Microstructures in granites and marbles in relation to their durability as a construction material

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Abstract

The microstructure is of great importance in understanding a rock's mechanical properties. The term microstructure includes the complete spatial and geometrical configuration of all those components that make up a rock. It covers concepts such as grain size, grain shape, and the orientation of grains and fractures, all of which are products of the rock's origin and tectonic history. The main issues studied in this thesis are the microstructure influence on granites resistance to fragmentation when it is used as an aggregate, and the microstructure influence on calcite marbles used as facade claddings.

Traditionally, most microstructural investigations are based on qualitative visual estimations. The aim of this thesis was to investigate which microstructural parameters are crucial for the mechanical properties as well as to quantitatively describe these parameters. This was done by using computerised image analysis and optical microscopy. For the granites, the mineral size, shape and spatial dispersion were quantified by measuring the perimeter of each mineral phase from SEM/BSE images. The degree of foliation was numerically described using a foliation index (FIX) based on linear-traverse measurements on thin sections using optical microscopy. In the calcite marbles, the texture ranges from granoblastic to seriate interlobate and is dependent on the metamorphic history of the rock. In order to distinguish the different textures adjacent grain analysis (AGA) was applied.

The results of the perimeter measurements of the granites showed that high values corresponded to fine-grained granite where the minerals occur as individual grains rather than monomineralic aggregates. High perimeter values corresponded to rock aggregates with high resistance to fragmentation. However, foliated samples do not show this relationship because the foliation creates mechanical weak discontinuities, which is not taken into account in the perimeter measurements. But by using the foliation index the intensity of variation in foliation can be numerically described.

The quantitative microscopic analyses of the calcite marbles show that there is a correlation between the microstructure and the magnitude of bowing. Samples with even-grained granoblastic textures showed the greatest bowing tendencies. With an increasing complexity of the texture, especially an increase of the fine-grained matrix, the degree of bowing decreased. This textural difference can be numerically described by using AGA.

The methods that have been established in this thesis show that it is possible to predict a rock's suitability as a construction material by doing an extensive investigation of the microstructure. Among the different image-analysing methods that have been established in this thesis, it is suggested that the perimeter measurements together with the foliation index (FIX) and adjacent grain analysis (AGA) could be alternative tools for determine the quality of rocks since it gives more information about the physical properties of a sample compared to traditional mechanical testing.

Key words: Microstructure; Image analysis; granite; calcite marble; mechanical properties