Comparative Study of Conventional R.C.C & Composite Structure

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ABSTRACT :- This paper presents a work done on seismic performance of reinforced concrete structure and composite structure of G+10 and G+15 buildings in seismic zones III & IV . This paper focus on the R.C.C Structure and Composite Structure having different shapes of columns and their relative significance . The results are obtained on the basis of Story Drift , Story Displacement , Self Weight . The seismic performance of buildings having reinforced concrete structure and composite structure is comparable but the differences exist.

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.

Key words:- *Composite steel-concrete systems, Soft storey, Equivalent static method, Response spectrum method, Base shear. Shear connector, ETAB software. ratio, Displacement, Infill frame, Inter-Storey, drift, Strut.*

I. INTRODUCTION

Steel concrete composite systems have become quite popular in recent times because of their advantages against conventional construction. Composite construction combines the better properties of the both i.e. concrete and steel and results in speedy construction. Composite members are made up of two different materials such as steel and concrete which are used for beams and columns. The steel and concrete structures have wide applications in multi-storey commercial buildings and factories as well as in case of bridges. Steel and concrete have almost the same thermal expansion, concrete is efficient in taking compression loads and steel is subjected to tensile loads Composite structures are becoming popular and steel or purely concrete structures can be minimized .in composite construction initial construction loads will be carried out by steel frame sections including self weight during the construction and then concrete is cast around the section or concrete is poured inside the tubular section . in the comparative study includes deflections of the members, size and material consumption of members in composite with respect to R.C.C. , seismic forces and behaviour of the building under seismic condition in composite with respect to R.C.C. foundation requirements and type of foundation can be selected for Composite structure with respect to building .

II. COMPONENTS OF COMPOSITE STRUCTURES

A. Composite slab

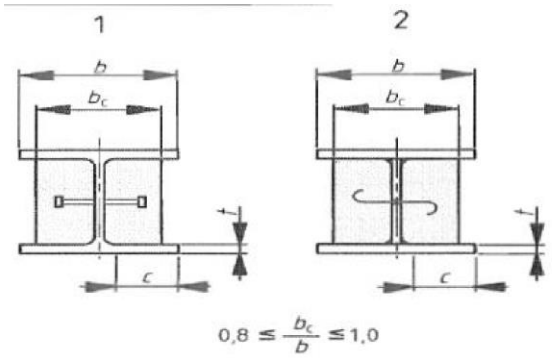
A composite slab in which steel sheets are connected to the composite beam with the help of shear connectors, initially steel sheets act as permanent shuttering and also act as bottom reinforcement for steel deck slab and later it is combined with hardened concrete.

B. 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.

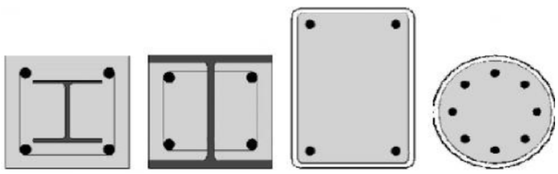
C. Composite beam

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



D. Composite column

Composite columns are a composite compression members 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

- 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 reduces by 70% and the same reduces by 50% using response spectrum case.
- Self weight is reduced by 10% in composites compared to RCC.
- Bending moment in X direction in composites is reduced by 11% compared to RCC, but in Y direction it is increased by70%.
- 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

- composite structure is nearly double than that of R.C.C structure but within permissible limit.
- 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 analyze 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

- 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.
- 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.
- 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.
- 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:

- To perform Dynamic analysis of multi Story buildings having composite column for different seismic zone in India.
- To observe the behavior of composite column under seismic conditions.
- To compare the behavior of multi Story buildings with using R.C.C columns and Composite columns.
- To validate which type of column give best result .

V. MODELING CONNFIGURATION

1. Plan dimensions: - 24m X 24m
2. Length in X-direction: - 24m
3. Length in Y-direction: - 24m
4. Floor to floor height: - 3.0m
5. No. of Story: - 11 & 16 Story
6. Total height of building: - 33 m, 48 m
7. Slab thickness: - 150mm
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, G+15 are referred as modal. Seismic analysis was perform 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	Steel	COMPOSITE	RC slab
G+15	Modal 3	RCC	RCC	RC slab
	Modal 4	Steel	COMPOSITE	RC slab

Respective modals of G+10, G+15 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.

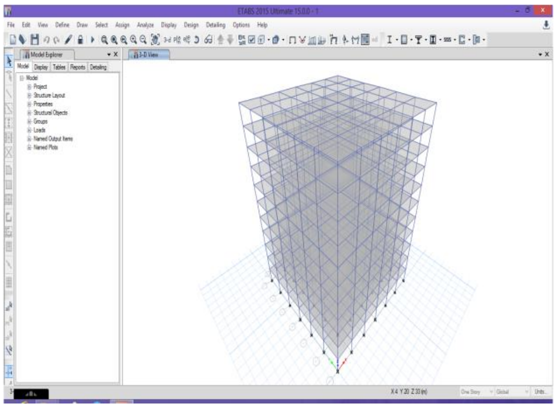


fig:1 Isometric View of Building (G+10)

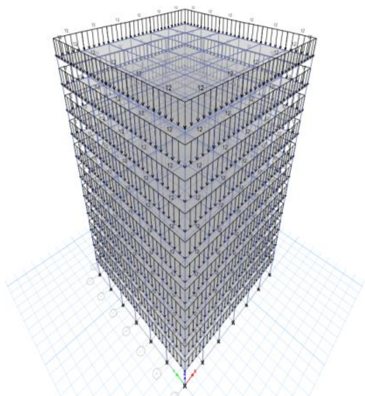


fig:2 Isometric View of Building (G+10) with loading

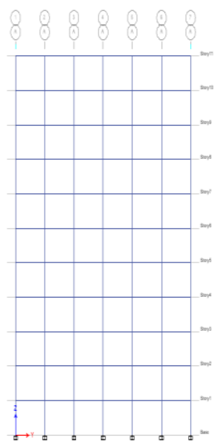


Fig:3 Elevation of G+10 Building

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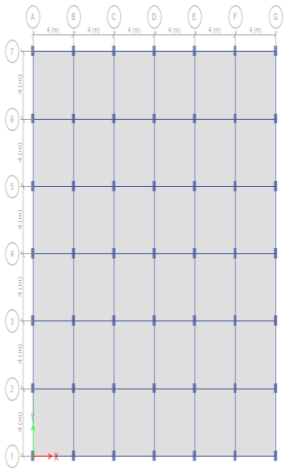

fig:4 Plan of Building with Rectangular RCC Column

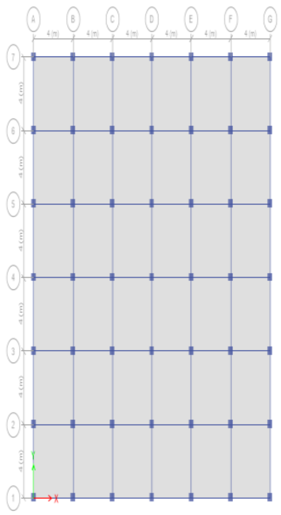

fig: 5 Plan of Building with Square Column

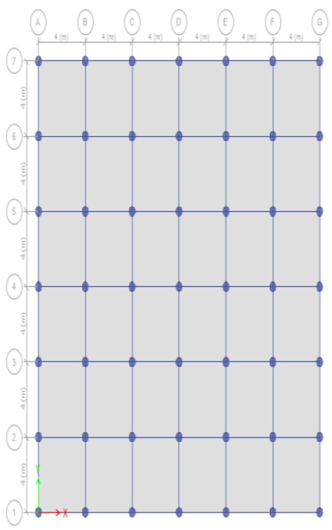

fig: 6 Plan of Building with Circular RCC RCC Column

Table 2. List of Beam for G+10

Story	Zone III		Zone IV	
	Composite	**RCC**	**Composite**	**RCC**
1	ISMB 200-1	300X450	ISMB 200-1	300X450
2	ISMB 200-1	300X450	ISMB 200-1	300X450
3	ISMB 200-1	300X450	ISMB 200-1	300X450
4	ISMB 200-1	300X450	ISMB 200-1	300X450
5	ISMB 200-1	300X450	ISMB 200-1	300X450
6	ISMB 200-1	300X450	ISMB 200-1	300X450
7	ISMB 200-1	300X450	ISMB 200-1	300X450
8	ISMB 200-1	300X450	ISMB 200-1	300X450
9	ISMB 200-1	300X450	ISMB 200-1	300X450
10	ISMB 200-1	300X450	ISMB 200-1	300X450
11	ISMB 200-1	300X450	ISMB 200-1	300X450

Table.3 Frame configuration for G+10

ZONE	COMPOSITE			RCC		
	RECTANGULAR	**SQUARE**	**CIRCULAR**	**RECTANGULAR**	**SQUARE**	**CIRCULAR**
III	300X500 + ISMB 300-1	400X400 + ISMB 300-1	400 mm DIA + ISMB 300-1	300X600	450X450	500 mm DIA
IV	300X500 + ISMB 300-1	400X400 + ISMB 300-1	400 mm DIA + ISMB 300-1	300X600	450X450	500 mm DIA

Table.4 List of Beam for G+15

Story	Zone III		Zone IV	
	Composite	RCC	Composite	RCC
1	ISMB 200-1	300X450	ISMB 200-1	300X450
2	ISMB 200-1	300X450	ISMB 200-1	300X450
3	ISMB 200-1	300X450	ISMB 200-1	300X450
4	ISMB 200-1	300X450	ISMB 200-1	300X450
5	ISMB 200-1	300X450	ISMB 200-1	300X450
6	ISMB 200-1	300X450	ISMB 200-1	300X450
7	ISMB 200-1	300X450	ISMB 200-1	300X450
8	ISMB 200-1	300X450	ISMB 200-1	300X450
9	ISMB 200-1	300X450	ISMB 200-1	300X450
10	ISMB 200-1	300X450	ISMB 200-1	300X450
11	ISMB 200-1	300X450	ISMB 200-1	300X450
12	ISMB 200-1	300X450	ISMB 200-1	300X450
13	ISMB 200-1	300X450	ISMB 200-1	300X450
14	ISMB 200-1	300X450	ISMB 200-1	300X450
15	ISMB 200-1	300X450	ISMB 200-1	300X450
16	ISMB 200-1	300X450	ISMB 200-1	300X450

Table.5 Frame configuration for G+15

ZONE	COMPOSITE			RCC		
	RECTANGULAR	SQUARE	CIRCULAR	RECTANGULAR	SQUARE	CIRCULAR
III	300X600 + ISMB 400-1	500X500 + ISMB 400-1	500 mm DIA + ISMB 400-1	300X830	600X600	650 mm DIA
IV	300X600 + ISMB 400-1	500X500 + ISMB 400-1	500 mm DIA + ISMB 400-1	300X830	600X600	650 mm DIA

VI. PERFORMANCE ANALYSIS

Result of G+10

For Zone III

For Drift in X-Y Direction

A. For Rectangular Column Structure

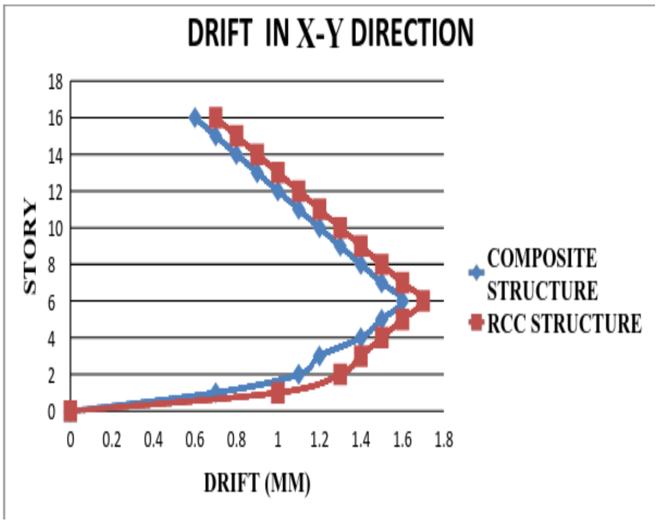

Fig. 7 Story Drift in x-y direction

From result it is observe that maximum storey drift in x-y direction for RCC Rectangular column structure is 26.31 % more than the drift for Composite Rectangular column structure. Drift are less than permissible limit as per IS code.

B. For Square Column Structure

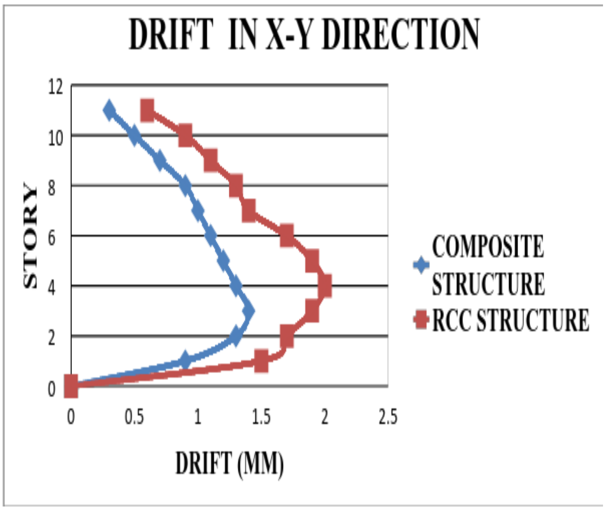

Fig. 8 Story Drift in x-y direction

From result it is observe that maximum storey drift in x-y direction for RCC Square column structure is 25.00 % more than the drift for Composite Square column structure. Drift are less than permissible limit as per IS code.

C. For Circular Column Structure

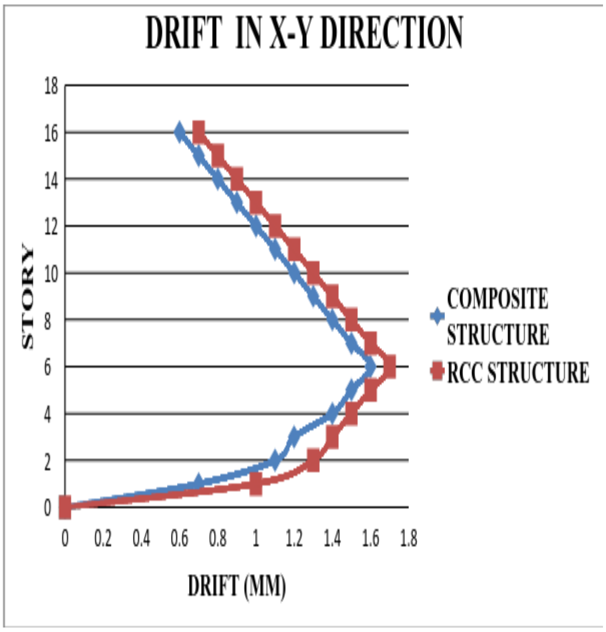

Fig. 9 Story Drift in x-y direction

From result it is observe that maximum storey drift in x-y direction for RCC Circular column structure is 30.43 % more than the drift for Composite Circular column structure. Drift are less than permissible limit as per IS code.

For Displacement in X-Y Direction

D. For Rectangular Column Structure

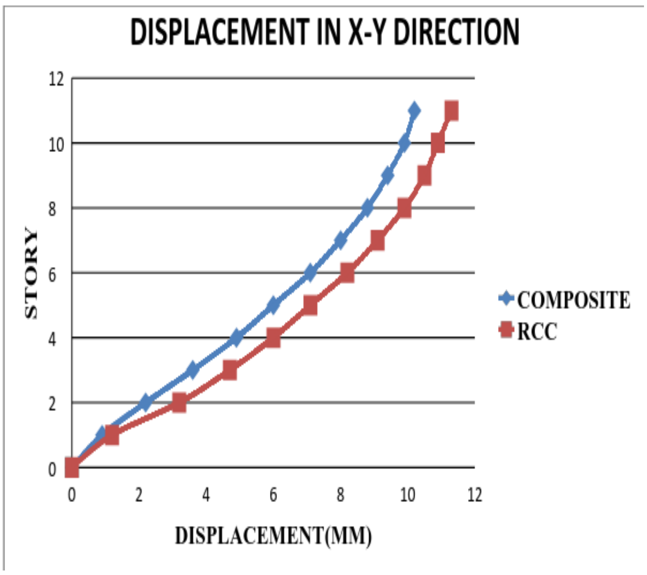

Fig. 10. Story Displacement in x-y direction

From result it is observe that maximum storey displacement in x-y direction for RCC Rectangular column structure is 15.00 % more than the displacement for Composite Rectangular column structure.

E. For Square Column Structure

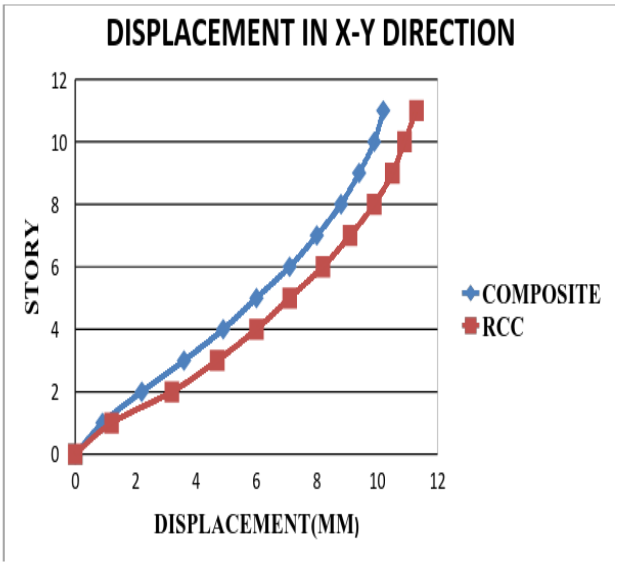

Fig. 11. Story Displacement in x-y direction

From result it is observe that maximum storey displacement in x-y direction for RCC Square column structure is 15.80 % more than the displacement for Composite Square column structure.

F. For Circular Column Structure

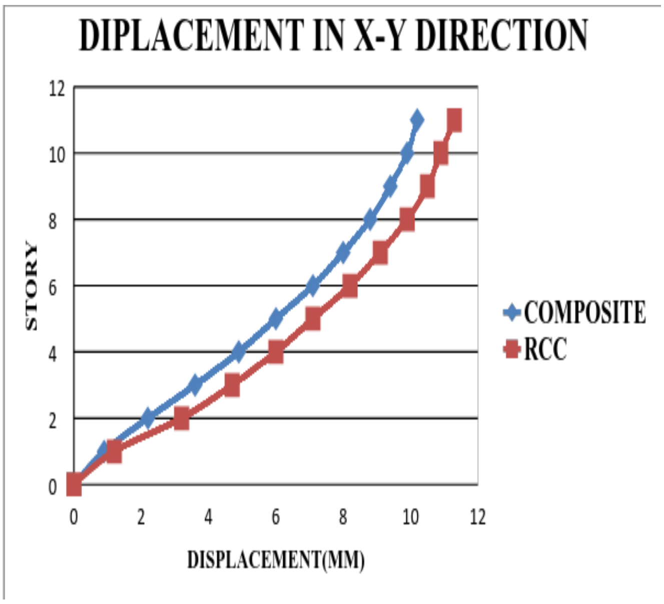

Fig. 12. Story Displacement in x-y direction

From result it is observe that maximum storey displacement in x-y direction for RCC Circular column structure is 19.11 % more than the displacement for Composite Circular column structure.

For Self Weight

A. For Rectangular Column Structure

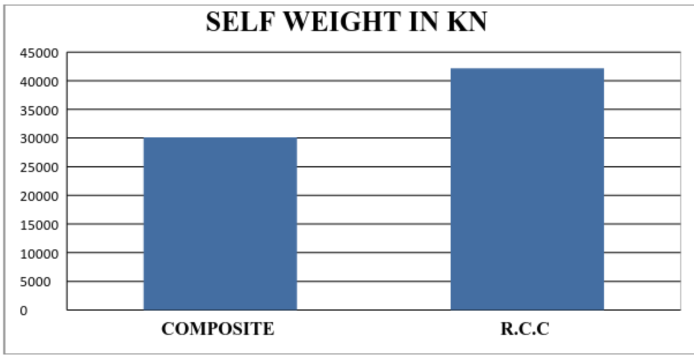

Fig. 13. Comparison of Self Weight

From result it is observe that Self Weight for RCC Rectangular column structure is 26.01 % more than the Self Weight for Composite Rectangular column structure.

B. For Square Column Structure

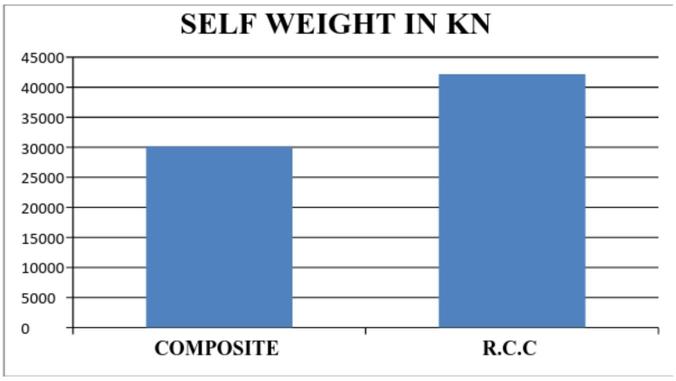

Fig. 14. Comparison of Self Weight

From result it is observe that Self Weight for RCC Square column structure is 26.79 % more than the Self Weight for Composite Square column structure.

C. For Circular Column Structure

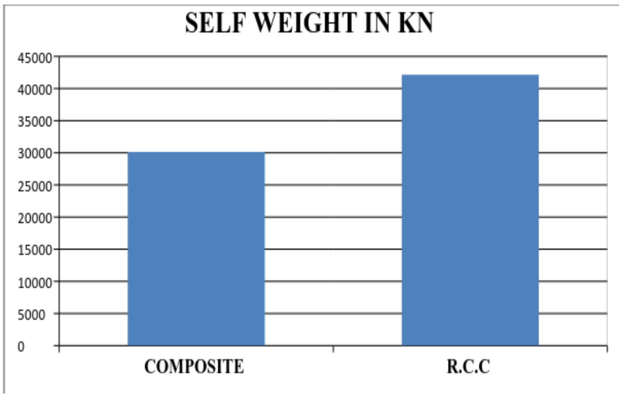

Fig. 14. Comparison of Self Weight

From result it is observe that Self Weight for RCC Circular column structure is 28.57 % more than the Self Weight for Composite Circular column structure.

VII. CONCLUSION

From the analysis done on G+10 and G+15 structure in zone III & zone IV . the following conclusions are made :

- 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 and G+15 modal.
- In zone III and zone IV the story drift for Circular composite column structure is more as compared to Square and Rectangular column structure.
- The drift of Circular composite column structure in zone III for G+10 is 6.25% more as compared to Square column structure and 12.5% more as compared to rectangular column structure.
- The drift of Circular composite column structure in zone IV for G+10 is 20% more as compared to Square column structure and 4% more as compared to rectangular column structure.
- The drift of Circular composite column structure in zone III for G+15 is 40% more as compared to Square column structure and 20% more as compared to rectangular column structure.
- The drift of Circular composite column structure in zone IV for G+15 is 18.75% more as compared to Square column structure and 6.25% more as compared to rectangular column structure.
- 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 and G+15 modal.
- In zone III and zone IV the story displacement for Circular composite column structure is more as compared to Square and Rectangular column structure.
- The displacement of Circular composite column structure in zone III for G+10 is 8.18% more as compared to Square column structure and 7.27% more as compared to rectangular column structure.
- The displacement of Circular composite column structure in zone IV for G+10 is 7.92% more as compared to Square column structure and 6.70% more as compared to rectangular column structure.
- The displacement of Circular composite column structure in zone III for G+15 is 40% more as compared to Square column structure and 20% more as compared to rectangular column structure.
- The displacement of Circular composite column structure in zone IV for G+15 is 14.28% more as compared to Square column structure and 13.60% more as compared to rectangular column structure.
- 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 and G+15 modal

- In zone III and zone IV the self weight for Circular composite column structure is less as compared to Square and Rectangular column structure.
- The self weight of Circular composite column structure in zone III & zone IV for G+10 is 4.58% less as compared to Square column structure and 3.34% less as compared to rectangular column structure
- The drift of Circular composite column structure in zone III and zone IV for G+15 is 9.97% less as compared to Square column structure and 0.38% more as compared to rectangular column structure.

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