COMPARATIVE STUDY ON BEHAVIOUR OF RCC AND STEEL - CONCRETE COMPOSITE MULTISTOREY BUILDING

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ABSTRACT: *Steel concrete composite construction is a relatively a new concept for the construction industry. Steel-concrete composite elements are used widely in modern building construction. Steel-concrete composite systems for buildings are formed to act as a single unit by connecting the steel beam to the composite deck slab or profile deck sheet with the help of shear connectors. For medium to high-rise buildings RCC structure is no extended economic because of their higher dead load, smaller amount stiffness, span limitation and hazardous formwork. In this present paper, G+9 multistorey building is modeled and analyzed using ETABS-2016. Three different types of model is madein this research. one for RCC, and remaining two for Steel Concrete Composite Structure with two different types of columns such as encased column and Concrete filled tubes. Cost Comparison for the above three types of buildings are done and comparison of parameters like Joint displacement, Story drifts and Story Shear is carried over and results are being compared.*

KEYWORDS: *Profile deck sheet, Encased Column, Joint displacement, Story drifts, Story Shear.*

1.INTRODUCTION

In the previous years, for the design of a building, the choice was usually 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 has enforced the structural engineers to look for the alternate method of construction. Use of composite or hybrid material is of particular interest, due to its significant prospective in improving the overall performance through rather modest alterations in manufacturing and constructional technologies. In India, most of the consulting engineers are unwilling 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 very economical structural systems with great durability, rapid erection and superior seismic performance characteristics.

The two materials are mostly used as building material those are steel and concrete for structures ranging from sky scrapers to pavements, although these materials possess different characteristics and properties, they both like to complement each other in various ways. Composite members are made up of two different materials such as steel and concrete which are used for beams and columns. The steel and concrete structures have extensive uses in multistory commercial buildings and factories as well as in case of bridges. Steel and concrete have almost the same thermal expansion, concrete is capable in taking compression loads and steel is exposed to tensile loads. Composite structures are becoming popular and preferred choice of structural Engineers. In composite construction preliminary construction loads will be supported by steel frame members including the self weight during construction and then concrete is cast around the section or concrete is poured inside the tubular section.

2. ELEMENTS OF COMPOSITE STRUCTURE

2.1 Shear Connectors

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

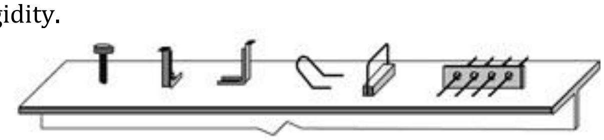

Fig. 2.1 Types of Shear Connectors

2.2 *Profiled Deck*

Composite floors with profiled sheet decking have become most popular in the West for high-rise buildings. Composite deck slabs are generally competitive where the concrete floor has to be completed rapidly and where standard level of fire protection to steel work is sufficient. There is presently no Indian standard covering the design of composite floor systems using profiled sheeting.

In composite floors, the structural behavior is likely to act as reinforced concrete slab, with the steel sheeting acting as the tension reinforcement.

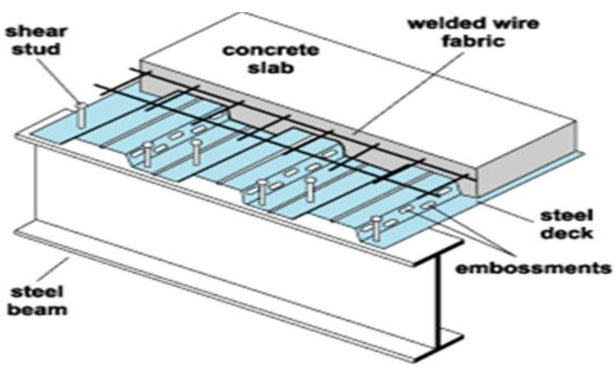

Fig. 2.2 Typical composite beam-slab details

2.3 Composite beam

A steel concrete composite beam contains a steel beam, over which a reinforced concrete slab is cast with shear connectors. The composite action reduces the beam depth. Rolled steel sections are found adequate for buildings and built up girders are generally avoidable. The composite beam can also be constructed with profiled sheeting with concrete topping or with cast in place or precast reinforced concrete slab.

