Sugarcane Bagasse Concrete Compressive and Tensile Strength Test Comparing with Coconut Fiber Concrete

This Thesis Paper is Submitted to the Department of civil Engineering, Sonargaon University (SU) Dhaka in Partial fulfillment of the Requirements for the Degree of Bachelor Science in Civil Engineering.

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Fall-2019

Sugarcane Bagasse Concrete Compressive and Tensile Strength Test Comparing with Coconut Fiber Concrete



DEPARTMENT OF CIVIL ENGINEERING

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Letter of Submission

To

Hamamah Sadiqa

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Subject: Submission of thesis report

Dear Mam,

We, the undersigned have successfully completed our thesis on “Sugarcane Bagasse Ash Compressive and Tensile Strength Test Comparing with Coconut fiber concrete”. We have completed the entire practical works at University Laboratory during the period of the study on above on compressive and Tensile strength of Fiber concrete with recycle Sugarcane Fiber. We have written this report on our laboratory observation and practical investigation.

In this connection, we therefore hope that you would be kind enough to receive this thesis paper and bless us heartily.

Yours faithfully

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Declaration

We thereby declare that the research reported in this thesis has been performed by us and this thesis work or any part of it has been submitted elsewhere for any other purpose expect when due reference is made in the text of this thesis.

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Abstract

In this research work we used Sugarcane bagasse concrete (SCBC).Sugarcane bagasse easily found in sugar factories of Bangladesh. Some of them are used as fuel in sugar mills and rest of them are dumped into environment without any commercial return. The disposal of this material is causing environmental problems around the sugar factories. On the other hand, urbanization and industrialization is rapidly increasing in Bangladesh. So, the construction industry is rapidly expanding. Currently large amount of cement is needed for this construction industry. It will be increasing day by day. The study examined the potentiality of using classified Sugarcane bagasse concrete (SCBC) to replace some part of sand in concrete. In this study, bagasse sample was collected from roadside Hawker in Farmgate, Dhaka. After collecting the sugarcane bagasse, it was dried in sun for a week and then it burned in oven at 150°C to 200°C temperature for 24 hours. Sand was replaced by SCBC at different percentage of 0%, 2%, 5%, 10%, and 12%. Where the fibber length was 0, 3.5, 10, 42.5, 75 and 88.5 mm, water cement ratio was 0.45 and cement, sand and aggregate ratios was 1:1.5:3. The objective of this study was to determine the compressive and tensile strength. Strength was tested for 28 days. The test results was comparing with coconut fiber concrete from the previous research work. Results indicated that the replacement of sand by bagasse ash was better concrete properties. It also showed the economic advantages by using SCBA as a partial sand replacement material.

Keywords: Sugarcane Bagasse, Sand replacement, Compressive strength, Tensile strength.

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Chapter One

Introduction

Concrete is not only the most heavily used man-made material in the world but also a widely used material for construction of highway facilities. Concrete is durable, inexpensive, readily molded into compliqned shapes, and has adequate compressive strength and stuffiness. However, concrete has low tensile Strength, low ductility, and low energy absorption. Due to its lack of tensile strength, concrete is often reinforced with steel reinforcing bars (re-bars) in structural applications. However, steel re-bar corrosion has contributed to the decay of reinforced concrete structures. Fiber reinforced concrete (FRC) is often made by adding a small fraction (usually below 2% by volume) of short fibers to the concrete mix during mixing. After extensive studies in the last three decades, it is now beyond doubt that such fiber reinforcement can significantly improve the tensile properties of concrete. Orders of magnitude increases in toughness (energy absorption) over plain concrete are commonly observed. Fiber reinforcement can also improve the fatigue strength and reduce the drying shrinkage of concrete. Fiber reinforced concrete is currently being used in many applications including buildings, highway overlays, bridges, and airport runways. In load bearing applications it is generally used along with traditional steel reinforcement. By using FRC instead of conventional concrete, section thickness can be reduced and cracking can be effectively controlled, resulting in more lightweight structures with longer expected life. This paper reports on an experimental program to evaluate the effectiveness of using recycled fibers from carpet waste for concrete reinforcement. The results suggest that using· such recycled fibers highway construction would not only improve the reliability and life of the highways, it but also could reduce the landfill spaces needed to dispose the waste material (Youjiang Wang,)

There are two ways to produce waste: 1. Pre-consumer Waste: `Pre-consumer waste is a material that was discarded before it was ready for consumer use. Pre-consumer recycled materials can be broken down and remade into similar or different materials, or can be sold "as is" to third party buyers who then use those materials for consumer products. Pre-consumer textile waste usually refers to waste by-products from fiber, yarn, textile, and apparel manufacturing. It can be mill ends, scraps, clippings, or goods damaged during

production, and most is reclaimed and reused as raw materials for the automotive, furniture, mattress, coarse yarn, home furnishing, paper, and other industries. 2. Postconsumer Waste: Postconsumer textile waste usually refers to any product that the individual no longer needs and decides to discard due to wear or damage and normally includes used or worn clothing, bed linens, towels, and other consumer textiles. Postconsumer waste which can be recovered are clothing, drapes/curtains, towels, sheets and blankets, clean rags and sewing remnants, table cloths belts hand bags paired shoes and socks (Bhatia, Sharma, & Malhotra).

1.1 Recycle Fiber

Recycling is the process of converting waste materials into new materials and objects. It is an alternative to "conventional" waste disposal that can save material and help lower greenhouse gas emissions. Recycling can prevent the waste of potentially useful materials and reduce the consumption of fresh raw materials, thereby reducing: energy usage, air pollution (from incineration), and water pollution (from landfilling). Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, and Recycle" waste hierarchy. Thus, recycling aims at environmental sustainability by substituting raw material inputs into and redirecting waste outputs out of the economic system. There are some ISO standards related to recycling such as ISO 15270:2008 for plastics waste and ISO 14001:2015 for environmental management control of recycling practice. Recyclable materials include many kinds of glass, paper, cardboard, metal, plastic, tires, textiles, batteries, and electronics. The composting or other reuse of biodegradable waste such as food or garden waste is also a form of recycling. Materials to be recycled are either delivered to a household recycling center or picked up from curbside bins, then sorted, cleaned, and reprocessed into new materials destined for manufacturing new products. In the strictest sense, recycling of a material would produce a fresh supply of the same material for example; used office paper would be converted into new office paper or used polystyrene foam into new polystyrene. This is accomplished when recycling certain types of materials, such as metal cans, which can become a can again and again, infinitely, without losing purity in the product. However, this is often difficult or too expensive (compared with producing the same product from raw materials or other sources), so "recycling" of many products or materials involves their reuse in producing different materials (for example, paperboard) instead. Another form of recycling is the salvage of certain materials from complex products, either due to

their intrinsic value (such as lead from car batteries, or gold from printed circuit boards), or due to their hazardous nature (e.g., removal and reuse of mercury from thermometers and thermostats) (There are some ISO standards related to recycling such as ISO 15270:2008 for plastics waste and ISO 14001:2015 for environmental management control of recycling practice., 2015).

1.2 Recycle Fiber Concrete

Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers – each of which lends varying properties to the concrete. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities JSTOR (September 2009) . Concrete is the most frequently used construction material in the world. However, it has low tensile strength, low ductility, and low energy absorption. An intrinsic cause of the poor tensile behavior of concrete is its low toughness and the presence of defects. Therefore improving concrete toughness and reducing the size and amount of defects in concrete would lead to better concrete performance. An effective way to improve the toughness of concrete is by adding a small fraction (usually 0.5–2% by volume) of short fibers to the concrete mix during mixing. In the fracture process of fiber reinforced concrete (FRC), fibers bridging the cracks in the matrix can provide resistance to crack propagation and crack opening before being pulled out or stressed to rupture. After extensive studies it is widely reported that such fiber reinforcement can significantly improve the tensile properties of concrete. An order of magnitude increases in toughness (energy absorption) over plain concrete is commonly observed (ACI 1982; Keer 1984; Wang et al. 1987; Bentur and Mindess 1990). Another application of fiber reinforcement is for the reduction of the shrinkage and shrinkage cracking of concrete associated with hardening and curing. Plastic shrinkage cracks occur in fresh, unhardened concrete when the rate of evaporation at the concrete surface is greater than the rate of water migration to the surface. The volume of the fresh concrete decreases when there is a net loss of water, which is greater at the surface. This gradient in shrinkage forces cracks to appear on the surface. Because the strength and stiffness of fresh concrete is very low, only a small amount of fibers are needed to effectively reduce the plastic shrinkage. Low volume fractions of synthetic fibers, e.g., 0.1% of polypropylene fibers, are often used to reduce plastic shrinkage cracking in

concrete. Other benefits of FRC include improved fatigue strength, wear resistance, and durability. By using FRC instead of conventional concrete, section thickness can be reduced and cracking can be effectively controlled, resulting in lighter structures with a longer life expectancy. FRC is currently being used in many applications, including buildings, highway overlays, bridges, and airport runways (ACI 1982; Keer 1984; Bentur and Mindless 1990). In load bearing applications it is generally used along with traditional steel reinforcement (ACI 1988). In building construction it has become a more common practice to use low-dosage synthetic fiber reinforcement for floor slabs. Fibers for concrete reinforcement generally need to be durable in the cementations environment, be easily dispersed in concrete mix, have good mechanical properties, and be of appropriate geometric configuration in order to be effective. Many fibers have been used for concrete reinforcement and some are widely available for commercial applications. They include steel, glass, natural cellulose, carbon, nylon, polypropylene, among others. According to the U.S. Environmental Protection Agency (USEPA 1992), the municipal solid waste generated in the United States is ;200,000,000 tons/year, among them about 38% being paper products, 8% plastic, and 3% carpets and textiles. The practice of disposal requires constant creation of new landfill spaces, which is in contradiction to the nation's environmental goals, including ecosystem protection. Significant effort has been devoted to the reduction, reuse, and recycling of the waste materials. Typically, recycling technologies are divided into primary, secondary, tertiary, and quaternary approaches. Primary approaches involve recycling a product into its original form. Secondary recycling involves processing a used product into a new type of product that has a different level of physical and/or chemical properties. Tertiary recycling involves processes, such as pyrolysis and hydrolysis, which convert the waste into basic chemicals or fuels. Quaternary recycling refers to waste-to-energy conversion through incineration. All four approaches exist for textile, plastic, and paper recycling. Studies have indicated that many forms of fibers recovered from various waste streams are suitable for concrete reinforcement. The advantages of using such recycled fibers include generally lower cost to process than virgin fibers, and the elimination of the need for waste disposal in landfills. This paper reviews some of the work on concrete reinforcement using recycled fibers, including tire cords/wires, carpet fibers, feather fibers, steel shavings, wood fibers from paper waste, and high density polyethylene (HDPE). This paper also provides a summary of the properties and applications of concrete reinforced with these fibers (On, Of, By, Lee, & Yoo, 1999).

1.3 Types of Recycle Fiber

Natural Fiber: Natural fibers or natural fibers (see spelling differences) are fibers that are produced by plants, animals, and geological processes. They can be used as a component of composite materials, where the orientation of fibers impacts the properties. Natural fibers can also be matted into sheets to make paper or felt (Chitosan et al., n.d.).

Manufacture or fiber: Manufactured fibers are made by processing natural or synthetic polymers into a fiber forming substance (Sinclair, 2015; Houck, 2010). These fibers differ to natural fibers because of the chemistry of the polymer (Kadolph, 2014).

Glass Fiber: Glass fiber (or glass fiber) is a material consisting of numerous extremely fine fibers of glass.

Glassmakers throughout history have experimented with glass fibers, but mass manufacture of glass fiber was only made possible with the invention of finer machine tooling. In 1893, Edward Drummond Libbey exhibited a dress at the World's Columbian Exposition incorporating glass fibers with the diameter and texture of silk fibers. Glass fibers can also occur naturally, as Pele's hair (Libbey et al., 1933).

Cardboard Fiber

Cardboard is a generic term for heavy-duty paper-based products having greater thickness and superior durability or other specific mechanical attributes to paper; such as fold ability, rigidity and impact resistance. The construction can range from a thick sheet known as paperboard to corrugated fiberboard which is made of multiple corrugated and flat layers.

Despite widespread general use in English and French, the term cardboard is deprecated in commerce and industry as not adequately defining a specific product. Material producers, container manufacturers, packaging engineers, and standards organizations, use more specific terminology (Various card stocks, n.d.).

