State of Wisconsin/Department of Transportation

RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: March 31, 2007

Program: SPR-0010(36) FFY99	**Part: II Research and Development**
Project Title: ***Detecting Deleterious Fine Particles in Concrete Aggregates And Defining Their Impact***	**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: $129,999	**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: 11%

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.)

In this second quarter of the project, development of a methodology began to detect deleterious clay particles. The first step was the calibration of the conductivity meter using seven standard solutions to obtain the constant of the cell of the electrode. The second step was to establish an initial range of sample concentrations for the method. A range was developed and adopted based on previous quarter work.

After previous steps, we start measuring conductivity (σ_{exp}) of six different electrolytes [$Ca(NO_3)_2$, $NaNO_3$, KNO_3, $LiNO_3$, $Mg(NO_3)_2$, $Cd(NO_3)_2$] and compared each one with a calculated conductivity (σ_{cal}). The σ_{cal} was calculated from the equivalent conductivities of the electrolytes at infinite dilution (Λ^o). Results showed a significant deviation (δ) from the σ_{exp}. This δ was eliminated by applying in the calculation of σ_{cal} the Kohlrausch's law correction. This adjustment was performed by representing the equivalent conductivity (Λ) of each electrolyte vs the square root of electrolyte concentrations. This new model was used for predicting σ_{ca} in ternary systems of two electrolytes and solvent. Several mixes of different selected electrolytes at different concentration ratios were prepared and σ_{exp} measured. Results showed two

main problems: 1) Kohlrausch's law is not sufficient to predict σ_{cal} in ternary systems since we again obtained a δ between the two conductivities and 2) the model is unable to distinguish in between $Ca(NO_3)_2$:$NaNO_3$ mixtures of 3:2 from 2:1. The first issue was partially solved by taking in to account another model base in the mixture rule, and acceptable values were obtained.

The goal of the research group was primarily to decrease the δ in ternary systems by applying a model based on the Onsager correction or an alternative based on the theory of mean spherical approximation (MSA). The second objective is to increase sensitivity of the method by choosing a different family of electrolytes. We intend to explore use of use acetates instead of nitrates.

Work Next Quarter:

The following activities are anticipated next quarter:

- Explore the possibility of minimize actual δ in ternary systems by applying Onsager correction and MSA theory.
- Investigate the possibility of use acetates to improve the sensibility of the method.
- Apply the most precise model to predict conductivity of clays immersed in electrolytes and compare those values with measure conductivity.

Circumstances Affecting Progress/Budget:

After a slow start, we are making progress in getting back on schedule.

Gantt Chart:

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