Geophysical Research Abstracts, Vol. 6, 07661, 2004
SRef-ID: 1607-7962/gra/EGU04-A-07661

MODELLING CATASTROPHIC LANDSLIDES TRIGGERED BY EARTHQUAKES

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Landslides and failure of slopes are caused by changes in the effective stresses, variation of material properties or changes in the geometry. Changes of effective stresses can be induced either directly, as consequence of variation of the external forces (earthquakes, human action), or indirectly through pore pressures (rainfall effects). Variations in material properties can be caused by processes of degradation (weathering and chemical attack). Finally, geometry can change because of natural causes (erosion) or human action (excavation, construction, reshaping...). Here we will focus on landslides triggered by earthquakes.

From a methodological point of view, we will consider an initiation phase followed by a propagation phase. Both will be analyzed using mathematical, constitutive and numerical models

Concerning initiation phase, it is important to note that soils and rocks are geomaterials with voids which can be filled with water, air, and other fluids. They are, therefore, multiphase materials, exhibiting a mechanical behaviour governed by the coupling between all the phases. Pore pressures of fluids filling the voids play a paramount role in the behaviour of a soil structure, and indeed, their variations can induce failure. Among the different alternative ways which can be used to describe the coupling between solid skeleton and pore fluids, we have chosen an approach closer to mixture theories than to the more classical approach used in Computational Geotechnique, and it provides a more general description which can be used both for initiation of failure and for propagation of catastrophic landslides. The mathematical model consists on Biot equations which can be discretized using standard Galerkin techniques. Constitutive equation should be able to reproduce soil behaviour under

earthquake loading. Here we will use a Generalized plasticity model modified to take into account the effects of partial saturation and collapse.

Concerning the propagation phase, once the landslide has taken place, it is important to know the velocity of the flow, how long will it reach, and what will be the path followed by them. In this way, it is possible to propose strategies based on channeling and protection structures. The prediction tools which will be presented in this work are based on mathematical and constitutive models for which there are extremely few analytical solutions. It has to be noticed that there exists a difficulty in the cases where the landslide evolves to flow type phenomena, where the soil changes from solid-like to fluid-like type of behaviour. We will present here a simplified model able to describe the pore pressure dissipation which results on a change in the apparent friction angle.

Finally, we will present examples of both initiational and propagation of landslides triggered by earthquakes.