National Concrete Bridge Council

2026 NCBC WEBINAR SERIES

ICRI Guides for Investigation, Assessment, and Repair of Reinforced Concrete Bridges

September 16, 2026

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NCBC Webinar Series 2026

<u>October 21</u>: Anchoring to Concrete- Part 3: Post-Installed Deformed Reinforcing Bars/Dowels

<u>November 18</u>: Silica Fume Sustainable / Low Carbon Concrete

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Industry Events 2026

Sep 30-Oct 2: PTI Committee Days, San Antonio TX

Oct 11-14: ACI Convention, Atlanta, GA

Oct 15-18: NRMCA Concrete Works, Nashville, TN

Oct 29: Webinar- Overview of ANSI/PCI 142-24 Specification for Precast Prestressed Concrete at 2:00 pm CT

1:00 – 2:00 PM ET

Nov 8-11: ASBI Convention, San Antonio, TX

Nov 15-18: CRSI Fall Meeting, Chicago, IL

Dec 1-2: World Bridge Engineering Conference, Miami, FL

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The views and opinions expressed in this presentation are the presenters' and do not necessarily reflect those of NCBC.

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National Concrete Bridge Council

Stephen Garrett, PE



- Senior Materials Engineer with RDM International, Inc.
- More than decade of experience in investigation and repair of reinforced concrete structures.
- He has lead numerous bridge inspection and rehabilitation programs
- Involved with ICRI, Chair of Life-Cycle and Sustainability Committee, Secretary of Corrosion Committee.

1:00 – 2:00 PM ET

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Presentation

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September 16, 2026

ICRI Guides for Investigation, Assessment, and Repair of Reinforced Concrete Bridges

Engineering Technology Research

Stephen M. Garrett
MSCE, MBA, PE, NACE CP-4
Senior Materials Engineer
RDM International, Inc.
Chicago, IL (North Suburbs)

The ideas expressed in this webinar are those of the speaker and do not necessarily reflect the views and opinions of ICRI, its board, committees, or sponsors.

Learning Objectives

- Learn the methods for assessing in-service reinforced concrete structures – from visual inspection to service life modeling
- Understand best practices for surface preparation of concrete and rebar
- Identify common challenges with repair detailing
- Understand the various ICRI guides, resources, and training available for concrete repair



Outline

- International Concrete Repair Institute (ICRI)
  - Membership, Training Opportunities, and Guidelines
- Cycle of Investigation, Assessment, & Repair
  - Visual & Non-destructive Evaluation
  - Service Life Modeling and Life Cycle Cost Assessment
  - Selection and Detailing
  - Repair and Mitigation Strategies
  - Construction Quality Control



ICRI

- Vision – Center for Repair Leadership
- Mission – Provide Education, Certification, and Networking
- Membership Benefits
  - Guides and Resources
  - Training Programs
  - Conventions – Locally and Nationally



Goals of Guide Development

- Through documentation in guides and other resources, transcend the mentorship gap
  - Both internally within an organization, and general industry knowledge
- Take the collective information available, and put it into a digestible format that it can be quickly understood, processed, and applied
- For example – new inspector is going to observe "protective coat" (e.g., silane) application, and then observe conformance testing (e.g., bond strength) of a new concrete overlay. How do you get them up to speed quickly?



Technical Committees

- COMMITTEE 110—GUIDE SPECIFICATIONS +
- COMMITTEE 120—ENVIRONMENTAL HEALTH AND SAFETY +
- COMMITTEE 130—GUIDELINES FOR CONTRACTS, WARRANTIES, AND AGREEMENTS +
- COMMITTEE 160—LIFE CYCLE AND SUSTAINABILITY +
- COMMITTEE 210—EVALUATION +
- COMMITTEE 310—SURFACE PREPARATION +
- COMMITTEE 320—CONCRETE REPAIR MATERIALS & METHODS +
- COMMITTEE 330—STRENGTHENING AND STABILIZATION +
- COMMITTEE 410—MASONRY +
- COMMITTEE 510—CORROSION +
- COMMITTEE 710—COATINGS AND WATERPROOFING +

110.1R-2026 ***Guide Specifications for Structural Concrete Repair: Section 030130 (New!)***

160.1-2026 ***Guide for Guide for Corrosion Related Service Life Prediction for Existing Reinforced Concrete Structures (Upcoming!)***

210.5R-2026 ***Guide for Selecting and Specifying Reinforcing Bar Cleaning Levels (New!)***

ICRI 310.2R-2013 ***Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair***

ICRI 510.3-2025 ***Guide for Conducting Corrosion Potential (Half-Cell) Testing for Steel Reinforced Concrete Structures (New!)***

Concrete Repair Terminology – June 2022

Approach to Asset Management

Reinforced Concrete Structures



Investigate → Assessment → Repair

- Investigate
  - Document Review
  - Visual and Hands-On
- Assessment
  - Nondestructive Evaluation
  - Material Testing
  - Durability Analysis
- Repair (Maintenance, Rehabilitation, Replacement)
  - Selection, Design, Specification
  - Implementation & QA/QC



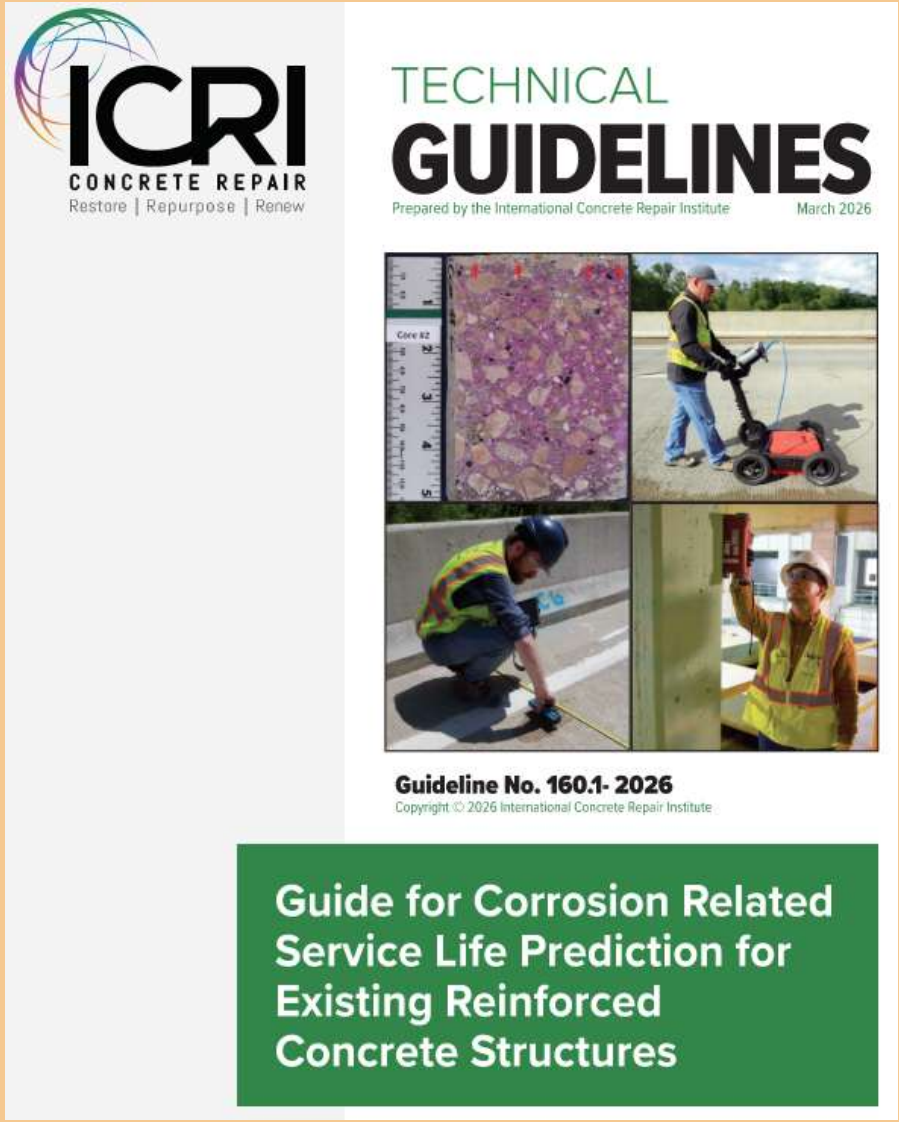
ICRI 160.1

Guide for Corrosion Related Service Life Prediction for Existing Reinforced Concrete Structures

Synopsis

Service life prediction for existing reinforced concrete structures is essential for owners, asset manager, and engineers. Service life prediction tools and the associated results help support better maintenance planning, repair scheduling, and more sustainable, cost-effective rehabilitation strategies. This guideline provides current best-practice guidance for predicting corrosion-related service and is intended to complement the ACI CODE-365-24 used for new structures by addressing the distinct challenges of evaluating in-service structures. The document is intended to guide readers in understanding available modeling approaches and selecting appropriate methods for specific projects.

Keywords: concrete, service life, corrosion, assessment, investigation, modeling, repair, evaluation, prediction, restoration, maintenance

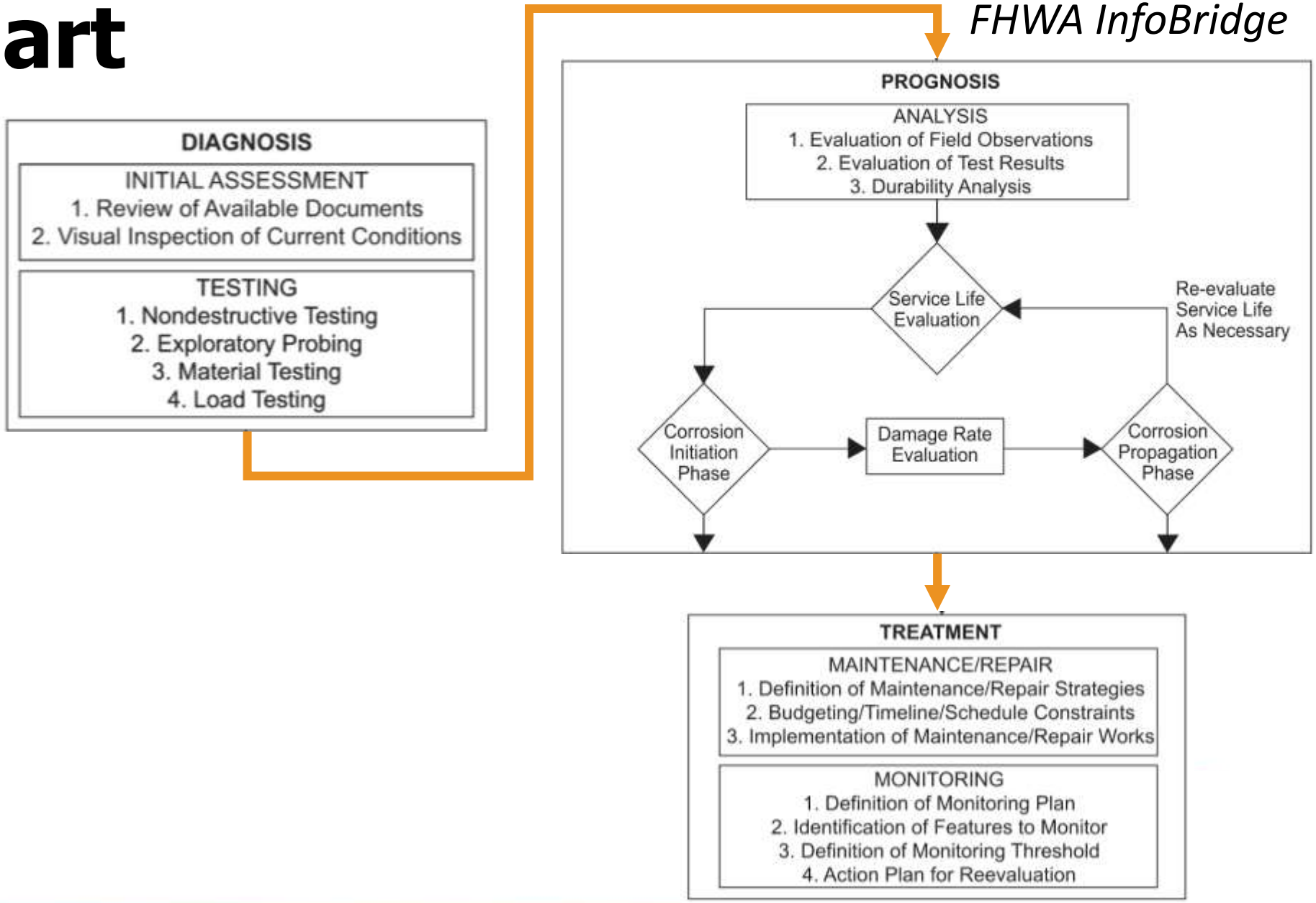


Flow Chart

AASHTO/Element Inspections
State DOT Bridge Manuals

ICRI and Other Industry Guides

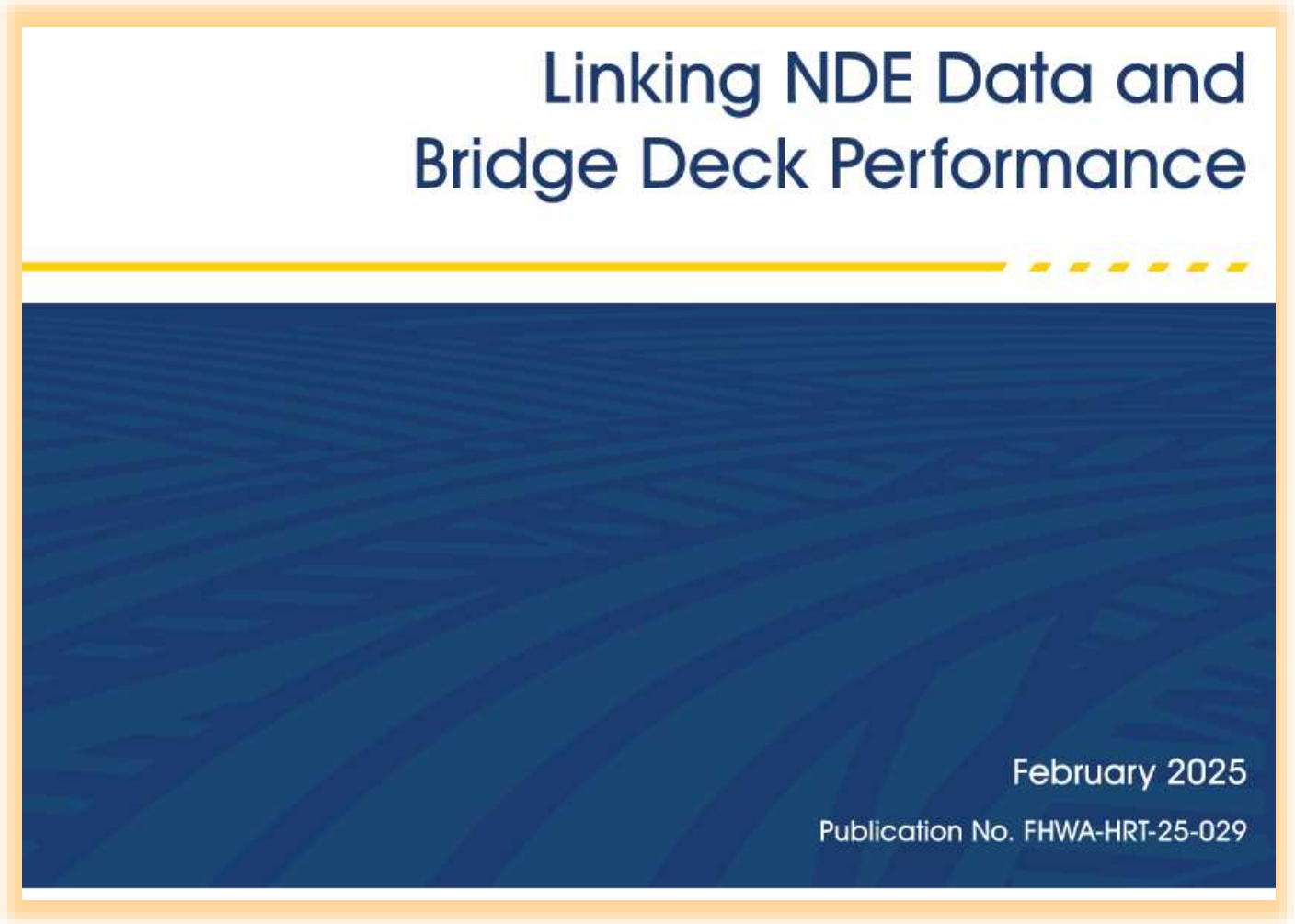
FHWA InfoBridge



ICRI 160.1 – Figure 17

Industry Literature

- AASHTO
  - Element Inspections
- State DOT
  - Bridge Manuals
  - Standard Specifications and Details
  - Special Provisions
- Industry Literature
  - ICRI Guides
  - Others (ACI, AMPP, etc.)



FHWA-HRT-25-029

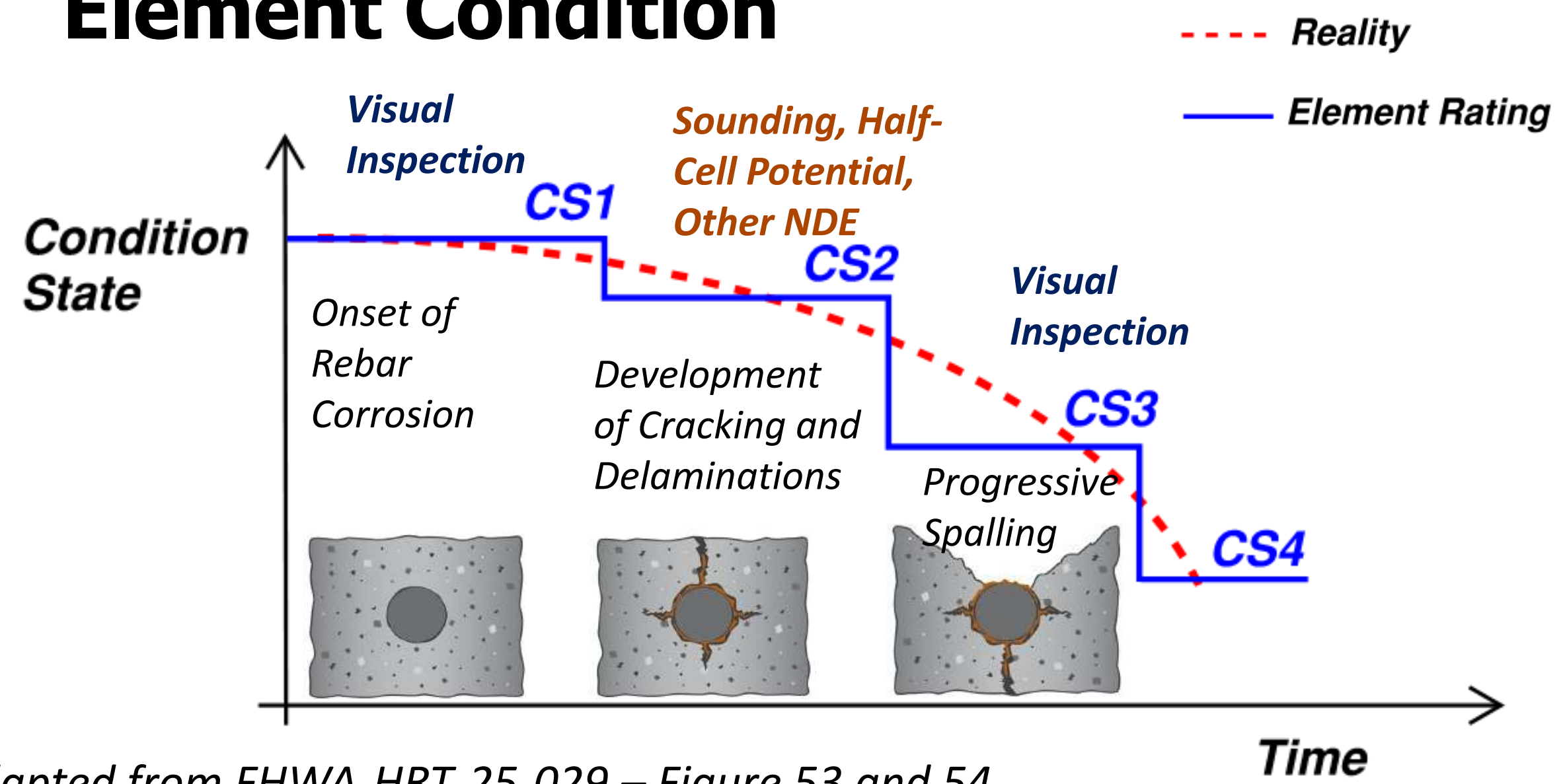
Initial Assessment

- Visual Inspection of Current Conditions
  - Inspection at arms length
  - Sounding of representative elements
- Base-Line Conditions with Time
- Determine needs for In-Depth Assessment





