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RCC BEAMS STRENGTHENING WITH GLASS FIBER REINFORCED POLYMER

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Abstract: *The existing features in modern compounds in the concrete structure building industry in reinforcement and maintenance are growing based on needs. Various reinforced concrete systems worldwide are in dire need of repair and maintenance due to deterioration due to various factors such as improper maintenance, corrosion of metal reinforcement, poor design, poor production, use of inferior fabric, better Design requirements due to load. - Improving public tolerance, exposure to hazardous environments and damage in the event of earthquakes such as earthquakes, and design advice. The use of fiber-reinforced polymer in the restoration and strengthening of reinforced concrete elements is currently internationally recognized. Fiber Reinforced Polymer (FRP) is a quite robust way to restore and reinforce systems that have become weak due to lifestyle and design defects. FRP repair systems provide an economically viable alternative to standard tissue and therapeutic device. It performed experimental investigations of the bending behaviour of FRP-reinforced RC beams without stopping. GFRP (Glass Fiber Reinforced Polymer) sheets bonded to epoxy to externally reinforced concrete beams are tested for failure with a static loading device focusing on two identical factors. Three sets of beams were cast for this pilot test program, and the tests were performed with multiple layers of fibers from a wide range.*

Keywords*: Glass Fiber Reinforced Polymer, Flexural strength; Strengthening, U Wrap, Control Beams, Strengthened Beams*.

I. INTRODUCTION

There are many existing concrete structures including buildings, bridge decks, girders, and offshore structures with only respectable improper maintenance, corrosion of steel reinforcement, poor design, poor production, use of inferior materials, aircraft carriers. Hundreds of design requirements inside have deteriorated due to rising. Damage to

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hazardous environments and seismic activity such as earthquakes and development in design indicators.

There is a huge need for repair and strengthening of deteriorated, damaged structures. There can be many reasons for the deterioration of structures, it can be due to environmental influences, inadequate design and construction or need for structural up-gradation so as to meet new seismic design requirements because of new design standards, deterioration due to corrosion in steel caused by exposure to an aggressive environment and accident events such as earthquakes, excessive deflections, and poor concrete quality, etc. or sometimes even to solve execution errors caused at the time of construction. For these purposes, various strengthening techniques have been developed to satisfy these strengthening requirements. The development of fibre reinforced polymer (FRP) materials in various forms such as non-woven, that is loose fibres, woven, that is braided fibres, textile or fabric, that is strongly braided along with a backing material such as latex backing or natural rubber backing, etc. and configurations offers an alternative design approach for the strengthening of new existing structures. FRPs offer designers an excellent combination of properties not available from other materials and present a potential solution to civil infrastructure's crisis hence are suitable materials for structural retrofitting, FRP composite materials also offer an attractive alternative to any other retrofitting technique in the field of repair and strengthening of concrete elements [1].

The advantages of FRP are numerous, along with the excessive strength to weight ratio, special excessive pulling force, correct fatigue resistance, ease of installation and wear resistance properties, easy repair, and extreme road resistance. They wanted and better last strength and lower density than metal, etc. They are some of the homes that make FRP ideal for reinforcement applications. But a great deal of theoretical experience and design recommendations. Necessary to ensure the safe, reliable and profitable use of FRP materials. Carbon fiber composites are the most commonly used devices in previous studies and retrofit applications [2].

Maintaining and rehabilitating structural contributors is one of the most fundamental issues in civil engineering. The variety of systems built in the other world using ancient design codes are structurally dangerous in keeping with more current design codes. Since the variant of these ill-regulated items involves a large amount of public money and time, hardening has become the viable way to improve the potential of sporting goods and increase the wearer's life. FRPs exhibit several improved housing consisting of high weight-to-electric ratio, excessive weight-to-stiffness ratio, design flexibility, non-corrosion, high-stress energy, and application simplicity. The use of fiber composites now does not significantly increase the weight of the limb structure. Due to its lightweight, transportation of FRP materials has little impact on the environment. These various factors combined lead to a significantly more straightforward and faster method of strengthening than using steel panels. Research shows that FRP can be used highly to reinforce weak concrete beams in bending, shearing and torsion. The present substantial arrangement requirements in India do not include any provisions for strengthening the bending, shearing and torsion of the structural contributors with FRP materials [3].

