Pecos Street over I-70 Bridge Replacement Project

Post-Bridge Move

Technical Workshop

July 31, 2013

DOT
DEPARTMENT OF TRANSPORTATION

WILSON & COMPANY
ENGINEERS & ARCHITECTS

Kiewit
Infrastructure Group

Project Goals

1. Advance knowledge, experience & cost efficiency of the CDOT construction program and the construction industry in ABC and CM/GC project delivery
2. Provide a well publicized, highly successful ABC project
3. Replace the poor structure, and improve traffic operations and safety within the project budget
4. Accelerate delivery of construction schedule & complete by October 1, 2013
5. Minimize inconvenience to traveling public, & maximize safety of workers & traveling public
6. Facilitate a collaborative partnership with all of the members of the project team and stakeholders
7. Provide a high quality design and construction

Project Timeline

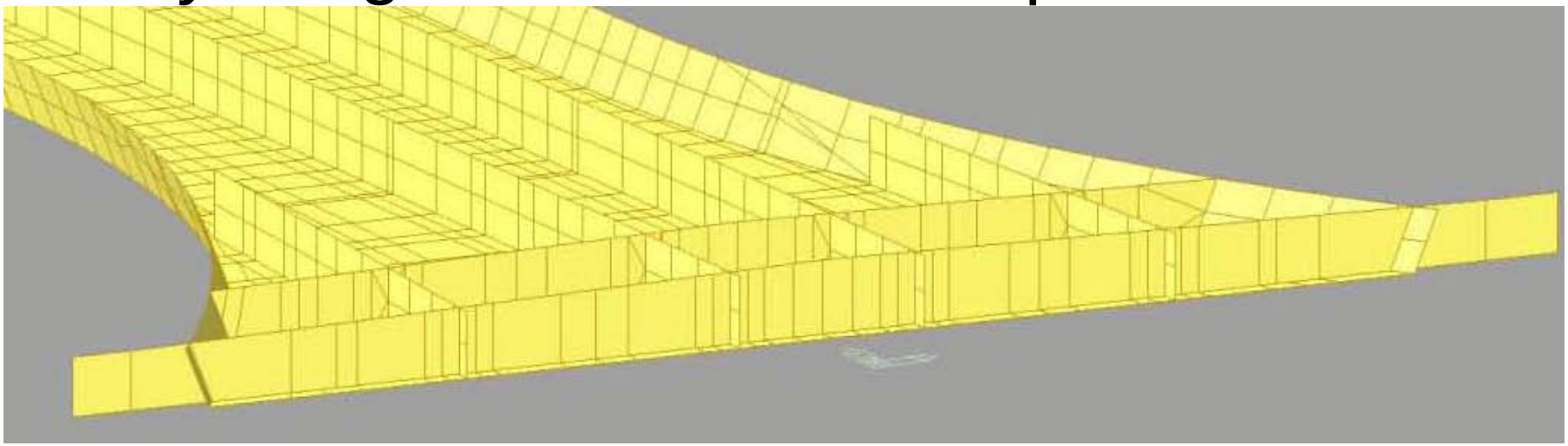
- November 2, 2012: Kiewit NTP
- January 2013: Begin Bridge Construction
- June 2013: Final Concrete Pour
- June 24, 2013: Close Pecos Street
- July 19-July 21: 50 hour Closure of I-70
  - 19th 10:30pm: close I-70, begin bridge demo
  - 20th noon: begin moving bridge
  - 21st 1am: place bridge in final position
  - 22nd 12:30am: open I-70
- September 2013: Complete Construction

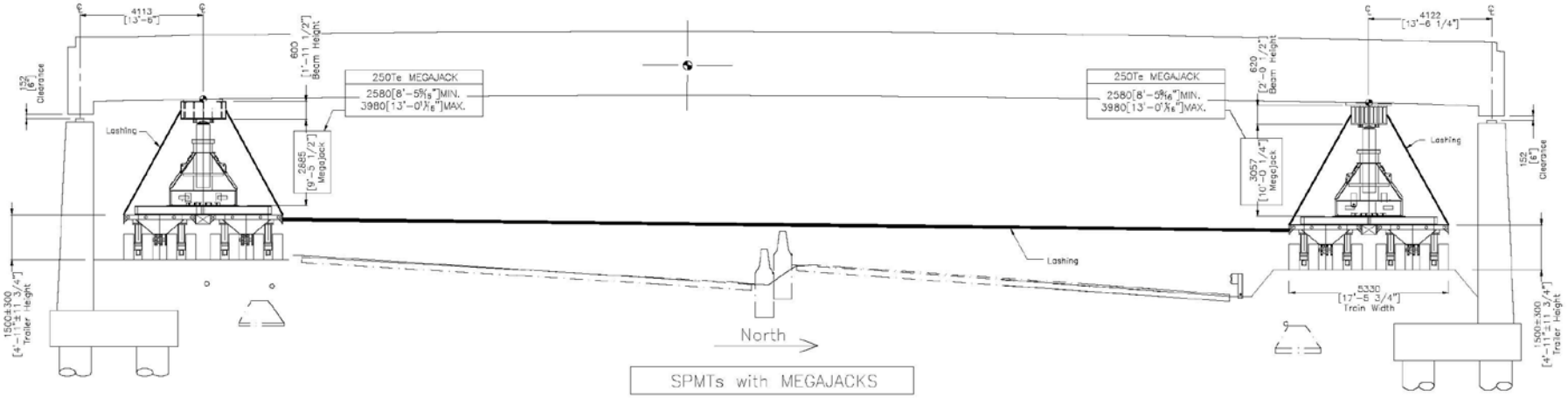
Preparations for the Bridge Move

- Unique bridge move using SPMTs required special superstructure design
- CMGC delivery method allowed collaboration between designer and contractor
- Lifting diaphragm over SPMTs was permanently built in to superstructure
- 631 Bridge Move (Roll) Specification required 10 submittals to approve equipment, travel path, move distortion monitoring, QC, etc.—and stamped by Colorado PE

