Study of Seismic and Wind Effect on Multi Storey RCC, Steel and Composite Building Using ETABS

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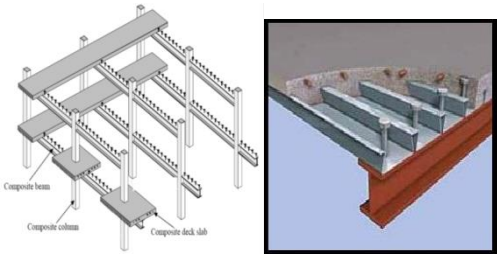
***Abstract*— In India reinforced concrete structures are mostly used since this is the most convenient & economic system for low-rise buildings. However, for medium to high-rise buildings this type of structure is no longer economic because of increased dead load, less stiffness, span restriction and hazardous formwork. So the Structural engineers are facing the challenge of striving for the most efficient and economical design solution. Also Wind & Earthquake engineering. This paper discusses analysis and design of G+15 stories R.C.C., Steel and Composite Building under effect of wind and earthquake using ETABS, it will proves that steel-concrete composite building will be better option.**

Index Terms*—ETABS, Siesmic, wind, RCC, Steel, Composite

I. INTRODUCTION

In today's modern era and faster growing economy with simultaneously increasing human population the 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. In recent trend, the composite mode of construction has gained several advantages in comparison with the conventional system construction. Steel structural members are generally fabricated as component consisting of thin plate and shell elements, so on loading, they are subjected to local and lateral buckling. . But when it comes to the need for vertical growth of buildings due to lack of land-space area and rapid growth of population. Therefore, there is need for check against the failure due to buckling and instability, while concrete structural elements are generally thick enough and less prone to buckle; but they are subjected to creep and shrinkage with time. For framed structural systems, steel-concrete composite system of construction proved to be the most economical solution to necessarily meet the engineering design requirements of stiffness and strength.



II.RELATED WORK

Syed Rehan[1] et. al., (2014) [1] - In India reinforced concrete structures are mostly used since this is the most convenient & economic system for low-rise buildings. However, for medium to high-rise buildings this type of structure is no longer economic because of increased dead load, less stiffness, span restriction and hazardous formwork.

Alhamd Farqaleet et. al., (2014) **[2]** - The important objective of earthquake engineers is to design and build a structure in such a way that damage to the structure and its structural component during the earthquake is minimize. This report aims towards the dynamic analysis of a multi-storey RCC building with symmetrical configuration. The maximum base shear in x and y direction was found to be 2528.2 kN and 184.59 kN respectively.

III OBJECTIVES

1. Comparison of seismic behavior of three types of multi-story framed structures consisting
   a) RCC framed structure.
   b) Steel frame with Deck.
   c) Steel beam, Deck and concrete filled steel tube (CFST) Composite columns.
2. Base shear, Displacement, Story drift, column forces and beam forces will be compared and studied.

3. To study the performance point and performance level of the considered building equivalent static and response spectrum analysis will be considered.
4. The results are compared and conclusions are made for all types of structures.
5. To identify the most suitable type of structure for seismic action.

IV.METHODOLOGY

- Type of structure – 15 storied framed multi-storey structure for RCC, Steel and composite. Concrete framed structure is taken as reference and compared with composite and steel structure. ETABS Software is used for analysis. The building frame is assumed to be Ordinary Moment Resisting Frame (OMRF) Analysis is to be carried out for the one possible location of the structure in: zone III. Steel columns are designed as per IS 800:2007 codal provisions. The Two alternative structures are compared with the following structural performance parameters: Base shear, storey drifts, storey overturning moments and roof displacements.
- Buildings are defined as structures utilized by thepeople as shelter for living, working or storage.

V.STRUCTURAL MODELLING AND LOADING

RCC Structure Detailing:-

The Building is G+15 Storey RCC building, the structure is 45m tall,25m wide,30m length. The story height is 3 m. Proposed slab thickness is 150 mm for all typical floors. Area of building 750 m^2.Member Properties, dimensions of the beams are 300 mm × 650 mm, The columns size upto 5 floors are 600×600 mm and for the above 5floors are 400×400 mm and thickness of internal and external walls 230mm. The live load is 4 kN/m^2, floor finish is $1kN/m^2$,Seismic zone IV Zone, Wind speed 39 m/s and wind load and seismic load calculations can be done directly by ETABS. Damping ratio 5%.The load combination is based on IS: 456 – 2000 and IS 1893 (Part 1): 2002.

