Multicell Box LFR Tutorial

MCB3 - Post-Tensioned Multicell Box LFR Example

Topics Covered

- Post-tensioned concrete multicell box data entry
- Live load distribution factor calculations
- LFR analysis and results

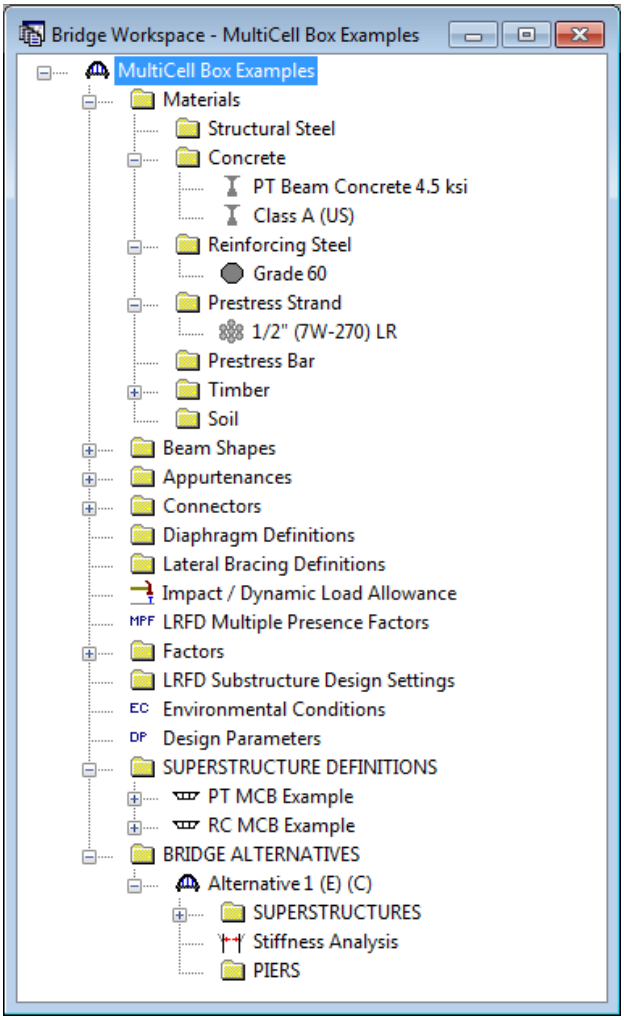
This example describes entering a post-tensioned multicell box superstructure into AASHTOWare BrR. The superstructure is not integral with the substructure.

Analysis Methods

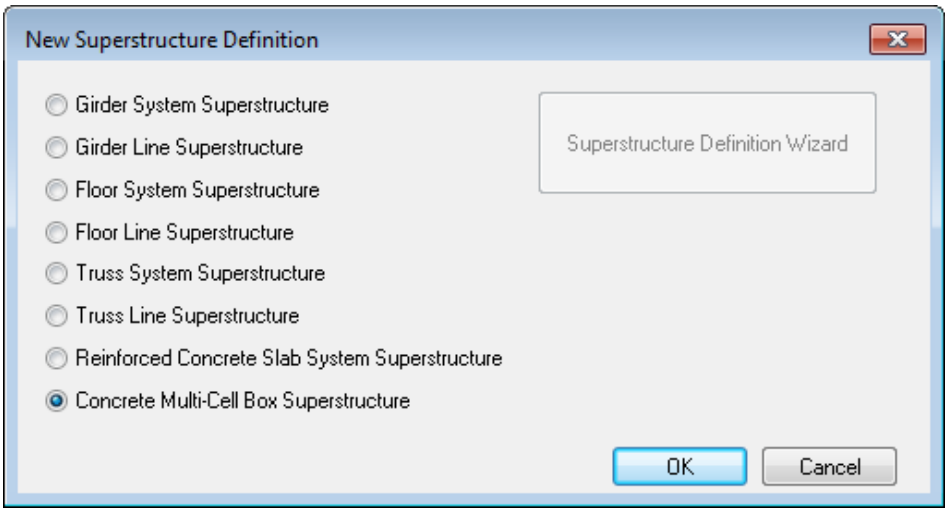
Post-tensioned concrete multicell box (MCB) superstructures can be analyzed in the following manners:

- LFR and LRFR
- Full box section including each individual webline

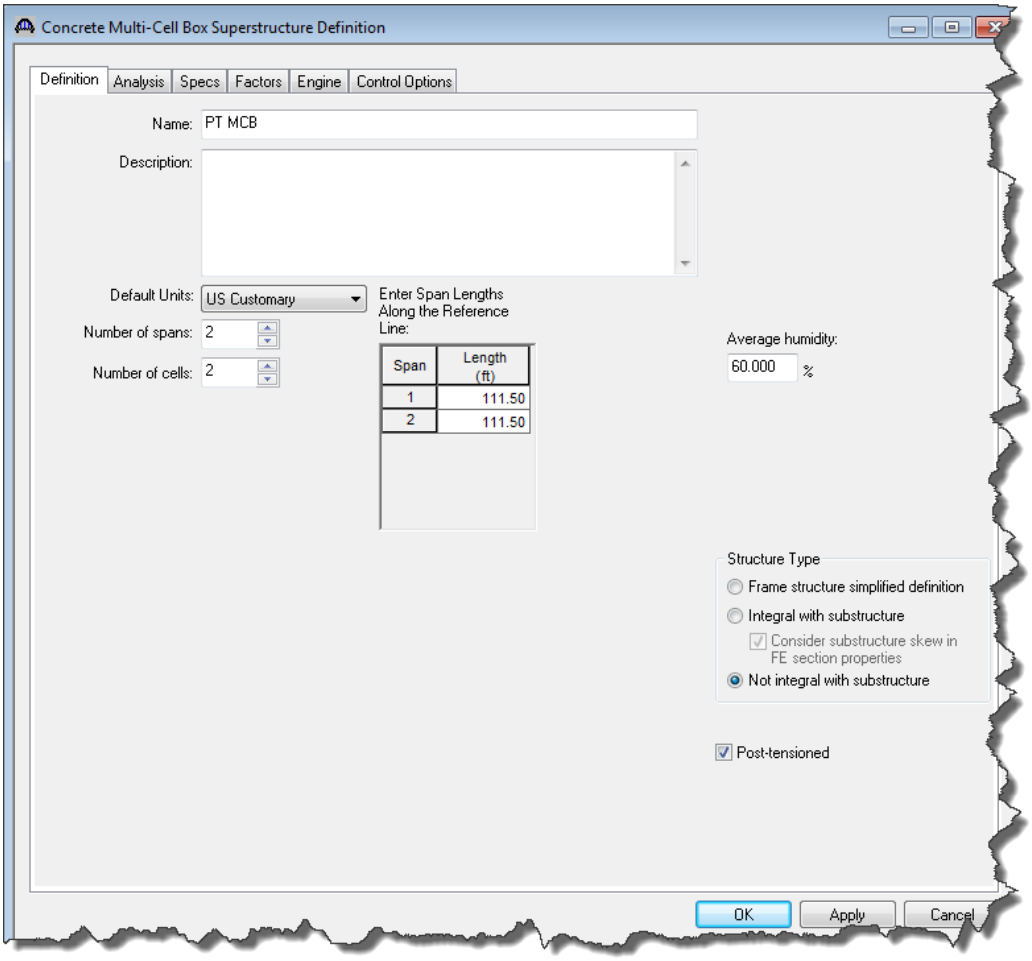
Open bridge BID 27 ‘MultiCell Box Examples’ in the sample database.



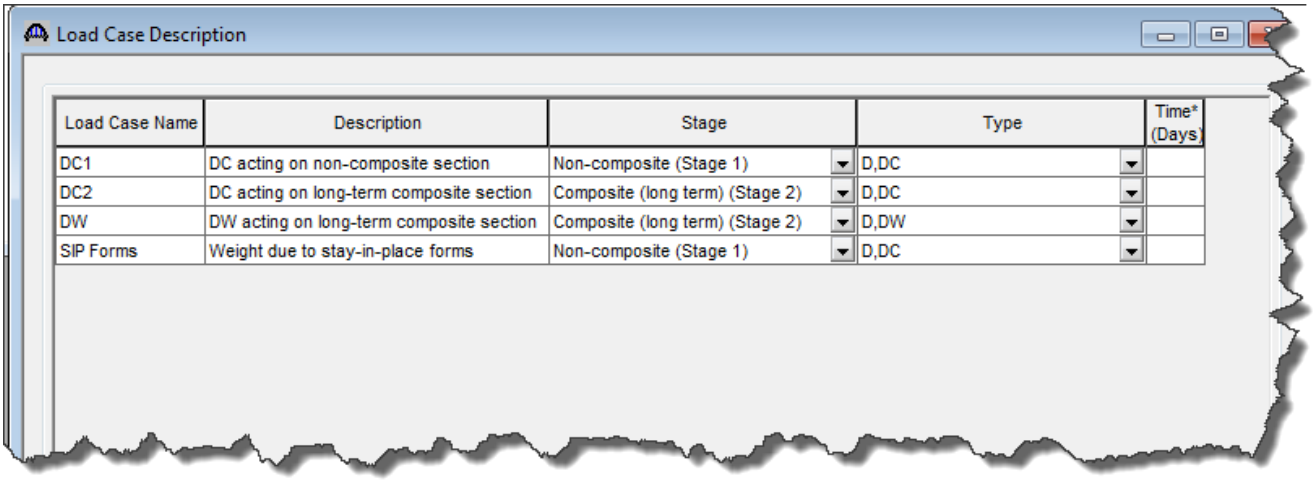
Create a new MCB (multicell box) superstructure definition.



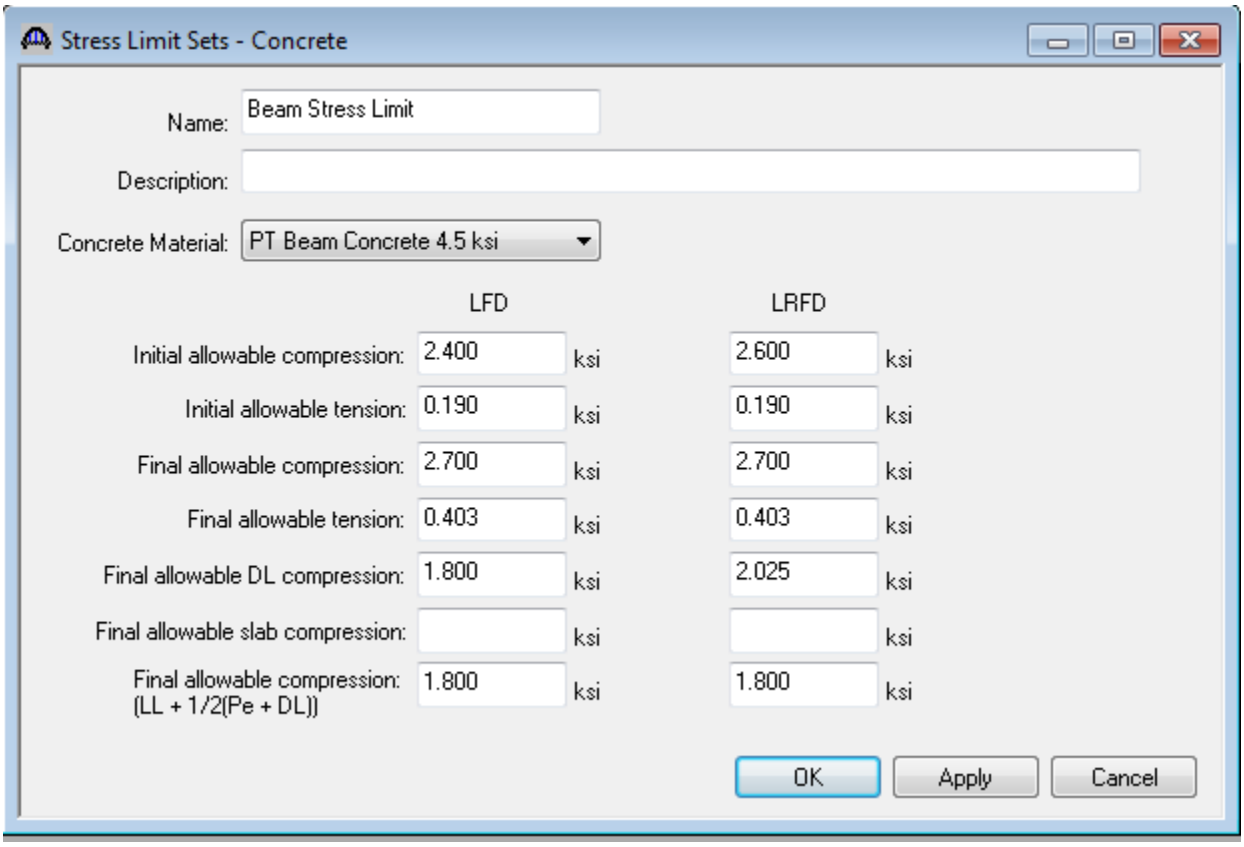
Enter the following data for the superstructure definition. Select the 'Post-tensioned' checkbox. This will display the PT windows in the user interface.



