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THE CONTRIBUTION OF PLANT ROOTS ON SLOPE STABILITY

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Men always used plants to protect slopes from water and wind erosion. During last decades, this use has spread in civil and environmental engineering. Naturalistic approach for slope stabilization and erosion control has been studied and experimented, on the basis of concepts of Naturalistic Engineering. To better understand soil-root interaction mechanism and to evaluate plants roots effect on soil shear strength and slope stability, theoretical and experimental studies about plant biotechnical and mechanical characteristics are needed (Gray and Sortir, 1996) . This work provides indications on mechanical strength parameters of some native plant roots. Tensile strength of two native Mediterranean species have been analysed by means of a series of experimental laboratory tests carried out at the Department of Civil Engineering and Architecture of University of Catania. Results indicate that tensile strength of roots is influenced by many factors, among which, type of species, root diameter, root moisture and location where plants have grown up.
Plants usually have a positive effect on the soil mechanical properties because, similarly to the case of reinforced earth, their roots anchor the shallower soil layers to the deeper ones, acting as biological nails.Usually the maximum tensile strength or pull-out resistance of roots, together with an assessment of root size and distribution, can be used to evaluate the appropriate root reinforcement values to be used in the stability analysis of a slope.
Shear strength increment due to roots can be represented as follows:

$$\tau_L^* = \tau_L + \Delta\tau_L \qquad (1)$$

Where τ_L is the soil shear strength and $\Delta\tau_L$ the increment in strength due to the root, that is (see Fig. 1):

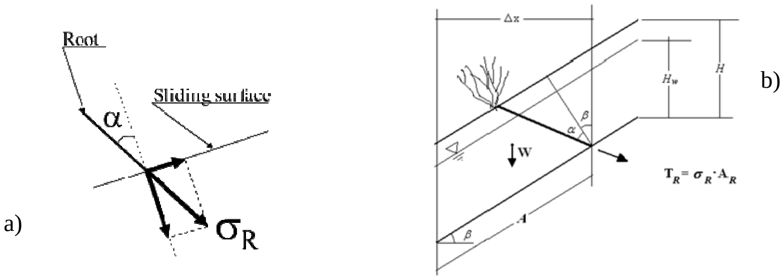

Figure1. Scheme of the stabilizing effect of a root: a) increase of soil shear strength; b) scheme of an infinite slope

Tensile stress σ_R must be the minimum value determined among all the possible failure mechanisms. We can distinguish the following limit cases in the soil-root system:
1 - ultimate limit state for achieved tensile strength in the root;
2 - ultimate limit state for achieved pull-out of the root
3 - ultimate limit state for the achieved failure of the soil arching between two adjacent roots.
The present study focused attention on tensile strength of two typical Mediterranean species (Fig. 2). Two different type of plants have been used for the experimental investigation named Asparagus Acutifolius and Spartium Junceum (Capilleri et al., 2017).Those plants grow up spontaneously and have been removed from their sites with their root balls. Maximum Root depth values were located within 0.20 m – 0.40 m for all the species of Asparagus while maximum root depth for Spartium Junceum was at about depth of 0.50 m – 1.50 m from the ground surface. Figure 2 shown the examined plants. There are significant differences in tensile properties between the two species analyzed thus the type of species have a great effect on tensile strength of roots. The tensile strength of Spartium Junceum is much greater than the tensile strength of Asparagus if compared with a similar moisture. From the laboratory tests analyzed, the tensile strength is significantly affected by the moisture (Yang et al., 2016). Results of the tests indicate that dry roots of Asparagus have a tensile strength greater than the wet roots.

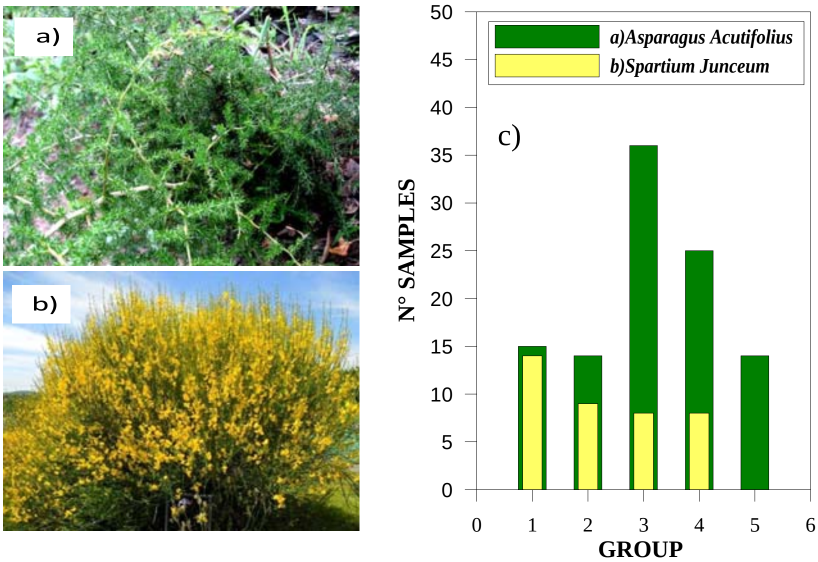

Figure2. Mediterranean species investigates: a) *Asparagus Acutifolius*; b) *Spartium Junceum*; c) number of samples analysed

Keywords: Bioengineering, Naturalistic Engineering, slope stability, root reinforcement, apparent cohesion.

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