Framework for Concrete Bridge Deck Management Practices in Utah

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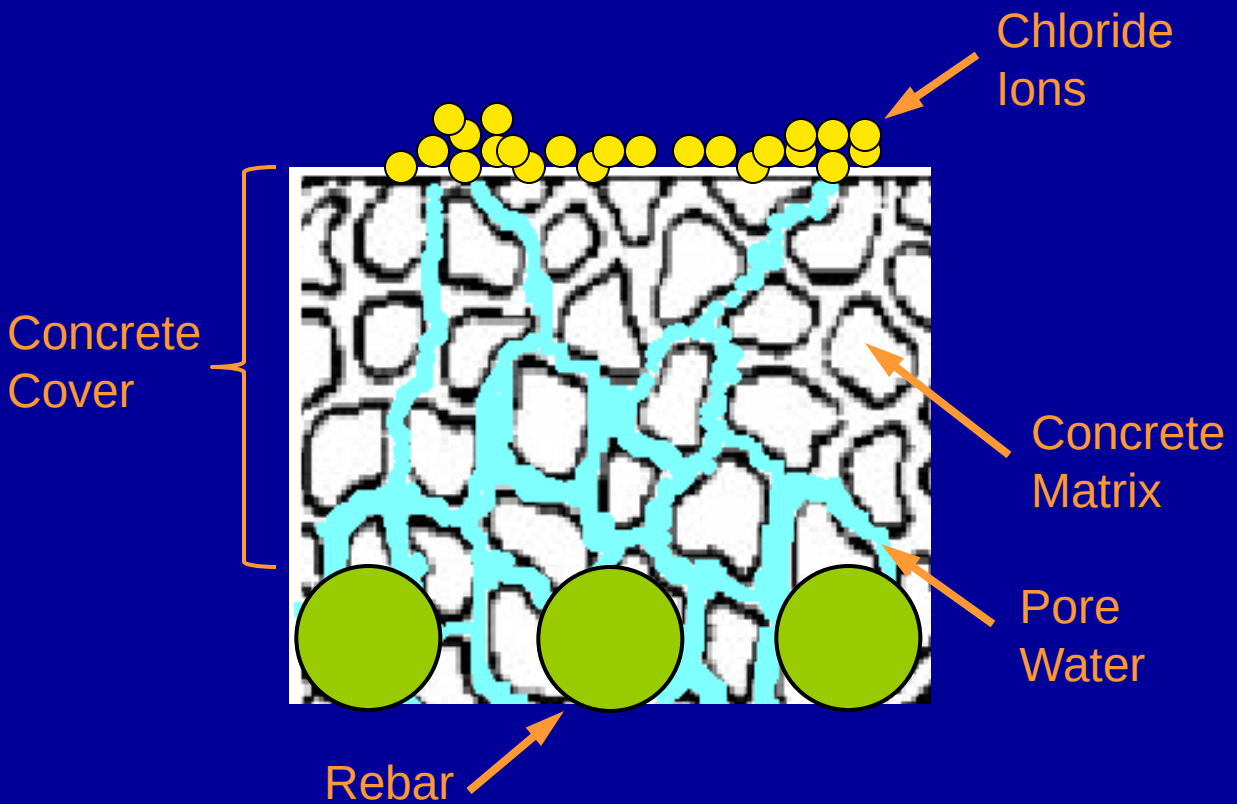
ROAD ICY
AHEAD
Western
PERFORMANCE GUARANTEED


15
NORTH
Salt Lake
EXITS 305 A-D
201
WEST
West Valley
2100 So.
1300 So.
900 So.
EXIT ONLY
FINE IMPOSED FOR KOV/TOLL VIOLATION
MACK

Chloride Diffusion



Corrosion threshold for black bar = 2.0 lb Cl^-/yd^3 of concrete

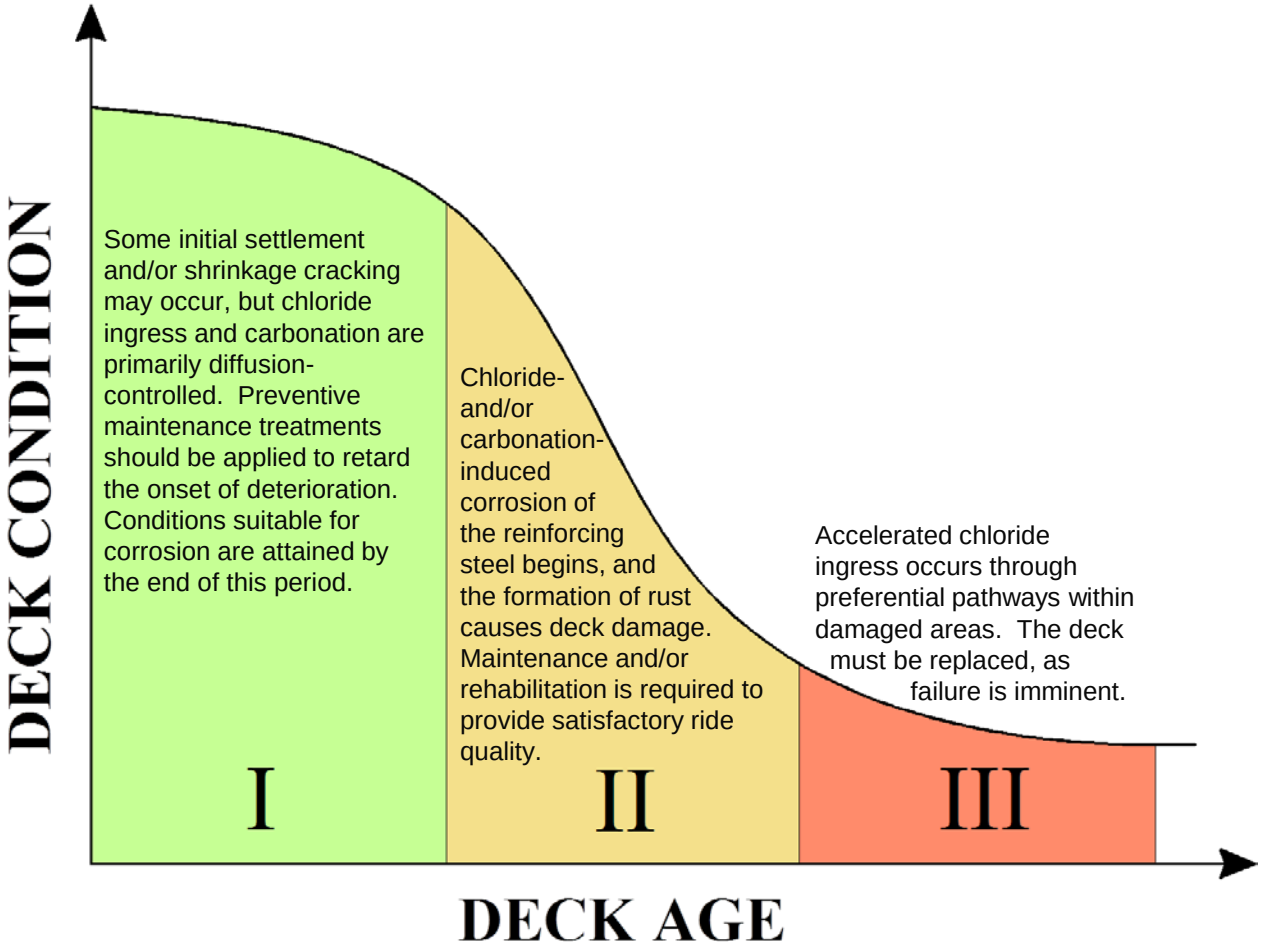
Stay-in-Place Metal Forms (SIPMFs)

