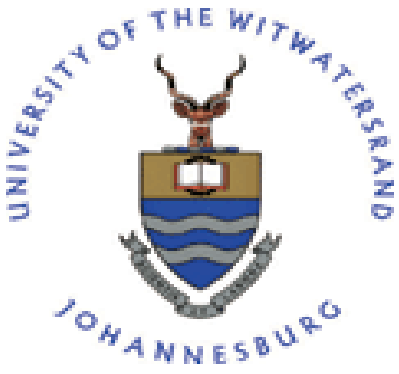

EVALUATION OF SELECTED REPAIR METHODS FOR CHLORIDE–INDUCED CORROSION OFSTEEL IN REINFORCED CONCRETE RAILWAY BRIDGES

Mohamed Jogiat

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Declaration

I declare that this research report is my own unaided work. It is being submitted to the Degree of Master of Science in Engineering to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

Mohamed Jogiat

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"The best among you are those who have the best manners and character"

Prophet Muhammed (peace be upon him)

Abstract

Premature deterioration of reinforced concrete railway bridges before and after repair is a serious concern as it is costly and poses a major risk on safety and performance. Reinforced concrete railway bridges in aggressive environments (near the sea) face the risk of ingress of corrosion agents (oxygen, moisture and chlorides) into the concrete to the reinforcing steel. Although, corrosion of the reinforcing steel is not the only cause of structural deficiencies in railway bridges, it is a significant contributor to deterioration and therefore of major concern.

In order to guide the selection of a suitable repair option, one repair material from each category (patch repair mortars, barrier systems, electrochemical methods and corrosion inhibitors) was investigated. The effectiveness of selection was assessed by employing electrochemical techniques to quantify the performance of each selected repair material in stifling chloride-induced corrosion in reinforced concrete.

This study focuses on the evaluation of selected repair materials for chloride-induced corrosion in reinforced concrete using 100 x 100 x 500 mm long beam specimens. The four selected repairs were applied to the reinforced concrete beams after a period of 200 days after casting. The beams had a constant concrete cover to reinforcing steel of 20mm. The beam specimens were casted using admixed chlorides into the mix and were subjected to a cycle of 3 days wetting (with 5% NaCl solution) and 4 days drying. The beam specimens were monitored for half-cell potential ($Cu/CuSO_4$), corrosion rate (coulostatic technique) and concrete resistivity (Wenner probe technique).

Results indicate that the selected repair materials in this study had varied influences on the half-cell potential and corrosion rate values. The patch repair material replaced the concrete cover with a more durable material, confirmed from the Durability Index (DI) tests conducted. The resistivity of the repair mortar was measured to be higher than the concrete. Due to the replacement of the concrete cover, the corrosion rate values reduced when compared to the control reinforced beam specimens. However, the half-cell potential values indicated the probability of corrosion is still high after application.

The barrier method, applied a silane-based sealer on the reinforced concrete beams. The resistivity of the concrete increased after application of the barrier method. The corrosion rates after application of the barrier method was lower than the corrosion rates of the control reinforced concrete beams. The half-cell potential results indicated the corrosion risk is still high after application of the barrier method.

The electrochemical repair was the only repair material that showed more negative potentials than the control beams and corrosion rates were significantly higher than all the other repair methods after application. The reason for this can be attributed to the zinc anode dominating the potential and corrosion rate values. Therefore, no conclusion can be made on the corrosion condition of the reinforcing steel. Alternative methods should be employed in determining the effectiveness of sacrificial anode repairs.

The corrosion inhibitor specimens were similar to the control specimens corrosion rate results after application but showed less negative values in the half-cell potential readings. However, the depth of the corrosion inhibitor was not assessed.

This study was effective in ranking a suitable repair method for a period of 110 days after application, under similar exposure conditions, in order of descending effectiveness: barrier method, patch repair and corrosion inhibitor.