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Effect of Carbonation on Fibrous Concrete Mixes

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Abstract: Corrosion of reinforcement in concrete is one of the major cause of structural degradation. The monetary misfortune and harm caused by the consumption of steel in RC makes it the one of the significant framework issue looked by on developing nations as of late. The maintenance of existing RC structure has become as important as the construction of new structure. The corrosion in RC maybe caused by the exposure of RC to chloride ions, carbonation or may be due to presence of two different metals in RC. This paper reports on the results of an investigation of utilization of jute fiber as additional material in concrete mixes to be used for carbonation study. Concrete mixes containing various contents of the fiber were prepared and basic characteristics such as compressive strength and carbonation depth were determined and compared with a control mix. Three concrete mixes with 0.0%, 0.1%, 0.2%, 0.3%, 0.4% and 0.5% of jute fiber as an additional material to the concrete were prepared for M-20, M-30 and M-40 concrete. The specimens were tested at 28-days and 60-days interval. The results of the investigation demonstrate that the introduction of jute fiber reduces the carbonation to 90% in the early life of concrete. So, the addition of fiber can be implemented to control the carbonation in the RC structures.
Keywords: Carbonation, Compressive Strength, Carbonation Depth, Reinforced Concrete (RC).

I. INTRODUCTION

The carbonation occurs when carbon-di-oxide (CO_2) from the atmosphere infiltrates into concrete and responds with hydroxide to form carbonates which ultimately reduces the pH of the concrete to nearly 8.5, at this level of pH the passive layer of steel becomes unstable and corrosion like condition occurs. Carbonation is a moderate procedure, it goes before at a rate relative to the square base of time. The carbonation in RC structure can be perceived outwardly in the field by the nearness of stained zone in the surface or it can be tested in laboratory by using phenolphthalein indicator or in the optical microscope carbonation is perceived by the nearness of calcite precious stone and the nonappearance of calcium hydroxide and unhydrated cement grains. The amount of carbonation depends highly on water-cement (W/C) ratio and other concrete mix parameters. It increments with a high W/C proportion, low bond content, exceedingly penetrable or permeable solid blend. But carbonation highly depends on relative humidity (RH) of concrete mix, between 50 to 75 percent RH the carbonation rate is highest while below 25 percent RH the carbonation rate is insignificant and above 75 percent RH the moisture present in the pores of concrete mix will restricts the CO_2 penetration. So the primary purpose of study is to discover how the expansion of strands of various sizes impacts the carbonation in RC.

II. EXPERIMENTATION

A. *Concrete Composition*

The OPC 43 grade cement (Wonder Cement) is used for concrete mix design which has a specific gravity of 3.15. The fineness modulus of sand used is 3.175 which is of grade of Zone-3. The aggregate used in the experimentation are of size 20mm and 10mm, which have been used in 65% and 35% of total mass obtained through trial error method. There are three cubes for three different grades of concrete (viz. M-20, M-30 & M-40 grade) are prepared for every variation of fiber percentage in the mix. The various percentage of fiber in the mixes are 0.0%, 0.1%, 0.2%, 0.3%, 0.4% & 0.5%. The table 2.1 below shows the various properties of material used in the concrete.

Table 2

	Cement	Sand (Grading Zone- 4)	Aggregate	Admixture
Specific Gravity	3.15	2.63	2.7	1.6
Initial Setting Time	50 min	-	-	-
Final Setting Time	206 min	-	-	-
Fineness	5.9%	-	-	-
Fineness Modulus	-	3.175	-	-
Loose Density	-	1579 kg/m^3	1425 Kg/m^3	-
Compacted Density	-	1590 kg/m^3	1610 Kg/m^3	-
Water Absorption	-	-	0.8%	-
Impact Value	-	-	7.78%	-
Abrasion Value	-	-	5%	-

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B. *Testing Method*

Concrete carbonation is tested with the straight forward use of a chemical indicator; the most commonly used indicator is a solution of phenolphthalein in alcohol and/or water. Phenolphthalein solution is applied to fresh strongly alkaline concrete will turn pink, if the alkalinity has been lost the concrete will not turn pink. Before the test, the specimens were kept out of the water for drying for 24 hours then the concrete specimens of size 150x150x150mm were first tested in compression testing machine and then these specimens were then sprayed with phenolphthalein indicator solution to check for carbonation. The solution is sprayed on the fractured part of the specimen moving top to center, this is done in 2 to 3 regular points for each specimen.

