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An Experimental Study to Find the Influence of Corrosion of Rebar in RCC with Sisal Fibre

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***Abstract*—Corrosion of reinforcement is a major problem which influences the long term performance of the reinforced concrete structures. It adversely affects the durability of the concrete structures. Quality of concrete, cover thickness of concrete reinforcement, condition of reinforcement, effect of environment and other chemicals, porosity of concrete, effect of high thermal stress and freezing and thawing condition influence the corrosion in concrete structures. It is more important to understand the performance of corroded reinforced concrete under loading condition. The study is about the influence of corrosion of rebar in RCC with sisal fibre with different percentages 0%, 0.5%, 1% and 1.5%, also the degradation of bond between reinforcing steel and concrete and the crack profile developed under loading condition for normal concrete and concrete with sisal fibre of M_{30} grade. The corrosion is induced in steel rebar by using an electrochemical accelerated corrosion technique in each test specimens. The crack opening width and length were recorded after the corrosion process. A comparative study of compressive strength of fibre reinforced concrete with different percentages is intended in this particular paper.**

Keywords*—Rebar, Accelerated corrosion technique, Bond strength etc.

I. INTRODUCTION

Many research works are conducted today in the field of construction especially in concretes. Concrete is a composite material composed of cement, fine aggregate, coarse aggregate and water and widely used for construction. In order to achieve the desired physical properties of the finished material, certain additives and reinforcements are added to the plain cement concrete. It is to be understood that the plain cement concrete has relatively low tensile strength and durability as compared to the reinforced cement concrete. Concrete alone is good in compression, but reinforced concrete greatly increases the scope for making structures required to withstand other forms of mechanical force. The reinforcement is usually steel reinforcement and passively embedded in concrete before concrete sets. The reinforcements are designed in concrete for resisting the tensile stresses developed in any region that cause unexpected cracking and structural failures. Reinforced concrete is used in numerous ways, some of the larger and better known uses including roadways, bridges, car parks, residential buildings and in industry. Recently the aspects of concrete durability and performance have become a major subject for discussion especially when the concrete is subjected to a severe environment. Sometimes, the exposure condition of environment may affect the properties of concrete. One of the most current degradation of reinforced concrete structure is related to the corrosion of reinforcement in concrete. Corrosion of reinforcement influences the long term performance and durability of reinforced concrete structures. The studies reveal that corrosion products of steel expand seven times that of original size and it induces expansive stresses around the corroded steel bars. It causes possible cracking, spalling of concrete covers and loss of bonding between the steel and concrete. The factors influencing the corrosion in concrete are quality of concrete, cover thickness, condition of reinforcement, porosity of concrete, effect of chemicals etc. The environment provided by good quality concrete to steel reinforcement is one of high alkalinity due to the presence of the hydroxides of sodium, potassium and calcium produced during the hydration reactions. This oxide film protects the concrete from corrosion to a greater extent. The permeability of the concrete is important in determining the extent to which aggressive external substances can attack the steel. A thick concrete cover of low permeability is more likely to prevent chloride ions from an external source from reaching the steel and causing depassivation.

II. SCOPE OF THE STUDY

The existence of concrete structure in any environment is found to be a major thing. Nowadays, the construction fields are facing the problem of corrosion in concrete. So it is more important to know how such concrete performs under loading conditions. Along with that, the assessment of condition of such concrete structures in order to determine the remaining service life and method of repair is also to be considered. Repair and rehabilitation of existing corroded structures is becoming a difficult part of the present construction activities. It substantially increases the cost of the construction and difficulties. In order to select suitable remedial measures it is necessary to make an assessment of

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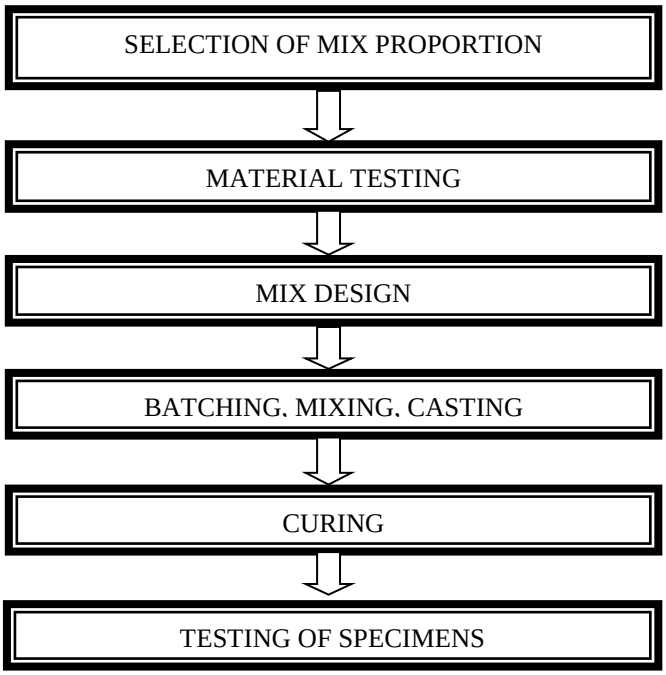
the residual strength and the residual life. It is a great thing to prevent the spreading of cracks in the corroded concrete along with reducing the corrosion of rebar. The studies show that, the cracking in fibre reinforced concrete is less than that of RCC. The load required to achieve the same crack width in fibre reinforced concrete is found to be more as that of RCC. So, it will be effective to find whether the fibre reinforced concrete has the capacity to compensate the tensile strength which is lost by corrosion of bars or not. This paper presents a study about the influence of corrosion of rebar in RCC with sisal fibre and also the degradation of bond between reinforcing steel and concrete and the crack profile developed under loading condition for normal concrete and concrete with sisal fibre of M_{30} grade. The study will reveal whether the fibre provides tensile strength to the concrete or not, to compensate the lost tensile strength during corrosion. The sisal fibre is a natural fibre which is obtained from agave plant. So it is abundantly available.

