**TRANSPORTATION POOLED FUND PROGRAM**

**QUARTERLY PROGRESS REPORT**

**Lead Agency: Utah Department of Transportation**

**INSTRUCTIONS:**

*Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.*

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| **Transportation Pooled Fund Program Project #**  **TPF-5(381)** | | **Transportation Pooled Fund Program - Report Period:**  **x Quarter 1 (January 1 – March 31, 2019)**  \_ Quarter 2 (April 1 – June 30, 2019)  \_ Quarter 3 (July 1 – September 30, 2019)  \_ Quarter 4 (October 1 – December 31, 2019) | |
| **Project Title:**  Evaluation of Lateral Pile Resistance Near MSE Walls at a Dedicated Wall Site – Phase 2 | | | |
| **Name of Project Manager(s):**  David Stevens | **Phone Number:**  801-589-8340 | | **E-Mail**  [davidstevens@utah.gov](mailto:davidstevens@utah.gov) |
| **Lead Agency Project ID:**  FINET 42085, ePM PIN 16761  UDOT PIC No. UT17.404 | **Other Project ID (i.e., contract #):**  UDOT Contract No. 19-8182 | | **Project Start Date:**  August 20, 2018 |
| **Original Project End Date:**  September 30, 2020 | **Current Project End Date:**  September 30, 2020 | | **Number of Extensions:**  1 |

Project schedule status:

**X** On schedule \_ On revised schedule \_ Ahead of schedule \_ Behind schedule

Overall Project Statistics:

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| **Total Project Budget** | **Total Cost to Date for Project** | **Percentage of Work**  **Completed to Date** |
| $220,000.00 (current contract)  $240,000.00 (total commitments) | $60,000.00 | 30% |

***Quarterly*** Project Statistics:

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| **Total Project Expenses**  **and Percentage This Quarter** | **Total Amount of Funds**  **Expended This Quarter** | **Total Percentage of**  **Time Used to Date** |
| 0% | $0.00 | 30% |

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| **Project Description**:  Bridge abutment piles are frequently surrounded by mechanically stabilized earth (MSE) walls rather than a soil slope. Piles near MSE walls must be designed for lateral loads from earthquakes and thermal expansion/contraction. In the TPF-5(272) Phase 1 study involving several state DOTs, a series of 31 tests on free-head piles provided p-multipliers as a function of pile spacing which can be used to account for reduced lateral soil resistance due to the presence of an MSE wall. Equations were also developed to compute the induced force developed in the reinforcements by the lateral pile loading. However, a number of questions came up when the results of the Phase 1 study were presented to engineers and those responsible for code changes. These issues involve (a) the effect of cyclic loading when previous testing was monotonic, (b) the effect of pile head fixity because previous tests were on free-head piles while most abutment piles are “fixed-head”, (c) the effect of pile group loading when previous tests were for single piles, and (d) the effect of pile diameter on the p-multiplier and induced force equations because previous tests were all for piles about 12 inches in diameter.  Objective: To provide closure relative to the outstanding issues described above, a series of additional tests will be conducted as a Phase 2 follow-up to the original test series.  The Phase 1 study included construction of a dedicated MSE wall site in Utah with instrumented piles behind the 20-ft high wall.  Tasks for this Phase 2 study include:  1. Excavate the top 6 ft of the soil backfill behind the existing MSE wall.  2. Instrument MSE reinforcements and piles with strain gauges.  3. Re-compact the top 6 ft of the soil backfill behind the existing MSE wall.  4. Conduct cyclic lateral pile load testing.  5. Conduct fixed-head lateral pile load testing.  6. Conduct lateral pile load testing of larger-diameter piles (24-inch diameter), to be newly placed between cut-off existing piles.  7. Conduct lateral pile load testing of a pile group.  8. Develop p-multipliers for Phase 2 lateral pile load testing results, compare these with the Phase 1 results, and update the overall p-multiplier equation as necessary.  9. Develop tensile force equations for Phase 2 lateral pile load testing results, compare these with the Phase 1 results, and update the overall tensile force equations as necessary.  10. Submit a final report that documents the Phase 2 research effort.  11. Report results to TAC committee members in video conferences.  12. Make presentations at AASHTO bridge engineers’ committee meetings and TRB events to aid in national efforts to implement the study results.  Dr. Kyle Rollins of BYU is the Principal Investigator for this research project. The technical advisory committee (TAC) for the study currently includes representatives from UT, CA, FL, KS, MN, NY, and WI state DOTs. |

