Theoretical and experimental considerations on the compressibility-dilatation phenomenon using comparative methods

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ABSTRACT

The paper presents the results of laboratory studies carried out on several rocks in order to separate the compressible from the dilatation field, employing the dilatation threshold. It is well-known that this parameter is very important as it concerns the rock's internal structure stability.

The method applied by the authors allows the accurate determination of the moment when the passage from one field to another occurs. While in the compressible field the volume decrease takes place until the dilatation threshold is reached, the exceeding of this value brings us in the dilatation domain, where the phenomenon became reversible, under the existing stresses effect.

The charts issued after volumetric density and porosity determination by laboratory tests are compared with those widely used for result accuracy checking. On this basis and analysing the behaviour in the compressible and dilatation domain, the rock action before the fracture can be assessed, with significant implication on underground mining excavations and on roof shock occurrence.

The paper is based on a huge amount of experimental data obtained on various size samples collected in-situ. The importance of precise determination of separation limit between the two domains is emphasized by the fact that passing from one to another occurs closely to the fracture point, a significant moment with a view to the rock behaviour at deformation regime.

Keywords: compressibility, dilatation, deformation, stress, cracks.

INTRODUCTION

The Rocks are mineral natural aggregates (mono or multi-minerals), three-phased, consisting of a solid, compact skeleton and pores, cavities and cracks comprising gasses (air) or liquids (water). In any physical state, rocks are considered as discontinuous, non-homogenous and isotropic bodies (Hirian, 1981, Arad, 1995).

When submitted to external forces, alterations can occur in shape and volume, depending on the type of action (compression, traction, shearing) (Todorescu, 1982).

The mechanical rock properties are different with respect to other materials, in the way that their volume is deformed, due to pores, cavities and micro-cracks existence (Cristescu, 1991). Because the rock's heterogeneity, the deformation behaviour is non-linear, the volumetric deformation is partial in the early deformation stages and completely irreversible at the final stage.

In the volume deformation process for a rock submitted to a non or multi-axial action two distinct phenomena are occurring, but they are interacting because one comes after another, namely: compressibility and dilatation.

The compressibility phenomenon is characterized through a positive volumetric deformation (Todorescu, 1986), induced by the initial rock volume decrease, as a consequence of pore and cavity closure inside the rock mass. In the compressible range always occurs a volume reduction with a corresponding limit deformation, a part of these deformations being non-reversible. If this boundary deformation limit is exceeded, and the generating strain is also exceeded, then the rock enters the dilatancy domain.

The dilatancy phenomenon is characterized through negative volume changes (swelling), as a consequence of the rock's initial volume increase, after micro-fractures are opened, new ones are developing and the rock fragmentation takes place (Todorescu, 1986).