ABSTRACT

The present study is carried out to investigate the factors influencing the flow resistance in overland flow and to develop a fundamental model for prediction of sediment transport rate. Resistance to flow is determined by two separate approaches. In the first approach the friction factors are taken as a single term whereas the second approach involves division of roughness into two additive terms of grain and bed form roughnesses. In this study, by dimensional analysis of the governing variables, functional relationships for both approaches are developed. The friction factors are estimated in terms of Darcy-Weisbach and Manning roughness coefficients by substituting these relationships in the momentum equation of two dimensional channel flow with uniformally distributed lateral inflow. For development of sediment transport model in case of overland flow, three alternative models have been used after incorporating the modifications for estimating friction slope. For deriving the coefficients of the above relationships for friction factors and sediment transport rate the experimental data are collected on a indoor set-up. The controlled variables involved in the study are fixed and mobile beds of three bed materials prepared by mixing non-cohesive sand and gravel in the ratios of 100:0, 80:20 and 50:50 respectively on volumetric basis, at five slope steepnesses (0.1 to 4 percent) and subjected to three base flow rates under no rainfall condition and rainfall intensities of 5 and 10 cm/hr. The study revealed that the approach of division of friction

factors is not beneficial in overland flow case as no relationship for bed form roughness could be established. However, grain roughness is found to have a strong correlation with Reynold Number, Froude Number and Relative Roughness. In case of overall roughness, instead of Froude Number, Grain Mobility Number is considered to additionally account for the effect of flowing fluid resistance offered by the weight of the particles to the lift forces. Here also, statistically sound relationship are developed for estimation of roughness coefficients. Finally, the analysis of sediment transportation data showed that the best fit model for sediment transport rate has a close resemblance to the Einstein-Brown model for turbulent stream flow. The coefficients of the model are worked out using experimental data. The limitations involved with the study are use of disturbed bed materials on comparatively small length and steepness of slopes subjected to only two rainfall intensities where the flow remained in sub-critical laminar range.

KEY WORDS

Overland Flow
Roughness
Sediment Transport
Momentum Equation
Laboratory Modelling
Discharge Relationship