Quarterly Progress Report:
Project Number and Title: 3.12—Lateral Loading of Unreinforced Rigid Elements and Basal Stability of Columns Supported Systems
Research Area: Geotechnical Infrastructure Engineering
PI: *Aaron Gallant, University of Maine*
Co-PI(s):
Reporting Period: *10/2020-12/2020*
Submission Date: *6/30/2020*

Overview: (Please answer each question individually)

*Provide **BRIEF** overview and summary of activities performed during the reporting period. This summary should be written in lay terms for a general audience to understand. This should not be an extensive write up of findings (those are to be included in the final report), but a high-level overview of the activities conducted during the last three months **no more than 3 bullet points no more than 1 sentence each** ….*

This project goal is to assess the basal stability of column supported systems. The systems are divided on two types: embankments and Mechanically Stabilized Earth (MSE wall). In this quarterly report, the basal stability of Mechanically Stabilized Earth (MSE wall) was investigated. Progress was made on the field case scenario at the Council Bluffs Interchange System (CIBS), some of the achievements were:

- Genetic algorithms and an environment using Matlab R2020, Python V 3.7, and Plaxis SoilTest 2020 v.03 were created allowing to optimize the parameters for the highly structured overconsolidated clay. Advanced parameters such as initial shear stiffness (Go) and the shear strain at 0.7 ($\gamma_{0.7}$) justified this effort, since they have an influence not only in the recompression curve, but also in the unloading curve of the oedometer, this makes very subjective the selection of both parameters.
- Modeling the rock fill material could be tricky. Hardening soil model was used to represent the arching mechanism between the columns representing a ground reaction curve (GRC). Dilatancy parameters and the cut-off was activated to have into account this GRC and the ultimate state condition (critical state). The parameters were validated with Varadarajan (2003).
- Water table variation affected the lateral deformation of the CBIS. For I4S, where the high modulus columns where embedded in a competent material, the long-term condition (i.e. lowest water table) resulted on an outward increasing of lateral deformation at the toe, since the stresses imparted below the fill shield for an inward deformation. However, for I1S, where a thin layer of a clay was found below the columns, an inward lateral deformation was found due to the higher increased deformation rate of the thin layer. Long term condition for this system resulted in an inward lateral deformation. This movement can be pictured as the columns slippering on the think soft layer.

Table 1: Task Progress

Task Number	Start Date	End Date	% Complete
Task 1: Assess stresses in subsoil.	06/2018	06/2019	100%
Task 2: Establish a numerical approach to account for fracture in basal stability.	06/2019	09/2019	100%
Task 3: Calibrate models with field measurements that include lateral and vertical deformations.	06/2019	12/2020	95%
Task 4: Perform parametric study for fill embankments.	01/2020	04/2020	100%
Task 5: Perform parametric study for MSE walls.	06/2020	07/2020	20%
Task 6: Recommended design guidance for industry.	03/2020	12/2020	40%
Overall Project:	06/2018	12/2020	85%

Table 2: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date***
$33,380	$33,380	100.0% (12/31/2020)

Include the date the budget is current to.

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
2020 TIDC annual Conference	Conference	Annual conference	University of Maine	August 12,2020
45th Annual Conference on Deep Foundations	Online conference	Annual conference	Online	October 27, 2020

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
Journal	Field Observations and Analysis of the Subgrade Response beneath GRCS Embankments at the Council Bluffs Interchange System	Gallant, Aaron, Ehab Shatnawi, and Danilo Botero-Lopez. 2019. "Field Observations and Analysis of the Subgrade Response beneath GRCS Embankments at the Council Bluffs Interchange System." Journal of Geotechnical and Geoenviromental Engineering.	2020	Accepted
Journal	Lateral Spreading of Embankments supported on Fractured Unreinforced high-modulus columns over Soft Soil	Gallant, Aaron, and Danilo Botero-Lopez. 2019. "Lateral Spreading of Embankments supported on Fractured Unreinforced high-modulus columns over Soft Soil." DFI Journal.	2020	Under review

Encouraged to add figures that may be useful (especially for the website)…

Participants and Collaborators:

Use the table below to list all individuals who have worked on the project.

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	**Email Address**	**Department**	**Role in Research**
Aaron Gallant	aaron.gallant@maine.edu	Civil	PI

Use the table below to list all students who have participated in the project during the reporting. (This includes all paid, unpaid, intern, independent study, or any other student that participated in this project.)

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
Danilo Botero-Lopez		Master	Civil Engineering	Research Assistant

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

Table 7: Student Graduates

Student Name	Role in Research	Degree	Graduation Date
N/A			

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

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**
Deep Foundations Institute (DFI)	Hawthorne, NJ	X				
Jacobs Engineering	Herndon, VA		X			

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.

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.)

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: Tanner Balckburn
Title: Chief Geotechnical Engineering
Organization: Hayward Baker
Location (City & State):
Email Address: jtblackburn@keller-na.com

Changes:
N/A

Planned Activities:

Future work will be focused on the analysis of the fracturing based on the calibrated models and parameters. A parametric study also is going to be performed to analyze another subsoil conditions and column geometry.

References:

Varadarajan, A., et al. "Testing and modeling two rockfill materials." *Journal of geotechnical and geoenvironmental engineering* 129.3 (2003): 206-218.