US60 OVER TENNESSEE RIVER
Timely Opening of New Truss

CRAIG R. KLUSMAN, PE

MICHAEL P. McGREGOR, PE

2016 PURDUE ROAD SCHOOL

MARCH 9, 2016

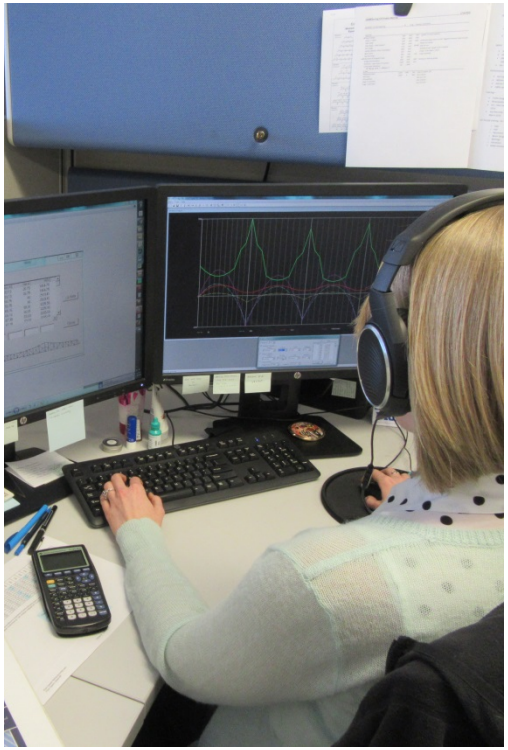
KENTUCKY TRANSPORTATION CABINET

AECOM


AECOM

US60 Tennessee River Bridge

Design



Construction

Demolition

KENTUCKY TRANSPORTATION CABINET

AECOM

Project Background

Project Team

URS

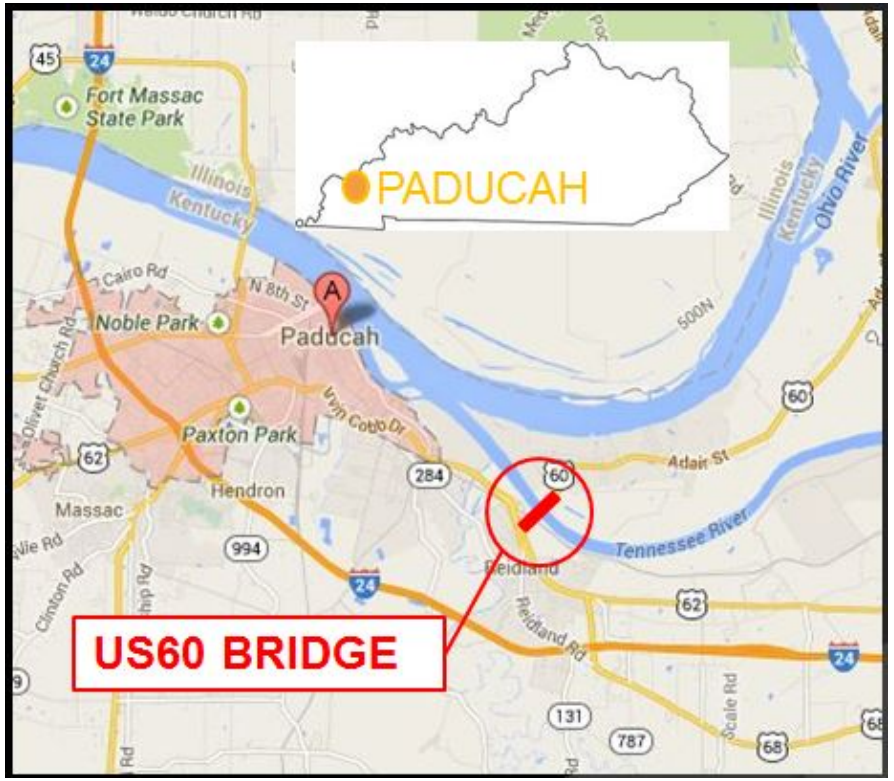
Stantec

AECOM

History

Bridge Replacement

- US60 over the Tennessee River
- George Rogers Clark Memorial Bridge
- Paducah, KY (McCracken County)
- Ledbetter, KY (Livingston County)




Bridge Replacement Project
Structurally and geometrically deficient
Navigation clearance

History

	Existing	New
Lanes	Two	Four
Shoulders	None	5-Foot (Barrier Divided)
Deck Width	20-Ft	70-Ft
Truss	Three Simple Spans	Three Continuous Spans
Truss Length	1,200-Ft	1,800 Ft
Load Rating	3-Tons	HS-25 LFD Design
		

KENTUCKY TRANSPORTATION CABINET

AECOM

History

Year	Item	Construction Cost
2003	Pier and foundation design by KYTC	---
2005	Contract let for substructure construction	$29 Million
2006	Public involvement process	---
2008	Truss design by URS (now AECOM) & Stantec	---
2010	Superstructure let to JV Haydon Bridge/Kay & Kay Contracting	$66 Million
2013	Bridge opening	---

KENTUCKY TRANSPORTATION CABINET

AECOM

Design

Visually Transparent Design

- Modified Warren Truss with no:
  - Verticals
  - Sway bracing
  - Portal bracing
- Truss Members
  - Painted, Welded, Closed Boxes
  - Steel Grade 50W/70W

Visually Transparent Design

A visualization comparison using the Taylor Southgate Bridge in Cincinnati

KENTUCKY TRANSPORTATION CABINET

AECOM

Visually Transparent Design

Sway Bracing and Verticals

Tunnel Effect

KENTUCKY TRANSPORTATION CABINET

AECOM

Visually Transparent Design

How does the elimination of Sway Bracing change the appearance of a truss?

KENTUCKY TRANSPORTATION CABINET

AECOM

Visually Transparent Design

How does the elimination of Portal Frames change the appearance of a truss?

KENTUCKY TRANSPORTATION CABINET

AECOM

Visually Transparent Design

How does the elimination of Verticals change the appearance of a truss?

KENTUCKY TRANSPORTATION CABINET

AECOM

Visually Transparent Design

Lets now compare the results.

