Geophysical Research Abstracts
Vol. 16, EGU2014-16910, 2014
EGU General Assembly 2014

Characteristic rockfall runout behaviour of three end-member rock forms

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Down-slope motion of rocks after detachment is governed by terrain and rock morphology, along with the rock-ground impact configuration, which includes orientation, dynamics and material properties. This study focuses on the influence of rock shape on the runout behaviour of rockfalls. We conducted small-scale physical experiments using three end-member rock forms (equant, elongate, platy) using a planar slope for which the slope angle could be adjusted. The test rocks were embedded with motion sensors that logged accelerations up to 250 g and maximum rotations of 40 rad • s-1 at 600 Hz about the principal inertial axes. The experiments were filmed using high speed video cameras to capture translational velocities, jump heights, impact orientation and apparent restitution coefficients.

Characteristic rotational and rebound behaviour could be observed for each rock form, which resulted in distinctive patterns of dispersion in run out. In particular, each rock form was found to have a preferred axis of rotation, and each had a tendency to develop rotations about its axis of greatest inertia. As the test rocks gained angular momentum, rotations about the largest inertial axis often became established, and in this rotational state the test rocks were stable such that they followed a nominally straight path. Where runout events were associated with unstable rotations, a higher level of lateral spreading was observed in the runout. For rebound (i.e. jump height) behaviour, the orientation of the test rock in conjunction with the magnitude of the moment arm between the external slope contact point and the centre of mass of the rock played a key role in determining rebound heights.

Thus, our data show that rock-shape is a key component to determining the dynamics and runout trajectories of rockfalls, and should be included in accurate rockfall run out modelling.