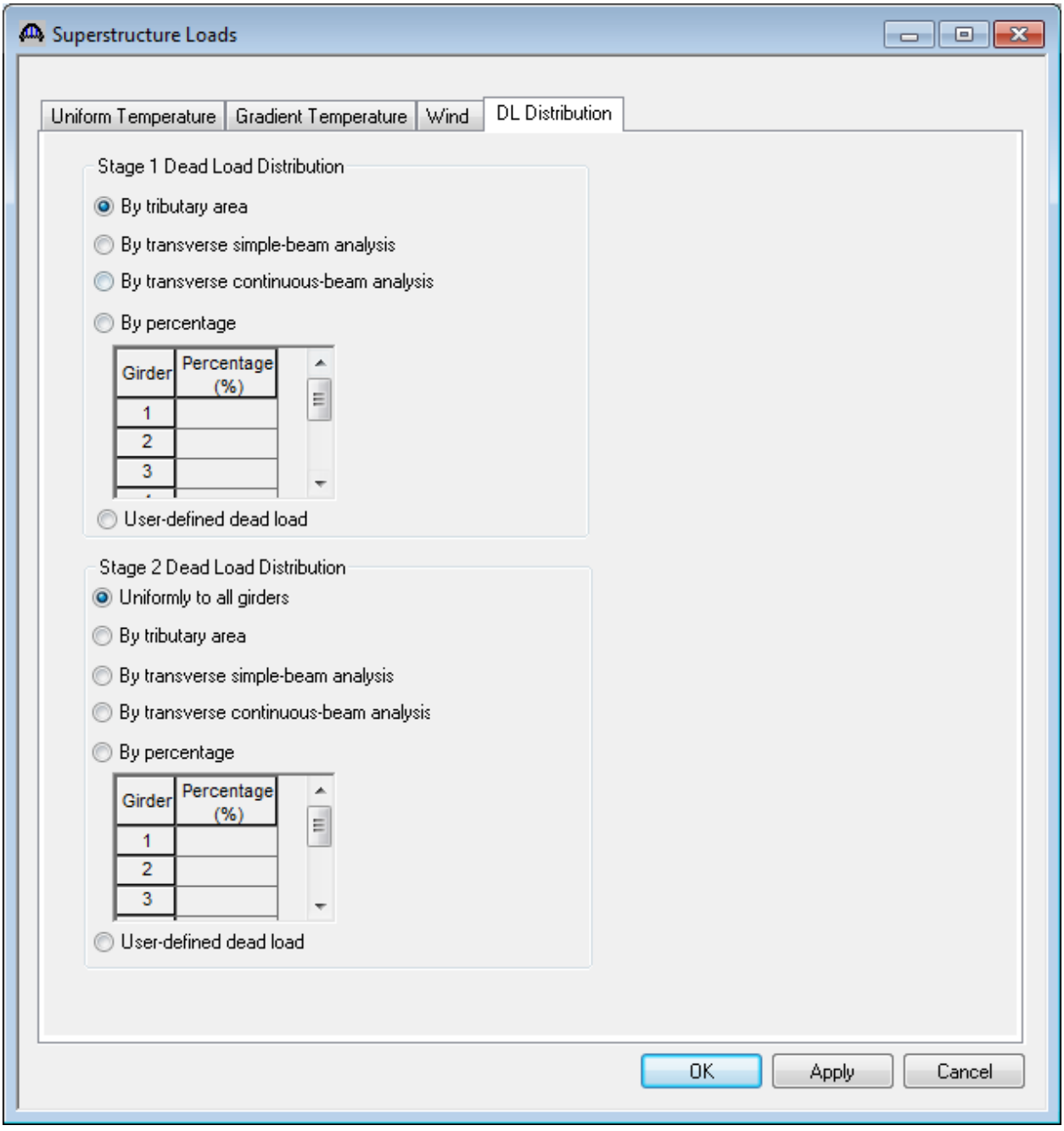


The schematic of the Structure Typical Section is shown below.

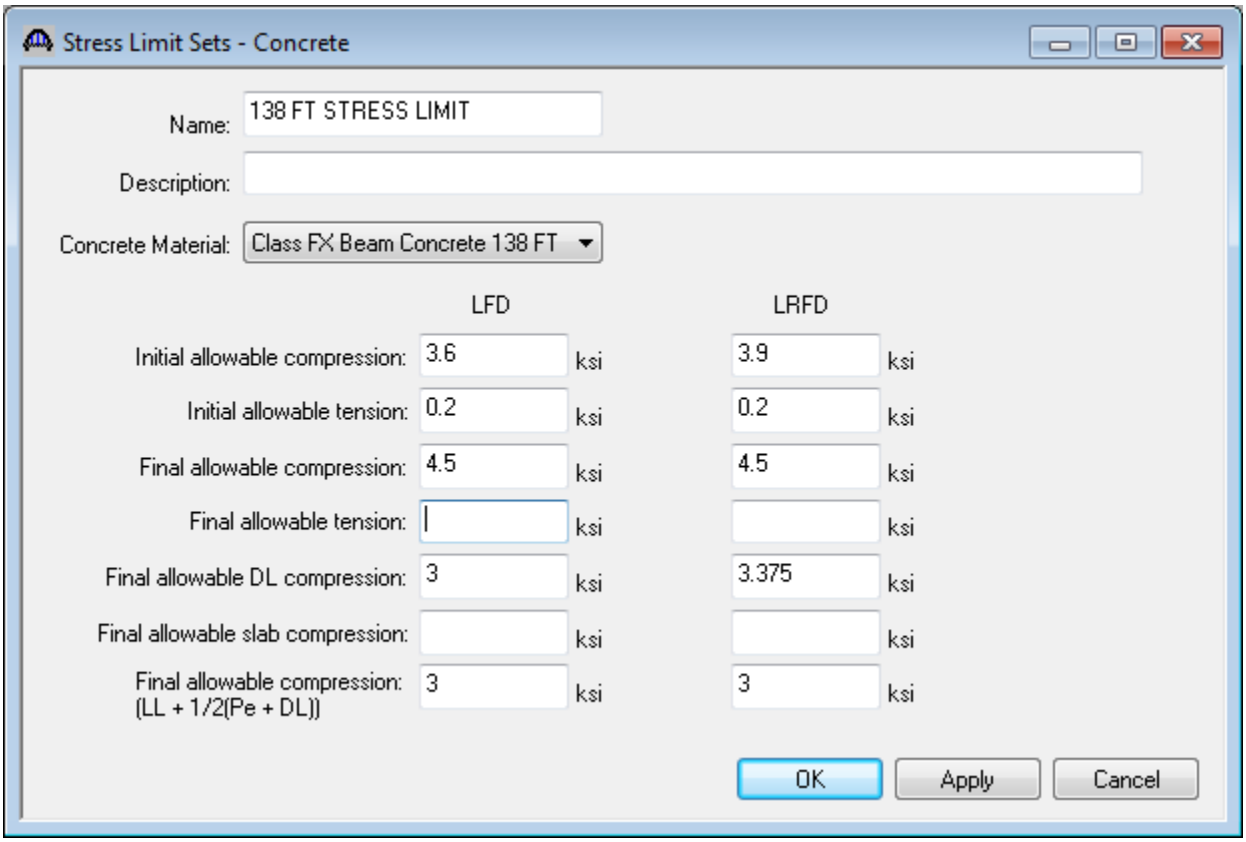
SR 429 PS14
SR 429 PS14 - AS BUILT THREE 138 FT SPANS
SR 429 / YOCKANOOKANY RIVER
01/31/18



The DL Distribution tab of the Superstructure Loads window is shown below. The BrD LRFD engine does not support the transverse continuous beam analysis option.

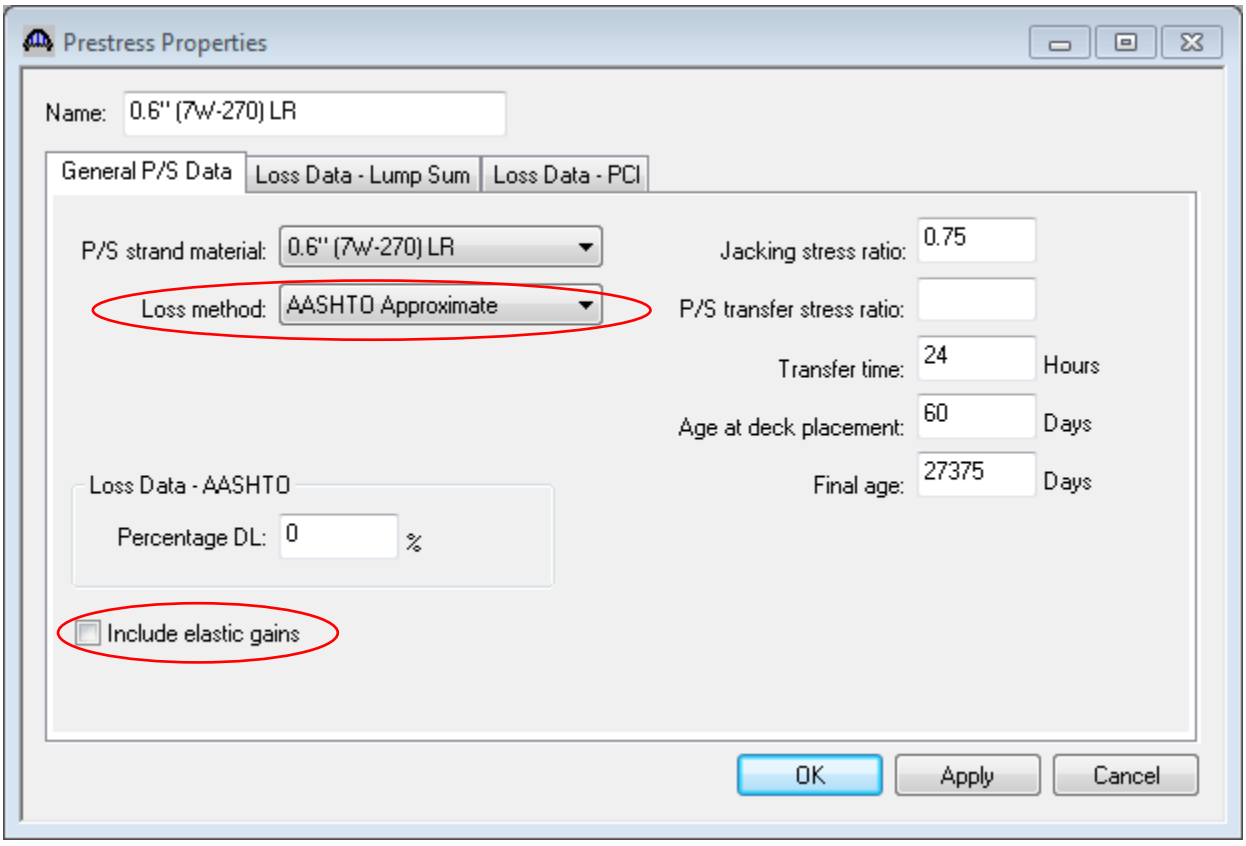


Create the following stress limit.



If you leave the allowable stresses blank in the stress limit the BrD LRFD engine will compute the allowable based on the AASHTO specification articles and the concrete material selected. The allowable slab compression is not computed for you since the deck is typically a different material than the girder.

Create the following Prestress Property. Select the loss method as 'AASHTO Approximate".

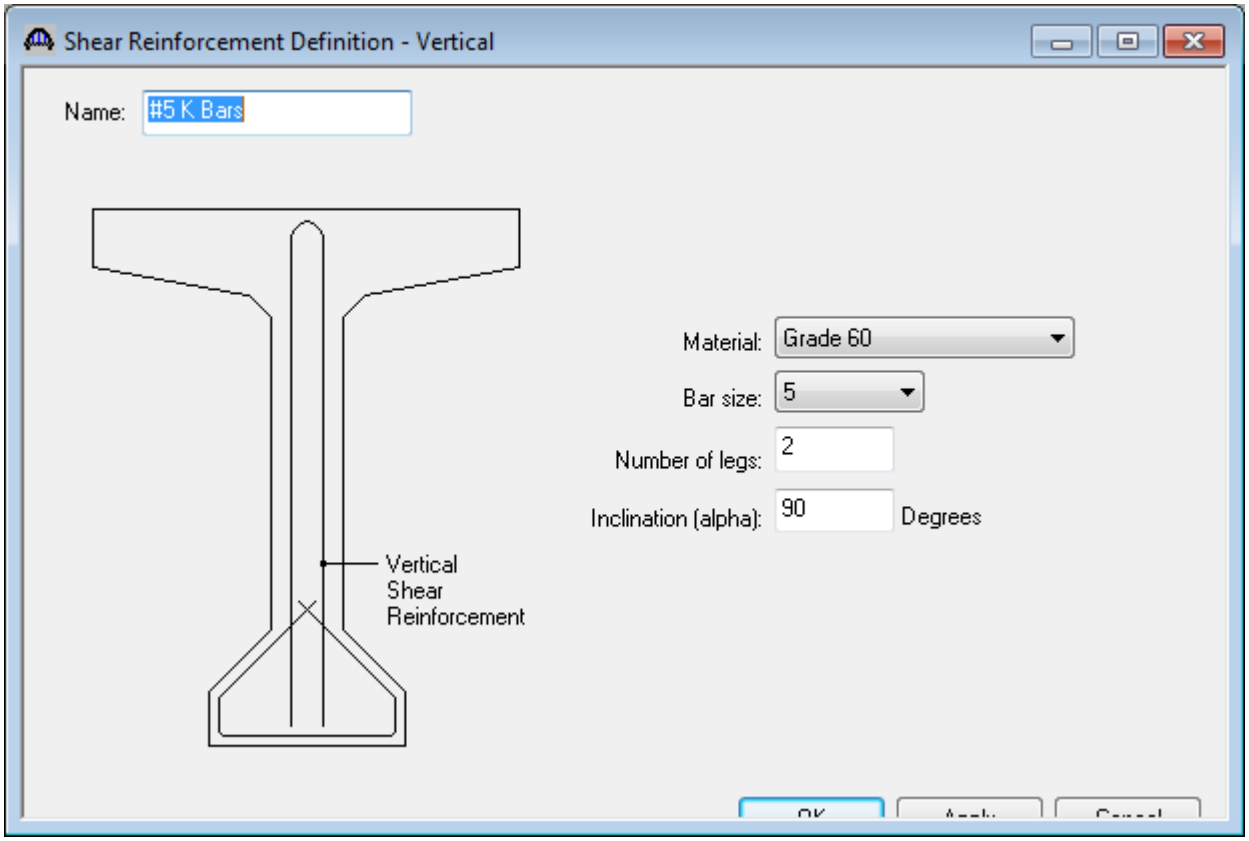


The following loss methods are available in the BrD LRFD engine:

- AASHTO Approximate
- AASHTO Refined
- Lump Sum
- PCI
- Pre-2005 AASHTO Refined (AASHTO Refined, Third Edition, 2004 without interims)

Another feature for prestress loss calculations in the BrD LRFD engine is the ability to include elastic gains and losses due to dead load application.

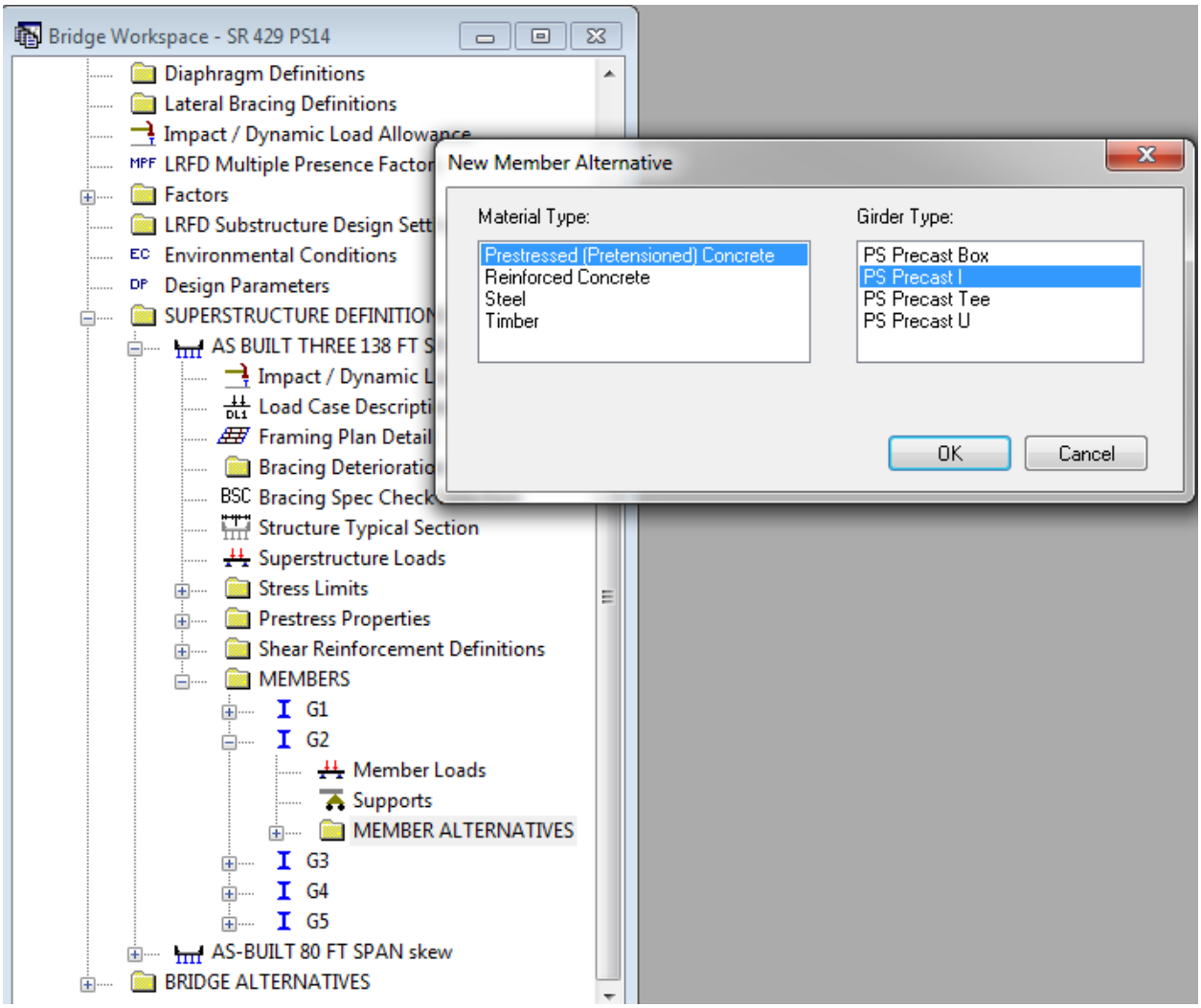
Define the Vertical Shear Reinforcement by double clicking on Vertical (under Shear Reinforcement Definitions in the tree). Note, #5 S Bars are the same definition as #5 K bars. Define the reinforcement as shown below. Click OK to save to memory and close the window.



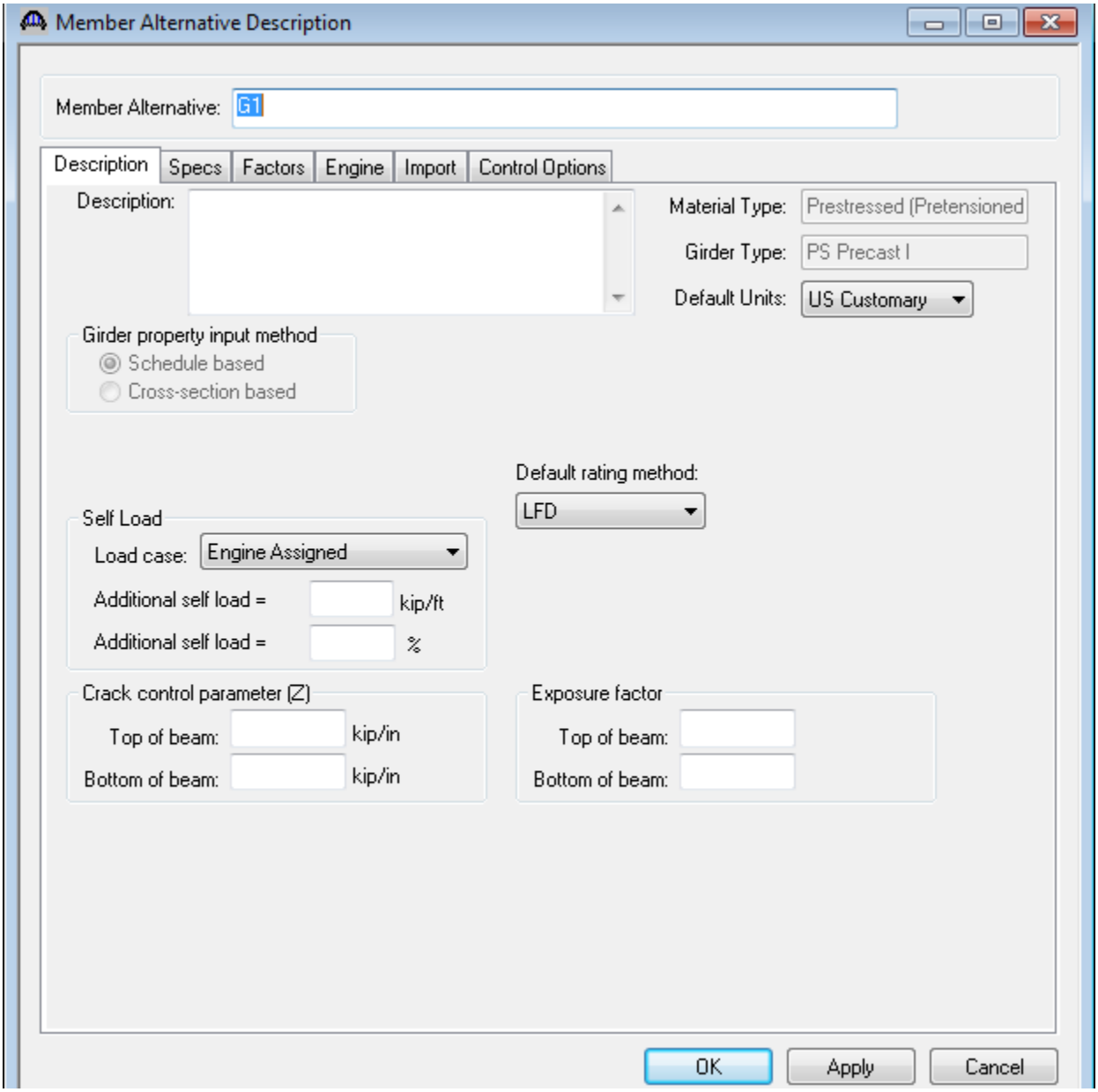
Describing a member:

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this Member.

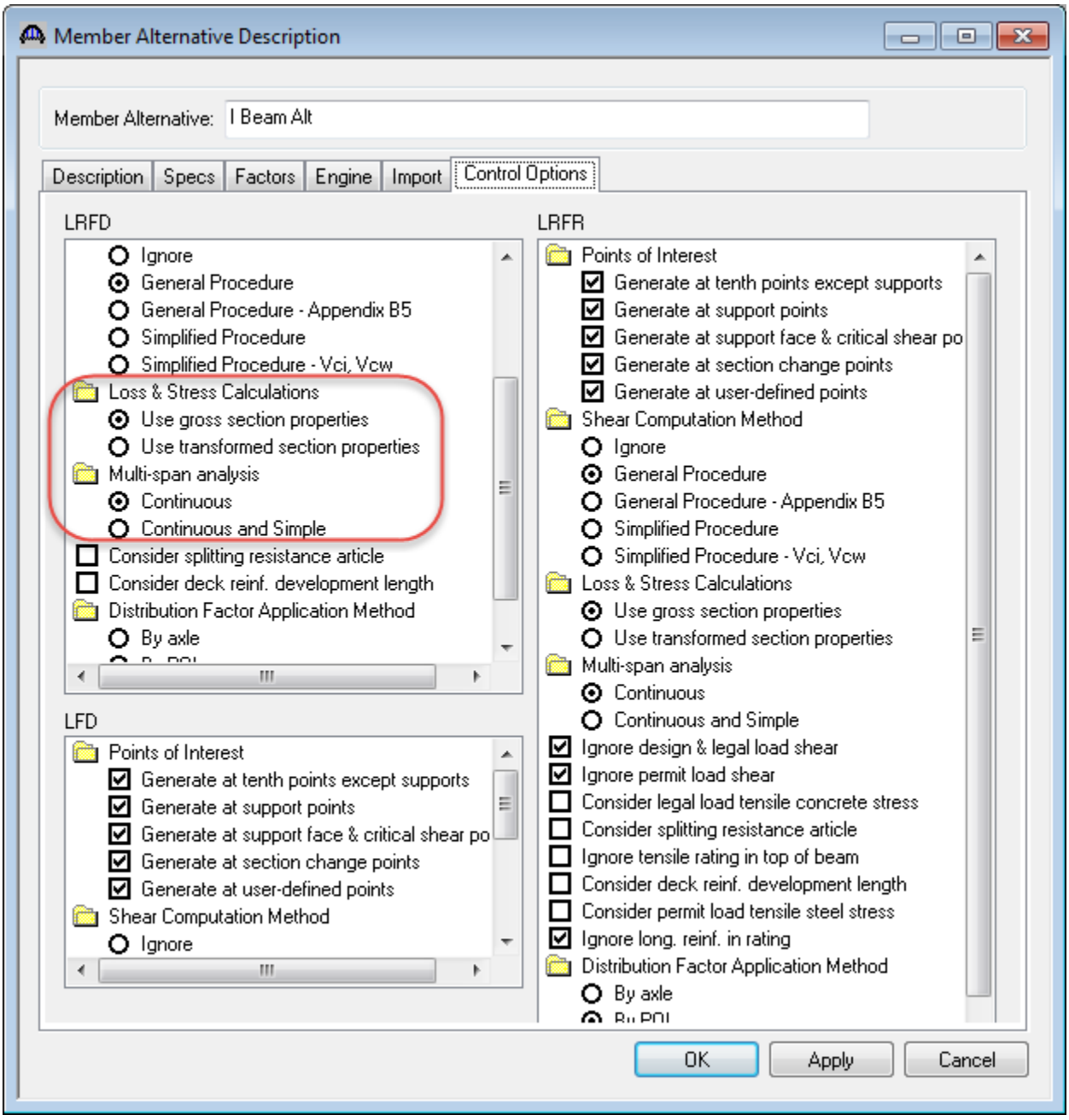
Now create a prestressed I beam alternative for member G2 by double-clicking on the ‘MEMBER ALTERNATIVES’ label.



Enter the following data in the Member Alternative window. The Schedule-based Girder property input method is the only input method available for a prestressed concrete beam.



The Control Options tab allows you to select the following control features.



The BrD LRFD engine allows you to select either gross or transformed section properties to be used in the loss and stress calculations. Note that the gross section properties are always used in the structural analysis.

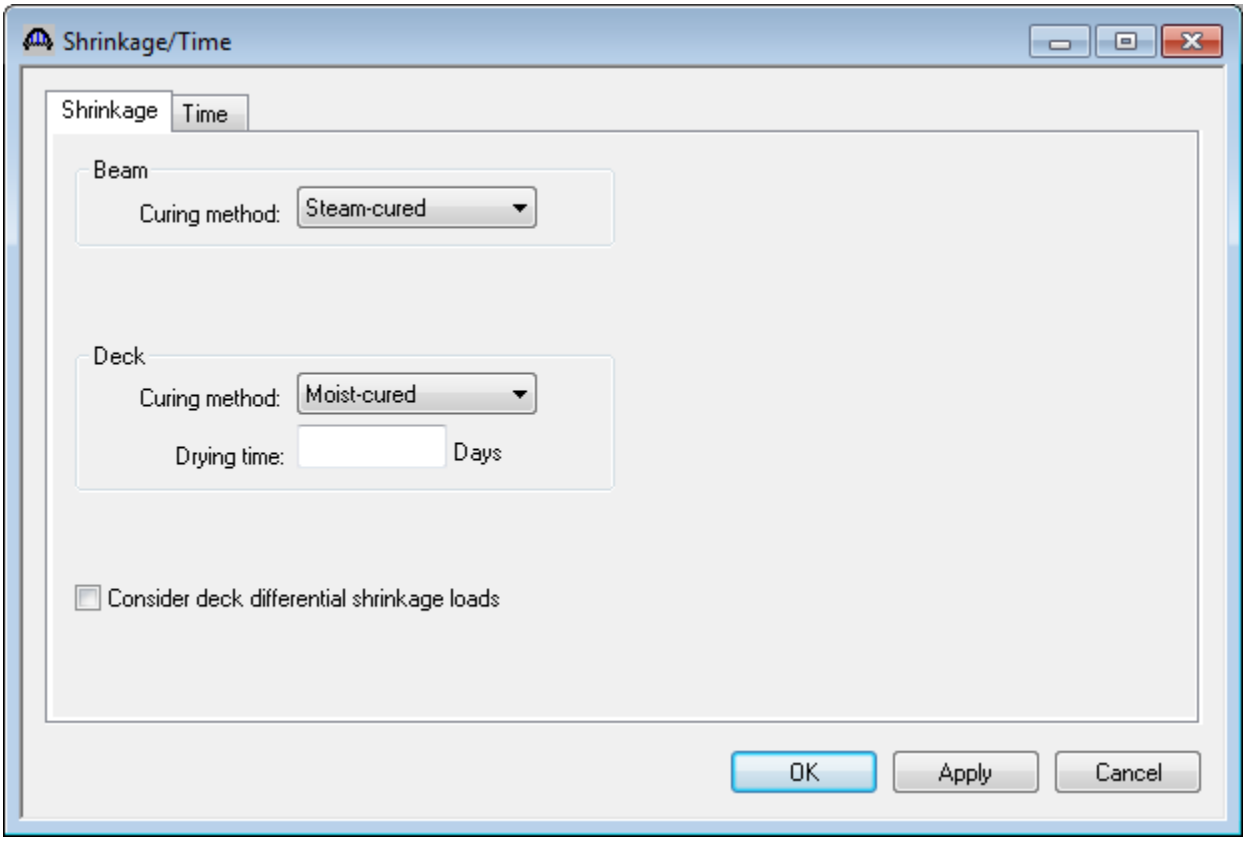
The BrD LRFD engine also allows you to model prestress beams made continuous for live load in 2 ways:

- The Continuous analysis method considers multi-span structures to be simply supported for beam self-weight and uncured deck and continuously supported for composite dead and live loads. This method takes advantage of the continuity connection to reduce the maximum positive moment at mid-spans.

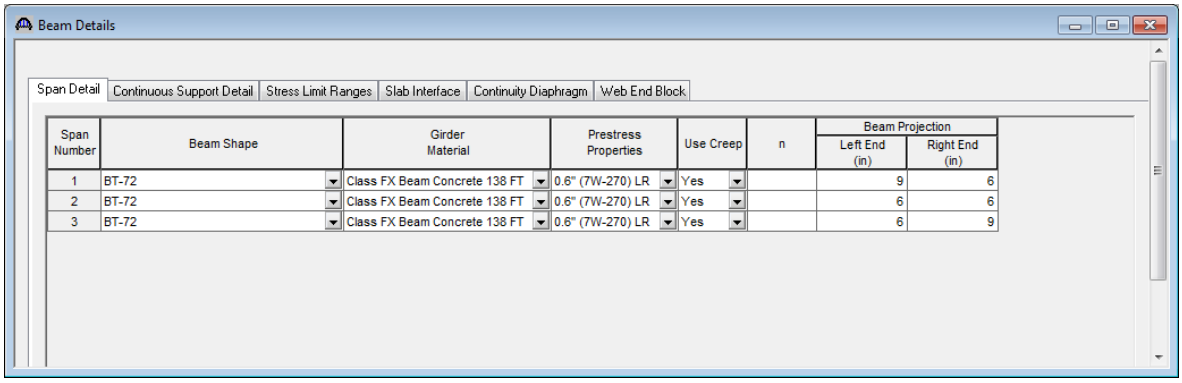
- The Continuous and Simple method analyzes the structure as simply supported for beam self-weight and uncured deck and both continuously and simply supported for composite dead and live loads. The maximum effects from the two analyses are then used in the specification checking. This method accounts for the condition where full continuity is not provided at interior supports and does not reduce the maximum positive moment at mid-spans.

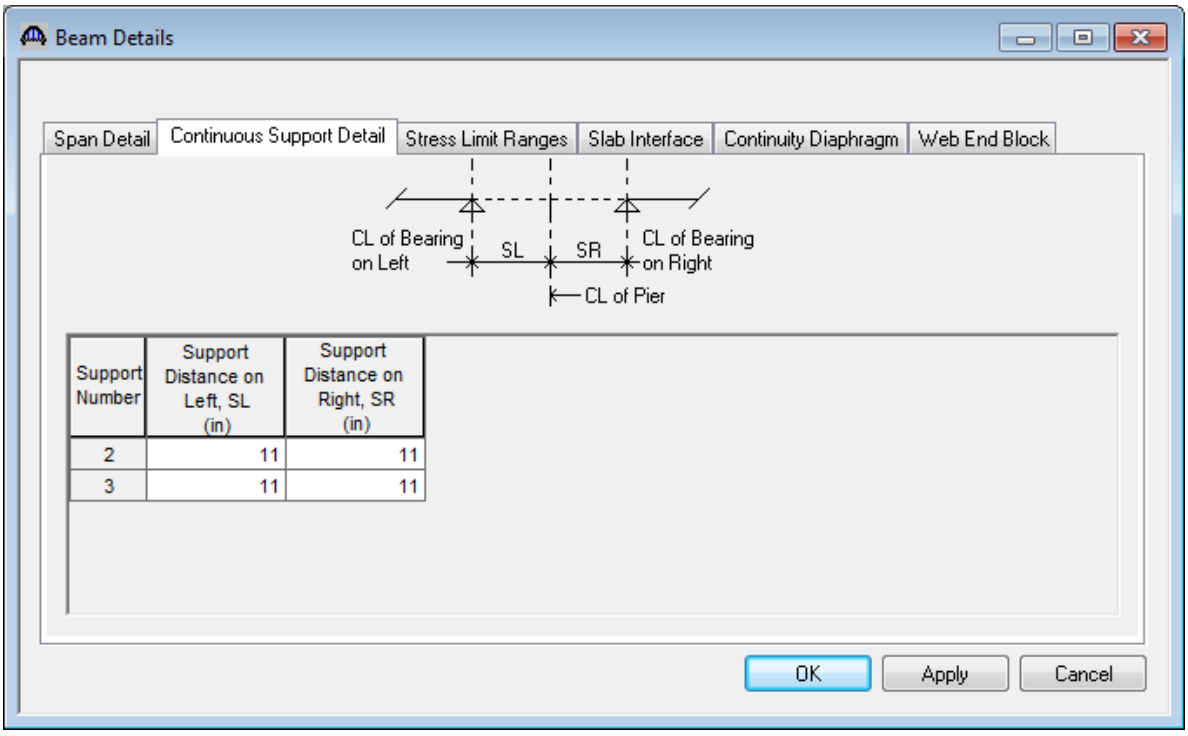
We will let the BrD LRFD engine compute the live load distribution factors for us so we will not enter them.

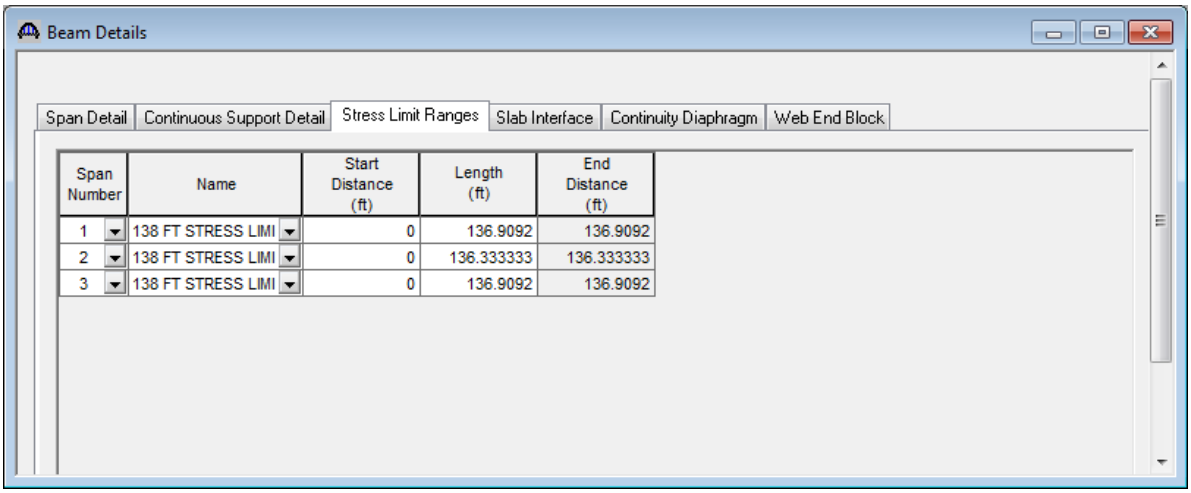
Enter the following data on the Shrinkage/Time window.