Visually Transparent Design

US60 Tennessee River Bridge

KENTUCKY TRANSPORTATION CABINET

AECOM

Visually Transparent Design

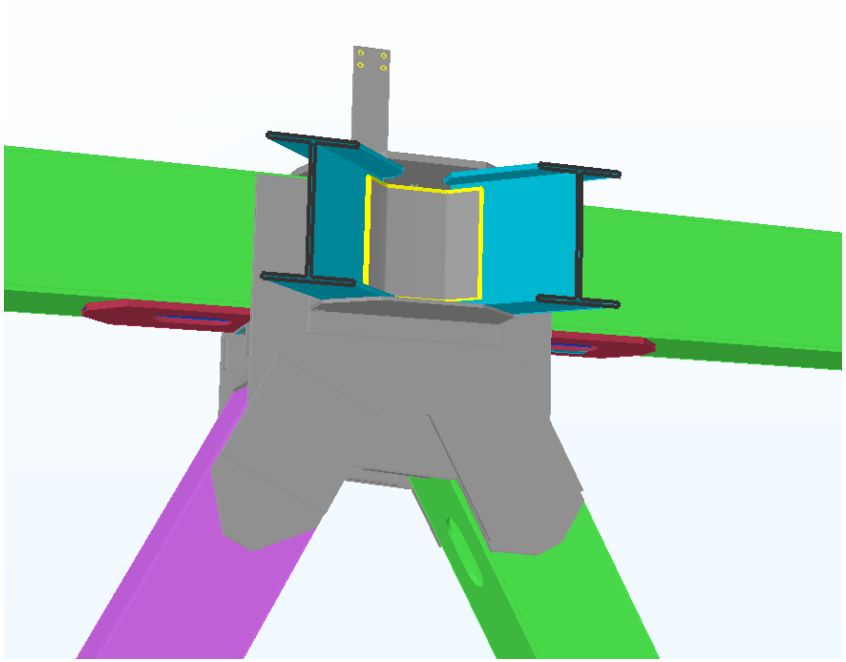
Elimination of Portal & Sway Bracing

KENTUCKY TRANSPORTATION CABINET

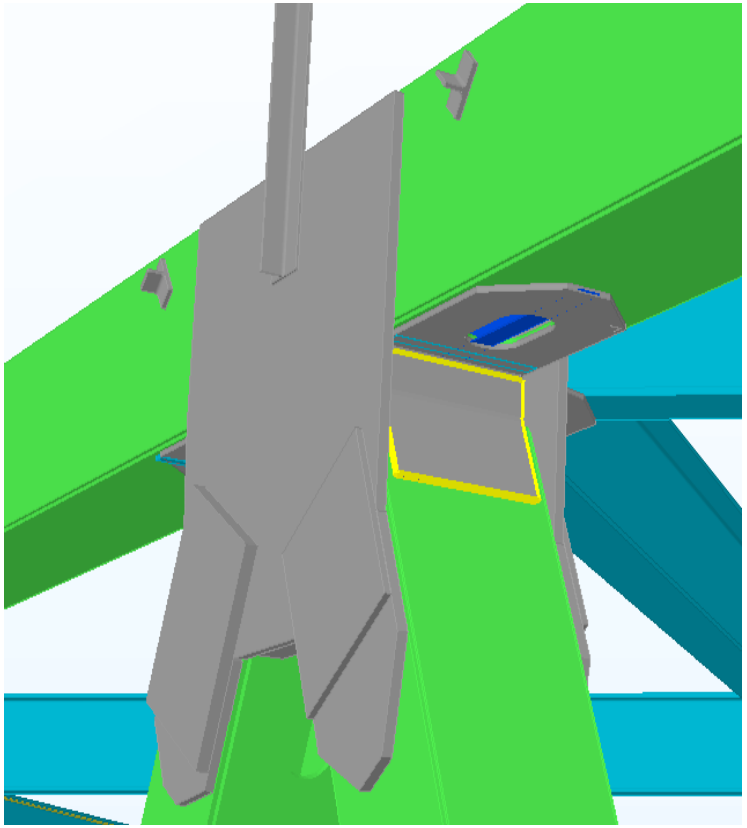
AECOM

Visually Transparent Design

– Moment-Resisting Frames



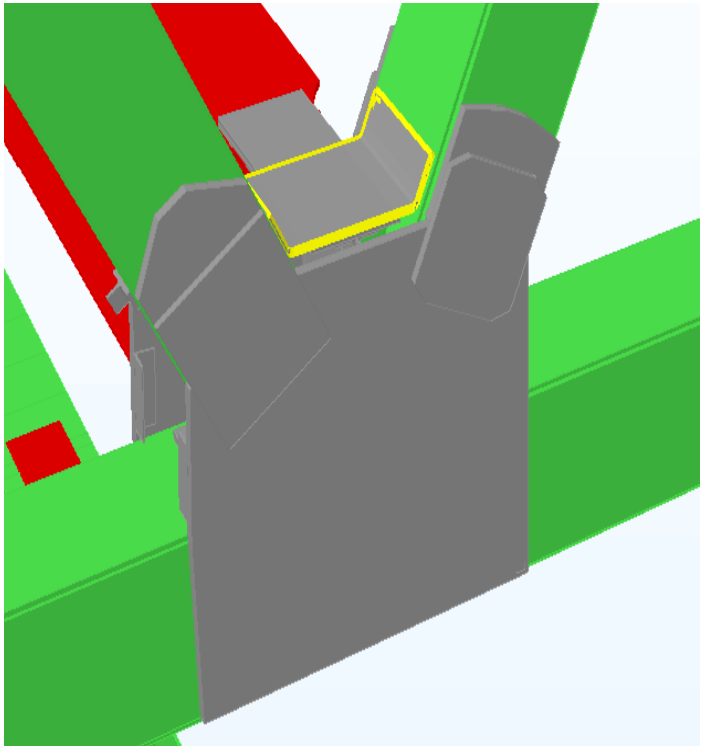
Upper Lateral Bracing Shear Plates



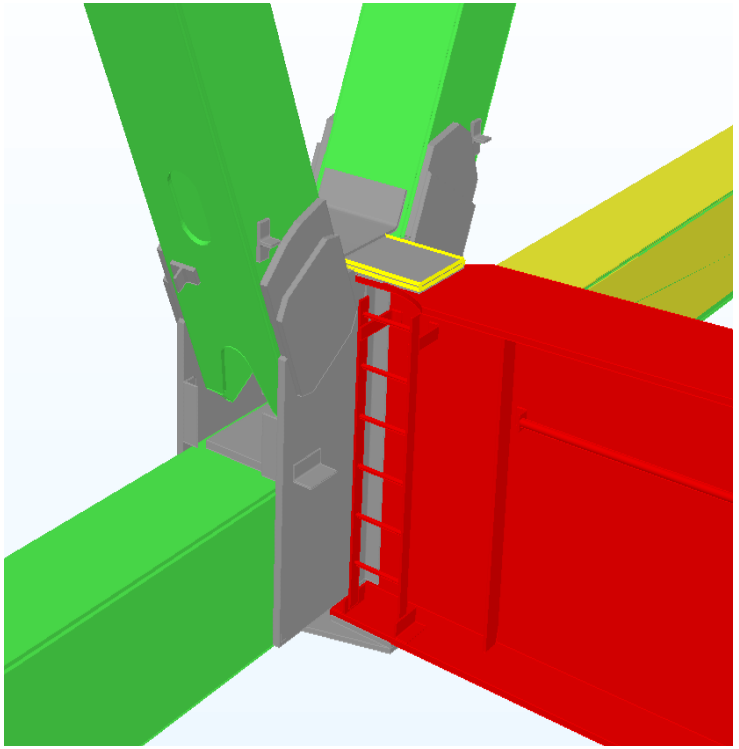
Diagonal Shear Plates

Visually Transparent Design

Moment-Resisting Frames



Diagonal Shear Plates



Floorbeam Tie Plates

KENTUCKY TRANSPORTATION CABINET

AECOM

Truss Design Challenges

- Challenge: Create a lightweight and constructible truss
