ABSTRACT

The unsteady two-dimensional Navier-Stokes equations and Navier-Stokes type model equations for porous flow were solved numerically to simulate the propagation of solitary waves over a permeable rippled bed. The free surface boundary conditions and the interfacial boundary conditions between the water and the porous bed are in complete form. A boundary-fitted coordinate system was used in this model. The accuracy of the numerical scheme was verified by comparing the numerical results for the spatial distribution of wave amplitudes on the impermeable and permeable rippled bed at resonant conditions with the analytical solutions. Our numerical results showed that when the crest of a solitary wave propagates into the ripple section, flow separation develops gradually into a clockwise vortex with a thickness of porous layer, and the porosity. In this study the unsteady two-dimensional Navier-Stokes equations and Navier-Stokes type model equations for pore flows proposed by Huang et al. (2003) were solved to investigate the flow behavior near the permeable rippled beds induced by solitary waves. The analytical solutions of Mase et al. (1995) for wave amplitude under the resonant condition are used herein to confirm the accuracy of the present numerical model. Following the verification of the numerical scheme, the flow fields and trajectories of the fluid particles near the permeable and impermeable rippled beds are compared and discussed.

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS

This study investigates the propagation of solitary waves over rigid permeable rippled beds. A schematic diagram of the permeable rippled beds located at the bottom of a two-dimensional numerical wave tank is shown in Fig. 1. A piston-type wavemaker with stroke $S_o$ is located at $x = 0$ and generates the incident waves. The still water depth is $h_o$.

The flow outside the permeable rippled beds was assumed to be laminar and obtained by solving the unsteady two-dimensional Navier-Stokes equations in a boundary-fitted coordinate system. The complete boundary conditions at the free surface and at the interface between water and the permeable rippled bed are satisfied. For details of the