



Porosity-Elastic modeling and measurement of rebar corrosion and crack formation using high frequency ultrasonics.

Principal Investigator:

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Project Goal:

To demonstrate the ability to detect early appearance of cracks in reinforced concrete due to rebar corrosion, using ultrasonic nondestructive acoustic testing with no direct contact between the sensor and the concrete block, in conjunction with a porosity-elastic ultrasound propagation model, originally developed by the PI for sediment applications, and adapted for corrosion and fracture in reinforced concrete.

Objectives:

- (1) Identify the proper measurement configuration and predict the performance, using the modeling of the ultrasound propagation in the reinforced concrete;
- (2) Perform a series of targeted measurements using the proper ultrasonic transducers on a set of existing reinforced concrete samples placed in partial or complete immersion;
- (3) Evaluate the degree of corrosion within the reinforced concrete with confidence levels according to the porosity-elastic model, and correlate the results with those obtained using traditional non-invasive techniques (e.g. corrosion current and corrosion potential measurements).



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Work Schedule and Milestones:

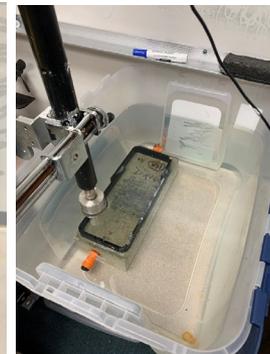
- Task 1 (Months 1-6): Improvement in the porosity-elastic model and development of the signal processing algorithms to identify rebar expansion and crack propagation.

Milestone 1: Operating signal processing algorithms at the end of Month 6.

- Task 2 (Months 1-6): Processing of simulated data sets.
- Task 3 (Months 1-6): Ultrasonic data collection on a limited number of reinforced concrete samples.
- Task 4 (Months 7-10): Signal processing of the collected data to identify rebar expansion and crack propagation.
- Task 5 (Months 11-12): Comparison between simulated and experimental results, drafting of the yearly report.

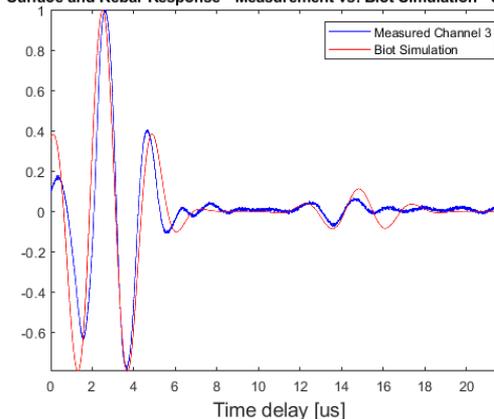
Milestone 2: Yearly report at the end of Month 12.

- Task 6 (Months 1-12): Further pursuit of an industry partnership with Olympus, in the likely form of a free loan or donation of an ultrasonic acquisition unit and contact transducers.



Ultrasonic testing of the reinforced concrete sample fully immersed in salt water. Left: side-view. Right: Top view.

Surface and Rebar Response - Measurement vs. Biot Simulation - 3/5/2021



Comparison between measured and simulated results. In blue: concrete echo and rebar echo obtained using an average across the ten ultrasonic signatures. In red: Porosity-elastic model simulation result.