# Experimental Study On Flexural Behaviour Of Hybrid Fibre Reinforced Concrete Member

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**Abstract - In a Hybrid Fibre Reinforced Concrete (HFRC), two or more different types of fibres are rationally combined to produce a cementitious composite that derives benefits from each of the individual fibres and exhibits a synergistic response. The main aim of the present experimental investigation was to combine different fibres namely crimped stainless steel fibre and Glassfibre to produce HFRC and thus to evaluate its performance under compression, tension and flexure types of loading. The dimension of test specimens are of cube 150mmx150mmx150mm, cylinder of diameter 150mm, height 300mm, beam of 1000mmx150mmx100mm and 500mmx100mmx100mm Based on I.S. Code method of mix design, proportion of different ingredients was obtained to get M25 grade concrete. Samples were prepared by varying the volume fraction of fibres from 0 to 1.25% for each fibres individually and then the optimum percentage of fibres were combined to obtain HFRC.**

**Keywords – compressive strength, split tensile strength, flextural strength.**

## I. INTRODUCTION

### 1.1 GENERAL

A composite can be termed as hybrid, if two or more types of fibres are rationally combined in a common matrix to produce a composite that drives benefits from each of the individual's fibres and exhibits a synergetic response. Addition of short discontinuous fibres plays an important role in the improvement of mechanical properties of Concrete. It increases elastic modulus; decreases brittleness controls cracks initiation and its subsequent growth and propagation.

Deboning and pull out of the fibre require more energy absorption, resulting in a substantial increase in the toughness and fracture resistance of the materials to the cyclic and dynamic loads.

### 1.2FIBRE REINFORCED CONCRETE

Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, where tensile strength is only approximately one tenth of its compressive strength. As a result of these characteristics, concrete member could not support such loads and stresses that usually take place, majority on concrete beams and slabs. Historically, concrete member reinforced with continuous reinforcing bars, withstand tensile stresses and compensate for the lack of ductility and strength. Furthermore, steel reinforcement is adopted to overcome high potentially tensile stresses and shear stresses at critical location in concrete member. The additional of steel reinforcement significantly increase the strength of concrete, but to produce concrete with homogenous tensile properties, the development of micro cracks is a must to suppress. The introduction of fibres was brought in as a solution to develop concrete in view of enhancing its flexural and tensile strength, which are a new form of binder that could combine Portland cement in the bonding with cement matrices. Fibres are most generally discontinuous, randomly distributed throughout the cements matrices. The term 'Fibre Reinforced Concrete' (FRC) is made up with cement, various sizes of aggregates, which incorporate with discrete, discontinuous fibres.

### 1.3 HISTORY OF HFRC

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 early 1900s, asbestos fibres were used in concrete, there was a need to find a replacement for the asbestos used in the concrete and other building materials once the health risks associated with the substance were discovered. By the 1960s, steel, glass, and synthetic fibres such as polypropylene fibres were used in concrete, and research in to new fibre reinforced concretes continues today.

### 1.4 EFFECT OF FIBRES IN CONCRETE

Fibre reinforced concrete is a composite material comprised of Portland cement, aggregate and fibres. Normal unreinforced concrete is brittle with a low tensile strength and strain capacity. The function of the irregular fibres distributed randomly is to fill the cracks in the composite. Fibres are generally utilized in concrete to manage the plastic shrinkage cracking and drying shrinkage cracking. They also lower the permeability of concrete and therefore reduce the flow of water. Some types of fibres create greater impact, abrasion and shatter resistance in the concrete. Usually fibres do not raise the flexural strength of concrete. The quantity of fibres required for a concrete mix is normally determined as a percentage of the total volume of the composite materials. The fibres are bonded to the material and allow the fibre reinforced concrete to withstand considerable stresses during the post- cracking stage. The actual effort of the fibres is to increase the concrete toughness.

## 1.5 TYPES OF FIBRE REINFORCED

### 1.5.1 Steel Fibre-Reinforced Concrete

Steel fibre-reinforced concrete is basically a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of prep work but make for a much stronger concrete.

Steel fibre-reinforced concrete uses thin steel wires mixed in with the cement. This imparts the concrete with greater structural strength, reduces cracking and helps protect against extreme cold. Steel fibre is often used in conjunction with rebar or one of the other fibre types.

