Centrifuge model tests on rainfall-induced slope failures

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ABSTRACT

Rainfall-induced landslides can cause damage to properties and infrastructure and may result in the loss of human life. These phenomena often take place in unsaturated soil slopes and are triggered by a change in the saturation level of the soil profile due to rain infiltration. The change in saturation levels leads to a reduction of the effective stresses and shear strength of the soil. Usually these phenomena occur unexpectedly and without prior warning so the initiation conditions cannot be monitored. Geotechnical centrifuge testing is a physical modelling technique in which full-scale ground stresses can be reproduced within small-scale experiments in a controlled environment. Geotechnical centrifuge testing works by inducing a gravity field that is N-times greater than normal gravity so that the self-weight stresses of the model are increased by the factor N. Soil slope deformation is a stress dependent process, therefore the behaviour of a small-scale model experiencing an N-times increase in its gravity field will be similar to a full-scale prototype N times larger.

The aim of this study is to determine rainfall thresholds for the initiation of landslides under well-defined initial and boundary conditions. Model tests of rainfall-induced landslides have been conducted in the Nottingham Centre for Geomechanics 50g-T geotechnical centrifuge. Initially unsaturated plane-strain slope models have been prepared at varying initial states at 1g and accommodated within a climatic chamber which provides controlled environmental conditions. During the centrifuge flight at 60g, rainfall events of varying intensity and duration were applied to the slope models causing the initiation of slope failures. The impact of soil state and rainfall characteristics to landslide initiation process is discussed. The variation of pore water pressures within the slope before, during and after simulated rainfall events is recorded using miniature pore pressure transducers buried in the soil models. Slope deformation is measured through a transparent window using digital cameras and image analysis techniques. The experimental results form part of a database of rainfall-induced landslide events which can be used as a benchmark for calibrating both continuum and discrete numerical models developed within MUMOLADE project.