International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 02 Issue: 04 | July-2015 www.irjet.net p-ISSN: 2395-0072

A COMPARATIVE AND EXPERIMENTAL STUDY ON THE MECHANICAL PROPERTIES OF VARIOUS STEEL AND GLASS FIBER REINFORCED HIGH STRENGTH CONCRETE

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Abstract

Cement concrete is the most extensively used construction material in the world. It has been found that different type of fibers 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 Fiber Reinforced Concrete is its superior resistance to cracking and crack propagation. In this paper effect of fibers on the different mechanical properties of grade M 70 have been studied. It optimizes 1.5% for steel Fiber content and 1% for glass fiber content by the volume of cement is used in concrete. The percentage increase in compressive strength at 28 days for hooked end steel fiber when compared to conventional concrete is 7.3% , crimped steel fiber with 6.08%, glass fiber with 4.3. The percentage increase in split tensile strength at 28 days hooked end steel fiber when compared to conventional concrete is 4.54% , crimped steel fiber with 3.40%, glass fiber with 2.27% and also The percentage increase of flexural strength at 28 days for hooked end steel fiber when compared to conventional concrete is 3.57% , crimped steel fiber with 2.380%, glass fiber with 2.140%.

Key Words: *Hooked Steel, Crimped Steel, Glass Fiber and Split Tensile Strength.*

1. INTRODUCTION

Fibre Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibres. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibresFRC increases the tensile strength of the concrete, it reduce the air voids and water voids the inherent porosity of gel. It increases the durability of the concrete. Fibres such as graphite and glass have excellent resistance to creep. The addition of small closely spaced and uniformly dispersed fibres to concrete would act as crack arrester and would substantially improve its static and dynamic properties.Fibre reinforced concrete is in use since many years in India, but the structural applications are very much limited. However, its application is picking up in the recent days.

2. FIBRES WITH CONCRETE

Steel fibres are the strongest commonly-available fibre, and come in different lengths and shapes. Steel fibres can only be used on surfaces that can tolerate or avoid corrosion and rust stains. In some cases, a steel-fibre surface is faced with other materials.

Glass fibre is inexpensive and corrosion-proof, but not as strong as steel. The design of glass fibrereinforced concretepanels proceeds from knowledge of its basic properties under tensile, compressive, bending and shears forces, coupled with estimates of behaviour under secondary loading effects such as creep, thermal response and moisture movement.

The main purpose of fibre reinforced concrete it to improve flexural behavior. Any material made from concrete can be reinforced using fibres.

HPFRCs possess the remarkable ability to strain harden under excessive loading. In layman's terms, this means they have the ability to flex or deform before fracturing, a behaviour similar to that exhibited by most metals under tensile or bending stresses. Because of this capability, HPFRCCs are more resistant to cracking and last considerably longer than normal concrete. Another extremely desirable property of HPFRCCs is their low density.

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3.MATERIALS USED

The materials used in the experimental investigation are locally available cement, sand, coarse aggregate, mineral and chemical admixtures. The chemicals used in the present investigation are of commercial grade.

3.1 Steel Fibres

Steel fibre-reinforced concrete (SFRC) is concrete (spray concrete) with steel fibres added. It has higher tensile strength than unreinforced concrete and is quicker to apply than weldmesh reinforcement. It has often been used for tunnels.

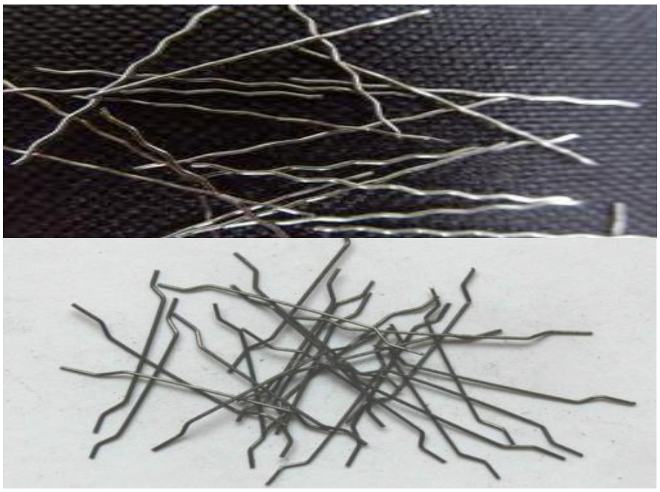

Fig -1: crimped and hooked steel fibres

3.2Glass Fibres

Glass fiber reinforced concrete is also known as GFRC or GRC, it is a type of fiber reinforced concrete. Glass fiber concretes are mainly used in exterior building façade panels and as architectural precast concrete. Somewhat similar materials are fiber cement siding and cement boards. The photograph of glass fibres is shown figure 2.

