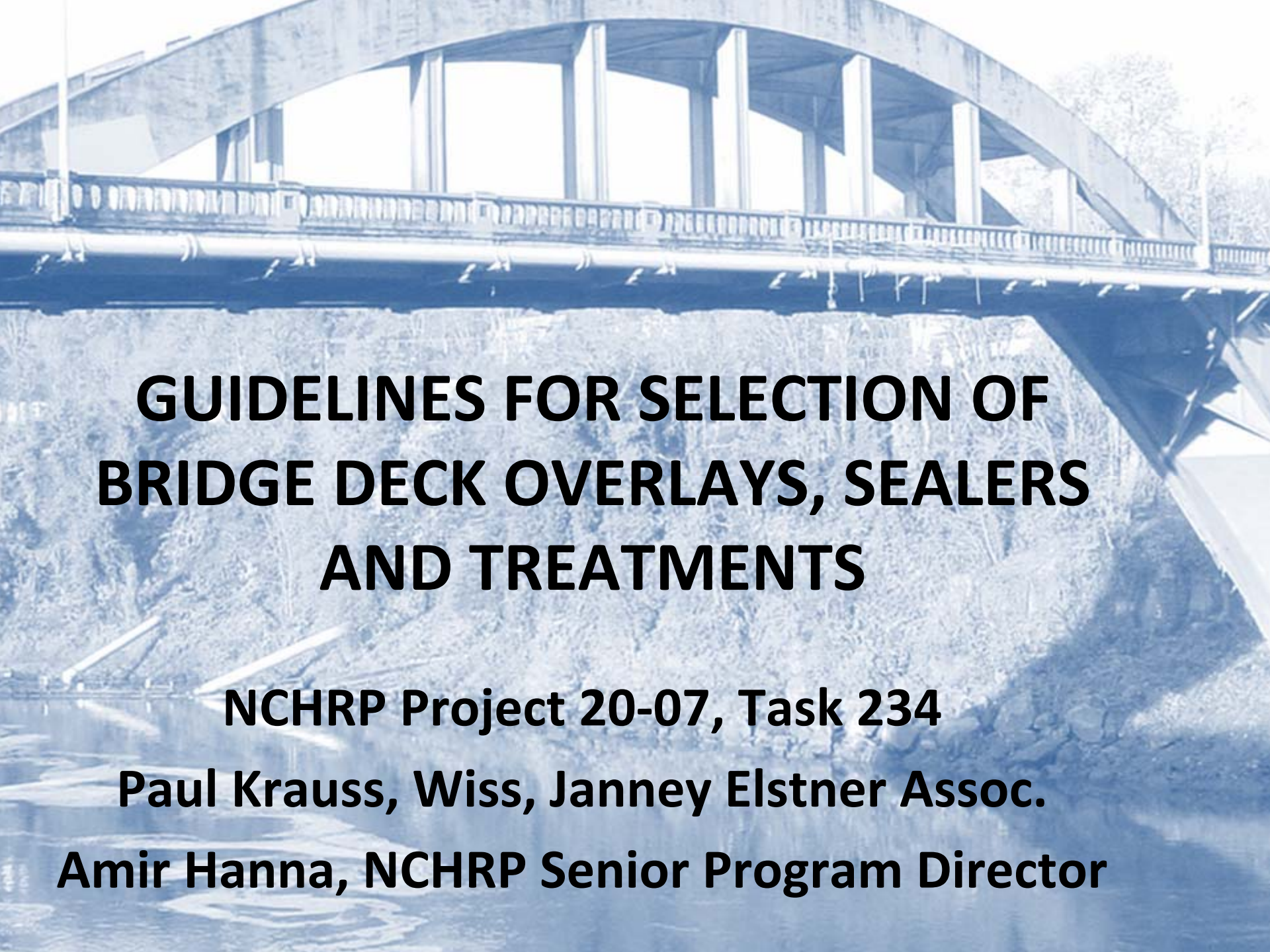

GUIDELINES FOR SELECTION OF BRIDGE DECK OVERLAYS, SEALERS AND TREATMENTS

NCHRP Project 20-07, Task 234

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Guidelines For Selection of Bridge Deck Overlays, Sealers and Treatments - Scope

- Agency Survey and Guidelines
- Review Literature

- Results:
- Deck Characterization
- Primary Repair Category Selection
- Selection of Repair Options

Agency Survey

- Extensive survey (46 agency responses)
- How are repair decisions made for decks?
  - 22 have procedures - only 10 written
- How do you characterize the deck condition?
- Experience on up to 5 different repair options

- Concrete, Steel and Timber decks

Repair Methods

- Portland cement concrete overlays
- Low slump concrete overlays
- High performance concrete overlays (rigid)
- Latex-modified concrete overlays
- Asphalt concrete overlays with a waterproofing membrane
- Miscellaneous asphalt overlays
- Polymer overlay (including thin-bonded and polymer concrete)
- Deck replacement (including partial deck replacement)
- Sealers
- Crack repair

Overlay Type/Use	New or Experimental	Current Common Practice	Historic Experience (Not Current Practice)	Never
Low slump, low water-cement ratio concrete overlays	4	12	14	11
Asphalt concrete overlay with a membrane	0	30	12	3
High performance concrete overlay	9	17	2	16
Fly-ash modified concrete overlays	7	7	6	24
Silica-fume modified concrete overlays	8	6	6	23
Polymer concrete overlays	12	16	7	9
Latex-modified concrete*	2	4	3	-

Sealer Type/Use	New or Experimental	Current Common Practice	Historic Experience (Not Current Practice)	Never
Silane sealers	4	15	9	12
Siloxane sealers	7	5	13	13
Epoxy sealers	11	13	5	13
Methacrylate sealers	10	11	9	10
Polyurethane sealers	8	4	8	18

Rehabilitation Method/Use	New or Experimental	Current Common Practice	Historic Experience (Not Current Practice)	Never
Epoxy Injection Crack Repair	4	22	8	9
Polyurethane crack repair	5	4	2	26
Methacrylate (HMWM) crack repair	7	15	9	10
Lithium salts	4	1	1	34
Cathodic protection	10	6	16	10
Corrosion inhibitors	14	6	8	14

Rehabilitation Method	Expected Service Life Range (years) [Mean]	Cost Range ($/sq. ft.) [Mean]	Overlay Thickness (in.) [Mean]	Estimated Installation Time	Current Use
Rigid Overlays					
High Performance Concrete Overlays	10 - 40 [16 - 29]	5 - 45 [17 - 25]	1 - 5 [1.6 - 3.5]	>3 days	Mixed
Low Slump Concrete Overlays	10 - 45 [16 - 32]	4 - 45 [13 - 19]	1.5 - 4 [2.0 - 3.1]	>3 days	Static
Latex Modified Concrete Overlays	10 - 50 [14 - 29]	1 - 150 [18 - 39]	1 - 5 [1.5 - 2.7]	<24 hrs (UHELMC)*, 1-3 days (LMC)**	Mixed
Asphalt-Based Overlays					
Asphalt Overlays with a Membrane	3 - 40 [12 - 19]	1.5 - 23.5 [3.1 - 7.6]	1.5 - 4 [2.4 - 3.1]	>3 days	Static
Miscellaneous Asphalt Overlays	5 - 20 [8 - 15]	1 - 3 [1 response]	0.38 - 2.5 [0.8 - 1.5]	1 - 3 days	Static

