

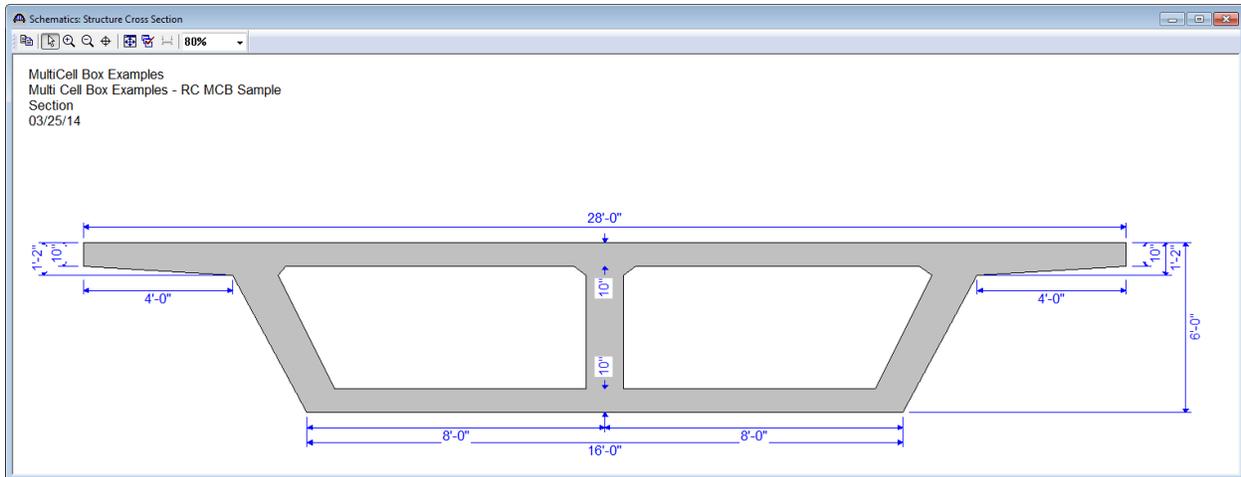
*AASHTOWare BrD 6.8*

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***Multicell Box Tutorial***

*MCB2 - Reinforced Concrete Multicell Box Example*

## MCB2 - Reinforced Concrete Multicell Box Example



### Topics Covered

- Analysis Methods
- Slab Reinforcement Data Entry
- Stirrup Wizard
- Web analysis
- Skewed structures

The data entry for a reinforced concrete multicell box superstructure is very similar to that for a post-tensioned multicell box. Example 'MCB1-PT MCB Example' describes in detail the process to define a PT multicell box. This example will focus on a few particular details for data entry.

### Analysis Methods

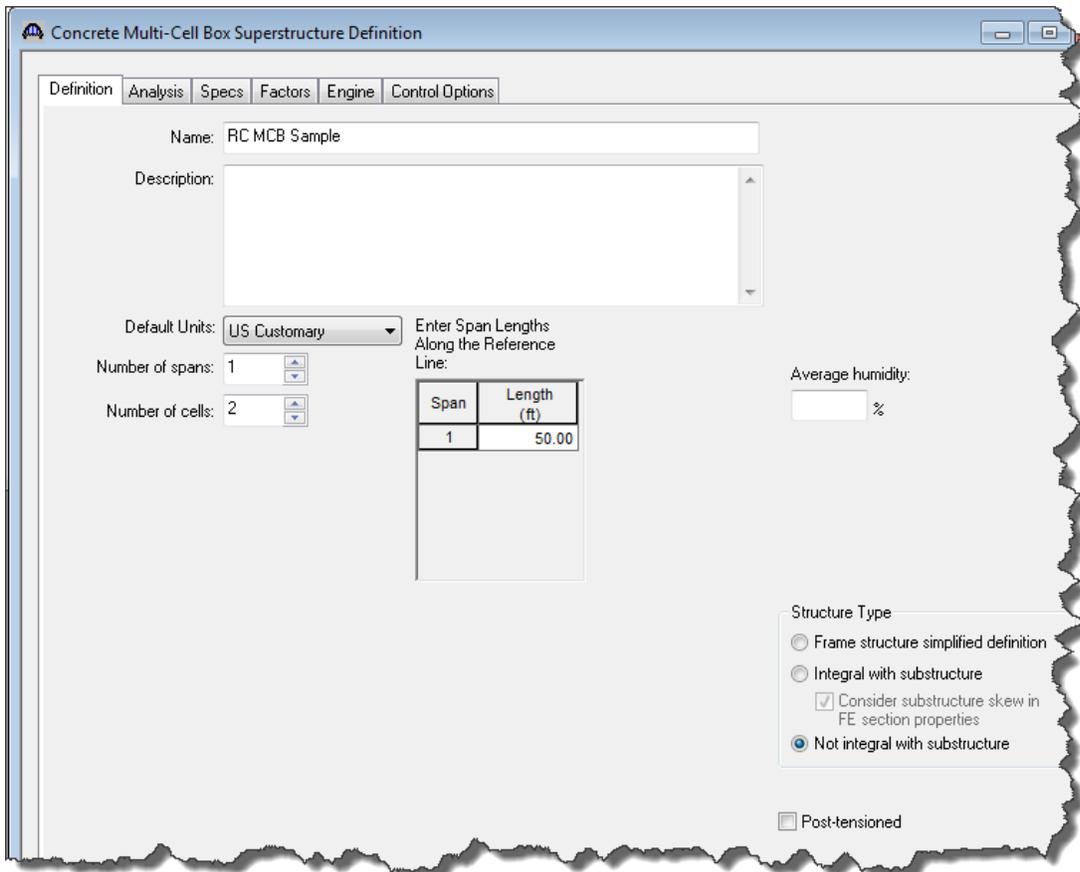
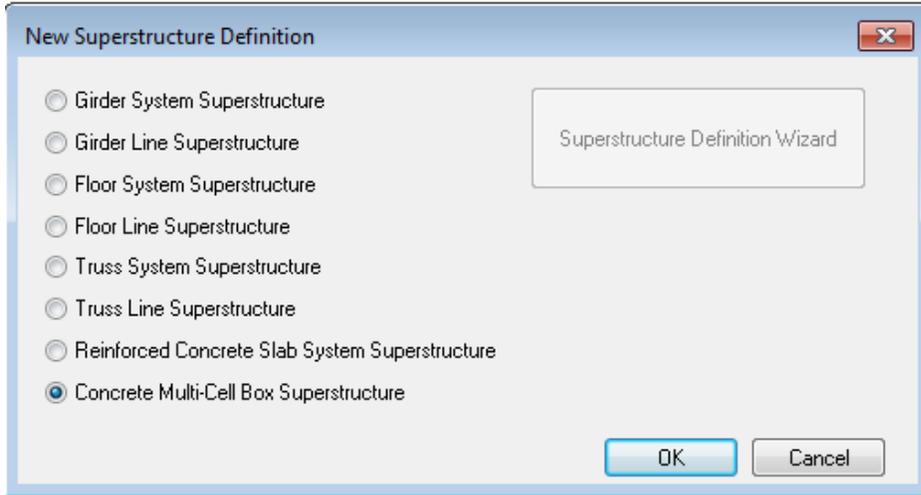
Reinforced concrete multicell box (MCB) superstructures can be analyzed in the following manners:

