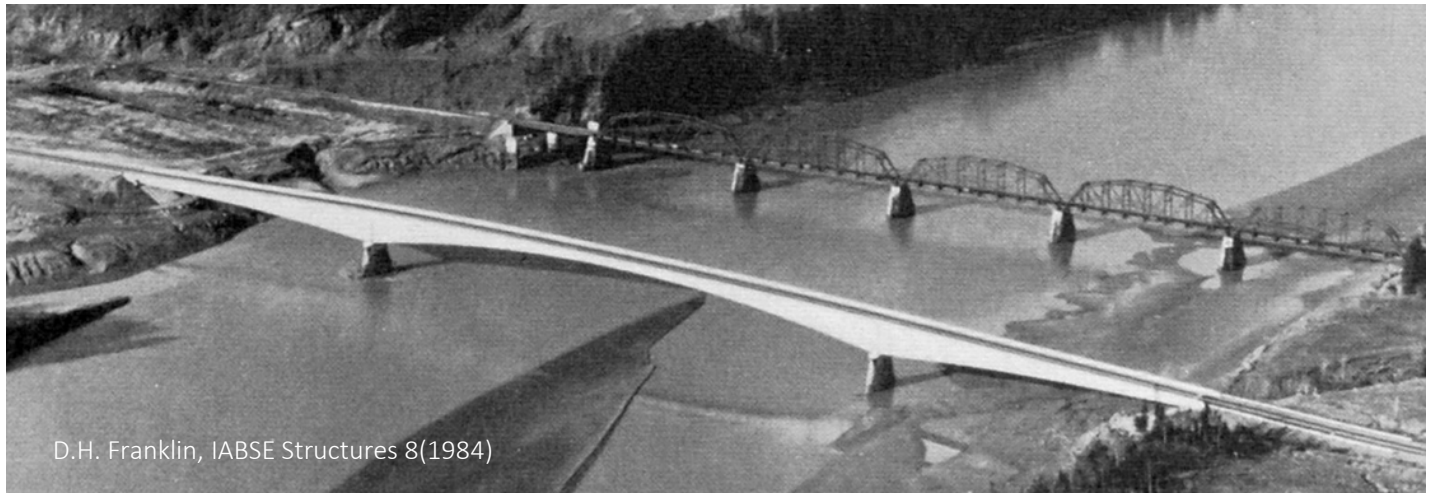
Clarence L. Gosse Memorial Bridge Rehabilitation



Christopher R. Dyck, M.Sc., P.Eng.
Senior Bridge Specialist

COWI

Western Bridge Engineers Seminar, Phoenix AZ, December 5-8, 2023

NOVA SCOTIA

Agenda

- Project Elements and Team
- Bridge Description
- Project Goals
- History of Construction and Midspan Sag Development
- Preventative Maintenance
- Concrete Deck Assessment
- Concrete Deck Repairs
- Waterproofing Membrane Selection and Replacement
- Expansion Joint Replacements
- Midspan Joint Bearing Block Replacements
- Midspan Sag Assessment
- Questions

Project Elements & Team

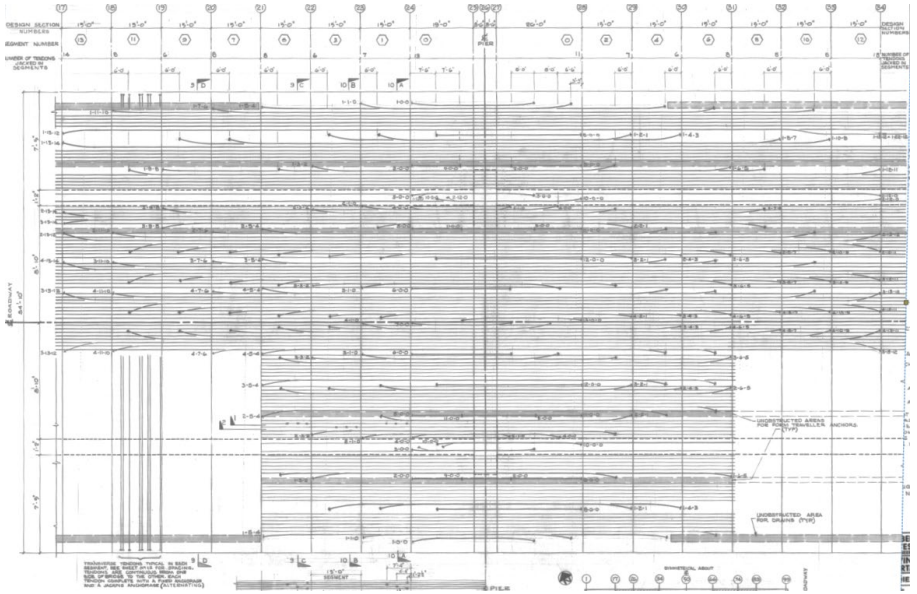
- **Design Management**: Nova Scotia Public Works (Chris Dyck, M.Sc. P.Eng.)
- **Construction Management**: Nova Scotia Public Works (Ray Daniels, P.Eng.)
- **Concrete Deck Assessment**: Wood (Chris Barnes, P.Eng., Ph.D.)
- **Tendon Assessment**: W.S. Langley Concrete (Wib Langley, P.Eng.)
- **Structural Design**: Harbourside Engineering Consultants (Wade Pottie, ing., P.Eng.)
- **Bridge Cleaning**: Balfour Property Restoration
- **Concrete Rehabilitation Contractor**: Wilcraft Concrete Services (Troy Grant, P.Eng.)
- **Licensed Membrane Installer**: Wilcraft Concrete Services (Troy Grant, P.Eng.)
- **Asphalt Contractor**: Miller Group under direction of Wilcraft

