EXPERIMENTAL INVESTIGATION ON ADDING E-GLASS FIBRE IN CONCRETE

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ABSTRACT: Concrete is one of the most durable building materials. Varieties of admixtures have been used so far. Hence an attempt has been made in the present investigation to study the behavior of E glass fibre in concrete. The main aim of the study is to study the effect of glass fibre in the concrete. Using M25 grade of concrete by replacing E-glass fibre which enhances properties of the conventional concrete. The high tensile strength and fire resistance properties, thus reducing the loss of damage during the fire accidents. In this project, to replace the constituent materials by E glass fibre 0%, 0.5%, 1.0% and 1.5% of additives also, it is proposed to use high performance concrete. Also High Performance concrete specimens with fiber and without fiber in size 150mmx150mmx150mm, cylinder of 150mmx300mm and prism of 100mmx100mmx500mm were cast and the strength tests were observed.

Keywords: E-glass, HPC- High Performance concrete

1.INTRODUCTION

1.1. General

Concrete is the most widely used man made construction material. It is obtained by mixing cement, water, aggregate and admixtures in required proportions. The mixer when placed in forms and allowed to cure becomes hard like stones. The strength, durability and other characteristics of concrete depend the properties of concrete ingredients, on the proportions of mix, the methods of compaction and other controls during placing and curing.

Concrete is being extensively used in most of the construction activities. The usage of steel is far less than the concrete. Concrete has the advantage of easy handling and transportation. It can endure very high temperatures from fire for a long time without loss of structural integrity and performs well during both natural, manmade disasters and even under the impact of flying debris. An electrically resistant glass fibre. Alumina-calcium-borosilicate glasses. Constitutes the majority of glass fibre production. Used in glass reinforced plastics as general purpose fibres where strength and high electrical resistivity are required.

1.2. Objective

- To determine the compressive, splitting tensile, flexural strength, for conventional concrete by adding hybrid fibres.
- To determine the compressive strength of HPC by adding hybrid fibres.
- To determine the splitting tensile strength of HPC by adding hybrid fibres.
- To determine the flexural strength of HPC by adding hybrid fibres

1.3 Methodology





2.COLLECTION OF MATERIALS

Materials used in this study were chosen according to the specifications that meets the requirement of appropriate standards.

2.1 Glass Fibre

A glass fibre or fibre glass can be defined as "A material consisting of extremely fine filament of glass that are combined in yarn and woven into fabrics, used in masses as a thermal and acoustical insulator, or embedded in various resins to make boat hulls, fishing rod.

2.2 Manufacturing Process

- 1. Direct Melt Process.
- 2. Marble Melt.

2.3 Direct Melting Process



- The fibre manufacturing process has effectively two variants. One involves the preparation of marbles, which are remolded in the fabrication stage.
- The other uses the direct melting route, in which a furnace is continuously charged with raw materials which are melted and refined as that glass reaches the fore hearth above a set of platinum–rhodium bushings from which the fibres are drawn.

2.5 Advantages Of Glass Fibre

- High Strength.
- Lightweight.
- Increased Life.
- Non-Conductive.
- Low Maintenance.
- Easily Assembled.
- Corrosion Resistant.
- Chemical Resistant.
- Fire Resistant.
- R.F. Transparent.
- Dimensionally

3.LITERATURE REVIEW

Dasari Venkateswara Reddy* Prashant Y.Pawade-2015

This paper "Combine Effect of Silica Fume and Steel Fiber on Mechanical Properties on Standard Grade of Concrete and Their Interrelations" investigation carried out on concrete due to the effect of silica fume with and without steel fibers on Portland Pozzolona cement. In this study we used concrete mixes with Silica Fume of with different ratios and with addition of crimped steel fibers of diameter 0.5 mm Ø with a aspect ratio of 60, at various percentages as by the volume of concrete on M35 grade of concrete. The effect of mineral admixture (silica fume) as cement replacement material with and without steel fibers on mechanical properties were analyzed and compared with normal concrete.

