Design of the IL 127 Kaskaskia River Bridge

Illinois Transportation and Highway Engineering Conference

February 24, 2015 | *University of Illinois at Urbana-Champaign*

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Project Overview

- PTB 155, Item 58
- Phase II Engineering Services
- IDOT District 8
- Modjeski and Masters, Inc. (MM)
- Lin Engineering, LTD. (Lin)
- Contract No. 76479
- Letting – April 2013

▲ **EXISTING** | Looking north along existing structure

▲ **EXISTING** | Looking north across Kaskaskia River

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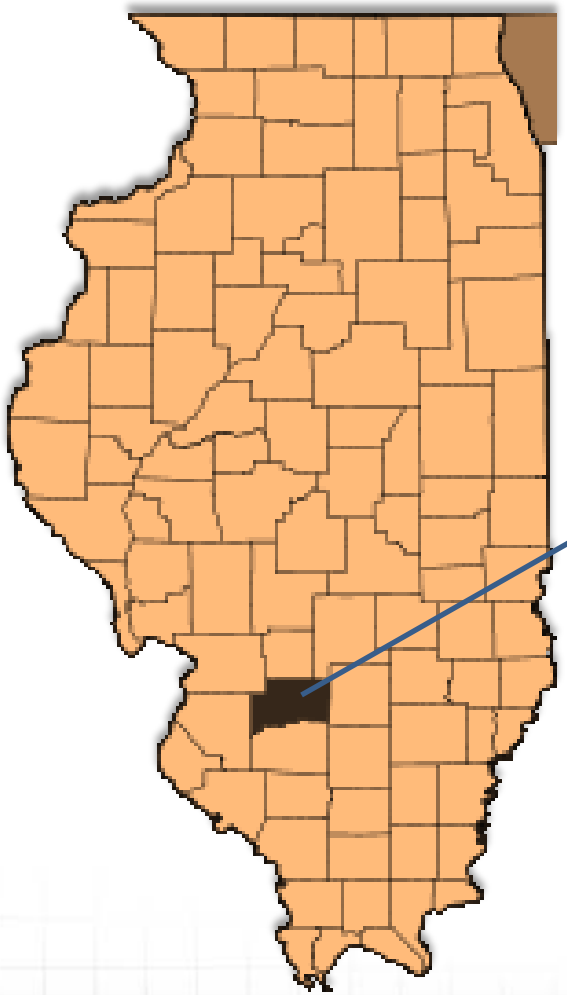
Project Location



Clinton County

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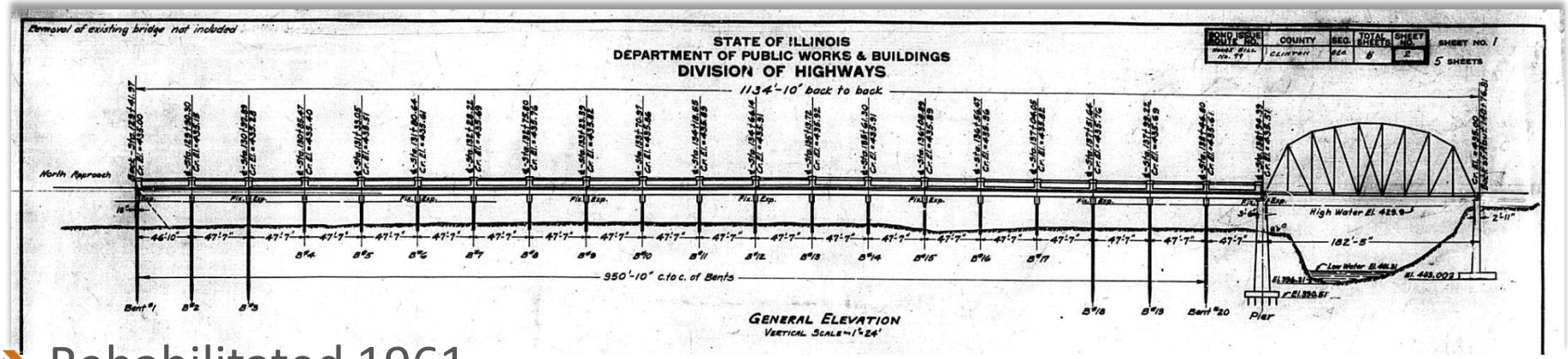
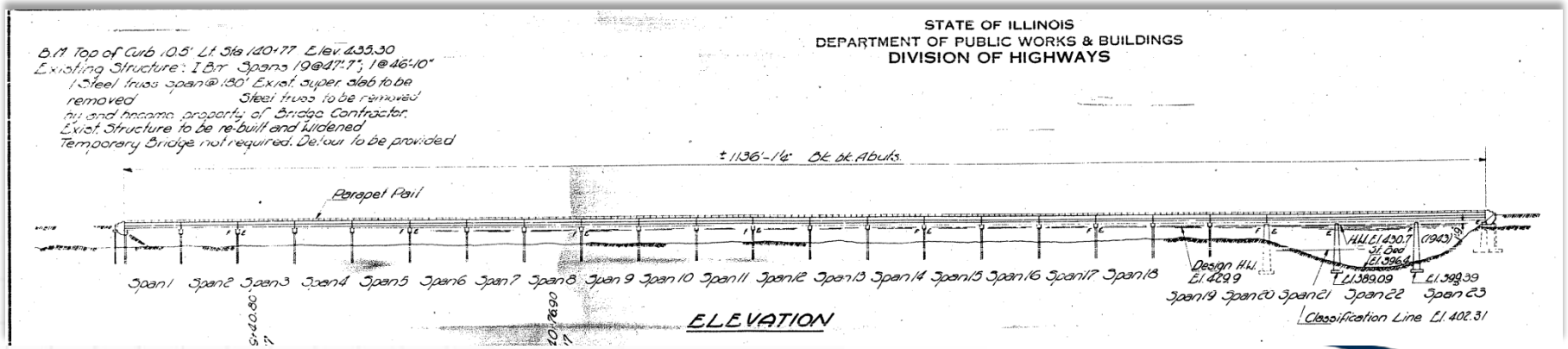
Structure History