Cotton Fiber: Cotton recycling prevents unneeded wastage and can be a more sustainable alternative to disposal. Recycled cotton can come from secondhand clothing or from textile waste or leftovers which are then spun into new yarns and fabrics. There are some notable limitations of recycled cotton, including separation of materials that are cotton/polyester mix. There may also be limits to durability in using recycled cotton (Jonathan Y. Chen, 2017).

Textile Recycling: Textile recycling is the process of recovering fiber, yarn or fabric and reprocessing the textile material into useful products. Textile waste products are gathered from different sources and are then sorted and processed depending on their condition, composition, and resale value. The end result of this processing can vary, from the production of energy and chemicals to new articles of clothing (Hawley, 2014).

Deinking (category Paper recycling): Deinking is the industrial process of removing printing ink from paper fibers of recycled paper to make deinked pulp. The key in the deinking process is the ability to detach ink from the fibers. This is achieved by a combination of mechanical action and chemical means. In Europe the most common process is froth flotation deinking.

Paper is one of the main targets for recycling. A concern about recycling wood pulp paper is that the fibers are degraded with each cycle and after being recycled 4–6 times the fibers become too short and weak to be useful in making paper (Claproth, Schmid, & Corrugated, 1843).

Cellulose fiber: Cellulose fibers (/ˈsɛljʊloʊs, -loʊz/) are fibers made with ethers or esters of cellulose, which can be obtained from the bark, wood or leaves of plants, or from other plant-based material. In addition to cellulose, the fibers may also contain hemicellulose and lignin, with different percentages of these components altering the mechanical properties of the fibers.

The main applications of cellulose fibers are in the textile industry, as chemical filters, and as fiber-reinforcement composites, due to their similar properties to engineered fibers, being another option for bio composites and polymer composites (Yasuo, 2005).

Wood-plastic composites (WPCs): Wood-plastic composites (WPCs), also known under the trade name Plastic-Wood® of Covema,[1] are composite materials made of wood fiber/wood flour and thermoplastic(s) such as PE, PP, PVC, or PLA.

In addition to wood fiber and plastic, WPCs can also contain other ligno-cellulosic and/or inorganic filler materials. WPCs are a subset of a larger category of materials called natural fiber plastic composites (NFPCs), which may contain no cellulose-based fiber fillers such as pulp fibers, peanut hulls, bamboo, straw, digest ate, etc. (Wood-plastic composite, n.d.).

Bio composite: A bio composite is a composite material formed by a matrix (resin) and a reinforcement of natural fibers. These kinds of materials often mimic the structure of the

living materials involved in the process keeping the strengthening properties of the matrix that was used, but always providing biocompatibility. The matrix phase is formed by polymers derived from renewable and nonrenewable resources. The matrix is important to protect the fibers from environmental degradation and mechanical damage, to hold the fibers together and to transfer the loads on it(Fazeli, Keley, & Biazar, 2018) .

Jute Fiber: Jute is a long, soft, shiny vegetable fiber that can be spun into coarse, strong threads. It is produced primarily from plants in the genus Corchorus, which was once classified with the family Tiliaceae, and more recently with Malvaceae. The primary source of the fiber is Corchorus olitorius, but it is considered inferior to Corchorus capsularis. "Jute" is the name of the plant or fiber used to make burlap, hessian or gunny cloth (White et al., n.d.).

1.4 Properties of Sugarcane Fiber

Concrete is made up of three main ingredients which is cement, aggregates and water. However, there were also other materials put into the concrete mix which is known as addictive to increase the strength of the concrete. Concrete has high compressive strength; corrosion and weathering effect are minimal. However, concrete has low tensile strength and easily can be crack due its characteristics which is brittle Nowadays, an increasing demand of concrete in the industries, researchers and scientist are developing alternate binders that are ecofriendly and contribute towards waste management especially for agricultural waste such as sugarcane .There have many previous experimental have been conducted by using different volume of sugarcane bagasse. Bagasse fiber is a by-product of sugarcane industry whose role is sugar, rum or biofuel production. Sugarcane can help to improve the deficient tensile strength of concrete due to its limited tensile strength. Sugarcane bagasse have a little impact on the compressive strength of concrete. The increasing of volume of concrete was reduced the compressive strength of the concrete. Olutoge was claimed that bagasse ash can increase the strength of concrete when used up to 10% cement and 30% fine aggregates replacement level. However, the flexural Strength of concrete is decrease after certain percentage replacement of sugarcane bagasse ash. The sugarcane bagasse ash concrete had higher compressive strength compare to the concrete without sugarcane bagasse ash [5].The optimal level of sugarcane bagasse ash content with 15% replacement. Many researchers show that sugarcane in high performance concrete as a partial replacement of Portland cement improved the rheological properties. The method was implemented by grinding treatment

that the ash received before its incorporation into the concrete mixtures. Cordeiro et al. found an influence of sugarcane ash on the properties of concretes. Concrete containing sugarcane ash was produced using a vibratory grinding machine in a dry open circuit. Conventional and high-performance concretes were produced using 0% to 20% of these ashes as a cement replacement. It can be concluded that the partial replacement of Portland cement sugarcane ash caused a slight increase in yield stress and a small reduction in plastic viscosity in both the conventional and high-strength concretes. The rheological evaluation of these causes is hardly to determine due to different particle sizes of the ingredients that form the mixture. This paper presents the results of research aimed to investigate the performance of sugarcane bagasse as an addition material in normal and lightweight concrete. The utilization of sugarcane bagasse in concrete mix produced desired compressive strength, tensile strength and optimum sugarcane fiber in concrete (Sheikh Khalid, Herman, & Azmi, 2017).

1.5 Sugarcane Bagasse Concrete (SCBC)

In this research work, our concern how to recycle Sugarcane Bagasse Concrete (SCBC) in construction. The sugarcane bagasse is the raw material obtain after the sugar has been removed from the sugarcane stocks. Then the material is modeled into plates, bowls, cups and other products. The products created from this process are 100% biodegradable and compostable. Sugarcane is definitely better than plastic and Styrofoam since the fiber lining of the sugarcane plants helps to create a more durable products. They are micro able, freezer safe and even oven safe. Also renewable and they help to create a healthier environment. Nowadays sustainable development and Environmental pollution are the major issues in the whole world. Over 5% of global CO2 emissions can be attributed to Portland cement production (Worrell et. al, 2001). Production of 1 ton of cement contributes to about 1.25 ton of CO_2 into atmosphere (Griffin, 1987). Demand for cement is increasing day by day in Bangladesh. Being a developing country urbanization and industrialization is rapidly increasing. The construction industry is rapidly expanding because of infrastructure development of the country. A lot of mega-structures such as tall buildings, bridges, offshore structures, dams, monuments, fly way over, metro rail, elevated express way etc. As most of structures are made by concrete so, it needs a large amount of cement production.

In Bangladesh, sugarcane bagasse concrete (SCBC) can be use in concrete as supplementary cementing materials due to its pozzolanic reactivity (Cordeiro et al.,

2004). In this country sugarcane bagasse as natural agro-waste materials and it also obtained with requiring low cost, energy and time. As per study by Mahamud et.al, 2012, in Bangladesh around 425,000 acres of land are under sugarcane and the annual production is about 7.5 million tons, of which only 2.28 million tons are used in sugar mills and the rest goes to molasses making. Bangladesh now produces about 150,000 tons of sugar, 100,000 tons of molasses and 800,000 tons of bagasse per year. Bagasses are use as fuel in sugar mills (Habibullah et.al, 2014). According to Cordeiro et al., 2004, the resulting bagasse ash represents approximately 0.62% of the sugarcane weight. Unfortunately, having technical benefits, most of sugarcane bagasse are dumped into environment without any commercial return. In consequence, environmental pollutions are increased day by day. Proper consumption of these sugarcane bagasse contributes in solving environmental pollution and production of cost-effective concrete; it can also play a vital role for the production of sustainable concrete (Chowdhury, 2011).In recent decades, a significant amount of attention has been focused on plastics recycling, primarily as it relates to the economics of vehicle recycling activities , which, together with natural fiber composites, have become more popular in industrial scenarios; however, these composites' mechanical behavior remains less well understood than single polymers' behavior after recycling. Natural fibers, when they are adequately combined with polymers, can provide better flexibility and improve mechanical resistance and toughness. In addition, in contrast to synthetic fiber recycling, natural fibers composite recycling is more environmentally sustainable. According to Luz et al, the use of an additive maintained or even increased the tensile strength of the original composite relative to that of the recycled composite without additives. Importantly, these reprocessed composites were subjected to additional mixing by using a high-intensity thermokinetic mixer. Although this process typically results in excessive breakdown and thermal degradation, the use of additives prevented these outcomes. In a recent work that used lignin as an additive in polypropylene/coir composites, the authors also concluded that the additive incorporation did not decrease the mechanical strength. In this work, sugarcane fiber composites were obtained and subjected to mechanical recycling. Sugarcane fibers are a renewable resource; the use of natural fibers may promote good mechanical properties, low abrasion, low energy consumption during preparation and lower costs compared with synthetic fibers. We have published several reports related to these fiber types. Different types of fibers have been used, including sugarcane bagasse, cellulose from bagasse, and sugarcane straw. In the last decade, considerable effort has

been directed towards using various natural fibers which are available and in abundance in tropical and sub-tropical countries as reinforcement in soil composites for producing cost-effective building materials. Natural fibers are usually used in weaving, sacking and ropes and have good potentials to be used as reinforcement in composite (Sen and Reddy, 2011) materials such as soil blocks. These materials have good physical and mechanical properties; provide good environmental benefits and low-cost advantage for use as building material. Natural fibers can be used in composite materials to reduce weight, increase strength and are also very safe during handling, processing and use (Sen and Reddy, 2011, Rodriguesa et al., 2011). Ali (2010) explained that natural fibers in composite can be applied in civil engineering for plastering, use as roofing material, slabs, boards, wall paneling systems, house construction and slope stabilization. The requirement for economical and environmentally friendly materials has extended an interest in the use of natural fibers (Ghazali et al., 2008). The use of natural fibers in composite materials helps to address sustainability issues. In tropical and subtropical regions, natural fibers such as sisal, bamboo, coconut husk, sugar cane residue (bagasse), oil palm and pineapple leaves are in abundance and cheap. The utilization of this bio-based waste in building material has attracted research interest by researchers to promote sustainable construction. Chopped barley straw (Bouhicha et al., 2005), processed waste tea (Demir (2006), vegetal (Achenza and Fenu, 2006), oil palm empty fruit bunches (Kolop et al., 2010), lechuguilla natural fibers (Juárez et al., 2010), pineapple leaves (Chan, 2011), cassava peel (Villamizar et al., 2012) and hibiscus cannabinus (Millogo et al., 2014) have been used to reinforced the properties of soil blocks/bricks. Studies on the possible use of other natural fibers such as sugarcane bagasse to enhance the properties of soil blocks will add to knowledge and extend the debate on the utilization of natural fibers in soil matrix. Ghazali et al. (2008) studied the characteristics of sugarcane bagasse in cement composite. There is therefore the need to also study the characteristics of sugarcane bagasse in soil matrix. The aim of the present work is to study the effect of sugarcane bagasse fiber on the strength properties of soil blocks. In tropical and subtropical regions, natural fibers such as sisal, bamboo, coconut husk, sugar cane residue (bagasse), oil palm and pineapple leaves are in abundance and cheap. The utilization of these bio-based waste in building material has attracted research interest by researchers to promote sustainable construction. Chopped barley straw (Bouhicha et al., 2005), processed waste tea (Demir (2006), vegetal (Achenza and Fenu, 2006), oil palm empty fruit bunches (Kolop et al., 2010), lechuguilla natural fibers (Juárez et al., 2010),

pineapple leaves (Chan, 2011), cassava peel (Villamizar et al., 2012) and hibiscus cannabinus (Millogo et al., 2014) have been used to reinforced the properties of soil blocks/bricks. Studies on the possible use of other natural fibers such as sugarcane bagasse to enhance the properties of soil blocks will add to knowledge and extend the debate on the utilization of natural fibers in soil matrix. Ghazali et al. (2008) studied the characteristics of sugarcane bagasse in cement composite. There is therefore the need to also study the characteristics of sugarcane bagasse in soil matrix. The aim of the present work is to study the effect of sugarcane bagasse fiber on the strength properties of soil blocks.

