International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

Strengthening of Concrete Structure Repair by Polypropylene and CFRP Sheet with Different Configuration

Chirag N Patel[1], Monika S Patel[2]

[1]*Post graduate student in Structural Engineering, Sankalchand Patel University, Visnagar*
[2]*Assistant Professor in Structural Engineering, Sankalchand Patel University, Visnagar*

Abstract - *Over the past decades, much research has been carried out on shear and axial strengthening of reinforced concrete structure using different types of FRP. Such a methods of strengthening of old structures by the help of new technology termed as "Retrofitting".*

In retrofitting and the earthquake resistance structure satisfy with structural application of synthetic fibre reinforced concrete (FRC). Looking, the strengthening of existing damaged or undamaged concrete structure like beam, column, slab etc. an attempt has been made through the study of older or damaged structure. Strength, durability and various characteristics. Researchers conducted so far are focused on the behaviour of FRP strengthened RC column externally confined with FRP composites. Experiment study of the present work is deal with of FRP for this investigation the various test specimens of casting concrete fibre polymer cube. All the specimens are tested and studied in experimentally and theoretically. These performance requirements, strengthening of structure are performed to improve performance that is directly related to mechanical characteristics. Also found its applications in increasing the strength of concrete structure as well as strengthening of Older or Damaged structure.

The experimental investigation was carried out to evaluate the feasibility use of CFRP composite strips in strengthening of RC column made with fibre reinforced concrete. The results obtained from experimental tests conducted on hardened concrete for normal and polypropylene fiber concrete with varying fiber dosages of 0%, 0.75% and 1%. The maximum percentage increase in compressive strength was achieved at 0.75% of fiber dosage and was found to reduce for 1% of fiber content. After test results synthetic Polypropylene fibre was used in the rate of 0.75% in the volume of concrete. CFRP strips were used to confine the column and the experimental parameters were effective spacing between CFRP strips (top, middle and bottom) and the number of CFRP layers (one and two layer). The column strengthened with CFRP strips enhancement in axial deformation control and ultimate strength, respectively, compared to that of normal column. From the test results obtained, strengthening of RC column made with FRC, the column confined with the one layers of different spacing provides an economical advantage compared to that of two layers.

Key Words: Reinforced concrete column, Carbon fibre reinforced polymer (CFRP), Polypropylene, Compressive Strength, Strengthening.

1. INTRODUCTION

An increasing number of structure have reached the end of their service life due to deterioration caused by natural calamities such as earthquakes, environment factors or due to increase in applied loads, which are also the reasons for failure of structural members. Rehabilitation and strengthening of old structures using advanced materials is a contemporary research in the field of Structural Engineering. During the past two decades, much research has been carried out on axial, shear and flexural strengthening of reinforced concrete column and beams using different types of fiber reinforced polymers and adhesives. Strengthening of old structures is necessary to obtain an expected life span.

Two kinds of fibres such as steel fibre and polypropylene fibre are used in the construction industry. The superior properties of polymer composite materials like high corrosion resistance, high strength, high stiffness, excellent fatigue performance and good resistance to chemical attack etc., has motivated the researchers and practicing engineers to use the polymer composites in the field of concrete structures. FRP has widely used in different structural and nonstructural applications, including column structures, tunnels, slabs, bridge piers, and where the FRP has good tensile, compressive and bending strength concern. Those mechanical properties are shown below table.

In addition the research outcomes revealed that the bonding of linear steel jackets were ineffective in providing confinement pressure. In contrast, use of fibre reinforced polymer (FRP) composites for rehabilitation does not have any of these drawbacks and, moreover, can enable the upgrading of deteriorated members without significantly altering the appearance of the members. In addition, FRP composites are lightweight, durable, and resistant to corrosion and have high tensile strength, stiffness, and fatigue strength. Over the past several decades, extensive researches have been conducted on retrofitting/strengthening of RC structures using various FRP composites. The experimental studies so far are concerned with the behavior of conventional RC column confined with various types of FRP composites and the results of the FRP composites can be used to enhance the strength and stiffness of the structures. However, over the past few decades, the fabrication of structural components using FRC has become widespread. The influence of FRP composites in strengthening of RC column fabricated using fibre reinforced concrete (FRC). Therefore, studies are

needed to address the behavior of FRP strengthened RC column made with FRC. The experimental parameters was carried out to use of CFRP composite strips in strengthening of RC column fabricated using FRC. Polypropylene (PP) fibre was added in concrete in the range of 0.75% in volume of concrete, which was obtained from the test results. Here is experiment strength obtained when Polypropylene (PP) fibres mixed with concrete as well as using of the CFRP wrapping with totally, four rectangular concrete columns. Among the four columns, were externally strengthened by CFRP composite strips having a constant width of 500mm with different parameters, CFRP strips were used to confine the column and the experimental parameters were effective spacing between CFRP strips (top, middle and bottom) and the number of CFRP layers (one and two layer). All the columns were tested under axial compression until failure. The failure modes of the strengthened FRC columns were discussed in a detailed manner.

