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# To Study the Effect on Mechanical Properties of Concrete by Partially Replacement of Coconut Fibre and GGBS

**Chiranji Lal Meena[1], Mahendra Saini[2]**

[1]M. Tech. Scholar, Department of Civil Engineering (Structural Engineering), Regional College for Education Research & Technology, Jaipur, Rajasthan, India
*chiranjiinsan251[at]gmail.com*

[2]Assistant Professor, Department of Civil Engineering, Regional College for Education Research & Technology, Jaipur Rajasthan, India
*ms. cen.735[at]gmail.com*

**Abstract:** ***In this study evaluate the performance of concrete with GGBFS and also replace cement by Coconut fiber. GGBFS admixture in the concrete for improves the workability and strength properties of concrete in this study use OPC (43 grade). In this study GGBFS has been replaced in OPC and also Coconut fiber replaced in OPC which varies from (0%, 1%, 2% and 3%) by total weight of OPC cement. A total twenty four mixes (trial mix, control mix and variation mix) were prepared for M35 of concrete. In this study examine the performance of Compressive strength for 7days and 28 days, Flexural strength of beam 28 days and Non - destructive were also conducted as Ultra Sonic Pulse Velocity and Rebound Hammer Test.***

**Keywords:** GGBS, OPC, High performance, building

## 1. Introduction

There are two main ways in which the building sector is changing. The advancement of industrial processes, such as the use of automated construction equipment, is one way. The second is the development of high - performance building materials, like the use of concrete with increased strength. Fiber Reinforced Concrete (FRC), one of these high - performance materials, is gradually gaining favour with civil engineers. In recent years, there has been a rapid increase in the research and development of fiber and matrix materials and manufacturing processes related to the construction industry. Their advantages over other building materials are their high tensile strength to weight ratio, ability to be moulded into various shapes and increased resistance to environmental conditions, resulting in potentially lower maintenance costs.

**Objectives and Scope**

The purpose of this study is to look at how coir fibre affects the physical characteristics of concrete. The objectives of this work are:

Detection of variation in compressive and flexural strength of CFRP using coconut processed fiber at different fiber content (0%, 1%, 2% and 3%) and comparing it with conventional concrete.

## 2. Literature Review

### 2.1 Overview

This chapter deals with the various research work done on Fiber Reinforced Concrete including CFRC. The properties of different fibers were studied and the benefits of coconut fiber over other fibers were highlighted to justify its selection in this research work.

**(Bhatia, 2016)** Studied the utility of fiber reinforced concrete in various civil engineering applications. Fibers include steel fiber, natural fiber and synthetic fiber—each of which gives concrete different properties. The study showed that the fibrous material enhances structural integrity. These studies inspired us to switch to natural fibers which are available in abundance and cheap.

**(Chouw et al., 2016)** investigated **t**he viability of employing coconut - fibre ropes as vertical reinforcement in low - cost homes constructed without mortar in earthquake - prone areas. The rope anchor is inserted into the top tie - beam and foundation to accomplish this. The tensile strength of the rope is also discovered to be rather strong, and the link between the rope and the concrete is significant in the stability of the building. To prevent the collapse of the structure, the rope tension created by the earthquake load should be lower than both the pull - out force and the rope tensile load.

**(Li et al., 2017)** investigated the fibre volume fraction by surface treatment with a wetting agent for coir mesh reinforced mortar using non - woven coir mesh matting. They performed a four - point bending test and found that cementitious composites with three layers of coir mesh and a low fibre content of 1.8% were 40% stronger in terms of flexural strength than standard concrete. The composite was discovered to be around 20 times stronger in terms of flexural ductility and roughly 25 times stronger overall.

**Asasutjarit et al., (2016)** after 28 days of hydration, the physical, mechanical, mechanical (modulus of ductility, modulus of rupture, and intrinsic bond), and thermal properties of coir - based light - weight cement board were determined. Using the Japanese industry standards JIS A 5908 - 1994 and JIS R 2618, the thermal properties of the physical and mechanical qualities were measured.

**(Liu et al., 2017)** investigated the effects of fibre lengths of 2.5, 5 and 7.5 cm on the characteristics of concrete at 1%, 2%, 3%, and 5%. The characteristics of plain cement concrete were utilised as a guide for an accurate examination. It was found that as the amount of fibre in a CFRC beam grows, so does its moisture content. The best results, it was found, were from CFRC with a fibre length of 5 cm and a fibre content of 5%. We added 4%, 5%, and 6% coconut fibre by weight of cement in our research because the optimum proportion of coconut fibre added in this study was 5%.

