STUDY ON BEHAVIOUR OF REINFORCED CONCRETE BEAM COLUMN JOINT WITH FRP WRAPPING

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ABSTRACT

The efficiency of beam-column joints have long been identified as a remarkable factor that affect the total performance of structures subjected to large lateral loads. If there is no proper design and detailing the reversal force may cause damage to the beam column joint. Fibre materials are used to give strength to different components to amplify the flexural, shear, and axial load carrying capacity of elements.it has been found that by wrapping high strength fibre reinforced polymer (FRP) we can enhance the strength, ductility and also will result in large energy absorption capacity of structural constituents. Fibre reinforced plastic sheets are used. An experimental examination of the behaviour of FRP wrapped exterior beam- column joints with detailing under static loading is presented.G+5 building is chosen for the analysis which comes under the seismic zone 3. The test specimens were assessed in terms of load-displacement relation, ductility, stiffness, load ratio and cracking pattern and results are compared with analytical modelling of beam column joint performed in STAAD.PR0. and ANSYS Software.

Keywords: beam column joint; FRP, STAAD.PR0. ANSYS

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INTRODUCTION

- In RC buildings, portions of columns that are common to beams at their intersections are called beam-column joints.
- Since their constituent materials have limited strengths, the joints have limited force carrying capacity.
- A new technique has emerged recently which uses fibre reinforced polymer (FRP) sheets to strengthen the beam-column joints which have a number of favourable characteristics such as ease to install, immunity to corrosion and high strength. The simplest way to strengthen the joints is to wrap fibre sheets in the joint region in two orthogonal directions.

METHODS AND MATERIALS

- A G+5 multi-storeyed building was designed using STAAD Pro. software under the zone 3 condition using IS 456 2000. The reinforcement details were obtained from the design.
- The section for research work has been selected from the designed G+5 building (beam column joint). And scaled down in the ratio of 2.5 as per the available laboratory conditions. Considering the present scenario Fe 415 grade steel and M40 grade concrete have been chosen for the experimental purpose. Formwork was prepared according to the scaled down section dimensions.
- (200 x 170) mm cross section, 1000mm long column and 500mm long beam section has been casted for the mix design using the code (IS 10262:2009 First Revision ICS 91.100.30). Specimens are given proper curing and testing has been conducted 14th and 28th days respectively. Beam column joints with and without FRP (.Fibre Reinforced Plastic) wrapping under laboratory conditions are subjected to static loading using hydraulic jack. Crack and deflection pattern was noted and represented by graph. And also the ultimate load was obtained from the experimental setup.
- Modelling and finite element analysis of beam column joint with and without FRP wrapping were done using the software ANSYS. Results were compared for the validation. New models has been proposed with the aid of software.

Figure 1. Crack pattern without FRP wrapping.

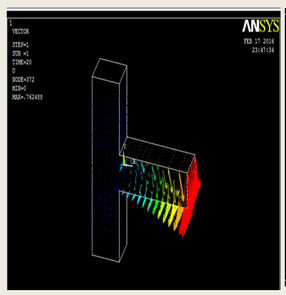

Figure 2. Deflection obtained in ANSYS.

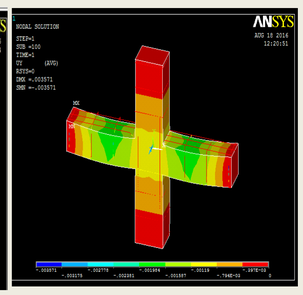

Figure 3. Deflection obtained for plus joint without FRP wrapping ANSYS.

Figure 4. Crack pattern with FRP wrapping.

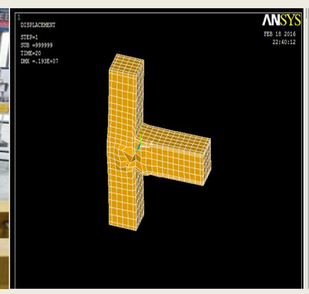

Figure 5. Crack pattern with FRP wrapping ANSYS.

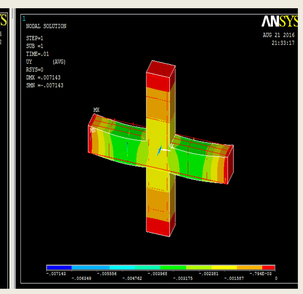

Figure 6. Deflection obtained for plus joint with FRP wrapping ANSYS.

RESULTS AND DISCUSSION

- Since in software analysis the model without deformities are taken and is not possible in practical situation. The curve obtained is smooth.
- From the chart1. max load obtained for the beam column joint without FRP wrapping is 64.1kN and the maximum deflection is 1.5cm.similarly Max load obtained for the beam column joint with FRP wrapping is 69kN and the maximum deflection is 1.1cm from chart2.

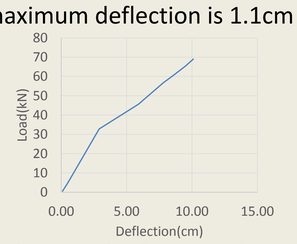

Chart1 . Load Deflection Graph- ASYS without FRP wrapping

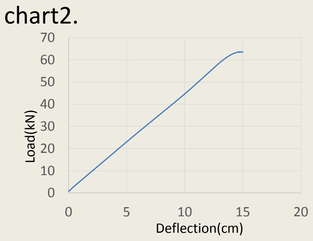

Chart2. Load Deflection Graph-ANSYS with FRP wrapping

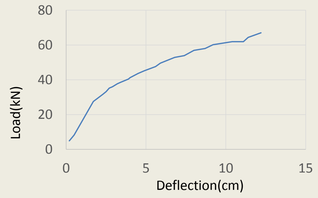

Chart 3. Load Deflection Graph-experimental without FRP

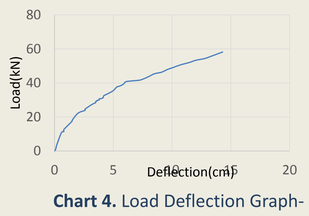

Chart 4. Load Deflection Graph-experimental with FRP

- But in the case of experimental analysis imperfections were considered. Maximum Load is obtained from chart3. for beam column joint without FRP is 58.3kN and the max deflection for the beam is 1.42cm. As per chart4. the maximum load for the beam column joint with FRP is 68.1kN and the deflection is 1.2cm.
- 1st crack was observed at the Load of 35.4kN. Further load has been given till the specimen was not taking any load for the further increment of load.
- The crack has been appeared in the junction of beam column joint as well as at the bottom of the specimen.
- After the validation of results a new model(plus joint) has been proposed and done with ANSYS software with and without FRP wrapping, graph obtained also support the initial assumptions.

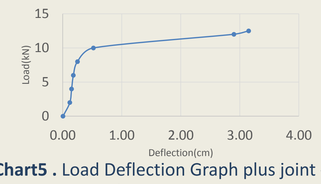

Chart5 . Load Deflection Graph plus joint -ASYS without FRP wrapping

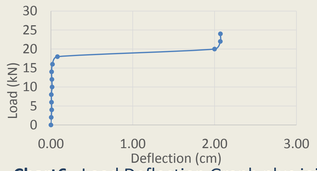

Chart6 . Load Deflection Graph plus joint -ASYS with FRP wrapping

		ANSYS results		Experimental results	
		Ultimate load	Deflection	Ultimate load	Deflection
Beam column joint Without FRP wrapping	T-Junction	64.1kN	1.5cm	58.3kN	1.42cm
	Plus Junction	12.5kN	3.15cm	-	-
Beam column joint With FRP wrapping	T Junction	69kN	1.1cm	68.1kN	1.2cm
	Plus Junction	24kN	2.5cm	-	-

Table 1. Comparison between ANSYS and Experimental setup

Comparative study of experimental analysis and software analysis are given. And shown in Table1

CONCLUSIONS

- Finite element analysis of beam column joint with and without FRP wrapping was carried out using ANSYS software. Analytical studies shows that load carrying capacity of retrofitted specimen is 30% more than control specimen. The load deflection characteristics also improve in retrofitted specimen.
- Crack pattern obtained from the ANSYS software were similar to the experimental analysis. whereas the ultimate load had a slight variation which could be because of the imperfection in casting and errors occurred during testing. However the difference in the value is less than 10%. So it is acceptable
- Both control and retrofitted specimen had been subjected to static loading. From the experimental results the retrofitted specimen exhibits better performance in resisting the load hence shows better performance in energy dissipation(area coming under load deflection curve). Energy dissipation was found from the load deflection curve. .
- In the software analysis smooth curve was obtained, since no imperfections were considered.
- Properties of resin also perform a nice role in enhancing the adhesive property between FRP and concrete increases it results in a better performance in all area. Therefore, using resins with better properties also will make drastic increment in strength of the section.

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