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# Effect of Chopped Glass Fibers on the Strength of Concrete Tiles

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**ABSTRACT**

**The effect of glass Fiber on flexural strength, split-tensile strength and compressive strength was studied for different Fiber content on M-20 grade concrete designed as per IS 10262.The maximum size of aggregates used was 20mm. To study the effect on compressive strength, flexural strength, split-tensile strength 6 cubes,6 prisms and 6 cylinders were casted and tested. After that a practical application of GFRC in the form of cement concrete tiles was taken into consideration and no special technique was used to produce these tiles. The thickness of the tiles was 20mm and maximum size of aggregates used was 8mm.The water cement ratio was kept consistent and the admixture content was varied from .8 to 1.5 percent to maintain slump in between 50mm to 100mm.The mix proportion used was 1:1.78:2.66. The sizes of short Fibers used were 30mm and the glass fibers were alkali resistant. The effect of these short fibers on wet transverse strength, compressive strength and water absorption was carried out. Six full sized tiles 400mm*400mm*20mm were tested and the results recorded. Pulse velocity tests were also conducted.**

## INTRODUCTION

### General

One of the most important building materials is concrete and its use has been ever increasing in the entire world. The reasons being that it is relatively cheap and its constituents are easily available, and has usability in wide range of civil infrastructure works. However concrete has certain disadvantages like brittleness and poor resistance to crack opening and spread. Concrete is brittle by nature and possess very low tensile strength and therefore fibers are used in one form or another to increase its tensile strength and decrease the brittle behavior. With time a lot of experiments have been done to enhance the properties of concrete both in fresh state as well as hardened state. The basic materials remain the same but super plasticizers, admixtures, micro fillers are also being used to get the desired properties like workability, Increase or decrease in setting time and higher compressive strength. Fibers which are applied for structural concretes are classified according to their material

As Steel Fibers, Alkali resistant Glass Fibers (AR), Synthetic Fibers, Carbon, pitch and polyacrylonitrile (PAN) Fibers.

### Glass Fiber Reinforced Concrete

Glass fiber reinforced concrete (GFRC) is a cementitous composite product reinforced with discrete glass Fibers of varying length and size. The glass Fiber used is alkaline resistant as glass fiber is susceptible to alkali which decreases the durability of GFRC. Glass strands are utilized for the most part for outside claddings, veneer plates and different components where their reinforcing impacts are required during construction. GFRC is stiff in fresh state has lower slump and hence less workable, therefore water reducing admixtures are used. Further the properties of GFRC depends on various parameters like method of producing the product. It can be done by various methods like spraying, casting, extrusion technique set c. Cement type is also found to have considerable effect on the GFRC. The length of the fiber, sand/filler type, cement ratio methods and duration of curing also affect the properties of GFRC.

### Applications

**The main area of FRC applications are as follows**

- Runway, Aircraft Parking and Pavements
- Tunnel lining and slope stabilization
- Blast Resistant structures

- Thin Shell, Walls, Pipes, and Manholes
- Dam sand Hydraulic Structure
- Different Applic5ations include machine too land instrument frames, lighting poles, water and oil tanks and concrete repairs.

**Advantages and Disadvantages of using Glass Fibers in Concrete**

**Advantages**

Lighter weight: With GFRC, concrete can be cast in thinner sections and is therefore as much as75%lighter than similar pieces cast with traditional concrete. According to JeffGirard's blog posttitled," The Benefits of Using a GFRC Mix for Counter tops", a concrete countertop can be 1-inch thick with GFRC rather than 2 inches thick when using conventional steel reinforcement. A manufactured rock made with GFRC will measure a little portion of what a genuine rock of comparable extents would measure, taking into account lighter establishments and decreased delivering Toughness: GFRC doesn't crack easily-it can be cut without chipping.

