iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 2017 **Issue:** onference **Month of publication:** September 15, 2017

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, September 2017- Available at www.ijraset.com

Analysis and Design of Composite Structure & Its Comparison with RCC Structure

Prof. Rajendra R. Bhoir[1], Prof. Vinay Kamble[2], Prof. Darshana Ghankute[3]
[1, 2, 3] Assistant Professor, Department of Civil Engineering, SIOT, Kharghar, Navi Mumbai.

Abstract*: Composite structure is a structure made with steel and concrete where hot rolled steel sections are used as structural members. Now-a-days 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 steel in construction, especially in the current development needs India and not using steel as an alternative construction material and not using it where it is economical is a heavy loss for the country. Two residential G+15 storied Composite and RCC structure are analyzed and designed in ETAB software with two different story heights,3m and 4m. It is found that the depth of beams in composite structure is lesser than of RCC structure, which results to also reduce the sizes of columns in composite structure. It is also seen that the concrete and steel consumption in composite structure is less but as we are using hot rolled sections the structural steel consumption is increased.
Keywords: Composite structure, Composite beam, Composite column, Composite slab, Shear connectors.

I. INTRODUCTION

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. Also, it is evident that now-a-days, the composite sections using Steel encased with Concrete are economic, cost and time effective solution in major civil structures such as bridges and high rise buildings.
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 have 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 improving the overall performance through rather modest changes in manufacturing and constructional technologies. In India, many consulting engineers are reluctant to accept the use of composite steel-concrete structure because of its unfamiliarity and complexity in its analysis and design. But literature says that if properly configured, then composite steel-concrete system can provide extremely economical structural systems with high durability, rapid erection and superior seismic performance characteristics.Paper is organized as follows. Section II describes automatic text detection using morphological operations, connected component analysis and set of selection or rejection criteria.

II. THEORETICAL CONTENT

The primary structural components use in composite construction consists of the following elements.

A. Composite Deck Slab

Composite floor system consists of steel beams, metal decking and concrete. They are combined in a very efficient way so that the best properties of each material can be used to optimize construction techniques. The most common arrangement found in composite floor systems is a rolled or built-up steel beam connected to a formed steel deck and concrete slab. The metal deck typically spans unsupported between steel members, while also providing a working platform for concreting work. The composite floor system produces a rigid horizontal diaphragm, providing stability to the overall building system, while distributing wind and seismic shears to the lateral load-resisting systems.
Composite action increases the load carrying capacity and stiffness by factors of around 2 and 3.5 respectively. The concrete forms the compression flange – the steel provides the tension component and shear connectors ensure that the section behaves compositely. Beam spans of 6 to 12 m can be created giving maximum flexibility and division of the internal space. Composite slabs use steel decking of 46 to 80 mm depth that can span 3 to 4.5 m without temporary propping. Slab thicknesses are normally

©IJRASET (UGC Approved Journal): All Rights are Reserved

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, September 2017- Available at www.ijraset.com

in the range 100 mm to 250 mm for shallow decking, and in the range 280 mm to 320 mm for deep decking. Composite slabs are usually designed as simply supported members in the normal condition, with no account taken of the continuity offered by any reinforcement at the supports.

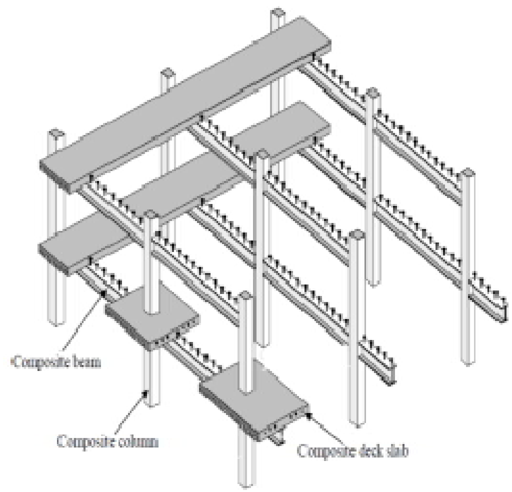


Fig. 1 Steel-concrete composite frame

B. Composite Beam

In conventional composite construction, concrete slabs rest over steel beams and are supported by them. Under load these two components act independently and a relative slip occurs at the interface if there is no connection between them. With the help of a deliberate and appropriate connection provided between them can be eliminated. In this case the steel beam and the slab act as a "composite beam" and their action is similar to that of a monolithic Tee beam. Though steel and concrete are the most commonly used materials for composite beams, other materials such as pre-stressed concrete and timber can also be used. Concrete is stronger in compression than in tension, and steel is susceptible to buckling in compression. By the composite action between the two, we can utilize their respective advantage to the fullest extent. Generally in steel-concrete composite beams, steel beams are integrally connected to prefabricated or cast in situ reinforced concrete slabs.

