UHPC Alternative for the West Wilson Bridge

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2022 ACI Concrete Convention

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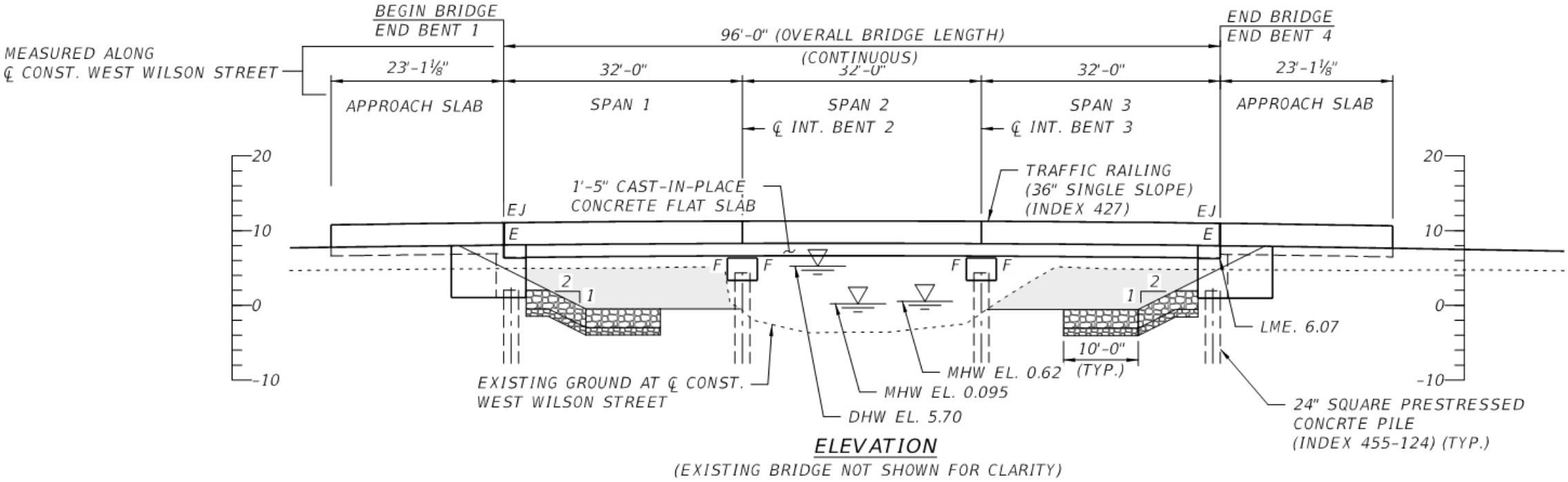
Original Cast-in-Place Slab Bridge

- 2% superelevation; 30° skew



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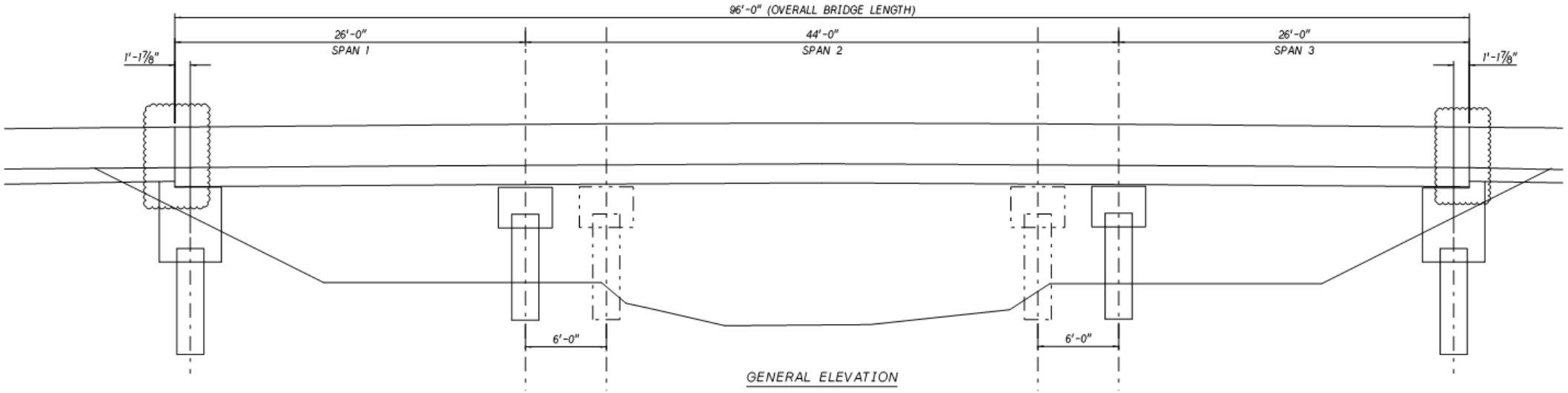
Proposed UHPC Bridge Elevation

- The piers are moved 6 ft away from the center.
- The box beam length covers the entire bridge length of 96 ft.
- Three spans: 26-44-26 ft



