**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(272)** | **Transportation Pooled Fund Program - Report Period:**\_Quarter 1 (January 1 – March 31, 2018) \_ Quarter 2 (April 1 – June 30, 2018)**x Quarter 3 (July 1 – September 30, 2018)**\_ Quarter 4 (October 1 – December 31, 2018) |
| **Project Title:**Evaluation of Lateral Pile Resistance Near MSE Walls at a Dedicated Wall Site |
| **Name of Project Manager(s):**David Stevens | **Phone Number:** 801-589-8340 | **E-Mail** davidstevens@utah.gov |
| **Lead Agency Project ID:**Finet 42053, ePM PIN 11075UDOT PIC No. UT11.404 | **Other Project ID (i.e., contract #):** UDOT Contract No. 148434  | **Project Start Date:** December 2, 2013 |
| **Original Project End Date:**September 30, 2016 | **Current Project End Date:** September 30, 2018 | **Number of Extensions:**5 |

Project schedule status:

 \_ On schedule **X** 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** |
| $322,000.00 (current contract)$302,000.00 (total committed online)$322,000.00 (total actual committed) | $322,000.00 | 100% |

***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** |
| $24,500.008% | $24,500.00 | 100% |

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| **Project Description**:Pile foundations for bridges with integral abutments must resist lateral loads produced by earthquakes and thermal expansion or contraction. Increasingly, right-of-way constraints are also leading to vertical mechanically stabilized earth (MSE) walls at abutment faces. Currently, there is relatively little guidance for engineers in assessing the lateral resistance of piles located close to these MSE walls. As a result, some designers assume that the soil provides no resistance whatsoever which leads to larger pile diameters and increased foundation cost. Other designers locate the abutment piles six to eight pile diameters behind a wall face to minimize the interaction and use conventional design approaches. However, this approach increases the bridge span and the cost of the bridge structure. Still other designers position the pile close to the wall face and reduce the lateral pile resistance using engineering judgment. However, the appropriate reduction factor to use as a function of pile spacing is not well defined. Recent testing conducted by Rollins et al (2013) and Pierson et al (2008) indicate that lateral resistance decreases substantially as pile spacing from the wall decreases; however, reinforcing can reduce this effect. Rollins et al also found that p-multipliers defined as a function normalized spacing and reinforcement length seemed to provide reasonable agreement with measured pile response. Furthermore, Rollins et al found that the tensile force in the reinforcements owing to the lateral load on the pile could be estimated for design purposes using a correlation with pile load, spacing behind the wall, and distance transverse from the pile load.  Although the tests to date provide a framework for understanding the mechanisms involved and likely design approaches, the available data is too limited to make firm design recommendations. To improve our understanding of pile-MSE wall interaction, this project will involve construction of a test embankment approximately 80 ft long and 20 ft tall where it will be possible to conduct a number of lateral pile load tests on different pile types behind an MSE wall with both strip and grid type steel reinforcements. Additional contributions to the project will consist of in-kind donations from various contractors and material suppliers.Objectives for this study include: 1. Measure reduced lateral pile resistance vs. displacement curves for circular, square, and H piles behind an MSE wall with steel strips and grid reinforcement. 2. Measure the increase and distribution of tensile force in the MSE reinforcement induced by lateral pile loading.3. Measure effect of special pile head geometry (e.g. corrugated pipe sleeves, double plastic sheeting) on lateral pile resistance. 4. Develop design rules (e.g. p-multipliers) to account for reduced pile resistance as a function of spacing and reinforcement.5. Develop equation to predict reinforcement force induced by pile loading.6. Develop design equations to account for pile shape and pile head geometry. Tasks for this study include: 1. Instrument test piles and reinforcements.2. Drive test piles and construct MSE wall to height of 15 ft.3. Perform lateral load tests on piles with 15 ft high MSE wall.4. Reduce data and develop report on the testing for the 15 ft high wall.5. Determine p-multipliers and reinforcement force equations for 15 ft high wall test results.6. Perform lateral load tests on piles with 20 ft high MSE wall.7. Reduce data and develop report on the testing for the 20 ft high wall.8. Determine p-multipliers and reinforcement force equations for 20 ft high wall test results. 9. Develop design recommendations to account for pile sleeves and plastic sheeting effects. 10. Prepare final report with recommendations based on all tests. 11. Hold Technical Advisory Committee (TAC) meetings.12. Present results of the study at AASHTO, TRB, and ASCE meetings.Dr. Kyle Rollins of BYU is the Principal Investigator for this research project. The technical advisory committee (TAC) includes representatives from UT, FL, IA, KS, MA, MN, MT, NY, OR, TX, and WI DOTs. |

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| **Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):**Task 1 – 100% CompleteTask 2 – 100% CompleteTask 3 – 100% CompleteTask 4 – 100% CompleteTask 5 – 100% CompleteTask 6 – 100% CompleteTask 7 – 100% CompleteTask 8 – 100% CompleteTask 9 – 100% CompleteTask 10 – 100% Complete. BYU revised the 7 final reports and delivered these to UDOT.Task 11 – 100% CompleteTask 12 – 100% CompleteContract – No changes. |
| **Anticipated work next quarter**:Task 1 – CompletedTask 2 – CompletedTask 3 – CompletedTask 4 – CompletedTask 5 – CompletedTask 6 – CompletedTask 7 – CompletedTask 8 – CompletedTask 9 – CompletedTask 10 – UDOT will publish all of the final reports. These include the 4 longer reports and the 3 shorter reports.Task 11 – CompletedTask 12 – CompletedContract – UDOT will work with internal finance and FHWA to close the TPF study. |

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| **Significant Results:** The comments relative to the 7 draft final reports were incorporated into the final reports, and the final reports were submitted to the Utah Department of Transportation. These reports complete all required work tasks and reporting for the study. The final reports will be distributed to the TAC members in the next quarter and published via the TPF website and the TRB TRID database. These reports include the following:* Lateral Resistance of Pipe Piles Adjacent to 15-ft High MSE Wall
* Lateral Resistance of Pipe Piles Adjacent to 20-ft High MSE Wall
* Lateral Resistance of H-Piles and Square Piles Behind an MSE Wall with Ribbed Strip and Welded Wire Reinforcements
* The Influence of Pile Shape and Pile Sleeves on Lateral Load Resistance in Sand
* Lateral Resistance of Abutment Piles Behind Mechanically Stabilized Earth (MSE) Walls (shorter report)
* The Influence of Pile Shape on Lateral Resistance (shorter report)
* Lateral Resistance of Piles Within Corrugated Metal Sleeves (shorter report)

A follow-up Phase 2 study is underway with study number TPF-5(381) which involves field tests and analysis to address cyclic loading, fixed-head piles, pile group loading, and larger-diameter piles. |
| **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).**Additional time was needed to revise the final reports based on TAC feedback. Therefore the contract was amended to reflect the project ending in September 2018 instead of the previous plan. |

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| **Potential Implementation:**We are working with the AASHTO SCOBS T-15 committee to have the results of the study incorporated into new AASHTO codes. Shorter papers/reports have been prepared to help communicate the research results. |