AASHTOWare™ BRIDGE DESIGN AND RATING

NEW Advanced Concrete MCB

BrDR 7.5.1

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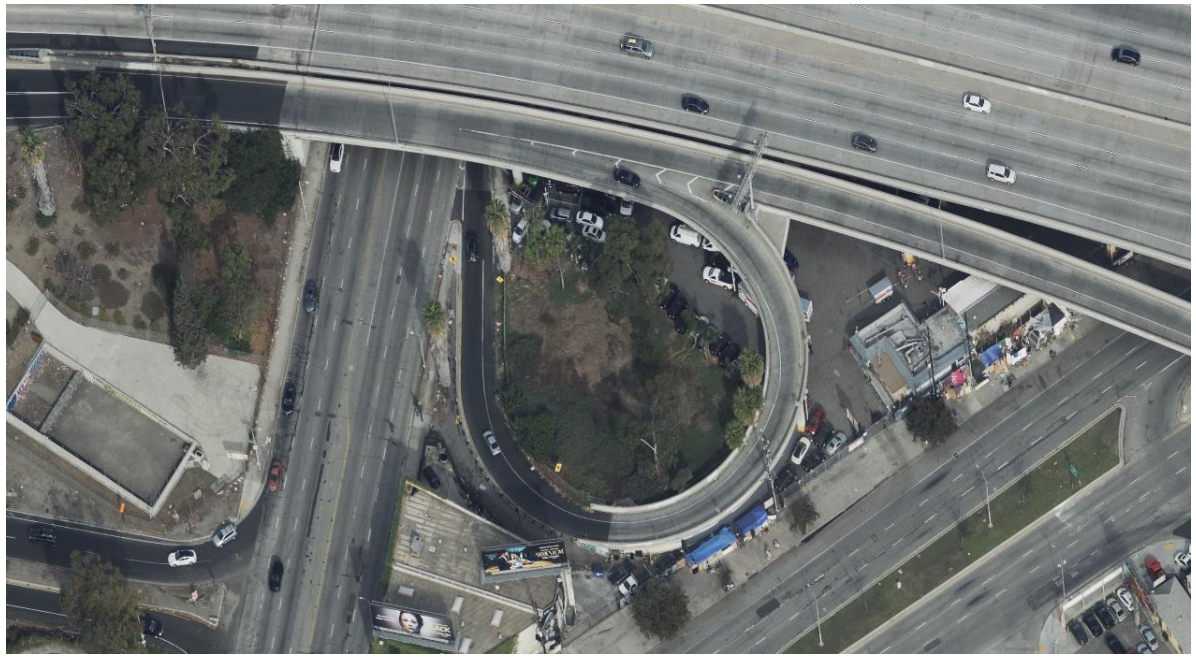
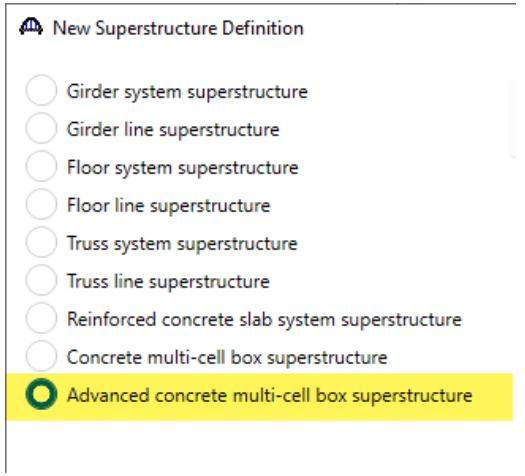
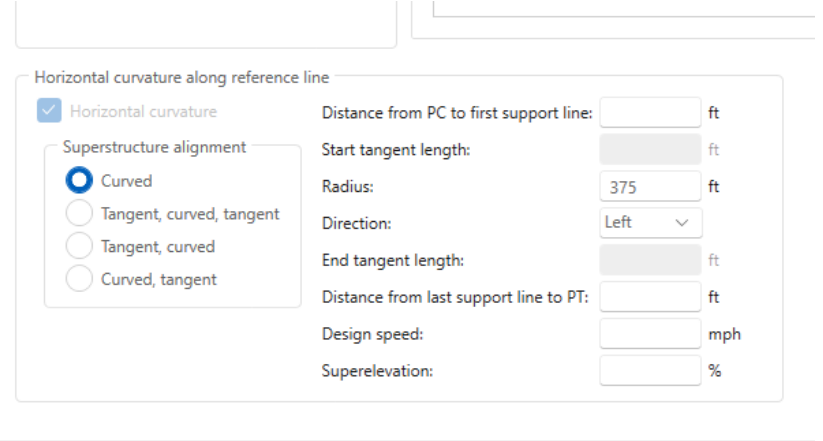


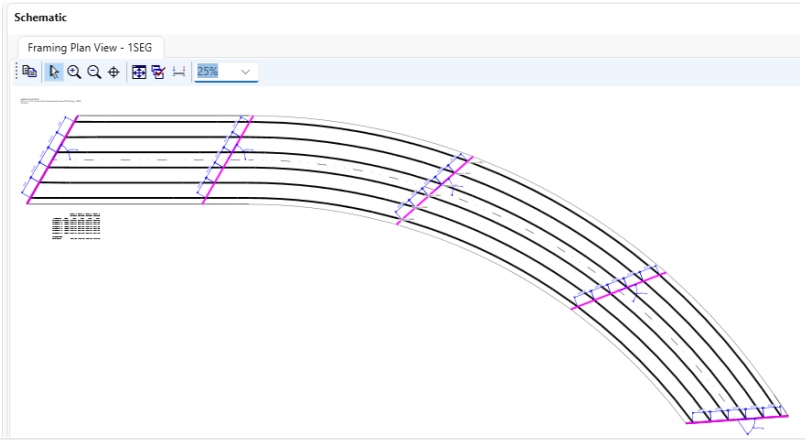
Why new Advanced MCB?

