Flextural Behavior of Plain Concrete Beams Strengthening With Glass Fiber Reinforced Polymer (FRP) By Varying Its Aspect Ratio

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Abstract- *Concrete is the most widely used construction material and it has desirable properties like high compressive stress, stiffness and durability but the concrete mix is brittle and weak in tension. The plain concrete has low tensile strength and low strain at fracture. These deficiencies are generally overcome by fiber reinforcing concrete. The present study is about the comparison of strength for different aspect ratio of fiber . Anti-crack, alkali resistant glass fiber of dia 14 micron and aspect ratio 857 and 2500 for a length of 12mm and 35mm was taken in percentages, varying from 0.33 to 1 percentage by weight of concrete mix and the properties of FRP like compressive strength, flexural strength were studied. The percentage increase in compressive strength for various grades of glass fiber concrete mix in comparison with control cubes for aspect ratio 857 is 3.26% and for 2500 is 10%. The use of glass fibers of length 35mm(aspect ratio 2500)which resist more compression load compare to fibers of length 12mm(aspect ratio 857).The percentage increase in flexural strength for various grades of glass fiber concrete mix in comparison with control beams for aspect ratio of 857 is 59% and for 2500 is 69%. The use of glass fibers of length 35mm(aspect ratio 2500)which resist more tension load compare to fibers of length 12mm(aspect ratio 857).*

Keywords- GFRP, beams, cubes, casting

I. INTRODUCTION

Glass Fiber Reinforced Concrete (GFRC) is a fiber-reinforced concrete. This is called as GRC in British English. It is mainly used for architectural precast concrete and building panels. Since alkalinity in the cement reacts with silica exhibits poor ductility for the original type of glass fiber, alkali resistance can be achieved by adding Zirconia to the glass. Increase in Zirconia content will also increase the resistance to alkali attack.

Usually Concrete mix are weak in tension, this problem is overcomes by providing a steel reinforcement but it fails in ductility load of compressive stress. Therefore to overcome this problem, fibers like Glass fiber, Carbon fiber etc...are used. Presence of uniformly dispersed fibers acts as a crack arrest because of increases in the crack strength.

1.1 Advantage and Disadvantage of FRP

Advantage:

The FRP materials will have high ultimate strength and low density compared to steel. Therefore these two properties when get together will lead into fiber composites having a strength/weight ratio higher than steel. The main advantage of FRP is it acts as a crack arrest. By adding fibers in a concrete mix it will act as a tension bar and gives more strength in addition to the steel reinforcement. Instead of steel bar the lower weight glass fibers makes handling and installation easier than steel because

- No laps and joints required.
- It can take irregularities in the shape of concrete surface.
- The materials installed readily behind the services.
- Since the material is thin, overlapping is easier.

Disadvantage:

- The main disadvantage of FRP material is the risk of fire or accidental damage.
- Damage to the plate will reduce the overall factor of safety and lead to collapse.
- Due to the lack of accepted design standards.
- Lack of experience and suitable staff to carry out the work.

II. OBJECTIVE OF STUDY

The purpose of this research is

- To study the behavior of concrete beams by varying the percentage of fiber from 0 to 1 percentage by weight in concrete.

- To understand the failure modes of strengthen and non-strengthened beams.
- Evaluate the effect of Glass fiber on flexural and compressive strength of strengthen and non-strengthened beams and cubes.
- Developing an Analytical procedure to calculate the flexural strength of concrete beam.
- Compare the Experimental results of strengthened concrete beams with the ordinary plain concrete beams.

The Aim of the present project is limited to particular size of concrete beams 100x100x500 mm length for strengthening purpose. The two point loading pattern is used to achieve pure bending.

2.1 Scope of the present study

The present study is about the comparison of strength for different Aspect ratio(AR) of fiber . Anti-crack, alkali resistant GF of dia 14 micron andAR 857 and 2500 for a length of 12mm and 35mm was taken in percentages, varying from 0.33 to 1 percentage by weight of concrete mix and the properties of FRP like compressive strength, flexural strength were studied. This paper gives the comparison of flexural strength for beams by varying the aspect ratio of fibers.