1) Advantages of Composite Beams

a) Keeping the span and loading unaltered, more economical steel section in terms of depth and weight) is adequate in composite construction compared with conventional non-composite construction.
b) Encased steel beam sections have improved fire resistance and corrosion.
c) It satisfied requirement of long span construction modern trend in architectural design
d) 4. Composite construction is amenable to fast track construction because of use of rolled steel sections.
e) Composite sections have higher stiffness than the corresponding steel sections and thus the deflection is lesser.
f) Permits easy structural repairs/ modification.
g) Provides considerable flexibility in design and ease of fabrication.
h) Enables easy construction scheduling in congested sites.
i) Reduction in overall weight of the structure and there by reduction in foundation cost.
j) Suitable to resist repeated earthquake loading which requires high amount of resistance and ductility.

C. Composite Column

A steel concrete composite column is a compression member, comprising either of a concrete encased hot rolled steel section or a concrete filled hollow section of hot rolled steel. It is generally used as a load bearing member in a composite framed structure. Composite members are mainly subjected to compression and bending. At present there is no Indian standard code covering the design of composite column. The method of design in this report largely follows EC4, which incorporates latest research on composite construction. Indian standard for composite construction IS 11384-1985 does not make any specific reference to composite columns. This method also adopts the European bucking curves for steel columns as a basic of column design.

1) Advantages Of Composite Column

a) Increased strength for a given cross sectional dimension.

©IJRASET (UGC Approved Journal): All Rights are Reserved

b) Increased stiffness, leading to reduced slenderness and increased bulking resistance.
c) Good fire resistance in the case of concrete encased columns.
d) Corrosion protection in encased columns.
e) Significant economic advantages over either pure structural steel or reinforced concrete alternatives.
f) Identical cross sections with different load and moment resistances can be produced by varying steel thickness, the concre
g) strength and reinforcement. This allows the outer dimensions of a column to be held constant over a number of floors inbuilding, thus simplifying the construction and architectural detailingErection of high rise building in an extremely efficient manner.
h) mwork is not required for concrete filled tubular sections.

D. Shear Connector

The total shear force at the interface between concrete slab and steel beam is approximately eight times the total load carried by the beam. Therefore, mechanical shear connectors are required at the steel-concrete interface. These connectors are designed to (a) transmit longitudinal shear along the interface, and (b) Prevent separation of steel beam and concrete slab at the interface. Commonly used types of shear connectors as per IS: 11384-1985. There are three main types of shear connectors; rigid shear connectors, flexible shear connectors and anchorage shear connectors.

1) *Types Of Shear Connectors :* There are three types of shear connectors are as below
a) *Rigid type :* As the name implies, these connectors are very stiff and they sustain only a small deformation while resisting the shear force. They derive their resistance from bearing pressure on the concrete, and fail due to crushing of concrete. Short bars, angles, T-sections are common examples of this type of connectors. Also anchorage devices like hoped bars are attached with these connectors to prevent vertical separation.
b) *Flexible type:* Headed studs, channels come under this category. These connectors are welded to the flange of the steel beam. They derive their stress resistance through bending and undergo large deformation before failure. The stud connectors are the types used extensively. The shank and the weld collar adjacent to steel beam resist the shear loads whereas the head resists the uplift.
c) 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. These connectors derived from the resistance through bond and anchorage action.

III. STRUCTURE DETAILS

The building considered here is a commercial building. The plan dimension is 63.20mx29.50m. The study is carried out on the same building plan for both R.C.C and Composite construction. The basic loading on both types of structures are kept same.

