A Critical Review on Comparative Study on the Analytical Results of GFRPRC Beam and CFRP RC Beam on ANSYS

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Abstract: **The utilization of composite materials, for example, Fiber Reinforced Polymers (FRP) in fortifying and fixing of structural components, especially those made of reinforced concrete, is generally spreading. However, for successful and practical applications, engineers must improve their insight concerning the real conduct of reinforced structures. FRP materials offers the designer an exceptional blend of physical and mechanical properties, for example, high rigidity, lightweight, improved stiffness, high fatigue strength, durability and incredible solidness. Since these frameworks are non-destructive, non-magnetic, and chemical resistant, they are an amazing alternative for outer support. The properties of FRP composites have brought about huge sparing in construction cost and decrease in shut down time of facilities when contrasted with the regular reinforcing techniques. In this study, an attempt is made to get a more clear knowledge onto which among the Glass Fiber Reinforced Polymer(GFRP) and Carbon Fiber Reinforced Polymer (CFRP) is better by leading an analytical investigation on both FRPs when wrapped over Reinforced Concrete (RC) beam using ANSYS software.**

Keywords: **Composite Materials, Fatigue Strength, Fibre Reinforced Polymers (FRP), Glass Fiber Reinforced Polymer(GFRP), Carbon Fiber Reinforced Polymer (CFRP), RC Beam, ANSYs.**

I. INTRODUCTION

There is a huge need for repair and strengthening of deteriorated, damaged structures. There can be numerous explanations behind the decay of structures, it may very well be because of ecological impacts, deficient plan and development or requirement for structural upgradation in order to meet new seismic plan necessities due to new plan guidelines, disintegration because of erosion in steel brought about by introduction to a forceful climate and mishap functions, for example, tremors, excessive deflection, poor concrete quality, and so on or once in a while even to understand execution mistakes caused at the hour of development. For these reasons, different reinforcing methods have been created to fulfill these fortifying prerequisites. The act of fiber reinforced polymers (FRPs) for the restoration of existing solid structures has become quickly throughout the most recent couple of years. Studies has demonstrated that FRP can be utilized proficiently in reinforcing the concrete beam frail in shear. Since the FRP materials are non-destructive, non-magnetic, and chemical resistant, they are progressively being utilized for outer support of existing concrete structures. From the past studies directed, it has been demonstrated that remotely fortified fiber reinforced polymers (FRP) can be utilized to improve the shear limit of RC beams. Because of the adaptable or flexible nature and ease of handling, combined with high tensile strength and stiffness, the adaptable Fiber strips are discovered to be profoundly powerful for fortifying of RC beam.

Due to increase in population cities area, demand for apartments has arisen and also to restoration of old structure has become important which is why such advanced technologies should are needed to explored. This study focuses on strengthening. Following are some of the reasons resulting in the need for strengthening:

- Stirrup not placed according to the spacing construction plan,
- insufficient longitudinal main reinforcements bars, insufficiently anchored reinforcements,
- casual placement of reinforcements,
- collapse of non-load-bearing walls and chimneys, using low quality concrete etc.

II. LITERATURE REVIEW

Ibrahim and Mahmood studied the finite element modelling of reinforced concrete beams strengthened with FRP laminates.They analyzed the model for reinforced concrete beams reinforced with Fibre reinforced polymer (FRP) laminates using finite elements method (FEM) adopted by ANSYS. The models have been set up using a spread breaking technique for cement and 3D-layered components for FRP composites. The results obtained have been matched with the experimental data for six beams with different conditions from researches. The results have been compared for load deflection curves and failure load at mid length which are in good agreement. The maximum difference is 7.8% for all cases included in ultimate loads. The numerical solution was adopted to evaluate the ultimate shear strength of the reinforced concrete beams reinforced with FRP laminates in simple, cheap straightforward, modest and rapid way exploratory full scale test. The overall practices of the limited component models show great agreement with perceptions and information from the test full-scale beam tests. The addition of FRP reinforcement to the control beam shifts the behaviour of the control beams from shear failure near the ends of the beam to flexure failure at the midspan.

