Mechanical Properties of Glass Fibre Reinforced Concrete using Jhama Bricks as Fine Aggregate Replacement

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Abstract: Fibre Reinforced Concrete (FRC) is a composite or a complex material comprising of mixtures of cement, fine aggregates and coarse aggregates and distinct, discontinuous, uniformly dispersed suitable fibres such as natural fibres, artificial fibres, used in civil engineering field and other applications. Fibre is a tiny piece of reinforcing materials holding definite characteristics properties. Fibres may be circular or flat. Conventional concrete has poor tensile strength so its capacity to absorb energy is limited. By strengthening the cement concrete matrix with reinforcing fibrous materials, the weakness in the tension zone can be overcome. Compressive strength, Tensile strength, flexural strength of the materials can improve by usage of fibres in concrete. The concrete is permeable and the porosity is owed to water-void sand air-voids. Due to presence of voids naturally strength of the concrete reduces. The addition of Glass fibres to the cement concrete matrix gradually increases the strength. GFRC is having advantage of being lightweight and thereby the overall cost of construction is reduced, ultimately it brings economy in construction. The addition of Glass fibres and Jhama powder to the cement concrete matrix gradually increases the strength. GFRC is having advantage of being light weight and thereby the overall cost of construction is reduced, ultimately it brings economy in construction. The alternative material can be used as partial or fully replacement of the conventional material. In this research we use the Jhama Brick Dust as an alternative material for the fine aggregate. Here we use the Jhama Brick Dust as partial replacement of the sand from 40% The various tests are carried out such as Compressive, Strength, Flexure Strength and Split Tensile Test at an age of 7 and 28 days of curing. Here the Grade of the concrete is M30 and the mix design is carried out as per IS provision the main purpose of this research is to use the waste material for making the concrete. Here we are using Glass fibre at 0%, 0.5%, 1%, 1.5%, 2% 2.5% and we use the Jhama Brick Dust at 40% as alternative material for fine aggregate.

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1. Introduction

The cement concrete is a well-known construction material in the civil engineering field and under environmental factors the cement concrete has a many desired properties like high compressive strength, stiffness and durability. We knowthat the concrete is brittle and possess a very low tensile strength. It is having widespread application and it gives strength at a comparative low cost. Concrete has some drawbacks like low post cracking capacity, low tensile strength, a low strain at facture, low impact strength, low ductility and brittleness and limited fatigue life. From many researches it has been shown that, reinforcing concrete in tensile one or in both zones can yield a composite of good compressive and tensile strength. But in order to obtain ductility and durability the cracks should be minimize. The presence of cracks is the main reason for dimness of cement concrete. The weakness of cement concrete can be taken out by the addition of fibres such as Natural fibres: coconut coir fibres, Vegetable fibres, Cotton fibres etc., and Artificial fibres: Carbon fibres, polymer fibres, Steel fibres, Glass fibres, Polypropylene fibres etc., in the concrete mixture. It attributes to fact that minimizes the mass of micro- cracks into macro-cracks and subsequently the tensile strength and flexural strength of concrete matrix increases. Such a concrete is called as fibre-reinforced concrete (FRC). FRC is a composite or a complex material consists of a matrix of a randomly distributed or dispersed small, either artificial or natural fibres, exhibits a high tensile strength. The cracking strength of concrete increased due to the presence of natural or artificial fibres which is uniformly distributed and dispersed. Fibres also act as a “Crack arresters”.

Hence conservation of the naturally available material is very important. Since the construction activities cannot be diminished. There is only way to search the alternative material which replaced partially or fully naturally available material. Jhama Brick Dust is such an alternative material which can be effectively being used in construction as partial replacement of natural sand. This is a waste product obtain while processing Jhama Brick Aggregate. Jhama Brick Aggregate is used where the stone is not available or it is costly. Various studies were carried out in which the Jhama Brick pieces are used as coarse aggregate. This brick is also known as 4th class brick.

The main aim of this work is to use the waste material and save the naturally available material. This work is helpful where the sand is not easily available or if available its cost is high. All materials are used in this work are locally available.

1.1Fibre Reinforced Concrete

Fibre reinforced concrete (FRC) is a composite or a complex material comprising of mixture of concrete mortar or cement mortar with discrete, discontinuous, uniformly dispersed appropriate fibres. When concrete is reinforced with any random dispersed fibres, positive behavior of repeated loads can be witnessed. The adding of fibre to the concrete makes its components tough and ductile. Already many type of fibres been used in concrete but not all the fibres can be used efficiently and economically. Each and every type of fibres has its own properties and boundaries. Addition of fibres into cement concrete not only improves the tensile and flexural strength but also minimizes the cracks. The characteristics like toughness and impact resistance can be improved by adding of fibres to the concrete have been show. The principle of fibre reinforced concrete

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(FRC) is when the body undergoes loading which consists of fibres where the surrounding matrix embedded; the fibre contributes capacity of the body to carry the load when the load is transmitted through the fibre ends. The fibre reinforced matrix is essential to full fill the following functions.

a. The load transfer generally rises as a result of different physical properties of the fibre and matrix. The incorporation of fibre into brittle cement matrix increases the fracture toughness of the compound by crack arresting process. As fibre have large value of failure strains, they give up extensibility in composite problems.

b. To bind the matrix together and safe guard their surfaces from destruction during the handling, fabrication and service life of the composite.

FRC has been in use for ages. Though technology is improved there is a redevelopment-taking place in technology in the modern world. It has improved significantly by not taking much time. Not only it has shown positive approach in other fields but also it has given considerable amount of success in the field of construction technique. Way back in early ages say Before Christ (BC) about 5000 years ago the Egyptians used to use straw pipes as reinforcement in the mud bricks. Horsehairs were used in mortar for making clay pots. Then during the 19th century asbestos were used as fibers in concrete. The advancement and research on fibre- reinforced concert began during 1950's. During the usage of asbestos as a fibre in the 1950's, it had come to notice that the asbestos would lead to poor health issues. New fibers were introduced in the 1960's, such as steel fibers, polypropylene fibers, synthetic fibers as a replacement to asbestos fibres. The detailed and developmental works was carried out on fibers started in the year 1970's. Then during the coming years the certified procedures were done on the use of fibers as reinforcement in concrete. In 20th century the fibers were a boon to the field of construction engineering to gain structural up gradation. It would be the greatest attainment and the researches into use of new techniques for different fibers as a reinforcement material continued till date.

1.2 Aspect ratio of fibre

The aspect ratio is well-defined as the difference or ratio of length to its diameter of the fibre. Typically aspect ratio ranges from 30 to 150. It has been noticed that aspect ratio up to 75, increases the ultimate strength of the concrete. This is another important factor, which affect the behavior and properties of the concrete. The fibre is generally expressed by an adaptable parameter known as "Aspect ratio". In my present research work I have considered the aspect ratio of the glass fibre is 857.

