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Comparative study of RCC and steel-concrete composite structures

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Abstract— **Reinforced cement concrete is the most commonly used building material in India, as it is the convenient and economic system. This is true in the case of low rise buildings. The use of RCC is no longer economic for high rise buildings because of their increased dead load, decreased stiffness and hazardous formworks. The structures provide more deflection and ductility to the structures which is required to resist the seismic loads. According to literature use of composite steel-concrete system can provide durable, economic and seismic resistant structures. The composite structures are most appropriate in opposing seismic strength when compared to RCC. This paper compares the effectiveness of steel-concrete composite fames over traditional RCC for buildings by analysis and design of G+12 stories using E-tabs.**

Keywords*— *High rise buildings, Steel-concrete system, Economic, Seismic resistant.

I. Introduction

In India the urban area is developing exponentially but with constrained properties the vertical development of structures is becoming necessary. For these tall structures utilization of composite members in the structures will provide greater success than the RCC members. Use of RCC for the tall structures leads to huge dead loads and a system which is helpless against risk. The use of composites i.e. steel-concrete system proves to be a time and cost effective system theoretically. It is evident nowadays that composite structures in bridges and high rise buildings are an economical solution in most of the developing countries. They also show resistance towards seismic loads. The fact that every material is used to its fullest advantage makes the composite structure more efficient and economical than RCC.

II. Objective

To compare the analytic results of the G+12 steel-concrete composite structure with the conventional RCC structure using the STAAD-pro software.

III. Composite structures

The failure of many RCC multi-storied buildings has forced the engineers to make use of alternative systems. In India people are reluctant to make use of concrete-steel composite structures because of its complexity in design and analysis. According to literature survey composite steel-concrete system can provide extremely economical structural system with high durability, rapid erection and superior seismic performance characteristics. In composite construction the different materials are tied together by the use of shear struds at the interface which saves material cost considerably. As the thermal expansion of steel and concrete being the same there will be no issue of different thermal stresses under temperature variations.

IV. Elements of the composite structure

A. Composite columns

Fig. 1. Section of the composite column

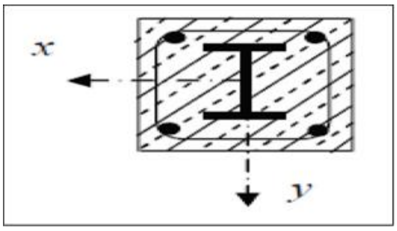
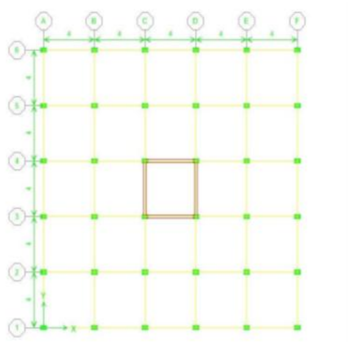


Fig. 2. Plan view of the columns

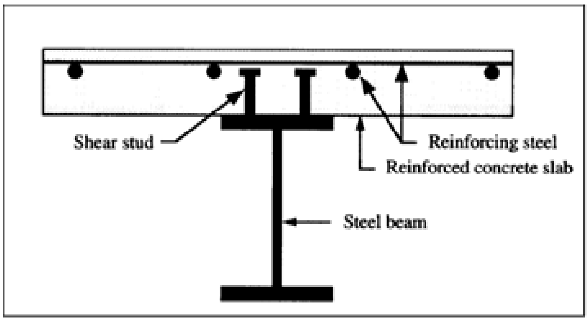


Columns are placed at 4m centre to centre and are taken to be square as square columns are more suitable for earthquake resistant structures. The study is carried on the same building plan for RCC and composite structure with some basic assumptions and loading is kept same for both the structures.

B. Steel Beams

I section members are used as the beam for the structure.

Fig. 3. Section of the beam and slab together



C. Shear Connectors

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

Fig. 4. Shear connectors

V. DATA FOR ANALYSIS

TABLE I. DATAS REQUIRED FOR ANALYSIS

PARAMETERS	VALUES-RCC	VALUES-COMPOSITE
Material used	M20, Fe 500 steel	M20 and M30 for concrete in composite column, Fe 500 steel
Plan dimension	20mx20m	20mx20m
Height of each storey	3m	3m
Density of concrete	25KN/m^3	25KN/m^3
Density of masonry	20KN/m^3	20KN/m^3
Seismic zone	III	III
Importance factor	1	1
Response reduction factor	5	5
Foundation soil	Hard	Hard
Slab thickness	150mm	150mm
Wall thickness	230m	230mm
Floor finish	1KN/m^2	1KN/m^2
Live load	3KN/m^2	3KN/m^2
Earthquake load	As per IS 1893-2002	As per IS 1893-2002

