



# Implementing Service Life Design Using the fib Bulletin 34 Methodology

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U.S. Department of Transportation  
Federal Highway Administration

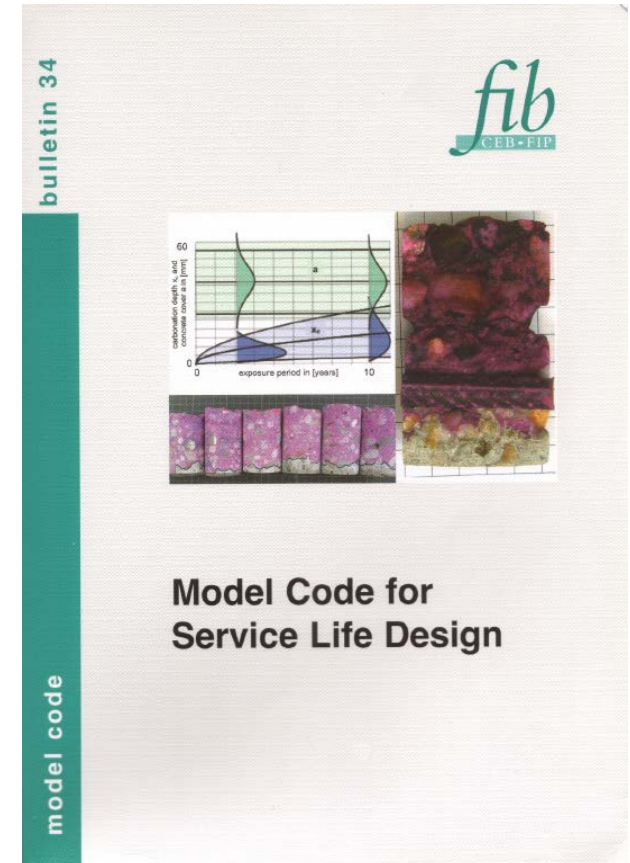
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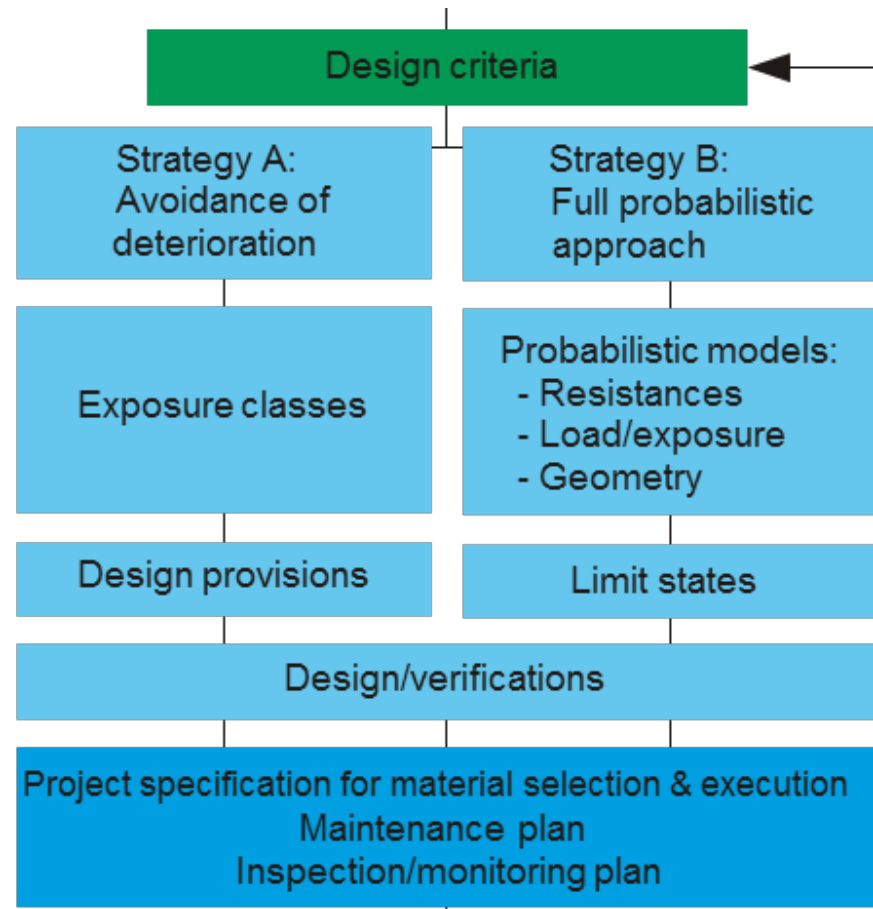
# *fib* Bulletin 34 Model Code for Service Life Design

