



Department of
Transportation

Modeling and Verification of a High Skew Bridge in BrD 3D FEM

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August 12, 2025

MEET YOUR PRESENTERS



Julianne M. Fuda, P.E.

- Rensselaer Polytechnic Institute – BS in Civil Engineering, 2009
- NYS PE License – 2013
- Working at NYSDOT for 10 years
- Director of Structures Design Bureau



Kelsey Roman, P.E.

- Ohio State University – BS in Civil Engineering, 2017
- NYS PE License – 2022
- Working at NYSDOT for 8 years
- Squad Leader for a Structures Design Bureau squad

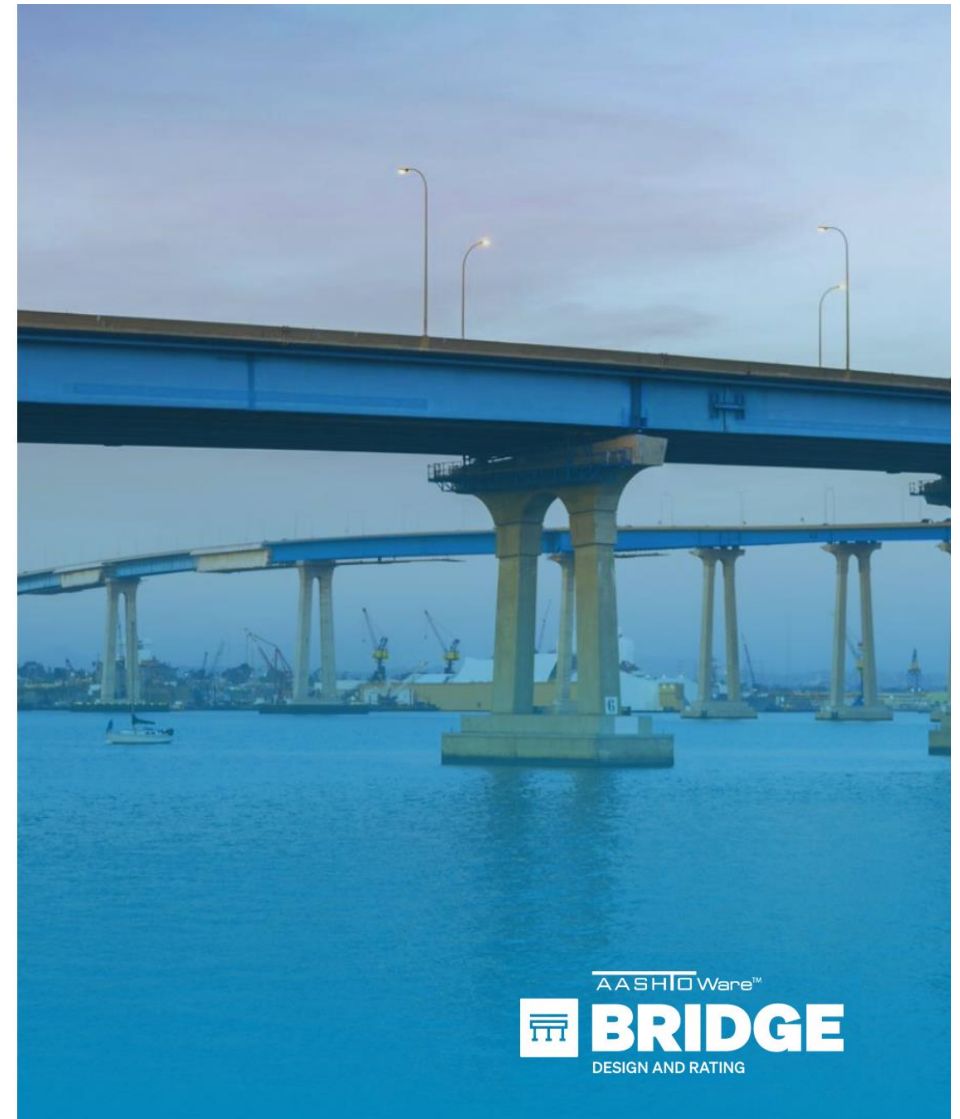
FUN FACT: NYSDOT just got a new mascot!



He may be hiding throughout this presentation...

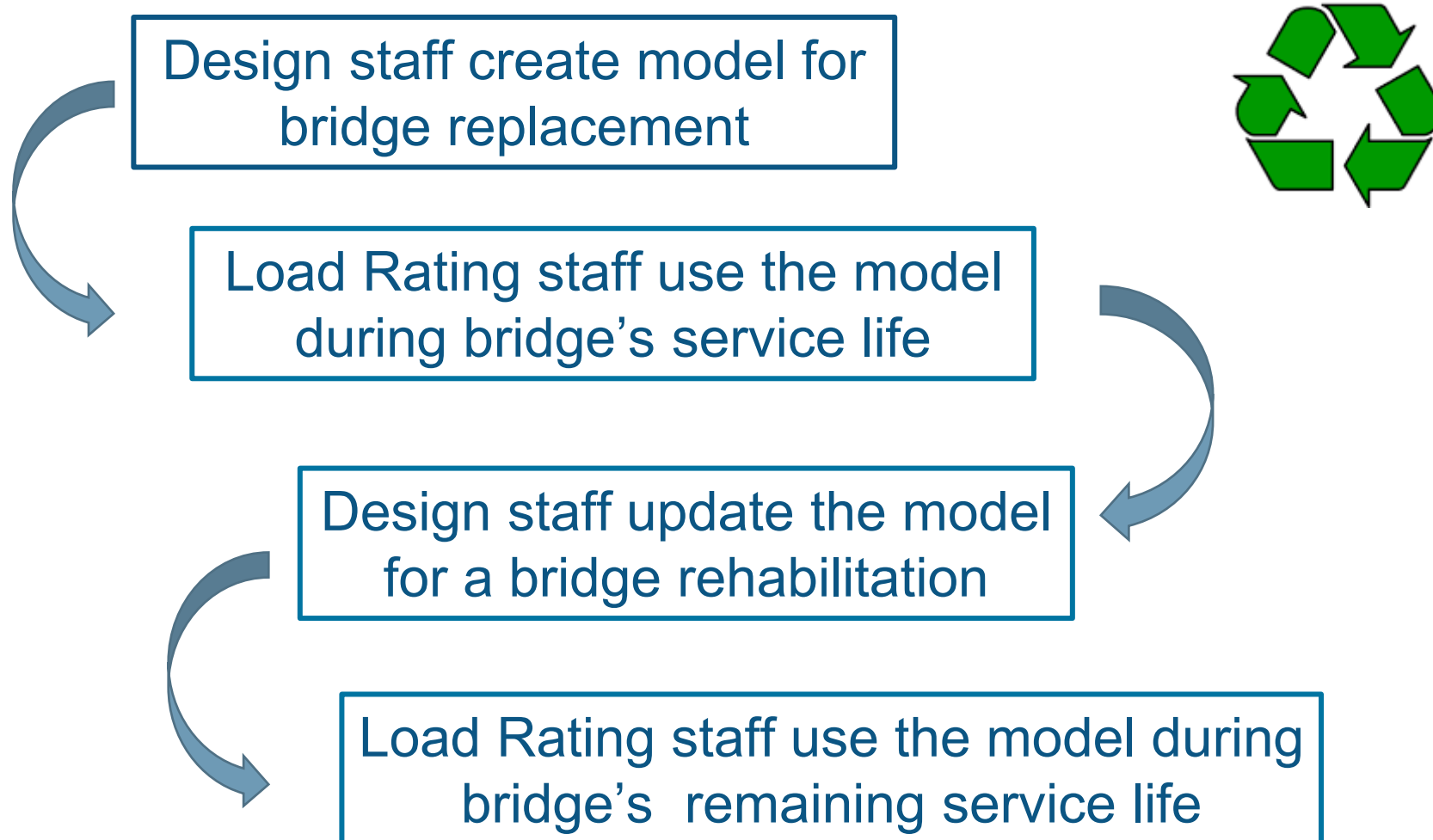
AGENDA

- NYSDOT's Life Cycle of a BrDR Model
- BrDR Analysis Capabilities
- Route 378 over Route 32 Background
- Atypical BrDR Inputs
- Running a 3D FEM Analysis
- Interpreting the 3D FEM Results
- Rating Results & Rehabilitation Scope
- Lessons Learned

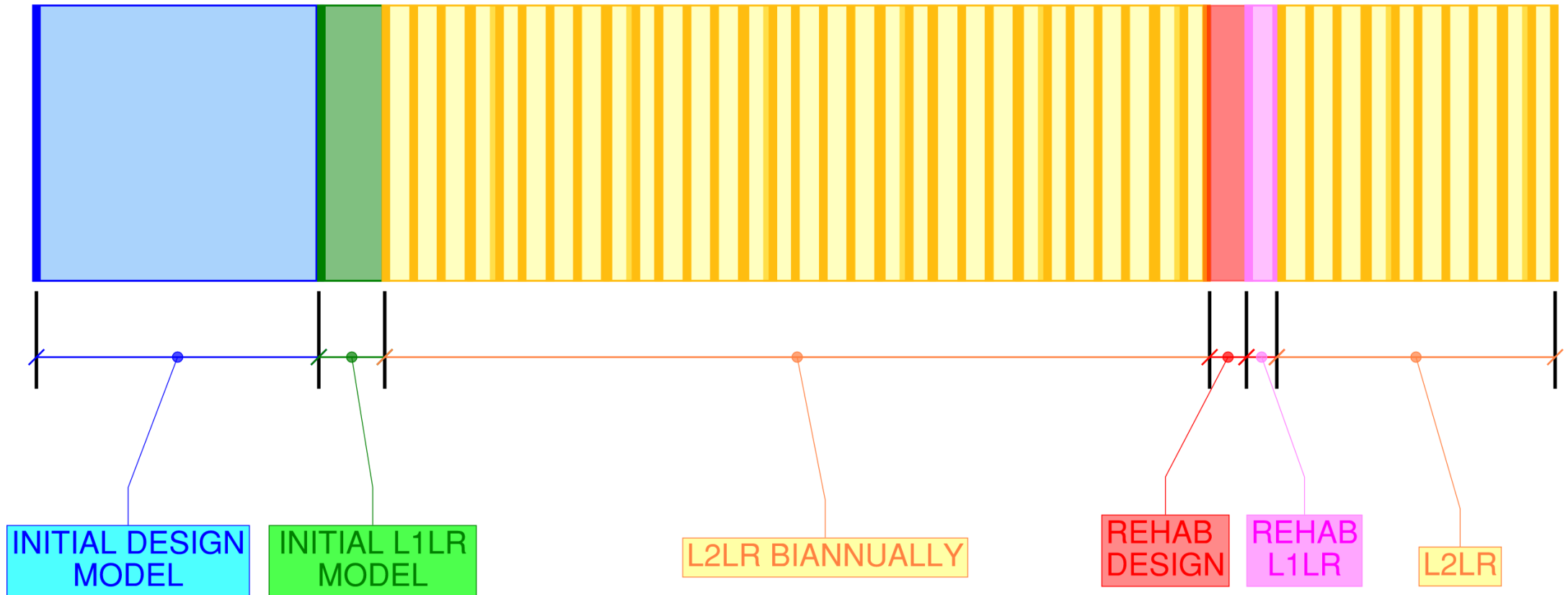


Life Cycle of a BrDR Model

Life Cycle of a BrDR Model at NYSDOT



Life Cycle of a BrDR Model

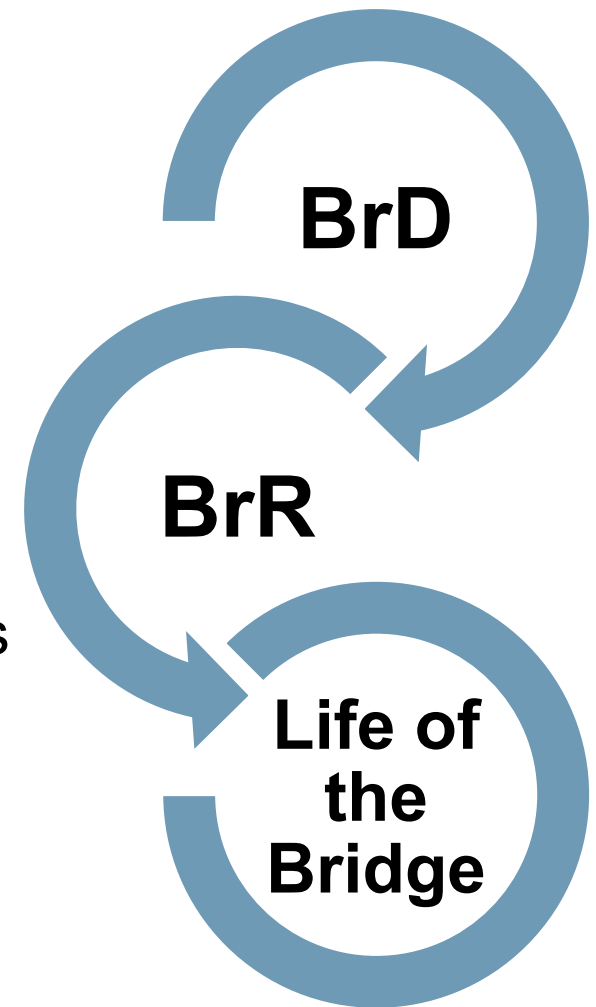


- Level 1 Load Rating (L1LR) vs. Level 2 Load Rating (L2LR)
- Updates to model during service life for:
 - Additional load (wearing surfaces, bridge railing/barrier)
 - Change in capacity (section loss)

Life Cycle of a BrDR Model at NYSDOT

Benefits:

- Keep BrDR models up to date for current design standards
- Cleans up the file periodically to improve rating accuracy
- Closer review with a “finer tooth comb” than the inspection/Level 2 process allows
- Time savings, models are not started from scratch
- Helps with overall efficiency, especially during emergencies
- Acts as an additional layer of QC, as shown by this case study



BrDR Analysis Capabilities

BrDR Analysis Capabilities

AASHTOWARE BRIDGE DESIGN



CURRENT FEATURES

BRIDGE CONFIGURATIONS AND CAPABILITIES

SUPERSTRUCTURES

- Reinforced concrete tee beams, slabs, I-beams, and multi-cell box beams
- Reinforced concrete box culverts
- Prestressed concrete box, I, tee, and U-beams (precast, pretensioned, continuity for live load, harped strands, and de-bonded strands)
- Steel rolled beams (including cover plates)
- Steel built-up plate I-girders
- Steel welded plate I-girders (including hybrid)
- Simple spans, continuous spans, hinges (steel and reinforced concrete)
- Parallel and flared girder configurations
- Parallel, tapered, parabolic, and circular webs
- Transverse and longitudinal stiffened steel girders
- Frame structure simplified definition
- Girder-line and 3D-FEM analyses
- 3-D analysis of steel and concrete multi-girder superstructures
- 3-D analysis of curved steel multi-girder superstructures
- U.S. customary and S.I. units

- Understand software capabilities
- AASHTOWare is constantly expanding
- BrDR User Group and enhancements
- Analysis capabilities in last 10-15 years
 - Curved Girders
 - Trusses
 - High Skews
 - Complex Framing
- Re-evaluate software, don't write off BrD!

BrDR Analysis Capabilities

Unratable Structure,
Span, or Framing Plan?

Create Model Anyway!