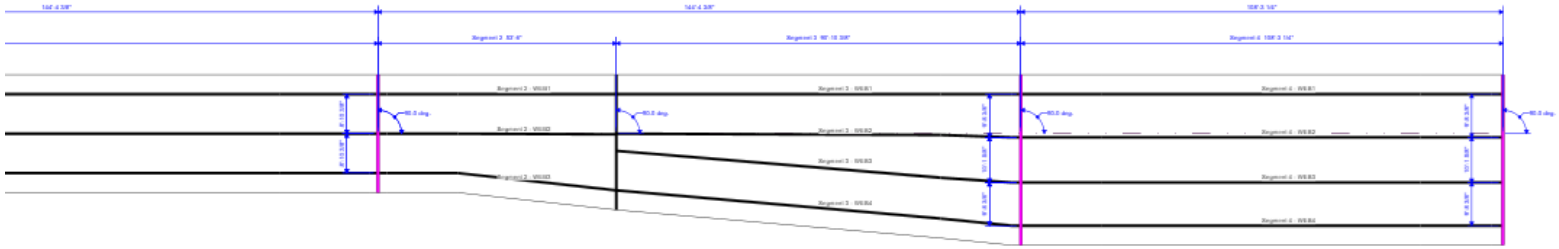
- Current Concrete MCB superstructure limitations:
  - No curved alignments
  - Varying width modeling is limited
  - No change in number of cells
- New Advanced MCB introduced in BrDR 7.5.1 to overcome limitations:
  - Curved alignments available
  - Ability to model various complex geometries with varying width
  - Number of cells can vary (full box only)