**Fig.1.1** Steel FibreReinforced Concrete

### 1.5.2 Glass Fibre Reinforced Concrete

Glass fibre-reinforced concrete uses fibreglass, much like you would find in fibreglass insulation, to reinforce the concrete. The glass fibre helps insulate the concrete in addition to making it stronger. Glass fibre also helps prevent the concrete from cracking over time due to mechanical or thermal stress. In addition, the glass fibre does not interfere with radio signals like the steel fibre reinforcement does.

**Fig.1.2** Glass Fibre Reinforced Concrete

### 1.5.3 Synthetic Fibres

Synthetic fibre-reinforced concrete uses plastic and nylon fibres to improve the concrete's strength. In addition, the synthetic fibres have a number of benefits over the other fibres. While they are not as strong as steel, they do help improve the cement pumpability by keeping it from sticking in the pipes. The synthetic fibres do not expand in heat or contract in the cold which helps prevent cracking. Finally synthetic fibres help keep the concrete from spalling during impacts or fires.

**Fig.1.3** Synthetic FibreReinforced Concrete

### 1.5.4 Natural Fibre Reinforced Concrete

Historically, fibre reinforced concrete have used natural fibres, such as hay or hair. While these fibres help the concrete's strength they can also make it weaker if too much is used. In addition if the natural fibres are rotting when they are mixed in then the rot can continue while in the concrete. This eventually leads to the concrete crumbling from the inside, which is why natural fibres are no longer used in construction.

**Fig.1.4** Natural FibreReinforced Concrete

**1.5.5 Polypropylene FibreReinforced Concrete**

The polypropylene fibres are hydrophobic, and they do not absorb water, and are non-corrosive. Moreover they have excellent resistance against alkali, chemicals and chloride and have low heat conductivity. By these characteristics, polypropylene fibres have therefore no significant effect on the water demand of the fresh concrete. They do not intervene in the hydration of cement and hence they do not influence unfavourably the effects of all constituents in the concrete mixture.

Polypropylene is the lightest synthetic polymer. Hence the count of fibre for a given weight is maximum in case of polypropylene. Unlike other fibres, they are also available in triangular cross-section. By simple calculation, one can see that a triangular fibre has 29% more surface area than circular fibre. Higher surface area results in better reinforcement and it is easy to use and they can disperse easily.

The length of fibres varies from 24mm to 42mm. The longer length fibre holds the different components of concrete together, while shorter length fibres increases the number of fibres, there by providing better reinforcement, crack prevention and increase in strength of concrete. These polypropylene fibres are suitable for structural works. It can be used to decrease or replace the steel in concrete, particularly in floors and certain precast. The customized blending of the fibres can be provided to obtain better results. As the fibre is long, it gives better anchorage and reinforcement and also increases the number of fibres in a given dosage, preventing crack formation. It is recommended for heavy structural concrete/load bearing structures. It is most popular among macro fibres and it gives better result.

**Fig.1.5** Polypropylene FibreReinforced Concrete

**1.6 APPLICATION OF FIBRE REINFORCED CONCRETE**

- Floors, driveway and walks to reduce shrinkage and cracking problems are desirable
- Increase of toughness in fibre-reinforced concrete is ideal for buildings and pavements subject to shatter, impact, abrasion, and shear.
- Its use in crack control and shrinkage for water retaining and reservoir structures to reduce the permeability and freeze-thawing conditions.
- Its replacement for temperature steel in sanitary sewer tunnels prevents corrosion and improves ductility.
- Runways are made more resistant to fuel spills with less permeable and shatter resistant fibre-reinforced concrete.
- Pumped concrete project gets easy and safe with fibre, making concrete more cohesive and prevent segregation.

**1.7 ADVANTAGES AND LIMITATIONS OF FIBRE REINFORCED CONCRETE**

- Increase impact and shatter resistance, fatigue endurance and shear strength of concrete.
- Requires no special equipment’s to install reinforcement.
- Increase crack resistance, long-term ductility, energy absorption capacity and toughness of concrete.
- Reduce labour and material costs in concrete applications.
- Provides multi-directional concrete reinforcement.
- Compatible with admixtures, all types of cement and concrete mixtures.
- Reduce plastic shrinkage and crack width formation.

Restrictions and limitations of using fibre-reinforced concrete are:

- Control crack as result of external stresses.
- Reduction in curling and creep.
- Justification for a reduction in the size of support columns.
- Higher structural strength development.