Kamal, M.A. Safan, Z.A. Etman, R.A. Salama-2014

In this paper "Behavior and Strength of Beams Cast with Ultra High Strength Concrete Containing Different Types of Fibers" carried out on Ultra-high performance concrete (UHPC) is a special type of concrete with extraordinary potentials in terms of strength and durability performance. Its production and application implement the most up-to-date knowledge and technology of concrete manufacturing. Sophisticated structural designs in bridges and high rise buildings, repair works and special structures like nuclear facilities are currently the main fields of applications of UHPC. This paper aimed to evaluate the behavior of ultra-high strength concrete beams. This paper also aimed to determine the effect of adding fibers and explore their effect upon the behavior and strength of the reinforced concrete beams.

R. Ramasubramani, P.Naga kishore reddy, S.Divya- 2014

This paper "A Study On Partial Replacement Of Cement With silica Fume In Steel Fibre Reinforced Concrete" investigates and evaluates the results for M-40 grade of concrete having mix proportion 1:1.45:3.12 with water cement ratio 0.35 of steel fibre reinforced concrete (SFRC) by partial replacing of cement with Silica Fume and containing steel fibres of volume fraction, steel fibres of 50 aspect ratio were used to study the compressive strength, flexural strength, Split tensile strength. A result data obtained has been analyzed and compared with control concrete specimens (0% fibre).

Er. Darole J. S., Prof. Kulkarni V.P., Prof. Shaikh A.P., Prof. Gite B.E-2013

In this paper "Effect of Hybrid Fiber on Mechanical Properties of Concrete" carried out and investigated Hybrid fibre can provide reinforcement at all the range of strains. Combination of low and high modulus fibres can arrest cracks at micro level as well as macro level. Overcome disadvantage of lower workability caused due to use of only higher percentage of steel fibres. Potential advantage in improving concrete properties as well as reducing the overall cost of concrete production. Compressive strength of HYFRC after 28days for 50-50 % (steel-polypropylene) hybridization ratio is maximum. It is increased by 21.41% with respect to normal concrete (i.e. Hybridization ratio 0-0 %). At 28 days Compressive strength of SFRC (i.e. Hybridization ratio 100-0 %) is increased by 7.37% with respect to normal concrete & compressive strength of PPFRC (i.e. Hybridization ratio 0-100%) increased by 6.68% with respect to normal concrete.

4.PROPERTIES OF MATERIALS

4.1. Introduction

The materials used for making concrete were tested before casting the specimen in order to design the mix proportions. The preliminary tests were conducted on the following materials.

- 1. Cement.
- 2. Glass fibre.
- 3. Fine Aggregate.
- 4. Coarse Aggregate.
- 5. Water.

4.2. Cement

Cement is a binder, a substance that sets and hardens independently, and can bind other materials together. Ordinary Portland cement of 53- grade is used. This is used to develop high strength and has low setting time. It gives much better results and compressive strength in 28 days.Properties of cement obtained from the tests conducted as per relevant BIS codes are given below.



Fig.3 Cement.

4.3. Standard Consistency

Trial No	Weight of Samples (gm)	Water added (in %)	Weight of Water added (ml)	Non- Penetration depth (mm)
1	300	25	75	37
2	300	27	81	35
3	300	29	87	28
4	300	31	93	17

The percentage of water required for obtaining cement rate of standard consistency 31%.

4.4 Setting Time

Initial setting time	= 30 minutes.
Final setting time	= 600 minutes.

Table 1 Standard Consistency.

4.5 Fineness

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Weight of cementW_1=100gWeight of cement on 90 micron sieveW_2= 6g
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 $= (W_1/W_2) \times 100$

Fineness of cement $= (W_1/$ Fineness of OPC 53 grade cement is 6%

As per IS 12269, fineness of cement shall not exceed 10%.

