AN EXPERIMENTAL STUDY ON STRUCTURAL BEHAVIOUR OF HYBRID FIBRE REINFORCED CONCRETE

Ms. S. Navothana priyadharsini[1], S.Sivakumar[2], M.Sureshkumar[3], V.Vignesh[4]

Assistant Professor[1],UG Student[2], UG Student[3], UG Student[4]
Department of Civil Engineering, SriVidya College of Engineering & Technology, Virudhunagar.

Abstract: *A study on the mechanical performance of Hybrid fibre Reinforced Concrete (HFRC). Hybrid fibre reinforced concrete can be defined as concrete that reinforced by two or more types of fibres. This study aims to study the mechanical properties of hybrid fibre reinforced concrete where the fibres used were consists of steel fibre and glass fibre. The addition of small closely spaced and uniformly dispersed fibres to concrete would act as crack resistor and would substantially improve its properties. This type of concrete is known as "Fibre Reinforced Concrete" . Fibres have been used to reinforce materials that are weaker in tension than in compression. The volume of steel fibre is kept constant as 1% and the volume of glass fibre varied as 1%, 3%, 5% and 7% .Slump Test was carried out to determine the workability of the hybrid fibre reinforced concrete. Meanwhile, compressive strength test, flexural strength test and split tensile strength test were carried out to study the mechanical properties of the hybrid fibre reinforced concrete. The expected outcome which is the strength of hybrid fibre reinforced concrete is higher than the strength of normal concrete is achieved. So, further research need to be carried out with some adjustments of methods or materials.*

KEYWORDS: Glass fibre, steel fibre, Compression Hybrid reinforced concrete, strength.

1. INTRODUCTION

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementatious materials, water, aggregate and some required proportions[1]. Fresh concrete or plastic concrete is freshly mixed material which can be moulded into any shape hardens into a rock- like mass known as concrete. The hardening is because of chemical reaction between water and cement. Cement mortar and concrete made with Portland cement is a kind of most commonly used construction material in the world. These materials have inherently brittle nature and have some dramatic disadvantages such as poor deformability and weak crack resistance in the practical usage. Also their tensile strength and flexural strength is relatively low compared to their compressive strength. Fibre Reinforced Concrete is concrete containing fibrous material which increases its structural integrity. The fibre can make the failure mode more ductile by increasing its tensile strength of concrete [1]. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel, glass, synthetic and natural each of which lend varying properties to the concrete. In addition, the character of fibre reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities. In a hybrid, two or more different types of are rationally combined to produce a composite that derives benefits from each of the individual and exhibits a synergistic response [2]. The hybrid combination of metallic and non-metallic fibers can offer potential advantages in improving concrete properties as well as reducing the overall cost of concrete production.

1.1 Fibre Reinforced Concrete (FRC)

Fibre reinforced concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinues, discrete, uniformly dispersed suitable fibres. Fibre is a small piece of reinforcing material possessing certain characteristics properties [3]. They can be circular or flat the fibre is often described by the parameter aspect ratio which is ratio of fibre length to its diameter. Typical aspect ratio variesfrom 20 to 150.Basically fibres can be divided into following two groups

(i) Fibres' whose moduli are lower than the cement matrix such as cellulose, nylon, polypropylene etc.

(ii) Fibres with higher moduli than the cement such as asbestos, glass, steel etc.

1.2 Hybrid Fibre Reinforced Concrete (HFRC)

The usefulness of hybrid fibre reinforced concrete in various Civil Engineering applications. Hybrid fibre reinforced concrete is use of two or more than two fibres in a single concrete matrix to improve overall properties of concrete. In well- designed hybrid composites, there is positive interaction between the fibres and the resulting hybrid performance exceeds the sum of individual fibre performances [4]. For optimal result, the different types of fibres may be combined and the resulting composite is known as hybrid-fibre reinforced concrete. In this experiment steel fibre (continuously crimped) and glass fibre have been tried.

