Quarterly Progress and Performance Indicators Report:
Project Number and Title: 1.8: Enhancing Intelligent Compaction with Passive Wireless Sensors
Research Area: Thrust # 1, Monitoring and Assessment for Enhanced Life
PI: *Ehsan Ghazanfari, The University of Vermont*
Co-PI(s): *Hamid Ossareh, The University of Vermont*
Reporting Period: *1/10/2021 to 12/31/2021*
Submission Date: *12/31/2021*

Overview:

During the past quarter, we continued to analyze the intelligent compaction (IC), pavement quality indicators, and nuclear gauge density data that we collected from field tests in Route 117 (Vermont) reclaimed asphalt pavement project as well as the data collected from another reclaimed stabilized base project in Vermont. The reliability of IC measurement values (ICMVs) and utilization of ICMVs as a function of vibration amplitude and frequency in the control system to optimize the compaction process and minimize the spatial variability of the ICMVs were investigated. Testing of the pressure sensor was conducted and viable options for the design/ruggedization of the sensor as well as integration options were explored. The performed work in previous months helps us move closer toward the next steps of the project and to improve the IC performance and facilitate the process of geomaterial compaction and pavement performance monitoring.

Task, Milestone, and Budget Progress:

Table 1: Task Progress

Task Number: Title	Start Date	End Date	% Complete
Task 1: IC in sub-base/asphalt	07/01/2018	08/30/2020	100%
Task 2: Passive sensor	06/01/2019	09/30/2021	90%
Task 3: Integration options/performance eval.	09/01/2020	12/31/2021	70%
Overall Project:	*07/01/2019*	*12/31/2021*	90%

Table 2: Milestone Progress

Milestone #: Description	Corresponding Deliverable	Start Date	End Date
The project is almost completed	Final report to TIDC	12/1/2021	3/31/2022

Table 3: Budget Progress

Project Budget	Spend – Project to Date	% Project to Date (include the date)
$254,732	$211,469	80.4%

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.)
   No

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.)
   No

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.)
   No

Technology Transfer:

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?		
None					

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)
None				

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?
   No

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?
   No

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?
   No

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.
   No

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).
   Yes, Vermont Agency of Transportation

Outputs:
Research is ongoing.

Outcomes:

Research is ongoing.

Impacts:
Research is ongoing

Participants and Collaborators:

Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members				
Individual Name & Title	**Dates involved**	**Email Address**	**Department**	**Role in Research**
Ehsan Ghazanfari	1/1/2021-present	Ehsan.ghazanfari@uvm.edu	Civil & Environmental Engineering	Principal Investigator
Hamid Ossare	1/1/2021-present	Hamid.Ossareh@uvm.edu	Electrical and Biomedical Engineering	Co-Principal Investigator

Table 7: Student Participants during the reporting period								
Student Name	**Start Date**	**End Date**	**Advisor**	**Email Address**	**Level**	**Major**	**Funding Source**	**Role in research**
Bijay K-C	1/9/2021	Cont.	Ghazanfari		Ph.D.	Civil & Environmental Engineering	TIDC	Graduate Research Assistant

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?**
None			Please list the organization or degree

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?**
None			Please list the organization or degree

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
None						

Table 11: Other Collaborators

Collaborator Name and Title	Contact Information	Organization and Department	Date(s) Involved	Contribution to Research
Callie Ewald, Geotechnical Engineering Manager	callie.ewald@vermont.gov	Vermont Agency of Transportation	1/1/2021-present	Technical Advisory Committee Chair

Table 12: Course List

Course Code	Course Title	Level	University	Professor	Semester	# of Students
None						

Changes:
None

Planned Activities:
Finalize sensor testing and integration options and prepare the final report