

Quarterly Progress and Performance Indicators Report:

Project Number and Title: 2.12 Evaluation of processed glass aggregate for utilization in transportation projects as a sand borrow

Research Area: Thrust 2 New Materials for Longevity and Constructability

PI: Mandar Dewoolkar, University of Vermont

Co-PI(s): Matthew Scarborough, Gregory Rowangould and Ehsan Ghazanfari, University of Vermont

Reporting Period: 01.01.2021 to 3.31.2022

Submission Date: 03.31.22

Overview:

Provide **BRIEF** highlights of activities performed during the reporting period.

- We continued testing deleterious material content control tests on lab-manufactured crushed glass (clean and with known deleterious materials).
- Based on TAC feedback, we began testing additional deleterious materials (e.g. organics, aluminum) through lab-manufactured crushed glass tests.
- We identified a need for a larger and better ventilated furnace through our discussions with TAC. VTrans had the appropriate furnace available and their personnel performed some testing for us, which yielded very promising results. We have ordered a new furnace to support this research.

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.

- Control tests on the lab-manufactured crushed glass are important for verifying that developed deleterious material content test methods are reliable.
- The newly introduced deleterious materials such as organics and aluminum broadens the applicability of our study.
- The new furnace will allow us to develop and validate an appropriate protocol for determining deleterious material content in recycled glass.

Accomplishments:

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

- We had a very productive TAC meeting during the reporting period. We were also invited to participate in VTrans' Recycled Materials Working Group meetings.

Task, Milestone, and Budget Progress:

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

Table 1: Task Progress			
Task Number: Title	Start Date	End Date	% Complete
Task 1: Literature review	01/16/21	06/30/21	95%
Task 2: Collection of PGA and sand borrow specimens	01/16/21	05/31/22	75%
Task 3: Methods for deleterious material content	01/16/21	11/15/22	75%
Task 4: Engineering properties determination, recommendations for design, and specifications	01/16/21	11/15/22	17%
Task 5: Economic analysis	12/01/21	11/15/22	1%
Task 6: Education, outreach and technology transfer	01/16/21	01/15/23	20%
Phase 1 Overall	01/16/21	01/15/23	45%
Phase 2 Overall	TBD	TBD	0%

Table 2: Milestone Progress			
Milestone #: Description	Corresponding Deliverable	Start Date	End Date
Milestone 1: Literature review	Results compiled and presented to TAC	01/16/21	06/30/21
Milestone 2: Collection of PGA and sand borrow specimens	A brief report/presentation to TAC	01/16/21	05/31/22
Milestone 3: Methods for deleterious material content	Presentation to TAC	01/16/21	11/15/22
Milestone 4.1: Laboratory testing program matrix	Presentation to TAC	01/16/21	11/15/22
Milestone 4.2: Engineering properties of PGA	Report and presentation to TAC	01/16/21	11/15/22
Milestone 4.3: Recommendations for design and specifications	Report and presentation to TAC	07/01/21	11/15/22
Milestone 5.1: Methodology for economic analysis	Presentation to TAC	04/01/21	06/30/21
Milestone 5.2: Results of economic analysis	Report and presentation to TAC	12/01/21	11/15/22
Milestone 6.1: Education	Recruiting and training of graduate (1) and undergraduate (at least 1 per year) students	Throughout the project	
Milestone 6.2: Technology transfer	DOT research days, TIDC conferences, regional ACEC and ASCE meetings and conferences, TRB annual meeting.	Throughout the project	
Milestone 6.3: Final report and presentation on phase 1	Final report to TAC and TIDC, webinar, 1-page information sheet	11/15/22	01/15/23

Table 3: Budget Progress

Project Budget	Spend – Project to Date	% Project to Date (include the date)
\$472,977	\$105,285	22.3%

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?

We engaged with VTrans and VTDEC personnel; their staff conducted testing on PGA and borrow soil materials for this project as an independent check on results obtained at UVM.

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?

PI’s Mandar Dewoolkar and Matthew Scarborough and graduate students Fiona Nutbeam and Brandon Nimberger participated in a TAC meeting on 01/24/22 to seek feedback on results and the focus of the project. About 10 people from VTrans and other organizations attended the meeting.

Graduate student Fiona Nutbeam participated in VTrans’ Recycled Materials Working Group Meeting on 02/15/22 to answer PGA Project progress questions. About 15 people from VTrans and other organizations attended the meeting.

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?

None.

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:

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 1 st Annual Conference) or who was the presentation given to?		
N/A	N/A	N/A	N/A	N/A	N/A

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	N/A	N/A	N/A	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?

