**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(296)** | | **Transportation Pooled Fund Program - Report Period:**  **x Quarter 1 (January 1 – March 31, 2014)**  \_ Quarter 2 (April 1 – June 30, 2014)  \_ Quarter 3 (July 1 – September 30, 2014)  \_ Quarter 4 (October 1 – December 31, 2014) | |
| **Project Title:**  Simplified SPT Performance-Based Assessment of Liquefaction and Effects | | | |
| **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:**  5H07009H, 42065, ePM PIN 12436  UDOT PIC No. UT13.407 | **Other Project ID (i.e., contract #):**  UDOT Contract No. 148753 | | **Project Start Date:**  March 6, 2014 |
| **Original Project End Date:**  November 30, 2016 | **Current Project End Date:**  November 30, 2016 | | **Number of Extensions:** |

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** |
| $88,000.00 (current contract)  $148,000.00 (total committed) | $0 | 5% |

***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 | 3% |

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| **Project Description**:  Liquefaction of loose saturated sands results in significant damage to buildings, transportation systems and lifelines in most large earthquake events. Liquefaction and the resulting loss of shear strength can lead to lateral spreading and seismic slope displacements, which often impact bridge abutments and wharfs, damaging these critical transportation links at a time when they are most needed for rescue efforts and post-earthquake recovery.  While most updated seismic provisions now adopt a risk-targeted approach to design ground motions for superstructures, other critical aspects of geotechnical engineering, such as liquefaction and ground deformation evaluation, are still based on the older concept of deterministic hazard evaluation. Recent advances in performance-based earthquake engineering (PBEE) in geotechnical engineering (e.g., Kramer and Mayfield 2007; Rathje and Saygili 2008; Bradley et al. 2011; Franke and Kramer 2013) have introduced probabilistic uniform hazard-based procedures for evaluating seismic ground deformations within a performance-based framework from which the likelihood of exceeding various magnitudes of deformation within a given time frame can be computed. However, the ability to apply these performance-based procedures on everyday projects is generally beyond the capabilities of most practicing engineers.  This study proposes to create and evaluate *simplified* performance-based design procedures for the *a priori* prediction of liquefaction triggering, lateral spread displacement, seismic slope displacement, and post-liquefaction free-field settlement using the standard penetration test (SPT).  Objectives for this study include:  1. Derive new simplified performance-based procedure for liquefaction triggering, lateral spread displacement, free-field post-liquefaction settlements, and Newmark seismic slope displacements.  2. Develop liquefaction parameter maps in GIS format associated with each of the hazards included in objective 1 at return periods of 475 years, 1033 years, and 2475 years for each of the states participating in the study.  3. Evaluate the new simplified performance-based liquefaction procedures against conventional (i.e., AASHTO) liquefaction analysis procedures.  4. Develop a simplified design procedure that will allow the designer to envelope the performance-based and conventional results to select which result will govern the design.  Tasks for this study include, regarding the participating states:  1. Derivation and validation of a new simplified liquefaction triggering model (Year 1).  2. Derivation and validation of simplified lateral spread displacement models (Year 1).  3. Derivation and validation of simplified post-liquefaction settlement models (Year 2). (Not funded in original contract.)  4. Derivation and validation of simplified Newmark seismic slope displacement models (Year 2). (Not funded in original contract.)  5. Assessment of grid spacing considerations in various seismic environments for map development (Years 1 & 2). (Partially funded in original contract.)  6. Development of liquefaction parameter maps at targeted return periods in GIS file format (Years 1 & 2). (Partially funded in original contract.)  7. Comparison of simplified, conventional, and deterministic analysis approaches (Years 1 & 2). (Partially funded in original contract.)  8. Development of a simplified design procedure and an analysis spreadsheet that incorporates both performance-based and conventional methods (Years 1 & 2). (Partially funded in original contract.)  9. Preparation of the annual and final reports (Years 1 & 2).  10. Dissemination of results in appropriate engineering journals and conferences (Years 1 & 2).  11. Technical Advisory Committee meetings (Years 1 & 2), including a final workshop to train partner states on the new performance-based liquefaction hazard methods.  Dr. Kevin Franke of BYU is the Principal Investigator for this research project. The technical advisory committee (TAC) for the study includes representatives from UT, AK, CT, ID, MT, and SC DOTs. |

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| **Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):**  Task 1 – 30% complete. BYU began work on this task.  Task 2 – 30% complete. BYU began work on this task.  Task 3 – Not funded currently.  Task 4 – Not funded currently.  Task 5 – No work yet.  Task 6 – No work yet.  Task 7 – No work yet.  Task 8 – No work yet.  Task 9 – No work yet.  Task 10 – No work yet.  Task 11 – 5% complete. A pre-contract kickoff web-conference was held in January with the TAC.  Contract – Alaska DOT joined the study and committed funds. The work plan was approved by the TAC, and a UDOT research contract was established with BYU. |
| **Anticipated work next quarter**:  Task 1 – Task will be completed.  Task 2 – Task will be completed. The TAC quarterly update report for Tasks 1 and 2 will be prepared and shared with the TAC in early June.  Task 3 – None.  Task 4 – None.  Task 5 – BYU will begin work on this task.  Task 6 – BYU will begin work on this task.  Task 7 – None.  Task 8 – None.  Task 9 – None.  Task 10 – None.  Task 11 – A web-conference will be held in June with the TAC to review progress on initial tasks.  Contract – No changes are planned. |

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| **Significant Results:**  Derivations for simplified performance-based liquefaction triggering and lateral spread displacement models are on-going. Preliminary analysis results have shown that the simplified results approximate the full performance-based results within 5% for most sites that were evaluated. However, additional validations and checking must be performed before the models are presented in an update report. |
| **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).** |

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| **Potential Implementation:** |