SOIL AND SITE CHARACTERIZATION USING ELECTROMAGNETIC WAVES

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ABSTRACT

Success in geotechnical analysis, design, and construction invariably requires that we have proper knowledge and understanding of (1) the strength, (2) the fluid flow properties, and (3) the stress-deformation behavior of the earth materials. These important engineering properties are primarily determined by the components and structure of a soil, which also dictate the soil's responses in an electromagnetic field. As a nondestructive technique, electromagnetic property measurements offer a promising approach to characterize earth materials and identify the effects of changes in environments.

However, despite many investigations in the last several decades, the relationship between the frequency-dependent electromagnetic properties of soils and their components and structure are still not well understood. Hence, estimation of engineering properties of a soil in a quantitative way from electromagnetic measurements can be uncertain.

In this research several tasks have been accomplished:

(1) Development of a physically based model that provides a means of investigating the coupled effects of important polarization mechanisms on soil electromagnetic properties, and a means of relating the electromagnetic properties of a soil to its

fines content, clay mineralogy, anisotropy, degree of flocculation and pore fluid chemistry;

(2) Deduction of the wide-frequency electromagnetic properties of a soil by measuring its responses to a step pulse voltage using time domain reflectometry (TDR);

(3) Proposal of a practically applicable method to determine the volumetric water content, specific surface area and pore fluid salt concentration simultaneously from the dielectric spectrum;

(4) Establishment of the relationships between the specific surface area, electromagnetic properties and compressibility, residual shear strength and hydraulic conductivity.

This study establishes a framework for quantifying soil engineering properties from their electromagnetic properties. If properly determined and interpreted, the electromagnetic properties can also provide insights into the causes of soil property changes over time and can be very useful in studying the effects of biological factors in geotechnical engineering, a field that may offer great potential for future advances.