International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 07 | July 2019 www.irjet.net p-ISSN: 2395-0072

Comparative Study on the Strength Parameters of Concrete Made using Natural and Artificial Waste Fibres

Deepika S[1], Anupama Natesh[2]

[1]*M.Tech Student, Department of Civil Engineering, Shree Devi Institute of Technology, VTU, Karnataka, India*
[2]*Asst. Professor, Department of Civil Engineering, Shree Devi Institute of Technology, VTU, Karnataka, India*

---***---

Abstract - *Concrete has several appealing characteristics that have made it as a widely used construction material. It is the material of choice where strength, performance, durability etc., are required and concrete is undoubtedly most versatile construction material. Today's developing world lays high emphasis on the waste management. Wastes generated through different source needs to be recycled & reused to convert them into useful resources & hence need to be treated well. Construction industries provide a wide platform in reusing these waste materials as an alternative of some conventional materials.*

Key Words: Natural and Artificial Fibers, Reuse of waste materials, Strength Parameters…….

1. INTRODUCTION

The Research on study of environmentally friendly, maintainable and durable materials have increased significant mindfulness in the development field. The present Research and Development is centred on the innovation of alternative materials which can be used in the concrete. The constituents of the concrete such as cement and aggregates can be replaced by the alternative material which can offer a better strength to concrete in turn this will be a solution for the over exploitation of the resources for the concrete manufacturing and the environmental problems.

2. NEED OF THE PROJECT

Studies have been showed that fibre reinforced concrete (FRC), enhances the strength properties of normal concrete; for example Split-Tensile Strength, Fatigue Strength, Compressive Strength, Modulus of Elasticity, Flexural strength, Toughness and Impact Resistance. It is also a known fact that the FRC can be used in the environmental condition where it is susceptible to the corrosion. Fibres make the structure fail in a ductile manner so that sudden failure of the structure can be avoided. Also, the fibres are found to be strong in sealing the cracks developed in the concrete. In this study an attempt is made to study the mechanical and workability properties of the concrete.

3. OBJECTIVES OF THE PROJECT

The project objective is to study the properties of the concrete made with different types of fibres.

1. To check the strength properties of the concrete like split tensile strength, compressive strength and flexural strength with different types of fibres.
2. To check the durability properties of the fibre by carbonation test.
3. To check the workability of the concrete made with natural and artificial fibres.
4. To find the best fibre which gives the better properties for the concrete.
5. To find the effect of fibre volume in the properties of the concrete for the different types of fibres using 0.5 % and 1% of fibre.

4. MATERIALS USED

4.1 Cement

Cement is an extremely fine material with durable properties and goes about as restricting material in concrete and contributes solidarity to the concrete. The characteristic of concrete are fundamentally impacted by the properties of cement. For the present study 'Ordinary Portland cement' of grade 43 in accordance to IS 8112-1989 is utilized.
a) Specific gravity = 3.15
b) Consistency = 29.2

4.2 Fine Aggregate

The sand which goes through 4.75 mm and left on 600 µ sieve is used in study. Basic tests and sieve analysis were done on fine aggregate to assess the fundamental properties and to choose the fine aggregate zonings.

a) Specific gravity = 2.58
b) Fineness modulus = 2.85
c) Moisture Content = 0.09%
d) Water Absorption =0.71%
e) Bulk density =1655kg/m^3

4.3 Course Aggregate

As per 'IS 383-1970' the coarse aggregates is defend as Aggregates, greater share of which is held on 4.75 mm IS Sieve and having less fine material as permitted for the dissimilar standard. Coarse aggregate with a max size of 20 mm is used in this study.

a) Specific gravity = 2.62
b) Fineness modulus = 2.74
c) Moisture Content = 0.18%
d) Water Absorption =0.49%
e) Bulk density =1590kg/m^3

4.4 Water

As indicated by 'IS 456: 2000', water applied for combination and relieving will be spotless and allowed from harmful measures of acids, oils, salts, alkalis or different materials that might be pernicious to cement or steel. The pH value of 6 is maintained.

