MODELLING ANALYSIS OF COMPOSITE BEAMS BY USING GLASS FIBER REINFORCED MORTAR BEAMS AT DIFFERENT PERCENTAGES

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Abstract-In this present modelling analysis of composite beams by using glass fiber reinforced mortar beams at different percentages of glass fiber with mild steel bars at the bottom of the beam. The fallowing percentage of glass fiber content taken as volume basis viz 0%,0.50%,0.75%,1%.The ratio of modelling beam to normal beam is 1:10 ratio. The glass fiber composite mortar beam is compared to normal M20 grade of concrete beam. The experimental tests can be done by using Universal Testing Machine to finding the deflection of the beam, peak load, breaking load. The tests conducted for 7days, 14days and 28days of curing period. The centre point load is used to find deflection of the beam and plotted graph between breaking load vs deflection, variation of glass fiber content with respect to breaking load vs deflection and finally analysis can be done all the graphs and test results.

Keywords—Breaking load, Peak load, Glass fibre reinforced beams, Composite beams, Modelling analysis

I. INTRODUCTION

The combination of Cement, fine aggregate, and water is called mortar and addition of this mortar plus coarse aggregates is called concrete. The composite materials is used to form a composite beams, in this paper the materials are cement, fine aggregate, glass fibers, mild steel bars and water content.Here the mild steel bars provided to increase tensile strength to the mortar beams and glass fibre is a material containing of numerous extremely fine fibres of glass. The glass fibres matrix is dispersed in the mortar randomly. The composite beams extremely used in many civil engineering, aerospace, medical equipment applications. The composite beam has less sectional dimensions and density also smaller compared to normal beams.

The composite beams are used where high strength and less weight in structural engineering applications. The addition of glass fibre content to mortar can reduce problems like bleeding and segregation. The glass fibres can be in the form of continuously or discontinues lengths. The composite beams strength is depends upon the type of arrangement of fibres in the mortar or concrete provide reinforcement for the matrix and useful functions like limiting crack formation and durability of composite beams increases. The fibre is waste product from many glass industries, so it leads pollution on the earth so we can reduce the pollution by using as a building material in the concrete or mortar.

These beams are less weight structures which will be found in several applications like marine structures, construction and automobile manufacturing industries and medical equipment manufacturing industries.

II. LITERATURE REVIEW

Yogesh Murthy(2012) He 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.

R.Gowri and M.AngelineMary examination, the present trend in concrete technology is towards expanding the quality and sturdiness of cement to fulfill the needs of the advanced development world at lower cost. These elements can be accomplished in concrete by including characteristic or manufactured fiber. The quality parameters of cement, for example, compressive strength and tensile strength were considered by changing the level of fiber from 0.025% to 0.075% of the weight of cement.

T.Subramani and C. Investigation, Concrete has been utilized in different structures everywhere throughout the world since most recent two decades. As of late a couple of framework ventures have likewise observed explicit utilization of concrete. The advancement of concrete has achieved the basic requirement for added substances both synthetic and mineral to improve the presentation of concrete.

C. SelinRavikumar and T.S. Thandavamoorthy, The examination there has been a significant increasing in the use of fibers in concrete for improving its properties, for example, tensile strength and ductility. The fiber concrete is likewise utilized in retrofitting existing concrete structures. Among a wide range of types of fibers accessible today, glass fiber is an ongoing presentation in the field of concrete technology innovation.

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 modeling reinforced with mild steel bars beam vs normal concrete beam deflection values and maximum load bearing capacity values are compared. The ratio between modeling beam to normal beam is taken as one : ten. That means the deflection values compared between model beam to normal beam and also maximum load is taken in to consideration.

I plotted a graph between breaking load vs deflection and variation of glass fiber content of breaking load vs deflections, variation of depth & fiber variation of breaking load to deflection of the beam .The glass fiber content variation is taken as follows 0.5%,0.75%,1% of volume of the mortar beam.

A. Mix design of mortar:

The mortar should homogeneously mixing is required for good strength and durability.To obtain good properties of mortar 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:

Based on the process of curing only strength and durability depends. The good curing is required for good 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. But the values provided below the tables for only 7days and 28days test results.

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

First we need to test cement, sand, water, individual because individual quality increase whole structure quality increases. The modeling beams taken as 600mmx20mmx25mm,600mmx20mmx35mm, by applying center point load on Universal Testing Machine we found that breaking load ,peak load ,deflection values in the below tables. The 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	Model beam dimensions (l X b X d)	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 25mm	175	525	78.75	7	14	21
2	600mm X 20mm X 35mm	245	735	110.25	9.8	19.6	29.4

Table 3 : Reinforcement with mild steel bars and no glass fiber 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	25	1.5	4.5	6.7
2	35	1.8	4.5	5.3

