

**Quarterly Progress 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:** 01/01/2020 to 03/31/2020

**Submission Date:** 3/31/2020

**Overview:**

During the past months, we continued to analyze the data (IC, nuclear gauge density (NGD), pavement quality indicators (PQI)) that we collected from field tests in Route 117 (Vermont) reclaimed asphalt pavement project to:

- (i) verify the reliability of IC measurement values (ICMV) to changes in the density and stiffness of the compacted material, and
- (ii) potential utilization of ICMVs as a function of vibration amplitude and frequency in the control system, with the goal of optimizing the compaction process, and spatial variability of the ICMVs using geo-statistical tools.

In addition, we continued the work with sensor manufacturing vendors to fine tune the viable options for design/ruggedization of the pressure sensors to survive the extreme pressure and temperature during compaction process. We have selected two sensor/sensing system alternatives to proceed with.

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.

<b>Table 1: Task Progress</b>			
<b>Task Number</b>	<b>Start Date</b>	<b>End Date</b>	<b>Percent Complete</b>
Task 1: IC in sub-base/asphalt	07/01/2018	08/30/2020	75%
Task 2: Passive sensor	06/01/2019	02/30/2021	45%
Task 3: Integration options/performance eval.	03/01/2021	06/30/2021	0%

<b>Table 2: Budget Progress</b>		
<b>Project Budget</b>	<b>Spend – Project to Date</b>	<b>% Project to Date</b>
\$148,581.92	\$75,964.12	51.13%

<b>Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events</b>				
<b>Title</b>	<b>Event</b>	<b>Type</b>	<b>Location</b>	<b>Date(s)</b>
None				

<b>Table 4: Publications and Submitted Papers and Reports</b>				
<b>Type</b>	<b>Title</b>	<b>Citation</b>	<b>Date</b>	<b>Status</b>
	The accepted ASCE Geo-Congress 2020 conference paper, reported in previous quarterly report, is published			
	The submitted ASCE conference paper ( <sup>4th</sup> International Conference on Transportation Geotechnics), reported in previous quarterly report, is still under review			

**Participants and Collaborators:**

<b>Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members</b>			
<b>Individual Name</b>	<b>Email Address</b>	<b>Department</b>	<b>Role in Research</b>
Ehsan Ghazanfari	Ehsan.ghazanfari@uvm.edu	Civil & Environmental Engineering	Principal Investigator
Hamid Ossareh	Hamid.Ossareh@uvm.edu	Electrical and Biomedical Engineering	Co-Principal Investigator

**Table 6: Student Participants during the reporting period**

Student Name	Email Address	Class	Major	Role in research
Maziar Foroutan		Ph.D.	Civil & Environmental Engineering	Graduate Research Assistant
Ahmad Ghazanfari		M.S.	Electrical and Biomedical Engineering	Graduate Research Assistant

**Table 7: Student Graduates**

Student Name	Role in Research	Degree	Graduation Date
None			

**Table 8: 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 9: Other Collaborators**

Collaborator Name and Title	Contact Information	Organization and Department	Contribution to Research
N/A			

*Who is the Technical Champion for this project?*

Name: Callie Ewald

Title: Geotechnical Engineering Manager

Organization: Vermont Agency of Transportation

Location (City & State): Berlin, Vermont

Email Address: callie.ewald@vermont.gov

**Changes:**

As part of protective measures against Covid-19 pandemic, the research laboratories at the College of Engineering and Mathematical Sciences (CEMS) were shut down in late March. At this point, there is no indication as to when the access to the research laboratories will resume and research activities will go back to normal. As a result, some of the research activities in the project will face delays. Specifically, (i) the laboratory experiments to verify the accuracy of the sensing system to changes in the density and stiffness of the compacted material, (ii) design/ruggedization of the pressure sensors to survive the extreme pressure and temperature during compaction process, and (iii) planning field tests for upcoming construction season will be delayed. To mitigate the negative impact of these delays on the overall progress of the project, we will shift our focus to other research activities including potential utilization of ICMVs as a function of vibration amplitude and frequency in the control system.

**Planned Activities:**

- (i) Analysis of the collected data from IC field tests aiming at IC performance improvement
- (ii) Continue exploring viable options for design and ruggedization of passive sensors in IC compaction