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Comparative Study of RCC and Composite Multi-storeyed Building

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Abstract: ***Steel-concrete composite systems for buildings are formed by connecting the steel beam to the concrete slab or profiled deck slab with the help of mechanical 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+20 story building which is situated in earthquake zone-IV and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. A three dimensional modelling and analysis of the structure are carried out with the help of ETAB software. The results are compared and found that composite structure more economical.***

Index terms - Composite column, Composite beam, shear connectors, ETAB Software

I. INTRODUCTION

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, columns. This paper includes comparative study of R.C.C. with Steel Concrete Composite G+ 20 story building which situated in earthquake zone IV. Equivalent Static Method and Response Spectrum Method of Analysis is used. For modelling of Composite and R.C.C. structures, ETAB software is used and the results are compared. Comparative study includes deflection, story drift, base shear, stiffness. It is found that composite structure is more economical and speedy than R.C.C. structure.

II. COMPSOITE CONSTRUCTION

In the past, for the design of a building, the choice was normally between a concrete structure and a masonry structure. The failure of many multi-storied and low- rise RCC and masonry buildings due to earthquake has forced the structural engineers to look for the alternative method of construction having lesser depth which saves the material cost. Use of composite or hybrid material is of particular interest, due to its significant potential in improving the overall performance through rather modest changes in manufacturing and constructional technologies. In composite construction the two different materials are tied together by use of shear studs at their interface.

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The reason why composite construction is often so good can be expressed in one simple way concrete is good in compression and steel is good in tension.

Elements of Composite Construction

A. Composite Column

Steel concrete composite column is a compression member, comprising either of a concrete encased hot rolled steel section or a concrete filled hollow section of hot rolled steel.

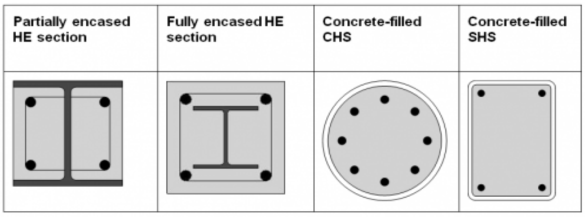

Fig.1. Composite Column

B. Composite Beam

A composite beam is a steel beam or partially encased beam which is mainly subjected to bending and it supports the composite deck slab.

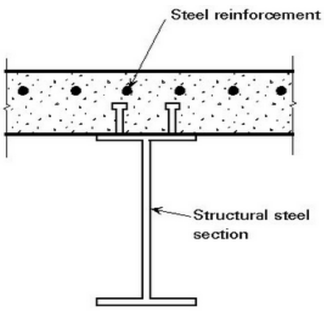

Fig.2. Composite Beam

C. Composite Slab

A composite slab in which steel sheets are connected to the composite beam with the help of shear connectors, initially steel sheets act as permanent shuttering and also act as bottom reinforcement for steel deck slab and later it is combined with hardened concrete.

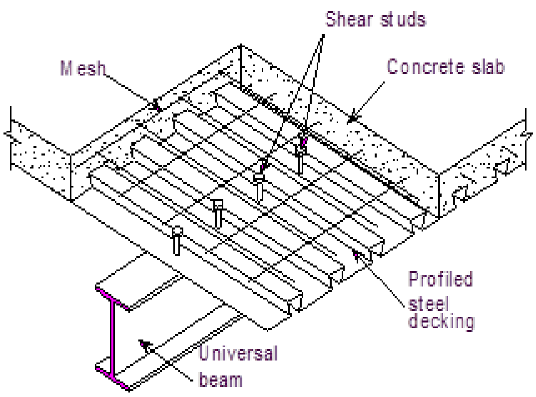

Fig.3. Composite Slab

D. Shear Connector

Shear connectors (studs) are used to connect the concrete and structural steel and they give the sufficient strength and stiffness to the composite member.

Advantages of composite construction

- Speed and simplicity of construction
- Lighter construction
- Good fire resistance
- Corrosion protection
- Reduction in overall weight of the structure and there by reduction in foundation cost.

III. BUILDI`NG DETAILS

The building considered here is an residential building having G + 20 storied located in seismic zone IV and for earthquake loading, the provisions of the IS:1893(Part1)-2002 is considered. The wind velocity 44m/s. The plan of building is shown in fig. the building is planned to facilitate the basic requirements of an residential building. The plan dimension of the building is 24 x 25 m. Height of each storey for composite and RCC is 3m. 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 4 meters respectively. 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.