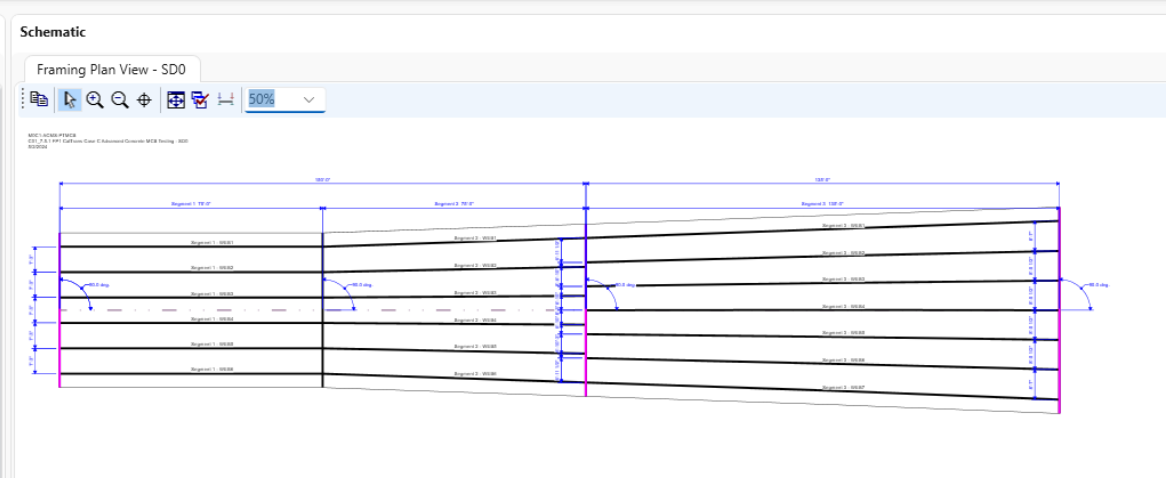




Bridge Configurations





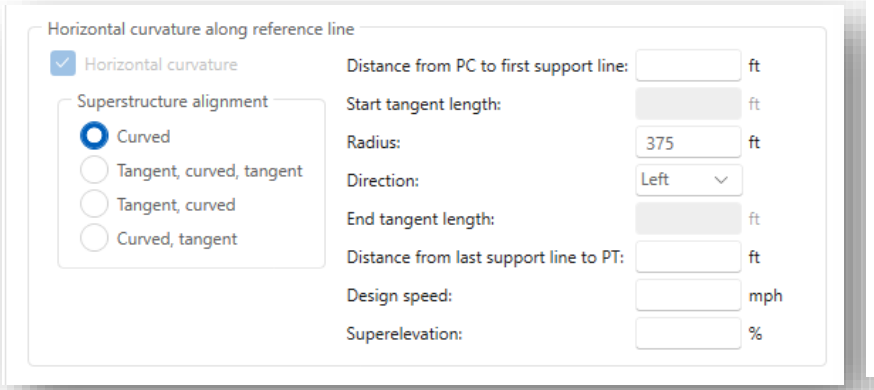


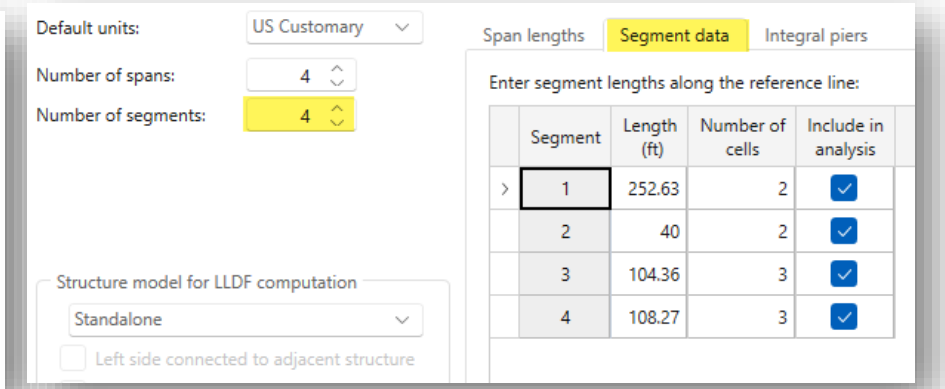
- Individual web analysis available for moment and shear if webs align; otherwise, full box only.
- Curved boxes include torsion effect (as effective shear) but control option available to turn off if needed.
- Tendons can be entered for full box or individual webs.

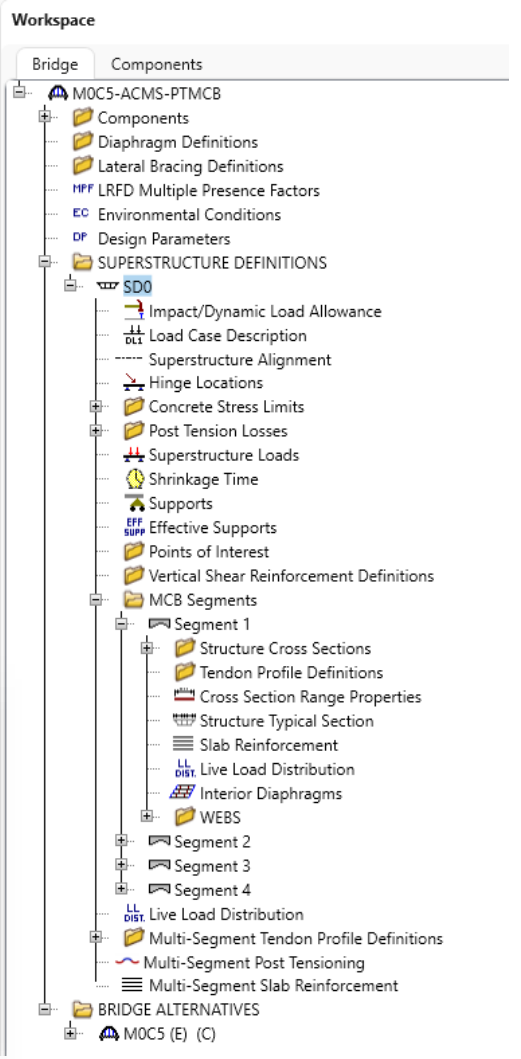
Graphical User Interface

Very similar to regular MCB except:

- Input to capture curve data
- Segment input to break up structure into segments when number of cells change.
  - All regular MCBs can be modeled as 1-segment Advanced MCB. Input is essentially identical.







Modeling

Spine model created:

1. along CL of bridge
2. along CL of each web (if ind. web analysis)

If curved, chorded segments along curve:

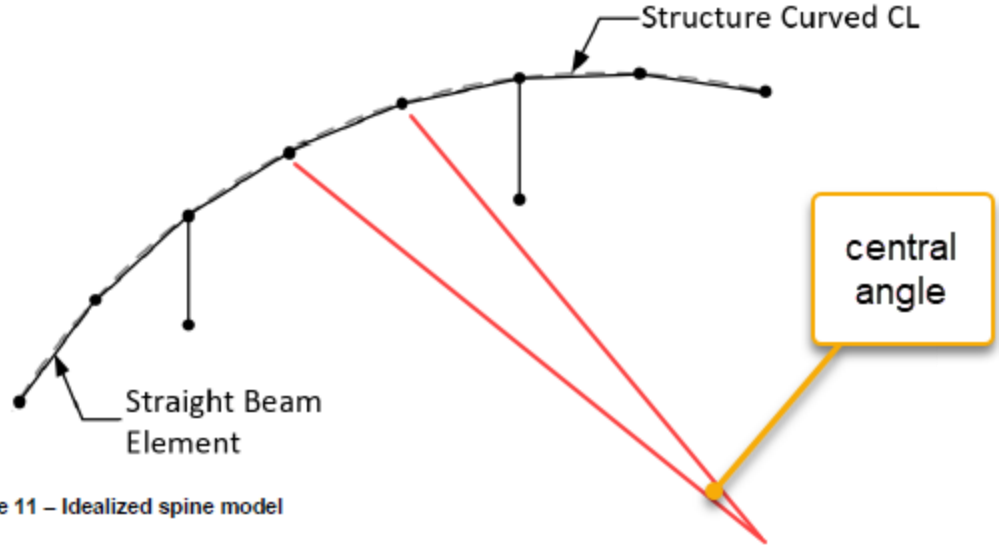
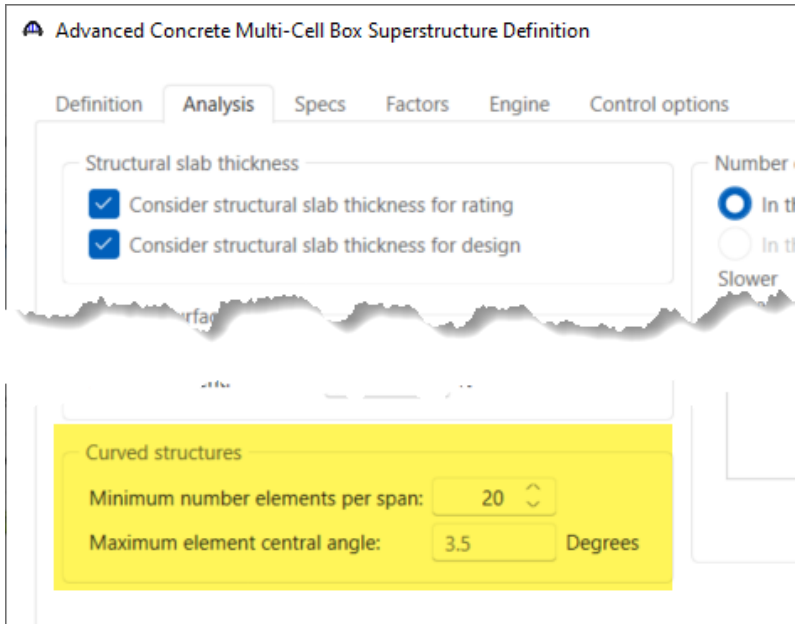
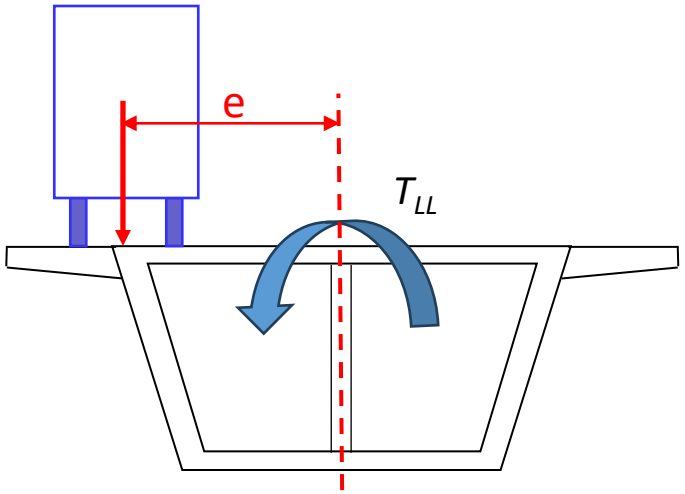


Figure 11 – Idealized spine model

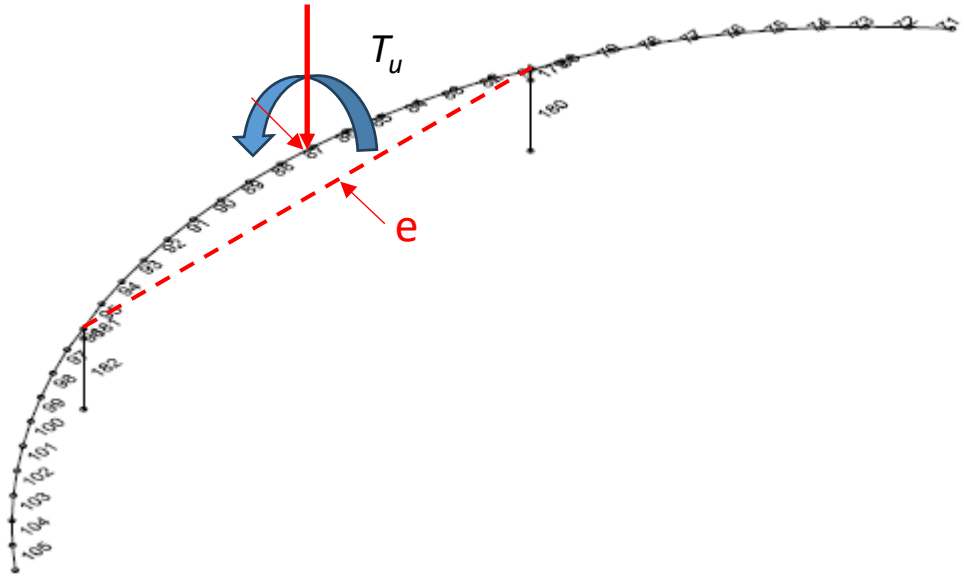


Curved Models: Torsion Demand T_U

1. T due to unsymmetric loading
   - T_{DL}: Occurs if section not symmetric
   - T_{LL}: Any LL Offset from CL. Occurs in all bridges regardless of curvature.



