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The Study of Half-cell Potential Behaviour of Reinforced Concrete in Marine Environment

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Abstract: ***Corrosion of reinforcement in concrete affects the strength and durability of reinforced concrete structure. Monitoring and maintenance of concrete structure throughout the service life prevent the ingress of corrosion at the initial stage. Half-cell potential meter was developed and fabricated to monitor the corrosion potential of reinforcement in a M25 grade concrete. Half-cell potential test and accelerated corrosion test has been carried out in marine environment of 3.5% of NaCl solution. The potential behaviour of specimen subjected to accelerated corrosion is studied throughout the test period. The results were obtained in terms of current flow behaviour and weight loss. Obtained results has been analyzed graphically and a comparative analysis has been carried out to know the rate of corrosion occurred in the specimen by accelerated corrosion test and half-cell potential test. Obtained results clearly indicates that the potential behaviour value increases with increase in time from 160 mV on day 1 to 949 mV on day 5. In the other way the compressive strength value for corroded specimen is lesser than the controlled specimen subjected to accelerated corrosion.***

Keywords: Corrosion, Marine environment, Half-cell potential, Accelerated Corrosion, Current flow

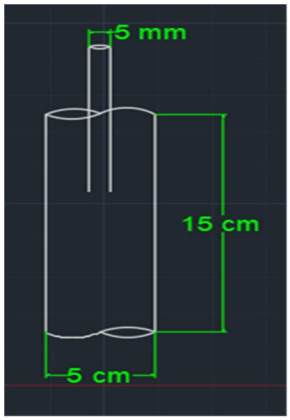
I. INTRODUCTION

Corrosion is an electrochemical process, where the metal reacts to the oxidant such as oxygen and sulphur. There are many prevention methods to prevent the occurrence of corrosion in a structure such as cathodic protection method, protection by paint, Inhabitation, corrosion resisting alloy, etc., but none of this methods will show the corrosion amount of corrosion occurred in a structure. So half-cell potential apparatus was developed to obtain the corrosion potential in a specimen and to find the initiation of corrosion in a specimen. Half-cell is a non-destructive process of measuring the potential difference between the surface, concrete and the rebar inside for a given potential using a standard cell. During this test the areas that are highly corroded shows less potential difference due to high conductivity. Before half-cell potential the specimen is subjected to electrochemical process, an electrochemical process is a redox reaction. Where, it consists of anode (‘+ve’)and cathode (‘-ve’). Accelerated corrosion test is one of the electrochemical process which was conducted in a marine environment. By performing accelerated corrosion test the rate of corrosion increases rapidly comparing to corrosion that occurs naturally.

II. MATERIAL AND CASTING

A. Preparation Of Specimen

Three concrete specimen of height 15 cm and 10cm diameter is casted. M25grade of concrete specimen is casted with a centrally embedded 8mm diameter HYSD bar. Mix ratio of 1:1:2 is used to prepare the specimen. The specimen is then curried for a period of 28days.

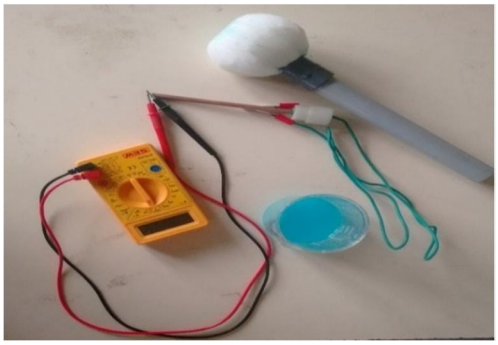


(Fig1. Concrete specimen)

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B. Half-Cell Apparatus

Half-cell apparatus is used to measure the potential difference between the surface of the concrete and the rebar inside the specimen. A half-cell apparatus consists of copper rod with a copper sulphate solution which is placed inside a non-conducting container. The container is sealed with a wooden cork to avoid leakage of copper sulphate solution. The cork is drilled about 1mm to supply sufficient amount of copper sulphate solution to conduct the test. One end of the copper rod is connected to the positive terminal of the multi-meter and the rebar is connected to the negative terminal of the multi-meter.

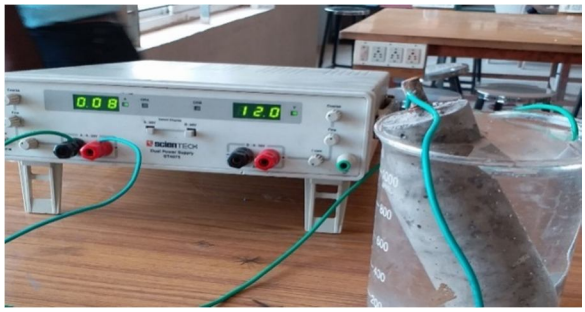


(Fig2. Half-cell apparatus)

