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Effects of Dilatancy on the Shearing Behaviour of Root-Permeated Soil

Anil Yildiz (1), Frank Graf (1), Christian Rickli (2), and Sarah M. Springman (3)

(1) WSL Institute for Snow and Avalanche Research SLF, Davos Dorf, Switzerland (contact@slf.ch), (2) Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland (wslinfo@wsl.ch), (3) Institute for Geotechnical Engineering, ETH Zurich, Zurich, Switzerland (info@igt.baug.ethz.ch)

The effects of vegetation and, in particular, of forests on the stability of slopes are well recognized and have been widely investigated. However, there is still a considerable lack of understanding on the underlying processes that contribute to triggering superficial soil failure in root-permeated soil. Therefore, it comes as no surprise that a period of heavy rainfall in August 2005, affecting an extensive area in Praettigau region in canton Grisons, resulted in numerous shallow landslides of which about half, 26 out of 50 events, occurred in the forest area. Thus, quantification of the vegetation effects on the shear strength of soil is important in order to be able to evaluate the contribution of root reinforcement to slope stability. Root reinforcement has been investigated through different approaches, including laboratory or in-situ shear tests of root-permeated soil, and analytical models of soil-root interaction. Traditional methods, generally, consider roots passing through the shear surface with full development of the roots' tensile strength. However, it has been shown that lateral roots contribute to strength as well, and that roots and soil do not necessarily fail simultaneously, and hence the strengths of both components of root-permeated soil are displacement dependent. A robust inclinable large-scale direct shear apparatus (ILDSA) was constructed in order to evaluate the combined effects of the root system on the shearing behaviour of soil. Two different sets of planted samples, a first set consisting of *Alnus incana*, *Trifolium pratense*, *Poa pratensis* and a latter set, consisting of these three species complemented with *Salix appendiculata*, *Achillea millefolium*, *Anthyllis vulneraria*, have been prepared in moraine (SP-SM) from a recent landslide area in Central Switzerland. Planted samples are maintained in shear boxes (500x500x400 mm) inclined at 30º, simulating a slope, and the corresponding natural growth of roots on it. Direct shear tests have been conducted on unplanted and planted soil samples at a constant rate of horizontal displacement of 1 mm/min to a maximum horizontal displacement of 200 mm. Three different applied normal stress levels, namely 6 kPa, 11 kPa and 16 kPa, were chosen to be comparable to the average depth of shallow landslides. An artificial rainfall at a constant intensity (100 mm/h) was applied prior to shearing in order to simulate the loss of strength after a heavy rainfall period under continuous monitoring of the matric suction with tensiometers, which was brought as close as possible to 0 kPa around the shear surface to ensure saturation. Dependence of contribution of root reinforcement to the additional shear strength of soil due to dilatancy was investigated in this study, and a comparison between the two levels of number of plant species, in terms of shear strength parameters, was presented.