


Design and Construction Challenges TRRA Merchants Bridge over the Mississippi River

Nick Staroski, PE, SE



TRANSYSTEMS


Project Location



TRANSYSTEMS

Bridge Description


- 4,340-ft Total Length:
 - (3) 523' Through Truss Spans
 - 447' East & 487' West DPG Approach
 - 745' Trestle East Approach Filled with Cellular Concrete



TRANSYSTEMS

History

- Bridge was designed and constructed by George Morison
- Begin late 1888 and completed in early 1890.
- St Louis Merchants Exchange funded to compete with Eads Bridge
- Panic of 1893 resulted in St Louis Merchants Exchange giving up ownership to TRRA
- First Major rehabilitation occurred in 1902
- Second Major rehab occurred in 2004




TRANSYSTEMS

History – Main Span

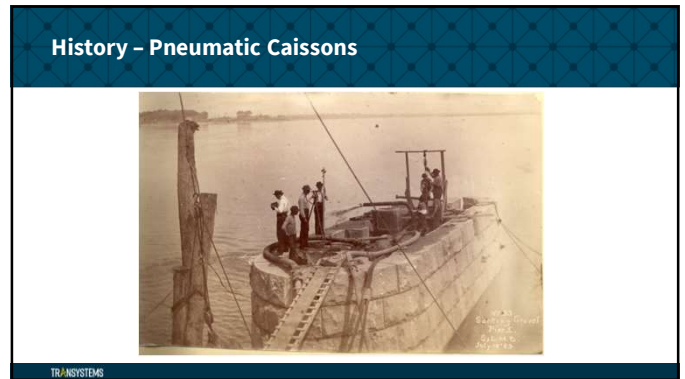
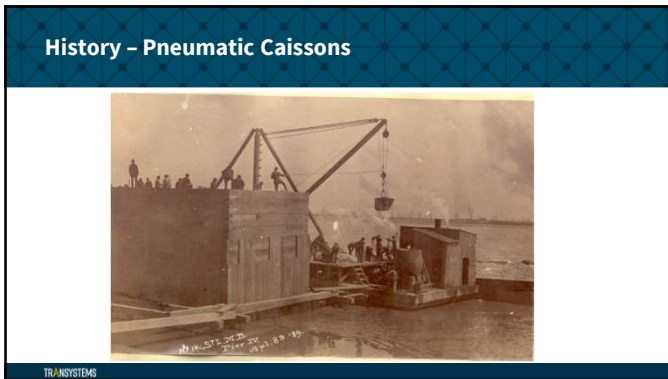


TRANSYSTEMS

History – East Approach



TRANSYSTEMS



Project Goals

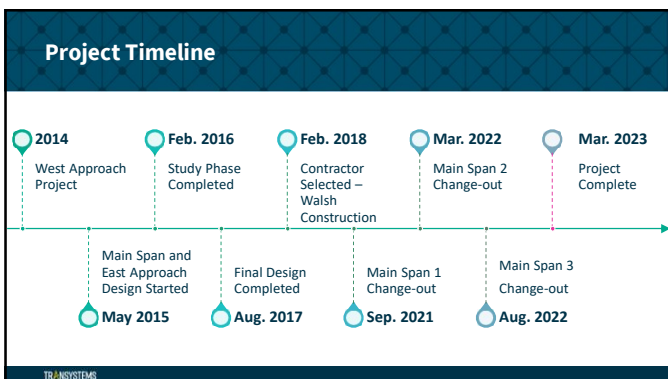
- Return service to both tracks across bridge at E80 loading
- 15-ft track centers
- Minimize maintenance
- Minimize impacts to rail and maritime traffic during construction
- Minimize risk due to vessel impact and seismic events
- Inspection access

TR/ANSYSTEMS

Project Team

- TRRA – Owner
- TranSystems – Prime Engineer
- Burns and McDonnell – Major Sub Engineer
- Walsh Construction II – General Contractor
 - Veritas Steel – Fabricator
 - Genesis Structures – Erection/Demolition Engineer
 - Mammoet – Heavy Lift