  - Three-Span (400-Ft, 900-Ft, 500-Ft)
  - Constant Depth (60-Ft)
- Solution:
  - Minimize number of truss joints
  - Simple details
  - Compact connections
- Result: Truss skeleton is less than 100 psf of deck area

KENTUCKY TRANSPORTATION CABINET

AECOM

Truss Design Challenges

Simple Detailing

- Upper Lateral Bracing
  - Rolled sections
  - Diamond pattern
- Lower Lateral Bracing
  - Rolled sections
  - Diamond pattern
  - Provides floorbeam lateral support

KENTUCKY TRANSPORTATION CABINET

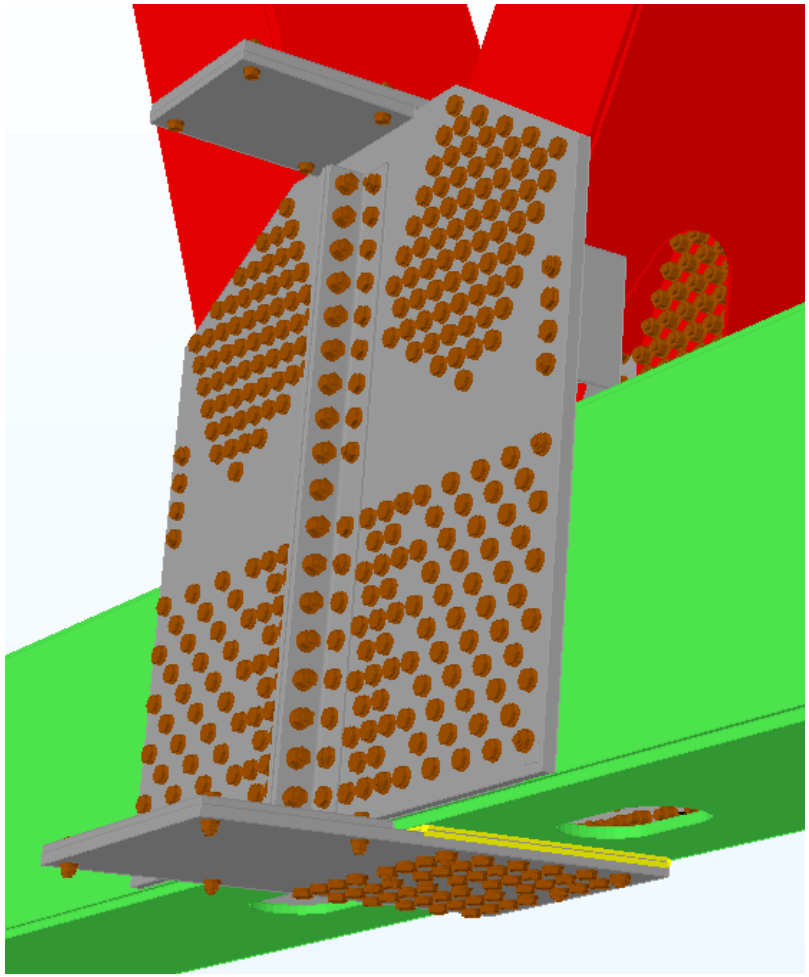
AECOM

Truss Design Challenges

- Challenge: Create compact connections
  - Reduce secondary moments
  - Floorbeam depth constrained gusset height

