제 1 인산 암모늄 사용량에 따른 시멘트 모르타르의 철근방청성능 평가에 관한 실험적 연구

Mitigation of Steel Rebar Corrosion Embedded in Mortar using Ammonium Phosphate Monobasic as Hreen Inhibitor

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Abstract

Phosphate based inhibitor is playing a decisive role in inhibiting the corrosion of steel rebar in chloride condition. We have used different amount of ammonium phosphate monobasic (APMB) as corrosion inhibitor in mortar with different amount of chloride ions. The compressive strength, flexural strength, open circuit potential (OCP), electrochemical impedance spectroscopy (EIS), potentiodynamic polarization resistance (PPR), scanning electron microscopy (SEM) and Raman spectroscopy were performed to access the effect of inhibitor on corrosion resistance. As the amount of inhibitor is increased, the compressive strength increased. The electrochemical results show that as the amount of inhibitor and chloride ions are increased, the total impedance and corrosion resistance of steel rebar increased attributed to the formation of the stable oxide films onto the steel rebar surface. It is suggested that APMB can work in high concentration of chloride ions present in concrete where phosphate ion helps in formation of stable and protective phosphate based oxide film.

키 워 드 : 친환경 억제제, 철근 부식, 모르타르
Keywords : green inhibitor, steel rebar corrosion, mortar

1. Introduction

Corrosion-related maintenance and reconstruction of RC structures have been estimated to cost multi-billion US dollar annually. Inhibitors adoption method has been recognized as one of the most effective method with several outstanding features i.e. low cost, eco-friendly as well as simple and safe. Besides, phosphate-based inhibitors were able to control the steel corrosion as well as apply effectively in maintenance work of chloride contaminated RC structures. Thus, it is critically necessary in applying the excellent inhibitor i.e. APMB into the mortar condition instead of only stomping in simulated concrete pores solution. In this study, the influence of APMB as eco-friendly inhibitor against rebar corrosion in mortar was carried on by electrochemical studies i.e. OCP, EIS, and PPR, steel rebar surface studies i.e. SEM, and Raman spectroscopy, and mechanical properties i.e. flow test, compressive strength test as well as flexural strength test.

2. Materials and methods

The ribbed steel rebar with 8 mm in diameter and 160 mm in length, which played as a reinforcement role in mortar samples with the dimension of 40x40x160 mm3. The rebar was guaranteed to install constantly in the mortar mold by two pieces of acrylic mold and was soldered with copper wire for measuring electrochemical studies. The mortar mixture including water, cement, standard sand, inhibitor i.e. APMB, and NaCl following Table. 1. Thus, the finishing samples is cured in acceleration condition i.e. wet-dry cycle and soaking in NaCl solution. This study investigated the compressive strength, flexural strength, OCP, EIS, PPR, SEM as well as Raman spectroscopy.

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Table 1. The mixture compositions of mortar samples (kg/m3)

ID Samples	Cement	Water	Sand	NaCl	APMB
A0-C0	512	256	1536	0	0
A0-C1.2				1.2	
A1-C0	512	256	1536	0	0.295
A1-C1.2				1.2	
A2-C0	512	256	1536	0	2.950
A2-C1.2				1.2	

3. Results and Discussion

Although the flexural strength enhanced negligibly, compressive strength increased significantly with the presence of APMB. APMB played an critical role in improvement the strength of mortar samples. It is ascribed to the formation of new products i.e. calcium phosphate from the reaction between the phosphate ions i.e. PO43- with the hydration products i.e. portlandite in mortar matrix. It was reported that this new products tend to fill in the pores structures and help improve dense and reduce the pore amount.

Prior to early cycle, it was observed that the OCP went to active state and went to cathodic direction later in case of samples without NaCl as shown in Figure 2a. For the NaCl added samples from Figure2b , the OCP values turned to passive direction on trend excepting A1, and A0 samples. It is attributed to the formation of iron phosphate, very stable and uniform on the steel surface, inhibits the corrosion initiation of the rebar.

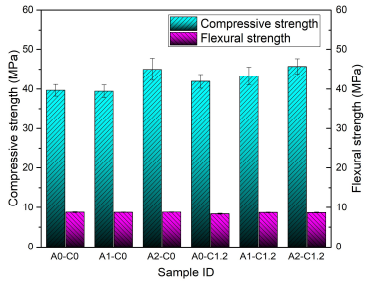
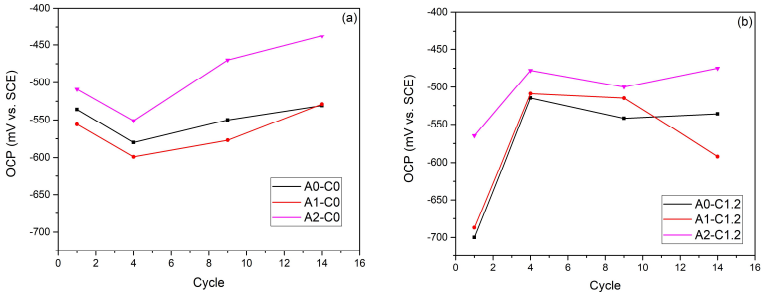


Figure 1. The compressive strength and the flexural strength of the mortar samples after 28-day-age



(a) (b)

Figure 2. Total impedance plots of samples containing (a) without NaCl addition, and (b) 1.2 kg/m3 NaCl addition

4. Conclusion

APMB is a green inhibitor totally providing the corrosion resistance ability to the steel rebar as well as the improvement in strength. Once the amount of APMB increases over 1M, the strength i.e. compressive strength and flexural strength gradually increased as well as the inhibition of corrosion initiation.

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