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Experimental investigation on glass fiber reinforced concrete with addition of fly ash

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ABSTRACT

Concrete is the widely used construction material in Civil Engineering field. The demand and cost of cement is increasing day to day, so experts are looking for supplementary materials with the main objective of reducing solid waste disposal problem, by using waste as supplementary by maintaining the same properties or by enhancing the properties, by using selected materials. Fly ash which is a solid waste generated from thermal power station is used in partial replacement of cement in various proportions which is environmental friendly and also different fibers are also used to increase tensile strength and reduce cracks in the concrete. Concrete is the most vital material in the modern construction, which has been in practice from olden days but concrete suffers from low tensile strength, limited ductility and little resistance to cracking. To overcome these weaknesses a new variety of concrete is desired. Therefore here fore here is an experimental study proposing changes to the conventional concrete to increase fire resistance, increase cracks resistance, increase ductility and flexural strength by partial replacement of fly ash to the cement and introducing fibers in the preparation of the concrete in the study fly ash in different volume fraction with 0%,0.5%,1%,1.5%,2% replacement of cement have been to study the effect on compressive strength, split tensile strength of concrete and compare it to the conventional concrete, for each mix standard size of cubes, cylinders and as per Indian standards were casted and tested for compressive strength, Split Tensile Strength at age of 7 & 28 days.

Keywords: Compressive Strength, Flexural Strength, Glass Fibre Reinforced Concrete (GFRC), Split Tensile Strength, Strength Characteristics.

INTRODUCTION

Reinforced concrete structures often have to face modification and improvement of their performance during their service life. Concrete is the most widely used construction material has several desirable properties like high compressive strength stiffness and durability under usual environmental factors. At the same time concrete is brittle and weak in tension. the strength, durability and other characteristics of concrete depend upon the properties of its ingredients, on the proportions of mix, the method of compaction and other controls during placing, compaction and curing .Fibre Reinforced Concrete (FRC) is

concrete contains, fibre material which increases its structural integrity. 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. recent attempts made it possible to incorporate relatively large volumes of steel, glass and synthetic fibre in concrete the fibres like glass fibres shows great performance in compressive test ,split tensile test and flexural test in this paper, an investigation has been made to find out the strength properties of glass fibre reinforced concrete incomparision with conventional concrete. Concrete is weak in tension and brittle in nature,

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so that to improve the structural characteristics, fibres are introduced in concrete. Addition of fibres makes concrete homogenous and isotropic. Fibres controls the crack and arrest the crack formation and increases the ductility property.

OBJECTIVES

To perform slump test for fresh concrete of M30 grade of concrete to check work ability. To perform following tests on hardened at the age of 7 & 28 days.

- Compressive test
- Split tensile test
- Flexural test

LITERATURE REVIEW

Based on the laboratory results the compressive and tensile strength was reported to increase up to 26.19% and 25.4%. However the workability of concrete mixes is not much affected by the addition of fibres. The tensile strength of concrete is improved which shows the use of glass fibres in concrete mixes may reduce its shortcoming of low tensile strength without affecting its workability and compressive strength.[1]

It has been widely used in the construction industry for non- structural elements, like façade panels , piping and channels. GRP offers many advantages, such as being lightweight fire resistance , good appearance and strength. In this study trial tests for concrete with glass fiber without glass fiber are conducted to indicate the difference in compressive strength and flexural strength by using cubes of varying sizes.[2]

GFRC has advantage of being light weight and thereby reducing the overall cost of construction there by bringing economy in construction. This work is only an accumulation of information about GFRC from all over the internet and some text

