Missouri DOT's 2018 Poplar Street Bridge Lateral Slide

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ACCELERATED BRIDGE CONSTRUCTION
UNIVERSITY TRANSPORTATION CENTER

Monthly Webinar
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Acknowledgements

- **Owners**: Missouri Department of Transportation (MoDOT) and Illinois Department of Transportation (IDOT)
- **Lead Contracting Agency**: Missouri Department of Transportation (MoDOT)
- **Engineer of Record** (Main Span): HDR Inc.
- **General Contractor**: KCI Construction
- **Slide Contractor**: Mammoet
- **Structural Steel Fabricator (Infill)**: DeLong's Inc.

Project Details

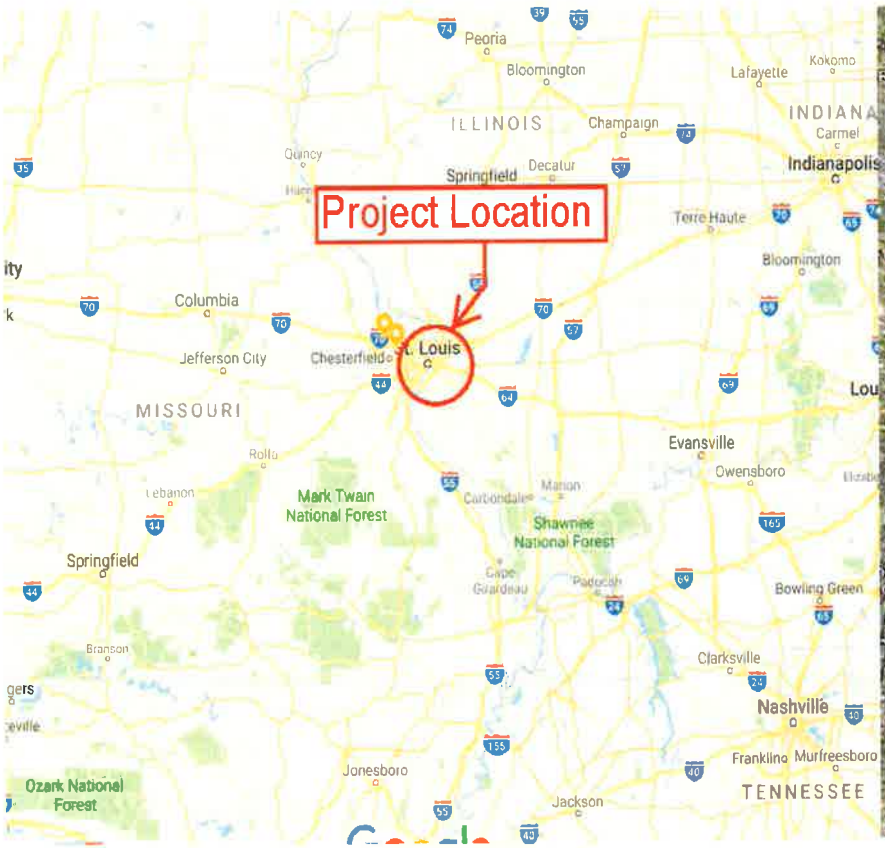
- Schedule: Bid: **October 2016**
  Slide: **Easter Weekend 2018**
  All Lanes Open to Traffic: **December 1, 2018**

- Costs: Total Award: **$54M**
  Widening River Bridge: **$28M**
  Bridge Slide Pay Item: **$3M**

