
The Zilwaukee Bridge:
Construction, Maintenance and Operation
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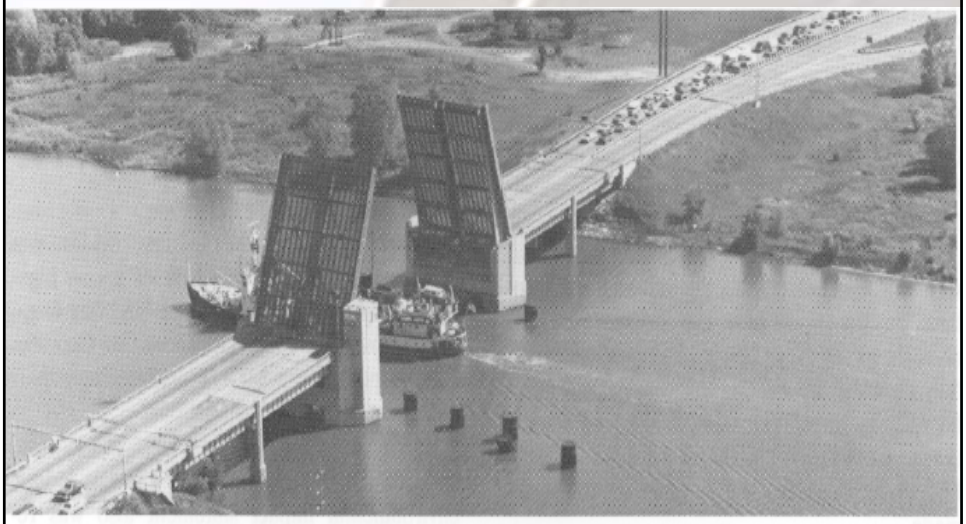
MDOT Bay Region

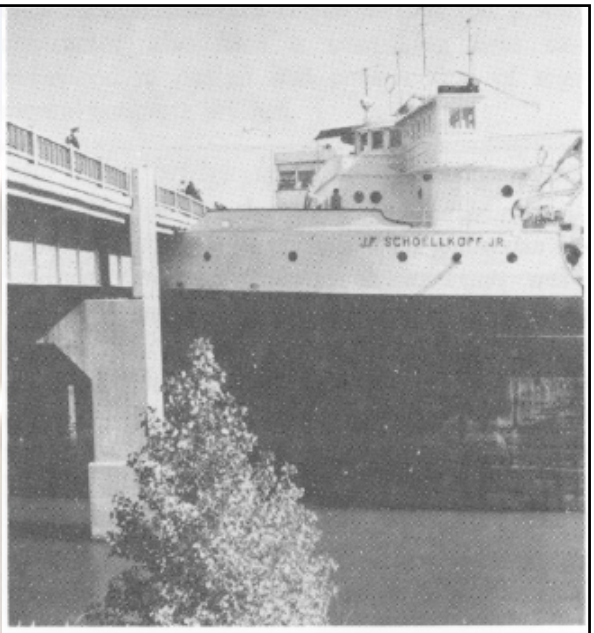

Agenda
Michigan's first segmental concrete bridge
History
Bridge Statistics
Original construction
August 28,1982 accident
Construction completion
Zilwaukee bridge costs
Winter maintenance
Routine maintenance
Current CM/GC bearing replacement project

History



Opening of the existing drawbridge causes long traffic back-ups and accidents.

