EFFECT OF CFRP WRAPPING IN DUCTILE BEHAVIOUR OF RCC BEAM COLUMN JOINT UNDER CYCLIC LOADING

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Abstract - *Beam-column joint is the most critical part in building system where the vertical load and lateral load are combined together before transferring to column. Beam column joints are usually designed based on the strong column weak beam design concept. This paper aims to study the effectiveness of CFRP confinement on the ductile behaviour of monolithic RCC beam column joint under cyclic loading. ANSYS 17 APDL software is using for the analysis. The effect of CFRP sheet on monolithic rcc beam column joint is studying in terms of ductility, stiffness, energy.*

***Key Words*: Ductility, Stiffness, CFRP, RCC, Energy.**

1.INTRODUCTION

Beam column joints are usually designed based on the strong column weak beam design concept. Since column is designed stronger than beam, column member remains elastic during strong earthquake, so it can provide strength and stability to the stories above. This is desirable beacause the inelastic actions take place in the beam plastic hinges, plastic hinges in the columns may result in soft storey mechanism. To enforce this mechanism it is necessary to ensure that the sum of the moment resisting capacities of the columns at a given node is superior to the sum of the moment resisting capacities of the beams that converge on the same node. Different international codes of practices have been undergoingperiodic updations to incorporate the research findings into practice. Beam-column joints is the regions in framed structures having the probability to undergo severe damage during seismic attack. As a result of seismic moments ,columns having opposite signs formed immediately above and below the joint, and similar beam moments reversal across the beam-column junction is subjected to horizontal and vertical shear forces whose magnitude is many times higher than in the adjacent beams and columns. If we are not properly designed for the additional shear force generated in the joint, it will cause the failure of joint. The moment formed across the joint will necessitates the provision of beam reinforcement on both faces Tension or Compression. In addition to high shear force generated, the high bond stresses required to sustain this force gradient across the joint may cause bond failure and corresponding degradation of moment capacity combined with excessive drift. The joint is defined as the portion of the column within the depth of the deepest beam that frames into the column. In a moment resisting frame, beam column joints are generally classified based on geometrical configuration and named as interior, exterior and corner joints. The basic requirement considered for design is that the joint must be stronger than the adjoining beam or column member. It is important to see that the joint size is adequate in the early design phase, otherwise the column or beam size will have to be suitably modified to satisfy the joint shear strength or anchorage requirements. The design of beam column joint is predominantly focused on providing joint shear strength and adequate anchorage within the joint. A review of the behaviour and design of different types of beam-column joints in reinforced concrete moment resisting frames under seismic loading condition illustrates that design and detailing provision for the joints in the current Indian seismic codes IS 13920:1993 and IS 1893:2002 are not adequate to ensure prevention of brittle failure due to large shear forces which develop in the joint during earthquake. Therefore, the current code needs to be updated to incorporate shear design provisions for beam-column joints.

1.1 FIBRE REINFORCED POLYMER(FRP)

High strength non metallic fibres, such as carbon, glass and armid fibres, combined features in a polymer matrix in the form of wires, bars, strands have shown great potentials as reinforcement for concrete, particularly where durability is of main concern. It is commonly known as fibre reinforced polymer or in short FRP. Even though there is the existence of being a recent development, numerous investigations have already been reported in the literature on various aspects of its structural use. Fibre Reinforced polymers (FRP) have been used for structural reinforcement materials and also for bridge construction materials such as bridge deck. One area where FRP can play a important role is in strengthening and retrofitting of degraded or strength deficient structures already in existence .Because of its light weight, extraordinarily high strength and high corrosion resistance, FRP presents an attractive material for structural rehabilitation. More than that , they are available in the form of thin sheets, such a system makes very little changes to the dimension of the existing member.

Carbon reinforced polymer is a type of fiber composite material in which carbon fibres constitutes the fiber phase. Carbon fibers are a group of fibrous materials containing essentially elemental carbon.

1.2 BEAM COLUMN JOINTS

The joint is defined as the portion of the column within the depth of the deepest beam that frames into the column. In a moment resisting frame, three types of joints can be identified viz. interior joint, exterior joint and corner joint. When four beams frame into the vertical faces of a column, the joint is called as an interior joint. When one beam frames into a vertical face of the column and two other beams frame from perpendicular directions into the joint, then the joint is called as an exterior joint. When a beam each frames into two adjacent vertical faces of a column, then the joint is called as a corner joint. The severity of forces and demands on the performance of these joints calls for greater understanding of their seismic behaviour. These forces develop complex mechanisms involving bond and shear within the joint.

1.3 OBJECTIVES OF THE STUDY

This study is an analytical study to investigate the ductile behaviour of monolothic beam-column joints subjected to cyclic loading. Also to find out the effect of CFRP confinement on the beam column joint during the seismic excitation.