*Robert R. S. and Prince A. G***.**examined finite element modelling on behaviour of reinforced concrete beam-column joints retrofitted with carbon Fibre reinforced polymer. The Finite Element Method (FEM) has gone to reproduce the actual lead of complex structure systems. The (FEA) programs have expanded typical affirmation among engineers in industry and examiners. The assessment of retrofitted with carbon Fiber strengthened polymer sheets (CFRP) using ANSYS have been shown in this paper. Three diverse fortified sheet of CFRP on strong shaft were shown using ANSYS. Both the ends of the beam in investigation have been kept pivoted.Static burden was associated at the free finish of the cantilever bar. The examinations have been led for the retrofitted shaft and the results have been displayed.

Banu D. et al. (2012) studied the numerical modelling of two-way reinforced concrete slabsstrengthened with carbon Fibre reinforced polymer strips. They applied FRP as an outer layer to the RC (Reinforced Concrete) beams and used ANSYS software to analyze the effect of FRP material as an outer layer to observe the effect of it on load carrying capacity. They have used SOLID65 element to model the 3D concrete beams while SOLID45 to design the thick shells. They have conducted their results for load-deflection and ultimate carrying capacity. The recorded estimations of load and deflection were utilized to draw the load deflection plots and the distortion relating to every addition of load for all specimen was noted. The result showed that the hybrid beam has more load carrying capacity than conventional beam and the flexural behaviour is also more compared to conventional beam. The deflection decreases with increase of percentage of hybrid Fibre. The flexural strength of Fibre reinforced concrete is higher than the conventional concrete.

*Jayajothi P. et al.*carried out investigation of finite element analysis of FRP fortified RC beams using ANSYS. Distantly braced FRP sheet can be used to increment flexural quality of fortified strong columns. Reinforced solid bars remotely sustained with fiber fortified polymer sheets using limited component procedure embraced by ANSYS. The accuracy of the limited component model is checked with assistance of connection its results with the preliminary outcomes. The stack redirection twists procured from the limited section examination holds incredible with the preliminary results.

MettuBhaskara Rao et al. studied the impact of Glass Fiber Reinforced Polymer (GFRP) flats under shear in RC beams. The goal of the examination was to consider the conduct of the bars strengthened with GFRP flats in shear. He saw that the beams strengthened with plain GFRP bars as shear support, had taken more shear than the control specimen, with no shear fortification, which demonstrated that the GFRP bars had the option to take shear and were equivalent to mild steel (Fe 250) fortification. It was seen that the failure of beams was not unexpected, however the failure of GFRP bars was abrupt and related with fragmenting of fiber in direct tension.

Parandaman and Jayaram examined the finite element analysis of RC beam retrofitted with various Fiber composites. They used Pro-E software for modelling and ANSYS for examination of the modelled geometry. They used glass Fiber reinforced polymer (GFRP) sheet for layering of RC beam. SOLID65 component for concrete beam and SOLID45 component for FRP has been utilized by them. They found that deflection has been limited around 65% contrasted with the conventional RC beam when GFRP utilized. Load carrying capacity increments by utilizing FRP overlays. Quality increments subsequently to utilizing FRP laminates.

Musmar et al. studied the nonlinear finite element analysis of shallow RC beams utilizing solid65 element. They focused on their examination towards the investigation of shallow reinforced concrete beam for transverse loading. SOLID65 eight node isotropic components have been utilized to model the concrete beam. The investigation has been conducted utilizing ANSYS. They reasoned that cracking at first happens in the vertical flexural from in the model. The cracking increments with increase in the load. The relationship between the load and deflection has been discovered to be linear elastic up to cracking moment strength then it inclines in horizontal plane.

