RESEARCH, DEVELOPMENT & TECHNOLOGY TRANSFER
QUARTERLY PROGRESS REPORT

Wisconsin Department of Transportation
DT1241 4/2010

INSTRUCTIONS:
Research project investigators and/or project managers should complete a quarterly progress report (QPR) for each calendar quarter during which the projects are active.

WisDOT research program category: ☐ Policy research ☐ Wisconsin Highway Research Program ☒ Other ☐ Pooled fund TPF#		Report period year: 2012 ☐ Quarter 1 (Jan 1 – Mar 31) ☒ Quarter 2 (Apr 1 – Jun 30) ☐ Quarter 3 (Jul 1 – Sep 30) ☐ Quarter 4 (Oct 1 – Dec 31)
Project title: Superhydrophobic Engineered Cementitious Composites for Highway Bridge Applications: Phase II		
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WisDOT project ID: n/a	Other project ID: CFIRE 04-09	Project start date: 10/1/2011
Original end date: 9/30/2012	Current end date: 9/30/2012	Number of extensions: 0

Project schedule status:
☒ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Project budget status:

Total Project Budget	Expenditures Current Quarter	Total Expenditures	% Funds Expended	% Work Completed
$75,786.00	$21,153.00	$55,365.00	73%	85%

Project description:
The strength and durability of highway bridges are the key components in maintaining a high level of freight transportation capacity on the nation's highways. Highways, bridges, and other critical transportation infrastructure works are rapidly deteriorating due to loading and deformation, aging, de-icing, and other detrimental factors in addition to rebar corrosion. production and recycling of basic concrete materials.
The focus of the research project is to develop a new hybrid engineered cementitious composite (ECC), using polyvinyl alcohol fibers and hydrophobic compounds, to create a substitute concrete which can provide the strength and durability demanded in key regions of highway bridges.
The superhydrophobic hybridization approach is a highly effective method for controlling the durability of concrete with large volumes of mineral additives or byproducts used as cement replacements. The developed superhydrophobic ECC will meet the top sustainability benchmarks and serve as the next technological level for sustainable concrete infrastructure with high performance and long service life.

Progress this quarter (includes meetings, work plan status, contract status, significant progress, etc.):
The majority of the work done for the quarter has been dealing with durability of SECC. A set of specimens were created which incorporated superhydrophobic emulsions. A reference set of specimens without any superhydrophobic emulsion were also created to determine the improved performance of the emulsions. Each set of specimens was created at a water to cementitious ratio of 0.3 and 0.45. These specimens also had a sand to cementitious ratio of 0.5 and 1.0 respectively. The superhydrophobic emulsions were created by the same means as before although nano- and micro- particles were added to increase the hydrophobicity. Another difference between these specimens and the specimens that were already tested for

freeze-thaw is that the only supplementary cementititous material that was used was ground granulated blast furnace slag. Slag cement was used at 50% replacement for portland cement. In the past, 45% of ground granulated blast furnace slag was used along with 5% silica fume. Results from this test show that all specimens performed very well making it difficult to distinguish between the samples with and without hydrophobic emulsions. Our theory was that the addition of the silica fume drastically increased the durability of the material. Although there was not much difference between the samples, the specimens with hydrophobic emulsions were performing slightly better than those without. Because of only slight differences, it was thought that the exclusion of silica fume from the samples would show a more distinct difference between samples with and without superhydrophobic emulsions.

Results from both tests show that specimens with a higher water to cementitious ratios show more deterioration. The new set of specimens that did not contain any silica fume has shown a great deal of deterioration, especially specimens without superhydrophobic emulsions. These specimens have already failed before reaching 300 cycles at -50 C, however the same mixture specimens but with superhydrophobic emulsions are still in good shape after 350 cycles. All specimens with lower water to cementitious ratio are performing well with the ones incorporating the emulsion having better performance.

Tests are also currently being performed on the same set of samples in both fresh water and salt water. Each of these are subjected to a minimum temperature of -20°C and -50°C. These tests are being performed simultaneously to prove the accuracy of an accelerated freeze-thaw testing method.

Samples were also created with embedded internal strain gauges. These allow us to see the deformations within the sample during freezing whereas before we could only test the specimens in the thawed state. The intent of this is to create a testing method for freezing and thawing that can be done remotely through a computer instead of manually testing every 25-50 cycles.

Anticipated work next quarter:

A set of specimens with the same proportions as mentioned above for the new freeze-thaw test were created for other durability tests. These tests will be performed within the next weeks and include; rapid chloride permeability, absorption, rate of absorption, and abrasion resistance.

Mixtures were also created in order to determine air-void analysis (hardened air content).

Selected ECC mixtures with superhydorpohobic admixtures will be used for larger beam bending tests to prove the performance in an approach slab.

The final report will be updated using these new results.

Circumstances affecting project or budget:

none

Attach / insert Gantt chart and other project documentation

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Staff receiving QPR:	Date received:
Staff approving QPR:	Date approved:

Task Number	Task	Year 2						Activities Progress, %
		Months 1-2	Months 3-4	Months 5-6	Months 7-8	Months 9-10	Months 11-12	
Task 1	Durability investigation will focus on adopting the existing accelerated methods							95
Task 2	Permeability investigation (RCPT)							85
Task 3	Determine the microstructure - water transport properties relationship							75
Task 4	Develop models for predicting SECC transport properties and freeze-thaw performance							25