


SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Overview of SHRP2 R19A and Activities Done by Other States

Virginia DOT Workshop – Charlottesville, VA

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CH2M

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U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

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 2nd Strategic Highway Research Program (SHRP2) initiated project R19A
  - Bridges for Service Life Beyond 100 Years: Innovative Systems, Subsystems and Components

SHRP2 Project R19A

SHRP2 R19A Team

RESEARCH – **TRB**

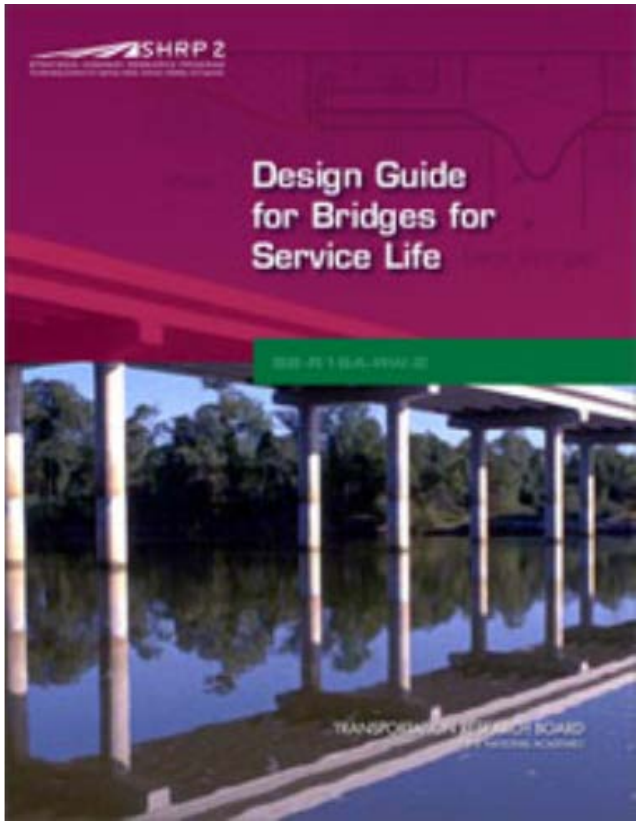
IMPLEMENTATION – **FHWA/AASHTO**

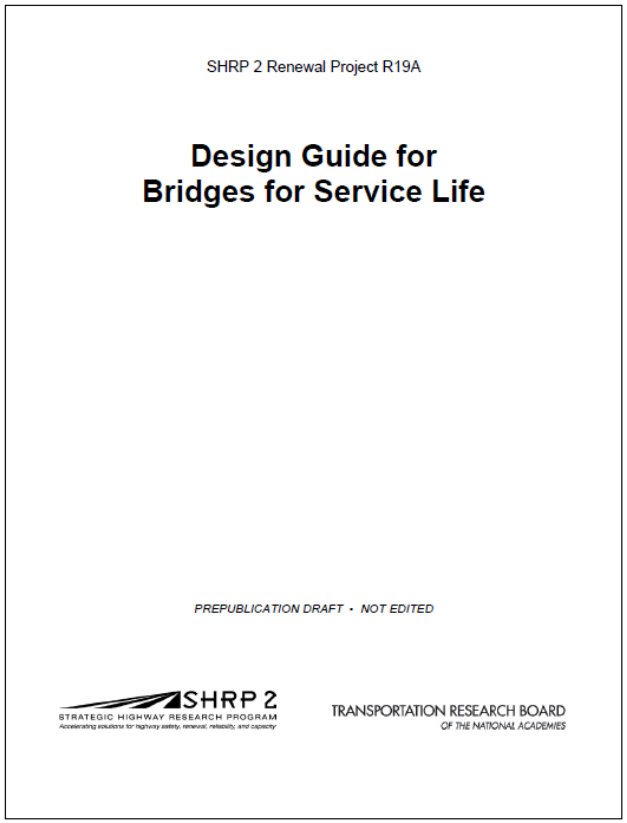
SUBJECT MATTER EXPERTS / LOGISTICS SME LEAD – **CH2M**
TECHNICAL SMEs – **COWI**

