PROPERTIES OF CONCRETE MADE OF JUTE FIBER

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

Department of Civil Engineering

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

Section: 18B

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DECLARATION

It is hereby declared that thesis/ project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Dedicated

To

"Our Respectful Teachers & Parents"

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ABSTRACT

The Bangladesh National Building Code (BNBC) specifies and regulates the general specifications for structural, architecture and design parameters in Bangladesh. In the last three decades, Civil Engineering techniques, knowledge, and materials as well as design parameters have been modified as per requirement.The base floors of the existing buildings are generally arranged as garages or offices. No walls are built in at these floors due to its prescribed usage and comfort problems. But upper floors do have walls separating rooms from each other for the residential usage. In these arrangements, the upper floors of most buildings are more rigid than their base floors. As a result, the seismic behaviours of the base and the upper floors are significantly different from each other. This phenomenon is called as the weak-storey irregularity. Weak stories are subjected to larger lateral loads during earthquakes and under lateral loads their lateral deformations are greater than those of other floors so the design of structural members of weak stories is critical and it should be different from the upper floors. In this paper; the seismic behaviour of weak-storey is studied. Calculations are carried out for the building models which are consisting of various stories, storey heights and spans. Some weak-storey models are structural systems of existing buildings which are damaged during earthquakes. The results are compared with the current earthquake code. The ratio of buildings which have weak-storey irregularity is determined for both Ankara and Eskisehir regions. It is observed that negative effects of this irregularity can be reduced by some precautions during the construction stage. Also some recommendations are presented for the existing buildings with weak-storey irregularity**.** Soft storeys in a high-rise building have a significant impact on its seismic performance. There is a discontinuity in the rigidity of the structure at the soft storey level due to a lack of infill walls or a variation in floor height. This continuity is the cause of structural failure in multi-story buildings subjected to earthquake loads.

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NOTATIONS

BNBC	Bangladesh National Building Code
ACI	American Concrete Institute
UTM	Universal Testing Machine
GR	Gauge Reading
AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
RMC	Ready Mix Concrete
PSI	Pound per Square Inch
W/C	Water Cement Ratio
PWD	Public Works Department
NSP	Nonlinear Static Procedures
RC	Reinforced Concrete
PGA	Peak Ground Acceleration
DL	Dead load
LL	Live Load
G	Gravitational Acceleration
H	Overall Thickness of Slab or Depth Of Beam In Inch
Hx	Height in Feet Above the Base to Storey Level I And X Respectively
I	Structure Importance Coefficient
L	Span Length of Beam in Inch
R	Response Modification Coefficient for Structural System
S	Site Coefficient for Soil Characteristics
T	Fundamental Period of Vibration of the Structure in Second
V	Total Design Lateral Force or Shear at the Base

CHAPTER 1

INTRODUCTION

1.1 General

It has been a technological challenge in both developing and industrialized countries to build low-cost, long-lasting fiber reinforced cement concrete. Steel, carbon, plastics, glass, and natural fibers are among the fibers now in use. Carbon fibers in cementitious composites have been limited to a commercial level due to their nonecological performance due to cost-effective concerns. Natural fibers have the potential to be utilized as reinforcement to overcome cementitious materials' inherent scarcity. Concrete is a composite material made by allowing a precisely proportioned combination of cement, sand and, gravel or other aggregates, and water to solidify into the required shape and size. The components are combined until cement paste forms, covering the majority of the spaces in the aggregates and resulting in dense, homogeneous concrete. Concrete has long been the most commonly utilized building material on the planet. Portland cement concrete has a unique set of properties. Plain unreinforced concrete has a limited strain capacity and is fragile. Micro concrete is currently the most commonly used building and repair material on the planet. As a result, it has always been critical from a civil engineering standpoint, and there has been a continual push to improve micro concrete's performance. The lack of ductility is the most significant restriction of this concrete, and enhancing this element of concrete is a top priority for civil engineers. Concrete is brittle and reasonably strong in compression but weak in tension. As a result, concrete has always been highly essential in civil engineering, and there has always been a continual push to improve concrete performance. A large number of researches are being carried out to improve ductility in concrete by introducing various types of fibers (steel fiber, jute fiber, glass fiber, fiber polymer, and so on) into concrete. Due to its enhanced ductility and lower brittleness, concrete reinforced with these fibers, also known as FRC (Fiber Reinforced Concrete), is considered to be one of the most promising new building materials. Fibers also change the behavior of the fiber-matrix composite after it has broken, increasing its toughness.

1.2 Definition and effects of Fiber in Concrete

Fiber-reinforced concrete (FRC) may be characterized as a composite material consisting of Portland cement, aggregate, and discrete interruptive fibers (ACI 544.4R-88, 1999). To strengthen concrete, two kinds of fiber are often used (natural fibers and man-made or artificial fibers). Natural fibers are the more promising of the two types of fibers (natural fibers and artificial polymer-based fibers) to employ as reinforcement to overcome the numerous weaknesses in FRCC reinforced with polymer-based fibers. Artificial fibers have several drawbacks, including a relatively high cost as well as health and environmental risks. Natural fibers, on the other hand, are made from naturally accessible resources such as the banana tree, coconut tree, cotton, and jute, and are biodegradable, affordable, ecologically benign, and readily available. To determine the amount of improvement, researchers have undertaken many types of research that the mechanical and physical conduct of concrete on the effect of natural fibers. In recent years, there have been persistent efforts to use natural fibers in FRC that aim to boost energy efficiency, cost savings, and environmental friendliness. The fibers' main contribution is to improve the concrete's toughness. The region under a load-deflection (or stress-strain) curve is referred to as toughness. As seen in Figure 1.1 adding fibers to concrete substantially enhances the material's durability. When the maximum strength of concrete is exceeded, it collapses abruptly. Fiber-reinforced concrete, on the other hand, can withstand significant loads even at deflections much beyond the fracture deflection of plain concrete. Fiber-reinforced concrete can withstand far more weight or strain than ordinary concrete.

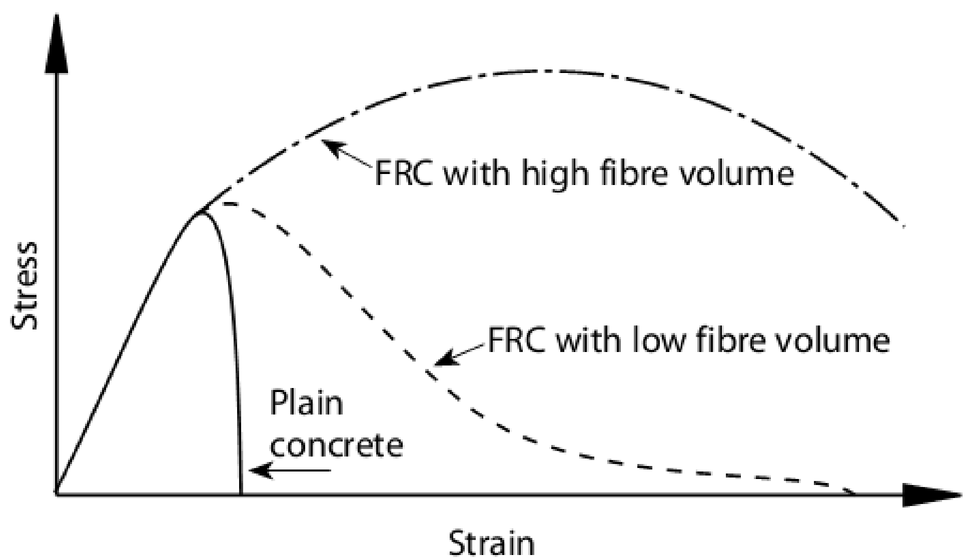

Figure 1.1: Typical stress-strain curves for FRC (El-Ashkar et al, 2006).

1.3 FRC-Perspective on the Past

The advancement of 1900s, asbestos fibers were used in concrete. Composite materials are a concept that was born in the 1950s, and fiber-reinforced concrete was one of the hot subjects. After the health risks associated with asbestos were identified, there was a need to find an alternative for the chemical in concrete and other building materials. Steel, glass fiber, and synthetic fibers were all utilized in concrete by the 1960s. The development of new fiberreinforced concretes is still ongoing.fiber reinforced concrete is slow (Wikipedia 2020). This is how far we've come, the use of fibers as reinforcement is not a new notion. Since ancient times, fibers have been utilized as reinforcement. Horsehair and straw were once utilized in mortar and mud bricks, respectively. In the early

1.4 Fiber-Reinforced concrete's Benefits

1. It strengthens the structure.

2. Lessen the need for steel reinforcement.

3. Reduce crack widths and carefully regulate crack widths to improve durability.

4. Increase abrasion and impact resistance.

5. Make the plastic more resistant to shrinking while curing.

6. Better hydration.

7. Increased resilience to freezing and thawing

1.5 Scope and Objectives

The primary goal of the proposed research is to compare the efficacy of Jute fiber in concrete to plain concrete. The following are the objectives for achieving the goal:

1. A review of the literature on measuring the usage of different fibers in concrete.

2. To compare the performance of plain concrete after cracking.

3. To investigate the compressive strengths of concrete using Jute fibers.

4. To compare and contrast the results of plain and fiber concrete.

1.6 Areas of Application of Fiber Reinforced Concrete Materials

There are various applications of fiber reinforced concrete in construction sectors. Areas of application of FRC can be summarized as follows:

1. Thin Sheet
2. Shingles
3. Roof Tiles
4. Pipes
5. Prefabricated Shapes
6. Panels
7. Shot Crete
8. Curtain Wall
9. Slabs on Grade
10. Precast Element
11. Composite Decks
12. Aircraft Parking and Pevement
13. Impact Resisting Strructure
14. Dams 17
15. Runway
16. Vaults, Safes
17. Hydraulic Structure

1.7 Organization of the Thesis:

Chapter 1: Introduction and Objective. This chapter provides the background of study and motivations of the research. The overall objectives and expected outcomes are also described in this chapter.

Chapter 2: Literature Review. This part discusses the previous analysis history about earthquake or seismic wave, soil properties describe, partition wall, recent research on seismic zone, seismic design requirements as per BNBC-2020, lift pit details specifications, wind load and wind load code provisions as per BNBC-2020, seismic load and seismic load code provisions as per BNBC-2020 for research of weak storied residential building using ETABS-2016.

Chapter 3: Methodology. This chapter discusses the analytical process in details step by step. The Zonally Parameters, Load principles and types of load acting on the structure are also discussed in this chapter.

Chapter 4: Results and Discussion. This chapter describes the results of the proposed buildings load and material properties, building load calculation. Different floor plan view and building analysis image are also shown in this chapter. Overall and zone to zone story drift, story displacement, Torsional irregularity and column, beam, shear wall, slab analysis data and results are also discussed in this chapter.

Chapter 5: Conclusions and Future Work. This chapter summarizes the conclusions and major contributions of this study and provides recommendations for future studies

CHAPTER 2

LITERATURE REVIEW

2.1 General

Concrete comes from the Latin verb compressor, which means "to grow together." When it originally appeared in English, "concrete" might have meant "linked by growth." The term "concrete" and its corresponding adjective did not begin to be used for the construction material made of cementing substance and sand, gravel, or similar elements until the nineteenth century (Merriam-online Webster's dictionary, 2017). Concrete is a composite material consist of cement and other cementations materials like fly ash and slag, aggregate (mostly a coarse aggregate of gravels or crushed rocks and sand as a fine aggregate), water, and admixtures (chemical). The qualities of concrete components, mix percentage, compaction method, and other variables during placement, and curing time determine its strength, durability, and other features. A chemical process known as hydration causes concrete to solidify and harden after it has been mixed with water and placed. The water reacts with the cement gradually it hardens bonds together with other components, creates a stone-like material. The fiber material is being utilized to strengthen fragile matrices to improve their mechanical characteristics. Concrete is a well-known brittle material that performs well in compression but poorly in tension. Fibers improve toughness by providing energy dissipation mechanisms and boost flexural strength by reducing and stopping the development of fractures in concrete. Many additional characteristics, including shear and compressive strength, are influenced by fibers. Many factors influence the strength and toughness of fiber reinforced concrete, including fiber characteristics, matrix properties, the fiber-matrix interface, size, geometry, and the volume/weight percentage of fibers.

