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Comparative Study of G+12 Residential Building for Rcc, Steel and Composite Structure

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ABSTRACT: Reinforced concrete structures are widely used in India as it is the most economical & suitable system for low-rise buildings. But, these structures become less economical for medium to high-rise buildings due to increased dead load, span limitation, less stiffness and unsafe formwork. Therefore, the most efficient and economical design tecnic is needed. Also Wind & Earthquake analysis should be extended to the design of wind & earthquake sensitive tall buildings. In this paper all the 3 types of buildings i.e G+12 residential building for RCC, Steel and composite structure is analysed by using ETABS software.

KEYWORDS:RCC structure, Steel structure, Composite structure, Comparison of analysis

I.INTRODUCTION

In Construction, two materials concrete and steel are the two widely and predictably used as construction for structures like buildings to bridges. Both the materials have different properties and characteristics. Steel is brilliant in resisting tensile loading but due to thin sections these members are susceptible to buckling. Similarly concrete is fine in resisting compressive force. Ductility provided by Steel is animportant criterion for high rise building, while concrete provides corrosion protection and thermal insulation and also buckling of steel can be checked by concrete. In order, to derive the optimum benefits from both materials composite construction is widely preferred. Also, it's evident that now-a-days, the composite sections using steel and concrete are proved to be economic, time and cost effective in structures like bridges and high rise buildings.

II. COMPOSITE MEMBER

Steel-concrete composite systems have become quite popular in recent times due to their advantages against conventional construction. Composite construction combines the good properties of the both i.e. concrete and steel and leads to speedy construction.Composite structures are often defined as the structures in which composite sections are made up of two Differing kinds of materials like steel and concrete are used for beams, and columns.

There are several reasons to use composite materials including increased strength, aesthetics, and environmental sustainability. In developing countries like India, most of the building structures fall under the category of low rise building. So these conventional Reinforced cement concrete and pure sectional steel construction prove to be convenient and economical in nature hence widely used all around. But when it comes to the need for vertical growth of building due to lack of land space area and rapid growth of population, medium high rise building emerges as a solution to full - fill this need.

[1].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. It is found that composite structure is more economical and speedy than R.C.C structure.

[2].In the past, for the design of a building, the choice was normally between a concrete structure and a masonry structure. But the failure of many multi-storied and low-rise R.C.C. and masonry buildings due to earthquake has forced the structural engineers to look for the alternative method of construction. Use of composite or hybrid material is of particular interest, due to its significant potential in

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improving the overall performance through rather modest changes in manufacturing and constructional technologies.

[3].The use of Steel in construction industry is very low in India compared to many developing countries. Experiences of other countries indicate that this is not due to the lack of economy of Steel as a construction material. There is a great potential for increasing the volume of Steel in construction, especially the current development needs in India. Exploring Steel as an alternative construction material and not using it where it is economical is a heavy loss for the country.

[4].In past structural engineer has the choice of masonry building and multi stories building with RCC framed structure or steel structure. Recently trend of going towards composite structure has started and going.

III. BUIDING DETAILS

The building considered here is a G+12 storey residential building located in Dehradun (earthquake zone IV) and having wind velocity 50 m/s. The building is planned to facilitate the basic necessities of a residential building. The plan about both the axes of building is kept symmetric.

Height of each storey is kept 3.0 m for each storey and total height of building is 39.0 m as shown in Figure 1. The plan dimension of the building is 24 m x 24 m as shown in Figure 2. The study is carried out on the same building plan for RCC, composite and steel construction through some basic assumptions made for deciding primary sections of these structures. The basic loading on the structures are kept same.

