EXPERIMENTAL ANALYSIS OF COMPOSITE BEAMS BY USING GLASS FIBER

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Abstract*-In this present study, the experimental analysis of composite beams by using glass fiber and mild steel bars at the bottom of mortar beam. The depth of beam varying 20mm depth to 40mm depth with an interval of 10mm.By testing these specimens placing on the UTM mechanism equipment I found that breaking load, peak load , and displacement of the specimens by varying percentages of fiber content throughout the beam viz.1%,0.75% and 0.50% the mechanical properties are compared to conventional concrete beam is intended for M20 grade. Here I am analysed the breaking load vs deflection and depth of beam vs Deflection and percentage varying of glass fiber vs deflection .From the above analysis how the breaking load ,deflection varying with respected to 7 days,14days,28 days curing period.

Keywords—composite beams, breaking load, glass fibre, mild steel bars, peak load, curing period

I. INTRODUCTION

Composite beams are composed of two or more dissimilar materials joined together form a structural member. In this paper the composite beams are combination of cement, fine aggregate, glass fiber ,mild steel bars, and water is called composite material. Mortar is a combination of cement, fine aggregate and water. In mortar cement is a binding material combined with sand and water that hardness progressively with time. He fundamental properties of the mortar generally dependent on the lime composition and with which type of cement made by lime. The mortar has a less strength compared to concrete so to increase strength by adding these composite materials like glass fiber ,mild steel reinforcement bars.

The glass fibre is a material containing of numerous extremely fine fibres of glass. The glass fibres matrix is dispersed in the mortar randomly. The glass fibre composite beams used in many civil engineering applications. The composite beam has less sectional dimensions like width and height are smaller in comparison to structure. Generally these beams are preferred due to high strength and less weigh in structural engineering applications. The glass fibre content in the mortar/concrete reducing the bleeding and segregation of the structures. The glass fibres used in the beams continuously or discontinues lengths. The fibres in the mortar or concrete provide reinforcement for the matrix and useful functions like limiting crack formation and durability of composite beams increases. Environmental waste also decreases by using these fibres as a building material. The beam is subjected to flexural bending. The column area unit for those members that are unit primarily subjected to axial compression and tension. These beams are light weight structures which will be found in several numerous applications as well as part, submarine, medical instrumentality, construction industry and motor vehicle companies.

II. LITERATURE REVIEW

Patil T.R. and Burile A.N.(2015) in their examinations inferred that the expansion of steel filaments at 0.5 % by volume of cement diminishes the breaks under various stacking conditions. The brittleness of concrete can likewise be improved by expansion steel fibers than glass fibers. Because concrete is exceptionally powerless in tension, the steel fibers are valuable in pivotal to increase tensile strength . Additionally, the proportion of compressive quality of chambers to the compressive quality of solid shape was observed to be about 3:4. Functionality of concrete influenced by expansion of fibers. Increasing of Steel fibers workability of concrete decreases. It was discovered that while utilizing glass fiber in Split Tensile test the break width continues decreasing with increasing of fiber portion.

A Yogesh Murthy(2012) considered the exhibition of Glass Fiber Reinforced Concrete. The examination uncovered that the utilization of glass fiber in cement not just improves the properties of concrete and a little cost cutting yet additionally give simple outlet to arrange the glass natural waste from the business. From the examination it could be revealed that the flexural strength of the beam with 1.5% glass fiber demonstrates practically 30% increases in the quality of strength. The decrease in slump observed by addition of glass fiber content.

Eng. Pshtiwan N. Shakor, Prof. S. S. Pimplikar (2011**)** In this paper concerned on glass reinforced concrete is a material made of a cementatious matrix made up of cement, sand, water and admixtures, in which short length glass filaments are scattered. It has been generally utilized in the development construction industry for non-auxiliary components, as façade boards, funneling and channels. GRC offers numerous favorable circumstances, for example, being lightweight, imperviousness to fire, great appearance and quality. In this examination preliminary tests for concrete with glass fiber and without glass fiber are led to show the distinctions in compressive strength and flexural strength by utilizing cubes of differing sizes.

S. H. Alsayed exhibition of glass fiber reinforced plastic bars as reinforcing material for solid structures. The examination uncovered that the flexural capacity of concrete beams reinforced by GFRP bars and by using the ultimate design theory. The investigation likewise uncovered that as GFRP bars have low modulus of elasticity, deflection values may be controlled.

Dr. P. Srinivasa Rao, was conducted durability studies on glass fiber reinforced concrete. The alkali resistant glass fibers were utilized to discover workability, resistance of concrete because of acids, sulfate and quick chloride permeability tests of M30, M40 and M50 evaluation of glass fiber reinforced concrete and conventional concrete. The durability of concrete was growing by addition of glass fibers in concrete. He demonstrated that increasing of glass fibers in concrete gives a decreases bleeding in concrete and also acid resistance of concrete increases.

G. JyothiKumari observed that behavior of concrete beams strengthened with glass fiber fortified polymer plats and saw that bars with silica covered Glass fiber reinforced polymer (GFRP) flat shear support have appeared at higher loads. Further they observed that GFRP flats as shear support show genuinely great ductility. The quality of the composites, flats depends on the fiber direction and fiber matrix to framework proportion while higher the fiber content higher the higher the tensile strength.

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III. MATERIALS

A .Cement:

Cement is a binding material used in concrete, mortar, stucco and most non-specially grouting purposes. Cement is developed from alternative kinds of hydraulic lime in England within the mid of 19th century and cement is originates from sedimentary rock. The mixing of lime stone ,clay mixture and maintaining required temperatures to form the clinker and adding some mounts of alternative materials. The general color of Portland cement is grey color.

B. Sand:

Sand is a naturally available granular material composed of finely divided rock and mineral particles. The main constituent of sand is silica (silicon dioxide, or SiO_2), generally in the form of quartz. The sand should contain properties of chemically non-reactive, should contain considerable hardness, it should be resistant to weathering. It is used as fine aggregate in mortar and concrete.

C. Water:

Water is used for mixing and curing of the mortar or concrete. Water should be free from injurious amounts of oils,acids,alkalis,salts,sugar,organic minerals or other substances that may be deleterious to concrete or steel. Water plays a major role in the strength of concrete.