4.6. Specific Gravity Test

Table 2 Specific Gravity Test						
Weight of empty bottle (W_1)	= 73 g					
Weight of empty bottle + cement (W_2)	= 124 g					
Weight of bottle + kerosene + cement (W_3)	= 327 g					
Weight of bottle+ kerosene (W ₄)	= 283 g					
Specific gravity	$=\frac{W_2-W_1}{(W_2-W_1)-(W_3-W_4)}$					
	$=\frac{(124-73)}{((124-73)-(327-283))}$					
Specific gravity of cement	= 3.13					

4.7 Glass Fibre

- A Glass fibre or Fibre glass can be defined as "A material consisting of extremely fine filaments of glass that are combined in yarn and woven into fabrics, used in masses as a thermal and acoustical insulator, or embedded in various resins to make boat hulls, fishing rods, and the like."
- Fiber glass materials are popular for their attributes of high strength compared to relatively light weight. Fiberglass really is made of glass, similar to windows or the drinking glasses. The glass is heated until it is molten, then it is forced through superfine holes, creating glass filaments that are very thin so thin they are better measured in microns.

4.8 E-Glass

An electrically resistant glass fibre. Alumina-calcium-borosilicate glasses. Constitutes the majority of glass fibre production. Used in glass reinforced plastics as general purpose fibres where strength and high electrical resistivity are required.



Fig.6 Glass Fibre.

4.9 E-Glass Fibre Composition

Silica-Increase strength and acid resistance .

Na₂O and CaO-makes the mixture more fluid, reduce durability.

B₂O₃-expands less on heating.

MgO-slow down the rate at which the glass crystallizes.

Al₂O₃, ZnO-increase durability, improve moisture resistance.

4.10. Fine Aggregate

To increase the density of the resulting mix, the aggregate is frequently used in two or more sizes. The aggregate serves as reinforcement to add strength to the overall composite material. Fine Aggregate may have more impact on the strength of the building than cement. Fine aggregate will consist of natural sand, manufactured sand, or a combination of the two, and will be composed of clean, hard, durable particles. Particles of the fine aggregate should be generally spherical or cubical in shape as practicable. Care must be taken to insure that contaminating substances are not present in fine aggregate are to assist in producing a dense workable and homogenous mixture. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.



4.10. Sieve Analysis Test

Fig.8 sieve analysis test apparatus.

Table 3 Sieve Analysis Test

treight of sumple 1	N 5			
Sieve size	Weight Retained on Sieve (gm)	Percentage weight retained	Ultimate percentage retained	Percentage of Finer
4.75 mm	35.7	3.57	3.57	96.43
2.36 mm	48.3	4.83	8.4	91.6
1.18 mm	593.6	59.36	67.76	32.24
600 micron	215.3	21.53	89.29	10.71
300 micron	86.5	8.65	97.94	2.06
150 micron	18.1	1.81	99.75	0.25
75 micron	2.5	0.25	100	0
Pan	-	-	-	-

Weight of sample = 1 kg

Tested results satisfies the Grading Zone I (IS: 383-1970)

Tested results satisfies the classification of soil as well graded soil Fineness modulus = Cumulative weight retained/100 = 466.71/100 = 4.66.

4.11. Specific Gravity of Fine Aggregate

Weight of empty pycnometer (W_1)		= 443 gm
Weight of pycnometer + Dry sand (W_2)		= 1489 gm
Weight of pycnometer + Dry sand + Water (= 915 gm	
Weight of pycnometer + Water (W ₄)		= 1205 gm
	Specific gravity of sand	W_2-W_1
	Specific Stavity of said	$(W_2 - W_1) - (W_3 - W_4)$

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 $=\frac{(915-443)}{((917-443)-(1489-1205))}$ = 2.60

4.12. Bulk Density of Fine Aggregate

The test shall normally be carried. Out on dry material when determining the voids, but when bulking tests are required material with a given percentage of moisture may be used. Rodded or Compacted Weight - The measure shall be filled about one-third full with thoroughly mixed aggregate and tamped with 25 strokes of the rounded end of the tamping rod. A further similar quantity of aggregate shall be added and a further tamping of 25 strokes given. The measure shall finally be filled to over-flowing, tamped 25 times and the surplus aggregate struck off, using the tamping rod as a straightedge. The net weight of the aggregate in the measure shall be determined and the bulk density calculated in kilograms per liter.

