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Soil type classification of a 3D ground volume through CPT measurements and geostatistical tools

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A large database of thousands of Cone Penetration Test (CPT) and Piezocone (CPTu) measurements along the first 30m depth under the ground surface have been collected by the Regional Planning office in Emilia Romagna territory (Italy). From the tip resistance qc and shaft resistance fs measures the Soil Behavior Type Index Ic (Robertson 2009) can be calculated in order to identify the soil type and the stratigraphy alongside depth. The almost continuous CPT measures enable to recognize in real-time the lithology of verticals although the lateral lithological variations are commonly disregarded especially if the CPTs are far away. Geostatistical tools such as spatial stochastic simulation can be helpful to get three main objectives: (1) to draw the 3D spatial variability structure of the soil properties measured through qc and fs profiles; (2) to detect the lithological characters of a volume of territory as large as hundreds up to thousands of kilometers; 3) to evaluate the uncertainties of predictions. The present study aims at doing a lithological characterization of the North-East portion of Bologna province (Italy), where about 145 CPTs have been carried out at kilometric distance. This area is made up of fine soils, sand, silt and clay alterations where hanging underground waters are located. Moreover, local variations of each soil fraction affect the engineering properties of these alluvial deposits. Therefore it is of engineering interest to study how the measurements of qc and fs along depth vary as a function of the sedimentary conditions. To this end, geostatistical tools have been used for reconstructing a large 3D volume of the soil stratigraphy with two different scales of recording (Castrignanò et al. 2007): the vertical scale of CPT measurements is 3 cm whereas the horizontal one is a few kilometers. Finally, the adopted method has enabled not only to reconstruct a 3D model of Ic values but also to estimate the uncertainties of the Ic calculated values.

References

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