The most widely used fibers, which can be used as reinforcement in FRP, for reinforcing concrete systems are carbon, glass, aramid synthetic fibers and many others. Carbon fiber is one of the most expensive fibers ever, combined with aramid fibers. Although it has the advantage of increasing the structural capacity with numerous folds, it also has a high total cost. Thus it cannot easily be considered a product in the market that relies mainly on excellent results. Although the demand for structural reinforcement is growing day by day with the deterioration of the growing urban infrastructure, the cost of these synthetic fibers increases with the increase in the various environmental demands imposed by these fibers' manufacture. Although fiberglass is cheaper than carbon and aramid fiber, it has caused dermatitis problems for many people who deal with fiberglass products and packaging.

Therefore, revolutionary reinforcement strategies, which utilize consumer-friendly and pocket-friendly fibers to produce and manufacture fiber-reinforced polymer, are increasingly becoming a staple number to enable prolonging a degraded urban infrastructure provider's useful life. It should also be taken into account that the materials selected Structural improvements, such as functionality and an increase or improvement in the various homes of the systems, must meet some criteria for sustainability and greater pleasure. For example, these materials must not pollute the environment and endanger biological reserves. They must be self-sufficient and promote self-sufficiency. They must assist in recycling polluted waste into usable materials, and they must make use of materials available at the regional level, using the skills. Local manpower and management systems must benefit the local economic system by generating income, it must be accessible to ordinary human beings, and it must have a low financial cost. In addition to enhancing the strength of the structure with FRP due to the raw materials, it is also important to use local materials in construction. Therefore, paints for systems conditioning are limited to the use of carbon fiber, glass, aramid and many others, and very few paints are transferred to improve structures or use available materials or natural fibers. Composite programs at skeletal centres generally focus on increasing hull strength with synthetic fibers and no longer address the problem of sustainability of these raw materials used for reinforcement purposes. In light of the increasing world population and the increasing purchasing potential, the need for raw materials required for structural reinforcement, which can meet the global market demand, is rapidly increasing [4].

II. REVIEW OF LITERATURE

Al-Rousan et al. [5] The document provides experimental and analytical inspection results involving static and heightened stress, verification of the performance of nine externally reinforced and reinforced concrete beams with unique span and configuration of CFRP panels. The firmness was tested for stress stages 0.25 years - zero 35 years, zero 45 years - 0.65 years, 0.65 years - zero 90 years, and zero 45 years - zero 90 years. After validating the nonlinear finite element analysis (NLFEA) with the analysis of the experimental results, NLFEA was extended to provide a greater understanding of the effect of the fatigue stress range, the CFRP layer range, and the proximity of CFRP contact with concrete in the performance of reinforced concrete (RC) beams. The stress ranges significantly affect the permanent deflection in the mid-range, mainly for the 0.45fy - 0.90fy stress range. Cyclic stress loading resulted in a time-dependent stress redistribution, causing a sudden drop in concrete stresses and slight growth in CFRP sheets and metal stresses as fatigue depleted. Additionally, the authors suggest that there are problems with fatigue design to account for the reduction in stiffness and the maximum loading capacity due to fatigue loading.

Correia et al. [6] this article presents the results of experimental and digital investigations on the structural behavior of composite beams manufactured from annealed glass panels and glass fiber reinforced polymer (GFRP) profiles. The primary goal of the precise structural responses presented here is to increase the glass's residual strength and flexibility after fracturing through GFRP reinforcement strips. The pilot program included (1) tensile controls on double-lap joints between glass and GFRP laminates, bonded with unusual patterns of structural adhesives, and (2) extensive bending controls on glass beams and composite glass beams. -GFRP, with specific stiffening geometry and structural adhesives. The results obtained in this analysis show that, in contrast to glass packages, in GFRP composite glass beams, it is possible to achieve high elastic failure modes, with significant growth in both capacity and potential for deformation after initial glass fracturing. The rigidity of the structural adhesive used, together with the GFRP reinforcement detail's geometry, has a fundamental influence on the structural response of the composite beams. Finite detail models were developed for all the tested beams, allowing their service behavior (before glass breaking) to be simulated with sufficient accuracy, especially classifying the shear reaction in the bonded interfaces.

Jiangfeng et al [7] this article presents experimental research on reinforced concrete (RC) beams with external flexural and bending strengthening through the use of fiber-reinforced polymer (FRP) panels composed of carbon FRP (CFRP) and FRP glass (GFRP).). The achieved panels examined the bending, bending and shear strengthening capabilities of adapted RC beams and indicated how the different reinforcement arrangements of CFRP and GFRP panels affected the behaviour of the reinforced RC beams. The research results suggest that the bending and shear strengthening bond is more effective than the bending bond in improving the stiffness, electrical shutdown and RC beam stiffness behaviour. Also, theoretical calculations have been developed to estimate the bending and shear capabilities of the tested beams, compared with the corresponding experimental results.