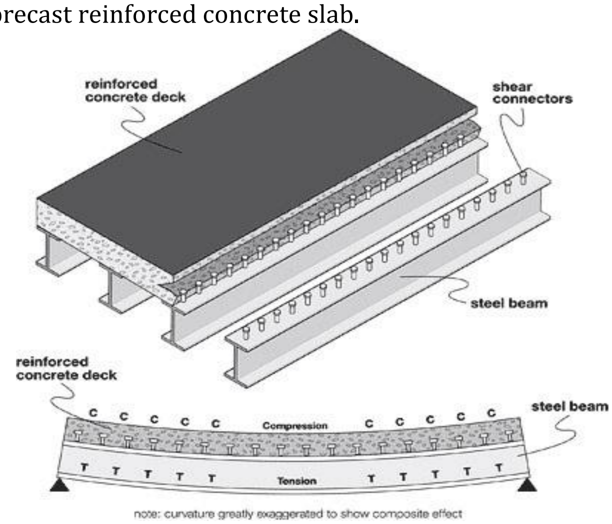

Fig. 2.3 Typical Composite beam

2.4 Composite Column

A steel – concrete composite column is usually 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.

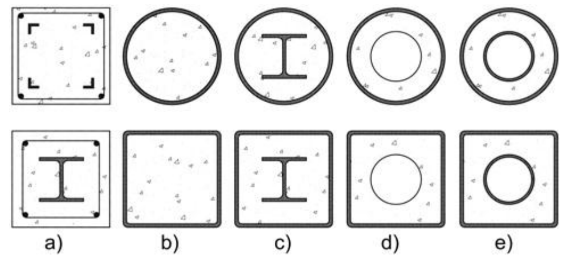

Fig. 2.4 Various types of composite columns: concrete encased steel (CES) (a), CFST (b), combination of CES and CFST (c), hollow CFST sections (d) and double skin sections (e).

3. STRUCTURAL DETAILS

The building considered here is a commercial building. The plan dimension is 20mx20m. The study is carried out on the same building plan for R.C.C, Steel Concrete Composite building with Encased Column and with Filled tubes. The basic loading on all types of structures are kept same.

