Modeling two-layer debris mixture flows

X. Meng and Y. Wang*

* Chair of Fluid Dynamics, Department of Mechanical Engineering
Technische Universität Darmstadt
64287 Darmstadt, Germany
e-mail: meng@fdy.tu-darmstadt.de, wang@fdy.tu-darmstadt.de

ABSTRACT

In consolidation processes, a phase separation occurs for both over-saturated and under-saturated regions. To investigate this phenomenon, a granular-fluid gravity- driven flow down a curved surface is modeled as a two-layer system. The system composes a lower layer of granular-fluid saturated mixture overlain by a pure fluid upper layer for the over-saturated case, or a dry granular upper layer for the under-saturated situation. The lower layer is described by a two-phase mixture model and the upper layer by the classical shallow water theory or a Coulomb plastic model, respectively. The lower and upper layers interact at the interface where the granular or fluid mass exchange may happen for which an additional equation is postulated to describe the mass exchange. The established field equations are presented referring to a curved coordinate system and expressed in a dimensionless form. The governing equations are simplified by depth-averaging and ordering approximations in terms of an aspect ratio accounting for the scale of the flowing mass. By means of a high-resolution shocking-capture scheme with the TVD property, we numerically solve the resulting 2D equations for the two-layer debris flows. Numerical solutions demonstrate that the present model can adequately describe the dynamic behavior of debris flows and the corresponding phase separation phenomenon.