MDOT
Michigan Department of Transportation

HNTB

Design and Construction of the I-475 Flint River Bridge

March 17th, 2026

Introductions

Juan Alcantar, PE	MDOT Bridge Project Manager
Eric Stone, PE	HNTB Bridge Project Manager
Tony Shkurti, PE	HNTB Bridge Project Manager

Teams

Design

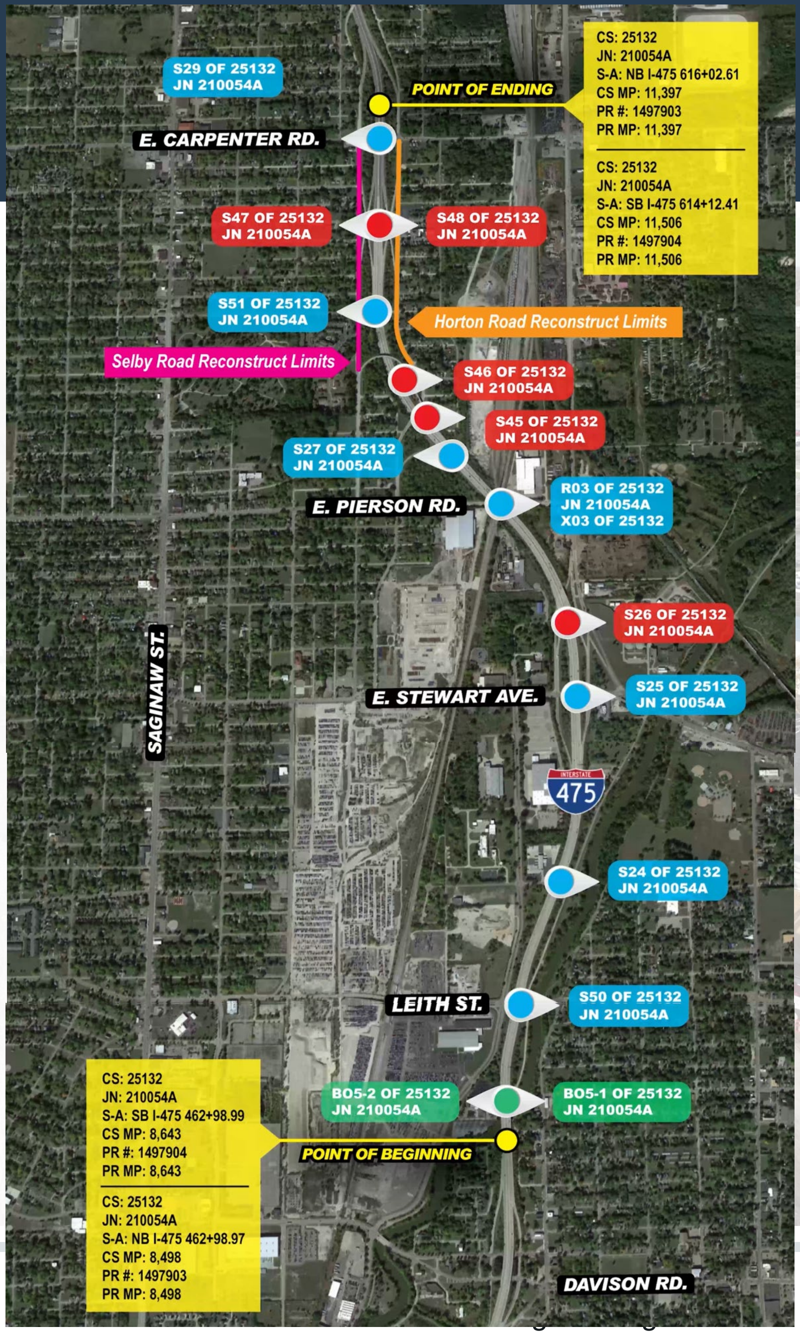
- MDOT
  - Davison TSC
  - Bay Region
  - Bureau of Bridges and Structures
- Consultant
  - HNTB
  - Fishbeck
  - ROWE Professional Services Company
  - Somat Engineering, Inc.

Construction

- Contractors
  - Dan’s Excavating, Inc.
  - C.A. Hull Co., Inc.
- Construction Oversite
  - MDOT Bay City TSC
    - Paul Schiefer, PE - Construction Engineer
    - Collin Lorenz, - Assistant Construction Engineer
  - ROWE Professional Services Company
    - Nate Whiting, PE

I-475 North Project Overview

- Carpenter Rd to Flint River
- Project Cost- $126 Million
- Delivery Method- Design Bid Build
- Road Reconstruction
  - 3 lanes to 2 conversion in each direction
  - Replacing storm sewer, median barrier, and lighting
  - Alt Bid
- Bridges
  - Work on 13 structures along the corridor
  - 1 full bridge replacement, 5 deck replacements, 2 epoxy overlays , 5 permanent bridge removals



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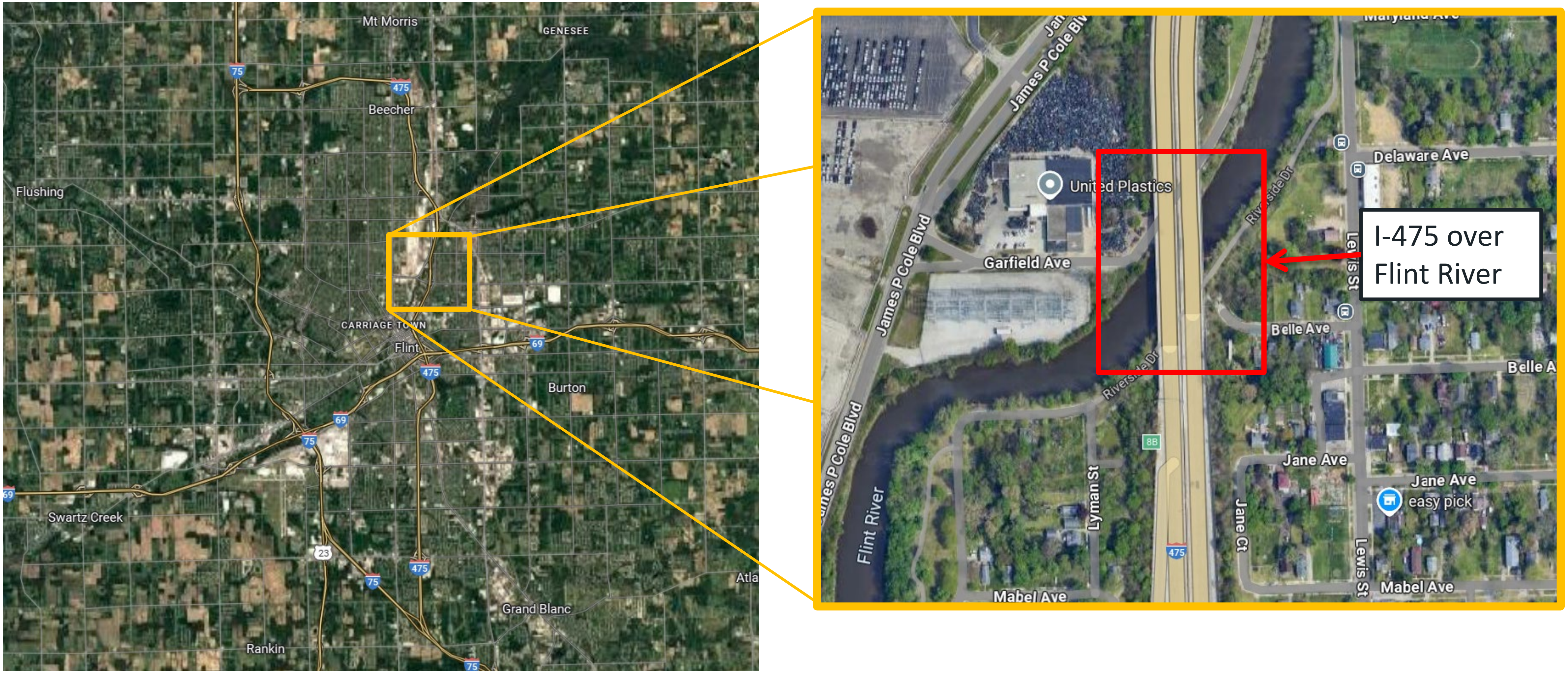
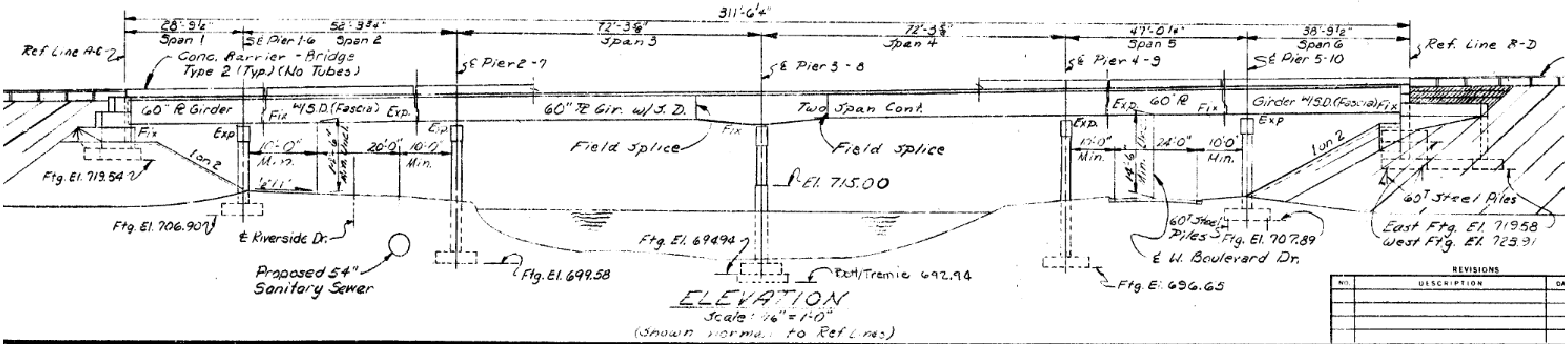
Flint River Bridge



Existing Bridge

- Built 1976
- Heavy skew (54deg)
- Steel Plate Girders w/ pin & hangers
- River piers supported on Spread footings



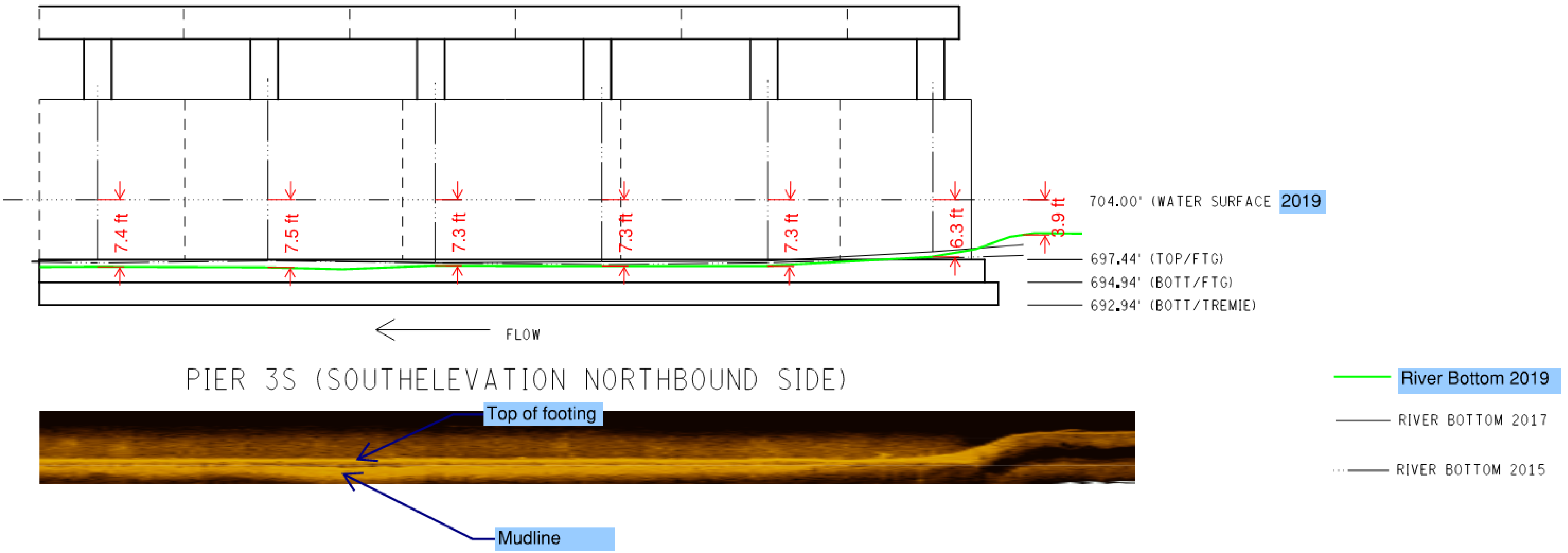
Existing Bridge

- Fair Condition
- Deck nearing end of life
- Temp. supports installed at abutments