1.6 Effect of Fiber in Concrete

Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion, and shatter resistance in concrete. Generally fibers do not increase the flexural strength of concrete, and so cannot replace moment resisting or structural steel reinforcement Indeed; some fibers actually reduce the strength of concrete. The amount of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), termed "volume fraction" (V_f). V_f typically ranges from 0.1 to 3%. The aspect ratio (l/d) is calculated by dividing fiber length (l) by its diameter (d). Fibers with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. If the fiber's modulus of elasticity is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increasing the aspect ratio of the fiber usually segments the flexural strength and toughness of the matrix. However, fibers that are too long tend to "ball" in the mix and create workability problems. Some research in the late 2000s indicated that using fibers in concrete has limited effect on the impact resistance of the materials. This finding is very important since traditionally, people think that ductility increases when concrete is reinforced with fibers. The results also indicated that the use of micro fibers offers better impact resistance to that of longer fibers. The High Speed 1 tunnel linings incorporated concrete containing 1 kg/m³ of polypropylene fibers, of diameter 18 & 32 μm, giving the benefits noted below (Some & See, n.d.). (Wikipedia, 2017).

1.7 Typical properties of Selected Fibers

Fibers can be divided into natural and man-made (synthetic) substance; their properties can affect their performance in many applications. Nowadays, man-made fiber materials are replacing other conventional materials like glass and wood in a number of applications. This is because man-made fibers can be engineered chemically, physically, and mechanically to suit particular technical engineering. In choosing a fiber type, a manufacturer would balance their properties with the technical requirements of the applications. Various fibers are available to select for manufacturing. Here are typical properties of the sample natural fibers as compared to the properties of man-made fibers.

Table (1): Typical Properties of selected Natural Fibers

Fiber Type	Fiber Diameter (in)	Specific Gravity	Tensile Strength (Ksi)	Elastic Modulus (Ksi)	Elongation at Break (%)	Water Absorption (%)
Wood Fiber (Kraft Pulp)	0.001-	1.5	51-290	1500-	N/A	50-75
Musamba	N/A	N/A	12	130	9.7	N/A
Coconut	0.004-	1.12-	17.4-29	2750-	10-25	130-180
Sisal	0.008-	1.45[14]	40-82.4	1880-	10-25	130-180
Sugar Cane	0.008-	1.2-1.3	26.7-42	2175-	1.1[15]	70-75
Bamboo	0.002-	1.5	50.8-	4780-	N/A	40-45
Jute	0.004-	1.02-	36.3-	3770-	1.5-1.9	28.64[16]
Elephant grass	0.003-	0.818[17]	25.8	710	3.6	N/Ab

a. Adapted from ACI 544. IR-96 P58, reference [12] P240 and [13]
b. N/A means properties not readily or not applicable

Table (2): Properties of Selected Man-made Fiber

Fiber Type	Fiber Diameter (in)	Specific Gravity	Tensile Strength (Ksi)	Elastic Modulus (Ksi)	Elongation at Break (%)	Water Absorption (%)	Melting Point (^{o}c)	Maximum Working Temp. (^{o}c)
Steel	4-40	7.8	70-380	30000	0.5-3.5	Nil	1370[18]	760[18]
Glass	0.3-0.8	2.5	220-580	10400-11600	2-4	N/A	1300	1000
Carbon	0.3-0.35	0.90	260-380	33400-55100	0.5-1.5	Nil	3652-3697[19]	N/A
Nylon	0.9	1.14	140	750	20-30	2.8-5.0	220-265	199
Acrylics	0.2-0.7	1.14-1.18	39-145	2500-2800	20-40	1.0-2.5	Decomp	180
Aramid	0.4-0.5	1.38-1.45	300-450	900-17000	2-12	1.2-4.3	Decomp	450
Polyester	0.4-3.0	1.38	40-170	2500	8-30	0.4	260	170
Polypropylene	0.8-8.0	0.9	65-100	500-750	10-20	Nil	165	100
Polyethylene Low High	1.0-40.0	0.92 0.95	11-17 50-71	725	25-50 20-30	Nil Nil	110 135	55 65

a. Adapted from ACI 544. IR-96 P58, reference [12] P240 and [13]
b. N/A means properties not readily or not applicable

The tables above just show typical properties of fibers.

1.8 Research Objective

The objectives of this work are:

1. To investigate tensile and compressive strength of Sugarcane Fiber Concrete (SFRC).
2. To determine the optimum amount of sugarcane fiber for suitable tensile strength.
3. To compare the strength of SCFA with coconut one.

1.9 Possible Outcomes:

1. Development of compressive and tensile strength of concrete.
2. Comparison between types of fiber and selection of best fiber.

Chapter Two

Literature Review

2.1 Overview

Researchers have begun to focus attention on natural fiber composites (i.e., bagasse fiber), which are composed of natural or synthetic resins, reinforced with natural fibers. Natural fibers exhibit many advantageous properties, they are a low-density material yielding relatively lightweight composites with high specific properties. These fibers also have significant cost advantages and ease of processing along with being a highly renewable resource, in turn reducing the dependency on foreign and domestic.

2.2 International Research of Fiber Concrete

Petroleum oil. Usmani M. Arthur et al (1981) described the evaluation of five water soluble phenolic resins as binders, at 5 percent concentration, for oriented and random bagasse-reinforced composite materials. Determined the amount of resin retained during processing when these phenolics are precipitated from water slurry onto the bagasse fibers. The physical properties of random oriented cured composites (wet and dry) were determined. Random fiber composites were also prepared by a "moist" process (in which no resin is lost) and compared. A specific resin was selected as best based on retained mechanical properties and minimal phenolic processing losses.

D. Maldas et al (1990) studied the effect of thermoplastics (e.g. polyvinyl chloride and polystyrene), as well as a coupling agent poly (methylene (polyphenylisocyanate)) (PMPPIC) and bagasse lignin, on the mechanical properties of particle boards of sugarcane bagasse. The mechanical properties of bagasse particle boards were compared to those of hardwood aspen fiber particle boards, dignified bagasse particle boards, as well as those of composites made from bagasse, polymers and coupling agents. Particle boards of bagasse comprising both thermoplastics and a coupling agent offer superior properties compared to those made of only thermoplastic or a coupling agent. The extent of improvement in the mechanical properties of particle boards depended on the concentration of polymers and the coupling agent; nature of the fiber, polymer and coupling agent; composition of PMPPIC and bagasse; as well as lignin content of the bagasse. Moreover, the mechanical properties and dimensional stability of coupling agent-treated particle boards are superior to nonrelated ones.

Monteiro S.N. et al (1998) studied the possible uses of bagasse waste as reinforcement in polyester matrix composites. Preliminary results have attested this possibility. Composites with homogeneous microstructures could be fabricated and the levels of their mechanical properties enable them to have practical applications similar to the ones normally associated with wooden agglomerates. Future developments are expected to increase the performance and competitiveness of these composites as compared to those of other materials in the same structural class.

Vazquez A. et al (1999) reported processing and properties of bagasse fiber-polypropylene composites. Four different chemical treatments of the vegetal fibers were performed in order to improve interface adhesion with the thermoplastic matrix: namely isocyanate, acrylic acid, mercerization and washing with alkaline solution were applied. The effects of the treatment reactions on the chemical structure of the fibers were analyzed by infrared spectroscopy. Optical photomicrographs indicate that a highly fibrillated surface is achieved when fibers are mercerized. The effects of the fiber chemical treatment on the tensile properties of the molded composite, produced by different processing routes, were also analyzed. It was observed that the tensile strength and the elongation at break of the polypropylene matrix composite decrease with the incorporation of bagasse fibers without treatment. However, isocyanate and mercerization treatments enhance the tensile properties of the composite. Moreover, creep measurements were also carried out on the various composites studied. The best results were obtained on materials with treated fibers. The highest creep activation energy was obtained on the composite with the mercerized fiber.

Hassan M.L et al (2000) investigated the conversion of bagasse into a thermo formable material through esterification of the fiber matrix. For this purpose, bagasse was esterified in the absence of solvent using succinic anhydride (SA). The reaction parameters of temperature reaction, time and amount of succinic anhydride added were studied. Ester content, Fourier transform infrared (FTIR), thermo gravimetric analysis (TGA), differential scanning calorimetry (DSC) and dynamic mechanical thermal analysis (DMTA) were used to characterize the chemical and thermal properties of the esterified fibers. The results showed that on reacting bagasse with SA in the absence of solvent, ester content up to about 48% could be obtained. Diester formation increased with increasing reaction time and temperature at high levels of ester content. Ester content determination of the esterified fibers and their corresponding holocelluloses showed that

the reaction took place in the lignin and holocellulose components of bagasse. The IR results showed that the crystallinity index of different esterified bagasse samples did not decrease as a result of increasing the ester content. DSC and TGA results showed that esterified-bagasse fibers were less thermally stable than the untreated fibers. DMTA results showed that esterification of the fibers resulted in a decrease in the tan δ peak temperature of the esterified fibers compared to the untreated fiber.

Hassan M.L et al (2000) investigated the conversion of bagasse into a thermo moldable material through esterification of the fiber matrix. For this purpose, bagasse fiber was esterified in the absence of solvent using succinic anhydride. The dimensional stability and mechanical properties of composites prepared from the esterified fibers were studied. Dimensional stability was found to be dependent on the total ester and monoester/diester content of esterified fibers and increased with increasing total ester and monoester content of the fibers. The mechanical properties (bending strength, tensile strength and hardness) were enhanced with increasing monoester contents. Scanning electron microscopy was used to prove the occurrence of thermo plasticization of the esterified fibers.

PaivaJ.M.F. et al (2002) confirmed that Lignin, extracted from sugarcane bagasse by the organosolv process, used as a partial substitute of phenol (40 w/w) in resole phenolic matrices. Short sugarcane fibers were used as reinforcement in these polymeric matrices to obtain fiber-reinforced composites. Thermoset polymers (phenolic and lignophenolic) and related composites were obtained by compression molding and characterized by mechanical tests such as impact, Differential Mechanical Thermo analysis (DMTA) and hardness tests. The impact test showed an improvement in the impact strength when sugarcane bagasse was used. The inner part of the fractured samples was analyzed by scanning electron microscopy (SEM) and the results indicated adhesion between fibers and matrix, because the fibers are not set free, suggesting they suffered a break during the impact test. The modification of fiber surface (mercerization and esterification) did not lead to an improvement in impact strength. The results as a whole showed that it is feasible to replace part of phenol by lignin in phenolic matrices without loss of properties.

Bilba K et al (2003) prepared various bagasse fiber/cement composites, the fibers having a random distribution in the composites. The influence of different parameters on the setting of the composite material has been studied: (1) botanical components of the fiber, (2) thermal or chemical treatment of the fiber, (3) bagasse fiber content and (4) added

water percentage. This study shows a retarding effect of lignin on the setting of the composite, for small amount of heat-treated bagasse (200 °C) the behavior of the composite is closely the same as the classical cement or cellulose/cement composite.

Thwe MM et al (2003) studied the effects of environmental aging and accelerated aging on tensile and flexural behavior of bamboo fiber reinforced polypropylene composite (BFRP) and bamboo-glass fiber reinforced polypropylene hybrid composite (BGRP), all with a 30% (by mass) fiber content, by exposing the samples in water at 25°C for up to 1600 h and at 75°C for up to 600 h. Reduction in tensile strength for BFRP and BGRP was 12.2% and 7.5%, respectively, after aging at 25°C for about 1200 h. Tensile and flexural strength of BFRP and BGRP were reduced by 32%, 11.7% and 27%, 7.5% respectively, after aging at 75°C for 600 h. While the strengths of the bamboo fiber reinforced composites reduce with sorption time and temperature, the environmental degradation process can be delayed by adding a small amount of glass fiber. Moisture sorption and strength reduction are further suppressed by using maleic anhydride polypropylene (MAPP) as a coupling agent in both types of composite system.