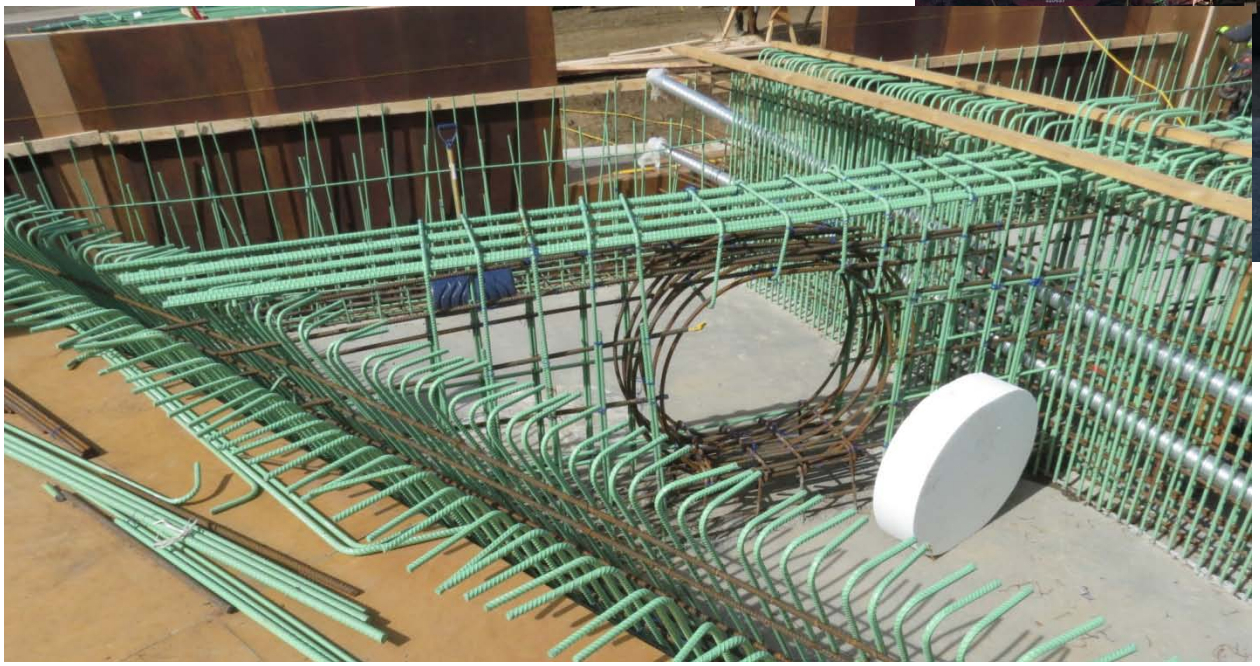
Lifting Diaphragm

- Key bridge element for transport





Lifting Diaphragm



Bridge Farm

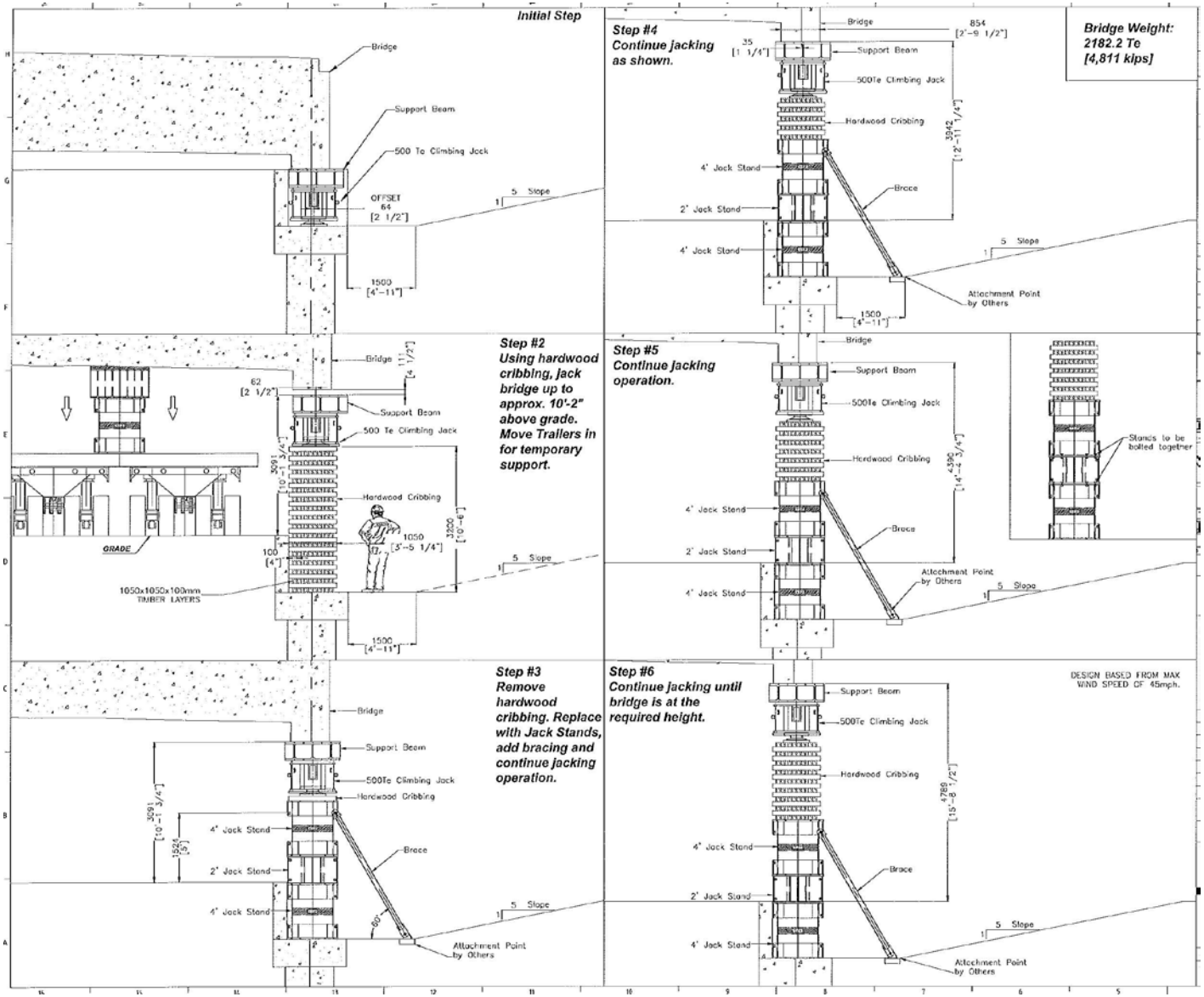
- Bridge cast on “rat slab” (concrete pad)
- Jack vaults built underground to lift bridge
- Bridge jacked up using ironwood and lifting jacks
- Load transferred to lifting diaphragms temporarily to switch out ironwood with jack stands
- All components designed and approved by CDOT

Bridge Farm – “Rat Slab”

“Rat slab”

