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An Ecofriendly Inhibitor- Influence of Mollugo pentaphylla in Reinforced Concrete

I.Regina Mary, T.Bhagavathi Pushpa

Abstract: ***In reinforced concrete structures corrosion is the most destructive challenging problem. Many techniques are available to reduce corrosion. Extracts from plant have been used as a protective coating for steel reinforcement.The corrosion inhibiting nature of the extract of Mollugo pentaphylla in M20 grade concrete was examined in this paper.The cube casted were exposed to 3% NaCl for 56 days and it was investigated by using gravimetric method,pH measurement, open circuit potential test and compressive strength test. The compressive strength test was conducted after curing for 28 days. The inhibitor solution was prepared using distilled water and extract of Mollugo pentaphylla for 0%, 50% and 100% concentration. From the results it has been observed that the inhibiting efficiency increases with the decrease in concentration.***

Keywords: Mollugo pentaphylla,sodium chloride,inhibitor, open circuit potential test.

I. INTRODUCTION

Corrosion is explained as the theory of unwanted waste materials deposited due to the reaction between the outside environment and inside environment. During the reaction the metals are transformed into compounds and these compounds are the final products of corrosion. In the electrochemical process transfer of electrons between the metals and electrolyte solution occurs. This theory involves the oxidation and reduction reaction. The first and foremost things responsible for corrosive actions are acids, salts and alkali solutions. These agents react with water or any other media and cause corrosion.

Corrosion is an important and destructive phenomenon in the marine environment. When concrete is subjected to this saline nature there is an aggressive nature of deterioration of concrete. Corrosion of steel in concrete occurs when the outside environment affects the nature of pore solution in concrete. Due to permeability of water or other salts the pore solution gets affected. Due to the continuous permeable nature the whole structure gets affected as years go by and it is a world wide challenge. The passive film protective coating around the rebars are continuously disrupted due to salt penetrating inside the concrete.

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***** Correspondence Author
I.Regina Mary*, Department of Civil Engineering, Mount Zion College of Engineering and Technology, Pudukkottai, India. mail:reginadensingh2016@gmail.com
Dr.T.Bhagavathi Pushpa, Department of Civil Engineering,University College of Engineering, Ramanathapuram, India. Email:.pushpathillai@gmail.com

Additionally the O_2 and Carbon-dioxide also penetrates through the minute pores on the surface of concrete and destroys the protective coating surrounded on steel and thus increases the pH of the pore solution. through the concrete and thus destroy the passive film formed on the steel surface by lowering the PH of the ore solution .This process further increases the corrosion.In this paper efforts are made to know the influence of Mollugo pentaphylla extract in reducing corrosion of rebar inside the concrete.

Ginger extract can be used as an inhibitor for acid environment .This extract prevents the intrusion of corrosion in regard to the absorption of any other compounds on its surface.This extract can be used in waste water treatment as it has no effect on E.Coli[1].Hydrophobic green plant can be used as an mixed type inhibitor which is eco friendly passifying in salt environment[2].Cinnamon oil extract can be used as an inbhibitor upto 150 ppm. Copper corrosion is reduced by using this inhibitor in the medium of sulphuric acid[3].Turmeric and ginger extract can be used to reduce corrosion for mild steel in acid medium. From the results obtained it is concluded that turmeric performs better than rhizome extract.[4].Bitter leaf extract was used in acid medium to resist steel intrusion in concrete. The lesser the concentration of extract better is the performance of concrete [5].Green plant inhibitor can be used which is of low cost,effective,durable and eco-friendly[6].

II. MATERIALS & METHODS

Botanical Name:Mollugo pentaphylla(M.P)
Common name:Five leaved carpet weed
Collected : Near Coimbatore
Used as a medicinal herb

2.1 Preparation of extract solution:

The plant leaves of M.P was washed and dried for 10-12 hours. It was then powdered and mixed with the required methanol solution and soaked for 24 hours. After then it was filtered to remove the impurities. The plant extract was made up to 50% and 100% using distilled water. The acid medium was 3% NaCl, which means 3 grams of NaCl is dissolved in 1000 ml of distilled water.

2.2 Steel specimen:

The mild steel bar used in this experiment is of 12 mm diameter and 150mm long. The steel bar is cleaned with an abrasive paper to remove any impurities. The chemical composition of the mild steel rod in % is C = 0.32, Fe = 0.2,Cr = 4.66,Ni = 0.16,Mn = 0.41,S = 0.3 and remaining trace elements.

2.3 Concrete specimen:

Concrete used in this experiment is of M 20 grade 1:1.66:3.29,w/c ratio of 0.45 and OPC 53 grade cement was used. The specific gravity of fine aggregate was 2.32 and the specific gravity of coarse aggregate was 2.65 .The plant extract was added at the time of concrete preparation. The steel bar was immersed at the centre of concrete cube 150 mm X 150 mm X 150 mm size during casting. The exposed portion is 30 mm and the remaining 120mm is inside the concrete. The exposed steel is painted to prevent any corrosion at its layer.

Fig 2.1 Cube casting

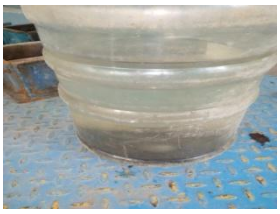

Fig 2.2 plant extract

2.4 Other methods

The other methods used in this experiment is gravimetric method(weight loss measurement),pH measurement and potential measurement for 0%,50% and 100% concentration of plant extract for the concrete cubes reinforced with steel bars.The compressive strength of concrete is also calculated for conventional concrete and plant extract mixed concrete after 28 days.

