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EXPERIMENTAL INVESTIGATION ON CORROSION RESISTING PROPERTY OF REINFORCED CONCRETE

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***Abstract*- The effect of inhibitors on the corrosion of reinforced steel in concrete (rebar) exposed to 5% NaCl solution has been studied by Impressed voltage method, Half-cell potentiometer. The Corrosion potential values and corrosion current are measured during impressed current technique applied on concrete specimen. The values from Half-cell potentiometer and Rapid Chloride penetration Test are co-related with each other at same current measurement to get the efficiency of the inhibitors at different concentration. The proportion of Natural inhibitors like JULIFERA, NEEM, in 5%, 10%,15% respectively is dissolved in 1000cc of developed primer to prepare 5%,10%,15%, concentration. The results show that the synthetic INHIBITOR acts as an excellent corrosion inhibitor with efficiency of 80.7% with increasing concentration of inhibitor, there is a regular increase in inhibition efficiency. However, at high amount of inhibitor there is a decrease in dispersion which may be related to the adsorption phenomenon.**

Keywords: Natural inhibitor, Synthetic Inhibitor, Corrosion

I. INTRODUCTION

Corrosion is a natural process of degradation of steel when in contact with atmosphere gas and moisture. In civil engineering, the Concrete structures durability is mainly affecting by life of steel that steel life reducing by corrosion. So research is going about prevention of corrosion. Prevention of corrosion by many methods, one of the best and easily applicable method is application of corrosion INHIBITORS. The degradation of reinforcing steel due to corrosion is predominant in concrete structures. Generally most structures are contaminated with chloride. In concrete structure the corrosion is occurs because of pores is present in concrete. Gas like carbon-di-oxide and moisture content entering into the pores then reacts with iron rod which is induce the corrosion progress. To avoid the entering moisture and carbon- di-oxide, **CONVENTIONAL CONCRETE** which is having low permeability and pore spaces shall be used. Applying corrosion inhibitors in form of coating on steel or coating in surface of concrete or mixing in concrete like admixtures. Here using coating of steel which forms as a passivation layer (protective layer) like primer that reduces the corrosion rate. Both **NATURAL AND SYNTHETIC INHIBITORS** are excellent corrosion inhibitors that is coating by % of weight of total.

II. EXPERIMENTAL METHOD

A. MATERIALS:

The following materials were used for this project, 1. Fe550 steel rods 16mm, 2.developed primer using polyurethane and zinc phosphate, 3.Ordinary Portland cement materials, 4. Stainless steel plate mesh, 5. Electricals setup for impressed voltage corrosion technique, 6. NaCl as electrolytic solution.

Material characteristics:

METHOD:

Making of Developed Primer: It is a trial and error process with combination of Polyurethane resin, Zinc phosphate, Turpentine. The trial with 40% of polyurethane resin, 35% of Zinc phosphate, 25% of Turpentine has the optimun dispersion consistency so trail 3 is taken as Developed Primer ratio.

Polyurethane resin	50%	
Zinc phosphate 83	40%	TRIAL 1
Turpentine	10%	

Polyurethane resin	40%	
Zinc phosphate 83	40%	TRIAL 2
Turpentine	20%	
(OPTIMUM DISPERSION)		
Polyurethane resin	40%	
Zinc phosphate 83	35%	TRIAL 3
Turpentine	25%	

Making of CONTROL MIX CONCRETE: Mixing of cement, fine aggregates, coarse aggregates and water. For getting the expected strength water cement ratio may be fixed from the standard graph.

Making of NATURAL INHIBITOR:

NEEM: Azadirachta indica (AZI, commonly recognized as "Neem") is noteworthy both for its chemical and for its biological actions. Tannin content in neem act as corrosion inhibitor Neem is taken and the leaves are powdered. Then they are dissolved in the ethanol for dissolving and kept in both higher and lower concentration. Then they are made to evaporate and the thick concentration liquid is taken as the inhibitor.

JULIFERA: MESQUITE

(PROSOPIS JULIFERA)

They are a shrub that grows upto 12m. Julifera is taken and the leaves are powdered. Then they are dissolved in the ethanol for dissolving and kept in both higher and lower concentration.Then they are made to evaporate and the thick concentration liquid is taken as the inhibitor.