**Disadvantages**

**Durability:** According to ACI 544.1R-96, State of the Art Report on Fiber Reinforced Concrete, "The strength of fully-aged GFRC composites will decrease to about 40 percent of the initial strength prior to aging." Durability can be increased through the use of low alkaline cements and pozzolans. GFRC as a material, however, is much more expensive than conventional concrete on a pound-for-pound basis.

**Present Investigation**

The purpose of this research is to explore the compressive strength, split-tensile strength and flexural strength properties of concrete reinforced with short discrete fibers. The study was carried out on M-20grade concrete the size of glass fibers used was 30mm and the fiber content was varied from 0% to 0.3% of the total weight of concrete. In studying the above three properties no admixture was used. Also the effect of glass fiber on cement and concrete tiles was studied whose fiber content was varied from 0% to 0.7% of the total weight of concrete. Cement and concrete are heavy duty tiles which are used at various places and are of practical use.

## LITERATURE REVIEW

**General**

Concrete which is one of the most important construction material and is brittle in nature with very good compressive strength but weak in tension and flexure as a result concept of Fiber reinforced concrete has developed. The term Fiber-reinforced concrete (FRC) is defined by AC1 116R, Cement and Concrete Terminology, as concrete containing dispersed randomly oriented Fibers. With time a lot of Fibers have be enused in order to improve the properties of concrete and even waste materials like fly ash, silica fumes have also been used. The concept of using natural Fibers has also evolved but its durability remains questionable. The work done by using different Fibers, waste materials and their effects are discussed below in a sequential manner.

Use of Fibers in a brittle is not a new concept, the Egyptians used animal hairs, straw to reinforce mud bricks and walls in houses, around 1500B.C.(Balagurueta l,1992). Ronald F.Zollo presented a report on Fiber reinforced concrete in which he had mentioned about 30 years of development and research in this filed. In the report it is claimed that the work on FRC started around 1960.Since than a lot of work has been done on FRC using different methods of production as well as different types of Fiber, size of Fiber, orientation and distribution. American Concrete Institute (ACI) Committee 544 divided FRC broadly into four categories based on Fiber material type. SFRC, steel Fiber FRC; GFRC, glass Fiber FRC; SNFRC, synthetic Fiber FRC including carbon Fibers; and NFRC,for natural Fiber FRC. The idea of fiber support has been produced in current times and weak cement based brittle matrix was strengthened with asbestos filaments when in around 1900 the alleged Hatschek innovation was created for creation of plates for material, funnels, and so forth. Later, glass Fibers were proposed for fortification of concrete glue and mortar by Biryukovichs.

**Waste Fibrous Materials:**

Huge amount of waste materials are produced in our country. These waste materials are both organic and inorganic. The amount of inorganic waste material produced is increasing day by day and to dispose them of without causing any harm to environment is a big problem. Many researches are now trying to use the waste material as construction materials. Also natural Fibers are available in abundant and can be an alternate for use in construction of cost effective materials in urban and rural buildings.

**Inorganic Fibers:**
Kenneth W. Stier and Gary D. Weeded (1999) investigated the feasibility of recycling coming led plastics Fiber in Concrete. It was found that the mechanical properties of concrete such as compressive and flexural strength showed improvement but however the durability aspect was questionable. Sekar(2004)studied on Fiber reinforced concrete from industrial lathe waste and wire winding waste and found that this waste significantly improved the compressive, split-tensile strength and the flexural strength values of concrete. It also stated that wire drawing industry waste decreased the strength values. Effect of re-engineered plastic shred Fiber were studied by Anbuvelan et al (2007).The engineering properties Compressive, split tensile, flexural, abrasion, impact strength and plastic shrinkage of the concrete was found to have improved.

