Investigation of nature-like rock joint shear behaviour using 3D printing

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ABSTRACT

Many numerical models still idealise rock joints as smooth parallel plate joints to simplify the modelling process. However, real rock joints have rough joint walls and irregular joint aperture, and water flows through joint void space during shearing. Coupled hydro-mechanical behaviour of rock joints requires a thorough understanding of the three-dimensional (3D) structure of rock joints to develop a realistic hydro-mechanical coupling model in fractured rocks. In order to prepare rock samples with the same 3D rock joint profile for laboratory direct shear tests and subsequent hydro-mechanical coupling experiments, 3D scanning and 3D printing techniques are used during the sample preparation process. Firstly, natural rock joints are scanned using photogrammetry technique to generate point clouds of their 3D structures in a laboratory setting. Secondly, computer-aided design (CAD) software is used to digitise moulds that replicate the 3D rock joint structure of the scanned rock. Then, a 3D printer is used to print these moulds for casting plaster rock samples that have the same 3D rock joint profile. Direct shear tests are conducted on these rock samples under different normal pressures to study their strength parameters and deformability properties, and these experimental results are compared with rock joints that have Barton's standard JRC profiles for validation of samples prepared.