EVALUATING LONG-TERM DURABILITY AND PERFORMANCE OF PRE-STRESSED CONCRETE BEAMS WITH EXTENSIVE SURFACE CRACKING

CENTER FOR TRANSPORTATION RESEARCH

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BACKGROUND

Unexplained **microcracks** found in **in-service**, pre-stressed concrete girders with low water-cementitious ratios, have led to concerns about the future integrity of these girders. In 2016:

- Over 90% of new bridges in Texas built were with prestressed concrete.
- Over 900,000 linear feet of prestressed concrete beams was fabricated.
- $239.3 million of public money was spent on maintenance of bridges.

While commercially available service life models can be used to estimate the service life of girders, it is not possible to account for cracking in these models. Hence, it is important to create a service life model that can account for not only the extent of cracking, but also the temporal behavior of cracking.

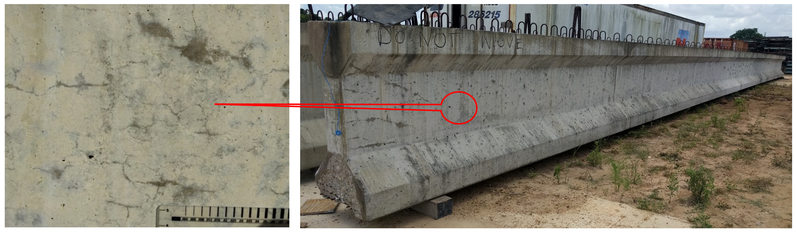


Fig: Typical pre-stressed girder showing surface microcracking

OBJECTIVES

- Determine the likelihood of long-term material and structural problems occurring from these cracks and thereby, improve the understanding of the temporal behavior of these microcracks on:
  - Mechanical Properties of Concrete.
  - Loss in Durability.
- Utilize the temporal data to develop a model for prediction of remaining service life.

METHODOLOGY

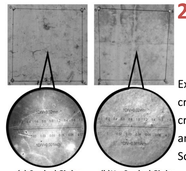
1. Select **field specimens** exhibiting surface microcracking

Rejected girders **not** subjected external loads

In-Service girders **subjected** to external loads

Exposure Blocks

2. Conduct **non-destructive testing** on Girders



(a) Cracked Girder (b)Un-Cracked Girder

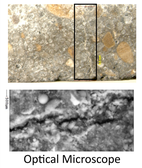
Extent of cracking via crack Grid and Crack Scope Images

Concrete condition via Ultra-sonic Pulse Velocity (UPV)

Surface Resistivity

Exposure conditions
- Location
- Local Temperature
- Orientation of Element
- Drainage Conditions
- Chemical Exposure
- Age

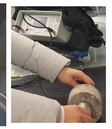
3. Laboratory testing of Cores



Optical Microscope and SEM Image

Cracking

Compressive Strength and Modulus



UPV

Strength Testing

Accelerated Weathering

Corrosion Potential Measurement (Surface, Bulk, RMT)

Durability Testing

4. Determine **relationships** between field and laboratory tests

5. Model the **rate of change** of cracking, loss in durability and strength

6. Determine **end of service life** conditions

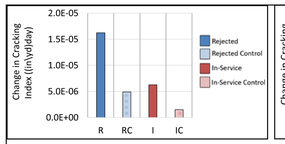
7. Extrapolate from the present to the end-of-service life state to establish **remaining service life**

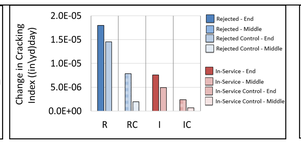
8. Validate Model

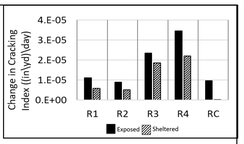
RESULTS, CONCLUSIONS AND FUTURE WORK

The following results were seen over a one year period:

- All girders have exhibited an increase in overall cracking and loss in durability.





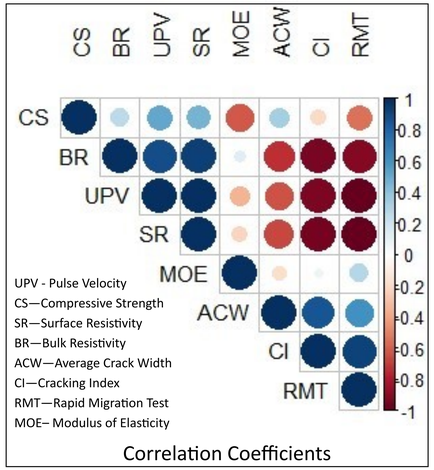


External Loading has not shown any effects yet.

Pre-existing cracks and exposure to the environment exacerbates the rate of cracking and loss in durability.

Temporal Evolution of Cracking Index in Girders

- Non destructive test measurements on cores correlate with durability and strength parameters, allowing for comparison of laboratory and field measurements.
- **Microcracks play an important role in the deterioration.**
- Additional field visits will be conducted to determine the **extent** of the **effect that microcracking** on the strength and durability properties of concrete.



Correlation Coefficients

ACKNOWLEDGEMENTS

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