A Study of Compressive and Flexural Strength Analysis of Concrete Cylinder on The Influence of Jute Fiber

By

MD FORIDUZZAMAN

MD RAHIAN ALI

RIFAT HASAN

A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

Department of Civil Engineering

Sonargaon University

147/I, Green Road, Dhaka-1215, Bangladesh

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By

MD FORIDUZZAMAN	ID: BCE 1901016046
MD RAHIAN ALI	ID: BCE 1901016201
RIFAT HASAN	ID: BCE 1901016240

Supervisor

Dewan Tanvir Ahammed,
Lecturer,
Department of Civil Engineering,
Sonargaon University

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The Thesis titled **"A study of Compressive and Flexural Strength Analysis of Concrete Cylinder on the Influence of Jute Fiber"** submitted by Md. Foriduzzaman (BCE1901016046), Md. Rahian Ali (BCE1901016201), Rifat Hasan (BCE1901016240), has been accepted a satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering on 9 September 2022.

………………………………………

1. Dewan Tanvir Ahammed,
   Lecturer,
   Department of Civil Engineering, SU — Chairman

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CERTIFICATION

This is to certify that the project paper on **“Examining the A study of Compressive and Flexural Strength Analysis of Concrete Cylinder on the Influence of Jute Fiber”** is the confined record of project work done by us as a group and others for partial fulfilment of the requirement of the degree of B.Sc. in Civil Engineering from the Sonargaon University (SU).

This project work has been carried out under my guidance and is a record of successful work.

Supervisor

Dewan Tanvir Ahammed

Lecturer

Department of Civil Engineering

Sonargaon University (SU)

147/1, Green Road, Tejgaon, Dhaka-1215, Bangladesh.

DECLARATION

We, hereby declare that the work presented in the **A study of Compressive and Flexural Strength Analysis of Concrete Cylinder on the Influence of Jute Fiber** to Department of Civil Engineering, SU for the degree of Bachelor of Science, is the outcome of the original work done by me under the supervision of Dewan Tanvir Ahammed, Lecturer, Department of Civil Engineering, SU. This work has not been submitted anywhere for the award of any other degree or diploma.

STUDENT NAME	STUDENT ID.	SIGNATURE
MD FORIDUZZAMAN	BCE 1901016046	
MD RAHIAN ALI	BCE 1901016201	
RIFAT HASAN	BCE 1901016240	

Dedicated

To

''TO OUR PARENTS, FAMILY AND TEACHERS''

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Finally, we grateful to almighty Allah for giving me the strength to continue the study and bring it to the present stage.

ABSTRACT

Concrete is a brittle material which is strong in compression but weak in tension. To improve the behavior of concrete various experiments have been done previously including the use of fibers. As Bangladesh has abundant production of jute, in this study jute fiber was used to observe the changes in mechanical properties of concrete. Mix design was done by conventional way, used in Bangladesh. The effect of various proportion of jute fiber along with the change in water-cement ratio on concrete, was measured by three strength parameters: compressive strength, split tensile strength and flexural strength. All the test procedures were done according to standard ASTM methods. Failure pattern was also observed. From the result obtained from the experiment, it can be stated that 0.20% jute fiber along with water-cement ratio of 0.45 improved the compressive strength. The split tensile strength of concrete was also found maximum for this combination. However, flexural strength was higher at 0.40% fiber dosage with 0.55% water-cement ratio. Concrete, with or without jute fiber underwent similar type of fracture. Jute fiber reduced the cracking level from macro-level to micro level by bridging the cracks.

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CHAPTER 1
INTRODUCTION

1.1 Background

Concrete is a highly complex heterogeneous material. It consists of coarse aggregate, fine aggregate and cement paste. The response of concrete to stress depends on the response of the individual components as well as upon the interaction between these components. The coarse aggregate is a linear elastic brittle material having strength above than that of the concrete. The cement paste has higher compressive strength than concrete but has a lower modulus of elasticity. The addition of fine aggregates can increase the modulus of elasticity but reduce the strength of concrete.

Compressive strength is considered one of the most important properties of concrete. Concrete is even classified based on the compressive strength of the concrete cube or cylinder. Designs of concrete structures are made based on the compressive strength of concrete. Comparing to compressive strength, the tensile strength of concrete is much lower. Cracks can propagate easily under tensile loads. Thus tensile strength is not usually considered in design. However, it is an important property as cracking in concrete most generally occurs due to the tensile stress which develops under loading or due to environmental changes. The failure of concrete in tension is governed by micro cracking, associated particularly with the interfacial region between the cement and the aggregate particles.

The modulus of elasticity is a very important mechanical property of concrete. The higher the value of the modulus, the stiffer the material is. Thus, comparing a high-performance concrete to a normal strength concrete, it is seen that the elastic modulus for high performance concrete will be higher, thereby making it a stiffer type of concrete. Concrete may be referred to as a brittle material. This is because concrete's behavior under loading is completely different from that of ductile materials like steel. To enhance the overall performance of concrete, Fiber Reinforcement Cement Concrete (FRC) is being used widely around the world. The design of a durable and low-cost fiber reinforced cement concrete for building construction is a technological 2 challenge in developing countries. The types of fiber currently being used include steel, glass, polymers, carbon and natural fibers. Economic considerations have restricted the use of carbon fibers in cementitious composites on a commercial level for their non-ecological performance. Natural fibers have the potential to be used as reinforcement to overcome the inherent deficiencies in cementitious materials. Considerable researches are being done for use of reinforcing fibers like jute, bamboo, sisal, akwara, coconut husk, sugarcane bagasse in cement composites mostly in case of building materials. Use of natural fibers in a relatively brittle cement matrix has achieved considerable strength, and toughness of the composite.

