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SEISMIC EVALUATION OF BEAM COLUMN JOINT USING GFRP AND BASALT BARS IN MULTI-STORY BUILDING

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Abstract - In the present construction technology it is generally accepted that Glass fiber-reinforced polymer (GFRP) and BASALT reinforcement as an alternative reinforcement to steel reinforcing bars for frame structures. In multi-story building the beam-column joint is one of the most critical regions. Beam column joint is the failure zones of frame structure. thus The objective of this research project is study seismic behaviour of beam-column joints reinforced with GFRP and BASALT bars in a multi-bay, multi-storey building .Their behaviour of G+3, G+6 and G+8 building reinforced with GFRP and BASALT bars are studied. The performance of building with GFRP ,BASALT and steel reinforcement in the G+3, G+6 and G+8 buildings are compared. Pushover analysis was carried out using ETABS 9.7. software And to study the particular beam- column joint behaviour reinforced with GFRP and BASALT bar at joint section ANSYS software used by considering critical joint particular beam column joint model is analysed. In ANSYS Deformation displacement tension compression various parameter are studied and compared.

Key words- Beam-column joint, Performance point, Displacement, Pushover analysis, ETABS software, ANSYS software.

I. INTRODUCTION

The behavior of frame structure depends not only upon the individual members but also on the reliability of the joints. Previous research shows that beam-column joints play a very important role in ensuring performance of RC Frame structures in withstanding the design forces, mainly which are induced by earthquakes .portion of reinforced concrete structure where columns that are common to beams at their intersections are called as beam column joint Beam-Column joints are the weakest link in reinforced concrete moment resisting frame Beam column joint is critical zone in RC framed structure. when large seismic force are produced mainly beam column joint get effected so beam-column joint must be take care by using FRP reinforcement .the fibre reinforced polymer(FRP) reinforcing bar are the new type of structural material in construction field, by using FRP bars steel corrosion problem can be solved and FRP bars have high tensile strength and it has low modulus of elasticity when elastic modulus is low stiffness will be less which is benefit for overall structural behaviour at earthquake zone.

II .LITERATURE REVIEW

1. Jerison scariah James,

In this study, investigations were carried out to evaluate performance comparison of ordinary concrete and fibre reinforced beam-column joint specimen. The experimental model consisted of casting and testing of 4 numbers of exterior RC beam-column joint specimens prepared of M25 grade concrete. Result concluded that The Beam-Column joint with fibers has high strength than normal joint. The joint having fibers can take highest loads The Fiber included Joint shows a superior performance in joint section failure.

2. Amitshaha Rafai1and Prakarsh Sangave

International Journal of Application is research oriented publication or it is Innovation in Engineering & Management (IJAIEM)The main objective of this project is to study seismic performance of multi-storey, multi bay structure by taking GFRP reinforcement by considering nonlinear pushover analysis..Pushover analysis was done using software ETABS 9.7. Result concluded that Load carrying capability of GFRP reinforces building is higher than steel reinforced building. And As we go for higher storey level it is seen that GFRP reinforced frames are performing very well hence GFRP bars can be efficiently used for high rise buildings.

3. Gajendra D K Kulkarni

This work involve in the study of seismic behavior of beam-column joint using GFRP bars in multi-bay, multi-storey buildings. Their behavior is considered for various building heights of G+3, G+5 an d G+7 using ETABS 9 software .pushover analysis is carried to study the performance of the building. The performance of joints in the G+3, G+5 and G+7 buildings is studied. Pushover analysis was carried out for M3 and V2 type of hinges for beams and P-M-M hinges for columns and Result concluded that GFRP bar with smaller thickness possess higher strength, the congestion of reinforcement in beam-column joint is less. When it consider that performance point , it is seen that as increase the GFRP reinforcement ratio, performance of building is becoming well within the permissible limits given in IS 1893 (part-1) 2002

4. Radhika J. Popat1, and Rajul K. Gajjar,

This research paper studied the behaviour of concrete beam-column joints reinforced with GFRP bars in a multi-bay multi storey building, by pushover analysis. Performance of joints in 5, 8 and 10 Storey building with reinforcement as GFRP bars. Pushover analysis was done using ETABS using M3 and V2 hinges for beams and P-M-M hinges for columns Result concluded that GFRP bars and stirrups can be used as reinforcement in the beam-column joints subjected to seismic loading conditions. The GFRP bars can resisting reversal tension-compression cycles without joint failure.

II. OBJECTIVE

1. To study the seismic behaviour of beam-column joint using GFRP and basalt bar in a multi-bay, multi-storey building, under seismic load using pushover analysis
2. To study the evaluation of concrete beam-column joints reinforced with GFRP and basalt bars at joint section.

III. METHODOLOGY

The building model is analysed using software ETABS 9.7 and Combination of gravity load (such as dead load live load floor finish) and earth-quake load is considered for the analysis . 3D modelling is done for analysis The building is analyzed by Pushover analysis and .different parameter such as displacement base shear are studied..all code recommendation are considered for the analysis..For particular beam column joint analysis ANSYS software were used

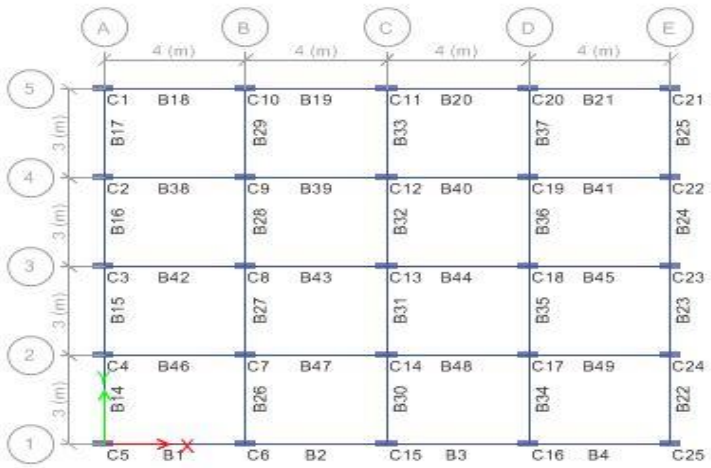


Figure 1 First floor typical plan at height 3m

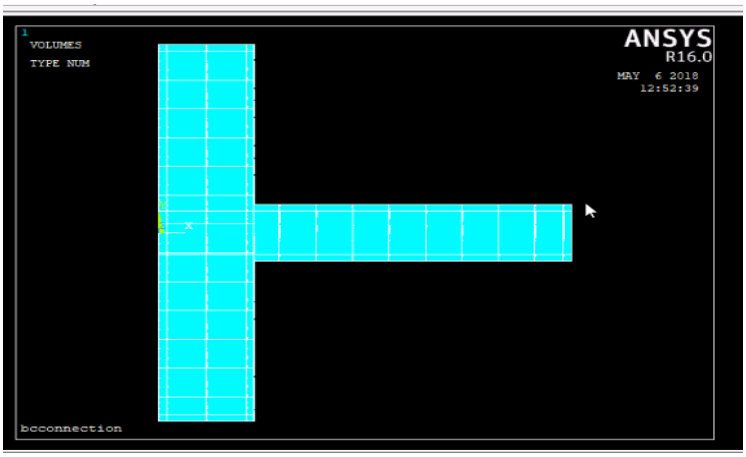


Figure 2 Beam Column joint modal

V. RESULTS AND DISCUSSIONS

After performing analysis in ETABS and ANSYS following results are obtained

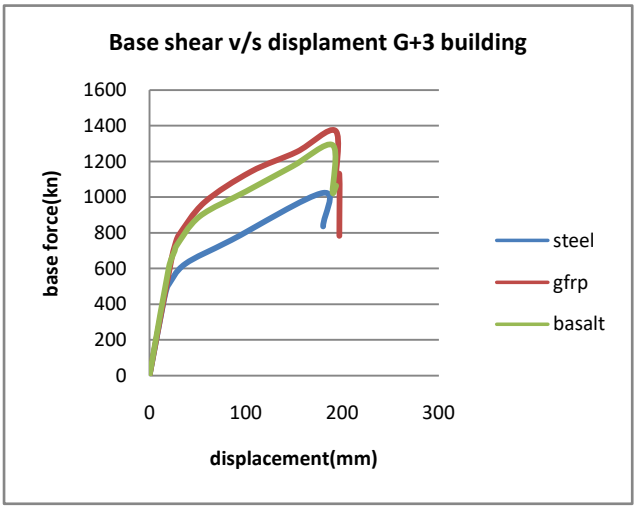
1. Performance point

In the following tables, the results are obtained for various models having different storeys with STEEL GFRP and basalt bars as reinforcement Table shows the performance point and base shear for all model from table it can be observed that GFRP and BASALR rebar reinforced building can sustain more base force then steel and displacement is more in GFRP and basalt reinforced building which is more advantage in overall structural behaviour.

Table I

Shows Comparison of performance point of models

Storey	G+3		G+6		G+8	
Cases	Performance Point (From Pushover Analysis)		Performance Point (From Pushover Analysis)		Performance Point (From Pushover Analysis)	
	Base force	Displacement	Base force	Displacement	Base force	Displacement
	KN	Mm	KN	mm	KN	mm
STEEL	1024	180	1181	246	1464	247
GFRP	1371	192	1513	260	1714	298
BASALT	1292	190	1482	258	1653	260



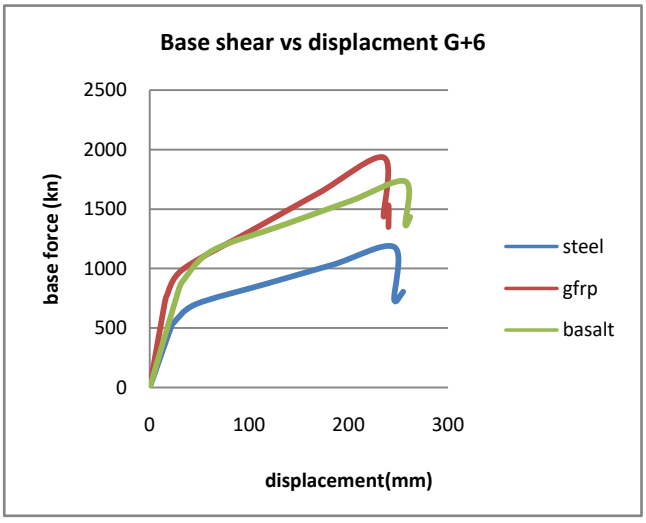


Fig 3 base shear vs. displacement G+3 building

Fig 4base shear vs. displacement G+6 building

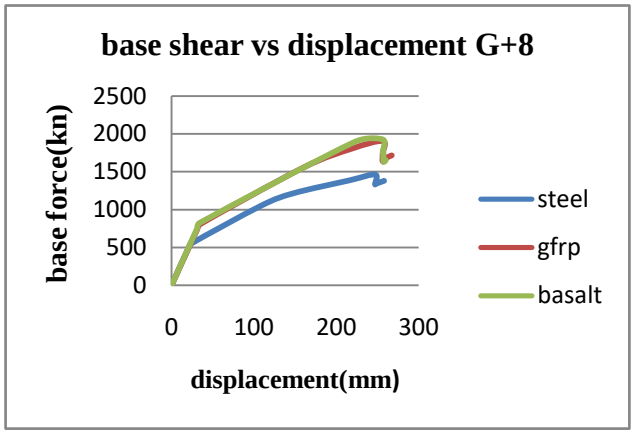


Fig 5.base shear vs. displacement G+8 building

Figure 3, 4 and 5 show base force v/s displacement for all models. From figure it observed that base force capacity of GFRP and basalt reinforced model is more compared to STEEL model, . As we are increasing number of stories performance of GFRP and basalt bar reinforced building increasing it is clearly seen, also GFRP and basalt reinforced model is deflecting more which is increasing flexibility of overall structure..at performance level the building reinforced with GFRP and BASALT bars showing more displacement then steel as the displacement is more stiffness will be less which advantage for overall structural behaviour..

