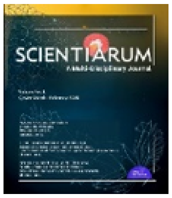

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Enhancing The Performance of Beam-Column Joint Using Artificial Fibers

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Abstract

In recent seismic events, numerous moment-resisting reinforced concrete frame buildings have experienced collapse due to shear failure at beam-column connections. Evidence from these earthquakes indicates that compromised beam-column joints significantly undermine the overall structural integrity of the buildings. The overall ductility of structures is also reduced considerably by brittle joint shear failure; As a result, dangerous failure mechanisms emerge. A variety of techniques have been developed to strengthen beam-column joints. Steel and concrete jacketing are examples of these techniques. A novel technique for enhancing structural components has been recognized for over a decade, utilizing fiber-reinforced polymer (FRP) as externally bonded reinforcement in critical areas of reinforced concrete (RC) elements. This paper investigates the impact of glass fiber-reinforced polymer wrapping on corner beam-column joint frames subjected to ultimate loads. The specimens prepared for this study will measure 700 mm x 700 mm, with a cross-sectional dimension of 200 mm x 100 mm. Twelve concrete specimens will be integrated with glass fiber-reinforced polymer to ensure adequate reinforcement.

Keywords: Beam column, LVDT, Data logger, Moment carrying capacity.

Introduction:

Beam column section joints are portions of segments that are normal to radiate at their crossing points in RC structures. Since beam column segment joints are the horizontal and vertical burden-bearing individuals in RC structures, they are especially powerless against disappointment during quakes, and thus their repression is basic to a viable seismic fortifying technique. Shear failure at beam-column joints is a leading cause of structural collapse in recent earthquakes. Evidence from recent earthquakes indicates that Steel and concrete jacketing are only two of the techniques that have been developed to reinforce beams. A new method for reinforcing structural elements using fiber-reinforced polymer (FRP) as externally bonded reinforcement in critical areas of reinforced concrete (RC) elements has been developed over the past decade. FRP materials offer several advantages over traditional materials like steel and concrete, making them an excellent option for structural applications.

OBJECTIVE

The essential goal of this investigation is to look at the use of GFRP texture wrap to reinforce solid bar section joints of M40 grade and the related disappointment modes. The impact quantity of GFRP layers to enhance strength and flexibility in shaft segment joints will be researched. To consider a definitive burden conveying limit, redirection of ordinary pillar segment joints and shaft segment joints fortified with GFRP texture wrap. An examination will likewise be finished with a definitive burden conveying limit also, avoidance of typical shaft section joints and pillar segment joints reinforced with GFRP wraps.

SCOPE

The scope of this study is to enhance the strength of existing structures, focusing on improving the performance of beam-column joints as part of an effective seismic strengthening strategy. By reinforcing these critical connections, the study aims to develop a comprehensive approach that increases the overall resilience of buildings during seismic events.

METHODOLOGY

a)MATERIALS

For this investigation, 53-grade Portland Pozzolana Cement (PPC) is employed. PPC is a blend of Portland cement and pozzolanic materials, which improves its durability and resistance to chemical attacks. Its high strength makes it particularly suitable for demanding construction applications, especially in environments that are harsh.

b) STEEL MOULD PREPARATION WORK

New concrete, while still in its plastic state, requires a specific type of construction work to shape and support it until it sets. The formwork must be adequately designed to bear both dead and live loads during the construction process, and it should be sufficiently rigid to withstand any bending or lateral forces due to the concrete's weight. The formwork used for casting all specimens is constructed from 3mm thick plates. The beam has a cross-section of 100 mm x 200 mm and a length of 500 mm, while the column features a cross-section of 100 mm x 200 mm and a height of 700 mm. These components are securely connected using bolts and nuts to ensure stability during the curing process.

"Figure 1. Preparation of mold"

c) CASTING OF SPECIMENS.

Three examples are ready for this investigation. To research a definitive burden enduring restriction of bar segment joints, examples are ready and designated as follows.

i) BCJ I Control specimens without reinforcement.

ii) BCJ II – Beam-column joints wrapped with a single layer of GFRP.

iii) BCJ III – Beam-column joints wrapped with two layers of GFRP.

Figure 2. Preparation of mold

Figure 3. Curing specimens

Figure 4. Woven GFRP

Figure 5. Application of the first layer of mix over the concrete.

Wrapping with GFRP is implemented up to one-third of the length of the beam-column joint. Three specimens serve as control specimens, three specimens were wrapped with one layer of GFRP, three specimens received two layers of GFRP wrapping, and three specimens received three layers of GFRP wrapping. Studies focus on beam-column joints subjected to maximum bending moments.

d) EXPERIMENTAL WORK

The self-stressing load frame, along with the hydraulic loading jack and load cell, is arranged to apply a concentrated force, as illustrated in Figures 5 and 6.