2. T due to horizontal curvature
   - Always present in curved structure but increased severity with smaller radius and longer spans.



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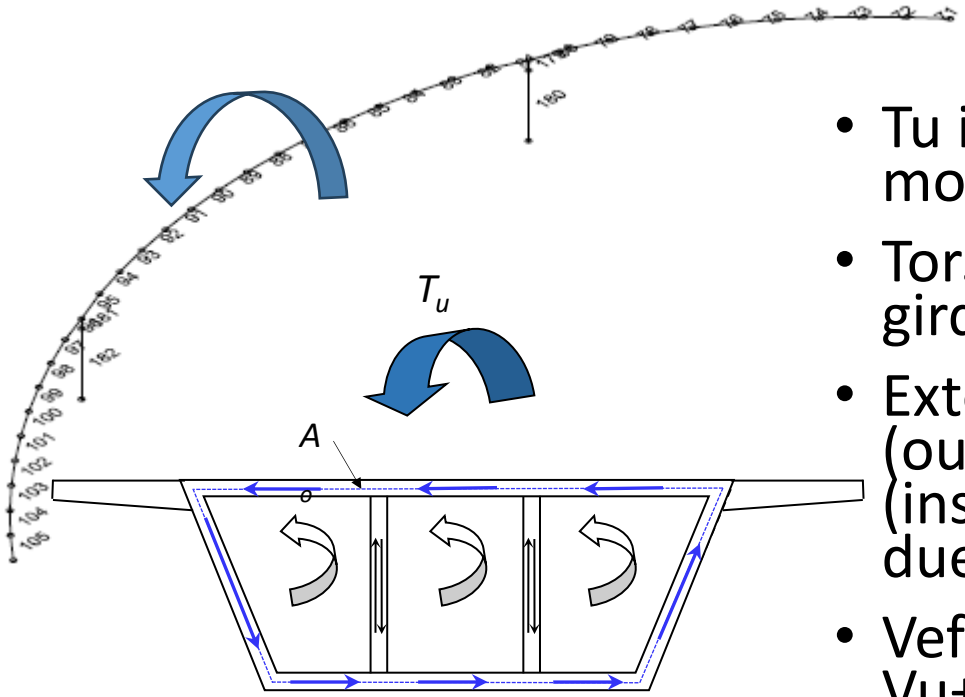


- Tu is determined from full box model
- Torsional shear flow in interior girders cancel each other
- Exterior girders see an increase (outside of curve) or decrease (inside of curve) in vertical SHEAR due to Tu. Decrease is ignored.
- Veff is determined by LRFR equation Vu+(Shear due to Torsion)

SECTION 5: CONCRETE STRUCTURES

Where consideration of torsion is required by the provisions of Article 5.7.2.1, V_u in Eq. 5.7.3.4.2-4 shall be replaced by V_{eff}.

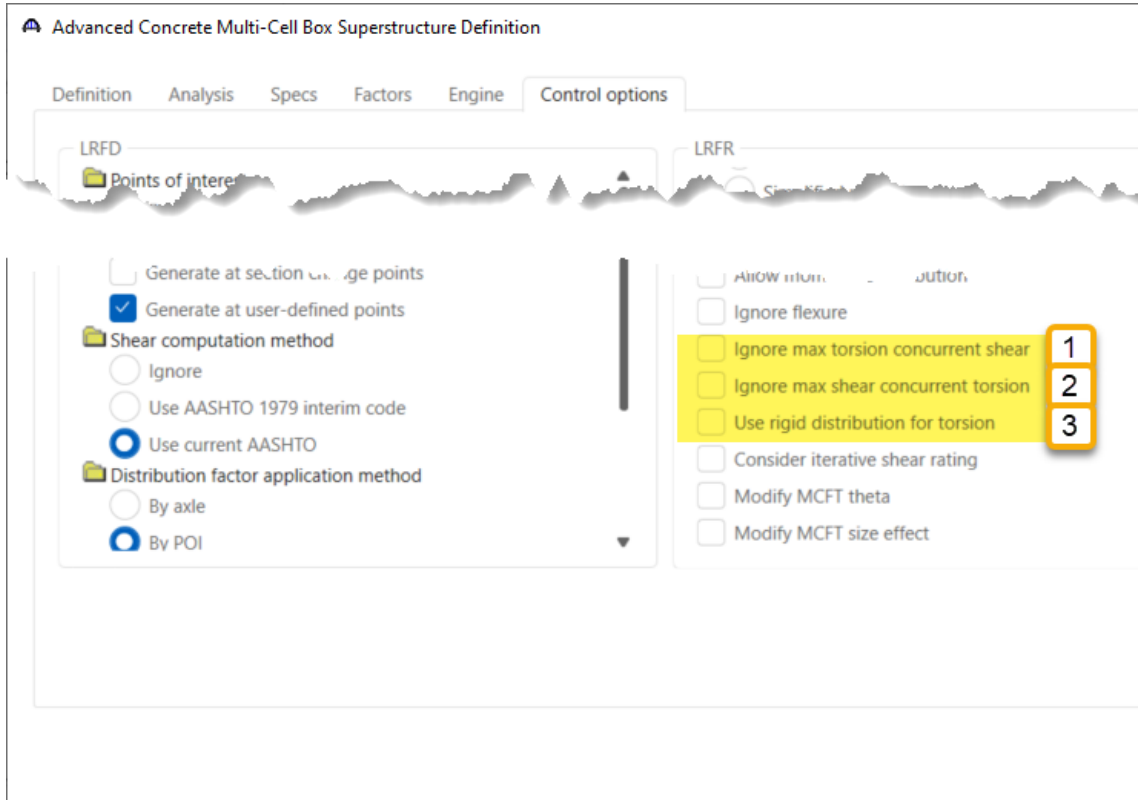
For solid sections:

