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Investigation of Strength of Concrete by Using Steel & Glass Fibers

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ABSTRACT : *Concrete is the most widely utilized "man-made" material globally for construction in many developing countries in all types of civil engineering works. Joseph Aspdin created the first true artificial cement by burning ground limestone and clay together. The burning process changed the chemical properties of the materials and Joseph Aspdin created stronger cement than what using plain crushed limestone would produces the other major part of concrete besides the cement is the aggregate. Aggregates include sand, crushed stone, gravel, slag, ashes, burned shale, and burned clay. Fine aggregate (fine refers to the size of aggregate) is used in making concrete slabs and smooth surfaces. Coarse aggregate is used for massive structures or sections of cement. In this study, an attempt is made to use mixed steel and glass fibers with varying percentages of fibers from 0.5, 0.75, 1.0 percentages of total fiber content for M 25 grade structural concrete with locally available aggregates (i.e. fine & coarse aggregates) and Portland pozzolanic Cement (i.e. PPC). The details of investigation along with the analysis and discussion of the test results are reported here in.*

KEYWORDS: *Steel fibers, glass fibers, Portland Pozzolanic Cement (i.e. PPC).*

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I. INTRODUCTION

Concrete is the most widely utilized "man-made" material globally for construction in many developing countries in all types of civil engineering works. Also, concrete is an environmental - friendly material and in areas of growing environment - related awareness that is of prime importance. It is construction material due to its many advantages such as high compressive strength, availability of ingredients at reasonable cost, mould-ability to any shape giving aesthetic appearance and resistance to fire and weathering. Concrete is a material used in civil engineering constructions, consisting of a hard, chemically inert particulate substance, known as an aggregate (usually made from different types of sand and stone), that is bonded together by cement and water.. In this experimental investigation cement used is Portland Pozzolanic Cement (RAASI GOLD' 53 grade).

Concrete is weak in tension and strong in compression. The low tensile strength is due to the propagation of internal micro cracks present even before loading. So, concrete exhibits little fracture. Hence steel fibers are used to overcome the above disadvantage. The concept of fiber reinforcement is an old as the use of brittle materials as clay, bricks or concrete. The modern use of fiber reinforced concrete started in the 1960s using after various sorts of fiber materials have been investigated ever since and are utilized for different applications. Steel fibers are the dominating material, but there are many others, such as polymeric fibers, mineral fibers and naturally occurring fibers. In this experimental investigation fibers of Perma-Fil E Glass Fibers and Cold Drawn Carbon Wire Steel Fibers are used.

Fiber reinforced concrete is a composite material essentially consisting of conventional concrete or mortar reinforced by randomly oriented, short continuous and discrete fibers of specific geometry. The fiber is a piece of reinforcing material usually described by aspect ratio. Aspect ratio is the ratio of length to diameter of fiber. The quantity of fiber is specified by volume fraction. These fibers act as

1.1 FIBER REINFORCED CONCRETE (FRC)

Fibers have been used since ancient times to reinforced brittle material. Horse hair was used to reinforce plaster, straws and asbestos fibers were used to reinforce bricks and Portland cement in early yearly in 1910, Porter first put forward the idea that concrete can be strengthened by inclusion of fibers. Little progress was made in the development of this material till 1963, when Ramouldi J.P and Batson G.B published their

classical paper on the subject. In the early 1970s Steel Fiber Reinforced Concrete (SFRC) has been used in pavement construction.

1.2 STEEL FIBERS:

It is one of the most commonly used fibbers it may vary from 0.25 to 1.00mm dia. Use of steel fibers makes significant improvements in flexural , impact and fatigue strength of concrete . It has been extensively used in various types of structures. The efficiency of fiber distribution depends on the geometry of the fiber, the fiber content, the mixing and compaction techniques, the size and shape of the aggregates and the mix proportions.

The following types of steel fibers are available in prevailing market.

(A) CARBON STEEL FIBER:

1. Cold Drawn Steel Fiber
2. Slit Sheet Steel Fiber
3. Glued Steel Fiber

(B) STAINLESS STEEL FIBER: -

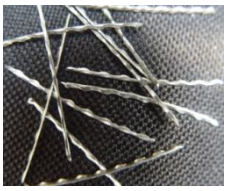
1. Meil Extract Stainless Steel Fiber
2. Slit Sheet Stainless Steel Fiber
3. Cold Drawn Stainless Steel Fiber

COLD DRAWN CARBON WIRE STEEL FIBER: -

Carbon steel fiber is produced from high-strength cold-drawn steel wire, conform to ASTM 820, widely used for concrete reinforcement.

