RESEARCH ARTICLE OPEN ACCESS

CHOPPED GLASS FIBERS ON THE MULTIPLES MEASURE ON TILES

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Abstract:
The effect of glass fibre on flexural strength, split-tensile strength and compressive strength was studied for different fibre content on M-20 grade concrete designed as per IS 10262.The maximum size of aggregates used was 20mm. 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 size of short fibres used were 30 mm and the glass fibres were alkali resistant. The effect of this short fibres on wet transverse strength, compressive strength and water absorption was carried out. Six full sized tiles 400 mm * 400 mm * 20 mm were tested and the results recorded. Pulse velocity tests was also conducted.

1. Introduction
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-20 grade concrete the size of glass fibers used was 30 mm 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 fibre 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 is of practical use.

General
One of the most important building material 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 fibres are used in one form or another to increase its tensile strength and decrease the brittle behaviour. 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 superplasticizers, admixtures, micro fillers are also being used to get the desired properties like workability, Increase or decrease in setting time and higher compressive strength.

Fibres which are applied for structural concretes are classified according to their material
As Steel fibres, Alkali resistant Glass fibres (AR), Synthetic fibres, Carbon, pitch and polyacrylonitrile (PAN) fibres.

Glass Fibre Reinforced Concrete
Glass fibre reinforced concrete (GFRC) is a cementitous composite product reinforced with discrete

glass fibres of varying length and size. The glass fibre used is alkaline resistant as glass fibre are 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 stiffin 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 likes praying, casting, extrusion techniques etc. Cement type is also found to have considerable effect on the GFRC. The length of the fibre, sand/filler type, cement ratio methods and duration of curing also effect the properties of GFRC.

Objectives of Thesis

- To examine the water absorption behavior of concrete due to addition of glass fibres.
- To determine the compressive strength of concrete with and without admixtures on adding glass fibres

LITERATURE REVIEW

General

composites that have high flexural quality and durability and low drying shrinkage, not with standing this they have great electrical properties, for example, voltage-touchy impact. Ease pitch carbon filaments is satisfactory for scaffolds, other structural designing structures further more for cladding for structures, Kucharska and Brandt. In the districts with Corrosive impact of marine climate and solid winds (e.g. in Japan) CFRC is utilized as apart of scaffold auxiliary components for preferred toughness over it would be conceivable utilizing steel filaments.
Fibre-reinforced polymer (FRP) bars can be used to replace steel reinforcement conventional steel has the inherent problem of corrosion as a result of which it undergoes expansion and concrete cracking may occur; therefore FRP rebar may be used as an alternate.The use of this fibres excludes the problem of corrosion and increases the ductility of the FRP-reinforced concrete beams but the load deflection was found to be higher.(Mohamed S. Issa, Ibrahim M.Metwally, Sherif M. Elzeiny 2010).
SIFCON (slurry penetrated fiber cement) is an in number composite in which a high volume of steel filaments is utilized by unique innovation. Strands are preplaced in a mold and the fiber frame work got is invaded by cements lurry. Fiber volume may achieve 8–12%, occasionally
Significantly higher, and filaments 100–200 mm long may be utilized. The concrete slurry is loaded with fines and, small scale total and exceptional added substances like fly-as hand silica fumes. The high smoothness (low consistency) of the slurry is vital for satisfactory in filtration of the thick fiber frame works in a mold. High-quality and resistance against near by effects and in filtration of shots describe the components made with SIFCON. At the point when rather than single filaments the woven or plaited mats are utilized, then the name SIMCON (slurry penetrated mat cement) is utilized. The fundamental uses of both materials are overwhelming obligation asphalts, hostile to terrorist shields, dividers in bank treasuries, and so forth.Where extra cost of materials and unique innovation are worth.

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 fibres 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. Weede (1999) investigated the feasibility of recycling coming led plastics

Fibre 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 fibre 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 in dustry waste decreased the strength values. Effect of re-engineered
plastic shred fibre 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 Fibres:

Natural fibres 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 fibre 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 fibre reinforced concrete. Ramakrishna et al (2002) looked at the hypothetical and exploratory examinations on the compressive equality and elastic modulus of coir and sisal fibre strengthened cements for different volume divisions. It was watched that both the exploratory and analytical values of flexible modulus had indicated15 % error, which can be viewed as relatively little. Rheological properties of coir fiber strengthened cement mortar were done by Ramakrishna and Sundararajan (2002). Flow value, cohesion and angle of internal friction were resolved for three different mix ratios and four different aspect ratios and fibre contents. In view of the rheological properties of fresh mortar, it was prescribed to uses hort filaments with low fibre-content for achieving workability and higher fibre content for better cohesiveness in wet state. Composites of blast furnace slag BFS based cement mortar strengthened with vegetable strands were presented by Holmer Savastano Jr et al(1998). Composites were produced through a straightforward and low-vitality expending strategy, including standard vibration and curing in a wet chamber. Eucalyptus pulp, coir fibres and with a mixture of sisal fibre and eucalyptus pulp gave a suitable performance but the performance deteriorated with time. The natural fibre composites may undergo a decrease in strength and toughness as a result of debilitating of fibres by the combination of alkali attack and mineralization throughthe migration of hydrogen products to lumens and spaces. Romildo D.ToledoFilhoetal (2003) reported their study on development of vegetable fibre-mortar composites of improved durability. So a few methodologies were proposed by the authors to enhance the solidness of vegetable fiber-concrete composites. These in corporate carbonation of the grid in a CO_2- rich environment; the drenching of strands in slurried silica fume earlier to joiningin Ordinary Portland Cement lattice; in complete substitution of Ordinary Portland Cement by undensified 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 seethe slurry before the expansion to the bond based composites was discovered to bean successful method for decreasing embrittlement of the composite in nature.Addition all yearly cure composites in a CO_2- rich environment and the fractional substitution of OPC by undensified silica smoke were the proficient methodologies in getting regular strands with enhanced sturdiness.

Materials and Methods

The main functions of the fibers are to carry the load and provide stiffness, strength, thermal stability, and other structural properties in the FRC.
Glass strands are filaments generally utilized as a part of the maritime and mechanical fields to create composites of medium-elite.Their unconventional trademark is their high quality. Glass is

basically made of silicon (SiO2) with at etrahedral structure (SiO4). So me aluminum oxides and other metallic particles are then included different extents to either facilitate the working operations or change a few properties (e.g., S-glass strands show a higher elasticity than E- glass).
The era development of fiberglass is fundamentally in light of turning a bunch made of sand, alumina, and limestone. The constituents are dry mixed and passed on to melting (around 1260°C)in a tank. The liquefied glass is conveyed straight forward lyon platinum bushing sand, by gravity, goes through specially appointed openings situated on the base.The fibers are then gathered to shape a strand ordinarily made of 204 fibers. The single fiber has a normal measurement of 10 μm and is regularly secured with a measuring. They arnsare then packaged, much of the time without curving, in a meandering. Glass filaments are like wise accessible as slim sheets, called mats. A mat may be made of both long persistent and short strands (e.g., irregular filaments with an ordinary length somewhere around 25 and 50 mm), haphazardly organized and kept together by a concoction bond. The width of such tangles is variable between 5 cm and 2m, their thickness being around 0.5 kg/m^2. Glass filaments normally have a Young modulus of versatility lower than carbon or a ramid strands and their scraped area resistance is moderately poor; consequently, alert in their control is needed. Likewise, they are inclined to crawl and have low exhaustion quality. To upgrade the bond in the middle of filament sand grid, and to secure the strand sit self against soluble operator sand dampness, strands experience estimating medicines going about as coupling specialists. Such medicines are helpful to improve toughness and weakness execution (static and element) of the composite material. FRP composites taking into account fiber glass are normally meant as GFRP.

Admixture

Admixtures are the chemical compounds that are used in concrete other than hydraulic cement (OPC),water and aggregates, and can also be called as mineral additives that are added to the concrete mix just before or during blending to adjust one or more of the particular properties of the concrete in the fresh or hardened state. The utilization of admixture is necessary to offer a change which is not financially achievable by changing the extents of water, cement and though not influencing the performance and durability of the concrete. Usually used admixtures are accelerating admixtures, retarding admixture, air-entraining admixtures and water-reducing admixture. In our case a water reducing admixture was used to obtain the desire workability as with increase in fibre content the mixture was becoming stiffer.
The experimental work consists of casting cubes, cylinders and prisms to study the effect of glass fibres on the compressive, flexural and split tensile strength of concrete. The effect was studied by varying the fibre content from 0% to 0.3%, no water reducing admixture was used for the experimental programme. To check the effect on concrete for fibre content variation 6 specimens each of cube, prisms and cylinders were casted. Test were conducted on the specimen after 7days and 28 days.
Further in order to get a practical use of glass fibres in concrete, concrete tiles were casted. The size of the tiles being 400 mm * 400 mm *20 mm.The maximum size of aggregates used for 8 mm in case of tiles and the testing for tiles were done as per IS 1237:2012.The fibre content varied from 0% to 0.7% and the main study of interest was Compressive strength, wet transverse strength and water absorption.