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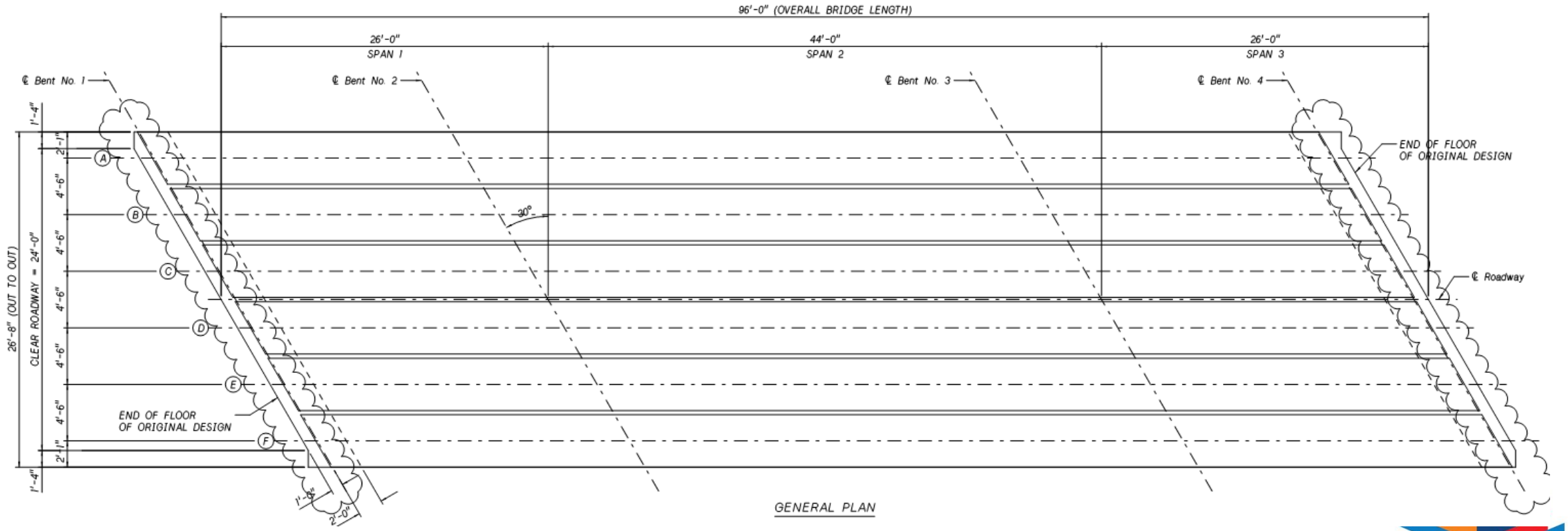
Proposed UHPC Bridge Plan



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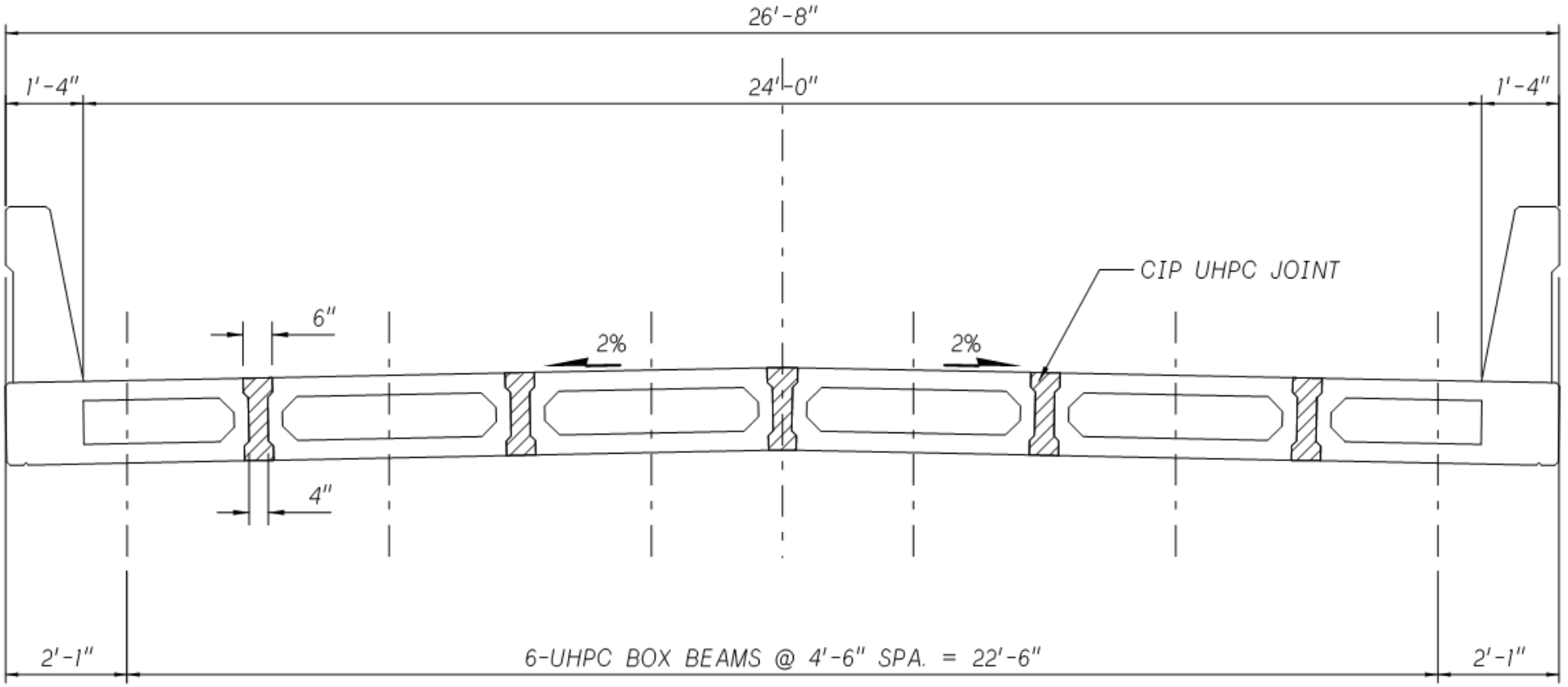
UHPC Bridge Cross Section