Steel structure Detailing ;-

Member Properties, dimensions of the beams are ISMB 350, Secondary beam are ISHB 150. The columns size upto 5 floors are ISHB 450and for the above 5 floors are ISHB 400 and thickness of internal and external walls 230mm. Thichness of deck slab 100mm.The live load is 4 kN/m^2, floor finish is $1kN/m^2$,Seismic zone IV Zone, Wind speed 39 m/s and wind load and seismic load calculations can be done directly by ETABS.Damping ratio 5%.The load combination is based on IS: 456 – 2000 and IS 1893 (Part 1): 2002.

Composite Detailing:-

The Building is G+5 Storey RCC building, the structure is 15m tall Member Properties, dimensions of the beams are ISMB 350, Secondary beam are ISHB 150. The columns size upto 5 floors are 400X400 Steel tube filled with concrete and for the above 5 floors are 300 X 300 Steel tube filled with concrete and thickness of all external walls 230mm. Thichness of slab 100mm.The live load is 4 kN/m^2, floor finish is $1kN/m^2$,Seismic zone IV Zone, Wind speed 39 m/s and wind load and seismic load calculations can be done directly by ETABS. Damping ratio 5%.The load combination is based on IS: 456 – 2000 and IS 1893 (Part 1): 2002.

For modelling three sets of models are to be considered. the first set of model is RCC model Second set of model is Steel model and the third set of model is composite model . Figure shows the modelling of RCC, Steel and Composite structures.

