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An Experimental Analysis on Flexural Strength of Concrete Beams using Silica Fumes & Fly ash including Coir Fibre with Admixture

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Abstract: ***There are so many modern construction materials (MCM) have been used in civil engineering construction based on their physical, chemical and mechanical properties. In this research modern construction materials have been used in the form of powder and ash included with fibres produced from industrial wastes and from agricultural wastes. In this regard, basic construction materials without them nothing can be started to construct but now-a-days these all are like cement, sand and aggregates are very costly materials so they may be partially replaced by percentage wise using industrial and agricultural waste materials for economical development and for the growth of the country. In this research paper an experimental analysis on Flexural strength of concrete beams has been conducted using silica fume & fly ash as a partial replacement material of cement in concrete including coconut fibre including admixture which have not been observed and determined in past till now. Admixture is added to increase the setting time of cement, workability of concrete and to improve the compressive and flexural strength of concrete. Grade of concrete has been kept constant as M-30 in all such kind of experimental research work. It is found that flexural strength has been increased by using silica fume including coir fibre with Admixture as compared to Fly Ash including coir fibre with admixture.***

Keywords*:* ***Silica Fume, Fly Ash, Coir Fibre, Admixture, Flexural Strength, Concrete Mix***

I. INTRODUCTION

In a fast developing country where almost each and every day construction activities takes place in a modern sense to improve the structural strength with economic value, uses of prior modern materials are required. Concrete can bear up the severest environmental conditions; however, in several conditions it may show very low characteristics. Hence, engineers worldwide are constantly trying to improve its characteristics with the aid of modern admixtures and waste materials, usually called as alternate building materials (ABM). In this regard, basic construction materials without them nothing can be started to construct but now-a-days these all are like cement, sand and aggregates are very costly materials so they may be partially replaced by percentage wise using industrial and agricultural waste materials for economical development and for the growth of the country. The special characteristics of silica fume viz., super fineness, high silica content gave the scope for enhancing the normal cement concrete when mixed with cement as a partial replacement. Fly ash (FA) is a fine powder which is a by product from burning pulverized coal in electric generation power plants. Fly ash is a pozzolanic, a material containing aluminous and siliceous material that forms cement in the presence of water. Rising rate of steel day by day is the main problem in construction of new building. As an alternate solution of this problem, I use coconut fibre in place of steel which is quite economical, easy available and have desirable strength. Coir fibre is a reinforced fibre which gives durability and strength to concrete and also improves workability of concrete. Admixture is added to increase the setting time of cement, workability of concrete and to improve the compressive and flexural strength of concrete. Grade of concrete has been kept constant as M-30 in all such kind of experimental research work.

R Sripragadeesh etal (2009) Investigation on the effect of different replacement levels of OPC in M25 grade with FA + SF in ternary cement blend on the strength characteristics and beam behavior was studied. The OPC was partially replaced (by weight) with different combinations of SF (5%, 10%, 15%, 20% and 25%) and FA as 50% (High Volume Fly Ash - HVFA). The amount of FA addition is kept constant at 50% for all combinations. The compressive strength and tensile strength tests on cube and cylinder specimens, at 7 and 28 days were carried out. Based on the compressive strength results, optimum mix proportion was found out and flexural behaviour was studied for the optimum mix. Pravin V Domke (2012), this paper describes about the results obtained from the detailed investigation done on the partial replacement of cement with RHA cement concrete and shows clearly up to how much percentage the cement can be replaced by RHA and COIR. Higher compressive strength obtained at the mix proportion of