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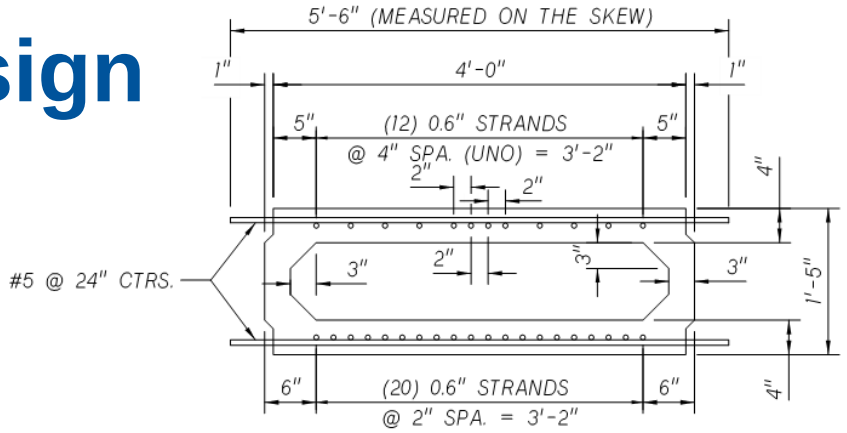
UHPC Box Beam Design

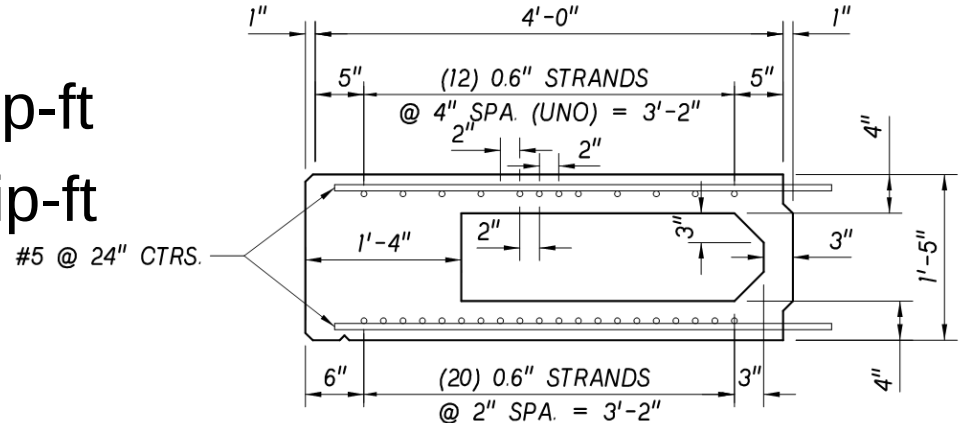
- 20-0.6” bottom strands
- 12-0.6” top strands
- No shear reinforcement!



Interior Typical Section

Design

- Positive moment : φM_n = 1,369 kip-ft > M_u = 304 p-ft
- Negative moment: φM_n = 877 kip-ft > M_u = 629 kip-ft
- Shear: φV_n = 179 kip-ft > V_u = 138 kip-ft (at pier)



