Comparative Study of R.C.C, Composite and Steel Structure Under Dynamic Condition

[1]Sayyed Faizuddin Hashmi, [2]Hemant.B.Dahake

[1]M.E Scholar, [2]Assistant Professor
G.H.Raisoni College of Engineering and Management, Amravati

***Abstract*: This paper presents a work done on seismic performance of reinforced concrete structure and composite structure of G+10 buildings in seismic zones III & IV. This paper focus on the R.C.C Structure and Composite Structure with their relative significance. The results are obtained on the basis of Story Drift, Story Displacement. The seismic performance of buildings having reinforced concrete structure and composite structure is comparable but the differences exist.**
The development of infrastructure sector is taking place at an unprecedented rate and it demands suitable materials to have our structure safer, sustainable and economical. Both the reinforced cement concrete structures and steel framed structures are suitable choice of building construction because of their versatility and reliable properties. Our main endeavour is to deal with the comparative study of structural analysis between steel framed structure and reinforced cement concrete structure. Mass material & storey stiffness, base shear, storey drift ratio, centre of mass, centre of rigidity and displacement is determined and compared to delve into a conceptual clarity regarding material choice. Three-dimensional model of RCC and steel structure are analysed with the help of software ETABS 2018.
Composite structure as on today was first used in both a building and bridges. as compared to R.C.C structure Composite structures are more famous due to Both speed and economy can be achieved in case of composite systems. Steel-concrete composite systems for buildings are form a bond with each other and they form a complete composite structure with the help of shear connectors etc.

***Keywords*: Composite steel-concrete systems, steel system, Soft storey, Equivalent static method, Response spectrum method, Base shear. Using ETAB software. Ratio, Displacement, Infill frame, Inter-Storey, drift, Strut.**

I INTRODUCTION

RCC and steel structures follows a similar load transfer method, they differ with one another in several factors. RCC is the composite material having concrete with steels bar embedded in it. They ensure better compression and tension withstanding capacity and are used in large number for structural construction to satisfy the basic requirements like stability, strength and serviceability. Steel structure is an assemblage of elements rolled to a basic cross-section making desired size and form in the site. On the other hand, due to the large strength to weight ratio, steel structures tend to be more economical than concrete structures for tall buildings and large span buildings and bridges and an eco-friendly material, which can easily be dismantled and sold as scarp.

The use of Concrete encased steel column in different areas of construction is becoming an attractive solution. It provides not only an increase in the load carrying capacity but also economy and rapid construction, and thus additional cost saving. Their use in multistory buildings has increased in recent years owing to the benefit of increased load carrying capacity for a reduced cross section.

Concrete encased steel columns have been utilized in dwelling houses, tall buildings and many types of arch bridges. Steel sections used as reinforcement in this composite structure. Concrete encased steel columns have established an appropriate loading capacity, ductility and energy absorption capacity. Steel in Concrete encased steel columns act as reinforcement for the structure. Concrete `composite material which is known as Concrete encased steel column fiber reinforced polymer. There composite action results in resisting development of crack and gives better ductility. Concrete encased steel columns exhibit higher strength and fire-resistant property over bare steel columns, larger stiffness and ductility. In previous, a large number of studies had been carried out to examine the realistic behavior of Concrete encased steel column under post fire conditions. Structural members will experience several phases like the initial loading, the heating phase with the development of fire, and the cooling phase when subjected to fire. If the member survives after the fire, its residual strength needs to be assessed to check its appropriateness for frequent use. During construction, the flange plate acts as both erection steel and forming for the composite column, decreasing the labour and materials required for construction and, consequently, lowering the construction cost.

II COMPONENTS OF COMPOSITE STRUCTURES

Composite slab

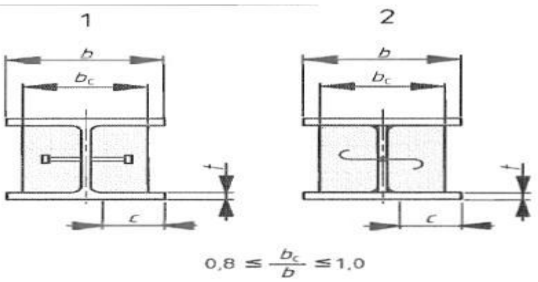
A composite slab in which steel sheets are connected to the composite beam with the help of shear connectors, initially steel sheets act as permanent shuttering and also act as bottom reinforcement for steel deck slab and later it is combined with hardened concrete.