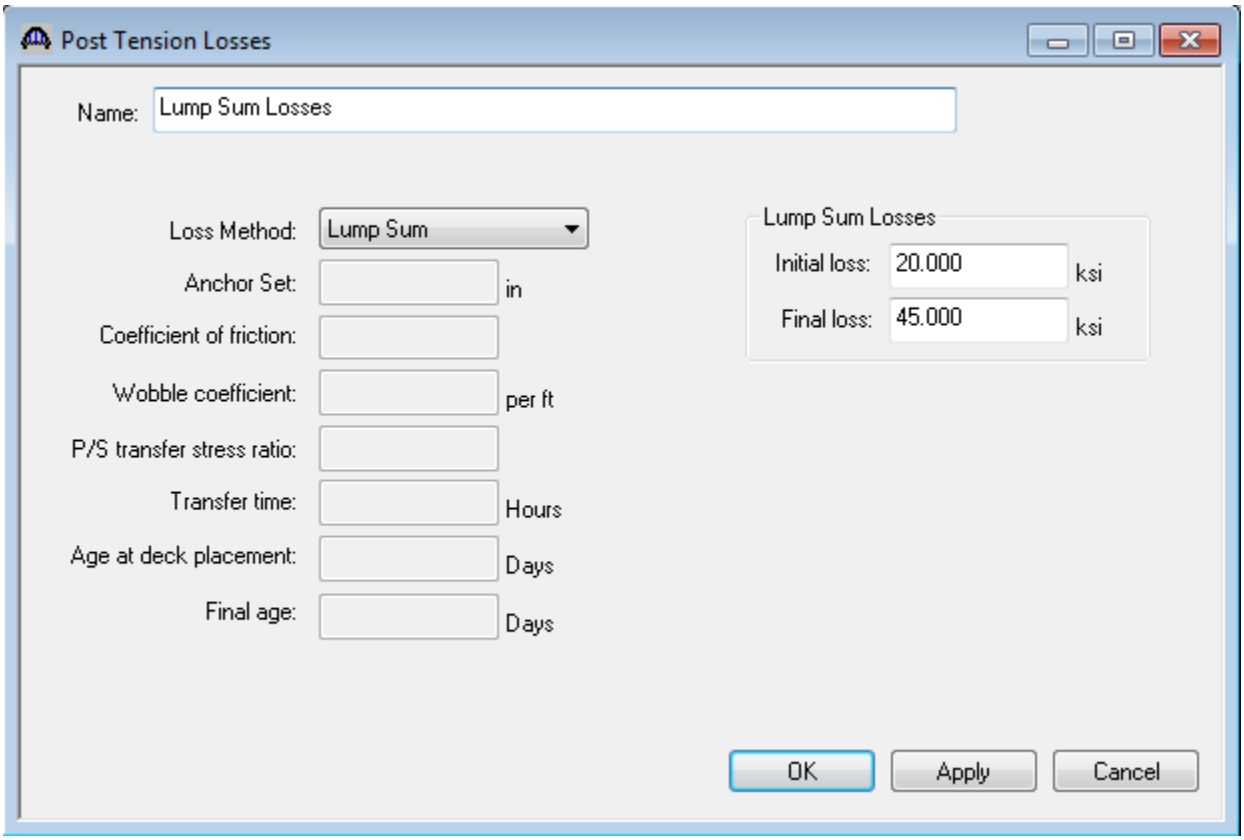
Open the Load Case Description window and use the 'Add Default…' button to create the following load cases.



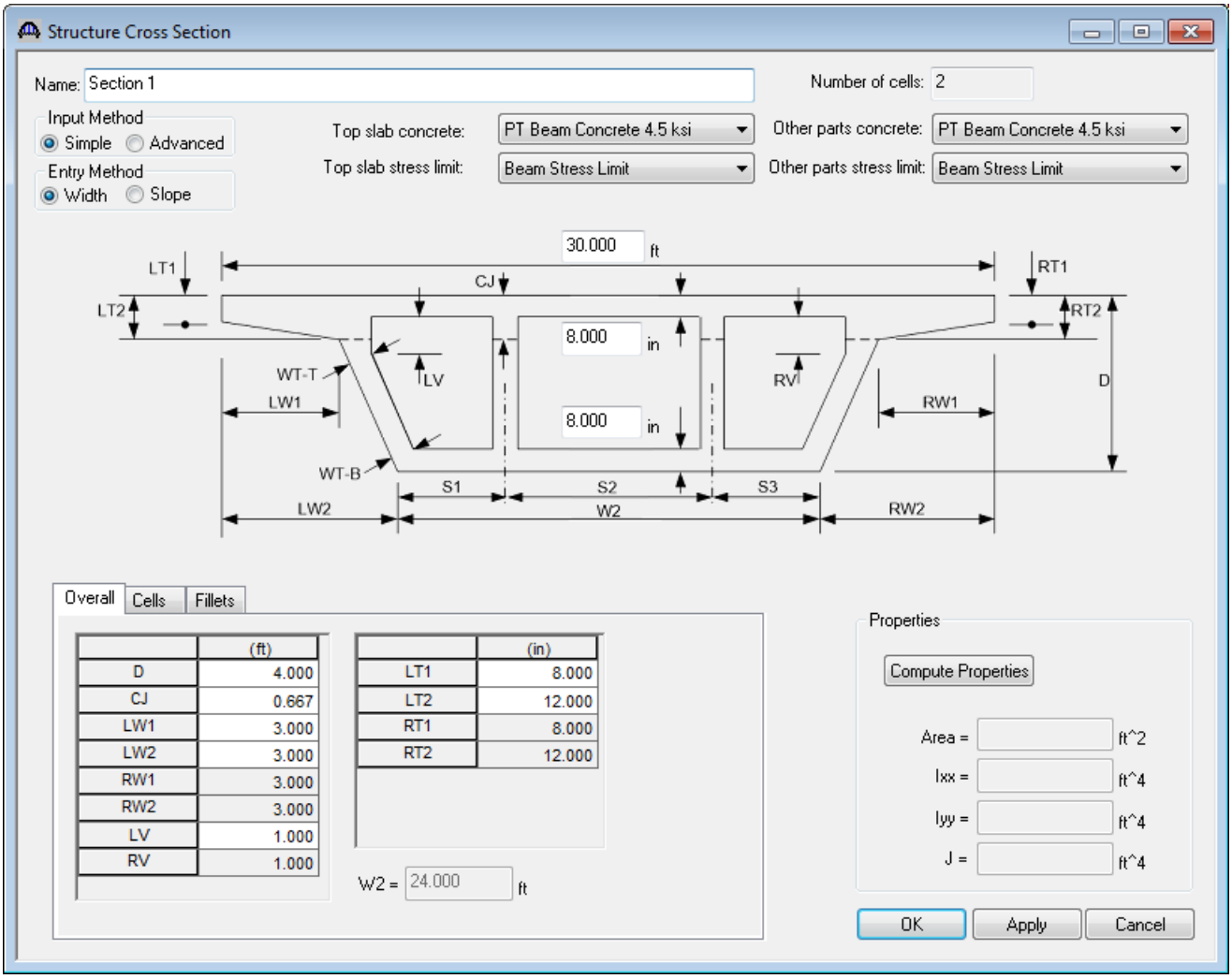
Create a stress limit for the beam concrete.

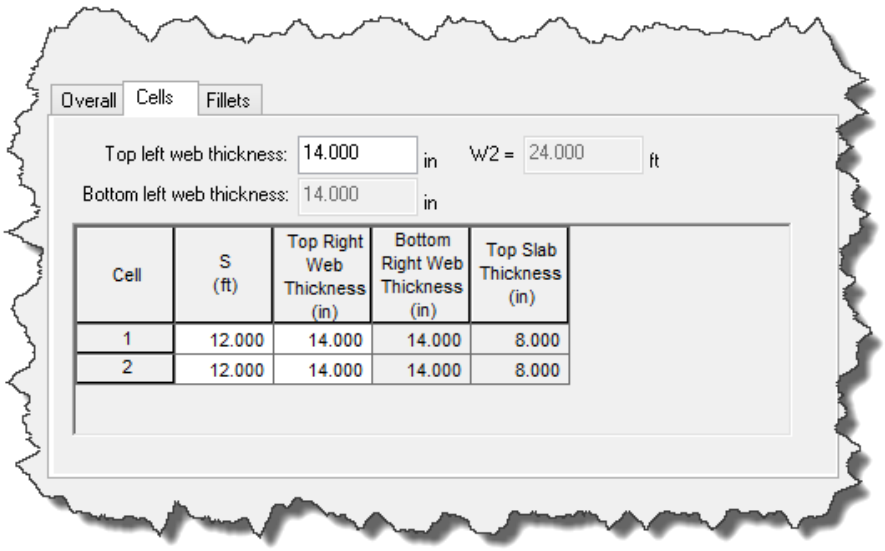


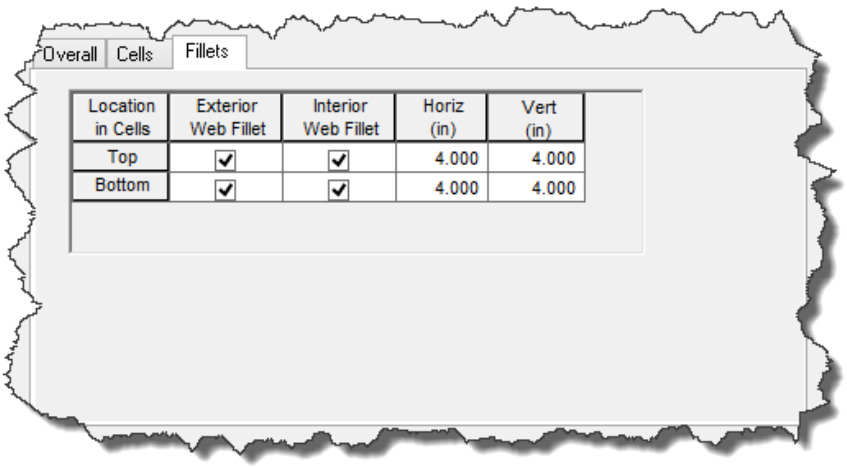
Create the following Lump Sum losses.



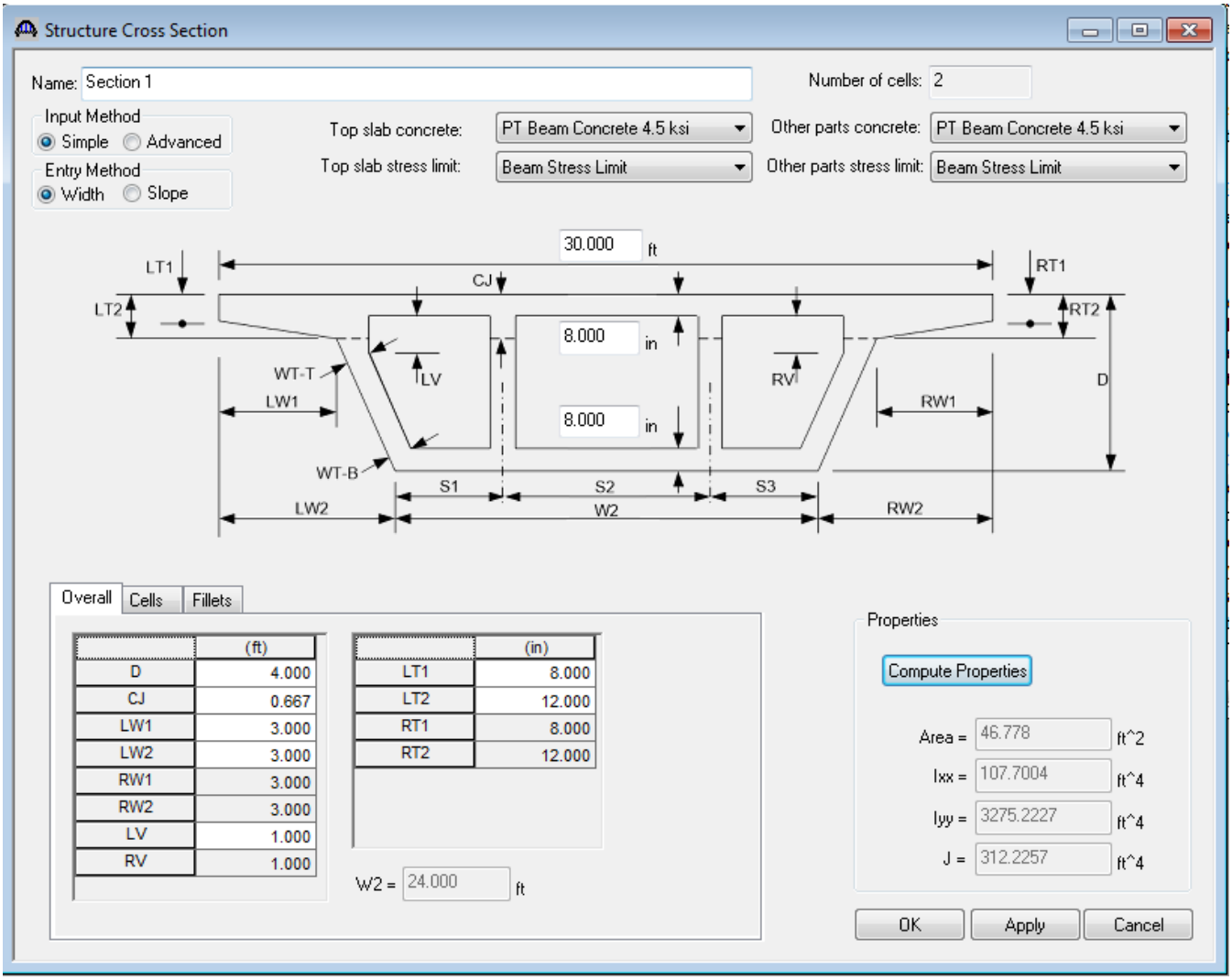
Create the following structure cross section.



