Zinc Paint for Impressed Current Cathodic Protection System of Reinforced Concrete

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Corrosion: 4% Annual Loss of World's Gross Domestic Product (GDP)

Introduction

- Corrosion of steel in concrete is one of the **biggest durability** issue for reinforced concrete (RC) structure leading to its reduced sustainable design life.
- **Impressed Current Cathodic Protection (ICCP)** is considered to be the most proven and effective approach and in some cases, the only rehabilitation technique for preventing and minimizing corrosion initiation in chloride rich environment in RC structures[1].
- Industry is still looking for an alternative anode material for ICCP, with easier and faster installation technique and better performance characteristics.
- This research evaluates the feasibility of **zinc rich paints (ZRP)** as an anode to provide ICCP to RC structures.
- The proposed ZRP anode system will be a **low cost, low carbon footprint, have high efficiency** and can be easily applied by roller or brush.

3m long beams coated with ZRP for polarization test

Aim and Objectives

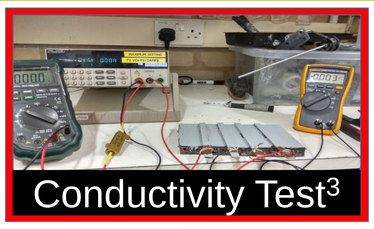
To develop specialist conductive coating anode system which is low cost, low carbon footprint and highly efficient for impressed current cathodic protection of steel in concrete structures

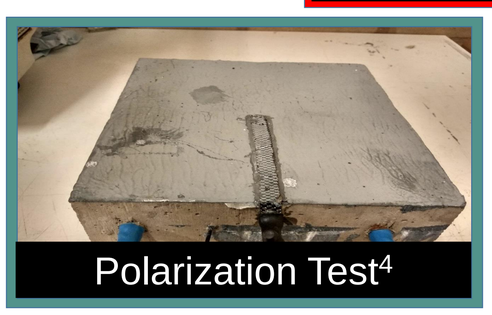
① To use zinc paint as anode and evaluate its performance to understand its mechanical, electrochemical behavior and its efficiency to cathodically protect chloride contaminated structure

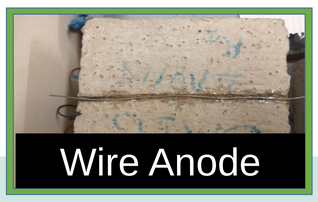
② To optimize the current density required for cathodically protecting reinforced concrete using ZRP as anode material.

③ To study microstructure of zinc paint and zinc-concrete interface before and after CP.

