Issues with Post-Tensioned Girders

March 4, 2016

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District Structure and Bridge Engineer

Outline

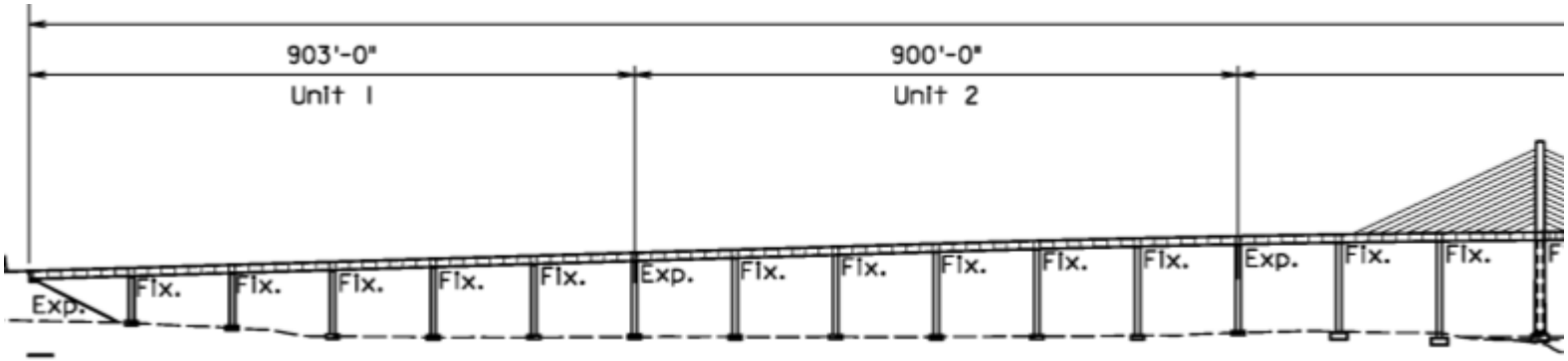
- **Discuss 4 post-tensioned bridges and the various issues experienced from construction thru service**
  - **Rte. 295 over James River, Varina-Enon Bridge**
  - **Rte. 123 over Occoquan River**
  - **Rte. 33 over Mattaponi River, Lord Delaware Bridge**
  - **Rte. 30 over Pamunkey River, Eltham Bridge**
- **Operational Impacts**

