Journal of Civil Engineering and Environmental Technology
Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 1, Number 4; August, 2014 pp. 84 – 87

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Basalt Fibre Reinforced Polymer (BFRP): Effective Replacement of Steel in Reinforced Concrete

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Abstract : **Concrete structures are usually reinforced because plain concrete has strong limitations to resist tension. One of the familiar reinforcing material is steel; it suits well as reinforcement but has quite well known pros and cons. Fibre Reinforced Polymer (FRP) have over the past years became an interesting choice as a reinforcement for concrete. There are widely researched range and types of FRP namely: Aramid FRP (AFRP), Carbon FRP (CFRP) and Glass FRP(GFRP). FRP shows various advantages out of which few are: high tensile strength, high strength-weight ratio, no corrosion and also light in weight. These many of such benefits suggest the structural designers to research & implement on a large scale the replacement of steel with different FRPs as a choice of reinforcing material for concrete. One of the choice that we have made is Basalt Fibres Reinforced Polymer (BFRP) which is rather a new material to structural design, although it has been known for several decades. They are made from basalt rock, are very light and have tensile strength, over twice as high as steel. Tensile strength of BFRP tendon is about twice the tensile strength of steel reinforcement and elongation of BFRP tendons is much more than of steel. To utilize the high tensile strength of BFRP and prevent cracking of concrete, the tendons could be prestressed. This paper focuses on the various performance based study of BFRP on reinforced concrete properties where we replaced reinforcing steel with BFRP and extended it as a prestress reinforcement to achieve few specialty in reinforced concrete elements.**

Keywords: Basalt Fibre Reinforced Polymer (BFRP), Fibre Reinforced Polymer (FRP), High-tensile strength, Pre stressed concrete, Special Concrete.

1. INTRODUCTION

Concrete is the world's most used man-made construction material today. It is relatively cheap and easy to form when cast in India. The most common reinforcing material for Reinforced Concrete (RC) used until now and is still used today is steel. Using steel as reinforcement has numerous advantages; it is strong in tension and has a high modulus of elasticity. The thermal expansion is similar to concrete and it works well with concrete under loading. The production process for steel is very stable and thus the material properties are also very stable, then steel is easy to form and work with. But using steel as reinforcement has also some disadvantages; it can corrode with time and has low fire resistance. The price of steel has also been rising over the last few years.

The main challenge for civil & structural engineers is to provide sustainable, environmental friendly and financially feasible structures to the society. Finding new materials that can fulfill these requirements is a must. FRP's have become increasingly more studied and utilized in the reinforcement and prestressing of structural members. However, most of the FRP materials to date have at least some type of major drawback which prevents them from becoming more widely utilized for structural applications. FRPs composed primarily of carbon (CFRP) for instance, demonstrate exceptional structural characteristics such as high Elastic Modulus and relatively good tensile strength. However, their performance under fire testing is less than desirable and its cost is prohibitive to its use in most applications. Another common FRP is fibreglass (GFRP). GFRPs exhibit good mechanical characteristics, but again serviceability concerns and cost (though considerably less than CFRPs) make it somewhat prohibitive in its implementation in real-world applications.

The relatively new development of an FRP composed of fibres of melted basalt rock (BFRP) is beginning to create excitement within the construction industry as a viable FRP alternative to CFRPs and GFRPs. Basalt is naturally occurring and is one of the most abundant materials on Earth. Though early investigations were performed in the United States in the 1920s about production methods for an FRP composed of basalt, successful and large scale production was not achieved until the 1980s. Up until 1995, production methods were kept secret, and its use was solely for defence purposes. Within the past two decades however, BFRP research and production methods have been declassified, and are now produced for civilian purposes with mechanical properties similar to those of GFRPs or CFRPs, but with generally better serviceability characteristics and at a significantly lower cost.

However, the FRP materials also have some disadvantages. They have low compression and shear strength compared to the same properties of steel. The same applies for the modulus of elasticity, which is considerably lower for the cheapest FRP materials, GFRP and BFRP, than for steel.

Conventional concrete fails before the tensile capacity of steel has been fully utilized. However, this problem can be solved by prestressing the FRP because BFRP and GFRP are considerably more flexible than steel.

