A Comparative Study on Cost Analysis of RCC and Composite Structures in India

Suraj Mishra[1], Suhail Khan[2], Ravi Singh[3], Anuj Kumar[4], Anuj Kumar Sharma[5], Mukesh Kumar[6]

[1,2,3,4]B.tech students, Department of Civil Engineering, Hi tech Institute of Engineering and Technology, Ghaziabad U.P. India

[5]Assistant professor, Department of Civil engineering, Hi tech Institute of Engineering and Technology, Ghaziabad U.P. India

[6]Head of department, Department of Civil engineering, Hi tech Institute of Engineering and Technology, Ghaziabad U.P. India

---

Abstract- We all know that the 70% Indians are live in rural areas, according to census of 2011, so it is cleared that maximum construction in India is going to low rise buildings. And we also know that our construction techniques are too old and too slow.

But now a days the future of construction is steel concrete composite structure, this construction technique is accepted by most of the developed and developing country, because it is economical, take less time in completion, it reduces cost and amount of material as compare to RCC structure for high rise buildings, and also steel concrete composite structure is more durable as compare to the RCC structure and at the time of earth quake the seismic behavior of steel concrete composite structure is very satisfactory as compare to RCC structure. While, for less than G+12 building construction it is not economical, instead of it shows high cost for the construction as compare to RCC or no major difference in cost and create the complexity in construction.

So, in this paper we study about different commercial buildings i.e; G+11, G+15 & G+20 to analyse them by using software Staad Pro.

Key Words: Steel concrete composite structure; RCC structure; cost analysis; high rise buildings; low rise buildings

1.INTRODUCTION

As we all know that concrete is good at compression and easily fail at tension

but steel is good at compression and as well as at tension, so when we bind these two material together they work as single unit and shows very good results as compare to RCC and this process of binding different types of material or heterogeneous materials is known as composite construction, so now we are deeply study about the cost analysis of composite structure and RCC structure for low rise buildings, because in India 3/4 population is live in rural areas so the low rise building construction is always in demand and due to this the consumption of steel in India is low as compare to other countries.

In this paper we analyse three various building models i.e; G+11, G+15 & G+20 by using software STAAD PRO.

2. COMPONENTS OF COMPOSITE STRUCTURE

A composite structure consist different components as follows:

1. Composite deck slab
2. Composite beam

3. Composite column

4. Shear connector

2.1 Composite Deck Slab

Composite slabs include reinforced concrete cast on top of profiled steel decking, which acts as formwork during construction and external reinforcement at the final stage. The decking may be either re-entrant or trapezoidal. Trapezoidal decking may be over 200 mm deep, in which case it is called deep decking. Slab thicknesses are normally in the range 100 mm to 250 mm for shallow decking, composite action increases the load carrying capacity and stiffness by factors of 2 and 3.5 respectively.

2.2 Composite Beam

Composite beams mainly subjected to bending, it consists of section action composite with flange ofreinforced concrete, also resist uplift forces acting at the steel concrete interface. In case of steel beam sections have improved fire resistance and corrosion. Composite sections have higher stiffness in comparison of steel sections and then the deflection is lesser.

2.3 Composite column

A steel concrete column or composite column is a compression member, it includes either of a concrete encased hot rolled steel section or a concrete filled hollow section of hot rolled steel. It is commonly used as a load bearing member in a composite framed structure. The component of composite structure or members of composite structure are mainly subjected to compression and bending. It has valuable economic advantages over pure structural steel or reinforced concrete alternatives. It increases the stiffness and bulking resistance, and leading to reduced slenderness.

2.4 Shear connector

Shear connections are very important for steel concrete composite construction as they integrate the compression capacity of Supported concrete slab with supporting steel beams to enhance the load carrying capacity as well as overall rigidity. The total shear force at the interface between concrete slab and steel beam is nearly eight times the total load carried by the beam.

Types of shear connector as follows -:

• Rigid type – This type of connector is very stiff and it maintain only a small deformation while resisting the shear force. Rigid type shear connector derives their resistance from bearing pressure on the concrete, and fail due to crushing of concrete.

• Flexible type - Headed studs, channels come under this category. These connectors are welded to the flange of the steel beam.