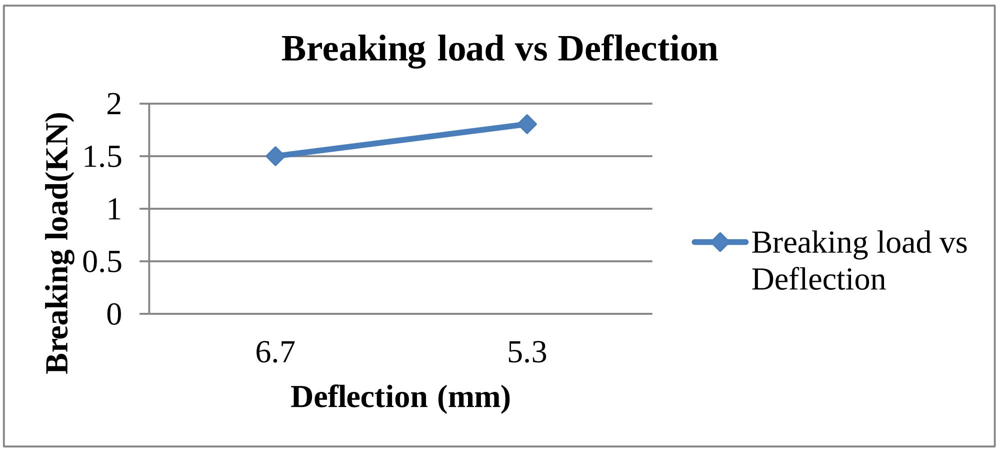

Figure 1: Reinforcement with mild steel bars and no glass fiber for 7 days

Table 4 : Reinforcement with mild steel bars and no glass fiber 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	25	1.9	3.7	1.8
2	35	2.1	4.8	3.8

