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EXTRINSIC RETROFFITTING OF BEAMS AND FLEXURAL BEHAVOIUR WITH APPLICATON OF GLASS FIBER REINFORCED POLYMER (FRP) CONCRETE

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Glass fibers reinforced polymer (FRP) composites have been prepared by various manufacturing technology and are widely used for various applications. Initially, ancient Egyptians made containers by glass fibers drawn from heat softened glass. Continues glass fibers were first manufactured in the 1930s for high-temperature electrical application. Nowadays, it has been used in electronics, aviation and automobile application etc. Glass fibers are having excellent properties like high strength, flexibility, stiffness and resistance to chemical harm. It may be in the form of roving's, chopped strand, yarns, fabrics and mats. Each type of glass fibers have unique properties and are used for various applications in the form of polymer composites.In buildings, bridges this method is being used which satisfies its efficiency and convenience.The FRP application can be made either by wet or by dry bonding it with the concrete member. Dry bonding is done when there is need to repair or rehabilitate the concrete member which has deteriorated due to any reason. These systems can be developed by wet bonding of FRP on the members of concrete structures.The Extrinsic Retrofitting of Beam and its Flexural behavior with Glass Reinforced Polymer Concrete has been reported.

Keywords: Extrinsic Retrofitting, Flexural Members strengthening, FRP, Glass Reinforced Polymer Concrete, Structural behavior.

I INTRODUCTION

Composite materials produces a combination properties of two or more materials that cannot be achieved by either fiber or matrix when they are acting alone. Fiber-reinforced composites were successfully used for many decades for all engineering applications. Glass fiber-reinforced polymeric (GFRP) composites was most commonly used in the manufacture of composite materials. The matrix comprised organic, polyester, thermostable, vinylester, phenolic and epoxy resins. Polyester resins are classified into bisphenolic and ortho or isophtalic. The mechanical behavior of a fiber-reinforced composite basically depends on the fiber strength and modulus, the chemical stability, matrix strength and the interface bonding between the fiber/matrix to enable stress transfer. Suitable compositions and orientation of fibers made desired properties and functional characteristics of GFRP composites was equal to steel, had higher stiff ness than aluminum and the specific gravity was one-quarter of the steel .The various GF reinforcements like long longitudinal, woven mat, chopped fiber (distinct) and chopped mat in the composites have been produced to enhance the mechanical and tribiological properties of the composites. The strengthening and maintenance of structural members is one of great concerns considering civil engineering. Greater strength may be required due to deficiency in structure ability to carry the original design load. This laciness may be due to deterioration such as corrosion of steel reinforcement, damage of structure considering example such as vehicular impact, fire, floods winds, and improper construction.

The FRP is also an attractive material which is gaining popularity. Having various unique characteristics it is being used in order to enhance the strength of the structural member. The FRP application can be made either by wet or by dry bonding it with the concrete member. Dry bonding is done when there is need to repair or rehabilitate the concrete member which has deteriorated due to any reason. A requirement of innovative structural systems is also gaining importance which can withstand for many years by minimizing the effect of environmental conditions, corrosion etc on its members. These systems can be developed by wet bonding of FRP on the members of concrete structures.

1.1 Fiber Reinforced Polymer (Frp) Composites

The use of FRP for structural reinforcement in combination with wood, steel, concrete has gained importance. FRPs have great properties such as good stiffness-weight ratio, non-corrosive, very good strength-weight ratio, ease of application etc. The FRP is used for strengthening the concrete beams weak in flexure, shear or torsion. Structural members can be strengthened by externally bonded FRP sheets. FRP can be used in both tension and compression sides of structural elements such as beams, slabs, columns in order to increase their strength or corresponding resistance. The application of FRP can also be seen in concrete or masonry walls to better their resistance against lateral loads. Their application can also be witnessed in circular structures, tanks pipelines etc. to resist internal pressure and reduce corrosion. Nowadays huge quantity of FRPs sheets are being produced and are being used in many strengthening purposes.

II. EXPERIMENTAL SET OF BEAMS

TYPE OF BONDING	WET BONDING		
	SINGLE LAYER	DOUBLE LAYER	TOTAL
BOTTOM BONDING	3	3	6
VERTICAL SIDE BONDING	3	3	6
U-SHAPE BONDING	3	3	6
ENTIRE SURFACE BONDING	3	3	6
3			
TOTAL 27			

2.1 Methodolgy

The experimental work consists of investigating the shear strength of the beams which are strengthened by using glass fiber reinforced polymer sheets. Two methods are employed to performing the work. WET BONDING METHOD& DRY BONDING METHOD

2.1.1 WET BONDING. Also may be regarded as pre-cure or wet layup process. The method involves casting of fiber sheets with concrete by applying epoxy on inner sides of polymer in order to form a bond between fiber and concrete.