2.2 Aggregate

The importance of choosing the right aggregate type and quality cannot be emphasized. Fine and coarse aggregates account for 60 to 75 percent of the volume of concrete (70 to 85 percent by mass) and have a considerable impact on the properties of newly mixed and cured concrete, as well as mixing proportions and economy. Natural sand or broken stone with most particles less than 5 mm make up fine aggregates. Coarse aggregates are made up of one or more gravels or crushed stone particles that are primarily bigger than 5 mm (0.2 inches) and range from 9.5 mm (3/8 inch) to 37.5 mm (1.2 inches). Pit-run gravel is a type of natural aggregate deposit. Comprised of gravel and sand that with minimum processing, may be utilized in concrete. The majority of natural gravel and sand is excavated or dredged from a pit, river, lake, or seabed. Quarry rock, boulders, cobbles, and big gravel are crushed to make crushed stone. Blast-furnace slag that has been crushed and cooled is also utilized as a fine or coarse aggregate. (Kosmatka and colleagues, 2002)

2.2.1 Aggregate Size

Triskele and Dzhavakhidze (1970) discovered that increasing the coarse aggregate improves the efficiency of cement usage in compression concretes. At the same time, the concrete's deformation is reduced while it's Young's modulus and unit weight rise. Increasing the aggregate size has a significant impact on the concrete's tensile strength. When the maximum grain size is increased to 120–180 mm, the tensile strength is reduced by 30–50% when compared to concretes with a maximum aggregate size of 20 mm. The size of aggregates affects the workability, strength, shrinkage, and permeability of concrete. Because of the decrease in specific surface area, mixtures with large maximum size of coarse aggregate generate concrete with greater workability (Washa, 1998). For a particular consistency and cement concentration, there is an ideal maximum size of coarse aggregate that gives the best strength (Popovics, 1998; Washa, 1998). According to Joshaghani et al. (2014), the strength decreases while permeability and porosity increase when the coarse aggregate's maximum dimension is increased.

The behavior of fresh and hardened concrete is influenced by aggregate properties. While aggregate properties differ depending on the size of the particle, the following classification is usually used: coarse aggregate retained in the No. 4 sieves, fine aggregate is passing the No. 4 sieves and retained in the No. 200 sieves, and micro fines are passing the No. 200 sieves. Table 2.1 summarizes this categorization. The influence of particle properties on concrete performance varies depending on whether the aggregates are micro fines, fines, of course.

Table 2.1: Classification of Aggregates Based on Particle Size (Ashraf, 2012)

Fraction of Aggregate	Range of Sizes
Coarse Aggregate	Retained in No. 4 sieve
Fine Aggregate	assing No. 4 – Retained in No. 200
Microfine	Passing No. 200 sieve

2.2.2 Surface Texture and Particle Shape

The characteristics of newly mixed concrete are influenced by the particle form and surface texture of an aggregate more than the qualities of hardened concrete. Smooth, rounded, compact aggregates require more water to make workable concrete than rough-textured, angular, elongated aggregates. As a result, angular aggregate particles require more cement to maintain the same water-cement ratio. Crushed and noncrushed aggregates (of the same rock kinds) offer approximately the same strength for the same cement factor when gradation is adequate. Pumping angular or poorly graded aggregates is likewise more challenging. As the particle size changes from smooth and rounded to rough and angular, the connection between cement paste and the aggregate increases. When choosing aggregates for concrete, this bond increase should be considered when bending strength is critical, or when high compressive strength is needed. The empty content of fine or coarse compounds may be used to measure the shape and textural variance amongst compounds of the same class. As the aggregate void content rises, the amount of mixing water and cement required rises as well. Aggregate angularity increases the number of voids between aggregate particles (Kosmatka et. al., 2002). Flat and elongated particles should be few in the aggregate. When the length to thickness ratio of a particle surpasses a certain threshold, it is referred to as flat and elongated. For determining flat and/or elongated particles, refer to ASTM D 4791. ASTM D 3398 specifies an indirect technique for determining a total particle index assessment of Particle form or texture Particle, whereas ASTM C 295 specifies petrographic inspection procedures for aggregate. Flat and elongated aggregate particles should be avoided or kept to less than 15% of the overall aggregate mass. Because fine aggregate formed by crushing stone typically comprises elongated and flat particles, this criterion is equally relevant for fine

Aggregate course and crushed. If the water-cement ratio is not changed, such aggregate particles demand more mixed water may decrease the concrete strength, especially in the bending process.

2.2.3 Gradation of Aggregate

Grading refers to a sieve analysis' determination of an aggregate's particle size distribution (ASTM C 136 or AASHTO T 27). Figure 2.1 depicts the range of particle sizes in aggregate. Wire-mesh sieves with square holes are used to determine the aggregate particle size. The apertures of the seven ASTM C 33 (AASHTO M 6/M 80) fine aggregate sieves range from 150 mm (No. 100 sieve) to 9.5 mm (3/8 inch.). The apertures of the 13 typical coarse aggregate sieves range from 1.18 mm (0.046 in.) to 100 mm (4in.). ASTM E 11 specifies tolerances for the size of sieve apertures (AASHTO M 92). For coarse aggregates, size numbers (grading sizes) refer to aggregate percentages (by mass) passing over different sieves. For general building and roadway work, Fine sands or aggregates have a single range of particle sizes. The proportion of material passing each sieve is generally used to represent grading and grading limitations. These limitations are shown in Figure 2.2 for coarse material size and fine aggregate. Grading limits and nominal maximum aggregate size are specified for a variety of reasons; the impact relative aggregate proportions, water, and cement needs, durability, porosity, economy, pump ability, shrinkage, and concrete workability. Grading variations can have a significant impact on the consistency of concrete. Extremely fine sands and coarse aggregate can combine to form harsh, unusable mixes. In general, aggregates with no large deficiency or excess size and a smooth grading curve will produce the best results.

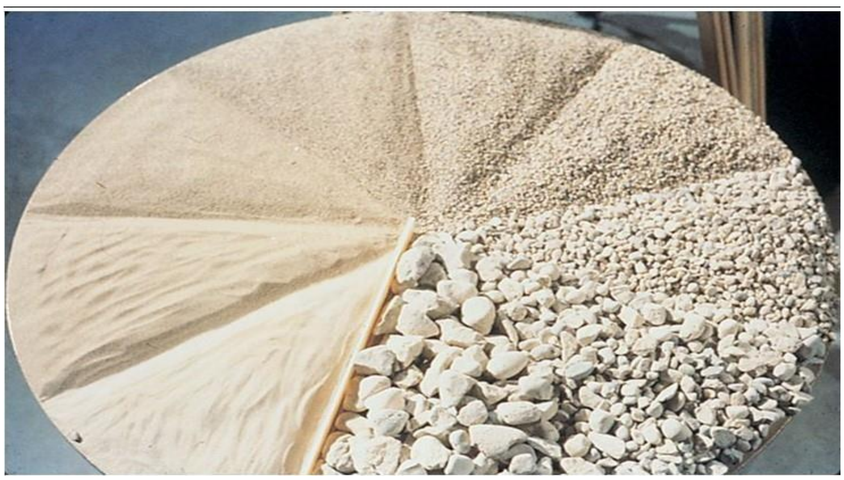

Figure 2.1: Particle size distributions found which used in concrete

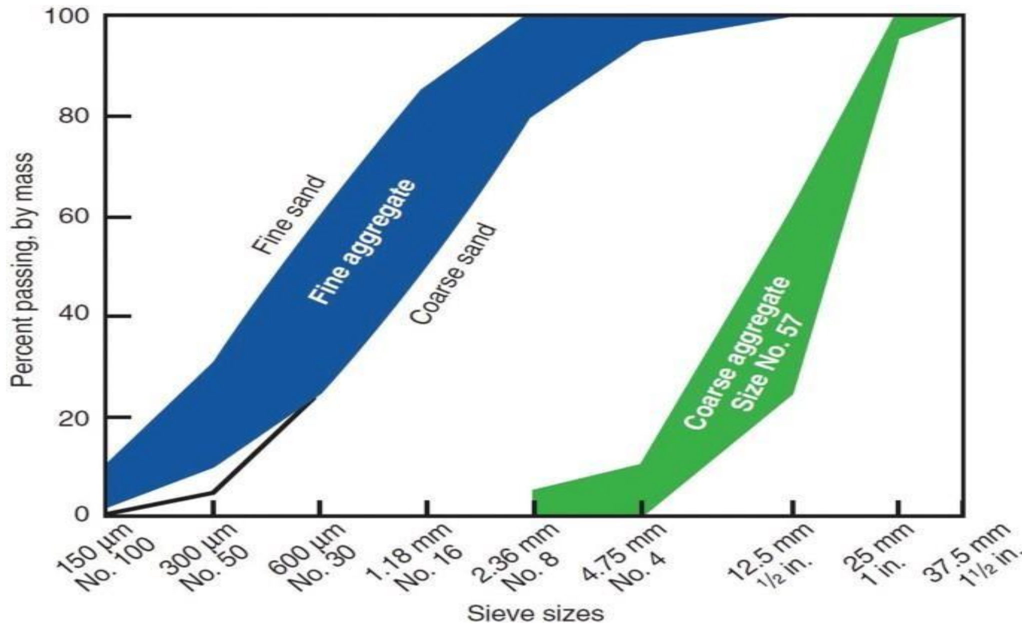

Figure 2.2: Curve indicating the limits specified in ASTM C33 for fine aggregate and coarse aggregate.

2.2.4 Fineness Modulus

According to ASTM C 125, the fineness modulus (FM) is determined by combining the cumulative percentages by mass retained on each of a set of sieves and dividing the total by 100. Different types of sieves sizes are 0 .15 mm (No. 100), 0.3mm (No. 50), 0.6mm (No. 30), 1.18 mm (No. 16), 2.36 mm (No. 8), 4.75 mm (No. 4), 9.5 mm (3/8 in.), 19.0 mm (3/4 in.), 37.5 mm (1.5 in.), 75 mm (3 in.), 150 mm (3 in.), 150 mm (3 in.). FM is a measure of aggregate's fineness; the greater the FM, the coarser the aggregate. The FM might be the same for different aggregate grading. Fine aggregate FM is useful for measuring fine and coarse aggregate quantities in concrete mixes (Kosmatka et. al., 2002).

2.2.5 Aggregate Band Gradation

With the 8-18 bands, Holland (1990) is widely recognized for introducing band gradation. The total proportion of fine and coarse aggregate retained on any one sieve must be between 8 and 18 percent according to the 8-18 band criteria (Figure 2.4). Many studies later advocated for the 8-18 (or 6-22) band rule, claiming that it minimizes shrinkage by lowering water consumption through better gradation (Harrison, 2004). Following widespread support for band gradations, it has already been incorporated into several regulations and standards (ACI 1999; USAF 1997). However, in addition to the band gradations in these standards, a coarseness factor chart (Shilstone, 1990) is advised for improved control of the mix characteristics. A coarseness factor chart is a tool for determining the size and uniformity of the combined aggregate distribution while keeping the fine aggregate component of the mix in mind. Contrary to popular belief, several researchers have discovered that the "8-18" band gradations have little or no effect on water consumption,shrinkage, or compressive strength when compared to concrete produced with standard proportionaggregates (Maccall et al., 2005)

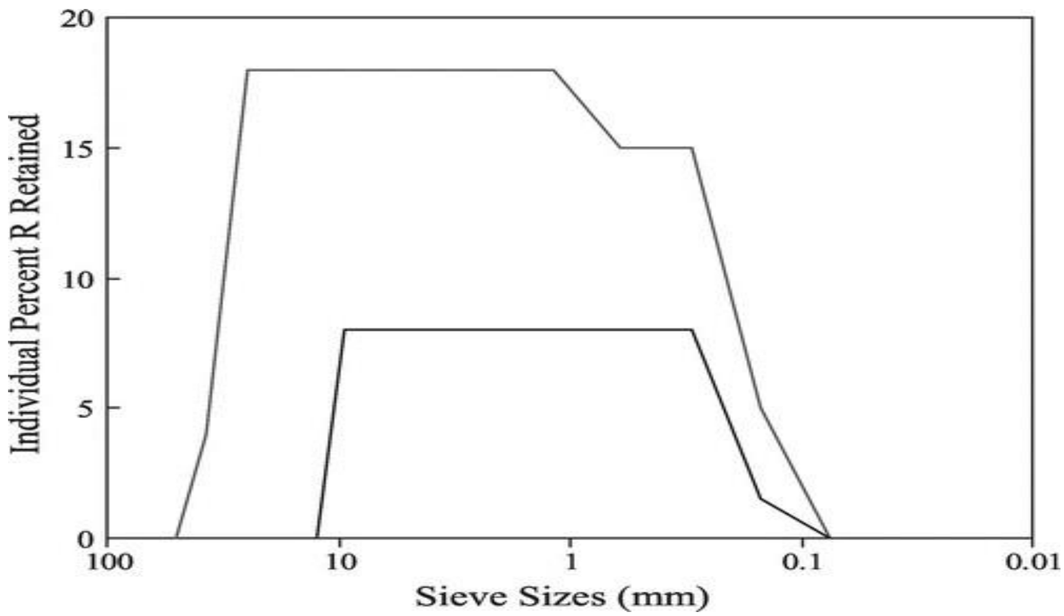

Figure 2.3: IPR Requirements for ―8-18 Band Gradation.

