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To Study the Flexural, Tensile and Compressive Strength of Reinforced Concrete by Adding Glass & Steel Fibers in Different Proportions

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Abstract

When different type of fibers are added to concrete to make it a composite mass and it gives maximum strength to concrete that type of concrete is known as hybrid reinforced concrete (HFRC). In this experimental work crimped steel fiber of length 45mm with aspect ratio 50 and alkali resistance glass fiber of length 12mm with aspect ratio 857.14 with different mix proportion have been used along with 53 grade ordinary Portland cement. M20 grade of concrete with 0.20%, 0.25%, 0.40%, & 0.45%, proportions of glass fibers and 0.30%, 0.35%, 0.50% , &0.55% proportions of steel fibers have been added with concrete. Variations in flexural, spilt tensile and compressive strength of concrete have been compared with M20 grade of concrete. Results indicate that Glass & steel fibers ratio 0.30% & 0.50% gives maximum results in all the strength parameters compare to other different proportions ratio after 7 and 28 days curing of curing.

Keywords: *Crimped Steel and Alkali Resistance Glass Fibers, Flexural Strength, Split Tensile Strength, Compressive Strength*

1. Introduction

Construction industry plays an important role for the construction of buildings, bridges, tunnels and also for developing infrastructures. Concrete is a most commonly used construction material. The utilization of concrete or cement based material is quite ancient. With the passage of time the significance of concrete has grown and the limitation of concrete have been gradually cut, making the concrete more durable and with a higher performance.

A very important development that took place in the history of concrete was the use of reinforced bars in concrete for structural elements. This technique was quite efficient in terms of resisting the macro cracks in concrete and in imparting bending strength in flexural members. The reason was to somehow affect the low tensile strength of concrete by strategically placing the bars. However, concrete as a material remained weak in tension and brittle. To improve the tensile strength of concrete, fiber reinforcement was added.

The introduction of Fiber Reinforced Concrete (FRC) is an important achievement in concrete technology. While the use of straws in bricks and hair in mortar predates the use of conventional Portland cement concrete, the use of advanced fibers in concrete has provided important opportunities. The use of FRC has increased over the last thirty years. Fibers are added to improve the strength of the concrete and also they are added to enhance the post crack behavior of concrete. In FRC, cracks are tied by fibers restrain their growth and providing post crack ductility. Fiber as reinforcement is effective in binding cracks at both micro and macro levels.

When a matrix is reinforced due to short fibers, the following improvement can be seen:

- Strengthening of the matrix
- Fiber bonding and frictional pullout
- Binding of fibers across the cracks and crack face stiffness
- Increase in the flexural strength, spilt tensile and compressive strength of concrete.

Fiber Reinforced Concrete can be used for various applications. Glass fibers can be used in thin sheet element production and steel fibers in pavements, tunnels and in variety of other constructions. In recent years, researchers have realized the benefits of combining fibers, in term of obtaining synergy and improving the response of composite material. A composite can be referred to as hybrid, if two or more types of fibers are reasonably combined to produce a composite mass.

2. Materials and Methods

Cement: In this experiment 53 grade ordinary Portland cement (OPC) with brand name Ultratech is used for all concrete mixes. The physical properties of cement used are as given in Table.1.

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Table: 1 Physical Properties of Cement

S.No.	Properties	Value	IS Specification and Test procedure
1	Specific gravity	3.15	IS:4031
2	Standard consistency	35%	IS:4031 & IS269
3	Initial setting time	35 Min.	>30, IS:4031 & IS 269
4	Final setting time	300 Min.	<600, IS:4031 & IS269

Fine aggregate: Locally available sand passing through 4.75mm sieve was used as fine aggregate for research work. The physical properties of fine aggregate are as given in Table 2.

Table: 2 Physical Properties of fine aggregate

S.No.	Properties	Value
1	Specific gravity	2.65
2	Fineness modulus	3
3	Grading of sand	Zone II

Coarse aggregate: The coarse aggregates used for the work is of 20mm and 10mm size which is free from deleterious materials like silt content and chloride contamination.

Table: 3 Physical Properties of Coarse aggregate

S.No.	Properties	Value
1	Specific gravity	2.70
2	Fineness modules	4

Water: Potable water is used for casting of specimen and as well as curing of specimen as per IS 456 – 2000.

Steel fiber: In this investigation crimped steel fibers have been used. Steel fibers were obtained from Bakul Wires Private Ltd. Dewas, M.P. The properties of steel fibers and specification are mentioned in Table 4.

Table: 4 Properties of steel fibers

Properties	Specifications
Types	Crimped steel fiber
Tensile strength (MPa)	1100
Diameter (mm)	0.90
Length (mm)	45
Aspect ratio	50

Fig.1 Steel Fibers

Glass Fiber: In this investigation the Alkali Resistance glass fibers with 12mm cut length and having tensile strength of 1700Mpa is used. The glass fibers were obtained from International Trade Company Mumbai, Maharashtra.

