


SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Documenting Durability Design & Construction

IBC Workshop: W-8 Service Life Design

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U.S. Department of Transportation
Federal Highway Administration

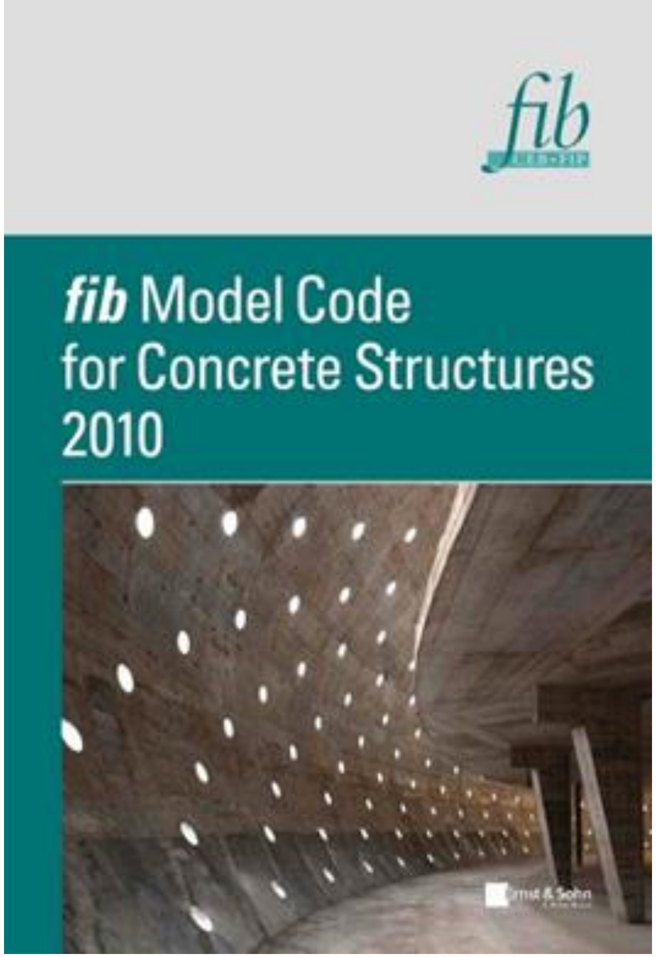
American Association of State Highway and Transportation Officials
AASHTO

Presentation Overview

- This part of the worked example covers:
  - Documenting design and construction data (birth certificate or as-built service life design report); and
  - Monitoring of service life during the life of the structure.

Birth Certificate Definition

- A document, report or technical file (depending on the size and complexity of the structure concerned) containing engineering information formally defining the form and the condition of the structure after construction.



Birth Certificate Purpose

- Documents parameters important to the durability & service life of the structure
- Provides means of comparing actual behavior/performance vs. design
- Facilitates ongoing (through-life) evaluation of the service life

Birth Certificate Purpose

- Outlines an Operational Schedule for:
  - Routine Maintenance
  - Regular Inspections
  - Durability Performance Monitoring
  - Replacement Activities

- Similar to an Automobile Owner's Manual

- Identifies Potential Demolition Schemes

Birth Certificate Process

- Initially Developed During Design Phase
  - Records the Intended Design
- Updated at Completion of Construction
  - As-Built Material Properties and Test Results
    - Concrete Classes / Mix Designs
    - Chloride Diffusion Coefficient
    - Steel Reinforcement / Prestressing Grades
    - Cover Dimensions
- Updated after Maintenance, Inspection & Long Term Performance Monitoring

Birth Certificate Table of Contents

- Identification of Structure
- Durability Design Parameters
- Environmental Exposure Conditions
- Deterioration Mechanisms & Models
- Durability Testing Requirements
- Material Durability Properties
- Structure Element Data
- In-Service Conservation Plan
- Dismantling Plan

