International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-5, January 2020

Mechanical Properties of Glass Fiber Concrete with Different Dosages of Glass Fiber

T.Sai Krishna Teja, Tiriveedhi Sai Krishna, Syed. Nizamuddin Khadri

Abstract : Conventional concrete i.e. the concrete generally has low tensile strength with limited ductility and low resistance towards cracking. The micro cracks that are developed internally are inherent among concrete and can be explained with the help of propagation of that micro cracks due to its inferior tensile strength. Different fibers, added at a certain percentage of concrete known to improve the deformation properties of concrete along with the plasticity against crack resistance, such as flexural strength. Mainly concrete & ferroconcrete research has been moved to steel fibers, and glass fibers have recently become more available, with no corrosion problems associated with glass fibers. This article describes an experimental study of the usage of glass fibers in the structural concrete. High-dispersion CEM-FILL fiberglass of 14 µm diameter with an aspect ratio of 857 was used at a dosage of 0.33% to 1% by weight in concrete and its mechanical properties such as compressive strength, flexural strength and modulus of elasticity.

Keywords: Glass fiber, aspect ratio, indirect split tensile strength.

I. INTRODUCTION

There is increase in concrete use with an increase in development of infrastructure [1]. Due to this, the consumption of concrete is constantly increasing, and the main natural components that make concrete, i.e. small & coarse aggregates were depleted at a very rapid rate. This necessitates of the use of alternative materials that will be added to the cement without reducing its strength performance [2]. It is an idea to added ingredients which improve the performance. In this regard, several researchers have worked on the use of materials such as rice husk, sugar cane buggas & fiberglass, etc. On addition of a new fiberglass to standard concrete, you should keep in mind the short & long term interaction [3]. Ingredient with other elements, the effect on compression strength, flexural strength, performance, durability, permeability, tensile strength, bonding and uniformity [4]. Performance requirements are dependent on many other major factors such as type of mixing, mixing time, modes of transportation, placement, use of impurities, curing methods, and climatic factors [5]. This paper uses CEM-FIL anti cracking HD glass fibers having a modulus of elasticity of 72 GPa, of diameter of 14 µm, specific gravity of 2.68, length of 12 mm, and a aspect ratio of 857.10. Approximately, 212 million fibers per kg were used to prepare standard M30 concrete by replacing the fine aggregate by 1.5%. Fibers are available in large quantities and are a waste of the glass industry [6]. Thus, the use of such fibers not only increases the flexural strength of concrete, but also paves the way for easy disposal of industrial waste. In addition, the fibers are known to delay plastic shrinkage and shrinkage.

Manuscript published on January 30, 2020.
***** Correspondence Author
T.sai krishna teja*, Civil engineering department, Hyderabad, India. Email: saikrishnat@aec.edu.in
Tiriveedhi sai krishna, civil department, Aditya engineering college, surampalem, india. Email: saikrishna_civil@aec.edu.in
Syed Nizamuddin khadri, civil department, Aditya college of engineering , surampalem, india. Email: khadri_civil@acoe.edu.in

II. MATERIALS AND METHODOLOGY

Natural sand adjacent to II zone that passes through 4.75 mm sieve and aggregates of nominal size 20 mm crushed stone are used as fine and coarse aggregates respectively. In this study, conventional OPC grade53 has used and the material properties are listed in the following table1.

Table1: Material Properties:

Material	Test for	Properties
Cement (OPC 53 Grade)	Specific gravity	3.4 Kg/m^3
	Fineness	2%
	Initial time	95 minutes
	Final time	185 minutes
	Consistency	31%
	Soundness	3mm
Fine Aggregate	Specific gravity	2.60 Kg/m^3
	Sieve analysis	Zone II
Coarse Aggregate	Sieve analysis	12.5-20mm
	Specific gravity	2.65 Kg/m^3
	Elongation index	12.5%
	Flakiness index	13.2%
	Water absorption	0.43%
Glass Fiber	Density	0.91
	Diameter	14µ
	Elasticity Modulus	72 GPA
	Water absorption	Nil
	Aspect ratio	857.1

Mix design for M35 Grade of concrete using glass fiber varying from 0.5 to 2.5% by weight in concrete were done by following the guidelines of IS 10262: 2009.

