Geophysical Research Abstracts
Vol. 18, EGU2016-17879, 2016
EGU General Assembly 2016

Effects of different vegetation types on the shear strength of root-permeated soils

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The effects of vegetation and, in particular, of forests on the stability of slopes are well recognized and have been widely studied in recent decades. However, there is still a lack of understanding of the underlying processes that occur prior to triggering superficial failures in root-permeated soil. Thus, appropriate quantification of the vegetation effects on the shear strength of soil is crucial in order to be able to evaluate the stability of a vegetated slope. Direct shear testing is widely employed to determine the shearing response of root-permeated soil. However, mechanical aspects of direct shear apparatuses may affect the shear strength parameters derived, which often remains unnoticed and hampers direct comparison between different studies. A robust Inclinable Large-scale Direct Shear Apparatus (ILDSA), with dimensions of 500x500x400 mm, was built in order to shear root-permeated soil specimens and to analyse the influence of the machine setup on the results, too. Two different sets of planted specimens were prepared using moraine (SP-SM) from a recent landslide area in Central Switzerland: a first set consisting of *Alnus incana*, *Trifolium pratense*, *Poa pratensis* and a second set, consisting of these three species complemented with *Salix appendiculata*, *Achillea millefolium*, *Anthyllis vulneraria*. Direct shear tests were conducted on specimens planted with the different vegetation types, at a constant rate of horizontal displacement of 1 mm/min up to a maximum horizontal displacement of 190 mm, and under three different applied normal stresses: 6 kPa, 11 kPa and 16 kPa. Artificial rainfall was applied at a constant intensity (100 mm/h) prior to shearing. Tensiometers had been installed close to the shear surface and were monitored continuously to obtain the matric suction during the saturation process. Suctions were reduced as close to 0 kPa as possible, in order to simulate the loss of strength after a heavy period of rainfall. The analyses of the above ground biomass and roots yielded a positive correlation (R^2 = 0.80) with their dry weights. On the one hand, the peak stress ratio, the ratio of peak shear stress and the normal stress, was calculated with the value of the applied normal load (W_{Upper}) and, on the other hand, with the value of the normal load transferred to the shear surface (W_{Lower}). There was no obvious relationship between the peak stress ratio calculated with W_{Lower} and the dry weight of the roots, as W_{Lower} is related to the dilatancy. However, different linear relationships were found between the peak stress ratio calculated with W_{Upper} and the dry weight of the roots for specimens with low level (R^2 = 0.75) and high level plant factor (R^2 = 0.51). Hence, it can be concluded that such variations indicate two different mechanisms of contribution of roots to the shear strength of the soil, which is due to the dominant growth angle and the amount of roots within the shear box.