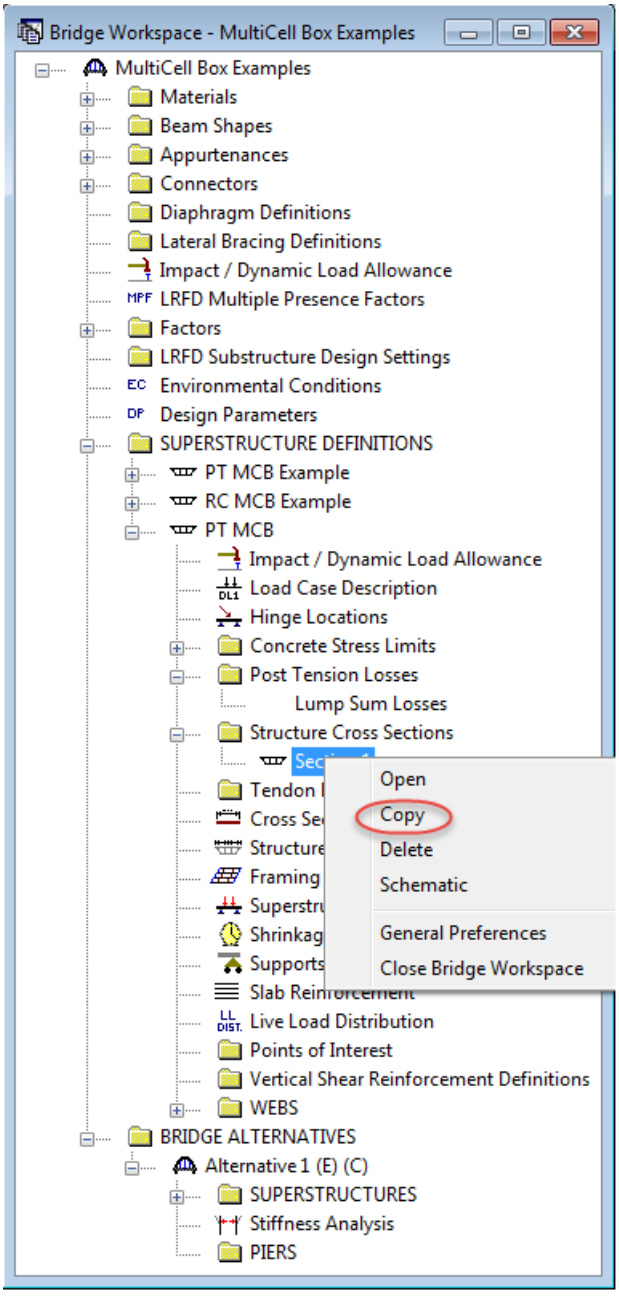


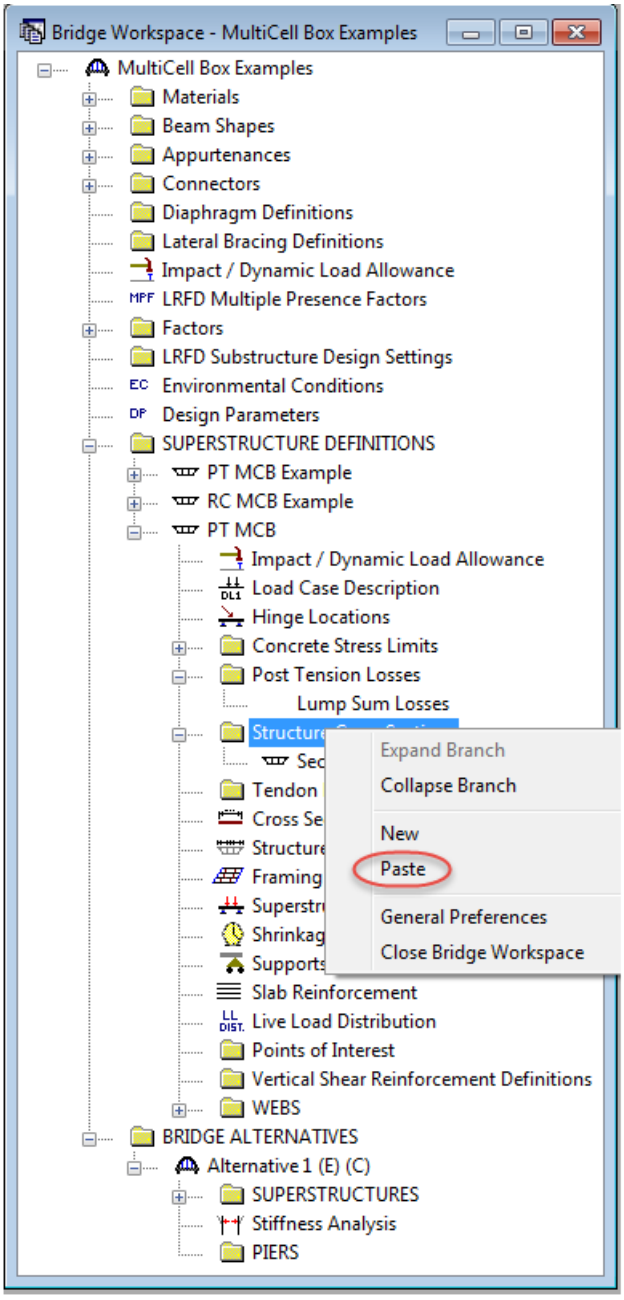


Now that all of the dimensions are entered, click the 'Compute Properties' button.

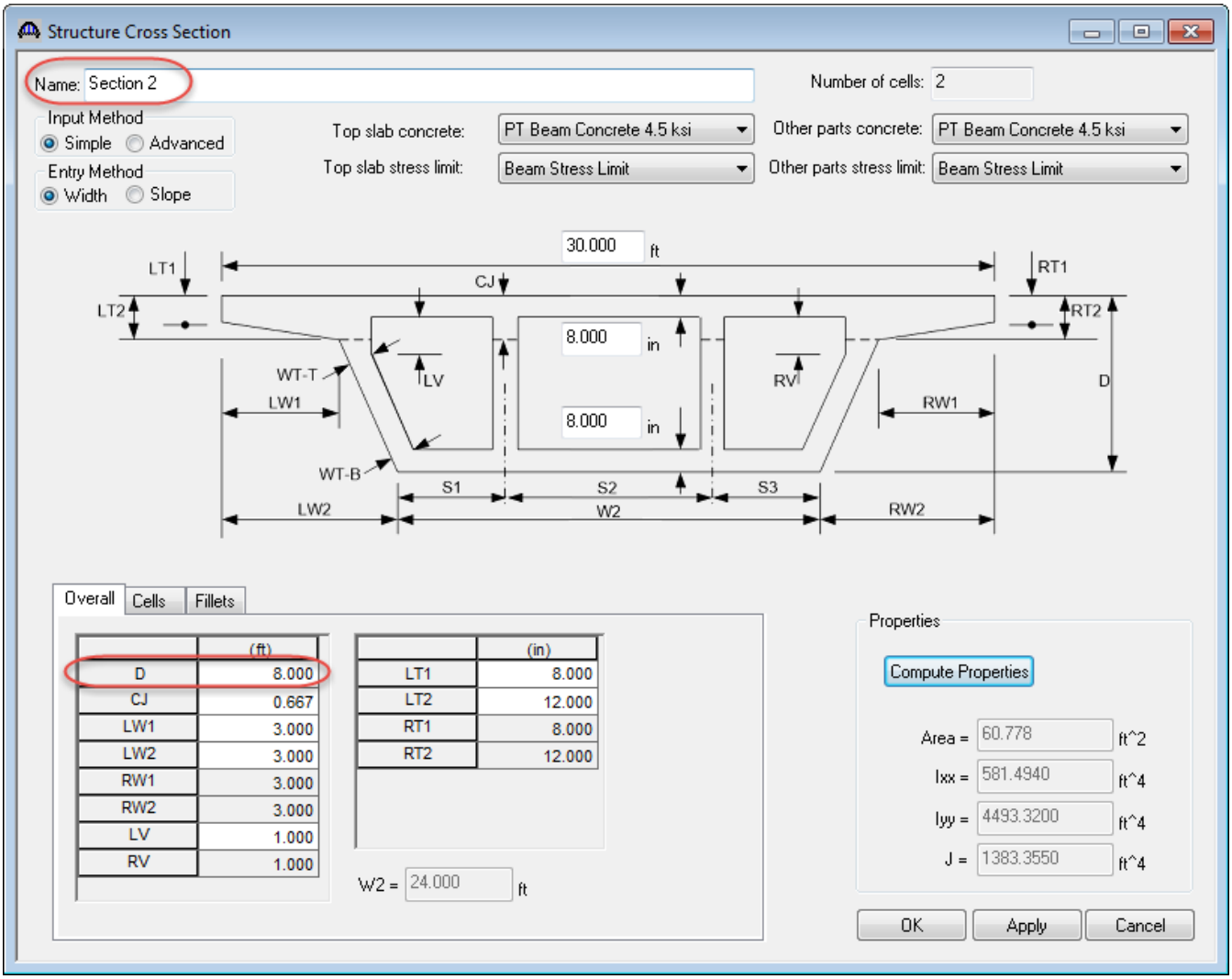


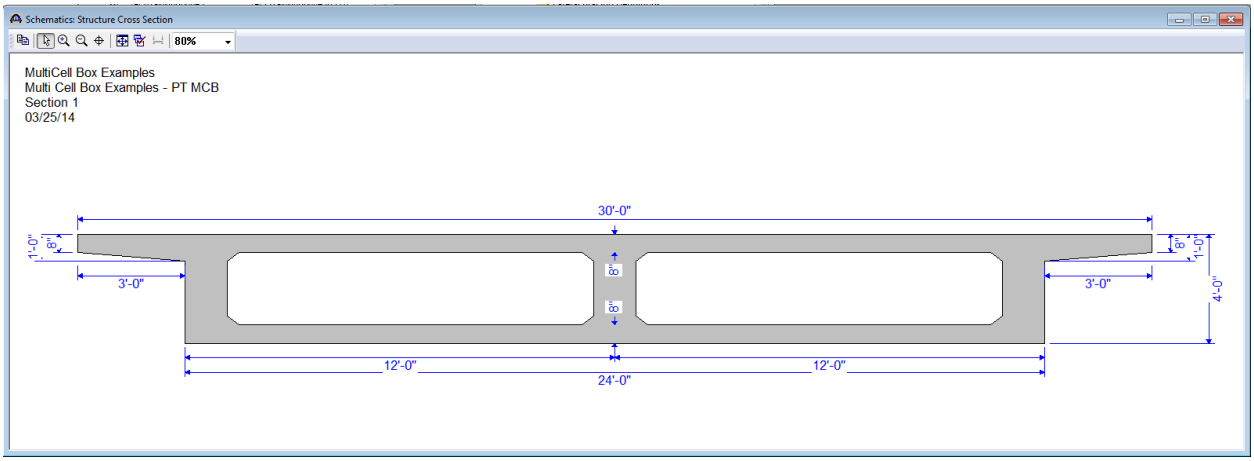
Make a copy of this cross section by using the right-click menu.



