MODELLING THE BEHAVIOUR OF A COMPOUND ROCK SLIDE

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Introduction

Compound rock slides are generally characterized by a complex temporal evolution. In the mid to long term, slow to very slow active phases can alternate with rapid to very rapid paroxysmal development phases (Skempton and Hutchinson, 1969). This paper presents a conceptual model that has been developed to analyze and quantify the main factors that contribute to the displacements (absolute and relative) of calcareous towers sliding on a clayey substratum.

The case study

The Piagneto rock slide is located in the northern Apennines of Italy. Since May 1974 the landslide has caused several damages to the local infrastructures. The rock slide affects Triassic limestone, Cretaceous clayshale, and Oligocene-Miocene arenaceous flysch which dip out of slope and overlap due to regional over-thrusts. The rock slide is composed of two main subunits. Subunit G1 can be classified as a compound rock slide (Figure 1) and is most probably structurally controlled by the clayshale acting as a weak layer dipping out of the slope from underneath limestone (Corsini et al. 2013). Analysis of aerial photographs of 1979 and 1986 showed that the G1 subunit underwent a major retrogressive evolution between these years. Long-term monitoring (over 3 years) of the main blocks composing the landslides has showed a complex displacement patterns, activated by the precipitation, with relative distance among the blocks evolving with time.

Modelling approach

The landslide body is modelled as composed of three rigid blocks sliding on a single plane (Figure 2.a). The blocks are separated by vertical fissures in which water can infiltrate and flow through; changes in the distances among the blocks contribute to vary the water level in the fissures. A finite difference approach is used to discretize the time. During each iteration, the velocity of the system is computed solving the momentum equations for the three blocks (Ferrari et al. 2011), taking into account destabilising and resisting forces, and viscous components. Computed velocities are iteratively used to compute the relative distances among the blocks, which in turn result in a variation of the water level in the fissures.

Results and conclusions

The back-analysis of the observed displacement combined with the existing laboratory characterization has let to quantify the model parameters. In general a good agreement is found between measured and computed absolute and relative displacements of the blocks (Figure 2.b).

The simulations have let to quantify the role of the water levels in the fissures on the behavior of this compound landslide.

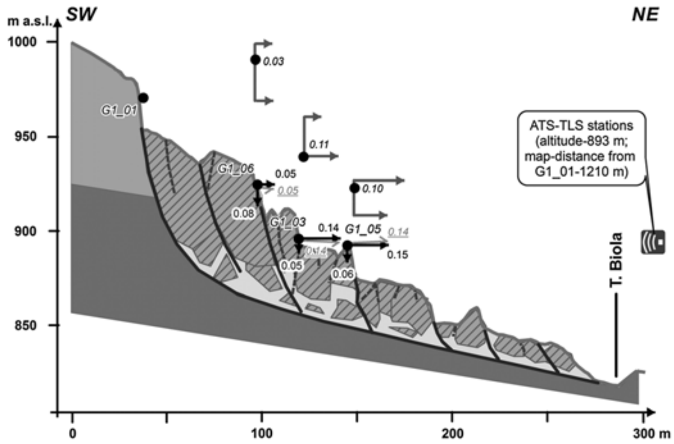
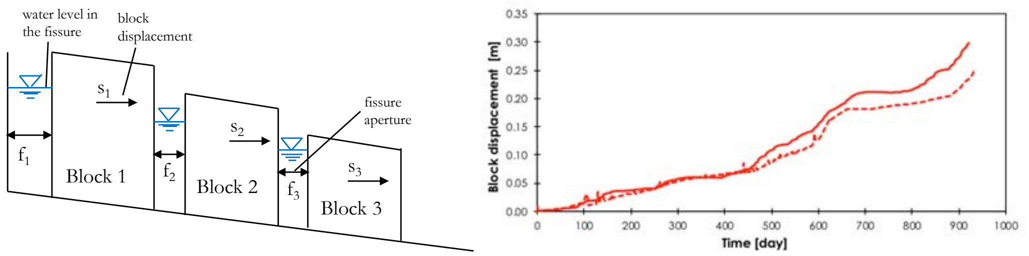


Figure 1. Cross section of the rock slide.



(a) (b)

Figure 2. (a) Conceptual model used to simulate the displacement patterns of the different blocks and, (b) comparison among modelled (continuous line) and measured (dashed line) displacement of Block 2.

Keywords: compound landslide, calcareous towers, fissures, viscous models.

References

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