Fig -2: Glass fibre

The materials used in the present investigation are

- Cement – OPC 53 grade conforming to IS 12269 – 1987
- Fine aggregate – natural sand – IS 383 – 1970
- Coarse aggregate-10mm to16mm size – IS383–1970
- Fly Ash 1 µm to more than 100 µm
- silica fume-1/100th the size of an average cement particle
- Ceraplast 300 M
- Steel fibres
- Glass fibres
- Potable water

Table-1: Properties of materials

Material test	Result
Specific gravity of cement	3.12
Specific gravity of fly ash	2.24
Specific gravity of silica fume	2.21
Specific gravity of coarse aggregate	2.74
Specific gravity of fine aggregate	2.7
Slump cone test	2 inches
Dry rod unit weight of fine aggregate	107.7 lb/ft^3
Dry rod unit weight of coarse aggregate	101 lb/ft^3
Initial and final setting time	96 min &207 min

4. OBJECTIVE

- To find out the mechanical properties of high strength concrete reinforced with different fibres.
- To compare the results with the properties of normal high strength concrete.

5. MIXING AND CASTING

For each mix, the required quantities of the constituents were batched by weight. Concrete was mixed in a 50 kg capacity drum type mixer in the laboratory. Before starting mixer machine, the mixer drum was fully washed and allowed for few minutes to dry the drum. Coarse aggregate were first placed and mixed with 40% of the calculated water for one minute. Then the fine aggregate

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and 30% of the water is added along with the super plasticizer. The mixing was continued for two minutes.
Finally the cement, Fly ash , Silica Fume and the remaining water were added and mixing as continued until the fresh concrete become homogeneous.

During assembling of the mould for use, the joints between the sections of mould were thinly coated with crude oil and a similar coating of crude oil was applied between the contact surfaces of the bottom of the mould and the base plate in order to ensure that no water escapes during the filling of concrete. The interior surfaces of the assembled mould also are thinly coated with crude oil to prevent adhesion of the concrete.

Test specimens were made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance. Compaction was done by means of an electric vibrating table. After the top layer has been compacted, the surface of the concrete was finished level with the top of the mould, using a trowel, and covered with plastic sheets for 24 hours to prevent the evaporation of water from the concrete. They were demoulded after 24 hours and cured in water at the room temperature of 25 - 280C until testing.

Table-2: Mix proportion

Cement	Fly Ash	Silica Fume	Fine Aggregate	Coarse Aggregate	Water	Super Plasticizer
1	0.28	0.28	1.38	2.38	0.23	0.01

5. TESTING OF SPECIMENS

Different tests were conducted on the specimens to determine and compare the mechanical properties between crimped steel fibres, hooked steel fibres and glass fibres.

5.1 .Compressive Strength test

Fig -3 Cube specimen under test

Table-3: Compressive strength Results

Sl no	cubes casted day	Conventional concrete (N/mm²)	Hooked end steel fiber (N/mm²)	Crimped steel fiber (N/mm²)	Glass fiber (N/mm²)
1	*3rd day*	*27*	*31.75*	*29.3*	*29*
2	*7th day*	*44*	*48*	*46.4*	*49*
3	*28th day*	*69*	*74*	*73.2*	*72*

Comparision chart of compressive strength

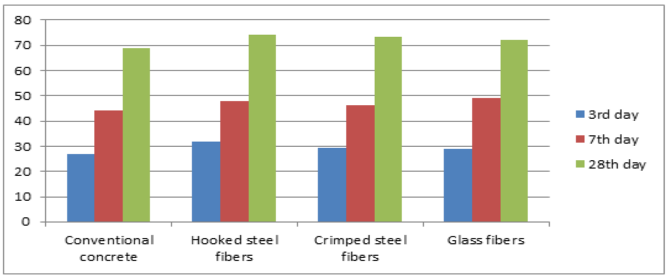

Chart-1 Comparison chart of compressive strength

5.2. Flexural test

Fig -4 Flexural beam specimen under test

Table-4:Flexure test results

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Comparison of flexure strength