- Built 1929



- Rehabilitated 1961



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Project Scope

- Final Scope of Services
  - Superstructure Type Study
    - WF Steel Beams
    - Steel Plate Girders
    - PPC Bulb T-Beams
  - TS&L (Steel Plate Girders)
  - Final Plans, Specifications and Estimates
- Design Considerations
  - Existing Structure Condition
  - Hydraulic Concerns
  - Spanning the Kaskaskia River

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Existing Structure Condition

- Stage Construction vs. Detour
- Length of Construction
- Accelerated Construction
  - Precast Deck Panels
  - Construct new piers under the existing structure

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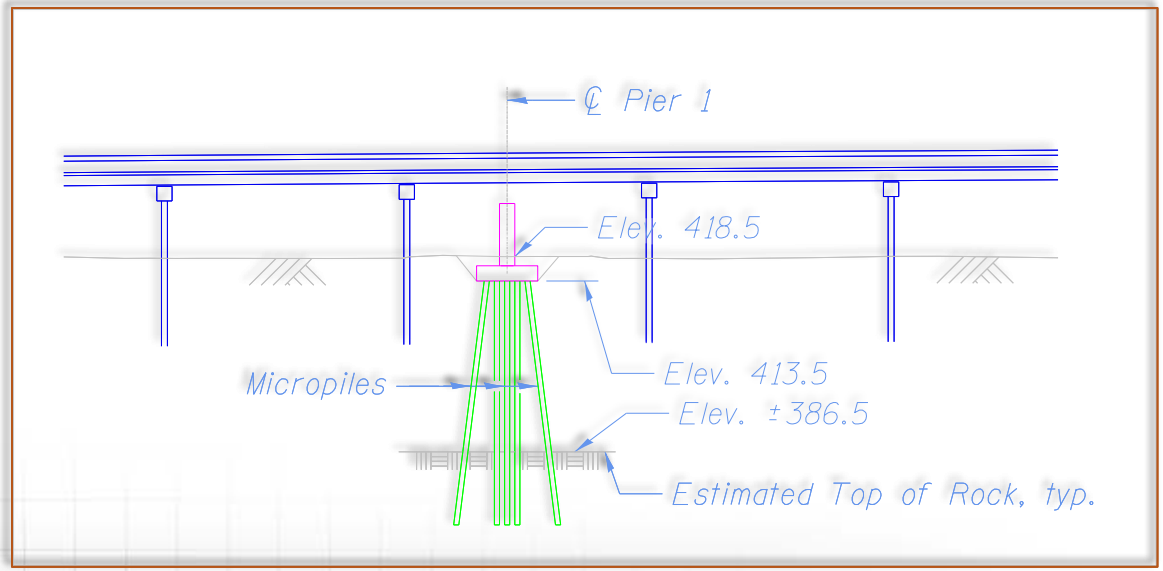
Accelerated Substructure Construction

- Construct New Piers Beneath Existing Structure
  - Proposed girders = estimated 70” web depth
  - Existing beams = 24”
  - Account for profile grade adjustments
- Micropile Foundations



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Hydraulic Concerns

DESIGN SCOUR ELEVATION TABLE

FREQ. YR.	DESIGN SCOUR ELEVATION (ft.)						
	N. Abut.	Pier 1	Pier 2	Pier 3	Pier 4	Pier 5	S. Abut.
100	423.40	408.50	409.10	411.80	409.20	388.90	423.98
500	423.40	406.50	407.10	409.80	408.20	388.70	423.98

- Oxbow
  - Theory of Stream Meandering
- Scour
  - Design for scour depths
  - Pier 5 scour to rock

