Electrochemical Chloride Removal Treatment of Reinforced Concrete at Different Ages

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Abstract. Electrochemical chloride removal (ECR) treatment of reinforced concrete at different ages was conducted to investigate to its availability. The experimental method is almost same to others. The experimental results obtained showed that ECE is efficient for the concrete of high porosity or old age.

1. Introduction

Much works was done to prove electrochemical chlorine removal (ECR) treatment of reinforced concrete is efficient, just as G.E. Abdelaziz[1]. Whereas, some people[2-5] found the durability of concrete was prolonged when elimination of chlorine was done effectively. The length of time required in ECR was depended on the length of coverage. However, ECR can not guarantee authenticity that prolongation was achieved always in any environments. The SECM study showed that the dynamic character of the chloride transport in a given environment that involves many factors including pore blockage and pore opening, and that this transport dynamics allowed interpreting the macroscopic results on the variation of the percolation resistance with time elapsing, and that the resistance increases mainly due to blockage of the porosity.

2. Experimental procedure

2.1. Preparation of the specimens

Two kinds of concrete were prepared in the paper. One is fresh concrete. Cylindrical concrete specimens in the paper is with radius of 25 mm, and length of 110 mm. the concrete specimens were reinforced with mild steel bars with radius of 4 mm (Fig. 1).

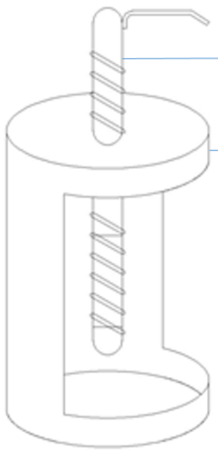

Fig. 1 sketch of concrete specimens used in the paper

The surface of the mild carbon steel was cleaned with dilute hydrochloric acid and then water. After chemical analysis, it is found that the composition of traditional reinforced concrete is as Table 1.

Table 1. Composition for concrete specimens

OPC	$308\ kg \cdot m^{-3}$
SS (0/4 R)	$846\ kg \cdot m^{-3}$
SG (4/12 R)	$1061\ kg \cdot m^{-3}$
Water	$192\ L \cdot m^{-3}$
w/c	0.57
compression	34.5 MPa

The cement used in the experiments is a kind of OPC whose chemical composition listed in Table 2. The reinforced concrete is cast in the flat steel formwork, curing for 20 at room temperature after forming, to guarantee the shape and size was achieved rightly. They were stored for 30 days before use. By soaking in chloride solution, the chloride ion can penetrate over a period of 300 days, with cycles of 3-day-immersion and 4-day-drying at 38°C.

Table 2. Chemical composition of the cement used

	CaO	SO_3	SiO_2	Al_2O_3	MgO	Fe_2O_3	Na_2O	K_2O
CEM I 52.5 R (%)	61.1	3.19	18.33	4.89	2.98	2.37	0.12	0.71

Other kind of concrete is that with long service life. Those specimens were prepared by cutting to the curve just as fresh concrete above.

Chloride concentration profiles were obtained from concrete cores extracted from the used specimens before, during and after the ECR experiments. Cores are of 10-mm radius and 20-mm length.

Fig. 2 illustrates the set-up of core extraction procedure. Measure procedure including total chloride concentration and the concrete resistivity are the same as in the literature [6].

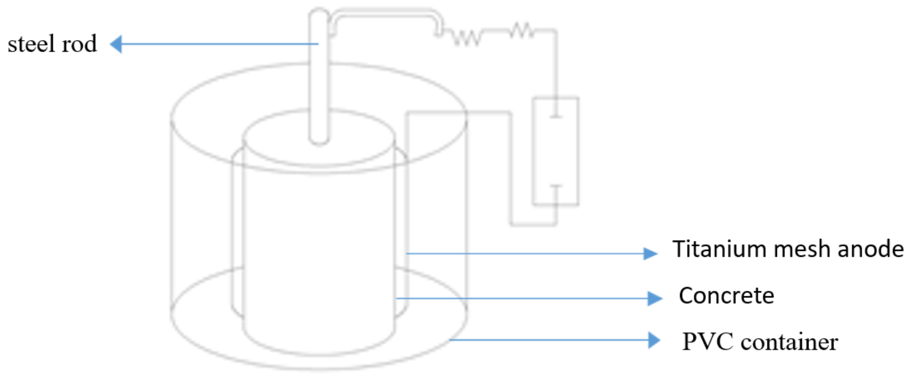

Fig. 2 ECR set-up.

2.2. Electrochemical chloride removal treatment

Fifteen specimens were placed in an insulated PVC container in turn, after titanium mesh anodes had been fixed on their surface to provide the electrical contacts. Distilled water was used as an anolyte to follow the movements of the ions towards the anode. To stabilize the selected current of 1 A/m^2 of steel surface applied between the two electrodes, a rheostat was connected in series. Every removal treatment was continued over the entire period without any interruption.