1.3 Types of Fibres

From many decades Fibres are used in construction industry as a productive material. Fibres are tiny piece of reinforcing material having diverse specific properties. The Fibres may be circular or flat, which is regularly termed by a parameter known as aspect ratio which is well-defined by its length to diameter ratio. Fibre standard aspect ratio generally ranges from 30 to 150. Fibres can be broadly classified into two types:

Natural Fibres

Artificial Fibres

a. Metal or hard fibres

b. Non-metal or soft fibres

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1.4 Natural Fibres

Fibres are hair-like constituents that are continuous strands or discontinuous or in distinct extended pieces, like pieces of thread. Fibres can be used as component of composite materials. The first indication for humans using fibres is the discovery of wool and dyed flax fibres initiated in an ancient cave in the Republic of Georgia that age back to 36000 BP. The natural fibre consists of plant fibre, animal fibre and a man-made fibre comprises of Synthetic fibres and regenerated fibres. Natural fibres also can be used as matted into sheets to create products like felt or paper. Some of the Natural fibres used in the reinforced concrete are Cotton, Coir (Coconut fibre) and Vegetable fibres.

1.4.1 Cotton fibre

Cotton fibre which is shown in figure 1.1 is the utmost vital fibres used in the textile industries world-wide. Cutting of fibre is highly labor-intensive, and on huge scale is regularly supported out by machine in some countries cutting is carried out by hands this picked is known as Cotton Wool is baled. In association with other natural fibres cotton fibres are weak. The cotton fibres can saturate up to 20% of its dry weight, without sense wet and it is a good conductor of heat. Clothes, carpets, blankets, medical cotton wool and mobs can be manufactured by cotton.

Figure 1.1 Cotton Fibre

1.4.2 Coir (Coconut fibre)

Coir as shown in figure 1.2 is found from the shell of the fruit of the coconut palm.

The coconut trees will grow up to the height of 20m, making harvesting a difficult job. To pick the nuts from the tree trained monkeys or people climb the tree, or a stick by an attached knife is used. The picked coconuts are de-husked with on a spine and later retting, the fibres are extracted after the husk was done with beating and washing. The coconut fibres are durable, weight less and effortlessly bear heat and salt water. Later 9-10 months of evolution, the nuts are quiet green in color and it contains white fibre, this can be used for manufacture of rope, yarn and fishing nets. Next 12-13 months of evolution, the fibres are brown in color and this can be used for brushes and beds.

Figure 1.2 Coir Fibre

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1.4.3 Vegetable Fibres

Vegetable fibres as shown in figure 1.3 are derived from plants. They are classified according to their source in plants as leaf, bast, or seed-hair. The fibres in leaf and bast will provide strength and support to plant structure. Vegetable fibres are usually stiffer but less tough than synthetic fibres. The bast fibres are flax, jute, and hemp. The leaf fibres are abaca and sisal. Vegetable fibres are graded according to color, luster, strength, fineness, cleanliness and uniformity.

Figure 1.3 Vegetable fibre

1.5 Artificial Fibres

Artificial fibres or synthetic fibres are the outcome of wide investigation by scientists to progress on naturally arising animal and plant fibres. Synthetic fibres are produced by imposing, regularly over extrusion, fibre developing materials over holes into the air and water making a thread. Earlier synthetic fibres were advanced; artificially manufactured fibres were finished from polymers got from petro chemicals. This fibre is termed synthetic fibres and also known as artificial fibres. Several artificial fibres used in the reinforced concrete are Carbon fibres, Polymer fibres, Steel fibres and Glass fibres. The fibers made of any metal fibres with lower carbon steel, galvanized iron, aluminum and steel are known to be metal or hard fibers. Most commonly used metallic fibre is steel fibers. Steel fibers have good physical properties.

1.5.1 Steel Fibres

Steel fibres are the most frequently used fibres. Steel fibres have higher tensile strength. Steel fibres added into the concrete to improve the crack resistance capability of the concrete. Less labor is required. Less construction time is required. It leads to increase in many properties related to cracking which are ductility, toughness, thermal loading, and the resistance to impact and energy absorption. Some of the steel fibre types are straight slit steel fibres, hooked end steel fibres, Paddled steel fibres and crimped steel fibres as shown in the figure 1.4, 1.5, 1.6 and 1.7.

Some of the Various Steel fibres are:

a) Straight Slit Steel fibre

b) Hooked End Steel fibre

c) Paddled Steel fibre

d) Crimped Steel fibre.

Figure 1.4 Straight Slit Steel fibre

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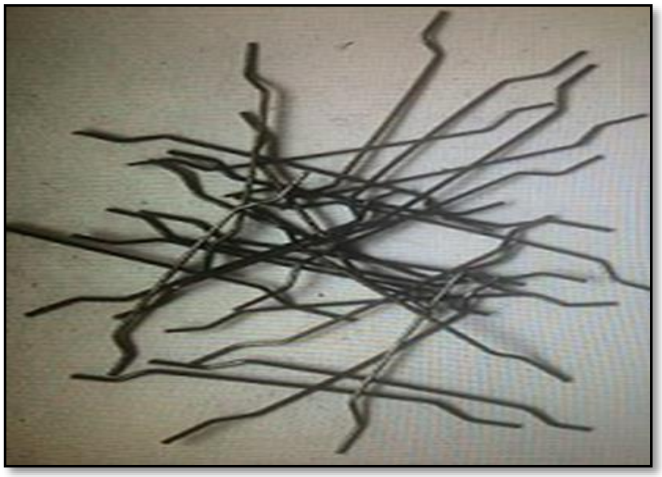

Figure 1.5 Hooked End Steel fibre

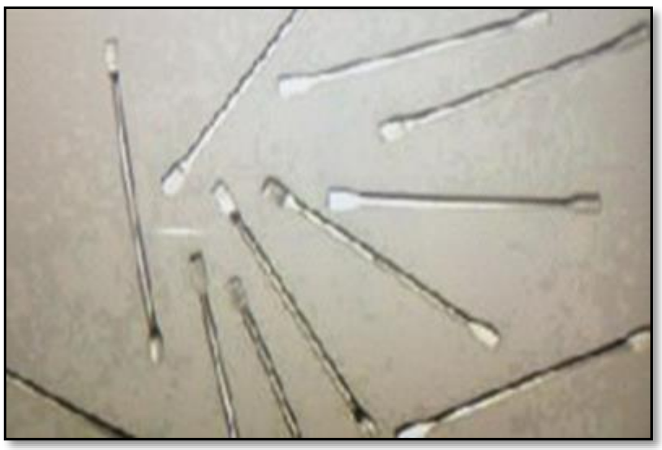

Figure 1.6 Paddled Steel fibre

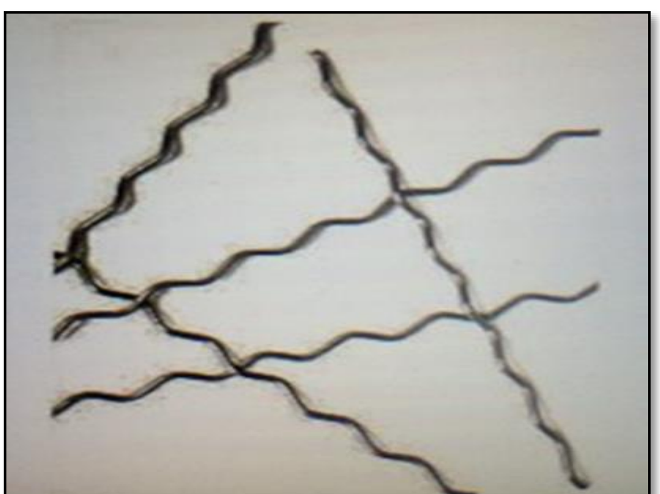

Figure 1.7 Crimped Steel fibre

1.5.2 Aluminum Fibres

Fibre such as aluminum fibre as shown in figure 1.8 are having less weight which is an advantage but at the same time it has a higher cost rate which is a disadvantage. Aluminum fibers are not in use due to some of their own limitations**.**

Figure 1.8 Aluminum fibres

1.5.3 Non-metal or soft fibres

Some of the Non-metal or soft fibers used are asbestos as shown in figure 1.9, glass fibers, carbon fibers, nylon fibers, polypropylene fibers, acrylic fibers, etc. They will have their own physical and chemical properties. These kinds of fires are used under necessary conditions.

