

Quarterly Progress Report:

Project Number and Title: 2.13: Performance Structural Concrete Optimized for Cost, Durability and Manufacturability

Research Area: Thrust 2 – New Materials for Longevity and Constructability

PI: Dryver Huston, University of Vermont

Co-PI(s): Ting Tan, University of Vermont

Reporting Period: 7/1/21 – 9/30/21

Submission Date: September 30, 2021

Overview:

This was the second quarter of the project. The activities included:

- Much of the activity during this quarter involved setting up and developing test procedures for assessing the performance of concrete mixes. A key item was to acquire shrinkage test rings. VTrans purchased a set of four shrinkage test rings for long term loan to UVM during the project. The transfer of equipment was delayed several months due to the need for putting in place a transfer agreement memorandum between VTrans and UVM. The agreement was signed late in this quarter and transferred to UVM. Figure 1 shows a shrinkage test ring set up and turned on at a UVM laboratory (Perkins 103). Adapted an impedance analyzer with built-in Kelvin probes to form a Wenner probe-based concrete electrical resistivity test of concrete sample durability parameters, Figure 2.
- Met with VTrans personnel to plan testing procedures and viable mix recipes. The plan tests include freeze-thaw frequency testing of concrete stiffness, alkali-silica reactivity length change, strength, permeability (water) based on electrical resistivity, air entrainment, and free shrinkage.

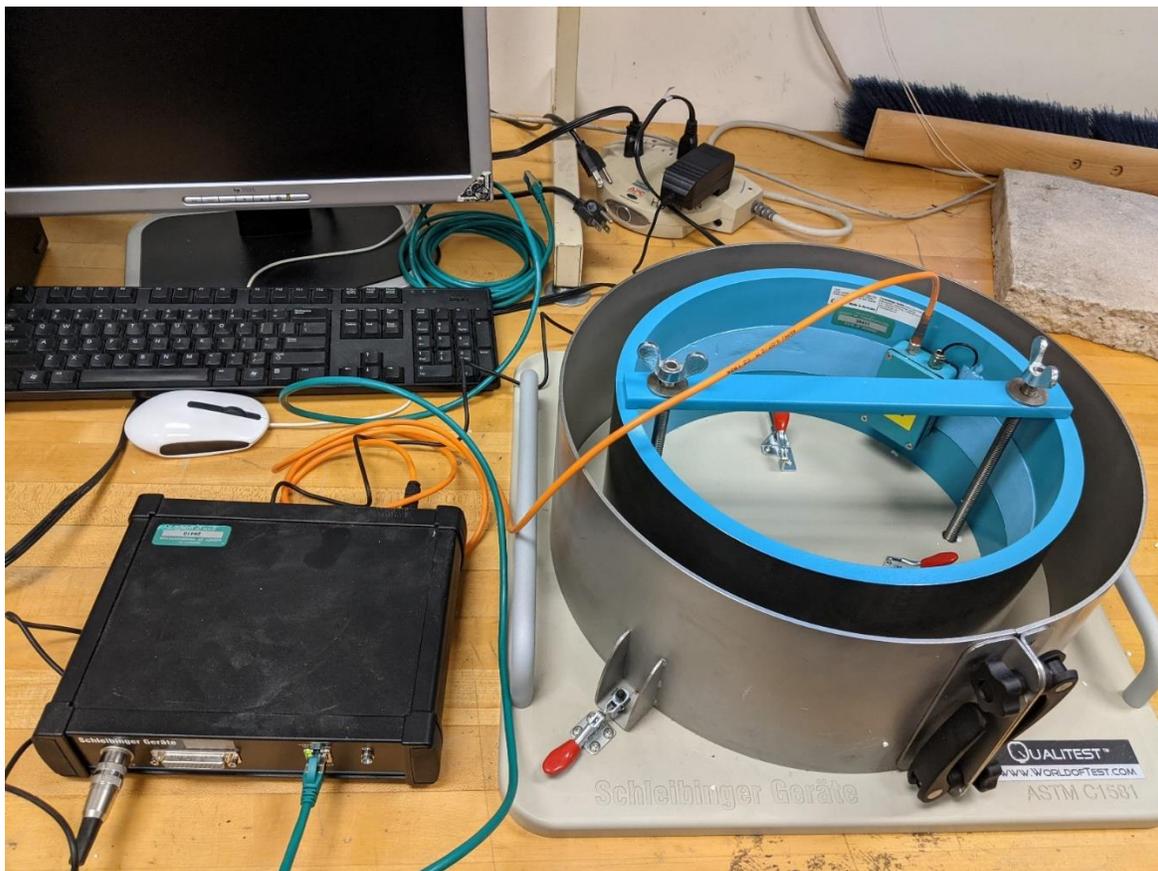


Figure 1 Shrinkage test ring set up and turned on at UVM laboratory.