Another important disadvantage of the 8-18 gradation covers a large range of mixed aggregate gradation, allowing fine aggregate to total aggregate (fa/ta) ratios ranging from 0.28 to 0.65, as well as a comparable wide range of FM (theoretically). This perplexing situation necessitated the employment of a coarseness factor chart, as well as the 8-18 or 6-22 band 15 gradations. The combined influence of WF and CF on mix characteristics, although the connections between various concrete properties and CF and WF are still unclear. Some studies have discovered that CF has a connection with concrete compressive strength (Ashraf and Noor, 2011a), others have found that aggregate characteristics have no obvious influence on hardened concrete parameters (Ashraf and Noor, 2011b) (Maccall et al., 2005).

2.3 Fresh Concrete Properties of FRC

a) Cement hydration

b) Setting time

c) Workability

d) Cement hydration: The addition of fibers has little to no effect on cement hydration.

e) Setting time: Lignin can be used as a set retarder. Fibers with lignin or other chemicals can have adverse effects on setting time. Fibers may absorb/desorbs water from the cement matrix or atmosphere affecting set time.

f) Workability: The addition of fibers decreases workability due to an increase in surface area.

2.4 Cement

Cement is a binder, which means it sets and hardens on its own and may hold other materials together. Portland cement is the most popular kind of cement. Hydraulic cement (cement that not only hardens by reacting with water but also forms a water resistant product) produced by pulverizing clinkers consisting primarily of calcium silicates, usually containing one or more forms of calcium sulfate as ground addition, according to ASTM C 150. Cement conforming to EN 197-1, termed CEM cement, when appropriately batched and mixed with aggregate and water, which capable of producing concrete or mortar which retains its workability for a sufficient time and shall attain specified strength levels after defined periods and also possess long-term volume stability. ASTM C 150 and AASHTO M 85 have specified certain physical requirements of cement. These properties include 1) fineness 2) soundness 3) consistency 4) setting time 5) compressive strength 6) heat of hydration 7) specific gravity and 8) loss on ignition.

2.4.1 Constituents

The following are the components of Portland cement, as specified by EN 197-1:

2.4.2 Portland Cement Clinker

Portland cement clinker must include at least 2/3 calcium silicates ($3CaO.SiO_2$ and $2CaO.SiO_2$) by mass, with the remaining clinker phases and other compounds comprising aluminum and iron. The mass ratio $(CaO)/(SiO_2)$ not less than 2.0. Magnesium oxide (MgO) concentration must not exceed 5.0 percent by mass.

2.4.3 Additional Cementing Materials

Through hydraulic or pozzolanic action, supplementary cementing materials (SCMs) contribute to the characteristics of hardened concrete. Fly ashes, slag, and silica fume are common examples. These can be used alone or in various combinations with Portland or mixed cement. Supplementary cementing ingredients are frequently added to concrete to make it more cost-effective, reduce permeability, enhance strength, or impact other characteristics.

(a) Fly Ash

Which is a by-product of thermal power plants, is the most widely used pozzolana in concrete. Fly ash is a commonly available, thinly divided byproduct from the combustion of powdered charcoal which is carried out with exhaust gasses from the furnace combustion chamber. Fly ash is produced by electrostatic or mechanical precipitation of particles that look like dust from flue gasses from pulverized coal furnaces. Fly ash can be either siliceous or calcareous. The former possesses pozzolanic characteristics, whereas the latter may have hydraulic properties as well. Multiple ready-mix companies employ fly ash as a substitute for Portland cement in concrete. The ready-mix maker gains financially from the addition of fly ash to concrete (fly ash is typically cheaper than Portland cement). Fly ash also improves the characteristics of both fresh and hardened concrete (Mindess et al.2003). It affects the rheological characteristics of new concrete as well as the hardened concrete's strength, finish, porosity, and durability (Malhotra and Ramezanianpour, 1994). For the following reasons, there is a widespread tendency nowadays to replace increasing levels of Portland cement with fly ash: 1. Cost-effective: Fly ash is less costly than Portland cement in most areas. As a result, the cost of producing concrete lowers as the degree of fly ash substitution increases. 2. Environmental: The greater the use of fly ash in concrete, the lower the need for Portland cement, the lower the production of Portland cement, and therefore the fewer CO2 emissions. 3. Technical: When utilized properly, concretes with large amounts of fly ash outperform regular Portland cement concrete in terms of durability.

(b) Slag Cement

Previously known as a ground, granulated blast-furnace slag, the granular substance is created when molten iron blast-furnace slag is rapidly cooled - generally by water sprays then crushed to cement fineness. Slag cement is hydraulic and may be used as an SCM in cement. Calcium oxide (CaO), magnesium oxide (MgO), and silicon dioxide make up at least two-thirds of the mass of granulated blast furnace slag (SiO2). The rest is made up mostly of aluminum oxide (Al2O3) and a few other chemicals. The mass ratio (CaO + MgO)/ (SiO2) must be greater than 1.0

(c) Silica Fume

Silica fume is a finely scattered residue created during the production of elementary silicon or ferrosilicon alloys, also known as condensed fume or micro silica fume. and transported away by the exhaust fumes from the furnace. High-strength concrete is frequently made using silica fume with or without fly ash or slag. Silica fume is composite of very small spherical particles including at least 85 percent amorphous Silicon dioxide and is the consequent reduction in the production of silicon and ferrosilicon alloy of high-quality quartz with coal in an electrical arc furnace.

(d) Natural Pozzolanas

Natural compounds with a siliceous or silica-aluminous composition, or a mix of the two, are known as pozzolanic materials. Pozzolanic materials do not harden in water, but when finely powdered and in the presence of water, they react with dissolved calcium hydroxide ($Ca(OH)_2$) to create strength-developing calcium silicate and calcium aluminate compounds at normal ambient temperature.

(e) Burnt Shale

Clinker phases, primarily dicalcium silicate and monocalcium aluminate, are found in burned shale. It also contains higher quantities of pozzolanic ally reactive oxides, particularly silicon dioxide, in addition to minor amounts of free calcium oxide and calcium sulfate. Burnt shale has significant hydraulic characteristics similar to Portland cement, as well as pozzolanic capabilities when finely crushed.

(f) Limestone

Limestone shall meet the following requirements: (a) The calcium carbonate ($CaCO_3$) content calculated from the calcium oxide content shall be at least 75 % by mass. (b) The clay content, determined by EN 933-9, shall not exceed 1.20 g/100 g.

2.4.4 Cement's Impact on Concrete Properties

The kind and content of cement have a major impact on many concrete qualities such as strength, workability, and durability. 2.4.5 Composition Table 2.3 shows the effects of cement on the most essential concrete characteristics. The composition and fineness of the cement have a significant impact on the qualities of the concrete. Like the amount of cement used in concrete influences the workability, and water content of a concrete mixture. Table 2.2: Effects of Cement on Concrete Property (RUMMAN, MIX DESIGN FOR DURABLE AND PUMPABLE CONCRETE USING LOCALLY AVAILABLE MATERIALS, 2018, p. 22)

Table 2.2: Effects of Cement on Concrete Property

Cement Property	Cement Effects
Peaceability	Cement amount, fineness, setting characteristics
Strength	cement composition (C3S, C2S, and C3A), loss on ignition, fineness
Corrosion of embedded steel	Cement Composition (esp. C3A content)
Drying Shrinkage	SO3 content, Cement Composition
Permeability	Cement composition, fineness
Resistance to sulfate	C3A content
Alkali-Silica Reactivity	Alkali content

The cement mix regulates the rate of hydration, which affects the permeability of concrete. The final porosity and permeability, on the other hand, remain unchanged (ACI Comm. 225R 1985; Powers et al. 1954). The coarse cement tends to produce pastes with higher porosity than that produced by finer cement (Powers et al. 1954)

2.4.5 Cement Types

The chemical reactivity of the cement has a significant impact on the final compressive strength and pace of strength development of concrete. The hydration rates of the various cement compounds may be used to illustrate how the relative quantities of these compounds impact the rate of strong growth. The C2S, for example, is a slow-reacting protein that adds to long-term strength gains. C3S, on the other hand, hydrate at a considerably faster rate and contribute to more early strength growth. Thus, cement with a higher proportion of C3S – as is the case with most of today cement – will tend to have a higher early strength, and allow for early form removal or post-tensioning. The strength gaining of cement mortars for different types of cement following the ASTM classification.

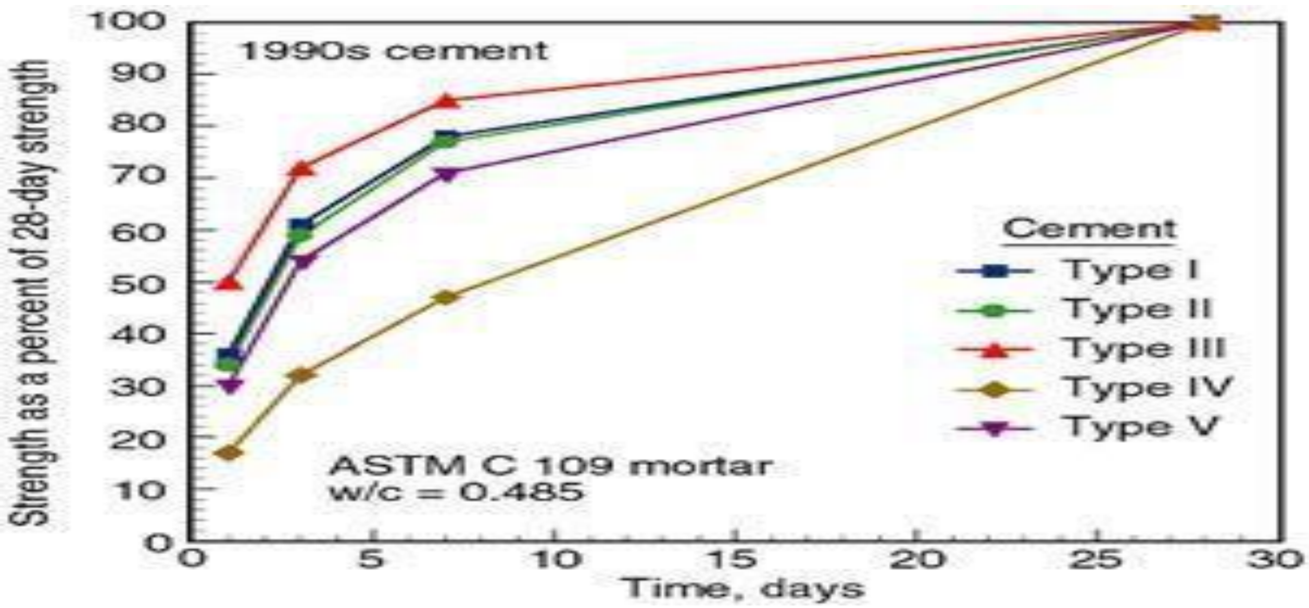

Figure 2.4: Strength Gaining with Time for Various Types of Cement (ASTM Classification)

Figure 2.5 shows concrete slumps for several kinds of cement. The CEM II cement has the widest slump range. The rest of the normal setting CEM I kind of cement has a medium grade. Grade 52.5 has a high rate of hydration, which has been found since water consumption is connected to rates of hydration and heat evolution. Low clinker concentration is linked to the excessive slump of CEM II cement mixtures.