III. RESULTS & ANALYSIS

A. The carbonation depth is reduced from 3.67mm to 0.33mm with the increment in fiber percentage after 28-days of curing in M20 grade concrete, which is 90% reduction in carbonation depth.
B. The carbonation depth is reduced from 3mm to 0mm with the increment in fiber percentage after 28-days of curing in M30 grade concrete, which is 100% reduction in carbonation depth.
C. The carbonation depth is reduced from 1.67mm to 0mm with the increment in fiber percentage after 28-days of curing in M40 grade concrete, which is 100% reduction in carbonation depth.
D. The carbonation depth is reduced from 4mm to 0.33mm with the increment in fiber percentage after 60-days of curing in M20 grade concrete, which is 92% reduction in carbonation depth.
E. The carbonation depth is reduced from 3.67mm to 0mm with the increment in fiber percentage after 60-days of curing in M30 grade concrete, which is 100% reduction in carbonation depth.
F. The carbonation depth is reduced from 2mm to 0mm with the increment in fiber percentage after 60-days of curing in M40 grade concrete, which is 100% reduction in carbonation depth.
G. The carbonation depth reduces from 3.67mm to 1.67mm with increase in grade of concrete from M20 to M40 in 28-days of curing, which is 55% reduction in carbonation depth. It is also seen that at 0.4% content of fiber in the concrete the carbonation depth becomes 0.00mm, hence it can be said that the 100% reduction in carbonation depth is observed with increase in fiber percentage with increase in grade of concrete in 28-days of curing.
H. The carbonation depth reduces from 4mm to 2mm with increase in grade of concrete from M20 to M40 in 60-days of curing, which is 50% reduction in carbonation depth. It is also seen that at 0.4% content of fiber in the concrete the carbonation depth becomes 0.00mm, hence it can be said that the 100% reduction in carbonation depth is observed with increase in fiber percentage with increase in grade of concrete in 60-days of curing.

