Comparison of Service Life Models

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Session 1

Learning Objectives

(1) Summarize background on the models;
(2) Identify what tests are needed to run the models;
(3) Discuss how boundary conditions are determined;
(4) Establish service life predictions for scenarios.

Session 2

Learning Objectives

(1) Discuss models for multiple layers that can address overlays and membranes;
(2) Explain the cracking of concrete in models;
(3) Propose how to address non-water saturation and chemical reactions specific to the concrete composition;
(4) Respond to questions from the audience to help in selection of the model to use.

Note that there will be overlap in the objectives between sessions 1 and 2

Overview

- Several models are available to predict service life of steel reinforced concrete exposed to corrosive environments. Today's discussions are concentrated on chloride induced corrosion.
- The various models have different input parameters and test methods to determine those parameters.
- An experimental data set was made available that determined several of the parameters required for the different models using on the same concrete mixes.
- The data was made available to all of the presenters to use to model the same exposure conditions.
- The goal is not to state that one model is better than the next one, but to provide a means of understanding how the results might differ.

Introduction to Concrete Mixtures, Parameters and Scenarios

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Concrete Mixtures Used

	CTRL	SF-8	Hyaloclastite Pozzolan-20
Cement, Type I/II (lb/yd^3)	658	605	526
Silica Fume (lb/yd^3)	0	53	0
Hyaloclastite Pozzolan (lb/yd^3)	0	0	132
Fine Aggregate (lb/yd^3)	1279	1263	1273
3/4" Crushed Coarse Aggregate (lb/yd^3)	1815	1815	1680
Total Water (lb/yd^3)	250	250	250
w/cm	0.38	0.38	0.38
Design Air (%)	6	6	6

Binder Chemical Compositions

	Type I/II Cement	Silica Fume	Hyaloclastite Pozzolan
SiO_2 (%)	19.80	94.04	48.90
Al_2O_3 (%)	4.70	0.20	14.90
Fe_2O_3 (%)	3.00	0.20	12.65
CaO (%)	63.60	0.38	8.70
MgO (%)	2.10	0.42	6.80
SO_3 (%)	2.70	0.13	0.14
K_2O (%)	0.40	0.59	1.05
Na_2O (%)	0.11	0.20	2.80
Loss on Ignition (%)	2.70	3.84	0.10

Test Results

	CTRL	SF-8	HP-20
ASTM C642 – Volume of Permeable Voids (%)			
28-Day	8.8	11.8	12.8
90-Day	11.4	11.8	12.2
ASTM C1556 – Apparent Diffusion Coefficient ($\times 10^{-12}$ m^2/s)	4.6	1.2	2.1
ASTM C1585 – Capillary Absorption ($mm/s^{1/2}$)			
Initial Absorption	0.0004	0.0003	0.0008
Secondary Absorption	0.0003	0.0002	0.0002
ASTM C1760 – Bulk Electrical Conductivity (mS/m)			
28-Day	11.0	3.3	6.5
56-Day	9.1	2.5	3.9
90-Day	8.3	2.3	2.4
NT Build 492 – Non-Steady-State Migration Coefficient ($\times 10^{-12}$ m^2/s)	14.0	3.6	9.6
STADIUM® IDC OH^- Diffusion Coefficient ($\times 10^{-11}$ m^2/s)			
28-Day	17.47	3.11	4.99
90-Day	12.85	2.41	1.91
STADIUM® MTC Permeability ($\times 10^{-22}$ m^2)			
28-Day	23.26	3.35	15.59
90-Day	11.50	2.71	5.76

**Unless otherwise specified, the tests were performed on 28-day wet-cured samples.*

Modeling Cases

	Case 1	Case 2	Case 3
Location	Boston, MA		
Element	Bridge Deck	Marine Pile	Marine Wall
Thickness/Diameter	8 in	36 in	8 in
Exposure	Deicing Salt	Submerged	Splash
Target Initiation Time with 90% Confidence	100 years		
Cover	2.5 in	3.0 in	3.0 in
Maximum Surface Concentration	5500 ppm	8000 ppm	10000 ppm
Black Bar Initiation Threshold	735 ppm		
Enhanced Initiation Threshold	2500 ppm		
Hydration Time	8 years		

Background Chloride at 85 ppm

Synopsis

- Various models are available to model service life for steel reinforced concrete structures.
- Different test methods are used to provide inputs to the models and one comparison to these results for the same concretes was presented and to be used in the presentations that follow.
- Means of increasing the chloride threshold value for corrosion initiation were addressed. This could be accomplished with more corrosion resistant alloys, coatings, or a corrosion inhibitor.
- Three modeling cases were provided for the presenters to use in their service life predictions.
- The emphasis today is on chloride-induced corrosion initiation.
- At the end of Session 2 there will be a panel discussion with the audience.