Finite Element Simulation of the Bearing Capacity of an Unsaturated Coarse-Grained Soil

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The mechanical behaviour of partially saturated soils can be very different from that of fully saturated soils. It has long been established that for such soils, changes in suction do not have the same effect as changes in the applied stresses, and consequently the effective stress principle is not applicable.

A procedure was proposed to define the soil water characteristic curve. Then this relation is converted to relation correlating the void ratio and matric suction. The slope of the latter relation can be used to define the H-modulus function. This procedure is utilized in the finite element analysis of a footing on unsaturated coarse-grained soil to investigate its bearing capacity.

The finite element results demonstrated that there is a significant increase in the bearing capacity of the footing due to the contribution of matric suction in the range 0 to 6 kPa for the tested compacted, coarse-grained soil. The ultimate pressure increases from about 120 kPa when the soil is fully saturated to about 570 kPa when the degree of saturation becomes 90%. This means that an increase in the bearing capacity of about 375% may be obtained when the soil is changed from fully saturated to partially saturated at a degree of saturation of 90%. This development in the bearing capacity may exceed 600% when the degree of saturation decreases to 58%.