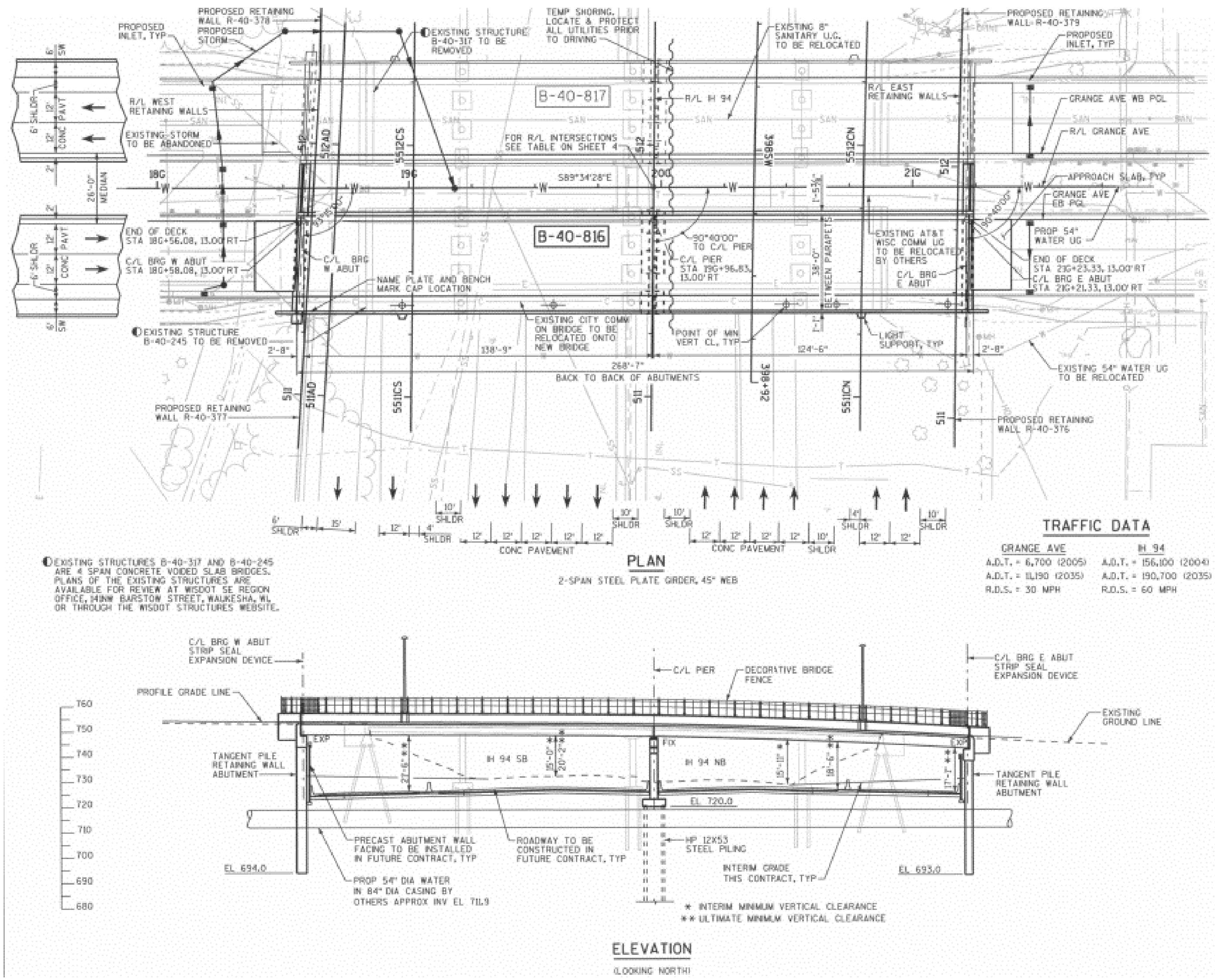
Identification of Structure

Owner	
Structure Classification	Bridge
Structure Name	New York City Bridge Example
Inventory ID #	12345
Structure Description	40'-6" wide by 264'-0" long bridge with cast-in-place concrete deck on 48" deep steel plate girders, supported by cast-in-place concrete abutments and pier. Abutment foundations have steel-cased concrete filled tangent piles, and center pier foundation has steel piles.
Geographic Location	Carries city street over Interstate Freeway in New York City, NY
Date Placed in Service	15-Dec-2016

Identification of Structure

Design	
Project #	XXXXX
Designer	(Name) (Address 1) (Address 2) (Phone)
Independent Checker	n/a
Design Start Date	1-Jan-2015
Design End Date	1-Feb-2016
Execution (Construction)	
Contract ID #	YYYYY
Bid Date	28-Apr-2016
Construction Start Date	9-May-2016
Construction End Date	15-Dec-2016
Contractor	(Name) (Address 1) (Address 2) (Phone)
Sub-Contractors / Suppliers	
Cast-in-Place Concrete	(Name) (Address 1) (Address 2) (Phone)