Songklanakarin et al (2009) investigated that Bagasse fly ash, a waste from the sugar industry can be used as a replacement for the current expensive methods of removing reactive dyes (Remazol Black B; RBB, Remazol Brilliant Blue R; RBBR and Remazol Brilliant Red F3B; RBRF3B) from aqueous solutions. Bagasse fly ash was collected from a local sugar factory in Saraburi province, Thailand. It was oven dried at 110ºC overnight and sieved to the desired particle size of 150 μm or smaller. The 50 mL plastic conical tubes containing solution and bagasse fly ash were shaken at room temperature (27±2ºC). The pH values of solutions were adjusted by addition of HNO3 and NaOH. The batch study indicated that initial pH of aqueous solutions did not affect dye removal. While the removal efficiency decreased with increasing initial concentration, it increased with increasing adsorbent concentration. The best adsorptions were obtained under condition of 50 mg/L concentration, original pH solution of about 5 and 240, 300 and 240 minutes contact time for RBB, RBBR and RBRF3B, respectively. Most adsorption experiments showed in the range of about 50% to 98% removal; that is, the efficiencies of RBB, RBBR and RBRF3B adsorption were found to be between 58.48-98.03%, 46.15-93.47% and 46.30- 94.60%, respectively. For the linear and nonlinear forms of the Langmuir and Freundlich models, the results indicated that the Langmuir adsorption isotherm fitted the data better than the Freundlich adsorption isotherm. Adsorption of these dyes onto

bagasse fly ash was favorable sorption. Therefore, bagasse fly ash, the low-cost agricultural waste in Thailand, is suitable for use as adsorbent for RBB, RBBR and RBRF3B under this investigation.

Sausa de M.V et al (2010) evaluated the effect of three processing parameters on the flexural mechanical behavior of chopped bagasse–polyester composites. The parameters evaluated were: the size of the chopped material, the pre-treatment derived from the previous processing of the bagasse material on mills for extraction of sugar and alcohol or liquor and the molding pressure. The results obtained showed that composites fabricated with bagasse with size under mesh #20 sieve and pre-processed for sugar and alcohol extraction showed the best mechanical performance. This behavior was associated, respectively, with the increase of the surface area and with an almost complete cleaning of the bagasse surface. The molding pressure affects the mechanical behavior only after a threshold value is attained. Its effect was related to the promotion of a closer contact between bagasse and the resin matrix and the reduction of entrapped voids. The results obtained enable the selection of the best combination of bagasse origin, size and molding pressure Shinichi Shibata et al (2005) by experiment investigated flexural modulus of the press-molding composites made from bagasse fiber and biodegradable resin and numerical prediction with Cox's model that incorporates the compression ratio of the bagasse fiber in the cross section. The effect of the volume fraction of bagasse fiber and its length on the flexural modulus was examined. Up to 65% volume fraction in the experiment, the flexural modulus increased with increase of the fraction of the bagasse fiber. The numerical prediction was in good agreement with the experimental result. Above 65% volume fraction, however, the flexural modulus decreased in the experiment, while the prediction increased. It seemed that the biodegradable resin was insufficient to cover all the surface of bagasse fiber in the composite. Moreover, the decrease of the flexural modulus was found below 3 mm at the fiber length in the experimental and the same trend was shown in the numerical prediction.

Shibata S. et al (2006) prepared biodegradable composites reinforced with bagasse fiber before and after alkali treatments and mechanical properties were investigated. Mechanical properties of the composites made from alkali treated fibers were superior to the untreated fibers. Composites of 1% NaOH solution treated fibers showed maximum improvement. Approximately 13% improvement in tensile strength, 14% in flexural strength and 30% in impact strength had been found, respectively. After alkali treatment,

increase in strength and aspect ratio of the fiber contributed to the enhancement in the mechanical properties of the composites. SEM observations on the fracture surface of composites showed that the surface modification of the fiber occurred and improved fiber–matrix adhesion.

S.M. Luz et al (2007) performed the compression and injection molding processes in order to evaluate the better mixer method for fiber (sugarcane bagasse, bagasse cellulose and benzylated bagasse) and matrix (polypropylene). The samples (composites and polypropylene plates) were cut and submitted to mechanical tests in order to measure flexural and tensile properties. The morphological and microstructural analyses of fracture surface and specimens from composites can be easily evaluated by microscopic techniques. The fracture surface was evaluated by SEM and selected specimens from composites were analyzed by reflected light in OM. The better tested method for composites obtainment was the injection molding under vacuum process, by which composites were obtained with homogeneous distribution of fibers and without blisters. The mechanical property shows that the composites did not have good adhesion between fiber and matrix; on the other hand, the fiber insertion improved the flexural modulus and the material rigidity.

Zheng Yu-Tao et al (2007) studied the surface treatments of bagasse fiber (BF) with benzoic acid as a surface/interface modifier and the mechanical properties of BF-polyvinyl chloride (PVC) composite. A typical process for the preparation of the composite was as follows: A mixture of PVC, BF, benzoic acid and other processing additives were dry-blended in a two-roll mill followed by compression molding. The experimental results indicated that the ratio of PVC/BF, the content of benzoic acid and processing temperature had a significant effect on the mechanical properties of the composite, which was examined by the orthogonal optimal method. The interface modifier improved significantly on the tensile strength and little on the impact strength of the composite, for example, the tensile strength changed between 42 and 52 MPa comparing to the tensile strength of untreated BF/PVC composite (38 MPa) and the impact strength changed between 8.3 and 9.2 kJ/m2 comparing to the impact strength of untreated BF/PVC composite (7.5 kJ/m2) when the content of benzoic acid changed between 3 and 10%.

Tayeb et al (2008) studied abrasive wear behavior of polymer reinforced with natural fiber. Specifically, untreated sugarcane fiber (SCF) was used in two forms to reinforce polyester (SCRP). Chopped SCFs with different lengths (1, 5, 10 mm) randomly dispersed (C-SCRP) and continuously unidirectional fibers (USCRP) with two different orientations were prepared using hand-lay-up and closed mould techniques. Despite the good adhesion between fiber and matrix, results of mechanical tests showed poor tensile strength of SCRP composite. This was attributed to the weak site inside the fiber itself which could not bear the stress transfer from matrix via the fiber. Experimental results of abrasive wear tests revealed that wear of SCRP composite was sensitive to variations of load, fiber length and fiber orientation and less sensitive to sliding velocity. In C-SCRP composite, the lowest wear resistance was observed for composite with 1 mm fiber length as the fibers had no support and removed easily with minimum resistance to the action of abrasive particles followed by 10 and 5 mm fiber length. Meanwhile, C-SCRP composite with 5 mm fiber length offered the highest resistance to material removal compared to the other fiber length used. In U-SCRP composite, the antiparallel-orientation (APO) exhibited better wear performance compared to the parallel-orientation (PO) one. The predominant wear mechanisms in the case of C-SCRP composite were plastic deformation, micro-cutting, pitting in the matrix and fiber removal. In the case of U-SCRP composite in (PO) wear mechanisms were micro-cutting, plugging, fragmentation of wear debris in the matrix and excessive deterioration of fiber surface followed by delamination, while in (APO) the wear mechanisms were micro-cutting in the resin matrix and tearing the fiber transversely at their ends.

Acharya S.K et al (2008) found that the sugar cane residue bagasse is an underutilized renewable agricultural material. Bagasse is generally grey-yellow to pale green in color. It is bulky and quite non uniform in particle size. As it is produced at the sugar mills, bagasse is used as fuel in the power plant. However, wherever there is large scale production of sugarcane, there will be excess bagasse which must be disposed of by other methods such as burning, dumping, land burial, etc. Thus, an economic use of the excess bagasse could both increase the profits of the sugar mill and solve an environmental problem. The attempt to upgrade the value of this agricultural residue has been made by bonding with resin to produce composites for suitable applications.

C.P. da Silva et al (2009) used natural fibers both pre-treated and modified residues from sugarcane bagasse. Polymer of high density polyethylene (HDPE) was employed as

matrix in to composites, which were produced by mixing high density polyethylene with cellulose (10%) and Cell/ZrO2•nH2O (10%), using an extruder and hydraulic press. Tensile tests showed that the Cell/ZrO2•nH2O (10%)/HDPE composites present better tensile strength than cellulose (10%)/HDPE composites. Cellulose agglomerations were responsible for poor adhesion between fiber and matrix in cellulose (10%)/HDPE composites. HDPE/natural fibers composites showed also lower tensile strength in comparison to the polymer. The increase in Young‘s modulus is associated to fibers reinforcement. SEM analysis showed that the cellulose fibers insertion in the matrix caused an increase of defects, which were reduced when modified cellulose fibers were used.

V. S. Aigbodion et al (2010) characterized the chemical and physical nature of bagasse ash in order to evaluate the possibility of their use in the industry. X-ray diffractometric, determination of composition and presence of crystalline material, scanning electron microscopy/EDAX examination of morphology of particles, as well as physical properties and refractoriness of, bagasse ash has been studied.

V. S. Aigbodion et al (2010) developed the thermal ageing behavior model of Al-Cu-Mg/Bagasse ash particulate composites with 2-10wt% bagasse ash particles produced by double stir-casting method in terms of weight fraction of bagasse ash, ageing temperature and time. Hardness values measurement was used in determining the ageing behavior, after solution and age-hardened heat-treatment. The experimental results demonstrate that the bagasse ash was the major parameter in the ageing behavior, followed by ageing temperature. The hardness values decreased as the ageing time increases. Moreover, the optimal combination of the testing parameters could be predicted. The predicted hardness values were found to lie close to that of the experimentally observed ones. The developed mathematical model can be employed for optimization of the process parameters of the ageing behavior of Al-Cu-Mg/Bagasse ash particulate composites with respect to hardness values.

S. K. Acharya et al (2010) carried out experiments to study the effects of impingement angle and particle velocity on the solid particle erosion behavior of Bagasse Fiber Reinforced Polymer Composites (BFRPCs). The erosive wear is evaluated at different impingement angles from 30° to 90° at four different velocities of 48, 70, 82 and 109 m/s. The erodent used is silica sand with the size range 150 – 250 _m of irregular shape. The

result shows brittle behavior with maximum erosion rate at 90° impingement angle. The morphology of the eroded surfaces was examined by using Scanning Electron Microscopy (SEM).

S. K. Acharya et al (2010) conducted experiments to determine the abrasive wear behavior of bagasse fiber reinforced epoxy composite in different directions, namely parallel orientation (PO), anti-parallel orientation (APO) and normal orientation (NO) by using a two body abrasion wear tester. Three different types of abrasives wear behavior have been observed in the composite in three orientations and follow the following trends: WNO < WAPO < WPO, where WNO, WAPO and WPO are the wear in normal, antiparallel and parallel directions of fibers orientation, respectively. The fiber bundles present in the composite provide unique directional abrasive wear properties. Wear anisotropy magnitude of the composite is found to be a function of load and abrasive grit size. The worn surfaces were observed by using a SEM after the wear test. It has been found that in PO type samples the abrasion takes place due micro plugging, where as in APO and NO type samples micro cutting found to be responsible for the wear process.

John .O. Osarenmwinda et al (2010) investigated the potential of carbonized bagasse (waste from sugar cane) as filler in rubber products. The products were evaluated for Tensile strength, Compression test, Abrasion resistance, Hardness and Elongation at break. Results shows that as the filler loading increased the tensile strength, abrasion resistance, Hardness properties improved. It was also observed that decrease in filler loading enhanced the Elongation at break and compression set properties. The possibilities of utilizing the low cost bagasse as an alternative filler material in natural rubber have been achieved in the work.

Martin et al (2011) used pre-treated sugarcane bagasse with glycerol (40-80% (w/w)) either in the presence of NaOH or H2SO4, or without any chemicals, at 190 °C, 10% biomass load, for 1 to 4 hours. The pre-treatments resulted in cellulose-enriched fibers and different degrees of xylem and lignin solubilisation. Cellulose recovery was higher in pre-treatments with NaOH addition and without any chemicals, than in those with H2SO4. Xylem solubilisation was almost complete in all H2SO4-assisted treatments whereas, in the other experiments, it decreased with the increase in glycerol concentration and increased with the pre-treatment time. Lignin solubilisation increased proportionally with glycerol concentration. Under all conditions applied, the pre-treatment improved the

enzymatic hydrolysis of cellulose. The highest overall cellulose convertibility's were achieved in the glycerol pre-treatments without other chemicals (85-94%). Convertibility decreased with time in acidic pre-treatments and increased slightly for the other ones. Enzymatic conversion of the xylan retained in the fibers was also detected.