TR/ANSYSTEMS



Design – East Approach

• DPG Retrofit

TR/ANSYSTEMS

Design – East Approach

- DPG Retrofit

TRANSYSTEMS

Design – East Approach

- Steel DPG Trestles Constructed 1902

TRANSYSTEMS

Design – East Approach

- 70-ft Deep ACP
- Long. Grade Beam
- Trans. Grade Beam
- Slab
- CIP Culverts

TRANSYSTEMS

Design – East Approach

- Cellular Fill
- 42pcf to 36pcf
- 220 psi 28-day strength
- 50/50 cement/fly ash
- Dry density vs wet density
- Wet is 5 to 7 pcf higher depending on oven-dry or in-situ dry testing
- Lift height ~12"

TRANSYSTEMS

Design – East Approach

- CIP Culverts and Encasement Slab

TRANSYSTEMS

Design – Main Spans

- Truss Design

TRANSYSTEMS

Design – Main Spans

- Truss Floor System

The drawing shows a cross-section of a truss floor system. It includes labels for 'TOP OF RAIL', 'TOP OF FLOORBEAM', 'BOTTOM CHORD', 'BOTTOM OF FLOORBEAM', and 'STRINGER SPACING'. Dimensions include 11'-6" for the truss chord, 7'-6" for the track, and 3'-0" for the bridge. A detail view shows a '3" PLATE' and 'APPLY REINFORCING AFTER COVER PLATE TO BRIDGEL'. The TR/ANSYSTEMS logo is at the bottom left.

Design – Main Span Piers

- Four main river piers
- Cofferdam construction
- New footings on micropiles
- 3' Concrete encasement
- Cap tension rods
- Drilled dowels

The photograph shows a large cylindrical bridge pier under construction. It is surrounded by a cofferdam structure. The pier is encased in concrete. The TR/ANSYSTEMS logo is at the bottom left.

Design – Main Span Piers

- Four main river piers
- Cofferdam construction
- New footings on micropiles
- 3' Concrete encasement
- Cap tension rods
- Drilled dowels

The diagram shows a cross-section of a pier. It includes labels for 'CIP CONCRETE ENCASUREMENT', 'TENSION ROD', and 'DRILL & GROUT DOWEL'. Dimensions include 7'-0" and 3'-0" for the pier width, and 6'-0" for the height. The TR/ANSYSTEMS logo is at the bottom left.

Pier Strengthening

The drawings show the pier strengthening details. The 'FRONT ELEVATION' shows a 6,000 klp load and a 32'-0" width. The 'SIDE ELEVATION' shows a 108'-0" height and 14'-0" width. 'SECTION A-A' shows a 'DRILLED DOWEL (TYP.)' and 'CL EXIST. BRIDGE'. A legend identifies 'EXISTING PIER CORE', 'CONCRETE ENCASUREMENT', and 'EXISTING GAISSON'. The TR/ANSYSTEMS logo is at the bottom left.

Existing Truss Strengthening

- Existing L0 pin connected
- Initial U-shaped plate concept to pick at pin

The photograph shows two workers in safety gear working on a bridge structure. The close-up shows a truss joint with a U-shaped plate. The TR/ANSYSTEMS logo is at the bottom left.

Existing Truss Strengthening

- Existing truss 3.8M LB
- New gusset to bypass pin
- Holes cut in cover plate
- Temporary stiffening rods
- Local buckling capacity
- Temporary batten plates

The drawing shows a truss joint with labels for 'LIFTING PLATE', 'END DIAGONAL', 'STIFFENING ROD (TYP.)', 'LIFTING GUSSET', 'BEARING PIN', and 'BOTTOM CHORD'. The TR/ANSYSTEMS logo is at the bottom left.

Existing Truss Strengthening

- Removal barge configuration
- Timber Blocking

EXISTING TRUSS ELEVATION

TR/ANSYSTEMS

Main Span Replacement Options

- Option 1 – Traditional Float-In

TR/ANSYSTEMS

Main Span Replacement Options

- Option 2 – Strand Jacks

TR/ANSYSTEMS

Gantry Tower by Mammoet

TR/ANSYSTEMS

Main Span Changeout Timeline

- Pre-Outage Work
 - Transport Barges to Site
 - Erection Mammoet FW Towers
- Day 1-2
 - Attach Existing Span Demo Lugs to Gantry
 - Float-in / Position Demo Barges
 - Lower Old Truss
- Day 3-4
 - Pour New Risers on Pier, Install Masonry Plates
- Day 5-6
 - Float in New Truss
 - Slide and set down with gantry
 - Weld Bearings
- Day 7-8 – Install Ballast and Track