- Written and distributed by the International Federation of Structural Concrete (*fib*)
- A reliability-based service life design methodology for concrete structure
  - Similar to Load-Resistance Factor Design
- ISO 16204:2012 Service Life Design of Concrete Structures



# *fib* Bulletin 34 Model Code for Service Life Design

- All degradation mechanism addressed with 1 of 2 strategies
- Avoidance approach applied for:
  - Carbonation-induced corrosion
  - Sulfate attack
  - DEF
  - AAR
  - Freeze/thaw degradation
- Full probabilistic approach for:
  - Chloride-induced corrosion

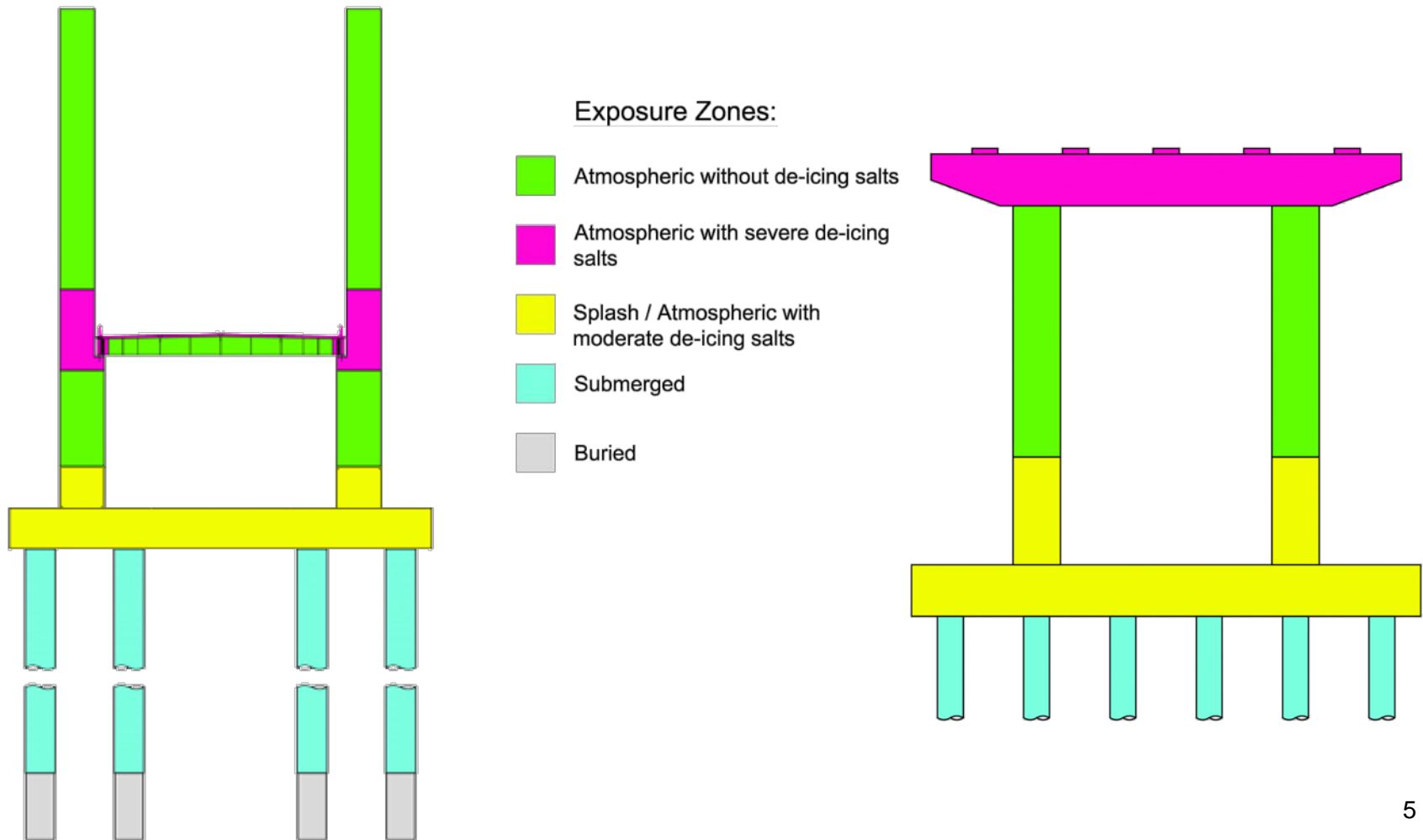


# *fib* Bulletin 34 Model Code for Service Life Design Strategy - Probabilistic Analysis

1. Define exposure zones and degradation mechanisms
2. Select limit state
3. Design Parameters
  - Materials
  - Concrete quality
  - Concrete cover
4. Project Specifications
5. Construction → pre-testing and production testing

# Service Life Assessment

## 1. Define exposure zones and degradation mechanisms



# Service Life Assessment



## 1. Define exposure zones and degradation mechanisms

- Temperature
- Extent of splay/spray zone?
- Chloride surface concentrations?
- Data should be gathered:
  - water (chlorides, sulfates, pH)
  - soil (chlorides, sulfates, pH)

