TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): INDOT - Indiana Department of Transportation

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF - 5 (179) SPR 3280	☐Quarter 1 (January 1 – March 31) ☑Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☐Quarter 4 (October 1 – December 31)

Project Title:		
Evaluation of Test Methods for Permeability (Transport) and development of Performance Guidlines for Durability		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Tommy Nantung	(765) 463-1521 ext. 248	tnantung@indot.in.gov
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
INDOT		07/01/2008
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
06/30/2012	12/31/2014	1

Project schedule status:

☐ On schedule ☑ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$1,005,000.00	$934,923.39	99%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$24,879.73 (2.5%)	3.1%	92.2%

Project Description:

The primary purpose of this project is to develop a test procedure that directly evaluates the permeability (transport properties) of concrete and relates these to anticipated field performance with the use of exposure conditions. This consists of the following distinct objectives:

• Evaluation of existing permeability (transport) test procedures.
• Development of new, or improvement of existing test, procedures to evaluate permeability (transport) properties of concrete.
• Correlation between permeability (transport) properties and measured material response to existing 'durability' tests.
• Develop guidelines to relate permeability, exposure conditions, and field performance for use in specifications and quality control processes

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

Please see the report attached. It will be divided in the following sessions:
Session 1: Purdue University
Session 2: Papers from this and previous quarters
Session 3: NRMCA National Ready Mixed Concrete Association

Anticipated work next quarter:

The next quarter will be dedicated to finalizing the remaining portions of the project that still need to be completed (see below). Simultaneously, all results obtained during the project will be gathered and the draft of the final report will be prepared for review and shared at the end of the next quarter.

Following the discussion had during the TPF presentation (20th of November, 2013) INDOT (dr. T. Nantung) and Purdue University (prof. J.W. Weiss) are planning the SAC meeting. It will be held during early fall in West Lafayette, IN.

Comparison of methods for diffusion coefficient evaluations

The drying of cementitious materials has been attracting the interest of the concrete community since it relates to several durability aspects. Drying of concrete is usually described using a non-linear differential equation function of the so-called non-linear moisture diffusion coefficient. The quantification of the moisture diffusion equation is challenging and requires lengthy tests or sophisticated instruments. Different modeling approaches and different experimental approaches will be compared. One method is currently under investigation at ASTM and SIMCO technologies have a standard procedure that is used in their durability predictions. The study will be finalized in the next quarter.

Significant Results:

Resistivity of layered cementitious composites:

A study was finalized that measured the electrical response of layered cementitious composites using uniaxial and surface resistance measurements. The interest in layered composited is related to the presence in the field of gradients generated by moisture, chemical changes, ionic gradients, carbonation, finishing operations, etc. When evaluating the resistivity of cementitious composites, this work suggests the use of two types of corrections: k, which account for geometrical homogeneity and Γ that represents a correction for heterogeneity. This paper also proposes a method for determining the presence of a heterogeneity problem: by conducting both uniaxial and surface resistance measurements on the same specimen, and correcting these measurements using their respective geometry factors. If the specimen is homogenous, one would expect that the surface and uniaxial test methods would result in equal estimates for the resistivity. Further practical implication of this would include the use of resistivity to assess the diffusion coefficient and testing the resistivity on a surface that was no longer homogenous, through drying or leaching of alkalis. By applying the geometry correction and ignoring the correction due to inhomogeneity, it is possible to overestimate/underestimate the quality of the concrete.

Ruggedness testing of permeability tests:

The complete series of mixtures have been cast (0.42 w/c, 0.48 w/c and 0.54 w/c). The series of transport have been completed for the following tests: electrical resistivity tests, SIMCO ionic diffusion test, SIMCO moisture diffusion test, RCPT (ASTM C1202), Nord Test (NT BUILD 492) and ponding test (ASTM C1583). The comparison among the all series of transport test methods performed will be presented in the final report.

Continue in the next session

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

A no cost extension was requested during the conference call held on the 20th of November. The extension was approved trough the end of July to provide the time needed to assemble all the information gathered until now and to prepare the final documentation. The draft report of the project will be available August 1, 2014 with time for review comment that will enable publishing by the end of 2014.

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Implication of saturation of air entrained voids on transport
Air entrainment is commonly used to improve the durability of concrete materials exposed to freezing and thawing. While the influence of air voids on freeze/thaw damage and salt scaling is frequently studied, the influence of entrained air voids on ionic transport has been studied less frequently. A study has been conducted to address this topic by looking at the implication on chloride transport. Results showed that the saturation of air voids in the concrete materials is not easily achieved with immersion and boiling method as described in ASTM C642-13. However, it can be achieved using a sufficient level of vacuum saturation of 7 ± 2 Torr. Due to non-saturation of air voids the surface chloride concentration from the ponding test resulted in a 25% decrease, as well as the current registered during steady-state migration test (Stadium® IDC tests) decreased of 25%. Similarly the resistivity was 25% higher for the material with air voids not saturated compared to the material completely saturated.

Potential Implementation:

A potential standard was forwarded to AASHTO in August of last year. To date comments have not been received. Additional draft standards will be able to be developed based on the tests still being conducted.