T Shape Beam Column Joint Retrofitting by using GFRP

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Abstract - *Retrofitting existing structures is one of the key issues faced by current civil engineering structures, as most of them will require extensive repairs in the near future. Concrete jacketing and steel were the two most used ways for reinforcing faulty RC Beam Column Joints until the early 1990s. Fiber reinforced polymer sheets such as Carbon FRP, glass GFRP, and aramid FRP have recently developed as a new technique for reinforcing the beam-column junction. Using the FEM, the response RCC structures retrofitted by FRP laminates are predicted. In this study, Using ANSYS software, the FEM analysis of T joints with FRP is done to evaluate the results. ANSYS workbench 17 is used.*

Key Words: Retrofitting, Beam-column joint, GFRP

1.INTRODUCTION

The Reinforced concrete structure designed in early 1980s before the establishment of advanced seismic situated codes provides insufficient response to lateral loads in earthquake. The old existing concrete structures are either designed with gravity load consideration or designed without ductile detailing. Many R.C. structures have been seriously damaged during the earthquake and the major factor causing the lateral resistance in conventional RC framed system is mainly due to beam-column joints, these joints are vulnerable to serious damage. Earthquake causes shear failure of junction. In previously constructed Structures, reinforced concrete beam column joints are not designed with the reference of IS 13920:1993 which needed to be strengthened to meet the important requirements like Strength, stiffness and ductility etc. Recently many techniques have developed for strengthen the beam column joint like steel jacketing, epoxy resins, Carbon FRP, Glass FRP, FRP laminates, Hybrid composite connectors etc. FRP for retrofitting is very good strengthening technique and used over last few years and there is improvement in the seismic performance. Comparatively FRP have better performance over steel. They are light weight with excellent strength along with stiffness to weight ratio also possesses high corrosion resistance and mouldability into the concrete structure. Seismic retrofit techniques for concrete structures have evolved in recent decades to include strengthening of weakened members such as beam-column junction, beams and columns to get better overall seismic performance. This research proposes the behavior of beam column joint under the seismic loading with the use of fiber reinforced polymer with developing models of beam column joints using software analysis.

2. Modelling of T joint

2.1 General

ANSYS is software that performs finite analysis. ANSYS offers a straightforward and adaptable platform for structural analysis. With pinpoint precision ANSYS is made up of two separate programs. APDL and workbench platforms are two examples.

The workbench gives the user more automated options. operations analysis. Typically, numerical approximation is used in this case.

2.2 Modelling

T shape is modeled in Ansys workbench. C/s of column is 230 x 450 mm with an overall length of 1500 mm, while the c/s of beam is 230 x 450 mm with a length of 750 mm. Control specimens (CS) were created.

Both beams and columns were reinforced with 4 no. of bars of 12 mm diameter Fe500 bars, and beam reinforcement is anchored in columns up to 750 mm in length. The ties are made up of square hoops of 8 mm diameter Fe250 bars placed 150 mm c/c in both the column and beam portions. The concrete grade M20 was used.

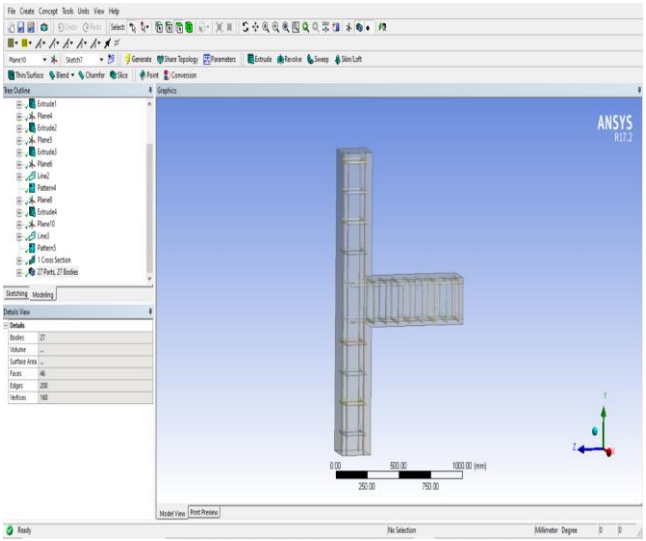

Fig -1: Modelling of T joint

2.3 Modelling of Retrofitted specimen

Three specimens Strengthened with GFRP. Ansys modelling is done to study the response of the beam-column junction retrofitted with different FRP wrapping schemes. Figure demonstrates the various GFRP wrapping arrangements These specimens' characteristics are as follows

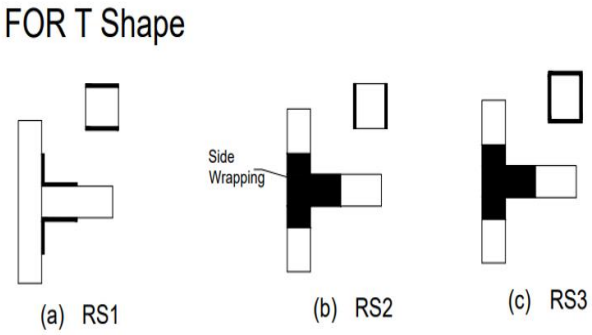

Fig -2: Retrofitted specimens

2.4 Material properties

The table below shows the material properties. The concrete and steel bar properties are in table. After going through literature and after several initial trials, the elements for modeling various materials were finalized and the details of elements used are shown in Table no.1

Table -1: Material properties

SR. NO.	Material	Element type
1.	Concrete	Solid 65
2.	Steel	Link 180

2.4 Loading and boundary conditions

The cyclic loading is applied on the tip of the beam and constant load is applied at one end of the column and other end is fixed. The same load is applied on the non-retrofitted and retrofitted specimens.

3. Analysis and Results

For illustrating results, the comparison is made between the non-retrofitted and retrofitted T beam column joint. The load carrying capacity is find out for all specimens by using Ansys software.

3.1 Maximum Equivalent stress

- **Non retrofitted T shape**

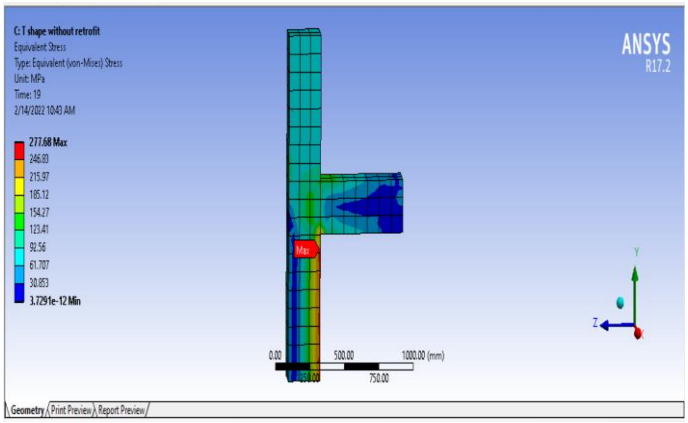

Fig -3: Analysis of non-retrofitted T joint

- **Retrofitted T shapes**
- **RS1**

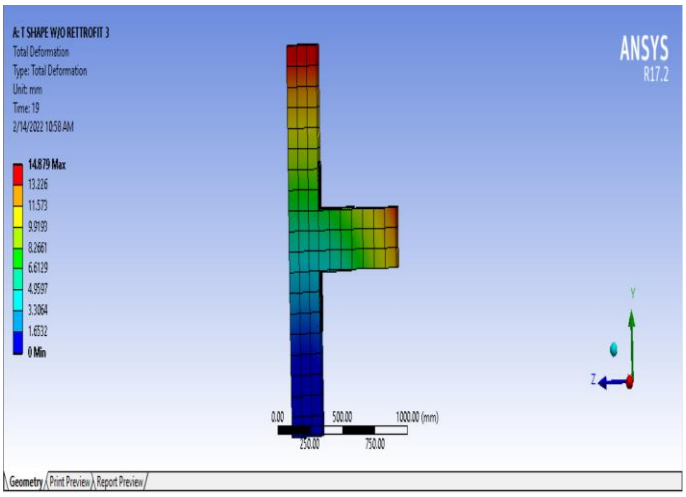

Fig -4: Analysis of retrofitted T joint (RS1)

