OREGON DEPARTMENT OF TRANSPORTATION

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SPR Quarterly Progress Report
1/1/16 through 3/31/16

Date: April, 15, 2016

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1. Project

Validation of Tsunami Design Guidelines for Coastal Bridges
SPR TPF 5(307)

Project Description

The functionality and survivability of coastal bridges under earthquake and tsunami excitations is a major concern of western US states. A significant number of these bridges are vital to the emergency first response transportation of coastal cities immediately after a Cascadia Subduction Zone earthquake or other major earthquake events that generate tsunami waves in the Pacific Ocean, which will likely be followed by a local tsunami 15 to 60 minutes afterward. At least two numerical studies sponsored by California and Oregon of tsunami loads on a number of coastal bridges have been completed or nearly completed. Several studies have also been conducted on the effects of the "Great Japan Earthquake" of 2011 by Japanese research institutes as well as at UNR. Significant progress in the development of a tsunami design guideline has been made and the results appear promising. However, the reliability of the numerical results is unknown at this point due to a lack of experimental data needed for verification and validation. Thus, it is essential that experiments be conducted to provide data to verify and validate the numerical results to assess the accuracy of the load prediction equations. When validated, the numerical model can then be used to further improve the numerical analysis and development of practice design guidelines.

2. Key Dates

Start Date for ODOT:	April 16, 2015 (contract execution)
Completion Date for ODOT:	June 30, 2018

3. Principal Investigator and Teams

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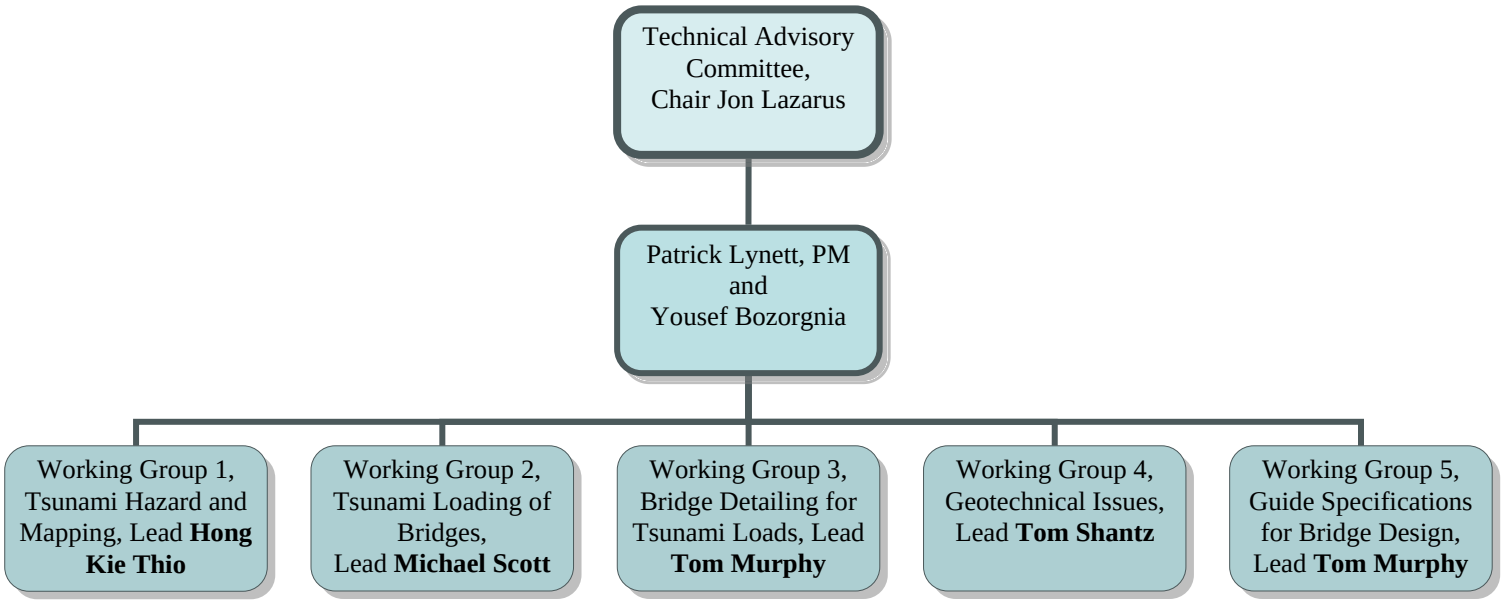
Tom Shantz		916-227-7245

