Abstract View

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Interaction of Tsunamis with the Hawaiian Islands Calculated by a Finite-Element Numerical Model

James R. Houston

Waterways Experiment Station, Vicksburg, Miss. 39810

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ABSTRACT

A finite-element numerical model is used to determine the interaction of tsunamis with the Hawaiian Islands. The model employs a finite-element grid which telescopes from a large cell size in the deep ocean to a very small size in shallow coastal waters and covers a region which includes the eight major islands of the Hawaiian Islands. The numerical model solves the problem of tsunami propagation from the deep ocean to the coasts of these islands. Although time periodic motion is assumed in the solution, the interaction of an arbitrary tsunami waveform with the islands can easily be determined within the framework of a linear theory by superposition. The deep-ocean waveforms of the 1960 and 1964 Alaskan tsunamis are determined for use as input to verify the finite-element model by employing a finite-difference numerical model which assumes as an initial condition that the uplift movement of the sea floor in the source region during an earthquake is instantaneous and results in a water surface elevation identical to the known permanent vertical displacement of the sea floor. The finite-difference model propagates the waves radiated from the source regions to a deep-ocean area near the Hawaiian Islands using a two-dimensional spherical coordinate grid to solve the linear long-wave equations. The finite-element model is verified by determining time history responses at coastal locations using these deep-water time histories as input. Numerical model calculations are shown to be in good agreement with tide gage recordings of the 1964 Alaskan tsunami at Kabului, Maui; Honolulu, Oahu; and Hilo, Hawaii; and the 1960 Chilean tsunami at Honolulu, which was the only location where the 1960 tsunami did not destroy the gage.