Run Analysis when
Capability Arrives

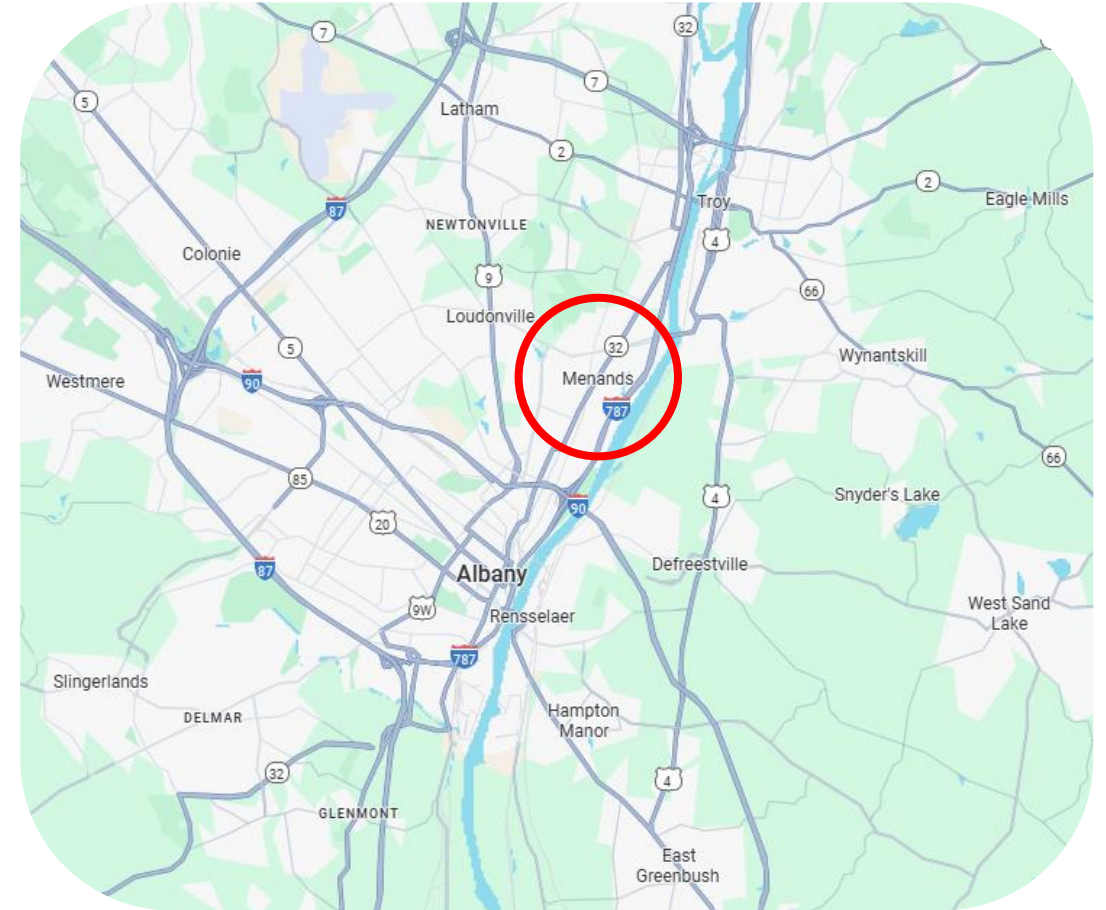
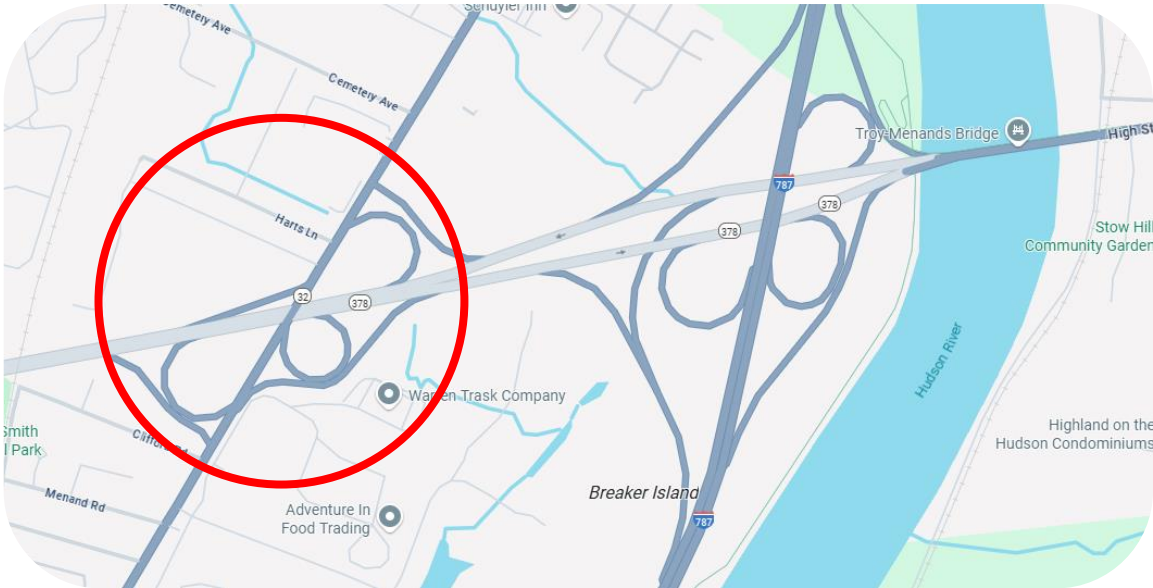
Example

- Line Girder is go-to analysis method
- New software capability for 3D FEM
 - Opportunity for refined analysis
 - Check appropriateness of analysis assumptions
- Line girder results can be unconservative as shown in case study

Bridge Configurations and Capabilities		AASHTO LRFD Design Review	AASHTO LRFR, LFR, ASR Rating
Superstructures ⁴	Reinforced concrete tee beams, slabs, I-beams, and multi-cell box beams	X	X
	⁵ Reinforced concrete box culverts	X	X
	Prestressed concrete box, I, tee, and U-beams (precast, pretensioned, continuity for live load, harped strands, and de-bonded strands)	X	X
	Steel rolled beams (including cover plates)	X	X
	Steel built-up plate I-girders	X	X
	Steel welded plate I-girders (including hybrid)	X	X
	Steel trusses and floor systems		X
	Timber beams and decks (AASHTO engine available in Version 7.3.1)		X
	Corrugated metal decks		X
	Simple spans, continuous spans, hinges (steel and reinforced concrete)	X	X
	Parallel and flared girder configurations	X	X
	Parallel, tapered, parabolic, and circular webs	X	X
	Transverse and longitudinal stiffened	X	X
	Frame structure simplified definition	X	X
Girder-line and 3D-FEM ¹	3-D analysis of steel and concrete multi-girder superstructures	X	X
	⁶ 3-D analysis of curved steel multi-girder superstructures	X	X
Substructures	Bridge piers including wall, hammerhead and multi-column pier bents	X	
	Single drilled shaft for substructure	X	
Load Rating Features	Girder-floor beam-stringer configurations		X
	Truss-floor beam-stringer and floor-truss configurations		X
	Timber and corrugated metal decks		X
	Gusset-plate connections ² and splice connections ³		X
	⁵ Metal Culverts (pipe, pipe arch, structural plate pipe and boxes)		LFR/LRFR

Route 378 over Route 32 Background

Route 378 over Route 32 Background: Village of Menands



Route 378 over Route 32 Background: Bridge Layout and Geometry

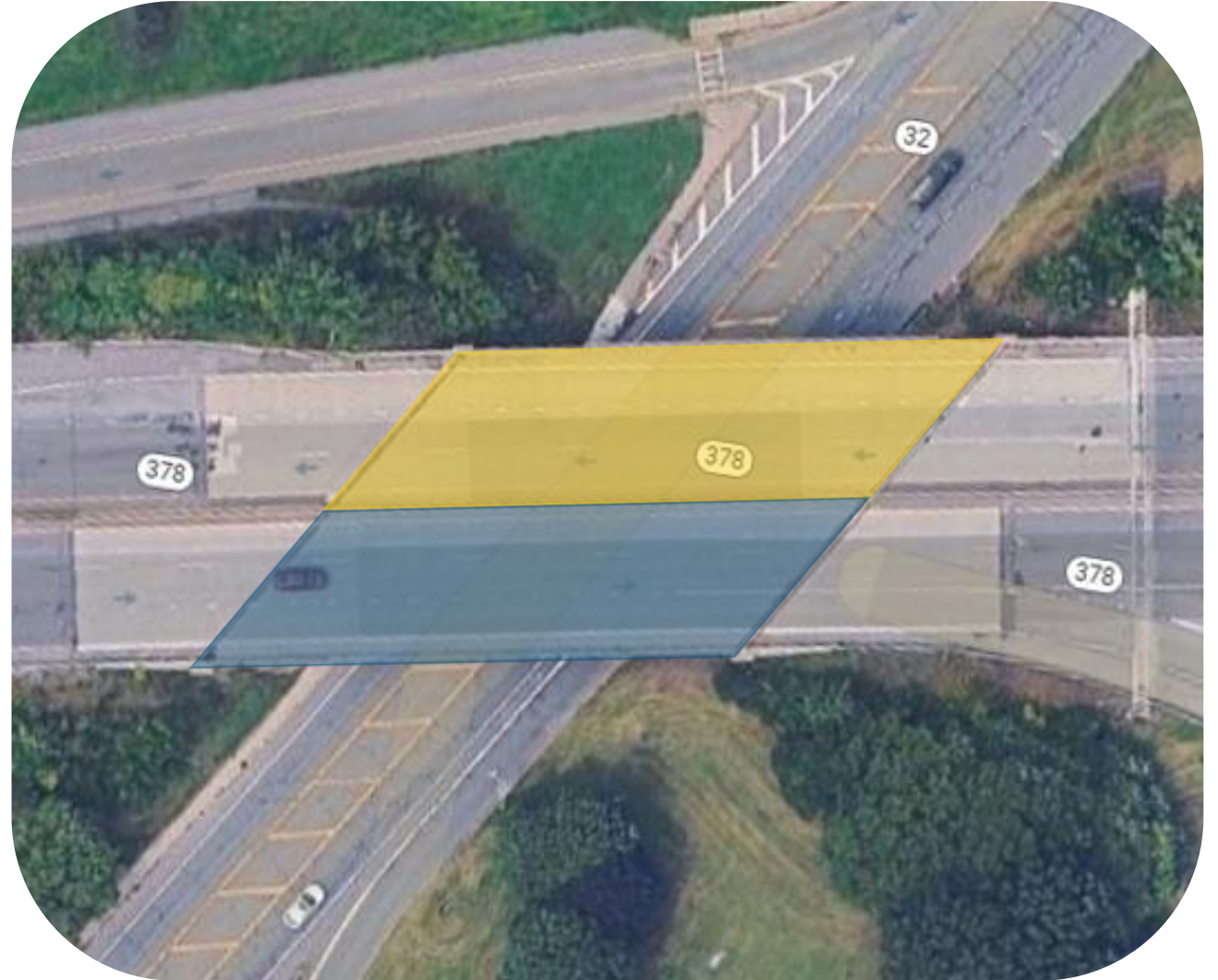
- 42°10'22" skew
- 155'-0" simple span
- 91'-0" overall width



Route 378 over Route 32 Background: Bridge Layout and Geometry

WB/EB

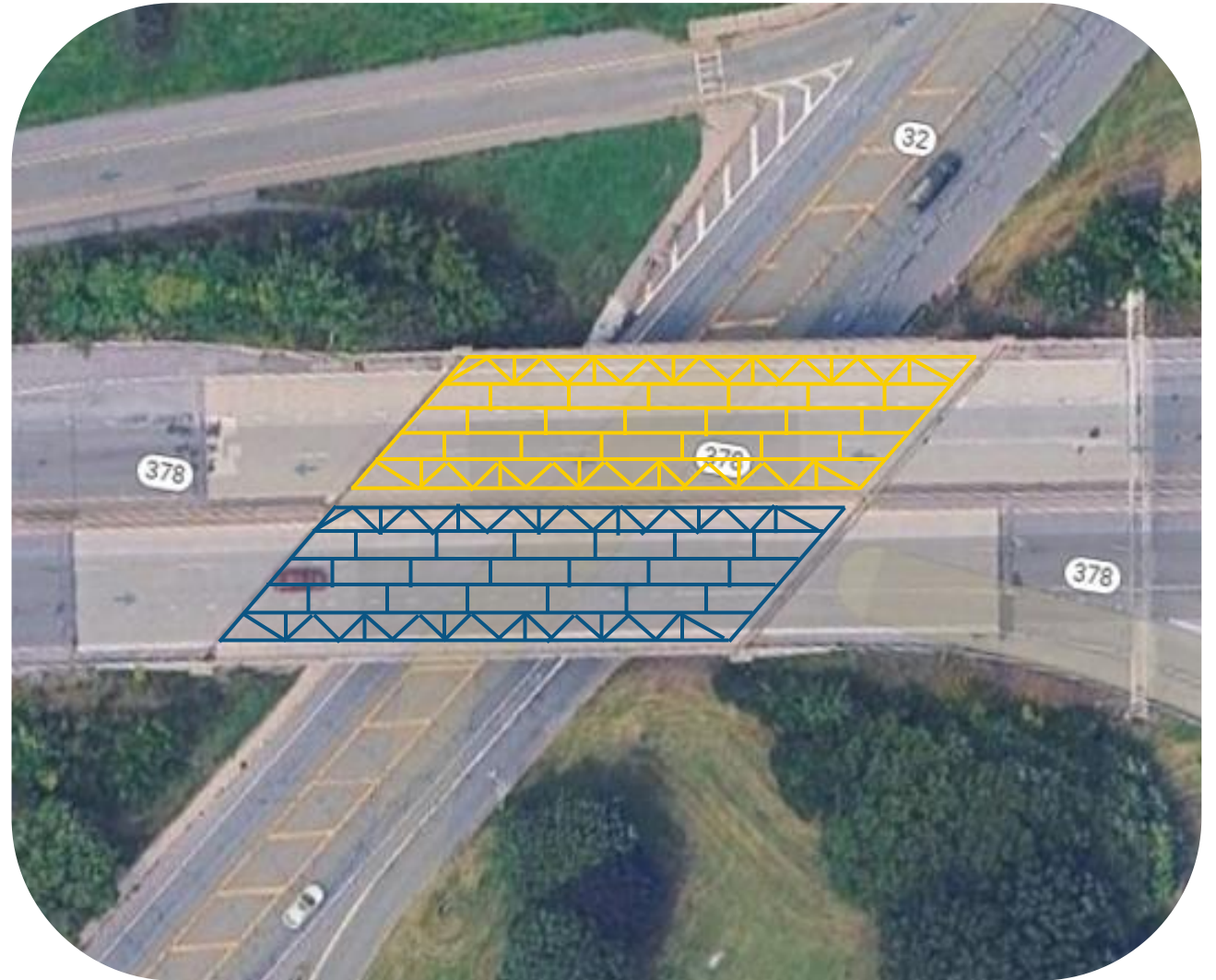
- 42°10'22" skew
- 155'-0" simple span
- 91'-0" overall width
- Two decks with longitudinal expansion joint
- Steel rail with brush curbs at fascias and median



Route 378 over Route 32 Background: Bridge Layout and Geometry

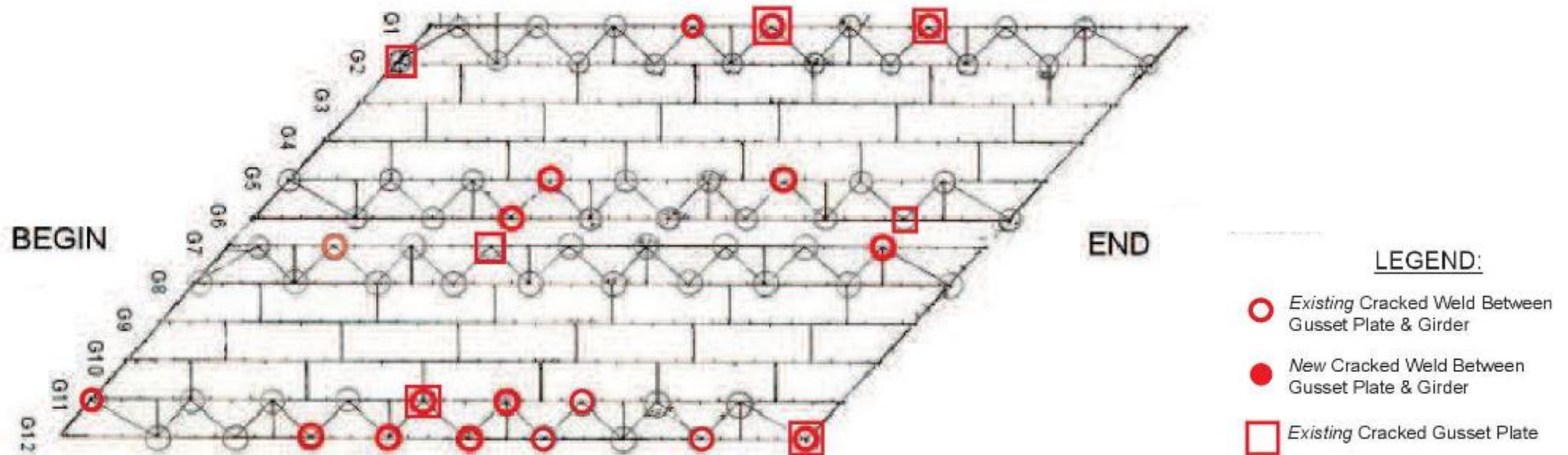
WB/EB

- 42°10'22" skew
- 155'-0" simple span
- 91'-0" overall width
- Two decks with longitudinal expansion joint
- Steel rail with brush curbs at fascias and median
- Steel multi-girder (plate girder)
- Bottom laterals in fascia bays
- Conventional spread footer abutments with U-walls hold both superstructures



Route 378 over Route 32 Background: Bottom Lateral Bracing

A Yellow Flag was issued due to cracks in gusset plates and gusset plate welds for bottom flange lateral bracing.