3. Results and discussions

3.1 Effectiveness of electrochemical chloride removal treatment for different kind of concrete

Five specimens were prepared in factor experiment: A, fly ash concrete with water cement ratio of 0.5; B, C, D, ODC concrete with water cement ratio of 0.5, 0.4, 0.3, respectively; and E, silica fume concrete with water cement ratio of 0.3. Experimental condition: cover depth of 20 mm.

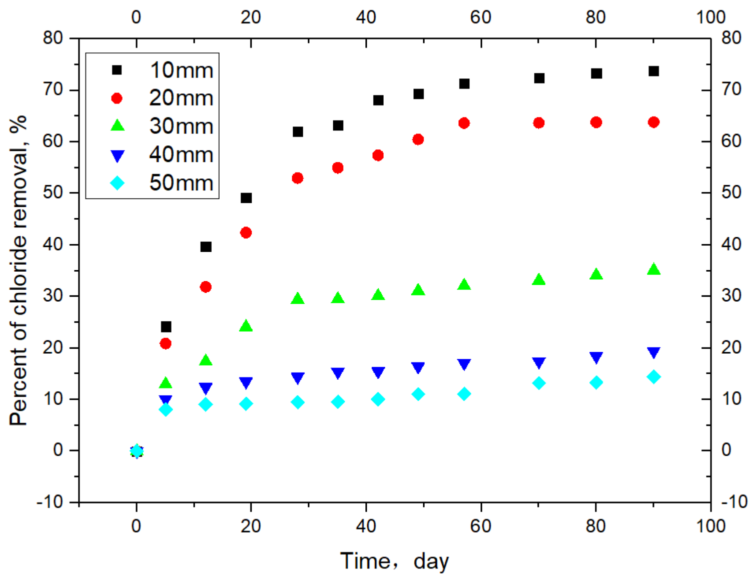

Fig. 3 Percent of chloride removal versus cover depth of 10, 20, 30, 40 and 50 mm.

Fig.3 shows that for effectiveness of electrochemical chloride removal treatment, fly ash concrete with water cement ratio of 0.5 is best, followed by ODC concrete, and last by silica fume concrete. As we know, silica fume concrete is the most compacting. Effectiveness of electrochemical chloride removal treatment depends by the compactness, which interprets that porosity affects the diffusion of chloride observably.

3.2 Effectiveness of electrochemical chloride removal treatment for ODC concrete with different cover depth

From Fig.4, it was found that cover depth affect chloride significantly. Delagrave, J. Marchand [7] found the assumption of non interacting diffusing flows, used in the mathematical treatment of diffusion and migration equations, is most probably incorrect. The results presented in this paper indicate that the values of the transport coefftcient appear to be dependent upon the test method used to measure and calculate that coefficient. Even if the discrepancy between the different methods can be, in certain cases very important, it appears that all these methods are quite sensitive to the material microstructure and can thus probably be used to qualitatively assess the ability of a cementitious system to resist the chloride ion ingress [8-9].

3.3 Effectiveness of electrochemical chloride removal treatment for ODC concrete at different age old

Experimental condition: cover depth of 40 mm.

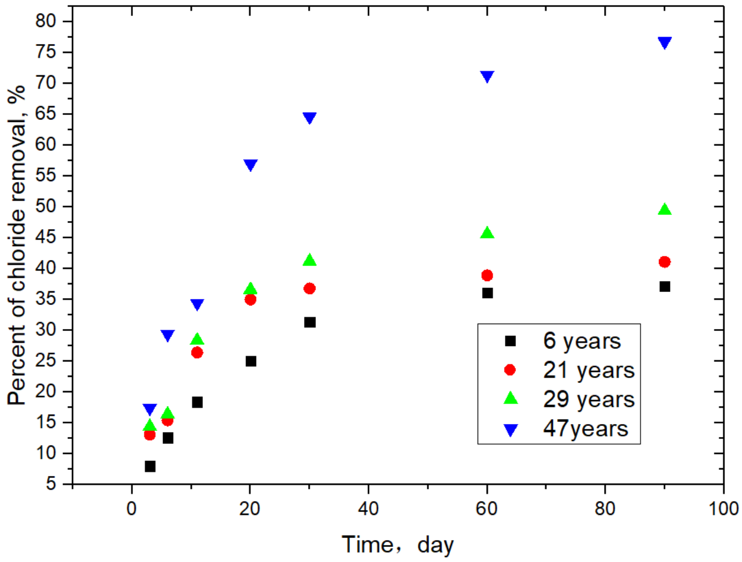

Fig. 4 Percent of chloride removal versus ODC concrete at different age old of 6, 21, 29 and 47years.

From Fig.4 shows effectiveness of electrochemical chloride removal treatment is increasing with prolonging service life. Corrosion and temperature generate internal stress, which causes the increase of porosity [10-11].

4. Conclusions

Three factor experimental also imply those conclusions as following.

(1) Porosity play key role on effectiveness of electrochemical chloride removal treatment.

(2) Cover depth affect effectiveness greatly, which may interpret that diffusion is controlling step in chloride extraction.

(3) Effectiveness of electrochemical chloride removal treatment for ODC concrete with longer service term is better.

Acknowledge

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