1.2 Objective

- To determine the mechanical fiber properties of concrete with or without jute fiber.
- To compare the mechanical strength with the change in fiber percentages and w/c ratio.
- To observe the failure pattern of concrete with or without jute fiber.
- To determine the optimum percentage of jute fiber.

1.3 Scope of the Study

Concrete is widely used in structural engineering with its high compressive strength, low cost and abundant raw material. But common concrete has two major deficiencies, a low tensile strength and a low strain at fracture. The tensile strength of concrete is very low because plain concrete normally contains numerous micro cracks. It is the rapid propagation of these micro cracks under applied stress that is responsible for the low tensile strength of the material. To overcome these deficiencies, additional materials are added to improve the performance of concrete. The current research is done looking for a new concept to increase the concrete's overall performance. This new generation technology utilizes fibers, which if randomly dispersed throughout the concrete matrix, provides better distribution of both internal and external stresses by using a three-dimensional reinforcing network. The primary role of the fibers in hardened concrete is to modify the cracking mechanism. By modifying the cracking mechanism, the macro-cracking becomes 3 micro-cracking. The cracks are smaller in width, thus reducing the permeability of concrete and the ultimate cracking strain of the concrete is enhanced. In this research jute fiber was used to observe the overall performance of concrete. And if this experiment obtains significant result of improvement of the characteristic of concrete, the use of jute in low economic country like Bangladesh, can be revolutionary.

CHAPTER 2

LITERATURE REVIEW

Plain concrete is strong in compression but weak in tension and has the disadvantages of being a brittle material. To overcome these shortcomings, there has been an increase in the use of fiber reinforced concrete (FRC) since the late 1960s. Their main purpose is to increase the energy absorption capacity and toughness of the material, but also increase tensile and flexural strength of concrete.

2.1 Fiber Reinforced Concrete (FRC)

Concrete containing a hydraulic cement, water, fine or fine and coarse aggregate and discontinuous discrete fibers is called fiber-reinforced concrete (FRC). It may also contain admixtures commonly used in conventional concrete. Fibers of various shapes and sizes produced from steel, plastic, glass, and natural materials are being used. However, for most structural and nonstructural purposes, steel fiber is the most commonly used of all the fibers. There is considerable improvement in the post cracking behavior of concretes containing fibers. Although in the fiber-reinforced concrete the ultimate tensile strengths do not increase appreciably, the tensile strains at rupture do. Compared to plain concrete, fiber reinforced concrete is much tougher and more resistant to impact. Generally, the fibers are not added to improve the concrete strength but to control the cracking of the concrete and to modify the behavior of the materials once the concrete matrix has cracked. This is done by bridging across the cracks as they begin to open and fibers provide the post-cracking ductility to the FRC.

2.2 Characteristic of FRC

In comparison to conventional reinforcement, the characteristics of fiber reinforcement are that:

- The fibers are generally distributed throughout a cross-section, whereas steel bars are only placed where needed.
- The fibers are relatively short and closely spaced, whereas the steel bars are continuous and not as closely placed.

- It is generally not possible to achieve the same area of reinforcement with fibers as with steel bars.
- In FRC crack density is increased, but the crack size is decreased.
- The failure mechanism is by pull-out.
- Fibers slow down the propagation of cracks.
- Concrete mixtures containing fibers possess very low consistencies; however, the place ability and compatibility of concrete is much better than reflected by the low consistency.
- Toughness of material can be increased (15-30%).
- Creep results don’t show much difference.
- Drying shrinkage show some difference.
- They are used for cavitation damage.

2.3 Compressive Strength

The compression strength of concrete has been shown to be only slightly affected by the addition of fibers, except at very early age, under 24 hours. This is due to the fact that polymer fibers have a lower modulus of elasticity than does concrete once the concrete cures. Thus, the fibers do not take load until the concrete cracks. However, at early age, the concrete has a lower modulus of elasticity, and the fibers take load. A study (Myers et. al., 2008) showed that polymer fibers had a distinct impact on the properties of concrete. At early age, polymer fibers greatly improved concrete behavior, compression strength was increased. In the long term, the impact of polymer fibers was minimal, because strength and drying shrinkage were not materially altered by the addition of fibers. However, it was shown that post-cracking the fibers come into play again, reducing crack widths and improving ductility. In another study (Balaguru and Khajuria, 1996) both normal and lightweight concrete were tested with polymeric fibers. It was found that the addition of fibers did not change the compressive strengths appreciably long term. The variation of unit weight among the control mix and fiber reinforced concrete, made with various fiber volumes, was not significant. By testing a number of aggregates and mixes with polypropylene fibers, it was found that the compressive strength of concretes containing fibers were slightly higher or lower than their plain concretes (under 10%) (Aulia, 2002). It means that the use of 0.2% polypropylene fibers alone contributed to the low influences on such concrete properties rather than the influences raised by the other concrete constituents. Essentially, there was no difference between the compressive strength with and without fibers. An interesting trend was found in research (Soroushian et. al., 1992). With the addition of more fibers, the compressive strength significantly decreased. The plain concrete had strength of about 6700 psi, while the average strength with fibers decreased with higher dosage rates to about 5200 psi at a 0.1% by volume dosage. It must be noted that when Soroushian et al. added fibers they also added a small amount of super plasticizer. An experiment (Velayutham and Cheah, 2014) showed that the incorporation of steel fiber into high strength concrete increased the compressive strength of the concrete. 8 The maximum compressive strength of 70.7 Mpa was attained at a steel fiber volume fraction of 3.0%. From a study (Song and Hwang, 2004) on steel fiber, it was concluded that the compressive strength of high-strength concrete improved with additions of steel fibers at various volume fractions. The strength showed a maximum at 1.5% fraction but a slight decrease at 2% fraction.

