**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(264)** | **Transportation Pooled Fund Program - Report Period:** \_ Quarter 1 (January 1 – March 31, 2014) \_ Quarter 2 (April 1 – June 30, 2014)**x Quarter 3 (July 1 – September 30, 2014)**\_ Quarter 4 (October 1 – December 31, 2014) |
| **Project Title:**Passive Force-Displacement Relationships for Skewed Abutments |
| **Name of Project Manager(s):**David Stevens | **Phone Number:** 801-589-8340 | **E-Mail** davidstevens@utah.gov |
| **Lead Agency Project ID:**FINET 42051, ePM PIN 10903UDOT PIC No. UT11.406 | **Other Project ID (i.e., contract #):** UDOT Contract No. 138123  | **Project Start Date:** August 13, 2012 |
| **Original Project End Date:**September 30, 2014 | **Current Project End Date:** December 15, 2015 | **Number of Extensions:**2  |

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** |
| $270,000.00 | $139,200.00 | 55% |

***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 | 65% |

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| **Project Description**: At present, about 40% of the 600,000 bridges in the FHWA database are constructed at a skew angle (Silas Nichols, Personal Communication). There is considerable uncertainty about the passive force on skewed abutments where the passive force develops at an angle relative to the longitudinal axis of the bridge structure. Although current design codes (AASHTO 2011) consider that the ultimate passive force will be the same for a skewed abutment as for a non-skewed abutment, numerical analyses performed by Shamsabadi et al. (2006) indicate that the passive force will decrease substantially as the skew angle increases. Reduced passive force on skewed abutments would be particularly important for bridges subject to seismic forces or integral abutments subject to thermal expansion. Unfortunately, there have not been any physical test results for skewed abutments reported in the literature which could guide engineers in making appropriate adjustments for skewed conditions. Nevertheless, some field evidence has clearly shown poorer performance of skewed abutments during seismic events and distress to skewed abutments due to thermal expansion (Shamsabadi et al. 2006, Steinberg and Sargand 2010). This study builds on previous pooled fund testing conducted by Rollins and his students at BYU to evaluate passive force-deflection relationships for non-skewed abutments (TPF-5(122), Dynamic Passive Pressure on Abutments and Pile Caps, Rollins et al, 2010). The test facilities can readily be modified to allow for the test program with relatively small additional costs because of the test fixtures (reaction shafts, reaction walls, and pile supported cap) which are already constructed at the site. Results from this study can be compared with previous testing to assess overall performance.Four objectives are outlined for this new study: 1. Determine static passive force-displacement curves for skewed abutments with and without wingwalls from large scale tests.
2. Provide comparisons of behavior of skewed abutments with that of normal abutments.
3. Evaluate the effect of wingwalls on skewed abutment response.
4. Develop design procedures for calculating passive force-displacement curves for skewed abutments.

The scope of work consists of twelve specific tasks, including new tasks 7 through 12: 1. Literature Review and Collection of Existing Test Data
2. Perform Laboratory Passive Force-Deflection Tests on 2 ft High Wall with Skew Angles of 0º, 15º, 30º, and 45º
3. Perform Field Passive Force-Deflection Tests on 5.5 ft High Wall with Skew Angles of 0º, 15º, and 30º and Transverse Wingwalls
4. Perform Field Passive Force-Deflection Tests on 5.5 ft High Abutment with Skew angles of 0º, 15º, 30º and MSE Wingwalls
5. Calibrate Computer Model and Conduct Parametric Studies
6. Preparation of Final Report
7. Perform Additional Field Passive Force-Deflection Tests on 5.5 ft High Abutment with a Skew Angle of 45º with and without MSE Wingwalls
8. Perform Field Passive Force-Deflection Tests on 3.0 ft High Unconfined Backfill with Skew Angles of 0º and 30º
9. Perform Field Passive Force-Deflection Tests on 5.5 ft High Pile Cap with Concrete Wingwalls and Skew Angles of 0º and 45º
10. Perform Field Passive Force-Deflection Tests on 3.5 ft High Unconfined Gravel Backfill with Skew Angles of 0º and 30º
11. Perform Field Passive Force-Deflection Tests on 3.5 ft High GRS Gravel Backfill with Skew Angles of 0º and 30º
12. Present the Results of the Study at TRB and AASHTO Meetings

