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3D Numerical Study of Time Dependent Bed Changes in the Flushing Channels for Free Flow Sediment Flushing in Reservoirs

○Taymaz ESMAEILI, Tetsuya SUMI, Yasuhiro TAKEMON

Due to this fact that dams are extensively used for different purposes (i.e. irrigation, water supply, flood control and hydro-electric power supply) around the world, the evaluation of different hydro-environmental aspects of these structures is necessary. One of the most important side effects of dam construction over the streams is disturbing the natural sediment transport trend from upstream to downstream area. When the stream flow enters the dam reservoir, the flow velocity decreases and subsequently the sediment deposition will occur. Deposition of sediments in the dam reservoir reduces the storage capacity of the dam reservoir during the operational period of dam. Between 1 and 2% of volumes in the worlds water reservoirs are lost annually due to the sedimentation (Mahmood, 1987). Moreover, deposited sediments in the dam reservoir may threaten the hydropower turbines and safe electricity providing.

Sediment flushing through dam reservoirs is one of the common techniques for reducing the sedimentation. This technique is more popular in Japan because of sufficient rain fall, economical issues, independency from other facilities and potential for high efficiency. However, because of the complex nature of flow interacting with the bed material, it is important to have an initial assessment of the efficiency of upcoming free-flow sediment flushing for conducting a sustainable dam reservoir management. Owing to this fact that advanced numerical models could simulate the hydraulic character of flow and sediment field very similar to the reality, application of these models could provide the basic evaluation of the flushing results in a dam reservoir.

Nowadays, application of numerical models that could simulate the flow and sediment field in three dimensions is more feasible than before because the computational time and cost have significantly reduced. In the present study, a fully 3D numerical model, SSIIM 2, used for assessing the bed changes during the free-flow sediment flushing in a flume. The SSIIM program is based on the finite volume method solving the Navier-Stokes equations with the various turbulence models for 3D flows, and solving sediment continuity equation for bed variations (Olsen et al. 1999). Furthermore, this model uses an adaptive grid which follows the water surface and therefore just the water phase will be computed. Also, the SSIIM 2 program uses a large number of flow and sediment calculation algorithms such as wetting/drying algorithms that enables the model to eliminate the dry cells and add the new wetted cells to the computational domain.

In this study, the time dependent bed level changes and development of the initial flushing channel has been simulated by SSIIM 2 model with different outlet dimensions. Results revealed that although the model could simulate the wetting/drying process, the final bed topography strongly depends on the outlet dimensions as well as the bed roughness. In order to increase the stability of numerical model, an iterative method has been used for calculating the free-water surface.