**1.8 HYBRID FIBRE REINFORCED CONCRETE**

A composite can be termed as hybrid, if two or more types of fibres are rationally combined in a common matrix to produce a composite that derives benefits from each of the individual fibres and exhibits a synergetic response. The advantages of hybrid fibre systems can be listed as follows

- To provide a system in which one type of fibre, which is stronger and stiffer, improves the first crack stress and the ultimate strength, and the second type of fibre, which is more flexible, and ductile leads to improved toughness and strain in the post-cracking zone.

- To provide hybrid reinforcement in which one type of fibre is smaller, so that it bridges the micro cracks of which growth can be controlled. This leads to a higher tensile strength of the composite. The second type of fibre is larger, so that it arrests the propagating macro cracks and can substantially improve the toughness of the composite.
- To provide a hybrid reinforcement, in which the durability of fibre types is different. The presence of the durable fibre can increase the strength or toughness relation after age while the other type is to guarantee the short-term performance during transportation and installation of the composite elements.

In the present approach the strengthening and toughening mechanisms for cement based composites are viewed on two different scales. To strengthen the matrix, the specific fibre spacing must be decreased in order to reduce the allowable flaw size. This may be achieved through the use of short discrete fibres. These fibres can provide bridging of micro cracks before they reach the critical flaw size. To provide the toughening component, fibres of high ultimate strain capacity are required so that they can bridge the macro cracks in the matrix.

The concept of hybridization was developed in conjunction with asbestos replacement, where it was difficult to produce synthetic fibres that would provide simultaneously a reinforcing effect and the filtering and solid retention characteristics, which are needed in the Hatschek process. The combination of different types of fibres to optimize the performance in the hardened state, with respect to strength and toughness, has been studied by various researchers, using asbestos, carbon, and steel to achieve strength, and polypropylene and polyethylene to improve toughness.

**Fig.1.6** Hybrid Fibre Reinforced Concrete

### 1.9 NEED FOR FIBRE REINFOCED CONCRETE

- Now a day concrete will be more crack in building.
- So the fibre should be reduced crack and also bleeding reduced.

### 1.10OBJECTIVES

- This study attempts to compare the strength parameters of HFRC with conventional concrete.
- To perform the experiments on the time- dependent compressive strength, split tensile strength of concrete containing mixed glass fibre and steel fibre and its strength were measured at the age of 7 and 28 days curing period.
- To study the crack arresting ability of fibres in concrete.

## II LITERATURE REVIEW

1. **Anandh and leeladharPammer (2016)** Plain cement concrete is good at providing reasonable compressive strength but it tends to be brittle in nature and is weak in tensile strength, and minimum resistance to cracking, poor toughness. To overcome the deficiencies of concrete, fibres are added to enhance the performance of concrete. In the present study hybrid fibres consists of two different types of fibre combinations i.e. glass and polypropylene fibres are used with conventional concrete. The fibre proportions of of 0%, 0.25%, 0.5%, 0.75%, 1% and 1.25% by weight of cement is used. Strength parameters are compressive strength and split tensile strength will be tested and results were analyzed.
2. **Preetha and Narayanan (2014)** Concrete is most widely used construction material in the world. Fibre reinforced concrete (FRC) is a concrete in which small and discontinuous fibre are dispersed uniformly. The addition of fibres can dramatically increase the compressive strength, tensile strength and flexural strength of concrete. In this paper effect of fibres on the strength of concrete for M25 grade have been studied by varying the percentages of fibres in concrete. 0.5%, 0.75% and 1% volume fraction of steel fibre and glass fibres of 0.15%, 0.2% and 0.25% weight of cement were used without any admixtures.
3. **Srikanthragi (2015)** Cement concrete is the most extensively used construction material in the world. It has been found that different type of fibre added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. It is now established that one of the important properties of hooked steel ,crimped steel& glass Fibre Reinforced Concrete is its superior resistance to cracking and crack propagation. In this paper effect of fibre on the different mechanical properties of grade M 70 have been studied. It optimizes 1.5% for steel Fibre content and 1% for glass fibre content by the volume of cement is used in concrete.