To increase the strength and durability, prestressed concrete is commonly used. By prestressing concrete it is possible to reduce or eliminate tensile stresses caused by applied load which usually makes the concrete crack resistance at serviceability stage. Prestressing has two ways to generate pre compression and pretensioning which are implemented to precast concrete through tendons which are stretched in the formwork before casting the concrete. After the concrete has cured for some time around the tendons then the tension in the tendons is transferred to the concrete to generate compression by releasing the tendons.

This study will therefore focus on prestressed concrete beams reinforced with BFRP.

2. OBJECTIVE

To study the various researches conducted on BFRP incorporating with normal and special concrete.

3. LITERATURE REVIEW

Jongsung Sim, Cheolwoo Park, Do Young Moon[2], have investigated the applicability of the basalt fibre as a strengthening material through experimental works for durability, mechanical properties, and flexural strengthening. The basalt fibre used in this study was manufactured in Russia and exhibited the tensile strength of 1000 MPa, which was about 30% of the carbon and 60% of the high strength glass (S-glass) fibre. From the accelerated weathering test, the basalt fibre was found to provide better resistance than the glass fibre. In the tests for flexural strengthening evaluation, the basalt fibre strengthening improved both the yielding and the ultimate strength of the beam specimen up to 27% depending on the number of layers applied.

Thilan Ovitigala[7] conducted study to examine the Bond strength, Flexural behavior of BFRP reinforced concrete beams and Shear behavior of BFRP reinforced concrete beams. In the pullout bond test it was concluded that Twenty times the bar diameter (20 d_b) can be considered as the development length for BFRP reinforced flexural specimens, since all the BFRP bars were failed by rupture without slippage or failure of the concrete and The maximum average bond stress increased when the diameter of the BFRP bar decreased for the same development length. Tests were conducted on light weight concrete where it was observed that BFRP reinforced beams showed higher ultimate load carrying capacity compared to steel reinforcement with lower area of reinforcement. While in Normal weight concrete beams, Serviceability criteria (deflection limits) can be achieved by increasing the area of BFRP reinforcement. However, the ultimate failure would be brittle in nature without prior warning due to lower deflection when the area of BFRP reinforcement increased. The maximum FRP reinforcement area limit was proposed by limiting the strain in the BFRP bars to be greater than or equal to 5000 με (≥ 5000 με). In the shear behavior it was observed that the failure mode of the specimens depends on the BFRP reinforcement area and the span to depth ratio (a/d). The failure was more brittle, when the area of reinforcement was higher. When the a/d increases, the failure mode changed from shear failure to flexural shear failure.

Tehmina Ayub, Nasir Shafiq, M. Fadhil Nuruddin[6] studied the material properties of an economical Hig Performance Fibre Reinforced Concrete (HPFRC) containing Basalt fibres which include compressive strength, elastic modulus and tensile strength. In this study, influence of addition of 1, 2 and 3% Basalt fibre volume fraction in three different mixes of high-performance concrete (HPC) is investigated. The first mix was prepared by using 100% cement(Series P) and other two mixes were prepared by replacing 10% cement content with silica fume (Series S) and locally produced met kaolin(Series M). Experimental results showed that the addition of Basalt fibres up to 2% fibre volume together with mineral admixtures improved the compressive strength as in Figure 1 while Figure 2 shows the variation in elastic modulus.

