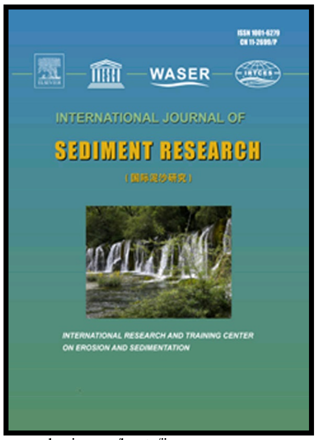

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On the mechanisms of the saltating motion of bedload

Youhua Chen[a], Yuchuan Bai[b*], Dong Xu[c]

Abstract: Saltation of sediment particles is an important pattern of bedload transport. Based on force analysis for sediment particles, a Lagrangian model was proposed for the saltating motion of bedload in river flows, which was then solved with numerical method. Simulation results on the saltating trajectories neglecting particle rotation and turbulence effects compare fairly well with experimental observations. The mean values of the saltation parameters (saltation height, length and velocity) also agree well with the previous experimental data. Based on the numerical results, regression equations for the dimensionless saltation height, length and velocity were presented. Using the numerically achieved characteristics of the sediment saltation, we also obtained mathematical expression for the sediment transport rate. The studies in this paper are significant for its contribution to mechanism of the bedload motion and the computation of sediment transport rate.

Key words: Bedload; Saltation; Numerical model; Transport rate

1 Introduction[1]

Sediment transport in river can generally be classified into two major patterns, namely, the bedload and the suspended load, which depends on both the particle size and the flow conditions. When the bed shear stress exceeds the critical value for incipient motion, the sediment begins to move by sliding or rolling over the bed. If the bed shear stress further increases, the particles will jump up from the bed and start to saltate. Bedload transport refers to movement of sediment particles by rolling, sliding and saltating. Many previous researches considered that the majority of the bedload transport occur in the pattern of saltating (Einstein,1942; Sekine & Kikkawa,1992; Wiberg & Smith,1987, 1989), however, there are also researchers argue that at the beginning of the motion under low flow velocities, the sediment transport mainly occurs in the pattern of sliding or rolling (Han & He1999; Gao,2008; Mazumder et al.,2008). Hence, it is necessary to investigate the other two major patterns, respectively. We have previously studied the "contact bedload" (namely bedload in sliding and rolling motion) and achieved reasonable results(Bai et al., 2006). Herein, we mainly focus on the saltation movement, in order to have an overall understanding of the bedload movement.

Most previous researches on the bedload transport focused on developing empirical or semi-empirical expressions for estimating sediment transport rates in unidirectional flow. Empirical expressions, for instance, the Meyer-Peter and Miiller Equation (1948), were usually obtained by fitting experimental data using several key parameters determined by dimensional analysis or physical reasoning. The semi-empirical bedload equations, such as those of Einstein (1942, 1950) and Yalin (1963), were derived based on the assumption that sediment moving in a saltating motion. These equations are closer to the real

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