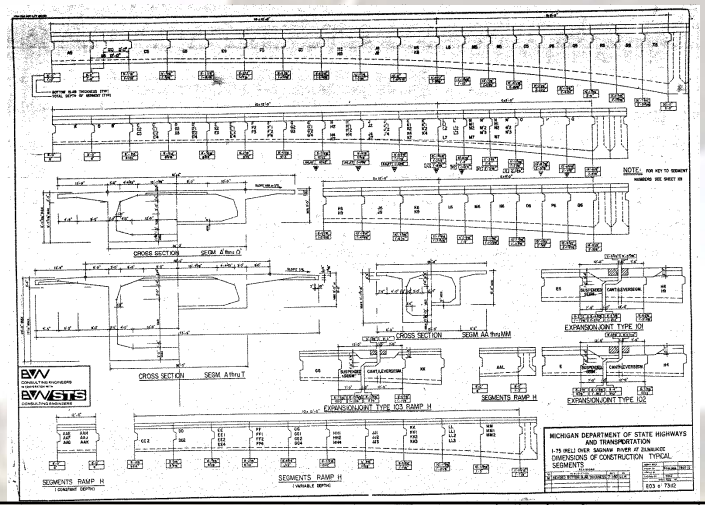
History



A Great Lakes limestone hauler rammed the bridge in 1967, forcing its closure while repairs were made.

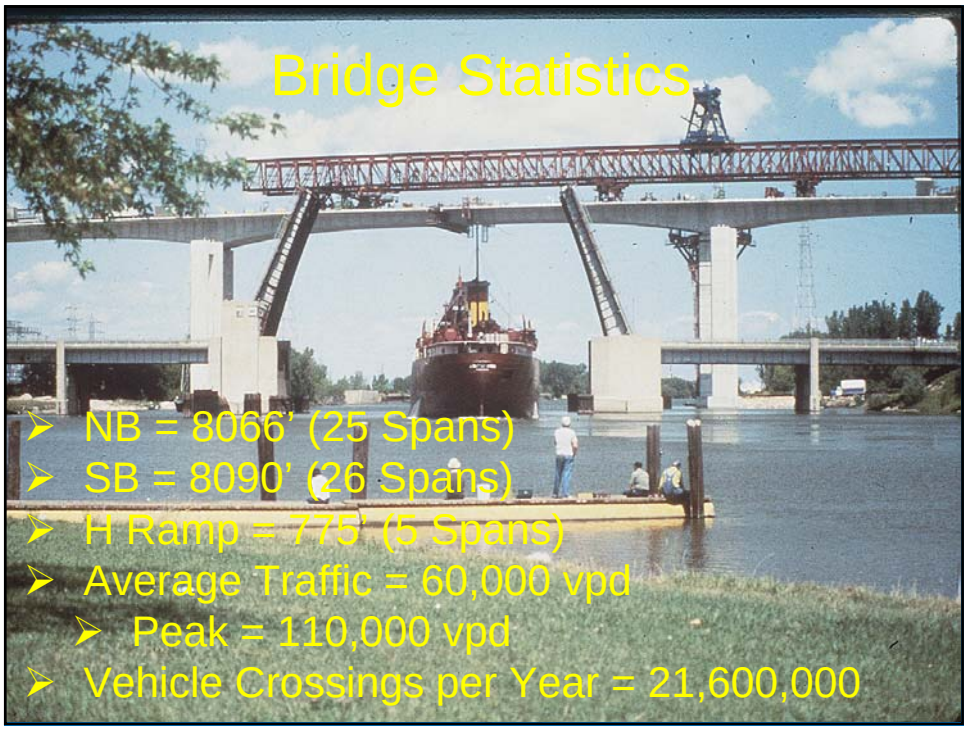
Michigan's First Post Tensioned Segmental Concrete Bridge

- One of the largest single cell segmental box girders in the U.S. at the time of construction

