Chapter 3


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ABSTRACT

Rock mass classification systems are the most commonly used empirical tools in preliminary design of rock slopes. In spite of numerous advantages, these systems lack the common drawbacks of classification systems originated from uncertainties. These drawbacks may lead to similar or so close quality scores for different rock mass properties. Fuzzy Sets is a rising trend in describing Geomechanical problems by including the expert opinion. Especially in the case of weak rocks it allows prediction of more realistic rock mass quality scores. Although the empirical systems form a basis for the preliminary slope stability investigation, slope height and overall slope angle are still two missing important characteristic slope parameters. However, there have been some attempts to describe the graphical presentation of rock quality score, slope height and overall slope angle relation. These charts are called as slope performance charts. This chapter presents a short review on integration of Fuzzy RMR with these charts to provide a useful modification for the case of weak rock slopes.

INTRODUCTION

Failure in rock slopes is a critical event to be detected prior to its occurrence owing to its negative socioeconomic consequences like injuries, deaths and loss of properties. No matter it is a natural slope or an engineered slope, reliable and user friendly tools are required either to analyze the risk of failure or to design safe slopes.

Rock slope instabilities are driven by either mass failure or structurally controlled failure. Mass failure is triggered by the deadweight or surcharge applied on the slope mass and generates a unique...
failure surface. Structurally controlled failure occurs on the pre-existing weak layers like joints, faults or beddings and result in planar, wedge or toppling types of failures.

This chapter presents a modified slope performance chart of Bieniawski to predict the safe conditions in terms of mass failure in weak rock conditions. Rock quality prediction is handled in terms of Fuzzy RMR system for better performance in weak rock conditions.

Although classification systems have some well-known problems, they are still useful and practical to distinguish the rock mass quality. Problems of these systems are due to uncertainties arising from the complex geological environment.

Nowadays, Fuzzy Sets is a popular way to define the uncertainties in a meaningful way. Its use in Rock Mechanics is also a rising trend among the researchers. In the scope of this chapter, the ambiguities of RMR system overcome by the application of Fuzzy Sets. Modified slope performance chart and FRMR are used in combination to establish a safe correlation between the overall slope angle and slope height parameters. The methodology is validated by two large-scale slope failures.

This chapter includes five topics. The first topic introduce a brief background on Geomechanical classification systems, fuzzy logic applied on rock mass characterization and slope performance charts. Shortcomes of Rock Mass Rating (RMR) are presented and fuzzy logic is recommended as a solution. Historical studies on fuzzy RMR were investigated. A new fuzzy RMR focusing on weak rocks is presented. The second topic presents validation of fuzzy RMR system developed specifically for weak rocks and the modified slope performance chart on two large slope failures in Turkish lignite mines. Third topic recommends some future research directions. Finally, conclusion drawn from this chapter are summarized.

BACKGROUND

Rock Mass Classification Systems

Overview of Geomechanical Classification Systems

Engineering design is an activity of blending scientific principles with field experience in order to produce safe, economic and useful systems for the benefit of the society. Rock engineers majorly rely on three methods to design safe and economical underground or surface rock structures, which are analytical, observational, and empirical methods. Analytical methods investigate stresses and deformations around openings by closed form solutions, numerical models, analog simulations and physical models. Observational methods keep track of in-situ ground stresses and deformations while the excavation is in progress. Calibrating the numerical model with field measurements provide a reliable validation tool. Empirical methods suggest quantitative relations derived from statistical data for the purpose of solving certain rock stability problems. Rock mass classification is one of the empirical methods that relies on case histories and requires periodical update.

In rock engineering, the most common chronological order of use begins by characterization of dominant geological units by rock mass classification systems. Laboratory tests not only help to identify the mechanical properties of rock units but also provide information for some of the rock mass characterization inputs. Later, numerical models are calibrated by field measurements gathered from trial pits or excavations, which require quite high budgets. Although it cannot replace the large scale field tests,