



Analytical and Experimental Investigation of Nonlinear Resonant Interaction between Surface Wave and Interfacial Waves

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Abstract

Nonlinear resonant interaction between surface waves and especially surface waves with interfacial waves is a powerful mechanism for causing instabilities by increasing interfacial wave's amplitude in special resonant conditions. In case of resonant interaction between surface wave and interfacial waves, Most of previous researches include nonlinear resonant interaction in 2nd order analytical solution by calculating initial growth rate of interfacial waves amplitude. Laboratory observations have been shown when interfacial waves reach to maximum amplitude with a constant exponential growth rate, the increasing stop and the amplitude approach to final constant amplitude oscillatory. The 2nd order perturbation analysis can not model the physical behavior of long time interaction. In present paper, the 3rd order perturbation analysis was used for obtaining resonant coefficients. For modeling the diffuse layer thickness, a new model has been presented which can consider the change of diffuse layer thickness from zero to maximum as a second order function of interfacial wave amplitude. The results show that 3rd order analysis with new diffuse layer model can predict the physical behavior of long time resonant appropriate.

Keywords: *interfacial waves, surface wave, resonant interaction, nonlinear effects, two-layer fluid.*

Introduction

Beds of most estuaries and coastal areas are covered with mud or sludge of silt and clay compositions. Mud erosion due to waves has recently received particular attention. Because of density gradients in depth of most fluid body, the passing surface wave can excite interfacial waves at interface of two layers fluid. The interfacial waves are oblique to the surface wave and short. If the frequency and wave number of interfacial waves be about half of surface wave frequency and wave number, the interfacial waves are called sub-harmonic waves. The amplitude of interfacial waves grows to maximum quantity because of non-linear resonant interaction with a constant growing rate. In long time, the interfacial waves attain constant amplitude [1],[2].

The initial growth rate of interfacial waves in the interaction process can be calculated by a 2nd order analysis and was investigated theoretically and experimentally by Hill and Foda(1996) and Jamali(1998) [1],[2]. The long-term behavior of the waves can not be predicted by 2nd order interaction analysis. Because of this, the 3rd-order analysis has been used. Hill(2004) used a 3rd order analytical solution for calculating interaction coefficients in special condition [3]. The two layers were assumed inviscid and the deep water condition was considered for lower layer. The