Existing Bridge

- Scour Critical

Bridge is scour critical; bridge foundations determined to be unstable for assessed or calculated scour conditions:



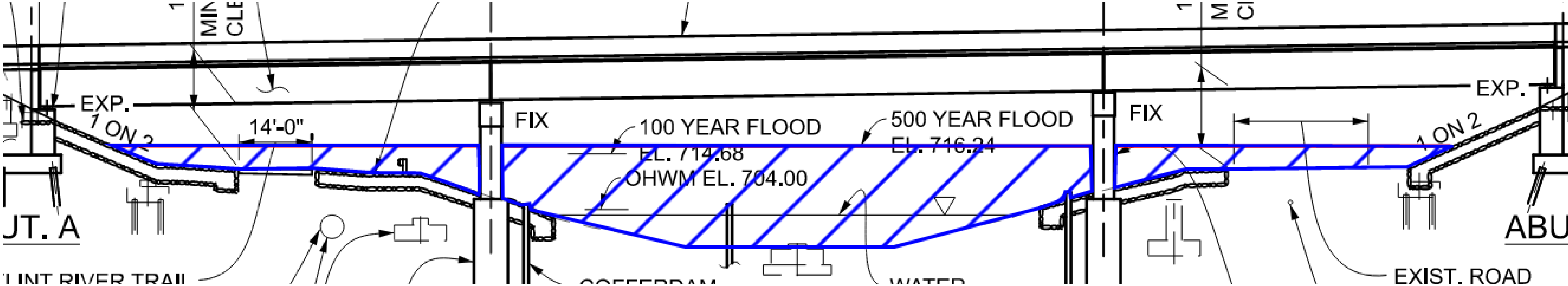
Bridge Replacement Structure Study

- A long, initial list of ideas was whittled down to six final alternatives explored in detail:

Alternative ID	No. Spans	Skew Angle	Span Lengths*	Girder Size	No. of Girders per bridge	Girder Spacing
1	2	54 deg	250’ -250’	Steel Plate Girder (96” Web)	12	11’-3”
2	3	54 deg	138’ – 246’ – 146’	Steel Plate Girder (96” Web)	12	11’-3”
3	4	54 deg	125’ – 125’ – 125’ – 125’	Steel Plate Girder (54” Web)	12	11’-3”
4	4	54 deg	125’ – 125’ – 125’ – 125’	Concrete BT 54”	16	8’-0”
5	3	54 deg	150’ – 200’ – 150’	Steel Plate Girder (84” Web)	12	11’-3”
6	3	54 deg	166’-8” – 166’-8” – 166’-8”	Concrete BT 84”	16	8’-0”

Hydraulics (MDOT Hydraulic Team)

- Opening must be large enough to pass the 100-year and 500-year floods -> 500 ft total bridge length
- Close coordination required between bridge and MDOT Hydraulic team:
  - Pier and drilled shaft thicknesses.
  - Proposed groundlines
  - Scour countermeasure details
  - Use of cofferdams and causeways



Geotechnical (Somat & MDOT Geotech. Team)

- Drilled shafts preferred at piers due to potential for significant scour (~15-20ft)
- Hard drilling conditions were encountered during soil borings

Table 6: Design Soil Profile – Piers 1 and 3

(Borings BB-02, BB-02A, BB-02B, BB-02C, BB-07, BB-07A, BB-07B)

Layer	*Soil Type*	*Average N-Value*	*Unit Weight Total (Effective[A])*	*Friction Angle*	*Uniaxial Compressive Strength*
El. 705 to 696 feet	Fill / River Sediment	5	110 pcf (48 pcf)	30°	----
El. 696 to 645 feet	Extremely Dense Sands	50+	130 pcf (68 pcf)	38°	----
El. 645 to 626 feet	Layers of Sandstone and Fine Sand (completely weathered sandstone)	----	140 pcf (78 pcf)	40° [B]	----
El. 626 to 606 feet	Sandstone rock	----	150 pcf (88 pcf)	----	1,000 – 6,000 psi

[A] Groundwater table at El. 715 feet (artesian condition)

[B] Weak layers of rock assumed to behave as granular soils.

Environmental (MDOT)

- Flint River is a state water trail. Have to allow access during construction or provide means of safety moving thru the site during construction.
- MDOT established that this site was not conducive to mussels – therefore no survey or relocation was necessary.
- Potentially contaminated materials were identified near the pier locations.
- EGLE had concerns with contaminates rising from surface with stream impact. Sheeting was placed to contain flow of contaminates.

Recommended Alternative

- Alternatives 1-4 proved to have highest costs.
- Alternative 5 had a longer main span than 6 pushing the piers closer to the river banks making them easier to build.