Topics

- Bridge Overview
- Project Goals
- Construction

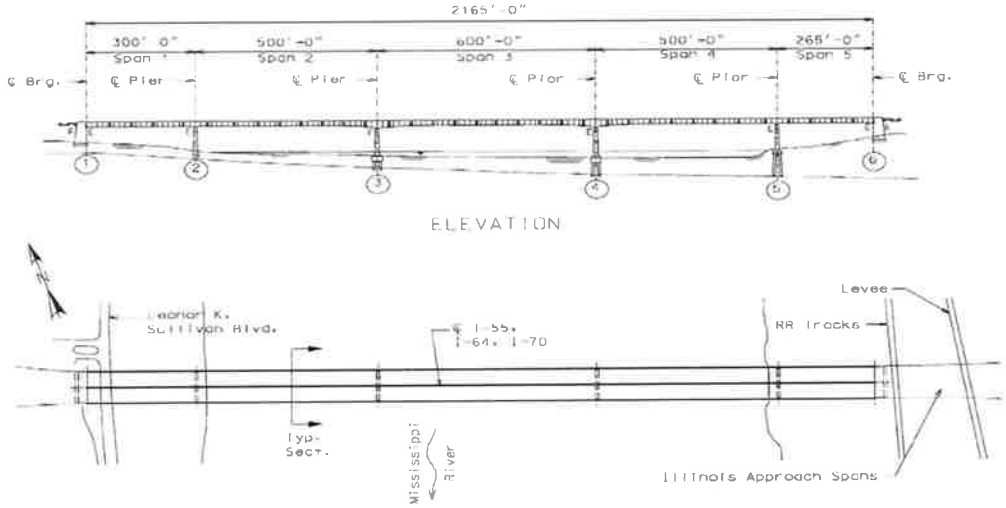
Bridge Overview



Bridge Overview

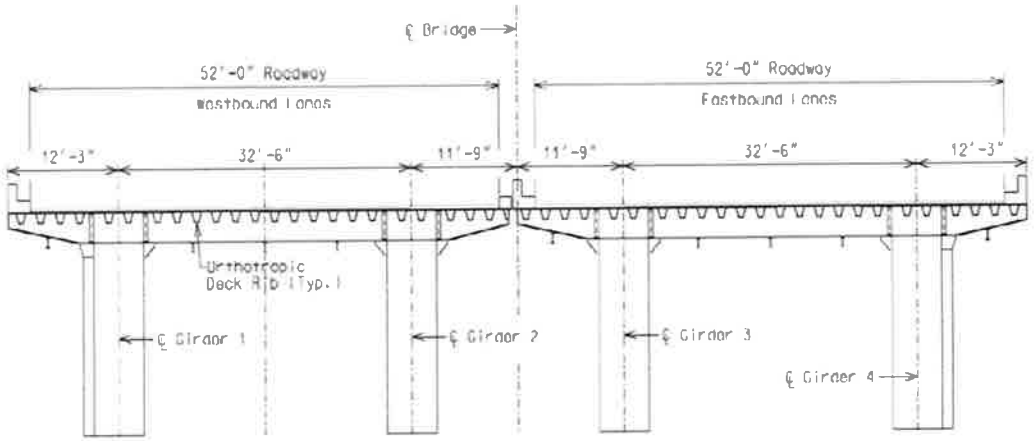
- Five Span Bridge (600' main channel span) carrying I-64, I-55 and I-70 over the Mississippi River – 1960's

- Variable Depth Steel Box Girders (25' max. depth at Piers 3&4) with Orthotropic Steel Deck



Bridge Overview

- Twin EB and WB Bridges; 2 girder system on each bridge
- Each bridge accommodates 4 lanes of traffic
- 104’ total roadway width; 113’ out-to-out



Project Goals

Relieve Congestion

Rehabilitation

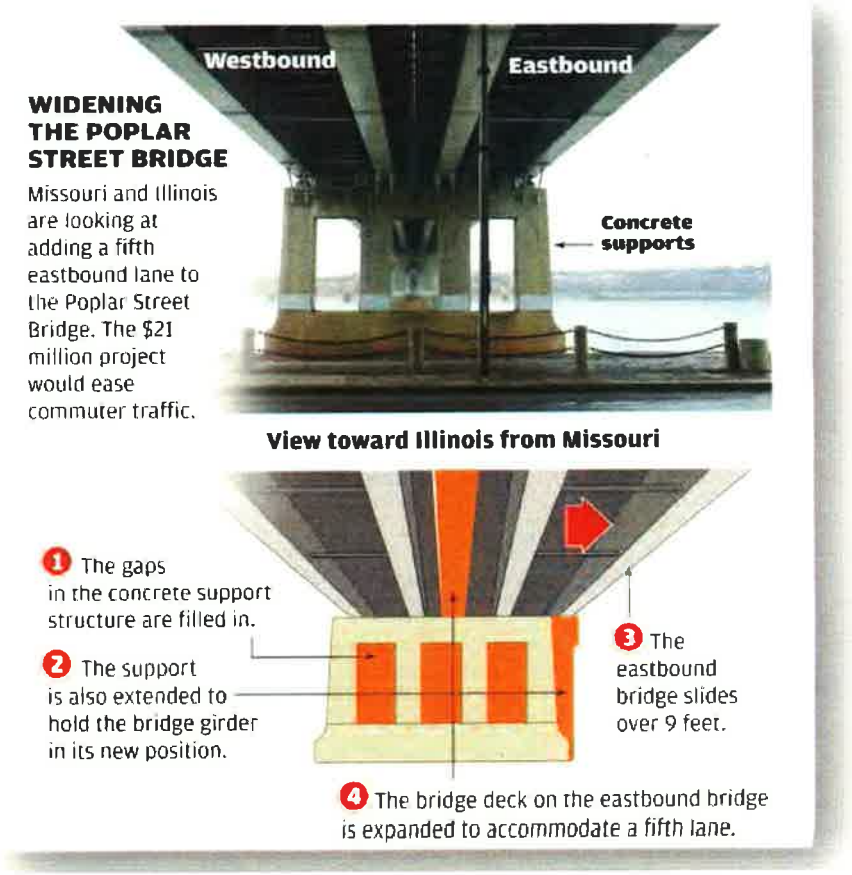
New Overlay

Relieve Congestion- Interchange Improvements

- Add 2nd Lane to NB to EB Ramp
- Remove SB to EB Ramp in coordination with new Stan Musial Bridge opening
- Improve WB to NB and WB to SB Ramp Geometrics
- Widen I-64 EB over River to 5 lanes, 3 thru lanes and 2 lanes from NB to EB Ramp