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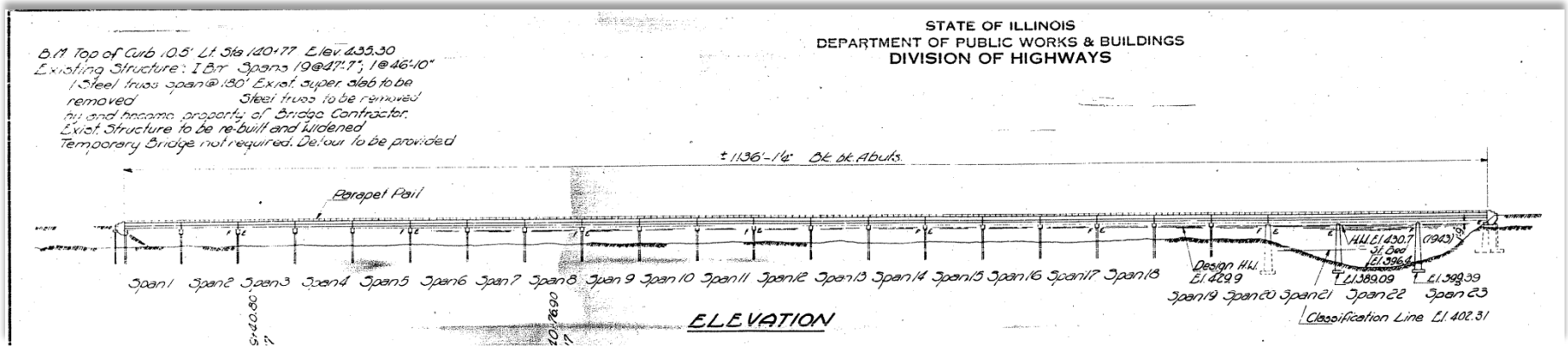
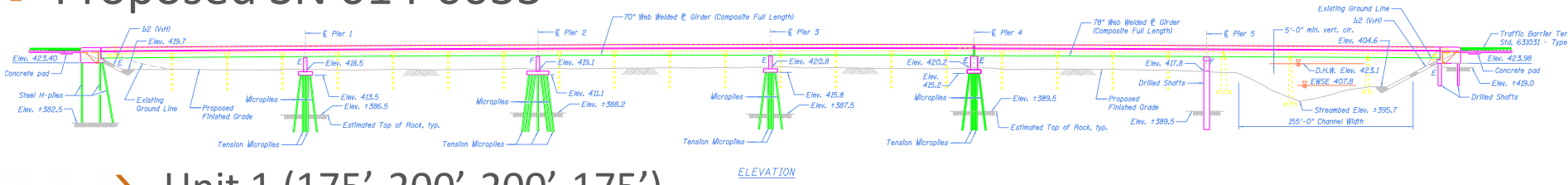
Spanning the Kaskaskia River

- Existing SN 014-0014



- Proposed SN 014-0033



  - Unit 1 (175’-200’-200’-175’)
  - Unit 2 (200’-200’)

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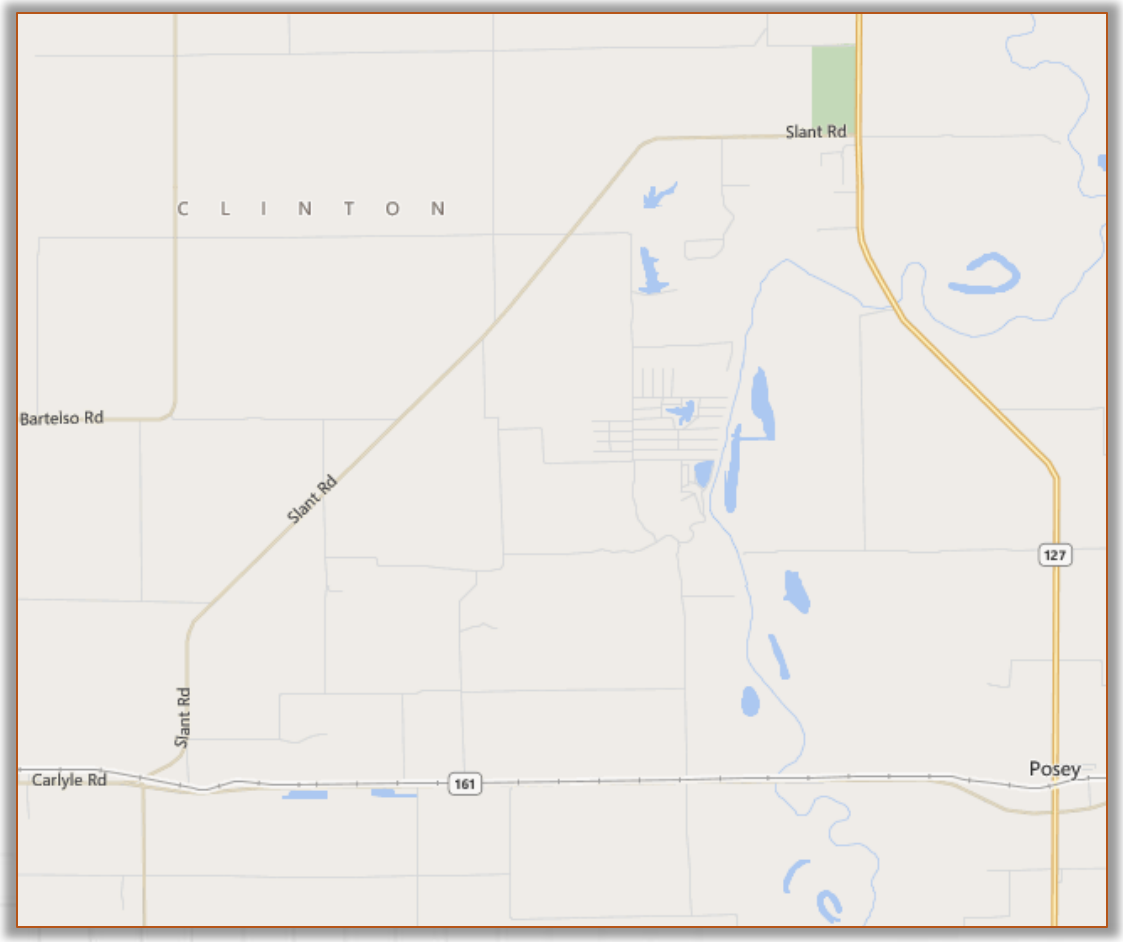
Sequence of Construction – Pre-Bridge Construction Phase