Identification of Structure



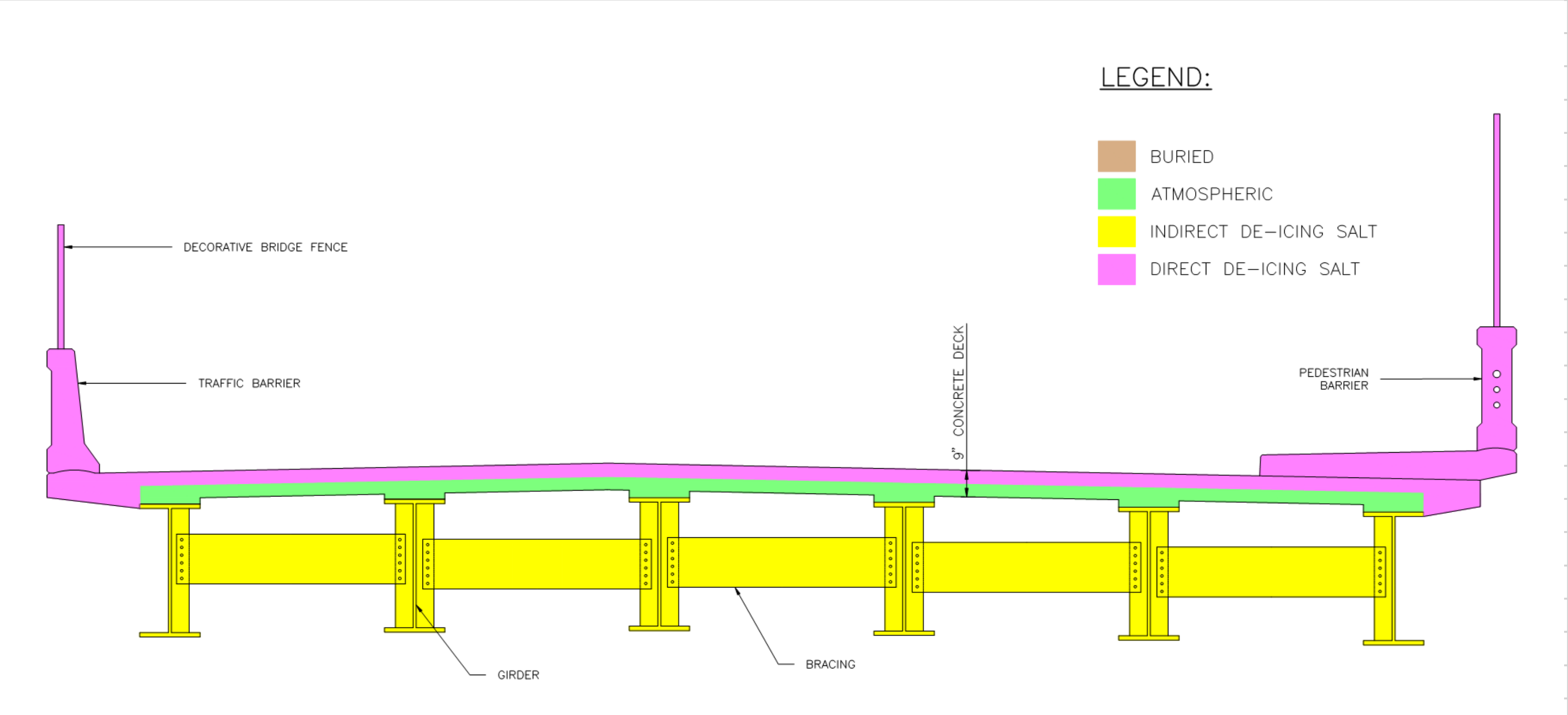
Durability Design Parameters

Durability Specifications			
Model Code for Service Life Design, fib Bulletin 34, 2006			
ACI 318-14 (for concrete exposure classes), ISO 12944 (for structural steel and coatings exposure classes)			
Environmental Exposure Conditions			
Macro Environment	Rural, Urban, Industrial, Coastal Marine	Urban	
Macro Climate	Cold, Temperate, Tropical (hot/humid), Arid (hot/dry)	Temperate	
Annual Climate/Weather Data	Source: NOAA Station ID: USW00094728, NY City Central Park NY (1960-2016)	Mean, μ	Std Dev, σ
High Temperature (°F)		62.5	1.2
Low Temperature (°F)		47.6	1.3
Average Temperature (°F)		55.1	1.2
Relative Humidity (%)	Local Climatological Data (LCD) Station WBAN-94728	63	-
Precipitation (in)		48.4	10.1
Time of Wetness (ToW)	No. of days per year with rainfall exceeding 0.1 in	120.3	10.8
Snowfall (in)		27	14.3
Deterioration Mechanisms			
Reinforcing Steel Corrosion	**C**arbonation, **De**-icing Chlorides, **S**ea water	yes, **D**	
Freeze/Thaw Damage		yes	
Salt Scaling Damage		yes	
Abrasion/Erosion	**R**utting, **I**ce action	yes, **R**	
External Chemical Attack	**S**ulfate, **A**cid, **L**eaching	yes, **S**	
Internal Chemical Attack	**ASR, AAR, DEF**	yes, **ASR**	
Coating Breakdown		yes	

Durability Design Parameters

Design Parameters		
Consequence Class (CC) - Loss of human life, economic, social or environmental	CC1 - Low	CC2
	CC2 - Normal	
	CC3 - High	
Design Supervision (DSL) - Checking of the design	DSL1 - Self	DSL2
	DSL2 - Same organization	
	DSL3 - Independent 3rd party	
Construction (Execution) Inspection Parameter		
Execution Class EXC) - Construction inspection	EXC1 - Self	EXC2
	EXC2 - Same organization	
	EXC3 - Independent 3rd party	
In-Service Conservation Parameters		
Condition Control & Conservation Class - periodic inspection & maintenance	A - Proactive (systematic monitoring of parameters relevant to deterioration proccesses critical to durability)	B
	B - Reactive (planned periodic inspection)	
	C - None (no direct inspection/testing)	
Condition Control Levels (CCL)/Inspection Regimes	CCL0 - None (not possible, e.g., buried)	CCL2
	CCL1 - Normal (arbitrary, no systematic regime)	
	CCL2 - Normal (regular visual inspection)	
	CCL3 - Extended (monitoring of parameters relevant to deterioration process critical to durability)	

Environmental Exposure Zones



Class Designation	Description of the Environment	Specific Exposure				
2 - Corrosion induced by chlorides other than seawater			Surface chloride concentration [wt-%/cem]			
			C_S		$C_{S,\Delta x}$	
			Mean, μ	Std Dev, σ	Mean, μ	Std Dev, σ
EN 206 XD1	Moderate humidity	Surfaces exposed to airborne chlorides	1.0	0.5	n/a	n/a
ISO 12944 C5-M	Areas with high salinity	Surfaces exposed to airborne chlorides	n/a	n/a	n/a	n/a
EN 206 XD3	Cyclic Wet and Dry	Surfaces exposed to de-icing chlorides	n/a	n/a	4.0	2.0

Deterioration Mechanism/Models

- Chloride Ingress – Fick's 2nd Law of Diffusion for Corrosion Initiation

$$C_{crit} \geq C(x = a, t) = C_o + (C_{s,\Delta x} - C_o) \cdot \left[1 - \mathrm{erf}\left(\frac{a - \Delta x}{2\sqrt{D_{app,C} \cdot t}}\right)\right]$$

$$D_{app,C} = k_e \cdot D_{RCM,0} \cdot k_t \cdot A(t)$$

$$k_e = \exp\left(b_e\left(\frac{1}{T_{ref}} + \frac{1}{T_{real}}\right)\right)$$

$$A(t) = \left(\frac{t_o}{t}\right)^{\alpha}$$

- **Red – Environmental Loading**
  - C_o & C_s are the Chloride Background and Surface Concentrations
  - T_{real} is the Annual Mean Temperature at the project site
- **Green – Material Resistance**
  - $D_{RCM,0}$ is the Chloride Migration Coefficient, α is the Aging Exponent, both are functions of the concrete mix (*W/C* ratio, SCMs)
  - a is the Concrete Cover

Deterioration Mechanism/Models

Deterioration Model	Fick's 2nd Law
Source	fib Bulletin 34 - Model Code for Service Life Design, Appendix B2

