Effects of Cementitious Coating on Steel in Simulated Concrete Pore Solution

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ABSTRACT

Hydration products formed on the steel surface may impose the resistance to corrosion of steel when a concrete is exposed to a salt environment. In the present study, ordinary Portland cement (OPC), calcium aluminate cement (CAC) and calcium hydroxide are applied as coating materials on the steel surface to consider the hydrations of each binder at corrosion. Corrosion is measured in terms of the corrosion potential and galvanic current to detect the effects in mitigating the corrosion behavior.

1. INTRODUCTION

Nowadays, in order to increase the resistance of corrosion in a salt environment, both galvanized coating and epoxy coating have been widely used around the world [1-2]. However, besides their benefits of increasing the time to corrosion initiation, these coatings may also cause severe problems such as reducing the adherence between the steel and concrete, as well as pitting corrosion on the steel. To avoid these kinds of problems, cement based coating has been applied in India for its inhibitive nature [3]. In the present work, ordinary Portland cement (OPC), calcium aluminate cement (CAC) and calcium hydroxide have been applied on steel to evaluate their effects in increasing the corrosion resistance of steel.

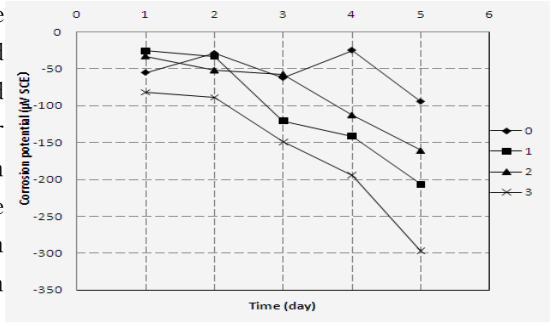

Fig1. Corrosion potential of calcium hydroxide coated steel

2. Experiments and materials

Three types of specimens coated with OPC, CAC and calcium hydroxide were tested in this experiment. 10mm×100mm cylindrical steel bars were used. The entire steel surface except the underside was coated with epoxy resin while the underside was coated with the three materials to be tested. The water cement ratio for OPC and CAC was 0.4. And the water cement ratio used

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in calcium hydroxide coating was 0.55. Each material was coated on the steel surface twice with a brush. For each specimen, three replicates were made. One day after coating, the values of corrosion potential and galvanic current were measured by a GAMRY Reference 6000 instrument every day for a total of five days. To simulate concrete pore solution, a solution mixed with saturated calcium hydroxide and 0.3 M sodium hydroxide was used. The chloride content added into the simulated solution was calculated by the ratio of $[Cl^-]$:$[OH^-]$. Four different levels of chloride (0,1,2,3) were added into the solution.

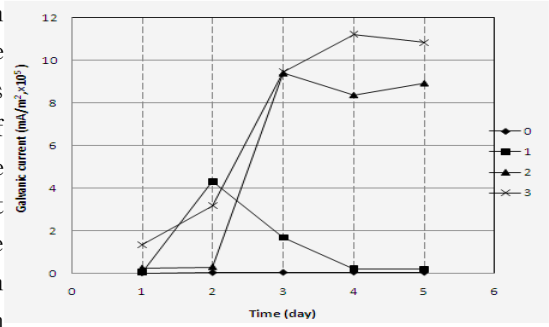

Fig2. Galvanic current of calcium hydroxide coated steel

3. Corrosion behavior

3.1 Corrosion potential

It was observed that with each coating material, the corrosion potential was found reducing in the order of 0,1,2,3 with the ratio of $[Cl^-]$:$[OH^-]$. For OPC and calcium hydroxide (Fig1) coated specimens, the corrosion potential values were all above -300μV, while for rebars coated with CAC, the potential of rebars in solution with a ratio of 2 and 3 reached around -645μV.

3.2 Galvanic current

For specimens in the solution with a $[Cl^-]$:$[OH^-]$ ratio of 0, the galvanic current detected was almost zero. The values showed an increase with an increase in chloride content in the solution. For OPC and CAC coated steel, all the galvanic current values vary from 0 to $35\times10^5 mA/m^2$. However, the vaules were all under $12\times10^5 mA/m^2$ in calcium hydroxide coated specimens(Fig2).

4. Conclusion

Of all the three materials used in this study, calcium hydroxide showed the best ability in resisting chloride-induced corrosion. Since this material was a passivating and barrier type of coating, no severe pitting problems like epoxy resin coating will be caused.

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