Exterior Typical Section

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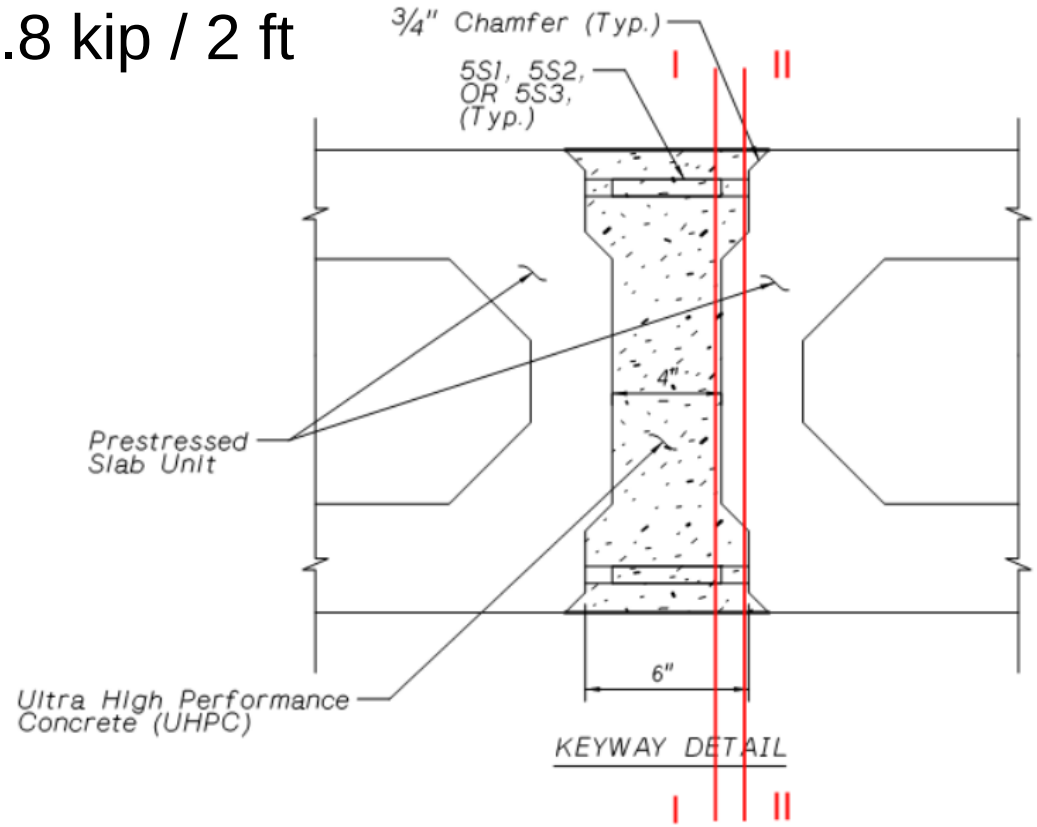
Longitudinal Joint, Moments

- Finite element modeling was completed to determine ultimate tension forces between adjacent boxes
- Ultimate tension force, T_u = 8.84 kip/ft
- A_s required $T_u/0.9/f_y$ = 0.16 in.^{2}/ft
- Provided #5 @ 2 ft = 0.31/2 = 0.16 in.^{2}/ft OK

Longitudinal Joint, Vertical Shear

- Ultimate interface shear = 22.8 kip / 2 ft
- At Section I-I:
  - V_{ni} = 364 kip / 2 ft (controls)
- At Section II-II:
  - V_{ni} = 423 kip / 2 ft