- LRFD, LRFR and LFR
- Full box section including each individual weblines
- Single weblines

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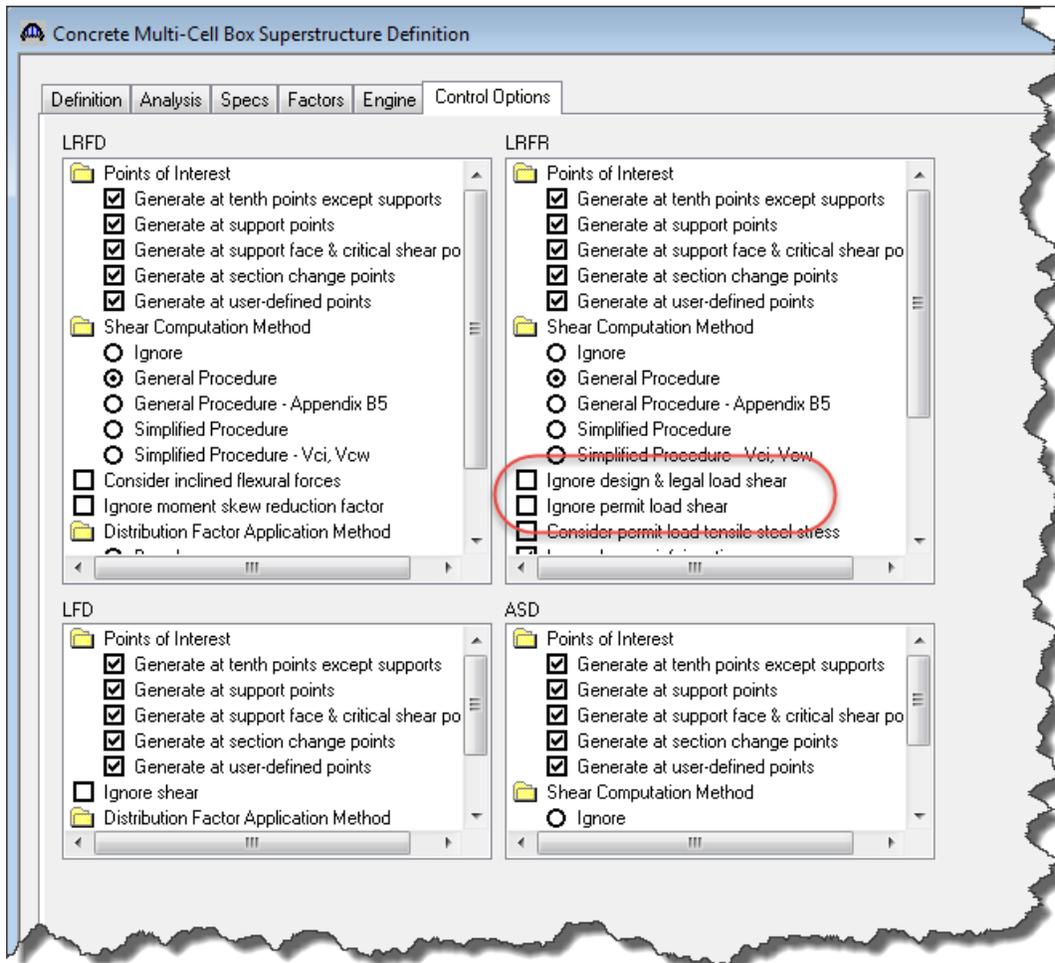
## Data Entry

Create a new concrete multicell box superstructure definition. Be sure to leave 'Post-tensioned' unchecked.



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Uncheck the LRFR Ignore shear checkboxes.



Create default load cases.

Load Case Name	Description	Stage	Type	Time* (Days)
DC1	DC acting on non-composite section	Non-composite (Stage 1)	D,DC	
DC2	DC acting on long-term composite section	Composite (long term) (Stage 2)	D,DC	
DW	DW acting on long-term composite section	Composite (long term) (Stage 2)	D,DW	
SIP Forms	Weight due to stay-in-place forms	Non-composite (Stage 1)	D,DC	

Create the following cross section.