4.5 Superplasticizer

Conplast SP430 is a market available retarder manufactured by the company FOSROC is used in this study. The properties of it is as given below.

a) Specific gravity = 1.20
b) Chloride Content =Nil
c) Solid Content =40%
d) Recommended Dosage =5ml to 2ml/kg of binder
e) Operating Temperature =10 to 40 degree Celsius
f) Colour =Dark Brown liquid

5. EXPERIMENTAL WORK

This section describes investigation of the fundamental properties of the materials utilized in this project and methods used to test the concrete samples at different stages of curing. Natural and artificial fibres and materials are collected and tested for their basic properties of the materials. Then mix design is done for M40 as per IS 12026-2009. The constituent is mixed in the specified manner with 0.5% and 1% of fibre. Various test to access the mechanical properties such has compression, split tensile and flexural strength were done. The durability properties such as carbonation test is also carried out and workability properties also accessed. The values obtained in the test is compared with the control mix.

5.1 Mix Proportioning For One Meter Cube of Concrete

Table-1: Proportion of Mix

Mix Proportion	1:1.65:2.92
W/C ratio	0.4
Cement	400kg
Water	160 kg
Coarse Aggregate	1168 kg
Fine Aggregate	660kg
Superplasticizer	2.4kg

5.2 Batching of Materials

Materials were batched dependent on weight batching and machine blending was adopted to blend the ingredients in this work. Gauge batching of every material made in this examination is appeared in the Table 1. The percentage replacement of ordinary cement by addition of different fibres and their material weight per cubic meter of concrete are given in Table 2. Samples made are given in Table 3.

Notation Used:

CM- Control Mix
BAG - Bagasse Fibre,
PLA - Plastic Fibre
BAN - Banana Fibre
COR -Coir Fibre
GLA – Glass Fibre

Table-2: Materials Weight

Mix Designation	Cement	Fiber	Coarse Aggregate	Fine Aggregate
	Kg	kg	Kg	kg
CM	400	-	1168	660
BAG1	400	2	1168	660
BAN1	400	2	1168	660
COR1	400	2	1168	660
GLA1	400	2	1168	660
PLA1	400	2	1168	660
SIS1	400	2	1168	660
BAG2	400	4	1168	660
BAN2	400	4	1168	660
COR2	400	4	1168	660
GLA2	400	4	1168	660
PLA2	400	4	1168	660
SIS2	400	4	1168	660

Table-3: Samples Made

Sl. No.	Type of Test	Type of Specimen	Dimension of Specimen	No. of Specimens
1	Compression Test	Cubes	150 mm x150 mm x150 mm	108
2	Split Tensile Strength	Cylinders	150 mm x 300 mm	108
3	Two Point Loading Flexural Test	Beams	150 mm x 150 mmx700 mm	108
4	Carbonation	Cylinders	150 mm x 300 mm	144

6. RESULTS AND DISCUSSION

6.1. Fresh Concrete

6.1.1. Workability

Slump test is the frequent technique to gauge steadiness of concrete which can be used in research laboratory or at place of construction. The slump value for the control mix is obtained as 75 mm but the samples with fibres slow the less value as compared to that of the control mix. Fig. 1 shows results of Slump Test.

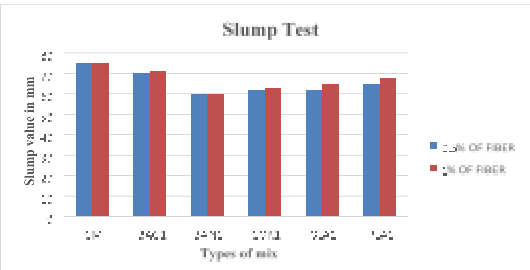

Fig-1: Slump Test Result

6.2 Hardened Concrete

6.2.1. Compression Test

The compressive strength test for cubes was conducted in compression testing machine as per IS: 516-1959. The cubes were tested in compressive testing machine at the rate of 140 kg/cm^2/min and the ultimate loads were recorded. Compressive testing machine is shown in Fig. 2.

