International Journal of Scientific Research in Civil Engineering
© 2019 IJSRCE | Volume 3 | Issue 3 | ISSN : 2456-6667

Analysis of a Tall Structure Considering Composite Steel Section Columns using ETAB

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ABSTRACT

The present work carried out to analyze the structural performance of high rise building structure constructed using composite columns in combination with RCC beam & Slab. In this study a model of stilt +10 storied framed structure subjected to seismic loading of Zone – II analyzed using equivalent static method as per IS 1893-2002 on software package ETABS. Two similar models were prepared with different type of columns – RCC Column and CFST Column and similar loading conditions were applied to them. Those two models were analyzed and result obtained were compared in terms of structural performance on following parameters – Maximum story displacement, Story shear, story drift, story overturning moment and section size reduction.

Keywords : Composite Structure, Analysis, Seismic, ETAB, Tall Structure, Rigidity, Sectional Design.

I. INTRODUCTION

India is a developing nation but steel consumption in construction sector in India is on very much lesser side as compared to other developed nation in the world. Due to tremendous increase in population, development concentration around urban areas and limited land chunks the population density in cities is increasing day by day. The increased population density resulted into growing demand of high rise buildings. In high rise building due to accumulation of load of all stories, vertical gravity load of columns dominates the design of building structure. Composite structure is being used as an alternate to steel structures due to its benefits over RCC structure and high cost of steel structure.

In general majority of the civil structures are designed with the assumption that all applied loads are static. The effect of dynamic load is not being considered because the structure is rarely subjected to dynamic loads, more its consideration in the analysis makes the solution more complicated and time consuming. This aspect of neglecting dynamic forces may sometimes become the cause of disaster. Particularly in case of earthquake.

An Earthquake is a natural disaster that unlike the other disasters like floods etc leaves no time for evacuation of people to safer places thus causing a huge loss of lives as well as property. Hence designing our buildings to resist these seismic loads is the only feasible alternative. Each damage case has provided important information for improving the design and construction practices thus trying to protect the occupants of the buildings. This chapter includes the code based procedure for seismic analysis, structural modeling concept and objective of the present study.

Seismic analysis of most of the structures is still carried out on the basis of lateral force assumed to be equivalent to the actual loading. The base shear which is the aggregate even power on the structure is computed on the premise of structure mass and key time of Vibration and comparing mode shape. The base shear is appropriated along the stature of the structure as far as sidelong powers as indicated by code equation. This strategy is normally traditionalist for low to medium stature structures with a general configuration.

II. SEISMIC LOADING

This strategy is appropriate for those structures where modes other than essential one influence altogether the reaction of the structure. In this technique the reaction of multi level of flexibility framework is communicated as the superposition of model reaction, each model reaction being resolved from the ghostly investigation of single level of opportunity framework, which are then joined to register the aggregate reaction. Display examination prompts the reaction history of the structure to a predefined ground movement.

III. LITERATURE SURVEY

All **Netravathi et. al, (2017):** In this paper conventional R.C.C. Column and composite column performance was studies by performing analysis one tabs by response spectrum. Regular and Irregular structures were studied for composite columns against conventional R.C.C. Column.

In regular structures for rectangular/ circular composite column section displacement reduced by 40% to 50% but shear increased by 60% to 70% and drift increased by 35% to 40%.

In irregular structures also displacement reduced by 40% to 50% but shear increased by 60% to 70% and drift increased by 35% to 40%. This may be concluded as shape of structure does not have any effect on using composite columns.

In this research work all the elements selected were composite sections so there is a further scope of exploring performance of individual composite elements with other structural elements of R.C.C.

Renavikar et. al. (July 2016) they did Comparative Study on Analysis and Cost of R.C.C. and Steel-Composite Structure. The paper involves Analysis of a residential building with steel-concrete composite and RCC construction. The proposed structure is a four multi-storeyed buildings of G+9, G+12, G+15, G+18, with 3.0m as the height of each floor with (plan dimension 15m x 9m). The analysis done by 2D modelling using software STAAD-Pro 2007, load combinations taken as per the IS Code. The project involves analysis of an equivalent RCC structure so that a cost comparison can be made between a composite structure and an equivalent RCC structure. Because of the inherent ductility characteristics, composite structure will perform better than conventional RCC structure. The axial forces, seismic forces, bending moment and deflections in RCC are more as compared to the composite structure. There is the reduction in cost of steel structure as compared to RCC structure due to reduction in dimensions of elements. Composite option is better than RCC for high rise building because Weight of composite structure is low as compared to RCC structure which helps in reducing the foundation cost and it is subjected to fewer amounts of forces induced due to the earthquake Composite structure is more economical than that of RCC structure. Composite structures are the best solution for high rise structure as compared to RCC structure. Speedy construction facilitates quicker return on the invested capital and benefits in terms of rent.

