STRENGTHENING OF REINFORCED CONCRETE BEAMS USING GLASS FIBER REINFORCED POLYMER WRAPPING

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ABSTRACT

Though there have been a number of studies on shear strengthening of RC beams using externally bonded fiber reinforced polymer sheets, the behavior of FRP strengthened beams in shear is not fully understood. This is partly due to various reinforcement configurations of sheets that can be used for shear strengthening and partly due to different failure modes a strengthened beam undergoes at ultimate state. Furthermore, the experimental data bank for shear strengthening of concrete beams using FRP remains relatively sparse due to which the design algorithms for computing the shear contribution of FRP are not yet clear. The objective of this study is to clarify the role of glass fiber reinforced polymer inclined strips epoxy bonded to the beam web for shear strengthening of reinforced concrete beams. Included in the study are effectiveness in terms of width and spacing of inclined GFRP strips, spacing of internal steel stirrups, and longitudinal steel rebar section

1. Introduction

Repair and strengthening of R.C beam is now becoming more and more important in the field of structural strengthening and retrofitting. Fiber reinforced polymer (FRP) externally bonding with epoxy resin is recently widely used in construction industry to increase the ultimate strength of structures. This paper presents the result of experimental studies carried out to get the effect of side bonded GFRP laminates to RC beams. The result indicates the strengthened beam by GFRP significantly increases more and more load carrying capacity as compared to reference GFRP to concrete surface. From this work, it is concluded that as deflection goes on increasing that is ultimate load directly varies with deflection. All strengthened beam gives sufficient warning compared to normal beam failure**.** RC beams most of the time suffered non-uniform loads which induce combine stress of flexure, shear and torsion.

2.WRAPPING

Beams were designed, so they are failed in flexure and strong in shear. To improve the capacity or performance level of a beam, it is necessary to strengthen or retrofit the beam in flexure. To improve the flexural strength, beams were retrofitted by full wrapped ,U wrapping, Bottom wrapping.

SURFACE PREPARATION

Before wrapping the composite fabric onto the concrete surface, special consideration was given to the surface preparation. The concrete surface was slightly grinded off. The grinded was used to remove material for enhancing good bounding. And then it was cleaned with air blower to remove all dirt and debris

EPOXY RESIN PREPARATION

Once the surface has been prepared to the required standard, the epoxy resin had been mixed in accordance with manufacturer's instructions. Mixing was carried out in a metal container (araldite GY 257 – 100 parts by weight and hardener HY840 – 50 parts by weight). And it was continued until the mixture of the araldite and the hardener becomes a uniform color. When this was completed, the epoxy resin was applied to the surface. The resin mixture flowed and filled the cracks by gravity. The mixture of araldite and the hardener resin should not already to mix. It should mix at the time of wrapping. Because the resin will become to solid state and it seems useless

GFRP

Glass fibers, typical form shown in Fig, are isotropic in nature and most widely used filament. Common types of glass fibers are E-Glass, S-Glass and C-Glass. The characteristic properties of glass fibers are high strength, low cost with good water resistance and resistance to chemicals. Glass Fibers are produced from wild range of glass types, E, S, R glass, which differ only in the proportioning of their contents. Such glass fibers are weak in alkali resistance. To overcome this problem, surface coating of glass fiber is used to reduce alkali effect and increase wearing resistance of fibers. Such glass fibers are known as alkali-resistance glass fiber. Alkali resistant glass fibers give good results when reinforced with alkaline environment of concrete. Nowadays Alkali-resistance glass fibers are used in FRC Many of the existing reinforced concrete structures throughout the world are in urgent need of rehabilitation, repair or reconstruction because of deterioration due to various factors like corrosion, lack of detailing, failure of bonding between beam-column joints, increase in service loads etc, leading to crack, loss of strength, deflection

II. GENERAL INSTRUCTIONS

1 EXPERIMENTAL SETUP

The beam is placed on the stand. The stand consists of roller support.The two rollers supported in the 75mm distance from each edges of the beam. And the beam is marked by 550mm each except the edges of the two sides of the beam. The load is applied on the center if the beam and for the deflectometre is placed below the beam. The deflectometer is placed in the distance of 550mm from the left and right side of edges of the beamThe deflection is placed under, where the load is applied on the RCC beam.