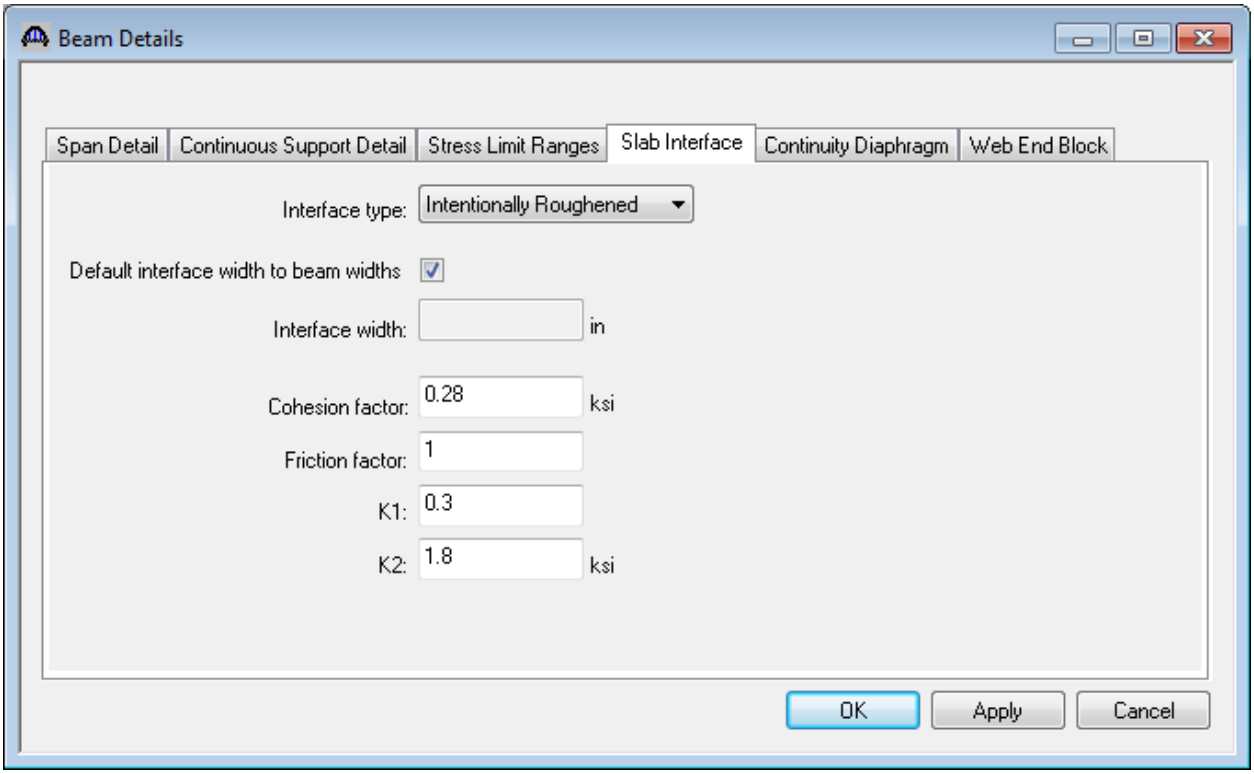


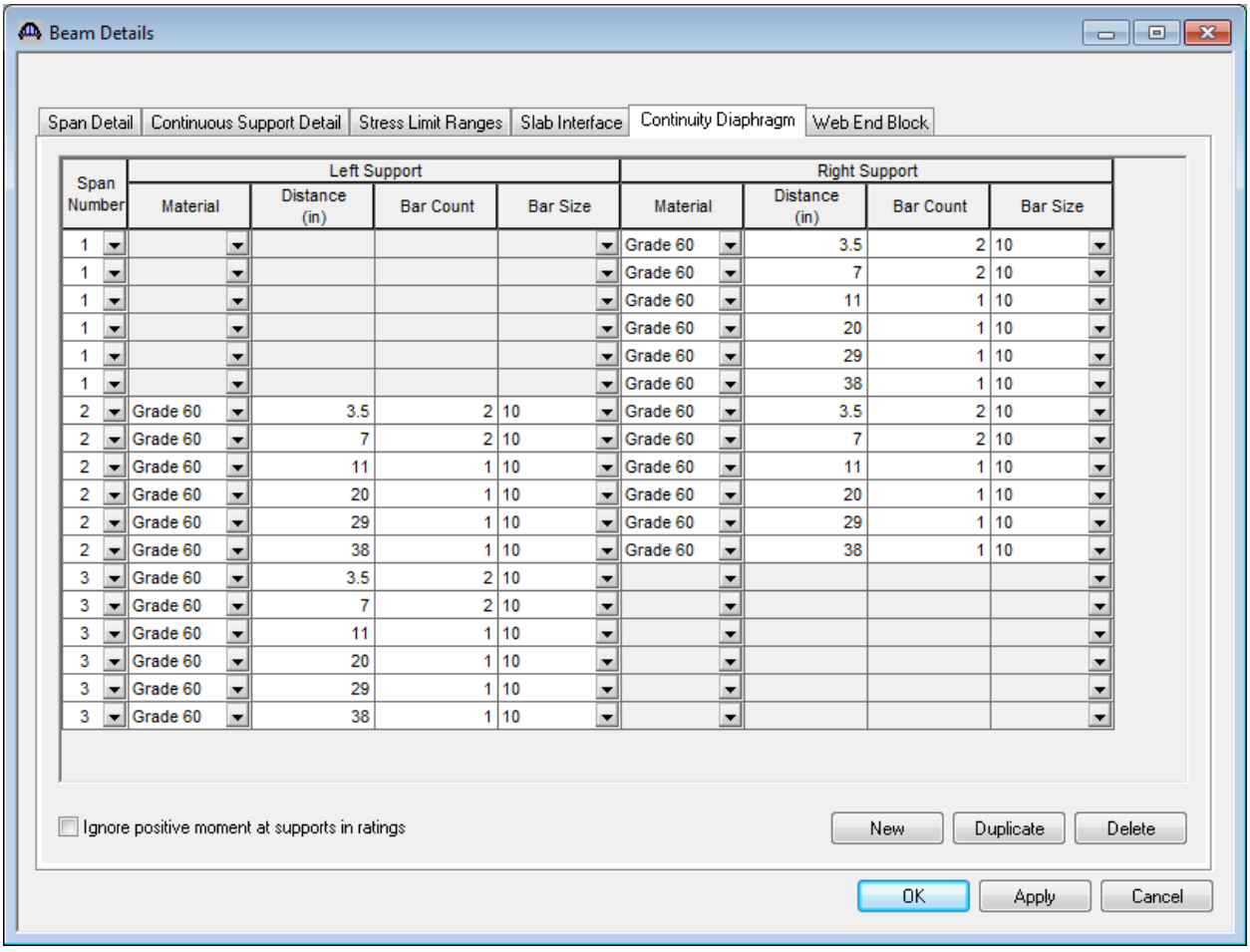
Enter the following data on the Beam Details window.



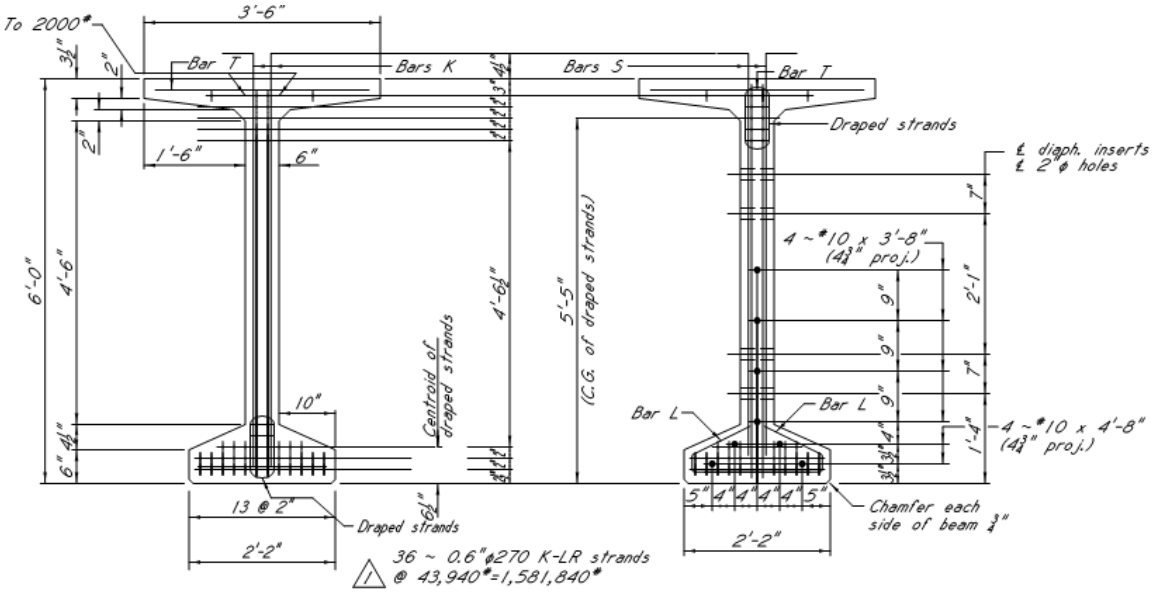


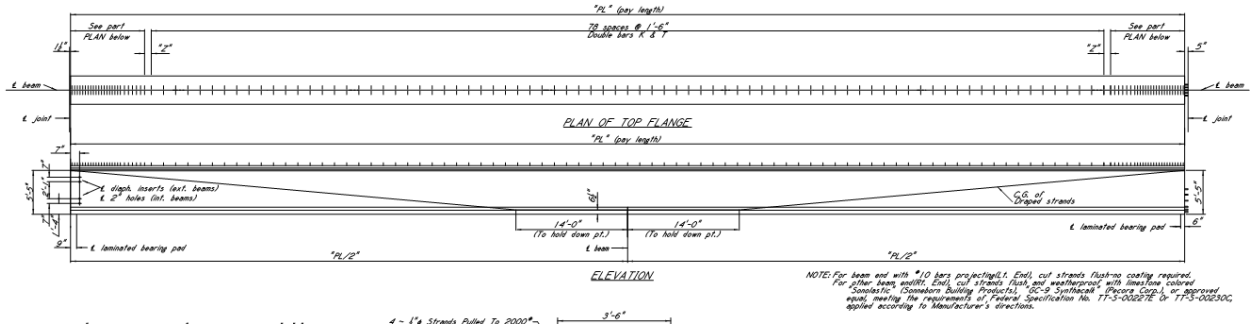


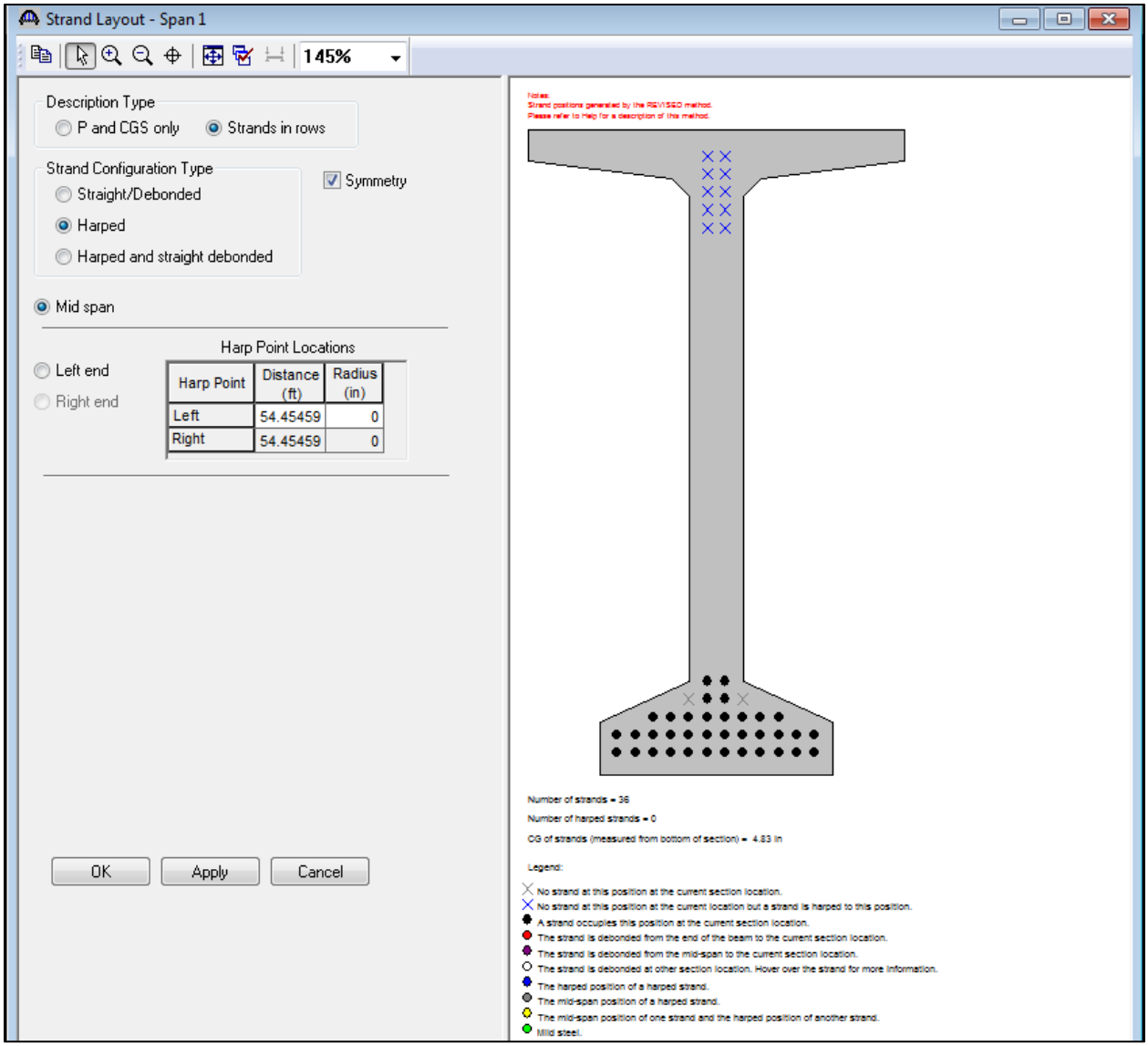

Beam Details
Span Detail
Continuous Support Detail
Stress Limit Ranges
Slab Interface
Continuity Diaphragm
Web End Block
Interface type:
Intentionally Roughened
Default interface width to beam widths
Interface width:
in
Cohesion factor:
0.28
ksi
Friction factor:
1
K1:
0.3
K2:
1.8
ksi
OK
Apply
Cancel


Beam Details
Span Detail
Continuous Support Detail
Stress Limit Ranges
Slab Interface
Continuity Diaphragm
Web End Block
Span Number
Left Support
Material
Distance (in)
Bar Count
Bar Size
Right Support
Material
Distance (in)
Bar Count
Bar Size
1 Grade 60 3.5 2 10
1 Grade 60 7 2 10
1 Grade 60 11 1 10
1 Grade 60 20 1 10
1 Grade 60 29 1 10
1 Grade 60 38 1 10
2 Grade 60 3.5 2 10 Grade 60 3.5 2 10
2 Grade 60 7 2 10 Grade 60 7 2 10
2 Grade 60 11 1 10 Grade 60 11 1 10
2 Grade 60 20 1 10 Grade 60 20 1 10
2 Grade 60 29 1 10 Grade 60 29 1 10
2 Grade 60 38 1 10 Grade 60 38 1 10
3 Grade 60 3.5 2 10
3 Grade 60 7 2 10
3 Grade 60 11 1 10
3 Grade 60 20 1 10
3 Grade 60 29 1 10
3 Grade 60 38 1 10
Ignore positive moment at supports in ratings
New
Duplicate
Delete
OK
Apply
Cancel

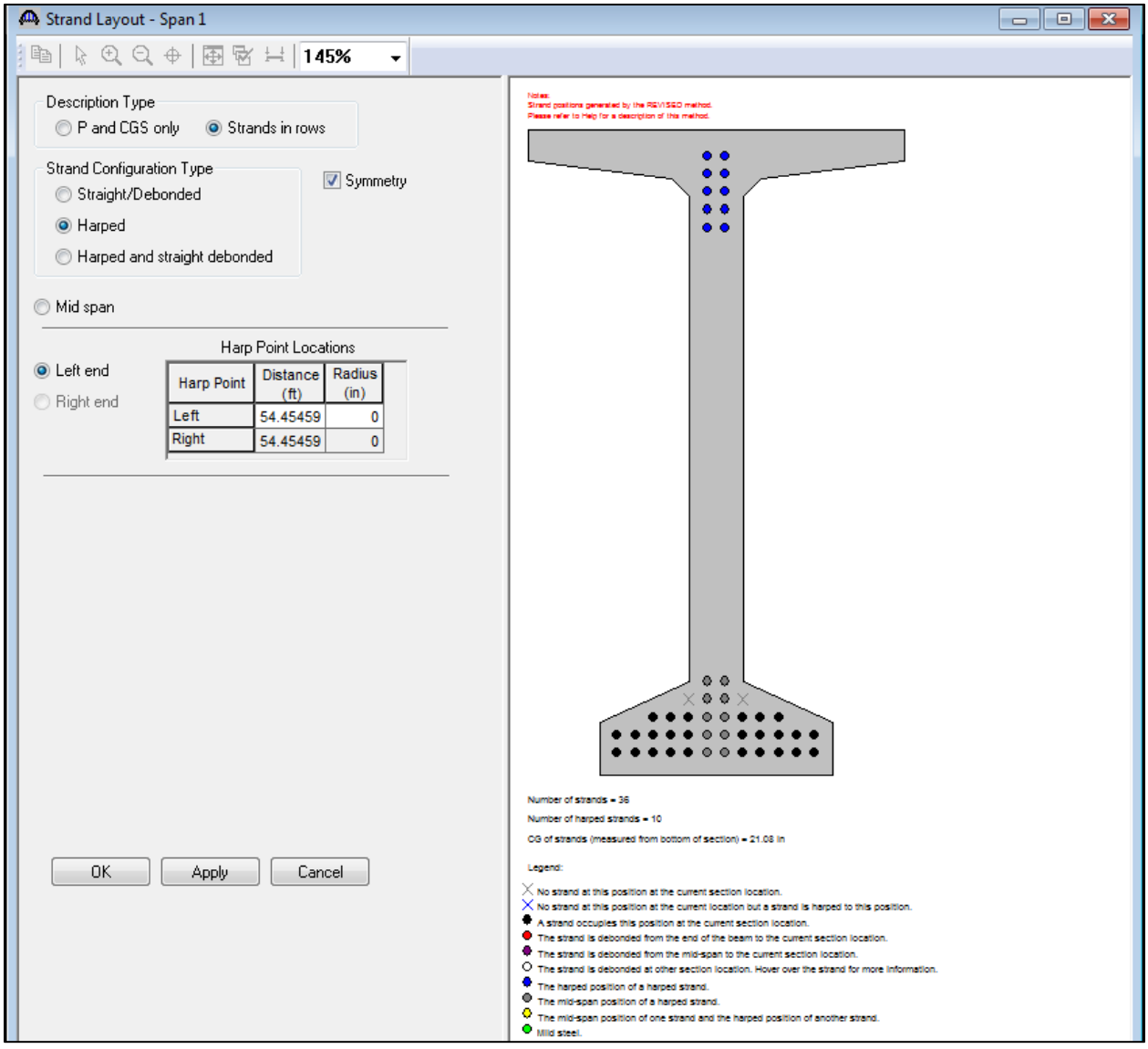
Now define the following strand layout at midspan using the screen captures from the drawings (shown below).





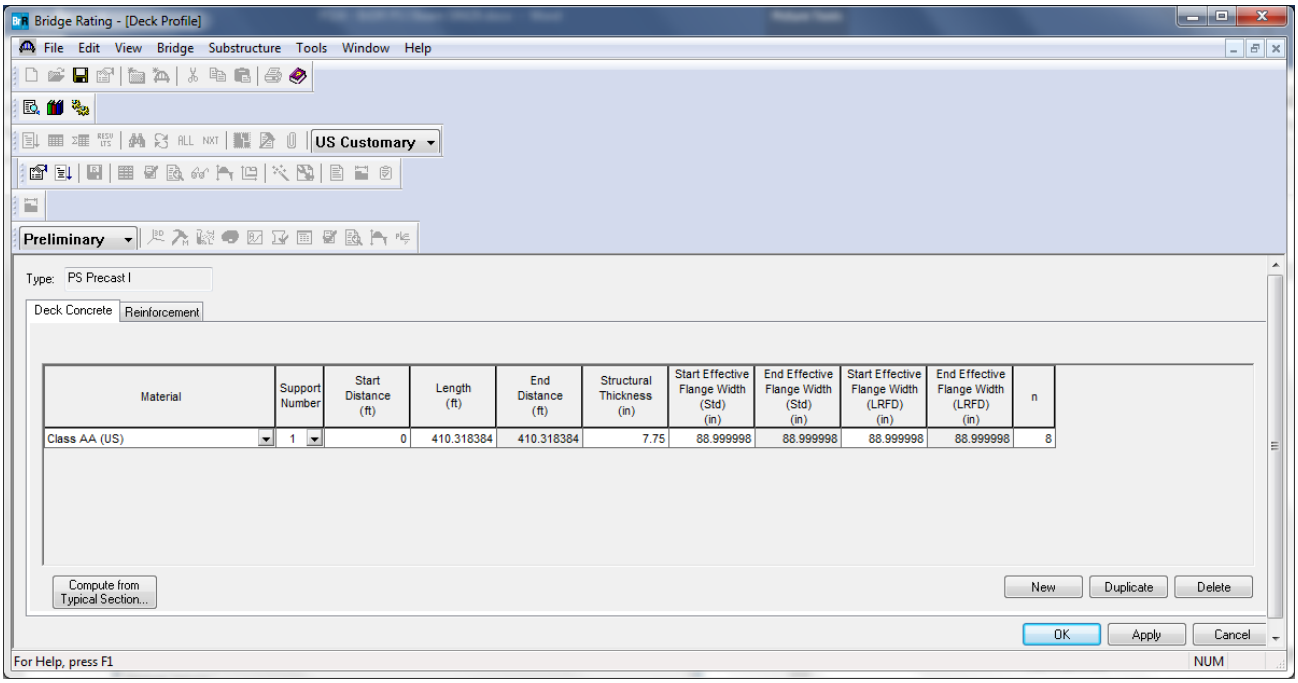

Strand Layout - Span 1
145%
Description Type
P and CGS only
Strands in rows
Strand Configuration Type
Straight/Debonded
Harped
Harped and straight debonded
Symmetry
Mid span
Left end
Right end
Harp Point Locations
Harp Point
Distance (ft)
Radius (in)
Left
54.45459
0
Right
54.45459
0
OK
Apply
Cancel
Number of strands = 36
Number of harped strands = 0
CG of strands (measured from bottom of section) = 4.83 in
Legend:
No strand at this position at the current section location.
No strand at this position at the current location but a strand is harped to this position.
A strand occupies this position at the current section location.
The strand is debonded from the end of the beam to the current section location.
The strand is debonded from the mid-span to the current section location.
The strand is debonded at other section location. Hover over the strand for more information.
The harped position of a harped strand.
The mid-span position of a harped strand.
The mid-span position of one strand and the harped position of another strand.
Mild steel.

Then define the following harped strands at this location.

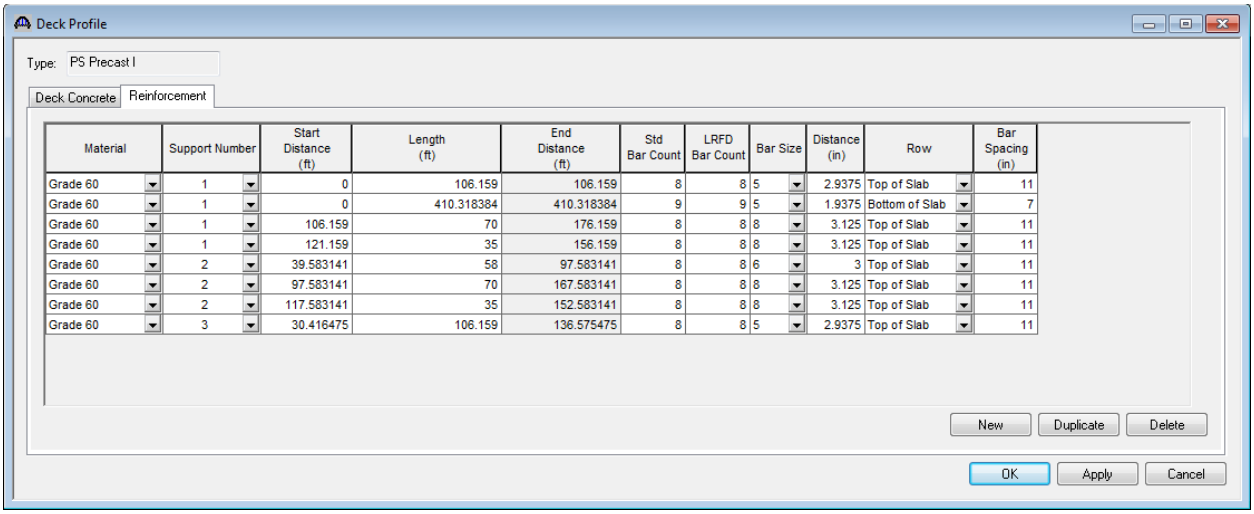


Repeat the process and describe the same strand layout for span 2 and Span 3. Span 2 Harp Point is located at 54.16666 ft and Span 3 Harp Point is located at 54.45460 ft.

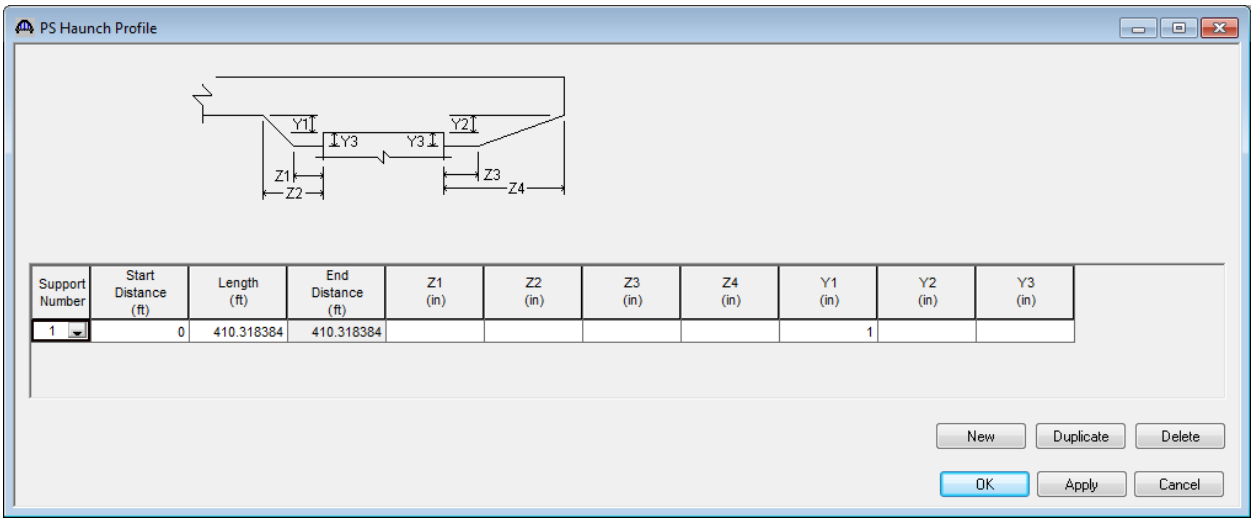
Describe the deck as follows:



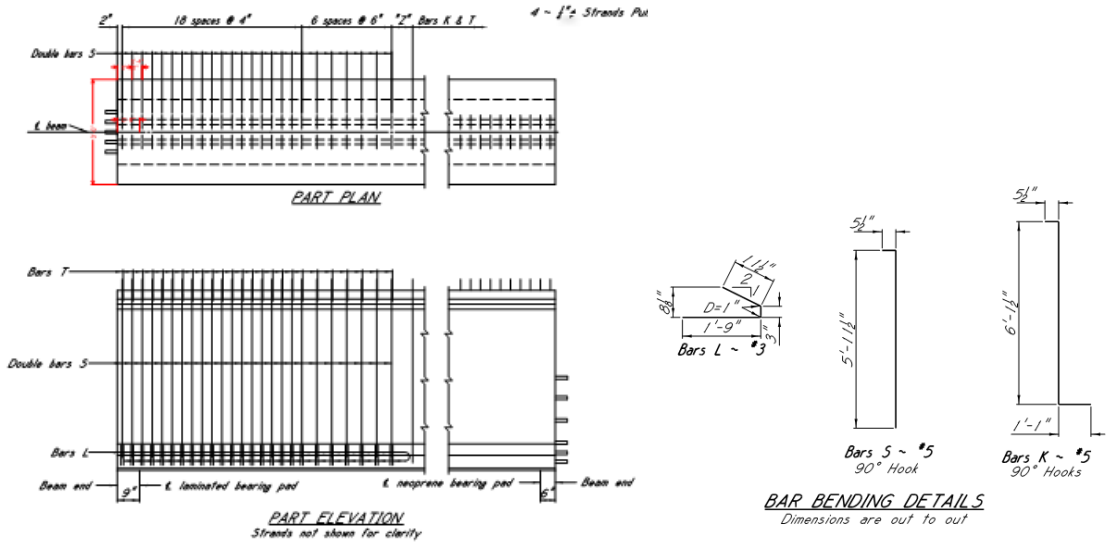
Describe the deck reinforcement as follows:



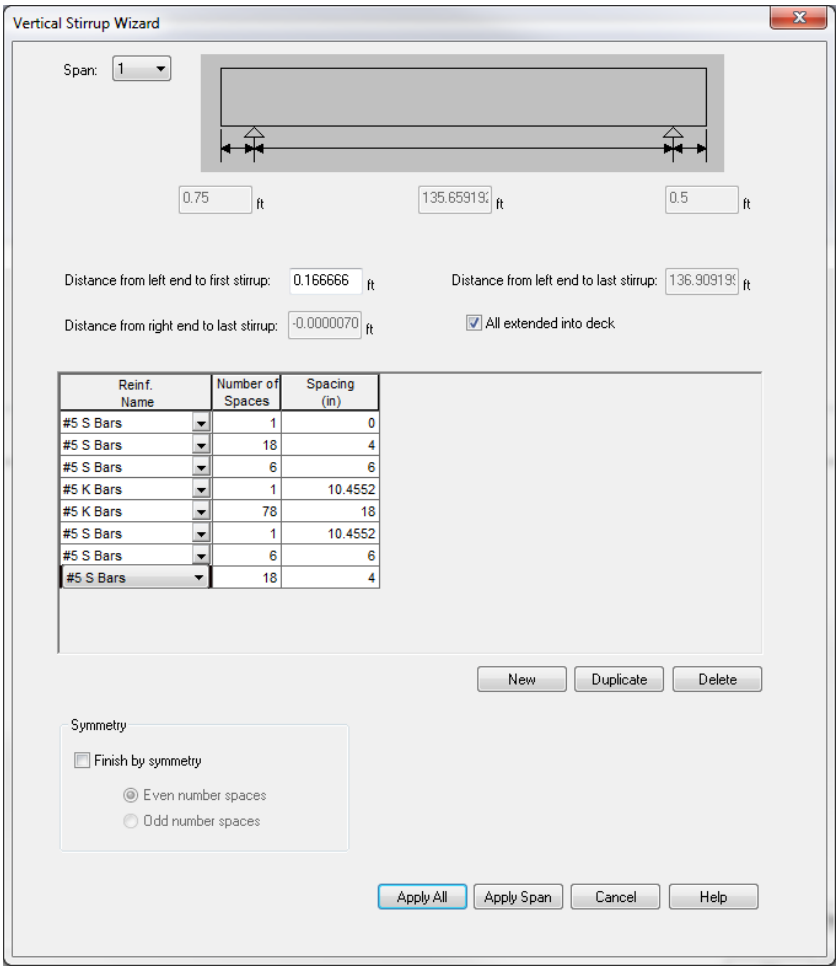
The Haunch Profile is shown below.

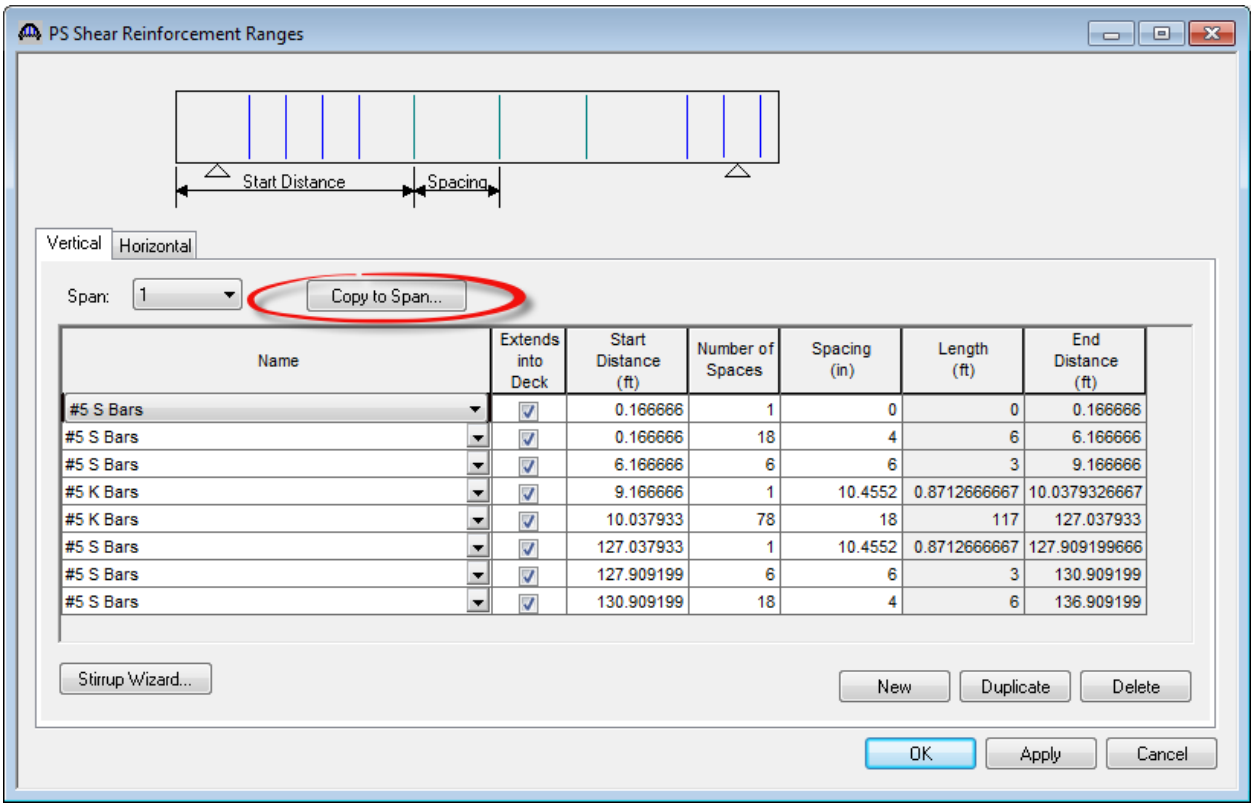


Use the Stirrup Wizard to create the following shear stirrups:

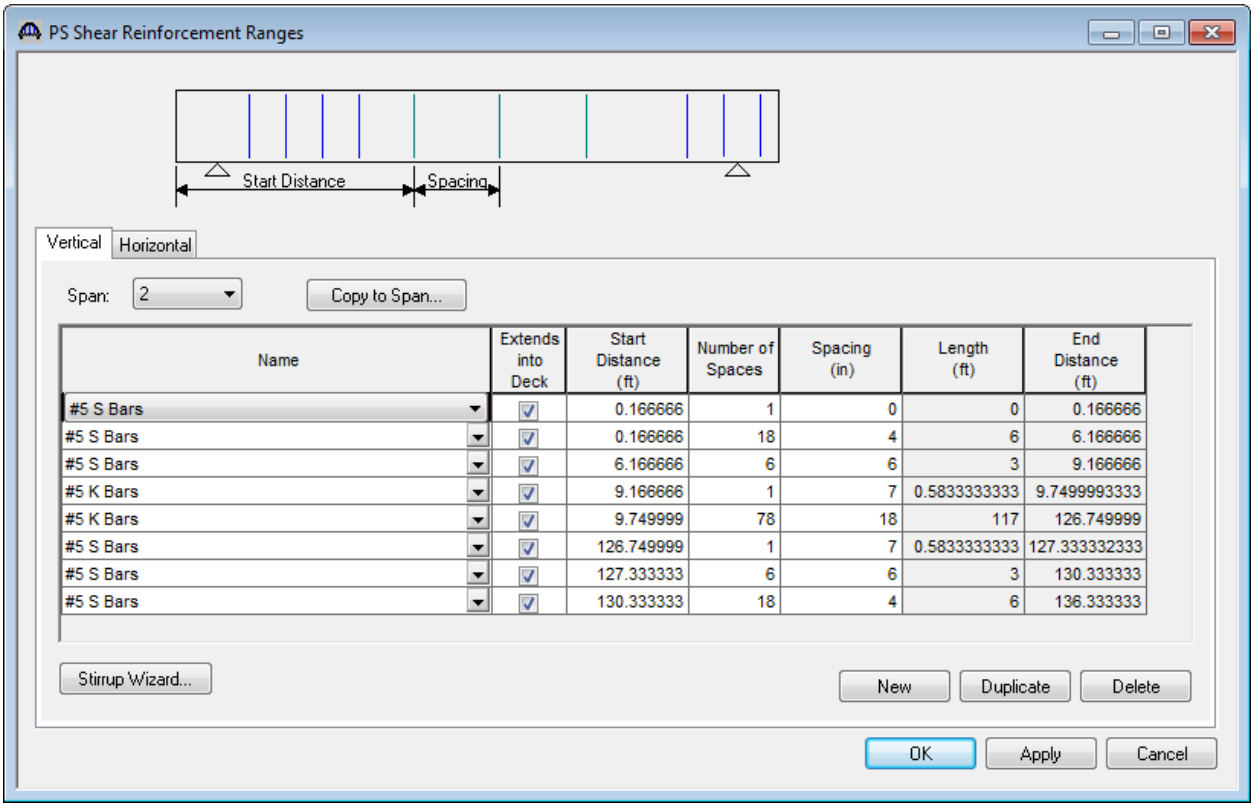


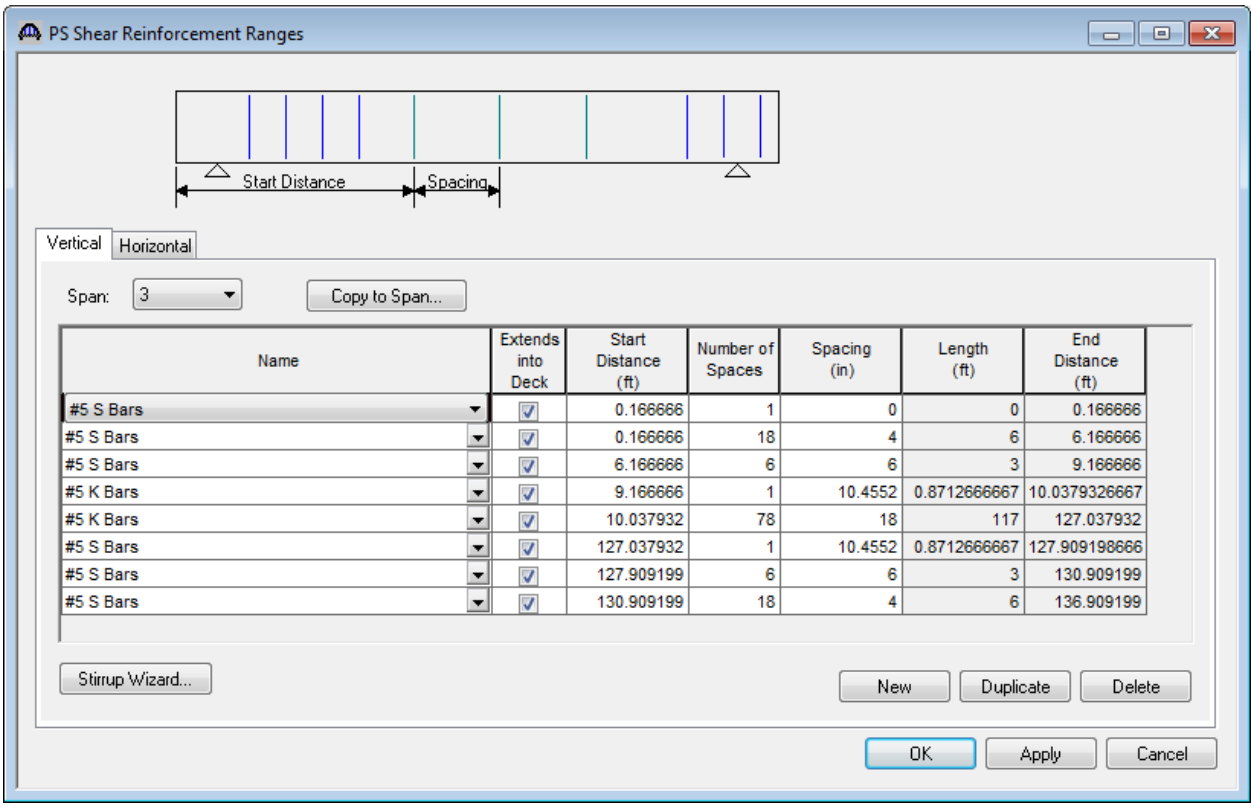
Beam Elevation Showing Stirrups



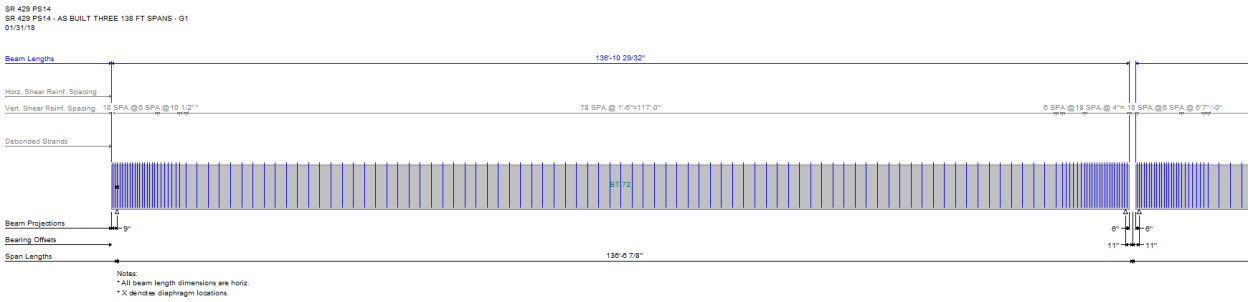


Then use the 'Copy to Span' button to copy the stirrups to Span 2 and Span 3. Update as needed.



