Geophysical Research Abstracts
Vol. 13, EGU2011-4969, 2011
EGU General Assembly 2011

The role of fractures in controlling the size and geometry of landslides; Insights from Discrete Element Method computer simulations

Oded Katz (1,2) and Julia K. Morgan (2)

(1) Geological Survey of Israel, Jerusalem, Israel (odedk@gsi.gov.il), (2) Rice University, Houston, TX

We study the failure of heterogeneous slopes using Discrete Element Method (DEM) numerical simulations. Our modeled 2D slopes are 1050 m high, with slope angles ranging from 30 to 70 degrees. They are constructed of numerous spheres simulating natural Coulomb materials, characterized by friction angle and cohesion. The slopes host hundreds of fractures, introduced by removing cohesion and reducing the friction along planar surfaces. Here, we analyze the effects of fracture length on slope failure and resulting landslide sizes and geometry.

Fractures were randomly distributed and oriented within the slope with lengths of up to 100 m. We first examined the conditions that lead to slope failure, and the details of the failure process. Using a single fracture distribution and orientation, we gradually increased fracture length for all fractures embedded in a stable slope. At a critical fracture length, failure initiated at the slope-foot, where the failure plane developed along pre-existing fractures. The failure plane then propagated upwards towards the slope crest by linking pre-existing fractures within the slope. The slope material between the linking fractures disintegrated with the loss of initial cohesion. Once a continuous failure plane developed, slope material above the sliding plane was mobilized. Slumping occurred only when the sliding plane ruptured to the slope crest.

We then studied the role of fractures in controlling the size of landslides. Landslide sizes were measured based on their post-failure surface length, l (scarp to toe) and maximal thickness, t (sliding plane to surface). Using a single fracture distribution and orientation, we analyzed the landslide size in unstable slopes with different fracture lengths (exceeding the above threshold length). We observed that landslide sizes increased systematically with increasing fracture length. Changing the fracture distribution and orientation for a given length did not change the landslide size significantly. Landslides geometry was analyzed as their aspect ratio, t/l. t/l did not change with fracture distribution or length and is similar to the one obtained in simulations of homogeneous slopes as well as to the one measured in field observations.

We conclude here that the presence and characteristics of fractures will play a major role in determining the sizes of landslides. This is mostly relevant to large, deep-seated natural landslides, which form below the upper unconsolidated and homogeneous part of the slope. Nevertheless, landslides geometry is independent of fractures presence and characteristics.