Application of 3D printing in rock mechanics: Can it be used to understand rock mass behaviour?

Background:

The concept of crack damage thresholds, including crack initiation and propagation, was discovered by early researchers studying intact rock strength (for example Brace et al. 1966). In more recent research, the focus has shifted to influencing factors on the damage thresholds (Amann et al. 2014). These factors include; grain size differences, micro crack density and orientation, bedding planes, veins, and other aspects creating heterogeneity in the intact rock. The heterogeneous nature of rock makes the study of these influencing factors challenging since the exact sample cannot be tested with different stress paths.

3D printing could be used to examine the heterogeneous nature of intact rock samples; including looking at grain size, lamination thickness, or vein orientation and density. Similarly, cracks in the printed samples could be incorporated and compared to wing crack and crack velocity data from the literature. Improvements in the representation of natural cracks will be possible with the 3D printed material, as the aperture, roughness, and 3D orientation can be controlled more precisely with the printing process. The final stage of this thesis will be to examine the suitability of 3D printing representative rock mass samples for triaxial laboratory testing (large scale 25 cm diameter) to support a PhD study of the Preonzo landslide by Sophie Gschwind.

Master Thesis Tasks:

- examine the suitability of 3D printed materials at being able to simulate fracture in intact rock
- examine crack propagation in the printed material (homogeneous cases) and compare with existing wing crack and crack velocity data from the literature
- examine the scale effects for application to rock mass testing

Master Thesis Goals:

The goals of this thesis are to determine an appropriate 3D printed material for rock mechanics purposes, to validate the 3D printed material behavior by comparison with data in the literature on rock material, and to assess the scaling for rock mass testing for application to landslides.

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