Rehabilitation Method	**Expected Service Life Range (years) [Mean]**	**Cost Range ($/sq. ft.) [Mean]**	**Overlay Thickness (in.) [Mean]**	**Estimated Installation Time**	**Current Use**
Other Rehabilitation Systems					
Polymer Overlays	1 - 35 [9 - 18]	3 - 60 [10 - 17]	0.13 - 6 [0.5 - 1.4]	<24 hrs	Increasing
Crack Repair	2 - 75 [19 - 33]	***	N/A	<24 hrs	Static
Sealers	1 - 20 [4 - 10]	0.33 - 15 [3 - 5]	N/A	<24 hrs	Increasing
Deck replacement	15 - 50 [27 - 32]	15 - 100 [43 - 53]	N/A	>3 days	Static

Steel Bridge Decks

Rehabilitation Method/Use	New	Current Common Practice	Historic Experience (Not Current Practice)	Never
Replacement of asphalt concrete overlay	0	10	4	12
Replacement of polymer concrete overlay	0	5	4	15
Coating with zinc-rich primer	0	6	2	18
Applying other coatings	0	1	1	19

Timber Bridge Decks

Rehabilitation Method/Use	New or Experimental	Current Common Practice	Historic Experience (Not Current Practice)	Never
Replacement the wearing surface with an asphalt concrete overlay	0	19	5	8
Replacement of the wearing surface with a polymer concrete overlay	3	0	1	26
Apply creosote wood preservatives	0	0	3	27
Apply pentachlorophenol wood preservative solutions	0	1	3	26
Apply water-borne wood preservative solutions containing copper, chromium, or arsenic	0	2	4	24

Evaluation Technique/Frequency of Use	Typically	Occasionally	Never
Visual Inspection	45	0	0
Hammer or chain sounding	34	10	0
Crack mapping/width measurement	13	24	6
Core sampling and strength testing	13	25	5
Core sampling and petrographic evaluation	5	22	15
Chloride measurement	21	21	4
Half-cell potential measurement	8	20	14
Corrosion rate	2	13	24
Infrared Thermography	0	8	30
Freeze/thaw testing or air content	2	7	30
Pulse velocity-ultrasonic	0	3	35
Ground penetrating radar (GPR)	1	18	19
Impact/echo	1	11	27

Deck Characterization

- ***Percent Deck Deterioration and NBI Ratings*** - percent of non-overlapping area of patches, spalls, delaminations, and half-cell potentials more negative than -0.35V CSE and NBI rating of the top and bottom deck surfaces
- ***Estimated Time-to-Corrosion*** - estimated time until sufficient chloride penetration occurs to initiate corrosion over a given percentage of the reinforcing steel
- ***Deck Surface Condition*** - consideration of poor drainage, surface scaling, abrasion loss, or skid resistance problems
- ***Concrete Quality*** - related to concrete durability (ASR/DEF/freeze-thaw) and strength issues

Primary Repair Decision

- ***Do Nothing***
- ***Maintenance*** that may include:
  - patching
  - crack repairs
  - concrete sealer
- ***Protective Overlay***
- ***Structural Rehabilitation*** that may include:
  - partial deck replacement
  - full depth deck replacement

Deck Replacement Criteria

- California – 20% Distress
- Virginia – 25% Distress
- Illinois – 35% Distress
- CT, MA, & KS – 50% Distress

TABLE 1 Primary Repair Category Selection Guidelines Based on Deck Characterization

		Deck Characterization Factor			
Primary Repair Category	[1]	% Distress plus Halfcells < -0.35, & NBI Ratings %	Time-to-Corrosion Initiation	Surface Issues	Concrete Quality ASR/DEF/ F-T/ Strength
1. Do Nothing [2]	i. % Distress	< 1%	> 10 years	None	None
	ii. % Distress + 1/2 cell	< 5%			
	iii. NBI Top	7 or greater			
	iv. NBI Bottom	7 or greater			
2. Maintenance	i. % Distress	1 - 10%	> 5 years or >10 years	None [3]	None [4]
	ii. % Distress + 1/2 cell	1 - 15%			
	iii. NBI Top	5 or greater			
	iv. NBI Bottom	5 or greater			

Primary Repair Category	[1]	% Distress plus Halfcells < -0.35, & NBI Ratings %	Time-to-Corrosion Initiation	Surface Issues	Concrete Quality ASR/DEF/Freeze-thaw/Strength issues
3. Overlay [7]	i. % Distress	2 to 35% [5]	Ongoing to >5 years	Yes [3]	Yes [6]
	ii. % Distress + 1/2 cell	10 to 50%			
	iii. NBI Top	4 or greater			
	iv. NBI Bottom	5 or greater			
4. Structural Rehabilitation	i. % Distress	> 35%	Ongoing	Yes [7]	Yes
	ii. % Distress + 1/2 cell	> 50%			
	iii. NBI Top	3 or less [8,9]			
	iv. NBI Bottom	4 or less [8,9]			

Table Notes:

[1] i - % Distress includes %patches, spalls, & delaminations
ii. % Distress plus 1/2 cell <-0.35 V (Cu-CuSO4)
iii. - NBI rating of top deck
iv. NBI rating of bottom of deck

[2] Select Do Nothing only if all conditions apply.

[3] If only skid resistance is a concern consider grooving or chip seal instead of overlay.
[4] If cracking due to ASR/DEF, deck life can be prolonged 2 to 5 years with HMWM treatment
[5] If deck has existing overlay, replace overlay if distress is greater than about 15 to 25 percent.

[6] Overlays may prolong deck life of decks with ASR; however, close monitoring is suggested. Compare partial and full depth replacement to cost of overlay and assess overall structure condition and the service life goals.