1.1 Experiment Specimen

Preparation of M30 Mix with coarse aggregate and fine aggregate and suitable proportion of cement and water. Preparation of concrete with different percentage (0%, 0.75%, 1%) of polypropylene fibre to added in concrete mix. However, concrete cube sizes 150 × 150 × 150mm, are casted to conduct test for compressive strength of mixes. A test for compressive strength was performed to determine the 7 and 28 days.

2. LITERATURE REVIEW

1.1 Review of selected Literature

1) **Yaman S. S. Al-Kamaki and Riadh Al-Mahaidi** - In general, concrete structures have high fire-resistance. When exposed to fire, however, the strength and stiffness of the concrete and reinforcing steel deteriorate significantly. Fibre-reinforced polymer (FRP) wraps are an excellent material for strengthening concrete to increase its axial load capacity. This paper describes an experimental study on fourteen concrete cylinders after exposure to 500oC for one hour and cooling to room temperature which were then wrapped and tested under axial compression to failure to determine the ultimate axial strength. The purpose of the study was to extend the Carbon fiber reinforced polymer (CFRP) confinement technique to investigate the residual concrete strength of post-heated RC cylinders strengthened/confined with CFRP fabrics. The experimental parameters included type of reinforcement and number of CFRP fabric layers. It was found that repairing heat-damaged cylinders with 1, 2 and 3 layers of unidirectional CFRP can be highly effective for enhancing the compressive strength of concrete damaged by high temperature. The residual concrete strength of post-heated cylinders can be restored to the original level or higher than that of unwrapped cylinders. The failure mode of the confined concrete was predominantly ruptured of the CFRP sheets.

2) **Mohd Irfan, Dr. Abhay Sharma and Dr. Vivek G arg** - Generally the people construct the structure to fulfill their current needs but with the passage of time they realize that their demands have increased and there is a need for the addition/alteration of the current structure. This demand can be fulfilled by constructing a new storey. However, provision for additional load due to the new construction over existing structure was not made in the structural design of the old structure. Therefore, the construction of new storey requires the strengthening of the old structure. The present study investigates the structural behavior of an RC frame under the additional load in the form of a new storey. The analysis of existing structure (two storey) and proposed structure (one additional storey constructed over existing two storey structure) is performed by using structural analysis software i.e. STAAD Pro. The analysis results of existing and proposed structure are compared to evaluate the increase in structural forces due to the construction of a new storey. The results indicates that the significant increase is found in the axial force and bending moment in columns. The weak and deficient columns are identified and strengthened for the additional loads and additional moments. The strengthening of columns is done by jacketing of the columns using four steel angles at corners, confined with the help of batten plates placed at equal spacing along the length of the column.

3) **Pragasit Juntanalikit a, Tidarut Jirawattanasomkul b, Amorn Pimanmas** - This paper presents an effective method for strengthening non-ductile reinforced concrete columns by applying an externally bonded Carbon Fiber Reinforced Polymer (CFRP) fabrics to enhance the shear capacity and confinement. Six rectangular reinforced concrete columns designed for gravity load only were tested under quasi-static cyclic loading. Three columns were provided with short lap-splice length of longitudinal reinforcements at the plastic hinge location to study the effect of lap splice. The experimental results indicate that, by means of CFRP jacketing, the shear strength under reversed cyclic loading is significantly improved as compared to the un-strengthened columns tested in the previous studies. In addition, owing to the confinement from CFRP, the columns exhibit a dramatically improved displacement capability. The nonlinear analysis of columns is also conducted by

means of nonlinear fiber section frame element. The key attribute of the nonlinear analysis is to include the effect of lap splice of longitudinal reinforcement through the lap-spring spring model formulated according to the tri-uniform bond stress model. By combining the stress-strain models of concrete, steel reinforcement, lap-splice's bond model, anchorage bond slip and nonlinear shear spring into the fiber section frame element, the numerical Results show a good agreement with experimental ones.

4) **Drishya Babu, Rajesh A.K -** Fibre – Wrapping using Fibre – Reinforced Plastic (FRP) shells is one of effective methods, significantly enhances the strength and ductility of concrete columns. The analysis is based on the behavior of the GFRP wrapped concrete columns under uniaxial compression. The compressive strength characteristics will consider for the study. The cross section of the concrete columns will be circular with diameter of 150mm and height 300mm. The strength determination is done experimentally and the results are verified by analytical method using ANSYS Civil FEM.