D. Glass fiber:

The E-glass or electrical grade glass was used in the project work. These are alkali resistant and low density and good chemical resistance. E- glass fiber is used throughout the my project work .

E. Mild steel bars:

The mild steel bars used in the beam to increase the tensile strength of beam. The diameter of mild steel bars is around 1.2mm.

IV. METHODOLOGY

The present study explains about breaking load vs deflection of beam. Next another things is the depth of beam varying according to the breaking load how is varying and deflection how is varying with 1% 0.75%,0.50 % and no fibers percentages of glass fiber in the beams. The objectives of the present study are elaborated below.

A. *Mix design of mortar*:

Good mortar is obtained from good mix proportions is required. In this mix design of mortar proportion is taken as 1:3 (cement : fine aggregate) and w/c ratio (water/cement ratio) is taken as 0.45. The glass fiber content also adding to mortar the following percentages are 1%,0.75%,0.50 and no fibers. The bottom of the beam I provided a 1.2 mm mild steel reinforcement bars at the bottom of beam.

B. *Curing:*

Proper curing is the most important thing to gain the strength of mortar or concrete. During the process of curing increases the strength of specimens and avoids cracking. In this project curing period is taken 7 days,14 days, 28 days.

C. *Breaking load and deflection comparative strength studies of a beam:*

First we need to test individual tests for cement and sand otherwise it will affect the strength of mortar. Casting the beams of sizes 600mmx20mmx20mm,600mmx20mmx30mm,600mmx20mmx40mm testing for center point load for various percentages of glass fiber content viz. 0.50%, 0.75%,1%.The tests was conducted for 7days,14days and 28 days Mix proportion of mortar is 1:3 and water to cement ration taken as =0.45.

Table 1:Mortar mix proportion

Water	Cement	Fine aggregate
0.45	1	3

Table 2 :Mortar mix proportion ingredients required

S.No	Beam Dimensions (l * b * h)	Cement content(g)	Sand content(g)	Water content(ml)	1 % Glass fiber(g)	0.5 % Glass fiber(g)	0.75 % Glass fiber(g)
1	600mm X 20mm X 20mm	140	420	63	5.6	11.2	16.8
3	600mm X 20mm X 30mm	210	630	95	8.4	16.8	25.2
5	600mm X 20mm X 40mm	300	900	135	12	24	36

Table 3 :Reinforcement with mild steel bars and bars no glass fiber

S. No	7 Days test results			
	CENTER POINT LOAD			
	Depth of beam(mm)	Breaking load(KN)	Peak load(KN)	Deflection(mm)
1	20	1.31	4.6	6.8
2	30	1.6	4.4	6.6
3	40	2	4.42	5

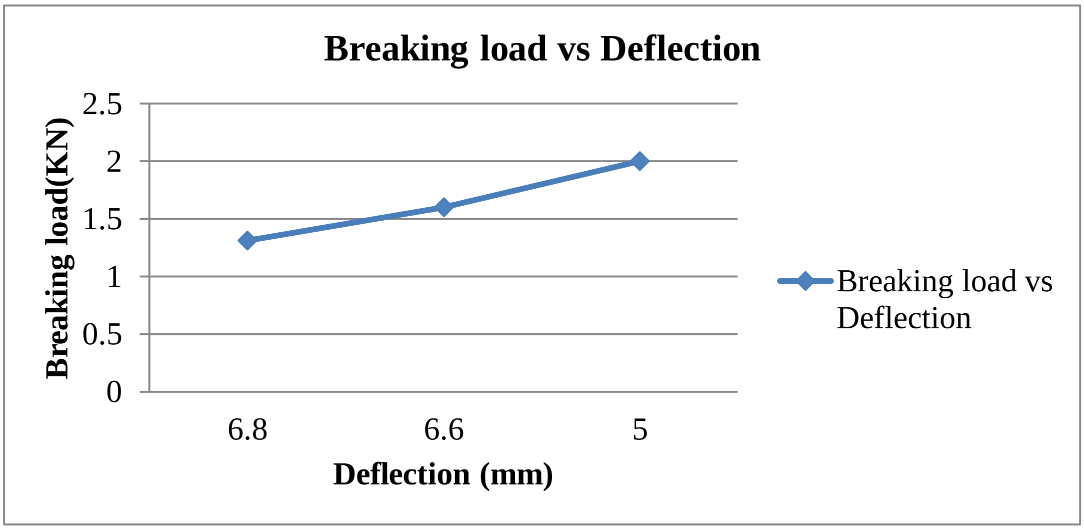

Figure 1:Reinforcement with mild steel bars and no glass fiber for 7 days

Table 4 :Reinforcement with mild steel bars and bars no glass fiber

S. No	28 Days test results			
	CENTER POINT LOAD			
	Depth of beam(mm)	Breaking load(KN)	Peak load(KN)	Deflection(mm)
1	20	1.36	3.5	1.5
2	30	2	4.3	2.5
3	40	2.2	5	6.3

