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"NON-LINEAR ANALYSIS OF A HIGH RISE BUILDING FRAME CONSIDERING COMPOSITE COLUMNS USING ETABS"

Anshul Jain [1], Prof. P. H. Patil [2]

[1] *MTech Scholar, Department of Civil Engineering, IES ITM, Bhopal*

[2] *Professor, Department of Civil Engineering, IES ITM, Bhopal*

ABSTRACT

Composite columns are the compression element which constitutes of concrete encased steel section or concrete filled steel tubes. Concrete steel composite columns are the combination of concrete and steel hence uses both the materials for their advantages. In this paper a model of Ground +10 storied framed structure subjected to non linear dynamic loading of Zone – V is utilized as per IS 1893-2016 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 dissected and result acquired were analyzed as far as structural execution on following parameters – Maximum story displacement, Story shear, story drift, story overturning moment and section size reduction.

Keyword: *Analysis, ETABS, column, composite material, displacement, moment, forces.*

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 utilized as an other to steel structures because of its advantages over RCC structure and mind-boggling expense of steel structure.

All in all dominant part of the common structures are planned with the supposition that every connected burden are static. The impact of dynamic burden isn't being considered in light of the fact that the structure is once in a while exposed to dynamic burdens, more its thought in the investigation makes the arrangement increasingly entangled and tedious. This part of disregarding unique powers may now and then become the reason for catastrophe. Especially if there should be an occurrence of seismic tremor.

Steel concrete composite column sections are being promoted as an alternate option of pure steel/ R.C.C. column due to its following advantages –

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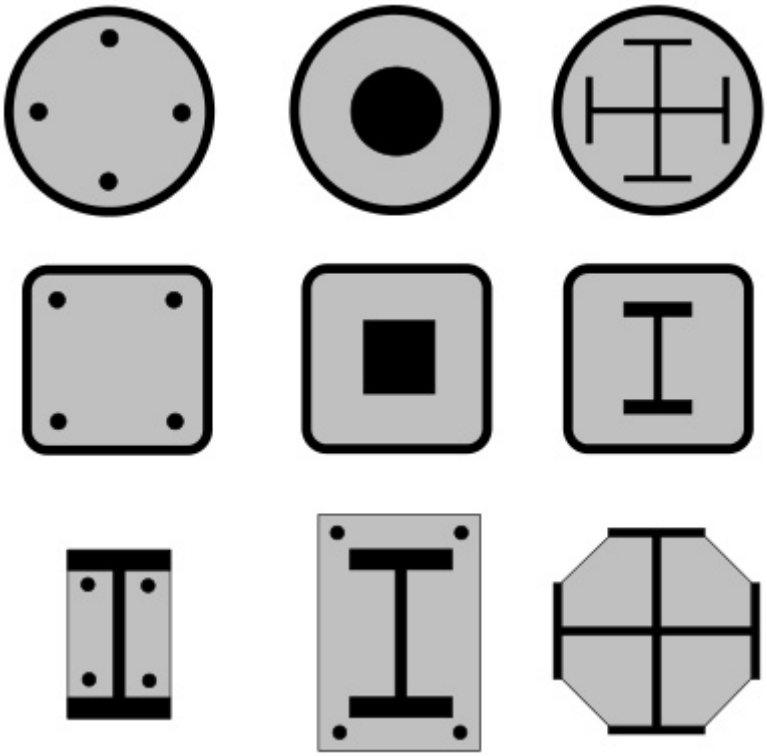

Fig 1: Different composite column sections

- High load bearing capacity.
- High Fire resistance.
- Economical in terms of material cost.
- Speedy in construction.

High load carrying capacity of composite columns allows structural designer to provide smaller sections than R.C.C. column with more resistance to bending moment and shear force.

This investigative examination expects to discover the conduct of encircled structure comprised with composite segments furnished with regular R.C.C. beam and slab. The structural examination and plan programming e tabs will be utilized for investigation and plan of structure.

The main motive of this study is to determine the effect of composite columns over a high rise structure under non linear dynamic loading.

II. OBJECTIVES

The main objectives of this study are –

1. To determine the structural performance of of high rise building structure –
   A. Considering general R.C.C. Structure.
   B. Considering structure with CFST composite columns and RCC Beam & slab.
   C.

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. Optimization of column size in CFST composite column.
3. Cost analysis comparison of these two structure is carried out.