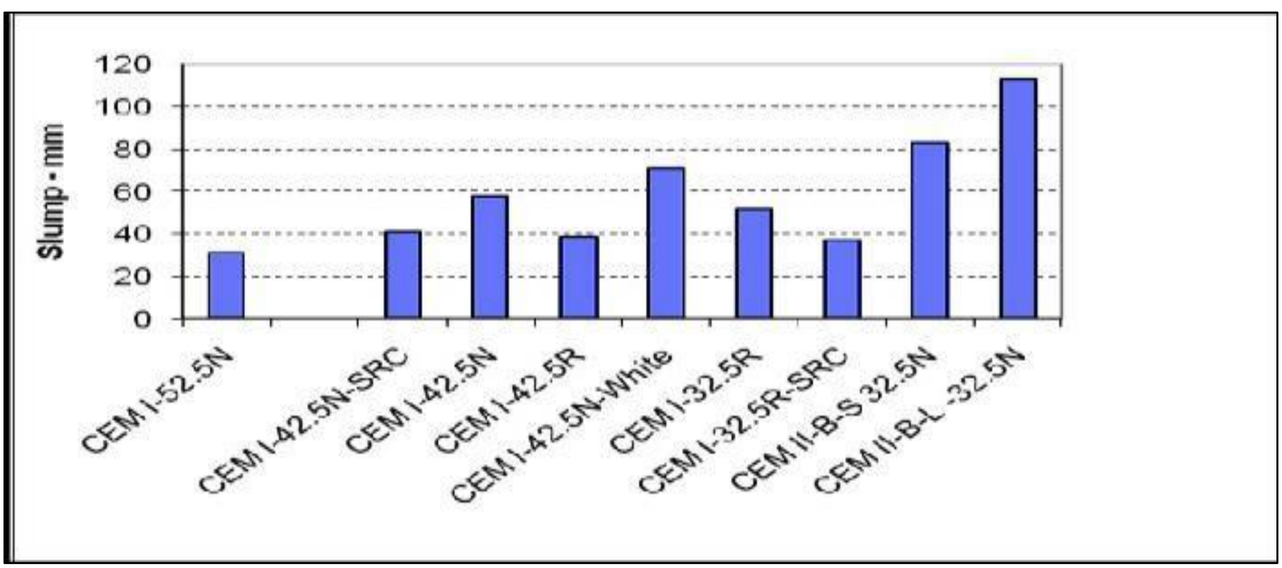

Figure 2.5: Slump Variations for Various Types of Cement (EN 197 Classifications)

2.5 Concrete Mix Design

Concrete mix design is the process of selecting acceptable concrete components and establishing their relative proportions to create concrete with minimum strength, durability, and workability at the lowest cost feasible. The necessary performance of concrete in two stages, namely the pliable and hardened states, governs the proportioning of ingredients in concrete. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance (Gambhir, 2014). The compressive strength of hardened concrete which is generally considered to be an index of its other properties depends upon many factors, e. g. quality and quantity of cement, water, and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plants, and labor. The differences in material costs are because cement is many times more expensive than aggregate; therefor the goal is to make a lean mix as feasible. Rich mixtures, from a technical standpoint, may lead to shrinkage and fracture of structural concrete as well as high hydration heat development of the solid concrete that might lead to cracks.

2.6 Degree of Saturation

The combination of hydraulic shearing of the lubricating layer and friction of the solid particles in contact with the pipe wall is considered to be the cause of resistance to concrete flow in a pipeline. The effectiveness of frictional resistance, on the other hand, is highly dependent on the concrete's saturation condition. The magnitude of frictional resistance in saturated concrete (i.e., when there is enough water in the mix to overfill the spaces in the dry components) is negligible when compared to that found in unsaturated concrete. Ede (1957) demonstrated this effect by measuring the flow resistance of a single concrete with different W/C ratios. The flow resistance rose when the W/C ratio and therefore the workability were lowered, and there was a critical threshold of water-cement ratio, in this case, 0.45, below which the frictional resistance drastically increased. The rapid rise in flow resistance might be due to the transition from saturated to unsaturated state. According to Ede (1957), unsaturated materials transmit stresses through inter-particle contact and cause a pressure build-up when movement begins, which is exponential with distance pumped in a non-tapering duct. Sufficient water/cement paste saturation reduces the resistance to a favored linear type, subject to the speed increase, but without operating pressure.

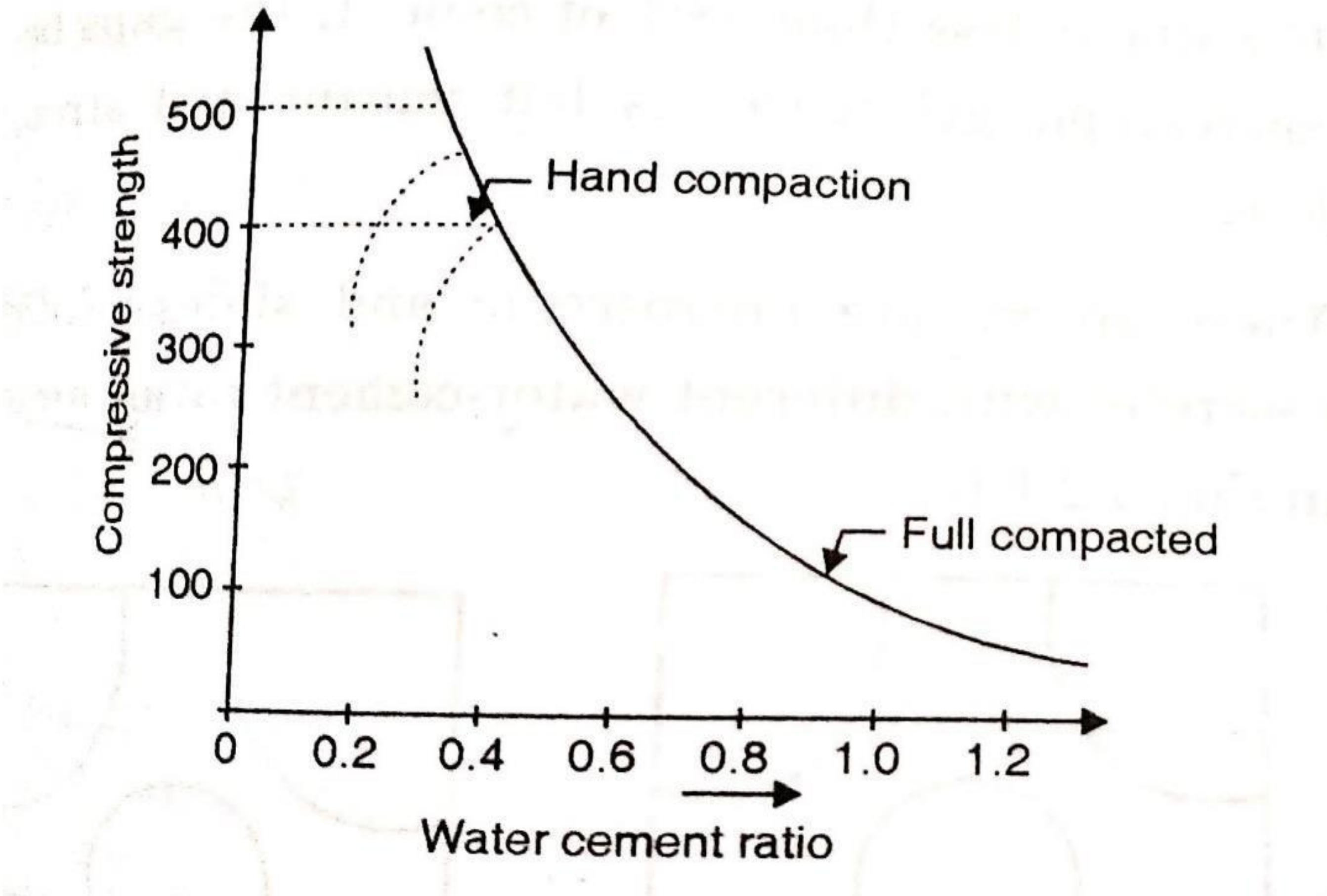

Figure 2.6: Effect of water-cement ratio on flow resistance for a given mix(Ede, 1957) (1 kgf/cm2= 14.22 psi)

2.7 Natural Fiber

Natural fiber-filled polymer composites are materials in which natural fiber serves as a reinforcing ingredient. As illustrated in Figure 2.1, natural fibers can be categorized according to their sources. Cotton, linen, jute, flax, ramie, sisal, and hemp are examples of vegetable fibers that are mostly made up of cellulose. Fibers are a hairlike sort of substance that is similar to a thread, either in continuous or isolated stretch pieces. Filaments, thread, or rope may be split into it. They can be utilized in composite materials as a component. They may also be matted into sheets to create items like paper and felt. Natural fibers come from a variety of sources, including plants, minerals, and animals. Cellulose fibers are used in the production of paper and fabric. Proteins make up the majority of animal fibers, such as wool, silk, and angora. Mineral fibers are fibers 34 derived from minerals that are either naturally occurring or have been significantly changed. The only naturally occurring mineral fiber among them is asbestos.

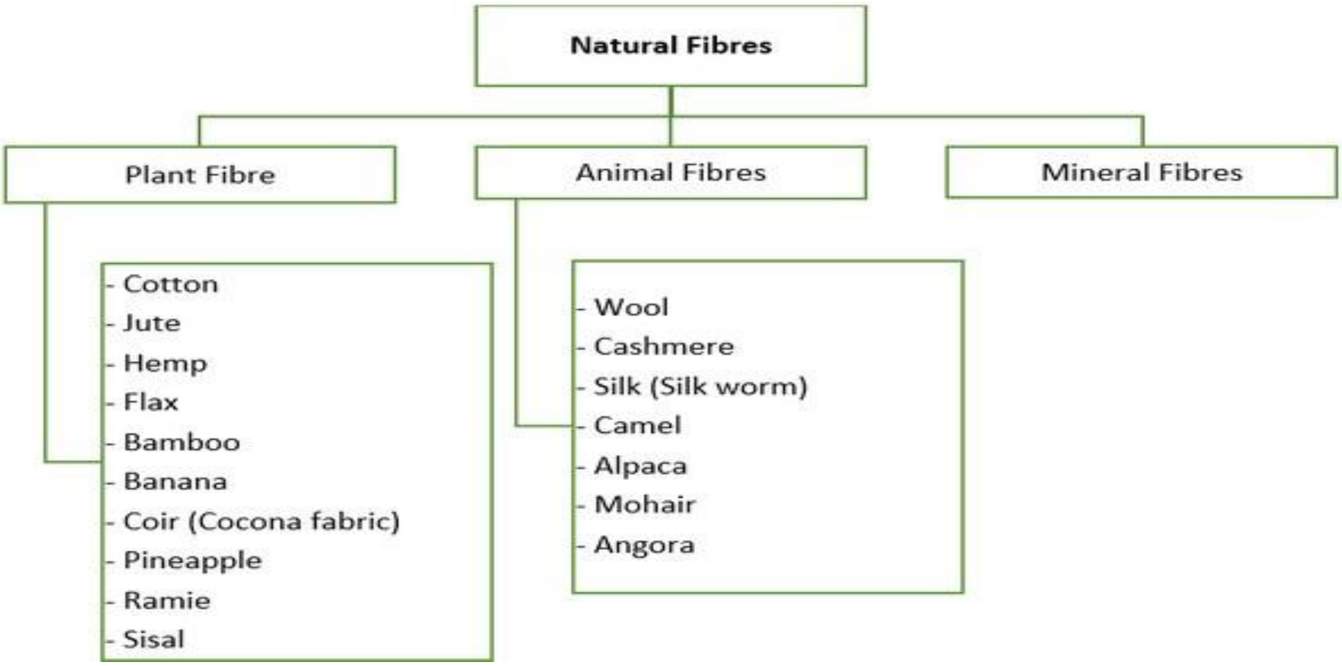

Figure 2.7: Classification of natural fiber

2.8 Characteristics of Fiber-reinforced Systems

Some features of fiber reinforced concrete systems are provided below:

(a) With continuous reinforcing bars, the fibers are short and closely spaced,

(b) When compared to reinforcement bars, the reinforcement ratio is low.

(c) Fibers do nothing to halt the first fracture, but they do limit the spread of cracks.

(d) Material toughness can be improved (15-30 percent).

(e) There isn't much of a difference in creep outcomes.

(f) There is a variation in drying shrinkage.

2.9 Mechanical properties of hardened fiber reinforced concrete

The addition of fibers to concrete influences its mechanical properties which significantly depend on the type and percentage of fiber (Johnston, 1974).