2. EXPERIMENTAL PROGRAMME

2.1 Properties of Steel Fibre

The crimped steel fibre and glass fibre are used in this model. Crimped fibre is a cold drawn wire fibre. It is continually deformed to provide optimum performance with in the concrete

Fig.1. Steel Fibre

mix. The steel fiber is added to the concrete in order to improve the crack resistance capacity of the concrete [3]. Traditional re-bars are generally used to improve the tensile strength of the concrete in particular direction, whereas steel fibers are useful for multidirectional reinforcement. Fig.1. shows the steel fibre. Table 1 shows the Properties of Steel Fibre

Table1. Properties of Steel Fibre

S.No	Properties	Values
1	Fiber length	50mm
2	Fiber diameter	0.75mm
3	Tensile strength	1100N/mm^2
4	Aspect ratio	67

2.2 Properties of Glass Fibre

Highly durable and safe. Design freedom since GFRC is able to be molded any shape and color. Weather and fire resistance. Installation is quick. Requires low maintenance. Fig.2. shows the glass fibre [2].

Fig.2. Glass Fibre

Table2. Properties of Glass Fibre

S.No	Properties	Values
1	Fiber length	10μm
2	Fiber diameter	3μm
3	Tensile strength	4137N/mm^2
4	Aspect ratio	3.33

2.3 Portland Cement

A cement is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and aggregate together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete . Ordinary Portland cement(OPC) of 53 grade are used to made the concrete specimen's. The properties of cement are given below in Table3.

Table 3. Properties of Cement

S.No	Properties	Values
1	Specific gravity	3.15
2	Initial Setting time	28minutes
3	Final Setting time	3 hrs

2.4. Aggregates

Fine Aggregate:-

The natural river sand is used as fine aggregate. Aggregate that pass through a 4.75mm IS sieve and having not more than 5 percent coarser material are known as fine aggregate. The properties of fine aggregate are given below in Table 4

Table 4. Properties of Fine Aggregate

S.No	Properties	Values
1	Zone	II
2	Specific gravity	2.65
3	Fineness modulus	2.86
4	Water absorption	1.04%

Coarse Aggregate:-

The properties of Coarse aggregate is given in the below Tab.3. The aggregate having size more than 4.75 mm is termed as coarse aggregate. The graded coarse aggregate is described by its nominal size i.e. 40mm, 20mm,16mm, 12.5mm etc. 80mm size is the maximum size that could be conveniently used for making concrete.

Table5. Properties of Coarse Aggregate.

S.No	Properties	Values
1	Specific gravity	2.68
2	Fineness modulus	7.5
3	Water absorption	0.31%
4	Size of aggregate	20mm

3.MIXING AND CASTING

3.1 Mixing Proportion

1.Cement = 340 kg/m^3

2.Water = 153 lit/m^3

3.Fine aggregate = 749 kg/m^3

4.Coarse aggregate = 1275 kg/m^3

5. Water-cement ratio = 0.45

Mix ratio = **1: 2.2 :3.75**

M30 grade concrete was prepared with and without fibre. For hybrid fibre reinforced concrete, specimens are reinforced with 10% of steel fibre plus 0.1% ,0.2% and 0.3% of glass fibres by weight of cement. The concrete was placed uniformly in the steel mould in three layers each layer is damped satisfactorily. Remoulding was done after 24 hours and specimens were cured under water. After 28 days specimens were removed from curing tank and taken for testing [5].

4. TESTING

4.1 Compressive Strength test

The specimens are placed in the machine in such a manner that the load is applied to opposite sides of the cubes as cast is shown in Fig 3. The axis of the specimen is carefully aligned with the centre of thrust of the spherically seated plate. A spherically seated block is brought to bear on the specimen; the movable portion is rotated gently by hand so that uniform seating may be obtained [4]. The compressive strength machine of 1000kN capacity is used, to apply the axial force of compression. Test results for 28days and 7 days shown in Fig4 and Fig 5 respectively. Fig 6 shows the failure pattern for conventional and *HFRC.*

