Thesis: Studio dell'avanzamento della porosità in marmi degradati.
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AIM OF THE WORK AND TEST METHODS

The presence of closed or interconnected voids in compact rock is one of the main features that govern the processes of degradation of stone materials. Although the marble are characterized by a low porosity, there is an obvious correlation between the phenomena of alteration and the dimension/distribution of pores. These phenomena can be better understood through the study of porosity in order to obtain useful information in the field of modern building, but also for the protection and recovery of artistic and architectural heritage.

In this work has been compared the physical and mechanical properties of seven different types of marble slabs (Canaloni, Gioia, Buca, Corchia, Lorano, Sławniowice and Ekeberg) exposed to external degradation from 2003 to 2013, with the properties of the same materials in natural state.

Several techniques has been applied to measure porosity: water absorption in atmospheric pressure, that measures how much water can get into the specimen during the period of immersion in water until a constant, and water absorption by means of a contact sponge, that measures how much water can be absorbed by a flat surface in a defined time.

An image analysis using the jPOR script for ImageJ has also been applied to investigated the seven kinds of rock in natural state and after natural weathering to integration of the more frequent test methods, such as the determination of ultrasound pulse velocity and flexural strength. For Gioia marble, the most weathered material, has also been performed a SEM analysis at Espoo and Outukumpu GTK (Finland).

Finally, the properties of marble slabs in two different climates have been compared: marble exposed on the roof of Polytechnic of Turin and on Finland Hall in Helsinki.

RESULTS

The results show how the different crystalline microstructure affects the level of degradation of marbles: idiomorfic crystals with polygonal microstructure, such as Gioia marble, facilitate the degradation process, while marble Corchia has a different behavior influenced by his typical microstructure of a breccia marble. Marbles Buca, Sławniowice and Ekeberg, with sutured or lobed grains show less obvious signs of deterioration.

Mainly from water absorption tests, we can deduce the type of porosity, which is closed for the marbles Canaloni, Buca, Sławniowice and Ekeberg, and more open type for the marbles Gioia and Corchia.

Image analysis performed with jPOR confirms the higher porosity in Gioia compared to the other marbles and how the degradation process propagates from the surface towards the inner part of the slabs with different speeds depending on the material. jPOR analysis represents a simple and fast methodology for studying the porosity which does not requires special equipment or specific knowledge. The obtained results also show a good correlation with the data obtained from laboratory tests.

The classification of intergranular voids obtained analyzing thin sections of Gioia marble with SEM indicates the presence of intercrystalline micropores ($d < 5\ \mu m$) with local macroporosity ($d > 5\ \mu m$) heterogeneously distributed.

Based on the results obtained by UPV tests, degradation inside the material is roughly similar in Turin and Helsinki, while water absorption through contact sponge shows that surface degradation is significantly greater on the slabs exposed in Helsinki. This behaviour is due in first place to the presence of anchors, which have prevented the natural expansion and contraction of calcite crystals, and in second place due to the different environmental conditions of the two cities.