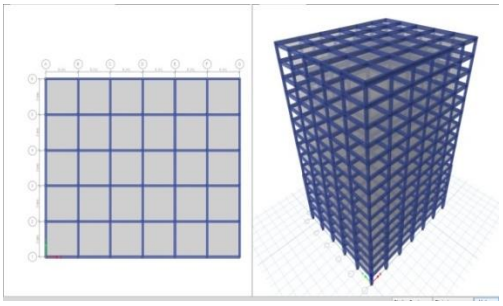


Figure1. Shows that the defined properties are assigned to structure

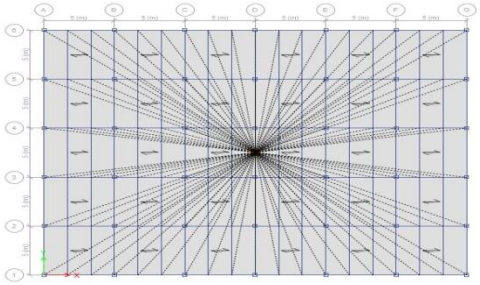


Figure2. Shows that assign of diaphragm to model

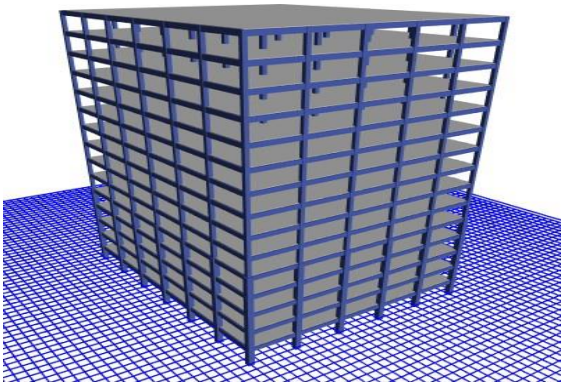


Figure 3 Model of concrete frame structure

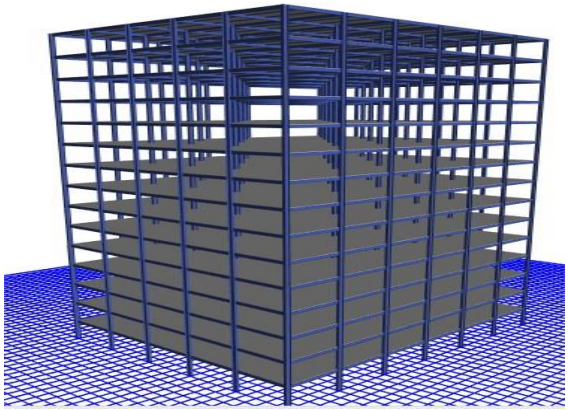


Figure 4 Model of steel frame structure

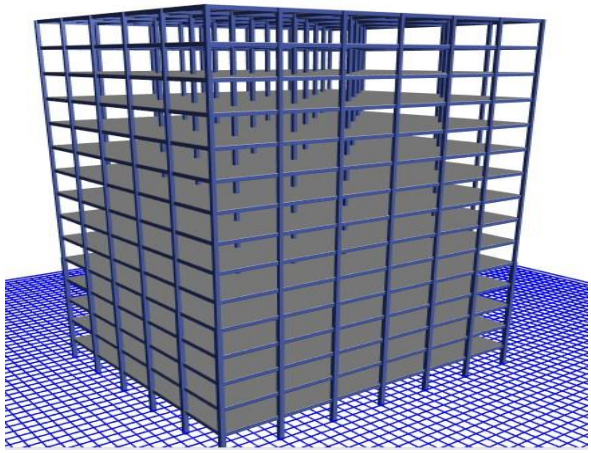
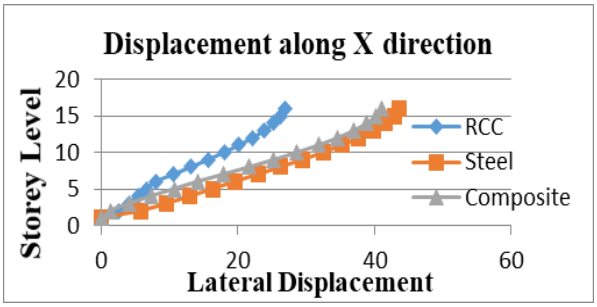


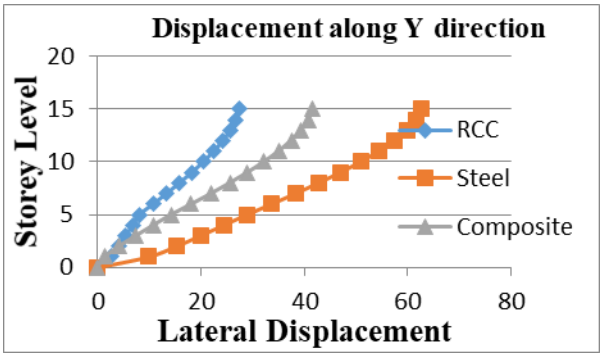
Figure 5 Model of Composite frame structure

VI. RESULTS AND DISCUSSIONS

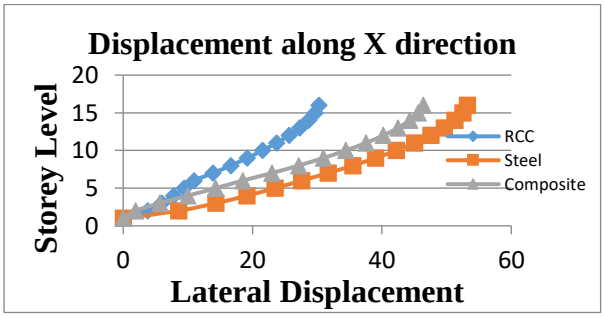
The behaviour of each model is studied and the results are tabulated. The variation of systematic parameters like story lateral displacement, story drift, storey shear, natural time period and base shear has been studied for both equivalent static analysis method and response spectrum analysis method. The results of all the models are observed and the most suitable model is selected by comparing the results of each and every model.