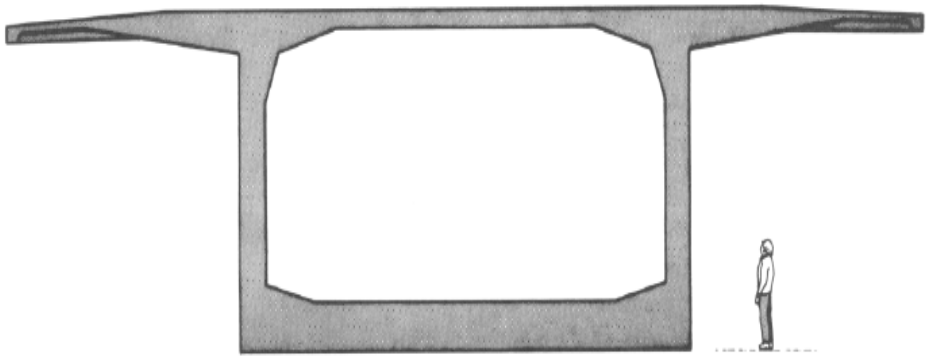


Bridge Statistics

- Each bridge approx 1.5 miles long
- 125' High at Saginaw River span
- 325' approach spans, 393' river span
- Approx 23 Acres of Deck
- 32 expansion bearings, 102 pier bearings



Construction

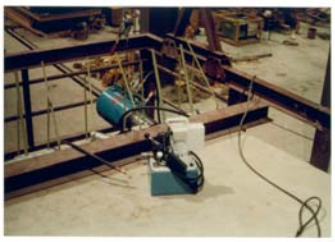


Reinforced concrete segments, cast of specially designed high-strength concrete, form the bridge decks. Each is 73.5 feet wide. The 1,592 segments weigh up to 160 tons each.

Original Construction

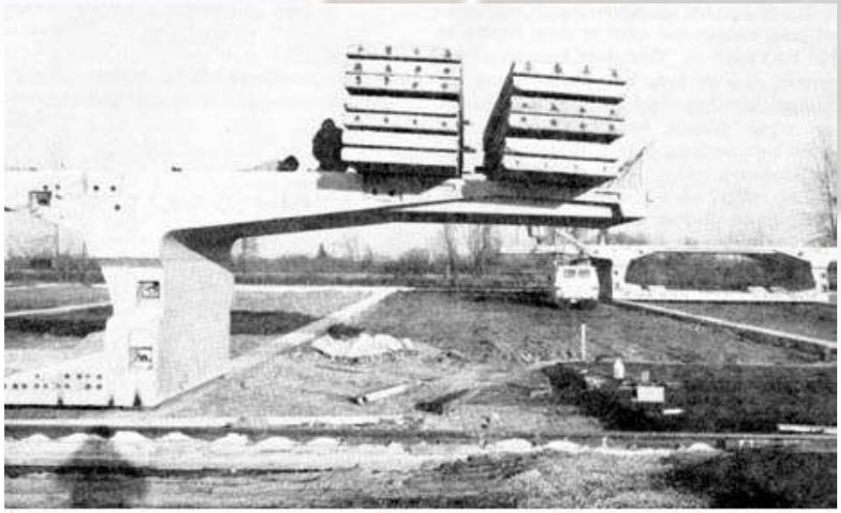
- Segment casting – modular forms

Original Construction



- Segment match casting

Original Construction



Load-testing a bridge deck segment. Thirty-nine tons of concrete slabs were placed on each of the segment "wings."

Original Construction

- Segment erection – launching girder

Original Construction

- Segment erection – segment transporter, loading gantry

Original Construction

- Segment erection – setting segment

Original Construction

- Segment erection – temporary PT and epoxy

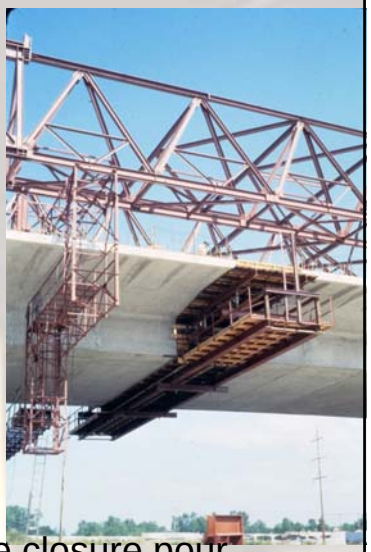
Original Construction

- Segment erection – alignment and strand stressing

Original Construction

- Typical Tendon Configuration
  - 12 Strands per Tendon
  - 7 Wires per Strand
- Each Strand is tensioned with hydraulic jacks to approximately 200 tons
- Locked in place with tapered steel wedges
- Conduits grouted to protect tendons

