Numerical analysis on erosion process of replenished sediment on rock bed

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Abstract

As a method of countermeasure to bed degradation and armoring phenomena of bed material in the downstream area of dam reservoirs, sediment augmentation (replenished sediment) has been carried out in many Japanese rivers. In general, bed of the replenished sediment site is composed of rocks, because the site is located in the downstream area of the dams and sediment supply is very small.

Bed deformation process hasbeen researched by many researchers. However, most of them can treat movable bed only and cannot be applied tothe bed deformation process of sediment on rocks. If the friction angle between the sediment and the bed surface is assumed to be the same as the friction angle between the sediment and the sediment, sediment transport rate must be smaller without sediment deposition layer on the rocks. As a result, the reproduced bed geometry is affected very well. In this study, non-equilibrium transport process of non-cohesive sediment on rigid bed is introduced into the horizontal two dimensional bed deformation model and the model is applied to the erosion process of replenished sediment on rock in the Nakagawa, Japan. Here, the Japanese largest scale sediment augmentation has been performed in the Nakagawa.

The results show thatthe amounts of the eroded sediment and the remained sediment reproduced by the developed numerical model are 56300$m^3$and 26800m^3, respectively. On the other hand, the amounts of the eroded sediment and the remained sediment measured in the field after the floods are 56600m^3 and 26500m^3, respectively. The difference between the model and field data is very small. Furthermore, the bed geometry of the replenished sediment after the floods reproduced by the developed model has a good agreement with the measuredbed geometry after the floods. These results indicate that the developed model is able to simulate the erosion process of replenished sediment on rocks very well. Furthermore, the erosion speed of the replenished sediment during the decreasing process of the water discharge is faster than that during the increasing process of the water discharge. The replenished sediment is eroded well, when the top of the replenished sediment is covered by the water. In general, water surface level is kept to be high during the decreasing process of the discharge during floods, because water surface level at the downstream end is high. Hence, it is considered that the high water surface level during the decreasing process of the water discharge affects on the fast erosion of the replenished sediment.

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