Rahman Muhammad Bozlur et al (2011) describes a method to fabricate short bagasse /bamboo fiber reinforced biodegradable composites and investigated their flexural properties. Bagasse/bamboo fibers were simply randomly mixed with biodegradable resin and composite specimens were fabricated by a cylindrical steel mosuld by the press forming. The effects of holding time and fibers content on the flexural properties of bagasse / bamboo fiber composites were investigated. The flexural properties of bagasse / bamboo fiber reinforced biodegradable composites were strongly affected by the holding time and amount of fiber content. During fiber processing on different holding time, it was found that flexural properties increased with the increased the holding time up to 10 min. Above 10 min, flexural properties decreased due to insufficient resin. In processing on fiber content, it was observed that the flexural properties increased with the increase in the fiber content up to 50% & above 50% flexural properties decreased due to high fiber weight fraction and poor bonding between fiber and matrix. The flexural modulus for holding time showed maximum of 2384 MPa for bagasse and 2403 MPa for bamboo composites. The cross sectional structure of bagasse fiber was porous and bamboo fiber was solid.

P. C. Gope et al (2012) developed bagasse-glass fiber reinforced composite material with 15 wt.%, 20 wt.%, 25 wt.% and 30 wt.% of bagasse fiber with 5 wt.% glass fiber mixed in resin. Scanning electron microscopy (SEM) shows that bagasse fibers 13.0 μm in diameter and 61.0 μm in length are well dispersed in the resin matrix. Addition of fiber increases the modulus of elasticity of the epoxy. Mixing of bagasse with glass fiber also improves the modulus of elasticity. Addition of bagasse fibers decreases the ultimate tensile strength. But addition of glass fiber further increases the ultimate tensile strength in comparison to commercially available bagasse based composite. Bagasse-glass reinforced fibers improve the impact strength of epoxy materials due to fiber has more elasticity in comparison to matrix material. Addition of fibers increases the capacity of water absorption. This test is necessary where composites are used in moisture affected areas. Addition of bagasse fiber reduces bending strength. But addition of glass fiber further increases the bending strength in comparison to commercially available bagasse based composite.

Chapter Three

Material and Methodology

3.1 General

For the purpose of constructing fiber reinforced concrete following materials were used.

3.1.1 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 gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Cement is the most widely used material in existence and is only behind water as the planet's most-consumed resource. In this work, we used Fresh Portland Composite Cement (Shah) for all types of test.

3.1.2 Coarse Aggregate

The stone chips, size 3\4 down were collected from Amin Bazar, Gabtoli. Almost 80 kg of natural color stone chips were purchased. Then we took a CNG for our material transport. Then we get down the material take went to the lab. Then we took 20 mm and 9.5 mm sieve for sieve analysis. The type of crusher used for the crushing influence the shape of coarse aggregates. Rounded, Angular, Flaky, Elongated and Irregular are some types on shapes of coarse aggregates. The CAA test estimates coarse aggregate angularity by visually inspecting a small sample of coarse aggregate and separating the sample into those pieces with a fractured face and those without (Figure 2). If more than one fractured face is specified, the same test can be done using two fractured faces as the decision criteria.



Figure 1. Collecting coarse aggregate (Stone Chips)

3.1.3 Sand as Fine Aggregate

Best quality coarse sand (Brown in color) locally known as ‘sylhet sand’ was used as the fine aggregate. We collect this sand from the local market**.** . Fineness modulus of Sylhet sand is determined by conducting sieve analysis. Fine aggregate means the aggregate which passes through 4.75mm sieve. To find the fineness modulus of fine aggregate we need sieve sizes of 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm. Fineness modulus of finer aggregate is lower than fineness modulus of coarse aggregate. The respective values of specific gravities of Sylhet sand is obtained 2.71 following ASTM C128-84. The FAA test estimates fine aggregate angularity by measuring the loose uncompacted void content of a fine aggregate sample. On a sample of known gradation, the loose uncompacted void content is indicative of the relative angularity and surface texture of the sample. The higher the void content, the higher the assumed angularity and rougher the surface.



Figure 2. Collecting fine aggregate (sylhet sand)

3.1.4 Reinforcing fiber

In this study we were used sugarcane bagasse fiber in construction. We were collected this fiber from the Farmgate and karwan bazar without cost. Almost one week surrounding to cut this fiber by using scissors. Before this work we were pulling-out smooth fiber by using comb from the sugarcane bagasse.



Figure 3. Collecting Sugarcane Bagasse ash from road side hawker.

3.1.5 Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials. Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. The pH value shall not be less than 6.

3.2 Procedure of coarse aggregate sieve analysis

We nest the sieve in order of decreasing size of opening from top to bottom and place the sample 1500gm on the top sieve. In that case we used 20mm, 9.5mm & 4mm sieve. (Where 20mm pass and 9.5mm retain) Agitate the sieves by hand for a sufficient period. We performed in a proper sequence (forward & backward motion, left & right motion, clockwise (CW) & counter- clockwise (CCW) motion & frequent jolting) Then we carefully remove the sieves one at a time and weight each sieve deducting the weight of corresponding sieve and determine the weight of each size increment by weighting on a balance to the nearest 0.1% of the total original dry sample weight. The total weight of the material after sieving we checked closely with original weight of sample place on the sieves.



Figure 4. Sieve analysis of coarse aggregate

3.3 Procedure of coarse aggregate sieve analysis

We nest the sieve in order of decreasing size of opening from top to bottom and place the sample 1200gm on top sieve. Agitate the sieves by hand for a sufficient period. We performed in a proper sequence (forward and backward motion, left and right motion, clockwise (CW) and counter-clockwise (CCW) motion and frequent joint). Then we

carefully remove the sieves one at a time and weight each sieve with its retained fine aggregate. Then we calculate the mass of material retained on each sieve deducting the weight of corresponding sieve and determine the weight of each size increment by weighting on a balance to the nearest 0.1% of the total original dry sample weight. The total weight of the material after sieving we checked closely with original weight of sample placed on the sieves.



Figure 5. Sieve analysis of fine aggregate

3.4 Preparation of SCBA

After Collect smooth fiber, soak it in water tank for 24 hours. After soak it 24 hours arise the fiber from the water tank, then cut it in several length.



Figure 6. SCB 75mm



Figure 7. SCB 88.5mm

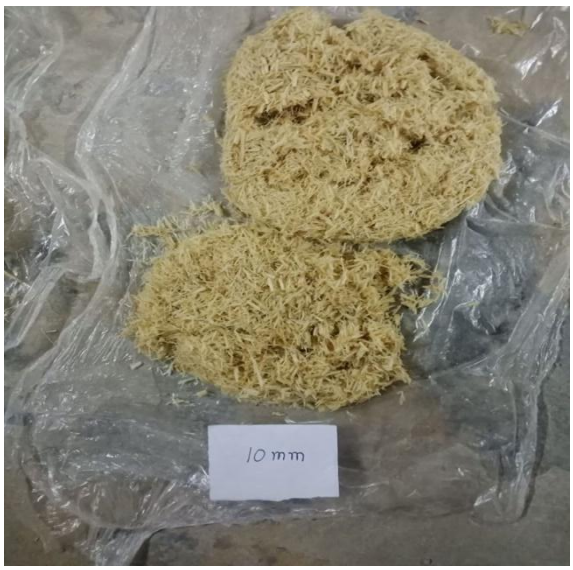


Figure 8. SCB 10mm



Figure 9. SCB 42.5mm

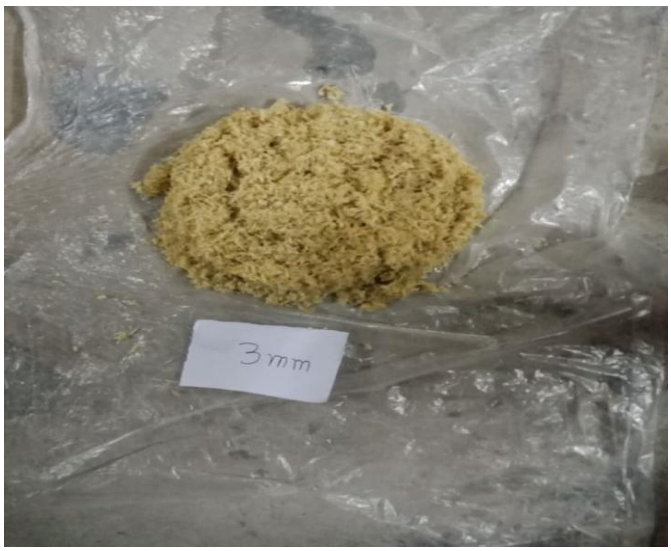


Figure 10. SCB 3.5mm.

3.5 Preparation of Specimen

In concrete specimen, the SCBA was used as a replacement of OPC by 0%, 2%, 5%, 10 and 12%. Concrete was tested for compressive and tensile strength. For this test cylinder dia and hight was 4inc. & height 8 inch. Concrete cylinders were casted. The mix design used for making concrete is given in Table 1. It is to be noted here that no admixture was used in this study.

Table 3. Concrete mix proportion

Binder	Fine Aggregate	Coarse Aggregate	W/C Ratio
1	1.5	3	0.45

3.5.1 Casting of Specimen

After preparation of specimen, then were starting to prepare casting specimen. At first we took a steel sheet on the ground, then we took coarse aggregate (stone) and Fine aggregate (sylhet sand) kept on the steel sheet. Then we added cement and sugarcane fiber with coarse aggregate (stone) and Fine aggregate (sylhet sand). Then we prepared dry concrete mixture by hand mixing. Aggregate cement for both aggregate was kept 1:1.5:3 for previous concrete, aggregate were bonded together with help of cement mixing. Then water is added carefully making sure no water is lost during mixing, while adding water care should be taken to added it in stage so as to prevent bleeding which may affect the strength formation of concrete rising of water required for hydration to the surface. The mix was prepare with cement, coarse aggregate, fine aggregate and water keeping water cement ratio of 0.45 for all mixes. Then we took clean and oiled mould for each category was then placed. Cylinder mould was 4” (100 mm) in diameter and 8” (300 mm) in height. Wet concrete was placed inside mould in three layers with each layer compacted with help of stoned tamping road (16 mm diameter and 650 mm height) 25 times and then placed in the mould for 24 hours.



Figure 11. Mixing Materials



Figure 12. Specimen Cylinder.



Figure 13. Casting Materials of specimen.



Figure 14. Compection by Tamping Rod.

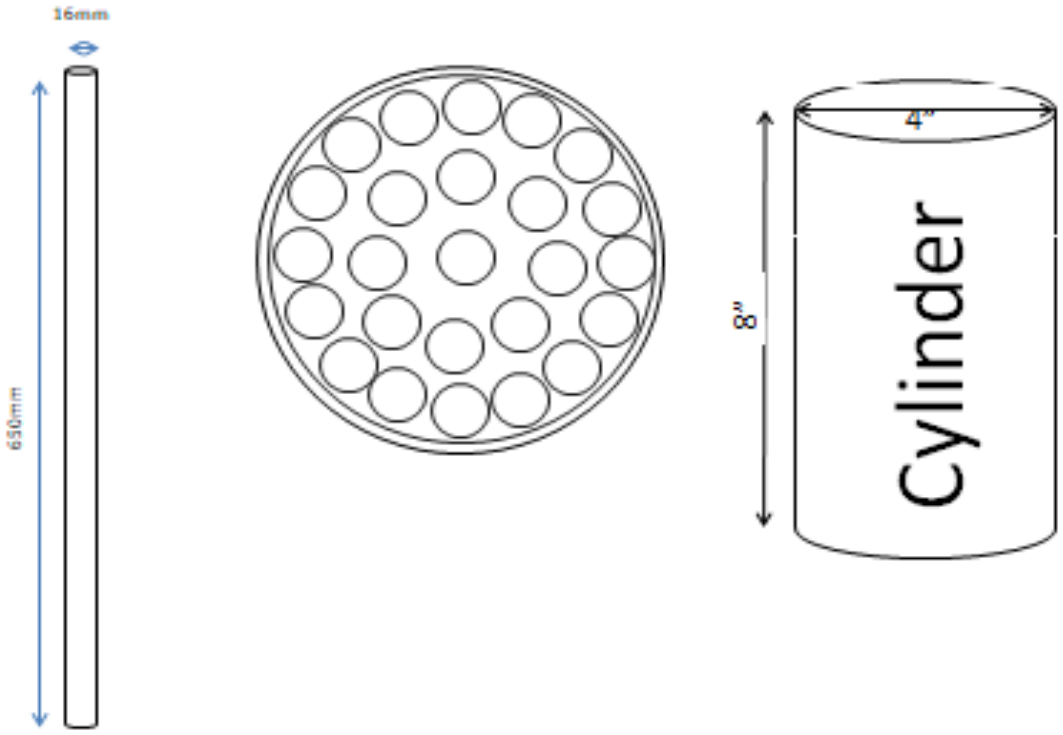


Figure 15. Cross section of cylinder & tamping road



Figure 16. Lebeling Cylinder

3.5.2 Curing of Specimen

After 24 hours the cylinder specimen were remolded and placed inside water tank in room temperature cured according to the ASTM C192 Standard. Specimens were tested on 28 days to determine the compressive strength and tensile strength. Casting date second December 2019.