Lose Weight - The measure shill be filled to overflowing by means of a shovel or scoop, the aggregate being discharged from a height not exceeding 5 cm above the top of the measure. Care shall be taken to prevent, as far as possible, segregation of the particle sizes of which the sample is composed. The surface of the aggregate shall then be leveled with a straightedge. The net weight of the aggregate in the measure shall then be determined and the bulk density calculated in kilogram per liter.

Empty weight of container $(W_1) = 7 \text{ kg}$ Weight of container + aggregate $(W_2) = 15.5 \text{ kg}$ Weight of container + water $(W_3) = 12 \text{ kg}$ Weight of loose sand $(W_4) = 15 \text{ kg}$ Volume of container $=W_3-W_1/1000$ $=(12 \cdot 7)/1000$ $= 0.005 \text{m}^3$

Bulk density

 $= (W_4 - W_1) / V$ = (15-7) / 0.005 = 1600 kg/ m³

4.13. Coarse Aggregate

Coarse aggregate is a material that will pass the 20mm sieve and will be retained on the 12.5mm sieve. As with fine aggregate, for increased workability and economy as reflected by the use of less cement, the coarse aggregate should have a rounded shape. Use of the largest permissible maximum size of coarse aggregate permits a reduction in cement and water requirements.

4.14.Specific Gravity of Coarse Aggregate

Weight of empty mould (W_1)	=	0.656Kg
Weight of mould + coarse aggregate (W_2)	=	1.262 Kg
Weight of mould + coarse aggregate + Water (W_3)	=	1.872kg
Weight of mould + Water (W_4)	=	1.487kg
Specific gravity of CA	$=\frac{1}{(1)}$	$\frac{W_2 - W_1}{W_2 - W_1) - (W_3 - W_4)}$

4.15. Water

Water is the most important and least expensive ingredient of concrete. A part of mixing water is utilized in the hydration of cement to form the binding matrix in which the inert aggregates are held in suspension until the matrix has hardened. The remaining water serves as lubricant between the fine and coarse aggregate and makes concrete workable i.e., readily place able in forms. The water used for mixing and curing of concrete should be free from deleterious materials. Generally cement requires about 3/10 of its weight of water for hydration. But the concrete containing water in this proportion will be very harsh and difficult to place. Additional water is required to lubricate the mix which makes the concrete workable; this additional water must be kept to the minimum. Since too much water reduced the strength of concrete.

5.MIX DESIGN

1.Concrete Mix Proportioning Grade designation= M_{25} Type of cement= OPC 43 grade Maximum nominal size of aggregate= 20mm Workability= 0.9 compacting factor Exposure condition= mild Degree of supervision= Good Type of aggregate= Crushed angular

2. Test Data For Materials

Cement used= OPC 43 Specific gravity of cement= 3.13 Chemical admixture= Super plasticizer **Specific gravity of:** Coarse aggregate= 2.70 Fine aggregate= 2.65 **Water absorption:** Coarse aggregate= 0.5percent Fine aggregate= 1.0percent **Free (surface)moisture:** Coarse aggregate= Nil Fine aggregate= Nil

3.Target Strength For Mix Proportioning

f'ck=fck+1.65s Where, f'ck=Target average compressive strength at 28 days, fck=Characteristic compressive strength at 28 days, From Table t=1.65 & s=5 N/mm² Therefore, target strength =40+1.65x 5=48.25N/mm²

4. Selection Of Water-Cement Ratio

From Table 5 of IS 456, Maximum water-cement ratio=0. 32.

5. Selection Of Water Content

From Table 2, Maximum water content for 20 mm aggregate =186 liter (for 25 to 50 mm slump range). Estimated water content for 100 mm slump $-186+3/100 \times 186=191.6$ liter.

