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An Approach to Adaptive Correction Factors in Depth-Averaged Model for Debris Flows

Yih-Chin Tai, Chin-Kai Cheng, and Guan-Cen Lai

National Cheng Kung University, Department of Hydraulic and Ocean Engineering, Tainan City, Taiwan (yctai@mail.ncku.edu.tw)

In modeling the debris flows, the governing equations are often given in depth-averaged form, where scaling analysis is employed to reduce the complexity and expense in computation. As a result, the non-uniform distributions of the sediment concentration and velocity along the flow thickness bring the correction parameters into the equation system. Since the flows are generally not at steady state, these distributions vary dynamically, so that the values of the correction factors should not be given by constant values. With the concept of two-phase mixture, we revisit the depth-averaged balance equations, where four correction factors are present and inevitable in the resultant model equations if the distributions of the sediment concentration and velocity along the flow thickness are non-uniform. Through theoretical analysis and experimental investigation, we found that a piecewise-linear distribution for velocity and a linear distribution of sediment concentration in the immature debris flows (where the clear water exists) seem plausible. This assumption may significantly simplify the complicated determination of the correction factors. In the resultant model equations, the correcting parameters due to the non-uniform distributions are present, which are of significant impacts on the characteristic of the equation system, and play crucial roles in performing the numerical simulation. In this study, the values of these factors with respect to the corresponding profiles are investigated. By means of numerical examples, we shall illustrate their impacts on the flow behaviors, such as the concentration variation, the geometry of the deposit and the maximum run-out distance.