Challenges in the characterization of block-in-matrix geomaterials

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Abstract

The mechanical characterization of soils is a crucial phase in evaluating the stability of slopes and designing remedial measures. However, when dealing with geologic units composed of a weak matrix (weak rock or hard soil) enclosing stronger rock inclusions (i.e. block-in-matrix geomaterials), the collection of undisturbed specimens and laboratory testing are extremely challenging tasks. Specifically, important physical disaggregation and loss of structure often occur while sampling heterogeneous formations with a clayey or loose matrix. Moreover, major difficulties arise in the determination of their mechanical properties, which have to be used for the design and construction of civil engineering works.

If undisturbed samples cannot be retrieved, unconventional methods are required to perform laboratory tests and the use of reconstituted specimens can generally not be avoided. In this last case, the particle size distribution is generally altered with respect to the natural one and only some dimensional classes are used. Thus, the specimens are usually made of gap graded soils, whose strength and deformability are highly dependent on the particle size distribution chosen. Furthermore, due to the inherent spatial and structural variability of these heterogeneous geomaterials, laboratory tests do not always provide results that are representative of the overall mechanical behavior of these complex heterogeneous formation.

In light of the above, the determination of the strength and deformability properties of these geomaterials is rather complex and can be affected by many errors. As a consequence, technical problems in the execution phases can be induced if the mechanical parameters obtained from laboratory tests are used to model the behavior of the same material at the site scale.

To overcome the technical difficulties highlighted above, conservative and convenient approaches are commonly followed by geopractitioners in the design practice. These approaches ignore the presence of the larger rock inclusions and assign the properties of the matrix to the ground considered to be an equivalent
homogeneous material. However, this choice often leads to expensive mischaracterizations.

In this paper, the results obtained from laboratory tests are described, which were performed to study the influence of the presence of strong and big particles on the mechanical behavior of a block-in-matrix material. These tests were carried out on reconstituted homogeneous and heterogeneous specimens.

To prepare the reconstituted geomaterial, the clayey matrix of an Italian complex formation with a block-in-matrix fabric was remolded, properly sieved and one-dimensionally consolidated. Heterogeneous specimens were obtained by adding gravel blocks to the matrix before consolidating it. Observations on the peak and residual strengths are provided, based on ring shear tests and confined compression tests. Specifically, a significant influence of the gravel particles was observed on the global deformability, strength, strain at failure and post-peak behavior. Moreover, tortuous failure surfaces were observed in the heterogeneous specimens, indicating that cracks originate within the matrix and propagate around the blocks, as matrix-block interfaces constitute weakness zones. These observations are in agreement with previous findings from the literature on the behavior of complex formations with a block-in-matrix fabric.

**Keywords:** Heterogeneous formations, block-in-matrix, laboratory tests, reconstituted samples, gap-graded soils