Casting of Tiles

The tiles were prepared as per the guidelines of IS 1237:2012.The size chosen was one of the standard sizes mentioned in the code. The size was 400mm*400mm*20mm.The tiles were prepared from a mixture of Portland slag cement, natural aggregates and after casting this tiles were vibrated. The tiles were single layered and outmost care was taken to prepare them so that thickest and thinnest tile in the sample when compared did not exceed 10% of the minimum thickness. The mix was prepared by machine and then the mix prepared was poured in the moulds one at a time and then first they were hand compacted after that vibrated on the vibrator table. The surface finishing was done by using a finishing trowel. After pouring in the moulds and compacting on the vibrator table the moulds were put down on the surface and allowed to set for 24hrs.The mould for casting tiles is shown in figure 1.

Figure1 Mold for casting of tiles

Materials For Casting

Cement

Portland slag cement (PSC) – 43 grade (Kornak Cement) was used for the experimental programme. It was tested for its physical properties in accordance with IS standards.

Fine Aggregates

The fine aggregates used for experimental programme was obtained from bed of river Koel. The fine aggregates used passed through 4.75 mm sieve and had a specific gravity of 2.68. The fine aggregates belonged to Zone III according to IS383 .

Coarse Aggregates

The coarse aggregates used were non-reactive and as per the requirements to produce a good and durable concrete .The coarse aggregates were of two different grading and as such a definite mix proportion was used to obtain the desire grading for coarse aggregates.One grade has maximum size of 10mm and minimum 4.75mm and for the other the maximum size was 20mm and minimum 10mm.This combination was used for casting cubes, cylinders and prisms.For casting cement and concrete tiles a maximum size of 8mm and retained on 4.75mm was used. The coarse aggregates for casting tiles was obtained by sieving 10mm down aggregates.

Water

Ordinary tap water which is safe and potable for drinking and washing was used for producing all types of mix.

Glass Fibers

Glass fiber also known as fiberglass is made from extremely fine fibres of glass. It is a light weight, extremely strong and arobust material. Glass fibres are relatively less stiff and made From relatively less expensive material as compared to carbon fibres It is less brittle and also has lower strength than carbon fibers.There are various types of glass fibers:

1. A-glass: Also known as alkali glass and is made from soda lime silicate.
2. AR-glass:Alkali resistant glass and is made from zirconium silicates. This type of glass fibers are used in cement substrates.
3. C-glass: This type of glass fibers are used in acid corrosive environments Made from calcium borosilicate's
4. D-glass: Low dielectric constant made with boro silicate's.
5. E-glass: This glass fibers have very high electrical resistance and are very commonly used.
6. ECR-glass: An E-glass which has higher acid corrosion resistance
7. R-glass: It is a support glass and is utilized where higher quality and corrosive erosion resistance is needed.
8. S-glass:Also known as structural glass and are in use where high quality,high firmness, compelling temperature resistance and destructive resistance is required.
   In our case AR-glass fibers were used. The glass fibers used had a density of 2.7 gm/cm^3, tensile strength 1700 MPa and Young's Modulus 72GPa.

EXPERIMENTAL SETUP

Various tests conducted on the specimens are described below along with the description and importance.There were two ways in which the investigation was carried out one in which only cubes, cylinders and prisms were casted and the grade of concrete was M-20.The proportioning of the concrete was.The nominal maximum size of aggregate was 20 mm and no admixture was used.

Compressive strength

The most important property of concrete is its compressive strength and durability. Concrete is mostly used in construction where load transferred is mostly via compressive strength. In order to check the effect of fibres on the compressive strength of concrete150 mm cubes were cast and tested .The cubes were tested at the age of 7days and 28 days and the variation was noted.
Fibre content was varied from 0% to 0.3% when the nominal maximum size of aggregates was 20mm and no admixture was used. The water cement ratio was fixed at 0.5. The workability of the mix was observed to come down but however no extra water was used.

