SEDIMENT EFFECTS ON RESPONSES OF COASTAL STRUCTURES

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ABSTRACT

The objective of this thesis is to study the effect of a sediment layer on the dynamical response of the coastal structures under the earthquake excitation. The formulation is derived from fundamental theories in various fields, including marine hydrodynamics, flow in porous medium, and structural dynamics. While analytical results were obtained for some simplified cases, the bulk of this study was carried out numerically using both the finite-difference and finite-element methods.

The dynamical response of a rigid coastal structure under a constant external force was first examined. The results show that, except during the very early stage, the averaged force acting upon the surface of the structure embedded in the sediment is greater than that submerged in the water. The structure experiences an oscillation during the excitation, which decays rapidly and then approaches a finite value. As the porosity of the sediment increases, the amplitude of the oscillation grows and the frequency becomes higher; this is due to the fact that increasing porosity reduces the bulk modulus of the overall system. On the other hand, if the thickness of the sediment layer increases, the system thus becomes stiffer, resulting in a higher frequency and faster decay oscillation. The results also demonstrate that the asymptotic value of the oscillation is proportional to the thickness of the sediment layer.

If the flexibility of the structure is added, the results show that the maximum force exerted on the structure always occurs at the lower end near the bottom. The distribution of the displacement along the surface of the structure has shown a monotonical increase from the bottom to the top. The assumption of either plain strain or plain stress was invoked to examine the difference which might incur; the results have shown little discrepancies.

Finally, a series of real earthquake data were used as inputs to a canonical structural system; the dynamical responses were generated and analyzed. These results may serve as a source of reference for the design of coastal structures in practical applications.