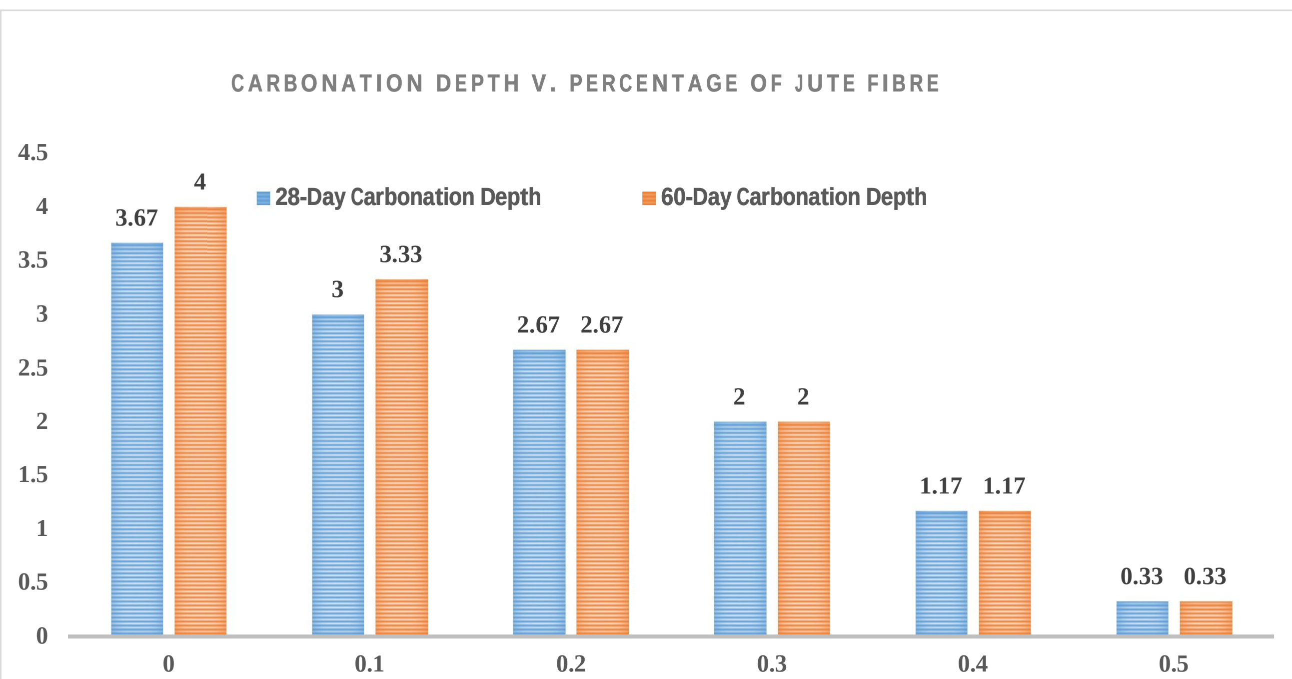

Figure 3.1 Comparison of Carbonation Depth for M20 grade Concrete

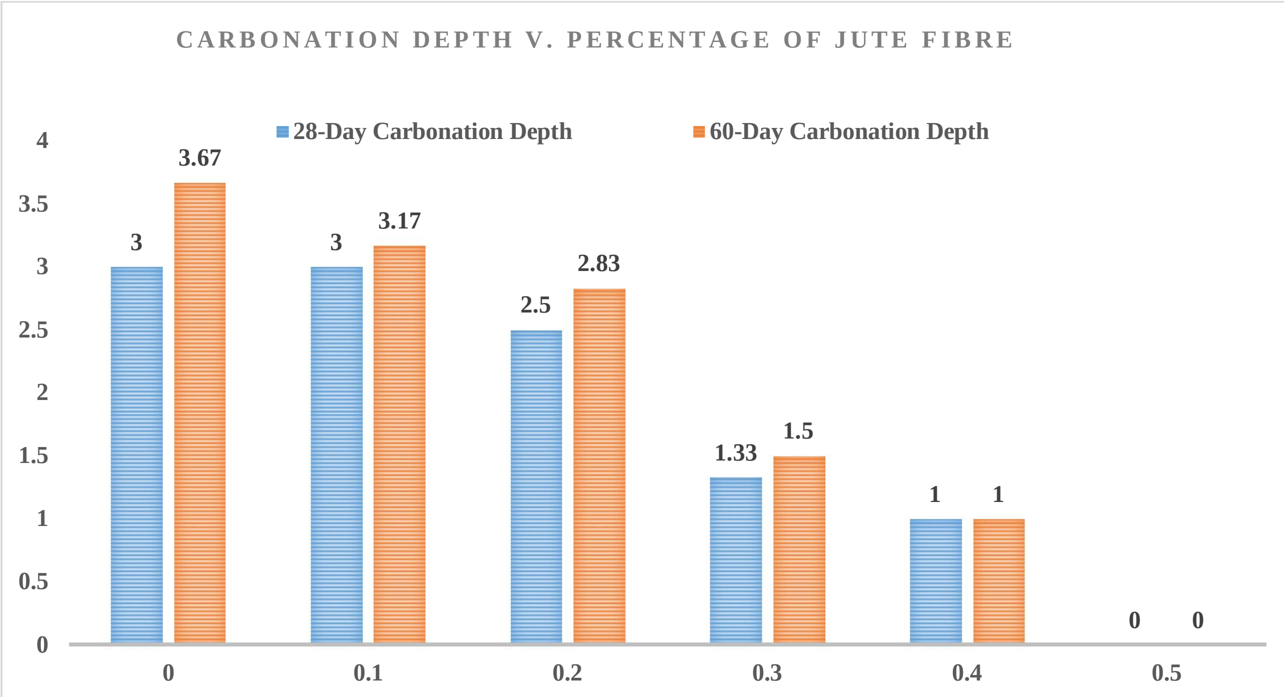

Figure 3.2 Comparison of Carbonation Depth for M30 grade Concrete

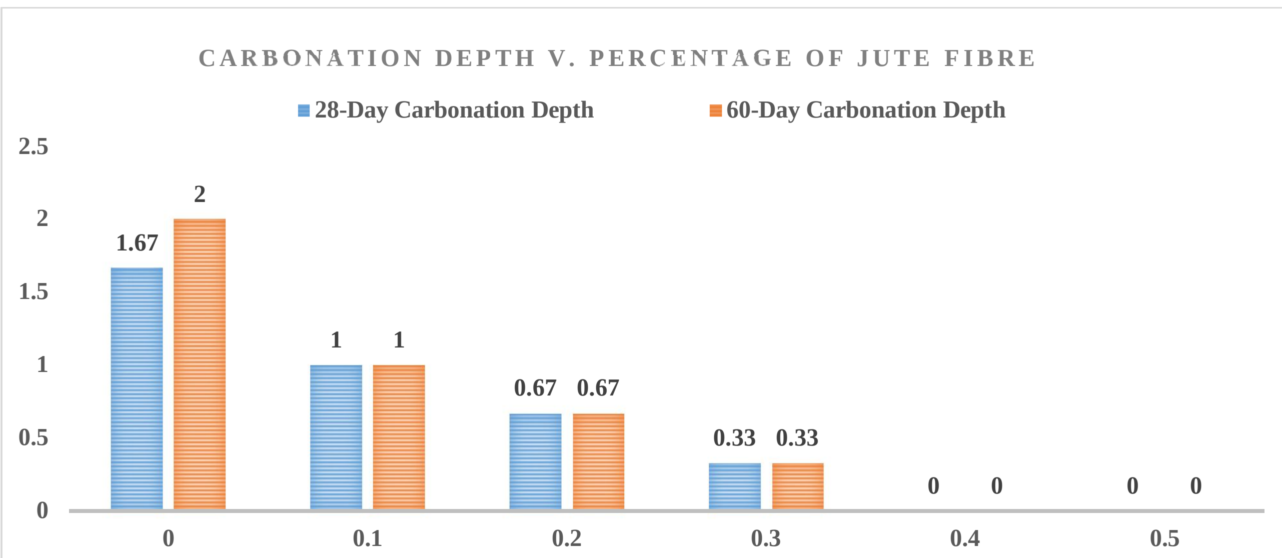

Figure 3.3 Comparison of Carbonation Depth for M40 grade Concrete

IV. CONCLUSION

Increase in compressive strength and reduction in carbonation depth is observe as the percentage of fiber in the mix is increased for various mix proportions. Since