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# A Review Paper on Experimental Study on Retrofitting of Beam With CFRP

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***Abstract:*** ***Existing structures must be modified, repaired, restored, or rebuilt in today's society due to a variety of circumstances, including the loss of the bond between the beam and column joint, corrosion-related damage, natural disasters, etc. These elements cause our buildings to break, rendering them useless.***
***Consequently, these structures need to be modified. The experimental study on RC beams with one-way and two-way CFRP plates is presented in this publication. This study's primary goal is to examine how RC beams behave after being retrofitted with CFRP plates.***
***Keywords: Retrofitting, Crack Pattern, Deflection, RC Beams, CFRP plates.***

## I. INTRODUCTION

Ageing structures and a higher standard for newly constructed buildings caused an urgent demand for retrofits in older buildings.
In addition to being necessary for construction and administration in urban areas, renovation of structures like buildings—which includes rehabilitating, maintaining, and reinforcing the structure—also presents a challenge for civil engineers working in the real estate management sector.
Retrofitting is the practise of altering already-existing structures, such as buildings, bridges, and monuments, to increase their resilience to earthquakes and other natural catastrophes.
Plastic that has been strengthened with fibres is known as fibre reinforced plastic (FRP). Usually, glass, carbon, aramid, or basalt fibres are used.
Rarely were other fibres like paper, wood, boron, or asbestos used.

Types of FRP
1) Carbon Fiber Reinforced Polymers (CFRP)
2) Glass Fiber Reinforced Polymers (GFRP)
3) Aramid Fiber Reinforced Polymers (AFRP)
4) Basalt Fiber Reinforced Polymers (BFRP)

CFRP, or carbon fibre reinforced polymer, is the abbreviation for this substance. A material known as CFRP is made up of two additional reinforcing elements, carbon fibre that is embedded in the matrix, as well as a base or carrier substance that is also known as a matrix. The matrix material of choice is typically synthetic resin.
Fibreglass Reinforced Polymer - In general, silica sand, limestone, folic acid, and other inconsequential ingredients are mixed to create fibreglass. At about 1260°C, the mixture is heated to the point of melting.
Aramid fibres are used to strengthen polymers; the full name of the material is aromatic polyamide. Depending on quality, fibres have final elongations of 1.5–5% and moduli ranging from 70–200 GPa. Due to its high breaking energy, aramid is utilised to make bulletproof garments and helmets.
Basalt fibre reinforced polymer rods are a new kind of raw material reinforced alternative material that have the benefits of corrosion resistance, high strength, light weight, and strong dielectric characteristics.
Where other materials have reached their limits, CFRP is typically used. The low weight and durability of CFRP are particularly significant; it is up to five times lighter than steel and weighs only approximately 60% as much as aluminium.

