SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Implementing Service Life Design Using the fib Bulletin 34 Methodology

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AASHTO

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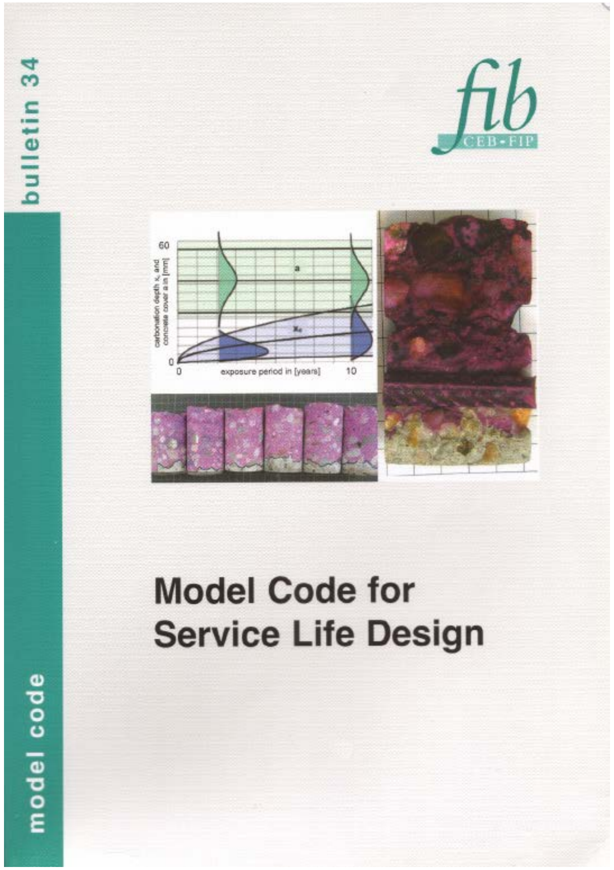
fib Bulletin 34 Model Code for Service Life Design