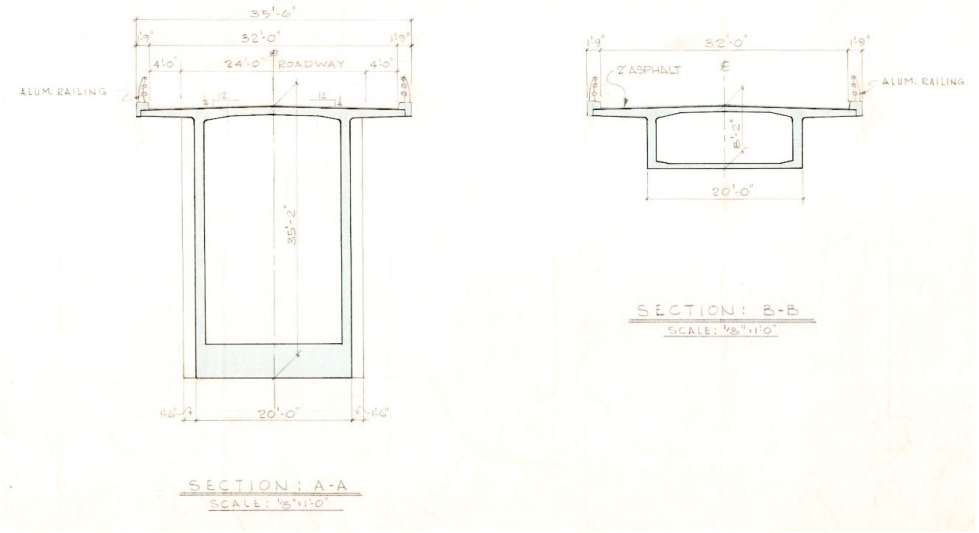
Bridge Description

- Rt 236 over Shubenacadie River
- Tributary to Bay of Fundy
- Swift river currents
  - 6 to 12 ft/s
- Tide effects:
  - -1ft to +32ft
  - River width varies 300’-1400’
  - Ice flows on tide cycle
- Main span 700’
- Side Spans 372’
- Total length 1444’

Bridge Description

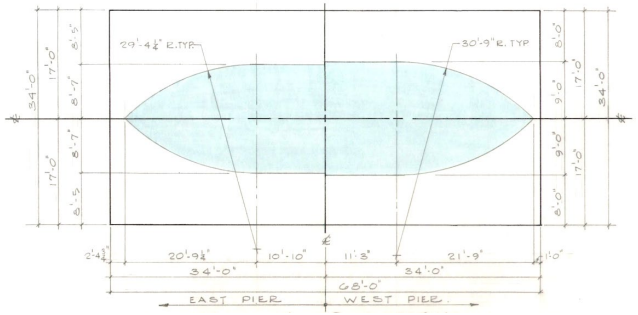
- 32’ driving surface with 2” Asphalt + Curb O/H
- Superstructure:
  - 20’ Box girder width; 7’-5” Cantilever overhangs
  - 8’ to 35’ Box girder depth
  - 14” Webs; 10” to 13” Top slab; 6” to 5’-6” Bot Slab
  - 354 - 1 ¼” DYWIDAG bar tendons crossing pier table
  - 8 – 1 ¼” DYWIDAG bar tendons anchored midspan

