A NON-DIMENSIONAL APPROACH TO PREDICT BED LOAD TRANSPORT IN STEADY FLOW

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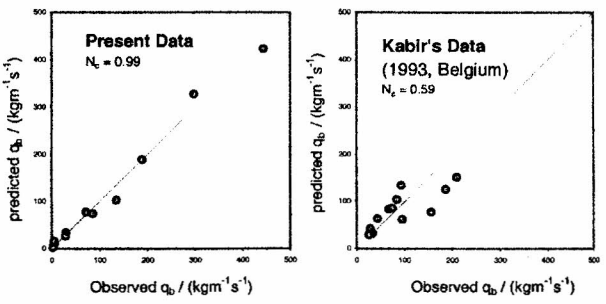
In this research, a series of laboratory experiments were conducted to measure sediment transport rates in several different steady flow conditions. The experiments were carried out in a rectangular, re-circulating, tilting flume in the Hydraulics Laboratory of University of Peradeniya. The flume consists of a sediment trap that collects the transported sediment to a chamber. The chamber is suspended through a load cell. The accumulated weight of the sediment given by the load cell was continuously recorded in a computer through an A/D converter. The purpose of these measurements is to correlate the steady state transport rates with the governing hydraulic parameters.

The observed transport rates were compared with calculated rates using several well-known bed load formulas. The comparison shows that most of the formulas give diverging results. This may be due to the variability of prevailing test conditions used in developing the different empirical equations. Although these formulas can be calibrated to suite the test conditions of the present study, developing a new formula based on the present observations would enable a better comparison and analysis of steady to unsteady behavior of bed load transport.

This paper presents the analysis and the development of a new formula based on dimensional analysis. Two important non-dimensional parameters, which govern the sediment transport, were analyzed and a linear relationship between them was found. It was also observed that the gradient of this linear trend varies with the slope of the channel bed. The new bed load formula was developed based on these observations, and an attempt was made to verify the model with a set of sediment transport data measured elsewhere under similar test conditions. The two plots show the comparison of the model prediction with the present data and data from elsewhere. A fairly good agreement was found, but more experimental data covering a wider range are necessary for detailed analysis. The developed formula is,

$$\frac{q_b}{\rho u_*^3} = (72 - 1980S)\frac{\rho u_*^2}{(\rho_s - \rho)gd} + 2.9$$

Where q_b is weight of sediments passing through unit width in unit time, g gravitational acceleration, ν kinematic viscosity, ρ density of fluid, ρ_s grain density, d grain diameter, u_* shear velocity and S channel slope.



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