**Natural Fibers:**
Natural Fibers were traditionally used in the past as reinforcing materials and their use so far has been traditional far more than technical. They have served useful purposes but the application of natural Fiber as a reinforcing material for concrete is a new concept. Improved tensile and bending strength,, greater resistance to cracking and hence improved impact strength and toughness ,greater ductility are some of the properties of natural Fiber reinforced concrete. Rama krishna et al (2002) looked at the hypothetical and exploratory examinations on the compressive quality and elastic modulus of coir and sisal Fiber strengthened cements for different volume divisions. It was watched that both the exploratory and analytical values of flexible modulus had indicated 15% error, which can be viewed as relatively little. Rheological properties of coir fiber strengthened cement mortar were done by Ramakrishna and Sundar rajan (2002).Flow value, cohesion and angle of internal friction were resolved for three different mix ratios and four different aspect ratios and Fiber contents. In view of the rheological properties of fresh mortar, it was prescribed to use short filaments with low Fiber-content for achieving workability and higher Fiber content for better cohesiveness in wet state. Composites of blast furnace slag BFS based cement mortar strengthened with vegetable strands were presented by Holmes Savastano Jr etal (1998). Composites were produced through a straightforward and low-vitality expending strategy, including standard vibration and curing in a wet chamber.

Eucalyptus pulp, coir Fibers and with a mixture of is sale Fiber and eucalyptus pulp gave a suitable performance but the performance deteriorated with time. The natural Fiber composites may undergo a decrease in strength and toughness as a result of debilitating of Fibers by the combination of alkali attack and mineral is ation through the migration of hydrogen products to lumens and spaces. Romildo D.Toledo Filhoetal(2003) reported their study on development of vegetable Fiber-mortar composites of improved durability. So a few methodologies were proposed by the authors to enhance the solidness of vegetable fiber-concrete composites. These incorporate carbonation of the grid in a CO2- rich environment; the drenching of strands in slurried silica fume earlier to joining in Ordinary Portland Cement lattice; in complete substitution of Ordinary Portland Cement by unidentified silica fume or blast furnace slag.

The execution of adjusted vegetable fiber-mortar composites was investigated in terms of impacts of maturing in water, presentation to cycles of wetting and drying and open air weathering on the microstructures and flexural conduct.It was recommended that submersion of common strands in a silica see the slurry before the expansion to the bond based composites was discovered to bean successful method for decreasing embrittlement of the composite in nature. Additionally early cure composites in a CO2- rich environment and the fractional substitution of OPC by unidentified silica smoke were the proficient methodologies in getting regular strands with enhanced sturdiness.

**Modelling Approach**
Mechanical characterization and impact behavior of concrete reinforced with natural Fibers were studied by Al-Oraimi and Seibi(1995). Here, an exploratory study was led utilizing palm tree and glass filaments on high quality cement. Mechanical quality properties, for example, compressive strength, part ductile, flexural qualities and post breaking toughness were concentrated on. It was reasoned that common strands will be similar with glass filaments. A limited component examination was additionally do reutilizing ANSYS programming. Both the expository and test results were analyzed and adequate.

Antonia F.Barbosa and Gabriel O. Ribeiro (1998)worked on ANSYS for limited component investigation of reinforced solid structures. An essentially up held fortified concrete bar subjected to consistently conveyed burden was taken as a basic sample in that study Two different models were considered for steel reinforcement such as discrete and smeared. Load – deflection curves obtained through ANSYS have been compared with experimental results and they have been found to be satisfactory.

Finite element analysis using ANSYS was done by Greeshma and Jaya(2007) to analyse a shear wall under seismic loading. Modelling of shear 21 wall was done using SOLID65 model and reinforcements were modeled using LINK 8

element. The analyses were carried out for the shear wall, subjected to both static and dynamic loading.

**Analytical Approach**

One of the important applications of Fiber reinforced concrete involves making earthquake resistant structures. Not only earthquakes, most of the unanticipated loadings are cyclic in nature. The behavior of Fiber reinforced concrete beams under cyclic loading which simulate esse is mic motion is important from study point. The critical seismic design n parameter called cumulative ductility Indicator was proposed by Banon et al (1981).

Roufail and Meyer (1987) proposed some analytical modeling of hysteretic behaviour of reinforced concrete structures. Measures of stiffness degradation have been considered as damage indicators: But in the equation used, the effect of repeated cyclic loading was not considered.