Relationship/Project Chart



Planned Project Schedule

			Year	2015		2016				2017				2018	
			Quarter	July-Sept	Oct-Dec	Jan-Mar	Apr-Jun	July-Sept	Oct-Dec	Jan-Mar	Apr-Jun	July-Sept	Oct-Dec	Jan-Mar	Apr-Jun
Description	Task	Budget %	Personnel (meeting method)	YR 0.25	YR 0.50	YR 0.75	YR 1.0	YR 1.25	YR 1.50	YR 1.75	YR 2.0	YR 2.25	YR 2.50	YR 2.75	YR 3.00
Discussion of WG1 tasks	WG1.1-3	0%	WG1, (Webex)												
WG1 Workshop @ PEER	WG1.1-3	4%	WG1, WG2 rep (PEER)												
Documentation of Task WG1.1	WG1.1	16%	HKT, PL												
Documentation of Task WG1.2	WG1.2	5%	PL, HKT												
Documentation of Task WG1.3	WG1.3	4%	PL, HKT												
Review of WG1 tasks by WG2	WG2.2	1%	MS (email, Webex)												
Discussion of WG2 tasks	WG2.1-3	0%	WG2, (Webex)												
Literature Review of loading	WG2.1	3%	MS												
WG2 Workshop @ PEER/OSU	WG2.1-2	4%	WG2, WG1 rep (PEER/OSU)												
Documentation of Task WG2.1	WG2.1	1%	MS												
Modeling / Testing (gaps)	WG2.2	9%	MS, PL												
Documentation of Task WG2.2	WG2.2	3%	MS, PL												
WG2 Workshop @ PEER/OSU	WG2.3	4%	WG2, WG1 rep (PEER/OSU)												
Documentation of Task WG2.3	WG2.3	6%	MS, PL, HKT												
Detailing Recommendations	WG3.1	3%	TM												
Identify Geo code issues	WG4.1	4%	TS												
Draft Guide Specifications	WG5.1	14%	TM, WG reps												
Workshop to discuss Draft	WG5.1	4%	WG5												
Final Guide Specifications	WG5.2	15%	TM, WG reps												

Red boxes indicate quarters when deliverables (Task Reports) are to be completed

Personnel:	PL	Patrick Lynett
	HKT	Hong Kie Thio
	MS	Michael Scott
	TM	Tom Murphy
	TS	Tom Shantz
	WG1, 2, ..	Working Group 1, 2, ...

4. Progress

Working Group 1: Tsunami Hazard and Mapping	30% of total project
Percent completed reported in last quarterly report:	10%
Percent completed after this quarter:	25%

Key Progress-To-Date

- WG1 has reviewed the current status of tsunami hazard databases, including the up-to-date progress of the ASCE7 inundation maps. Preliminary conclusions of these efforts indicate that uncertainties in any one model can be very large for a local velocity prediction, but that using an ensemble approach (either many trials of the same model or using different models) can yield a more stable and thus higher confidence result.
- Although there are some limited efforts underway in various states to produce tsunami hazard maps, we find that the procedures and input models are far from uniform and also not consistent with the ASCE maps. Therefore, to produce the 1000 year design maps, we are currently comparing and calibrating our inundation models using 30-60m grids for 2500 years to those produced by NOAA for ASCE 7-16. Once we have established a good correlation between our results and the ASCE 7-16 inundation zones, we will be able to proceed with the development of 1000 year inundation maps that are consistent with the procedures used to create the 2500 years ASCE maps.
- WG1 has begun to investigate the available alternatives for site-specific hydrodynamic predictions. In particular, the use of transect models is being pursued. While numerical model base transect analysis (i.e. not using the Energy Grade Line method) would be preferred, some infrastructure is needed to maintain and disperse such tools.
- [NEW]: WG1 has collected high-resolution bathymetry data for the western states from a variety (mostly NOAA-based) sources. An overview map of these areas has been distributed to the panel for review.
- [NEW]: WG1 has received some input (from Oregon) regarding target areas with rankings. The intent is to model most areas with 30m resolution, but to use 10m resolution for the top-tier locations. Setup for these areas is now underway.

Problems

- [NEW]: Progress in initiating a PEER-based project to develop the necessarily infrastructure to host transect modeling tools has stalled

Work Planned for Next Quarter

- Building database of tsunami hazard maps [TASK WG1.1]
  - Check with the remaining stakeholders regarding areas of interest for modeling
  - Developing new maps at the 1000-yr hazard level, developing using a mix of the "scaling" approach and new modeling in selected locations
  - Task completion expected 7/16
- Quantification and inclusion of uncertainties in the onshore propagation and other uncertainties not formally or rigorously included in the ASCE7 probabilistic maps [TASK WG1.2]

    - Will be based on ongoing work by the PEER Tsunami group (PTG)
    - With the results from the PEER project, some discussion in WG1 will be needed in order to determine a method to incorporate this uncertainty on a site-specific basis
    - Task completion expected 10/16
- Method to provide the hydrodynamic information needed (max, mins, time series, etc) for design using the ASCE7 maps as input [TASK WG1.3]
    - Options include using the Energy Method (ASCE7) or some Numerical Model Transect tool in the general vicinity of the structure
    - Easiest path will be to use the ASCE7 Energy method
    - Will require WG1 consensus, and review/discussion with WG2
    - Task completion expected 7/16