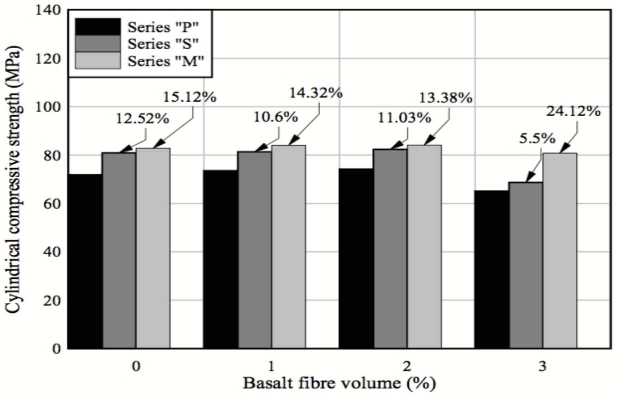

Figure 1. Variation in compressive strength

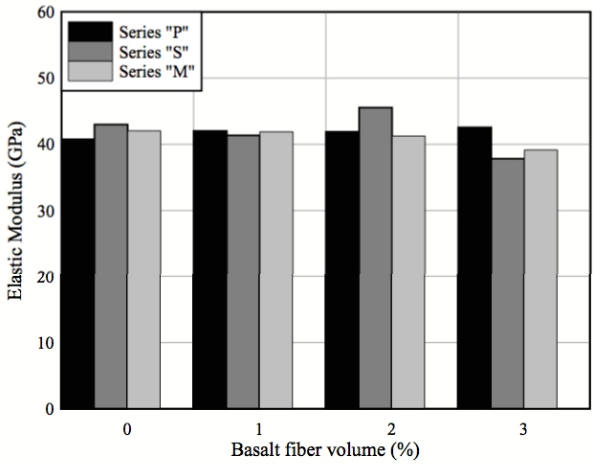

Figure 2. Variation in elastic modulus

Marek Urbanski, Andrzej Lapko, Andrzej Garbacz[3] have tested simply supported beams under flexure, reinforced with BFRP bars, compared to the reference beams with steel reinforcement. It was noted that critical load for tested beams reinforced with BFRP bars was much greater than the carrying capacity of beams with conventional steel reinforcement. The failure of beams with BFRP reinforcement did not occur suddenly and this effect was a result of transformation of the beam into a tie system because of flexural basalt reinforcement remained unbroken. Due to the relatively lower elasticity modulus of basalt rods, compared to steel ones, both: the deflection and width of cracks can be a major factor in the designing the BFRP reinforced concrete beams.

Maximus Pearson, Ted Donchev, and Juan Salazar[5]**,** have studied about the information about long-term behavior of such reinforcement under prestressing loading would be helpful to estimate prestress losses. A testing rig has been build to evaluate the behavior of BFRP rebars in constant loading conditions with a direct correlation to steel rebars and cables. It was noticed that the most sensitive period for the materials (in particular Steel rebar and BFRP) was the initial loading as in Figure 3. In the end it was concluded that Prestress Loses are seen to be equal or less with BFRP and Steel in comparison to steel cable.

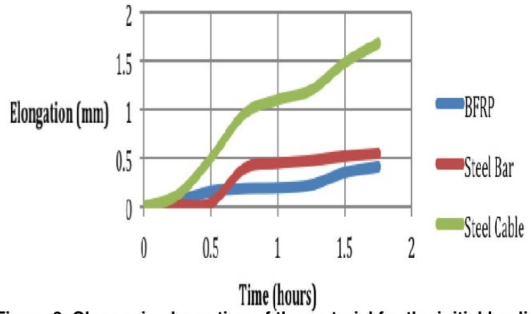

Figure 3. Change in elongation of the material for the initial loading

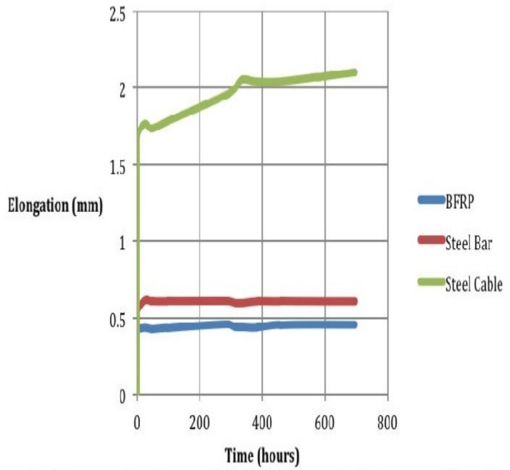

Figure 4. Change in elongation of the materials over time(30 days)

Maximus Pearson, Ted Donchev[4] have investigated the opportunity to reduce the deformability of Fibre Reinforced Polymers (FRP) reinforced beams via introducing different levels of prestress. The prestressing force is applied via a post-tensioning technique. As in Fig.5, the comparison between ungrouted basalt prestressed with 16kN of tension (BU16) and grouted basalt prestressed to 16kN (BG16) indicates a higher external force for the same level of force to the reinforcement in the grouted beam.

This is a clear indication that the grouted beam is distributing the stresses more uniformly, thus allowing lesser stresses on the reinforcement. Similar results are observed when comparing the steel reinforced beams (ungrouted steel 16kN of prestress, SU16 and SG16, grouted steel prestressed to 16kN) this again shows a higher external force for the same level of internal stresses for the grouted beam. When comparing the differences between ungrouted basalt prestressed to 16kN (BU16) and 16kN grouted basalt prestressed beam (BG16) the differences between ungrouted steel 16kN of prestress and grouted steel prestressed to 16kN, it is visible that the effect of grouting on steel reinforced beams is more significant than the effect on BFRP reinforced beams. As in Figure 5.

