



NEW Advanced Concrete MCB

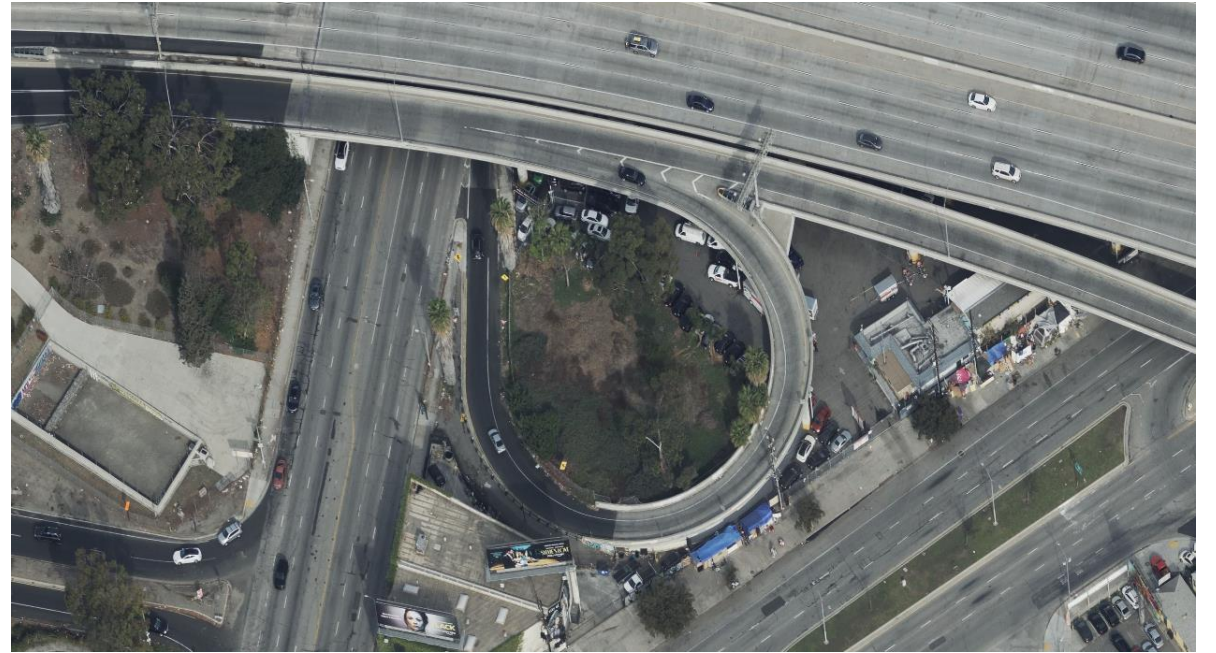
BrDR 7.5.1

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RADBUG 2024 | August 6-7 | Buffalo, NY

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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)

New Superstructure Definition

- Girder system superstructure
- Girder line superstructure
- Floor system superstructure
- Floor line superstructure
- Truss system superstructure
- Truss line superstructure
- Reinforced concrete slab system superstructure
- Concrete multi-cell box superstructure
- Advanced concrete multi-cell box superstructure