# MCB2 - Reinforced Concrete Multicell Box Example

Structure Cross Section

Name: Section Number of cells: 2

Input Method:  Simple  Advanced

Top slab concrete: Class A (US) Other parts concrete: Class A (US)

Entry Method:  Width  Slope

Overall Cells Fillets

	(ft)
D	6.000
CJ	
LW1	4.000
LW2	6.000
RW1	4.000
RW2	6.000
LV	
RV	

	(in)
LT1	10.000
LT2	14.000
RT1	10.000
RT2	14.000

W2 = 16.000 ft

Properties

Compute Properties

Area =  ft<sup>2</sup>

Ixx =  ft<sup>4</sup>

Iyy =  ft<sup>4</sup>

J =  ft<sup>4</sup>

OK Apply Cancel

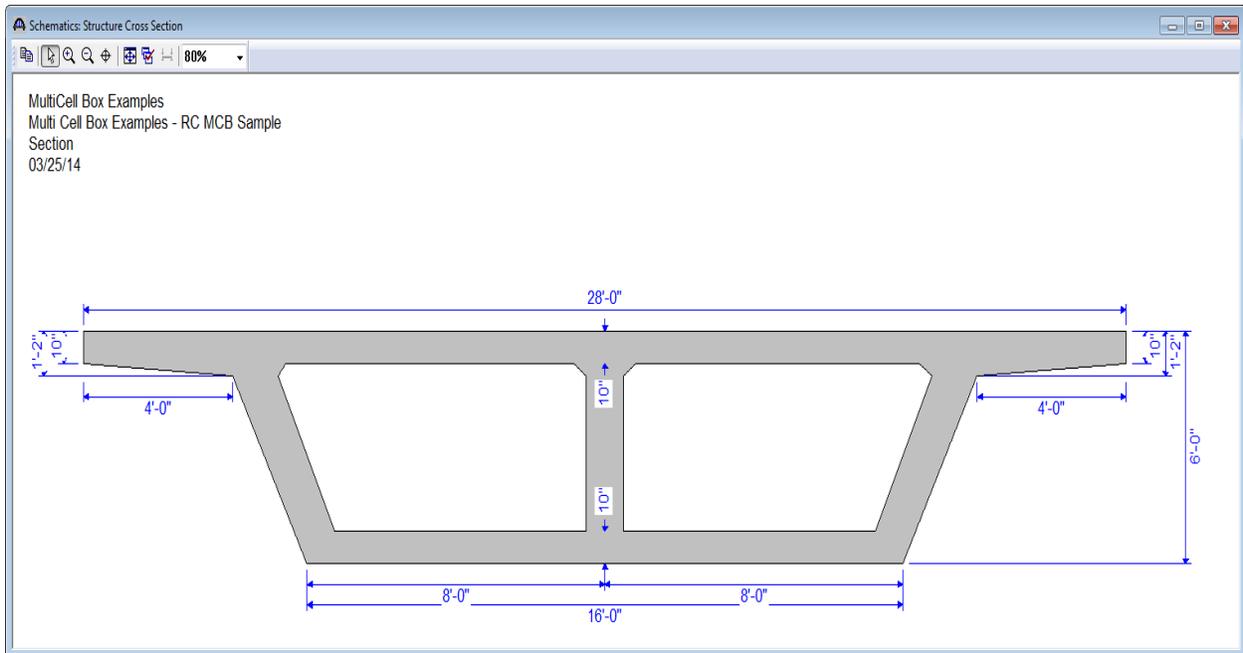
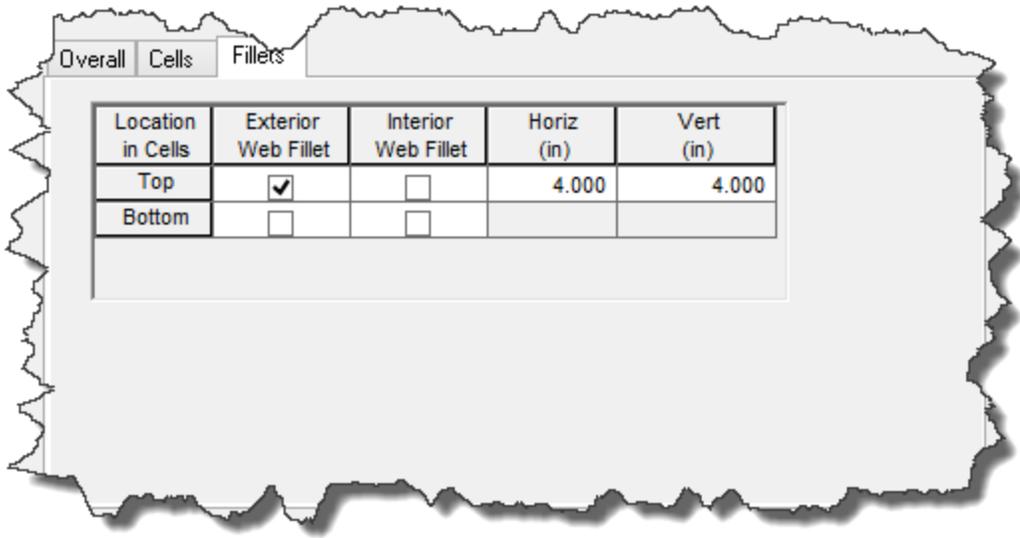
Overall Cells Fillets

Top left web thickness: 12.000 in W2 = 16.000 ft

Bottom left web thickness: 12.000 in

Cell	S (ft)	Top Right Web Thickness (in)	Bottom Right Web Thickness (in)	Top Slab Thickness (in)
1	8.000	12.000	12.000	10.000
2	8.000	12.000	12.000	10.000

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## MCB2 - Reinforced Concrete Multicell Box Example

Assign the cross section to the length of the superstructure.

Cross Sections Ranges

Cross Sections Effective Supports

Left end projection: 12.000 in Right end projection: 12.000 in

Start Section	End Section	Depth Vary	Solid Section	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)
Section	Section	None	<input checked="" type="checkbox"/>	1	0.000	3.000	3.000
Section	Section	None	<input type="checkbox"/>	1	3.000	44.000	47.000
Section	Section	None	<input checked="" type="checkbox"/>	1	47.000	3.000	50.000

New Duplicate Delete

OK Apply Cancel

Locate the superstructure definition reference line in the center of the structure.