Split Tensile Strength

Concrete maybe subjected to tension in very rare cases and is never designed to resist direct tension. However, the load at which cracking would occur is important and needs to be determined. The tensile strength of concrete as compared to its compressive strength is very low and is found to be only 10-15 % of the compressive strength. There are various factors which influence the tensile strength of concrete like aggregates, age, curing, air-entrainment.
To conduct the split tension test a cylindrical concrete specimen is loaded along its length as a result of the loading tensile stresses are developed along the central diameter along the lateral direction. The specimen splits into two when the limiting tensile strength is reached and this value

can be calculated from the load given below
A diagram is shown to show how the test is carried out:

Flexural Strength

Flexural strength is also a measure of the tensile strength of concrete. In practical concrete may not be subjected to direct tension but it is subjected to flexure in many cases particularly in beams which is a flexural member. Flexural strength is also referred to as modulus of rupture. In order to calculate the flexural strength a

Tests carried out on Cement and Concrete Tiles

Cement and concrete flooring tiles are tested as per IS1237:2012 There are various tests given in the code but we have done the water absorption test and wet transverse strength. Other tests that were conducted on the tiles was the pulse velocity test which is anon-destructive test and predicts the quality but not the grade of concrete.The IS code does not say anything about the compressive strength test but however in order to check the compressive strength six100 mm cubes were cast and tested at 7 days and 28 days.

Water absorption test

Six tiles were immersed in water for 24hrs, than the tiles were taken out and wiped dry. Each tile was immediately weighted after saturation. The tiles were then placed in an oven at 65^{0}C for 24 hrs and then cooled and reweighed at room temperature.

$$\frac{M1 - M2 \ X100}{M2}$$

Where

M1= mass of the saturated specimen;
M2=mass of the oven-dried specimen.

Wet Transverse Strength Test

In order to determine the wet transverse strength of tiles six full sized tiles are tested at 28days as per the guidelines given by IS 1237:2012. Before performing the test the tiles are soaked in water for 24 hrs and then placed horizontally on two parallel steel supports, the wearing surface is up wards and its sides parallel to supports.The load is applied in such a way that the steel rod is parallel to supports and midway between them. It is required that the length of the supports and of the loading rod shall be longer than the tile. The diameter of the loading rod shall be 12 mm and be rounded. The load is applied at a uniform rate of 2000N/min, until the tile breaks. The wet transverse strength is calculated using the formula given in IS code as given below:

$$\frac{3PI}{2bt^2} N/mm^2$$

Where,

P=breaking load in N;

I=span between supports,in mm; b = tile

width, in mm; and
t= tile thickness, in mm.

Compressive Strength

To get the compressive strength variation due to glass fibres 100mm cubes were cast with the same mix as used for casting concrete tiles with the same amount of admixtures. Six 100mm cubes were cast for each fibre content. Three cubes were tested at 7days and three at 28 days. The compressive test was done on universal testing machine.The cubes were cured using pond curing method and before testing they were allowed to surface dry. The formula used for calculating compressive strength is given below:

$$c = \frac{P}{A}\ N/mm^2$$

Where,
P=load in Newton (N) at which failure occurs, A=surface area in $mm^{2.}$

RESULTS

The 28 days Split Tensile strength was studied and the values of 3 samples studied are shown in the tabular form.Table 4 shows the data of 28 days compressive strength obtained.Table 4 gives the 28 days compressive strength of concrete with maximum nominal size of aggregates 20mm.The 28 days Split Tensile strength was also plotted Fig5 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table4 28 days Split Tensile Strength of Concrete

Serial number	Without fibre	0.1%	0.2%	0.3%
1	2.829	2.83	2.97	2.97
2	2.76	2.83	2.97	2.97
3	2.829	2.97	3.35	2.97