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Figure 1.9 Asbestos

1.5.4 CARBON FIBRES

Carbon Fibre-reinforced plastic (CFP) or Carbon Fibre-reinforced polymer (CFRP) as shown in figure 1.10 is an enormously durable. Carbon fibres are costly to produce but whenever high strength-to-weight ratio and stiffness are essential will be used in aerospace, locomotive and in the field of civil engineering to increase the technical applications.

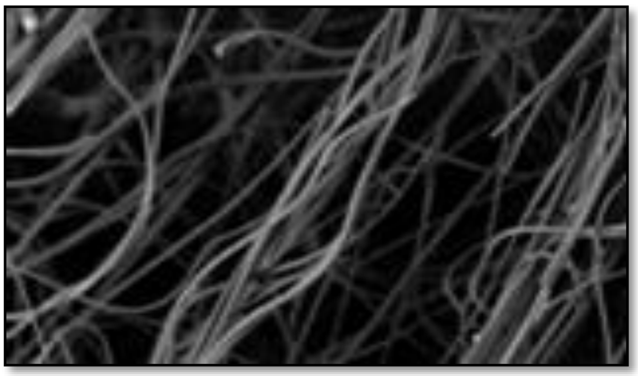

Figure 1.10 Carbon fibres

1.5.5 Polymer Fibres

The polymers fibres as shown in figure 1.1 are man-made fibres are produced from chemical mixtures. The polymer fibres are manufactured from whose chemical arrangement, assembly, and properties are knowingly improved during the whole process. Some of the polymers found man-made fibres are the similar to compounds that make up plastics, surface coatings, rubbers and adhesives.

Figure 1.11 Polymer fibres

1.5.6 Polypropylene Fibres

Polypropylene fibre as shown in figure 1.12 is the lightest of all fibres and is even lighter than water. The specific gravity of these fibres is 0.90 – 0.91 gm/cm3. Polypropylene fibres are low in thermal conductivity of any natural or synthetic fibre. Polypropylene fibres are not attacked by bacteria and are inherently resistant to the growth of bacteria. The polypropylene fibres are recyclable and ecologically friendly. Polypropylene fibres are uniformly dispersed in concrete matrix as millions of fibres in cubic meter to reduce the crack settlements. They reduce honeycombing, bleeding and corrosion of reinforcement.

Figure 1.12 Polypropylene Fibre

1.5.7 Glass Fibres

Glass fibre as shown in a figure 1.13 is a complex material comprising of several finely chopped fibres of glass. Glass wool is one of the products called “fibre glass”; it was created in the year 1932-1933 by Russell Games Slayter of Owens-Corning, as a material to be used as thermal building insulation. Glass fibre has unevenly similar mechanical properties to other artificial or non-metallic fibres like carbon fibres and polymer

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fibres. Glass fibres are found in constant or chopped lengths. Lengths of fibres are up to 35mm is used in applications like spray and 25mm lengths in applications like premix. The Glass fibres ensure benefits like Excellent workability, Homogeneous mix, indistinguishable on the completed surface, glass fibres ensures no rust, Glass fibres controls and stoppage the cracking in fresh concrete, it is very active at very small dosage, Glass fibres are nontoxic, easy to handle and safe.

Figure 1.13 Glass fibre

- In the present work the study conducted glass fibre reinforced concrete (GFRC) and the specimen casted and tested to know the mechanical properties of GFRC for various percentages of Glass Fibres.
- In the present research work the glass fibres here used are of AE-Glass: ANTI-CRAK HD – sliced filaments for plastic shrinkage control with fibre length of 12mm, filament diameter of 14microns, modulus of elasticity 72Gpa, specific gravity is 2.68 and the aspect ratio of 857: 1. The 212 million is the numbers of fibres which present per kg.

1.6 JHAMA BRICK

Bricks that are versatile and durable building and construction material with good load bearing properties. The Bricks are burnt up to temperature of 800-900 degree centigrade in the brick Kiln. If the temperature in the brick kiln is uncontrolled then the bricks are burnt excessively up to the temperature 1100-1200 degree centigrade. These bricks are also known as Jhama bricks.

Literature Survey

Kavita Kene, et al.(2015); Conducted experimental study on behavior of steel and glass Fiber Reinforced Concrete Composites. The study conducted on Fiber Reinforced concrete with steel fibers of 0% and 0.5% volume fraction and alkali resistant glass
fibers containing 0% and 25% by weight of cement of 12 mm cut length, compared the result.

G. Jyothi Kumari, et al.(2013); Studied behavior of concrete beams reinforced with glass fiber reinforced polymer flats and observed that beams with silica coated Glass fiber reinforced polymer (GFRP) flats shear reinforcement have shown failure at higher loads. Further they observed that GFRP flats as shear reinforcement exhibit fairly good ductility. The strength of the composites, flats or bars depends upon the fiber orientation and fiber to matrix ratio while higher the fiber content higher the higher the tensile strength.

Yogesh Murthy, et al.(2014); Studied the performance of Glass Fiber Reinforced Concrete. The study revealed that the use of glass fiber in concrete not only improves the properties of concrete and a small cost cutting but also provide easy outlet to dispose the glass as environmental waste from the industry. From the study it could be revealed that the flexural strength of the beam with 1.5% glass fiber shows almost 30% increase

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in the strength. The reduction in slump observed with the increase in glass fiber content.

Sadam Hussain Jakhran,et.(2019); this study investigated the effect of three different coarse aggregates on the mechanical properties, durability, and microstructure of concrete. Concrete specimens were made using aggregates obtained from three regions with different mineralogy. The specimens were also made by replacing cement with silica fume. The specimens were analyzed in terms of compressive, flexural, and splitting tensile strengths, chloride penetration, carbonation, mercury intrusion porosimetry, and scanning electron microscopy. The results demonstrate that the specimens made with rougher coarse aggregates and silica fume had enhanced performance in comparison to those made with smoother aggregates.

Gurdeep Singh, Rajwinder Singh Bansal, et al (2017); In this paper we present an experimental investigation of effect of silica fume and quarry dust as partial replacements of cement and sand respectively on concrete. This effect has been studied on compressive strength, workability and durability of M25 concrete. Replacement levels of 8, 10 and 12% for silica fume and 20, 30 and 40% for quarry dust have adopted. The results of various tests conducted on control mix and other mixes with different proportions of silica fume an quarry dust have been compared. The mix with 10% silica fume and 30% quarry dust has shown better results than control concrete.

