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Analysis of soil failure modes and possible hydrological triggers using flume tests

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A landslide that is triggered by a hydrological process can show a variety of different failure modes which depend on the given conditions of the slope such as geometry, material behaviour, joints and discontinuities. The analysis of these failure modes can give a better understanding of the processes governing landslide development. This study deals with the investigation of failure modes of landslides by performing flume tests in the laboratory. To trigger slope failure a groundwater table is created by means of water supply from the bottom (upward infiltration) of the slope. Many flume experiments are done on sandy or non-cohesive materials. Triggering small-scale landslides on cohesive or more clayey materials by hydrological processes experiments is rather rare. This work considers both flume tests on sandy and cohesive materials. On the basis of these flume experiments the main differences in failure modes with respect to the material are discussed. To characterize failure modes four criteria are taken into account, (1) the time displacement behaviour, (2) the total time of the failure, (3) the geometry of failure and (4) possible mechanisms leading to the observed failure. The displacement fields are computed from multi-temporal images correlation using an adaptation of the CORRELI2D algorithm.

Whereas failure in the performed flume experiment on sand occur relative fast and retrogressively in multiple slumps, the formation of a fully developed shear surface in the test on a clayey material is initialized over a long time period and takes place progressively. The failure in sandy materials shows liquefaction. The mechanisms leading to liquefaction are not clearly identified yet

To explain the failure mechanism of the test on clay, a model for the growth of landslide shear surfaces, i.e. for progressive failure, is used, where shear surface growth starts with micro-cracking. After point interaction and coalescence of micro-cracks is achieved further shear surface development leads to stress concentration and acceleration of the sliding movements.