12.5%Rha+2%COIR. At 2% and 3% COIR fiber gives maximum compressive strength. After addition of COIR fibers compressive strength increased up to 3%-4%. Saurabh Samander etal (2013), this investigation is done to study of the effect of silica fume on fly ash cement bricks. The fly ash cement - bricks are tested after 7 days, 14 days and 28 days curing in concrete material testing laboratory of the institute. The experimental results showed that in the compressive strength of fly ash cement brick decreases with increase in content of silica fumes as replacement of cement whereas increases with increase in content of silica fume as addition. Shubha Khatri (2014) investigated that the compressive strength of concrete cubes for M-20 and M-40 grade concrete mix design by doing an experimental study by using Coconut Fibre and Polypropylene Woven Fibre (PPWF) including Admixture in the form of Super-plasticizer as CONPLAST (G-8) 410. Results show that compressive strength of concrete cube increases with admixture. Another study with Coconut fibre and PPWF including admixture also proves that compressive strength of concrete cubes increases much more as compared to with and without admixture-concrete cubes. Abdul Nazeer (2014), the maximum tensile strength was found for 15 mm length of coir fibers. The mechanical properties of polyester composites reinforced with coir fiber have been studied and discussed here. Here, they have used randomly discontinuous fiber layout in the composite, so that the ratio of fibers in the composite is high. This investigation shows that increase in length of fiber increases the tensile strength. The NaOH treatment on coir fiber would remove the impurity and rougher fiber surface may result after treatment. This would increase the adhesive ability of the coir fiber with the matrix in the fabricated composite resulting in good tensile strength. The treated fiber has better reinforcing property than un-treated fiber. Anoopsingh Chandel etal (2016), this paper presents an experimental study of coir fibre reinforced concrete and its strength comparison with plain cement concrete. The compressive strength of Coir fibre reinforced concrete (CFRC) is nearly 13% more than that of a Plain cement concrete (PCC). 2. The tensile strength of CRFC is nearly 40% more than the PCC. Ankit Kumar and N Kisku (2016), in the present work a series of tests were carried out to make comparative studies of various mechanical properties of concrete mixes prepared by using Reliance OPC 43 grade cement. The mixes are modified by 7.5%, 10% and 12.5% of silica fume in replacement. Pozzolanic materials have significant influence on mechanical properties of concrete. The maximum compressive strength increased by 1.43% after 7 days and 4.42% after 28 days at 10% replacement of cement by weight with silica fume. However when silica fume was blended with fly ash in different percentages, a continuous decrease in compressive strength was recorded. The maximum split tensile strength increased by 3.83% after 28 days at 10% replacement of cement by weight with silica fume. However when silica fume was blended with fly ash in different percentages, a continuous decrease in splitting tensile strength was recorded. The maximum flexural strength increased by 1.79% after 28 days at 10% replacement of cement by weight with silica fume.Anshul Jain & Shubha Khatri (2017), did an experimental analysis on the mechanical properties of concrete using fly ash as a partial replacement material of cement with polypropylene woven fiber including admixture and it was found out that with 30 % added fly ash as a partial replacement of cement gives higher compressive strength and flexural strength as compare to 10 and 20% fly ash replacement.

II. METHODOLOGY

In this paper an experimental analysis has been carried out in laboratory with respect to initial and final setting time of cement, workability of concrete by slump cone test and then by compaction factor test to find out the properties of cement and concrete. To find out the flexural strength of concrete beams mould size is taken 100mm×100mm×500mm and grade of concrete is M-30. Silica fumes & Fly ash as a partial replacement material of cement have been uses in concrete. Coir fibres as a reinforcing material and admixture in the form of super-plasticizer have been used by weight of cement and they are added to the mix. Beams moulds are prepared for 7 and 28 days. Here percentages of silica fume & fly ash have been used from 10% & 20% respectively for 5%-10% coir fibre including 5%admixture.

First of all normal concrete mix designed concrete beams are moulded with 0% silica fume & fly ash and without coir fibre & admixture for 7 and 28 days and flexural strength has been checked. Then again concrete beams with 0% silica fume & fly ash but with 5% and 10% coir fibre including 5%Admixture have been moulded for 7 and 28 days to check the flexural strength. Then again this procedure was repeated for 10%-20% silica fumes and fly ash as a partial replacement of cement with 5%-10% coir fibre including 5% admixture. Then flexural strength for this entire procedure has been checked.

III.EXPERIMENTAL ANALYSIS

As per above discussions observation tables are presented here. Following are values are obtained according to experimental analysis. Table 1 and Table 2 show the slump and compaction factor according to water/cement ratio with different amount of silica fumes & fly ash with coir fibre including admixture. In this table water-cement ratio has been kept as 0.45 and silica fume and fly

ash as a partial replacement of cement have been used as 10%-20% by weight of cement. Percentage of coir fibre is kept as 5%-10% including 5% admixtures in form of super-plasticizer as a water reducing agent for concrete mix design for M-30 grade.