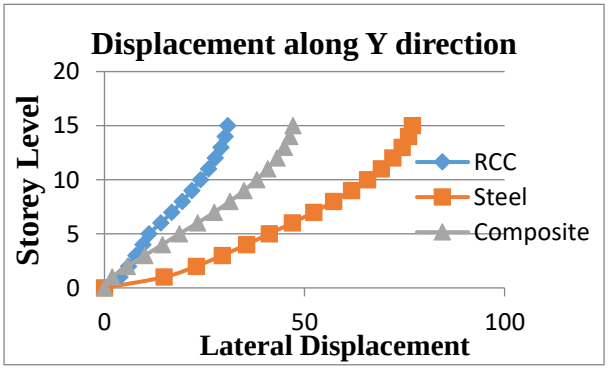
VI.1 STORY DISPLACEMENT





Fig; Variation of displacement for zone-3 for static analysis both X and Y Direction

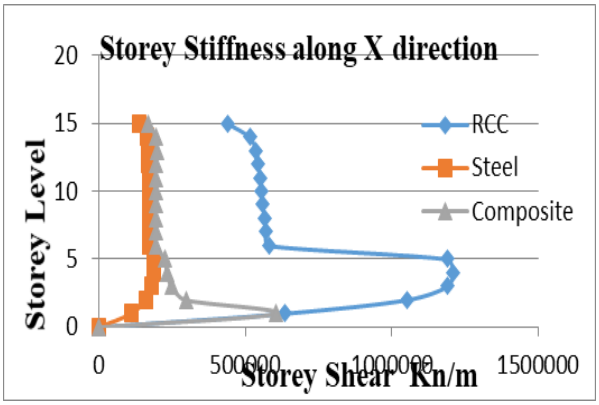




Fig; Variation of displacement for zone-3 *for response spectrum analysis* both X and Y Direction

By studying from Table and comparing their values in the Fig we can see that displacement increases as storey height increases. As compared with different structure as reinforced concrete cement structure, steel structure and composite structure. Reinforced concrete cement structure is showing lesser lateral displacement as compared steel structure. Composite structures are showing lesser lateral displacement as compared with steel structure. In both cases along X and Y direction RCC structure showing optimum lateral displacement.

VI.2 Storey Stiffness



By studying from Table 5.13 to Table 5.16 and comparing their values in fig. 5.13 to 5.16 we can see that variation in shear as storey height increases both X and Y direction respectively for equivalent static analysis and response spectrum analysis. RCC structure is showing the higher storey stiffness when comparing with other two structures in both the methods. In RCC structures higher stiffness in lower storey and decreases in higher storey.

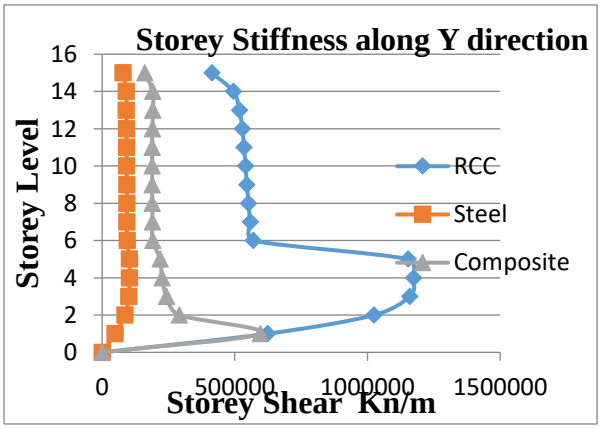
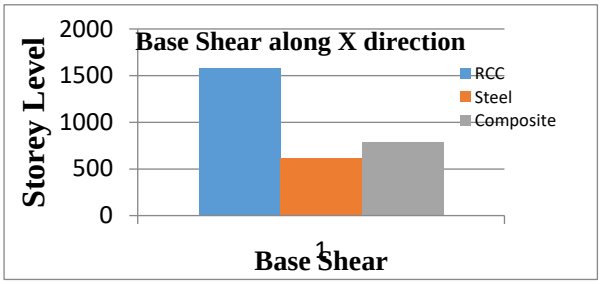


Fig: Variation of Storey Stiffness for zone-3 Response Spectrum Analysis both X and Y Direction

