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Mechanisms of large rock avalanche propagation

Elisabeth Bowman
Department of Civil and Structural Engineering, University of Sheffield, Sheffield, United Kingdom

Large rock avalanches present a serious mountain hazard to lifelines, infrastructure and lives. They are one of a class of low frequency, high impact events for which there is a still considerable debate over the transport mechanism. The behaviour of large rock avalanches, sometimes referred to as sturzstrom or “stream flow” after Heim, is characterised by a volumetric dependence, so that very large rock avalanches tend to travel with a greater spreading “efficiency” than smaller ones.

In this work we propose a mechanism for the volumetric dependence of rock avalanche spread (or runout) in light of the ubiquitous dynamic fragmentation behaviour of brittle solids, Terzaghi’s principle of effective stress as used most commonly in soil mechanics, and concepts of momentum transfer. The proposed conceptual model is based on both observations of field scale events, such as made at Elm in Switzerland, Huascaran in Peru and Falling Mountain in New Zealand, and small scale physical model experiments using analogue rock materials which have been conducted at elevated g-level so as to increase stress levels within the experiments. In particular the model aims to explain how momentum transfer between elements within a fragmenting rock avalanche mass may lead to the greater mobility or spreading efficiency that is observed at large scale and may provide insight as to the conditions needed for rock avalanche propagation and arrest.