Structure Typical Section

Distance from left edge of deck to superstructure definition ref. line

Superstructure Definition Reference Line

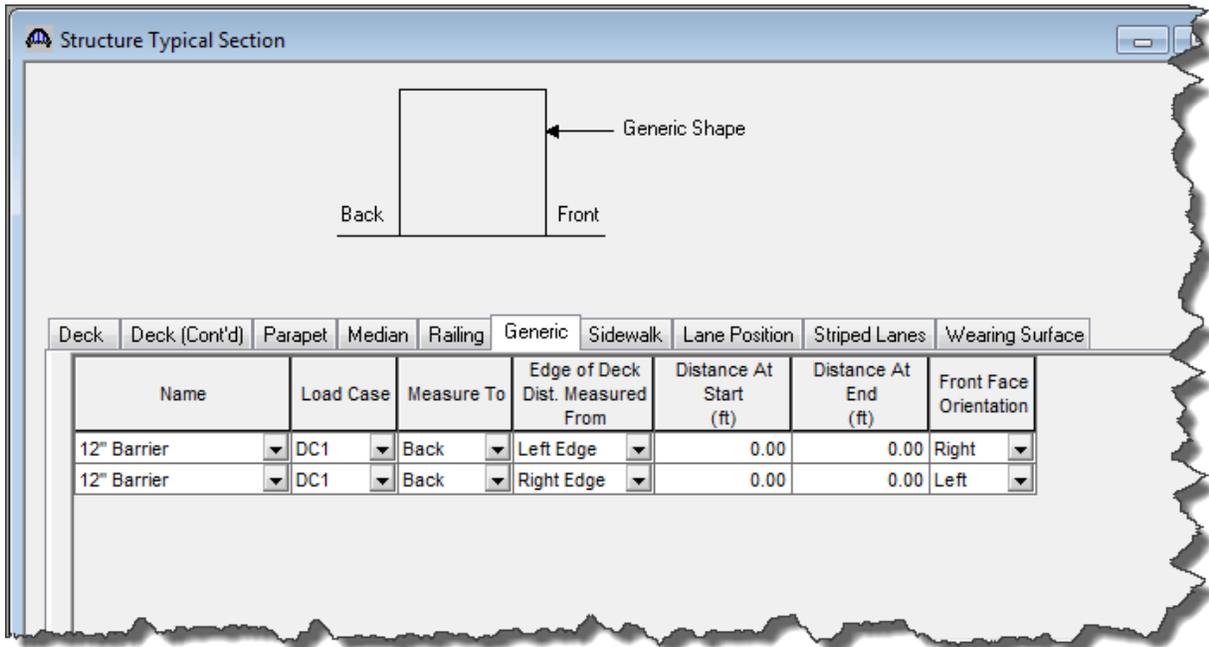
Deck Deck (Cont'd) Parapet Median Railing Generic Sidewalk Lane Position Striped Lanes Wearing Surface

Superstructure definition reference line is to the right of the left edge of deck.

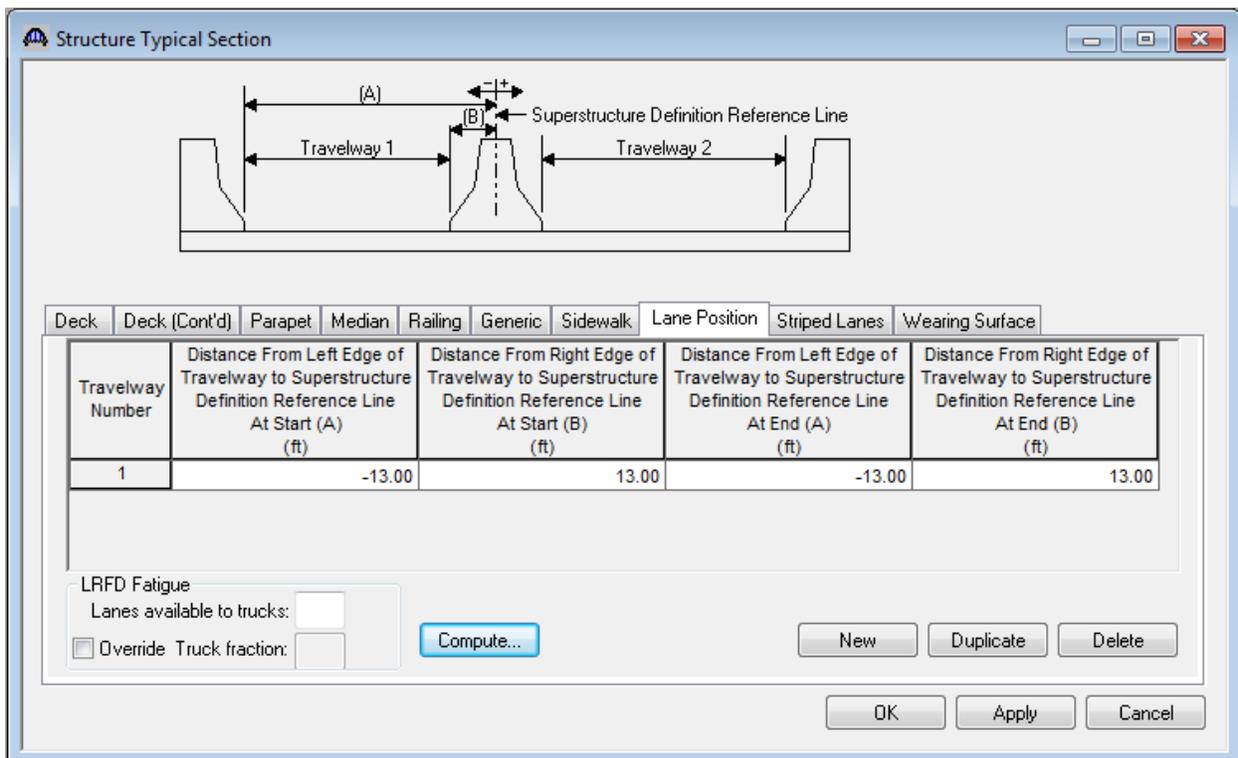
Distance from left edge of deck to superstructure definition reference line = Start 14.00 ft End 14.00 ft

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Locate the barriers.



