Quarterly Progress and Performance Indicators Report:
Project Number and Title: Durability of Modified Helical Piles under Lateral and Torsional Loads: Embracing Efficient Foundation Alternatives to Support Lightweight Transportation Structures
Research Area: Thrust 3
PI: *Aaron Gallant, Assistant Professor, University of Maine*
Co-PI(s): Maine Keith Berube, Associate Professor, University of Maine; Aaron Bradshaw, Associate Professor, University of Rhode Island
Reporting Period: *1/1/2022-3/31/2022*
Submission Date: *3/31/2022*

Overview:

*Provide **BRIEF** highlights of activities performed during the reporting period.*

Non-dimensional torsional analysis of the collar vane is shown in Fig 1. The predictions (dashed black line in Fig. 1) correspond well with field observations.

- The Collar Vane (CV) significantly increases the lateral resistance of helical piles. Fig. 2 shows the lateral resistance mobilized with the collar normalized by the resistance mobilized with no collar vane.

Meeting the Overarching Goals of the Project:

How did the previous items help you achieve the project goals and objects? Please give one bullet point for each bullet point listed above.

- Demonstrates torsional capacity can be predicted.
- Demonstrate that lateral resistance is increased.

Accomplishments:

List any accomplishments achieved under the project goals in bullet point form…

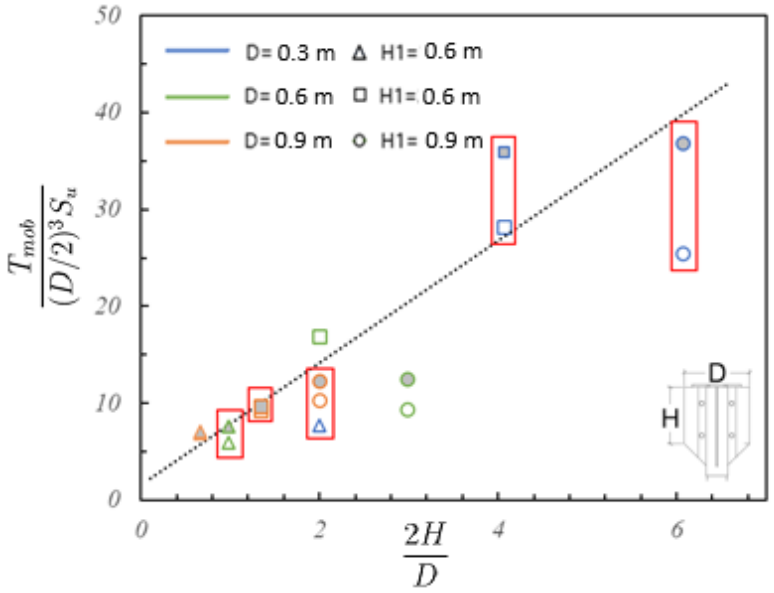

Figure 1. Non-Dimensional analysis. Red boxes are cases when geotechnical failure was reached.

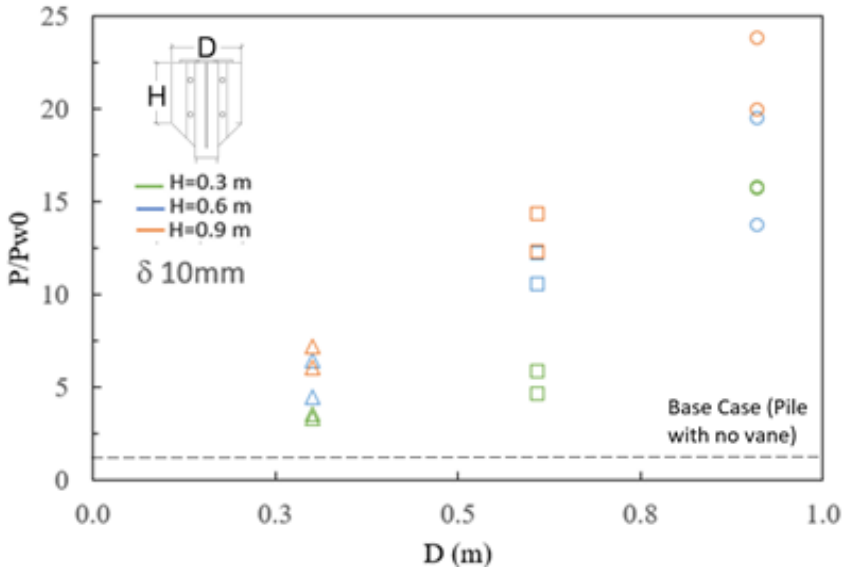

Figure 2. Normalized force required to displace HP with Collar Vane 10 mm. Force is normalized with base case (HP without CV)

Task, Milestone, and Budget Progress:

Complete the following tables to document the work toward each task and budget (add rows/remove rows as needed, make sure you complete the Overall Project progress row and include all tasks even if they have ended or have not been started)…

Table 1: Task Progress			
Task Number: Title	**Start Date**	**End Date**	**% Complete**
Task 1: Acquire instrumentation, prepare install procedures, test DAQ.	January 2021	June 2021	100%
Task 2: Aquire hydraulic jacks, test DAQ.	January 2021	June 2021	100%
Task 3: Collar Vane and HP Manufacturing	January 2021	June 2021	100%
Task 4: Manufacture helical piles, collar vanes, reaction beams, and pile caps.	January 2021	June 2021	100%
Task 5: Full-scale load tests	June 2021	August 2021	80%
Task 6: Develop normalized p-y and T-θ relationships from full-scale field tests	September 2021	June 2022	20%
Task 7: Numerical demonstration of applicability of helical piles to lightweight transportation structures.	September 2021	June 2022	
Task 8: Spring load tests to test seasonal effects.	May 2021	June 2022	0%
Task 9: Final reporting and journal article preparation	January 2022	June 2022	20%

Table 2: Milestone Progress			
Milestone #: Description	**Corresponding Deliverable**	**Start Date**	**End Date**
Milestone 1: N/A			
Milestone 2: N/A			
Milestone 3: N/A			

Table 3: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date (include the date)**
$258,068	$54,221	21%

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.)
   N/A

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.)
   N/A

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.)
   N/A

Technology Transfer:
Complete all of the tables below and provide additional information where requested.

Use the table below to complete information about conference sessions, workshops, webinars, seminars, or other events you led/attended where you shared findings as a result of the work you conducted on this project:

Table 4: Presentations at Conferences, Workshops, Seminars, and Other Events					
Type	**Title**	**Citation**	**Event & Intended Audience**	**Location**	**Date(s)**
N/A	N/A	N/A	N/A	N/A	N/A

Use the table below to report any publications, technical reports, peer-reviewed articles, newspaper articles referencing your work, graduate papers, dissertations, etc. written as a result of the work you conducted on this project. Please list only completed items and exclude work in progress.

Table 5: Submitted/Accepted Publications, Technical Reports, Theses, Dissertations, Papers, and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
N/A	N/A	N/A	N/A	N/A

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?

   N/A

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?

   N/A

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?

   N/A

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.

   N/A

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).

   N/A

Please add figures/images that can be included on the website and/or in marketing/social media materials to further clarify your research to the general public. This is very important to our Technology Transfer initiatives.