Murtuza S. Aainawala (June 2016) He assess and think about the seismic execution of G+15 story made up of RCC and composite structures by ETABS 2015 programming. Both steel and solid composite structures having concrete filled steel tube and RCC structures were having delicate story at ground level, structures were situated in the locale of quake zone IV on a medium soil. Equal static and reaction range strategy is utilized for investigation. Story float, Displacement, self weight, twisting minute and shear drive, are considered as parameters. At the point when analyzed composite structures indicates preferred execution over RCC.

IV. OBJECTIVES

1. Comparison of structural performance of two type of high rise building structure –

A. Conventional RCC Framed Structure.

B. Frame with CFST composite columns and RCC Beam & slab.

   Maximum story Displacement, Story Shear, Overturning Moment, Story Stiffness, Story Drift, Modal period and frequency are the structural parameters considered for comparison of structural performance.

2. Possibility of Size reduction in CFST composite column.
3. Cost comparison of both type of structure is carried out.

V. METHODOLOGY

Step-1: Review of literatures related to our research area.

Step-2: Selection of objectives and problem formulation.

Step-3: Selection of tools and data.

Step-4: Analysis using ETAB and assigning composite structures.

Step-5: Analyzing results and comparison.

Table 1: Geometrical data

Table-1 Data for Modeling of Building Frame Structure		
1.	Number of Stories	Stilt +10+mumty
2.	Height of stilt floor	3.0 mt.
3.	Height of upper stories	3.5 mt.
4.	Depth of foundation	-2.5 mt
5.	Grade of concrete for RCC Beam & Slab	M-20
6.	Grade of concrete for Columns	M-25
7.	Steel used for longitudinal reinforcement	HYSD 500
8.	Steel used for lateral reinforcement	HYSD 415
9.	Steel Sections	Fe 345
10.	Masonry	Brick Masonry
11.	Seismic Zone	Zone - II

Table 2: Sectional properties

Table-2 Section properties		
Conventional Reinforced Concrete Frame		
1.	Column	650mm x 650mm
2.	Beam	400 mm x 600 mm
3.	Slab	200 mm thick
4.	Masonry	200 mm thick
Composite Column with RCC Slab & Beam		
1.	CFST Composite Column	450 mm x 450mm
2.	Beam	400 mm x 600 mm
3.	Slab	200 mm thick
4.	Masonry	200 mm thick

Table 3: Loading conditions

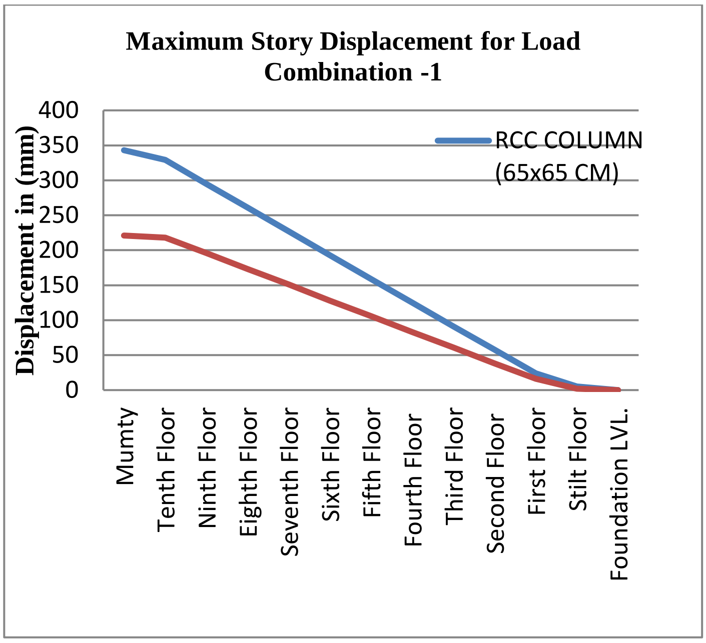
Table -3 Load Details		
1.	Dead Load	Self weight of structure
2.	Live Load	Occupancy load on floors.
3.	Super Dead Load	Floor Finish & Ceiling plaster
4.	EQ +X	Seismic load in X direction
5.	EQ +Y	Seismic load in Y direction

