TIDALLY INDUCED CROSS-SHORE SAND-MUD TRANSPORT AND LONG TERM BED PROFILE EVOLUTION

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Thesis submitted for the degree of Doctor of Philosophy
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January 2008

Abstract

A numerical study on the transport of sediments involving sand and mud mixture and associated long-term morphological changes under cross-shore tidal current is presented. The primary purpose of research is to extend the knowledge on the initiation of motion of sand-mud mixture and develop an accurate numerical model to simulate muddy beach profile evolution over extended period.

In predicting the critical shear stress for sand and mud mixture, a new formulation based on the critical shear for pure sand and pure mud together with sediment distribution was developed. This formulation was calibrated with the experimental data by Panagiotopoulos et al., (1997) to obtain the value for the single empirical coefficient in the formula. Then the formula is verified using the experimental data by Ockenden and Delo (1988) with good agreement between the predictions and data being achieved. In comparison with the existing formulation, the new formulation has advantages of being applicable to any types of mud and mixtures with any sand and mud fractions. In addition the formula contains only one tuning coefficient which can be easily determined using site-specific data.

For investigation on the morphological behaviour of hump bed under cross-shore tidal current, a one dimensional numerical model based on the shallow water equations, suspended sediment transport formulae and bed material conservation equation was developed and tested using the benchmark problems of dam break problem, wave propagation and hump morphodynamics. Among the numerical schemes tested for the shallow water equations the finite volume method associated with approximate Roe's Riemann solver was found to be most accurate, especially when a data reconstruction and slope limiter were applied to solve the system of equations.

To study the behaviour of idealised hump bed the finite volume shallow water equation model was dynamically coupled with the sediment transport. Then the bed level model

was solved separately. Two types of hump beds consisting of pure mud and sand/mud mixtures were selected to study their morphodynamic behaviour with varying cross-shore tidal currents and sediment properties. In order to expedite the calculation of morphological changes, the morphological factor was introduced and its effect was evaluated using the computational results obtained with and without the use of the morphological factor. It found that the predicted morphological behaviours of the hump beds under the cross-shore tidal current for a five year period show approximately similar trends. For the pure bed and as well as sand/mud mixture bed, the height of hump profiles is reduced at the top and increased at the both sides. The amount of decreasing and increasing of bed profile depends on tidal height and sediment parameters such as erosion rate, sediment settling velocity and critical shear stress for deposition and erosion. However, for the same case of pure mud, the effect of settling velocity shows slightly different the behaviour of bed profile compares to the others. For the sand and mud mixture, the sand content of 40 produces the highest peak of hump bed profile.