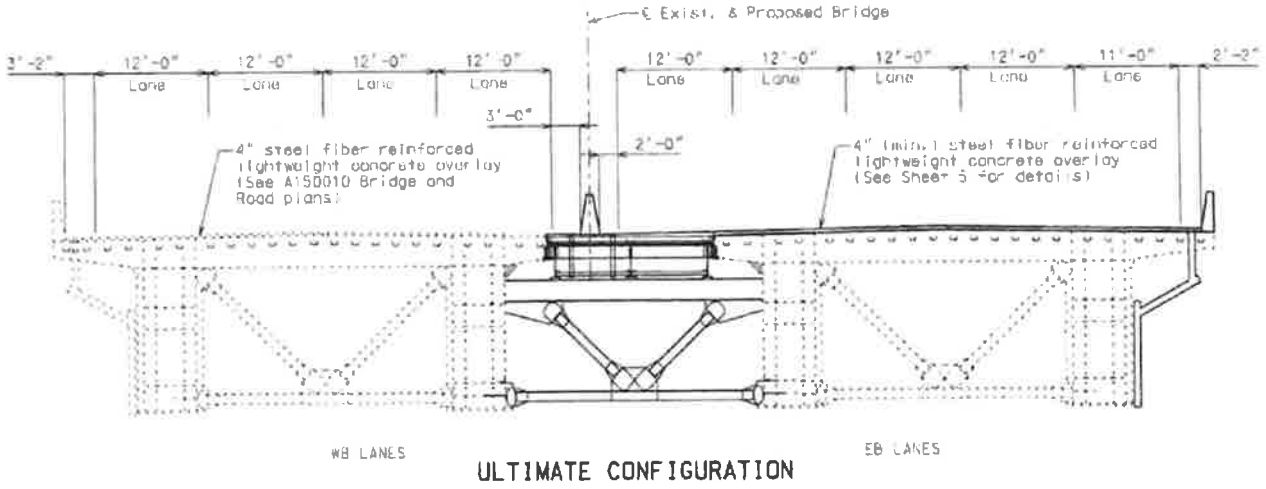
Relieve Congestion– Widen EB Poplar Street Bridge to 5 Lanes

- Traditional widening costly
  New I-Girder (Must match Box Girder Stiffness); Overbuild, Additional Foundations in River
- Solution: Slide EB Bridge 9' to the South and connect Superstructures
- Use ABC techniques even though not schedule driven



Relieve Congestion– Widen EB Poplar Street Bridge to 5 Lanes

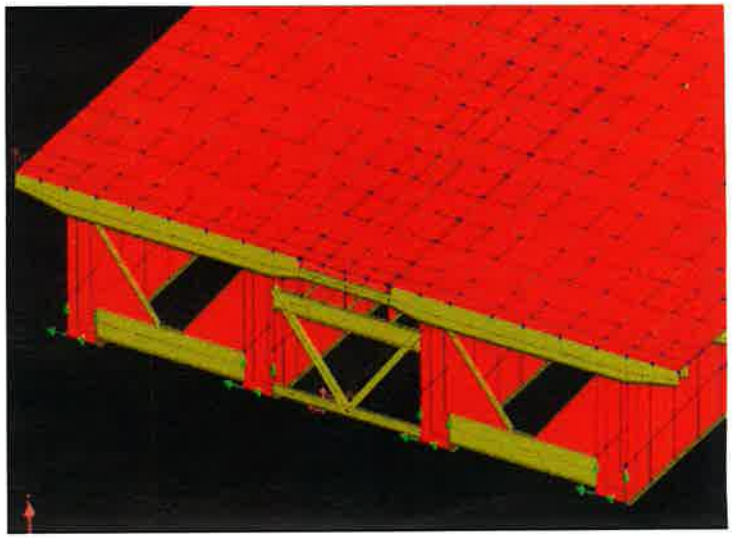
- One 4 Girder Bridge instead of two 2 girder bridges (Redundancy)
- Use R/C deck on sub-stringers for in-fill between superstructures.



ULTIMATE CONFIGURATION

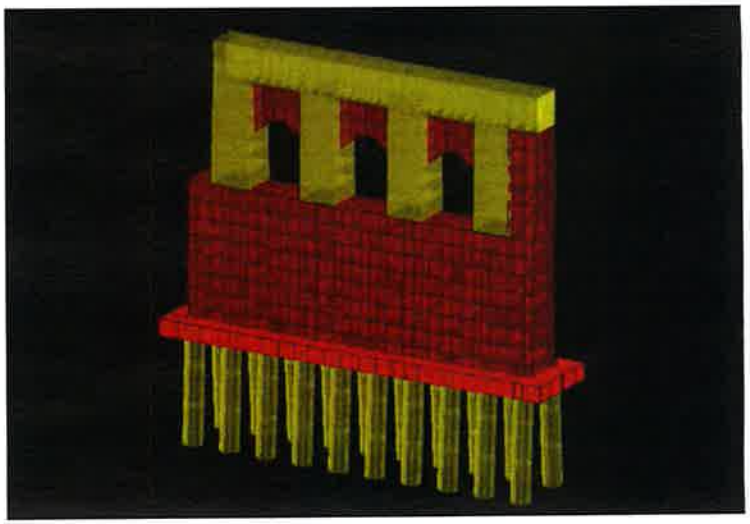
Relieve Congestion– Feasibility of Bridge Slide

- Confirm existing structure OK for 5th Lane
- Superstructure - Improved performance for 4 girder bridge for live load distribution factors (connecting superstructures distributes load to 4 girders)
- Maintain continuity by embedding studded channel into deck & bolting to angle welded to steel deck



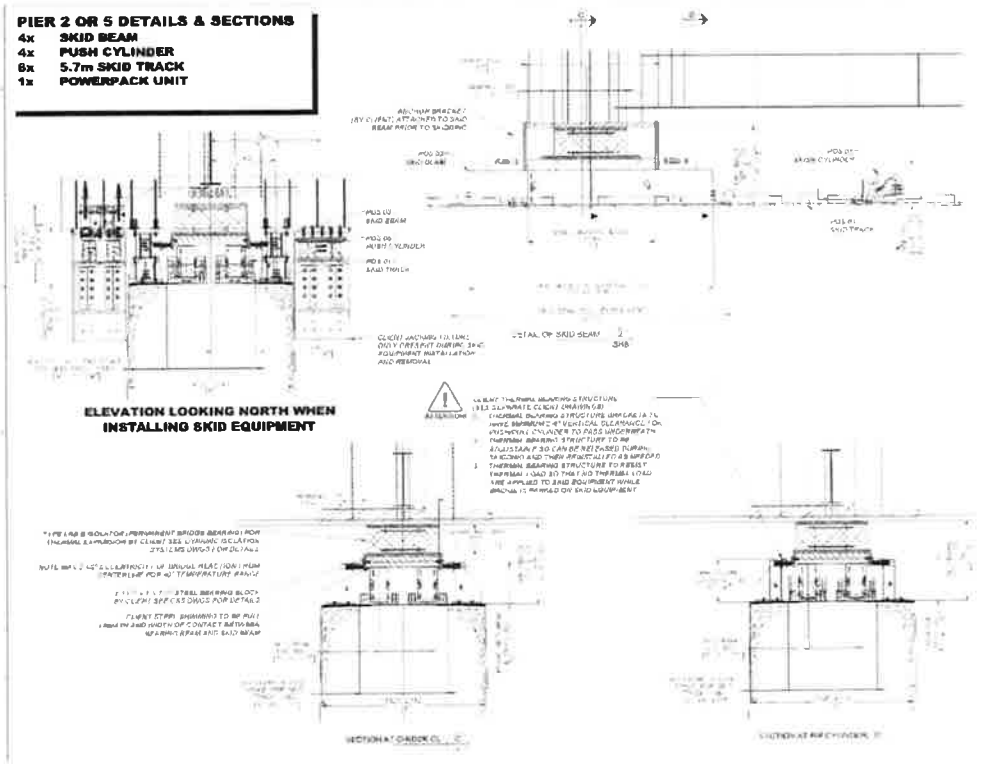
Relieve Congestion– Feasibility of Bridge Slide

- Confirm existing structure OK for 5th Lane
- Substructure - Extend cap & exterior column as ledge – PT bars to accommodate translated girders
- Concrete in-fill between columns to support cap, pre-slide 4 girders located directly on 4 columns
- Confirm existing foundations OK for 5th lane



Relieve Congestion– Feasibility of Bridge Slide

- Final contract plans showed "feasible schematic concept" for the Jacking & Slide
- Contractor designed the jacking and slide equipment and procedure with approval by MoDOT
- Actual process similar to the schematic concept