$$V_{eff} = \sqrt{V_u^2 + \left(\frac{0.9 p_h T_u}{2A_o}\right)^2} \qquad (5.7.3.4.2\text{-}5)$$

For hollow sections:

$$V_{eff} = V_u + \frac{T_u d_s}{2A_o} \qquad (5.7.3.4.2\text{-}6)$$

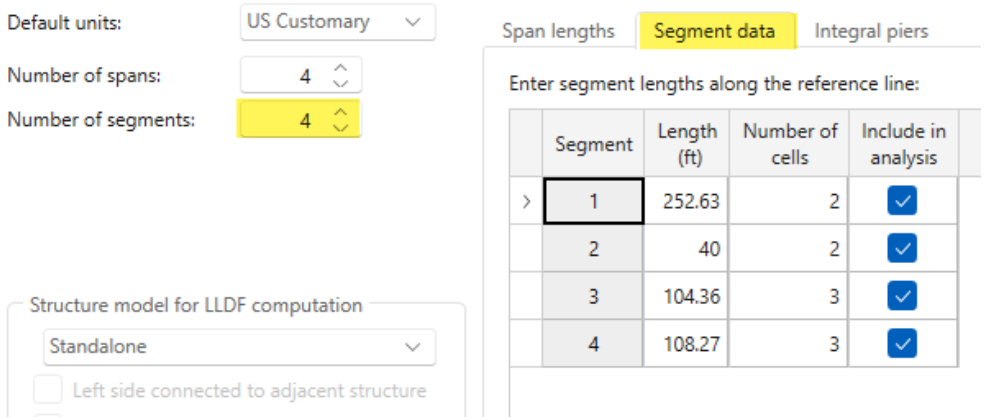
Control Options

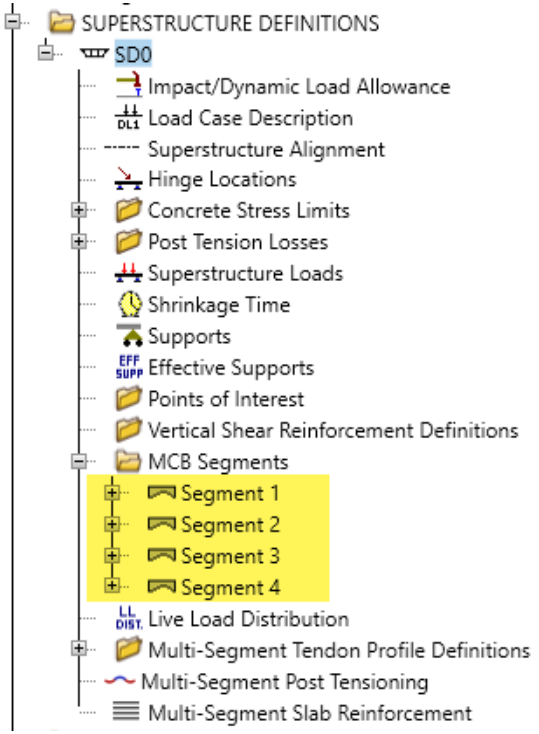


- If 1&2 checked, Torsion will be ignored in analysis and only shear without torsion will be considered
- If 3 checked, instead of AASHTO Veff equation, rigid body rotation will be used to determine additional shear due to torsion

Segment Concept

- Define bridge in segments
- When #cells changes, begin new segment
- Rebar and tendons can be defined within a segment or multiple segments