Jain and Sikka experimentally showed the impacts of glass Fiber reinforced polymer (GFRP) retrofitted RC beams under balanced or symmetrical four-point static loading system. The quality of strength of bar wrapped by GFRP on beam fit in U shape was discovered to be 32% more than that of Plain concrete cement and the quality of bar wrapped on two parallel sides was nearly more than the strength of plain concrete cement yet lesser than the enclosed by one side. From the above exploration and results we can presume that GFRP enveloped by U shape gives better quality of strength when contrasted with GFRP wrapped on two parallel sides. The fortifying of beam wrapped in U shape was discovered to be more viable than in sides of beam. Lastly, it was presumed that the GFRP can build or improve the shear limit of beam. The utilization of GFRP sheets as an outer support was prescribed to upgrade the shear limit of RC Beams with anchorage system.

Singh et. al. carried out study on the simulation of concrete reinforced beam utilizing ANSYS. Impact of various Fiber Reinforced Polymer were studied. The Fiber Reinforced Polymer (FRP) as an outer fortification was utilized to manage the quality necessities identified with flexure and shear in structural system. First the simple concrete beam was modelled in ANSYS and afterward the FRP material was overlaid over it. Impact of strain and different loading condition were concentrated on in the research.

Patel and Parikh examined the impact of GFRP composites and adhsives, impact of dimension of beams, type of FRP sheets, number of layers, their setup, impact of debonding, failure type, load versus deflection conduct for RC bar in shear and flexure. They found that there was a huge expansion in the flexural strength between 41% to 123% accomplished by bonding GFRP sheets to the tension face of the RC beams. There was a critical expansion in the shear strength up to 50% accomplished by bonding GFRP sheets to the sides of the RC beams.

Salama examined the conventional method for fortifying reinforced concrete (RC) beams in flexure through bonding carbon-Fiber reinforced polymer (CFRP) overlays to the beam's soffit. Nonetheless, the beam's soffit could be restricted or distant for reinforcing. To overcome such obstacle, this paper investigates the practicality of reinforcing RC beams in flexure by side-bonded CFRP composite sheets. Accordingly, a sum of nine RC beams have been cast, eight of which were fortified in flexure with various designs of base reinforced and side bonded CFRP sheets, and tested under four-point bending till failure. The load-deflection response curves, failure modes, and ductility of the tested specimen were recorded and discussed. Generally, it is seen that specimens fortified with comparable amount of reinforcement with percent increase in the flexural strength over the control beam went from 62 to 92% for bottom bonded and 39.7–93.4% for side-bonded reinforced beam. Furthermore, a systematic model dependent on ACI 440.2R-08 rules is developed and the anticipated flexural strength was in good agreement with trial results with differences in the range of 2.4% and 6.8%. It is presumed that the proposed side-reinforced fortifying plan is a legitimate alternative in contrast to the bottom bonded plan of fortifying of RC beam in flexure.

Ism and Rabie tentatively did an investigation on the impact of fortifying plans on the flexural behaviour of continous R.C. beam under a wide range of parameter. Seven beams were constructed experimentally and studied two parameters which are the length and number of layers of carbon fiber reinforced polymers (CFRP) sheets. Additionally, Finite Element Models (FEM) was developed by using ANSYS. The test results were utilized as confirmation for the FEMs' results. A parametric report was led by utilizing 540 specimen to examine more parameters. Test results showed that the common mode of failure in hogging zone is rupture, while de-bonding happens at the sagging zone. When the number of layers has increasedthe method of failure is likely de-holding. The parametric examination concluded the fortification proportion influences the failure mode by 22%. The fcu has an impact upon numerous factors up to 40%. A relationship was derived between vafriables with which the designer will be able to predict the mode of failure and the CFRP sheets' failure strain of any strengthened equal spans continuous R.C. beam.

