# Influence of Natural extract of Hibiscus on the corrosion resistance of mild steel immersed in Reinforced concrete

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## *Abstract*

*To measure the corrosion resistance of mild steel rod in the presence and absence of natural inhibitor in Reinforced concrete, which is immersed in the concrete mixture prepared in well water in the presence and absence of natural inhibitor. It is cured for seven days, after that period the mild steel specimen immersed in concrete is subjected to polarization study and AC impedance spectra in 3.5% NaCl solution, and the influence of inhibitor on strength of the concrete is measured by compressive strength test method.*

***Keywords:*** *Mild steel, concrete corrosion, Hibiscus, Natural inhibitor*

## 1. Introduction

In construction reinforced concrete is widely used engineering material, and its durability is a most important problem disturbing the service life of the engineering structures due to the corrosion of steel structures inside the reinforced concrete. Which results in a vast damage to men and economic loss. In general reinforcing steel inside the concrete structures can be protected from corrosion by forming a compact passive film by the basic medium (pH 12.5-13.5) of concrete pore solution. Still the passive film can be damaged on the surface and leads to the corrosion of reinforcing steel structures due to various external factors. When pH or the chloride concentration at the Steel/ concrete interface, reach the critical values for corrosion [1-3]. The pH of concrete pore solution decreased during concrete. In the present study natural inhibitor. Hibiscus is chosen to study their corrosion inhibition property on mild steel in reinforced concrete. The inhibition property of this natural inhibitor are studied by polarization study and the influence of inhibitor on strength of the concrete is measured by compressive strength test method.

## 2. Methods and Results

### 2.1 Preparation of Concrete Mixture

The type of cement used in this study is Ordinary Portland Cement (Ultra tech) 43 grade, river sand conforming to zone II, as per IS 383-1970, coarse aggregate 6 mm size are selected. The concrete mixture ratio is 1:2:4. That is cement is 50g, sand is 100g and coarse aggregate is 200g. The grade of concrete used for this research work is M20 and the mixture ratio of concrete is 1:1.5:3 with water cement ratio is 0.42 and natural inhibitor dissolved in well water and the extract is used for concrete mixture preparation [4-5].

### 2.2 Analyses of Potentiodynamic Polarization Study and Ac Impedance Spectra

Electrochemical study such as Polarization study has been used to substantiate the development of protective film on the metal surface during corrosion inhibition process [6 - 7]. If a protective film is formed on the metal surface, the linear polarization resistance value (LPR) increases and the corrosion current value ($I_{corr}$) decreases and the values are given in the Table 1.

AC impedance spectra (electro chemical impedance spectra) have been used to substantiate the development of protective film formed on the metal surface [8-10]. If a protective film is formed on the metal surface, the charge transfer resistance ($R_t$) increases, double layer capacitance value ($C_{dl}$) decreases and the impedance log (z/ohm) value increases are given in the Table 2. It is observed that in the presence of inhibitor the corrosion resistance of mild steel increases. This is substantiated by the fact that in presence of inhibitor, linear polarization resistance value increases, corrosion current decreases, charge transfer resistance value increases, impedance value increases and double layer capacitance value decreases.

**Table 1 Corrosion parameters of mild steel immersed in Concrete mixture prepared in well water in the absence and presence of Hibiscus inhibitor system obtained from Potentiodynamic Polarization Study**

| Concrete System | Ecorr mV vs SCE | bc mV/ decade | ba mV/decade | LPR Ohm cm2 | Icorr Acm-2 |
|---|---|---|---|---|---|
| (blank) | 985 | 270 | 78 | 941 | 2.80 x10-5 |
| HIBISCUS | -1038 | 161 | 289 | 30341998 | 1.475 x10-9 |

**Table 2 Impedance parameters of mild steel immersed in Concrete mixture prepared in well water in the absence and presence of Hibiscus inhibitor system obtained from AC impedance spectra**

| Reinforced concrete System | Nyquist plot | | Bode plot |
|---|---|---|---|
| | Rt ohm cm2 | Cdl F/cm2 | Impedance value log (z/ohm) |
| Absence of inhibitor | 40.36 | 12.6 x10-8 | 1.176 |
| Presence of hibiscus extract | 4943 | 10.31 x10-10 | 6.851 |

