International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

Comparative Study on Performance of RCC, STEEL & CFST Frames Column in Irregular Building.

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Abstract – *Steel concrete composite construction has gained wide acceptance worldwide as an alternative to pure steel and pure concrete construction. The use of steel in construction industry is very low in India compared to many developing countries. There is a great potential for increasing the volume of composite structure in construction, especially in the current development needs India and not using composite structure as an alternative construction material and not using it where it is economical is a heavy loss for the country. In this paper study of three various multistore buildings with vertical irregularity and mass irregularity of RCC, STEEL and CFST (Concrete filled steel tube) column frames. i.e. G+15, G+20, G+30 is designed by using ETABS software Where analysis is to be carried out by response spectrum method and cost estimation are carried out using MS-Excel programming and from obtained result comparison can be made between R.C.C and composite structure.*

***Key Words*: Shear wall, Location, ETABS, Dynamic analysis, Response spectrum,**

1. INTRODUCTION

Composite structures can be defined as the structures in which composite sections made up of two different types of materials such as steel and Concrete are used for beams, and columns. Various materials are used to make columns and beams which are vital components of any structural system. Concrete and steel are pioneer materials amongst these. The choice of material depends upon numerous factors like type and purpose of building, size of building, availability of materials, topography of land, climatology and budget. RCC and steel frames have been the most common frame systems for long times whereas composite frame system has also emerged as popular system for high rise buildings for few decades. Multi-story composite frames are generally composed of structural steel members made composite with concrete. The use of concrete filled steel tubes (CFST) in building construction has seen renaissance in recent years due to their numerous advantages, apart from its superior structural performance. Their usage as columns in high-rise and multi-story buildings, as beams in low-rise industrial buildings and as arch bridges, has become wide spread in countries like China and many other countries in last few decades with abundant examples. But, their usage in India is a new concept. Hence, this study shall primarily emphasis to investigate the various aspects of CFST members as beams and columns and as part of frames in the building industry primarily considering the various aspects of these members which have turned its unique phase with the advancement of technology.

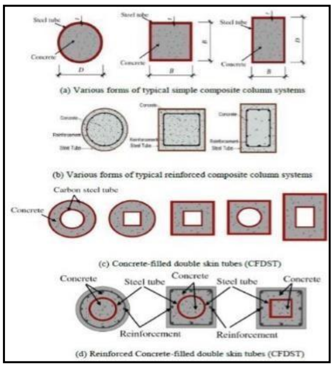


Fig:1 Types of CFST column

2. OBJECTIVES

(i) To do comparative study of CFST, RCC and Steel building. To study its effectiveness in high rise structure.

(ii) To understand the Comparison of Story drift in RCC, Steel and CFST column system. Base shear and Story Displacement of structural system can be considered.

(iii) Behaviour of concrete filled tube structural system. To study economy of structure.

3. LITREATURE VIEW

Jadhav Gorakhnath S, Sutar Shrikant R, Bankar Shriprasad V (2015): - From the equivalent linear analysis, it is seen that the story drift reduces appr up to 49 % As Compared with RCC from pushover analysis it is seen that story displacement is decreases as compare to RCC. The Also story drift of composite is considerably reduced as compared with RCC.

Manjari Blessing B, Gayathri S :- This paper presents the seismic analysis for G+9 story structure for both RCC and CFST column using ETABS software. The RCC and CFST structures were modeled as per codal provisions. RCC structure was designed as per IS 456-2000.and composite structure was design as per AISC standards. In this paper, comparing parameters like Story Drift, Story Displacement, Story Shear and Story Stiffness for both R.C.C and Composite structures are shown below in tables and graphs.

Shweta A. Wagh, Dr. U. P. Waghe : - Steel construction is showing comparatively more deformations and very less stiffness resulting into less convenient construction.
In case of a composite structural system because of the lesser magnitude of the beam end forces and moments compared to an R.C.C system, one can use lighter section in a composite structure. Thus, it is reducing the self-weight and cost of the structural components.

Vidhya Purushothaman, Archana Sukumaran.: - In the present study, an attempt is made to find which type of composite column is effective to resist lateral deformation in a multistoried building by Response Spectrum Analysis. The seismic analysis is carried out taking into consideration that all the buildings are located in zone III i.e. Thiruvananthapuram region as per code. The base shears, story drift and story displacement are plotted and compared for each model. The mode shapes corresponding to each time period are obtained. It was concluded that concrete filled steel tube columns performed better in regular buildings and composite column with encased I section columns performed well in irregular buildings.