TABLE I
DETAILS OF SLUMP & COMPACTION FACTOR WITH SILICA FUMES AS A PARTIAL REPLACEMENT OF CEMENT WITH COIR FIBRE AND ADMIXTURE

S. No.	w/c Ratio	Silica Fume	Coir Fibre + Admixture	SLUMP (mm)	Compaction Factor
1	0.45	10%	5%Coir fiber+5%Admix	120	0.85
			10%Coir fibre+ 5% Admix	115	0.85
2	0.45	20%	5%Coir fiber+5%Admix	110	0.9
			10%Coir fibre+ 5% Admix	105	0.9

TABLE III
DETAILS OF SLUMP & COMPACTION FACTOR WITH FLY ASH AS A PARTIAL REPLACEMENT OF CEMENT WITH COIR FIBRE AND ADMIXTURE

S. No.	w/c Ratio	Fly Ash	Coir Fibre + Admixture	SLUMP (mm)	Compaction Factor
1	0.45	10%	5%Coir fiber+5%Admix	116	0.80
			10%Coir fibre+ 5% Admix	112	0.80
2	0.45	20%	5%Coir fiber+5%Admix	105	0.85
			10%Coir fibre+ 5% Admix	100	0.85

Table 1 shows the experimental results related to slump cone test for workability of concrete mix with silica fume 10% and 20% replaced by cement with coir fibre and admixture additive materials. Similarly Table 2 shows the experimental results related to slump cone test for workability of concrete mix with fly ash 10% and 20% replaced by cement with coir fibre and admixture additive materials. Slump decreases with workability increases. In the mean time compaction factor is also observed.

TABLE IIIII
FLEXURAL STRENGTH TEST OF CONCRETE BEAMS OF SIZE 100MM×100MM×500MM FOR 7 AND 28 DAYS CURING WITH COIR FIBER AND ADMIXTURE AT DIFFERENT CONTENT AND SILICA FUME AS A PARTIAL REPLACEMENT OF CEMENT WITH 10% AND 20% BY WEIGHT OF CEMENT

S. No.	Silica Fume % (replacement by wt. of cement)	Coir Fibre %+ Admixture % (By weight of cement)	Flexural Strength of Beams N/mm^2	
			7Days	*28 Days*
1	0% (Control Concrete)	0% Coir fiber+0% Admix	1.85	3.22
2	0%	5% Coir fibre +5% Admix	1.89	3.4
		10% Coir fibre + 5% Admix	1.95	3.62

3	10%	5% Coir fibre +5% Admix	2.65	3.82
		10% Coir fibre + 5% Admix	3.3	4.1
4	20 %	5% Coir fibre +5% Admix	3.4	3.7
		10% Coir fibre + 5% Admix	4.2	5.0

Fig 1 Concrete Mix

Table 3 shows the experimental results related to flexural strength test with silica fume 0%,10% and 20% replaced by cement with coir fibre as 5% and 10% including admixture as an additive material by percentage weight of cement for water-cement ratio as 0.45 for concrete mix design M-30 grade. Similarly, Table 4 shows the experimental results related to compressive strength test with fly ash 10% and 20% replaced by cement with coir fibre as 5% and 10% including admixture as an additive material by percentage weight of cement for water-cement ratio as 0.45 for concrete mix design M-30 grade.

TABLE IVV

FLEXURAL STRENGTH TEST OF CONCRETE BEAMS of size 100mm×100mm×500mm FOR 7 AND 28 DAYS CURING WITH COIR FIBER AND ADMIXTURE AT DIFFERENT CONTENT AND FLY ASH AS A PARTIAL REPLACEMENT OF CEMENT WITH 10% AND 20% BY WEIGHT OF CEMENT

S. No.	Fly Ash % (replacement by wt. of cement)	Coir Fibre %+ Admixture % (By weight of cement)	Flexural Strength of Beams N/mm^2	
			7Days	*28 Days*
1	0% (Control Concrete)	0% Coir fiber+0% Admix	1.85	3.22
2	0%	5% Coir fibre +5% Admix	1.89	3.40
		10% Coir fibre + 5% Admix	1.95	3.62
3	10%	5% Coir fibre +5% Admix	1.97	3.50
		10% Coir fibre + 5% Admix	2.5	3.7
4	20 %	5% Coir fibre +5% Admix	2.2	3.7
		10% Coir fibre + 5% Admix	2.6	3.91

IV. RESULTS & DISCUSSIONS

After conducting experimental analysis results are plotted in excel sheet and discussions have been made.

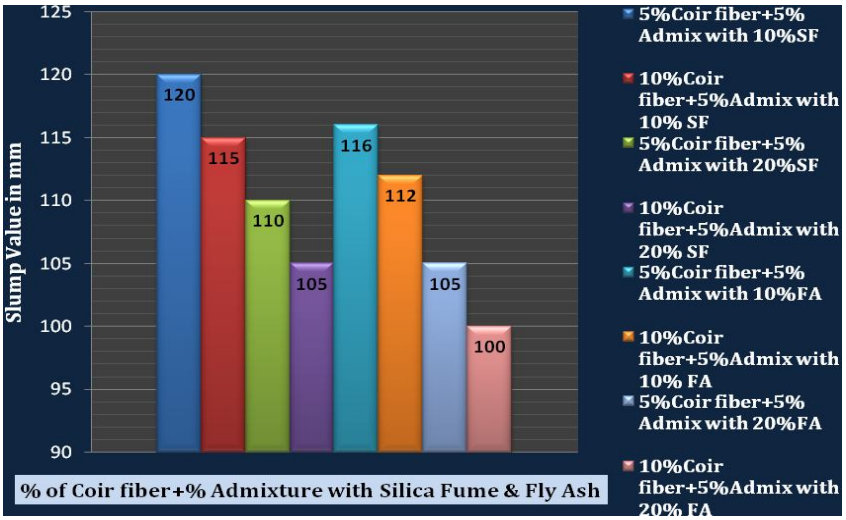
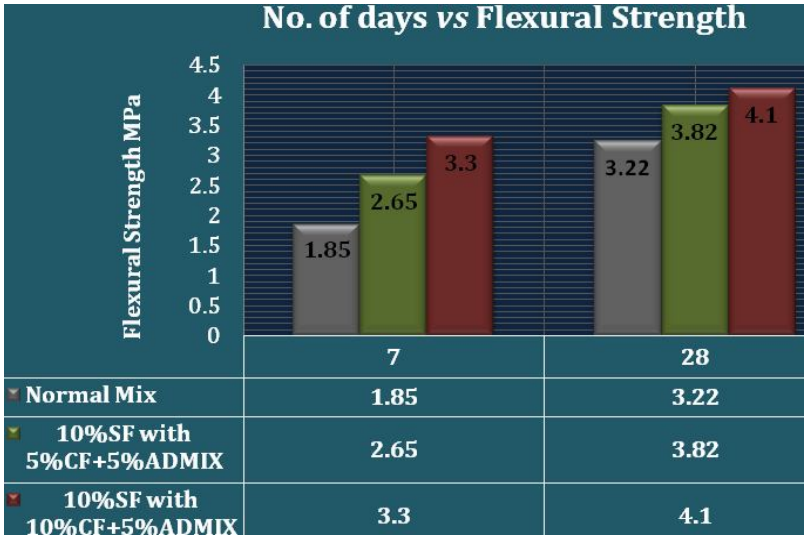


Fig 2 Workability Analysis of M-30 grade concrete mix with different percentage of Silica fume-Fly ash-Coir Fibre+ Admixture

As shown in figure 2 that by increasing the amount of silica fume (SF) from 10% to 20% with inclusion of 5% and 10% Coir Fiber (CF) plus 5% Admixture slump value is decreasing continuously. In the mean time it is also noticed that compaction factor has been increased because workability is directly connected to compaction factor. Workability has been increased by increasing the amount of silica fume while slump value has been decreased. Coir Fiber including percentage of admixture by weight of cement has been mixed in concrete for M-30 grade so by increasing these amounts with different percentage of silica fume slump value is decreased. For 5% Coir Fiber+5% ADMIX with 10% SF slump value is 120mm & for 10% Coir Fiber + 5% ADMIX with 10% SF it is 115mm.