## 3. Materials and Experimental Program

### 3.1 Materials

**3.1.1 Cement: -** Cement is a binder that binds and hardens the other constituent materials of concrete together. Cement can be classified into hydraulic and non - hydraulic cement based on the nature of cement used in the presence of water. The cement used for this study was Ordinary Portland Cement Grade 43 which conforms to IS: 8112 - 1989.

**3.1.2 Fine aggregate: -** Coarse, medium, and fine sand are the different sizes of fine aggregates. Depending on the grading, the IS standard divides the fine aggregate into four categories or zones (zones 1 through zone 4).

**3.1.3 Coarse aggregates: -** Coarse aggregate may either gravel or crushed stone comprise of particles size greater than 4.75 mm diameter with nominal size of aggregate 20mm and particles smaller than this is allowed as described in IS - 383: 1970 according the nominal size i.e. 40mm, 20mm etc.

**3.1.4 Coconut fibres:** locally available coconut fibres from the shells of coconut available at local shop.

### 3.2 Collection of Raw Materials

The materials used in this study are:
**Portland cement (OPC):** OPC Grade 43
**Natural sand:** locally available river sand passing through 4.75 mm sieve
**Coconut fibre:** fibres are obtained directly from outer skin of coconut available at local shops.
**Water:** Collected from local fresh water
**Coarse aggregate:** Aggregates passing through 20mm sieve.

### 3.3 Material Tests

Material Testing and Experimental programme
Tests on cement
Tests on coarse aggregates
Tests on fine aggregate
Mix design
Selection of air content
Mix proportion
Cement = 394 kg/m3
Water = 197 kg/m3
Coarse aggregates = 1138 kg/m3
Fine aggregates = 687 kg/$m^3$

### 3.4 Casting and Curing

For the first 24 hours, these specimens were left in the steel mould at room temperature. These were then carefully remoulded so that no edges were damaged, and they were put in the tank at room temperature for curing. The cubes were submerged in water for 7, 14, and 28 days after being remoulded using the steel mould's screws.

**Figure 3.9:** Casting of cubes

### 3.5 Tests on Hardened Concrete

#### 3.5.1 Compressive Strength

At a water cement ratio of 0.5, coconut fibre reinforced concrete was added to concrete in varied amounts (0%, 1%, 2%, and 3% of the weight of cement). At this ratio, traditional concrete achieved the requisite slump value and compressive strength.

#### 3.5.1 Flexural Strength Test

Standard beams of 15 cm x 15 cm x 70 cm were used for the flexural strength tests. Three samples of each type of concrete—plain concrete and reinforced concrete with coconut fiber—were cast with increasing amounts of fibre (1%, 2%, and 3%). The 28 - day strength values for each case were determined by loading under a flexural strength equipment.

The tensile strength of concrete is measure by conduct flexural strength test on beam. This test is also conducted on the basis of IS 516: 2004. The size of specimen according to IS code is 100 x 100 x 500mm were casted and test after the curing period of specimen is completed. The modulus of rupture (Fb) is given by these equations.

**Fb = pl / bd² ……. . (1)**

**Fb = 3pa/ bd² ………. . (2)**

Where p = maximum load in KN

L = length of beam in mm

b = width of the beam in mm

d = depth of beam in mm

a = distance between line of fracture to the nearest point.

**Ultrasonic pulse velocity test (IS 13311 part - 1: 1992)**

It is a non - destructive test that is frequently used to determine the interior density and dynamic modulus of elasticity of concrete specimens. To determine the density of a mortar specimen, it is also utilised to locate any cavities or weak spots inside the mortar.

Take a sample that is 25mmx25mmx285mm in size. The designated moulds are filled with it, and when they have been removed, they are placed in a water tank for 28 days to cure.

