Behavior of Piezoresistivity and Shear Stress between Corroded Steel Rebar and Smart Polymer Concrete

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Abstract
In this study changes in corroding steel rebar with time was monitored using a smart polymer concrete coating. The laboratory tests indicated changes in piezoresistivity properties were observed for the corroding steel rebars embedded in the polymer concrete coating under compression loading. But no piezoresistivity changes were observed for the specimens embedding non-corroded steel rebars under compression loading.

1. Introduction

The long-term performance of a coating such as polymer concrete is influenced significantly by its ability to adhere properly to the material to which it is applied. This is not simply because the coating might flake away or detach from the surface but because poor adhesion will allow moisture or corrosion products to undercut the coating film from areas of damage (Saha et al, 2010). Hence, the bond strength between steel rebars and polymer concrete is important to the effectiveness of the coating. In the industry of gas and oil, corrosion of steel casing is of concern because it requires almost immediate repairs and rehabilitation to extend the service life of the structures.

2. Objective

The objective of this study was to investigate the corroding of a steel rebar using smart polymer concrete coating. The corrosion at the interface between the steel rebars and polymer concrete coating was quantified.

3. Materials and Methods

Polymer concrete specimens embedding two kinds of rebar have been prepared for laboratory tests. The specimens have cylindrical shape with diameter of 2 inches and height of 4 inches. The polymer concrete was composed of polyester coating (20% by total weight) and sand (80% by total weight). Methly ethyl ketone peroxide and Naphthenate were used as hardener and catalyst respectively. To improve the electrical properties, conductive filler was also added into the composite. The rebars used had size of #3 and length of 6 inches. The specimens were instrumented with 2 silver-paint wires connected to the polymer concrete. Compression loading was applied to the specimens up to 210 lbs. The total impedance of between the steel and the polymer concrete was measured with impedance analyzer precision LCR meter.

4. Discussion

The equivalent circuit adopted based on expected behavior of the material under this study is shown in Fig 1. The total impedance of the equivalent circuit is given as follows:

$$Z = R_b + \frac{R_c}{1 + \omega^2 {R_c}^2 {C_c}^2} + \frac{R_i}{1 + \omega^2 {R_i}^2 {C_i}^2} - j\left(\frac{\omega {R_c}^2 C_c}{1 + \omega^2 {R_c}^2 {C_c}^2} + \frac{\omega {R_i}^2 C_i}{1 + \omega^2 {R_i}^2 {C_i}^2}\right)$$

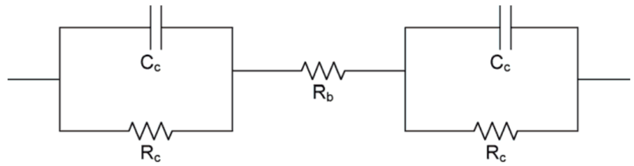

Figure 1. Equivalent circuit

In the equation, ω is the angular frequency of the applied signal. Applied signal was carried out with frequency range of 20 Hz to 300 kHz. Figure 1 shows the real impedance vs frequency under compression loads for both corroded and non-corroded steel rebars embedded in smart polymer coating. For corroded specimens, the Zreal in low frequency decreases while that of non-corroding specimen shows no change as the compression stress increases.

Table 1. Real impedance variations for specimens under compression loading

Specimen types	**Z_{real} (ohm)**			
	0 psi		**1901 psi**	
	20 Hz	**300 kHz**	**20 Hz**	**300 kHz**
Corroded	1.20E+08	4.50E+03	6.00E+07	4.60E+03
Non-corroded	5.04E+07	5.51E+03	5.04E+07	5.60E+03

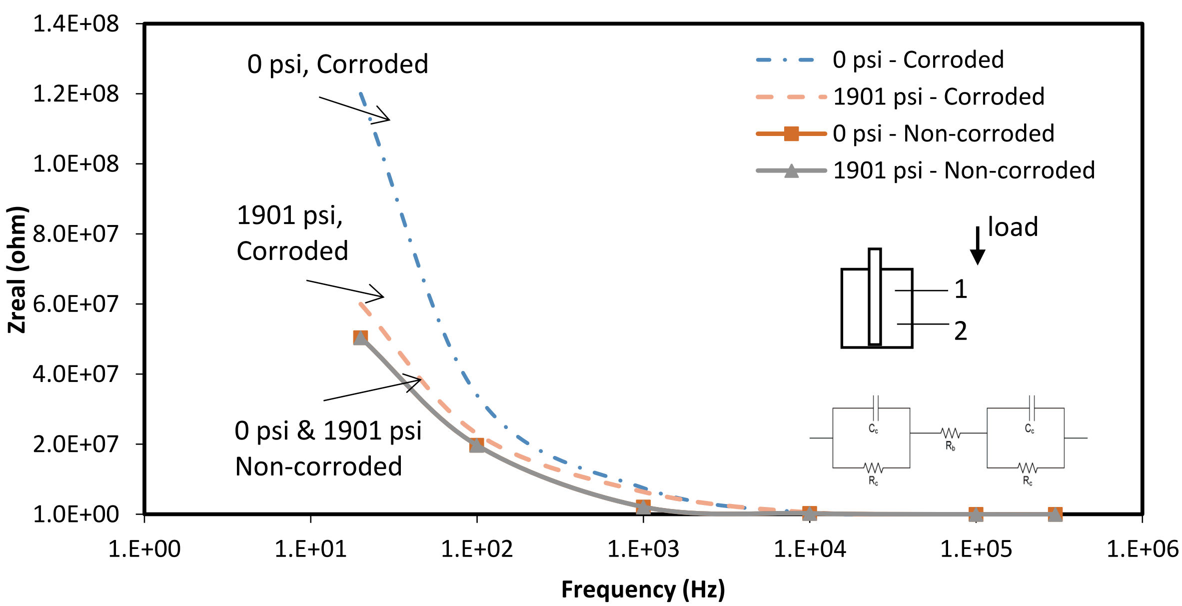

Figure 2. Shear stress vs R*C

5. Conclusion

In conclusion, the change in Zreal of the corroded rebars and non-corroded rebars embedded in smart polymer concrete coating was identified. In low frequency range the Zreal decreased when applied compression load increased for corroded specimens. Whereas for non-corroded specimens, the Zreal did not indicate change when applied compression load increased.

6. Acknowledgement

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7. References

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