Daddan Khan et. (2017) Due to the abundant usage of concrete as a construction material, there is a fast dwindling source of aggregates. There are regions where there is scarcity of coarse aggregate, so to resolve this problem, Bricks Aggregates can be used as coarse aggregate. A concrete mix ratio of 1:2:4 having characteristics strength of 3000 psi has been used in this experimental work. Compressive and tensile strength of concrete mix where 50% coarse aggregate is replaced with brick aggregate and concrete mix where 100% coarse aggregate is replaced with brick aggregate and addition of silica fume as a supplementary cementing material have been evaluated at 7, and 28 days of age. The experimental test results revealed the compressive and tensile strength of concrete where coarse aggregate is replaced at 50% is almost the same as that normal concrete at the 7, and 28 days.

Materials & Methodology

3.1 MATERIALS USED

3.1.1 Cement:

Cement is a fine, grey powder. It is mixed with water and materials such as sand, gravel, and crushed stone to make concrete. The cement and water form a paste that binds the other materials together as the concrete hardens.

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Fig.: CEMENT

TABLE:-I Properties of Cement

Sr. No.	Characteristics	Values obtained	tandardvalues
1	Normal consistency	33%	
2	Initial Setting Time	48 min	Not less than 30 min.
3	Final Setting Time	240 min.	Not Greater than 600 min.
4	Sp.Gr.	3.09	
5	Fineness	4.8	

3.1.2 Coarse Aggregate:

The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per Indian Standard Specifications IS: 383-1970.

Fig. :- Coarse aggregate

TABLE II: - Properties of Coarse Aggregate

Sr. No.	Characteristics	Value
1.	Type	Crushed
2.	Maximum Size	20 mm
3.	Specific Gravity (20mm)	2.825
4.	Total Water Absorption Absorption (20mm)	0.995%

3.1.3 Jhama Class Brick

Bricks are a versatile and durable building and construction material with good load bearing properties. Various researchers have been carried out in porosity, permeability and absorption of brick. The traditional clay bricks are manually produced by pressing clay with certain amount of sand in the wooden mould. Then the wet bricks are first dried in the sun and air and then transported to the brick kiln for subsequent burning process. The bricks are burnt up to temperature of 800-900C in the brick kiln. If the temperature in the brick kiln is uncontrolled then the bricks are burnt excessively up to the temperature 1100-1200C. Due to this the bricks are sold at cheaper rate as they become out of shape. Therefore, this type of brick is known as over burnt brick. These bricks are also known as Jhama bricks.

Fig. :- Jhama Class Brick Materials

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These bricks, however, possess higher strength than the normal burnt clay bricks. Therefore, one of the cheaper alternatives for brick foundation, floors, roads etc. because of the fact that the over burnt bricks have a compact structure and hence they are sometimes found to be stronger than even the first class brick. Over burnt bricks have high compressive strength between 120 to 150 Kg/cm2. However they have very poor shape. Brickwork using these bricks utilizes 40% of more mortar than traditional brickwork. However this cost is offset by the price at which over burnt bricks are available. Due to over burnt, the bricks become black and its edges also become curved. It is not used in brick work of building main wall, partition wall and some other purposes.

TABLE IV:-Comparison between Coarse aggregate and Jhama Brick Aggregate

Properties	Coarse Aggregate	Jhama class brick
Aggregate Impact Value	7.24	19.35
Aggregate Crushing Value	16.85	32,2
Specific Gravity	2.83	2.67
Water Absorption	0.995%	11.08%

3.1.4 Glass Fibres

Glass fibre as shown in a figure below is a complex material comprising of several finely chopped fibres of glass. Glass wool is one of the products called "fibre glass"; it was created in the year 1932-1933 by Russell Games Slayter of Owens-Corning, as a material to be used as thermal building insulation. Glass fibre has unevenly similar mechanical properties to other artificial or non-metallic fibres like carbon fibres and polymer fibres. Glass fibres are found in constant or chopped lengths. Lengths of fibres are up to 35mm is used in applications like spray and 25mm lengths in applications like premix. The Glass fibres ensure benefits like Excellent workability, Homogeneous mix, indistinguishable on the completed surface, glass fibres ensures no rust, Glass fibres controls and stoppage the cracking in fresh concrete, it is very active at very small dosage, Glass fibres are nontoxic, easy to handle and safe.

Figure Glass fibre

•In the present work the study conducted glass fibre reinforced concrete (GFRC) and the specimen casted and tested to know the mechanical properties of GFRC for various percentages of Glass Fibres.

•In the present research work the glass fibres here used are of AE-Glass: ANTI-CRAK HD – sliced filaments for plastic shrinkage control with fibre length of 12mm, filament diameter of 14microns, modulus of elasticity 72Gpa, specific gravity is 2.68 and the aspect ratio of 857: 1. The 212 million is the numbers of fibres which present per kg.

3.1.5 WATER

The clean portable water is used in this work which is free from any suspended impurities and it is suitable for the drinking purpose.

3.2 METHODOLOGY

GENERAL

The cement, m-sand and coarse aggregates are weighed and batched according to the mix proportions of M30 grade concrete proportioned as per the guidelines in IS-10262-2009. The varying percentages like 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres to the weight of Cement in the concrete matrix and also 40% of Jhama Brick by the weight of cement is added. The specimens were casted, cured and tested for 7 days and 28 days respectively.

3.2.1.**Mix Preparation: -**

The batching of all the ingredients was performed by weight. The Jhama Brick was air dried in the laboratory before mixing. First the surface was damped with water then all the aggregates (Natural Coarse Aggregate, Glass Fibre, Jhama class brick coarse Aggregate) were spread on the surface area till the aggregates. After thorough mixing of aggregates cement was introduced on the ground surface and water were added slowly as per W/C ratio. The concrete was mixed for approximately three minutes after the water was added.

3.2.2. **Mix Casting: -**

It is found that the Jhama brick-bats based Concrete is dark in color and is cohesive. The amount of water in the mixture plays an important role on the behavior of fresh concrete. When the mixing time is long, mixtures with high water content bled and segregation of aggregates and the paste occurred. This phenomenon is usually followed by low compressive strength of hardened concrete. From the preliminary work, it was decided to observe the following standard process of mixing in all further studies,

1. Take the suitable proportion of the ingredients of the concrete.
2. After that put the coarse aggregate as well as Jhama brick, and Glass Fibre.
3. After that add the water in suitable quantity.
4. And continue the wet mixing for another four minutes.

Then the fresh prepared mix was casted standard cube moulds, cylinders and beams.

3.2.3. **Curing: -**

All the moulds were cured by immersing in a curing tank in the lab. The specimens were brought out from water approximately 24 hours before testing and kept at room temperature till testing.

3.3 TESTING TECHNOLOGIES

Following test were conducted for this experimental work,

- Flexural Strength Test
- Compressive Strength Test
- Split Tensile Strength Test

3.3.1 FLEXURAL STRENGTH TEST

Prism sizes of 150mm x 150mm x 700mm were casted for M30 grade concrete. To the dry concrete mix add glass fibre of 0%, 0.5%, 1%, 1.5%, 2% and 2.5% by the weight of cement, 0.5% of super plasticizer Conplast-SP430 by the weight of cement is added. A total of 8 Prisms were casted and tested for 7 days and 28 days respectively. The Flexural strength is calculated using following expression and results were tabulated.

