

### **Quarterly Progress and Performance Indicators 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):**

**Reporting Period:** 1/1/22 – 3/31/22

**Submission Date:** March 31, 2022

### **Overview:**

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

- Setup and used concrete shrinkage ring testers on four different mixes of bag cement, Figure 1
- Met with supplier of ground glass pozzolanic cement (Pozzotive), discussed mix details, and received samples of the cement, Figure 2.
- Met with VTrans and Vermont concrete producers to discuss mixes, new low-carbon concretes, and test procedures, March 31, 2022.

### **Meeting the Overarching Goals of the Project:**

*How did the previous items help you achieve the project goals and objects? Please give one bullet point for each bullet point listed above.*

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.

- Setup and used concrete shrinkage ring testers – This activity aligns with Goal 1. Develop cost optimized mixes in the laboratory using New England sourced materials.
- Met with supplier of ground glass pozzolanic cement - This activity aligns with Goal 1. Develop cost optimized mixes in the laboratory using New England sourced materials; 2. Interact with concrete suppliers
- Met with VTrans and Vermont concrete producers – This activity aligns with Goal 1. Develop cost optimized mixes in the laboratory using New England sourced materials 2. Interact with concrete suppliers; and Goal 5. Reporting and technology transfer.

### **Accomplishments:**

*List any accomplishments achieved under the project goals in bullet point form...*

- Used concrete shrinkage ring testers on four different types of bag cement.
- Student researcher on the project, Anna Casavant, received a prestigious Barrett Fellowship for her planned work on low carbon concrete related directly to this project.

**Task, Milestone, and Budget Progress:**

Complete the following tables to document the work toward each task and budget

<b>Table 1: Task Progress</b>			
<b>Task Number: Title</b>	<b>Start Date</b>	<b>End Date</b>	<b>% Complete</b>
Task 1: Develop and verify laboratory testing procedures	4/1/21	12/1/21	55%
Task 2: Identify and test prototype HPC mix	4/1/21	2/28/22	25%
Task 3: Meet with concrete suppliers	4/1/21	2/28/22	35%
Task 4 Develop plan for pilot test, including partner participation.	6/1/21	2/28/22	
Task 5 Conduct pilot test batch run of HPC at industrial partner's facility	4/1/22	7/30/22	
Task 6 Evaluate performance of HPC prepared at industrial partner's facility	9/1/22	2/28/23	
Task 7 Test large planar structural elements	8/1/22	2/28/23	
Task 8 Reporting	4/1/23	11/30/23	20%
Overall Project:	4/1/21	12/31/23	17%
Phase 1 Overall	Enter the Phase 1 Actual Start Date	Enter the Phase 1 Planned/Actual End Date	Enter the Phase 1 % Complete
Phase 2 Overall	Enter the Phase 2 Actual Start Date	Enter the Phase 2 Planned/Actual End Date	Enter the Phase 2 % Complete
Phase 3 Overall	Enter Phase 3 Actual Start Date	Enter Phase 3 Planned/Actual End Date	Enter Phase 3 % Complete

<b>Table 2: Milestone Progress</b>			
<b>Milestone #: Description</b>	<b>Corresponding Deliverable</b>	<b>Start Date</b>	<b>End Date</b>
Milestone 1: Develop and verify laboratory testing procedures	Report describing concrete laboratory testing procedures and experiments that verify testing performance	4/1/21	pending

Milestone 2: Identify and test prototype HPC mix	Prototype HPC mix designs	4/1/21	pending
Milestone 3: Meet with concrete suppliers	Report describing input and results from meeting with concrete suppliers	4/1/21	pending
Milestone 4: Develop plan for pilot test, including partner participation	Report describing plan for pilot test at concrete supplier	4/1/21	9/30/22
Milestone 5: Conduct pilot test batch run of HPC at industrial partner's facility	Report describing results of pilot test batch run of HPC at concrete supplier	7/1/22	2/28/23
Milestone 6: Evaluate performance of HPC prepared at industrial partner's facility	Report describing results of tests performed on specimens created at concrete supplier in pilot test run	7/1/22	2/28/23
Milestone 7: Test large planar structural elements	Report describing durability and strength tests at UVM on large planar structural elements cast at concrete supplier in pilot test run	2/1/23	1/31/24
Milestone 8: Reporting	Quarterly, final and other required project reports	4/1/21	1/31/24