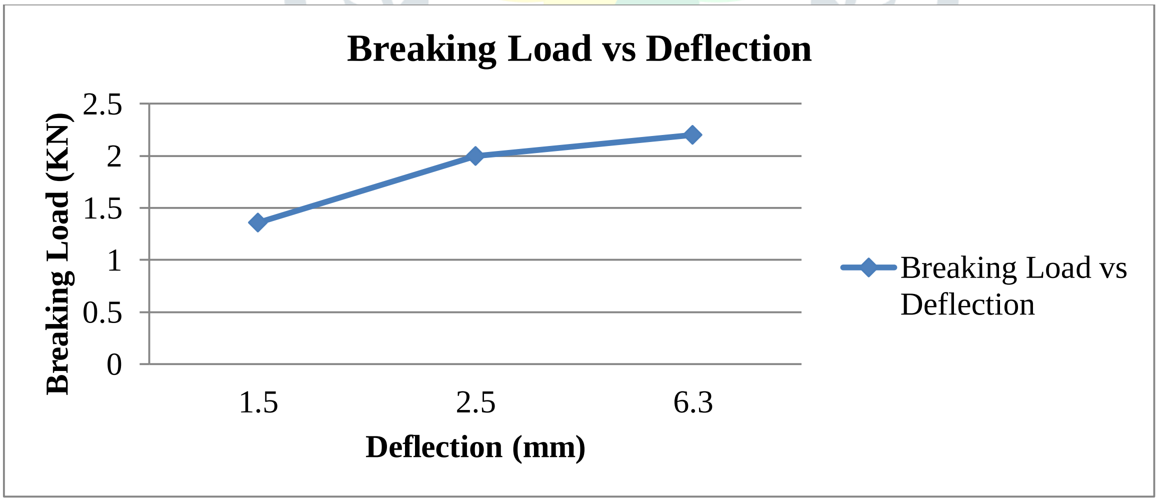

Figure 2 : Reinforcement with mild steel bars and no glass fiber for 28 days

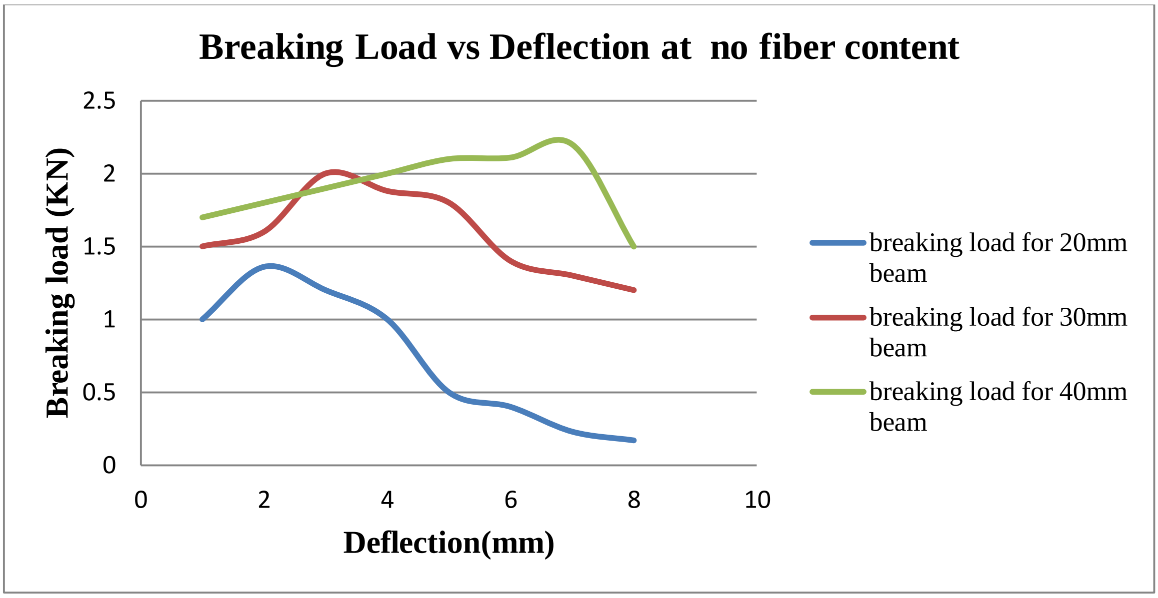

Figure 3 : Variation of deflection under breaking load for no glass fiber content for 28 days

Table 5: Reinforcement with mild steel bars and 1% glass fiber content for 7 days

S. No	7 Days test results			
	CENTER POINT LOAD			
	Depth of beam(mm)	Breaking load(KN)	Peak load(KN)	Deflection(mm)
1	20	1.4	4	4.2
2	30	2	4.7	5.6
3	40	2.9	5.9	8.7

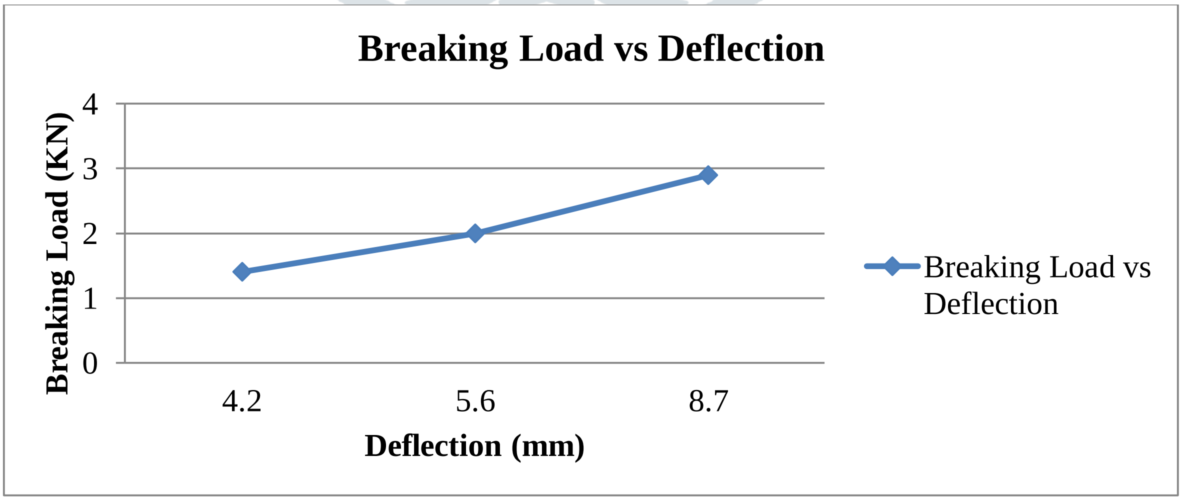

Figure 4:Reinforcement with mild steel bars and 1% glass fiber for 7 days

Table 6 :Reinforcement with mild steel bars and 1% glass fiber content for 28 days

S. No	28 Days test results			
	CENTER POINT LOAD			
	Depth of beam(mm)	Breaking load(KN)	Peak load(KN)	Deflection(mm)
1	20	1.36	3.7	2.4
2	30	2.8	4.1	4.4
3	40	3.5	4.2	4.7