Route 378 over Route 32 Background: Bottom Lateral Bracing



Route 378 over Route 32 Background: Section Loss

Not part of the Yellow Flag, but web perforations were included in scope of repair work to be completed.

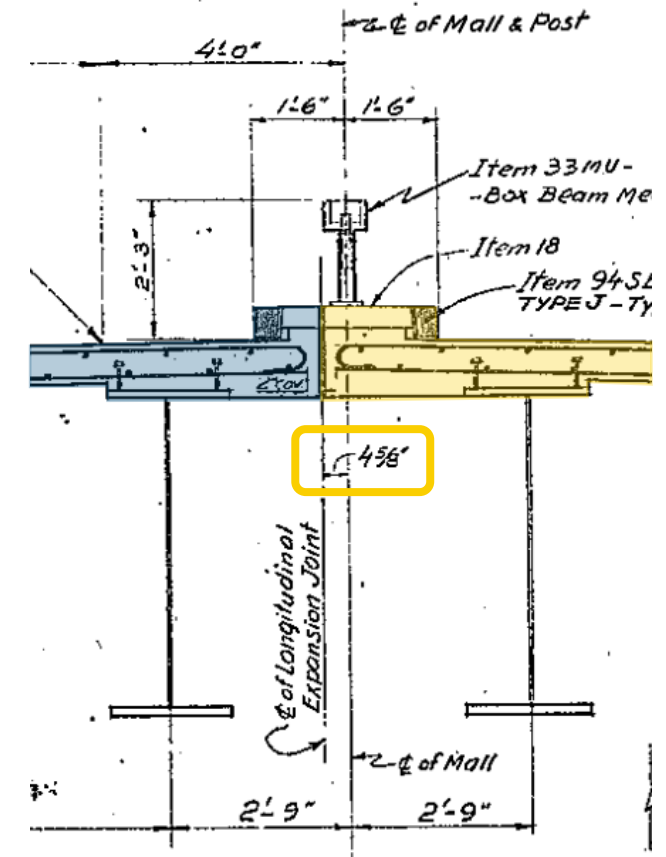
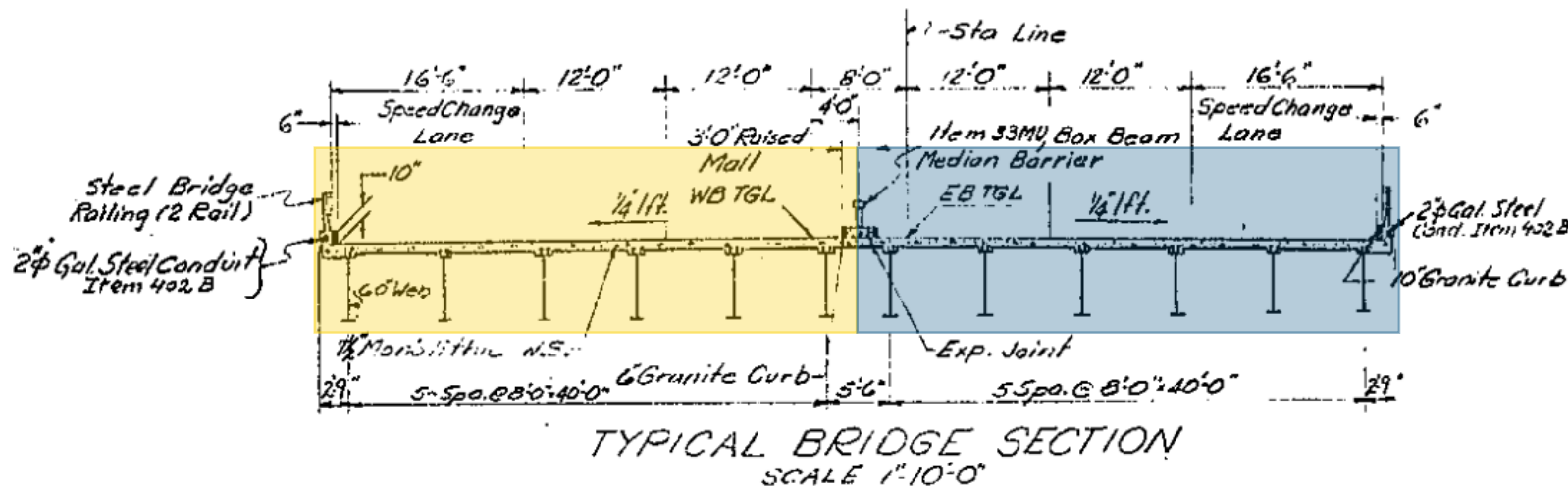


Atypical BrDR Inputs

Atypical BrDR Inputs: Longitudinal Expansion Joint

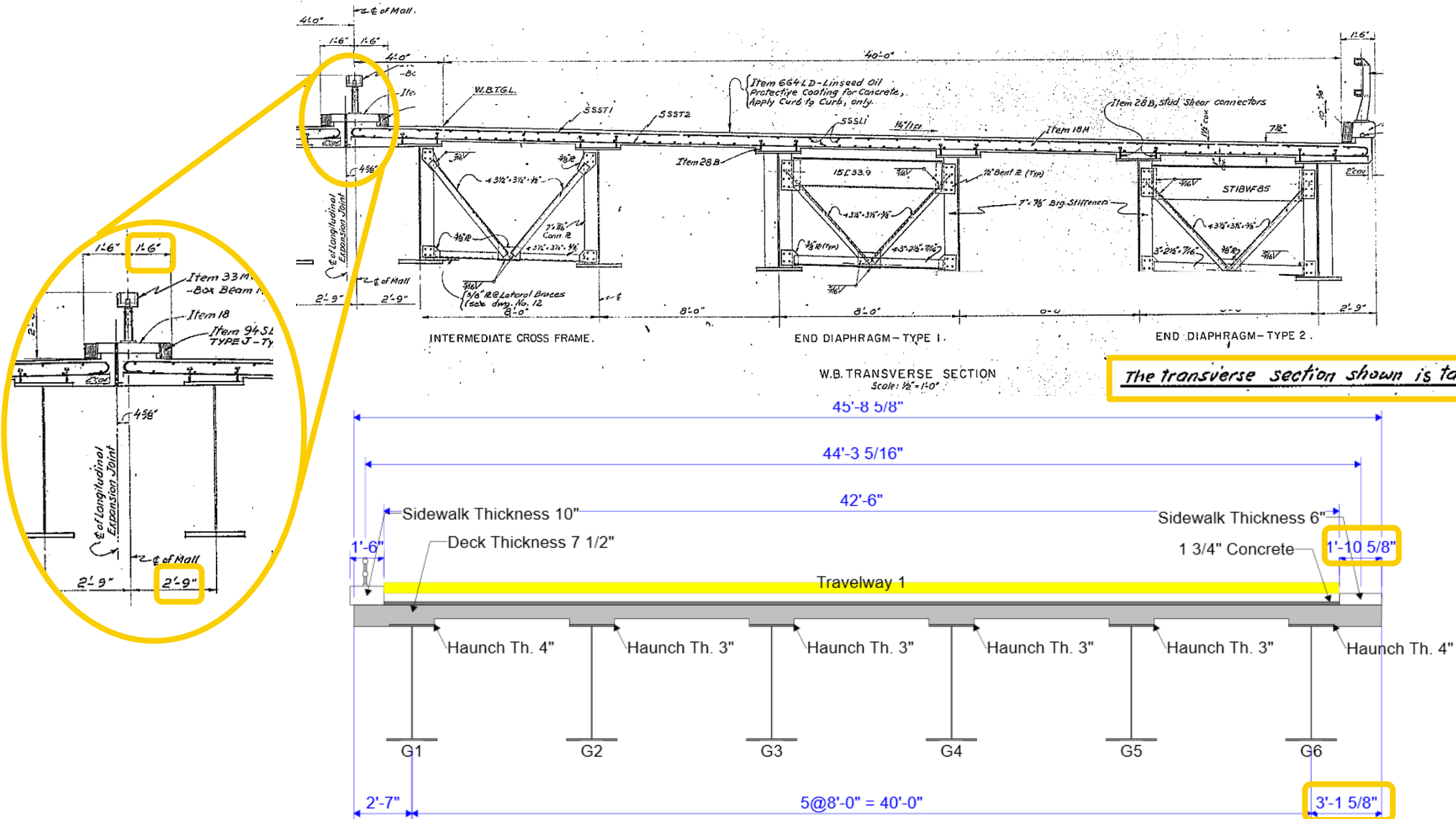
WB/EB

Longitudinal expansion joint between decks is offset $4\frac{5}{8}"$ from center (two superstructure models).



Atypical BrDR Inputs: Longitudinal Expansion Joint

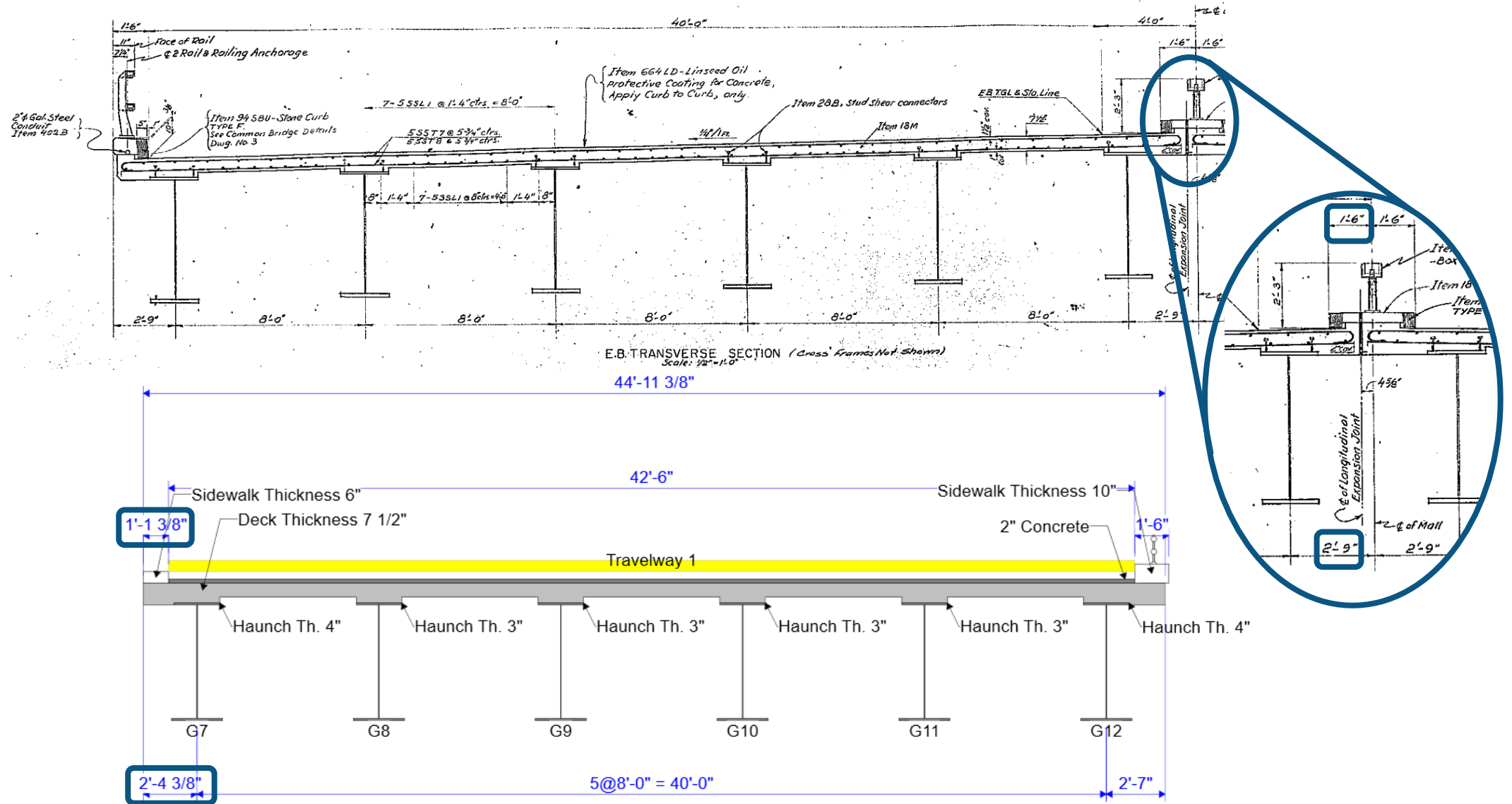
WB/EB



The transverse section shown is taken looking down station.