VI. RESULTS

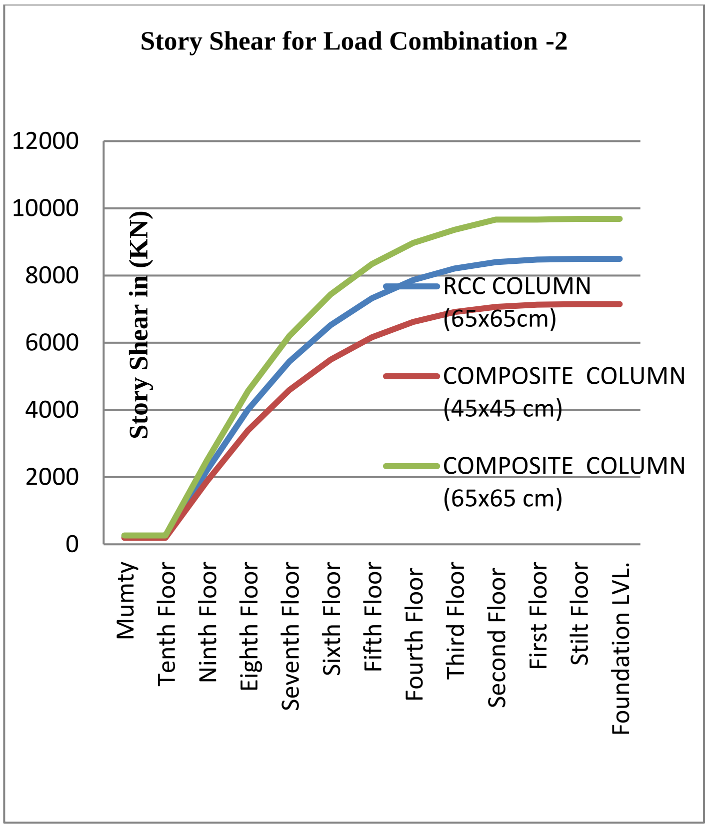
Storey data:

Name	Height mm	Elevation mm	Master Story	Similar To	Splice Story
Mumty	3500	38000	No	None	No
Floor-10	3500	34500	No	Floor -1	No
Floor-9	3500	31000	No	Floor -1	No
Floor-8	3500	27500	No	Floor -1	No
Floor-7	3500	24000	No	Floor -1	No
Floor- 6	3500	20500	No	Floor -1	No
Floor-5	3500	17000	No	Floor -1	No
Floor-4	3500	13500	No	Floor -1	No
Floor-3	3500	10000	No	Floor -1	No
Floor-2	3500	6500	No	Floor -1	No
Floor -1	3000	3000	Yes	None	No
Stilt	2500	0	No	None	No
Foundation Lvl	0	-2500	No	None	No

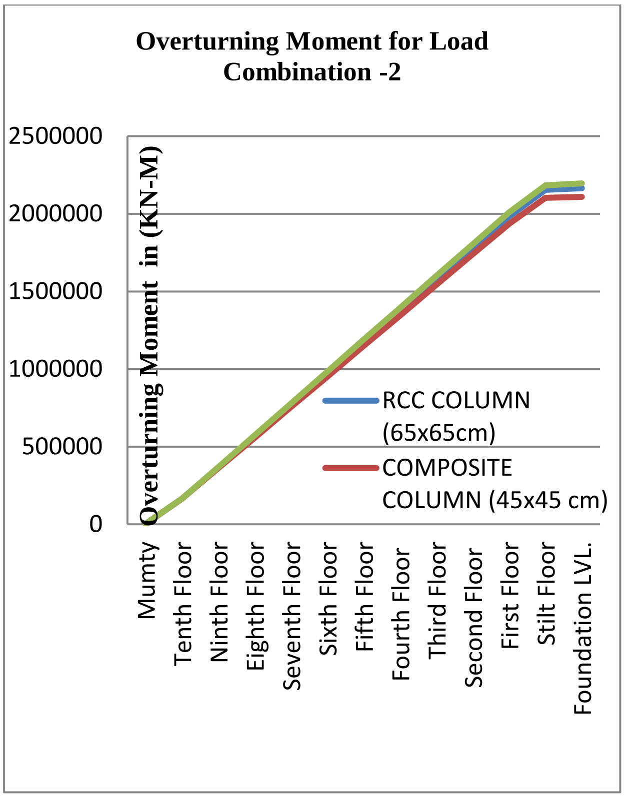
Storey Displacement:



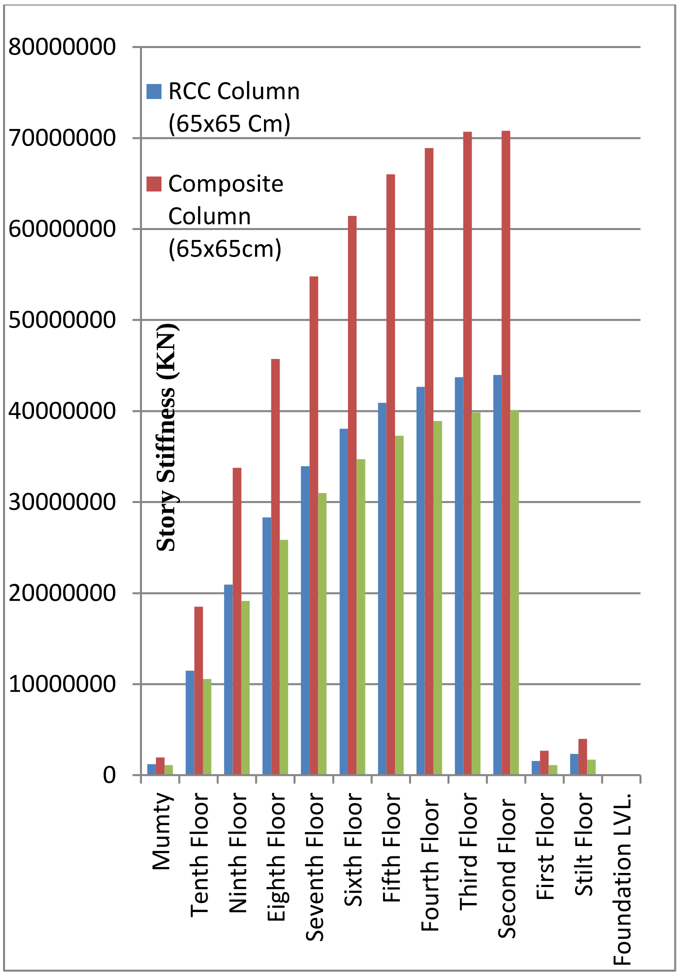
Storey Shear:



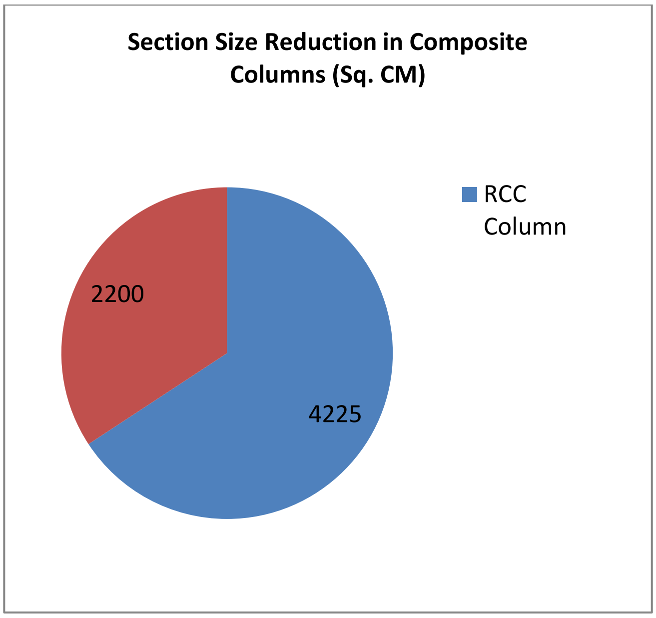
Overturning moment:



Storey Stiffness:



Cost Analysis



VII. CONCLUSION

1. Due to confinement of concrete in CFST columns, its load carrying capacity has been increased. For this model column section required in RCC is 650x650 mm whereas on designing same model with composite columns section size reduced to 450x450 mm.
2. Maximum story displacement in RCC columns is 49% to 55 % higher than the composite columns of same section size. The section size required in composite columns is less so on reduction of section size maximum story displacement of composite columns is 6% to 12% higher than RCC columns.
3. Maximum story shear for frame with RCC columns (65x65 CM) is 17% to 19% higher than the frame with composite columns (45x45cm). Story shear in composite columns are less due to reduced weight of structure with composite columns.
4. Overturning moments in composite columns of size 45x45 cm is marginally higher than the RCC columns of size 65x65 cm.
5. Story Stiffness in RCC columns of Size 65x65 CM is 8% to 26% higher than the composite columns of size 45x45 CM.

6. It is observed that damping in RCC Column is 4 % to 18 % higher so composite columns should be more preferred for the structure designed for seismic loads & wind loads.
7. Due to reduction in section size, the cost of composite column is 4 % less than the cost of RCC columns. Foundation size and design for composite columns is also light due to reduction in dead weight of structure.

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Cite this article as :