REVIEW PAPER ON EXPERIMENTAL INVESTIGATION NOF CRPF CONFINED PRE-LOADED COLUMN

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# ABSTRACT

# Column repair is a critical aspect of structural rehabilitation in buildings and infrastructure. Traditional repair methods often involve the use of conventional materials such as steel plates or concrete jackets, which can be labor-intensive and time-consuming. In recent years, fibre reinforced polymer (FRP) sheets have emerged as a promising alternative for column repair due to their excellent mechanical properties and ease of installation.

# INTRODUCTION

Fiber Reinforced Polymer (FRP) Composites are defined as “A matrix of polymeric material that is reinforced by fibers or other reinforcing material”. Polyester, vinyl ester, or epoxy may be used as the matrix. It comes ina range of shapes and sizes, including random chopped strands, weaved roving, and continuous roving. Hybrids can also be developed and used to suit various environments.Civil engineers have been urged to look at measures to improve and upgrade existing civil engineering infrastructure to accommodate changes in use and general deterioration. The creation of FRP composites for these purposes was prompted by years of searching and studying for a new solution for developing a new strengthening technique. FRP Intermediate length fiber reinforcement is the longer the fibers, the more difficult it is to coat the fibers enough to reap strength benefits, and low viscosity thermosets “wet-out” the materials better than high viscosity thermoplastics They are very long fibers or continuous fibers. They are typically used with thermosets, also for “wet-out” reasons, and are used generally in advanced composite parts and have greater material property requirements. Generally, use epoxy resin reinforcement and there are main types of fibers are fiberglass, carbon fiber or graphite organic fibers, and aramids.

# LITERATURES

 **Gao Ma et.al (2021)** have presented an experimental investigation of the size and slenderness effect on the axial-compressive behavior of basalt fiber-reinforced polymer. In this research five groups of concrete cylinders with different sizes and slenderness ratios were designed and tested. The cylinders were axially preloaded to three pre-damage levels, then repaired using BFRP, and reloaded. The test results concluded that the ultimate strength of BFRP-confined concrete decreased with an increase in size and slenderness ratio, and the size and slenderness effect decreased with an increase in BFRP confining pressure, while these increased with the severity of concrete pre-damage.

 **Vui Van Cao (2020)**, In this paper, an investigation of preload effects on the behavior of FRP confined concrete is presented. In this study, three specimens of diameter 150 mm and height 300 mm were used to test the compressive strength of concrete to compute the preload 20%, 30%, and 40% of the average strength of these specimens. All specimens were tested under axial compression to failure. FRP-wrapped specimens have been found to be prone to explosive failure. From this, we infer that when the concrete cylinder is subjected to preloads 20%, 30%, and 40% and wrapped by 2 and 3 FRP layers it decreases 12-13% the elastic and second stiffness of concrete specimens wrapped by 2 FRP layers. The stiffness loss can be reduced by increasing the number of FRP layers. In this study, the mechanism of preload effects is explained. Finally, to account for preload effects, a modification of the widely used un-preload FRP confined concrete model is given, and the modified model is explained accurately.

 **I.A. Tijani, A.M et.al (2020**), In this paper, they investigated how the mechanical response of FRP-Confined pre-damaged concrete under compression is affected by load eccentricity. 72 short concrete cylinders with a wide range of damage severity and load eccentricity, but identical FRP confinement stiffness, were subjected to eccentric compression tests in this study. We infer from the study the mechanical response of CFRP-confined pre-damaged concrete with load eccentricity. They have established a new model which is capable of predicting the mechanical response of the eccentrically loaded FRP-confined pre-damaged concrete specimens. The proposed model included damage degree and load eccentricity, and it is theoretically reasonable. Although the global structural response of FR Pconfined pre-damaged concrete has a softened stiffness with increasing load eccentricity, the stress-strain relationship for cross-sectional analysis does demonstrate a hardening effect due to load eccentricity, according to the analysis.

**Gao Ma et.al (2020),** In this paper, the authors intended to study the Monotonic and Cyclic Axial Compressive Properties of Basalt FRP-Retrofitted pre-damaged short columns. In this study, cylinder specimens were pre-damaged under three axial compressive loading levels corresponding to peak strength, 10%, and 20% and were retrofitted with 2- and 4- layer BFRP. From this study, we infer that BFRP can enhance the compressive strength and deformation capacities of pre-damaged concrete, even though the cracks were not repaired by epoxy injection. Pre-damage had no effect on the ultimate strain and lateral strain of FRP-retrofitted concrete, but more research is needed to determine its effect on the lateral strain of BFPR retrofitted concrete. Based on the test results, a modified strength model, an ultimate strain model, and a monotonic compressive stress–strain model were developed for BFRP-retrofitted concrete.