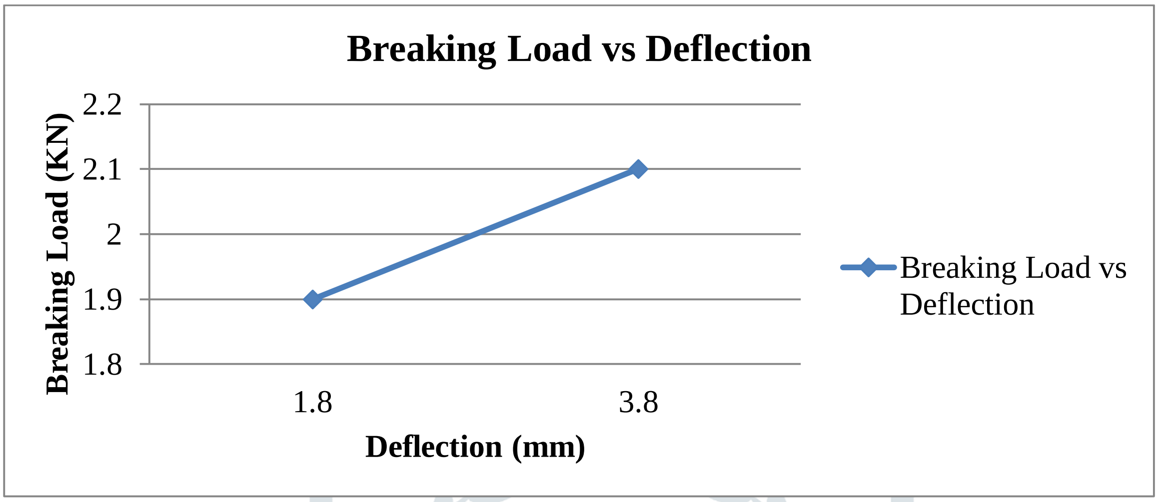

Figure 2 : Reinforcement with mild steel bars and no glass fiber for 28 days

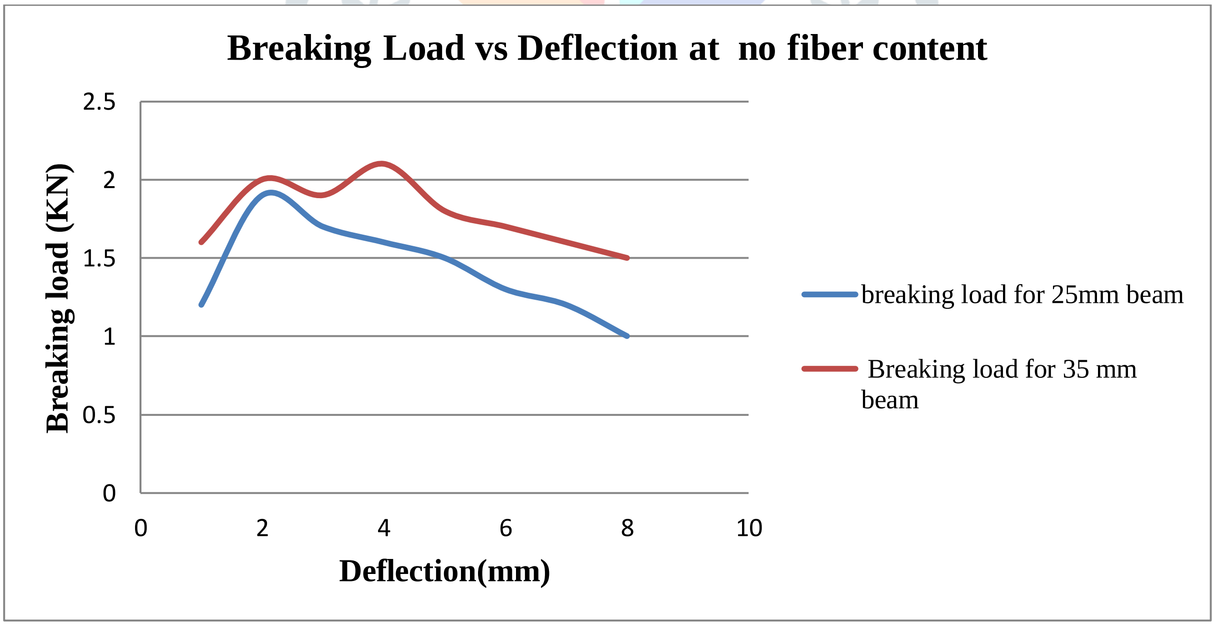

Figure 3 : Variation of deflection under breaking load for no glass fiber content for 28 days

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	25	1.8	4.5	5.8
2	35	2.4	5.1	5.2

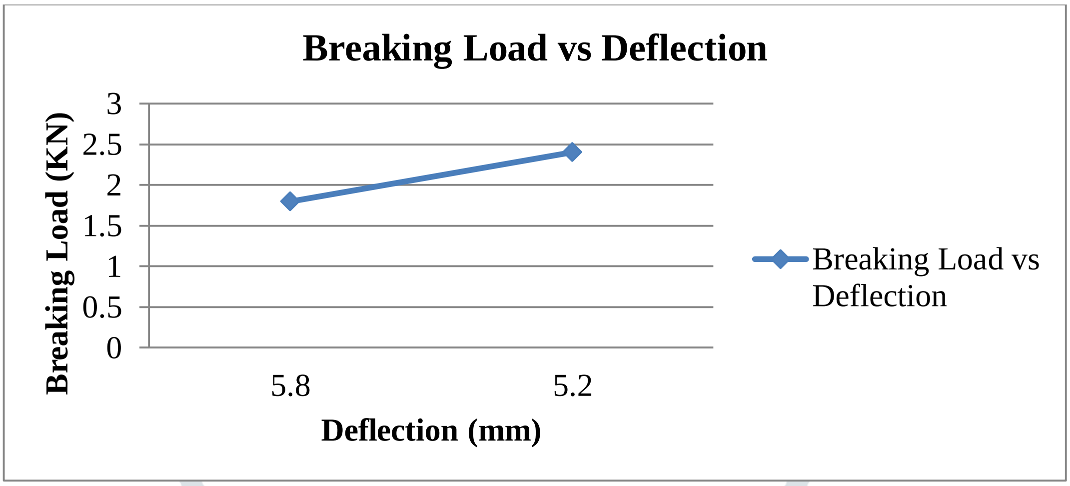

Figure 4:Reinforcement with mild steel bars and 1% glass fiber for 7 days

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	25	2.4	3.9	3.2
2	35	3.2	4.1	4.6