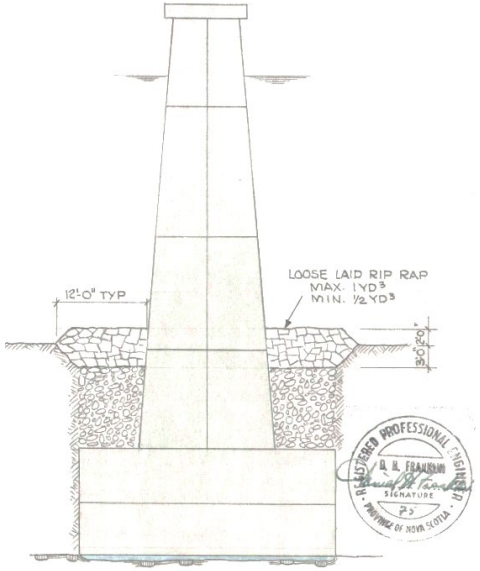




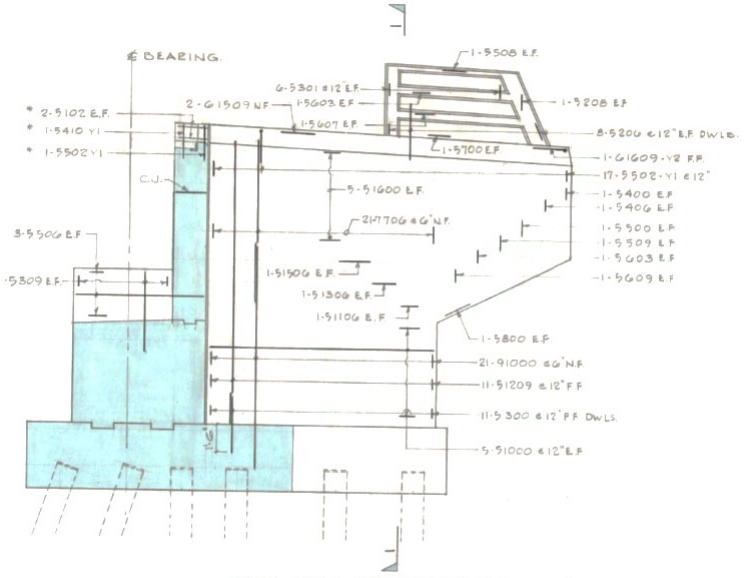
Bridge Description

- Substructure:
  - East Pier on Bedrock
  - Piled West Pier (182 H piles)
  - Piled Abutments (10 H piles)
  - 1” Steel/4” Concrete Ice Shielding on Piers





⑭ CAST FINAL SECTION OF PIER & REMOVE FRAME: 1 & SHEET PILES



WING WALL REINFORCING (2-SIMILAR)
SECTION : A-A

Project Goals

- Achieve Additional 40–50-year Service Life:
  - Improve Riding Surface
  - Clean the Bridge
  - Repair Concrete Deck, Curb, and Rail
  - Preserve the Concrete Deck Following Repair
  - Replace the Midspan Joint Bearings
  - Replace all Expansion Joints
  - Assess the Midspan Sag

History of Construction and Midspan Sag Development

- Cast-in-place balanced free cantilever method
  - East pier/cantilevers completed in winter weather
  - West pier/cantilevers completed 9 months after East half finished
  - Longest span of this type in NA at the time
- Midspan Sag Development
  - Different concrete placement, curing environments
  - Delay and non-concurrent cantilever construction difficult to overcome
  - Challenging field construction through all weather
  - More difficult at that time to predict creep and shrinkage
  - 1978-2018: 2 ft midspan sag

History of Construction and Midspan Sag Development

East Span – Note Icy Winter Conditions

West Span – Summer construction

History of Construction and Midspan Sag Development

- South Side (Facing up-river)

October 27, 1978

November 28, 2018

History of Construction and Midspan Sag Development

- North Side (Facing Bay of Fundy)

January 8, 1979

October 19, 2018

Preventative Maintenance

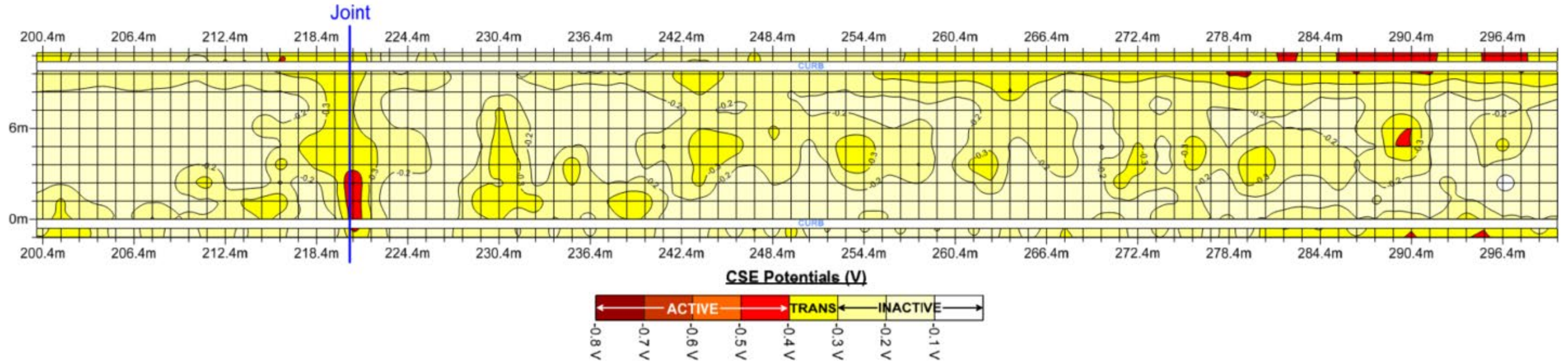
- Vandalism resulted in serious bird infestation
- Heavy steel covers installed to prevent vandalism and bird damage

