

State of Wisconsin/Department of Transportation
 RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: December 31, 2007

Program: SPR-0010(36) FFY99		Part: II Research and Development	
Project Title: <i>Detecting Deleterious Fine Particles in Concrete Aggregates And Defining Their Impact</i>		Project ID: 0092-07-02	
Administrative Contact: Nikki Hatch		Sponsor: Wisconsin Department of Transportation	
WisDOT Technical Contact: Jim Parry		Approved Starting Date: 10/1/2006	
Approved by COR/Steering Committee:		Original End Date: 10/1/2008	
Project Investigator (agency & contact): Steve Cramer (UW-Madison)		Current End Date: 10/1/2008	
		Number of Extensions: 0	

Percent Complete: 40%

Request a No Cost Time Extension (Please Select One): YES NO

Reason for No Cost Time Extension:

Project Description:

Currently, WisDOT specifications limit the fine particle content (passing the #200 sieve) of coarse aggregates to 1.5 percent by weight. There is increasing evidence that within some reasonable limits this is not an issue of the *quantity* of fine material but rather its mineralogical nature. Clays have been shown to influence the parameters controlling hydration of the cement paste and providing a structural barrier to the bond with aggregates.

The objectives of this research are to:

- 1) Develop a rapid test to detect clay particles in aggregate sources that is both indicative of their quantity and their physical and chemical nature. This is intended to indicate whether these clays are harmful or innocuous.
- 2) Quantify the impact of total (from combined coarse and fine aggregates) clay content on concrete strength development, shrinkage and porosity. Advance a fundamental knowledge of the role of clays in concrete performance so that mitigation strategies can be formed in future research.
- 3) Quantify clay content from several Wisconsin sources of aggregates to determine the relative contribution of clay fines from coarse aggregates and from fine aggregates.

Progress This Quarter:

(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

Building on discussion initiated in the previous quarter, a system was put into place to receive aggregate samples potentially containing microfines for evaluation of the new test procedure, characterization of the microfines and for consideration for conducting concrete testing. Cramer and McMullen contacted the Wisconsin Aggregate producers seeking their cooperation and Parry contacted the WisDOT districts. The efforts by Parry resulted in aggregate samples being provided to WisDOT and in turn these samples were transported to the university. It is anticipated aggregate samples directly from the aggregate producers will begin to arrive in the next quarter. The recent success in soliciting aggregate samples has allowed for redefinition of the project and this is being explored within WHRP.

As in previous quarterly reports, the new technical accomplishments were divided in two lines of work: 1) refinement of new test procedure to characterize microfines and 2) gathering material to begin task 2 involving the evaluation of concrete containing microfines.

- 1) Refinement of new test procedure. The effectiveness of potassium carbonate to distinguish binary mixes of calcium and sodium has been evaluated. Results have shown that experimental conductivity of ternary systems formed by sodium-calcium nitrates and potassium carbonate is lower than those calculated. These last values were adjusted due the presence of atmospheric CO₂. Due this added complexity in working with carbonate microfines in the presence of open atmosphere the research group decided to simplify the system by working with phosphates as complexation agent.
- 2) Gathering material to begin task 2. The 28th of November, a total of 15 samples of pit run material collected by WisDOT were received in our laboratories. A draft characterization plan has been developed to classify and allow down selection of the most interesting coatings under the presumption that the work plan will be modified in the next quarter as alluded to above. There are two main objectives of this selective process: I) evaluate harmful, beneficial or innocuous character of the microfines, and II) select the most interesting coatings for studying their impacts on concrete performance.