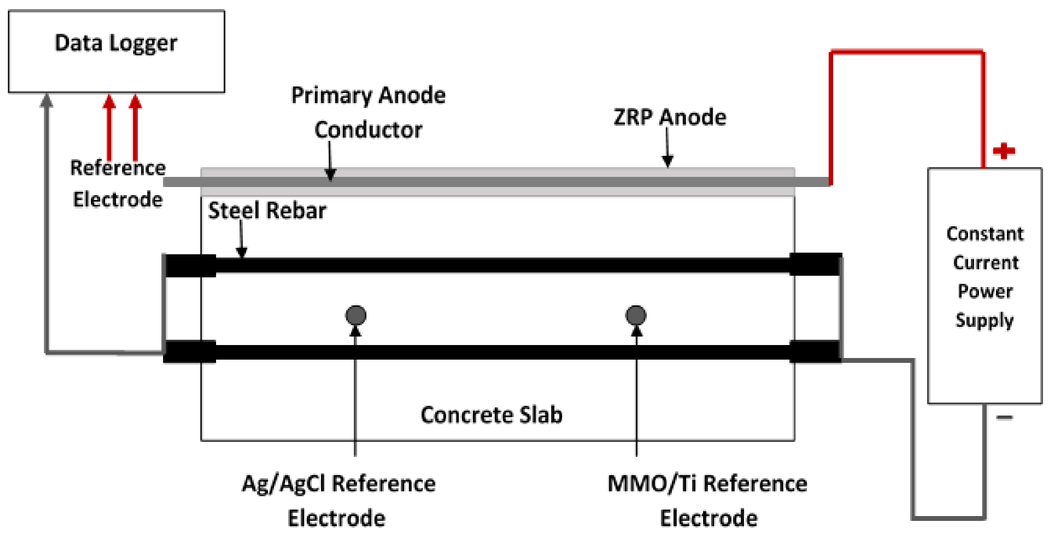
Experimental Plan







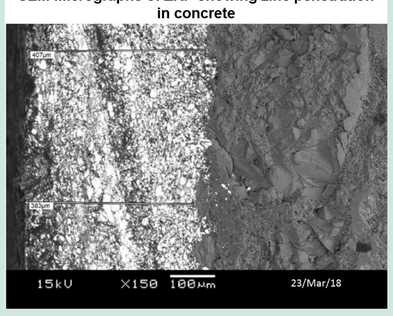
Schematic of Polarization Test



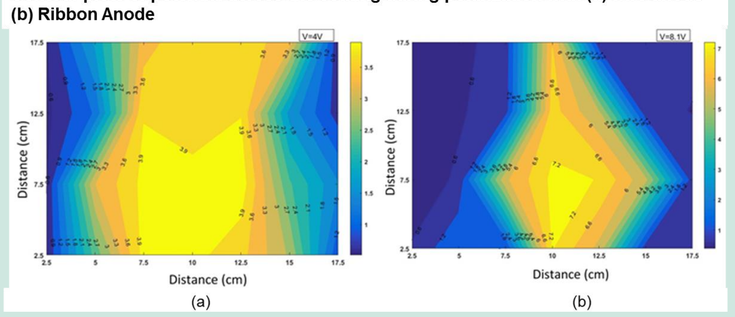
Results

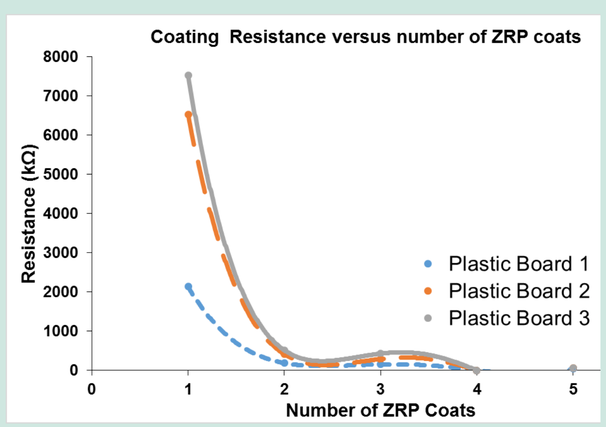
- ❑ Maximum conductance and bond with 3 layers of ZRP on medium roughness concrete surface.
- ❑ Anomet Cu/Nb/Pt wire more suitable as primary anode conductor compared to MMO/Ti ribbon conductor.
- ❑ Polarization results showed satisfactory performance of the ZRP anode coating subjected to a current density of 12.50 mA/m^2 per anode surface area.

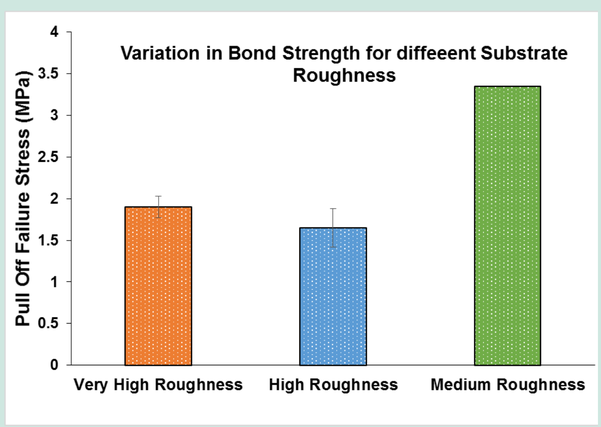
SEM Micrographs of ZRP showing zinc penetration in concrete

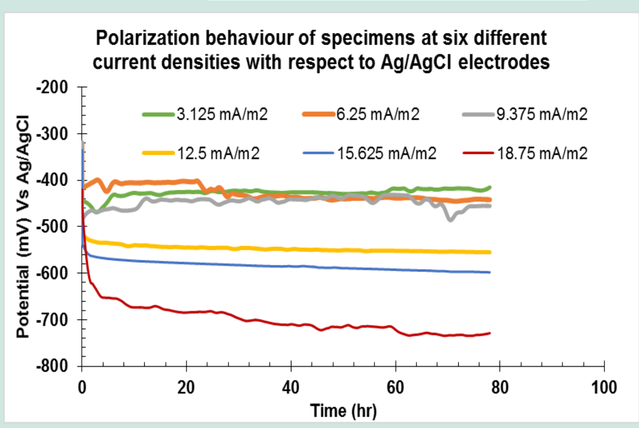


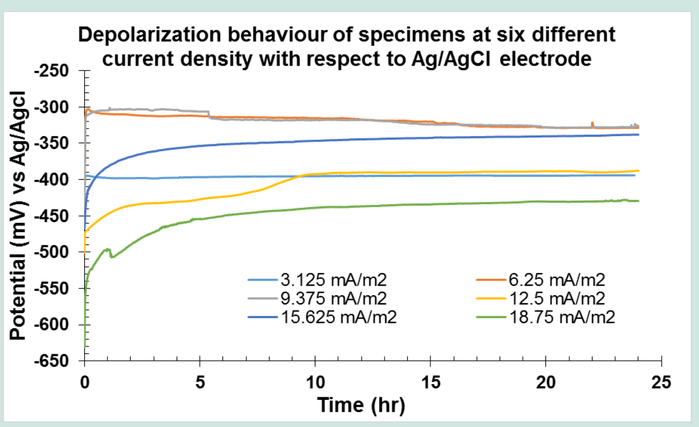
Contour plots of potential across the coating during polarization with (a) wire anode (b) Ribbon Anode











Conclusion

ZRP conductive coating can be used successfully as an effective ICCP anode system and satisfy the performance criteria in accordance to NACE SP 0290[5] and BS EN 12696[4] standards

References

1. Byrne, A.; Holmes, N.; and Norton, B.; "State-of-the-art review of cathodic protection for reinforced concrete structures", *Magazine of Concrete Research*, No. January, 2016, pp. 1–14.
2. ASTM, 2013; "Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers", *ASTM D7234-12*.
3. TM 0105; "Evaluation of Coatings Containing Conductive Carbon Pigmentation for Use as an Anode on Atmospherically Exposed Reinforced Concrete", NACE International, No. 21247, 2016.
4. BS EN ISO 12696; "Cathodic protection of steel in concrete", *British International Standard*, 2016.
5. SP0290; "Impressed Current Cathodic Protection of Reinforcing Steel in Atmospherically Exposed Concrete Structures", NACE International, 2007.