Typical Chloride Concentration Profiles for Utah Bridge Decks

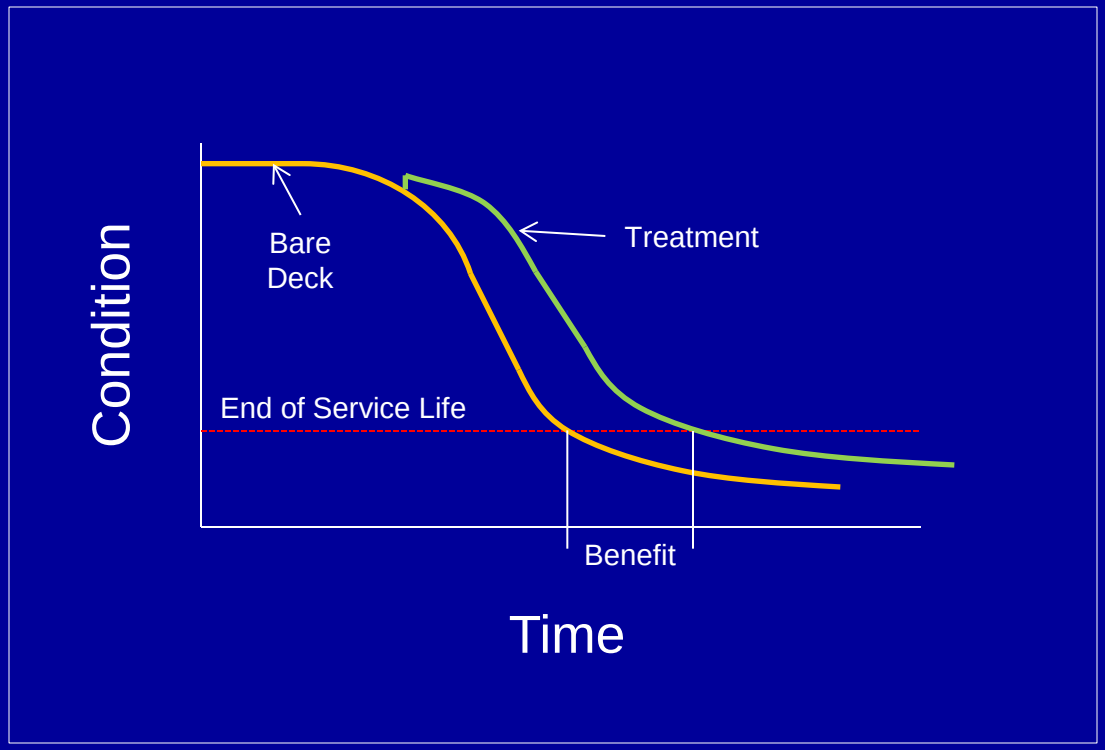
Depth (in.)	Chloride Concentration (lbs Cl^-/yd^3 Concrete)	
	With SIPMFs	Without SIPMFs
1	21.9	16.6
2	13.2	7.0
3	6.9	2.4
4	3.0	1.1
5	1.1	0.2
6	0.4	0.1
7	0.2	0.1
8	0.1	-

