REDUCING DEFLECTION OF A RC BEAM BY USING JUTE FIBER WRAPPING TECHNIQUE

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***Abstract*: The main aim of the experimental work is to reduce the deflection of the reinforced concrete beam by using wrapping technique. For wrapping techniques there are lot of glass fibers are available in market, which are mostly used for strengthening purpose (increasing load carrying capacity of the beam). No material is used for reducing the deflection of the beam, so that I have used jute fiber in this project for reducing the deflection of the beam. Jute is one of the locally available materials, because India is basically an agricultural country and jute is agricultural by-product. Jute is good in tension at the same time jute has poor in ductility, so that deflection will be arrested when compared with other ductile materials. Due to poor in ductility, the failure of the beam will be sudden; it will not give any failure warning.**

Index Terms - RC Beam, Jute Fiber, Wrapping Technique, Polyester resin, Deflection.

1. INTRODUCTION

This experimental work is carried out to reduce the deflection of the beam by adding the tension material on the soffit region of the beam and shear face of the beam. By reducing the deflection of the beam development of the stress can be arrested so that formation of crack in infill materials can be avoided. By reducing the deflection, load carrying capacity of the beam will also expected to increase.

The tensile material can be added to the structural member by using resin. There are many resin compound are available in market, they are polyester resin, vinyl ester resin and epoxy. These can have various properties and the cost of the material also differs. In this project we use polyester resin.

In this experimental work, I have employed wrapping technique. Wrapping is the most common technique used to adopt for adding tension material in the beam.

1.1 Need of The Project Work

In concrete world, deflection of the beam is very common, when load is increased, deflection will also increase. To avoid this, we need to use alternative material to reduce deflection, so that we can avoid stress development in infill material.

1.2 Objective

The main objective of the project work is pointed as follows:

- To reduce the deflection of the beam
- To avoid development of stress in infill material
- To improve the efficiency of the beam

2. SPECIMEN DETAILS

The beam size is 150mm X 200mm with span of 1500mm. The grade of concrete is M25 and steel is Fe415 TMT bars. The beam has been casted by using OPC 43 grade cement with the water-cement ratio of 0.4. For Tension Reinforcement two numbers of 12mm dia rod is provided and for compression reinforcement two number of 12mm dia rod is provided, 8mm dia rod is provide as shear reinforcement at 100mm c/c distance. Shear reinforcement is provided with two legs, with a leg length of 35mm. Details of the specimen where tabulated in table -1.

Table – 1: Details of Specimen

Specimen Details	
Depth	200mm
Width	150mm
Tension Rod	2 Nos of 12mm Dia
Compression Rod	2 Nos of 12mm Dia
Shear Rod	8mm Dia rod @ 100mm c/c distance

No of Legs	2 Legged (35mm length)
W/c Raion	0.4
Cement Grade	OPC 43
Concrete Grade	M25
Steel Grade	Fe415
Cover on X Axis	20mm
Cover on Y Axis	25mm

For beam specimen typical cross section drawing of beam is shown in figure –1 with the details of its size, reinforcement details.