SLIT SHEET CARBON STEEL FIBER	
	Slit sheet carbon steel fiber is used as a replacement for traditional reinforcement in various concrete applications.
GLUED STEEL FIBER	
	Glued steel fibers are filaments of wire, deformed and cut to lengths, for reinforcement of concrete, mortar and other
MELT EXTRACT STAINLESS STEEL FIBER	
	Melt extract stainless steel fiber is produced by melting elements in a crucible. A flywheel is then introduced

SLIT SHEET STAINLESS STEEL FIBER

	Slit sheet stainless steel fiber is manufactured from coil by chopping the width of the stainless coil. Used for precast shapes.
COLD DRAWN STAINLESS WIRE STEEL FIBER	
	Cold drawn stainless steel fiber is manufactured by high quality stainless steel wire. Used for castable requirements.

GLASS FIBER:

Glass fibers are made of silicon oxide with addition of small amounts of other oxides. Glass fibers are characteristic for their high strength, good temperature and corrosion resistance, and low price. There are two main types of glass fibers: E-glass and S-glass. The first type is the most used, and takes its name from its good electrical properties. The second type is very strong (S-glass), stiff, and temperature resistant.

Used as reinforcing materials in many sectors, e.g. automotive and naval industries, sport equipment etc. They are produced by a spinning process, in which they are pulled out through a nozzle from molten glass (thousands of meter/min).

For E-glass fibers:

E-modulus: ca. 72.4 GPA

Tensile strength: 2400 MPa

For S-glass fibers:

E-modulus: ca. 85.5 GPa

Tensile strength: 4500 MPa

Originally used in conjunction with cement have found to be affected by alkaline condition of cement. Therefore alkali – resistant glass fiber by trade name **"Cem - Fil"** and "**Perma - Fil E Glass Fibers**" has been developed. In this experimental investigation "**Perma - Fil E Glass Fibers**" is used. Glass fiber reinforced concrete is suitable for use in direct spray techniques and premix processes. Glass fiber reinforced concrete products are used extensively in agricultural cladding components and for small containers. Photo copy of model glass fiber is shown below.

Fig. Glass-Fiber-Twisted-Rope photo

II. Experimental Investigation

In the present experimental investigation the following tests were carried out namely: Compressive Strength Split Tensile Strength and Flexural Strength Tests for replacement of glass with steel fiber by 0%, 25%, 50% 100% from total content of 0.50, 0.75 and 1.00 percentages by weight have been attempted over the concrete specimens such as cubes, cylinders and beams respectively. The program consists of casting and testing of specimens for various mixes.

Testing Programme:

In the present investigation, it is intended to study the behavior of concrete and various strength parameters that are compressive, tensile and flexural strength with laboratory samples are evaluated. The mixed glass and steel short fibers with varying percentages of 0%, 25%, 50% 100% from 0.5, 0.75, 1.0 percentages of total fiber content are used for structural concrete. For each replacement of glass with steel fibers by 0%, 25%, 50% 100% from each 0.5, 0.75, 1.0 percentages of total fiber content, 6 cubes & 6 cylinders were cast. Totally 18 cubes & 18 cylinders were cast with locally available good materials and are taken for testing in this investigation. These 18 cubes & 18 cylinders for 28 days were used for finding compressive strength, split tensile strength and flexural strength test respectively.

TEST RESULTS AND GRAPHS:

The concrete specimens using steel and glass fibers are prepared in the laboratory have been tested as per the standard specifications. The results of the Compressive Strength, Split Tensile Strength and Flexural Strength for 0.5, 0.75 & 1.0 percentage total fiber content at 28 days are reported. Further the Cracking characteristics and ductility characteristics were studied. The graphs are plotted based on the test results. The test results are tabulated for easy and better evaluation.

Compressive Strength Test

a) *Concrete Specimens Details:*

Mix : M25

Specimens designation : C_{1-1} to C_{1-6}

Concrete specimen No.	**Glass Fiber %**	**Steel Fiber %**	**Ultimate Compressive Load in KN**	**Compressive Strength in N/mm2**	**Increase in Strength %**
C_{1-1}	0	100	1180	52.44	27.12
C_{1-2}	25	75	1160	51.56	25.87
C_{1-3}	50	50	1060	47.11	18.87
C_{1-4}	75	25	980	43.56	12.25
C_{1-5}	100	0	930	41.33	7.53
C_{1-6}	Conventional Concrete		860	38.22	00.00