2.4 Flexural Strength

The bending strength is not substantially affected by the addition of fibers. This is again primarily due to the low modulus of elasticity of the fibers. However, after cracking, the fibers come into play, and permit a greatly increased ultimate strain, though the load carrying capacity is decreased. The flexural strength of fiber-reinforced mixes was (Soroushian et. al., 1992) studied. It was found that a moderate increase in the flexural strength with the addition of fibers, increasing with higher dosage rates of fibers. Another study (Balaguru and Khajuria, 1996) showed that, the flexural strength of fiber-reinforced samples did not change appreciably. Addition of fibers (up to 2.40 kg/m3) did not change the flexural strengths significantly. It was noted that a moderate improvement in bending strength with the addition of fibers, but stated that the major difference was in the behavior after reaching the ultimate load. Instead of brittle failure, the fiber mix showed somewhat ductile behavior, with ultimate deflection four times that of the plain concrete (Li, 2002). It can be seen from a previous study of (Mohamed) that flexural strength increased significantly up to maximum at 0.5 vol. % polypropylene fiber. Further increase of polypropylene caused content then slight decrease of the flexural strength of concrete. The increase may be resulted primarily from the fibers intersecting the crack in the tension half of the reinforced beam. In another study (Pešić et al) it was found that flexural strength is one of the key advantageous properties of high-density polyethylene (HPDE) FRC over the plain concrete as 0.75-1.25% of added HDPE fibers (by volume) can maintain a constant post-cracking tensile capacity of concrete at the level of 30-40% of the peak flexural capacity.

2.5 Jute Fiber

Jute is a long, soft, shiny vegetable fiber that can be spun into coarse, strong threads. It is produced by primarily from plants in the genus 7orchorus, which was once classified with the family tiliaceae, and more recently with malvaceae. The word jute is probably coined from the word jhuta or jota, an Oriya word.

Physical Properties of Jute

Diameter (mm)	0.5-0.10 mm
Tensile strength (Mpa)	108
Youngs modulus (Gpa)	3.42
Specific Gravity	1.48-1.50
Stretch and Elasticity	Not good and 2% elongation at break
Resiliency	Not Very Good
Abrasion Resistance	Relatively Good
Dimensional Stability	Good
Moisture Absorption	13.75%

Why use Jute?

The advantages of jute fibers over the conventional reinforcing fibers like glass, synthetic (e.g., polypropylene, polyethylene and polyolefin, polyvinyl alcohol), carbon, steel etc., are:

- Abundant availability.
- Low cost.
- Less abrasiveness.
- Ability to absorb mechanical impact.
- Easy to handle and process and environmental friendliness.

- Can be used in various fields of applications such as permanent frameworks, paver blocks, wall panels, pipes, long span roofing elements, strengthening of existing structures and structural building members.
- Likely to encounter a range of static overload and cyclic loading due to possible wind or earthquake loading. When concrete matrix cracks under load, the fibers bridge the cracks and transfer the loads to its surrounding bulk as well as absorb a portion of the load by virtue of its flexible nature.

Among various natural fibers, researchers are giving priority to jute fiber. In India, researchers are experimenting to find out the contribution of jute in the strength of concrete. Two separate studies, conducted in India, explained the properties of jute fiber. It was observed that when the raw jute is added in concrete by 1% weight of cement then the compressive strength of concrete cube increased by 17.5% and by adding modified jute compressive strength increase by 26.5%. Reduction in the compressive strength of concrete has been observed at higher fiber content. Despite the reduction in the compressive strength of jute fiber reinforced concrete, there is an improvement of ductility after cracking of concrete through stress transfer across the cracks and the fiber arrests the rapid crack propagation and prolongs the strain life to continue beyond the ultimate. The split tensile strength of concrete cylinder increased by 7% and by adding modified jute split tensile strength increase by 9% when the raw jute is added in concrete by 1% weight of cement and the flexural strength of concrete cube increased by 1% and by adding modified jute flexural strength increased by 4% (Kshatriya et. al., 2016; Goel et. al., 2017). 13 In a study (Sabarinathan et. al., 2017) it was found that the compressive strength and split tensile strength of jute fiber reinforced concrete increased gradually with the increase in the percentage of fiber. It has been clearly noted that adding fiber gives good strength with ratio 0.45. Although in another research (Krishna and Yadav, 2016) showed a different result. Early age of compressive strength of concrete i.e., at 7 and 28 days, decreases with increase in jute content. For extension in period of curing i.e., 56 and 90 days, the compressive strength increases up to 1% and then decreases with further increase jute loading. Flexural strength and split tensile strength of concrete increases up to 1% of jute loading and decreases with further increment. The mechanical strength properties of concrete with 1% jute content have attained their maximum strengths for a curing period of 56 days and on further curing i.e., for 90 days the mechanical strengths decrease. Similar type of results was obtained in other studies (Warke et. al., 2016).

2.6 Cement

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and aggregate together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Mainly two types of cement are used widely.

2.7 Ordinary Portland Cement (OPC)

It is the most common cement used in general concrete construction when there is no exposure to sulphates in the soil or groundwater. Portland cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco, and most non-specialty grout. It was developed from other types of hydraulic lime in England in the mid-19th century and usually originates from limestone. To retard the faster setting time of cement resulted from (C3A) compound a percentage of raw gypsum (selenite) is added during the grinding of the clinker. OPC is environment friendly as well as economical.