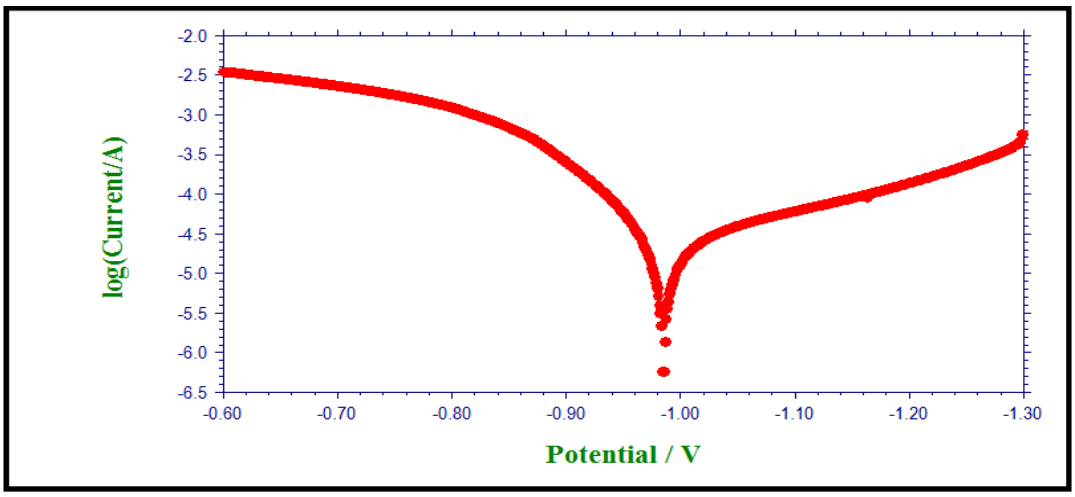


**Fig 1 Polarization curve of mild steel immersed in Concrete**

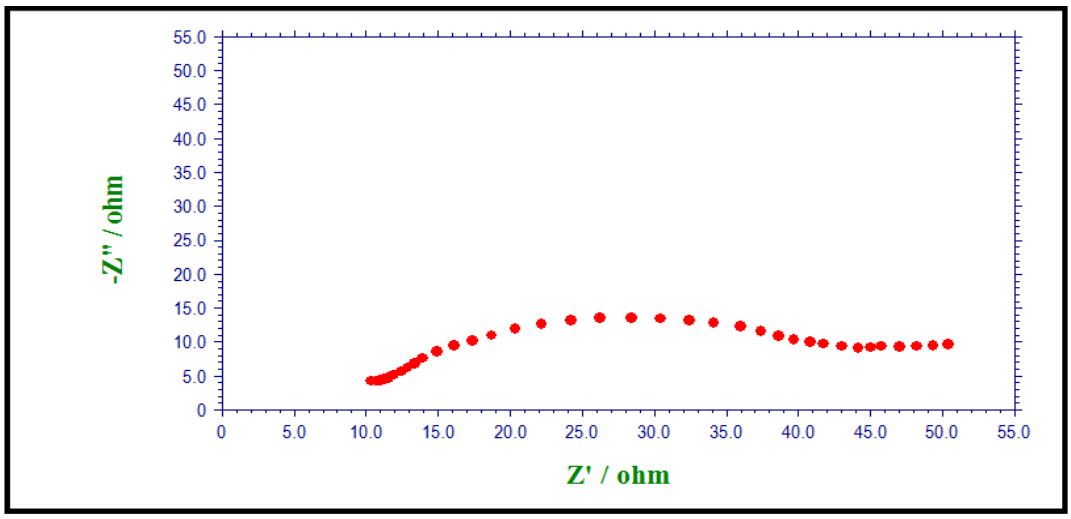


**Fig 2 AC Impedance spectra of mild steel immersed in Concrete (Nyquist plots)**

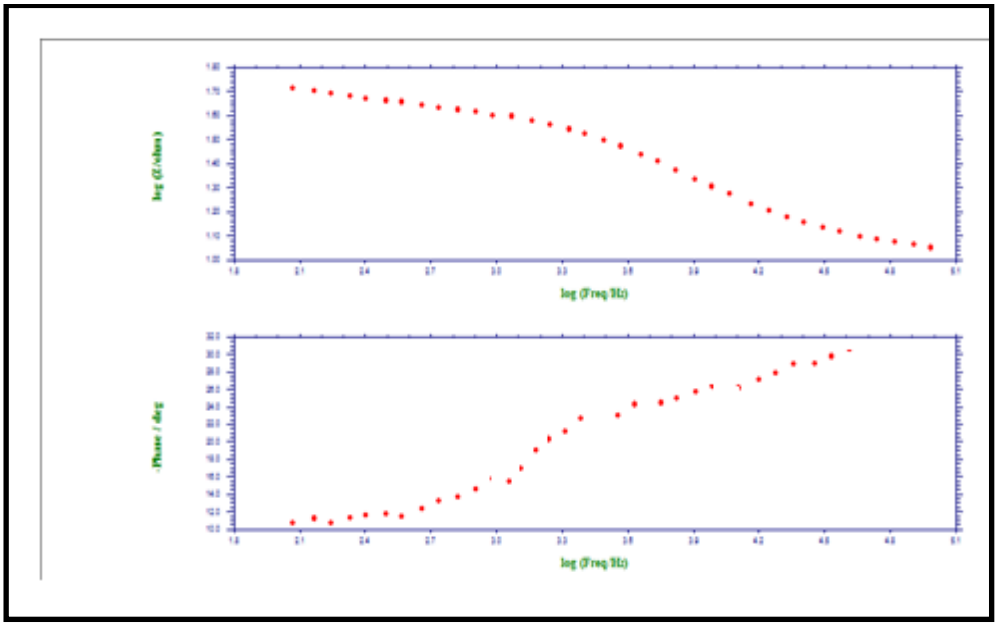

**Fig 3 AC Impedance spectra of mild steel immersed in Concrete (Bode plots)**

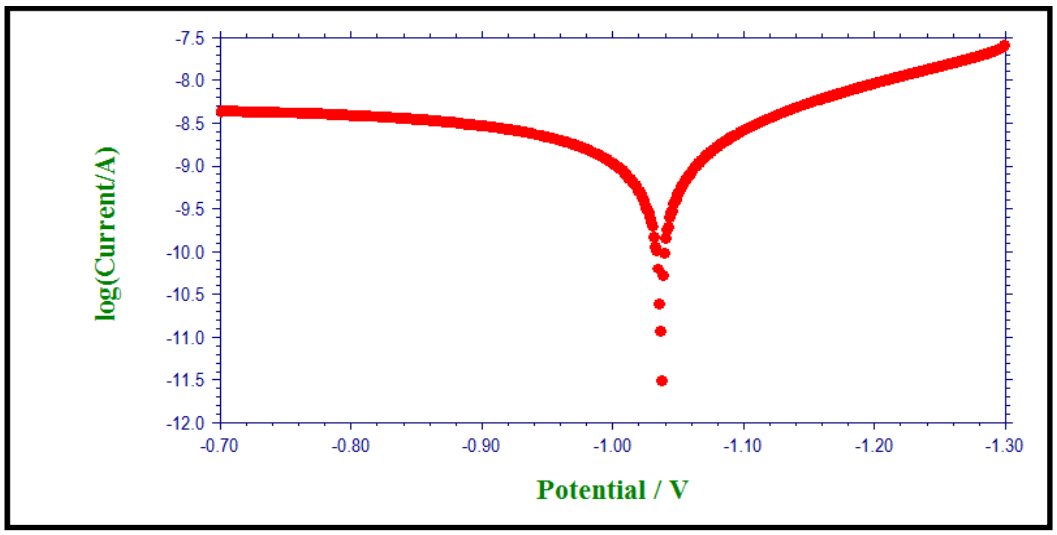


**Fig 4 Polarization curve of mild steel immersed in Concrete with Hibiscus extract**

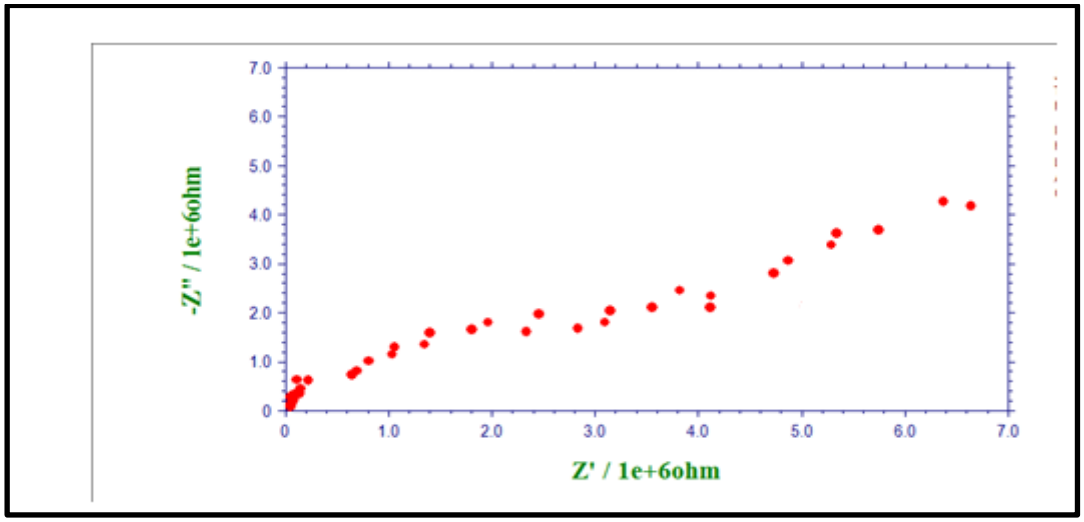


**Fig 5 AC Impedance spectra of mild steel immersed in Concrete with Hibiscus extract (Nyquist plots)**

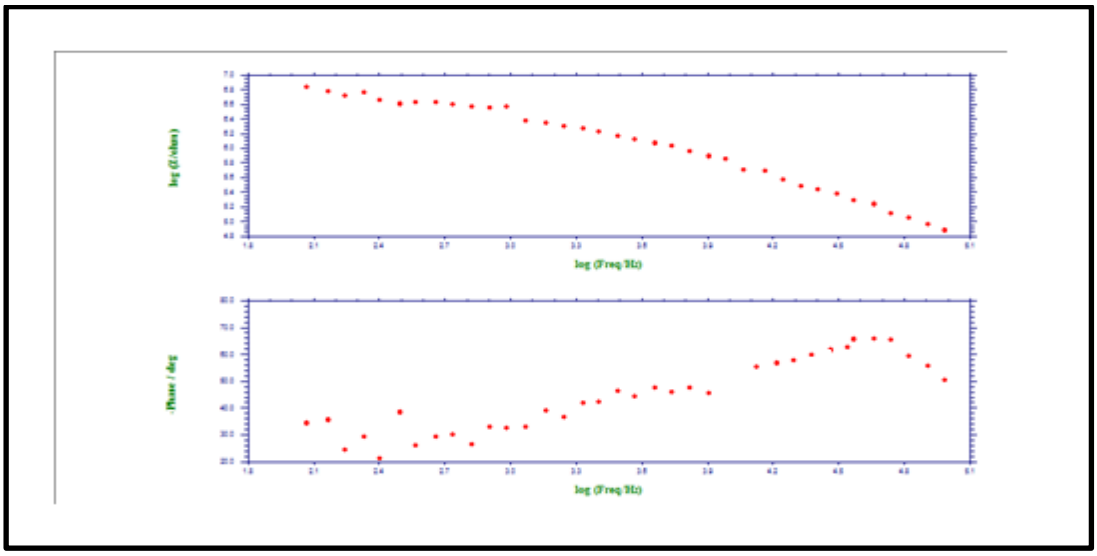

**Fig 6 AC Impedance spectra of mild steel immersed in Concrete with Hibiscus extract (Bode plots)**

### 2.3 Analysis of Compressive Strength

The compressive strength results of cubes after 7 and 28 days of curing are given in the Table 3 without inhibitor