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WAVE-INDUCED FLUIDIZATION OF COHESIVE SEDIMENT BEDS

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Abstract

In this paper, the complex process of fluidization of the partially consolidated mud is examined theoretically and experimentally. Experiments were made in a wave-flume using artificial clay. The motion of fluid mud is visually distinguished from the lower stable layer using colored mud, as a tracer. The flume experiments indicate that depth of fluidized mud layer increases by applying higher wave heights or decreasing consolidation period as well as increasing test duration. Also, the experimental results show that the fluid mud thickness varies nonmonotonically with wave period. The maximum wave-induced shear stress in the bed at the onset of fluidization that is calculated by an analytical model, assuming that the consolidated mud has a linear elastic behavior before fluidization, is shown to be just larger than the yield strength of the bed at a particular level in the bed. The yield strength of the bed is determined independently with rheological experiments for various water content of the bed. The comparison between the measured fluid mud thickness and the theoretical values show general agreement.

Introduction

The shallow water lakes, estuaries and coastal zones in the world contain large amounts of cohesive sediments. Furthermore, some of these sediments may be heavily polluted causing a severe problem for the quality of the waters. These sediments may originate from the rivers that flow through the seas. The transport of these sediments is strongly affected by waves, as waves can cause rapid erosion of the deposits, where water waves rather than currents dominate sediment transport. On the other hand the susceptibility of a cohesive sediment bed to erosion and re-suspension of bed material depends to a large extent on its structure. The bonds between sediments particles then impart a certain yield strength to the bed, which significantly increases its erosion resistance in cases. The aggregate network may be failed by stresses acting on the bed and in it ([11]; [12]).

One of the various causes by which such stresses come into existence is the presence of water waves. It has been observed, both in the field and the laboratory that a cohesive sediment (mud) bed with a substantial strength may be weakened by waves so that a top layer of high-concentration, fluid-like bed material is formed ([10]; [18]; [20]). In the literature, this change in state, from solid to fluid, is termed fluidization or liquefaction. Some other formation mechanisms for fluid mud generation have been recognized; it may be caused by open water dredged material disposal (e.g.,