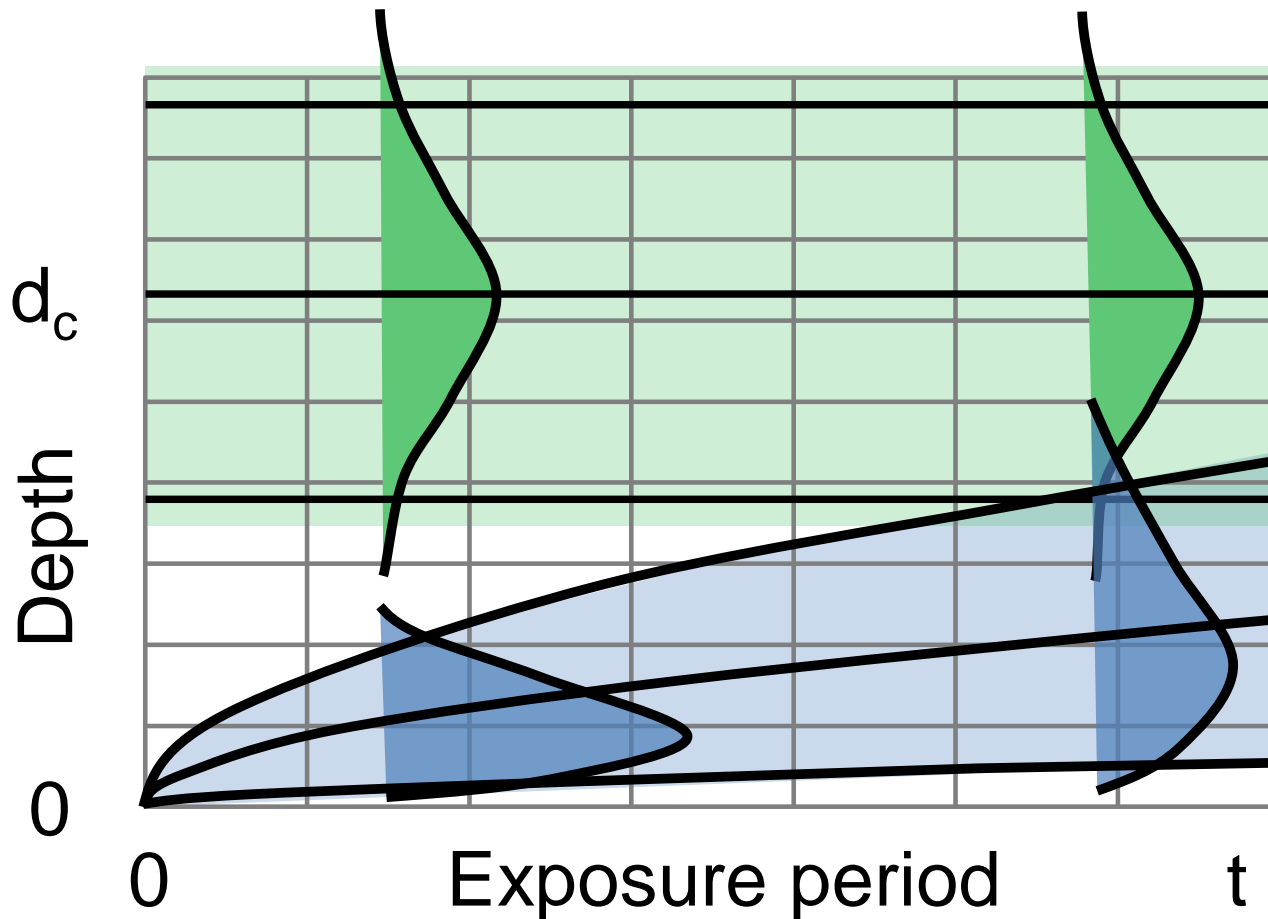
# Modelling Chloride-induced Corrosion

## 2. Select limit state

- Depassivation of reinforcement marks end of service life
- Occurs when critical chloride threshold is reached at reinforcement
- Serviceability limit state:
  - 10% probability that corrosion will initiate within the service life
  - 90% probability that it will not!

# Modeling Chloride-induced Corrosion

## 3. Design Parameters



# Service Life Assessment

## 3. Design Parameters

## 4. Input in Project Specification

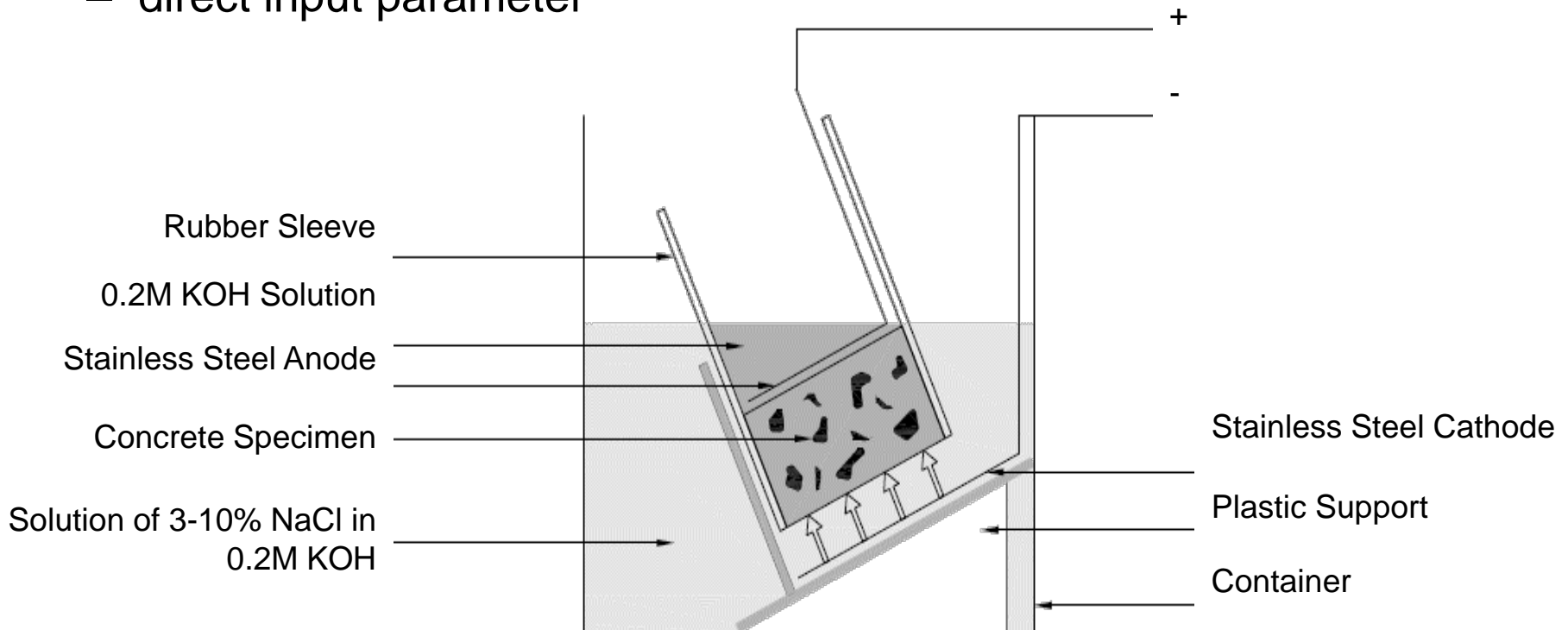
				Mix 1	Mix 2	Mix 3
Exposure Zone	Structural Element	Nominal cover	Max. w/cm	Max. mean Chloride Migration Coefficient		
		[in]	[-]	$D_{28} \times 10^{-9} [\text{in}^2/\text{s}]$		
De-icing salt spray	Towers, pier caps, abutments	3.0	0.40	14.1	3.4	4.9
	Deck			11.3	2.7	4.0
	Concrete barriers	2.75		12.4	3.4	4.6
Atmospheric	Towers, pier caps, pier columns	3.0	0.40	15.0	11.0	12.0
Splash	Towers, pier caps, pier columns	3.0	0.40	15.0	5.1	7.1
	Pile caps	4.0			9.9	12.0
Submerged	Concrete plug for piles	2.5	0.40	15.0	5.8	8.3

