Water Wave-Induced Soil Fluidization in a Cohesionless Fine-Grained Seabed

by

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Committee in charge:

Professor Mostafa A. Foda, Chair
Professor James R. Hunt
Professor Neville G. W. Cook

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Abstract

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This is a study on the response of a fine-grained cohesionless silty soil bed to water wave loading. Experimental measurements of pore pressure inside a silty soil bed under propagating water waves revealed a diverse spectrum of responses. These responses are then classified into three typical groups, and in one of them a new resonant stage has been identified. Resonance is detected as the sudden appearance of the new growing oscillations in the pore-pressure record. In the initial stage of resonance, the linear component of the resonant wave plays the most important role in the pressure records. This new linear oscillation, having the same frequency as that of the water wave, will grow to dominate the pore-pressure signals within a span of just a few wave periods. Associated with the appearance of the resonant oscillations, a significant rise in the mean pore pressure indicates that a fluidization process is taking place within the soil mass. The rise in the mean pore pressure is interpreted as a result of the dismantling of part of the

soil's solid skeleton, where some of the soil grains are forced into suspension within the pore fluid. The weight of this suspension load would be entirely supported by the pore pressure, hence accounting for the rise in the mean pressure.

A conceptual model is formulated based on the experimental observations. We assume that the observed resonance is initiated around some localized "weak spots" or cavities within the inherently inhomogeneous soil skeleton. The eigen value problem of oscillation at the idealized cavities inside an elastic medium are worked out, and the resulting dispersion relations are compared to relevant experimental results.

Mastafa A. Foda
Committee Chairman

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