(a) Compressive Strength: The inclusion of fibers may modify the failure mechanism of cylinders or cubes, although the fiber influence on compressive strength values will be modest. Composites with a high fiber concentration might have lower compressive strengths. Strength loss is most likely due to an increase in entrapped air caused by the presence of fibers. The majority of studies believe that volume fractions of less than 1% do not affect compressive strength. Steel fibers have a varied impact on concrete compressive strength.

(b) Tensile Strength of Splitting Concrete: Adding fiber to concrete can improve its tensile strength. To obtain optimum strength, two factors must be considered: fiber distribution in the mix must be uniform, and fiber percentage must be properly determined. The tensile strength grows until the fiber content reaches a specific limit. Tensile strength is decreasing when the proportion of fiber content is increased.

(c) Hardness: The toughness of FRC is approximately 10 to 40 times that of ordinary concrete. The region under a stress-strain curve is referred to as toughness.

2.9.1 Types of fiber

Fibers are made from diverse materials and come in a variety of forms and sizes. Typical fiber materials (Concrete society, 1973) are given below:

Glass-made Fibers:

Straight diameters of glass fiber range from 0.005 to 0.015mm (may be bonded together to form elements with a diameter of 0.13 to 1.3 mm). Resistant to alkalis Glass fiber is used to make glass reinforced cement (GRC) products, which can be utilized in a variety of applications. Glass fiber has a high modulus of elasticity (70-80 GPa) and tensile strength (2-4 GPa), but brittle stress-strain properties (2.5-4.8 percent elongation at break) and minimal creep at ambient temperature. Figure 2.1 depicts glass fiber (a).

Synthetic Fiber:

These fibers are manufactured fibers that are the outcome of petrochemical and textile industry research and development. Acrylic, Aramid, carbon, nylon, polyester, polyethylene, and polypropylene are several fiber kinds that have been tried in cement concrete matrice

Acrylic Fiber:

In several fiber-reinforced concrete products, such as those depicted in figure 2.1, acrylic fibers have been utilized to replace asbestos fiber (b). Fibers are first distributed in dilute water and cement mixture in this procedure. Using a pressure forming technique and vacuum dewatering, a composite thickness is produced up in layers. Acrylic fibers have also been used in small amounts to decrease the effects of plastic shrinkage cracking in traditional concrete.

Nylon:

Nylon is a generic name that identifies a family of polymers. Properties of nylon fiber are given by the type of base polymer, varied additive quantities, production conditions, and the diameters of fiber. Currently, only two types of nylon fiber are marketed for concrete. Nylon is heat stable, hydrophilic, relatively inert, and resistant to a wide variety of materials. Nylon 37 is particularly effective in imparting impact resistance and flexural toughness and sustaining and increasing the load-carrying capacity of concrete. Nylon fiber is shown in figure 2.1 (d).

Polyester:

Polyester monofilament fibers belong to the thermoplastic polyester group and are accessible in monofilament form. They are temperature sensitive, and their characteristics may be changed if they are exposed to temperatures over typical operating temperatures. Polyester fibers have a hydrophobic property. Polyester fibers have been utilized to prevent plastic shrinkage cracks in concrete at low concentrations (0.1 percent by volume). Figure 2.1 depicts polyester fiber (e).

Polyethylene:

Polyethylene has been produced for concrete in monofilament form with wart-like surface deformations shown in Figure 2.1(f). Polyethylene in pulp form may be an alternate to asbestos fibers. Concrete reinforced with polyethylene fibers at contents between 2 and 4% by volume exhibits a linear flexural load-deflection behavior up to the first crack.

Steel fiber:

Since the early 1900s, steel fibers have been utilized in concrete. The wire was cut to the necessary length and the early fibers were spherical and smooth. Modern fibers have rough surfaces, hooked ends, and are either crimped or undulated throughout their length. Steel fiber typically has comparable diameters of 0.15mm to 2mm and lengths ranging from 7mm to 75mm. Aspect ratios range from 20 to 100. Carbon steels are very certainly utilized in the manufacture of fibers. Steel fiber is highly tensile (05-2 GA) and elasticity modulus of about 200 GA, as well as a ductile plastic stressstrain characteristic and low creep. Steel fiber content typically ranges between 0.25 percent and 2 percent by volume. Moreover 2% fiber content in the mortar results in poor workability and fiber dispersion, but it may be utilized successfully if the paste content is raised and the aggregate size is less than 10 mm. Steel fibers in concrete have been proven to have significantly enhanced impact resistance and higher ductility of failure in compression, flexure, and torsion (Johnston C.D, 1974). The concrete's fatigue resistance is said to have enhanced by up to 70%. In Figure 2.1, steel fiber is seen (g).

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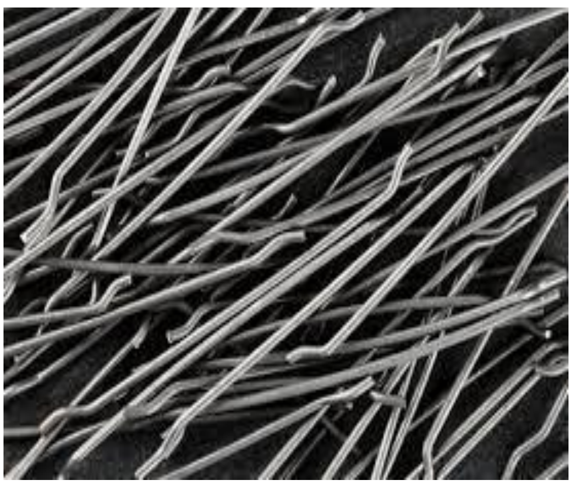
Galvanized iron fiber:

Nowadays galvanized steel wire is using as fiber reinforcement to boost up the strength of concrete Galvanized steel wire is constructed of carbon steel that has been zinc plated. The zinc coating 38 provides corrosion resistance, allowing for a wide range of applications such as weaving galvanized wire mesh, galvanized hardware cloth, welded iron wire mesh, poultry netting, and so on. In the saltwater corrosion resistance alloy coated steel wire, galvanized steel wire with hot- dipped zinc coating is employed of 0.13-6.0 mm. The diameter of the wire generally varies from
0.30 mm to 1.2 mm. The specific gravity of the G.I. wires is also ranged between 6000-7500 kg/m3. Its ultimate tensile strength generally varies between 200- 350MPa. Elastic modulus also ranges between 5-8 GPa. Its ultimate elongation varies between 2-3%. In Bangladesh, it is very cheap and easily available in the local market. Figure 2.8 (h) shows the galvanized iron wire.

(a) Jute Fiber

(b) Glass Fiber



(b) Steel Fiber

(d) Nylon Fiber

Figure 2.8: Different type of Fiber

2.10 Introduction of Jute

Jute is a lignocelluloses best fibre that is biodegradable, inexpensive, non-toxic, and environmentally benign. With only 120-150 days from seed to fibre or maximum Biomass, it is a flexible and fast-growing renewable biomass and light-reactive crop. Jute and jute commodities are losing market share in major nations due to the introduction of low-cost synthetic alternatives, bulk handling, containerization, and soil storage. To keep the jute industries from collapsing further, they must be used in a variety of ways. Jute is a biomass resource that is replenished every year. As a result, different developed and emerging countries are becoming increasingly interested. As a substitute for composite, jute is readily accessible. Jute stems are made up of two fibrous components, both of which may be used to make a variety of goods. The bark fiber is roughly 2.5 mm long and accounts for 25-35 percent of the stem's weight. The shorter core fiber is roughly 0.6 mm long and accounts for 60-65 percent of the stem's weight. Both are suitable for making diversified products. The bark is similar to soft fiber, while the core fiber has strength properties similar to that of hardwood fibers

Figure 2.9: Diversified use of jute

The usage of synthetic alternatives is eroding the conventional jute product industry, such as packaging materials for agricultural products (including sacks, bags, backing cloth, and packaging for fertilizer, cement, and chemicals). To avoid future deterioration of the jute industry, it is necessary to diversify the usage of jute (Figure 2.2) by establishing important new market outlets. The potential use of jute composite manufacturing is one option that has received a lot of attention recently.

2.10.1 Chemical Composition of Jute Fibers

The two varieties of jute Corchorus olitorin and Corchorus capsularis are widely cultivated and most suitable for diversification use. The whole jute plant, jute fiber, jute stick, and jute cutting can be used for various applications. The chemical composition of jute suitable for qualitative use is given in Table 2.3

Table 2.3: Chemical composition of jute (R.Islam, 2018)

Element	Jute fiber (%)	Jute stick (%)	Element	Jute fiber (%)
Cellulose	58-63	34.18-45.20	Water Soluble	0.6-1.2
Lignin	12-14	22.21-23.50	Polyuronide	4.8-5.2
Wax(Oil Materials)	0.4-0.8	7.18-7.25	Acetyl Value	2.8-3.5
Ash Content	-	0.37-0.4	Nitrogenous matter	1.56-1.87
Oxalic acid	-	13.3-22.3	Material Substances	0.5-0.79
Hemi-cellulose	20-23	-	-	-

Jute belongs to the genus Corchorus in the Liliaceae family. Jute fibers are finer and stronger than Mesta fibers, making them of higher quality. White jute's natural fiber color is white creamy, while Tosca jute's is golden. The yearly output of jute and related fiber in the globe is rising day by day, depending on demand.

2.10.2 Structure of Cellulosic Fiber

The epidermis, cortex, massive phloem, cambium, white xylem or wood, and core pith tissue make up the structure of the jute fiber stem. The most significant tissue is the phloem, which is linked to fiber formation. The phloem tissue is also known as bast. Jute is made up of 40 different species, most of which are found in tropical areas. Jute takes around 3-5 months to fully mature. C. capsularis cultivars reach a height of around 5-12 feet at harvest, whereas C. olitorin varieties reach a height of 5-15 feet or higher. Both of their stems are cylindrical. When compared to Mesta, ramie, and flax, jute has the shortest fiber length. The average length of fibers from the outside sections of the wedge in jute is 0.3-2 mm, whereas the average length from the interior parts is only 1-5 mm.Jute fiber has a hierarchical structure, which is important to observe. Every fiber comprises a primary wall (the initial layer deposited during cell formation) and the secondary wall (S), which is made up of three layers (S1, S2, and S3 (Figure 2.9) make up each fiber cell wall. These layers include variable quantities of cellulose, hemicelluloses, and lignin in all cellulosic fibers. A lignin-rich area known as the middle lamella holds the individual fibers together. The S2 layer (approximately 50 percent cellulose) has the highest concentration of cellulose, whereas the middle lamella (about 90 percent lignin) has the highest concentration of lignin. A large number of elongated primary fibers, or fiber-cells, with a diameter of 20 to 30 m. The S2layer is The thickest layer is frequently by far the thickest and has the most influence on the fiber's qualities.