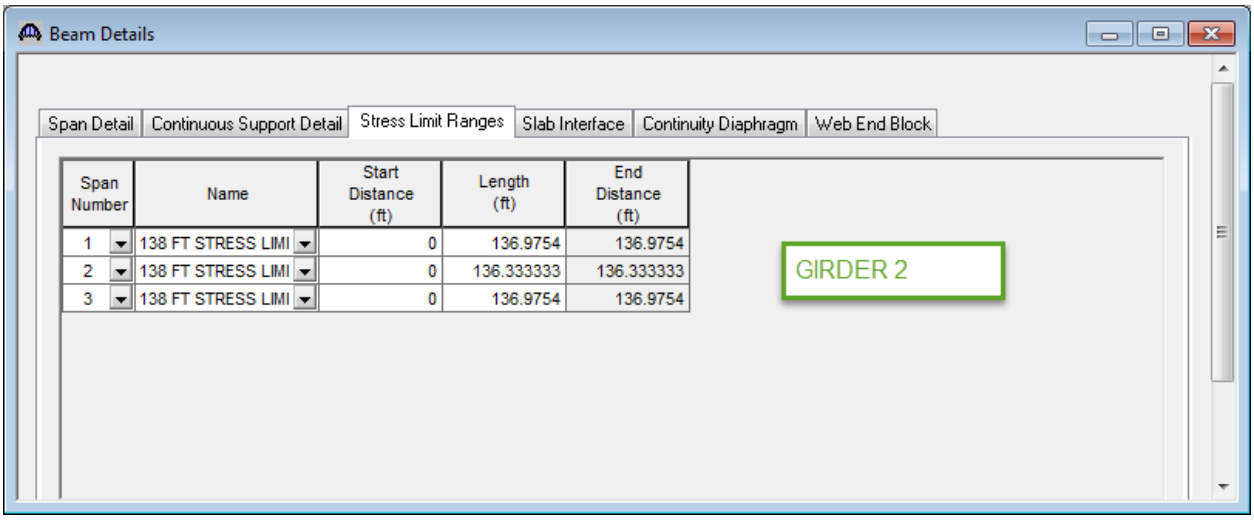


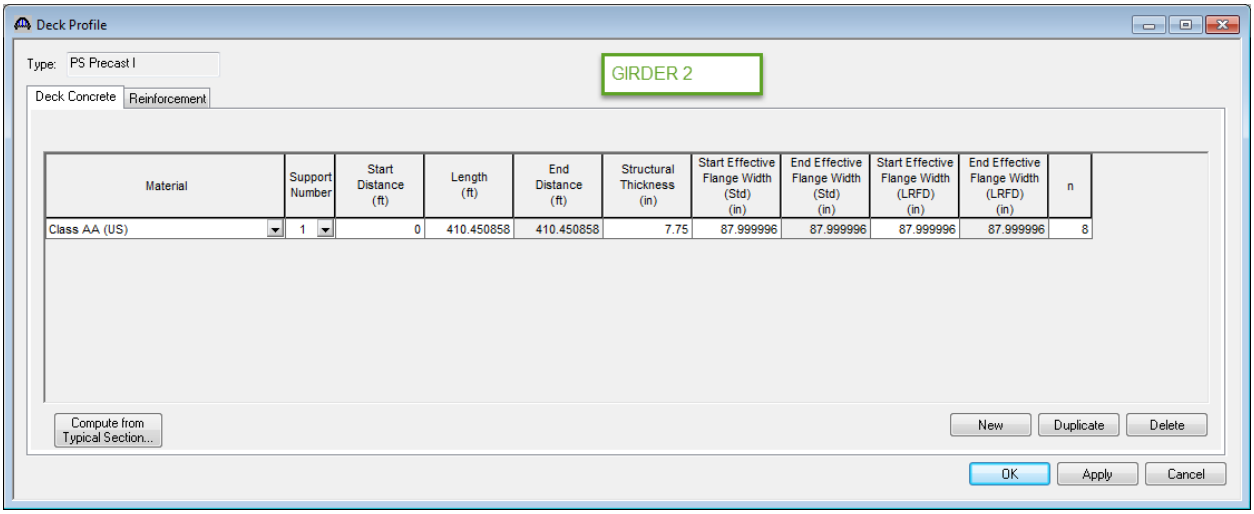
The Member Alternative Schematic is shown below:

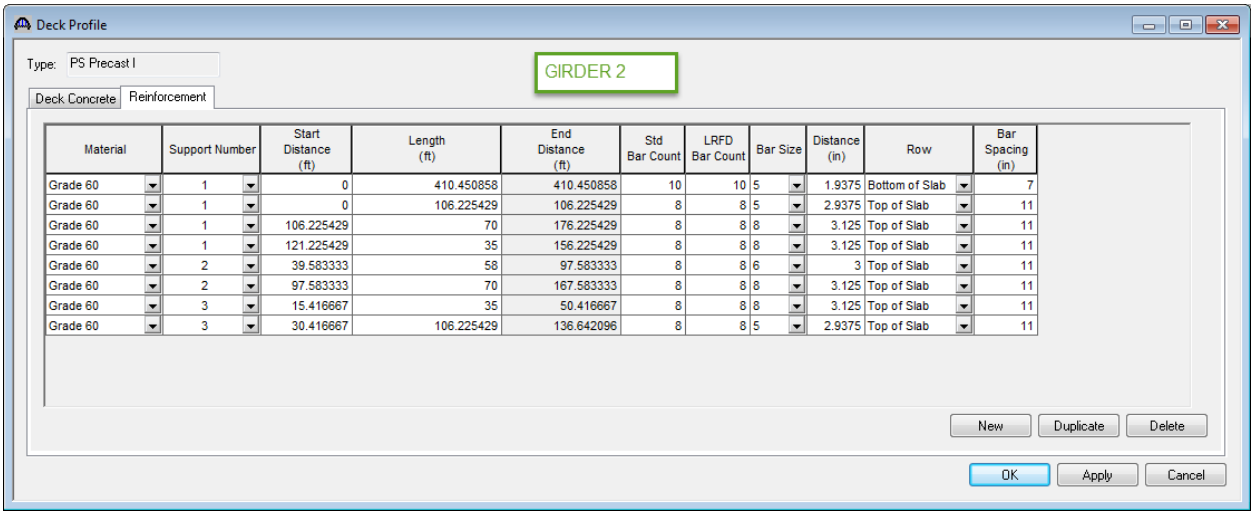


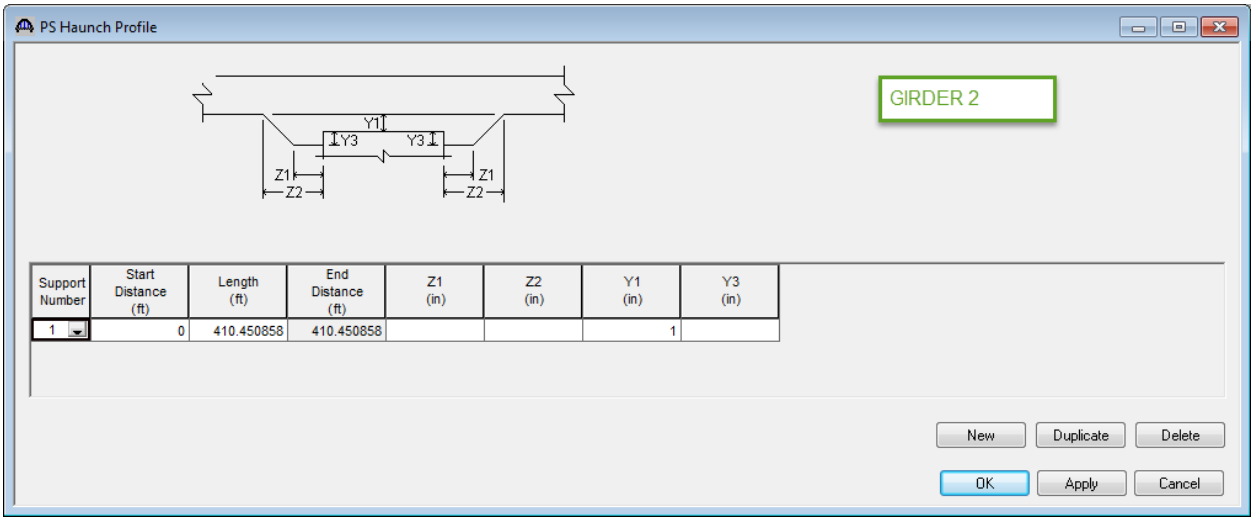
Girder 1 is complete. Girders G2-G5 are similar but the lengths are different.

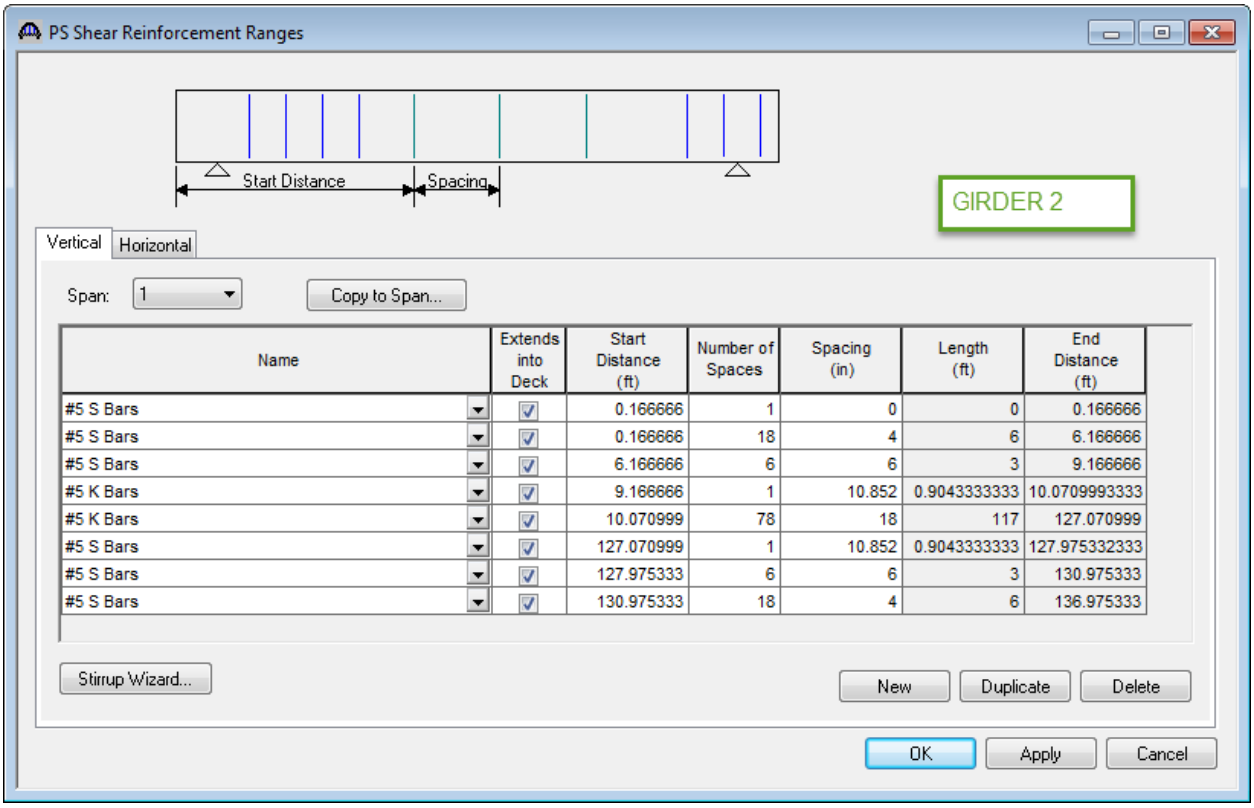
Harp Locations			
Girder	Span 1	Span 2	Span 3
1	54.45460	54.16667	54.45460
2	54.48771	54.16667	54.48771
3	54.52083	54.16667	54.52083
4	54.55395	54.16667	54.55395
5	54.58707	54.16667	54.58707

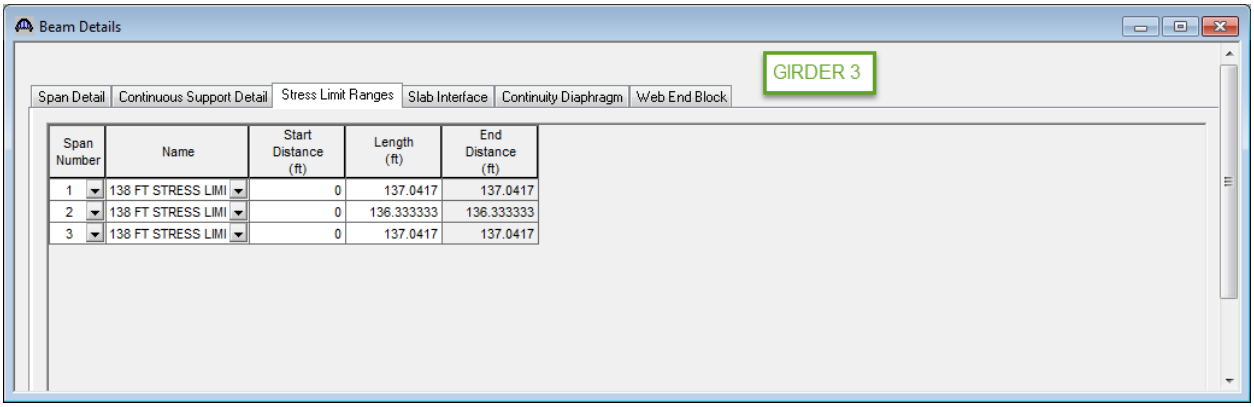

Beam Details
Span Detail
Continuous Support Detail
Stress Limit Ranges
Slab Interface
Continuity Diaphragm
Web End Block
Span Number
Name
Start Distance (ft)
Length (ft)
End Distance (ft)
1 138 FT STRESS LIMI 0 136.9754 136.9754
2 138 FT STRESS LIMI 0 136.333333 136.333333
3 138 FT STRESS LIMI 0 136.9754 136.9754
GIRDER 2

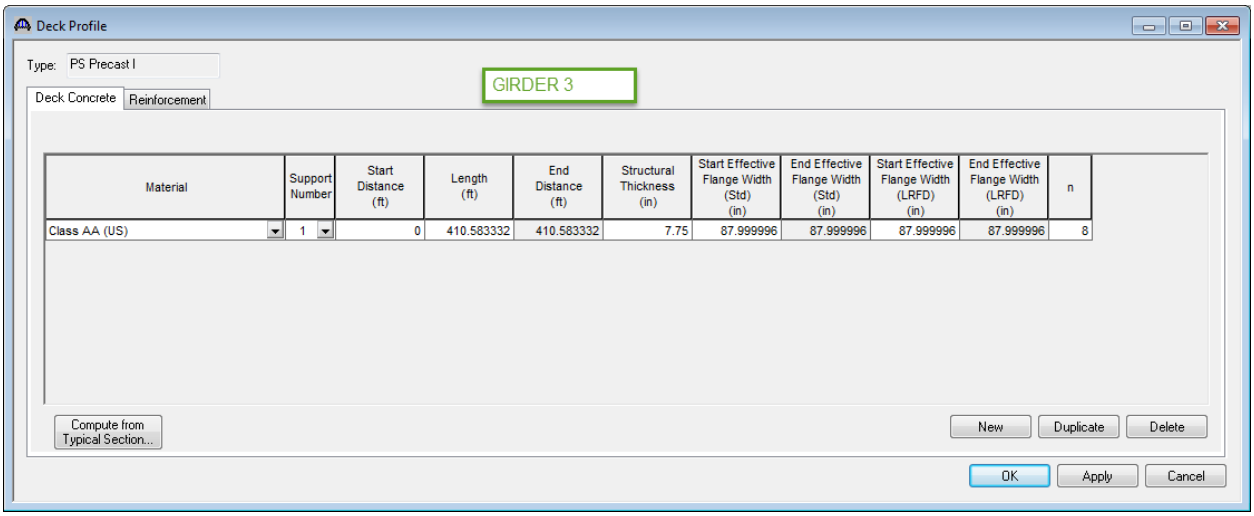

Deck Profile
Type: PS Precast I
GIRDER 2
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Structural Thickness (in)
Start Effective Flange Width (Std) (in)
End Effective Flange Width (Std) (in)
Start Effective Flange Width (LRFD) (in)
End Effective Flange Width (LRFD) (in)
n
Class AA (US) 1 0 410.450858 410.450858 7.75 87.999996 87.999996 87.999996 87.999996 8
Compute from Typical Section...
New
Duplicate
Delete
OK
Apply
Cancel

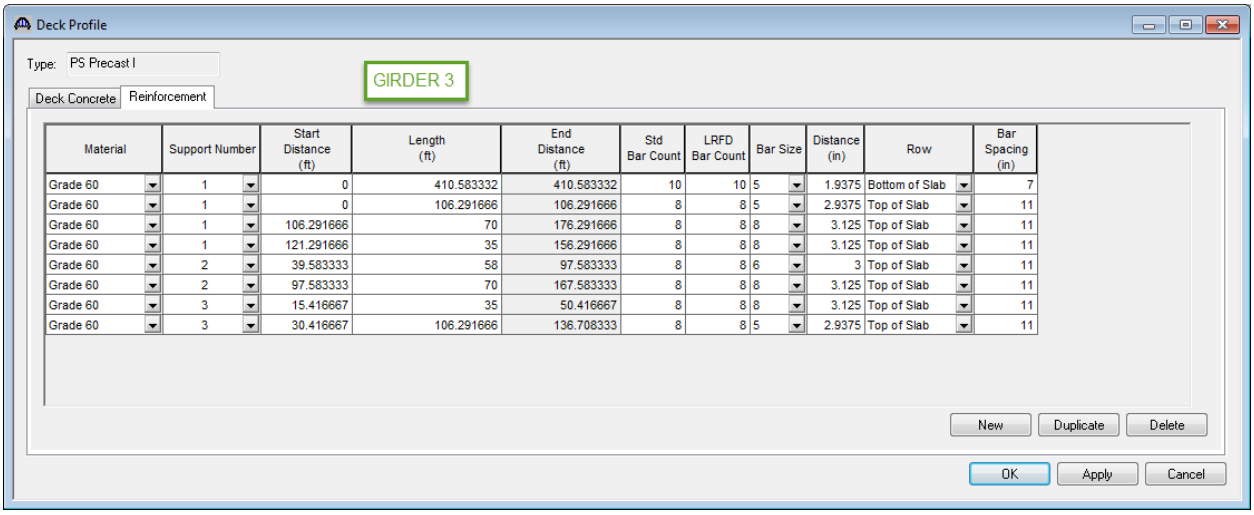

Deck Profile
Type: PS Precast I
GIRDER 2
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Std Bar Count
LRFD Bar Count
Bar Size
Distance (in)
Row
Bar Spacing (in)
Grade 60 1 0 410.450858 410.450858 10 10 5 1.9375 Bottom of Slab 7
Grade 60 1 0 106.225429 106.225429 8 8 5 2.9375 Top of Slab 11
Grade 60 1 106.225429 70 176.225429 8 8 8 3.125 Top of Slab 11
Grade 60 1 121.225429 35 156.225429 8 8 8 3.125 Top of Slab 11
Grade 60 2 39.583333 58 97.583333 8 8 6 3 Top of Slab 11
Grade 60 2 97.583333 70 167.583333 8 8 8 3.125 Top of Slab 11
Grade 60 3 15.416667 35 50.416667 8 8 8 3.125 Top of Slab 11
Grade 60 3 30.416667 106.225429 136.642096 8 8 5 2.9375 Top of Slab 11
New
Duplicate
Delete
OK
Apply
Cancel

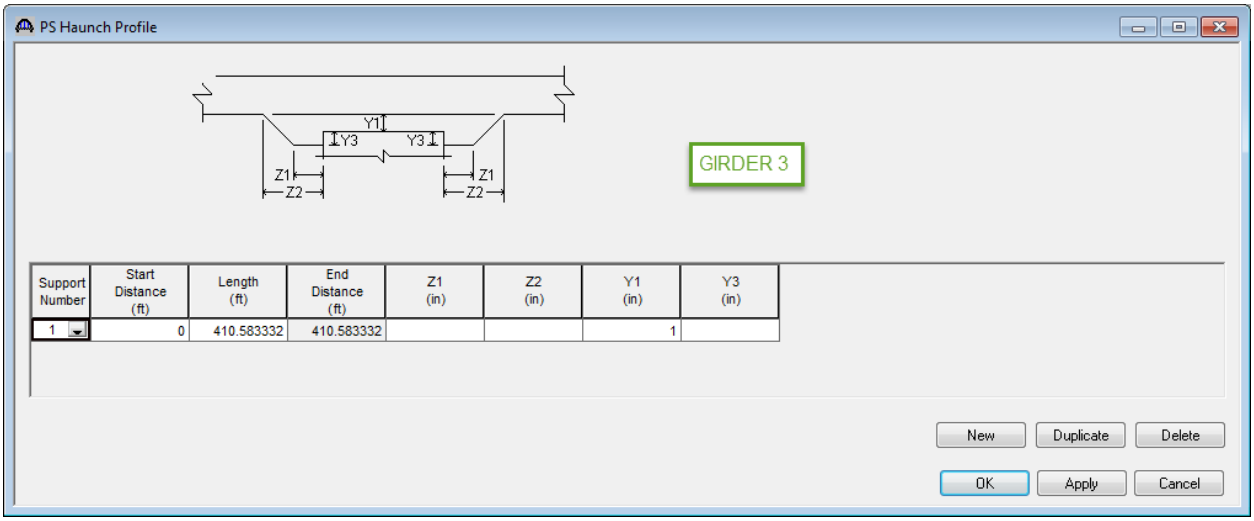

PS Haunch Profile
Y1
Y3
Y3
Z1
Z2
Z1
Z2
GIRDER 2
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Z1 (in)
Z2 (in)
Y1 (in)
Y3 (in)
1
0
410.450858
410.450858
1
New
Duplicate
Delete
OK
Apply
Cancel

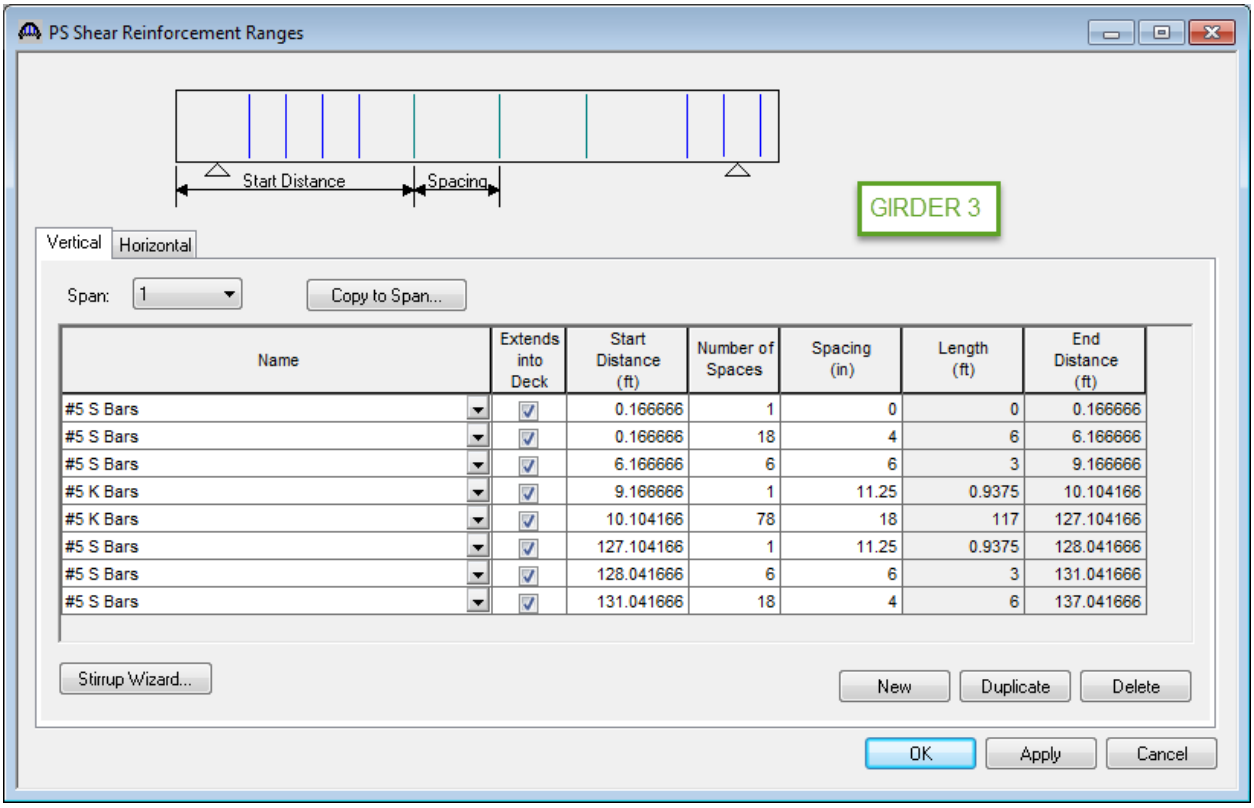

PS Shear Reinforcement Ranges
Start Distance
Spacing
GIRDER 2
Vertical
Horizontal
Span:
1
Copy to Span...
Name
Extends into Deck
Start Distance (ft)
Number of Spaces
Spacing (in)
Length (ft)
End Distance (ft)
#5 S Bars 0.166666 1 0 0 0.166666
#5 S Bars 0.166666 18 4 6 6.166666
#5 S Bars 6.166666 6 6 3 9.166666
#5 K Bars 9.166666 1 10.852 0.9043333333 10.0709993333
#5 K Bars 10.070999 78 18 117 127.070999
#5 S Bars 127.070999 1 10.852 0.9043333333 127.975332333
#5 S Bars 127.975333 6 6 3 130.975333
#5 S Bars 130.975333 18 4 6 136.975333
Stirrup Wizard...
New
Duplicate
Delete
OK
Apply
Cancel

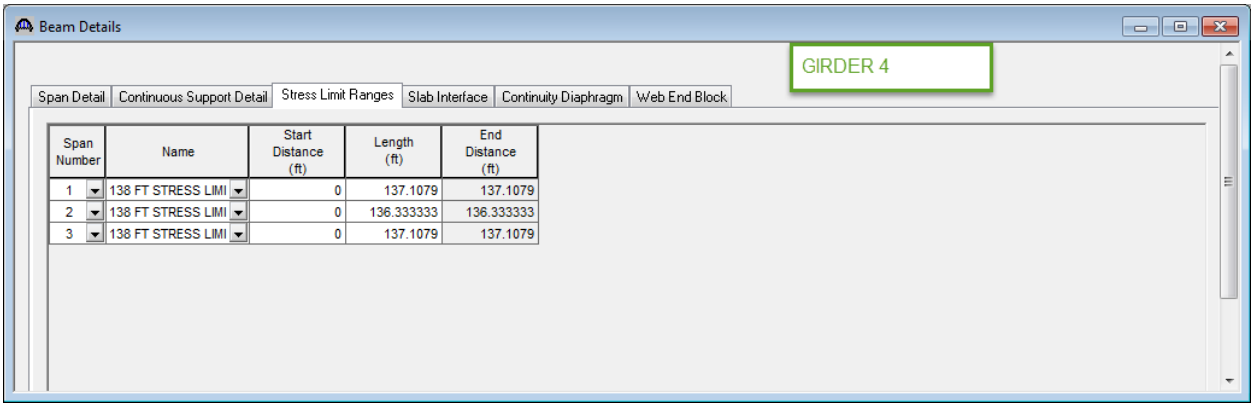

Beam Details
GIRDER 3
Span Detail
Continuous Support Detail
Stress Limit Ranges
Slab Interface
Continuity Diaphragm
Web End Block
Span Number
Name
Start Distance (ft)
Length (ft)
End Distance (ft)
1 138 FT STRESS LIMI 0 137.0417 137.0417
2 138 FT STRESS LIMI 0 136.333333 136.333333
3 138 FT STRESS LIMI 0 137.0417 137.0417

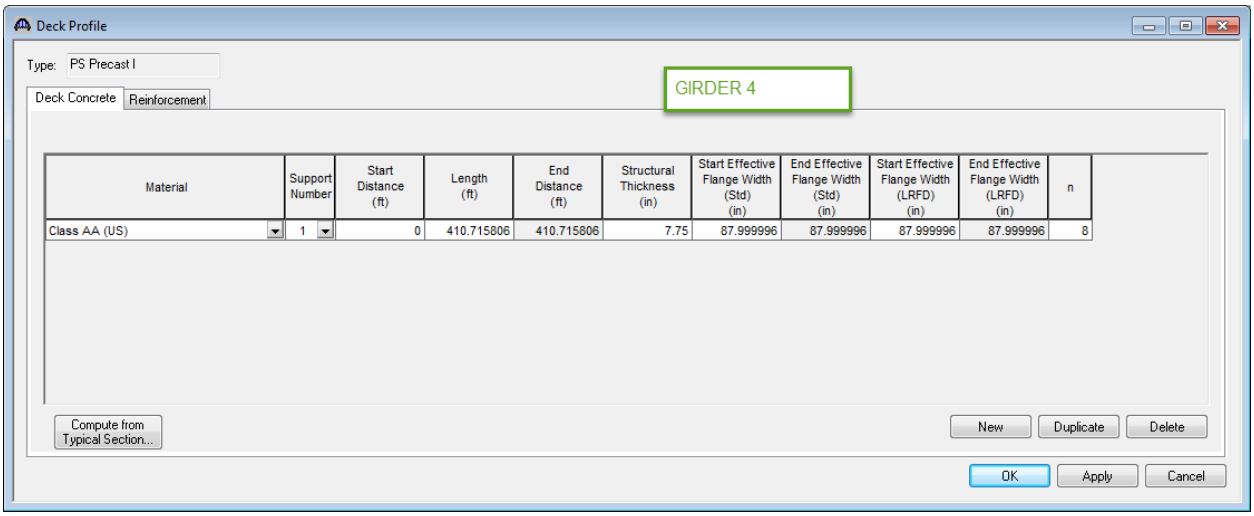

Deck Profile
Type: PS Precast I
GIRDER 3
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Structural Thickness (in)
Start Effective Flange Width (Std) (in)
End Effective Flange Width (Std) (in)
Start Effective Flange Width (LRFD) (in)
End Effective Flange Width (LRFD) (in)
n
Class AA (US) 1 0 410.583332 410.583332 7.75 87.999996 87.999996 87.999996 87.999996 8
Compute from Typical Section...
New
Duplicate
Delete
OK
Apply
Cancel

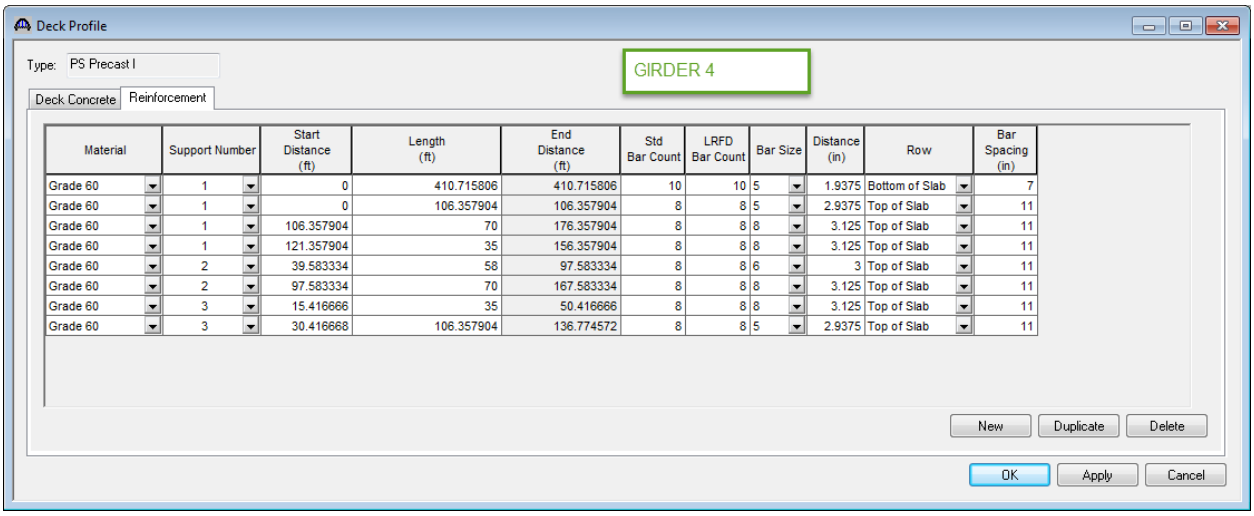

Deck Profile
Type: PS Precast I
GIRDER 3
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Std Bar Count
LRFD Bar Count
Bar Size
Distance (in)
Row
Bar Spacing (in)
Grade 60 1 0 410.583332 410.583332 10 10 5 1.9375 Bottom of Slab 7
Grade 60 1 0 106.291666 106.291666 8 8 5 2.9375 Top of Slab 11
Grade 60 1 106.291666 70 176.291666 8 8 8 3.125 Top of Slab 11
Grade 60 1 121.291666 35 156.291666 8 8 8 3.125 Top of Slab 11
Grade 60 2 39.583333 58 97.583333 8 8 6 3 Top of Slab 11
Grade 60 2 97.583333 70 167.583333 8 8 8 3.125 Top of Slab 11
Grade 60 3 15.416667 35 50.416667 8 8 8 3.125 Top of Slab 11
Grade 60 3 30.416667 106.291666 136.708333 8 8 5 2.9375 Top of Slab 11
New
Duplicate
Delete
OK
Apply
Cancel