LEAD ADOPTER AGENCIES

Research Work Completed

- Project R19A – Service Life Design Guide

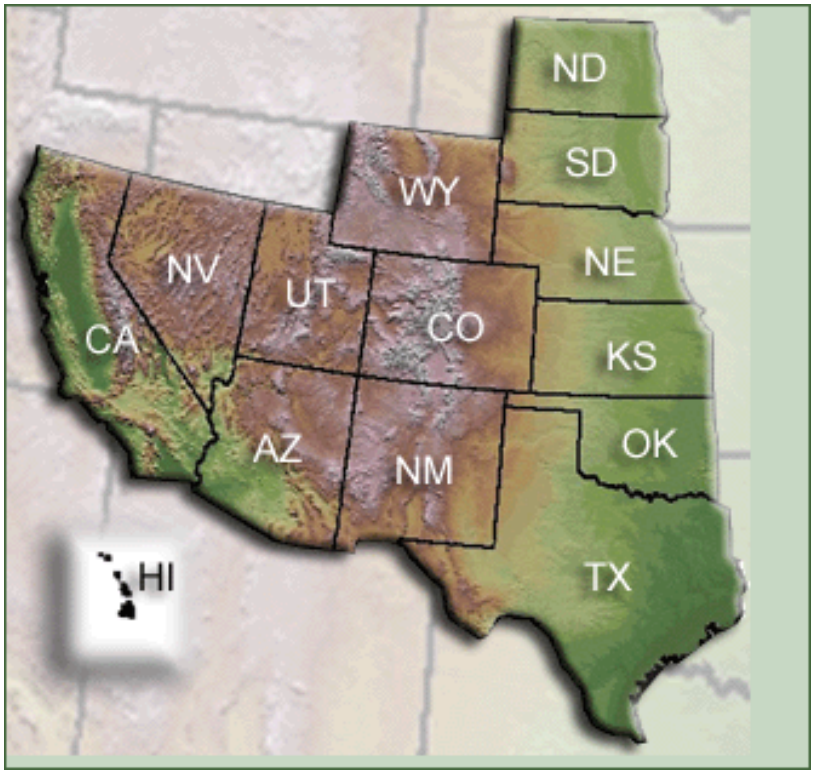




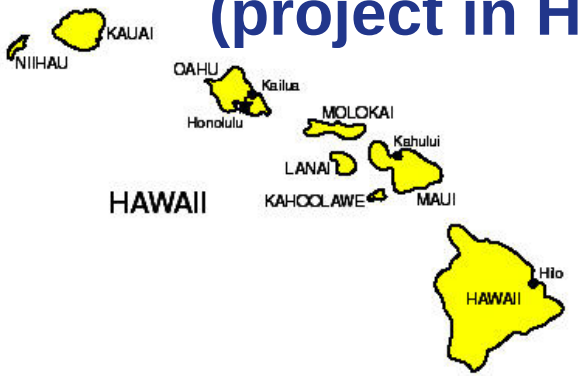
  - http://www.trb.org/Main/Blurbs/168760.aspx

IAP Lead Adopter Agencies

Oregon



Central Federal Lands (project in Hawaii)



