The 9th International Conference on Coasts, Ports and Marine Structures (ICOPMAS 2010)
Tehran, Iran, 29 Nov.-1 Dec. 2010

Estimating wave-Induced Bottom Velocity in the vicinity of reflective structures

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Key Words: *Nonlinear wave, reflective structure, undertow, wave-current interaction.*

ABSTRACT

The undertow, the seaward return flow of wave mass transport, induces a seaward stress on the bottom sediment particle. A nonlinear theory equation is presented for estimating the vertical and horizontal distribution of undertow in the surf zone for reflective beaches. The present model is a modification of the original model presented by Okayasu et al., (1990) for natural, non-reflective beaches wherein the wave set up, radiation stress and mass flux due to breaking waves are modified as described by Mehrdad and Neshaei (2004) to include the effect of partially reflected waves. Furthermore, the nonlinearity of waves is provided by Fenton's Fourier series theory and the wave-current interaction in calculation of undertow is applied. Also, the nonlinear mass drift of the incident wave is included in the proposed model. The results of experimental investigation and model development show that existence of reflective conditions on beaches results in a reduction in the magnitude of undertow and modifies its distribution across the beach profile.

1. INTRODUCTION

One of the serious problem in coastal engineering is beach erosion because it often compromises structural integrity or alters the hydrodynamic characteristics of the flow adjacent to the structure. Although beach erosion occurs frequently at coastal structures, engineering procedures for predicting scour potential are relatively underdeveloped. Scour can be caused by combinations of hydrodynamic phenomena involving wind waves, currents, and low –frequency water level changes interacting with structures. This paper develops Okayasu's model (1990) by taking the nonlinear theory equation (Fenton's theory (1990)) and wave-current interaction for estimating time mean flow into account. The time mean flow, or undertow, is considered one of the dominant mechanisms in the erosion of beaches [1, 2]. In order to predict the sediment transport in the surf zone, it is necessary to estimate the cross-shore distribution of the undertow. Although there exist advanced models, which predict the undertow for natural beaches, surprisingly there has been only a limited number of works on estimating the undertow in the case of reflective beaches where partially standing waves are presented [3]. Such beaches can be observed in front of reflective seawalls and natural steep slopes particularly during storm conditions.