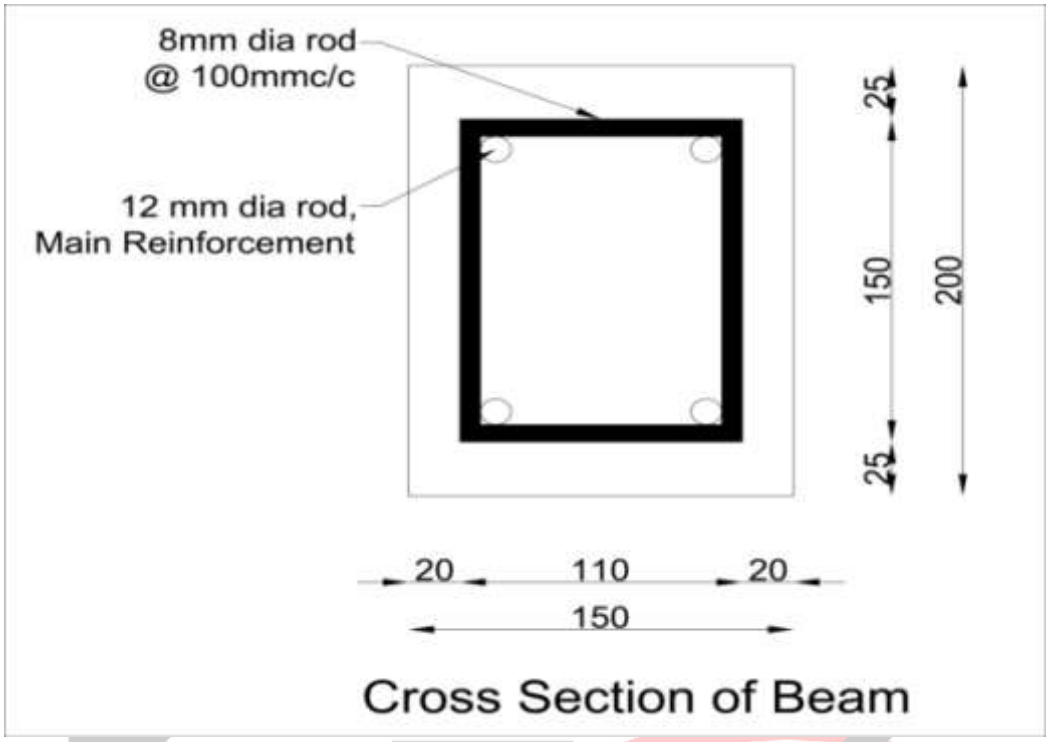

Fig – 1: Cross Section of Beam

3. MATERIALS USED

3.1 Jute Fiber

In this project I have used jute fiber to reduce the deflection of the beam. India is a one the agricultural country, the source of jute is agricultural. So that it is abundantly available in India. The cost of just is not much higher due to it's easily availability. And jute will be available in and around every places of the India.

Jute Fiber is one of the easily available materials in India. The manufacturing process of the jute fiber is much each and it is the done as a homemade business in many of the small villages in India. When jute fiber is compared with the glass fiber in the aspect of the cost it is much cheaper material. But in the aspect of the strength jute will not perform as much as glass fiber, still jute is used for rehabilitation work because of it availability and cost of the material. The jute material which is used for rehabilitation purpose is shown in the below figure.

Fig – 2: Jute Fiber

3.2 Bonding Material – Polyester Resin

For this project work, polyester resin is used as bonding agent. It is used in majority of the composite industry. Polyester resin require accelerator and catalyst, by mixing both compound reaction in the resin takes place and binding will takes place. Cobalt is used as accelerator in this project.

For curing or Hardening purpose catalyst is added with the polyester. MEKP compound is used as the catalyst in this project work. MEKP is typically known as Methyl Ethyl Ketone Peroxide. MEKP is naturally UV (Ultraviolet) resistant, so it will have long last durability when exposed to sunlight.

The type of polyester used for this project work is General Type polyester Resin, which is generally views as easy to use, fast curing, tolerant of temperature and catalyst variations and they are less expensive then epoxy system.

3.2.1 Concentration Details

Polyester Resin, Accelerator and Catalyst are needed to mix in a correct proportion so that the curing period can be determined. For 100ml of polyester, first 15 drop of accelerator is added and stirred well. Then catalyst is added lastly to the resin. MEKP is added 15 drop to the 100ml of the polyester resin and stirred well. Thus from the time where catalyst stirred well, the pot life of polyester is 30 min only.

4. RESULTS & DISCUSSIONS

Totally 6 Beam specimens were used for testing purpose. In that 3 specimens are used as controlled and another 3 were used as contemporary beam. To calculate the maximum deflection the beam is tested for its ultimate load. The load and deflection readings are taken for further analysis and the results are discussed. Test details are tabulated as follows, with the model details:

Table - 2: Details of Test

S.No	Model Type	No. of. Specimen
1	Controlled	3
2	Contemporary	3

The entire contemporary beam models are wrapped with the jute fiber bonded with polyester resin, the wrapping is done in soffit region and shear face of the beam and the top face left as usual. Top face of the beam experience compression force load only, thus soffit face experience only tensile force and side face experience only shear force. So that side and soffit faces are wrapped with the jute fiber.

4.1 Results for Controlled Specimen

Testing was done for controlled beam and the readings are noted and all the readings are tabulated in Table no 3. All the test are done in loading frame

Table – 3: Test on Controlled Specimen

Specimen 1		Specimen 2		Specimen 3	
Load, Kn	Deflection, mm	Load, Kn	Deflection, mm	Load, Kn	Deflection, mm
22	1.2	20	1.2	21	1.1
29	1.7	23	1.6	26	1.6
36	2.8	32	2.1	34	2.4
43	3.7	41	3.3	43	3.5
47	4.5	49	4.8	50	4.6
50	5.3	56	5.2	53	5.3
56	6.1	57	6.5	57	6.4
60	7.2	59	8.9	59	8.0
61	8.9	60	10.8	61	9.8
62	10.5	63	12	62	11.3
64	12.8	64	13	63	12.9
65	14.2	65	14.1	66	14.0

From the specimen no 1, the beam has attained the ultimate load of 65Kn and the maximum deflection attained by the 14.2mm. From the specimen no 2, the beam has attained the ultimate load of 65Kn and the maximum deflection attained by the 14.1mm. From the specimen no 3, the beam has attained the ultimate load of 66Kn and the maximum deflection attained by the 14.0mm.

