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Measurement of in-situ Horizontal Root Tensile Strength of Herbaceous Vegetation for Improved Evaluation of Slope Stability in the Alps

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Abstract : Vegetation plays an important role for the stabilization of slopes against erosion processes, such as shallow erosion and landslides. Plant roots reinforce the soil, increase soil cohesion and often cross possible shear planes. Hence, plant roots reduce the risk of slope failure. Generally, shrub and tree roots penetrate deeper into the soil vertically, while roots of forbs and grasses are concentrated horizontally in the topsoil and organic layer. Therefore, shrubs and trees have a higher potential for stabilization of slopes with deep soil layers than forbs and grasses. Consequently, research mainly focused on the vertical root effects of shrubs and trees. Nevertheless, a better understanding of the stabilizing effects of grasses and forbs is needed for better evaluation of the stability of natural and artificial slopes with herbaceous vegetation. Despite the importance of vertical root effects, field observations indicate that horizontal root effects also play an important role for slope stabilization. Not only forbs and grasses, but also some shrubs and trees form tight horizontal networks of fine and coarse roots and rhizomes in the topsoil. These root networks increase soil cohesion and horizontal tensile strength. Available methods for physical measurements, such as shear-box tests, pullout tests and singular root tensile strength measurement can only provide a detailed picture of vertical effects of roots on slope stabilization. However, the assessment of horizontal root effects is largely limited to computer modeling. Here, a method for measurement of in-situ cumulative horizontal root tensile strength is presented. A traction machine was developed that allows fixation of rectangular grass sods (max. 30x60cm) on the short ends with a 30x30cm measurement zone in the middle. On two alpine grass slopes in South Tyrol (northern Italy), 30x60cm grass sods were cut out (max. depth 20cm). Grass sods were pulled apart measuring the horizontal tensile strength over 30cm width over the time. The horizontal tensile strength of the sods was measured and compared for different soil depths, hydrological conditions, and root physiological properties. The results improve our understanding of horizontal root effects on slope stabilization and can be used for improved evaluation of grass slope stability.

Keywords : grassland, horizontal root effect, landslide, mountain, pasture, shallow erosion
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