It was concluded that Grouting has a beneficial effect on reducing the deformability and on increasing the ultimate capacity of BFRP reinforced samples. A higher level of prestressing significantly reduces the deformability of BFRP reinforced beams in the case of grouted reinforcement. The effect of higher levels of prestressing from ungrouted beams is not so significant.

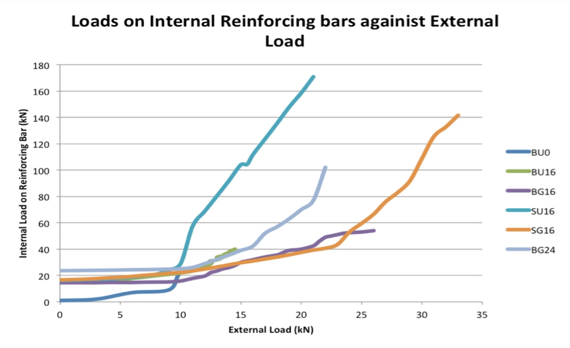

Figure 5. Internal forces on the reinforcing bars at various external loads

Chaohua Jiang, Ke Fan, Fei Wu, Da Chen[1], have conducted a series of mechanical property tests on basalt FRC. The results obtained show that addition of BF to the concrete leads to a decrease in the workability of concrete. The mechanical performance of basalt FRC is better than that of PP FRC. Compared with the plain samples, concrete reinforced with BF presents high flexural strength and tensile strength. But the compressive strength of concrete reinforced by BF increases slightly at the early age and even decreases at the late age. The length of BF presents a beneficial effect on the mechanical proper- ties of concrete. Compared with the strengths of plain concrete, the compressive, splitting tensile and flexural strengths of concrete reinforced by 12 mm long BF increase by 0.18–4.68%, 14.08– 24.34% and 6.30–9.58%, and the corresponding strengths of FRC with BF of 12mm in length increase by 0.55–5.72%, 14.96– 25.51% and 7.35–10.37% after 28 days. With the increase of BF content, the improvement of mechanical properties of BF concrete becomes more obvious.

4. OUTCOME

- Strengthening of concrete by Basalt fibre improves the yielding strength as well as ultimate strength of beam specimen upto 27% depending on the number of layers applied.
- The developmental length of BFRP reinforced specimens is twenty times the bar diameter (20d_b).
- While increasing the area of BFRP reinforcement, serviceability criteria (deflection limits) can be achieved.
- The ratio of BFRP reinforcement area and the span to depth ratio (a/d) determines the failure mode of the specimen. When a/d increases, the failure mode changes from shear failure to flexural shear failure.
- Adding Basalt fibres with mineral admixtures improved the compressive strength of the specimen.
- The critical load for beams reinforced with BFRP bars was much greater than the carrying capacity of beams with conventional steel reinforcement.
- Beams reinforced with BFRP do not face sudden failure because the beam transforms into a tie system because of flexural basalt reinforcement remains unbroken. This gives the structure a warning and does not lead to a catastrophic failure.
- In comparison with steel cable, the prestress losses are less in BFRP.
- Grouting has a beneficial effect on reducing the deformability and on increasing the ultimate capacity of BFRP reinforced specimens.
- When the level of prestressing in grouted beams increases, it reduces the deformability of BFRP reinforced beams. But increasing the level of prestressing in ungrouted beams, does not affect it significantly.

5. WAY FORWARD

From the above said literature review of the research done in the past, it is noted that not much is known about BFRP tendons while incorporating it in prestressed concrete. In this advanced technology era, prestressed concrete is widely used in the construction practice and the BFRP tendons can be an effective solution for the replacement of steel and addition of high shear and tension strength to the specimens. For the modern application, I will be conducting my PG research for analyzing all the behavior and effects of BFRP tendons in pre stressed concrete replacing steel.

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Journal of Civil Engineering and Environmental Technology
Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 1, Number 4; August, 2014 pp. 88 – 92

http://www.krishisanskriti.org/jceet.html

Study of Effect on Compressive Strength of Concrete Using Natural Fibre as Reinforcement

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Abstract : **India is a country in which most of the population still lives in the villages and the farm products constitute the joints and bones of the backbone of the country's economy. Out of these natural fibre and its composites has been an important and profitable product since the beginning of business. A variety of such fibres have been proposed for our work such as jute and coir. In our work, 48 specimens were cast and tested. Based on the experimental results of workability and compressive strength studies, a constant length of 20mm of fibres and three volume fractions such as 0.5%, 1% and 1.5% are chosen. By analyzing the results, empirical relations also have been proposed for compressive strength properties and compared with the experimental results. From these results, it is observed that with the increase in percentage of natural fibre in concrete upto a certain limit, the compressive strength increases, after that there is a decrease in compressive strength of plain concrete.**

1. INTRODUCTION

Regular concrete is a brittle material which possesses a high compressive strength but on the other side has a low tensile strength. The combined use of regular concrete and steel reinforcing bars was able to overcome that disadvantage leading to a material with good compressive and tensile strengths but also with a long post-crack deformation. Unfortunately reinforced concrete has a high permeability that allows water and other aggressive elements to enter, leading to carbonation and chloride ion attack resulting in corrosion problems. On the other hand, reinforced steel is a high cost material, and has high energy consumption and comes from non renewable resource. Natural fibres are a renewable resource and are available almost all over the world. Therefore the use of concrete reinforced with vegetable fibres could be a way to improve concrete durability and also sustainable construction. This paper deals with the subject of natural fibre reinforced concrete. It includes fibre characteristics, compressive strength of the concrete by adding different proportion of natural fibre into the concrete and to determine the compressive strength of it. It also includes the properties and durability performance of concrete reinforced with natural fibres and since plain concrete possesses compressive strength, fibre reinforcement is used as reinforcement for tensile strength.

Moreover it is seen that fibre reinforcement is more economical than steel reinforcement. The cost of construction in such a project is less compared to steel reinforcement. While constructing in such type of projects, skilled workers are also not required. The concept of using fibres as reinforcement is not new. Fibres have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and straw in mud bricks. In the 1900s, asbestos fibres were used in concrete. In the 1950s, the concept of composite materials came into being and fibre-reinforced concrete was one of the topics of interest. By the 1960s, steel, glass (GFRC), and synthetic fibres such as polypropylene fibres were used in concrete. As fibres are found abundant in nature, in 21st century it plays a vital role as construction material. Nowadays many people use fibre for constructing their houses and to decorate the interior of large buildings, hotels, cinema halls etc. Though fibre reinforcement is widely used all over the world nowadays but there are certain disadvantages as well. We cannot construct large projects which includes construction of large bridges, industrial buildings etc.

Fibres are produced from different materials in various shapes and sizes. Typical fibre materials are steel fibre, glass fibre, natural organic and mineral fibre, polypropylene fibre, carbon fibre, and other synthetic fibres. The different natural fibres used for this purpose are jute fibre, coir fibre, hemp fibre, sisal fibre, palm fibre, pineapple fibre, etc.

1.1. Mechanical Properties of Fiber Reinforcement Concrete

Addition of fibre to concrete influences its mechanical properties which significantly depend on the type and percentage of fibre with end anchorage and properties and application of fibre reinforcement concrete has high aspect ratio that has been found to improve effectiveness. It is seen that for the same length and diameter; crimped-end fibres can achieve the same properties as straight fibres using 40 percent less fibres. In determining the mechanical properties of FRC, the same equipment and procedure as used for conventional concrete can also be used. Below are cited some properties of fibre reinforced concrete-

1.1.1. Compressive Strength. The presence of fibres may alter the failure mode of cylinders, but the fibre effect will be minor on the improvement of compressive strength values (0 to 15 percent).

1.1.2. Modulus of Elasticity. Modulus of elasticity of FRC increases slightly with an increase in the fibre content. It was found that for each 1 percent increase in fibre content by volume there is an increase of 3 percent in the modulus of elasticity.

1.1.3. Flexure. The flexural strength was reported to be increased by 2.5 times using 4 percent fibres.

1.1.4. Toughness. For fibre reinforcement concrete, toughness is about 10 to 40 times that of plain concrete.

1.1.5. Splitting Tensile Strength. The presence of 3 percent fibre by volume was reported to increase the splitting tensile strength of mortar about 2.5 times that of the unreinforced one.