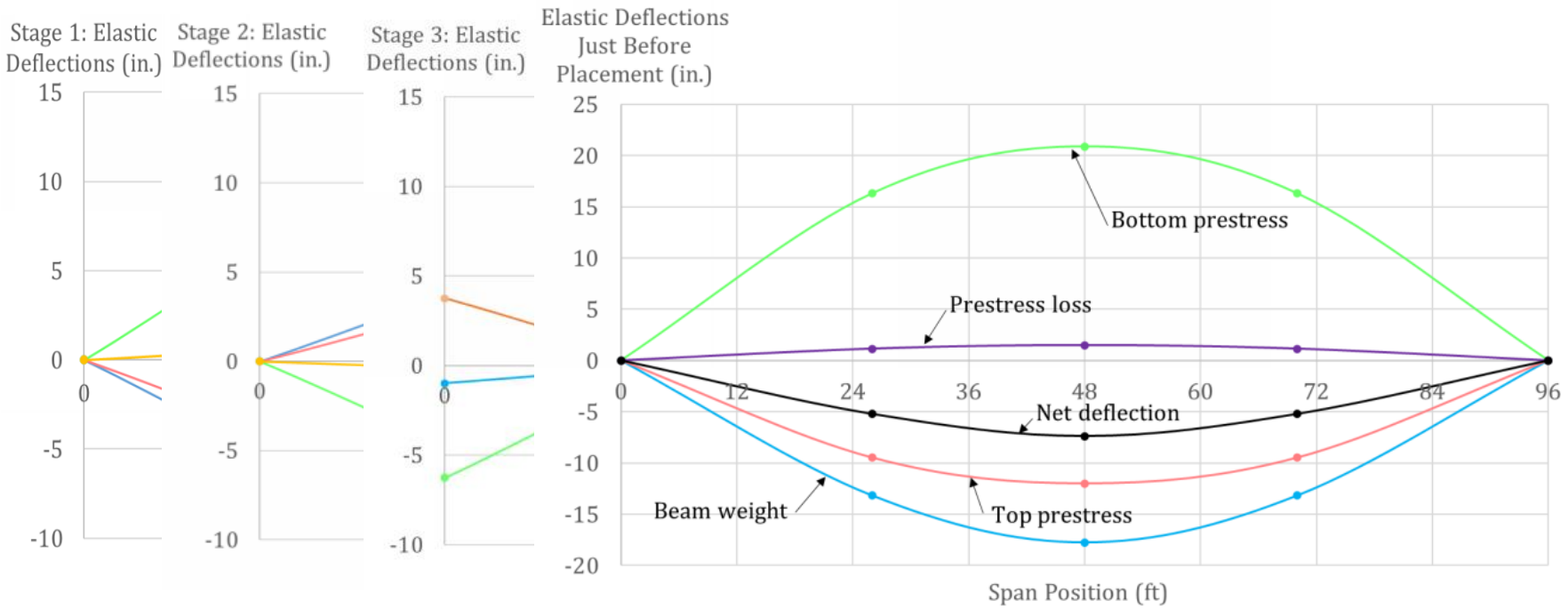


Assumed Construction Schedule

- Establishing the construction sequence was important to determine deflection and camber at each stage
- Targeted camber = 4 in.

Step	Concrete Age (days)	Location	Support conditions	Event
1	1	Yard	2, 91.94 ft	Right after release, set in the yard on dunnage
2	120	Shipping	2, 91.94 ft	Ship to bridge site
4	120	Jobsite	24.49, 68.49 ft	The beam is set on the pier supports, and does not touch the end bent
5	141	Jobsite	0.48, 24.49, 68.49, 93.46 ft	Cast end bent
6	148	Jobsite	0.48, 24.49, 68.49, 93.46 ft	Joint and barrier concrete are poured/attached
7	20,000	Service	0.48, 24.49, 68.49, 93.46 ft	Final condition

Camber and Deflection Analysis



- At final time, net midspan camber = 5.4 in.
- To bring this down to 4 in., an upward load can be applied near the ends of the beams

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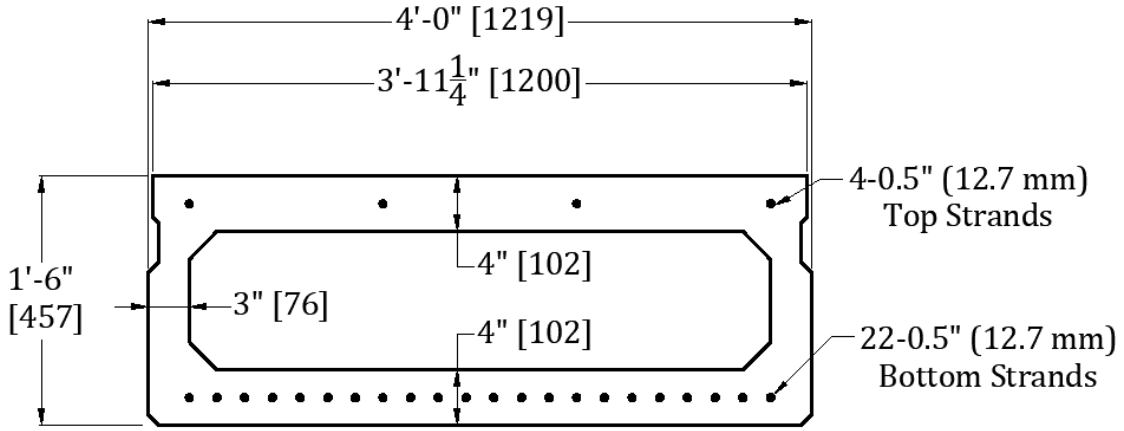
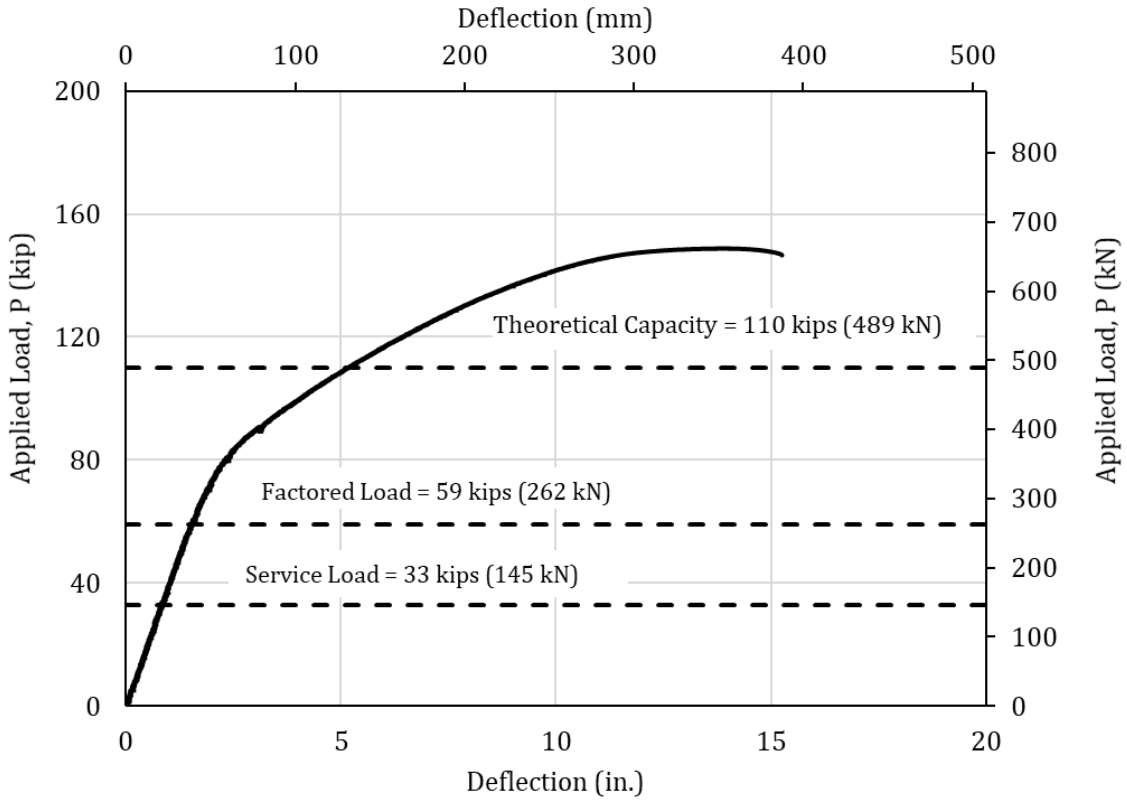
Experimental Verification - Flexure





