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# Micromechanical Analyses of Sturzstroms

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Sturzstroms are very fast landslides of very large initial volume. As type features they display extreme run out, pared with intensive fragmentation of the involved blocks of rock within a collisional flow.

The inherent danger to the growing communities in alpine valleys below future potential sites of sturzstroms must be examined and results of predictions of endangered zones allow to impact upon the planning processes in these areas. This calls for the ability to make Type A predictions, according to Lambe (1973), which are done before an event. But Type A predictions are only possible if sufficient understanding of the mechanisms involved in a process is available. The motivation of the doctoral thesis research project presented is therefore to reveal the mechanics of sturzstroms in more detail in order to contribute to the development of a Type A run out prediction model.

It is obvious that a sturzstrom represents a highly dynamic collisional granular regime. Thus particles do not only collide but will eventually crush each other. Erismann and Abele (2001) describe this process as dynamic disintegration, where kinetic energy is the main driver for fragmenting the rock mass. In this case an approach combining the type features long run out and fragmentation within a single hypothesis is represented by the dynamic fragmentation-spreading model (Davies and McSaveney, 2009; McSaveney and Davies, 2009). Unfortunately, sturzstroms, and fragmentation within sturzstroms, can not be observed directly in a real event because of their long “reoccurrence time” and the obvious difficulties in placing measuring devices within such a rock flow. Therefore, rigorous modelling is required in particular of the transition from static to dynamic behaviour to achieve better knowledge of the mechanics of sturzstroms, and to provide empirical evidence to confirm the dynamic fragmentation-spreading model.

Within this study fragmentation and their effects on the mobility of sturzstroms have been made observable and reproducible within a physical and a distinct element numerical modelling environment (DEM). As link between field evidence gained from the deposits of natural sturzstroms, the physical model within the ETH Geotechnical Drum Centrifuge (Springman et al., 2001) and the numerical model PFC-3D (Cundall and Strack, 1979; Itasca, 2005), serves a deterministic fractal analytical comminution model (Sammis et al., 1987; Steacy and Sammis, 1991). This approach allowed studying the effects of dynamic fragmentation within sturzstroms at true (macro) scale within the distinct element model, by allowing for a micro-mechanical, distinct particle based, and cyclic description of fragmentation at the same time, without losing significant computational efficiency.

Theses experiments indicate rock mass and boundary conditions, which allow an alternating fragmenting and dilating dispersive regime to evolve and to be sustained long enough to replicate the spreading and run out of sturzstroms. The fragmenting spreading model supported here is able to explain the run out of a dry granular flow, beyond the travel distance predicted by a Coulomb frictional sliding model, without resorting to explanations by mechanics that can only be valid for certain, specific of the boundary conditions. The implications derived suggest that a sturzstrom, because of its strong relation to internal fractal fragmentation and other inertial effects, constitutes a landslide category of its own. Its mechanics differ significantly from all other gravity driven mass flows. This proposition does not exclude the possible appearance of frictionites, Toma hills or suspension flows etc., but it considers them as secondary features.

The application of a fractal comminution model to describe natural and experimental sturzstrom deposits turned out to be a useful tool for sturzstrom research. Implemented within the DEM, it allows simulating the key features of sturzstrom successfully and consistent, based on standardised rock and rock mass properties. It also allows revealing the micro mechanical and energetically aspects of a sturzstrom, which suggests that the DEM, modified and developed in the frame of the research project is a promising tool for further research on sturzstroms. This study provides therefore good empirical evidences both to confirm the dynamic fragmentation-spreading model, and to provide a basis on which a successful Type A run out prediction model of sturzstrom may be developed.

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