Horizontal curvature along reference line

Horizontal curvature

Distance from PC to first support line: ft

Start tangent length: ft

Radius: ft

Direction: ▾

End tangent length: ft

Distance from last support line to PT: ft

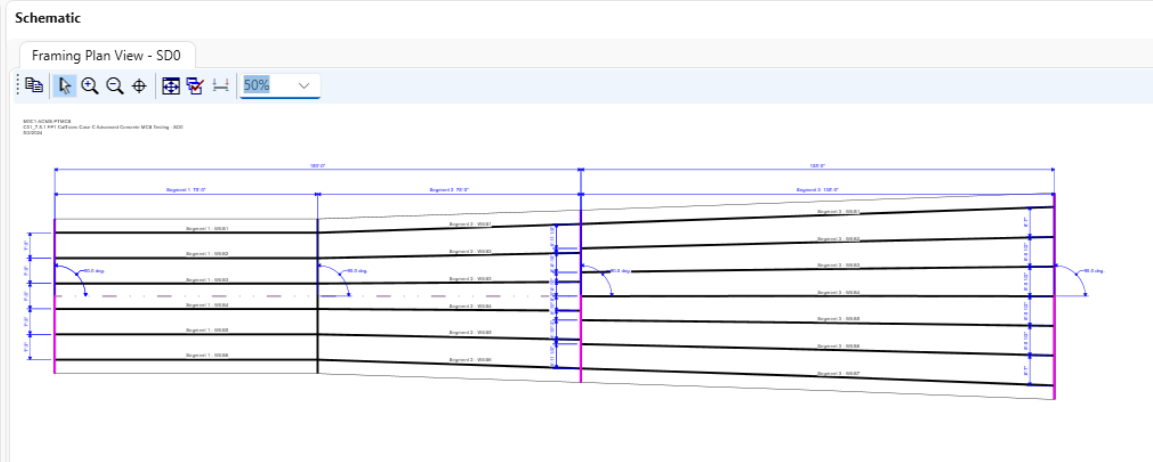
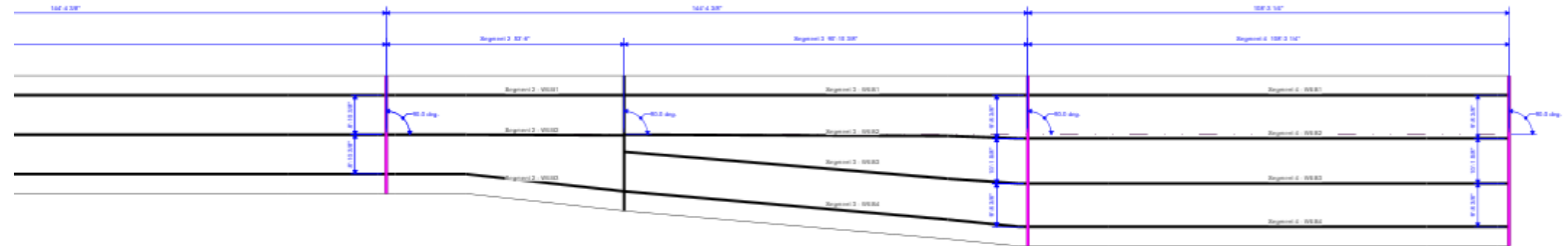
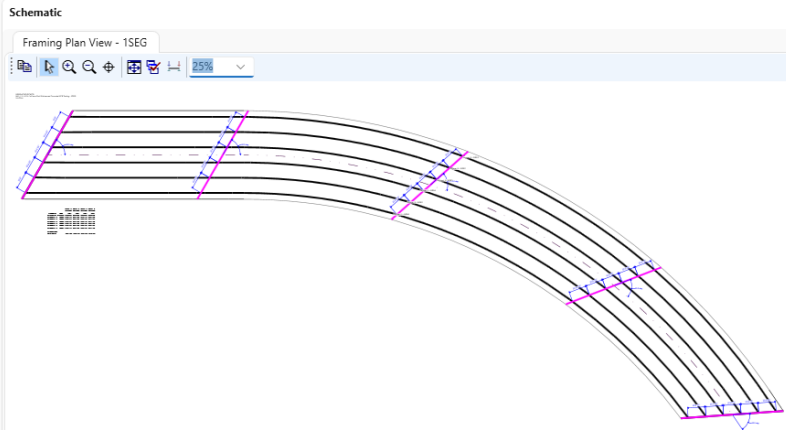
Design speed: mph

Superelevation: %

Superstructure alignment

- Curved
- Tangent, curved, tangent
- Tangent, curved
- Curved, tangent

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.

Horizontal curvature along reference line

Horizontal curvature

Superstructure alignment

Curved

Tangent, curved, tangent

Tangent, curved

Curved, tangent

Distance from PC to first support line: ft

Start tangent length: ft

Radius: ft

Direction: ▾

End tangent length: ft

Distance from last support line to PT: ft

Design speed: mph

Superelevation: %

Default units: ▾

Number of spans: ▾

Number of segments: ▾

Span lengths Segment data Integral piers

Enter segment lengths along the reference line:

Segment	Length (ft)	Number of cells	Include in analysis
> 1	252.63	2	<input checked="" type="checkbox"/>
2	40	2	<input checked="" type="checkbox"/>
3	104.36	3	<input checked="" type="checkbox"/>
4	108.27	3	<input checked="" type="checkbox"/>

Structure model for LLDF computation

▾

Left side connected to adjacent structure

Workspace

Bridge Components

- MOC5-ACMS-PTMCB
 - Components
 - Diaphragm Definitions
 - Lateral Bracing Definitions
 - MPF LRFD Multiple Presence Factors
 - EC Environmental Conditions
 - DP Design Parameters
 - SUPERSTRUCTURE DEFINITIONS
 - SDO
 - Impact/Dynamic Load Allowance
 - Load Case Description
 - Superstructure Alignment
 - Hinge Locations
 - Concrete Stress Limits
 - Post Tension Losses
 - Superstructure Loads
 - Shrinkage Time
 - Supports
 - Effective Supports
 - Points of Interest
 - Vertical Shear Reinforcement Definitions
 - MCB Segments
 - Segment 1
 - Structure Cross Sections
 - Tendon Profile Definitions
 - Cross Section Range Properties
 - Slab Reinforcement
 - Live Load Distribution
 - Interior Diaphragms
 - WEBS
 - Segment 2
 - Segment 3
 - Segment 4
 - Live Load Distribution
 - Multi-Segment Tendon Profile Definitions
 - Multi-Segment Post Tensioning
 - Multi-Segment Slab Reinforcement
 - BRIDGE ALTERNATIVES
 - MOC5 (E) (C)

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:

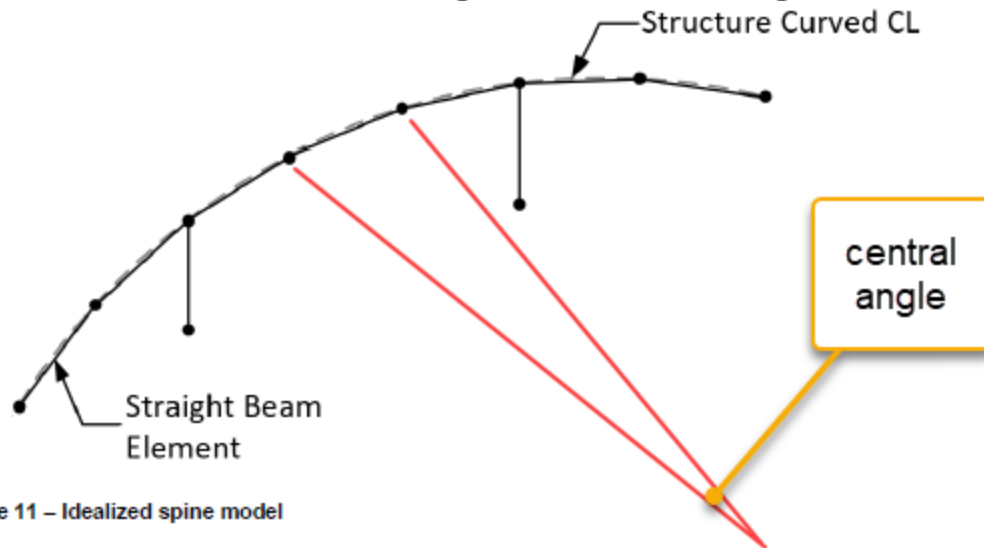
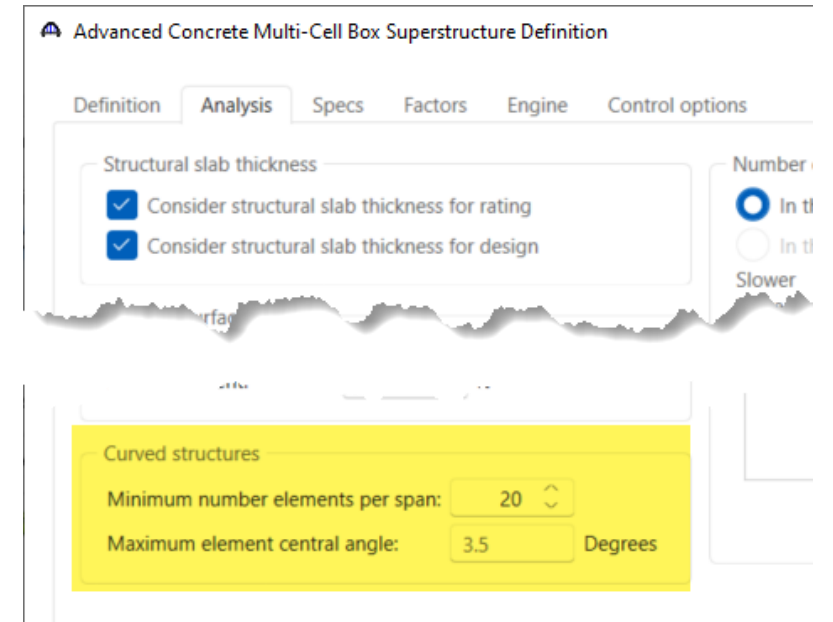