A. Structural Data For R.C.C Building & Composite Building.

Building Plan for R.C.C Structure:

Plan for Steel Concrete Composite Structure:

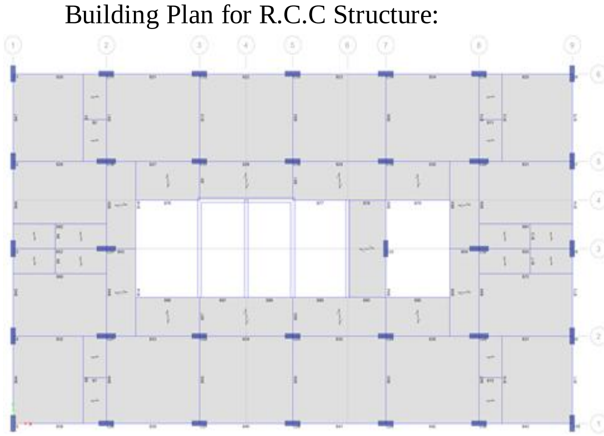


Fig.2: Plan showing typical floor of R.C.C Structure

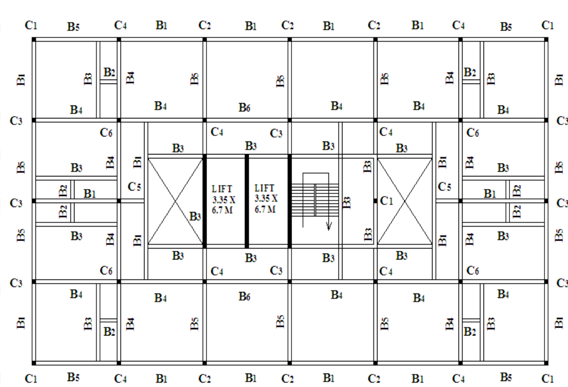


Fig.3: Plan showing typical floor of composite

©IJRASET (UGC Approved Journal): All Rights are Reserved

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, September 2017- Available at www.ijraset.com

Table 1 : Structural data of R.C.C. Structure		
Plan dimension		44.10m X 25.50 m
Total height of building		45 m. & 60 m
Height of each storey		3.0 m & 4.0 m
Height of parapet		1.0 m
Type of Beam		Size of Beams
B1,B2,B3,B4,B,5,B6		300mm x 600mm
Type of columns		Size of columns
From 1st Upto 5 TH Floor	C1 type & C2 type	400 mm x 1200mm
	C3 type	400mm x 1500mm
From 6th. Upto 10 TH Floor	C1 type & C2 type	400 mm x 1000mm
	C3 type	400mm x 1200mm
From 11 th Upto 15th Floor	C1 type & C2 type	400 mm x 900mm
	C3 type	400mm x 1000mm
Thickness of slab		130mm to 175 mm
Thickness of walls		150 mm
Seismic zone		III
Wind speed		39 m/s
Soil condition		Medium soil
Importance factor		1
Zone factor		0.1
Floor finish		1.5 kN/m^2
Live load at all floors		3.0 kN/m^2
Grade of concrete		M45
Grade of reinforcing steel		Fe500
Density of concrete		25 kN/m^3
Density of brick		20 kN/m^3
Damping ratio		5%

Table 2 : Structural data of Composite Structure	
Plan dimension	44.10m X 25.50 m
Total height of building	45 m. & 60 m
Height of each storey	3.0 m & 4.0 m
Height of parapet	1.0 m
Type of Beam	Size of Beams
Type B1	ISMB500
Type B2, B3	ISMB200
Type B4	ISMB450
Type B5,B6	ISMB350
Type of columns	Size of columns
C1 type & C2 type (ISHB450)	550 mm x 350 mm
C3 type(ISHB350)	450 mm x 350 mm
Thickness of slab	130mm to 175 mm
Thickness of wall	150 mm
Seismic zone	III

©IJRASET (UGC Approved Journal): All Rights are Reserved

Wind speed	39 m/s
Soil condition	Medium soil
Importance factor	1
Zone factor	0.1
Floor finish	1.5 kN/m^2
Live load at all floors	3.0 kN/m^2
Grade of concrete	M45
Grade of reinforcing steel	Fe500
Density of concrete	25 kN/m^3
Density of brick	20 kN/m^3
Damping ratio	5%

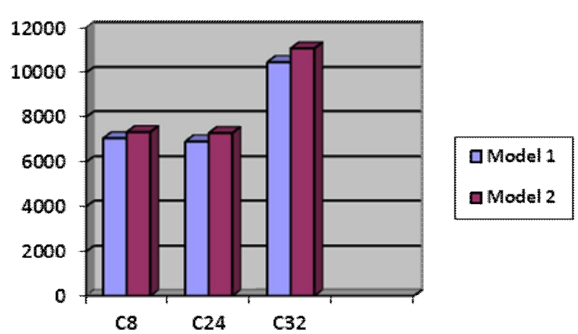
B. Analysis

The explained 3D building models are analyzed using Equivalent Static Method. The building models are then analyzed by the software ETAB. Different parameters such as shear force & bending moment are studied for the models. Seismic codes are unique to a particular region of country.