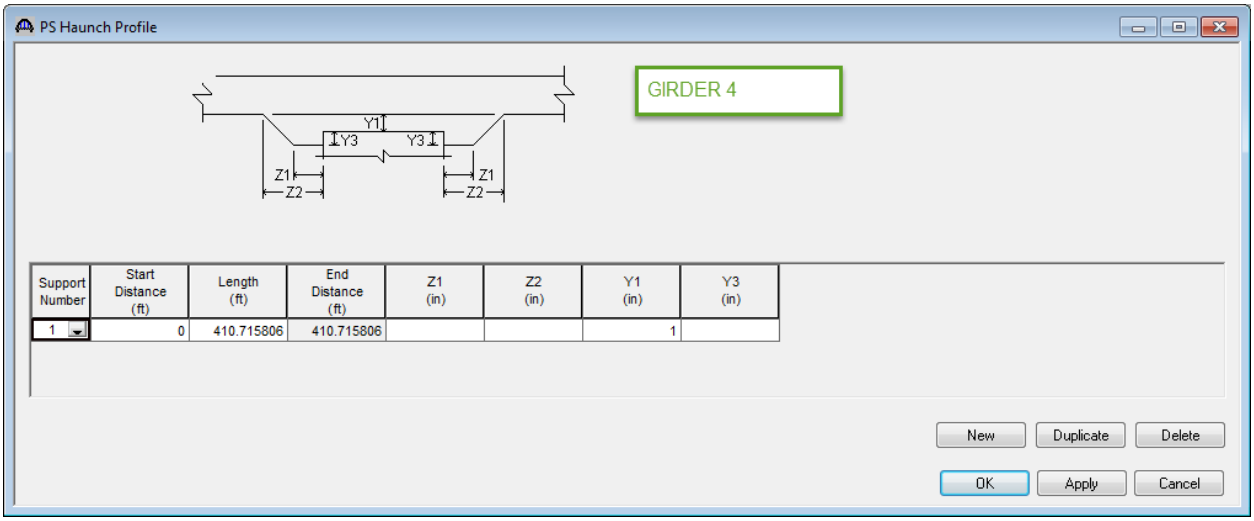

PS Haunch Profile
Y1
Y3
Y3
Z1
Z2
Z1
Z2
GIRDER 3
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Z1 (in)
Z2 (in)
Y1 (in)
Y3 (in)
1
0
410.583332
410.583332
1
New
Duplicate
Delete
OK
Apply
Cancel

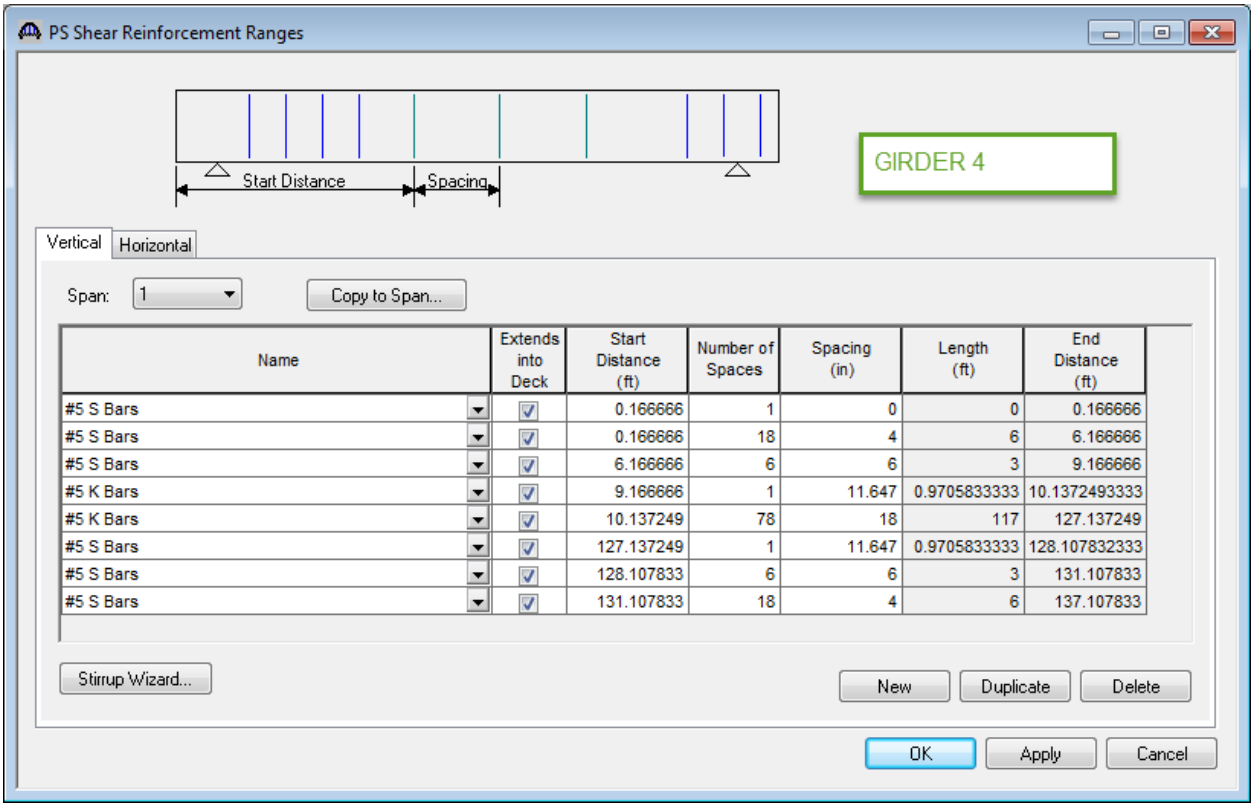

PS Shear Reinforcement Ranges
Start Distance
Spacing
GIRDER 3
Vertical
Horizontal
Span:
1
Copy to Span...
Name
Extends into Deck
Start Distance (ft)
Number of Spaces
Spacing (in)
Length (ft)
End Distance (ft)
#5 S Bars 0.166666 1 0 0 0.166666
#5 S Bars 0.166666 18 4 6 6.166666
#5 S Bars 6.166666 6 6 3 9.166666
#5 K Bars 9.166666 1 11.25 0.9375 10.104166
#5 K Bars 10.104166 78 18 117 127.104166
#5 S Bars 127.104166 1 11.25 0.9375 128.041666
#5 S Bars 128.041666 6 6 3 131.041666
#5 S Bars 131.041666 18 4 6 137.041666
Stirrup Wizard...
New
Duplicate
Delete
OK
Apply
Cancel

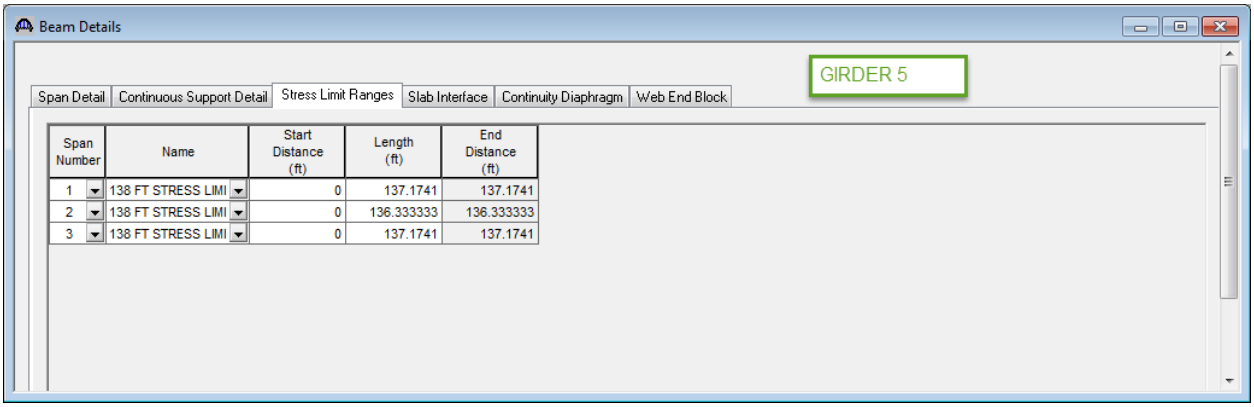

Beam Details
GIRDER 4
Span Detail
Continuous Support Detail
Stress Limit Ranges
Slab Interface
Continuity Diaphragm
Web End Block
Span Number
Name
Start Distance (ft)
Length (ft)
End Distance (ft)
1 138 FT STRESS LIMI 0 137.1079 137.1079
2 138 FT STRESS LIMI 0 136.333333 136.333333
3 138 FT STRESS LIMI 0 137.1079 137.1079

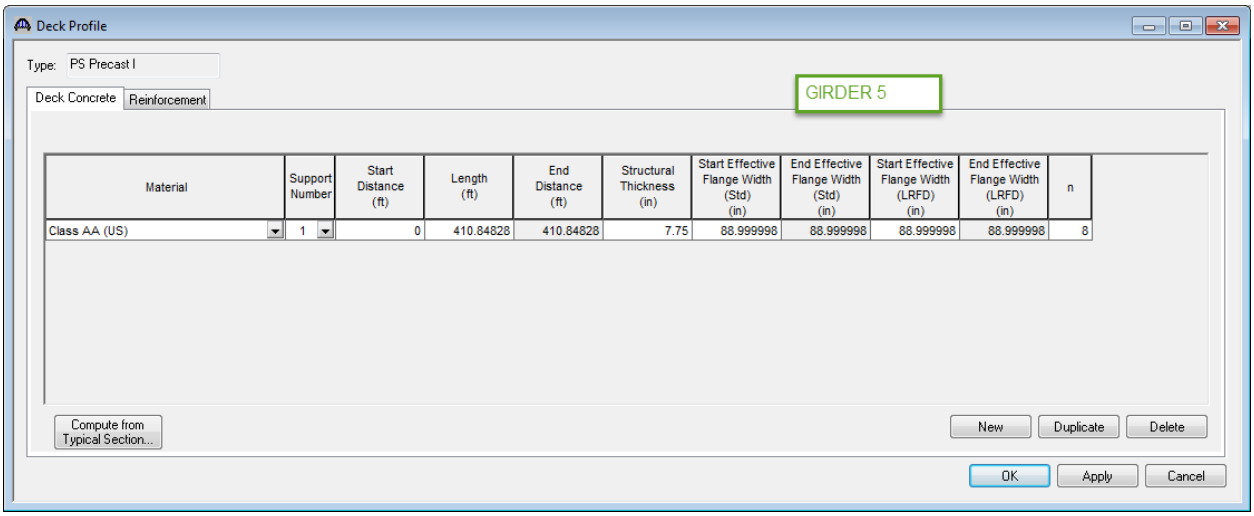

Deck Profile
Type: PS Precast I
GIRDER 4
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Structural Thickness (in)
Start Effective Flange Width (Std) (in)
End Effective Flange Width (Std) (in)
Start Effective Flange Width (LRFD) (in)
End Effective Flange Width (LRFD) (in)
n
Class AA (US) 1 0 410.715806 410.715806 7.75 87.999996 87.999996 87.999996 87.999996 8
Compute from Typical Section...
New
Duplicate
Delete
OK
Apply
Cancel

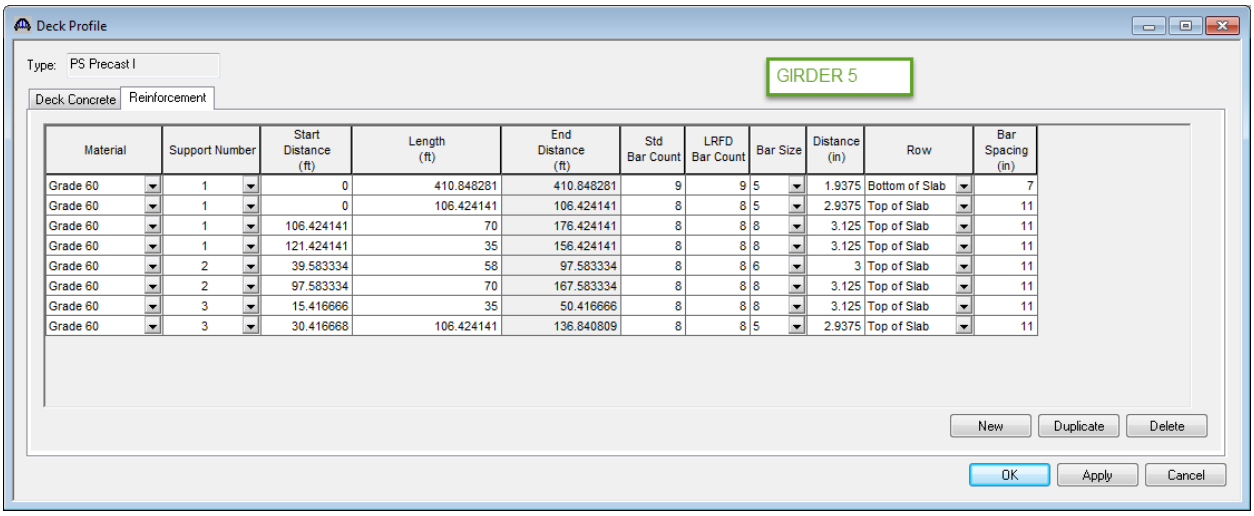

Deck Profile
Type: PS Precast I
GIRDER 4
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Std Bar Count
LRFD Bar Count
Bar Size
Distance (in)
Row
Bar Spacing (in)
Grade 60 1 0 410.715806 410.715806 10 10 5 1.9375 Bottom of Slab 7
Grade 60 1 0 106.357904 106.357904 8 8 5 2.9375 Top of Slab 11
Grade 60 1 106.357904 70 176.357904 8 8 8 3.125 Top of Slab 11
Grade 60 1 121.357904 35 156.357904 8 8 8 3.125 Top of Slab 11
Grade 60 2 39.583334 58 97.583334 8 8 6 3 Top of Slab 11
Grade 60 2 97.583334 70 167.583334 8 8 8 3.125 Top of Slab 11
Grade 60 3 15.416666 35 50.416666 8 8 8 3.125 Top of Slab 11
Grade 60 3 30.416668 106.357904 136.774572 8 8 5 2.9375 Top of Slab 11
New
Duplicate
Delete
OK
Apply
Cancel

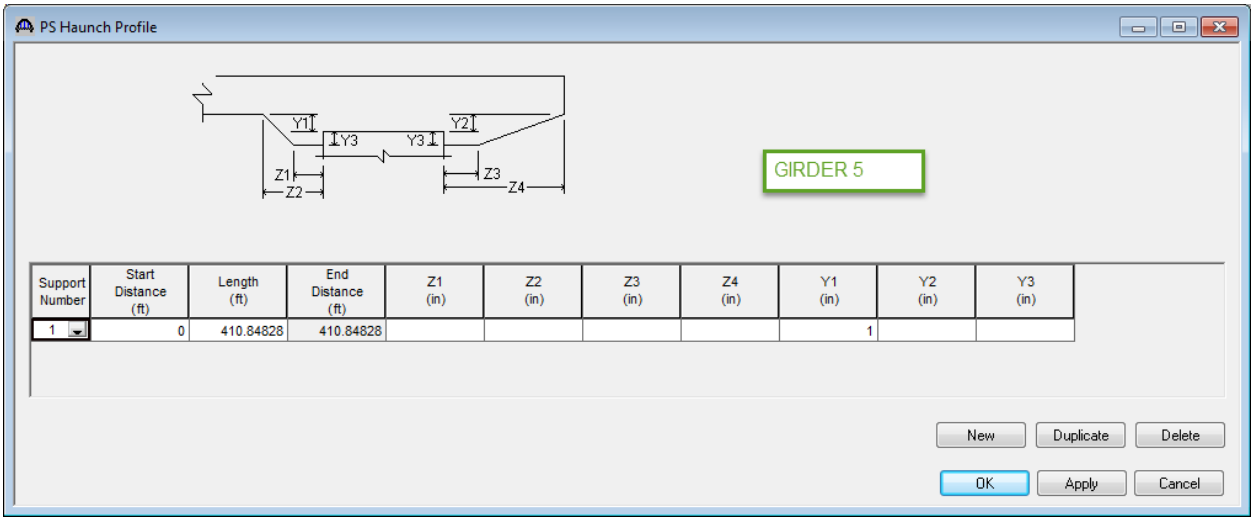

PS Haunch Profile
GIRDER 4
Y1
Y3
Y3
Z1
Z2
Z1
Z2
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Z1 (in)
Z2 (in)
Y1 (in)
Y3 (in)
1
0
410.715806
410.715806
1
New
Duplicate
Delete
OK
Apply
Cancel

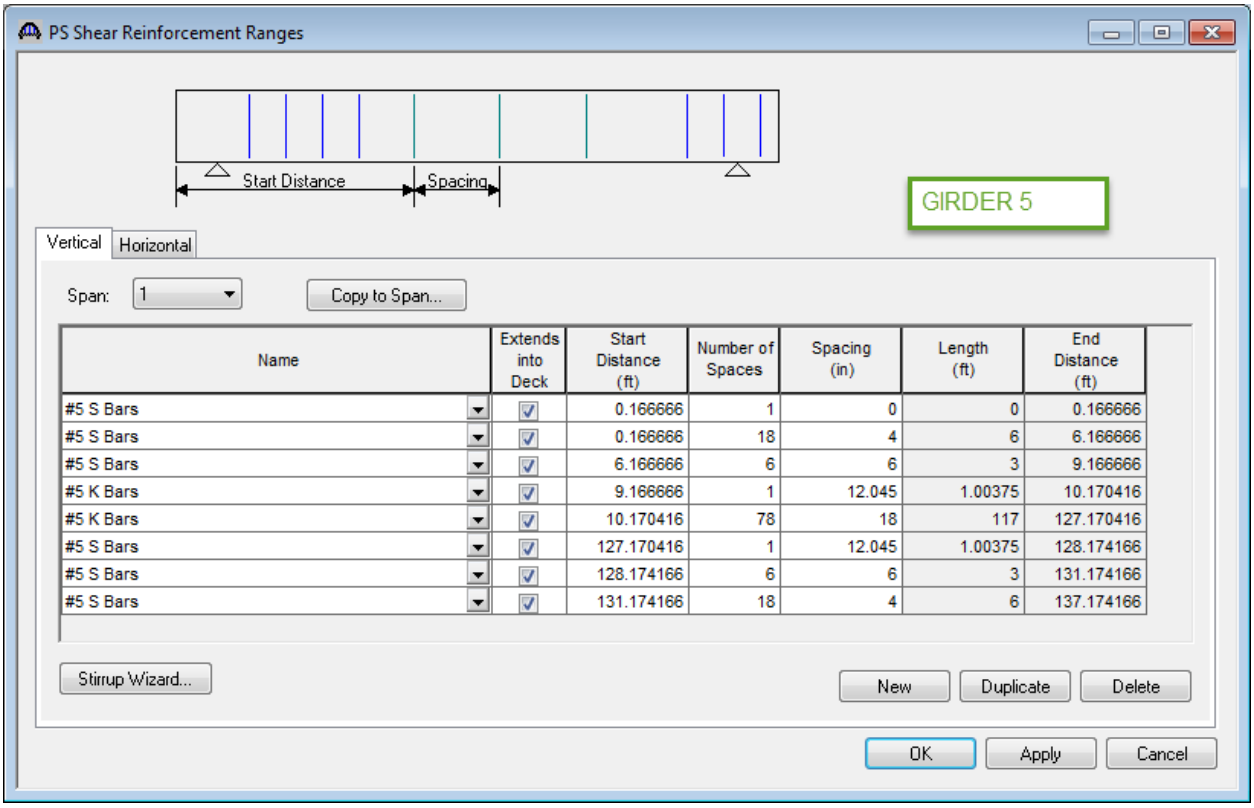

PS Shear Reinforcement Ranges
Start Distance
Spacing
GIRDER 4
Vertical
Horizontal
Span:
1
Copy to Span...
Name
Extends into Deck
Start Distance (ft)
Number of Spaces
Spacing (in)
Length (ft)
End Distance (ft)
#5 S Bars 0.166666 1 0 0 0.166666
#5 S Bars 0.166666 18 4 6 6.166666
#5 S Bars 6.166666 6 6 3 9.166666
#5 K Bars 9.166666 1 11.647 0.9705833333 10.1372493333
#5 K Bars 10.137249 78 18 117 127.137249
#5 S Bars 127.137249 1 11.647 0.9705833333 128.107832333
#5 S Bars 128.107833 6 6 3 131.107833
#5 S Bars 131.107833 18 4 6 137.107833
Stirrup Wizard...
New
Duplicate
Delete
OK
Apply
Cancel


Beam Details
GIRDER 5
Span Detail
Continuous Support Detail
Stress Limit Ranges
Slab Interface
Continuity Diaphragm
Web End Block
Span Number
Name
Start Distance (ft)
Length (ft)
End Distance (ft)
1 138 FT STRESS LIMI 0 137.1741 137.1741
2 138 FT STRESS LIMI 0 136.333333 136.333333
3 138 FT STRESS LIMI 0 137.1741 137.1741

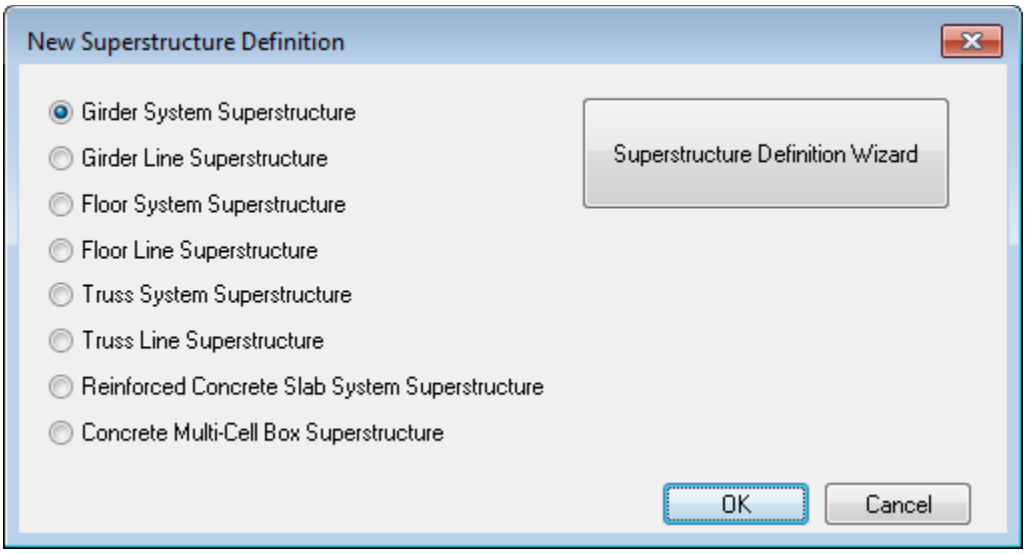

Deck Profile
Type: PS Precast I
GIRDER 5
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Structural Thickness (in)
Start Effective Flange Width (Std) (in)
End Effective Flange Width (Std) (in)
Start Effective Flange Width (LRFD) (in)
End Effective Flange Width (LRFD) (in)
n
Class AA (US) 1 0 410.84828 410.84828 7.75 88.999998 88.999998 88.999998 88.999998 8
Compute from Typical Section...
New
Duplicate
Delete
OK
Apply
Cancel


Deck Profile
Type: PS Precast I
GIRDER 5
Deck Concrete
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 0 410.848281 410.848281 9 9 5 1.9375 Bottom of Slab 7
Grade 60 1 0 106.424141 106.424141 8 8 5 2.9375 Top of Slab 11
Grade 60 1 106.424141 70 176.424141 8 8 8 3.125 Top of Slab 11
Grade 60 1 121.424141 35 156.424141 8 8 8 3.125 Top of Slab 11
Grade 60 2 39.583334 58 97.583334 8 8 6 3 Top of Slab 11
Grade 60 2 97.583334 70 167.583334 8 8 8 3.125 Top of Slab 11
Grade 60 3 15.416666 35 50.416666 8 8 8 3.125 Top of Slab 11
Grade 60 3 30.416668 106.424141 136.840809 8 8 5 2.9375 Top of Slab 11
New
Duplicate
Delete
OK
Apply
Cancel

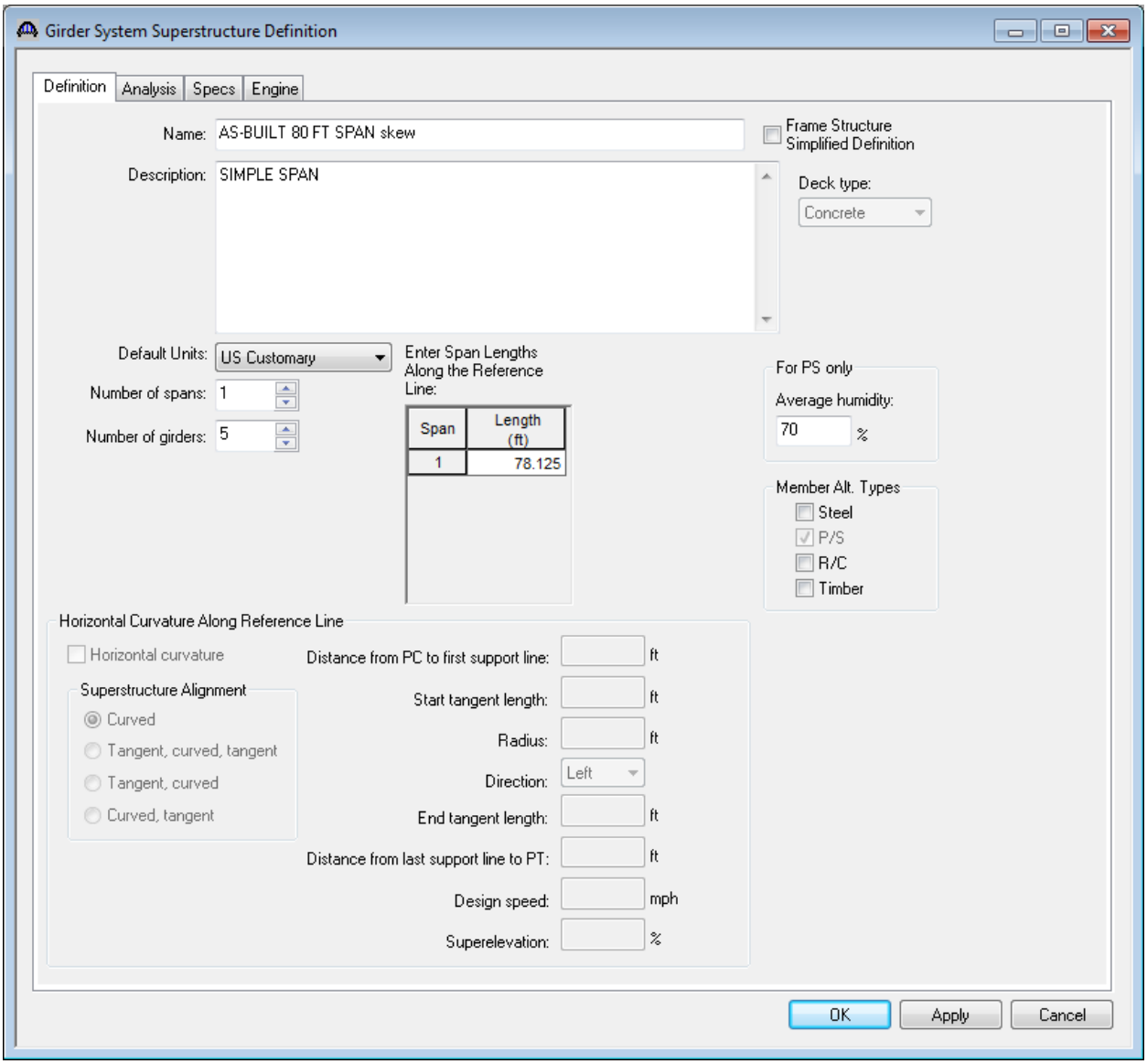

PS Haunch Profile
Y1
Y2
Y3
Y3
Z1
Z2
Z3
Z4
GIRDER 5
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Z1 (in)
Z2 (in)
Z3 (in)
Z4 (in)
Y1 (in)
Y2 (in)
Y3 (in)
1
0
410.84828
410.84828
1
New
Duplicate
Delete
OK
Apply
Cancel


PS Shear Reinforcement Ranges
Start Distance
Spacing
GIRDER 5
Vertical
Horizontal
Span:
1
Copy to Span...
Name
Extends into Deck
Start Distance (ft)
Number of Spaces
Spacing (in)
Length (ft)
End Distance (ft)
#5 S Bars 0.166666 1 0 0 0.166666
#5 S Bars 0.166666 18 4 6 6.166666
#5 S Bars 6.166666 6 6 3 9.166666
#5 K Bars 9.166666 1 12.045 1.00375 10.170416
#5 K Bars 10.170416 78 18 117 127.170416
#5 S Bars 127.170416 1 12.045 1.00375 128.174166
#5 S Bars 128.174166 6 6 3 131.174166
#5 S Bars 131.174166 18 4 6 137.174166
Stirrup Wizard...
New
Duplicate
Delete
OK
Apply
Cancel

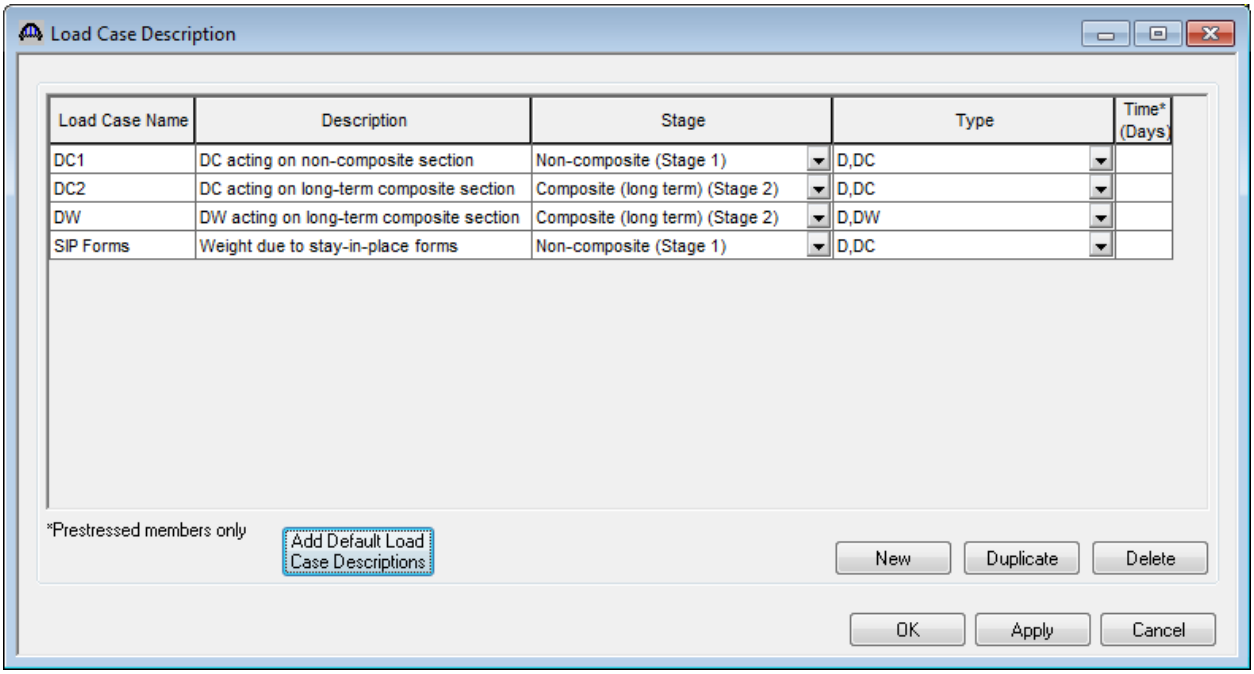
Double-click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and select File | New from the menu or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the popup menu) to create a new superstructure definition for the 80 ft span. The following dialog will open.



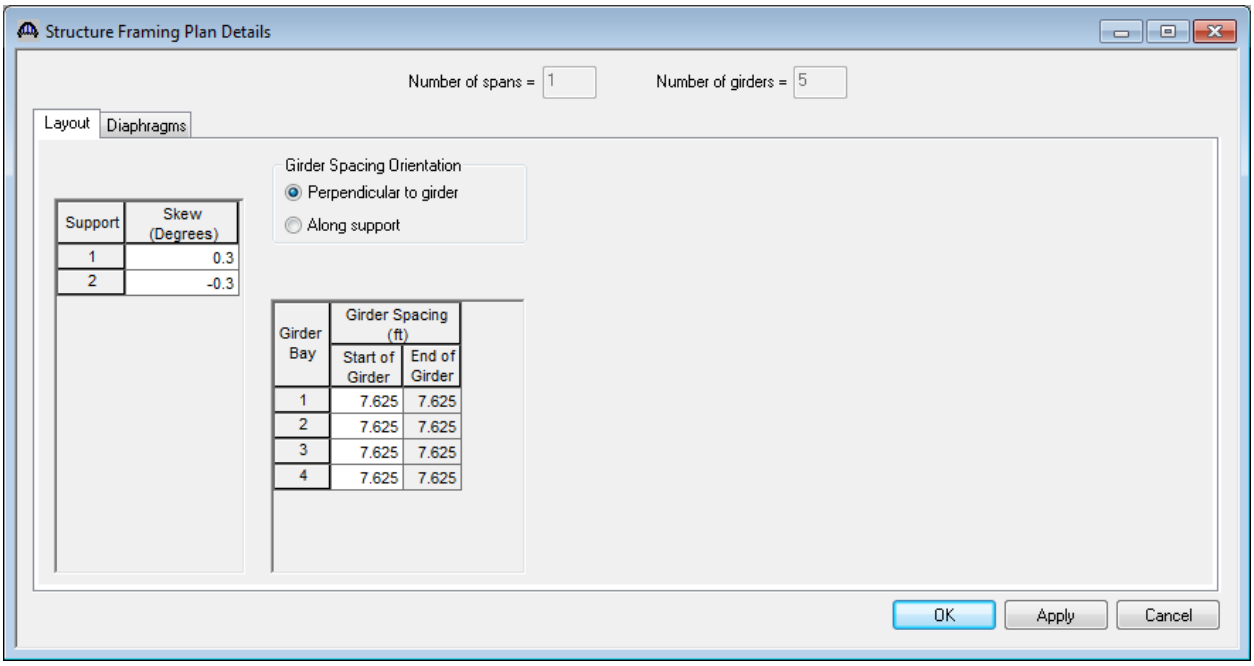
Select Girder System and the Structure Definition window will open. Enter the appropriate data as shown below:



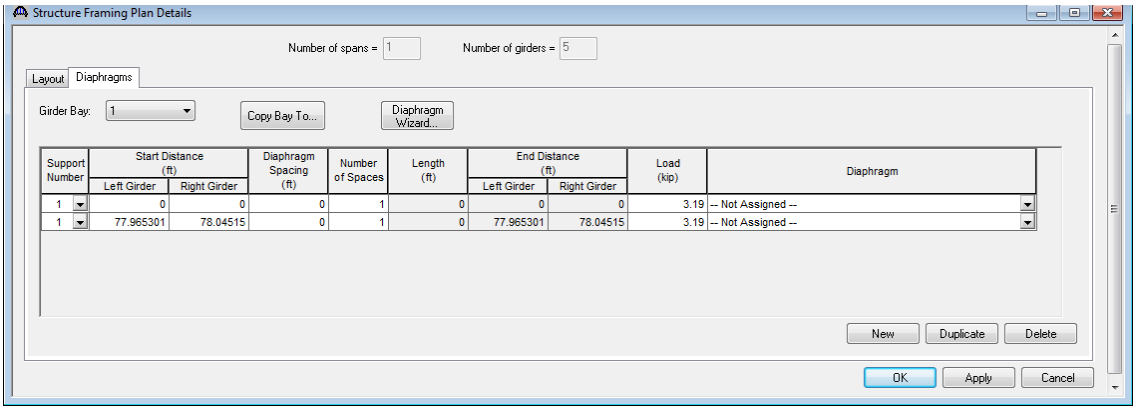
Click Load Case Description to define the dead load cases. Use the "Add Default…" button to create the following load cases.

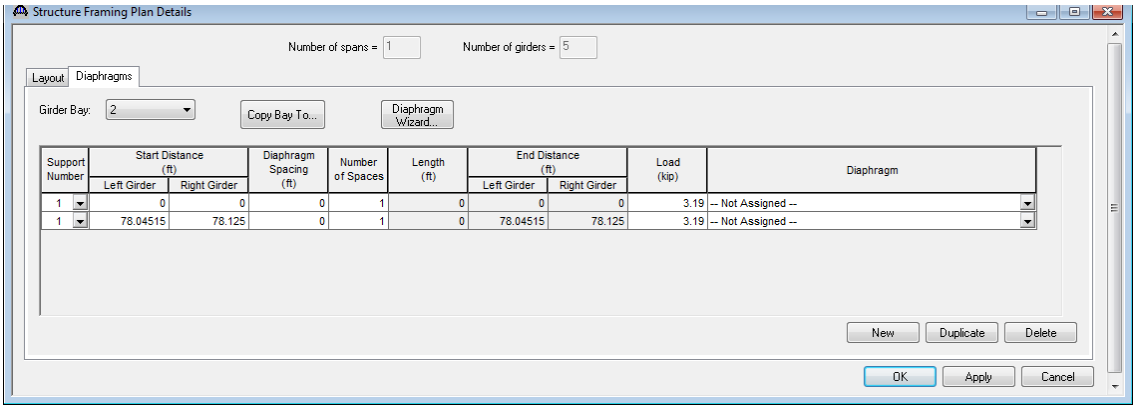


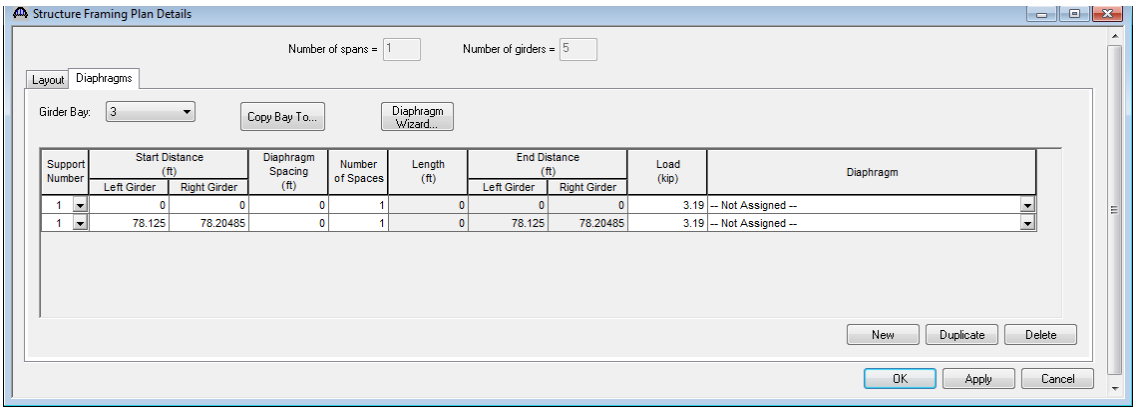
Double-click on Framing Plan Detail to describe the framing plan. Enter the appropriate data as shown below.