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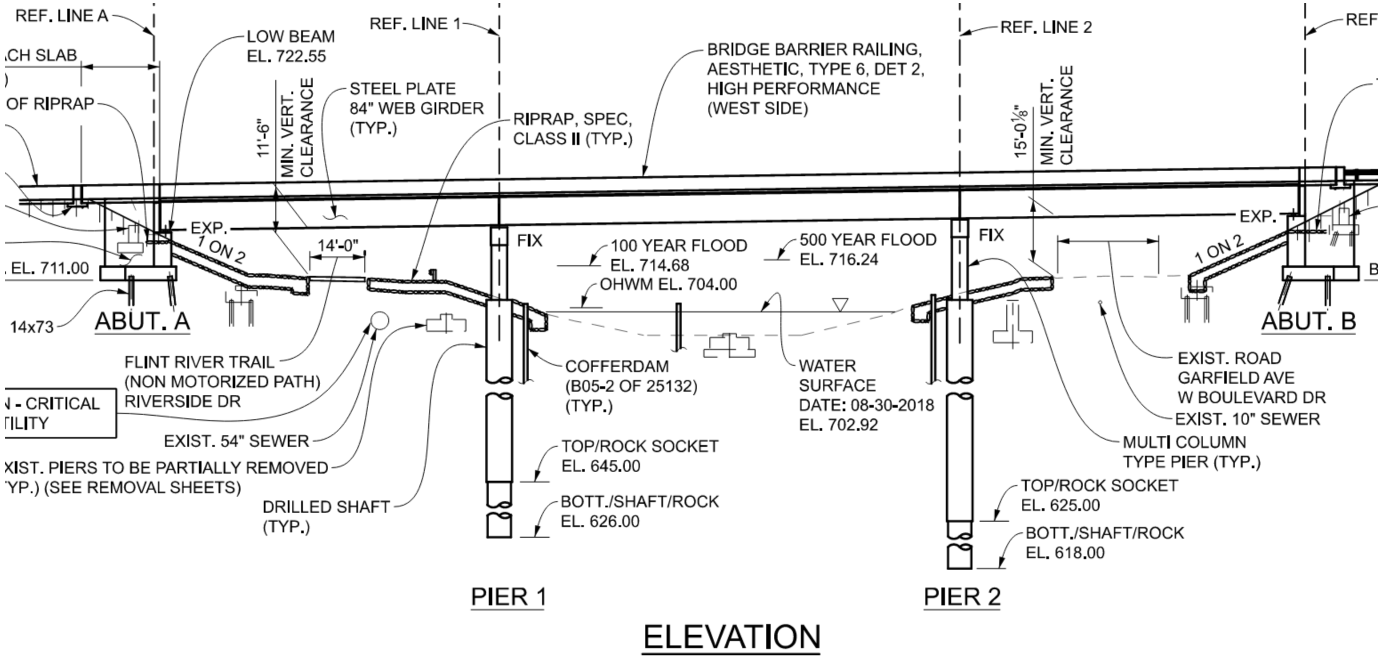
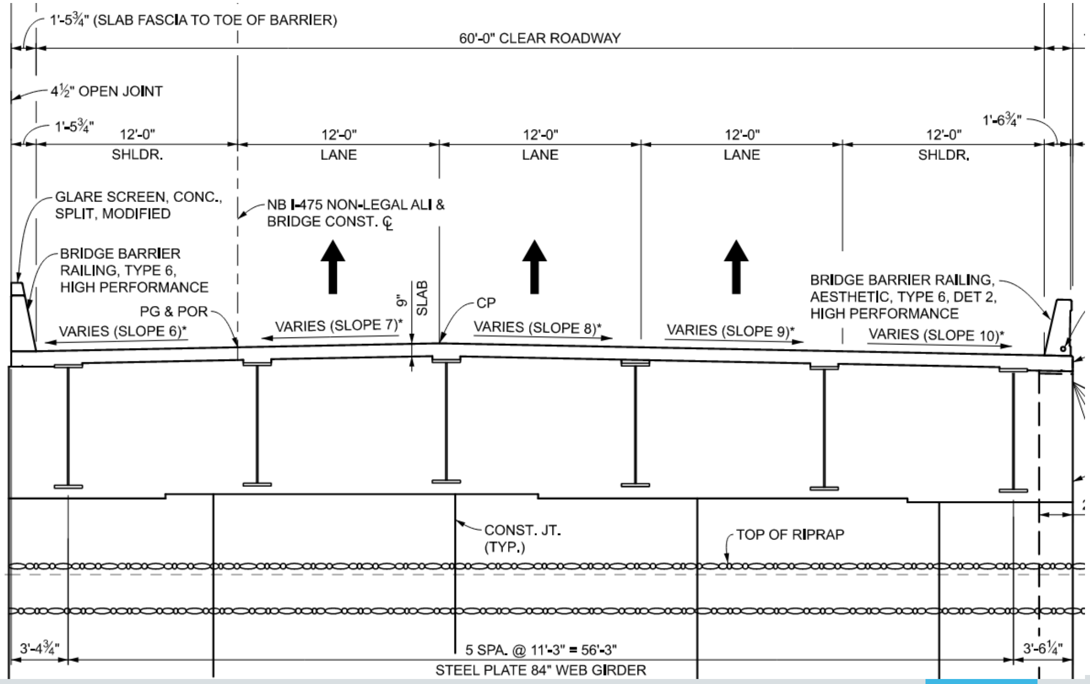
Recommended Alternative

- 200ft main span over the river with 150ft side spans, 54deg skew
- Steel plate girders – 84” deep webs
- Piers supported on 6’-6” drilled shafts, abutments on HP 14x73 piles





Design Considerations – Skew

- Bridge Skew Index per AASHTO 4.6.3.3.2:

$$I_S = \frac{w_g \tan\theta}{L_s} \qquad (4.6.3.3.2\text{-}2)$$

- Flint River Bridge:
  - Spans 1/3: I.s = 0.52
  - Span 2: I.s = 0.39
- AASHTO: I.s > 0.3 -> must consider I-girder warping rigidity
- NHCRP 725 indicates that with this skew, 1D and traditional 2D analysis would have major errors.
- MDOT BDM 7.01.14: skew > 45 = refined methods required
- ➢ 3D FEM is warranted

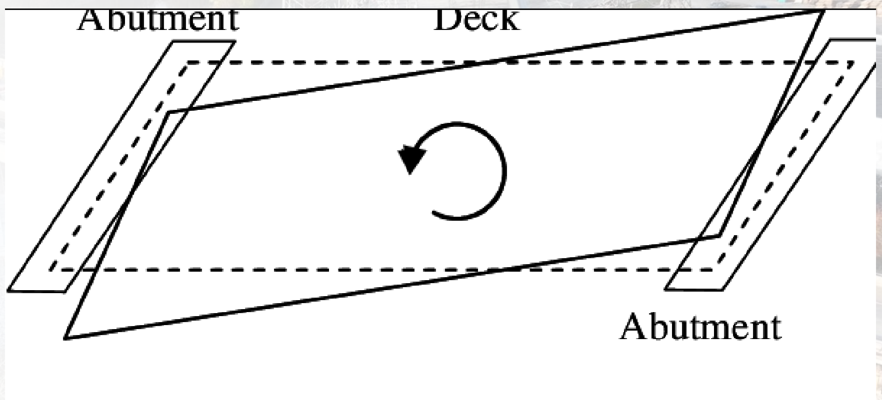
NCHRP 725 Scoring Matrix:

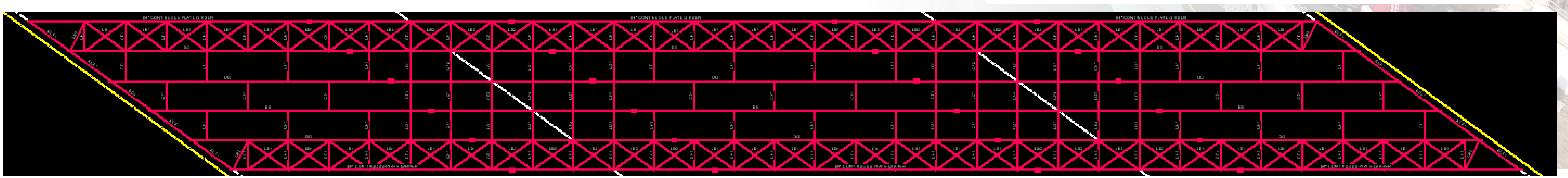
Table 3-1. Matrix for recommended level of analysis—I-girder bridges.

