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A Comparative Study on the Performance of RCC Structure with Composite Structure Subjected to Earthquake Load

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Abstract: High-rise structures are becoming quite common everywhere because of the increasing population and less land area. Generally, High-rise buildings are constructed of RCC, but in RCC buildings due to the bulky size of components of the structure self-weight will be more due to the heavy density of the material. After observing such difficulties, we have come up with the idea of a Steel-Concrete Composite Structure. The composite structure consists of composite columns, beams, and a deck slab which is connected with shear connectors. In this project, the comparative study of f performance of RCC and Composite structure shall be done. The composite structure consists of structural steel and concrete which may provide more ductility and flexibility to the structure and hence it may perform well during an earthquake. The modeling and analysis of the structure shall be done using ETAB software and the parameters like base shear, story drift, displacement, stiffness, strength, period,etc. shall be compared

Keywords: composite column, ETABS Modelling, load deformation, story displacement, story drift, symmetrical building, base shear, RCC structure

I. INTRODUCTION

The Structure, which is constructed using Different Materials such as Concrete, Steel, Stone, Brick, Block, and Timber is known as a Composite Structure. The Proper Combination of any two of these Materials is made and the Composite Structure is Constructed. This Paper includes an analysis and Comparison of G+10 Symmetric R.C.C Structure with G+10 Symmetric Composite Structure and G+10 Unsymmetric R.C.C Structure with G+10 Unsymmetric Composite Structure. This Structure is situated in Earthquake Zone III. The analysis is done by Equivalent Static Method and Response Spectrum Method in ETABS 18. The analysis of Earthquake Loading is Carried out by Using IS-1893-2016. The different Parameters like base shear, story drift, displacement, stiffness, strength, and are Compared to the RCC structure and Composite Structure.

II. ADVANTAGES OF COMPOSITECOLUMNS

1) It has great fire and corrosion resistance in concrete-encased columns.
2) Composite columns are Economic over the conventionaluse of structural steel or reinforced concrete.
3) It increases the available usable floor-to-floor height for a given strength.
4) Drying shrinkage is a smaller part of composite membersthan ordinary conventional reinforced concrete.
5) Outer dimensions of the column over several floorsare constant. So, architecture detailing and construction becomes easy.

III. ADVANTAGES OF COMPOSITE BEAMS

1) The depth and weight of the beam requirement are less so that construction depth also reduces by-product to increase the headroom of the building.
2) The higher Stiffness in composite beams leads to less deflection.
3) The span of the slab can be more by using Composite Beams without using any intermediate columns.
4) The beam which is encased has higher resistance against fire and corrosion.
5) The speed of construction became fast by using the composite beam.
6) Concrete and Steel both are utilized properly in the composite structure.

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IV. LITERATUREARE REVIEW

A. Seismic Performance Of Rc Buildings WithShear Wall

In this study, it has been observed that with the inclusion of infill panels and shear walls, the strength and rigidity of the frame structure were found increasing and neglecting them in the analysis and design of the structure will lead to failure due to stiffness irregularity.

Author: Mohd Danish, Mohd Shariq.

B. Analysis Of RC Structure With And Without Shear Wall And Optimum Location Of Shear Wall

Here is to conclude that story displacement for structureswith a shear wall at corners is less as compared to that of structures with a shear wall at the Centre and a structure without a shear wall. Hence it is feasible to provide a shear wall at corners. At last, we can observe that structure with shearwalls at corners gives better results as in the case of the othertwo structures.

Author: Wadmare Aniket, Konapure Nijagunappa.

C. History, Concept, and Types of CompositeColumns

This method will be the future of construction in developing countries like India because this technique provides more strength as compared to normal RCCsections of the same cross-sectional area. This technique alsoreduces the cost and time of construction.

Author: Madhav University.

D. Chhatrapati Shivaji International Airport-Integrated Terminal Building

Composite Columns leads to a smaller number of column section which gives a bigger clear span and economical advantage.

Author: B. C. Roy.

E. Installation & Placement of Composite FloorDecking

Decking with embossed ribs to develop a mechanical shear bond with concrete. Ends are die-set for a neat fit and side laps are interlocking.

