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Development of Standards and Guidelines for Assessment of Tsunami Inundation Hazards for Marine Facilities

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Abstract

We review here standards and guidelines (S+G) for inundation models that are used to evaluate hazards to marine facilities from landslides-triggered and tectonic tsunamis. These S+G have evolved over the past two years to assist the assessment of critical facilities that may be subject to tsunami attack. The standards refer to benchmark tests for numerical model validation, while the guidelines to procedures to ensure that the adoption of any particular set of predictions for the impact of future tsunamis represents best current practice.

Introduction

The evolution of tsunamis from their source region to their target needs be calculated numerically to obtain estimates of tsunami currents, forces and runup on coastal structures or inundation of coastlines.

The interaction of tsunamis with structures remains one of the quintessential problems in tsunami hazard mitigation. The unavailability of instrumental recordings of tsunamis in the open ocean –until recently– resulted in tsunami science and engineering evolving differently than analysis in other extreme natural hazards researches. While the basic equations for analysis have been known for decades, the existing “grand” synthesis had to await the development of sophisticated modeling tools, high-resolution laboratory experiments in the 1980s, the field survey results of the 1990s, and the tsunameter recordings of 2003 and since. Field results in the 1990s served as crude proxies to free-field tsunami recordings –field surveys typically provide measurements of the maximum onland penetration of the tsunami, versus free-field recordings that are time histories of the free surface elevation of the passing tsunami in the open ocean. Nonetheless, these measurements of the elevation of the maximum penetration of the tsunami compared with the initial shoreline (a distance often referred to as runup), they allowed for the validation of numerical procedures. [1] discuss in detail the milestones in the evolution of tsunami hydrodynamics.

The need for standards for numerical codes whose predictions are used for structural design or for hazard assessment is obvious. By some accounts, more than 20 new tsunami codes have been counted in the aftermath of the 2004 Boxing Day tsunami. Even so, some numerical predictions for the impact of past tsunamis in the US, they kept being presented in international meetings in 2005, even though they differed by factors up to 4 from established paleotsunami measurements. These “new” predictions were based largely on untested models, or extrapolation of procedures developed for processes of different physical scales. The predictions attracted press attention leading to additional efforts from hazard mitigation professionals to explain to the public the differences between peer reviewed models and predictions and the alternatives.

The process of establishing standards has been the outcome of three landmark scientific meetings that have significantly contributed to our understanding of tsunami hydrodynamics. All three have been supported by the National Science Foundation of the United States, i.e., the 1991 Catalina Island, California, 1996 Friday Harbor, Seattle, Washington, and 2004 Catalina Island, California workshops on Wave Runup Models ([2], [3]). In these workshops, benchmark problems were proposed and modelers asked to present comparisons of their model predictions with either analytical solutions or laboratory or field data. The workshops and their resultant publications established the basis for the standards and guidelines for tsunami inundation models, as they have evolved to date.

As a preamble, no established standards exist yet for assessing fluid-structure interaction, as is most often performed in offshore engineering. However, given that the existing practice relies largely on procedures used for extreme wind waves, it is important to ensure that