Working Group 2: Tsunami Loading of Bridges	30% of total project
Percent completed reported in last quarterly report:	8%
Percent completed after this quarter:	15%

Key Progress-To-Date

- Literature review of available experimental data is complete. This includes tsunami bore impact on bridge decks at PWRI in Japan; tsunami bore impact on bridge decks at OSU (with UNR); and tsunami bore impact on bridge columns at UW. Additional data is available from experiments on storm surge loading of bridge decks at OSU. While this is not tsunami bore impact, the data will provide additional confidence in simulation models. Data for tsunami bore impact on buildings (experiments at OSU) will be available in the coming months and will also provide increased confidence of simulation models. With the NSF-funded NHERI system coming online this year and the awarding of OSU's wave research lab as an experimental facility, more data will likely become available during the project.
- [NEW]: New additions to the literature review in light of presentation by Denis Istrati and Ian Buckle at the PEER annual meeting in late January. Additional experimental data will thus be available for this project. Review of analytical methods is nearing completion.

Problems

- N/A

Work Planned for Next Quarter

- Hiring a graduate student is the top priority so that simulation models of the aforementioned experiments can be developed in both OpenSees and OpenFOAM.
- [NEW] Organize a TAC meeting and WG2 workshop on the OSU campus for mid-July. The planned date was moved back to summer (reported to be held in Spring in last quarterly report). The workshop will be held at a mutually agreed upon location such as the OSU campus. The objective of the workshop is to determine gaps in knowledge for

numerical simulation of tsunami loads on bridges to a) determine what model refinements are necessary and to b) determine if additional experiments are needed in order to increase our confidence in the numerical models.

- Literature review of existing and ongoing methods to estimate loads on bridges / tsunami loads on general structures [TASK WG2.1]
    - [NEW]: Development of a table of all available and planned model tests with the scale, test configuration, testing protocols and results to aid in the identification of gaps in validation of possible simplified design equations. Additional experiments will be conducted by Istrati and Buckle in May at the Hinsdale Wave Research Laboratory at OSU.
    - Determine whether existing methods can be extended tsunami loads on bridges
    - If additional information or testing is needed, develop a plan to obtain
    - Preliminary loading calculation approach, based on expected newly obtained data
    - Task completion expected 5/16 [Target Date 1/16]

Working Group 3: Bridge Detailing for Tsunami Loads	3% of total project
Percent completed reported in last quarterly report:	0%
Percent completed after this quarter:	0%

Key Progress-To-Date

- N/A

Problems

- N/A

Work Planned for Next Quarter

- Efforts in WG3 are scheduled to initiate in July, 2017

Working Group 4: Geotechnical Issues (Scour and drawdown induced liquefaction)	4% of total project

Percent completed reported in last quarterly report:	0%
Percent completed after this quarter:	0%

Key Progress-To-Date

- N/A

Problems

- N/A

Work Planned for Next Quarter

- Efforts in WG4 are scheduled to initiate in April, 2017

Working Group 5: Guide Specifications for Bridge Design for Tsunami Hazard	33% of total project
Percent completed reported in last quarterly report:	0%
Percent completed after this quarter:	0%

Key Progress-To-Date

- N/A

Problems

- N/A

Work Planned for Next Quarter

- Efforts in WG5 are scheduled to initiate in April, 2016

CONTINGENCY PLAN FOR DEVELOPING 1000-YR HAZARD MAPS	0%
Percent completed reported in last quarterly report:	0%
Percent completed after this quarter:	0%

Key Progress-To-Date

-
-

Problems

-

Work Planned for Next Quarter

- There is currently no identified need or authorization to proceed with the development of these hazard maps

7. Finances

SPR Project Summary

8. Project Summary (Completed by ODOT)

SPR Project Summary

State	Commitment					Transferred					Comments
	FY15	FY16	FY17	FY18	Total	FY15	FY16	FY17	FY 18	Total	
Alaska	25000	25000	25000		75000	25000	25000	25000		75000	$75,000 in 3 payments of $25,000 starting in 2013 (recommitted by e-mail May 2014)
Oregon	20000	120000	20000	20000	180000	20000	120000	20000	20000	180000	$60,000 in 3 payments of $20,000 starting in 2014. Payments will be increased to cover research coordinator's time. 5/12/15 an additional 100,000 was committed by the ODOT bridge section.
FHWA					100000	100000				100000	$100,000 allocated by FHWA memo from HIBT may 2014
Hawaii	20000	20000	20000		60000	20000				20000	E-mail intent to contribute $60,000 in 3 payments starting in 2014 (recommitted by e-mail May 2014)
Washington	20000	20000	20000		60000	20000	20000	Pend-ing		40000	E-mail intent to contribute $60,000 in three payments of $20,000 starting in 2015 (recommitted by phone call May 2014)
California	20000	20000	20000		60000	20000	20000	20000		60000	
					$535,000					**$475,000**	