Author: Saddam M. Ahmed

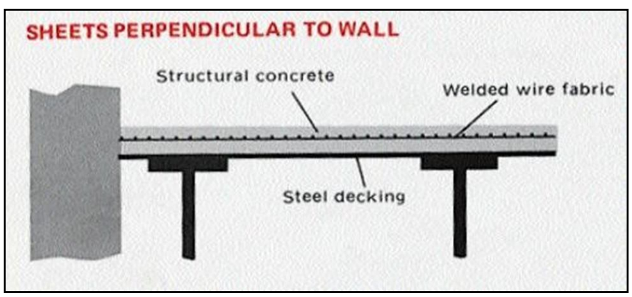

Fig 1: Sheets perpendicular to the wall

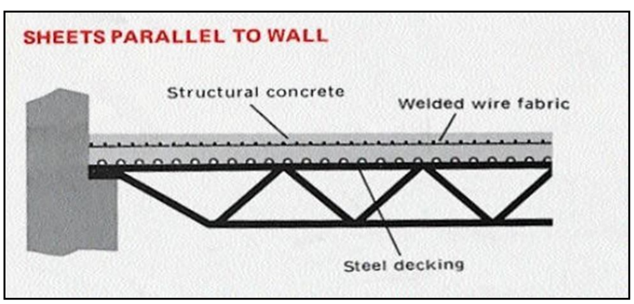

Fig 2: Sheets parallel to the wall

V. COMPOSITE STRUCTURECONNECTION DETAILS

Concrete with steel composite column is a full compression type member, which has major two types concrete encased in steel section and concrete infilled tube steel section and it is usually used as a load bearing Members in a composite frame.
Because of big construction and high-rise buildings of 15 and above, the size of columns increases because of the revised IS codes and FSI. In some cases, the size of columns increases too much in RCC structures of more than 1m. For this type of problem, Composite columns are the best solution.

A. Shear Connector

Shear connectors connected on the top flange of the steel girders provide the composite action between the steel girders and slab, increasingboth stiffness and strength. This kind of arrangement plays an important role in the seismic response of a structure.A major element of composite structure: 1. Composite column 2. Composite Beam 3. Deck slab 4. Shear Connectors Major elements of Shear Connector: 1. Perfobond ribs 2. Oscillating Perfobond strips 3. Waveform Strips 4. Channel connector 5. Pyramidal Shear Connectors 6. Rectangular Shaped Collar Connectors.

