



## **Efficacy of chemical treatment of the Pietra cantone limestone in the restoration of historic buildings of Cagliari (southern Sardinia, Italy)**

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The present work aims to evaluate the efficacy of some chemical products in the restoration works of the "Pietra cantone" limestone, a calcarenitic rock belonging to the carbonatic miocenic series (lower Tortonian) of Cagliari (southern Sardinia, Italy), widely used in historic buildings. Such stone, once used in the masonry, if is not protected by plaster or in the presence of aqueous solutions circulating, frequently shows problems of chemical-physical decay, due to their petrophysical characteristics. In fact, being characterized by a highly porous (on average 35-42% vol.) carbonate matrix low-medium cemented, are easily alterable by weathering processes (i.e. dissolution, sulfation, etc.) and by cyclic mechanism of crystallization/solubilisation of salts and hydration/dehydration of hygroscopic phases belonging to the clay component of these calcarenites. These processes induce negative effects on physical-mechanical properties of stone, producing various macroscopic forms of alteration such as decohesion, disintegration, exfoliation, alveolation, etc. Where the decay of the walls is in an advanced stage, there was a strong retreat of the vertical profile of the facade of the building, resulting in critical static-structural.

As a case study was taken the historic building of a tobacco manufacture, one of the first industrial establishments in Cagliari, then owned by the Italian State Monopoly. The factory dates back to the early decades of the XVIII century, the walls of which, however, belonged to the convent of the "Fratelli Minori" built towards the end of the XIV century along the wall that closed the east the historic district of "Marina" in front of the port of Cagliari.

In addressing the structural restoration of this building, before selecting chemical products for dealing adequately of limestone, we proceeded at the outset to a thorough analysis of the structures built in "Pietra Cantone", and their physical-mechanical decay.

Only thereafter the stone taken of this building was suitably treated with chemicals consolidating as "mineral silicate" in hydro-alcoholic dilution (i.e. potassium silicates in greater quantities, lithium and barium silicates) and ethyl silicate in hydro-alcohol dilution (i.e. ethyl ester of silicic acid with a concentration of 70% wt.), and with protective hydrophobic product with low molecular weight (used as gel), nanomolecular monomer silane-based (alkyl-alkoxy-silane-monomer with a concentration of 42-43% wt.). We have chosen this type of products consolidating because more compatible in chemical and physical terms with the carbonatic matrix of calcarenites studied.

The evaluation of the efficacy of chemicals was made by comparing the data of the physical properties (porosity, bulk density, water absorption, gas permeability, etc.) and mechanical strengths (compression, flexion, index of resistance to punching) before and after treatment carried out in the laboratory, according to the most appropriate conditions and application doses of the chemicals. The results show that the properties of compressive and punching strengths are improved and, at the same time, have remained almost unchanged the characteristics of resistance to compression-traction strains (as evidenced by the results of the tests of resistance to flexion) and the breathability of this calcarenites, as demonstrated by the tests of permeability to water vapour.

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