Use the Compute button to create the lane positions.

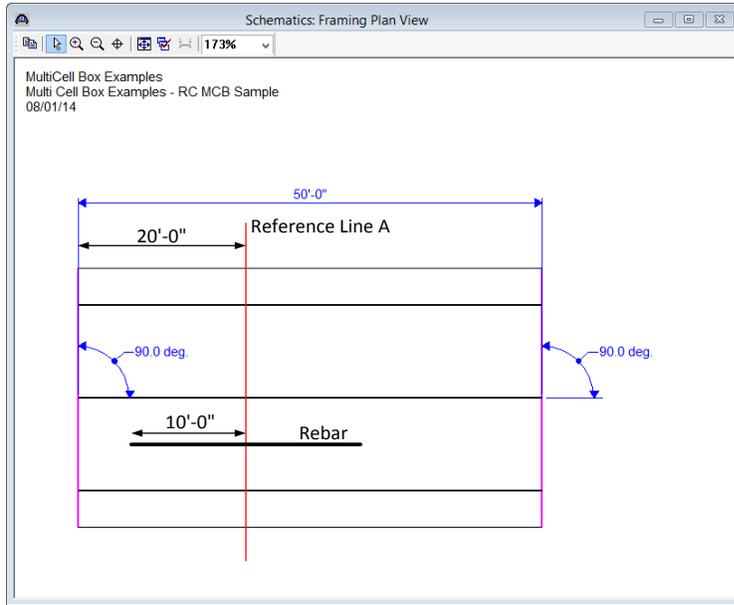


# MCB2 - Reinforced Concrete Multicell Box Example

## Slab Reinforcement

Slab reinforcement can be located in several ways for multi-cell boxes.

The user can create user defined transverse reference lines from which to locate the reinforcement. A user defined reference line is shown in the following sketch.



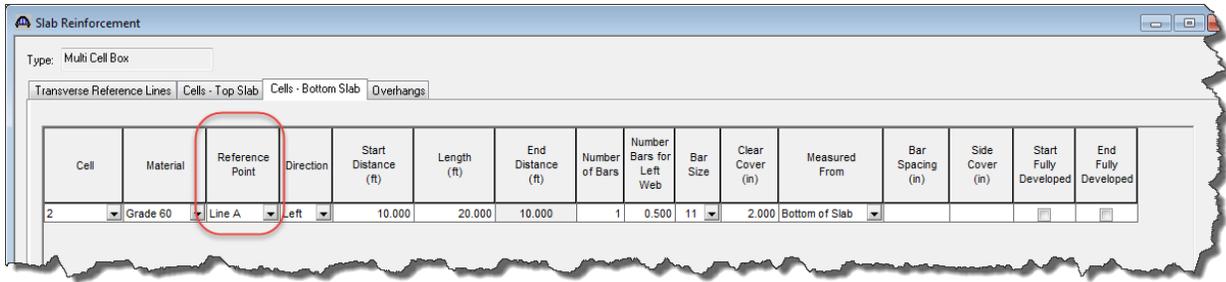
The data entry for this rebar is shown below.

The screenshot shows the "Slab Reinforcement" dialog box. The "Type" is set to "Multi Cell Box". The "Transverse Reference Lines" tab is selected. The "Input Method" is set to "Distance". A table displays the data for "Line A":

Reference Line	Measured From Support	Distance along Left Edge Deck (ft)	Distance along Right Edge Deck (ft)
Line A	1	20.000	20.00

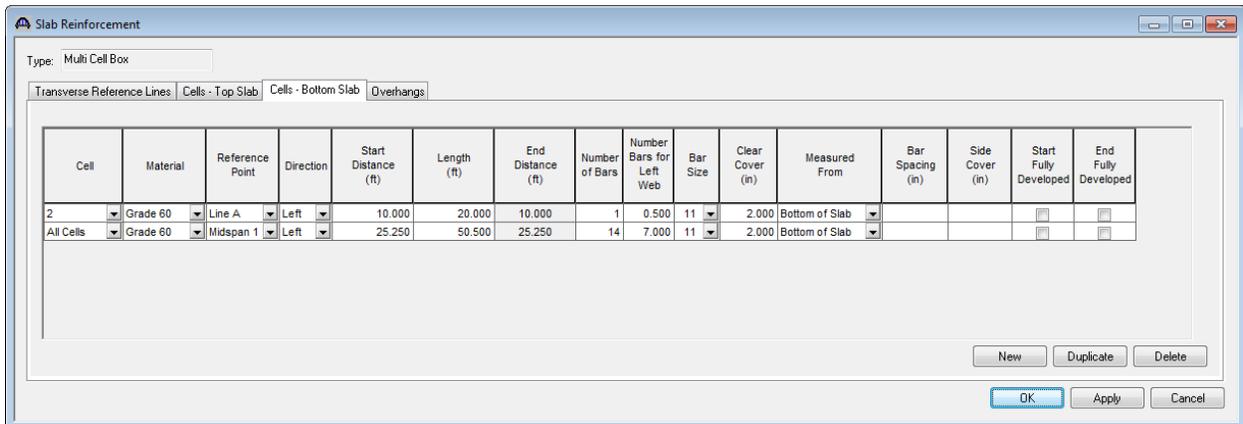
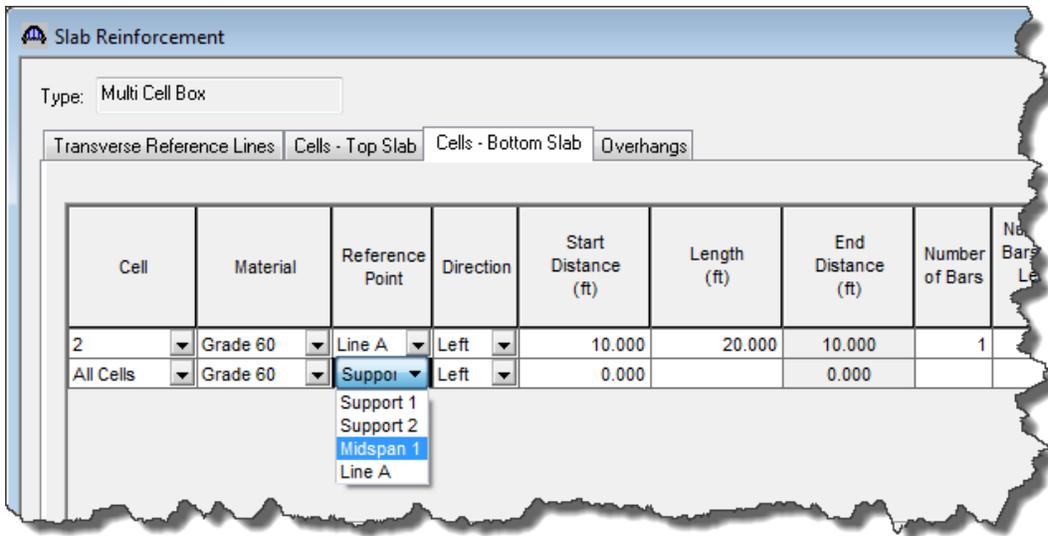
Buttons for "New", "Delete", "OK", "Apply", and "Cancel" are visible at the bottom of the dialog.

