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Comparative study of Reinforced Concrete frame structure & Steel-Concrete composite structure subjected to static and dynamic loading

Parag P. Limbare, Prof. P. A. Dode

Abstract— **The word 'composite' in composite material signifies that two or more materials are combined on a macroscopic scale to form a useful material and the individual materials are easily distinguishable. In the present work RCC structure with steel concrete composite options are considered for comparative study of G+20 story building which is situated in earthquake zone-II and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. The design and analysis of the structure are carried out with the help of STAAD-PRO software. The results are compared and found that composite structure more economical.**

Index Terms— **Composite column, Static analysis, shear Connectors, STAAD-PRO Software**

I. INTRODUCTION

A composite member is formed when a steel component, such as an I beam, is attached to a concrete component, such as a floor slab or bridge deck. This paper includes comparative study of Reinforced concrete frame structure with Steel Concrete Composite structure having G+ 20 story which situated in earthquake zone II. Equivalent Static Method and Response Spectrum Method of Analysis is used. For modelling of Composite and R.C.C. structures, STAAD-PRO software is used and the results are compared. Comparative study includes deflection, axial force, story drift, base shear. It is found that composite structure is more economical and speedy than R.C.C. structure.

II. COMPOSITE CONSTRUCTION SYSTEM

Abroad, the use of structural steel has been growing, and has now become one of the important input materials of construction. In India, until nineties, availability of structural steel was in less and weather resistant and /or strength grades were not readily available. Thus, steel did not make much in-roads in building construction and highways, and its share in bridge construction also started decreasing. This coupled with many other reasons led to stagnation of steel demand, while large scale production capacity has been created in the country during initial liberalization period of our country. Hence, proper development of steel application sectors has become an important issue and the steel framed composite construction is considered to be a cost effective solution for multi-storied buildings due to optimum use of materials.

Mr. Parag P. Limbare (PG Student) Civil Engg Dept., Datta Meghe College of Engineering, Navi Mumbai
Prof P. A. Dode (Guide) Civil Engg Dept., Datta Meghe College of Engineering, Navi Mumbai

1. Shear connectors

Shear connections are essential for steel concrete construction as they integrate the compression capacity of supported concrete slab with supporting steel beams /girders to improve the load carrying capacity as well as overall rigidity.

Figure 1. Shear connector

2. Profiled Deck

Composite floors using profiled sheet decking have become very popular in the West for high-rise buildings. Composite deck slabs are generally competitive where the concrete floor has to be completed quickly and where medium level of fire protection to steel work is sufficient.

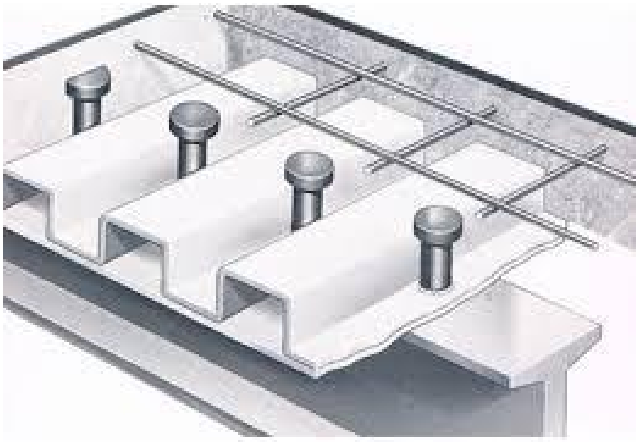

Figure 2. Profiled deck slab

3. Encased column

Steel concrete composite column is conventionally a compression member in which the steel element is a structural steel section. There are three types of composite columns used in practice which are Concrete Encased, Concrete filled, Battered Section.

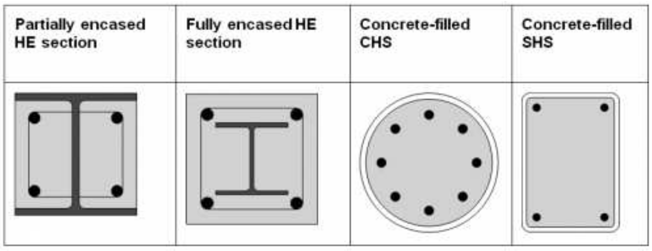

Figure 3. Encased column

4. Composite beam

Composite beams, subjected mainly to bending, consist of steel section acting compositely with flange of reinforced concrete.