Compressive Strength=P/A (Mpa)

Where,
P= Load (N)
A= Cross sectional area of cube (mm)

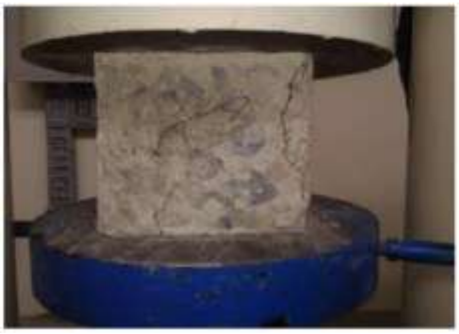

Fig-2: Compression Testing Machine

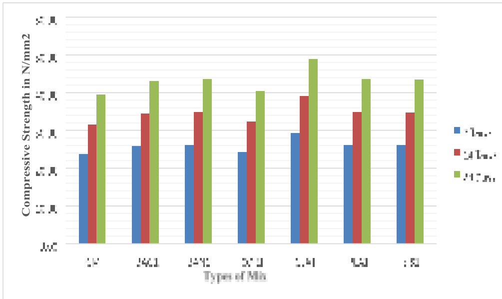

Fig-3: Compressive strength result for 0.5% of fibres

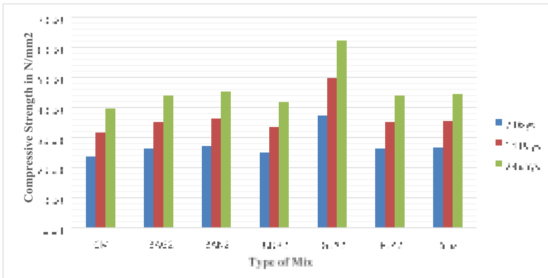

Fig-4: Compressive strength result for 1% of fibres

From the test results it is seen that the addition of the fibres enhances the compressive strength of the samples as compared to that of the control mix at 7, 4 and 28 days of curing. All the specimens with various type of fibres and different fraction of fibres show better compressive strength as compared to the control mix. The maximum strength is observed for the specimen made with glass fibre sample and low value is observed for the specimen made out of coir fibre; but the value is more than that of the control mix.

It can be observed that as the fibre volume increased the strength also enhanced for the all specimens with different types of fibres at 7, 14 and 28 days. It is similar in case of 0.5% and 1% of fibre. Among all the fibres glass fibre displays higher value as compared to the other fibres. Compressive test results of 0.5% and 1% fibre is shown in Fig. 3 and Fig. 4 respectively.

6.2.2. Split Tensile Test

Cylinders of size (100 x 300) mm were used for testing the split tensile strength of the concrete at 28 days of curing and is performed according to the IS: 5816-1999. The test specimen is placed in between the two steel strips in top and bottom of the specimen in testing machine and load is gradually applied on specimen at the rate 0.23 N/sec until specimen is failed then failure load is noted and tensile strength is calculated with the help of formula given below and the Split tensile testing machine is shown in Fig. 5.

$$\text{Split tensile strength (N/mm2)} = \frac{2P\pi}{lD}$$

Where,

P= Compressive stress on cylinder in N
D= cylinder diameter (mm)
L= cylinder length (mm)