- Experimental/Theoretical = 1.35
- Experimental/Demand = 2.52
- Experimental/Service Load = 4.51

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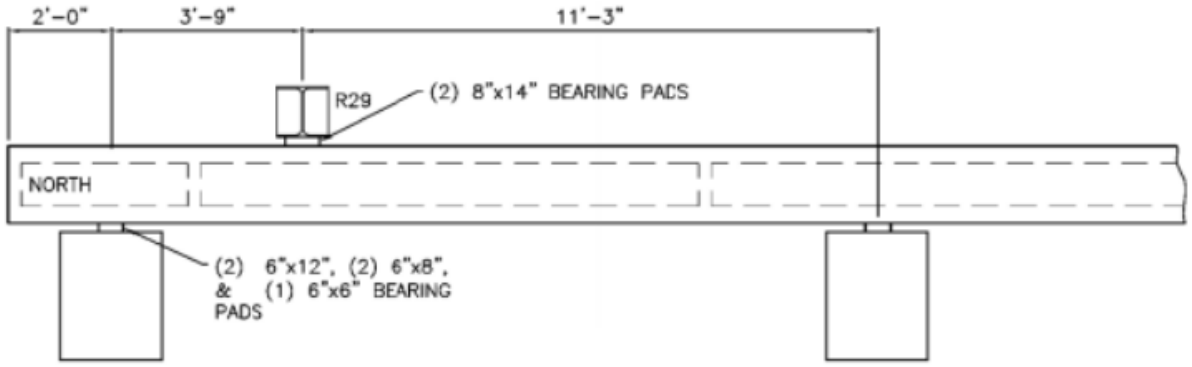
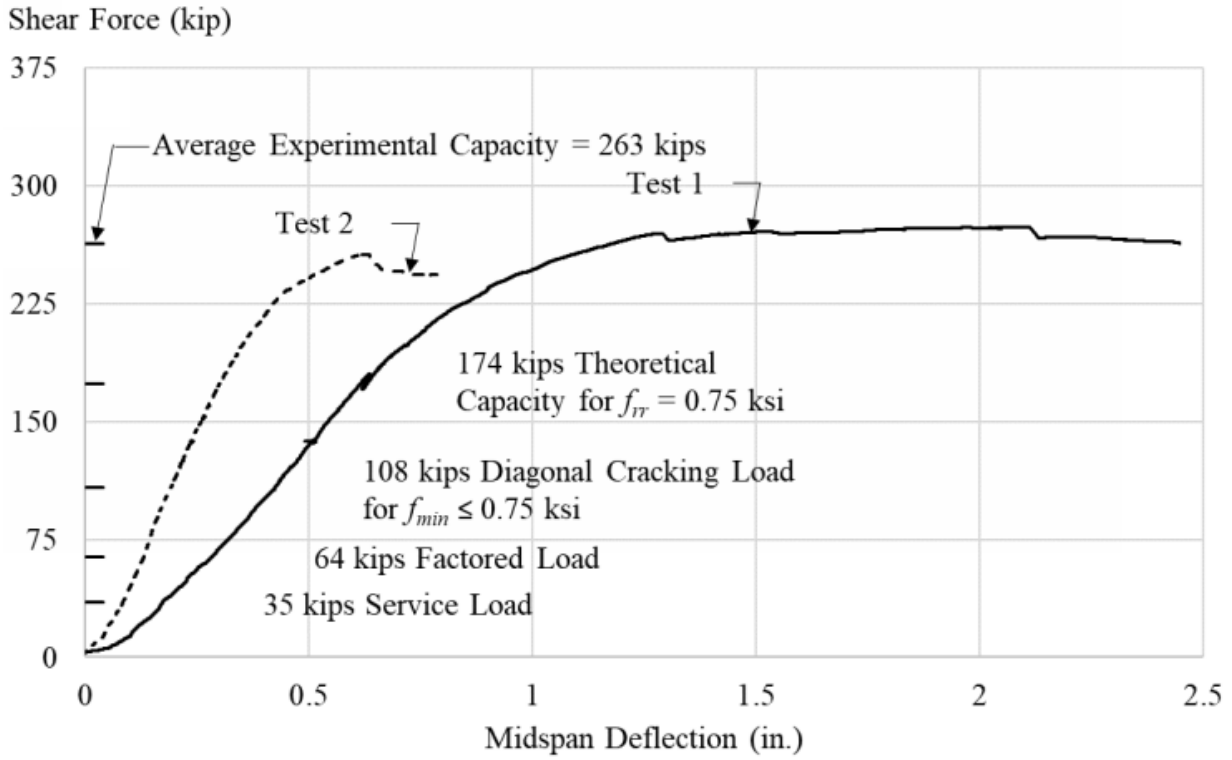
Experimental Verification - Shear





