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STUDIES ON STRENGTHENHANCEMENT OF CONCRETE BY COIR FIBRE

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Abstract –*This paper presents the results on impact of coir fibre substitution in concrete performance. M20 grade fibre reinforced concrete was tested after adding coir fibre. Compressive strength, Split tensile strength and Elastic modulus were conducted with addition of 0%, 0.5%, 1.0%, 1.5% coir percentages. The test specimens were cured for 3,7,28 days in water under laboratory condition. The correlation between the strength properties were predicted and compared. Based on the test results, it is concluded that the addition of 1% coir fibre is not shown any reduction in workability and the tensile strength of concrete were improved up to 1.5% coir fibre.*

Key words**:** *Coir fibre, workability, compressive strength, Split tensile strength, Elastic modulus.*

1. INTRODUCTION

Theconcrete made from Portland cement is relatively strong in compression but weak in tension and tends to be brittle (1).The weakness in tension can be overcome by the use of conventional steel bars reinforcement and to some extent by the mixing of a sufficient volume of certain fibers (2). The use of fibers recalibrates the behavior of the fiber-matrix composite after it has cracked through improving its toughness (3).A fibre is a small discrete reinforcing material produced from various materials like steel, plastic, glass, carbon and natural materials in various shapes and size(4). A numerical parameter describing a fibre as its aspect ratio, which is defined as the fibre length, divided by an equivalent fibre diameter [l/d].Typical aspect ratio [l/d] range from 30 to 150 for length dimensions of 0.1 to 7.62 cm typical fibre diameters are 0.25 to 0.76 mm for steel and 0.02 to 0.5 mm for plastic (5-7). The plain concrete fails suddenly when the deflection corresponding to the ultimate flexural strength is exceeded, on the other hand fiber reinforced concrete continue to sustain considerable loads even at deflections considerably in excess of the fracture deflection of the plain concrete.

2. MATERIALS AND METHODS

2.1 Materials:

The materials selected for this experimental study includes normal natural coarse aggregate, manufactured sand as fine aggregate, cement, coir fibre and portable drinking water. The physical and chemical properties of each ingredient has considerable role in the desirable properties of concrete like strength and workability.

2.1.1Cement:

Market available Portland Pozzolana Cement (PPC) was used in this experiment.

Table 1 Physical properties of cement

Standard consistency	34%
Initial setting time (minutes)	147
Final setting time (minutes)	325
Specific gravity	3.11
28 days Compressive strength (MPa)	45.07

2.1.2 Aggregates:

Fine Aggregate (FA): FA of size passed through IS Sieve 4.75 mm was used. The fineness modulus of the FA was found to be 2.65 and the presence of silt contents was less than 4%. The specific gravity and grading limit of FAwere found as 2.62 and zone II respectively (8).

Coarse Aggregate (CA): Locally available CA of size passed through 20 mm size IS sieve was used in the investigation (8). The fineness modulus of the CA was found to be 6.75 and the specific gravity was found as 2.85. The grain size distribution results was shown that the CA chosen in this investigation belongs to well graded aggregate. Both FA and CA complied with the requirements of IS: 383-2016.

2.1.3 Fibre:

Coir fibre which is available in agricultural industry was used in this experiment and as shown in the Figure 1.

Fig.1 Coir fibre

2.1.4 Mix proportioning

The details of mix proportioning of M20 grade concrete are shown in Table 2. The fibre content varies from 0 to 2% by weight of cement used in the mix.

Table 2 Mix proportioning

Mix ID	Quantity of ingredient (kg/m³)				Fibre	
	Cement	FA	CA	Water	%	(kg/m³)
M0	350	735	1150	175	0	0
M1	350	735	1150	175	0.5	1.75
M2	350	735	1150	175	1	3.5
M3	350	735	1150	175	1.5	5.25
M4	350	735	1150	175	2.0	7.0

2.1.5 Methodology

The effect of adding coir fibre on the strength properties were evaluated by compressive strength, split tensile strength and Elastic modulus as mentioned in the flow diagram as shown in Figure 2.It is predicted the correlation between compressive strength and tensile strength and elastic modulus of coir fibre reinforced concrete (9).

2.1.6 Testing methods

The workability of the fresh concrete was evaluated using slump cone test. The concrete specimens of150 X 150 X 150mm was used for compressive strength test and the surface of the cube specimens were cleaned before placing in the compression testing machine. The compressive strength of the concrete was determined by dividing the load applied before failure by cross sectional area of the cube specimen. The load was applied at the rate of 2.5kN/s as per IS: 516-1959. The testing of cube specimen in compression testing machine is shown in Figure 3.

The split tensile strength test was performed using the concrete specimens of 150 mm diameter and 300 mm height cylinder for finding the indirect tensile strength of concrete using the formula and the testing of cube specimen in compression testing machine is shown in Figure 3.

$$f_t = \left[\frac{2P}{\pi LD}\right]$$

Where:

T = splitting tensile strength.

P= maximum applied load

D= diameter of the specimen, mm.

L= length of the specimen in mm.