the compressive strength of concrete are 17.50 N/mm$^2$ for 7 days and 28.60 N/mm$^2$ for 28 days. When 5% of Hibiscus extract is added as admixture in the concrete the compressive strength increases to 17.54 N/mm$^2$ for7 days and 23.80 N/mm$^2$ for 28 days respectively [11-15]. From the compressive strength results it is evident that Hibiscus extract inhibitors show a slight increase in concrete compressive strength when compared to control specimen.

**Fig 7 Testing of compressive strength of Cube**

**Table 3 Compressive Strength of Concrete Cube, M20 Grade Concrete**

| S.No | Specimen Description | Compressive strength in N/mm2 | |
|---|---|---|---|
| | | 7 days | 28 days |
| 1. | Absence of Hibiscus extract in concrete | 17.50 | 24.60 |
| 4. | Presence of Hibiscus extract in concrete | 17.54 | 24.85 |

## Conclusion

- The mild steel specimens immersed in concrete with natural extract was subjected to polarization study and AC impedance spectra in 3.5% NaCl solution. It is observed that in the presence of inhibitors the corrosion resistance of mild steel increases.
- This is substantiated by the fact that in presence of inhibitors, linear polarization resistance (LPR) value increases, corrosion current decreases. Charge transfer resistance value increases, impedance value increases and double layer capacitance value decreases.
- From the results of the compressive strength tests, it is observed that the inhibitor added specimens show slightly a higher strength than the control specimen. The only reason for improvement of strength is bonding. The natural inhibitors have good bonding property with concrete mixture.
- The compressive strength results show that addition of natural inhibitor as admixtures does not decrease the strength of concrete any way.

## ACKNOWLEDGMENT

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