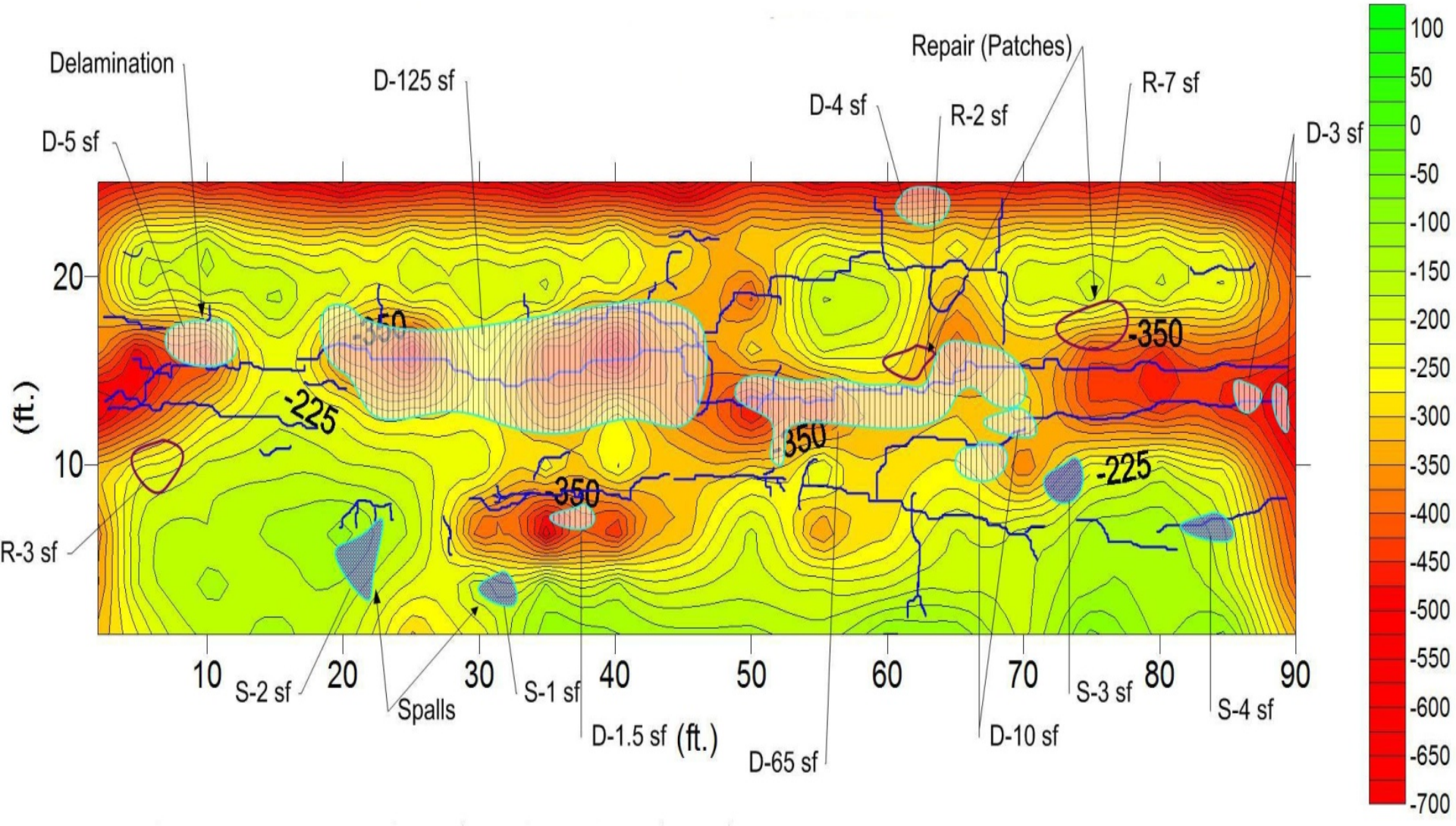
[7] If the deck already has been overlaid twice previously and concrete cover is a problem, consider structural rehabilitation.

[8] Partial depth replacement an option if NBI bottom is 6 or greater. Assess corrosion condition of lower mat of reinforcing steel due to splash, cracks and leakage.

[9] Replace deck full depth

1. Percent Deck Deterioration and NBI Ratings

- Visual survey of deck
- Measure patched and spalled areas
- Sound deck for delaminations
- Rate top side and bottom side of deck (if accessible)
- Perform half-cell survey
- Determine percent of non-overlapping area of patches, spalls, delaminations, and half-cell potentials more negative than -0.35V CSE


Delamination
D-5 sf
D-125 sf
D-4 sf
Repair (Patches)
R-2 sf
R-7 sf
D-3 sf
-350
-225
350
-350
-225
R-3 sf
S-2 sf
Spalls
S-1 sf
D-1.5 sf
D-65 sf
D-10 sf
S-3 sf
S-4 sf
(ft.)
(ft.)
20
10
10
20
30
40
50
60
70
80
90
100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
-550
-600
-650
-700

Code	Deck Rating (NBI) Description
9	Excellent condition (Superior to present desirable criteria).
8	Very Good Condition - no problems noted (desirable criteria).
7	Good Condition - some minor problems (Better than minimum criteria).
6	Satisfactory Condition - structural elements show some minor deterioration (Equal to present minimum criteria).
5	Fair Condition - all primary structural elements are sound but may have minor section loss, cracking, spalling (tolerate being left in place as is).
4	Poor Condition - advanced section loss, deterioration, spalling or scour (Meets minimum tolerable limits to be left in place as is).
3	Serious Condition - loss of section, deterioration, spalling have seriously affected structural components. Local failures possible. (Basically intolerable requiring high priority of corrective action).
2	Critical Condition - advanced deterioration of primary structural concrete may be present… may be necessary to close the bridged until corrective action is taken (intolerable requiring high priority of replacement).
1	Imminent Failure Condition - major deterioration or section loss present in critical structural components. Bridge is closed to traffic but with corrective action may be put back in light service.
0	Failed Condition - out of service (Bridge closed).

TABLE 1 Primary Repair Category Selection Guidelines Based on Deck Characterization

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1. Do Nothing [2]	i. % Distress	< 1%	> 10 years	None	None
	ii. % Distress + 1/2 cell	< 5%			
	iii. NBI Top	7 or greater			
	iv. NBI Bottom	7 or greater			
2. Maintenance	i. % Distress	1 - 10%	> 5 years or >10 years	None [3]	None [4]
	ii. % Distress + 1/2 cell	1 - 15%			
	iii. NBI Top	5 or greater			
	iv. NBI Bottom	5 or greater			

Primary Repair Category	[1]	% Distress plus Halfcells < -0.35, & NBI Ratings %	Time-to-Corrosion Initiation	Surface Issues	Concrete Quality ASR/DEF/Freeze-thaw/Strength issues
3. Overlay [7]	i. % Distress	2 to 35% [5]	Ongoing to >5 years	Yes [3]	Yes [6]
	ii. % Distress + 1/2 cell	10 to 50%			
	iii. NBI Top	4 or greater			
	iv. NBI Bottom	5 or greater			
4. Structural Rehabilitation	i. % Distress	> 35%	Ongoing	Yes [7]	Yes
	ii. % Distress + 1/2 cell	> 50%			
	iii. NBI Top	3 or less [8,9]			
	iv. NBI Bottom	4 or less [8,9]			

2. Estimate Time to Corrosion

- Detailed approach using Ficks 2nd law
- Simplified approach using estimations of eff. Diff. coeff. and Cs. and charts (Appendix B) - rate of advancement.
- Determine if corrosion is occurring at 20%*of steel depth as:
  - Ongoing
  - Within 5 years
  - Within 10 years