Shear connectors

Shear connectors (studs) are used to connect the concrete and structural steel and they give the sufficient strength and stiffness to the composite member.

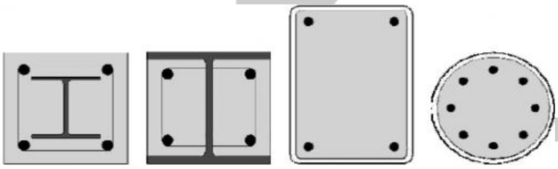
Composite beam

A composite beam is a steel beam or partially encased beam which is mainly subjected to bending and it supports the composite deck slab.



Composite column

Composite columns are a composite compression member or bending and compression members with steel encased sections partially or fully and concrete filled tubes.



Plastic resistance of a composite column of a cross section will be determined by following equation

For concrete encased and partially concrete encased sections
PPC = Aa*fyd + 0.85Ac*fcd + As*fsd

For concrete filled sections
PPC = Aa*fyd + Ac*fcd + As*fsd

Aa – cross sectional area of structural steel
Ac – cross sectional area of concrete
As – cross sectional area of reinforcing steel
fyd – design value of yield strength of structural steel
fcd – design value of yield strength of cylindrical compressive strength of concrete
fsd – design value of yield strength of reinforcing steel

III LITERATURE REVIEW

Umesh P.Patil , Suryanarayana (june 2015) evaluate and compare the seismic performance of G+ 15 storey's made of RCC and composite structures ETABS 2013 software was used for the purpose. Both steel and concrete composite structures and RCC structures were having soft storey at ground level, structures were located in the region of earthquake zone III on a medium soil. Equivalent static and response spectrum method is used for analysis. Storey drift, self weight, bending moment and shear force, are considered as parameters. When compared composite structures shows better performance than RCC. It was concluded that the

1) Storey drift is reduced by 10% in composite models compared to RCC in soft storey level. In other storey's using equivalent static case, storey drift is reducing by 70% and the same reduces by 50% using response spectrum case.
2) Self weight is reduced by 10% in composites compared to RCC.
3) Bending moment in X direction in composites is reduced by 11% compared to RCC, but in Y direction it is increased by70%.
4) Shear force in X direction in composites is reduced by 16% compared with RCC, but in Y direction increases by 65%.

Shweta A. Wagh*, Dr. U. P. Waghe (April 2014) they study Four various multi-storeyed commercial buildings i.e. G+12, G+16, G+20, G+24 are analysed by using ETABS 2013 software. Where design and cost estimation is carried out using MS-Excel programming and from obtained result comparison made between R.C.C and composite structure. It was concluded that
1) Composite structure is nearly double than that of R.C.C structure but within permissible limit.
2) The Shear force and Axial force in R.C.C structure is on higher side than that of composite structure.

D. R. Panchal and P. M. Marathe (December 2011)they analyse steel concrete composite, steel and R.C.C. options are considered for comparative study of G+30 storey commercial building which is situated in earthquake zone IV. Equivalent Static Method of Analysis is used. For modelling of Composite, Steel and R.C.C. structures, ETABS software is used and the results are compared It was concluded that
1) The reduction in the dead weight of the Steel framed structure is 32 % with respect to R.C.C. frame Structure and Composite framed structure is 30 % with respect to R.C.C. framed structure.
2) Shear forces in secondary beams are increased by average 83.3% in steel structure and reduced by average 10 % in composite structure as compared to R.C.C. framed structure while in main beams shear forces are increased by average 131% in steel structure and reduced by average 100 % in composite structure as compared to R.C.C. framed structure.
3) Bending moments in secondary beams are increased by average 83.3% in steel structure and reduced by average 48 % in composite structure as compared to R.C.C. framed structure while in main beams bending moments are increased 131% in steel structure and increased by average 117 % in composite structure as compared to R.C.C. framed structure.
4) Total saving in the composite option as compared to the R.C.C. results in 10 % so as with Steel it will be 6-7%.