Equation (B2.1-1) $$C_{crit} = C(x = cov, t) = Co + (C_{S,\Delta x} - C_o) \cdot \left[1 - erf\left(\frac{cov - \Delta x}{2\sqrt{D_{app,C} \cdot t}}\right)\right]$$

Equation (B2.1-2) $$D_{app,C} = k_e \cdot D_{RCM,0} \cdot k_t \cdot A(t)$$

Equation (B2.1-3) $$k_e = \exp\left(b_e\left(\frac{1}{T_{ref}} - \frac{1}{T_{real}}\right)\right)$$

Equation (B2.1-4) $$A(t) = \left(\frac{t_o}{t}\right)^{\alpha}$$

Deterioration Mechanism/Models

Function Variables	Description	Units	Distribution Function
t	Time	[yr]	n/a
x	Depth with corresponding content of chlorides C(x,t)	[in]	n/a
C_{crit}	Critical chloride content	[wt.-%/cem]	Beta, a=0.2, b=2
C_o	Initial chloride content of the concrete	[wt.-%/cem]	Constant
$C_{S,\Delta x}$	Chloride concentration at surface or a depth Δx	[wt.-%/cem]	Log-Normal
Δx	Depth of the convection zone (concrete layer, up to which the process of chloride penetration differs from Fick's 2nd law of diffusion)	[in]	Beta, a=0, b=50
cov	Concrete cover	[in]	Log-Normal
$D_{app,C}$	Apparent coefficient of chloride diffusion through concrete	[in^2/yr]	n/a
D_{RCMO}	Chloride migration coefficient	[in^2/yr]	Normal
k_t	Transfer parameter	[-]	Constant = 1
k_e	Environmental transfer variable	[-]	n/a
b_e	Regression variable	[°K]	Normal
T_{ref}	Standard test temperature	[°K]	Constant = 292.9
T_{real}	Temperature of the structural element or the ambient air	[°F]	Normal
A(t)	Subfunction considering the ageing	[-]	n/a
t_o	Reference point of time	[yr]	Constant = 0.0767
α	Aging exponent	[-]	Beta, a=0.2, b=2

Durability Testing Requirements

Objective	Testing Specification	Information Obtained
Design		
Determine design chloride loading from concrete cores taken from existing/nearby structures	ASTM C1543 - Determining the Peneration of Chloride Ion into Concrete by Ponding (Salt Ponding Test) / with ASTM C1152 and ASTM C1556	Chloride Surface Concentration, C_S (or $C_{S,\Delta x}$ and Δx) used in chloride deterioration model
Determine design chloride durability resistance properties from trial batch mix designs	Nordtest Method NT Build 492 / Chloride Migration Coefficient from Non-Steady-State Migration Experiments (Rapid Chloride Migration, RCM)	Design Chloride Migration Coefficient, $D_{RCM,0}$ used in chloride deterioration model
Construction		
Verify chloride durability resistance properties during production	Nordtest Method NTBuild 492	As constructed Chloride Migration Coefficient, $D_{RCM,0}$ used in chloride deterioration model
Determine initial chloride content of concrete during production	ASTM C1152 - Acid Soluble Chloride in Mortar and Concrete	As constructed Initial Chloride Content, C_O used in chloride deterioration model
Verify clear concrete cover in completed structure	BS1881:204 Testing concrete. Recommendations on the use of electromagnetic covermeters	As constructed clear cover dimensions in hardened concrete
In-Service Monitoring		
Develop chloride profiles from concrete cores taken from structure to verify concrete chloride durability resistance properties and chloride loading	ASTM C1543 / with ASTM C1152 and ASTM C1556	Determine Apparent Chloride Diffusion Coefficient, $D_{app,C}$ as it changes with time, and verify Chloride Surface Concentration, C_S or $C_{S,\Delta x}$ and Δ_x

Material Properties - Concrete

Concrete Class	Mix Designation	Cementitious Materials									
		Cement		Supplemental Cementitious Materials (SCMs)						Cement + SCM Unit weight	Water/ Cement Ratio w/c
		AASHTO/ ASTM Spec.	Type	Fly Ash (FA) AASHTO M295/ ASTM C618		Slag (GGBFS) AASHTO M302/ ASTM C989		Silica Fume (SF) AASHTO M307/ ASTM C1240			
				%	Class C/F/N	%	Grade 100/120	%		(lb/yd^3)	
Design											
F	OPC	M85/C150	I/II							716	0.40
HP	OPC+20-35FA	M85/C150	I	20-35	C			6		675	0.40
Construction											
F	OPC	M85/C150	III							710	0.38
HP	OPC+20%FA	M85/C150	III	20						800	0.34

Material Properties - Concrete

Concrete Class	Mix Designation	Materials: Cement + SCM Unit weight (lb/yd^3)	Materials: Water/Cement Ratio w/c	Durability Design Properties (per fib Bulletin 34): Chloride Migration Coefficient, $D_{RCM,0}$ (in^2/yr) - (Normal Distribution function) – RCM Test per Nordtest - NTBuild 492: Mean, μ	Std Dev, σ	Aging Exponent, α - (Beta Distribution function, a=0, b=1): Mean, μ	Std Dev, σ
Design							
F	OPC	716	0.40	0.734	0.294	0.30	0.12
HP	OPC+20-35FA	675	0.40	0.342	0.137	0.60	0.15
Construction							
F	OPC	710	0.38	0.460	0.184	0.30	0.12
HP	OPC+20%FA	800	0.34	0.313	0.125	0.60	0.15