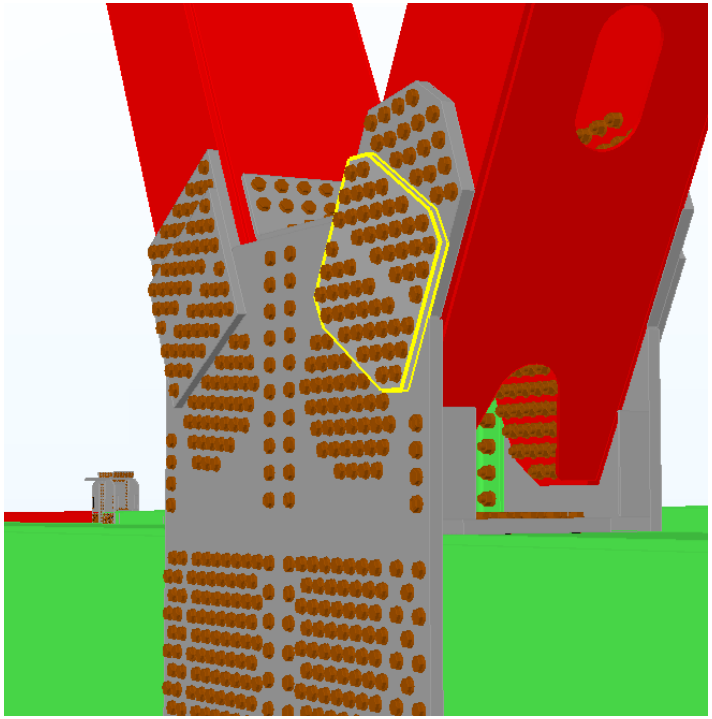
Truss Design Challenges

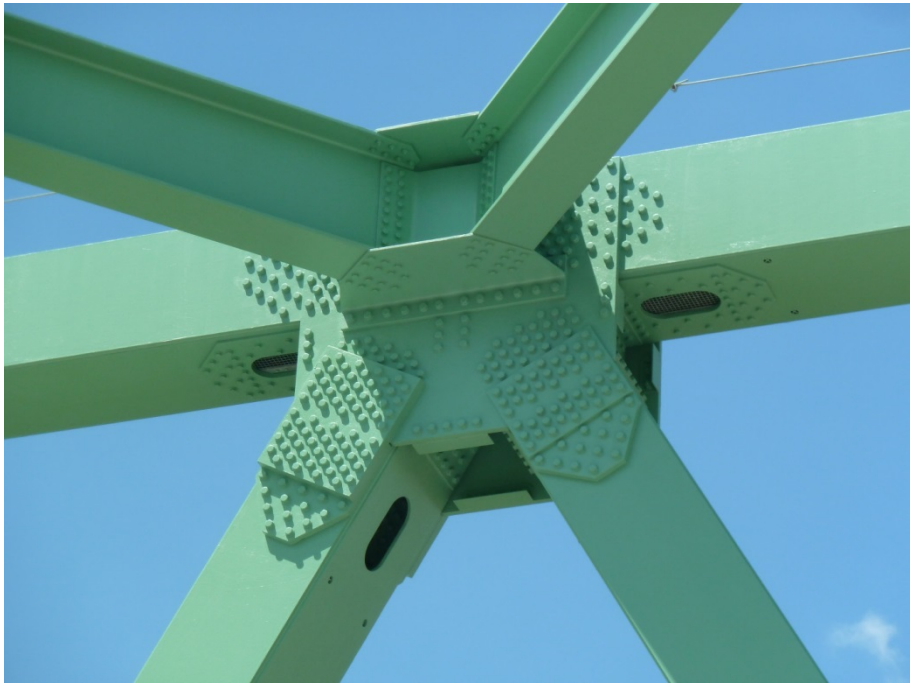
- Solution:
  - 1 1/8” dia A325 bolts
  - Staggered Bolt Pattern
  - Threads precluded from the shear plane
  - Double Shear Splice Plates



Truss Design Challenges

Double-Shear Splice Plates on Diagonals





Truss Design Challenges

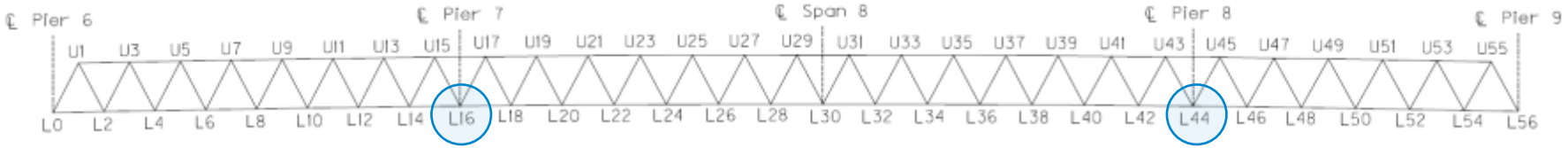
- Challenge: Seismic Design
- Problem:
  - New Madrid Fault Zone
  - Accommodate Existing Piers
- Solution:
  - Develop a Proper Design Response Spectrum
  - Uncouple Truss from Piers
  - Seismic Isolation Bearings

KENTUCKY TRANSPORTATION CABINET

AECOM

Truss Design Challenges

- Challenge: Significant truss forces at L16 & L44
- Solution:
  - Knuckle Bearing Assemblies
  - Mill-to-Bear Chords
  - Spliced Diagonal Connections



KENTUCKY TRANSPORTATION CABINET

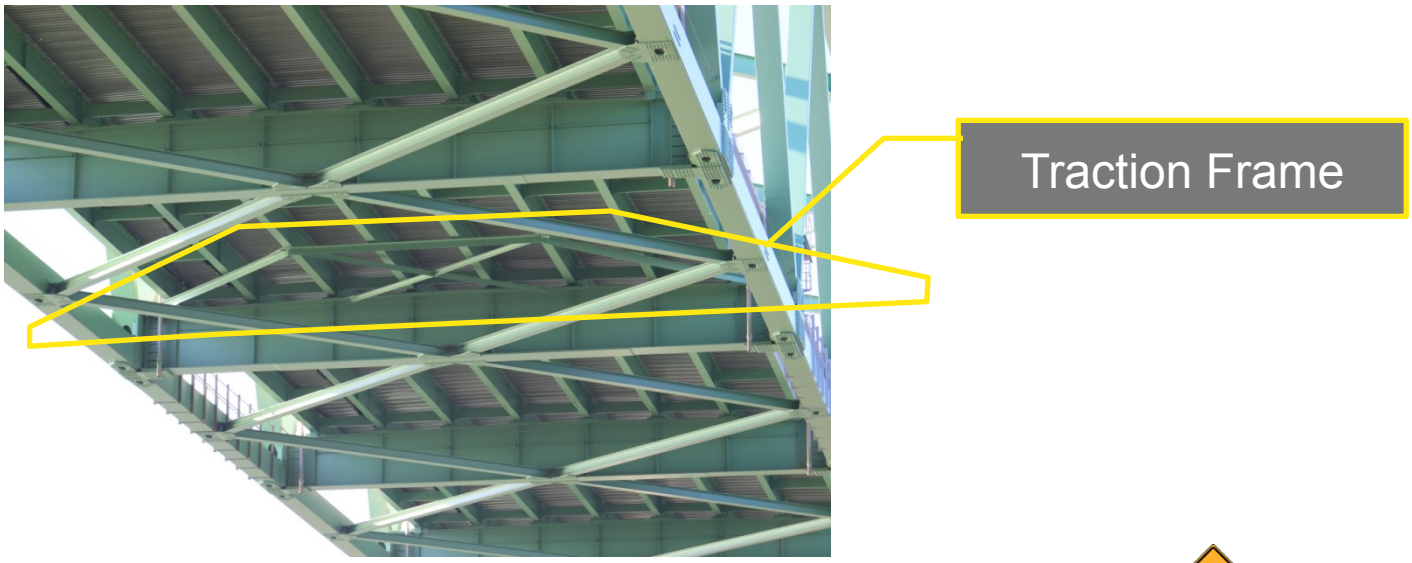
AECOM

Truss Design Challenges

- Challenge: Provide Inspection Friendly Bridge
- Solution:
  - Fall Protection Safety Lines
  - Gusset Steps
  - Floorbeam Handrails
  - Ladders
    - Portals
    - Floorbeams
    - Lower Chord Access
    - Navigation Lights