Bond or anchorage type - It is used to resist horizontal shear and to prevent separation of girder from the concrete slab at the interface through bond.

3.BUILDING DETAILS AND ANALYSIS

This is a commercial building having a plan dimension of 64mx30m. The study has been done on this plan for both R.C.C. & composite construction. The basic loading is same for both structures. The details of both buildings are as follows-

3.1 STRUCTURAL DATA FOR R.C.C AND COMPOSITE BUILDING

Table 1 : Structural data of R.C.C. Structure

Plan dimension	64mx30m	64mx30m
Height of each storey	3.6m	3.6m
Height of parapet	1.0m	1.0m
Type of Beam	Size of Beams	Size of Beams
B1	300mmx650mm	ISMB450
B2	230mmx300mm	ISMB300
B3	230mmx230mm	ISMB200
Type of columns	Size of columns	Size of columns
C6, C7	750mmx750mm	500mmx500mm
C11	450mmx450mm	-
C9	350mmx750mm	350mmx400mm
C8	350mmx600mm	300mmx300mm
Thickness of slab	200mm	200mm
Thickness of walls	230mm	230mm
Seismic zone	II	II
Wind speed	44 m/s	44 m/s
Soil condition	Medium soil	Medium soil
Importance factor	1	1.0
Zone factor	0.1	0.10
Floor finish	1.0 kN/m2	1.0 kn/m2
Live load at all floors	4.0 kN/m2	4.0 kn/m2
Grade of concrete	M30	M30
Grade of reinforcing steel	Fe415	Fe415
Density of concrete	25 kN/m3	25 kn/m3
Density of brick	20 kN/m3	20 kn/m3
Damping ratio	5%	5%

The analysis of both structures is done by using Equivalent Static Method and then analyzed by the software STAAD PRO. In this analysis we find out different parameters of both structures such as deflection, shear force & bending moment. Seismic codes are unique to a particular region of country. In India, Indian standard criteria for earthquake resistant design of structures IS 1893 (PART-1): 2002 is the main code that provides outline for calculating seismic design force. Wind forces are calculated using code IS-875 (PART-3) & SP64.

4.RESULTS AND DISCUSSION

We have done analysis of three various building structures and from that following results are comes out:-

4.1 Comparison of R.C.C. and Composite structures w.r.t to their various parameters:-

Story	G+11		G+15		G+20	
Comparison Property	Composite	R.C.C	Composite	R.C.C	Composite	R.C.C
Max. Axial Force In Y- DIR (kN)	16892.49	17132	21633.05	26381.32	26076.06	29762.01
Max. Shear Force In X- DIR (kN)	198.79	243.01	218	308.10	246	401.30
Max. Shear Force In Z- DIR (kN)	238.46	151.5	265	193	306	241.20
Max. B.Moment (kNm)	545.72	555.25	707	736.3	838.23	936.39

4.2 Comparison of deflection (column no. 25)

The below chart shows the deflection of R.C.C. and Composite structure:-

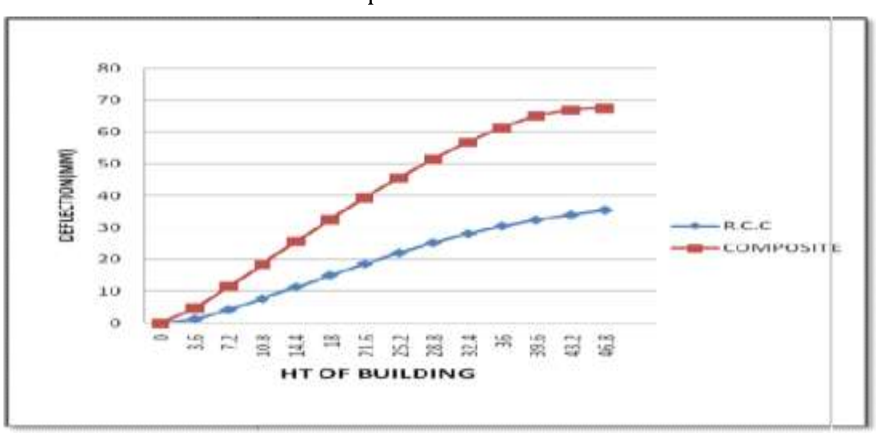


Fig.1: Comparison of deflection (column no. 25)

The Fig.1 shows that the deflection in composite structure is nearly double than that of structure but within permissible limit.