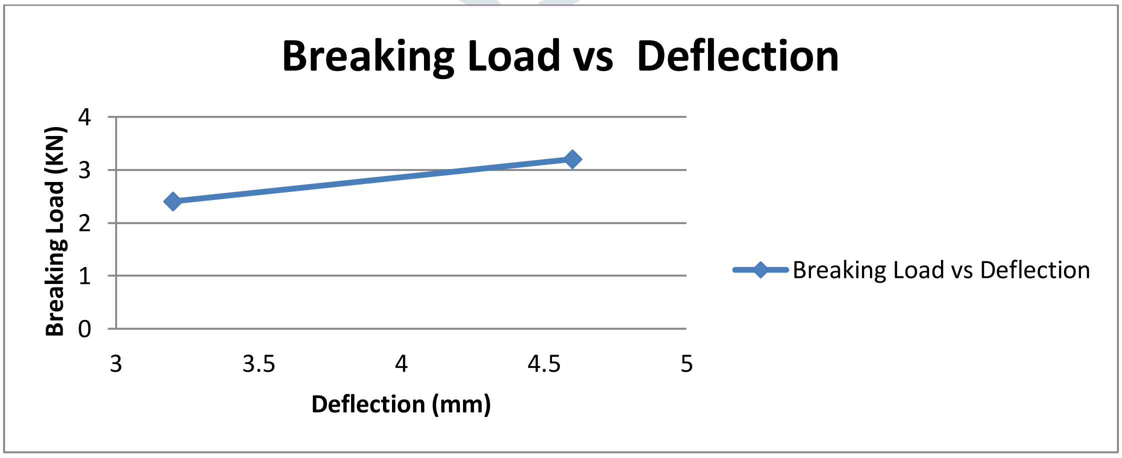

Figure 5: Reinforcement with mild steel bars and 1% glass fiber for 28 days

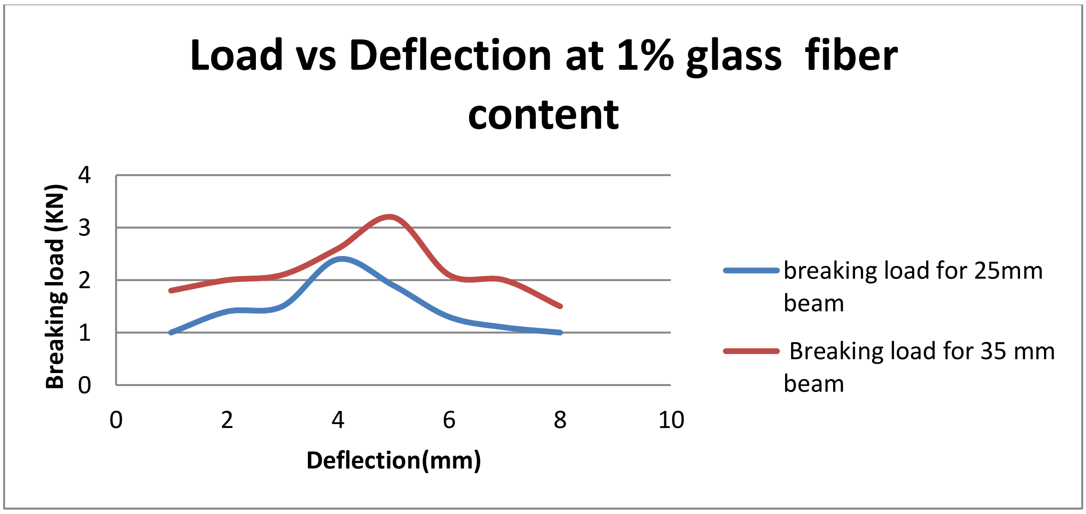

Figure 6: Variation of deflection under breaking load for 1% glass fiber content for 28 days

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	25	1.9	4.4	4.2
2	35	2.3	4.6	6

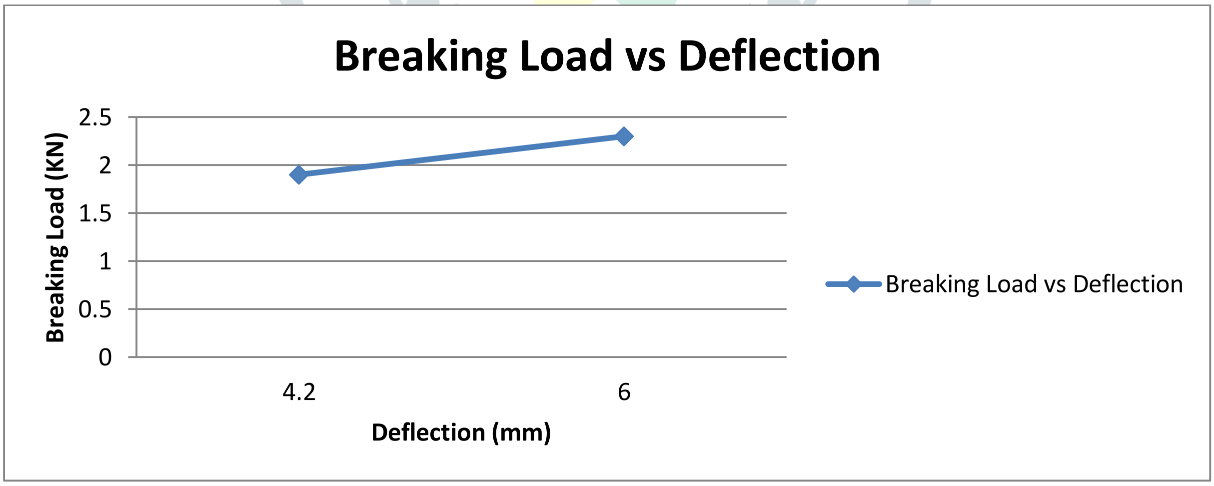

Figure 7 :Reinforcement with mild steel bars and 0.75 % glass fiber for 7 days

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	25	2.2	3.7	2.4
2	35	3.4	4.2	3.2