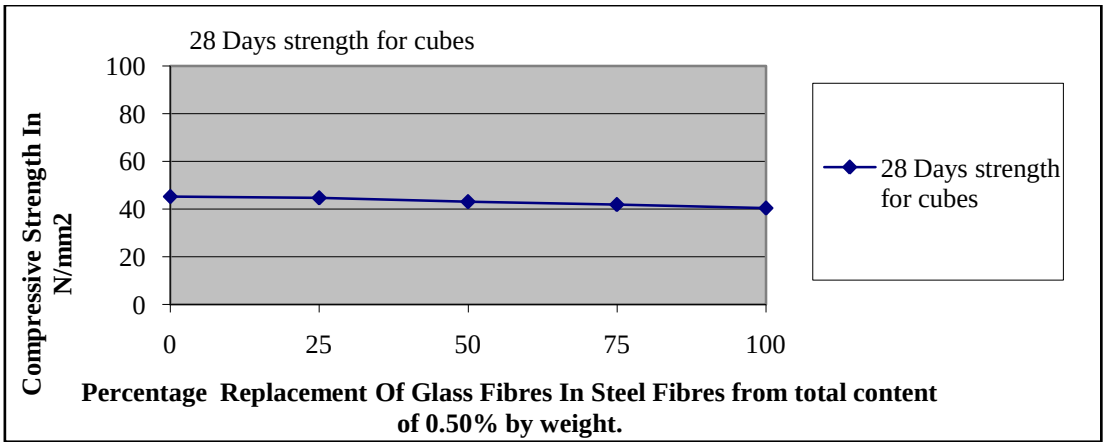
Split Tensile Strength Test

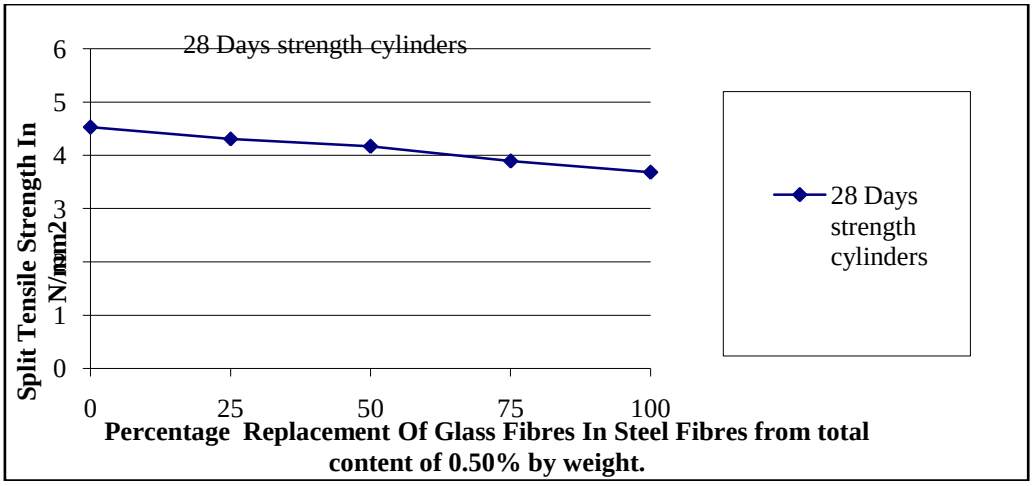
A. *Concrete Specimens Details: -*

Mix : M25

Specimens Designation : S_{1-1} to S_{1-6}

Concrete specimen No.	**Glass Fiber %**	**Steel Fiber %**	**Ultimate Split Tensile Load in KN**	**Split Tensile Strength in N/mm2**	**Increase in Strength %**
1	2	3	4	5	6
S_{1-1}	0	100	320	4.53	21.85
S_{1-2}	25	75	305	4.31	17.87
S_{1-3}	50	50	295	4.17	15.11
S_{1-4}	75	25	275	3.89	9.00
S_{1-5}	100	0	260	3.68	3.80
S_{1-6}	Conventional Concrete		250	3.54	00.00





III. Discussion On Test Results

This chapter deals with discussion of test results. The tests results are studied with reference to the results of the Compressive Strength, Split Tensile Strength and Flexural Strength at 28 days are reported.

Compressive Strength:

Percentages of fibers in concrete specimens		**For 0.50% total fiber content Compressive Strength in N/mm2**	**For 0.75% total fiber content Compressive Strength in N/mm2**	**For 1.00% total fiber content Compressive Strength in N/mm2**
Glass Fiber %	**Steel Fiber %**			
1	2	3	4	5
0	100	52.44	53.78	56.44
25	75	51.56	52.89	54.67
50	50	47.11	49.33	51.11
75	25	43.56	44.44	47.11
100	0	41.33	43.11	44.89
Conventional Concrete		38.22	38.22	38.22

The cube compressive strength results obtained at the age of 28 days are presented in the above table for 0%, 0.5%, 0.75% and 1.00% total fiber content. The glass fiber content is varied from 0% to 100% in the above table and the results compared with that of plain concrete specimens. Likewise, the results of 0.75% total fiber content and the results for 1% total fiber content are compared with that of plain concrete specimens.
Hence the results presented in the above table shows the variation of compressive strength at the end of 28 days with various percentages of glass fibers of 0%, 25%, 50%, 100% by volume used as replacement of steel fiber in total fiber content of 0%,0.5%, 0.75% and 1.0% by volume,

IV. Discussion:

It is observed that as the percentage of total fiber content (steel fibers and glass fibers) is increased, the compressive strength also increases. It may also be observed that as the percentage replacement of steel fiber by glass fiber increased and steel fiber percentage is decreased, the compressive strength goes on decreasing.