III. RESULTS & DISCUSSION

3.1 pH measurement

The pH values are measured for concrete cubes containing 0%, 50% and 100% concentration of M.P leaves extract. The pH values was measured with concrete cured after 28 days. After 28 days the specimens are immersed in 3% NaCl solution and measured after 7 days .The solution is changed once in a weak to rebound the corrosion properties. The pH values of 100% concentration shows a decreasing values when compared to conventional concrete and 50 % concentration of plant extract.

Table 3.1 pH readings

Exposure days	pH of Control concrete	pH of 50% concentration of plant extract	pH of 100% concentration of plant extract
0	11.02	11.57	10.82
7	10.32	11.59	10.27
14	10.21	11.32	10.33
21	10.42	10.84	9.56
28	9.74	10.68	9.32
35	9.72	10.37	9.29
21	9.48	10.22	8.81
49	9.30	10.07	8.78
56	9.32	9.86	8.62

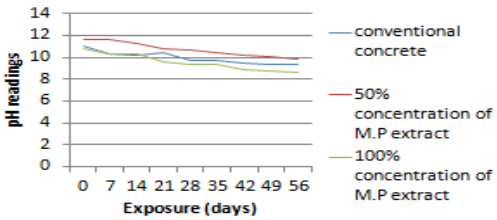

Fig 3.1 pH values

From the above table and graph it is inferred that with the increase in the percentage of concentration the pH values goes on decreasing. There are also some fluctuations in the values.

3.2 Open circuit Potential Test:

Cylindrical reinforced concrete specimens of size 50 mm diameter and 100 mm height were casted for all the three combinations. The cylinders were cured for 28 days. After 28 days the specimens were taken out and immersed in 3% NaCl solution in order to accelerate corrosion. The potential of the embedded rebar was measured against saturated calomel electrode (SCE) and taking readings using a multimeter. The potential readings were taken in a week once. The specimens are subjected to alternate wet and and dry condition for 3 days.

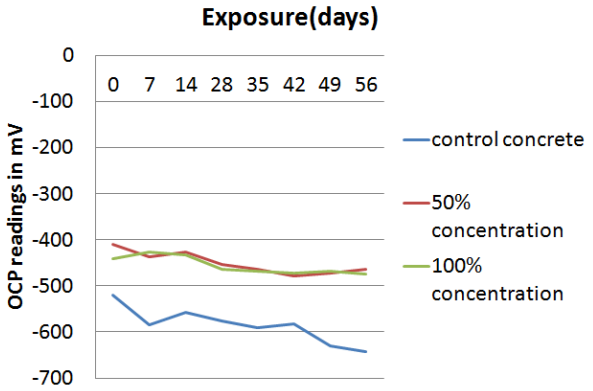

Fig 3.2 OCP readings

From the open circuit potential values it is very clear that with the addition of plant extract the potential readings are well behaved when compared to conventional concrete, more or less both concentrations are one and the same. It is less than -275 mV which indicates that there is less corrosion. During the exposure to 3% NaCl the plant extract combines with concrete and forms a passive coating around the steel which reduces the rate of corrosion.

3.3 Weight loss measurements

The rebars are weighed before casting of concrete. After the experiments are over the rebars are removed and measured. The initial weight, final weight and weight loss are shown in the following table.

Table 3.2 Corrosion inhibition of M.P plant extract

ID	Initial weight(mg)	Final weight(mg)	Loss of weight(mg)
Control concrete	125	123.5	1.5
50% concentration	110.1	109.7	0.2
100% concentration	111.2	111	0.4

From the above table it is understood that the inhibitor efficiency increases with the decrease in concentration of the extract. The loss of weight of steel is less for 50% concentration when compared to other concentration.

3.4 Compressive strength Test:

The compressive strength of concrete is an important factor in deciding the mechanical property of concrete. The steel is removed and the cubes are subjected to the compressive strength test.

The compressive strength result shows that the addition of higher concentration extract results in lower strength when compared to lesser concentration of plant extract.

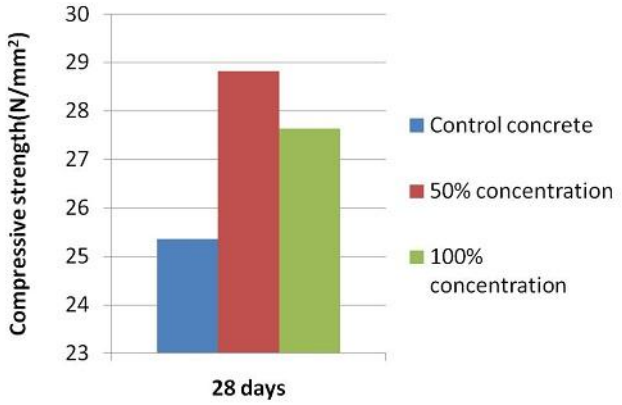

Fig 3.3- 28 days Compressive Strength values

From the results it is seen that the compressive strength of adding 50% concentration is greater than other two concentrations.

IV. CONCLUSION

The performance of Mollungo Pentaphylla plant extract was studied when incorporated into concrete.

- ✓ In the measurement of pH value the values goes on decreasing when the concentration of the plant extract increases. There are some remarkable variations due to the slow movement of ions in the electrochemical reaction. The intrusion of salt inside the concrete reduces and thus the pH of the pore solution is not altered.
- ✓ In open circuit potential test the behaviour of 50% and 100% concentration is almost the same. From the results it is seen that there is a formation of passive coating around the steel bars which reduces the permeability of NaCl inside the concrete and thus reduces the corrosion.
- ✓ In the gravimetric method the addition of 50% concentration exhibits lesser weight loss when compared to conventional concrete.
- ✓ The compressive strength shows greater strength for 50% concentration of plant extract when compared to conventional concrete.
- ✓ Hence it can be seen that the addition of 50% concentration of plant extract (Mollugo pentaphylla) in RCC shows good result when compared with conventional concrete.

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