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Investigation of Shear Strength, and Dilative Behavior of Coarse-grained Samples Using Laboratory Test and Machine Learning Technique

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Abstract : Coarse-grained soils are known and commonly used in a wide range of geotechnical projects, including high earth dams or embankments for their high shear strength. The most important engineering property of these soils is friction angle which represents the interlocking between soil particles and can be applied widely in designing and constructing these earth structures. Friction angle and dilative behavior of coarse-grained soils can be estimated from empirical correlations with in-situ testing and physical properties of the soil or measured directly in the laboratory performing direct shear or triaxial tests. Unfortunately, large-scale testing is difficult, challenging, and expensive and is not possible in most soil mechanic laboratories. So, it is common to remove the large particles and do the tests, which cannot be counted as an exact estimation of the parameters and behavior of the original soil. This paper describes a new methodology to simulate particles grading distribution of a well-graded gravel sample to a smaller scale sample as it can be tested in an ordinary direct shear apparatus to estimate the stress-strain behavior, friction angle, and dilative behavior of the original coarse-grained soil considering its confining pressure, and relative density using a machine learning method. A total number of 72 direct shear tests are performed in 6 different sizes, 3 different confining pressures, and 4 different relative densities. Multivariate Adaptive Regression Spline (MARS) technique was used to develop an equation in order to predict shear strength and dilative behavior based on the size distribution of coarse-grained soil particles. Also, an uncertainty analysis was performed in order to examine the reliability of the proposed equation.

Keywords : MARS, coarse-grained soil, shear strength, uncertainty analysis
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