Ghandour et al. [8] This article examines the shear efficiency and bending strengthening of CFRP concrete girders. Half-size girders, with unique internal metal shear and flexible proportions, were reviewed in 3 modifiable factors. Necessary bending or shearing beams are equipped with longitudinal panels made of carbon fiber reinforced plastic or U-caps. Critical shear and bending beams are provided with shear or embedded structures. In the case of excellent bending damage, a discount of 38.3% was established in the shear strengthening efficiency at higher flexibility.

Simultaneously, the bending strengthening performance was reduced with the help of sixty-five, 7% to the excessive shear damage, from a power perspective. The U-coil was energized by 22%, while the entire plate was energized and reduced by breaking the pin by 30.8% with excessive shear damage. While ACI 318M-05 and ACI 440.2R-08 accurately predicted the individual disasters, the combined disasters were not.

Yeong et al [9] This paper reports on pilot studies of reinforced concrete (RC) beams that have been modified with a new machine for hybrid fiber-reinforced polymer (FRP) consisting of FRP carbon (CFRP) and FRP glass (GFRP). This essay aims to observe the effect of hybrid FRPs on the structural conductivity of conditioned RC beams and to verify whether the characteristic sequences of CFRP and GFRP panels of hybrid FRPs have an impact on improving RC beam reinforcement. . For this purpose, 14 RC beams are manufactured and upgraded with mixed FRPs containing unique combinations of CFRP and GFRP panels. The beams are loaded in different sizes before retrofitting to investigate the effect of the initial load on the modified shaft's bending conductivity. The critical thing to look at the variants is the joining sequence of FRP hybrid layers and the preload sizes. Under loading conditions, the beams are upgraded with two or three layers of hybrid FRP; then, the load increases until the rays fail. The test results concluded that the effects of reinforcement of hybrid FRPs on the flexibility and stiffness of the RC beams depend on FRP layers' arrangement.

III. MATERIALS USED

The specifications and the properties of materials used for casting and strengthening of specimens are:

In the assay, Ordinary Portland Cement (OPC) Grade 53 conforming to IS: 12269-1987 was used for sample casting. The properties of the cement used are shown in the table below

Table.1 Properties of Cement

Sl. No.	Properties	Test results	IS specification
1	Specific gravity	3.023	3.15-3.19
2	Standard consistency (%)	32	26-33
3	Initial setting time (minutes)	76	>30
4	Final setting time (minutes)	360	<600

Fine Aggregate

The processed sand was converted for use in the test. They are milled aggregates produced from solid cubic granite stone with ground edges and are washed and graded frequently for use in place of river sand. The properties of the rough texture

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used for appearance are displayed on the desktop.

Table 2: Properties of fine aggregate

Sl. No.	Properties	Test results
1	Specific gravity	2.74
2	Water absorption	2.47%
3	Fineness modulus	3.07
4	Grading zone	Zone II

Table 3: Properties of coarse aggregate

Sl. No.	Properties	Test results
1	Specific gravity	2.75
2	Water absorption	1.11%
3	Aggregate crushing value	29.82

Coarse mixture used are two sorts, 20mm and 12mm.The residences of coarse aggregates are given inside the table

IV. EXPERMENTAL

The beta program included three sets of packages. The packages in SET I were designed as a controlled sample (CB1, CB2), Since FRP was not implemented, the packages in SETII were designed to verify the effect of full encapsulation technology

90 ° (three-sided U shell), to reinforce the curvature provided using single layer FRP glass (SB1, SB2) and SETIII was a double layer

Wrapped Beams (SB3, SB4) all details of the reinforcement followed for the three sets of beams are given below

