Multi-scale characterization of rock mass discontinuities and rock slope geometry using terrestrial remote sensing techniques

Matthieu Sturzenegger

Terrestrial remote sensing techniques including both terrestrial digital photogrammetry and terrestrial laser scanning, represent a useful complement to conventional field mapping and rock mass discontinuity characterization. Several recent studies have highlighted practical advantages at close-range (< 300m), including the ability to map inaccessible rock exposures and hazard reduction related to both traffic and rockfall along investigated outcrops. In addition, several authors have demonstrated their potential to provide adequate quantification of discontinuity parameters. Consequently, their incorporation into rock slope stability investigations and design projects has grown substantially over recent years.

As these techniques are increasingly applied by geologists and geological engineers, it is important that their use be properly evaluated. Furthermore, guidelines to optimize their application are required in a similar manner to standardization of conventional discontinuity mapping techniques. An important thesis objective is to develop recommendations for the optimal application of terrestrial remote sensing techniques for discontinuity characterization, based on quantitative evaluation of various registration approaches, sampling bias and extended manual mapping of 3D digital models.

It is shown that simple registration networks can provide adequate measurement of discontinuity geometry for engineering purposes. The bias associated with terrestrial remote sensing mapping is described. The advantages of these techniques over conventional mapping are demonstrated, including reliable discontinuity orientation measurement. Persistence can be accurately quantified instead of approximately estimated resulting in a new class for extremely persistent discontinuities being suggested. Secondary roughness and curvature can also be considered at larger scales. The techniques are suitable for the definition of discontinuity sets, and the estimation of both trace intensity and block size/shape, if sampling bias is correctly accounted for. A new type of sampling window, suitable for the incorporation of remote sensing data into discrete fracture network models is presented.

Another significant thesis objective is the extension of terrestrial digital photogrammetric methods to greater distances (> 1km), using f=200-400mm lenses. This has required a careful investigation of the observation scale effects on discontinuity parameters. The method has been applied in a large open-pit mine and on the Palliser rockslide. It allows detailed characterization of the failure surfaces, volume estimations and pre-slide topography reconstruction.