TESTING

The GFRP wrapped RCC beam is tested in the LOADING FRAME MACHINE. After the all setup is done the load is applied on the beam. The test is carried by two point loading system. The load is applied on the middle of the beam. The load is noted and the deflection is noted at in the deflectometre. The same procedure is carried out for all beams. The test is carried out by three point loading system. Because the three point load system shows the two deflections on either side of the beam. In the calculation we will consider the average value of the both deflection. The initial load is taken when the hinge is touched the beam. And the further readings are taken continuously when load applying on the beam by impressing the jockey. The loads and the deflections are taken simultaneously.The initial crack load is taken and the breaking load is noted for strength calculation and for the plotting of graph.When the initial crack is obtained then the load applying is increasing in slow manner. The will increase gradually when it was applying. When it was get reversed suddenly in load it means the RCC beam got failure. The load applying is stopped, and the RCC beam is taken out, and the same procedure is carried out for all other beams also.

4.2Author information

4.2.1 Name

Full names of authors are preferred in the author field, but are not required.

4.2.2 Affiliation

Different affiliations shall be listed in separate lines. Do not insert any punctuation at the end of each affiliation. If all the authors are affiliated to the same organization, type that affiliation just once.

4.2.3 Superscripts

To match authors and their own affiliations, please insert numerical superscripts, i.e., "1, 2, 3, 4 …" followed by a space, after name and, correspondingly, before affiliation. If all the authors are affiliated to the same one organization, any number is no need.

Do not forget to denote the corresponding author with a superscript asterisk (*).Offer only one valid email of the corresponding author.

5. Math

5.1 Equations

(1) **DESIGN OF RC BEAM**
(2) Breath, b = 125 mm
(3) Depth, d = 200 mm
(4) Fck = 20 N/mm2= 415 N/mm2
(5) Take clear cover = 25 mm
(6) Diameter of bar = 12 mm
(7) Effective depth of the beam= 200-12/2-25
(8) = 170 mm
(9) For balanced section,
(10) Xu max = 0.48d
(11) = 0.48 x 170
(12) = 82 mm
(13) Area of steel, Ast = 3 x π/4 x 122
(14) = 339.12 mm2
(15) Depth of neutral axis
(16) Xu = (0.87fyAst) / (0.36fckb)
(17) = (0.87*415*339.12) / (0.36*20*125)
(18) = 56.71 mm

(19) **XU < XU MAX**

(20) **Hence the section is under reinforced.**
(21) **M = 0.87 fy Ast d {1-[(Ast.fy) / (bdfck)]}**
(22) = 0.87*415*339.12*170{1-[(339.12*415) / (125*170*20)]}
(23)
(24)
(25)
(26)
(27)
(28) **Taking moment about center,**

(29) $$\left(\frac{wl}{2}+\frac{W}{2}\right)*\frac{l}{2}-\frac{W}{2}*\frac{l}{6}-w*\frac{l}{2}*\frac{l}{4} \quad =13.92KNm$$

(30) $$\frac{wl^2}{4}+\frac{Wl}{4}-\frac{Wl}{12}-\frac{wl^2}{8} \quad =13.92\times10^6$$

$$\frac{wl^2}{8}+\frac{Wl}{6} \quad =13.92\times10^6$$

(31) $$\frac{0.625s*1.8^2}{8}+\frac{W*1.8^2}{6} \quad =13.92\times10^6$$

$$W \quad =31.83KN$$

(32) $$R_A = R_B = \frac{wl}{2}+\frac{w}{2}$$

(33) $$= \frac{0.625*1.8}{2}+\frac{31.83}{2}$$

(1)

6. Tables and Figures

6.1 General

Briefly and descriptively title each table and caption each figure. Place figure captions below the figures whereas table titles above the tables. Please do not include captions as part of the figures, or put them in "text boxes" linked to the figures. Also, do not place borders around the outside of your figures.

(1) All the table titles and figure captions should be centered, Times New Roman font and 10 pts in size. Just capitalize the first letter of words, phrases and sentences which are included in tables and figures.
(2) Reference each table and figure within the text by writing: e.g., Table 1 or Figure 1 (instead of Tab. 1 or Fig. 1). If possible, place tables and figures in the order mentioned in the text, at top or bottom of page, as close as possible to text reference.
(3) Allow 12 pts spacing between the table title and the table (or between the figure and its caption). The equal spacing is allowed between the table or figure and the following text.

6.2 Tables

Words within a table should use 9pts, left aligned. The table number should be in bold type.

In general, if a table is too long to fit one page, the table number and heading should be repeated on the next page before the table is continued. Alternatively the table may be spread over two consecutive pages (first an even numbered, then an odd-numbered page) turned by 90, without repeating the heading. Please do not use bold font in tables.

Here is a table template:

Table 1. Table title

	LOAD IN N	DEFLECTION AT LEFT SIDE IN mm	DEFLECTION AT MID POINT IN mm
	455	0	0
	1235	0.02	0.02
	2925	0.05	0.05
	6240	0.1	0.1
	12870	0.19	0.18
	21840	0.39	0.32
	31005	0.66	0.6

6.3 Figures

Once the surface has been prepared to the required standard, the epoxy resin had been mixed in accordance with manufacturer's instructions. Mixing was carried out in a metal container (araldite GY 257 – 100 parts by weight and hardener HY840 – 50 parts by weight). And it was continued until the mixture of the araldite and the hardener becomes a uniform color. When this was completed, the epoxy resin was applied to the surface. The resin mixture flowed and filled the cracks by gravity. The mixture of araldite and the hardener resin should not already to mix. It should mix at the time of wrapping. Because the resin will become to solid state and it seems useless.

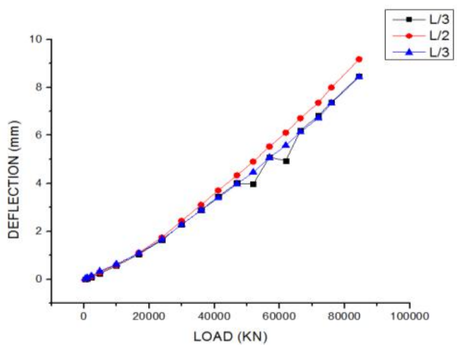
(a) **BOTTOM WRAPPED GFRP BEAM FAILURE**

(b) BOTTOM WRAPPED GFRP BEAM FAILURE

Fig. 4beams

Fig.1EPOXY RESIN

Fig.5BONDING



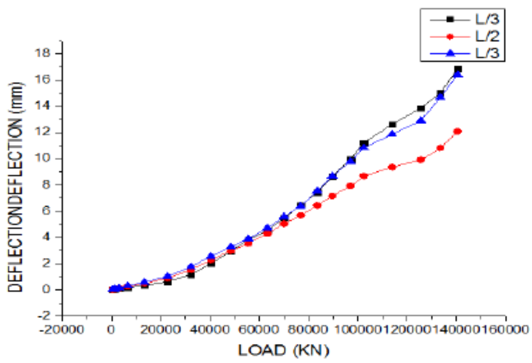


Fig. 6 Average Nusselt number for varying ratio

Fig.6LOAD vs DEFLECTION OF U WRAPPED GFRP BEAM

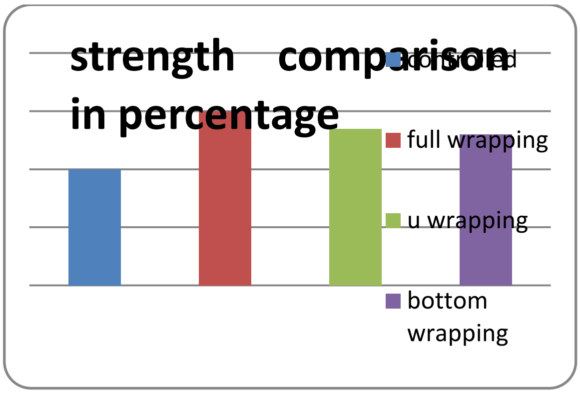


Fig.7 Percentage of **6LOAD vs DEFLECTION OF U WRAPPED GFRP BEAM**

7. Conclusions

GFRP is provided to increase the flexural strength existing concrete beams when bonded to the full side, bottom side and U-Shape by using GFRP wrap as compare to control beam, however the mode of failure associates with application of GFRP was more ductile and proceeded by warning signs such as snapping sounds or peeling of the GFRP. Yet the results of this study show that GFRP can be used to increase the flexural strength of beams without causing catastrophic brittle failure associated with this strengthening technique.

Based on results from experimental study for the beams strengthened in flexure with GFRP, the following conclusions are drawn .The flexural strength can be increased by GFRP wrapping by different methods are given belowBy full wrapping 50% of strength will increased by single layer wrapping.By U wrapping 35% of strength will increased in RCC beam.By bottom wrapping 30 % of strength will increased in RCC beam.Among these three methods full wrapping of the GFRP over the RCC beam will give better result and strength.

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Nomenclature

B	dimensionless heat source length
CP	specific heat, J. kg-1. K-1
g	gravitational acceleration, m.s-2
k	thermal conductivity, W.m-1. K-1
Nu	local Nusselt number along the heat source

Greek symbols

α	thermal diffusivity, m2. s-1
β	thermal expansion coefficient, K-1
ϕ	solid volume fraction
ϴ	dimensionless temperature
μ	dynamic viscosity, kg. m-1.s-1

Subscripts

p	nanoparticle
f	fluid (pure water)
nf	nanofluid

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(2) Appendix. If there is an Appendix section in your paper, please place the section after Nomenclature and follow the format of the text body.

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