Jacking vaults

Bridge Farm – Jacking Bridge



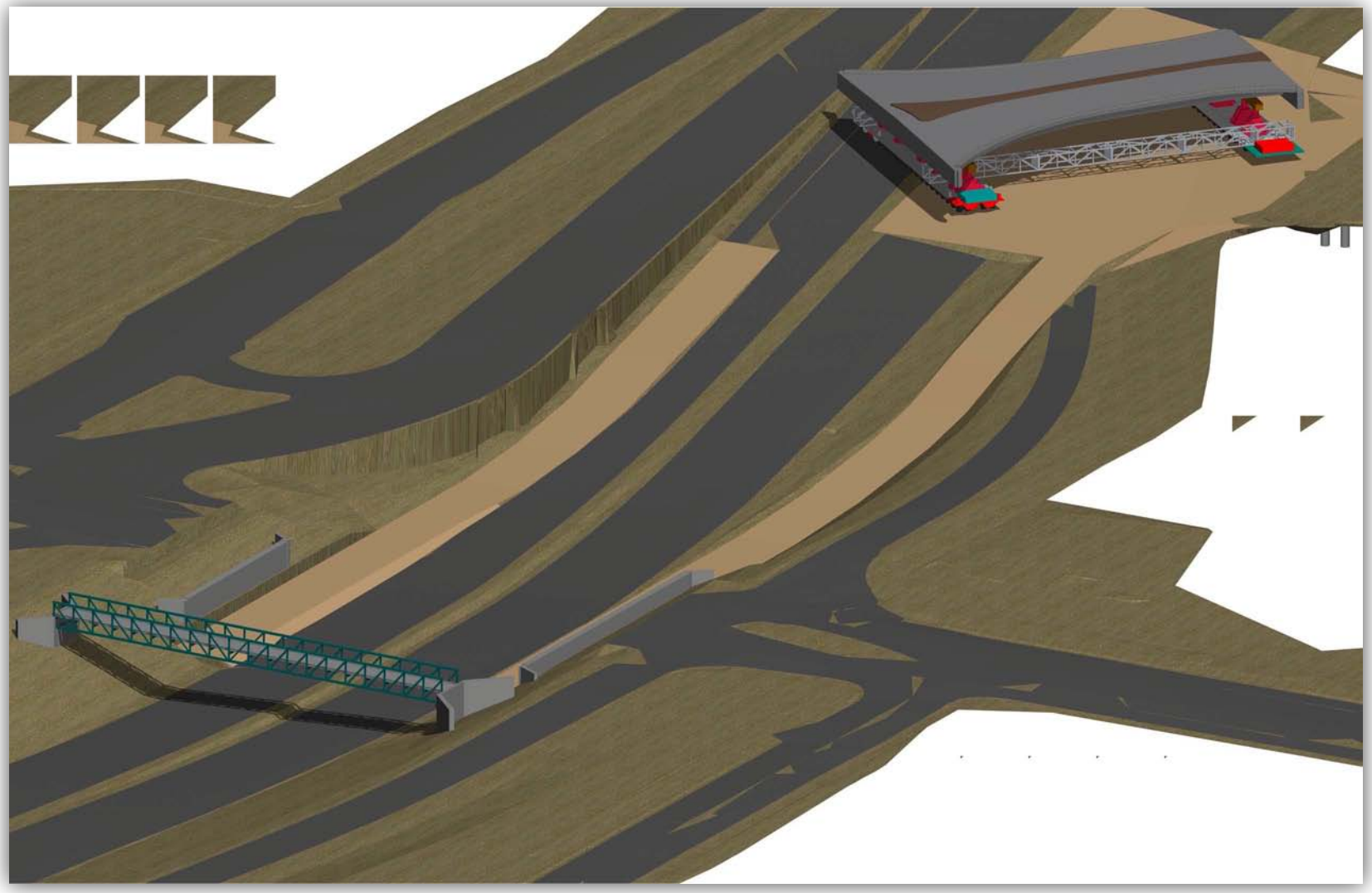
Bridge Farm – Jacking Bridge

Bridge Farm – Jack Stands

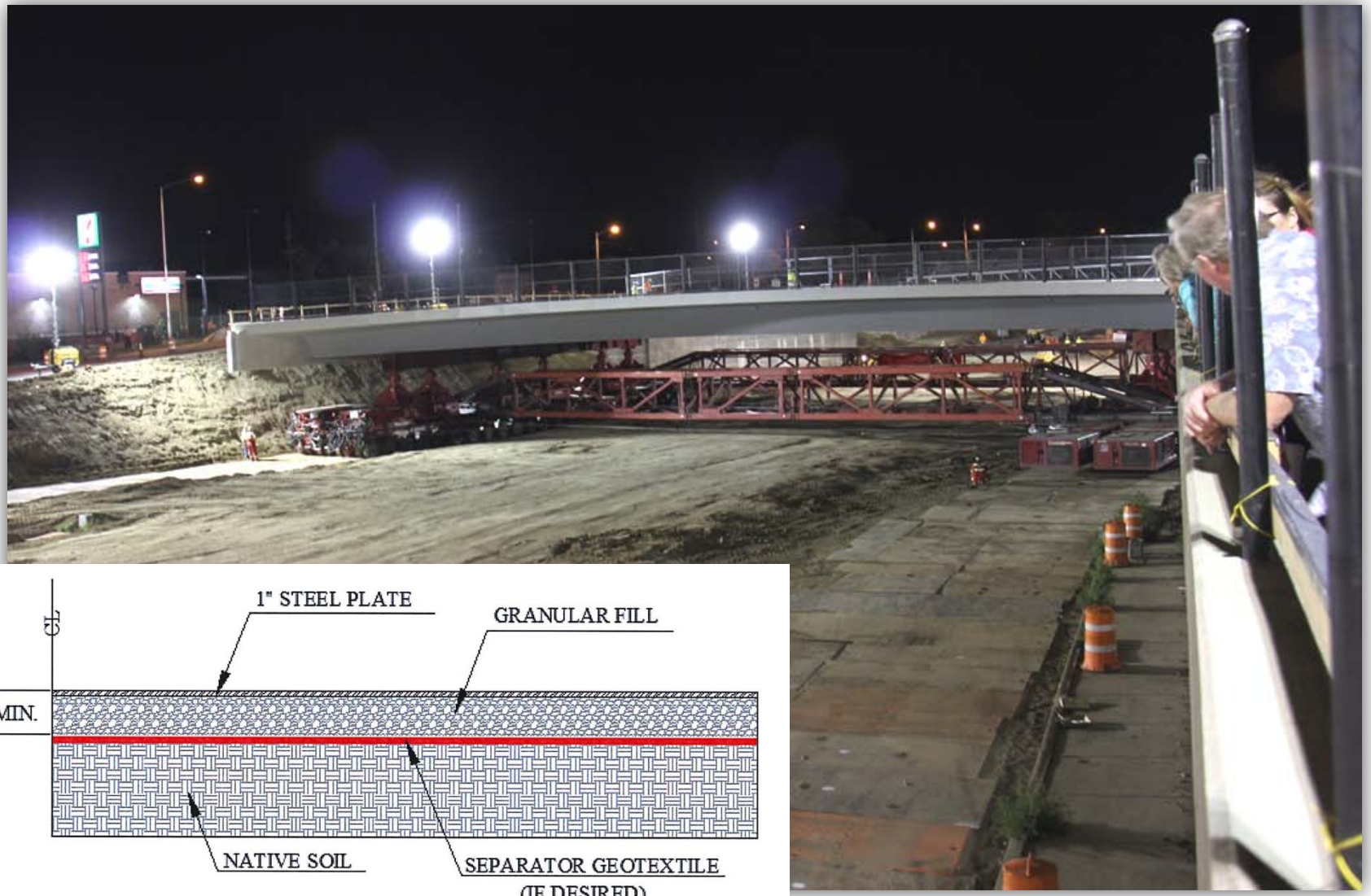
Preparation of Travel Path

- Travel path alignment designed to be compatible with bridge footprint
- Maximum path grades were limited to 3% (2% for SPMTs)
- Foundation fortified to support 6.5 ksf
- Travel path surface used 1-inch thick steel street plates to prevent tires from digging in to soil

Travel Path Geometry



Travel Path Foundation Design



Travel Path for SPMT's

- How SPMT's work
- Working with Mammoet
- Temp Bearing Plates
- Crack Repair

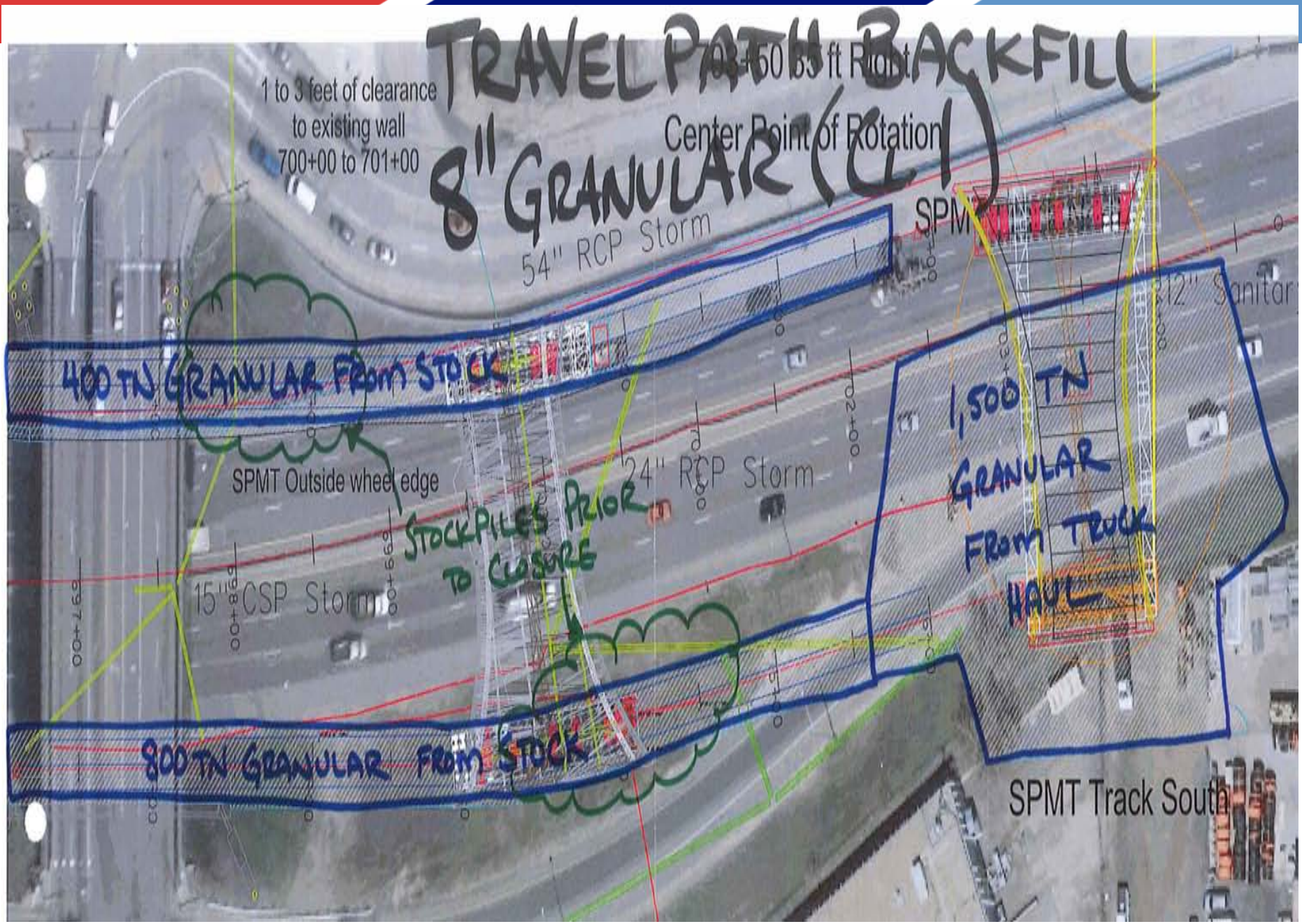
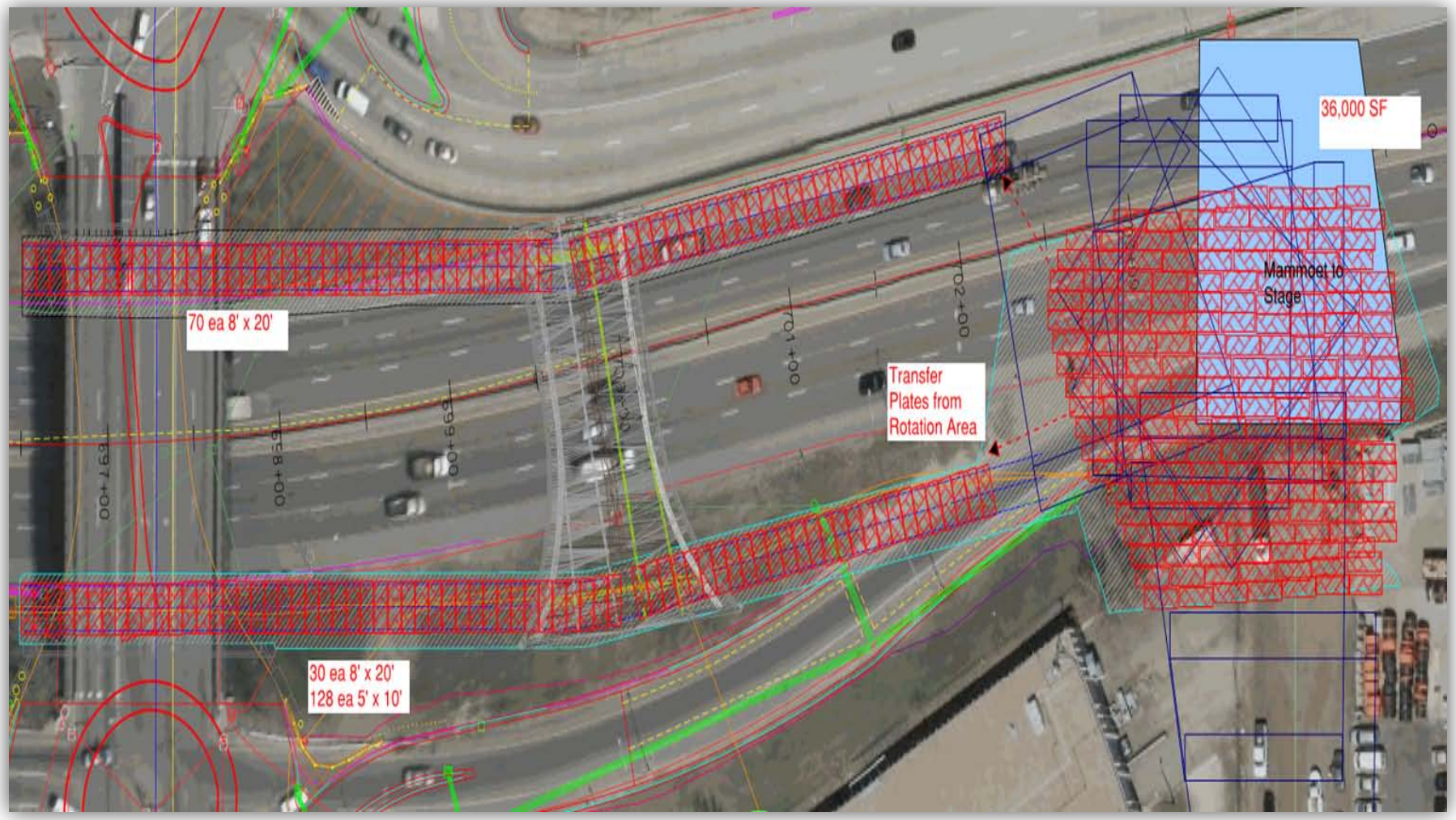

