Experimental Study on Effect of Glass Fiber on Replacement of Cement by Fly Ash

SURAJ SANDEEP KHARADE[1], PROF. P. K. BHANDARI[2]
[1] *Student M.E, Dept. of Civil Engineering, Dr. Vitthalrao Vikhe Patil College of Engineering, Ahmednagar.*
[2] *Assistant Professor, Dept. of Civil Engineering, Dr. Vitthalrao Vikhe Patil College of Engineering, Ahmednagar.*

Abstract— The use of fly ash as an addictive material, as some replacement of cement. The most important benefit is reduced permeability to water and chemicals. FRC has found many applications in civil engineering field. Based on the laboratory experiment on fiber reinforced concrete (FRC), cube, cylinders and beam specimens have been designed with Glass fiber reinforced concrete (GFRC). For concrete mixes 43 grade of ordinary Portland cement and class F type fly ash is used Water/ cement ratio 0.5%. Concrete cubes are casted with varying percentage of Glass fiber by 0.5%, 1%, 1.5%, 2% by weight of cement of 12mm cut length where used with admixture. And fly ash replacement 25% fly ash is used. The size of cubes is 150mm x 150mm x150mm. Water/cement ratio 0.5%. Test is carried out after 7 days, 14 days and 28 days of curing period. The tests conducted on concrete specimens are compressive strength, Split tensile strength, Flexural strength. Comparing the result of (FRC) with plain M20 grade concrete, this paper validated the positive effect of different fibers with percentage increase in compression and splitting improvement of specimen at 7, 14 and 28 days, analyzed the sensitivity of addition of fibers to concrete with different strength.

Indexed Terms- FRC, GFRC, Concrete, UTM, Fly Ash.

I. INTRODUCTION

In an ancient time of construction, construction activities were carried out with the help of mudstones from mudstone industry. When the coal is burned in high temperature from thermal plants finally get a finely divided particles of fly ash, fly ash is byproduct of coal. Fly Ash is a by-product of burned coal from power station some efforts are being taken all over the world to proper utilize of industrial, agricultural waste and mineral byproducts as supplementary cementations component to improve the strength, workability and other various properties of concrete.

In modern construction age, every structure has its own purposes and to meet these purposes, a mandatory modification in traditional concrete has become essential. Micro cracks in mortar aggregate results in weakness of plain concrete. This can be removed by adding Fibers to the mixture. Fibers are reinforcing materials having certain characteristic properties which are available in circular triangular and flat cross section. Addition of Fiber into the concrete mixture increases the toughness and posses an ability to resist crack growth. They helps in transferring loads at the internal micro cracks. Such a concrete is called Fiber-reinforced concrete (FRC). The principle reason for adding Fibers into the concrete mix is to increase the toughness and tensile strength and to improve the cracking deformation of the concrete.

1.1. Significance

- Fibers are generally used as resistance of cracking and strengthening of concrete.
- Glass fiber reinforced concrete is very light in weight and has high compressive and tensile strength as compared to conventional concrete.
- In facade cladding, concrete containing glass fibers is used. The function of the glass fiber is to provide reinforcement for the concrete, as concrete is weak in tension, and glass fibers have high tensile strength. With the change in the properties of glass, fibers can lead to change the properties of this composite GFRC. As the properties of GFRC depend on the fiber's length, size, manufacturing process, application techniques, curing condition, etc.
- The compressive strength of GFRC is increased with the controlled volume of fibers. an excessive amount of fibers results in a decrease in workability and compressive strength

- There is no significant influence on the modulus of elasticity of concrete with glass fibers.
- The Fibers reduce the micro-crack in fresh concrete and increase the flexural strength as compared to the traditional concrete.

II. STATE OF DEVELOPMENT

The necessary literature studies were carried out through national, International journals, periodical conferences, books and recent data from the internet source also the studies carried out Review books, review journal paper and reputed books.