# MCB2 - Reinforced Concrete Multicell Box Example



The start distance for this bar is located 10' to the left of the reference Line A.

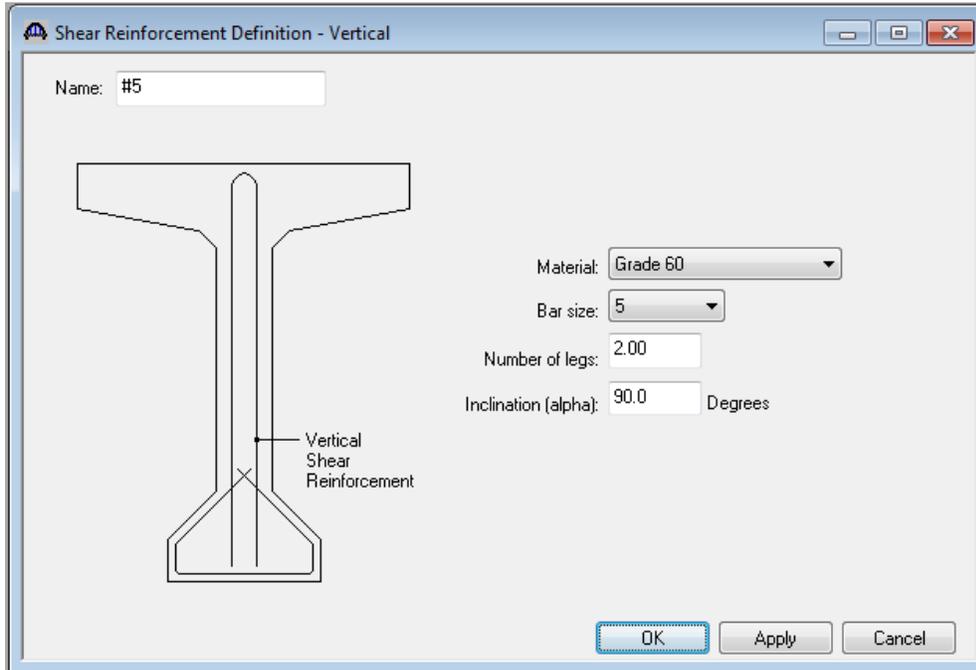
Another way to reference reinforcement in a MCB is from the middle of a span:



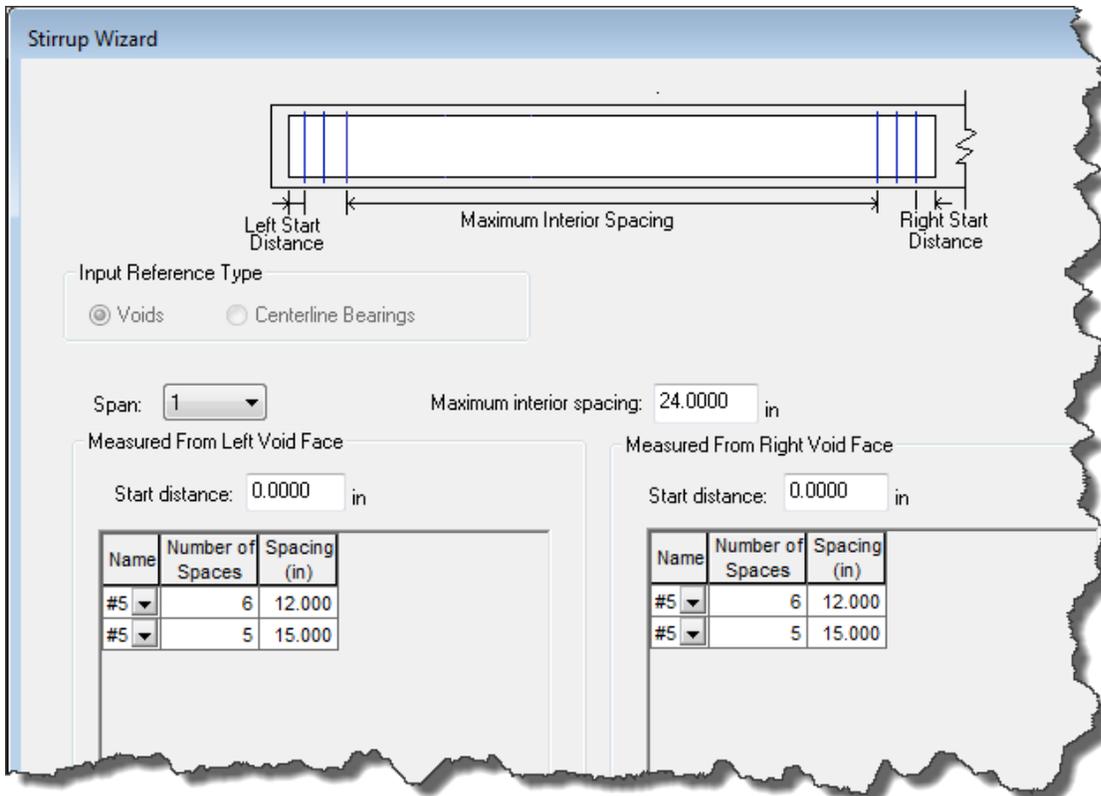
# MCB2 - Reinforced Concrete Multicell Box Example

## Stirrup Wizard

Create the following shear stirrup.

