Characterizing and Extrapolating Rock Joint Properties in Engineering Practice

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With 10 Figures

Summary — Zusammenfassung — Résumé

Characterizing and Extrapolating Rock Joint Properties in Engineering Practice. The engineering properties of a rock mass are influenced, often for the largest part, by the joints and other discontinuities within the mass. To determine and evaluate these properties it is necessary, therefore, that an acceptable method of sampling, processing and interpreting the joint population be used. Any extrapolation of these properties to other portions of the mass requires that the region to which extrapolation applies is delineated. This requires in part that certain important aspects such as regional tectonic history and joint patterns, genesis of jointing, assessment of structural controls, and so forth, are considered.


Comment caractériser et extrapolier pour l'ingénieur les propriétés des roches fissurées. Les propriétés techniques d’un massif rocheux sont influencées, souvent d’une façon déterminante, par les fissures et autres discontinuités.

Pour déterminer et évaluer ces propriétés il est donc nécessaire qu’une méthode acceptable d’échantillonnage, de traitement et d’interprétation de la population des fissures soit utilisée. Toute extrapolation de ces propriétés à d’autres parties du massif exige que soit délimitée la région à laquelle l’extrapolation est appliquée. Ceci demande en particulier que certains aspects importants soient considérés, tels l’histoire tectonique régionale ainsi que les réseaux de fissures, la genèse de la fissuration, la détermination des relations entre tectonique et structure, etc.

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1. Introduction

An important objective of the civil and mining engineer concerned with structures in rock such as tunnels, open pits, dam foundations and so forth is the creation of a safe and efficient design. This necessitates an estimate of the immediate and long-term performance of the surface or subsurface opening or foundation, whichever the case may be. This in turn requires a quantitative estimate of those physical and mechanical properties of the rock mass which govern its strength, permeability and deformation characteristics. To a lesser or greater extent, depending upon the type of engineering structure considered, these properties are a function of the 1) attitude, 2) geometry and 3) spatial distribution of the joints and other discontinuities in the mass. All three factors can be determined, since the joints are detectable features whose characteristics can be quantitatively measured and described.

Joints are universally present in rock masses and have strength, permeability and deformational characteristics appreciably different from those of the intact rock. Depending upon the origin of the joints sets, their characteristics can vary greatly. Not only can the average spacing between joints vary within wide limits, but the nature and degree of joint infilling material, physical characteristics of their planes and their degree of development can be vastly different. Because of variations in these properties one joint set can have very different effects than another on, for example, shear characteristics. Hence, each joint set should be examined individually for its properties.

The important question which arises is how these joints can be characterized. Also, the nature and reliability of the prediction techniques used to assess whether these joint characteristics are similar or different in other parts of the rock mass where information is limited represents one of the more important considerations relating to the overall problem. Some of these fundamental aspects are discussed in the following, particularly with reference to experience with open pit and highway slope stability and tunnel stability problems. But the basic principles, however, apply to the assessment of any rock support system.

Understanding the three-dimensional structural aspects of a rock mass requires either that interpolation is made between two known conditions or that various forms of extrapolation from known conditions to areas where information is negligible or entirely unknown are carried out. Almost all phases of engineering geology problems in rock require a considerable amount of extrapolation, i.e. projection from the known to the unknown. How well this extrapolation is performed has obvious practical implications, since extensive subsurface exploration can be reduced considerably. At the same time, reasonable estimates of the final design of the rock support system can be made, impending problems can be foreseen, and so forth.

The question of the reliability of applying information acquired from one section of the rock mass to other parts of the mass where information is not available, and where the advancing rock face or final boundary of the