- Srinivasa R, et al. (2010)

In this experimental work glass fiber was added to the concrete at 0.03% by concrete volume. Comparison study was carried out to show the effectiveness of with and without glass fibers. The increase in compressive strength for all the grades of concrete mixes was varied from 20 to 25% when compared with 28 days strength. The flexural and split tensile strength for all the grades of concrete mixes was varied from 15% to s20% when compared with 28 days strength.[5]

- Shamsuddin H, et al. (2012)

In this experimental work glass fiber was added to the concrete at 0.03% by concrete volume. Comparison study was carried out to show the effectiveness of with and without glass fibers. It has been observed that the workability of concrete decreases with the addition of Glass Fibers. Flexural strength, Split tensile strength for M-20, M-30 and M-40 grade of concrete at 3, 7 and 28 days are observed to be 20% to 30%, 25% to 30% and 25% to30% respectively when compared with 28 days strength of Plain Concrete.[12]

- Kartikey T, et al. (2013)

He suggested that when the cement is partially replaced with fly ash, fly ash improves the properties of structural concrete. In this work characteristic strength and properties of various grades of concrete were studied, the various grades were M15, M20 and M25 for all this grades fly ash was used with cement at 20%, 40% and 60%. When the cement is partially replaced with fly ash workability of concrete was increased with increased percentage of fly ash. For each grade of concrete three cubes were tested for compressive strength. The optimum strength was obtained for M15 grade was 14.48 N/mm2 for 20% replacement, 14 N/mm2 for M20 grade at 20% replacement level and 14.05 N/mm2 for M25 grade at 20% replacement. From this work finally concluded that fly ash replacement up to 20% shows greater strength than 40% and 60% for all three grades at 28 days of curing period. [11]

III. PROBLEM STATEMENT

For laboratory experiments on fibre reinforced concrete (FRC), cubes, cylinders, and beam specimens have been designed with glass fibre reinforced concrete (GFRC). For concrete mixes, M20 grades of ordinary Portland cement and class F type fly ash are used at a water to cement ratio of 0.5%. Concrete cubes are cast with varying percentages of glass fibre by 0.5%, 1%, 1.5%, and 2% by weight of cement, with a 12 mm cut length where used with admixture. And for fly ash replacement, only 25% of fly ash is used. The size of the cubes is 150mm x 150mm x 150mm. water/cement ratio of 0.5%. Tests are carried out after 7 days, 14 days, and 28 days of the curing period. The tests conducted on concrete specimens are compressive strength, split tensile strength, and flexural strength. This research compared the results of FRC with plain M20 grade concrete. The research validated the positive effect of different fibres with a percentage increase in compression and splitting improvement of specimens at 7, 14 and 28 days, and analysed the sensitivity of the addition of fibres to concrete with different strengths.

IV. CASTING AND TESTING

In this work, mixture was designed per Indian Standard specification IS 10262-1982 to have 7 days, 14 days and 28 days compressive strength of 27 Mpa and 40 Mpa respectively.

4.1 Cube

Concrete cubes, 150mm x 150mm x 150mm are casted for testing of specimen. All the specimens were prepared in accordance with Indian Standard Specification IS 516-1959. Every specimen consisting 12 cubes.

Fig 1 Casting of cubes

4.2 Cylinder

Concrete cylinder, 150mm Diameter and 300mm Height are casted for testing of specimen. All the specimens were prepared in accordance with Indian Standard Specification IS 516-1959. Every specimen consisting 12 Cylinder for the Split Tensile Strength Of this concrete.

Fig 2 Casting of cylinder

4.3 Testing Programmer

Fig 3 Testing Programmer

V. RESULTS AND DISCUSSION

5.1 Results For 25% Fly-Ash & Glass Fibers

- Compressive strength

Table 1 Compressive strength Test (Glass Fibers And 25% Of Fly Ash)

Glass Fiber %	7 days	14 days	28 days
0%	13.78	19.08	21.20
0.5%	15.32	21.22	23.57
1%	16.09	22.28	24.75
1.5%	16.89	23.39	26.66
2%	14.36	19.88	22.09