## III.MATERIALS USED

### 3.1 GENERAL

This research work may be used as a guideline of the Steel Fibre and Glass fibre reinforced concrete. It is defined as concrete made with hydraulic cement containing Fine and coarse aggregate and discontinuous discrete fibre. In Steel Fibre and

Glass fibre, thousands of small fibres are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties However the intense construction activity is resulting in growing shortage and price increase of the natural sand in the country in addition the aggregate and concrete industry are presently facing a growing public awareness related to environmental threats. Therefore, looking for a viable alternative for natural sand is a must.

### 3.2 MATERIAL AND METHODS

The cement used in this experimental study is 53 grade Ordinary Portland Cement. All properties of cement are tested by referring IS 12269-1987 specification of 53 grade Ordinary Portland Cement.

Fine aggregate used in this research is River sand. Fine aggregates are the aggregates whose size is less than 4.75mm. Natural or River sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing.

Coarse aggregate of nominal size of 20mm and 12mm is chosen and tests to determine the different physical properties as per IS 383-1970. Test results conform to the IS 383 (PART III) recommendations.

Steel fibre and glass fibre with an aspect ratio 50 was chosen. Corrugated steel fibres and glass offer cost efficient concrete reinforcement. They were evenly distributed in concrete mixtures to improve the tensile strength.

Mix design of concrete is the process of selecting the required ingredients of concrete and finding their relative proportion with the aim of producing an economical concrete of certain strength and durability. The mix design is prepared as per IS 10262-2009.

Mix design was done for M25 concrete as per the Indian standard code specifications (IS 10262-2009). Initial tests on all the ingredients of concrete were done and the results were tabulated. Fresh concrete tests such as slump cone test, flow table test etc., were also conducted. Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works.

The compressive strength, as one of the most important properties of hardened concrete, in general is the characteristic material value for classification of concrete. Splitting tensile strength is an indirect method used for determining the tensile strength of concrete. Tests are carried out on 150mmx300mm cylinders conforming to IS 5816: 1976 to obtain the splitting tensile strengths at the age of 28 days. Tests are carried out on 100mmx100mmx500mm beams conforming to IS 516: 1959 to obtain the flexural strength at the age of 28 days.

This research work may be used as a guideline doing our project in a better manner and it is used to work easily. The flow chart showing the methodology is given

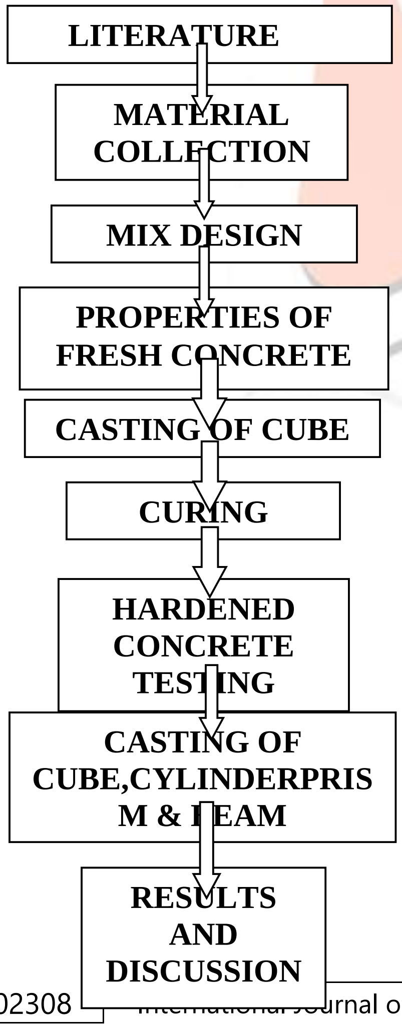

Fig.3.1 Flow Chart

## IV MATERIALS

### 4.1 INTRODUCTION

In developing the concrete mix for high strength concrete, it is important to select proper ingredients, evaluate their properties and understand the interaction among different material for optimum usage. The ingredients used for this investigation were cement, fine aggregate, coarse aggregate, water, steel fibre and glass fibre.

Effective production of high strength concrete is achieved by carefully selecting, controlling and proportioning all ingredients. In order to achieve high strength concrete, optimum proportion must be selected, considering the characteristics of cementitious materials, aggregate quality, paste proportion, aggregate paste interaction and meticulous care in mixing and handling.

### 4.2 MATERIALS

#### 4.2.1 Cement

The cement used in this experimental study is 53 grade Ordinary Portland Cement. All properties of cement are tested by referring IS 12269-1987 specification of 53 grade Ordinary Portland Cement. The physical properties of cement as shown in table 4.1.