IAP Lead Adopter Agencies

Iowa

Maine

Pennsylvania

Virginia

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

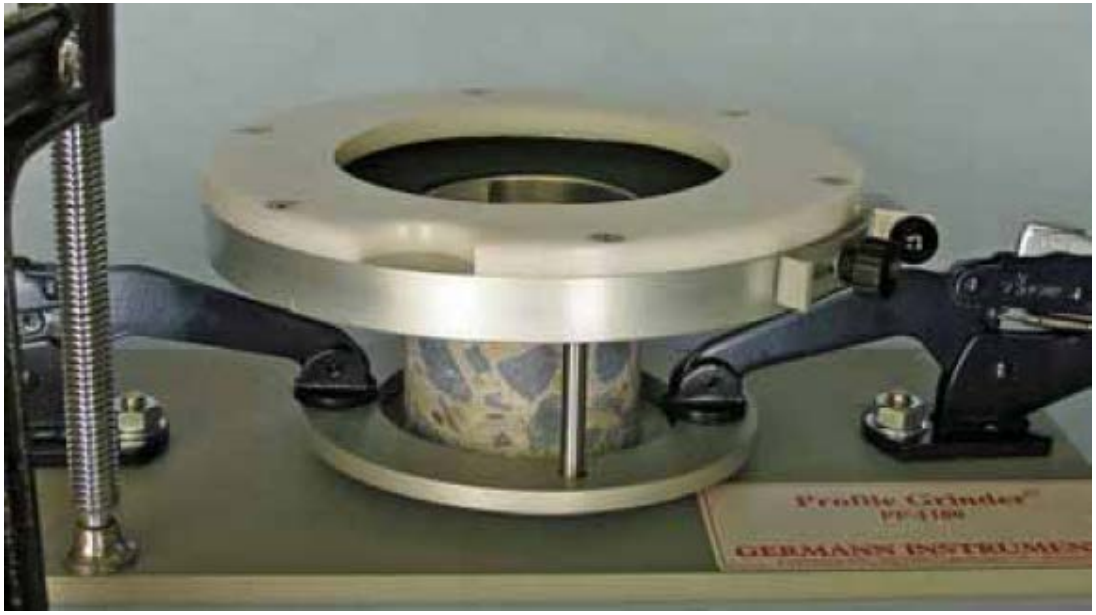
Current Work Focus Areas

- 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