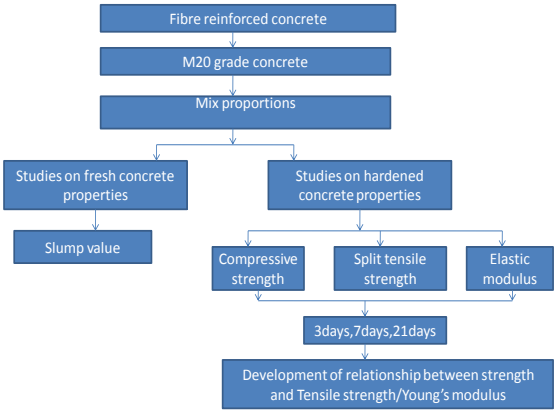

Fig.2Methodology

Fig.3Compressive Strength test on cube

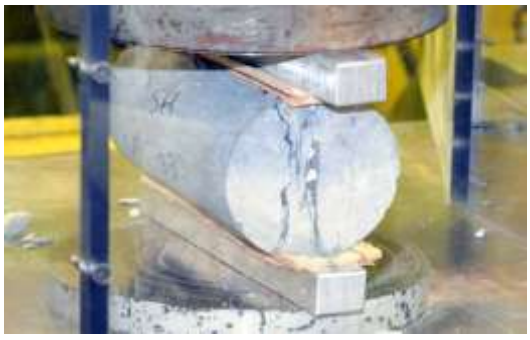

Fig.4Compressive Strength test on cube

The Modulus of elasticity of concrete test was conducted using the concrete specimens of 150 mm diameter and 300 mm height cylinder and the deflection of specimen due to the axial compressive load was measured by deflecto-meter. The deformation of the specimen with respect to different load was expressed by stress-strain graph. The slope of the curve gives the modulus of elasticity of concrete.

3 RESULTS AND DISCUSSION

3.2.4 Test Results

The workability of fresh concrete with and without coir fibre content is shown in Figure 5. It is clearly shown that the addition of coir fibre is reduced the slump value in all the substitution levels.

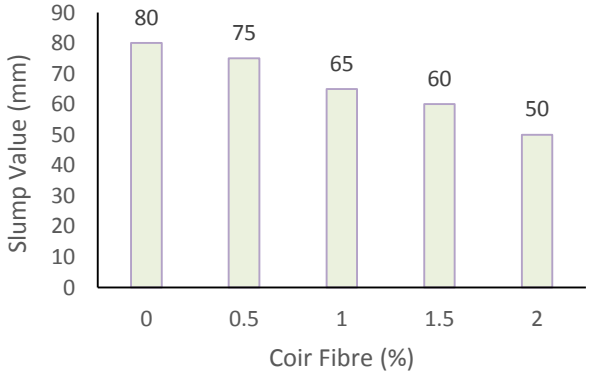

Figure 5.Slump value of coir fibre reinforced concrete.

The compressive strength development of the different mixes with respect to curing period is shown in Figure 6. The substitution of coir fibre had shown increases the strength up to 1% of coir fibre. Based on the 28 days compressive strength of 1% coir fibre mixed concrete is 18.2% more than control concrete. However the fibre content in the concrete composition more than 1% reduces the strength concrete due to the reduction of bond between the paste form and aggregate. The split tensile strength of 28 days cured different concrete mixes with coir fibre are illustrated in Figure 7. The tensile strength of fibre reinforced concrete was increased up to 1% substitution of coir fibre similar to the compressive strength. The tensile strength of control concrete is measured as 9% of compressive strength. But the addition of 1% coir fibre increases the split tensile strength up to 13% of compressive strength. The comparison of split tensile strength and compressive strength at 28 days is shown in Figure 8. It is predicted the correlation between compressive strength and tensile strength coir fibre reinforced concrete as $f_t = 0.63(f_{ck})^{0.54}$ with higher correlation coefficient.

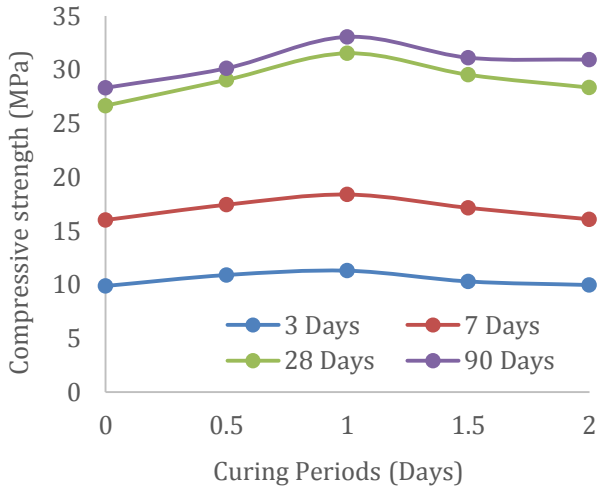

Figure 6. Compressive strength development of coir fibre reinforced concrete

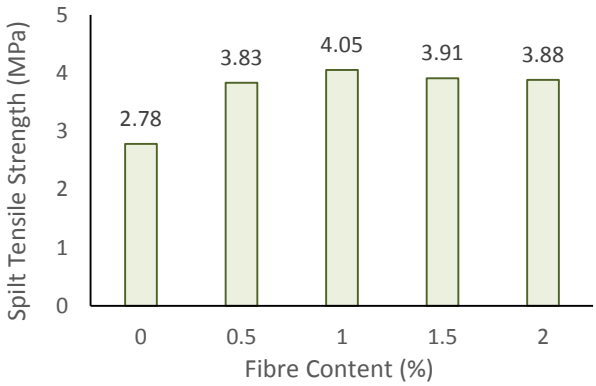

Figure 7. Split tensile strength of coir fibre reinforced concrete after 28 days curing

