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Modeling the shear strength of unsaturated pyroclastic ashes from the water retention curve

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Unsaturated pyroclastic deposits covering steep slopes, characteristic of large mountainous areas of Campania (southern Italy), are often affected by shallow landslides triggered by rainfall. The equilibrium of such deposits is in fact usually guaranteed by the contribution to soil shear strength offered by soil suction, which decreases when soil approaches saturation. More specifically, suction affects the effective stress of the soil, exerting a compressive stress on solid particles (i.e. suction stress), which increases shear strength thanks to friction. The so-called Bishop coefficient was introduced by Bishop (1959), to take into account that suction is only partially transmitted to solid particles, owing to the surrounding pores only partially occupied by water. Experimental evidence and theoretical arguments show that the Bishop coefficient, originally proposed to be equal to the degree of saturation of soil, is a nonlinear function of matric suction, and several models can be found in the literature to express this relationship. In this study, the model of Lu et al. (2010), which assumes that the fraction of soil suction effectively transmitted to solid particles is proportional to the effective degree of saturation of the soil, and a recently proposed model, based on the assumption that suction is transmitted to soil solid particles only through the wetted fraction of their external surface area (Greco and Gargano, 2015), are applied to predict soil suction stress and shear strength of pyroclastic ashes from their water retention curve, expressed with various relationships.
Experimental data of shear strength of pyroclastic ashes from various sites in Campania are compared with the values of shear strength predicted with the various tested models. The investigated soils are loose silty sands, characterized by a porosity larger than 0.7, friction angle ranging between 36 and 38, and small or even null cohesion. In all cases, the best agreement between modeled and experimental shear strength is obtained by means of the model of Greco and Gargano (2015). The obtained results highlight the importance of accurate modeling soil suction stress to correctly predict shear strength of unsaturated pyroclastic granular deposits.

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