Response	Geometry	Worst-Case Scores		Mode of Scores	
		Traditional 2D-Grid	1D-Line Girder	Traditional 2D-Grid	1D-Line Girder
Major-Axis Bending Stresses	C ($I_C \le 1$)	B	B	A	B
	C ($I_C > 1$)	D	C	B	C
	S ($I_S < 0.30$)	B	B	A	A
	S ($0.30 \le I_S < 0.65$)	B	C	B	B
	S ($I_S \ge 0.65$)	D	D	C	C
	C&S ($I_C > 0.5$ & $I_S > 0.1$)	D	F	B	C
Vertical Displacements	C ($I_C \le 1$)	B	C	A	B
	C ($I_C > 1$)	F	D	F	C
	S ($I_S < 0.30$)	B	A	A	A
	S ($0.30 \le I_S < 0.65$)	B	B	A	B
	S ($I_S \ge 0.65$)	D	D	C	C
	C&S ($I_C > 0.5$ & $I_S > 0.1$)	F	F	F	C
Cross-Frame Forces	C ($I_C \le 1$)	C	C	B	B
	C ($I_C > 1$)	F	D	C	C
	S ($I_S < 0.30$)	NA[a]	NA[a]	NA[a]	NA[a]
	S ($0.30 \le I_S < 0.65$)	F[b]	F[c]	F[b]	F[c]
	S ($I_S \ge 0.65$)	F[b]	F[c]	F[b]	F[c]
	C&S ($I_C > 0.5$ & $I_S > 0.1$)	F[b]	F[c]	F[b]	F[c]
Flange Lateral Bending Stresses	C ($I_C \le 1$)	C	C	B	B
	C ($I_C > 1$)	F	D	C	C
	S ($I_S < 0.30$)	NA[d]	NA[d]	NA[d]	NA[d]
	S ($0.30 \le I_S < 0.65$)	F[b]	F[e]	F[b]	F[e]
	S ($I_S \ge 0.65$)	F[b]	F[e]	F[b]	F[e]
	C&S ($I_C > 0.5$ & $I_S > 0.1$)	F[b]	F[e]	F[b]	F[e]
Girder Layover at Bearings	C ($I_C \le 1$)	NA[f]	NA[f]	NA[f]	NA[f]
	C ($I_C > 1$)	NA[f]	NA[f]	NA[f]	NA[f]
	S ($I_S < 0.30$)	B	A	A	A
	S ($0.30 \le I_S < 0.65$)	B	B	A	B
	S ($I_S \ge 0.65$)	D	D	C	C
	C&S ($I_C > 0.5$ & $I_S > 0.1$)	F	F	F	C

Design Considerations – Framing Plan

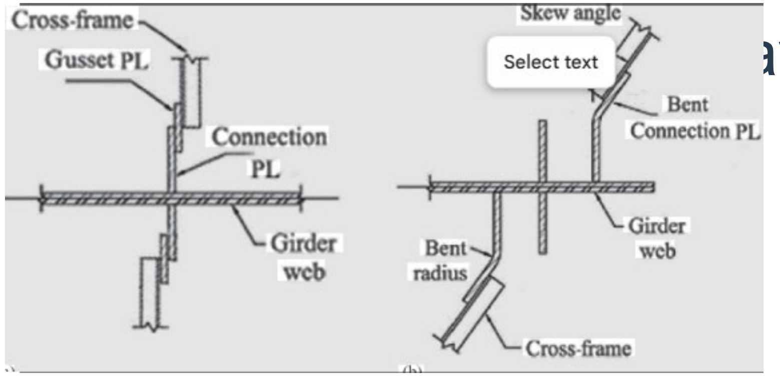
- Torsional loads will be significant,
- Highly skewed supports make end & pier diaphragms/cross frames inefficient,
- 3D truss like behavior was designed to transfer torsion to the bearings and ground,
- Differential deflections due to skew between adjacent girders near supports impose high demands on intermediate cross frames
- Skewed Bridges tend to rotate in plan with time,
- Special Bearing layout plan used.