TRAVEL PATH BACKFILL
8" GRANULAR (CL)
1 to 3 feet of clearance
to existing wall
700+00 to 701+00
Center Point of Rotation
54" RCP Storm
SPMT
400 TN GRANULAR FROM STOCK
SPMT Outside wheel edge
24" RCP Storm
STOCKPILES PRIOR TO CLOSURE
15" CSP Storm
1,500 TN GRANULAR FROM TRUCK HAUL
900 TN GRANULAR FROM STOCK
SPMT Track South

Plate Plan View
(Over 520 Plates)



SPMT's

- 96 axles lines
- 4 trailer lines
  - (coupled in pairs)
- 2 Pairs
  - North Abutment = 114'- 10"
  - South Abutment = 119'- 5 1/2"
- 11ea 250Tn Mega Jacks
- 261,933 lbs support beams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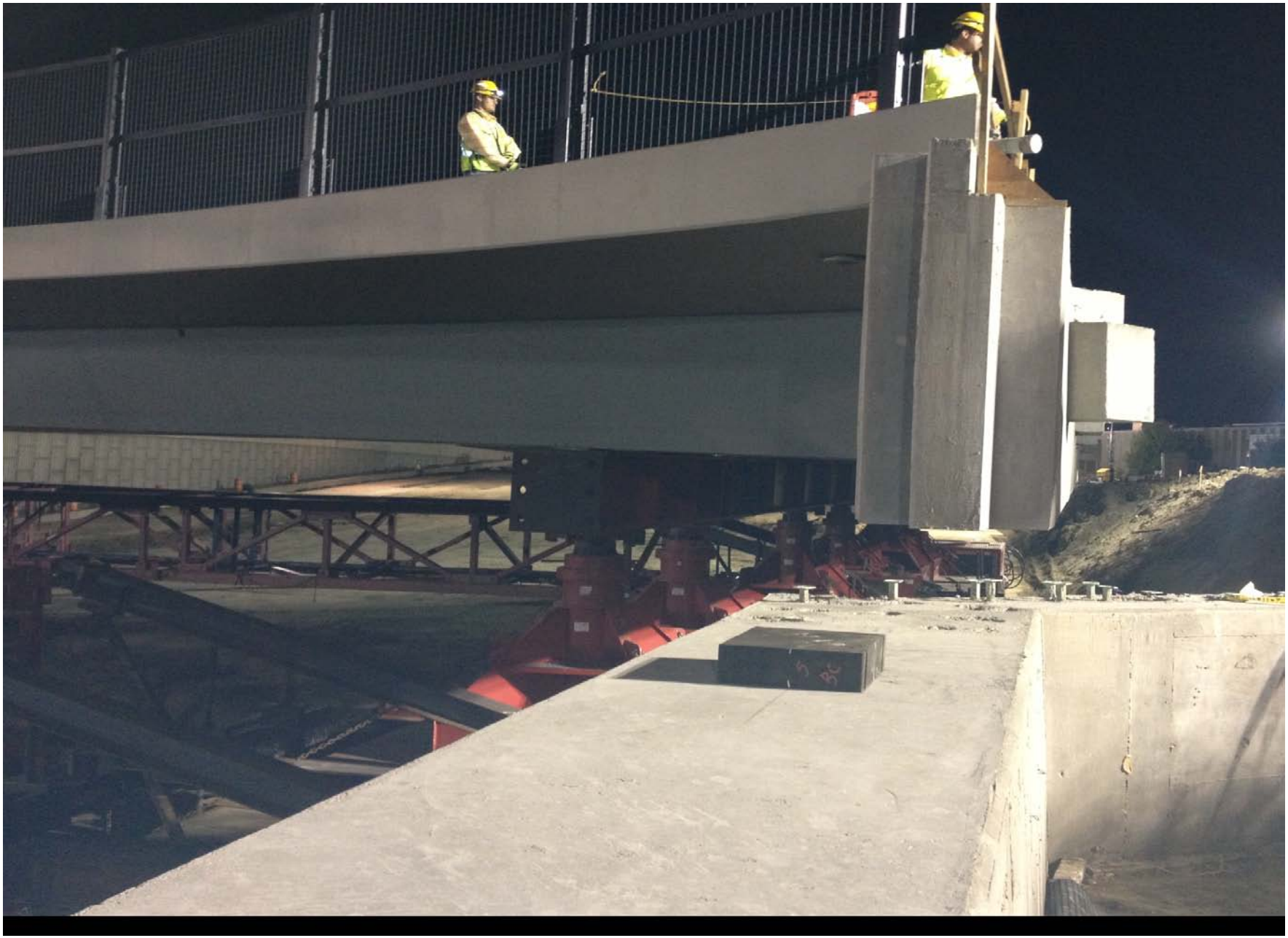
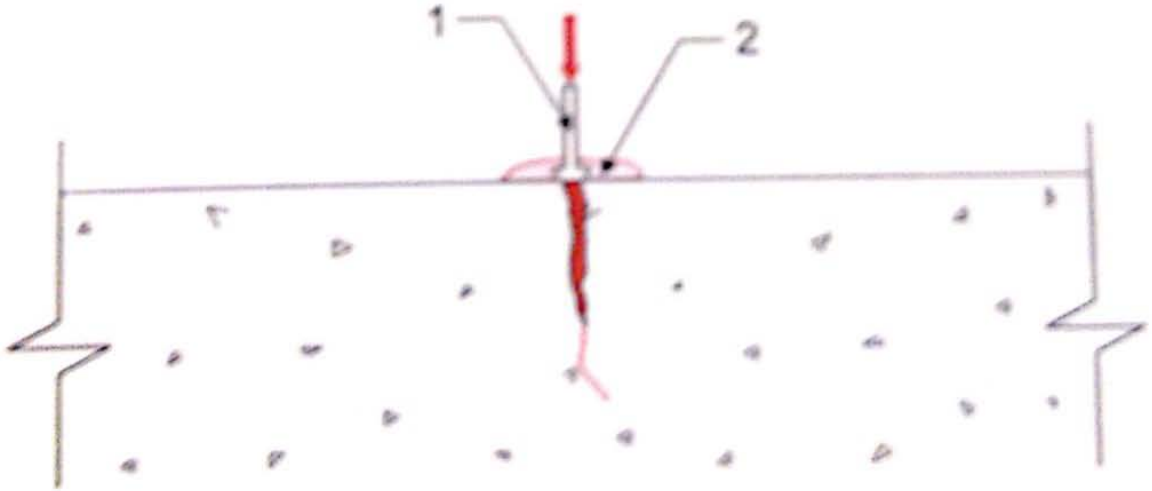
Mammoet's Crew

