DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Validation of Tsunami Design Guidelines for Coastal Bridges

Geotech/ Structures

AUGUST 2021

Project Title:
Validation of Tsunami Design Guidelines for Coastal Bridges

Task Number: 2768

Start Date: April 16, 2015

Completion Date: June 30, 2020

Task Manager:
Tom Shantz
Senior Research Engineer
tom.shantz@dot.ca.gov

WHAT WAS THE NEED?

California, Oregon, Washington, Alaska, and Hawaii all border the Pacific Ocean and share a significant tsunami hazard along their shoreline. While an earthquake in the Cascadia subduction zone is the largest potential tsunami source (except in Hawaii), very distant earthquakes can also cause tsunamis that travel across the ocean and cause substantial damage. Recent tsunamis such as that caused by the 2010 Tohoku earthquake demonstrated the extreme damage a tsunami can cause, including damage to bridges. Currently, State Department of Transportations (DOTs) do not design bridges for tsunami loading and lack the design methods to do so. This study was initiated to begin the development of these needed design methods.

WHAT WAS OUR GOAL?

The goal of this research was to develop a tsunami design guideline for coastal bridges. The guideline would include tsunami hazard information (wave heights and velocities) for each state's coastline. This information would then be used as input into loading equations for bridges. The guideline also would include recommendations on the placement of these loads and bridge performance requirements.

WHAT DID WE DO?

Several working groups were created to address various aspects of the guideline development. One working group focused on the development of tsunami hazard information along each state's coastline. This group was able to leverage hazard work already performed for California and also used modeling results developed for an American Society of Civil Engineers study.

Another working group focused on validating some of the computer codes used for tsunami propagation and made estimates of the modeling uncertainty associated with their predictions. Case history information was used to validate run-

up estimates, wave heights, and flow velocities. Another working group obtained a small-scale flume study of wave loading on bridges from Japanese researchers. Numerical models of these tests were developed and used to guide hydrodynamic loading equation development. The project team also collaborated with researchers from the University of Nevada at Reno, who performed under separate Federal Highway Administration (FHWA) funding, a series of larger-scale flume tests evaluating wave impacts on a bridge deck. Numerical models of these tests were also used to guide the development of simplified loading equations. A final working group led the development of the guidance document. This document was written to conform to American Association of State Highway and Transportation Officials (AASHTO) formatting so that it could be formally adopted by AASHTO.

WHAT WAS THE OUTCOME?

All working groups were successful in delivering the assigned components for the guidance document. This document was finalized and submitted to AASHTO for future adoption. Tsunami hazard data (maximum wave height, momentum flux, and velocity) were developed for each state and submitted digitally to each state. As this project was being completed, a team at UCLA and USC were collaborating on the development of a website tool that helps engineers make the final determination of tsunami hazard values. That website is now operational.

WHAT IS THE BENEFIT?

This project has enabled DOTs to adopt tsunami-related hazard considerations into their design process. This represents a major achievement since designing for potential tsunamis involves many complex issues ranging from source characterization to wave propagation, bathymetric investigation, hydrodynamics, and structural engineering. Including tsunami hazards into our design process will enable better-performing bridges during a tsunami event, potentially saving lives and supporting recovery efforts.