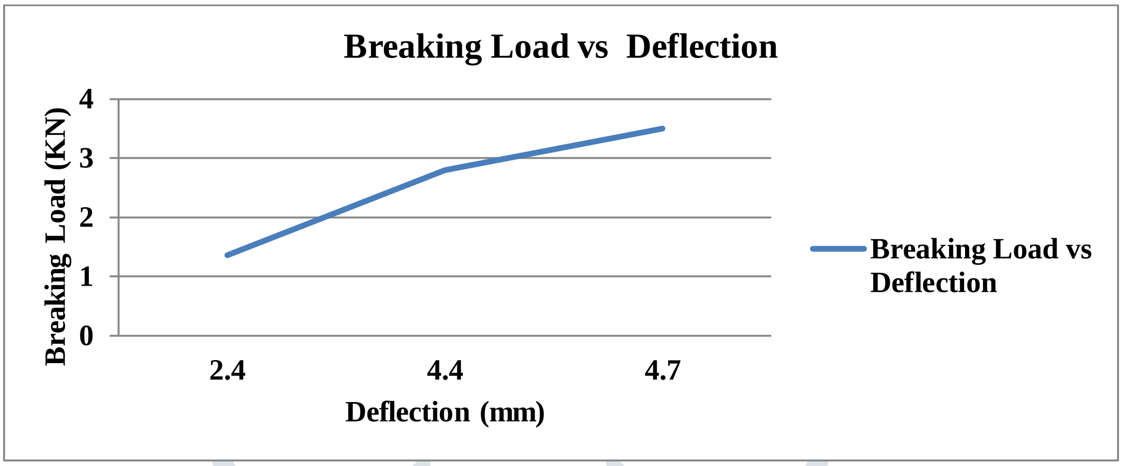

Figure 5:Reinforcement with mild steel bars and 1% glass fiber for 28 days

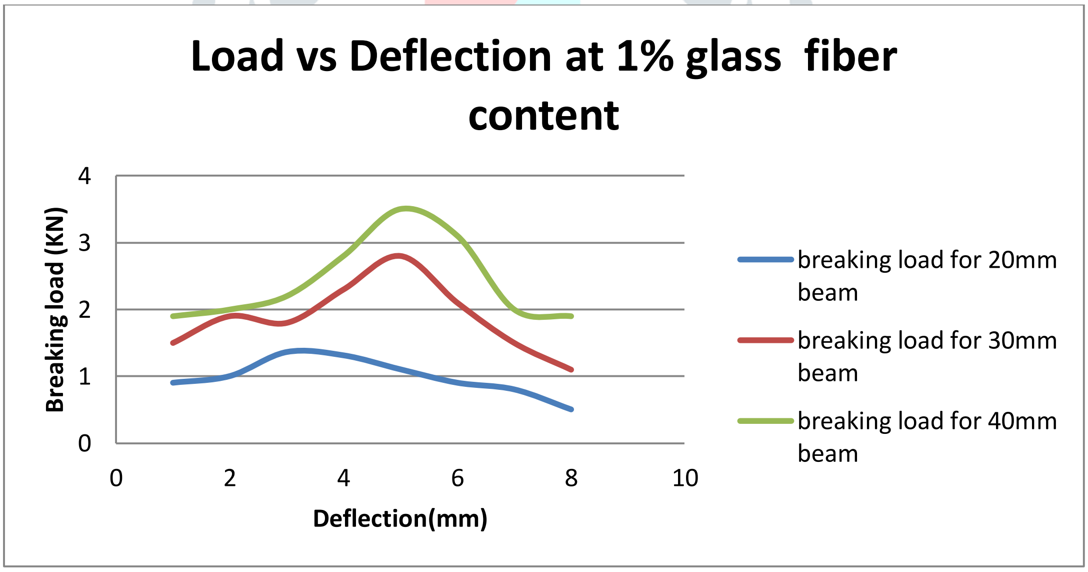

Figure 6: Variation of deflection under breaking load for 1% glass fiber content for 28 days

Table 7 :Reinforcement with mild steel bars and 0.75 % glass fiber content for 7 days

S. No	7 Days test results			
	CENTER POINT LOAD			
	Depth of beam(mm)	Breaking load(KN)	Peak load(KN)	Deflection(mm)
1	20	1.34	4.3	4.1
2	30	2.2	4.5	4.3
3	40	2.5	4.7	5

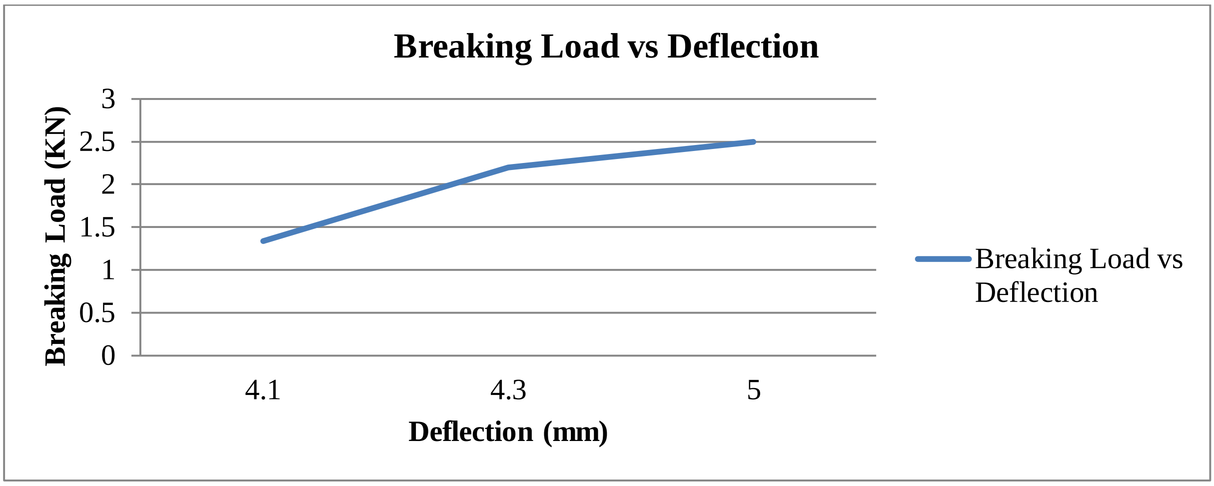

Figure 7 :Reinforcement with mild steel bars and 0.75 % glass fiber for 7 days

Table 8 :Reinforcement with mild steel bars and 0.75 % glass fiber content for 28 days

S. No	28 Days test results			
	CENTER POINT LOAD			
	Depth of beam(mm)	Breaking load(KN)	Peak load(KN)	Deflection(mm)
1	20	1.2	3.5	2.2
2	30	2.8	4.1	2.8
3	40	3.6	4.3	4.5

