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Numerical simulation of the earthquake-triggered Jiufengershan landslide

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The Jiufengershan rock-and-soil avalanche was one of the largest landslides triggered by the Chi-Chi Taiwan earthquake, mobilizing as much as 42 million cubic meters of rock-and-soil from a dip slope. The initiation and propagation of the avalanche were simulated using a discrete element method, which integrates the following parameters and processes: a) the structure and rheology of rock layers; b) the pore pressure in the granular media; c) the shear strength drop resulting from frictional heating at the surface of rupture; d) seismic shaking; e) the geometry and the friction coefficient at the original ground surface (OGS). The mechanical properties of three different materials according to the existed literature were analyzed including: intact rock, weathered rock, and partially weathered rock. Five topographic profiles across the debris deposit were compared with results from simulations. The best fit between observed profiles, field data and simulations was obtained using the partially weathered rock rheology, a water table height above the surface of rupture hw=30 m, and a friction coefficient at the OGS mu=0.2. The destabilization of the slope during the earthquake is enhanced by raising the water table or decreasing rock strength. Avalanche triggering is associated with a pop-up observed at the foothill. As the avalanche propagates, the pop-up is progressively deformed into an overturned fold, which overrides the OGS along a décollement level. The displaced mass forms a wedge that is pushed forward as deformed rocks are accreted at its rear. The granular layers that undergo downslope translational motion above the surface of rupture are characterized by increasing velocities that reachn ˜35 m/s (125 km/h). The results from numerical simulations give new insights on the mechanical processes occurring during the initiation and the propagation of the rock-and-soil avalanche.