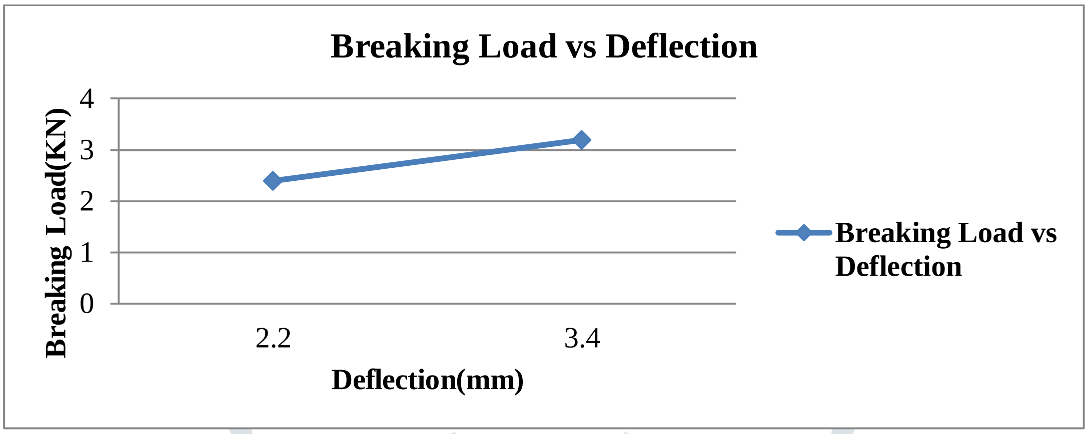

Figure 8 :Reinforcement with mild steel bars and 0.75 % glass fiber for 28 days

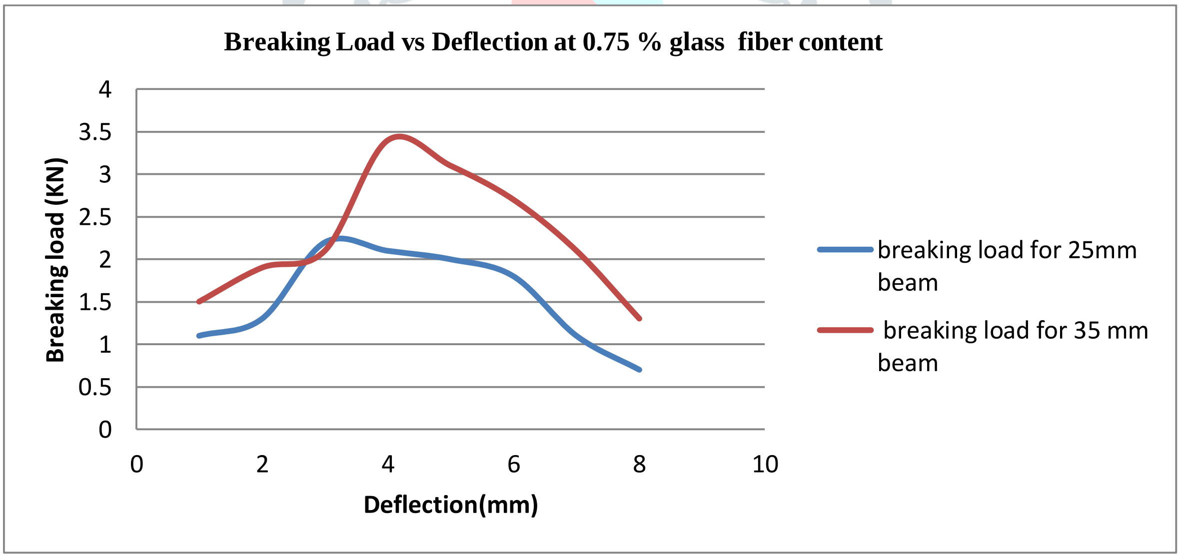

Figure 9 :Variation of deflection under breaking load for 0.75 % glass fiber content for 28 days

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	25	2.4	2.3	2.8
2	35	3.4	3.2	4.2

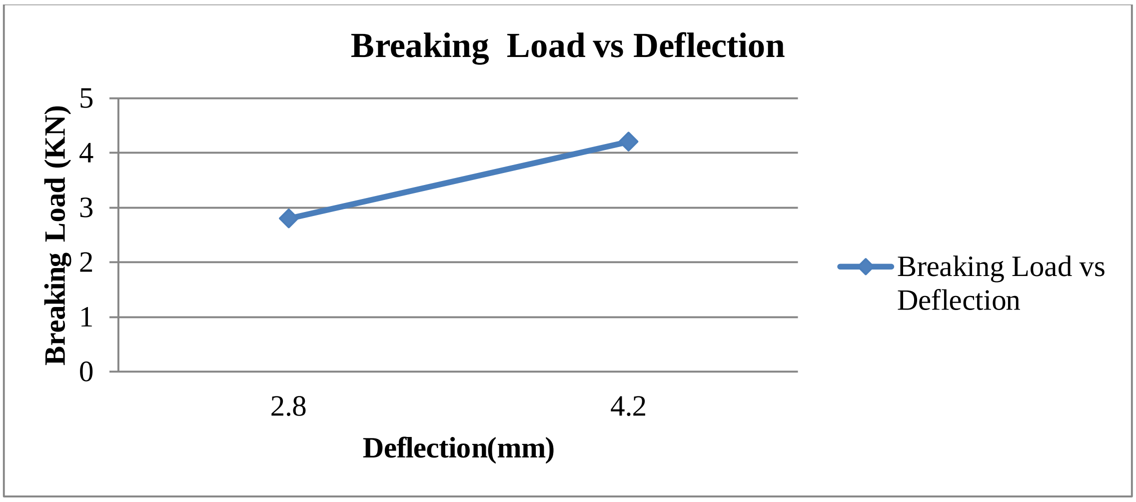

Figure 10 : Reinforcement with mild steel bars and 0.50 % glass fiber for 7 days

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	25	1.9	3.8	2.5
2	35	2.5	4.4	3.4