Modified Solution to Fick's 2nd Law *

$$Initiation\,(\%,t) = 100\sum_{i=1}^{n} \Delta F(Cs_i)\cdot \Delta F(D_i)\cdot F(doc_i,t)$$

where

$$\Delta F(Cs_i) = F(Cs_{i+1}) - F(Cs_i) = P(Cs_i < Cs < Cs_{i+1})$$

$$\Delta F(D_i) = F(D_{i+1}) - F(D_i) = P(D_i < D < D_{i+1}),\ and$$

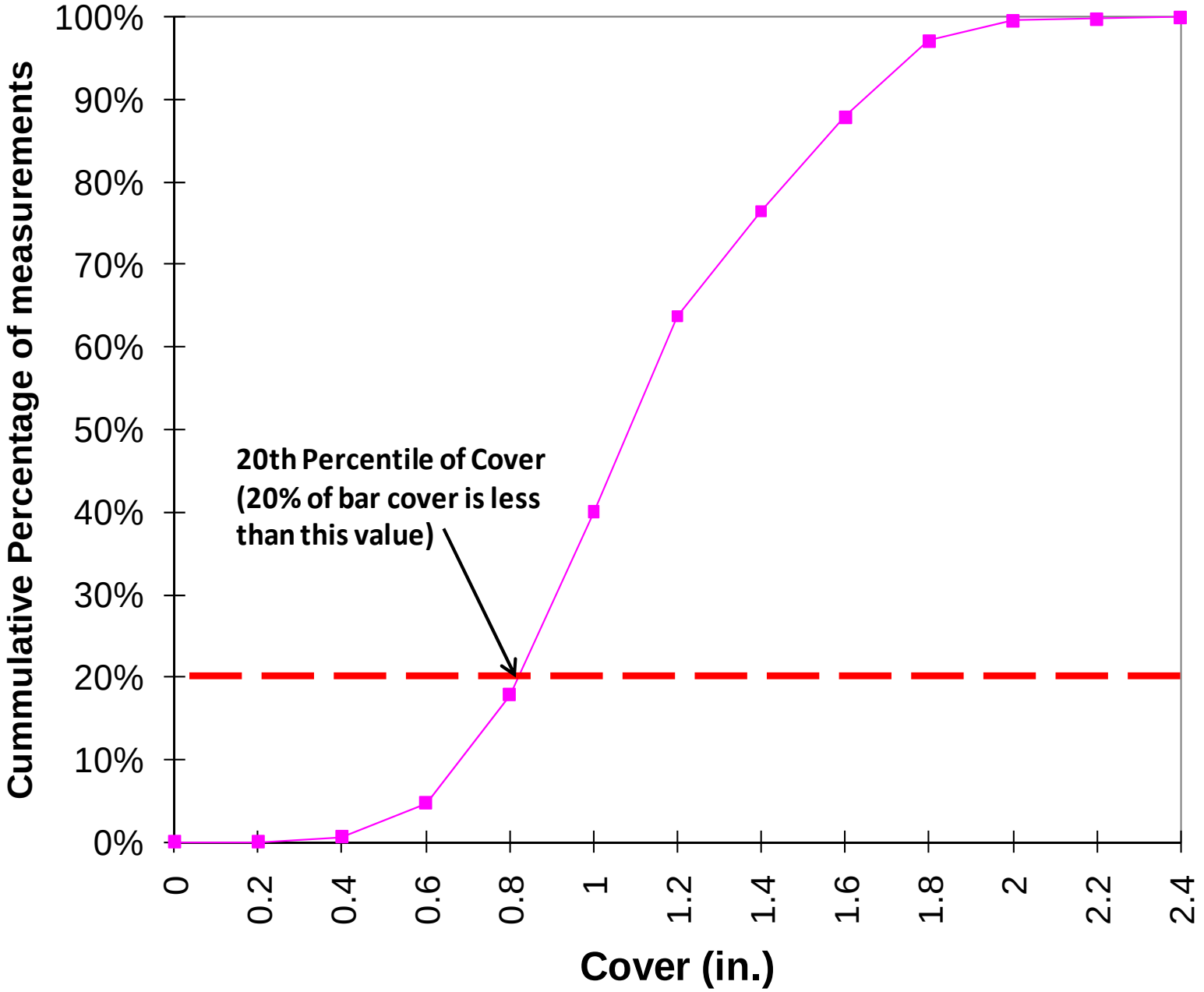
$$doc_i = 2\sqrt{D_i \cdot t}\cdot erf\left(1 - \frac{Cth - Co}{Cs - Co}\right)$$

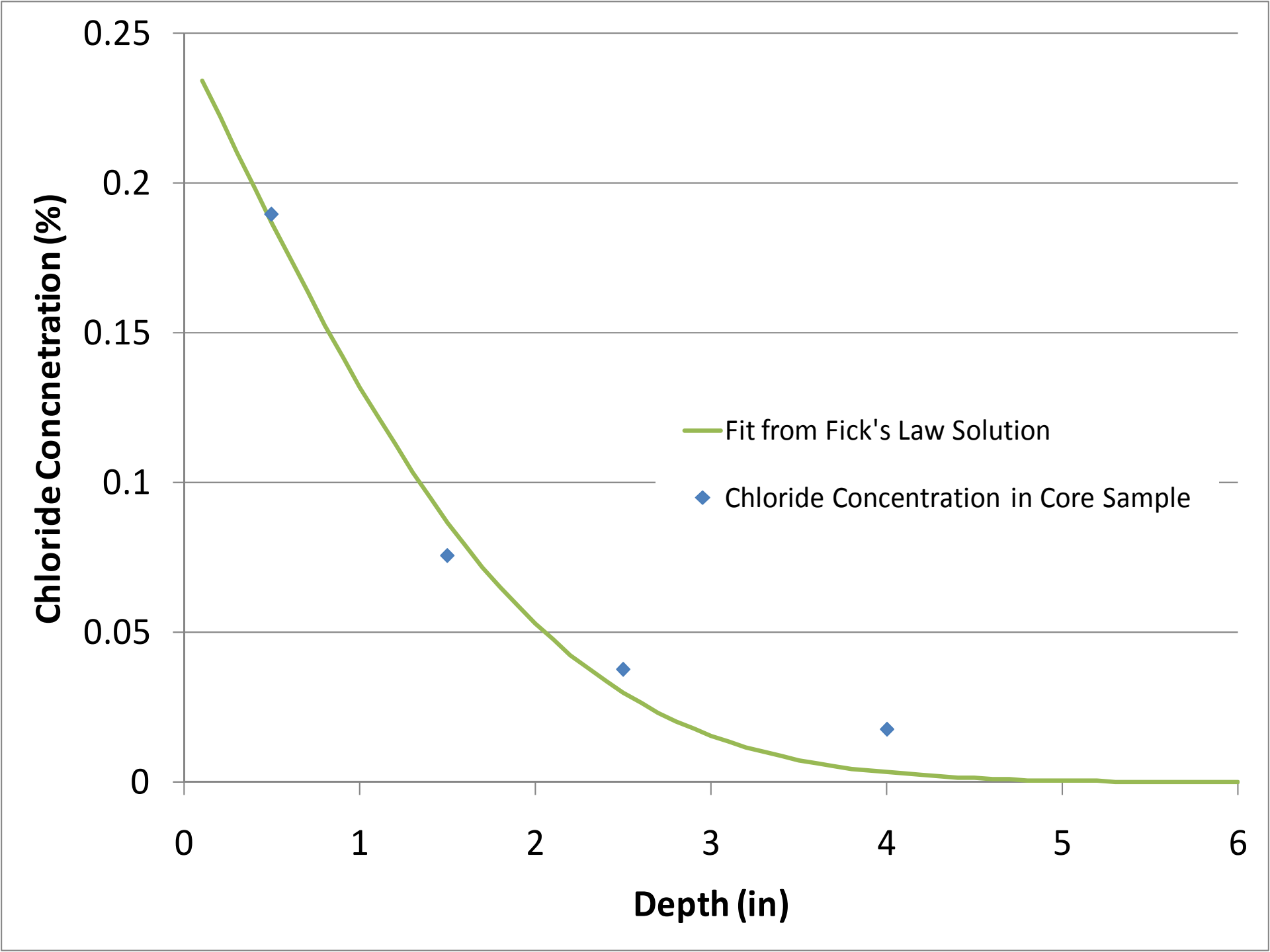
* Sagues, Scannell, Soh, and Sohanghpurwala 1997.