Fig.2 Glass Fibers

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Percentage variation of fibers in mix

Glass and steel fibers were used in different proportions. Glass fibers were added by weight of cement and steel fibers were added by volume of concrete in the concrete mix.

Table: 5 Percentage variations of fibers

Mix designation of Concrete	Glass fibers by weight of cement (%)	Steel fibers by volume of concrete (%)
N_1	0	0
N_2	0.20	0.40
N_3	0.25	0.45
N_4	0.30	0.50
N_5	0.35	0.55

Concrete Mix Proportions

In this study, M20 grade of concrete was used. The concrete mix design was done as per IS 102062:2009. The water cement- ratio adopted is 0.55 for the proper workability of concrete. Beams, cylinders and cubes were casted with addition of glass and steel fibers in different proportions cured for 7 and 28 days. The mix proportions are shown in Table 6.

Table: 6 Concrete Mix Proportions

Materials	Quantity	Proportion
Cement	386 Kg/ m^3	1
Sand	648 Kg/ m^3	1.68
Coarse Aggregate	1273 Kg/ m^3	3.3
Water	212 Kg/ m^3	0.55

3. Results and Discussion

Beams, cylinders and cubes specimens were tested on universal testing machine of capacity 2000KN. The beam specimens of size 500×100×100mm were tested to determine the flexural strength. Cylindrical specimens of diameter 150mm and height 300mm were tested to determined spilt tensile strength and cube specimens were tested to determined compressive strength. An average of three specimens was tested for strength.

Table: 7 Flexural Strength Test

Mix design of concrete	Glass fiber by weight of cement (%)	Steel fiber by volume of concrete (%)	Flexural strength in 7 Days (N/mm^2)	Flexural strength in 28 Days (N/mm^2)
N1	0	0	2.6	3.02
N2	0.20	0.40	2.82	3.24
N3	0.25	0.45	2.95	3.38
N4	0.30	0.50	3.045	3.56
N5	0.35	0.55	2.73	3.30

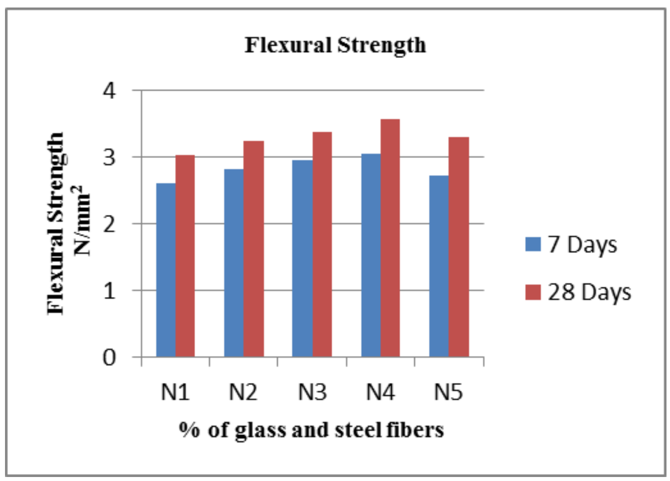

Fig. 3 Flexural strength test results

It is clear from the Table 7 and Figure 3 that there is increase in the flexural strength with the addition of glass & steel fibers. However maximum increase in strength was observed from glass & steel fibers proportions 0.30% & 0.50% respectively. There is also gradual increase in flexural strength of concrete for N2 to N4 design mix however for N5 where glass and steel fibers proportions 0.35% & 0.55% respectively, increase in strength is less in comparison to N4 design mix.

Table 8 Split Tensile Strength Test

Mix design of concrete	Glass fiber by weight of cement (%)	Steel fiber by volume of concrete (%)	Split tensile strength in 7 Days (N/mm^2)	Split tensile strength in 28 Days (N/mm^2)
N1	0	0	1.78	2.45
N2	0.20	0.40	1.94	2.70
N3	0.25	0.45	2.03	2.75
N4	0.30	0.50	2.10	2.90
N5	0.35	0.55	1.84	2.54

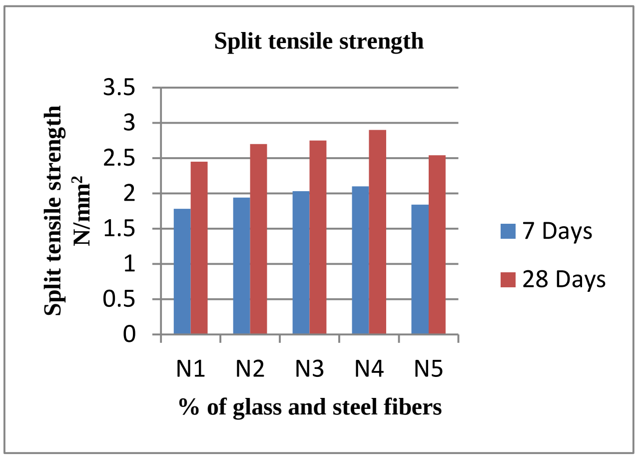

Fig. 4 Split tensile strength test results

It is clear from the Table 8 and Figure 4 that there is increase in the split tensile strength with the addition of glass & steel fibers. However maximum increase in split tensile strength was observed from glass & steel fibers proportions 0.30% & 0.50% respectively. There is also gradual increase in spit tensile strength of concrete for N2 to N4 design mix however for N5 where glass and steel fibers proportions 0.35% & 0.55% respectively, increase in strength is less in comparison to N4 design mix.

