Service Life Design and Durability of Steel Bridges: North Commuter Parkway and Traffic Bridge Project

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Agenda

- Introduction
- Project Overview
- Project Requirements
- Service Life Assessment of Structural Steel
- Conclusions
Introduction

• Infrastructure deteriorates long before it is supposed to.

• The goal: design for service life.

• Use of a rational approach to design and quantify service life
North Commuter Parkway and Traffic Bridge Project

• Located in Saskatoon, Saskatchewan, Canada

• Owner: City of Saskatoon

• Design-Build Project (PPP) with 30 years concession period for O&M
  – Graham Commuter Partners
  – COWI North America

• Scheduled to be open to traffic: Oct 2018
Parkway Bridge
Replacement of Traffic Bridge
Replacement of Traffic Bridge
Traffic Bridge
• Service life requirements well defined, for each component:
  – A minimum service life in years
  – Durability criteria
  – End of service life definition provided
## Project Requirements

<table>
<thead>
<tr>
<th>Element</th>
<th>MSL  (Years)</th>
<th>Durability Criteria and End of Service Life Definition&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weathering Steel</td>
<td>100</td>
<td>Any Fair Condition State on any component or cracks.</td>
</tr>
<tr>
<td>Coatings</td>
<td>25</td>
<td>Any Fair Condition State defect.</td>
</tr>
<tr>
<td>Expansion Joints (Gland)</td>
<td>20</td>
<td>Any Poor Condition State defect.</td>
</tr>
<tr>
<td>Expansion Joint Armouring or Cover Plates</td>
<td>40</td>
<td>Leakage between armouring and concrete or Poor Condition State defects.</td>
</tr>
</tbody>
</table>
Structural Steel Components

• Weathering steel: 100 year service life
  – end of service life means any "fair" condition state on any components or cracks
  – structural design allows for corrosion loss up to 10% of cross section

• Coatings: 25 year service life
  – end of service life means any fair condition state defects
  – type of coating system specified
  – locations of coatings specified: deck level up to 3m, within 3m of expansion joints
• Define exposure zones for superstructure steel components

• Develop exposure zones that related to ISO 12944: international standard on corrosion protection of steel structures by protective paint
## ISO 12944 – Corrosivity Categories

<table>
<thead>
<tr>
<th></th>
<th>Bridge Exposure Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 very low</td>
<td></td>
</tr>
<tr>
<td>C2 low</td>
<td>Rural</td>
</tr>
<tr>
<td>C3 medium</td>
<td>Urban. Low salinity</td>
</tr>
<tr>
<td>C4 high</td>
<td>Coastal moderate salinity</td>
</tr>
<tr>
<td>C5-M very high</td>
<td>Coastal high salinity</td>
</tr>
<tr>
<td></td>
<td>Atmospheric</td>
</tr>
<tr>
<td></td>
<td>Indirect Deicing Salts</td>
</tr>
<tr>
<td></td>
<td>Direct Deicing Salts</td>
</tr>
</tbody>
</table>
Parkway Bridge: exposure zones for a typical section at midspan
• Parkway Bridge: exposure zones for section at expansion joint
Exposure Zones

- Traffic Bridge: Exposure zones for a typical section at midspan at a truss penetration points
Exposure Zones

- Traffic Bridge: Exposure zones for a typical section within 3m of expansion joint
Exposure Zones

- Traffic Bridge: Exposure zones for lower chord node
• Estimation of corrosion section loss

• Estimate of coating service life

  *New Paper is no.7422, 2016
### Design

**Exposure Zone** | **Design**
---|---
Atmospheric (category C3) | Bare weathering steel:  
- corrosion allowance 0.5 mm/surface

Indirect Deicing Salts (category C4) | Bare weathering steel:  
- corrosion allowance 0.8mm/surface  
- corrosion allowance 1.5 mm/surface under breather joints  
Three coat paint system approved by Owner for steel below deck within 3m of expansion joints.

Direct Deicing Salts (category C5-M) | Three coat paint system approved by Owner.

Project Requirements: for truss lower chords - sections will be sized so that estimations of corrosion loss over service life do not exceed 10% of the cross section required for structural capacity.
Recent Construction Photos
Conclusions

• The superstructure steel components of Parkway Bridge and Traffic Bridge have been designed for a 100 year service life

• Definitions of exposure zones consistent with ISO 12944

• Choice of mitigation methods:
  – corrosion allowances based on ASTM G101
  – coating service life based on NACE paper 08279
Questions?

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AASHTO SHRP2 R19A Website:
http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx

FHWA GoSHRP2 Website:
www.fhwa.dot.gov/GoSHRP2/