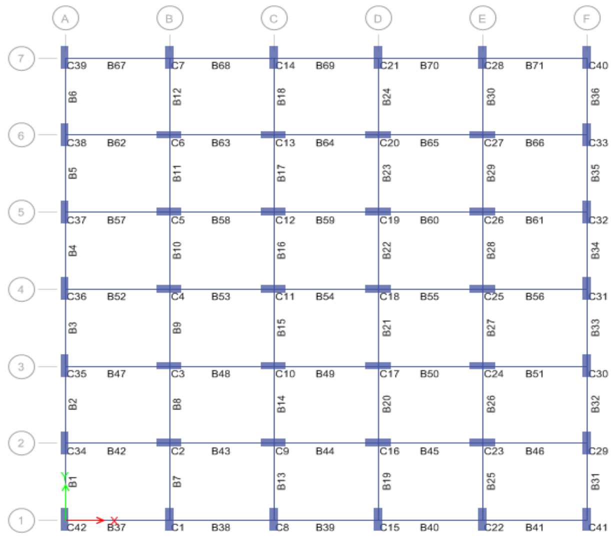

Fig.4. Typical Floor Plan

Table I : Data for RCC and Composite Structure

Plan dimension	24 m x 25 m
Height of each storey	3 m
Height of parapet	1.5 m
Thickness of slab	0.150 m
Thickness of external wall	0.230 m
Thickness of internal wall	0.150 m
Floor Finish	1 KN/m ²
Live Load	2 KN/m ²
Grade of reinforcing steel	Fe 415
Density of concrete	25 KN/m³
Density of brick	18 KN/m³
Grade of concrete for beams	M 40
Grade of concrete for columns	M 40
Grade of concrete for slab	M30
Seismic zone	0.24
Soil condition	Medium soil
Wind speed	44 m/s
Importance factor	1
Zone factor	IV
Damping ratio	5 %
Column size R.C.C	400 mm X 1200 mm
Beam size R.C.C.	230 mm X 600 mm
Column size Composite	800 mm X 600mm ISHB 450
Beam size Composite	Primary ISWB 450
	Secondary ISMB 200

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 ± 1.5 WL 1.2(DL + LL ± WL)

1.2(DL + LL ± EQ)

V. ANALYSIS OF BUILDING

The explained 3D building model is analysed using Equivalent Static Method and Response Spectrum Method. Different parameters such as deflection, story drift, base shear and time period are studied for the models. The dead load and live load are considered as per IS-875(part 1 &2) and wind load is considered as per IS-875(part 3).For earthquake loading IS: 1893 (Part1)-2002 is used.