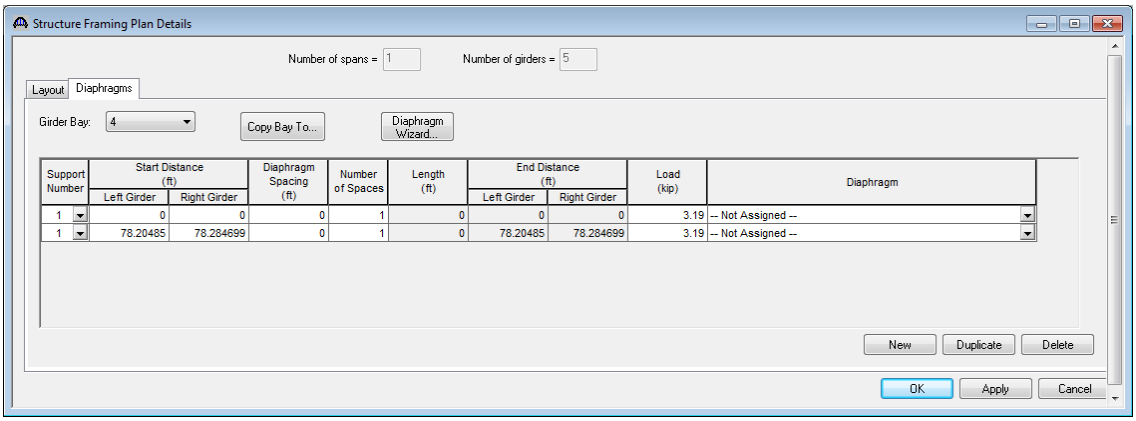


Switch to the Diaphragms tab and enter diaphragm spacing.

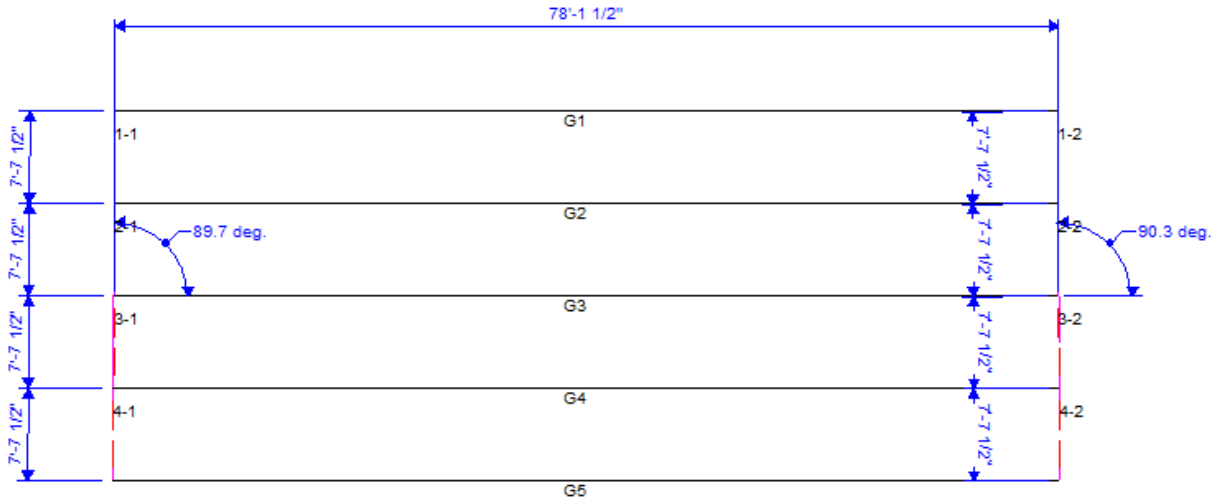

Structure Framing Plan Details
Number of spans = 1
Number of girders = 5
Layout
Diaphragms
Girder Bay: 1
Copy Bay To...
Diaphragm Wizard...
Support Number
Start Distance (ft)
Left Girder
Right Girder
Diaphragm Spacing (ft)
Number of Spaces
Length (ft)
End Distance (ft)
Left Girder
Right Girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 3.19 -- Not Assigned --
1 77.965301 78.04515 0 1 0 77.965301 78.04515 3.19 -- Not Assigned --
New
Duplicate
Delete
OK
Apply
Cancel


Structure Framing Plan Details
Number of spans = 1
Number of girders = 5
Layout
Diaphragms
Girder Bay: 2
Copy Bay To...
Diaphragm Wizard...
Support Number
Start Distance (ft)
Left Girder
Right Girder
Diaphragm Spacing (ft)
Number of Spaces
Length (ft)
End Distance (ft)
Left Girder
Right Girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 3.19 -- Not Assigned --
1 78.04515 78.125 0 1 0 78.04515 78.125 3.19 -- Not Assigned --
New
Duplicate
Delete
OK
Apply
Cancel


Structure Framing Plan Details
Number of spans = 1
Number of girders = 5
Layout
Diaphragms
Girder Bay: 3
Copy Bay To...
Diaphragm Wizard...
Support Number
Start Distance (ft)
Left Girder
Right Girder
Diaphragm Spacing (ft)
Number of Spaces
Length (ft)
End Distance (ft)
Left Girder
Right Girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 3.19 -- Not Assigned --
1 78.125 78.20485 0 1 0 78.125 78.20485 3.19 -- Not Assigned --
New
Duplicate
Delete
OK
Apply
Cancel

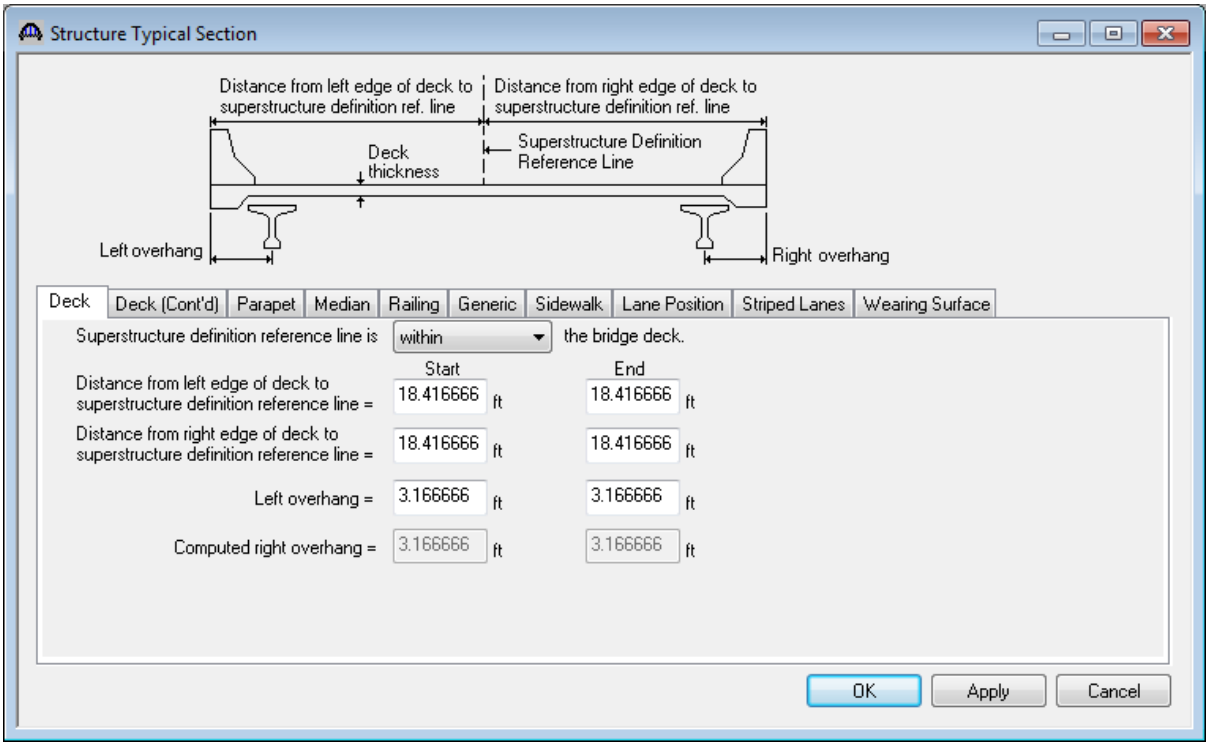

Structure Framing Plan Details
Number of spans = 1
Number of girders = 5
Layout
Diaphragms
Girder Bay: 4
Copy Bay To...
Diaphragm Wizard...
Support Number
Start Distance (ft)
Left Girder
Right Girder
Diaphragm Spacing (ft)
Number of Spaces
Length (ft)
End Distance (ft)
Left Girder
Right Girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 3.19 -- Not Assigned --
1 78.20485 78.284699 0 1 0 78.20485 78.284699 3.19 -- Not Assigned --
New
Duplicate
Delete
OK
Apply
Cancel

The following data appears in the Framing Plan Details window and the Framing Plan Schematic is shown below.

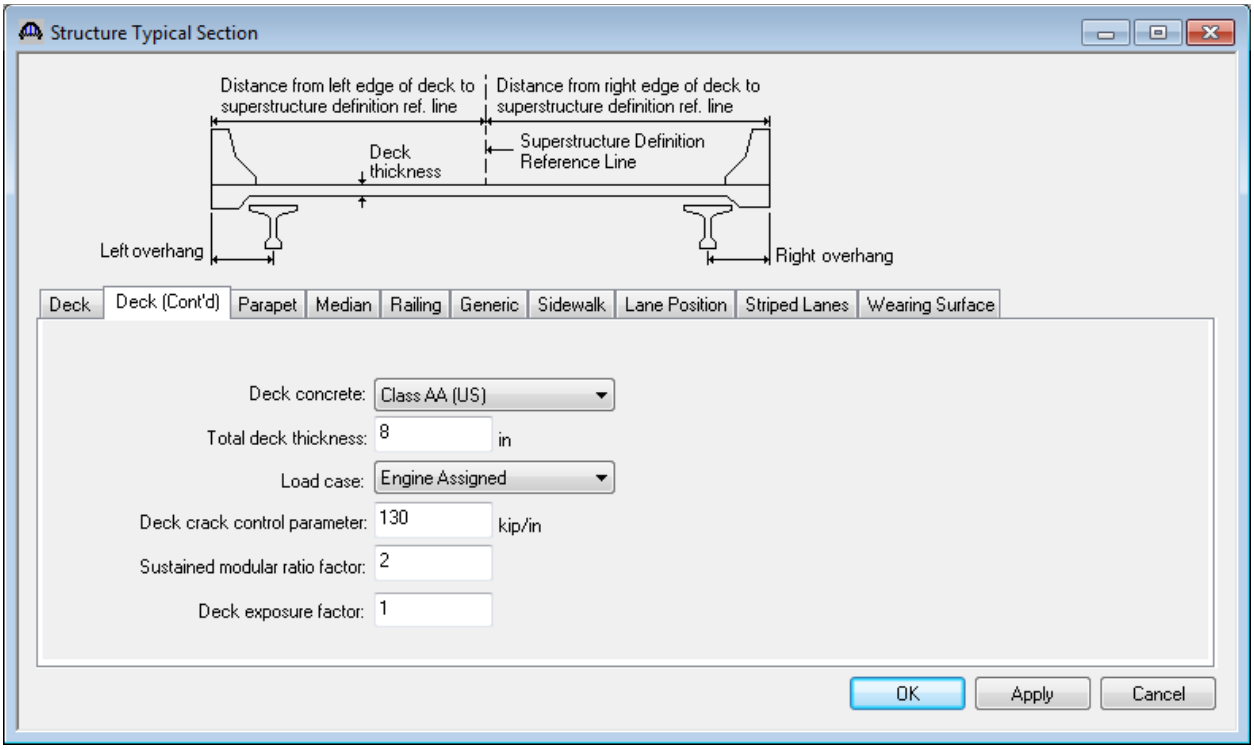


Next define the structure typical section by double-clicking on Structure Typical Section in the Bridge Workspace tree. Input the data describing the typical section as shown below. This screen initially shows steel girders as the default girder type until the member alternatives are defined.

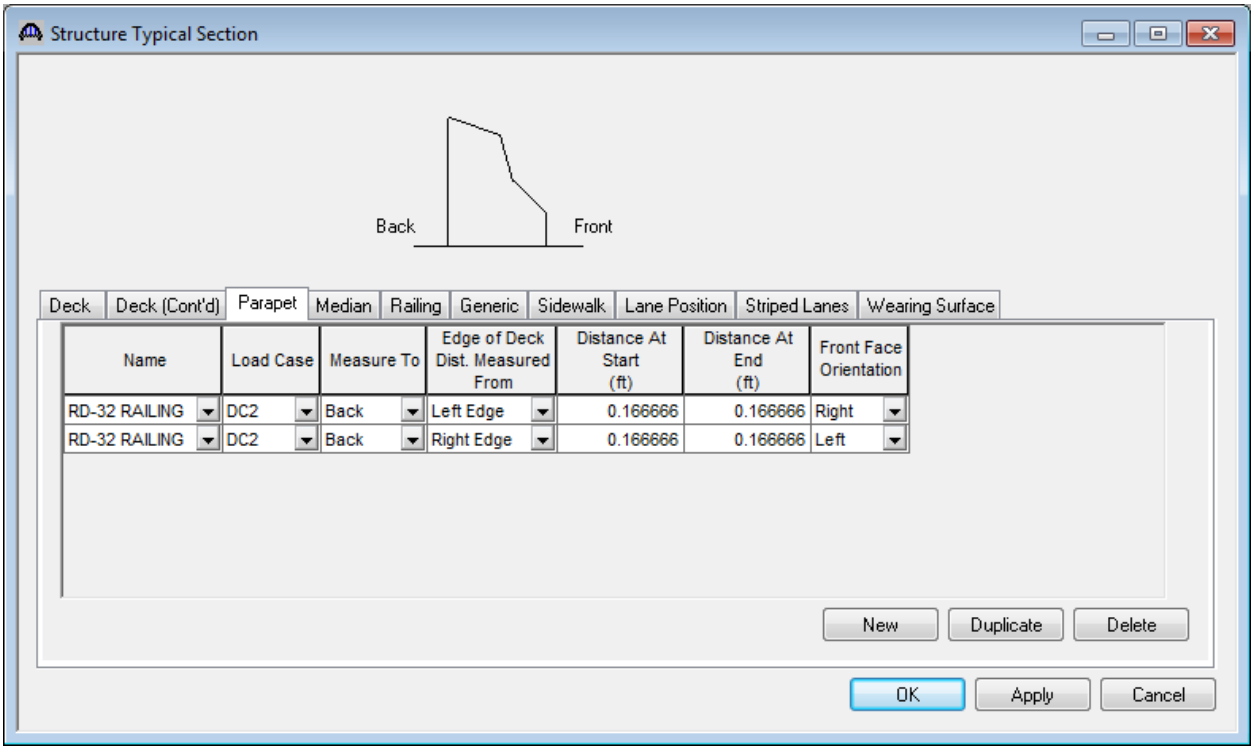
Basic deck geometry:



The Deck (cont'd) tab is used to enter information about the deck concrete and thickness.

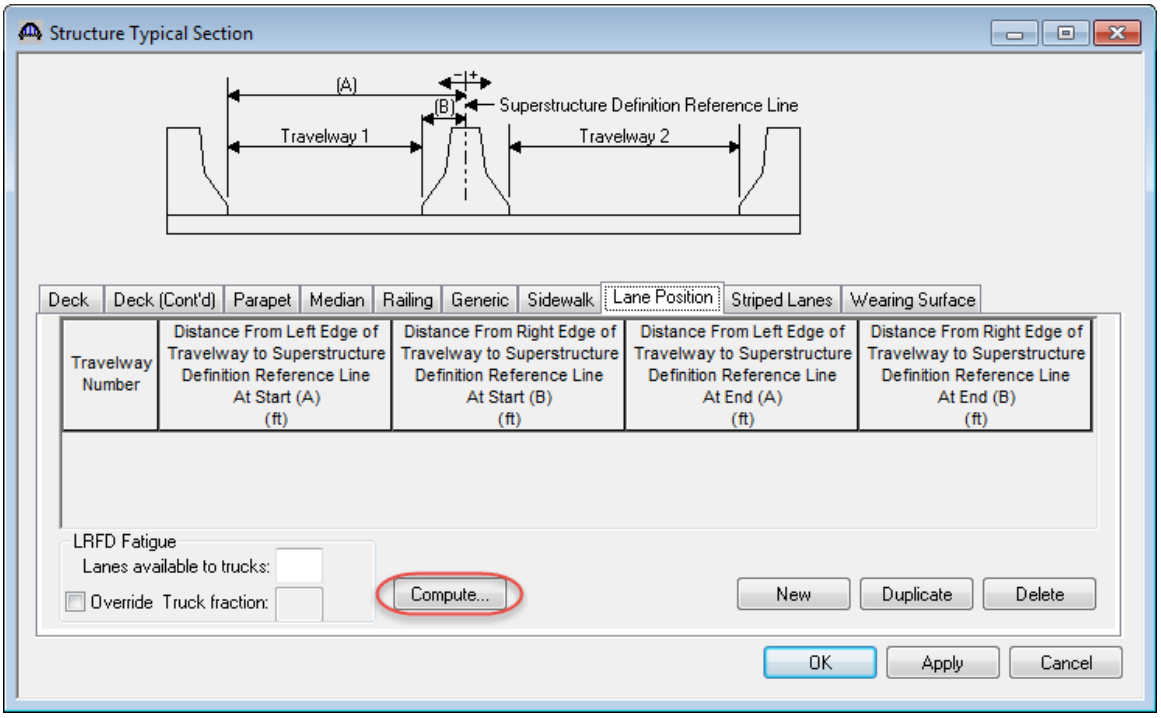


Enter the following parapets:

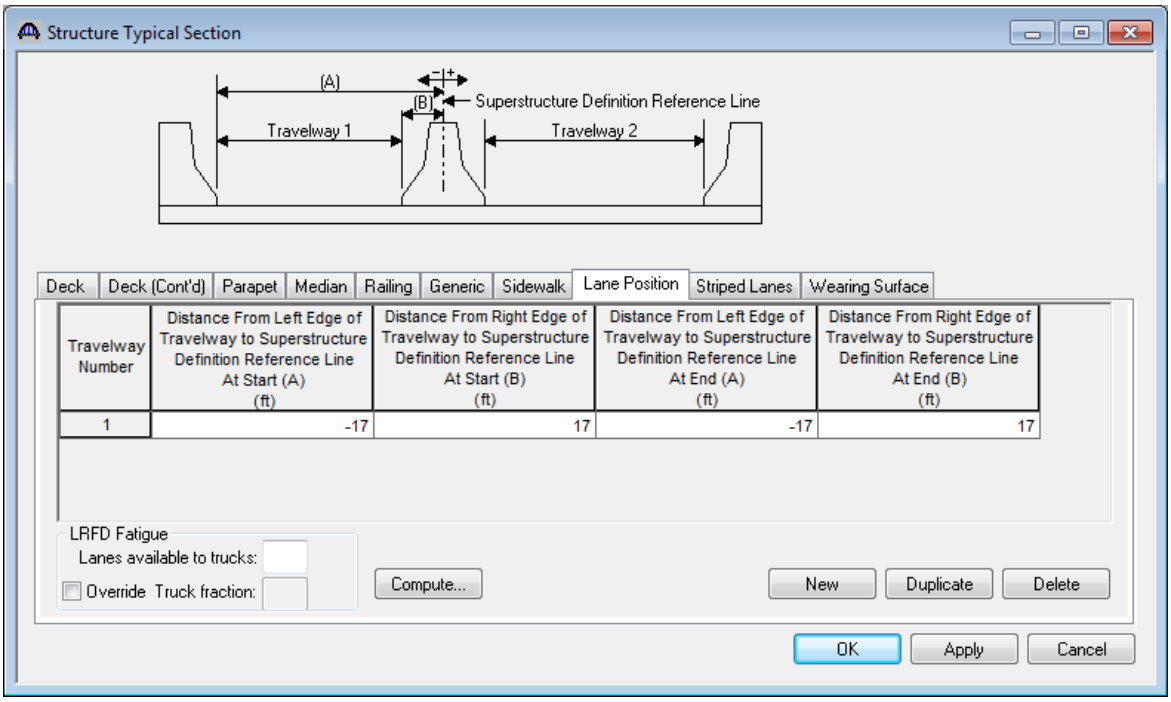


Lane Positions:

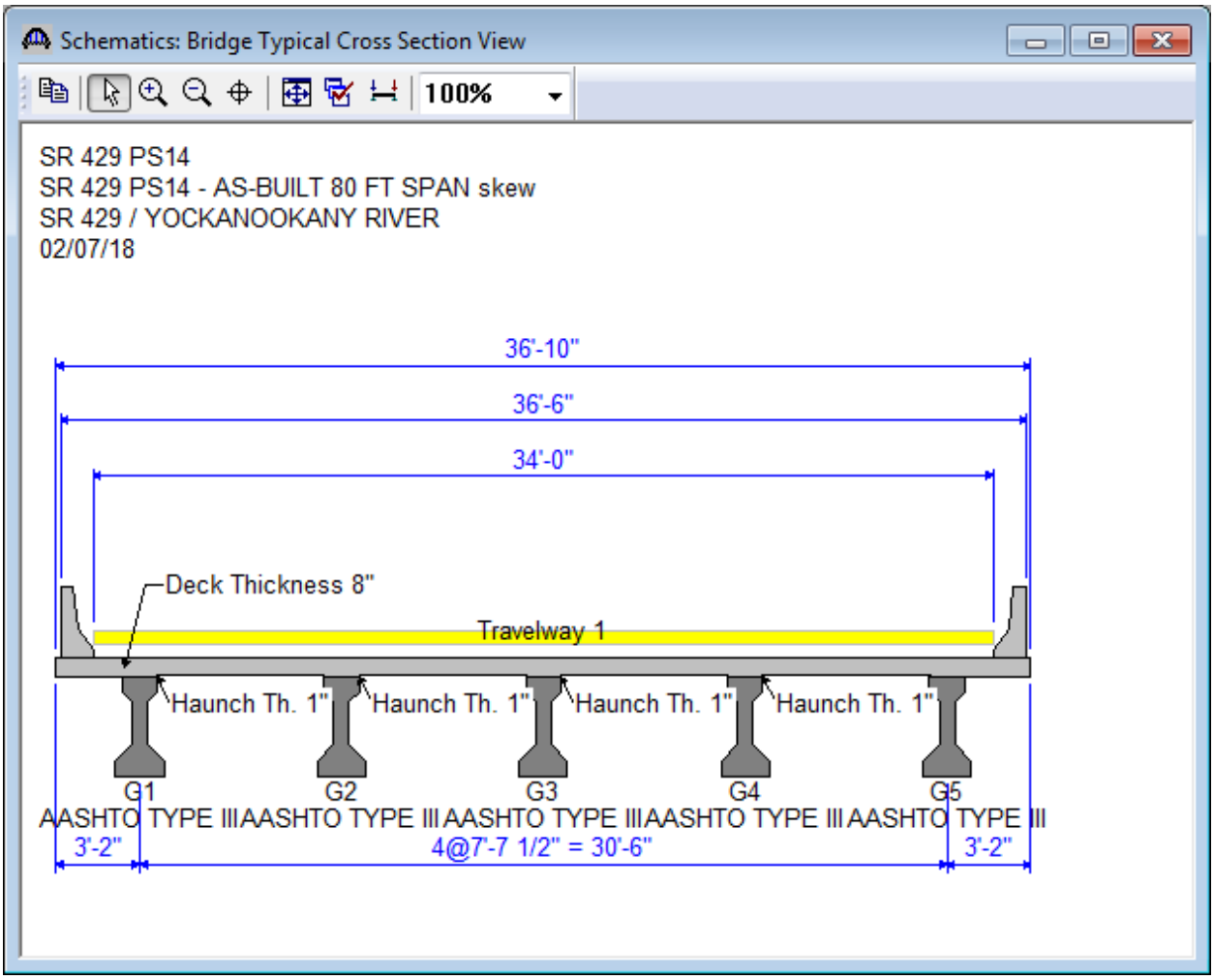
Use the ‘Compute’ button to have BrD compute the lane positions for you. These lane positions are used by BrD to compute the LRFD live load distribution factors.



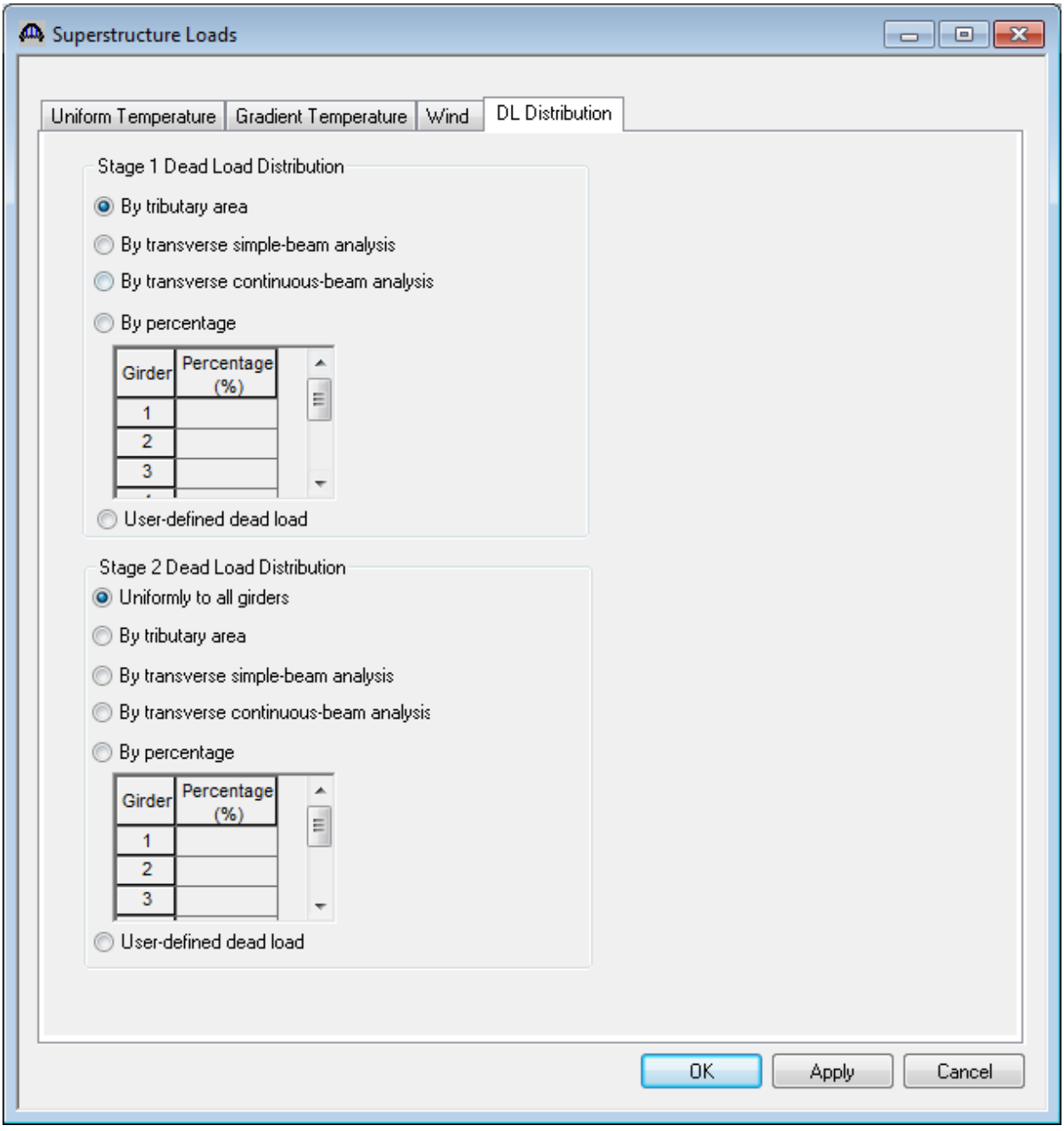
The computed values are shown below.



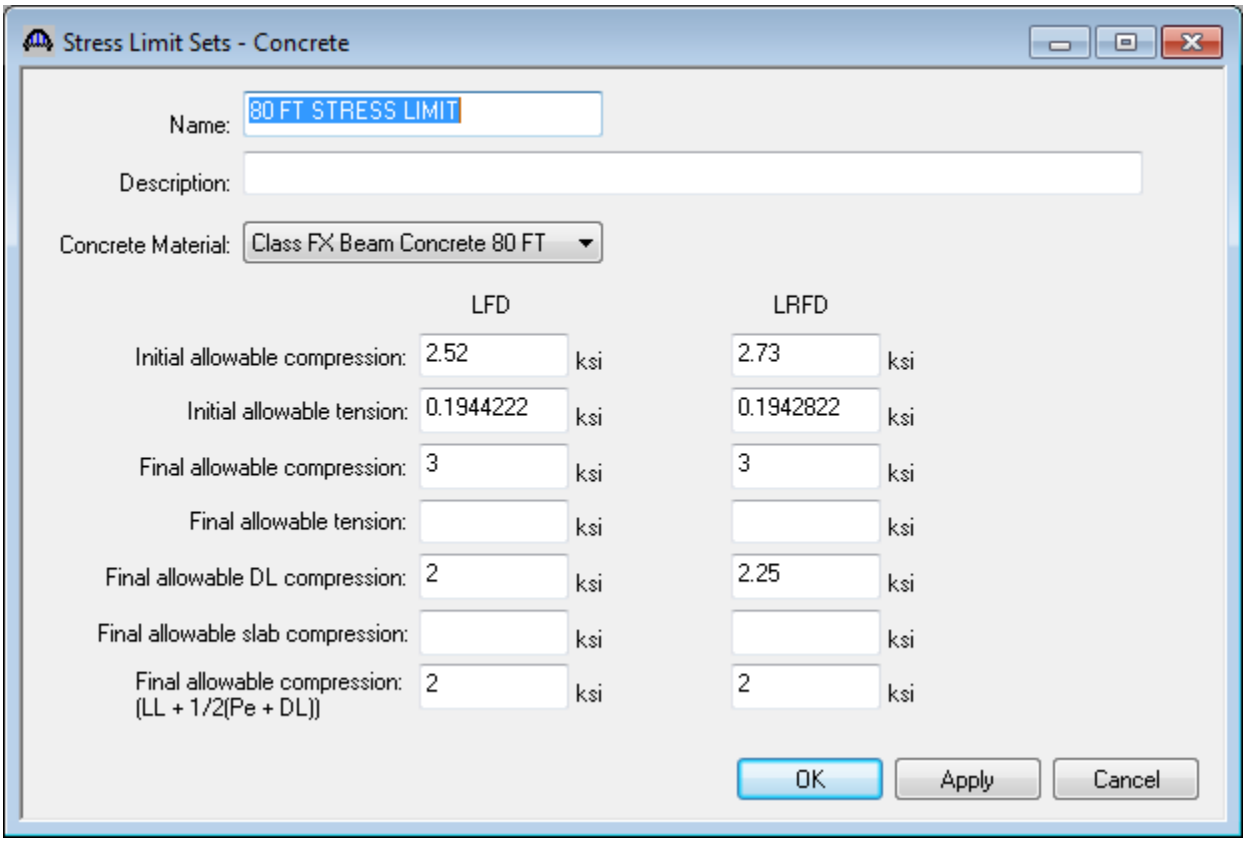
The schematic of the Structure Typical Section is shown below.



The DL Distribution tab of the Superstructure Loads window is shown below. The BrD LRFD engine does not support the transverse continuous beam analysis option.

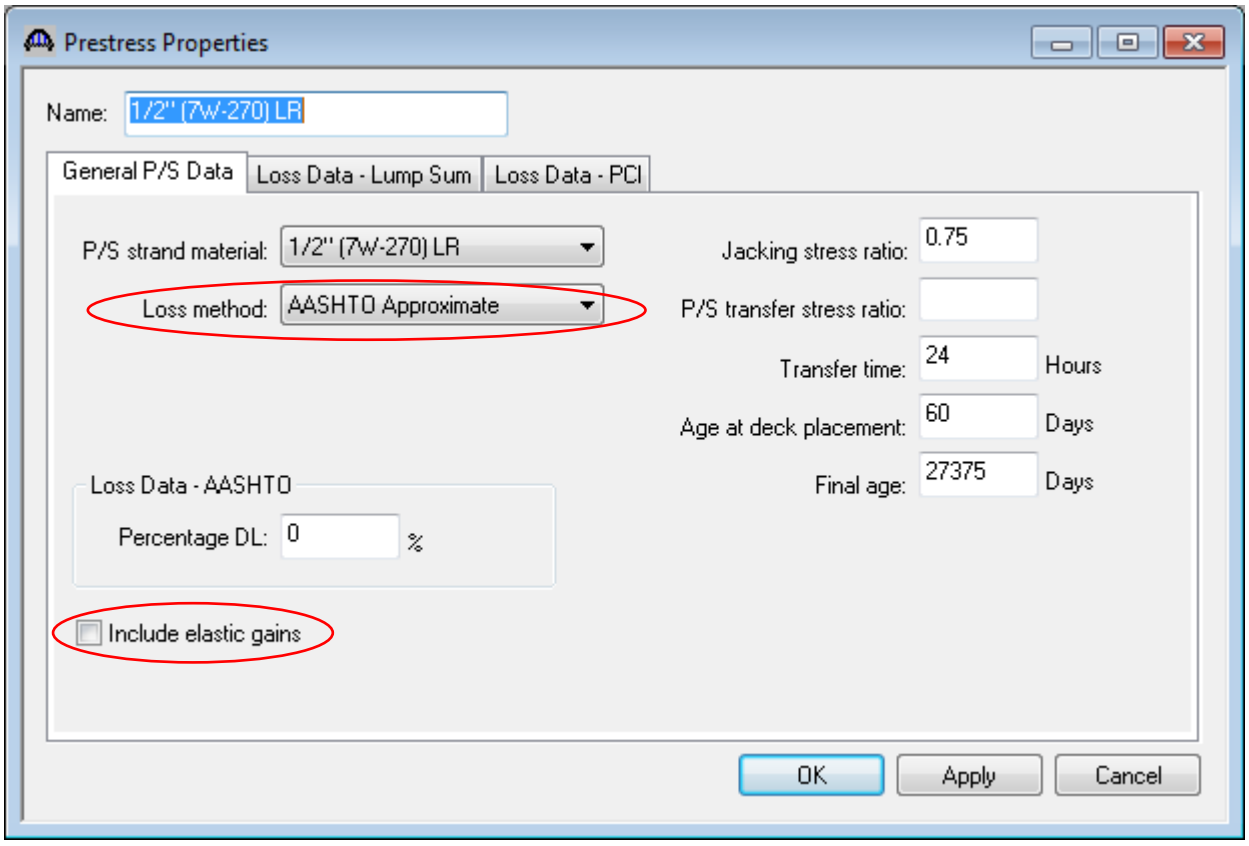


Create the following stress limit.



If you leave the allowable stresses blank in the stress limit the BrD LRFD engine will compute the allowable based on the AASHTO specification articles and the concrete material selected. The allowable slab compression is not computed for you since the deck is typically a different material than the girder.

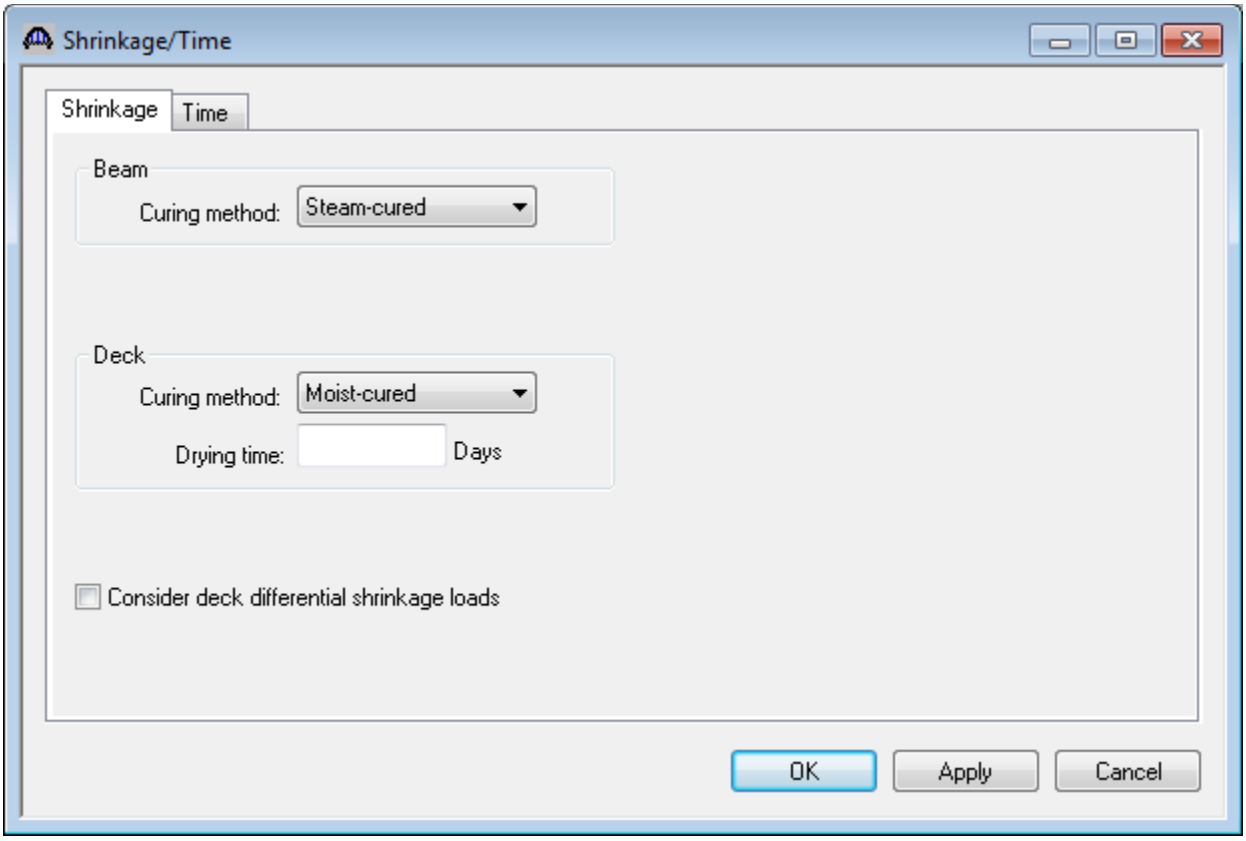
Create the following Prestress Property. Select the loss method as 'AASHTO Approximate".