Element Condition



Adapted from FHWA-HRT-25-029 – Figure 53 and 54

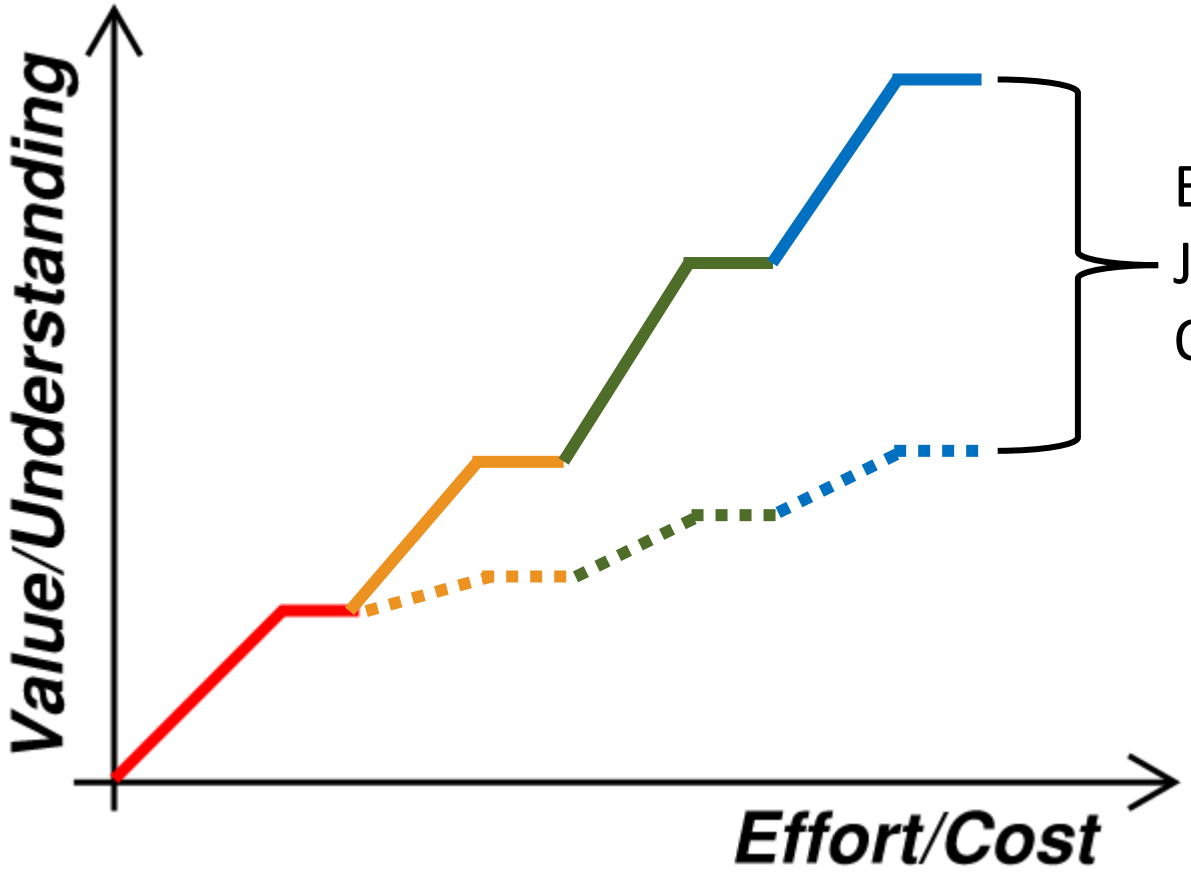
Condition Documentation



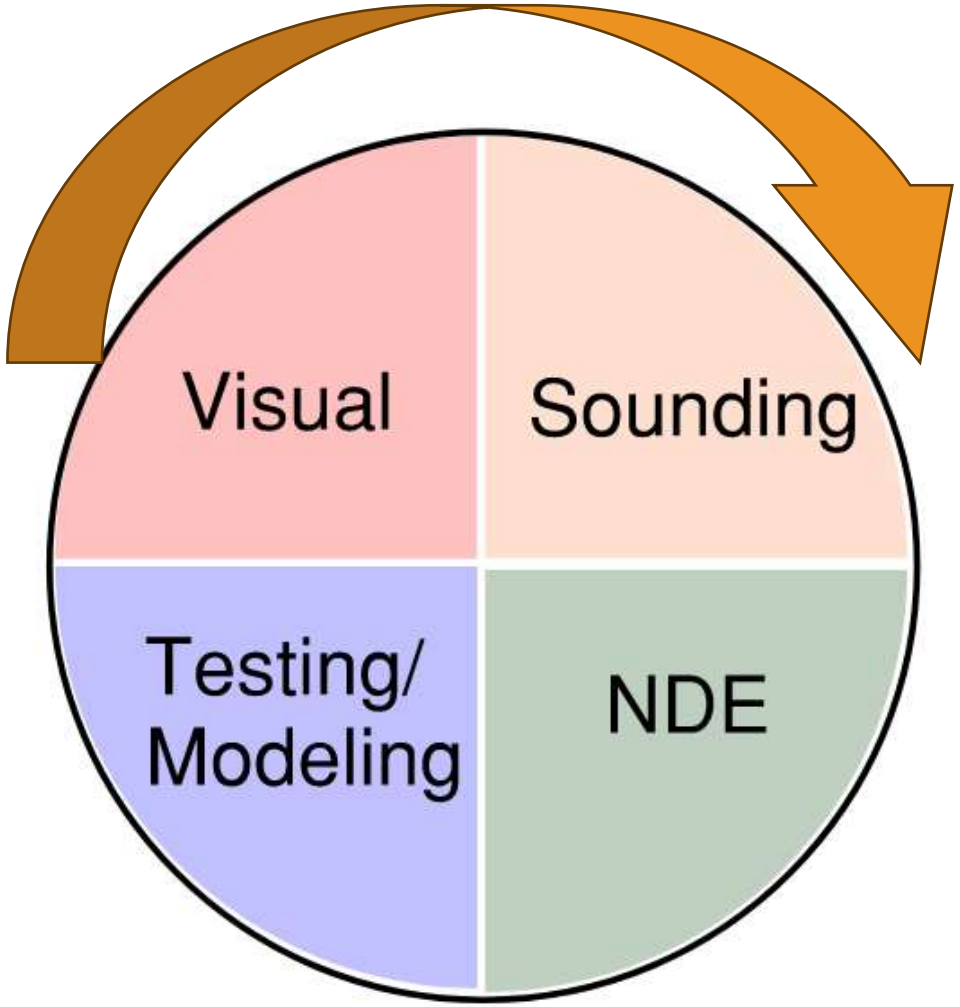




Understanding vs. Effort

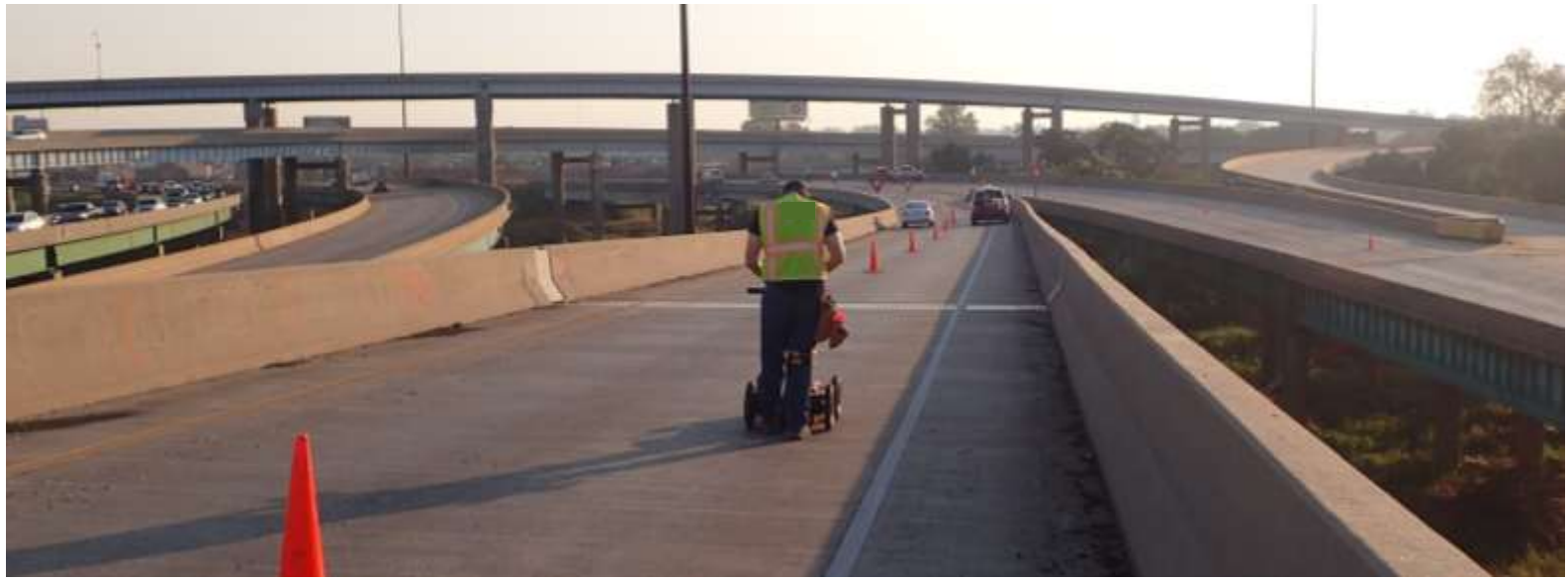


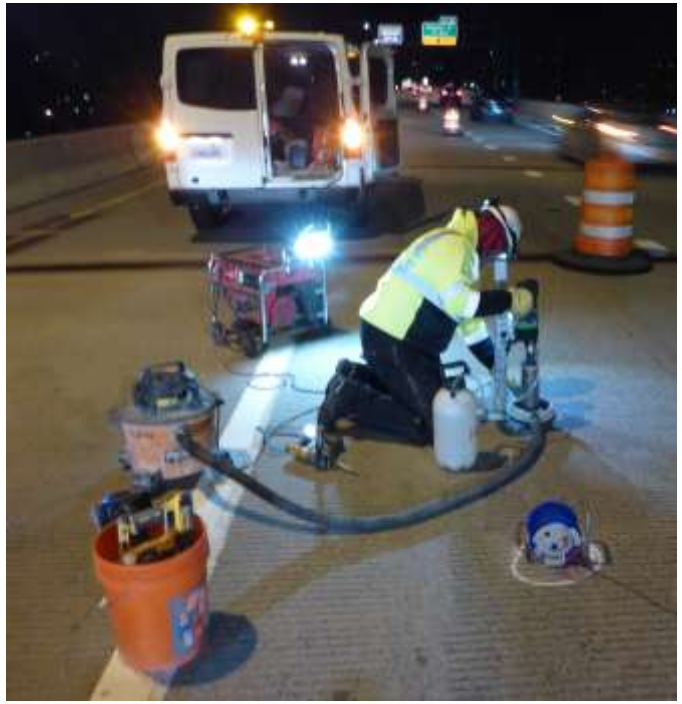
Engineering Judgement / Owner Needs

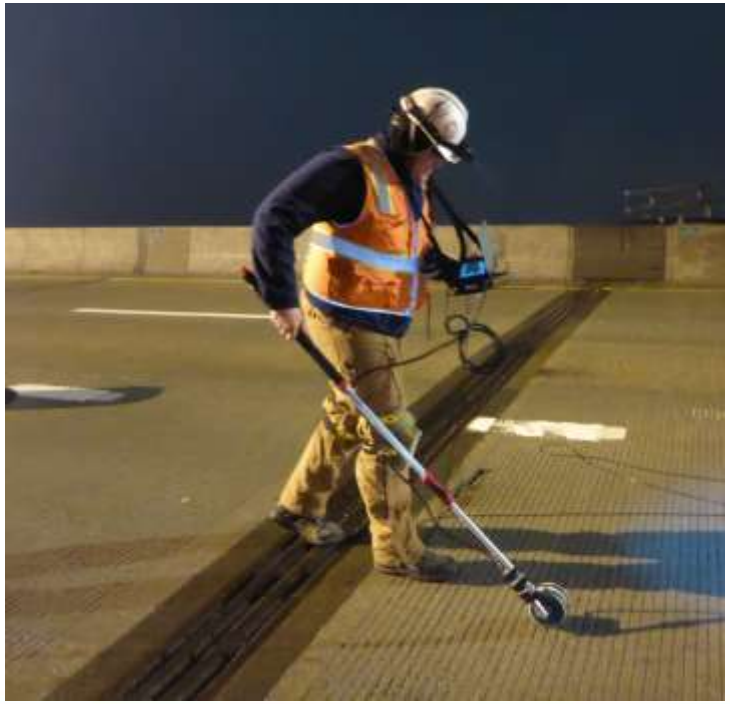


In-Depth

- NDE
- Inspection Openings
- Material Testing









ICRI 210.4R

3.0 Nondestructive Evaluation (NDE) Program

The reasons for NDE usage, benefits, limitations, general approach, and correlation with invasive/laboratory tests are discussed below. An understanding of these considerations will lead to the development of an NDE program to meet project objectives for assessment and repair of concrete structures.

A.2.20 Half-Cell Potential Method for Corrosion Activity (ASTM C876)

The half-cell potential method involves measuring the voltage (identified with the electrochemical term "potential") difference between steel reinforcement and a standard reference electrode. More negative voltage potentials indicate a higher probability of corrosion activity occurring at the time of measurement. The reinforcing steel must have a good electrical connection to a voltmeter that is also connected to a half-cell (typically copper-copper sulfate) as shown in Fig. 22. For long-term monitoring, silver-silver chloride half-cells are generally used. Areas of greater corrosion activity are associated with more negative half-cell potential voltage readings.

The half-cell potential method requires an electrical connection to the reinforcing steel to complete the electrical measurement circuit. The connection requires that the reinforcement be exposed either at a drilled hole that intercepts the reinforcing bar or at an excavated area. Wetting of the surface is required if the concrete has a high electrical resistance because it is not moist enough for corrosion to be occurring at the time of measurement, otherwise inaccurate readings can occur.

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Guide for Nondestructive Evaluation (NDE) Methods for Condition Assessment, Repair, and Performance Monitoring of Concrete Structures

ICRI 510.3

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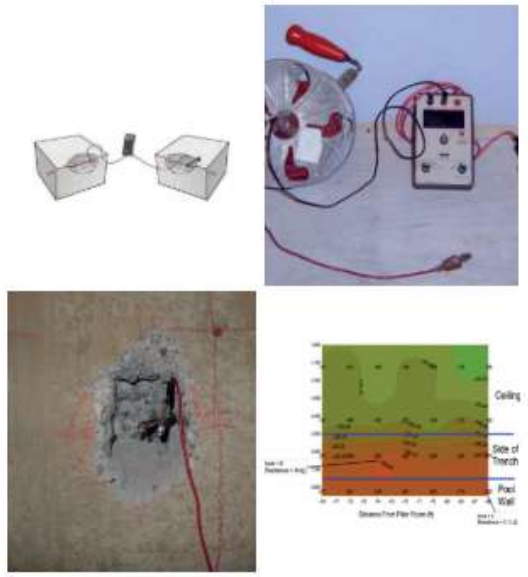

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Guide for Conducting Corrosion Potential (Half-Cell) Testing for Steel Reinforced Concrete Structures

Synopsis

This guide is intended to provide information and guidance on the "half-cell" corrosion potential test, described in ASTM C876. It describes recommended tools and materials, selection of testing locations, connections to reinforcing steel, measurements and verification associated with this test. The information presented is based on the experience of owners, engineers, contractors, and suppliers.

5.0 Data Analysis 11
5.1 Data Analysis 11
5.1.1 Numeric Magnitude Method 11
5.1.2 Potential Difference Method 12
5.2 Presentation of Results 12
6.0 Common Problems and Solutions 13
7.0 Reference Standards and Reports 15
Appendix A - Typically Required Tools and Equipment 17

Examples of Half-Cell Testing

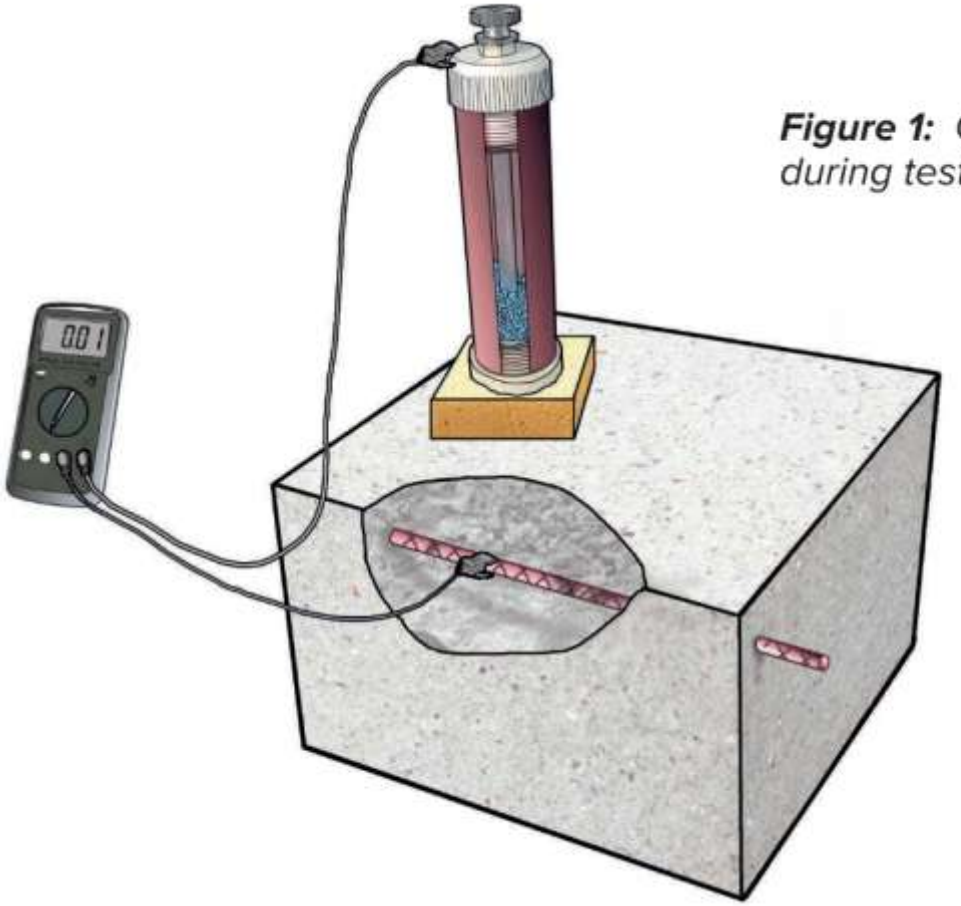


Figure 1: *Configuration of half-cell during testing.*

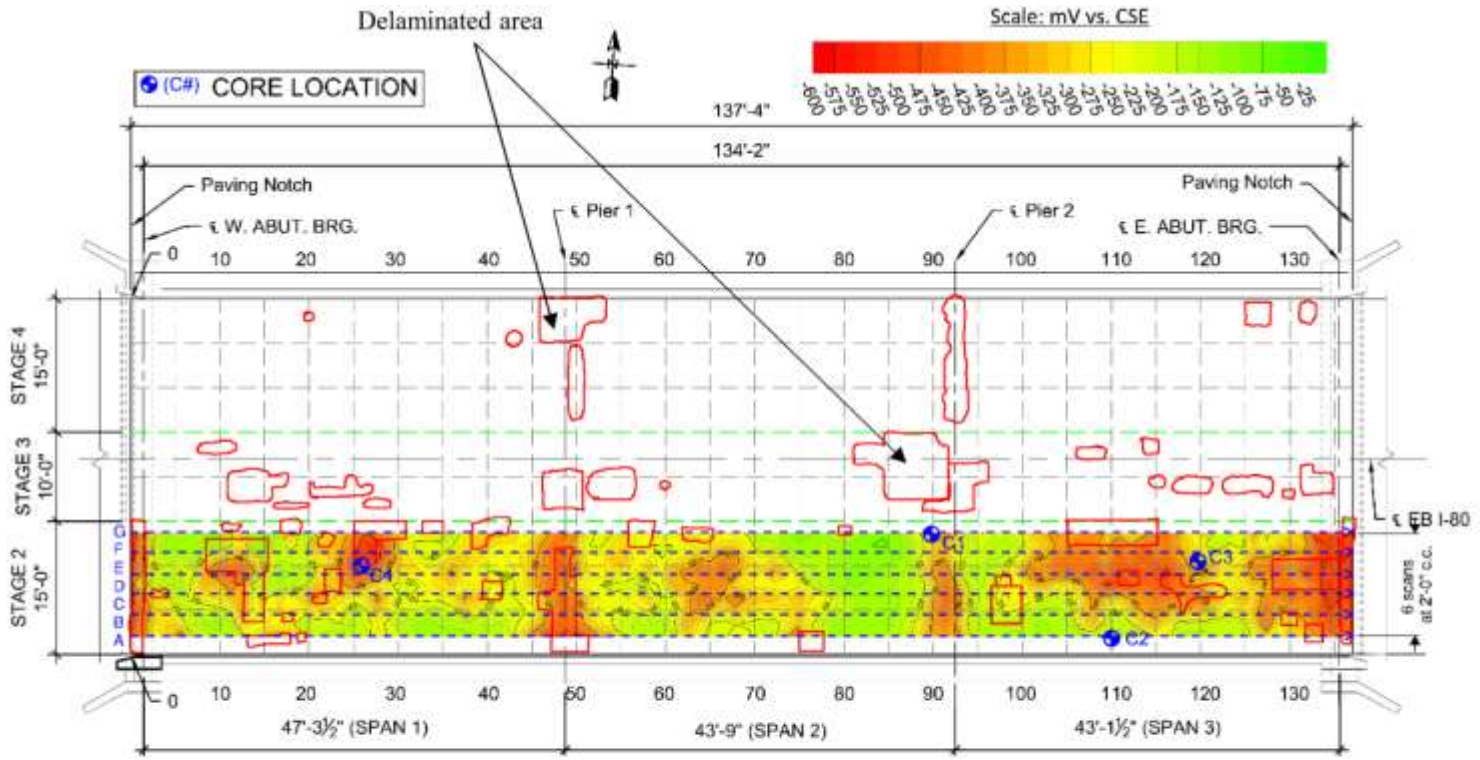


ICRI 510.3 – Figure 1

Contour Plots



ICRI-CRB Vol 37, No.5
Data-Driven Approaches for Optimizing Concrete Bridge Deck Preservation



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Note: delaminated areas are circled.

A. Delaminated areas overlaid over HCP contour.

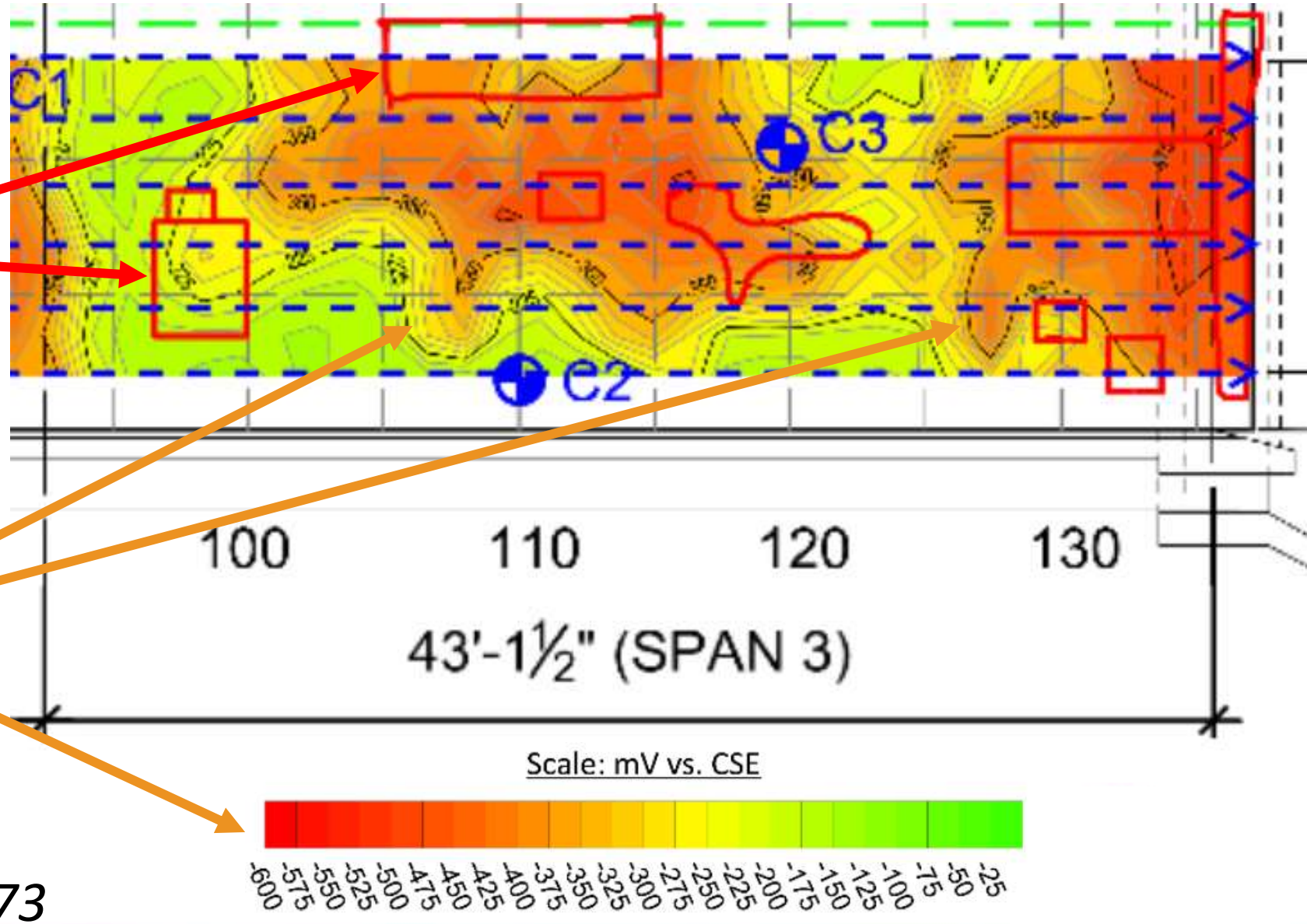
Figure 73. Graphs. Jasper County bridge (ElBatanouny at al. 2022).

