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Modelling of a slow landslide in the Upper-Austrian Alps

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For urban and regional planning in mountainous areas early detection of potential catastrophic landslides, and if possible their prediction, are almost indispensable. Up to now in research to the development of landslides still little attention is paid to the long-term slow movements of the slope, that often can be observed in advance of the triggering of landslides. In this study it is tried to analyse these slow movements by simulating them with the so-called viscohypoplastic material law. Compared with many existing classical elasto(visco)plastic material laws, this recently developed model has proven to describe the stress-strain-time behaviour of soil material in a very accurate way and has the additional advantage that it requires only a few state variables, that all can be determined with ordinary triaxial and oedometer tests.

This viscohypoplastic model has been tested on the 'Stambach-earthflow', located in the Upper-Austrian Alps. This is an inactive earthflow, which is moving a few mm a year since its last activation in 1982. Inclinometer measurements as well as geodetical measuring of movements of the slope surface, both over a period of over 15 years, have given insight in the kinematics of the movements and were used to validate the simulations. The pore water distribution within the slope body was derived from piezometric measurements and free water tables in the boreholes. From several locations on the slope soil samples were taken for laboratory tests in order to determine the required material parameter.

The simulation procedure started with the calibration of the model by simulating the triaxial tests with a 1D element test program, in which the viscohypoplastic law was implemented. After this, the same program was used to simulate a number of borehole sections, in different depths, where each section was considered as a single element. The results were compared with the inclinometer measurements in that particular depth.

Then the deformations of larger slope sections were analysed 2D by using the finite element method. The results were compared with the inclinometer and geodetic measurements. The finite element method also allows the development of shear bands, which plays an important role in the initiation of the earthflow.

It is assumed that the triggering mechanism of the ‘Stambach-earthflow’ is strongly related to rock fall events in the upper part of the slope, during which the almost completely saturated, low permeable slope materials are loaded undrained by rock fall material stemming from the rock faces directly above the earthflow. With both the 1D and the finite element model such triggering scenarios can be simulated.