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Discontinuum modelling of a deep-seated rockslide in crystalline rock

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A deep-seated rockslide located in Tyrol (Kaunertal, Austria) was investigated to study the sliding mechanisms and processes along a continuous brittle shear zone (representing the sliding surface). The slide mass appears to be post-glacially activated, reaching depths of about 50 m with an estimated volume of 3.2 million m3. Observations made at the primary scarp of the slide mass indicate a total slip of 10 to 15 m. Internal deformation and shearing of the slide mass resulting from these downslope movements were also analysed. The study area is situated within a foliated paragneissic rock unit of the Oetztal-crystalline basement. The sliding mass represents a displaced mountain ridge, the spatial and geomorphologic configuration of which enables both the observation of the exposed sliding zone near the primary scarp as well as it's lateral flanks. Intensive structural mapping indicates that the foliation of the gneissic rock mass dips into the slope (i.e. kinematically favourable with respect to slope stability). Instead, shear plane development and slope deformations appear to be promoted and controlled by meso-scale tensile joints and internal shear fractures. A main fracture set orientated sub-parallel to the eastwards dipping slope and two steeply inclined sets striking N-S and E-W were observed in this respect. It should be noted that the mean dip of the eastward dipping fracture set is steeper (mean 42°) than the shear sliding surface itself (mean 31°). This suggests that the pre-existing meso-scale fractures and their reactivation in shear do not directly act as the sliding surface, but form weak links through which the shear plane evolved. In this sense, the non-persistent fractures reduce the rock mass strength sub-parallel to the mean slope, thereby favouring the formation of a continuous failure plane through progressive failure processes (i.e. sub-critical crack growth and fracture coalescence) in a simple shear stress regime.

In addition, field observations clearly show that the slope instability is predominately characterized through a translational sliding mechanism. The geomorphological configuration of the slope and homogenous rock mass geology (the slide mass only incorporates paragneissic rock) enables the development of a numerical model characterized by simplified boundary conditions; i.e. the lateral confining stresses acting on either side of the sliding mass are negligibly small, consistent with a two-dimensional plane strain assumption. The findings from a detailed numerical analysis performed using the commercial 2-D distinct element code UDEC were presented. Results from this study are discussed with respect to: (a) the back-calculation of the Mohr-Coulomb shear strength parameters along the sliding zone, (b) large shear displacements along the sliding zone and their mechanical influence on the internal structure and deformation of the sliding mass, (c) stabilizing effects created by the accumulation of slide material at the foot of the slope, and (d) shear and normal stress evolution along the sliding zone before and during sliding.