Concrete Mix Design

Mix Producer	XYZ Redi-Mix Co.			
Mix ID	OPC+20%FA			
Concrete Specification	NYSDOT Standard Specifications			
Concrete Class	HPC Deck			
Materials	Type/Specification	Supplier	Wt. (lbs)	
Cementitious				
Cement	Type III/ AASHTO M85	ABC Cement	640	
Supplemental Cementious Materials (SCMs)				SCM %
Fly Ash (FA)	Type F	Fly Ash Direct	160	20%
		Total Cementitious	800	
Aggregates				
Coarse		Acme Sand & Gravel	1790	
Fine		Acme Sand & Gravel	974	
		Total Aggregate	2764	
Water				
Batch Water			272	
Aggregate Moisture Water				
Admixture Water			2	
		Total Water	274	
Total Batch				
Adjusted Cementitious Content			800	lb/yd^3
Water/Cement Ratio		w/c=	0.34	

Material Properties - Reinforcing

Type	AASHTO/ ASTM Spec	Yield Strength, Fy (ksi)	Tensile Strength, Fu (ksi)	Alloy Type	UNS Designation	Critical Chloride Threshold (% wt of cementitious) Beta Distribution function, a=0.2, b=2	
						Mean, μ	Std Dev, σ
Plain Carbon Low Alloy	M31/A615	60	90	n/a	n/a	0.60	0.15
Plain Carbon - Galvanized	M31/A615	60	90	n/a	n/a	1.00	0.25
Low-Carbon Chromium (MMFX)	M334/A1035	100	150	CM	K42050	1.20	0.3
Low-Carbon Chromium (MMFX)	M334/A1035	120	150	CM	K42050	1.20	0.3
Low-Carbon Chromium (MMFX)	M334/A1035	100	150	CS	K81550	2.40	0.6
Austenitic Stainless	M334/A955	60	90	316L	S31603	3.60	0.9
Duplex Stainless	M334/A955	75	100	2205	S31803	6.00	1.5

Concrete Component Summary

	1 - Deck	2 - Sidewalk	3 - Traffic Railing	4 - Pedestrian Railing	5 - Abutment Tangent Piles	6 - Abutment Pile Cap/Wingwalls	7 - Pier Footings	8 - Pier Columns	9 - Pier Caps				
Service Life Requirements													
Non-Replaceable	x	x			x	x	x	x	x				
Replaceable			x	x									
Service Life Duration (years)	75	75	50	50	75	75	75	75	75				
Reinforcement Deterioration Mechanisms													
Corrosion from Chlorides	x	x	x	x				x	x				
Corrosion from Carbonation													
Environmental Exposure (per EN 206-1)													
Class (**XC**arbonation/ **XD**e-icing/ **XS**eawater)	XD	XD	XD	XD				XD	XD				
Level (1-4)	3	3	3	1				3	1				
Design Strategy													
Avoidance													
Deterioration Modeling	Fick's 2nd Law (fib 34, annex B2)												
Deemed-to-satisfy													
Partial Factor													
Full-Probabilistic	x	x	x	x				x	x				
Reliability Index, β=	1.3	1.3	1.3	1.3				1.3	1.3				
Protection Strategy													
Material's own resistance	x	x	x	x				x	x				
Multi-stage system (overlay/coating)													
Use non-reactive materials (CRR)													
Cathodic Protection													
Limit State													
Corrosion initiation (Depassivation)	x	x	x	x				x	x				
Corrosion Propagation (cracking)													
Corrosion Propogation (spalling)													
Corrosion Propagation (section loss)													