Figure 6. Testing of beam-column specimens in the loading frame

Linear Variable Differential Transformers (LVDTs) are installed at locations where deflections need to be measured on the specimens. The beam-column joint specimens include control samples, as well as those wrapped with one, two, and three layers of glass fiber reinforced polymer (GFRP), all of which are subjected to failure testing to determine their ultimate load capacity.

Figure 7. Loading Frame with Data logger

Visible cracks form first at the joints and spread diagonally. The results show that the GFRP-wrapped beam-column joint specimens exhibited higher ductility as compared to control specimens. The data logger recorded ultimate load and deflection.

Results and Discussions

Ultimate load test

Table 1 portrays the relationship between ultimate loads and the number of GFRP layers applied. Table 2 provides a bar chart comparing ultimate loads for different GFRP layers in M40-grade concrete.

The Load vs. Deflection Curve

Deflections are measured at mid-span (W1) and one-third span (W2) of the beam. A plot of the load vs. deflection for these test specimens is made to show the correlation. The graphical representation of the ultimate load versus the number of GFRP layers is shown in both tables.

Experimental and Analytical Results of beam-column joints with different spacing of stirrups were explained in the Load vs. deflection Figure and Tabular column.

No of Layers GFRP	**Ultimate Load(KN)-M40**
0	15.23
1	37.52
2	45.23

Table: 1-Load Vs Deflection

Load (KN)	Control Beam	GFRP-I Layer --I	GFRP-I Layer --I
0	0	0	0
5	1	1	0.5
10	2	1.5	2.5
15	3	2	3.5
20	4	2.3	4.5
25	5	3.2	5.6
30	6	4	6.3
35	7	4.2	7.2
40	8	5	7.9
45	9	5.2	8.2
50	10	6	9.5

Table 2. Ultimate Load on Beam-Column Joint Specimens

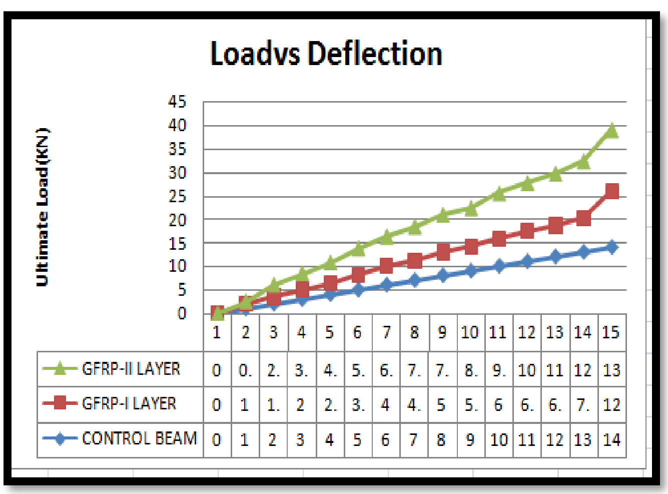

Figure 8. Comparative graph of ultimate load vs. number of GFRP layers

Load VS Deflection Graph

The evaluation of the beam-column joint was conducted, and deflections were recorded for various applied loads. Measurements were taken at the mid-span (W1) and one-third of the span (W2) of the beam. A load versus deflection curve was then plotted to illustrate the relationship between the applied loads and the resulting deflections.

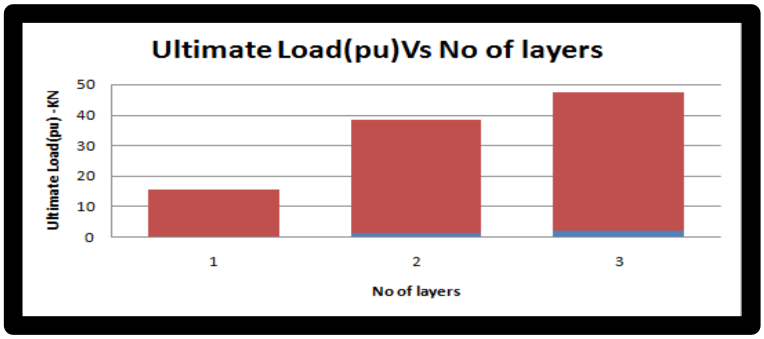

Figure 9. Load vs. deflection curve

Conclusion

The ultimate load-carrying capacity of beam-column joints increases with the addition of layers of GFRP.

A 52.77% increase in ultimate load (Pu) is captured for BCJ I over that of the control specimen.

A 35.13% increase in ultimate load (Pu) is seen for BCJ II over BCJ I.

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