Fig-5: Split Tensile Testing machine

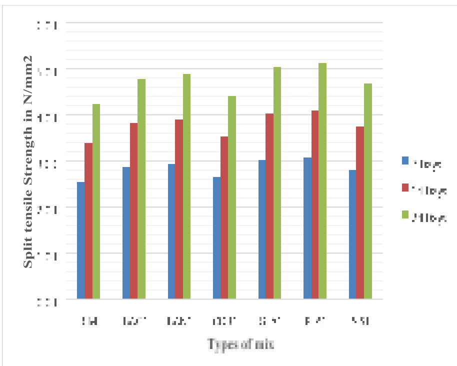

Fig-6: Split tensile strength result for 0.5% of fibres

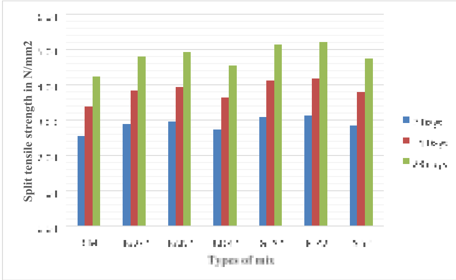

Fig-7: Split tensile strength result for 1% of fibres

Fig. 6 and Fig. 7 shows the Split tensile strength results for 0.5% and 1% fibre. From the results it is observed that the addition of the fibre enhances the tensile strength of the specimen. The maximum tensile strength is seen for the specimen made up of plastic fibre and glass fibre and showed a value of 5.12 N/mm² and 5.04 N/mm². The strength is increase by 28% as compared to the control mix.

The tensile strength for specimens with glass fibre for a fibre volume of 0.5% is 5.04 N/mm², while the tensile strength of the control mix is 4.23 N/mm². Same variation is observed for all the samples and is due to the reason that the fibres have good tensile strength.

6.2.3. Flexural Strength Test

Flexural strength test is led on arrangement of beams size of (150 x 150 x 700) mm at 28 days of curing samples as indicated by IS: 516-1959. Beam is set in testing machine, two-point loading strategy is received and step by step connected load at rate of 0.23 N/sec is applied until the beam crack and last loading is noted. Fig. 8 demonstrates the Flexural Strength Test.

The flexural strength of the specimen f_b can be found by

$$f_b = \frac{P \times l}{a \times d^2}$$

Where 'a' is the distance from the crack point to the nearer Support. The above equation is valid when 'a' is > than 20.0 cm for the specimen of 15 cm or > 13.3 cm for a specimen of 10.0 cm, or

$$f_b = \frac{3P \times a}{b \times d^2}$$

The above equation is valid when 'a' < than 20.0 cm but > 17 cm for 15 cm sample, or < 13.3 cm but > 11.0 cm for a 10.0 cm sample.