Original Construction



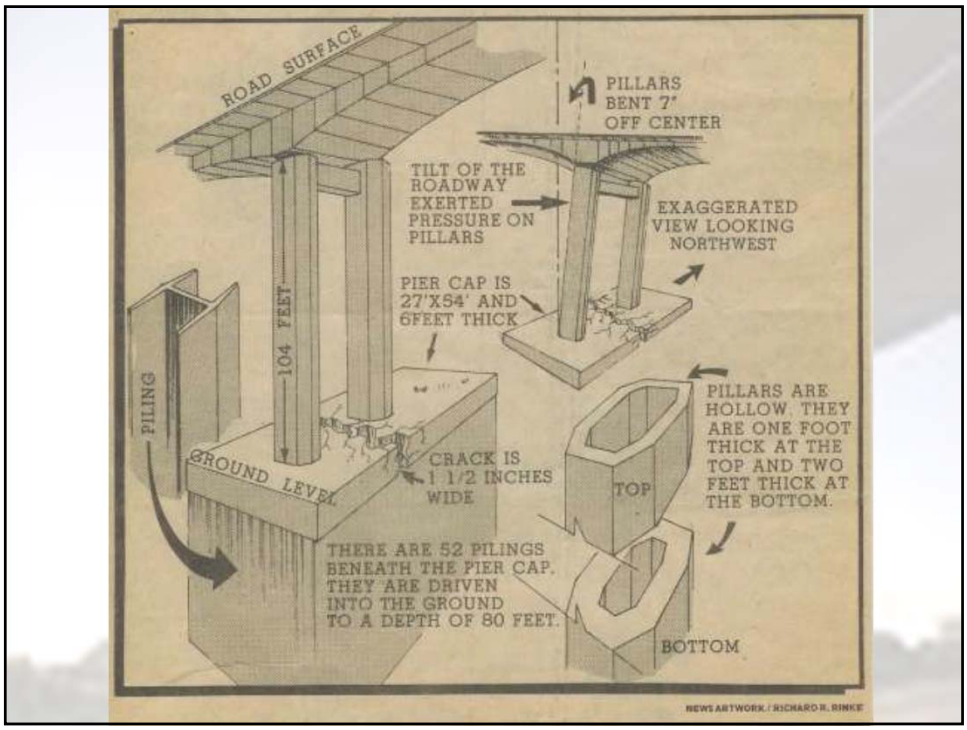
- Segment erection – cast in place closure pour