- 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

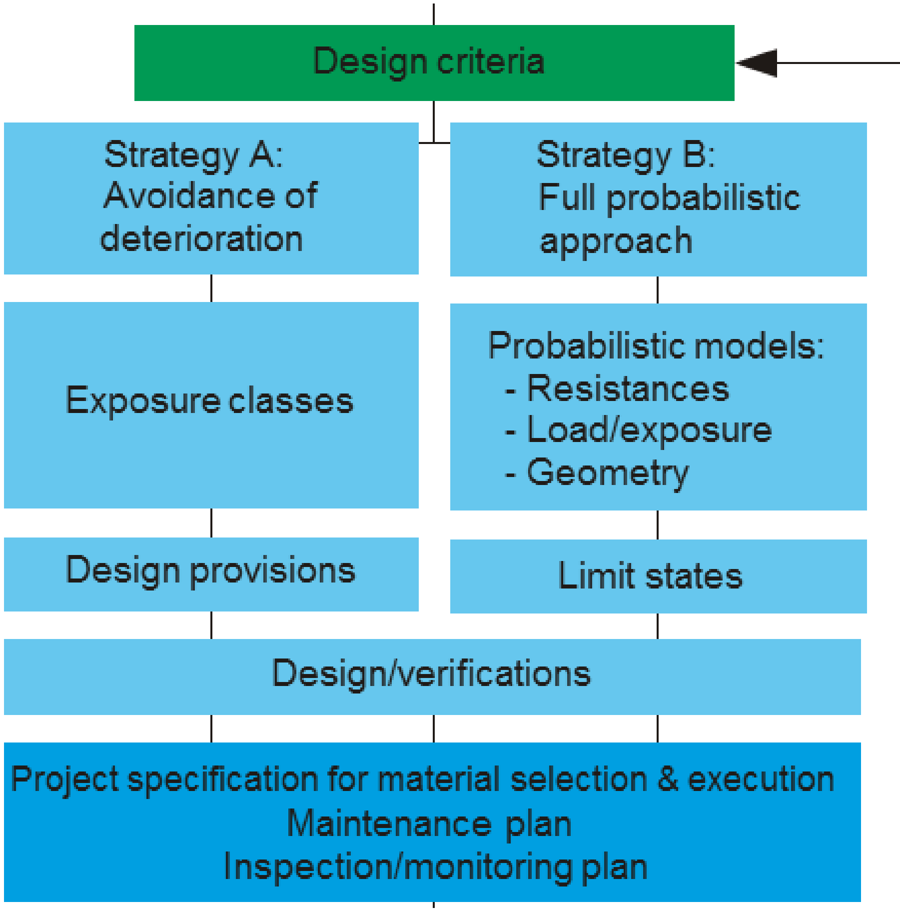


fib Bulletin 34 Model Code for Service Life Design

- 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

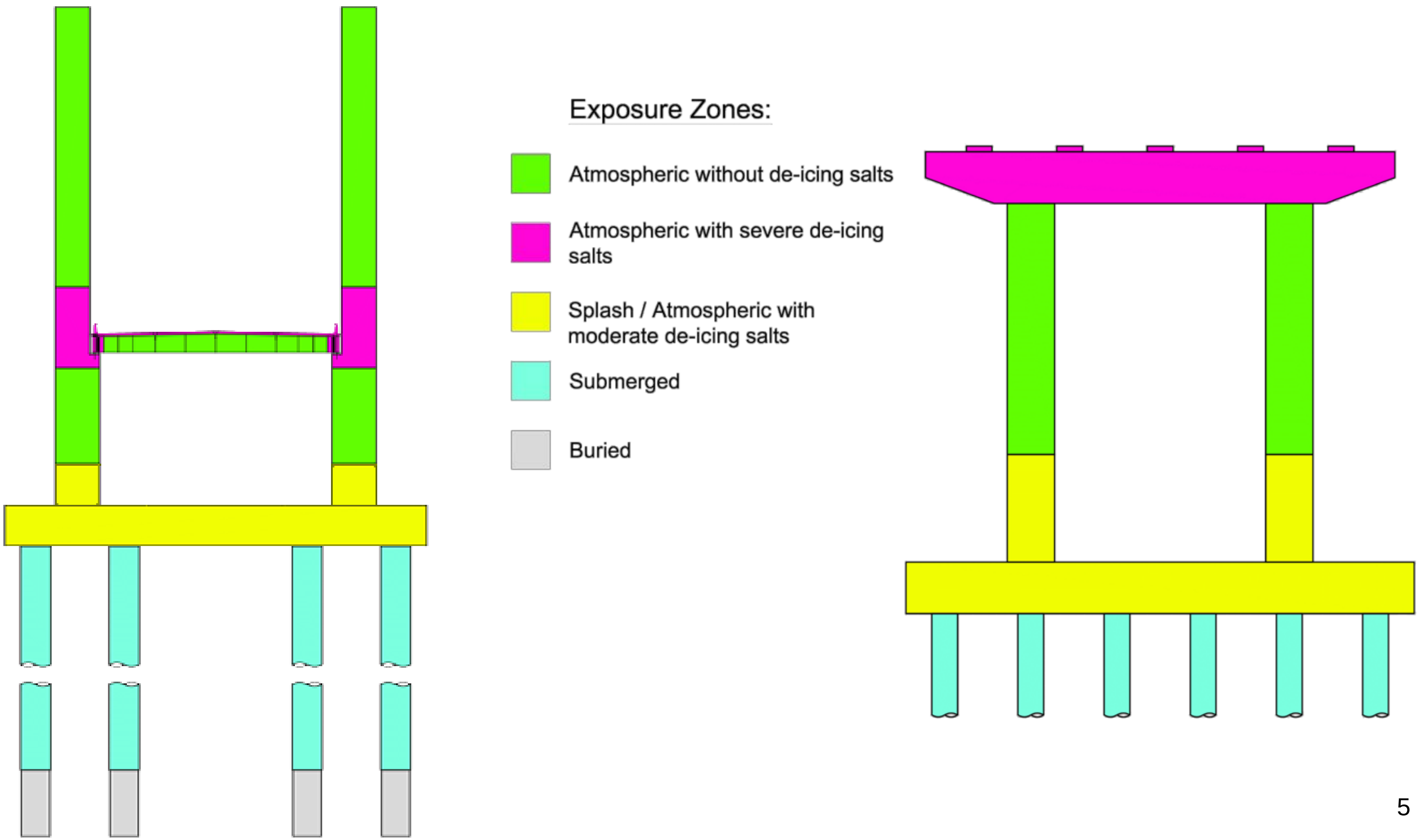
3. Design Parameters
   - Materials
   - Concrete quality
   - Concrete cover

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)

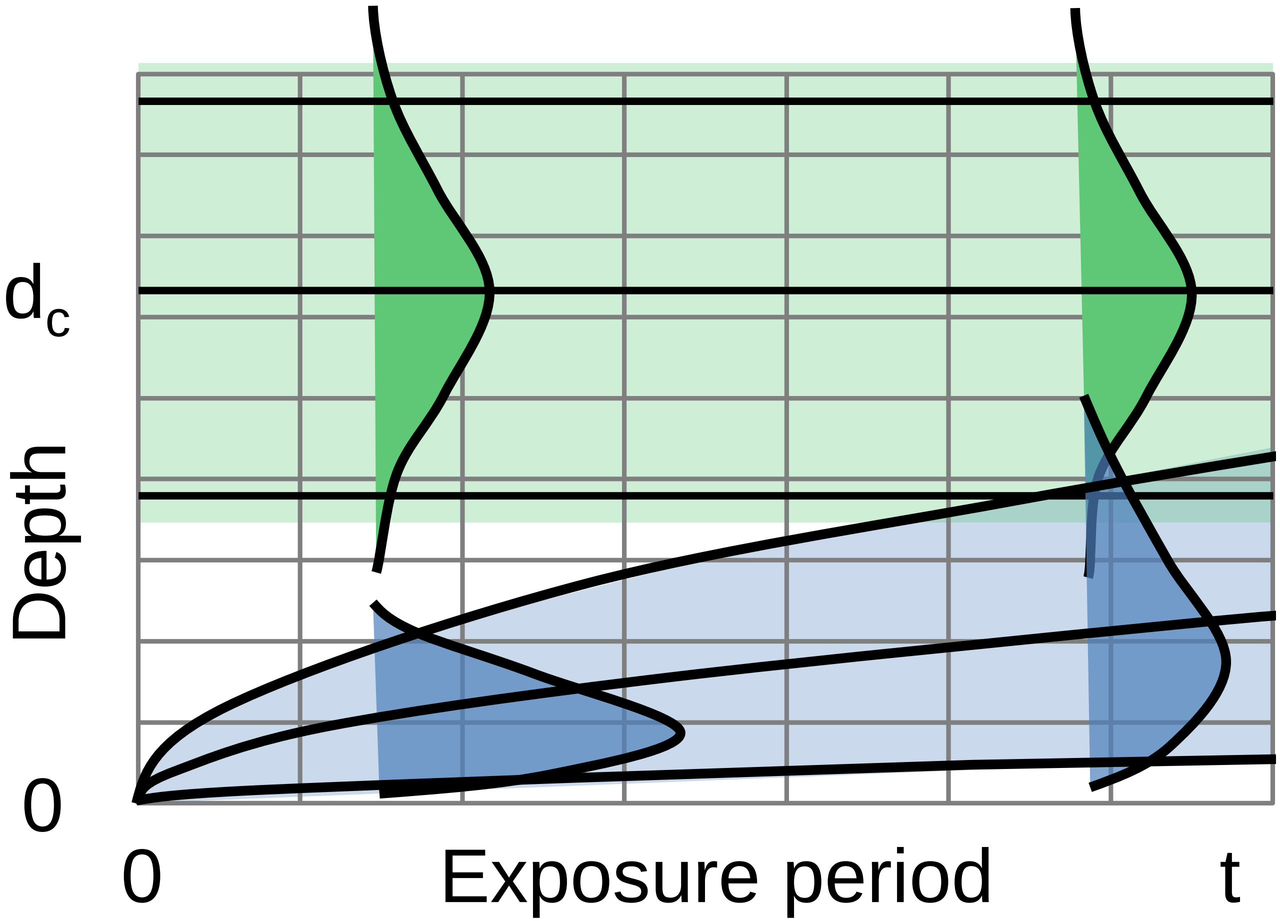
Modelling Chloride-induced Corrosion

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

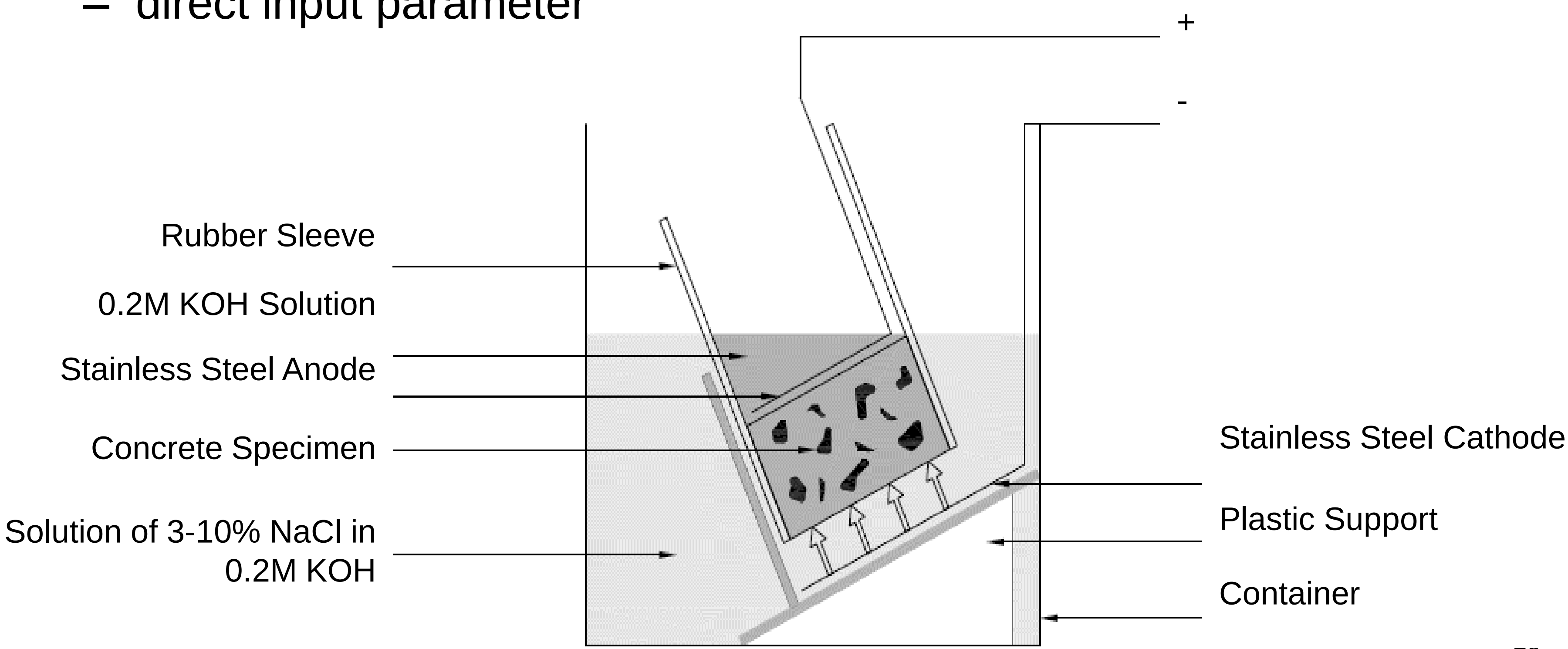
Exposure Zone	Structural Element	Nominal cover [in]	Max. w/cm [-]	Max. mean Chloride Migration Coefficient $D_{28} \times 10^{-9}$ [in^2/s] Mix 1	Mix 2	Mix 3
De-icing salt spray	Towers, pier caps, abutments	3.0	0.40	14.1	3.4	4.9
	Deck			11.3	2.7	4.0
	Concrete barriers	2.75		12.4	3.4	4.6
Atmospheric	Towers, 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

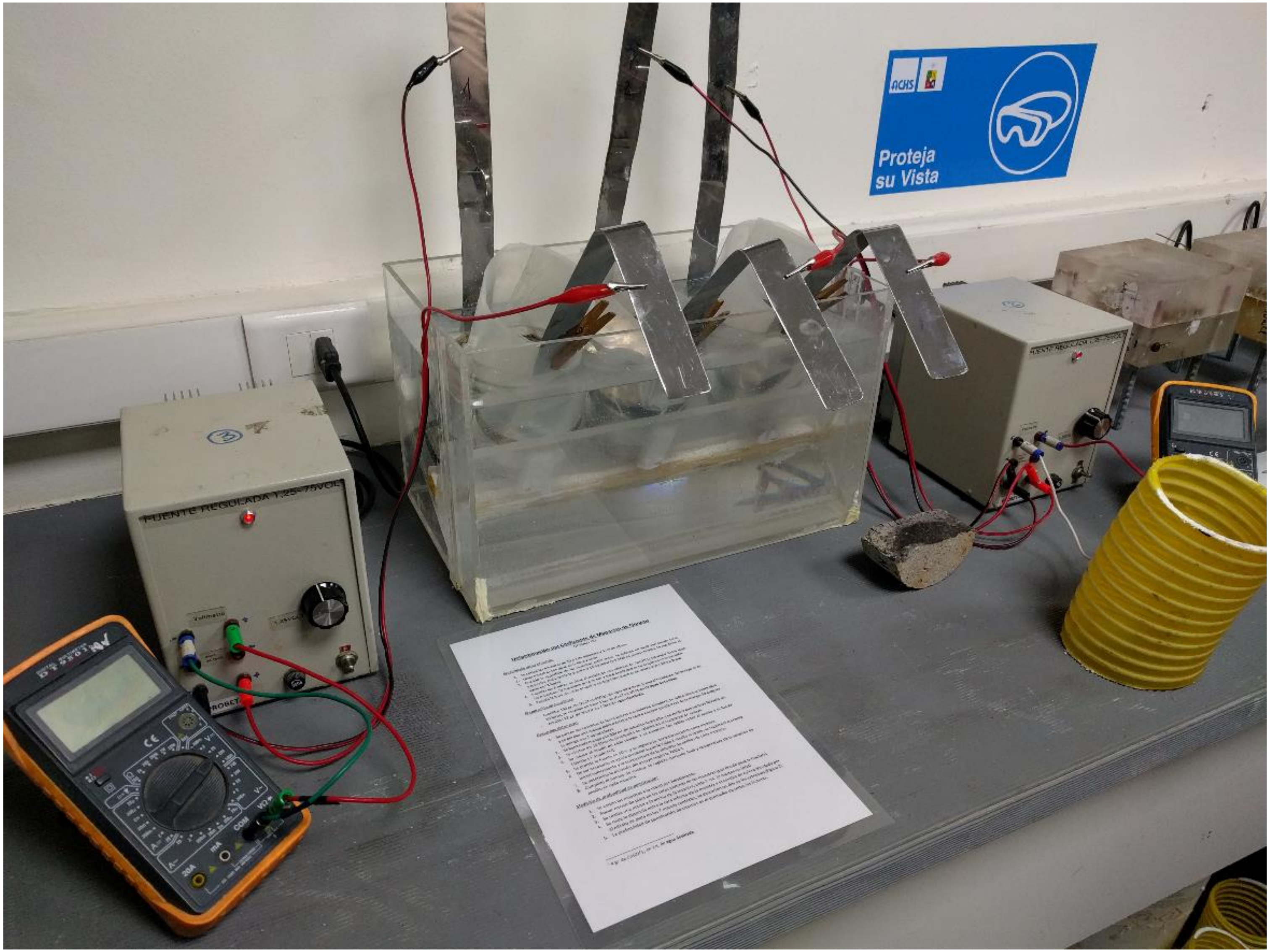
5. Construction → Pre-testing and production testing

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, $D_{RCM,0}$

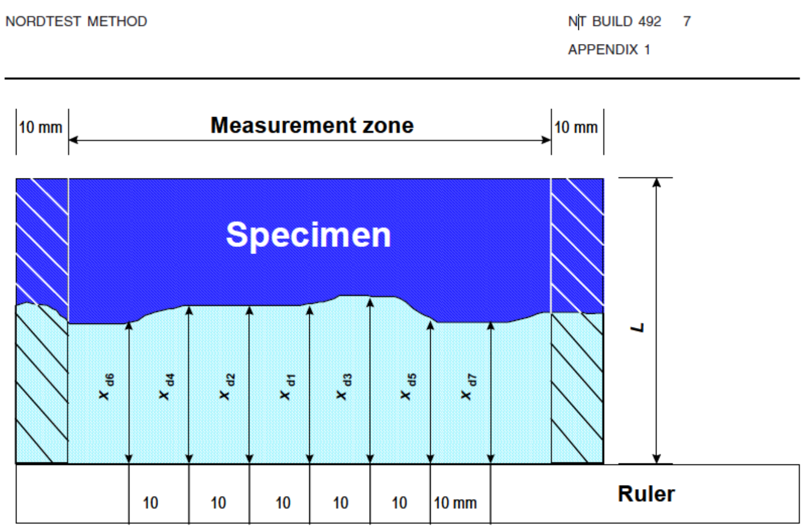


Fig. 5. Illustration of measurement for chloride penetration depths.

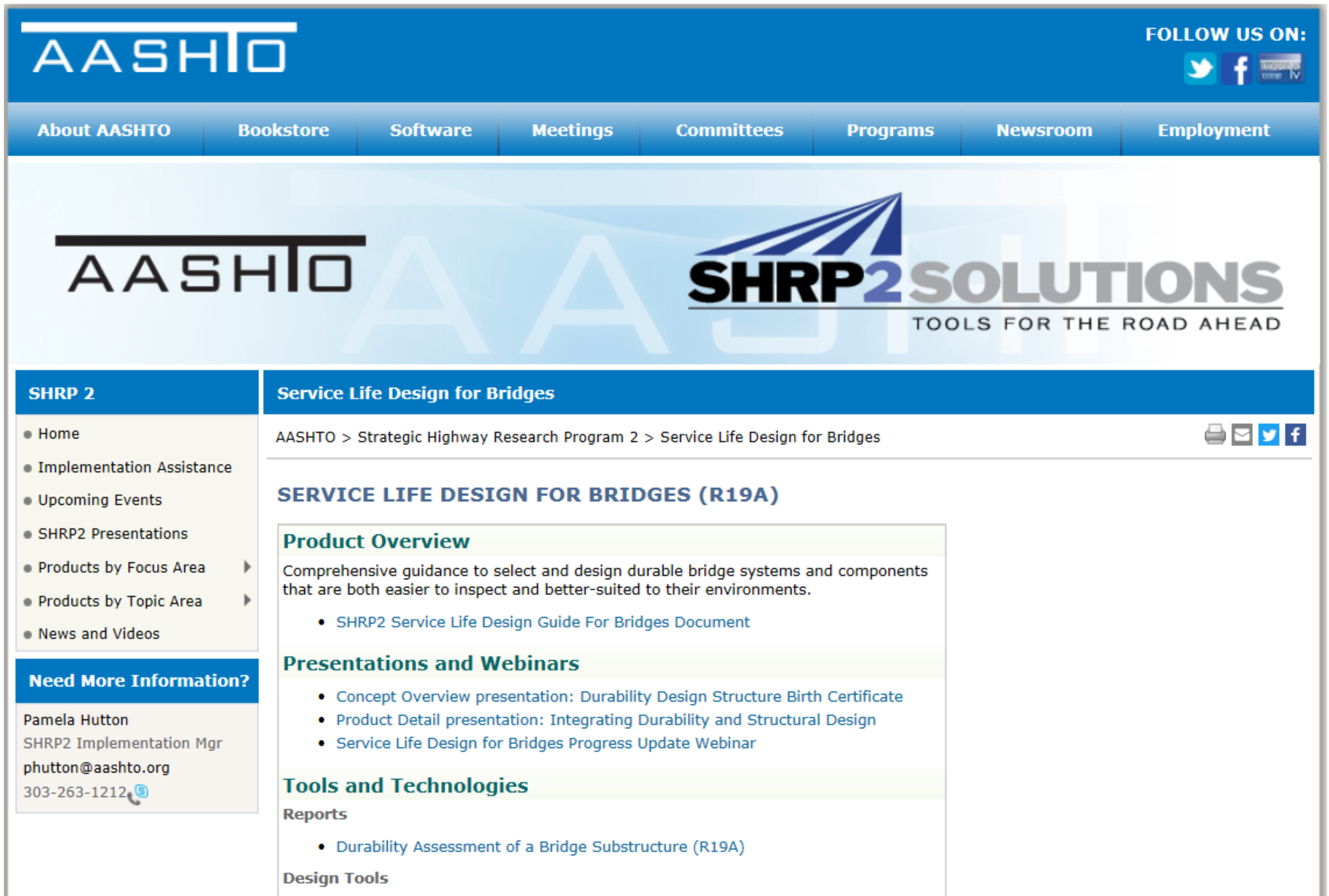
NT Build 492 Test Summary

- 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



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

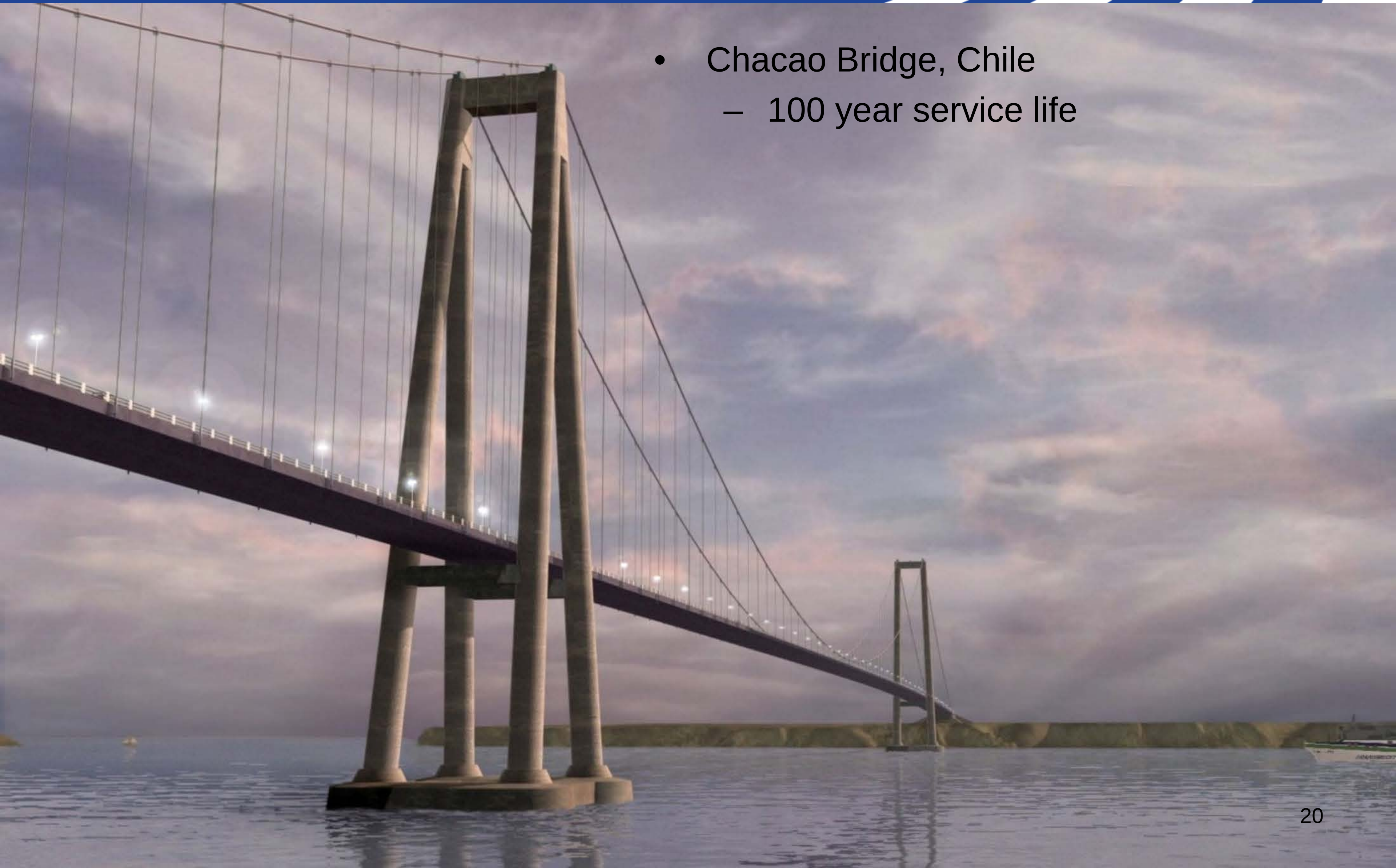
- Abraham Lincoln Bridge (KY-IN)
  - 100 year service life

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/