Figure 17. Curing of specimen.

3.5.3 Loading of specimen

After 28 days curing the cylinder arise from the tank and dry 24 hours.Then curing cylinder specimen to be prepared for the strength test of specimen.



Figure 18. After Curing Cylinder.



Figure 19. Measuring Cylinder Length.



Figure 20. Cylinder weight.



Figure 21. Measuring Diameter.

3.6 Compressive strength test

In this test we took a cylinder of vertical axis and kept on universal testing machine. Then a metal plate install on the cylinder and load applied. In this way we were tested cylinder for compressive strength.



Figure 22. Compressive strength test.



Figure 23. Crushing compressive test

3.7 Tensile Strength Test

For tensile strength test we took a cylinder of horizontal axis and kept on the testing machine. Then install a metal plate over the cylinder and load applied.

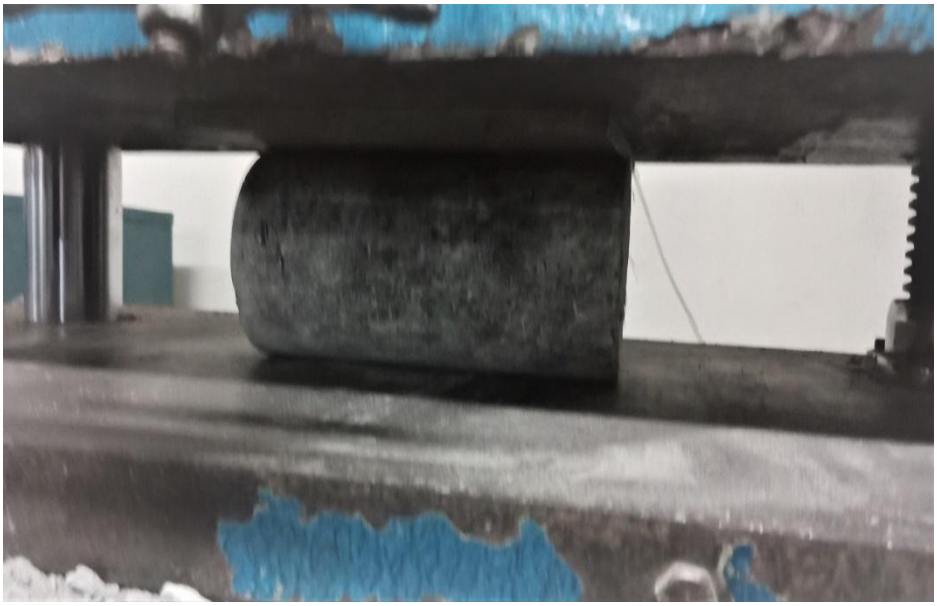


Figure 24. Preparing for Tensile Test of speciment.



Figure 25. Tensile Loaded into the Testing cylinder.

Chapter Four

Collection and Data analysis

4.1 Table Given in Data Analysis.

Table 4. Showing fiber length, percentage and weight.

Case No.	Fiber Length (mm)	Fiber percentage (%)	Fiber weight (gm)
1	0	0	0
2	3.5	5	285.30
3	10	10	570.60
4	42.5	2	114.12
5	42.5	5	285.30
6	42.5	12	684.72
7	75	10	570.60
8	88.5	5	285.30
		Total fiber	2795.94

4.2 Sieve analysis of Coarse Aggregate.

The sieve set was of ¾", 3/8", 4, 8, 16, 30, 50 & 100. Nos. sieve and pan. We took 19.05, 9.5, 4.75, 2.36, 1.19, 0.59, 0.30, 0.15 mm and shacked the retain of sieves were 807, 675, 22, 0, 0, 0, 0 ,0, 14 gm. respectively, and no retaining found on 53.8, 43.8, 1.47, 0, 0, 0, 0, 0, 0.93 # sieve, the sieve analysis data is given in the table no. **4.1**. The FM found form sieve analysis is **8.4582**. Grading curve is given in figure.

Table 5. Data sheet for Corse Aggregate.

Sieve Number	Sieve Opening (mm)	Materials Retained (gm.)	% Material Retained	Cumulative % Retained	Percent finer
¾”	19.05	807	53.8	53.8	46.2
3/8”	9.5	657	43.8	97.6	2.4
4	4.75	22	1.47	99.07	0.93
8	2.36	0	0	99.07	0.93
16	1.19	0	0	99.07	0.93
30	0.59	0	0	99.07	0.93
50	0.30	0	0	99.07	0.93
100	0.15	0	0	99.07	0.93
Pan		14	0.93		
Total				**845.82**	

FM=8.45

4.2.1 Grain Size Distribution

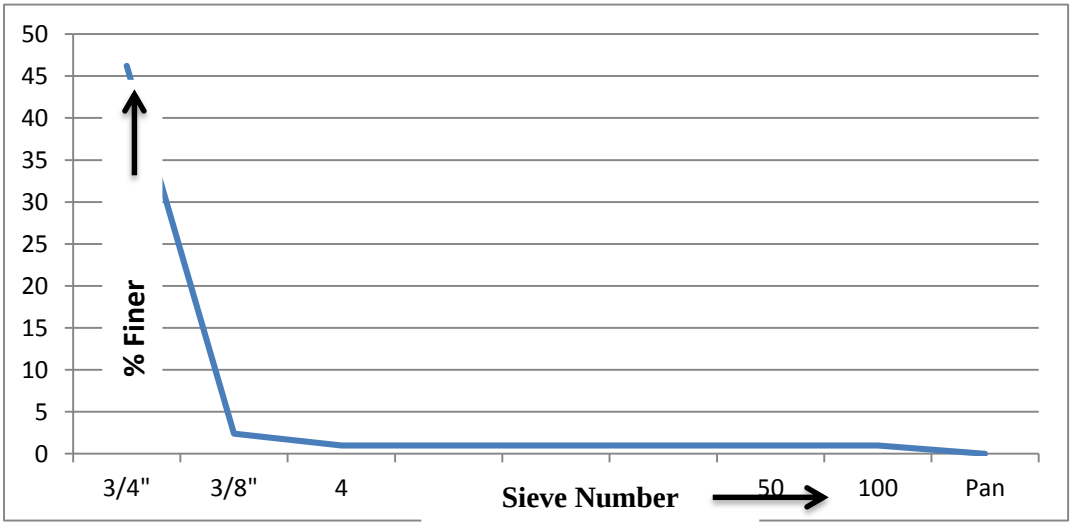


Figure 26. Grain Size Distribution Curve of Coarse aggregate (stone chips)

4.3 Sieve analysis of Fine Aggregate.

The sieve set was of 4, 8, 16, 30, 50 & 100. Nos. sieve and pan. We took 4.74, 2.36, 1.1, 0.59, 0.30, 0.15 mm and shaked the retain of sieves were 0, 93, 331, 366, 303, 88, 19 gm. respectively, and no retaining found on0, 7.75, 27.58, 30.50, 25.25, 7.33, 1.58 # sieve, the sieve analysis data is given in the table no. **4.1**. The FM found form sieve analysis is **2.98.** Grading curve is given in figure.

Table 6. Data sheet for fine Aggregate.

Sieve Number	Sieve Opening	Materials Retained	% Material	Cumulative %	Percent finer
4	4.75	0	0	0	100
8	2.36	93	7.75	7.75	92.25
16	1.1	331	27.58	35.33	64.67
30	0.59	366	30.50	65.83	34.17
50	0.30	303	25.25	91.08	8.92
100	0.15	88	7.3	98.41	1.59
Pan		19	1.58		
Total		1200		298.40	

FM=2.98

4.3.1 Grain Size Distribution

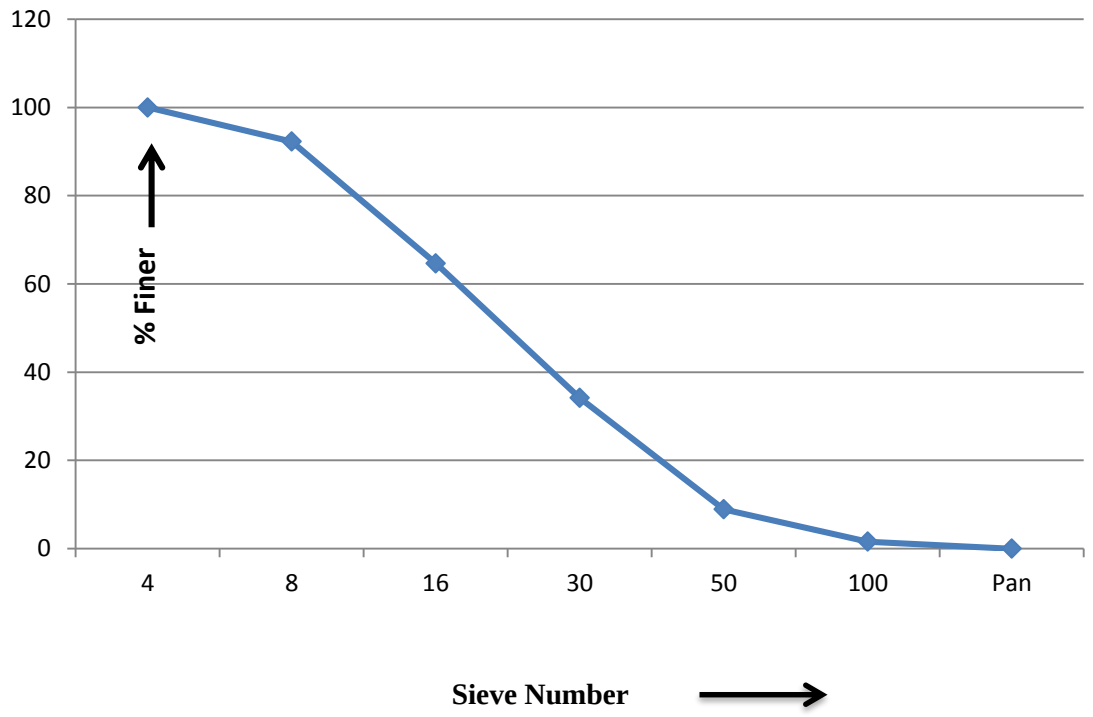


Figure 27. Grain Size Distribution Curve of fine Aggregate (Sylhet sand)

4.4 Data sheet for compressive strength and Tensile strength of 0% fiber and 0mm length.

We prepared three cylinders for fiber length Zero the fiber was taken 0% of the total concrete. Hence fiber weight per cylinder was 0 gm. Load for compression was found **255,253, 257 KN** respectively. It was **73, 70, 76 KN** for tensile loading.

Age 28 days
Specimen area-12.56 in^2
Cement, Sand and Aggregate ratio **1:1.5: 3**

Table 7. Load obtained for compressive strength test cylinder (Fiber length 0 mm, 0%)

General Information		Compressive Strength					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength(KN)
1	0.45	0	103.6	102.9	206	8020.57	255
2			102.6	101.9	205	8144.26	253
3			102.0	102.3	205	8156.91	257

Table 8. Load obtained for Tensile strength test cylinder (Fiber length 0 mm, 0%)

General Information		Tensile Strength					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	0	101.0	102.0	205	8091.56	73
2			101.9	102.4	205	8197.76	70
3			102.1	102.0	203	8174.48	76

4.5 Data sheet for compressive strength and Tensile strength of 5% fiber and 3.5mm length.

We prepared three cylinders for fiber length 3.5mm the fiber was taken 5% of the total concrete. Hence fiber weight per cylinder was **47.55 gm**. Load for compression was found **210, 235, 228 KN** respectively. It was 90, 88, 92 **KN** for tensile loading.

