Flexural Behaviour of RC Beam Retrofitted With GFRP

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ABSTRACT

Fiber reinforced polymer (FRP) is a composite material generally it consisting of carbon, glass fibers in a polymeric matrix form. Present paper going to discuss about the flexural behavior of glass fiber reinforced polymer (GFRP) strengthened reinforced concrete (RC) beams. The Main focus of the paper is compares the normal RC beam and reinforced concrete beam with glass fiber. The Reinforced concrete beam with GFRP sheet and without GFRP was tested in both experimental and analytical, the analytical part was done in finite element method software (FEM) in ANSYS.

Keywords: GFRP, RC beam, finite element method (ANSYS).

1. INTRODUCTION

The concrete beams provided by the glass fiber reinforced polymer (GFRP) sheets can be an efficient technique for the structural strengthening [1]. The principle advantages of this technique are high strength to weight ratio, good fatigue properties, non-corroding characteristics of GFRP and the easier facility of its applications.

Fiber reinforced polymer mats are becoming increasingly popular materials for strengthening of reinforced concrete beams. The strengthening technique involves epoxy bonding mats of fabrics increasing both the strength and stiffness of the beam. The main reason for FRP being used is because it offers a combination of properties seldom found in any other material high strength and dimensional stability with low weight. The researchers determined that fiber glass bonded to sides of the beams produced a moderate (25%) [2] Increase in flexural capacity.

Fiber reinforced polymer (FRP) is a composite material generally consisting of carbon, armed or glass fibers in a polymeric matrix. FRP is an isotropic material characterized by high strength in the direction of the fiber orientation [3]. Externally bonded FRP mats are used to increase the strength as well as axial deformation. They are classified as follows.

2. CLASSIFICATION OF FRP

In general the fiber based reinforcements shall be classified based on the type of fiber and resins used in the principal directions, sectional shapes of the fibers, surface shape and treatment methods. The detailed classifications are covered in the subsequent sections of this chapter.

Classification of fibres:

a) Inorganic

1)	Carbon fibres	2)	Glass fibre
	Alkali resistant glass		Pan based
	Pitch based		E glass

b) Organic
- 1) Armed fibre
- 2) Poly vinyl alcohol (vinyl on) fibres

3. SCOPE AND OBJECTIVE

- The objective of this investigation is to study the effectiveness of GFRP sheets and to study the increase of the flexural strength of concrete beams by the addition of fibre-reinforced systems (FRP).
- Calculating the effect of GFRP sheets on the flexural strength.
- Evaluating the failure modes.
- Developing an analytical procedure to calculate the flexural strength of concrete beams with GFRP composites.
- Comparing the analytical calculations with experimental results.

4. EXPERMENTAL INVESTIGATION

The casting of specimens testing the two beams where one is normal RC beam and remaining is RC beam with GFRP sheets. The sizes of the beam 3200*125*250 mm, providing reinforcement Of the beam is 2-12 # at bottom, 2-10 # at top using 6mm dia stirrups @ 150 mm c/c (Fig1). Where the beam casted M20 grade of concrete and Fe 415 grade steel. Cast along the beam where tested where compression to determine the 28-day compressive strength and modulus elasticity the GFRP sheet bonded by using epoxy method. In this two beams one is normal RC beam (Fig 2) where tested in four point load. The reaming beam bonded with GFRP beam (Fig3) and tested until failure at four point load. The beam testing results shown in Table1.