Corrosion threshold for black bar = 2.0 lb Cl^-/yd^3 of concrete

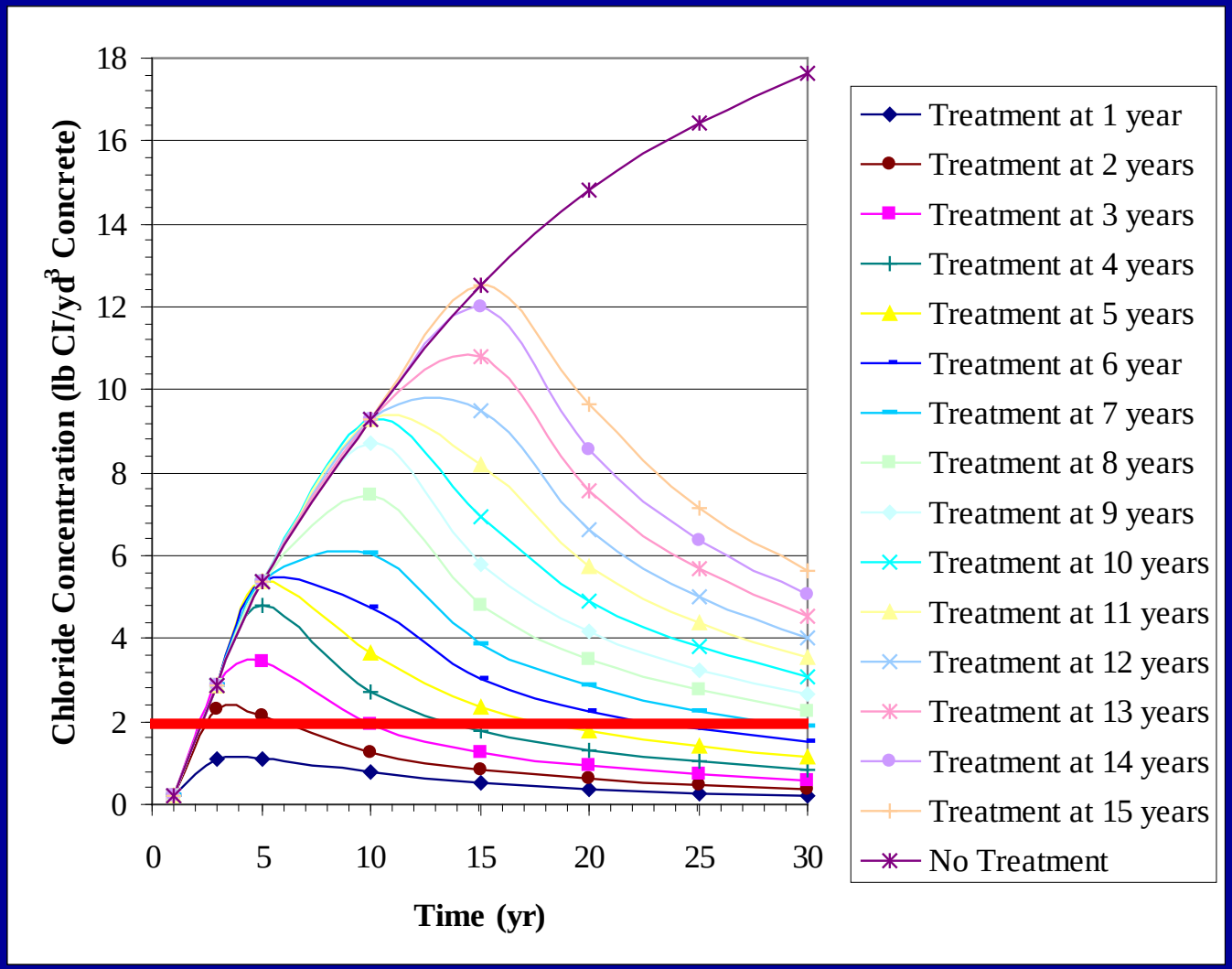
Bridge Deck Deterioration



Preservation Strategy



Effect of Surface Treatment Timing



Chloride concentrations through time at a depth of 2 in. on a deck with SIPMFs for different surface treatment timings

(Compilation of 128 simulations)

Recommended Surface Treatment Timing for Utah Bridge Decks

Cover Depth (in.)	Deck Age for Surface Treatment Application (yr)	
	With SIPMFs	Without SIPMFs
2.0	1	5
2.5	3	9
3.0	5	15

Each additional 0.5 in. of cover beyond 2.0 in. allows an extra 2 years for decks with SIPMFs and 5 years for decks without SIPMFs before a surface treatment must be placed to prevent future accumulation of chlorides in concentrations above the threshold value