	7	28
Normal Mix	1.85	3.22
10%SF with 5%CF+5%ADMIX	2.65	3.82
10%SF with 10%CF+5%ADMIX	3.3	4.1

Fig 3 Flexural Strength of Concrete Beams with: 5% & 10 % of CF+5%Admixture with 10 % Silica Fume

A Comparison study of Flexural Strength of Concrete Beams of size 500mm×100mm×100mm for 7 & 28 days curing with normal mix concrete and with different amount % of coir fiber including % of Admixture by weight of cement mixed with 10% SILICA FUME has been carried out. From figure 3 it is observed that Flexural strength of concrete beam for normal mix is obtained as 1.85 N/mm2 and 3.22 N/mm2 for 7 and 28 days respectively. When 5%coir fiber+5%admixture by weight of cement is added to the mix

so it gives slightly higher value of flexural strength with 10% silica fume as a partial replacement of cement i.e. 2.65 N/mm2 and 3.82 N/mm2. While 10% coir fibers + 5% admixture is added to the mix by weight of cement so it gives 3.3 N/mm2 and 4.1 N/mm2 for 28 days respectively as compare to earlier values i.e. @ 7 days.

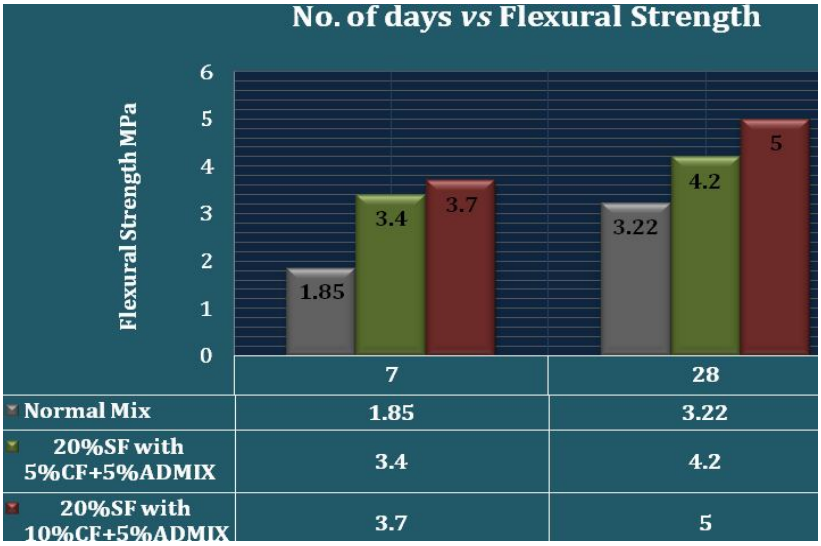


Fig. 4 Flexural Strength of Concrete Beams with: 5% & 10 % of CF+5%Admixture with 20 % Silica Fume

A Comparison study of Flexural Strength of Concrete Beams of size 500mm×100mm×100mm for 7 & 28 days curing with normal mix concrete and with different amount % of coir fiber including % of Admixture by weight of cement mixed with 20% SILICA FUME has been carried out. From figure 4 it is observed that Flexural strength of concrete beam for normal mix is obtained as 1.85 N/mm2 and 3.22 N/mm2 for 7 and 28 days respectively. When 5%coir fiber+5%admixture by weight of cement is added to the mix so it gives slightly higher value of flexural strength i.e. 3.2 N/mm2 and 4.07 N/mm2 with 20% silica fume as a partial replacement of cement. While 10% coir fibers + 5% admixture is added to the mix by weight of cement so it gives 3.7 N/mm2 and 5.0 N/mm2 for 28 days respectively as compare to earlier values i.e. for 7 days. Percentage increment is 42.18% and 50% for 7 days respectively. Percentage increment is 20.88% and 35.6% for 28 days respectively.

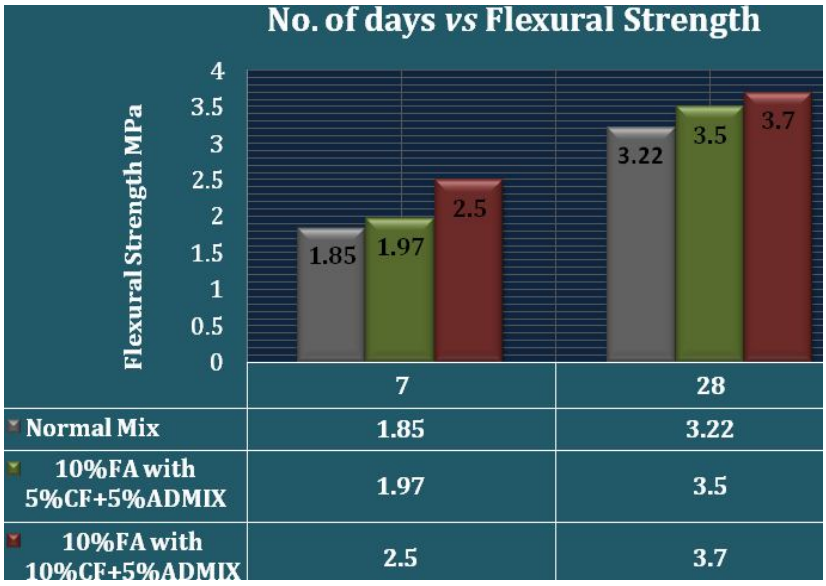


Fig 5 Flexural Strength of Concrete Beams with: 5% & 10 % of CF+5%Admixture with 10 % Fly Ash