**Pulse velocity= Distance between the two probes (Path Length) / Time of travel**


## 4. Test Results and Analysis

### 4.1 Study on materials used

#### 4.1.1 Overview

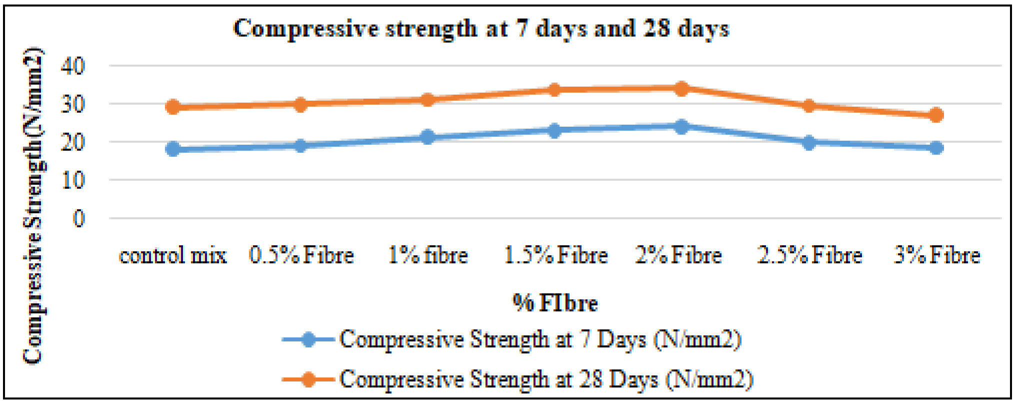
Concrete is a freshly mixed material which can be moulded in to any shape. Concrete is a site made material unlike other material of construction such as can vary to a very great extent in its quality, properties and performance owing to the use of natural material except cement.

**Test results of test on hardened concrete**

#### 4.1.2 Compressive Strength Test

**Table 4.1:** Compressive strength of concrete with different fibre percentages

| % Fibre | Compressive Strength at 7 Days (N/mm2) | Compressive Strength at 28 Days (N/mm2) |
|---|---|---|
| 0% fibre | 18.21 | 29.43 |
| 0.5% fibre | 19.15 | 30.12 |
| 1% fibre | 21.35 | 31.24 |
| 1.5% fibre | 23.20 | 33.97 |
| 2% fibre | 24.24 | 34.31 |
| **2.5% fibre** | 20.05 | 29.73 |
| **3% fibre** | 18.62 | 27.21 |




**Graph 4.1:** Graph showing variation of compressive strength at 7 days and 28 days

**Inference**

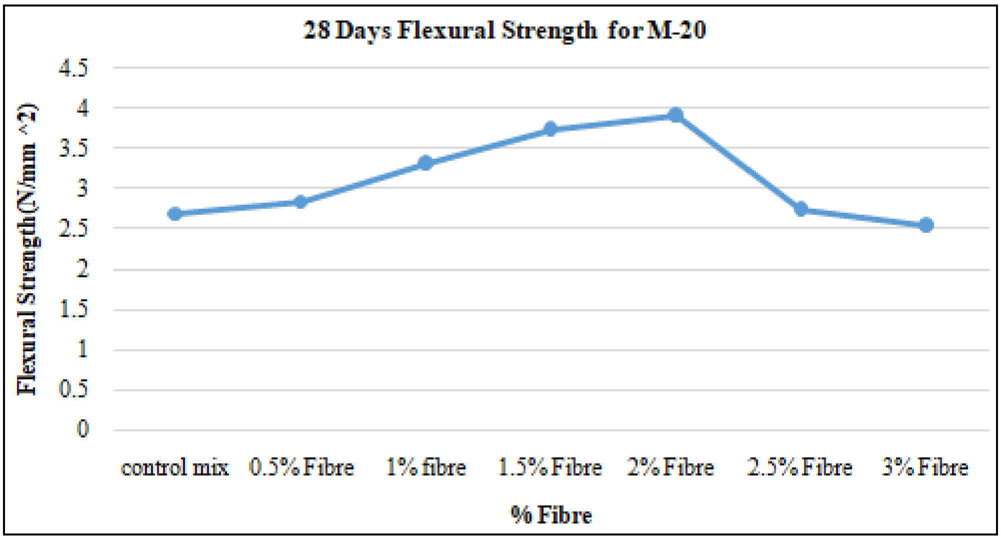
The value obtained for 1% addition of coconut fibre water cement ratio 0.5 yielded highest results for compressive strength. However, the compressive strength decreased on the increase in fibre addition.

**Flexural Strength after 28 days**

Flexural strength of concrete was carried out after 28 days of casting on grades of concrete M20 having fibre content 0%, 1%, 2% and 3%.