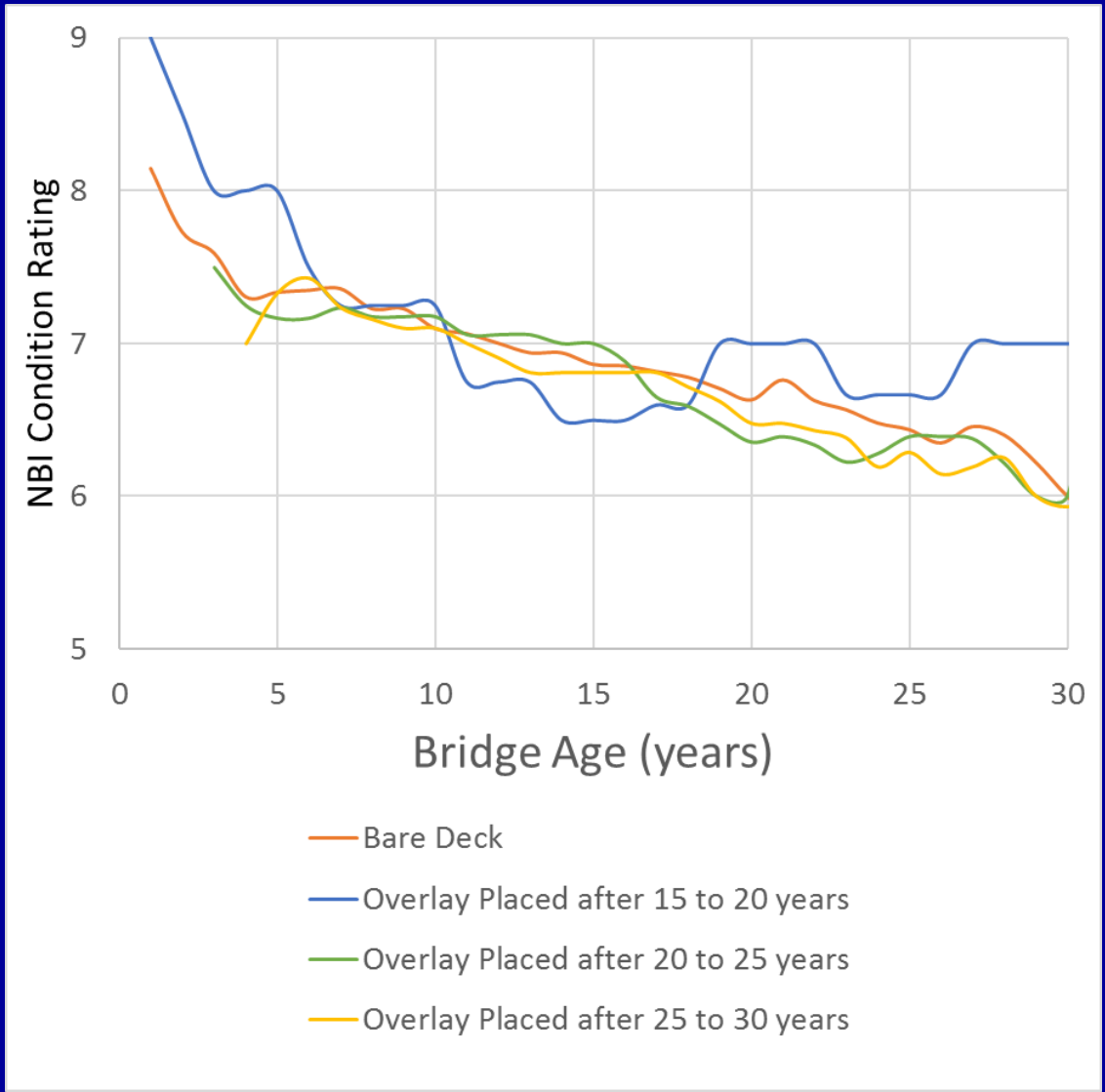
Example Surface Treatments

Bituminous Overlay

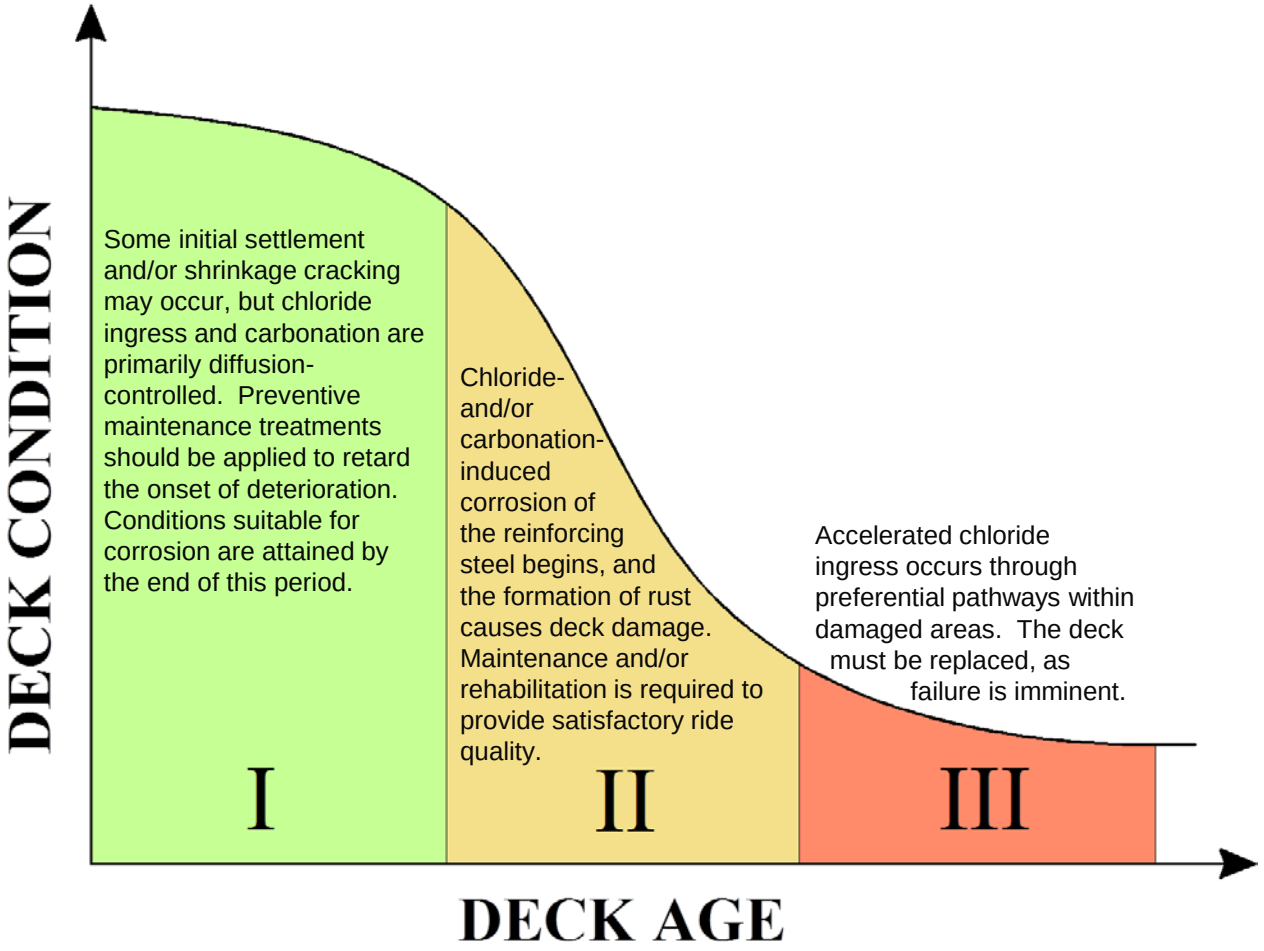
Epoxy Overlay

Polyester Overlay

Example Data for Bituminous Overlay Placement in Utah



Bridge Deck Deterioration

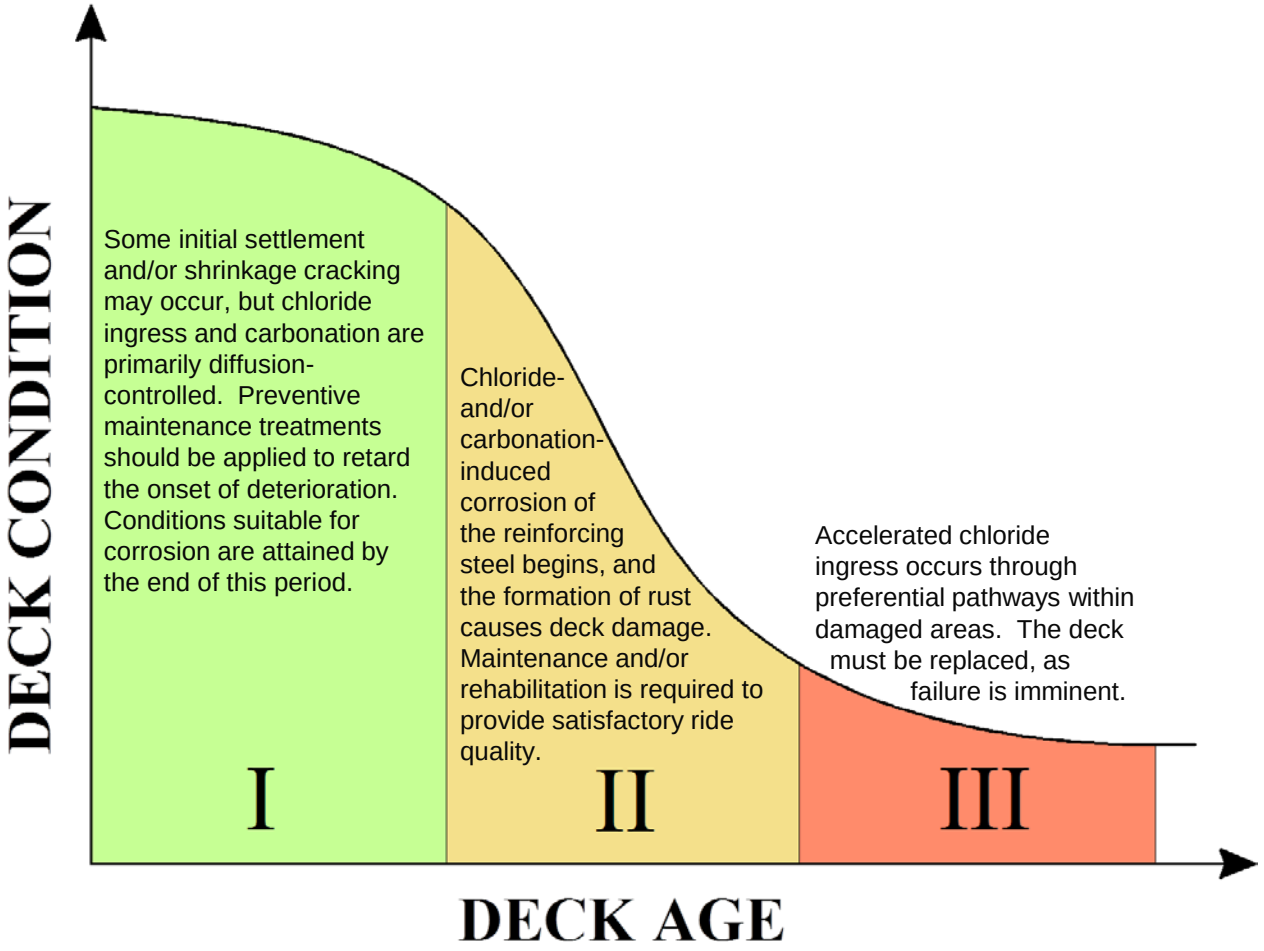



highway
later control
NEW HOLLAND

Recommended Scarification and Overlay Timing for Utah Bridge Decks

Decks with SIPMFs				
		Scarification Depth (in.)		
Original Cover Depth (in.)	Overlay Depth (in.)	0.5	1.0	1.5
		Recommended Deck Age for Treatment (yr)		
2.0	1.5	2	2	2
2.0	2.0	2	2	2
2.5	1.5	2	4	4
2.5	2.0	2	4	4
3.0	1.5	4	6	6
3.0	2.0	4	6	6
Decks without SIPMFs				
		Scarification Depth (in.)		
Original Cover Depth (in.)	Overlay Depth (in.)	0.5	1.0	1.5
