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Effect of Strength of Concrete on Corrosion of Reinforcing Steel

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Abstract

Corrosion is one of the major problem in R.C.C. Construction facing the civil engineers these days. Chloride intrusion and the carbonation are the two extensive deteriorating processes that cause the depassivation of steel embedded in concrete leading to damage to concrete structures and the costs of repair become substantial.

The corrosion process of reinforcing bars in concrete is a function of number of variables such as environmental factors in which the concrete is used, steel surface at the steel concrete interface, and concrete properties etc. The corrosion of metals, especially reinforcing steel, in concrete has received increasing attention in recent years because of its widespread occurrence in various types of structures and high cost of repairs.

The assessment of reinforcement corrosion have been the subject of extensive study and research during recent years. In most of the related literature, the risk of corrosion of reinforcement in concrete is assessed by measuring the half cell potentials, concrete resistivity values, impedance etc. The measurements by these methods only represent the qualitative estimation with certain limitations. The classical measuring method for recording the rate of corrosion is to measure the weight loss, which involves recording that, which is sought, namely metal loss, unlike above methods which usually provide relative values.

The high alkalinity of cement paste offers satisfactory protection against corrosion of steel reinforcement in concrete. This protection is due to existence of self generating protective layer at the steel concrete interface. The protective layer has normally been considered to be a tightly adhering film of γ-Fe2O3. The steel reinforcement is further protected by the physical shielding afforded by the concrete cover, which lowers the steel susceptibility to corrosion. However despite these protective mechanisms, a decline in the durability in reinforced cement

concrete structure as a result of corrosion is not uncommon. This can be readily envisaged in the light of the diverse and often severe conditions of the environment and service encountered by the structures. Cases of particular relevance include, chloride attack and carbonation. These two mechanisms are unusual in that they do not attack the integrity of the concrete. Instead, aggressive chemical species pass through the network of pores, often with substantial interconnectivity, into the concrete and attack the steel.

In this paper an attempt has been made to study the effect of compressive strength of the concrete on the corrosion of three grades of steel, viz., the smooth round Mild Steel bars, HYSD bars of grade Fe 415, and CRS (Corrosion Resistant Steel), in a laboratory accelerated corrosion test by classical mass loss measurement technique which is the only method to assess the corrosion rate quantitatively.

With the help of the study conducted, it can be concluded that the concrete quality and the thickness of concrete cover largely determine the effectiveness of general defensive shield against corrosion. The mass loss of the steel are significantly influenced by strength of the concrete. The rate of decrease of the mass loss for all types of steel are maximum up to concrete strength 35 to 40 MPa. Beyond this strength the mass loss of the embedded steel decreases but at a relatively slower rate. The study also brings out that the higher carbon content of the steel exhibit more mass loss due to corrosion. Also Mild Steel bars are capable to extend the time to initiation of the corrosion process in concrete but exhibit relatively a large amount of pitting type of corrosion, with areas of rusting separated by clean steel, as compared to HYSD steel and CRS bars. The performance index of CRS lies in the range of 1.3 to 1.5 and this index increases as the quality of concrete increases and decreases with the time of exposure in LACT.

The data developed in the proposed study show the value of concrete strength in resisting the corrosion of different types of reinforcing steel. The data will help in the selection of reinforcing steel in conjunction of strength of concrete in chloride corrosion situations.