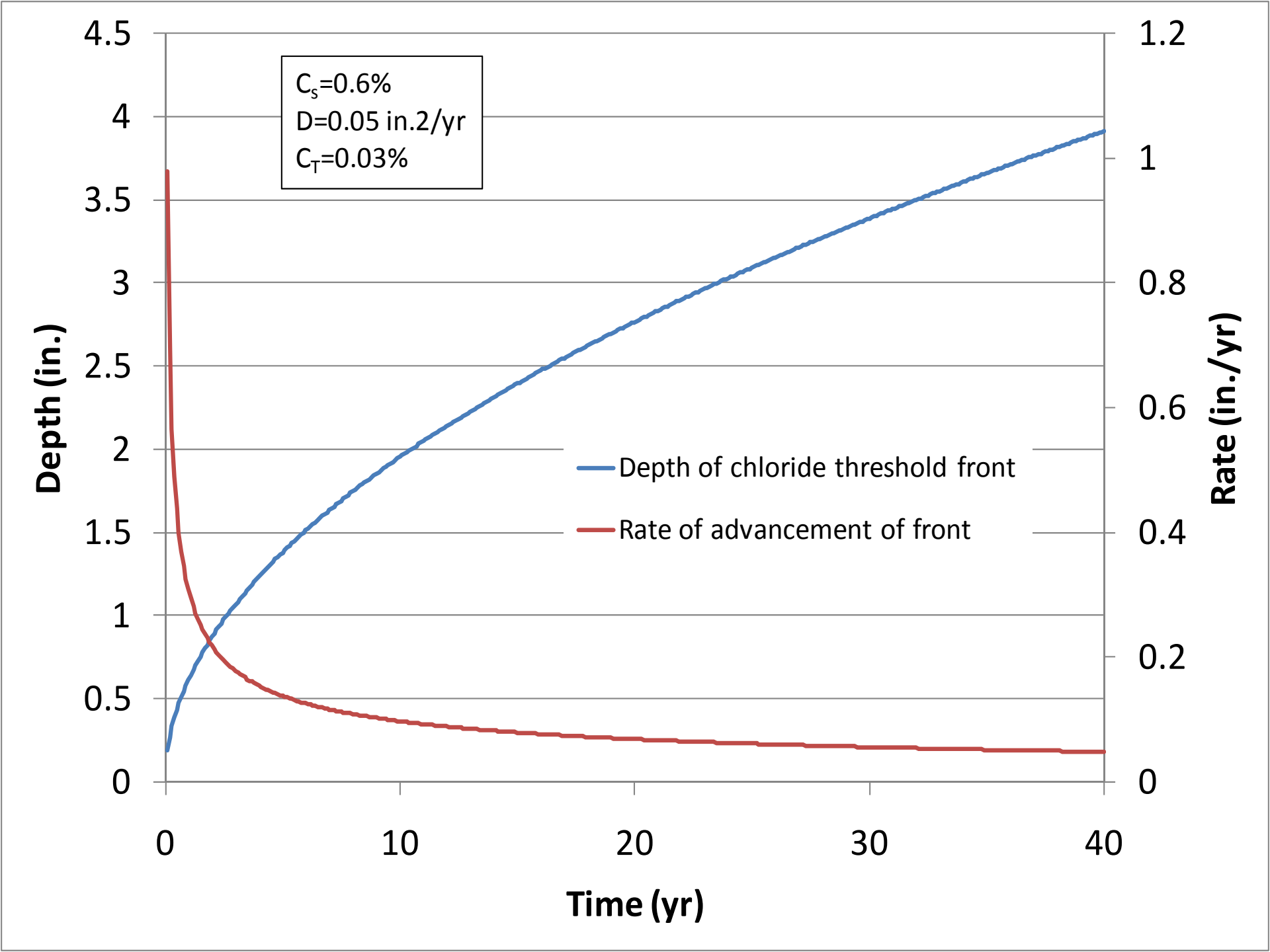
Finds Cs and D

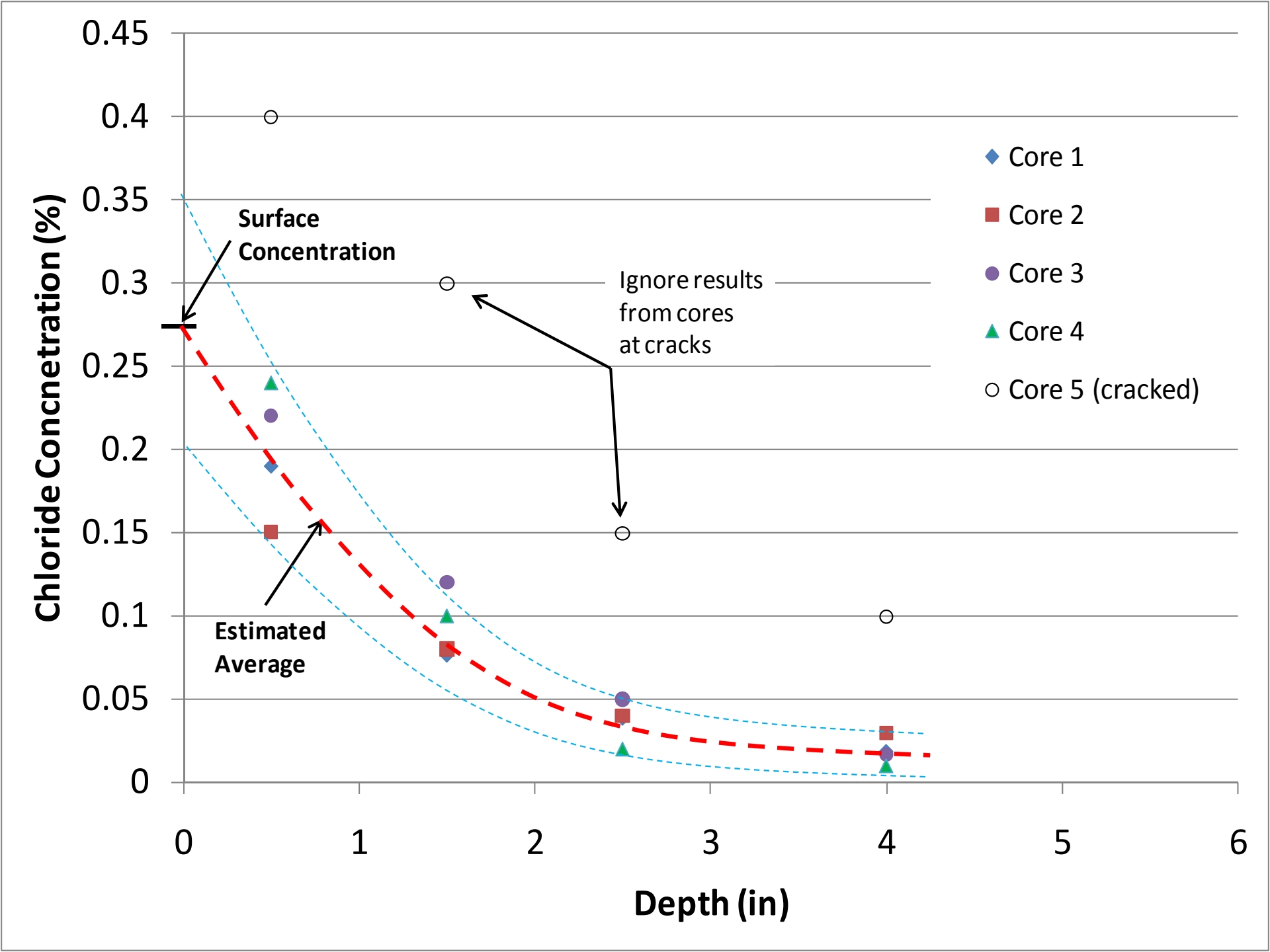
2. Estimate Time to Corrosion

- Measure concrete cover over the top reinforcing steel and plot cumulative distribution. Identify the 20th percentile of low cover values (20% of bars have concrete cover less than this value). Other percentile depths can be chosen by the user, if deemed appropriate.
- Take cores representative of the deck.
- Determine the chloride content of the concrete with depth using cores.
- Measure concrete carbonation depth using a pH indicator.
- Determine extent of characteristic full depth cracking, and estimate the average spacing of the cracks per length of deck.


Cummulative Percentage of measurements
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
20th Percentile of Cover
(20% of bar cover is less
than this value)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
Cover (in.)


0.25
0.2
0.15
0.1
0.05
0
Chloride Concnetration (%)
0
1
2
3
4
5
6
Depth (in)
Fit from Fick's Law Solution
Chloride Concentration in Core Sample


C_s=0.6%
D=0.05 in.2/yr
C_T=0.03%
Depth of chloride threshold front
Rate of advancement of front
Depth (in.)
Rate (in./yr)
Time (yr)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
0.2
0.4
0.6
0.8
1
1.2
0
10
20
30
40


0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Chloride Concnetration (%)
Surface Concentration
Ignore results from cores at cracks
Estimated Average
Core 1
Core 2
Core 3
Core 4
Core 5 (cracked)
0
1
2
3
4
5
6
Depth (in)

THRESHOLD = 0.03% (Black Steel)

TABLE. Rate of advancement of chloride threshold front (in./yr)

Bridge age = 10 years, Chloride threshold = 0.03% by wt. of concrete (black steel).

Surface Concentration (% by weight of concrete)		Diffusion Coefficient					
		0.05 $in.^2/yr$ ($1.0x10^{-12}$ m^2/s)	0.1 $in.^2/yr$ ($2.0x10^{-12}$ m^2/s)	0.15 $in.^2/yr$ ($3.1x10^{-12}$ m^2/s)	0.2 $in.^2/yr$ ($4.1x10^{-12}$ m^2/s)	0.25 $in.^2/yr$ ($5.1x10^{-12}$ m^2/s)	0.3 $in.^2/yr$ ($6.1x10^{-12}$ m^2/s)
Mild	0.1	0.052	0.073	0.090	0.104	0.116	0.127
	0.2	0.072	0.102	0.125	0.144	0.161	0.176
Moderate	0.3	0.082	0.116	0.142	0.164	0.184	0.201
	0.4	0.089	0.126	0.154	0.178	0.199	0.218
Severe	0.5	0.094	0.133	0.163	0.188	0.210	0.230
	0.6	0.098	0.138	0.169	0.196	0.219	0.240
	0.7	0.101	0.143	0.175	0.202	0.226	0.248

Simplified Approach

1.Plot chloride versus depth for each core.
2.Draw curve through data (look like Figure 1.)
3.Select a chloride threshold for the type of steel.
4.Estimate the depth of the chloride threshold front. If current depth is greater than the 20th percentile of cover, report corrosion as "Ongoing".
5.The surface concentration, C_s, estimated from plot (depth = 0)
6.Estimate the effective diffusion coefficient, D. See tables - very low (0.05), moderate (0.10 to 0.20) to high (0.3 in.^{2}/yr).