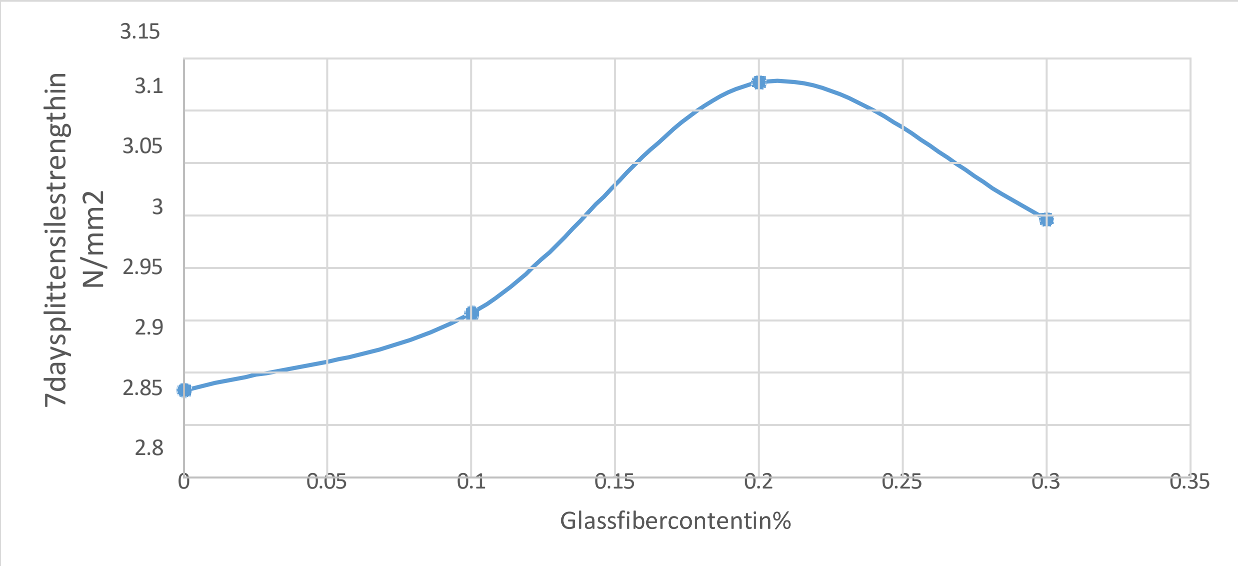

Figure5 Effect of Glass fibers on 28days Split Tensile Strength

Flexural Tensile Strength (in N/mm^2)

The 7days Flexural Tensile strength was studied and the values of 3 sample studied are shown in the tabular form. Table5 shows the data of 7days flexural tensile obtained.Table 5gives the 7day compressive strength of concrete with maximum nominal size of aggregates 20 mm.The 7 days compressive strength was also plotted Fig 6 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table5 7 days Flexural Strength of Concrete

Serial number	Without fibre	0.1%	0.2%	0.3%
1	4.6	4.744	4.988	5.744
2	4.7	4.776	4.988	5.424
3	4.8	4.756	4.9	5.704

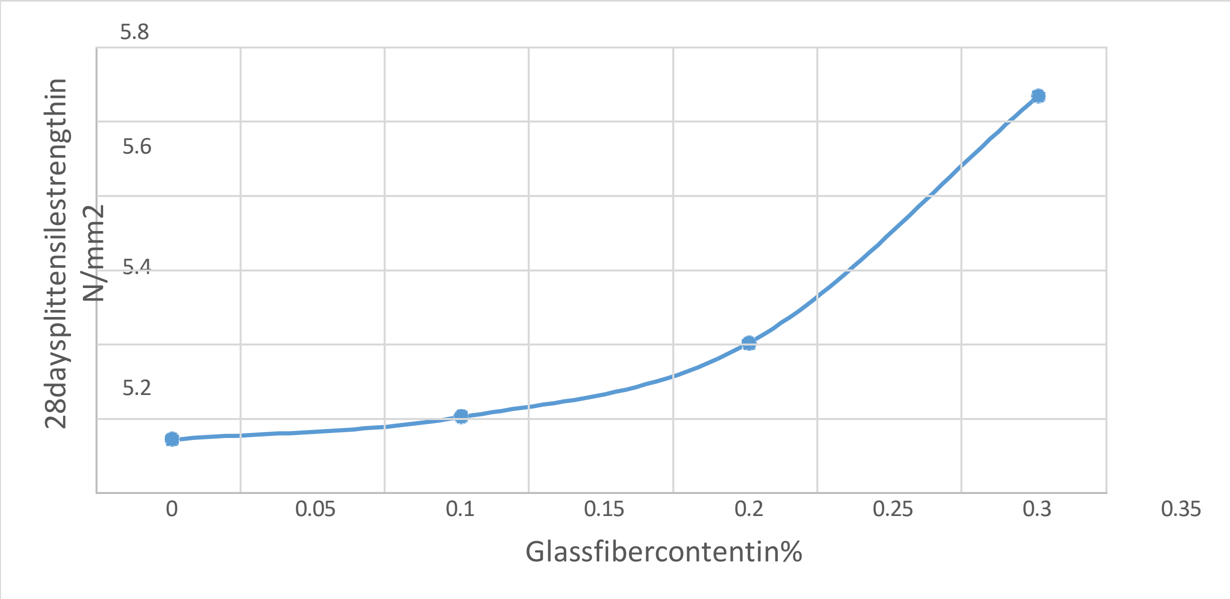

Figure6 Effect of Glass fibers on7 days Flexural strength

The 28 days flexural tensile strength was studied and the values of 3samples studied are shown in the tabular form.Table 6 shows the data of 28 days compressive strength obtained. Table 6 gives the 28 days flexural tensile strength of concrete with maximum nominal size of aggregates 20mm.The 28 days flexural tensile strength was also plotted Fig7 by taking the average of this three values overall an increase in the compressive strength was observed with addition of fibers.