2.8 Portland Composite Cement (PCC)

The Portland Composite Cement is a kind of Blended Cement which is produced by either inter grinding of OPC clinker along with "mineral admixtures‟ or "supplementary cementing materials‟ in certain proportions or grinding the OPC clinker, „mineral admixtures‟ or „supplementary cementing materials‟ separately and thoroughly blending them in certain proportions. Portland Composite Cement also commonly known as PCC cement. These types of cement are manufactured by using pozzolanic materials as one of the main ingredients. The percentage of pozzolanic material used in the preparation should be between 10 to 30. If the percentage is exceeded, the strength of cement is reduced. Pozzolana is a natural or artificial material containing silica in a reactive form. It may be further discussed as siliceous or siliceous and aluminous material which in itself possesses little, or no cementitious properties but will in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties. It is essential that pozzolana be in a finely divided state as it is only then that silica can combine with calcium hydroxide (liberated by the hydrating Portland Cement) in the presence of water to form stable calcium silicates which have cementitious properties.

Why use PCC over OPC?

- **Strength:** PCC may slow the curing rate of concrete, resulting in low break strengths at early tests, such as a 1-day test, when compared to Ordinary Portland Cement (OPC). In the long term, PCC typically achieves strengths equal to or usually greater than OPC.
- **Cost:** PCC is cheaper than OPC.
- **Weather Resistance:** PCC shows greater resistance to aggressive weather than OPC does and high chemical resistance to Sea water, chloride diffusion, sulphate attack.
- **Effect on Environment:** PCC has several advantages, such as lower environmental pollution, energy consumption and is more economical than OPC.
- **Quality:** PCC has improved pump ability, compatibility, improved fresh concrete properties, lower heat of hydration, low permeability, dense structure, low effective alkali content.

CHAPTER 3
METHODOLOGY

In this chapter the methodology of this study is discussed.

3.1 Mix Design

In many countries including Bangladesh, no specific mix design is followed for low rise building. People rely on masons without consulting any civil engineer and typical ratio-based mix (nominal mix) is used. So, specific strength cannot be obtained from such design. The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratios of cement, fine and coarse aggregates. The proportions are either by volume or by mass. The water-cement ratio is usually expressed in mass.

As this research intend to use fiber for various structure including typical low-rise building, mix design was done according to the local practice. A ratio of 1: 1.5: 3 was used, where 1 part cement, 1.5 parts fine aggregate and 3 parts coarse aggregate was used on basis of their volume.

3.2 Test Procedures

Three types of tests were carried out in this study to assess the strength of concrete specimen. At first, standard test for determining compressive strength of concrete was conducted. This was followed by splitting tensile strength test and flexural strength tests respectively. Detailed description of the testing procedure of each type of tests is as follows.

3.3 Compressive Strength Test

A cylindrical specimen having 4-inch diameter and 8-inch height was used for compressive strength test. The test was done in accordance with the standard test method as issued by ASTM (Designation: C 39/C 39M – 03). The test involved 19 applying a compressive axial load to molded cylinders or cores at a rate which is within a prescribed range until failure occurs.

The testing of the cured specimen was carried out shortly after it was removed from moist storage, to ensure that the compressive strength determined was for moist condition of specimen. Prior to testing the specimen, it was verified that the load indicator was set to zero. After the specimen was placed in the testing machine, load was applied continuously and without shock. The rate of loading was set 0.15-0.35 MPa/sec. The load application was continued until the specimen failed, and the maximum load carried by the specimen during the test was recorded. The type of failure and the appearance of the concrete were also noted. The compressive strength of the specimen was calculated by dividing the maximum load carried by the specimen during the test by the average cross-sectional area of specimen. As the specimen length to diameter ratio (8/4=2) was greater than 1.75 no correction factor was required.

Figure 3.1: *Compression Testing Machine*

3.4 Flexural Strength Test

The testing specimen for flexural strength test was a simple beam of having the dimensions 3inch×3inch×11inch. The test was done in accordance with the standard test method as issued by ASTM (Designation: C 293– 02). Results were calculated and reported as the modulus of rupture. The cured specimens were subjected to test shortly after removal from moist storage, as surface drying of the specimen would result in a reduction in the measured flexural strength. Then load was applied to the specimen continuously and without shock. The center point loading method was used in flexure tests of concrete specimen, which ensured that forces applied to the beam, was be perpendicular to the face of the specimen and applied without eccentricity. The load was applied at a constant rate of 0.9 and 1.2 MPa/min to the breaking point. To determine the dimensions of the specimen cross section for use in calculating modulus of rupture, measurements across one of the fractured faces were recorded after testing. For each dimension, one measurement at each edge and one at the center of the cross section was taken. The three measurements for each direction were used to determine the average width and the average depth. All measurements were rounded to the nearest 0.05 in.

Figure 3.2: *Universal Testing Machine for Flexure*

The modulus of rupture was calculated by following equation:

$$R = 3PL/2bd^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots(3.2)$$

Where,

R = modulus of rupture, psi, or MPa,

P = maximum applied load indicated by the testing machine, lbf, or N,

L = span length, in., or mm,

b = average width of specimen, in., or mm, at the fracture, and

d = average depth of specimen, in., or mm, at the fracture.

Detailed calculations are shown in the following chapter.

CHAPTER 4
MATERIALS

In this chapter, a brief discussion on data obtained from material and specimen testing are made.

4.1 Materials Properties

The property of various materials which are used in concrete influences the characteristic of concrete. So, it is very much important to know the properties of the materials. The properties of the materials used in this experiment such as fine and coarse aggregate, were found through various test of aggregates.

4.2 Coarse Aggregate

The size of coarse aggregate used in this study was 10 mm and the aggregate gradation was well-graded. The coarse aggregates were collected from local market.