III. EXPERIMENTAL TEST SET UP AND PROCEDURE

The testing procedure of all the specimens is same. Universal Testing Machine of capacity 10 Ton and Four point loading arrangement system is used to perform the test. The beams are properly cleaned or wiped. The loading is applied manually with a lever arm attached to the machine and a loading rod having pair of circular ridged rods 210 mm apart. The ends of the beams are supported on roller supports which are 630 mm apart, leaving bearing of 60mm on each end. A span of 210 mm is subjected to shear stress and the portion is expected to undergo the shear failure. The dial gauge arrangement is made in order to note the deflection. The load is recorded by a load meter attached with the machine.

IV. RESULTS FLEXURAL TESTING OF BEAMS

4.1 Wet Bonding Method Results

The method involves casting of glass fiber sheets along with the concrete. The bond between the two is made by applying epoxy on the inner sides of fiber sheets while casting. The following results were obtained for beams strengthened with different configuration and layers of GFRP.

Table 4.1:- Load carrying capacity comparison Wet Bonding

Type of Bonding	Load Carrying Capacity in KN-Wet Bonding		
	Conventional	Single Layer	Double Layer
Bottom Bonding	58	61.5	65.86
Vertical Side Bonding	58	67	72.16
U-Shape Bonding	58	74.16	85.16
Entire shear Bonding	58	82.83	90.5

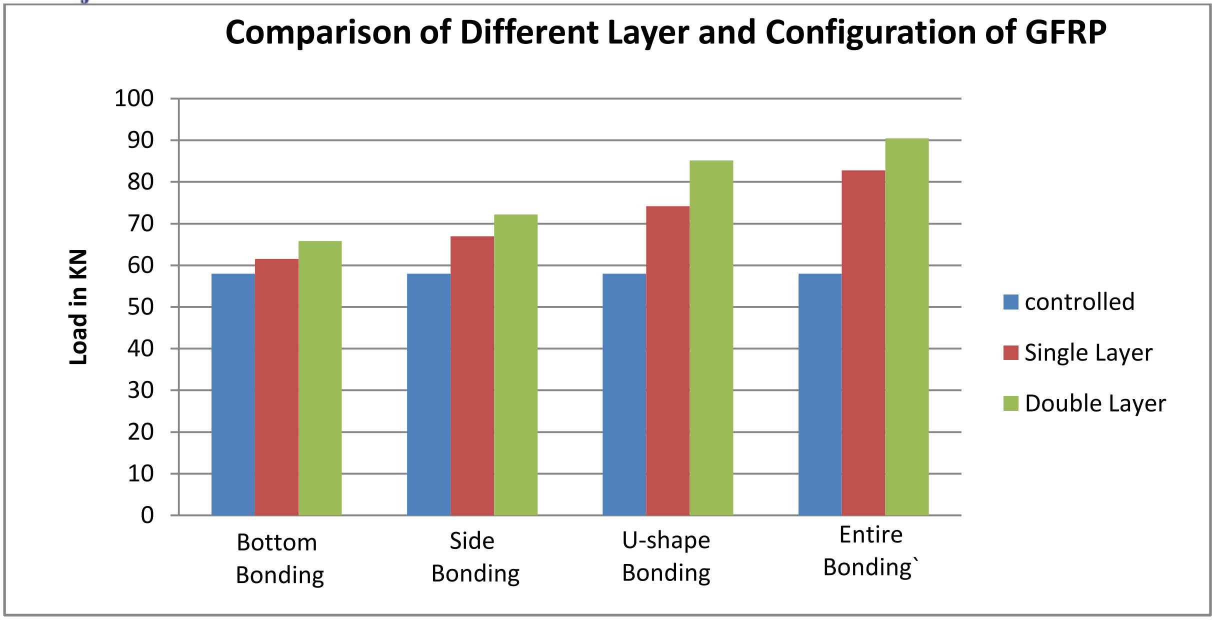

Fig.4.1:- Load carrying capacity comparison wet bonding

The table 4.5 and figure 4.1 shows the comparison between the load carrying capacity of beams strengthened with GFRP sheets. It is clearly visualized that the complete wrapping of the fiber around the section provides the maximum strength followed by U-shape, side wrap and bottom wrap. Also increase in the layer of fiber from one to two gives an appreciable increase in the strength of beam.

