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NONDESTRUCTIVE TESTING FOR ADVANCED MONITORING AND EVALUATION OF DAMAGE IN CONCRETE MATERIALS

PROBLEM STATEMENT

Nondestructive testing (NDT) has the potential to be a powerful investigative tool for transportation professionals because it can be used to detect problems in concrete structures without inducing (further) damage and, moreover, can do so with minimal expenditures of time and manpower. Unfortunately, in Florida, there is a significant lack of expertise with regard to performing NDT and understanding the fundamental relevance of NDT results.

OBJECTIVES

The purpose of this research was to provide the groundwork for future research aimed at using nondestructive testing to monitor new structures for compliance with FDOT performance specifications. The research was intended to improve the state of knowledge of the processes prerequisite to devising nondestructive testing regimes that can be used to monitor new structures to ensure adequate performance and detect defects or damage present in existing structures.

Identifying the deterioration mechanisms and defects most relevant to bridge structures in Florida was the first task, which was to be accomplished through a survey of relevant structures in Florida by reviewing inspection records, searching the Pontis Bridge Management System database, interviewing FDOT personnel, and examining a limited number of structures in the field.

Also, researchers reviewed previously published literature to assist in identifying specific nondestructive techniques, or combinations of techniques, which would be most effective for evaluating the damage mechanisms expected in Florida bridges. In order to evaluate the effectiveness of the chosen NDT techniques, the most prevalent deterioration mechanisms identified in the survey were reproduced in the laboratory. In this case, micro-structural cracking was induced through exposure of concrete specimens to a sulfate solution.

FINDINGS AND CONCLUSIONS

When considering factors such as effectiveness, applicability, ease of use, and cost, the most effective nondestructive testing techniques for the evaluation and monitoring of new concrete are those implementing pulse wave velocity measurements, specifically ultrasonic pulse velocity and impact echo. Though not able to actually identify the type or source of damage, per se, they are definitely capable of detecting damage and measuring severity on a relative scale over time. They are thus well suited for periodic monitoring of new structures, or even older structures once a baseline condition is assessed. Using these techniques in a tomographic imaging strategy to create a

three-dimensional “image” of a concrete member is particularly effective, not only at defining damage but also in locating and delineating the extent of the damage.

Researchers found that the wave velocity techniques were indeed sensitive to small changes in physical properties, which were determined from destructive testing. Field testing showed that these techniques were not only effective in detecting large-scale cracking, but could also physically locate such damage precisely when a tomography approach was used.

The most prevalent form of damage was found to be cracking, both macro-scale (induced by structural loading, reinforcement corrosion, shrinkage, creep, etc.) and micro-scale (induced by sulfate attack or wet-dry cycling among others). Other forms of deterioration included surface damage due to seawater exposure and delamination of improperly repaired sections.

BENEFITS

This research provides guidance for the use of the studied nondestructive testing technologies for evaluation of concrete bridge structures in Florida. Though the tests themselves could be implemented immediately, additional work is needed to formulate a procedure that will render their use in bridge inspections effective and expeditious. The ultimate result will be a more effective approach to bridge damage inspection. Detection of deterioration problems will be possible at earlier ages and thus help to reduce long-term maintenance costs. Nondestructive testing is expected to become a critical component of the evaluation process that will be implemented as part of FDOT’s move to performance-based specifications.

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