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Cost Comparison of R.C.C. and Composite Structures

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ABSTRACT
Steel-concrete composite construction has gained wide acceptance worldwide as an alternative to pure steel and pure concrete construction. Reinforced concrete members are used in the framing system for most of the buildings since this is the most convenient and economic system for low-rise buildings. However, for medium to high-rise buildings this type of structure is no longer economical because of increased dead load, less stiffness, span restriction and hazardous formwork. Steel-concrete composite frame system can provide an effective and economic solution to most of these problems in medium to high rise buildings. An attempt has been made in this study to explore cost effectiveness of composite construction. Study concludes that composite structures can be best suited as compared Reinforced Concrete Structure.
Keywords: R.C.C., Cost, Composite, Analysis and Design

I. INTRODUCTION

As our country is one of the fastest growing countries across the globe and need of shelter with higher land cost in major cities where further horizontal expansion is not much possible due to space shortage, we are left with the solution of vertical expansion. Steel-concrete composite construction has gained wide acceptance worldwide as an alternative to pure steel and pure concrete construction. Steel-concrete composite frame system can provide an effective and economic solution to most of these problems in medium to high-rise buildings and for buildings having longer spans. An attempt has been made in this study to explore the cost effectiveness of composite construction for high-rise buildings and for the long span composite system.

In due consideration of the above fact, this project has been envisaged which consists of analysis and design of composite structures with steel solid beams using Steel-Concrete composite option. The project also involves analysis and design of R.C.C structure, composite structure with steel beams so that a cost comparison can be made between a Reinforced concrete structures, Composite structures with steel solid beams.

1.1 COMPOSITE STRUCTURES

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 as shown in figure 1.1. Composite beams are similar to concrete T-beam where flange of the T-beam is made up of concrete and web of beam is made up of steel section. In such a composite T-beam, the comparatively high strength of the concrete in compression complements the high strength of the steel in tension. The fact that each material is used to the fullest advantage makes composite Steel-Concrete construction very efficient and economical. However, the real attraction of such construction is based on having an efficient connection of the Steel to the Concrete, and it is this connection that allows a transfer of forces and gives composite members their unique behavior.

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1.1.1. Composite beam, Slab and Shear Connectors
A steel concrete composite beam consists of a steel beam, over which a reinforced concrete slab is cast with shear connectors. The composite action reduces the beam depth. Rolled steel sections themselves are found adequate frequently for buildings and built up girders are generally unnecessary. The composite beam can also be constructed with profiled sheeting with concrete topping or with cast in place or precast reinforced concrete slab.

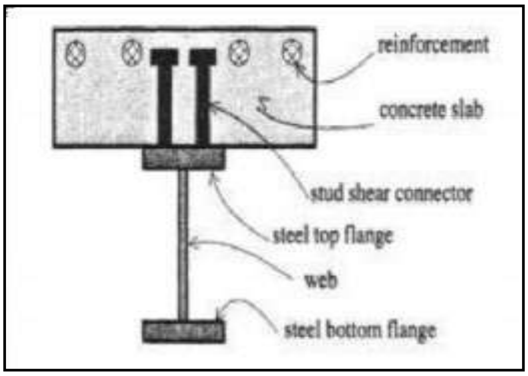

Chart -1:Composite beams

1.2 MERITS OF COMPOSITE CONSTRUCTION

The most effective utilization of steel and concrete is achieved:

- Keeping the span and loading unaltered, a more economical steel section (in terms of depth and weight) is achievable in composite construction compared with conventional non-composite construction.
- As the depth of beam reduces, the construction depth reduces, resulting in enhanced headroom.
- Encased steel beam sections have improved fire resistance and corrosion.
- Considerable flexibility in design, pre-fabrication and construction scheduling in congested areas.

II. LITERATURE REVIEW

- Anish N. Shah and P.S. Pajgade (2013) did a comparative study on G+15 storey office building which is situated in earthquake zone IV & wind speed 39m/s. Equivalent Static Method of Analysis wad used. For modelling of Composite & Reinforced concrete. Structures, staad-pro software is used and the results are compared; and it was found that composite structure are more economical. It was concluded that composite structures behave well than Reinforced concrete structures from structural parameters point.
- Shweta A. Wagh and Dr. U. P. Waghe (2014) Steel concrete composite construction has gained wide acceptance world-wide 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 of India, and not using steel as an alternative construction material and where it is economical is a heavy loss for the country. In this paper study of Four various multistoried commercial buildings i.e. G+12, G+16, G+20, G+24 are analysed by using STAAD-Pro software. Where design and cost estimation is carried out using MS-Excel programming and from obtained result comparison can be made between R.C.C and composite structure.
- Anamika Tedia1 and Dr. Savita Maru (2014) Steel-concrete composite construction means steel section encased in concrete for columns & the concrete slab or profiled deck slab is connected to the steel beam with the help of mechanical shear connectors so that they act as a single unit. Steel concrete composite with R.C.C. options are considered for comparative study of G+5 storey office building with 3.658 m height, which is situated in earthquake zone III(indore)& wind speed 50 m/s. The overall plan dimension of the building is 56.3 m x 31.94 equivalent Static Method of Analysis is used. For modeling of Composite & R.C.C. structures, staad-pro software is used and the results are compared; and it is found that composite structure is more economical.
- Mahesh Suresh Kumawat and L G Kalurkar (2014) Steel concrete composite construction means the concrete slab is connected to the steel beam with the help of shear connectors, so that they act as a single unit. In the present work steel concrete composite with RCC options are considered for comparative study of G+9 storey commercial building which is situated in earthquake zone-III and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. A three dimensional modeling and analysis of the structure are carried out with the help of SAP 2000 software.

