TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT
Q4/2023

Lead Agency:
Washington State Department of Transportation (WSDOT)

INSTRUCTIONS:
Lead Agency contacts 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.

Transportation Pooled Fund Program Project # ***TPF-5(491)***	**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)

TPF Title (follow link to TPF webpage)**:**

Super-Elastic Copper-Based and Iron-Based Shape Memory Alloys and Engineered Cementitious Composites for Extreme Events Resiliency

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Lead Agency Project ID: UCB 1874	**Other Project ID (i.e., contract #):** T-1874	**Project Start Date:** 2022-12-01
Original Project Start Date: 2022-12-01	**Original Project End Date:** Phase 1 - 2023-11-30 Phase 2 – 2025-11-30	**If Extension has been requested, updated project End Date:** N/A

Project schedule status:

☐ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

(A) Overall Project Statistics:

Commitments to date $ (3yrs)	Obligations to date $	% Obligated	Contracted to date $	Expended to date $	Expended to date as % of $ contracted	Completed this quarter $
350,000	270,000	77%	210,000	111,964	23%	68,590

(B) Project Description:

The objective of this research project is to:

1. evaluate and test several innovative columns which have self-centering feature to provide minimum residual displacement after earthquake.
2. improve column serviceability after earthquake by decreasing damage and spalling of concrete within column plastic hinge region; and
3. provide cost comparison among columns having different engineered materials; and
4. develop self-centering column design specifications. Particularly, in this proposed research, the low-cycle fatigue characteristics, corrosion resistance, machinability and coupling mechanisms with traditional steel rebar, and cost of CAM and Fe-SMA super-elastic alloy (SEA) bars will be studied.

Direct comparisons will be made with Nickel-Titanium (NiTi) SEAs (and traditional steel reinforcing bars as applicable) to illustrate the advantages/disadvantages of each material. If successfully demonstrated for their suitable characteristics, the CAM and Fe-SMA SEA bars could replace their NiTi counterparts at a significantly lower (up to ten times) cost and accelerate their applications in bridges. Therefore, the outcomes of this project are directly relevant to state departments of transportation and bridge and structural engineers and designers. This proposed project will build on the success of previously implemented WSDOT's application of shape memory alloy/engineered cementitious composite (SMA/ECC) in the columns of the SR-99 on-ramp bridge in downtown Seattle while making a direct impact on advancing and securing the national transportation network.

(C) Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

All the analysis of data from material testing and moment-curvature analysis has been completed. The final report has been prepared and submitted to the sponsor. The second phase of the project has been initiated. The SMA materials for the column tests have been determined as NiTiCo and FeSMA based on the results from Phase I of the project. The column design has been finalized, moment-curvature analysis has been performed, and the SMA materials have been ordered from the manufacturers.

(D) Anticipated work next quarter:

Headed coupling of steel reinforcement with the SMA reinforcement will be studied. The necessary additional materials will be ordered for building the columns. The fabrication of the columns will be initiated.

(E) Significant Results:

Final report for Phase I of the project has been completed and submitted.

A 16 inch diameter column has been designed and analyzed. The results indicated that the replacement of the plastic hinge reinforcement with NiTiCo SMA does not significantly alter the moment capacity.

The SMA materials have been ordered from the manufacturers.

(F) 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).

The TAC unanimously voted to continue the work and Phase 2 was broken up into smaller tasks. A task proposal was requested from the researchers for Task 3a and adopted after comments by the SMEs and revision by USC for a task order to the value of $90k. This task includes fabrication and testing of two columns at the end of which, given the funding we will continue with two more columns.

The project is currently being extended to testing of the remaining two columns under Task 3b as additional funding has become available since awarding of the Task 3a contract.

(G) Potential Implementation:

We will have a better idea on the implementation trajectory of the findings during Phase 2, within the scope of this pooled fund, if successful and if adequate funding is committed and obligated to conduct Phase 2. The results of Phase 1 look very promising so far!