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| **Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):**  **Task 1** – Completed.  **Task 2** – Completed.  **Task 3** – Completed.  **Task 4** – Started memo reporting on this completed testing.  **Task 5** – Started memo reporting on this completed testing.  **Task 6** – Started memo reporting on this completed testing.  **Task 7** – Started memo reporting on this completed testing.  **Task 8** – Not started.  **Task 9** – Not started.  **Task 10** – Not started.  **Task 11** – Not started.  **Task 12** – Not started.  **Contract** – UDOT added some funding transfers received from the TPF study partner states to the research contract and authorized work on Tasks 8-12. |
| **Anticipated work next quarter**:  **Task 1** – Completed.  **Task 2** – Completed.  **Task 3** – Completed.  **Task 4** – Submit the task completion memo with test layout, procedure, basic results, and load-deflection curves.  **Task 5** – Submit the task completion memo with test layout, procedure, basic results, and load-deflection curves.  **Task 6** – Submit the task completion memo with test layout, procedure, basic results, and load-deflection curves.  **Task 7** – Submit the task completion memo with test layout, procedure, basic results, and load-deflection curves.  **Task 8** – Develop p-multipliers for Phase 2 lateral pile load testing results, and submit the task completion memo.  **Task 9** – Start developing reinforcement tensile force equations.  **Task 10** – None planned.  **Task 11** – Consider holding a TAC web conference to provide updates and discuss progress.  **Task 12** – None planned.  **Contract** – Consider adding the remaining pooled fund commitment amount to the contract for face-to-face TAC meetings or additional numerical analysis and pressure cell analysis. |

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| **Significant Results:**  Data reduction work continued this past quarter with work on the lateral pile group load test. This test involved simultaneous lateral loading of three 12.75 inch diameter pipe piles located about three pile diameters behind the wall (center-of-pile to back of wall). Each pile was connected to a steel frame that transferred load to each pile by a tie-rod attached to the frame with a pinned-head connection. Load was applied to the frame using two 120 kip actuators with load cells and each tie-rod was instrumented with strain gauges to measure the load carried by each pile in the group. String potentiometers were attached to each pile at the load point to measure pile head deflection relative to an independent reference frame. In addition to the pile group test, a lateral load test was performed on an identical single pipe pile that was located about four pile diameters behind the wall, a spacing where pile group interaction with the wall should have been relatively minor. Pile head load versus pile head deflection curves for each of the test piles in the group (east, center, and west) and the single pile are presented in Fig. 1.    **Fig. 1 Pile head load vs. pile head deflection curves for each test pile in the group relative to a single pile.**  For a given deflection, the load-deflection curve for the single pile test plots higher than those for the piles in the group. However, this is expected considering that the single pile was located at 4D behind the wall while the piles in the group were at 3D behind the wall. For a given deflection, the center pile carried the greatest load which was somewhat lower than the single pile. In contrast, the east and west piles carried lower loads than the center pile but with nearly identical load-deflection curves.  Fig. 2 provides pile head load vs. pile head deflection curves for each test pile in the group relative to a single pile after correction for the difference in distance behind the wall. After this adjustment, the load-deflection curve for the single pile and the center pile are almost the same, while the load-deflection curves for the east and west piles are lower. This may result from the tensile reinforcements near the center pile being more fully developed from displacement of the soil around the test pile while the deflection of the soil around the test piles on the east and west sides of the group might be smaller and allow less tensile reinforcement to develop. However, this hypothesis will need to be investigated in more detail when the strain gauge data for the reinforcements is reduced and analyzed.    **Fig. 2 Pile head load vs. pile head deflection curves for each test pile in the group relative to a single pile after correction for the difference in distance behind the wall.**  Fig. 3 shows the pile head load versus deflection curves for the adjusted single pile test and for the average pile in the group. Because of the reduced lateral resistance of the east and west piles during this test, the average lateral pile head load for the group is lower than that for the single pile. However, it is unclear at this point whether the lateral pile resistance for the group would be closer to the load-deflection curve for the single pile.    **Fig. 3 Pile head load vs. deflection curves for the adjusted single pile test and for the average pile in the group.** |
| **Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that**  **might affect the completion of the project within the time, scope and fiscal constraints set forth in the**  **agreement, along with recommended solutions to those problems).**  None. |

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| **Potential Implementation:** |