METHODOLOGY

- Structural analysis methods can be divided into the following categories:

1. Equivalent Static Analysis

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2. Response Spectrum method
3. Time history method
4. Linear Dynamic Analysis

III. PROBLEM FORMULATION

The plan dimensions of buildings are shown in table below. The plan view of building, elevation of different frames is shown in figures below.

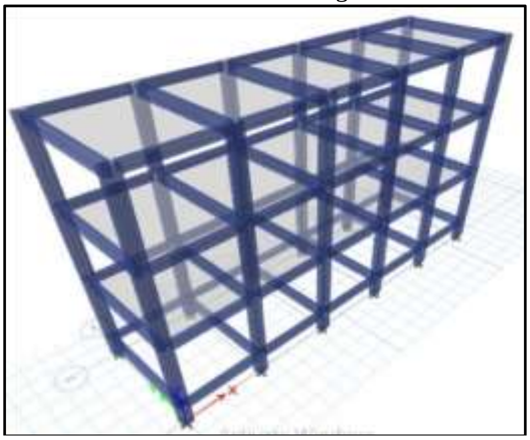

Chart -2:3D View of Building

Table-1: Detail Features of Building

Sr. No.	Parameters	Values
1	Material used	Concrete-M25 Reinforcement Fe-500 Structural steel 250-Mpa
2	Plan Dimension	(3.5mx5m) (3.5mx7.5m)
3	Height of each Storey	4m
4	Density of concrete	25 kN/m^3
5	Poisson Ratio	0.3-concrete 0.2-steel
6	Density of masonry	20 kN/m^3
7	Damping	5%-R.C.C. 2%-Steel 2%-Composite
8	Seismic zone	III
9	Importance Factor	1
10	Response Reduction Factor	5
11	Foundation soil	Medium
12	Slab thickness	125mm
13	Wall thickness	230mm
14	Floor Finish	1 kN/m^2
15	Live load	2.5 kN/m^2
16	Earthquake load	As per IS 1893-2002

IV. RESULT AND CONCLUSION

➢ BASE SHEAR (kN):

It is the total design lateral force at the base of the structure. Variation of Base Shear in X and Y direction has been studied. Variation of base shear in X-direction and Y -direction for Reinforced concrete structures, composite structures without opening and composite structures with opening are shown in Table-2.

Table-2: Variation of Base Shear (KN) in X-Direction and Y-Direction

Trials	Direction	Zone	R.C.C.	Composite With steel beam
Trial 1 (3.6m X 5m)	EQx	III	142.066	89.544
	EQy		120.372	62.938
Trial 2 (3.6m X 7.5m)	EQx		217.415	141.648
	EQy		181.618	134.987

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- COST ANALYSIS FOR R.C.C. STRUCTURE:

Table-3 Variation of cost for R.C.C. Structure (Trial 1)

Material	Quantity used	Rate of steel /kg	Rate of concrete /m^3	Total (Rs.)
Reinforced steel (kg)	5100	75	-	382500
Concrete(m^3)	52	-	4500	234000
				6,16,500.00

Table-4 Variation of cost for R.C.C. Structure (Trial 2)

Material	Quantity used	Rate of steel /kg	Rate of concrete /m^3	Total (Rs.)
Reinforced steel (kg)	9233	75	-	692475
Concrete(m^3)	81	-	4500	364500
				10,56,975.00

- COST ANALYSIS FOR COMPOSITE STRUCTURE WITH SOLID SECTIONS:

Table-5 Variation of cost for Composite Structure with solid sections (Trial 1)

Material	Quantity used	Rate of steel /kg	Rate of concrete /m^3	Total (Rs.)
Reinforced steel (kg)	12233	75	-	917475
Concrete(m^3)	30	-	4500	135000
				10,52,475.00

Table-6 Variation of cost for Composite Structure with solid sections (Trial 2)

Material	Quantity used	Rate of steel /kg	Rate of concrete /m^3	Total (Rs.)
Reinforced steel (kg)	16703.8	75	-	1252750
Concrete(m^3)	42	-	4000	189000
				14,41,785.00

FINAL OBSERVATIONS

1. As it can be seen that base shear for composite structure with solid sections has reduced by 36.97% compared to that of Reinforced concrete structure in X-direction.
2. As it can be seen that base shear for composite structure with solid sections has reduced by 47.71% compared to that of Reinforced concrete structure in Y-direction.
3. Column forces in composite structure with solid sections have reduced compared to that of Reinforced concrete structure.
4. Column forces in composite structure with openings have reduced compared to that of Reinforced concrete structure.
5. As span goes on increasing beam moments in composite structure with solid sections
6. Column moments in composite structure have reduced by on an average of 4.85%, 8.8% and 30.24% for ground floor, first floor and second floor respectively compared to that of Reinforced concrete structure.
7. Deflection of all the beams in structures are within permissible limit.
8. As performance of these structures from structural parameters point is better than reinforced concrete structures, they can be used effectively in areas of high seismic intensity.

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