**Table 4.2:** 28 Days Flexural Strength for M - 20

| S. No | % Fibre | Flexural Strength at 28 days (N/mm ^2) | Avg. Flexural Strength (N/mm ^2) | % Increase/Decrease |
|---|---|---|---|---|
| 1 | 0% Mix | 2.83 | 2.68 | 0 |
| | | 2.48 | | |
| | | 2.73 | | |
| 2 | 0.5% Fibre | 2.91 | 2.83 | 31.65 |
| | | 2.89 | | |
| | | 2.65 | | |
| 3 | 1% fibre | 3.27 | 3.31 | 17.39 |
| | | 3.31 | | |
| | | 3.38 | | |
| 4 | 1.5% fibre | 3.88 | 3.74 | 6.5 |
| | | 3.62 | | |
| | | 3.73 | | |
| 5 | 2% fibre | 3.87 | 3.92 | 4.8 |
| | | 3.95 | | |
| | | 3.93 | | |
| 6 | 2.5% Fibre | 2.73 | 2.74 | 30.10 |
| | | 2.72 | | |
| | | 2.76 | | |
| 7 | 3% Fibre | 2.55 | 2.54 | 7.29 |
| | | 2.42 | | |
| | | 2.67 | | |




**Graph 4.2:** Bar graph showing variation of flexural strength of CFRC at 28 days

**Inference**

The graph shows that flexural strength increases as fibre content increases, reaching a maximum at 1% of fibre. However, a downward slope of the curve is shown when the fibre content is raised over this level.

**Table: 4.3:** Pulse velocity test Different % fibre and their pulse velocity

| Proportions | Pulse velocity (Km/s) | Concrete quality grading |
|---|---|---|
| control mix | 3.83 | Good |
| 0.5% Fibre | 3.95 | Good |
| 1% fibre | 4.03 | Good |
| 1.5% Fibre | 4.12 | Good |
| 2% Fibre | 4.72 | Excellent |
| 2.5% Fibre | 3.58 | Doubtful |
| 3% Fibre | 3.21 | Doubtful |

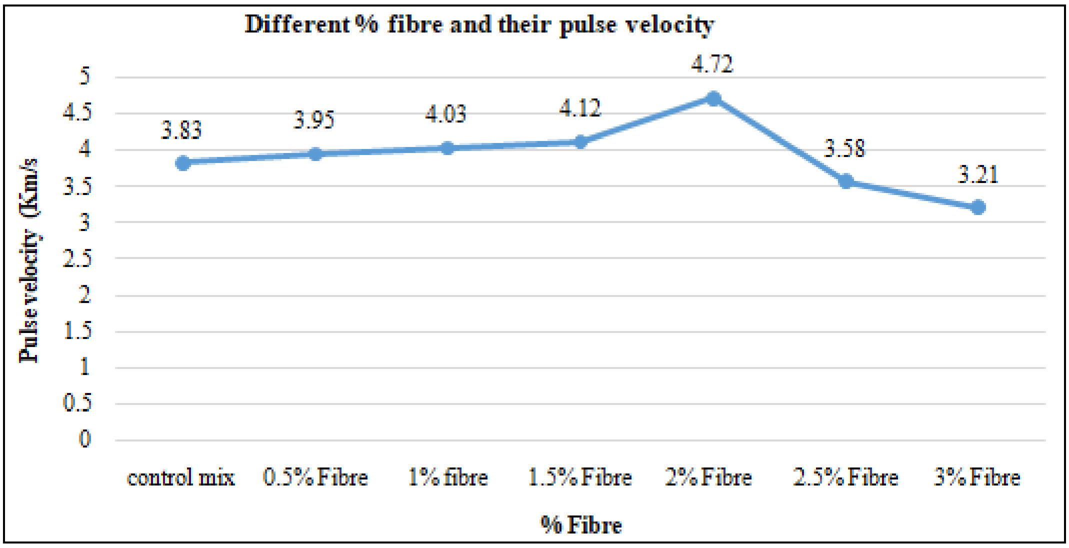



**Figure 4.3:** Bar chart showing the pulse velocity of different proportions

**Water Permeability Test**

To check the water permeability of concrete, DIN test was performed. Three cubes of side length 150 mm was oven dried. Before placing the cubes in the apparatus, weighing of cube was done. The cubes were placed in such manner that the direction of water pressure (0.5 $N/mm^2$) was normal to the direction of concrete filling in the mould for three days.

