Joint Transportation Research Program

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Implementing Rapid Durability Measure for Concrete Using Resistivity and Formation Factor

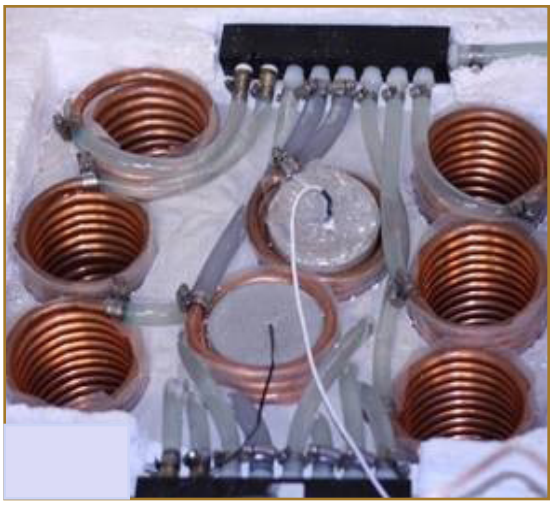
Introduction

Ensuring adequate durability of in-place concrete is a high priority. Several studies have been conducted by INDOT to use resistivity as a measure of fluid transport- or permeability-related properties. Resistivity has been shown to be dependent on the chemistry of the pore solution. Formation factor is a more fundamental measure of transport properties and can be obtained experimentally by normalizing the resistivity of the concrete by its pore solution resistivity. A procedure has been developed (AASHTO TP-119-19 Option A) to enable an apparent formation factor to be determined, since the moisture condition is well defined and the pore solution composition is known (0.127 Wm). An accelerated aging procedure is described in this report. This project aligns INDOT pioneering work with the national-level efforts (such as those of ASASHTO TP-119-19 Option A and AASHTO PP-84-16). This project can benefit the Indiana Department of Transportation (INDOT) with a potential specifiable property which can improve the quality of concrete obtained in the field.

Findings

This project has several findings including the following:

- Resistivity can be measured using AASHTO TP-119-19 (Option A). This testing procedure was developed based on the findings from INDOT studies and other related studies.
- Samples were tested to establish the current levels of performance for concrete pavements in the state of Indiana.
- Sample conditioning indicates that submerging samples in a simulated pore solution enables the matrix saturation to be reached. This measures transport through the matrix. These findings are consistent with AASHTO TP-119-19 Option A.



- Field samples were tested and may indicate that high paste contents can have a greater connectivity due to the increased porosity of the concrete. It is also noted that concrete with a very low paste content can have an increase in connectivity, presumably due to the connection of the interfacial transition zones and potentially insufficient consolidation.
- Testing can be conducted using a procedure of holding the sample at 23°C for 3 days, followed by 25 days at 50°C to achieve an equivalent age of 91 days. The use of this procedure enables the reactions of supplementary materials to be more fully considered.
- A methodology is reviewed whereby the formation factor can be related to the apparent diffusion coefficient if chloride binding is considered. This could be utilized to establish service life for concrete used in reinforced elements like bridge decks.
- AASHTO PP-84-16 recommends a formation factor of 1,000 for concrete paving mixtures exposed to deicing salts. As such, it is recommended that when AASHTO TP-119-19 Option A is used for testing the trial batch target a resistivity value of 14.8 kW·cm or greater is achieved, while the acceptance value for resistivity used during construction should be 12.7 kW·cm or greater.

Implementation

This research has been instrumental in the development of standard procedures that have been accepted by AASHTO as AASHTO TP-119-19. INDOT can implement the measurement of resistivity and specification of formation factor using this test. Further, this procedure outlines an accelerated aging procedure. Findings of this research have been presented at several SAC meetings as well as at the national concrete consortium. National studies are underway to assess precision and bias for AASHTO TP-119-19.

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