Where
P=Maximum load in N
L= Span of the Specimen

d= Depth of Specimen
b= Width in cm of Specimen

Fig-8: Flexural Test

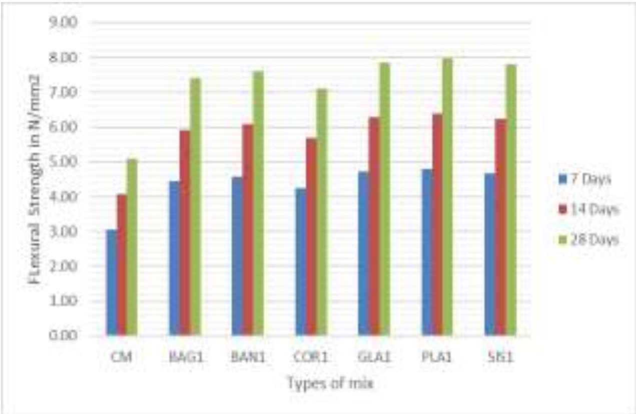

Fig-9: Flexural Strength result for 0.5% of fibres

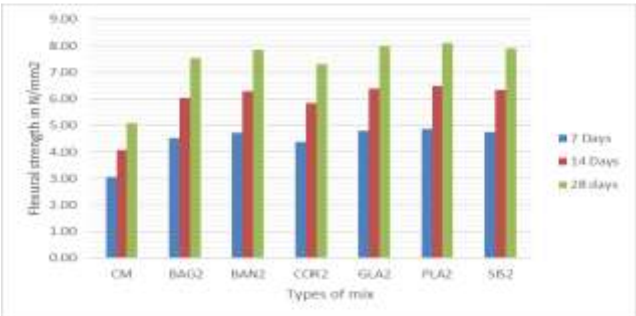

Fig-10: Flexural Strength result for 1% of fibres

Flexural strength is carried for the standard beams made using the different type of fibres and for different proportion. The results are graphically represented in Fig. 9 and Fig. 10. The increased value of the flexural strength is observed for all the specimens which are made out of different types of fibres. The maximum flexural strength is observed for the specimen made up of plastic fibre, sisal and glass fibre. The specimens with plastic sisal and glass fibre show a value of 7.98 N/mm², 7.8 N/mm² and 7.86 N/mm². The strength is increase by 37% as compared to the control mix.

The specimens with plastic for a fibre volume of 0.5% is 7.98 N/mm², while the flexural strength of the control mix is 5.1 N/mm². Addition of the same in the matrix make the concrete good in flexural strength.

6.2.4. Carbonation Test

Carbonation of concrete is showing reinforcement corrosion in the RCC. The response begins when the CO_2, in the environment come in contact with dampness, responds with hydrated concrete minerals to convey carbonates, for instance, calcium carbonate. The procedure of carbonation can be clarified as the balance of the base constituents of cementitious materials by means of carbonic corrosive which have been delivered by the disintegration of CO_2 in the pore the arrangement of the material. The reaction is explained for calcium hydroxide.

$$CO_2+H_2O \rightarrow H_2CO_3$$

$$H_2CO_3+Ca(OH)_2 \rightarrow CaCO_3+2H_2O$$

Fig-11: Carbonation Test

Fig. 11 shows Carbonation Test conduction on specimens. The depth of carbonization made with various fibres were obtained through a carbonation test, the average value of the carbonation depth is taken from 3 samples at 7th, 28th and 56th day.

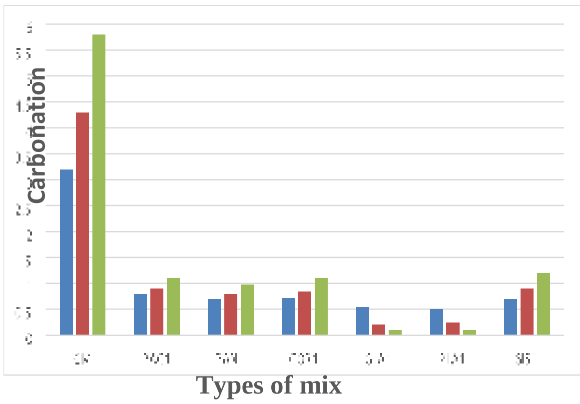

Fig-12: Carbonation Test result for 0.5% of fibers

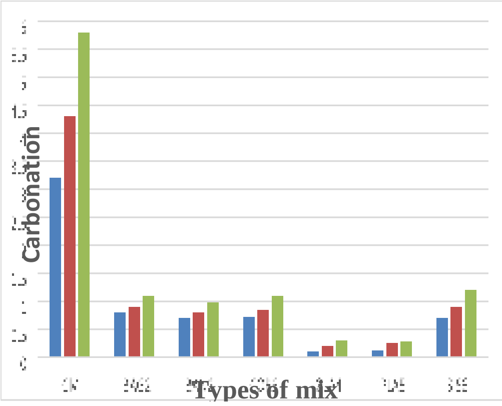

Fig-13: Carbonation Test result for 1% of fibers

Fig. 12 and Fig. 13 shows carbonation test results of 0.5% and 1% fibre. From the results it can be seen that carbonation depth of concrete increased with age. Control mix exhibited poor carbonation resistance because connected pores existed inside the concrete matrix. The addition of fibres prevented the development of cracks. The fibres filled up the pores, thus enhancing the carbonation resistance of concrete.

