



Cost Comparison of Composite And RC Frame for Mid Rise Building

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Abstract : Steel concrete composite construction is preferred over conventional RC Construction to get maximum benefit of steel and concrete and to produce efficient and economic structure. Composite construction combines the better properties of both steel and concrete along with lesser cost, speedy construction, fire resistance, high durability and superior seismic performance characteristics. Thus it has been gained wide acceptance worldwide as an alternative to pure steel and concrete construction, not only stimulating the Indian structural designer to take keen interest in it, but also enhancing the composite construction in India. In this study an attempt has been made to compare seismic performance of midrise building [six story (G+5) RCC and Composite Institutional building situated in seismic zone IV]. Equivalent static method is preferred for seismic analysis and ETABS is used for modelling, analysing and designing the structures. Analytical results were compared to achieve the most economical structure against the seismic forces. Comparative analysis shows reduction in the cost of Composite frame (9%) compared with the cost of RCC frame. This involves material cost only and doesn't include fabrication cost, transportation cost, labor cost etc. Percentage may increase for larger span and multi storied building.

Index Terms -Composite construction, Equivalent static method, ETABS. Cost effectiveness

I. INTRODUCTION

The performance of building during an earthquake depends upon several factors, such as stiffness, ductility, lateral strength and Simple and regular configuration. 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 the earthquake. This problem forced the structural engineers to look for the alternative method of construction. Concrete structures are bulky and impart more seismic weight and less deflection whereas Steel structures instruct more deflections and ductility to the structure, which is beneficial in resisting seismic forces. In such circumstances, use of composite construction is of particular interest, due to its significant potential in improving the seismic performance of structure without much more changes in manufacturing and construction techniques.

2. COMPOSITE STRUCTURE

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. Numbers of the studies are carried out on composite construction techniques by different researchers in different parts of the world and found it to be better earthquake resistant and more economical as compared to RCC construction. In composite construction different types of composite sections are used such as composite beams (RCC slab rest over steel beam), encased composite beams (steel sections encased in concrete), pure steel column sections, composite column sections (encased composite column sections and concrete filled in steel tubes column sections). Sometimes composite deck slabs (concrete slab on steel profiled sheets) are also used in the construction of high rise buildings.

2.1 Elements of Composite Construction:

The primary structural components used in composite construction consist of the following elements.

- A. Composite slab
- B. Composite beam
- C. Composite column
- D. Shear connector

3. BUILDING DESCRIPTION

The building selected for the study is an Institutional building having G+5 storied which is located in seismic zone IV. Dimension of the building is 24m x 15m, and total height of the building is 20.5 m. The study is carried out for R.C.C and Composite buildings.

Table: 1 Data for Analysis of R.C Structure.

Plan dimension	24m x 15m
Total height of building.	20.5m.
Height of story	3.5m
Height of parapet	1.0m
Depth of foundation	3.0m
Size of beams 6.0 m span	230mm x 600mm
Size of beams 5.0 m span	230mm x 520mm
Size of beams 4.0 m span	230mm x 450mm
Size of beams 3.0 m span	230mm x 380mm
Size of outer columns	450mm x 650mm
Size of internal columns	450mm x 680mm
Thickness of slab	150mm
Thickness of internal & external walls	230mm
Seismic zone	IV
Soil condition	medium soil
Live load at roof	2.0 KN/m ²
Floor finishes	1.0 KN/m ²
Live load at all floors	4.0 KN/m ²
Grade of concrete	M30
Grade of reinforcing steel	Fe415
Density of concrete	25 KN/m ³
Density of brick	20 KN/m ³
Damping ratio	5%

Table: 2 Data for Analysis of Composite Structure.

Plan dimension	24m x 15m
Size of Main beams	ISMB 200
Size of secondary beams	ISLB 200
Size of outer columns	300mm X 350mm (ISMB 200)
Size of internal columns	300mm X 350mm (ISMB 200)
Thickness of slab	150mm
Thickness of internal & external walls	230mm
Seismic zone	IV
Soil condition	Medium soil
Importance factor	1.0
Zone factor	0.24
Live load at roof	2.0 KN/m ²
Floors finish	1.0 KN/m ²
Live load at all floors	4.0 KN/m ²
Grade of concrete	M30
Grade of reinforcing steel	Fe415
Density of concrete	25 KN/m ³
Density of brick	20 KN/m ³
Damping ratio	5%
Total height of building.	20.5m.
Height of story	3.5m
Height of parapet	1.0m
Depth of foundation	3.0m

4. Cost Comparison Analysis

Table 3 and 4 shows the cost of composite and RCC building. It is observed that cost of composite building is less than RC building because composite building required lesser sizes of members as compare to RCC building. And the difference between the cost of RCC and composite building is found as Rs.1, 80,252/-

Table 3: Composite Frame Structure

Material	Quantity Used	Rate of material	Amount
Structural Steel (kg)	29125.4	Rs-50/kg	Rs-14,56,270
Reinforcing bar (kg)	3463.7	Rs-40/kg	Rs-1,38,548
Concrete used (m3)	51	Rs-5000/m3	Rs-2,25,000
Total Sum			Rs-18,19,818/-

Table 4: RCC Frame Structure

Material	Quantity Used	Rate of material	Amount
Reinforcing bar (kg)	10207.74	Rs-40/kg	Rs-4,70,889.6
Concrete used (m3)	305.84	Rs-5000/m3	Rs-15,29,180
Total Sum			Rs-20,00,070/-

$$\begin{aligned} \text{Reduction Factor for Composite} &= \text{Cost of Composite/Cost of RCC} \\ &= 18,19,818/20,00,070 \\ &= 0.91 \end{aligned}$$

Hence, reduction in cost of composite frame is 9% compared with cost of RCC frame. This involves material cost only and doesn't include fabrication cost, transportation cost, labour cost etc.

5. CONCLUSIONS

From the analysis and design of RCC and composite building, it is concluded that,

1. The floor displacement is maximum for composite buildings as compared to RCC buildings. RCC building has the lowest values of displacement because of its high stiffness.
2. Story drift in Equivalent Static Analysis along X and Y direction is more for Composite building as compare to RCC building.
3. RCC frame has the lowest values of story drift because of its high stiffness.
4. The differences in story drift for different stories along X and Y direction are owing to orientation of column sections. Moment of inertia of column section is different in both directions.
5. Story shear for RCC building is maximum because the weight of the RCC building is more than the composite building. Story shear gets reduced by 89.15 % in X- direction and 90.3 % in Y-direction for Composite building in comparison with the RCC building.
6. Reduction in cost of Composite frame is 9% compared with cost of RCC frame. This involves material cost only and doesn't include fabrication cost, transportation cost, labour cost etc. Percentage may increase for larger span and multi storied building.

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