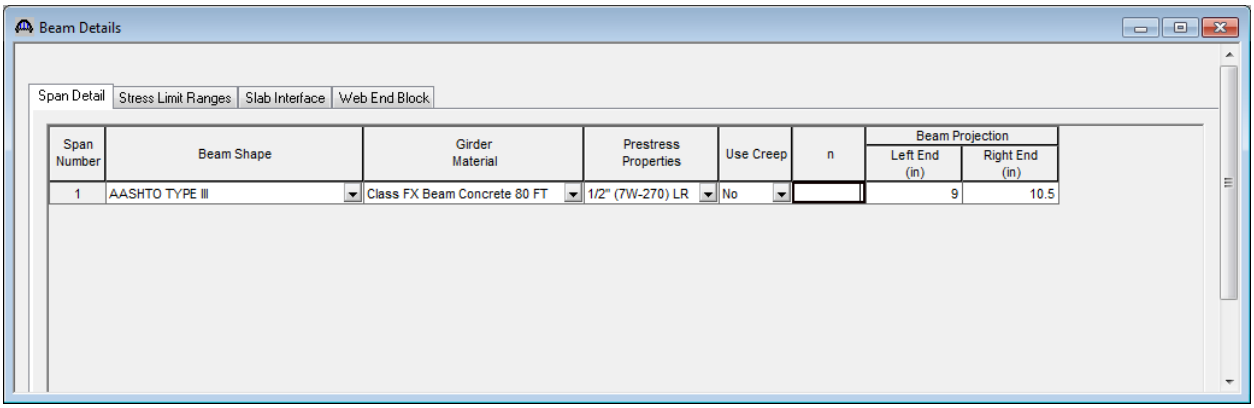
The vertical shear reinforcement bars are the same as the 138 foot unit.

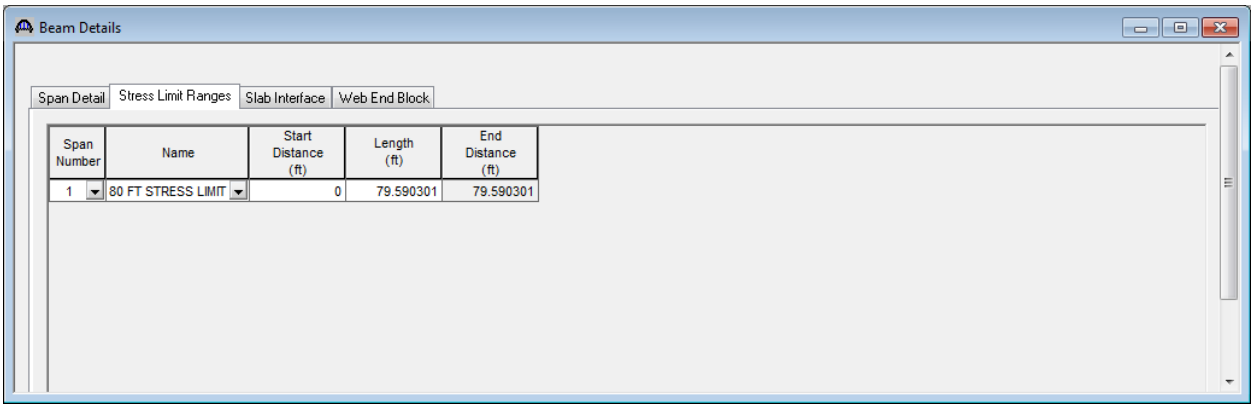
Now create a prestressed I beam alternative for member G1-G5 by double-clicking on the ‘MEMBER ALTERNATIVES’ label.

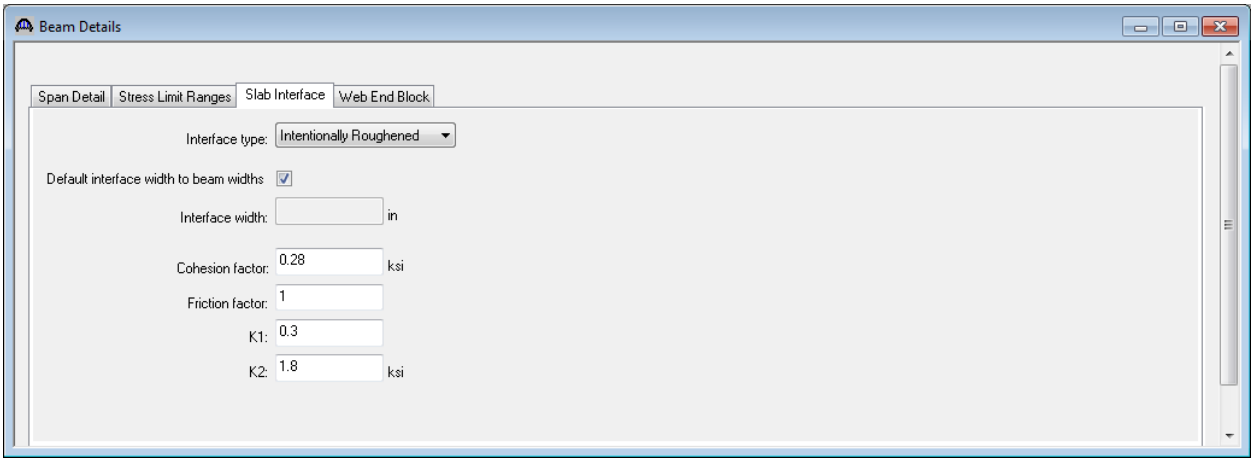
Enter the following data on the Shrinkage/Time window.



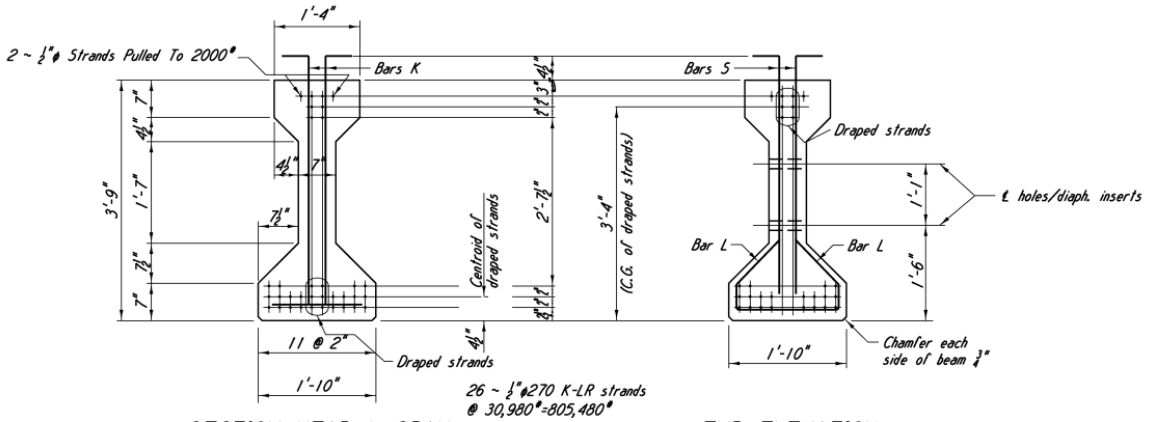
Enter the following data on the Beam Details window.

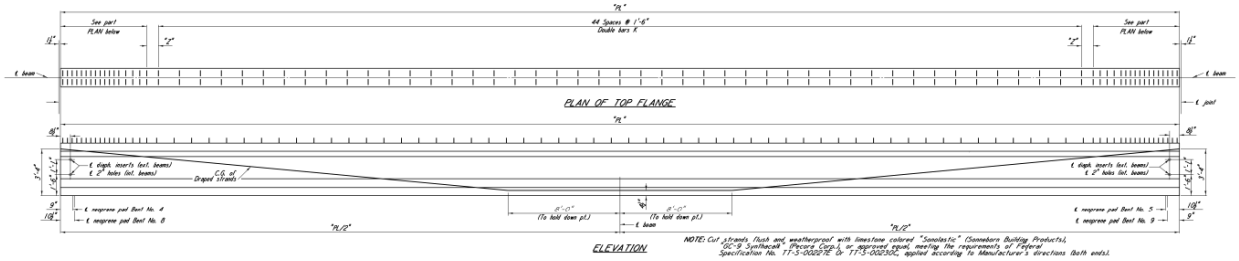


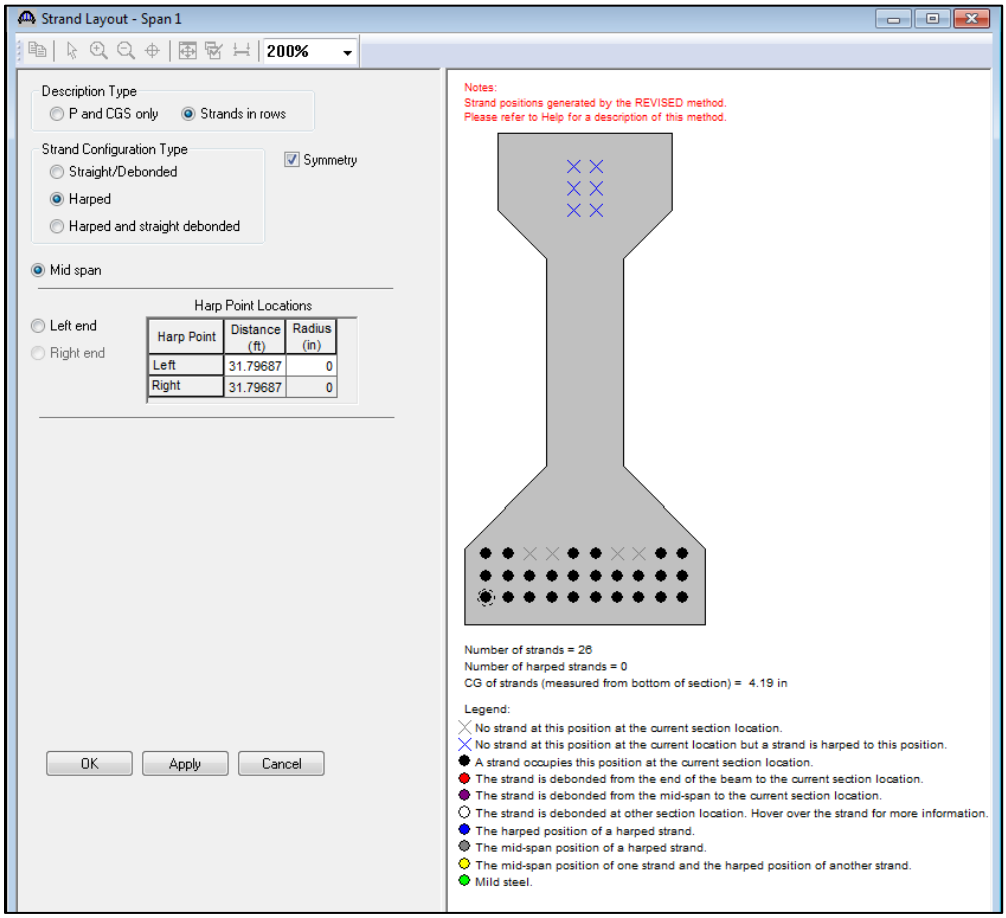




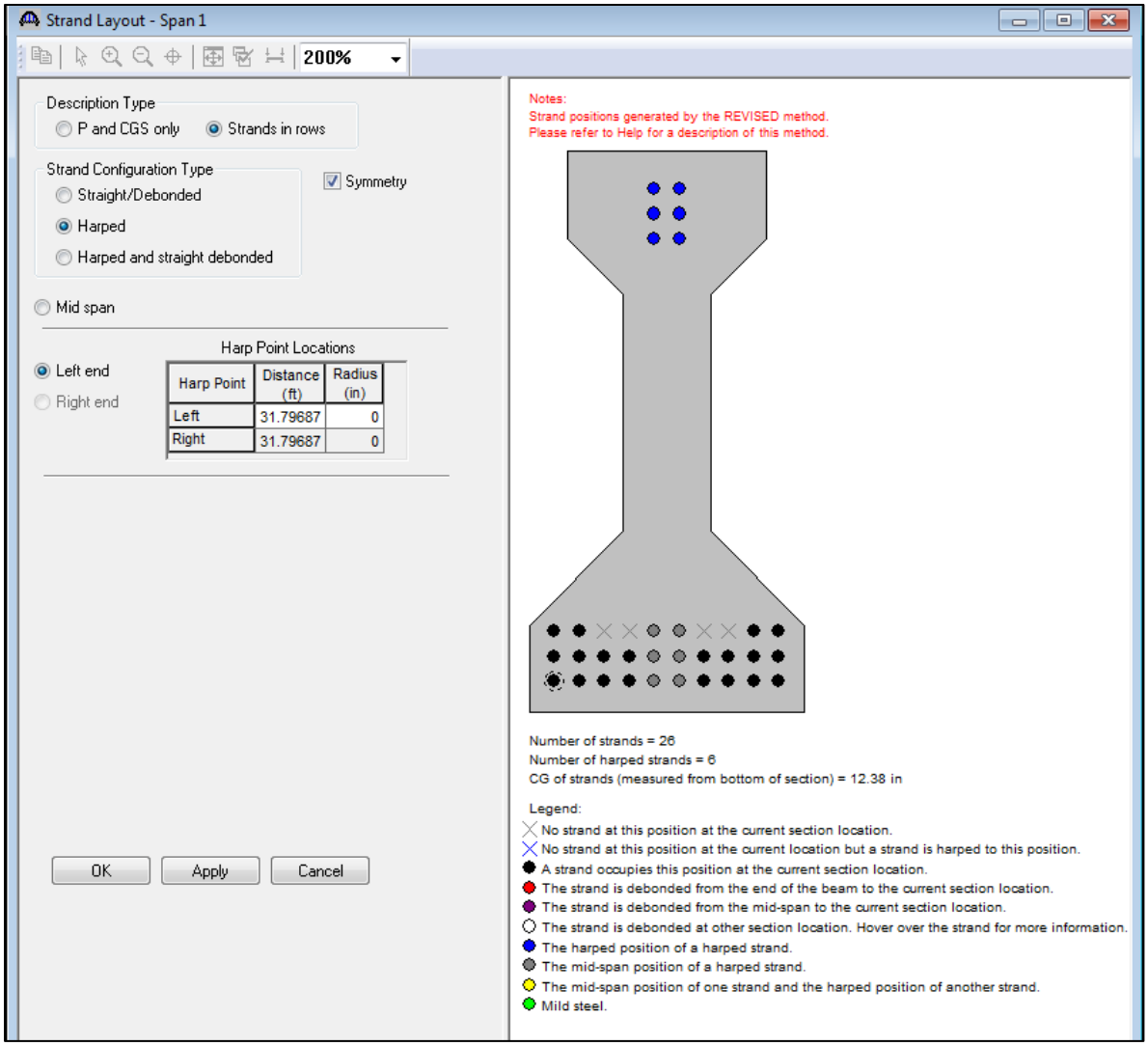
Now define the following strand layout at midspan using the screen captures from the drawings (shown below).



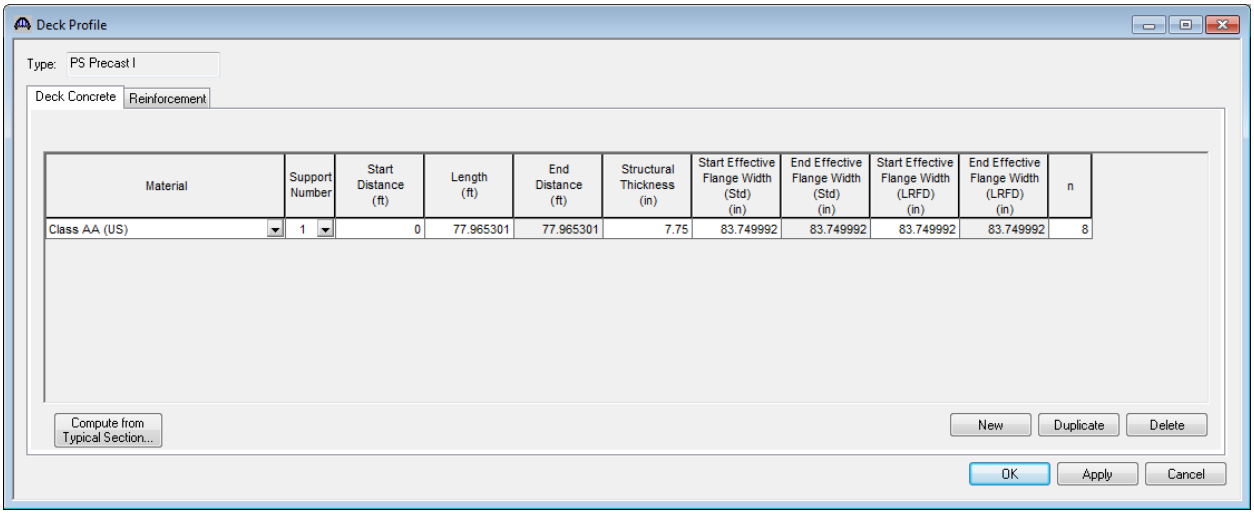




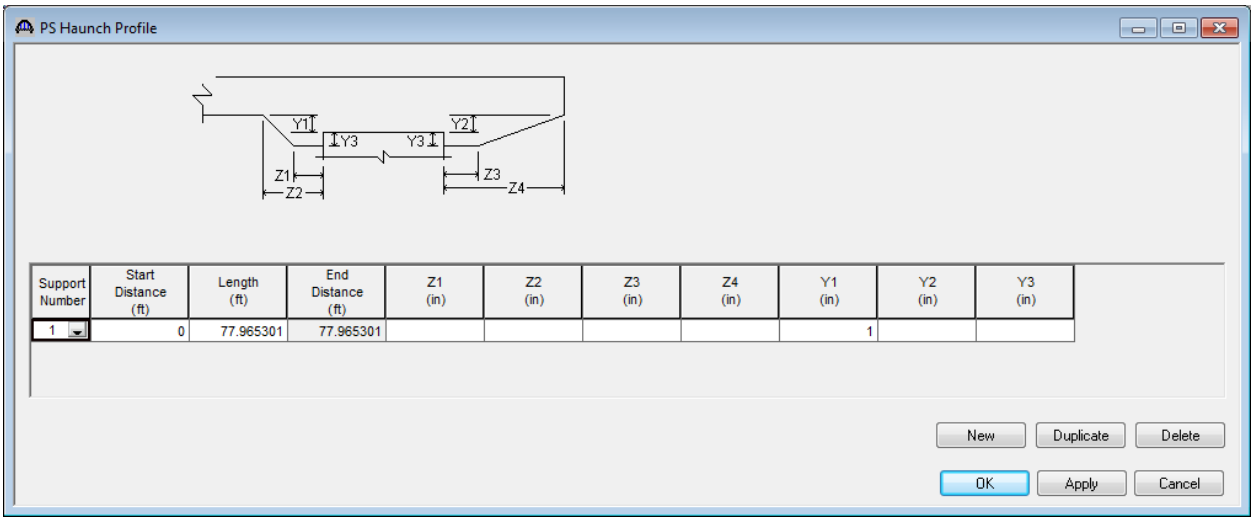
Then define the following harped strands at this location.



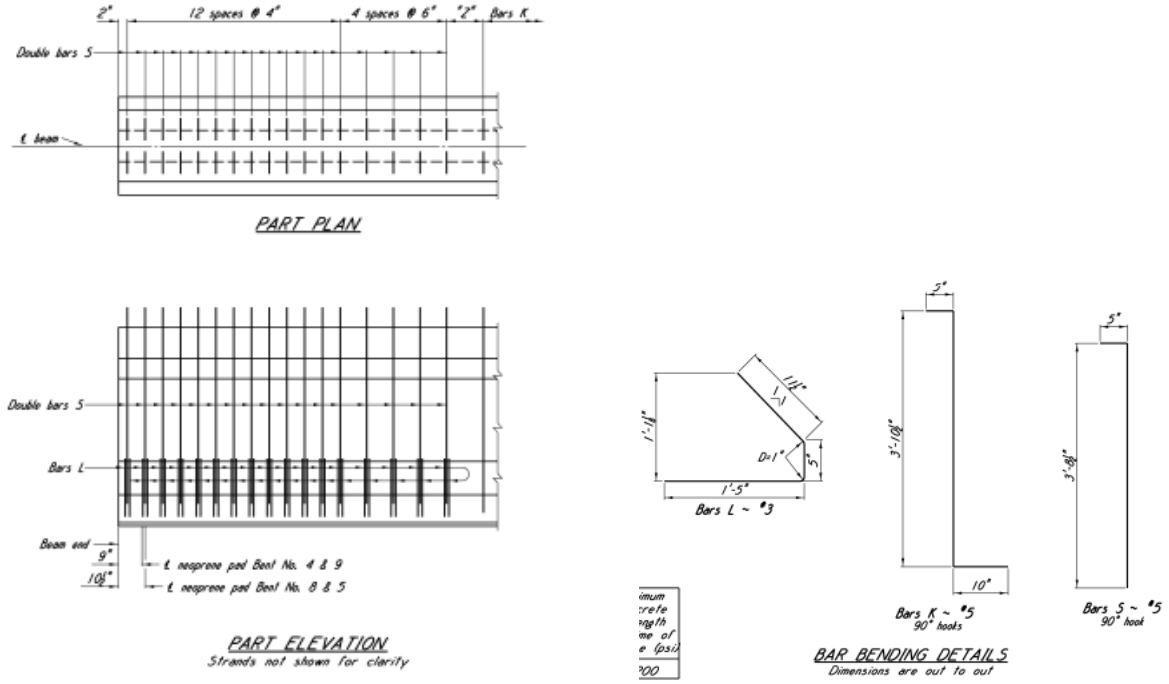
Describe the deck as follows:

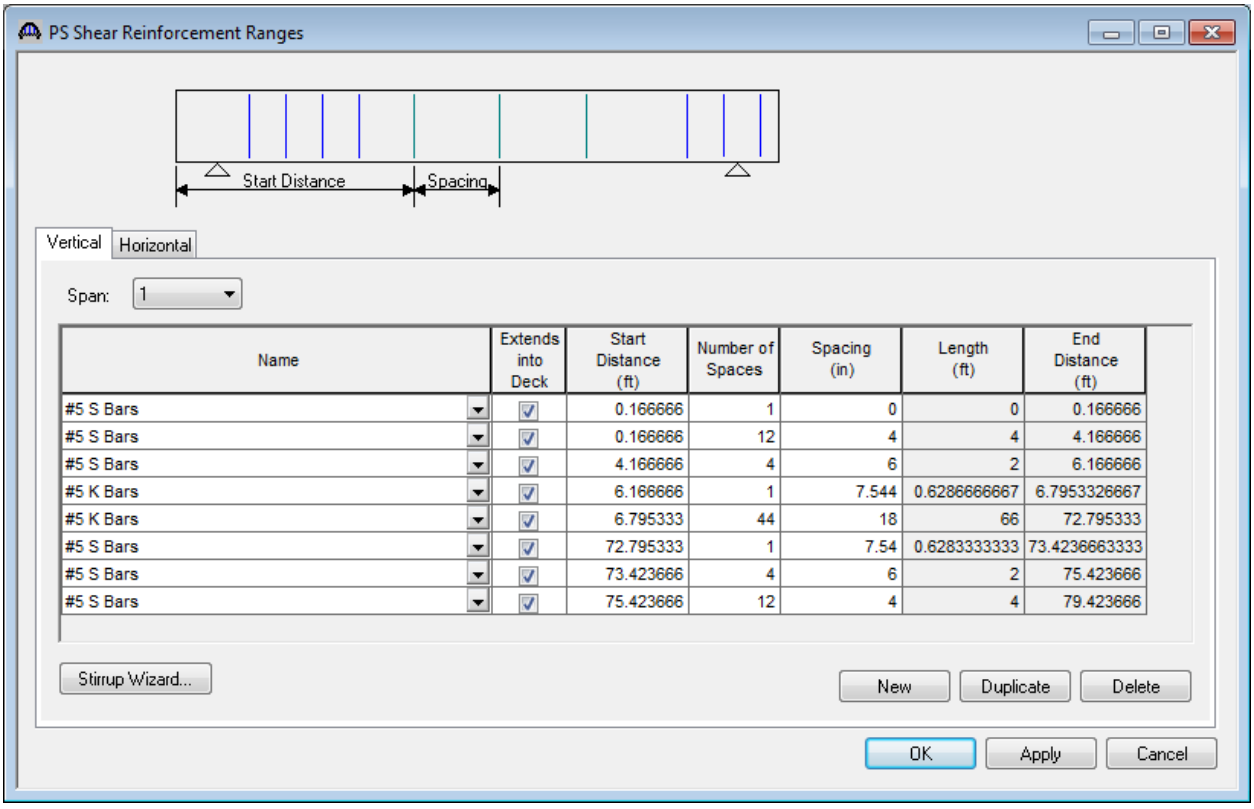


The Haunch Profile is shown below.

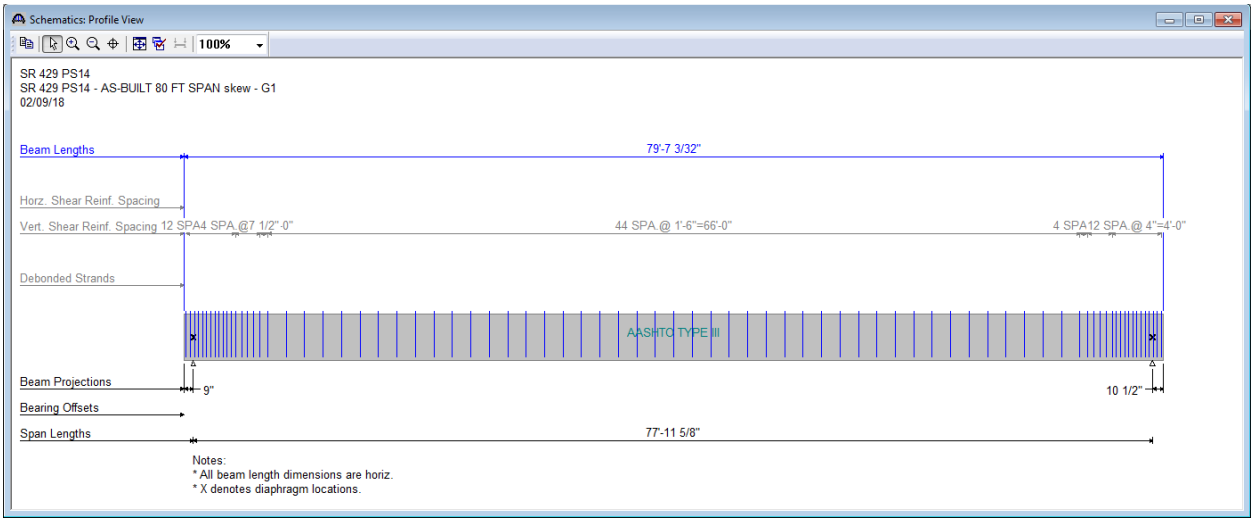


Create the following shear stirrups:



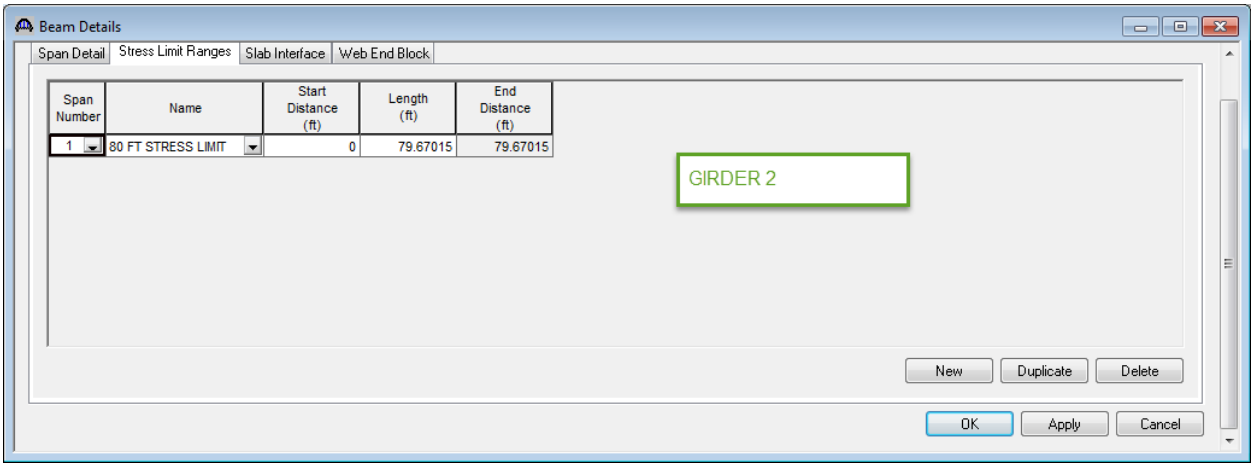


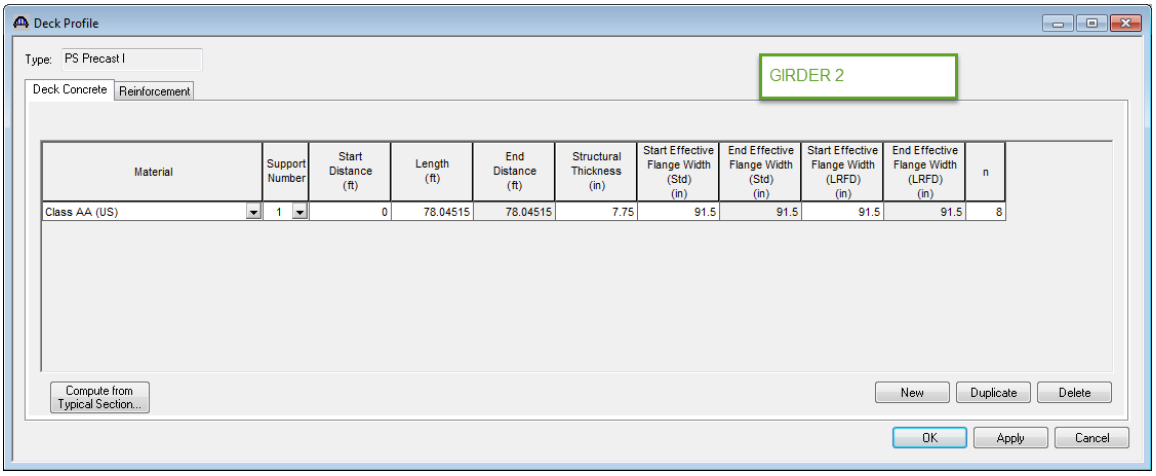
The Member Alternative Schematic is shown below:

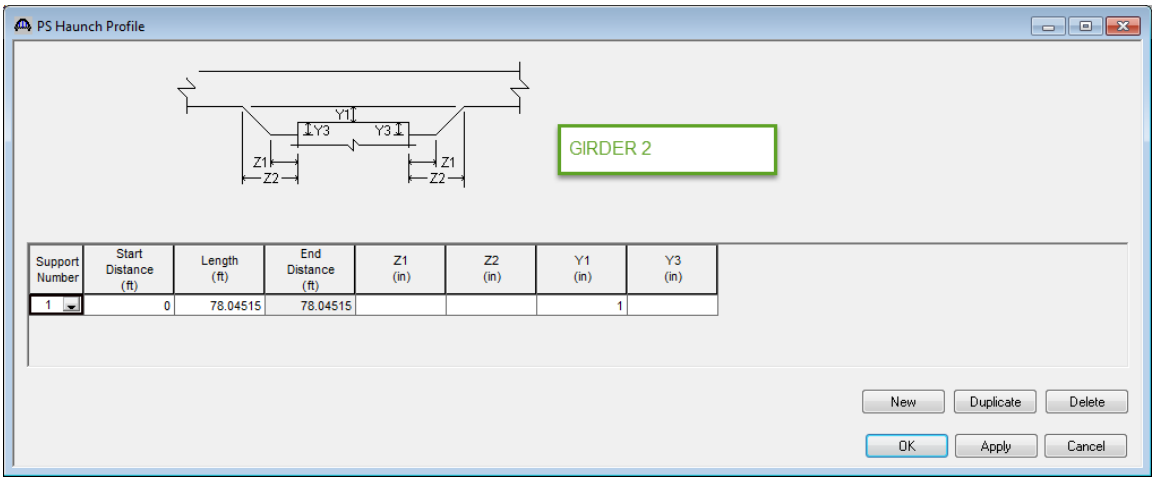


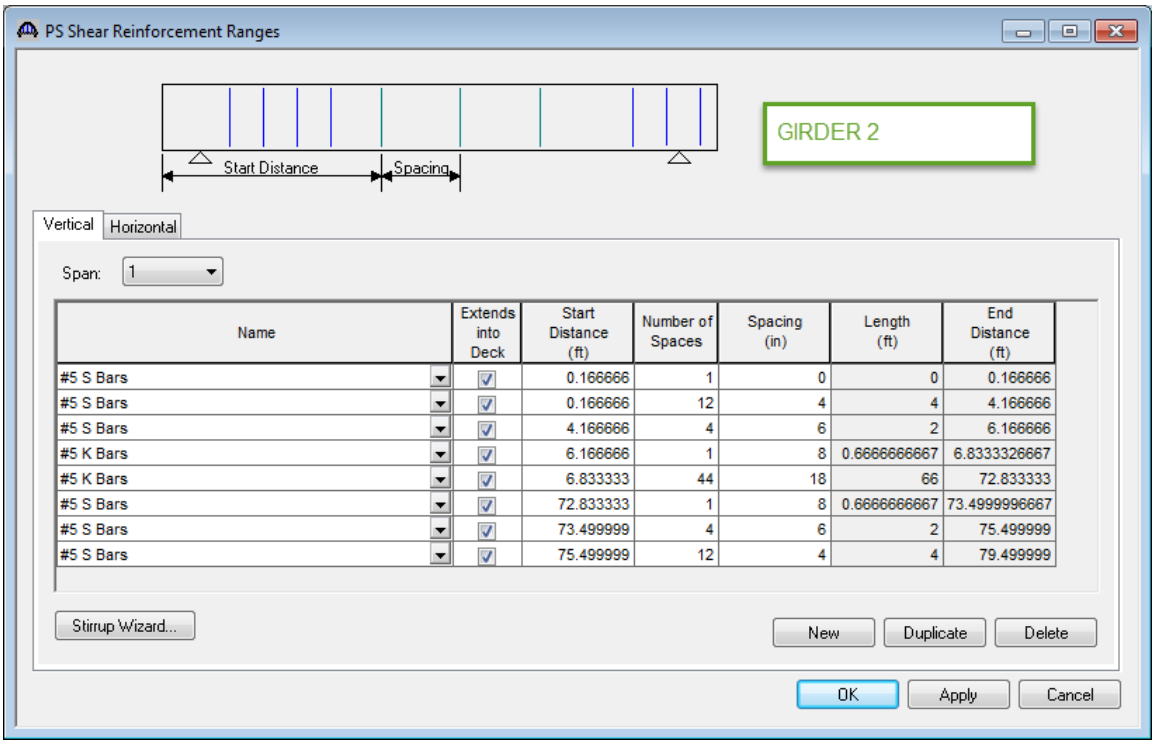
Girder 1 is complete. Girders G2-G5 are similar but the lengths are different.