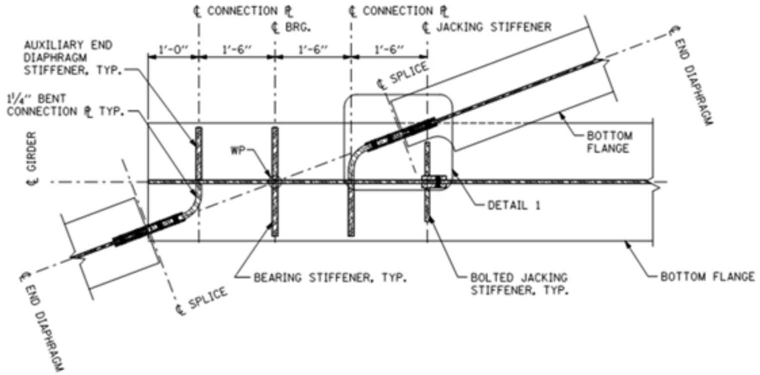




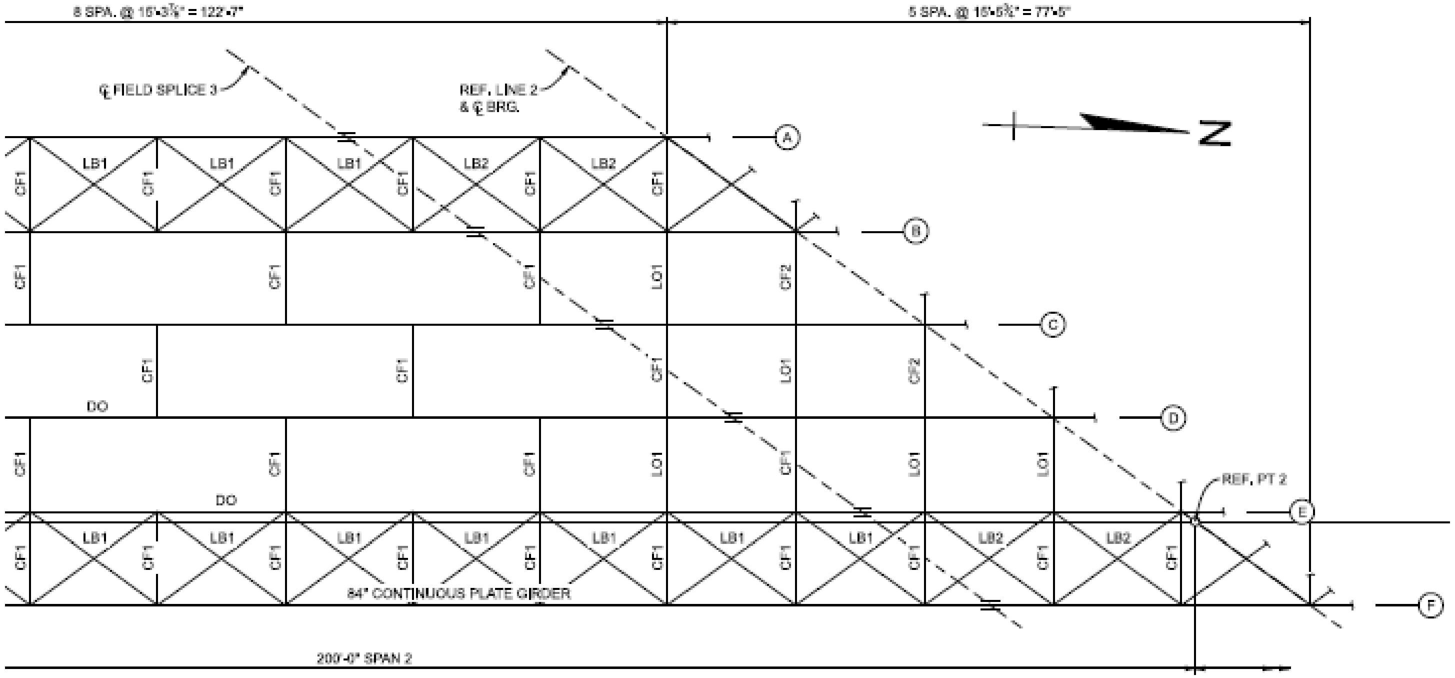
Design Considerations – Laterals/Xframes