Table 9 Compressive Strength

Mix	Glass fiber by weight of cement (%)	Steel fiber by volume of concrete (%)	Compressive strength at 7 days (N/mm^2)	Compressive strength at 28 days (N/mm^2)
N1	0	0	23	29
N2	0.20	0.40	27.91	32.22
N3	0.25	0.45	28.58	37.07
N4	0.30	0.50	29.06	40.02
N5	0.35	0.55	24.65	30.28

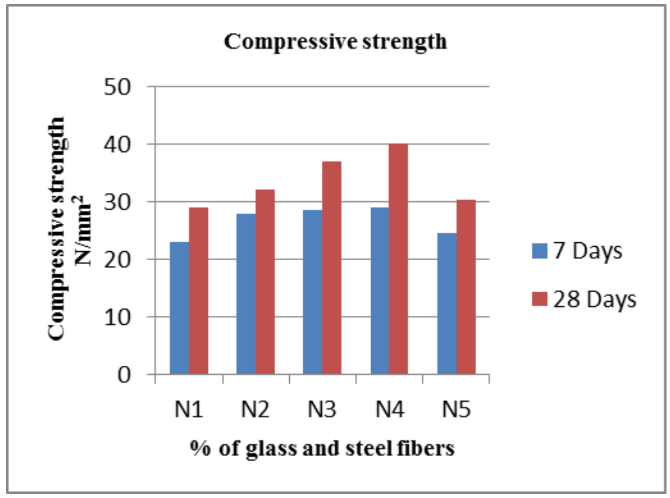

Fig. 5 Compressive strength test results

It is clear from the Table 9 and Figure 5 that there is increase in the compressive strength with the addition of glass & steel fibers. However maximum increase in compressive strength was observed from glass & steel fibers proportions 0.30% & 0.50% respectively. There is also gradual increase in compressive strength of concrete for N2 to N4 design mix however for N5 where glass and steel fibers proportions 0.35% & 0.55% respectively, increase in strength is less in comparison to N4 design mix.

4. CONCLUSIONS

- The highest flexural strength of sample N4 was found 17.88% greater than conventional concrete mix (N1). Three other samples, N2 (0.20% & 0.40%), N3 (0.25% & 0.45%) and N5 (0.35% & 0.55%) also showed the higher flexural strength as compare to control concrete N1. These increments are 7.28%, 11.92% and 8.27%. All results are greater than the normal concrete mix (N1).
- The highest split tensile strength of sample N4 (0.3% & 0.5%) was increased 18.36% compared with the conventional concrete and samples N2, N3 & N5 gives split tensile strength slightly higher than the conventional concrete mix (N1). The increasing percentage of split tensile strength of samples N2,

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N3, N4 and N5 are 10.20%, 12.24%, 18.36% and 3.60% respectively.

- The highest compressive strength of sample N4 was observed 38% compared with the control concrete mix (N1). The increasing percentage of compressive strength of samples N2, N3, N4 and N5 are 11.10%, 27.87%, 38% and 4.41% respectively compared with the control concrete mix.
- It was observed that the workability of conventional concrete is more compare to hybrid fiber reinforced concrete; it was found that % of glass and steel fibers increase means there is reduced in workability.

References

[1] Praveen kumar Goud.E, Praveen K.S "Optimization of percentages of steel and glass fiber reinforced concrete" International Journal of Research in Engineering and Technology Volume 4, Issue 4, April 2015.

[2] SrikanthRagi "A Comparative and Experimental Study on the Mechanical Properties of Various Steel and Glass Fiber Reinforced High Strength Concrete" International Research Journal of Engineering and Technology Volume 2, Issue 4, July 2015

[3] Bureau of Indian Standards: IS- 456-2000, "Indian Standard Plain and Reinforced concrete code of practice (fourth revision)", 2000.

[4] Vikrant S. Vairagade, Kavita S. Kene, Dr. N. V. Deshpande "Investigation of Steel Fiber Reinforced Concrete on Compressive and Tensile Strength" International Journal of Engineering Research & Technology Vol. 1 Issue 3, May – 2012

[5] Bureau of Indian Standards: IS- 10262-1982, "Indian Standard Recommended Guidelines for concrete mix design".

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