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Modelling the time dependent movements of the La Saxe Rockslide by a dynamic visco-plastic model

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A challenging issue in geological and geotechnical problems associated with slope stability concerns the analysis of sliding masses subject to continuous slow movements and intermittent stages of slowing and accelerating motion.
In this work an attempt for simulating and forecasting the movement of the La Saxe rockslide (Aosta valley; Italian Western Alps; volume: about 8*10e6 m3) will be shown. The La Saxe rockslide movement could be interpreted as the result of two specific behaviours: i) a continuous creep-like movement occurring independently on groundwater conditions, even under dry-winter conditions, when the water table is mainly below or close to the failure surface; ii) a superimposed acceleration-exhaustion trend, occurring during the snow melting period (late spring-early summer) and directly related to the associated water table fluctuations, which disappears when the water inputs are reduced (late summer and winter conditions).
A reliable, monitoring-driven approach to model such rockslide behaviour should account for: a) the time-dependent behaviour by means of a viscous-plastic constitutive law reproducing the creep behaviour; b) the water table fluctuation as main input to reproduce the late spring - early summer acceleration; c) 3D rockslide behaviour maintaining at the same time an high level of simplicity so to allow implementation within EWS (Early Warning System) for risk management.
To this purpose a 1D pseudo-dynamic visco-plastic Newmark approach, based on Perzyna's theory (Secondi et. al 2011) has been applied. Newmark's approach considers the slope as a rigid block placed in the centre of mass of the rock slide, where the active forces are: the landslide weight, the inertial forces and the seepage force deriving from the water table level which is a function of time. All the non-linearities are condensed in an interface thin layer between the rigid block and the bedrock, whose mechanical response is assumed to be visco-plastic.
In order to cope with the complex geometry of the La Saxe rockslide a specific discretization in 5 zones has been considered. Each zone is assumed to behave as a rigid independent block with its specific inclination and height resting on a visco-plastic shear band of a predefined thickness .
The model has been applied and validated by considering the 2010-2012 displacements of Mont de La Saxe slope. Calibration, by back analysis, of the model parameters (viscous parameter, shear band thickness and strength parameters) has been carried out using the displacements and groundwater datasets. In such a way a tool for movement forecasting has been implemented.

Secondi M., Crosta G., Di Prisco C., Frigerio G., Frattini P., Agliardi F. (2011) "Landslide motion forecasting by a dynamic visco-plastic model", Proc. The Second World Landslide Forum, L09 - Advances in slope modelling, Rome, 3-9 October 2011, paper WLF2-2011-0571