1.1.6. Fatigue Strength. The addition of fibres increases fatigue strength of about 90 percent and 70 percent of the static strength at 2 x 106 cycles for non-reverse and full reversal of loading, respectively.

1.1.7. Impact Resistance. The impact strength for fibrous concrete is generally 5 to 10 times that of plain concrete depending on the volume of fibre.

1.1.8. Corrosion of Steel Fiber. A steel fibrous mortar to outdoor weathering in an industrial atmosphere showed no adverse effect on the strength properties. Corrosion was found to be confined only to fibres actually exposed on the surface. Steel fibrous mortar continuously immersed in seawater for 10 years exhibited a 15 percent loss compared to 40 percent strength decrease of plain mortar.

1.2. Advantages of Natural Fibre Used in Concrete

A natural fibre is any hair like material directly obtainable from an animal, vegetable, or mineral source. It abundantly found in nature and less in price compared to other fibres.

1.3. Disadvantages of natural fibre

Disadvantage of natural fiber is with respect to the supply and demand cycle based on product of availability.

1.4. Applications of Fibre Reinforced Concrete

The uniform dispersion of fibres in the concrete mix provides unique isotropic properties. The main area of Fibre reinforced concrete application are as follows-

1.4.1. Runway, Aircraft Parking and Pavements. For the same wheel load FRC slabs could be about one half the thickness of plain concrete slab. Compared to a 375mm thickness' of conventionally reinforced concrete slab, a 150mm thick crimped-end FRC slab was used to overlay an existing as properties and applications of fibre reinforced concrete 53 phallic- paved aircraft parking area. FRC pavements are now in service in severe and mild environments.

1.4.2. Tunnel Lining and Slope Stabilization. Steel fibre reinforced shotcrete (SFRS) are being used to line underground openings and rock slope stabilization. It eliminates the need for mesh reinforcement and scaffolding.

1.4.3. Blast Resistant Structure. When plain concrete slabs are reinforced conventionally, tests showed that there is no reduction of fragment velocities or number of fragments under blast and shock waves. Similarly, reinforced slabs of fibrous concrete, however, showed 20 percent reduction in velocities, and over 80 percent in fragmentations.

1.4.4. Thin Shell, Walls, Pipes and Manholes. Fibrous concrete permits the use of thinner flat and curved structural elements. Steel fibrous shotcrete is used in the construction of hemispherical domes using the inflated membrane process. Fibre reinforced cement or concrete (FRC) made by the spray-up process, have been used to construct wall panels. Steel and glass fibres addition in concrete pipes and manholes improves strength, reduces thickness, and diminishes handling damages.

1.4.5. Dams and Hydraulic Structure. FRC is being used for the construction and repair of dams and other hydraulic structures to provide resistance to cavitations and severe erosion caused by the impact of large Waterboro debris.

1.4.6. Other Application. These include machine tool frames, lighting poles, water and oil tanks and concrete repairs.

2. MATERIAL INVESTIGATION

2.1. Jute fibre

Jute is a rainy season crop, sown from March to May according to rainfall and type of land. It is harvested from June to September depending upon whether the sowings are early or late. To grow jute, farmers scatter the seed on the cultivated soil. When the plants are about 15-20cm tall, they are thinned out. About 4 month after planting, harvesting begins. The plants are usually harvested after they flower, before the flower goes to seed. The stalks are cut off close to the ground. The stalks are tied into bundles and soaked in water about 20 days. The process softens the tissues and breaks the hard pectin bond between the bust and jute inner woody fibre stick and the process permits the fibres to be separated. Jute requires a warm and humid climate with temperature between 24° C to 37° C. Constant rain or water-logging is harmful. The new gray alluvial soil of good depth, receiving salt from annual floods, is best for jute. Flow ever jute is grown widely in sandy loams and clay loams.