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1. If a > 20cm for 15cm specimen

Flexural Strength = PL / (bd^2) N /

2. If a < 20cm and a>17 for 15cm specimen

Flexural Strength = 3Pa / (bd^2) N /

'P' is Failure of load in N

'L' is Prism length in mm

'b' is Prism breadth in mm

'd' is Prism depth in mm

'a' is Distance between the line of Fracture and the near support in mm

3.3.2 COMPRESSION STRENGTH TEST

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates.

The cube sizes of 150mm x 150mm x150mm will be casted for M30 grade concrete. To the dry concrete mix, add glass fibre of 0%, 0.5%, 1%, 2% and 2.5% respectively to the weight of cement and replacement of 40% of fine aggregates as jhama brick dust. A total 12 cubes will be casted, cured and tested. This concrete is poured in the mold and appropriately tempered so as not to have any voids. After 24 hours, molds are removed, and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth. This is done by placing cement paste and spreading smoothly on the whole area of the specimen. These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm^2 per minute till the specimens fails.

The compressive strength is calculated by using the following expression and the results are tabulated.

Compression Strength=P/bd N/mm^2

Where,
P is Failure of load in N
b is Cube width in mm
d is cube depth in mm

Figure 3.2.2 Compression testing machine

3.3.3

3.3.4 SPLIT TENSILE STRENGHTH TEST

A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete.

The Split Tensile strength of GFRC with the different percentage variations like 0%, 0.5%, 1%, 2% and 2.5% of glass fibres to the weight of cement are tested

Cylinder sizes of 150mm diameter and 300mmin height will be casted for M30 grade concrete. To the dry concrete mix, add glass fibre of 0%, 0.5%, 1%, 2% and 2.5% by the weight of the cement and replacement of 40% of jhama brick as fine aggregate. A total of 12 cylinders will be casted

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and tested. After molding and curing the specimens in water, they can be tested. The cylindrical specimen is placed in a manner that the longitudinal axis is perpendicular to the load. The load shall be applied without shock and increased continuously at a nominal rate within the range 1.2 N/(mm2/min) to 2.4 N/(mm2/min). Record the maximum applied load indicated by the testing machine at failure.

The Split tensile strength is calculated by using the following expression and
the results are tabulated

Split tensile strength=2P/πdl N/mm^2

Where,
P is Failure of load in N
d is Cylinder diameter in mm
l is Cylinder length in mm

Figure 3.2.3 Split tensile strength

Results and Discussion

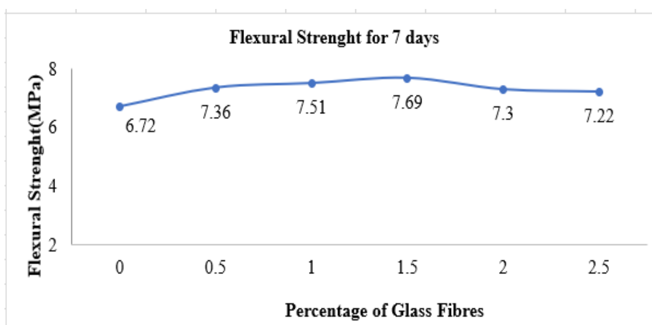
The Various tests conducted on Glass Fibre Reinforced Concrete (GFRC) with Varying percentages of 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres along with 40% of Jhama brick by the weight of cement. Here, the test results are presented numerically and graphically.

4.1 Flexural Strength Test Results for 7 days

The Flexural strength of GFRC with the different percentage variations like 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres to the weight of cement are tested and the obtained results are tabularized in the below table and their different variations are plotted in figure for 7 days.

Tabulation for Flexural strength results of GFRC for 7 days.

Glass Fibre (%)	Jhama brick In (%)	Load (kN) specimen 1	specimen 2	specimen 3	Average Load (kN)	7 days Flexural Strength(Mpa)
0	**40**	23.39	24.10	23.63	23.71	6.72
0.5	**40**	27.65	27.03	27.41	27.36	7.36
1.0	**40**	28.17	28.05	28.31	28.18	7.51
1.5	**40**	**29.47**	**29.04**	**29.09**	**29.20**	**7.69**
2	**40**	27.11	26.89	27.02	27.01	7.3
2.5	**40**	26.26	26.81	26.53	26.53	7.22



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Variation of Flexural strength of GFRC with varying percentage of Glass Fibres.

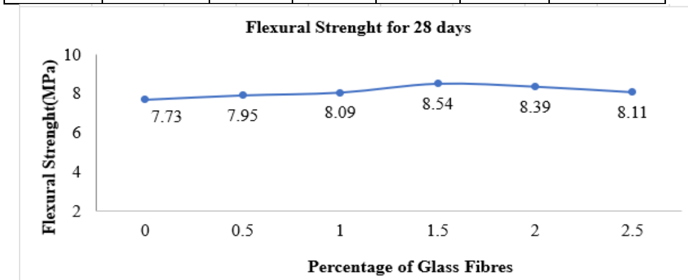
The Flexural strength of GFRC enhanced with increase in the Glass Fibre quantity up to 1.5% and decreases beyond that. From the table the maximum strength of Glass fibre is 7.69 Mpa is observed. Change in strength with respect to percentage of glass fibre quantity is graphically shown in the figure.

Flexural Strength Test Results for 28 days

The Flexural strength of GFRC with the different percentage variations like 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres to the weight of cement are tested and the obtained results are tabularized in the below table and their different variations are plotted in the figure for 28 days.

Tabulation for Flexural strength results of GFRC for 28 days

Glass Fibre (%)	Jhama Brick	Load (kN)			Average Load (kN)	28 days Flexural Strength (Mpa)
	In(%)	specimen 1	specimen 2	Specimen 3		
0	40	29.43	29.10	29.80	29.44	7.73
0.5	40	30.26	31.01	30.64	30.64	7.95
1.0	40	31.65	31.78	30.96	31.46	8.09
1.5	40	34.07	34.12	33.80	34.00	8.54
2	40	33.26	32.99	33.13	33.13	8.39
2.5	40	31.56	31.52	31.66	31.58	8.11



Variation of Flexural strength of GFRC with varying percentage of Glass Fibres

4.2 Compressive Strength Test Results

The compressive strength of GFRC with the different percentage variations 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres with 40% of Jhama brick to the weight of cement are tested and the obtained results are tabularized in the table and their different variations are plotted.