Preventative Maintenance

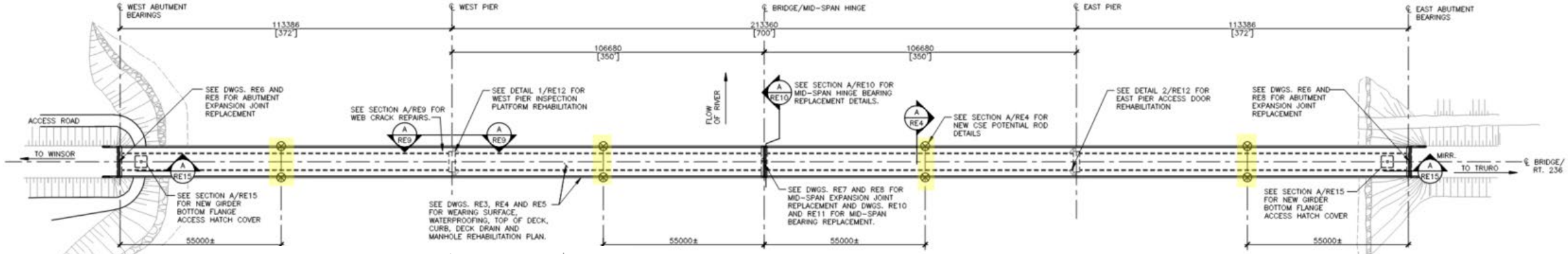
- Deck drain reinstatements
- Extension below girder soffit

Concrete Deck Assessment

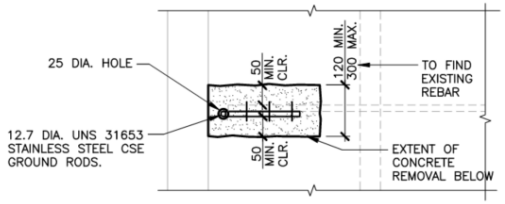
- Copper Sulphate Electrode (CSE) potential testing
  - Active and transition potential maps
    - Total Active + Transition Area = 4000 Sq.ft.
    - Actual Repair Area of Deck = 3700 Sq.ft.



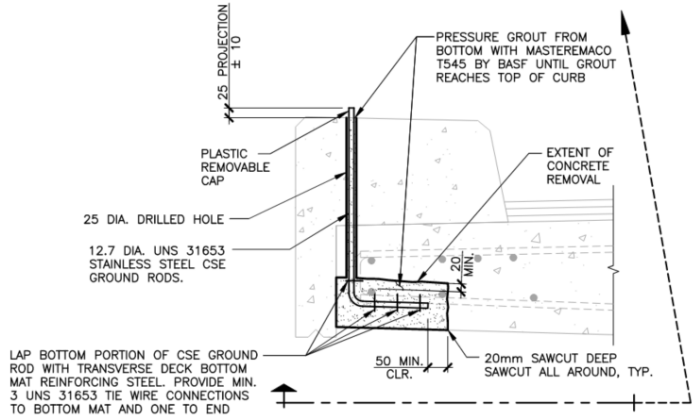
Concrete Deck Assessment



PLAN
1:650



LOOKING UP



A RE1 SECTION – NEW CSE POTENTIAL ROD
1:8

CSE POTENTIAL ROD NOTES:

1. BLAST CLEAN EXISTING STEEL TO COME IN CONTACT WITH NEW POTENTIAL RODS IN ACCORDANCE WITH DIVISION 5, SECTION 13 ON NSTIR STD. SPEC TO ENSURE PROPER CONDUCTION/ELECTRICAL CONTINUITY.
2. ELECTRICAL CONTINUITY MEASUREMENTS SHALL BE TAKEN BETWEEN GROUND ROD LOCATIONS AND SHALL NOT EXCEED 0.003 OHMS. ELECTRICAL CONTINUITY SHALL BE VERIFIED AND RECORDED BEFORE AND AFTER GROUT PLACEMENT.