The following Table 2 gives the adopted mix proportions per m^3 of M35 grade of concrete and Table 3 gives the quantity of fiber to be added for each batch mix [7].

Table 2: Mix Proportions

Mix Proportions	Concrete grade	Cement	Sand	Coarse aggregate	Water to Cement ratio	Percentage of glass fibers added (%)
	M35	1	1.04	2.52	0.4	0.5%-2.5 %

Table 3: Fiber requirement for all mix batches:

Fiber % added	Quantity (Kg)
0.5	0.166
1.0	0.338
1.5	0.507
2.0	0.718
2.5	0.816
Total	**2.54Kg**

III. EXPERIMENTAL RESULTS

3.1WORKABILITY TESTS:

To enable the concrete to be a fully compacted with given efforts normally a higher water cement ratio then that theoretical calculations may be required [8]. The lubrication required for handling concrete without segregation, the quality of concrete satisfying the above requirement is termed as workable concrete [9] . The workability can be finding out by using following tests

1. Slump Cone test
2. Compaction factor test

3.1.1 SLUMP CONE TEST:

The slump test is the most versatile test for assessing the workability of fresh concrete in site. Though the sedimentation "does not measure the workability of concrete", it helps in "obtaining a difference in the consistency of fresh concrete" and to identify "variations in the uniformity of the concrete mix" [10]. The dimensions of the form according to IS 456 2000 were given below. Bottom circular diameter = 20cm, top diameter = 10cm and vertical height of cone = 30cm.

FIG-1: SLUMP CONE TEST

The test resulted in a decrementing pattern with the percentage increment of fiber. Table 4 shows the height of slump noted during the test for each percentage of glass fiber mix batches and are compared to conventional concrete batch**.**

Table 4: Slump cone test result

Glass fiber % in each batch mix	Slump height(mm)
0	140
0.5	90
1	75
1.5	65
2	50

The following graph indicates that the workability of the glass fiber reinforced concrete followed a decrementing trend with the incremented fiber dosage [11]. It designates that GFRC has less workability than the concrete without Glass fiber. There was an immensely colossal defragmentation of slump height when fibers are added in the concrete mix. The slump was observed to be dropped to 90mm at 0.5% of fiber which indicates that the concrete mix is not at all workable as the concrete was arduous to compact [12].

As the bulk dose of fiber dosage incremented to 1.0%, 1.5% and 2%, the decline gradually decremented to 75, 65 and 50 mm. Sediment obtained from the concrete cumulation was considered copacetic. The results obtained show the least workability of glass fiber reinforced concrete compared to conventional concrete [13].

3.1.2 COMPACTING FACTOR TEST:

The compaction factor test setup consists of two conical buckets, each of which is in the form of a cone, and 1 cylinder at the bottom, which are located one above the other along the axis. The hinged door is located at the bottom of the bins [14]. The extent of self-compacting is to be compared with the maximum accruable compaction for fresh concrete. IS456-2000 verbally expressed that the volume of fresh concrete compacted under these situations would vary between each individual batches

FIG-2: COMPACTION FACTOR TEST

Similar to the drop test, the seal factor test decreases as the percentage of fibers increases.

Table no 5 gives the results of the test for the coefficient of compaction is very similar to the test for decline. It has been shown that, whenever fiber is added to concrete, the workability of reinforced concrete decrease [15].

As the main dose of fiber dosage incremented to 1.0%, 1.5% and 2%, the compaction factor gradually decremented to 75, 65 and 50 mm. The precipitate obtained from the concrete coalescence was considered copacetic.The values of compaction factor test results of different percentages of fiber mixes are given in table-5

Table 5: Compaction factor test results

% of fiber mix	M1(Kg)	M2(Kg)	Compaction Factor Ratio
0	2619	26.31	0.995
0.5	23.26	24.54	0.948
1.0	22.68	24.59	0.922
1.5	21.66	24.63	0.879
2.0	20.68	24.68	0.837
2.5	20.12	24.45	0.823

3.2 DESTRUCTIVE TESTS ON CONCRETE

Concrete samples majorly depending upon various factors such as shape, temperature of sample preparation, loading rate, moisture content, type and test method will affect their mechanical strength. The compressive strength properties of concrete are customarily determined by destructive and non-destructive testing in the laboratory. The destructive tests performed in this study are described in detail below.