- ays

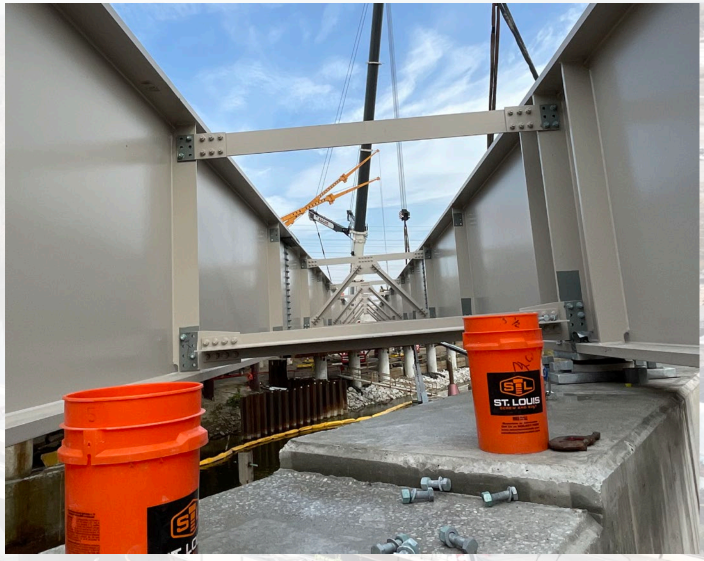




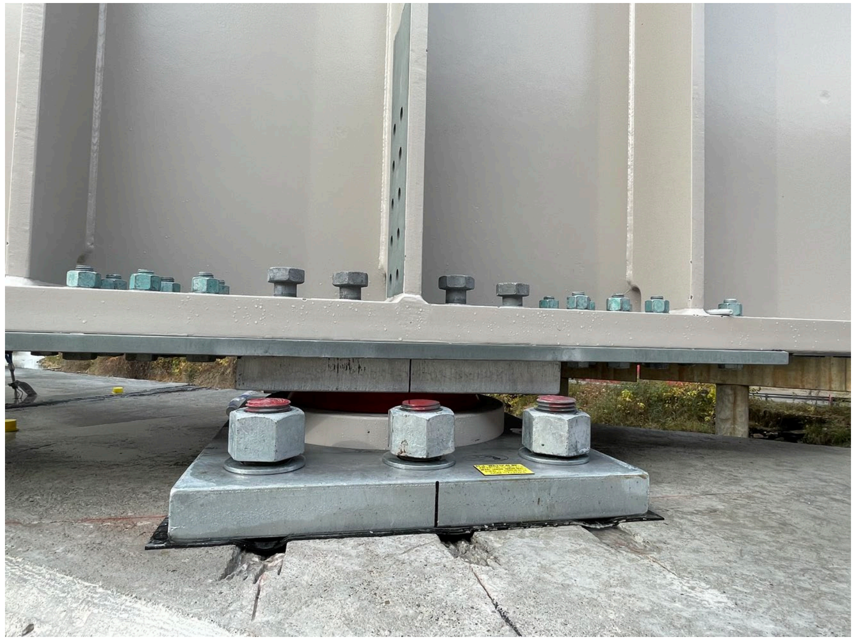
Design Considerations – Lean-On Bracing



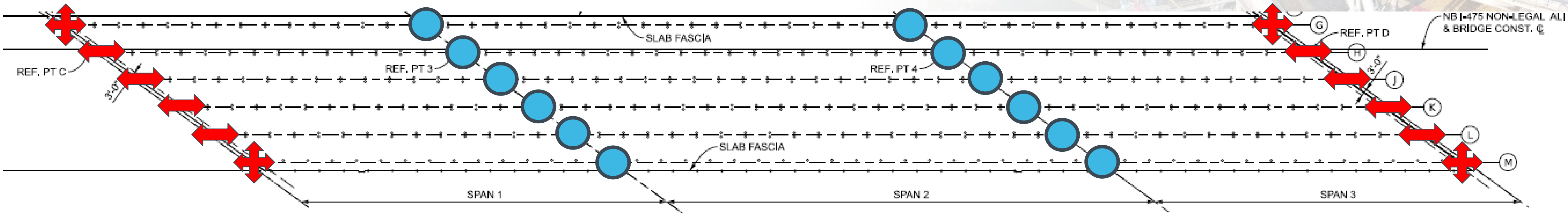
ERECTION DIAGRAM



Design Considerations – Bearings

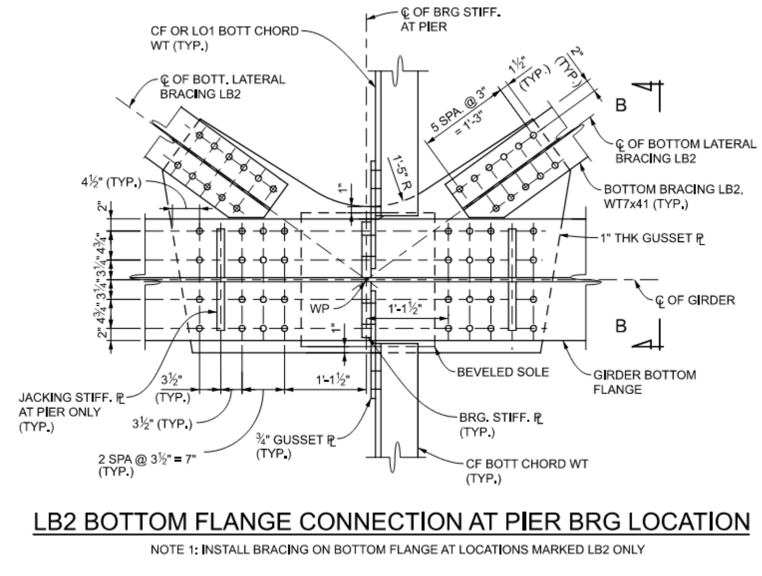


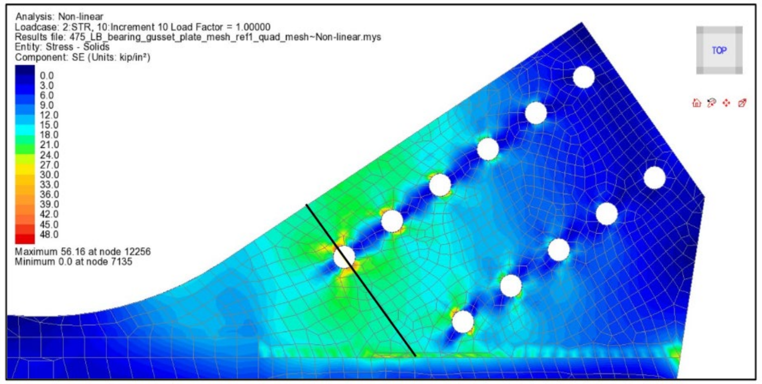
- **Disc Bearings at each substructure**
  - High Load capacity
  - High Rotational capacity in every direction providing flexibility during erection and accommodation of skew behavior
- **Fixity considerations**
  - Tall piers (with lots of scour) = flexibility
  - Control movements at the abutments and the approach slab to prevent unwanted movement over time



Design - Lateral Bracing Gusset

- Diagonal lateral bracing reactions need to be delivered to the fixed bearings.
- Multiple members converging at the same location.
- Solution was to place gusset plate underneath the girder.
- FEA used to validate design checks.