**Fig.4.1** OPC 53 Grade cement

#### 4.2.2 Fine Aggregate

Fine aggregate used for high strength concrete should be properly graded to give minimum void ratio and be free from deleterious materials like clay, silt content and chloride contamination etc. High strength concrete contains large quantity of fine cementitious materials. The optimum gradation of river sand for high strength concrete is determined more by its effect on water requirement than on physical packing.

For this present investigation, river sand was used as fine aggregate. The sand was washed and screened at site to remove deleterious materials and tested as per the procedure given in BIS: 2386-1968 and they were conforming to the grade zone 3. The sieve analysis of fine aggregate sample is also given.

**Fig.4.2** River sand

#### 4.2.3 Coarse Aggregate

Aggregates are important constituents of concrete. It gives body to the concrete, reduce shrinkage. Aggregate occupy 70 to 80 percent of volume of the concrete. The aggregates combine with the binder (cement and pozzolana) and water to produce concrete. Basically there are two types of aggregates, the fine aggregate and the coarse aggregate.

The coarse aggregate is the strongest and the least porous component of concrete. It is also a chemically stable material. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture. Coarse aggregate contributes to impermeability in concrete provided that it is properly and the mix is suitably designed. Coarse aggregate in cement and there is a weak interface between cement matrix and aggregate surface in cement concrete. These two factors result in lower strength of cement concrete. But in high strength concrete, by restricting the maximum size of aggregate and also by making the transition zone stronger by usage of mineral admixtures, the cement concrete becomes more homogenous and there is a marked enhancement in the strength properties as well as durability characteristics of concrete.

Properties such as crushing strength, durability, modulus of elasticity, maximum size, gradation, shape and surface texture characteristics, percentage of deleterious materials as well as flakiness and elongation indices need special consideration while selecting the coarse aggregate for high strength concrete. The aggregate should be sound, free from deleterious materials and must have crushing strength at least 1.5 times that of concrete.

**4.2.4 WATER**

Water is an important ingredient of concrete as it actively participates in the chemical reactions with cement to form the hydration product, calcium-silicate-hydrate (C-S-H) gel. The strength of the cement concrete depends mainly from the binding action of the hydrated cement paste gel. A higher water-cement (w/c) ratio will decrease the strength, durability, water-tightness and other related properties of the concrete. The quantity of water added should be the minimum requirement for chemical reaction of unhydrated cement, as the excess water would end up only in the formation of undesirable voids (capillary pores) in the hardened cement paste of concrete. The strength of cement paste is inversely proportional to the dilution of the paste. Hence, it is essential to use a little paste as possible, consistent with the requirement of workability and chemical combination with cement.

The water used for making concrete should be free from undesirable salts that may react with cement and reduce their efficiency. Silts and suspended particles are undesirable as they interfere with setting, hardening and bond characteristics. Algae in mixing water may cause marked reduction in strength of concrete either by combining with cement to reduce the bond or by causing large amount of air entrainment in concrete.

Water confirming to the requirements of BIS: 456-2000 is found to be suitable for making high strength concrete. It is generally stated that water fit for drinking is fit for making concrete.

**4.2.5 Steel Fibre Reinforced Concrete**

Steel fibre-reinforced concrete is basically a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of prep work but make for a much stronger concrete.

Steel fibre-reinforced concrete uses thin steel wires mixed in with the cement. This imparts the concrete with greater structural strength, reduces cracking and helps protect against extreme cold. Steel fibre is often used in conjunction with rebar or one of the other fibre types.

**Fig.4.4** Steel Fibre

**Table 4.1 Properties of steel fibre**

| Sl.No | Property | Value |
|---|---|---|
| 1 | Length | 30 mm |
| 2 | Diameter | 0.6mm |
| 3 | Type of steel | Stainless steel |
| 4 | Density | 7800 $Kg/m^3$ |

**4.2.6 Glass Fibre Reinforced Concrete**

Glass fibre-reinforced concrete uses fibre glass, much like you would find in fibreglass insulation, to reinforce the concrete. The glass fibre helps insulate the concrete in addition to making it stronger. Glass fibre also helps prevent the concrete from cracking over time due to mechanical or thermal stress. In addition, the glass fibre does not interfere with radio signals like the steel fibre reinforcement does.

