



Article Title: Experimental Investigation on Corrosion Prevention in RCC by Enhancing the Durability Properties using Organic and Inorganic Additives

Experimental Investigation on Corrosion Prevention in RCC by Enhancing the Durability Properties using Organic and Inorganic Additives

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ABSTRACT

Corrosion of reinforcing steel and other embedded metals is the leading cause of deterioration in concrete. When steel corrodes, the resulting rust occupies a greater volume than the steel. This expansion creates tensile stresses in the concrete, which can eventually cause cracking, delamination, and spalling. General corrosion occurs when most or all of the atoms on the same metal surface are oxidized, damaging the entire surface. There has been increasing search for organic and inorganic corrosion inhibitors, due to the toxic behavior of some inhibitors. Green inhibitors are the compounds containing one or more polar groups such as O, N, P, S atoms and π electrons which prevent corrosion on the metal surface. In this experimental project, the inhibitors are added as three proportions of inhibitors while giving coating to the steel bar. Neem powder, Zinc powder, fine aggregate, coarse aggregate, water were the materials used for this investigation. Considering the mechanical and durability properties, it was found that increase of organic inhibitors gave better strength to the concrete than inorganic inhibitor and reduces the corrosion compared to the conventional concrete. An organic inhibitor coating given to the steel bar increased the bond strength and well behaved in durability testing.

Keywords: Neem powder, Zinc powder, Aloe vera gel, Corrosion resistance, Durability properties.

1 Introduction

Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement that hardens over time. Concrete, in itself, has poor tensile strength. To increase the tensile strength of concrete, steel reinforcement is used. Steel bars are embedded within the concrete mass. These steel bars carry most of the tensile load applied to the concrete. The concrete renders the steel bars passive due to its highly alkaline nature, thus preventing them from corrosion. Still, due to various other reasons, the steel bars may get corroded over a long period of time. And due to the corrosion of the steel bars, various



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weaknesses arise in the concrete structure, which may eventually collapse if not taken proper care of within suitable time.

Corrosion of steel reinforcement bars is basically an electrochemical reaction. Corrosion of reinforcing steel and other embedded metals is the leading cause of deterioration in concrete. When steel corrodes, the resulting rust occupies a greater volume than the steel. This expansion creates tensile stresses in the concrete, which can eventually cause cracking, delamination, and spalling. Steel corrodes because it is not a naturally occurring material. Rather, iron ore is smelted and refined to produce steel. The production steps that transform iron ore into steel add energy to the metal.

2 Materials and Methods

The methodology adopted in this experimental work includes Investigation of corrosion resistance using organic and inorganic inhibitors, Material study and testing of materials, Fresh concrete tests, Casting of cubes with 2.5g, 5g & 7g of inhibitors with 50ml, 100ml & 150 ml of their corresponding gels, Harden concrete test, Result and conclusion.

The organic inhibitors used in this experiment are neem powder and aloe vera gel. The inorganic inhibitor used are zinc powder and sodium silicate gel.

3 Proposed Work Explanation

3.1 Preparation of Organic Extract

2.5g of Neem powder has been weighed. The weighed powder was soaked in a 50ml distilled water and the certain quantity of Aloe-Vera gel also added for the gel consistency. It was heated for 60°C and after that it was left for cooling. Finally the extract was filtered twice without any solid particles. Same as the above repeated for 5 g of neem powder soaked in 100 ml and for 7.5g of Neem powder soaked in 150 ml.

3.2 Preparation of Inorganic Extract

2.5g of zinc powder has been weighed. The weighed powder was soaked in a 50ml sodium silicate gel. Same as the above repeated for 5g of zinc powder soaked in 100 ml and for 7.5 g of zinc powder soaked in 150 ml of sodium silicate gel.

4 Results and Discussion

Quality tests on concrete are performed as a part of quality control of concrete structures. Different quality tests on concrete such as compressive strength tests, slump tests, permeability tests etc. are used to assure the quality of the concrete that is supplied for a given specification. The 1500mm x 150mm x 100mm specimen was used for both tests. 12 mm diameter of steel bar is used. The universal testing machine was used for loading.



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4.1 Compressive Strength Test

The compressive strength of any material is defined as the resistance to failure under the action of compressive forces.