7.Based on threshold, D and C_s, and deck age – use tables provided to estimate the rate of advancement of chloride threshold front.
8. Determine the expected depth of the chloride threshold front in 5 and 10 years.

Depth in 5 years = current depth + rate of advancement (t) x 5 years
Depth in 10 years = current depth+ rate of advancement (t) x 10 years

If this depth exceeds the 20th percentile cover after 5 years, report "time-to-corrosion < 5 years."
If this depth exceeds the 20th percentile cover after 10 years, report "time-to-corrosion < 10 years."

3. Deck Surface Conditions

- Rate deck scaling per ASTM C672 *Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals*. If present, take core samples and conduct a petrographic examination (ASTM C856). If poorly air entrained, perform air content analysis (ASTM C457).
- Visually assess deck texture and grooves and assess abrasion loss.
- Measure skid resistance per AASHTO T242 *Full-Scale Tire or* T278 *British Pendulum*
- Visually assess deck drainage (wet deck or survey)
- Examine joint conditions, including grade, slope and transitions.

Rating	Condition of the Surface (AASHTO T161)
0	no scaling
1	very slight scaling (3 mm [1/8 in.], no coarse aggregate visible)
2	slight to moderate scaling
3	moderate scaling (some coarse aggregate visible)
4	moderate to severe scaling
5	severe scaling (coarse aggregate visible over entire surface)

4. Concrete Quality

- Examine concrete for pattern cracking, excessive crazing, scaling, excessive cracking, spalling unrelated to reinforcing corrosion, and other signs of concrete disintegration. If present, remove several core samples and examine petrographically per ASTM C856
- Test multiple cores for compressive strength. Also test cores for wet static modulus if ASR or DEF is suspected.
- Determine cause of concrete distress and risk of future deterioration.

Concrete Quality

- Determine if ASR/DEF is a concern for long term durability.
- Determine if poor air entrainment and cyclic freezing is a concern for long term durability.
- Determine if low strength is a concern for long term durability.
- Determine if other deterioration is present that could affect deck durability.

Section Within Primary Repair Categories

- A. Do Nothing
  - All criteria in Table 8 must be meet.

- B. Maintenance
  - Patching
  - Crack Repair
  - Sealers – based on chloride profiles

C. Overlay Considerations

- Traffic constraints on construction closures
- Previous deck overlays and repairs
- Dead load/clearance restrictions and drainage and slope corrections needed
- Costs and Service Life
- Contractor and DOT experience
- Special objectives, such as cathodic protection, deck strengthening, deicer systems, etc.