Table6 28 days Flexural Strength of Concrete

Serial number	Without fibre	0.1%	0.2%	0.3%
1	5.104	6.368	s7.544	7.156
2	5.204	6.456	7.104	7.96
3	5.242	6.652	6.844	8.32

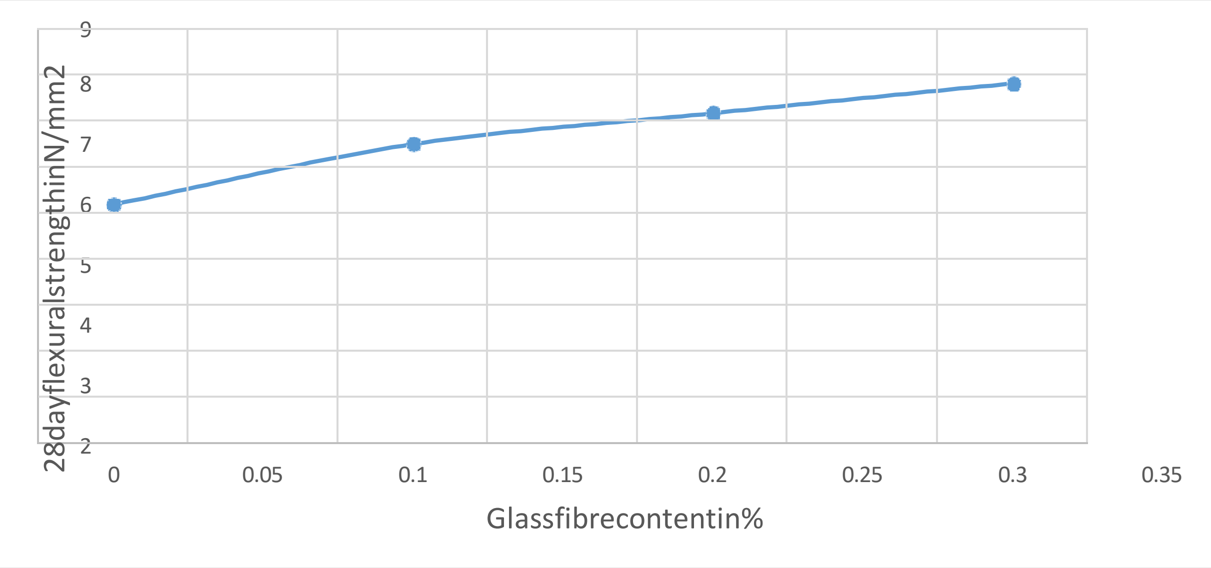

Figure 7 Effect of Glass fibers on 28 days Flexural strength

Tests carried out on cement and concrete tiles

Cement and concrete tiles were tested as per IS 1237:2012.The test performed were wet transverse strength, water absorption test .Compressive strength test is not mentioned in the code but it was performed as fibers can reduce the strength of the concrete.Pulse velocity test and natural frequency test were also conducted. The results obtained are given below in tabular form:

Compressive strength test

The 7 days compressive strength was studied and the average values of 3 samples studied are shown in the tabular form. Table 7 shows the data of 28 days compressive strength obtained. Table 7 gives the 7 days compressive strength of concrete with maximum nominal size of aggregates 8 mm. The 7 days compressive strength was also plotted as shown in Fig 8 overal la decrease in the compressive strength was observed with addition of fibers.

Table7 7 days Compressive Strength of Concrete

Fibre content (%of the total Weight of concrete)	WEIGHT(KG)	Average 7 days compressive strength (N/mm^2)
0	2.495	32
0.1	2.478	28
0.2	2.478	30
0.3	2.500	31
0.4	2.487	28
0.5	2.500	27
0.6	2.400	26
0.7	2.390	25

CONCLUSIONS

1. The wet transverse strength of tiles increases and the increase has been found with addition of fibers
2. The water absorption of the concrete also decreases with increase in fiber content.
3. 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 .

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