AGENDA

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Introduction

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Background

[Map showing the location of DelDOT BR 1-813 along I-495 Emergency Repairs]
Background
Background

- BR 1-813
- I-495 over the Christina River
- ADT=90,000
- Length – 4,390-ft
- 38 spans
- Welded Steel Plate Girder Superstructure
- Variable Foundations
- Inspected October 2012
  - No deficiencies
Background

- **Spans 11 thru 14**
  - 4-span continuous
  - All spans 109-ft
  - Piers 10 thru 14
  - Pier 10 – Cast-in-Place Concrete Piles
  - Remainder – H-Piles to rock

- **Span 15**
  - Simple span
  - SB – 160.03-ft
  - NB – 132.87-ft
  - Pier 15 – H-Piles
Background

• Soil Profile
  – Soft Organic Clay
  – Dense Sand
  – Stiff Silty Clay
  – Bedrock (Diorite)
Missed Opportunities

- April 15, 2014: A 911 call from a motorist reported a difference in the barrier elevations between NB and SB on the bridge.
- May 29, 2014: An engineer studying movements on an oil line adjacent to the bridge reported the condition as slightly out of plumb to the Department and advised us to check it out.
- May 30, 2014: Another 911 call from a motorist reported a dip in the bridge.
- June 2, 2014: Bridge was closed.
High Priority Road Conditions

• Reports that involve the structural integrity of a bridge, sign structure, high mast light or dam are High Priority Conditions
• Positive contact must be made with M&O and the Bridge Section
• Response must be immediate
• Both M&O and Bridge must approve before a HPWO can be closed
• TMC to notify the “requestor” of the resolution of the WO
Site Conditions

• June 2\textsuperscript{ND} at 2:30 PM
  – Arrived on-site 3:15 PM
• Piers Tilted to the Right (Facing North)
• Tension Cracks in Soil
• Displacement of Bridge Superstructure
Site Conditions

- NB and SB Superstructure Rotated to the East
  - 18-inch difference in elevation of median barriers
  - + 3-inch gap in median barriers
Site Conditions

Can a dirt pile move a bridge?

- 400’ long x 150’ wide x 25’ high from ground
- Over 50,000 tons
- Settled over 4’
CURRENT CONDITION

- SUPERSTRUCTURE
- PIER CAP
- PIER COLUMN
- DIRTT PILE
- EXISTING GROUND
- TOP OF PILE CAP EL: 61
- FOOTER

- SOFT ORGANIC CLAY
- DENSE SAND
- STIFF SILTY CLAY
- BEDROCK (IDRITE)

- EXISTING PILES COMPROMISED AND UNRELIABLE
- PILE (TYP)

- PILE SELECTION LOSS DUE TO ADVANCED CORROSION NOT OBSERVED
Response

• Close Bridge To Traffic
• Get Disaster Declaration
• Inspect Structure (Super & Sub)
• Quantify Pier and Deck Movements
  – Install Tiltmeters
  – Field Survey
• Remove Soil Embankment
  – Began night of 6/2/2014
  – 24-hour a day operation
  – Completed 6/10/2014
• Subsurface Investigation
  – Piezometers & Inclinometers
  – Borings & Rock Cores
## Pier and Deck Movements

<table>
<thead>
<tr>
<th>Pier</th>
<th>Translation</th>
<th>Rotation</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>At Base</td>
<td>Transverse</td>
</tr>
<tr>
<td></td>
<td>(ft)</td>
<td>ft</td>
</tr>
<tr>
<td>11W</td>
<td>0.11</td>
<td>0.114</td>
</tr>
<tr>
<td>11E</td>
<td>0.27</td>
<td>0.443</td>
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<tr>
<td>12W</td>
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<td>12E</td>
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<tr>
<td>13W</td>
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<td>0.930</td>
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<tr>
<td>13E</td>
<td>1.17</td>
<td>1.440</td>
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<tr>
<td>14W</td>
<td>-0.07</td>
<td>0.212</td>
</tr>
<tr>
<td>14E</td>
<td>0.31</td>
<td>0.104</td>
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Pier and Deck Movements