5) **Tabish Rasool Sheikh, Mohd Kashif Khan and Tabish Izhar-** In this Paper, the overall review about the change in strength and the ductility behavior of Reinforced concrete square columns is discussed when strengthened with classical reinforced concrete jacketing. Although on a large scale numerous laboratory studies on strengthening of columns by RC jacketing are conducted and then reported, but there is still an apparent need for finding and executing new ways to improve the performance of classical RC jacketing. As in the case of RC structure, columns are subjected to uniform and continuous loading which increases with the increase in no. of storey and may lead to partially damage or even total failure of the column. In order to overcome the total failure of RC columns even before its service period is over an immediate attention is required in and the damaged part of reinforced concrete is repaired by classical reinforced concrete jacketing. This paper also focuses on the effect of providing dowel rebars by drilling holes, and the use of concrete jackets made with different types of concrete. And it was found that both using dowel rebars and different types of concrete increases the bond strength, overall load carrying capacity and first crack load.

6) **Yaman Sami Shareef Al-Kamaki, Gulan Bapeer Hassan and Gehan Alsofi -** This paper presents an experimental study of behavior of externally strengthened short reinforced concrete (RC) corbels by carbon fiber reinforced polymer (CFRP) fabrics. For this purpose, twelve specimens were prepared and tested. The study inspected the effect of some parameters on the structural behavior of corbels. The parameters included: the amount of internal secondary steel bars and external composite sheets configurations. The ultimate load obtained from static load resulted in up to 27% increase in the load bearing capacity through external CFRP composite reinforcement compared to control samples. The diagonal 45 CFRP reinforcement constrained widening and growth of the shear cracks, and hereafter, improved the gain in the load capacity and axial toughness. The addition of secondary reinforcement at the mid-height of the corbels produced additional strength increase. Finally, the cracking and failure pattern modes of corbels are presented.

7) **Pedram Sadeghian and Brandon Fillmore -** This paper presents the results of an experimental study on the distribution of strain on a unidirectional basalt fiber-reinforced polymer (FRP)wrapped around concrete cylinders. A total of 12 cylinders (150mmx300mm) were wrapped with 2, 4, and 6 layers of basalt FRP (BFRP) and the distribution of hoop strain underaxial compression load was studied using multiple strain gauges. The new aspect of this study is the use of BFRPs as a new construction material for wrapping concrete elements with a focus on the distribution of hoop strain towards refining design strain of the wrap. Also, the effect of number of BFRP layers on the premature upture of the wrap with respect to flat coupon test was evaluated in the form of a strain efficiency factor .It was concluded that the maximum hoop strain was not necessarily associated with the ruptured areas of the wrap. Also, an analysis of variances showed that the difference between hoop strains in the overlap and non-overlap regions was non-significant and an average hoop strain can represent the overall dilation of the specimens. The average strain efficiency factor was found ranging from 0.61 to 0.86. The test data was added to alarged at a base of concrete cylinders wrapped with unidirectional FRPs and after statistical evaluations are fined strain efficiency factor of 0.70 was proposed instead of the current factor of 0.55 in ACI 440.2R-17 for design applications.

8) **Navya H A, Dr. Nayana N Patil** - Concrete is a composite material consisting of a hard inert particulate substance known as aggregates and bonded together by cement and water. Brittleness and crack formation are weaknesses of concrete related to its durability. The present research trend in concrete technology is towards increasing the strength and durability of concrete to meet the

demands of the modern construction. Fibers are added to concrete primarily to control the propagation of cracks and limit the crack width. This paper deals with experimental investigations carried out on M25 grade of concrete reinforced with carbon fiber dosages of 0%, 0.75%, 1.00% and 1.25% by weight of concrete. The strength and durability characteristics are studied. The mechanical properties studied are compressive, split tensile and flexural strengths. The test specimens were also subjected to acid and sulphate attacks and tested for their durability. The results show that there is an increase in compressive, split tensile and flexural strengths of carbon fiber reinforced concrete. Inclusion of 1% carbon fibers showed the maximum enhancement in strength and it can be considered as optimum dosage. When compared to conventional concrete, the crack width also reduced in carbon fibre reinforced concrete.

9) **Kathu Pradeep, Ajesh. K. Kottuppillil -** To avoid disaster in future calamities, one of the methods of retrofitting the reinforced concrete building is concrete jacketing. The retrofitting is done by introducing additional stirrups and longitudinal bars to the existing building along with layer of concrete, to enhance the flexure and shear capacity. In this study, model a T-beam-column joint, and to analyze these under cyclic loading conditions. Then strengthen the same T-beam-column joint using concrete jacketing and reanalyze under the same loading conditions.