III. OBJECTIVES OF THE STUDY

The main objective of this paper is to investigate the compressive strength of concrete with different percentages of sisal fibre. Along with that, workability of concrete with fibre is also studied.

IV. METHODOLOGY



V. MATERIALS

A. *Cement*

Cement is a binder, a substance that sets and hardens independently, and can bind other materials together. In this study, the cement used was Ordinary Portland Cement (OPC) of grade 53 having specific gravity 3.15 and consistency 28%.

B. *Aggregates*

Coarse aggregates of 20mm size with specific gravity 2.68 were used. M sand having specific gravity of 2.35 was used as the fine aggregate.

C. *Water*

Water is an important ingredient of concrete as it actively reacts with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be considered very carefully.

D. *Sisal fibre*

Sisal fibre is one of the most widely used natural fibre and is obtained from sisal plant, known formally as Agave sisalana. These fibres are straight, smooth and yellow in color. Strength, durability and ability to stretch are some important properties of sisal fibres. To remove the wax and dirt in the fibre, it was subjected to alkali treatment (5% of NaOH solution).

Fig1. Sisal fibre

TABLE 1. PROPERTIES OF SISAL FIBRE

Fibre length (mm)	2.5
Fibre diameter (mm)	0.25
Aspect ratio	100
Tensile strength (GPa)	268

V. MIX DESIGN

From the obtained results from material testing, the mix design for M_{30} grade concrete was done as per IS 10262: 2009. The mix proportion was obtained as1:2.08:3.13.

VI. WORKABILITY TEST

By conducting the workability tests such as slump test and compaction factor test in the absence of admixture, the concrete is seemed to be not workable. Therefore, to increase the workability of concrete an admixture named Ceraplast 300 is added.

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TABLE 2. SLUMP VALUES

	0%	0.5%	1%	1.5%
Without admixture	-	-	-	0
With admixture	80mm	78mm	76mm	75mm

TABLE 3. RESULTS OF COMPACTION FACTOR TEST

	0%	0.5%	1%	1.5%
Without admixture	-	-	-	0.75
With admixture	0.91	0.9	0.89	0.87

VII. CASTING OF SPECIMENS

Concrete cubes were casted in wooden moulds of size 15x15x15cm. Concrete with four different percentages (0, 0.5, 1 and 1.5%) of sisal fibre was prepared and three specimens of each percentage were produced. After 24 hours, the cubes were remolded and immersed in a curing tank to cure for strength gain.

Fig 2. Casted cubes

VIII. TEST RESULTS

The compressive strength of concrete can be measured by compression testing machine. The compressive strength of cubes with different percentages of fibres was obtained as follows.

Fig 3. Compression testing machine

TABLE 4. COMPRESSIVE STRENGTH RESULT

		Compressive strength (N/mm^2)		
Sl No.	Percentage of fibre	7 days	14 days	28 days
1.	0%	20.6	28.2	31.5
2.	0.5%	25.7	29	34.2
3.	1%	25.1	27.7	32.6
4.	1.5%	17.6	25.9	30.3

IX. CONCLUSION

Maximum value of compressive strength of concrete was obtained when the sisal fibre percentage was 0.5%. The compressive strength at 1% of fibre is also greater than that of the conventional concrete. But, at 1.5% of fibre, the value is comparatively lower than that of conventional concrete.

X. FURTHER STUDY

The authors propose to continue investigation to study the following.

A. The bond strength between fibre reinforced concrete and rebar after corrosion

The bond strength between fibre reinforced concrete and rebar can be finding out by pullout test on cubes casted with rebar. After the curing of 28 days, the specimens were subjected to accelerated corrosion process to increase the corrosion rate in the rebars. The specimens were corroded using an electrochemical accelerated corrosion technique that involves applying a current of specified intensities through the specimens for a specified period to accelerate the oxidation process in a 5% sodium chloride (NaCl) solution.

B. The flexural strength of concrete

The beams of specified size cast with minimum reinforcement along with different percentages of fibre to find the flexural strength of concrete. The beams also subject to accelerated corrosion process to investigate the influence of corrosion in fibre reinforced concrete.

C. The crack opening width and length of concrete specimen

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