FHWA-HRT-25-029 – Figure 73

Findings

Zones of Unsound Concrete

Zones of Corrosion Activity

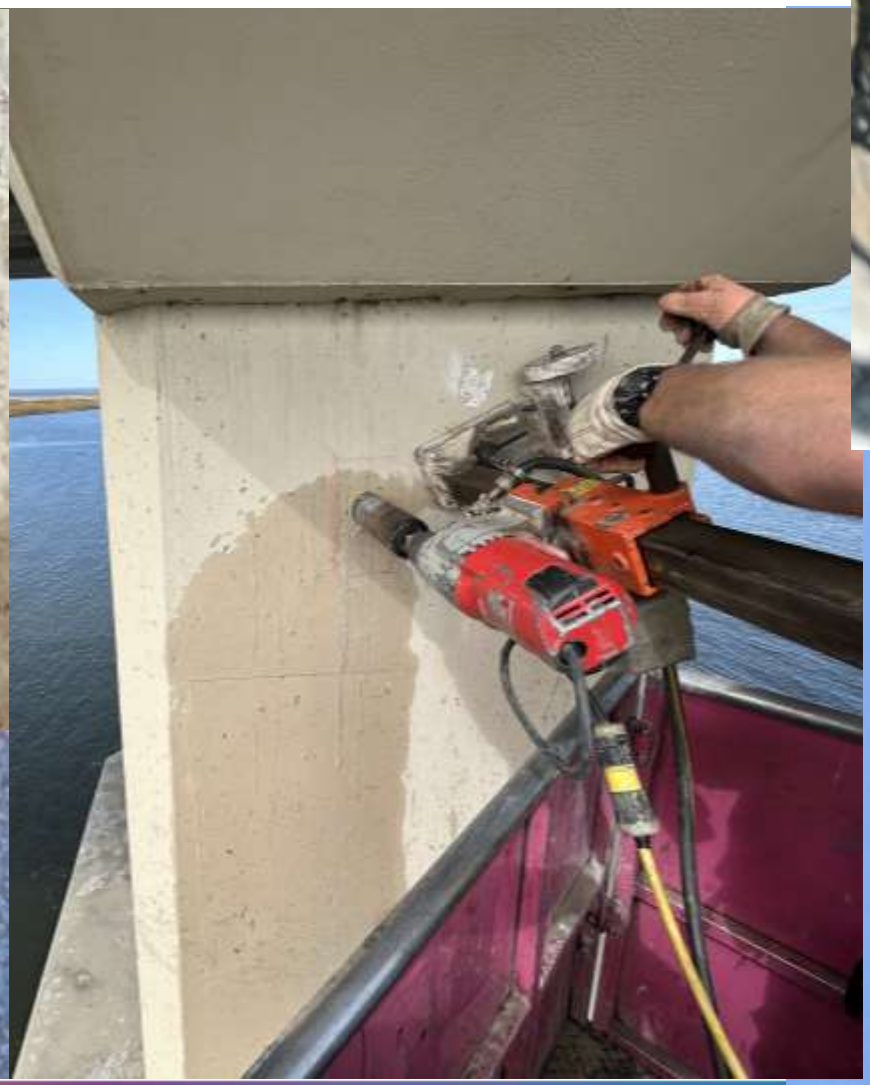


FHWA-HRT-25-029 – Figure 73

Material Sampling



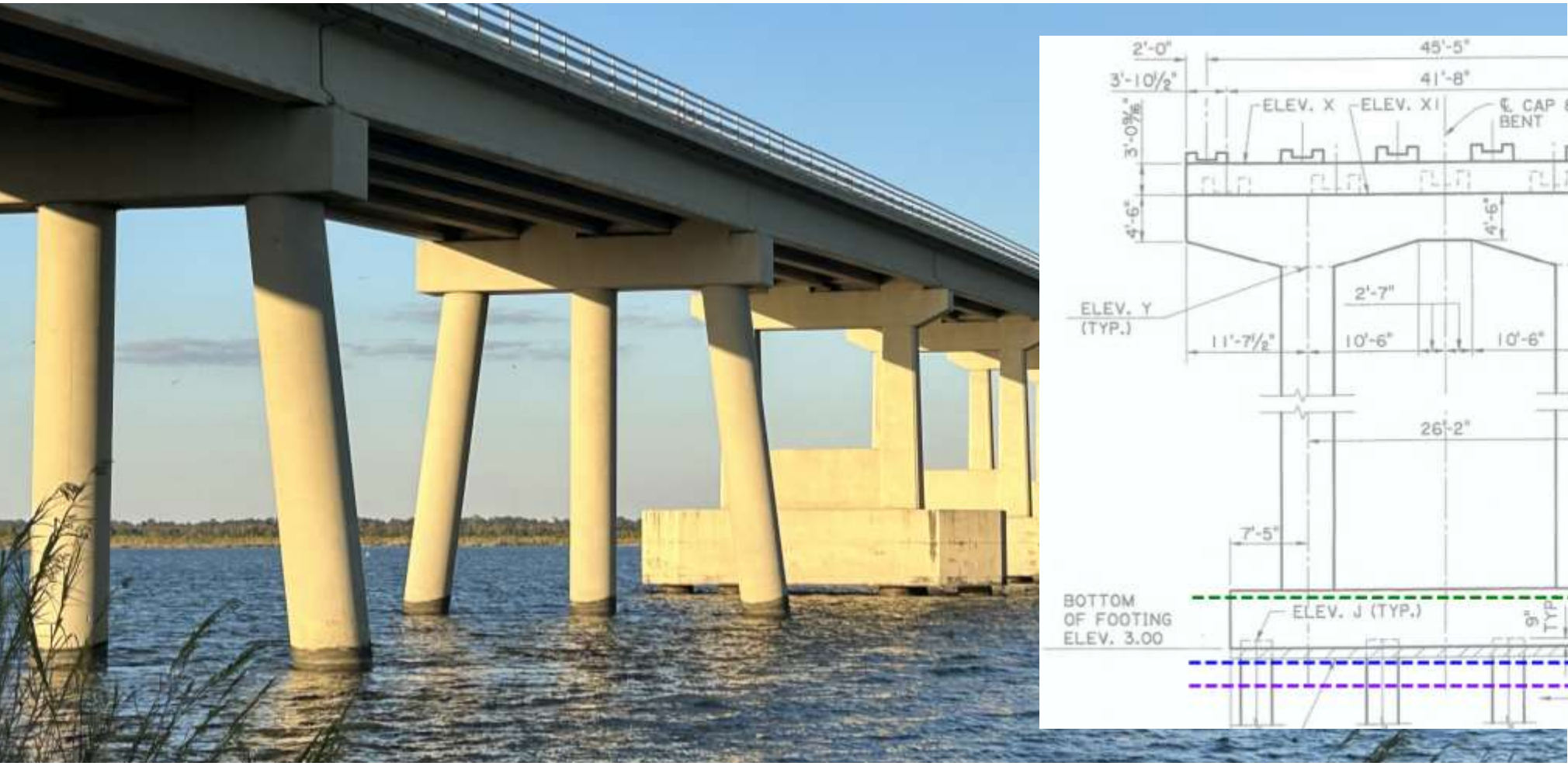




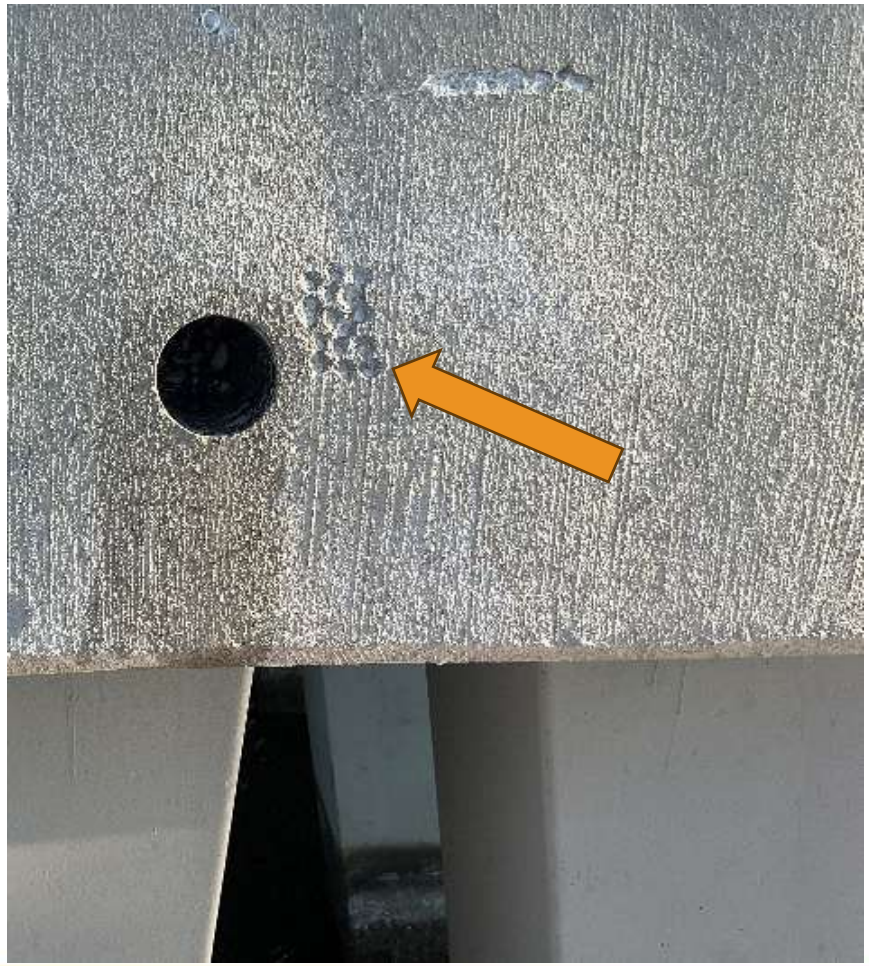


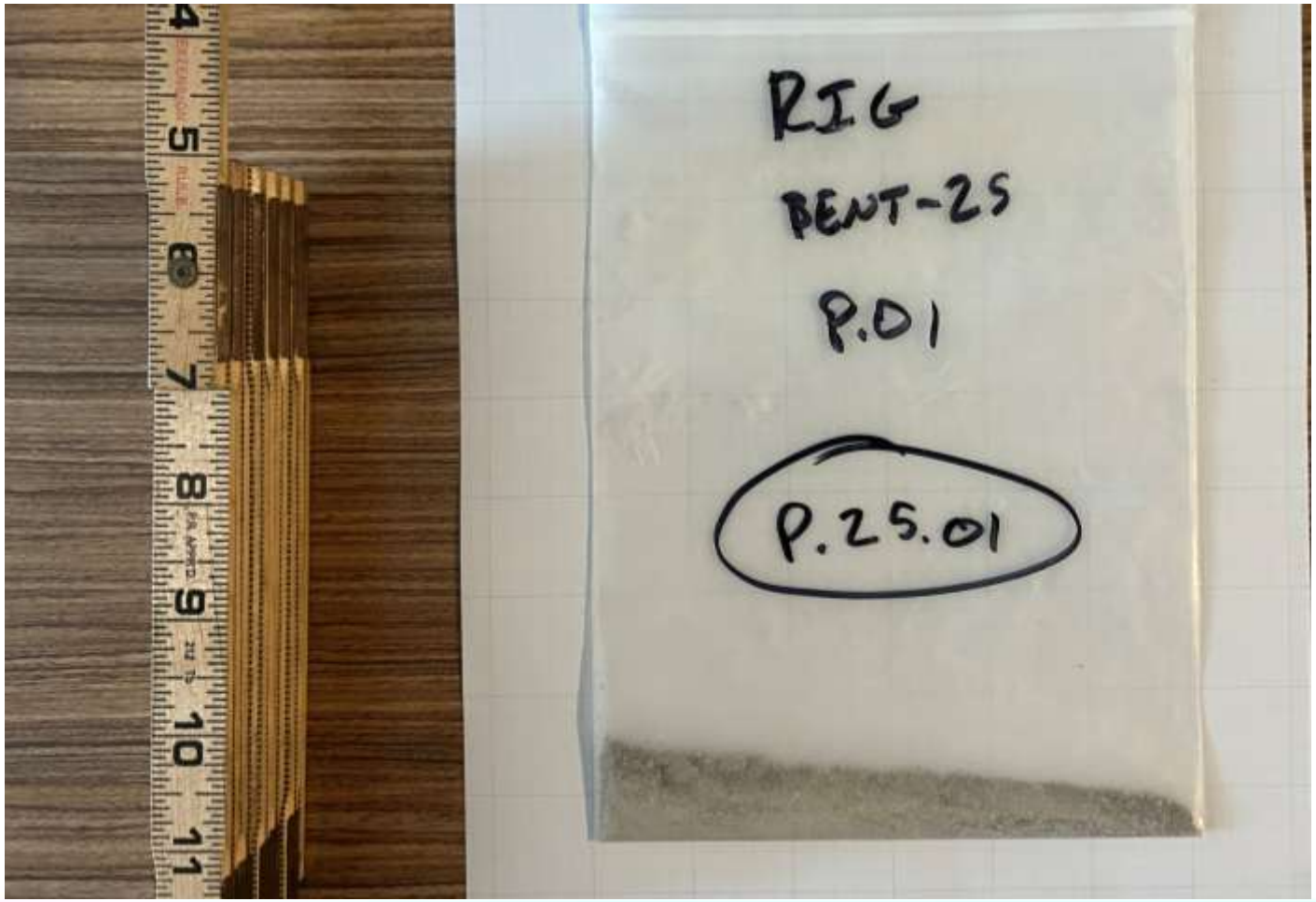


Marine Exposure

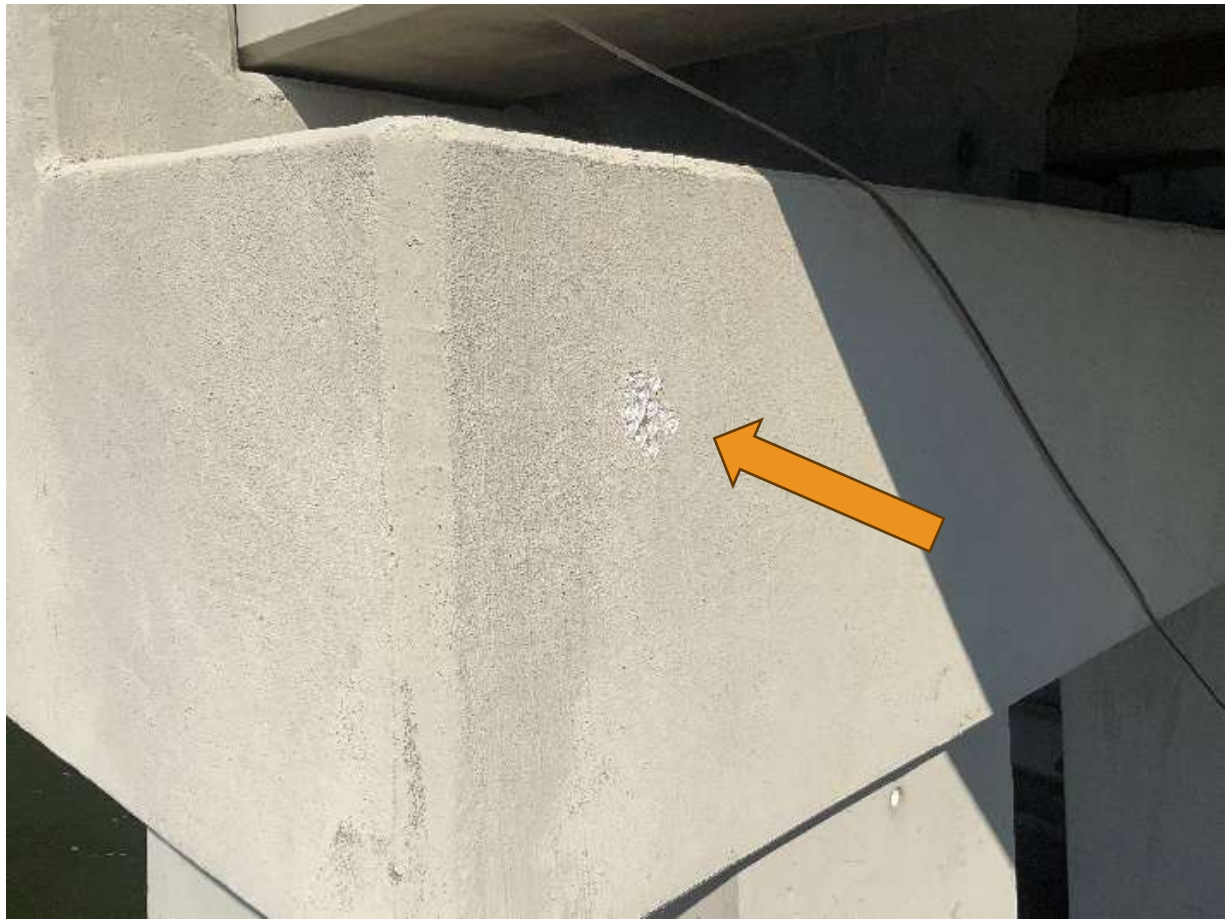


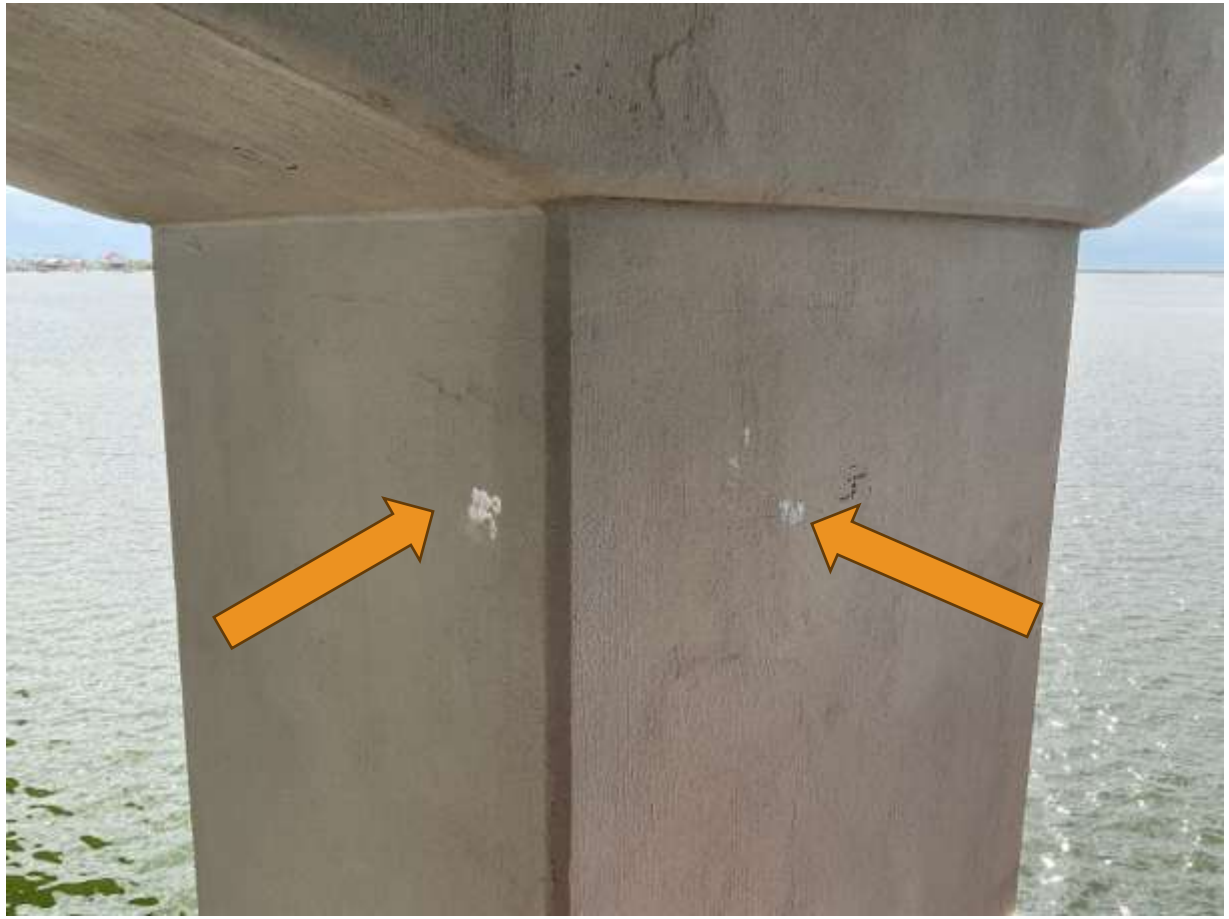
Cores and Powder Samples



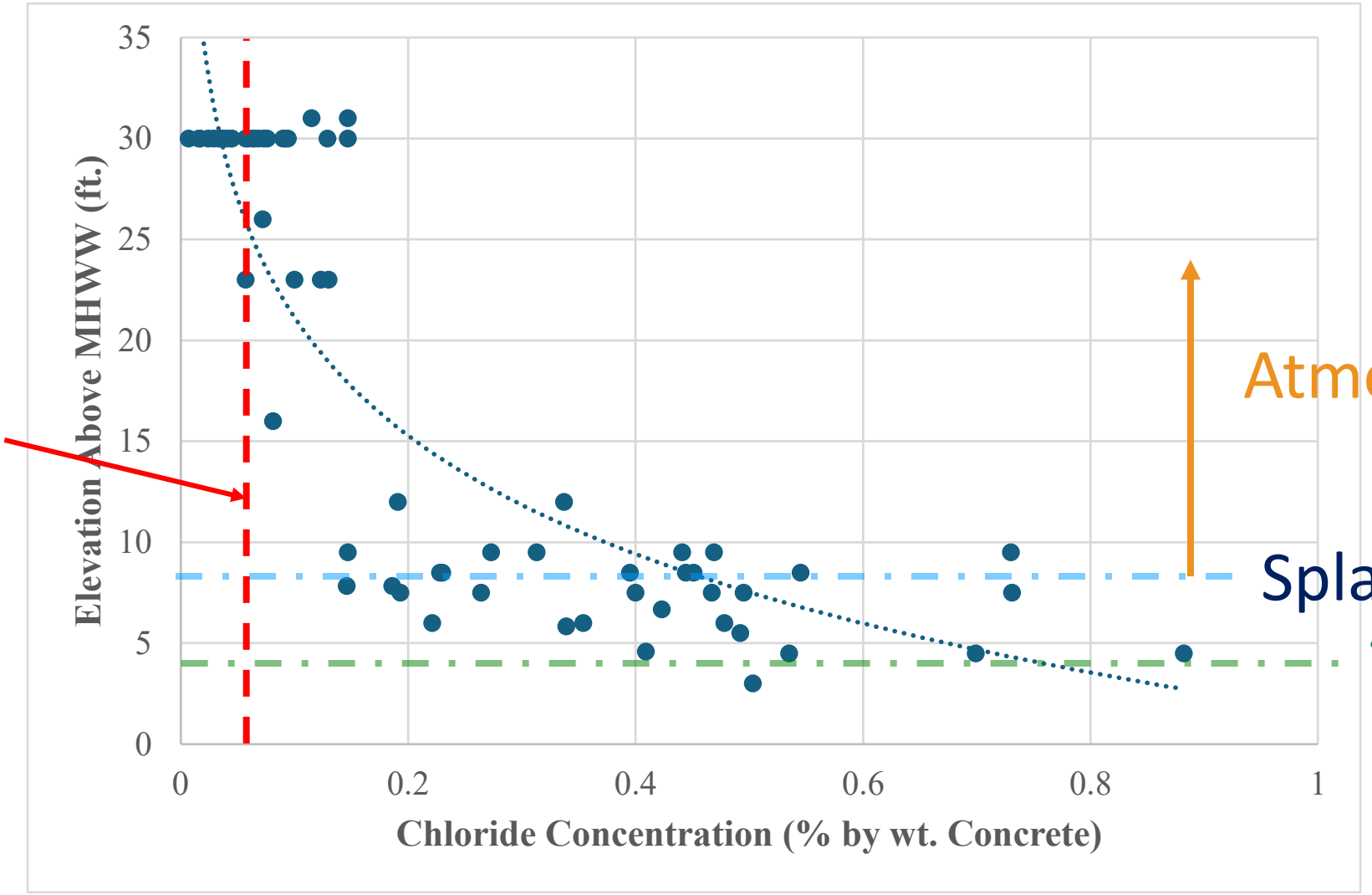


Various Locations/Exposures





Surface Chloride Deposition



Corrosion Threshold

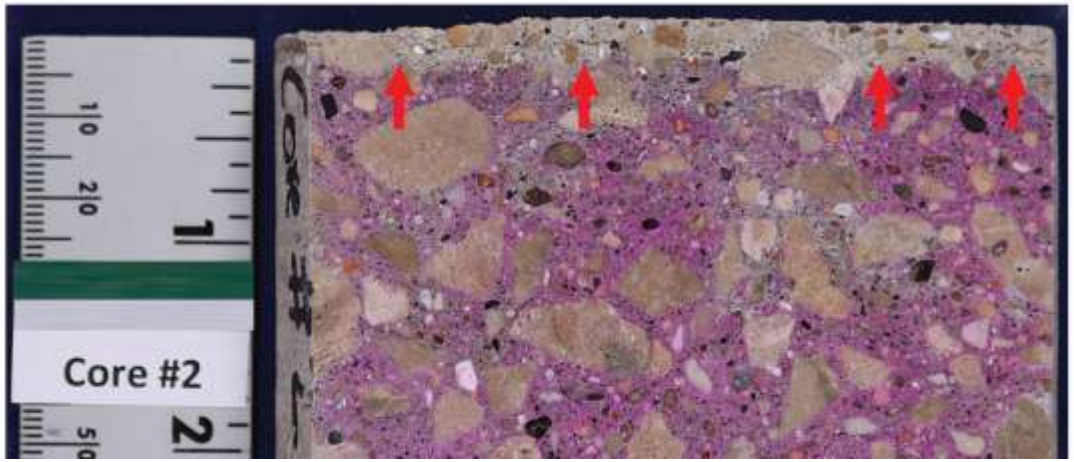
Atmospheric

Splash

Tidal

Prognosis

- Durability Analysis and Service Life Modeling
- Material Degradation Risk
- Preservation, Repair, and Rehabilitation Recommendations







Examples of DOT Guidance

Deck Repair vs. Replacement Assessment Table		
Equal Width Decks[1]:	Decks Requiring Widening[1,2]:	Recommendation:
≤ 25%	≤ 15%	Deck repair cost effective[3]
26-35%	16-25%	Deck repair cost effective only in well documented cases[4]
> 35%	> 25%	Deck replacement appropriate

Notes to Table:
(1) – Deck area calculated using length x face-face parapet width.
(2) – This column pertains to deck widening which requires additional beam/s only.
(3) – For decks containing sidewalks and raised medians with significant amounts of repair/replacement work required, separate cost analysis estimates should be completed to justify deck repair versus deck replacement.
(4) – In this case deck repair may be considered appropriate when a detailed cost analysis and/or well documented exterior constraints indicate deck repair is more advantageous.