**Xiaojie Lao et.al (2019),** In this paper, the authors have carried out research on the effectiveness of repairing pre- damaged square RC columns with externally wrapped CFRP sheets. In this study, pre- damage levels and quantities of internal transverse stirrups and externally wrapped CFRP sheets were taken as test variables. 27 square RC columns were they have fabricated 27 square RC columns and they were concentrically stressed to five specified axial deformation levels. They have reloaded the damaged RC columns up to failure under monotonic or cyclic loads after being repaired with CFRP sheets. Although the damage had unfavorable impacts on the initial elastic modulus, ultimate strength, and ultimate strain of CRDSCC, the test results show that external CFRP wrapping is highly effective for enhancing/restoring the strength and strain capacity of pre-damaged steel-confined concrete. A stressstrain model for CRDSCC was also developed, and it is concluded that the strong match between prediction and test results demonstrated that the proposed model may accurately represent the effect of pre-damage on CRDSCC behavior.

**M. F. Ferrotto et.al (2018),** In this paper, the authors have conducted research on the analysis of a stress-strain model of CFRP confined circular concrete columns with applied preload. In this research, they have taken the preloading stress levels as Lower preloading stress levels: 40–55%, Medium preloading stress levels: 60–70% High preloading stress levels: 80–90% of the unconfined concrete. They have taken specimens of diameter equal to 150 mm and height of 600 mm. In this research, the compressive tests were separated into two phases: a first phase in which the specimens were preloaded to a fixed stress/load level, and a second phase in which the preloaded specimens were wrapped before the collapse tests after the composite jackets had ripened. They have shown that overall comparisons of the results obtained from normal monotonic compressive testing and preloading tests revealed a comparable outcome for all of the specimens evaluated.

 **Peng Gaoa et.al (2018),** In this paper, the authors have studied the effect of pre-damage on the compression performance of CFRP-confined rectangular steelreinforced concrete columns. In this paper, they have tested 13 large scale CFRP confined SRC columns. The pre-damage level and the number of CFRP layers were the main variables All of the confined columns collapsed due to CFRP laminates rupturing following the peak load. With increasing pre-damage level, both the working strain of CFRP and the peak load of columns are reduced. They have also presented a new finite element numerical model for the nonlinear analysis of confined columns. From the research they have inferred that even all confined SRC columns failed with the rupture of CFRP after the peak load, the confined columns showed good performance in improving ductility and capacity.

**Yi Pan et.al (2017),** In this paper, the authors have conducted a study on the stress-strain relation of concrete confined by CFRP under preload. In this study, they have presented the experimental and analytical results of 32 Concrete columns with a circular section and 16 square sections contained by CFRP sheets while being compressed axially. They have analyzed the failure modes, mechanical behaviors, and reasons for the descending of the peak stress and strain of the confined concrete in columns. The findings of their experiment revealed that the preload ratio had an effect on the effectiveness of CFRP confinements. The final stress and strain both dropped as the preload ratio was increased, and the negative effect will be increased by the addition of CFRP piles. This paper also concluded formulas about the second stiffness, lateral expansion coefficient, and peak under a specific preload ratio, and the concrete columns contained by CFRP experience stress and strain. A new designoriented stress-strain model for the circular and square concrete column restrained by CFRP sheets under preload was developed on the basis of these inferred formulas.

 **Hongyi Li et.al (2017**), In this paper, the researchers intended to establish an analysis-oriented stress-strain model for FRP-confined concrete in circular-section or square-section with preload. This paper has provided the detail of the experimental results of 42 concrete columns confined with carbon fiber reinforced polymer (CFRP) with Afterward, based on the test results and a new failure surface theory for FRP confined concrete that took into account the influence of preload was developed in this study..They have concluded in their study that the preload reduces peak-stress and peak-strain in FRP-confined concrete, and the decreased amount tends to rise as the preload ratio is increased. The main cause of this occurrence is a micro crack in the concrete and tensile strain lag in FRP sheets.

**Mehdi M. Lima et.al (2016),** In this paper, the researchers have studied the effects of CFRP orientation on the strengthening of reinforced concrete structures. They have focused on the ultimate failure loads as they have taken different CFRP orientations to the loading directions. Two RC beams, two columns, two slabs, and six walls were tested in the lab to confirm the finite element analysis presented in this work. The FRP orientation clearly has a significant impact on the ultimate failure load of FRP-strengthened RC elements. In a reinforced beam, column, or slab, the CFRP sheet orientation is perpendicular to the loading direction, and it contributed to load carrying by extending through its major direction. The stress direction and CFRP fiber orientation are, however, parallel in RC wall panels.

