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Investigating the stability conditions of the Canossa cliff (Reggio Emilia, Italy)

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The geological setting of the study area shows the superimposition of a stiff and brittle arenaceous plate belonging to the Arenarie of Bismantova Formation, on a marly layer of the Antognola Formation, which, in turn, overlies a thick chaotic unit of sedimentary origin, called the Canossa Melange.

Thus, the mechanical characteristics of the materials comprising the rock slab – soft substratum system are very different in terms of strength, stiffness and brittleness; this leads to typical geomorfological processes such as flow phenomena on the underlying ductile units and brittle ruptures involving the overlying rock masses. The latter are often linked to huge sub-vertical joints, that isolate large blocks.

Due to the high steepness of the rock mass slopes we can find, associated with the slow – long term evolution of the rock slab – soft substratum system, small scale rapid instability phenomena, that may lead to dangerous rock falls.

For these reasons we considered both of the following topics, in order to find the most suitable risk reduction measures:

- overall mechanism of instability involving the whole rock slab – soft substratum system, which is responsible for the damage to the castle ruins;
- rockfalls from the steep cliff that create conditions of high risk for the provincial road, some dwellings and the recreational footpath winding around the cliff.

In order to determine which of the cliff slopes were more prone to rockfalls, we performed a kinematic analysis, together with an inventory of fallen blocks.

Based on these analyses several numerical rockfall simulations were carried out, in order to evaluate the trajectories and associated energy of falling blocks.

The numerical modelling allowed the reconstruction of the overall deformational processes of the Canossa rock slab – soft substratum system.

The digital elevation model (DEM) employed in the analyses was obtained from a Laser Scanner survey. The Laser Scan data were used to integrate the geostructural data from impervious areas and to determine the deformational field of the main cliff slopes by comparing point clouds acquired at different times.