VI. RESULT

A. Weight of Structure for RCC and Composite

Table II : Variation of Wt. of Structure

WEIGHT OF STRUCTURES IN KN	
RCC	93566.2
COMPSOITE	72092.694

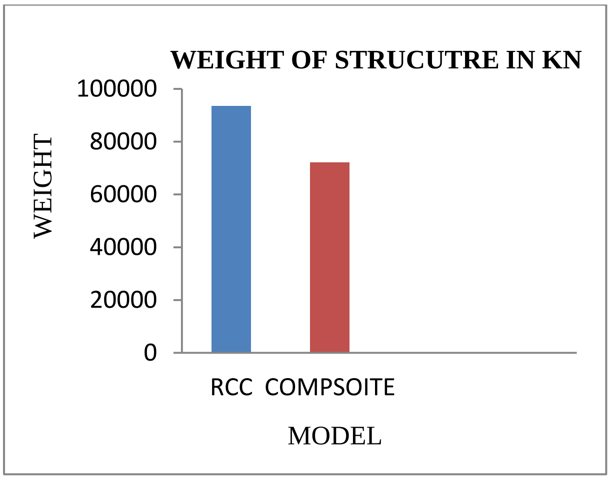

Fig.5.Graph for Wt. of Structure

B. Base Shear of RCC and Composite

Table III: Variation of base shear

BASE SHEAR IN X DIRECTION	
RCC	2501.25 KN
COMPOSITE	1985.27 KN

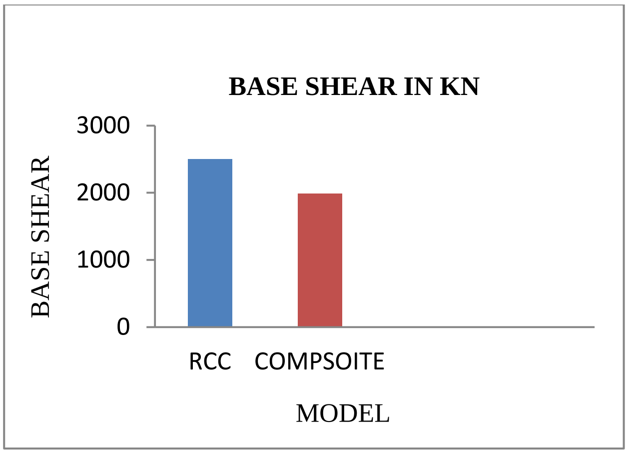

Fig.6.Graph for Base Shear

C. Axial force on Corner Column RCC and Composite

Table IV: Variation of Axial force

AXIAL FORCE ON CORNER COLUMNS IN KN	
RCC	4476
COMPSOITE	3823

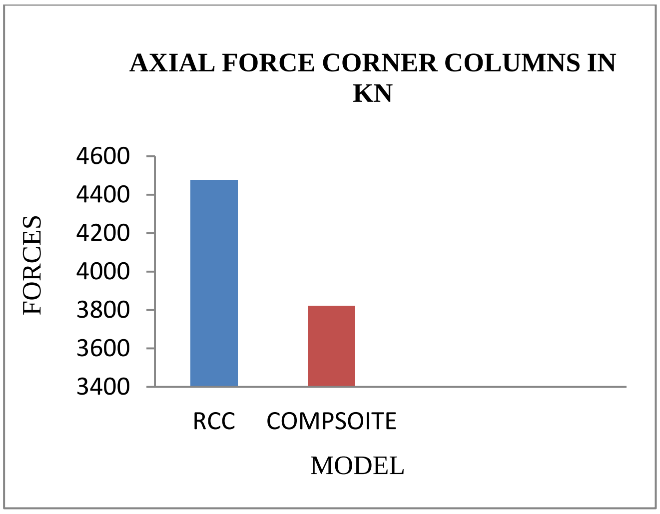

Fig.7.Graph for Axial force in Corner column

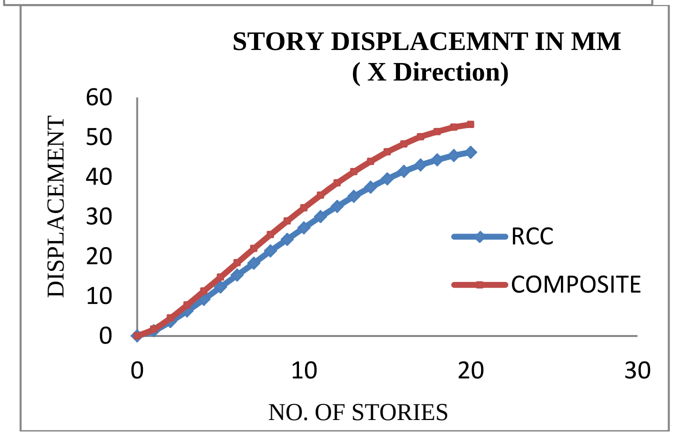

Fig.9.Graph for Story Displacement

D. Time period for RCC and Composite

Table V: Variation of Time Period

TIME PERIOD IN SEC.	
RCC	2.7
COMPOSITE	3.31

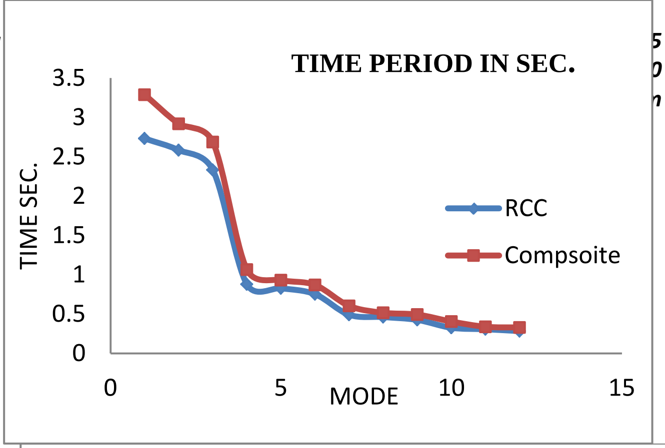

Fig.8.Graph for Time Period

E. Story Displacement of RCC and Composite

Table VI: Variation of Story Displacement

STORY DISPLACMENT IN MM X DIRECTION		
STORY NO.	RCC	COMPOSITE
20	46.2	56.3
15	39.5	48.9
10	27.2	34.1
5	12.3	15.7

VII. CONCLUSION

1. From table II .it is clear that the wt. of Composite structure is reduced by 23% as compared with RCC Structure.

2. From table III. it is clear that the base shear of Composite structure is reduced by 20% as compared with RCC structure.

3. From table IV. It is clear that the axial force in Composite structure is less as compare with RCC by 18%, because the self wt. of the RCC structure is more.

4. From table V. It is clear that the time period of Composite is more as compare to RCC.

5. The displacement of Composite structure is more as compare with RCC. Deflection is within permissible limit.

6. Composite structure is more economical than the RCC structure

7. Time required for construction of composite structure is less as compare with RCC structure because no form work is required.

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