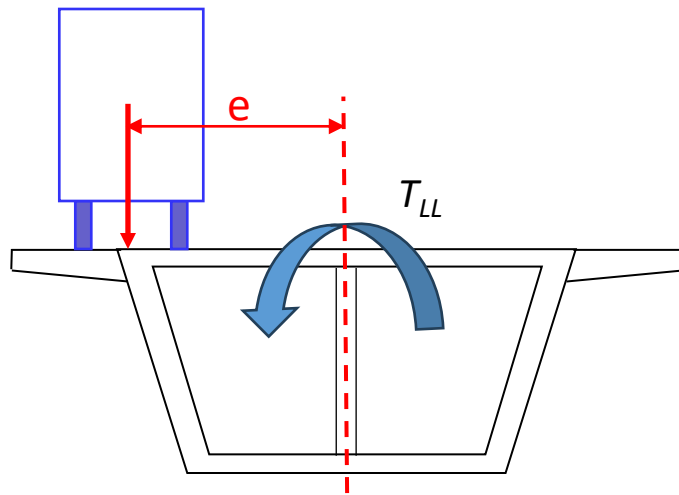
Figure 11 – Idealized spine model



Curved Models: Torsion Demand T_U

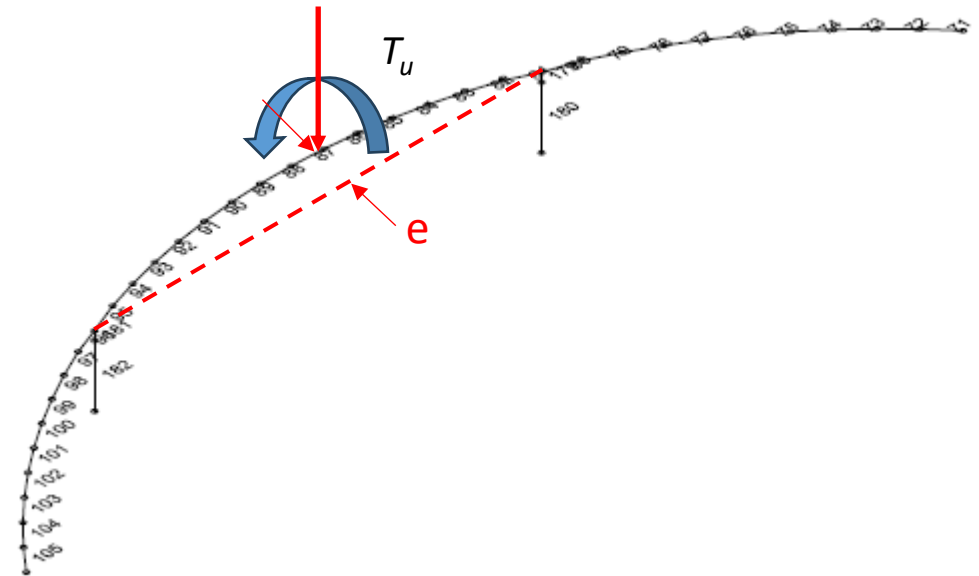
1. T due to unsymmetric loading

- T_{DL} : Occurs if section not symmetric
- T_{LL} : Any LL Offset from CL. Occurs in all bridges regardless of curvature.

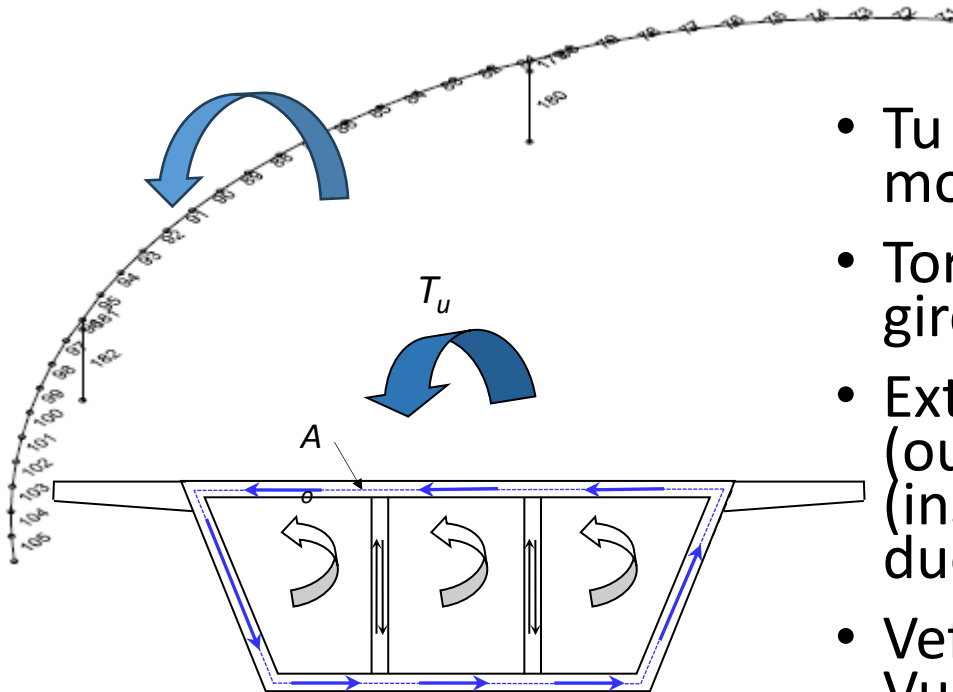


2. T due to horizontal curvature

- Always present in curved structure but increased severity with smaller radius and longer spans.



Curved Models: Torsion Demand T_u



- T_u 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 T_u . Decrease is ignored.
- V_{eff} is determined by LRFR equation $V_u + (\text{Shear due to Torsion})$

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:

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

For hollow sections:

$$V_{eff} = V_u + \frac{T_u d_z}{2A_o} \quad (5.7.3.4.2-6)$$

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 V_{eff} 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

