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Field, geomechanical and laboratory investigations to develop and parametrize a numerical stress-strain model for the reconstruction of the Sasso Maurigno instability events (Valgrosina, northern Italy)

Christian Casarotto[1,2], Andrea Citrini[2,3], Andrea Morcioni[2], and Corrado A.S. Camera[2]
[1]Science Museum of Trento MUSE, Research and Museum Collections Office, Italy
[2]Dipartimento di Scienze della Terra "Ardito Desio", Università degli Studi di Milano, Italy
[3]Department of Global Ecology, Carnegie Institution for Science, Stanford, CA, USA

The western slope of Sasso Maurigno (3057 m, Valgrosina, Sondrio, Italy) is affected by frequent instability events (mainly rockfall), the most recent occurring on 25 June and 11 October 2022. This study aimed to conduct geomorphological and geological-technical field surveys and geotechnical laboratory tests to characterize the Sasso Maurigno rock masses and set up a conceptual model of their behaviour. The output of field surveys and geotechnical laboratory tests (Geological Strength Index – GSI and Rock Mass Rating – RMR values, resistance parameters of intact rock and discontinuities) became the input parameters of a numerical stress-strain model which was developed, with the distinct element method (DEM) and the numerical code UDEC7 (Universal Distinct Element Code). Modelling was carried out for two scenarios: post glacial (Late Glacial), simulating the mechanical behaviour of the slope no longer affected by the Würmian glacial cover, and present-day. The mechanical characterisation of the materials in the post-glacial context was determined by increasing the present-day GSI and strength values by 15%.

At the highest elevations of the Sasso Maurigno slope, granitoid gneisses of the Grosina Unit (middle Austroalpine) outcrop and present a GSI of 40 and a RMR of 38.9. The gneisses are also characterized by five sets of discontinuities that led to the development of a wide tensile fracture at the top of the slope.

Modelling results show that in the post-glacial scenario, the deformations appear limited, but they are already visible at the top of the slope (up to 0.85 m). In the current context, the deformations increase by an order of magnitude (up to 4.89 m), describing an instability concentrated at the highest elevations and attenuating towards the foot of the slope and with depth. The recent rockfall episodes are in good agreement with the results of the numerical calculation, demonstrating how the field survey and laboratory investigations were able to characterise, objectively and reliably, the mechanical and strength components of the materials. The agreement between the numerical calculation and the real context also appears considering the position of the tensile crack observed at the summit of Sasso Maurigno, which is also highlighted in terms of displacements by the model.

Modelling has thus successfully described the behaviour of the slope in stationary terms, becoming an expression of the mechanical parameters collected on the terrain and in the laboratory and identifying the factors predisposing to collapse. The study and inclusion of the weather, climate and hydrogeological elements could promote the development of a conceptual model capable of considering triggering factors, also from a climate change perspective.