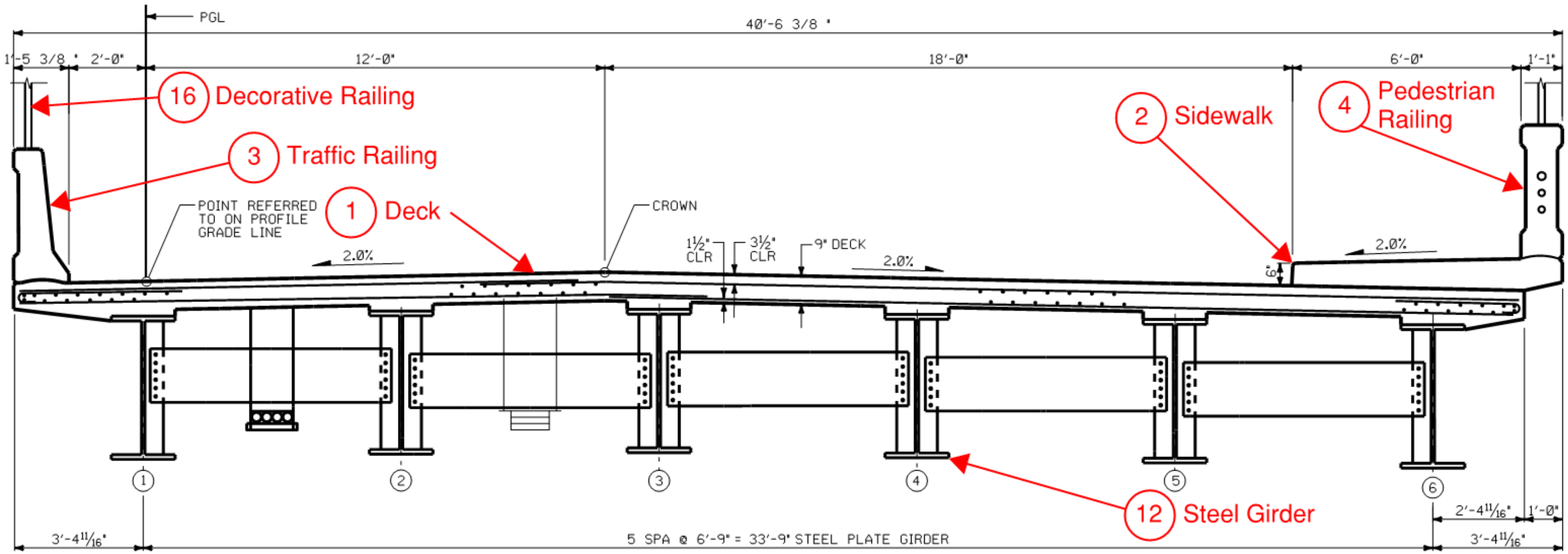
Concrete Component Summary

	1 - Deck	2 - Sidewalk	3 - Traffic Railing	4 - Pedestrian Railing	5 - Abutment Tangent Piles	6 - Abutment Pile Cap/Wingwalls	7 - Pier Footings	8 - Pier Columns	9 - Pier Caps				
Concrete Deterioration Mechanisms													
Freeze-Thaw	x	x	x	x		x	x	x	x				
Salt Scaling	x	x	x	x		x	x	x	x				
Abrasion/Erosion	x												
Chemical Attack (**S**ulfate/**A**cid/**L**eaching)							S						
Internal Chemical Attack (**AAR**/**ASR**/**DEF**)	ASR	ASR	ASR	ASR		ASR	ASR	ASR	ASR				
Environmental Exposure (per EN 206-1)													
Class (**XF**reeze-Thaw/Chemical **XA**ttack)	XF	XF	XF	XF		XF	XF	XF	XF				
Level (1-4)													
Design Strategy													
Avoidance	x	x	x	x		x	x	x	x				
Deterioration Modeling													
Deemed-to-satisfy	x												
Partial Factor													
Full-Probabilistic													
Reliability Index, β=													
Protection Strategy													
Use non-reactive materials													
Restrict material sources													
Air Entrainment	x	x	x	x		x	x	x	x				
Thermal Curing Plan													
Protective Barrier (overlay)													

Steel/Other Component Summary

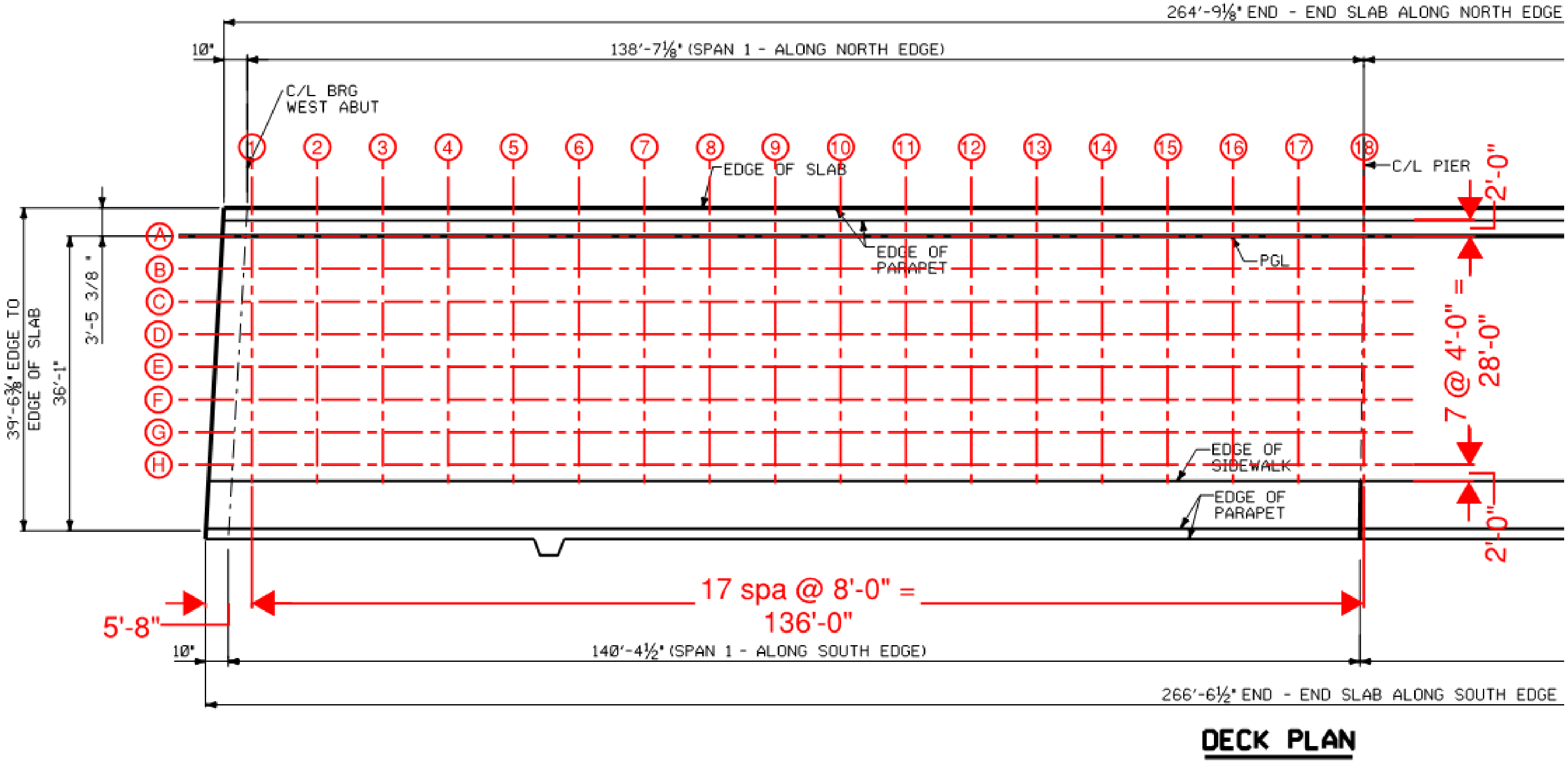
	10 - Tangent Pile Steel Casings	11 - Steel H-Piles	12 - Structural Steel Girders/Diaphragms	13 - Bearings - Metal Rocker	14 - Bearings - Elastomeric	15 - Expansion Joints	16 - Decorative Metal Railing	17- Inorganic Zinc/ Polyurethane (IOZ)	18 - Galvanized	19 - Organic Zinc/ Polyurethane (OZ)			
Service Life Requirements													
Non-Replaceable	x	x	x				x						
Replaceable				x	x	x		x		x			
Service Life Duration (years)	75	75	75	50	50	30	75	25		25			
Metal Deterioration Mechanisms													
Corrosion from Chlorides			x	x		x							
Corrosion from Water/Moisture													
Environmental Exposure (per ISO-12944)													
Corrosivity Category			C4	C4		C5-M	C5-M	C4	C5-M	C5-M			
Categories for Water and Soil	Im3	Im3											
Design Strategy													
Avoidance													
Deterioration Modeling													
Deemed-to-satisfy	x	x	x	x		x	x	x	x	x			
Partial Factor													
Full-Probabilistic													
Reliability Index, β=													
Protection Strategy													
Material's own resistance	x	x											
Use non-reactive materials													
PT Corrosion Protection Level (**PL1/PL2/PL3**)													
Protective Coating			IOZ	Galv		Galv	OZ						
Limit State													
Corrosion Propagation (thickness loss)	x	x											
% Surface coating defects			5%				5%						