		Recommended Deck Age for Treatment (yr)		
2.0	1.5	6	6	6
2.0	2.0	6	6	6
2.5	1.5	10	10	10
2.5	2.0	10	10	10
3.0	1.5	16	18	18
3.0	2.0	16	18	18

Bridge Deck Deterioration



Apply the right treatment to the right bridge at the right time


GRANITE

Tools for Assessment

Rebar Protection

- Concrete cover thickness
  - Cover meter
  - Ground-penetrating radar
- Quality of concrete cover
  - Vertical impedance
  - Resistivity
  - Chloride concentration
- Rebar coating integrity
  - Electrical continuity

Rebar Corrosion

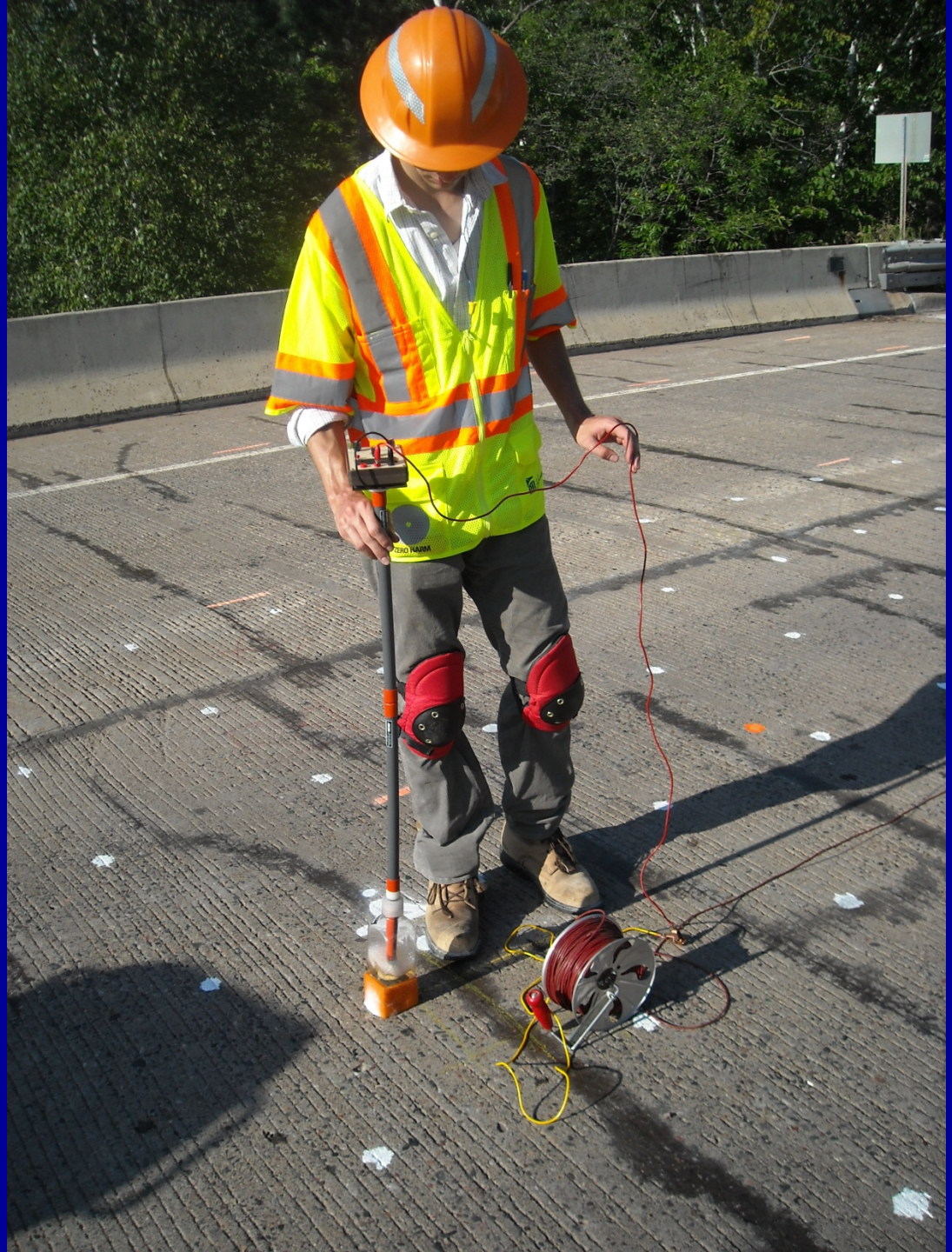
- Rebar corrosion activity
  - Half-cell potential
  - Visual inspection (rust staining)
- Rebar corrosion rate
  - Linear polarization