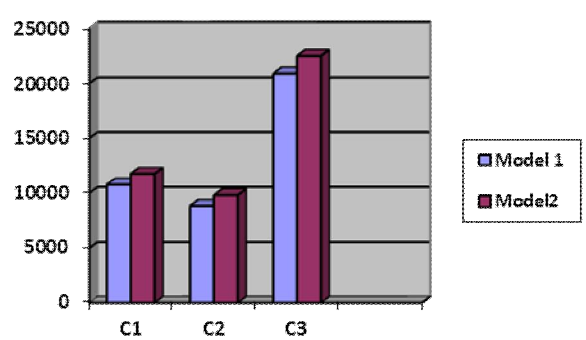
Fig. 4 Model of Building

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). The results of beams are obtained and discussed. The analysis and design of composite columns are in progress.

IV. EXPERIMENTAL RESULTS



Graph No.1Comparison of Axial Force at Floor 1



Graph No. 2 Comparison of percentage of steel in column at Floor1

©IJRASET (UGC Approved Journal): All Rights are Reserved

Graph no.1 shows the axial forces coming on the RCC model1 and RCC model 2. As floor height is increased the load on columns also increased. As column size is same in both RCC models, the percentage of steel is increased. The Graph no.2 shows the differences.

Table 3 Comparison of volume of Concrete, Reinforcing Steel & Structural steel (Model 1)				
Structure	Model 1			
	Material	Beams	Columns	Total
RCC Structure	Conc. Vol. (M^3)	1131.87	624.434	1756.304
	Reinf. Steel(M^3)	22.8	10.965	33.765
Composite Structure	Conc. Vol. (M^3)	-	265.19	265.19
	Reinf. Steel(M^3)	-	3.12	3.12
	Structural Steel(M^3)	54.3	3.18	57.48

Table 4 Comparison of volume of Concrete, Reinforcing Steel & Structural steel (Model 2)				
Structure	Model 2			
	Material	Beams	Columns	Total
RCC Structure	Conc. Vol. (M^3)	1131.87	832.588	1964.458
	Reinf. Steel(M^3)	22.8	11.873	34.673
Composite Structure	Conc. Vol. (M^3)	-	353.518	353.518
	Reinf. Steel(M^3)	-	4.159	4.159
	Structural Steel(M^3)	54.3	4.24	58.37

From Table 3 and Table 4, it is seen that the concrete required for RCC structure is much higher than composite structure. Vice versa in composite structure, the steel used for structural purpose is absent in RCC structure.

Table No. 5 Comparison of Cost of Model 1 Structure				
Structure	RCC Structure	Composite Structure	Difference	In %
Concrete	1,14,15,976	17,23,735	96,92,241	-84.9
Formwork	87,81,520	13,25,950	74,55,570	-84.9
Reinf. Steel	1,06,02,210	9,79,680	96,22,530	-90.76
Reinfocing Charges	21,20,442	1,95,936	19,24,506	-90.76
Structural Steel	-	1,80,48,720	1,80,48,720	-
Fabrication Charges	-	90,24,360	90,24,360	-
Total	3,29,20,148	3,12,98,381	16,21,767	-4.93

Table No. 6 Comparison of Cost of Model 2 Structure				
Structure	RCC Structure	Composite Structure	Difference	In %
Concrete	1,27,68,977	22,97,867	1,04,71,110	-82.0
Formwork	98,22,290	17,67,590	80,54,700	-82.0
Reinf. Steel	1,08,87,322	13,05,926	95,81,396	-88.0
Reinfocing Charges	21,77,465	2,61,186	19,16,279	-88.0
Structural Steel	-	1,80,48,720	1,83,28,180	-
Fabrication Charges	-	90,24,360	91,64,090	-
Total	3,56,56,054	3,27,05,649	29,50,405	-8.27

From this tables, we can see the cost analysis for both the structure of Model 1 & Model 2. The table shows the cost required for material like concrete, reinforcing steel as well as structural steel and its construction costs. The table 6.8 shows the cost difference for composite structure is Rs.16,21,767.00 is less than the RCC structure. It is about 4.93% less than the RCC structure. Where for Model 2 the difference is Rs.29,50,405.00 which is 8.27% less than the RCC structure.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, September 2017- Available at www.ijraset.com