Age 28 days
Specimen area-12.56 in^2
Cement, Sand and Aggregate ratio **1:1.5: 3**

Table 9. Load obtained for compressive strength test cylinder (Fiber length 3.5 mm, 5%)

General Information		**Compressive Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	3.5	101.6	102.3	205	8160.16	210
2			101.3	101.3	203	8061.10	235
3			102.4	101.3	205	8145.87	228

Table 10. Load obtained for tensile strength test cylinder (Fiber length 3.5 mm, 5%)

General Information		**Tensile Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	3.5	101.3	101.1	198	8045.20	90
2			101.1	102.0	203	8102.72	88
3			101.3	101.3	201	8058.71	92

4.6 Data sheet for compressive strength and Tensile strength of 10% fiber and 10mm length

We prepared three cylinders for fiber length **10mm** the fiber was taken 10% of the total concrete. Hence fiber weight per cylinder was **95.1 gm**. Load for compression was found **150, 145, 155 KN** respectively. It was **87, 90, 85 KN** for tensile loading.

Age 28 days

Specimen area-12.56 in^2

Cement, Sand and Aggregate ratio **1:1.5: 3**

Table 11. Load obtained for compressive strength test cylinder (Fiber length 10 mm, 10%)

General Information		**Compressive Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	10	102.7	102.4	204	8258.85	150
2			101.6	102.3	205	8159.35	145
3			101.3	102	206	8117.00	155

Table 12. Load obtained for tensile strength test cylinder (Fiber length 10 mm, 10%)

General Information		**Tensile Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength(KN)
1	0.45	10	101.3	99.5	204	7923.09	87
2			102.4	102.6	201	8255.62	90
3			101.3	102.1	205	8120.21	85

4.7 Data sheet for compressive strength and Tensile strength of 2% fiber and 42.5mm length.

We prepared three cylinders for fiber length 42.5mm the fiber was taken 2% of the total concrete. Hence fiber weight per cylinder was **19.02 gm**. Load for compression was found **180, 178, 182 KN** respectively. It was **120, 123, 117 KN** for tensile loading.

Age 28 days

Specimen area-12.56 in^2

Cement, Sand and Aggregate ratio **1:1.5: 3**

Table 13. Load obtained for compressive strength test cylinder (Fiber length 42.5 mm, 2%)

General Information		**Compressive Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	42.5	101.4	102.1	202	8124.97	180
2			101.3	101.3	202	8058.71	178
3			102.2	101.5	201	8140.96	182

Table 14. Load obtained for tensile strength test cylinder (Fiber length 42.5 mm, 2%)

General Information		**Tensile Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	42.5	101.3	101.3	205	8063.70	120
2			101.2	101.3	203	8058.71	123
3			101.7	101.0	199	8065.17	117

4.8 Data sheet for compressive strength and Tensile strength of 5% fiber and 42.5mm length

We prepared three cylinders for fiber length 42.5mm the fiber was taken 5% of the total concrete. Hence fiber weight per cylinder was **47.55 gm**. Load for compression was found **295, 285, 297 KN** respectively. It was **90, 95, 91 KN** for tensile loading.

Age 28 days

Specimen area-12.56 in^2

Cement, Sand and Aggregate ratio **1:1.5: 3**

Table 15. Load obtained for compressive strength test cylinder (Fiber length 42.5 mm, 5%)

General Information		**Compressive Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	42.5	101.9	100.9	202	8074.00	295
2			101.5	100.8	205	8042.88	285
3			102.4	102.3	205	8223.43	297

Table 16. Load obtained for tensile strength test cylinder (Fiber length 42.5 mm, 5%)

General Information		**Tensile Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	42.5	100.7	101.3	97	8011.14	90
2			101.5	101.5	107	8093.76	95
3			102.7	101.6	90	8198.76	91

4.9 Data sheet for compressive strength and Tensile strength of 12% fiber and 42.5mm length

We prepared three cylinders for fiber length 42.5mm the fiber was taken 12 % of the total concrete. Hence fiber weight per cylinder was **114.12 gm**. Load for compression was found **138, 140, 142 KN** respectively. It was **95, 89, 93 KN** for tensile loading.

Age 28 days

Specimen area-12.56 in^2

Cement, Sand and Aggregate ratio **1:1.5: 3**

Table 17. Load obtained for compressive strength test cylinder (Fiber length 42.5 mm, 12%)

General Information		**Compression Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	42.5	102.3	102.8	205	8267.75	138
2			101.8	100.9	206	8034.90	140
3			101.4	102.1	205	8124.97	142

Table 18. Load obtained for tensile strength test cylinder (Fiber length 42.5 mm, 12%)

General Information		**Tensile Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	42.5	101.2	101.7	204	8081.04	95
2			102.4	101.9	205	8196.97	89
3			102.7	102.6	202	8270.11	93

4.10 Data sheet for compressive strength and Tensile strength of 10% fiber and 75mm length

We prepared three cylinders for fiber length 75mm the fiber was taken 10 % of the total concrete. Hence fiber weight per cylinder was **95.1 gm**. Load for compression was found **85, 82, 88 KN** respectively. It was **95, 89, 93 KN** for tensile loading.

Age 28 days

Specimen area-12.56 in^2

Cement, Sand and Aggregate ratio **1:1.5: 3**

Table 19. Load obtained for compressive strength test cylinder (Fiber length 75 mm, 10%)

General Information		**Compressive Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	75	101.2	101.3	201	8045.19	85
2			101.3	102.0	205	8117.00	82
3			102.1	101.1	205	8105.10	88

Table 20. Load obtained for tensile strength test cylinder (Fiber length 75 mm, 10%)

General Information		**Tensile Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	75	101.0	101.3	200	8033.30	85
2			101.3	101.1	198	8046.00	83
3			101.1	102.0	204	8102.70	87

4.11 Data sheet for compressive strength and Tensile strength of 5% fiber and 88.5mm length

We prepared three cylinders for fiber length 88.5mm the fiber was taken 5 % of the total concrete. Hence fiber weight per cylinder was **47.55 gm**. Load for compression was found **135, 132, 138 KN** respectively. It was **92, 90, 94 KN** for tensile loading.

Age 28 days

Specimen area-12.56 in^2

Cement, Sand and Aggregate ratio **1:1.5: 3**

Table 21. Load obtained for compressive strength test cylinder (Fiber length 88.5 mm, 5%)

General Information		**Compressive Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	88.5	103.6	102.9	205	8373.70	135
2			102.6	101.9	207	8213.87	132
3			102.0	102.3	203	8198.54	138

Table 22. Load obtained for tensile strength test cylinder (Fiber length 88.5 mm, 5%)

General Information		**Tensile Strength**					
Specimen Nos.	W/C Ratio	Fiber Length (mm)	Cylinder Dia		Height (mm)	Average Cross section Area (mm^2)	Load for Compressive Strength (KN)
1	0.45	88.5	101.3	102.9	205	8185.00	92
2			100.1	101.6	204	7992.47	90
3			101.1	102.3	205	8126.77	94

Chapter Five

Result and Discussion

5.1 Result analysis:

The compressive and tensile strength result are presented in table 21 and 22 .We prepared three cylinder for fiber length 0mm, the fiber was taken 0% of the total concrete. Hence fiber weight per calendar was 0 gm load for compression was 85, 82, 88 Mpa respectively. It was 85, 83, 87 Mpa for tensile loading. We used 0.45 W/C ratio, the average compressive strength was 31.45 Mpa and tensile strength 8.95 Mpa.

Table 23. Result obtained for average compressive strength test cylinder (Fiber length 0mm, 0%)

Fiber Length	Fiber Percentage	Load for Compressive Strength (KN)	Average Cross Sectional Area	Compressive Strength Test (Mpa)	Average strengthTest (Mpa)
0mm	0%	255	8020.57	31.79	31.45
		253	8144.26	31.06	
		257	8156.91	31.51	

Table 24. Result obtained for average tensile strength test cylinder (Fiber length 0mm, 0%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile Strength Test (Mpa)	Average strength Test (Mpa)
0mm	0%	73	8091.56	9.02	8.95
		70	8197.76	8.54	
		76	8174.48	9.29	

The compressive and tensile strength result are presented in table 24 and 25. We prepared three cylinder for fiber length 3.5mm,the fiber was taken 5% of the total concrete. Hence fiber weight per calendar was 0 gm load for compression was 210,235,228 Mpa respectively. It was 90,88,85 Mpa for tensile loading. We used 0.45 W/C ratio, the average compressive strength was 27.62 Mpa and tensile strength 11.15 Mpa.

Table 25. Result obtained for average compressive strength test cylinder (Fiber length 3.5mm, 5%)

Fiber Length	Fiber Percentage	Load for Compressive Strength (KN)	Average Cross Sectional Area	Compressive Strength Test (Mpa)	Average strength Test (Mpa)
3.5mm	5%	210	8160.16	25.73	27.62
		235	8061.1	29.15	
		228	8145.87	27.98	

Table 26. Result obtained for average tensile strength test cylinder (Fiber length 3.5mm, 5%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile Strength Test (Mpa)	Average strength Test (Mpa)
3.5mm	5%	90	8045.2	11.18	11.15
		88	8102.72	10.86	
		85	8058.71	11.42	

The compressive and tensile strength result are presented in table 25 and 26.We prepared three cylinders for fiber length 10 mm, the fiber was taken 10% of the total concrete. Hence fiber weight per calendar was 0 gm load for compression was 150,145,155 Mpa respectively. It was 90, 87, 85 Mpa for tensile loading. We used 0.45 W/C ratio, the average compressive strength was 18.34 Mpa and tensile strength 10.78 Mpa

Table 27. Result obtained for average compressive strength test cylinder (Fiber length 10mm, 10%)

Fiber Length	Fiber Percentage	Load for Compressive Strength (KN)	Average Cross Sectional Area	Compressive Strength Test (Mpa)	Average strength Test (Mpa)
10mm	10%	150	8258.85	18.16	18.34
		145	8159.35	17.77	
		155	8117	19.09	

Table 28. Result obtained for average tensile strength test cylinder (Fiber length 10mm, 10%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile StrengthTest (Mpa)	Average strength Test (Mpa)
10mm	10%	87	7923.09	10.98	10.78
		90	8255.62	10.9	
		85	8120.21	10.47	

The compressive and tensile strength result are presented in table 27 and 28. We prepared three cylinder for fiber length 42.5 mm, the fiber was taken 2% of the total concrete. Hence fiber weight per calendar was 0 gm load for compression was 180,178,182 Mpa respectively. It was 120,123,117 Mpa for tensile loading. We used 0.45 W/C ratio, the average compressive strength was 22.20 Mpa and tensile strength 14.88 Mpa.

Table 29. Result obtained for average compressive strength test cylinder (Fiber length 42.5mm, 2%)

Fiber Length	Fiber Percentage	Load for Compressive Strength (KN)	Average Cross Sectional Area	Compressive Strength Test (Mpa)	Average strength Test (Mpa)
42.5mm	2%	180	8124.97	22.15	22.20
		178	8058.71	22.09	
		182	8140.96	22.36	

Table 30. Result obtained for average tensile strength test cylinder (Fiber length 42.5mm, 2%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile Strength Test (Mpa)	Average strengthTest (Mpa)
42.5mm	2%	120	8062.7	14.88	14.88
		123	8058.71	15.26	
		117	8065.17	14.51	

The compressive and tensile strength result are presented in table 29 and 30. We prepared three cylinder for fiber length 42.5 mm, the fiber was taken 5% of the total concrete. Hence fiber weight per calendar was 0 gm load for compression was 295, 285, 297 Mpa respectively. It was 90, 95, 91Mpa for tensile loading. We used 0.45 W/C ratio, the average compressive strength was 36.02 Mpa and tensile strength 11.35 Mpa

Table 31. Result obtained for average compressive strength test cylinder (Fiber length 42.5mm, 5%)

Fiber Length	Fiber Percentage	Load for Compressive Strength (KN)	Average Cross Sectional Area	Compressive Strength Test (Mpa)	Average strength Test (Mpa)
42.5mm	5%	295	8074	36.53	36.02
		285	8042.88	35.43	
		297	8223.43	36.1	

Table 32. Result obtained for average tensile strength test cylinder (Fiber length 42.5mm, 5%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile Strength Test (Mpa)	Average strength Test (Mpa)
42.5mm	5%	90	8011.14	11.23	11.35
		95	8093.76	11.73	
		91	8198.76	11.09	

The compressive and tensile strength result are presented in table 31 and 32. We prepared three cylinder for fiber length 42.5 mm, the fiber was taken 12% of the total concrete. Hence fiber weight per calendar was 0 gm load for compression was 138,140,142 Mpa respectively. It was 95,89,93 Mpa for tensile loading. We used 0.45 W/C ratio, the average compressive strength was 17.20 Mpa and tensile strength 11.28 Mpa

Table (33): Result obtained for average compressive strength test cylinder (Fiber length 42.5mm, 12%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile Strength Test (Mpa)	Average strength Test (Mpa)
42.5mm	12%	138	8267.75	16.7	17.20
		140	8034.9	17.42	
		142	8124.97	17.47	

Table 34. Result obtained for average tensile strength test cylinder (Fiber length 42.5mm, 12%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile Strength Test (Mpa)	Average strength Test (Mpa)
42.5mm	12%	95	8081.04	11.75	11.28
		89	8196.97	10.85	
		93	8270.11	11.24	

The compressive and tensile strength result are presented in table 33 and 34. We prepared three cylinder for fiber length 75 mm, the fiber was taken 10% of the total concrete. Hence fiber weight per calendar was 0 gm load for compression was 85, 82, 88 Mpa respectively. It was 85, 83, 87 Mpa for tensile loading. We used 0.45 W/C ratio, the average compressive strength was 10.51 Mpa and tensile strength 10.55 Mpa.