Truss Design Challenges

- Challenge: Create a maintenance free deck
  - Eliminate leaky joints
- Solution:
  - 1,800-Foot Continuous & Jointless Deck
  - Stringer Fixity Plan
  - Traction Frame



Construction

Construction

Phase one: Substructure

Phase Two:
Superstructure and Approaches

KENTUCKY TRANSPORTATION CABINET

AECOM

Construction

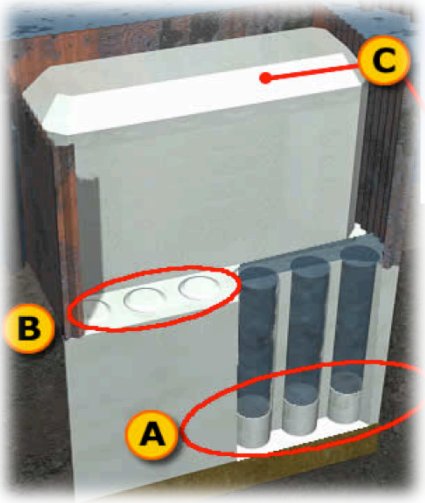
	Phase One: Substructure	Phase Two: Superstructure
Letting	December 16, 2005	July 30, 2010
Contractor	CJ Mahan Construction	Kay & Kay JV Haydon Bridge
Construction Cost	$28.5 Million	$66.4 Million
Structural Steel	N/A	15.3 Million Pounds
Concrete	25,300 CY	17,000 CY
Steel Reinforcement	3.2 Million Pounds	2.5 Million Pounds
Completion Date	June 2010	October 31, 2013

KENTUCKY TRANSPORTATION CABINET

AECOM

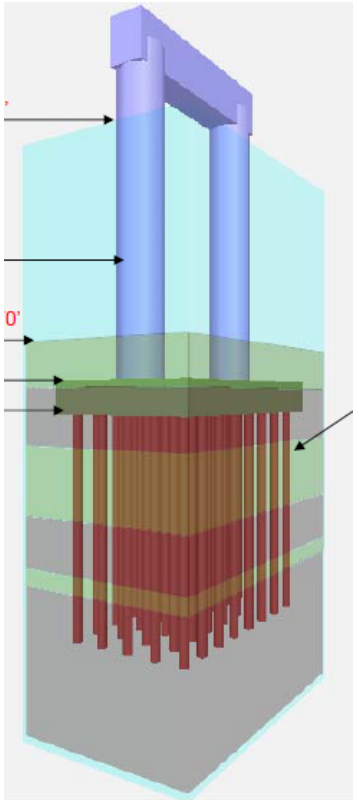
Construction

- Pier 7 Original Design:
  - Dredged Caisson
  - Similar to Greenville Bridge



Source: www.greenvillebridge.com

- Pier 7 Design/ Build Option
  - Cofferdam and Concrete Tremie System
  - 48” Dia. Pipe Piles