Kratzig et al (1989) proposed a model to evaluate the damage index in reinforced concrete under cyclic loading. The proposed damage index was based on the hysteric energy absorbed by a member. The first loading cycle at given amplitude is termed as primary half cycl , with

Subsequent cycle at the same or smaller amplitudes termed as follows. Then, the damage index for the positive half cycle was defined. A similar index was defined for a negative cycle, the overall damage index was calculated. Wang and Shah (1987) proposed a reinforced concrete hysteric model on the damage concept. The proposed damage was a simple one in which the rate of accumulation of damage is assumed proportional to the damage already incurred.

An extensive study of literature suggests that glass Fibers may enhance the toughness, flexural strength, tensile strength, impact strength, fatigue performance as well as the failure mode of the concrete when compared to plain concrete. The fire resistance of glass Fiber reinforced concrete is also good.

## CONCLUSIONS

In this experimental program the effect of short discrete glass fibers on the compressive, split tensile strength and flexural strength of concrete was studied.

The effect of glass Fibers on cement and concrete tiles which are produced by vibration method are also studied. The properties studied are compressive strength, wet transverse strength and water absorption .The concrete mix gets harsher and less workable with increase of fiber content therefore use of admixture become necessary. However even after giving dosage of admixture as high as 1.5% proper workability could not be obtained and some segregation was observed. Therefore it was not possible to go beyond 0.7% fiber content.

**The various observations based on the experimental result are as follows:**

The compressive strength of concrete without admixture is not affected by the presence of short discrete glass fibers with Fiber content in the range 0.1 to 0.3 % of fiber content by weight of concrete.

The split tensile strength of concrete increases with the addition of glass fibers.

The flexural strength of concrete increases within crease in fiber content and as such the tension carrying capacity of concrete may increase in flexure

The wet transverse strength of tiles increases and the increase has been found with addition of fibers

The water absorption of the concrete also decreases with increase in fiber content.

The compressive strength of concrete with admixture was not affected upto 0.4 % fiber content but decreased with the presence of higher amount of fibers .

## REFERENCES

[1] CookD.J.,Pama R.P.,WeerasingleH.L.S.D.“Coir Fiber reinforced cement also cost roofing material”. Build Environ 1978;13(3):193–8.

[2] Perez-Pena .M and Mobasher .B, “Mechanical properties of fiber reinforced light weight concrete composites”. CementandConcreteResearch,Vol.24,No.6,pp. 1121-1132,1994

[3] Brandt AM. “Cement-based composites: materials, mechanical properties and performance”. London: E&FN Spon; 1995. p. 470

[4] Nakamura H, Mihashi H. “Evaluation of tension softening properties of fiber reinforced cementitious composites.” Fracture Mechanics of Concrete Structures 1998; I:499e510.
[5] MirzaF.A.,So roushian ndP.“Effects of alkali-resistant glass fiber reinforcement on crack and temperature resistance of lightweight concrete.” Cement and Concrete Composites 2002;24(2):223–7
[6] Robert S.P. Coutts .“A review of Australian research into natural Fiber cement composites” Cement & Concrete Composites 27 (2005) 518–526
[7] Khosrow Ghavami.“Bamboo as reinforcement in structural concrete elements”. Cement & Concrete Composites 27 (2005) 637–649
[8] Huang Gu, Zuo Zhonge “Compressive behavior of concrete cylinders reinforced by glass and polyester filaments”. Materials and Design 26 (2005) 450–453
[9] Andrzej Brandt.M“Fiber reinforced cement-based (FRC) composite safte rover 40 years of development in building and civil engineering”. Composite Structures 86 (2008) 3–9
[10] LuizC. Roma Jr., LucianeS. Martello, Holmer Savastano Jr.“Evaluation of mechanical, physical and thermal performance of cement-based tiles reinforced with vegetable fibers”. Construction and Building Materials 22 (2008) 668–674