C. Overlays (its about speed)

- Conventional Rigid Overlays (HPC, LMC, Low-slump, Fiber-reinforced)
- Waterproofing Membrane/AC Overlay
- Fast Curing Overlays -Weekend closures (VHE-LMC, polymer)
- Very Rapid Curing Overlays- Less than 24 hours, night closures (polymer overlays)

D. Deck Replacement (Partial or Full Depth)

- Partial Depth Repair
  - Below top mat level of steel
- Full Depth Replacement

Report Contents

- Survey Results and Literature Review
- Agency Bridge Deck Maintenance and Repair Selection Processes
- Deck Characterization and Repair Selection
- Deck Evaluation and Characterization Testing Methods (how to do the survey & what data to collect)

Appendices

- Dot Survey Responses for Repair Methods
  - Agency Responded
  - Advantages/Disadvantages
  - Use History
  - Why system is selected & Conditions addressed
  - Anticipated Lifespan
  - Cost
  - Installation Procedures & Thickness
  - General Recommendations for Peers
- Tables of Rates of Advancement of Chloride Threshold Front
- Discussion of Repair Techniques

NCHRP PROJECT
TESTING PROTOCOLS FOR SURFACE APPLIED CONCRETE SEALERS

Project No. 20-07/Task 245

Paul Krauss, John Lawler, Kim Steiner

Wiss, Janney Elstner Associates

Tasks

- Survey DOT's, Australia, UK, Germany
- Literature Review
- Compile results
- Develop recommended testing procedures

Survey of DOT's

- Current test methods
- Sealers used, Approved materials
- Surface preparation
- Desired tests
  - laboratory product qualification,
  - routine product quality assurance,
  - field application quality assurance,
  - field performance and re-application quality assurance.

33 responses

- Twenty-six(26):

  AR, CO, FL, IA, IL, ME, MO, MS, NH, NV, NY, OH, OR, RI, TX, VA, VT, WV, Alberta, British Columbia, Manitoba, Newfoundland, Prince Edward Island, Ontario, Quebec, Germany

Penetrating sealer usage (26 Responses Total)

Sealer Type	Number of Responses
Silane	23
Siloxane	9
Silane/Siloxane Blend	6
Silicone	1
Silicate	3
Linseed Oil	10
Stearates	1
Other	1 (epoxy)

Barrier sealer usage (19 Responses Total)

Sealer Type	Number of Responses
Synthetic Gum Resins	0
Polyurethane	2
Polyester	1
Epoxy	14 (including 1 epoxy-urethane)
Acrylic	6
MMA (may include HMWM* crack repair sealers)	10
Other Barrier-Type Sealer	4 (asphalt seal coat, aliphatic urethanes, AASHTO M 224, mixed polymers)

Resources used when selecting sealers

Source	Number of Responses
Agency Guidelines	18
Qualified Products Lists	21
Application or Testing Protocols	17
Research Studies	5
Industry or Association Guidelines or Manuals	4

Concrete surface preparation method prior to using penetrating sealer (23 Responses Total).

Preparation Method	Number of Responses
No Prep	3
Air sweep	11
Broom	3
Sandblast	8
Shot Blast	6
Hydro-demolition	1
Water/grit blast	2
Water blast	11
Milling	0
Crack Routing	1
Other	4 (steam, wire brush, acid etch)

Concrete surface preparation method prior to using barrier-type sealer (19 total responses).

Preparation Method	Number of Responses
No Prep	2
Air sweep	7
Broom	3
Sandblast	9
Shot Blast	5
Hydro-demolition	2
Water/grit blast	4
Water blast	6
Milling	1
Crack Routing	1
Other	5 (not specified, wire brush, manufacturer's recc.)

The universal properties (U) of all sealers used for concrete highway structures include:

- Resistance to water penetration
- Resistance to chloride ion (deicer or seawater) penetration
- Permits vapor transmission
- Resistance to outdoor weathering and alkali found in concrete
- Reasonable curing times

Traffic-bearing deck surfaces (T)

- Abrasion resistance
- Skid resistance
- Time-to-Cure

Improvement in concrete durability

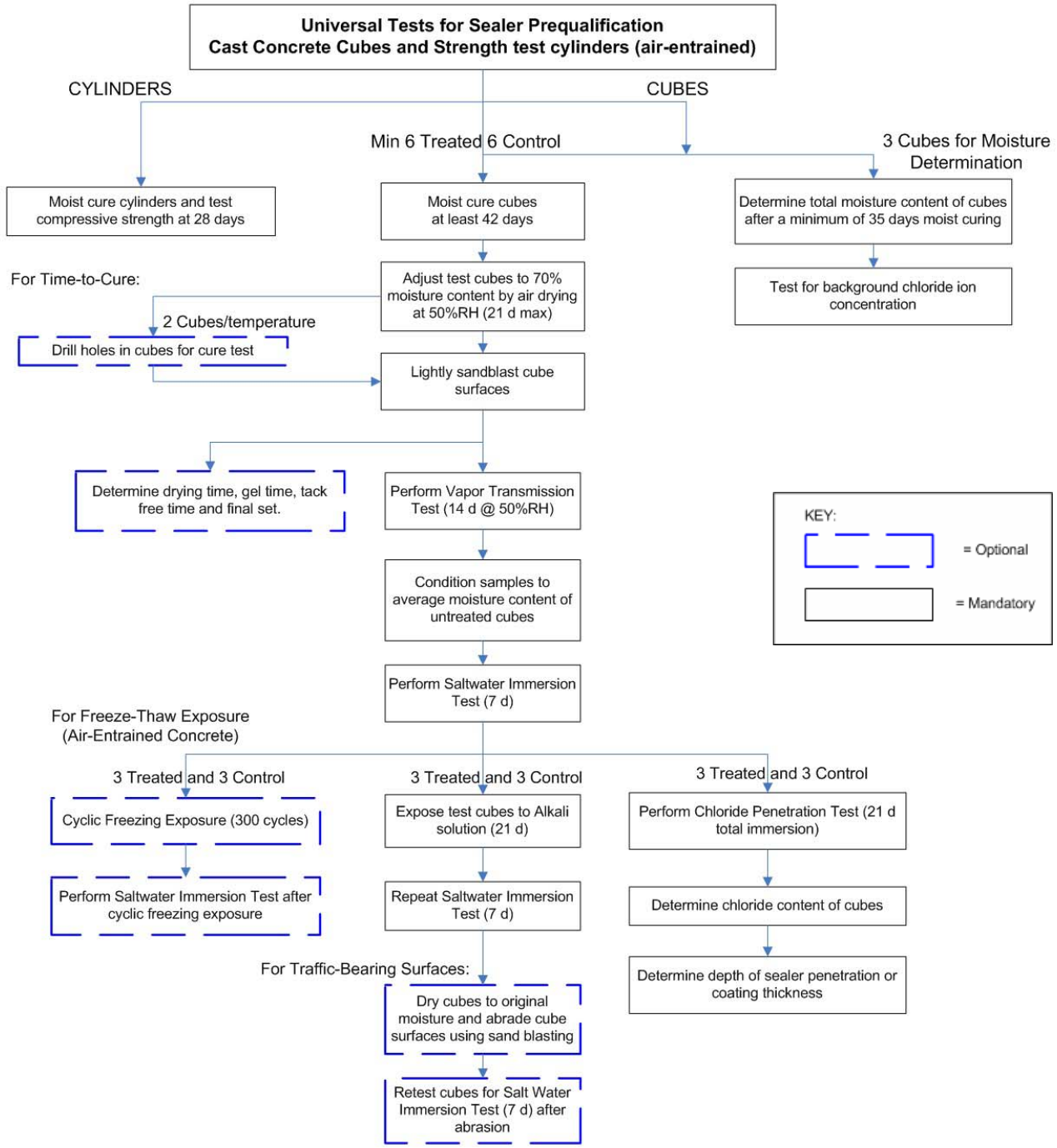
- Freeze-thaw resistance
- Scaling resistance