Figure 4.1: *Coarse Aggregate*

Various properties of Coarse and Fine Aggregate

Aggregate Properties

Properties	Coarse Aggregate	Fine Aggregate
Apparent Specific Gravity, Sa	2.68	2.69
Bulk Specific Gravity (O-D basis), Sd	2.65	2.55
Bulk Specific Gravity (SSD basis), Ss	2.66	2.6
Absorption Capacity (D) in %	0.4	1.94
Unit weight (lb/cu ft)	95.03	94.146
Gradation	Open	graded
	Well	graded

4.3 Fine Aggregate

The Sylhet sand used as fine aggregate in this study which was collected from the local market. The fineness modulus of the fine aggregate was 2.47 and the gradation was well-graded.

Figure 4.2: *Fine Aggregate*

4.4 Cement

Portland Composite Cement (PCC) was used as binding material. The cement was consisted of fly ash, slag and limestone.

Figure 4.3: *Cement*

4.5 Jute Fiber

Jute fiber was collected from the local market and then cut into desired length. No chemical treatment was done prior to the use of fiber. The properties jute fiber used are given below:

Figure 4.4: *Jute Fiber*

Properties of Jute Fiber

Properties of Jute	Value
Specific gravity	1.49
Length of fiber	05-10 mm
Volume	0.20% or 0.40%

CHAPTER 5
RESULT AND DISCUSSION

Introduction

Results obtained from the current experiment can be discussed from two points of views, "Effect of fiber percentage" and "Water-cement ratio". In the current experiment three water-cement ratios were used (0.45, 0.5 and 0.55). Three fiber percentages were used for each water-cement ratio. The failure pattern can also indicate the change in characteristics of concrete with or without fiber.

5.1. Effect of Fiber Percentage

Fiber dosage doesn't follow any specific patterns in changing the various strengths such as compressive, split tensile and flexural strength of concrete. However, some trends can be found in specific strength criteria of concrete. For example, change in compressive strength can be observed from various fiber percentages and optimum dose for higher compressive strength can be found though this optimum fiber dose may not give higher value of split tensile or flexural strength.

5.2 Effect of w/c ratio

Water-cement ratio did not follow any specific patterns regarding the compressive, split tensile or flexural strength of concrete with fixed dose of fiber.

5.3 Compressive Strength

From that the compressive strength of concrete increases with increase in fiber dosage but after obtaining maximum compressive strength it decreases with further increase in fiber dosage. And this trend is irrespective of the water-cement ratio used in this experiment. For 0.45 w/c ratio the value increases from 2237 psi for 0% fiber to 1700 psi for 20% fiber. After that the compressive strength started to decrease with further addition of fiber and obtained the lowest value of 1610 psi for 40% fiber. For 0.5 w/c ratio the compressive strength increases from 1610 psi for 20% fiber to 1467 psi for

40% fiber. After that the compressive strength started to decrease with further addition of fiber and obtained the lowest value of 1467 psi for 40% fiber.