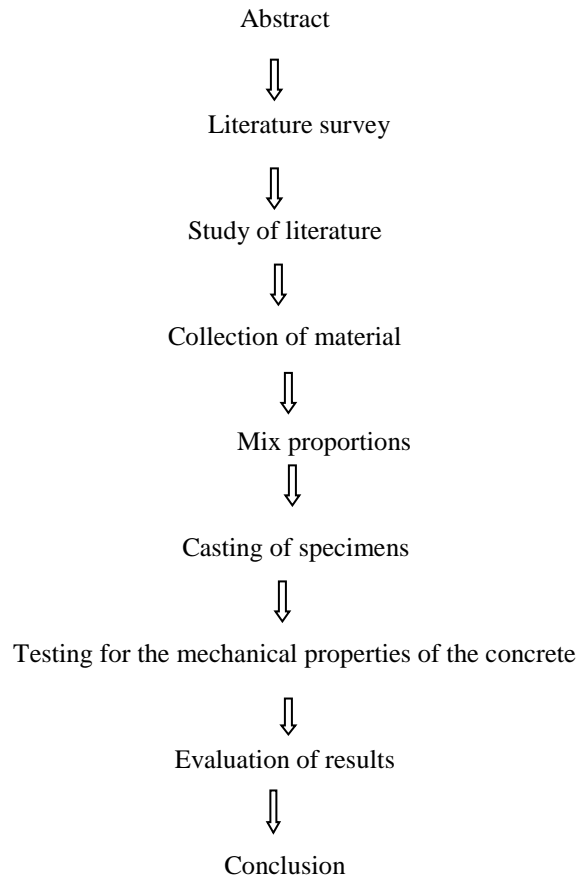
books. GFRC is concrete that uses glass fibres for reinforcement instead of steel. It is typically cast in a thin section of around ½” to ¾”. Since the fibres cannot rust like steel, there is no need for a protective concrete cover thickness to prevent rusting. With the thin, hollow construction of GFRC products, they can weigh a fraction of weight of traditional precast concrete. [3]

Glass Fiber Reinforced Concrete is a recent introduction in the countryside of concrete technology. The nearby day world is observer the building of extremely challenging and hard Civil Engineering structure. Concrete life form the good number important and extensively used material is called upon to have extremely elevated strength and adequate workability properties. Concrete the large amount extensively used construction substances have more than a few attractive property like far above the ground compressive strength, stiffness, durability under common environmental factor. By the similar time concrete is brittle and pathetic in tension.[4]

The use of fly ash a part replacement of cement in mortar and concrete at the construction site has been made all over the world including India and is well known. Since a huge quantity of cement is used in concrete in mass concrete construction and the cost of fly ash is negligible as compared to that of the cement, the use of fly ash concrete brings about a substantial saving in cement consumption and overall construction cost. [5]

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METHODOLOGY



MATERIALS USED

Cement

Ordinary Portland Cement of 43 Grade was preferably used referring to IS-8112:1989 of BIS.

The grade manifests the compression strength (MPa) of the concrete that will attain after 28 days of setting, shall be minimum 42 MPa or 430 kg/sqcm.

Table-1 Physical Properties of Cement

Property	Value
Specific gravity	3.15
Initial setting time	34mins
Final setting time	400mins
Fineness modulus	1.62%
Soundness	6.9

Fine aggregate

The fine aggregates utilized were easily accessible from the local market. Fine aggregate can be classified as those particles which roughly

pass the 4.75mm IS sieve and significantly retains on the 75micron sieve. Fine Aggregates having specific gravity value of 2.79, fineness modulus as 2.51 was used.

Table-2physical properties of fine aggregate

Property	Fine Aggregate (River sand)
Specific gravity	2.60
Bulk density(kg/m ³)	1460
Water absorption(%)	1.00
Moisture content(%)	1.55
Aggregate impact value(%)	–
Fineness modules	3.44
Fineness particles Less than 150mm(%)	4.14

Coarse aggregate

The aggregates passing through 40mm sieve and retain at 4.75mm sieve was used as coarse aggregate. In this experiment, natural aggregates

that are available locally, formed out of the rock disintegrated naturally, which was deposited by various agents. The two sizes of coarse aggregates were used, 10 mm & 20mm, having the specific gravity as 2.90 with the fineness modulus of 6.59.

Table-3physical properties of coarse aggregate

Property	Coarse Aggregate
Specific gravity	2.26
Bulk density (kg/m ³)	545
Water absorption(%)	1.15
Moisture Content (%)	0.2
Aggregate impact value(%)	38
Fineness modules	6.5
Fineness particles Less than 50mm (%)	0 to 10

Fly ash

Fly ash containing low calcium having color of whitish grey, specific gravity of 2.55, fineness of 8.4% moisture content of 0.17% was used as replacement for cement. The fly ash will be obtained from Rajiv Gandhi Super Thermal Power

Project which is located between Khedar in Hisar, Haryana. To get the optimal replacement of the cement material, the particles of fly ash was passed through 90 micron sieve throughout the experimental works.

Table-4physical properties of flyash

Property	Value
Specific gravity	2.55
Fineness	8.4%

Glass fibre

In this experiment, alkali resistant glass fibres, 12mm long, having the tensile strength as 1700

MPa, specific gravity value of 2.68, modulus of elasticity as 72 GPA, having an aspect ratio of 321 and filament diameter of 14 micrometers was used.



Fig 1. Glass fibre

Table-5 physical properties of glass fibre

Properties	Values
Diameter(μm)	14
Cut Length(mm)	45
Aspect Ratio	321

MIX PROPOSTION

Fresh concrete test

Slump test

Slump is a measurement of concretes workability, or fluidity. It's an indirect

measurement of concrete consistency or stiffness. A slump test is a method used to determine the consistency ,or stiffness, indicates how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirement for the finished product quality.

Table-6slump test of glass fibre

% of Fibre	Glass fibre(mm)
6	113
12	102
18	31
24	78

Compaction factor test

The ratio of the weight of partially compacted concrete to the weight of the concrete when fully compacted in the same mould. The compacting

factor Apparatus is used to determine the compaction factor of concrete with low, medium and high workability.

Table-7compaction factor test

W/C Ratio	Compaction factor
0.45	0.77
0.50	0.85
0.55	0.93

Flow table test

The open flow table is a data structure that resides in the high speed data plane of an open flow switch. Its contents determine the forwarding

behavior and packet handling behavior of that .open flow switch an open flow table has one or more flow entire.

Table-8flow test

Aggregates	Flow test (mm)
Fine Aggregate	166
Coarse Aggregate	168
Glass Aggregate	186

CASTING OF SPECIMENS

Mixing of Concrete, Casting and Curing of Test Specimens

Hand mixing was done during the entire process of casting of specimens. Initially the dry mix constituents of the mix namely cement, fine aggregate and coarse aggregate was mixed for two

minutes in the mixer and then the water were added and mixing continued for another 2 minutes. The total mixing time was kept at 4 minutes until a homogeneous mixture was obtained. Compaction was achieved by means of Tamping rod. Test specimens consisting of 150×150×150 mm cubes, 150×300 mm cylinders and 500×100×100 mm prisms were cast .



Fig 2. casting of specimen

RESULT AND DISCUSSIONS

Compressive strength

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. For cube test two types of

specimens either cubes of 15cmx15cmx15cm depending upon the size of aggregate are used. For most of size 15cmx15cmx15cm are commonly used. The maximum compressive strength value is obtained when 20% of cement replaced with fly ash along with 2% of glass fibre. Compressive strength value gradually increased with the increase of glass fibre percentage.

Table-9conventional concrete compression streng results for m30 grade of concrete

S.NO	Conventional Concrete	7Days N/mm ²	28Days N/mm ²	Average Result
1		24.9	40.2	
2	1:0.75:1.5	26.5	42.7	42.73
3		26.4	45.3	

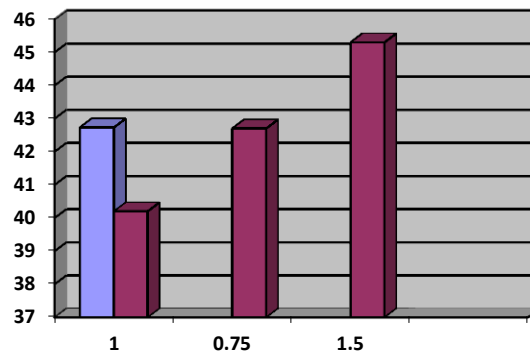


Chart 1.compressieive strength

Table-10compression strength results for m30 grade of concrete

Grade of concrete	%of glass fibre	7days(N/mm2)	28days(N/mm2)	28DaysN/mm ² Average Results
M30	0	20.50	39.24	
	0.5	23.66	42.82	
	1	27.78	44.20	42.89
	1.5	28.44	44.16	
	2	30.15	44.06	