- Construct Piers 1 - 4
- Prepare Detour Route
  - Slant Road Improvements
  - Intersection of Slant Road and IL 161
  - Park and Ride Lot

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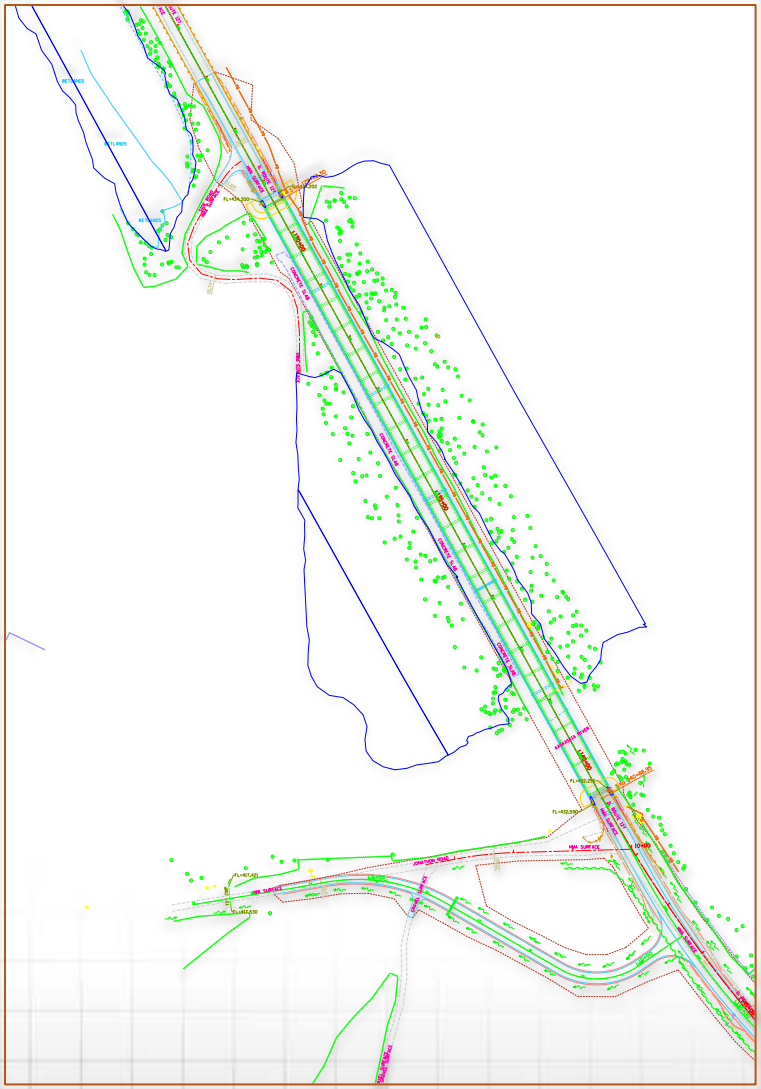
Sequence of Construction – Bridge Construction Phase



- Detour Traffic
- Replace Bridge
  - Remove Existing Structure
  - Construct Remaining Substructure Units
    - North Abutment
    - Pier 5
    - South Abutment
  - Construct Superstructure
- Jonathan Road Reconstruction

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Structure Design

- Seismic Design Criteria
  - Seismic Performance Zone (SPZ) = 2
  - Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.262g
  - Design Spectral Acceleration at 0.2 sec (S_{DS}) = 0.608 g
  - Soil Site Class = D
- Multi-modal Seismic Analysis
  - Per IDOT BM – Multi-unit bridges are considered irregular by the Department and require multi-modal analysis in Zone 2.
  - Analysis
    - LUSAS
    - FB Multi-Pier
    - GROUP and L-Pile

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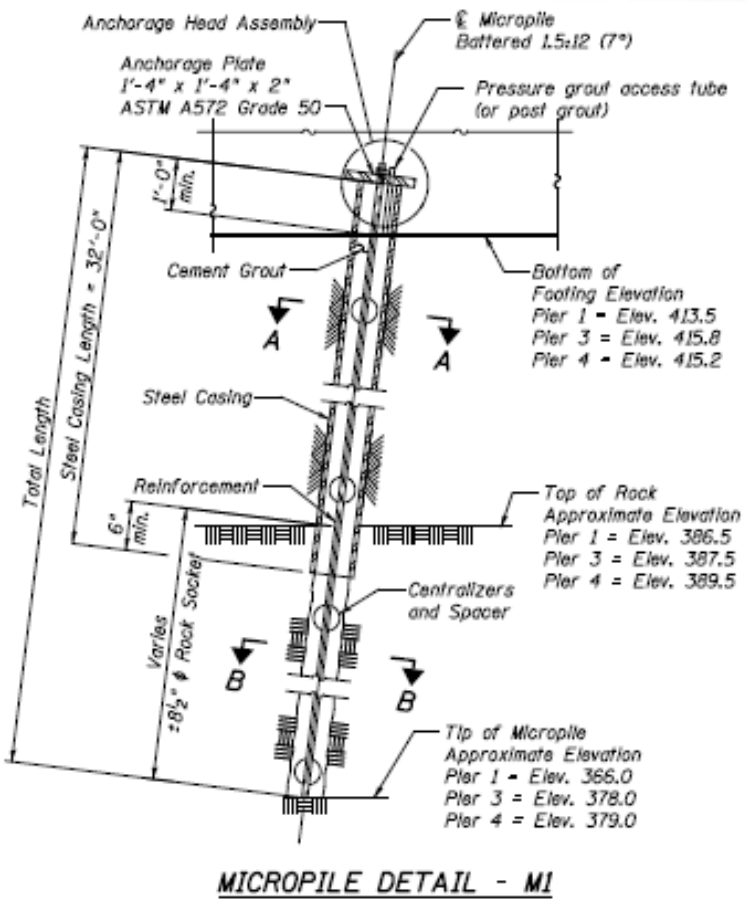
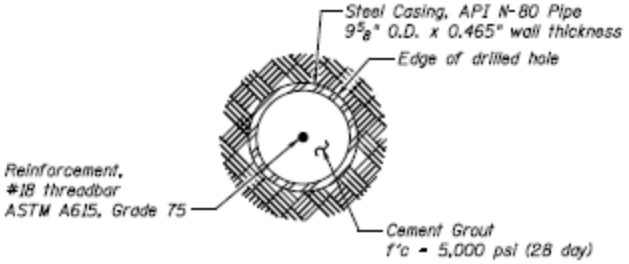
Micropile Design

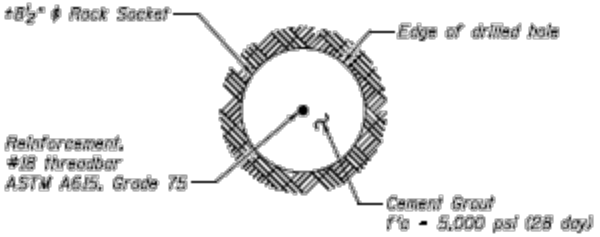
- Micropile
  - Provide compressive and tensile resistance



MICROPILE DETAIL - M1



SECTION A-A



SECTION B-B

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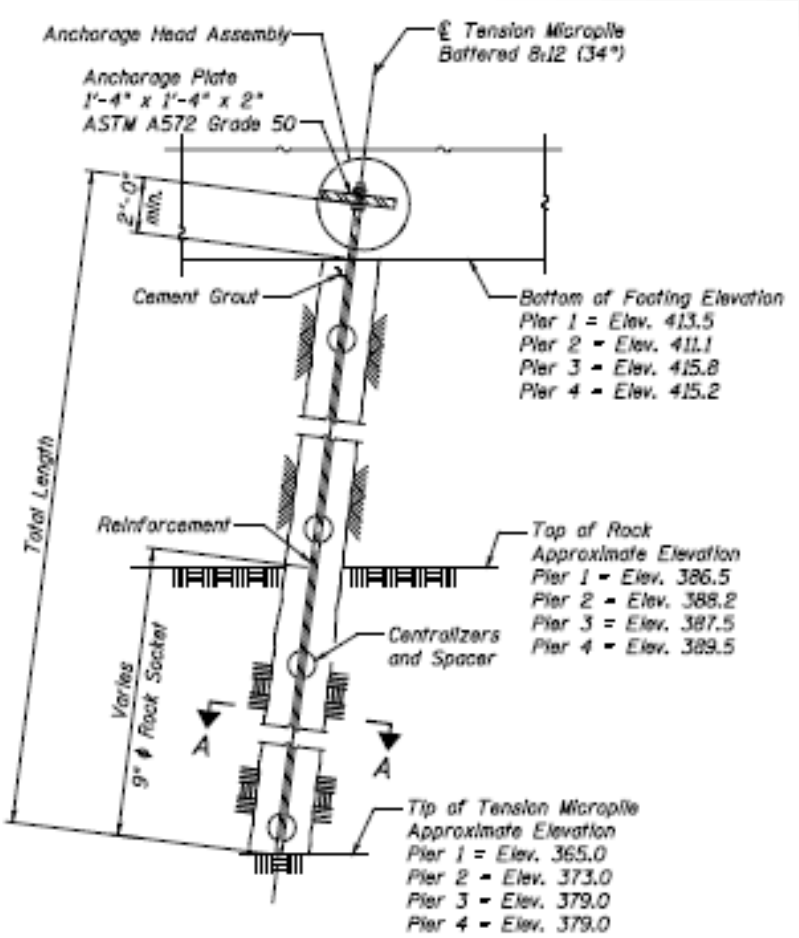
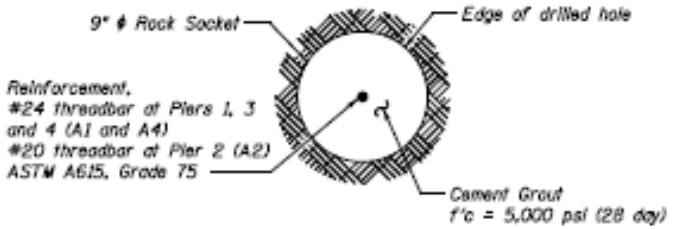
Micropile Design