# Service Life Assessment

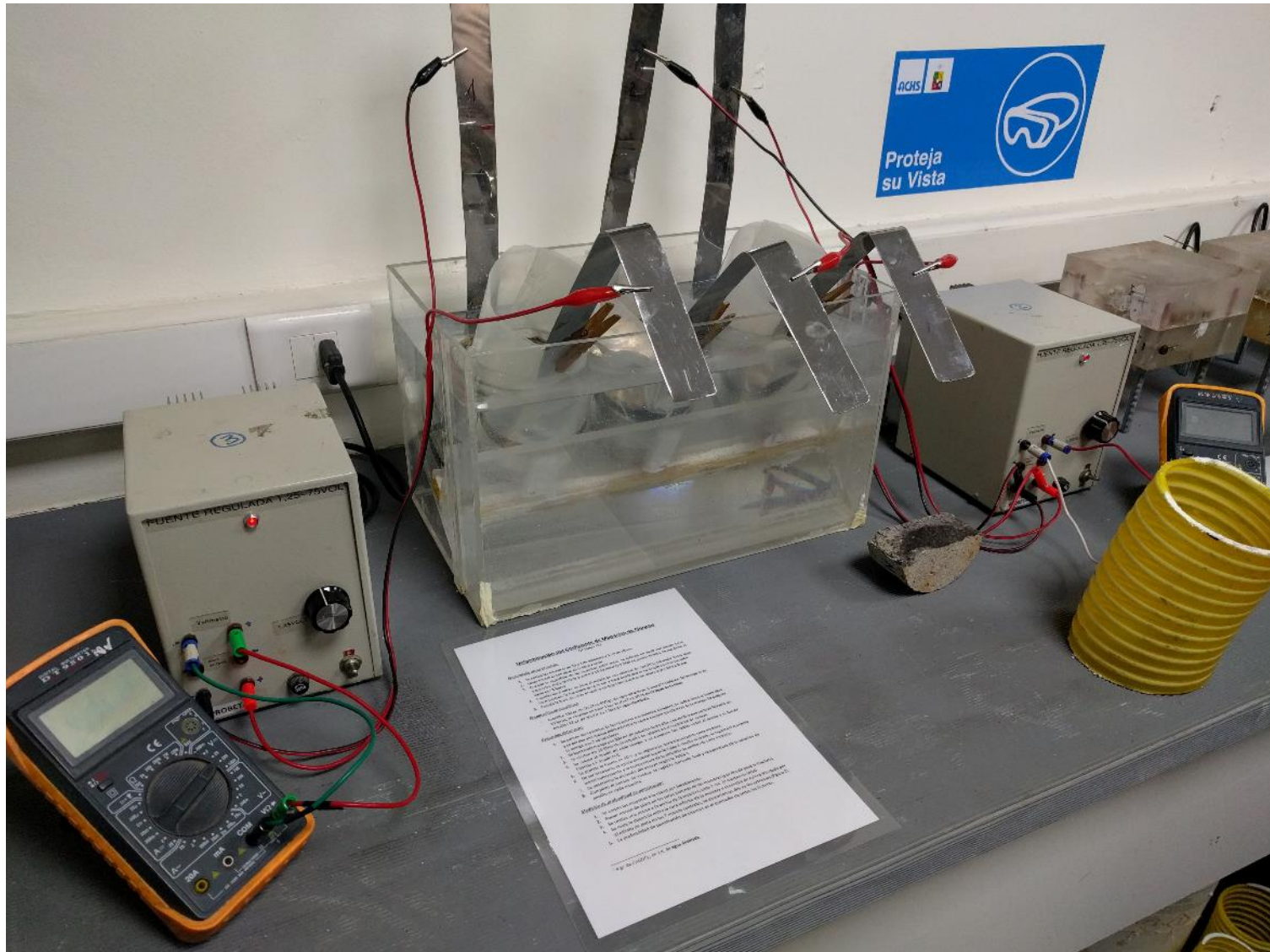
## 5. Construction → Pre-testing and production testing

fib Model Code is based on **NT Build 492: Rapid Chloride Migration Test**

- measure the migration coefficient of concrete at 28 days
- direct input parameter