III. ELECTRO-CHEMICAL PROCESS: M40 CONCRETE

- Specimen dimensions: 50mm diameter and 100mm height of cylinder.
- Only one sample is taken as O% and 3 samples are taken for 5%, 10%, and 15% for natural inhibitor 1 and similarly for other natural inhibitors 2.
- 3 samples are taken for chemical inhibitor 1 as 5%, 10%, 15% and other 3 samples for chemical inhibitor 2.
- The concrete cylinders specimens immersed in 5% NaCl solution containing box.
- Then constant DC supply (10V to 12V) applying all the rebar takes as a positive (parallel connection for to avoid the dividing the volts) and stainless steel plate takes as negative, both the terminals are connected to the voltage regulator equipment.
- From that day readings has to be noted.

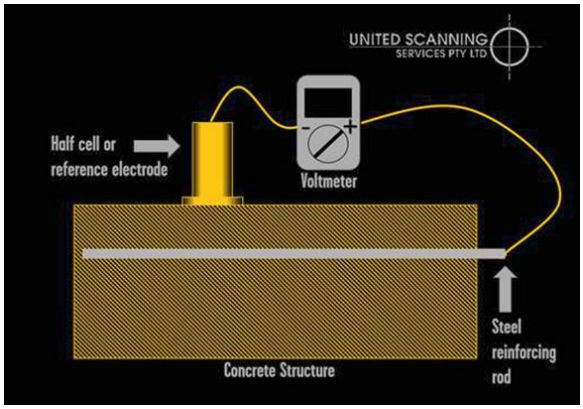
(Impressed current technique experimental setup)

IV. CORROSION TESTS

Corrosion tests are conducted to the all cylinders.

1. HALF-CELL POTENTIAL TEST

It is an electrochemical method for corrosion rate measurement is the simplest monitoring technique. In this test copper – copper sulphate half cell was used according to ASTM – C 876-87 G3. The copper sulphate solution poured into half cell container and 3mm copper rod inserted to the half cell container it's called as electrode. Then the electrode is connected in negative terminal in voltmeter with the help of wire.



Now the iron rod is cleaned then positive clamp is attached to that, at a same time the electrode is placed on concrete surfaces at 2 or more close intervals

The whole test should conducted in dry condition for specimens. Not to be directly measured while immersing or current impressing technique progress.

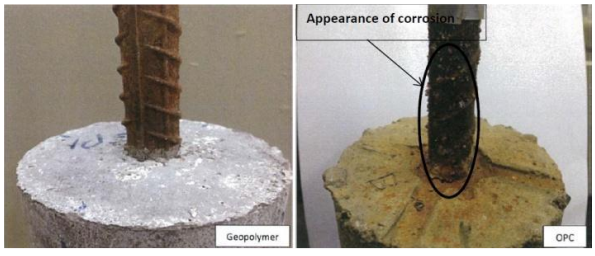
Neem- 125mV in M40 concrete

Julifera- 112mV in M40 concrete

The Julifera gives the best results in M40 concrete when compared to Neem as inhibitor

V. CORROSION RATE MEASURMENT AFTER IMMERSION DURATION

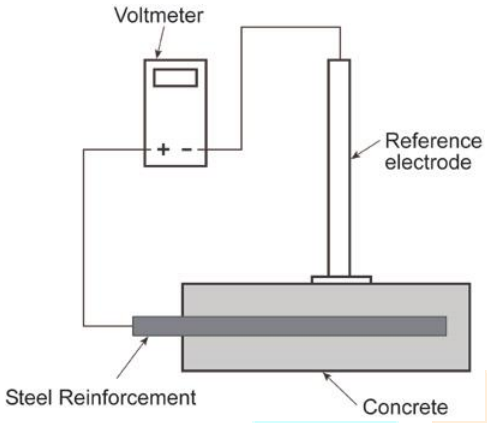
It is evident that the corrosion rates of the unprotected carbon steel increased dramatically from 0.8mm/yr to 0.9mm/yr and then reduced slight to 0.0885mm/yr at the end eight weeks. On the other hand, Zinc Phosphate inhibitors proved to be effective at 2% v/v in 5%NaCl solution. In similar trend, Corrosion rates for samples with calcium nitrite inhibitors increased from 0.005 mm/yr in day 7 to 0.0066 mm/yr in the second week and declined significantly to 0.007 mm/yr at the end of test. The presence of tannins, alkaloids and saponnins in verrnonia amygdalina act as a barrier on the metal surface, thus preventing the diffusion of ions from the surface of a corroding their by blocking the anodic or cathodic site which consequently reduces corrosion rates.