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## II. LITERATURE REVIEW

1) And Obaidat, Y.T., Heyden, S., Dahlblom, O., Abu-Farsakh.: "Retrofitting of reinforced concrete beams using composite laminates". Submitted in Construction & Building Materials, 2010. Abstract: This paper presents the results of an experimental study investigating the shear or flexural behavior of structurally damaged reinforced concrete beams with CFRP laminates in full scale. The main variables considered were the internal reinforcement ratio, the position of the retrofitting and the length of the CFRP. Experimental results generally indicate that beams modified in shear and flexure with CFRP laminates are structurally efficient and are restored to stiffness and strength values nearly equal to or higher than the control beams. It was found that the flexural effectiveness of the CFRP strengthening technique varied with length. The main mode of failure in the experimental works was the boning of the sheet metal in the retrofitted beams.
2) N.F. Grace, G.A. Sayed, A.K. Soliman and K.R. Saleh: "Strengthening Reinforced Beam Using Fiber Reinforced Polymer (FRP) Laminates" ACI Structural journal/ September- 1999. Summary: This paper present in different types of fiber reinforced polymer laminates is tested with 14 simply supported cross-section beams. Each beam was reinforced with FRP laminates that were initially loaded above their cracking load and tested to failure. Carbon/Glass Fiber Reinforced Polymer (CFRP/GFRP) strengthening materials were used for the external connection to the beams. Different layers of frp sheet, types of epoxies and reinforcement pattern are investigated and to calculate absorbed energy to total energy, or energy ratio. A proper combination of vertical and horizontal plates is provided; the right epoxy can double the maximum beam load. In conclusion, it can be said that the behavior of beam reinforcement shows a higher factor of safety in design.
3) Tarek H. Almusallam and Yousef A. Al-Salloum."Retrofitting of RC Beam-Column Joints Using FRP Laminates":2007 presented a procedure for analytical prediction of bond shear strength of internal beam-column joints reinforced with externally bonded fiber-reinforced polymer plates. A program was developed to implement the available shear capacity prediction formulation. Using this program, the shear capacity of the joint and the variation of the shear stress of the joint at different stages of loading were predicted and compared with experimental observations. It has been observed that even a small amount of FRP can significantly increase the shear capacity of a joint.
4) Ramakrishnan. V. "Strengthening of Rc beam using BFRP" 2003 Summary: Investigated and found basalt fiber can be used in concrete. After research, basalt fiber was used in concrete for the first time in the world. And they also find that beams reinforced with plain basalt bars failed in flexure due to insufficient bond between steel and concrete. All the actual ultimate moments were much smaller than the calculated steel pullout ultimate failure moments. The fiber beam showed primary flexural and shear failure followed by secondary splitting failure and also tensile, micro-crack resisted bond between all modified basalt reinforcement and concrete was extremely good. Best moment compared to normal concrete. In general, basalt fibers are suitable for use in reinforced concrete profiles.
5) Priti A. Patel, Ph.D. Atul K. Desai and Dr. Jatin A. Desai, "Evaluation of Engineering Properties of Polypropylene Fiber Reinforced Concrete", 2012 Studied the properties of polypropylene fiber reinforced concrete. From experimental studies, properties such as compressive strength, bending strength, tensile strength, etc
6) Pmeikandaan, Ramachandra Murthy (2017) conducted an investigation is based on flexural behavior of RC beam wrapped with GFRP sheets, an experimental study is carried out by externally bonded GFRP sheets to the RC beam and to tested under the two-point static loading system. For this they prepared six reinforced concrete beams, noted that all six beams are weak in flexural and having same reinforcement detailing. They separated three beams are used as control beams and other three are strengthened using GFRP in tension zone, by the experimental results they concluded that the bottom of GFRP sheet wrapping in 70% preloaded beam can increase flexural capacity of the beam by 14% (on ultimate load) as compared to the control beam.
7) Praveenkumar, Chiranjeevi, Kowshiken, and Dineshmarthu. Chiran et. al. (2017) [4] has examined the possibility of using externally bonded hybrid fibre reinforced polymer (HYFRP) with combination of glass (GFRP) and carbon (CFRP)based laminates to strengthen the reinforced concrete beam (RC)against flexure. The study is on total number of five beams of cross section 150mm×250mm×3000mm long and International Journal of Scientific Research in Science, Engineering and Technology (ijsrset.com) 54 2800mm simply supported span were casted and tested under four-point bending was applied to examine the flexure strength. Out of five beams one beam is stood as reference beam and the other four were made with hybrid FRP laminates, the parameters observed spacing of stirrups, thickness of HYFRP laminates and composite ratio. The test results showed that the hybrid fibre reinforced polymer (HYFRP) strengthened RC beam exhibit increased strength and composite action until failure.

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*8)* Abhishek Sharma, Tara Sen, Joyanta Pal (2016) have conducted experimental research on Flexural Characteristics of RC Beams Retrofitted using FRP and Cement Matrix Composite. In this study flexural strength of beams retrofitted using cement matrix composite and conventional epoxy binder are compared. The matrix is made using cement, fly ash, admixtures and fibres. A total number of ten beams of cross section 100×135 mm. And overall length of 1000mm is casted. Concrete of grade M-25 and reinforcement of HYSD 500 steel bars are used. In those total beams two of the beams treated as control beams. The other eight beams are strengthened using EB technique. All the beams are reinforced with 2 bars of 8mm in the tension (bottom) zone and 2 bars in the compression (top) zone. 8mm bars are used as longitudinal bars for both compression and tension side while 6mm are used as shear stirrups. All the beams are designed as fails in flexure only. Group 1 having 2 beams strengthened with glass fibers and other 2 beams with sisal fibers using cement matrix composite. Group 2, having 2 beams strengthened with glass fibers and 2 beams with sisal fibers using sikadur lp 32 epoxy binder. Both the fibers are applied in the flexure zone in both above describe groups.

*9)* Piero Colajanni, Maurizio Papia, Nino Spinella and Antonino Recupero (2014) have done an experimental investigation on RC beams retrofitted in flexure and shear by pre tensioned steel ribbons, by three- and four-point bending test. As per this investigation the stainless steel pre stressed ribbon play role of adjunctive transversal reinforcement as well as it confine the structural element. In the present six beams of flexural deficiency and nine beams of shear deficiency were casted and tested. In the first group four beams were retrofitted with bottom stainless steel angles and transversal ribbons, with two different spacing, while in the second group three specimens were retrofitted by wrapping the beam with ribbons, and other three specimens were strengthened by perforation of the beam beneath the slab height, and by partially wrapping the beam by inserting the ribbons through the hole, and concluded that the test results obtained are prove effectiveness of the retrofitting system for both flexure and shear deficiency beams.