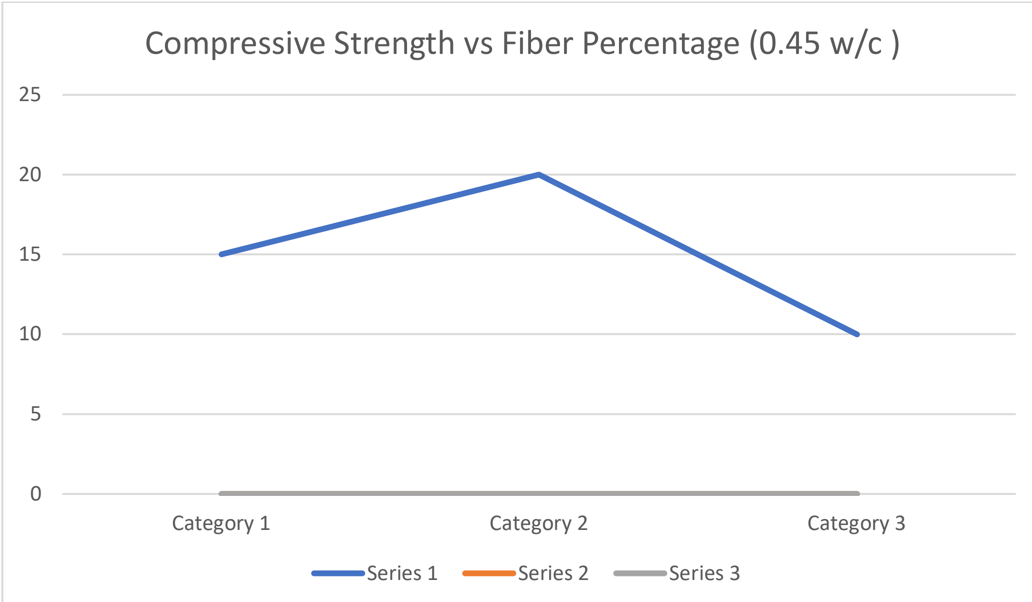

Figure 5.1: *Compressive Strength vs Fiber Percentage (0.45 w/c)*

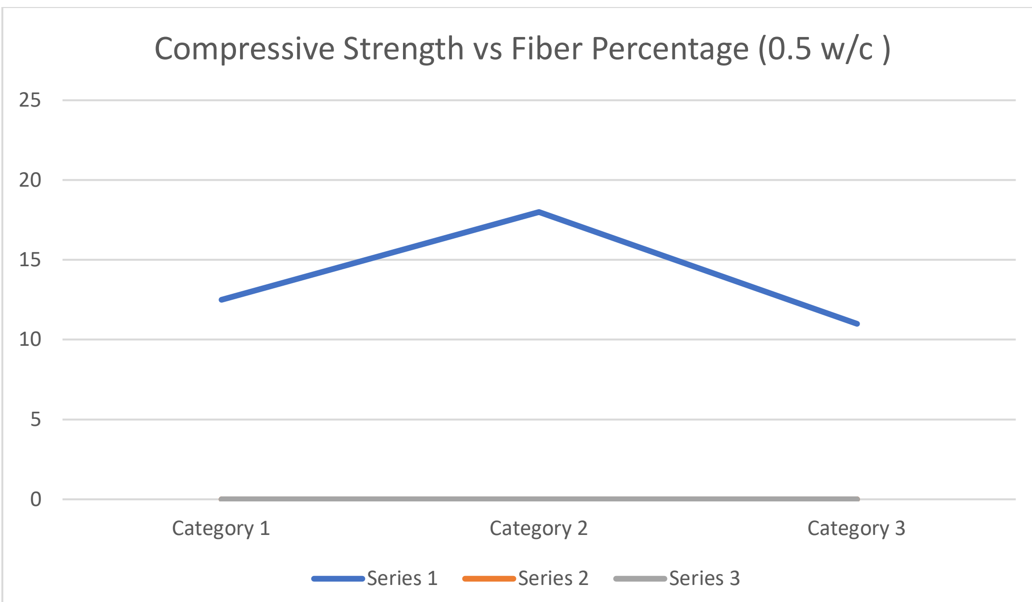

Figure 5.2: *Compressive Strength vs Fiber Percentage (0.5 w/c)*

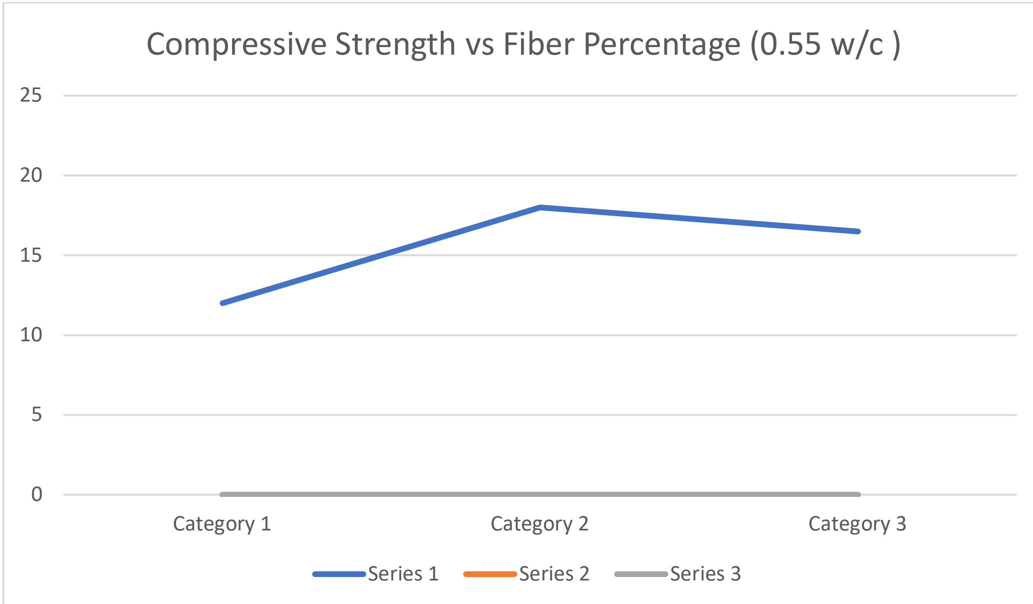

Figure 5.3: *Compressive Strength vs Fiber Percentage (0.55 w/c)*

For 20% fiber content the compressive strength started to fall from 2505 psi for 0.45 w/c ratio to 2416 psi for 0.5 w/c ratio. Then the value again increased with the increase of w/c ratio and obtained a value of 2541 psi for 0.55 w/c ratio.

For 0% fiber, indicates the increase of compressive strength with the increment of w/c ratio. From a lower value of 2416 psi for 0.45 w/c ratio it obtained its highest value of 2541 psi for 0.55 w/c ratio.

5.4 Sieve Analysis of Sand

Sieve analysis of fine aggregates is one of the most important tests performed on-site. Aggregates are inert materials that are mixed with binding materials such as cement or lime for the manufacturing of concrete. It is also used as filters in mortar and concrete. The standard size sieves are 3/4 (19.0 mm), 3/8 (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300µm), and No. 100 (150 µm). It is used for the purpose of estimating the quantity of coarse aggregate to be used in the concrete mix design.

Table 5.1: *Result of Sieve Analysis of Sand*

Sieve No.	Retain(gm)	% of Retain (gm)	Cumulative % Retain	% Finer	F.M.
#4 (4.75 mm)	0	0	0	100	306.85/100 =3.07
#8 (2.36 mm)	48	5.98	5.98	94.02	
#16(1.19 mm)	248	30.88	36.86	63.14	
#30 (0.59mm)	280	34.87	71.73	28.27	
#50 (0.30mm)	172	21.42	93.15	6.85	
#100 (0.15mm)	48	5.98	99.13	0.87	
Pan	7				

Total = 803 gm Total =306.85

Sieve Analysis of Coarse Aggregate

Table 5.2: *Sieve Analysis of Coarse Aggregate*

Sieve No.	**Retain(gm)**	**% of Retain (gm)**	**Cumulative % Retain**	**% Finer**	**F.M.**
#3/4"(19.05mm)	550	55.61	55.61	44.39	752.88/100 =7.53
#3/8"(9.52mm)	412	41.66	97.27	2.73	
#4(4.75mm)	27	2.73	100	0	
#8(2.36mm)	0		100	0	

#16(1.19mm)	0		100	0	
#30(.59mm)	0		100	0	
#50(.33mm)	0		100	0	
#100 (0.15mm)	0		100	0	
Pan	2				

Total = 989 gm   Total =752.88

5.5 Flexural Strength

Flexural strength also followed the path of the compressive and split tensile strength of not giving any indication of changes of strength with the change of w/c ratio for a fixed fiber content no fiber content, we can see that the flexural strength of concrete decreased with the increase of w/c ratio. From the highest flexural strength of 2237 psi for 0.45 w/c ratio, the lowest flexural strength of 2226 psi was obtained for 0.55 w/c ratio.