III. MATERIAL CHARACTERIZATION

The strength of concrete is mainly depend on the ingredients are to be used in the concrete. Following are the ingredients used in the experiment.

1. River sand as fine aggregate
2. Coarse aggregate
3. OPC 43 Grade cement
4. Glass fibers
5. Water

3.1 Basic material tests conducted in the Laboratory

SL NO	TESTS ON CEMENT	TESTS ON FINE AGGREGATE	TESTS ON COARSE AGGREGATE
1	Sp. gravity of cement	Sp. gravity of FA	Sp. gravity of CA
2	Fineness of cement	Fineness	Fineness
3	Initial setting time(Is)		
4	Final setting time(Fs)		
5	Standard consistency of cement(Sc)		

3.2 Glass fiber

Glass fibers from Ashwini traders, Davangere, Karnataka

Physical properties of glass fibers of different length

1. For Fiber of 12mm length

Aspect Ratio = L/D = $\frac{12}{14} \times 1000$

= 857.14

1	Diameter(D)	14 micron
2	Length(L)	12mm
3	Aspect ratio	857

2. For Fiber of 35mm length

Aspect Ratio = L/D = $\frac{35}{14} \times 1000$

= 2500

1	Diameter	14 micron
2	Length	35mm
3	Aspect ratio	2500

IV. METHODOLOGY

The mix design procedure adopted in the present work to obtain M30 grade of concrete is in response to IS10262-2009.

4.1 Proportion of Material

SL NO	Materials	Quantity/m^3in kg
1	Cement43grade	423
2	Fine aggregate	663
3	Coarse aggregate	1122
4	Water	186
5	Fiber	0-1% by weight of mix

4.2 Casting of specimen

While casting the first step is to clean the moulds and oil the inside surface, the mould should be properly tightened by the bolts to get proper finishing. Then the quantity of materials required should be weighed such as cement, fine aggregate, coarse aggregate, water and fiber as per the mix design proportions.

Here, the mixing is done for varying the percentage of fibers for different aspect ratio like 0%, 0.33%, 0.66, 1%. The comparison is made between control beams v/s FRP beams (857&2500 aspect ratio).

Beam of size 100x100x500 in mm and cube of size 150x150x150 in mm were used for casting.
For control beams: having 0%fiber three beams and three cubes were cast.

For Beams of Aspect ratio 857: three beams and three cubes were cast for each percentage of 0.33%, 0.66%, and 1% of fiber. Similarly

For Beams of Aspect ratio 2500: Three beams and three cubes were cast for each percentage of 0.33%, 0.66%, and 1% of fiber.

The materials should be poured into the mixer and allow the drum to rotate for a minute to make a dry mix there after add water to the mixer then the fibers should be add slowly to achieve mixing and stop the drum when the uniform mixing is achieved. The mix should not be sloppy.

Casting of Cubes and Beams

Prepared specimen for Experimentation

V. EXPERIMENTAL RESULTS

5.1 Comparison for percentage increase in compressive strength b/w Glass Fiber concrete mix and Ordinary Concrete mix at 28 days

Aspect Ratio	% Fiber	Comp. Strength
857	0.33	-21.82%
	0.66	3.26%
	1	-12.37%
Max compressive strength occurs at 0.66% (3.26%)		
2500	0.33	-4.71%
	0.66	9.82%
	1	-12.0%
Max compressive strength occurs at 0.66% (9.82%)		

As per the test result, aspect ratio 2500 shows the increase in compressive strength up to 9.82% nearly equal to 10% in compare with the ordinary concrete cube. But the curve of aspect ratio 857 shows only 3.26% increase in Compressive Strength in compare with ordinary concrete.

5.2 Comparison for percentage increase in flexural strength b/w Glass Fiber concrete mix and Ordinary Concrete mix at 28 days

Aspect Ratio	% Fiber	Flexural Strength
857	0.33	43.47%
	0.66	59.28%
	1	52.76%
Max flexural strength occurs at 0.66% (59.28%)		
2500	0.33	26.48%
	0.66	52.76%
	1	68.57%
Max flexural strength occurs at 1% (68.57%)		

As per the test result, aspect ratio of 2500 shows increase in Flexural strength to 68.57% in case of adding 1.0% fiber in compare with the ordinary concrete Beam. But aspect ratio of 857 shows 59.28% increase in Flexural Strength in compare with ordinary concrete Beam.