Structural Component Identification



CROSS SECTION THRU ROADWAY

Cover Measurements – Span 1



Cover Measurements – Span 1

Component Name	Deck		Standard	German Concrete and Construction Association - DBV,
Location	Span 1	top mat		Concrete Cover and Reinforcement per Eurocode 2
			Sampling	Grid sampling

As-Constructed Cover Dimensions at Grid Points [in]																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	2.52	2.20	2.60	2.99	2.05	2.87	2.72	2.80	3.11	2.99	3.11	2.83	2.52	2.62	3.11	2.83	2.52	2.20
B	2.40	2.20	2.48	2.72	2.72	2.76	2.91	2.99	2.17	2.83	2.99	2.09	2.40	2.71	2.99	2.09	2.40	2.20
C	2.24	2.24	***1.46***	***1.57***	2.52	2.20	2.36	2.20	2.20	2.17	2.20	2.24	2.34	2.44	2.54	2.56	2.45	2.51
D	1.93	2.01	***1.65***	2.01	2.24	2.28	2.24	2.13	2.32	2.48	2.52	2.80	2.62	2.56	2.52	2.80	2.51	2.01
E	2.28	2.40	2.09	1.93	2.01	***1.89***	2.17	1.97	2.46	2.60	2.56	2.32	2.28	2.40	2.56	2.32	2.28	2.40
F	2.99	3.11	2.48	2.09	3.15	2.91	2.83	2.56	2.83	2.72	2.83	2.28	2.99	3.11	2.83	2.28	2.99	3.11
G	2.24	2.99	3.15	***1.75***	2.60	2.91	2.44	2.99	2.24	2.48	2.24	2.40	2.24	2.99	2.24	2.40	2.24	2.99
H	2.13	***1.85***	2.20	2.20	2.13	2.83	2.52	2.40	2.20	2.26	2.32	2.48	2.13	2.65	2.32	2.48	2.13	2.75

Statistical Evaluation of Measured Cover Depths, all units [in]

Target threshold %		5%
Nominal cover	c_{nom}	2.5
Safety margin	Δc	0.6
Req'd minimum cover	c_{min}	1.9
Sample size	N	144
Median	X_M	2.44
Min	X_{min}	1.46
Mean	X	2.47
Std. Dev.	s	0.36

Qualitative Procedure					
# measurements < c_{min}	6	# allowed per N	11	OK	
Quantitative Procedure					
Outlier cover	X_{OG}	$= 2.5X_M - 1.5X_{min}$	3.91		
Location parameter	r	$= (X + X_M)/2$	2.45		
Form parameter	k	$=1.8\ r/s$	12.36		
Threshold value	c(5%)	$= r/(19^{1/k})$	1.93		
Parameter p(x)	p(x)	$= c_{min}/r$	0.77		
% of cover depth <c_{min}	F(x)	$= p(x)^k/(1+p(x)^k)$	4%	OK	