**Fig.4.5** Steel Fibre

**4.3 MIX DESIGN CALCULATION FOR M25 GRADE OF CONCRETE**

**Table.4.2**Mix Proportion

| Mix Base | Water ( ℓ ) | Cement (Kg) | Fine Aggregate (Kg) | Coarse Aggregate (Kg) |
|---|---|---|---|---|
| Weight | 197 | 392 | 670 | 1093 |
| Ratio | W/C=**0.50** | Ratio = **1** : **1.70** : **2.78** | | |

## V RESULTS

### 5.1 COMPRESSIVE STRENGTH ON CONCRETE

Three cube samples each for various percentages of steel fibre and glass fibre River sand were tested to determine the 7 days and 28 days compressive strength using a 2000kN Compression Testing Machine. The compressive strength test on cubes is conducted as per standards. It is seen that 28-days compressive strength increases up to 1.25 % of steel fibre and glass fibre adding in the volume of concrete. The average compressive strength on cube is shown in table 5.1.

**Table.5.1 Average Compressive Strength on Cube**

| S.no | Steel fibre % | Glass fibre % | Average Compressive strength on 7 days ($N/mm^2$) | Average Compressive strength on 7 days ($N/mm^2$) |
|---|---|---|---|---|
| S1 | 0 | 0 | 23.43 | 32.56 |
| S2 | 0.25 | 0.25 | 26.62 | 35.06 |
| S3 | 0.50 | 0.50 | 28.25 | 39.45 |
| S4 | 0.75 | 0.75 | 32.39 | 42.45 |
| S5 | 1.0 | 1.0 | 34.84 | 46.27 |
| S6 | 1.25 | 1.25 | 31.56 | 43.86 |

The average compressive strength on cube is in graphical representation as shown in the fig.5.1.

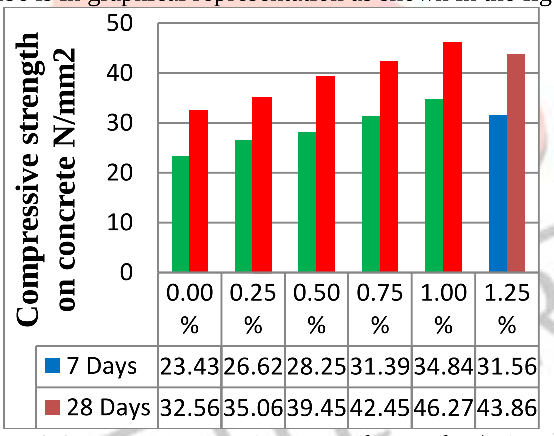


**Fig.5.1** Average compressive strength on cube ($N/mm^2$)

### 5.2 SPLIT TENSILE STRENGTH ON CONCRETE

Three cylinder samples each of the mix with various percentages of River Sand were tested to determine the split tensile strength after 28 day using a 2000kN The average split tensile strength on concrete is in graphical representation as shown in the fig.5.2.

Compression Testing Machine. The tests were conducted as per standard specifications. The test results are tabulated in Table 5.3. It is seen that 28-day split tensile strength increases up to 1.25 % of steel fibre and glass fibre adding in the volume of concrete. The average split tensile strength on concrete is shown in table 5.3.

**Table.5.3 Average split tensile Strength on Concrete**

| Specimen | Steel fibre (%) | Glass fibre(%) | Average split tensile strength on 28 days (N/mm2) |
|---|---|---|---|
| S1 | 0 | 0 | 2.35 |
| S2 | 0.25 | 0.25 | 3.08 |
| S3 | 0.50 | 0.50 | 3.67 |
| S4 | 0.75 | 0.75 | 4.64 |
| S5 | 1.0 | 1.0 | 5.12 |
| S6 | 1.25 | 1.25 | 4.16 |

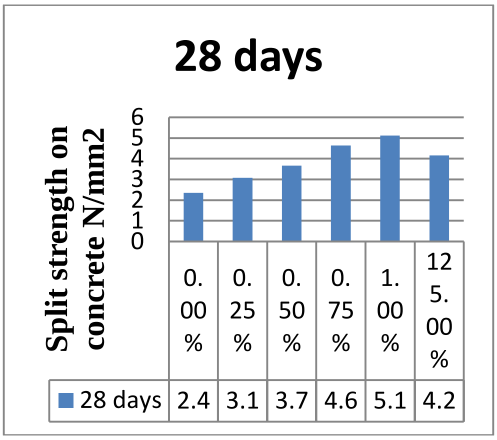


**Fig.5.2** Average spilt tensile strength on cylinder

## 5.4 FLEXURAL STRENGTH ON CONCRETE

Three beam samples each of the mix with various percentage of M-Sand were tested to determine the flexural strength after 28 days using a 30 Tone Schimadzu Universal Testing Machine. The tests were conducted as per standard specifications. The flexural strength of Concreteis given in Table 5.4. It is seen that the 28-day flexural strength increases upto 1.25 % of steel and glass fibre adding in the volume of concrete. The average flexural strength on concrete is shown in the table 5.4.