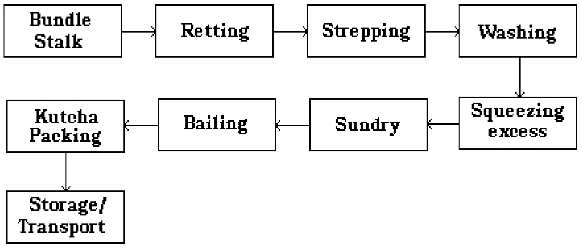

Figure 1. Process of Fibre Extraction

2.1.1. Properties of Jute Fibres

Table 1. Physical properties of jute fibre

Ultimate length	1.5-4mm
Ultimate diameter	0.015-0.020mm
Fibers length	5-12ft
Color	White,off white, yellow, brown, gray, golden
Strength (tenacity)	3-4 gm/den
Elongation	1.7% at the break
Specific gravity	1.5
Moisture content	13.75%
Resiliency	Bad
Dimensional stability	Good
Abrasion resistance	Average
Effect of light and heat	Average
Effect of micro-organism	Good

Table 2. Chemical properties of jute fibre

Effect of acid	Easily damage by the hot dilute acid and conc. cold acid
Effect of alkalis	Fibers are damaged by strong alkali. Fiber losses weight when it heated with caustic soda
Effect of beaches	Resistant to bleaching agent (bleaching agent, H2O2, NaOcl , Naclo2 , Na2O2 , CH3COOH, KmNO4 etc
Effect of light	Color change slightly in presence of sun light. It happens due to presence of lignin in fiber
Effect of mildew	Prevention ability is better than cotton and linen
Dyeing ability	Easy to dyeing .basic dye is used to color jute fiber

2.2. Coir Fibre

Coconuts are harvested every two months throughout the year. Green coconuts, harvested after about twelve months on the plant, contain pliable white fibres. Brown fibre is obtained by harvesting fully mature coconuts when the nutritious layer surrounding the seed is ready to be processed into copra and desiccated coconut. The fibrous layer of the fruit is separated from the hard shell by driving the fruit down onto a spike to split it (de-husking). They are then beaten, to separate out the long coir fibers. Coconut trees are tall – commonly 25 meters high – and this fibrous layer around the seedpod is a strong shock-absorbing mesh that protects the seed from damage.

2.2.1. Properties of Jute Fibres

Table 3. Physical properties of coir fibre

Ultimate length	6-8’’
Density	1.4 gm/cc
Tenacity	10g/tex
Diameter or width	16 micron
Breaking elongation	30%
Swelling in water	5% in dia

Table 4. Chemical properties of coir fibre

Water solubles	5.25%
Pectin and related compounds	3.3%
Hemi-cellulose	0.25%
Lignin	45.84%
Cellulose	43.44%
Ash	2.22%

3. METHODOLOGY

The concrete is made up of coarse aggregate, fine aggregate, cement and water. As we are using natural fibres in concrete so we cannot use nominal mixes in our work. So we used mix design to get the required strength of M25. To find out the required quantity of different material in the concrete we have to know the different properties and characteristics of various ingredients.

Table 5. Stipulation for proportioning

Parameters	Essent
Grade Designation	M25
Type of cement	OPC43
Maximum nominal size of aggregate	10 mm
Minimum cement content	340 kg
Maximum Water – Cement ratio	0.40
Workability	75 mm

Exposure Condition	Severe
Method of Concrete Placing	Manually
Type of aggregate	Crushed

Table 6. Test data for materials

Cement used	OPC 43 grade
Specific gravity of cement	3.15
Specific gravity of coarse aggregate	2.39
Specific gravity of fine aggregate	1.58
Water absorption of coarse aggregate	11%
Water absorption of fine aggregate	34%
Sieve analysis coarse aggregate	10 mm crushed angular aggregate
Sieve analysis fine aggregate	Confirming to grading zone III of table 4 IS 383

Using this test data 42 cubes were casted using jute and coir fibre. Three percentages of fibres of 20 mm length were used as reinforcement in concrete. Proper curing was done to get required results for 7 and 28 days.

Table 7. Percentage of fibres used

No of cubes	% of jute added			% of coir added		
	0.5%	1.0%	1.5%	0.5%	1.0%	1.5
	6	6	6	6	6	6

Table 8. Length and diameter of the fibres used

Sl. No	Dimensions	Jute	Coir
1	Length (mm)	200	75
2	Diameter (mm)	0.1-0.2	0.1-0.4

4. EXPERIMENTAL RESULTS

The ability of a material to resist forces that attempt to squeeze or compress the material together is known as compressive strength. The compression test is to be conducted using compressive test machine at the material lab of RGI as specified in the test method BS 1881-Part (116)1983. An increasing compressive load is applied to the specimen until failure occurred to obtain the maximum compressive load. The specimen dimension is taken before the testing. Concrete cubes of 150mm in length, width and height are used to determine the compressive strength.

