Prevention of Corrosion by Generating Potential in Reinforcement Steel Using Piezoelectric Material

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Summary

This paper deals with a solution to rectify the problem of corrosion in RCC structures. The problem arises due to electrochemical reactions occurring inside the structure on the surface of the reinforcement (steel). These reactions result in oxidising the steel and eventually lead to formation of a voluminous product which induces internal stresses and finally cracks the structure. These reactions, typically, take place at potentials between -0.7V to +0.7 V. So, an applied external potential of magnitude greater than that (+ve or -ve) would be capable of preventing them. If positive, this external potential results in passivation; and if negative, it makes steel reach the immunity zone. Piezoelectric materials such as Quartz, Tourmaline etc. have the characteristics of accumulating charge on their faces under some mechanical pressure. They can be used in the construction of bridges where the required pressure is easily provided by moving vehicles. These materials can then suitably be connected with the reinforcement bars to induce potential in them. Hence, one of the extreme problems can be nullified thereby increasing the quality and durability of the structure.

Keywords: Corrosion, Reinforcement Steel, Bridges, Electric Potential, Piezoelectric Effect, Passivation, Impressed current, Immunity condition.

1. Introduction

Corrosion is an electrochemical process in which metals and alloys undergo transformation into predominantly oxides, hydroxides and aqueous salts. In reinforced concrete, the presence of moisture results in formation of corrosion.

In corrosion process, two reactions take place. In one, the anodic reaction, metal atoms are ionised and passed into the solution leaving their electrons within the original metal surface. In the second, the cathodic reaction, the free electrons within the metal are taken by chemical species such as and in reduction reaction.

2. Research Idea

The potential difference E across the interface between a metal and a solution is the key factor controlling both, the products of an electrode reaction and the rate at which they are formed. At negative potentials metallic iron itself is in the stable form hence in this region no corrosion is possible and this is referred to as the Immunity condition. At more positive potentials the oxide formed is and this is usually present as a thin adherent film. Since this oxide forms at the surface, its presence leads to the blockage of surface reaction and hence corrosion rates are reduced.

This is called passivation and the oxide film on the surface is known as passive layer.

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"Deduction: Protection against corrosion can be provided by keeping the cathode either at negative potential; more negative than -0.7V such that it reaches its immunity zone or at higher positive potential which leads to passivation".

As illustrated above, we can prevent corrosion of reinforced steel using an external electric potential. To provide this external potential, we can use piezoelectric materials in the construction of bridges.

Piezoelectric materials can be used in the bridge structures and placed suitably to form a piezoelectric generator. The mechanical pressure required can be provided by the gravitational load of vehicles passing over the bridge. This will induce opposite charges on different faces of the material resulting into the flow of an impressed current through the steel. Maintaining a voltage supply of 1V or more by connecting the terminals, the flow of impressed current in steel rods can be maintained. Thus proper current supply and potential in steel rods will lead to the control of corrosion.

3. Conclusion

Even after a lot of studies and numerous theories being given to prevent it, corrosion still remains one of the biggest problems for RCC members. By using the above processes we can not only prevent corrosion but also do so effectively by just installing the setup once. This will hence result into improved strength and prolonged life of the structures.

4. References

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