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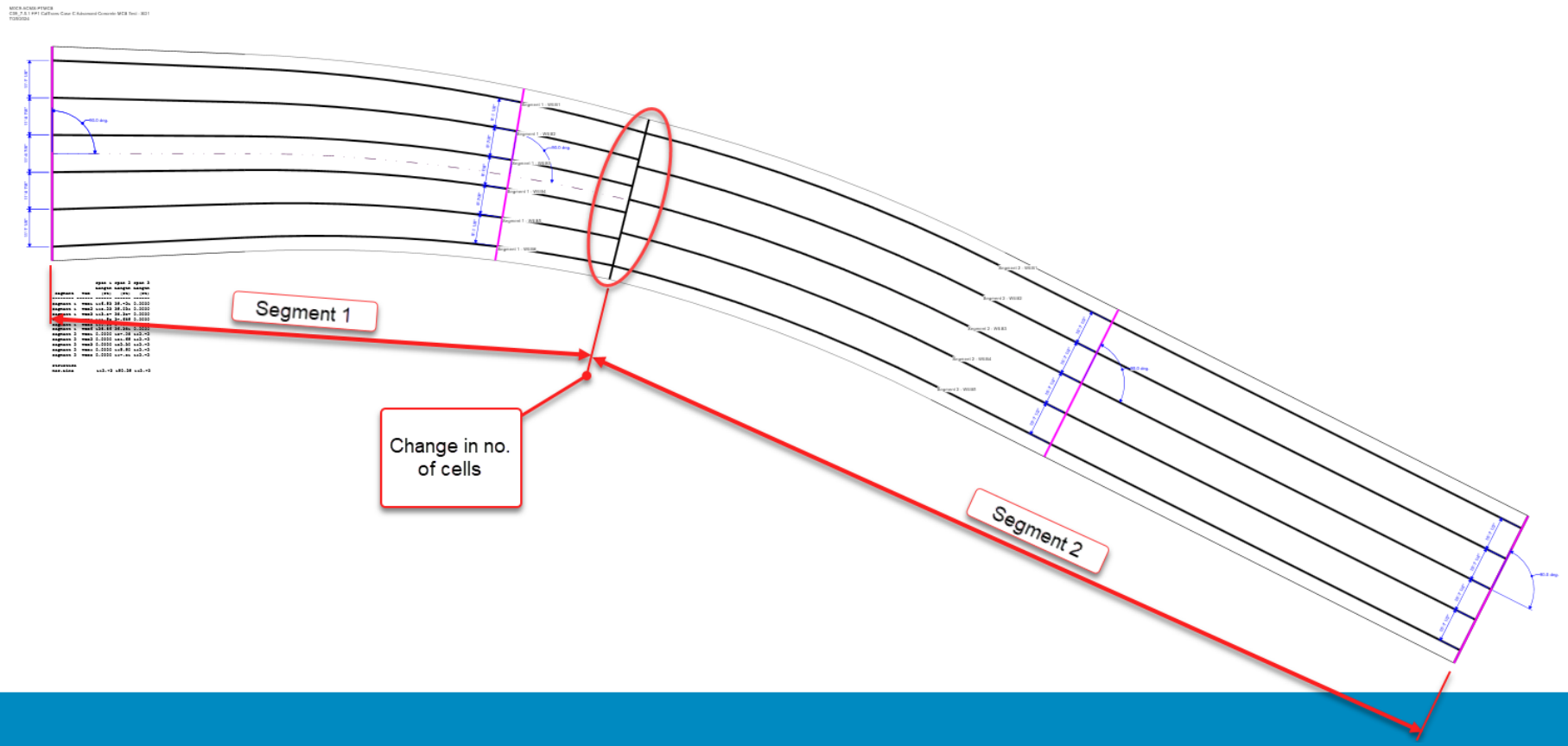
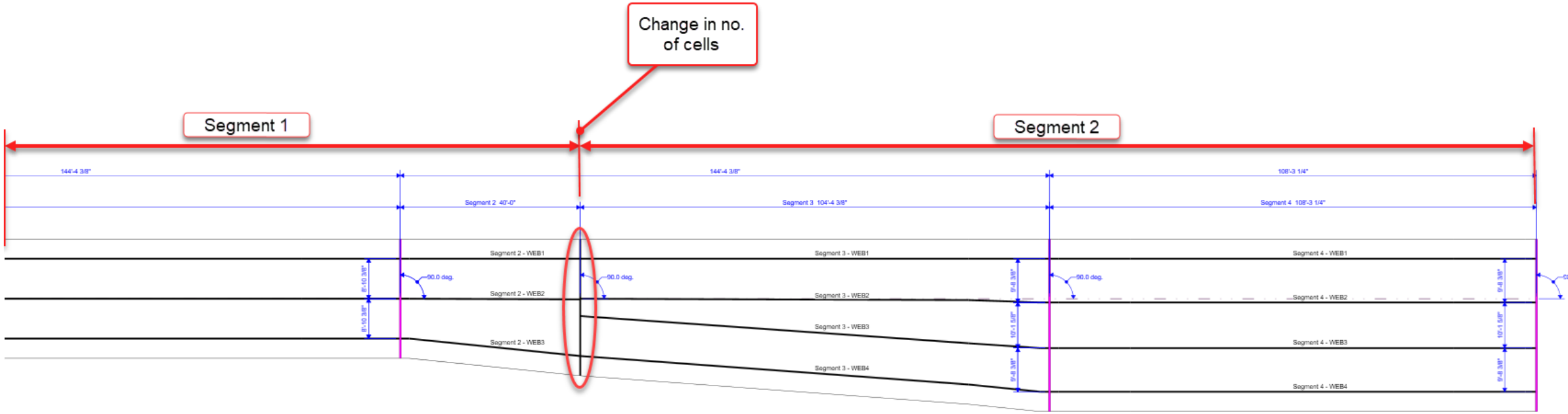