N/A

2. 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?

N/A

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?

N/A

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

N/A

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.

N/A

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).

N/A

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.



Glass crusher and lab manufactured processed glass aggregate (LM-PGA), LM-PGA samples post-furnace process, metal collected from LM-PGA

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

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:

We have made good progress in developing the protocol for deleterious materials content. Because VTrans and VTDEC are engaged in the process from the proposal development phase and through TAC, we anticipate adoption of our developed protocol at least by VTrans and VEDEC.

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:

N/A for this quarter

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. List any outcomes accomplished during this reporting period:

N/A for this quarter

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
Mandar Dewoolkar, Professor & Chair	01/16/21-current	Mandar.Dewoolkar@uvm.edu	Civil and Environmental Engineering	Primary Investigator
Matthew Scarborough, Assistant Professor	01/16/21-current	Matthew.Scarborough@uvm.edu	Civil and Environmental Engineering	Co-Primary Investigator
Gregory Rowangould, Associate Professor	01/16/21-current	Gregory.Rowangould@uvm.edu	Civil and Environmental Engineering	Co-Primary Investigator
Ehsan Ghazanfari, Associate Professor	01/16/21-current	ehsan.ghazanfari@uvm.edu	Civil and Environmental Engineering	Co-Primary Investigator

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
				Email is not included in the external report and is only used for internal purposes.	(i.e. UG, MS, PhD)		(i.e. TIDC, Other university funds, , unpaid intern, etc.	What work are they conducting?
Fiona Nutbeam	01/16/21	Current	Matthew Scarborough & Mandar Dewoolkar		MS Student	Civil & Environmental Engineering	TIDC	Laboratory work on the determination of deleterious content in PGA

Brandon Nimberger	09/01/21	current	Mandar Dewoolkar		MS Student	Civil & Environmental Engineering	For credits	Laboratory characterization of lab-manufactured PGA – clean and with deleterious materials
Matthew Aeschleman	02/01/22	current	Matthew Scarborough		Undergrad	Environmental Engineering	UVM funds	Laboratory work on the determination of deleterious content in PGA

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?
N/A	N/A	N/A	N/A

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?
			Please list the organization or degree
N/A	N/A	N/A	N/A

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
		List the amount	List the amount	Mark with an "x" where appropriate		
Chittenden Solid Waste District (CSWD)	1021 Redmond Road, Williston, VT 05495	\$10,000 (over the project period)	\$20,200 (over the project period)	X		TAC members
Vermont Agency of Transportation (VTrans)	219 N. Main St, Barre, VT 05641		\$10,000 (over the project period)			TAC members
Vermont Department of Environmental Conservation (VTDEC)	1 National Life Drive, Davis 1, Montpelier, VT 05620-3702					TAC members

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
	For internal use only			(i.e. technical champion, technical advisory board, test samples, on-site equipment, data, etc.)
Arles August Geotechnical Engineer		VTrans	01/16/21 - current	TAC member

Callie Ewald, P.E., Manager, Geotechnical Engineer		VTrans	01/16/21 - current	TAC member
Dr. Ian Anderson, Manager, HMA Materials		VTrans	01/16/21 – current	TAC member
Nick Van Den Berg, Materials Manager		VTrans	01/16/21 – current	TAC member
Dr. Emily Parkany, P.E., Research Manager		VTrans	01/16/21 – current	TAC member
Tanya Miller, Research Engineer		VTrans	01/16/21 – current	TAC member
James Surwilo, Environmental Analyst		VTDEC, Solid Waste Management Program	01/16/21 – 02/08/22	TAC member

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?
CE 295/ 395	Earthquake Engineering	Undergrad & Grad	UVM	Mandar Dewoolkar	Spring 2022	22
CE 243	Transportation Demand Models	Undergrad & Grad	UVM	Gregory Rowangould	Spring 2022	13
CE 395	Transportation Economics & Policy	Graduate	UVM	Gregory Rowangould	Spring 2022	9
CE 180	Geotechnical Principles	Undergraduate	UVM	Ehsan Ghazanfari	Spring 2022	63
CE 182	Geotechnical Principles Lab	Undergraduate	UVM	Ehsan Ghazanfari	Spring 2022	62

Changes:

List any actual or anticipated problems or delays and actions or plans to resolve them (list no-cost extension requests here)...

None at this time

List any changes in approach and the reasons for the change...

N/A

Planned Activities:

List the activities planned during the next quarter.

- Continue laboratory testing on PGA, Sand borrow, and lab-manufactured PGA specimens. Acquire additional PGA and sand borrow specimens.