Overview of SHRP2 R19A and Activities Done by Other States

Oregon DOT Workshop – Portland, OR

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Regional Discipline Lead, North American Bridges
CH2M

January 17, 2018
Presentation Overview

• Need for Service Life Design

• SHRP2 R19A Implementation Action Program
  – Program Goals
  – Work Focus Areas
  – Participating Agency (Lead Adopter) Projects
  – Lessons Learned

• Summary
Need for Service Life Design

• Growing interest by the industry to make bridges more durable with longer expected lives

• Influenced by political motivation – popular to state that a new bridge will last 100+ years…

• Evident by requirements in recent Owner’s RFPs – particularly on Design Build projects
Service Life Designed Structures

- Ohio River Bridge, KY – 2016 (100 years)
Service Life Designed Structures

- Tappan Zee Bridge, NY – 2018 (100 years)

courtesy of New York State Thruway Authority
Need More Focus on These

• Representing the majority of the 600,000+ bridges in the US
Need for Service Life Design

• Expectations of SLD requirements often unclear

• A more robust definition was needed for SLD

• FHWA in conjunction with AASHTO and TRB through the 2\textsuperscript{nd} Strategic Highway Research Program (SHRP2) initiated project R19A
  – Bridges for Service Life Beyond 100 Years: Innovative Systems, Subsystems and Components
Research Work Completed

- Project R19A – Service Life Design Guide

- [http://www.trb.org/Main/Blurbs/168760.aspx](http://www.trb.org/Main/Blurbs/168760.aspx)
IAP Goals

• Promote SLD concepts through:
  – Marketing, outreach & training
  – Workshops & Peer Exchanges

• Assist Lead Adopter agencies in developing in-house SLD skills

• Build a strong technical foundation
  – Develop training & reference materials
  – Develop “Academic Toolbox”
  – Lessons learned summaries
Current Work Focus Areas

- Performing tests on material durability properties of concrete mix designs
  - Concrete chloride diffusion coefficients (NT Build 492)
  - Measurement of as-constructed concrete cover

Elcometer
Current Work Focus Areas

• Tests on existing bridges to assess environmental loading and material behavior
  – Taking concrete cores to measure chloride loading from de-icing chemicals or sea water

Source: Germann Instruments
Current Work Focus Areas

- Developing design tools and processes to aid in SLD
  - Excel spreadsheet for chloride profiling
Implementation Products – Dedicated Webpage

AASHTO > Strategic Highway Research Program 2 > Service Life Design for Bridges

SERVICE LIFE DESIGN FOR BRIDGES (R19A)

Product Overview
Comprehensive guidance to select and design durable bridge systems and components that are both easier to inspect and better-suited to their environments.
- SHR2 Service Life Design Guide For Bridges Document

Presentations and Webinars
- Concept Overview presentation: Durability Design Structure Birth Certificate
- Product Detail presentation: Integrating Durability and Structural Design
- Service Life Design for Bridges Progress Update Webinar

Tools and Technologies
Reports
- Durability Assessment of a Bridge Substructure (R19A)

Design Tools
- Service Life Design – Graphical Solution
  - Calculations Instructions
  - Oregon Charts
- Service Life Design – Full Probabilistic Tools

- http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx
IAP Projects - Round 4
Initiated Fall 2014
IAP Team Leaders

- FHWA Central Federal Lands
  - Bonnie Klamerus, Mike Voth
- Iowa DOT
  - Ahmad Abu-Hawash, Norm McDonald
- Oregon DOT
  - Bruce Johnson, Paul Strauser, Zach Beget, Ray Bottenberg, Andrew Blower, Craig Shike
- Pennsylvania DOT
  - Tom Macioce
- Virginia DOT
  - Prasad Nallapaneni, Soundar Balakumaran
FHWA Central Federal Lands

- Tropical Coastal Exposure on North Shore, Island of Kauai, HI
  - 3 bridge replacements - 500’ to 1,000’ from the coastline
• Testing brackish water salinity

• Coring of existing abutments at water line / splash zone for surface chloride concentration

• NT Build 492 tests performed on baseline concrete mix designs
New Bridge at Site with Extreme De-Icing Spray Exposure

- Using A1010 High Chromium Structural Steel
- Lab and field testing A1010 for steel corrosion resistance performance
- Recommendations from ODOT experience - Hormoz Seradj
Replacement of Twin Structures on I-35 over South Skunk River near Ames

- Chloride profile testing on existing structures
- NT Build 492 tests on concrete mix designs
- SB Bridge – Designed to current Iowa DOT policies
- NB Bridge – Will be designed using SLD
- Final Product – Side-by-side comparison report between the two structures
Pennsylvania DOT

- **Statewide Evaluation of Chloride Resistance of Concrete**
  - Performed NT Build 492 tests on 105 samples from 7 ready mix and 2 precast concrete suppliers
• **PennDOT Concrete Classifications tested**
  - Class A – Structures & Misc., 3000 psi (31 samples)
  - Class AA – Structures & Misc., 3500 psi (36 samples)
  - Class AAAP – Bridge Decks, 4000 psi (30 samples)
  - Class HES – High Early Strength, 3500 psi (3 samples)
  - SCC – Self-Consolidating, must meet requirements of above classifications (6 samples)
<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Use</th>
<th>Cement Factor&lt;sup&gt;(3)(5)&lt;/sup&gt; (lbs/cu. yd.)</th>
<th>Maximum Water Cement Ratio&lt;sup&gt;(6)&lt;/sup&gt; (lbs/lbs)</th>
<th>Minimum Mix&lt;sup&gt;(2,9)&lt;/sup&gt; Design Compressive Strength (psi) Days</th>
<th>Proportions Coarse&lt;sup&gt;(1)&lt;/sup&gt; Aggregate Solid Volume (cu. ft./cu. yd.)</th>
<th>28-Day Structural Design Compressive Strength (psi)</th>
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<td>Min.</td>
<td>Max.</td>
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Chloride Migration Coefficient by Concrete Class