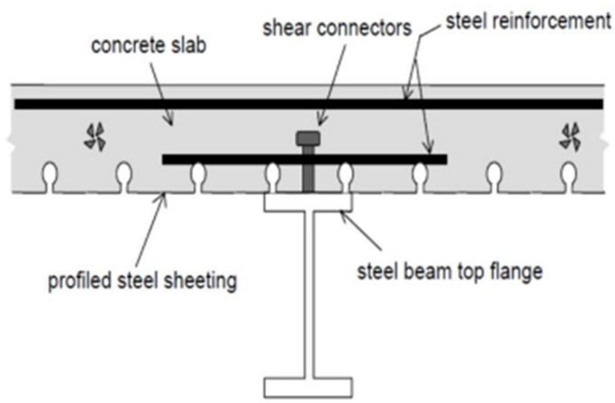

Fig 3: Element of composite beam & slab

VI. SOFTWARE VALIDATION

Details, Modelling, and Results

A. Details of Symmetric G+25 Building plan

1) Design of Beam

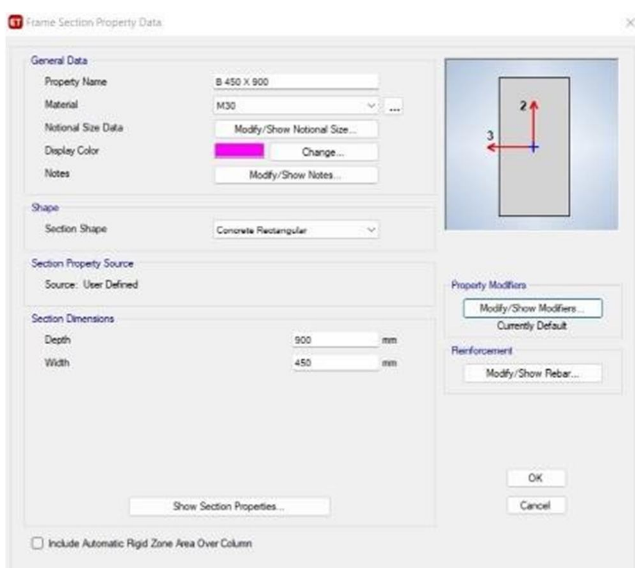

Fig 4: Composite Beam

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2) Design of Column

Fig 5**:** Composite Column

3) Load Cases

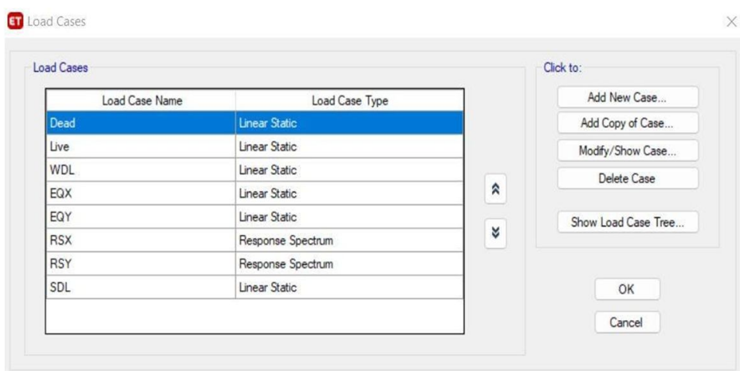

Fig 6: Load Cases

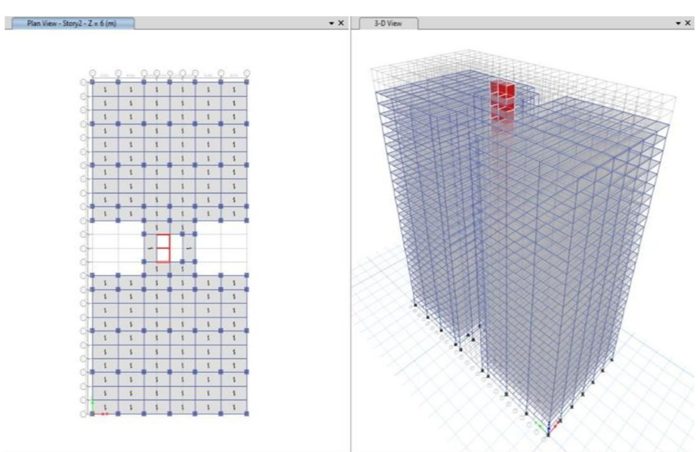

Fig 7: Building Plan & Elevation

B. Details of Symmetric G+25 Symmetric Composite Building

Section Type	Section Property (mm)
Columns (Concrete Encasement Rectangle)	750 x 750 & ISMB 600 embedded section
Main Beams	ISMB 550
Secondary Beams	ISMB 400
Deck Slab	100mm thick concrete filled Slab
Shear Wall	150mm thick RCCwalls
Plan Area	(36 x 72) m
Number of Story	29

Table 1: Details of G+25 Symmetric Composite Building

C. Details of Symmetric G+25 Symmetric RCC Building

Section Type	Section Property(mm)
Column (Storey 1 to Storey 6)	1075 x 1075
Column (Storey 7 to Storey 10)	950 x 950
Column (Storey 11 to Storey 15)	850 x 850
Column (Storey 16 to Storey 24)	750 x 750
Column (Storey 25 to Storey 28)	650 x 650
Main Beams	450 x 900
Secondary Beams	300 x 600
One Way Slab	125 mm thick Slab
Shear Wall	150mm thick RCC wall
Plan Area	(36 x 72) m
Number of Story	29

Table 2: Details of Symmetric G+25 Symmetric RCCBuilding:

D. Comparison of G+25 R.C.C. ANDG+25 Composite Structure (Symmetric Structure)

1) Load Comparison of R.C.C. structure and compositestructure

G + 25 (Symmetric Building)			
Load Parameter	R.C.C	Composit e	Differenc e
Base Shear	10798.978 2	3523.828 8	66%
Storey Displacement (mm)	23.726	29.745	20%
Storey Drift (mm)	0.000377	0.000485	22%
Overturning moment (kNm)	657717.00 25	217897.0 5	66%
Dead Load of the Structure (kN)	1020979.3 3	408654.3 4	60%

Table 3: Comparison of load parameters

Load Cases

a) Dead Load (DL)
b) Super Dead Load (SDL)
c) Live Load (LL)
d) Earthquake Load (EQ) 4.1 EQX 4.2 EQY
e) Response Spectrum (RS) 5.1 RSX 5.2 RSY 6. Wind Load(WL)

2) Cost Comparison of R.C.C. structure and composite structure

Cost of the Structure			
	R.C.C Structure(INR)	Composite Structure(INR)	Difference (%)
G+25	1,06,02,90,000/-	74,84,40,000/-	30%

Table 4: Cost Comparison

VII. CONCLUSION

By using a Composite Structure overall weight of thestructure is reduced in composite structure so that shear at the base is less. So, in earthquake-affected areas performance of the composite structure is better. We have observed that R.C.C structures are more likely to overturn during an earthquake compare to the composite structure. So, in this case, also composite structures are more suitable. Around 90% of Structural Steel can be recovered and reused for the composite structure. In terms of cost, Composite Structures are more economical than R.C.C. structures.

