PERFORMANCE OF OHIO’S
CONCRETE ARCH BRIDGE
REHABILITATION

Why?
CEDAR POINT ROAD BRIDGE
• 86-YEARS OLD
• HISTORIC BRIDGE IN A
  PARK SETTING

OWNER:
PREFERS REHAB W/ 75-YEAR
ADDED SERVICE LIFE

What the Bridge Owner Wants

FHWA/NHI BRIDGE
CONDITION RATING SCALE

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>9</td>
</tr>
<tr>
<td>Very Good</td>
<td>8</td>
</tr>
<tr>
<td>Good</td>
<td>7</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>6</td>
</tr>
<tr>
<td>Fair</td>
<td>5</td>
</tr>
<tr>
<td>Poor</td>
<td>4</td>
</tr>
<tr>
<td>Serious</td>
<td>3</td>
</tr>
<tr>
<td>Critical</td>
<td>2</td>
</tr>
<tr>
<td>Failure</td>
<td>1</td>
</tr>
<tr>
<td>Imminent Failure</td>
<td>0</td>
</tr>
</tbody>
</table>

Concrete Bridges –
A Historical Perspective of Durability

Concrete bridges are permanent improvements.
Concrete bridges require neither painting nor repairs.
Concrete Bridges – A Historical Perspective of Durability

North Hills Viaduct
Akron, Ohio
1922-1977

Concrete Bridges – A Historical Perspective of Durability

Ashtabula Viaduct, Opened 1922

Concrete Bridges – A Historical Perspective of Durability

Ashtabula Viaduct, Demolished 1997

Ohio’s Conventional Concrete Arch Rehabilitation – 1980s to 2010

Brookpark Road Viaduct Rehabilitation, 1987-88

• Opened 1936
• Park Setting

Brookpark Road Viaduct Rehabilitation, 1987-88

Summary of Quantities
Brookpark Road Viaduct Rehabilitation, 1987-88

**Construction Budget:** $3 Million
**Final Construction Cost:** $9 Million

"WE COULD HAVE GOT A NEW BRIDGE FOR $12 MILLION!"
- ODOT Resident Engineer -
Brookpark Road Viaduct, 2016

Brookpark Road Viaduct, 2016

Brookpark Road Viaduct, 2016

Brookpark Road Viaduct, 2016

Cleveland’s Detroit-Superior Bridge, 1917

ONE OF CLEVELAND’S ICONS
Detroit-Superior Bridge Rehabilitation, 1995-97

<table>
<thead>
<tr>
<th>Members</th>
<th>Total Members</th>
<th>Members Replaced</th>
<th>Total Percent Replaced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Deck Floor Beams</td>
<td>686</td>
<td>354</td>
<td>51%</td>
</tr>
<tr>
<td>Upper Deck Columns</td>
<td>693</td>
<td>179</td>
<td>26%</td>
</tr>
<tr>
<td>Upper Deck Arch肋s</td>
<td>564</td>
<td>280</td>
<td>45%</td>
</tr>
<tr>
<td>Lower Deck Floor Beams</td>
<td>548</td>
<td>50.5</td>
<td>11%</td>
</tr>
<tr>
<td>Lower Deck Columns</td>
<td>379</td>
<td>73</td>
<td>19%</td>
</tr>
<tr>
<td>Lower Deck Arch肋s</td>
<td>520</td>
<td>176</td>
<td>34%</td>
</tr>
<tr>
<td>Lower Deck Columns</td>
<td>488</td>
<td>8</td>
<td>2%</td>
</tr>
<tr>
<td>Upper Exterior Pier Beams</td>
<td>32</td>
<td>17.5</td>
<td>55%</td>
</tr>
<tr>
<td>Lower Exterior Pier Beams</td>
<td>28</td>
<td>5.5</td>
<td>20%</td>
</tr>
</tbody>
</table>

Cleveland’s Detroit-Superior Bridge, 1995-97 Rehabilitation

GENERAL OPINION: PATCHES ONLY LAST 10 YEARS!