In above figure 5 a graph has been plotted between 5% CF + 5% Admixture & 10% CF + 5% Admixture with 10% FLY ASH as a partial replacement of cement. For normal mix concrete values are already determined like 20.1 N/mm2 and 30.3 N/mm2 for 7 and 28 days respectively. Now for 5% CF+5% Admixture and 10% CF+5% Admixture with 10% FLY ASH as a partial replacement of cement, Compressive Strength is increased like 23.5N/mm2 and 34N/mm2 for 7 & 28 days respectively. Similarly, for 5% CF+ 5% Admixture and 10% CF + 5% Admixture with 10% fly ash as a partial replacement of cement, compressive strength is increased like 32.3N/mm2 and 41.5N/mm2 for 28 days respectively. Percentage increment is also determined with respect to compressive strength and i.e.14.46% and 37.77% for 7 days respectively when compared with normal mix.

	7	28
Normal Mix	1.85	3.22
20%FA with 5%CF+5%ADMIX	2.2	3.7
20%FA with 10%CF+5%ADMIX	2.6	3.91

Fig 6 Flexural Strength of Concrete Beams with: 5% & 10 % of CF+5%Admixture with 20 % Fly Ash

In above figure 6 a graph has been plotted between 5% CF + 5% Admixture & 10% CF + 5% Admixture with 20% FLY ASH as a partial replacement of cement to find the difference between flexural strength of beams @ 7 & 28 days respectively. Now for 5% CF+5% Admixture flexural strength has been improved as compare to normal mix and i.e. 2.2 N/mm2 and 3.7 N/mm2 @ 7 & 28 days respectively. Similarly, with 10% CF+5% Admixture with 20% FLY ASH as a partial replacement of cement, flexural strength is increased like 2.6N/mm2 and 3.91N/mm2 @ 7 & 28 days respectively. Percentage increment in flexural strength is also determined and i.e.15.9% and 26% @ 7 days respectively when compared with normal mix. Percentage increment is also determined in flexural strength compared with normal mix and i.e. 12.97% and 17.64 % @ 28 days respectively.

V. CONCLUSIONS

A. Flexural strength of concrete beam for normal mix is obtained as 1.85 N/mm2 and 3.22 N/mm2 for 7 and 28 days respectively. When 5%CF+5%Admixture by weight of cement is added to the mix it gives slightly higher value of flexural strength i.e. 1.89 N/mm2 and 3.4 N/mm2 and percentage increment is 2.11% and 5.12% for 7 days respectively when compared with normal mix. While 10%CF+5%admixture is added to the mix by weight of cement so it gives 1.95 N/mm2 and 3.62 N/mm2 @ 7 and 28 days respectively.

B. When 5%coir fiber+5%admixture by weight of cement is added to the mix so it gives slightly higher value of flexural strength with 10% silica fume as a partial replacement of cement i.e. 2.65 N/mm2 and 3.82 N/mm2. While 10% coir fibers + 5% admixture is added to the mix by weight of cement so it gives 3.3 N/mm2 and 4.1 N/mm2 for 28 days respectively.

C. Flexural strength of concrete beam for normal mix is obtained as 1.85 N/mm2 and 3.22 N/mm2 for 7 and 28 days respectively. When 5%coir fiber+5%admixture by weight of cement is added to the mix so it gives slightly higher value of flexural strength i.e. 3.2 N/mm2 and 4.07 N/mm2 with 20% silica fume as a partial replacement of cement. While 10% coir fibers + 5% admixture is added to the mix by weight of cement so it gives 3.7 N/mm2 and 5.0 N/mm2 for 28 days respectively.

D. Now for 5% CF+5% Admixture flexural strength has been improved as compare to normal mix and i.e. 1.97 N/mm2 and 3.5 N/mm2 @ 7 & 28 days respectively. Similarly, with 10% CF+5% Admixture with 10% FLY ASH as a partial replacement of cement, flexural strength is increased like 2.5N/mm2 and 3.7N/mm2 @ 7 & 28 days respectively.

E. Similarly, with 10% CF+5% Admixture with 20% FLY ASH as a partial replacement of cement, flexural strength is increased like 2.6N/mm2 and 3.91N/mm2 @ 7 & 28 days respectively.

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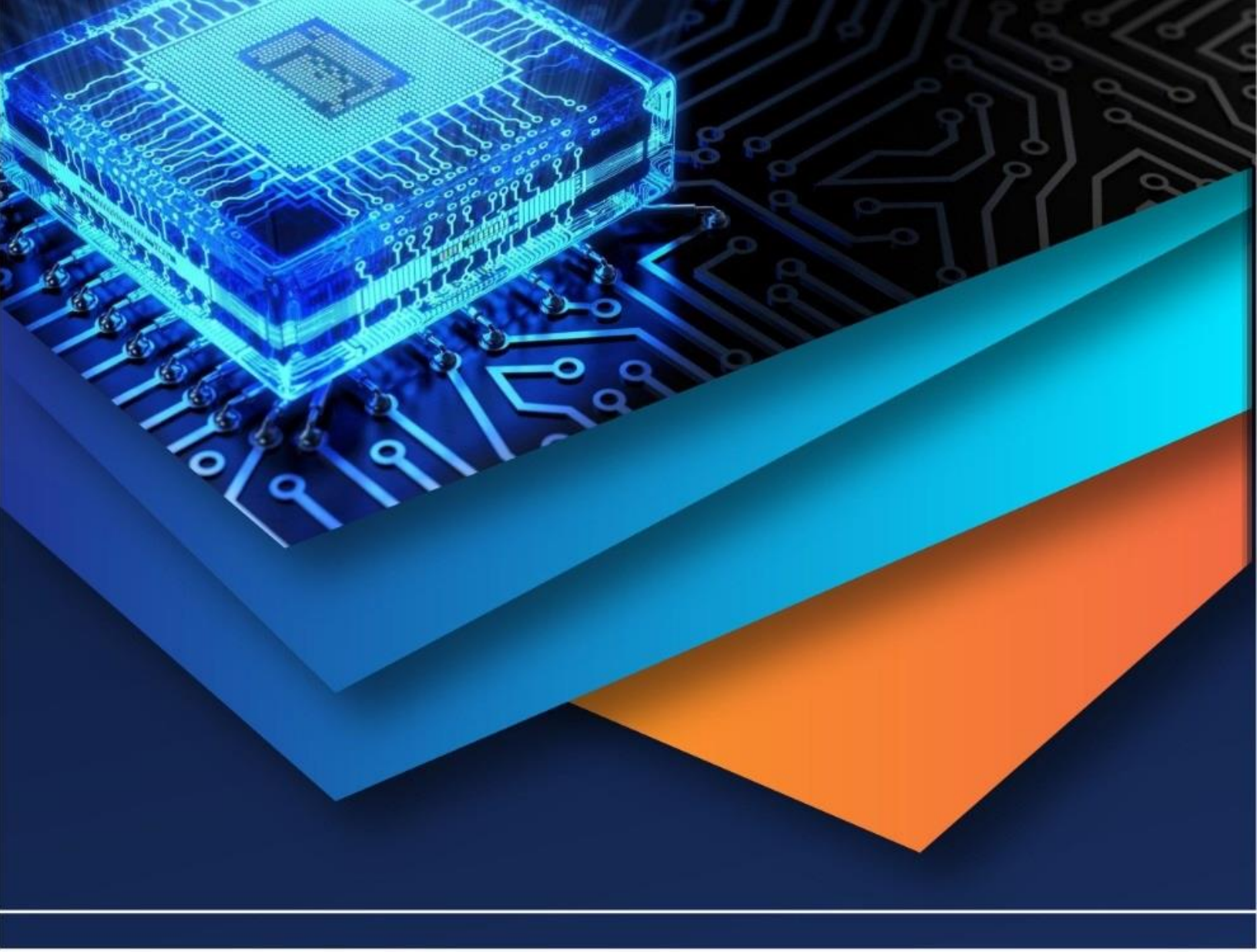

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