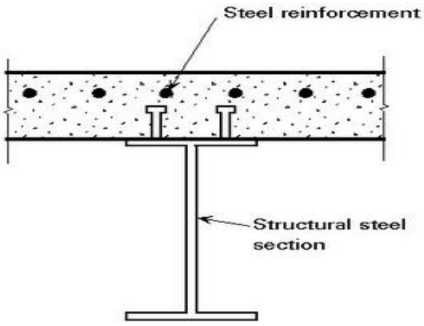

Figure 4. Composite beam

III. BUILDING DESCRIPTION

The building considered here is a residential building having G + 20 storied located in seismic zone II and for earthquake loading, the provisions of the IS:1893(Part1)-2002 is considered. The wind velocity 55m/s. The plan of building is shown in fig. 5. The building is planned to facilitate the basic requirements of an commercial building. The plan dimension of the building is 30 x 23 m. Height of each storey for composite and RCC is 4.2m. The floor plans were divided into five by six bays in such a way that center to center distance between two grids is 5 meters by 5 meter srespectively. The study is carried out on the same building plan for RCC and composite construction with some basic assumptions made for deciding preliminary sections of both the structures. The basic loading on both types of structures are kept same, other relevant data is tabulated in table 1.

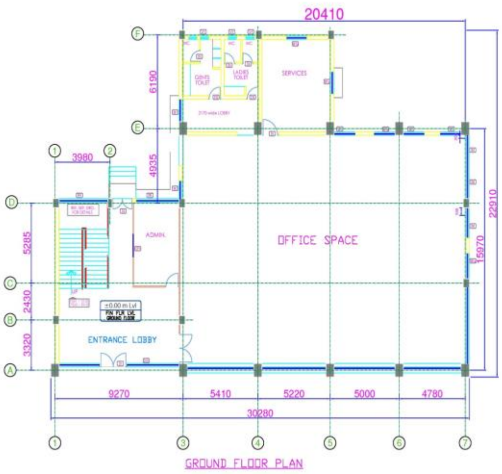

Figure 5. Typical floor plan

Table 1. Data required for analysis

DESCRIPTION	RCC STRUCTURE	COMPOSITE STRUCTURE
Plan dimension	30m x 23 m	30m x 23 m
Total height of building	85m	85m
Height of each storey	4.2m	4.2m
Height of parapet	1.0m	1.0m
Depth of foundation	3.3m	3.3m
Size of beams 6.0m span	300x650 mm	ISWB 450
Size of beams 4.0m span	230x500 mm	ISMB 200
Size of columns	400 mm X 1200mm	800 mm X 600mm + ISHB 450
Thickness of slab	125mm	100 mm
Thickness of walls	230mm	230mm
Seismic zone	II	II
Wind speed	55m/s	55m/s
Soil condition	Medium soil	Medium soil
Importance factor	1	1
Zone factor	0.1	0.1
Floor finish	1.2 kN/m2	1.2 kN/m2
Live load at all floors	2.0 kN/m2	2.0 kN/m2
Grade of concrete beam/column	M40	M40
Grade of concrete slab	M35	M35
Grade of reinforcing steel	Fe500	Fe500
Density of concrete	25 kN/m3	25 kN/m3
Density of brick	20 kN/m3	20 kN/m3
Damping ratio	5%	5%

IV. LOAD COMBINATIONS

The gravity loads and earthquake loads will be taken for analysis. The basic loads are Dead loads (DL), Imposed load (LL), Earthquake load (EQ) along X and Y in positive and negative direction. As per IS 1893 (Part I): 2002 Clause no. 6.3.1.2, the following Earthquake load cases have to be considered for analysis.

1.5(DL + LL)
0.9DL ± 1.5EQ
1.5(DL ± WL)
1.5(DL ± EQ)
0.9DL ± 1.5WL
1.2(DL + LL ± WL)
1.2(DL + LL ± EQ)

V. ANALYSIS

The explained 3D building model is analyzed using Equivalent Static Method and Response spectrum method. The building models are then analysed by the software Staad Pro. Different parameters such as deflection, story drift, shear force & bending moment are studied for the models. 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.

