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Mechanical Properties of Rock Joints

KARMO I → **KARMO II** → KARMO III

Rock Joint Photogrammetry

A new method was developed to digitally record the geometry of rock joints using Structure from Motion photogrammetry (**Fig. 1**). The point spacing reached is in the range of 0.150 … 0.250 mm, which is sufficient for replicas or numerical simulation of rock joints. The loss of accuracy resulting from photogrammetry was small compared to loss of geometry from mortar replica production (**Fig. 2**). In conclusion, the developed photogrammetric method is promising, but requires meticulous execution.

Fig. 1. SfM photogrammetry.

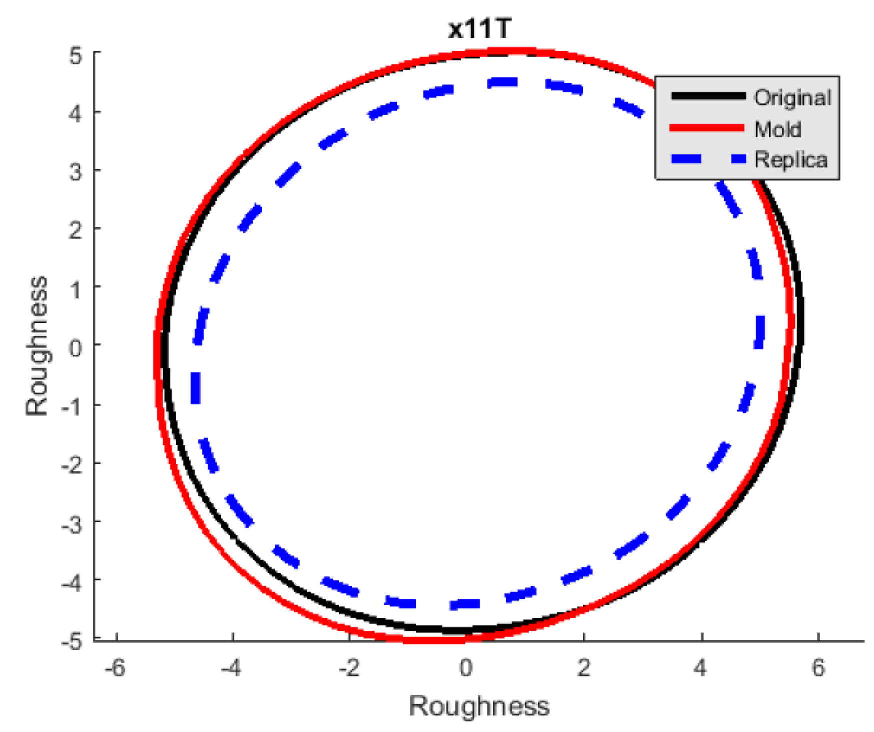

Fig. 2. Directional roughness.

Digital Roughness Metrics

Three different digital roughness metrics were studied to evaluate which one is most suitable with fresh, unweathered rock joints. For traditional 2D roughness, the Maerz *et al.* 1990 R_p produced consistent results. For directional 3D roughness, the El-Soudani 1978 R_s is a visual way to communicate the results. The roughness was well retained in only 5 out of the 33 samples measured (**Fig. 3**). The photo-grammetric requirements were also studied and published. To analyze the error of 3D printing, the top and bottom pairs were also cross-compared and the mean deviation was 3 % (**Fig. 4**).

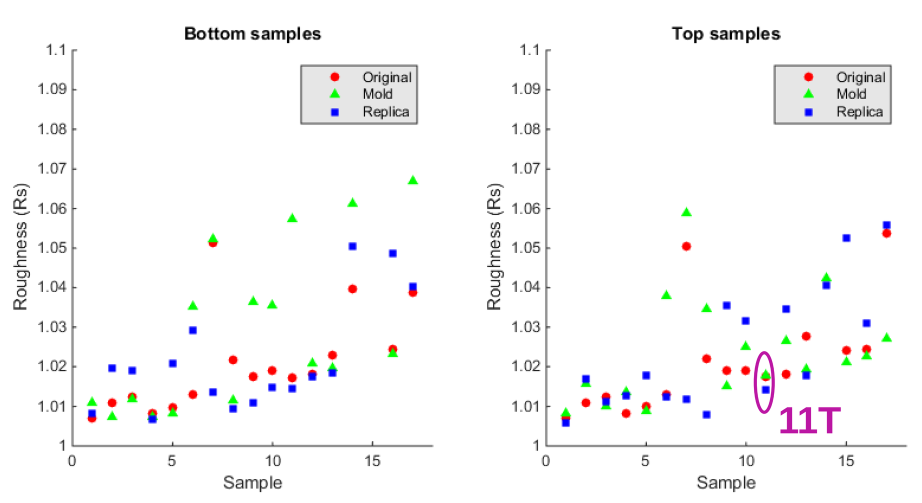

Fig. 3. Roughness persistence.