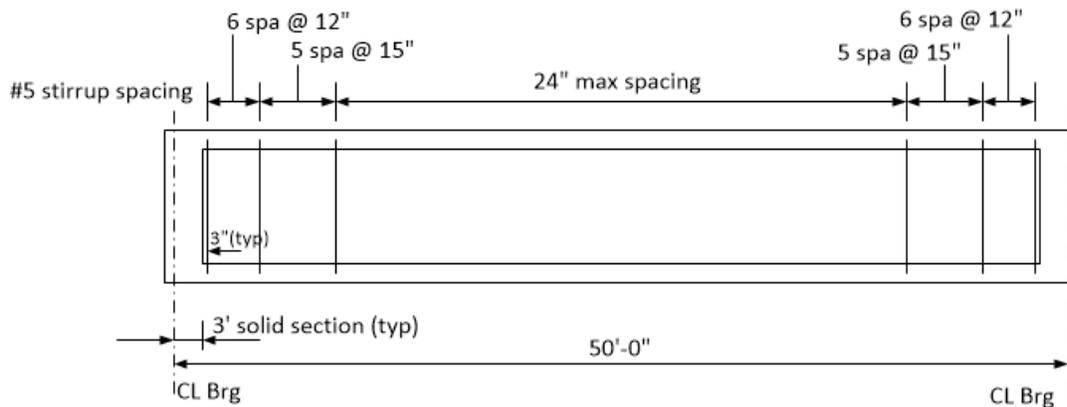


Open the Web1 Shear Reinforcement Ranges window and use the Wizard to enter the following data.



## MCB2 - Reinforced Concrete Multicell Box Example

The stirrup ranges are created as follows. Consider the following typical sketch from a set of design drawings.



During construction the region for the interior stirrups may have been divided into a number of equal spaces each less than 24" or the stirrups may have been placed at 24" max with one spacing less than 24". Since we do not know for sure how the stirrups were placed, the conservative approach is taken to locate the stirrups. The stirrups are placed at the 24" max with an odd space less than 24" placed at the center of the span where the shear is the lowest.

$$\text{Span length between void faces } L = 50' - 2(3') - 2(0.25) = 43.5'$$

$$\text{Interior Range } L = 43.5' - 2*(6(1.0') + 5(1.25')) = 19.0'$$

$$\text{Number spaces at max spacing} = \text{int}(19.0' / 2' \text{ max spacing}) = 9.5$$

$$\text{Odd space} = 19.0' - 9*2' = 1.0'$$

Odd space is positioned near the middle of the span.

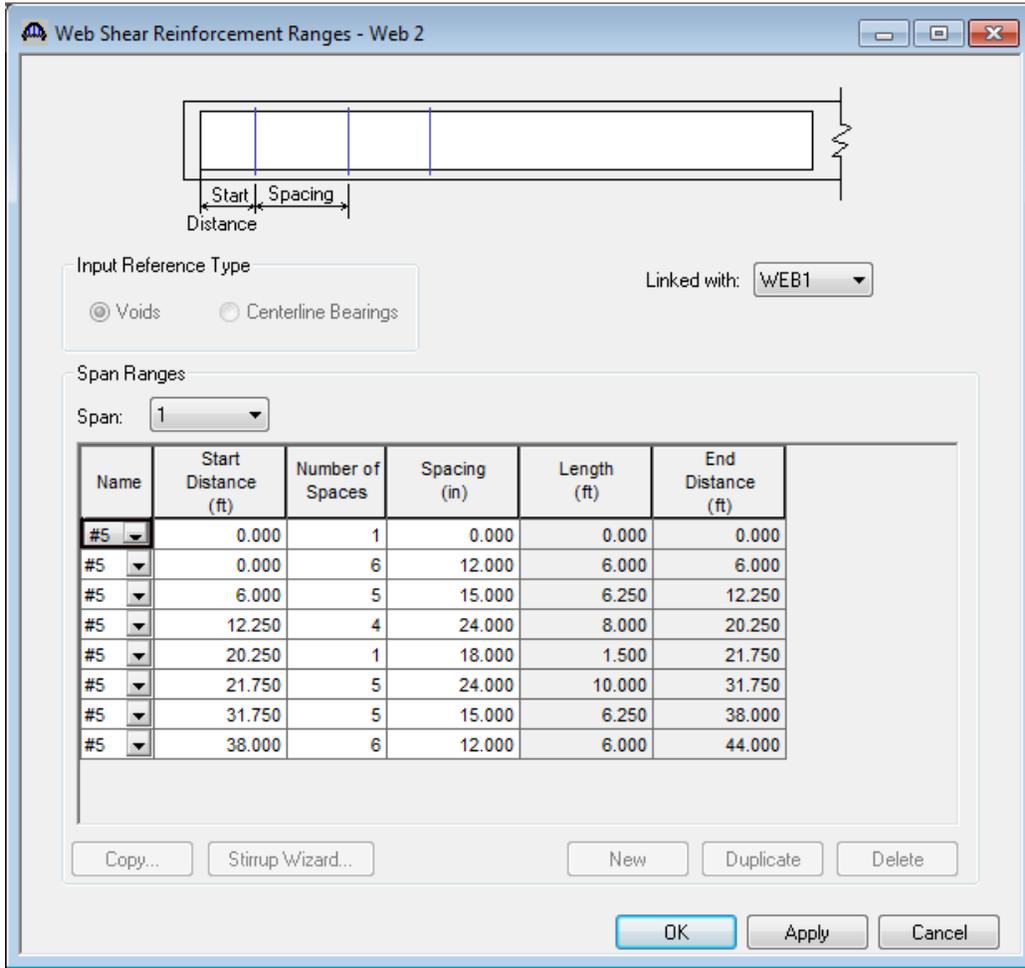
Input Reference Type:  Voids  Centerline Bearings. Linked with: None

