**TRANSPORTATION POOLED FUND PROGRAM**

**QUARTERLY PROGRESS REPORT**

Date: \_\_\_\_\_\_1/26/2018\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lead Agency (FHWA or State DOT): \_\_\_\_\_\_Washington State DOT\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**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(276)* | **Transportation Pooled Fund Program - Report Period:**Quarter 1 (January 1 – March 31)Quarter 2 (April 1 – June 30)Quarter 3 (July 1 – September 30)Quarter 4 (October 1 – December 31) |
| **Project Title:****Full-Scale Shake Table Testing to Evaluate Seismic Performance of Reinforced Soil Walls** |
| **Name of Project Manager(s):****Lu Saechao** | **Phone Number:****360.705.7260** | **E-Mail**saechal@wsdot.wa.gov |
| **Lead Agency Project ID:** | **Other Project ID (i.e., contract #):****GCB1359** | **Project Start Date:**2012 |
| **Original Project End Date:** | **Current Project End Date:****6/30/2018** | **Number of Extensions:**0 |

Project schedule status:

* 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** |
| $289,937(Ph1 $49,938 & Ph2 $239,999) | $237,724.67(Ph1 $49,938 & Ph2 $187,786.67) |  |

***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** |
|  | $8,380.76 |  |

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| **Project Description**:

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| Phase 1 (completed)The objective of this project is to perform numerical studies and use the LHPOST to investigate the dynamic performance of one or two full-scale (7 m) reinforced soil retaining walls constructed using realistic materials and methods. Considering that these walls will be substantially taller than for any similar previous research (by a factor of 2), a key focus of the proposed research will be on the influence of wall height on overall system response (i.e., stability/deformation) and the distribution of dynamic tensile forces (i.e., seismic demand) in the soil reinforcement. Other focus areas will include dynamic earth pressure on facing elements, effects of dynamic loading on soil-reinforcement stress transfer mechanisms, and permanent deformations after dynamic loading. The tests will be conducted using a unique large soil confinement box (LSCB) that is currently under construction as part of a recently funded NSF grant. The scale of these tests will permit wall construction using realistic soil types, compaction methods, and structural elements. The box will also have a unique design that permits different boundary conditions at the rear of the soil mass, including a water-filled bladder or geofoam layer. Phase 2 (current work)The objective of Phase II is to perform reduced-scale shake table tests and numerical studies to further characterize the seismic performance of MSE abutments. Numerical modeling work will be conducted using FLAC-3D and allow us to extrapolate results from the reduced-scale physical tests to simulate seismic performance of MSE abutments for bridges with spans up to 150 ft. The results of this work will be used to assess whether or not a Phase III investigation, consisting of full-scale MSE abutment tests, will be conducted on the UCSD large outdoor shake table. |
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| **Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):**90% of the Phase 2 work has been completed. The project is on scope, on schedule and within budget. This pooled fund study is leveraging a Caltrans study. UCSD completed the experimental testing program and data interpretation which was submitted as the final report for the Caltran project, closing out the Caltrans part of the project. UCSD is currently finalizing the numerical simulation part of the project which will be submitted as the final report for the pooled fund project. Task 1 (literature review) is ongoing throughout the duration of the project, and Task 2 (detailed design) and Task 3 (MSE abutment testing program) have been completed. This quarter UCSD finished responding to comments on the final report on the experimental testing program that includes a synthesis and interpretation of results as well as appendices of all instrumentation data and photographs of the experiments, so Task 4 is also complete. The other efforts included refining the numerical simulations of the MSE abutments in FLAC2D (Task 5). Our activities related to numerical modeling include refining the constitutive models for the soil and geosynthetic reinforcements, performing 3D simulations in addition to 2D simulations, incorporating new design-level analyses (K-stiffness method, AASHTO method, limit equilibrium), and development of design recommendations for the seismic response of MSE bridge abutments based on the simulation results. The pre-test 2D numerical simulations in FLAC2D indicated a good match of the quasi-static bridge seat settlement, quasi-static lateral wall deflections, and seismic bridge seat settlement, but indicated an over-estimate of the seismic lateral wall deflections. This means that the numerical simulations are conservative in their current form. However, the soil properties are currently being simulated using the UBCsand model to account for stiffening effects as the soil densifies during cyclic loading, nonlinear soil behavior, soil-geosynthetic interface properties and the inter-block connection properties to better match the seismic lateral deflections. Planning for a full-scale test on the Englekirk shaking table was also performed in this quarter (Task 6). This quarter included salaries to support Yewei Zheng, the main PhD student (and now Post-doc) working on the project and Wenyong Rong, a PhD student working on 3D numerical simulations, cyclic simple shear testing of the sand, and bender element testing of the sand. A summary of the specific tasks that were completed:1. UCSD responded to comments (from pooled partners) on the final report for the experimental testing program, which will be formally submitted by the end of January 2018 (Task 4).
2. Improving the dynamic 2D and 3D numerical simulations through validation with the experimental results and consideration of new constitutive models (Task 5).

Budget:$8,380.76 was expended on the project this quarter. |
| **Anticipated work next quarter**:The Phase 2 testing program is now complete, so the main efforts are related to analysis and improving simulations, which will be the contents of the final report for the pooled fund project:1. Evaluate design tools for MSE bridge abutments and compare with numerical simulations and experimental data (Task 5).
2. Continue improving numerical simulations of the different experiments, and continue to explore 3D simulations (Task 5).
3. Continue cyclic simple shear testing on the sand to improve the constitutive model used in the model simulations (Task 5).
4. Perform small-strain shear modulus measurements on the sand using bender elements (Task 5)
5. Planning a full-scale MSE abutment testing program for the Englekirk shaking table (Task 6).
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| **Significant Results:**Final experimental report published. |
| **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:**  |