6.Calculation Of Cement Content

Water-cement ratio Cement content = 0.32= 191.6/0.32 $= 598.75 \text{kg/m}^3$

7. Determination Of Coarse And Fine Aggregates Content

From Table3. Volume of coarse aggregate corresponding to 20 mm size aggregate and the amount of entrapped air in the wet concrete is 2percent. Taking this into account and applying equations from 3.5.1,

= $(191.6 + 383/3.1 3 + 1/0.315 \cdot f_a/2.65) * 1/1000 = 495.199 \text{ kg/m}^3$

 $0.98 \text{ m}^3 = (191.6 + 383/3.1 \text{ } 3 + 1/0.685 \text{ } . \text{ } \text{C}_a/2.70) * 1/1000 \text{ } \text{CA} = 1108.08 \text{ } \text{kg/m}^3$

8. Mix Proportions For Trial Number

Cement	$=598 \text{ kg/m}^{3}$
Water	$=191.6 \text{ kg/m}^3$.
Fine aggregate	$=495.199 \text{ kg/m}^3$.
Coarse aggregate	= 1108.08kg/rn ³ .

Table 5 Mix Proportion.					
Water Cement Fine Aggregate Coarse Aggregate					
191.6 kg/m ³	598 kg/m ³	495 kg/m ³	1108kg/m^3		
0.45	1	1.02	2.20		

6.PREPARATION OF CONCRETE

6.1. Mould Details (As Per Is 10086 - 1982)

- Cube moulds of size 150mm x 150mm x 150mm and cylinder moulds of diameter 75mm and height 150mm were used.
- In assembling the mould for use, the joints between the sections of mould shall be thinly coated with mould oil and similar coating of mould oil shall be applied between the contact surface of the bottom of the mould and the base plate in order to ensure that no water escapes during the filling.
- The interior surfaces of the assembled mould shall be thinly coated with mould oil to prevent the adhesion of the concrete.

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- With and without replaced concrete was then filled in mould and then compacted using a vibrating table.
- After 24 hours the specimen was de moulded and subjected to water curing.



Fig .10 Cube Mould.



Fig.11 Beam Mould.



Fig.12 Cylindrical Mould.

6.2. Batching

Batching is the process of weighing or volumetrically measuring and introducing into a mixer the ingredients for a batch of concrete. To produce a uniform quality concrete mix, measure the ingredients accurately for each batch. Most concrete specifications require that the batching be performed by weight, rather than by volume, because of inaccuracies in measuring aggregate, especially damp aggregate.

Batching by using weight provides greater accuracy and avoids problems created by bulking of damp sand. Specifications generally require that materials be measured in individual batches within the following percentages of accuracy: cement 1%, aggregate 2%, water 1%, and air-entraining admixtures 3%. Equipment within the plant should be capable of measuring quantities within these tolerances for the smallest to the largest batch of concrete produced. The accuracy of the batching equipment must be checked and adjusted when necessary.



Fig.13 Batching Of Concrete.

6.5. Proportioning

Proportions of materials including water, in concrete mixes used for determining the suitability of material available, shall be similar in all respects to those to be employed in the work. Where proportions of the ingredients of the concrete as used on the site are to be specified by volume, they shall be calculated from the proportions by weight used in the test cubes and the unit weight of the materials.

6.3. Weighing

The quantities of cement, each size of aggregate and water for each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.

6.4. Mixing

Concrete should be mixed until it is uniform in appearance and all the ingredients are evenly distributed. The mixing should ensure that the mass becomes homogenous, uniform in color and consistency. Each batch of concrete shall be of such a size as to leave about 10 percent excess after moulding the desired number of test specimens. There are two methods adopted for mixing of concrete: hand mixing and machine mixing.

a) Machine Mixing:

When the machine mixing drum is charged by a power loader, all the mixing water shall be introduced into the drum before the solid materials, the skip shall be loaded with about one half of the coarse aggregate, then with fine aggregate on top where the mixing is hand loaded, it shall be charged with dry materials in a similar manner, and the water shall be added immediately before rotation of the drum is started. The period of mixing shall be not less than 2 minutes after all the materials are in the drum, and shall continue till the resulting concrete is uniform in appearance. When using pan mixers, the concrete shall be heaped together before sampling.

b) Hand Mixing:

The concrete batch shall be mixed on a water-tight, non-absorbent plat with a shovel, trowel or similar suitable implement, using the following procedure:

The cement, silica fume, steel fibre, glass fibre and fine aggregate shall be mixed dry until the mixture is thoroughly blended and is uniform in color. The coarse aggregate shall then be added and mixed with the cement, silica fume, steel fibre, glass fibre and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch. The water shall then be added and the entire batch mixed until the concrete appears to be homogenous and has the desired consistency.