Tabulation for Compressive strength results of GFRC for 7Days

Glass Fibre (%)	Jhama Brick	Load (kN)			Average Load (kN)	7 days Compressive Strength (Mpa)
	In(%)	specimen 1	specimen 2	Specimen 3		
0	40	721.3	715.0	727.8	721.37	34.56
0.5	40	889.6	951.5	922.2	921.10	43.44
1.0	40	997.0	953.3	975.6	975.30	45.85
1.5	40	1029.6	1014.3	1015.9	1019.93	47.83
2	40	850.4	840.9	874.7	855.33	40.51
2.5	40	734.0	761.3	765.8	753.70	36

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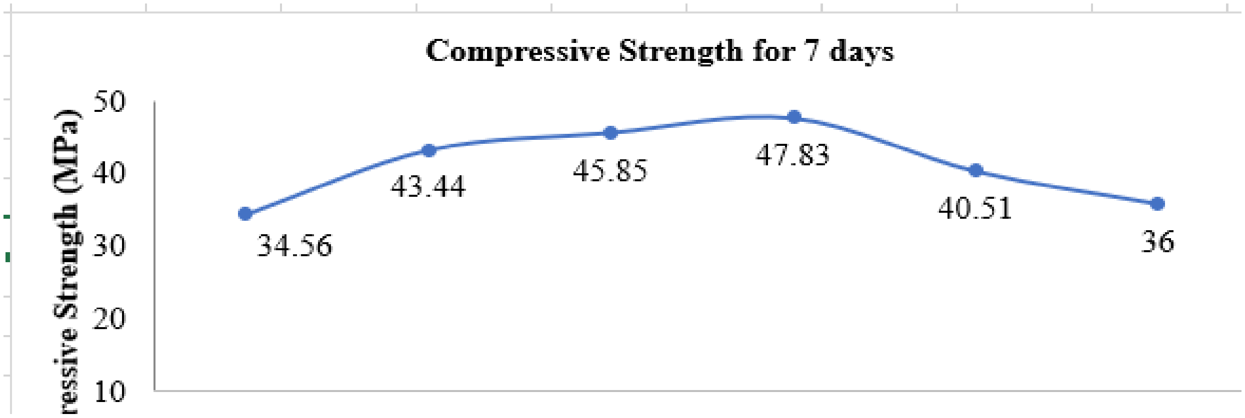

Variation of Compressive strength of GFRC with varying percentage of

The compressive strength of GFRC enhanced with increase in the Glass Fibre quantity up to1.5% and decreases beyond that. From the table the maximum strength of Glass fibre is 47.83 Mpa is observed.

4.2.2 Compressive Strength Test Results for 28 days

The compressive strength of GFRC with the different percentage variations like 0%, 1%, 1.5%, 2% and 2.5% of glass fibres with 40% of Jhama brick to the weight of cement are tested and the obtained results are tabularized in the below table and their different variations are plotted in figure for 28 days.

Tabulation for Compressive strength results of GFRC for 28 days

Glass Fibre (%)	Jhama Brick In (%)	Load (kN)			Average Load (kN)	28 days Compressive Strength (Mpa)
		specimen 1	specimen 2	specimen 3		
0	**40**	933.7	920.2	938.2	930.70	43.86
0.5	**40**	1206.0	1190.2	1158.7	1184.97	55.17
1.0	**40**	1341.6	1323.1	1319.2	1327.97	61.52
1.5	**40**	**1384.7**	**1422.4**	**1406.0**	**1404.37**	**64.92**
2	**40**	1170.7	1221.5	1199.0	1197.07	55.7
2.5	**40**	963.1	953.1	984.4	966.87	45.47

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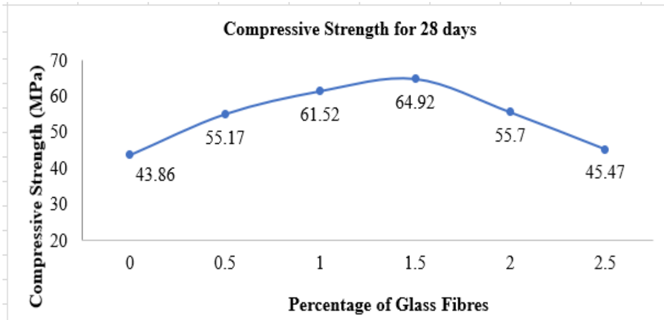
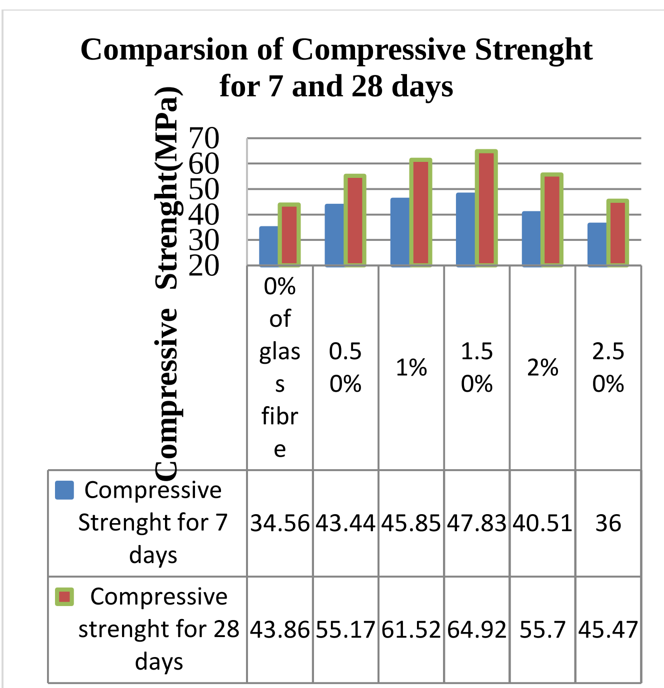


Variation of Compressive strength of GFRC with varying percentage of Glass Fibres

The compressive strength of GFRC enhanced with increase in the Glass Fibre quantity up to 1.5% and decreases beyond that. From the table the maximum strength of Glass fibre is 64.92 Mpa for 28 days is observed. Change in strength with respect to percentage of glass fibre quantity is graphically shown in the figure.

4.2.4 Comparison between Compressive Strength Results for 7 days and 28 days



	0% of glass fibre	0.50%	1%	1.50%	2%	2.50%
Compressive Strenght for 7 days	34.56	43.44	45.85	47.83	40.51	36
Compressive strenght for 28 days	43.86	55.17	61.52	64.92	55.7	45.47

4.2.4 Figure Comparisons between 7 days and 28 days for Compressive strength of GFRC with varying percentage of Glass Fibres

The comparison between 7 days and 28 days compressive strength of GFRC results with the varying percentage like 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres with 40% of Jhama brick to the weight of cement and their variations are plotted in the figure above Strength enhanced with increase in the Glass Fibre quantity up to 1.5% and decreases beyond that for 7 days and 28 days respectively. The compressive strength of GFRC in the amount of glass fibre quantity of 1.5% was found to be 47.83 Mpa for 7 days and 64.92 Mpa for 28 days and when compared to 0% of glass fibres it is increased 34.56% for 7 days and 43.86% increased for 28 days.