Pennsylvania DOT
Chloride Migration Coefficient by Concrete Supplier

Pennsylvania DOT
• Final Service Life Design Workshop held August 16, 2016 in Harrisburg, PA

- Overview of Service Life Design for Bridges
- Chloride Induced Corrosion Modeling
- Concrete Deterioration Mechanisms
- Implications of Cracks in Concrete on Service Life
- Service Life Design Requirements for RFPs
- Service Life Design for Steel Structures
Virginia DOT

- **Statewide Evaluation of Chloride Surface Loading and Resistance of Concrete**
  - Compared historic chloride surface loading to fib-34 methods
  - Performed NT Build 492 tests on over 20 ongoing bridge construction projects around the state
  - Developing a database of reference values specific to Virginia for use in modeling
• Categorization of chloride loading by zones

<table>
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<th>Color</th>
<th>Region</th>
<th>Historical data (Williamson, 2007)</th>
<th>fib 34-predicted</th>
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Final Service Life Design Workshop held October 4, 2017 in Charlottesville, VA

- Overview of SLD – SME Team
- Concrete Material Testing Program – Virginia Tech
- Chloride Profiling of Existing Bridges – Virginia Tech
- Specifications on Corrosion Resistant Reinforcing – VDOT
- SLD Tools developed – SME Team
- SLD for Alternative Delivery Projects – SME Team
- R19A work done by other agencies – SME Team
IAP Projects - Round 7
Selected Summer 2016
IAP Team Leaders

- Iowa DOT
  - Ahmad Abu-Hawash, Norm McDonald
- Maine DOT
  - Dale Peabody
• Thin Deck Overlays as a Bridge Preservation Action
  – Evaluation of structures on US-18 corridor
  – Kick-off Meeting to take place on June 20, 2017
Maine DOT

• Replacement of Beals Island Bridge in cold weather coastal environment
  – Chloride profiling on existing bridge
  – NT Build 492 tests on proposed concrete specifications
Lessons Learned
Lessons Learned

• Chloride profiling on core samples produce much better results than powder samples from rotary drilling
• Deicing application is low enough in some parts of Oregon to disregard corrosion from chlorides
• Need to develop contour maps of chloride loading
• Chloride migration tests (NT Build 492) are relatively easy to implement
  – Virginia and Iowa performing in-house testing
Lessons Learned

• Most state concrete classifications are flexible in w/c ratio, and % flyash or slag replacing cement

• Mix design flexibility ≠ Consistent durability properties
  – Chloride migration test values (NT Build 492)
  – Aging coefficients (need ≥ 20% flyash to benefit)

• Need to develop guidelines for more consistent concrete specifications for SLD
IAP Next Steps

• Conduct Agency Final Training Workshops for CFL, IA, ME

• Develop Reference Material Documentation / add to AASHTO/SHRP2 web page
  – Academic Toolbox
  – Life Cycle Cost Example
  – Lessons Learned Summaries

• Develop 5 FHWA Peer Exchanges in non-IAP states
• Uniform Service Life Design Guide Specification
  – Sponsored by AASHTO T-9 – Bridge Preservation Technical Committee
  – Modjeski & Masters / John Kulicki / Rutgers University / COWI / NCS GeoResources

• Project Goals
  – Develop Case Studies to Demonstrate the Application of the Proposed Guide
• Deemed-to-Satisfy and Avoidance of Deterioration Strategies to form the majority of the Guide Specification
  – Calibrated by more rigorous approaches
• Full Probabilistic and Partial Factor Methods
  – Included as an Appendix
• Environmental Classification
• Recommended Service Life
  – Main Structure Components
  – Replaceable Components
  • Bearings, Joints, etc.
Current Research – NCHRP 12-108

• Work Plan / Schedule
  – Tasks 1 & 2 – Literature Review and Synthesis
  – Task 3 – Develop Proposed Methodology
  – Tasks 4a & b – Propose Annotated ToC & Case Studies
  – Task 5 – Interim Report #1
    (all completed 03/10/17)

  – Tasks 6, 7 & 8 – Develop & Execute Methodology & Sample Section & Interim Report #2 (scheduled 10/01/17)

  – Tasks 9 & 10 – Develop Guide and Case Studies (scheduled 07/01/18)

  – Tasks 11 & 12 – Revisions & Final Deliverables (scheduled 12/01/18)

  – End of Project (scheduled 02/28/19)
Summary

- Service Life Design is necessary to promote more durable, longer lasting structures
- Current implementation
  - SHRP2 R19A projects (FHWA CFL, IA(2), ME, OR, PA, VA)
- Tools being developed to assist designers
  - [http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx](http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx)
- AASHTO T-9 Initiated Research
  - NCHRP 12-108 Uniform Service Life Design Guide
Questions?

Implementation Leads:

• Patricia Bush, AASHTO Program Manager for Engineering, pbush@aashto.org
• Raj Ailaney, FHWA Senior Bridge Engineer, Raj.Ailaney@dot.gov

Subject Matter Expert Team:

• Mike Bartholomew, CH2M, mike.bartholomew@ch2m.com
• Anne-Marie Langlois, COWI North America, amln@cowi.com

Resource: AASHTO’s R19A Product Page

• http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx