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Strength Enhancement of Concrete using Coir Fiber

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Abstract: ***Now a day's erosion of rivers and considering the environmental issues, there is scarcity of river sand which is using as a fine aggregate. The non-availability or shortage of river sand will affect the construction industry. Hence, there is a need to find the alternative material to replace the river sand. These current research intends to study the possibility of increasing the strength of the concrete using coir fiber for partial replacement of fine aggregate.The research work involved the casting of cube test specimenmx150mmx150mm and cylindrical test specimen of length 300mm and diameter of 150mm and prism test specimen of length 500mm ,width of 100mm and height of 100mm with concrete mix proportion of 1:1.86:2.89 for M40 grade concrete and water cement ratio of 0.40.The Coir fiber is added in partial replacement of fine aggregate by 0%, 1%, 1.5% and 2%.The compressive strength test is conducted at 7 days ,14 days and 28 days to find compressive strength and tensile and flexural test are conducted to determine tensile strength at 28 days respectively. Up to addition of 1% of coir fiber shows increasing in compression and tensile, after increasing the percentage of coir fiber shows decrease in strength. On the other hand, the flexural strength increase as percentage of coir fiber increases.***

Keyword: Fiber Reinforced concrete, coir fiber, Aspect Ratio, Compression strength, Tensile strength, Flexure strength

I. INTRODUCTION

Concrete has a vital role in development of infrastructure and living accommodation. Concrete posses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to propagation of such micro cracks, eventually leading to brittle fracture of the concrete. When loaded, the micro cracks propagate and opens up and addition cracks form in place of minor defects.

A. Effects of Fibers In Concrete

Fiber reinforced can be defined as a composite material consisting of cement based matrix contained on randomly distribution of fibers. Concrete is weak in tension, these drawbacks are overcome by addition of fibers in the concrete mix.The commonly used fibers are nylon, steel ,coir fiber, glass, etc.The principal reasons for incorporating fibers in concrete is to increase the toughness and tensile strength and to improve the cracking deformation of the concrete.

B. Coir Fibers

Coir fiber is extracted from the coconut shell. Coir is lingo-cellulose natural fiber. Total production coir in the world is around 250000 tones. The coir fiber is particularly important in the some part of developing countries .Over 50% of coir fiber production is annually consumed in the countries of origin, mainly in India

C. Physical Properties Of Coir Fiber

Properties	Value
Diameter	0.5mm
Specific gravity	0.87
Water absorption	104%
Density	2057kg/m^3
Elastic modulus	2.8x10^{3}Mpa
Tensile strength	210Mpa
Elongation at failure	27.4%

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II. MATERIAL USED

1) *Cement:* The OPC 53 grade is used in the research work conforming to IS: 12269:1987.
2) *Fine Aggregate:* Natural sand of size which passing the 4.75mm sieve is taken for research work. The specific gravity of fine aggregate is 2.65.The fine aggregate is corresponds to zone-II. The unit weight of fine aggregate is 1622 kg/m^3.
3) *Coarse Aggregate:* The coarse aggregate is a crushed angular which was passing in 12.5mm sieve is used in the research work. The specific gravity of fine aggregate is 2.7. The unit weight of fine aggregate is 1800 kg/m^3.
4) *Water:* The portable water which is free from deleterious materials with ph of 7.
5) *Coir Fibers:* The coir fiber of length 5cm and equivalent diameter of 0.5mm is used in this research work. The aspect ratio of coir fiber is found to be 100.
6) *Super Plasticizer:* The super plasticizer is used to impart workability to concrete, because the addition of fiber affects the workability of concrete.The poly carboxylic ether form of super plasticizer named CONXL PCE DM-09 is used at 0.6% by weight of cement.

III. METHODOLOGY

A. *Mix Design*

The mix design can be done as per IS-10262:2009.The mix proportion was found to be 1:1.86:2.89 with water-cement ratio as 0.40.

B. *Casting of Specimen*

The concrete mix is mixed with the partial replacement of fine aggregate with 0%, 1%, 1.5% and 2% of coconut fiber. The concrete mix is filled in mould in 3 layers.Each layer is tamped by 25 blows.

C. *Compressive Strength Test*

The test can be performed as per IS: 519-1959.The compressive strength of concrete was in determined by using universal testing machine. The three specimen of cube with the size of 150x150x150mm were tested for 7, 14 and 28 days of curing. Average compressive strength of concrete at each age was determined by taking the average of three specimens. The compressive strength can be computed by using the formulae;

Compressive strength=P/A

P= Load at failure of specimen in Newton

A=Surface area of specimen in mm^2

D. *Tensile Strength Test*

The test can be performed as per IS: 516-1959.The tensile strength of concrete was determined using the standard cylinder of length 300mm and diameter of 150mm. The three specimen of were tested for 28 days of curing. Average tensile strength of concrete at each age was determined by taking the average of three specimens. The Tensile Strength can be computed by using the formulae;

Tensile Strength=2P/ 3.14DL

P=load at failure of specimen in Newton.

D=Diameter of test specimen in mm.

L=Length of test specimen in mm.

E. *Flexural Strength Test*

The test can be performed as per IS: 516-1959. The three prism specimen of 500mm length and 100mm wide a00 mm height of were tested for 7, 14 and 28 days of curing. The Flexural Strength can be computed by using the formulae;

Flexural strength=PL/bd^2

P=Load at failure of specimen in Newton.

L=Length of test specimen in mm

b=Width of test specimen in mm

d=Height of test specimen in mm

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IV. RESULTS AND DISCUSSIONS

The test specimen after 28 days of curing is tested for compressive strength test using Universal Testing Machine.

Table: 1 Compressive Strength at 7 days for 0% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	731.5	32.51	**32.52**
2	728	32.35	
3	736	32.71	

Table: 2 Compressive Strength at 14 days for 0% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	795	35.33	**35.33**
2	780	34.66	
3	810	36	

Table: 3 Compressive Strength at 28 days for 0% of coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	1085	48.22	48.25
2	1165	51.77	
3	1007	44.76	

Table: 4 Compressive Strength at 7 days for 1% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	1095	48.66	48.69
2	1100	48.88	
3	1092	48.53	

Table: 5 Compressive Strength at 14 days for 1% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	1152	51.2	51.28
2	1200	53.33	
3	1110	49.33	

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Table: 6 Compressive Strength at 28 days for 1% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	1206	53.6	53.61
2	1195	53.11	
3	1218	54.13	

Table: 7 Compressive Strength at 7 days for 1.5% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	820	36.44	**36.39**
2	817	36.31	
3	820	36.44	

Table: 8 Compressive Strength at 14 days for 1.5% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	972	43.2	**43.28**
2	985	43.77	
3	965	42.88	

Table: 9 Compressive Strength at 28 days for 1.5% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	1001	44.49	44.48
2	995	44.22	
3	1007	44.75	

Table: 10 Compressive Strength at 7 days for 2% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	800	35.55	35.42
2	796.5	35.4	
3	795	35.33	

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Table: 11 Compressive Strength at 14 days for 2% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	895.5	39.8	
2	850	37.77	
3	875	38.88	39.81

Table: 12 Compressive Strength at 28 days for 2% of Coir fiber

S.No	Load at failure (k N)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
1	950	42.22	
2	946	42.04	
3	945	42	42.08

Table: 13 Comparison of Compressive Strength of various % of coir fiber

% of coir fiber	Days of curing		
	7 days	14 days	28 days
0	32.52	35.33	48.25
1	48.69	51.28	53.61
1.5	36.39	43.28	44.48
2	35.42	39.81	42.08

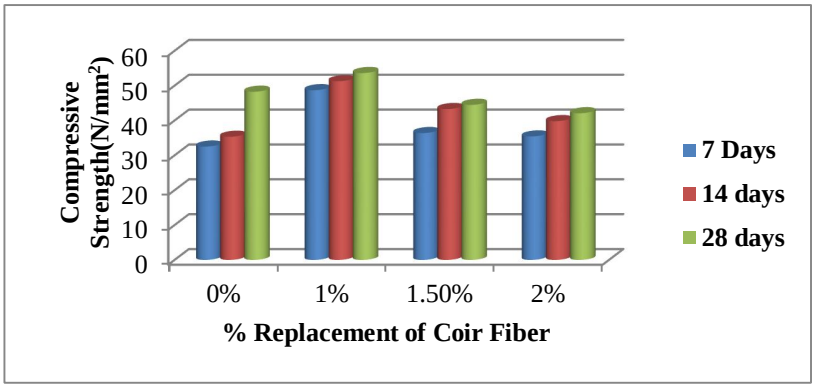


Figure: 1 Compressive Strength VS % of Coir Fiber

Table: 14 Tensile Strength at 28 days for 0% of Coir fiber

S.No	Load at failure (k N)	Tensile strength (N/mm^2)	Average Tensile strength (N/mm^2)
1	215	3.04	
2	220	3.11	**3.04**
3	210	2.97	

Table: 15 Tensile Strength at 28 days for 1% of Coir fiber

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S.No	Load at failure (k N)	Tensile strength (N/mm^2)	Average Tensile strength (N/mm^2)
1	364	5.14	**5.15**
2	360	5.09	
3	370	5.23	

Table: 16 Tensile Strength at 28 days for 1.5% of Coir fiber

S.No	Load at failure (k N)	Tensile strength (N/mm^2)	Average Tensile strength (N/mm^2)
1	238	3.36	**3.35**
2	230	3.32	
3	240	3.39	

Table: 17 Tensile Strength at 28 days for 2% of Coir fiber

S.No	Load at failure (k N)	Tensile strength (N/mm^2)	Average Tensile strength (N/mm^2)
1	221	3.12	3.13
2	225	3.18	
3	220	3.11	

Table: 18 Comparison of Tensile Strength for various % of Coir Fiber

% of coir fiber	Tensile strength at 28 days
0	3.04
1	5.15
1.5	3.35
2	3.13

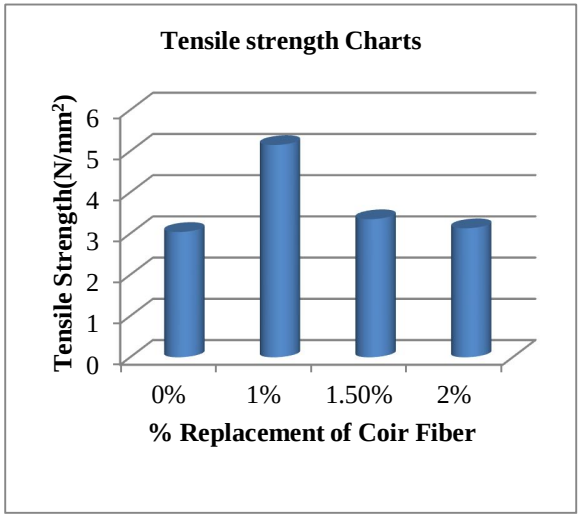


Figure 2: Tensile Strength VS % of Coir Fiber

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Table: 19 Flexural Strength at 28 days for 0% of Coir fiber

S.No	Load at failure (k N)	Flexural strength (N/mm^2)	Average Flexural strength (N/mm^2)
1	10	5	**5.16**
2	11	5.5	
3	10	5	

Table: 20 Flexural Strength at 28 days for 1% of Coir fiber

S.No	Load at failure (k N)	Flexural strength (N/mm^2)	Average Flexural strength (N/mm^2)
1	11.5	5.75	**6.00**
2	12.5	6.25	
3	12	6	

Table: 21 Flexural Strength at 28 days for 1.5% of Coir fiber

S.No	Load at failure (k N)	Flexural strength (N/mm^2)	Average Flexural strength (N/mm^2)
1	12.5	6.25	6.41
2	13	6.5	
3	13	6.5	

Table: 22 Flexural Strength at 28 days for 2% of Coir fiber

S.No	Load at failure (k N)	Flexural strength (N/mm^2)	Average Flexural strength (N/mm^2)
1	14	7	6.83
2	13.5	6.75	
3	13.5	6.75	

Table: 23 Comparison of Flexural Strength for various % of coir fiber

% of coir fiber	Flexural strength at 28 days
0	5.16
1	6
1.5	6.41
2	6.83

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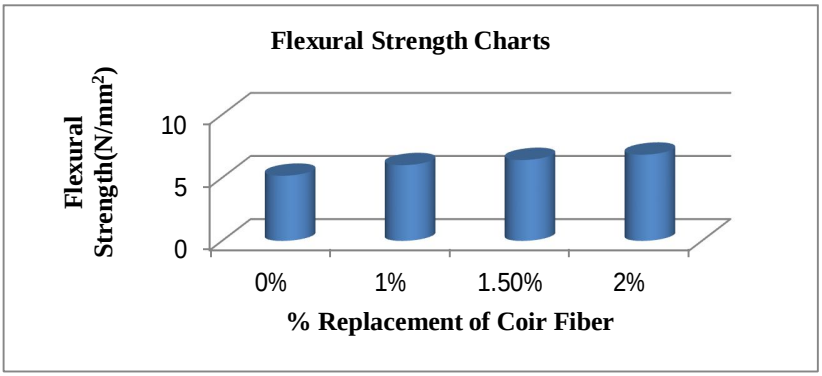


Figure: 3 Flexural Strength VS % of Coir Fiber

V. CONCLUSIONS AND FUTURE SCOPE

A. The concrete mix with increasing the % replacement of fine aggregate with coir fiber shows increase in the compressive strength up to 1% of coir fiber.
B. The concrete mix with increasing the % replacement of fine aggregate with coir fiber shows increase in the Tensile strength up to 1% of coir fiber.
C. The concrete mix with increasing the % replacement of fine aggregate with coir fiber shows increase in the Flexural strength.
D. The maximum increase in compressive strength for 1% replacement of fine aggregate with coir fiber is 11% as compared with concrete mix without coir fiber at 28 days.
E. The decrease in compressive strength for 1.5% replacement of fine aggregate with coir fiber is 7% as compared with concrete mix without coir fiber at 28 days.
F. The maximum decrease in compressive strength for 2% replacement of fine aggregate with coir fiber is 12.7% as compared with concrete mix without coir fiber at 28 days.
G. The maximum increase in Tensile Strength for 1% replacement of fine aggregate with coir fiber is 62% as compared with concrete mix without coir fiber at 28 days.
H. The decrease in Tensile Strength for 1.5% replacement of fine aggregate with coir fiber is 9% as compared with concrete mix without coir fiber at 28 days.
I. The maximum decrease in Tensile Strength for 2% replacement of fine aggregate with coir fiber is 2.6% as compared with concrete mix without coir fiber at 28 days.
J. The maximum increase in Flexural Strength for replacement of fine aggregate with coir fiber is 32.36% as compared with concrete mix without coir fiber at 28 days.
K. From this research work, optimum partial replacement of fine aggregate with coir fiber is 1%.

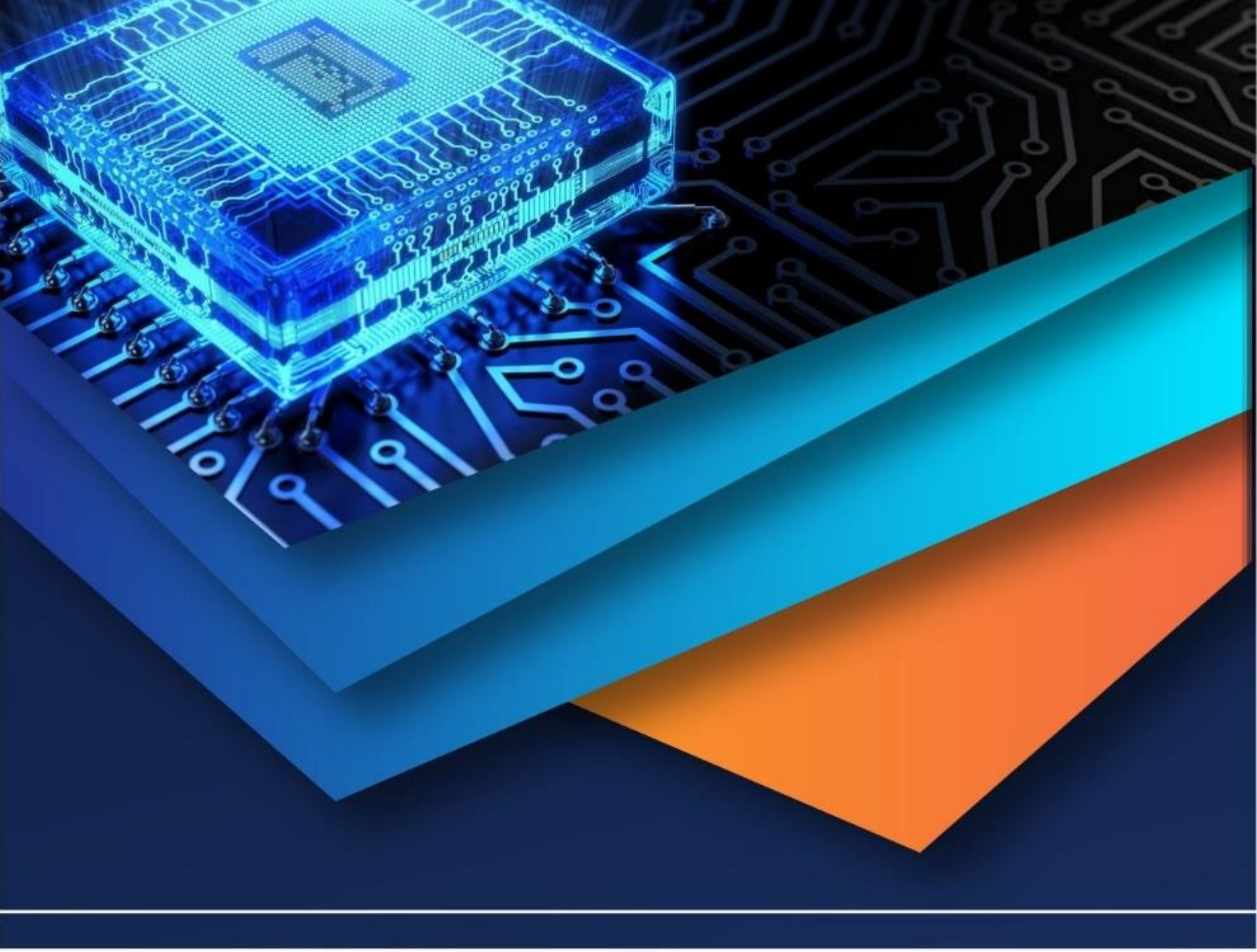
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