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

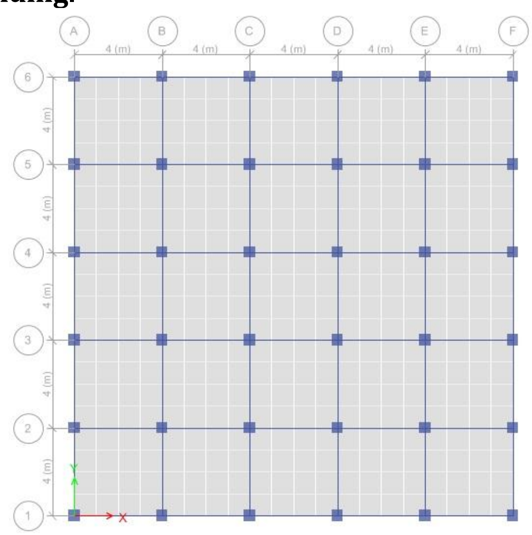

Fig. 3.1 Plan for R.C.C building

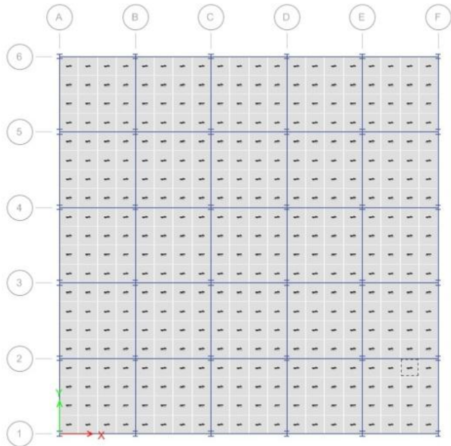

Fig. 3.2 Plan for Composite Encased Column building

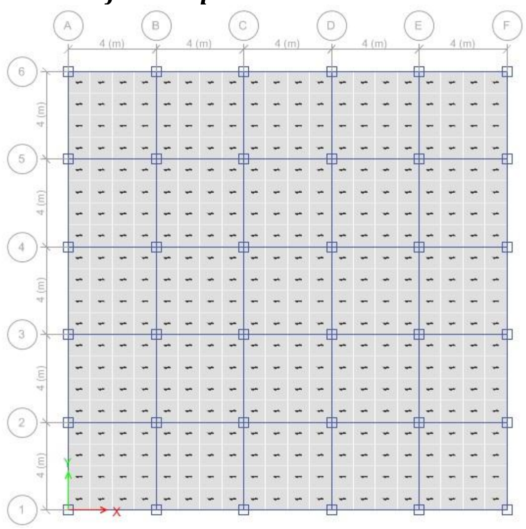

Fig. 3.3 Plan for Composite Filled Tube building

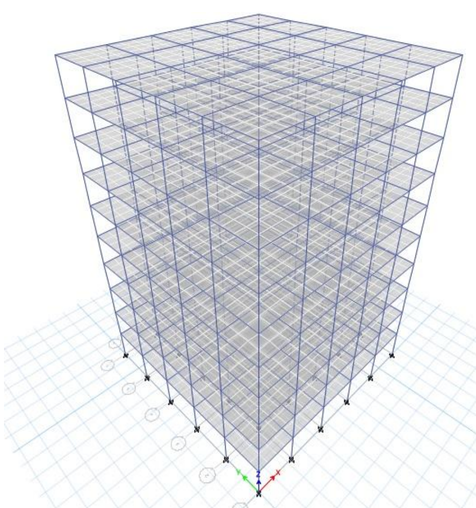

Fig3.4Model of building

Table 1: Description of the RCC model

SI. NO.	Description of the RCC model	
1	No. of Storey	G+9
2	Typical Floor height	3m
3	Ground Floor height	3m
4	Plan dimension	20 m x 20 m
5	Beam size	300x450 mm
6	Column size	500x500 mm
7	Thickness of slab	125 mm
8	Concrete grade	M 30
9	Rebar Grade	Fe 415
10	Dead load on slab	1 kN/m^2
11	Live load on slab	3 kN/m^2
12	Seismic load	As per IS 1893:2002
13	Load Combinations	As per IS 1893:2002
14	Seismic Zone	Zone 3
15	Type of Soil	Medium Soil
16	Importance Factor (I)	1
17	Response Reduction Factor (R)	5

Table 2: Description of the Composite Encased Column model

SI. NO.	Description of the Composite Encased Column model	
1	No. of Storey	G+9
2	Typical Floor height	3m
3	Ground Floor height	3m
4	Plan dimension	20 m x 20 m
5	Beam	ISHB150-1
6	Column size	450x450 mm
7	Encased Steel section	ISHB 250-1
8	Composite Profile Deck Slab thickness	125 mm
9	Thickness of concrete above Profile Sheet	60 mm
10	Depth of Profile Sheet	65 mm
11	Thickness of Profile Sheet	1 mm
12	Diameter of Shear Stud	18 mm
13	Height of Shear Stud	80 mm
14	Concrete grade	M 30
15	Rebar Grade	Fe 415
16	Dead load on slab	1 kN/m^2
17	Live load on slab	3 kN/m^2

18	Seismic load	As per IS 1893:2002
19	Load Combinations	As per IS 1893:2002
20	Seismic Zone	Zone 3
21	Type of Soil	Medium Soil
22	Importance Factor (I)	1
23	Response Reduction Factor (R)	5

Table3: Description of the Composite Filled tubes model

SI. NO.	Description of the Composite Encased Column model		
1	No. of Storey		G+9
2	Typical Floor height		3m
3	Ground Floor height		3m
4	Plan dimension		20 m x 20 m
5	Beam		ISHB150-1
6	Column size		450x450 mm
7	Concrete Filled Steel tube	Flange Thickness	20 mm
		Web Thickness	20 mm
8	Composite Profile Deck Slab thickness		125 mm
9	Thickness of concrete above Profile Sheet		60 mm
10	Depth of Profile Sheet		65 mm
11	Thickness of Profile Sheet		1 mm
12	Diameter of Shear Stud		18 mm
13	Height of Shear Stud		80 mm
14	Concrete grade		M 30
15	Rebar Grade		Fe 415
16	Dead load on slab		1 kN/m^2
17	Live load on slab		3 kN/m^2
18	Seismic load		As per IS 1893:2002
19	Load Combinations		As per IS 1893:2002
20	Seismic Zone		Zone 3
21	Type of Soil		Medium Soil
22	Importance Factor (I)		1
23	Response Reduction Factor (R)		5

4. RESULTS AND DISCUSSION

The model was analyzed by Equivalent Static Method. The building model was then analyzed by using Etabs-2016 for RCC, Steel Concrete Composite with Encased Column and Steel Concrete with Filled tubes. In India, IS 1893 (PART-1): 2002 is the main code that governs the outline for Seismic design force. The parameters such as Joint Displacement, Storey Drift, Storey Shear and Cost Comparisons are made as follows:

4.1 Joint Displacement

The Joint Displacements for each storey level for RCC and Encased Column, CFST structures presented in table 4.