Ketan Patel, Sonal Thakkar: -

For 30 story building permissible displacement limit is 180mm as per deflection criteria and RCC building top story displacement was 179.6mm very near to permissible limit. Therefore, it can be said that beyond 30 story RCC will not useful with this geometric frame structure.
Percentage reduction in time period was 26.2 % and 3.5 % for a 30 story CFT building compared to RCC and steel building while for 20 story it was 25.5 and 17.8% compared RCC and Steel structure. Load carrying capacity for 20 story CFT structure increased by 19.1 % and 27.3% compared to steel and RCC structure while for 30 story CFT structure Presents work shows the use of concrete filled steel tube columns has been consistently applied in the design of tall buildings as they provide considerable economy in comparison with conventional steel building. Also, performance wise result good compared to RCC and Steel building.

4. METHEDOLOGY

4.1 MODELLING OF BUILDING

In the present study G+15, G+20, & G+30 high-rise regular buildings and irregular buildings with height and mass irregularity are modelled using ETABS. The response spectrum method is considered as per IS 1893-Part 1-2016. Seismic zones II considered. Type of soil medium considered.

4.2 BUILDING PLAN AND DIMENSION DETAILS

G+15, G+20, & G+30 story building of RCC, STEEL & CFST column frames designed by ETABS software and optimization of a section is done at every three sequential floors. In RCC column frame, optimum column section selected by the many trial and error method in a such manner of Longitudinal Reinforcement area comes between in a 2% to 3% of the cross-sectional area. In CFST column frame, optimum section selected by the design capacity ratio. And the section provided such as the capacity ratio comes into the range of 0.75 to 0.95.

Parameter	Values
Concrete grade	M25
Steel grade	Fe 500
Thickness of slab	125mm
Dimension of beam	230mm X 575mm
Dimension of column	300mm X 300mm, 450mm X 450mm 600mm X 600mm 750mm X 750mm
Floor height	3000 mm

Table -1: Parameter and Values

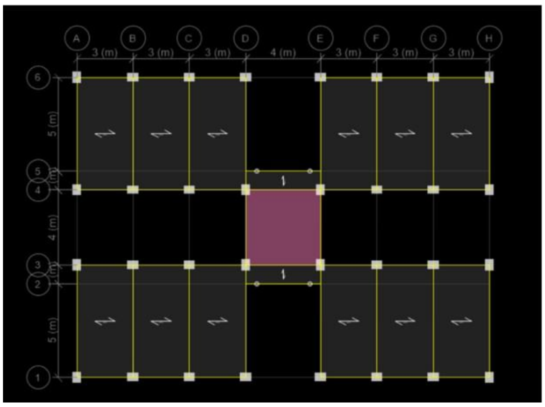


Fig 1: Plan of G+15 story RCC building (22 m x 16 m)

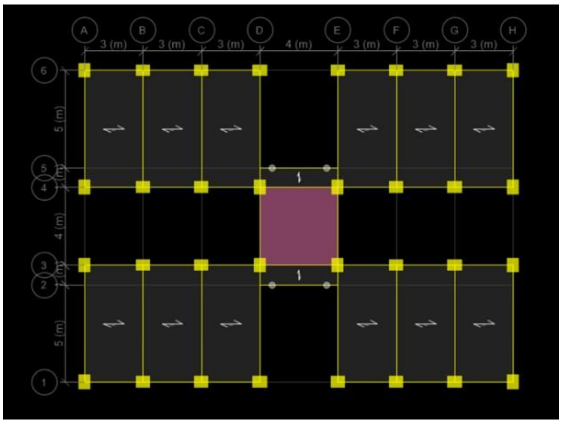


Fig 2: Plan of G+20 story RCC building (22 m x 16 m)

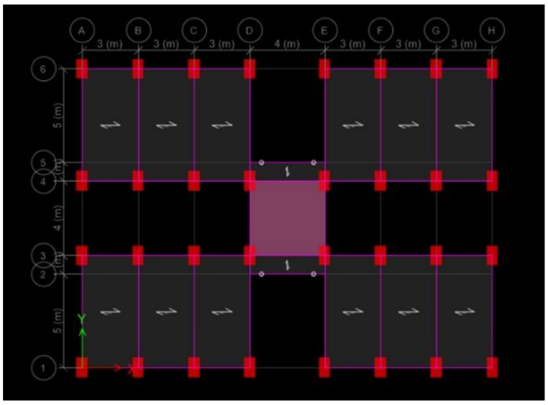


Fig 3: Plan of G+30 story RCC building (22 m x 16 m)

