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THE CUTTABILITY OF EVAPORITES

CRITERES D'ABATTAGE DES EVAPORITES

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Summary

With ever-rising labour costs, the mining engineer and the underground civil engineer look to mechanical excavation systems to increase productivity. The research described in this paper was part of a major and long term programme of experimental work carried out in the Mining Engineering Department of the University of Newcastle upon Tyne. One of the objectives of this research was to investigate the cuttability of evaporites. To this end each rock which has been tested for its cutting properties has also been subjected to a wide range of physical and mechanical tests. All the results are discussed in this paper.

Résumé

Le prix actuel de la main-d'œuvre conduit les ingénieurs des mines et de génie civil travaillant en souterrain, à développer l'abattage mécanique. La présente communication est une partie d'un long travail effectué au sein de l'université de "Newcastle Upon Tyne". L'un des buts de ce travail était l'étude de l'abattage des roches, dont des évaporites. Pour ce faire les essais d'abattage ont été conduits en fonction des propriétés physiques et mécaniques des différents types de roche. La discussion des résultats a été faite le plus amplement possible dans ce papier.

Introduction

The increasing rate of industrial and environmental development demands more tunnels. By its nature, tunnelling is a complex and often expensive undertaking, but the advantages that a tunnel facility offers make it a highly desirable method of construction for urban rapid transit systems, utility conduits, sewers, aqueducts etc.

Tunnel boring machines usually promise high advance rates compared with cyclic excavation methods. There are other numerous advantages to be gained by tunnel boring. There is increased safety as explosives are not used, there is little danger of collapse, less labour is required and overbreak is usually less than 5 per cent.

The cutting material directly affects the performance of a tunnel boring machine by its physical and mechanical properties. Laboratory cutting experiments usually give the basic data to choose the most suitable cutting tool and to design a cutting head of a tunnel boring machine for a given rock mass. In order to clarify this aspect of the problem, the cutting characteristics of gypsum and anhydrite are described in this paper.

Planning of the experiments

Any experiment is carried out to determine the variation of a dependent variable due to changes in one or a number of independent variables. For example, we may wish to determine the relationship between a dependent variable FT, and the independent variables, p, ϕ, D and S. The independent variables here may be such that the magnitude of the effect of each on FT varies with the magnitude of the others. This variation, commonly termed interaction, should be investigated throughout the experiment, so that the desired information can be obtained with sufficient precision.

Conventional factorial experimental designs measure the effect of varying a single factor while the other factors are kept constant, so that any variation in the results of the experiment can be directly attributed to the factor which is being altered. Such designs are limited in application by the large number of tests which the design requires to be performed. For example, if disc penetration, disc edge angle, disc diameter and cutting speed are each studied at five levels, it would be necessary to carry out 5^4 tests. When working on rocks, a measure of replication is essential in order to gain greater statistical integrity and four replications of any test is considered a minimum [6].

The factorial experiment previously discussed would require 2500 individual cutting tests and several blocks of experimental rock would have to be used. Clearly, a more efficient experimental design is desirable for this type of investigation. The partial factorial method of Protodyakonov and Teder [5] has been used for the design of the experiments. By the manipulation of orthogonal latin squares, this method reduces the required tests from 2500 to 100. When combined and averaged in the correct manner, the results of the partial factorial method may be analysed to produce a mathematical model to describe the effects of the independent variables on the dependent variable. This method is widely and successfully used in the U.S.S.R.

Rock cutting rigs

The 9 kW Butler Shaping Machine [2] was used to conduct the experiments with picks in gypsum. This machine has a maximum stroke of 660 mm, a speed range of 0.13 to 0.63 m/s, and a work table which could be raised, lowered and traversed horizontally. The head of the machine had been modified to accept the mounting of a dynamometer tool holder.