Deck Damage

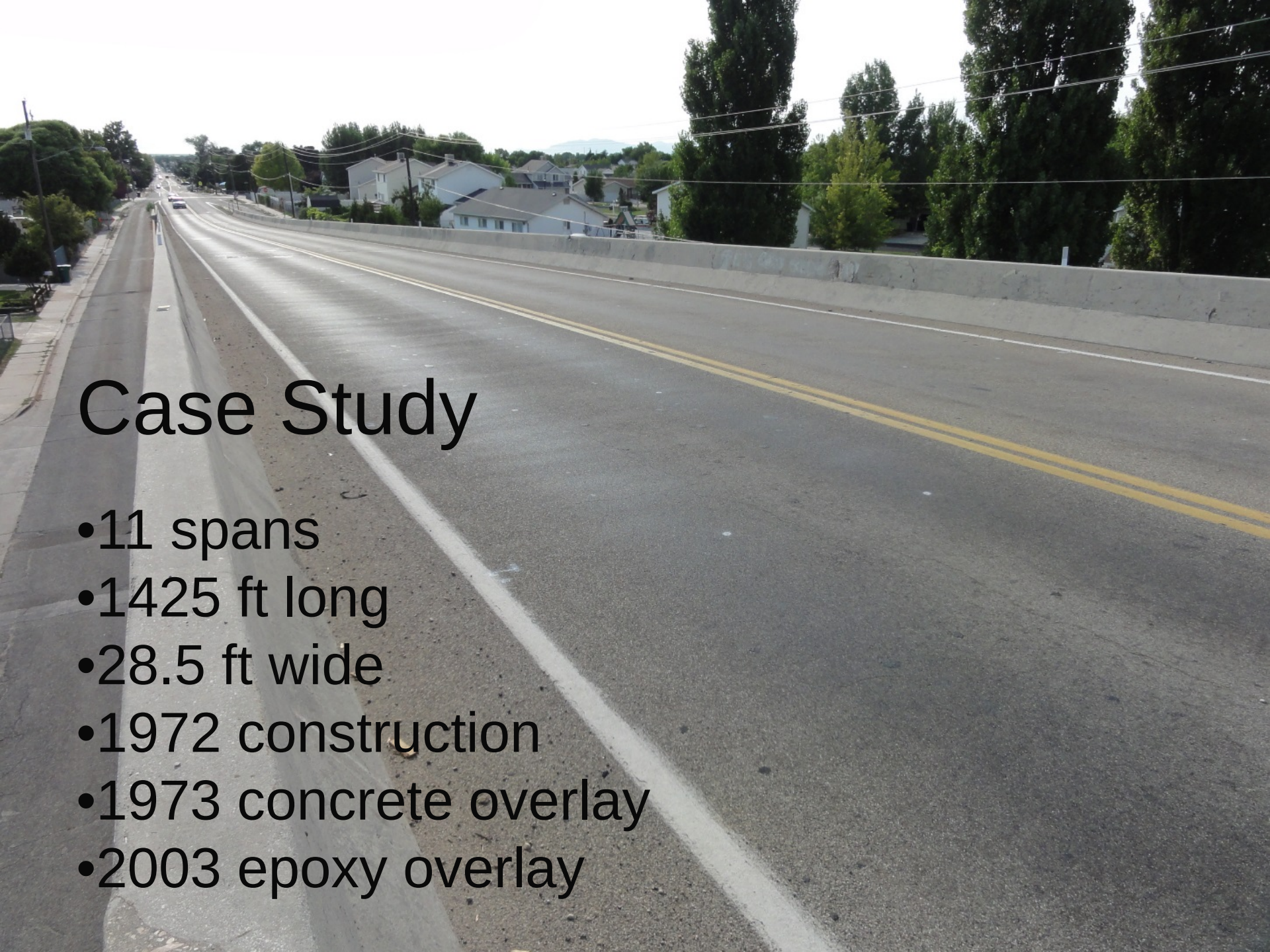
- Delamination presence
  - Impact-echo testing
  - Chaining
  - Hammer sounding
  - Infrared thermography
- Delamination depth
  - Coring
- Spalling (potholes)
  - Visual inspection


