RELATION BETWEEN ROOT DISTRIBUTION, SOIL PERMEABILITY AND SUCTION IN UNSATURATED PYROCLASTIC SLOPE

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In Campania region (Southern Italy) flowslides are widespread in the western part of the region. These landslides, triggered by intense rainfalls, drag part of the pyroclastic soil cover (2 to 3 m thick) resting on the limestone bedrock. Soils involved are characterized by critical friction angles ranging between 35° and 38° while slopes are usually very steep (37° to 45°), thus, the stability is guaranteed only by apparent cohesion[1,2] due to the suction regime acting in the shallow cover. Therefore, the monitoring of the subsoil hydraulic conditions is very useful to investigate slope stability and even for prediction.

The monitoring of water content, suction and meteorological conditions is going on at a test site in Mount Faito (40°40'30.08"N, 14°28'23.98"E; Naples, Italy). Additionally to the traditional monitoring, the special attention has been given to vegetation, mainly composed of chestnuts, shrubs and ferns and root distribution has been determined. Apart from the mechanical contribute due to root reinforcement, the effect of vegetation consists also of: (i) the effect of roots on the soil structure, which causes changes in the soil hydraulic properties, such as the saturated permeability and water retention capacity[3,4]; and (ii) the water uptake resultant from the transpiration of the plants, which results in suction increase[4,5].

The effect of roots on the saturated permeability was investigated by performing saturated permeability tests in the laboratory using different types of soil collected at Mount Faito (A1, A2, C1 and C2). The soil samples with higher dry biomass also presented higher saturated permeability (Figure 1.a). Nevertheless, the higher permeability is also associated to higher porosity (Figure 1.b), which was known as one of the effects related to the presence of roots[6].

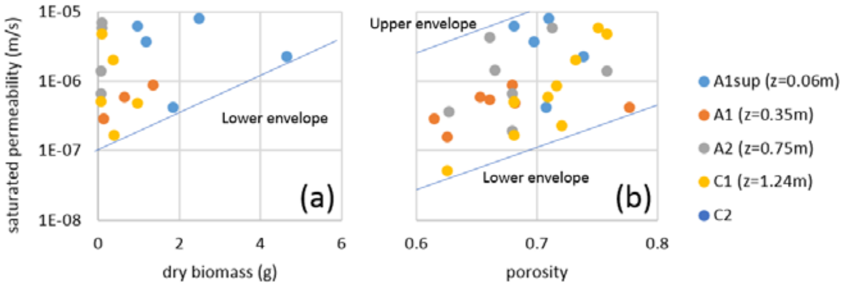

Figure 1. Effect of (a) dry biomass and (b) porosity on saturated permeability.

The effect of roots on the water pore pressure was investigated by comparing soil suction measurements collected at two instrumented verticals at the site (N and C) to the number of root tips with diameter smaller than 0.5 mm (Figure 2.a). This trait can be associated to the suction because the water is uptaken in the area just before the root tip. As shown in Figure 3, suction along vertical C is lower than along vertical N in the surficial soil layer (z=0.2-0.5m), particularly in the period from June to October, when the vegetation reaches maturity and transpiration is maximum, because vertical C presents less root tips in the first 0.5 m of soil. Also, more intense suction oscillations occur at z=0.2 m in vertical N during October and November as a consequence of the higher hydraulic conductivity caused by greater root length in vertical N above 0.2 m (Figure 2.b). In this case, the best indicator of hydraulic conductivity is the root length because roots create channels for preferential flow, facilitating the infiltration[6].

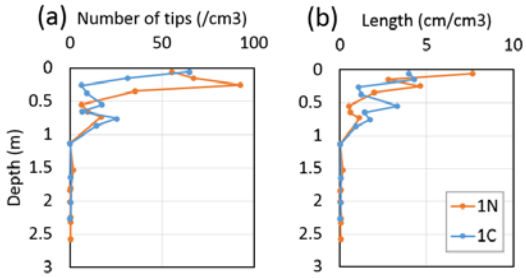

Figure 2. Distribution of the (a) number of tips and (b) length per cm^3 of soil with depth.

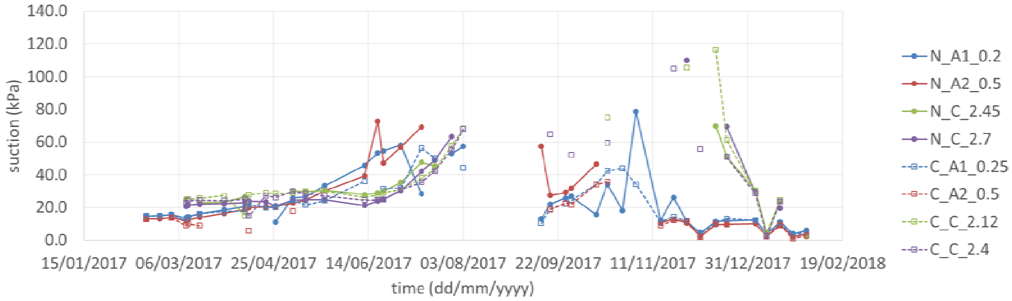

Figure 3. Suction measurements over one year.

Therefore, the safety factor is expected to be higher within the first meter at vertical N than at vertical C from June to October. The critical period for the occurrence of landslides is the winter, when plants are not active. During this period, suction is similar in both verticals but vertical N shows a faster response to the rainfall in terms of suction variation because the root length is greater, increasing the soil overall hydraulic conductivity.

Keywords: slope stability, soil permeability, unsaturated soils, pyroclastic slope, root distribution, vegetation.

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