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Debris flow impact on mitigation barriers: a new method for particle-fluid-structure interactions

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Channelized debris-flows are a type of mass movements that involve water-charged, predominantly coarse-grained inorganic and organic material flowing rapidly down steep confined pre-existing channels (Van Dine, 1985). Due to their rapid movements and destructive power, structural mitigation measures have become an integral part of counter measures against these phenomena, to mitigate and prevent damages resulting from debris-flow impact on urbanized areas. In particular, debris barriers and storage basins, with some form of debris-straining structures incorporated into the barrier constructed across the path of a debris-flow, have a dual role to play: (1) to stimulate deposition by presenting a physical obstruction against flow, and (2) to guarantee that during normal conditions stream water and bedload can pass through the structure; while, during and after an extreme event, the water that is in the flow and some of the fine-grained sediment can escape.

A new method to investigate the dynamic interactions between the flowing mass and the debris barrier is presented, with particular emphasis on the effect of the barrier in controlling the water and sediment content of the escaping mass. This aspect is achieved by implementing a new mechanical model into an enhanced two-phase dynamical mass flow model (Pudasaini, 2012), in which solid particles mixture and viscous fluid are taken into account. The complex mechanical model is defined as a function of the energy lost during impact, the physical and geometrical properties of the debris barrier, separate but strongly interacting dynamics of boulder and fluid flows during the impact, particle concentration distribution, and the slope characteristics. The particle-filtering-process results in a large variation in the rheological properties of the fluid-dominated escaping mass, including the substantial reduction in the bulk density, and the inertial forces of the debris-flows. Consequently, the destructive power and run-out are reduced, leading to positive effects on hazard assessments. The validation of the new approach through numerical modeling of some laboratory experiments and back-analysis of the flowing mass impacting against existing debris-flow barriers located in some catchment basins in the Italian Alps will contribute in understanding the comprehensive dynamic phenomenon and in the design of new control barriers.

References:

Van Dine, D.F., 1985. Debris flows and debris torrents in the southern Canadian Cordillera. Canadian Geotechnical Journal, 22: 44-68.

Pudasaini, S. P., 2012. A general two-phase debris flow model. Journal of Geophysical Research, 117, F03010, doi: 10.1029/2011JF002186.