6.5. Workability

Each batch of concrete shall be tested for consistency immediately after mixing by one of the methods described in IS 1199-1959 provided that care is taken to ensure that no water or other material is lost, the concrete used for the consistency tests may be remixed with the remainder of batch before making the test specimen. The period of remixing shall be as short as possible yet sufficient to produce a homogenous mass. The workability was found out by slump test.

6.6. Placing

It is not enough that a concrete mix correctly designed, batched, mixed and transported. It is of utmost importance that the concrete must be placed in systematic manner to yield optimum results.

6.7. Compaction

Compaction is the process adopted for expelling the entrapped air from the concrete. The test specimens shall be 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. The concrete shall be filled into mould in layers approximately 5cm deep. In placing each layer of concrete, the layers shall be around the top edge of the mould as the concrete slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Each layer shall be compacted either by hand or vibration. After the top layer has been compacted, the surface of the concrete shall be finished level with the top of the mould, using a trowel, and covered with a glass or metal plate to prevent evaporation.

When compacting by vibration, each layer shall be vibrated by means of an electric or pneumatic hammer or vibrator or by means of a suitable vibrating table until the specified condition is attained. For compaction, we are using table vibrator. Table vibrator is the special case of formwork vibrator, where the vibrator is clamped to the table, or table is mounted on the spring which is vibrated transferring the vibration to the table. They are commonly used for vibrating concrete cubes and cylinders. The concrete mix is poured as three layers in the mould and each layer is vibrated for about 30 seconds for proper compaction.

6.8. Curing

Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. Curing is designed primarily to keep the concrete moist, by preventing the loss of moisture from the concrete during the period in which it is gaining strength. For this purpose, we are using water curing for curing the concrete specimens.

Water curing is carried out by supplying water to the surface of concrete in a way that ensures that it is kept continuously moist. The water used for this purpose should not be more than about 5°C cooler than the concrete surface. Alternate wetting and drying of the concrete must also be avoided as this causes volume changes that may also contribute to surface crazing and cracking. The test specimen shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27°C for 24 hours from the time of addition of water to the dry ingredients. After this period, the specimens shall be marked and removed from the moulds and, unless required for test within 24 hours, immediately submerged in clean, fresh water and kept there until taken out prior to test. The specimen shall not be allowed to become dry at any time until they have been tested. There are several important reasons why one should cure concrete

7.EXPERIMENTAL INVESTIGATION

7.1. General

In this chapter, results based on the experimental investigation carried out to determine the compressive strength of concrete cubes, tensile strength of cylinders and flexural strength of concrete are given.

7.2. Strength Test

- 1. Compressive strength.
- 2. Split tensile strength.

7.2.1. Compressive Strength Test

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to performs, and partly because most of the desirable characteristics properties of the concrete qualitatively related to its compressive strength.

The compressive test is carried out on specimens cubical or cylindrical in shape. Prism is also sometimes used, but it is not common in our country. In our country cube is used.