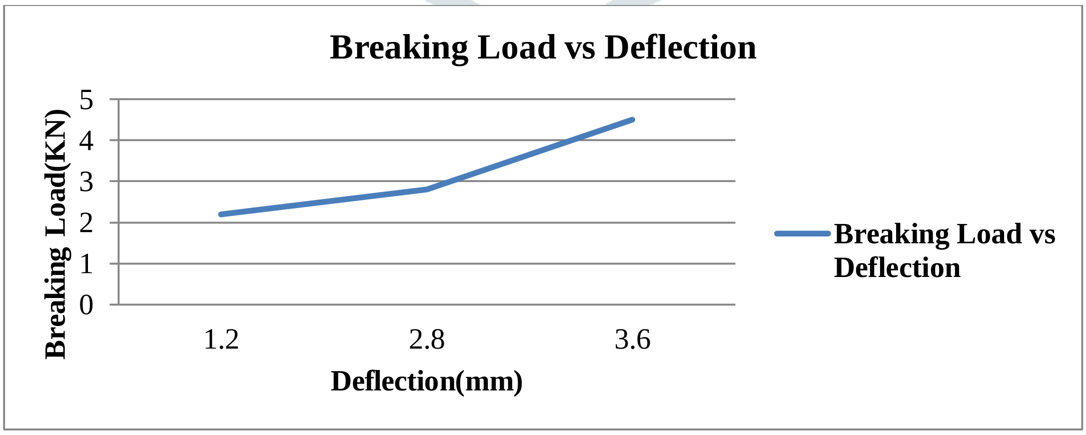

Figure 8 :Reinforcement with mild steel bars and 0.75 % glass fiber for 28 days

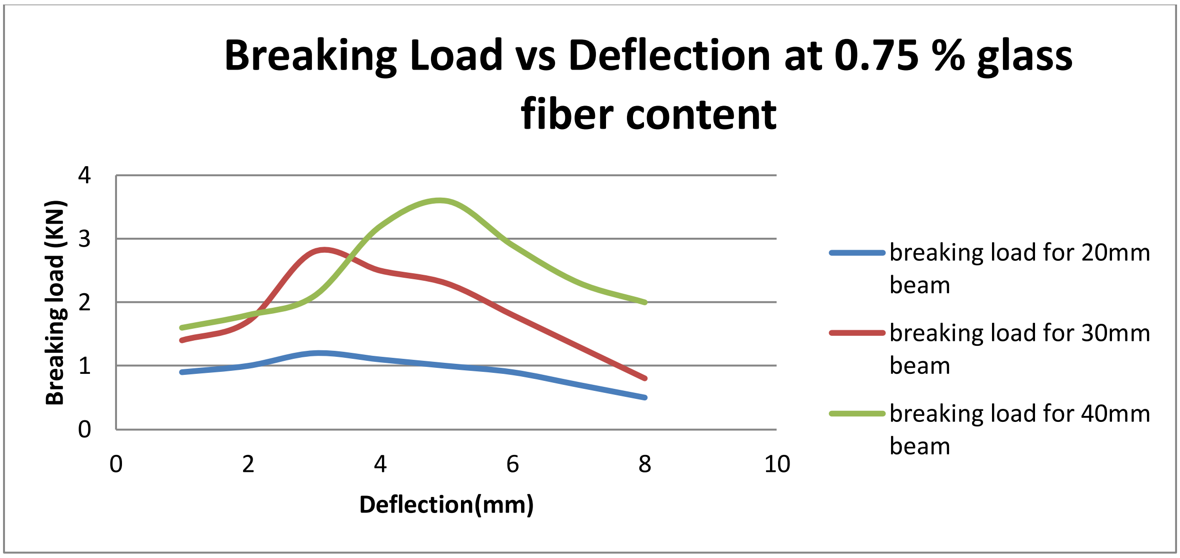

Figure 9 :Variation of deflection under breaking load for 0.75 % glass fiber content for 28 days

Table 9: Reinforcement with mild steel bars and 0.50 % glass fiber content for 7 days

S. No	7 Days test results			
	CENTER POINT LOAD			
	Depth of beam(mm)	Breaking load(KN)	Peak load(KN)	Deflection(mm)
1	20	1.4	2.2	2.5
2	30	2.8	2.8	3.6
3	40	3.9	3.9	4.7

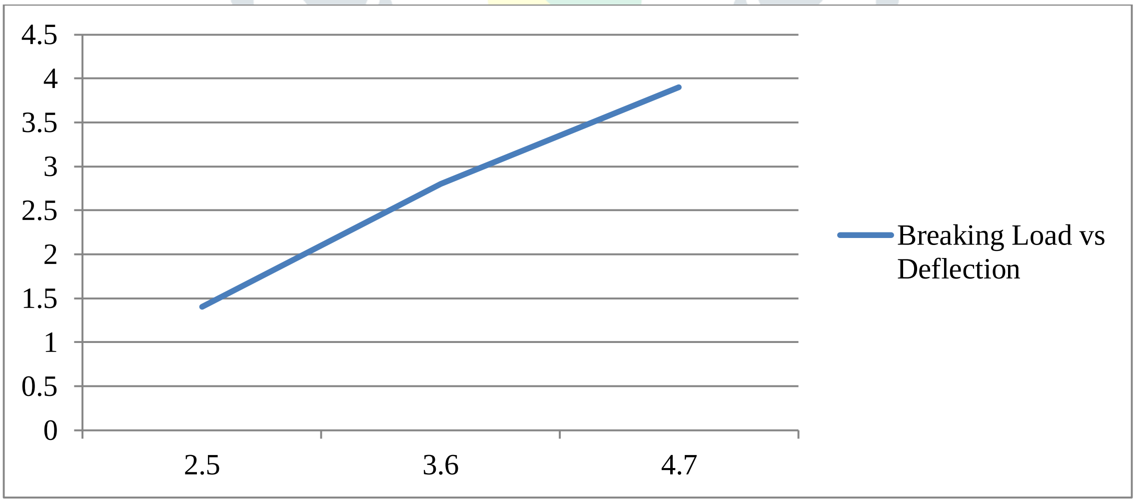

Figure 10 : Reinforcement with mild steel bars and 0.50 % glass fiber for 7 days

Table 10 :Reinforcement with mild steel bars and 0.50 % glass fiber content for 28 days