REVISED PATCHING STRATEGIES USED:
- **SAWCUT EDGES**
- **SHOTCRETE – HIGH QUALITY CONTROL, LOW PERMEABILITY MIXES.**

Cleveland’s Detroit-Superior Bridge, 1995-97 Rehabilitation

Cleveland’s Detroit-Superior Bridge, 1995-97 Rehabilitation

Cleveland’s Detroit-Superior Bridge, 1995-97 Rehabilitation

Cleveland’s Detroit-Superior Bridge, 1995-97 Rehabilitation

Graph showing Detroit-Superior Bridge Superstructure Condition with peaks and troughs.
Ohio Patching of Spalls

**GENERAL OPINION:** STILL PATCHES ARE TEMPORARY!

**NEXT REVISED PATCHING STRATEGIES USED:**
- Poured-in-place patches preferred
- 2005: Stainless Steel Hooked Dowels

Ohio Patching of Spalls

**STAINLESS STEEL HOOKED DOWELS**
(ANCHOR THOSE PATCHES)

Cathodic Protection & Ohio’s Bridges, 1993 - Present

**I-90 Bridge Decks Rehabilitation, 1993**

- I-90 OVERPASSES BUILT IN 1960s
- WEARING SURFACE REPLACEMENT AFTER 30 YEARS
- CATHODIC PROTECTION: INSTALLED TITANIUM MESH WITH IMPRESSED CURRENT.
A good wearing surface means a good deck.
All impressed current systems were powered down in 2013. Condition is being monitored closely.

All concrete structure was removed down to arch ribs.

Titanium mesh cathodic protection place on perimeter of all arch surfaces.

No corrosion, no efflorescence.
Blaine Hill Viaduct, SE Ohio

Richland Avenue Bridge, Athens, Ohio (1932)

Richland Avenue Bridge Rehabilitation (2013)

Richland Avenue Bridge Rehabilitation (2013)

Richland Avenue Bridge Rehabilitation (2013)

STA-172 Bridge, Canton, Ohio (1925)

NO CORROSION, EFFLORESCENCE MAY BE LITHIUM HYDROXIDE
STA-172 Bridge, Canton, Ohio (1925)

NO CORROSION, EFFLORESCENCE (TASTES LIKE CALCIUM CHLORIDE)

A Trend Toward FRPs – Securing Patches through Confinement

US 23 SB over Iuka Ravine, Columbus (1916)

FRP WRAP INSTALLED FOR CONFINEMENT, 2006
Jericho Bridge, SE Ohio

Possible Corrosion

Detroit-Superior Bridge, 2015

Caution with FRP Wraps for Confinement

LONG-TERM MONITORING OF CARBON FIBER-REINFORCED POLYMER-WRAPPED CONCRETE COLUMNS UNDER SEVERE ENVIRONMENT, ACI STRUCTURAL JOURNAL, NOV.-DEC. 2006.

• ACCELERATED 48-MONTH CHLORIDE ATTACK ON SPECIMENS.

CONCLUSION:

FRP WRAP REDUCE CORROSION TO 10% OF NORMAL ACTIVITY.

Caution with FRP Wraps for Confinement

USE OF FRP WRAPS DOES PRESENT A NEED TO EDUCATE BRIDGE OWNERS THAT FRPs MAY HAVE SOME LIMITATIONS TO THE LONG-TERM SERVICE OF THEIR BRIDGES.

WRAP AND WALK AWAY IS THE NOT THE ANSWER!
Conclusion

We need to:
1. Monitor the performance in-service cathodic protection applications, and tell bridge owners how it is working.
2. Continue to educate bridge owners on value of cathodic protection and its long-term value and need to be used with FRP confinement, because opinions and knowledge varies.
3. Continue to educate bridge engineers on proper methods to evaluate concrete, including testing for carbonation.

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