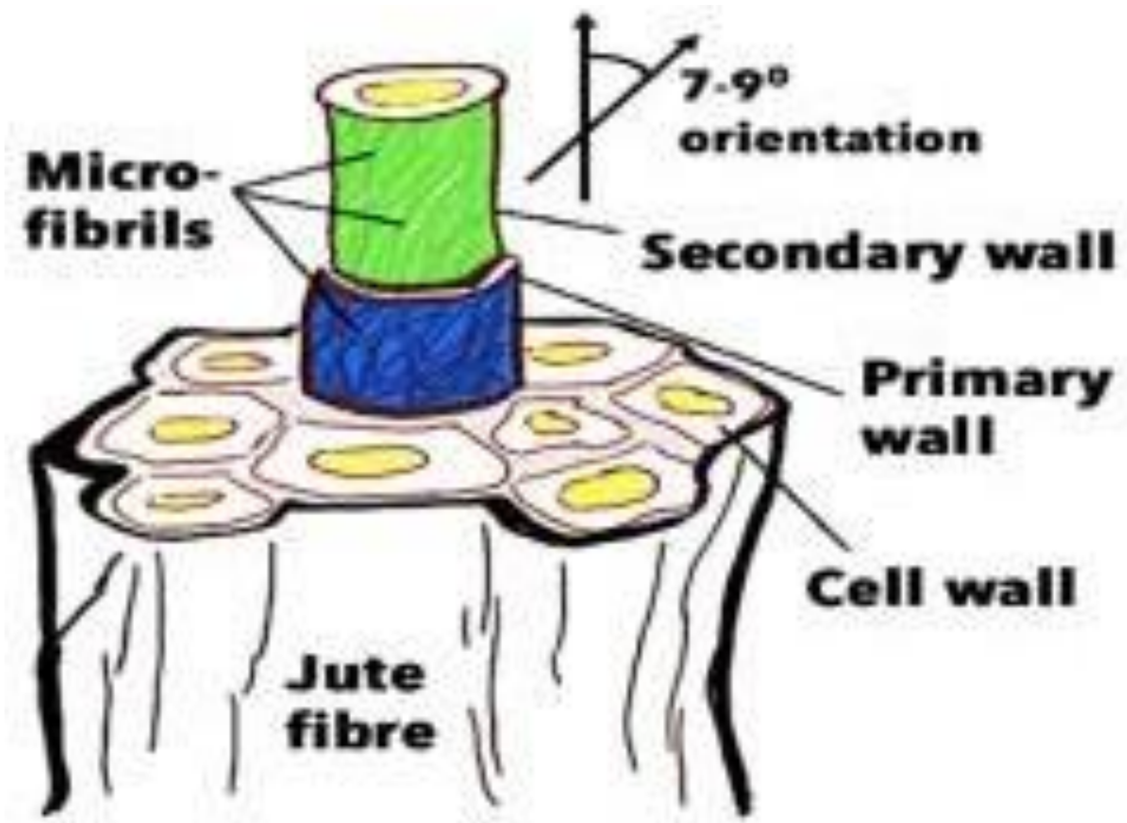


Figure 2.10: Microstructure of natural fiber. (Habib Awais, 2021)

All plant fibers are made up of cellulose, which is the most fundamental structural component. It is the most important and plentiful organic chemical generated by plants. The cellulose molecule is made up of glucose units that are connected in long chains, which are then joined together in micro-fibrils. The cellulose microfibrils have high tensile strength. It has the highest tensile strength of any known material, with a theoretical tensile strength of 7.5 GA (1,087,500 pounds per square inch).The micro-fibrils in the S2 layer run roughly parallel to the fiber axis. S2, which makes up roughly half of the cell wall, offers the fibers a high tensile strength. Plant fibers contain hemicelluloses as well. Hemicelluloses are polysaccharides linked together in a short, branching chain (Figure 2.10). They are inextricably linked to the cellulose microfibril, which they embed in a matrix.Hemicelluloses are very hydrophobic containing many sites to which water can readily bond. The plant's stiffness is due to the lignin component. Plants cannot reach enormous heights (as shown in trees) or stiffness without lignin (as found in some annual crops). Lignin is a polymer with a three-dimensional structure and a high molecular weight. Lignin, the least water-loving of

the three fiber components, is predicted to be the least water-loving. Another essential property of lignin is that it is thermoplastic (i.e., it begins to soften at approximately 90°C and begins to flowat around 170°C). Jute fibers contain lignin, which makes them resistant to microbial assault and improves strength, hardness, and brittleness. Most physical and chemical characteristics, such as biodegradability, flammability, thermoplasticity susceptibility to moisture, UV-light degradability, and so on, are due to lignin and hemicelluloses.Figure 2.10 shows several monomeric unit configurations for the primary polymeric components of cellulosic plant fibers. The presence of hydroxyl groups in natural fibers makes them chemically modifiable. The hydroxyl groups inside cellulose molecules may be engaged in hydrogen bonding, activating thesegroups or introducing new moieties that create effective interlocks within the system. Chemical treatment can enhance surface properties such as wetting, adhesion, surface tension, and fiber porosity. The flaws on the fiber surface influence the mechanical interlocking at the contact. By making suitable adjustments to the components, the interfacial characteristics can be enhanced, resulting in changes in physical and chemical interactions at the contact. In the realm of fiber modification, a tremendous amount of research has been done [7-13]. The current study focused on modifying jute fiber to make it rot, fire, and water-resistant

2.10.3 Jute Scenario in Bangladesh

In 2007-2008, Bangladesh produced about 24.80% of world jute production. Jute andjute goods are the third most important source of foreign exchange earnings afterwoven garments and knit garments. Jute is becoming more popular day by daybecause of its environment friendliness compared to harmful synthetic substances.Jute goods are manufactured all over the world. Jute products are divided into two categories: traditional items and diverse products. Traditional products comprise hessian, carpet backing cloth, and sacking, while diversified products include a blanket, decorative fabrics, gift articles, shopping bags, etc.Bangladesh is now the world's second-largest jute fiber producer. India is at the top of the list. Bangladesh grows the best jute fiber in the world and exports it to the rest of the globe. Bangladesh, on the other hand, is lagging behind other rivals as a result of recent technical developments. Bangladesh is the world's largest exporter of jute fiber and jute products, accounting for more than 65 percent of global jute fiber and jute product exports. According to research, the country's top five jute-producing districts are Faridpur, Rajbari, Madaripur, Kushtia, and Magura. These five districts contribute about 31.44% of the total jute production in Bangladesh. Mymensingh and Dhaka are well known for high-quality jute production. But the jute production fluctuates due to weather conditions and natural calamities. Hence the price also fluctuates. Table 2.4 shows the grade-wise control jute price in BDT/bale in Bangladesh and Table 2.11 shows the diversified use of jute Table 2.4: Grade wise control jute price amount in BDT/bale in Bangladesh

Table 2.4: Different applications of jute fiber composite

Grade	2008	2009
Excellent	6,825	8,175
Good	5,025	6,225
Medium	4,150	5,250
Poor	3,050	4,200

2.10.4 Thermal degradation

Because of the intrinsic organic nature of natural fibers, it is critical to understand the impact of natural composites processing temperatures on processing time. Thermal degradation during composite manufacture is one of the most important factors since it defines the temperatures and parameters at which the fiber is not damaged.Thermal stability is generally recognized to be one of the primary disadvantages of natural fibers, with the initial breakdown occurring at temperatures exceeding 1800C. It has been determined that no deterioration occurs until the temperature reaches

1600°C. Thermal stability steadily diminishes above this degree, and the fibers decompose. Hemicelluloses, followed by cellulose and lignin, are considered to degrade first. Furthermore, the number of contaminants present may hasten the onset of heat deterioration [15 - 17]. In Fig. 2.07, the loss in tensile strength due to the greater temperature and length of exposure is visible.

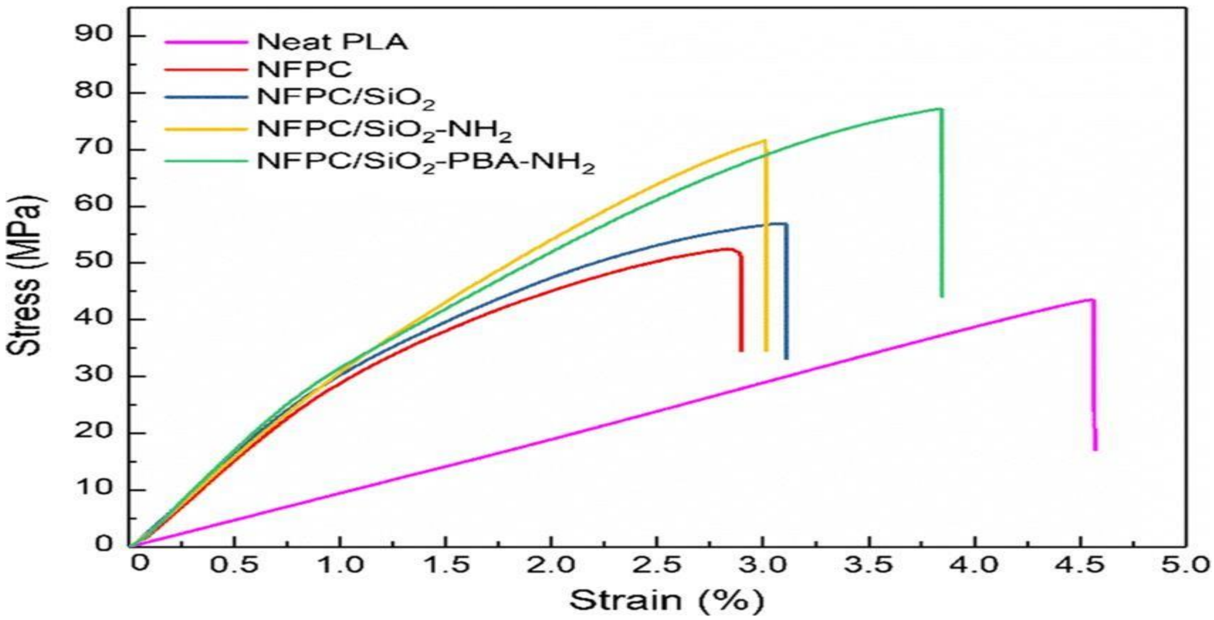


Figure 2.11: Effect of thermal stress on the mechanical properties.

The fibers were subjected to varying temperatures of air. In the case of cotton fibers,rapid deterioration of strength occurs above 1600C. The stiffness remains constant between 80 and 1400C. Above 1800C it begins to decrease relatively rapidly

2.10.5 Fiber Quality

Fiber quality is determined based on the length of the fiber and how well the pith is removed from the fiber.

2.10.6 Soaking Process

The basic criterion for determining fiber quality is to soak husks in water. The hard component of the husks softens after soaking; the fibers relax, making fiber extraction easier; the fibers don't get cut as much, preserving fiber length; and pith removal from the fiber improves significantly

CHAPTER 3

METHODOLOGY

3.1 General

Coarse aggregate, fine aggregate, Ordinary Portland cement (OPC), and jute fiber were utilized in this investigation. The key to attaining desired outcomes in concrete is proper proportioning of component elements, often known as "mix-design." A lot of variables influence the art of mixed design. The primary effort involved in producing fiber reinforced concrete is mix design to get the proper mix percentage and mixing procedures. To summarize, the experimental part of the project aims to conduct the following tests:

1. The slump test.

2. Compressive strength of cylindrical concrete

3. Tensile strength of cylinder concrete.

3.2 Components

3.2.1 Cement

It is the most crucial element of concrete because cement is the binding agent. Portland cement is the most extensively used cement in the world, made by grinding clinker and gypsum. Ordinary Portland Cement (OPC) and Portland Composite Cement (PCC) are the two primary types of Portland cement in Bangladesh, based on the proportion of clinker (PCC).Ordinary Portland cement (OPC) with a strength class of 52.5 N was utilized in this experiment. This cement's first setting time was 45 minutes, and its early strength was 20 MPa after two days. The specific gravity of OPC was determined to be 3.12, and it contains 95-100 percent clinker and 0-5 percent gypsum. As a result, Shah Ordinary Portland cement was used in the study since it was readily available.

3.2.2 Aggregates

Aggregates are inert granular materials like sand, gravel, or crushed stone that are used as filler in concrete mixtures. The significance of selecting the correct aggregate type and quality cannot be overstated. Aggregates are classified into two categories: fine and coarse aggregate.As a fine aggregate, coarse sand was used, while crushed stone chips were used as coarse aggregate in this investigation, with grading done according to ASTM C33. Sylhet was the source of these aggregates. The following table represents the physical characteristics of these aggregates

Table 3.1: Aggregate physical properties

Property	Sand	Stone Chips
Bulk Specific Graivety	2.45	2.5
Absorptin Capacity (%)	1.33	4.16
Fineness Modulus (FM)	2.58	_
Dry Rodded Unit Weight (kg/m3)	1580	1650

3.2.3 Jute Fiber

Jute is a lignocellulosic bast fiber that is biodegradable, inexpensive, nontoxic, and environmentally benign. Jute is one of the most significant long vegetable fibers in the world. Between the internal hollow woody core and the outer skin, jute is made up of fiber bundles organized in multiple layers. It is a long, silky, and lustrous vegetable fiber that ranges in color from off-white to brown. Jute fiber is mostly made up of cellulose, hemicellulose, and lignin. It is more durable than cotton and other natural fibers. Jute fiber has low extensibility and high tensile strength. It's also a concrete reinforcing and crack-resistant substance, as seen in figure 3.2. Table **3.3** lists the properties of jute fiber.

Figure 3.1: Jute Fiber

Table 3.2: Aggregate Details

Length	20 mm
Length	30 mm
Diameter (mm)	0.05 mm
Aspect Ratio (l/d)	200
Aspect Ratio (l/d)	300
Density	1400 (kg/m3)
Tensile Strength	400 (Mpa)
Color	Off White or Brown
Specific Graivity	1.3
Elongation and Break %	1.6

3.2.4 Water

Portable water was used for mixing and curing whose p^H is about 6.5-9.5.