IV OBJECTIVES

The salient objectives of the present study have been identified as follows:

i. To perform Dynamic analysis of multi-Story buildings having composite column, RCC column, steel column for different seismic zone in India.
ii. To observe the behavior of RCC column, steel column and composite column under seismic conditions.
iii. To compare the behavior of multi-Story buildings with using RCC columns, steel Column and Composite columns.
iv. To validate which type of column give best result.
v. To compare results of composite structure with RCC frame structure according to their performance.

V MODELING CONNFIGURATION

1) Plan dimensions: - 12m X 12m
2) Length in X-direction: - 12m
3) Length in Y-direction: - 12m
4) Floor to floor height: - 3.0m
5) No. of Story: - 11 Story
6) Total height of building: - 33 m
7) Slab thickness: - 135mm
8) Outer wall thickness: - 230mm
9) Inner wall thickness: - 115mm
10) Grade of Concrete: - M25
11) Grade of Steel: -Fe415
12) Importance factor: - 1
13) Response Reduction factor: - 3
14) Zone Factor

Zone	Factor
III	0.16
IV	0.24

In the present work building of G+10, are referred as modal. Seismic analysis was performed for Zone III and Zone IV.

Table.1 List of Modal

Story	Modal	Beam	Column	Slab
G+10	Modal 1	RCC	RCC	RC slab
	Modal 2	RCC	COMPOSITE	RC slab
	Modal 3	STEEL	STEEL	RC slab

Respective modals of G+10, are analysed and compared considering parameter such as story drift, joint displacement, story shear, self-weight, Bending moment.

Method adopted for analysis of structure was response spectrum method. IS 1893-2002 was used for seismic analysis of modal.

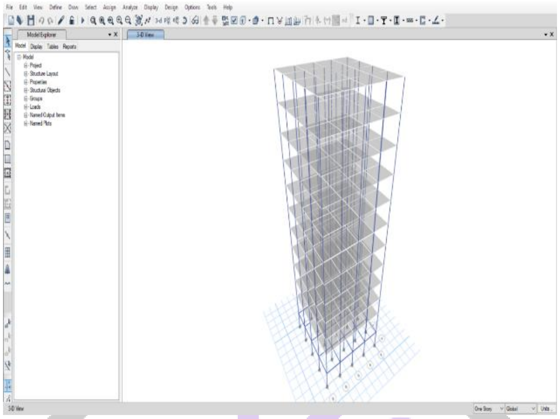


Fig: 1 Isometric View of Building (G+10).

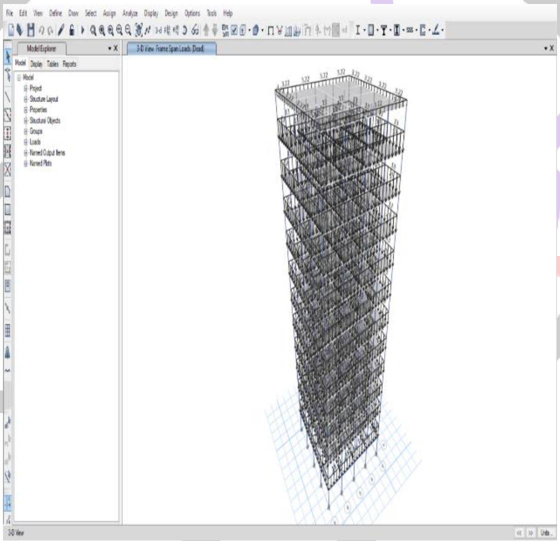


Fig: 2 Isometric View of Building (G+10) with loading.

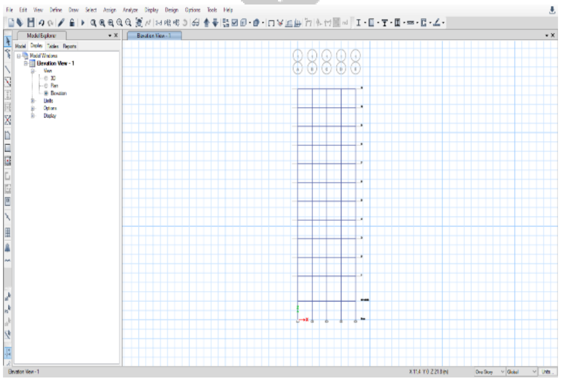


Fig: 3 Elevation of G+10 Building.

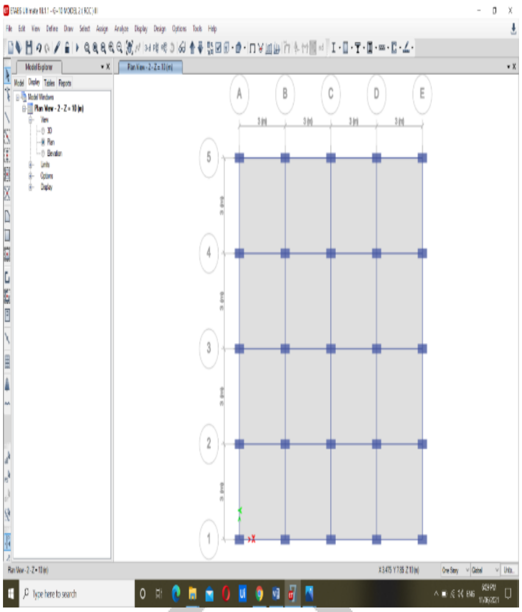


Fig: 4 Plan of Building with Rectangular RCC Colum.

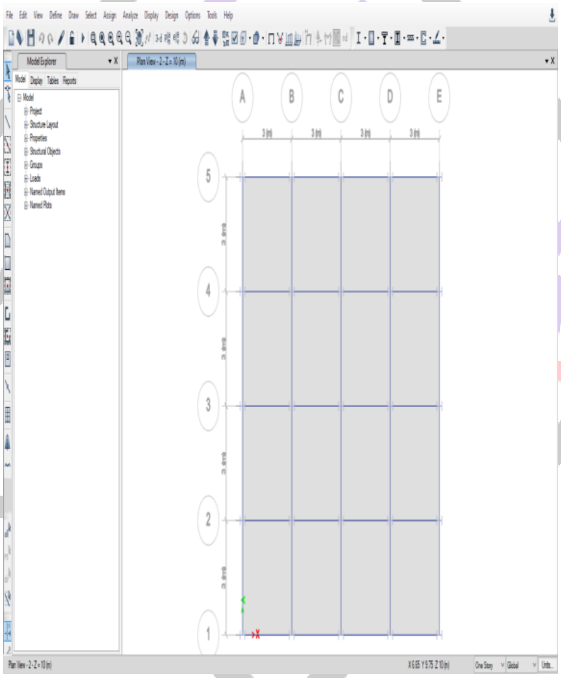


Fig: 4 Plan of Building with steel Colum.

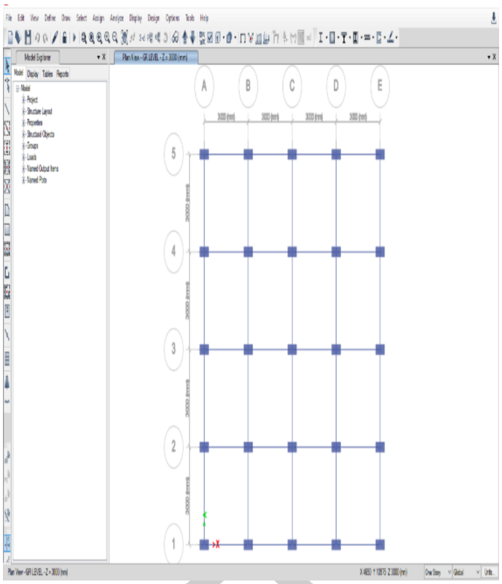


Fig: 4 Plan of Building with Rectangular composite Colum.

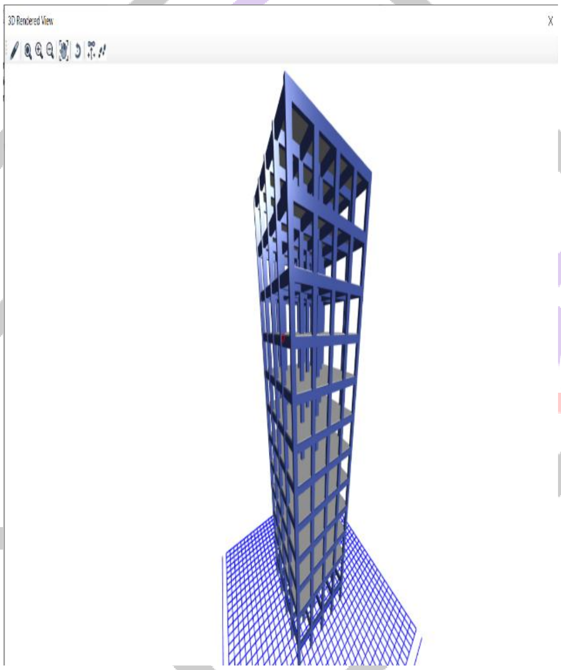


Fig: 4 3D view of Building.

Table 2. List of Beam for G+10

Story	Zone III			Zone IV		
	Composite	RCC	Steel	Composite	RCC	Steel
1	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
2	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
3	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
4	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
5	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
6	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
7	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
8	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
9	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
10	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1
11	ISMB 250-1	300X600	ISHB 300-1	ISMB 250-1	300X600	ISHB 300-1

Table.3 Frame configuration for G+10

ZONE	Composite	RCC	Steel
	RECTANGULAR	RECTANGULAR	I SECTION
III	300X600 + ISMB 250-1	300X600	ISHB 300-1
IV	300X600 + ISMB 250-1	300X600	ISHB 300-1

VI. PERFORMANCE ANALYSIS
Result of G+10
For Zone III
For Drift in X-Y Direction
For Rectangular Column Structure

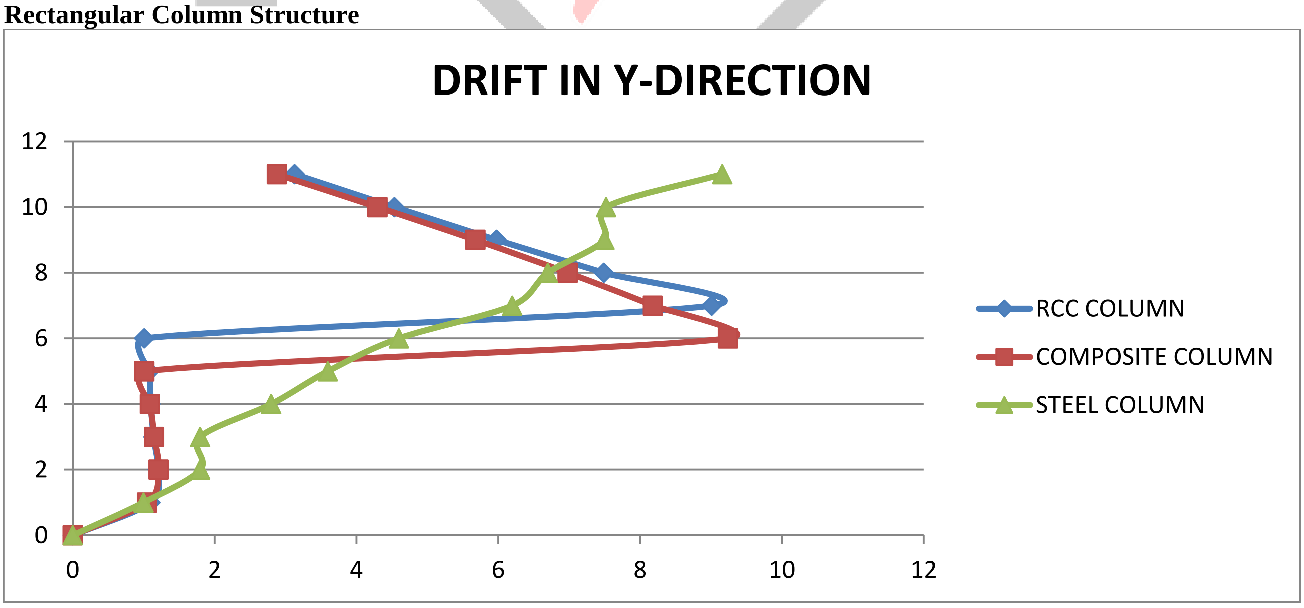


Fig. 7 Story Drift in x-y direction

From result it is observed that maximum storey drift in x-y direction for RCC Rectangular column structure is more than the drift for Composite, steel column structure.

For Displacement in X-Y Direction
For Rectangular Column Structure

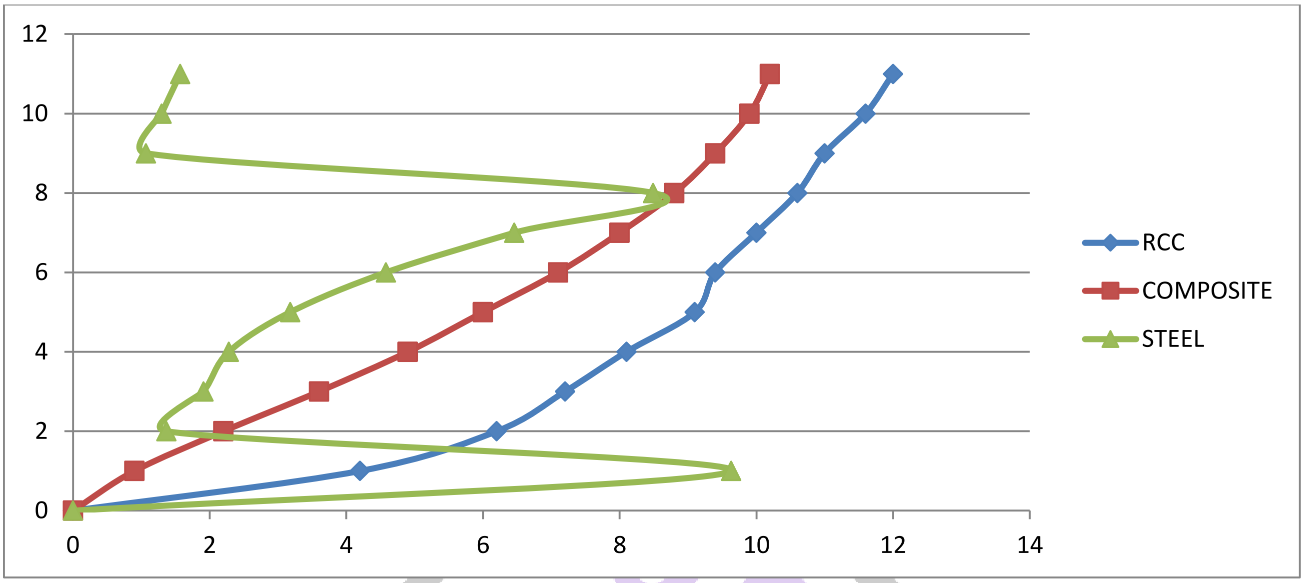


Fig. 10. Story Displacement in x-y direction

From result it is observed that maximum storey displacement in x-y direction for RCC Rectangular column structure is more than the displacement for Composite, steel column structure.

Result of G+10
For Zone IV
For Drift in X-Y Direction
For Rectangular Column Structure

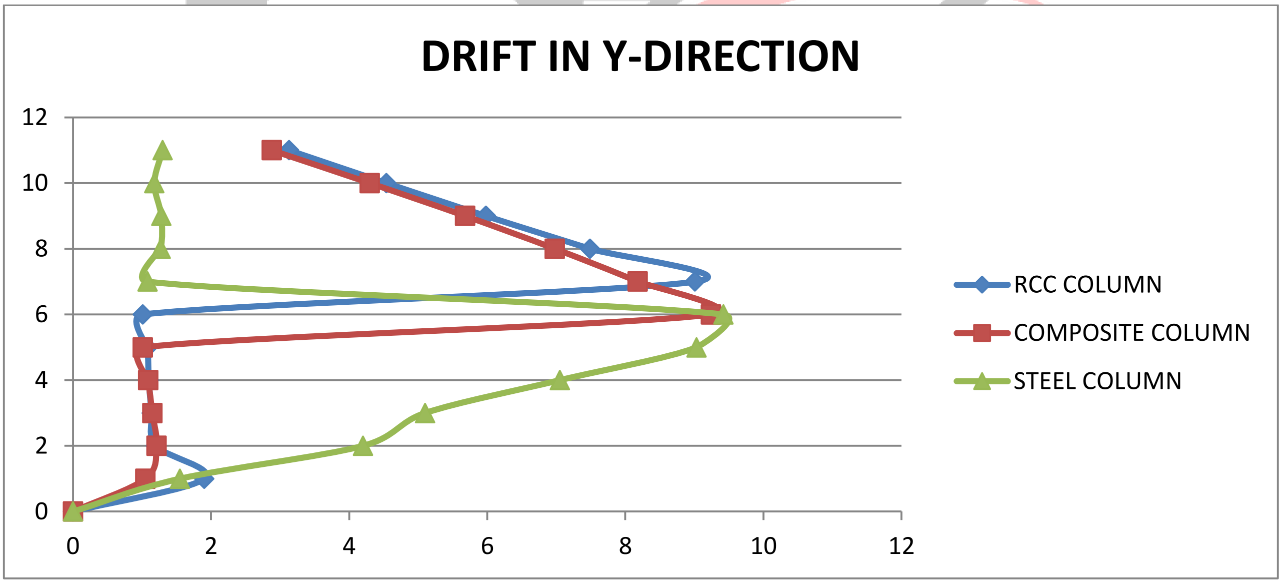


Fig. 7 Story Drift in x-y direction

From result it is observed that maximum storey drift in x-y direction for RCC Rectangular column structure is more than the drift for Composite, steel column structure.

For Displacement in X-Y Direction
For Rectangular Column Structure

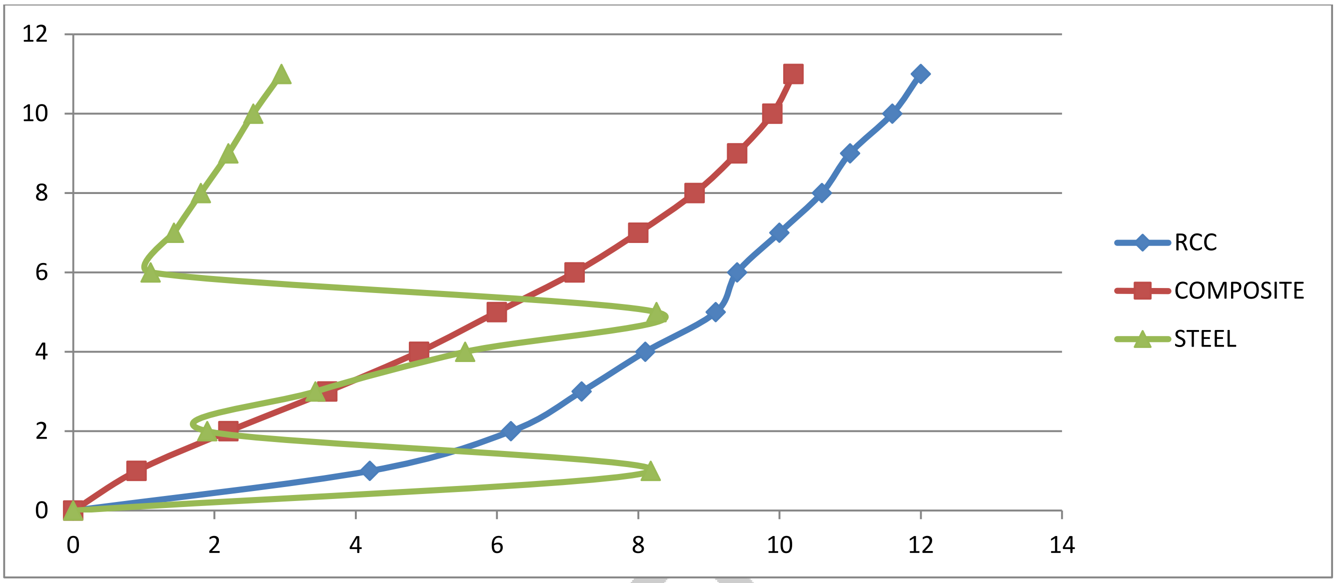


Fig. 10. Story Displacement in x-y direction

From result it is observed that maximum storey displacement in x-y direction for RCC Rectangular column structure is more than the displacement for Composite, steel column structure.

VII CONCLUSION

From the analysis done on G+10 structure in zone III & zone IV. the following conclusions are made:

1) In zone III & zone IV story drift is coming out to be less for composite, column structure as compared to RCC column structure for G+10 modal.

2) In zone III & zone IV story displacement is coming out to be less for composite column structure as compared to RCC column structure for G+10 modal.

3) In zone III & zone IV self weight is coming out to be less for composite column structure as compared to RCC column structure for G+10 modal.

4) Composite and Steel structure show to be economical.

5) Composite structures are being more ductile, resist lateral load better than RCC structures.

6) From the result it can be concluded that for low rise building and high-rise building composite structure gives best result than RCC frame under seismic analysis.

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