VI. CONCLUSION

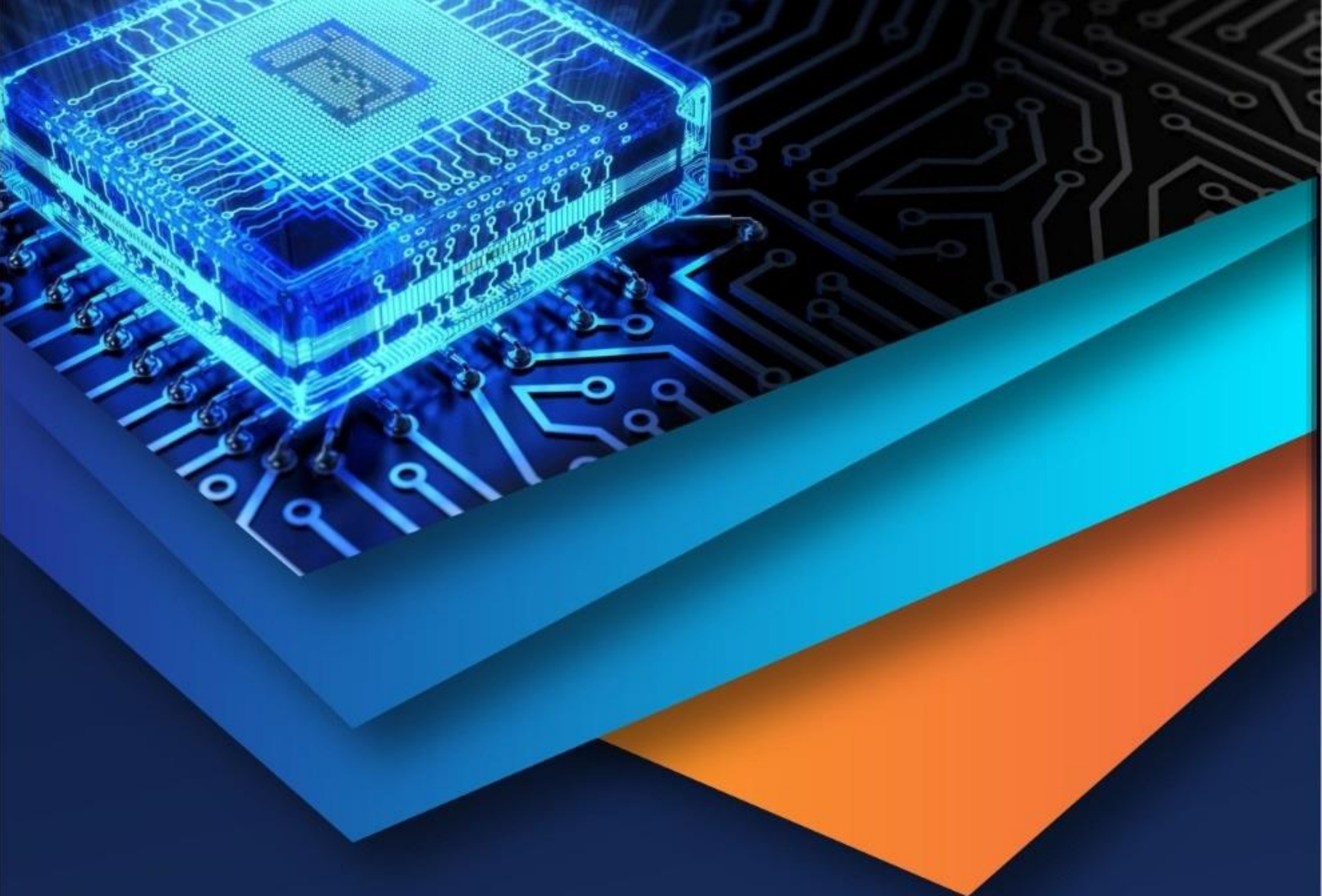
Analysis and design of building can be done and comparison can be made between them and from that result conclusions can be drawn-out are as follows:-

A. As for same axial forces, bending moments we designed composite structure for same specification and loading. We designed smaller sections for same loading in beams and columns.
B. For same structure, when we increased the floor height of structure, it is found that, it doesn't make big changes to axial forces and bending moments. Which results to the sizes of columns and beams remains same.
C. As we are using steel member for beams, the concrete is reduced in beam sections.
D. In composite structure, the column size is lesser than the RCC structure which also reduces the volume of concrete. As concrete reduces, the reinforcing steel also reduced.
E. For Model 1 the cost of Composite Structure is 4.93% less than cost of RCC structure and for Model 2 it is 8.27 % less than cost of RCC structure.
F. Under earthquake consideration because of inherent ductility characteristics, steel-concrete composite structure performs better than a R.C.C structure.
G. Due to reduction in concrete and reinforcing steel in composite structure, it is cost effective than RCC structure.
H. 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.