VI. RESULTS AND DISCUSSION

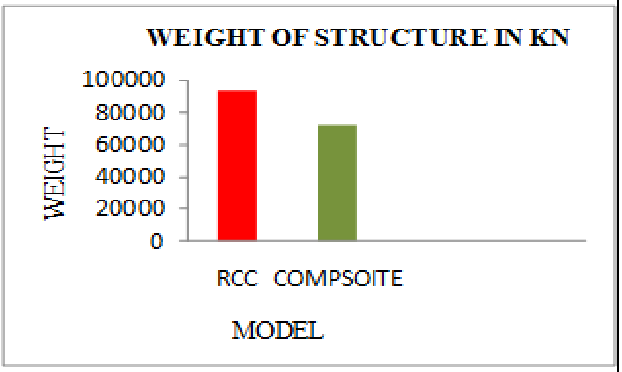

Figure 5. Graph for Wt. of Structure

Table 2: Variation of Wt. of Structure in KN

RCC	95566.5
Composite	73092.534

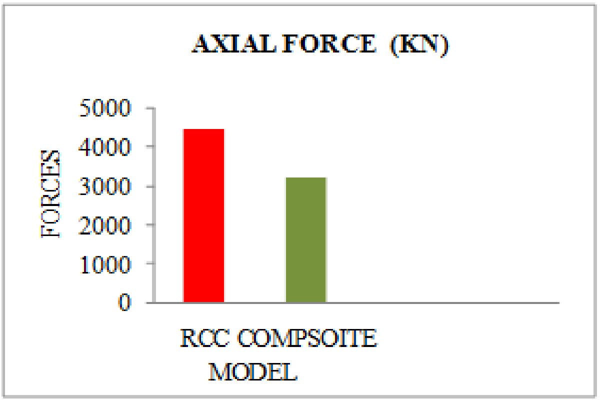

Figure 6. Graph for Axial force

Table 3: Variation of Axial force (KN)

RCC	4523
Composite	3754

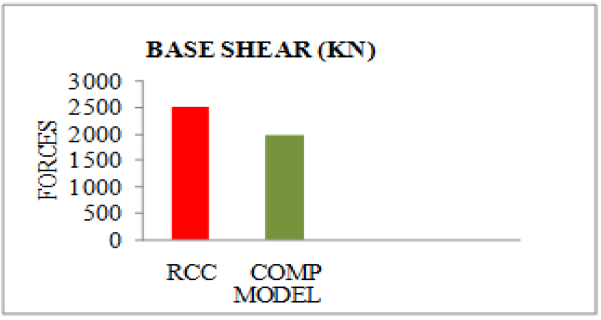

Figure 7. Graph for Base Shear

Table 4: Variation of Base Shear in X direction

RCC	2498.29 KN
Composite	2001.77 KN

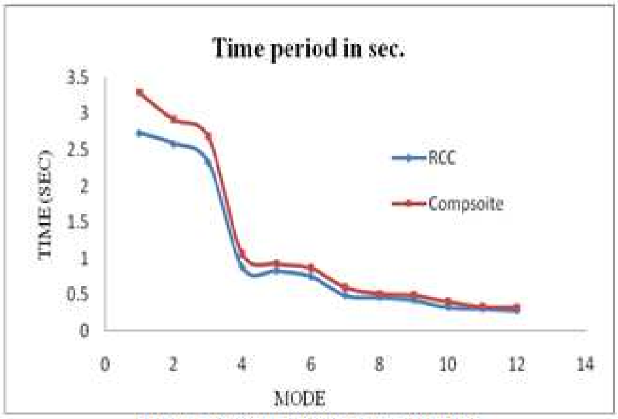

Figure.8.Graph for Time Period

Table 5: Time Period in seconds

RCC	2.9
Composite	3.45

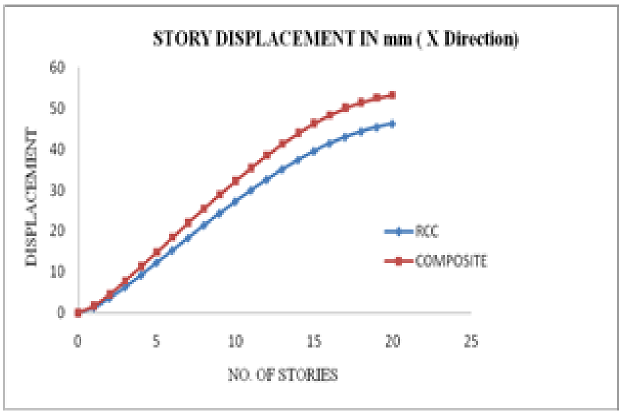

Figure.9.Graph for Story Displacement

Table 6: Variation of Story Displacement in X Direction (mm)

Story No	RCC	Composite
20	46.1	58.3
15	41.2	48.8
10	26.5	34.1
5	12.4	15.4

Figure 10. Graph for Story Drift

Table 7: Variation of Story Drift in X Direction (mm)

Story No	RCC	Composite
20	0.000266	0.000258
15	0.000799	0.000750
10	0.00111	0.000997
5	0.001301	0.001050

VII. CONCLUSION

1. From table 2, it is clear that the wt. of Composite structure is reduced by 23.52% as compared with RCC structure.
2. The story displacement of Composite structure is 20.93% more as compare with RCC.
3. From table 4, it is clear that the base shear of Composite structure is reduced by 24.8% as compared with RCC structure.
4. From table 3, It is clear that the axial force in Composite structure is less as compare with RCC by 20.48%
5. From table 5, It is clear that the time period of Composite is more as compare to RCC by 18.97%.
6. Time required for construction of composite structure is less as compare with RCC structure because no form work is required.

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Parag P. Limbare: He has done his B.E. in Civil engineering from university of Mumbai.

Prof. P. A. Dode: He has done his M.E. Civil and having total 16 years of experience in teaching as well as 3 years in industry.