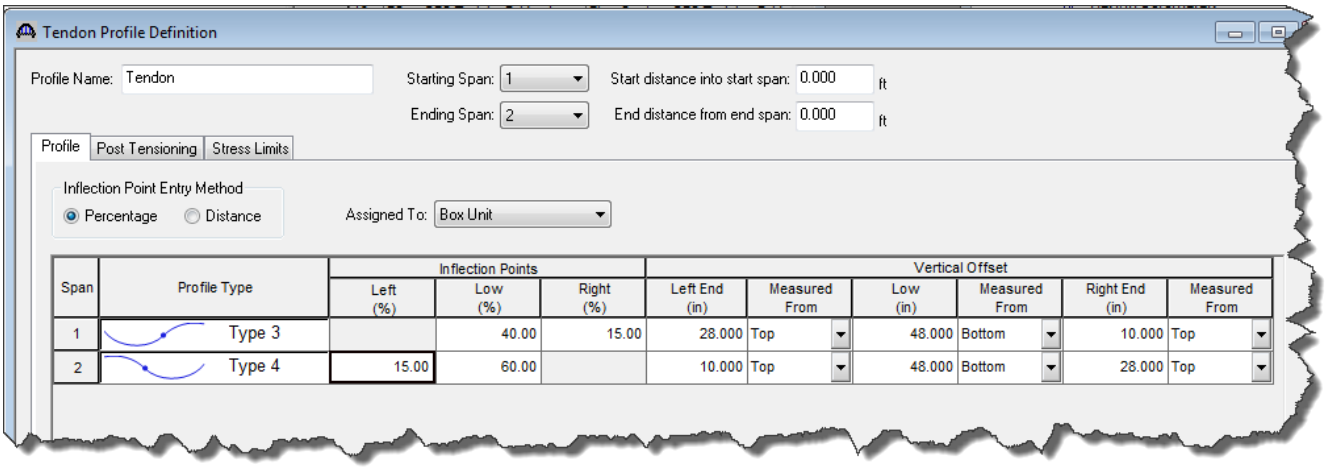


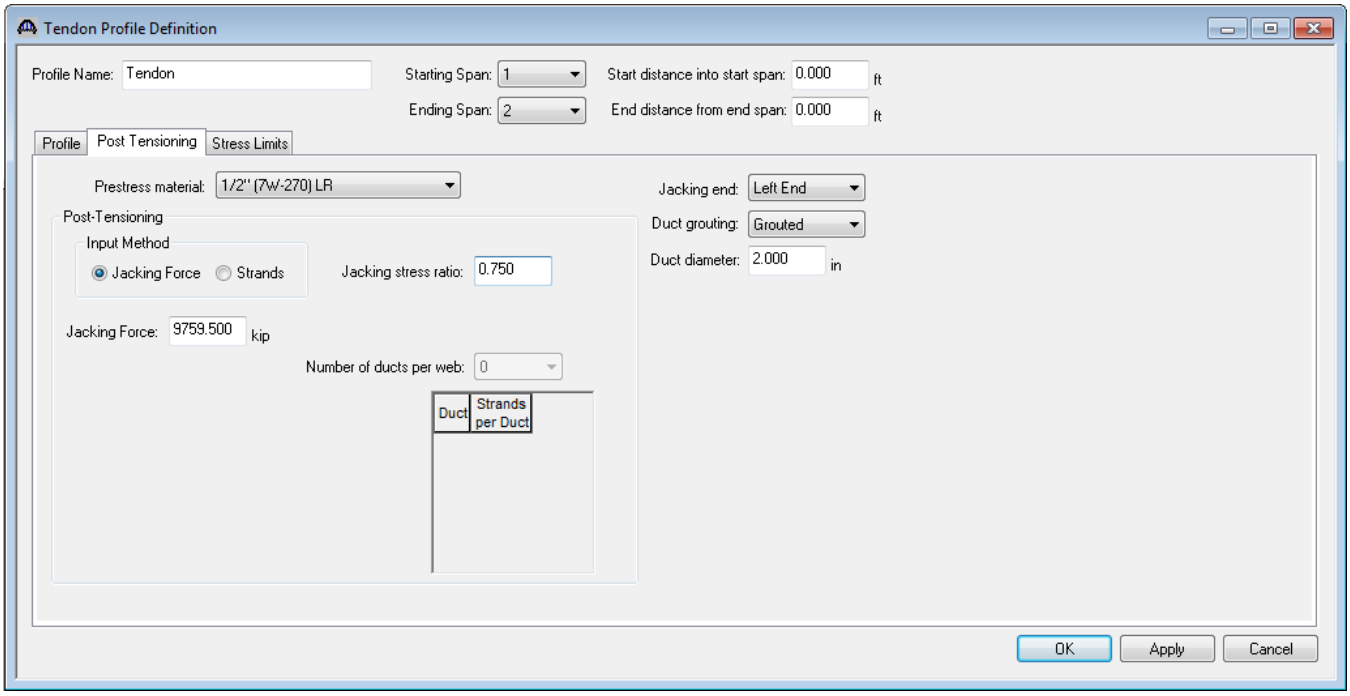
Rename the new cross section and revise the depth to 8 ft.

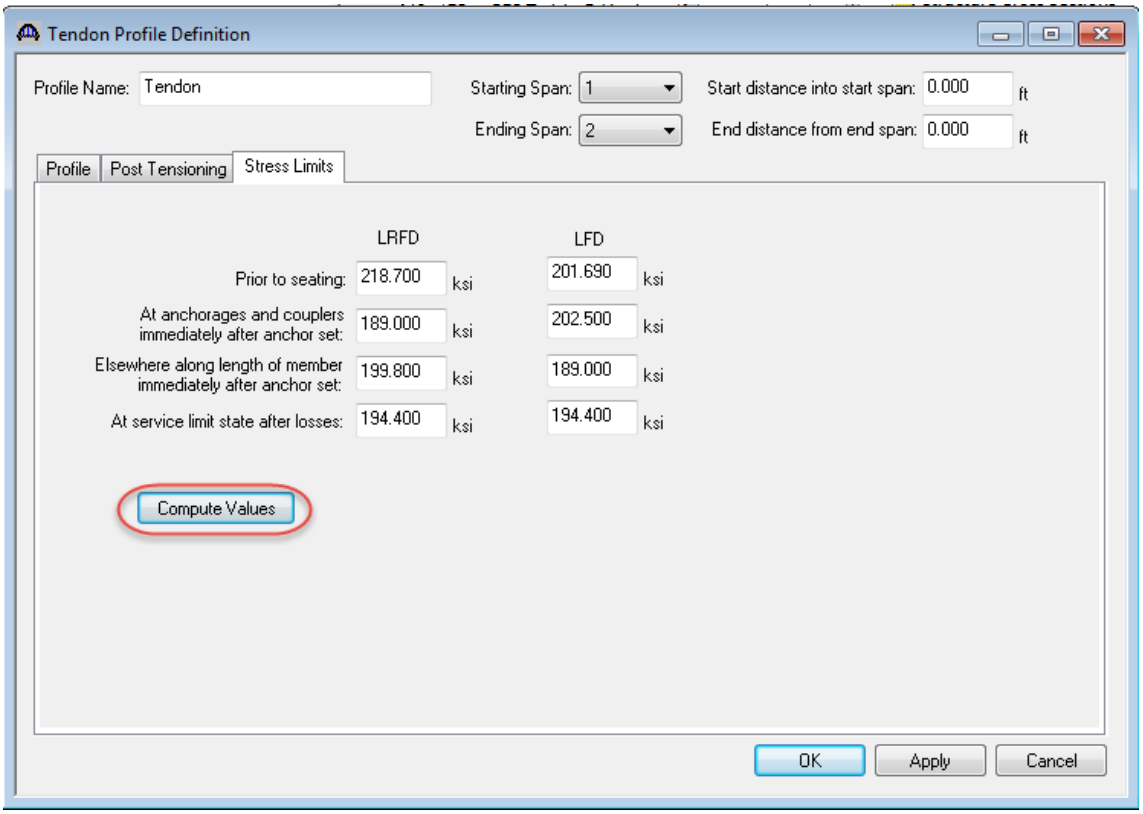




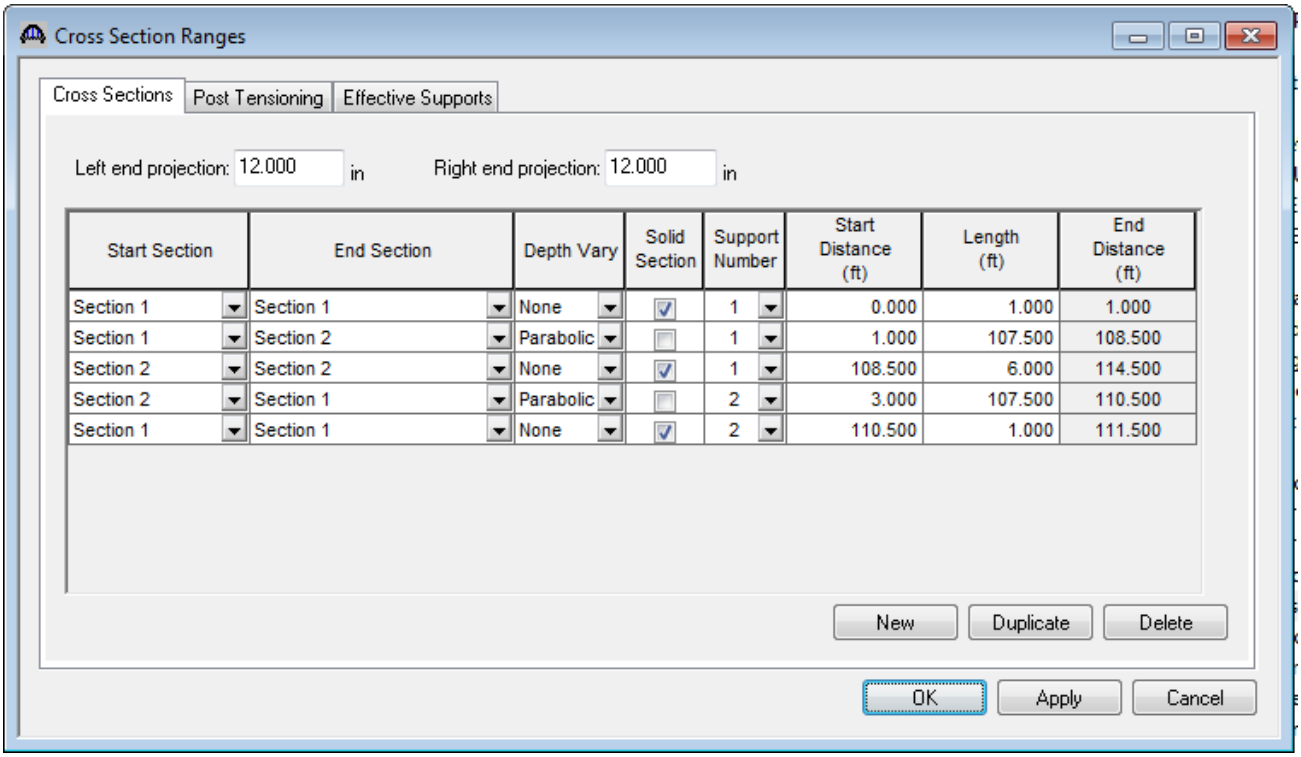
Create the following tendon profile.

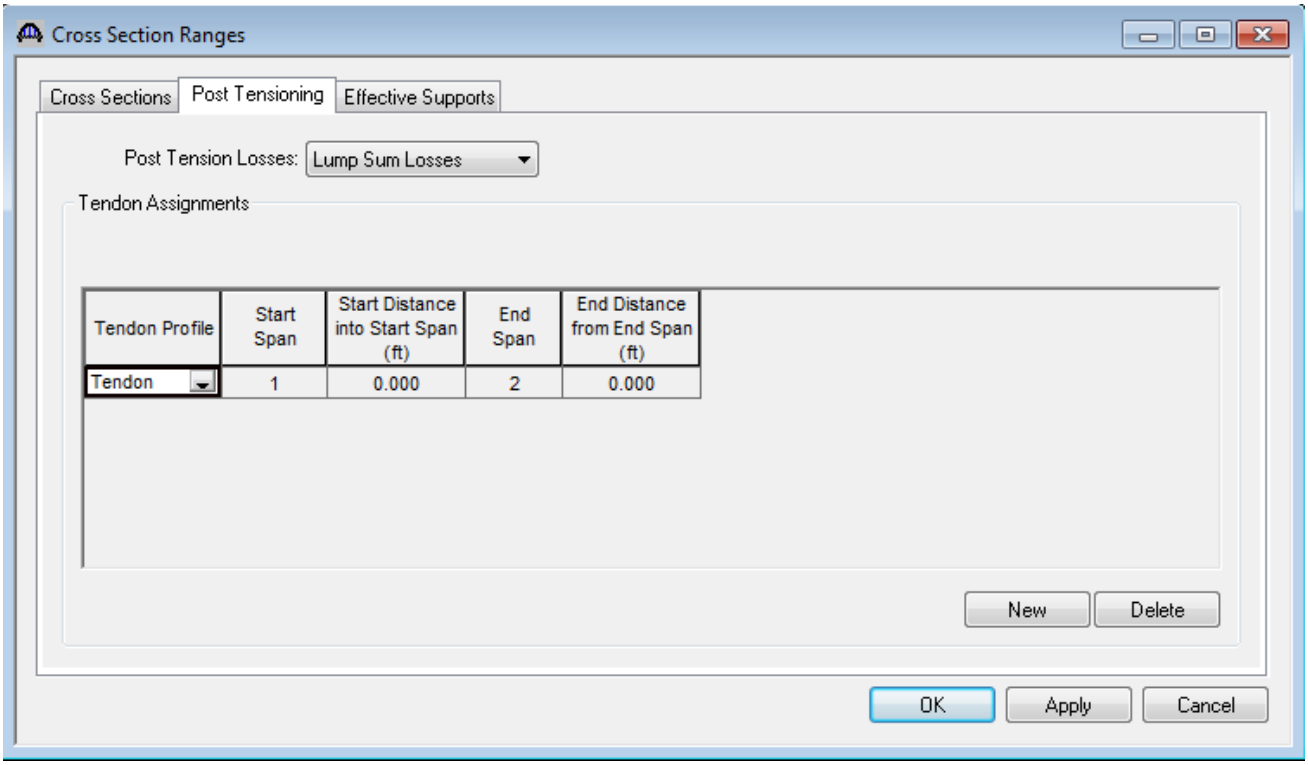




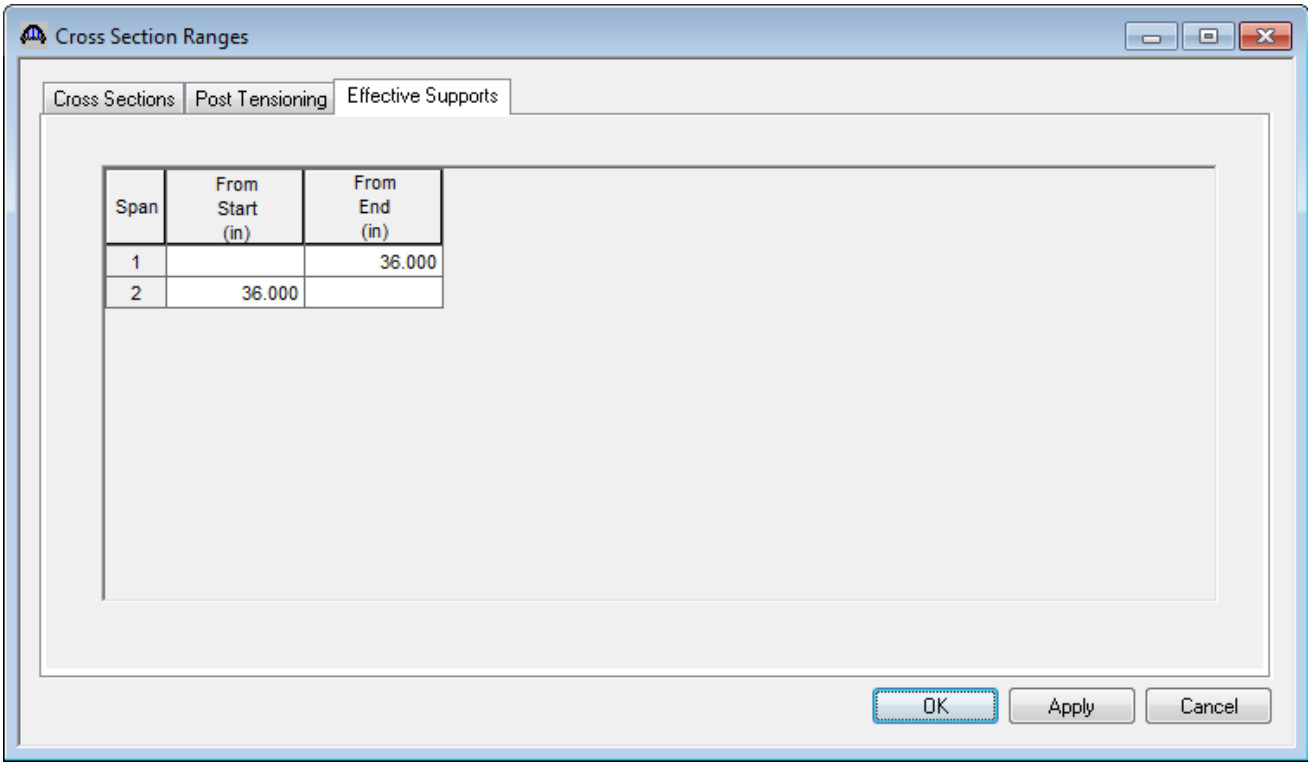


Open the Cross Section Range Properties window and assign the cross sections as follows.