Corrosion of steel in Julifera and Neem

VI. INHIBITION EFFICIENCY

Julifera as inhibitor with developed primer gives more efficiency than neem as inhibitor with developed primer. This is because the alkaline property in neem is less than Julifera and thus the efficiency is reduced. So, we suggest using Natural Inhibitor Julifera with developed primer to prevent corrosion in M4o grade conventional concrete



Half cell potential experimental setup

VII. CONCRETE EFFICIENCY

The ordinary control mix concrete is applicable for the Natural and synthetic Inhibitors. Whereas M40 grade concrete has low porous property to prevent corrosion inhibiting property and shows a good result towards Natural Inhibitors and synthetic Inhibitor. M40 grade of concrete has more structural advantages is taking high compression etc.., when gives good bonding with Natural Inhibitors and synthetic inhibitor. So, we suggest the use of M40 grade concrete as a perfect for structural elements.

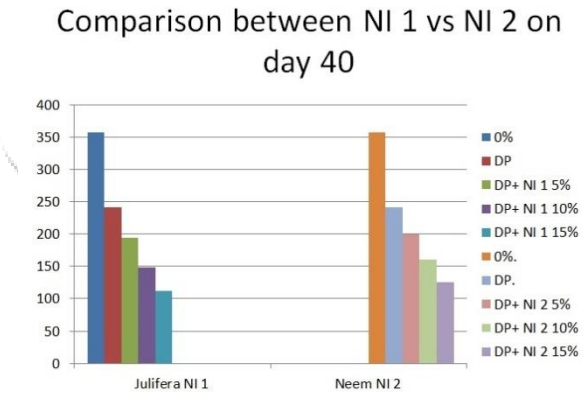
VIII. CONCRETE RESISTIVITY

The zinc phosphate inhibitors assumed a lower resistant position. This is in accordance with the previous study. The lower resistivity is due to higher ions as a result of the presence of sodium and nitrite in the aqueous phase filling the pores capillary according to Morris , Reinforcing steel are in active corrosion risk and when resistivity is below 10k Ω centimetre and attain passivity and resistivity greater than 30k Ω centimetre . Previously study reveals that resistivity above 20kΩ centimetre indicates negligible corrosion risks while between 10k Ω cm to 20k Ω cm suggest low corrosion risk . However 5% weight zinc phosphate exhibits a lower resistivity of about 15k Ω cm is experimentally confirmed by the above reasons. In addition it is also obvious to reiterate that zinc phosphate inhibitor gives optimum inhibition effect in concrete with inhibition composition between 2-3%wt by cement.

IX. CONCLUSION

The results of half-cell potentiometer it is observed that on increasing days of induced corrosion the intensity of rate of corrosion is increased in every sample. By comparing the samples it is observed that on increasing rate of corrosion sample with zero coating has high intensity of corrosion and minimum in developed primer with 15% of Julifera as natural inhibitor. Even though there is minimum rate of corrosion in developed primer with 15% of Julifera as natural inhibitor sample, the powder volume concentration value (PVC value) is high so the mode of applying the paint makes difficult in manual and spray action, so adaptation of developed primer with 10% of Julifera as natural inhibitor is feasible and easy mode of application on steel and the intensity of corrosion is also minimum.

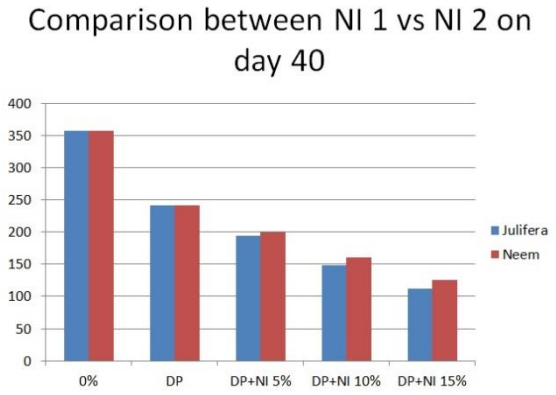
Neem which is used as an other natural inhibitor shows similar results but intensity of corrosion is bit high than Julifera and also neem has more medicinal values which is commonly used by human race for betterment of health parameter .So usage of Julifera as corrosion inhibitor is more efficient and environmental friendly.it.