3.3 The following test are required to conduct:

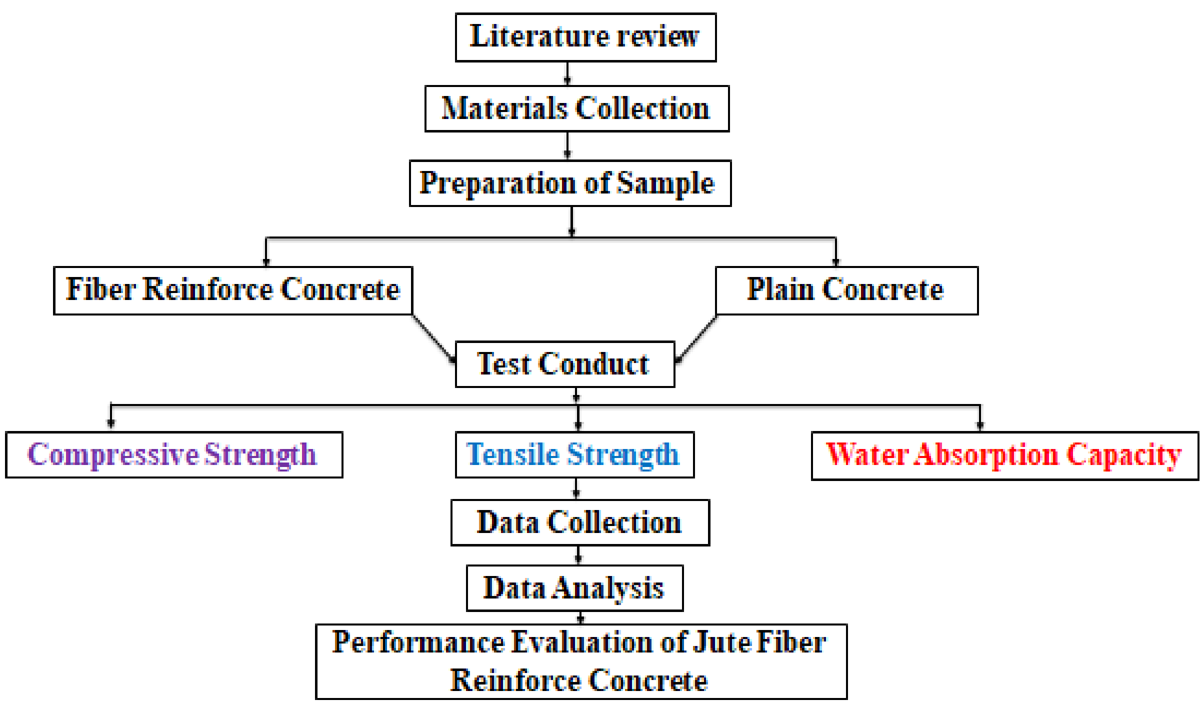


Figure 3.2: Flow chart of required test.

3.4 Mix Proportions of Concrete

Mix design s carried out by the American Concrete Institute (ACI, 211.1-91). With a slump of 3 in to 4 in. Before mixing, all of the aggregates must be soaked and surface dry (SSD). The following is a step-by-step mix design according to the American Concrete Institute (ACI, 211.1-91):

Step 1: Slump value selection
To make flowing concrete, slump= 75 mm

Step 2: Selection Coarse aggregate selection
Maximum size of Course Aggregate = 20 mm

Step 3: Mixing water content and air content estimation
Entrapped air content = 2%

Step 4: W/C ratio selection

Step 5: Fine aggregate content calculation
w/c =0.5
Cement = 595 kg/m3
Water = 225 kg/m3

Step 6: Estimation of coarse aggregate content
Dry rodded bulk volume of CA= 0.64 m3 per 1m3 concrete
Dry mass of CA = 0.64 × 1550 kg = 992 kg per 1m3 concrete
SSD mass of CA =992 (1+0.68/100) = 998 kg/m3
Step 7: Calculation of fine aggregate content
SSD mass of fine aggregate= 2345-225-595-998 = 527 kg/m3
OD mass of fine aggregate = 519.5 kg/m3

Table 3.3: Concrete Mix Proportions

Mix	**Water (kg/m3)**	**Cement (kg/M3)**	**Coarse aggregate (kg/m3) [SSD]**	**Fine aggregate (kg/m3) [SSD]**	**Fiber (kg/M3)**
Normal Concrete	225	1440	1200	1120	00
JF1 (5%, 20mm)	225	1440	1200	1120	1300
JF2 (10%, 20mm)	225	1440	1200	1120	1300
JF3 (15%, 20mm)	225	1440	1200	1120	1300
JF4 (5%, 30mm)	225	1440	1200	1120	1300
JF5 (10%, 30mm)	225	1440	1200	1120	1300
JF6 (15%, 30mm)	225	1440	1200	1120	1300

Table 3.4: Test Plan

Criteria	% of Jute (Volumetric Weight)	Length of Fiber (mm)	Diameter of Cylinder (in)	Height of Cylinder (in)	Number of Cylinder	Total Volume of cylinder
Normal Concrete	0	_ _	4	8	5	502.65
JFR Concrete	5%	20	4	8	5	502.65
JFR Concrete	10%	20	4	8	5	502.65
JFR Concrete	15%	20	4	8	5	502.65
JFR Concrete	5%	30	4	8	5	502.65
JFR Concrete	10%	30	4	8	5	502.65
JFR Concrete	15%	30	4	8	5	502.65

3.5 Mixing of Concrete

Before mixing the concrete, cement was kept dry and placed in a moisture-proof container to prevent the initiation of hydration and difficulties in handling. The surface of the fine and coarse aggregate was kept moist and dry for 24 hours before use. All of the concrete materials were kept at room temperature, ranging from 20 to 30 degrees. by ASTM C 192-90a (1990) A correct mixing is required to guarantee that all surfaces of the aggregate particles are covered with cement paste and that the materials are mixed in a consistent mass. The drum mixer was employed for this test. In this inquiry, the workability tests utilized were concrete slump tests. The slump test was performed according to ASTM C143-90a (1990).

Figure 3.3: Jute Fiber 20 (mm) and 30 (mm)

Figure3.4: Mixing (In Laboratory)

Figure 3.5: Concrete ingredient with a uniform dispersion of the fiber

Figure 3.6: Slump

Figure3.7: Slump test (In Laboratory)

3.6 Curing of Specimen

To acquire its best characteristics, concrete must be thoroughly cured. To avoid evaporation of water from the un-hydrated concrete, the specimens were immediately covered with a wet gunny sack after being shaped. After 24 hours (ASTM C192, 1990), the specimens were removed from the molds and wet cured at 23.17°C for 7 & 28 days. The specimens were loaded for compressive strength testing after wet curing was completed.

Figure3.8: Curing Condition

3.7 Compressive Strength Test

The specimens were examined by the Universal Testing Machine (UTM) 28 days of curing. For equal load distribution, bearing plates were installed at the top and bottom. A Universal Testing Machine (UTM) constantly applied compressive stress without shock. The load was gradually increased at a rate of 2mm/min until the specimens failed. During the test, the maximum load borne by the specimen is recorded. By dividing the load at failure by the area of the specimen, the compressive strength of concrete was estimated. Figure 3.8 depicts the test setup.

Figure 3.9: Set up for Compressive Test

Figure 3.10: Compressive Failure Pattern

3.8 Tensile Strength Test

The specimens were examined by the Universal Testing Machine (UTM) 28 days of curing. For equal load distribution, bearing plates were installed at the top and bottom. A Universal Testing Machine (UTM) constantly applied Tensile stress without shock. The load was gradually increased at a rate of 2mm/min until the specimens failed. During the test, the maximum load borne by the specimen is recorded. By dividing the load at failure by the area of the specimen, the compressive strength of concrete was estimated

Fig 3.11: Set up for Tensile Strength

Fig 3.12: Failure pattern for Tensile Strength

CHAPTER 4

RESULTS AND DISCUSSION

4.1 General

This section presents the findings of an experimental study with different fiber quantities and lengths of a compressive strength test.The cylinders have been cast and the following tests have been performed after 28 days of water treatment. Both diagrammatically and tabular the results will be presented. The influence of jute fibers has been assessed and results are diagrammatically presented.

4.2 Slump

Slump is an indication of the working of concrete during placement and casting. Without enough slumps, the concrete can be challenging for various reasons and the desired performance.

Figure 4.1: Slump Test

4.2.1 Slump Test Result

It has been found that the value of slump reduces with increases in fiber content. The slump was detected at 4 inches with 0.1% of JFRC, and 3 inches with 0.2% of JFRC, and 2.5 cm with 0.3% of JFRC.Again, the slump drops drastically to one inch for fiber content. Therefore, the amount of concrete slump decreases dramatically after 0.3 percent fiber content. However, the use ofchemical admixture can improve this feature (Superplasticizer).

4.3 Compressive Test Result

Compressive strength tests were done at 28 days of treatment with Universal Testing Machine (UTM) on specimen concrete cylinder combined with different percentage points of jute fiber. The compressive strength of the concrete was compared to a variety of jute fiber (5%, 10%, and 15%) for the lengths 20mm and 30mm. The results reflect a minor impact on compressive strength by incorporation of Jute fiber into the mix.In the graph, the highest compressive strength is observed at 5 % fiber content for jute fibers both 20mm and 30mm in length. Compared to normal concrete, 64.34% and 70.9% enhanced the compression strength of 28 days of 20 and 30mm lengths respectively. A declining trend in the content of fibers can be explained by lowering the specific gravity of the composites, and as a result of low specific gravity, improper mixing, and high porosity of the jute fiber concrete by adding jute fiber into concrete.When adding a high volume and a higher fiber length, a reduced compressive strength has been found.The mechanical performance of fiber cement composites, which are effectively correlated by fibers to surrounding concrete, depends mainly on many factors such as geometry, type and surface properties, orientation fiber, fiber volume ratio, fiber distribution, the chemical composition of the fiber, and more. Fiber composites are also the most significant facts. The effects of jute fiber have been tested and results have been evaluated.The percentage of Jute Fiber Reinforced Concrete compressive strength variation (JFRC) to a single compared to three distinct jute fiber doses; where flat concrete without jute fiber is made. It is noted that just 10 mm fiber with 5% jute content; the 30 mm fiber length causes a maximum loss of strength of cement composites is noticed for the noteworthy enriching effect on the compressive strength.The composite strength affects a mix ratio, and both the right concrete mixture and the stronger enhancement result in higher cement content. Fibers may be spread evenly through the concrete mix in the presence of more cement and the regular fiber arrangement, which produces more resistant composite material, opposed to the functional forces can be achieved. The second strongest improvement in JFRC is 20mm fiber in the mixing ratio with 5% dosage. The introduction of greater fiber length (30 mm) and contents leads to an unanticipated decrease in pressure strength. Because various researches included reinforcement materials, i.e. coarse aggregate like fibers or yarns, despite the thin aggregate fraction, the addition of yarns increases the coarse aggregate percentage, potentially leading to substantial porosity in the cement matrix. A decreasing trend of fiber can be justified by reducing the specific gravity of the composites by adding the jute yarn in concrete and by reducing the low specific gravitation, inadequate mixing, and high JFC porosity, in the case of high volume and larger lengths of yarn a lowers compressive strength was added in particular. Similar findings have been achieved by Shimizu et al. (1992). Finally, the JFRC is the most promising combination of compression strength increase with less than 15mm fiber cut length with less than 5% fiber content dozing.