# NT Build 492 – Test Setup



# NTBuild 492 - Testing



# NT Build 492

- Split specimen axially into 2 pieces
- Spray silver nitrate solution on broken surface
- Measure chloride penetration depth
- Calculate Chloride Migration Coefficient,  $D_{RCM,0}$

NORDTEST METHOD

NT BUILD 492 7  
APPENDIX 1

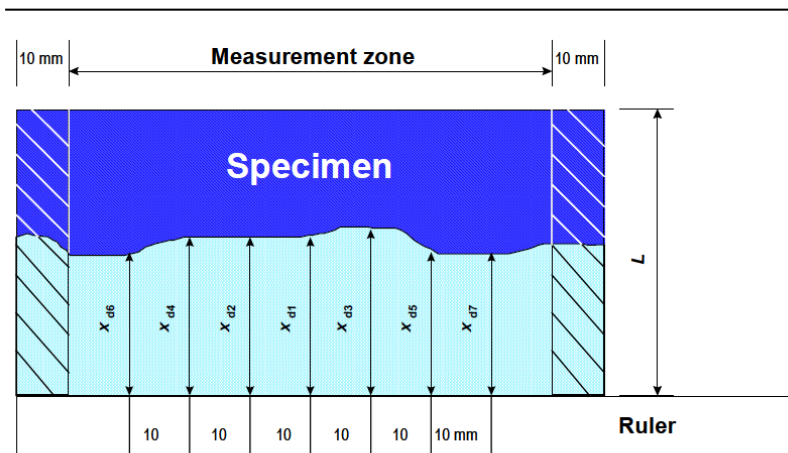


Fig. 5. Illustration of measurement for chloride penetration depths.