The total removal area is based solely on technical considerations and represents that necessary to assure that at least half of the repaired deck achieve the service lives given in Chapter III. At some locations, conditions may exist requiring greater confidence in longevity of the rehabilitation. Specifically, 100% deep concrete removal may be justified on bridges in urban areas with high-traffic density whenever one or more of the following conditions are met:

1. Area of spalls exceeds 2%,
2. Area of delamination exceeds 30%,
3. Area of half-cell potential greater than 0.35 exceeds 40%, or
4. Total damaged area exceeds 50%.

These conditions are exclusive of distress within 2 ft. of a bridge joint.

ICRI Guide 510.1

Synopsis

This guideline is intended to provide information on electrochemical techniques used to mitigate the corrosion of steel in atmospherically exposed concrete structures. The information presented is based on testing and the experience of owners, engineers, contractors, and suppliers. This guideline includes information on impressed current and galvanic cathodic protection, electrochemical chloride extraction, and realkalization.



TECHNICAL
GUIDELINES

Prepared by the International Concrete Repair Institute June 2013



Guideline No. 510.1-2013

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Guide for Electrochemical Techniques to Mitigate the Corrosion of Steel for Reinforced Concrete Structures

Service Life Model Formulation

- Structure Information
- Field Inputs and Baseline Material Properties
- Deterministic vs. Probabilistic
- Need for Model Validation

4.0 Basics of Service-Life Modeling

This section discusses the foundations of modeling corrosion initiation and propagation, as well as validation for the various types of service-life modeling tools available.

Additional discussion on the analysis of these service-life models is provided in Section 5.

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March 2026



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Guide for Corrosion Related Service Life Prediction for Existing Reinforced Concrete Structures

Previous NCBC Webinar



Recordings

February 2026 Webinar: Register to View Recording | Download Presentation

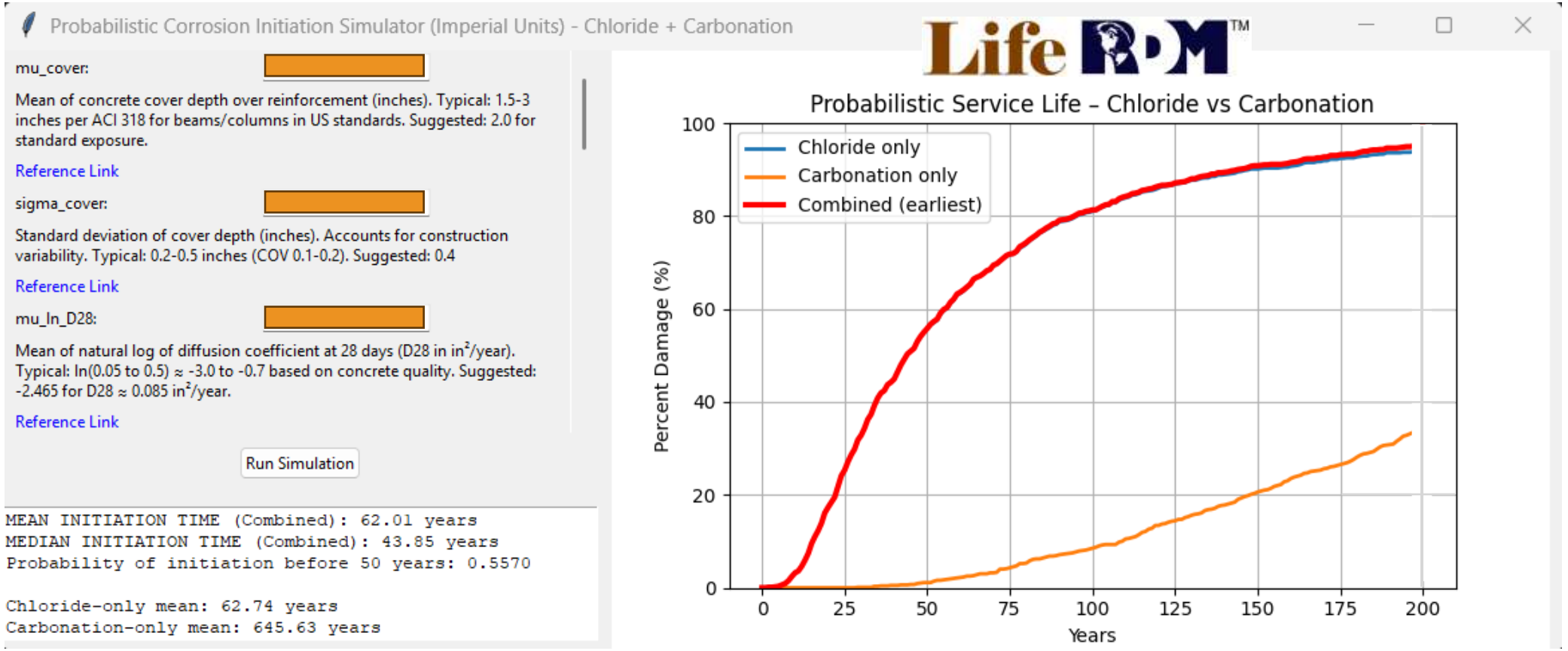
Introducing Life-365™- a Web App for Estimating the Service Life of Concrete Mixture Designs and Corrosion Protection Systems

Presented by Mark A. Ehlen, PhD

This webinar offers information on the latest version of Life-365™. The presentation takes you through the updates and how to use this web-based application to estimate service life and life-cycle costs of concrete mix designs.

Open-Source Model for Chloride-Diffusion Based Corrosion

Service Life Modeling



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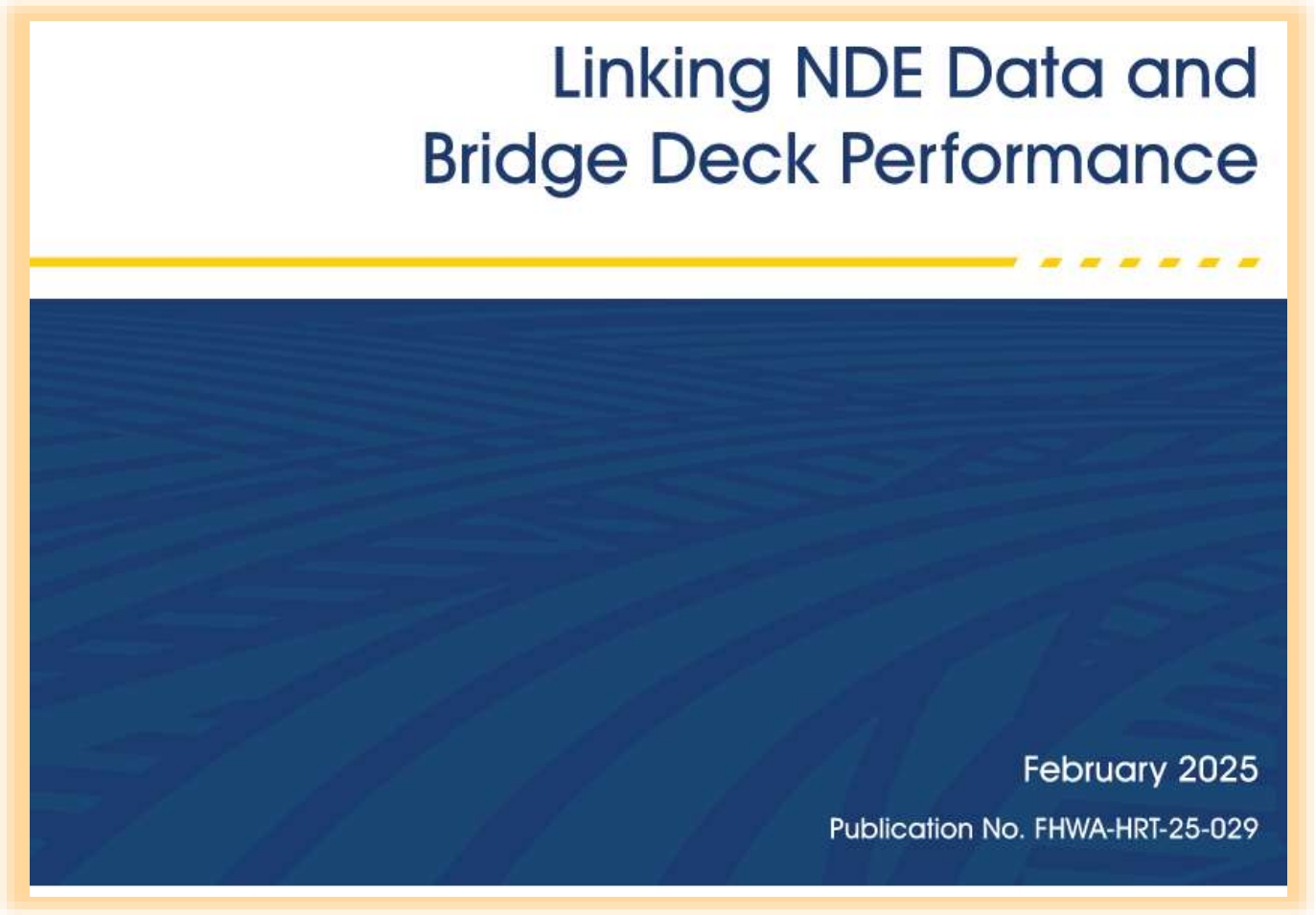
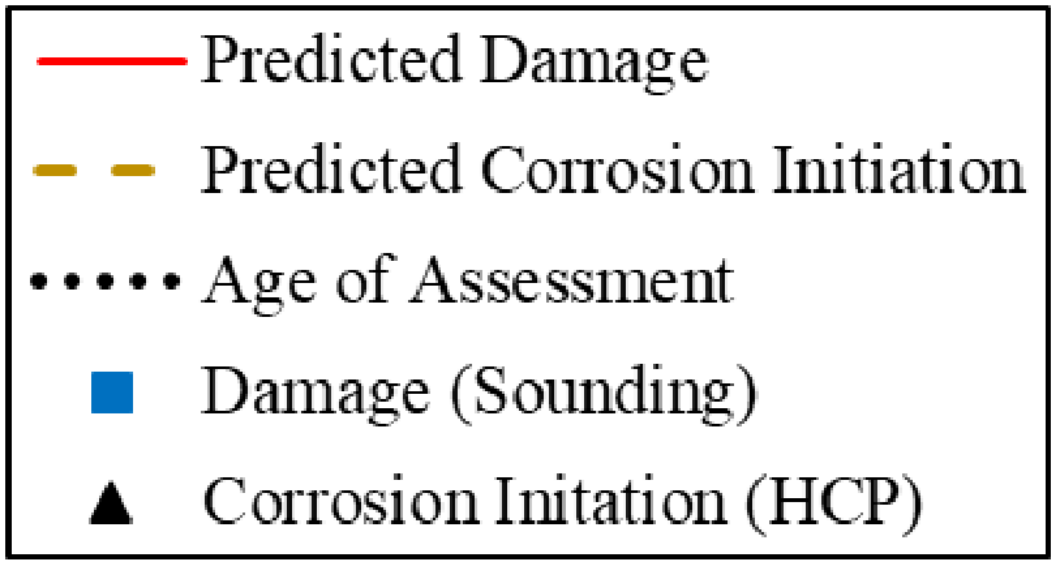
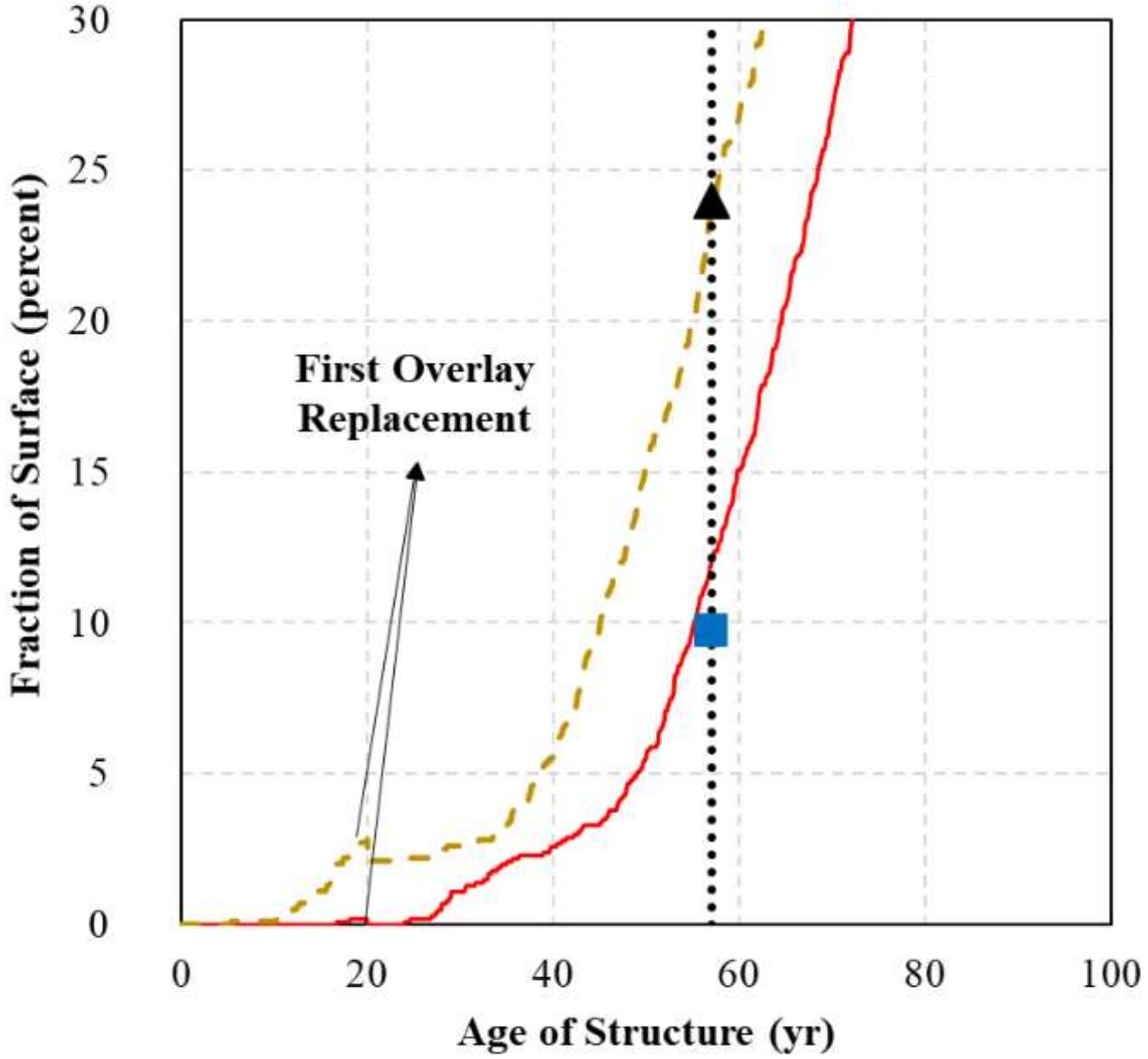


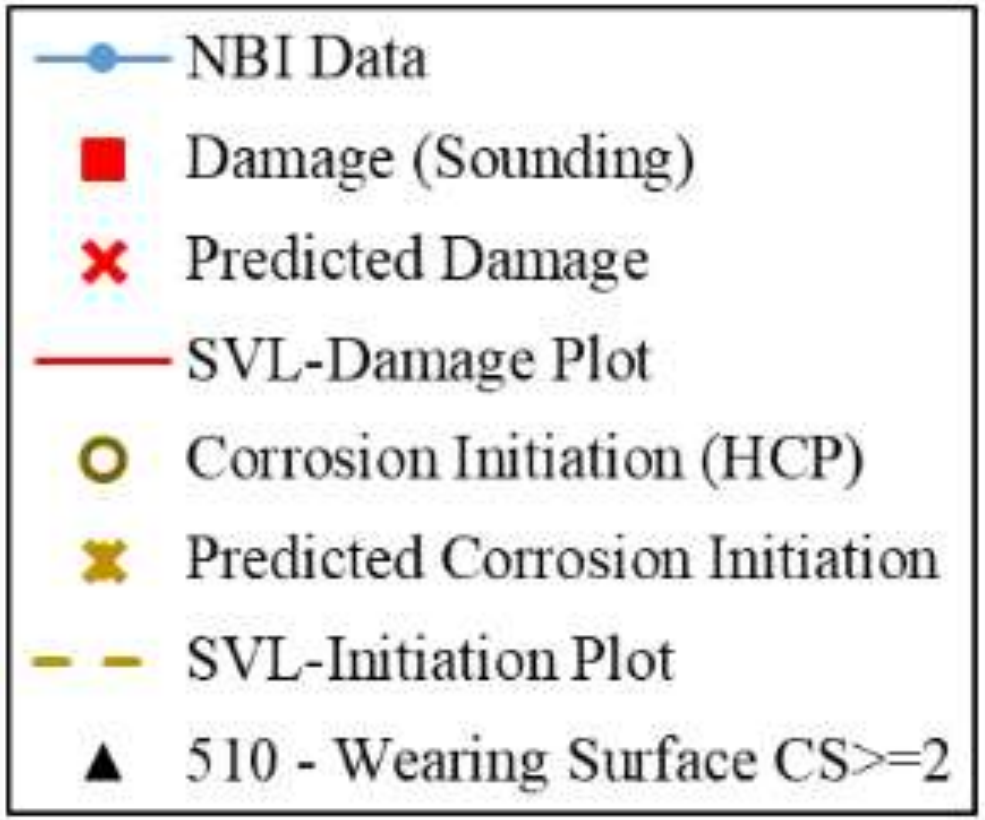
Corrosion vs. Distress

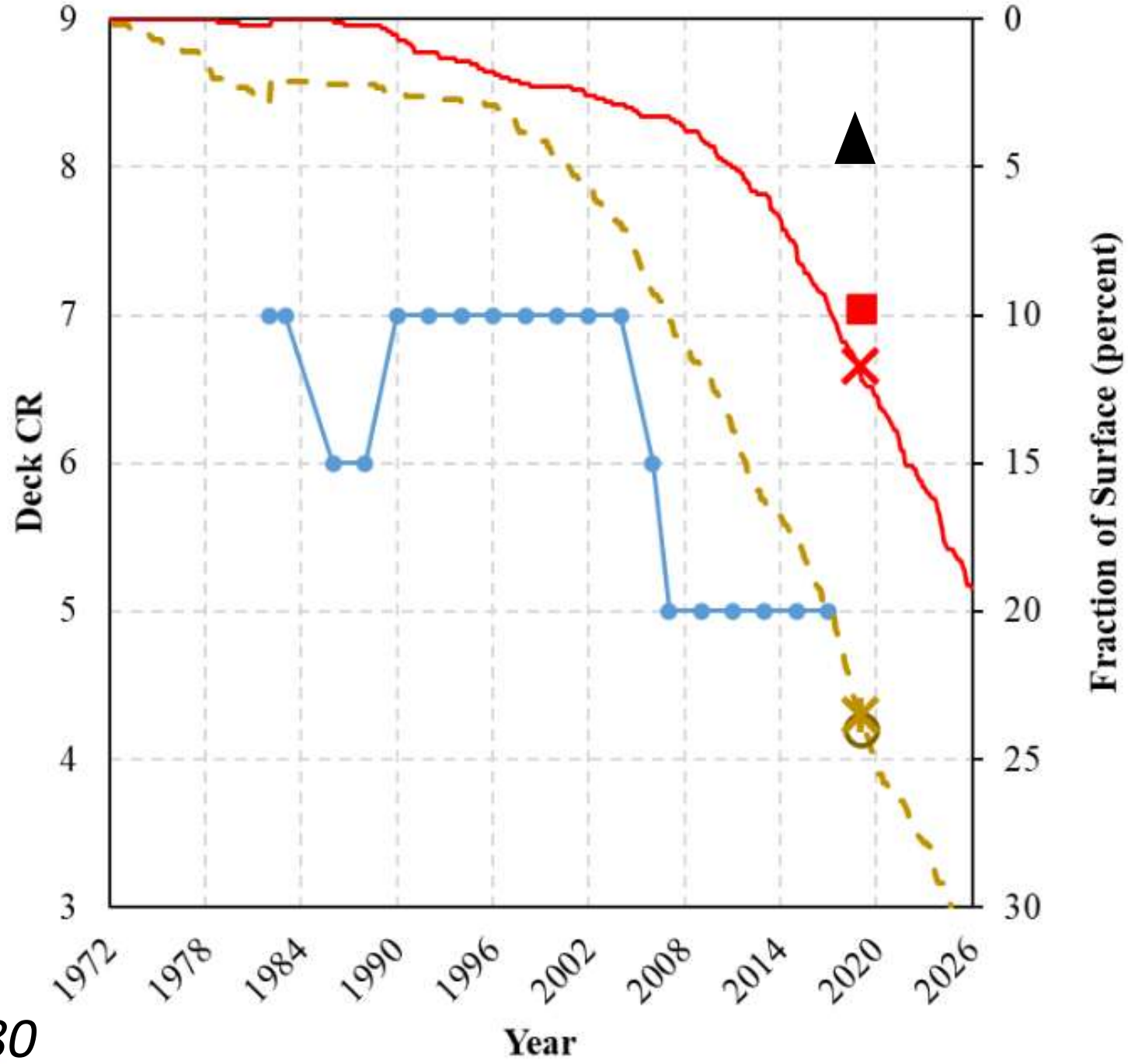




FHWA-HRT-25-029 – Figure 76

Data Fusion





FHWA-HRT-25-029 – Figure 79 & 80

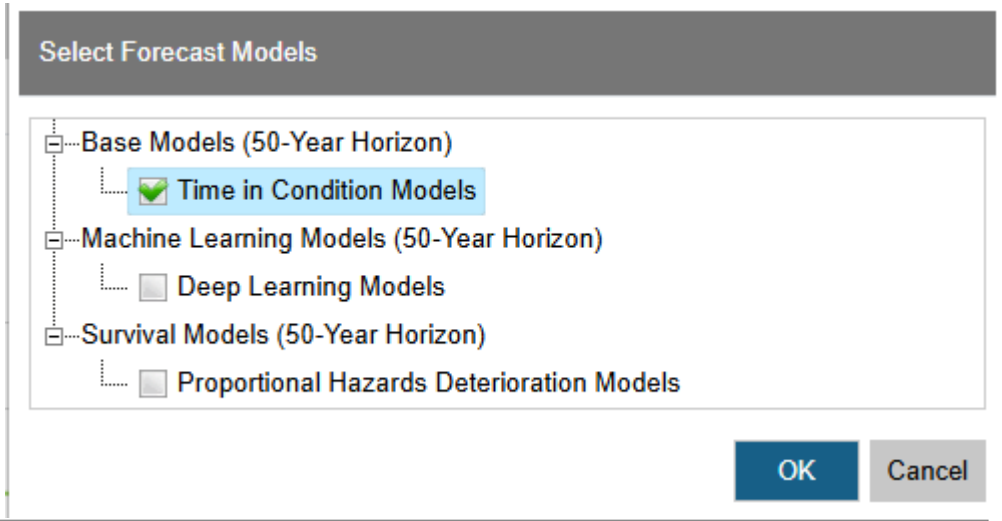
FHWA – InfoBridge™

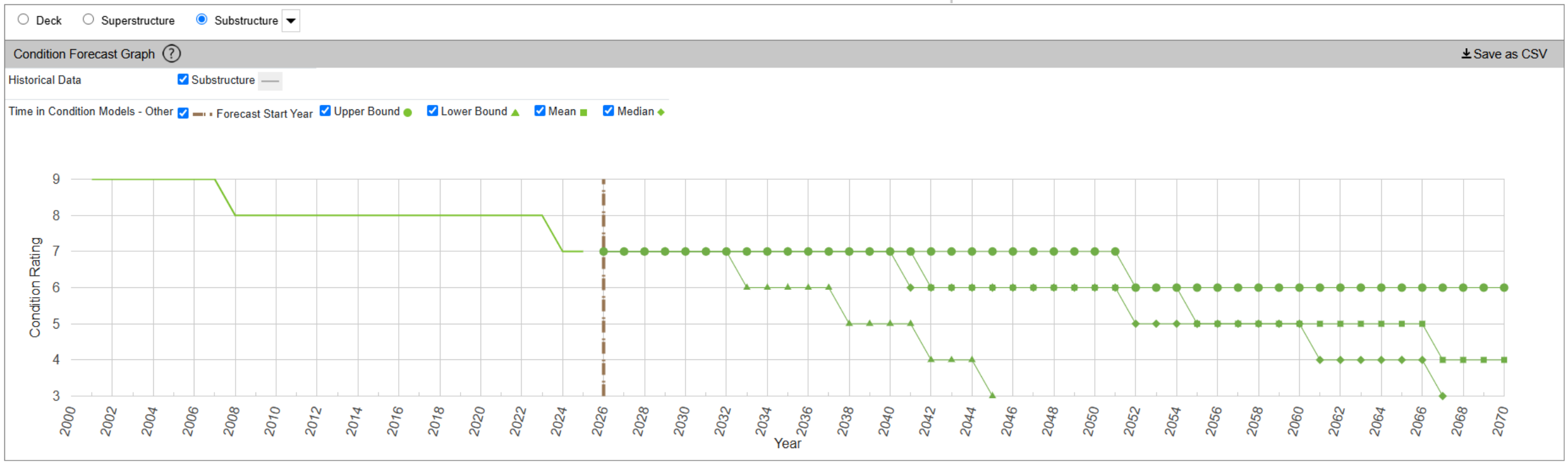
- Long-Term Bridge Performance (LTBP) Program
- Aggregates available condition state data
- Predictions for Condition Rating
  - Including: Deck, Superstructure, and Substructure
- Other tools available, such as Bridge Deck Preservation Tool (BDPT)



LTBP InfoBridge: https://infobridge.fhwa.dot.gov/

Condition Forecasting





Bridge Deck Preservation Tool (BDPT)

Introduction to the Bridge Deck Preservation Tool (BDPT)

The BDPT is a decision-making aid intended to be used at a project or asset level to compare different preservation or maintenance strategies for a given bridge deck. The comparison is based on the strategies' relative initial costs, service life benefits, life cycle costs, and risk (expressed in terms of the uncertainty in the estimated service life impact).

