EROSION OF SEDIMENT BED IN A RIGID RECTANGULAR CHANNEL DUE TO FLOW OF CLEAR WATER

R. NARAYANAN[1] and M.H. OMID[2]

[1]Professor, Faculty of Eng., Universiti Teknologi Malaysia, Skudai, Johor, Malaysia
[2]Asst. Professor, Dept. of Irrigation and Reclamation Eng., Univ. of Tehran, Tehran, Iran
Address for correspondence: Dr. M.H. Omid, Assistant Professor, Department of Irrigation and Reclamation Engineering, University of Tehran, Tehran, Iran.
(Tel/Fax: +98-261-224-1119 e-mail: momid@ut.a.ir)

The erosion of a layer of cohesionless sediments on the bed of a rigid rectangular channel exposed to the flow of clear water is of concern in this paper. Bed load is the only mode of transport studied. The process of removal of the sediments is studied both experimentally and numerically. The speed at which the layer of sediments moves downstream as it is eroded, is determined. The bed forms assumed by the sediments during the process of erosion have been observed. St. Venant's equations and erosion equation for the bed of sediments are used as the governing equations with empirical input for the sediment discharge due to erosion. These equations are solved numerically by finite difference method using Lax explicit scheme. The speed of retreat of the toe of the sediment layer is computed and is compared with the experimental results. The bed forms and the water surface profiles are computed at various times and presented together with the experimental results. However the numerical procedure should include the continuity of sediment motion in greater detail if it is to predict the bed forms more accurately. The position of the upstream end of the deposit with respect to time is computed and compared with the experimental results. The two sets of results compare well; it is not altogether surprising because the sediment transport equation 4 has been obtained from the experimental data. The predicted water surface profiles and bed forms at various times are compared with the experimental data. In the computation procedure, the process leading to the formation of the raised bed with its length increasing with time has not been properly simulated. The computed results do not show the raised bed. The reason for this is that the quantity of sediment transported is assumed to be constant everywhere along the flow. In the numerical model, the bed load transport along the raised bed and the sediment transport along the thinner bed downstream have to be related to the local features of flow in order to get the details correct. The simple computational model proposed here can predict the speed at which the bed of sediment is flushed out.

The following are the conclusions:

Sediments eroded at the toe of a bed of sediments in a rigid rectangular channel by the flow of clear water move along a raised bed to be deposited at a step downstream. The toe moves downstream with a speed depending on the velocity of flow, the sediment diameter and the thickness of the initial bed. A numerical model based on St.Venant's and erosion equations are solved numerically to determine the speed at which the toe of the sediment bed moves downstream due to erosion. Satisfactory agreement is obtained with the experimental results.

Comparison of the computed bed forms with the experimental results shows that the sediment discharge on the bed of sediments should be properly related to the flow locally in order to determine the height of the raised bed.

Keywords: Bed load; Bed forms; Erosion; Rigid channel; Sediments