For 0.40% fiber content the flexural strength increased from 1610 psi for 0.45 w/c ratio and the strength started to decrease and obtained a value of 1467 psi for 0.55 w/c ratio. From (0.20% fiber), it can be concluded that the flexural strength of concrete increased with the increment of w/c ratio. From the lowest value of 1700 psi for 0.45 w/c ratio, the flexural strength increased to obtain the maximum value of 1610 psi for 0.55 w/c ratio.

Table 5.3: *Compressive Strength Test 7 days*

M20 Grade Concrete	% of Recycle Coarse Aggregate	% of jute fiber	Compression Strength (in PSI)	Average Compression Strength (in PSI)	Average Compression Strength (in PSI)
Normal Cylinder – 100%	100%	0	2237	2231.5	2231.5
		0	2226		
Jute Fiber – 5mm	100%	.40%	1610	1655	1655
		.20%	1700		

Jute Fiber – 10mm	100%	.40%	1467	1538.5	1538.5
		.20%	1610		

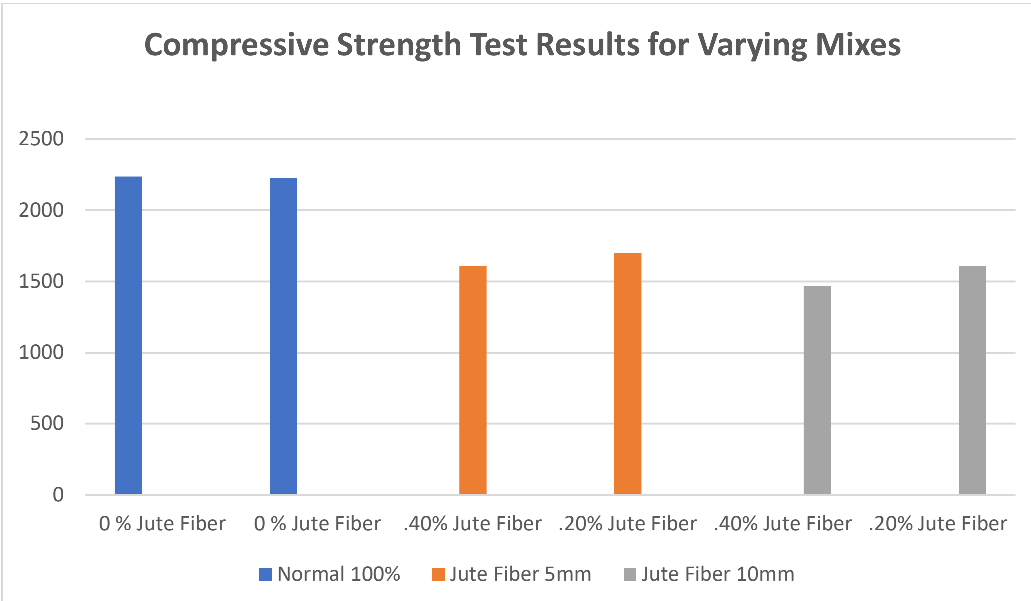

Figure 5.4: *Compressive strength test results for varying mixes.*

The figure 5.4 shows, maximum compressive strength 2237 Psi for 100% Normal aggregate mixing for 7 days as well as maximum compressive strength 1610 Psi for 0.40% and 1700 psi for 0.20% of 5mm length jute fiber concrete aggregate mixing for 7 days as weel maximum value of compressive strength at same duration is 1467 Psi for 0.40% and 1610 psi for 0.20% of 10mm length jute fiber concrete aggregate mixing for 7 days.

Table 5.4: *Compressive Strength Test 14 days*

M20 Grade Concrete	% of Recycle Coarse Aggregate	% of Jute Fiber	Compression Strength (in PSI)	Average Compression Strength (in PSI)	Average Compression Strength (in PSI)
Normal Cylinder – 100%	100%	0	2505	2523	2523
		0	2541		
Jute Fiber – 5mm	100%	.40%	2416	2460.5	2460.5
		.20%	2505		
Jute Fiber – 10mm	100%	.40%	2111	2263.5	2263.5
		.20%	2416		

