Geophysical Research Abstracts
Vol. 18, EGU2016-9023-2, 2016
EGU General Assembly 2016

Density Estimations in Laboratory Debris Flow Experiments

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Bulk density and its variation is an important physical quantity to estimate the solid-liquid fractions in two-phase debris flows. Here we present mass and flow depth measurements for experiments performed in a large-scale laboratory set up. Once the mixture is released and it moves down the inclined channel, measurements allow us to determine the bulk density evolution throughout the debris flow. Flow depths are determined by ultrasonic pulse reflection, and the mass is measured with a total normal force sensor. The data were obtained at 50 Hz. The initial two phase material was composed of 350 kg debris with water content of 40%. A very fine pebble with mean particle diameter of 3 mm, particle density of 2760 kg/m^3 and bulk density of 1400 kg/m^3 in dry condition was chosen as the solid material.
Measurements reveal that the debris bulk density remains high from the head to the middle of the debris body whereas it drops substantially at the tail. This indicates lower water content at the tail, compared to the head and the middle portion of the debris body. This means that the solid and fluid fractions are varying strongly in a non-linear manner along the flow path, and from the head to the tail of the debris mass. Importantly, this spatial-temporal density variation plays a crucial role in determining the impact forces associated with the dynamics of the flow. Our setup allows for investigating different two phase material compositions, including large fluid fractions, with high resolutions. The considered experimental set up may enable us to transfer the observed phenomena to natural large-scale events. Furthermore, the measurement data allows evaluating results of numerical two-phase mass flow simulations. These experiments are parts of the project avaflow.org that intends to develop a GIS-based open source computational tool to describe wide spectrum of rapid geophysical mass flows, including avalanches and real two-phase debris flows down complex natural slopes.

Project web site: http://www.avaflow.org/