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Bond Strength of Nano Silica Concrete Subjected to Corrosive Environments

Authors : Muhammad S. El-Feky, Mohamed I. Serag, Ahmed M. Yasien, Hala Elkady

Abstract : Reinforced concrete requires steel bars in order to provide the tensile strength that is needed in structural concrete. However, when steel bars corrode, a loss in bond between the concrete and the steel bars occurs due to the formation of rust on the bars surface. Permeability of concrete is a fundamental property in perspective of the durability of concrete as it represents the ease with which water or other fluids can move through concrete, subsequently transporting corrosive agents. Nanotechnology is a standout amongst active research zones that envelops varies disciplines including construction materials. The application of nanotechnology in the corrosion protection of metal has lately gained momentum as nano scale particles have ultimate physical, chemical and physicochemical properties, which may enhance the corrosion protection in comparison to large size materials. The presented research aims to study the bond performance of concrete containing relatively high volume nano silica (up to 4.5%) exposed to corrosive conditions. This was extensively studied through tensile, bond strengths as well as the permeability of nano silica concrete. In addition micro-structural analysis was performed in order to evaluate the effect of nano silica on the properties of concrete at both; the micro and nano levels. The results revealed that by the addition of nano silica, the permeability of concrete mixes decreased significantly to reach about 50% of the control mix by the addition of 4.5% nano silica. As for the corrosion resistance, the nano silica concrete is comparatively higher resistance than ordinary concrete. Increasing Nano Silica percentage increased significantly the critical time corresponding to a metal loss (equal to 50 μm) which usually corresponding to the first concrete cracking due to the corrosion of reinforcement to reach about 49 years instead of 40 years as for the normal concrete. Finally, increasing nano Silica percentage increased significantly the residual bond strength of concrete after being subjected to corrosive environment. After being subjected to corrosive environment, the pullout behavior was observed for the bars embedded in all of the mixes instead of the splitting behavior that was observed before being corroded. Adding 4.5% nano silica in concrete increased the residual bond strength to reach 79% instead of 27% only as compared to control mix (0%W) before the subjection of the corrosive environment. From the conducted study we can conclude that the Nano silica proved to be a significant pore blocker material.

Keywords : bond strength, concrete, corrosion resistance, nano silica, permeability
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