**Table 3: Budget Progress**

<b>Project Budget</b>	<b>Spend – Project to Date</b>	<b>% Project to Date (include the date)</b>
\$503,744	\$ 80,548.28	15.99%
Enter Phase 2 Full Budget	Enter Phase 2 Full Spend Amount (Federal + Cost Share)	Enter Phase 2 % Spent
Enter Phase 3 Full Budget	Enter Phase 3 Full Spend Amount (Federal + Cost Share)	Enter Phase 3 % Spent

**Is your Research Project Applied or Advanced?**

**Applied** (The systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met.)

**Advanced** (An intermediate research effort between basic research and applied research. This study bridges basic (study to understand fundamental aspects of phenomena without specific applications in mind) and applied research and includes transformative change rather than incremental advances. The investigation into the use of basic research results to an area of application without a specific problem to resolve.)

**Education and Workforce Development:**

Answer the following questions (N/A if there is nothing to report):

1. Did you provide any workforce development or training opportunities to transportation professionals (already in the field)? If so, what was the training? When was it offered? How many people attended?  
NA
2. Did you hold meetings with any transportation industry organizations or DOTs? If so, what was the meeting’s purpose? When was it offered? How many people attended?  
NA
3. Did you host/participant in any K-12 education outreach activities? If so, what was the activity? What was the target age/grade level of the participants? How many students/teachers attended? When was the activity held?  
NA

**Technology Transfer:**

Complete all of the tables below and provide additional information where requested.

Use the table below to complete information about conference sessions, workshops, webinars, seminars, or other events you led/attended where you shared findings as a result of the work you conducted on this project:

<b>Table 4: Presentations at Conferences, Workshops, Seminars, and Other Events</b>					
<b>Type</b>	<b>Title</b>	<b>Citation</b>	<b>Event &amp; Intended Audience</b>	<b>Location</b>	<b>Date(s)</b>
i.e. Conference, Symposium, DOT/AOT presentation, Seminar, etc.	Presentation Title	Full Citation	Name of event (i.e. TIDC 1 <sup>st</sup> Annual Conference) or who was the presentation given to?		
NA	NA	NA	NA	NA	NA

Use the table below to report any publications, technical reports, peer-reviewed articles, newspaper articles referencing your work, graduate papers, dissertations, etc. written as a result of the work you conducted on this project. Please list only completed items and exclude work in progress.

**Table 5: Submitted/Accepted Publications, Technical Reports, Theses, Dissertations, Papers, and Reports**

Type	Title	Citation	Date	Status
i.e. Peer-reviewed journal, conference paper, book, policy paper, magazine/newspaper article	Publication title	Full citation		i.e. Submitted, accepted, under review (by org. submitted to)
NA	NA	NA	NA	NA

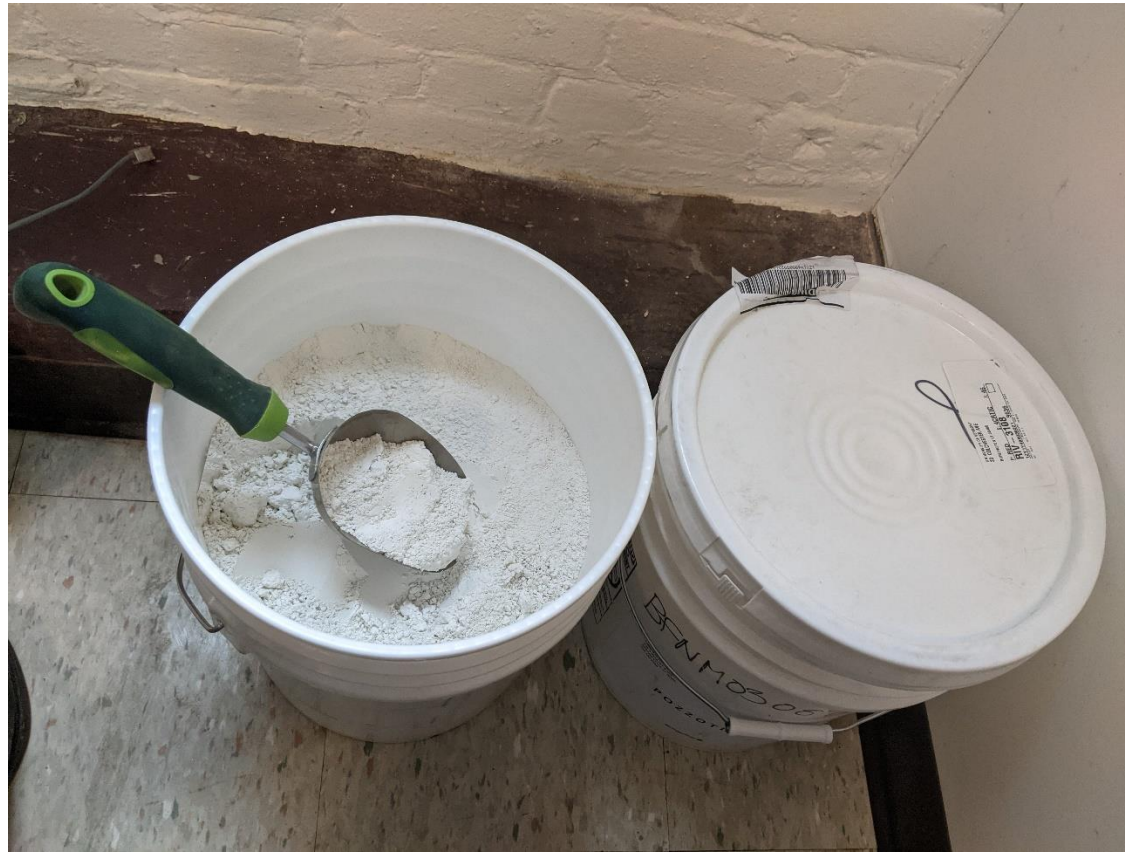
Answer the following questions (N/A if there is nothing to report):