Segment Concept



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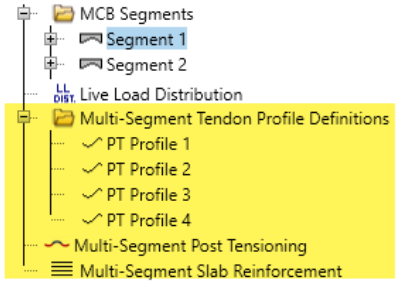
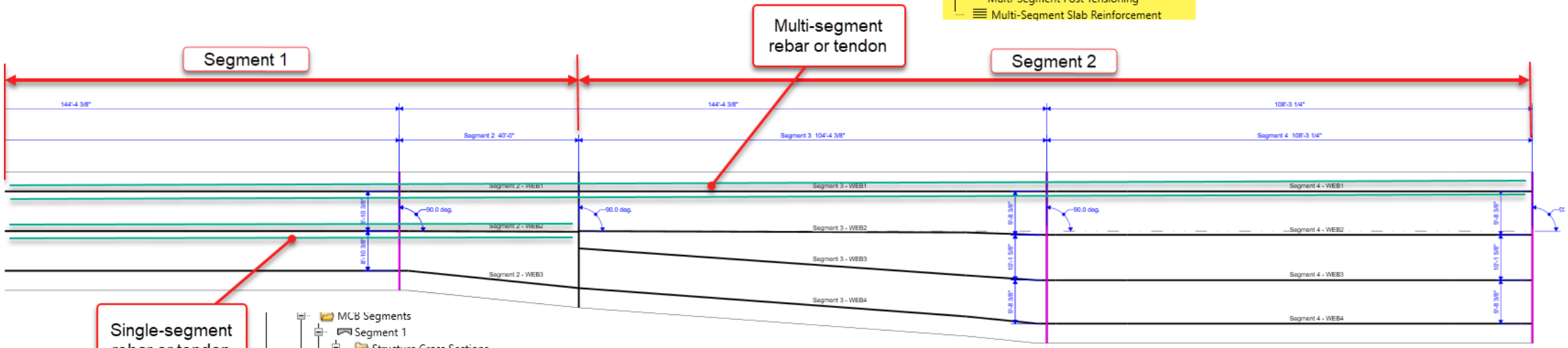
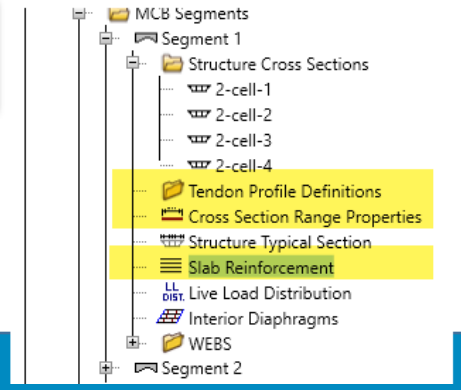
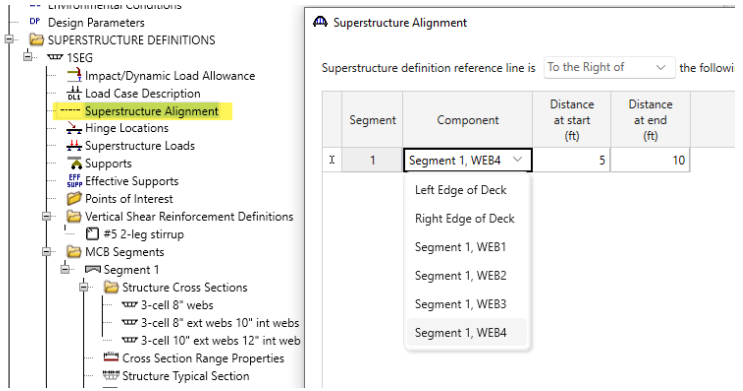






Additional Capabilities

- Prestress tendons
  - Overlapping and stacked tendons
  - Partial length tendons
  - Individual web or full box
- Analysis
  - Individual web analysis available for PS box with varying length webs



- Modeling
  - Ability to set reference line along either edge of deck or any CL of web
  - Advanced Support Definitions (separate definitions for Stage 1, 2 and 3)
  - Varying travelway along bridge length

Advanced MCB limitations

- Simplified analysis approximating complex 3D behavior.
  - Uses spine model and AASHTO LLDF
  - Assumption that LLDF includes torsion due to eccentric placement of LL per NCHRP-620. BrDR adds only additional torsion due to horizontal curvature.
  - Integral bent modeled as frame. Bent cap modeled as I section with built in factors to approximate rigid behavior. Modeling a solid, integral connection as frames requires simplifying assumptions that can result in deviation from 3D results, especially for individual webs.
  - See Method of Solution manual on modeling and analysis assumptions

Possible Improvements

- To improve analysis, can add option for full 3D analysis with deck and integral cap as shell elements and transverse vehicle positioning. This is already available within BrDR for Steel and PSI girders.
- Since regular MCB can be modeled as 1-segment Advanced MCB with no extra effort, develop tool to migrate all regular MCB into Advanced MCB and sunset regular MCB.
- Variable depth in transverse direction
- Coming in BrDR 7.6: User POIs at web level.

- Thanks to the Promiles team for making the Advanced MCB from concept into a reality!
- Additional training: https://www.aashtowarebridge.com/bridge-rating-and-design/training/
- Method of Solution
  (Bridge Workspace > Help)

Questions?