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Anisotropy indices and the effects on the hydric behaviour of natural stone

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Building stone is an anisotropic material. Each type of rock (granite, limestone, slate, marble, etc.) has a different anisotropy, which is related to its own geological history, i.e. formation conditions and alteration processes. Knowing the anisotropy of natural stone is a matter of interest for determining the most adequate way to extract it from the quarry, for a better use during its manufacture or processing, to determine the quality of elements to be used as ashlars/masonry or as ornamental elements carving, as well to their arrangement in a structure. At the same time, material′s anisotropy will condition the placing of, for instance, anchorages in dressing stone slabs.

Anisotropy of natural stone controls water entry and its mobility, together with atmospheric pollutants′s, processes that favour the stone decay in building works, mainly those that shows a marked directional component, as it is the case of capillary water absorption. Water tends to be absorbed differently along the distinct main anisotropy directions, which are principally marked due to the arrangement and distribution of porosity in the rock.

The aim of this study is to perform a comparative analysis of the various anisotropy indices commonly used when dealing with natural stone, determined by ultrasonic propagation techniques, in order to establish how anisotropy (by means of these indices) affect the process of capillary water absorption.

Different type of natural stones have been selected, according to their traditional use for the construction of buildings in the region of Madrid (Spain). Their petrophysical properties have been determined (density, porosity, water absorption, etc), as well as ultrasonic transmission velocity has been measured along the three spatial directions of the test specimens (from 50 to 100 for each petrological type). According to this, the stone specimens were classified in different anisotropy levels or classes.

Results show that stones with the highest anisotropy are those with the highest capillarity coefficient. It can also be observed that for each petrological variety, this capillarity coefficient is higher in the specimens classified as a high level anisotropy class. At the same time, when capillary water is absorbed along the direction perpendicular to the anisotropic planes, the absorption capacity diminishes, no matter the anisotropy level of the stone is. On the contrary, capillary coefficients are higher when measurements are performed in a parallel direction to that of the greatest anisotropy of the stone specimen, where absorption tends to be faster with higher coefficients according to the porosity size and its geometry.

These increments are more significant in the stone varieties in which anisotropy is mainly due to fissuring or schistosity planes, or related to stromatolitic planes or oriented minerals accumulation.

The arrangement and placing of rocks used as building materials with a significant anisotropy will highly condition the durability and lifetime of a considered element. For that reason, is essential to determine anisotropy indices to obtain the best and most adequate arrangement of stone elements in building works, minimizing water entry and thus, the material decay.

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