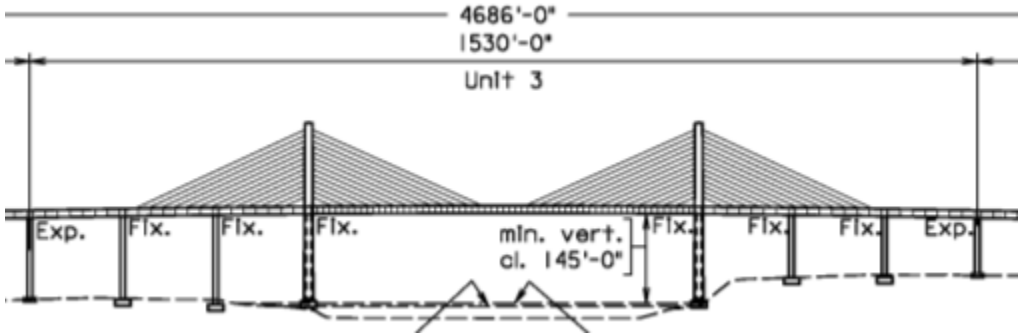
Varina-Enon Bridge

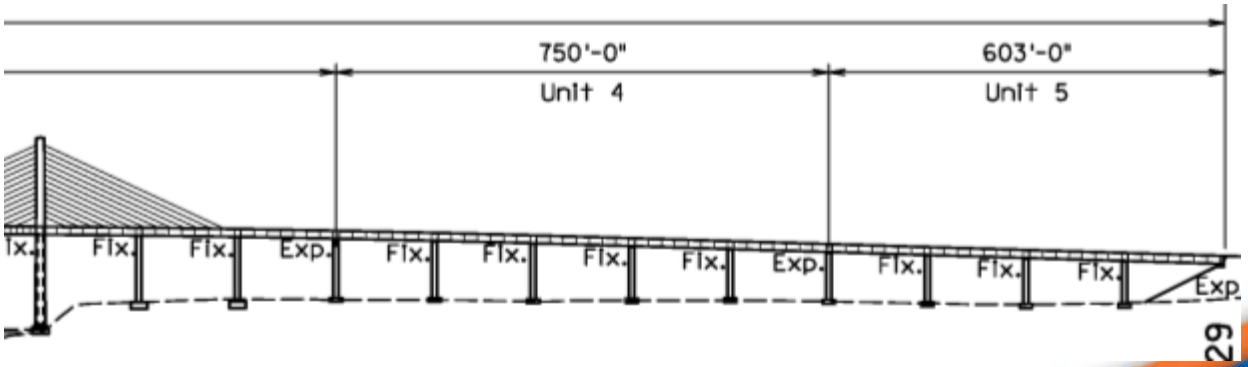
Varina-Enon Bridge

- Completed 1990
- Henrico County
- Richmond District
- 6 Travel Lanes
- ADT 17,400 avg. one way (rounded)
- Width 126 ft
- Length 4,686 ft
- Superstructure General Condition Rating 5 – Fair