Atypical BrDR Inputs: Longitudinal Expansion Joint

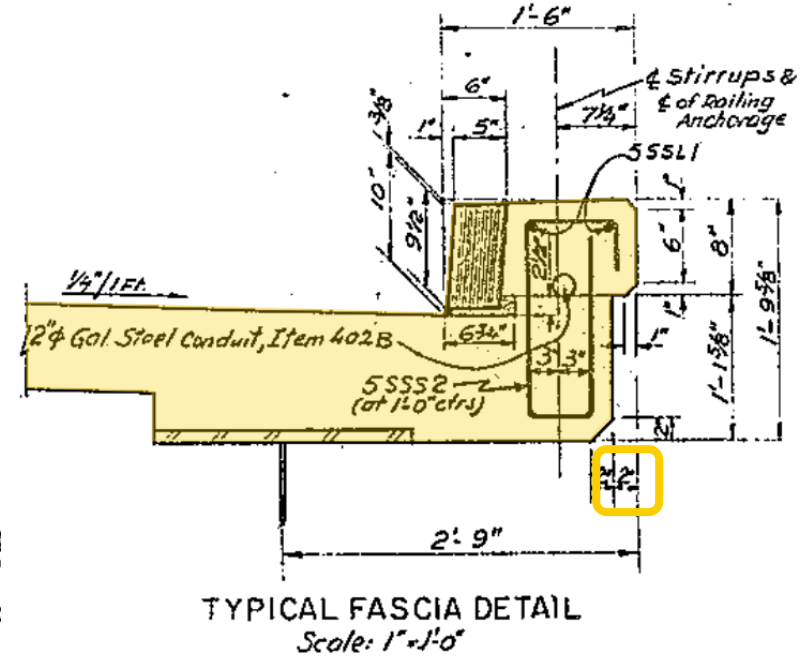
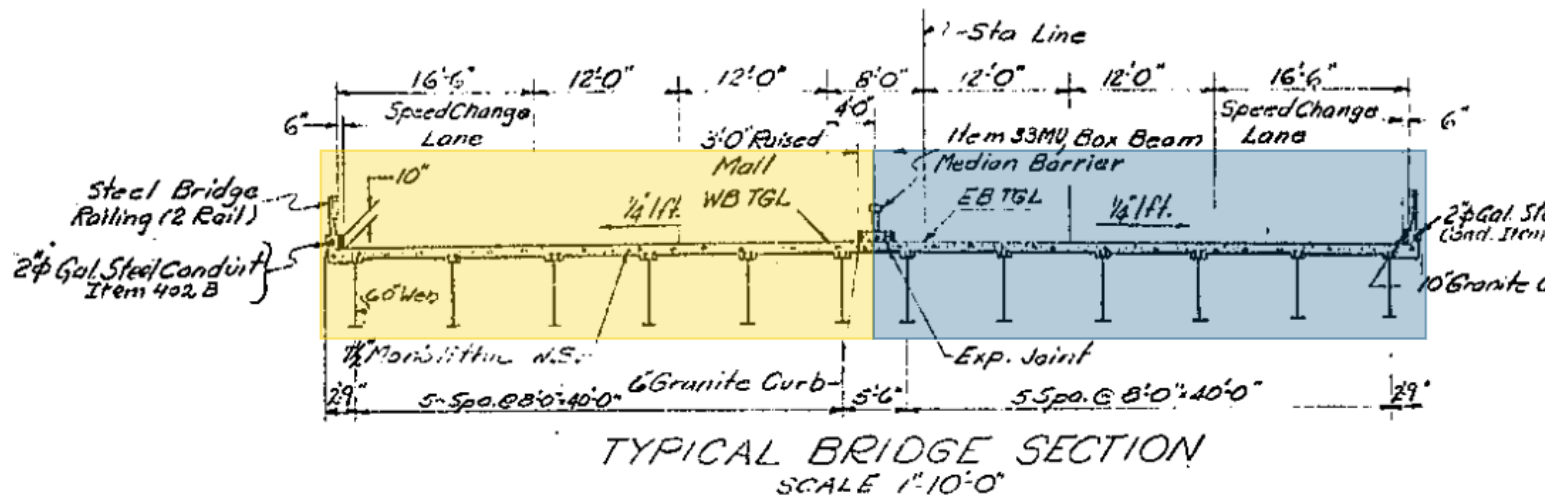
WB/EB



Atypical BrDR Inputs: Brush Curb Overhang

WB/EB

Brush curbs overhang the deck fascia by 2" on both sides.

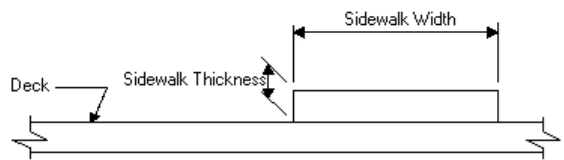


WB/EB



Atypical BrDR Inputs: Brush Curb Overhang

Structure Typical Section



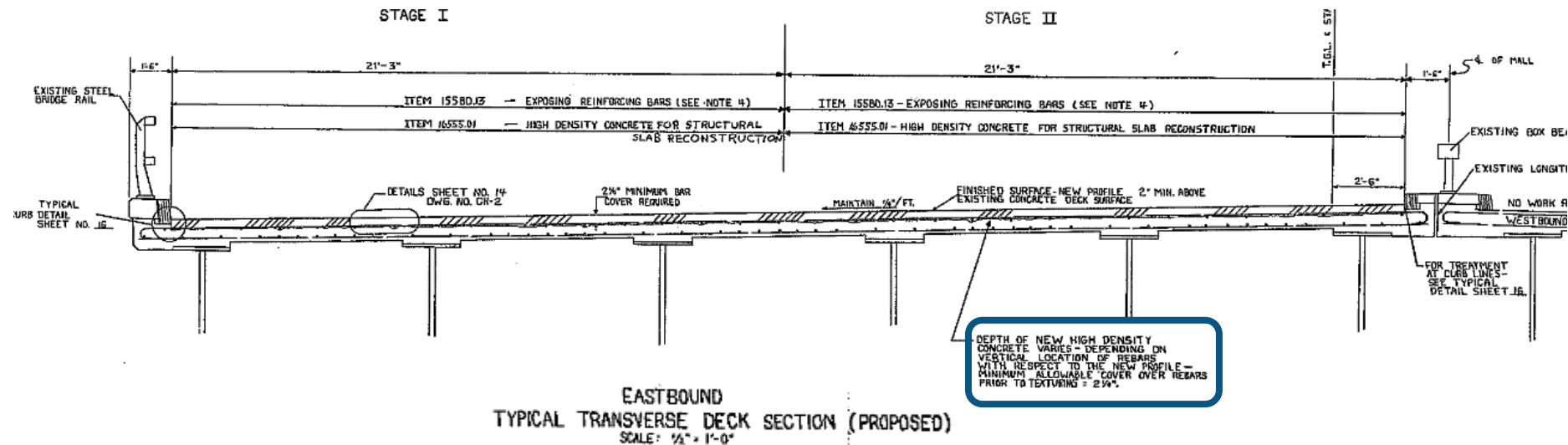
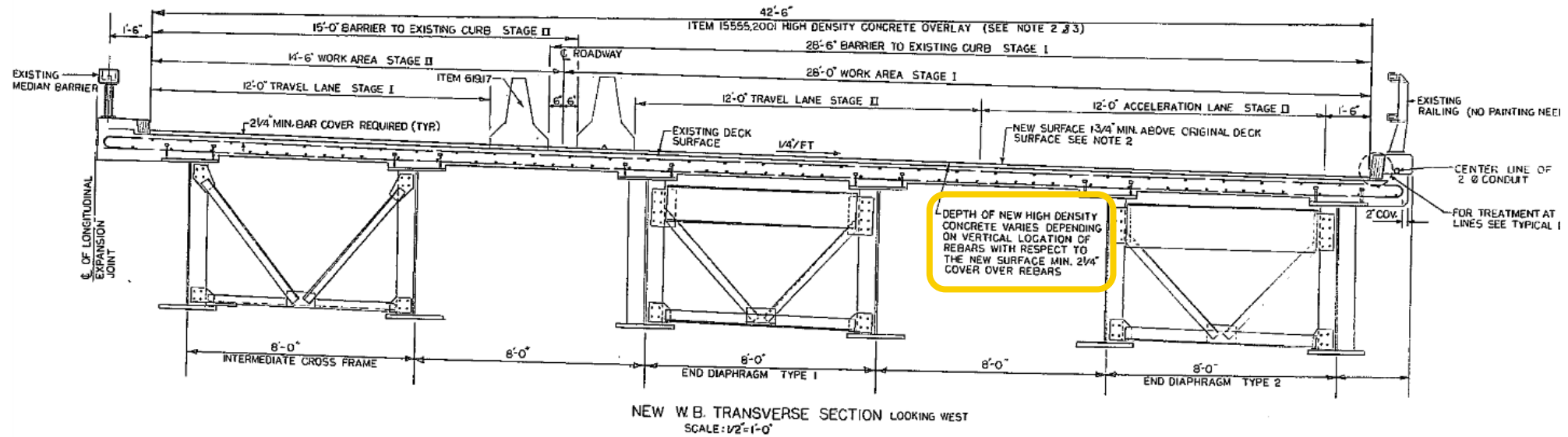
Deck Deck (cont'd) Parapet Median Railing Generic **Sidewalk** Lane position Striped lanes Wearing surface

	Width (in)	Thickness (in)	Concrete material	Load case	Measure to	Edge of deck dist. measured from	Distance at start (ft)	Distance at end (ft)	Pedestrian load (ksf)
>	18	10.0000	3000 psi deck concrete	Side...	Right	Left Edge	1.33	1.33	
	22.62...	6.0000	3000 psi deck concrete	Side...	Right	Right Edge	0.00	0.00	

New Duplicate Delete

OK Apply Cancel

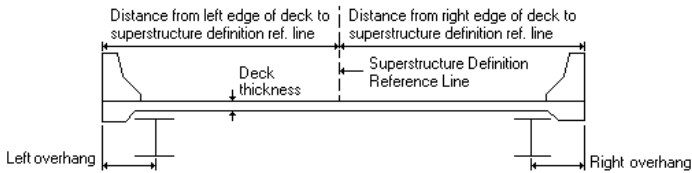
Atypical BrDR Inputs: Concrete Overlay



Atypical BrDR Inputs: Concrete Overlay

WB/EB

Structure Typical Section



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

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

Deck thickness

Superstructure Definition Reference Line

Left overhang

Right overhang

Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface

Deck concrete: 3000 psi deck concrete

Total deck thickness: 7.5000 in

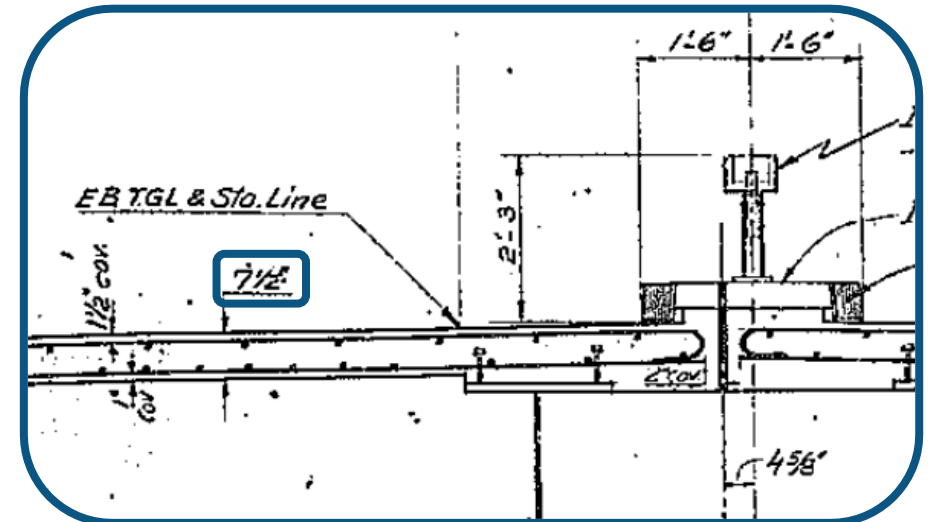
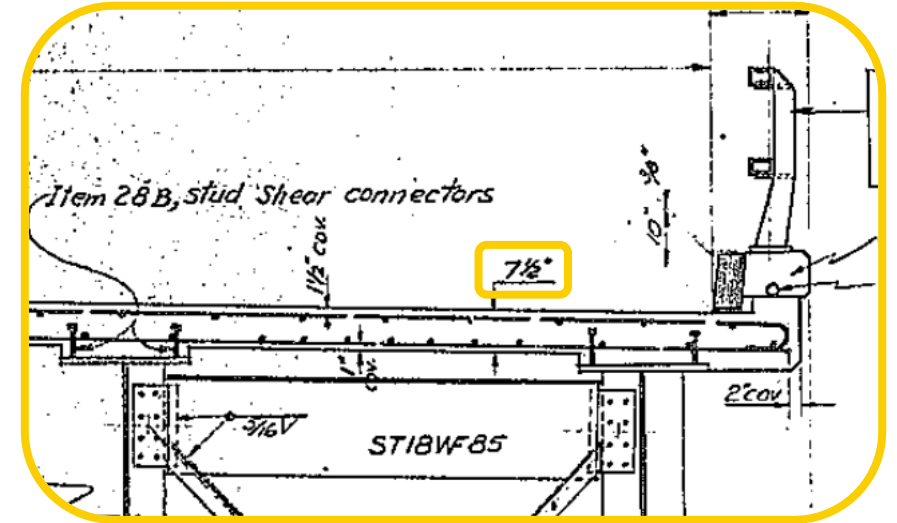
Load case: Engine Assigned

Deck crack control parameter: kip/in

Sustained modular ratio factor: 3.000

Deck exposure factor:

OK Apply Cancel



Atypical BrDR Inputs: Concrete Overlay

WB/EB

Structure Typical Section

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

Deck thickness | Superstructure Definition Reference Line

Left overhang | Right overhang

Deck | Deck (cont'd) | Parapet | Median | Railing | Generic | Sidewalk | Lane position | Striped lanes | Wearing surface

Wearing surface material: Concrete

Description: Concrete

Wearing surface thickness: 1.7500 in

Wearing surface density: 180.000 pcf

Load case: Wearing Surface

Thickness field measured (DW = 1.25 if checked)

Copy from library...

Girder System Superstructure Definition

Definition | Analysis | Specs | Engine

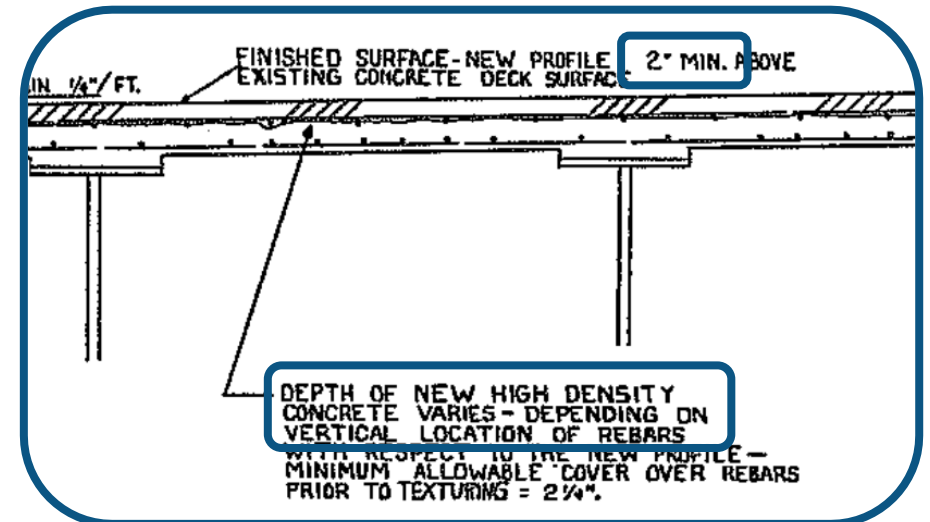
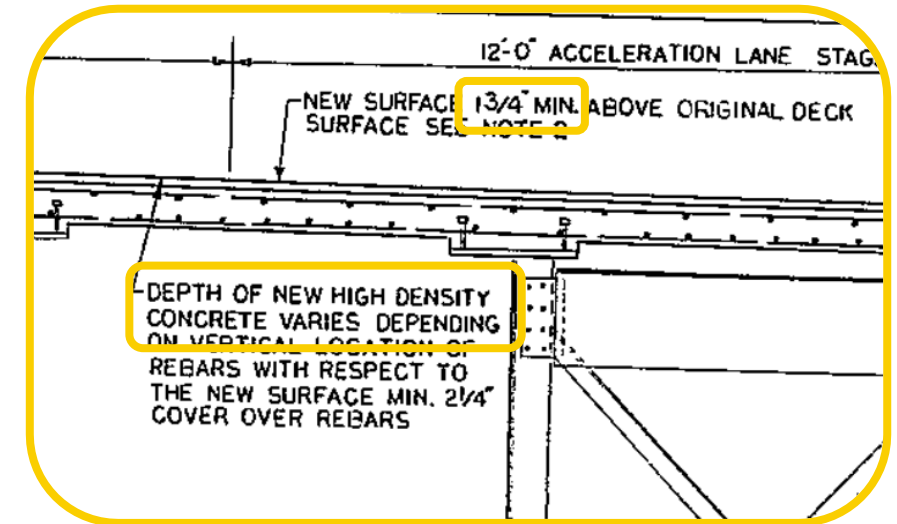
Structural slab thickness

