# Chapter 27
# A Review of Soft Computing Methods Application in Rock Mechanic Engineering

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## ABSTRACT

*Engineering behavior of rock mass is controlled by many factors, related to its nature and the environmental conditions. Determining all the parameters, ranking their weights, and clarifying their relative effects are very difficult tasks to accomplish. To overcome these difficulties, many researchers have employed soft computing methods in rock mechanics engineering. The soft computing methods have taken an important role in rock mechanics, and their abilities to address uncertainties, insufficient information and ambiguous linguistic expressions stand out in treating complex natural rock mass. This chapter briefly will review the development of soft computing techniques in rock mechanics engineering, especially in predicting of rock engineering classification system and mechanical properties of rock material and rock mass, determination weathering degree of rock material, evolution of rock performance, blasting and, rock slope stability. In addition, the future of the development and application of soft computing in rock mechanics engineering is discussed.*

## 1. INTRODUCTION

Rock mechanics is the theoretical and applied science of behavior of rock. It is that branch of mechanics with the response of rock to the field of its environment. Rock mechanics engineering is the branch of engineering concerned with mechanical properties of rock and application of this knowledge in dealing with engineering problems of rocks (Gundewar, 2014). As discussed in following, rock mechanics is a subject that addresses uncertainties. Therefore, it is said that rock mechanics applied to engineering is both an art and a science.

The rock will be used either as a building material so the structure will be made of rock material or a structure will be built on the rock mass, or a structure will be built in the rock mass. The engineering properties of rocks play a significant role in planning and designing of mining and civil

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engineering projects such as tunnel design, slope stability, dam design, drilling, support design, embankments (Sonmez et al., 2006).

A rock mass consists of two components: intact rock and discontinuities, each of which has a significant effect on the engineering behavior of rock mass. It is also known that weathering significantly influences the engineering properties of rocks in-situ (Ceryan, 2012).

The mathematical models used to simulate the behavior of rock materials are often limited in their ability to account for the effect of the variables of instinct properties. This condition is valid in predicting weathering state of rock material. Strength and deformation test require high-quality core samples with regular geometry. Standard cores cannot always be extracted from weak, highly fractured, thinly bedded, foliated and/or block-in-matrix rocks. In addition, careful execution of this test is difficult, time-consuming, and expensive, as well as involving destructive tests (Gokceoglu & Zorlu, 2004). To overcome this difficulty, various predictive models based on index tests and basic mechanical tests have been developed by many researchers. These tests are faster and more economical. However, the index tests always include a certain level of uncertainty. One study observed no consistency between the equations suggested by these methods. While certain equations exhibit the same trend, others differ (Fener et al., 2005). Also, serious shortcomings, limitations and problems are related to basic mechanical tests (Yilmaz, 2009; Kayabali & Selcuk, 2010; Nefeslioglu, 2013). In the rock mechanics literature, some empirical relations exist between engineering behavior and other rock properties, such as index properties and basic mechanical tests. However, statistical analyses suffer from some major limitations. The past use of specific rock types is the main limitation of the existing empirical equations (Sridevi, 2000; Sonmez et al., 2006; Maji & Sitharam, 2008).

Engineering behavior of rock mass is controlled by many factors, related to its nature and the environmental conditions. The rock mass is largely discontinuous, anisotropic, inhomogeneous and not-elastic and a rock mass is also a fractured porous medium, under complex in situ conditions of stresses, temperature and fluid pressures (from Jing, 2003, Figure 1). It is known that rock masses are under stress and continuously loaded by dynamic movements of the upper crust of the Earth, such as tectonic movements, earthquakes, land uplifting/subsidence, glaciation cycles and tides (from Jing, 2003). Most of these factors take effect simultaneously and have complicated interactions with each other in practical engineering (Yang & Zhang, 1997). Determining all the

*Figure 1. Medium-strength rock interbedded soft layer and closely jointed rock mass*