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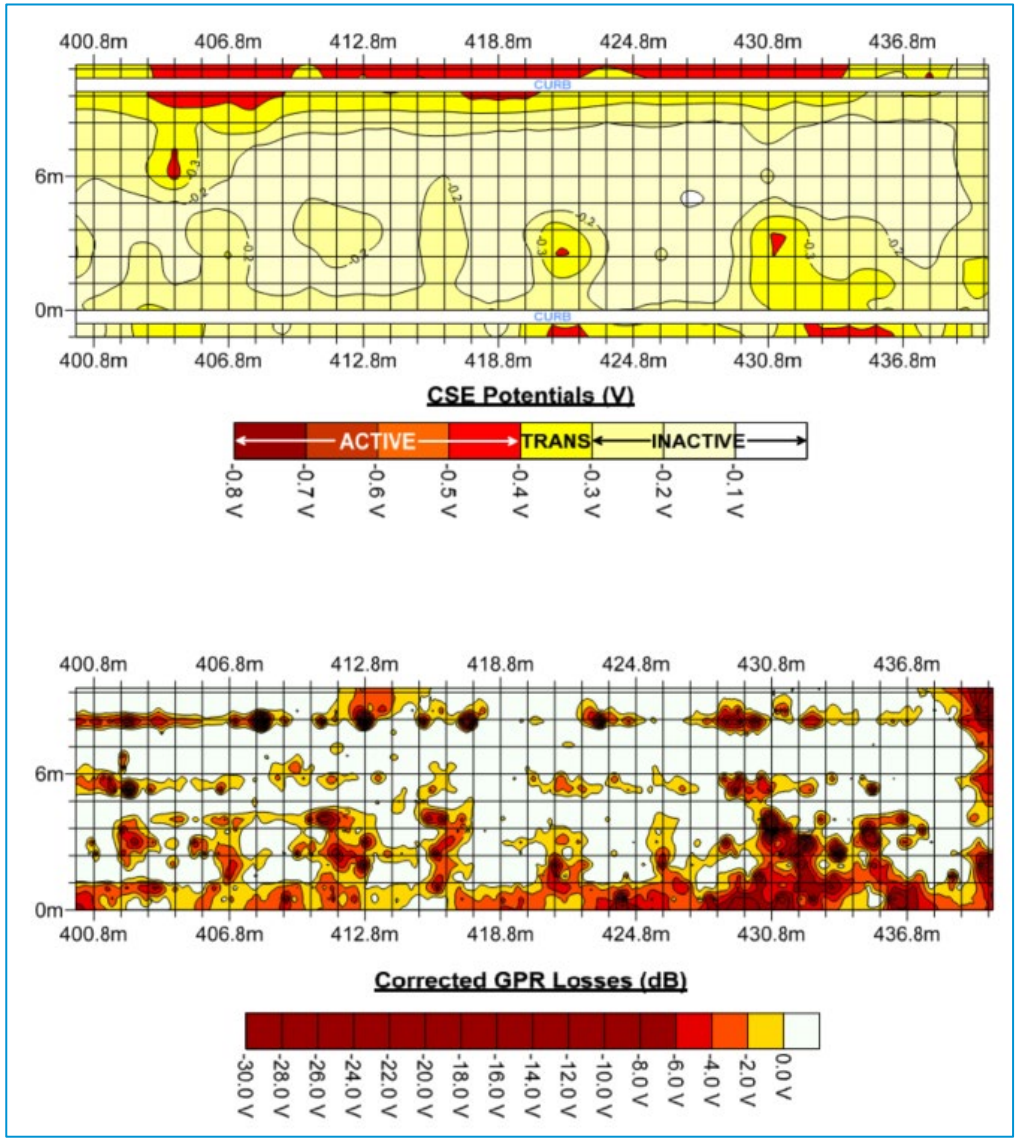
Concrete Deck Assessment

- Ground Penetrating Radar (GPR)
- Tendon Investigation



Concrete Deck and Curb Repairs

- Chain sounding of entire deck by NSDPW and Contractor
  - 3700 Sq.ft. of main deck repaired = 8% of total deck area
  - 2000 Sq.ft. of curb repaired
- Special Mix Design
  - Small aggregate
  - Low shrinkage
  - Congestion
- Tendon Protection
  - Duct perforations & exposed tendons repaired with epoxy suitable for cold climate
  - 15lb Hammers
  - Extreme caution around all tendons

Concrete Deck and Curb Repairs

Concrete Deck and Curb Repairs

Concrete Deck and Curb Repairs

Waterproofing Membrane Selection and Replacement

- Crack bridging
- Chemical, abrasion and puncture resistance
- Repairable (interlayer adhesion)
- Matacryl Membrane Selected

Waterproofing Membrane Selection and Replacement

- Matacryl CM primer applied directly to prepared concrete deck
- Quartz sand was broadcast into the wet primer