S. No	28 Days test results			
	CENTER POINT LOAD			
	Depth of beam(mm)	Breaking load(KN)	Peak load(KN)	Deflection(mm)
1	20	1.45	3.6	2.3
2	30	2.3	4.3	2.9
3	40	3.8	4.5	4.6

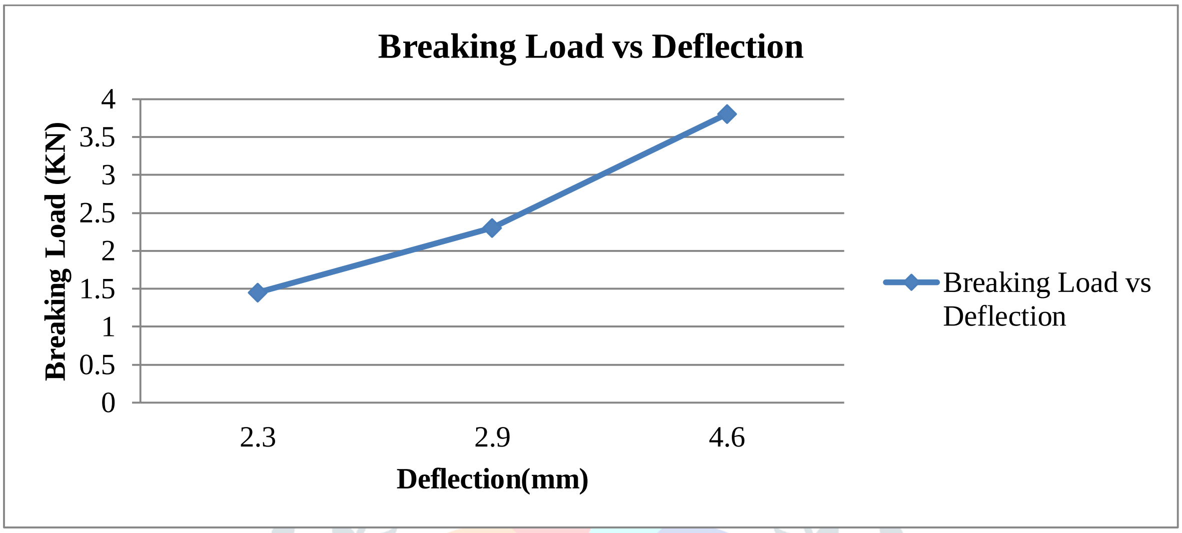

Figure 11: Reinforcement with mild steel bars and 0.50 % glass fiber for 28 days

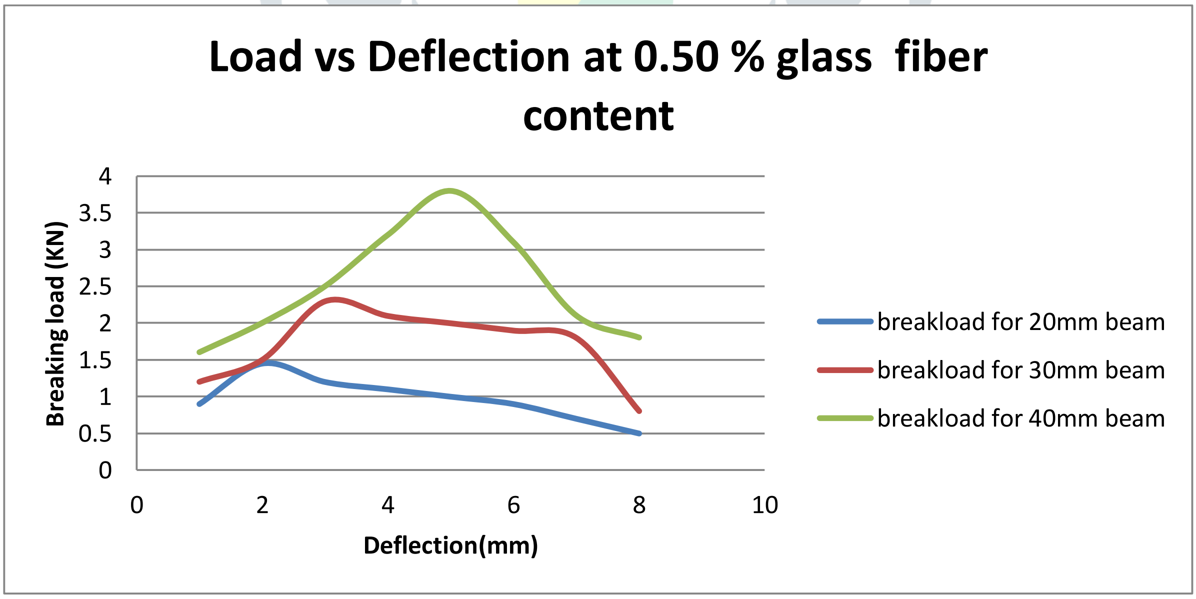

Figure 12:Variation of deflection under breaking load for 0.50 % glass fiber content for 28 days