- Compressive strength is one of the important properties of concrete. Specimens were prepared by following steps:
- Cube moulds of size 150mm x 150mm x 150mm were used. If the largest nominal size of the aggregate does not exceed 20mm, 10mm size aggregate may also be used as an alternative.
- The moulds were cleaned thoroughly and properly oiled along the faces. The concrete is filled in the mould in three layers and each layer is compacted by using tamping rod.
- The top surface is cleaned and smoothened by using trowel. In order to determine the compressive strength, a total number of 30 cubes were casted. After 24 hours of casting, the specimens were de-moulded and cured under water.
- The specimen is removed from water after specified curing time and excess water is wiped out from the surface. At the end of the curing period, the above specimens were tested in a compression testing machine as per IS: 516-1959.
- The cube specimen is tested for compressive strength for 7 and 28 days. The specimen is then placed in the machine in such a manner that the load shall be applied.
- > The maximum load at failure was taken and compressive strength is calculated using the equation.
- Compressive strength (f_{ck}) is calculated from the expression (f_{ck}) = P/A
- Where, $(f_{ck}) = Compressive Strength (Mpa)$

P= Applied Load (N)

A=Cross Section Area of the Specimen (mm²)



Fig.15 Compressive Strength Test.

7.2.2. Split Tensile Strength Test

Splitting tensile strength is generally greater than direct tensile strength used to find the tensile strength of cylinder by subjecting the cylinder to a compressive force.

- Cylinder moulds of diameter 150mm and height 300mm were used.
- The moulds were cleaned thoroughly and properly oiled along the faces.
- The concrete is filled in the mould in three layers and each layer is compacted by using tamping rod. After 24 hours the \geq specimen were remolded and subjected to water curing.
- The cylinder specimen is tested for compressive strength for 7 and 28 days.
- Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place. Keep are plywood strip on the lower plate and place the specimen.
- \triangleright Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate. Place the other plywood strip above the specimen. Bring down the upper plate to touch the plywood strip.
- The load shall be applied by placing the specimen horizontal. \triangleright
- The maximum load at failure was taken and split tensile strength is calculated using the equation. \triangleright
- Split tensile strength = $2P/\pi DI$

Where,

- P = Maximum load at failure (N)
- D = Diameter of cylindrical specimen (mm)
- l = Length of cylindrical specimen (mm)



7.3. Durability Test

Fig.16 Split Tensile Stength.

In general, durability of concrete is the ability to resist weathering action, chemical attack, abrasion, or any other process of deterioration. Durable concrete will retain its original form, quality, and serviceability when exposed to its environment.

7.3.1. Acid Attack Test

Concrete is susceptible to acid attack because of its alkaline nature. The components of the cement paste break down during contact with acids. Acids such as nitric acid, hydrochloric acid and acetic acid phosphoric acid and humic acid, Sulphuric acid are used. We are using dilute Hydrochloric Acid in our project.

The cube size 150mm x 150mm x 150mm was cast and stored in a place at a temperature of 27 °C for 24 hours and then the remolded specimens were water cured for 28 days. After 28 days curing, the specimens are taken out and allowed to dry one day. Initial weights of the cubes were taken. For acid attack, 5% dilute hydrochloric acid (Hcl) by volume of the water.

After that cubes were immersed in the above said acid water. After 28 days of curing, the cubes were taken out and the surfaces of the cubes were cleaned. Then the weight of the concrete cubes were taken and tested by non destructive test methods.

7.4.2. Interpretation of Results

The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation, etc indicative of the level of workmanship employed, can thus be assessed using the guidelines given below, which have been evolved for characterizing the quality of concrete in structures in terms of the rebound hammer.

8.RESULTS AND DISCUSSION

8.1. General

The specimens were tested for compressive strength, tensile strength, flexural strength, water absorption, acid attack, sulphate attack, NDT. The results obtained were discussed in this chapter.

8.2. Compressive Strength Test Results

8.2.1. Compressive Strength of Concrete Specimens In 7 Days

Table 7 compressive strength of concrete in 7 days

E-glass fibre	Name of the	Compressive	Compressive Stress	Mean			

(%)	specimen	Strength (KN)	(P/A) (N/mm ²)	Strength (N/mm ²)
	Cube 1	291.375	29.8	
Conventional Concrete	Cube 2	265.5	29.8	29.785
	Cube 3	303.75	29.8	
	Cube 1	348.75	35.2	
0.5	Cube 2	339.75	35.2	35.42
	Cube 3	351	35.2	
	Cube 1	389.25	40.9	
1	Cube 2	400.5	40.9	40.388
	Cube 3	396	40.9	
	Cube 1	324	33.9	
1.5	Cube 2	331.875	33.9	33.856
	Cube 3	337.95	33.9	