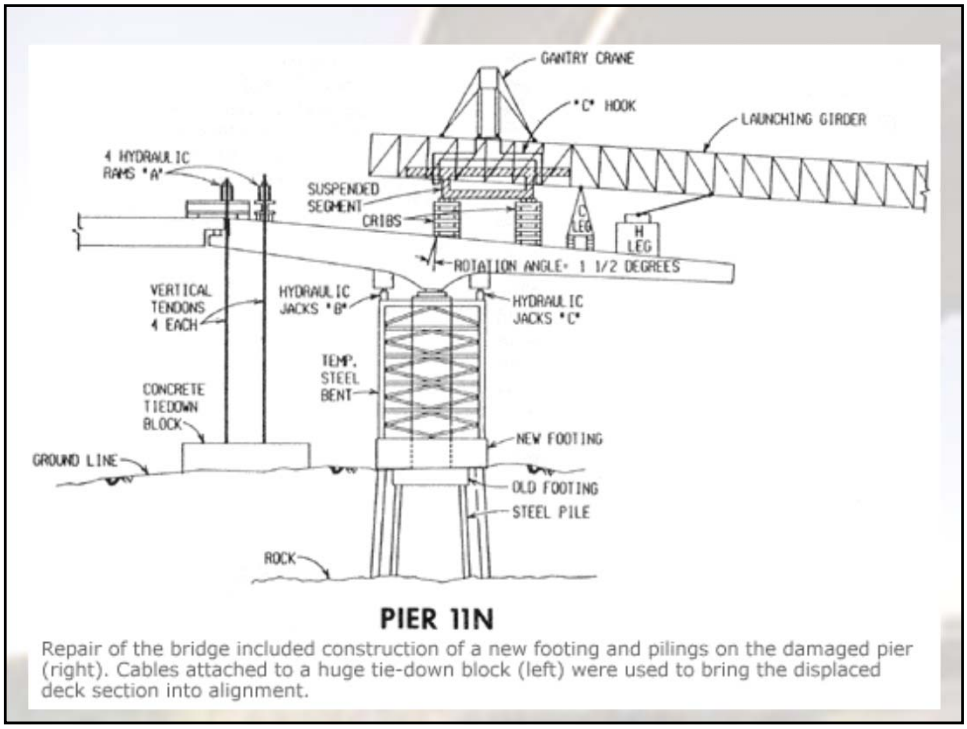
Original Construction

- Rotation of cantilevers 11N & 11S

Construction Accident: August 28, 1982

- Span 12 expansion hinge damage





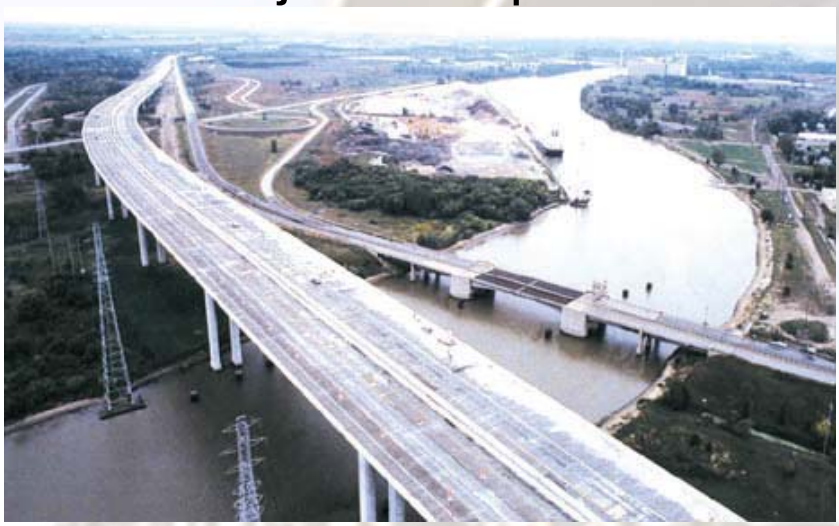
PIER 11N

Repair of the bridge included construction of a new footing and pilings on the damaged pier (right). Cables attached to a huge tie-down block (left) were used to bring the displaced deck section into alignment.

Construction Accident: August 28, 1982

- Due to the accident, and other issues that arose during construction, the safety and durability of the bridge were called into question by local and national politicians.
- As a result, MDOT load tested the bridge in 1987 using a 258 ton vehicle (almost 4 times the largest legal load allowed in Michigan), and the bridge performed as designed
- Keeping the 20,000 miles of steel wires holding the segments together protected is done by:
  - Latex overlay
  - Wires in galvanized conduit
  - Wires encased in grout

Project Completion



- Open to traffic: NB – December 1987, SB – September 1988

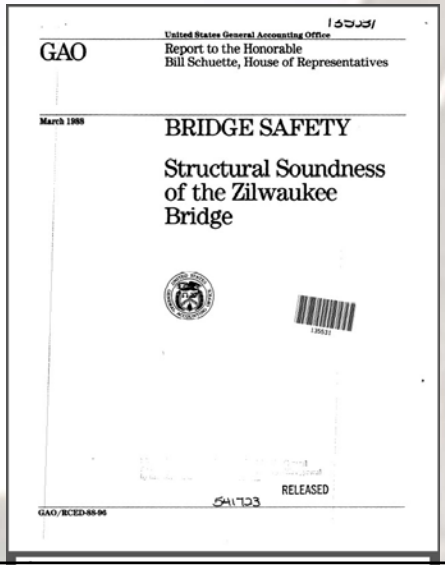
Bridge Construction Costs

- Low Bid $77 Million in 1979
- First contract – $75 million (1979 – 1982)
- Repair contract – $6 million (1983 – 1984)
- Second contract – $38 million (1985 – 1988)
- Final Cost $120 Million in 1989