*10)* Kothandaraman, and Vasudevan (2010) have studied flexural retrofitting of RC beams using external bars at soffit level. An experimental study the authors proposed the external bars to be kept at the soffit level of the beam section, thus eliminating the use of deflectors, mechanical anchoring devices and making it amenable, simple and effective. Additional advantages of the present technique are the enhanced moment carrying capacity, reduced deflection and crack width and improved ductility. Existing retrofitting technique such as section enlargement, bonded steel plating, external post-tensioning strengthening with FRP composite sheets have innate demerits such as high coast, need of sophisticated instruments, increase sectional area, surface preparation. Occurrence of de-bonding failures, low benefit-cost ratio high maintenance, etc., The proposed technique of keeping reinforcement externally at soffit level has many advantages, such as simple and speedy execution, minimal disruption during installation; involve less in the self-weight and no appreciable reduction in headroom.

## III.CONCLUSION

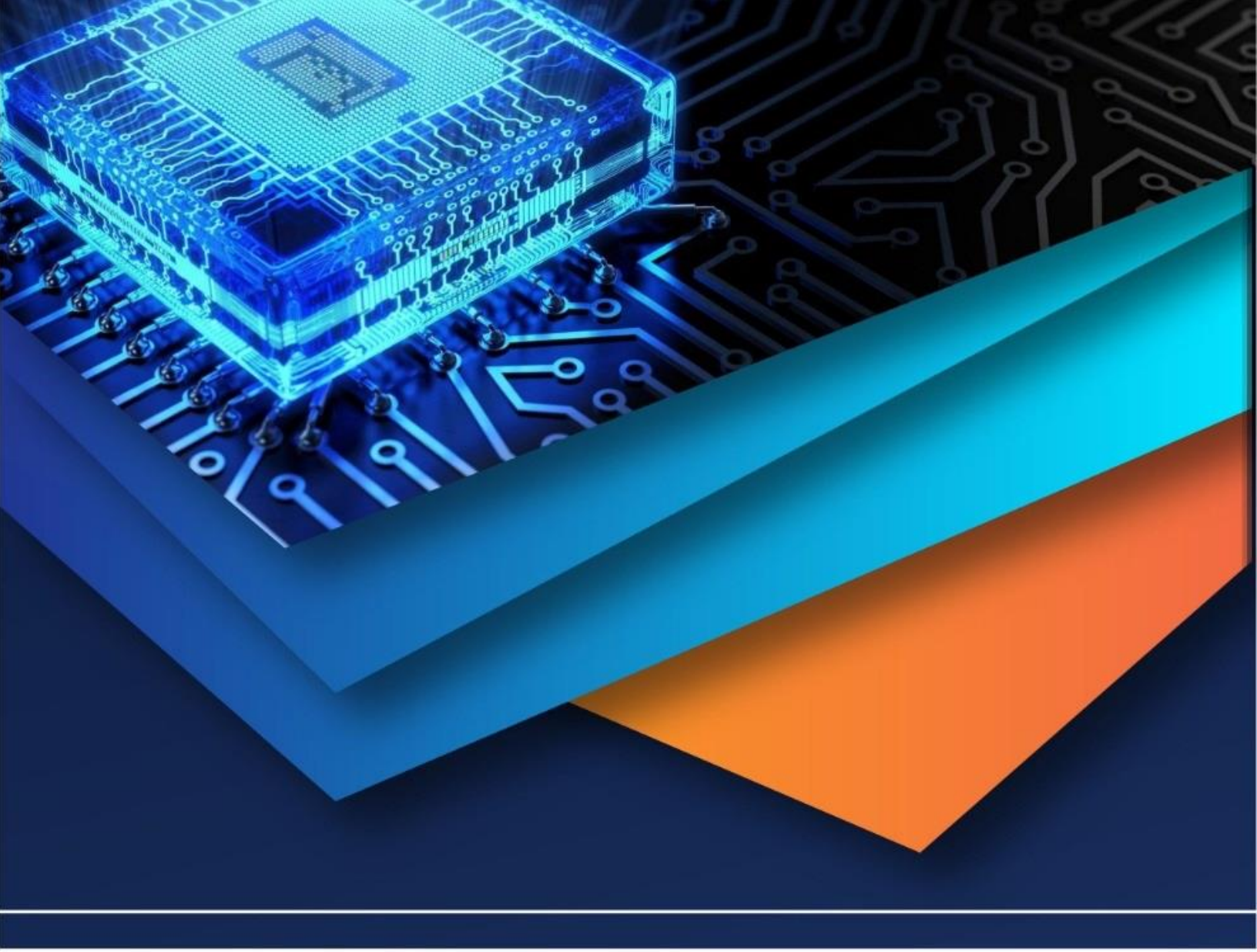
After reading these reviews, we came to the conclusion that the experimental study on retrofitting reinforced concrete beams with CFRP is based on a theoretical and experimental analysis of both control and modified reinforced concrete beams.

According to the research article, every beam that has had its major reinforcement reduced from 100% to 70% and 50% has been analysed, and the beam failure process has also been noted. From the current study, the following results are drawn.

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