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Sample Preparation and Coring of Highly Friable and Heterogeneous Bonded Geomaterials

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Abstract : Most of the Earth's crust surface rocks are technically categorized as weak rocks or weakly bonded geomaterials. Deeply weathered, weakly cemented, friable and easily erodible, they demonstrate complex material behaviour and understanding the overlooked mechanical behaviour of such materials is of particular importance in geotechnical engineering practice. Weakly bonded geomaterials are so susceptible to surface shear and moisture that conventional methods of core drilling fail to extract high-quality undisturbed samples out of them. Moreover, most of these geomaterials are of high heterogeneity rendering less reliable and feasible material characterization. In order to compensate for the unpredictability of the material response, either numerous experiments are needed to be conducted or large factors of safety must be implemented in the design process. However, none of these approaches is sustainable. In this study, a method for dry core drilling of such materials is introduced to take high-quality undisturbed core samples. By freezing the material at certain moisture content, a secondary structure is developed throughout the material which helps the whole structure to remain intact during the core drilling process. Moreover, to address the heterogeneity issue, the natural material was reconstructed artificially to obtain a homogeneous material with very high similarity to the natural one in both micro and macro-mechanical perspectives. The method is verified for both micro and macro scale. In terms of micro-scale analysis, using Scanning Electron Microscopy (SEM), pore spaces and inter-particle bonds were investigated and compared between natural and artificial materials. X-Ray Diffraction, XRD, analyses are also performed to control the chemical composition. At the macro scale, several uniaxial compressive strength tests, as well as triaxial tests, were performed to verify the similar mechanical response of the materials. A high level of agreement is observed between micro and macro results of natural and artificially bonded geomaterials. The proposed methods can play an important role to cut down the costs of experimental programs for material characterization and also to promote the accuracy of the numerical modellings based on the experimental results.

Keywords : Artificial geomaterial, core drilling, macro-mechanical behavior, micro-scale, sample preparation, SEM photography, weakly bonded geomaterials
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