Temporary Bearing Plates

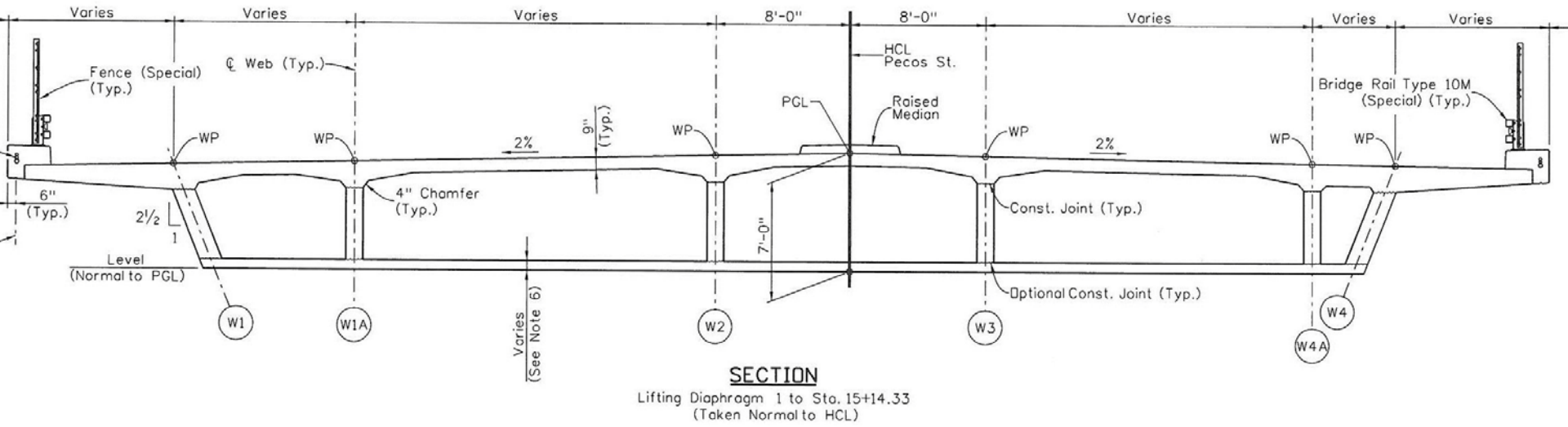


Typical Crack Repair



Post-Tensioning in Superstructure

- Bridge plan-view configuration affected by roadway geometry, especially roundabouts
- Post-tensioned cast-in-place concrete box girder
- Multi-cell box girder

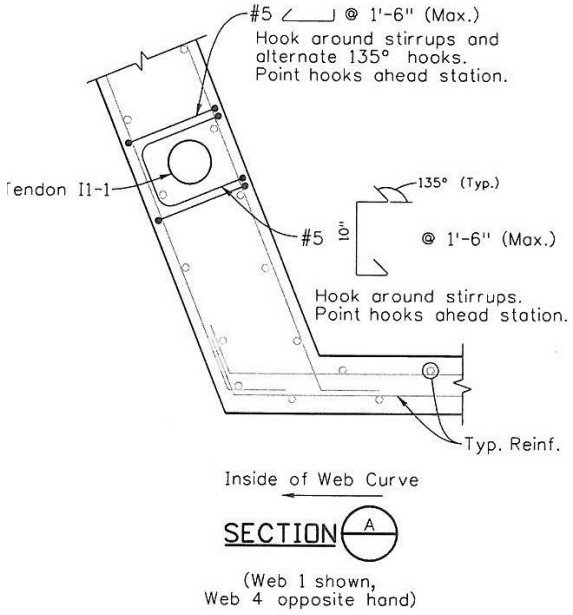


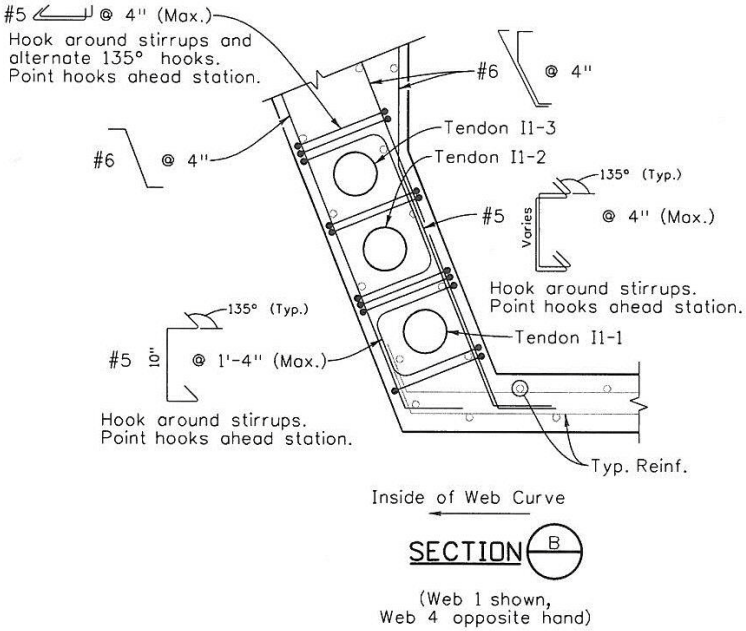
Post-Tensioning in Superstructure

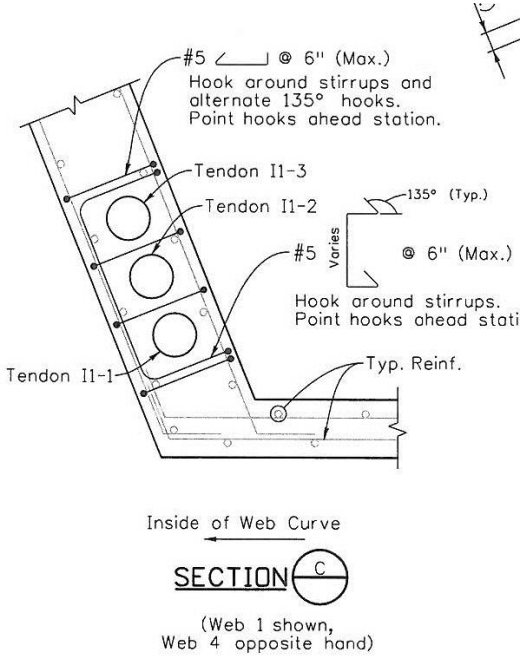
4 types of post-tensioning in superstructure