Span Ranges: Span: 1

Name	Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)
#5	0.000000	1	0.000000	0.000	0.000
#5	0.000000	6	12.000000	6.000	6.000
#5	6.000000	5	15.000000	6.250	12.250
#5	12.250000	4	24.000000	8.000	20.250
#5	20.250000	1	18.000000	1.500	21.750
#5	21.750000	5	24.000000	10.000	31.750
#5	31.750000	5	15.000000	6.250	38.000
#5	38.000000	6	12.000000	6.000	44.000

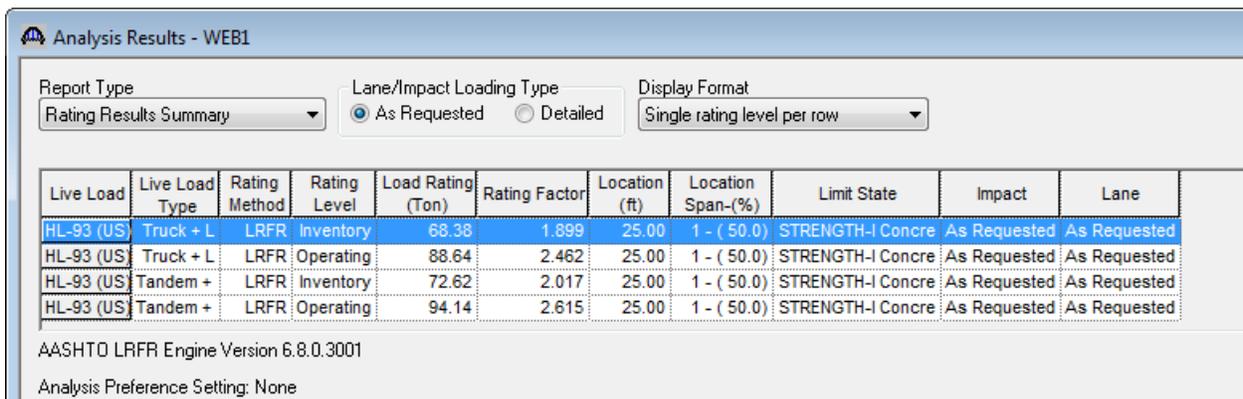
# MCB2 - Reinforced Concrete Multicell Box Example

Open the Web 2 and Web 3 Shear Reinforcement Ranges windows and link those webs to Web 1.



## Web Analysis

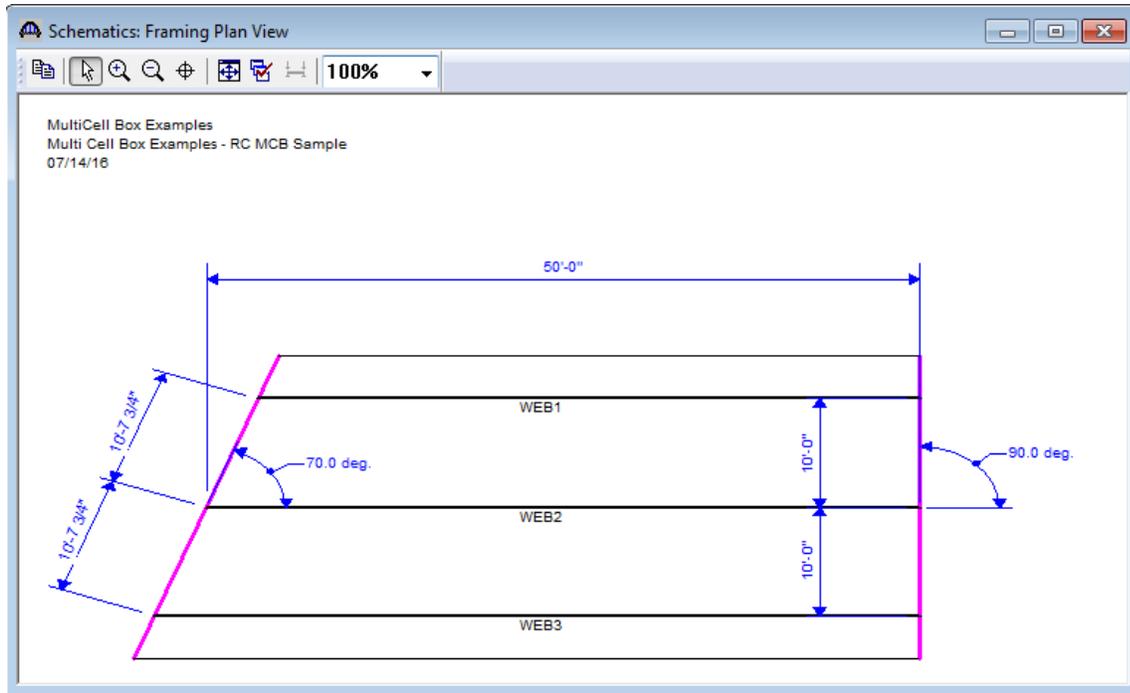
Select "Web 1" in the BWS tree and initiate an LRFR rating. The results are shown below.



## Skewed Structures

### Unequal Skews

For structures that have unequal skewed supports, like in the framing plan shown below, analyzing the structure definition will only analyze the full box width and not each individual weblines. The weblines should be analyzed individually for this case.



The following warning message will appear in the analysis progress dialog.

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