3.2.1 COMPRESSIVE STRENGTH TEST

The compressive strength test is performed on cubes of standard size of 15cm x15cm which are cured for 3,7 and 28 days respectively under compression testing machine according to IS 516-1959 as shown in following figure

FIG-3: COMPRESSION TESTING MACHINE

The following table-6 gives the average Compressive strength values of conventional and glass fiber reinforced concrete at 3, 7 and 28 days of age.

Table 6: Compressive Strength Test Results:

% of fiber in each mix batch	Average compressive strength (N/mm^2)		
	3 days	7 days	28 days
0	12.23	26.47	39.51
0.5	12.68	26.61	39.73
1	12.89	26.74	39.92

The test results indicated that the addition of glass fibers to concrete has increased the strength of concrete at an optimum dosage f 1.5%. The following Fig 4 shows the variation of strength of concrete at 3,\ ad 28 days of curing.

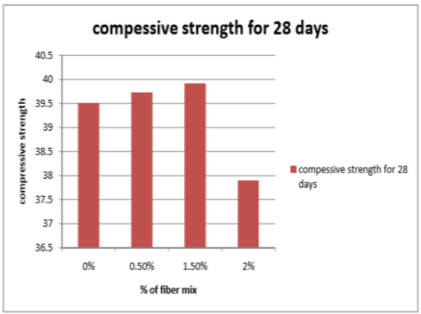

Fig 4 COMPRESSIVE STRENGTH GRAPH FOR 28 DAYS

3.2.2 INDIRECT (SPLIT) TENSILE STRENGTH TEST:

The split tensile strength test was performed on standard cylindrical samples of diameter 10cm and height 30cm which were cured for 3,7 and 28 days. The samples are tested under compression testing machine provided with a split base plate in order to split the specimen into two halves for finding out the tensile strength.

The tensile strength of fiber reinforced concrete was observed to be increased with the increase in fiber dosage. The table-7 below shows the average indirect tensile strength recorded during the test and the percentage difference in strength for all batches of the cumulation compared to the control lot. It is observed that the conventional specimens containing 0% fiber has failed suddenly once the crack initiated, while the glass fiber reinforced concrete specimens were still intact together.

Table 7: Split tensile strength test results

% of fiber mix batch	Average split Tensile Strength (MPa)		
	3 days	7 days	28 days
0	2.50	2.55	3.06
0.5	2.61	6.42	9.74
1	2.98	7.07	10.76
1.5	3.22	8.01	12.10
2	2.49	6.78	10.13

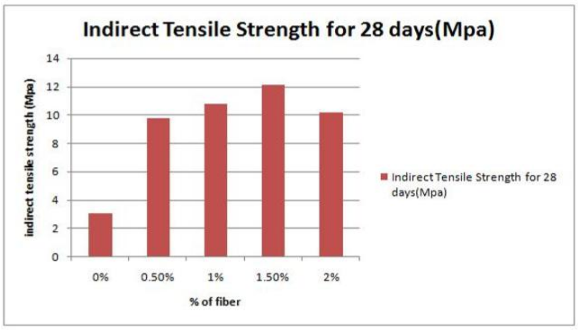

Fig 5: Indirect tensile strength graph for 28 days

IV. CONCLUSIONS AND COMMENDATIONS

From the test results mentioned above, the following conclusions can be drawn.

•This study on the effective utilization of glass fibers in structural concrete enhances the mechanical properties of concrete. Also provides an isotropic properties that are adapted in ordinary concrete

• The usage of glass fibers in concrete has decreased workability of the fresh concrete. The evidence of poor performance of glass fiber reinforced concrete was shown in the results of the performance test obtained in the standard slump cone test and compaction factor tests.