Table 1: *Compression test on cubes*

Percentage of compound added	Load (KN)	Compressive strength 14 days(N/mm ²)	Compressive strength 28 days(N/mm ²)
0	100	18	17.4
O (2.5%)	85	14	15.6
O (5%)	90	16.9	16.8
O (7.5%)	115	16.8	19.9
IO (2.5%)	85	14.6	15
IO (5%)	85	16.3	15.4
IO (7.5%)	100	16.6	17.1

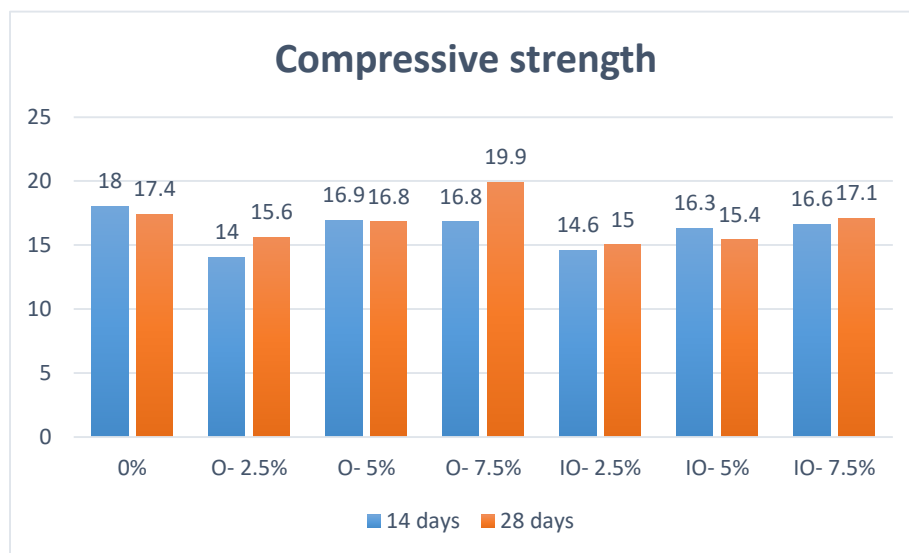


Figure 1: *Graphical representation of compressive strength*

4.2 Split Tensile Test

Table 2: *Split tensile test on cube*

Sl.no	Curing period in days	Failure load (KN)	Ultimate tensile strength (N/mm ²)
1	14	120	1.69



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2	28	170	2.41
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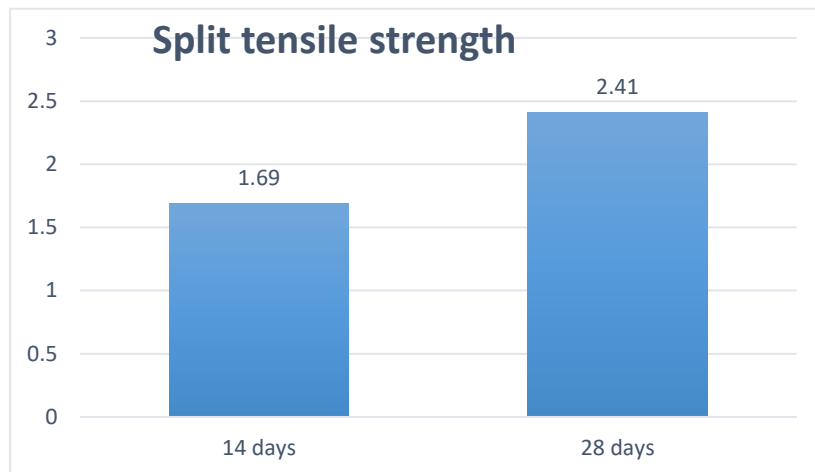


Figure 2: Graphical representation of tensile strength

4.3 Flexural Strength Test

Flexural strength of concrete beam specimens are tested after 28 days. The test is done by using Universal testing machine.

Table 3: Flexural strength test on cubes

Percentage of inhibitor added	Flexural strength 14 days(N/mm ²)	Flexural strength 28 days(N/mm ²)
0	3.42	4.18
O (2.5%)	3.53	4.36
O (5%)	3.59	4.51
O (7.5%)	4.12	4.95
IO (2.5%)	2.91	3.98
IO (5%)	3.46	3.51
IO (7.5%)	3.99	4.47