From the above test results, the mean value of the ultimate load and deflection are calculated. And the mean values are tabulated as follows.

Table – 4: Mean Ultimate Load for Controlled Beam

S.No	Specimen No	Cracking Load	Mean Value
1	Specimen 1	65	65.33Kn
2	Specimen 2	65	
3	Specimen 3	66	

The Ultimate load carrying (Mean) capacity of the beam is calculated as 65.33Kn. The Theoretical value of the beam is calculated as 61.60Kn, when compared with the theoretical value to the experimental value, the beam is carrying 3.73Kn higher load than the theoretical value.

The comparison of theoretical and experimental value of the ultimate load carrying capacity of the beam is compared and the values are charted in fig no 3

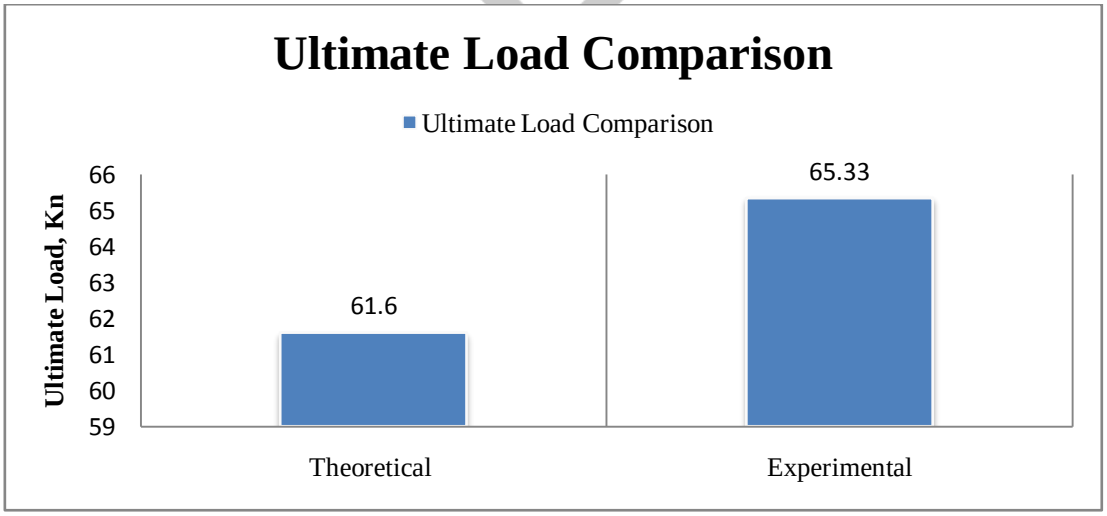

Fig – 3: Ultimate Load Comparison for Theoretical and Experimental values

The mean value of the deflection is calculated from the test results and tabulated as follows.

Table – 5: Mean Deflection for Controlled Beam

S.No	Specimen No	Deflection	Mean Value
1	Specimen 1	14.2	14.1mm
2	Specimen 2	14.1	
3	Specimen 3	14	

From the test results of the controlled beam the mean deflection is calculated as 14.1mm.

4.2 Results for Contemporary Model

The contemporary models are tested after wrapping of jute fiber. For curing the beam were kept ideal for 24 hours. After the curing the beam is test with the loading frame. The results are noted and tabulated in table no 6.

Table – 6: Test on Contemporary Specimen No 1

Specimen 1		Specimen 2		Specimen 3	
Load, Kn	Deflection, mm	Load, Kn	Deflection, mm	Load, Kn	Deflection, mm
22	1.1	23	1.3	21	1.1
23	1.6	26	1.7	24	1.5
31	2.2	32	2.4	28	2.1
36	2.7	36	2.8	37	2.9
43	3.2	42	3.1	45	3.2
48	3.5	47	3.3	49	4.6
51	4.5	54	3.9	52	5.1
55	5.3	55	4.5	55	5.8
56	6.9	59	5.2	59	7.0
60	8.4	63	6.4	60	7.9
62	9.2	65	7.7	62	9.2
64	9.8	67	9.5	65	10.3
65	10.5	68	10.6	66	11.0
66	11.2	69	11.7	67	11.5
67	12.3	70	13	68	12.0

From the test, the ultimate load obtained for the specimen no 1 is 64kn and the deflection in 9.8mm. Form the test, the ultimate load obtained for the specimen no 2 is 67kn and the deflection is 9.5mm. From the test, the ultimate load obtained for the specimen no 3 is 68kn and the deflection is 12mm.