8.2.2. Compressive Strength Of Concrete Specimens In 28days

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E-glass fibre (%)	Name of the specimen	Compressive Strength (KN)	Compressive Stress (P/A) (N/mm ²)	Mean Strength (N/mm ²)
	Cube 1	291.375	29.8	
Convention al Concrete	Cube 2	265.5	29.8	29.785
	Cube 3	303.75	29.8	
	Cube 1	348.75	35.2	
0.5	Cube 2	339.75	35.2	35.42
	Cube 3	351	35.2	
	Cube 1	389.25	40.9	
1	Cube 2	400.5	40.9	40.388
	Cube 3	396	40.9	
1.5	Cube 1	324	33.9	
	Cube 2	331.875	33.9	33.856
	Cube 3	337.95	33.9	





Mix Proportion % Compressive strength...



8.4. Flexural Strength Test Result
8.4.1. Flexural Strength of Concrete Specimens in 7 Days

Table 11 Flexural Strength Of Concrete In 7Days

Glass fibre (%)	Name of the specimen	Flexural strength (N/mm ²)	Mean strength (N/mm ²)
	1	2.39	
0%	2	2.42	2.40
	3	2.41	
	1	2.45	
0.5	2	2.47	2.46
	3	2.46	
	1	2.08	
1	2	2.87	2.65
	3	3.01	
	1	2.52	
15	2	2.50	2.51
1.5	3	2.53	

8.4.2. Flexural Strength Of Concrete Specimens In 28 Days

Table 12 Flexural Strength Of Concrete In 28 Days

Glass fibre (%)	Name of the specimen	Flexural strength (N/mm ²)	Mean strength (N/mm ²)
	1	2.8	
0%	2	2.79	2.82
	3	2.87	
0.5	1	3.07	
	2	3.14	3.09
	3	3.06	
	1	3.36	
1	2	3.48	3.4
	3	3.5	
1.5	1	3.26	
	2	3.18	3.24
	3	3.28	

8.5. Acid Attack Test Results 8.5.1. Reduction In Weight Of Cubes After Acid Attack Table 13 Reduction In Weight Of Cubes After Acid Attack

Mix proportions Glass fibre (%)	Weight of concrete before sulphate attack (kg)	Weight of concrete after sulphate attack (kg)	Reduction in weight of concrete (kg)	Reduction in compressive strength after sulphate attack (%)
0%	8.256	8.132	0.124	1.501

0.5	8.582	8.367	0.215	1.408
1	8.446	8.292	0.154	1.323
1.5	7.888	7.668	0.142	0.991

8.6. Sulphate Attack Test Results

8.6.1. Reduction Of Weight Of Cubes After Sulphate Attack

Mix proportions Glass fibre (%)	Weight of concrete before sulphate attack (kg)	Weight of concrete after sulphate attack (kg)	Reduction in weight of concrete (kg)	Reduction in compressive strength after sulphate attack (%)
0%	8.384	8.238	0.146	1.741
0.5	8.367	8.176	0.191	1.345
1	8.128	8.065	0.063	1.526
1.5	8.182	8.092	0.090	1.282
2	8.238	8.124	0.114	2.099

Table 15 reduction of weight after sulphate attack

CONCLUSION

- Composite material has been used all over the world in the area where high strength and durable concrete were required.
- Glass fibre increases the tensile strength by controlling the occurrence of micro cracks into macro cracks. The use of glass fibre imparts strength to concrete and durability.
- In HPC with and without fibre of hybrid fibre of compressive strength of cube was in 126.93% and split tensile strength was increased 125% and flexural test of beam was increased 121.42% as compared to conventional concrete at 28 days.
- In this project aimed to conclude the strength product on concrete using glass fibres in the following percentage 0.5%, 1.0% and 1.5% glass fibres respectively.
- Durability properties HPC mixes 1% of glass fibres have better resist against Hcl and MgSo₄ compared to conventional concrete.

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