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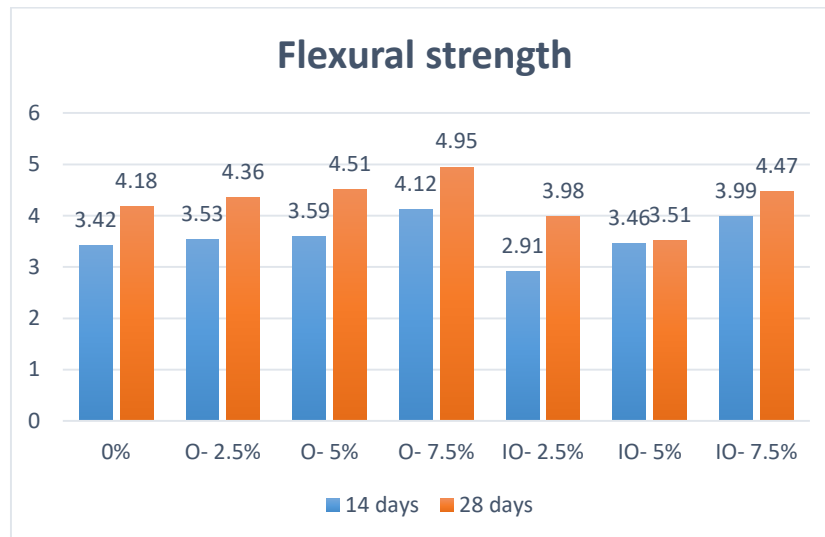


Figure 3: Graphical representation of flexural strength

4.4 Water Absorption Test

Water absorption is used to determine the amount of water absorbed under specific condition. The specimen coated steel bar using organic and inorganic inhibitor were cured for 14 and 28 days and examined.

Table 4: Water absorption test on cubes

Percentage of sample added	Weight loss in % 14 days	Weight loss in % 28 days
0	24.2	32.8
O (2.5%)	18.5	22.8
O (5%)	15.9	19.5
O (7.5%)	12.6	17.7
IO (2.5%)	19.7	27.7
IO (5%)	16.8	22
IO (7.5%)	23.2	34.5



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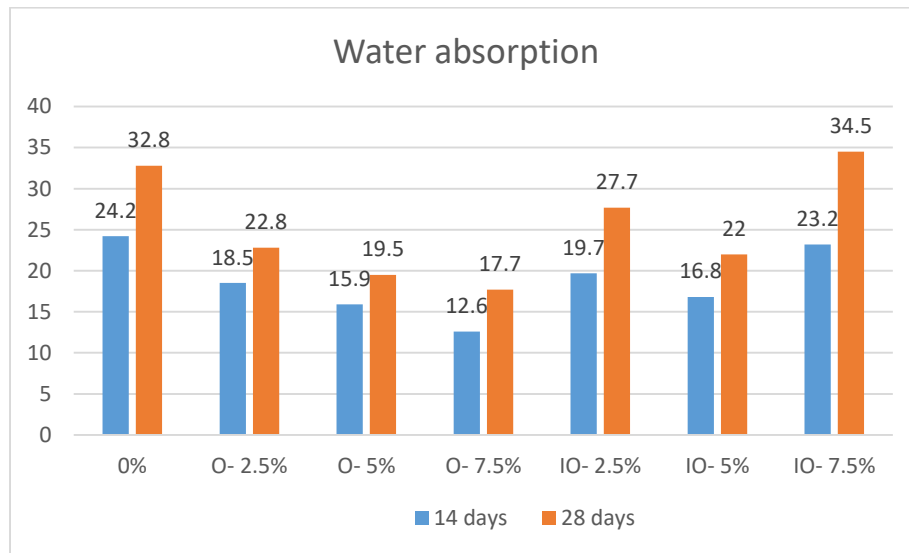


Figure 4: Graphical representation of Water absorption test

4.5 Discussion

The study intended to improve the performance of corrosion using organic and inorganic compounds. Here, concrete properties were measured include: compressive strength, flexural strength, water absorption test. The percentage of inhibitors added are 2.5%, 5% and 7.5%. Better result was given by organic compound in 7.5% for compressive strength test 16.8N/mm² for organic inhibitor and 16.6N/mm².

5 Conclusion

In Split tensile test, the bond strength increases while increasing the proportion of Organic inhibitors compared to Inorganic inhibitor and the conventional specimen. Compression strength increases at the increasing of proportion of both organic and inorganic inhibitors than the conventional specimen. In water absorption the weight loss of the steel bar had reached lesser corrosion than the conventional specimen. The concrete specimen with steel bar with Organic coating had increased the strength and durability of the steel bar. After the test results, it was observed that the usage of organic inhibitor increases the mechanical strength and durability than the inorganic inhibitor and conventional specimen.

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