Proceedings of the Eighteenth (2008) International Offshore and Polar Engineering Conference
Vancouver, BC, Canada, July 6-11, 2008

ISBN 978-1-880653-70-8 (Set); ISBN 1-880653-68-0 (Set)

A Numerical Model for Gravel Beach Deformation Based on Two-way Method

Kwang-Ho Lee
Department of Civil Engineering, Nagoya University
Nagoya, Japan.

Norimi Mizutani
Department of Civil Engineering, Nagoya University
Nagoya, Japan.

Do-Sam Kim
Division of Civil and Environmental Engineering, Korea Maritime University
Busan, Korea

Toshiaki Fujii
Department of Civil Engineering, Nagoya University
Nagoya, Japan.

ABSTRACT

Fluid motions of waves interact with bed materials mainly through the bottom shear stress caused by water particle motion near the bottom, which leads to topographical changes. The altered bottom profile, in turn, affects the wave fields, and changes in these fields can lead sequential bottom profile change. Most of the studies on the sediment problems, however, have not considered the effects of the altered bottom profile on wave fields. To predict topographical changes more accurately, the changed bottom profile should be reflected in calculation of wave fields over time, i.e., the two-way method is required. In this study, a numerical model considering dynamic interactions between wave fields and topography change caused by on-offshore sediment transports is proposed to estimate the topographic change of gravel beaches. The model is composed of a wave model and a sediment model. Comparison between numerical and existing experimental results showed that the present model is useful to simulate wave fields and beach topographical change of gravel beaches.

KEY WORDS: Topographic change, sediment, two-way method, gravel beach, wave field

INTRODUCTION

Beach erosion caused by broken coastal balance is one of the serious important problems and of large interest in coastal engineering. So far, various attempts have been made to assess beach deformations. However, it is not simple to simulate beach morphodynamics directly because of the complexity of the underlying mechanisms involved in sediment transport. Therefore, most numerical models for predicting beach evolutions are based on the quantitative relationships for the sediment transport and fluid motion, mainly established by laboratory experiments. As a consequence, various empirical and semi-empirical formulations have been proposed and used to achieve topographic changes in most numerical investigation. For example, Madsen and Grant (1976) found a relationship between an averaged sediment transport rate and the Shields parameter under unidirectional flow. Watanabe (1981) and Watanabe et al. (1984) proposed the semi-empirical equation for sediment transport considering the effect of return flow, and developed the three-dimensional beach deformation model under wave-current coexistence fields. Shibayama and Horikawa (1982) performed laboratory and field investigations to formulate a predictive model of two-dimensional beach profile change, and proposed sediment formula based on the observed transport patterns. Sato and Kabilling (1994) found the sediment transport equation capable of calculating the instantaneous local sediment transport rate with time development according to the bed load and suspended load of sediment transport, and succeeded in predicting sediment transport in the swash zone. Pedrozo-Acuña et al. (2006) applied the sediment transport equation considering the effect of slope corrections and friction angle by revising the formula for sediment transport rate proposed by Meyer-Peter and Muller (1948) to gravel beaches. Also, from a sensitivity analysis, they showed that the topographic changes could be reproduced to some degree although it couldn't get enough quantitative agreement between experimental and calculation profiles. However, most numerical models, based on the Navier-stokes equation solver (not depth-averaged equation), for predicting beach profile are based on a one-way method in which topographical change is updated based on the information of already computed fluid motions, i.e., in these approach, the effects of the altered bottom profile on fluid fields or vice versa are completely