In the present experimental investigation regarding the compressive strength, the following is observed from the above table.

V. Conclusions

On the basis of experimental studies carried out and the analysis of test results, the following conclusions are drawn.

1. The structural integrity of the tested concrete specimens is found to be good under loading.
2. With the above test results, the concrete mixed with dual fibers can be recommended for earthquake resistance structures.
3. In addition to the fibrous contents, some of the admixtures/plasticizer can be mixed to enhance some of the strength properties of concrete satisfactorily.
4. It can be concluded that the concrete mixed with dual fiber would also have much more life in comparison with the conventional concrete.
5. The fibrous concrete is found to have maximum ultimate load carrying capacity as conventional concrete.
6. The fibrous concrete is stiffer than the conventional concrete inappreciable way.
7. For the nominal M25 mix with a water cement ratio of 0.5 used in the present investigation, the workability of concrete is only marginally affected even with a total fiber content of 1.0 percent by volume.
8. The compressive strength of dual fiber concrete is found to be maximum at 1.0% total fiber content of steel at 28 days compared to plain concrete. Also, with a total of 1.0 % glass fiber by volume the increase of compressive strength at 28 days compared to plain concrete.
9. There is substantial increase in the compressive strength for mixed fiber combination.
10. As the percentage of steel fiber is reduced and glass fiber is increased, the compressive strength is getting reduced compared to that of 100% steel fiber in the matrix.

VI. Scope For Future Study:

Various research activities on properties of concrete in aggressive media are carried out; there is a wide scope for further research. The advert of various mineral admixtures and chemical admixtures necessities active exploration and experimental investigation. The following avenues may be investigated.

1. Further study can be made for the same case of loading with different cements and different grades of concrete.
2. The comparative study can be made on the strength properties of concrete with various dual fibers such as Carbon fibers and Steel fibers, Glass fibers and Carbon fibers and other combinations of fibers.
3. Present work can be studied further by using mineral admixtures, Fly ash & glass fibers with partial replacement of cement.
4. This study can also be extended by considering the effect of single and two points loading with effect of shear also.
5. Creep, Impact and Fatigue tests for beams with different percentages of fibers under different loading conditions can be studied.
6. Further investigations can be carried out on the permeability property of concrete with fibers.
7. Behavior of fiber reinforced concrete with dual fibers under uni-axial and biaxial bending for columns can be studied.
8. Further work may be carried out on the high strength concrete/self compaction concrete using dual fibers.
9. Tests on slabs and beams (prototype) may be conducted to arrive at the design strength of fiber reinforced concrete with dual fibers.
10. Further investigation can be done at the end of 45 days,90 days and1 year to life time.

References

[1]. IS.456-2000, "Indian Standard Code of Practice for Plain and Reinforced Concrete", Indian Standards Institution, Maniac Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi-2.
[2]. IS.516-1959, "Methods of Tests for Strength of Concrete", Bureau of Indian Standards, ManakBhavan, 9 Bahadur Shah Zafar Marg, New Delhi-2.
[3]. Satander Kumar (2005), "Alternate Materials for Civil Engineering Construction", Central Road Research Institute, New Delhi.
[4]. Sikder, P.K, Gupta, S and Kumar, S. (2004), "Application of Fiber as Secondary Reinforcement in Concrete", NSW & CW, December.

[5]. MoRTH Specification for Road and Bridge Works (2001), Fourth Revision.
[6]. BIS 10269:1987,"Specification for 53 Grade Ordinary Portland Cement", Bureau of Indian Standard, New Delhi.
[7]. BIS 2386:1963, "Methods of Test for Aggregates for Concrete", Bureau of Indian Standard, New Delhi.
[8]. BIS 383:1970,"Coarse and Fine Aggregate from Natural Sources of Concrete", Second Revision, Bureau of Indian Standard, New Delhi.
[9]. BIS 9103:1999, "Admixtures for Concrete", First Revision, Bureau of Indian Standard, New Delhi.
[10]. BIS 10262:1999' "Recommended Guidelines for Concrete Mix Design.

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