Science and Art: A Future for Stone

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John Hughes & Torsten Howind

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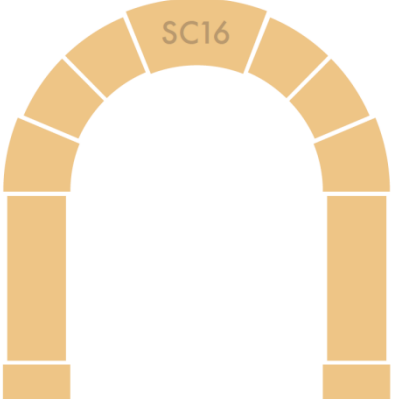

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Cover image: The front door of the Paisley Technical College building, now University of the West of Scotland. T.G. Abercrombie, architect 1898. Photograph and cover design by T. Howind.

INVESTIGATION METHODS:

PORE-SCALE FREEZE-THAW EXPERIMENTS WITH ENVIRONMENTAL MICRO-CT

T. De Kock[1*], H. Derluyn[1], T. De Schryver[2], M.A. Boone[1,3] and V. Cnudde[1]

This abstract presents a laboratory study on the pore-scale processes involved in freeze-thaw experiments. Micro-CT has proven to be a useful tool in the analysis of (geo-)materials. Creating 3D images, it provides spatial information on materials' structure. As such, it is applied on building stones to characterise the pore network or to evaluate decay phenomena on the pore scale (typical from 1 µm to > 100 µm). At the Centre for X-ray Tomography of the Ghent University (UGCT; www.ugct.be), an Environmental Micro-CT (EMCT) was developed to study dynamic processes in materials. This gantry-based system allows stationary samples to be scanned at very high speed (i.e. scans < 1 minute). In addition, it easily configures with add-on modules designed for specific applications. For this research, a cooling stage was designed to perform freeze-thaw cycling on rock samples of 10 mm diameter. Samples from an miliolid limestone from the Paris Basin, with 35 vol.-% porosity, were subjected to freeze-thaw cycles between +20°C and -15°C. The samples were scanned at the end of each freezing and thawing stage, and continuous scanning was performed during each cooling stage. It can be seen that a fracture develops in function of the amount of freeze-thaw cycle. Subsequent scans illustrate that the fracture opens during freezing and closes during subsequent thawing. In addition, continuous scanning during the cooling stage allowed for visualising the sample at the moment just before and just after the occurrence of an exotherm, measured by a temperature sensor and interpreted as a proxy for ice crystallisation. This illustrates that the fracture opening coincides with the exotherm. Fracturing is thus a result of ice crystallisation. Furthermore, the location of the fracture could be linked to the stone's texture and water uptake. Altogether, the spatial and temporal information provided by micro-CT provides valuable information on the process of freeze-thaw decay and it's relation to the stone's intrinsic properties.

Keywords: limestone, freeze-thaw decay, environmental micro-CT, dynamic imaging

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