SIMULATION OF SEDIMENTATION IN TRENCHES USING A TWO-DIMENSIONAL VERTICAL (2DV) NUMERICAL MODEL

Mohsen Ebrahimi
University of Tehran

ebrahimim@ut.ac.ir

Peyman Badiei
University of Tehran

pbadiei@ut.ac.ir

1. INTRODUCTION

Accurate estimation of sedimentation rate in harbors' entrance channels, which affects the costs of dredging operations, is a challenging task for coastal engineers. Moreover, assessment of backfilling rates in trenches dredged for pipelines or cables is an interesting problem for marine environment engineers. Accurate prediction of this phenomenon will provide the possibility of better design and maintenance of these channels. Numerical simulation is a common and efficient technique for prediction of sedimentation and erosion in trenches. Over last decades, lots of numerical models have been developed to study the sediment transport process in trenches and channels. Nevertheless, a few of these models have addressed sedimentation and morphological changes. Van Rijn (1987) modeled trench migration using SUTRENCH numerical model, which consists of velocity and sediment mixing coefficient profiles calibrated by experimental data and results of $k-\varepsilon$ model. Solving 2-D Navier-Stokes equations, Jensen and Fredsøe (2001) simulated backfilling of trenches in oscillatory flow. In a similar study, Liang et al. (2005) simulated backfill of pipeline trenches in both steady and oscillatory flows.

In the present study, a numerical model is introduced for simulating sedimentation in trenches under 2-D vertical flow conditions, and the results are compared with experimental data. Numerical modeling of sedimentation in trenches requires flow, sediment transport and morphological sub-models. The flow model recently developed by Ahmadi et al. (2007) has been used as one of sub-models. It is an implicit non-hydrostatic model which simulates free-surface flows by solving Navier-Stokes equations and models the turbulence using $k-\varepsilon$ model. Sediment transport computations have been accomplished based on the concentration model already developed and explained by Ebrahimi and Badiei (2007). This model simulates concentration field in a boundary-fitted curvilinear grid by solving advection-diffusion equation of sediment concentration. In the present study the focus is mainly on morphological sub-model. This model employs a staggered grid system along with a variable adaptive time step based on the acceleration of morphological changes. The computational results of bed-level changes exhibit a reasonable agreement in comparison with experimental measurements.

2. GOVERNING EQUATIONS

2.1. Sediment Transport

Governing equations of flow and concentration models have already been presented by Ahmadi et al. (2007) and Ebrahimi and Badiei (2007) respectively, and here the governing equations for morphological sub-model is going to be explained. Knowing the velocity and concentration fields from related sub-models, one can define the suspended load transport (q_s) as:

$$q_s = \int_a^h \left[uc - \nu_s \frac{\partial c}{\partial x} \right] dz \qquad (1)$$

where a is reference level; h is water depth; u is velocity component in x direction; c is volumetric sediment concentration; and ν_s is sediment mixing coefficient. It is also assumed that in a narrow layer near the bed, sediment particles are conveyed as bed load transport. There are number of bed