- ☒ Consider structural slab thickness for rating
- ☒ Consider structural slab thickness for design

Wearing surface

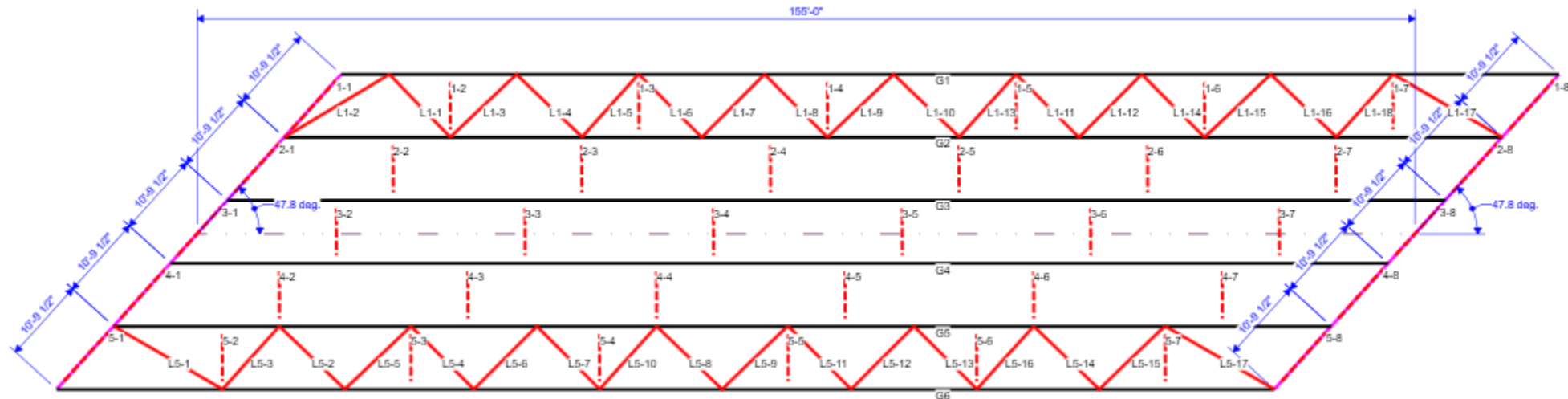
- ☒ Consider wearing surface for rating
- ☒ Consider wearing surface for design

OK | Apply | Cancel



Atypical BrDR Inputs: Bottom Lateral Bracing

Opted to model bottom lateral supports as designed, as repairs to these welds were already included in the scope of work.



Atypical BrDR Inputs: Bottom Lateral Bracing

Structure Framing Plan Details

Number of spans: 1 Number of girders: 6

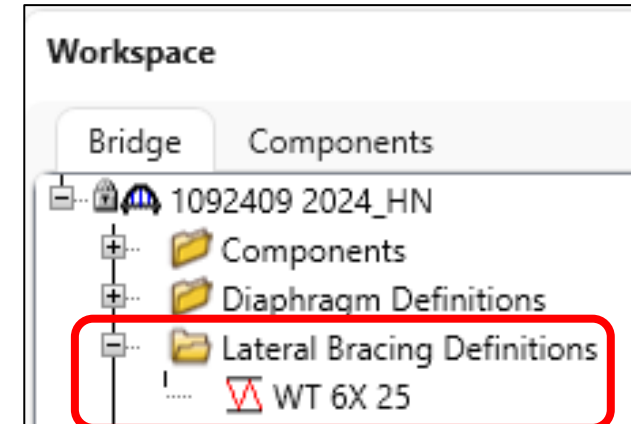
Layout Diaphragms Lateral bracing ranges

Girder bay: 1 Copy bay to...

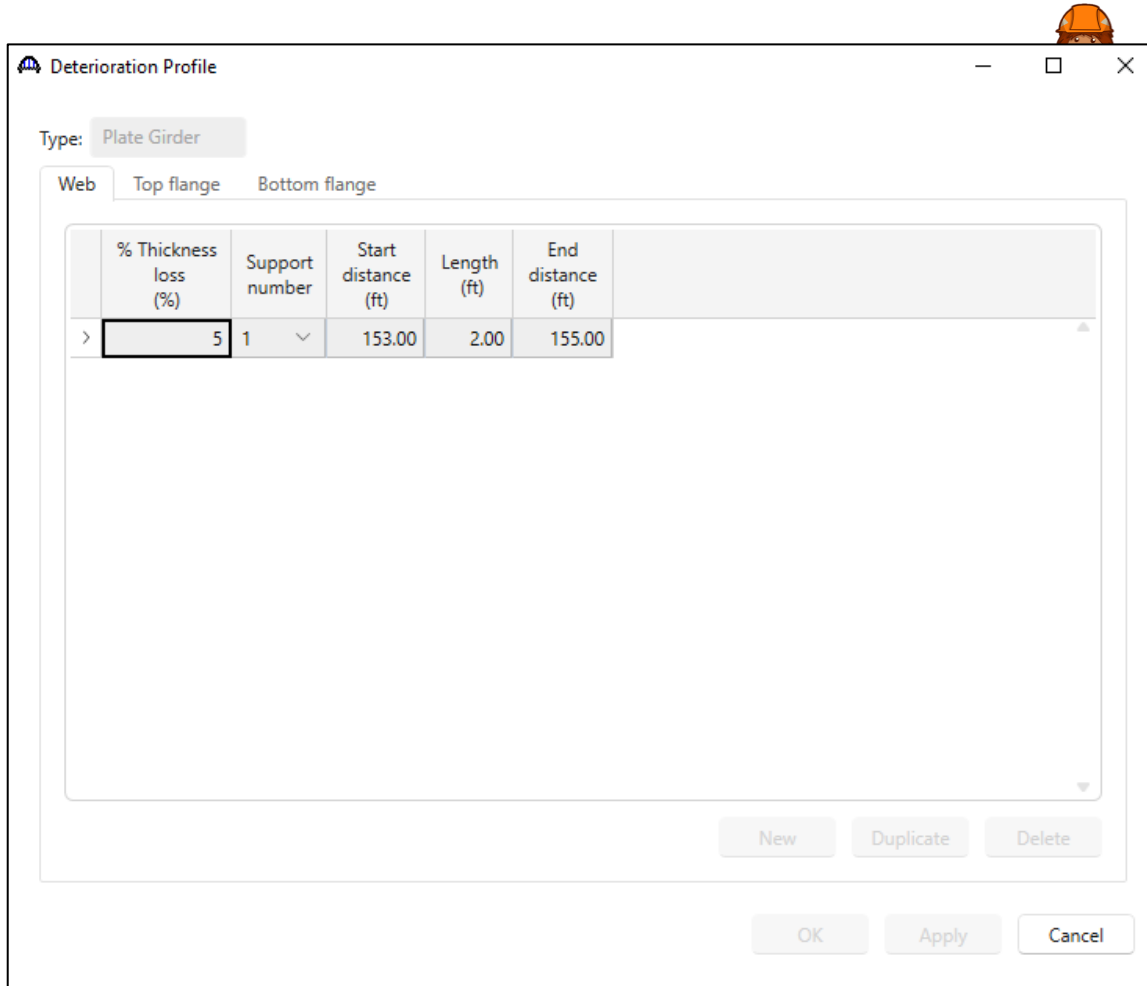
Lateral bracing pattern	Support number	Start distance (ft)		Bracing length (ft)		Number of braces	Lateral bracing	Length (ft)		End distance (ft)	
		Left girder	Right girder	Along left girder	Along right girder			Left	Right	Left	Right
Single /	1		85.8750		7.2500		WT 6X 25	0.0...	7.2500	0.0...	93.1...
Single /	1		133.8750		7.2500		WT 6X 25	0.0...	7.2500	0.0...	141...
Alternating \	1		117.1250		8.4160		WT 6X 25	0.0...	16.8...	0.0...	133....
> Alternating \	1		69.1250		8.4160		WT 6X 25	0.0...	16.8...	0.0...	85.9...
Single /	1		0.0000		13.3730		WT 6X 25	0.0...	13.3...	0.0...	13.3...
Single /	1		37.8750		7.2000		WT 6X 25	0.0...	7.2000	0.0...	45.0...
Alternating \	1		21.1230		8.4160		WT 6X 25	0.0...	16.8...	0.0...	37.9...
Single \	1	6.1250		7.7500			WT 6X 25	7.7...	0.0000	13....	0.0000
Alternating V	1	37.8750		8.0000			WT 6X 25	16....	0.0000	53....	0.0000
Single \	1	53.8770		8.0000			WT 6X 25	8.0...	0.0000	61....	0.0000
Alternating V	1	85.8750		8.0000			WT 6X 25	16....	0.0000	10....	0.0000
Single \	1	101.8770		8.0000			WT 6X 25	8.0...	0.0000	10....	0.0000
Single \	1	133.8750		13.8750			WT 6X 25	13....	0.0000	14....	0.0000

New Duplicate Delete

OK Apply Cancel



Atypical BrDR Inputs: Section Loss



The screenshot shows a software window titled "Deterioration Profile" with a small orange hard hat icon in the top right corner. The window has a "Type:" dropdown menu set to "Plate Girder". Below this are three tabs: "Web", "Top flange", and "Bottom flange". The "Web" tab is selected. Inside the tab is a table with the following columns: "% Thickness loss (%)", "Support number", "Start distance (ft)", "Length (ft)", and "End distance (ft)". The first row of data is highlighted with a black border and contains the values: 5, 1, 153.00, 2.00, and 155.00. Below the table are buttons for "New", "Duplicate", and "Delete". At the bottom of the window are buttons for "OK", "Apply", and "Cancel".

% Thickness loss (%)	Support number	Start distance (ft)	Length (ft)	End distance (ft)
5	1	153.00	2.00	155.00

Used separate hand calculation for perforations in bearing area.



Running a 3D FEM Analysis

Running a 3D FEM Analysis: Analysis Settings

F1

Girder System Superstructure Definition

Definition Analysis Specs Engine

Structural slab thickness

- ☒ Consider structural slab thickness for rating
- ☒ Consider structural slab thickness for design

Wearing surface

- ☒ Consider wearing surface for rating
- ☒ Consider wearing surface for design

☐ Consider striped lanes for rating

Default analysis type: Line Girder

Longitudinal loading

Vehicle increment: 1.000 ft

Transverse loading

Vehicle increment in lane: 2.000 ft

Lane increment: 4.000 ft

3D analysis control options

- ☐ LFR: Model non-composite regions as non-composite
- ☐ LRFD: Model non-composite regions as non-composite
- ☐ LRFR: Model non-composite regions as non-composite

Number of shell elements

☒ In the deck between girders

☐ In the web between flanges

Slower More accurate Faster Less accurate

10 9 8 7 6 5 4 3 2 1

Target aspect ratio for shell elements

Slower More accurate Faster Less accurate

1 1.5 2 2.5 3 3.5 4

3D FE node generation tolerance

☒ Percentage

☐ Length

Span	Length (ft)	Tolerance (%)
> 1	155.00	0.100

3D bracing member end connection analysis

☒ Calculated factored member force effects

☐ Maximum of average (stress + strength) and 75% resistance

Bracing member LRFR factors

Condition factor: Good or Satisfactory

☐ Field measured section properties

OK Apply Cancel

Default Settings

AASHTOWare BrDR - Help

Show Back Print Options

Select the condition from the drop down menu and check the check box if the section properties are field measured.

Girder System:

Number of shell elements

In the deck between girders

In the web between flanges

Select the FE mesh generation control as either the number of shells in the deck or the number of shells in the web between flanges.

The number of shells in the web between flanges applies only to steel members. If the number of shell elements in the deck between girders is selected, the deck will be divided into this many equal segments between each girder. The length of each shell element in the deck along the length of the bridge will then be computed based on the selected target aspect ratio. For steel beams, the number of shells in the web will be computed using the shell element along the length of the bridge and the target aspect ratio. The minimum number of shells in the web is set to two.

For steel beams, if the number of shells in the web between flanges is selected, the web will be divided into this many equal shells. The length of each shell element in the web along the length of the beam will be computed based on the target aspect ratio. The deck shell elements between the girders will use the same length as the web shells along the bridge. The number of deck shells between girders will be computed to maintain the aspect ratio of the deck shell elements.

Target Aspect Ratio for shell elements

Select the target aspect ratio for the shell elements controlled by the preceding selection. Give an FE definition of target aspect ratio.

3D FE node generation tolerance

Select Percentage to enter a tolerance based on a percent of each span length or select Length to enter a tolerance based on a length value. The default node generation tolerance is 0.1%.

This data defines a tolerance to use when determining if two locations along the length of the structure should be considered as the same location when generating the nodes for the 3D FE analysis. Adjustment of this tolerance may help eliminate small elements in the generated 3D FE model. The resulting generated 3D FE model should be viewed graphically in the Model Viewer in BrDR to determine if the entered tolerances produce an acceptable model.

In the AASHTOWare 3D engines, nodes are created at: supports, tenth points, hinges, section change points, diaphragms and bottom flange lateral brace points, member load application points and user defined points of interest. Rectangular deck slab shells require the same number of nodes along each girder. A percentage of the span length is identified for each node on each girder and compiled for the full structure. If needed, nodes are added to each girder at these percentages so the resulting model will have the same number of nodes on each girder in each span. The tolerance entered here is used to merge nodes along each girder when they are within the entered tolerance of each other. Note that nodes may sometimes be shifted by a distance that exceeds the entered tolerance. The user should review the "Model Generation Node Merge Report" that is available for review via the Engine Outputs button on the Analysis ribbon.