• The dosage of glass fibers above 1.5% showed that the concrete significantly becomes hard and laborious to seal.

• Glass fiber concrete is used to increase the impact resistance and fatigue resistance

• In addition, it shows that increasing the volume of fiber dosage will generally lead to a higher tensile strength of 1.5% of the fiber dose and, in addition, an increase in fiber dose will result in a tensile strength.

REFERENCES

1. Muthumani Krishnamurthi., Swamy Nadh Vandanapu. (2019), ‘Microstructural properties of oil palm shell lightweight concrete’, International journal of microstructural and material properties, 14(5), 448-461.
2. A study on transparent concrete by Bhavin K. Kashiyani, Varsha Raina, Jayeshkumar Pitroda, Dr. Bhavnaben K. Shah in feb 2013.
3. Swamy Nadh, V., Muthumani, K. (2018), ‘Properties of structural lightweight concrete containing treated oil palm shell as coarse aggregate’, Asian journal of civil engineering, 19(6), 673-678.
4. Swamy Nadh Vandanapu., Muthumani Krishnamurthy. (2018), ‘Seismic performance of light weight concrete structures’, Advances in civil engineering, 2018, 1-6.
5. Swamy Nadh, V. and Muthumani, K. (2017) ‘Critical review on structural light weight concrete’, International Journal of Civil Engineering and Technology, Vol. 8, No. 2, pp.111–127.
6. Natrayan, L and M. Senthil Kumar. Influence of silicon carbide on tribological behaviour of AA2024/Al_2O_3/SiC/Gr hybrid metal matrix squeeze cast composite using Taguchi technique." Mater. Res. Express, 2020, 6 1265f9. (DOI:10.1088/2053-1591/ab676d).
7. Parhizkar, T., & Najimi, M. (2012). Application of pumice aggregate in structural lightweight concrete. Asian Journal of Civil Engineering, 13(1), 43–54.
8. L.Natrayan et al. Optimization of squeeze cast process parameters on mechanical properties of Al_2O_3/SiC reinforced hybrid metal matrix composites using taguchi technique. Mater. Res. Express; 5: 066516. (DOI: 10.1088/2053-1591/aac873,2018).
9. L.Natrayan, P. Sakthi shunmuga sundaram, J. Elumalai. Analyzing the Uterine physiological With MMG Signals using SVM, International journal of Pharmaceutical research, 2019, 11(2); 165-170.
10. L.Natrayan, V Sivaprakash, MS Santhosh, Mechanical, Microstructure and wear behavior of the material AA6061 reinforced SiC with different leaf ashes using advanced stir casting method, International Journal of Engineering and Advanced Technology, 2018,8(2S);366-371.
11. Kumar, M. Senthil, et al. "Processing and characterization of AA2024/Al_2O_3/SiC reinforces hybrid composites using squeeze casting technique." Iran. J. Mater. Sci. Eng 16.2 (2019): 55-67.
12. Natrayan L, Senthil kumar MS, “Optimization of tribological behaviour on squeeze cast Al6061/Al_2O_3/SiC/Gr HMMCs based on taguchi method and artificial neural network,” Journal of Advanced Research in Dynamical and Control Systems,11(7), pp. 493-500.
13. S.Yogeshwaran, R.Prabhu, Natrayan.L, Mechanical Properties Of Leaf Ashes Reinforced Aluminum Alloy Metal Matrix Composites, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 13, 2015.
14. Natrayan, L., M. Senthil Kumar, and Mukesh Chaudhari. "Optimization of Squeeze Casting Process Parameters to Investigate the Mechanical Properties of AA6061/Al_2O_3/SiC Hybrid Metal Matrix Composites by Taguchi and Anova Approach." Advanced Engineering Optimization Through Intelligent Techniques. Springer, Singapore, 2020. 393-406.
15. P.Sakthi Shunmuga Sundaram , N.Hari Basker , L.Natrayan. Smart Clothes with Bio-sensors for ECG Monitoring, International Journal of Innovative Technology and Exploring Engineering, Volume 8, Issue 4, 2019, Pages 298-301.