From the results the mean ultimate load and deflection is calculated and the graphs are plotted.

Table – 7: Mean Ultimate Load for Contemporary Beam

S.No	Specimen No	Ultimate Load	Mean Value
1	Specimen 1	67	68.33Kn
2	Specimen 2	70	
3	Specimen 3	68	

Table – 8: Mean Deflection for Contemporary Beam

S.No	Specimen No	Deflection	Mean Value
1	Specimen 1	12.3	12.43mm
2	Specimen 2	13	
3	Specimen 3	12	

Form the calculation, the mean values for the test of contemporary model are arrived, the mean ultimate load is 68.33kn and the deflection is 12.43mm.

4.3 Discussion

The ultimate load carrying capacity of the contemporary model is compared with the controlled model and theoretical value. This comparison is shown in the below figure.

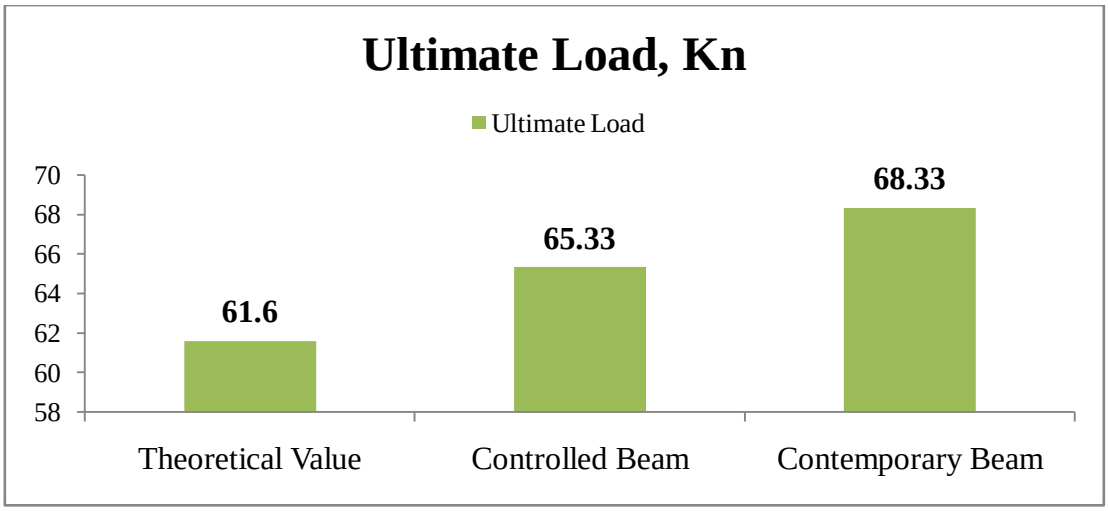

Fig – 4: Ultimate Load Comparison for Theoretical, Controlled and Contemporary Beam

The main aim of this project work is to reduce the deflection of the beam; here I have found that the load carrying capacity of the beam is also increased when the fiber is wrapped in the beam. The strength has been increased merely 5%, when compared with the controlled beam. The strength has been increased merely 11%, when compared with the theoretical value of the controlled beam model.

The deflection of the contemporary model is compared with the controlled model and theoretical value. This comparison is shown in the below figure.