Usage | Constraints | Limitations | Resources

The BDPT analysis is designed for reinforced concrete bridge decks for which the following is true:

- The current deck general condition rating (NBI Item 58 or SNBI Item B.C.01) is at least 5.
- The governing deterioration mechanism is chloride-induced corrosion of the topside of the deck.
- A comparative analysis between preservation or maintenance strategies using only the inputs available in InfoBridge is deemed sufficient by the user for decision making purposes.

At a minimum, the deck general condition rating must be known and a deterioration model forecasting the deck general condition rating must be available. Users are encouraged to provide any available element-level data and detailed inspection data, such as crack mapping information, in addition to the general condition rating.

Users are strongly encouraged to provide their own cost estimates for the different maintenance actions available for analysis.

Maintenance Actions

- [x] Penetrating Sealer
- [ ] Crack-Chasing of Concrete
- [x] Floodcoat
- [x] HMA Overlay with a Waterproofing Membrane
- [x] Modified Asphalt Overlay
- [x] PCC/HPC Overlay
- [x] UHPC Overlay
- [x] LMC Overlay
- [x] Thin Polymer Overlay
- [x] PPC Overlay

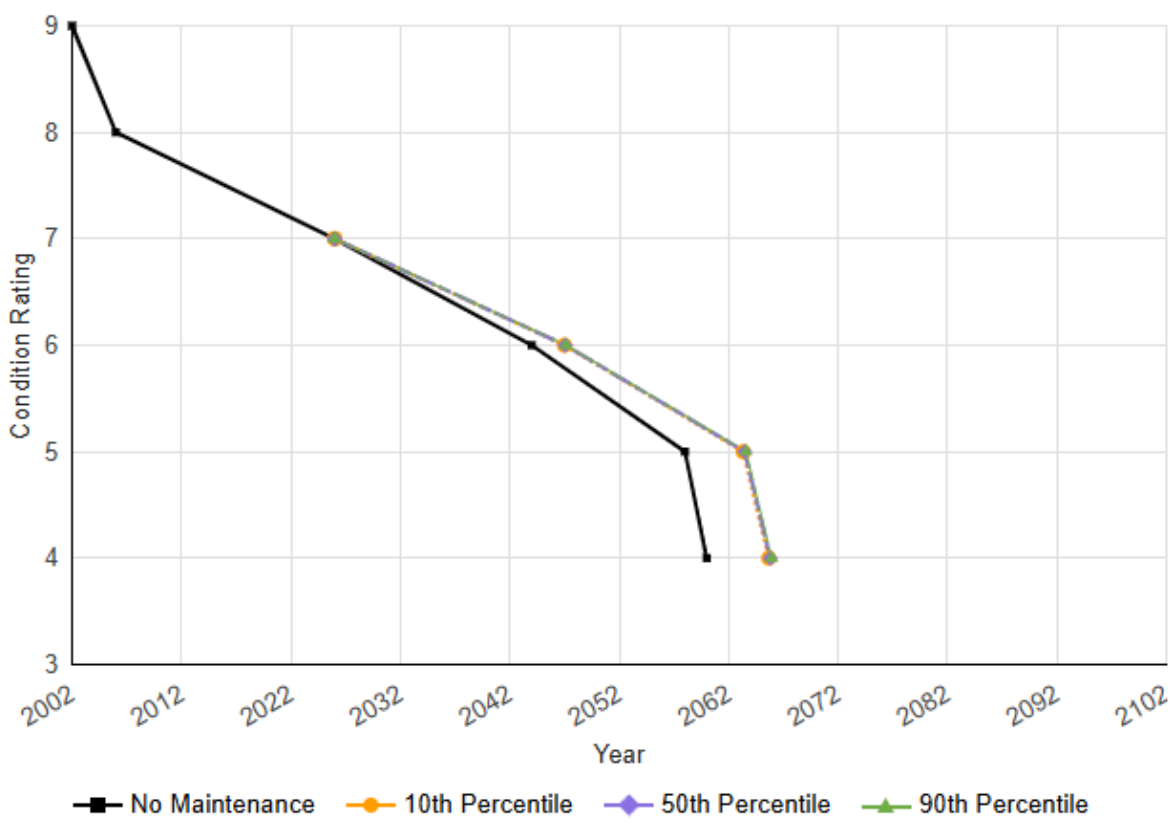
Bridge Deck Preservation Tool (BDPT)

Detailed Inspection Data ⓘ

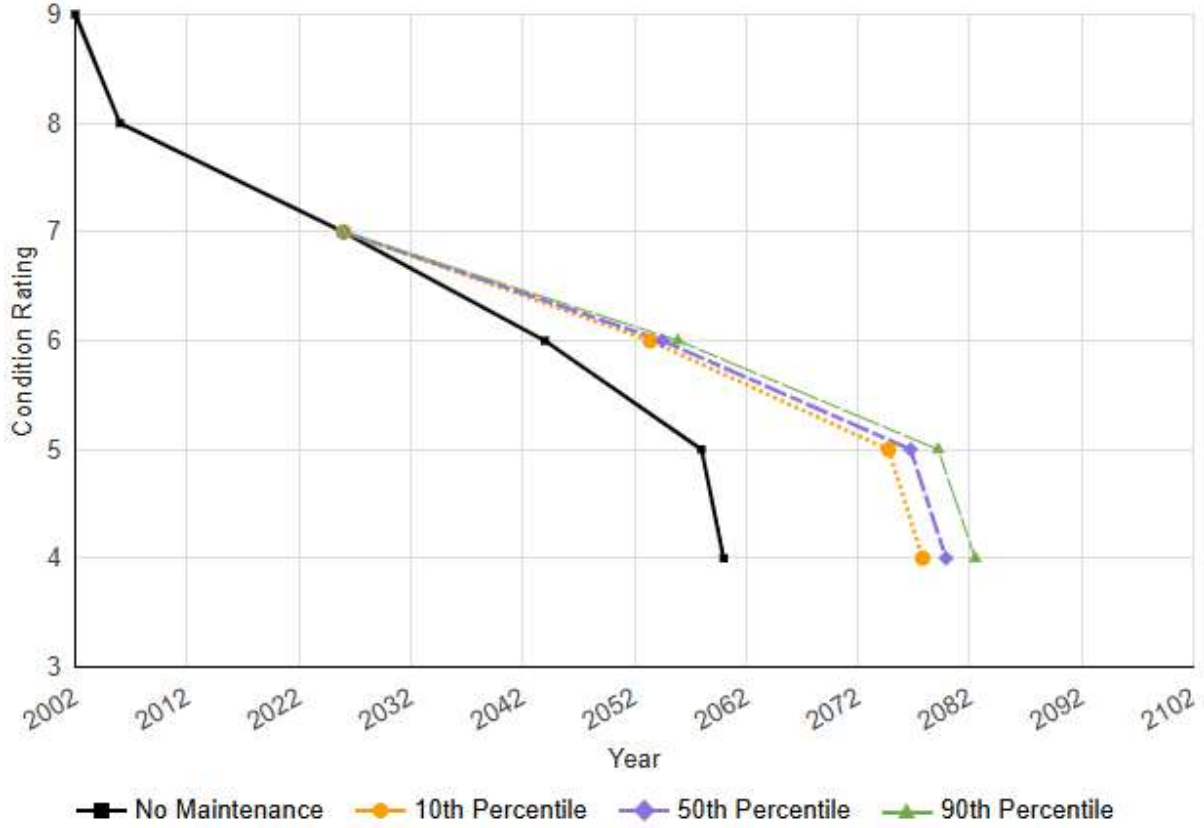
Is detailed inspection data available? ⓘ		(•) Yes ( ) No
Crack Map Information	Typical Crack Widths ⓘ	
	Crack Density (ft/ft^2) ⓘ	
Delamination Survey	Total Delaminated Area (%)	
Half-Cell Potential Data	Area likely to be corroding (%) ⓘ	
Chloride Data	Is the chloride concentration at the depth of the reinforcing steel sufficiently elevated such that corrosion is a risk? ⓘ	

Comparisons of Preservation Actions

Sealer



PPC Overlay



InfoBridge™ 'Cautions'

InfoBridge condition forecast models are the results of research performed by FHWA's Long-Term Bridge Performance Program. The Base Model is a statistical deterministic model. Survival and Machine Learning models are probabilistic. All three models are based on National Bridge Inventory items.

InfoBridge users should not develop their bridge preservation/replacement program relying directly on models' output. Bridge owners are advised to consider additional site- and bridge-specific data when developing their bridge programs.

Life Cycle Cost Analysis

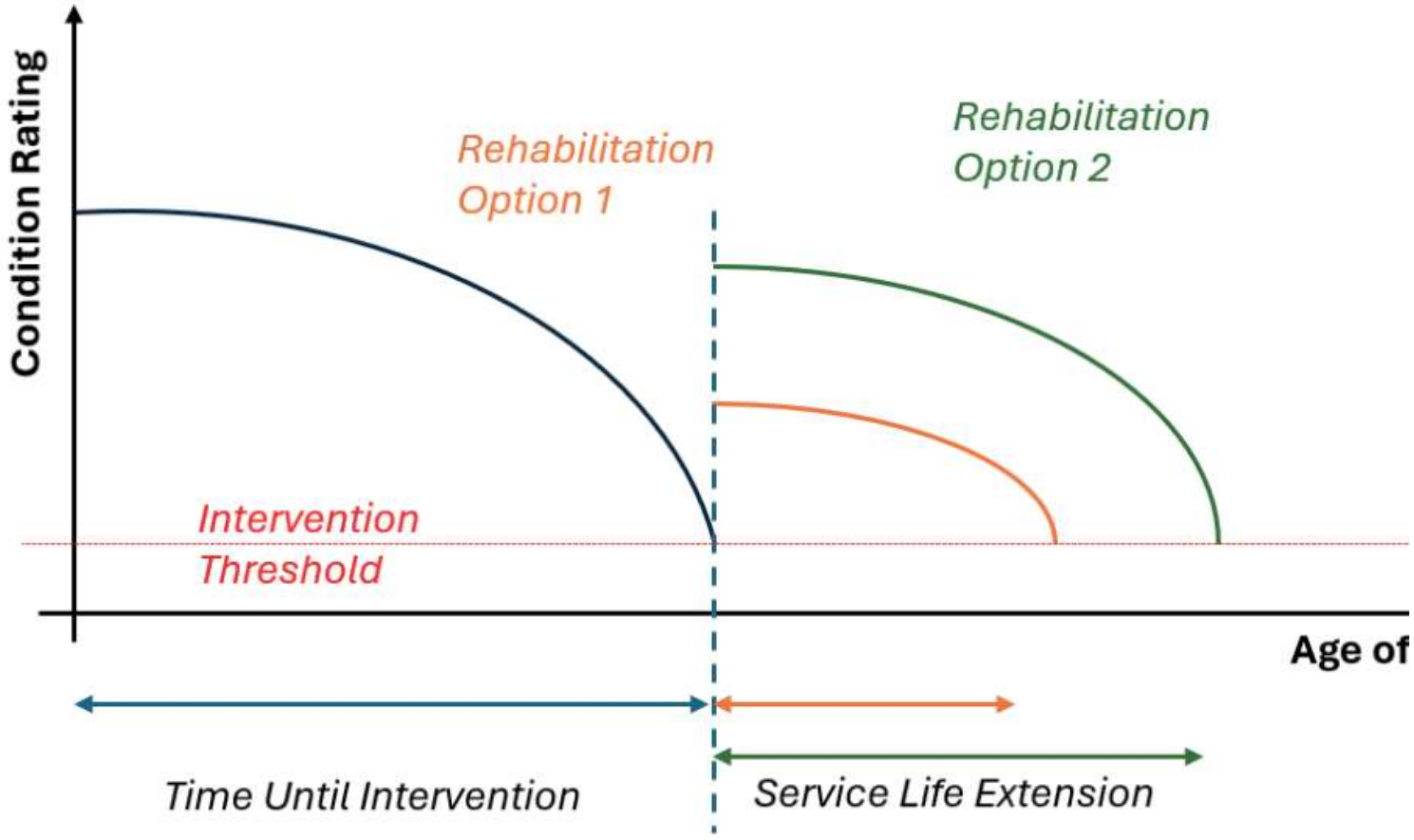


Figure 16. Schematics show condition rating predictions with time and effect of remediation measures.

7.1 Benefits

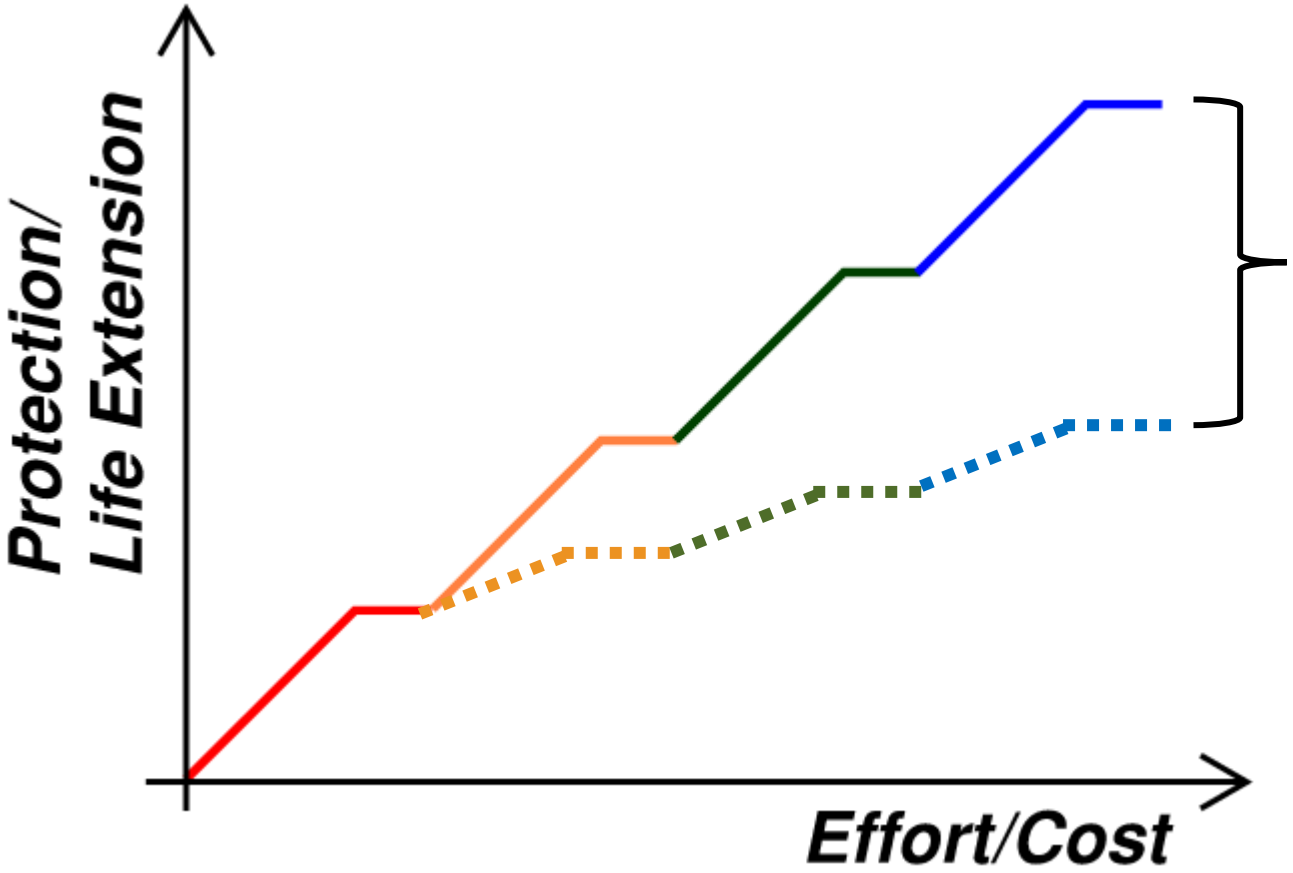
Service life modeling, when done correctly, can offer tremendous value to Engineers and asset Owners. Being able to contextualize the current condition of the structure and predict future performance allows for informed decision making with regards to rehabilitation and replacement. Service life modeling, in conjunction with life-cycle cost analysis (LCCA) and other analyses, allows for cost effective and appropriately timed decisions to be made, as well as to evaluate and validate the effectiveness of countermeasures taken[7].

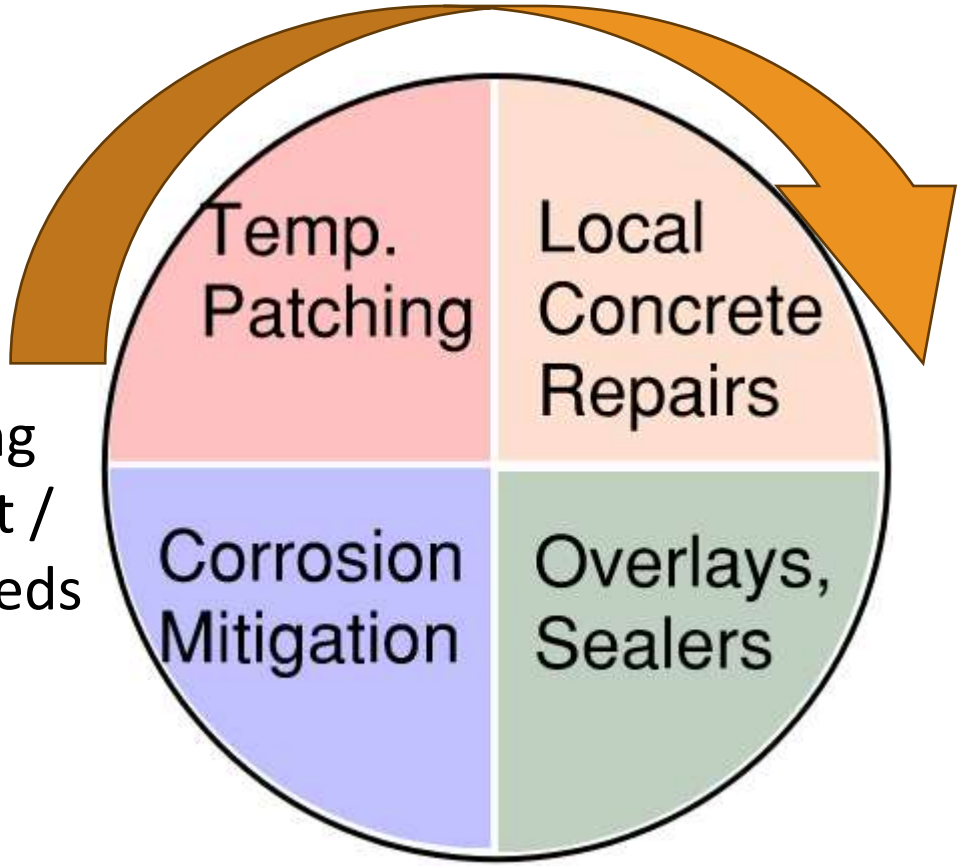
ICRI 160.1 – Figure 16

Concrete Repair



Value Engineering (Protection vs. Cost)

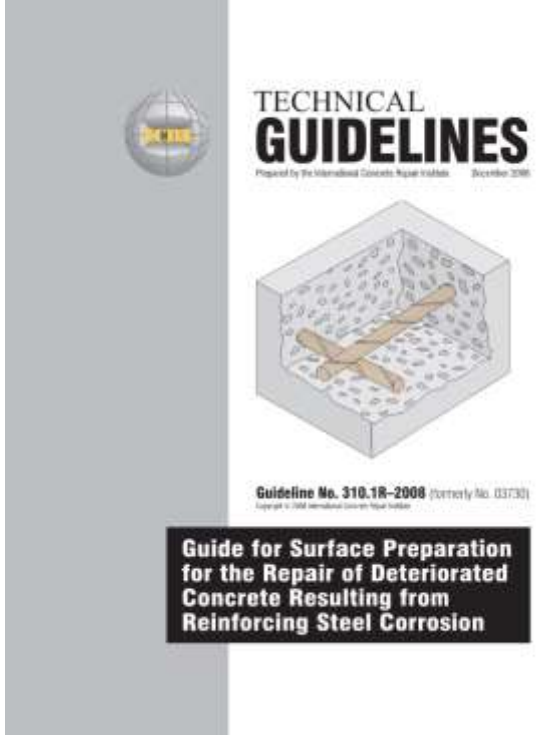


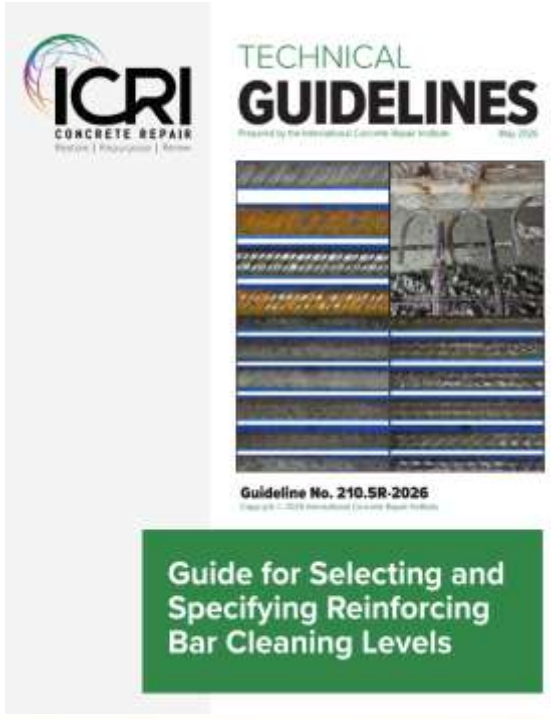


Responsibility

- Engineer
  - Document conditions and determine repair needs
  - Design constructable repairs
- Inspector
  - Verify Quantities
  - Verify Conformance









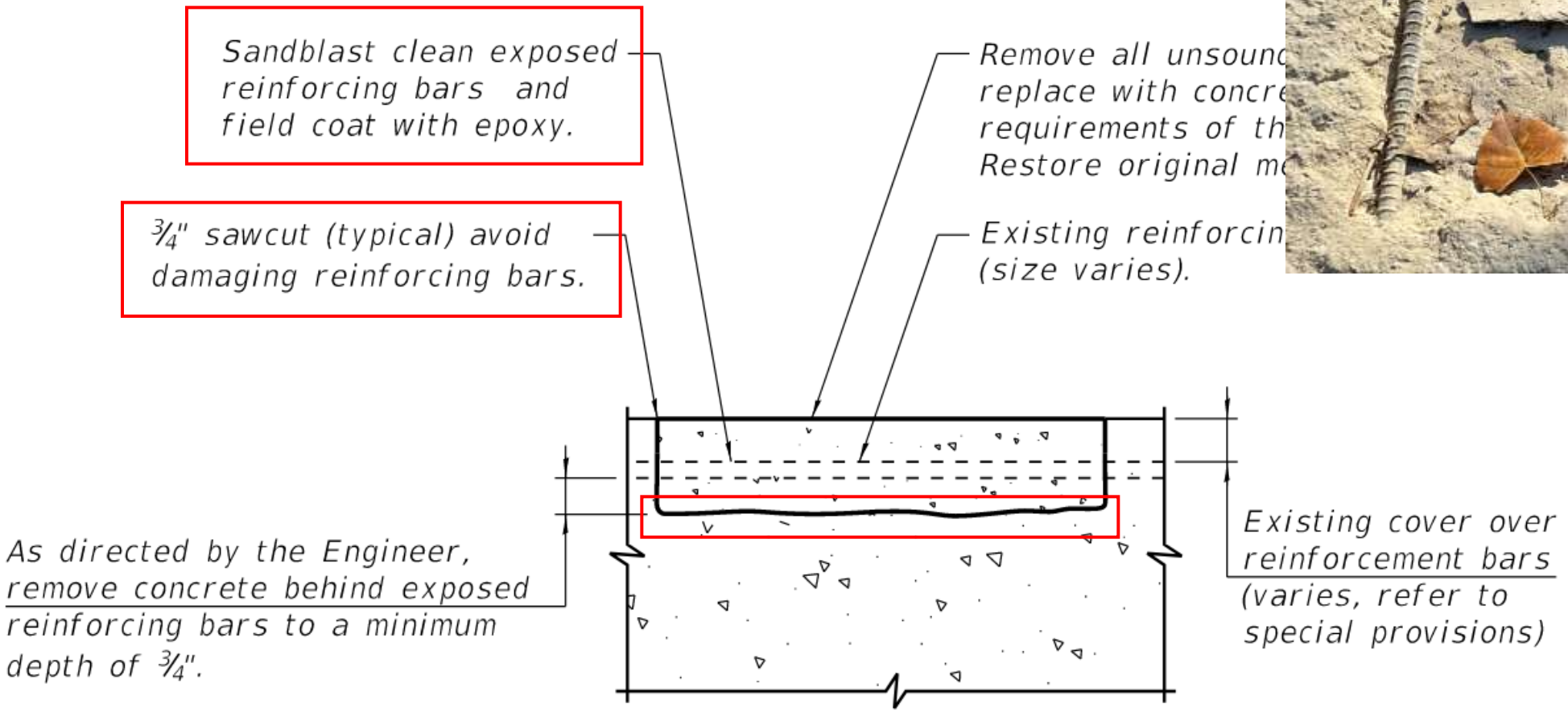
Repair Implementation





Deck Slab Repair





HORIZONTAL SURFACE REPAIR (PARTIAL DEPTH)