2. MODELLING OF BEAM COLUMN JOINT

Beam column joint is made with a full-scale 1: 1. Column dimensions are 350 x 300 x 2000 mm and beam 350 x 300 x2500 mm. The exterior beam-column joint is considered to study joint behavior subjected to cyclic loading. The exterior beam column joint is analyzed using ANSYS17 software. The elements used are solid i.e. concret65 and link i.e.spar8. Concrete65 element was used to model the concrete of eight nodes with three degree of freedom at each node and Spar8 element was used to model steel reinforcement of two nodes with three degree of freedom at each node.

joint

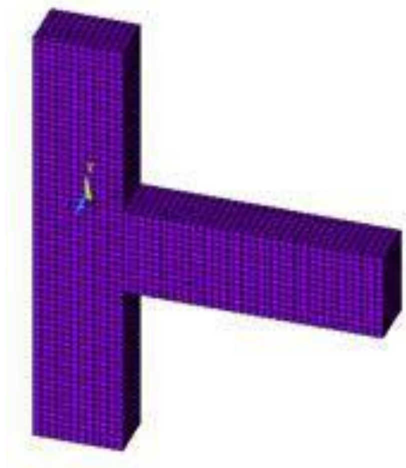

Fig-2.1: Beam column joint

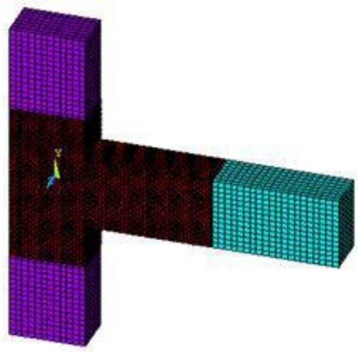

Fig-2.2: Beam column joint with 1mm thick CFRP

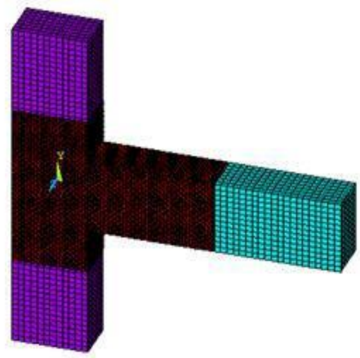

Fig-2.3: Beam column joint with 2mm thick CFRP

3. ANALYSIS

Cyclic loading is given to the beam column joint, then evaluated the ductility, stiffness, energy dissipation capacity.

1) Beam column joint

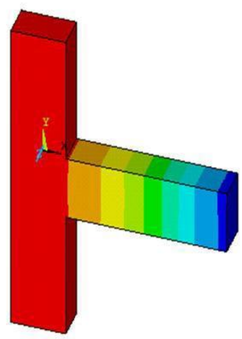

Fig-3.1: Deflection diagram

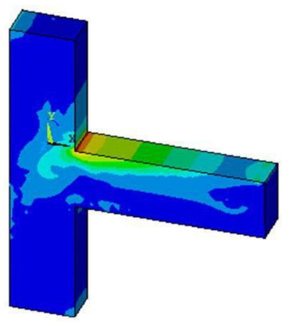

Fig-3.2: Stress intensity

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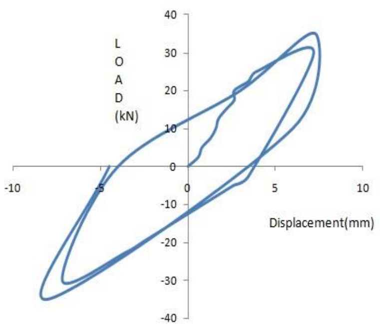
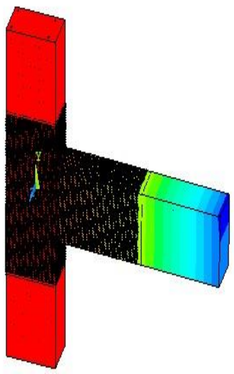


Fig-3.3: Hysteresis ccurve

2) Beam column joint with 1mm thick CFRP

In this beam column joint is wrapped with 1mm thick CFRP sheet.



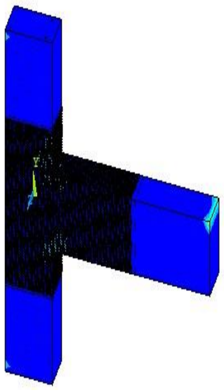


Fig-3.4: Deflection diagram **Fig-3.5**: Stress intensity

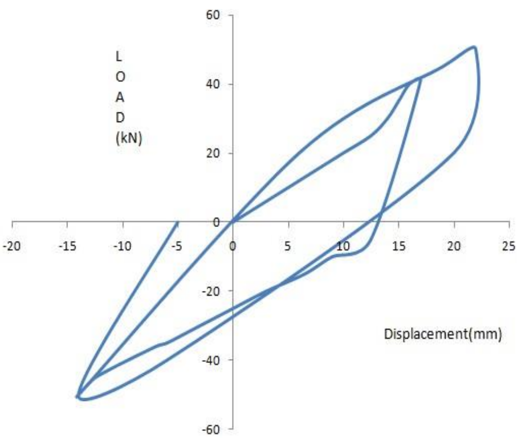
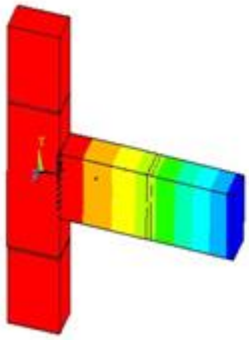


Fig-3.6: Hysteresis curve

3) Beam column joint with 2mm thick CFRP

In this beam column joint is wrapped with 2mm thick CFRP



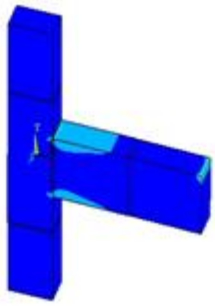


Fig-3.7: Deflection diagram **Fig-3.8**: Stress Intensity

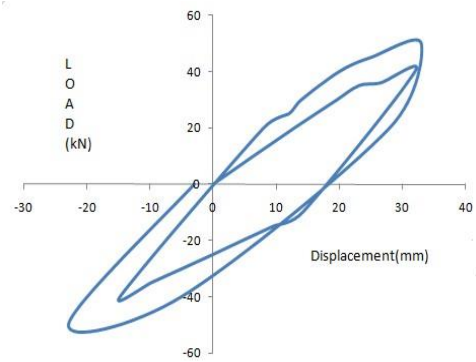


Fig-3.9: Hysteresis curve

4.RESULTS AND DISCUSSIONS

Ultimate load carrying capacity of monolothic beam column joint with 1mm CFRP is 34.61% higher as compared with monolothic beam column joint. Ultimate load carrying capacity of monolothic beam column joint with 1mm CFRP is 27.65% higher as compared with monolothic beam column joint.

4.1Cumulative Energy Dissipation

The area enclosed by the hysteresis loop in load – displacement. Curve at a given cycle represents the energy dissipated by the specimen during that cycle. Beam column joint confined with CFRP of 1mm thickness is having 18% more energy dissipation capacity as compared with monolithic beam column joint. Monolothic beam column joint confined with CFRP of 2mm thickness is having 33% more energy dissipation capacity.

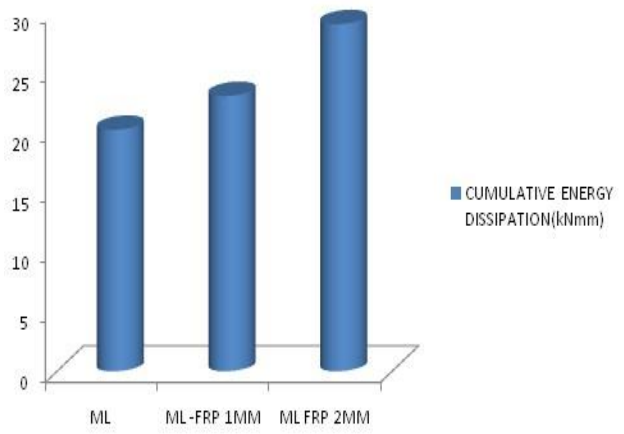


Chart-1: Ductility

4.2 Ductility

Ductility measured in terms of displacement ductility factor, which is the ratio of maximum deformation that can structure or an element undergo without significant loss of Initial yielding resistance to the initial yield deformation.
It is observed that ductility value of monolithic beam column joint with 2mm CFRP is higher as compared to other models.

Model	Ductility
Monolothic beam column joint	1.5
Monolothic beam column joint with 1mm thick CFRP	1.58
Monolothic beam column joint with 2mm thick CFRP	1.83

4.3 Stiffness

Stiffness get degraded when the joint is subjected to cyclic loading. During cyclic loading concrete concrete and reinforcement bars

5. CONCLUSIONS

As Energy absorption and ductility are the character which makes the structure perform better under seismic forces.

- Monolothic specimen shows comparatively better hysteresis curve due to the confinement of reinforcement in joint region.
- Provision of CFRP sheet improves the ductile behaviour.
- As the thickness of CFRP sheet increases ductility, energy dissipation ,stiffness value of beam column joint shows increase.

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