Abstract

In Central Europe underground openings in hardrock conditions are predominantly constructed by using "conventional" excavation methods such as the drill and blast method or by using roadheaders. The wear of machine parts and rock cutting tools strongly influences the choice of method and its effectiveness during the construction phase. Low excavation rates, interruptions in the working cycle, machinery stand-still and rising personnel costs are often associated with high tool wear rates. Therefore the interpretation, prediction and optimisation of tool wear is an important task before and during large tunnelling projects.

Following some general remarks on rock cutting basics and wear classification 4, suitable categories of wear mechanisms (*abrasive wear, wear due to macroscopic material failure, thermal wear* and *special wear forms*) are presented for general classification of rock tool wear. Schemes for the classification of wear rate and wear type of button bits and point attack picks are specified. The specific wear type schemes can easily be used for assessing the wear mechanisms and major causes of wear.

The wear of rock cutting tools is the result of a very complex system. A vast amount of factors from the main fields of geology, tools and logistics can dramatically influence tool wear. Geological influences are referred to as the "abrasivity" of the excavated rock mass.

The prediction of tool wear rates can be based on a numerous variety of testing procedures. These procedures cover a wide range from on-site real-scale drilling testing, model testing with simplified tools to microscopic and chemical analysis of rocks and minerals. Some of the most important procedures are investigated and compared with tool wear rates from 17 projects. This leads to some general findings:

- *Drilling and cutting tests* using the original tools and machines and being carried out on site or on large blocks are considered to give suitable values for estimating wear and excavation rate. When carried out on representative rock mass or rock samples, most geological and machine-dependent influences are sufficiently considered. These procedures are normally rather expensive with regard to personnel and material costs.
- *Model tests* using small scale tools or *simplified model tests* (referred to as "index tests") are not considered effective methods for predicting tool wear. The mainly cost-intensive procedures disregard relevant geological and machine-dependent influencing factors. The data sets presented for the widespread CERCHAR scratch test show that model tests may give an idea of the rocks abrasivity but show no distinct correlation between encountered tool wear rates. To make things worse, different model test often lead to differing and non-transferable test results.
- *Geotechnical wear parameters* (referred to as "wear indices") normally use standard parameters that are also needed for other considerations (e.g. stability assessment, suitability of excavated rock for further construction purposes). Therefore the calculation of these indices requires no or only little extra expenditure. Additionally the widespread wear indices *Equivalent Quartz Content*, *VHNR* and *Schimatzek's Wear Index*, another easy to obtain wear index, the so-called *Rock Abrasivity Index* (RAI) are also presented. The data sets show that Rock Abrasivity Index, Schimatzek's Wear Index and Equivalent Quartz Content, can be considered suitable parameters for predicting the tool wear rate of button bits and point attack picks.

A scheme is specified to predict tool wear based on conventional rock parameters and to transfer rock abrasivity indices onto a rock mass. Rock mass influences are qualitatively taken into consideration by using negative and positive factors.