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NUMERICAL EVALUATION OF BEAM COLUMN JOINT REINFORCED WITH GFRP BARS AND STIRRUPS

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Abstract - *Reinforced concrete beam column joins are often used in buildings such as parking areas and viaducts which may be visible to extreme weather conditions. The objective of this project is to assess the seismic behavior of concrete beam column joints reinforced by glass GFRP and stirrups. In this paper GFRP and steel are mainly used. The main objectives of the projects are, to analyse the effect of corner beam- column joints using steel and GFRP rebar under cyclic loading, to analyse the effect of interior beam- column joints using steel and GFRP rebar under cyclic loading. From the analysis, the beam column joint with GFRP main bars and steel stirrups have the extreme energy absorption capacity and have great yield strength as compared to other models. This indicates the feasibility of using GFRP and stirrups as reinforcement on the beam column joints subjected to seismic type loading.*

***Keywords**: Beam column joint, GFRP, Energy absorption capacity, Reinforcement.*

1. INTRODUCTION

Fiber reinforced polymer (FRP) reinforcement was currently being used as a viable temporary to steel in new concrete structures especially those in harsh environments. The main driving force behind this effort is the greater performance of FRP in destructive environments attributable to its non-corrodible nature. The beam column joint in the critical zone in a reinforced concrete (RC) frame exposed to large forces during several ground pulsating events, and its behavior has a significant influence on the response of the structure. Beam column joints are the bond between horizontal and vertical structural elements, and therefore, the joints are directly involved in the transfer of seismic forces.

1.1 NUMERICAL INVESTIGATION USING ANSYS WORKBENCH 2021 R2

Modelling of 4 different types of beam column joints are examined. The main objectives of the projects are, to analyse the consequence of corner beam column joint using steel and GFRP rebar under cyclic loading, to analyse the consequence of interior beam column joint using steel and GFRP rebar in repeated loading. This project was used to assess the seismic behaviour of concrete beam column joints reinforced with glass GFRP bars and stirrups. In this paper GFRP and steel are mainly used. The material properties of different ingredients are shown Table 1 and Table 2.

Table -1: Material Property.

	Concrete	Steel
Mix/Grade	M20	Fe 415
Density	2500 kg/m³	7850 kg/m³
Young's modulus (GPa)	22360.679 N/mm²	2x10⁵
Poisson's ratio (ν)	0.2	0.3
Bulk modulus	12422.56 N/mm²	1.6667x10⁵ N/mm²
Shear modulus	9316.95 N/mm²	7.6923x10⁴ N/mm²

Table -2: Material Property of GFRP

Material properties	Diameter of bar		
	8mm	12mm	16mm
Young's modulus	42000 N/mm²	45400 N/mm²	46400 N/mm²
Tensile strength	489.30 N/mm²	7465.54	715
Poisson's ratio	0.26	0.26	0.26
Density	2500 kg/m³	2500 kg/m³	2500 kg/m³
Bulk modulus	29166.67 N/mm²	31527.78 N/mm²	32222.22 N/mm²
Shear modulus	16666.67 N/mm²	181015.87 N/mm²	18412.69 N/mm²

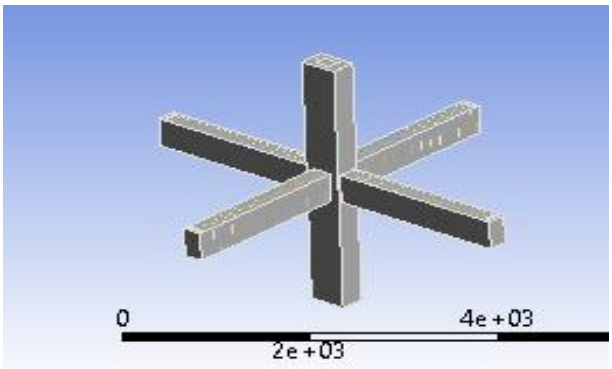

Fig -1: Geometry of interior beam column joint

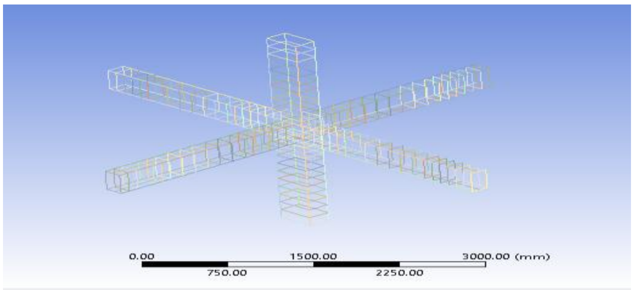

Fig -2: Reinforcement details

Figure 1 shows a Geometry of interior beam column joint, Figure 2 shows the reinforcement details and figure three shows the meshing of beam column joints.

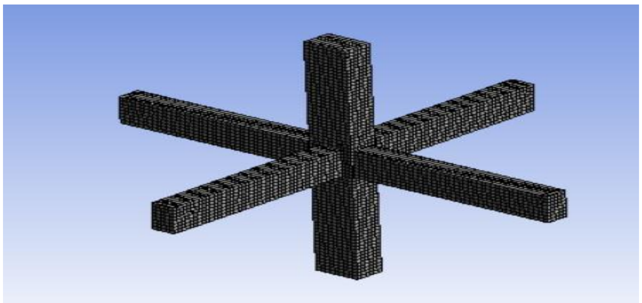

Fig -3: Meshing

2. Loading and boundary conditions

The boundary conditions are provided such that translation, one side z direction free, other side – axial displacement. Direction in which the force is acting can be clearly visible from the figure 4. Fixed support and remote displacement is also provided.

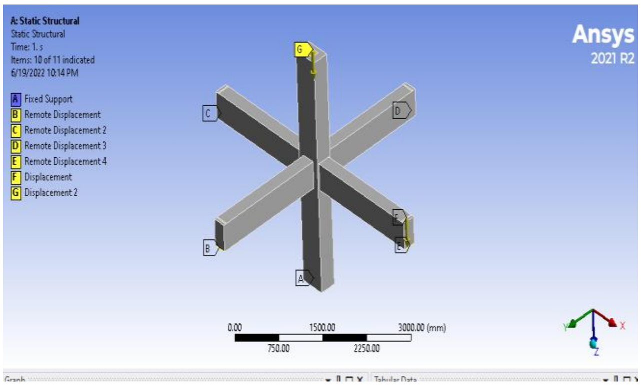

Fig-4: Boundary condition

3. RESULTS AND DISCUSSIONS

When various materials such as steel and GFRP are mainly used. In first case steel is used as main bar, in second case GFRP was used as main bar, In third case beam column joint with GFRP main bars and steel-stirrups were used and last example beam-column joint by steel main bars and GFRP stirrups were used. Figure 5 to Figure 8 shows the equivalent stress in various beam column joint.

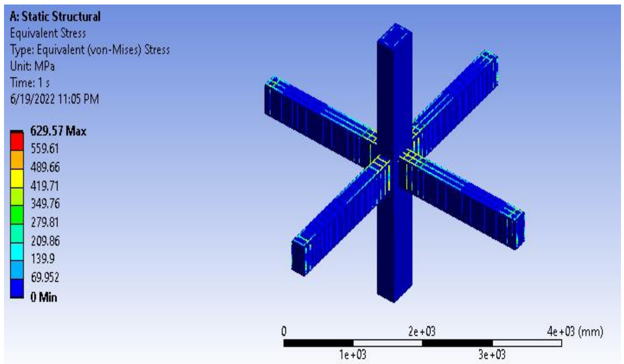

Fig -5: Equivalent stress of steel main bars and stirrups

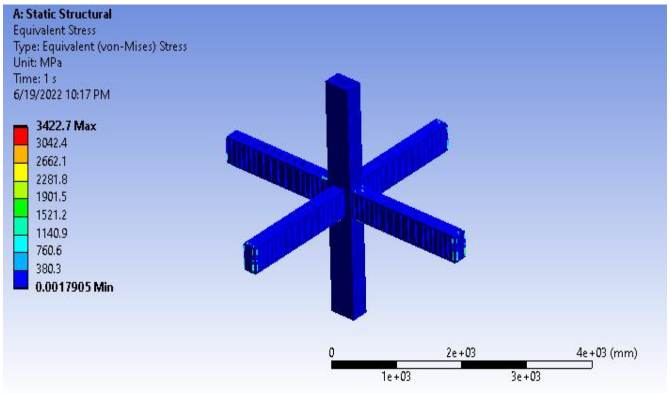

Fig -6: Equivalent stress in GFRP main bars and stirrups

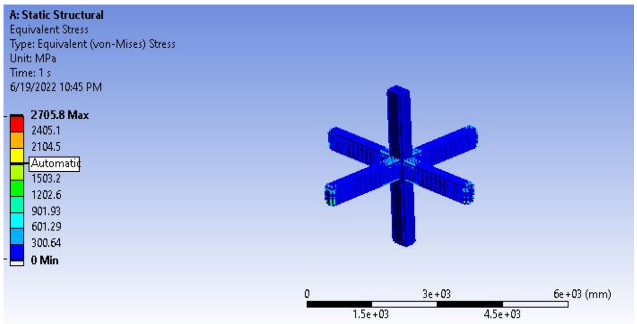

Fig -7: Equivalent stress of steel main bars and GFRP stirrups

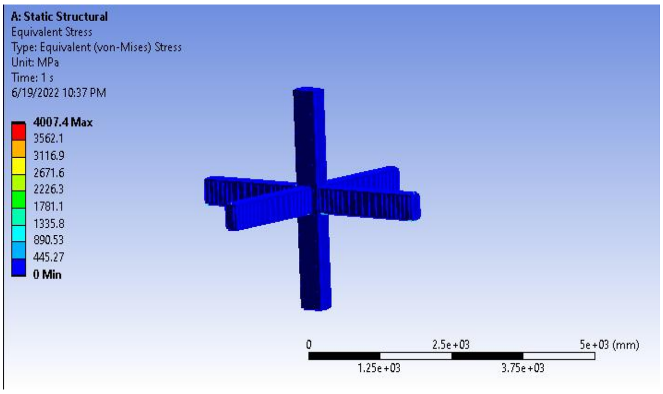

Fig -8: Equivalent stress of GFRP main bars and steel stirrups

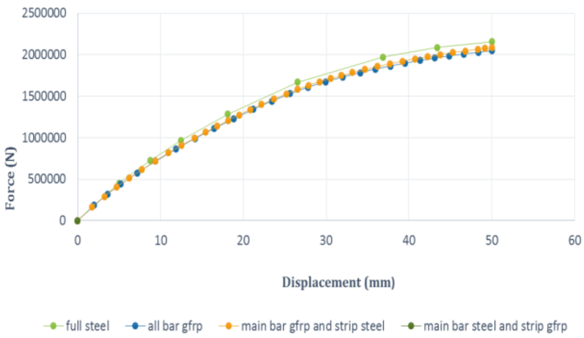

Chart-1: Behavior of corner beam column joint and interior beam column joint under cyclic loading

Table -3: Energy absorption capacity

Name of model	Energy absorption
Full GFRP	194640805.1
Full steel	61000280
GFRP main bars and steel stirrups	253703981.7
Steel main bars and GFRP stirrups	203137251.3

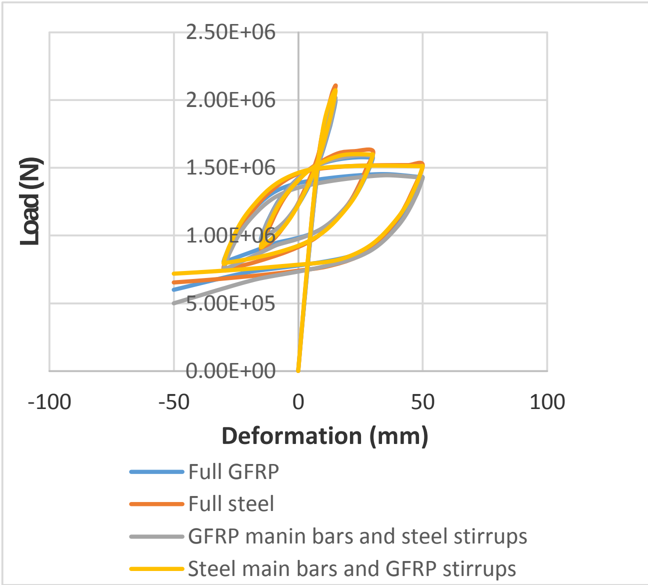

Chart-2: Hysteries loop of beam column joint with different materials.

4. CONCLUSIONS

This study mainly used to compare different types of material that are used in beam column joint. From these we can conclude that,

- When we are providing full steel, maximum force is obtained.
- The force value is on the range of 200 to 250kN.
- And the corresponding displacement is about 50mm.
- Beam- column joint with GFRP main bars and steel stirrups have high deformation 328.6mm.
- Beam - column joint by GFRP main bars and steel stirrups have the maximum energy absorption capacity and high yield strength.

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