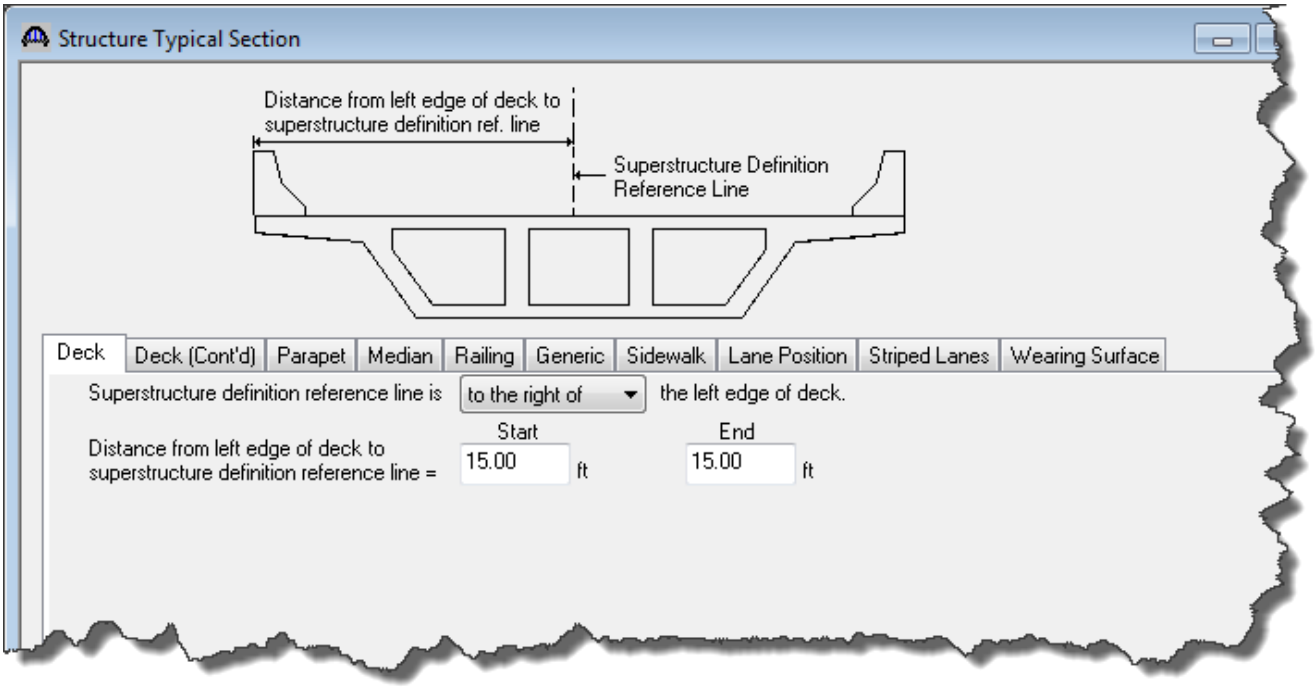


Effective supports allow you to shift the specification check point at the centerline of the support to the location entered below. Shear will be checked at a distance dv from the location entered below.

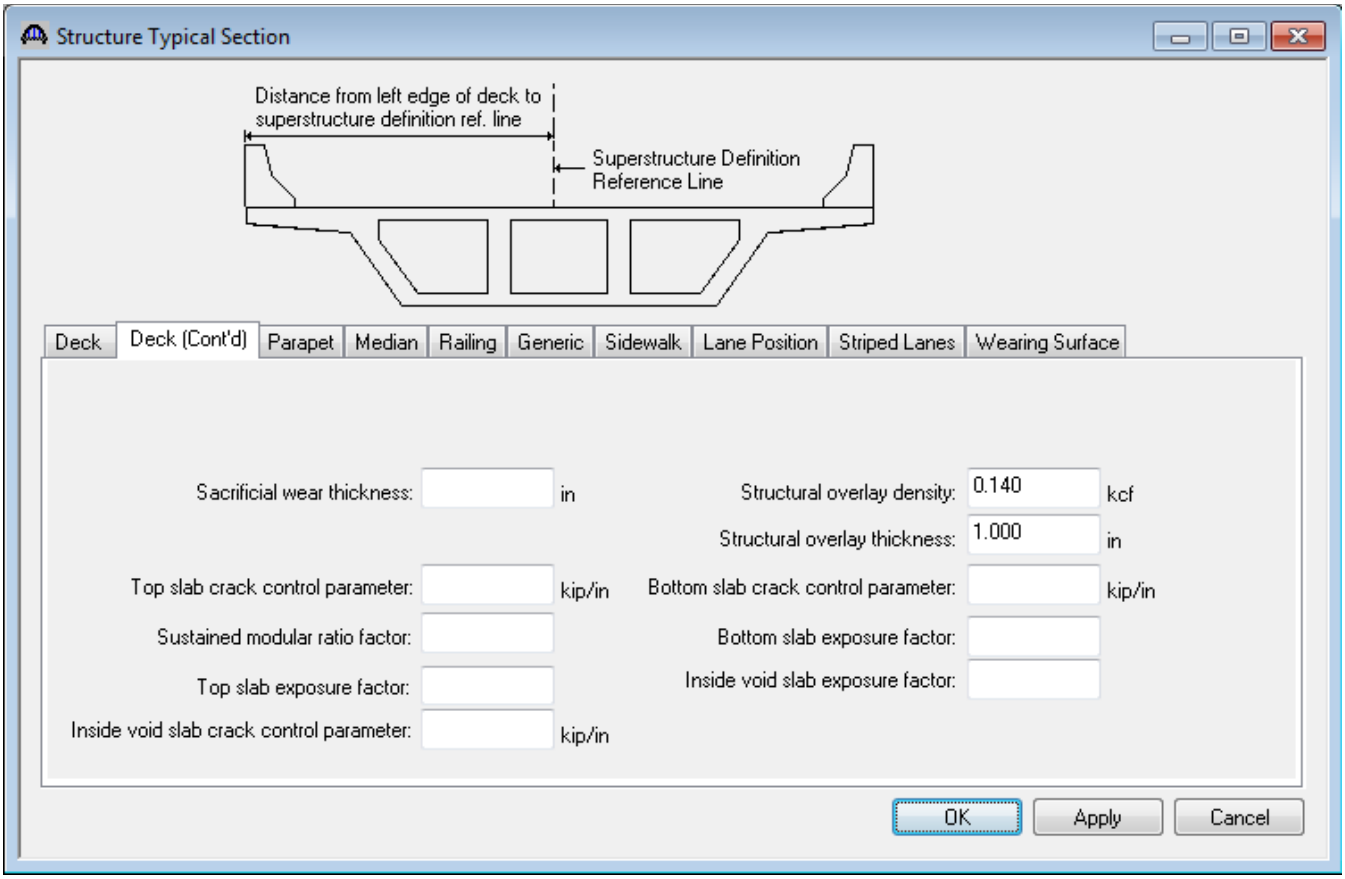


Select ‘Cross Section Range Properties’ in the BWS tree and open the following Schematic from the toolbar.

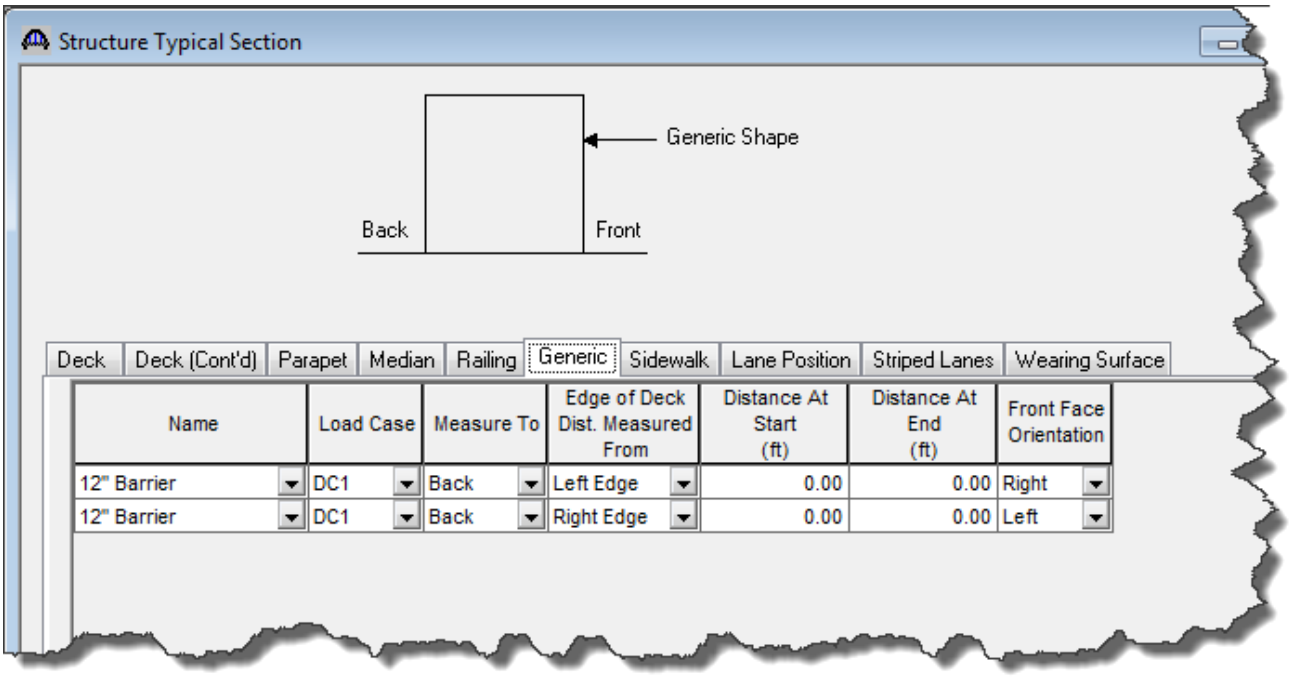
Open the Structure Typical Section window and locate the superstructure definition reference line as follows.



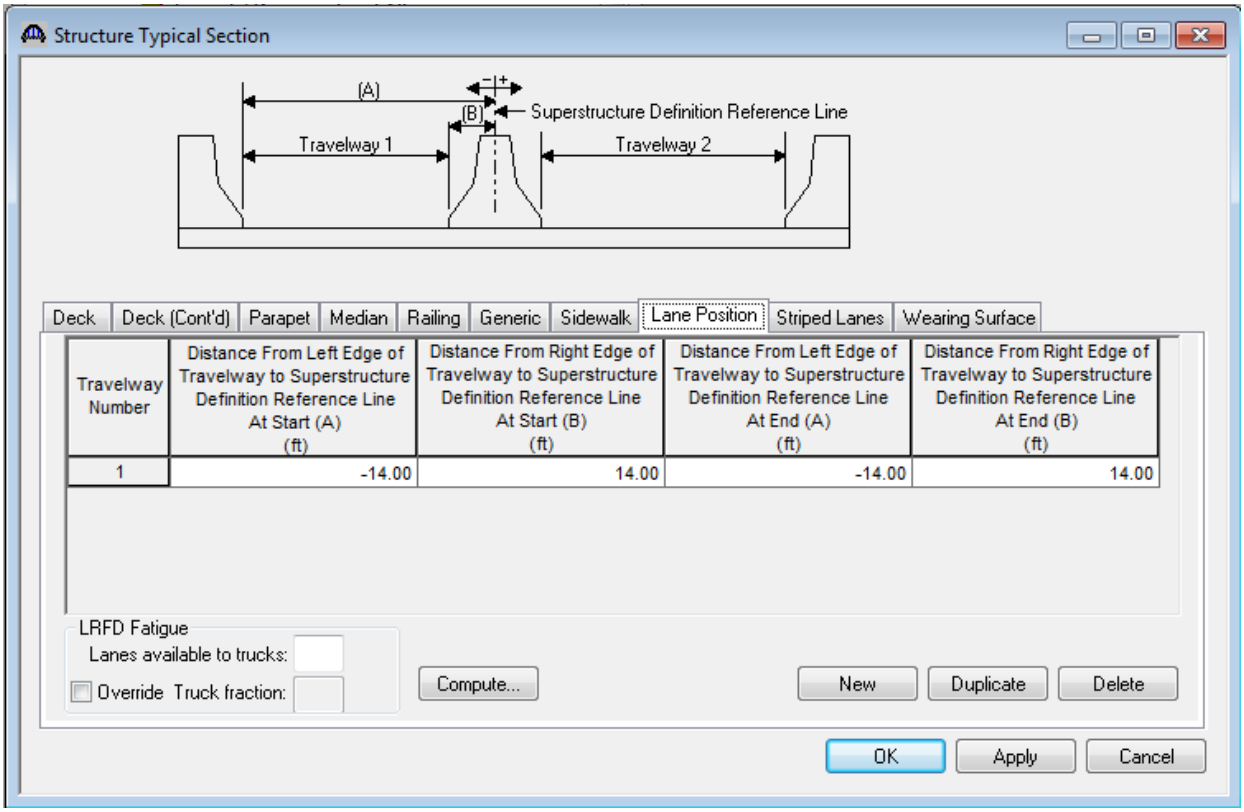
Enter the following data for the structural overlay. The overlay is applied in the self load DC load case.



