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The Evaluation of the Performance of CaCO3/Polymer Nano-Composites for the Preservation of Historic Limestone Monuments

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Abstract : The stone surfaces of historical architectural heritage in Egypt are under threat from of various environmental factors such as temperature fluctuation, humidity, pollution, and microbes. Due to these factors, the facades of buildings are deteriorating deformation and disfiguration of external decoration and the formation of black accretion also often from the stone works. The aim of this study is to evaluate the effectiveness of $CaCO_3$ nano-particles as consolidation and protection material for calcareous stone monuments. Selected tests were carried out in order to estimate the superficial consolidating and protective effect of the treatment. When applied the nanoparticles dispersed in the acrylic copolymer; poly ethylmethacrylate (EMA)/methylacrylate (MA) (70/30, respectively) (EMA)/methylacrylate (MA) (70/30, respectively). The synthesis process of $CaCO_3$ nanoparticles/polymer nano-composite was prepared using in situ emulsion polymerization system. The consolidation and protection were characterized by TEM, while the penetration depth, re-aggregating effects of the deposited phase, and the surface morphology before and after treatment were examined by SEM (Scanning Electron Microscopy). Improvement of the stones' mechanical properties was evaluated by compressive strength tests. Changes in water-interaction properties were evaluated by water absorption capillarity measurements, and colorimetric measurements were used to evaluate the optical appearance. Together the results appear to demonstrate that $CaCO_3$/polymer nanocomposite is an efficient material for the consolidation of limestone architecture and monuments. As compared with samples treated with pure acrylic copolymer without Calcium carbonate nanoparticles, for example, $CaCO_3$ nanoparticles are completely compatible, strengthening limestone against thermal aging and improving its mechanical properties.

Keywords : calcium carbonate nanoparticles,consolidation, nanocomposites, calcareous stone, colorimetric measurements, compressive strength
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