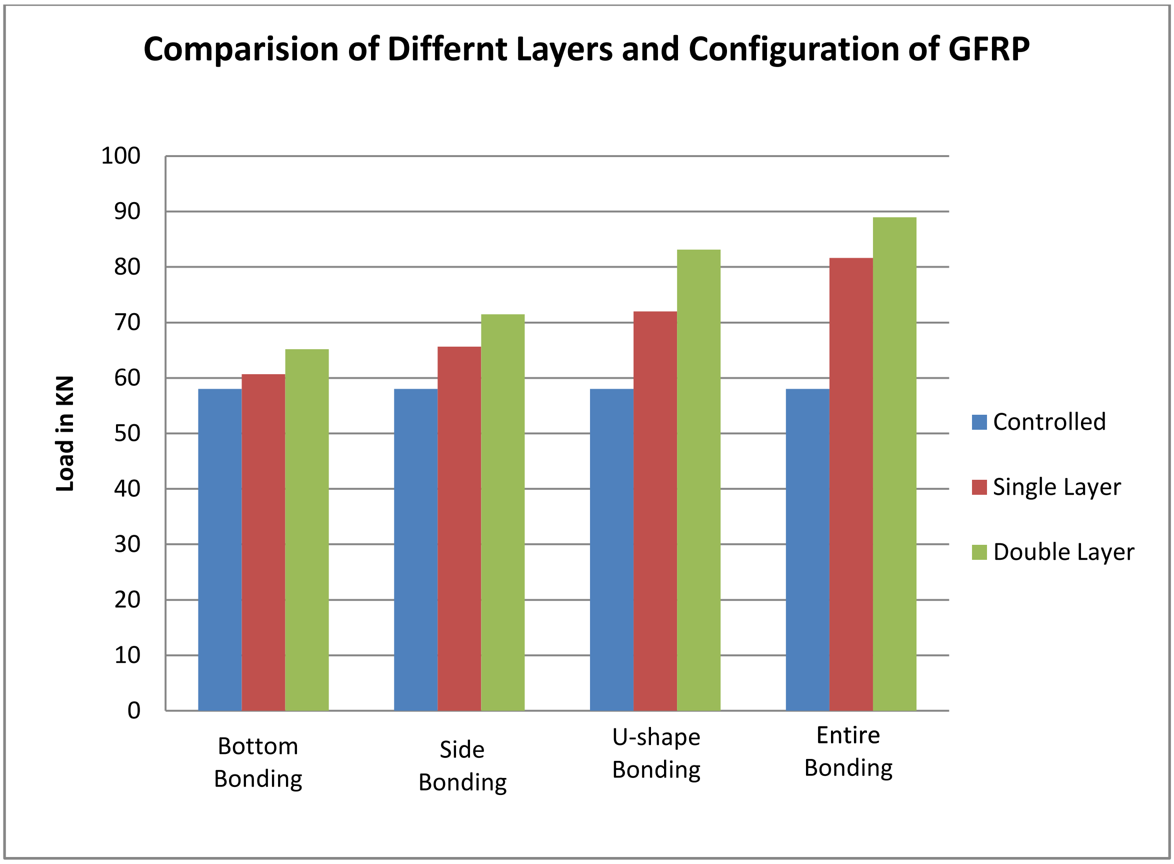

Fig.4.2:- Load carrying capacity comparison dry bonding

The table 4.10 and figure 4.2 shows the comparison between the load carrying capacity of beams strengthened with GFRP sheets bonded by dry bonding method. The complete wrapping of the fiber around the section showed maximum load carrying capacity followed by U-shape, side wrap and bottom bonding. With the increase in number of layer of fiber from one to two gives an appreciable increase in the strength of beam.

V. CONCLUSIONS

Effective GFRP bonding enhances the strength of beams considerably.The bonding of GFRP along the entire shear surface of beam provides better results of load carrying capacity which are followed by bonding along three sides (U-shape), vertical sides and bottom side.With the strengthening of beams with GFRP the failure became more ductile and preceded signs of warning as delamination of fiber or snapping sounds.The bottom side singly bonded GFRP beam has showed an increase of 6.03% when compared with controlled beam while as bottom side doubly bonded GFRP beam has shown an increase of 13.5% when compared with controlled beam. The vertical parallel sides singly bonded GFRP beam has showed an increase of 15.52% when compared with controlled beam while as vertical parallel sides doubly bonded GFRP beam showed an increase of 24.14% when compared with controlled beam.The U-shape singly bonded GFRP beam has showed an increase of 27.86% when compared with controlled beam while as U-shape doubly bonded GFRP beam has showed an increase of 46.82% when compared with controlled beam.The entire singly bonded GFRP beam has showed an increase of 42.81% when compared with controlled beam while as entire doubly bonded GFRP beam showed an increase of 56.03% when compared with controlled beam.GFRP strengthening decreased the crack formation and crack width of the strengthened beams. The GFRPC is much economical than CFRPC as its cost is less than CFRPC.

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