Waterproofing Membrane Selection and Replacement

- Matacryl membrane applied in several coats to required thickness

Waterproofing Membrane Selection and Replacement

Waterproofing Membrane Selection and Replacement

- Matacryl HM Tack Coat Prior to Paving

Waterproofing Membrane Selection and Replacement

- Wearing course over Matacryl membrane

Expansion Joint Replacements

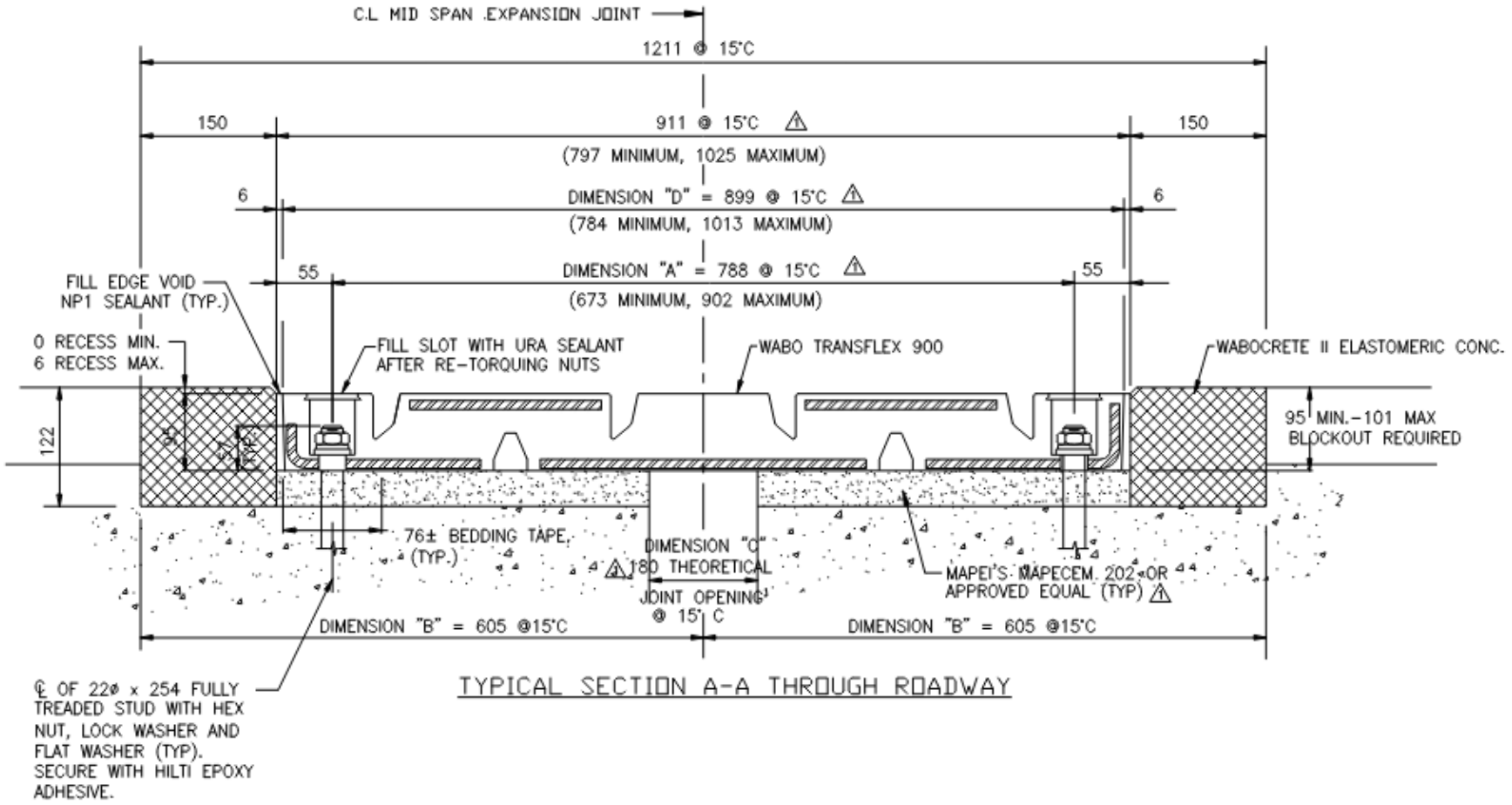
- Expansion Joint Replacements – Midspan joint assessment 2018-2019