VI.3 Base Shear



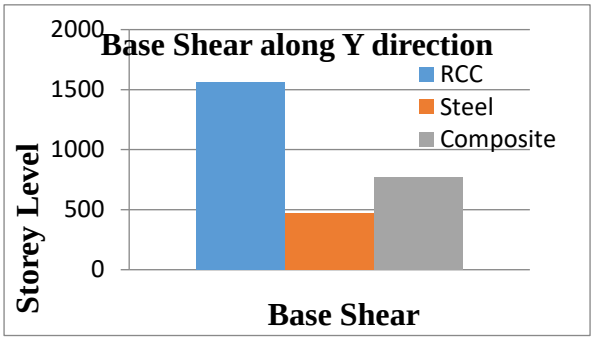
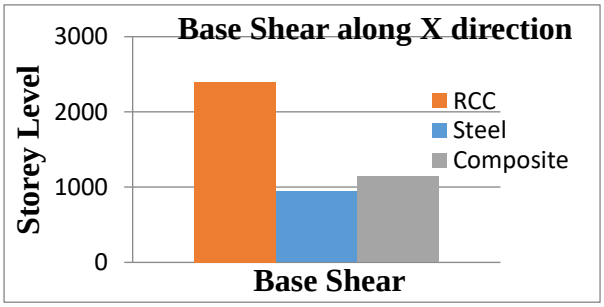


Fig: Variation of Base Shear for zone-3 Static Analysis both X and Y Direction



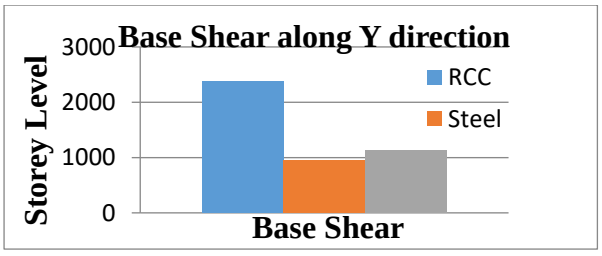


Fig: Variation of Base Shear for zone-3 Response Spectrum Analysis both X and Y Direction

By studying from Table and comparing their values in Fig.we can see that variation in base shear in X direction & Y direction respectively for linear static analysis and response spectrum analysis. The Base Shear is more in RCC structure when compared with other two structures

and steel structure has a very less base shear as compare to other two structures.

VI.4 Modal Time Period

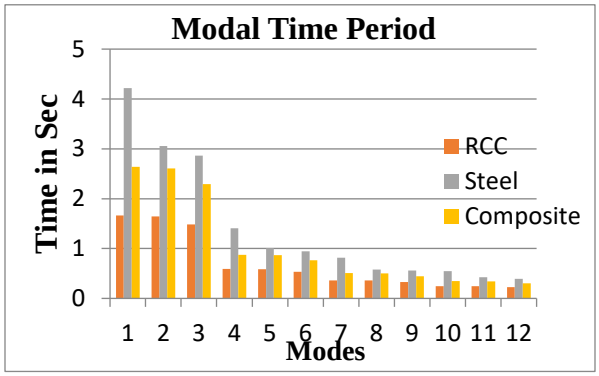


Fig: Variation of time period for zone-3

By studying from Table 5.21 and comparing their values in fig. 5.21 we can see that variation in Time period according to mode shapes, by default software will consider 12 mode shapes in which first three modes are considered for analysis.

Also it is observed that the value of Time period is more for steel structures compared to RCC structures so RCC structure increases the stiffness and reduces the displacement and time period.

VII. CONCLUSION

The present work is focused on the study of behavior of structure with varying materials are studied and displacement, drift, storey shear, storey stiffness, time period and base shear are the parameters considered for analysis done. From the above study we can observed that the lateral storey displacement is lower in RCC structure. The steel structure is showing a very higher lateral displace along X and Y direction with both analysis. In all the parameter the values are higher in response spectrum analysis when compared with linear static analysis. RCC structure increases the stiffness and reduces the displacement and time period for both axis along X and Y direction. RCC structure has very high base shear as compare to the steel structures in both axis along X and Y direction. We can observe that storey stiffness is higher in RCC structures in both the axis and stiffness is very less in steel structures. All the parameters we have got in within the limits.

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