At Bridge Deck, Parapet, and Substructure

Guide Specifications for Structural Concrete Repairs

MARCH 2026

ICRI CONCRETE REPAIR
Restore | Repurpose | Renew

Guide No. 110.1R-2026

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GUIDE SPECIFICATIONS for
STRUCTURAL CONCRETE REPAIRS
SECTION 030130

SECTION 030130 — STRUCTURAL CONCRETE REPAIRS

TABLE OF CONTENTS

PART 1 – GENERAL 1

1.1 SUMMARY 1
1.2 DEFINITIONS 2
1.3 REFERENCED STANDARDS AND REPORTS 2
1.4 UNIT PRICES 6
1.5 SUBMITTALS 7
1.6 PREINSTALLATION CONFERENCE 11
1.7 QUALITY ASSURANCE 11
1.8 PRECONSTRUCTION TESTING 12
1.9 DELIVERY, STORAGE, AND HANDLING 13
1.10 PROJECT CONDITIONS 13
1.11 SAFETY 15

PART 2 – PRODUCTS 15

2.1 EQUIPMENT 15
2.2 PRODUCTS AND MANUFACTURERS 16
2.3 BONDING AGENTS 16
2.4 PACKAGED REPAIR MATERIAL 17
2.5 CONCRETE MATERIALS 20
2.6 READY MIXED CONCRETE MIXTURES 23
2.7 SHOTCRETE MIXTURES 25
2.8 STEEL REINFORCEMENT AND ACCESSORIES 25
2.9 CURING MATERIALS 26
2.10 MISCELLANEOUS MATERIALS 27

PART 3 – EXECUTION 28

3.1 EXAMINATION 28
3.2 PROTECTION 29
3.3 FORMWORK AND SHORING 29
3.4 PREPARATION AND BONDING 30
3.5 CONCRETE MIXING, CONVEYING, AND PLACEMENT 37
3.6 FINISHING AND CURING 38
3.7 FIELD QUALITY CONTROL 39
3.8 PAY BASIS 43

Mock-ups

B. Mockups: Provide mockups for concrete removal, surface preparation, and concrete repair material placement to demonstrate the quality and appearance of the repair Work. Mockups shall be constructed using the same personnel, equipment, and materials that will be used for the final work. Locate the mockups in areas designated by the Design Professional. Notify the Design Professional in writing at least 48 hours in advance of the mockup placement to allow for inspection and acceptance of the Work.

1. *Accepted mockups are permitted to become part of the completed Work if undisturbed at the time of Substantial Completion.*
2. *The manufacturer's representative shall review the mockup when requested by the Design Professional.*

Partial Depth Concrete Repair

A. Partial-depth Concrete Removal: Removal of deteriorated concrete, surface preparation, and provisions for reinforcement in areas to be repaired shall be conducted in accordance with ICRI 310.2R. The surface of the repair area shall be roughened to a minimum surface profile of CSP 10, as described in ICRI 310.2.R. In addition, the following criteria shall be met within the repair locations:

1. Repair configurations should be kept as simple as possible and shall preferably have square corners.
2. Odd shapes shall be avoided. If they cannot be avoided, re-entrant corners shall be mitered or reinforced to limit cracking at these locations.
3. Remove concrete using power equipment such as impact breakers or as required for hydrodemolition
4. Concrete removal must not be performed beyond limits compatible with safety, structural integrity and shoring requirements. This is particularly true for columns but may apply to other members as well.

Practical Considerations

- Extents and Geometry
- Quality Control
- Detailing and Specifying
- Executing Safely

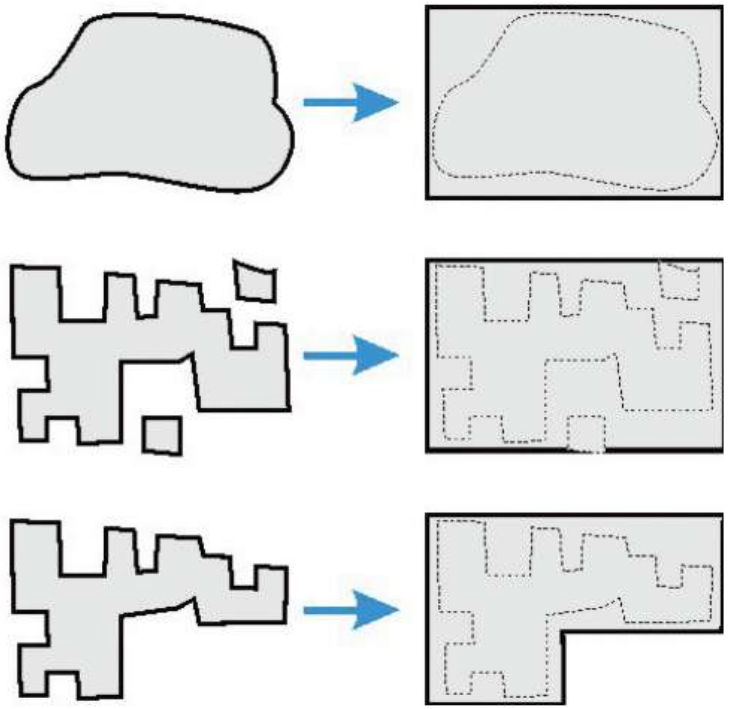

Fig. 6.1: Areas of deterioration and recommended removal configurations

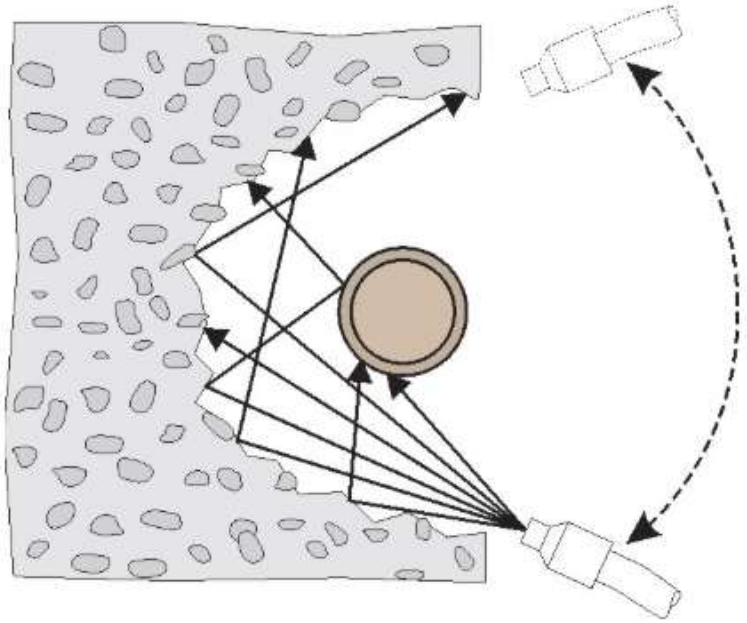

Fig. 7.3: Abrasive blasting to clean substrate and reinforcing

ICRI 310.2R

Synopsis

Proper surface preparation is a key element in determining the success of a concrete restoration project. Improper surface preparation may lead to the failure of the protective system or repair material, resulting in further repairs, added expense, and loss of use, and may ultimately compromise the integrity of the structure.

Surface preparation is the process by which a sound, clean, and suitably roughened surface is produced on a concrete substrate. Surface preparation includes the removal of laitance, dirt, oil, films, paint, coatings, sound and unsound concrete, and other materials that will interfere with the adhesion or penetration of a sealer, coating, polymer overlay, or repair material. Surface preparation will open the pore structure of the concrete substrate and establish profiles suitable for the application of the specified protective system or repair material.

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GUIDELINES

Prepared by the International Concrete Repair Institute October 2013



Guideline No. 310.2R–2013

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Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

Concrete Surface Profile (CSP)

Caution! *The texture and appearance of the profile obtained will vary depending on the concrete strength, the size and type of aggregate, and the finish of the concrete surface. On sound substrates, the range of variation can be sufficiently controlled to resemble the referenced CSP standard. As the depth of removal increases, the profile of the prepared substrate will be increasingly dominated by the type and size of the coarse aggregate.*



Fig. 6.1: CSP 1 (acid-etched)

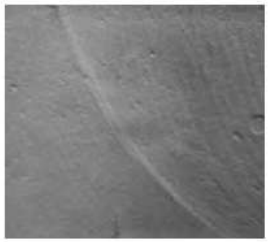


Fig. 6.2: CSP 2 (grinding)



Fig. 6.3: CSP 3 (light shotblast)



Fig. 6.4: CSP 4 (light scarification)



Fig. 6.5: CSP 5 (medium shotblast)



Fig. 6.6: CSP 6 (medium scarification)



Fig. 6.7: CSP 7 (heavy abrasive blast)

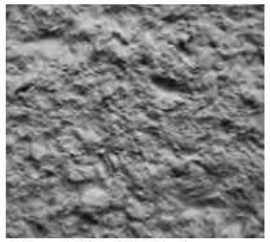


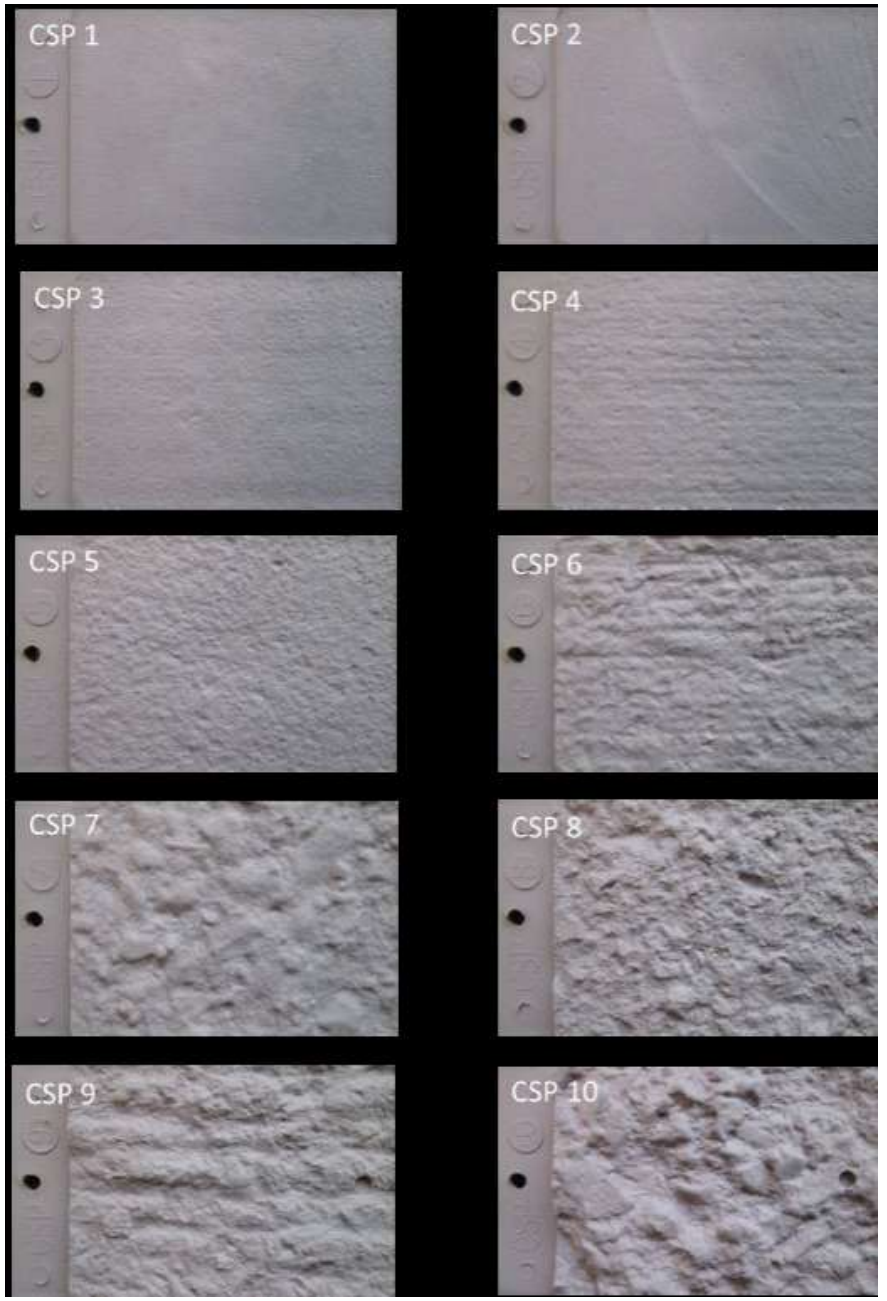
Fig. 6.8: CSP 8 (scabbled)



Fig. 6.9: CSP 9 (heavy scarification—rotomilled)



Fig. 6.10: CSP 10 (handheld concrete breaker followed by abrasive blasting)



Rebar Surface Preparation



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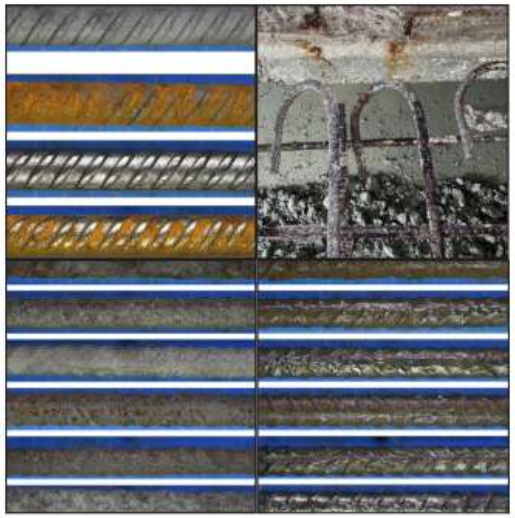
May 2026



Guideline No. 210.5R-2026

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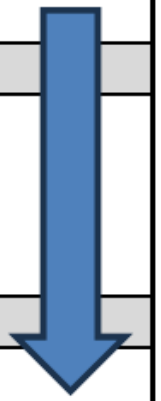
Guide for Selecting and Specifying Reinforcing Bar Cleaning Levels

Cleanliness Level

Table 2. Preparation Method and Cleanliness Level Matrix

Rebar Cleanliness Level	Label	Description	Degree of Cleaning
RCL 0	U0	Uniformly Corroded without preparation	None
	P0	Pitted without preparation	
RCL 1	AP1	Pitted with Abrasive Media Blast Cleaning- Level 1	Least
	AU1	Uniformly Corroded with Abrasive Media Blast Cleaning- Level 1	
	MP1	Pitted with Mechanical Equipment Cleaning Level- 1	
	MU1	Uniformly Corroded with Mechanical Equipment Cleaning- Level 1	
RCL 2	AP2	Pitted with Abrasive Media Blast Cleaning- Level 2	
	AU2	Uniformly Corroded with Abrasive Media Blast Cleaning- Level 2	
	MP2	Pitted with Mechanical Equipment Cleaning Level- 2	
	MU2	Uniformly Corroded with Mechanical Equipment Cleaning- Level 2	
RCL 3	AP3	Pitted with Abrasive Media Blast Cleaning- Level 3	Most
	AU3	Uniformly Corroded with Abrasive Media Blast Cleaning- Level 3	
	MP3	Pitted with Mechanical Equipment Cleaning Level- 3	
	MU3	Uniformly Corroded with Mechanical Equipment Cleaning- Level 3	



Surface Preparation Methods

Table 3. Cleanliness Levels (Abrasive Media Cleaning)

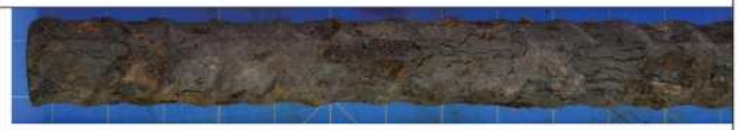
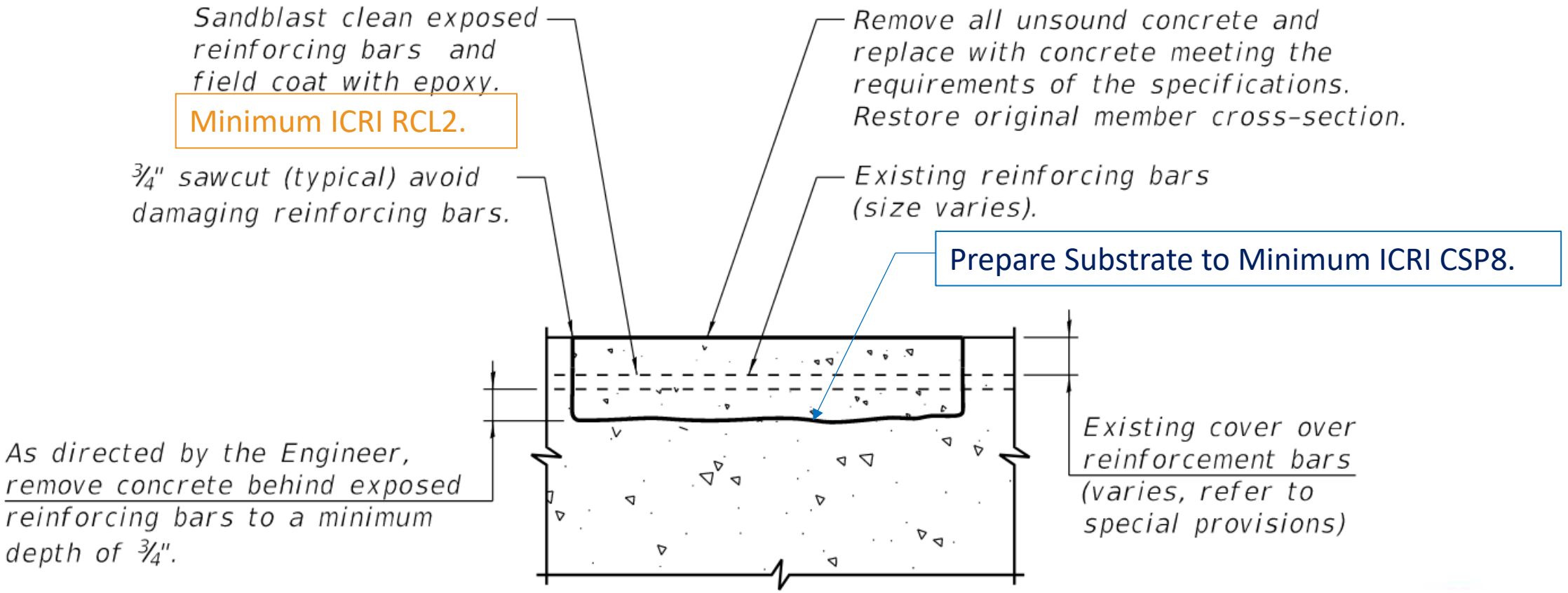
Type	Description	Level	Photo
Abrasive-Cleaned	Pitted	1	
		2	
		3	
	Uniform	1	
		2	
		3	

Table 4. Cleanliness Levels (Mechanically Cleaned)

Type	Description	Level	Photo
Mechanical-Cleaned	Pitted	1	
		2	
		3	
	Uniform	1	
		2	
		3	

Deck Slab Repair - Improved



HORIZONTAL SURFACE REPAIR (PARTIAL DEPTH)

At Bridge Deck, Parapet, and Substructure

Case Study – Deck Repairs and Overlay Installation

Polyester Polymer Concrete (PPC)

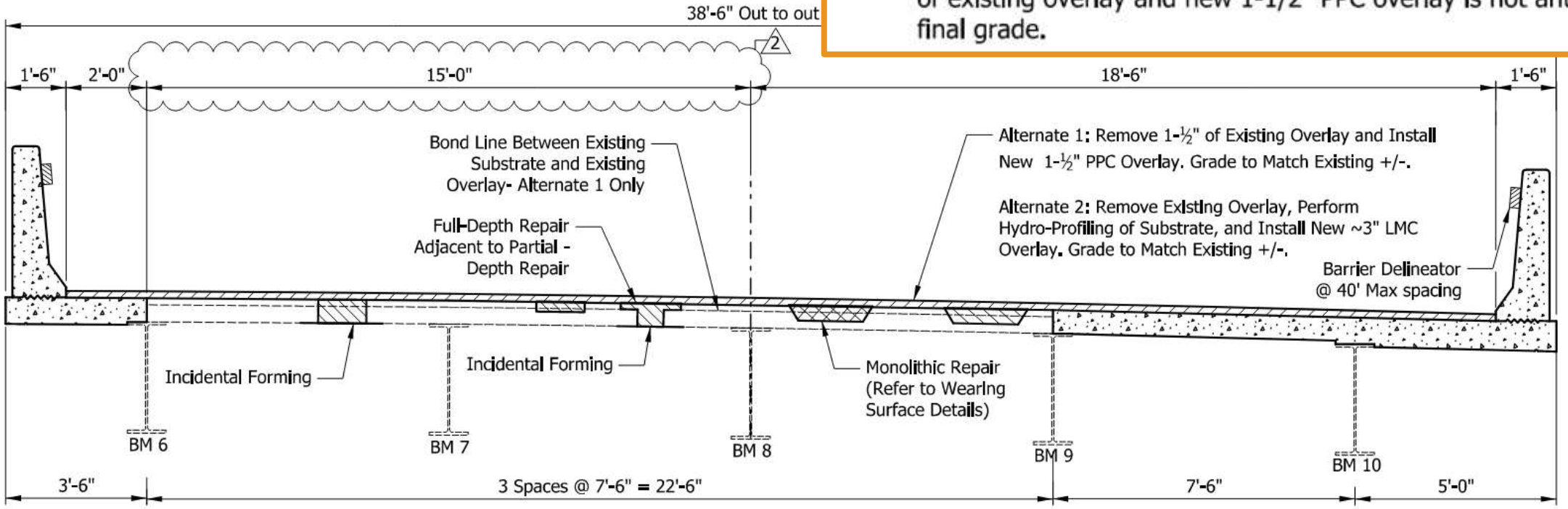


Bridge Deck Overlay



Existing Conditions and Final Grade

1. Based on 2020 field measurements and core samples, existing dimensions for Structure 01A.1 are as follow. Average cover depth to top layer of reinforcement is 4.9 inches, varying from 3.2 to 6.9 inches. Average overlay thickness is 3.1 inches, varying from 2.1 to 4.7 inches (excluding previous partial-depth repairs). Calculated total deck thickness, including overlay and based on repair history, is approximately 9 inches. Anticipated partial-removal of existing overlay and new 1-1/2" PPC overlay is not anticipated to change final grade.



ICRI 210.3R

Synopsis

This guide provides a recommended method of evaluating the adequacy of concrete surface preparation and tensile bond strength of cementitious and polymer concrete surface repairs using the in-situ drilled core tensile pull-off test. This guide outlines equipment and material requirements, the test procedure, reporting, and acceptance criteria.

Keywords: Acceptance criteria, bond, bond failure, cohesive failure, composite, failure mode, mockup, pull-off strength, pull-off test, repair composite, substrate, surface repair, tensile bond strength.

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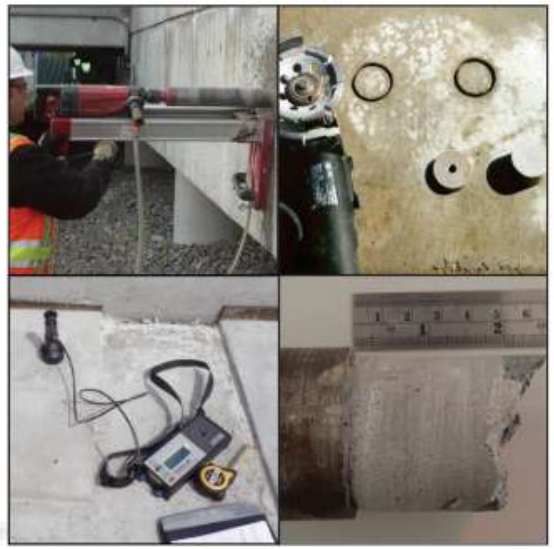

Guideline No. 210.3R–2022

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Guide for Using In-Situ Tensile Pull-Off Tests to Evaluate Concrete Surface Repairs and Bonded Overlays

Bond Testing

- Evaluate substrate strength
- Evaluate bond strength
- Bonding Surface:
  - As-Found/In-situ vs. As-Prepared



Evaluation of Bond

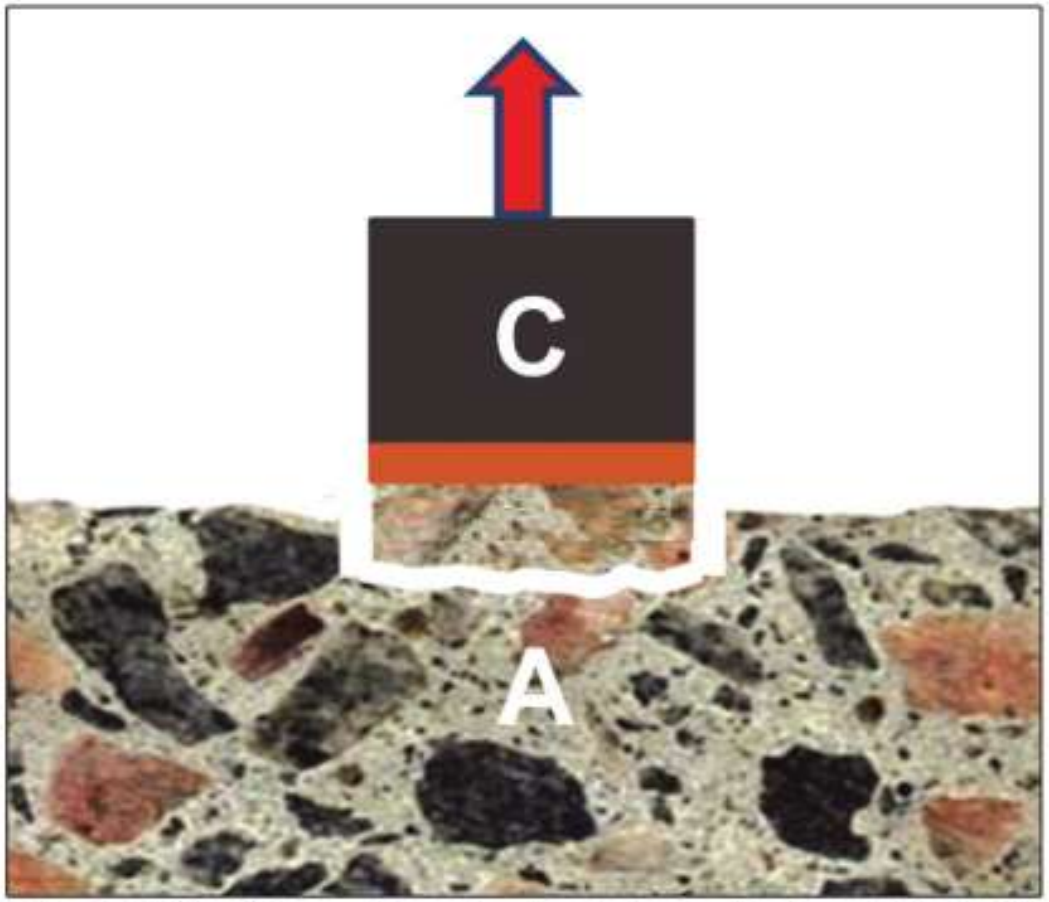


Fig. 3.10.b: Concrete substrate test: Failure Mode S2

Prepared Substrate Test

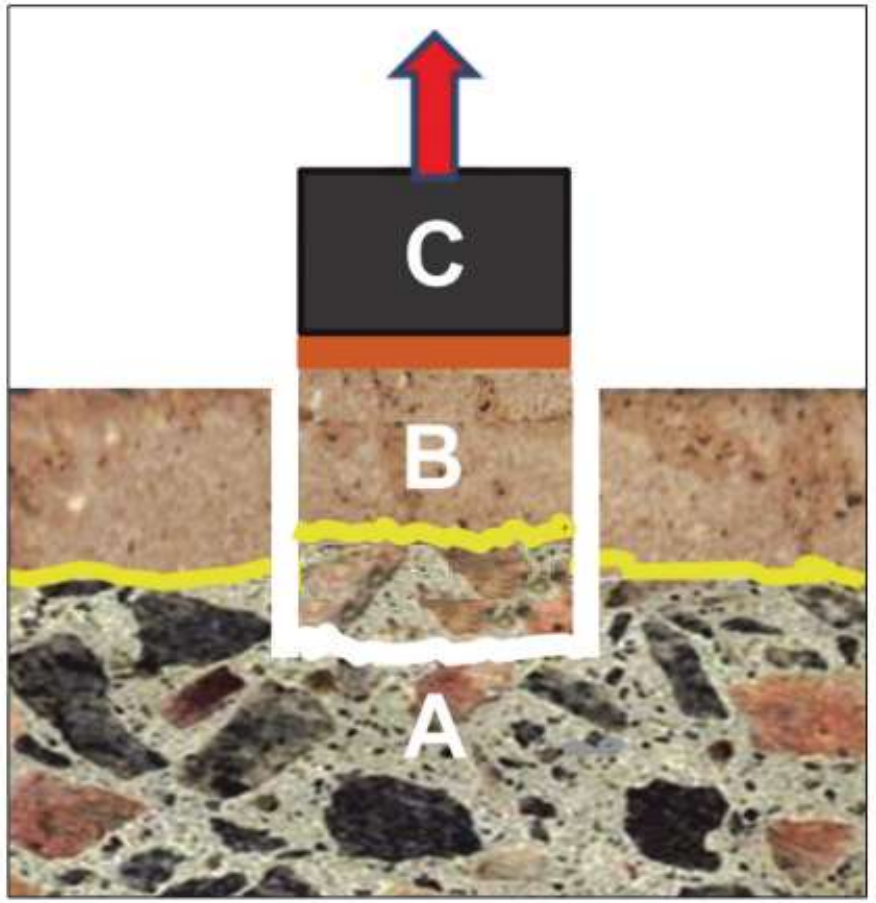


Fig. 3.10.h: Composite repair test: Failure Mode R6

Repair/Overlay Bond Test

Pre-Placement Bond Testing



- Milling to final grade

- Core through Bond-Line





- Bond-testing in "Representative" Areas

Setup – Sound Concrete w/o Rebar



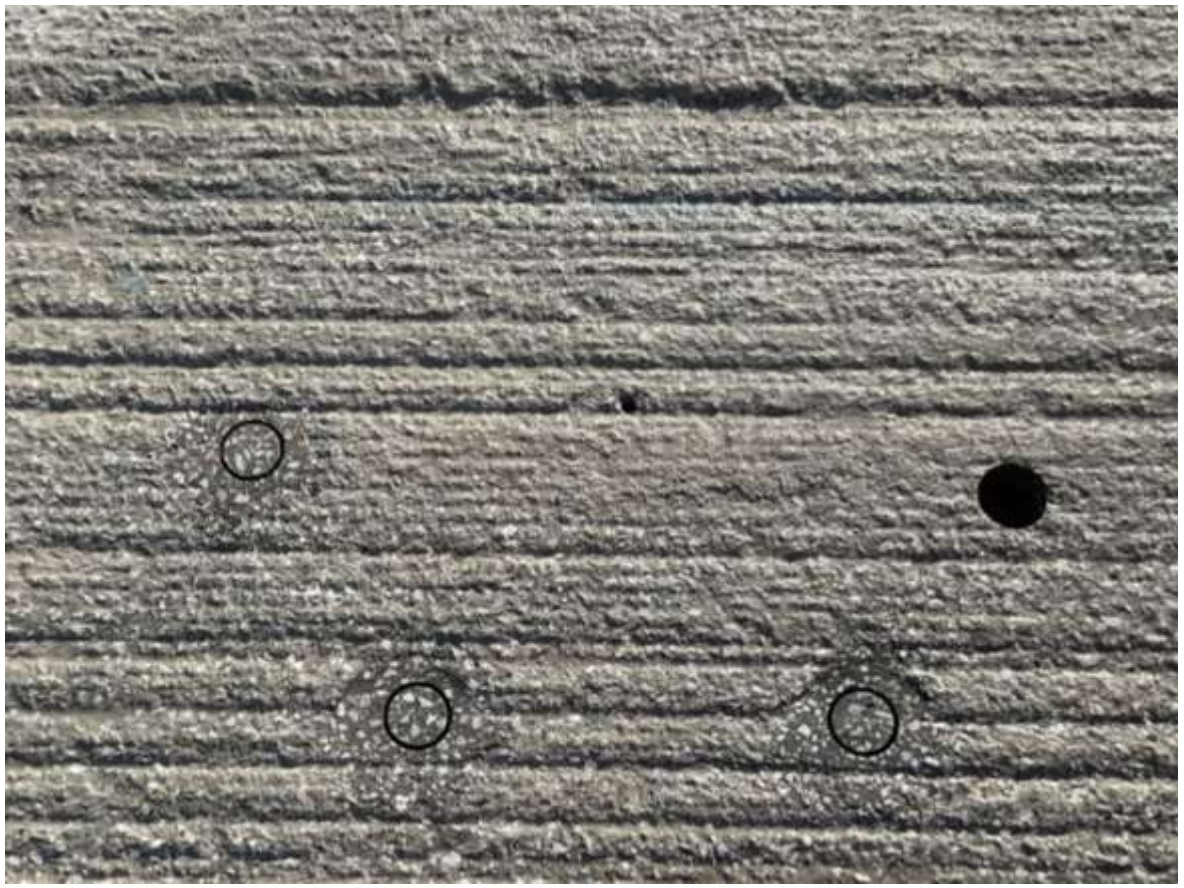


Results

Sample ID	Span	Pull-off Strength (psi)	Failure Location Notes	Average Overlay Thickness (in.)[1]
4	Span 1	410	Failed 70% in substrate, 30% at bond line	2 1/2
6	Span 2	320	Failed 50% in substrate, 50% at bond line	2 1/2
	Average	*365*	-	*2 1/2*

[1] Measured from overlay-substrate bond line to top surface of test sample which was ground by up to about 1/4 inch to attach puck for pull-off testing





PPC Overlay Installation





Other Relevant ICRI Resources and Training

Concrete Repair Bulletin (CRB)

https://www.icri.org/news-events/concrete-repair-bulletin/

SAFETY SOLUTIONS

"CAN YOU HEAR ME NOW?"

How to Preserve Hearing in the Concrete and Masonry Repair Environment

Concrete and masonry repair, restoration, and strengthening involve tasks that produce dust, vibration, debris, and noise. These tasks generally involve altering an existing structure or substrate so as to provide an improvement or enhancement of the functionality or aesthetics of the structure. Concrete and masonry are generally hard surfaces that require aggressive mechanical means for demolition, surface preparation, and replacement. These procedures, including chipping, blasting, cutting, grinding, sawing, and pumping, use equipment and tools that generate loud noises, which can cause hearing loss.

WHAT WE KNOW ABOUT HEARING LOSS

Hearing loss is one of the most pervasive problems in today's occupational environment, affecting workers across a broad spectrum, including manufacturing, construction, transportation, agriculture, and the military. Approximately 30 million American workers are exposed to hazardous noise levels. At present exposure limits, one in four will develop a permanent hearing loss as a result of their occupational exposure to these hazards. The gradual progression of hearing loss due to noise may be less dramatic than an injury resulting from a workplace accident, but it is a significant and permanent issue for the affected individual. Loss of hearing denies people sensory experiences that contribute to the quality of their lives. For some, loss of hearing may impede their ability to be gainfully employed. The good news is that occupational hearing loss *is* preventable.[1]

When an individual's 8-hour, time-weighted average (TWA) exposure to sound exceeds 90 decibels (dB), OSHA requires that feasible engineering and/or administrative controls be used. If such controls fail, personal protective equipment (PPE) should be provided and used to reduce sound exposure. However, OSHA Section 1910.95(c)(1)[2] goes on to say that "the employer should administer a continuing, effective hearing conservation program whenever the employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels…" While employers must provide engineering controls and/or PPE when sound levels exceed 90 dB, they must also administer a continuing, effective hearing conservation program when the sound exposure equals or exceeds 85 dB ("action level") in an 8-hour period.

EXPOSURE LEVELS

The loudness of sound is measured in dB. The sound intensity with an "A" contour filter is called dBA. The filter adjusts the measurement to account for the way in which the ear responds to different frequencies of sound.[3] But what does 85 or 90 dB really mean? The following table shows common sounds and their associated sound levels.[4]

This is the second in a series of papers developed by ICRI Committee 120, Environmental Health and Safety, to provide information that the industry can use to improve the awareness of common job-site hazards while providing guidance on regulatory requirements and recommendations for solutions. The initial white paper, "Silica in the Repair Environment: What You Need to Know about the Issues and Solutions," was published in the September/October 2009 *CRB*.

This paper focuses on hearing conservation. It describes how the ear works and how hearing can be damaged, with specific emphasis on tasks that are common to the repair industry; Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) regulations related to hearing; and recommended means of protecting the hearing of the workers, inspectors, and other parties.

ICRI Committee 120 is committed and dedicated to enhancing the safety and health of the worker while minimizing the impact on productivity, along with environmental considerations. We believe that a well-planned project, staffed with an informed workforce trained in the methods of occupational safety and health, will achieve a high level of productivity and quality.

SILICA IN THE REPAIR ENVIRONMENT: WHAT YOU NEED TO KNOW ABOUT THE ISSUES AND SOLUTIONS

BY THE ICRI ENVIRONMENTAL HEALTH AND SAFETY COMMITTEE:
SCOTT GREENHAUS, CHAIR; STEVE BECHTEL; BETH NEWBOLD; BARB SAMPLE; PATRICK WINKLER;
AND CONSULTANTS DON CAPLE AND LEE SIZEMORE

Every year, millions of workers in the U.S. are exposed to crystalline silica. Occupational exposure to crystalline silica dust causes or contributes to the development of silicosis, a potentially disabling disease.

Silica is a natural constituent of the earth's crust and is a major component of sand and granite. Crystalline silica, or free silica, is a term for the chemical compound silicon dioxide (SiO_2) when it occurs as a crystalline structure. Crystalline silica occurs naturally in many different forms, but the three most common forms are quartz, which is the most abundant; cristobalite; and tridymite. Exposure results from quartz in the form of respirable dust produced by chipping, grinding, sandblasting, and mixing operations. Activities such as jack hammering, rock drilling, concrete mixing, concrete drilling, brick and concrete block or slab cutting, and shotcreting are also associated with potential exposure to crystalline silica dust.[1]

WHAT IS DUST?

Dust is the general name for minute solid particles with a diameter of less than 500 micrometers. Dust is generated from a wide range of activities, both industrially and domestically. Activities such as mining, construction, demolition, and agriculture are industries that are large contributors to general atmospheric dust levels. Dust is produced in a very wide range of sizes. Larger, heavier particles tend to settle out of the air and onto surfaces; smaller, lighter particles have a tendency to hang indefinitely in the air.

Dust exposure is contingent on the amount of dust emitted and the physical characteristics of the material, in addition to the methods of handling of the material. Dust exposure generally occurs from, but is not limited to, coming in contact with dust from one or more of the following tasks:

- Abrasive blasting involving harmful materials;
- Demolition of concrete and masonry structures;
- Breakage or crushing of ore; and
- Release of previously generated dust through the loading or dumping of materials.

WHAT ARE THE HAZARDS OF DUST?

In construction, demolition, and renovation situations, dust is created from a variety of sources. In addition to being a potential health problem for workers, dust emissions, in some sectors, also create another threat by increasing the probability of fires or explosions.

Health risks occur when workers are exposed to excessive amounts of harmful dust. The harmfulness





Data-Driven Approaches for Optimizing Concrete Bridge Deck Preservation

by Stephen Garrett, Marwa Abdelrahman, and Mohamed ElBatanouny



Fig. 1: Bridge Engineers performing in-depth assessment of a reinforced concrete bridge deck (photograph by WJE)

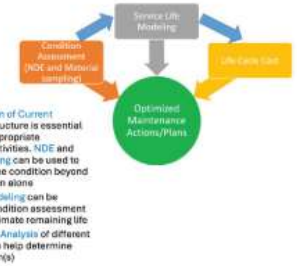


Fig. 2: Conceptual framework for use of condition assessment data, combined with service life and life cycle cost analyses to select optimized maintenance actions or plans

INTRODUCTION

Service disruptions associated with maintaining and upgrading aging infrastructure systems are costly to transportation agencies and burdensome to the public. Engineers and asset managers responsible for maintaining bridge performance are tasked with determining inspection needs and selecting strategies to provide optimal value to the end users of these critical systems. To this end, implementing data-driven inspections and condition assessment practices can increase the knowledge base for decision-making, reducing decision risks and life-cycle costs (Figure 1).

Recent trends in advanced assessment techniques have endeavored to minimize traffic disruptions by performing inspections using rolling lane closures with rapid assessment tools. Certainly, there is value added by performing routine assessments without significant operational disturbances; however, a more accurate understanding of the structure's condition gained through hands-on, advanced assessment techniques can then inform service life modeling, which combined with engineering judgment can offer insight into alternative repair strategies and ultimately the optimal course of action for a given structure (Figure 2).

CURRENT STATE OF PRACTICE FOR REQUIRED INSPECTIONS

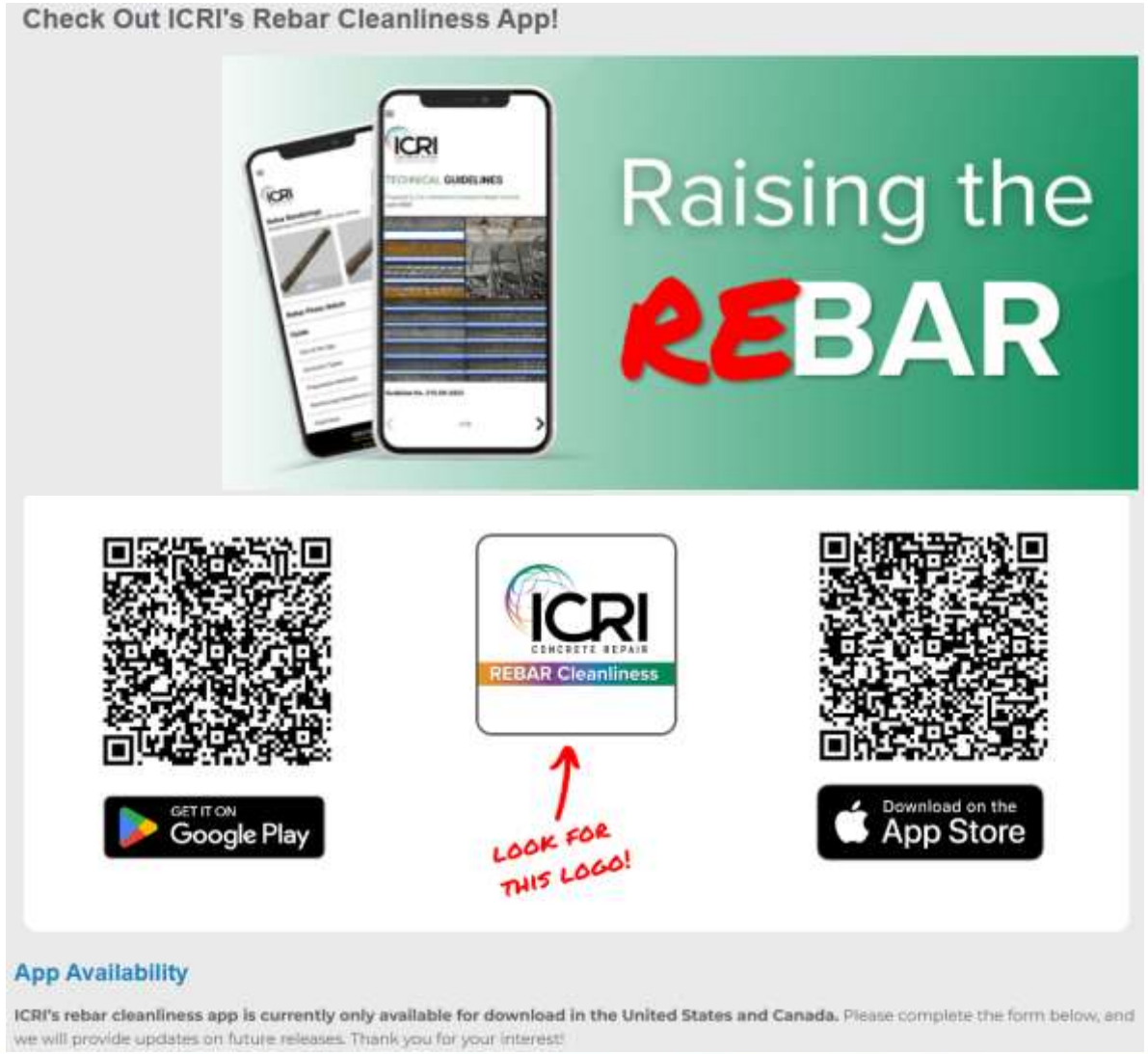
In the United States, highway bridge inspections have been standardized with the National Bridge Inspection Standards (NBIS) framework. The NBIS framework guides inspectors and agencies in performing and interpreting bridge conditions from a holistic and elemental level (Figure 3).

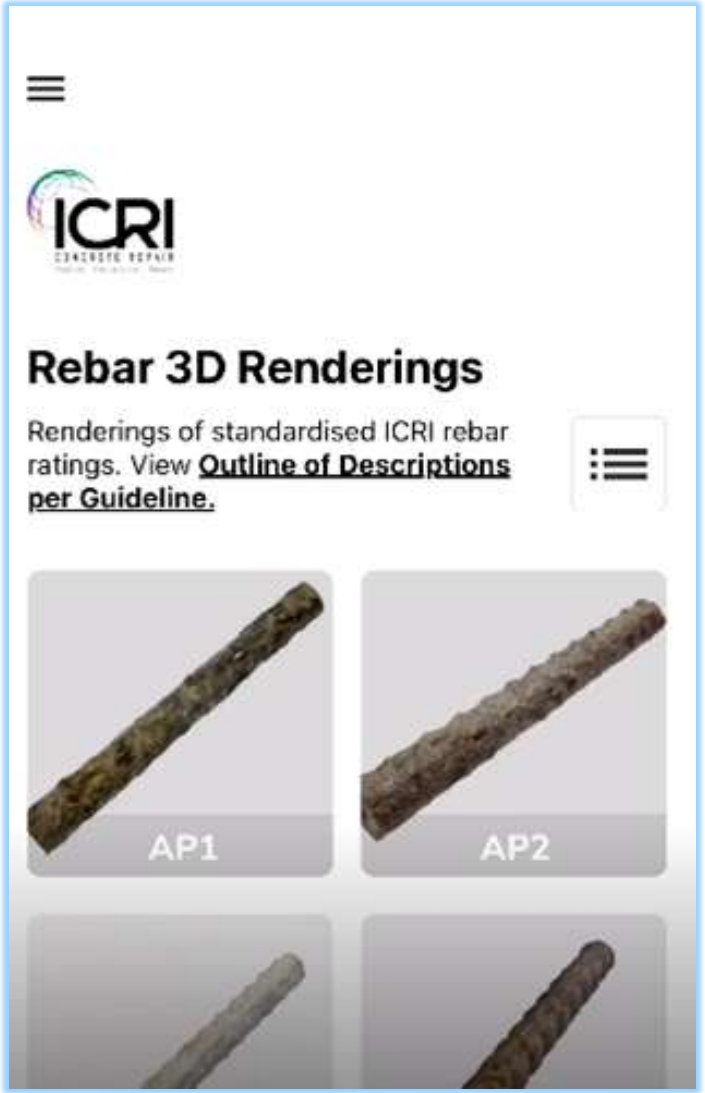
Through the routine NBIS inspection framework, bridge deck assessment techniques typically include visual assessments to identify cracking, delaminations, spalls, and other deterioration mechanisms. Quantification of these conditions factors into the overall condition rating for a structure. Inspections also provide a normalized basis for asset-level decision-making. The Federal Highway Administration (FHWA) states that the NBIS inspection data *"is necessary for bridge owners to make informed investment decisions as part of an asset management program."*[5] The inspection results include both the general condition ratings of the component and the element-level inspection data.

