Geometrical Characterization of Fracture Systems in Rock Mass by Means of Terrestrial Laser Scanner

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Abstract

Objectives: The measurement of individual geometrical characteristics on each fracture is a common practice among geologists and engineers when defining fracture systems in rock mass. This procedure is a slow field task generally truncated by the inaccessibility of the outcrop. Here, we propose a Terrestrial Laser Scanner (TLS) data processing technique to increase the fracture system characterization quality by means of a new set of detection and measurement algorithms followed by statistical procedures. These algorithms aim to characterize the geometry of fracture systems to be used in Discrete Fracture Networks (DFNs) construction. Procedures: TLS data needs to be acquired with enough resolution as to capture fracture surfaces. The developed algorithms measure orientation, position and size (i.e., length and height) of fractures geometrically simplified by planar structures. The relationship between these characteristics are hereafter used to obtain a series of geological and engineering parameters according to the position, quantity or size of fractures within previously- defined Mechanical Units (M.U.). Fracture spacing, fracture impedance, number of fractures, P10, P11, P20, P21, P22, P32, Fracture Spacing Ratio (FSR) and Fracture Spacing Index (FSI) can be deducted. Finally, statistical procedures are applied to the results. Results: The methodology has been applied for several case studies in selected outcrops from the Spanish Pyrenees represented by fractured limestones within macro-scale thrust-related anticlines. The outcrops characterization was used to modelling reservoir analogues. The results are summarised in a datasheet with graphical information arranged by fracture set and M. U. Conclusions: Identified fracture surfaces are reconstructed and classified by a supervised process. Fracture system characterization algorithms used a non-supervised process. These automatic algorithms provide a rapid way to characterize the fracture systems geometry in rock mass; however, the previous tasks to define fracture sets or supervise the reconstructed fractures increase the time consuming. Despite the careful previous tasks, the improvements achieved increasing the number of statistical data and the surveyed area are of great use to characterize fracture system geometry.