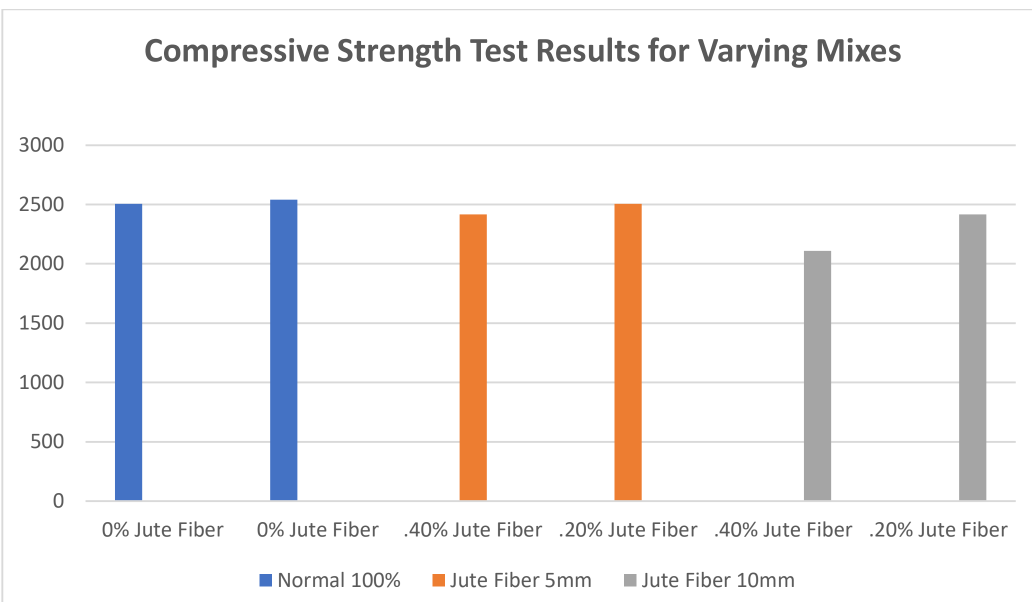

Figure 5.5: *Compressive strength test results for varying mixes*

The figure 5.4 shows, maximum compressive strength 2541 Psi for 100% Normal aggregate mixing for 14 days as well as maximum compressive strength 2416 Psi for 0.40% and 2505 psi for 0.20% of 5mm length jute fiber concrete aggregate mixing for 14 days as weel maximum value of compressive strength at same duration is 2111 Psi for 0.40% and 2416 psi for 0.20% of 10mm length jute fiber concrete aggregate mixing for 14 days.

5.6 Compression

Crushing pattern of concrete under compression for various fiber contents did not vary. Both type of cylinder, with or without fiber, had similar kind of cone and split type of fracture. Though the type was same, the fracture of fiber reinforced concrete was not visible enough like normally reinforced concrete for 0.20% fiber, it can be seen that the failure is visible clearly. The specimen faced a cone and split type of fracture. For 0.40% fiber content the fracture type was also cone and split type but the fracture was not clearly visible.

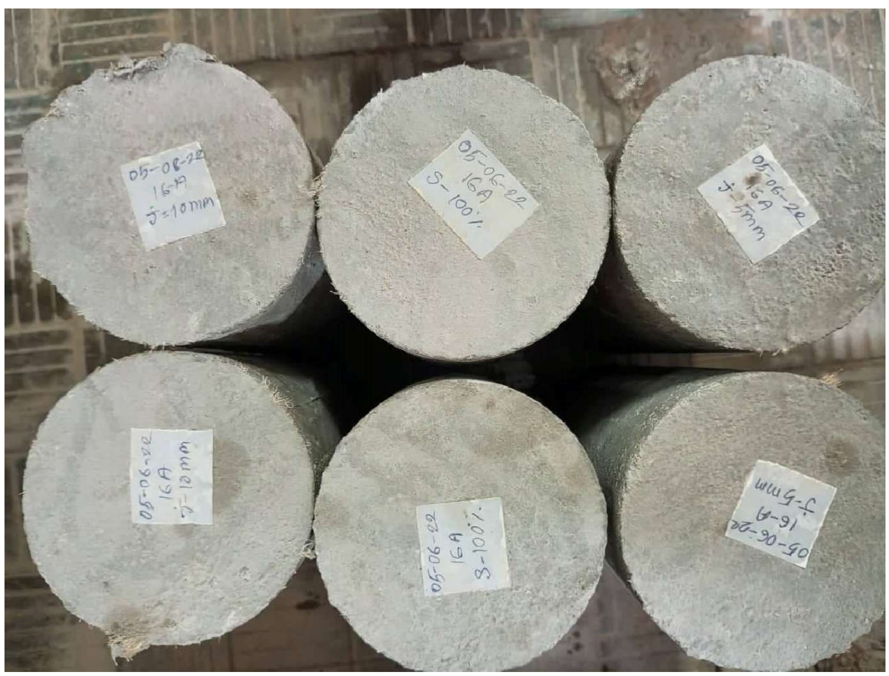

Figure 5.6: *Specimen Compression Test Cylinder*

5.7 Flexure

Under flexural test loading, specimens with or without fiber both broke in tension on the convex tension surface of the concrete beam. Further loading broke the beam in two parts which can be seen from Specimen with fiber content showed some resistance due to the pull-out effect of fiber.

Figure 5.*7: Specimen Flexure*

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Following conclusions can be drawn from the results of the tests conducted.

6.2 Compressive Strength

- Increasing the amount of jute fiber in concrete decreases the compressive strength.
- The compressive strength was 2231.5 psi at 0% fiber. After using .20% jute fiber of 5 mm, it decreased to 1655 psi, and using 0.40% jute fiber of 10 mm, it further decreased to 1538.5 psi in 7 days test for cylinder.
- The compressive strength was 2523 psi at o% fiber. After using .20% jute fiber of 5 mm, it decreased to 2460.5 psi, and using 0.40% jute fiber of 10 mm, it further decreased to 2263.5 psi in 14 days test for cylinder.
- Both fiber specimens, with or without fiber faced cone and split type of fracture.

6.3 Flexural Strength

- Flexural strength have changed according with the change of fiber content.
- Flexural strength decreased for fiber content.
- Similar type of tensile crack was observed in convex plane for fiber specimen having fiber content could not be parted easily due to fiber pull out effect.

6.4 Recommendations

- In low rise or high-rise building construction work jute fiber cannot be used in concrete. Because the minimum strength of concrete in construction work as per BNBC code is not achieved by using jute fiber.
- We tasted the 7 days and 14 days strength test to get a basic idea of fiber concrete.
- The strength of fiber concrete is tasted using stone as coarse aggregate by increasing the length of the jute fiber. If the concrete has sufficient strength, then it can be used in construction work.

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