- **RS2**

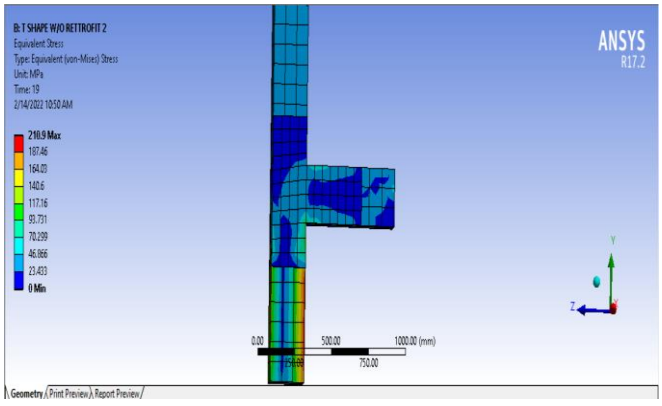

Fig -5: Analysis of retrofitted T joint (RS2)

- **RS3**

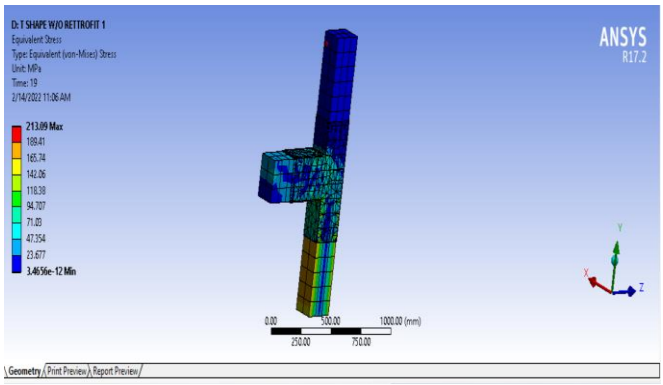

Fig -6: Analysis of retrofitted T joint (RS3)

The results of Non retrofitted and retrofitted T joints are shown in table-2

Table -1: Material properties

Load (KN)	Maximum Equivalent stress in MPa			
	NR	RS1	RS2	RS3
0	0	0	0	0
30	48.838	20.801	49.147	22.945
0	36.986	3.3585	33.951	17.666
60	74.254	38.667	67.094	44.062
0	44.693	3.3585	33.951	17.666
90	99.678	56.535	85.057	65.187
0	52.399	3.3585	33.951	17.666
120	125.1	74.402	103.03	86.313
0	60.106	3.3585	33.951	17.666
150	150.53	92.269	121.	107.44
0	67.813	3.3585	33.952	17.666
180	175.96	110.14	138.98	128.57
0	75.516	3.3585	33.952	17.667
210	201.39	128.	156.96	149.7
0	83.223	3.3585	33.952	17.667
240	226.82	145.87	174.93	170.83
0	90.93	3.3586	33.952	17.667
270	252.25	163.74	192.91	191.96
0	98.636	3.3586	33.952	17.667
300	277.68	181.61	210.9	213.09

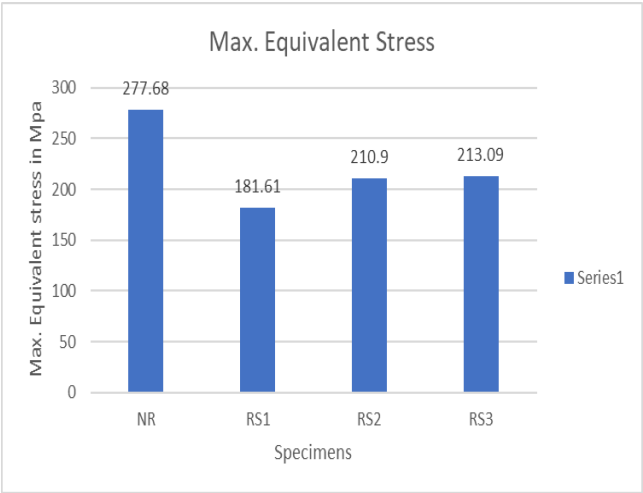

Fig -6: Specimens vs Max. Stress

4. CONCLUSIONS

The conclusions are as follows:

- Using existing software, a realistic non-linear study of an RC beam column junction with FRP overlay could be accomplished.
- The comparison of non-retrofitted and retrofitted specimens is done by comparing of maximum equivalent stress.
- The load carrying capacity of T shaped non retrofitted and retrofitted beam column joint is find out.
- For NR T joint the maximum equivalent stress is 277.68 MPa for an ultimate load of 300 KN.
- For retrofitted T joint the maximum equivalent stress of RS1 RS2 and RS3 is 181.61 MPa, 210.09 and 213.09 respectively for an ultimate load of 300 KN.
- The load carrying capacity of retrofitted T joint is increased by 34.54%, 24.04% and 23.29% for RS1, RS2 and RS3 respectively as compared to non-retrofitted beam column joint.

5. REFERENCES

[1] A. Niroomandi, A.Maheri, Mahmoud R. Maheri, S.S. Mahini, "Seismic performance of ordinary RC frame retrofitted at joint by FRP sheets"Engineering structures 32 (2010) 2326-2336.

[2] B. Venkatesan, R. Ilangovan, P. Jayabalan, N. Mahendran, N. Sakthieswaran "Finite element analysis (FEA) for the beam column joint subjected to cyclic loading was performed using ANSYS" Circuits and systems, 2016, 7, 1581-1597.

[3] Mohammad S. Alhaddad; Nadeem A. Siddiqui; Aref A. Abadel ; Saleh H. Alsayed ; and Yousef A. Al-Salloum, "Numerical investigations on the seismic behavior of FRP and TRM upgraded RC exterior beam column joints" Journal composites of construction © ASCE / MAY/ JUNE 2012.

[4] Yazan B. Abu Tahnat, Mahmud M.S. Dwaikat, Mohammad A. Samaaneh, "Effect of using CFRP Wrap on the strength and ductility behavior of exterior reinforced concrete joint" Composite structure 201 (2018) 721-739.

[5] Saptarshi Sasmal, K. Ramanjaneyulu, Balthasar Novák , V. Srinivas , K. Saravana Kumar , Christian Korkowski , Constanze Roehm , N. Lakshmanan , Nagesh R. Iyer, "Seismic retrofitting of non-ductile beam column joint sub-assemblage using FRP wrapping and steel plate jacketing" Construction and building materials 25 (2012) 175-182.

[6] A. GHOBARAH and A. SAID, "Seismic rehabilitation of Beam-column joints using FRP laminates" Journal of Earthquake Engineering, Vol. 5, NO. 1 (2001) 113-129.

[7] Kien Le-Trung, Kihak Lee, Jaehong Lee, Do Hyung Lee, Sungwoo Woo, "Experimental study of RC beam-column joints strengthened with CFRP composites" Composites: Part B 41 (2010) 76–85.

[8] Ciro Del Vecchio; Marco Di Ludovico; Alberto Balsamo; Andrea Prota ; Gaetano Manfredi ; and Mauro Dolce, "Experimental investigation of Exterior RC beam column joints retrofitted with FRP systems" Journal of Composite Construction, 2014, 18(4): 1--1.

[9] Khair Al-Deen Bsisu, Belal O. Hiari, "Finite element analysis of Retrofitting techniques for reinforced concrete beam column joint" Journal of American Science 2015;11(8).

[10] IS-13920, "Ductile detailing of reinforced concrete structures subjected to seismic forces - code of practice", Technical report, Bureau of Indian Standards (BIS), New Delhi, 1993.

[11] IS-15899, "seismic evaluation and strengthening of existing reinforced concrete buildings-guidelines", Technical report, Bureau of Indian Standards (BIS), New Delhi, 2013.