Table 4:Joint Displacement

Storey	RCC	Encased Column	CFST
10	17.852	52.288	49.197
9	17.101	48.296	44.11
8	15.921	43.622	38.689
7	14.353	38.171	32.899
6	12.478	32.029	26.827
5	10.379	25.403	20.655
4	8.128	18.593	14.643
3	5.791	11.997	9.12
2	3.446	6.148	4.49
1	1.273	1.791	1.25

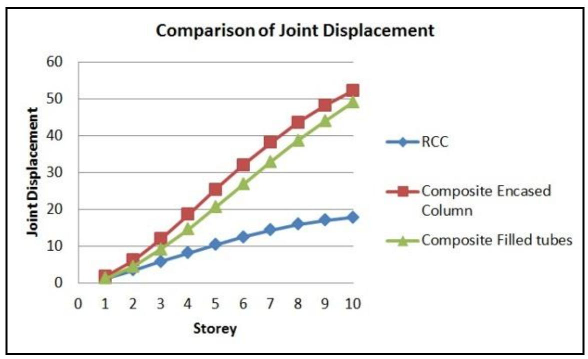

Fig.4.1 Comparison of Joint Displacement

4.2 Storey Drifts

The Storey Drifts for each storey level for RCC and Encased Column, CFST structures presented in table 5.

Table 5: Storey Drift

Storey	RCC	Encased Column	CFST
10	0.00025	0.0013	0.0017
9	0.00039	0.0016	0.0018
8	0.00052	0.0018	0.0019
7	0.00063	0.0020	0.0020
6	0.00070	0.0022	0.0021
5	0.00075	0.0023	0.0020
4	0.00078	0.0022	0.0018
3	0.00078	0.0020	0.0015
2	0.00073	0.0015	0.0011
1	0.00042	0.0006	0.0004

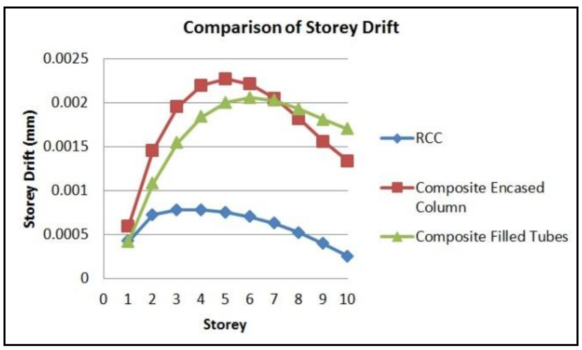

Fig.4.2 Comparison of Storey Drift

4.3 Story Shear

The Story Shear for each storey level for RCC and Encased Column, CFST structures presented in table 6.

Table 6:Storey Shear

Storey	RCC	Encased Column	CFST
10	267.04	61.58	73.13
9	503.09	117.98	141.86
8	689.59	162.54	196.17
7	832.39	196.65	237.75
6	937.30	221.72	268.29
5	1010.15	239.13	289.51
4	1056.78	250.27	303.08
3	1083.01	256.53	310.72
2	1094.66	259.32	314.11
1	1097.58	260.01	314.96

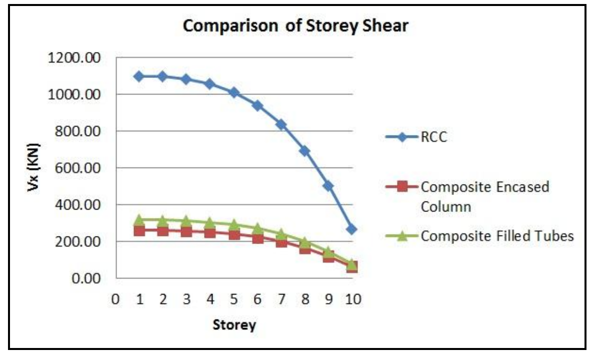

Fig.4.3 Comparison of Storey Shear

D. Comparison of cost for Composite & R.C.C. Structure:

Table 7.Cost Comparison for R.C.C and Encased Column

Structure	RCC Structure	Encased Column	Differe-nce In %
Conc.,	6536147	2239127	**65.7**
Reinf.. Steel	1447752.2	548391	**62**
Struct., Steel	**-**	7000949	**-**

Table8 .Cost Comparison for R.C.C and CFST

Structure	RCC Structure	CFST	Difference in %
Conc.,	6536147	2286768	65
Reinf., Steel	1447752.2	-	-
Structural Steel	-	3986602	-

5. CONCLUSION

1. In general, Composite structures are economical than that of RCC structure.
2. Due to the inherent ductility nature of Composite structure they perform well then R.C.C structure under earthquake conditions. Structure they perform well than R.C.C structure under earthquake consideration.

3. Story drifts of composite structures are comparatively more than RC structures but within permissible limits.
4. Story Shear is low for Composite structure than with R.C.C structure but the Deflection level is within permissible limit.
5. Cost for concrete is almost 65% lower for Composite structure while comparing with R.C.C structure.
6. Joint Displacement is on higher side for Composite structure but within permissible limits.
7. For High rise building Composite structure is more economical than the conventional method.
8. Composite structure deals with indirect cost such as fast completion of work will turns to fast return on investment and no formwork is needed in case of CFST structure.

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