In order to achieve both objectives the proposed classification process has been divided in three levels of analysis. Each level will be use as selective filter and the degree of information provided by each one will be more specific. The different test in each level, the type of information obtains, and the criterions of selection of samples are described in details in the table below:

Level	Test	Information	Selection Criterions
1	X-ray Diffraction	Presence of peaks at low angles characteristics of clay with moderate to high water absorption capacity	Samples with potential presence of clay microfines with moderate-high water absorption capacities
	Cation Exchange Capacity (CEC)	Nature and quantity of exchangeable cations present in the microfine	
	Conductivity Test		
2	P200	Preliminary quantification of the impacts of microfines in concrete, specifically in water absorption	Microfines with a potential impact on concrete properties
	Methylene Blue Test		
	California Cleanness Test		
3	X-Diffraction	Elucidation of the microfine mineralogy	
	Thermogravimetric Analysis		
	EDS Analysis		
	Particle Size Distribution	Size distribution of the microfines	

Once the characterization protocol was set up, the samples started to be processed. As a first step, fine and coarse aggregate were separated and three types of microfines were obtained, two microfines coatings from fine and coarse aggregate, respectively, and microfines obtained from drying sieve of the fines aggregates. Sufficient quantities of microfines materials were gathered to perform the proposed tests in level 1. Then, oriented samples of all microfines were prepared and analyzed with X-Ray diffraction. Finally, a bibliographic research was done to determine the most suitable methodology to measure the CEC of the samples. A methodology based on copper diethylenamine complex absorption was chosen. The methodology was set up with a montmorillonite of known CEC and then used to start the measurement of the samples.

Work Next Quarter:

The following activities are anticipated for next quarter:

- Evaluation of potassium phosphate to discriminate between calcium and sodium conductivity
- Finish microfines samples characterization and selection for proceeding with task 2.









Circumstances Affecting Progress/Budget:

In the past, the inability to obtain meaningful aggregate samples has limited and delayed the progress of the research to the point that it had fallen behind schedule. The sudden availability of ample quantities of aggregate samples offers an exciting new opportunity for this research. Changes to the schedule, budget and work plan are being proposed.

Gantt Chart:

See next page

ID	Task Name	Duration	Start	Finish	2007												2008												2						
					Half 2, 2006						Half 1, 2007						Half 2, 2007						Half 1, 2008							Half 2, 2008					
					M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F		M	A	M	J	J	A
1	Deleterious Fine Particles Total Project by Federal FY	522 days	Mon 10/2/06	Tue 9/30/08	40%																														
2	Task 1: Develop aggregate screening test	190 days	Mon 10/2/06	Fri 6/22/07	86%																														
3	Initial clay conductivity tests in different electrolyte solutions	90 days	Mon 10/2/06	Fri 2/2/07	95%																														
4	Develop, verify, and refine test procedure	120 days	Mon 1/8/07	Fri 6/22/07	80%																														
5	Task 2: Demonstrate proposed test and evaluate concrete	285 days	Mon 4/16/07	Fri 5/16/08	18%																														
6	Screen Wisconsin combined fine and coarse aggregates for clays	140 days	Mon 4/16/07	Fri 10/26/07	80%																														
7	Select and obtain aggregates for concrete specimen prep	120 days	Mon 5/14/07	Fri 10/26/07	10%																														
8	Prepare and cure concrete specimens	100 days	Mon 6/25/07	Fri 11/9/07	0%																														
9	Evaluate strength and shrinkage	100 days	Mon 10/15/07	Fri 2/29/08	0%																														
10	Conduct microlevel studies	120 days	Mon 10/15/07	Fri 3/28/08	0%																														
11	Analyze project data	95 days	Mon 1/7/08	Fri 5/16/08	0%																														
12	Task 3: Reporting	510 days	Wed 10/18/06	Tue 9/30/08	48%																														
13	Prepare interim reports and TOC meetings as needed/requested	510 days	Wed 10/18/06	Tue 9/30/08	60%																														
14	Prepare final report	60 days	Mon 4/7/08	Fri 6/27/08	0%																														
15	Review, revise and submit final report	67 days	Mon 6/30/08	Tue 9/30/08	0%																														

Project: clay2006sched v2003 Date: Wed 1/2/08	Task		Milestone		External Tasks	
	Split		Summary		External MileTask	
	Progress		Project Summary		Split	