Source: EL Robinson

Construction

Pier 7 Construction

KENTUCKY TRANSPORTATION CABINET

AECOM

Construction

Pier 7 Construction

Construction Challenges: Flooding

Construction Challenges: Crane Issues

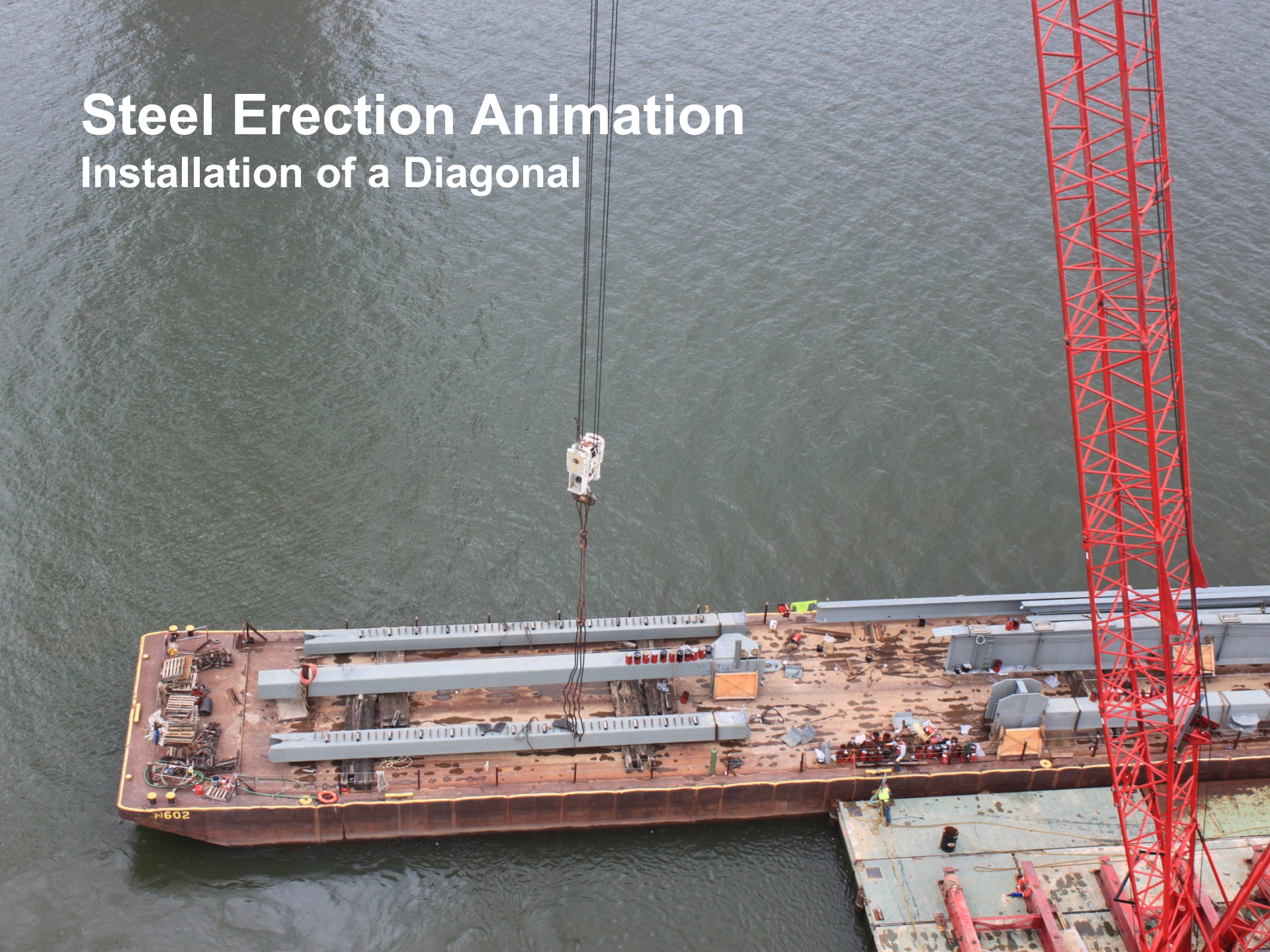
KENTUCKY TRANSPORTATION CABINET

AECOM

Construction: Truss

Steel Erection Animation

Installation of a Diagonal

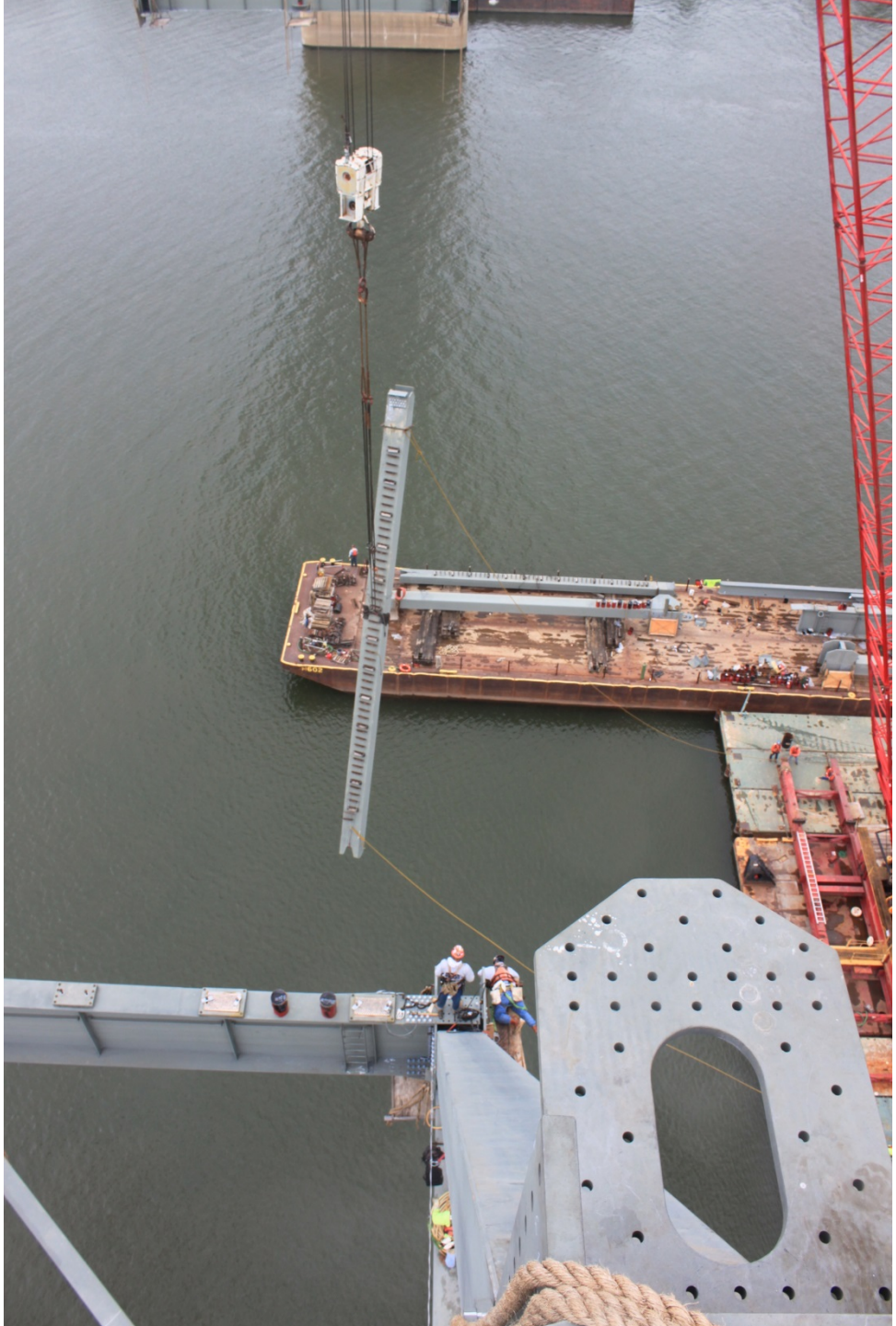



M602


1602

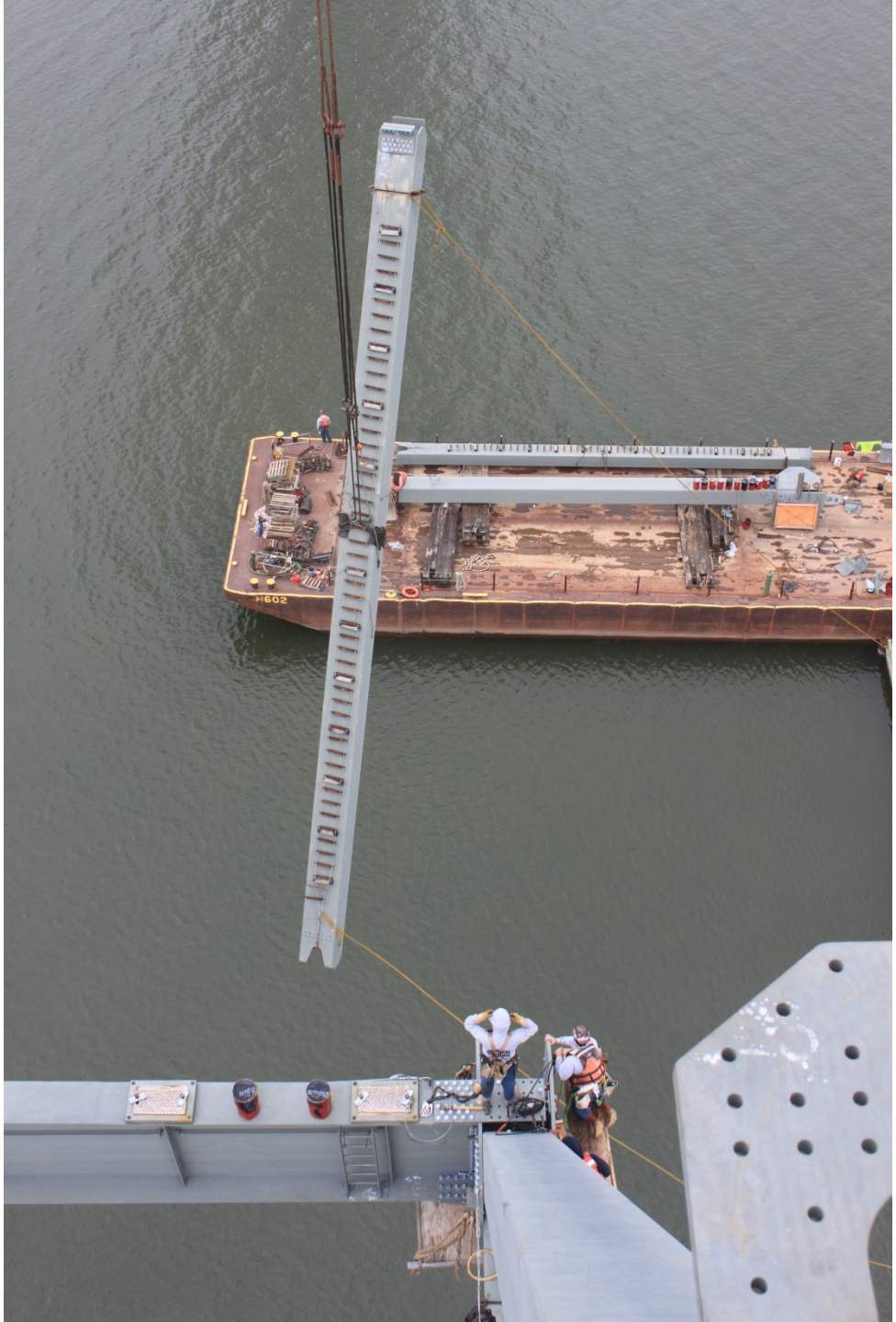

M602


M602



KENTUCKY TRANSPORTATION CABINET

AECOM



KENTUCKY TRANSPORTATION CABINET

AECOM

KENTUCKY TRANSPORTATION CABINET

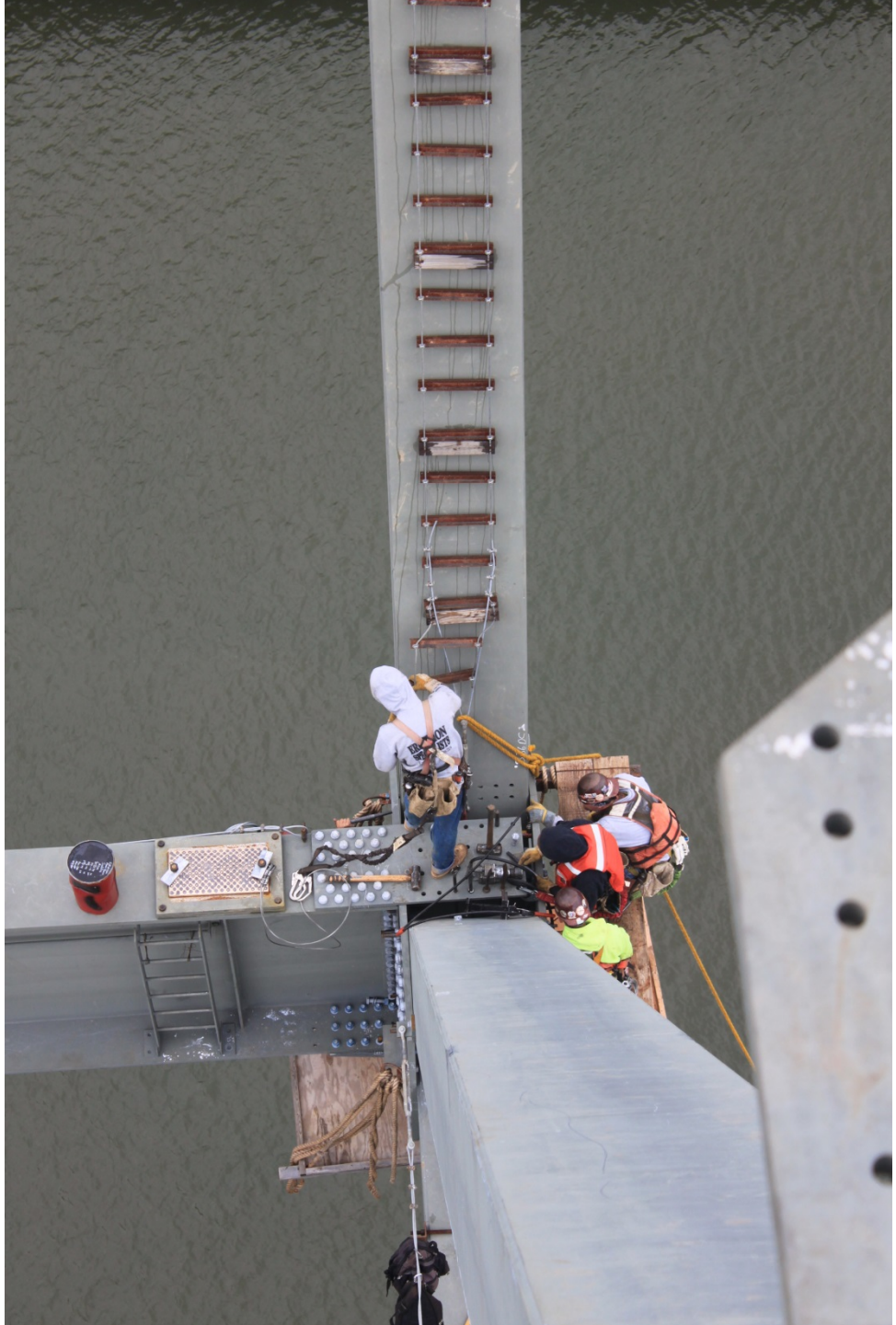
AECOM

KENTUCKY TRANSPORTATION CABINET

AECOM

KENTUCKY TRANSPORTATION CABINET

AECOM



