FACTORS AFFECTING MICROCRACKING IN PRE-STRESSED CONCRETE GIRDERS

CENTER FOR TRANSPORTATION RESEARCH

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BACKGROUND

Low water-cement ratio concretes are commonly used in bridge girders by TXDOT where high strength and low permeability are required. However, due to the low water-cement ratio and limited curing period of these pre-stressed girders, these mixtures may be more susceptible to microcracking.

This leads to concerns about **durability and corrosion** of the pre-stressing strands and rebar, as the cracks can provide easy access to deleterious substances and can eventually lead to reduced service life.

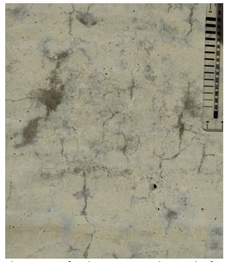


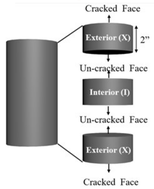
Fig: Microcracks in In-Service Girders

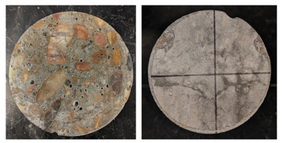
OBJECTIVES

- Determine which of the factors that can have a critical role in the growth of microcracks in in-service girders: Sustained Loading, Exposure to Environment and Presence of Pre-Existing Cracks.
- Quantify the role these factors play on the temporal behavior on the rate of growth in microcracking and loss in durability.
- Estimate the loss in durability and resulting reduction in service life of pre-stressed concrete girders with microcracking.

METHODOLOGY

- Determine the factors that have the biggest impact on rate of growth of Microcracking.
- 22 Alternate wetting and drying cycles conducted on samples with various degrees of initial microcracking and non destructive tests were conducted at the end of each:
  - **Dry Cycle**—Cracking, Mass and Volume Measurements
  - **Wet Cycle**—Mass, Ultrasonic Pulse Velocity (UPV), Bulk Resistivity Measurements.





Sample Preparation

Accelerated Weathering Test

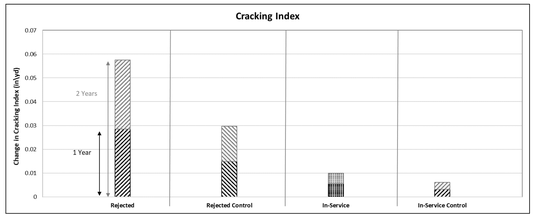
RESULTS - FACTORS AFFECTING CRACKING

The following results were obtained after monitoring the growth in cracking of five rejected and eight in-service girders for two years:

- In-service girders (Loaded) have **lower** rate of increase when compared to Rejected girders (Unloaded).

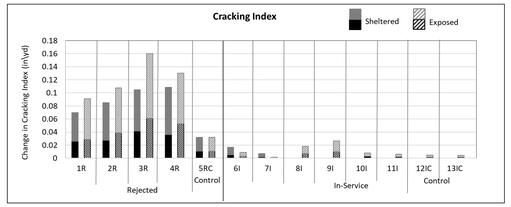
Rejected Girder

In-Service Girder



- Sheltered faces have **lower** rate of increase when compared to Exposed faces of the girders.

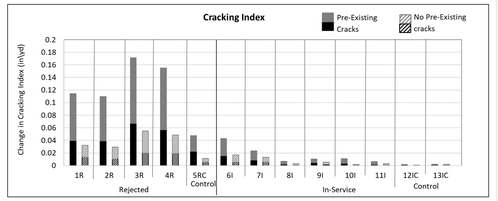
(a)View from Right Side (b) View from Left Side



- Un-cracked Sections (Middle) have **lower** rate of increase when compared to Cracked Sections (Ends).

Typical Rejected Girder

Test Locations on Rejected Girder

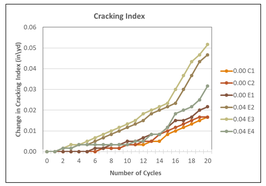


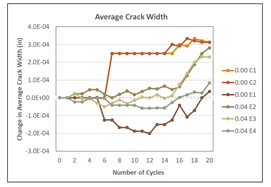
- Sustained Loading ⟷
- Exposure to Environment
- Pre-Existing Cracks ↑

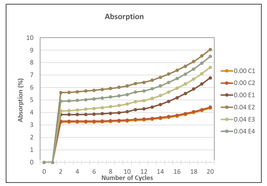
RESULTS - ACCELERATED WEATHERING TEST

The following results were seen at the end of 22 cycles:

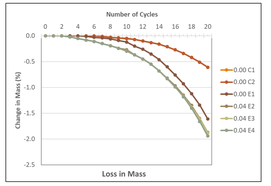
- **Increase** in Cracking, and Absorption

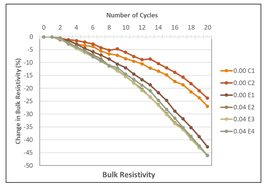


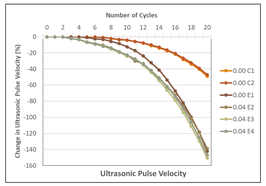




- **Decrease** in Mass, Ultrasonic Pulse Velocity, and Bulk Resistivity







- Good correlation have been observed between **initial** cracking, UPV and resistivity values and **cumulative final loss** in durability.
- Samples with higher initial cracking have higher durability loss at the end of the accelerated weathering test.

Correlation Coefficients (R^2) between Initial and Final Durability Parameetrs

Initial Value / Final Value	CI	CW	UPV	BR
Cracking Index (**CI**)	0.69	0.15	0.62	0.56
Average Crack Width (**CW**)	0.24	0.58	0.02	0.03
Ultrasonic Pulse Velocity (**UPV**)	0.64	0.14	0.72	0.83
Bulk Resistivity (**BR**)	0.72	0.11	0.84	0.70
Mass	0.80	0.18	0.76	0.74
Density	0.51	0.06	0.73	0.70
Volume	0.54	0.05	0.73	0.72
Absorption	0.69	0.25	0.60	0.36

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