Relieve Congestion– Feasibility of Bridge Slide

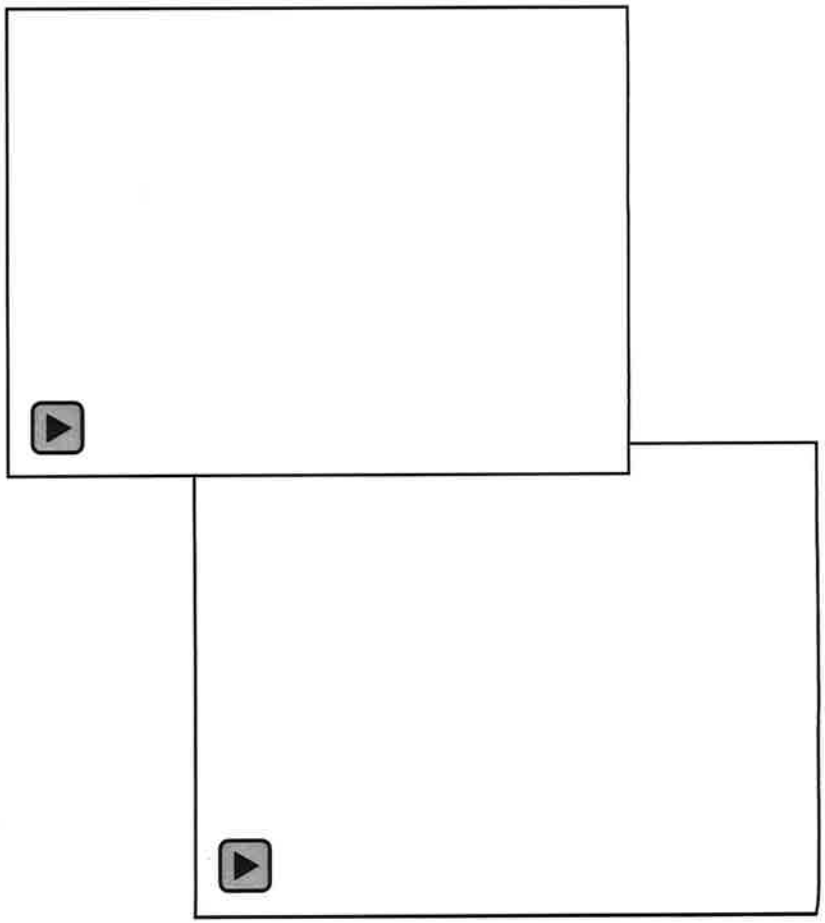
- Existing finger plate expansion joints at each end of bridge
- Removed fingers in stages leading up to slide and replaced with steel plates over gap
- Steel plates removed and reinstalled during slide weekend
- In weeks after slide, modular expansion joints installed

Overlay – Two Critical Functions

- 1. Riding Surface
  - Failure = Unsafe driving conditions
- 2. Contributes to stiffness of deck system
  - Failure = Deck plate cracking
- Provide solution to continuing problems
- Minimize future maintenance and repairs

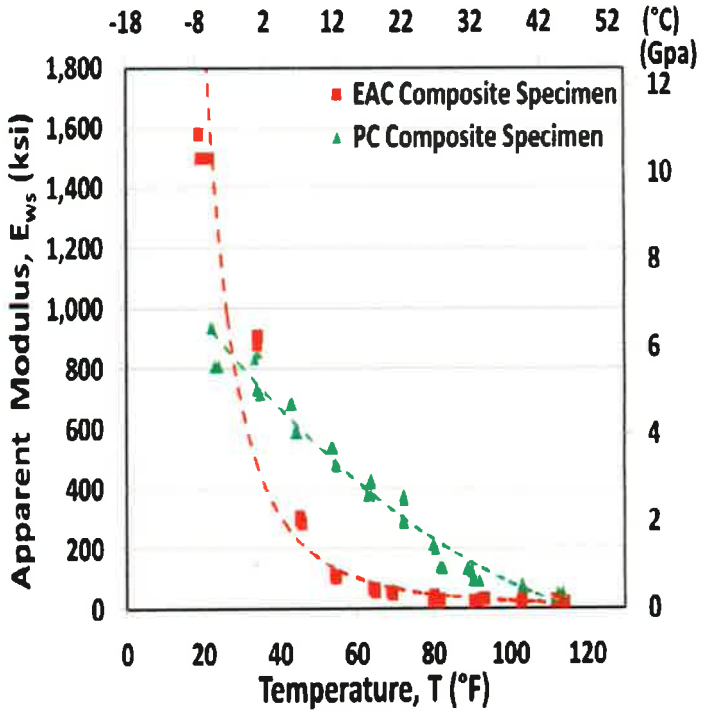
Overlay - Existing

- Thin Layer 0.5” Epoxy Concrete Overlay installed in 2006
- Summer 2013 – Failure of overlay system, de-bonding
- Steel deck plate exposed in numerous locations
- Emergency overlay Fall 2013



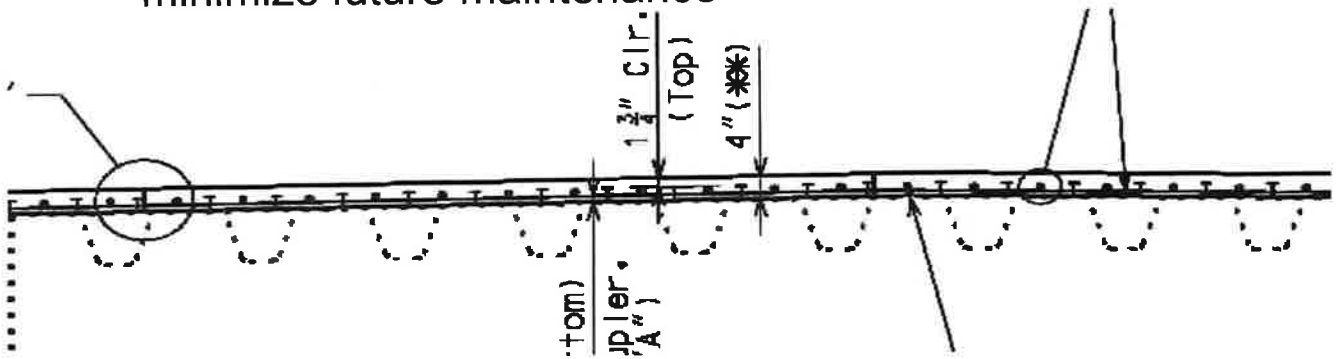
Overlay – Epoxy Asphalt & Polyester Concrete Options

- Tests show material stiffness (E) is reduced significantly with high temperatures (see plot)
- E < 200 ksi for Polyester Concrete with Temperature > 80 degrees; Epoxy asphalt even worse
- Minimal overlay stiffness = flexible deck = Deck Plate susceptible to cracking



Overlay – 4" Steel Fiber Reinforced Lightweight Concrete

- Structural check of girders and substructure for additional dead load
- Layer of mild steel
- Mechanical bonding to deck plate by shear studs
- Improved driving surface & deck stiffness 30 – 40 year life and minimize future maintenance



Rehabilitation – In-Depth & Fracture Critical Inspection

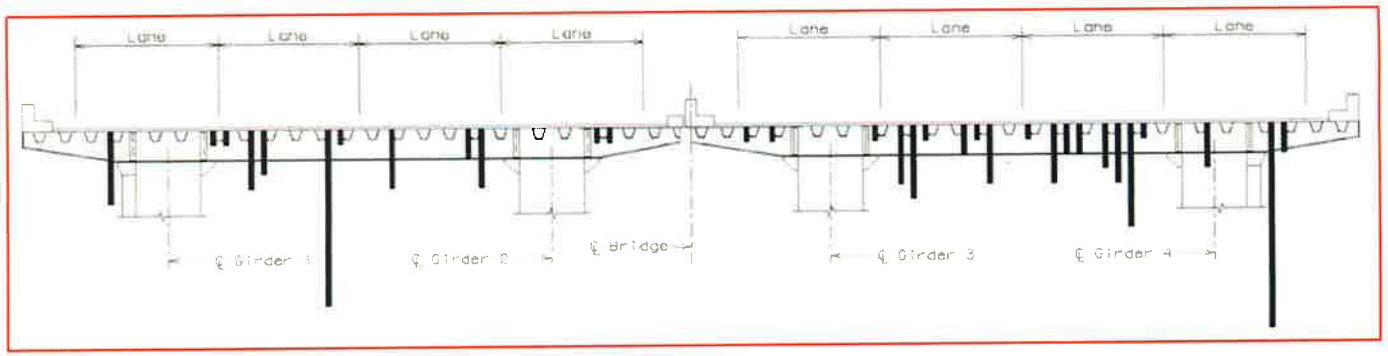
- Main River Bridge
  - Deck Surface
  - Orthotropic Steel Deck
  - Interior & Exterior of Girders
  - Bearings & Joints
  - Paint System
  - Substructure
- Illinois Approach
  - Superstructure
  - Substructure

Rehabilitation – Orthotropic Steel Deck

- Numerous rib web to deck weld cracks (>100 locations)
- Some have propagated into web of rib
- Most near floor beam, some large at mid-bay up to 60" maximum observed
- Recommend bolted repair
- Cause?!?!

Rehabilitation – Orthotropic Steel Deck

- Plot below shows number of cracks transversely along bridge
- Cracks generally correspond to wheel lines
- Flexibility of deck contributing to cracking
  Thin, de-bonded overlay contributing no stiffness to deck
- Cracks will continue to progress & develop unless deck is stiffened
- Solution: Thicker & Stiffer Overlay!



Rehabilitation - Bearings

- Evidence existing bearings not performing as intended (no thermal movement)
- Shock transmission units (STU) previously installed as part of seismic retrofit
- Concern of poor performance, sent 4 STU's to lab for testing

Rehabilitation - Bearings

- Confirmed 1 of the 4 STU's fluid had leaked out and did not pass verification testing
- Potential for lack of response under seismic loading
- Remove existing STU's & replace existing bearings with lead core seismic isolation bearings

Removal of Existing Overlay

Gouges From Previous Overlay Removals

Sand Blasting

Placing Block Out Magnets for Shear Stud Template

Zinc Coating Application

Thermal coating
99.9% Zinc

Shear Studs

> 1,000,000 studs on deck

Steel Fiber Reinforced Lightweight Concrete Overlay Pour

Finished Overlay

- 4-in. thick
- 196 lbs fiber/yd^3
- 120 lbs/ft^3 max. equilibrium density
- 6,000 psi design strength
- 800 psi flexural strength
- 425 psi splitting tensile strength

Bearing Replacement

Pier 5 Widened to Accommodate Slide

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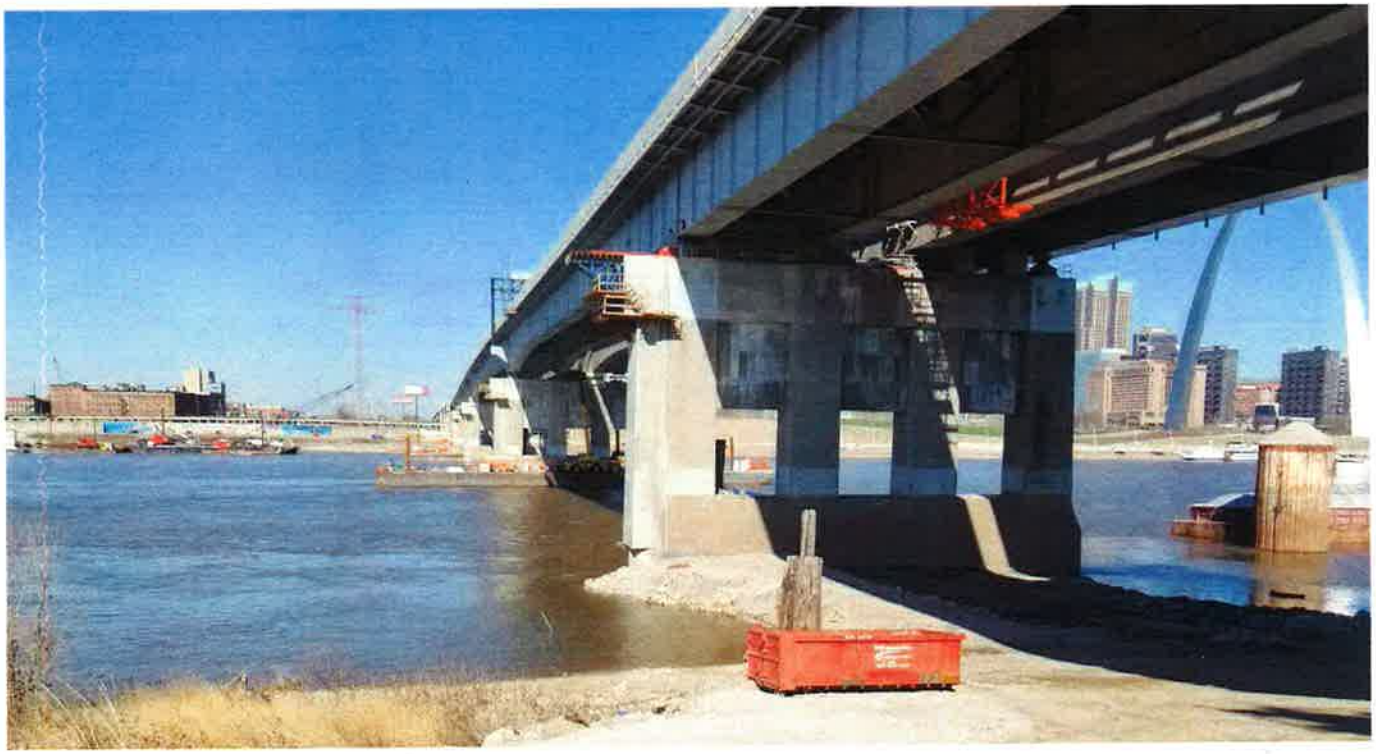
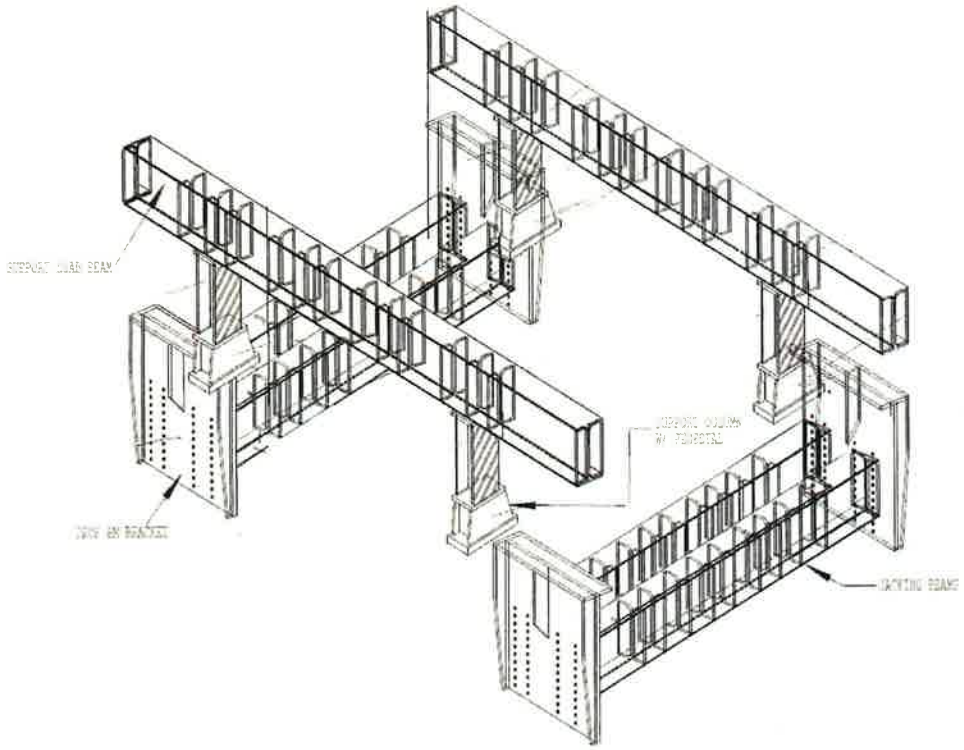


Median Removal

Jacking Equipment



Bridge Slide Details

- 6 piers – Moving simultaneously
- Each pier with different dead load reaction requires different pushing force to move at same rate
- 2,165' long – 2nd longest slide in U.S.; Longest for an existing bridge
- 54'-2" wide & 20.4 million pounds – Largest bridge slide in U.S. based on total deck area and weight

Slide Track System

Bridge Slide

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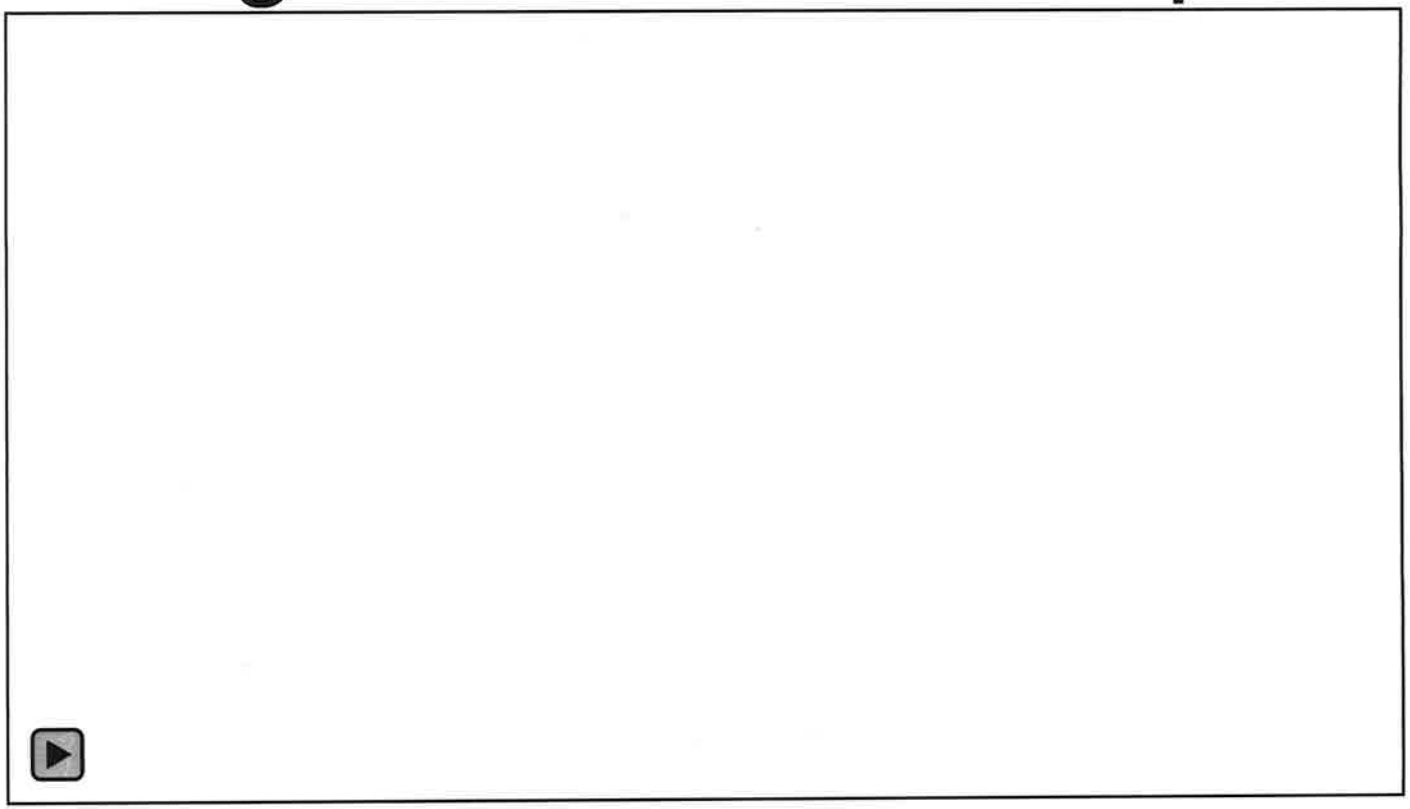
Bridge Slide – Time Lapse



Infill Steel Installation

Final Configuration

Lessons Learned

- Job Special Provision for the Slide should be more prescriptive. Specifically require the Contractor to have jacks linked or more stringent monitoring.

- Require more stringent tolerances on slide due to needing to bridge the median gap with new structural steel.

Questions?