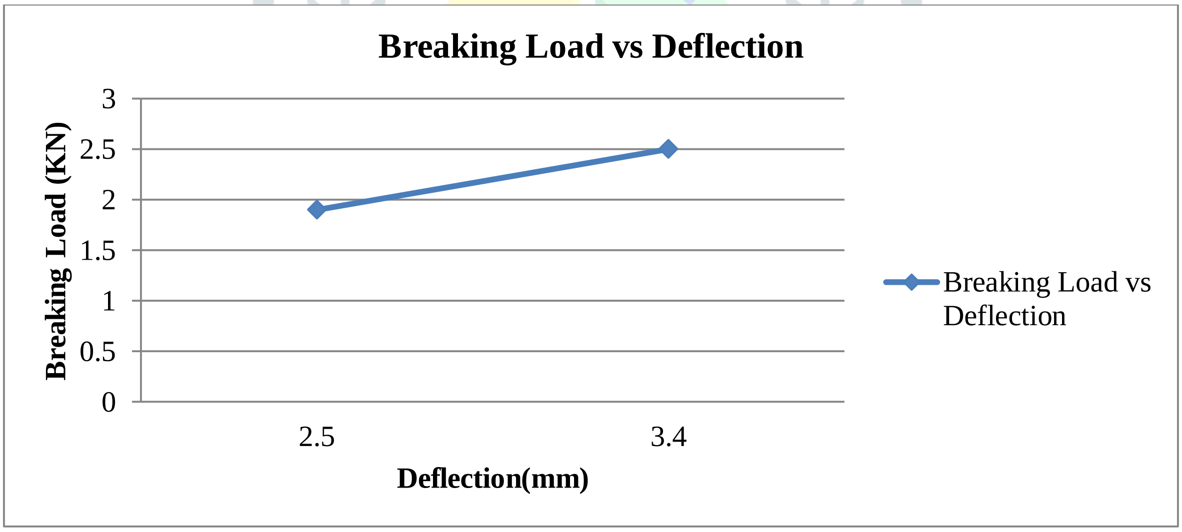

Figure 11: Reinforcement with mild steel bars and 0.50 % glass fiber for 28 days

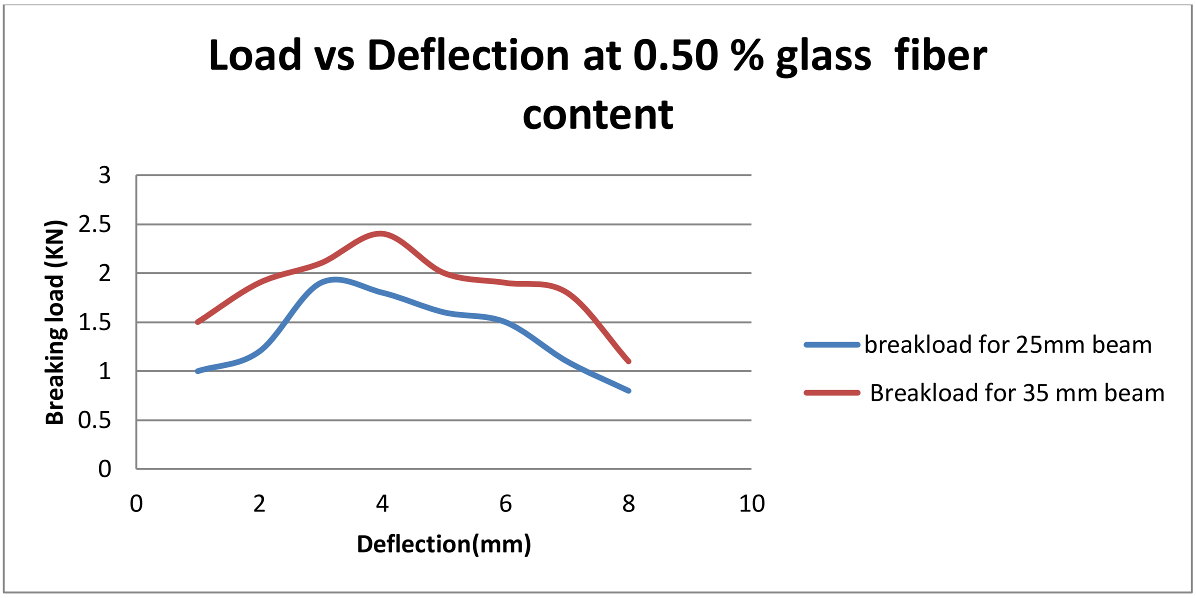

Figure 12: Variation of deflection under breaking load for 0.50 % glass fiber content for 28 days