Structural Component Data

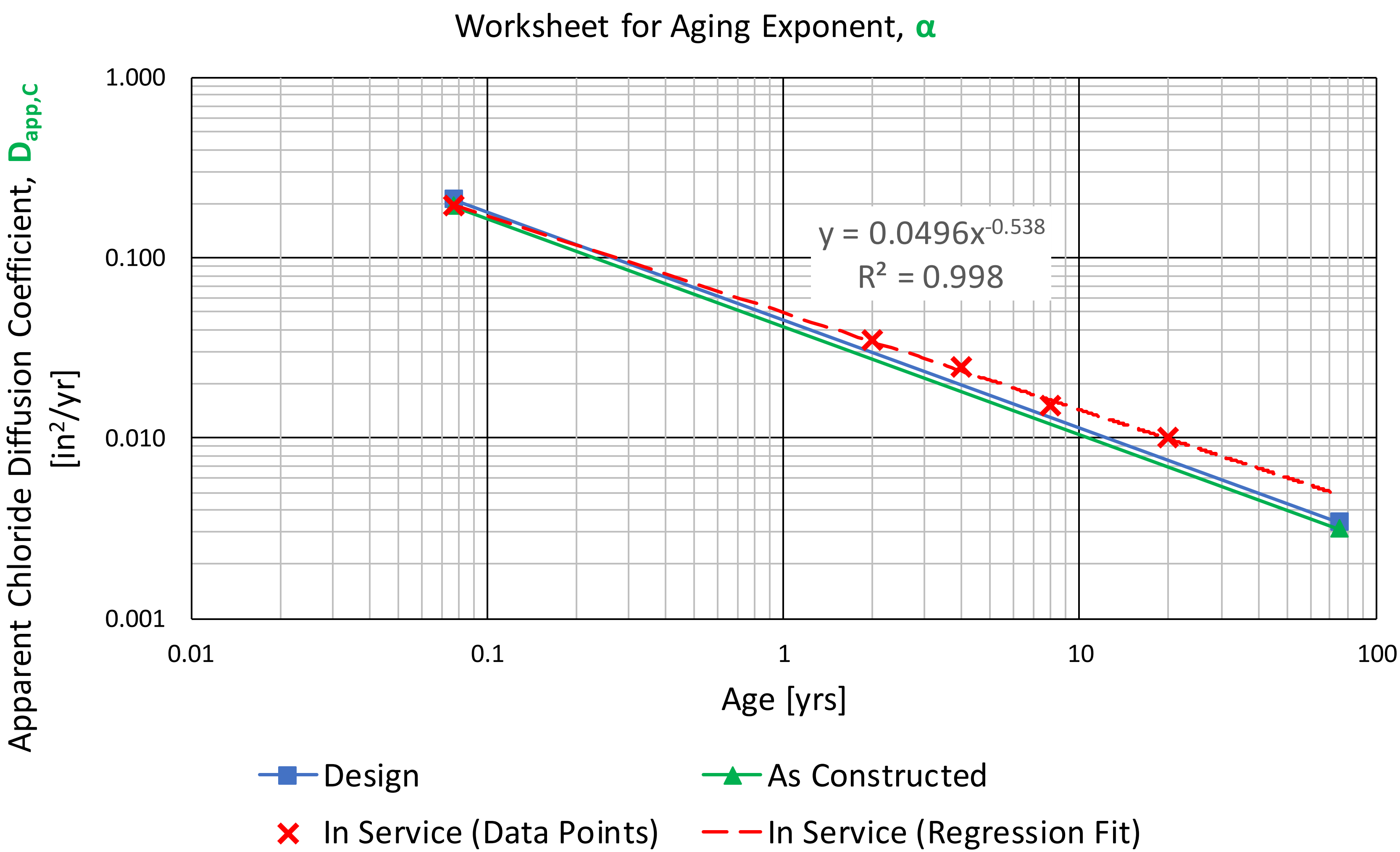
Component Name	Deck	Figure ID	Superstructure 1	Required Service Life [yr]	75
Location	Span 1			Reliability Index, β	1.3

Deterioration Model - fib Bulletin 34, Annex B2, Full probabilistic design method for chloride induced corrosion - uncracked concrete					Design		As-Constructed	
Property		Variable	Units	Distribution	Mean, μ	Std Dev, σ	Mean, μ	Std Dev, σ
Environmental Parameters								
Exposure Class	XD3							
Surface Chloride Concentration		$C_{S,\Delta x}$	[wt-%/cem]	Log-Normal	4.00	2.00		
Transfer Function		Δx	[in]	Beta a=0, b=50	0.35	0.22		
Temperature at Site		T_{real}	[°F]	Normal	52.7	3.6		
			[°K]		284.7	2.00		
Standard RCM Test Temperature		T_{ref}	[°K]	Constant	292.9			
Temperature Regression Variable		b_e	[°K]	Normal	4800	700		
Concrete Properties								
Class/Mix Design	HP					OPC+20-35		OPC+20FA
Initial Chloride Content		C_o	[wt-%/cem]	Constant	0.1			
Chloride Migration Coefficient		$D_{RCM,0}$	[in^2/yr]	Normal	0.342	0.137	0.313	0.125
Aging Exponent		α	n/a	Beta a=0, b=1	0.60	0.15	0.60	0.15
RCM Testing age (28 days)		t_o	[yr]	Constant	0.0767			
Transfer Parameter		k_t	n/a	Constant	1.0			
Steel Reinforcement Properties								
Reinforcing Type/ Grade	Carbon	A615						
Critical Chloride Threshold		C_{crit}	[wt-%/cem]	Beta a=0.2, b=2	0.6	0.4		
Clear Cover		cov	[in]	Log-Normal	2.75	0.3	2.72	0.36

Structural Component Data

In-Service Monitoring			Chloride Diffusion Coefficient at age t, $D_{app,C}(t)$		Surface Chloride Concentration, C_S or $C_{S,\Delta x}$		Aging Exponent, α		Service Life, t_{SL}	End of Service Date
Life Cycle Stage	Age, t [yr]	Test Method	[in^2/yr]		[wt-%/cem]		n/a		[yr]	[yyyy]
			Mean, μ	Std Dev, σ	Mean, μ	Std Dev, σ	Mean, μ	Std Dev, σ		
Design/Construction										
Assumed Design	0.0767	NT Build 492	0.213	0.1	4.00	2.00	0.60	0.15	75	2092
	75		0.003							
As-Constructed	0.0767	NT Build 492	0.195	0.1	4.00	2.00	0.60	0.15	90	2107
	75		0.003							
In Service Durability Monitoring			Measured Properties from Chloride Profiling Tests				Regression Calculation		Monte Carlo Calculation	
Inspection 1	2		0.035		4.00	2.00	0.526	0.132	42	2059
Inspection 2	4		0.025		4.00	2.00	0.521	0.130	40	2057
Inspection 3	8		0.015		4.00	2.00	0.540	0.135	48	2065
Inspection 4	20		0.010		4.00	2.00	0.538	0.135	46	2063
Inspection 5										
Inspection 6										
Inspection 7										
Inspection 8										
Inspection 9	75									

Structural Component Data



Summary

- Birth Certificate documents durability properties to assist in evaluating durability performance

- Birth Certificate provides a means for collecting data for future development of deterministic code provisions

Questions?

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Resource: AASHTO's R19A Product Page

- http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx