WYOMING DEPARTMENT OF TRANSPORTATION

PROGRESS REPORT

Project title: Comprehensive Field Load Test and Geotechnical Investigation Program for Development of LRFD Recommendations of Driven Piles on Intermediate GeoMaterials

Project Number: RS05219 (TPF 5-391)

Progress period: April 1st, 2021 to June 30th, 2021

Principal Investigator and all others who have worked on the project: Kam Ng (0000-0001-5099-5454); Shaun S. Wulff (0000-0002-5695-4925); Rasika Rajapakshage (postdoc); Nafis Masud (PhD student); Opeyemi Oluwatuyi (PhD student); Shafiqul Islam (MS student); Harish Kalauni (MS student), Rebecca Holt (MS student-graduated), Tyler Johnson (MS student-graduated), Carmen Elliott (MS student), and Chooi Kim Lau (Undergraduate student-graduated)

1. Please state whether the project is ahead of schedule, on time, or behind schedule: On time.

2. Percentage of overall work completed: 45.02%.

3. Activities and Accomplishments: The information provided in this section allows WYDOT to assess whether satisfactory progress has been made during the reporting period. Please be as detailed as possible, but try to keep your report to three to four pages in length, if possible.

   a. What are the major goals and objectives of the project?

   The overall goal of the research project is to develop LRFD recommendations for driven piles on IGMs. The research objectives are (1) determine representative engineering properties of soil and IGM; (2) evaluate the variability of soil and IGM properties; (3) recommend best geotechnical investigation practices for IGM; (4) develop advanced static analysis methods for pile resistance estimation on IGM; (5) validate and improve the accuracy of dynamic analysis methods; (6) investigate pile setup and/or relaxation; (7) develop LRFD resistance factors for piles on IGM; and (8) recommend changes and improvements to current pile design and construction practices. The research plan has two phases (I and II) and total 14 tasks. Their proposed completion dates, scheduled percent completion and actual percent completion are summarized in the following table.

Task	Description	Proposed Completion Date	Scheduled Percent Completion	Actual Percent Completion
I-1	Historical Pile Data Collection	31-Dec-19	100.00%	100.00%
I-2	Expand Electronic Database	31-Dec-22	53.75%	64.29%
I-3	Identify Bridge Projects for Field Test	31-Dec-19	100.00%	66.67%
I-4	Detailed Geotechnical Investigation	31-Dec-20	100.00%	58.33%
I-5	Innovative Static Load Tests	30-Jun-21	100.00%	23.08%
I-6	Reporting for Phase I	31-Dec-21	0.00%	0.00%
II-1	Geotechnical and Pile Data Interpretation	31-Dec-20	100.00%	100.00%
II-2	Pile Resistance Estimation	30-Jun-22	49.93%	92.86%
II-3	Pile Setup/Relaxation Investigation	30-Sep-22	0.00%	20.00%
II-4	Variability Analysis	31-Dec-22	24.69%	35.00%
II-5	Development of LRFD Resistance Factors	31-Mar-23	0.00%	70.00%
II-6	Cost-Benefit Analysis	30-Jun-23	0.00%	0.00%
II-7	Outcomes and Recommendations	30-Sep-23	0.00%	0.00%
II-8	Reporting for Phase II	31-Dec-23	0.00%	0.00%
Average Percent Completion			44.88%	45.02%

b. Describe what was accomplished under these goals.

1. Major activities.

Agency	Major Activities by Research Team
WYDOT	• Developed an electronic database. • Completed the static pile load test for the Lodgepole Creek bridge project. • Finalized the static pile load test plan for the I-80 bridge project. • Conducted analysis on geological and variable uncertainties on the Lodgepole Creek bridge project. • Complete triaxial tests on IGM samples from Lodgepole Creek and I-80 projects. • Conducted a finite element analysis to simulate the pile load test of the Lodgepole Creek bridge project. • Conducted regression analysis to develop static analysis methods and LRFD resistance factors for piles in IGMs.
IADOT	• Completed pile load tests for Wapello and Adair bridge projects. • Evaluated and applied three PDA/CAPWAP test results from six bridge projects. • Conducted inherent variability study of Wapello project. • Conducted a finite element analysis to simulate the pile load test of the Adair County bridge project.
CDOT	• Evaluated historical test pile reports and reported missing information. • Identified two bridge projects for pile load testing. • Conducted triaxial rock tests on shales for the I-05-VA project. • Conducted triaxial tests on three rock types for the York bridge project. • Prepared a guidance for dynamic testing. • Provided comments to pile load test plans and specifications.
KDOT	• Evaluated historical pile data.

	• Developed electronic database. • Completed historical pile data interpretation. • Conducted regression analysis to develop static analysis methods for piles in shale. • Performed wave equation analysis program on historical test pile data. • Completed the calibration of LRFD resistance factors for piles in shales.
ITD	• Evaluated historical pile data. • Developed electronic database. • Completed historical pile data interpretation. • Conducted regression analysis to develop static analysis methods and LRFD resistance factors for piles in IGMs.
MDT	• Received and evaluated historical pile data from MDT. • Conducted geotechnical and pile data interpretation. • Conducted regression analysis to develop static analysis methods and LRFD resistance factors for piles in IGMs.
NDDOT	• Collected and evaluated historical pile data. • Identified a bridge site for static pile load test. • Attended several project meetings with NDDOT. • Completed triaxial tests on IGM samples from the bridge site. • Conducted regression analysis to develop static analysis methods and LRFD resistance factors for piles in IGMs.
University of Wyoming	• Tenth TAC conference meeting was conducted on April 28th, 2021. • Submitted four journal manuscripts for review. • Submitted three papers to ASCE Geocongress 2022 conference for full review. • Submitted a paper for the Deep Foundation Institute (DFI) student paper competition. • Preparing four manuscripts for journal submissions. • Preparing a paper for TRB2022 annual meeting.

2. Specific objectives. Too early to report.
3. Significant results (both positive and negative). Too early to report.
4. Key outcomes and other achievements. Too early to report.
5. Goals not met. Not applicable.

c. What opportunities for training and professional development has the project provided? Nothing to Report.

d. How have the results been disseminated to communities of interest?
We submitted four manuscripts for journal review and are preparing four manuscripts for journal submissions. Furthermore, we submitted three papers to the ASCE Geocongress 2022 conference and a paper for the Deep Foundation Institute (DFI) student paper competition. We are preparing a paper for the TRB 2022 annual meeting.

e. What do you plan to do during the next reporting period to accomplish the goals and objectives? The research team will conduct the following works:

- Work with KDOT and CDOT to finalize bridge sites for static pile load tests.
- Investigate the pile setup and relaxation in IGMs.
- Expand the variability study to other test piles.
- Submit journal manuscripts and conference papers.
- Expand the electronic database to include pile data from CDOT and IADOT.
- Conduct static pile load tests in WY and ND.
- Incorporate geological uncertainty and inherent variability into LRFD calibration.
- Start the cost-benefit analysis.

f. List any products resulting from the project during the reporting period. Include in this list:

1. Publications, conference papers, and presentations. In progress.
2. Website(s) or other internet sites (List the URL). Too early to report.
3. Technologies or techniques. Too early to report.
4. Inventions, patent applications, and/or licenses. Too early to report.
5. Other products. Too early to report.

g. Impact:

1. How will this project impact WYDOT? Too early to report.
2. How will this project impact other agencies? Too early to report.

h. Changes to Scope of Work. Provide the following changes, if applicable:

1. Scope of work or objectives of the project. No change.
2. Changes in key persons. No change.
3. Disengagement from the project for more than three (3) months, or a twenty five (25) percent reduction in time devoted to the project. Not applicable.
4. The inclusion of costs that require prior approval. Not applicable.
5. The transfer of funds between line items in the budget. Not applicable.
6. The subawarding, transferring or contracting of work. No change.
7. Changes in the approved cost-sharing or match. Not applicable.