

Quarterly Progress and Performance Indicators Report:

Project Number and Title: 2.17 – Design and Development of High-Performance Composites for Improved Durability of Bridges in Rhode Island

Research Area: Thrust 2: New materials for longevity and constructability

PI: *Sumanta Das, University of Rhode Island*

Co-PI(s): *Mayrai Gindy, University of Rhode Island*

Reporting Period: 07/01/2022 – 09/30/2022 (*Project duration: 1/1/2022-12/31/2023*)

Submission Date: 09/30/2022

Overview:

- Successfully developed Modeling/Prediction Tools for 3D printed composites
- Started fabrication of composite samples

Meeting the Overarching Goals of the Project:

- Modeling/Prediction Tools help us design the composites for manufacturing and experiments.
- Fabricated samples and relevant experimental evaluation will help us validate our models.

Accomplishments:

- Simulation models are successfully developed for 3D printed composites as well as concrete strengthening.
- The fabrication process is finalized, and composite fabrication is currently in progress.

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 1.1: Evaluate the strengthening needs in Rhode Island	01/01/22	04/30/22	100%
Task 1.2: Develop Modeling/Prediction Tools	03/01/22	08/31/22	100%
Task 1.3: Fabrication of samples for experiments	09/01/22	12/31/22	20%
Task 2.1: Experimental Performance assessment	12/01/22	04/30/23	0%
Task 2.2: Life cycle cost assessment (LCCA)	05/01/23	08/31/23	0%
Task 2.3: Evaluate the best design strategies	09/01/23	12/31/23	0%
Phase 1 Overall	01/01/22	12/31/22	50%
Phase 2 Overall	01/01/23	12/31/23	0%

Table 2: Milestone Progress

Milestone #: Description	Corresponding Deliverable	Start Date	End Date
Milestone 1.1: Strengthening needs	Identify critical strengthening needs	01/01/22	04/30/22
Milestone 1.2: Numerical models	Design of composites to meet the strengthening needs Design of composite-strengthened components	03/01/22	08/31/22
Milestone 1.3: prepare composite-strengthened samples for the experiment	Degraded Concrete samples strengthened with fabricated 3D printed composites	09/01/22	12/31/22
Milestone 2.1: Experimental performance evaluation for composite-strengthened concrete samples	Tension, compression, bending, shear, impact, and fracture response of composites; Compression, bending, and fracture response of composite-strengthened concrete samples	12/01/22	04/30/23
Milestone 2.2: Life cycle cost Assessment	Life cycle cost considering various composite-strengthening design strategies and complete renewal of the degraded structures with full-composite replacement	05/01/23	08/31/23
Milestone 2.3: Design strategies	Integrate all the earlier findings from the previous tasks and identify suitable and efficient strengthening design strategies	09/01/23	12/31/23

Table 3: Budget Progress

Project Budget	Spend – Project to Date	% Project to Date (include the date)
Phase 1 Full Budget: \$159,878	\$111,920 (Federal + Cost Share)	70% (09/30/2022)
Phase 2 Full Budget: \$160,736	\$0 (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? (i.e. The research team provided an in the field training for the SAR technology for 3 maintenance crew members of the MassDOT on 3/31/2021. The members learned how to use the technology and interrupt the data.) N/A

- 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?

The research team meets with the Technical Champion John W. Preiss, Deputy Chief Engineer/ State Bridge Engineer, RIDOT to discuss the project plans and to update them on the progress of the research findings. The next meeting will be held over the next quarter.

- 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? N/A

We hope to invite students/teachers next year after our strengthening strategies are finalized and successful strengthening design samples are fabricated for demo and explanations.

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 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.

Here are some figures from our preliminary simulations.