GMC
Ziploc


HONDA



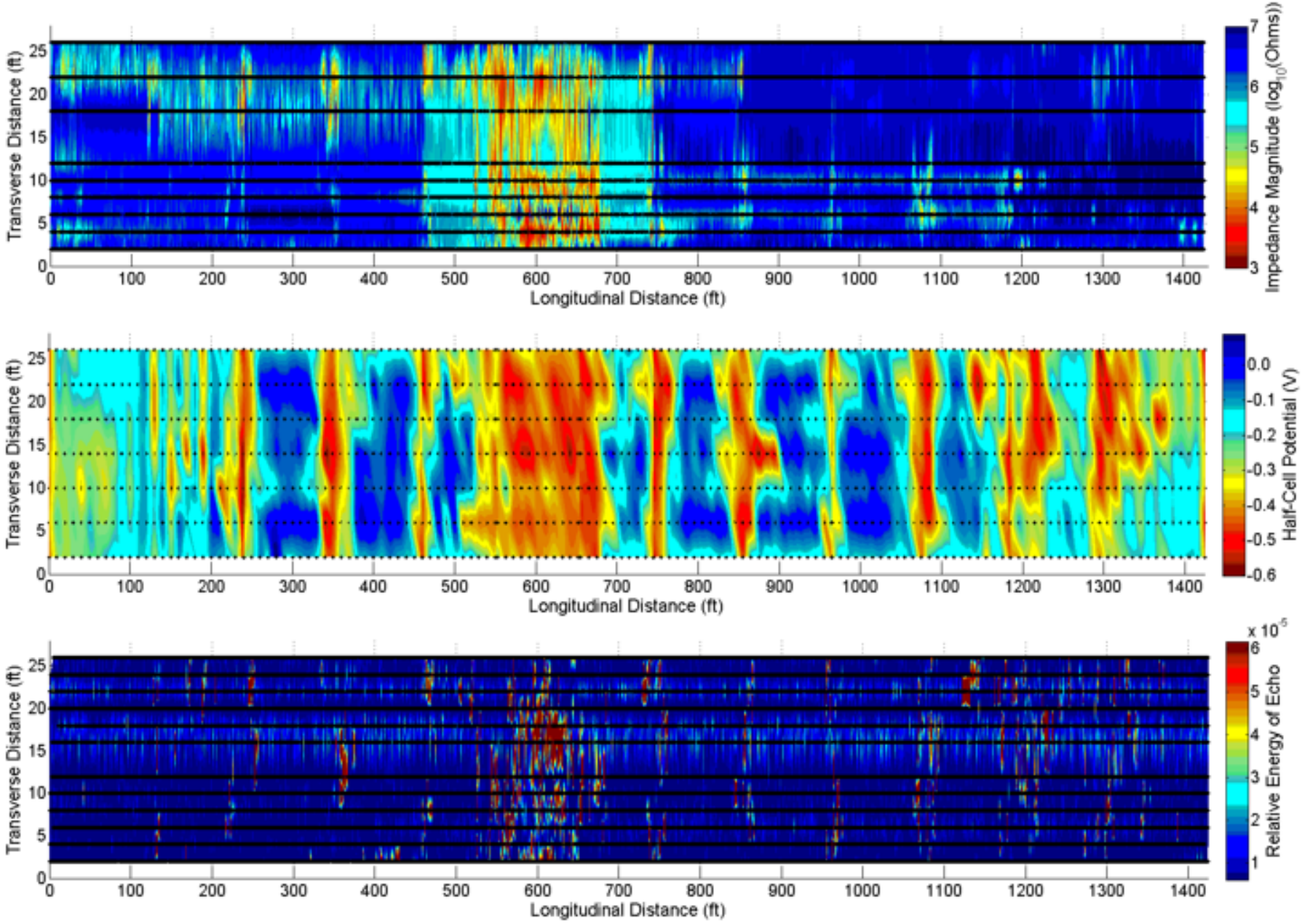

KOR-IT Inc.

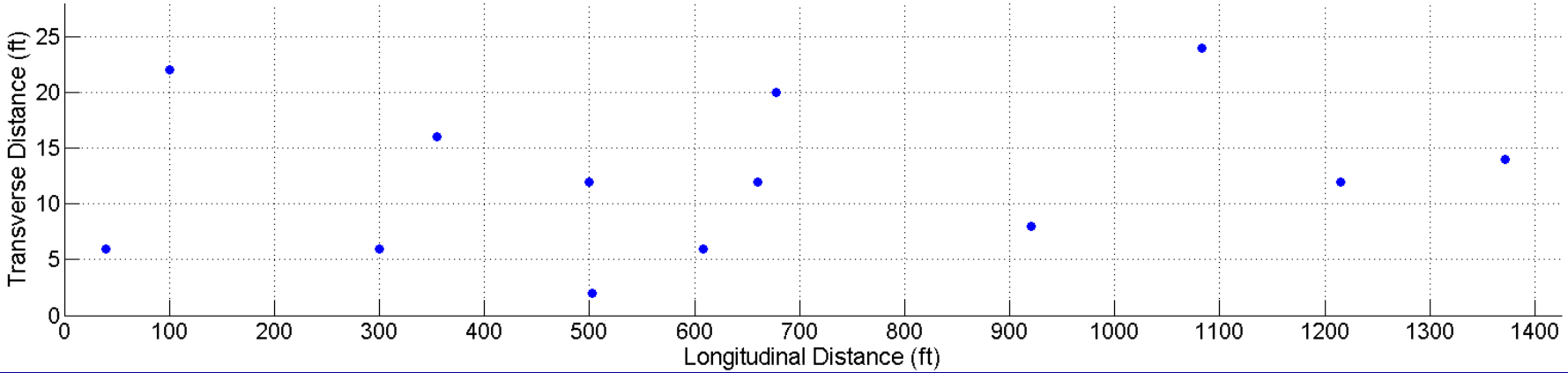


Case Study

- 11 spans
- 1425 ft long
- 28.5 ft wide
- 1972 construction
- 1973 concrete overlay
- 2003 epoxy overlay

