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HALF-CELL POTENTIOSTATIC STUDY 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 concrete of M25 grade. Half-cell potential test and accelerated corrosion test was 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 were plotted graphically and the result comparison of accelerated corrosion test and half-cell potential test was done to know the rate of corrosion occurred in the specimen. Obtained results clearly show that when rate of accelerated corrosion increases the rate of potential difference obtained in half-cell potential also increases. Compression test was carried in both controlled specimen and in the specimen subjected to accelerated corrosion.

Keywords- *Corrosion, Half-cell potential, Accelerated Corrosion, Marine environment, 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 as mentioned by Talakokulaa (2016) 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 these 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. this process has been considered by Ali Imam Sunny et al., (2014)

Before half-cell potential the specimen is subjected to electrochemical process as explaine by Ran Zhaoa et al., (2014) an electrochemical process is a redox reaction. Where, it consists of anode (+'ve') and cathode (-'ve'). Accelerated corrosion test is one of the electrochemical processes 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

Three concrete specimen of height 15 cm and 10cm diameter is casted with the dimensions mentioned in figure 1.

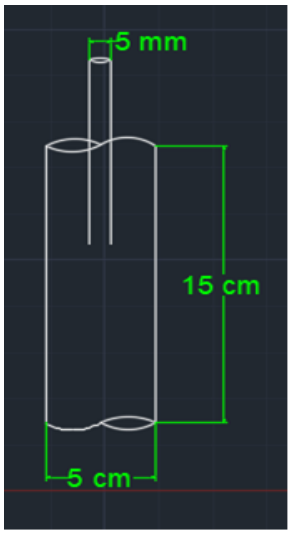


Fig. 1: concrete specimen

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.

III. 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 as shown in fig. 2 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.

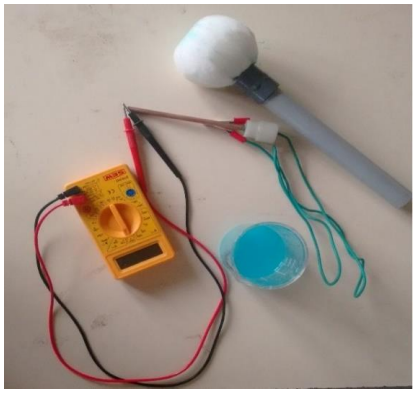


Fig. 2: Half-cell apparatus

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.

IV. EXPERIMENTAL STUDIES

ACCELERATED CORROSION TEST: Accelerated test is carried out as shown in fig. 3 in a non-coated rebar; this test is carried out in room temperature. A concrete cylinder which has been casted already is used for this test. The specimen is placed inside a glass beaker and filled with aqueous solution of NaCl solution of 3.5%. The rebar of the specimen acts as the anode and the stainless-steel acts as the cathode. A constant power supply of 12V is supplied throughout the course of the test. The ammeter reading is noted for every 24 hours (Ali et al., 2014, Zhaoa et al., 2014, Satheesh Babu et al., 2010, Talakokulaa et al., 2016)). The specimen is examined of discolouring and cracks regularly. A sudden increase of ammeter reading indicates the onset of corrosion and crack in the specimen.

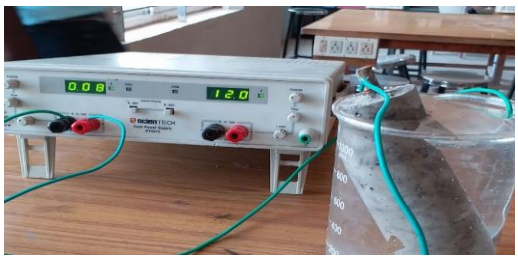


Fig. 3 Accelerated corrosion test

HALF-CELL TEST: Half-cell apparatus has been already built for this test as shown in fig. 4. The area of the specimen which needs to be scanned is wetted for better conductivity of the cell. The voltmeter reading is obtained by connecting a multi meter to the rebar. The test has been carried out simultaneously while the accelerated corrosion test is carried out. The test reading is obtained, the reading shows the potential of the metal of the specimen.

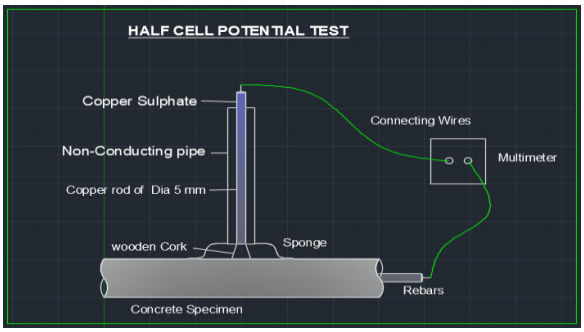
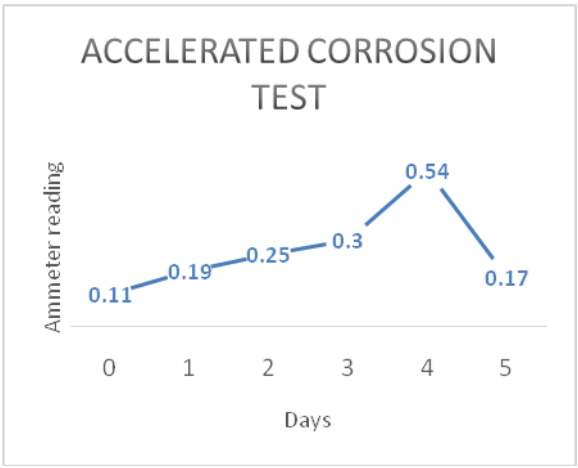


Fig. 4. Half-cell potential test

V. RESULT AND DISSCUSSION

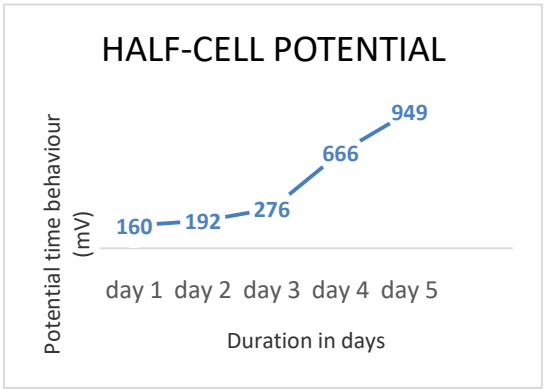
Accelerated corrossion test



Graph 1: 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.

HALF-CELL POTENTIAL TEST



Graph 2: Results for Half-cell potential

The accelerated corrosion test has been conducted from the day 1 since the accelerated corrosion test has been conducted. 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.

VI. CONCLUSION

A half-cell potential device was successfully built, tested in marine environment and evaluated. This is the one of the non-destructive tests that can be promoted for monitoring the corrosion potential in building structures.

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