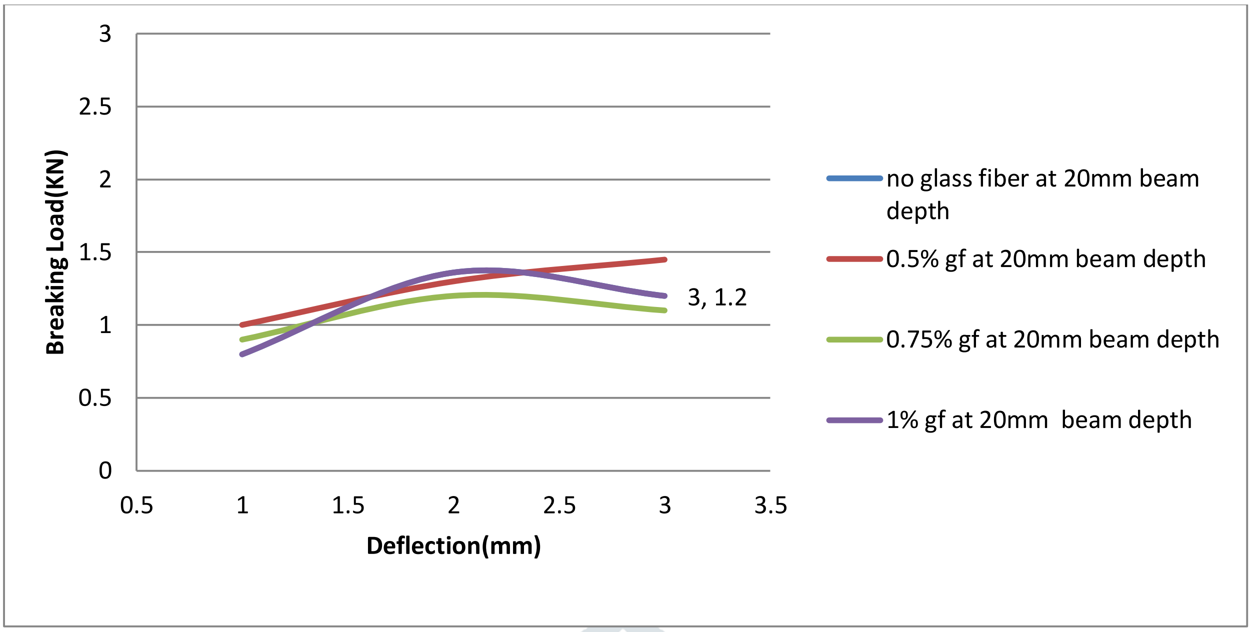

Figure 13 : Variation of glass fiber percentage under breaking load for 20mm depth of beam for 28 days

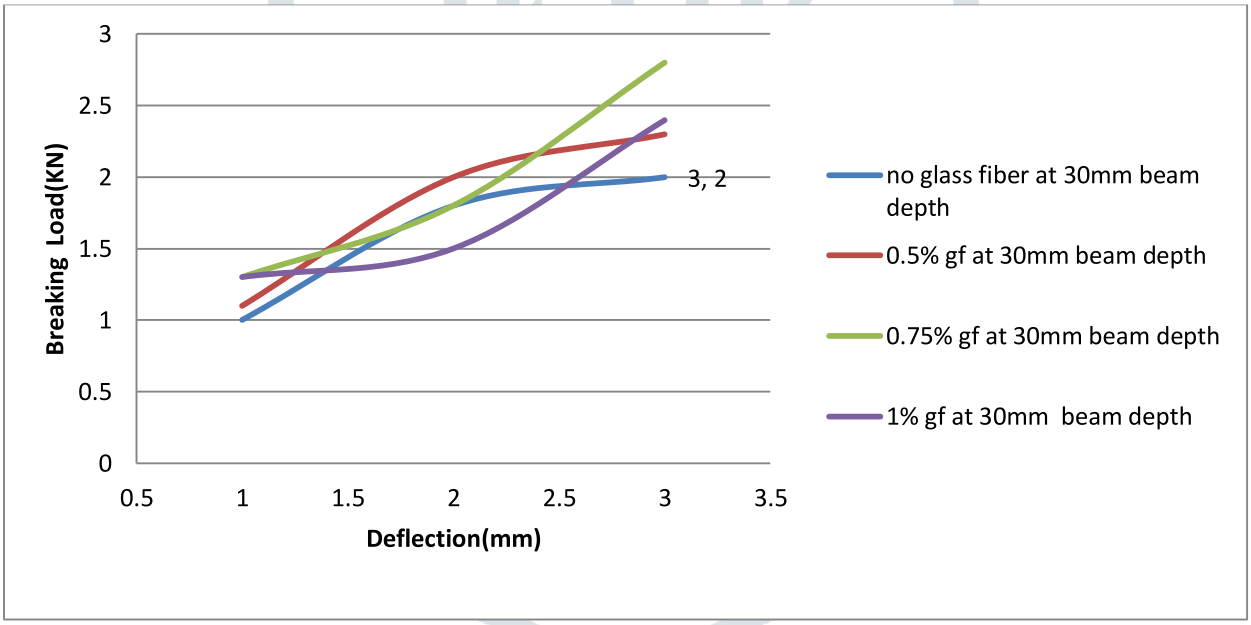

Figure 14 : Variation of glass fiber percentage under breaking load for 30mm depth of beam for 28 days

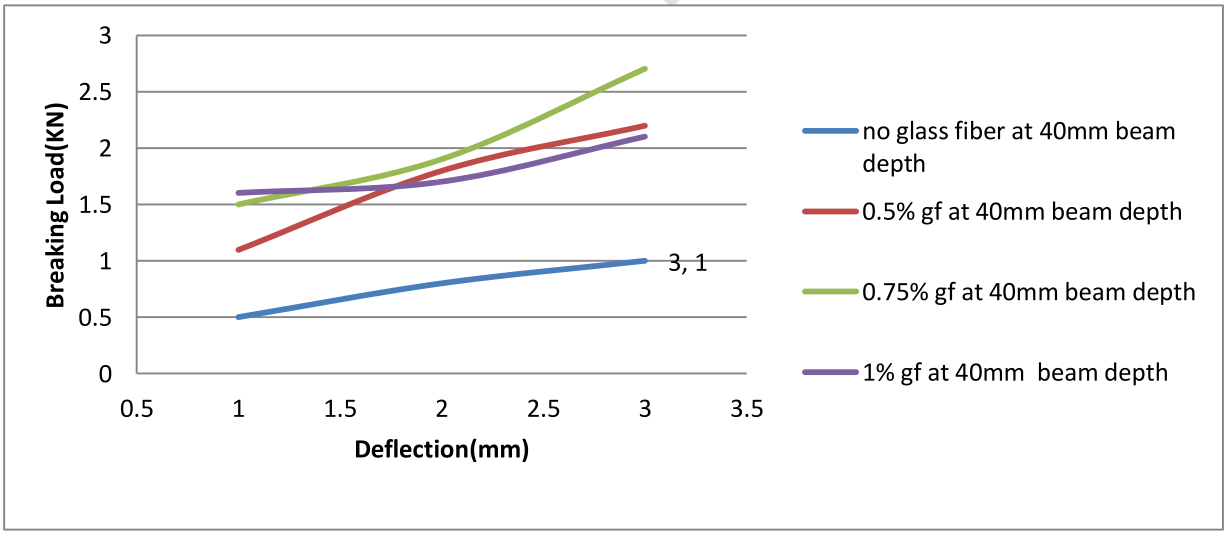

Figure 15: Variation of glass fiber percentage under breaking load for 40mm depth of beam for 28 days