Default units: US Customary

Number of spans: 4

Number of segments: 4

Structure model for LLDF computation

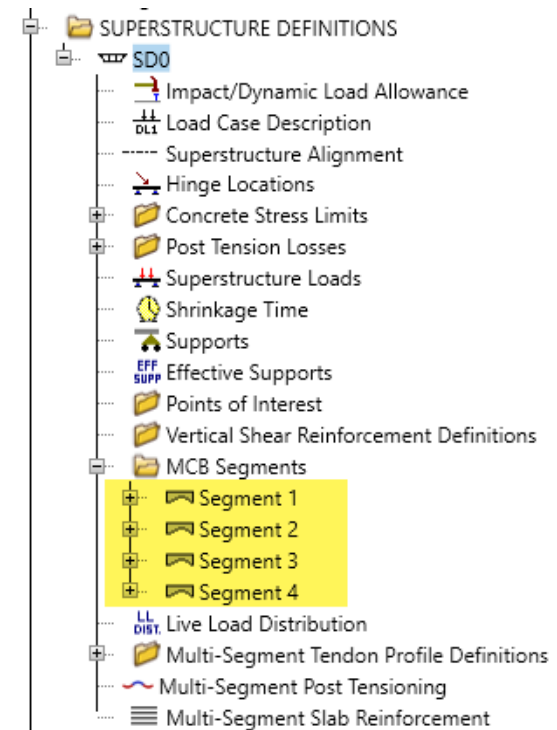
Standalone

Left side connected to adjacent structure

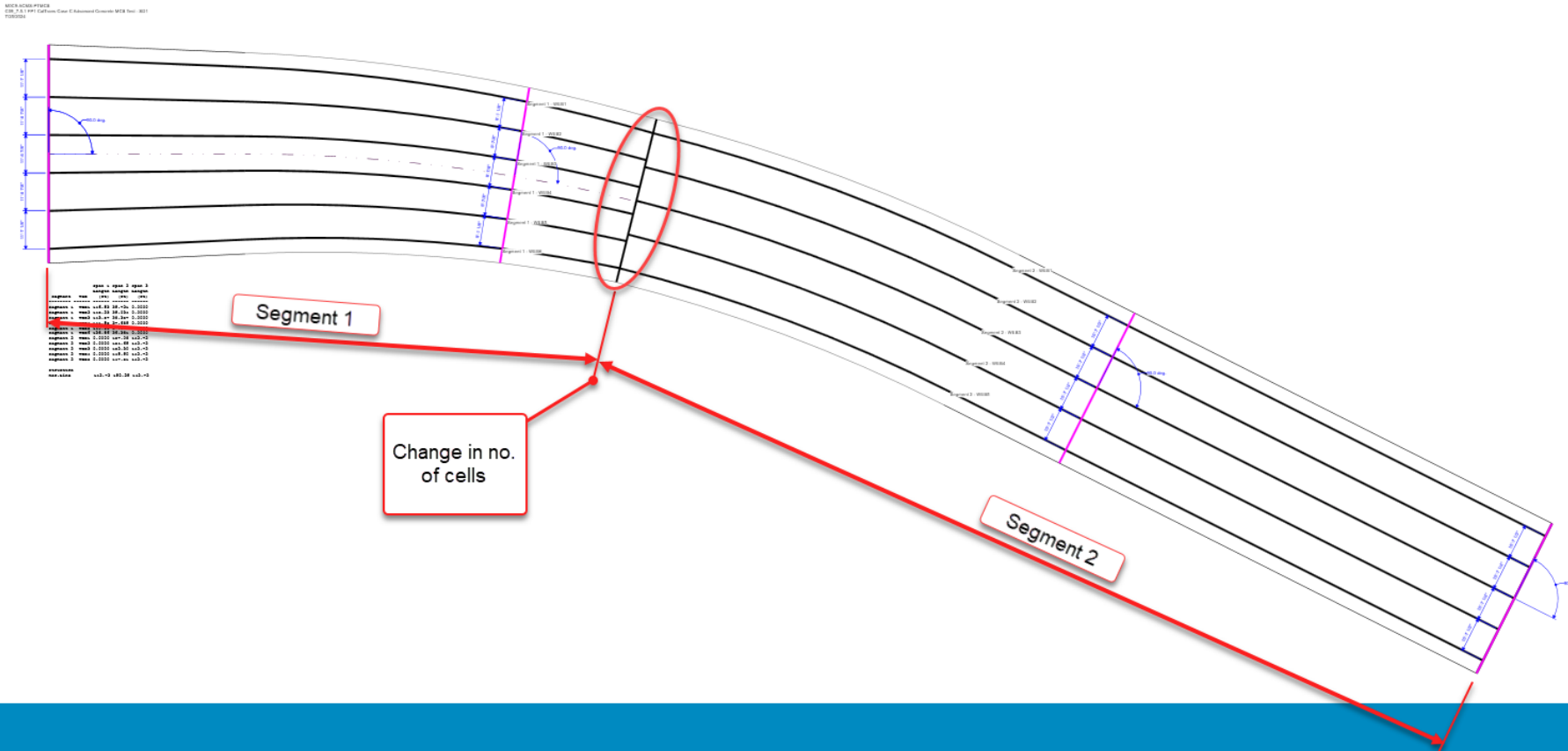