Bridge Rehabilitation Costs

- 1995 Pier 17N Strengthening = $500, 000
- 2002 Modular Joint Replacement = $4.5 million
- 2008 Expansion Bearing Replacement = $3 million (no bearings replaced)
- 2013-2014 Bearing Replacement, overlay and barrier repairs = $36 million

US Government Accountability Report



GAO

United States General Accounting Office
Report to the Honorable
Bill Schuette, House of Representatives

March 1988

BRIDGE SAFETY

Structural Soundness of the Zilwaukee Bridge

RELEASED

GAO/RCED-88-96

MDOT agreed to adopt Maintenance Manual

- Included frequency and scope of inspections
- Epoxy Inject Cracks >0.004”
- Use non-corrosive deicers for winter maintenance

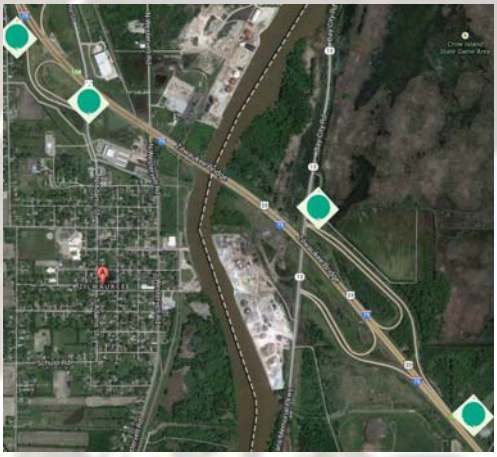
Non-Corrosive De-icers

- CMA
- Contains no chloride
- Slightly more expensive than salt
- Avg salt cost this year = $44 / ton
- CMA contract cost = $1787 / ton
- FHWA participates in cost

Non-Corrosive De-icers

- SPC 5000
- Contains no choride
- Slightly more expensive than brine or CaCl
- Current Contract cost = $4.12 / gallon

CMA Limits



Zilwaukee Bridge Winter Maintenance

- Old Snow/Ice Removal Method
  - Two Tandem Axles for Solid & Pre-wetting
  - Material Use (3 year average):
    - CF-7 = 53,850 gallons; $177,705
    - CMA = 273 mton; $343,895
    - Total Material Costs = $521,600
    - Application Rate = **197 gal/mton**

Zilwaukee Bridge Winter Maintenance

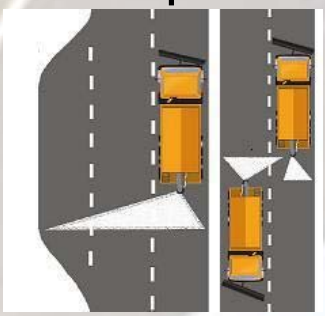
- New Snow/Ice Removal Method
  - One Tandem Axle with Epoke® Combination
    - Pre-wetting on the disc
  - 3 months material use with Epoke®:
    - SPC-5000 = 5,290 gallons
    - CMA = 32 mton
    - Application Rate = **165 gal/mton**

Epoke® Combination Spreader

Epoke® Combination Spreader

- 4 cyd dry material hopper capacity
- 935 gallons liquid capacity
  - 2 - 265 gal polyethylene internal liquid tanks
  - 1 - 240 gal and 1 - 165 gal polyethylene side tanks
- EpoMaster® in cabinet control
- Electric Spreader Symmetry Control
- Level indicators for dry and liquid materials
- 2 rear amber beacons & 1 rear work light
- Leg System for easy storage & loading
- D-ring tie down kit
- Rubber spin chute cover & front spinner guard