III. EXPERIMENTAL STUDIES

A. Accelerated Corrosion Test

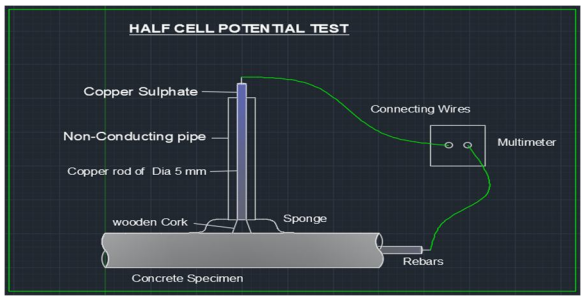
The accelerated test for the experiment was carried out in a non-coated rebar at room temperature by taking a casted concrete cylinder. The specimen was kept inside a glass beaker and it was filled with aqueous solution of NaCL of 3.5%. The rebar was acting as anode and the stainless steel was acting as cathode of the specimen. The test was continued for a time period till the crack was formed with 12V electric supply and the temperature was reading in every 24hr interval of time by the help of ammeter. The specimen was continuously examined having discolouring and cracking repeatedly and in a time with sudden rise of the reading in ammeter the reading indicated the onset corrosion and crack in the specimen.



(Fig3. Accelerated corrosion test)

B. Half-Cell Test

The specimen was wetted in the water for better conductivity of the cell. To know the reading in voltmeter, a multi meter was connected with the rebar and the test was carried out simultaneously with the accelerated corrosion test. The test reading was carried out showing the potential of the metal of the specimen.



(Fig4. Half-cell potential test)

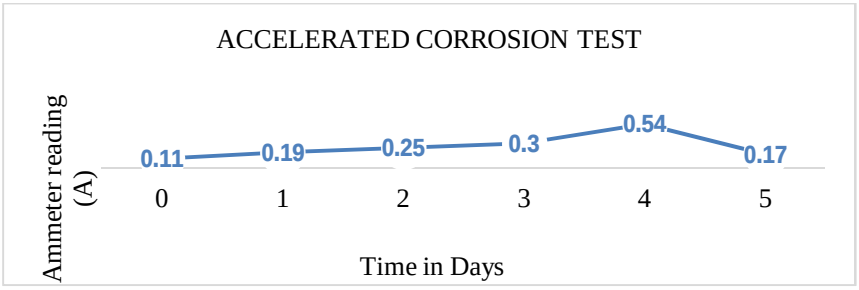
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C. Compression Test

The specimen which has been casted is placed under the compression testing machine. A uniform load is being applied until the specimen fails, and the maximum load carried by the specimen during the test is recorded and the reading is measured in terms of N/mm². The further calculation has been carried out.

IV. RESULT AND DISSCUSSION

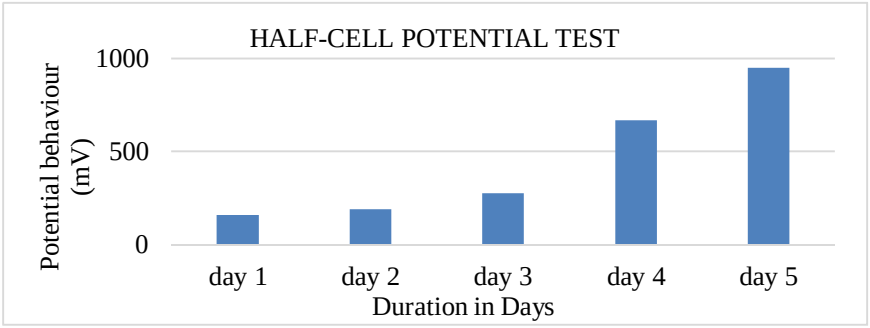
A. Accelerated Corrossion Test



(Graph1. Result for accelerated corrosion test)

The accelerated corrosion test results obtained in the terms of Ammeter readings. The initial reading has been noted and further readings are noted after every 24 hours since the test has been initiated. The test result shows that there is sudden increase and drop of the ammeter reading which indicates the failure or discolour has been occurred in the test specimen.

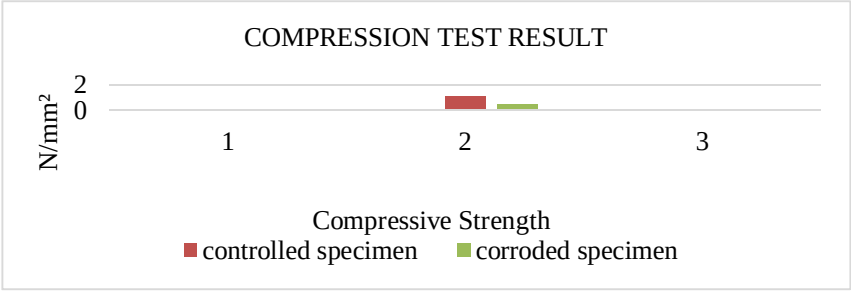
B. Half-Cell Potential Test



(Graph2. Results for Half-cell potential)

The accelerated corrosion test has been conducted from the day 1 to know the status of the specimens. The results have been obtained in terms of potential behaviour (mV). The steady increase in potential behaviour shows the rate of corrosion has been increased in the metal bar.