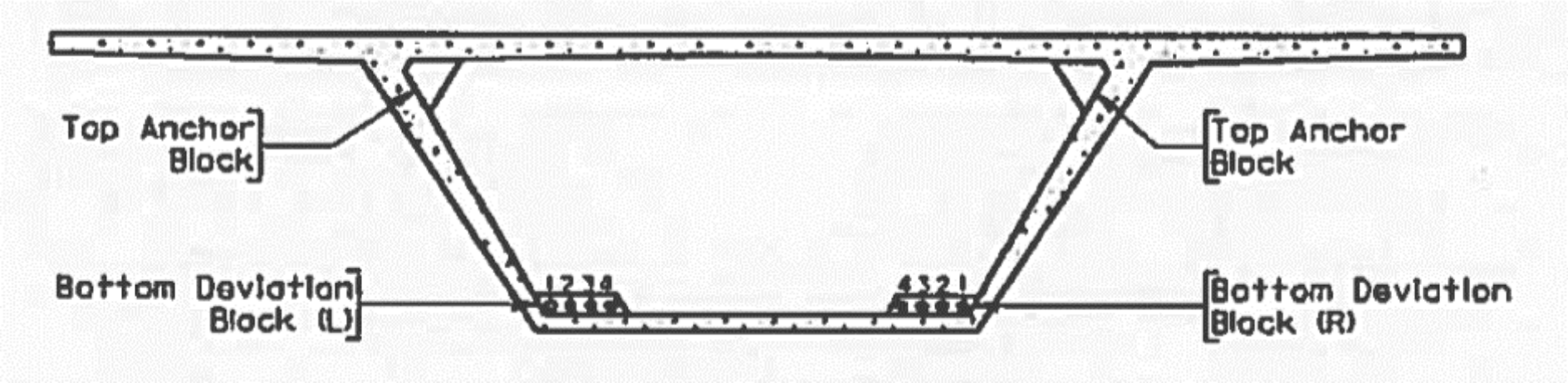
Varina-Enon Bridge







Varina-Enon Bridge



Varina-Enon Bridge

1991

One Year after Being in Service

Damper System

on

Stay Cables

Varina-Enon Bridge

2003-2004

Grouted Partially Voided Post-Tensioning Ducts

2,146 LF

Varina-Enon Bridge

Varina-Enon Bridge

Additional Rehabilitations

2012 – Approach Slab Settlement

2013 – Interior Bridge Lighting

2015 – Epoxy Deck Overlay

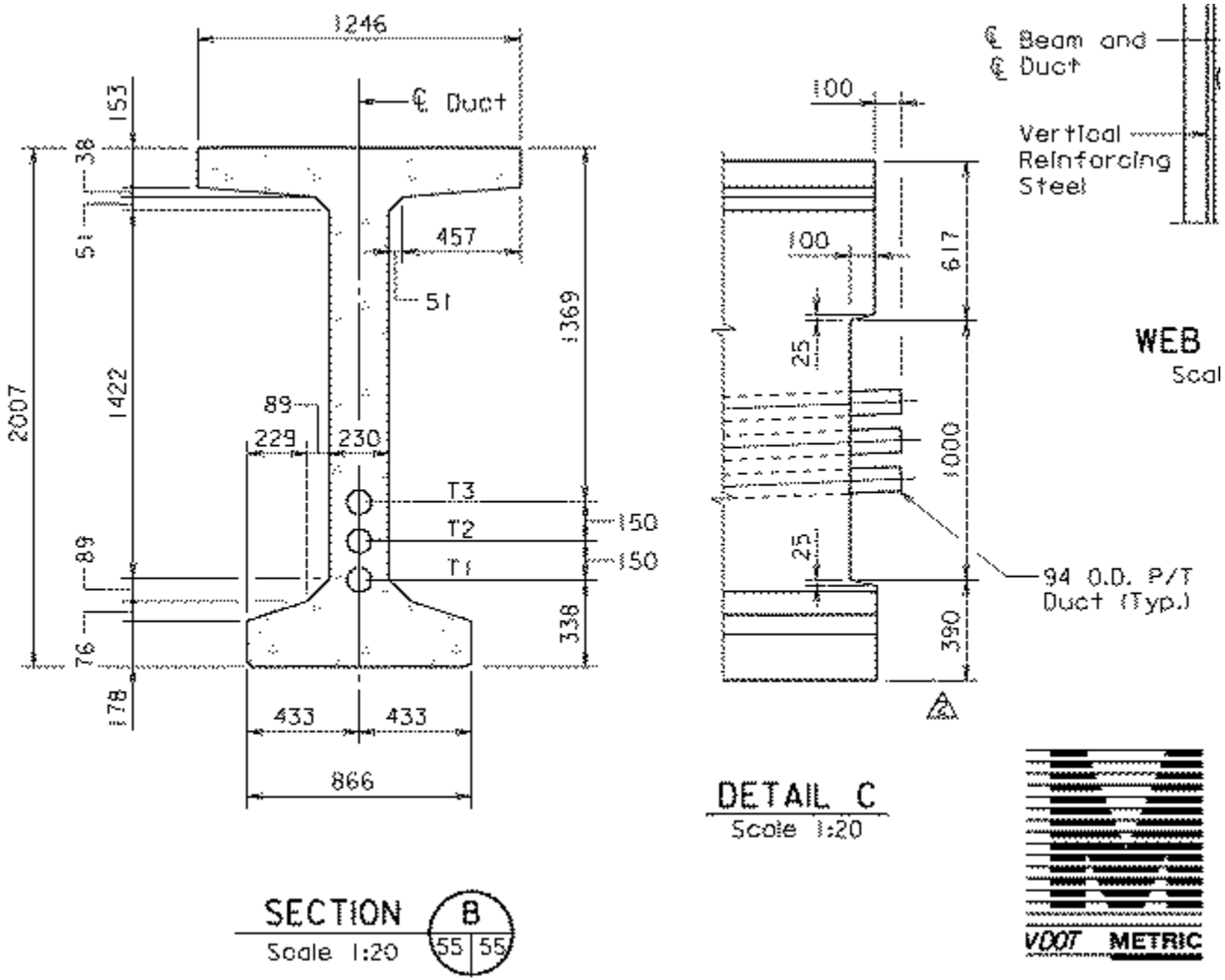
2015 – Strand Impregnation

Occoquan River Bridge

Occoquan River Bridge

- Completed 2006
- Prince William County
- Northern Virginia District
- 7 Travel Lanes
- ADT 41,700 (rounded)
- Width 124 ft
- Total Length 1,181 ft
- Superstructure General Condition Rating 7 – Good
- 3 spans continuous post-tensioned
  - 180.5 ft – 239.5 ft – 181.2 ft = 601.2 ft

Occoquan River Bridge



Occoquan River Bridge

Occoquan River Bridge

Occoquan River Bridge

Occoquan River Bridge Conclusion

One

- **Reduction of net section along duct profiles due to increased duct size.**
- **Calculations indicated tensile stresses in reduced section were at or above the tensile strength of concrete.**

Two

- **Accelerated cure with steam heat.**
- **Side forms expanded vertically pushing against girder top flange and bottom flange**

Occoquan River Bridge Conclusion

Three

- **Rate of change in the temperature increase during the curing.**
- **Varied from casting bed to casting bed**

