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Block volume and shape and their role in rockfall problems

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The Distinct Element Method – Application in Rock Engineering Projects

Dr. José G. Gutiérrez-Ch, Assistant Professor at ETSI de Caminos, Canales y Puertos of the Universidad Politécnica de Madrid, UPM (Spain)

Using synthetic rocks to investigate the link between microstructural attributes and mechanical properties of porous rocks

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Block volume and shape and their role in rockfall problems

Abstract

Block size and shape are a consequence of the discontinuities of a rock mass: therefore, it is possible to derive these two parameters from the geometrical features of the discontinuity sets (orientation, spacing, and persistence). Although traditional contact methods are still extremely common and viable, non-contact surveying techniques applied to rock mass characterization offer many advantages in terms of data numerosity, precision and accuracy; thus, performing a rigorous statistical analysis of the database is possible. It should be noted how uncertainties in spacing and orientation data could significantly amplify the uncertainties connected with the In-situ Block Size Distribution (IBSD, i.e., the relation between each possible volume and its probability of not being exceeded). Through analytical equations it is possible to calculate the expected value and variance of volume distributions. In addition to volume, block shape can also be considered a derived parameter that suffers from uncertainties. Volume and shape have immediate consequences on numerical simulations of block trajectories and are, therefore, extremely important. Quantifying the effect of both volume and shape variability through synthetic cases, it is possible to quantitatively compare different datasets and evaluate the overall uncertainty effect on the dispersion of the results. Moreover, block shape distributions can be obtained and compared, confirming the variability of shapes within the same IBSD.

Speaker

Battista Taboni holds a degree in Applied Geology from the University of Torino (Torino, Italy), where he is currently a PhD student, since 2021. He specializes in slope stability, rock mass characterization through contact and non-contact methods, site investigation and modelling. The focus of his current research is the assessment of rockfall phenomena: from the description and quantification of key features of the source rock mass, to the identification and quantification of the parameters required for a proper protection works design, particularly by means of probabilistic methods.

The Distinct Element Method – Application in Rock Engineering Projects

Abstract

The Distinct Element Method (DEM) is a powerful numerical solution initially developed to analyse the macro- and micro- mechanical behaviour of rocks, and its application has been extended to study the response of soils, and other materials. The domain of such materials is discretized by variably-sized rigid particles that interact each other's through forces and moments.   The solution scheme is based on the application of Newton's second law to the particles and a force-displacement law at the contacts. In this work, the Author's experiences are used to illustrate the applicability of DEM modelling in rock engineering projects, with particular attention to modelling of laboratory tests, and the response of axially loaded rock-socketed piles.

Speaker

Dr. José G. Gutiérrez-Ch is currently an Assistant Professor at ETSI de Caminos, Canales y Puertos of the Universidad Politécnica de Madrid (UPM, Spain), holding masters on Soil Mechanics and Geotechnical Engineering, and on Applied Mathematics to Engineering. Also, he holds bachelors in Civil Engineering and in Geologist Engineering. He completed his PhD in Engineering Structures, Foundations and Materials at UPM in July 2020 with the highest academic score and Cum Laude distinction. The key achievements of his PhD work were developing innovate numerical modelling and centrifuge testing to quantify the socket roughness effect on increasing capacity of rock-socketed piles (RSPs), and the proposal of new guidelines in deep foundations for practitioners to do a more efficient design of RSPs. His PhD Thesis was awarded as the Universidad Politécnica de Madrid (UPM)'s Extraordinary Doctoral Thesis Award 2021, and the Best Doctoral Thesis Award 2020 in Geotechnical Engineering by the Fundación José Entrecanales Ibarra. Currently at UPM, Dr. Gutiérrez-Ch is focus on Geotechnical Engineering, with a special interest in developing advanced numerical models as well as in conducting field and laboratory tests. So far, Dr. Gutiérrez-Ch generated excellent publications including high-quality peer-reviewed journals with an international network of collaborators.

Using synthetic rocks to investigate the link between microstructural attributes and mechanical properties of porous rocks

Abstract

Experimental rock mechanics studies underpin our understanding of the relationship between microstructural attributes and bulk mechanical properties of natural materials. Considerable progress has been made but intrinsic variability from sample to sample and structural heterogeneity remain limitations to the study of the contribution of each microstructural parameter independently. In this work, synthetic rocks for which these parameters can be predetermined and designed are used to unravel the contribution of microstructural attributes on the hydraulic and mechanical properties of rocks. Combining systematic petrophysical characterisation and experimental rock deformation methods with analyses of the microstructure, the first-order control of porosity and grain size on the onset of inelastic compaction are exposed and grain size distribution is shown to have a significant influence on the propensity for compaction localisation under triaxial loading.

Speaker

Dr. Lucille Carbillet is a post-doctoral researcher with a background at the Institut Terre et Environnement de Strasbourg in Strasbourg, France. She will soon be joining the Rock Deformation team at the École Polytechnique Fédérale de Lausanne in Lausanne, Switzerland. Her doctoral research focused on exploring the evolving relationship between the microstructure of porous rocks and their bulk mechanical properties during granular densification. Additionally, she investigates changes in permeability under varying pressure and temperature conditions, employing a high-pressure high-temperature permeameter that she designed and implemented in Strasbourg. Beyond her scientific pursuits, Lucille advocates for art-science collaborations and actively participates in several music bands, where she contributes as a singer, cellist, and banjo player.