Expansion Joint Replacements

- Expansion Joint Replacements – removal of midspan joint April 2020

Expansion Joint Replacements

- Expansion Joint Replacements – WABO Transflex 900 installed

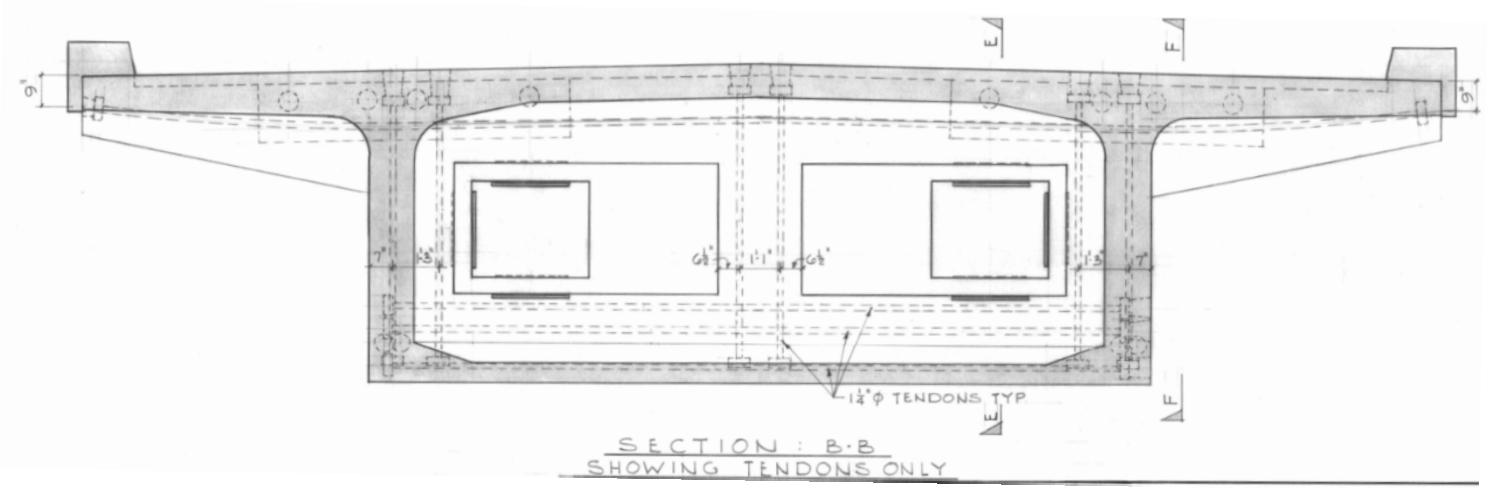


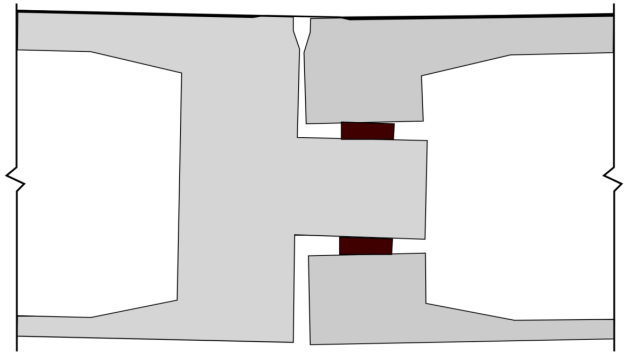
Expansion Joint Replacements

Expansion Joint Replacements

Midspan Joint Bearing Block Replacements

- Midspan sag created challenges for removal of the bearing blocks





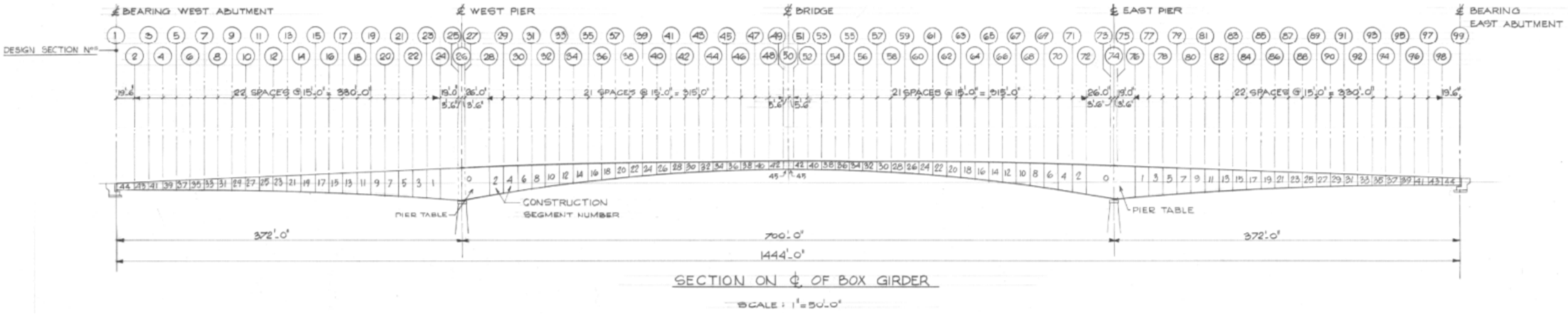
Midspan Joint Bearing Block Replacements