7. CONCLUSIONS

In this study an attempt is made to study the effect of different types of fibre in the properties of concrete. The basic constituent of the concrete is collected and test are conducted to check the properties of the materials. Then mix design is done for the M40 grade of concrete. Different specimens were made with fibres such as coir, banana, sisal, plastic, glass fibre and bagasse fibres. The fibre volume is changed between 0.5% to 1%. After the specified days of the curing, the test are conduct to study the strength and durability properties of the concrete. The important conclusion of the study is given in this particular section.

1. Highest Compressive Strength of 62.2 N/mm^2 is obtained in case of addition of Glass fibers.
2. Split tensile strength and Flexural strength was found to be highest by 5.21N/mm^2 and 8.10 N/mm^2 in case of Plastic Fiber.
3. Durability aspect also enhanced and is due to the fact that fibers arrests the cracks, and carbonation amount is reduced. It is only 0.3N/mm^2 when Glass fiber is used in mix.
4. Workability properties of concrete is reduced due to addition of fibers, which makes the mix harsh. Increased volume of fiber reduces the slump values. Least slump value obtained is 60mm for 1% addition of Banana Fiber.
5. The addition of higher fiber volume of 1% enhances the mechanical and durability properties.
6. The fibers are the better solution to resist the cracking of the concrete which leads to the sustainable development.

ACKNOWLEDGMENT

I express my sincere gratitude for the valuable guidance and constant encouragement given by my project guide and coordinator Mrs. Anupama Natesh, Assistant Professor, Department of Civil Engineering, SDIT, who showed great interest in project and gave guidance for the proceedings to handle this project in a systematic manner.

REFERENCES

[1] Anush K Chandrappa and Krishna Prapoorna Bilgiri, “Flexural-fatigue characteristics of pervious concrete: Statistical distributions and model development”, Construction and Building Materials Volume 153, Pages 1-15, 30 October 2017.

[2] Balte Sanjaykumar, and Prof. S. N. Daule, “Use of Plastic Fiber in the Concrete”, SSRG International Journal of Civil Engineering, pp 4-7, 4.11(2017).

[3] Chouw et al, Majid Ali, Anthony Liu, Hou Sou, “Mechanical and dynamic properties of coconut fibre reinforced concrete”, Construction and Building Materials, pp 814– 825, 30 (2012).

[4] Dang Hanh Nguyen, Nasim Sebaibi, “A modified method for the design of pervious concrete mix”, Construction and Building Materials, Volume 73 Pages 271-278, 30 October 2014.

[5] Dhawal Desai, “Pervious concrete – Effect of material proportion on porosity”, International journal of engineering and science ,Volume - 2,Issue-3,April 2010.

[6] Gaurav Uttam Shinde, Dr S.S Valunjkar,“An experimental study on compressive strength, void ratio and infiltration rate of pervious concrete” ,International journal of Engineering Research and technology ,Volume-4,Issue-4,April 2015.

[7] Marwan Mostafa, Nasim Uddin, “Experimental analysis of compressed Earth Block (CEB) with Banana fibres resisting flexural and compression forces”, Department of civil, Construction and Enviornmental Engineering University of Alabama at Birmingham.26 July 2016.

[8] Nalini Thakre,” Comparative Study on Strength and Permeability of Pervious Concrete by Using Nylon and Polypropylene Fibre”, IJCAT International Journal of Computing and Technology, Volume 1, Issue 4,ISSN : 2348 – 6090, May 2014.

[9] Rui Zhong,Kay Wille, " Compression response of normal and high strength pervious concrete", construction and building materials, Volume 109 ,15 April 2016.

[10] S. Suresh, M. Sai Charan, "Strength and behaviour of concrete by using natural and artificial fibre combinations", International Journal of Civil Engineering and Technology (IJCIET), Volume 8, Issue 4, pp. 1652–1658 April 2017.