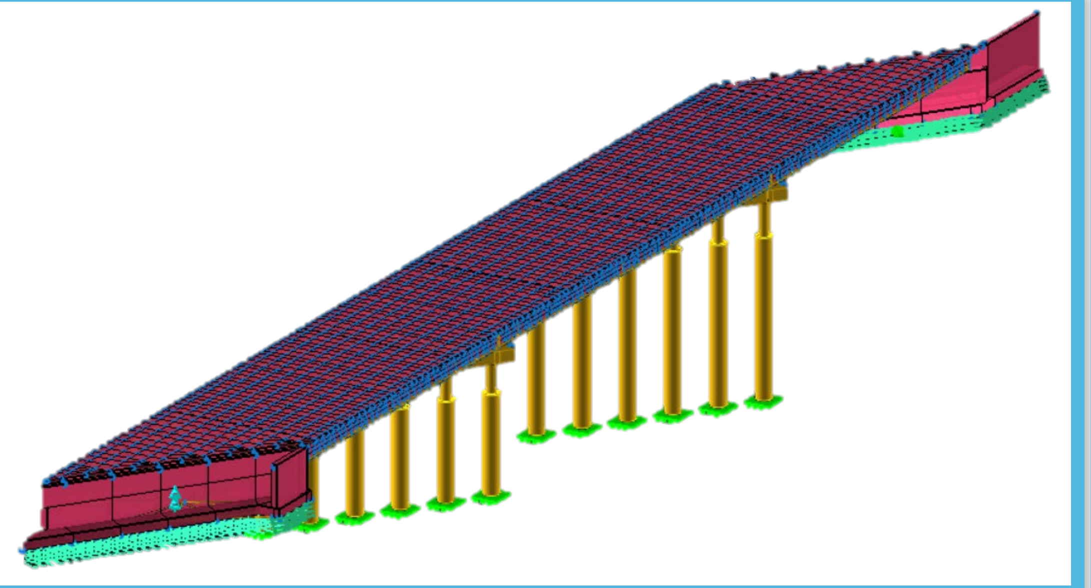




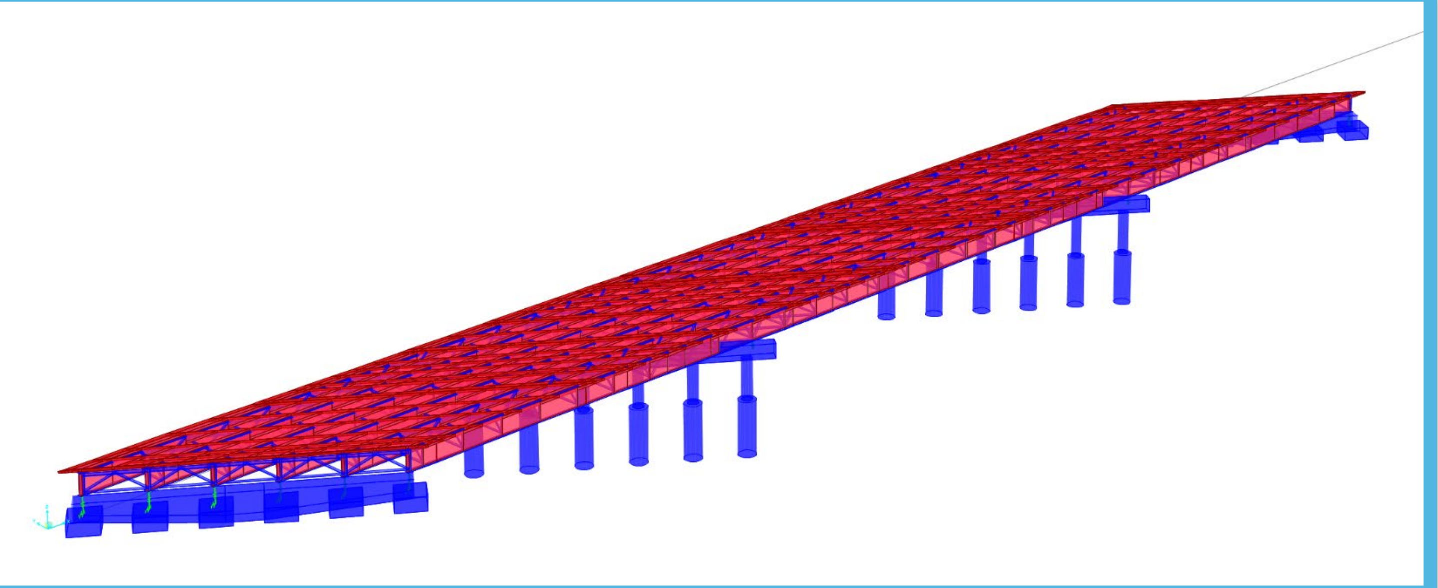
Superstructure Analysis

- 3D analysis model using shells for deck and girder web, frames for flanges and cross-frames was used.
- Influence surface analysis for live loading
- Near impossible to perform quality control on such a complicated model. Therefore, an independent model in a 2nd software package was used.

Originator Model:

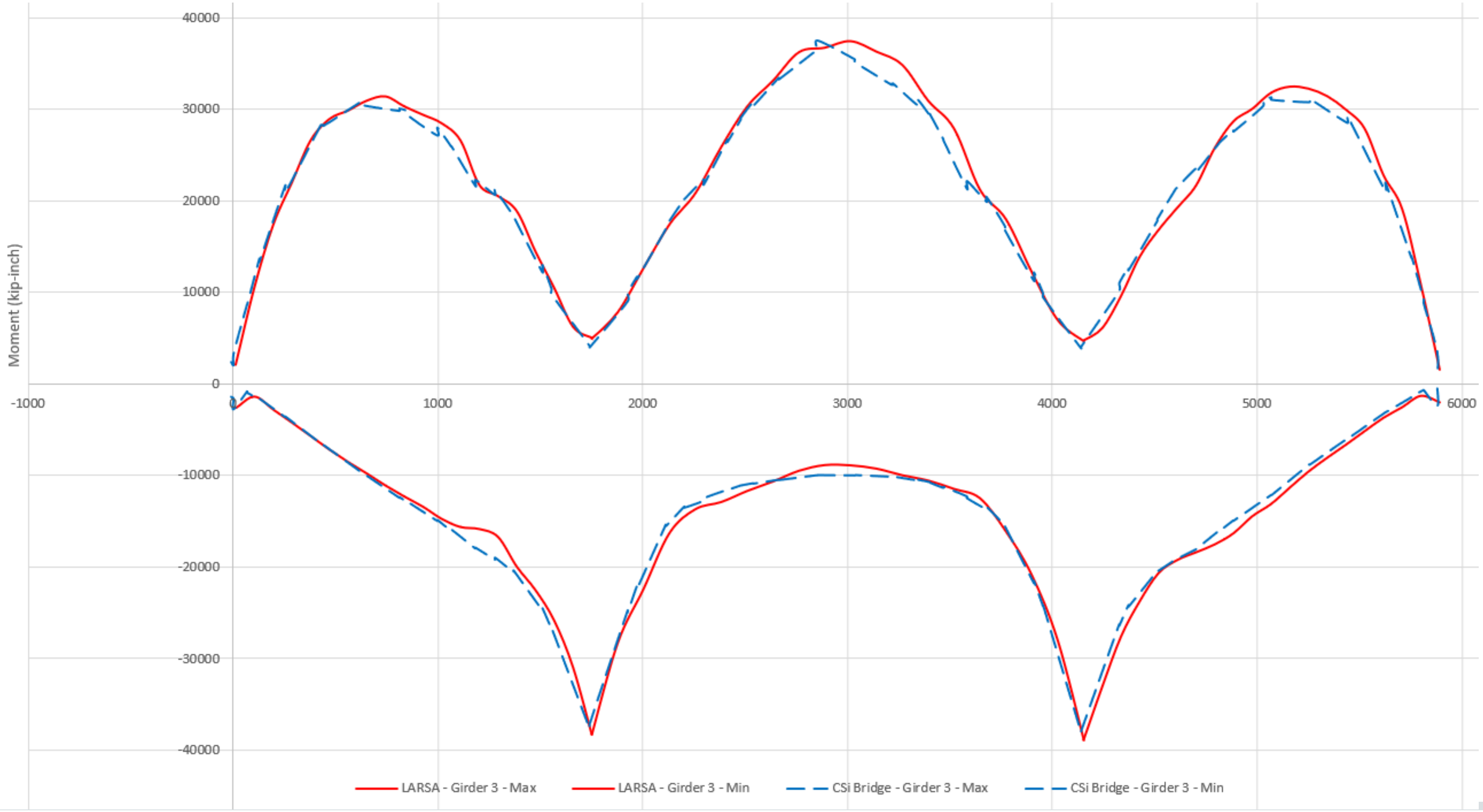


Checker Model:



Superstructure Analysis

- Live Load Moment Comparison (Typical Interior Girder)



Originator Model

Check Model

Drilled shaft design and construction

- Challenges:
  - Artesian conditions required keeping positive head control during construction
  - Rock that acted as poorly cemented sand
  - Gas monitoring (methane/H2S)
  - Potentially contaminated soils
  - Cobbles and boulders
- Design
  - Shafts designed for side-friction resistance
  - Weak rock treated as dense granular material
- Construction
  - Close supervision by MDOT staff
  - CSL testing
  - Somat validated installed lengths

Maintenance of Traffic: Haul Road

- MOT scheme provided full detour of one bound and limited traffic in other bound.
- This provided room for a contractor access path on the other bound.

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Thank You

ANY QUESTIONS?

Juan Alcantar
alcantarj1@michigan.gov

Eric Stone
estone@hntb.com

Tony Shkurti
TShkurti@HNTB.com