<table>
<thead>
<tr>
<th>PIER</th>
<th>SB Fascia Gutter</th>
<th>NB Fascia Gutter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horiz. (ft)</td>
<td>Vert. (ft)</td>
</tr>
<tr>
<td>14</td>
<td>0.21L</td>
<td>+0.03</td>
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<tr>
<td>13</td>
<td>0.18L</td>
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<tr>
<td>12</td>
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<td>11</td>
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<td>+0.13</td>
</tr>
<tr>
<td>10</td>
<td>0.11R</td>
<td>+0.04</td>
</tr>
</tbody>
</table>
Response

- Pile Cap Inspection
  - Large Horizontal Cracks
  - No Pile Corrosion
  - Local Buckling on One Pile
Response
Response

• June 3: Meeting with AECOM to discuss alternatives
• June 4: Meeting of minds in the “war room”. (DelDOT Bridge, DelDOT Construction, AECOM, FHWA, U of D, JD Eckman, Ted Zoli from HNTB)
• June 5: Scope for repairs is set.
Response

• Initial Considerations
  – Which piers are damaged
  – Which piers are ok
  – Minimize disturbance to structure
  – Schedule
    • How long will I-495 be closed
  – Repair approach
    • Bridge replacement
    • Pier replacement
    • Underpinning
    • Shafts or micro piles
  – Temporary support used in final product

• Decisions
  – Piers 10 and 15, OK as is
  – Underpin Piers 11 and 14
  – Replace Piers 12 and 13
  – Drilled Shafts and Grade Beams
    • 4-ft diameter
    • Casing to bedrock
    • Rebar from Tappan Zee
  – Superstructure OK
  – Tie piers together at top
  – Work southbound bridge (west piers) first
  – Bridge Jacking to return superstructure to as-built condition
  – Jack at piers 12 and 13 first
PROPOSED FOUNDATION REPAIR

- Superstructure
- Existing Pier Column (Typ)
- Existing Ground
- Proposed Drilled Shaft Foundation (Typ)
- Approx Pile Tip EL -144

Soil Layers:
- Soft Organic Clay
- Dense Sand
- Stiff Silty Clay
- Bedrock (Didrite)
PROPOSED FOUNDATION REPAIR
PROPOSED FOUNDATION REPAIR
PROPOSED FOUNDATION REPAIR
A new three column pier will be constructed. The new pier will rest upon the new grade beam and drilled shafts.
Construction Overview

- Putting the team together, planning, and execution
Construction Overview

• Construction
  – Began 6/9/2014
    • Site grading
    • Causeway
    • Pier ties
  – Drilling Began 6/13/2014
  – 32 of 32 drilled shafts installed by 7/16/2014
  – Grade Beams Constructed at:
    • 12 and 13 SB North & South – 7/8/14
    • 12 and 13 NB North & South – 7/25/14

Pier Ties Installed
Construction Overview

- **Shoring Towers**
  - 12 and 13 SB North & South – 7/22/14
  - 12 and 13 NB North & South – 8/5/14

- **Underpinning**
  - Pier 11 & 14 SB – 7/26/14
  - Pier 11 & 14 NB – 8/05/14

- **Jacking**
  - SB 7/29/14
  - **SB Open** – 7/31/14
  - NB 8/20/14
  - **NB Open** – 8/23/14

*First Delivery of Casing Arrives 6/12/2014*
Construction Efforts

First Drill Rig on Site
6/13/2014

Rebar Cage from Tappan Zee
6/16/2014
Construction Efforts

Lifting 160 foot long Rebar Cage
Construction Efforts

First Drilled Shaft Reinforcing Cage
6/21/2014
Construction Efforts

Access Holes in Bridge Deck for Placement of Drilled Shaft Rebar
Construction Efforts

• Drilled Shafts – Pouring PCC
  – Casings went to bedrock and were filled with a slurry.
  – SCC concrete was tremie poured from the bottom and slurry was pumped out and recycled.
Construction Efforts

• Grade Beams (Piers 12 & 13)
  – Grade beams were formed on each side of the piers.
  – Poured in 2 segments. SB portions poured first.
  – Because of the mass of the pours, a thermal plan circulating water from the river to regulate the temperatures had to be used.
Construction Efforts