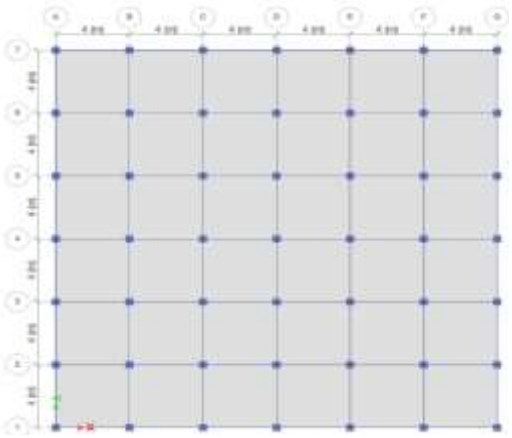

Fig 1. Plan of r.c.c building

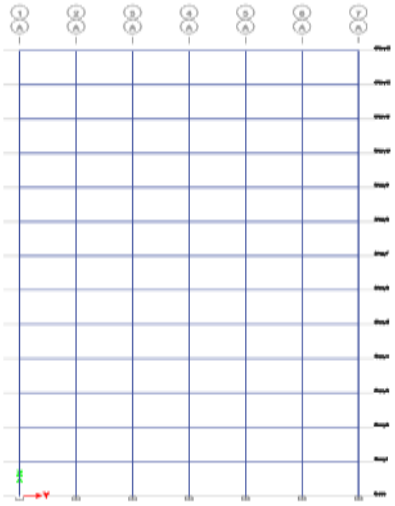

Fig 2. Elevation of r.c.c building

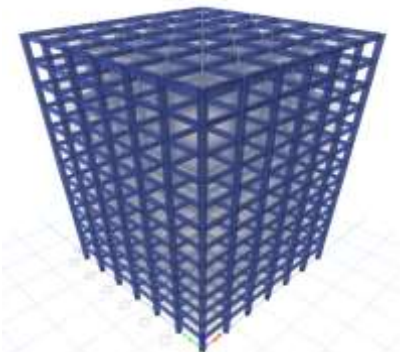

Fig 3. Render view of buildingin 3d view

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3.1 Structural Data For RCC Building

Table 1. Data for RCC Building

Plan dimension	24 m x 24 m
Total height of building	39.0 m
Height of each storey	3.0 m
Size of beams	0.3 x 0.5
Size of columns	0.5 m x 0.5 m
Slab thickness	0.150 m
thickness of external wall	0.100 m
Seismic zone	IV
Wind speed	50 m/s
Importance factor	1
Zone factor	0.24
Floor finish	1.0 KN/m²
Live load(except roof)	2.0 KN/m²
Grade of concrete	M25
Density of concrete	24 KN/m³
Density of steel	7850 Kg/m³
Grade of reinforcing steel	Fe415
Concrete cover(slabs)	0.020 m
Concrete cover(beams)	0.030 m
Concrete cover(columns)	0.050 m

3.2 Structural Data for steel structure

Beams and columns are of Fe 345 grade structural steel and slab in this steel structure is same as in RCC structure.

3.3 Structural Data for composite structure

Column used here is a composite column with a steel I section ISHB150-3 OF grade fe345 is embedded in a concrete column of crossection 300 mm x 300 mm. The frame section property data of composite column section is shown in fig 4. Beams are designed as steel beams. Slabs are designed as RCC slab of M25 grade of concrete and having thickness of 150 mm same as in RCC structure

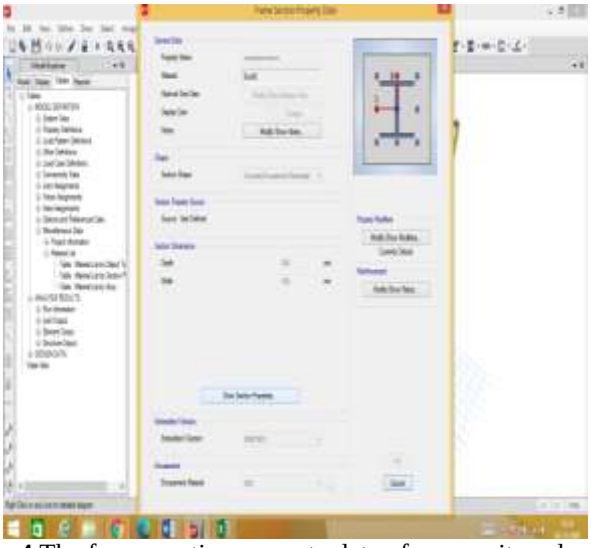

Fig 4 The frame section property data of composite column

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IV. ANALYSIS

Analysis of all three RCC, Steel and Composite structure is done using ETABS Software and the method used is limit state method. Different parameters such as maximum axial force in a column, maximum shear force and maximum bending moment in a member and maximum story displacement are studied for the model