the jute fiber is natural fiber, then it is locally available, eco-friendly solution to support sustainable construction. Considering the carbonation criteria, the replacement of cement by jute fiber is feasible. Hence it can be concluded that utilization of jute fiber in concrete as to control the carbonation growth is possible.

V. ACKNOWLEDGEMENT

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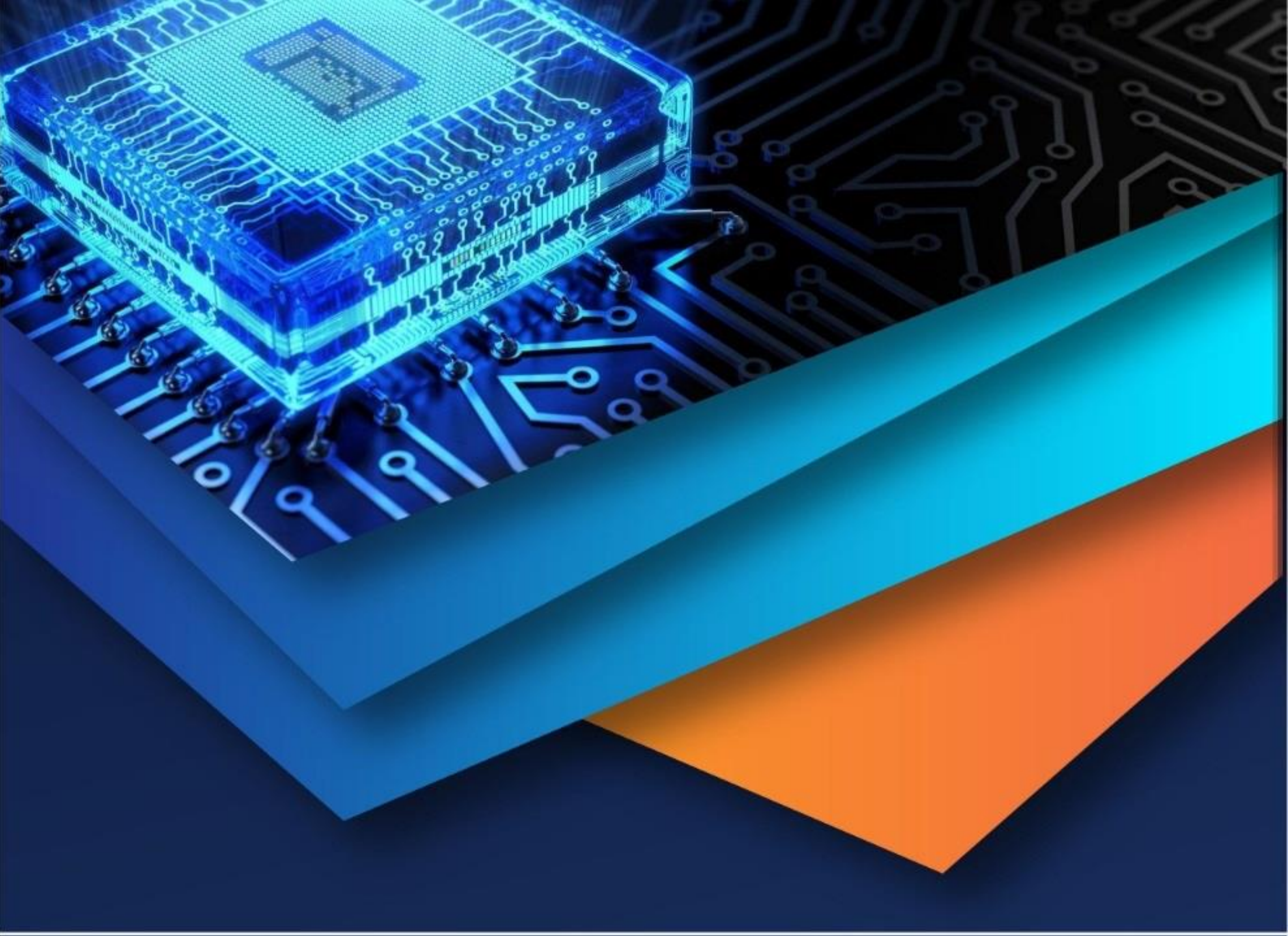

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