Lord Delaware Bridge

Lord Delaware Bridge

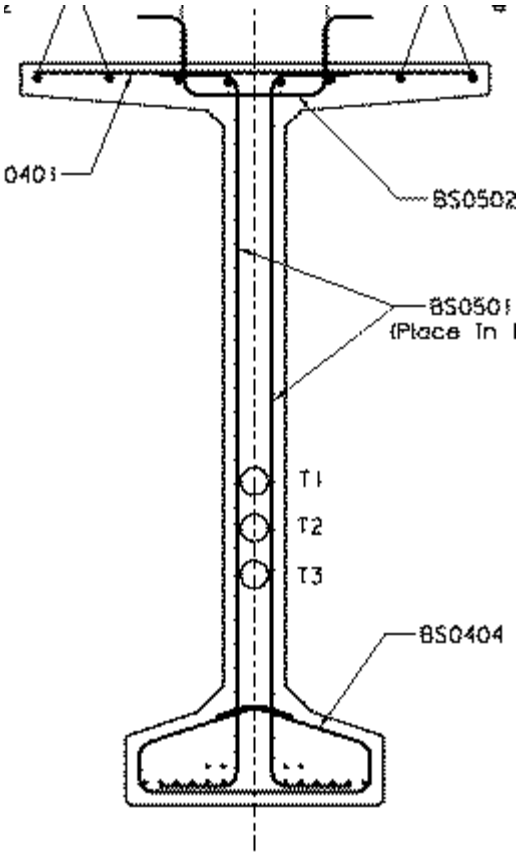
- Completed 2006
- King and Queen County
- Fredericksburg District
- 4 Travel Lanes
- ADT 15,000 (rounded)
- Width 70 ft
- Total Length 3,545 ft
- Superstructure General Condition Rating 5 – Fair
- 2 Units at 4 spans continuous internally post-tensioned
  - 200 ft – 240 ft – 240 ft – 200 ft = 880 ft

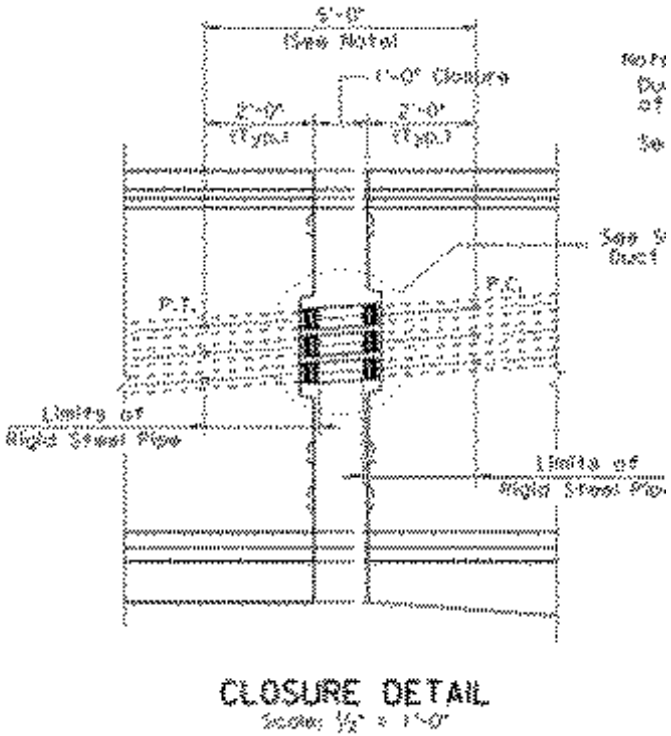
Eltham Bridge

Eltham Bridge

- Completed 2007
- King William County
- Fredericksburg District
- Movable Bascule – Structural Steel
- 4 Travel Lanes
- ADT 17,600 (rounded)
- Width 70 ft
- Total Length 5,354 ft
- Superstructure General Condition Rating 5 – Fair
- 2 Units at 4 spans continuous internally post-tensioned
  - 200 ft – 240 ft – 240 ft – 195 ft = 875 ft