- Tension Micropile
  - Provide tensile resistance



TENSION MICROPILE DETAIL - A1, A2 AND A4



SECTION A-A

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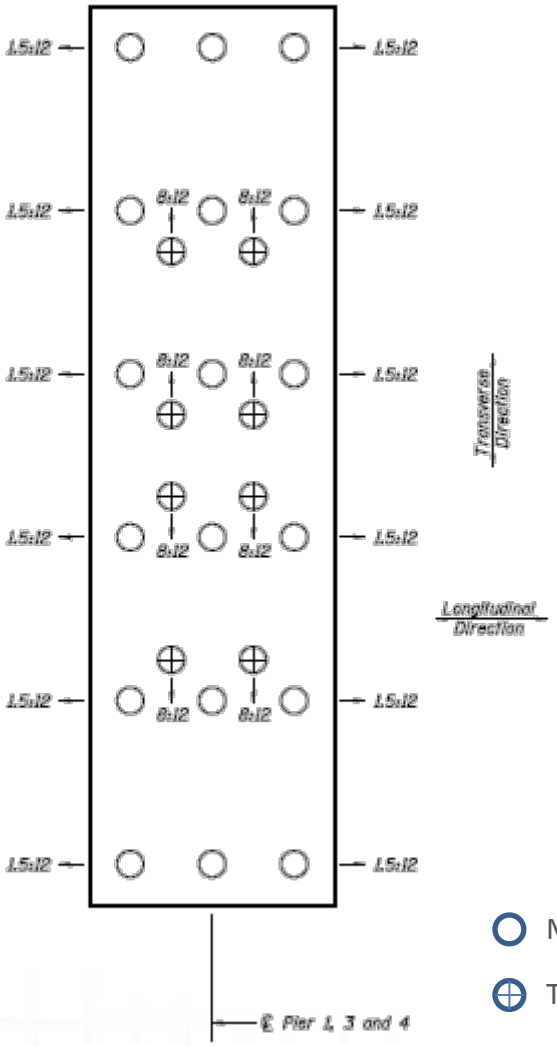
Micropile Design



- Piers 1, 3 and 4 – Expansion Piers
  - Extreme Event Load Case Controls
  - Micropile
    - Straight and battered longitudinally
    - Provide compressive and tensile resistance
  - Tension Micropile
    - Provide transverse tensile resistance
  - Max Design Loads
    - 371k (compression)
    - 508k (tension)

○ Micropile Straight and Battered at 1.5:12 Longitudinally

⊕ Tension Micropile Battered at 8:12 Transversely

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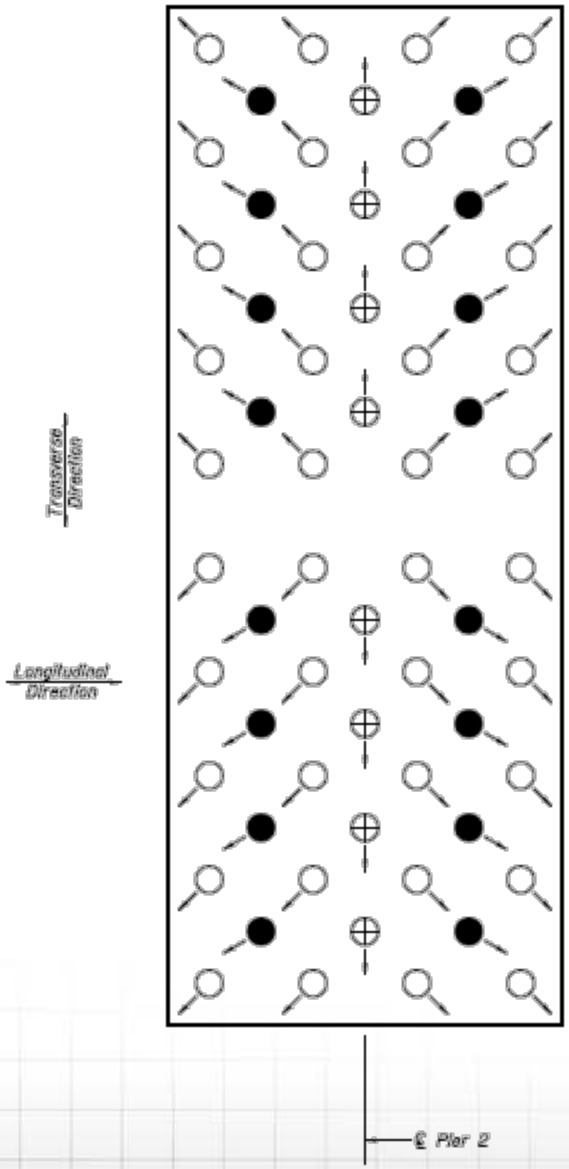

Micropile Design

- Pier 2 – Fixed Pier
  - Majority of longitudinal force carried by Pier 2
  - Extreme Event Load Case Controls
  - Micropile
    - Battered longitudinally and transversely
    - Provide compressive and tensile resistance
  - Tension Micropile
    - Provide transverse tensile resistance
    - Provide transverse and longitudinal tensile resistance
  - Max Design Loads
    - 555k (compression) / 315k (tension)

○ Micropile Battered at 2:12 Transversely and 2:12 Longitudinally

⊕ Tension Micropile Battered at 8:12 Transversely

● Tension Micropile Battered at 2:12 Transversely and 5.5:12 Longitudinally

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Micropile Design

- Micropile Summary
  - 94 required
    - Pier 1 – 18
    - Pier 2 – 40
    - Pier 3 – 18
    - Pier 4 – 18
  - 4 Proof Load Tests
  - Cost
    - $8,600 per production pile
    - $40,700 per proof load test

- Tension Micropile Summary
  - 48 required
    - Pier 1 – 8
    - Pier 2 – 24
    - Pier 3 – 8
    - Pier 4 – 8
  - 4 Proof Load Tests
  - Cost
    - $6,400 per production pile
    - $5,800 per proof load test

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Micropile Construction

- Micropile Layout
  - Pier 2 shown
  - Contractor installed seal coat
    - Beneath bottom of footing
    - 12” – 18” thick
    - Work Platform
    - Pile Layout

