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Impact behavior of granular and debris flows with obstacles

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The present study focuses on the three-dimensional Distinct Element Method (DEM) applied to describe the dynamical interaction between rapid granular and debris flows and rigid obstacles. The most often utilized theories for successful modeling of rapid, free-surface flows of geomaterials are based on the depth-averaged balance laws of mass and momentum, suitable for smooth topographic changes and vanishingly small shearing rates in the direction normal to the sliding surface. However, if the flow is suddenly interrupted by an obstacle the conditions for the depth-averaged theory are not fulfilled locally. The DEM offers an alternative approach for modeling rapid flows and flow regime changes in the vicinity of an obstacle and in the run-out and deposition zone. This method, which is based on a force – displacement law, describes the microscopic interaction between distinct spheres, allows a realistic simulation of the impact behavior with rigid bodies. The fundamental processes and flow regime changes are investigated in detail by numerous laboratory chute and channel experiments including the shockwave formation and propagation in rapid dense granular and debris flows. Experimental data are employed to analyze the impact forces with rigid obstacles and run-out behavior of granular avalanches. Finally, the DEM simulations are compared with laboratory experiments.