KENTUCKY TRANSPORTATION CABINET

AECOM

KENTUCKY TRANSPORTATION CABINET

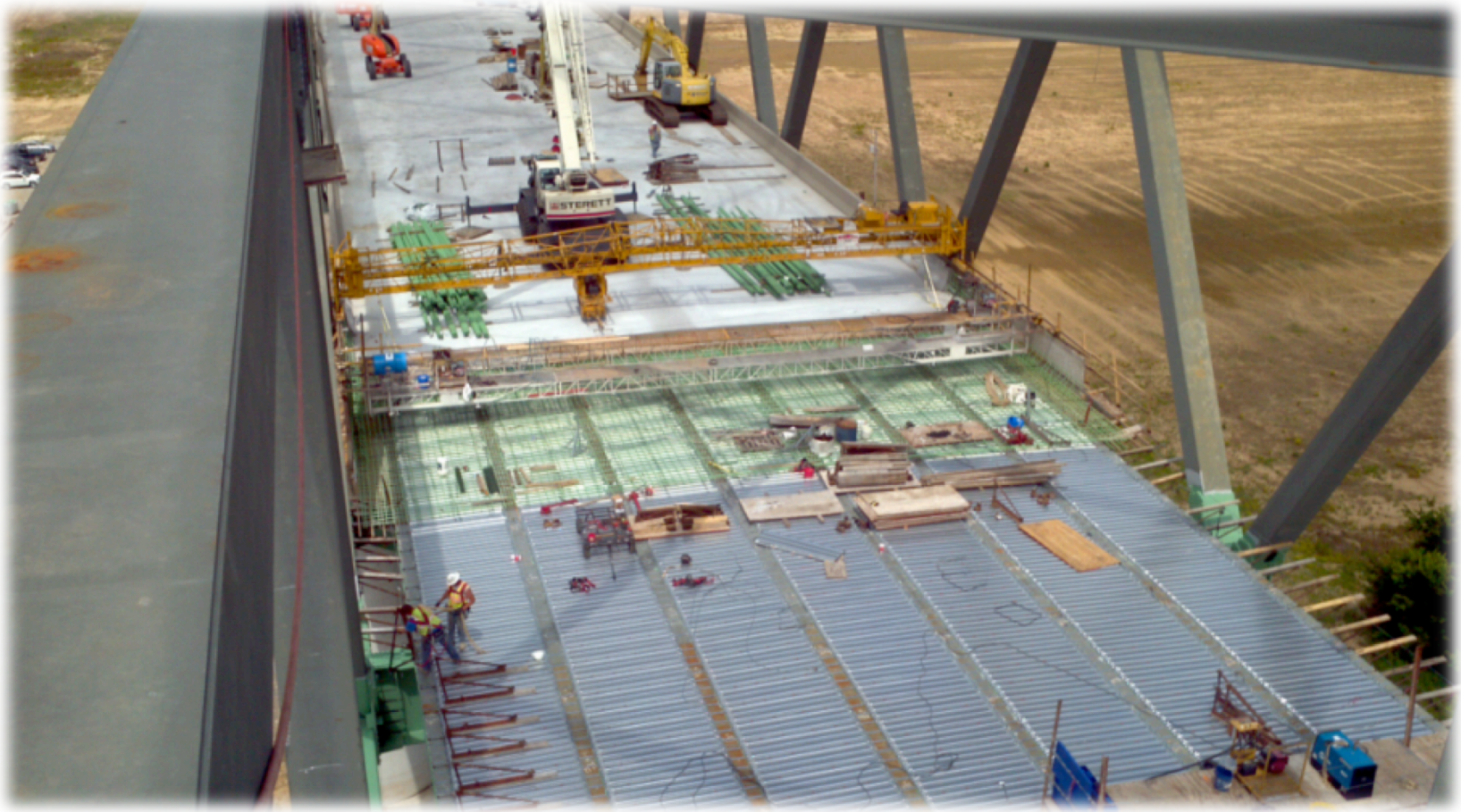
AECOM

Drift Pin Installation


Completed
Diagonal

Construction: Truss

Construction: Deck



KENTUCKY TRANSPORTATION CABINET

AECOM

Construction Challenge: Old Bridge Deterioration

- Problem: Weight Limit Reduction (Jan. 2012)
  - Cars and passenger trucks
- Solution: Contractor Incentive Package
  - Accelerated Schedule
    - Original: July 2014
    - Actual: July 2013 (2-lanes)
    - Actual: Oct. 2013 (4-lanes)

KENTUCKY TRANSPORTATION CABINET

AECOM


Completed Truss
and Approaches

Demolition

Demolition of Existing Bridge

KENTUCKY TRANSPORTATION CABINET

AECOM

Demolition

McCracken Co. Approach Spans, April 30, 2014:

- Deflection Noted
- Bluff Slumping

Demolition

Demolition

June 22, 2014: Eventual Collapse

Demolition

Demolition

Result

– Expedite a contract for demolition

– $5.6 Million Change Order to Joint Venture

Demolition Plan

– Truss Cuts (40-ft sections)

– Controlled Explosives

– Three Blasts

– Debris Removal

  • 24 Hours in Navigation Channel

  • 48 Hours elsewhere

KENTUCKY TRANSPORTATION CABINET

AECOM

Demolition

1500-Foot Safety Zone

Demolition

Demolition

Demolition

3rd Detonation

- Significant Damage to Piers
- Revised Demolition Plan
  - Original: 100% Blasting
  - Final: Dredge and bury portion above construction joint

Demolition

Questions

KENTUCKY TRANSPORTATION CABINET

AECOM