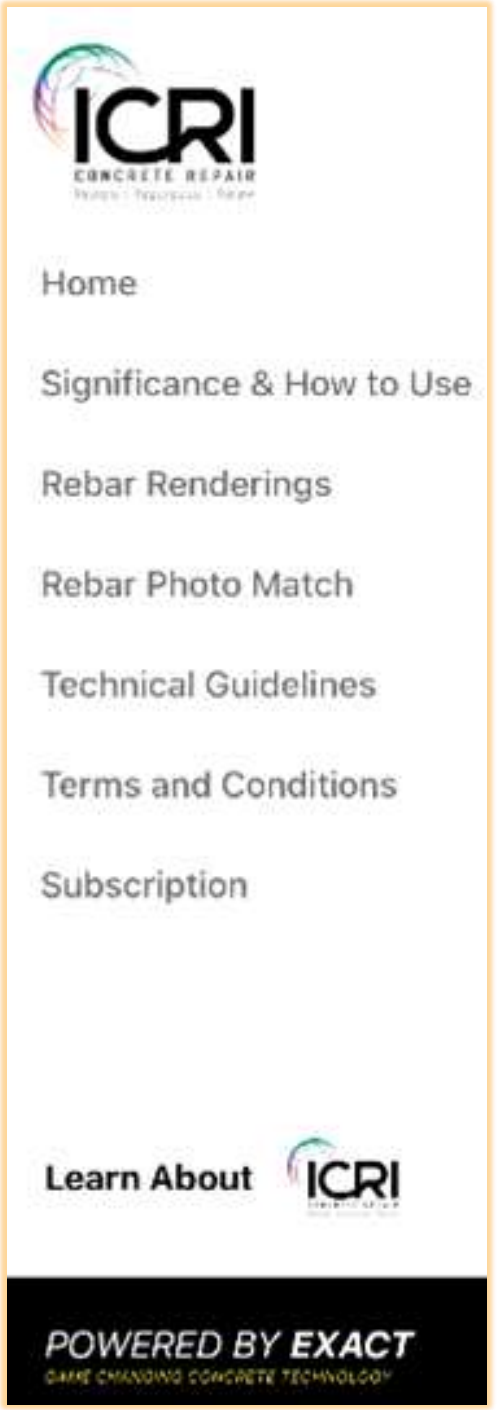


Fig. 3: Bridge Inspection Engineer performing routine inspection of a bridge deck

Rebar Cleanliness App







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Direct Tensile Pull-off Testing

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R³ CONCRETE GUIDE

COMMITTEE 210—EVALUATION

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R3.1.210-2025: DIRECT-TENSILE PULL-OFF TESTING

WHAT IS DIRECT-TENSILE PULL-OFF TESTING?

Direct-tensile pull-off testing is frequently used to evaluate substrate conditions, substrate preparation, and bond strength of repair materials. It is used in mock-up trials, evaluations, and quality control testing. It is critical to understand that the test only measures the "weakest link" in the tested system, and as such, careful performance, documentation, and evaluation of the testing is required. The test method is described in detail in ASTM C1583 and ICRI Guideline 210.3R-2022 (see references section). This Technical Field Guide provides an overview and guidance for performing the test.



Figure 1: Coring using a rigidly-mounted core drill



Figure 2: Hand-held core drill unsuitable for use in direct-tensile pull-off testing.

HOW TO PERFORM DIRECT-TENSILE PULL-OFF TESTING

- Select test locations; avoid testing over reinforcement.
- Verify calibration of the testing device.
- Select steel disc/core diameter (typically 2").
- Mount the core drill solidly; do not use a hand-held core drill (Figures 1 & 2).
- Drill at least 1/2 in. (13 mm) into the substrate using a core barrel with an inside diameter equal to or slightly greater than the steel disc.
- Clean the surface of the concrete to remove coring residue and dry the surface.
- Attach the steel disc to the concrete surface with epoxy adhesive and allow it to cure; ensure that disc is centered on the core (Figure 3).
- Position the loading apparatus so the tensile load is parallel to the core axis, and couple to the steel disc.
- Apply a tensile load to the test specimen in a smooth, continuous rate of 5.0 + 2.0 psi/sec (35+ 15kPa/sec) without interruption (Figure 4).
- Record the ultimate tensile load and the failure mode (Figures 5 and 6).
- Remove any remnant materials from the core hole and document the features of the core hole.
- Photograph the retrieved pieces and the failure surfaces.
- Calculate the bond pull-off or tensile strength (Tensile load ÷ test specimen area) in psi or MPa.
- Provide a test report and evaluate per the Project Specifications and applicable Test Standards.

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COMMENTARY

While not part of the test procedure or standard, reported operating experience provides the following:

- Overhead and vertical testing requires special expertise and equipment to avoid alignment errors and undesirable prying forces on the test (Figure 1).
- Commercial two-part epoxy adhesives typically require overnight curing. Methacrylate or polyisocyanurates may require shorter curing times.
- Adhering the disc on very rough surfaces may require particular care and the use of temporary sleeves or masking for containing the adhesive and maintaining disc alignment.

REFERENCES

- ICRI Guideline 210.3R-2022 - Guide for Using In-Situ Tensile Pull-Off Tests to Evaluate Concrete Surface Repairs and Bonded Overlays
- ASTM C1583 - Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

This Technical guide is intended to provide general support and guidance regarding the subject matter. It is not intended to cover every situation or to replace the judgment of any involved parties. See the Contract Documents and the References for additional information. It is intended for the use of individuals who are competent to evaluate the significance and limitation of its content and recommendations.

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"*" indicates required fields

Help us build the next R³ Concrete Guide! We are looking for topics to develop a library of essential, one-page field manuals, based on existing **ICRI Technical Guidelines**. Select the relevant technical committee and tell us which procedure or task would be most helpful to have as a streamlined, one-page reference.

Questions? Please contact Matthew Carter at **matthewc@icri.org**.

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– COMMITTEE 210—EVALUATION

R3.1.210-2025: DIRECT-TENSILE PULL-OFF TESTING

– COMMITTEE 310—SURFACE PREPARATION

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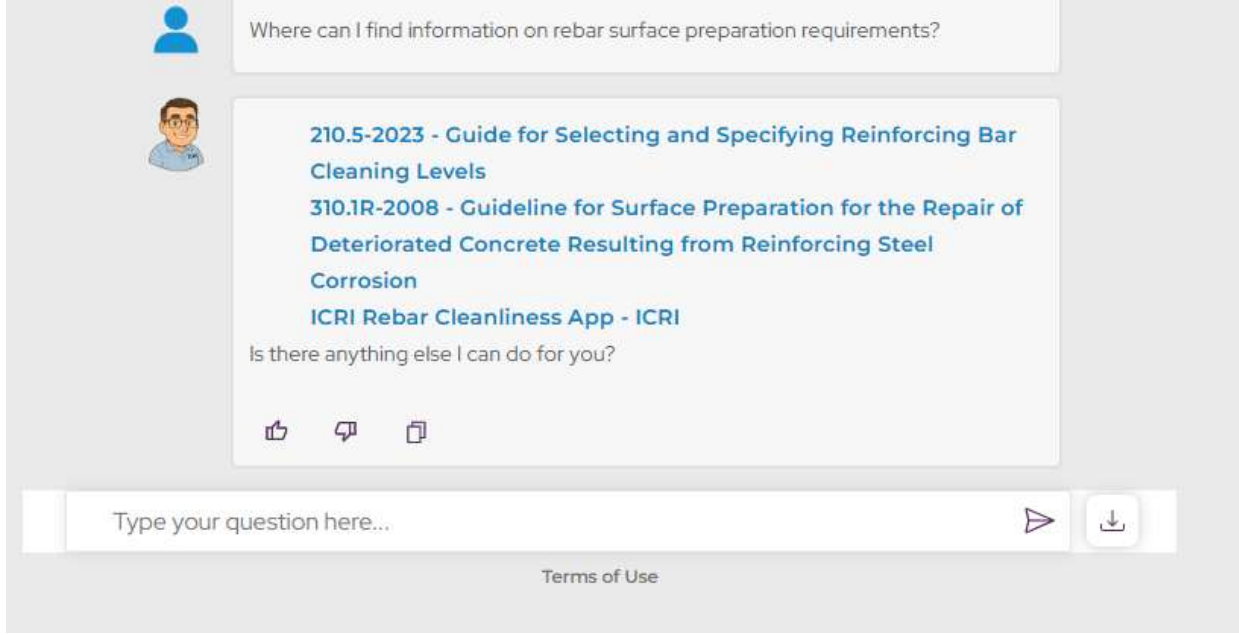

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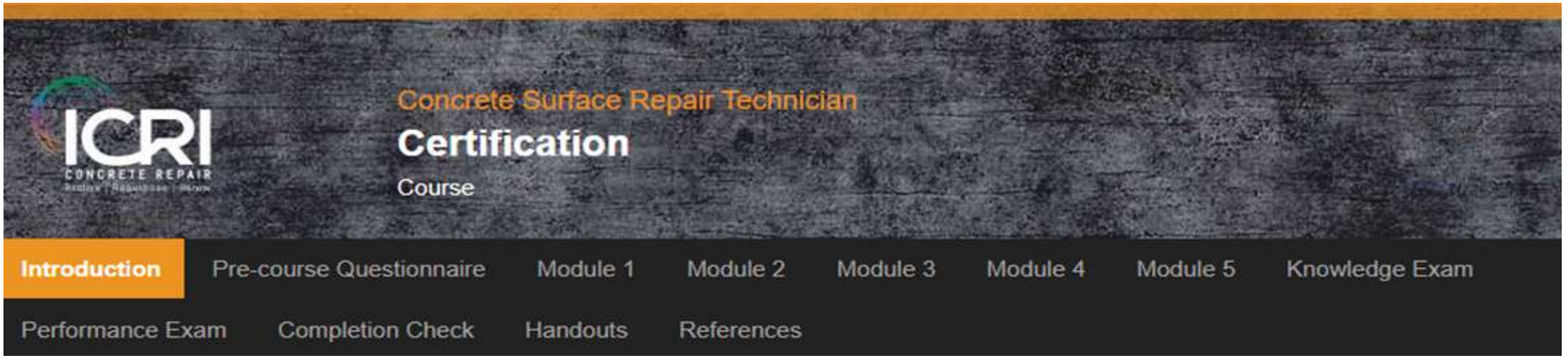
Concrete Surface Repair Technician (CSRT) Course



Module 1

- Concrete 101
- Concrete Deterioration
- Corrosion Process

Module 2

- Evaluating Structural Concrete
- Removing Deteriorated Concrete
- Surface Preparation
- Cleaning/Replacing Reinforcement
- Repair Geometry

Module 3

- Repair Methods and Materials
- Mixing
- Placement Methods
- Influence of Ambient Conditions
- Curing

Module 4

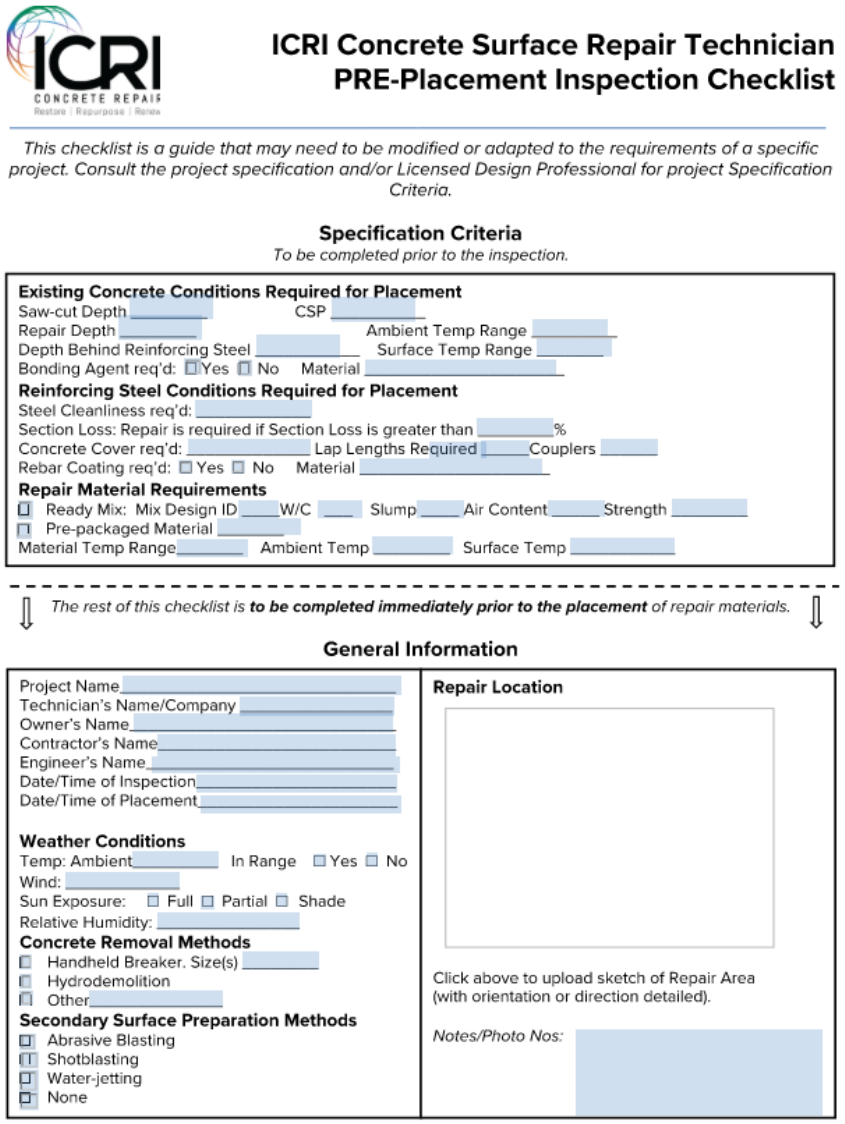
Pre-Placement Inspection

- Existing Substrate Conditions
- Surface Preparation
- Testing

Module 5

Post-Placement Inspection

Check-lists



ICRI Concrete Surface Repair Technician
PRE-Placement Inspection Checklist

This checklist is a guide that may need to be modified or adapted to the requirements of a specific project. Consult the project specification and/or Licensed Design Professional for project Specification Criteria.

Specification Criteria

To be completed prior to the inspection.

Existing Concrete Conditions Required for Placement
Saw-cut Depth _____ CSP _____
Repair Depth _____ Ambient Temp Range _____
Depth Behind Reinforcing Steel _____ Surface Temp Range _____
Bonding Agent req'd: ☐ Yes ☐ No Material _____

Reinforcing Steel Conditions Required for Placement
Steel Cleanliness req'd: _____
Section Loss: Repair is required if Section Loss is greater than _____%
Concrete Cover req'd: _____ Lap Lengths Required _____ Couplers _____
Rebar Coating req'd: ☐ Yes ☐ No Material _____

Repair Material Requirements
☐ Ready Mix: Mix Design ID _____ W/C _____ Slump _____ Air Content _____ Strength _____
☐ Pre-packaged Material _____
Material Temp Range _____ Ambient Temp _____ Surface Temp _____

*The rest of this checklist is **to be completed immediately prior to the placement** of repair materials.*

General Information

Project Name _____
Technician's Name/Company _____
Owner's Name _____
Contractor's Name _____
Engineer's Name _____
Date/Time of Inspection _____
Date/Time of Placement _____

Weather Conditions
Temp: Ambient _____ In Range ☐ Yes ☐ No
Wind: _____
Sun Exposure: ☐ Full ☐ Partial ☐ Shade
Relative Humidity: _____

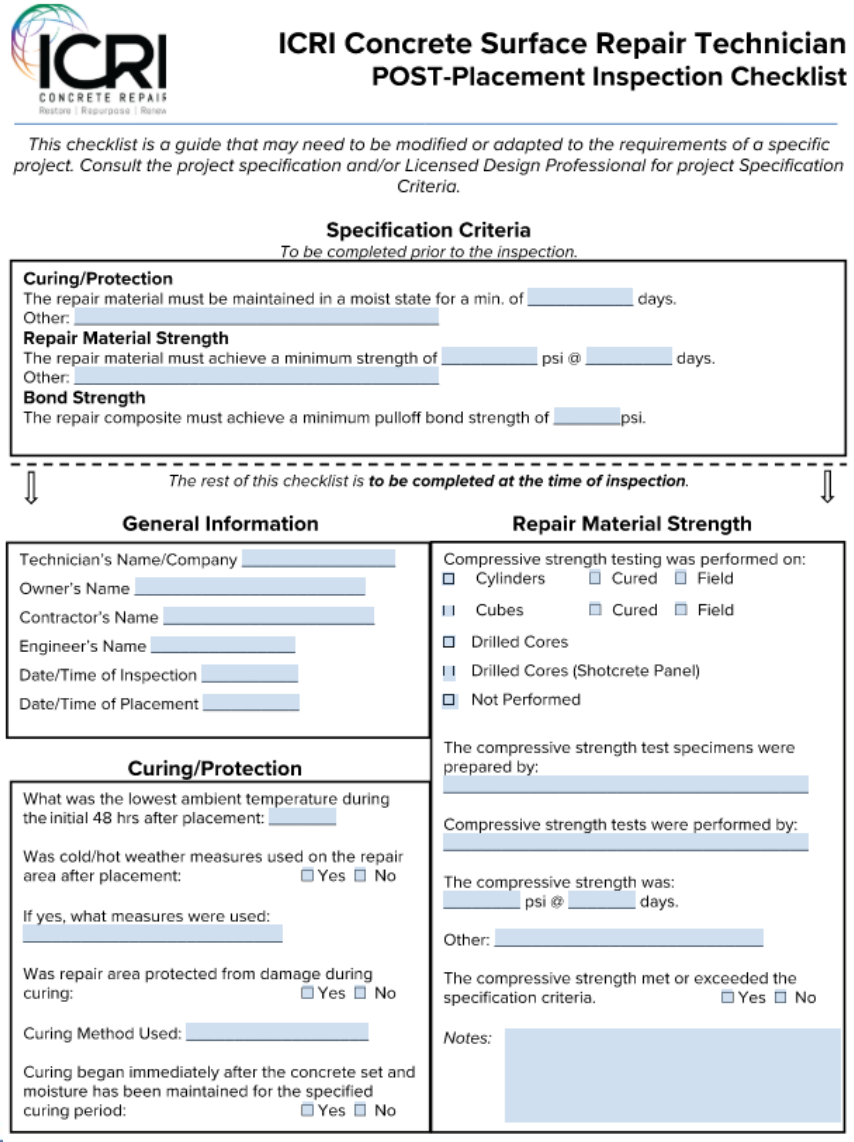
Concrete Removal Methods
☐ Handheld Breaker. Size(s) _____
☐ Hydrodemolition
☐ Other _____

Secondary Surface Preparation Methods
☐ Abrasive Blasting
☐ Shotblasting
☐ Water-jetting
☐ None

Repair Location

Click above to upload sketch of Repair Area (with orientation or direction detailed).

Notes/Photo Nos:



ICRI Concrete Surface Repair Technician
POST-Placement Inspection Checklist

This checklist is a guide that may need to be modified or adapted to the requirements of a specific project. Consult the project specification and/or Licensed Design Professional for project Specification Criteria.

Specification Criteria

To be completed prior to the inspection.

Curing/Protection
The repair material must be maintained in a moist state for a min. of _____ days.
Other: _____

Repair Material Strength
The repair material must achieve a minimum strength of _____ psi @ _____ days.
Other: _____

Bond Strength
The repair composite must achieve a minimum pulloff bond strength of _____psi.

*The rest of this checklist is **to be completed at the time of inspection**.*

General Information

Technician's Name/Company _____
Owner's Name _____
Contractor's Name _____
Engineer's Name _____
Date/Time of Inspection _____
Date/Time of Placement _____

Curing/Protection

What was the lowest ambient temperature during the initial 48 hrs after placement: _____

Was cold/hot weather measures used on the repair area after placement: ☐ Yes ☐ No

If yes, what measures were used: _____

Was repair area protected from damage during curing: ☐ Yes ☐ No

Curing Method Used: _____

Curing began immediately after the concrete set and moisture has been maintained for the specified curing period: ☐ Yes ☐ No

Repair Material Strength

Compressive strength testing was performed on:
☐ Cylinders ☐ Cured ☐ Field
☐ Cubes ☐ Cured ☐ Field
☐ Drilled Cores
☐ Drilled Cores (Shotcrete Panel)
☐ Not Performed

The compressive strength test specimens were prepared by: _____

Compressive strength tests were performed by: _____

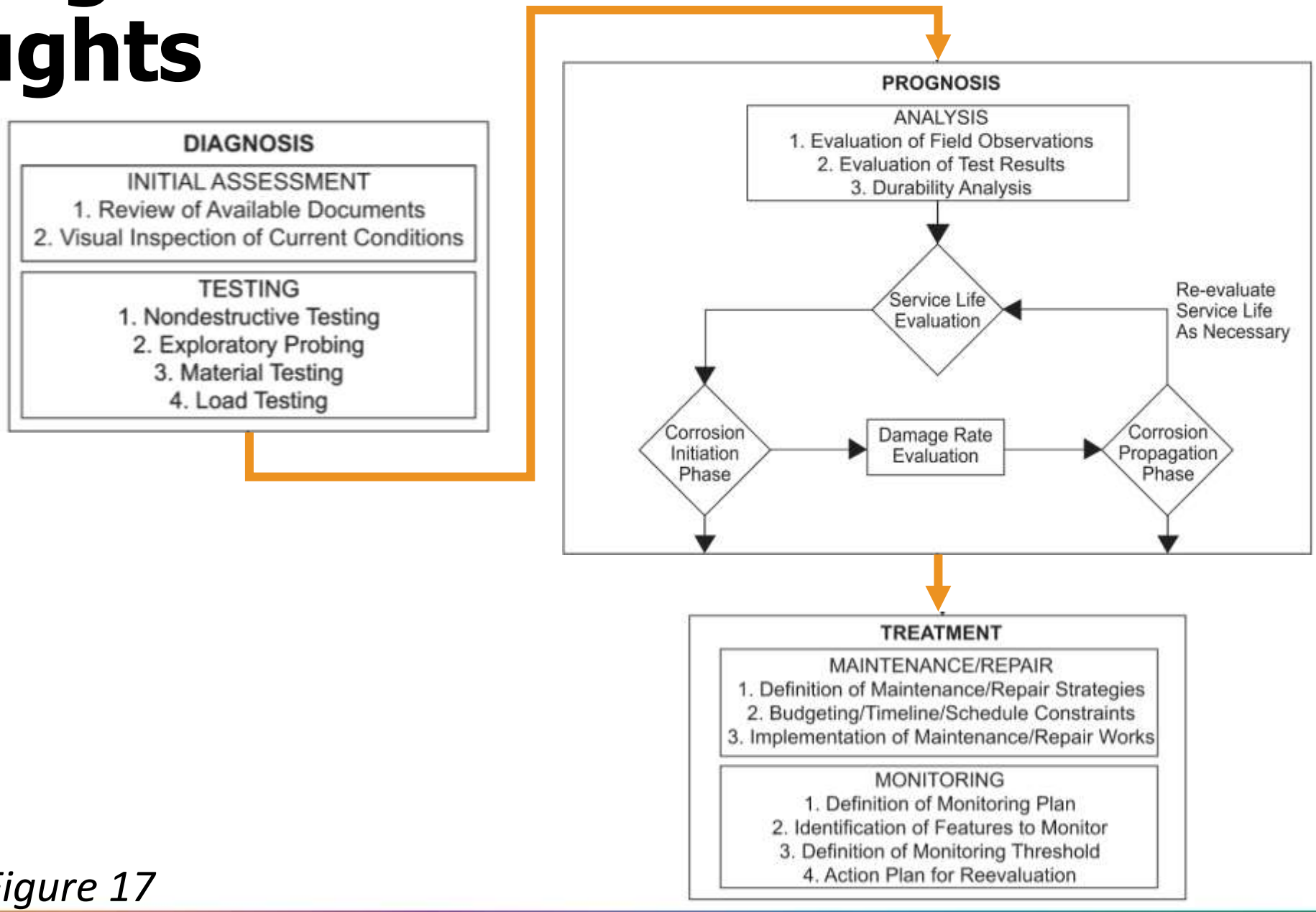
The compressive strength was: _____ psi @ _____ days.

Other: _____

The compressive strength met or exceeded the specification criteria. ☐ Yes ☐ No

Notes:

Closing Thoughts



ICRI 160.1 – Figure 17

Acknowledgments and References

- The following agencies supported the projects and research discussed in this presentation
  - Federal Highway Administration
  - Illinois Department of Transportation
  - Iowa Department of Transportation
  - Indiana Toll Road Concession Company (ITRCC)
  - Louisianna DOTD

Referenced Documents

- *FHWA-HRT-25-029 – Linking NDE Data and Bridge Deck Performance*
- *IOWA DOT TR-775 – Late Life Low Cost Deck Overlays*
- *ICRI Guide Documents*

Questions?

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