The Cerchar Abrasivity Index and Its Relation to Rock Mineralogy and Petrography

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With 2 Figures

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Summary

The Cerchar Abrasivity Index and Its Relation to Rock Mineralogy and Petrography. To evaluate the relation between the Cerchar Abrasivity Index (a parameter used in calculating advance rates of full face tunnelling machines) and the petrography of the rocks, measurements were made on minerals and monomineralic rocks. From these data a theoretical abrasivity (quartz equivalence) can be calculated for every rock composition. From the comparison of the theoretical and experimentally determined abrasivity the influence of fabric and other factors besides mineralogical composition were deduced.

Introduction

The increasing replacement of classic tunneling methods by modern mechanical full face tunneling shows that far better understanding of rock mechanical as well as petrographical properties of the rock are needed in order to predict realistic advance for any kind of “full face”.

From the large number of parameters which influence a tunneling machine’s performance it is necessary to chose a few but relevant ones, which can be determined without any large expenditure. Besides other parameters like Compressive Strength and Point Load Test the Cerchar Abrasivity Index (Valantin, 1973) has been used extensively in our laboratory to try to predict tunneling machine performances.

In the present paper special emphasis is laid on the relations between the petrography, mineralogy and fabric of rocks and their Cerchar Abrasivity Index.

Abrasivity and Its Measurement

The resistance of a tool to wear when in contact with a rock is the most common principle for measuring a rock’s abrasivity. Different types of rock contact (abrasive wear by impact, pressure, attrition) are distinguished
by the Commission on Standardization of Laboratory and Field Tests (International Society for Rock Mechanics, ISRM 1978) to classify some abrasivity testing methods. Many other methods like the one of Schimazek (1970) or the abrasivity index (Cerchar Abrasivity Index) of Belougou, Valantin, Guillon (1964) would also fit in ISRM's classification.

Szlavin (1974) gives a different definition of the abrasivity of a rock. He defines it: “The mean rate of increase in specific energy required to drill consecutive holes”. Also related with a rock’s drillability is the method of White (1969). The profile of cutting edges of test bites are measured with a planimeter and used as an abrasivity index.

All methods of abrasivity measurements are comparative and no absolute results or values are available. Some are complicated and industrious so that a cheap, fast handling method like the Cerchar Abrasivity Index could turn out to be very advantageous.

**Description of the Cerchar Abrasivity Index**

The Cerchar Abrasivity Index is determined as the abrasion of a metal pin after scratching over the freshly broken surface of a rock. This pin is made of certain steel quality (200 kg/mm$^2$, Rockwell Hardness 54—56) and is terminated by a 90° "infinitely" conical point, sharpened on a high precision lathe.

Valantin (1973) defines the Cerchar Index as follows: “During one second and under a static load of 7 kg, this pin is pulled over one centimeter of the fresh fracture surface of rock. The diameter of the resulting abraded flat on the steel point, measured in 1/10 mm, determines the Index of Cerchar Abrasivity”. The diameter is measured with a binocular.

The arithmetic average of five scratches was empirically found to give already a representative Cerchar Abrasivity Index on rock samples with less than one millimeter grain size. On coarser rocks the Cerchar Abrasivity Index can only be measured if accordingly more scratches are made.

Depending on the roughness of the rock surface and its abrasive mineral content different scratch pattern will be noticed on the scratched pin. It is therefore very important to follow up a clearly defined measuring method and to run all tests under precisely equal conditions.

Special attention has to be given also to the relief of the broken rock surface. Representative results are only obtained on horizontal or slightly inclined or curved scratch planes. Otherwise too much force is additionally needed to scratch and too high Cerchar Abrasivity Indexes result.

As discussed later a grain size below one millimeter has no influence on the Cerchar Abrasivity Index.

**Mineralogy and Cerchar Abrasivity Index**

In order to obtain the relation between Cerchar Abrasivity Index and the mineral composition of natural rocks, the contribution of each mineral to the Cerchar Abrasivity Index is needed. Once the Cerchar Abrasivity Index