Table 35. Result obtained for average Compressive strength test cylinder (Fiber length 75mm, 10%)

Fiber Length	Fiber Percentage	Load for Compressive Strength (KN)	Average Cross Sectional Area	Compressive Strength Test (Mpa)	Average strength Test (Mpa)
75mm	10%	85	8945.19	10.56	10.51
		82	8117	10.1	
		88	8105.1	10.86	

Table 36. Result obtained for average tensile strength test cylinder (Fiber length 75mm, 10%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile Strength Test (Mpa)	Average strength Test (Mpa)
75mm	10%	85	8033.3	10.58	10.55
		83	8046	10.32	
		87	8102.7	10.74	

The compressive and tensile strength result are presented in table35 and 36. We prepared three cylinder for fiber length 88.5 mm, the fiber was taken 5% of the total concrete. Hence fiber weight per calendar was 0 gm load for compression was 135,132,138 Mpa respectively. It was 92, 90, 94 Mpa for tensile loading. We used 0.45 W/C ratio, the average compressive strength was 16.34 Mpa and tensile strength 11.36 Mpa.

Table 37. Result obtained for average compressive strength test cylinder (Fiber length 88.5mm, 5%)

Fiber Length	Fiber Percentage	Load for Compressive Strength (KN)	Average Cross Sectional Area	Compressive Strength Test (Mpa)	Average strength Test (Mpa)
88.5mm	5%	135	8373.7	16.12	16.34
		132	8213.87	16.07	
		138	8198.54	16.83	

Table 38. Result obtained for average tensile strength test cylinder (Fiber length 88.5mm, 5%)

Fiber Length	Fiber Percentage	Load for Tensile Strength (KN)	Average Cross Sectional Area	Tensile Strength Test (Mpa)	Average strength Test (Mpa)
88.5mm	5%	92	8185	11.24	11.36
		90	7992.47	11.26	
		94	8126.77	11.57	

5.2 Result Compering with C.F.R.C. with compressive strength

Table 39. Showing S.F.R.C. result comparing with C.F.R.C. compressive strength

Fiber Length(mm)	Percentage (%)	Sugarcane fiber Compressive strength	Coconut Fiber Compressive strength	Remarks
3.5	5	27.62	18.15	Satisfied
10	10	18.34	9.41	Satisfied
42.5	2	22.2	26.53	Not Satisfied
42.5	5	36.02	14.05	Satisfied
42.5	12	17.2	7.88	Satisfied
75	10	10.51	12.14	Not Satisfied
88.5	5	16.45	16.06	Satisfied

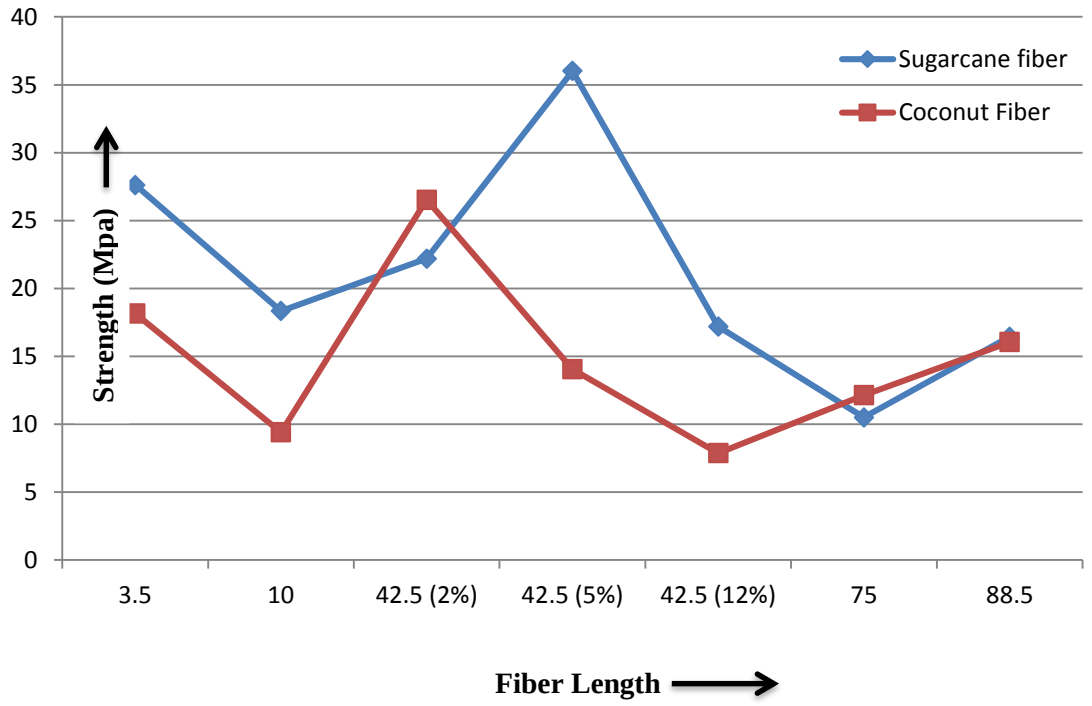


Figure 28. Comparing with S.F.R.C and C.F.R.C Compressive strength.

5.3 Result Compering with C.F.R Concrete with Tensile strength

Table 40. Showing S.F.R.C. result comparing with C.F.R.C. tensile strength

Fiber Length(mm)	Percentage (%)	Sugarcane fiber Compressive strength	Coconut Fiber Compressive strength	Remarks
3.5	5	11.15	5.42	Satisfied
10	10	10.78	5.13	Satisfied
42.5	2	10.51	4.79	Satisfied
42.5	5	11.35	4.57	Satisfied
42.5	12	11.28	2.96	Satisfied
75	10	10.55	3.67	Satisfied
88.5	5	11.36	5.97	Satisfied

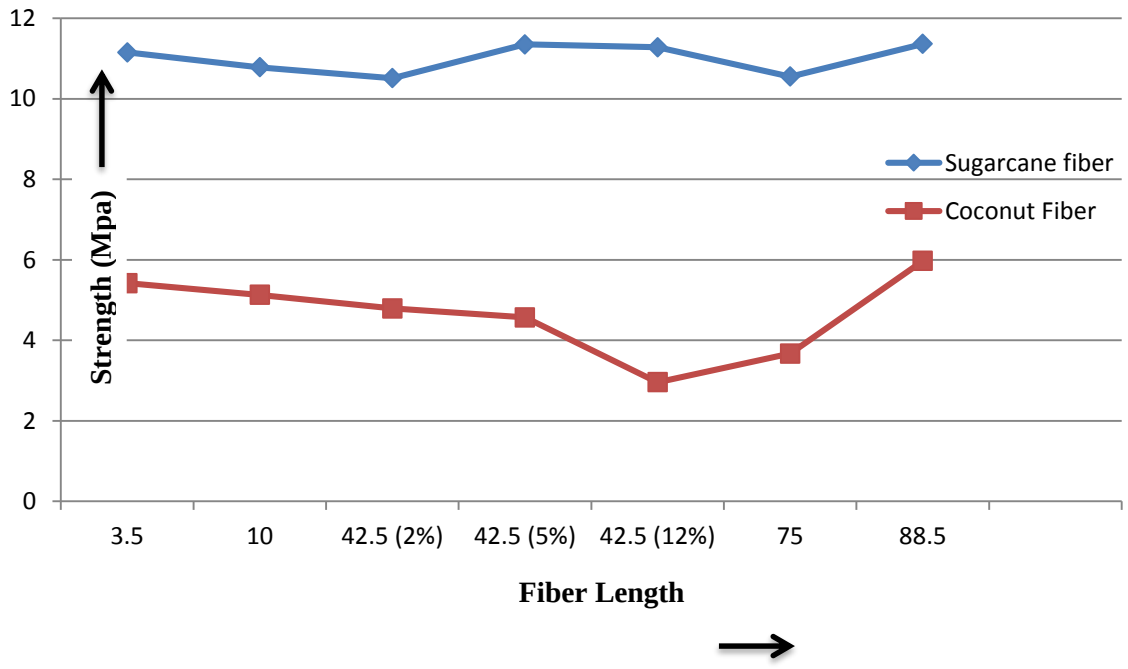


Figure 29. Comparing with S.F.R.C and C.F.R.C Tensile strength.

Chapter Six

Conclusion and Recommendation

6.1 Conclusion

A large amount of Sugar cane waste is disposed of in landfills each year. That not only poses economic and environmental problems to the society but also represents a severe waste of resources. Although the environmental awareness of the general public has increased significantly in recent years, still their willingness to actively participate in waste reduction by recycling needs to be enhanced. Fiber recycling technologies, usage and range of application of recycled fibers described in this paper will become a handy tool to assimilate the waste as value added product, which waste was earlier considered as garbage and sold unduly. So people those are impetuous for waste disposal would think rationally about the rejuvenation of waste fibers for raise the profit for their firm and also it reflects noble cause for society by reducing the contamination in environment.

Tests carried out and conductive to understand the fiber concrete such as compressive strength, Tensile strength, Fitness modulus, made from recycled fiber concrete. The tests ware done conforming to all the standards of ASTM. The properties of fiber concrete ware compared to that of compressive strength test and tensile strength test. At the end of end of all successful tests and analysis describe above, the following conclusion can be drown out.

Based on the laboratory investigations, it was observed that, the fineness modulus of fine aggregate was 2.98 and the F.M of course Aggregate was 8.45.

Fiber Reinforcement aggregate concrete achieved maximum compressive strength 31.45 Mpa and tensile strength 8.95 Mpa (When Fiber Length was 0 mm, 0%). Fiber Reinforcement aggregate concrete achieved maximum compressive strength 22.2 Mpa and tensile strength10.51 Mpa (When Fiber Length was 42.5 mm and 2%). Fiber Reinforcement aggregate concrete achieved maximum compressive strength 36.02 Mpa and tensile strength 11.35 Mpa (When Fiber Length was 42.5 mm, and 5%).

When fiber length was 42.5 mm, 12% we get compressive strength was 17.2 Mpa and tensile strength was 11.28 Mpa.

When the fiber length was 3.5, 10, 75 and 88.5 mm and the percentage was 5, 10, 10 and 5%. The compressive strength was found 27.62, 18.34, 10.51 and 16.45 Mpa and the tensile strength was found 11.15, 10.78, 10.55, and 11.36 Mpa. In this work water cement ratio was 0.45, cement, sand and aggregate ratio was 1:1.5:3 and at the age of 28 days.

6.2. Recommendation:-

1. Others natural fiber can be tested for research work (etg: Glass Fiber, Cardboard Fiber, Cotton Fiber, Jute Fiber etc.).
2. In future, more batches of different mix to ensure a wide range of compressive strength and tensile strength should be tested.
3. In this research work we used stone chips as coarse aggregates and sylhet sand as fine aggregates. We recommended used of brick chips as coarse aggregates and local sand as fine aggregates and study the behavior.
4. Use proper w\c ratio for concrete mixing not, not lower or higher. And must be following the maximum duration of curing.
5. The environment effect of SFC could be studied.
6. Use of some admixture for further experiment may be done.
7. Should be economically low cost.

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