C. Compression Test



(Graph3. compression test result)

Compression test result clearly shows that the strength of the non-corroded specimen is high competitively to corroded specimen. Because while the rate of corrosion increases the strength of the specimen gets decreases.

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V. CONCLUSION

A half-cell potential device was successfully built, tested in marine environment and evaluated. The result of accelerated corrosion has been found from 0.11A to 0.17A on day1 to day 5 respectively. The potential behaviour value increases from 160 mV on day 1 to 949 mV on day which shows that the accelerated corrosion increases with increase in time. The compression test result for controlled specimen found to be 1.1 N/mm² which is higher than the corroded specimen having 0.5 N/mm². This is the one of the non-destructive test that can be promoted for monitoring the corrosion potential in building structures.

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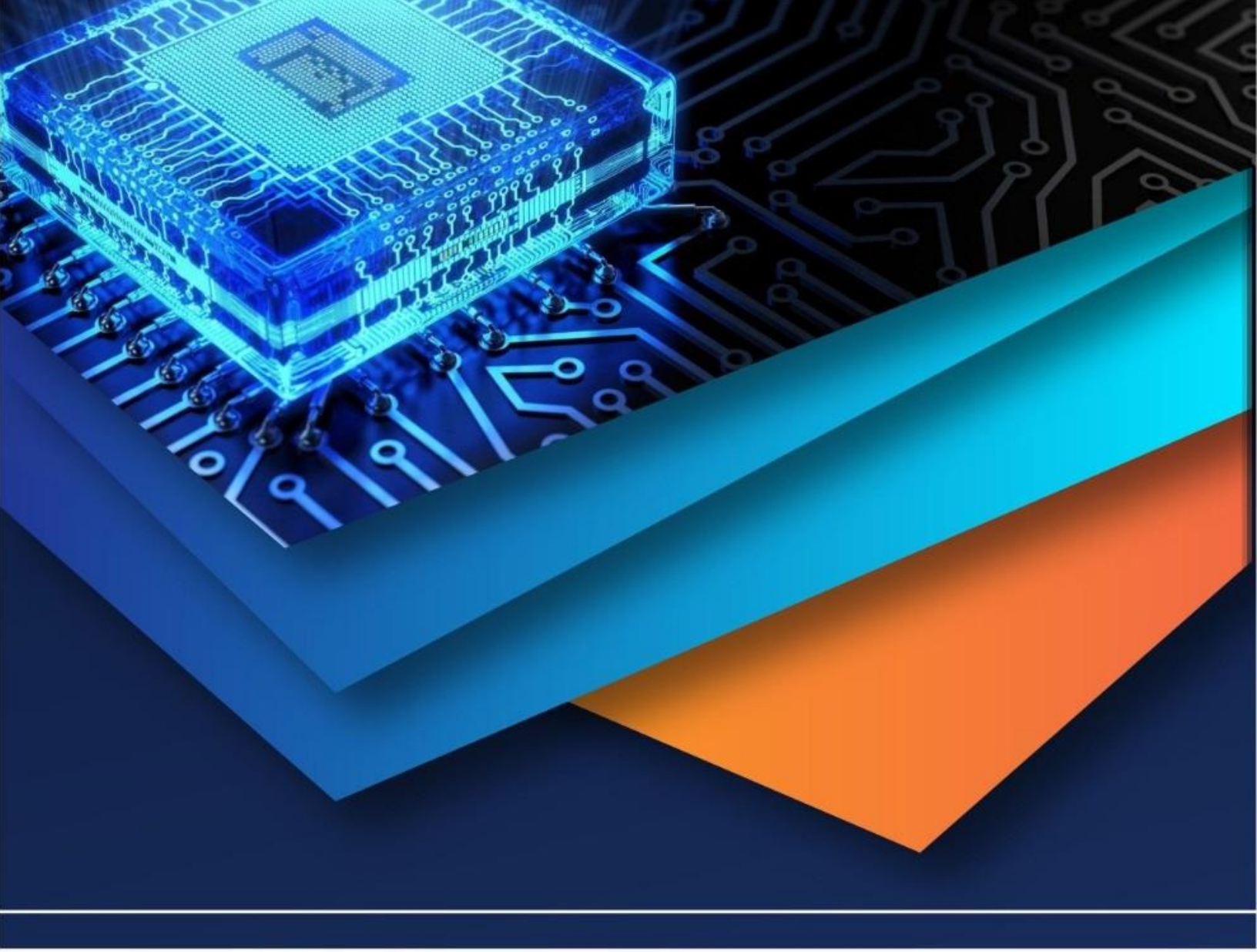
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