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Micropile Construction

- Micropile Layout
  - Piers 1, 3, and 4
  - Contractor cored holes in seal coat
    - Cored holes at correct batter
    - Easy set-up for drill alignment

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Micropile Construction

- Micropile Load Test

Micropile Construction

- Micropile Drill Rig
  - Low Headroom
  - Set-up over cored hole in seal coat

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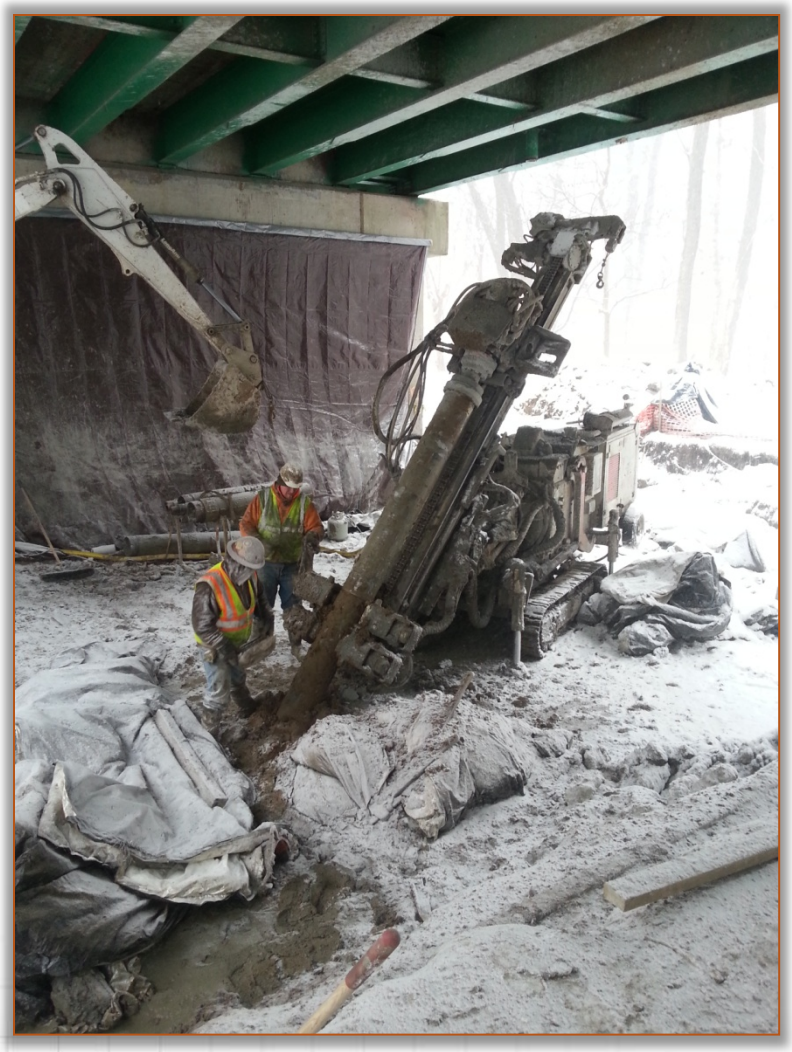
Micropile Construction



- Micropile Drill Rig
  - Low Headroom
  - Drilling tension micropile

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Micropile Construction

- Pier 2
  - Micropile
  - Tension Micropile

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Micropile Construction

- Piers 1, 3 and 4
  - Micropile
  - Tension Micropile

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Pier Construction

- Pier Reinforcement

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Pier Construction

- Pier Formwork

Structure Demolition

- Deck Removal

Structure Demolition

- Superstructure Demolition

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Structure Demolition

- Superstructure Demolition

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Bridge Construction Phase

- North Abutment Construction

Bridge Construction Phase

- Steel Plate Girders

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Bridge Construction Phase

- Steel Plate Girders

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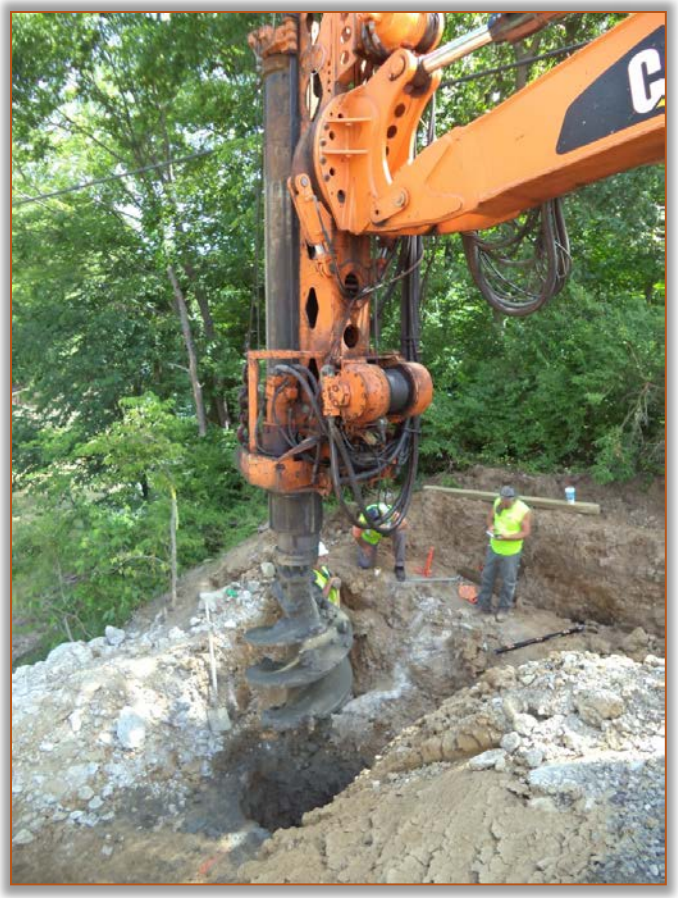
Bridge Construction Phase