VI. RESULTS

TABLE II. VARIATIONS OF BASE SHEAR

	DIRECTION	ZONE	RCC	COMPOSITE
G+12	X	III	767.87 kN	455.99 kN
	Y	III	716.77 kN	420.15 kN

Fig. 5. Graph for variation of base shear

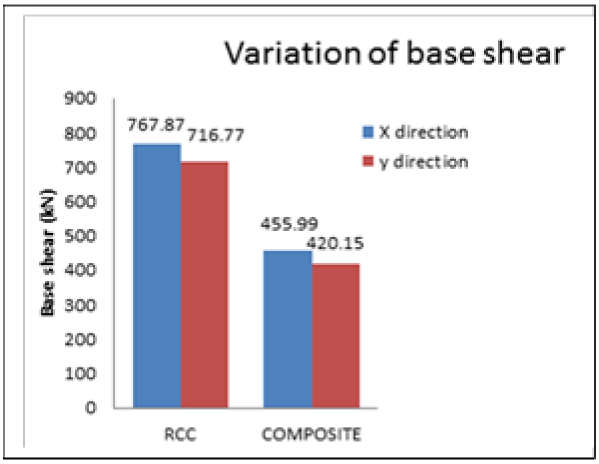


TABLE III. VARIATION OF DISPLACEMENT

DISPLACEMENT(mm)		
STOREY N0.	RCC	COMPOSITE
14	16.575	21.989
13	15.354	20.057
12	14.264	18.081
11	12.804	16.038
10	11.377	14.030
9	9.898	11.989
8	8.388	9.974
7	6.377	8.019
6	5.401	6.166
5	3.999	4.459
4	2.718	2.949
3	1.610	1.688
2	0.734	0.732
1	0.142	0.134

Fig. 6. Graph for variation in displacement

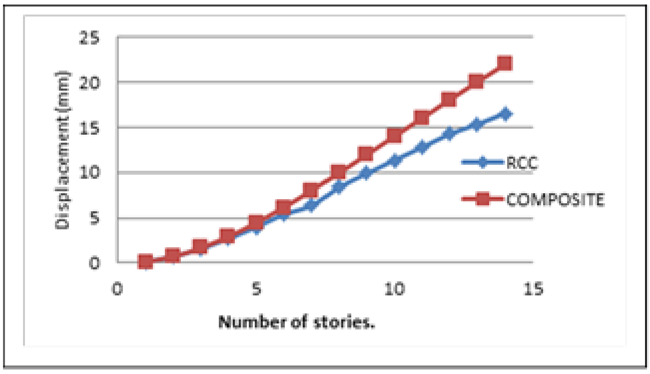


TABLE IV. VARIATION IN COLUMN FORCES

COLUMN FORCES (kN)		
G+12		
COLUMN	RCC	COMPOSITE
Corner column	2591.65	1835.98
Side column	3559.54	2844.25
Inner column	3921.36	3641.75

Fig. 7. Graph for variation in column forces

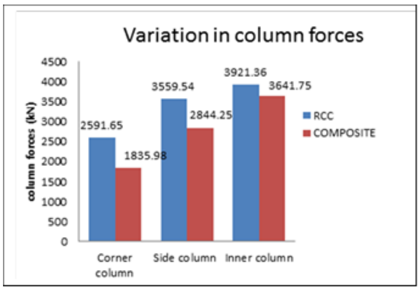


TABLE V. VARIATION IN BEAM MOMENTS

BEAM MOMENTS		
G+12		
MOMENT (kNm)	RCC	COMPOSITE
Support	394.40	209.229
centre	205.384	119.206

Fig. 8. Graph for variation in beam moments

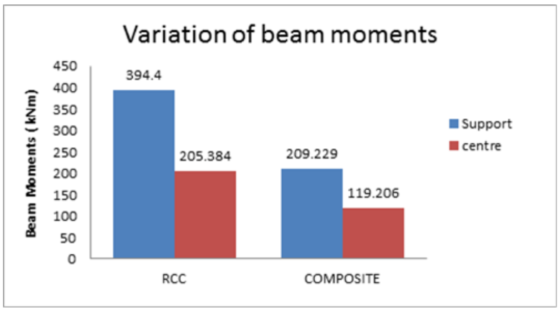
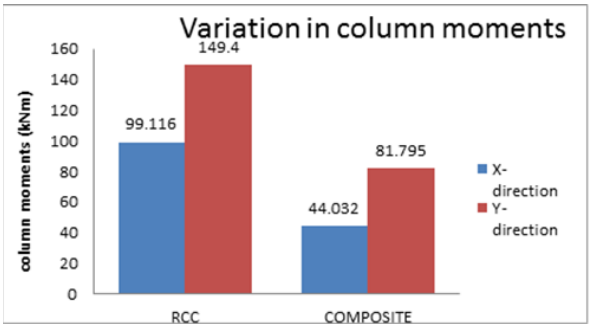


TABLE VI. VARIATION IN COLUMN MOMENTS

COLUMN MOMENTS		
G+12		
MOMENT (kNm)	RCC	COMPOSITE
X	99.116	44.032
Y	149.400	81.795

Fig. 9. Graph for variation in column moments



VII. Conclusion

A. The base shear for composite structures has reduced by 25.56% to 41.38% compared to that of RCC structures.

B. The displacement for composite structures has increased by 10.78% to 24.62% compared to that of reinforced concrete structures.

C. Column forces in composite structures have reduced by 15.32% to 29.16% compared to that of RCC structures.

D. As column forces have reduced sizes of the footings also reduces compared to that of RCC structures.

E. Beam moment has reduced considerably compared to that of RCC structure.

F. The time required for construction of steel-concrete composite structures is less than that required for RCC.

G. Use of formworks and the cost for them will be reduced considerably.

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