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Removal of chloride from concrete using an electrochemical technique

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The role of chloride is very much significant in the corrosion of reinforced concrete structures. This chloride may be contributed by the atmosphere, water used for mixing concrete and the contaminated aggregates and cement. If this chloride is removed from concrete and the chloride level is brought to less than allowable level, then the reinforced concrete structure may be saved from corrosion to a certain extent and the longevity of the structure increased. This paper explains a method of removing chloride from concrete using electrochemical technique based on the fact that on electrolysing an electrolyte containing chloride ion, by passing a small current, chloride ion moves towards the anode. Different currents were applied and the amount of chloride removed was estimated using analytical technique.

Key words: Concrete corrosion, chloride removal

INTRODUCTION

Chloride has been identified as a main source in causing the reinforcement corrosion and consequent premature failure of strategic structures and therefore avoidance of chloride contamination or removal of chloride may be expected to minimise reinforcement corrosion. Only little work in this direction has been done so far [1]. The electrochemical removal of chloride from the concrete is based on the fact that the chloride ions in concrete migrate under the influence of an electrical potential gradient through the concrete surface into an electrolyte contained above the surface [2,3]. This potential gradient is induced by applying a direct current between the reinforcing steel and an electrode kept in the electrolyte. In this paper, the results of the laboratory preliminary investigation of removal of chloride by using an electrochemical technique has been presented.

EXPERIMENTAL

M 20 mix concrete slabs of size 900 × 230 × 75 mm with mild steel reinforcement mesh embedded in them were made use of in this study. During casting 60,000 ppm of chloride in the form of NaCl was admixed with concrete. The reinforcing steel embedded into the concrete was made the cathode and a Titanium Substrate Insoluble Anode mesh kept above the surface of the concrete immersed in the electrolyte as the anode (Fig. 1). 0.04N $Ca(OH)_2$ solution was used as the electrolyte. Different current densities such as 0, 0.25, 0.50, 0.75, 1.00, 1.50 and 2 A m^{-2} were impressed for a period of 100 hrs. continuously. The chloride removed from the concrete and collected in the electrolyte was estimated using Mohr's method [4].

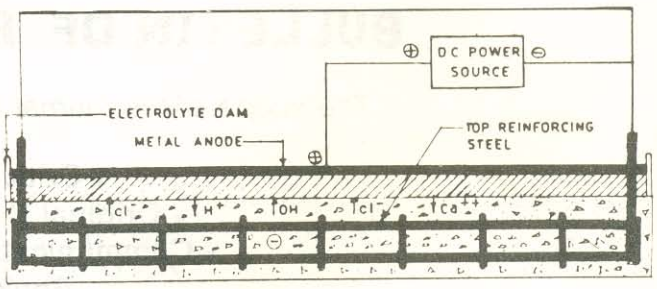

Fig. 1: Test set up

RESULTS AND DISCUSSION

Table I shows that the amount of free chloride removed increases with applied current values. However, the amount removed is quite appreciable for 1.50 and 2 A m^{-2} current densities. Earlier studies showed that only one fifth of total chloride added in concrete can remain as free chloride and influence reinforcement corrosion [5]. On the basis of the above, 12,000 ppm of chloride only may be expected to be free in our model slab (out of 60,000 ppm of chloride admixed). Figure 2 shows a bar chart on the percentage of free chloride removed at different applied current densities for a period of 100 hrs. It is clearly seen that upto 1 A m^{-2} current density only about 11.5% is removed. When the current density is increased to 1.5 A.m^{-2} and above, about 35% of free chloride is removed. Still considerable free chloride remains to be removed. Perhaps we may have to pass this current density for a further period of 200 hrs.

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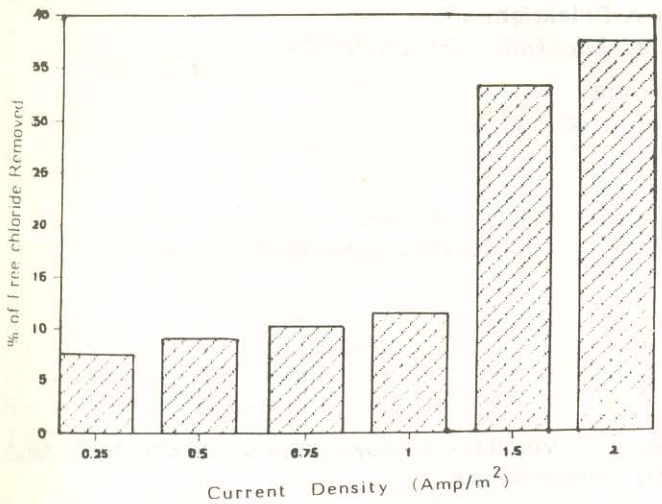

Fig. 2: % Removal of chloride from concrete

Cost effectiveness of the technique

About 500 ampere hours of electrical energy is to be spent to effect complete removal of free chloride from 1 m^2 area of concrete of 25 mm. This is less than 1 rupee m^{-2}.

CONCLUSION

About 35% of free chloride can be electrochemically removed by passing a current density of 1.5 A m^{-2} for a period of 100 hrs.

TABLE–I: Removal of free chloride with current

S.No.	Current density applied (A m^{-2})	Free chloride removed (ppm)
1.	0.25	900
2.	0.50	1100
3.	0.75	1250
4.	1.00	1400
5.	1.50	4000
6.	2.00	4500

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