Bridge Construction Phase

- Pier 5 Construction

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Bridge Construction Phase

- Pier 5 and South Abutment
  - Removal of existing river piers

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Bridge Construction Phase

Metallizing

- All beams, bearings and other structural steel within 5 ft (measured along the beam) of either side of deck joints shall be metallized in the shop and field painted with the top coats specified for the remainder of the structural steel. See Special Provision for Metallizing Structural Steel.

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Bridge Construction Phase

- South Abutment Construction

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Bridge Construction Phase

- Deck Construction

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Bridge Construction Phase

▲ **PROPOSED** | New structure opened to traffic on January 21, 2015.

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Acknowledgements

- Illinois Department of Transportation
  - District 8
    - Tim Padgett – Project Engineer
    - Don Hayden – Project Manager
    - Larry Hilmes – Resident Engineer
  - Bureau of Bridges and Structures
    - Derek Verhulst – Planning
    - Dewey Coultas – Design
    - William Kramer and Brad Hessing – Foundations & Geotechnical Unit
- Lin Engineering, LTD.

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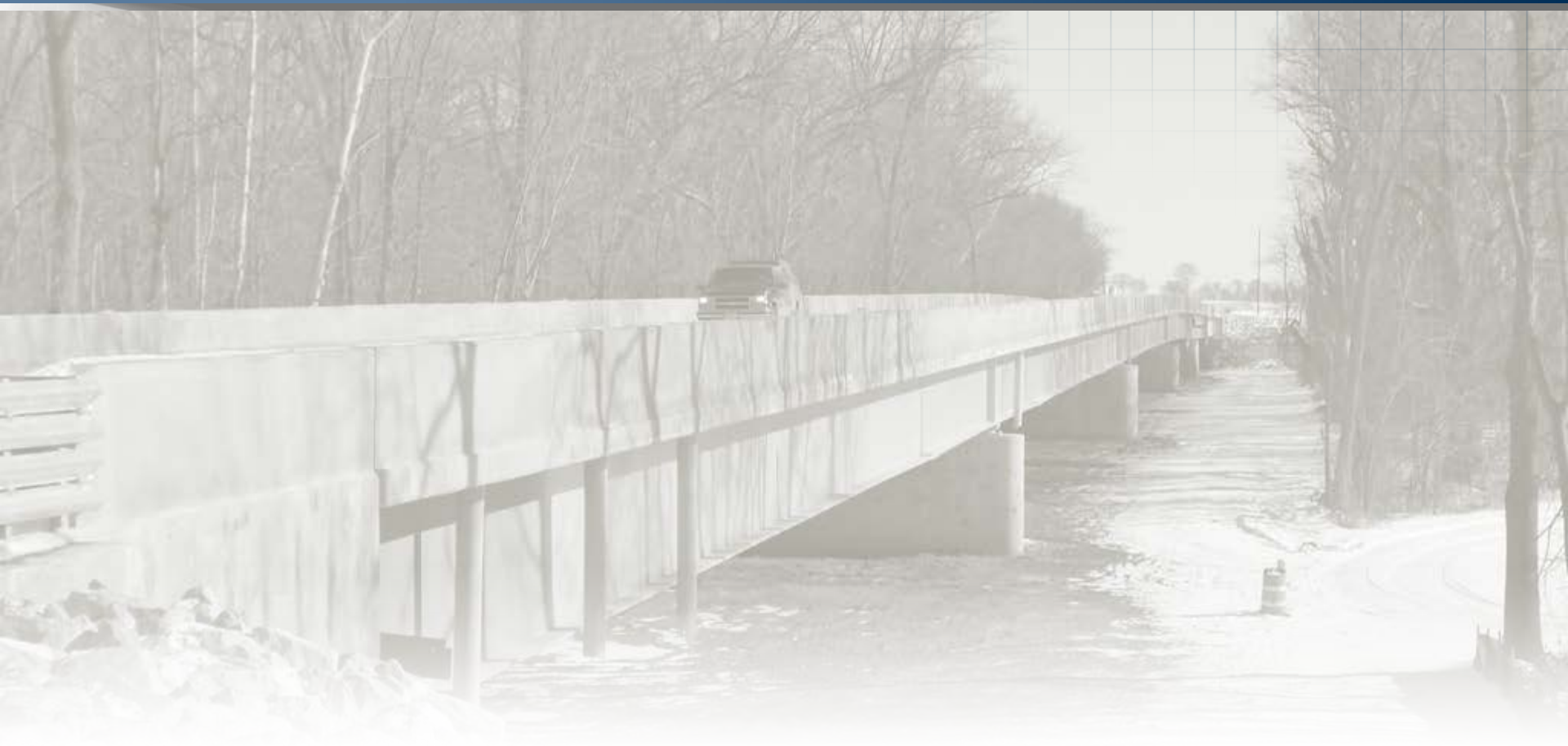

Thank You!

Questions?

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