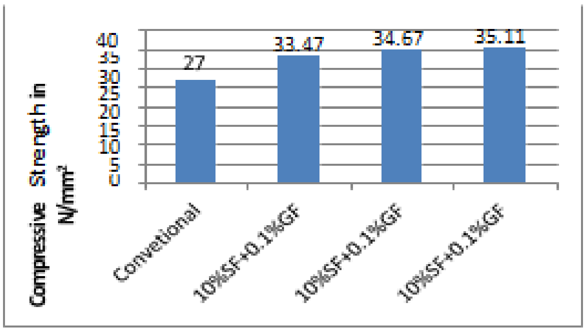


Fig 4. Compressive strength for 28 days

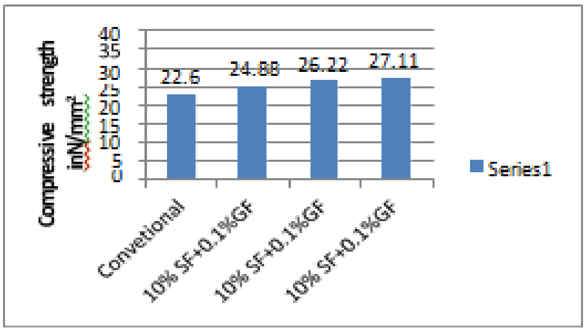


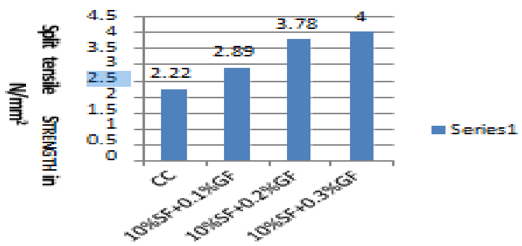
Fig 5 . Compressive strength for7 days

Fig 6 . Failure Pattern

4.2 Split tensile Strength

For tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 7 and 28 days. These specimens were tested under compression testing machine. In each category, three cylinders were tested and their average value is reported. Test results for 28days and 7 days shown in Fig7 and Fig 8 respectively. Fig 9 shows the failure pattern for conventional and HFRC.

Fig 7.Split tensile strength for 28 days



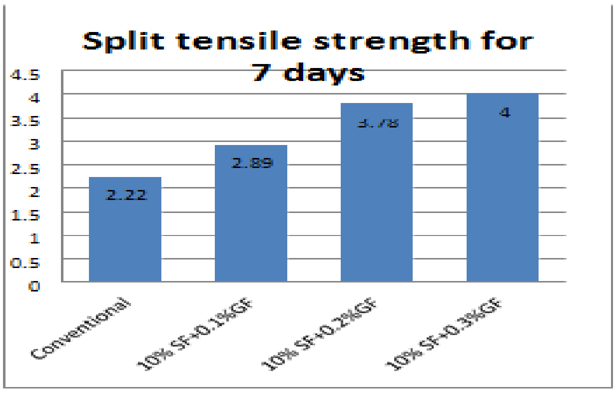


Fig 8.Split tensile strength for 7 days 9 Failure Pattern

5. CONCLUSIONS

Hybrid Fibre Reinforced Concrete utilizes two (steel and glass) complementary fibres to improve the properties of concrete, and the performance of HYFRC is better than that of single FRC.

a). The addition of steel fibres aids in converting the properties of brittle concrete to a ductile material but addition of steel fibres with glass fibre makes the results better than that.

b). There was 13% increase in the compressive strength as a result of hybridization. It also increases the split tensile strength by 12.7%.

c). Hybrid fibres were more effective in crack reduction compared to individual steel fibres. Non-metallic fibres reduced the number of cracks and width of cracks. It doesn't allow concrete to break and fall down at failure.

6.REFERENCES

[1] P.S. Song and S. Hwang, "Mechanical properties of high-strength steel fibre-reinforced concrete Construction and Building Materials", Elsevier Journals Ltd., Vol.18, pp.669-673, 2012.

[2] Ibrahim I .S and Bakar M.B, "Effects on mechanical properties of industrialized steel fibres addition to normal weight concrete, Proceeding engineering", pp.26162626, 2011.

[3] A. Siva Kumar, " Influence of hybrid fibres on the post crack performance of high strength concrete, Journal of civil Engineering and Construction Technology "Vol.2 (7), pp. 147-159,2011.

[4] Zhiguo You, " Ductility and strength of hybrid fibre reinforced self-consolidating concrete beam with low reinforcement ratios, Proceeding Engineering 65, pp. 290-295, 2011.

[5] S. Kumaravel, N. Veeragurunath, D. Anandram, E. Vairavi, "Influence Of Hybrid Fibre Reinforced Concrete", pp Vol. 10 No.51 (2015).