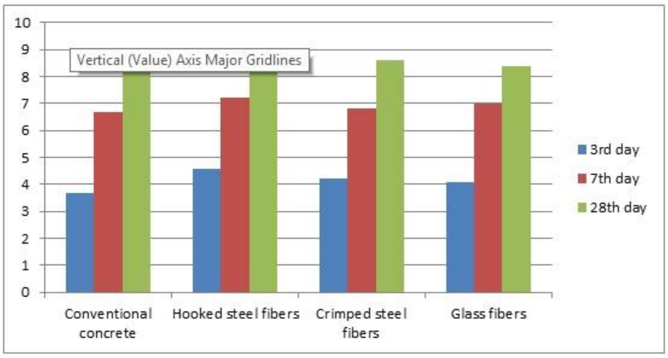

Chart-2 Comparision of flexure strength

5.3.Split tensile test

Fig -5 Cylinderspecimen under test

Table-5: Split tensile strength results

Sl no	Cylinders casted day	Conventional concrete (N/mm²)	Hooked end steel fiber (N/mm²)	Crimped steel fiber(N/mm²)	Glass fiber (N/mm²)
1	3rd day	1.9	2.6	2.4	2.3
2	7th day	5.2	5.7	5.3	5.5
3	28thday	8.8	9.2	9.1	9.0

Comparison of split tensile Strength results

Sl no	Beams casted day	Conventional concrete	Hooked end steel fiber	Crimped steel fiber	Glass fiber
1	3rd day	3.7	4.6	4.2	4.1
2	7th day	6.7	7.2	6.8	7.0
3	28th day	8.4	8.7	8.6	8.5

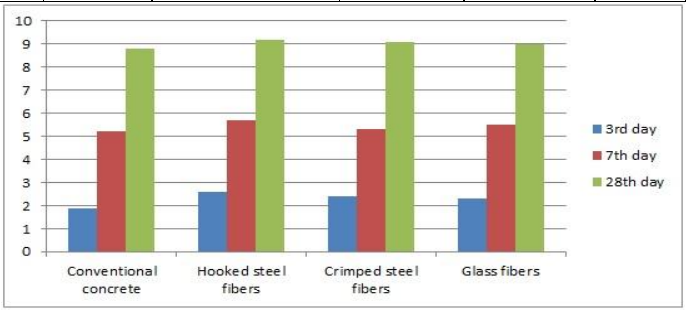

Chart-3 Comparison of split tensile Strength

CONCLUSIONS

The present study is about using different fibres i.e., crimped steel fibres hooked steel fibres and glass fibresafteroptimising them; comparison is made between the three fibres for different mechanical properties.

- The increasing percentage of compressive strength of hooked end steel fiber reinforced concrete cubes when compared to the conventional concrete cubes at 28 days is 7.3%.And the increasing percentage of compressive strength of crimped steel fiber reinforced concrete cubes when compared to the conventional concrete cubes at 28 days is 6.08%.And The increasing percentage of compressive strength of hooked end steel fiber reinforced concrete cubes when compared to the conventional concrete cubes at 28 days is 4.34%.

- The increasing percentage of split tensile strength of hooked end steel fiber reinforced concrete cylinders when compared to the conventional concrete cylinders at 28 days is 4.54%.And the increasing percentage of split tensile strength of crimped steel fiber reinforced concrete cylinders when compared to the conventional concrete cylinders at 28 days is 3.40%.And The increasing percentage of compressive strength of hooked end steel fiber reinforced concrete cylinders when

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compared to the conventional concrete cylinders at 28 days is 2.27%.

- The increasing percentage of flexural strength of hooked end steel fiber reinforced concrete beams when compared to the conventional concrete beams at 28 days is 3.57%.And the increasing percentage of flexural strength of crimped steel fiber reinforced concrete beams when compared to the conventional
beams at 28 days is 2.380%.And The increasing percentage of flexural strength of glass fiber reinforced concrete beams when compared to the conventional concrete beams at 28 days is 2.140%.

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