Running a 3D FEM Analysis: Analysis Settings

Girders System Superstructure Definition

Definition Analysis Specs Engine

Structural slab thickness

- ☒ Consider structural slab thickness for rating
- ☒ Consider structural slab thickness for design

Wearing surface

- ☒ Consider wearing surface for rating
- ☒ Consider wearing surface for design
- ☐ Consider striped lanes for rating

Default analysis type: Line Girder

Longitudinal loading

Vehicle increment: 1,000 ft

Transverse loading

Vehicle increment in lane: 2,000 ft

Lane increment: 4,000 ft

3D analysis control options

- ☐ LFR: Model non-composite regions as non-composite
- ☐ LRFD: Model non-composite regions as non-composite
- ☐ LRFR: Model non-composite regions as non-composite

Number of shell elements

- ☒ In the deck between girders
- ☐ In the web between flanges

Slower More accurate Faster Less accurate

10 9 8 7 6 5 4 3 2 1

Target aspect ratio for shell elements

Slower More accurate Faster Less accurate

1 1.5 2 2.5 3 3.5 4

3D FE node generation tolerance

- ☒ Percentage
- ☐ Length

	Span	Length (ft)	Tolerance (%)
>	1	155.00	0.100

3D bracing member end connection analysis

- ☒ Calculated factored member force effects
- ☐ Maximum of average (stress + strength) and 75% resistance

Bracing member LRFR factors

Condition factor: Good or Satisfactory

☐ Field measured section properties

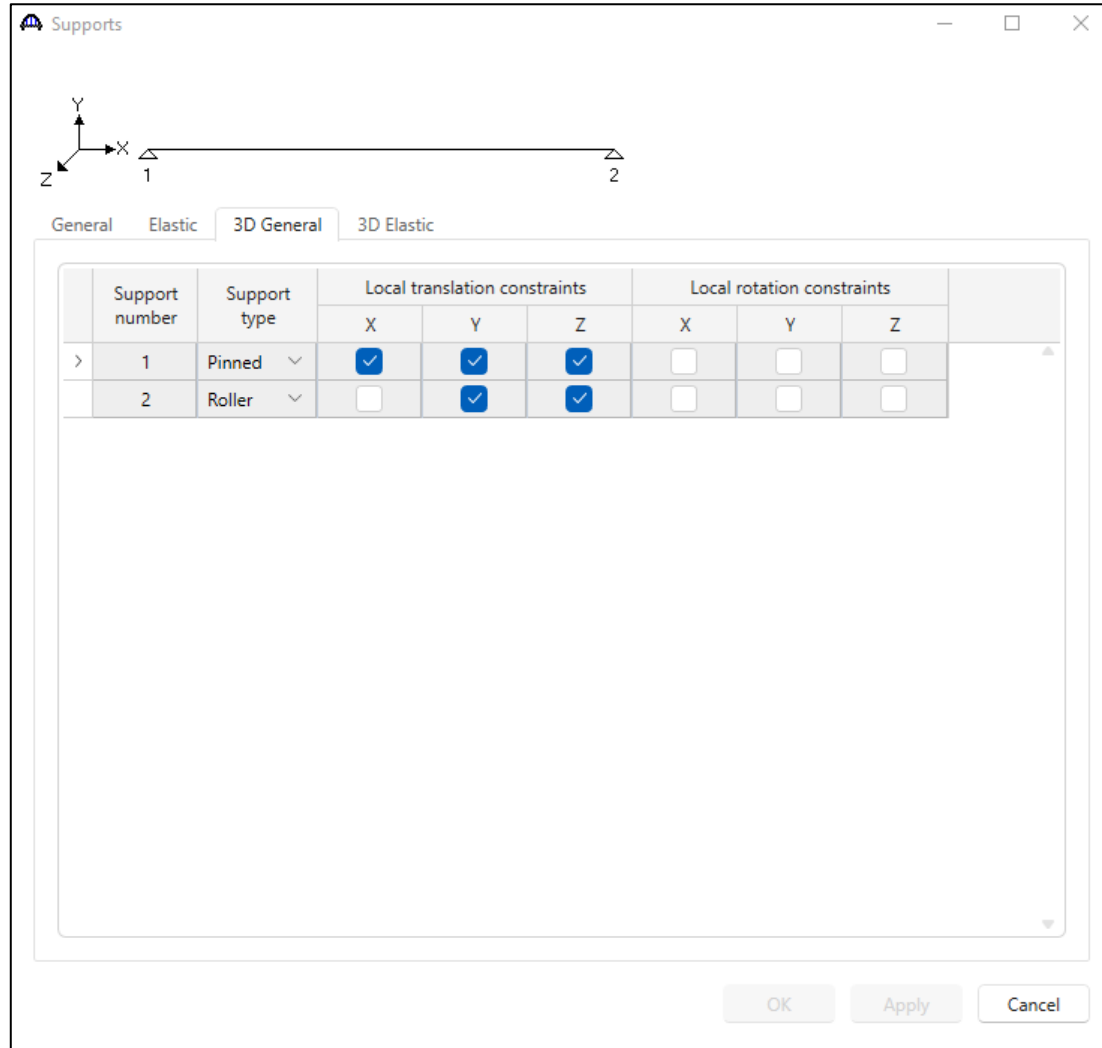
OK Apply Cancel

Adjust speed for more/less accurate results. Recommend starting with less accuracy for design.

Check on boxes as needed.

Running a 3D FEM Analysis: Supports

F1



Support number	Support type	Local translation constraints			Local rotation constraints		
		X	Y	Z	X	Y	Z
1	Pinned	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

AASHTOWare BrDR - Help

Show Back Print Options

Support Constraints - Beam: 3D General

The 3D General tab of the Support Constraints - Beam window allows you to define 3D general support constraints. You must select a constraint on the [Support Constraints - Beam: 3D General](#) tab in order to be able to input a spring constant on the [Support Constraints - Beam: 3D Elastic](#) tab. Enter the required information and click another tab or the OK button.

[Engine Related Help](#)

Support Number

Displays each of the beam support numbers.

Support Type

Select the support type as either pinned, roller, fixed, free, or other. Check marks will automatically appear in the appropriate boxes for translation and rotation constraints to correspond with the selected support type.

Translation Constraints

X
Check the box if the support is constrained from moving in the X (longitudinal) direction. The appropriate support type will automatically change to correspond with the checked translation and rotation constraints.

Y
Check the box if the support is constrained from moving in the Y (vertical) direction. The appropriate support type will automatically change to correspond with the checked translation and rotation constraints.

Z
Check the box if the support is constrained from moving in the Z direction. The appropriate support type will automatically change to correspond with the checked translation and rotation constraints.

Rotation Constraints

X
Check the box if the support is constrained from rotating about the X axis. The appropriate support type will automatically change to correspond with the checked translation and rotation constraints.

Y
Check the box if the support is constrained from rotating about the Y axis. The appropriate support type will automatically change to correspond with the checked translation and rotation constraints.

Z
Check the box if the support is constrained from rotating about the Z axis. The appropriate support type will automatically change to correspond with the checked translation and rotation constraints.

Running a 3D FEM Analysis: Lateral Bending

Member Alternative Description

Member alternative: G1

Description Specs Factors Engine Import Control options

LRFD

- ☐ Use Appendix A6 for flexural resistance
- ☒ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Consider deck reinf. development length
- ☐ Must consider user input lateral bending stress
- ☐ Consider concurrent moments in Cb calculation
- ☒ LTB GammaE Method
 - ☒ Method A
 - ☐ Method B
- ☒ Distribution factor application method
 - ☒ By axle
 - ☐ By POI

LFR

- ☒ Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
- ☐ Allow moment redistribution
- ☐ Allow plastic analysis of cover plates
- ☒ Include field splices in rating
- ☐ Include bearing stiffeners in rating
- ☒ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Ignore overload operating rating

LRFR

- ☒ Include field splices in rating
- ☐ Consider deck reinf. development length
- ☐ Consider tension-field action in stiffened web end p
- ☐ Must consider user input lateral bending stress
- ☐ Consider concurrent moments in Cb calculation
- ☐ Use compact web alternate Cb calculation
- ☒ LTB GammaE Method
 - ☒ Method A
 - ☐ Method B
- ☒ Distribution factor application method
 - ☒ By axle
 - ☐ By POI

ASR

- ☒ Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Consider deck reinf. development length
- ☐ Consider tension-field action in stiffened web end p

OK Apply Cancel

Check off for
3D FEM.

Lateral Support

Top lateral support ranges Top lateral support locations Bottom lateral support locations Flange lateral bending

Lateral bending stress load cases

Load case name	Description	Stage	Type	Include in analysis		Consider for design review	Consider for LRFR rating
				Line girder	3D FEM		

Add default load case descriptions

New Duplicate Delete

Diaphragm	Support number	Unfactored lateral bending stress (ksi)		Support	Girder reaction adjustment factor
		Top flange	Bottom flange		

Add diaphragm locations... New Duplicate Delete

OK Apply Cancel

Running a 3D FEM Analysis: Running the Analysis

F1

Analysis Settings

☒ Design review ☐ Rating

Design method: LRFD

Analysis type: 3D FEM

Analysis option: DL, LL and Spec-Checking

Lane / Impact loading type: As Requested

Apply preference setting: None

Vehicles Output Engine Description

Traffic direction: Both directions

Refresh Temporary vehicles Advanced

Vehicle selection

Design vehicles

Standard

- Alternate Military Loading
- EV2
- EV3
- HL-93 (SI)
- HL-93 (US)
- HS 20 (SI)
- HS 20-44
- HS-20-(SI)
- LRFD Fatigue Truck (SI)
- LRFD Fatigue Truck (US)
- LRFD-Fatigue-Truck-(SI)

Agency

- 12
- 2
- 3
- 5
- 6
- 7x HS20
- aamtraining truck
- Auto
- C DE 30-C3 Load
- C M7 Load
- C NYAR 286 KIP
- C-Eq E80
- Cooper E80

Add to >>

Remove from <<

Reset Clear Open template Save template OK Apply Cancel

AASHTOWare BrDR - Help

Show Back Print Options

Analysis Option

Select the desired Analysis Option:

DL only - Perform dead load analysis. Skip vehicle validation, live load analysis and specification checking.

LL only - Perform live load analysis. Skip dead load analysis and specification checking.

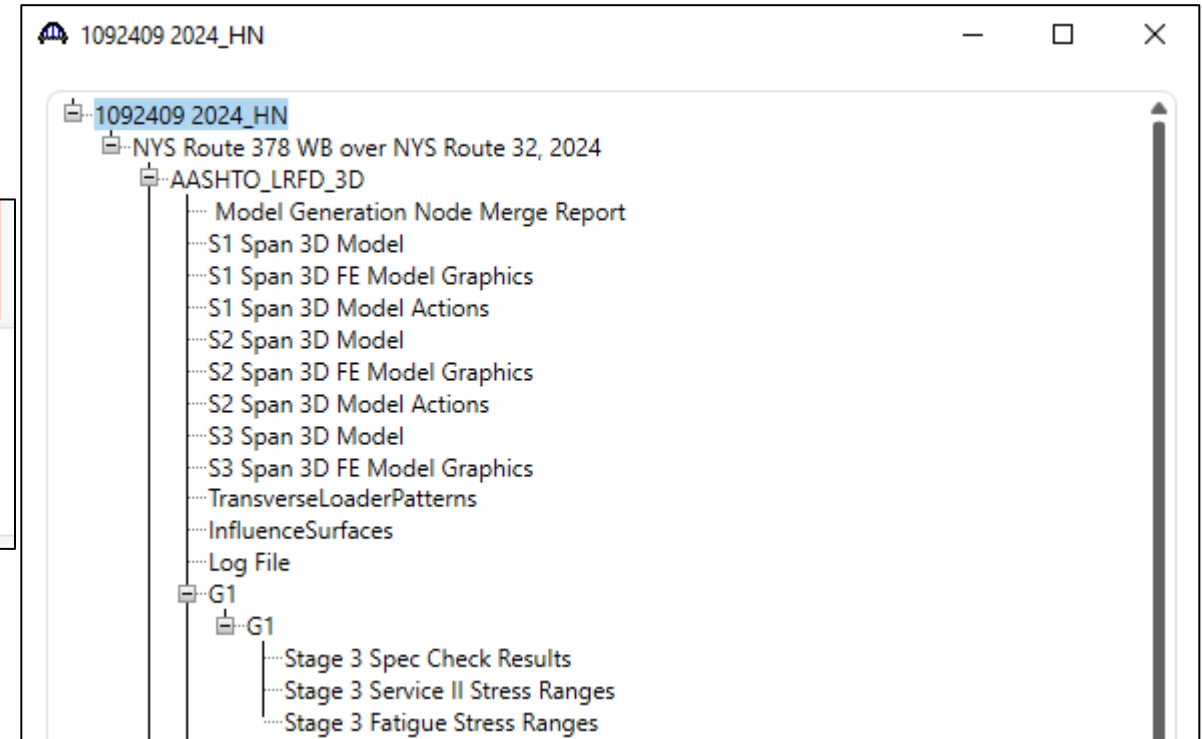
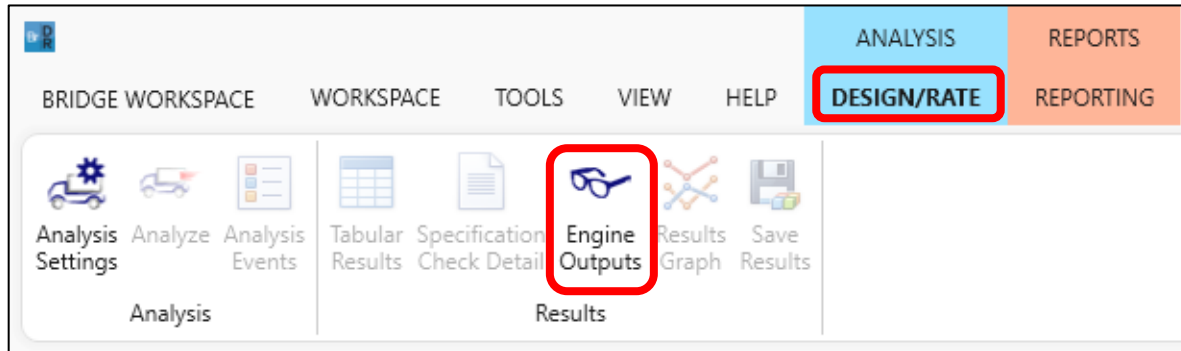
DL and LL - Perform dead load and live load analyses. Skip specification checking.

DL, LL and Spec-Checking - perform dead load analysis, live load analysis and specification checking.

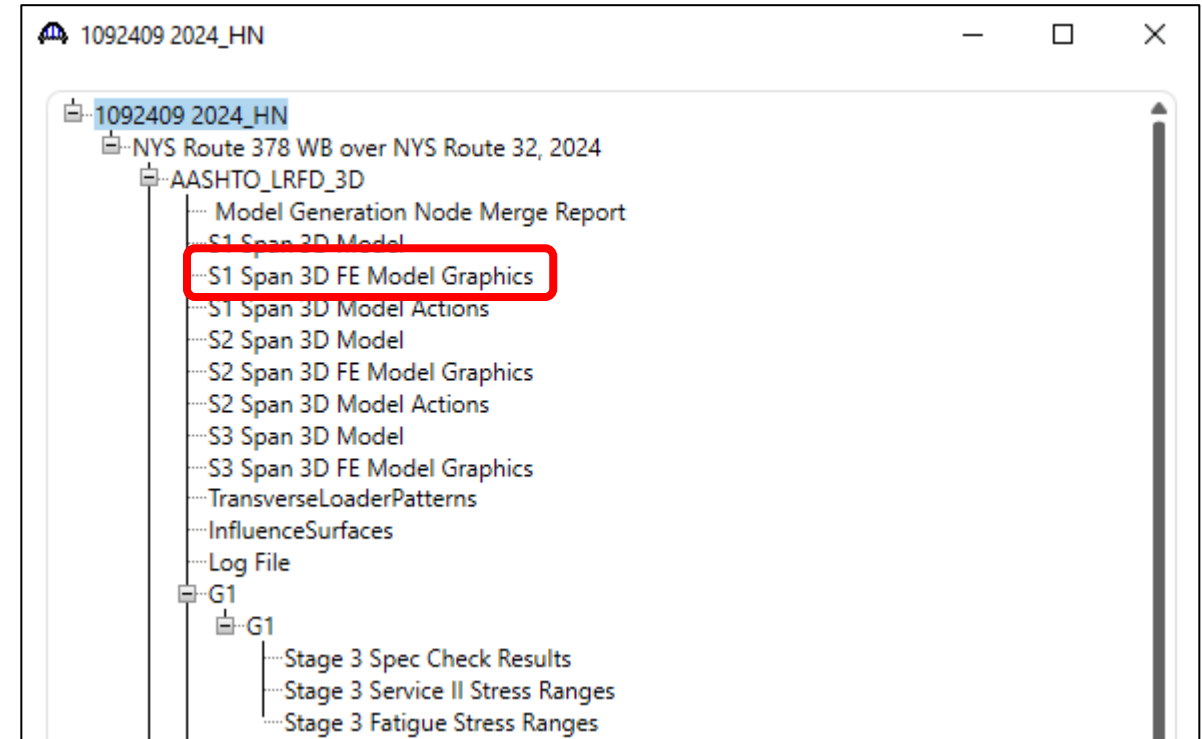
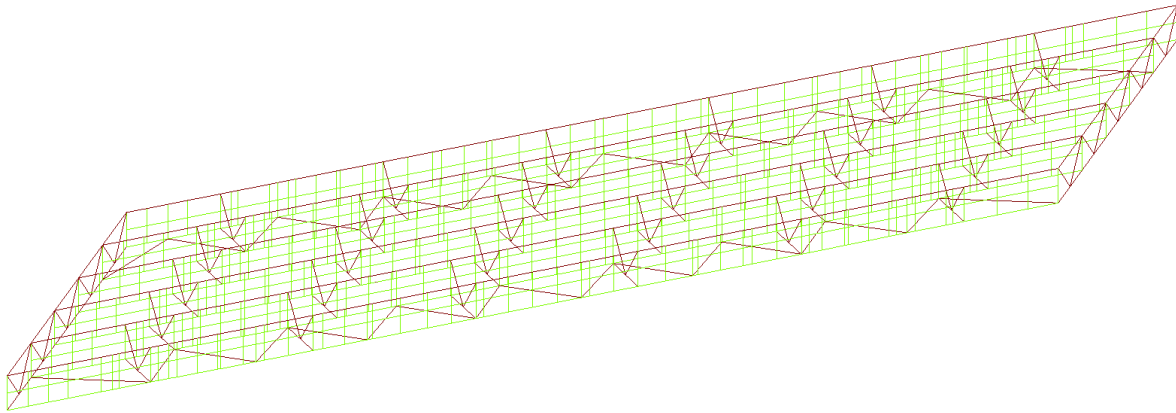
Spec-Checking Only - Perform specification checking based on previously saved dead and live load analysis.