- Longitudinal internal tendons
- Longitudinal external tendons
- Vertical tendons in end diaphragms
- Transverse deck tendons

Longitudinal Internal Tendons

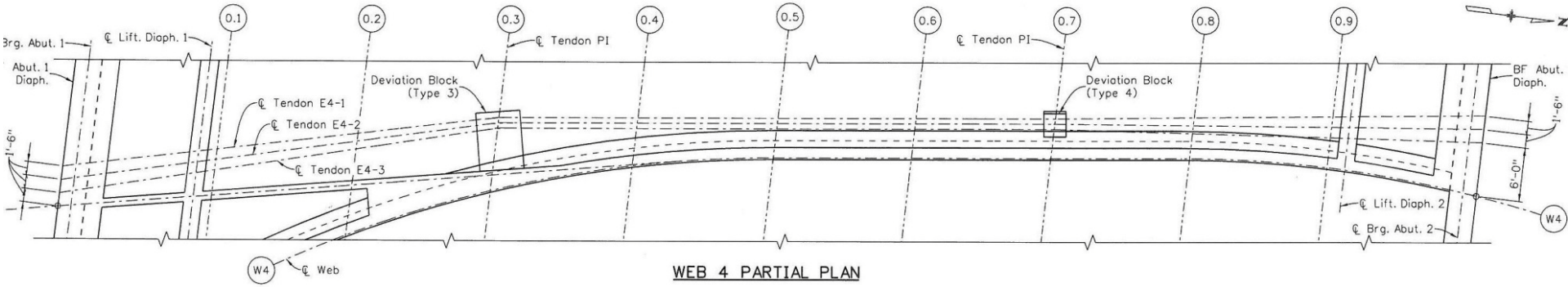




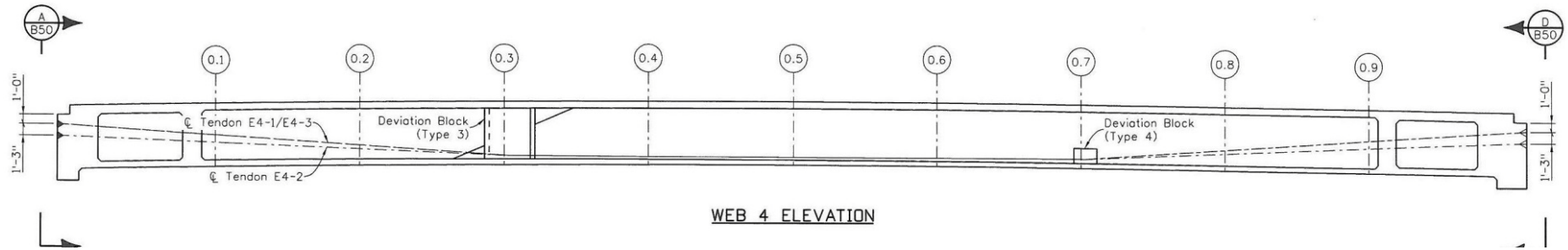


Longitudinal Internal Tendons

Longitudinal External Tendons



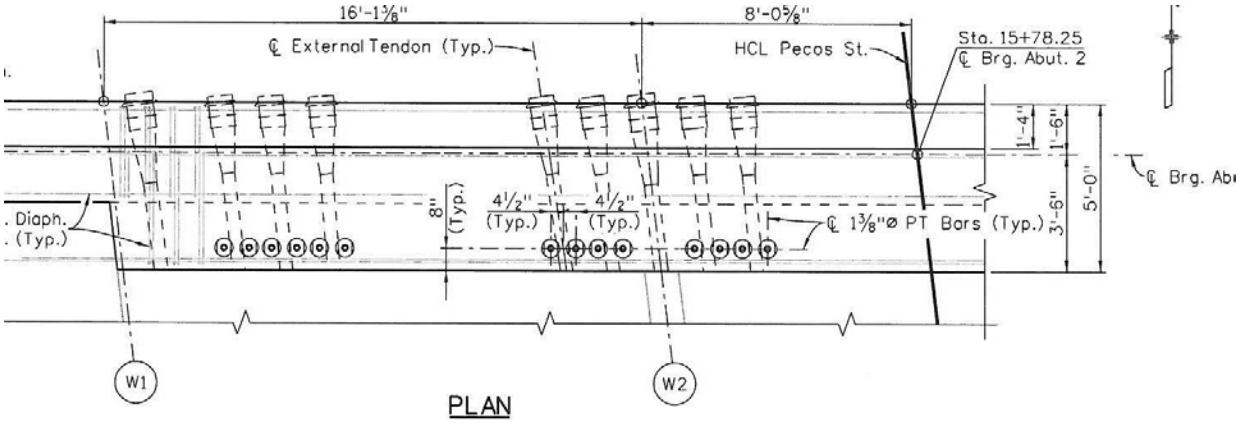
WEB 4 PARTIAL PLAN

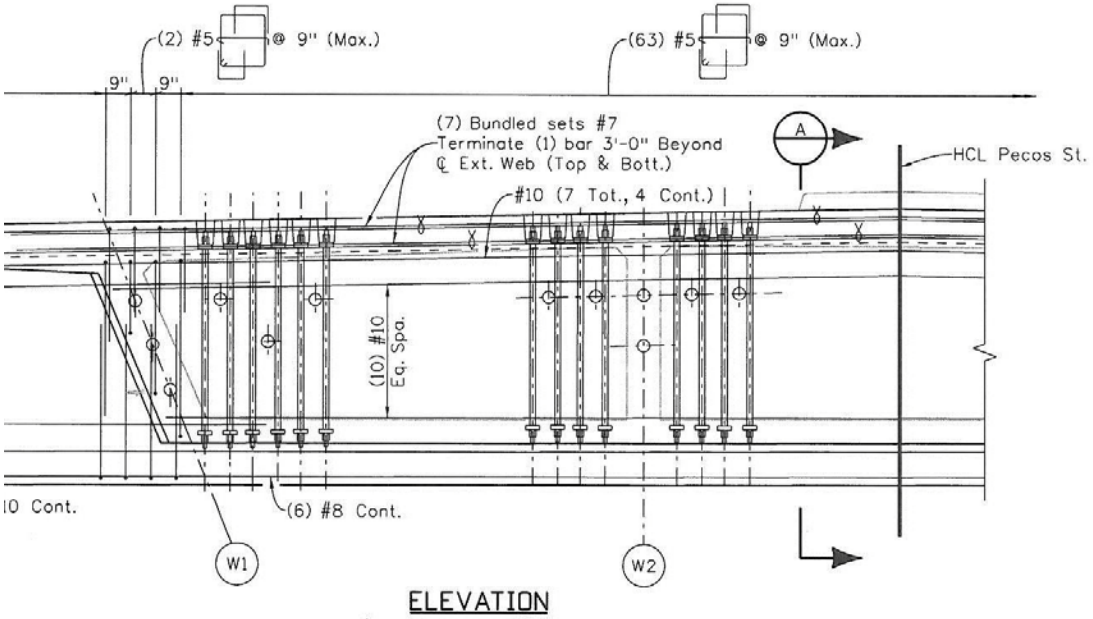


WEB 4 ELEVATION

Longitudinal External Tendons

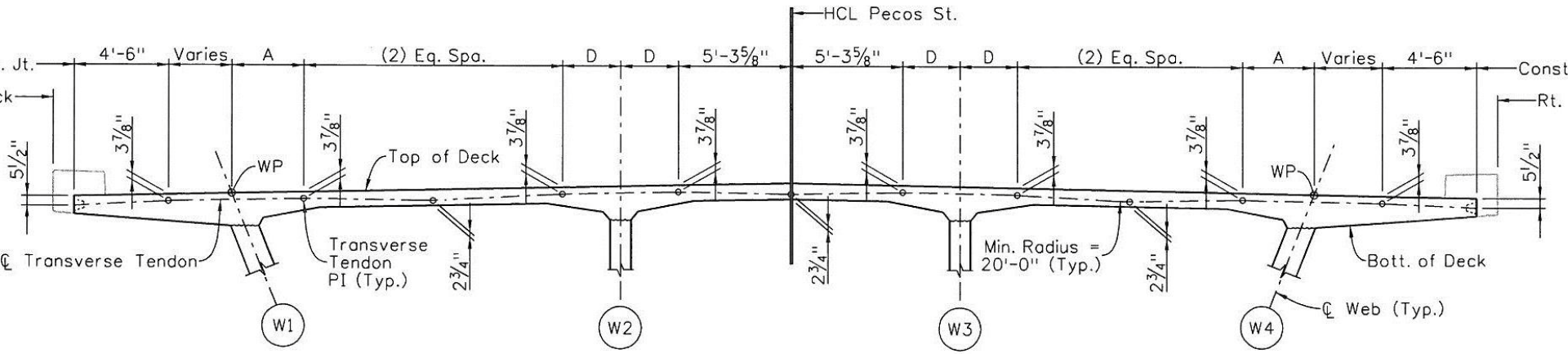
Vertical Tendons in End Diaphragms





Vertical Tendons in End Diaphragms

Transverse Deck Tendons



TENDON PROFILE - TYPE IV

(For Dimensions A & D, see Notes)