- Midspan Joint General Layout

Midspan Joint Bearing Block Replacements

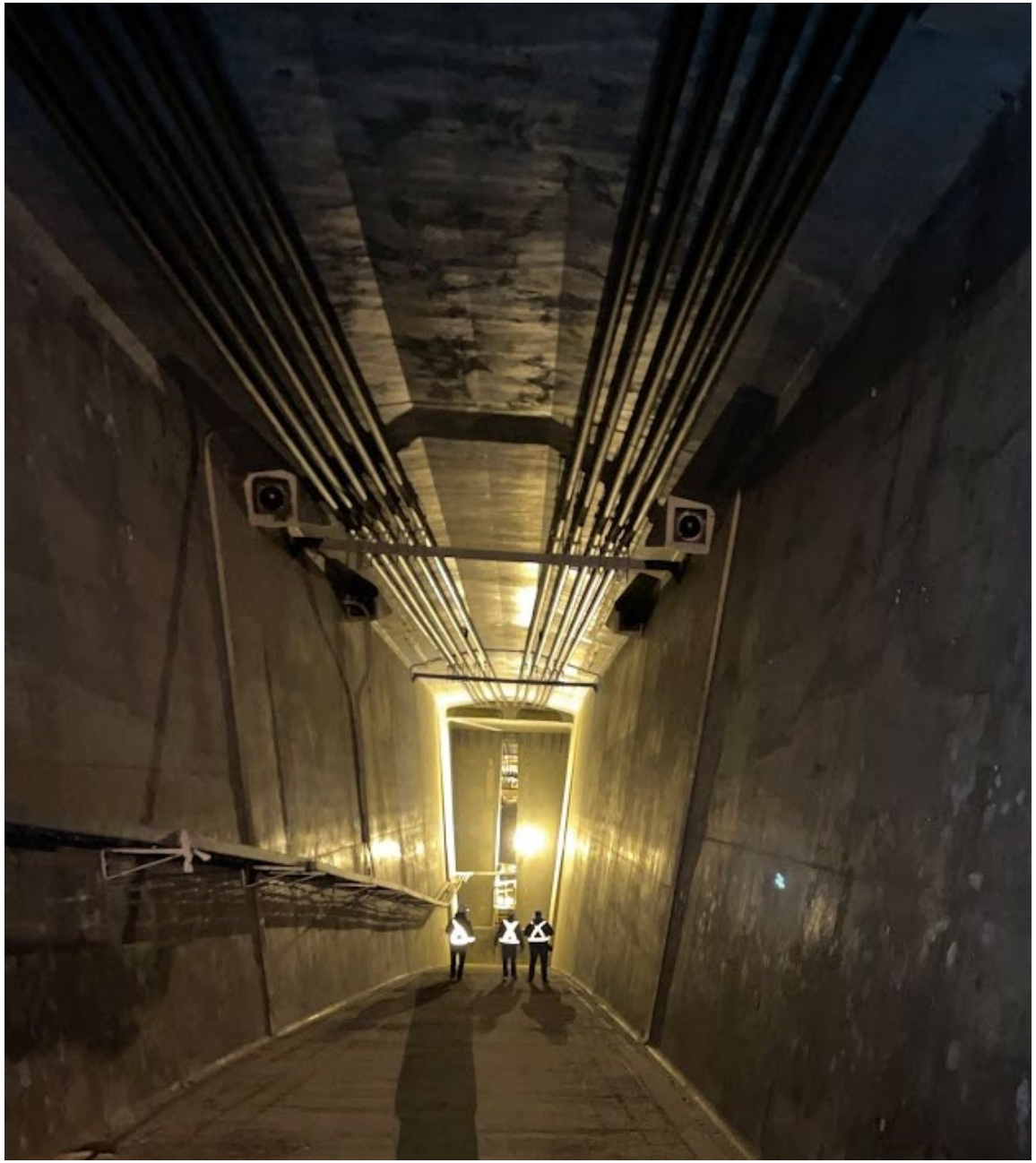
Midspan Sag Assessment

- DYWIDAG consulted (original designer from 1970s)
- All sections of cantilevers structurally stable and in equilibrium



Midspan Sag Assessment

- External PT considered to compensate for midspan sag



Midspan Sag Assessment

- External PT considered to compensate for midspan sag
  - Sufficient doubt introduced when studying the available information from the Koror–Babelthuap Bridge collapse in 1996 in Palau (Western Pacific)

Source: The Structural Engineer, 6 June 2006

  - Conclusion: Sag primarily service issue to be monitored for remaining bridge life

Conclusion

- Improved the Riding Surface
- Cleaned the Bridge
- Repaired Concrete Deck, Curb, and Rail
- Preserved the Concrete Deck Following Repair
- Replaced the Midspan Joint Bearings
- Replaced all Expansion Joints
- Assessed the Midspan Sag
- Service Life Monitoring will be ongoing (40-50 year life extension)
  - Maintaining gates and screens
  - CSE testing to monitor potentials in the deck
  - Structural Inspections

Questions?

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