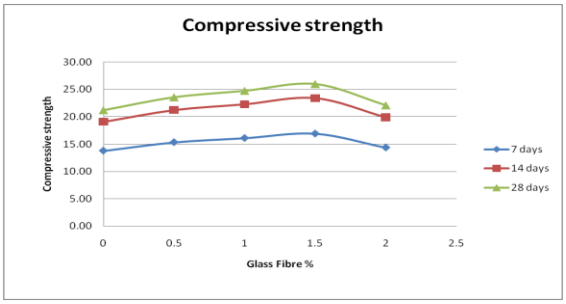

Fig 4 Compressive strength Test (Glass Fibers And 25% Of Fly Ash)

Above Results show that there is a marginal increase in Compressive strength in replacement of glass Fibers and 25% of fly ash ate the 1.5% of at the age of 7, 14, 28 days and gets slightly decreased at the 2%

- Split Tensile Strength

Table 2 Split Tensile Strength (Glass Fibers And 25% of Fly Ash)

Glass Fiber %	7 days	14 days	28 days
0	1.16	1.60	1.78
0.5	1.26	1.74	1.94
1	1.37	1.90	2.11
1.5	1.49	2.06	2.29
2	1.28	1.77	1.97

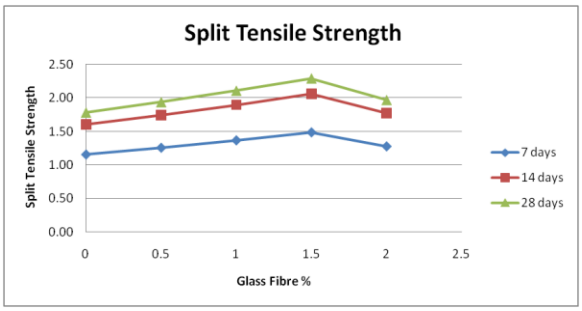

Fig 5 Split Tensile Strength (Glass Fibers And 25% of Fly Ash)

Above Results show that there is a marginal increase in Split Tensile Strength in replacement of glass Fibers and 25% of fly ash ate the 1.5% of at the age of 7, 14, 28 days and gets slightly decreased at the 2%.

5.3 Results for Glass Fibers Only

- Compressive strength

Table 3 Compressive strength Test (Glass Fibers only)

Glass Fiber %	7 days	14 days	28 days
0%	11.38	15.75	17.50
0.5%	12.65	17.51	19.46
1%	13.28	18.39	20.43
1.5%	13.95	19.31	21.45
2%	11.85	16.41	18.24

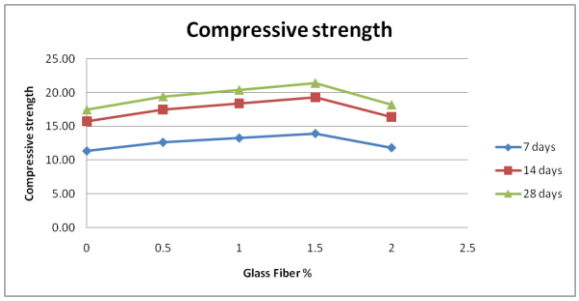

Fig 6 Compressive strength Test (Glass Fibers only)

Above Results show that there is a marginal increase in Compressive strength in replacement of glass Fibers and 25% of fly ash ate the 1.5% of at the age of 7, 14, 28 days and gets slightly decreased at the 2%.

- Split Tensile Strength

Table 4 Split Tensile Strength (Glass Fibers only)

Glass Fiber %	7 days	14 days	28 days
0	0.94	1.30	1.44
0.5	1.02	1.41	1.57
1	1.11	1.53	1.70
1.5	1.20	1.67	1.85
2	1.03	1.43	1.59

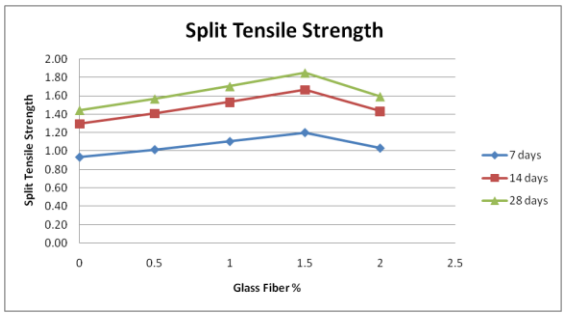

Fig 7 Split Tensile Strength (Glass Fibers only)

Above Results show that there is a marginal increase in Split Tensile Strength in replacement of glass Fibers and 25% of fly ash ate the 1.5% of at the age of 7, 14, 28 days and gets slightly decreased at the 2%.

CONCLUSION

A detailed study has been carried out on the flexural and tensile strength of fiber reinforced concrete with varying the various percentage of glass fiber. Hence the following conclusion is considered based on the results and observations are following.

- Inclusion of glass fiber reduces the slump values. This is due to the resistance of fibers for the free flow of concrete.
- From the test results obtained during the experiment work it is clear that the strength of fiber reinforced concrete significantly higher than the normal concrete. The crack formation is also very small in fiber specimen compared to non-fiber specimen.
- The highest Compressive Strength of Sample GF1.5% was observed that 14.60% at 28 days compared with the conventional concrete mix GF0

REFRENCES

[1] Tarun R. Naik and Bruce W. Ramme, High Strength Concrete Containing Large Quantities of Fly Ash, ACI Materials Journal, March-April (1989) 111-116.

[2] Bureau Of Indian Standards: IS-516: 1959 "Methods of Test for Strength of Concrete", New Delhi 2003.

[3] Sivakumar. A, Manu Santhanam, "Mechanical Properties of High Strength Concrete Reinforced with Metallic and Non-Metallic Fibers", Cement & Concrete Composites, 29 (2007) 603–608.

[4] Dr. Mrs. S. A. Bhalchandra, Mrs. A. Y. Bhosle," Properties of Glass Fiber Reinforced Geopolymer Concrete" International Journal of Modern Engineering Research (IJMER) Vol. 3, Issue. 4, Jul - Aug. 2013 Pp-2007-2010.

[5] Srinivasa R, Pannirselvam N, Seshadri T.S, And Sravana P., (2010), "Strength Properties of Glass Fiber Concrete" ARPN Journal of Engineering and Applied Sciences, VOL. 5, Issue 4.

[6] Okan Karahan, Cengiz Duran Atis (2010) "The Durability Properties of Polypropylene Fiber Reinforced Fly Ash Concrete", Materials and Design.

[7] Gomale Avinash, Quadri S Ibrahim, Quadri S Mehmood, Syed Md Akram Ali, Hussaini Shed Shamsuddin (2012). Strength Aspect of Glass Fiber Reinforced Concrete. International Journal of Scientific Engineering Research. ISSN 2229-5518.

[8] Performance Of Steel Fiber Reinforced Concrete,Milind V. Mohod, P.R.M.I.T.&R., Badnera. International Journal of Engineering and Science Vol. 1, Issue 12 (December 2012), Pp 01-04.

[9] Verma Upendra, Kumar A.D (2013). Glass Fiber Reinforced Concerte. A Upendra Verma Et Al. International Journal Of Engineering Research And Applications. ISSN: 2248-9622 VOL. 3.

[10] Selin C. Ravikumar, Thandavamoorthy T.S (2013). Application Of FRP For Strengthening and Reinforting of Civil Engineering Structures.ISSN(P). International Journal of Civil, Structural, Environmental and Infrastrcture Engineering Resaech and Development (IJCSEIERD) ISSN(P): 2249-6866; ISSN(E): 2249-7978.

[11] Kartikey T, Jatale A, Khandelwal S, (2013), "Effects On Compressive Strength When Cement Is Partially Replaced By Fly-Ash" IOSR Journal Of Mechanical And Civil Engineering (IOSR-JMCE) Volume 5, Issue 4, Jan-Feb 2013.

[12] Shamsuddin H, et al. (2012)," Experimental Study on Partial Replacement of Cement by Fly Ash with Glass Fiber Reinforcement", International Journal of Engineering Research and Technology (IRJET) Vol. 4 Issue 05, May-2015.

[13] Dr. N. Ganesan, Dr. P.V.Indira, Mr. P.T. Santhosh Kumar (2006)," Experimental Study On Glass Fiber Concrete", International Journal Of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published By, Www.Ijert.Org RICESD – 2015