Interpreting the Results

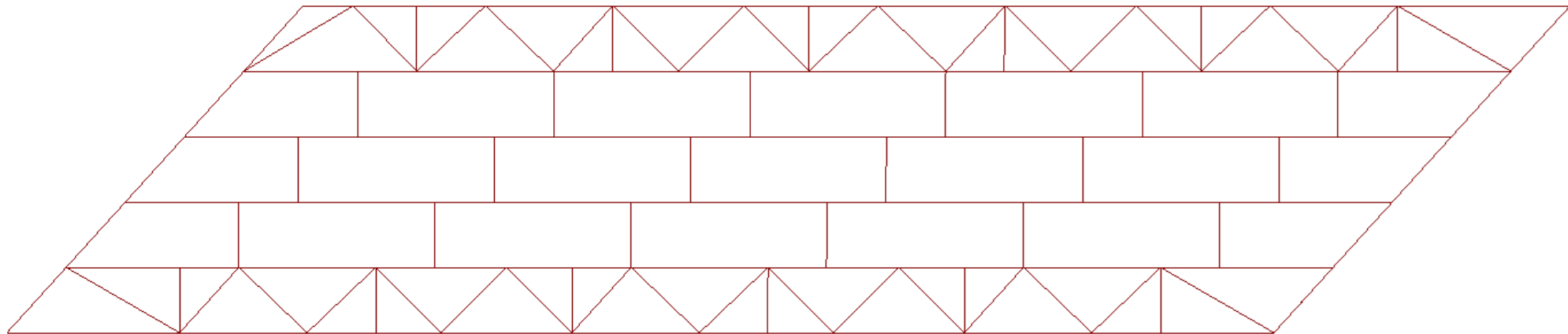
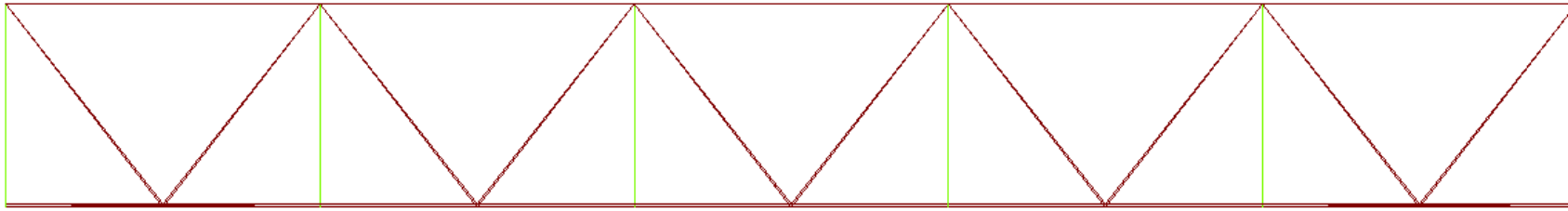
Interpreting the Results: FE Model Graphics



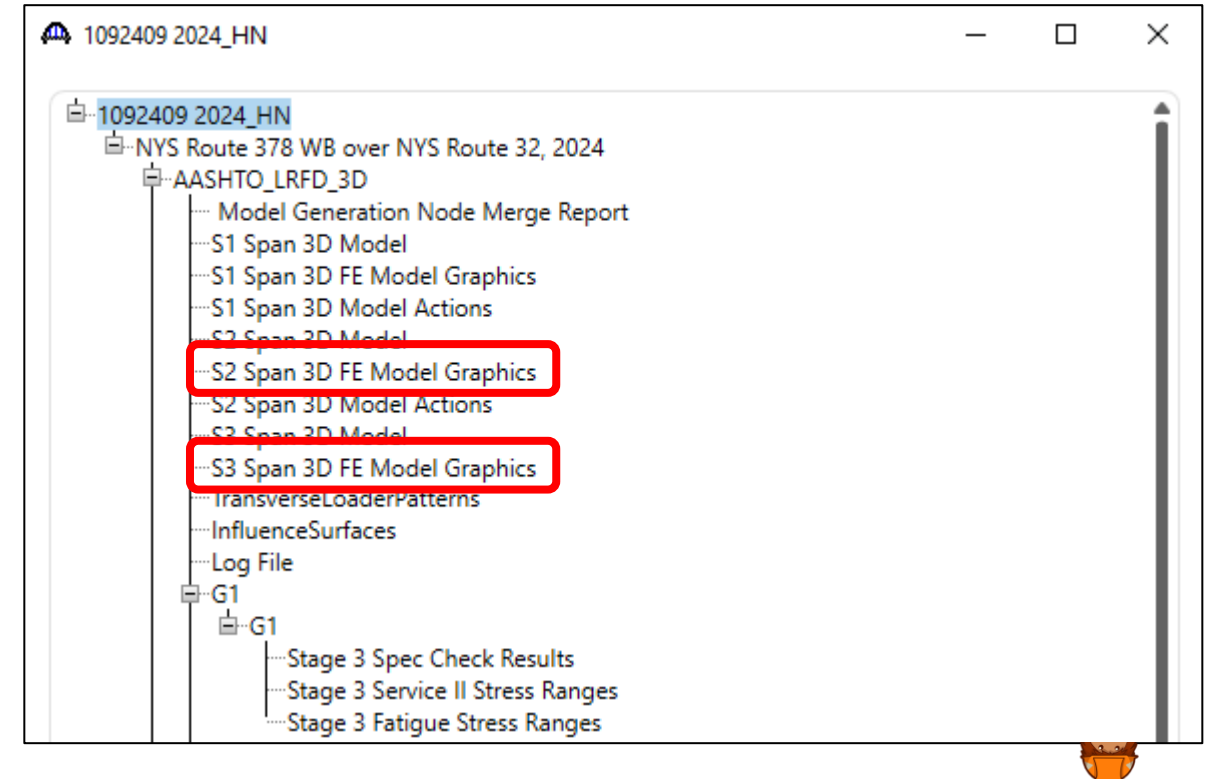
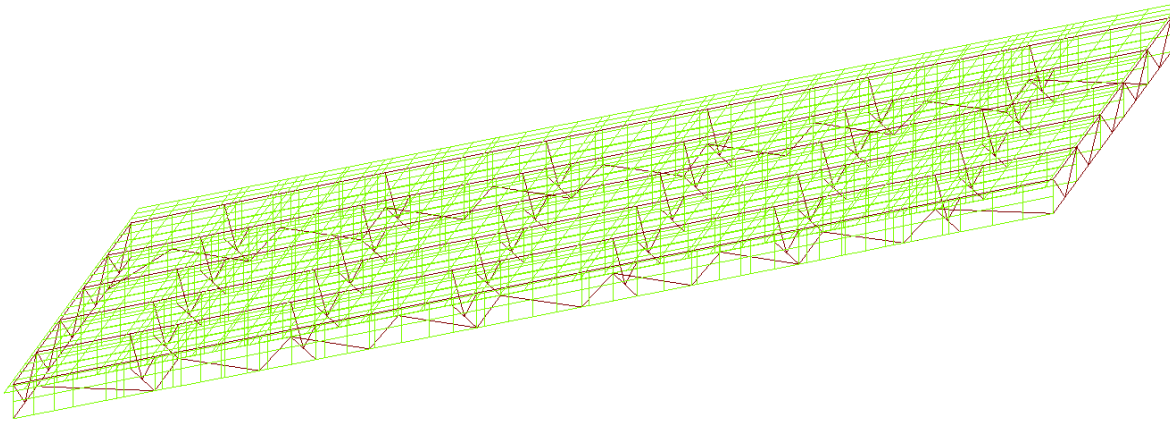
Interpreting the Results: FE Model Graphics



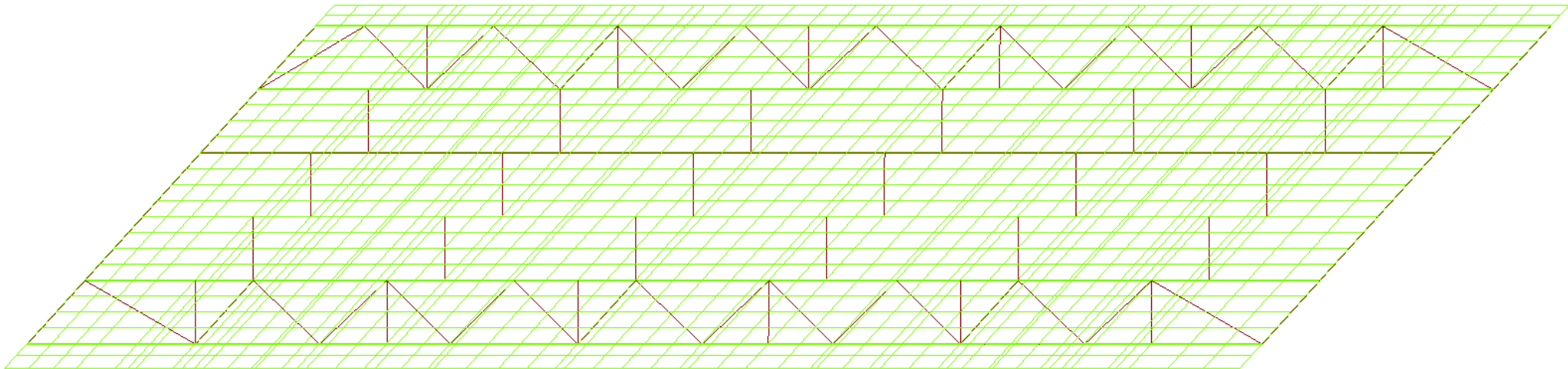
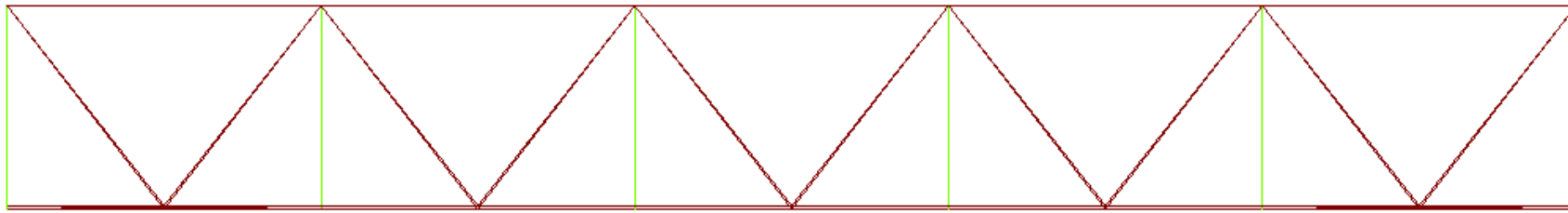
Interpreting the Results: FE Model Graphics



Interpreting the Results: FE Model Graphics



Interpreting the Results: FE Model Graphics



Interpreting the Results: Influence Surfaces

1092409 2024_HN

1092409 2024_HN

NYS Route 378 WB over NYS Route 32, 2024

AASHTO_LRFD_3D

Model Generation Node Merge Report

S1 Span 3D Model

S1 Span 3D FE Model Graphics

S1 Span 3D Model Actions

S2 Span 3D Model

S2 Span 3D FE Model Graphics

S2 Span 3D Model Actions

S3 Span 3D Model

S3 Span 3D FE Model Graphics

TransverseLoaderPatterns

InfluenceSurfaces

Log File

G1

G1

Stage 3 Spec Check Results

Stage 3 Service II Stress Ranges

Stage 3 Fatigue Stress Ranges

File

Tools

Help

Open...

Save Image

Close All

Close Polygons

Exit

Open

« NYSRoute378WBoverNYSRoute322024 » AASHTO_LRFD_3D » S3 Span » Data

Search Data

Organize

New folder

BIN 1092409 - L1

Drawing Markup

Timesheets

Training

OneDrive - New Y

My Computer (W

3D Objects

Desktop

Documents

Downloads

Music

Pictures

Videos

Windows (C:)

Name

Date modified

Type

Size

FiniteElementModel.FEM

InfluenceSurfaces.sur

InfluenceSurfaces

TransverseLoaderPatterns

7/31/2025 1:44 PM

7/31/2025 1:55 PM

7/31/2025 1:55 PM

7/31/2025 1:45 PM

FEM File

SUR File

Text Document

Text Document

725 KB

90,884 KB

404,913 KB

57 KB

File name: Inf

Influence Surface

Influence Surface Information

Bridge ID:

1092409_KAR

Bridge:

1092409_KAR

Superstructure Definition:

NYS Route 378 WB over NYS Route 32,

User:

kgeyer

NBI Structure ID:

1092409_KAR

Bridge Alternative:

Date:

7/31/2025

Influence Surface Selection

Girder:

Deck Node:

Action:

Face:

G3

601

Moment-Z

Left

3-1

621

Shear-Y

Right

3-2

625

Moment-Y

3-3

633

Moment-Y Top Flange

3-4

641

Moment-Y Bottom Flange

3-5

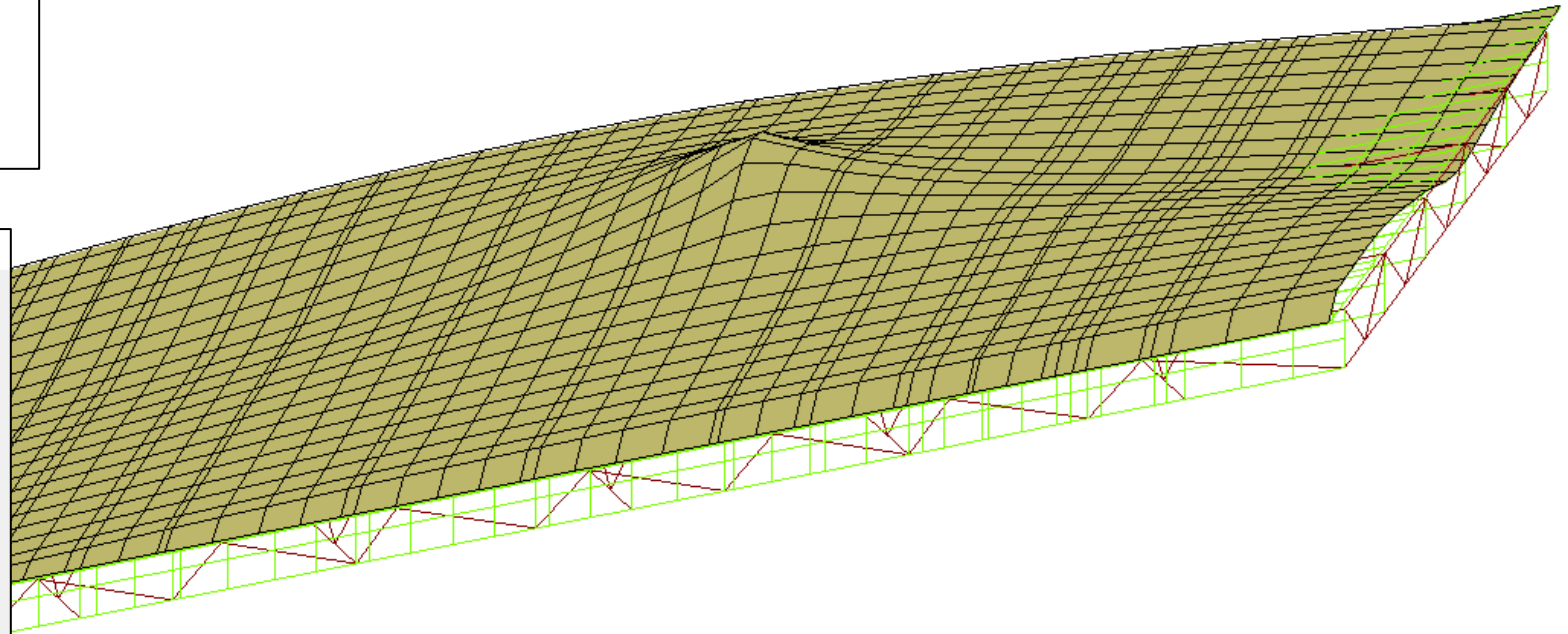
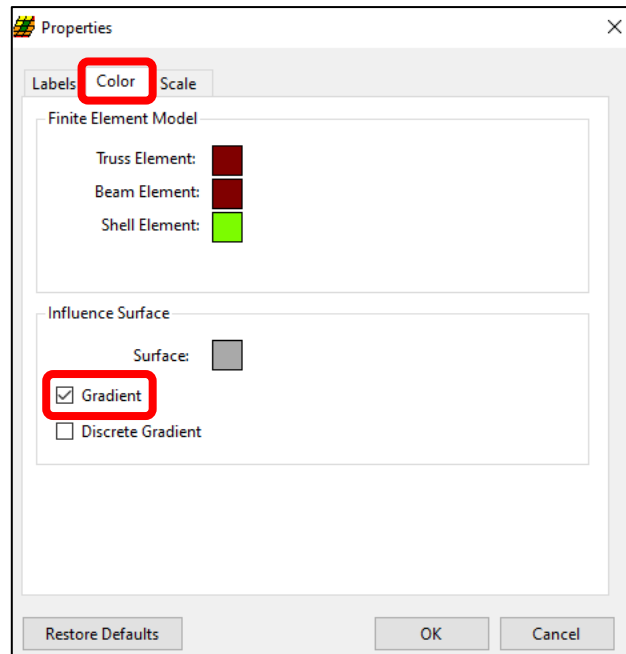
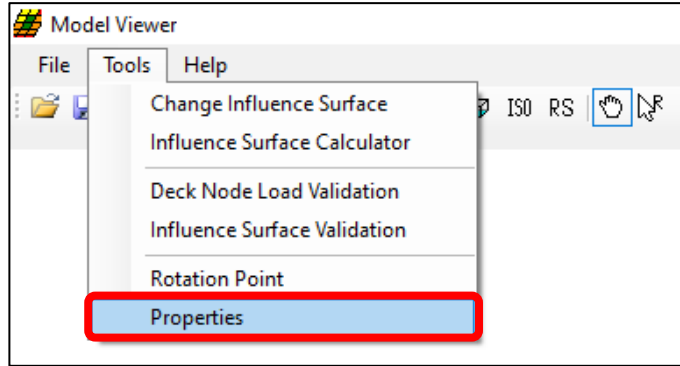
645

Deflection-Y

OK

Cancel

Interpreting the Results: Influence Surfaces



Interpreting the Results: Influence Surfaces

Influence Surface

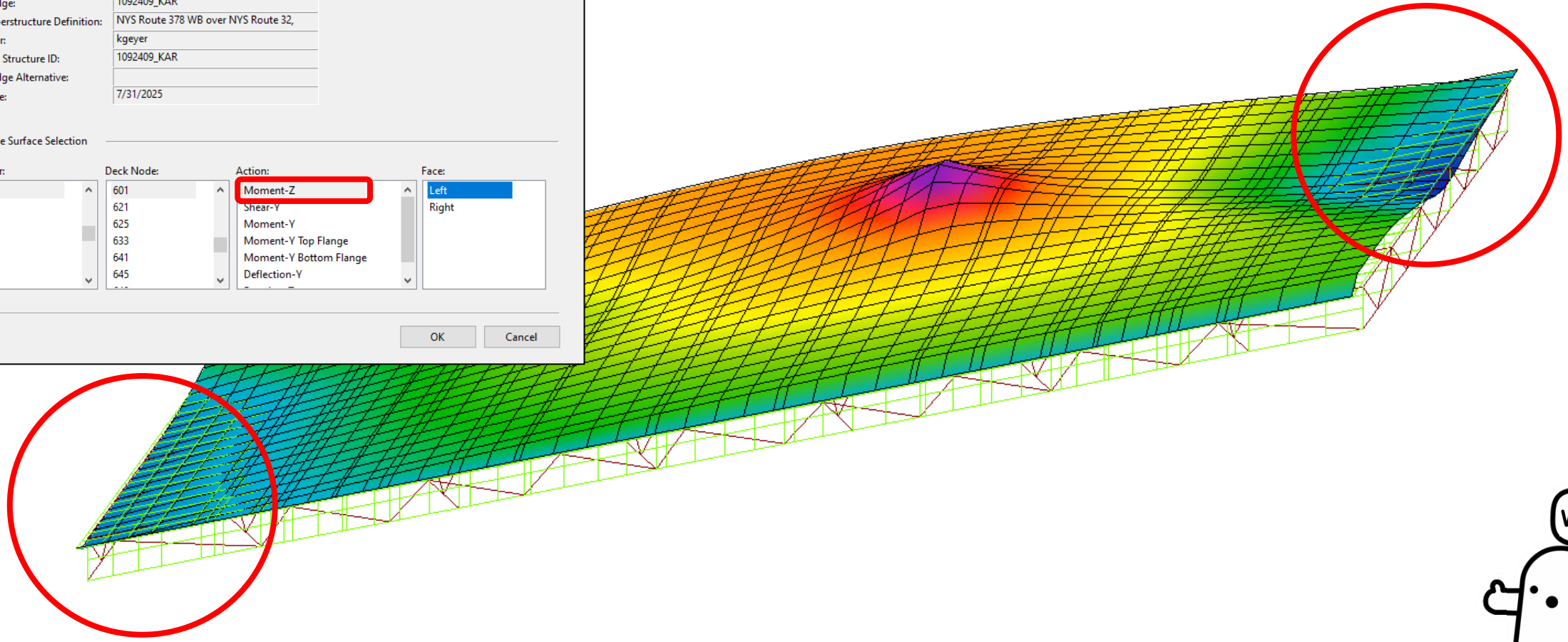
Influence Surface Information

Bridge ID:	1092409_KAR
Bridge:	1092409_KAR
Superstructure Definition:	NYS Route 378 WB over NYS Route 32,
User:	kgeyer
NBI Structure ID:	1092409_KAR
Bridge Alternative:	
Date:	7/31/2025

Influence Surface Selection

Girder:	Deck Node:	Action:	Face:
G3	601	Moment-Z	Left
3-1	621	Shear-Y	Right
3-2	625	Moment-Y	
3-3	633	Moment-Y Top Flange	
3-4	641	Moment-Y Bottom Flange	
3-5	645	Deflection-Y	

OK Cancel



Interpreting the Results: Sanity Check

Design and Performance of Highly Skewed Deck Girder Bridges

Pinar Okumus, Ph. D.
Mauricio Diaz Arancibia
University at Buffalo, the State University of New York

Michael G. Oliva, Ph. D.
University of Wisconsin, Madison

WisDOT ID no. 0092-16-05
May 2018



WISCONSIN DOT
PUTTING RESEARCH TO WORK

Problems Associated with Skew

A literature review, interviews with Wisconsin regional bridge maintenance engineers, a survey to New York State bridge maintenance engineers and field inspections revealed the following related to high skew:

- Skew bridge geometries can affect girder live load distribution due to modified load paths. Due to the skewed geometry, the shortest path to supports becomes the region joining obtuse corners of a span. Higher shear forces are seen near obtuse corners, while reduced shear forces are found near acute corners, possibly leading to uplift. In addition, girder moments are reduced with increasing skews. Torsion and negative moments at bridge ends also develop in skewed geometries.

Final Rating Results and Rehabilitation Scope

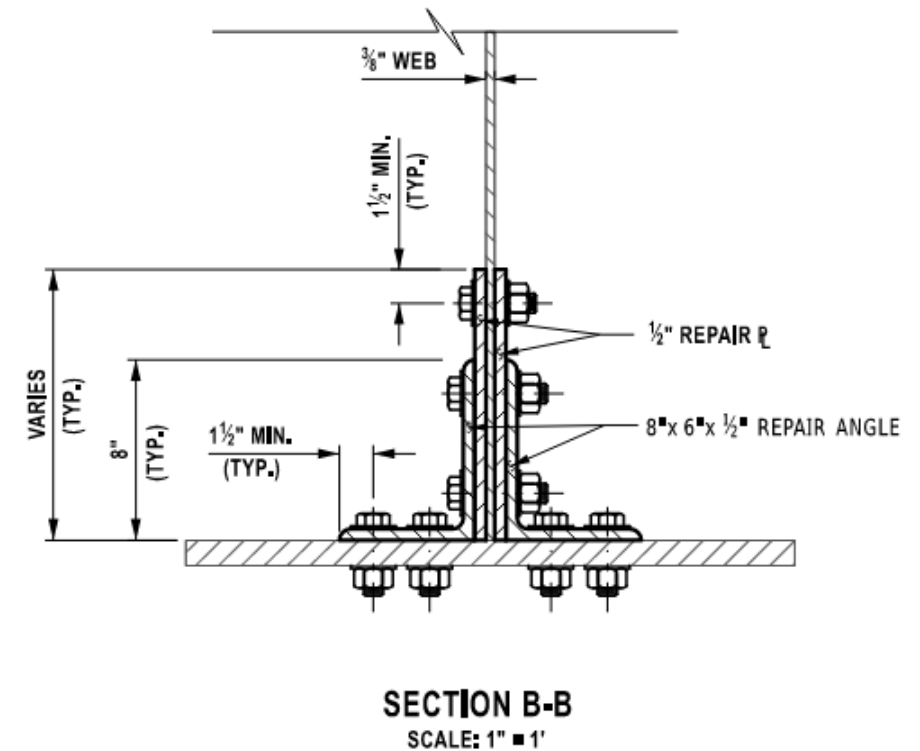
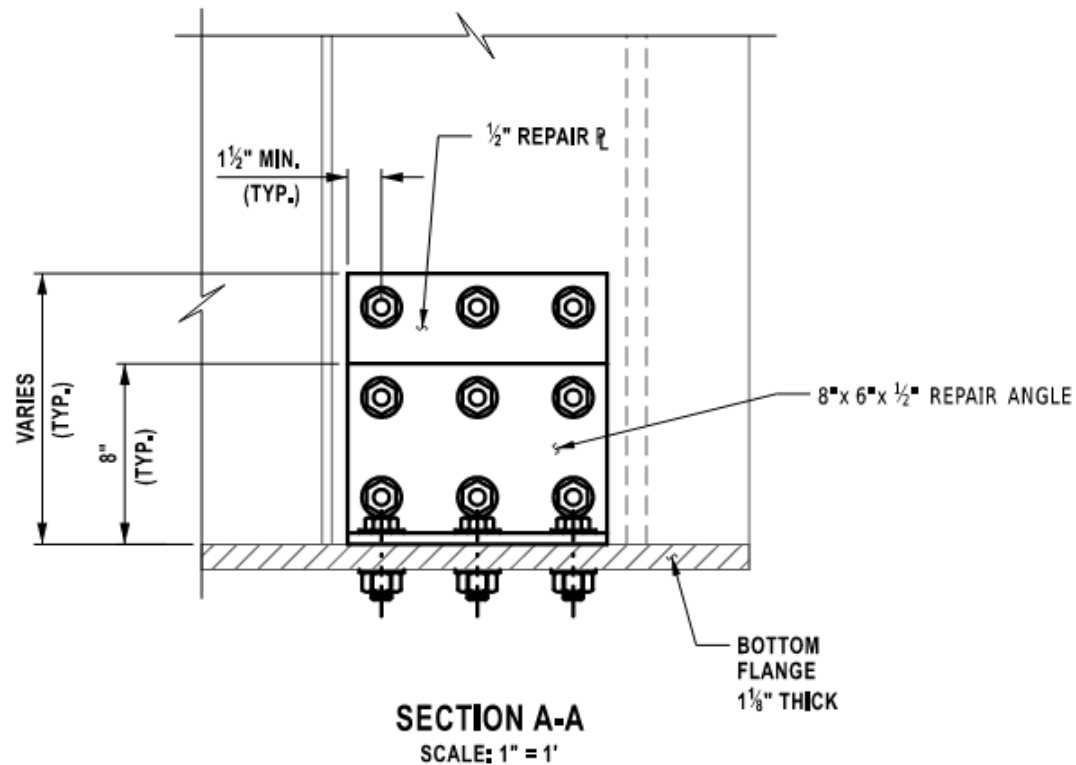
Final Rating Results and Rehabilitation Scope: LFR and LRFR Ratings

HS20 — LOAD FACTOR RATING SUMMARY TABLE			
Rating Type	HS Equivalent	Tonnage	Controlling Member
INVENTORY	HS 40.55	73.00 Tons*	G12 @ 150.0 ft, Shear – Steel
OPERATING	HS 67.77	122.00 Tons*	G12 @ 150.0 ft, Shear – Steel

HL93 — LOAD AND RESISTANCE FACTOR RATING SUMMARY TABLE			
Rating Type	Truck	Rating	Controlling Member
INVENTORY	HL-93	0.971	G11 @ 130.00 ft, Strength I- Steel Flex. Stress
OPERATING	HL-93	1.259	G11 @ 130.00 ft, Strength I- Steel Flex. Stress

Final Rating Results and Rehabilitation Scope: Angle Retrofit

Typical repair type at locations with web perforations.



Lessons Learned

Lessons Learned

1092409 2024

Year t

Interior Girders G8-G11 control in Flexure at Midspan.

RATING L1 (TONS): HS20 **, **, H20 **, **
 RATING L2 (TONS): HS20 60, 101; H20 33, 56 (2019)
 RATING L2 (TONS): HS20 60, 101; H20 33, 56 (2020)
 RATING L2 (TONS): HS20 60, 101; H20 33, 56 (2021)
 RATING L2 (TONS): HS20 60, 101; H20 33, 56 (2022)
 RATING L2 (TONS): HS20 60, 101; H20 33, 56 (2023)
 RATING L2 (TONS): HS20 60, 101; H20 33, 56 (2024)

LEVEL 2 LOAD RATING LRFR:
 HL-93: Inv. RF = 1.14, Opr. RF = 1.47 (2023)
 HL-93: Inv. RF = 1.14, Opr. RF = 1.47 (2024)

HS20 — LOAD FACTOR RATING SUMMARY TABLE			
Rating Type	HS Equivalent	Tonnage	Controlling Member
INVENTORY	HS 40.55	73.00 Tons*	G12 @ 150.0 ft, Shear – Steel
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HL93 — LOAD AND RESISTANCE FACTOR RATING SUMMARY TABLE			
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- Level 2 Ratings were consistent, but unconservative using Line Girder.
- Difference in rating results would not have been found if the rating model wasn't used to start with for design project, using a BrDR model life cycle approach
- Re-evaluate software capabilities, verify analysis methodology is appropriate
- NYSDOT is changing design standards for high skew structures, rating standards are being evaluated

QUESTIONS



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Department of Transportation