Investigation of the Safety of Seawalls against Scouring

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Abstract

Scouring phenomena is one of the most important issues in Coastal Engineering. Constructing of protective structures such as seawalls on shoreline can cause scouring and estimation of scouring depth in front of such structures is one of the important problems in design of their foundation. In this paper, based on experimental data, the beach level changes and potential of scouring at different locations in front of the constructed seawalls and in case of natural coast without protective structures are estimated and compared which can be useful in coastal engineering studies and design and management of coastal defense projects. The results predicted by the model are compared with the experimental data indicating the good accuracy of the proposed model. The results obtained from the present work clearly indicate that, the construction of seawalls at the shoreline results in a reduction of the associated seaward sediment transport and bed profile evolution but increases the local scouring depth which may cause damage to such structures. Incorporating the nonlinear effect of wave and wave current interaction into the proposed model has resulted in an improvement in prediction of sediment transport, bed level changes and scouring depth in front of seawalls. This, in turn, results in a more effective design of seawalls to increase their safety against scouring.

Key Words: scouring depth, seawall, sediment transport, undertow, wave-current interaction

1. Introduction

One of the important issues in coastal engineering is beach erosion. Beach erosion occurred as a result of marine structures construction or changing hydrodynamic characteristics of flow adjacent to the structures. Study of hydrodynamics in front of reflective structures shows that seawalls can modify the velocity field if they are located around the active zone. Therefore, it can be expected that seawalls can contribute in cross-shore sediment transport resulting in beach profile change during storm conditions.

The 2-D scour in front of a vertical-wall breakwater has been investigated by different researchers and to determine the mode of sand transport, some criteria were introduced in the literature.

The scour depth decreases with decreasing values of the reflection coefficient. These models of estimation of scouring depth which already mentioned are not accurate enough, so more investigations should be made to improve the accuracy of prediction. The obtained bed load \((q_b)\) and suspended load \((q_s)\) should be inserted in the equation of continuity for the sediment at the bed which is solved for scouring depth to update the bed morphology. In this study, scouring depth is taken as a time-dependent parameter whereas previous models of scouring have not taken such time-dependent function into account.

2. Theoretical Development

2-1 Hydrodynamics

According to the literature, magnitude of the undertow is reduced in the presence of partially standing waves. A model was presented to estimate the distribution of undertow in the surf zone for arbitrary beach topography by Okayasu et al (1990) in which the horizontal and vertical distribution of undertow is given through a set of semi-empirical equations. Another theoretical model for cross-shore distribution of bed return flow velocity was developed by Svendsen (1984) which reads as:

\[
U(h) = \sqrt{gd} \gamma^2 \left( B_0 + \frac{\alpha d}{\sqrt{gd}} \right) \exp\left(-\frac{y d}{H_{rms}}\right)^2 \]

(1)

where: