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Estimation of Relative Subsidence of Collapsible Soils Using Electromagnetic Measurements

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Abstract : Collapsible soils are weak soils that appear to be stable in their natural state, normally dry condition, but rapidly deform under saturation (wetting), thus generating large and unexpected settlements which often yield disastrous consequences for structures unwittingly built on such deposits. In this study, a prediction model for the relative subsidence of stressed collapsible soils based on dielectric permittivity measurement is presented. Unlike most existing methods for soil subsidence prediction, this model does not require moisture content as an input parameter, thus providing the opportunity to obtain accurate estimation of the relative subsidence of collapsible soils using dielectric measurement only. The prediction model is developed based on an existing relative subsidence prediction model (which is dependent on soil moisture condition) and an advanced theoretical frequency and temperature-dependent electromagnetic mixing equation (which effectively removes the moisture content dependence of the original relative subsidence prediction model). For large scale sub-surface soil exploration purposes, the spatial sub-surface soil dielectric data over wide areas and high depths of weak (collapsible) soil deposits can be obtained using non-destructive high frequency electromagnetic (HF-EM) measurement techniques such as ground penetrating radar (GPR). For laboratory or small scale in-situ measurements, techniques such as an open-ended coaxial line with widely applicable time domain reflectometry (TDR) or vector network analysers (VNAs) are usually employed to obtain the soil dielectric data. By using soil dielectric data obtained from small or large scale non-destructive HF-EM investigations, the new model can effectively predict the relative subsidence of weak soils without the need to extract samples for moisture content measurement. Some of the resulting benefits are the preservation of the undisturbed nature of the soil as well as a reduction in the investigation costs and analysis time in the identification of weak (problematic) soils. The accuracy of prediction of the presented model is assessed by conducting relative subsidence tests on a collapsible soil at various initial soil conditions and a good match between the model prediction and experimental results is obtained.

Keywords : collapsible soil, dielectric permittivity, moisture content, relative subsidence
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