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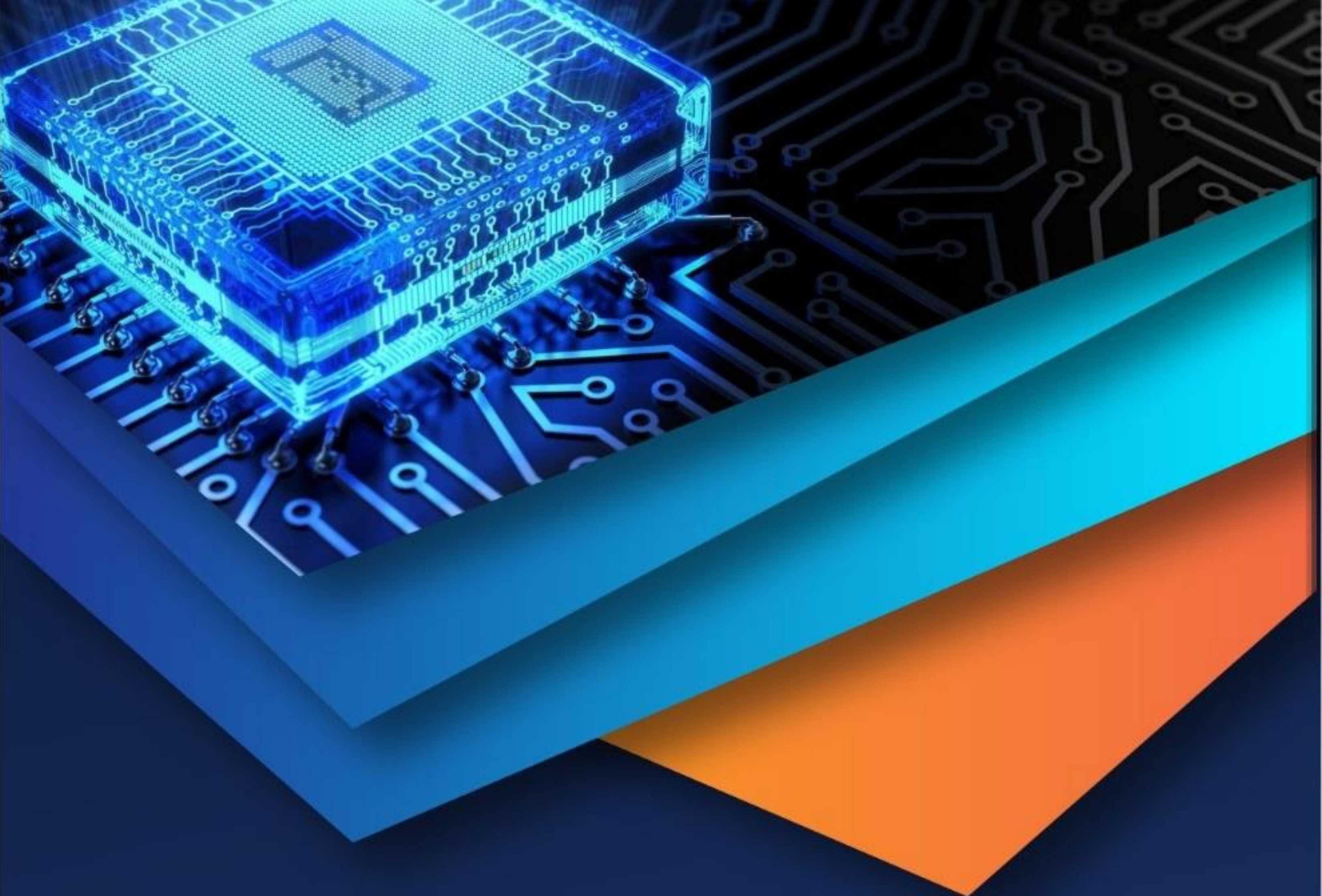

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