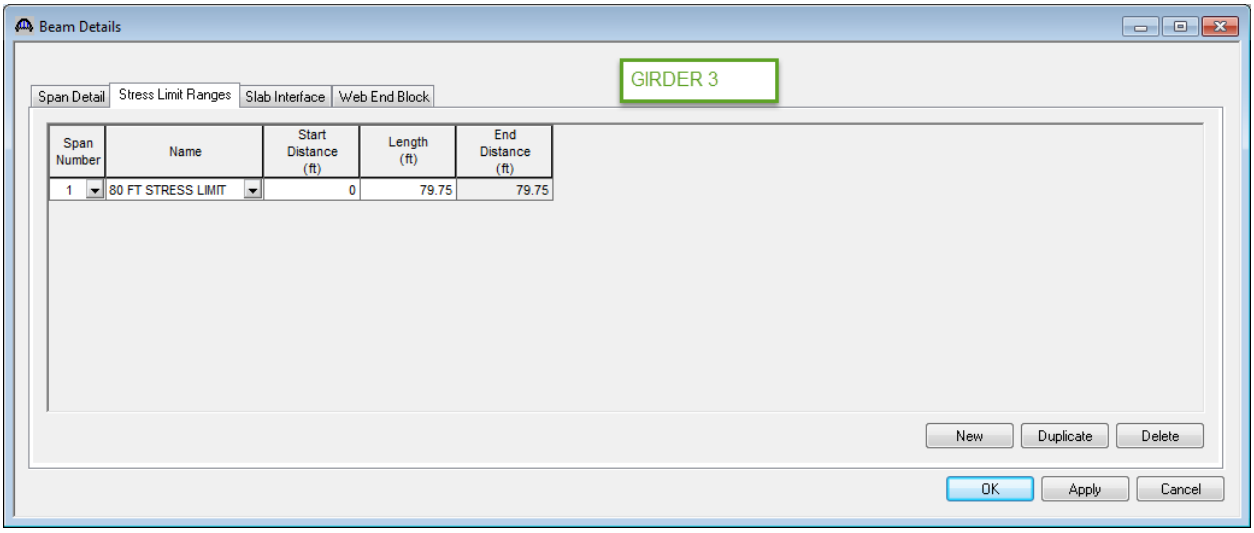
Harp Locations	
Girder	DRAPE
1	31.79688
2	31.83333
3	31.875
4	31.91667
5	31.95833

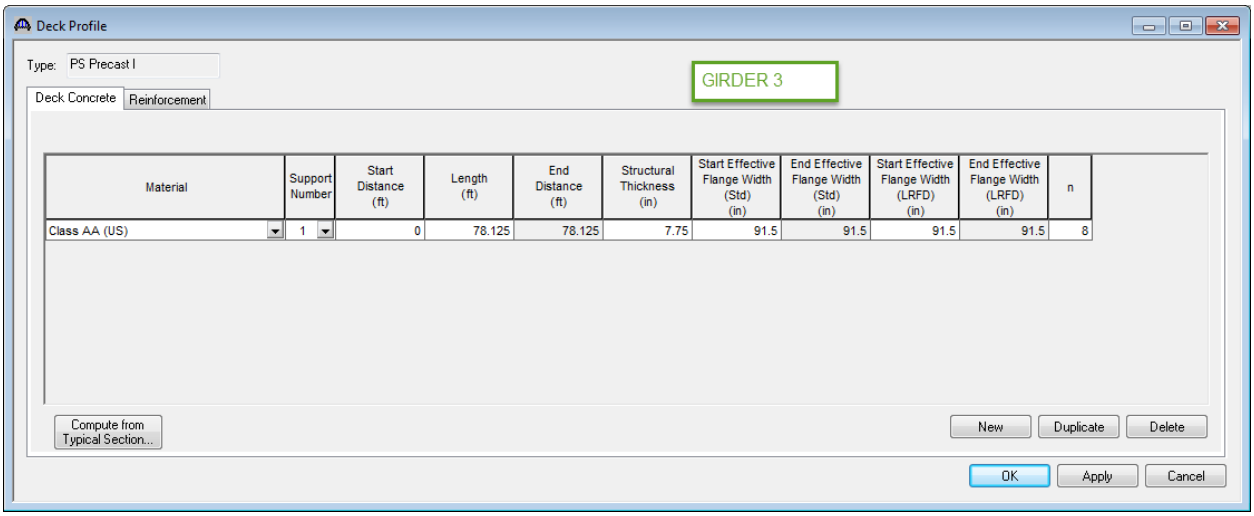


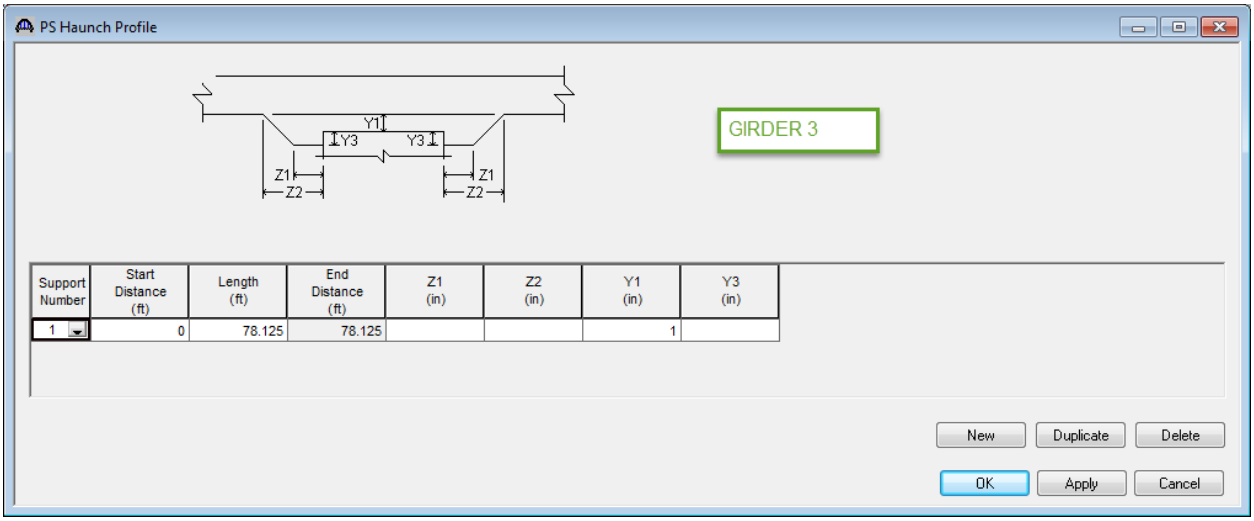

Deck Profile
Type: PS Precast I
Deck Concrete
Reinforcement
GIRDER 2
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Structural Thickness (in)
Start Effective Flange Width (Std) (in)
End Effective Flange Width (Std) (in)
Start Effective Flange Width (LRFD) (in)
End Effective Flange Width (LRFD) (in)
n
Class AA (US) 1 0 78.04515 78.04515 7.75 91.5 91.5 91.5 91.5 8
Compute from Typical Section...
New
Duplicate
Delete
OK
Apply
Cancel

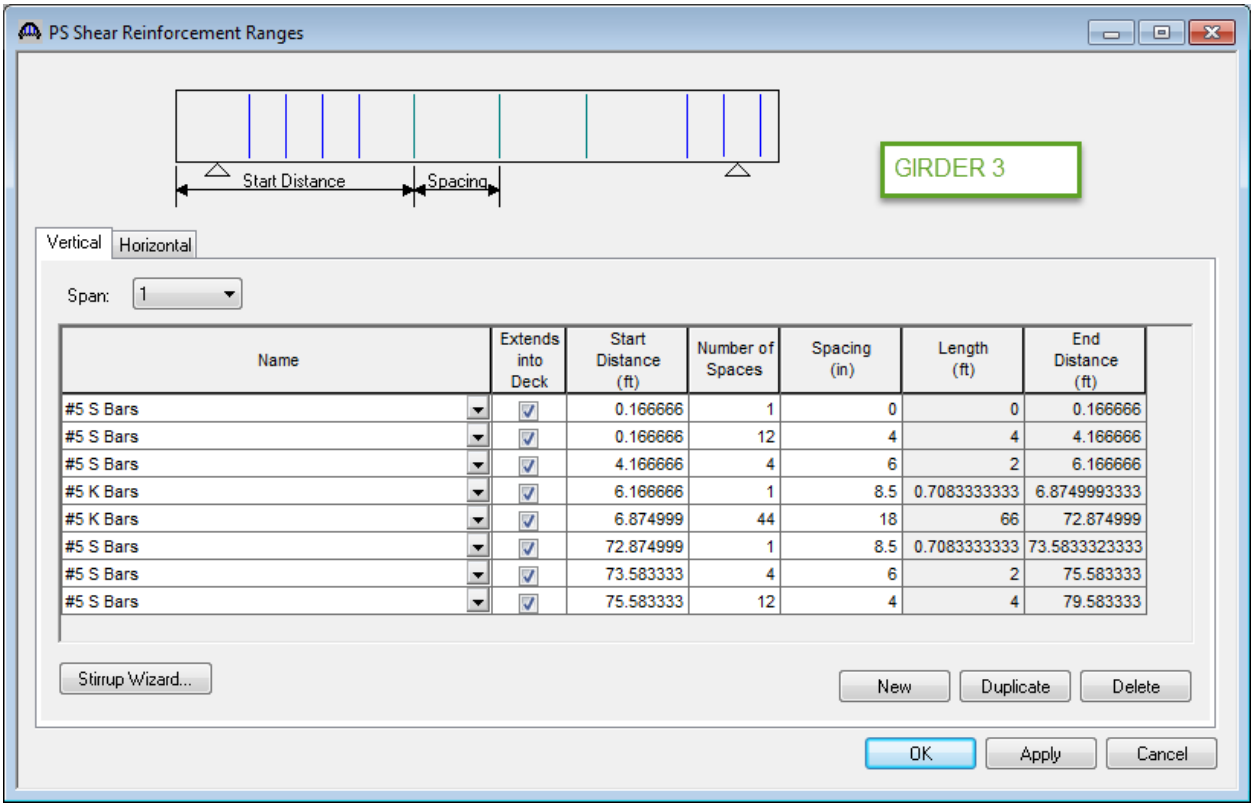

PS Haunch Profile
Y1
Y3
Y3
Z1
Z2
Z1
Z2
GIRDER 2
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Z1 (in)
Z2 (in)
Y1 (in)
Y3 (in)
1 0 78.04515 78.04515 1
New
Duplicate
Delete
OK
Apply
Cancel

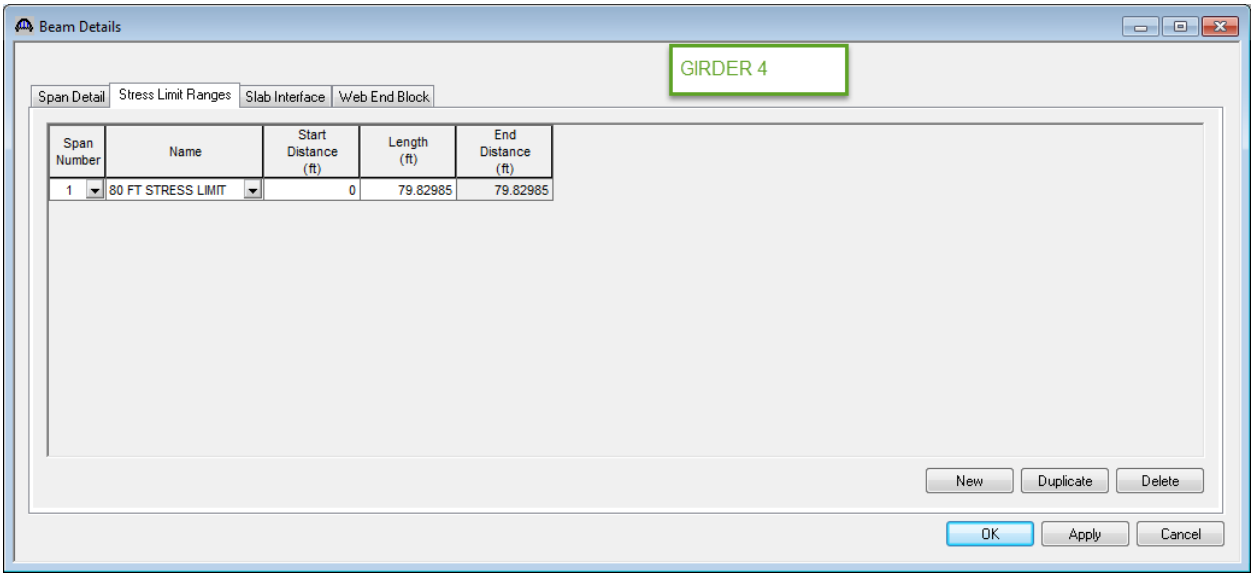

PS Shear Reinforcement Ranges
Start Distance
Spacing
GIRDER 2
Vertical
Horizontal
Span: 1
Name
Extends into Deck
Start Distance (ft)
Number of Spaces
Spacing (in)
Length (ft)
End Distance (ft)
#5 S Bars 0.166666 1 0 0 0.166666
#5 S Bars 0.166666 12 4 4 4.166666
#5 S Bars 4.166666 4 6 2 6.166666
#5 K Bars 6.166666 1 8 0.6666666667 6.8333326667
#5 K Bars 6.833333 44 18 66 72.833333
#5 S Bars 72.833333 1 8 0.6666666667 73.4999996667
#5 S Bars 73.499999 4 6 2 75.499999
#5 S Bars 75.499999 12 4 4 79.499999
Stirrup Wizard...
New
Duplicate
Delete
OK
Apply
Cancel

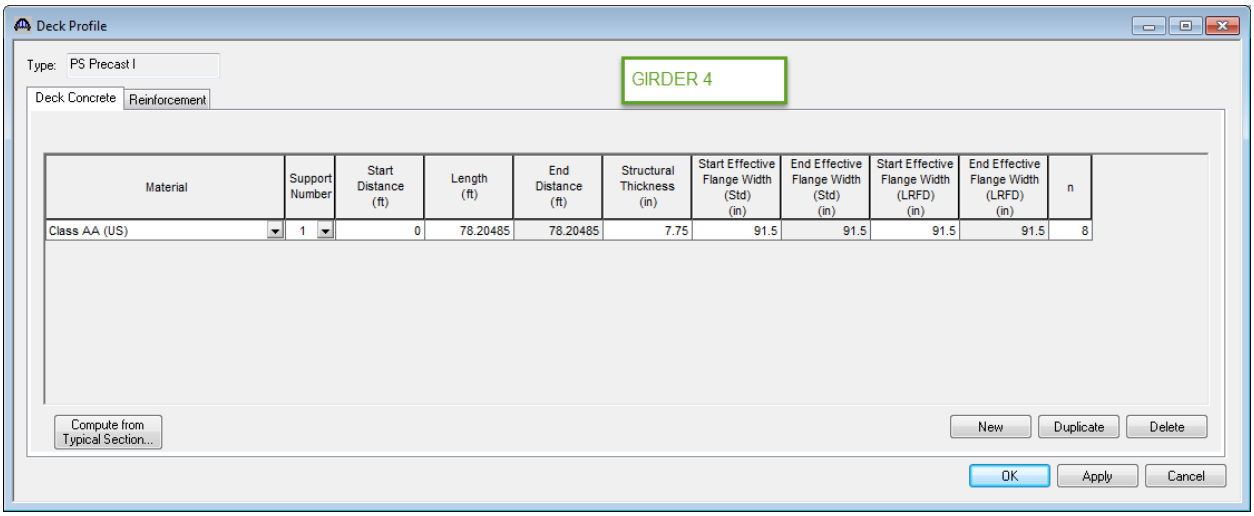

Beam Details
GIRDER 3
Span Detail
Stress Limit Ranges
Slab Interface
Web End Block
Span Number
Name
Start Distance (ft)
Length (ft)
End Distance (ft)
1
80 FT STRESS LIMIT
0
79.75
79.75
New
Duplicate
Delete
OK
Apply
Cancel

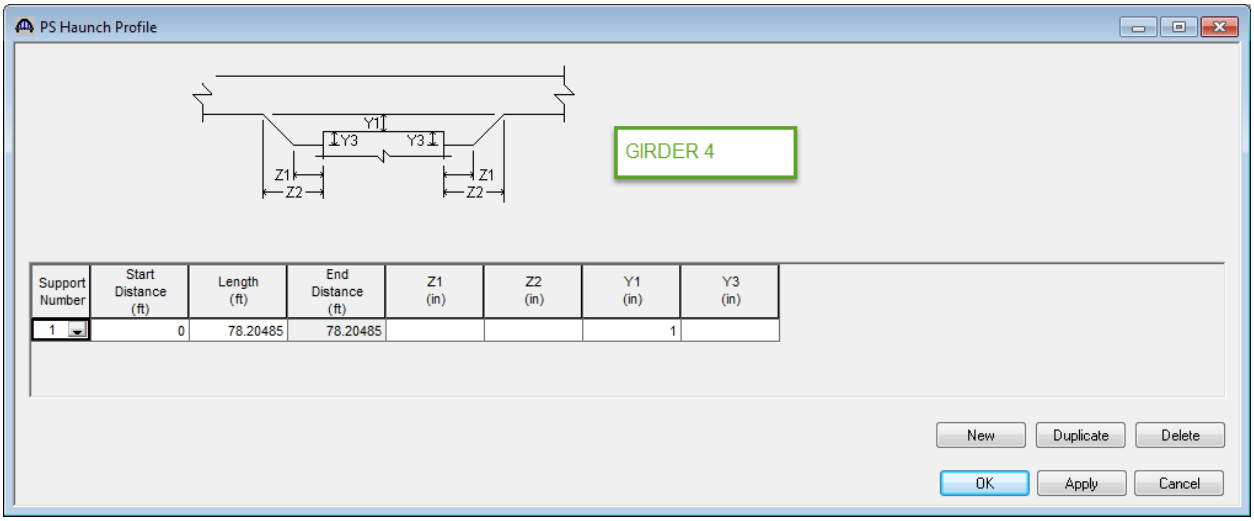

Deck Profile
Type: PS Precast I
GIRDER 3
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Structural Thickness (in)
Start Effective Flange Width (Std) (in)
End Effective Flange Width (Std) (in)
Start Effective Flange Width (LRFD) (in)
End Effective Flange Width (LRFD) (in)
n
Class AA (US)
1
0
78.125
78.125
7.75
91.5
91.5
91.5
91.5
8
Compute from Typical Section...
New
Duplicate
Delete
OK
Apply
Cancel

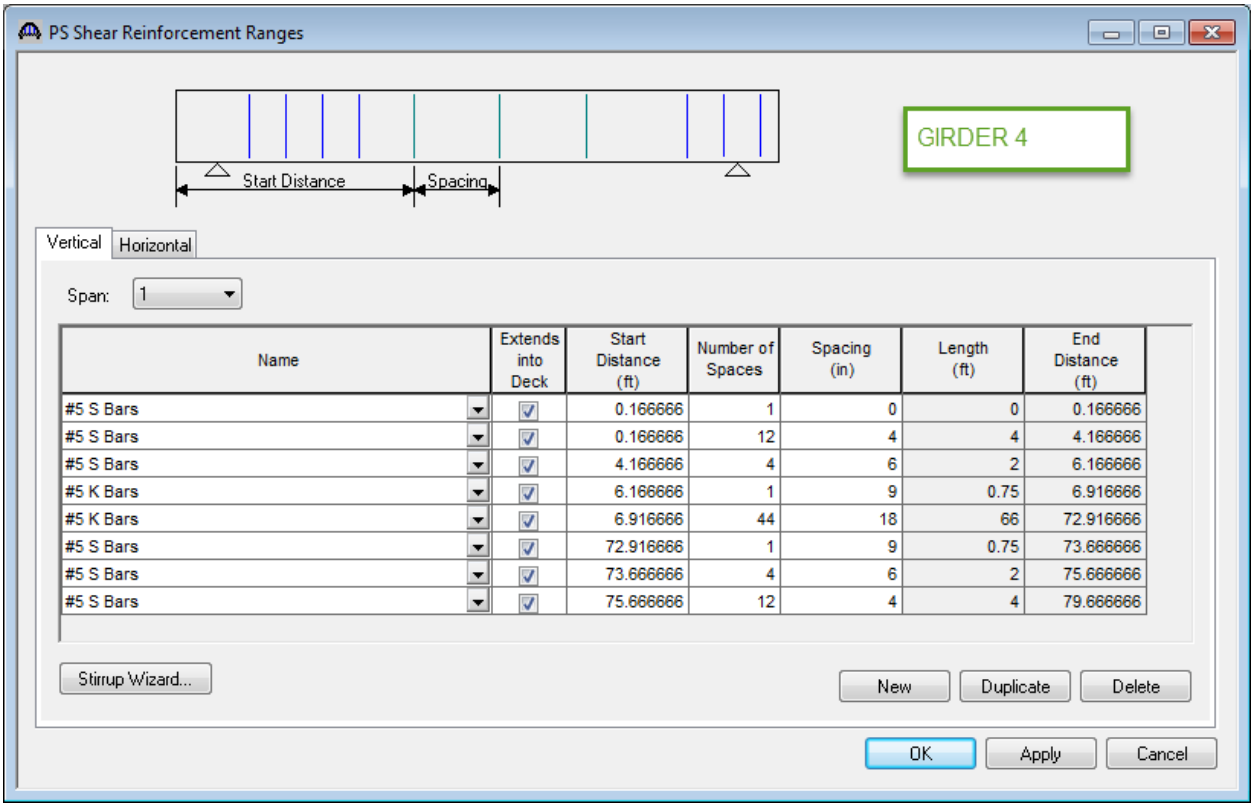

PS Haunch Profile
Y1
Y3
Y3
Z1
Z2
Z1
Z2
GIRDER 3
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Z1 (in)
Z2 (in)
Y1 (in)
Y3 (in)
1
0
78.125
78.125
1
New
Duplicate
Delete
OK
Apply
Cancel

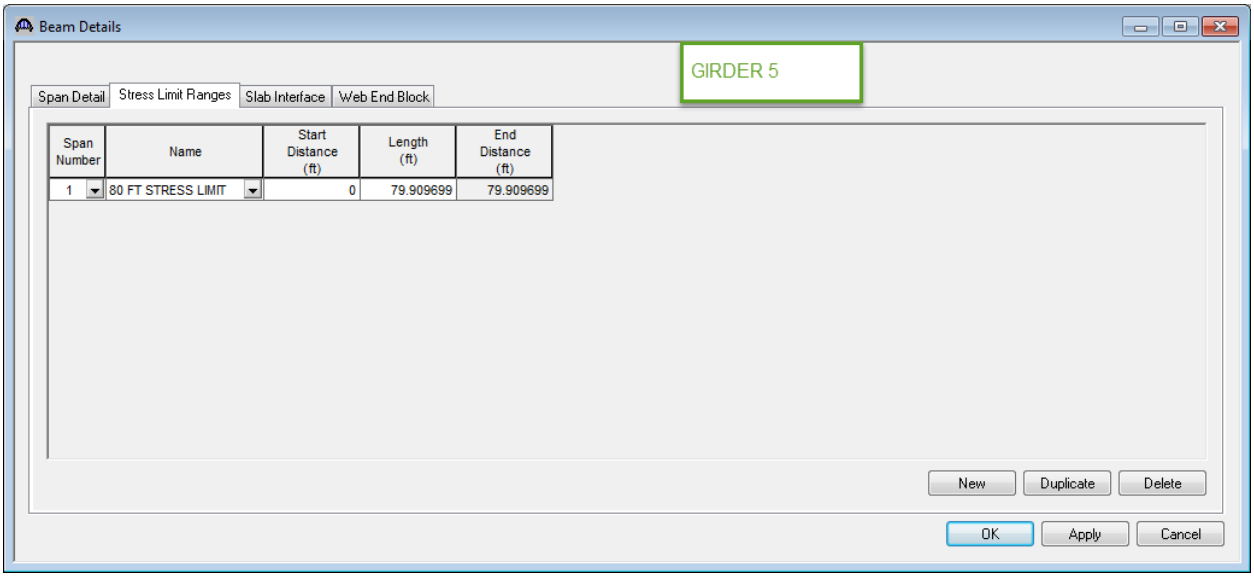

PS Shear Reinforcement Ranges
Start Distance
Spacing
GIRDER 3
Vertical
Horizontal
Span:
1
Name
Extends into Deck
Start Distance (ft)
Number of Spaces
Spacing (in)
Length (ft)
End Distance (ft)
#5 S Bars 0.166666 1 0 0 0.166666
#5 S Bars 0.166666 12 4 4 4.166666
#5 S Bars 4.166666 4 6 2 6.166666
#5 K Bars 6.166666 1 8.5 0.7083333333 6.8749993333
#5 K Bars 6.874999 44 18 66 72.874999
#5 S Bars 72.874999 1 8.5 0.7083333333 73.5833323333
#5 S Bars 73.583333 4 6 2 75.583333
#5 S Bars 75.583333 12 4 4 79.583333
Stirrup Wizard...
New
Duplicate
Delete
OK
Apply
Cancel

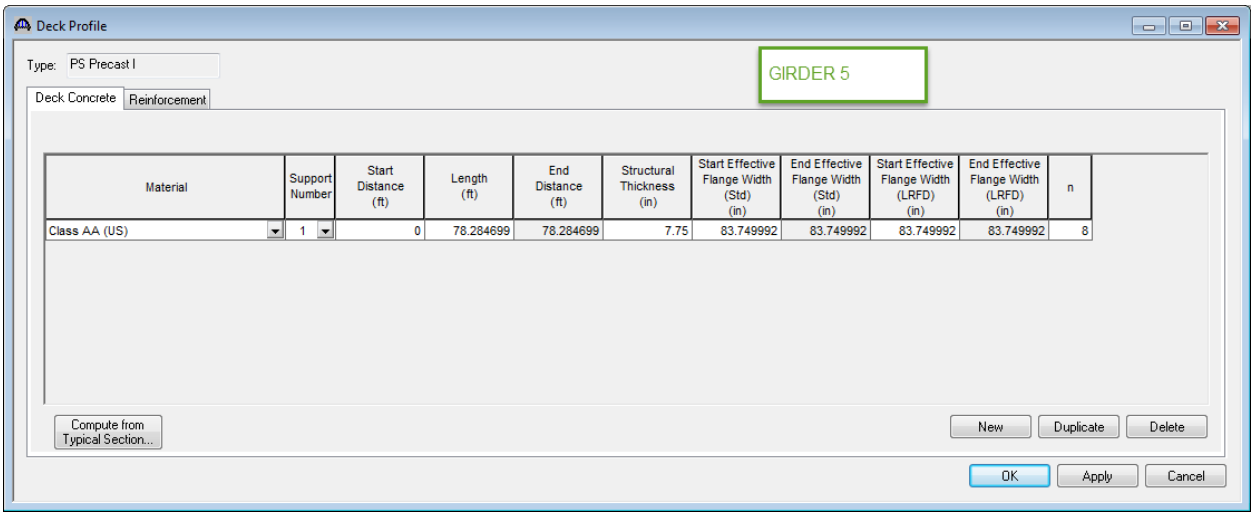

Beam Details
GIRDER 4
Span Detail
Stress Limit Ranges
Slab Interface
Web End Block
Span Number
Name
Start Distance (ft)
Length (ft)
End Distance (ft)
1
80 FT STRESS LIMIT
0
79.82985
79.82985
New
Duplicate
Delete
OK
Apply
Cancel

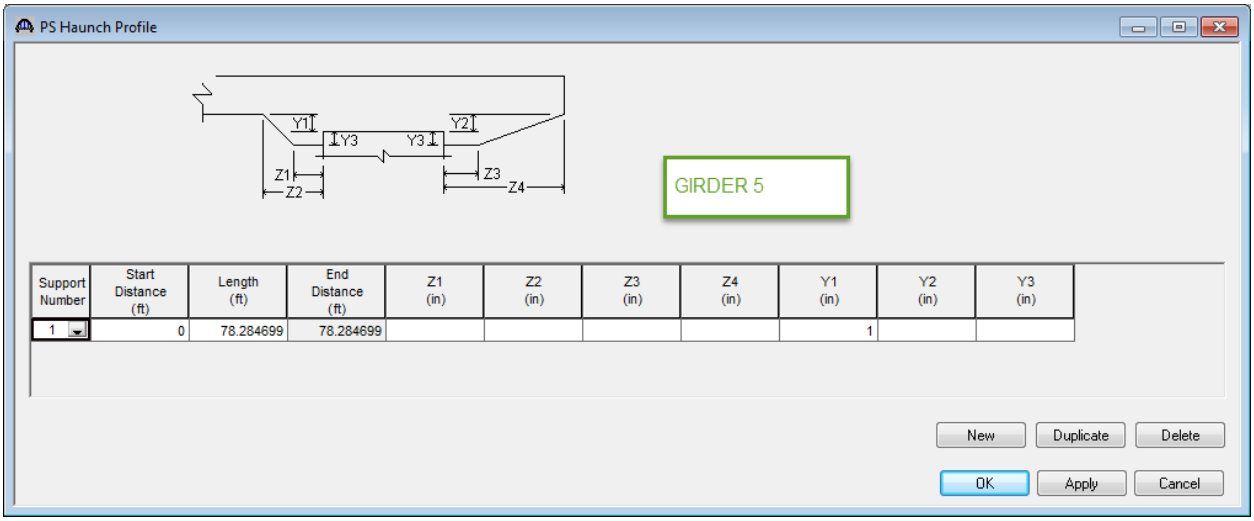

Deck Profile
Type: PS Precast I
GIRDER 4
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Structural Thickness (in)
Start Effective Flange Width (Std) (in)
End Effective Flange Width (Std) (in)
Start Effective Flange Width (LRFD) (in)
End Effective Flange Width (LRFD) (in)
n
Class AA (US)
1
0
78.20485
78.20485
7.75
91.5
91.5
91.5
91.5
8
Compute from Typical Section...
New
Duplicate
Delete
OK
Apply
Cancel

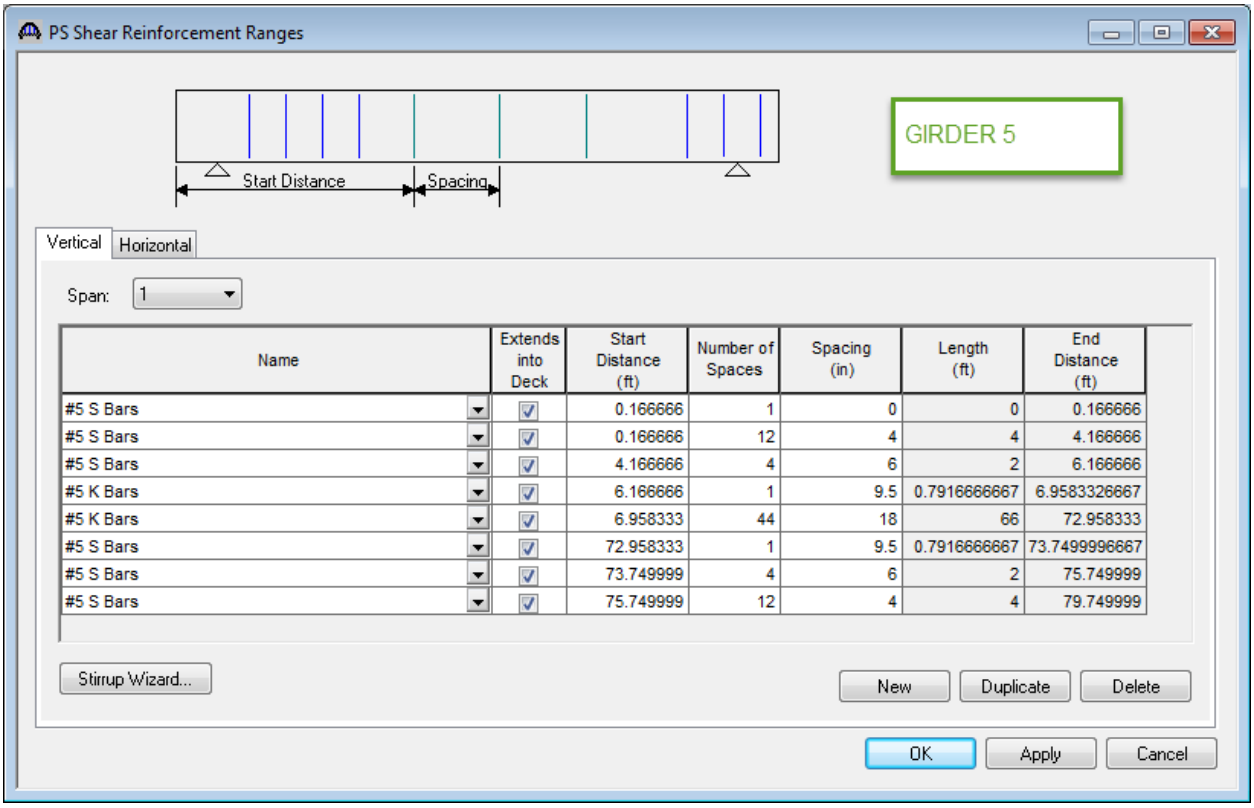

PS Haunch Profile
Y1
Y3
Y3
Z1
Z2
Z1
Z2
GIRDER 4
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Z1 (in)
Z2 (in)
Y1 (in)
Y3 (in)
1
0
78.20485
78.20485
1
New
Duplicate
Delete
OK
Apply
Cancel


PS Shear Reinforcement Ranges
Start Distance
Spacing
GIRDER 4
Vertical
Horizontal
Span:
1
Name
Extends into Deck
Start Distance (ft)
Number of Spaces
Spacing (in)
Length (ft)
End Distance (ft)
#5 S Bars 0.166666 1 0 0 0.166666
#5 S Bars 0.166666 12 4 4 4.166666
#5 S Bars 4.166666 4 6 2 6.166666
#5 K Bars 6.166666 1 9 0.75 6.916666
#5 K Bars 6.916666 44 18 66 72.916666
#5 S Bars 72.916666 1 9 0.75 73.666666
#5 S Bars 73.666666 4 6 2 75.666666
#5 S Bars 75.666666 12 4 4 79.666666
Stirrup Wizard...
New
Duplicate
Delete
OK
Apply
Cancel


Beam Details
GIRDER 5
Span Detail
Stress Limit Ranges
Slab Interface
Web End Block
Span Number
Name
Start Distance (ft)
Length (ft)
End Distance (ft)
1
80 FT STRESS LIMIT
0
79.909699
79.909699
New
Duplicate
Delete
OK
Apply
Cancel

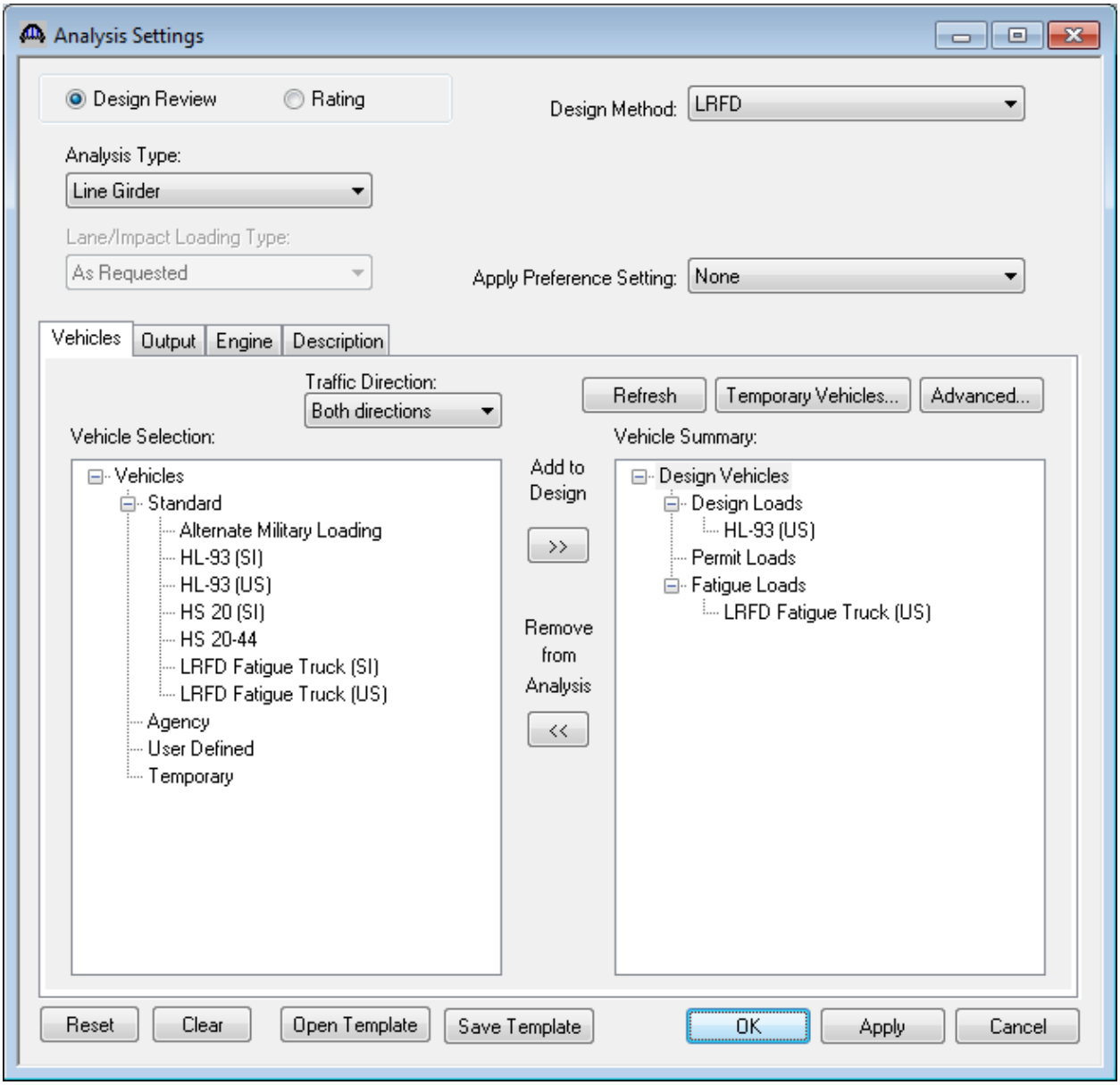

Deck Profile
Type: PS Precast I
GIRDER 5
Deck Concrete
Reinforcement
Material
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Structural Thickness (in)
Start Effective Flange Width (Std) (in)
End Effective Flange Width (Std) (in)
Start Effective Flange Width (LRFD) (in)
End Effective Flange Width (LRFD) (in)
n
Class AA (US)
1
0
78.284699
78.284699
7.75
83.749992
83.749992
83.749992
83.749992
8
Compute from Typical Section...
New
Duplicate
Delete
OK
Apply
Cancel


PS Haunch Profile
Y1
Y2
Y3
Y3
Z1
Z2
Z3
Z4
GIRDER 5
Support Number
Start Distance (ft)
Length (ft)
End Distance (ft)
Z1 (in)
Z2 (in)
Z3 (in)
Z4 (in)
Y1 (in)
Y2 (in)
Y3 (in)
1
0
78.284699
78.284699
1
New
Duplicate
Delete
OK
Apply
Cancel