Sivanaskar et. al introduced the Finite Element (FE) analysis of Square Hollow Steel (SHS) tubular section externally wrapped with Carbon Fiber Reinforced Polymer (CFRP) strips under axial compressive load. CFRP sheets are utilized as strip structure and the width of the strip is 50 mm. The spacing between the strips is considered as a constant of 20 mm and the number of layers are one, two and three in the horizontal direction. All the specimens are subjected by axial compressive load till arrived at their ultimate failure load. From the test outcomes, the failure style, axial load and displacement, ultimate load and stress strain behaviour were discussed with the control and each other. Finally, a mathematical analysis were designed for failure style, stress strain, ultimate load and axial displacement utilizing ANSYS and approved and validated with the test results. FEM gave a reasonable wrapping plan to SHS tubular member.

III. MATERIALS AND METHODOLOGY

Glass-Fibre Reinforce Polymer: GFRP composite materials are essentially composed of glass-fibre filaments and a resin matrix. The filaments have a high tensile strength and a high modulus of elasticity and are the load bearing component.

Table1: Properties of Glass Fiber Reinforced Polymer

S.No	Properties of glass fiber	Value
1	Density of fiber	1.7g/cm^3
2	Fiber layer thickness	0.117mm
3	Tensilestrength	4900N/mm^2
4	Ultimate strain	1.55%
5	Modulus of elasticity	240N/mm

Carbon-Fibre Reinforce Polymer: CFRP is an extremely strong and light Fibre-reinforced plastic which contains carbon Fibres. CFRPs can be expensive to produce, but are commonly used wherever high strength-to-weight ratio and stiffness (rigidity) are required, such as aerospace, superstructures of ships etc.

Table 2: Properties of Carbon Fiber Reinforced Polymer

S.No	Properties of glass fiber	Value
1	Density of fiber	2.6 g/cm^3
2	Fiber layer thickness	0.131mm
3	Tensilestrength	4300N/mm^2
4	Ultimate strain	4.5%
5	Modulus of elasticity	238000N/mm

Epoxy Resin: Epoxy is an adhesive, plastic, or other material made from a class of synthetic thermosetting polymers containing epoxide groups. Epoxy has been widely used with fiber reinforced polymer composites. The success of the strengthening technique also depends on the performance of the epoxy resin used.

Table 3: Properties of Epoxy Resin

S.No.	Properities	Density	Specific Gravity	Flexural Strength
1	Araldite GY 257	1.15 g/cm3	1.8	450 – 550 kg/cm^2
2	Hardener HY 840	0.98 g/cm3	2.0	300 – 400 kg/cm^2

ANSYS: ANSYS is a computer aided-engineering software ranging in principles that includes finite element analysis, fluid dynamics, etc. ANSYS Version worked on – 16.0 The

ANSYS structural analysis software is used to solve complex structural engineering problems and make better, faster design decisions. With finite element analysis (FEA) tools, we can customize and automate simulations, and parameterize them to analyze multiple design scenarios. ANSYS Structural Mechanics software easily connects to other physics analysis tools, providing even greater practicality in predicting the behaviour and performance of complex products.

IV. CONCLUSION

From the above research it can be concluded that the utilisation of FRPs is in complete favour of optimization of natural resources. Utilization of CFRP and GFRP on RC beam for the strengthening and fixing of old structure is avery useful advanced technique considering how cost effective to the present days population demand for structure with high strength, maximum durability and other properities. From the experimental results it can be concluded that:

- The specimens fortified with comparable amount of reinforcement with percent increase in the flexural strength over the control beam went from 62 to 92% for bottom bonded and 39.7–93.4% for side-bonded reinforced beam [11].
- **T**here was a huge expansion in the flexural strength between 41% to 123% accomplished by bonding GFRP sheets to the tension face of the RC beams [10].
- There was a critical expansion in the shear strength up to 50% accomplished by bonding GFRP sheets to the sides of the RC beams [10].
- GFRP enveloped by U shape gives better quality of strength when contrasted with GFRP wrapped on two parallel sides [8].
- The deflection has been limited around 65% contrasted with the conventional RC beam when GFRP utilized [7].

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BIOGRAPHY

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