TR/ANSYSTEMS

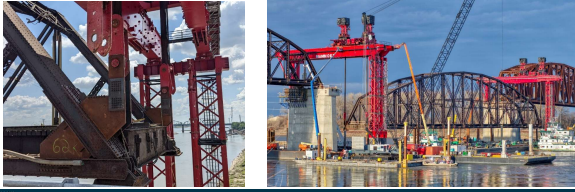
Pre-Outage Work – Gantry Beams

- 130 ft overhead gantry beams installed 80-ft above average water EL
- Max beam weight +/-350 kip
- Installation plan required multiple ringer setups and set downs

TR/ANSYSTEMS

Changeout Day 1-2

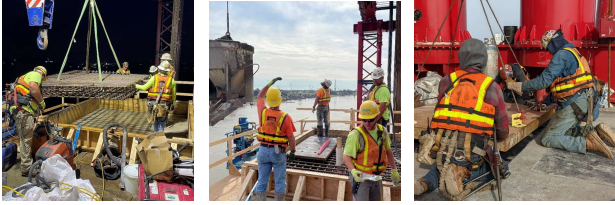
- Attach Existing Span Demo Lugs to Gantry
- Float-in / Position Demo Barges
- Lower Existing Truss



TR SYSTEMS

Changeout Day 3-4

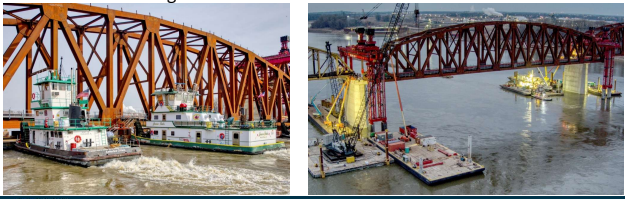
- Drill Anchor Holes
- Install Rebar Cages
- Pour New Risers on Pier
- Install Masonry Plates



TR SYSTEMS

Changeout Day 5-6

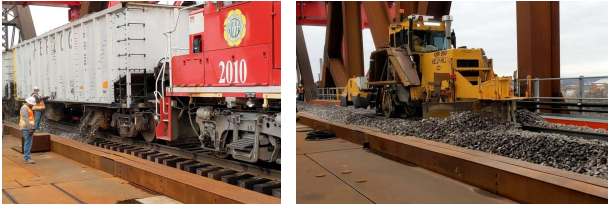
- Float in New Truss
- Lift, Slide and set down with gantry
- Weld Bearings



TR SYSTEMS

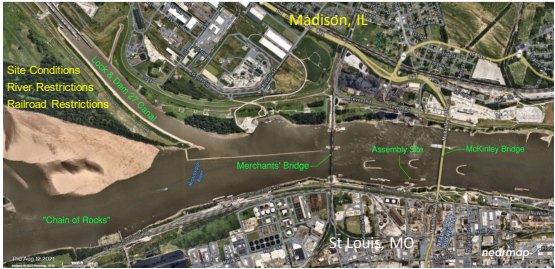
Changeout Day 7-8

- Install Ballast & Track




TR SYSTEMS

Assembly Location



TR SYSTEMS

River Conditions



TR SYSTEMS

River Conditions

Span 1

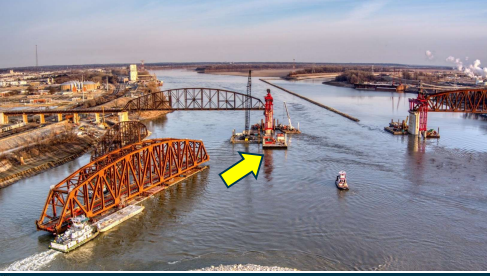
- Located within Main Navigation Channel
- Peak Stream flow 1-2 fps
- Tugs served as main control of tow
- Winches and cables use for controlled adjustments

Span 2 & 3

- Located outside Main Navigation Channel
- Peak Stream flow **8-13 fps**
- Tugs served as main control of tow – **14,000 HP!**
- Backup winches and cables installed in event tugs lose tow

TRANSYSTEMS

Span 2 - Changeout



TRANSYSTEMS

Span 2 - Changeout



TRANSYSTEMS

Span 2 - Changeout



Secondary mooring lines to Winches

14,000 HP of Tugs

TRANSYSTEMS

Span 2 - Changeout



TRANSYSTEMS

Span 3 - Remove Existing Span



TRANSYSTEMS