Figure 2. Impedance analyzer with 4-point Kelvin probe configured to take electrical surface resistivity measurements of concrete samples with a Wenner probe configuration.

Meeting the Overarching Goals of the Project:

The overarching goal(s) of the project are: 1. Develop cost optimized mixes in the laboratory using New England sourced materials. Machine learning methods will be applied to accelerate the identification of the most promising mixes; 2. Interact with concrete suppliers; 3. Participate in pilot tests at concrete supplier; 4. Evaluate performance on large scaled structural elements; 5. Reporting and technology transfer.

The progress in this quarter primarily focused on Goal 1 with the development of testing methods for concrete samples.

Accomplishments:

The accomplishments were the transfer and setup of shrinkage ring testing system, setup of Wenner test of surface resistivity indicating hydraulic permeability of concrete. Met with VTrans personnel to coordinate testing protocols.

Task Progress and Budget:

Table 1: Task Progress			
Task Number	Start Date	End Date	% Complete
Task 1: Develop and verify laboratory testing procedures	1/1/21	9/1/21	35%
Task 2: Identify and test prototype HPC mix	1/1/21	11/30/21	15%
Task 3: Meet with concrete suppliers	1/1/21	11/30/21	15%
Task 4 Develop plan for pilot test, including partner participation.	2/1/21	11/30/21	
Task 5 Conduct pilot test batch run of HPC at	1/1/22	4/30/22	

industrial partner's facility			
Task 6 Evaluate performance of HPC prepared at industrial partner's facility	5/1/22	11/30/22	
Task 7 Test large planar structural elements	5/1/22	11/30/22	
Task 8 Reporting	1/1/23	8/31/23	
Overall Project:	1/1/21	8/31/23	11%

Table 2: Budget Progress

Project Budget	Spend – Project to Date	% Project to Date*
\$503,744	\$ 50,669.13	10.06%

Professional Development/Training Opportunities:

NA

Technology Transfer:

NA

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events

Title	Event	Type	Location	Date(s)
Performance Structural Concrete Optimized for Cost, Durability and Manufacturability	VT STIC Stakeholders Meeting and the 2021 AOT Research and Innovation Symposium	Poster and online presentation	Online	9/8-9/2021

Table 4: Publications and Submitted Papers and Reports

Type	Title	Citation	Date	Status
NA				

Participants and Collaborators:

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members

Individual Name	Email Address	Department	Role in Research
Dryver Huston	dryver.huston@uvm.edu	Mechanical Engineering	PI
Ting Tan	Ting.Tan@uvm.edu	Civil and Environmental Engineering	Co-PI

Table 6: Student Participants during the reporting period

Student Name	Email Address	Class	Major	Role in research
Matt Kaplita		Junior	Civil Eng	Laboratory testing

Table 7: Students who Graduated During the Reporting Period

Student Name	Degree	Graduation Date	Employment or continued degree
NA			

Table 8: Research Project Collaborators during the reporting period

Organization	Location	Contribution to the Project				
		Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges
VTrans	Montpelier, VT		Ring shrinkage test equipment			

Table 9: Other Collaborators

Collaborator Name and Title	Contact Information	Organization and Department	Contribution to Research
James Wild	Vermont Agency of Transportation	Materials	Technical Champion
Nick van den Berg	Vermont Agency of Transportation	Materials	Advised planning

Who is the Technical Champion for this project?

Name: James Wild
 Title: Concrete Materials Manager
 Organization: Vermont Agency of Transportation
 Location (City & State): Montpelier, VT
 Email Address: Jim.Wild@vermont.gov

Changes:

The project did not start until January 1, 2021, instead of the proposed September 1, 2020. The task schedule in Table 1 has been adjusted accordingly.

A graduate student has not yet been hired on the project. During the summer of 2021, an undergraduate Civil Engineering graduate student has been hired to conduct laboratory experiments.

Co-PI Prof. Ting Tan will no longer be active on this project due to a change in his primary institution.

Planned Activities:

1. Continue to develop formulations for mix designs, including those that use silica fume nanoparticles
2. Continue to develop laboratory test procedures
3. Use laboratory tests on preliminary mixes
4. Acquire aggregate samples from Vermont and Northern New England based suppliers
5. Attempt to replace Prof. Ting Tan with a suitably qualified Co-PI Faculty Member.