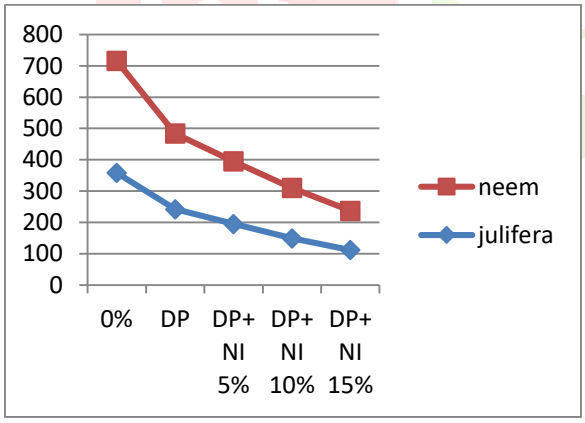
COMPARATIVE RESULTS

INHIBITION EFFICIENCY

Efficiency in PERCENTAGE (%)



INHIBITOR % / CONCRETE	0%	DP	DP+ NI 5%	DP+ NI 10%	DP+ NI 15%
Julifera	**358**	**242**	**195**	**149**	**112**
Neem	**358**	**242**	**200**	**161**	**125**



X. REFERENCES

1. S. Elliott, R. Hristova, J.J. Beaudoin, B. Brousseau RandBaldock. "A study of corrosion inhibition performance in chloride contaminated concrete by electrochemical impedance spectroscopy". *ACI Materials Journal.5: 385-395. DhouibiL, TrikiE and RaharinaivoA. 1988.*

2. C.A Loto, R.T Lot and A.P.I Popoola.. "Effect of Neem leaf (*Azadirachitaindica*) extract on the corrosion inhibition of mild steel in dilute acid". *International Journal of Physical Science.6(9):2249-2257.*

3. F.A Ayeni., I.A Madugu, P.Sukop, Ihom., O.A.PAlabi, R.Okara and M.Abdulwahab. Effect of aqueous extracts of bitter leaf powder on the corrosion inhibition of Al-Si Alloy in 0.5M caustic soda solution. *Materials Characterization and Engineering.11:667-670.*

4. D.G. Eyu, H. Esah., C. Chukwuekezie., J. Idris and I. Mohamad, Effect of green inhibitors on the corrosion behaviour of reinforced carbon steel in concrete. *Corrosion Prevention and Control Journal.50:43-49.*

5. Y.P. Asmara., J.P. Siregar., C.Tezara., Wan Nurlisa and Jamiluddin., Long term corrosion experiment of steel rebar in flyash based Geo-polymer concrete in NaCl solution.

6. P Gu, S Elliott, R Hristova, J.J Beaudoin, R Brousseau and B Baldock. A study of corrosion inhibition performance in chloride contaminated concrete by electrochemical impedance spectroscopy.*ACI Materials Journal. 5: 385-395.*

7. L Dhouibi, E Triki and A Raharinaivo. Laboratory experiments for assessing the effectiveness of inhibitors against steel corrosion in concrete. *Proceedings of the sixth international symposium on advances in electrochemical science and technology. Chennai, Indian.*

8. C.A. Loto, R.T. Loto and A.P.I. Popoola. Effect of Nee leaf (Azadirachita indica) extract on the corrosion inhibition of mild steel in dilute acid. *International Journal of Physical Science. 6(9): 2249-2257.*

9. F.A Ayeni, I.A Madugu., P. Sukop, A.P Ihom, O.Alabi, R.Okara and M. Abdulwahab. Effect of aqueous extracts of bitter leaf powder on the corrosion inhibition of Al-Si Alloy in 0.5M caustic soda solution. *Materials Characterization and Engineering. 11: 667-670.*

10. C.A. Loto. The effect of bitter leaf on the inhibition of mild steel in HCl and H2SO4. *Corrosion Prevention and Control Journal. 50: 43-49.*

11. S.A Ali, H.A Al-Muallem, S.U. Rahman and M.T. Saeed. Bis-isoxazolidines: A new class of corrosion inhibitors of mild steel in acidic media. *Corrosion Science. 50(11): 3070-3077.*

12. M.A.G Tommaselli, N.A. Mariano and S.E Kuri. "Effect of Corrosion inhibitor in saturated calcium hydroxide solution acidified by acid rain compound". *Construction and Building materials.23(1): 328-333.*

13. H Arup. corrosions centralen. (The mechanisms of the protection of steel by concrete. (1st Ed.). *Published Ellis Horwood Ltd. Chichester. p. 151*.

14. L Bertolini, B Elsener, P Pedeferri. and R Polder. Corrosion of steel in concrete. *Wiley-VchVerlag GmbH and Co KGaAWeinheim. p. 243.*

15. M Collepardi, R Fratesi. and G Moriconi. Use of nitrite salt as corrosion inhibitor admixture in reinforced concrete structures immersed in sea-water. *Enco. Engineering Concrete, Spresiano, Italy.*