

## Influence of microstructure on ceramic/mortar adhesion – a contribution to restoration

### Summary

The objective of this research work is to analyze the microstructure of tiles from various historical and productive contexts, to improve conservation and rehabilitation actions for facades and other tile elements. Only knowledge of the adhesion mechanisms will allow the appropriate choice of laying mortar and appropriate intervention. The spectrum to be analyzed will consist of samples of portuguese tiles from facades from the end of the 19th century and beginning of the 20th century, as well as international samples that allow for a comparative analysis. The investigation will consist of the following phases of analysis: microstructural characterization of portuguese facade tiles, evaluation, in a hardened state, of laying mortars commercially sold and currently dosed on site in Portugal, performance of historical ceramic/mortar interface and durability of the set.

The ceramic study phase will include the visual characterization of the samples through photographic recording, dimensional analysis, determination of masses and inspection of their integrity. Verification of the mineralogical constitution of the material will be carried out using x-ray diffraction (XRD), x-ray fluorescence (XRF) and scanning electron microscopy with energy dispersive spectroscopy (SEM/EDS). The behavior in relation to water will also be analyzed using porosimetry by mercury intrusion and water absorption by capillarity. This step is intended to be carried out after the electrochemical desalination process of the samples. The desalination of historic tiles is essential to ensure the removal of soluble salts, a factor that causes various pathological manifestations in the coverings. The elimination of soluble salts will be done by immersion with distilled water and renewed periodically, so that the process can only be considered complete when the desalination water sample presents a conductivity similar to that of tap water.

The study phase of laying mortars will begin with market research to identify the main manufacturers, as well as the types of laying mortar currently dosed on site in Portugal. Laboratory tests will be carried out for samples in the hardened state and cured for 28 and 90 days under controlled conditions of 20°C and 65% humidity. Verification of the mineralogical constitution of the material will be carried out using x-ray diffraction (XRD), x-ray fluorescence (XRF) and scanning electron microscopy with energy dispersive spectroscopy (SEM/EDS). The dynamic modulus of elasticity will be determined by resonance frequency, the apparent mass density in the hardened state, the open porosity by hydrostatic weighing after vacuum immersion, the behavior against water by the capillary water absorption test and resistance to tensile flexion and axial compression.

The performance of the ceramic/mortar interface will be evaluated through the area of mortar/tar adhesion, the extent of adhesion using a stereoscopic magnifying glass and the resistance to tensile adhesion. In order to also identify the degree of suction of the mortars by the ceramics, as indicated in the method created by Botas (2019), the mortars will be applied in two different humidity conditions: ceramics immersed in water immediately before application and ceramics saturated in water 24h before application. The microstructural arrangement in the ceramic/mortar interfacial zone and the crystalline morphology of the samples will be verified by SEM/EDS.

Finally, the durability of the set will be evaluated through an aging test in accelerated curing cycles that will allow the detection of possible detached ceramics, with the aid of thermography and/or visual inspection of the natural degradation due to the cycles applied. With the doctoral thesis, it is expected to identify patterns of behavior in the interaction of porous structures of historical materials, considering the historical period, type of manufacture and origin, as well as the in-service performance of commercial mortars or mortars made building. As an output, the degree of suitability of these in terms of appropriate use in restoration practices can be established.

### Keywords

Portuguese tile, manufacturing process, rehabilitation, reversibility, commercial mortars.



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