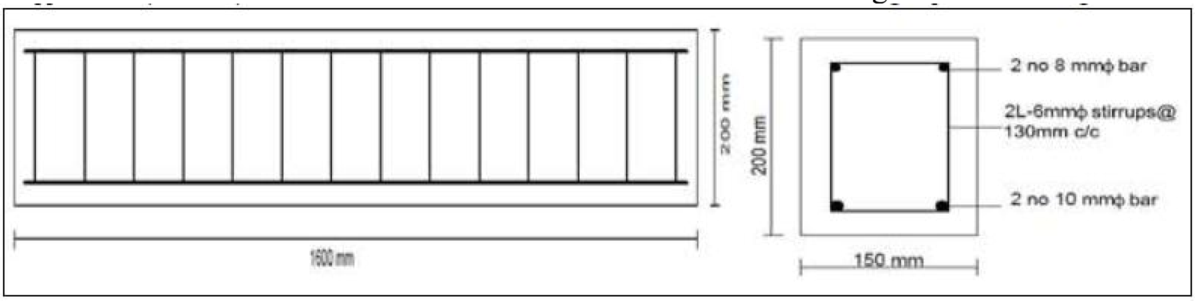

Fig.1 Detailing of Reinforcement

Beams were cast with plywood. After the molds were removed, the samples were cured for 28 days. The beams were arranged by milling three side surfaces; This was done to strengthen the three aspects of the package that an FRP program could achieve. After polishing, the three faces of the beams were cleaned to remove any remaining dust. In the same way, the peripheral zone was organized for the columns. According to the manufacturer's manual, the ratio of resin and hardener mixture, Araldite AW106-100 elements by weight and Hardener HV953-80 elements by weight was also noted. The epoxy resin was applied to the concrete surface, and on the fiberboard, which was cut to the preferred size, the fiber sheet was wrapped under the beams' neutral axis. Fiberglass sheets were wrapped in samples. Air bubbles trapped at the interface have also been removed. All reinforced concrete beams were treated for 24 hours at room temperature before the beams were tested.

Fig. 2: Casting of Beams

Fig.3 Casted Beams

Fig. 4: Applying Glass Fiber Sheet on Beams

RESULTS AND DISCUSSIONS

The average wear potential rate of the closing load of the beam preparation is described along with the nature of the failure and the table's deviations.

Table.4 Summary of Results

Group designation	Failure of FRP	Deflection at mid span (mm)	Ultimate load(KN)	Strengthening effect (%)
SET I	-	18.25	54	-
SETII	Yes	26.18	79.5	48%
SETIII	Yes	28.65	86	60%

A. Load vs. Deflection

Deflection variation with load is faster for drive beam compared to single and double layer coiled samples. The gradual release of deflection under load is for double-layer wrapped packages compared to single-layer coiled samples. As for the positive charge cost, the deviation is more for sample handling observed by single-layer sample and double layer pattern..

B. Ultimate Load Carrying Capacity

Reinforced beams have better bearing capacity than drive girders. Control beam, single layer FRP coiled beam, double layer FRP coiled beam has a maximum load-bearing capacity of 54KN, seventy-nine, 5KN, 86KN.

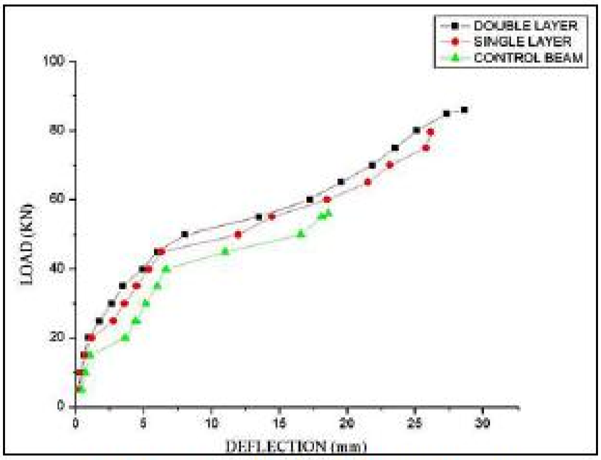

Fig.5 Comparison of Load vs. Deflection of Samples

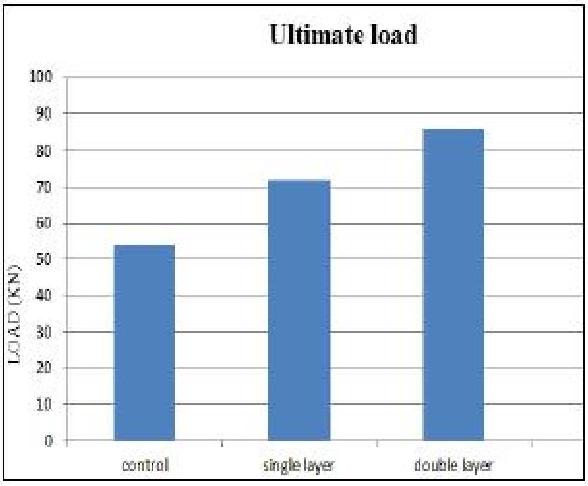

Fig. Ultimate Load

V. CONCLUSION

The single layer glass fiber wrapped beams can carry 48% extra load than the control beams

- The double layer glass fiber wrapped beams can carry 60% extra load than control beams
- The deflection of single layer glass fiber wrapped beams at a certain load is lesser than that of control beams
- The deflection of double layer glass fiber wrapped beams at a certain load is lesser than that of single layer glass fiber wrapped beams
- FRP debonding, failure by FRP rupture are the important mode of failures of FRP
- There remains substantial reserve capacity of beam even after the yielding of steel

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