Figure of Casting of Cubes

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Figure of Testing of Cubes

Figure of Cubes after failure under Compression load

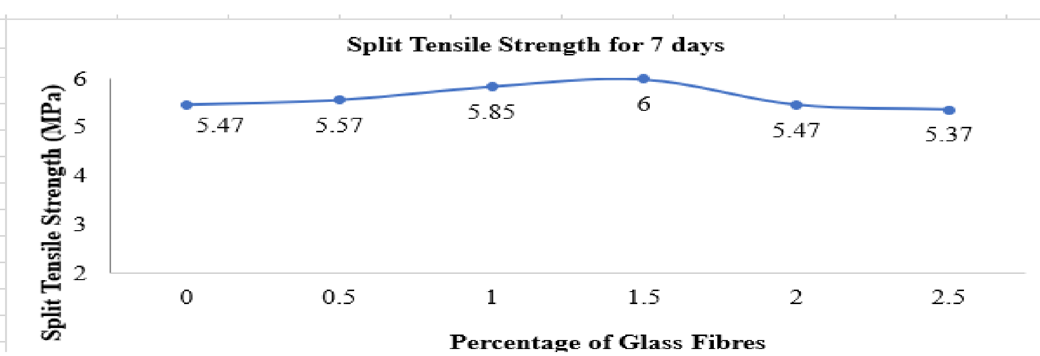
4.2 Split Tensile Strength Test Results

4.2.1 Split Tensile Strength Test Results for 7 days

The Split Tensile strength of GFRC with the different percentage variations like 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres with 40% of Jhama brick to the weight of cement are tested and the obtained results are tabularized in the below table and their different variations are plotted in figure for 7 days.

Tabulation for Split Tensile strength results of GFRC for 7 days.

Glass Fibre (%)	Jhama Brick In(%)	Load (kN)			Average Load (kN)	7 days Split Tensile Strength (Mpa)
		specimen 1	specimen 2	specimen 3		
0	**40**	211.3	204.0	213.8	209.70	5.47
0.5	**40**	225.0	225.2	200.3	216.83	5.57
1.0	**40**	233.6	237.0	240.1	236.90	5.85
1.5	**40**	**251.0**	**249.1**	**241.6**	**247.23**	**6**
2	**40**	206.2	208.3	215.6	210.03	5.47
2.5	**40**	199.3	201.5	207.6	202.80	5.37



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Variation of Split Tensile strength of GFRC with varying percentage of Glass Fibres 4.2.2 4.2.3

The Split Tensile strength of GFRC enhanced with increase in the Glass Fibre quantity up to 1.5% and decreases beyond that. From the table 4.5 the maximum strength of Glass fibre is 3.50 Mpa is observed. Change in strength with respect to percentage of glass fibre quantity is graphically shown in the figure.

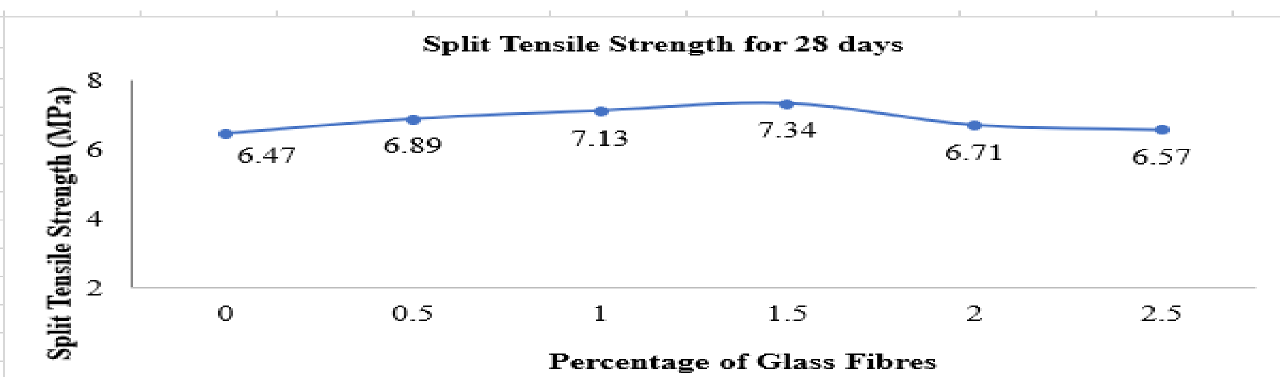
Variation of Split Tensile strength of GFRC with

Split Tensile Strength Test Results for 28 days

The Split Tensile strength of GFRC with the different percentage variations like 0%, 0.5%, 1%, 1.5%, 2% and 2.5% fibres with 40% of Jhama brick to the weight of cement are tested and the obtained results are tabularized in the below table and their different variations are plotted in figure for 28 days.

Tabulation for Split Tensile strength results of GFRC for 28 days

Glass Fibre (%)	Jhama Brick	Load (kN)			Average Load (kN)	28 days Split Tensile Strength (Mpa)
	In(%)	specimen 1	specimen 2	specimen 3		
0	**40**	281.0	277.3	283.1	280.47	6.47
0.5	**40**	309.8	309.6	312.5	310.63	6.89
1.0	**40**	325.8	332.2	324.4	327.47	7.13
1.5	**40**	**339.9**	**344.2**	**341.4**	**341.83**	**7.34**
2	**40**	297.5	301.8	293.3	297.53	6.71
2.5	**40**	283.2	287.6	291.9	287.57	6.57



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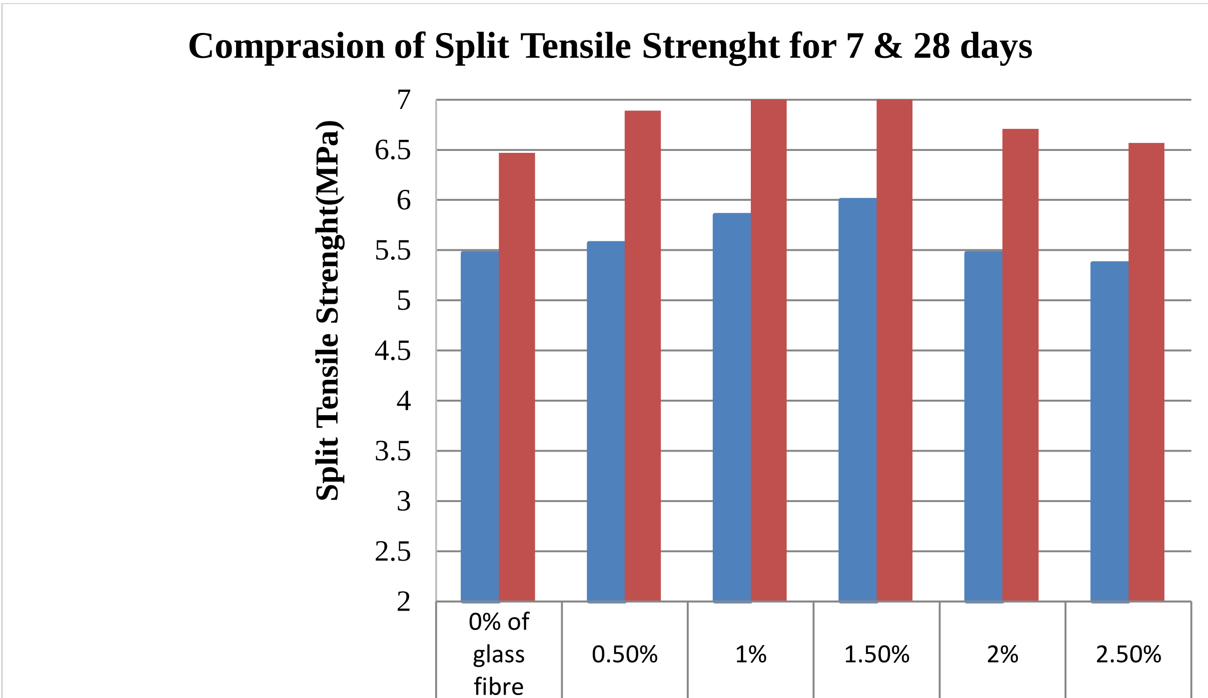
The Split Tensile strength of GFRC enhanced with increase in the Glass Fibre quantity up to 1.5% and decreases beyond that. From the table the maximum strength of Glass fibre is 4.84 Mpa increased for 28 days.

for 28 days is observed. Change in strength with respect to percentage of glass fibre quantity is graphically shown in the figure.