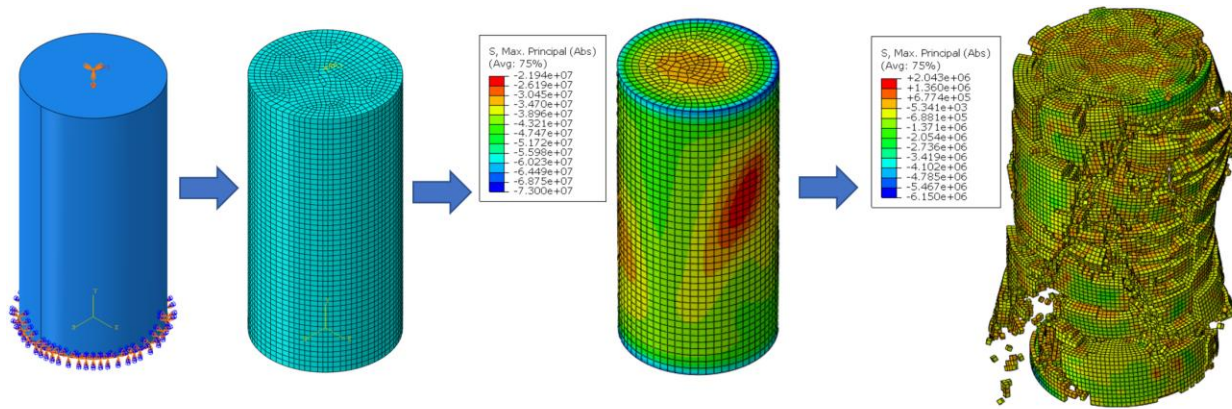


Figure 1: Modeled concrete cylinder, discretized concrete model, and Von Mises criterion showing the deformed concrete.

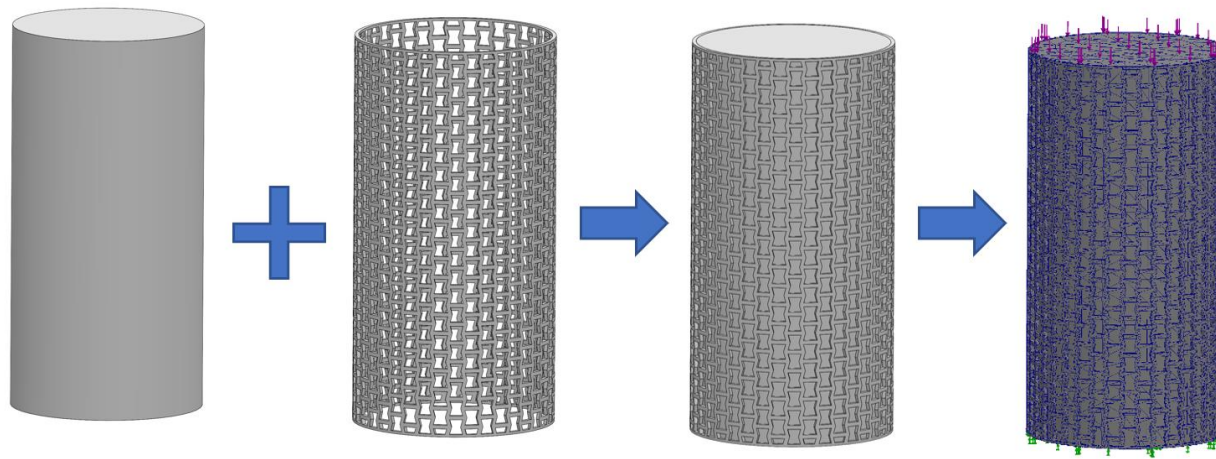


Figure 2: Concrete cylinder with a TPU confinement with reentrant honeycomb auxetic unit cell core, discretized and compressed uniaxially.

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: N/A

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:

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:

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
Sumanta Das, Assistant Professor	01/01/22 - present	Sumanta_das@uri.edu	Civil Engineering, URI	PI
Mayrai Gindy, Professor	01/01/22 - present	mayraig@uri.edu	Civil Engineering, URI	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
Bolaji Oladipo	01/01/22	---	Sumanta Das		PhD	Civil Eng.	TIDC	Developing numerical models and composite fabrication
Sami Doner	01/01/22	---	Sumanta Das		PhD	Civil Eng.	Paid from another project	Composite 3D printing approaches

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). N/A

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?
Gideon A. Lyngdoh	PhD	August 2022	Assistant Professor, George Fox University, Newberg, OR

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

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?
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. N/A

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		
N/A						

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
John W. Preiss, RIDOT Bridge engineer		RIDOT Bridge Engineering Division	01/01/22 - present	technical champion

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: N/A

Table 12: Course List						
Course Code	Course Title	Level	University	Professor	Semester	# of Students
N/A						

Changes:

No changes are requested this quarter.

Planned Activities:

List the activities planned during the next quarter.

- Complete Composite fabrication and sample preparation for concrete
- Start performing strengthening experiments.