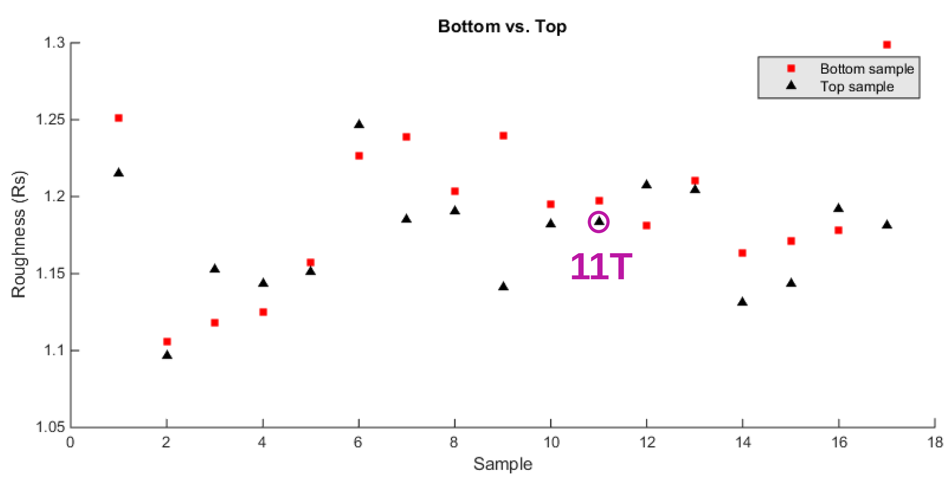

Fig. 4. Top/bottom roughness.

Rock Joint Shear Testing

Two Kuru granite samples with sizes 0.50 m x 0.25 m and 2 m x 1 m with fresh, unweathered artificially induced tensile rock joints were manufactured. The larger sample, which is also largest in the world, was shear-pulled four times under different normal pressures (**Fig. 5**). The smaller sample was sheared in a push arrangement using the same testing pattern. Test results were compared to photogrammetric predictions and for the smaller push test the prediction is consistent, but the larger shear-pull test has issues and it is recommended to be retested as a push test. The results from the smaller test allow the numerical simulation stage (KARMO III) to begin. The simulations are planned in cooperation with the KTH Royal Institute of Technology (Sweden).

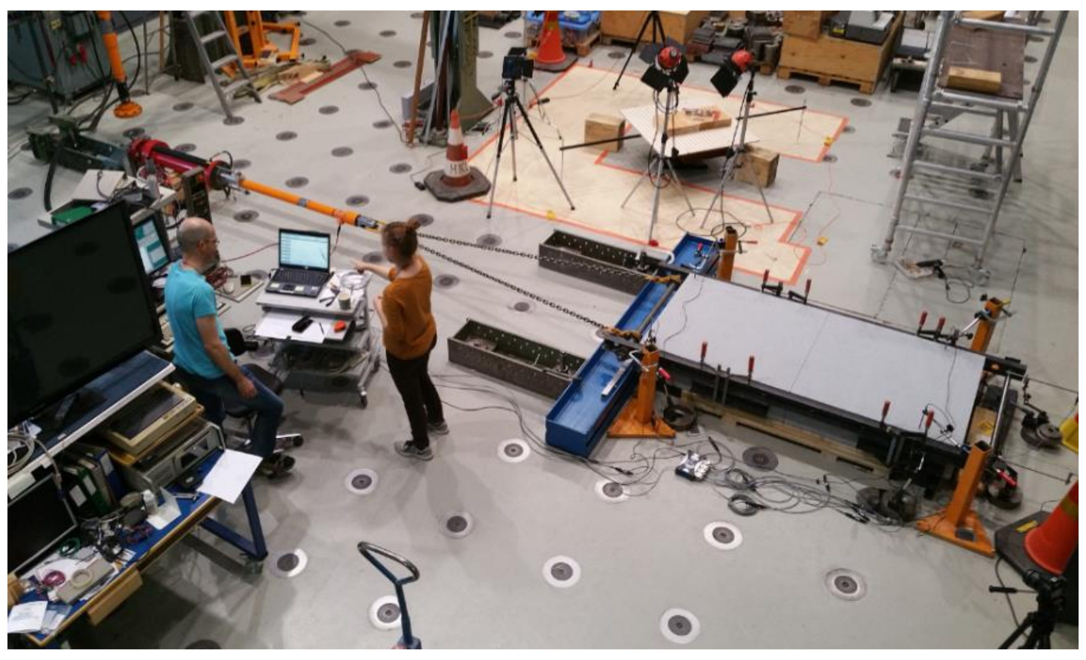

Fig. 5. 2 m x 1 m shear-pull.