

Quarterly Progress Report:

Project Number and Title: 2.9: Carbonating Subgrade Materials for In-Situ Soil Stabilization

Research Area: New Materials for Longevity and constructability

PI: Aaron Gallant, Ph.D., P.E., University of Maine

Co-PI(s): Warda Ashraf, Ph.D., University of Texas at Arlington

Reporting Period: 04/01/2021-06/30/2021

Submission Date: 06/30/2021

Overview:

During the reporting period:

- Alternative methods to introduce CO₂ gas (aqueous-phase vs. gaseous-phase) were investigated. Testing results reveal both effectively result in the precipitation of calcium carbonate. However, there are practical limitations to aqueous-phase carbonation, including CO₂ solubility limits, which will prevent pursuit of this method on larger scales. It has been decided that gaseous-phase introduction is a more practical avenue to scale up the carbonation process.
- A large-scale experiment has been planned for summer and fall 2021. A large-scale (pseudo-field) demonstration of soil carbonation technology will be demonstrated using a large-scale soil box. These experiments will address what influences the spatial uniformity and rate of binder formation and the efficiency of CO₂ storage/consumption during carbonation (i.e. sustainability). Elemental testing from years 1 and 2 were incorporated in planning and designing soil box testing. The large-scale experiments (2 m x 1 m x 0.6 m tall) will be conducted behind the Advanced Structure and Composite Center (ASCC). The soil box has been constructed, experimental soil materials, mixing equipment, and space, has been identified. Instrumentation (Figure 1) is currently being procured and/or constructed.

One peer-reviewed conference paper has been published in ASCE Geotechnical Special Publication No. 315 and was presented at Geo-Congress 2020 in Minneapolis, MN. An update on project progress was also recently presented at the TIDC Showcase Presentation on April 21, 2021.

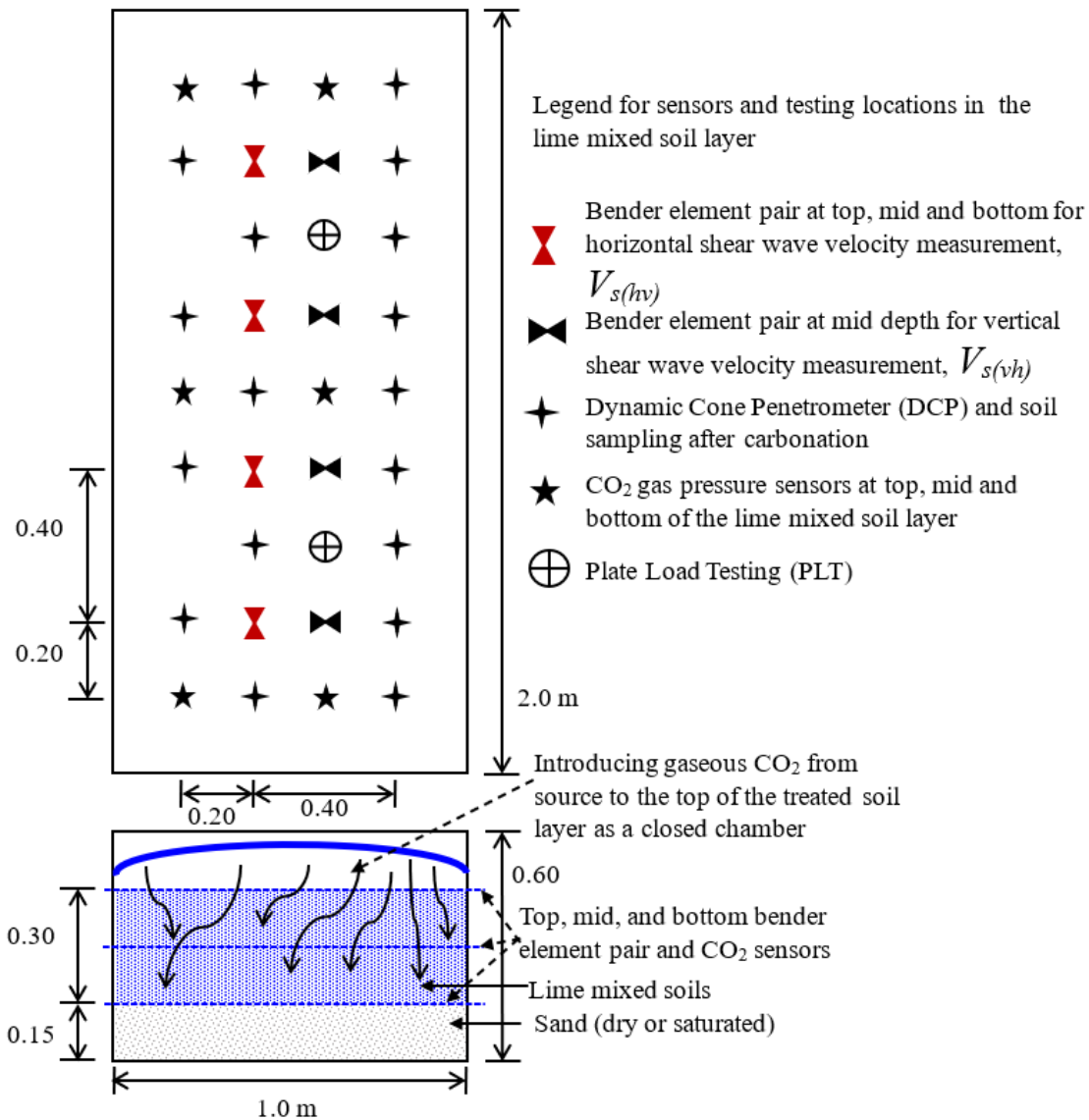


Figure 1. Proposed carbonation (to introduce gaseous CO_2) method to stabilize subgrade soils with soil box instrumentation and testing plan.

Table 1: Task Progress			
Task Number	Start Date	End Date	% Complete
Task 1: Literature review	September 2018	Ongoing	100% to date
Task 2: Elemental testing	December 2018	December 2020	100%
Task 3: Laboratory trial of aqueous-phased carbonation.	February 2021	April 2021	100%
Task 4: Bench scale trial (gaseous carbonation at elevated pressure)	April 2021	May 2021	50%
Task 5: Pseudo field trial (soil box testing)	May 2021	August 2021	40%
Overall Project:	September 2018	August 2021	75%

Table 2: Budget Progress		
Project Budget	Spend – Project to Date	% Project to Date*

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events

Title	Event	Type	Location	Date(s)
Soil state dependency of carbonation for rapid strength improvement	2020 TIDC Student Poster Contest	Student poster competition	Virtual	10/21/2020
Rapid cementation of soils via carbonation: Challenges and opportunities	2021 TIDC Showcase Presentation	TIDC Technical Presentation	Virtual	04/21/2021

Table 4: Publications and Submitted Papers and Reports

Type	Title	Citation	Date	Status
Peer-reviewed conference paper	Elemental testing of carbonated silty sand treated with lime	Hossen, S. B., Gallant, A. P., & Ashraf, W. (2020). Elemental Testing of Carbonated Silty Sand Treated with Lime. <i>Geo-Congress 2020</i> , ASCE GSP 315, Minneapolis MN, pp. 562-571.	February 21, 2020	Published
Peer-review Journal	Influence of initial soil state parameters on rapid strength gain of granular soils under low CO ₂ pressure conditions	Hossen, S. B., Gallant, A. P., & Ashraf, W. (2021). Influence of initial soil state on calcium carbonate binder precipitation and strength improvement of lime mixed granular soils via accelerated carbonation. <i>J. Geotech. Geoenviron. Eng.</i> , ASCE (In preparation).	-	Under in-house review for final submission

Participants and Collaborators:

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members

Individual Name	Email Address	Department	Role in Research
Aaron Gallant, PhD, PE	aaron.gallant@maine.edu	Civil Engineering, University of Maine	PI
Warda Ashraf, PhD	warda.ashraf@uta.edu	Civil Engineering, UT Arlington	Co-PI

Table 6: Student Participants during the reporting period

Student Name	Email Address	Class	Major	Role in research
SK Belal Hossen, EI		PhD	Civil and geotechnical engineering	Graduate Research Assistant

Use the table below to list any students who worked on this project and graduated during this reporting period. NA

Table 7: Student Graduates

Student Name	Role in Research	Degree	Graduation Date

Use the table below to list organizations have been involved as partners on this project and their contribution to the project. NA

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

List all other outputs, outcomes, and impacts here (i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings). Please be sure to provide detailed information about each item as with the tables above. **NA**

Have other collaborators or contacts been involved? If so, who and how? (This would include collaborations with others within the lead or partner universities; especially interdepartmental or interdisciplinary collaborations.) **NA**

Table 9: Other Collaborators

Collaborator Name and Title	Contact Information	Organization and Department	Contribution to Research
			(i.e. Technical Champion)

Who is the Technical Champion for this project?

Name: Dale Peabody

Title: Director of Transportation Research

Organization: Maine DOT

Location (City & State): Augusta, ME

Email Address: dale.peabody@maine.gov

Changes:

NA

Planned Activities:

We will perform the soil box testing this summer to demonstrate the field implementation of soil carbonation technology for stabilization of shallow subgrade soils behind the Advanced Structure and Composite Center (ASCC).