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Finite element analysis of the failure mechanism of gentle slopes in weak disturbed clays

Piernicola Lollino (1), Giuseppe Mezzina (2), and Federica Cotecchia (2)
(1) CNR - IRPI, Bari, Italy, (2) Technical University of Bari, Bari, Italy

Italian south-eastern Apennines are affected by a large number of deep slow active landslide processes that interact with urban structures and infrastructures throughout the region, thus causing damages and economic losses. For most landslide processes in the region, the main predisposing factors for instability are represented by the piezometric regime and the extremely poor mechanical properties of the weak disturbed clays in the lower and central portions of the slopes that are overlaid in some cases by a stiffer cap layer, formed of rocky flysch, e.g. alternations of rock and soil strata. Based on phenomenological approaches, landslide processes are deemed to be triggered within the weaker clay layer and later on to develop upward to the stiffer cap, with the shear bands reaching also high depths.
The paper presents the results of two-dimensional numerical analyses of the failure mechanisms developing in the unstable slopes of the region, carried out by means of the finite element method (Plaxis 2011) applied to slope conditions representative for the region. In particular, the effects of slope inclination, along with the thickness and the strength of the material forming the caprock at the top of the slope, on the depth of the sliding surface, the mobilised strengths, the evolution of the landslide process and the predisposing factors of landsliding have been explored by means of the finite element analysis of an ideal case study representative of the typical geomechanical context of the region. In particular, the increase of slope inclination is shown to raise the depth of the shear band as well as to extend landslide scarp upwards, in accordance with the field evidence. Moreover, the numerical results indicate how the increase of the caprock thickness tends to confine the development of the shear band to the underlying weaker clay layer, so that the depth of the shear band is also observed to reduce, and when the stiffer top stratum becomes involved in the retrogression of the failure process. The numerical results allow also for the investigation of the variation in seepage conditions that combine with the variations in litostratigraphy in determining the variations of the features of the failure mechanism.