

Discontinuous deformation analysis in rock engineering modelling

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ABSTRACT: The discontinuous deformation analysis (DDA) method can help study both the static and dynamic behavior of fractured rock masses, in which the fractures can be represented explicitly with independent physical parameters. In this paper, three application examples are used to demonstrate the DDA's capability in rock engineering application. In the first example, the stability for a classic rock slope is investigated by the DDA, which is compared with the results from the Sarma's method. Next, the DDA is applied to study the response of rockbolts under the static pullout tests. The last example is a coupled hydro-mechanical model to estimate the inflow rate and the hydraulic pressure distribution for an underground rock cavern considering the grouting effect.

1 INTRODUCTION

The fractured rock mass is a discontinuous medium with full of geological structures, such as randomly distributed joints and cracks (Fu et al, 2015). These structural planes divide the fractured rock mass and greatly influence the stability of the underground structures. Thus, it is important to study the mechanical behaviours for this discontinuous blocky system.

Compared with the experimental study, the numerical analysis is more convenient to address the discontinuity problems. Different from the continuum methods (FEM), the discontinuous methods are considered more appropriate to deal with a mesh created by the real rock joints. Among the discontinuous methods, the discontinuous deformation analysis (DDA) proposed by Shi (1998) is considered as an attractive numerical tool for geotechnical problems, such as slope engineering, reinforcement, coupled hydro-mechanical analysis for tunnels/caverns and so on.

In this paper, the DDA will be applied to three engineering applications, including the safety estimation for a rock slope, response of rockbolts in the static pull-out test and the coupled hydro-mechanical analysis for the rock caverns. The purpose is to demonstrate the applicability of DDA for the practical problems.

2 THEORY OF THE DISCONTINUOUS DEFORMATION ANALYSIS (DDA)

The DDA is an implicit method that represents the deformability of the block systems. In this method, both the static and dynamic analyses are considered. Large displacements, deformations and also the rotations are allowed. In the DDA model, displacements are the unknowns and represented by six basic variables in the first-order approximations (three rigid body motion and three constant strain components) to solve for the global equilibrium equations (Jing, 2003). The displacement (u, v) at any point (x, y) inside a block can be expressed as follow (Shi, 1988; Hatzor et al, 2004; Bao, 2007; Sun et al, 2011; Ning et al, 2012):

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