V. RESULT AND DISCUSSION

Analysis is done for all the three buildings and following are the result

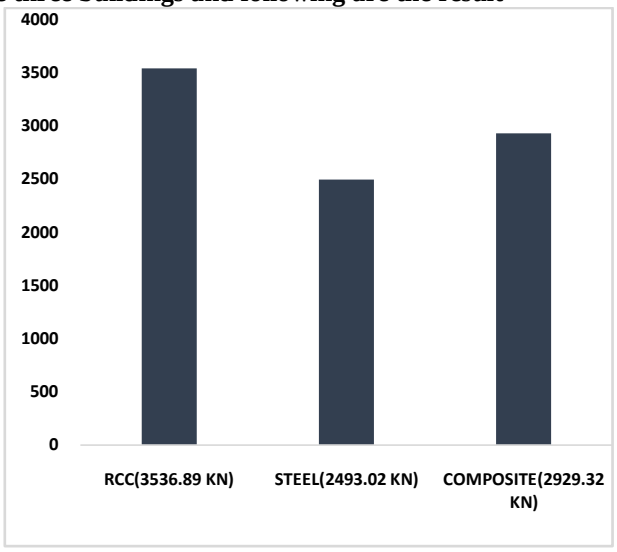

Fig 5 Comparison of Maximum Axial Force

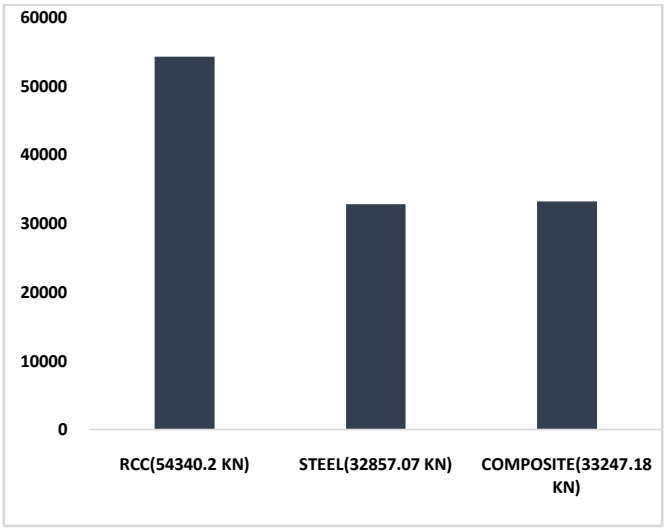

Fig 6 Comparison of weight of structure

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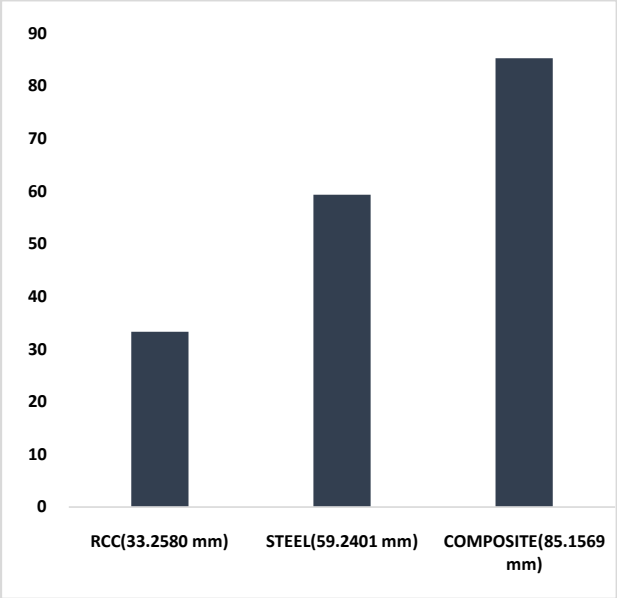

