시멘트 모르타르에 매립된 철근의 생태학적 부식방지제로서 폐기물 바이오매스의 적용

Application of waste biomass as ecological corrosion inhibitors for steel rebar embedded in cement mortar

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Abstract : In this present study, the corrosion mitigation effect of conifer cone extract (CC) was examined in the cement mortar to improve the steel rebar (SR) corrosion resistance. The corrosion inhibition properties of the SR embedded in cement mortar (CM) admixed with different percentage (0, 0.5, 1.0, 1.5, 2.0 %) of CC was studied by open circuit potential (OCP) and electrochemical impedance spectroscopy (EIS) tests. This result confirms that the CM with 0.5% of CC added has better corrosion resistance than the blank specimen (0 % of CC). Although, the percentage of CC increase above 0.5%, the CC could yield a negative impact on CM properties in terms of reducing the corrosion resistance due to the reduction of cement hydration reaction. It was highlighted that the SR embedded in CM containing 0.5% of CC had increased corrosion resistance.

키워드 : 부식, 친환경 부식방지제
Keywords : corrosion, eco-friendly corrosion inhibitor

1. Introduction

According to practical and economic considerations, corrosion inhibitors are one of the most common ways to minimize the corrosion of SR in a concrete environment[1]. The majority of the corrosion inhibitors were studied in the simulated concrete pore solution with 3.5% NaCl. A few studies were conducted in actual cement mortar or concrete environments. This scrutinizes, the SR embedded in cement mortar (CM) that was cast with different percentages of conifer cone extract (CC) and which were exposed to a 3.5% of NaCl environment. The corrosion performance of SR embedded in CM admixed with CC was examined by electrochemical methods.

2. Materials and methods

2.1 Preparation of ESSRE and concrete specimens

In this study, Ordinary Portland cement (OPC) of Type 1 (KS: L5201-2016) and the fine aggregates (passed through 2.36) were used. Thermo-mechanical treated (TMT) steel rebars were used in this investigation. The detailed process of preparation of conifer cone extract has been described in our previous report[3].

2.1 Preparation of cement mortar

The cylindrical cement mortar specimens of size Ø 28 mm × 100 mm length were cast with Ø 8 mm and 120 mm length of SR and having a active area of 12.56 cm^2. The mix proportions of 1:2 (cement and sand) and water-to-cement ratio (w/c) 0.5 were chosen for casting the CM specimens. During casting, the different percentages (by weight of cement) of CC were admixed with CM. After 28 days of curing, the CM specimens were exposed to 3.5% NaCl and the corrosion performance of SR embedded in CM was examined by electrochemical methods such as OCP and EIS through Versa-STAT (Princeton Applied Research, Oak Ridge, TN) potentiostat.

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3. Results and discussions

3.1 Electrochemical studies

The results of OCP measurements are shown in Figure 1(a). As compared with blank, it is obvious that the addition of 0.5% of CC shifts the potential towards a negatively lesser value, with a distinct shift (about 80–85mV) at the inhibitor CC concentration of 0.5%, which may be indicated the mixed corrosion inhibitors. Namely, it is reducing the anodic and cathodic reaction on the SR surface.

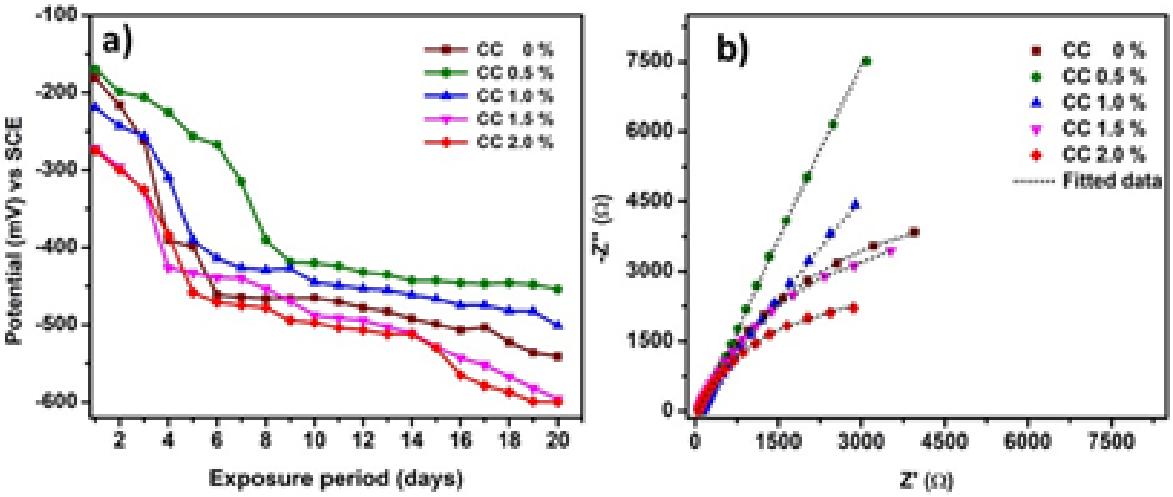

Figure 1. Electrochemical studies a) OCP measurement and b) Nyquist plot

The EIS results of cement containing various percentages of CC are shown in Figure 1(b). The 0.5% of CC admixed CM, the dimension of the semi-circle arc is higher than blank. Further increasing the concentration of CC the semi-circle arc reduced, which indicates the negative impact on CM properties in terms of reducing the corrosion resistance due to the reduction of cement hydration reaction. From OCP and EIS results indicate that 0.5% of CC is suitable for improving the corrosion resistance properties of SR embedded in CM.

4. Conclusions

The CC extracts were obtained from the waste biomass of the conifer cone. The obtained CC extract act as an effective and ecological corrosion inhibitor for SR embedded in CM under the 3.5% NaCl environment. The extract of CC hinders the corrosion reaction between SR and aggressive ions. Further, it can be verified that 0.5% of CC extract can able to reduce the corrosion rate of SR embedded in CM under a chloride environment.

Acknowledgment

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government(MSIT) (No. NRF-2018R1A5A1025137).

References

1. Muralidharan S, Saraswathy V, Thangavel K, Srinivasan S. Competitive role of inhibitive and aggressive ions in the corrosion of steel in concrete. Journal of applied electrochemistry. 2000. p. 1255-1259.
2. Karthick S, Lee HS, Mandal S, Park TJ. Conifer Cone (Pinus resinosa) as a Green Corrosion Inhibitor for Steel Rebar in Chloride-Contaminated Synthetic Concrete Pore Solutions. ACS Applied Materials & Interfaces. 2021. p. 43676-43695.