5. BEAM DESIGN WITH REINFORCEMENT DETAILS

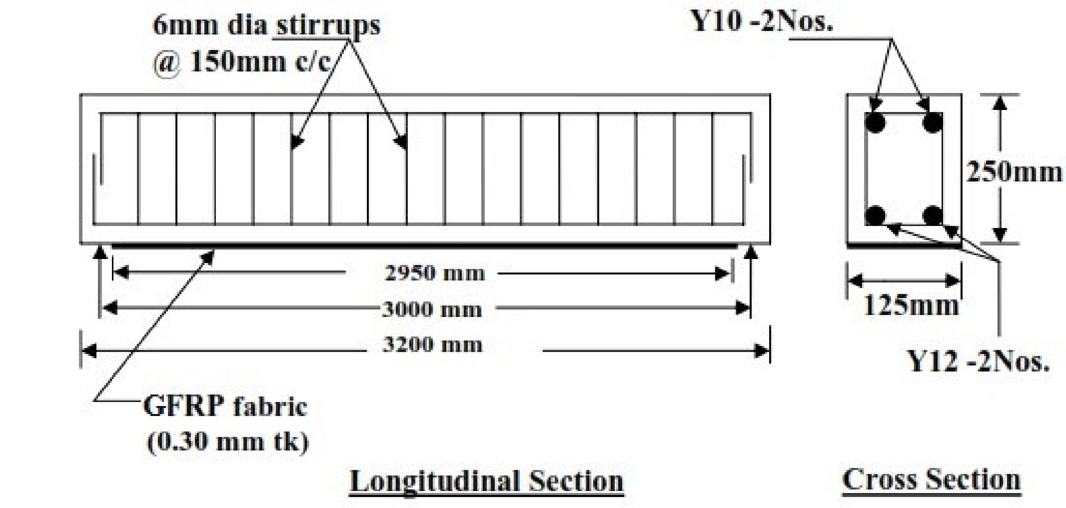


Fig1:Reinforce arrangement of RC beam with GFRP sheat

The above figure shows the reinforcement arragment for bonded GFRP beam, for the normal RC beam GFRP sheat is provided with using epoxy method. The GFRP sheat thickness is

6. TESTING THE BEAMS

Beams are tested over a simply supported span 3000mm under four-point bending, the load of which was monotonically increased under the static loading and compression.

Fig 2, Normal RC beam where tested under four-point load

Fig 3: Bonded GFRP beam where tested under four-point load

The above figures shows the experimental investigation for normal beam and bonded GFRP beam using four point load machine. The cracks are observed from above figures.

TABLE 1:load and deflection table in experimental

S.No		Normal RC beam	GFRP beam
1	Ultimate load	40 KN	40 KN
2	Deflection	18.6 mm	15.47mm

7. ANALYTICAL RESULTS LOAD DEFLECTION BEHAVIOR

FEM software in ANSYS adopted for predicting the load displacement response of the beams numerically (TABLE 2). The mesh model defined 375 nodes and 45 elements. The programmed offers solid 65 for beam element link 8 for steel element and solid 45 for GFRP fabric element the generated model for beams. The loading pattern and boundary conduction in FEM model in ANSYS Fig 4, 5, 6, 7.

TABLE 2: Deflection result in ANSYS

beam	First crack stage		Service stage		Yield stage		Ultimate stage		Crack width
	Load KN	Deflection mm	Load KN	Deflection mm	Load KN	Deflection mm	Load KN	Deflection mm	
Normal beam	17	3.75	28	15.23	34.6	17.6	41.2	19.89	0.12
GFRP beam	17	3.12	28	14.5	34.6	16.7	41.2	17.48	0.85