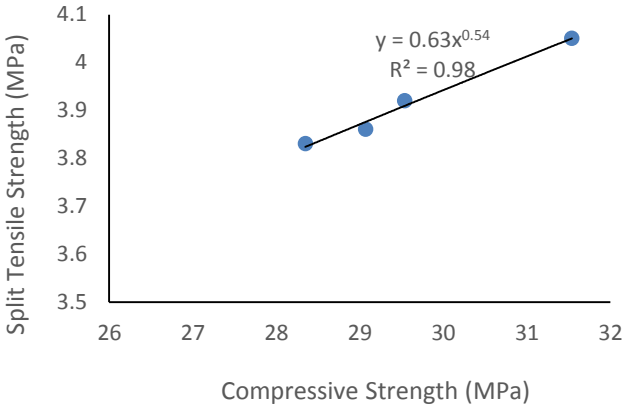

Figure 8.Comparision between compressive strength and Split tensile strength of coir fibre reinforced Concrete

The elastic modulus of 28 days cured concrete mixes with various % of coir fibres are illustrated in Figure 9. The elastic modulus of fibre reinforced concrete was increased

up to 1% substitution of coir fibre. The elastic modulus of control concrete is determined as 25350 MPa.The addition of 1% coir fibre increases the elastic modulus up to 28090 MPa. The comparison of elastic modulus and compressive strength at 28 days is shown in Figure 10. It is predicted the correlation between compressive strength and tensile strength coir fibre reinforced concrete as $f_t = 5134(f_{ck})^{0.508}$ with higher correlation coefficient. IS: 456-2000 specified correlation between the compressive strength and tensile strength of concrete as 0.7 $\sqrt{f_{ck}}$ and compressive strength and elastic modulus as 5000 $\sqrt{f_{ck}}$. However, the results of this investigation concluded that the substitution of 1% coir fibre had shown more than the code recommendation for normal concrete.

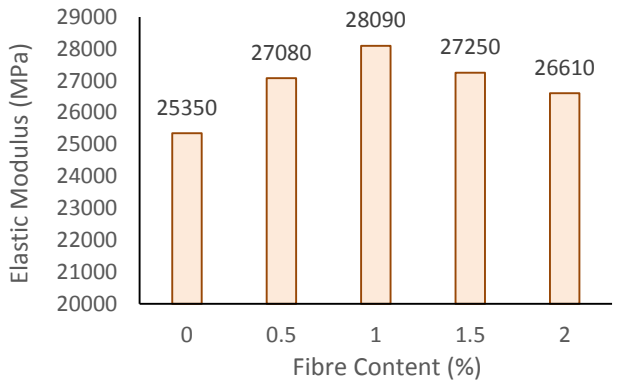

Figure 9.Elastic Modulus of coir fibre reinforced concrete after 28 days curing

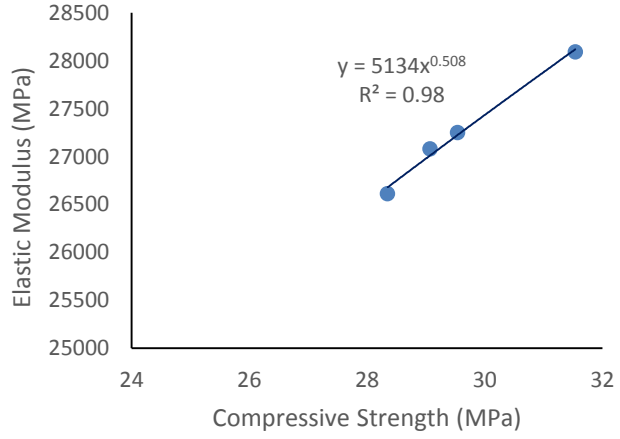

Figure 10. Comparision between compressive strength and Elastic modulus of coir fibre reinforced Concrete

4. CONCLUSION

The Experimental investigation are concluded that the substitution of coir fibre for the development of fibre reinforced concrete reduces the slump value. The compressive strength, split tensile strength and elastic modulus of coir fibre reinforced concrete was increased up to the substitution of 1% coir by weight of cement. The relationship between compressive strength and tensile strength was found as $f_t = 0.63(f_{ck})^{0.54}$ with higher correlation coefficient. The correlation between compressive strength and elastic modulus was found as $f_t = 5134(f_{ck})^{0.508}$.

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