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: 7/1/22 – 9/30/22
Submission Date: October 3, 2022

****IMPORTANT: Please fill out each section fully and reply with N/A for questions/sections with nothing to report. For ease of reporting to the USDOT, please do not remove, or change the order of, any sections/text. You may remove/add each rows in tables as needed. Thank you! ****
The report is due on the last day of the reporting period in .doc format to tidc@maine.edu.

Overview:

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

- Improved concrete ring testing technique by moving tests into a temperature-controlled Darwin chamber, Figure 1 .

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.

- Continued with a series of tests on performance 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
- Brought new graduate student onto the project. This addition should help increase the pace of progress.

Accomplishments:
List any accomplishments achieved under the project goals in bullet point form…
- Continued with a series of tests on the performance of ground glass pozzolanic cement. The results showed improvement in electrical resistivity corresponding to chloride penetration, and variable results with regards to strength.
- Recruited new graduate student on the project starting in Fall 2022. Conducted series of training exercises and project planning meetings.

Task, Milestone, and Budget Progress:
Complete the following tables to document the work toward each task and budget (add rows/remove rows as needed, make sure you complete the Overall Project progress row and include all tasks even if they have ended or have not been started)…

Table 1: Task Progress			
Task Number: Title	**Start Date**	**End Date**	**% Complete**
Task 1: Develop and verify laboratory testing procedures	4/1/21	12/1/21	70%
Task 2: Identify and test prototype HPC mix	4/1/21	2/28/22	45%
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	0%
Task 5 Conduct pilot test batch run of HPC at industrial partner's facility	4/1/22	7/30/22	0%
Task 6 Evaluate performance of HPC prepared at industrial partner's facility	9/1/22	2/28/23	0%
Task 7 Test large planar structural elements	8/1/22	2/28/23	0%
Task 8 Reporting	4/1/23	11/30/23	25%
Overall Project:	4/1/21	12/31/23	17%
Phase 1 Overall	Phase 1 Actual Start Date 4/1/21	Phase 1 Planned/Actual End Date 6/30/23	Phase 1 22.5% 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

Table 2: Milestone Progress			
Milestone #: Description	**Corresponding Deliverable**	**Start Date**	**End Date**
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

Project Budget	Spend – Project to Date	% Project to Date (include the date)
$503,744	$116,078.34	23.04%
Enter Phase 2 Full Budget	Enter Phase 2 Full Spend Amount (Federal + Cost Share)	0%
Enter Phase 3 Full Budget	Enter Phase 3 Full Spend Amount (Federal + Cost Share)	0%

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? Project Co-PI made presentation on this project, which was mostly that of the work by Anna Casavant on green concrete mix design at the Vermont Agency of Transportation Research Symposium September 14, 2022.

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? (i.e., The research team held a meeting with MaineDOT to update them on the progress of the research findings and how the findings can be implemented on 3/31/2021. 15 DOT maintenance members were present at the meeting.) 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? (i.e. 25 8th graders and 2 teachers visited the concrete lab and created small concrete trinkets like Legos on 3/31/2021. They learned about the different types of fibers that can be used in the concrete.) NA

Technology Transfer:

Complete all of the tables below and provide additional information where requested. Please provide ALL requested information as this is one of the most important sections for reporting to the USDOT. ***ONLY provide information relevant to this reporting period.***

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:

Table 4: Presentations at Conferences, Workshops, Seminars, and Other Events

Type	Title	Citation	Event & Intended Audience	Location	Date(s)
i.e. Conference, Symposium, DOT/AOT presentation, Seminar, etc.	Presentation Title	Full Citation	Name of event (i.e. TIDC 1st Annual Conference) or who was the presentation given to?		
Symposium	Analyzing the Effect of Ground Glass Pozzolan as a Supplementary Cementitious Material	Casavant A, Worley II R, Huston D. (2022) "Analyzing the Effect of Ground Glass Pozzolan as a Supplementary Cementitious Material" presented at VTrans Annual Research Symposium, September 2022	VTrans Annual Research Symposium	Barre, VT	September 14, 2022

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)
N/A				

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

1. 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

2. Was any technology adopted by industry or transportation agencies as a result of this work? If so, what was the technology? When was is adopted? Who adopted the technology? NA

3. 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

4. Were any licenses granted to industry as a result of findings from this work? If so, when? To whom was the license granted? NA

5. 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

6. 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.