2. Joint displacement

In ETABS rigid diaphragm is provided on each story so all joints at a particular story will have same amount of displacement. Table 2 and Figure show comparison of displacement for g+3 storey building. From table it can be seen that joints in GFRP and basalt model is having higher displacement than STEEL model, this is because GFRP bars are having low modulus of elasticity, which makes them flexible.

Table II

Shows Comparison of displacement of G+3 models

Storey	Joint no.	Displacement in mm		
		STEEL	GFRP	BASALT
4	4	208	228	225.7
3	3	133	146	144.8
2	2	66	73	72.1
1	1	18	20.3	20
BASE	0	0	0	0

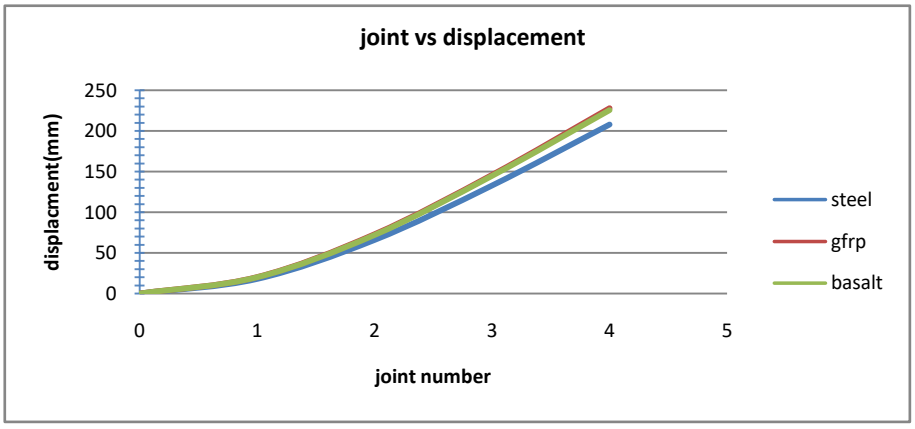


Fig. No.6 Joint VS Displacement of G+3 Models

Table III

Shows Comparison of displacement of G+6 models

Storey	Joint no.	Displacement in mm		
		Steel	GFRP	Basalt
6	6	360	374	357
5	5	267	284	265
4	4	180	197	177
3	3	102	119	100
2	2	42.4	56	41.27
1	1	7.21	14.1	6.9
Base	0	0	0	0

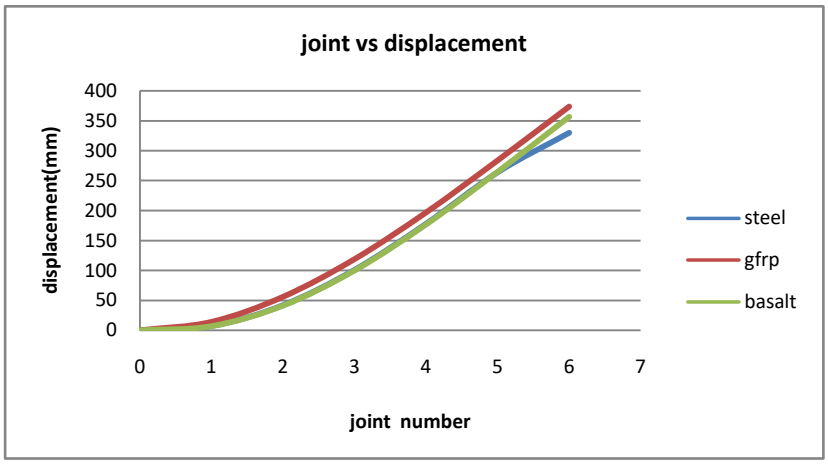


Fig. No. 7 Joint VS Displacement of G+6 Models

Table IV

Shows Comparison of displacement of G+8 models

Storey	Joint no.	Displacement in mm		
		Steel	GFRP	Basalt
8	8	319	439	431
7	7	267	372	370
6	6	214	305	304
5	5	162	234	233
4	4	111	162	161
3	3	66	95	93
2	2	29	40	39
1	1	5	7	6.9
Base	0	0	0	0

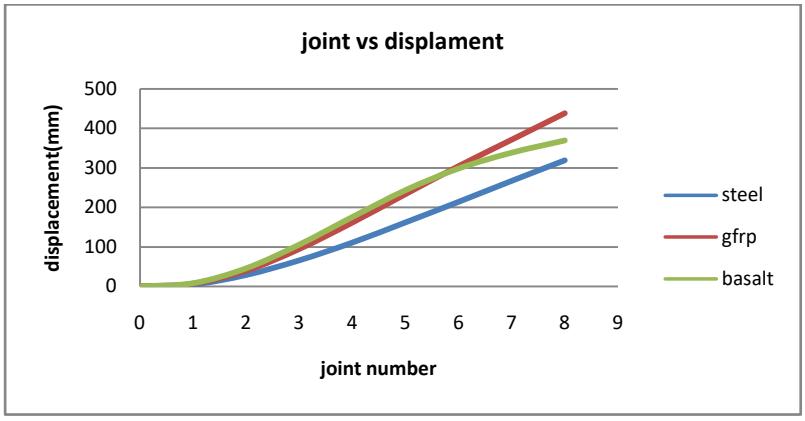


Figure .8 Joint VS Displacement of G+8 Model

Table 2,3.4 and Figure5,6,7 show comparison of displacement for eight storey building. From table it can be seen that joints in GFRP model is having higher displacement than STEEL model, this is because GFRP bars are having low modulus of elasticity, which makes them flexible. From the ANSYS analysis.

Case	Force (kN)	Bar type	Deformation
@joint	500	Steel	7.43336
		GFRP	7.92748
		Basalt	7.84384

From ANSYS it is observed that steel rebar used beam column joint is undergoing tension 22.72 MPa and compression 20.62MPa And GFRP rebar used beam column joint undergoing tension 29.75MPa and compression 24.90MPa Similarly basalt rebar used beam column joint undergoing tension 23.87MPa And compression 21.71MPa.

VI. CONCLUSION

- .As we raise the storey height it is observed that GFRP AND BASALT bars are performing very well as compare to STEEL , hence GFRP & BASALT Rebar can be used effectively use for high rise buildings.
- As far as performance point is concerned, it is found that GFRP Rebar can take higher Base shear than BASALT & STEEL rebar that is GFRP can take 33.9% more base shear the steel and basalt 26.17% more then steel
- The large deformations were showed by GFRP & BASALT Rebar, which allows the GFRP& BASALT Rebar reinforced building to satisfactorily dissipate the seismic energy
- from base shear vs. displacement curve it is seen that building reinforced with GFRP and basalt rebar fails at higher displacement then steel so we can say that low modulus of elasticity GFRP and basalt reinforcement led to reduce overall stiffness of structure which is considered as advantage on overall structural behavior
- from joint vs. displacement curve it is seen that GFRP and basalt rebar reinforced joint giving more displacement then steel so we can say that larger the displacement stiffness will be less which is more advantage overall structural behavior
- as we compared GFRP bar reinforced building with BASALT bar reinforced building there is no much difference in GFRP AND BASALT but when compared with steel both performing well
- from ANSYS model it shows that GFRP and BASALT reinforced beam column joint is capable resisting more tension and compression then steel
- from ANSYS model of beam column joint it can be conclude that GFRP and BASALT reinforced beam column joint giving more deformation then steel so larger the deformation stiffness will be less which is advantage to dissipate the seismic energy

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