10) **S. Theerkadharshini, A. Uma Mageshwari, S. Sharutha and I. Elizabeth Ann -** The phenomenon of ageing, exposure to severe environment, effect of natural disasters, column failure etc. results in deterioration of structures. It is economically infeasible to replace the deteriorated parts of the structure, but we can retrofit them. The cube and cylinder concrete samples were taken for the experimental investigation program for analyzing the retrofitting techniques and the bonding agents. The bonding agents that were used in the test procedure are multipurpose epoxy concresive1414 and thixotropic Emacos88c. The tests that were opted on these concrete specimens are compressive and tensile strength test for the period of 7 to 28days. After analyzing the test results it is concluded that the multipurpose epoxy Concresive1414 performs better than thixotropic.

11) **J.Jenishtalouis, P.Ramshankar, R.Arun Prathap, and Sharanya Balki -** Usefulness of Polypropylene fibre reinforced concrete (PFRC) in various civil engineering applications is indisputable. Fibre reinforced concrete has so far been successfully used in construction of structures like slabs on grade, bridges, industrial structures, shotcrete, architectural panels, precast products, offshore structures, structures in seismic regions, thin and thick repairs, crash barriers, footings, hydraulic structures and many other applications. This paper presents a brief state of report on mechanical properties and durability of concrete reinforced with polypropylene fibres. Based on the trial mixes, the optimum percentage of Polypropylene fibres to be added has been identified.

3. CONCLUSIONS

The structures are affected by a lot of stress, whenever the stress exceeds the limit the structures. Reconstruction of building in a way depletes our natural recourses is not economical. Retrofitting of a structure increases the life span of it with minimum or no usage of natural recourses.
Preliminary investigation of coarse aggregate, fine aggregate, cement were conducted and the value obtained as per IS specification.
.

1. Optimum concrete mix ratio is 1:2.28:2.59
2. Optimum value of polypropylene fiber in concrete mix is obtained at 0%, 0.75% and 1% replacement.
3. With an increase in of polypropylene fiber dosages from 0%, 0.75% and 1% the workability decreases.
4. Compressive strength for M-30 grade of concrete for different dosages of Polypropylene fiber at 0%, 0.75% and 1% when compared with conventional concrete was found to increase by 30.58, 33.63, and 32.07 respectively.
5. The maximum percentage increase in compressive strength was achieved at 0.75% of fiber dosage and was found to reduce for 1% of fiber content.

4. REFERENCES

[1] Strain distribution of basalt FRP-wrapped concrete cylinders by Pedram Sadeghian *, Brandon Fillmore (2018)
[2] Experimental study of the behaviour of RC corbels strengthened with CFRP sheets by Yaman Sami Shareef Al-Kamaki*, Gulan Bapeer Hassan, Gehan Alsofi (2018)
[3] A review on Strengthening of RCC square columns with Reinforced Concrete Jacketing by Tabish Rasool Sheikh1, Mohd Kashif Khan2, Tabish Izhar3 (2018)
[4] Experimental Study on Polypropylene Fiber Reinforced Concrete by J.Jenishtalouis1, P.Ramshankar2, R.Arun Prathap3, Sharanya Balki4 (2019)
[5] Compressive strength of concrete damaged by elevated Temperature and confined by CFRP fabrics by Yaman S. S. Al-Kamaki 1,2,* and Riadh Al-Mahaidi 1 (20132016
[6] Experimental Studies On Behaviour Of Carbon Fiber

Reinforced Concrete by Navya H A, Dr. Nayana N Patil (2018)

[7] Experimental and numerical study of strengthening non ductile RC columns with and without lap splice by Carbon Fiber Reinforced Polymer (CFRP) jacketing by Pragasit Juntanalikit a, Tidarut Jirawattanasomkul b, Amorn Pimanmas a, (2015)

[8] Dynamic Behavior of Reinforced Concrete Beam Column Joint Strengthened with Concrete Jacketing by Kathu Pradeep, Ajesh. K. Kottuppillil

[9] Performance of Bonding Agents by Retrofitting in M30 Concrete by 1 S. Theerkadharshini, 2 A. Uma Mageshwari, 3 S. Sharutha, 4 I. Elizabeth Ann

[10] Strengthening Demand of Columns in A RCC Structure Due To Construction of An Additional Storey by Mohd Irfan, D r . Abhay Sharma, Dr. Vivek G arg

[11] Study of Glass Fibre Wrapped Concrete Column under Axial Compression by Drishya Babu, Rajesh A.K

[12] Bureau of Indian Standards, "Guidelines for concrete mix proportioning," IS 10262:2009, Bureau of Indian Standards, New Delhi, India, 2009.

[13] Bureau of Indian Standards, "Guidelines for concrete mix proportioning," IS 456:2000, Bureau of Indian Standards, New Delhi, India, 2000