- **Underpinning (Piers 11 & 14)**
  - 4 Drilled Shafts per Pier
  - Poured in 2 lifts over existing footing.
  - Post tensioned to existing footing.
  - Also required a thermal plan due to the mass concrete pour.
Construction Efforts

View of Site Looking East
6/27/2014
Construction Efforts

Shoring Towers on Grade Beam with Header Beam at 12 SB
7/24/2014
Construction Efforts

Southbound Jacking
7/29/2014
Construction Efforts

Southbound Jacking  7/29/14 - 7/31/14

“…The credit belongs to the person who is actually in the arena…”

T. Roosevelt

Project team working through one unpredicted structural response during jacking.
Construction Efforts

Longitudinal Bracing
Construction Efforts

Southbound Opening
7/31/2014
Construction Efforts

Erecting Shoring Towers on NB 8/4/2014
Construction Efforts

Northbound Jacking
8/20/2014
Construction Efforts

Bridge Superstructure Displaced from Bearing and Pier at Pier 12 NB
Construction Efforts

Completed underpinning and longitudinal bracing
Construction Efforts

Northbound Opening
8/23/2014
Construction Efforts

Removal of Existing Piers 12 & 13
Construction Efforts

Cutting Pier Caps with Wire Saw
Construction Efforts

Lowering Exterior Cut Section
Construction Efforts

Lowering Interior Cut Section
Construction Efforts

Removing Columns
Construction Efforts

Pier 12E Removed
10/15/2014
Construction Efforts

Geofoam place between grade beams and caps poured.
10/30/14
Construction Efforts

Columns for new 3 Pile Bent Going Up
12/08/14
Construction Efforts

Temporary support structure for pier cap
Construction Efforts

Temporary Support structure for pier cap (limited room)
Construction Efforts

Tie complete rebar cage for pier cap.
Installed cooling tubes.
Set bulkheads.
Set pier cap forms.
Construction Efforts

Installation of Bearings at Pier 11.
Construction Efforts

New Pier 12 with Temporary Formwork and Towers still up.
Construction Efforts

New Completed Pier 12.
Public Relations Efforts

- All interview requests went through PR Section.
- A project website was set up the day after the bridge was closed.
- Weekly project updates were posted on the website.
- Conducted interviews with many engineering magazines, newspapers and television news programs.
- There were 16 FOIA requests related to this incident.
- The DelDOT PR Section and the Secretary’s Office did an excellent job of managing the message that the Department sent to the public.
Public Relations Efforts

Shailen Bhatt
Secretary of Transportation
Public Relations Efforts

First Press Conference 6/3/2014
Public Relations Efforts

The Governor Visits the Bridge 6/5/2014
Public Relations Efforts

Secretary Foxx Visits the Bridge
6/13/2014
Public Relations Efforts

President Obama Visits the Bridge
7/17/2014
Lessons Learned

- Don’t become complacent. The responsibility of being a bridge owner is huge. DelDOT now has a new High Priority Road Condition process.
- Grab a journal and document EVERYTHING.
- When responding to an emergency, know that PR will be a vital component and have them on the project team. They need to be at meetings and understand the project to accurately convey the message to the media.
- Write every e-mail and memo as though it will be in the paper…because it probably will.
- Assemble the proper team. If construction is complex, bring the Contractor in early.
- Limit the number of chefs in the kitchen.
Lessons Learned

• You must rely on all members of your team to do their part. We are typically at our best in emergency situations.

• Daily progress reports ensure that any delays are dealt with immediately (especially when they are given to the Secretary and the Governor).

• Don’t forget to take care of yourself. (Eat. Stay hydrated. Sleep. ) Adrenaline carries you at first. Fatigue and stress can affect your decision making.

• Keep a positive outlook and focus on getting the job done.
Inspirational Quotes at the Field Office

“I am convinced that life is 10% what happens to me and 90% of how I react to it.”

“Everything will be fine in the end. If it’s not fine now, it’s not the end.”
Acknoweldgements

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  – Ted Zoli, PE

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  – Joe Rovnan

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IT'S OPEN!

QUESTIONS?