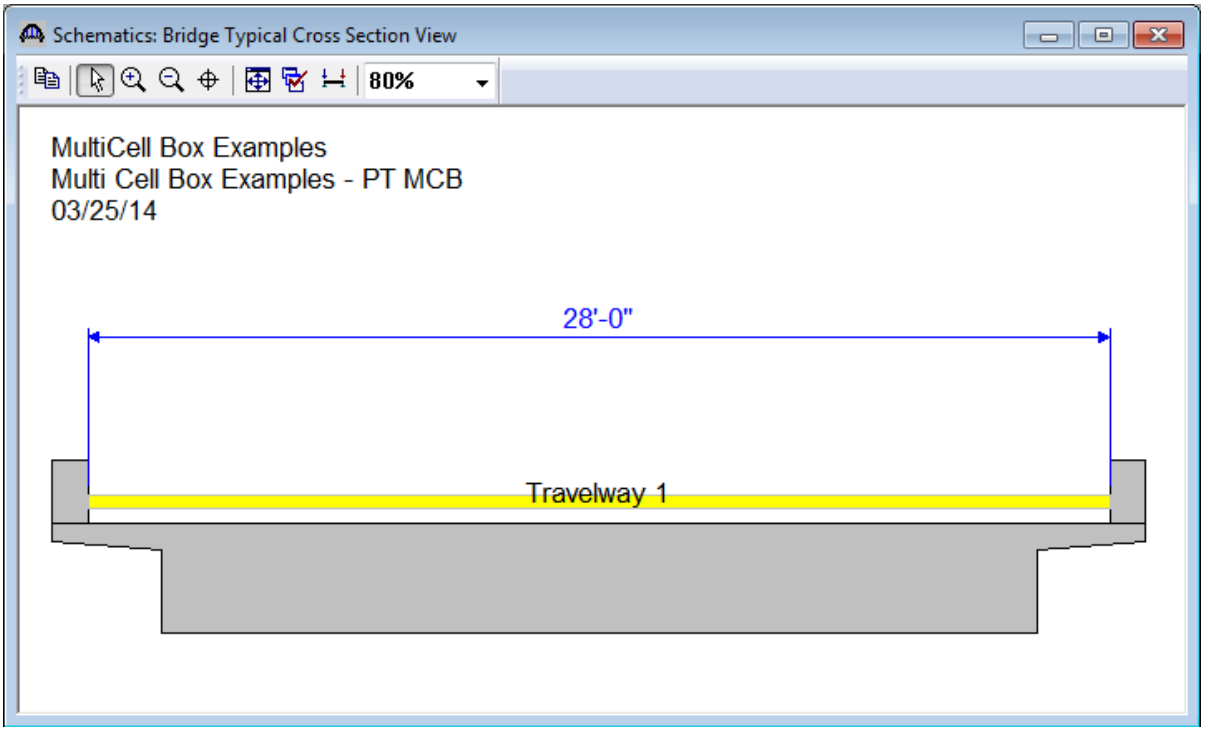
Enter the barriers.



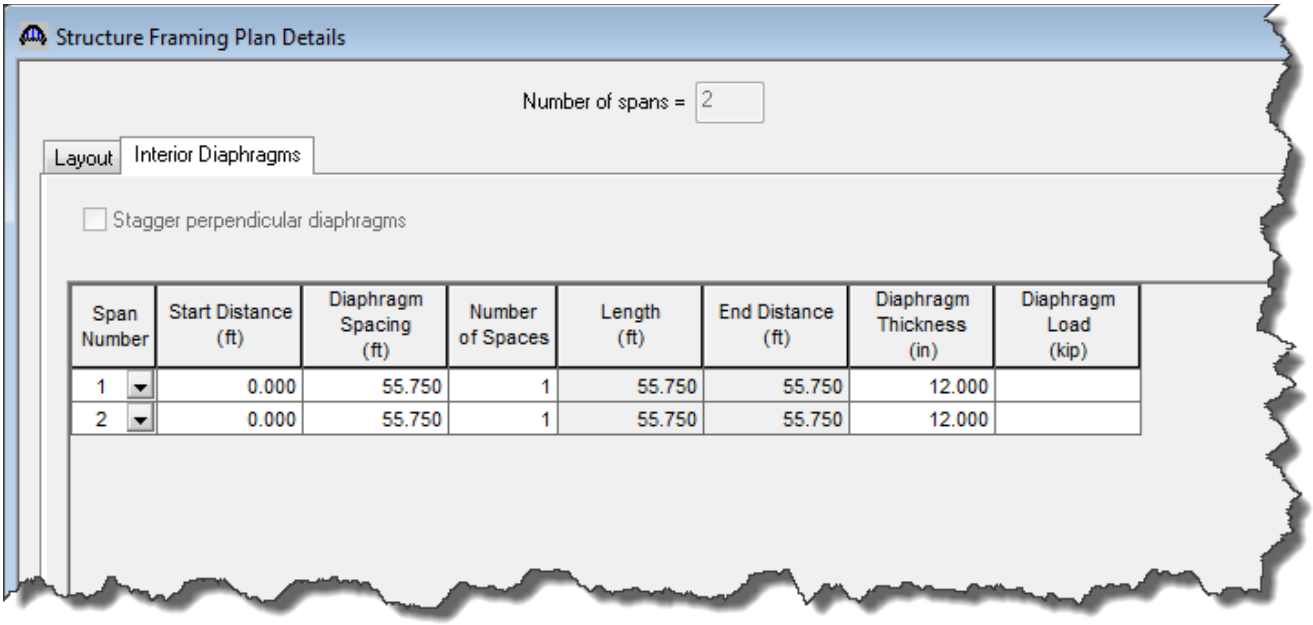
Use the Compute button to enter the following lane positions.



The Structure Typical Section will appear as follows. The webs are not visible in the schematic because the cross section at the start of the structure was marked as 'Solid'.

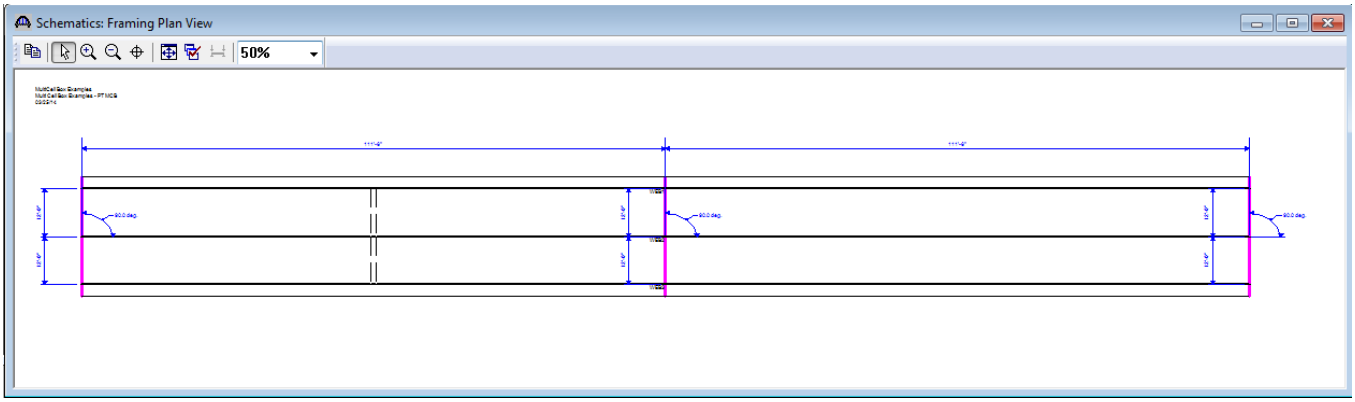


Enter the following diaphragm locations on the Framing Plan Details window. The diaphragms only contribute to the dead load on the structure. They do not provide a structural role in the box analysis. Enter the diaphragm thickness and the AASHTO engine will compute diaphragm load based on the box cross section properties and diaphragm thickness.



Span Number	Start Distance (ft)	Diaphragm Spacing (ft)	Number of Spaces	Length (ft)	End Distance (ft)	Diaphragm Thickness (in)	Diaphragm Load (kip)
1	0.000	55.750	1	55.750	55.750	12.000	
2	0.000	55.750	1	55.750	55.750	12.000	

The Framing Plan schematic appears as follows.

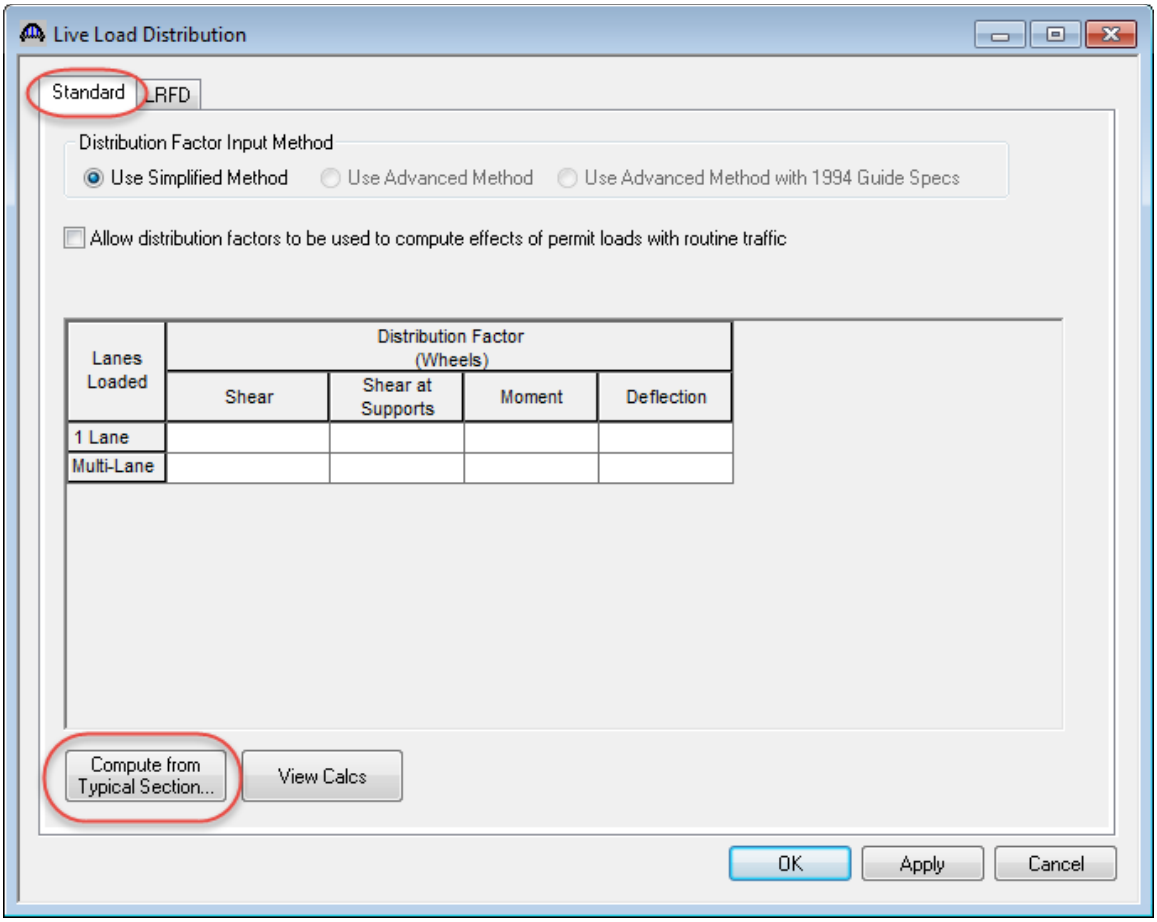


Full beam multicell box live load distribution factors is sum of each web live load distribution factors. If user has entered the live load distribution factors for each web, the beam distribution factors will be the sum of the user entered distribution factors.