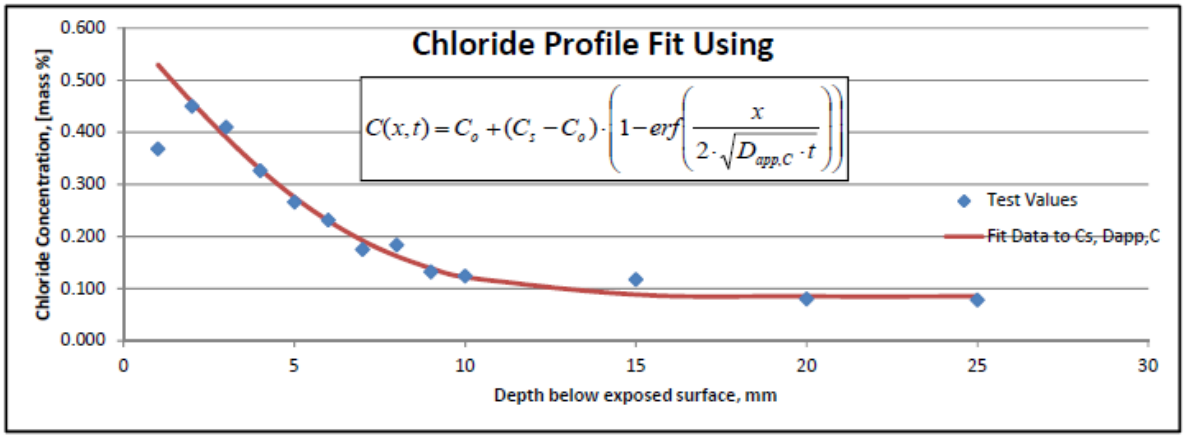
Source: Germann Instruments

Current Work Focus Areas

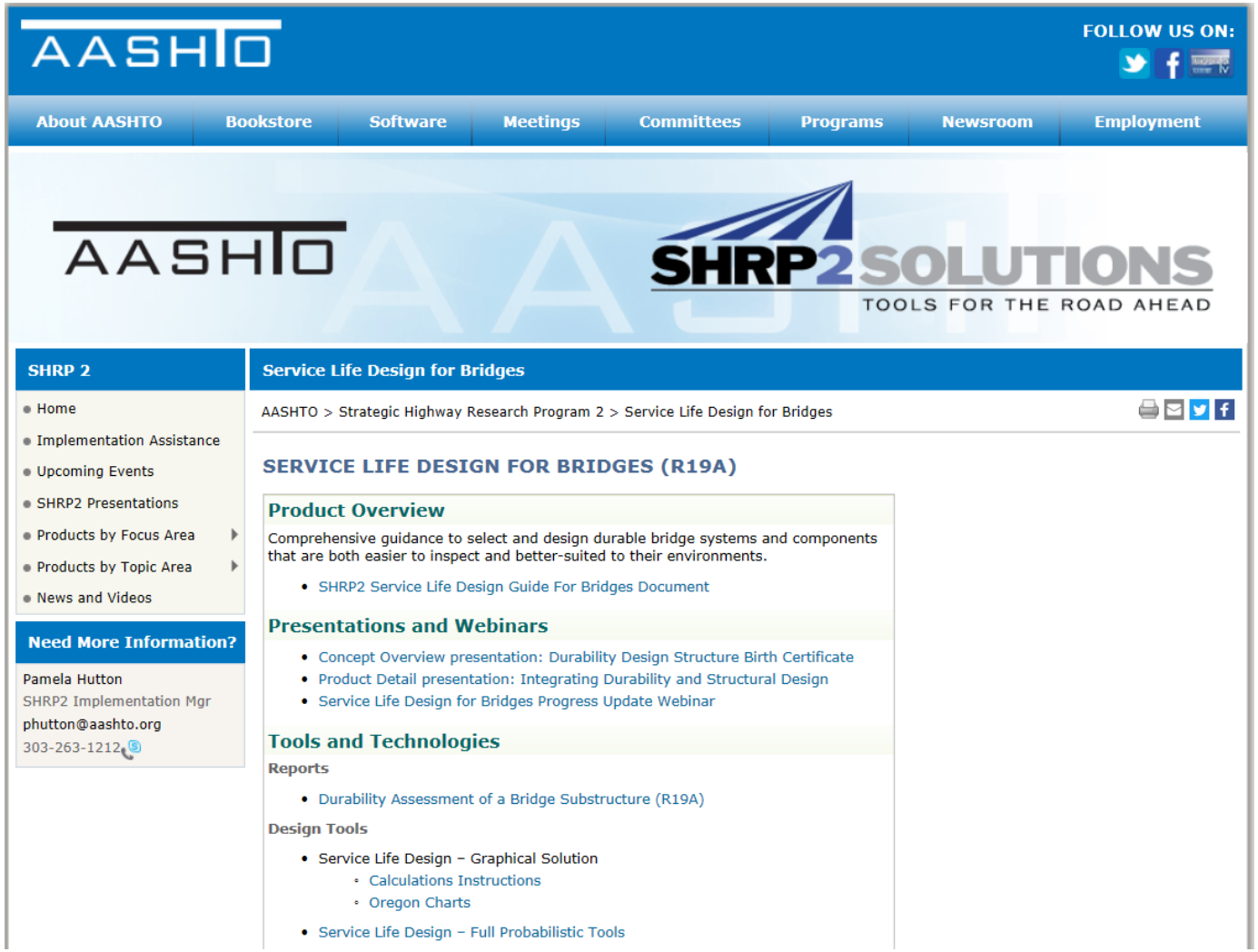
- Developing design tools and processes to aid in SLD
  - Excel spreadsheet for chloride profiling