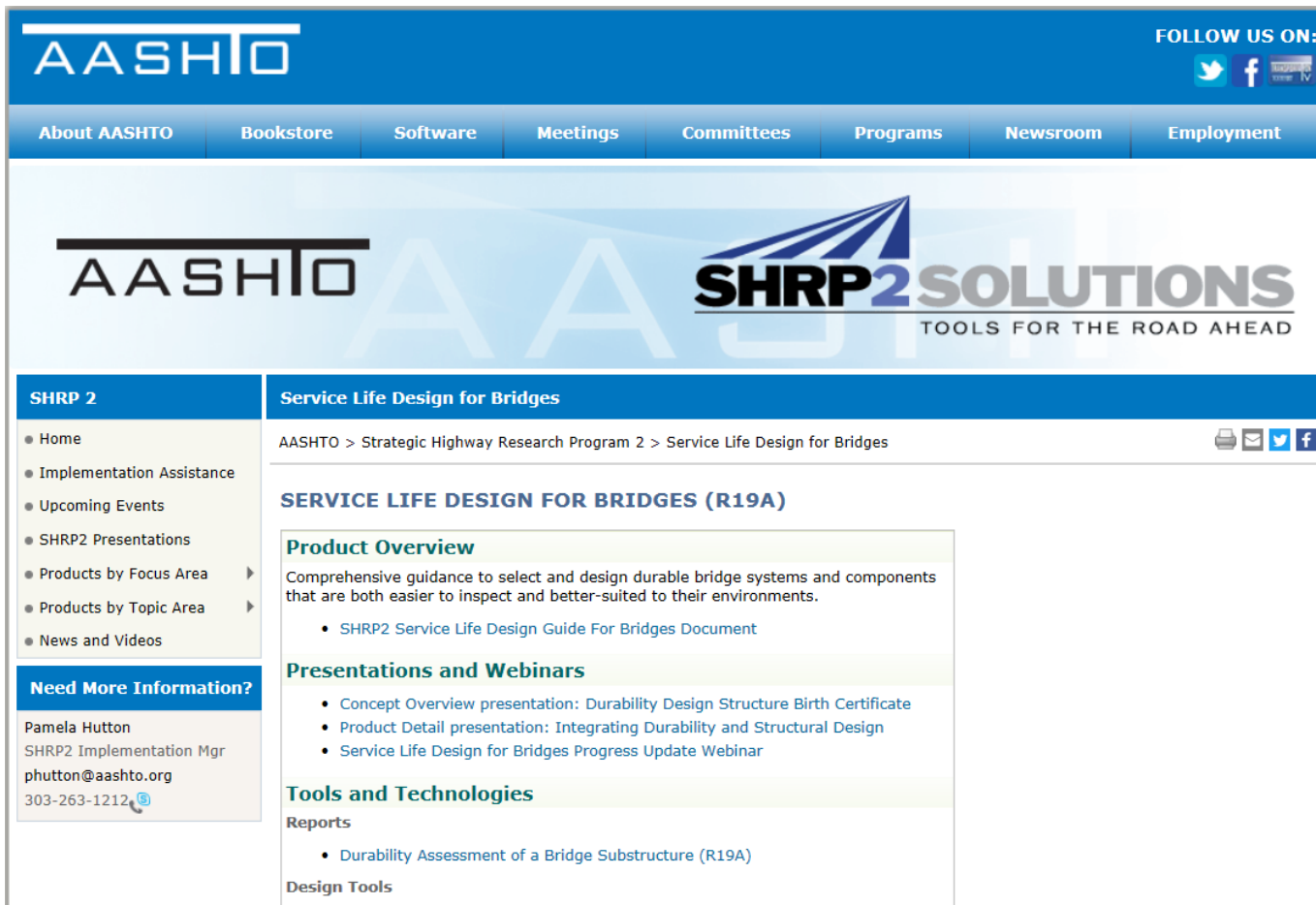
# NT Build 492 Test Summary



- Important to perform test at 28 days
- Test usually takes 24 hours
- One test includes 3 specimens
- Cost of a single test is approximately \$1,000+
- Note: specify the test frequency wanted during construction

# Design Tools

- SHRP2 Website:
- <http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx>



The screenshot shows the AASHTO SHRP2 Solutions website. The header features the AASHTO logo and a navigation menu with links: About AASHTO, Bookstore, Software, Meetings, Committees, Programs, Newsroom, and Employment. A 'FOLLOW US ON:' section includes icons for Twitter, Facebook, and YouTube. The main banner displays the AASHTO logo and the SHRP2 SOLUTIONS logo with the tagline 'TOOLS FOR THE ROAD AHEAD'. The left sidebar contains a 'SHRP 2' menu with links to Home, Implementation Assistance, Upcoming Events, SHRP2 Presentations, Products by Focus Area, Products by Topic Area, and News and Videos. Below this is a 'Need More Information?' section with contact details for Pamela Hutton, SHRP2 Implementation Mgr, including her email (phutton@aaashto.org) and phone number (303-263-1212). The main content area is titled 'Service Life Design for Bridges' and includes a breadcrumb trail: AASHTO > Strategic Highway Research Program 2 > Service Life Design for Bridges. It features a 'SERVICE LIFE DESIGN FOR BRIDGES (R19A)' section with a 'Product Overview' (comprehensive guidance to select and design durable bridge systems), 'Presentations and Webinars' (Concept Overview presentation, Product Detail presentation, Service Life Design for Bridges Progress Update Webinar), 'Tools and Technologies' (Reports: Durability Assessment of a Bridge Substructure (R19A), Design Tools), and a 'Need More Information?' contact box.

**AASHTO**

**SHRP2 SOLUTIONS**  
TOOLS FOR THE ROAD AHEAD

**SHRP 2**

- Home
- Implementation Assistance
- Upcoming Events
- SHRP2 Presentations
- Products by Focus Area
- Products by Topic Area
- News and Videos

**Need More Information?**

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**Service Life Design for Bridges**

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.