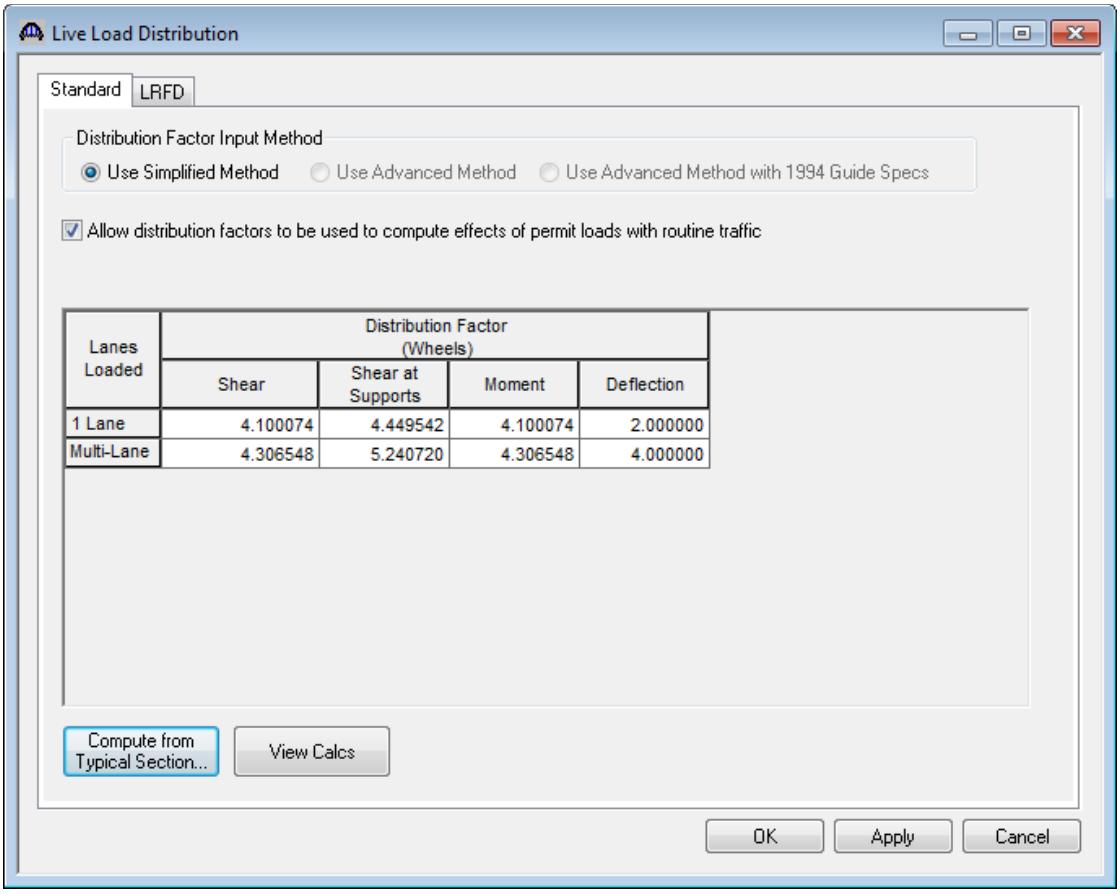
If the web distribution factors are empty, each web distribution factors are computed and sum of all the web distribution factors are used as the beam distribution factors.

If the both beam and web distribution factors are not entered or computed, program computes the distribution factors during the analysis.

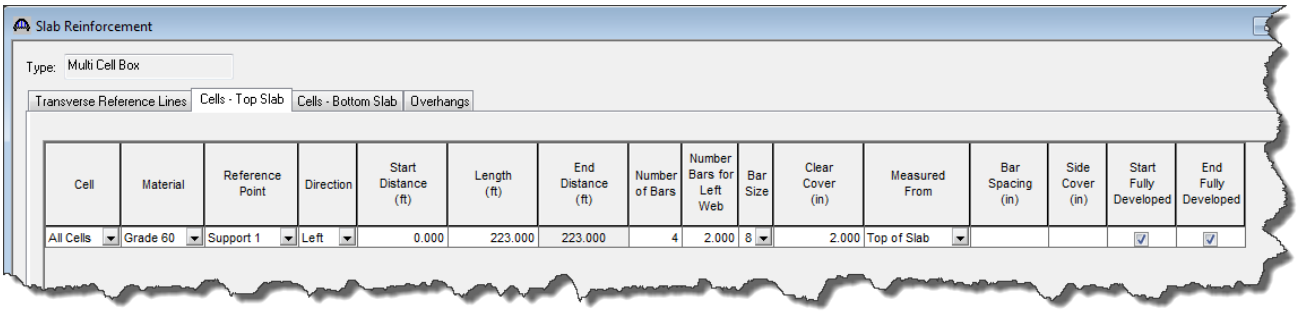
Standard live load distribution factors for entire beam using the ‘Compute from Typical Section’ button.

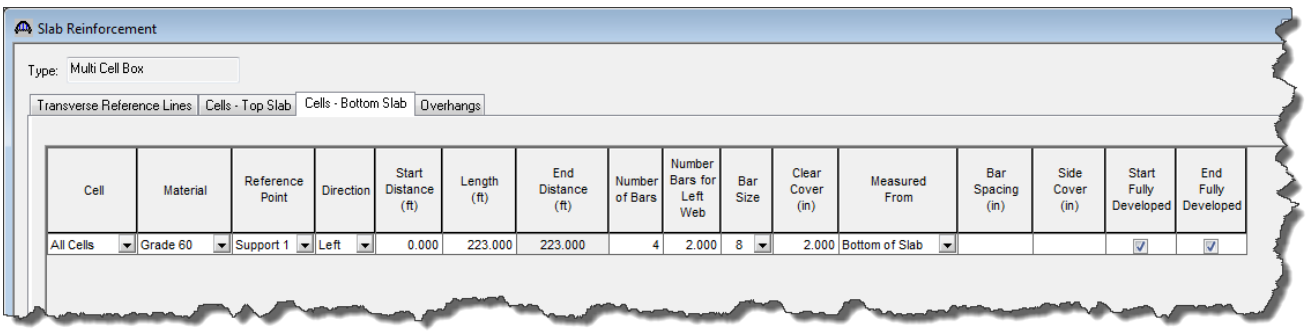


The computed Live Load Distribution window is shown below.

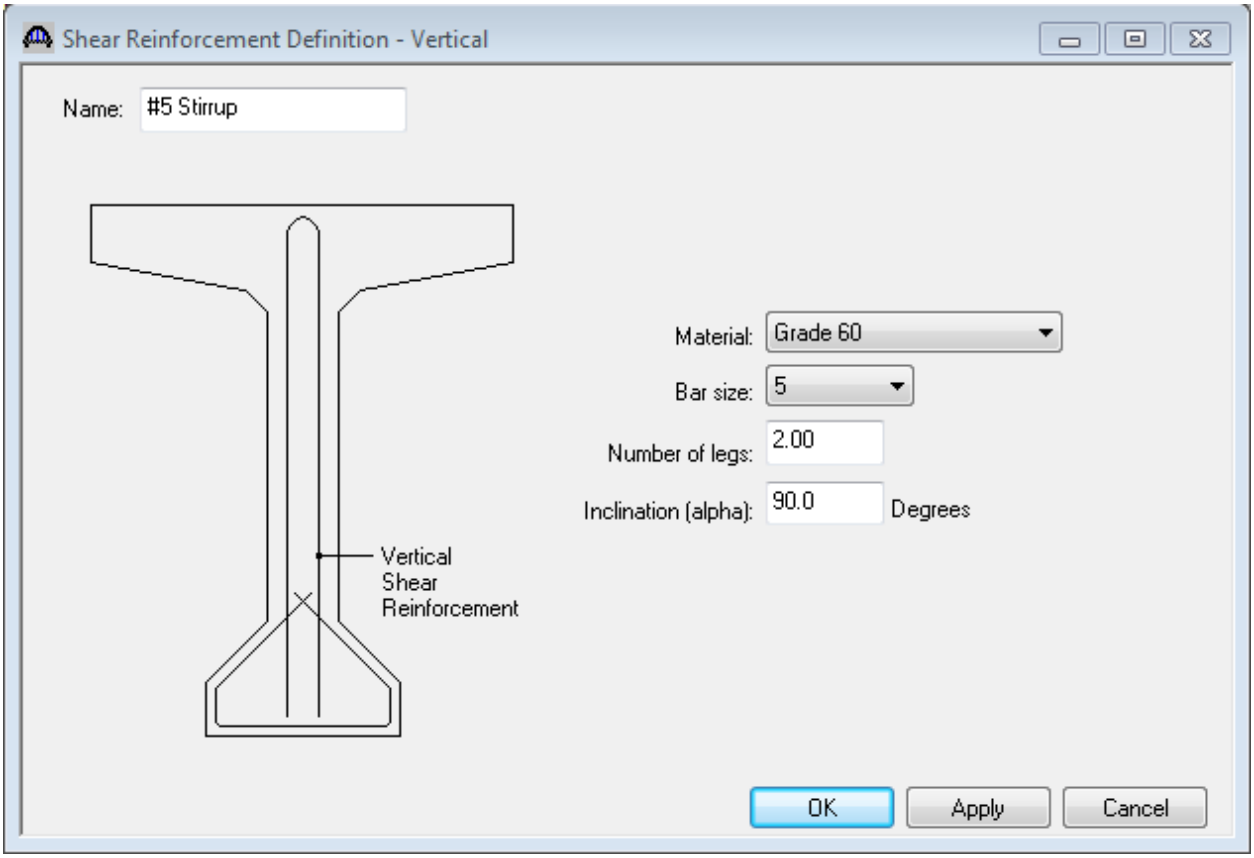


Enter the following reinforcement in the top and bottom slabs of the box.

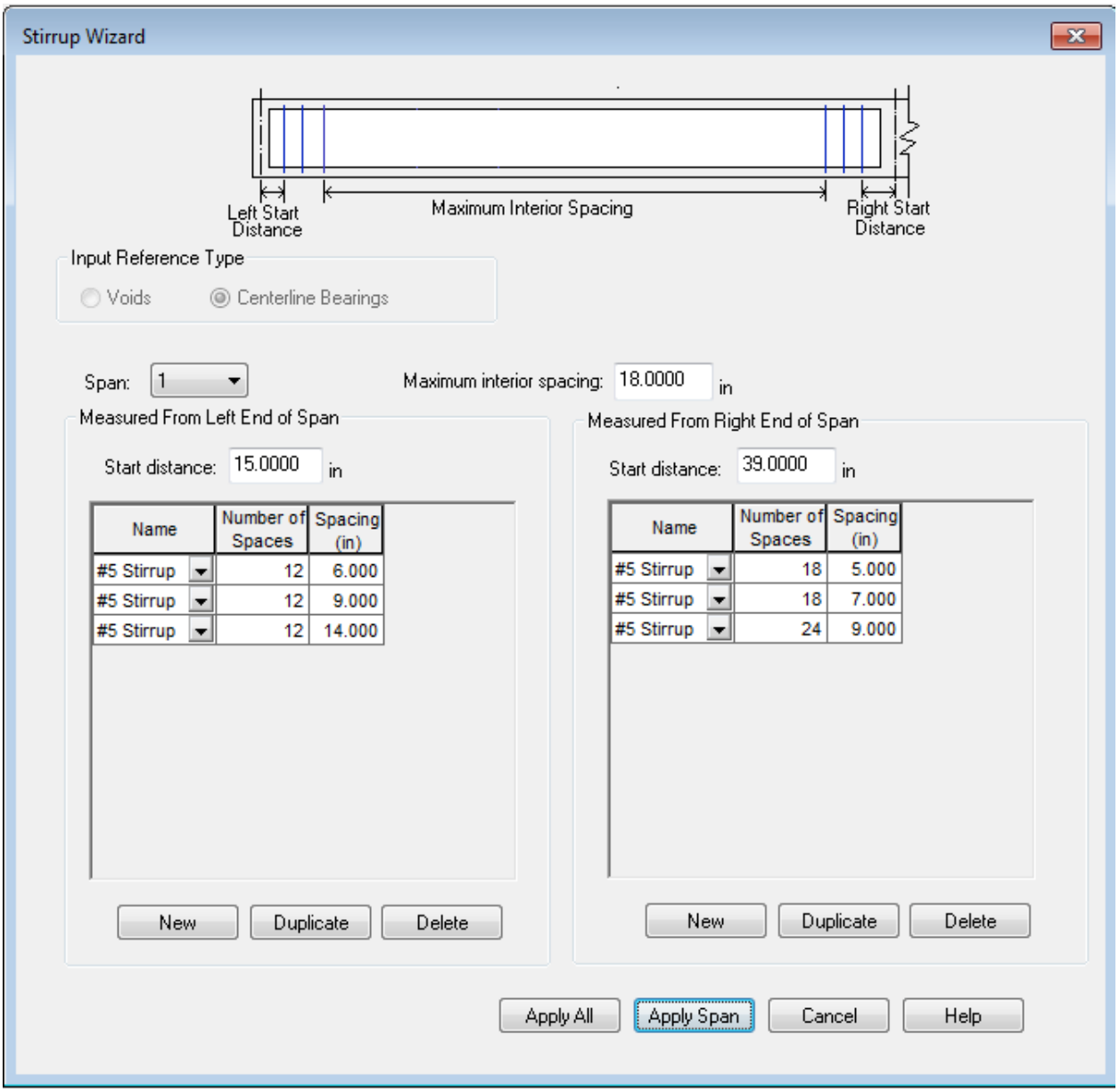




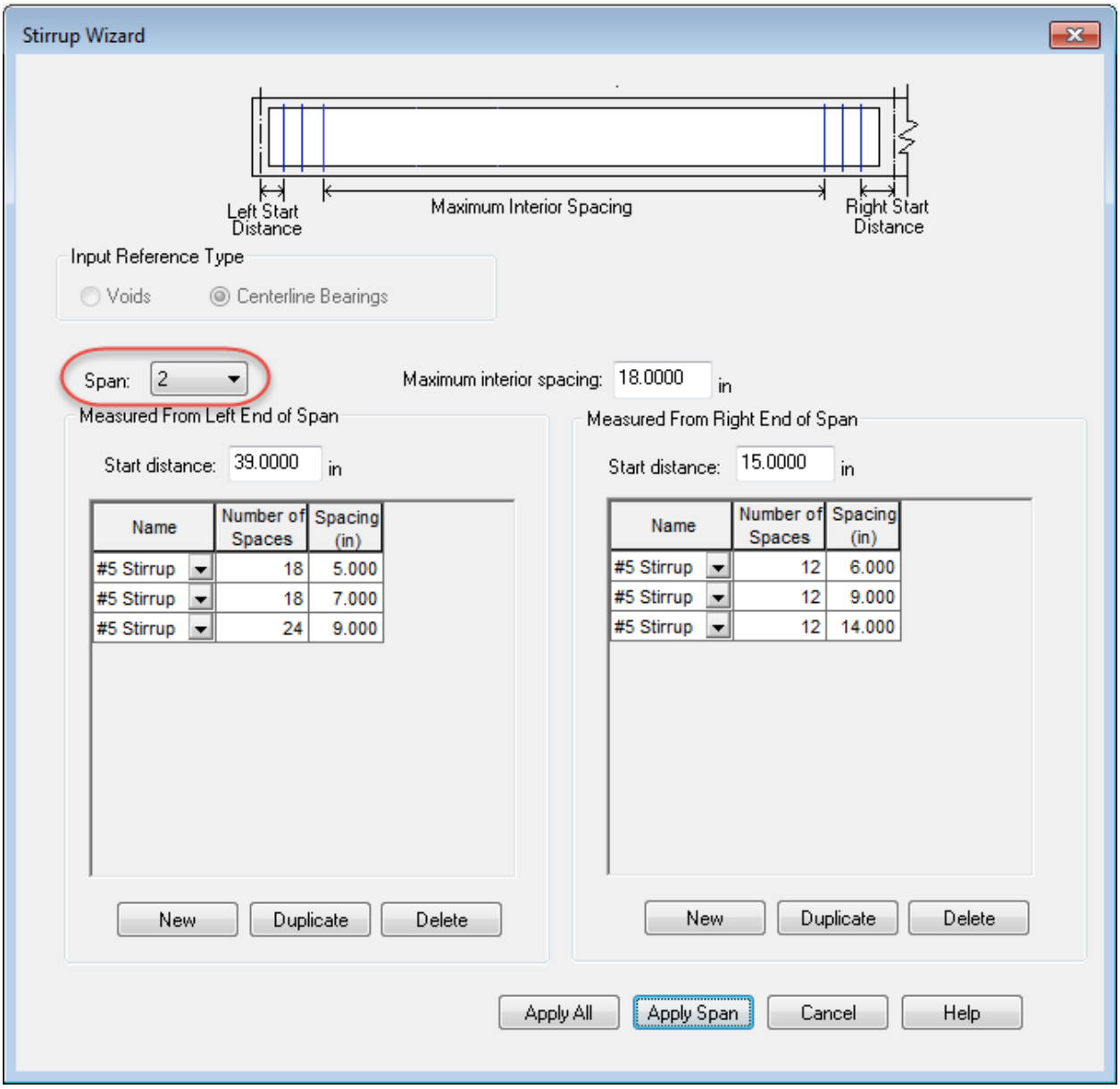
Create the following stirrup definition.



Open the Web 1 Shear Reinforcement Ranges window. Select the input reference type as 'Centerline of Bearings'. Click the Stirrup Wizard button and enter the following data.

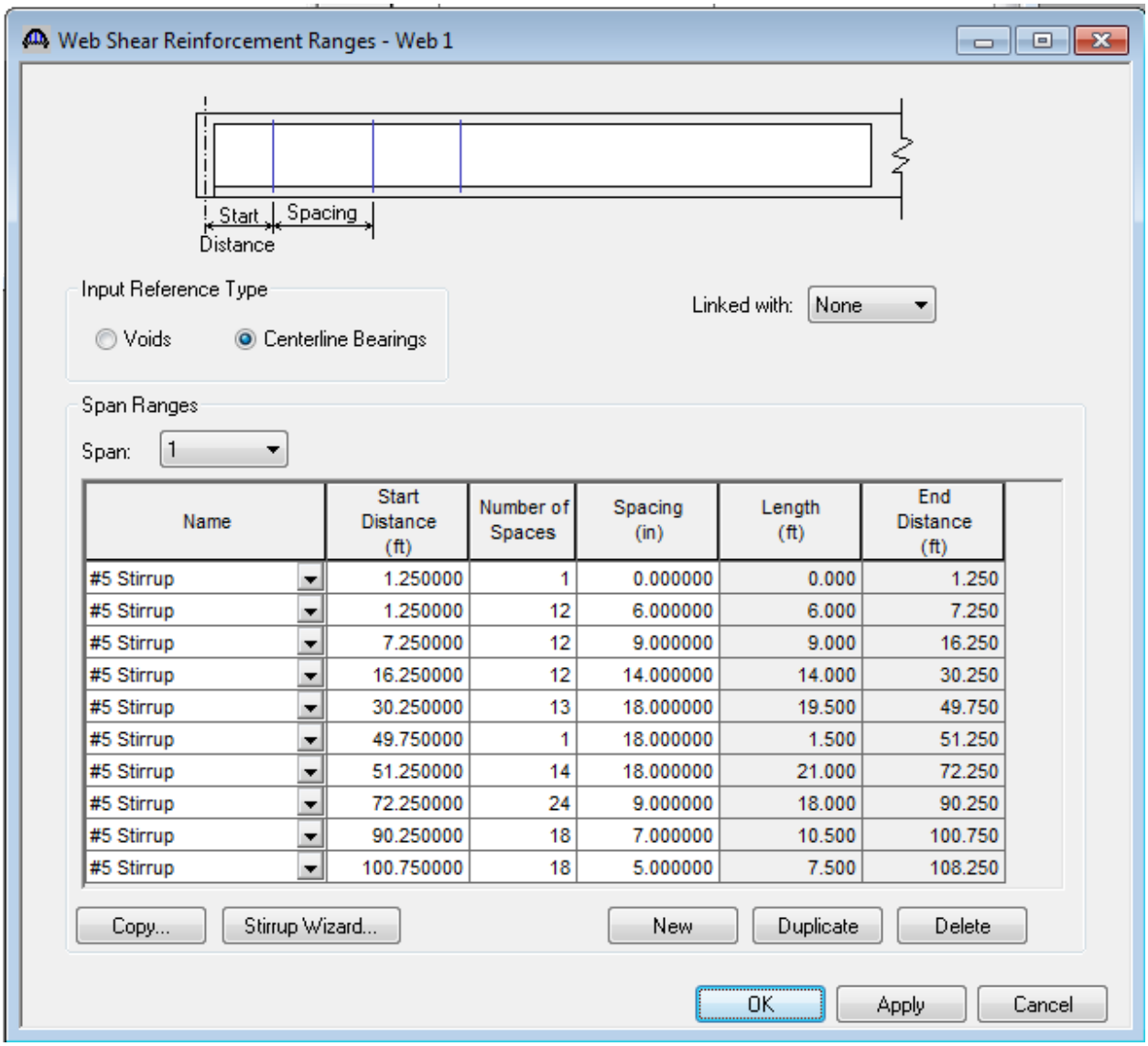


Select ‘Span 2’ in the Wizard and enter similar data for Span 2.

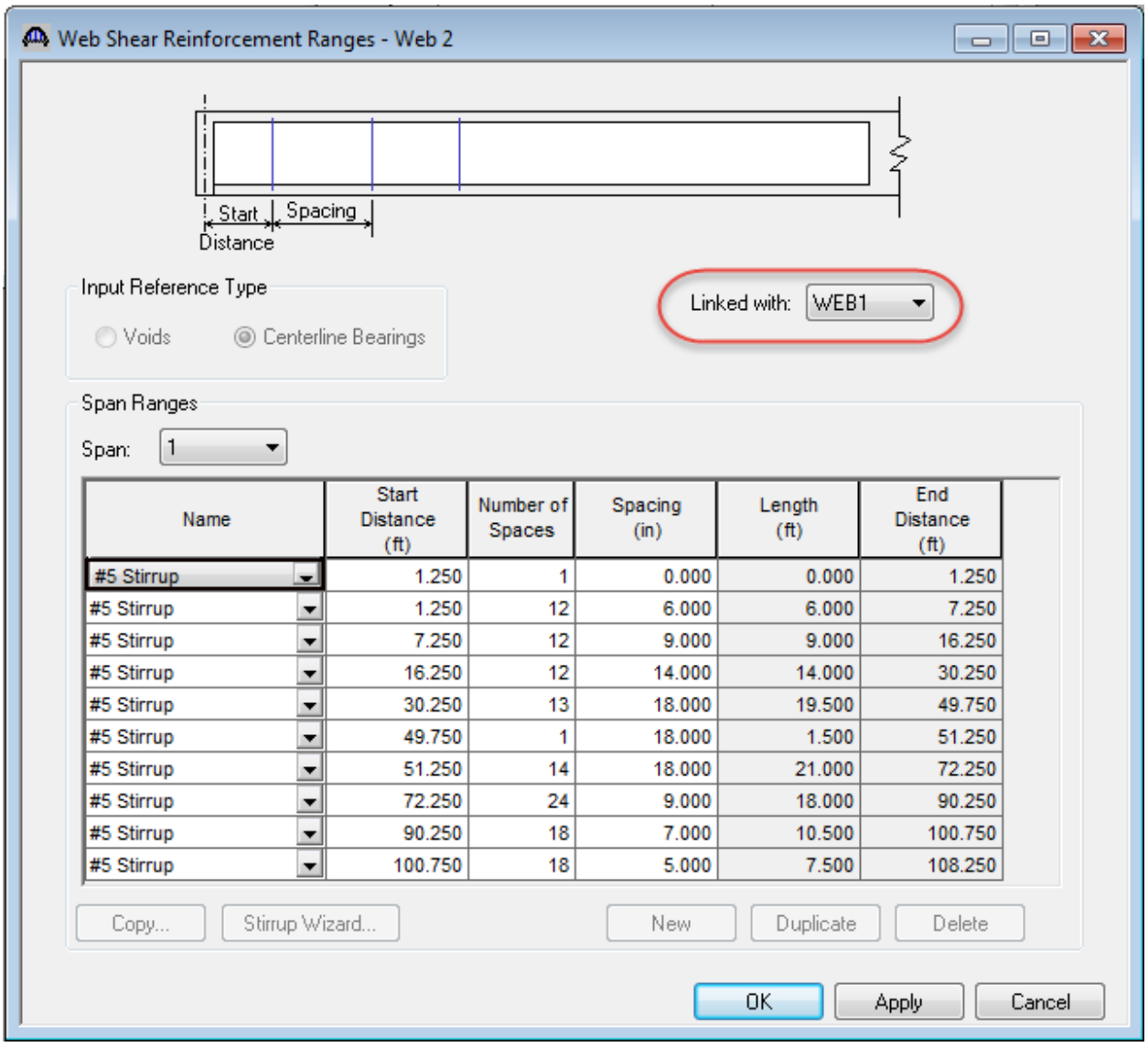


Click the ‘Apply All’ button to create the stirrup ranges for each span.

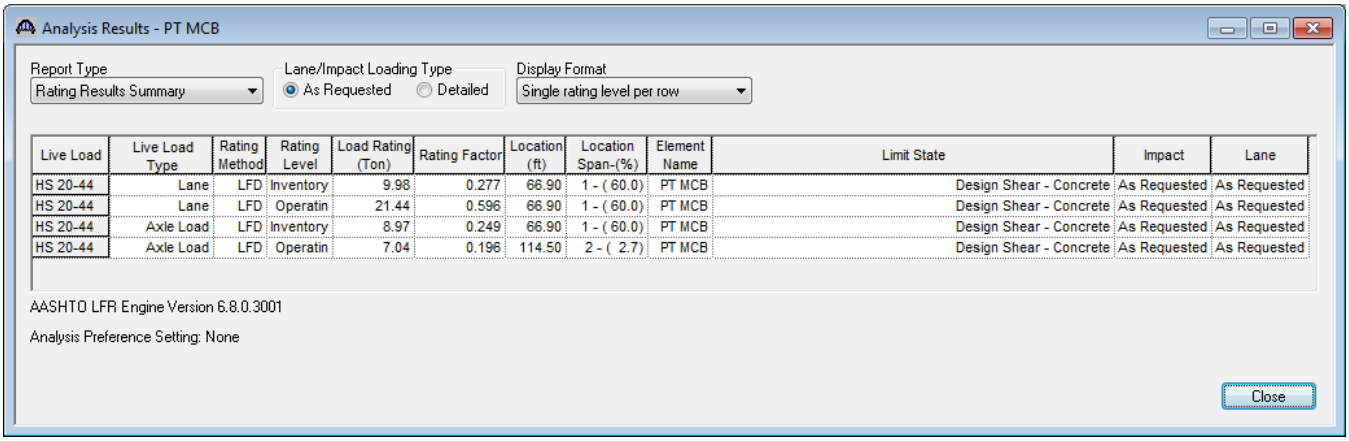
Span 1 will show the following data.



Open the Web 2 Shear Reinforcement Ranges window. Select 'Web 1' in the 'Link With' field. The data from Web 1 will appear in this window as read only. If data is changed in the Web 1 Shear Reinforcement Ranges window in the future, those changes will be reflected in this window. Do the same for Web 3, linking it to Web 1.



We can now sit on our superstructure definition in the BWS tree and launch an LFR analysis. The full multicell box width is analyzed for flexure and shear and then each webline is analyzed for shear. The Analysis Results window shows the critical rating factors considering the full box and each webline.



Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Element Name	Limit State	Impact	Lane
HS 20-44	Lane	LFD	Inventory	9.98	0.277	66.90	1 - (60.0)	PT MCB	Design Shear - Concrete	As Requested	As Requested
HS 20-44	Lane	LFD	Operatin	21.44	0.596	66.90	1 - (60.0)	PT MCB	Design Shear - Concrete	As Requested	As Requested
HS 20-44	Axle Load	LFD	Inventory	8.97	0.249	66.90	1 - (60.0)	PT MCB	Design Shear - Concrete	As Requested	As Requested
HS 20-44	Axle Load	LFD	Operatin	7.04	0.196	114.50	2 - (2.7)	PT MCB	Design Shear - Concrete	As Requested	As Requested

Spec check details are available for the full box and each webline.