**Table 5.4 Flexural strength on Beam**

| Specimen | Steel fibre (%) | Glass fibre(%) | Average split tensile strength on 28 days (N/mm2) |
|---|---|---|---|
| S1 | 0 | 0 | 7.78 |
| S2 | 0.25 | 0.25 | 8.23 |
| S3 | 0.50 | 0.50 | 8.47 |
| S4 | 0.75 | 0.75 | 8.66 |
| S5 | 1.0 | 1.0 | 8.87 |
| S6 | 1.25 | 1.25 | 8.12 |

The average flexural strength on concrete is in graphical representation as shown in the fig.5.3.

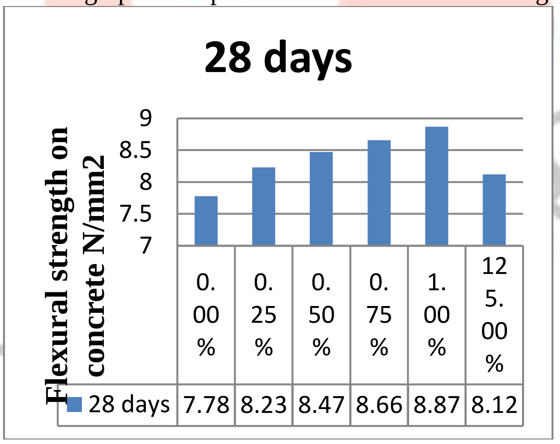


**Fig.5.3 Average flexural strength of beam (N/mm2)**

**Table 5.4 Flexural strength on RcBeam**

| Load (KN) | Deflection in mm | | | | | |
|---|---|---|---|---|---|---|
| | 0% | 0.25% | 0.50% | 0.75% | 1.0% | 1.25% |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0.25 | 0.21 | 0.20 | 0.18 | 0.13 | 0.16 |
| 14 | 0.42 | 0.37 | 0.38 | 0.35 | 0.28 | 0.31 |
| 21 | 0.55 | 0.51 | 0.49 | 0.46 | 0.40 | 0.42 |
| 28 | 0.79 | 0.75 | 0.73 | 0.69 | 0.62 | 0.66 |
| 35 | 1.05 | 0.98 | 0.96 | 0.92 | 0.87 | 0.90 |
| 42 | 1.38 | 1.30 | 1.28 | 1.22 | 1.12 | 1.17 |
| 49 | 1.62 | 1.56 | 1.53 | 1.45 | 1.31 | 1.37 |
| 56 | 2.15 | 2.04 | 2.01 | 1.92 | 1.78 | 1.84 |
| 63 | 2.87 | 2.68 | 2.59 | 2.45 | 2.16 | 2.23 |
| 70 | 3.56 | 3.39 | 3.26 | 3.12 | 2.97 | 3.02 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 77 | 4.25 | 4.09 | 3.98 | 3.85 | 3.69 | 3.74 |
| 84 | 5.12 | 4.89 | 4.81 | 4.62 | 4.45 | 4.50 |

## CONCLUSION

- The results proved that 100% of fine aggregate by River Sand induced good compressive strength, split tensile strength, flexural strength. Thus the environmental effects, illegal extraction of sand and cost of fine aggregate can be significantly reduced.
- While using the steel fibre and glass fibre has the optimum results on 1 % of total volume of concrete. Using the hook end fibre gives the best tensile strength on concrete. At 1.25% of steel fibre and glass fibre the strength will be reduced.
- When compared to the M1,M2,M3,M4,M5 and M6 gives the better result. Because of increasing the steel fibre and glass fibre content. It also increase the tensile strength of the concrete.
- In a nutshell we have to use River sand, steel fibre and glass fibre in concrete without affecting strengths of the ordinary concrete.

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