- SHRP2 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**

# Summary

- Scientific approach to quantify service life
- fib Bulletin 34 / Probability-based mathematical modelling
- Environmental loads and materials resistances
- Defined durability requirements
- Specifications shall be developed considering applicable deterioration mechanisms, available materials, and work methods

# A Few Key Projects

- New NY (Tappan Zee) Bridge
  - 100 year service life



# A Few Key Projects

- Abraham Lincoln Bridge (KY-IN)
  - 100 year service life



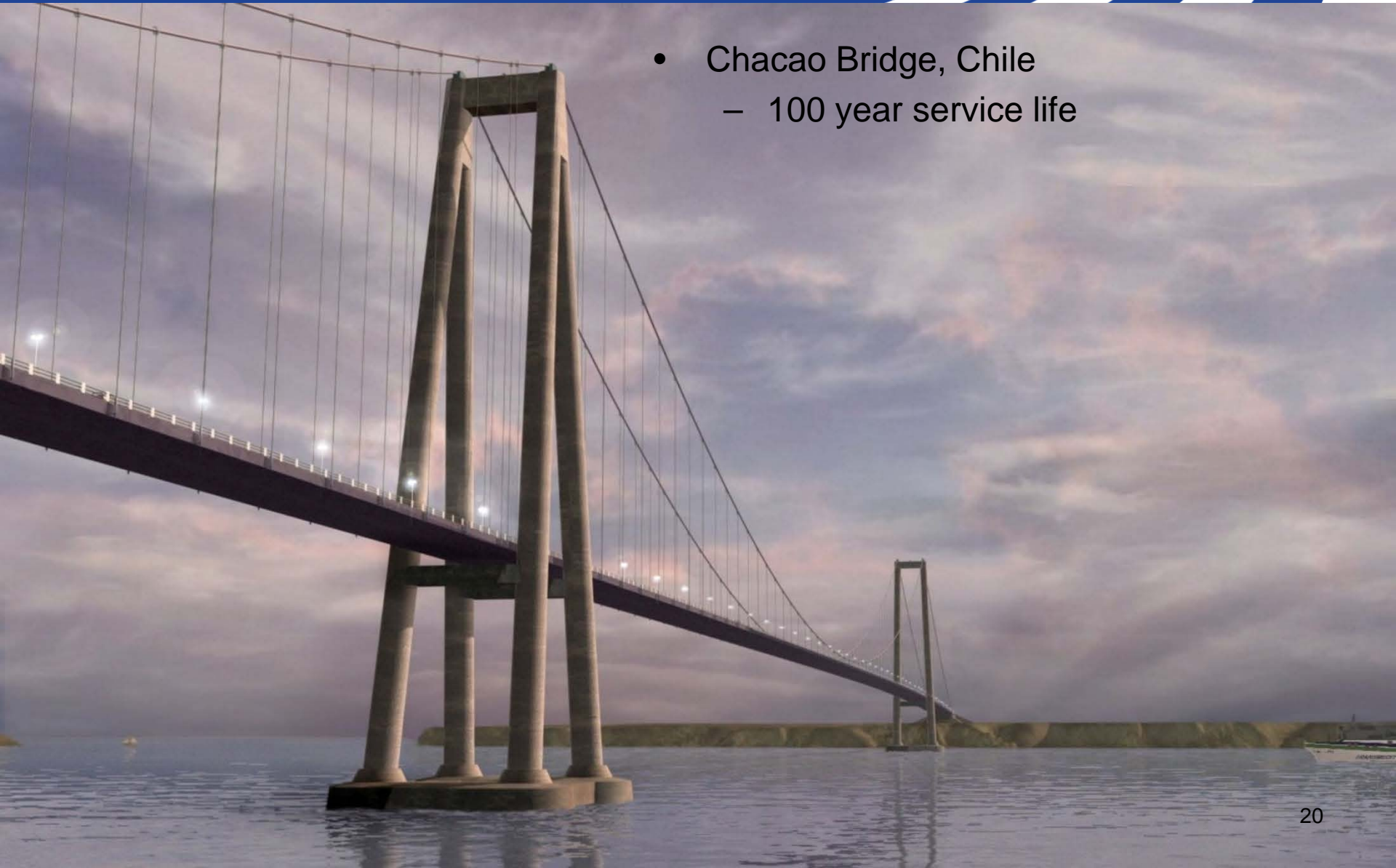
# A Few Key Projects

- North Commuter and Traffic Bridge Replacement Project, SK, Canada
  - 75 year service life



# A Few Key Projects

- Chacao Bridge, Chile
  - 100 year service life



# Questions?

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## **AASHTO SHRP2 R19A Website:**

<http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx>

## **FHWA GoSHRP2 Website:**

[www.fhwa.dot.gov/GoSHRP2/](http://www.fhwa.dot.gov/GoSHRP2/)