Eltham and Lord Delaware Bridges





Cracks in Deck End

Cracks In and Adjacent to Beam Closure

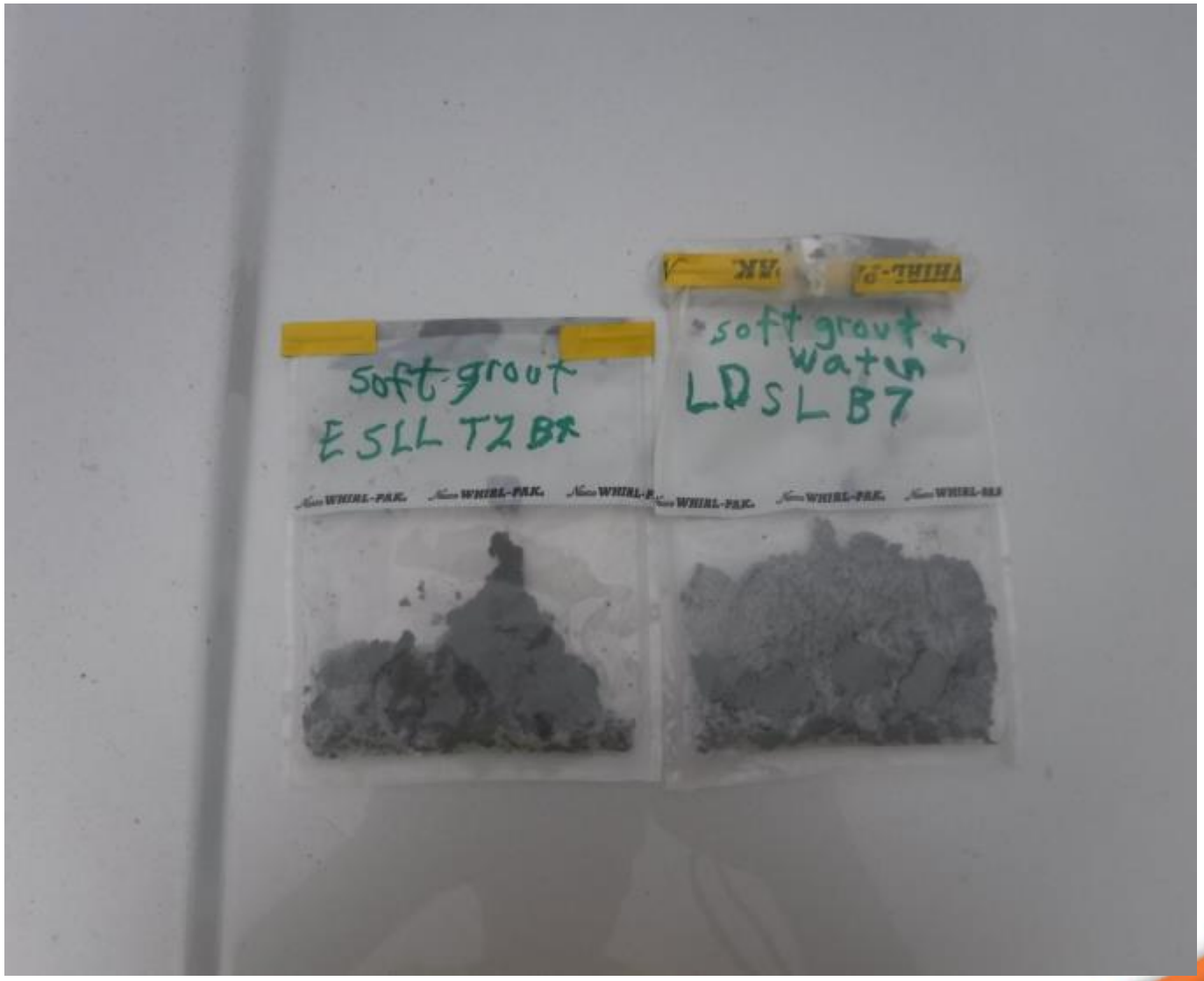
Eltham Bridge

Eltham Bridge

Lord Delaware Bridge

Lord Delaware Bridge

Soft Grout Samples



Research Council Concrete Freeze Test

6x12 cylinder with lightweight concrete

3.5” conduit filled with water

Frozen overnight

Timeline

During Construction
Narrow cracks following tendons repaired by fabricator prior to shipping

May 2014 Regular Inspection
Hairline cracking in beams GCR 6

July 2014 QA Inspection
Single beam on Lord Delaware with minor delamination and spall, Bridge decided to monitor since appeared to be isolated case
Water leakage observed but no rust staining indicating corrosion

Timeline, continued

May 2015 Regular Inspection
Extensive cracking in beams following path of conduits

August 2015 Research Council and CO Investigation

September 2015 Consultant Delineation Inspection

February 2016 Consultant Load Rating
Bonded and Un-bonded Conditions

March 2016 Research Council
Determine limits of soft grout/water in additional conduits

Bridge Inspection Impacts

Increased Inspection Costs

Lack of efficient and effective non-destructive evaluation and bridge safety inspection techniques for grouted tendons

Operational Impacts

Unexpected Rehabilitation Costs

- **Maintenance required sooner than normal**

Impacts to Traffic

- **Work zone disruptions**
- **Load postings with potential for total closures**

Uncertainty in Service Life

QUESTIONS?