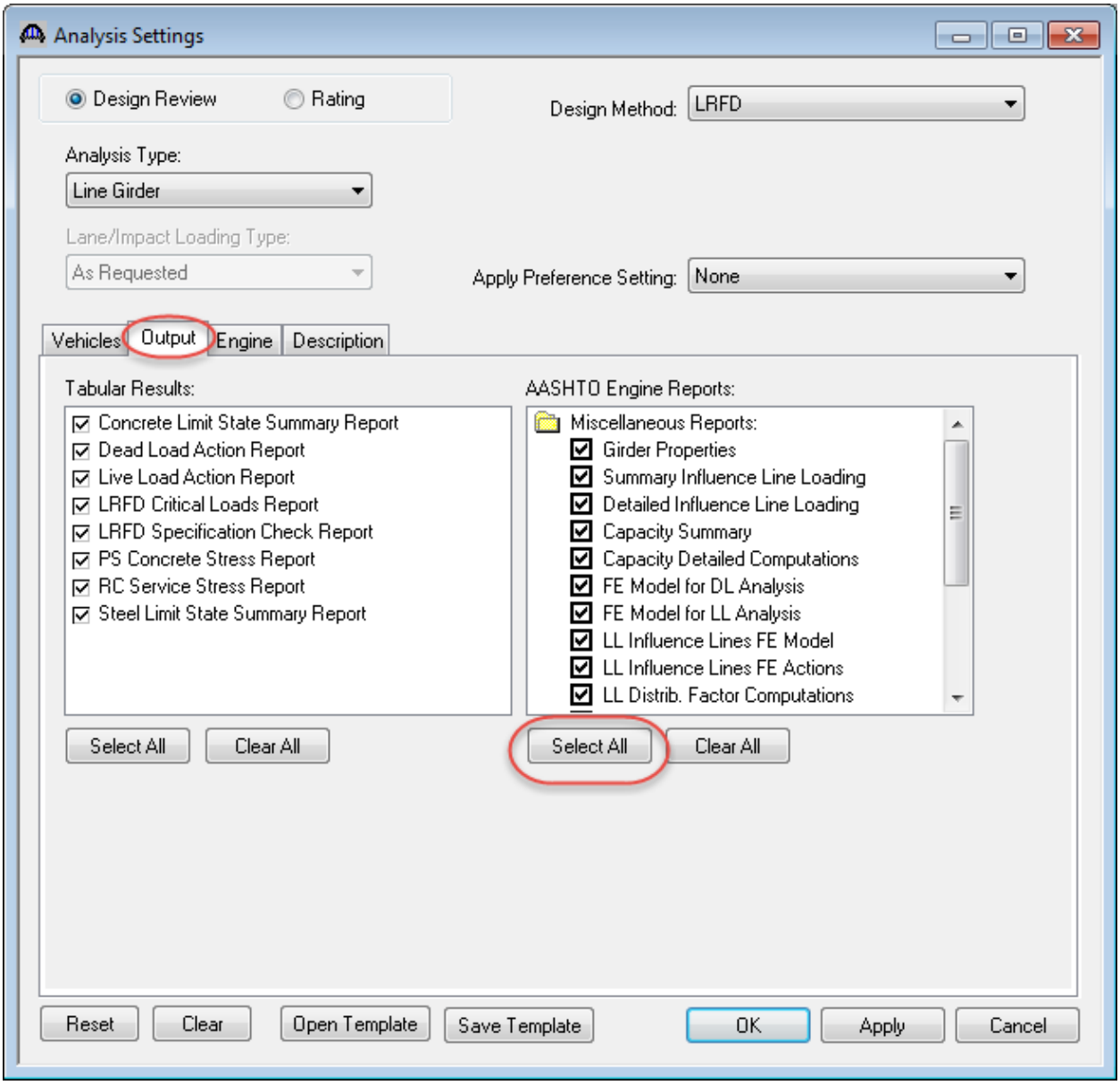

PS Shear Reinforcement Ranges
Start Distance
Spacing
GIRDER 5
Vertical
Horizontal
Span:
1
Name
Extends into Deck
Start Distance (ft)
Number of Spaces
Spacing (in)
Length (ft)
End Distance (ft)
#5 S Bars 0.166666 1 0 0 0.166666
#5 S Bars 0.166666 12 4 4 4.166666
#5 S Bars 4.166666 4 6 2 6.166666
#5 K Bars 6.166666 1 9.5 0.7916666667 6.9583326667
#5 K Bars 6.958333 44 18 66 72.958333
#5 S Bars 72.958333 1 9.5 0.7916666667 73.7499996667
#5 S Bars 73.749999 4 6 2 75.749999
#5 S Bars 75.749999 12 4 4 79.749999
Stirrup Wizard...
New
Duplicate
Delete
OK
Apply
Cancel

Analysis and Results

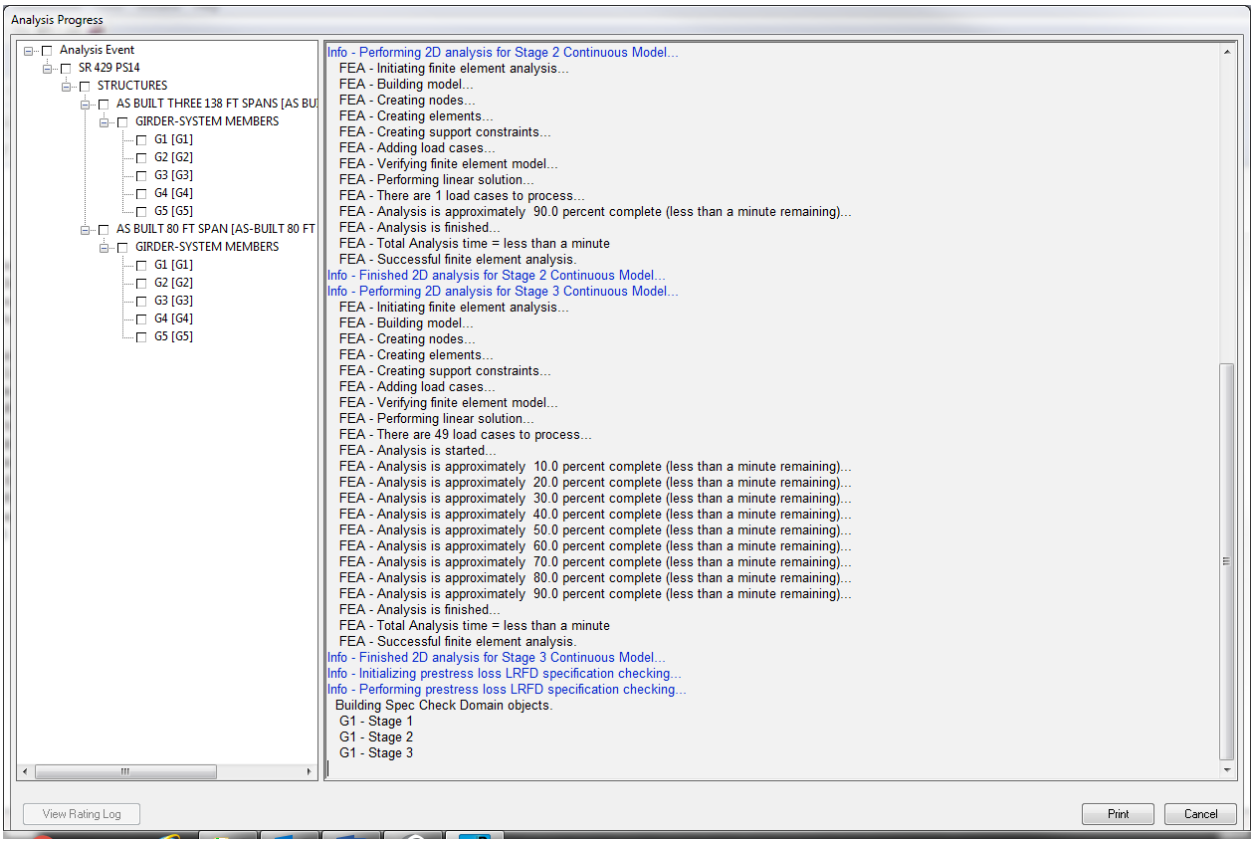
To perform a design review, select the View Analysis Settings button on the toolbar to open the window shown below. Use the “HL-93 Design Review” template to select the vehicles to be used. This is done inside the file.



Next go to “Output” tab and click on “Select All” under AASHTO Engine Reports and then click Ok.



Next click the Analyze button on the toolbar to perform the design review. The Analysis Progress dialog will appear and should be reviewed for any warning messages.



The following steps are performed when doing a design review of a multi-span prestressed beam using the BrD LRFD analysis engine:

1. Finite element models are generated for the dead load and live load analyses. A Stage 1 FE model is generated for the dead loads on the non-composite simple span prestressed concrete beam.

   For Continuous method of analysis:
   A Stage 2 FE model is generated for the continuous final span condition for composite dead load analysis.
   A Stage 3 FE model is generated for the continuous final span condition for the live load analysis.

   For Continuous and Simple method of analysis:
   Two Stage 2 FE models are generated:
   Continuous final span condition
   Simple span condition

   Two Stage3 FE models are generated:
   Continuous final span condition
   Simple span condition

Stage 2 models contain section properties corresponding to the sustained modular ratio factor entered in BrD (eg, 2n). Stage 3 models contain section properties corresponding to the modular ratio (n).

The model generated by the export to the BrD LRFD analysis engine will always contain node points at the middle of each simple span, at simple support locations, at harp points, at debond locations and at prestress strand transfer length locations so that the prestress force distribution can be computed.

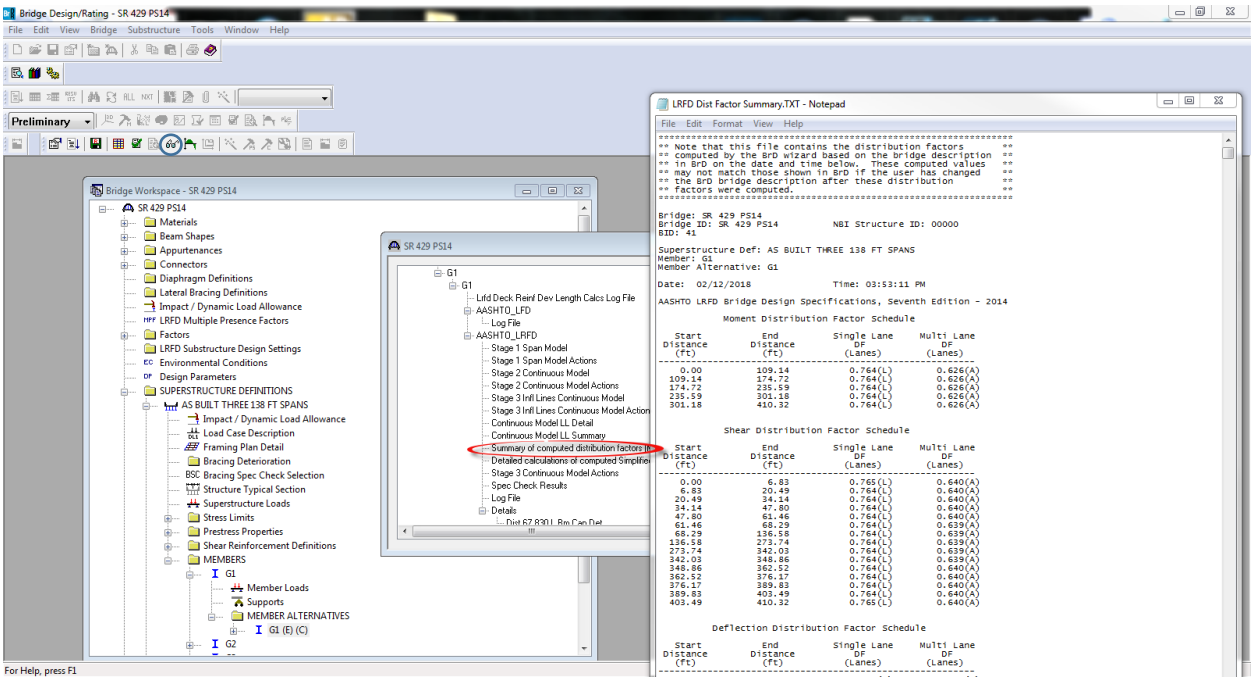
2. The Stage 1 and 2 FE models are analyzed for the dead load. The prestress loss calculations are then performed along with determining the prestress forces at transfer and the restraint effects for the creep and shrinkage analysis for multi-span structures.

3. The final analysis then takes place. The prestress forces at transfer are applied to the Stage 1 FE model solely to determine the prestress camber in the beam. They are not included in the load combination generation. Creep and shrinkage forces are applied to the Stage 2 FE model.

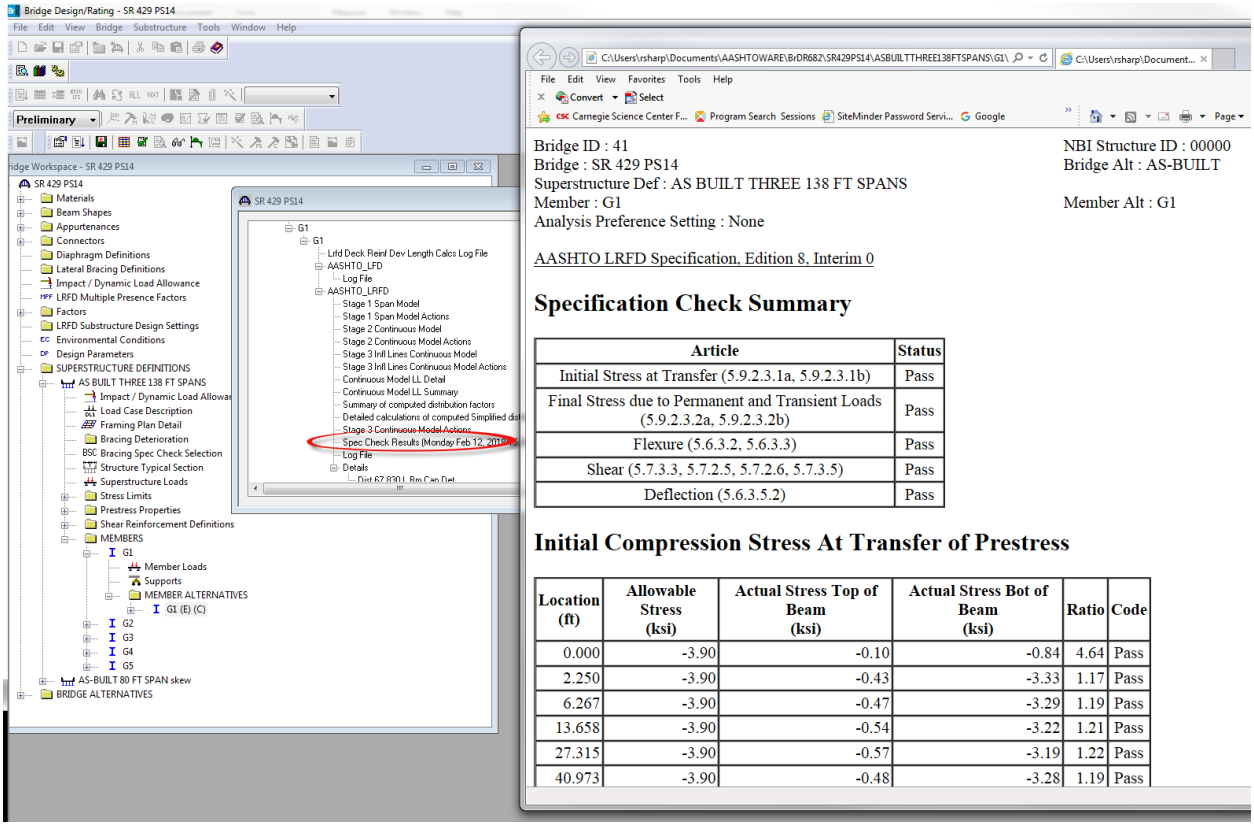
   The Stage 1 and 2 FE models are analyzed for the dead load. The Stage 3 FE model is loaded with unit loads at each node to generate influence lines for the beam. The influence loads are then loaded with the selected vehicles to find the maximum live load effects.

4. Load combinations are generated for the loadings and specification checks are performed at each of the nodes in finite element model. For the Continuous and Simple method of analysis the maximum force effects between the 2 sets of models are used to generate the load combinations.

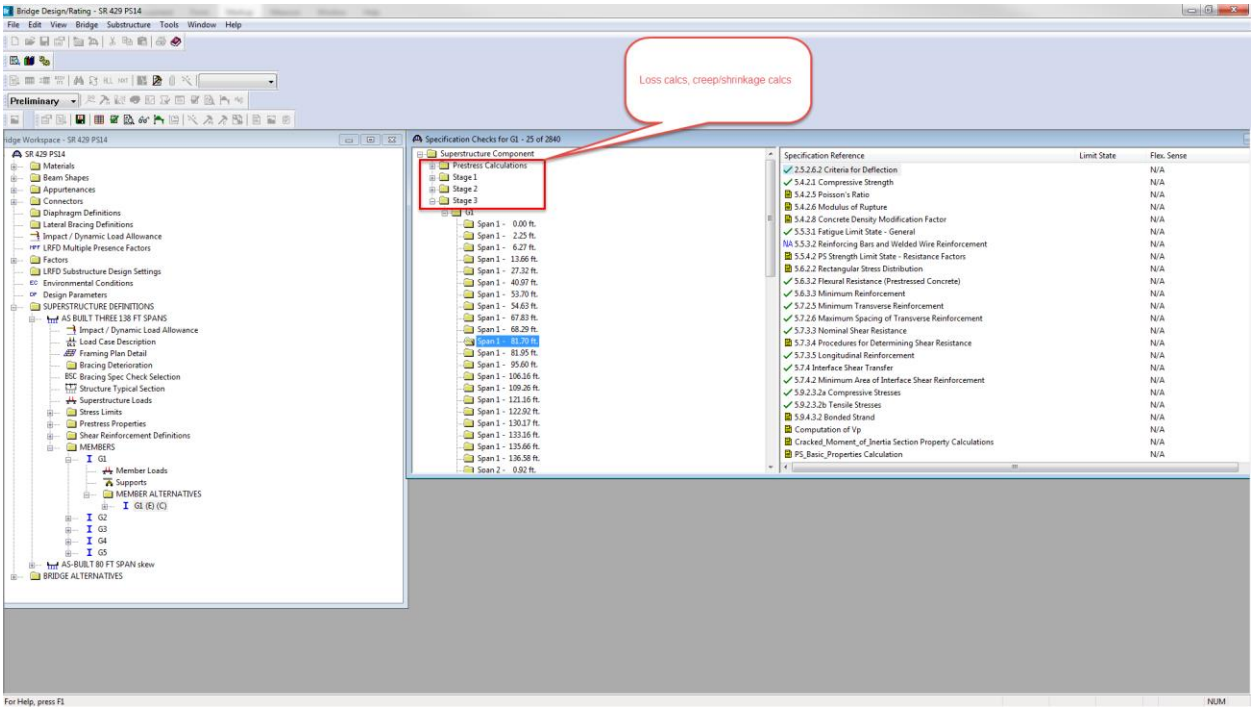
A summary and a detailed report of the computed live load distribution factors are available.



A summary report of the specification check results is also available. This summary report lists the design ratios for each spec article at each spec check location point. The design ratio is the ratio of capacity to demand. A design ratio less than one indicates the demand is greater than the capacity and the spec article fails. A design ratio equal to 99.0 indicates the section is subject to zero demand.

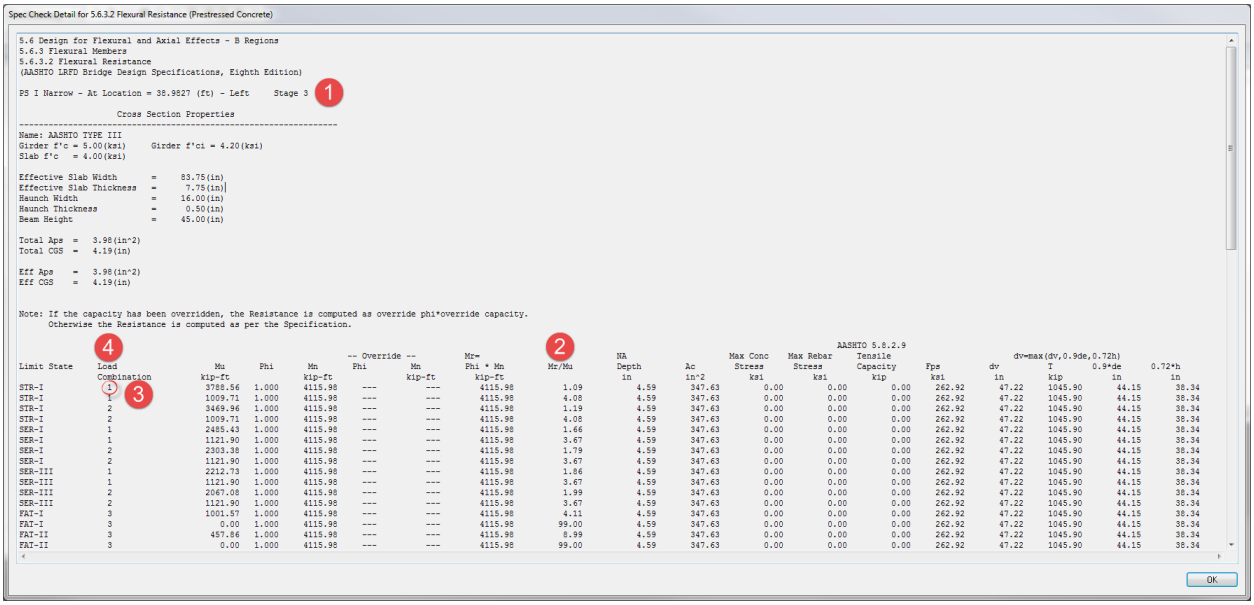


The specification checks can be viewed by selecting the “View Spec Check” button.



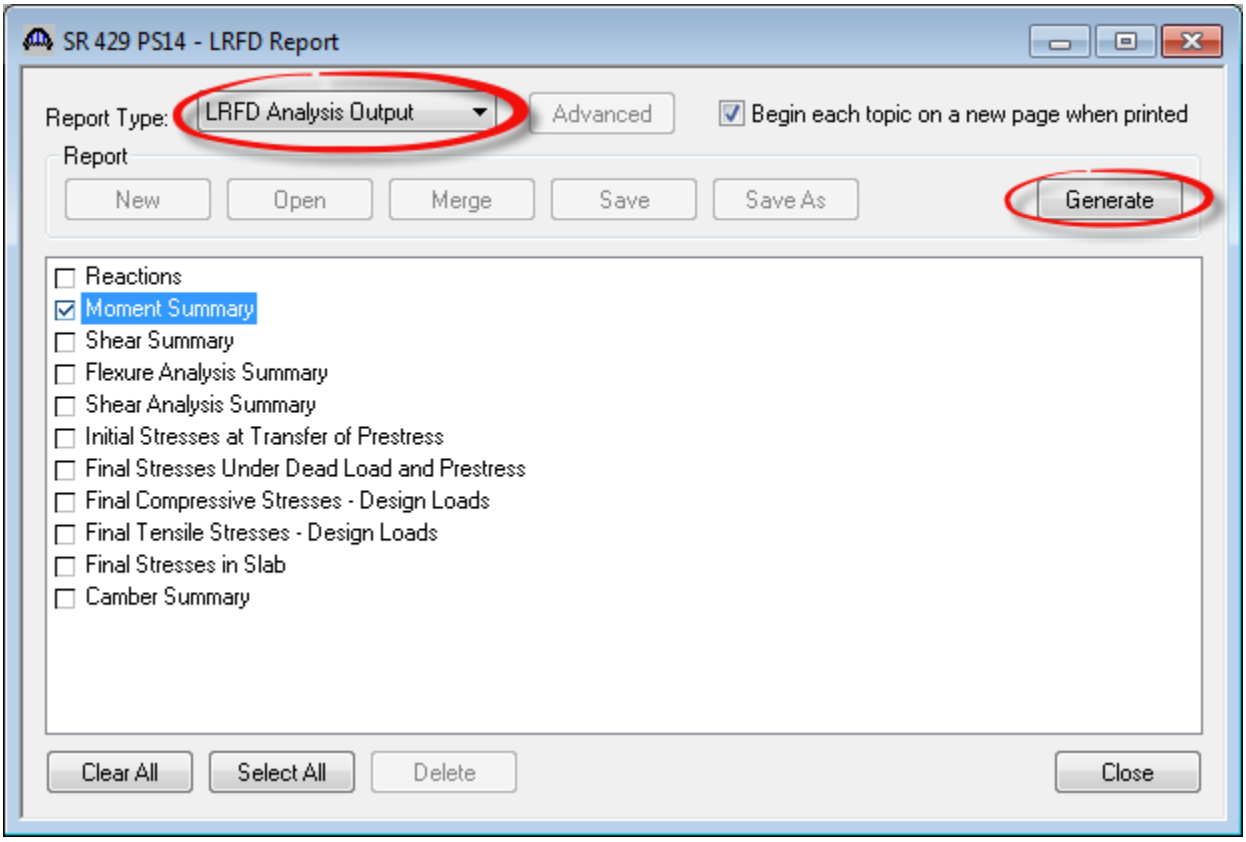
Open the spec check detail window for the flexural resistance at the middle of the simple span. The following is noted for this window, other spec articles are similar:

1. For each spec check location, both the left and right sides of the point are evaluated. The Deflection article is an exception to this since deflection must be the same between the left and right sides of a point.
2. The design ratio is printed out for the article. The design ratio is the ratio of capacity to demand. A design ratio less than one indicates the demand is greater than the capacity and the spec article fails. A design ratio equal to 99.0 indicates the section is subject to zero demand.
3. The Strength-I, Service-I, Service III and Fatigue limit states are the only limit states investigated. For each limit state, the max and min force effect is checked. Thus each limit state shows two rows of data.
4. The LL load combination is shown in this column. If the location is not at a node in the FE model (eg, the node is at a point where the rebar is fully developed), this column will list two load combinations separated by a comma. The first load combination is the combination considered at the left end and the second load combination is the combination considered at the right end of the FE element that contains this location. The resulting load displayed is a linear interpolation between the two displayed load cases.

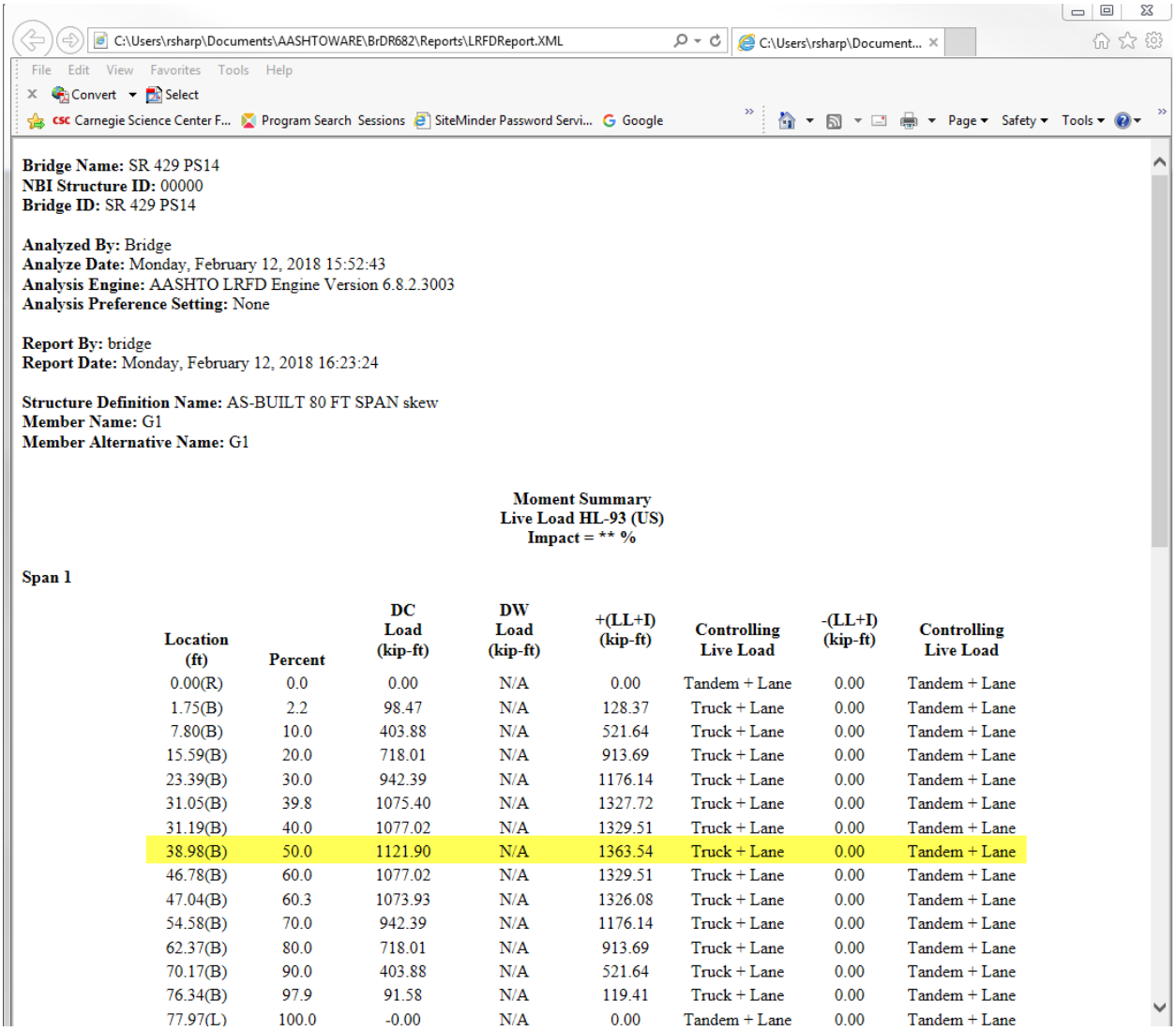


The loads making up the Mu = 3788.56 k-ft for the maximum Strength-I limit state can be tracked down in Moment Summary report.

The Moment Summary report can be viewed by selecting the “Report Tool” button  on the toolbar to open the window shown below. Select “LRFD Analysis Output” in “Report Type”.



Select Moment Summary check box and click on “Generate” button will populate the moment summary report as shown below.



C:\Users\rsharp\Documents\AASHTOWARE\BrDR682\Reports\LRFDReport.XML

Bridge Name: SR 429 PS14
NBI Structure ID: 00000
Bridge ID: SR 429 PS14

Analyzed By: Bridge
Analyze Date: Monday, February 12, 2018 15:52:43
Analysis Engine: AASHTO LRFD Engine Version 6.8.2.3003
Analysis Preference Setting: None

Report By: bridge
Report Date: Monday, February 12, 2018 16:23:24

Structure Definition Name: AS-BUILT 80 FT SPAN skew
Member Name: G1
Member Alternative Name: G1

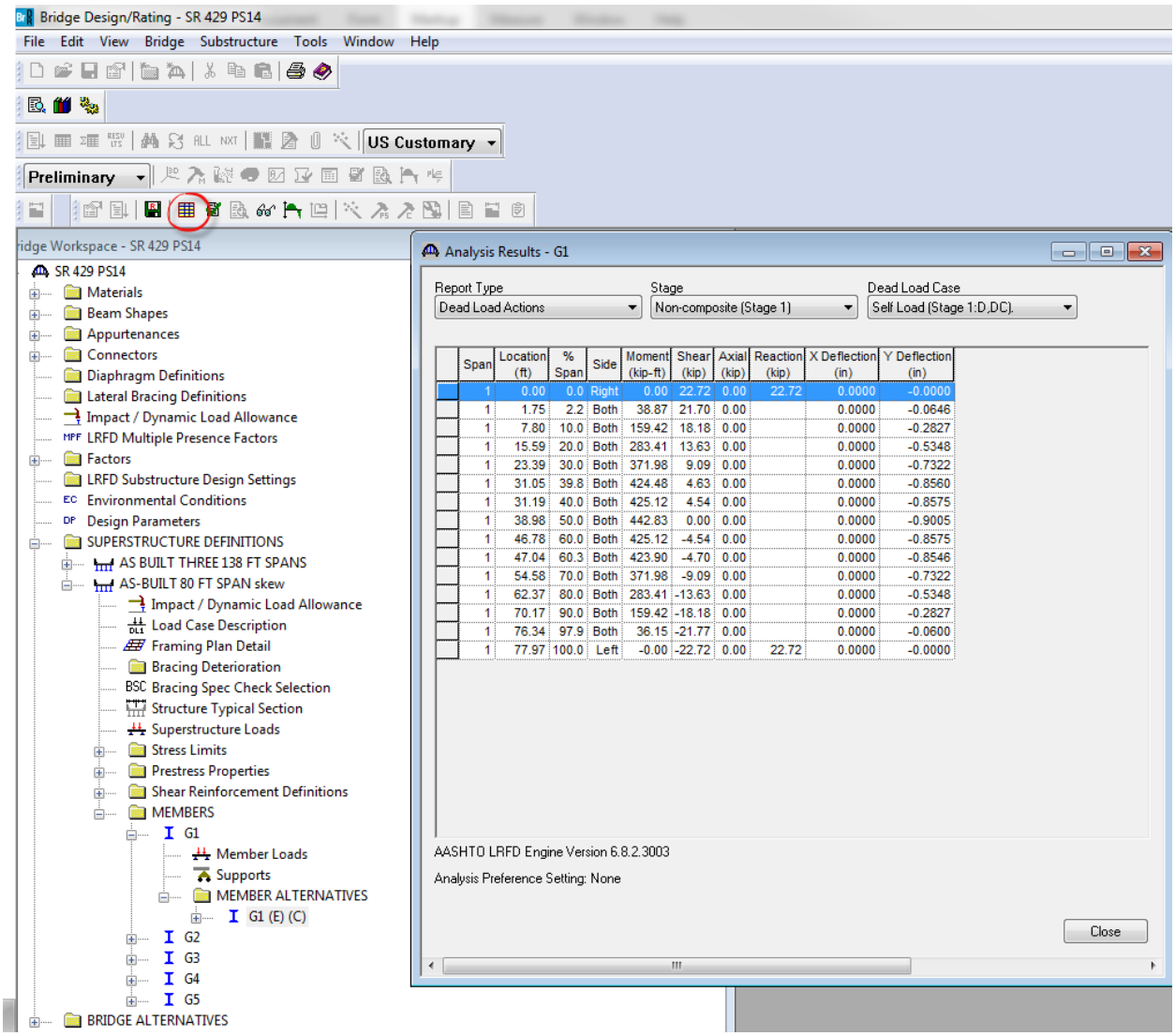
Moment Summary
Live Load HL-93 (US)
Impact = ** %

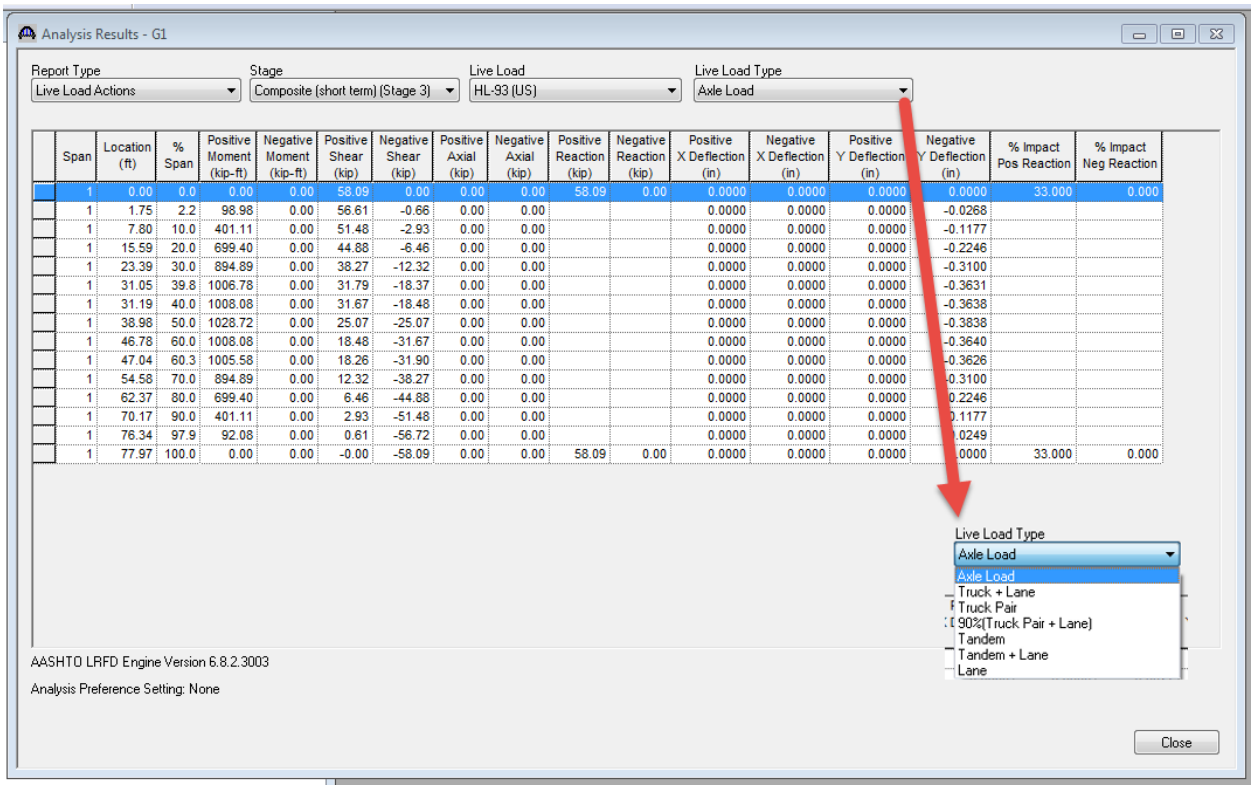
Span 1

Location (ft)	Percent	DC Load (kip-ft)	DW Load (kip-ft)	+(LL+I) (kip-ft)	Controlling Live Load	-(LL+I) (kip-ft)	Controlling Live Load
0.00(R)	0.0	0.00	N/A	0.00	Tandem + Lane	0.00	Tandem + Lane
1.75(B)	2.2	98.47	N/A	128.37	Truck + Lane	0.00	Tandem + Lane
7.80(B)	10.0	403.88	N/A	521.64	Truck + Lane	0.00	Tandem + Lane
15.59(B)	20.0	718.01	N/A	913.69	Truck + Lane	0.00	Tandem + Lane
23.39(B)	30.0	942.39	N/A	1176.14	Truck + Lane	0.00	Tandem + Lane
31.05(B)	39.8	1075.40	N/A	1327.72	Truck + Lane	0.00	Tandem + Lane
31.19(B)	40.0	1077.02	N/A	1329.51	Truck + Lane	0.00	Tandem + Lane
38.98(B)	50.0	1121.90	N/A	1363.54	Truck + Lane	0.00	Tandem + Lane
46.78(B)	60.0	1077.02	N/A	1329.51	Truck + Lane	0.00	Tandem + Lane
47.04(B)	60.3	1073.93	N/A	1326.08	Truck + Lane	0.00	Tandem + Lane
54.58(B)	70.0	942.39	N/A	1176.14	Truck + Lane	0.00	Tandem + Lane
62.37(B)	80.0	718.01	N/A	913.69	Truck + Lane	0.00	Tandem + Lane
70.17(B)	90.0	403.88	N/A	521.64	Truck + Lane	0.00	Tandem + Lane
76.34(B)	97.9	91.58	N/A	119.41	Truck + Lane	0.00	Tandem + Lane
77.97(L)	100.0	-0.00	N/A	0.00	Tandem + Lane	0.00	Tandem + Lane

The resulting maximum moment for Strength-I at the midspan is equal to (1.25 * 1121.90) + (1.75 * 1363.54) = 3788.56 kft.

Tabular dead load and live load analysis results are available in the Analysis Results window.





Note these values include dynamic load allowance, distribution factors and any live load scale factor entered on the Analysis Settings window.