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Behavior of Hungarian monumental stones in fire

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Numerous historic building is lost by fire and many contain stone parts either as decoration or supporting element. The decay occurred through a fire is rapid and irreversible in the building stones of these monuments and the restoration needs data of the changing of stones. Since the protection of historic monuments nowadays got more and more into the focus of interests the knowledge of the effects of such disasters is very important.

First the forms of fire damages by natural stones were defined, which are: change in colour, spalling, scaling, cracking, rounding off the edges, disintegration.

The most used natural stonetypes at ancient Hungarian monuments were investigated by heat effect. Laboratory simulated burning were carried out on 3 types of limestones, 2 types of sandstones and rhyolite tuff with oven-based techniques. The heating wasn't directional and the samples were subject all around to air circulation. The testing temperatures were as follows: 22 ("nonburnt" condition), 150, 300, 450, 600, 750, 900˚C.

The changes in the inner structure and components of quarry fresh samples were analysed after heating at different temperatures. In the laboratory the petrographic characterization (polarizing microscope, X-ray, SEM) was obtained and the petrophysical properties (density, porosity, water adsorption, ultrasonic sound velocity, duroskop rebound, uniaxial compressive and indirect tensile strength, colour measurement) were also investigated on the 4 cm diameter cores.

The tests have shown that all samples showed macroscopic changes, the texture and mineral composition of stones are altered by heating. These facts have also an effect on the strength and durability of stone material.

As a result it could be observed that after heating an intensive discolouration detected in all cases. The colour changes are related to mineral transformation. The most drastic colour change is caused by the oxidation of iron-bearing minerals to hematite.

Micro-cracking can be observed at grain boundary and within the grain, it occurs a porosity increase at all studied stones when they were heated, but the rate of changing depends on the compactness of stone types. The limestone samples were the most sensitive to effect of heating due to calcinations processes and the clayey sandstone and the rhyolite tuff were the most fire-resisting. It was observed that the different stone types show various features to fire due to the diverse inner structure and mineral components.