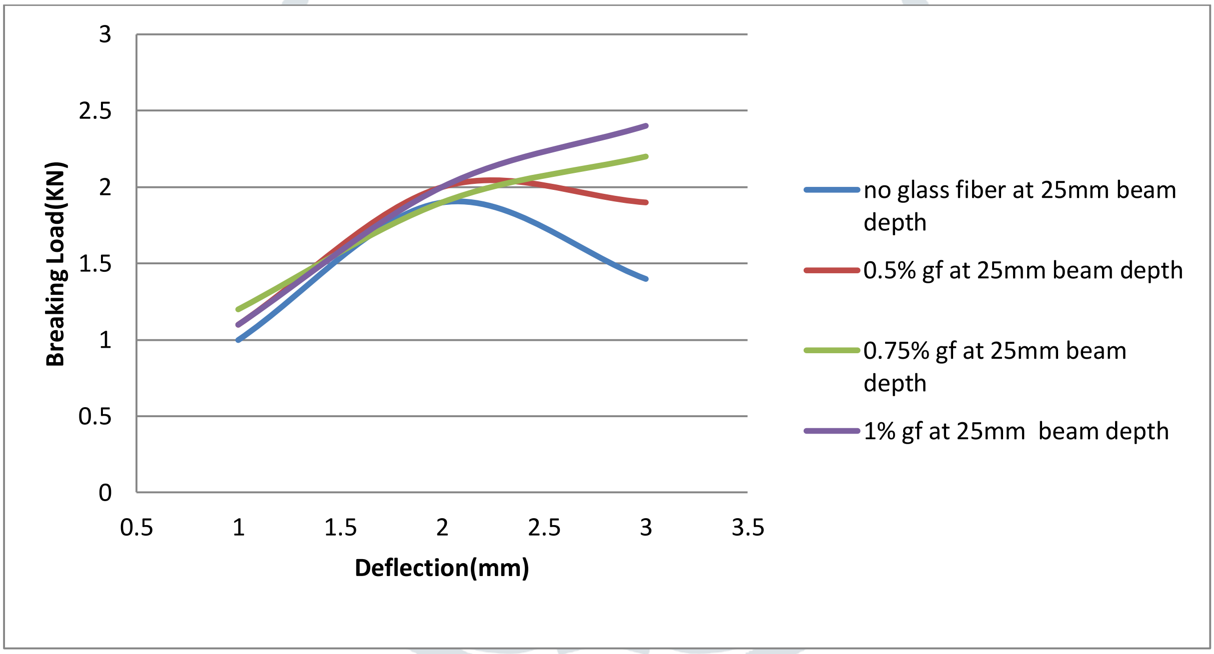

Figure 13 : Variation of glass fiber percentage under breaking load for 25mm depth of beam for 28 days

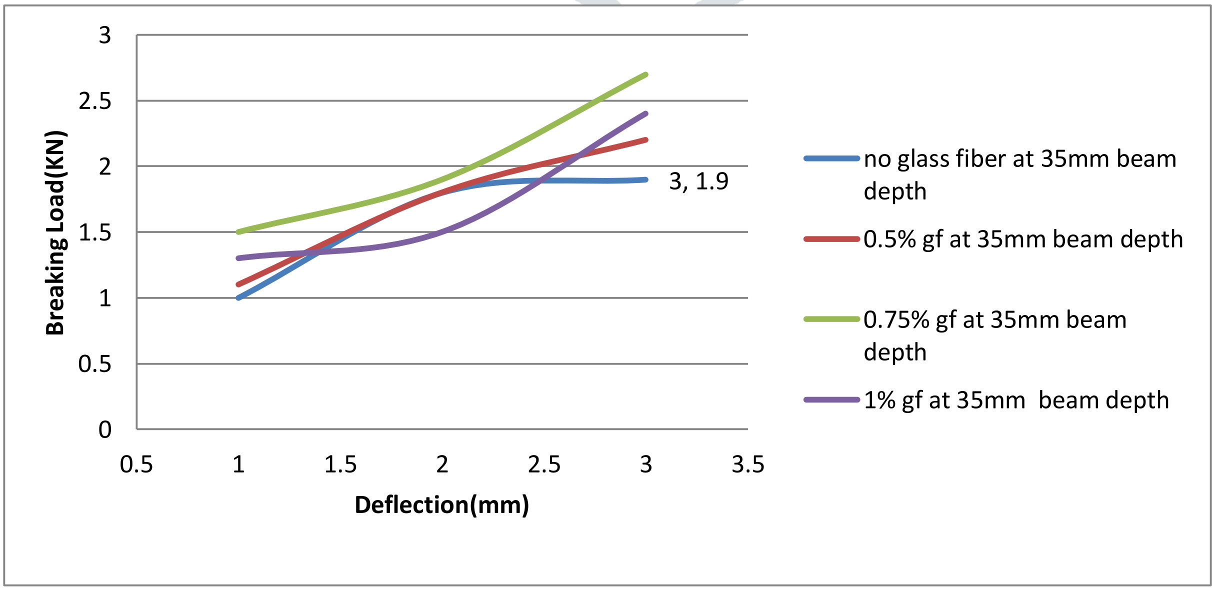

Figure 14: Variation of glass fiber percentage under breaking load for 35mm depth of beam for 28 days

V. MODELLING ANALYSIS

A. Reinforced concrete beam calculation

Table 11: Reinforced beam calculations

Grade	$\frac{X_u}{d}max$	M_u	Dimensions of beam in m
250	0.530	0.149 $f_{ck}bd^2$	6 *0.2*0.23

$$M_u = 0.36 f_{ck} bd^2 (1 - 0.42(\frac{X_u}{d}))\frac{X_u}{d})$$

$$M_u = 0.36 * 20 * 200 * 230^2 \big(1 - 0.42(0.53)\big)0.53$$

M_u=31386187.87 N-mm

Maximum bending moment of simply supported beam $= \frac{Wl}{4} = M_u$

=31386187.87 N-mm

$M_u = \frac{W*6000}{4}$

W $= \frac{31386187.87*4}{6000}$ N

W =20924.12525 N

Simply supported beam maximum defection at the center of the beam δ = $\frac{Wl^3}{48\,EI}$

