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N-line Beach Evolution Model Considering Advection and Diffusion Effects of Nourished Sand

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ABSTRACT

This study is concerned with a N-line model that takes account of contour line change after beach nourishments. The behavior of the sand materials after beach nourishments is represented using two-dimensional advection diffusion equation in the horizontal plane. The contour line changes are calculated by solving the fundamental equation for the conservation of bed material, which combined with the advection diffusion equation. Firstly, the proposed model was applied to some model tests, and then the performance of the model was investigated. Secondly, the presented model was applied to the sand recycle project at Yumigahama Coast, Japan, in order to investigate the applicability of the model. Finally, the applicability of the model was discussed.

KEY WORDS: Beach evolution; beach nourishment; shoreline change; N-line model.

INTRODUCTION

Beach nourishments are not only effective technique to restore shoreline in the erosion area but also for preservation of environment and utilization. In the implementation of beach nourishments, prediction of beach evolution is needed in order to evaluate the environmental changes in the future. Beach evolution models are classified into three models: the coastline model, the coastal area model and the beach profile model (e.g. de Vriend *et al.*, 1993). Coastline model, which is a one-line model, is a very practical tool to predict the shoreline change, and evaluate the effect of the nourishments. Furthermore, contour line (N-line) models are also a useful technique to determine 3D contour changes. Many numerical one-line models have been proposed (e.g., Ozasa et al.,1980, Hanson at al.,1989, Dabees et al.,1998), and Shibutani et al.(2007) have also proposed a new one-line model with the effect of advection and diffusion of nourished sand materials, which is based on the one-dimensional advection and diffusion equation in the alongshore direction. However, the prediction techniques of shoreline changes after beach nourishment have not been completed.

In the beach nourishments, the sand materials are injected near shoreline because the shoreline is made to restore effectively. In the problems of transportation and cost, however, the nourishments in the offshore area are required. In general, when the erosion controls are implemented, predictions of the beach evolution are needed. In the predictions, although the one-line model is used as a simple practical tool to predict the shoreline change, the model cannot predict to the beach nourishments in the offshore region. Therefore contour line change (N-line) model is needed. Previously, many N-line models have been proposed (Uda et al. 1996, Dabees et al. 2000). Furthermore, Oya et al.(2006) have proposed a contour line change model that can predict the change of grain size with mixed size sands.

The purpose of this study is to propose a new N-line model for predicting contour line changes considering the advection and diffusion effects of sand material nourished in the offshore area. To consider the effects of advection and diffusion of nourished sand, two-dimensional advection diffusion equation is adapted to the presented N-line model. The behavior of nourished sand due to wave action is reproduced.

NUMERICAL MODEL

The N-line model presented in this study is composed by waves, alongshore sediment transport rates, behavior of injected material, and contour line change calculations. The outline of the proposed model is shown in Fig. 1.

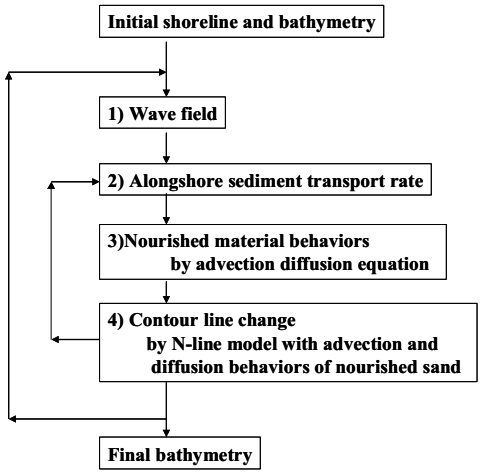

Fig.1 Flow chart of the presented model