Epoke® Combination Spreader

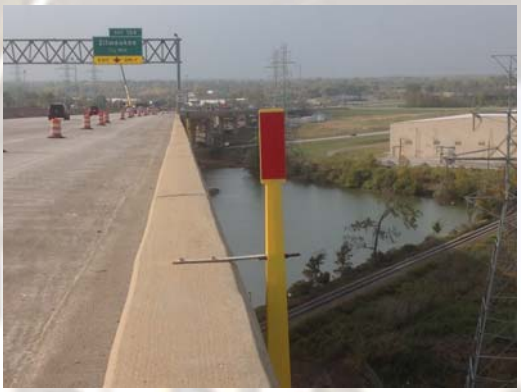


Epoke® Advantages

- Optimal Material Placement
  - Est. Application Rate Reduction = **16 %**
    - [(197-165) gal/mton / 197 gal/mton]
  - Est. Annual Cost Savings of SPC-5000 = **$30,000**
- Enhanced Safety
  - Symmetry function permits application across multiple lanes from outside lane
- More Efficient Use of CMA
  - Conveyor system minimizes loss of dry material in hopper
- One Tandem vs. Two Tandems
- Easy Storage and Safe Handling

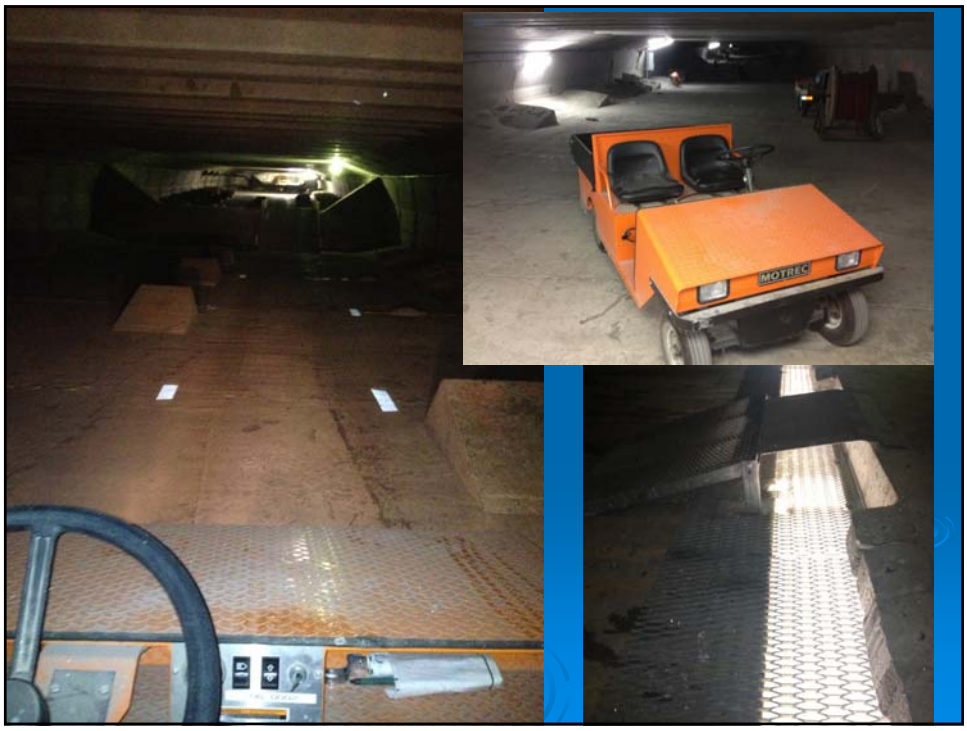
Previous Method for Snow Removal

Current Method for Snow Removal



Routine Maintenance

- Full Time Bridge Crew
  - 4 Person Crew
  - Duties Include:
    - Inspection
    - Deck Patching
    - Mowing
    - Rail Repair
    - Drainage Maintenance