 **Rui Guo et.al (2017),** In this paper the researchers intended to establish an analysis-oriented stress-strain model for FRP-confined concrete in circular-section or square-section with preload. This paper has provided the detail of the experimental results of 42 concrete columns confined with carbon fiber reinforced polymer (CFRP) with This work first proposed a new failure surface theory for FRP-confined concrete taking into account the influence of preload based on the test findings. They have concluded in their study that the preload reduces peak-stress and peak-strain in FRPconfined concrete, and the decreased amount tends to rise as the preload ratio is increased. The main cause of this occurrence is a micro crack in the concrete and tensile strain lag in FRP sheets. The analysis-oriented model suggested in this study was shown to have enough accuracy to predict the peak-stress, peak-strain, and skeleton curves of the FRP-confined concrete under preload when compared to experimental and finite element simulation findings.

 **M.C. Sathwik et.al (2019),** In this paper the author has studied the compressive behavior of CFRP wrapped cylindrical concrete specimens subjected to different preloading conditions. In this study, concrete specimens were subjected to uniaxial compression before wrapping CFRP sheets and after that CFRP sheets were wrapped and their effects on the pre- damaged concrete specimens were investigated. They have compared their experimental results with the numerical results obtained using ABAQUS software. Two different pre- loading conditions i.e. 50% and 70% were taken in this investigation. It has been concluded that the specimens wrapped with a single layer of CFRP have an average of 55% increase in strength compared to unwrapped specimens. The specimens wrapped with a single CFRP have an average of 80% increase in axial deformation compared to unwrapped specimens. Hence, it is concluded that CFRP strengthening improves the ductility of concrete. Their experimental results were in good agreement with the numerical results obtained in ABAQUS software**.**

**Ataur Rahman et.al (2018)**, In this paper the authors have experimentally investigated the behavior of FRP Confined Concrete Cylinder Wrapped by Two Different FRPs. For their investigation, they have chosen two fibers such as synthetic high strength CFRP composites and composites using natural fiber like Jute. Twentysix small scale cylindrical concrete specimens (100mm diameter & 200 mm height) were subjected to uniaxial compression up to failure and the accompanying stressstrain behaviors were recorded in this experimental research. They have shown that when concrete is wrapped with JUTE-FRP both strength and ductility are improved. Four different types of mix ratios were used in this research. They have concluded that when the column has a circular portion, CFRP appears to be fairly useful for external wrapping to strengthen the column. Their results show that CFRP increases the strength and durability of high strength concrete whereas Jute-FRP does not increase the strength and durability of high strength concrete. But Jute-FRP increases the strength and durability of low strength concrete.

**Rami Eid et.al. (2016),** In this paper the authors have conducted experimental investigation on compressive behavior of FRP-confined reinforced concrete columns. In this investigation, they have presented a unified stress-strain model to represent the axial behavior of circular and square/rectangular Axially constrained reinforced concrete columns with TSR, externally with FRP, or both internally and externally with TSR and FRP, respectively. Six FRP/TSR-constrained square reinforced-concrete columns were tested under compressive axial loads. The test programme described in this research work comprises of six reinforced NSC square specimens (150x150x300 mm) subjected to axial compressive loads. It has been concluded that in that model, the behavior of the effective confinement index (a) is related to confined concrete, which considers the concrete's mechanical and geometrical qualities, and transverse steel reinforcement and FRP.

 **Daiyu Wang et.al ( 2016),** In this paper the researchers have studied seismic performance of CFRP-confined circular high-strength concrete columns with high axial compression ratio. In this experiment, A total of eleven 1/2 scale columns were built, with nine of them encased in CFRP wraps at probable plastic hinge points. All columns were subjected to a cyclic lateral displacement excursion and a high axial compression load. The axial compression stress level, concrete strength, and the extent of the CFRP wrapping at the plastic hinge region were the main variables in the testing. Three of the confined specimens were first tested for residual seismic capacity of CFRP-constrained columns and after that, the load was withdrawn, and the same columns were loaded to failure. Their test results showed that CFRP wraps applied at potential hinge regions resulted in significantly improved ductility and energy dissipation capacities of the columns even when tested under a high axial compression ratio.

**3 METHODOLOGY**

Preliminary tests for materials were done as per IS codes. Next, the mix design was done for M25 grade concrete using the properties of materials obtained in the testing of materials and columns of size 150mm diameter and 800mm height are to be casted and tested for 7 days and 28 days. Next specimens are preloaded to different levels. Next CFRP is wrapped .