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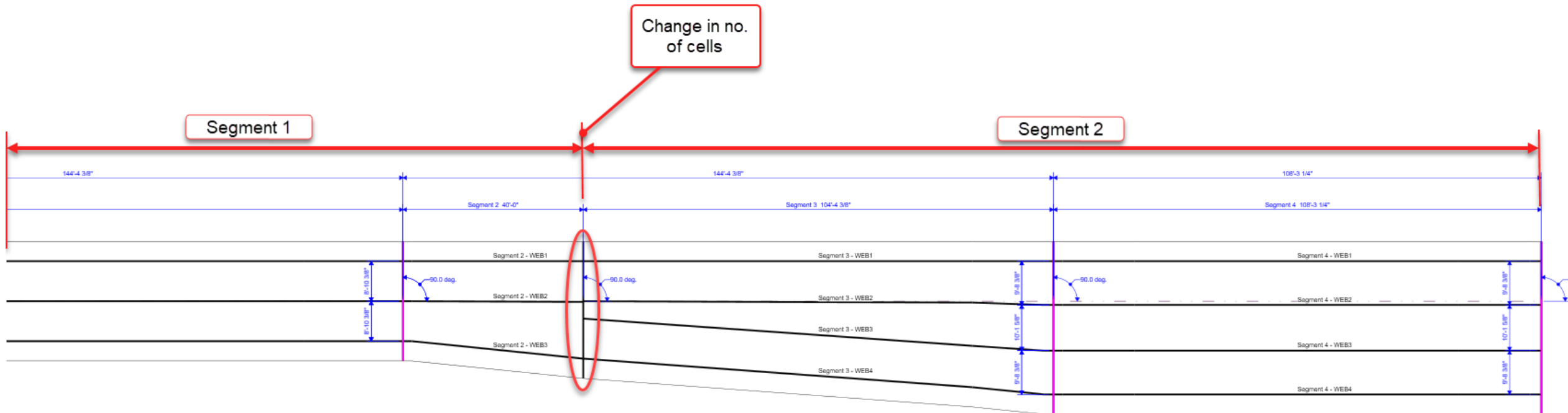
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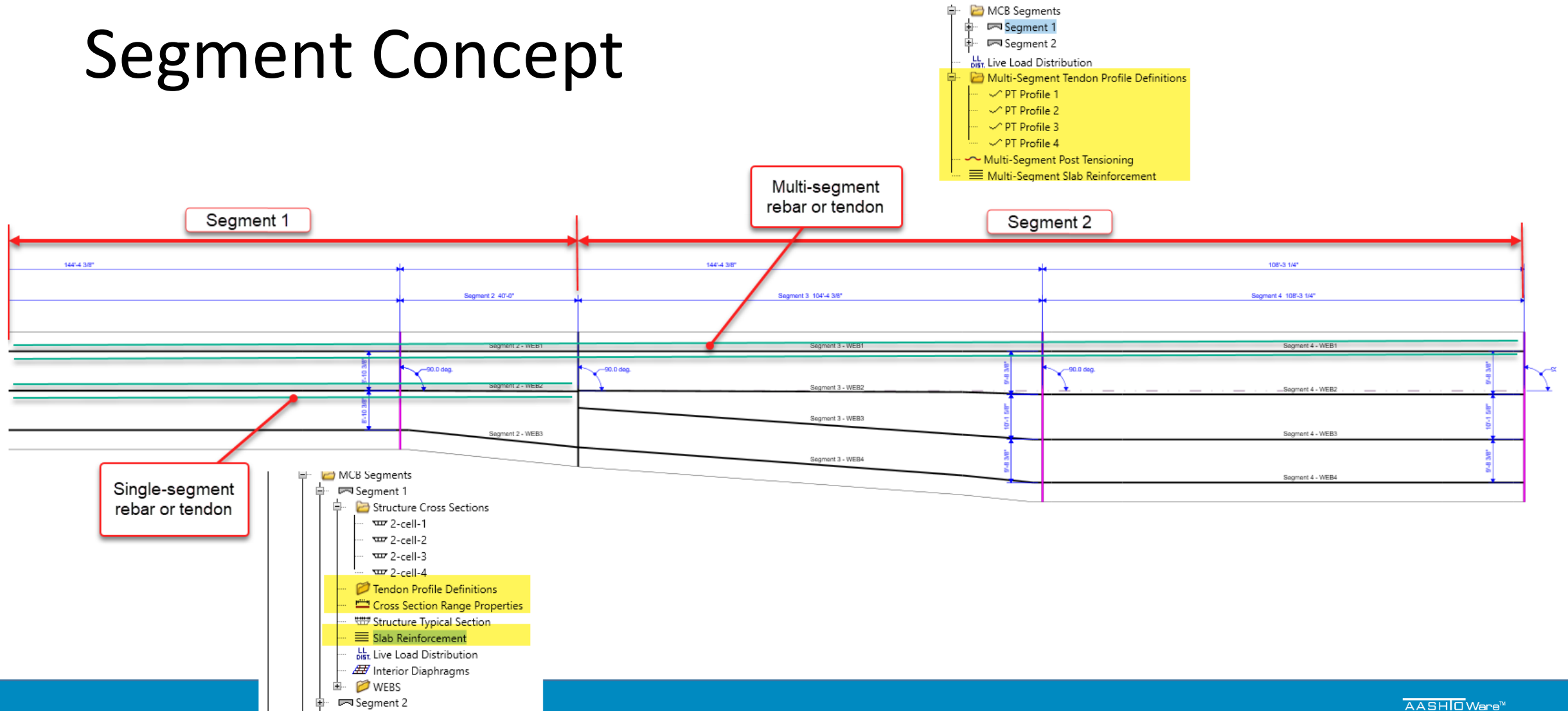
Segment Concept



Segment Concept



Segment Concept

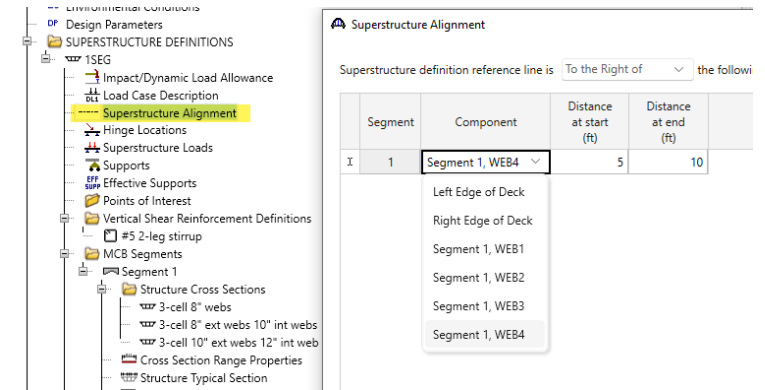


Additional Capabilities

- 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.

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- 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?