REFERENCES

[1] Panchal D. R., Marathe P. M. (2011), "Comparative Study of R.C.C, Steel and Composite (G+30 Storey) Building", International Conference 4 on Current Trends In Technology, pp 01-06.
[2] Tedia Anamika, Dr. Maru Savita (2014), "Cost, Analysis and Design of Steel-Concrete Composite structure RCC Structure", IOSR Journal of Mechanical and Civil Engineering, vol. 11, issue 1, pp 54-59.
[3] Koppad Shashikala, Dr. Itti S.V. (2013), "Comparative Study of RCC and Composite Multistoried Buildings", International Journal of Engineering and Innovative Technology (IJEIT), vol. 3, issue 5, pp 341-345.
[4] Wagh Shweta A., Dr. Waghe U. P. (2014), "Comparative Study of R.C.C and Steel Concrete Composite Structures", International Journal of Engineering Research and Applications, Vol.4, Issue 4, pp 369-376.
[5] LIU Jingbo, LIU Yangbing (2008), "Seismic behavior analysis of steel-concrete composite frame structure systems", The 14th World Conference on Earthquake Engineering.
[6] Dunne David, Dr. Subedi Nutan (2009), "Assesmnet of steel–concrete-steel shear wall", International Conference on Applications of Structural Fire Engineering, pp 478-547.
[7] IS 800:2007, "Indian Standard code of practice for General Construction in steel" Bureau of Indian Standards, New Delhi, India.
[8] IS 456:2000, "Indian Standard code of practice for Plain and Reinforced concrete", Bureau of Indian Standards, New Delhi, India.
[9] IS 11384:1985, "Code of Practice for Design of Composite Structure", Bureau of Indian Standards, New Delhi, India
[10] Euro code 3, "Design of Steel Structures", European committee for Standardization committee European de normalization europaisches committee fur normung.
[11] Euro code 4, "Design of composite steel and concrete structures", European committee for standardization committee European de normalization europaisches committee fur normung.
[12] M. Nageh, "How To Model and Design High Rise Building Using ETABs Program" Cairo 2007.
[13] M. Willford, A. Whittaker and R. Klemencic, "Recommendations for Seismic Design of High-Rise Buildings" Council of Tall building and Urban habitat Feb 2008.
[14] J. Zils and J. Viis, "An Introduction To High Rise Design" Structure Magazine Nov 2003.
[15] IS: 1893, Criteria for earthquake resistant design of structures – general provisions for buildings, Part 1, Bureau of Indian Standards, New Delhi, 2002.
[16] Handbook on Composite Construction-Multi-Storey Buildings-Part-3,(2002),Institute for Steel Development and Growth (INSDAG).
[17] Handbook on Code of Practice for Design Loads (Other than Earthquake)for Buildings and Structures (IS : 875(Part 1) –1987),Bureau of Indian Standards, New Delhi, 1989.
[18] Handbook on Code of Practice for Design Loads (Other than Earthquake)for Buildings and Structures (IS : 875(Part 2) –1987),Bureau of Indian Standards , New Delhi ,1989.
[19] Handbook on Code of Practice for Design Loads (Other than Earthquake)for Buildings and Structures (IS : 875(Part 3) –1987),Bureau of Indian Standards , New Delhi, 1989.
[20] Handbook on Criteria for Earthquake Resistant Design of Structures (IS : 1893(Part 1) – 2002),Bureau of Indian Standards , New Delhi, 1989...
[21] Johnson R. P., Composite Structures of Steel and Concrete, Volume 1, Blackwell Scientific Publications, UK, 2004.
[22] D. R. Panchal, Dr. S. C. Patodi, "Steel-Concrete Composite Building Under Seismic Forces", Applied Mechanics Department, Faculty of Technology and Engineering, The M. S. University of Baroda, Vadodara and Professor, Civil Engineering Dept. Parul Institute of Engineering & Technology, Limda Vadodara.

©IJRASET (UGC Approved Journal): All Rights are Reserved



10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)