V. DISCUSSION

1. Reinforcement with mild steel bar and no glass fiber case the 7 days test results we plotted a graph between breaking load vs Deflection form this graph breaking loads are 1.31KN 1.6KN, 2KN followed by deflection of the beam 6.8mm,6.6mm,5mm. The breaking load increase top to bottom of the beam it leads decreasing of deflection values. The depth of beam increase the deflection values are decreasing.
2. Reinforcement with mild steel bar and no glass fiber case the 28 days test results we plotted a graph between breaking load vs Deflection form this graph breaking loads are 1.36KN, 2KN, 2.2KN followed by deflection values are 1.5mm, 2.5 mm, 6.3mm . The breaking load increase from 20mm depth of beam to 40 mm depth of beam it leads to increasing the deflection values. The depth of beam increase the deflection values are also increasing.
   - ✓ From the above graph we can observed that whenever breaking load reached maximum the deflection value also maximum, after that deflection values are increasing gradually.
   - ✓ 20mm depth of beam reached early maximum breaking load is 1.36 KN with a deflection of 1.5 mm.
3. Reinforcement with mild steel bars and 1% glass fiber the 7 days test results we plotted a graph between breaking load vs Deflection form this graph breaking loads are 1.4KN,2KN,2.9 KN followed by deflection values are 4.2mm, 5.6mm,8.7mm. The breaking load increases 20mm depth of beam to 40mm depth of beam, it leads to increasing the deflection values. The depth of beam increase the deflection values are also increasing.
4. Reinforcement with mild steel bars and 1% glass fiber the 28 days test results we plotted a graph between breaking load vs Deflection. graph breaking loads are 1.36KN, 2.8KN, 3.5 KN followed by deflection values are respectively 2.4mm,4.4 mm,4.7mm. The breaking load increase from 20mm depth of beam to 40 mm depth of beam it leads to increasing the deflection values. The depth of beam increase the deflection values are also increasing.
   - ✓ From the above graph we can observed that whenever breaking load reached maximum deflection values are also maximum after that deflection values are increasing gradually.
   - ✓ The first 20mm depth of beam taken minimum deflection value at the breaking load of 1.36 KN.
   - ✓ 20mm depth of beam reached minimum breaking load 1.36 KN with a deflection of 2.4 mm.
5. Reinforcement with mild steel bars and 0.75 % glass fiber the 28 days test results we plotted a graph between breaking load vs Deflection form this graph breaking loads are 1.2KN, 2.8KN,3.6KN followed by deflection values are 2.2mm, 2.8 mm,4.5mm. The breaking load increase from 20mm depth of beam to 40 mm depth of beam it leads to increasing the deflection values. The depth of beam increase the deflection values are also increasing.
   - ✓ From the above graph I observed that minimum breaking load at 1.2KN at a deflection of 2.2mm.
   - ✓ Same as maximum braking load at 3.6kN fallowed by deflection of 4.5mm.
   - ✓ So finally we can analyze that depth of beam increases the deflection also increases.
6. Reinforcement with mild steel bars and 0.50 % glass fiber 28 days test results we plotted a graph between breaking load vs Deflection from this graph breaking loads are 1.45KN, 2.3KN, 3.8KN followed by deflection of the beam 2.3mm, 2.9 mm, 4.6 mm. The breaking load increase from 20mm depth of beam to 40 mm depth of beam it leads to increasing the deflection values. The depth of beam increases the deflection values are also increasing.
   - ✓ From the above graph I observed that minimum breaking load at 1.45KN at a deflection of 2.3mm.
   - ✓ Same as maximum braking load at 3.8kN fallowed by deflection of 4.6mm.

7. Variation of glass fiber percentage under breaking load for same depth of beam for 28 days

   i. 20 mm depth of beam
      - ✓ Maximum breaking load observed at 0.50 % of glass fiber.
      - ✓ Minimum breaking load observed in the case of reinforcement with mild steel bars no fiber content for different percentages of glass fiber variation of the beams except 0.75 % of glass fiber content

   ii. 30 mm depth of beam
      - ✓ Maximum breaking load observed in the case of 0.75 % & 1% of glass fiber content.
      - ✓ Minimum breaking load observed in the case of no glass fiber content in the beam.

   iii. 40 mm depth of beam
      - ✓ Maximum breaking load observed in the case of 0.5 % of glass fiber content in the beam.
      - ✓ Minimum breaking load observed in the case of no glass fiber variation in the beam.

VI. CONCLUSIONS

The present study concluded that the addition of glass fibers at 0.5%, 0.75% and 1% of cement reduces the cracks under different loading conditions.

1. By addition of 1 % glass content the workability of mortar decreases.
2. The workability of mortar decreases by addition of 1% of glass fiber to the mortar.
3. The brittleness of mortar could be improved with addition steel fibers and not so much with glass fibers.
4. The bleeding of mortar can be reduced by addition of glass fiber to the mortar mix.
5. From the above results and discussions I concluded that depth of beam increases 20mm depth of beam to 40mm with an interval variation of 10 mm depth of beam the depth of beam increases the deflection also increases.
6. The minimum breaking load observed in the case of with reinforcement of mild steel bars no fiber content in the beam.
7. The economical percentage of glass fiber is 0.75% because which gives good mix compared to 0.50%, 1%glass fiber content in the project.
8. The glass fiber variation with depth of beam vs deflection analysis I observed that 30mm depth of beam got medium deflection so it is not too high deflection not too less deflection so 0.50% glass fiber content and 30mm depth of beam is good to analyze here.
9. In this project the glass fiber as a composite material with addition of reinforcement with mild steel bars use and model analysis with the normal beam.
10. The ratio is taken as one: ten ,that means model beam dimensions : normal beam dimensions.
11. Glass fiber causes environmental pollution causes so this can alternatively used as a construction material in the civil engineering field.
12. Glass fiber composite are less cost compared to metal composite material and available in less density material.

The glass fiber composites have many advantages like incombustibility, corrosion resistance, and high strength at low densities, good thermal insulation and sound insulation, used in many special electrical purposes.

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