Deterioration Factors at Girder Ends

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Connecticut Department of Transportation
September 29, 2010

Northeast Bridge Preservation Partnership Meeting
Hartford, CT
Overview

One of the most problematic areas at bridges is girder ends.

• Major contributing factors of deterioration

• The effects of corrosion

• What we can do to minimize corrosion
Corrosive Materials:

- Dirt and debris
- Bird droppings
- Salt and deicing chemicals
- Combination of the above
Dirt and Debris

Feature Carried: 1-95
Feature Crossed: West River and Kimberly Avenue
Date Inspected: 4/28/05
Project No.: 170-2357

Photo # 26: Typical condition of bearings at pier 9 with heavy laminated rust, up to ¼ inch loss on rockers and masonry plate and heavily covered with bituminous concrete.
Bridges are Homes to Pigeons
Bird Droppings
The most frequently mentioned corrosion concern in cold regions of the country is the application of salt and deicing chemicals.
Aetna Viaduct Bridge, Hartford, CT
Deicing Chemical Facts

Over $2 billion is spent each winter in this country on roadways and 15 million tons of deicing salts.

New equipment for upcoming winter
Connecticut’s Use of Deicing Chemicals During a Storm

- In the winter of 2007 Connecticut eliminated the use of sand and began applying salt brine prior to storms. During the storm, salt or salt pre-wetted with calcium chloride or magnesium chloride is applied.

- New practice works well in a wider range of temperatures.

- Eliminates costly sand clean-up on roadways and sand build-up on bridge seats.

- Better for the environment.

- But troublesome to bridges.
Calcium Chloride and Magnesium Chloride

<table>
<thead>
<tr>
<th>Delcer</th>
<th>Lowest Effective Temperature, F*</th>
<th>Effect on Concrete/Metal</th>
<th>Effect on Carpet/Floors</th>
<th>Effect on Vegetation</th>
<th>Effect on Environment/Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium chloride</td>
<td>-6</td>
<td>severe</td>
<td>slight</td>
<td>severe</td>
<td>moderate</td>
</tr>
<tr>
<td>Calcium chloride</td>
<td>-67</td>
<td>severe</td>
<td>severe</td>
<td>moderate</td>
<td>slight</td>
</tr>
<tr>
<td>Magnesium chloride</td>
<td>-28</td>
<td>severe</td>
<td>severe</td>
<td>moderate</td>
<td>slight</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>+13</td>
<td>severe</td>
<td>slight</td>
<td>moderate</td>
<td>slight</td>
</tr>
<tr>
<td>Calcium Magnesium Acetate</td>
<td>+15</td>
<td>slight</td>
<td>moderate</td>
<td>slight</td>
<td>slight/moderate</td>
</tr>
<tr>
<td>Urea and other nitrogen salts</td>
<td>variable</td>
<td>none/severe</td>
<td>moderate</td>
<td>slight</td>
<td>severe</td>
</tr>
<tr>
<td>Sand or gravel</td>
<td>–</td>
<td>slight</td>
<td>moderate</td>
<td>none</td>
<td>slight</td>
</tr>
</tbody>
</table>

*The effective melting temperature depends on the concentration of the deicing chemical. Values generally represent the lowest effective melting temperature possible with highly concentrated solutions of the compound. (Source: Utah State University Extension, 2199)

Severe corrosion effects on metals and concrete
Accelerated Deterioration?

- In the past few years, significant increases of deterioration have been observed by the same inspection crew at the same bridge.

- At some bridges, NBI condition ratings between inspection cycles have been downgraded by two categories (satisfactory to poor or fair to critical).

- In several instances, critical findings required repairs at bridges recently rehabilitated.

- Worse case, newly discovered deterioration added to ongoing construction projects by change order.
Effects of Deterioration
Result of Corrosion
Frozen Bearings

Broken Bearings
Frozen bearings can result in damage to the substructure…
Spalling of Concrete Girder
Precast Deck Unit Bridge
Combating Deterioration

Construction → Inspection → Teamwork → Communication → Design → Maintenance
Resources + Personnel + $$$$$$$$$$$

“Buy-in” from key decision makers is essential in the efforts to protect our massive capital investment in bridges.
What can be done to minimize corrosion at bridges?

- Design maintenance-free/maintainable bridges
- Preventative bridge maintenance program
- Bird netting
- Washing bridges to remove roadway salts, deicing chemicals, dirt, and bird droppings
Select and detail good deck joints

Failed deck joint during rain storm
Elements of a Good Bridge Design

Weathering steel, elastomeric bearings, proper deck drainage

Continuity over piers, painting of girder ends
Slab over backwall
Integral Abutments and Piers

Before concrete pour  After concrete pour
Preventative Maintenance Program

Cleaning Drainage System

Painting Girder Ends

Sealing Joints
Bird Netting
Managing deicing chemicals

- Train personnel on deicing equipment use
- Calibration of equipment and spot check
- Increase use of roadway and vehicle equipped temperature sensors
- Bridge washing program
Who washes bridges? - survey result

- Maine – Yes, and applies a protective oil
- Maryland – Used to but no longer because of environmental issues
- New Hampshire – Yes, has Best Management Practices
- New Jersey – No
- New York – Yes, MOU excludes washing over trout streams, disrupting migratory birds, and dislodging flaking paint
- Pennsylvania – Yes, under general maintenance permit and utilizes Federal funds
- Vermont – Yes, has policy with environmental agencies but discussions are ongoing.
- Rhode Island - Yes
### RIDOT ARRA Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
<th>RI Contract Number</th>
<th>City/Town</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Washing C - 11</td>
<td>Powerwashing of 65 of Rhode Island's 772 bridges to remove road salts, dirt and bird droppings. Includes: Burrillville, Charlestown, Cranston, East Greenwich, Exeter, Hopkinton, Johnston, Narragansett, North Kingstown, Richmond, South Kingstown, Warwick, West Greenwich, West Warwick, and Westerly. RIDOT goal of powerwashing all bridges with 10 contracts every 5 years.</td>
<td>2009-CM-025</td>
<td>Statewide</td>
<td>$984,000</td>
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<tr>
<td>Bridge Washing C - 10</td>
<td>Powerwashing of 65 of Rhode Island's 772 bridges to remove road salts, dirt and bird droppings. Includes: Cumberland, East Providence, Lincoln, North Smithfield, Pawtucket, Portsmouth, Providence, and Tiverton. RIDOT goal of powerwashing all bridges with 10 contracts every 5 years.</td>
<td>2009-CM-024</td>
<td>Statewide</td>
<td>$1,392,000</td>
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</table>
Connecticut does not wash bridges due to environmental issues but we have begun discussing the need for such a program.
I’d like to end my presentation with the question…

What are your experiences with cleaning bridges?

Thank you.
References

• United State Environmental Protection Agency (EPA) “Source Water Protection Practices Bulletin,” August 2010

• Rhode Island ARRA information, n.d., from: http://www.recovery.ri.gov/programs/TransportationMap.php#statewide

• Utah State University Extension, February 1999