d	depth from surface	[mm]	1	2	3	4	5	6	7	8	9	10	15	20	25	
C_m	Test Values	[mass %]	0.368	0.450	0.410	0.326	0.266	0.231	0.175	0.183	0.132	0.124	0.117	0.080	0.078	
C_c	Fit Data to C_s, $D_{app,C}$	[mass %]	0.530	0.458	0.391	0.329	0.275	0.230	0.192	0.162	0.139	0.122	0.089	0.085	0.085	$\sum (C_m-C_s)^2$
$(C_m - C_s)^2$	Sum of least squares			6.72E-05	3.76E-04	1.10E-05	9.01E-05	1.55E-06	2.93E-04	4.34E-04	5.00E-05	4.66E-06	8.12E-04	2.66E-05	4.90E-05	2.22E-03

C_o	Initial chloride content (measured)	[mass %]	0.085
t	Exposure time	[yr]	1
C_s	Chloride content at exposed face	[mass %]	0.605
$D_{app,C}$	Apparent coefficient of chloride diffusion	[mm^2/yr]	15.324



Implementation Products – Dedicated Webpage



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

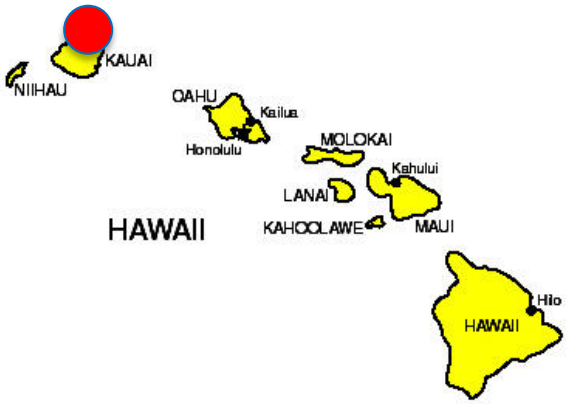
IAP Projects

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



FHWA Central Federal Lands

- 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

Iowa DOT

- **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

Iowa DOT

- **Replacement of Twin Structures on I-35 over South Skunk River near Ames**

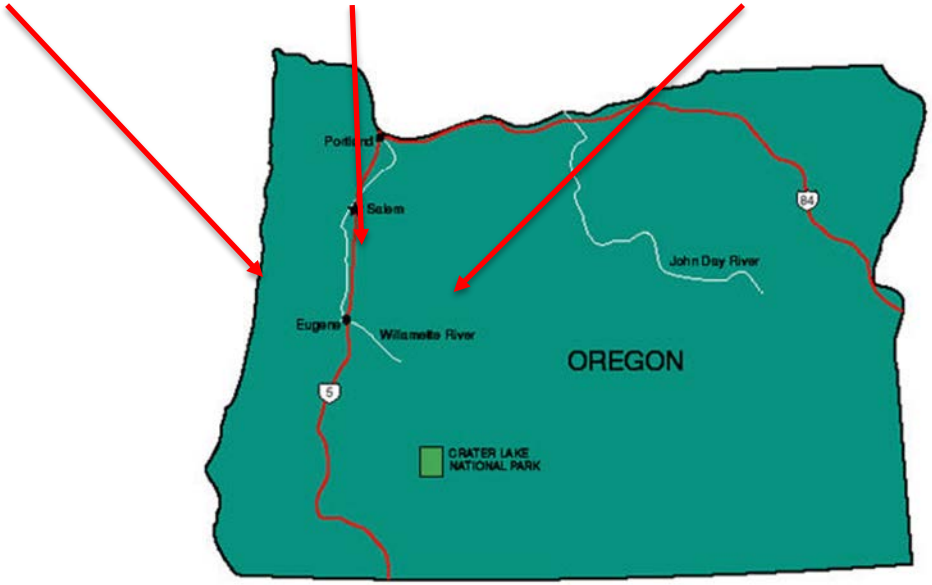
  - Chloride profile testing on existing structures
  - NT Build 492 tests on concrete mix designs
  - SB Bridge – Designed to current Iowa DOT policies
  - NB Bridge – Will be designed using SLD
  - Final Product – Side-by-side comparison report between the two structures

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

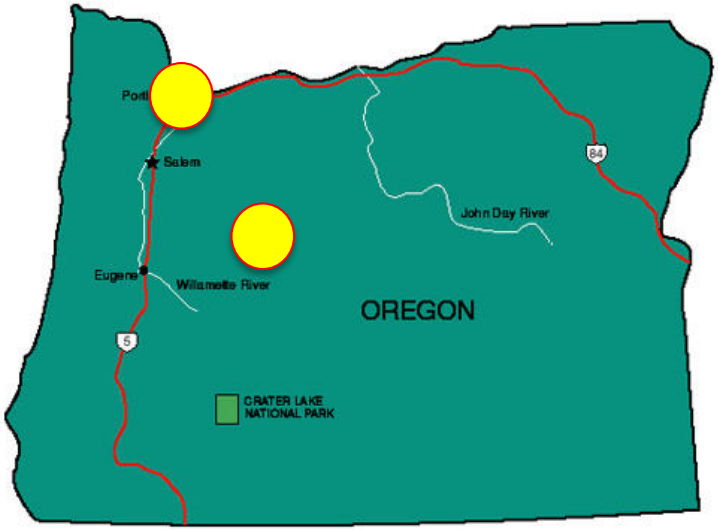
Oregon DOT

- **Bridge Deck Evaluation in Various Chloride Exposure Zones**
  - Performed chloride profile testing and categorization of chloride loading by geographic/climatic zones (Pacific Coast, Willamette Valley, Cascade Mountains and east)



Oregon DOT

- **I-5 Columbia River Crossing Design/Build – Portland to Vancouver**
  - Evaluate/modify RFP requirements for contractor to design/document to a 100-year service life
- **Replacement Bridge over Ochoco Creek in Prineville**



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

Figure 1: Company location map relative to PennDOT districts

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, OR, ME
- Develop Reference Material Documentation / add to AASHTO/SHRP2 web page
  - Academic Toolbox
  - Lessons Learned Summaries
- Develop 5 FHWA Peer Exchanges in non-IAP states

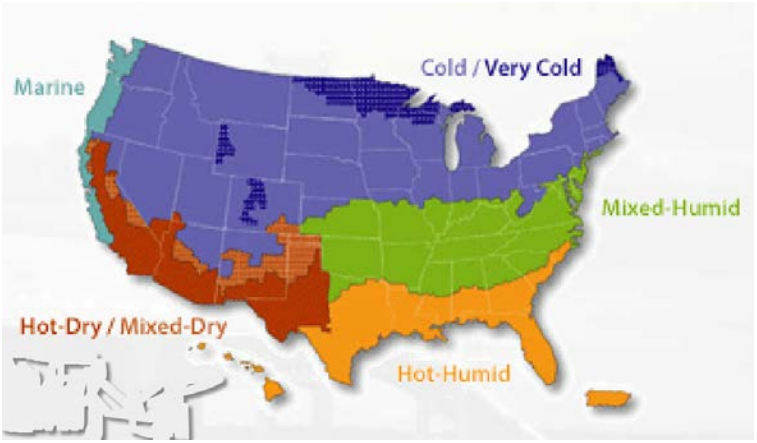
Current Research - NCHRP 12-108

- 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 AASHTO Guide Specification for Service Life Design of Highway Bridges
  - Develop Case Studies to Demonstrate the Application of the Proposed Guide

Current Research - NCHRP 12-108

- 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
- 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