- Did you deploy any technology during the reporting period through pilot or demonstration studies as a result of this work? If so, what was the technology? When was it deployed?  
NA
- Was any technology adopted by industry or transportation agencies as a result of this work? If so, what was the technology? When was it adopted? Who adopted the technology?  
NA
- Did findings from this research project result in changing industry or transportation agency practices, decision making, or policies? If so, what was the change? When was the change implemented? Who adopted the change?  
NA
- Were any licenses granted to industry as a result of findings from this work? If so, when? To whom was the license granted?  
NA
- Were any patent applications submitted as a result of findings from this research? If so, please provide a copy of the patent application with your report.  
NA
- Did industry organizations or DOTs provide cost-share (cash or in-kind) to your research during the reporting period? Who was the organization? Please provide an in-kind support invoice from the organization with your report (this is kept confidential and used for record keeping purposes only).  
NA

*Please add figures/images that can be included on the website and/or in marketing/social media materials to further clarify your research to the general public. This is very important to our Technology Transfer initiatives.*



**Figure 1** Shrinkage rings testing four different types of bag cement



**Figure 2** Ground glass pozzolanic cement from Possotive

*Describe any additional activities involving the dissemination of research results not listed above under the following headings: NA*

**Outputs:**

*Definition: Any new or improved process, practice, technology, software, training aid, or other tangible product resulting from research and development activities. They are used to improve the efficiency, effectiveness, and safety of transportation systems. List any outputs accomplished during this reporting period:*

- Examples: New sensing technology was developed. This technology will... A UAV was created to hold new monitoring technology. This will allow maintenance crews to... A new college course was created based on the research findings. This will train future transportation professionals to...
- NA

**Outcomes:**

*Definition: The application of outputs; any changes made to the transportation system, or its regulatory, legislative, or policy framework resulting from research and development activities. List any outcomes accomplished during this reporting period:*

- Example: The developed sensing technology was installed in Bridge A in town, state on 1/1/2021. This installation will... The UAV was successfully used by \_\_\_ Organization to inspect \_\_\_ Bridge in in town, state on 1/1/2021... The newly created college course was taken/completed by \_\_\_ students in the 2021 fall semester.
- NA

**Impacts:**

*Definition: The effects of the outcomes on the transportation system such as reduced fatalities, decreased capital or operating costs, community impacts, or environmental benefits. The reported impacts from UTCs are used for the assessment of each UTC and to make a case for Federal funding of research and education by demonstrating the impacts that UTC funding has had on technology and education. NOTE: The U.S. DOT uses this information to assess how the research and education programs (a) improve the operation and safety of the transportation system; (b) increase the body of knowledge and technologies; (c) enlarge the pool of people trained to develop knowledge and utilize technologies; and (d) improves the physical, institutional, and information resources that enable people to have access to training and new technologies. List any outcomes accomplished during this reporting period:*

