

Research Notes

Program Steering Committee (PSC): Geotech Structures

June 2014

Title: Validation of Tsunami Design Guidelines for Coastal Bridges TPF - 5(307)

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Product Category: New or improved manual, handbook, guidelines, or training.

Task Manager: Harold Hunt, Sr. Environmental Planner

harold_hunt@dot.ca.gov

TITLE:

Validation of Tsunami Design Guidelines for Coastal

This research will develop bridge design guidelines for the estimation of tsunami loads on highway bridges.

WHAT IS THE NEED?

The integrity 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, 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. 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 an experiment 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 design development for a practice design guideline.

WHAT ARE WE DOING?

This research will be accomplished via the following tasks:

Task 1: Literature Review: Review technical literature, including consideration of the results of FEMA 646 to determine whether the results can be extended from buildings to bridges.

Task 2: Testing and Verification Plan Development and Data Collection

Task 3: Develop three-dimensional models of tsunami impact on bridge superstructures to

better understand the interaction between the wave and structure forces and to study the effect of span length, superstructure type, superstructure depth, effects of buoyancy for varying superstructure type/depth, effectiveness of shear keys for girders on bearings, open vs. closed barrier rail, etc., on computations of the tsunami forces.

Task 4: Perform laboratory experiments of tsunami impact on bridge superstructures and compare the test results with previous numerical estimates.

Task 5: Develop force distribution models on each girder in the bridge cross-section to evaluate reaction forces at connections between the deck and the girders or on flat soffit bridges typical of western US coastal bridges.

Task 6: Prepare final design recommendations and a final report documenting the testing and analytical studies.

Task 7: Prepare draft American Association of State Highway and Transportation Officials specification language for consideration by the Subcommittee on Bridges and Structures.

WHAT IS OUR GOAL?

The objective is to develop bridge design guidelines for the estimation of tsunami loads on highway bridges. It is proposed that the work include verification of the guidelines by model testing or comparison with observed results to calibrate the predictive capability of numerical models for analysis of tsunami loads on coastal bridges. Generalized bathymetry and topography parameters will be modeled analytically and replicated experimentally. For example, options may include a shallow submarine shelf case or deep submarine trench as bathymetry and coastal plain or river valley as topography. The resulting data will be analyzed to determine their appropriateness and compared against the numerical predictions.

WHAT IS THE BENEFIT?

This research will result in bridge designs that are better to withstand tsunamis.

WHAT IS THE PROGRESS TO DATE?

This pooled fund project has not yet started. The next step is to transfer California's contribution and start the project.