4.3 Comparison of S.F. X-dir. and axial force (column no.-25)

The below chart shows the Shear force in x-direction of R.C.C. and Composite structure:-

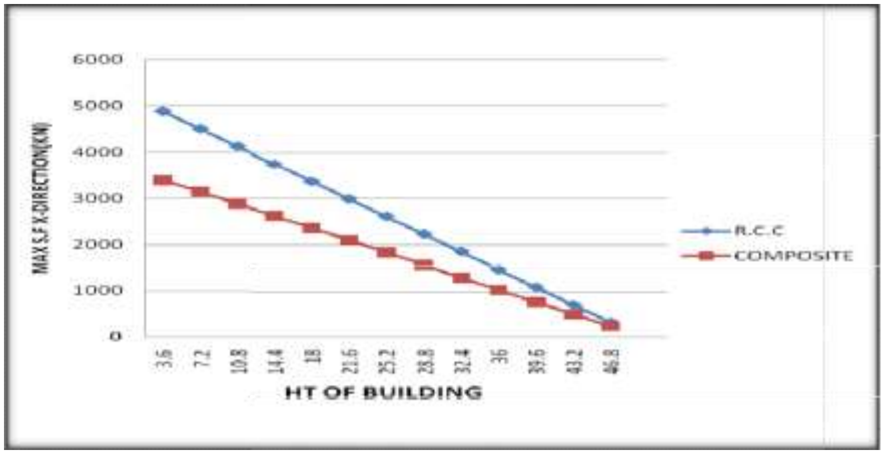


Fig.2: Comparison of S.F X-dir.(column no. 25)

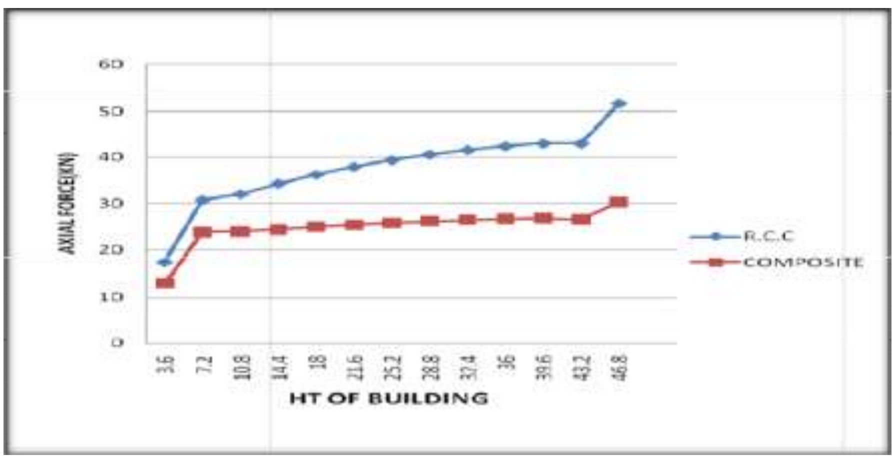


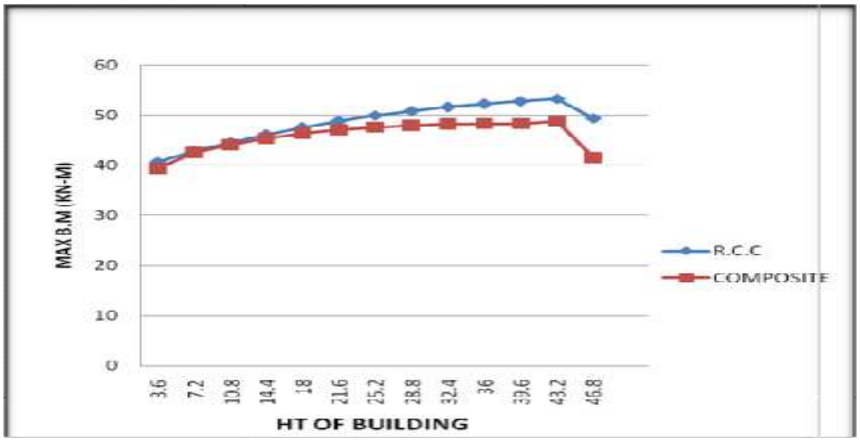
Fig.3: Comparison of axial force (column no. 25)

The Fig.2,3 shows that the Shear force and Axial force in R.C.C structure is high as compare to the composite structure.

