Abstract

In recent decades, the concrete for years considered unchangeable and with an unlimited life, with exceptional mechanical properties which have determined principally its success, was in fact subject to phenomena of degradation which over time alter its durability.

The degradation of concrete is hardly attributable to a single cause because often multiple processes can occur simultaneously, interacting in a synergistic way. Any degradation mechanism occurs, it is closely related to transport and diffusion of water in the concrete, i.e. the degree of porosity. Although the porosity of the concrete substrate is an intrinsic characteristic of the material itself, and therefore unavoidable, its control is crucial.

The protective polymer-based resins are the most commonly used for concrete structures, because they are very effective to provide a physical barrier to the ingress of water, ions and gases. Despite their good efficacy in prolonging the service life of the structures, there is a need for further increase the barrier properties and their compatibility with the substrate in aggressive environmental conditions.

In recent times, polymer-organoclay nanocomposites have emerged as a new class of high performance materials: in these systems nanoparticles are homogeneously dispersed in the polymer matrix in order to obtain an exfoliated structure. The high aspect ratio, which means a strong interactions between the nanofillers and the polymer, make the nanocomposites excellent organic-inorganic systems (compared to pure polymer or microcomposite systems), in terms of mechanical, thermal, optical and barrier properties.

This is the reason why, it has been thought to use these systems as potentially effective protective coating for building structures, even in the most severe environmental conditions.

In this thesis work different systems obtained by mixing a filler, in particular two kind of montmorillonite organically modified, with fluoro-based resins and silane-siloxane have been studied.

The protective efficacy of these systems, at different charge content has been verified and the results demonstrate the potential application of polymer/organoclay nanocomposites as surface treatment materials for concrete structures.

Moreover, in literature very often the use of some additives such as micro and nanoparticles is studied because it is expected that both strength and durability of a concrete could be enhanced if the overall porosity is reduced. In particular in the last years different kinds of inorganic nanoparticles, due to their physical and chemical properties, are very often integrated with cement-based building materials; in fact, thanks to their high surface area to volume ratio they can react with calcium hydroxide ($Ca(OH)_2$) crystals, arrayed in the interfacial transition zone, and produce C–S–H gel which fills the voids to improve the density of the interfacial zone. Stable gel structures can be formed and the mechanical and the service-life properties of hardened cement paste can be improved when a smaller amount of nanoparticles is added.

On the other hand, the same hydrophobic agents used as surface protective, thanks to their capability in reduction significantly the molecular attraction between the water and the concrete, could be directly added in the concrete mix in order to make the whole concrete bulk hydrophobic.

Thus, in this work the research is aimed to investigate the separated and combined effect of a hydrophobic resin (silanes and siloxanes in water base) and of the nanoparticles (two montmorillonites organically modified, the Cloisite 30B and the Halloysite) on concrete durability in relation with the analysis of transport properties of cement based systems, not yet deepened in literature.