δ = 20.76 mm

B. Model beam calculation

$$M_u = 0.36 * 20 * 20 * 23^2 \big(1 - 0.42(0.53)\big)0.53$$

M_u =31386.18787 N-mm

Maximum bending moment of simply supported beam $= \frac{wl}{4} = M_u$

=31386.18787 N-mm $= \frac{W*600}{4}$

W=$\frac{31386.18787 *4}{600}$

=209.241N

Simply supported beam maximum defection at the center of the beam δ = $\frac{Wl^3}{48\,EI}$

δ = 2.076 mm

From the above calculation we observed that

Maximum load carrying capacity of the reinforced concrete beam will be =20924.12525 N

Maximum deflection of the simply supported beam = 20.76 mm

For model beam calculations we compared to original beam the deflection will be 2.07mm

Experimental deflection value from mild steel bars reinforcement with no glass fiber content test results for 7 days will give deflection 6.7mm and peak load is 4500N.

The calculated deflection value from reinforced concrete beam deflection is 20.76mm and ultimate load is 20924.12525 N

Model beam values are 6.7mm >2.07mm hence safe 209.24 N <4500 N safe

VI. DISCUSSION

From the above graphs drawn between breaking load vs deflection and variation of percentages of glass percentage of breaking load vs defection curves will following points will fallows

1) **For 28 days no fiber content only mild steel bars reinforcement**

   Based on the 28 days test results we plotted a graph between breaking load vs Deflection form this graph breaking loads are 1.9KN, 2.1KN followed by deflection values are 1.8mm, 3.8mm . The breaking load increase from 25mm depth of beam to 35 mm depth of beam it leads to increasing the deflection values. The depth of beam increase the deflection values are also increasing.

2) **For 28 days 1% glass fiber content and mild steel bars reinforcement**

   Based on the 28 days test results we plotted a graph between breaking load vs Deflection. graph breaking loads are 2.4KN, 3.2KN followed by deflection values are respectively 3.2mm, 4.6mm The breaking load increase from 25mm depth of beam to 35 mm depth of beam it leads to increasing the deflection values.

3) **For 28 days 0.75% glass fiber content and mild steel bars reinforcement**

   Based on the 28 days test results we plotted a graph between breaking load vs Deflection form this graph breaking loads are 2.2KN, 3.4KN followed by deflection values are 2.4mm, 3.2mm .The breaking load increase from 25mm depth of beam to 35 mm depth of beam it leads to increasing the deflection values. The depth of beam increase the deflection values are also increasing.

4) **For 28 days 0.50% glass fiber content and mild steel bars reinforcement**

   Based on the 28 days test results we plotted a graph between breaking load vs Deflection from this graph breaking loads are 1.9KN,2.5KN followed by deflection of the beam 2.5mm, 3.4mm. The breaking load increase from 25mm depth of beam to 35 mm depth of beam it leads to increasing the deflection values. The depth of beam increases the deflection values are also increasing.

   So finally we can analyze that depth of beam increases the deflection also increases.

5) **Glass fibre supplementary at various % throughout the beam**

i. Variation of glass fiber for 25 mm depth of beam
   - Maximum breaking load observed in the case of 1% of glass fiber content.
   - Minimum breaking load observed in the cases of no glass fiber content and 0.5% of glass fiber variations.

ii. Variation of glass fiber for 35 mm depth of beam
   - Maximum breaking load observed in the case of 0.75% of glass fiber content in the beam.
   - Minimum breaking load observed in the case of no glass fiber content in the beam.

6) **Modeling analysis of beam**

i. The modeling analysis of beam means my modeling beam compared to original reinforced beam load and deflection values are tested those are modeling deflection value is calculated as 2.076 mm and my experimental value of deflection is 6.7mm . so experimental values is greater and my calculated value is less than the maximum deflection values so it is safe.

ii. Same as maximum load of modeling beam calculated value is 209.241N and experimental values is 4500 N which is greater than the calculated value so it is safe.

iii. From the summary of above two points is the calculated values are less then the experimental values so the beam it can take more load bearing capacity.

VII. CONCLUSIONS

From the on top of discussions the following conclusions have created

1. From the above results and discussions the depth of the beam increases deflection also increases. But in case of no glass fibre content only mild steel bars at the bottom of the beam the depth of beam increases the deflection value is reduces.
2. For the addition of glass fibers and mild steel bars at the bottom of mortar beams the tensile strength is increases. Without glass fibers and mild steel bars the beam acts as a brittle material unable to take any load simply breaks.
3. The addition glass fibers to mortar slump values gradually decreases but bleeding and segregation can be prevent somewhat.
4. From the model analysis experimental deflection values are greater than calculated one hence safe and calculated maximum load of beam less compared to experimental values so no problem to use hence it is safe.
5. Glass fiber causes environmental pollution causes so this can alternatively used as a construction material in the civil engineering field.
6. Glass fiber composite are less cost compared to metal composite material and available in less density material.

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