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Stone Monuments Consolidation with Nanomaterials

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Abstract. Historical monuments suffer different forms of degradation, due to some improper works on architecture structure, vibrations caused by blasting, traffic, the inadequate restoration, the phenomenon of freeze-thaw, air pollution, humidity and temperature variations, friable mortar, deposits adhering impurities (dust, smoke, tar), soluble efflorescence, poorly soluble or insoluble salts (nitrate, sulfate, chloride, carbonate), and the action of microorganisms. Nowadays, the nanomaterials represent an alternative in architecture conservation, mainly due to their improved mechanical properties, their compatibility as consolidating materials, and because they obey the principle of authenticity of historical monuments. In this paper, hydroxyapatite nanoparticles (HAp) are applied to the chalk samples prelevated from Basarabi monument. Some physico-chemical and mechanical properties have been evaluated and discussed for untreated chalk stone and for the treated one with HAp.

Introduction

The stone materials with mineral-inorganic nature, due to their hydrophilic properties, are deteriorated by acid attack (caused by rains and humidity), soluble salts cyclic crystallization, light and human unproper interventions [1]. For them restoration/conservation is necessary to develop materials (micro- and nano) compatible with natural and artificial stone [2].

The new recently developed consolidant based on hydroxyapatite nanoparticles dispersed in alcohols, are discussed in this paper. Hydroxyapatite [HAp, $Ca_{10}(PO_4)_6(OH)_2$], nano-particle dispersions in alcohols may be applied by spraying or by impregnation [3,4].

Some experiments have been achieved on some samples detached from Basarabi Chuck Church's wall, all the tested samples being without patrimony values. The Basarabi Church is located in the south-east part of Romania, very close of the Danube-Black Sea Channel, dated from 9^{th} - 11^{th} century and discovered on 1957 [5]. Now this historical building is highly degraded, fast and efficient solutions for restoration being required. The Basarabi whole cave has a special place in our history, being recognized as the first religious monument from medieval Dobrogea. Situated in the cliff of a chalk stone hill, this ensemble is built from calcium carbonate (chalk) and is very sensitive to humidity, frost, salts etc. Atmospheric pollution and acid deposition materials are recognized as the most important and common causes of decay of this heritage monuments [6].

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