5.3 GRAPHS FOR COMPRESSION AND FLEXURAL TEST RESULTS

The graph showing percentage increase in compressive strength in comparison between ordinary concrete mix and various grades of concrete mix has been given in the figure.1 for both the aspect ratio.

The graph showing percentage increase in flexural strength in comparison between ordinary concrete mix and various grades of concrete mix has been given in the figure.2 for both the aspect ratio.

The above graphs are drawn with % of fiber content as abscissa and % increase in strength as ordinates. Best curve has been fitted for the experimental values using the Microsoft XL software.

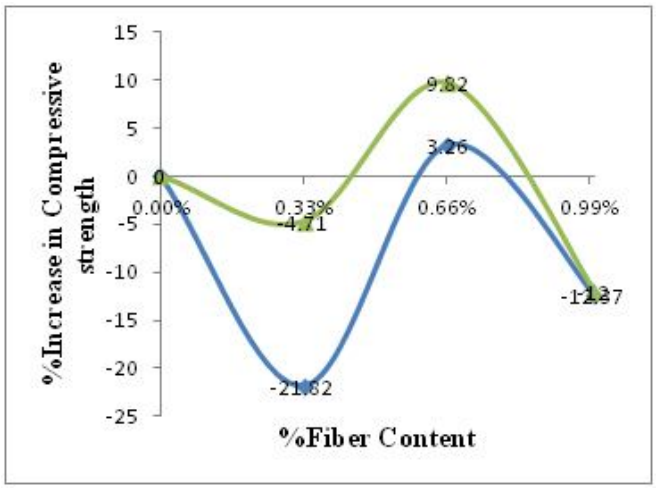

Fig.1: Percentage increase in compressive strength in comparison with ordinary concrete mix for aspect ratio of 857 and 2500

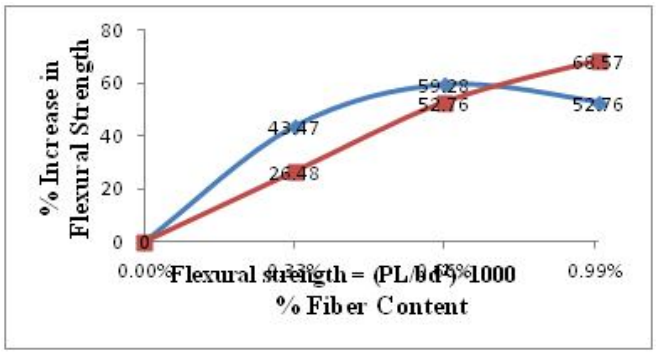

Fig.2 :Percentage increase in flexural strength in comparison with ordinary concrete mix for aspect ratio of 857 and 2500

VI. CONCLUSION

As per the test results, the percentage increase in compressive strength and flexural strengthhas been discussed below

6.1 Compressive Strength

The percentage increase in Compressive Strength has compared between two Aspect ratio of 857 and 2500. The practical results shows that there will be increase in compressive strength up to 10% for an Aspect ratio of 2500 for 0.66% fiber, but in case of 857, only 3.26% increase in compressive strength in compare with the ordinary concrete cube. Hence it proves that the fiber of length 35mm gives more strength than with the 12mm glass fiber.

6.2 Flexural Strength

The percentage increase in Flexural Strength for an Aspect ratio of 857 is about 59% whereas, for an Aspect ratio of 2500, the percentage increase will be 69% which is 10% more than that. Hence it shows that the glass fiber of length 35mm resist more tension force than the 12mm length glass fiber.

Scope of future work

1. M30 grade of concrete was used in the present project, which can be extended to higher grade in future work.
2. The Glass fibers of various percentages i.e. 0%, 0.33%, 0.66%, 1% was considered, which can be extended to higher or lower percentage of glass fibers in the future work.
3. In the present study, the Aspect ratio of 857 & 2500 was considered. This work can be extended to other Aspect ratio by varying the glass fibers length.
4. Any other low cost Fibers or Admixtures which can be blend to the concrete mix in future work.

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