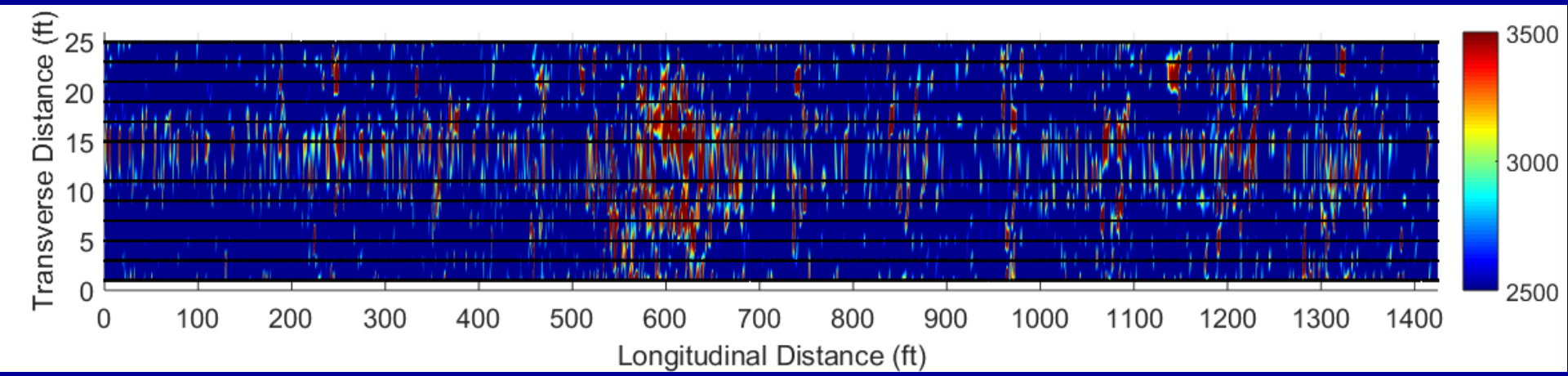

Marlboro

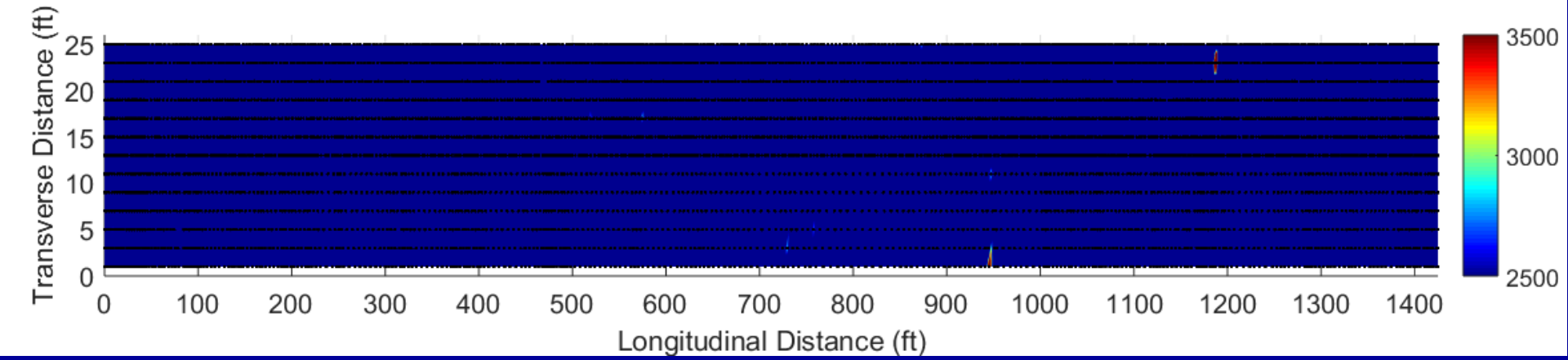

Transverse Distance (ft)
Longitudinal Distance (ft)
Impedance Magnitude (log10(Ohms))
Half-Cell Potential (V)
Relative Energy of Echo
x 10-5



Percentage of Deck Area (%) in Indicated Condition		Test Section	Cover Depth (in.)	Delamination Depth (in.)	Chloride Concentration (lb/yd^3)				Occurrence of Efflorescence at Bottom of Deck
					Top Surface Intact		Top Surface Delaminated		
Delaminated/ Patched	Actively Corroding				Top Mat	Bottom Mat	Top Mat	Bottom Mat	
0-10	0-10	A, J	3.1, 4.3	-	0.7	0.4	-	-	At End, along Side
	10-30	B, C, D, H, I, K, M	2.9, 3.2, 3.4, 3.4, 3.5	1.125, 1.5, 3.5	0.2, 0.4	0.2, 0.6	2.1, 2.3, 8.6	1.2, 7.0	At Both Ends
	>30	G, L	3.3, 3.4, 3.6	1.5, 4.25	0.3	3.2	3.0, 3.5	2.4, 2.8	At End
10-30	10-30	E	3.4, 3.6	1.125	0.2	0.2	0.6	0.3	Along Side
	>30	-	-	-	-	-	-	-	-
>30	>30	F	2.9	Asphalt Patch	-	-	3.1	3.5	At Both Ends, along Both Sides, in Middle

Overall Condition Index	Percentage of Deck Area (%)	Deck Area (ft^2)	Description
1	45.2	18371	Intact with inactive corrosion; conditions suitable for corrosion have probably not yet developed, and no delamination has occurred
2	26.8	10903	Intact with uncertain corrosion activity; conditions suitable for corrosion may or may not be developing, but no delamination has occurred
3	19.5	7925	Intact with active corrosion; conditions suitable for corrosion have probably developed, but no delamination has yet occurred
4	0.1	46	Delaminated with inactive corrosion; delamination probably does not extend beyond the polymer surface treatment or concrete overlay into the original deck surface
5	1.9	775	Delaminated with uncertain corrosion; delamination may or may not extend beyond the polymer surface treatment and concrete overlay into the original deck surface
6	6.4	2592	Delaminated with active corrosion; delamination probably extends beyond the polymer surface treatment and concrete overlay into the original deck surface


Transverse Distance (ft)
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
Longitudinal Distance (ft)
3500
3000
2500


Transverse Distance (ft)
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
Longitudinal Distance (ft)
3500
3000
2500

Summary

1. Bridge deck performance is affected by design, construction, and preservation actions
2. Understanding concrete bridge deck deterioration is critical for selecting appropriate condition assessment techniques
3. Condition assessment data can be used to guide decisions about preservation, rehabilitation, and reconstruction

Thank You

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