Routine Maintenance

- Epoxy Injections
  - Frequency: 2 to 4 years
  - Performed for 7 years
  - $800,000 per year
  - Total Spent: $5.6M
  - Currently completed as needed by Z Bridge Crew

2013 Bearing Replacement Project

- Design for replacement of all bearings started in the fall of 2010
  - 34 Expansion Bearings, 106 Pier Bearings, 10 Abutment Bearings
- MDOT decided to use Construction Manager / General Contractor (CM/GC) project delivery method to engage contractor with experience in segmental bridges during design phase
- CM/GC pre-construction services contract was executed in early 2012
- Work began in April 2013 with the closure of SB I-75

CM/GC Bearing Replacement

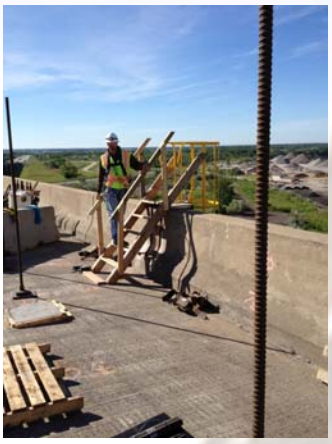
Pot Bearing

Disk Bearing

Work Platforms

- Supported by core holes through segment wings

Work Platforms

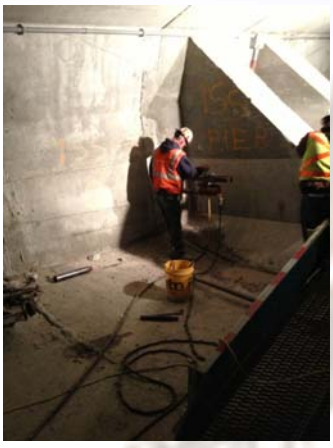


- Designed for weight of equipment and bearings

Work Platforms

- Amazing views

Pier Bearing Replacement



- Coring and placement of 1 ¾” transverse PT bars

Pier Bearing Replacement

- Placement of waler beams and stressing

Pier Bearing Replacement

- Setting and stressing of compression collars

Pier Bearing Replacement

- 600 ton jacks and custom pump with 8 manifolds

Pier Bearing Replacement

- Jacking layouts

Pier Bearing Replacement

- Jacking layouts

Pier Bearing Replacement

- Lift complete, lock rings engaged, hydraulics removed

Pier Bearing Replacement

- New disc bearings – max capacity 8100 kips

Pier Bearing Replacement

- Installing rebar and shimming bearings

Pier Bearing Replacement

- Forming and pressure grouting

Pier Bearing Replacement

- Completed bearings

Pier Bearing Replacement

- Completed bearings

Bearing Graveyard

Hinge Bearing Replacement

- Inserting of 2 ½" diameter PT bars through deck, overhead and underslung beams

Hinge Bearing Replacement

- Raising underslung beam into position

Hinge Bearing Replacement

- Strong back beam assembly and stressing of 2 ½" diameter PT bars

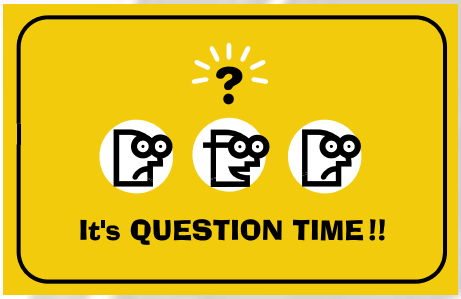
Hinge Bearing Replacement

- Completed assembly, awaiting jacking

Summary of CM/GC Project

- Status as of 10/14/2013:
  - 23 out of 25 piers complete
  - All 8 expansion joints complete
  - One abutment complete and the other scheduled for October
- SB work scheduled to be complete by early November 2013
- NB work to commence in April 2014, with anticipated completion of November 2014

Thank You!



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