- Experimental/Theoretical = 1.51
- Experimental/Demand = 4.11
- Experimental/Service Load = 7.51

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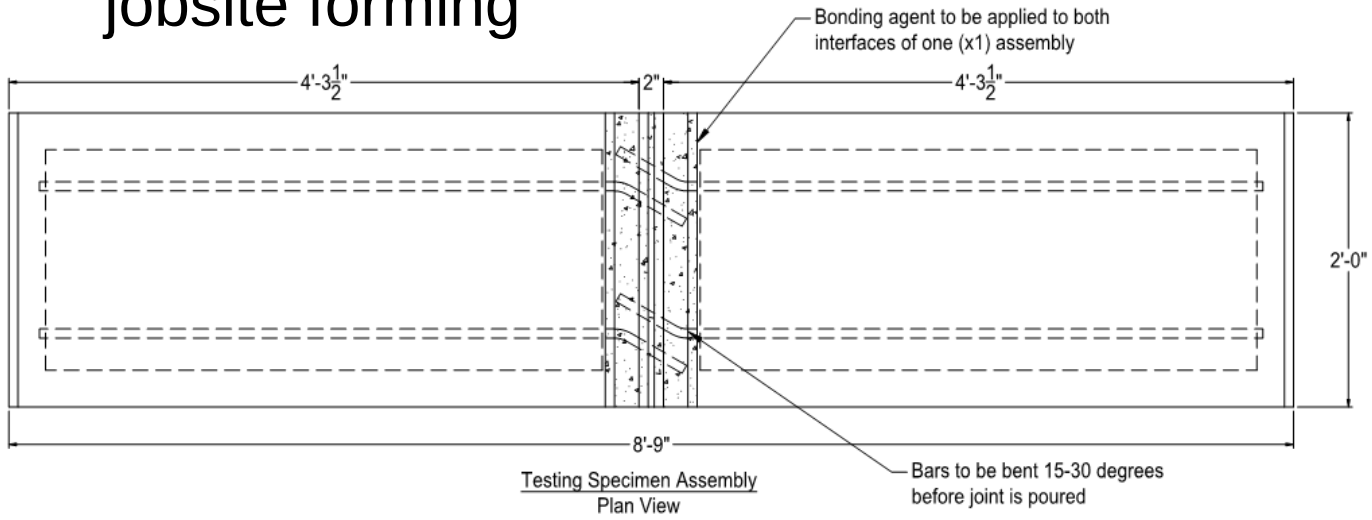
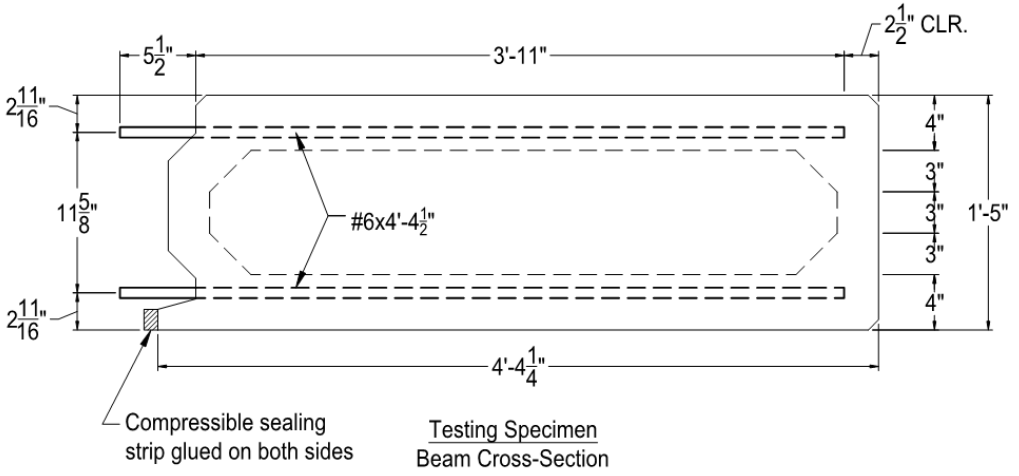
Experimental Verification – Longitudinal Joint