- Example: The developed sensing technology’s successful deployment resulted in the adoption of the technology by the StateDOT. The technology will be installed in all new bridge installments of this type. This adoption will... The new UAV monitoring technology was adopted by \_\_\_ organization to be used for \_\_\_ bridges inspections. This will allow inspectors to... The college course has been adopted by another member university...
- NA

**Participants and Collaborators:**

*Use the table below to list individuals (compensated or not) who have worked on the project other than students.*

<b>Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members</b>				
<b>Individual Name &amp; Title</b>	<b>Dates involved</b>	<b>Email Address</b>	<b>Department</b>	<b>Role in Research</b>
Dryver Huston, Professor	10/1/2021	dryver.huston@uvm.edu	Mechanical Engineering	PI



Use the table below to list **all** students who have participated in the project during the reporting period. (This includes all paid, unpaid, intern, independent study, or any other student that participated in this project.) **ALL FIELDS ARE REQUIRED.**

<b>Table 7: Student Participants during the reporting period</b>								
<b>Student Name</b>	<b>Start Date</b>	<b>End Date</b>	<b>Advisor</b>	<b>Email Address</b>	<b>Level</b>	<b>Major</b>	<b>Funding Source</b>	<b>Role in research</b>
Matt Kaplita	10/1/2021	3/31/2021	D. Huston		Junior	Civil Eng	TIDC/UVM	Laboratory testing
Josh Allen	10/1/2021	3/31/2021	D. Huston		Senior	Mech Eng	TIDC/UVM	Laboratory testing
Anna Casavant	1/1/2022	3/31/2021	D. Huston		Junior	Mech Eng	UVM	Laboratory testing
Lane Feldeisen	1/1/2022	3/31/2021	D. Huston		Graduate	Civil Eng	TIDC	Laboratory testing

Use the table below to list any students who worked on this project and graduated or received a certificate during this reporting period. Include information about the student's accepted employment during the reporting period (i.e. the student is now working at MaineDOT) or if they are continuing their students through an advanced degree (list the degree and where they are attending).

<b>Table 8: Students who Graduated During the Reporting Period</b>			
<b>Student Name</b>	<b>Degree/Certificate Earned</b>	<b>Graduation/Certification Date</b>	<b>Did the student enter the transportation field or continue another degree at your university?</b>
NA			Please list the organization or degree

Use the table below to list any students that participated in Industrial Internships during the reporting period:

<b>Table 9: Industrial Internships</b>			
<b>Student Name</b>	<b>Degree/Certificate Earned</b>	<b>Graduation/Certification Date</b>	<b>Did the student enter the transportation field or continue another degree at your university?</b>
NA			Please list the organization or degree

Use the table below to list **organizations** that have been involved as partners on this project and their contribution to the project during the reporting period.

Table 10: Research Project Collaborators during the reporting period						
Organization	Location	Contribution to the Project				
		Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges
Vermont Agency of Transportation	Barre, VT	\$0	Long term loan of shrinkage test rings	X	X	X

Use the table below to list **individuals** that have been involved as partners on this project and their contribution to the project during the reporting period. (**List your technical champion(s) in this table.** This also includes collaborations within the lead or partner universities who are not already listed as PIs; especially interdepartmental or interdisciplinary collaborations.)

Table 11: Other Collaborators				
Collaborator Name and Title	Contact Information	Organization and Department	Date(s) Involved	Contribution to Research
James Wild, Concrete Materials Manager		Vermont Agency of Transportation, Materials	10/1/2021-12/31/2021	Technical Champion
Nick van den Berg		Vermont Agency of Transportation, Materials	10/1/2021-12/31/2021	Advised planning

Use the following table to list any transportation related course that were taught or led by researchers associated with this research project during the reporting period:

<b>Table 12: Course List</b>						
<b>Course Code</b>	<b>Course Title</b>	<b>Level</b>	<b>University</b>	<b>Professor</b>	<b>Semester</b>	<b># of Students</b>
i.e. CE 123		Grad or undergrad?	Where was the course taught?	Who taught the course?	Enter Spring, Fall, Summer, Winter and the year	How many students were enrolled in the class?
NA						

**Changes:**

One full time graduate students was added to the project starting in January 2022.

**Planned Activities:**

- Continue with Tasks 1 – 4 as listed in Table 1.
- Send students to ACI concrete test procedure training with VTrans support in April 2022.
- Replace Co-PI Prof. Ting Tan.
- Add new graduate student to project team.