Insert figures here

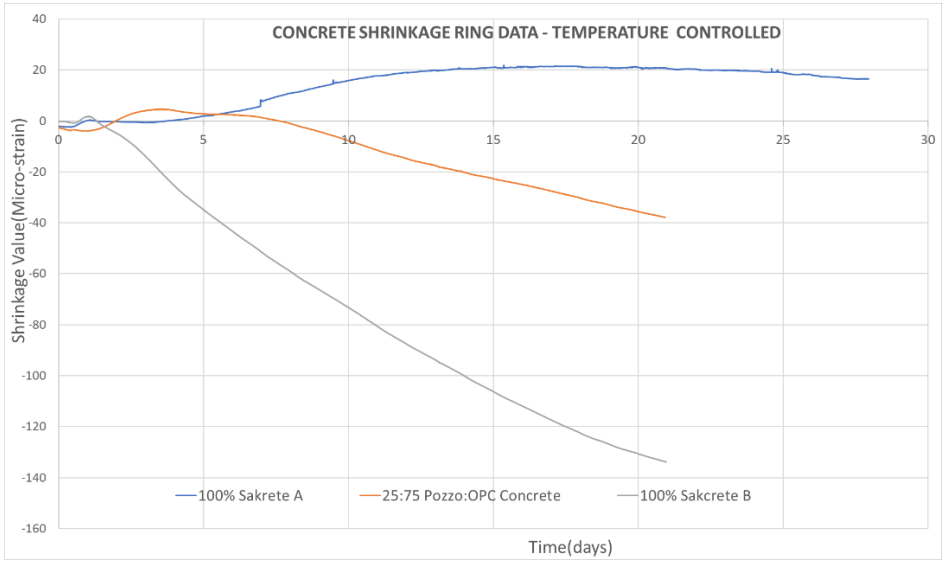

Figure 1 Concrete shrinkage ring test data in temperature-controlled environment produces improved smooth curves, with different mixes producing different rates of shrinkage

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:

- Undergraduate student researcher Anna Casavant had a prestigious Barrett Fellowship to conduct research on green concrete technologies related to this project. As part of the Barrett Fellowship, Anna made a presentation every two weeks to a review panel, and prepared materials for presentation at the VTrans Annual Research Symposium in September 2022.

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.

Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members

Individual Name & Title	Dates involved	Email Address	Department	Role in Research
Dryver Huston, Professor	10/1/2021-present	dryver.huston@uvm.edu	Mechanical Engineering	PI
Mandar Dewoolkar, Professor	4/1/2022-present	mandar.dewoolkar@uvm.edu	Civil and Environmental Engineering	Co-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.***

Table 7: Student Participants during the reporting period								
Student Name	**Start Date**	**End Date**	**Advisor**	**Email Address**	**Level**	**Major**	**Funding Source**	**Role in research**
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
Bismark Yeboah	9/1/2022	present	D. Huston		Graduate	Civil Eng	TIDC	Concrete mixing research

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).

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

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

Table 9: Industrial Internships			
Student Name	**Degree/Certificate Earned**	**Graduation/Certification Date**	**Did the student enter the transportation field or continue another degree at your university?**
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- present	Technical Champion
Nick van den Berg		Vermont Agency of Transportation, Materials	10/1/2021- present	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:

Table 12: Course List						
Course Code	**Course Title**	**Level**	**University**	**Professor**	**Semester**	**# of Students**
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 new full time graduate student was added to the project starting in September 2022. Professor Mandar Dewoolkar has assumed a role as a Co-Advisor for this student.

A meeting with TIDC and VTrans personnel on May 5, 2022 identified the potential need to redirect and refocus the direction of this project. A partial redirection has been undertaken in the summer with research focusing on glass additives. A more complete plan is being formulated for further discussions with VTrans in Fall 2022.

Planned Activities:

- Formulate revised plan for project and meet with VTrans
- Continue with Tasks 1 – 4 as listed in Table 1.