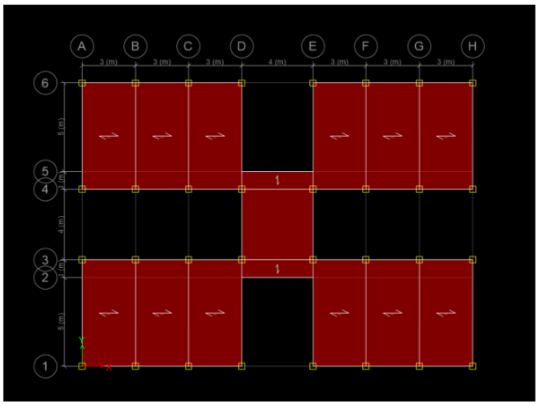


Fig 4: Plan of G+15 story CFST building (22 m x 16 m)

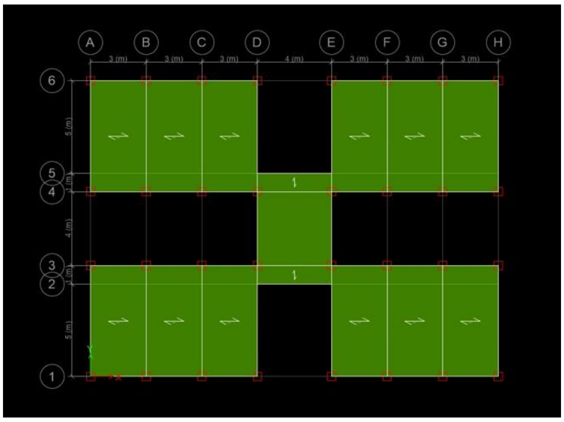


Fig 5: Plan of G+20 story CFST building (22 m x 16 m)

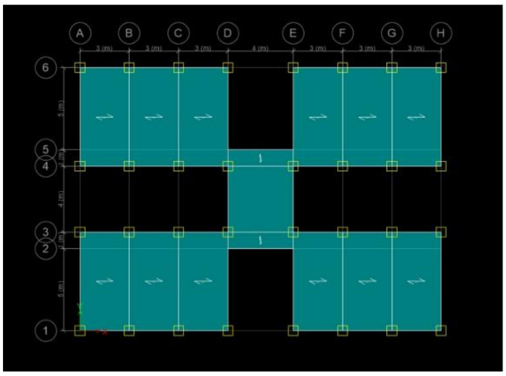


Fig 6: Plan of G+30 story CFST building (22 m x 16 m)

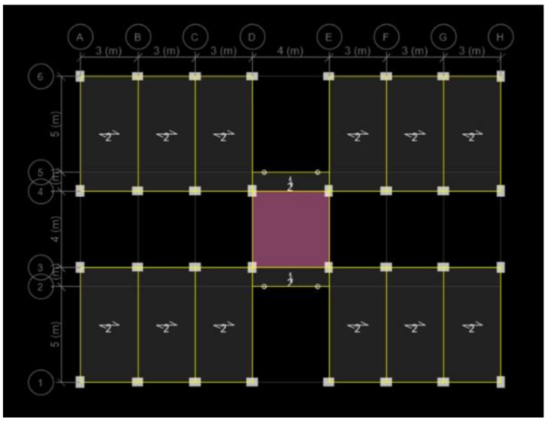


Fig 7: Floor Load of RCC Building with Mass Irregularity

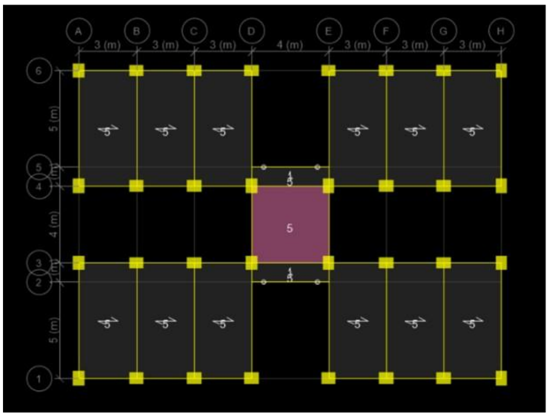


Fig 8: Live Load of RCC Building with Mass Irregularity

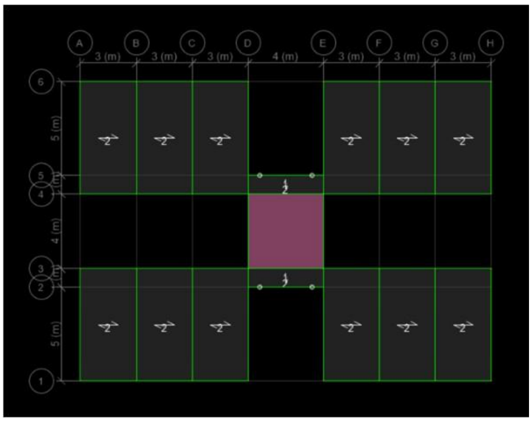


Fig 9: Floor Load of Steel Building with Mass Irregularity

5. SEISMIC ANALYSIS OF BUILDING

After analyzing the models, the following results were obtained for different types of column frames like RCC & steel and CFST. The charts were generated for easy comparison of the results for different parameters i.e. Base reactions, Joint reactions, Displacement and Story drift.

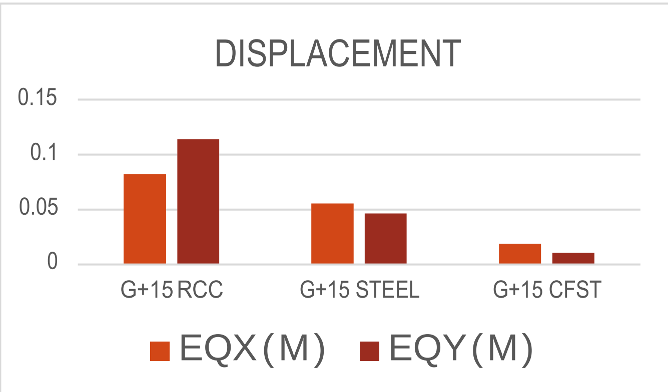
Seismic Properties	As per IS 1893:2016
Seismic Zone	0.16 (II)
Response Reduction Factor	5 (SMRF)
Importance Factor	1.2
Time period	1.032

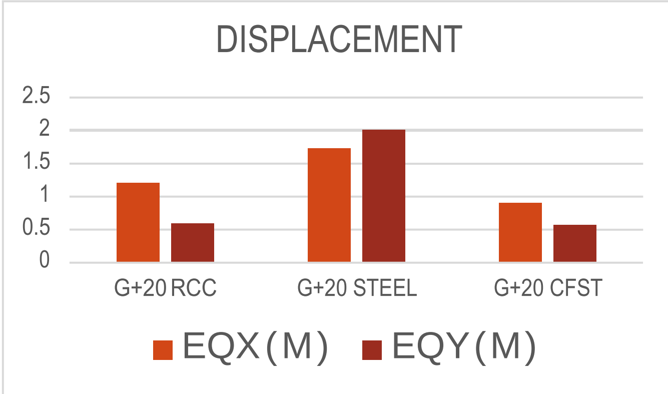
Table -3: Seismic properties

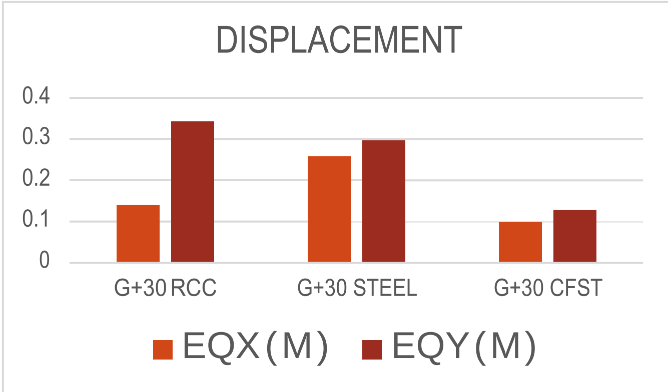
6. RESULTS

6.1 STOREY DISPLACEMENT

Graphical representation of displacement values for all models as shown in Chart 1 and Chart 2.







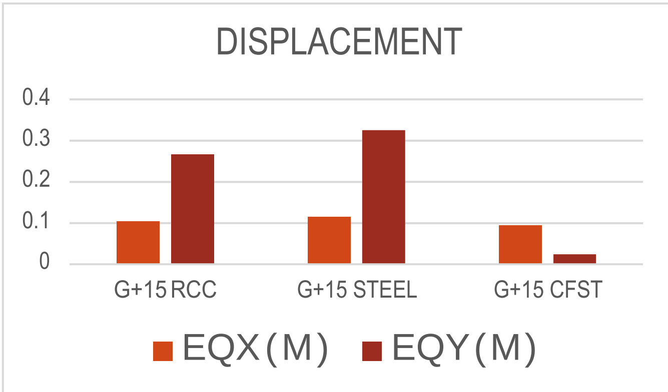


Chart1: Displacement graph of Model 1 to model 4

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
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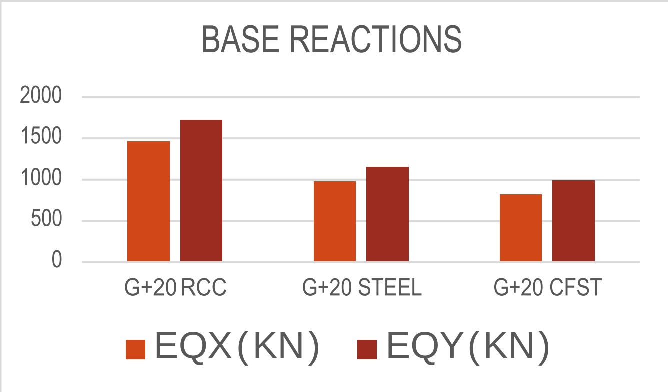
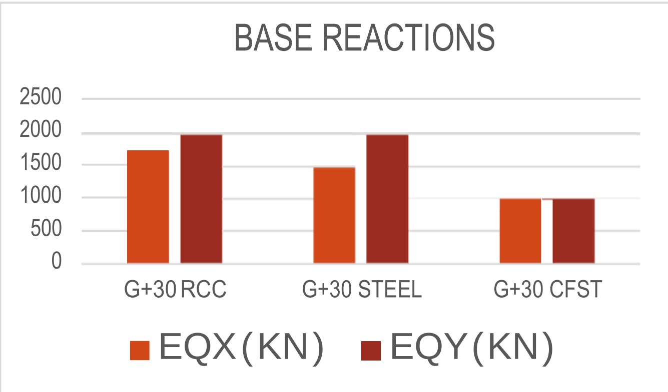
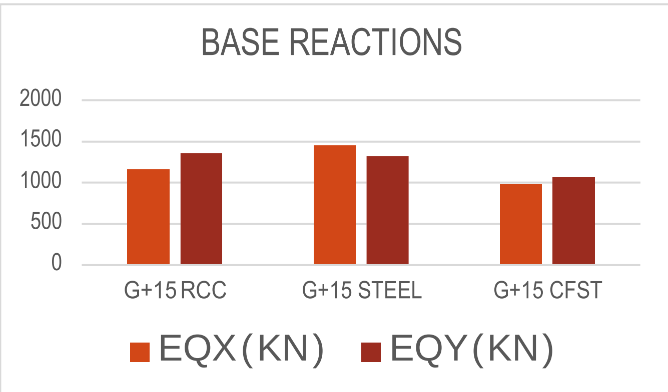
6.2 BASE REACTOIN

Graphical representation of Base values for all models as shown in Chart 3.







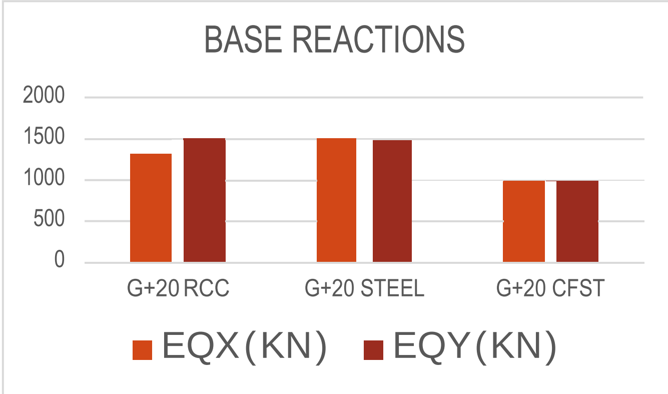
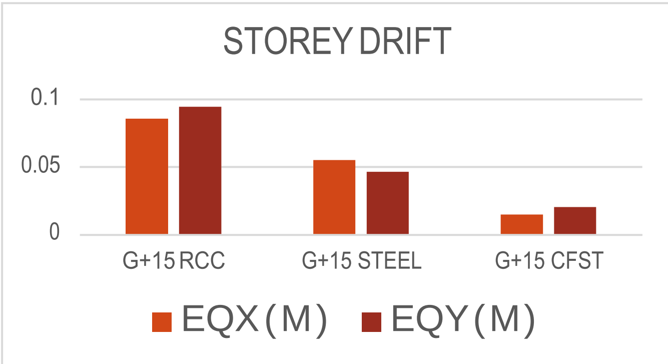
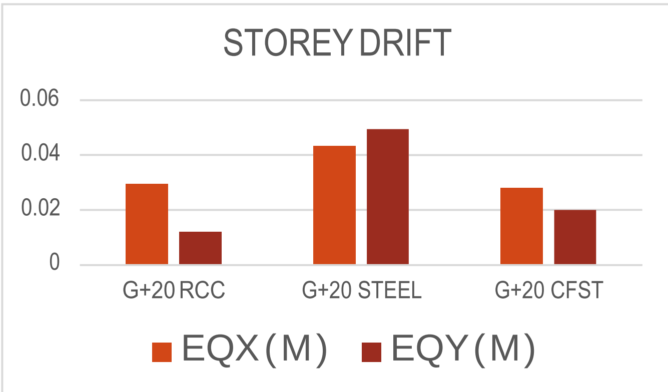


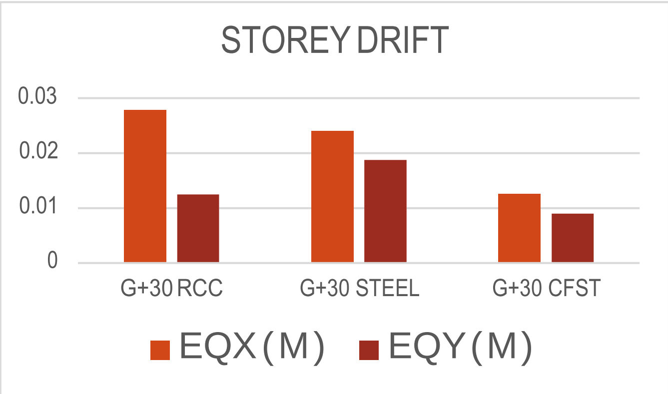
Chart 2: Base Reaction for all model

6.3 STOREY DRIFT

Graphical representation of storey drift values for all models as shown in Chart 4 and Chart 5.







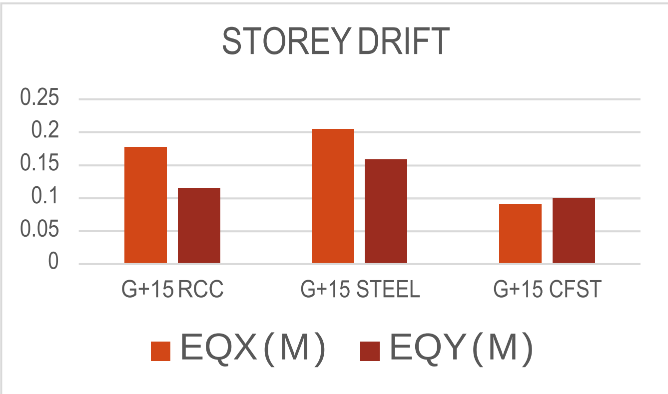


Chart 3: Drift graph of Model 1 to model 6

7. CONCLUSIONS

The important conclusions which can be derived from this research work are as follows:

In software verifications the ETABS gives nearest values to the manual calculations.

- Comparisons of cross section area shows the benefits up to an average 30% in CFST column cross sections. Thus, CFST column required less area and get to benefits in the carpet area of the flat.
- In worst load combination (1.5DL+1.5WL) story displacement data, CFST column frames gives less story displacement compare to RCC & STEEL frames and here CFST frames gives less displacement by average percentage of 10.5%, & 22.30% in X and Y directions respectively.
- Story drift data, CFST column frames gives less story displacement compare to RCC & STEEL frames and here CFST frames gives less story drift by average percentage of 7.5%, & 20% in X and Y directions respectively.
- Base reactions data, CFST column frames gives less base reactions compare to RCC & STEEL frames and here CFST frames gives less story drift by average percentage of 10%, & 20% in X and Y directions respectively.
- By cost analysis of RCC, STEEL & CFST column frames CFST column gives economy by 8%, 20% & 28% in G+10, G+20 & G+30 story building.
- Finally, we can say Concrete filled steel tube (CFST) column frames gives more economy, less base reaction, Joint reaction, Story drift & Story displacement and its constructions process is much faster than RCC and STEEL column frames.

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