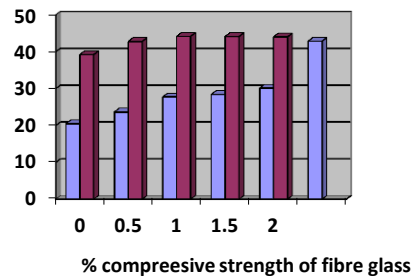


Chart -2 Compressive Strength

Split tensile strength

Split tensile strength of concrete decrease with an increase in fly ash content. The maximum split tensile strength value is obtained when 18% cement replaces with fly ash along with 3% glass fibre. It can be seen from the above tables and

figures the addition of glass fibre increase in tensile strength of concrete both at the curing age of 7 days and 28days. The percentage increase in strength of concrete at 28 days after adding 0,0.5,1,1.5,2% respectively. The tensile strength decrease after adding 24% fly ash with 2% glass fibre.

Table-11split strength results for m30 grade of concrete

Grade of concrete	% of glass fiber	7days (N/mm2)	28days (N/mm2)	28Days N/mm ² Average Results
M30	0	1.78	2.695	2.9224
	0.5	1.11	2.926	
	1	2.14	3.28	
	1.5	2.22	2.978	
	2	1.12	2.733	

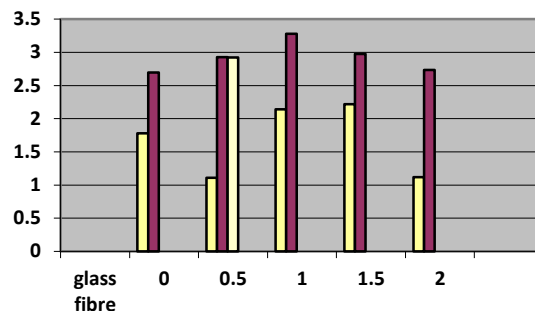


Chart-3 split tensile strength

Flexural strength behavior of specimens

Flexural strength of concrete increase gradually with the percentage of glass fibre. And it decreases

with an increase in fly ash content. The maximum flexural strength value is obtained when 18 % cement replaces with fly ash along with 3 %

glass fibre. It can be seen from the above tables and figures that the flexural strength of concrete mixes containing glass fibre are higher than the flexural strength of the control mix. The

percentage increase in flexural strength of concrete at 28 days after adding 0,0.5,1,1.5,2 respectively. The split tensile strength is decreased with 24% fly ash used with 2% glass fibre.

Table-12 flexural tensile strength results for m30 grade of concrete

Grade of concrete	% of glass fiber	7days (N/mm ²)	28days (N/mm ²)	28Days N/mm ² Average Results
M30	0	4.05	4.327	4.603
	0.5	4.26	4.732	
	1	4.349	4.786	
	1.5	4.312	4.69	
	2	4.326	4.48	

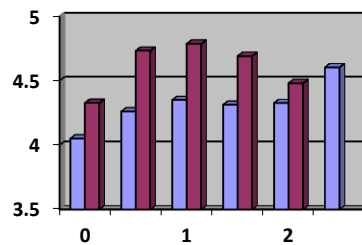


Chart 3. Flexural strength

CONCLUSION

Based on experimental investigation addition of Glass Fibre in plain concrete increases the strength and durability characteristics. The slump value for the glass fibre reinforced concrete is less when compared to conventional concrete without fibre. Initially addition of Glass Fibre in the plain concrete the strength characteristics like compressive, flexural and split tensile strength is

gradually increased. Finally certain percent addition of Glass Fibre attain that gradually decrease in strength. The optimum percentage of fibre is found as 0.1 %. The Compressive strength for 0.1% of fibre is increased when compared to conventional concrete. The tensile strength for 1% of fibre increasing strength and therefore at 1.1% decreasing strength.

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