- Tests were conducted to assess the joint
  - One specimen had a smooth interface, one had a roughened interface
- Note the modified bottom flange, which decreases the amount of required jobsite forming



Testing Specimen Assembly
Plan View



Testing Specimen
Beam Cross-Section

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Joint Test Results

- Specimen failed at the joint
- Bars pulled out, indicating lack of development
- Assumed to be due to both the bending and the lack of clear space around the bars

- Demand = 14.8 kip
- Smooth face capacity = 13.7 kip
- Rough face capacity = 18.4 kip

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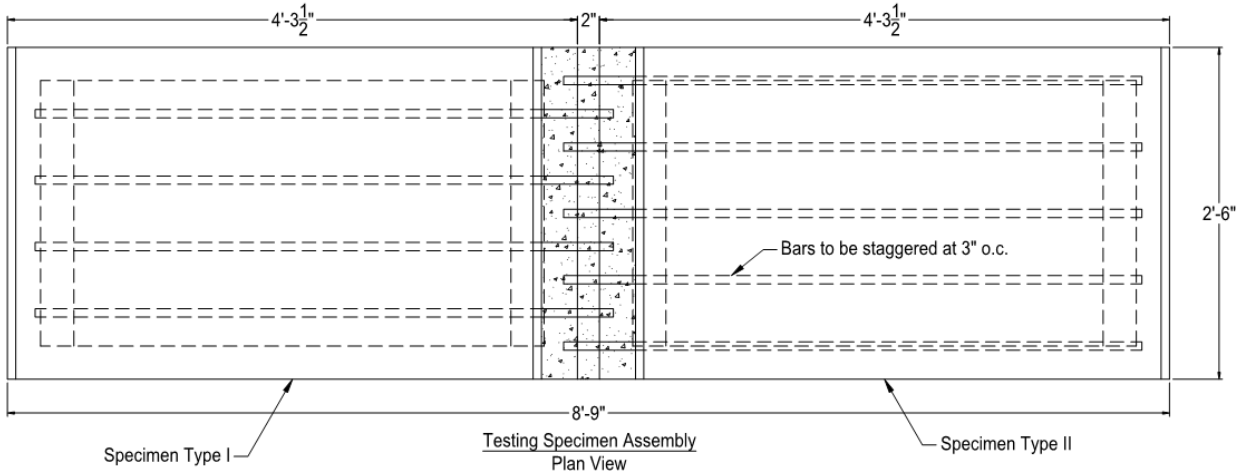
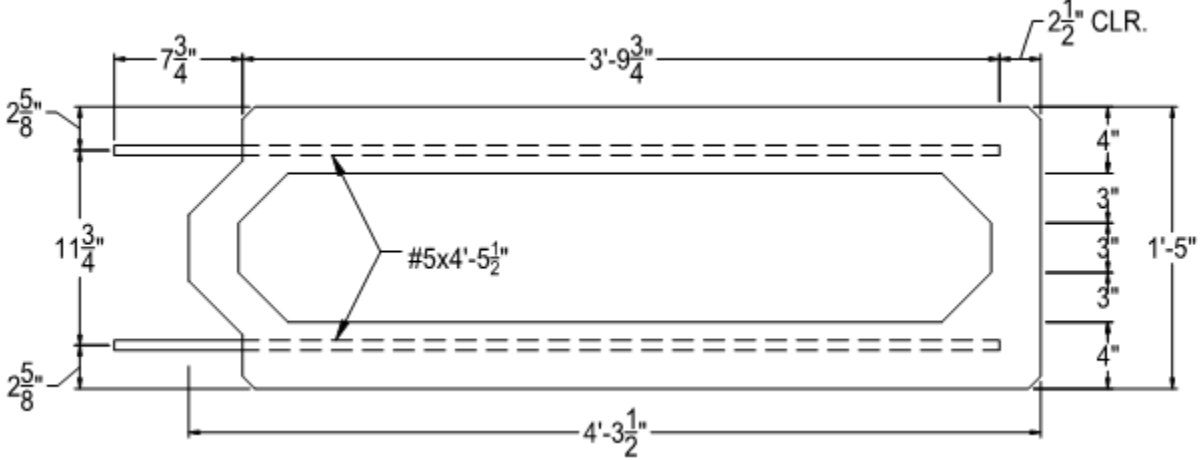
Future Testing

- Two more sets of specimens have been produced and await testing
  - Straight bars instead of bent
  - Longer embedment length
  - Larger clear space around the reinforcement





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Thank you!

Questions?

Feel free to email questions at:
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