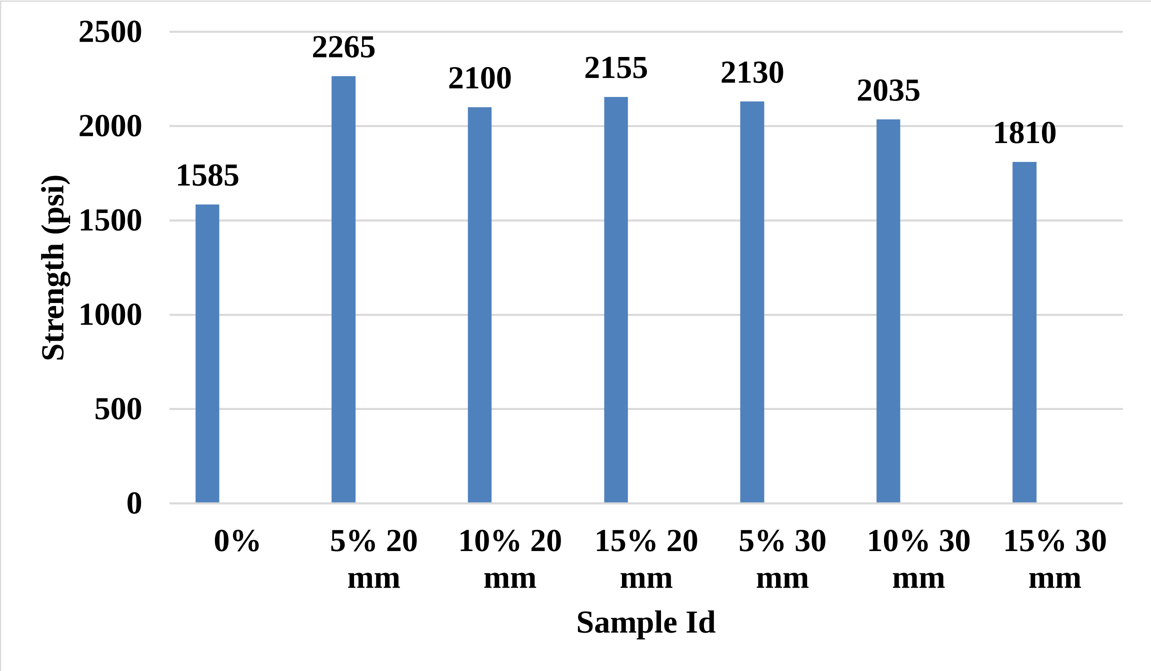


Figure 4.2: Compressive Strength Shown on the Graph

4.4 Tensile Test Result

Compressive strength tests were done at 28 days of treatment with Universal Testing Machine (UTM) on specimen concrete cylinder combined with different percentage points of jute fiber. The tensile strength of the concrete was compared to a variety of jute fiber (5%, 10%, and 15%)

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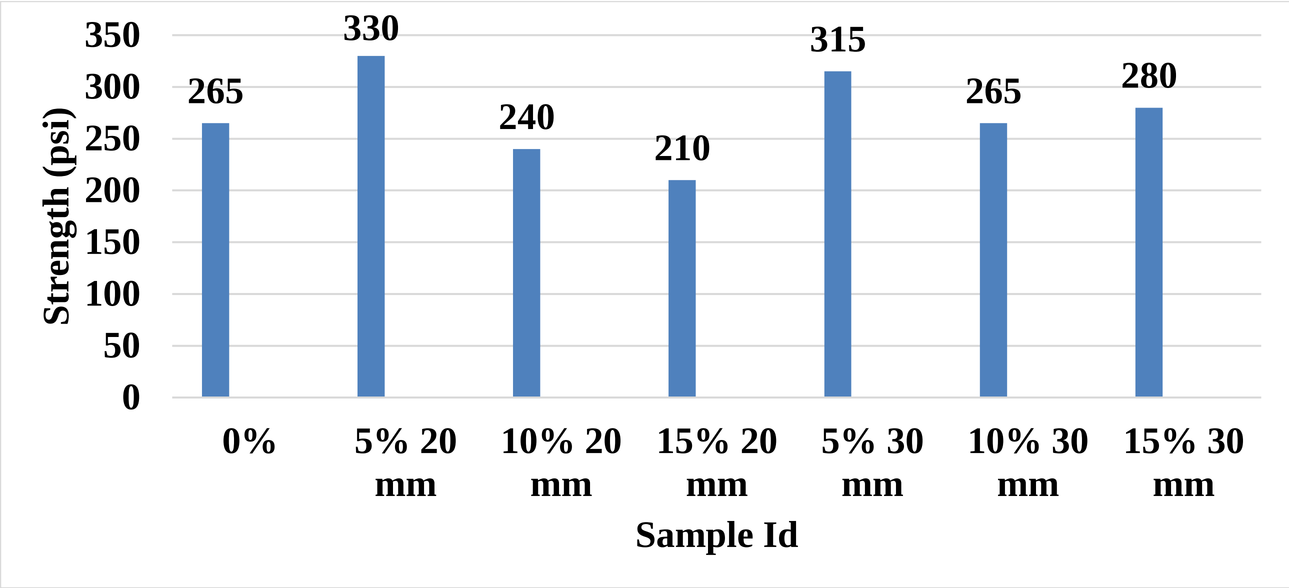

Figure 4.3: Tensile Strength Shown on the Graph

4.5 Water Absorption Capacity

Water absorption capacity (WAC) or water holding capacity (WHC) consists of adding water or an aqueous solution to material, followed by centrifugation and quantification of the water retained by the pelleted material in the centrifuge tube (Damoradan et al., 2010)

As The sieved earth was mixed with water up to a water content of 18% and wrapped in a hermetic plastic bag for at least two days before sample manufacture. The samples were manufactured in the Proctor mold, of a diameter of 10 cm with a hydraulic press.

Often regarding earthen materials, they can be considered either as soils or as construction materials, for each case a specific framework is usually used. In the case of the framework related to soils, several authors have pointed out the practical obstacles to measure the intrinsic permeability. Even if some experimental setups have been designed to overcome these difficulties [10]–[13], they remain quite sophisticated and not widespread. In [14], the Hazen formula, provides an evaluation of the intrinsic permeability from the particle size distribution; in [15], the multiscale network approach derives the hygroscopic permeability from the water vapor permeability; in [16], the capillary transport coefficient is approximated from the water absorption coefficient and the free water saturation.

Table 4.1: Water absorption capacity:

SL No	Percentage of fiber (%)	Length (mm)	Absorption Capacity (%)
1	0	-	1.321
2	5	20 mm	3.84
3	10	20mm	2.59
4	15	20mm	2.96

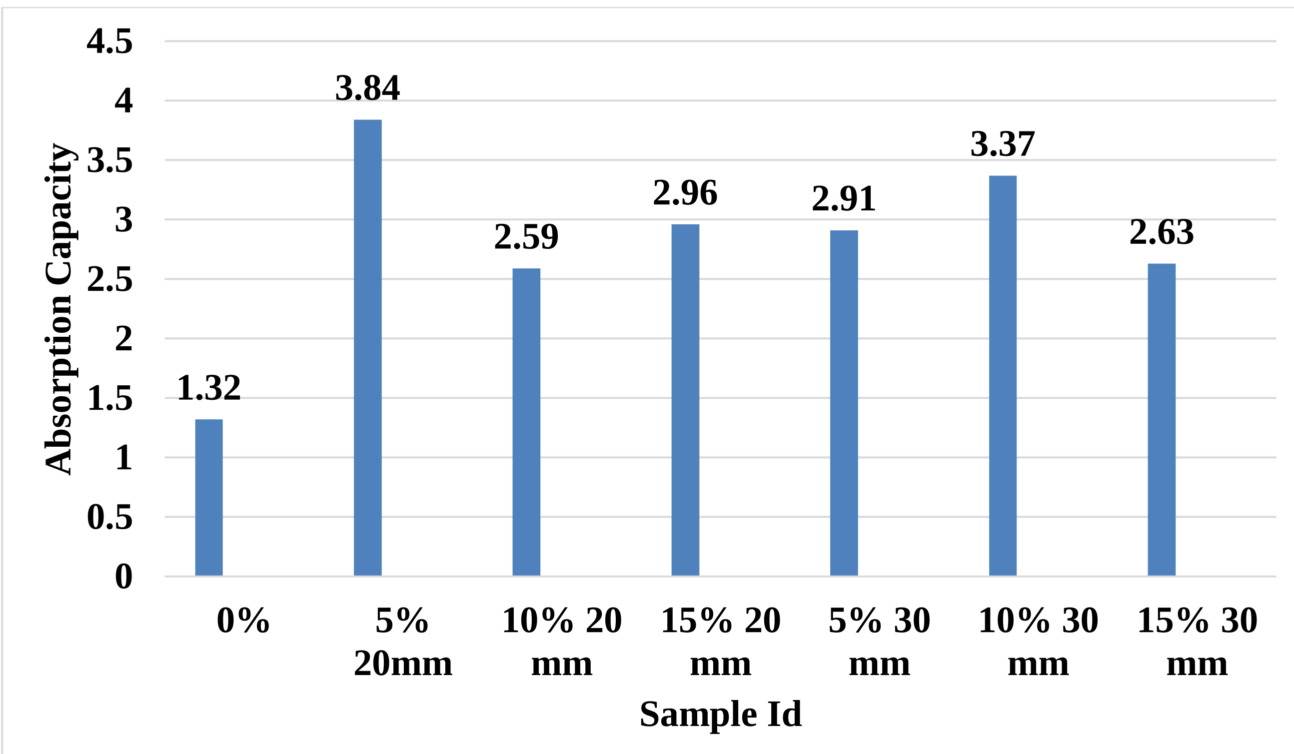

Figure 4.4: Water Asorption Capacity Graph

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 General

Concrete is a world-renowned substance. It depends on several elements, such as cement and aggregates, water quality, mixing method, compaction type, cure duration, and water quality, temperature, and moisture quality. The compliance of concrete with fibers is one of the main areas of investigation. An attempt was made in this study to incorporate native jute fiber in the micro concrete in Bangladesh as a substitute for commercially available polyester fiber. But the comportment and function of reinforced concrete such as jute fiber are still to be investigated. This research has therefore tried to identify numerous fundamental jute fiber reinforced concrete (JFRC) features mainly linked to strength, ductility. The study's main focus however was regardingthe fiber content effects on JFRC's above mentioned qualities. The fiber dosage thereby altered inlow volume. The strength attributes taken into consideration in the study are static compressive strength and compressive loading

5.2 Summary of Findings

The following findings can be concluded after tests and analysis of the results concerning the strength and ductility of fiber reinforced concrete. The main findings and suggestions for future studies are summarized in the following points

1. The addition of this jute fiber lowers the slump i.e. the concrete for this jute fiber is strong enough to retain its shape and collapse rapidly after the 15% jute fiber content.

2. Compressive strength is raised by 64.34% and 70.94% in jute fibers reinforced concrete, compared to normal concrete using 10mm and 15mm long fiber respectively.

3. By manufacturing cement concrete with varied amounts of jute fiber, the critical fiber content is optimized (5-15 % w.r.t. volumetric weight). At 5% fiber load in the cement compound, the maximum compressive strength is obtained.

4. Ratios. The concrete mixing process was improved to achieve sufficient workability of concrete duringcasting, with conventional sand, cement, brick chips, and water.

5. Ratios. The concrete mixing process was improved to achieve sufficient workability of concrete duringcasting, with conventional sand, cement, brick chips, and water.

6. The JFRC content of 5% fiber might be deemed to be the optimal content considering concretestrength, ductility, and durability parameters.

7. The technique of dispersal in concrete and mortar in short jute fiber (optimum length: 20 mm)on a dry and wet basis was optimized.

8. The optimal jute fiber content is 5 % for a length of 20 mm, the maximum compressive strengthobtained.

5.3 Recommendation and Future Work

There are still required study to obtain more information and produce better findings during the testing and analysis. In addition, as this is a new topic in the country's building industry, so it has possibility future in research. Some of these prospects for future research are recommended below,

1. The admixture was not employed in the functioning of the jute fiber integrated concrete mix. A further experiment on jute fiber with admixture can be carried out.
2. Other qualities like creep, fatigue, shear strength, chemical resistance, and electric characteristics should also be studied.
3. Hybrid composite, incorporating fibers other than jute (such as okra, fiber) can be researched since the performance of the composite system will undoubtedly be improved.
4. Structural jute-based composite materials with homogeneous densities, durability in an adverse environment, and high strength can also be made using high-performance adhesives and fiber modification.
5. The hybrid method of combining the glass mat with a woven jute fabric in the epoxy matrix can be used to enhance the mechanical performance and dimensional stability of the composite jute epoxy.
6. Modified jute reinforced composites can also be employed as moderate load bearing constructions in the car industry (door panels, dashboard cover, etc.) and domestics (false ceilings, tabletops, partitions, etc.).
7. To perform tests with a high sample size on each property of JFRC to establish a statistically meaningful link among numerous properties.

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