Experimental-DEM Hybrid Approach for Characterizing Micromechanical Strength of Ughelli Sandstone

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***Abstract*—Landslide has occurred in Nigeria recently, this has necessitated the simulation of crack number associated with tensile failures in sandstone subjected to tri-axial compressions. The aim is to relate the crack number to microscopic deformation which is the extent of isotropic and deviatoric components of the simulated seismic crack number to the microscopic failure mechanisms. Within the rock matrix, the cataclastic collapse occurs as the granular arrangement interferes with the applied forces which initiate a strong spatial anisotropic stress field depending on the level of applied force. The onset of the micro-cracking initiates the occurrence of the rock failure. The crack number was recorded simultaneously as the grain-to grain contacts breaks the montmorillonite mineral bond between the quartz grains. Experimental data were plotted as the contact strength reduces by tri-axial stresses induced on the rock, so that within the invisible cracks, a significant fraction of isotropic percentage in all directions were captured. The stress induced on the sample by axial and radial compression affect the waveforms and the recorded crack number are simultaneous. This micro-crack numbering provided microscopic deterioration between 5MPa to 25MPa, at this stress level no visible fracture occurring in the macroscopic feature was seen. This was achieved by representing the physical sandstone grain with an assembly of clump particle during procedural simulation of the sandstone. Thus, the interactions between clumps were governed by the defined micro-properties of spheres making the clumps. The strain in the sandstone was represented by a stiffness ratio of 1 which is in agreement with experimentally determined stiffness ratio obtained from the natural sandstone.**

***Keywords*— sandstone, simulation, tri-axial stress, crack-number, macro-fracture.**

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I. Introduction

THE elastic waves produced spontaneously due to the micro-fracturing of rock under stress are referred to Acoustic emissions (AE). The AE waveforms are directly represented as crack number in discrete element modelling (DEM) and thus, counting them can be used to describe the mechanism of silent micro fracture processes. Eberhardt et al (1998) has presented the use of acoustic emissions to provide deformation in granite. The deformation mechanisms in other brittle materials can be understudied by the research done by Graham et. Al., (2010). Thus the study of damage thresholds and crack accumulation in rock is evolving in order to reveals the behaviour of brittle materials under natural and physical conditions. Martins (1994) stated that, by taking the stress-strain behaviour of uniaxial compressive stress (UCS) tests into log space (stress vs. log strain) will highlight different damage thresholds. While all the damage thresholds crack initiation (CI), crack damage (CD) and peak strength are coincidental for a single test but using the direct tensile method, they can be more readily distinguished in a Brazilian test. Furthermore Matins (1994) represents the first notable deviation from linearity in a log space curve of stress strain as the initiation of the first crack in the specimen; the next was taken as the onset of systematic damage that is coincident with volumetric strain reversal. Thus the next point of deformation was interpreted as the crack coalescence and yielding limit which preceded rupture or splitting. Some other examples are the mechanisms understudied in brittle materials such as rocks and concretes have employed the use of AE for process definition one of such description is the procedure provided by Lockner et al., (1991), the procedure they adopted included slowing down macroscopic failure of granite whereby acoustic emissions were used as feedback control to the stress applied. Some applications of fracture mechanism included deformation occurring by pore pressure caused by injection of fluid Stanchits et al., 2011, (Heinze, et al., 2015)., compaction band has been used to defined the mechanism of deformation Fortin et al., 2006, Cho et al (2008)], the evolving breakouts in boreholes Dresen et al., 2010, macroscopic fractures under polyaxial loads Young, et al., 2012. There is a direct application to the understanding of fracture mechanism which is to predict the mechanical behaviour of granular structures (such as rocks) in stressed environments. However, fundamental limitations for