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A HYSTERESIS MODEL OF SOIL WATER RETENTION CURVES BASED ON BOUNDING SURFACE CONCEPT
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In 2004, Mid Niigata Prefecture had faced an earthquake that caused more than 3,000 slope failures. Before the earthquake, heavy rainfalls had occurred and the water content of the soil surface on slopes was high. These slope failures may be attributed to the combined earthquake and rainfalls effects, defined as cyclic loadings. In fact, little information is known about the cyclic loads effects. The investigation of such problems should introduce saturated-unsaturated consolidation analysis method or saturated-unsaturated seepage analysis methods which deal, in certain way, with such dynamic factors.

This presentation introduces a hysteresis model of soil water retention curve based on bounded surface concept. In the bounding surface concept, the plastic modulus is defined as a function of the distance between a current stress point and the conjugated stress point on the bounding surface. We have adopted the similar idea that the slope c of the soil water retention curves are defined as a function of the normalized distance between a current stress point and the conjugated points on main curves (main drying and wetting curves). The experimental process used to establish a soil water retention characteristics model consisted of those related to saturated-unsaturated consolidation analysis methods.

The modeling of main curves was conducted by the tangential model proposed by the author. Usually, in the modeling of water retention characteristics, the positive suction values were mostly taken into account. But the tangential model considers both of the effects of positive and negative suction values; and in another hand, it insures the continuity of the slopes of the soil water retention curves.

In order to verify the model, soil water retention curves of three samples, with cycles (drying and wetting) were simulated. The samples were: (1) white silica sand, (2) glass beads consisting of uniform glass spheres of about 180 micrometers in diameter and (3) smaller glass beads lightly sintered into aggregates, roughly 200 micrometers in diameter.

The simulation results were conclusive. Three main conclusions can be retained from the results: (i) the normalized distance was expressed by a variable r and only two parameters (hd and hw: material parameters) were required to describe the scanning curves; (ii) the tangential model may trace the retention curves as if pore water pressures are both positive and negative; and (iii) only three points are selected and the degree of saturation Sr, the suction s and the slope c at those points may be input.

キーワード: constitutive equation, degree of saturation, hysteresis, numerical analysis, soil water retention curve, suction (IGC: D4E7)
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