# 콘크리트 기공 솔루션에서의 열간 압연 및 열 기계 처리 철근의 부식 특성

## Corrosion Characteristics of hot rolled and thermo-mechanically treated steel rebar in concrete pore solution

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Abstract

Chemistry and microstructure of steel reinforcement bars play an important role to control the corrosion in concrete environments. In present study, we have chosen two different microstructure of steel rebars produced from companies and assessed their corrosion characteristics in simulated concrete pore (SCP) solution with prolonged exposure periods. Hot rolled steel rebar showed more corrosion resistance compare to thermo-mechanically treated (TMT) one. The growth of passive is greater in hot rolled (A) than TMT (B) due to orientation of microstructure. TMT steel rebar exhibit distorted microstructure with many micro cells which enhances the galvanic coupling and induce the deterioration while on the other hand hot rolled rebars exhibit fine grain boundary which responsible in growth of uniform, adherent and protective passive film resultant improved impedance was observed.

키 워 드 : 강철, 부식, 콘크리트 기공 솔루션
keywords : steel, corrosion, concrete pore solution

## 1. 서 론

Steel rebar posses two different composite micro-structures which consist outer rim as tempered martensite (TM) and inner core as pearlite ferrite (PF)[1]. Process for production of steel rebar after rolling consist different process such as quenching and other is hot rolled. The quenched steel rebar form hard tempered martensite structure at outer surface while hot rolled form soft and austenitic in between a bainitic transition zone. Due to quenching, outer surface consist complex and distorted microstructure therefore, it affects the corrosion properties of steel rebar. There is no study have been carried out by the researcher to study the corrosion mechanism of two different microstructure of same chemistry steel rebar in concrete pore solution. In present study, we have assessed the corrosion mechanism of hot rolled (A) and TMT (B) steel rebar in SCP solution at different exposure periods.

## 2. 재료 및 방법

The steel rebar containing C=0.22, Si=0.45, Mn=1.52, P=0.02, S=0.01, Cr=0.02, Cu=0.01, V=0.05 and Fe balance (wt.%) of 32 mm diameter were collected from different steel producing companies. Prior to start the electrochemical experiments, the steel rebars were cut through automatic cutting machine in 20 mm length. The two different i.e. A and B steel rebars produced through different processes ie. hot roll and quenching were polished on cross section with different size of emery paper and then cloth polished with 5 μm alumina paste. The following composition i.e. NaOH=8.33 g/l, KOH=3.36 g/l, CaO=2 g/l were dissolved in distilled water and prepare SCP solution[2].

The electrochemical impedance spectroscopy (EIS) and cyclic polarization experiments were performed by DC 105 and CMS 300 software with M/S Gamry instrument on cross sectional area of steel rebars. For electrochemical experiments, saturated calomel electrode (SCE) and pure graphite rod of 32 mm diameter and 150 mm length was taken as reference and auxiliary

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electrodes respectively. The EIS was performed at 10 mV sinusoidal voltage from 100 kHz to 10 mHz frequency ranges. The scan rate of potential was fixed at 0.01mV / second.

## 3. 결과 및 토론

The Bode plots of electrochemical impedance (EIS) and cyclic polarization results are shown in Fig. 1. After 1 h of exposure in SCP solution, impedance of A steel rebar is greater than B (Fig. 1a). The TMT (B) steel rebar exhibit distorted microstructure with many micro galvanic cells where as A (hot rolled) steel rebar exhibit uniform grain boundary and form less galvanic cell. As the exposure periods are increased up to 312 h, the impedance values of both studied steel rebar at 0.01 Hz decreased gradually (Fig. 1b). It might be attributed due to defective oxide passive film formed on steel rebars surface.

The cyclic polarization results of steel rebars after 312 h of exposure in SCP solution are shown in Fig. 1c. Hot rolled (A) steel rebar exhibit less corrosion current density than TMT (B). During reverse scanning, the TMT (B) steel rebar shows positive loop in greater size while hot rolled (A) steel rebar exhibits negative loop and small in size. This result attributed that TMT (B) steel rebar is susceptible to corrosion compare to hot rolled (A) in SCP solution.

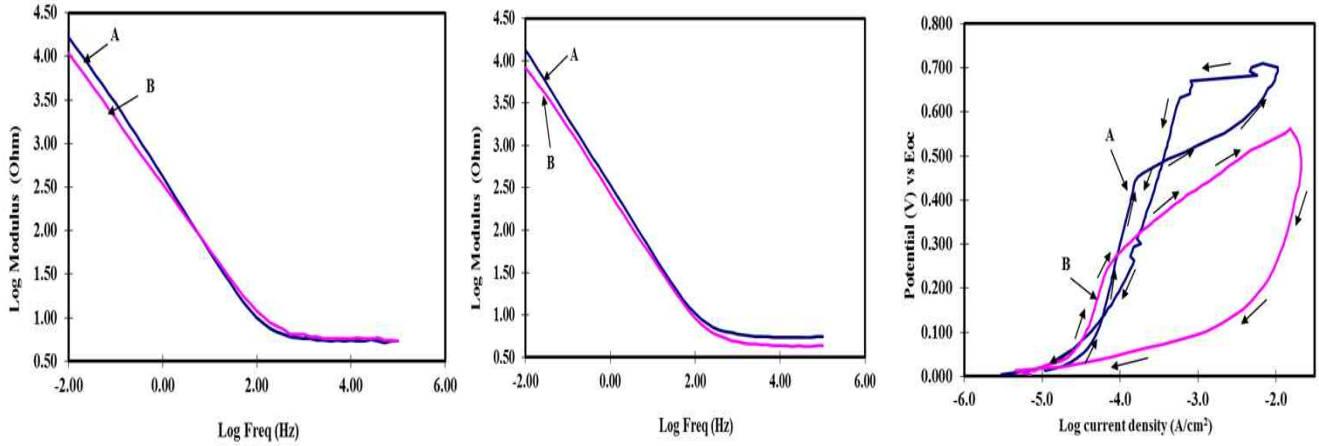


Figure 1. Electrochemical results of A and B steel rebars (a) log-modulus Bode plot after 1 h, (b) log modulus Bode plot after 312 h and (c) cyclic polarization after 312 h of exposure in SCP solution.

## 4. 결 론

The hot rolled steel rebar shows higher corrosion resistance at longer duration of exposure due to uniform corrosion compare to TMT which is susceptible to corrosion. As the exposure periods are increased, both steel rebar are exhibiting deterioration nature of formed passive film might be due to formation of more galvanic or half cell.

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