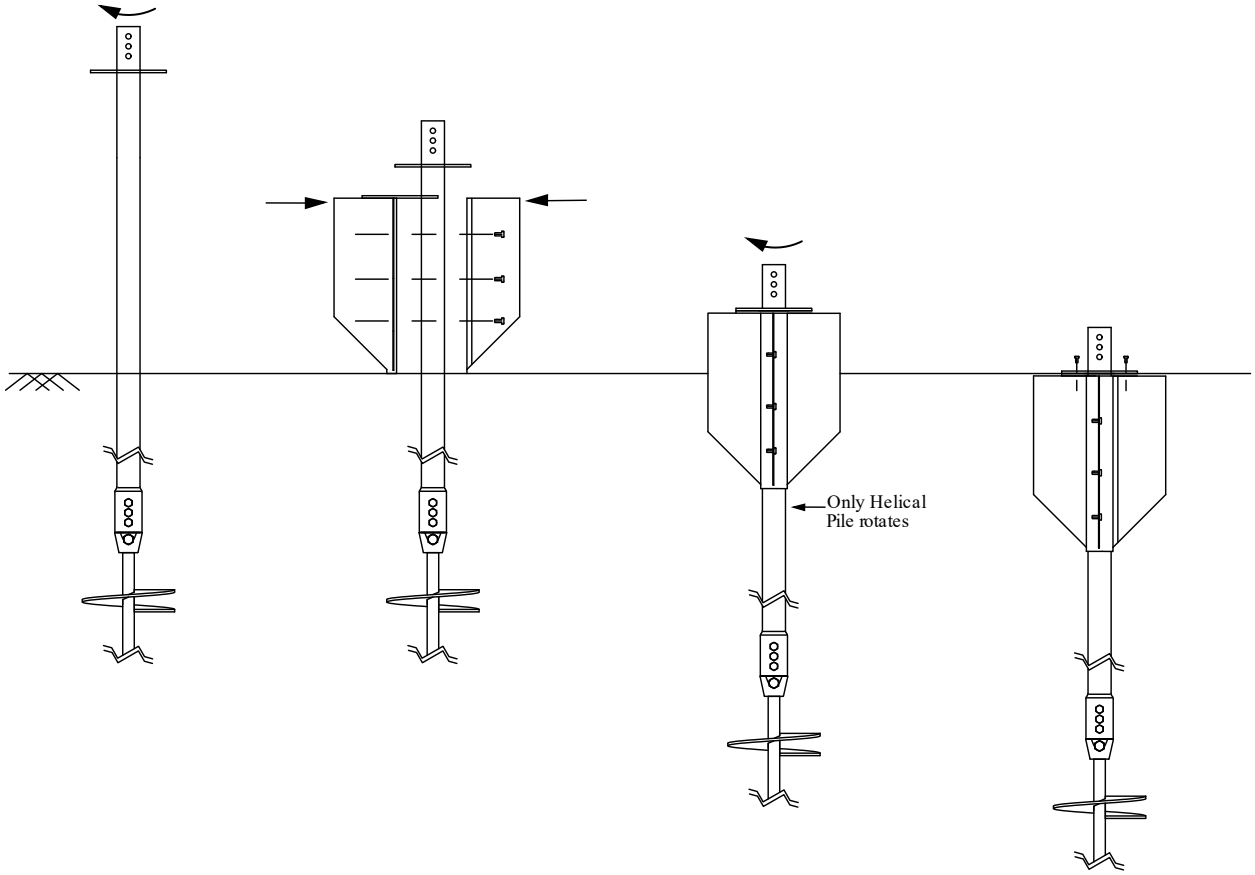

Figure 3. Collar Vane installation. (a)Helical Pile is installed by applying a mechanical torque and a crowd by a drive head. (b) Collar Vane is attached to the Helical pile bolting the two Collar Vane elements along the shaft. (c) Torque is applied to the Helical

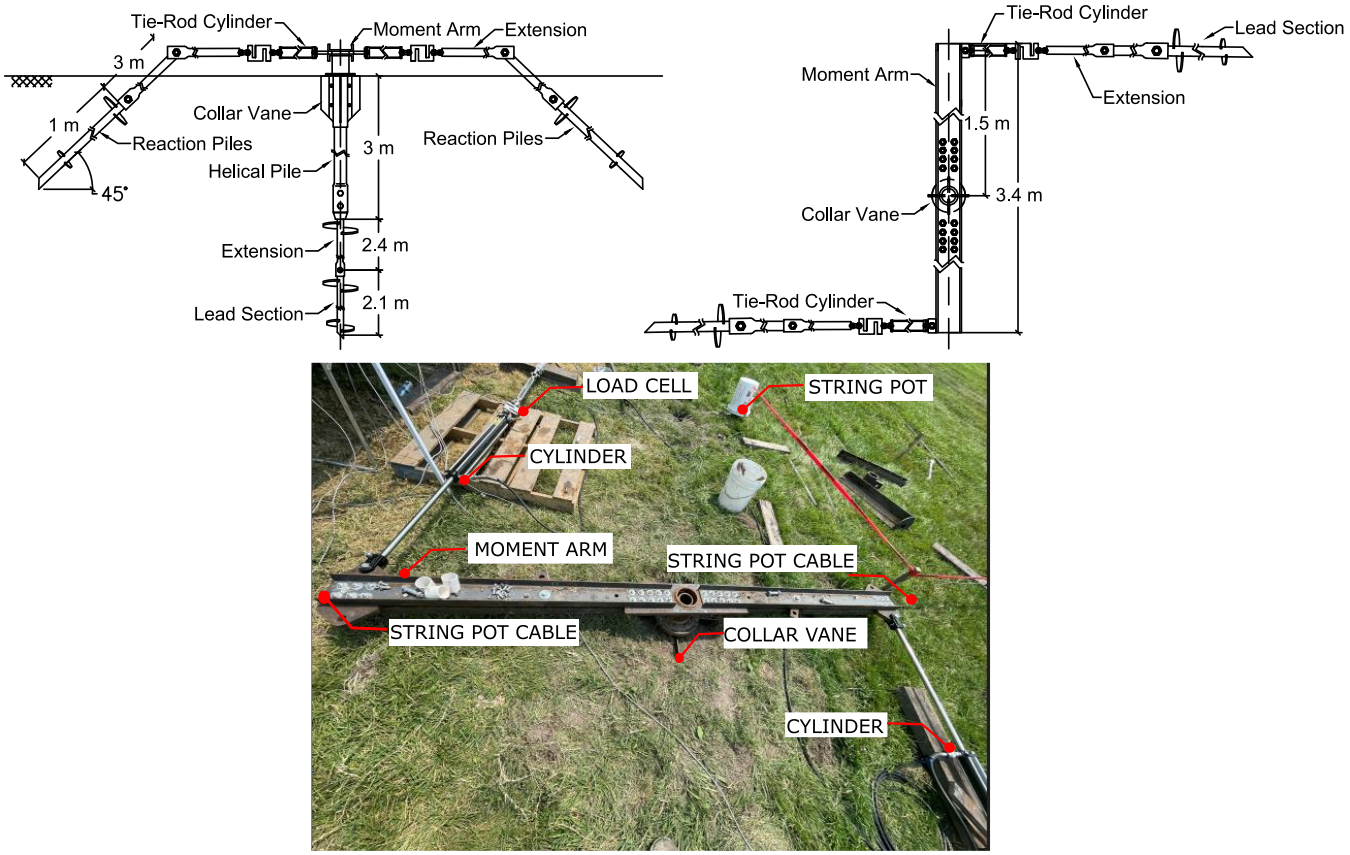

Figure 4. Test frame implemented to apply torsional loads. (Top) Schematic (Bottom) Field photo. Two 3000 psi Tie-Rod cylinders are attached to the moment arm ends to apply loads.

Describe any additional activities involving the dissemination of research results not listed above under the following headings:

Outputs:

Definition: Any new or improved process, practice, technology, software, training aid, or other tangible product resulting from research and development activities. They are used to improve the efficiency, effectiveness, and safety of transportation systems. List any outputs accomplished during this reporting period:

- N/A

Outcomes:
Definition: The application of outputs; any changes made to the transportation system, or its regulatory, legislative, or policy framework resulting from research and development activities. List any outcomes accomplished during this reporting period:

- N/A

Impacts:
Definition: The effects of the outcomes on the transportation system such as reduced fatalities, decreased capital or operating costs, community impacts, or environmental benefits. The reported impacts from UTCs are used for the assessment of each UTC and to make a case for Federal funding of research and education by demonstrating the impacts that UTC funding has had on technology and education. NOTE: The U.S. DOT uses this information to assess how the research and education programs (a) improve the operation and safety of the transportation system; (b) increase the body of knowledge and technologies; (c) enlarge the pool of people trained to develop knowledge and utilize technologies; and (d) improves the physical, institutional, and information resources that enable people to have access to training and new technologies. List any outcomes accomplished during this reporting period:

- N/A

Participants and Collaborators:

Use the table below to list individuals (compensated or not) who have worked on the project other than students.

Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members				
Individual Name & Title	**Dates involved**	**Email Address**	**Department**	**Role in Research**
Aaron Gallant	1/13/2021-	aaron.gallant@maine.edu	Civil and Environmental Engineering	PI
Keith Berube	1/13/2021-	keith.berube@maine.edu	Mechanical Engineering	Co-PI
Aaron Bradshaw	1/13/2021-	abrads@uri.edu	Civil Engineering	Co-PI

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

Table 7: Student Participants during the reporting period								
Student Name	**Start Date**	**End Date**	**Advisor**	**Email Address**	**Level**	**Major**	**Funding Source**	**Role in research**
Sebastian Carvajal	1/13/2021		Dr. Aaron Gallant		Master's	Civil Engineering	TIDC University of Maine	Student research assistant. Performing field testing and developing p-y model.

Use the table below to list any students who worked on this project and graduated or received a certificate during this reporting period. Include information about the student's accepted employment during the reporting period (i.e. the student is now working at MaineDOT) or if they are continuing their students through an advanced degree (list the degree and where they are attending).

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?**
N/A	N/A	N/A	N/A

Use the table below to list any students that participated in Industrial Internships during the reporting period:

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?**
N/A	N/A	N/A	N/A

*Use the table below to list **organizations** that have been involved as partners on this project and their contribution to the project during the reporting period.*

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**
Hubbell Power Systems, Inc	Centralia, MO	x	x	x		
Helix Mooring Systems, Inc	Cumberland, ME	x	x			

*Use the table below to list **individuals** that have been involved as partners on this project and their contribution to the project during the reporting period. (**List your technical champion(s) in this table.** This also includes collaborations within the lead or partner universities who are not already listed as PIs; especially interdepartmental or interdisciplinary collaborations.)*

Table 11: Other Collaborators				
Collaborator Name and Title	**Contact Information**	**Organization and Department**	**Date(s) Involved**	**Contribution to Research**
Gary L. Seider, Engineering Manager		Hubbell Power System Inc		Technical champion

Use the following table to list any transportation related course that were taught or led by researchers associated with this research project during the reporting period:

Table 12: Course List						
Course Code	**Course Title**	**Level**	**University**	**Professor**	**Semester**	**# of Students**
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Changes:

List any actual or anticipated problems or delays and actions or plans to resolve them (list no-cost extension requests here)…

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

Planned Activities:

List the activities planned during the next quarter.

- Start composing the paper manuscript for a spring submission on ASCE's Journal of Environmental Engineering.