Fig 7 Comparison of Maximum story Displacements

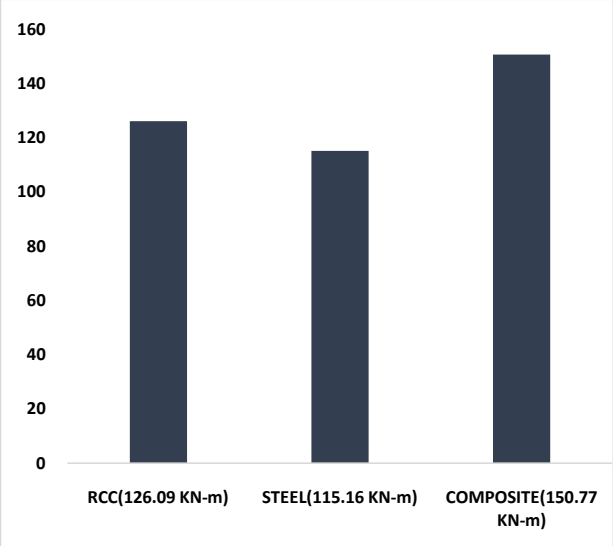

Fig 8 Comparison of Maximum Bending Moment

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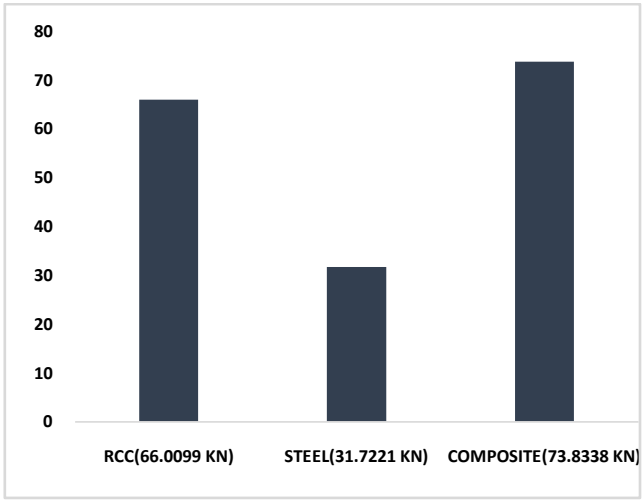

Fig 9 Comparison of Maximum Shear force in a member

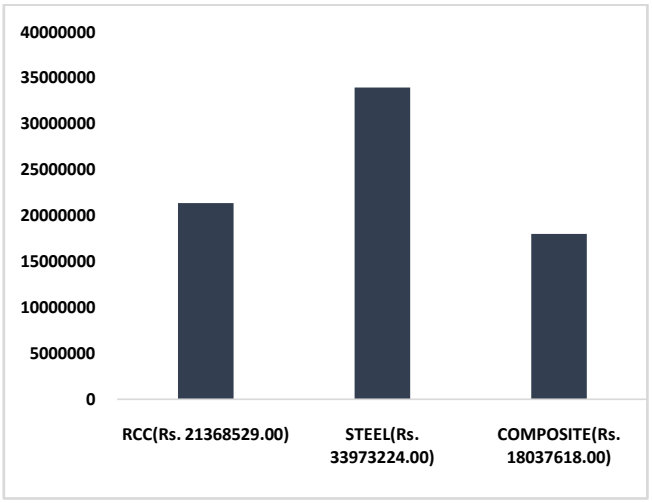

Fig 10 Cost Comparison of the structure

Table 2. Comparison between maximum parameters of structures

Comparison Parameter	RCC	Steel	Composite
Maximum Axial Force	3536.89 KN	2493.02 KN	2929.32 KN
Self-Weight of structure	54340.20 KN	32857.07 KN	33247.18 KN
Maximum Storey displacement	33.2580 mm	59.2401 mm	85.1569 mm
Maximum Bending Moment	126.09 KN-m	115.16 KN-m	150.7679 KN-m
Maximum Shear Force	66.0099 KN	31.7221 KN	73.83 KN
Cost of Structure	Rs. 21368529.00	Rs. 33973224.00	Rs. 18037618.00

VI. CONCLUSION

This study is an effort to address the issue of making steel-concrete composite structures for medium to high rise buildings. In this study, Using ETABS, G+12 residential building is analysed for RCC, Steel and Composite Structure and a number of conclusions are drawn.

- RCC structure have 20.74% more maximum axial force when compared with composite structure and 41.87% more maximum in a column than steel structure and
- RCC structure has 63.44% more weight than composite structure and 65% more when compared to steel structure. The weight of composite structure is quite RCC structure.
- It is seen that RCC structure has 9.49% more maximum bending moment in a member than steel structure and 16.37% less when compared to composite structure.
- The maximum shear force in a member for RCC structure is 108.09% more than steel structure and 10.60% less than composite structure. It is lowest for steel structure.
- The maximum node displacement for composite structure and steel structure is higher than RCC structure but it is highest for steel structure.
- The cost of composite structure is much lesser than both RCC and steel structure and highest for steel structure. Hence, composite structures are economical.

Further studies can be made in this regard for G+15, G+20 and more high rise residential or commercial structures. Location of building can be taken in any other earthquake zone and with different wind speeds for further research studies. The analysis of the buildings can be done using different software's such as STAAD Pro, ETABS, etc. More research can be carried out for both symmetrical and unsymmetrical buildings

SOME OF THE ADVANAGES FROM THE RESULTS

All the above analysis and calculations proves that the Steel-Concrete Composite Structures are economical and has light weight than RCC and Steel Structures. Therefore, for medium to high rise buildings Steel-Concrete Composite Structures are better than RCC and Steel Structures.

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