Dr. Kyle Rollins of BYU is the Principal Investigator for this research project. Individual task reports will be prepared for Tasks 1 through 5 and 7 through 11 when these are completed. Up to two in-person meetings with the multi-state technical advisory committee (TAC) are planned to be held in Salt Lake City, Utah during the project. Other TAC meetings will be tele-conference or web meetings. |

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| **Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):**Task 1 – 100% complete. Task 2 – 100% complete. Task 3 – 100% complete. Task 4 – 100% complete. Task 5 – 70% complete. BYU continued data analysis and worked on task report.Task 6 – 10% complete. Combining portions of other task reports for the Final Report.Task 7 – 80% complete. BYU continued data analysis and worked on task report.Task 8 – 80% complete. BYU continued data analysis and worked on task report.Task 9 – 80% complete. BYU continued data analysis and worked on task report.Task 10 – 80% complete. BYU continued data analysis and worked on task reports. They submitted a preliminary task report, which was shared with the TAC.Task 11 – 60% complete. BYU continued data analysis and worked on task reports.Task 12 – 60% complete. Dr. Rollins shared his presentation slides with the TAC from the June 2014 AASHTO SCOBS Meeting (T-3 Committee).TAC Meetings – None.Contract – The contract was amended to include recent funding from Wisconsin DOT to go towards additional computer modeling (in Task 5) for the case with reinforced concrete wingwalls (using Task 9 results). The contract schedule and remaining deliverable dates were also extended. |
| **Anticipated work next quarter**:Task 1 – None.Task 2 – None.Task 3 – None.Task 4 – None.Task 5 – BYU will work with Anoosh Shamsabadi of Caltrans to adjust their numerical models and help interpret the results. Additional modeling will be done related to the Task 9 test results. Work will continue on the task report.Task 6 – Combining portions of other task reports for the Final Report.Task 7 – Complete the full task report (the revised Tasks 3 and 4 reports).Task 8 – Complete the full task report.Task 9 – Complete the full task report.Task 10 – Complete the full task report.Task 11 – Complete the preliminary and full task reports.Task 12 – Prepare for upcoming AASHTO SCOBS meetings, with TAC input, to encourage implementation of research results.TAC Meetings – We will likely hold a TAC web conference to discuss completed task reports during this quarter.Contract – None.  |

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| **Significant Results:**During the past quarter the preliminary report on Task 10 testing (Skew testing with gravel backfill) was completed and sent to TAC members. In addition, work on the preliminary report on task 11 testing (skew testing with GRS backfill) was nearly completed and a draft report has been prepared. The report should be coming to TAC members within the next two weeks. The results from this testing indicate that the skew reduction factor is somewhat higher than predicted for the gravel backfill cases (0.58 to 0.63) relative to the predicted 0.51 value for a 30º skew. These results suggest that the gravel backfill may provide some additional resistance relative to the sand backfill used in the other tests. As we continue to analyze the passive force-deflection curves using the computer models PYCAP and ABUT along with PLAXIS3D, it has become evident that we need additional information regarding interface friction between the geotextile and the concrete wall of the pile cap. Therefore, we have taken a core sample of concrete from the cap wall and are presently conducting interface friction tests with the geotextile in a direct shear device. We anticipate that this information will help us to make more appropriate choices regarding input parameters in the computer models so that we can complete the final task reports for Tasks 10 and 11.  |
| **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).**Some of the analysis in the newer tasks has taken longer than originally planned. When the newer field testing tasks were added to the contract, the contract end date was not extended. During this quarter the contract was amended to reflect a revised schedule to complete all tasks and deliverables by the end of 2015. |

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| **Potential Implementation:** UDOT is considering early adoption of the skew reduction factor for passive force based on the laboratory and field test results, but no final decision has been made at this point. In June 2013 and June 2014, Dr. Rollins presented the results of the research to date to technical committees at the AASHTO Subcommittee on Bridges and Structures Annual Meeting in Oregon and Ohio on behalf of the project TAC. This interaction is intended by the TAC and Dr. Rollins to prepare the way for design code revisions once the research is completed. Caltrans is also promoting use of the research results in their design methods. |