8. MODELING IN ANSYS

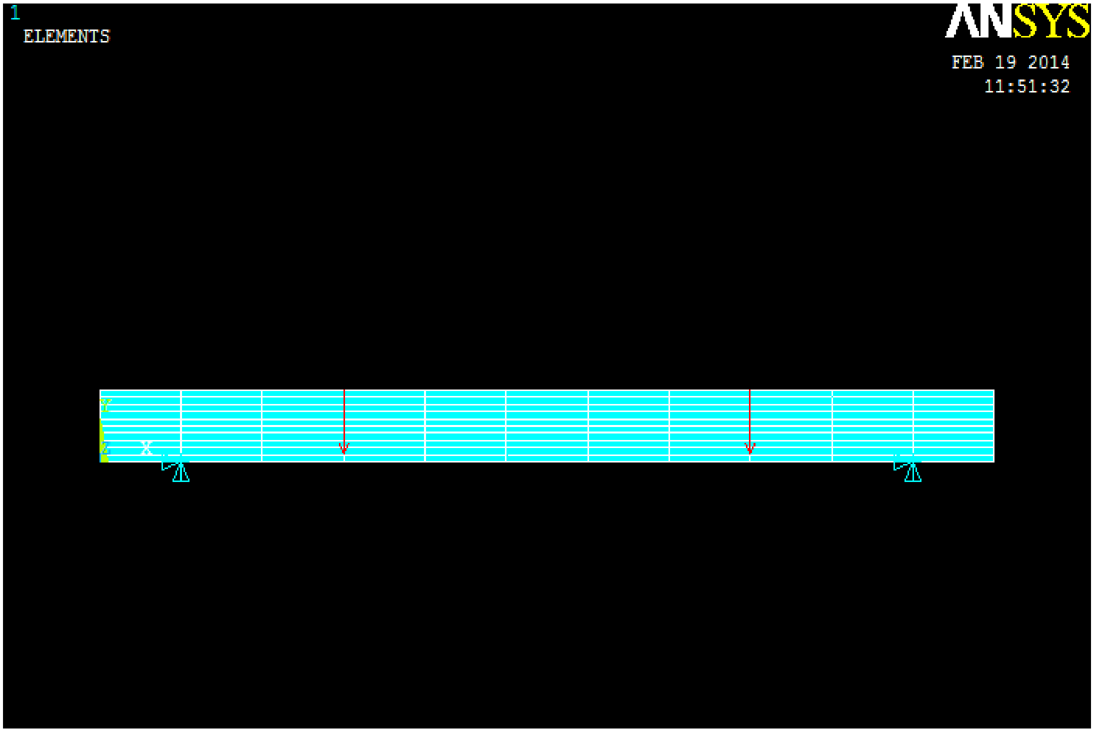


Fig 4, Normal RC beam when four-point loading

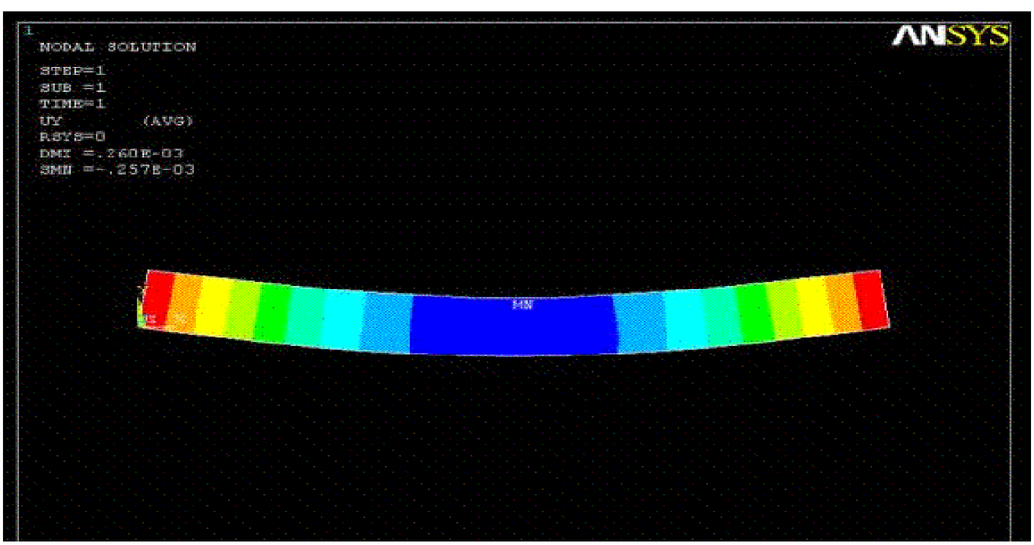


Fig 5, Appling a Load

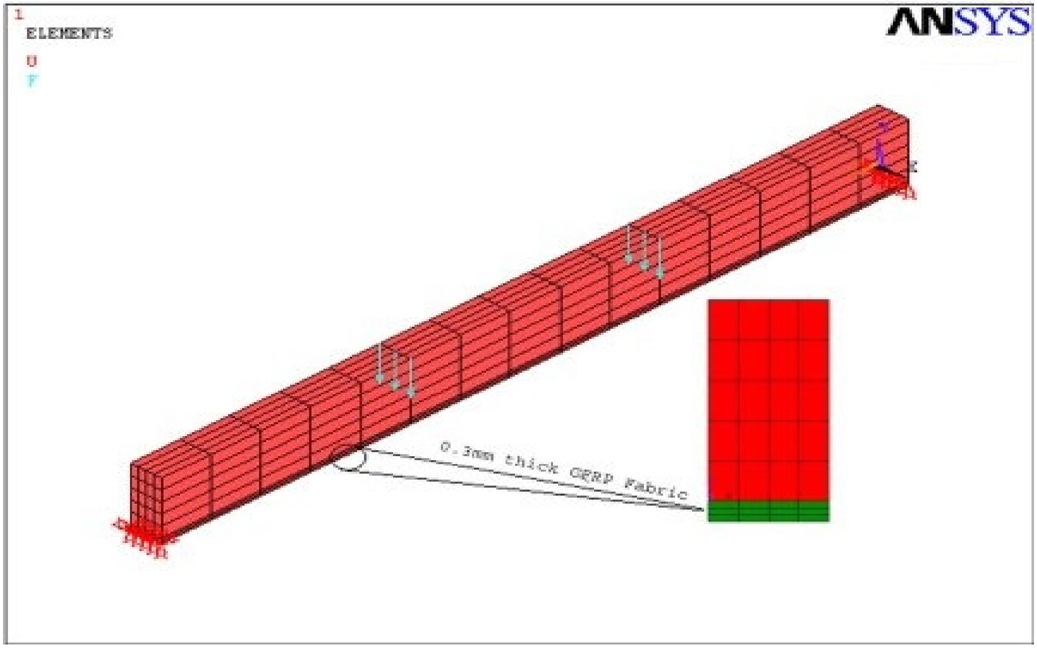


Fig 6, Modeld in GFRP beam

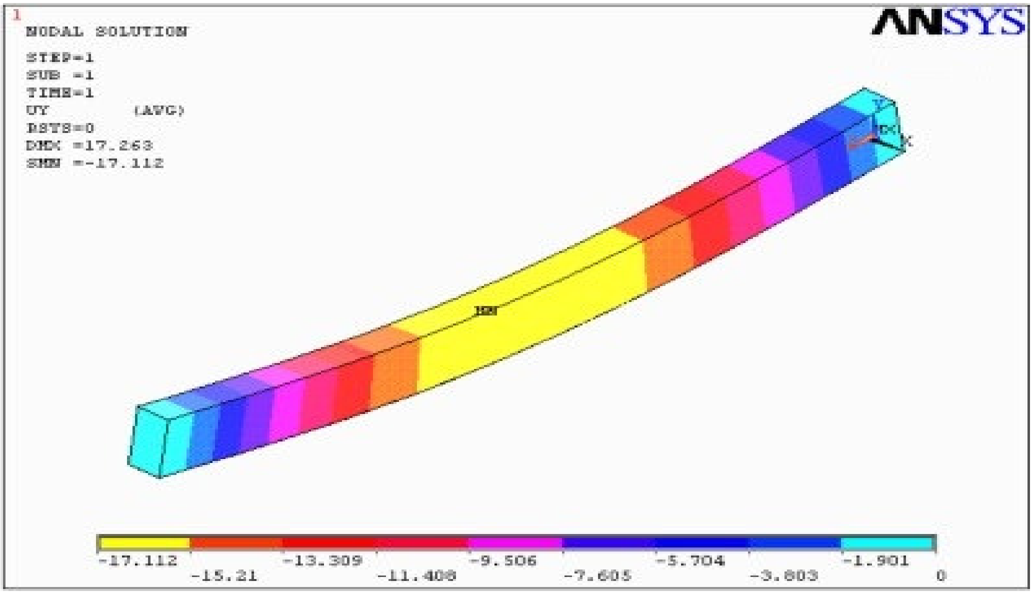
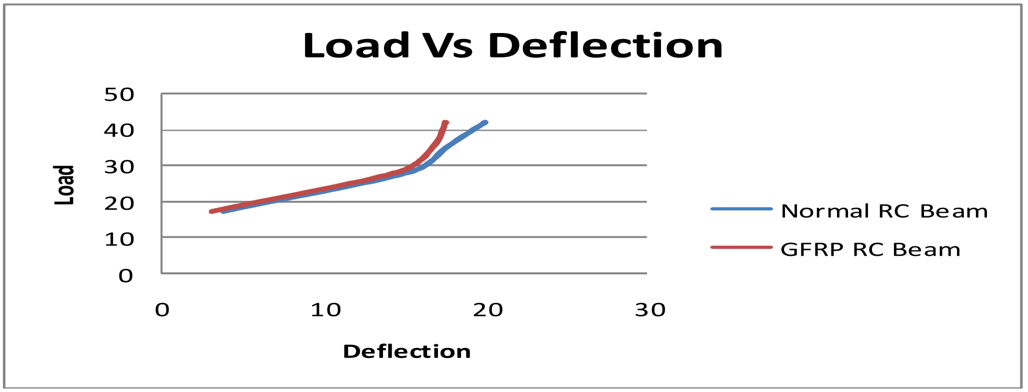


Fig 7, Appling a Load deflection

The above figers describe to modeling both normal(RC) and bonded GFRP beam in ANSYS using a shell 65 in link8 method.under load appling

9. DEFLECTED SHAPE OF STRENGTHENED BEAM



Graph 1: load vs deflection curve

The above graph shown load vs deflection curve under different loads. The GFRP beam had less deflection then compare to normal RC beam, wearing deflections sown above graph.

10. CONCLUSION

The new technique using the GFRP sheets bonding is a capable method for improving the flexural behavior as well as the serviceability of damaged concrete beams.

From the above discursions compares between normal RC beam and bonded GFRP beam in both analytical and investigational. In investigational results are shown that the deflection of GFRP is better than normal RC beam both analytical and experimental. In experimental investigation the normal beam had a deflection 18.6mm in 40 KN and the GFRP beam had a deflection 15.7 in 40KN, the above graph clearly shown the variation of deflection of beam in different loads.

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[3] Naaman and Jeong (1995), developed a new definition for the measurement of the ductility index. This is due to the inability of most FRP materials to yield.

[4] Meier et al (1991), studied the failure modes related to FRP repaired beams. A preliminary study dealt with three different failures.

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