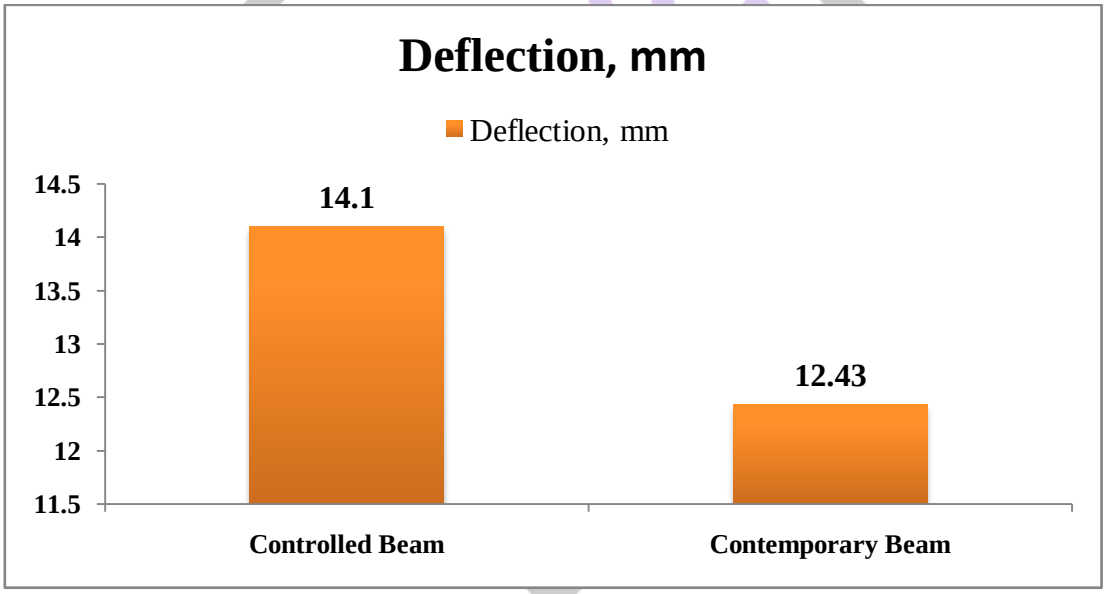

Fig – 5: Deflection Comparison for Controlled and Contemporary values

The deflection is compared for both the controlled and contemporary models. The contemporary beam show less deflection when compared with the controlled beam, the project main objective had been achieved. Thus the deflection is reduced by 1.67mm after wrapping the jute fiber, this reduction is merely 11.4% of the deflection of the controlled beam. So that 11.4% of deflection is reduced in the contemporary models.

4.4 Failure Study

The Failure of the contemporary beam is attain suddenly without giving any failure warning. It is because that the beam is fully wrapped with the fibre so that initial crack formation can't be seen in the beam, thus the failure is suddenly occurred.

Jute was good in tensile strength, but it doesn't have good ductility property so that the failure is sudden and we can't get any failure warning from the beam.

Fig – 6: Crack Formation in Contemporary Beam

5. CONCLUSION

From the experimental work, below mentioned points are concluded. They are as follows.

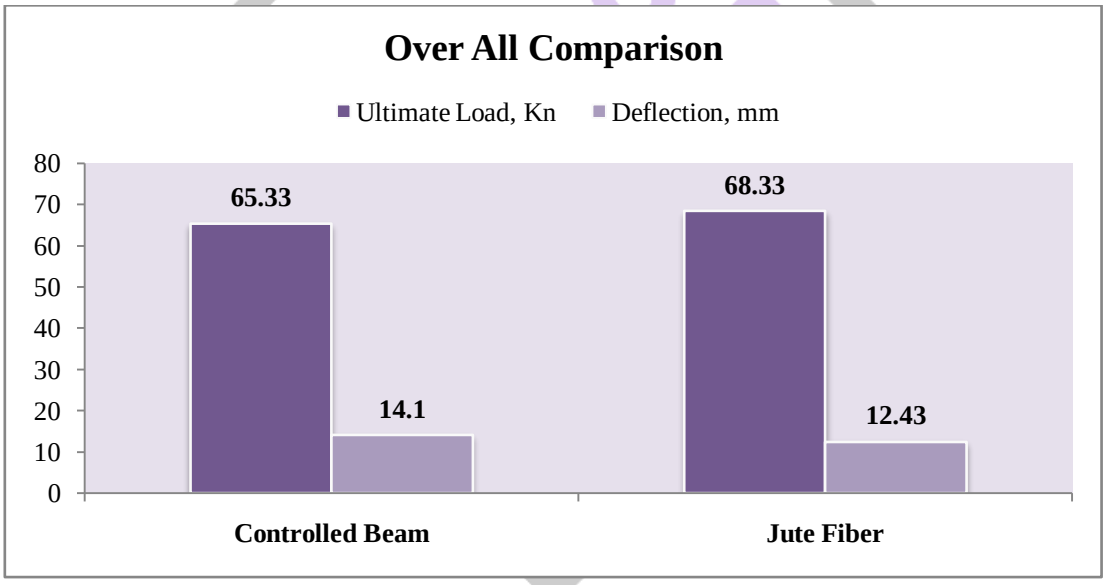

Fig-7: Over All Comparison

- Deflection of the beam is reduced 1.67mm when compared with the controlled beam to contemporary beam
- The reduction of the deflection is merely 11.4%
- The strength of the contemporary beam is increased when compared with the controlled beam
- The contemporary beam carries 3kN more load than the controlled beam
- The load carrying capacity of the beam is increased to 5%
- Failure modes in contemporary beam can't be identified because the beam is fully wrapped, so that initial cracks are not visible

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