Quarterly Progress Report:
Project Number and Title: (3.11) Assessment of Micropile-Supported Integral Abutment Bridges
Research Area: Civil Engineering
PI: *Aaron Gallant, Department of Civil and Environmental Engineering*
Co-PI(s): *Bill Davids, Department of Civil and Environmental Engineering*
Reporting Period: *10/1/2019-12/31/2019*
Submission Date: *December 31, 2019*

Overview: (Please answer each question individually)

A specific feature that contributes to the durability of Integral abutment bridges (IABs) is the absence of joints, which reduces the susceptibility of the superstructure and substructure to corrosion and reduces maintenance costs. These systems are also simpler to design and facilitate accelerated bridge construction. Continuity of the bridge deck, girders, and abutment subject the foundation to deformations imposed by the superstructure, including thermal fluctuations and creep/shrinkage of the bridge deck. Thus, the structural/lateral capacity of the foundation is a parameter influencing the design—and more specifically the allowable length—of IABs. In Maine, shallow bedrock sites are a common occurrence, which limits the depth of the foundation for conventional pile-supported IABs. Micropiles are an alternative foundation system drilled (i.e. not driven) into place and can penetrate bedrock to develop sufficient fixity. In this project the behavior of micropile-supported IABs—for which there is currently no design guidance—will be studied to understand the capacity and limitations of this foundation system for IAB systems. Numerical modeling via 3D finite-element analysis of IAB systems will be compared with more conventional (e.g. P-Y analysis) analysis performed by practitioners to assess soil-structure and soil-rock interaction between the bridge superstructure and foundation. The following activities were performed during the first reporting period of this project:

- Literature review of long-term monitoring and numerical modeling of pile-supported IABs. Literature review on micropile-systems and construction.
- Development and validation of simplified model for prediction of lateral displacements of a single micropile on a depth-varying soil profile considering elastic behavior.

The literature review was performed understand the global behavior of micropile-supported IABs, and to identify the main variables and conditions that must be accounted for when modeling and assessing adequacy of a micropile foundation system for IABs. Development of the simplified model is being considered as a potential complement to more advanced (and computationally expensive) finite element analyses that will provide insight into the loading conditions and deformations imposed on the foundation system—which may then be incorporated into simplified analyses that are computationally less expensive and ubiquitous in geotechnical engineering practice.. The ultimate goal is to generate design tools and guidance that will be adopted MaineDOT for assessment of micropile-supported IABs.

Table 1: Task Progress

Task Number	Start Date	End Date	Percent Complete
Task 1: Literature review	Sept-2019	Dec-2019	25%
Task 2: Numerical modeling	Sept-2019	Dec-2019	20%

Table 2: Budget Progress

Entire Project Budget	Spend Amount	Spend Percentage to Date
$186,480	$14,813	8% (12/31/2019)

A Master's thesis is currently under development by the graduate student Sebastian Montoya (listed in Table 6) with the advisement of professors Aaron Gallant and Bill Davids.

Describe any activities involving the dissemination of research results (be sure to include outputs, outcomes, and the ways in which the outcomes/outputs have had an impact during the reporting period. Please use the tables below for any

Publications and Presentations in addition to the description of any other technology transfer efforts that took place during the reporting period.)… Use the tables below to complete information about conferences, workshops, publications, etc. ***List all other outputs, outcomes, and impacts after the tables*** *(i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings).*

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
N/A				

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
N/A				

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

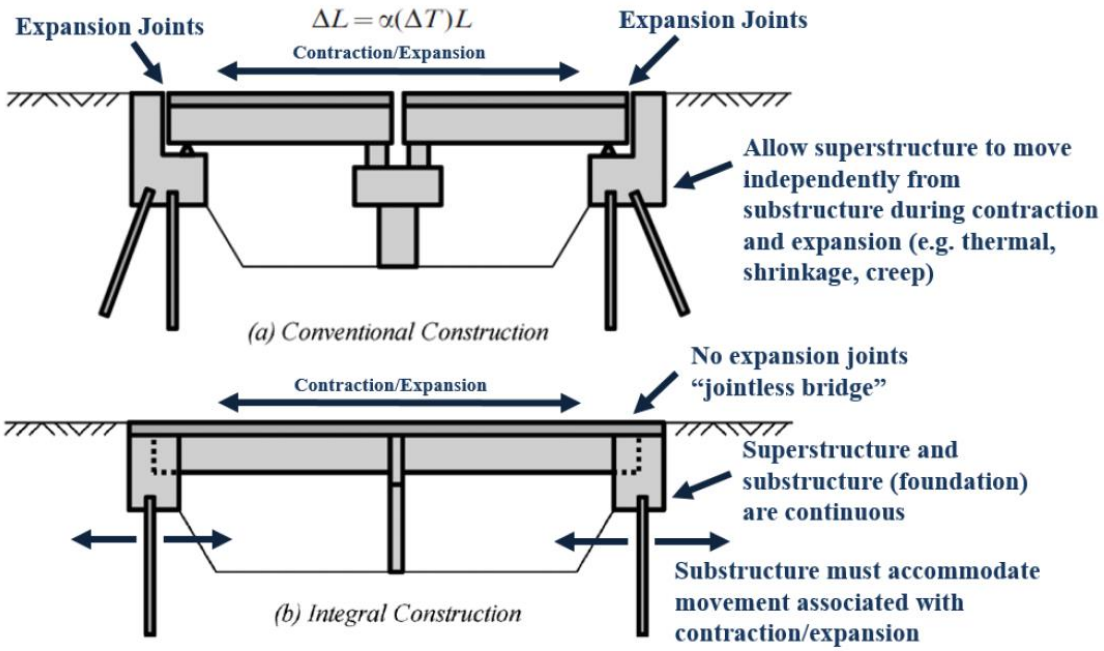

Figure 1: Conventional vs. Integral Abutment Bridge Construction (modified from FHWA, 2011)

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	CIE	PI
Bill Davids	william.davids@maine.edu	CIE	Co-PI

Use the table below to list all students who have participated in the project.

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
Sebastian Montoya		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**
Maine Department of Transportation	Maine	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.

Changes:

Discuss any actual or anticipated problems or delays and actions or plans to resolve them…

This project originally envisioned long-term monitoring of an micropile-supported IAB. This project was delayed by MaineDOT due to budgetary reasons in year 1 (delaying the start of the project). The outlook for construction and funding remains uncertain. Therefore, the monitoring of an actual bridge may be eliminated. However, we intend to overcome this limitation with existing data sets for other IAB bridges found in the literature. These data sets will be used to calibrate our finite element modeling procedures.

Discuss any changes in approach and the reasons for the change…

Planned Activities:

Continued development of a simplified numerical model, incorporating complex loading conditions assessed through advanced finite element analyses. The finite element and simplified models will be validated by comparison with existing data sets and measurements reported in the literature for IABs.