We have tested 42 no's of cubes. Out of those 18 no's of cube are jute fiber mixing, 18 no's of cube are coir fiber mixing and 6 no's of cubes are of design mixing. The compressive strengths of concretes are determined at the ages of 7 and 28 days.

Figure 2. Experimental set up

Table 9. Test results using jute fibre

Test results for jute fibre

% of fibre added	Compressive strength							
	For 7 days				For 28 days			
	Cube 1	Cube 2	Cube 3	avg	Cube 1	Cube 2	Cube 3	Avg
0.5%	15.11	15.08	15.17	15.13	24.45	23.78	24	24.07
1%	14.22	14	13.78	15.6	25	25.22	25.89	25.37
1.5%	15.56	16.89	14.34	15.6	21.78	19.56	20.52	20.62

Test results for coir fibre

% of fibre added	Compressive strength							
	For 7 days				For 28 days			
	Cube 1	Cube 2	Cube 3	avg	Cube 1	Cube 2	Cube 3	avg
0.5%	15.78	15.56	16	15.78	23.54	25.78	25.55	24.96
1%	12.45	13.45	13.22	13.04	25.65	25.44	25.22	25.44
1.5%	12.78	12.89	12.67	12.78	23.56	23.89	23.90	23.79

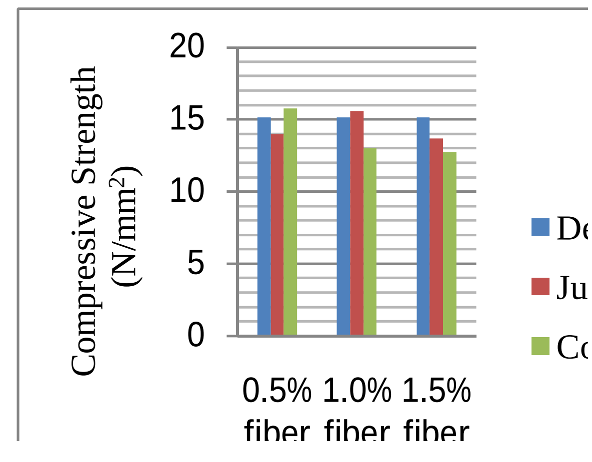

Figure 3. compressive strength for 7 days

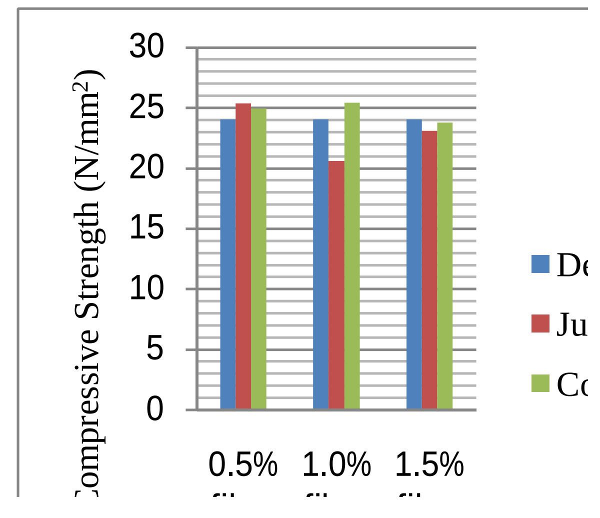

Figure 4. compressive strength for 28 days

5. CONCLUSION

Based on our experimental values we can conclude that

There is variation of the compressive strength in FRC with various percentages of coir and jute.
0.5% coir mix in concrete has increased 4.02% strength but 0.5% jute mix has decreased 7.71% strength of concrete than the design strength for 7days test. 1.0% jute mix has increased the strength by 2.83% but 1.0% coir mix in concrete has decreased the strength by 14.04% than the design strength for 7 days test. In case of 1.5% mix of jute and coir both has decreased the strength by 9.89% and 15.75% respectively than design strength for 7 days test.

Mixing of 0.5% jute and coir fibre in concrete has increased the strength in both the cases by 5.40% and 3.70% respectively after 28 days test. In case of 1.0% fibre mix in concrete jute has decreased the strength by 14.33% but coir has increased by 5.69% after 28 days test. 1.5% mix of jute and coir fibre in concrete has decreased the strength by 4.11% and 1.16% respectively than design strength in both the cases.

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