**Table 4.4:** Water Permeability Test for coconut fibre mixing

| S. No. | Sample | Initial Wt. ($W_1$) in Kg | Final Wt. ($W_2$) in Kg | Water Permeability (mm) |
|---|---|---|---|---|
| 1 | control mix | 8.01 | 8.06 | 54 |
| 2 | 0.5% Fibre | 7.855 | 7.995 | 50 |
| 3 | 1% fibre | 8.06 | 8.14 | 48 |
| 4 | 1.5% Fibre | 7.96 | 8.055 | 45.67 |
| 5 | 2% Fibre | 7.895 | 7.95 | 53.67 |
| 6 | 2.5% Fibre | 7.995 | 8.055 | 58 |
| 7 | 3% Fibre | 7.873 | 7.979 | 64.33 |

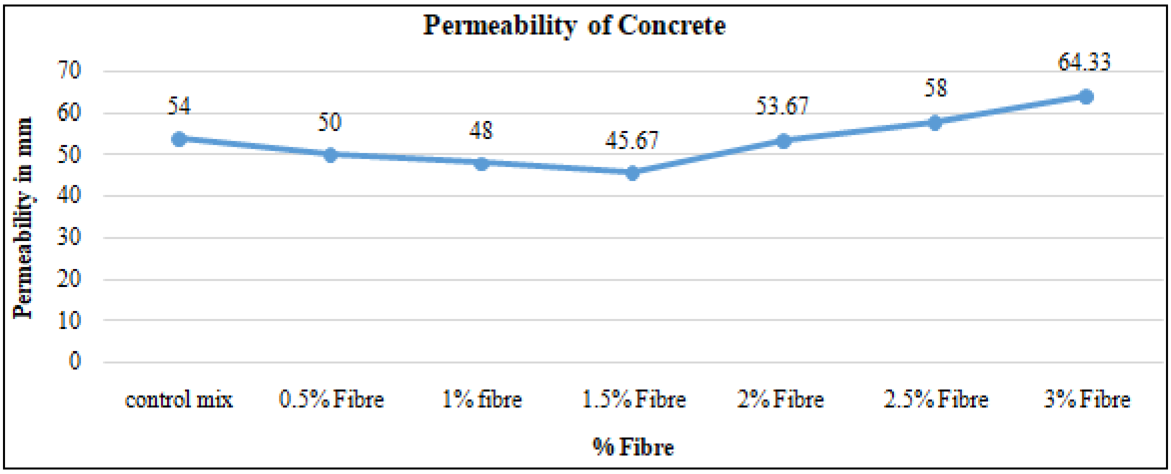



**Figure 5.13:** Water Permeability Test for Replacement Marble Slurry

## 5. Conclusion

1) At 1% addition of coconut fibre with a water cement ratio of 0.5, compressive strength tests yielded best results. However, the compressive strength decreased on further fibre addition. This must be due to the fact that when the fibres are initially added to concrete, the finer sized fine aggregates enter into the surface pores in the fibre creating a better bonding between the fibre and mix, however further addition of fibres resulted in formation of bulk fibre in the mix which will lead to decrease in bonding. Hence there is an optimum value of fibre to cement ratio, beyond which the compressive strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum fibre content was taken as 1%
2) When fibre content is increased there is an increase in flexural strength with a maximum at 1% of fibre. However when the fibre content is increased beyond this value a downward slope of the graph is observed. This is also due to the binding properties of coconut fibre owing to its high tensile strength of 21.5 MPa.

3) A decreasing trend in compressive strength was observed in concrete with mesh shaped fibres. This is due to formation of weak inter transition zone around these fibres, making the entire specimen weak. Moreover the thickness of the fibres can hinder better packing of the constituents of concrete thereby making it weak. The presence of dust and other impurities on the surface of fibres can also be another reason for this reduction in strength which may interfere with the bonding of mix and subsequent strength formation.
4) The tensile properties and cracking pattern of CFRC shows that it can be particularly useful in construction activities in seismic zones due to its high tensile strength and post peak load behaviour, which offers sufficient warning to the inhabitants before complete collapse of the structure.
5) Due to its relatively higher strength and ductility, it can be a good replacement for asbestos fibres in roofing sheets, which being natural in origin pose zero threat to the environment

**UPV test:**

- The results of UPV test increased 4.48% greater than control mix for series - 1 and 15% greater than control mix for series - 2.
- Mix of fibre and to some extent of cement is an economical option. Reduction of about 10% in cost of concrete is observed. New concrete also has less dead weight.

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