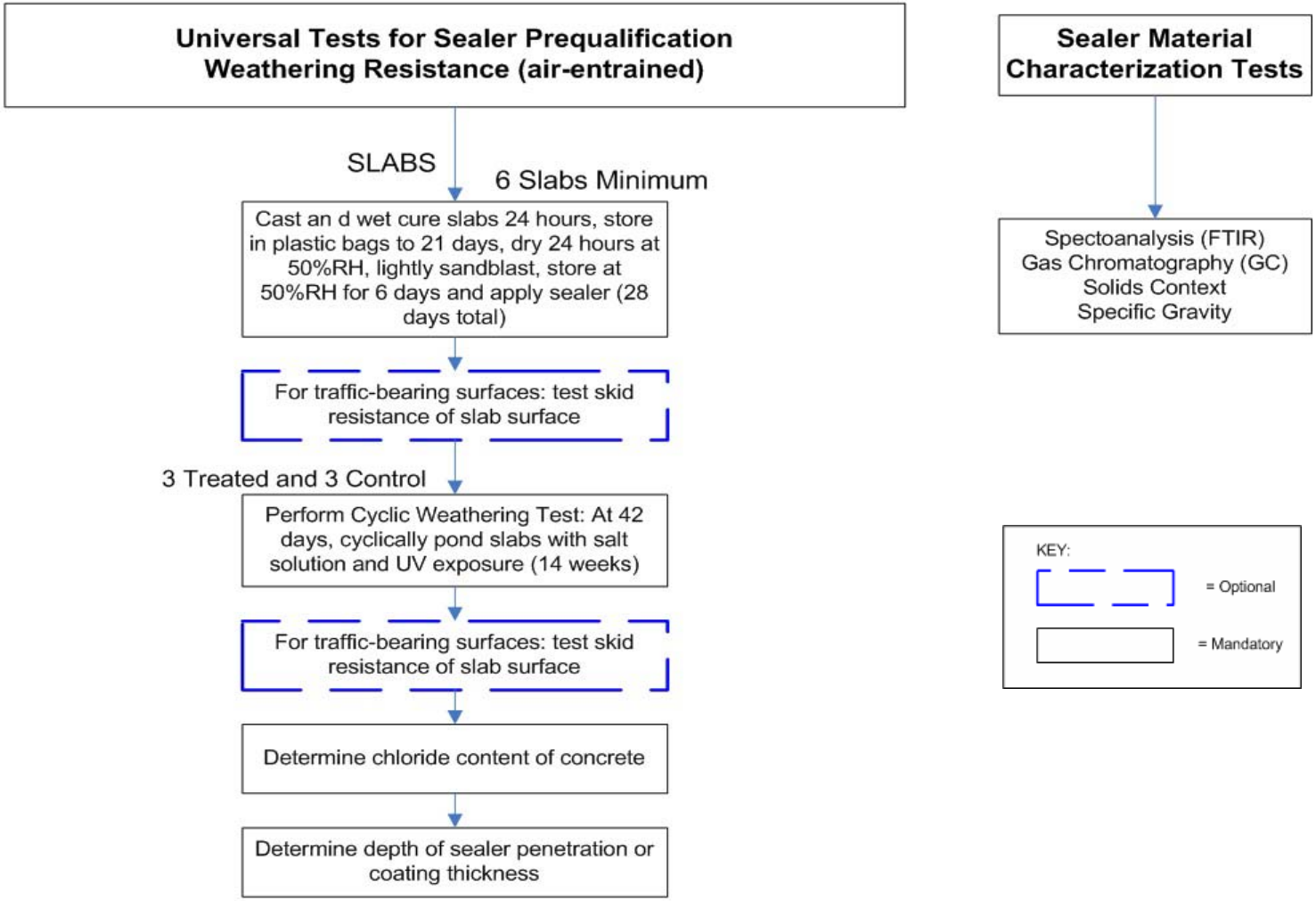
Effectiveness at various application temperatures and when applied to wet (SSD) concrete

- Resistance to water penetration
- Resistance to chloride ion (deicer or seawater) penetration
- Permits vapor transmission
- Resistance to outdoor weathering and alkali found in concrete
- Reasonable curing times

Other considerations

- Color and appearance
- Safety
- Economy
- Special situations and adverse conditions
- Effectiveness on cracked concrete


Universal Tests for Sealer Prequalification
Cast Concrete Cubes and Strength test cylinders (air-entrained)
CYLINDERS
CUBES
Min 6 Treated 6 Control
3 Cubes for Moisture Determination
Moist cure cylinders and test compressive strength at 28 days
Moist cure cubes at least 42 days
Determine total moisture content of cubes after a minimum of 35 days moist curing
Adjust test cubes to 70% moisture content by air drying at 50%RH (21 d max)
Test for background chloride ion concentration
For Time-to-Cure:
2 Cubes/temperature
Drill holes in cubes for cure test
Lightly sandblast cube surfaces
Determine drying time, gel time, tack free time and final set.
Perform Vapor Transmission Test (14 d @ 50%RH)
KEY:
= Optional
= Mandatory
Condition samples to average moisture content of untreated cubes
Perform Saltwater Immersion Test (7 d)
For Freeze-Thaw Exposure (Air-Entrained Concrete)
3 Treated and 3 Control
3 Treated and 3 Control
3 Treated and 3 Control
Cyclic Freezing Exposure (300 cycles)
Expose test cubes to Alkali solution (21 d)
Perform Chloride Penetration Test (21 d total immersion)
Perform Saltwater Immersion Test after cyclic freezing exposure
Repeat Saltwater Immersion Test (7 d)
Determine chloride content of cubes
For Traffic-Bearing Surfaces:
Determine depth of sealer penetration or coating thickness
Dry cubes to original moisture and abrade cube surfaces using sand blasting
Retest cubes for Salt Water Immersion Test (7 d) after abrasion


Universal Tests for Sealer Prequalification
Weathering Resistance (air-entrained)
SLABS
6 Slabs Minimum
Cast an d wet cure slabs 24 hours, store in plastic bags to 21 days, dry 24 hours at 50%RH, lightly sandblast, store at 50%RH for 6 days and apply sealer (28 days total)
For traffic-bearing surfaces: test skid resistance of slab surface
3 Treated and 3 Control
Perform Cyclic Weathering Test: At 42 days, cyclically pond slabs with salt solution and UV exposure (14 weeks)
For traffic-bearing surfaces: test skid resistance of slab surface
Determine chloride content of concrete
Determine depth of sealer penetration or coating thickness
Sealer Material Characterization Tests
Spectoanalysis (FTIR)
Gas Chromatography (GC)
Solids Context
Specific Gravity
KEY:
= Optional
= Mandatory

- Prequalification Testing
- Product Quality Assurance
- Routine QC/QA Testing
- Field Application Tests
- Performance and Reapplication Tests

Standard Method of Test for

Protective Sealers for Portland Cement Concrete

AASHTO Designation: *T -Proposed Draft

Guideline for

Quality Assurance, Job Site Quality Control, And Reapplication of Protective Sealers for Portland Cement Concrete

AASHTO Designation: *T -Proposed Draft (rev. 10.6.08pk,kas)