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

4.4 Comparison of bending moment (column no.-25)

The below chart shows the B.M. of R.C.C. and Composite structure:-



The Fig.4 shows that there is significant reduction in B.M of column (Z-DIR) in composite structure.

4.5 COMPARISON OF COST BETWEEN COMPOSITE & R.C.C STRUCTURE

From analysis we get Axial force and B.M. This value is used in MS-Excel programming for design and then cost estimation is done in excel. From that results are obtained and tabulated are as follows:-

Table 4: Comparison of total cost between R.C.C Structure and CompositeStructure

Story	Cost of R.C.C Structure (Cr)	Cost of Composite Structure (Cr)	% Difference
G+11	5,37,20,409	5,33,57,375	-0.101
G+15	7,00,29,483	6,66,98,793	-5.43
G+20	9,57,76,019	8,67,20,187	-10.44

From Fig.9 it is obvious that increase in the number of story results in increased cost for RCC construction as compared to composite construction.

5.CONCLUSION

Analysis and design of four various building can be done and comparison can be made between them and from that result conclusions can be drawn- out are as follows:-

- 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 reduces the self-weight and cost of the structural components.
- From Fig.3 & Fig.4 it is seen that the downward reaction (Fy) and bending moment in other two direction for composite structural system is less.

  Thus one can use smaller size foundation in case of composite construction compared to an R.C.C construction.
- Under earthquake consideration because of inherent ductility characteristics, steel-concrete composite structure perform better than a R.C.C structure.

- In the cost estimation for building structure no savings in the construction time for the erection of the composite structure is included. As compared to RCC structures, composite structures require less construction time due to the quick erection of the steel frame and ease of formwork for concrete. Including the construction period as a function of total cost in the cost estimation will certainly result in increased economy for the composite structure.

- The cost comparison reveals that steel-concrete composite design structure is more economical in case of high rise buildings and construction is speedy.

6.ACKNOWLEDGEMENT

This paper could not be complete without support of our Head of department and our guide.

7. REFERENCES

1. Mahesh Suresh Kumawat and L G Kalurkar “Analysis and Design of Multistory Building Using Composite Structure”, ISSN 2319 – 6009 Vol. 3, No. 2, May 2014
2. T.G.N.C.Vamsi Krishna, S.V. Surendhar, and M. Shiva Rama Krishna,” Comparison of Seismic Analysis of a Residential Composite and Rcc Structures”, ISSN: 2278-3075, Volume-8, Issue-6S3, April 2019
3. Prof. Rajendra R. Bhoir, Prof. Vinay Kamble and Prof. Darshan Ghankute, “Analysis and Design of Composite Structure & Its Comparison with RCC Structure”, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.88
4. Zafar Mujawar and Prakarsh Sangave “Comparative Evaluation Of Reinforced Concrete, Steel And Composite Structures Under The Effect Of Static And Dynamic Loads”, ISSN: 2248-9622, Vol. 5, Issue 1(Part5), January 2015, pp.41-44
5. Dr. S. H Mahure,“Cost Comparison of R.C.C, Steel and Composite Structures”, IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 05, 2016 | ISSN (online): 2321-0613
6. AnamikaTedia, Dr. SavitaMaru,“Cost, Analysis and Design of Steel- Concrete Composite Structure R.C.C. Structure”, IOSR Journal of Mechanical and Civil Engineering, Vol.11, Issue 1 Ver. II (Jan.2014)
7. A.Sattainathan Sharma, G.R.Iyappan and J.Harish, “comparative study of cost and time evaluation in RCC, steel & Composite high rise building” (2015)
8. Shweta A. Wagh and Dr. U. P. Waghe,“Comparative Study of R.C.C and Steel Concrete Composite Structures”, ISSN: 2248-9622, Vol. 4, Issue 4(Version 1), April 2014, pp.369-37