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Water-Driven Debris Impact Forces on Structures: Experimental and Analytical Program

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Holmes Hall 244

Thursday, September 18, 2014

4:30 -5:30 pm Seminar

Abstract

Water-driven debris generated during tsunamis and hurricanes can impose substantial impact forces on structures that are often not designed for such loads. The results of a recent experimental and analytical program to quantify these potential impact forces are presented. The project was funded by the U.S. National Science Foundation under the Network for Earthquake Engineering Simulation program.

The experimental program focused on two types of prototypical debris: a wood log (utility pole) and a standard shipping container. Full-scale impact tests of both debris objects were carried out at Lehigh University. These tests were carried out in-air, and were designed to provide baseline, full-scale results. A 1:5 scale shipping container model was used for in-water tests in the Oregon State University large wave flume. These tests were used to quantify the effect of the fluid on the impact forces. Results from both experimental programs are presented and compared with predictions based on analytical solutions developed at the University of Hawaii. The theoretical models consider the wave propagation in debris, as compared to the impulse-momentum, rigid body impact models typically assumed for such impact scenarios. The analytical models and associated interesting results will be discussed in some detail.

The analytical predictions are found to be in sufficient agreement such that they can be used for design. A fundamental takeaway is that the impact forces are dominated by the structural impact, with a secondary affect provided by the fluid. The results of this study have informed the development of provisions in a new, proposed chapter on tsunami loads and effects that is under consideration for the new ASCE 7 standard, 'Minimum Design Loads for Buildings and Other Structures.' These proposed provisions for debris impact will be reviewed as well.

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