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Modelling Mortisa large slow-moving landslide (Northern Italy) through geomorphological analysis

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The study deals with the modellization of a large slow-moving landslide in Cortina d'Ampezzo (Italian Dolomites).

The landslide is 3500 m long, with an average ground slope of 9° and its track crosses a national road that, due to the continuous movements, needs maintenance work every year. The monitoring system consists of inclinometers, piezometers and 30 GPS benchmarks installed in 2008. The measured movement rate ranges from 2 cm/year in the accumulation zone to 1.2 m/year in the intermediate zone near the road.

Through the geomorphological survey it was possible to understand the sequence of processes that generated the slope integrating the stratigraphic data resulting from 3 boreholes and using carbon dating. The landslide mass is formed by interdigitated layers of clay and gravel that originated in an alternation of earth and debris flows essentially occurred in post glacial time; therefore the slope is characterized by the presence of several gravel lenses or thin layers inside the clay matrix.

The soil taken very close to the slip surface is high-plasticity clay. Both direct shear and ring shear tests indicated an average residual friction angle φ'r of 13.5° in the range of the investigated effective stresses.

On the basis of the results collected by the monitoring network and of the geomorphological analysis, a numerical Finite Element model of the intermediate zone was set up, in order to back-analyse the landslide and estimate the effects of different kinds of possible countermeasure works.

In the model the gravel layer has been designed with a constant inclination in the track zone; in fact along the hillside the bumps and cracks are evenly distributed suggesting an infinite slope behaviour. Moreover, since it was observed that in the gravel strata the pore water level could rise several meters, an artesian groundwater has been inserted in this layer.

A first numerical analysis was performed in order to calibrate the artesian groundwater head and the soil parameters through a back analysis procedure. The best fit with the monitoring data was found for an imposed shear angle for the clayey material equal to 14°, in agreement with the laboratory tests.

Then the effects of two intervention cases, both including the slope re-profiling and the building of some anchored retain structures, but differing for the location of the specific interventions, were analysed. The approach of the composite intervention is the only one that allows for a significant improvement of stability conditions in the intermediate area, particularly along the national road track.