**REFERENCE**

* + Gao Ma, Xiaohuang Chen, Erkan Biçici and Chunxu Hou “Effect of Size andSlenderness on page 25 of the June 2021 publication of the Journal of Composites for Construction, "Axial-Compressive Behavior of Basalt FRP- Confined Predamaged Concrete"
	+ Vui Van Cao “Preload effects on behaviour of FRP confined concrete: Experiment, mechanism and modified model” Advances in concrete construction, Volume 9, May2020
	+ I.A. Tijani, A.M. ASCE, Cheng Jiang, C. W. Lim, F. ASCE and Yu-Fei Wu, M. ASCE “Effect of Load Eccentricity on the Mechanical Response of FRP- Confined Predamaged Concrete under Compression” Journal of composite for construction, August 2020
	+ Gao Ma, Xiaohuang Chen, Libo Yan and Hyeon-Jong Hwang “Monotonic and CyclicAxial Journal of Composite for Construction, April 2020, "Compressive
	+ Properties and Modeling of Basalt FRP-Retrofitted Predamaged Short Columns"
	+ Xiaojie Lao, Xiaolei Han, Jing Ji and Binbin Chen “The compression behavior of CFRP-repaired damaged square RC columns” Construction and building materials, July 2019
	+ M. F. Ferrotto, O. Fischer, L. Cavaleri “Analysis-oriented stress–strain model of CRFP-confined circular concrete columns with applied preload” Materials and

Structures, February 2018

* + Peng Gaoa, Jian Wanga, Zhongyuan Lib, Li Honga, Zhiliang Wang “Effects of predamage Engineering Structures, February 2018 "on the compression performance of CFRP-confined rectangular steel reinforced concrete columns"
	+ Marco Filippo Ferrotto, Oliver Fischer, Roland Niedermeier “Experimental investigation on the compressive behavior of carbon fibre reinforced polymer- confined concrete columns with short-term preloading International Journal of Structural Concrete, April 2017
	+ Yi Pan , Guo Rui, Hongyi Li , Hongyuan Tang , Long Xu “Study on stress-strain relation of concrete confined by CFRP under Preload” Engineering Structures, April2017
	+ Yi Pan, Rui Guo, Hongyi Li, Hongyuan Tang, Jingxiang Huan “Analysis-oriented stress–strain model for FRP–confined concrete with preload” Composite Structures, January 2017
	+ M.C. Sathwik, M.H. Prashanth, Sneha C. Naik, Aakash Satish “Experimental and numerical studies on compressive behaviour of CFRP Materials Today: Proceedings, November 2019. "wrapped cylindrical concrete specimens subjected to various pre-loading conditions."
	+ Ataur Rahman, Madhobi Mallick, Shantanu Ghosh “Experimental Behavior of FRP Confined Concrete Cylinder Wrapped by Two Different FRPs” Journal of Materials Science, Volume 7, 2018.
	+ Rami Eid, Patrick Paultre “Compressive behavior of FRP-confined reinforced concrete columns” Engineering Structures, November 2016
	+ Daiyu Wang, Zhenyu Wang, Scott T. Smith, Tao Yu “Seismic performance of CFRP- confined circular high-strength concrete columns with high axial compression ratio”Construction and Building Materials, December 2016
	+ Saleel Visal, Swapnil U. Deokar “A Review Paper on Properties of Carbon Fiber Reinforced Polymers” International Journal for Innovative Research in Science & Technology, Volume 2, May 2016.
	+ Imad Shakir Abbood, Sief aldeen Odaa, Kamalaldin F. Hasan c, Mohammed A. Jasim“Properties evaluation of fiber reinforced polymers and their constituent materials used in structures – A review” Materials Today: Proceedings, July 2020.
	+ Mehdi M. Lima, Jeung-Hwan Doh, Muhammad N. S. Hadi, Dane Miller “The effects of CFRP orientation on the strengthening of reinforced concrete structures” Struct. Design Tall Spec. Build., February 2016.
	+ Lin, G., and J. G. Teng “Stress-strain model for FRP-confined concrete in eccentrically loaded circular columns.” Journal of Composite Construction, 2019.
	+ Pengda Li, Lili Sui, Feng Xing, Mali Li, Yingwu Zhou, Yu-Fei Wu “Stress–Strain Relation of FRP-Confined Predamaged Concrete Prisms with Square Sections of Different Corner Radii Subjected to Monotonic Axial Compression” Journal ofComposite Construction, 2019.