Transverse Deck Tendons

Post-Tensioning Summary

- Post-Tensioning was accomplished in 5 days
- Grouting was accomplished in 3 nights

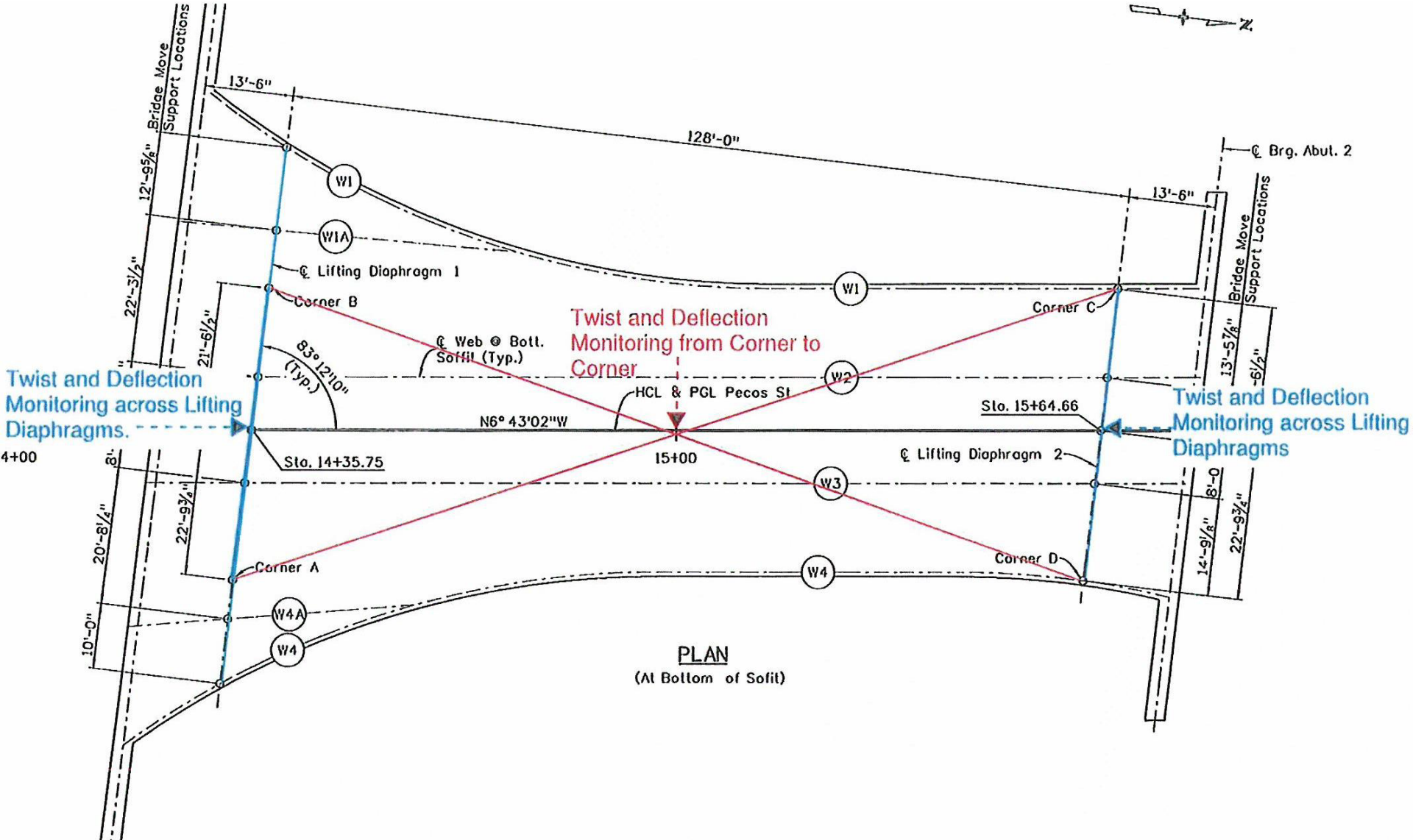
Monitoring During Lifting, Transport

- Bridge performance and durability
  - Strength limit state (capacity > loads)
  - Service limit state (stresses < allowables, deflections)
- Twist magnitude affected reactions for lifting
- Deflections and Twist monitored during lifting, transport
- Tolerances defined in Bridge Move specification
- Geometry Control Plan

Monitoring During Lifting, Transport

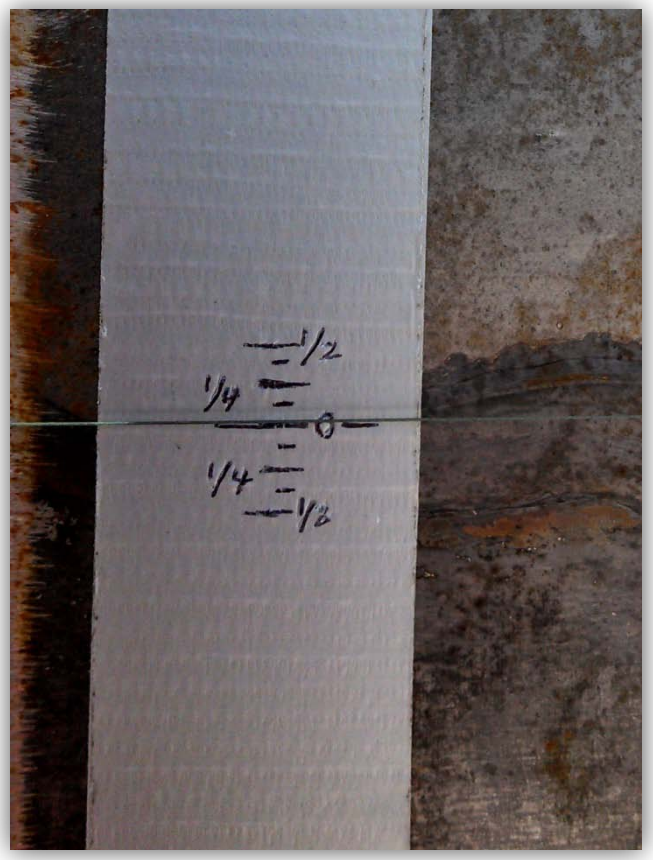
- Geometry control plan
- String lines for monitoring deflections, twist
- Survey monitoring
  - 4 point monitoring for pitch and roll
  - 12 point monitoring for twist
- String lines monitoring was primary

Monitoring During Lifting, Transport



Monitoring During Lifting

- Deflections, twist, monitored during lifting



Monitoring During Lifting

- Lifting was at 10 support locations under End Diaphragms
- Deflections and twist monitored at Lifting Diaphragms during lifting
- Long Lifting Diaphragm deflections 1/4” or 3/16”
- Twist max 3/4” : within tolerance