	0% of glass fibre	0.50%	1%	1.50%	2%	2.50%
Split Tensile strength for 7days	5.47	5.57	5.85	6	5.47	5.37
split Tensile strength for 28 days	6.47	6.89	7.13	7.34	6.71	6.57

Percentage of Glass Fibres

The comparison between 7 days and 28 days Tensile Strength of GFRC results with the varying percentages like 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres with 40% of Jhama brick to the weight of cement and their variations are plotted in the figure Strength enhanced with increase in the Glass Fibre quantity up to 1.5% and decreases beyond that for 7 days and 28 days respectively. The split tensile strength of GFRC in the amount of glass fibre quantity of 1.5% was found to be 6 Mpa for 7 days and 7.34 Mpa for 28 days and when compared to 0% of glass fibres it is increased 5.47% for 7 days and 6.47%

Figure of Casting of Cylinders

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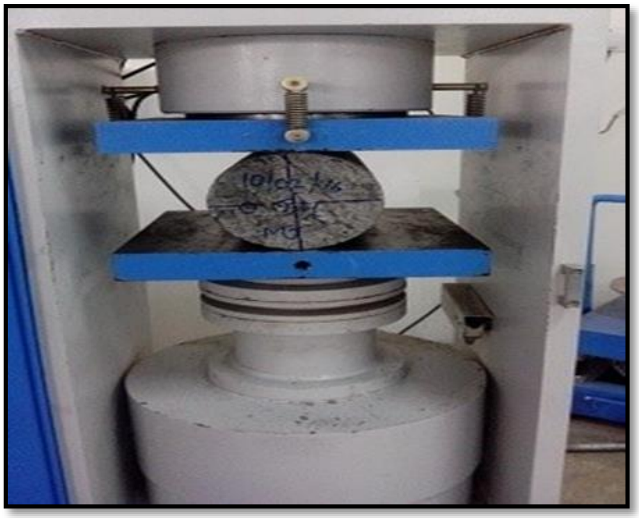

Figure of Testing of Cylinder

Conclusion

By the current research investigation conducted and from the obtained test results, the following conclusions are drawn below:

1) Glass fibres have showed better performance in the mechanical properties of concrete such as compressive, flexural and tensile strength of concrete. This may be due to bridging action of the glass fibres in presence of crack.

2) The flexural strength of GFRC in the quantity of glass fibre of 1.5% was found to be 7.69 Mpa for 7 days and 8.54 Mpa for 28 days and when compared to 0% of glass fibres it is increased 23.28% for 7 days and 15.68% increased for 28days.

3) The flexural strength of the 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres was obtained as 7.95 Mpa, 8.09 Mpa, 8.54 Mpa, 8.39 Mpa and 8.11 Mpa respectively for 28 days and are compared with control mix (0%) is 7.73 Mpa for 28 days.

4) The flexural strength of the 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres was obtained as 7.36 Mpa, 7.51 Mpa, 7.69 Mpa, 7.3 Mpa and 7.22 Mpa respectively for 7 days and are compared with control mix (0%) is 6.72 Mpa for 7 days.

The flexural strength of the 1.5% mix proportion gives the higher flexural strength at 28 days.

The compressive strength of GFRC in the quantity of glass fibre 1.5% was found to be 47.83 Mpa for 7 days and 62.42 Mpa for 28 days and when compared to 0% of glass fibres it is increased 41.30% for 7 days and 50.88% increased for 28 days.

7) The compressive strength of the 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres was obtained as 43.86 Mpa, 55.17 Mpa, 61.52 Mpa, 64.92 Mpa, 55.7 Mpa and 45.47 respectively for 28 days and are compared with control mix (0%) is 41.36 Mpa for 28 days.

8) The compressive strength of the 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres was obtained as 43.44 Mpa, 45.85 Mpa, 47.83 Mpa, 40.51 Mpa and 36 Mpa respectively for 7 days and are compared with control mix (0%) is 34.56 Mpa for 7 days.

9) The compressive strength of the 1.5% mix proportion gives the higher compressive strength at 28 days.

REFERENCE

[1]. Abdul-Aziz I. Al-Negheismish, Faisal H. Al-Sugair and Rajeh Z. Al-Zaid (1996),

[2]. "Utilization of Local Steel making Slag in concrete", Journal of Environmental science of sustainable society,Vol.1, pp. 39- 55.

[3]. Caballero-Morrison.K.E, J.L. Bonet , Juan Navarro-Gregori, J.R. MartíVargas , " Behaviour of steel-fibrereinforced normal-strength concrete

DOI- 10.18486/ijcsnt.2021.10.1.03
ISSN: 2053-6283

slender columns under cyclic loading" Engineering Structures 39 (2012) 162–175

[4]. Chinnaraju.K, V. R.Rramkumar, K. Lineesh, S. Nithya, V. Athish‟s "study on
concrete using ecosand as fine aggregate replacement", international journal of research in engineering & advanced technology, volume 1, issue 3, june-july, 2013 pp 2320 – 8791

[5]. DitaoNiu, Lei Jiang , Min Bai, Yuanyao Miao, "Study of the performance of steel

[6] Milena Rangel, Somayeh Nassir, Zhao Chen, Mark Russell, Jeffrey Uhlmeyer 2017 Quality evaluation test for pervious concrete pavement placement International Journal of Pavement Research and Technology Volume 10, Issue 3, Pages 245-253

[7] SK. Sind. Study and comparison of mechanical properties of pervious concrete and conventional Concrete. IJAR. 2015:1(10):676-681p.

[8] Md. Alum & Shagufta Nag 2015 Experimental Study of the Properties of No-Fines Concrete International Journal of Informative & Futuristic Research (IJIFR) Volume -2, Issue -10, June 2015 2nd Edition, Page No: 3687-3694

[9] KS USANi, (Nov 2014) Investigation of no fines concrete in building blocks. Ant J Struck Civil Eng. Res.2014; 3(4):1-8p.

[10] N. Ghafoor. Laboratory investigation of compacted no fines concrete for paving materials, J Mater Civil Engg.1995.

[11] AA. Mutter. Improving the mechanical properties of no fine concrete, J Babylon Unit/ Eng. Sci. 2013;.

[12] R. Punned. An innovative no fines concrete pavement model, IOSRJMCE. 2015.

[13] JK. Putrid. An experimental study on hardened property of pervious concrete, It Res J Eng. Technol. 2014: 2(3).

[14] Indian Standard (IS) For Cement: IS 4031; 1999.

[15] Indian Standard (IS) For Aggregate: IS 2386, Part I; 1963.

[16] Indian Standard (IS) For Water: IS 456; 1978.

[17] Indian Standard (IS) For No Fine Concrete: IS 12727; 1989

DOI- 10.18486/ijcsnt.2021.10.1.03
ISSN: 2053-6283