Monitoring During Transfer of Support

- Deflections, twist monitored during transfer of support to Lifting diaphragms

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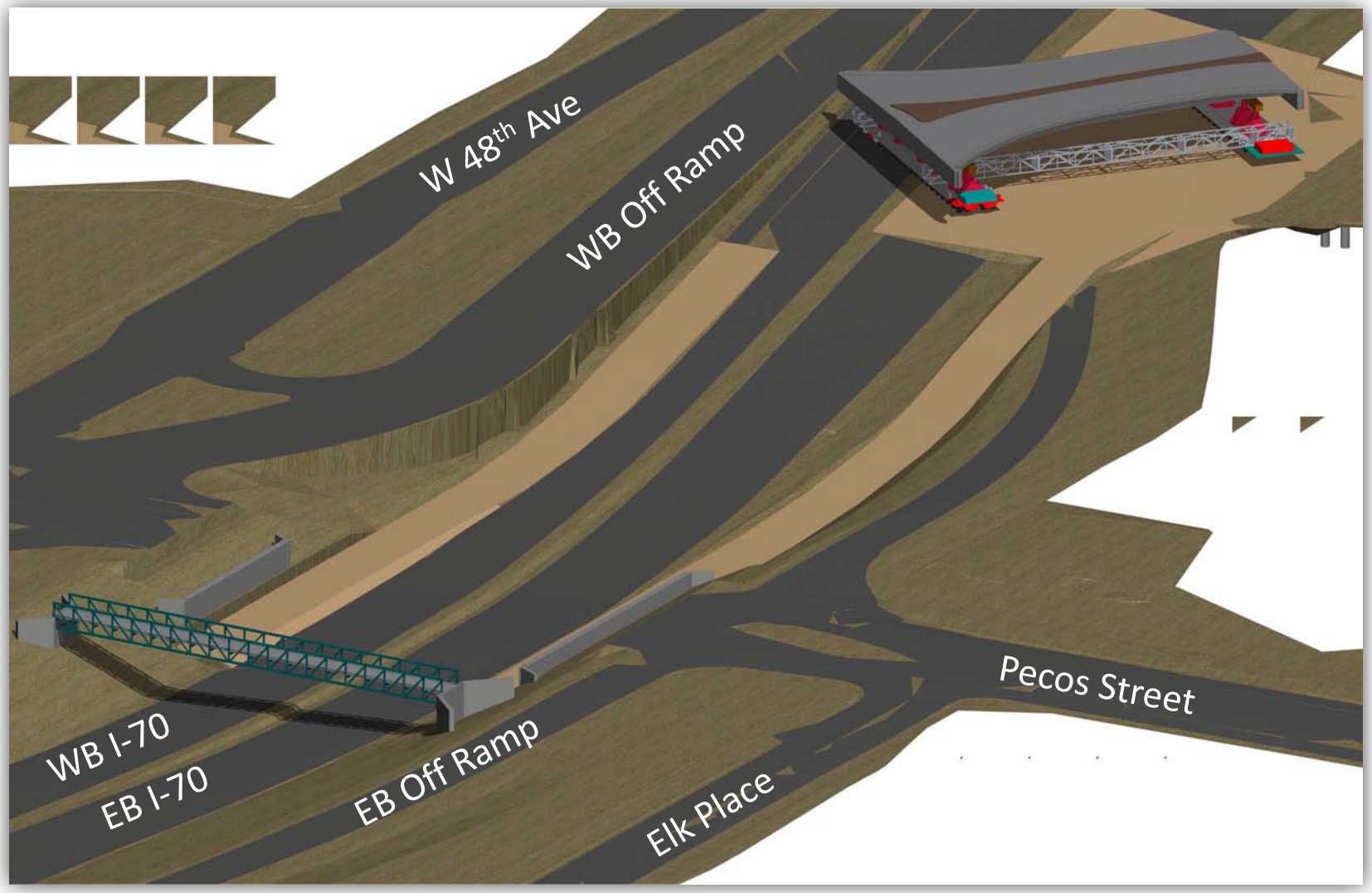
Monitoring During Transport

- Deflections monitored during transport
- Twist monitored during transport

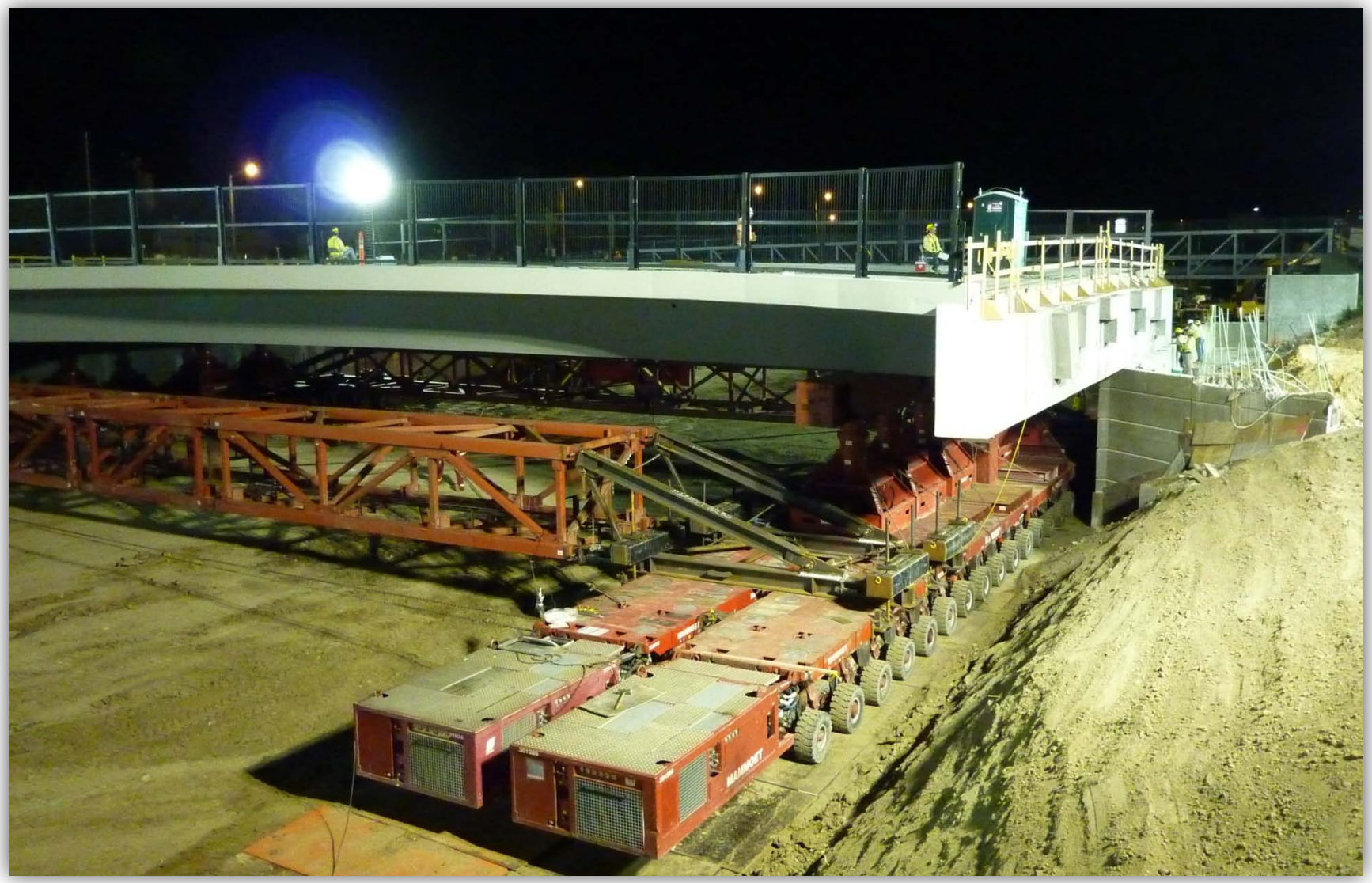
Monitoring During Transport



Monitoring During Transport

- Deflections, twist monitored during transport

Monitoring Final Position of Bridge



Monitoring Final Position of Bridge

- Accelerated Bridge Construction: superstructure and substructure constructed simultaneously
- Superstructure constructed 3/4” long, versus 1/2” elastic shortening due to post-tensioning
- Abutments constructed 1” toward fill, versus ~ 1/2” deflection due to lateral soil pressure
- Survey of superstructure and substructure
- Best fit longitudinal and transverse

Monitoring Final Position of Bridge

- Best fit of superstructure on substructure
- Transverse position (east-west)
- Longitudinal position north-south)

Monitoring Final Position of Bridge

- Bearing devices: supports of superstructure on substructure
- Shims installed on some bearings to achieve:
  - Uniform vertical support height
  - Deflections and twist within tolerance
- Assessment of superstructure condition for cracks or concerns per Bridge Move specification
- Very few cracks in superstructure
  - Bridge design, including post-tensioning
  - Lifting and transport design

Field Visit: Status of Construction

- Bridge superstructure is in final position on Abutments
- Retaining walls and wingwalls construction is on-going
- Flow-fill backfill placement for walls > 0.8 f’c
- Roundabouts

Field Visit: Viewing Location

- W 48th Ave / Osage; walk to gate; stay in group