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III. LITERATURE REVIEW:

Campian et. al, (2015): Steel-strong composite structure derives steel territory encased in concrete for sections and the strong piece or profiled deck chunk is related with the steel pillar with the help of mechanical shear connectors so they go about as a singular unit. Steel-strong composite with Reinforced bond strong decisions are considered for relative examination of G+15 story business environment which is masterminded in seismic quake zone IV and for tremor stacking, the plans of IS:1893(Part1)- 2002 is considered by Equivalent Static Method of Analysis. For exhibiting of Composite and R.C.C. structures, STAAD. virtuoso writing computer programs is used. In this assessment, the seismic structure and execution of composite steel-strong edges are discussed explicitly. Assessment of boundaries like time period, movement, minutes and weight passing on limit is done with steel and Reinforced bond strong structures. The results are investigated and it is found that composite structure are on the whole the more extraordinary in a couple of edge.

During test, it has been seen that segments built up with great concrete slumped out of nowhere in light of breaks yet when commonplace quality concrete is used for composite fragments, it besieged steadily and bearing cutoff diminished reliably.

This exploratory examination attests that totally encased composite portions can be used as a substitute response for seismic and non-seismic domains on account of its better execution. Composite segments with HSC show frail disillusionment plan during tests hereafter there is a further degree of exploratory examination here.

Netravathi et. al, (2017): In this paper regular R.C.C. Section and composite segment execution was concentrates by performing examination one tabs by reaction range. Ordinary and Irregular structures were read for composite segments against customary R.C.C. Section.

In standard structures for rectangular/round composite segment area relocation decreased by 40% to half yet shear expanded by 60% to 70% and float expanded by 35% to 40%.

In sporadic structures likewise uprooting decreased by 40% to half yet shear expanded by 60% to 70% and float expanded by 35% to 40%. This might be closed as state of structure doesn't have any impact on utilizing composite sections.

In this exploration work all the components chose were composite areas so there is a further extent of investigating execution of individual composite components with other auxiliary components of R.C.C.

Renavikar et. al. (July 2016) they did Comparative Study on Analysis and Cost of R.C.C. what's more, Steel-Composite Structure. The paper includes Analysis of a private structure with steel-solid composite and RCC development. The proposed structure is a four multi-storeyed structures of G+9, G+12, G+15, G+18, with 3.0m as the stature of each floor with (plan measurement 15m x 9m). The examination done by 2D demonstrating utilizing programming STAAD-Pro 2007, load blends taken according to the IS Code. The task includes investigation of an identical RCC structure so a cost examination can be made between a composite structure and a proportionate RCC structure. Due to the inborn malleability qualities, composite structure will perform better than ordinary RCC structure. The pivotal powers, seismic powers, bowing second and diversions in RCC are more when contrasted with the composite structure. There is the decrease in cost of steel structure when contrasted with RCC structure because of decrease in measurements of components. Composite alternative is better than RCC for tall structure since Weight of composite structure is low when contrasted with RCC structure which helps in decreasing the establishment cost and it is exposed to less measures of powers actuated because of the tremor Composite structure is more prudent than that of RCC structure. Composite structures are the best answer for skyscraper structure when contrasted with RCC structure. Rapid development encourages speedier profit for the put capital and advantages regarding rent.

IV. METHODOLOGY

Step-1: To evaluate the geometry to be consider for the study.
Step-2: To Select boundary conditions such as loading criteria, sections, material etc.
Step-3: To prepare modelling of the structure using analysis tool.

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Step-4: To Assign selected loading, column type and composite sections.
Step-5: To perform non linear dynamic analysis as per Indian Standards.
Step-6: To compare the result in terms of forces, moment, displacement.

Table 1: Geometry selected:

1.	**Number of Stories**	**G +10+mumty**
2.	Height of stilt floor	3.2 mt.
3.	Height of upper stories	3.2 mt.
4.	Depth of foundation	-2.0 mt
5.	Grade of concrete for RCC Beam & Slab	M-25
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	Infill brick
11.	Seismic Zone	Zone - V

Table 2: Sectional data

Conventional Reinforced Concrete Frame		
1.	Column	650mm x 650mm
2.	Beam	300 mm x 400 mm
3.	Slab	150 mm thick
4.	Masonry	130 mm thick
Composite Column with RCC Slab & Beam		
1.	CFST Composite Column	450 mm x 450mm
2.	Beam	300 mm x 400 mm
3.	Slab	150 mm thick
4.	Masonry	130 mm thick

Table 3: Loading conditions:

Name	**Type**
Dead	Linear Static
Live	Linear Static
Super Dead	Linear Static
EQ +X	Non-linear dynamic
EQ +Y	Non-linear dynamic

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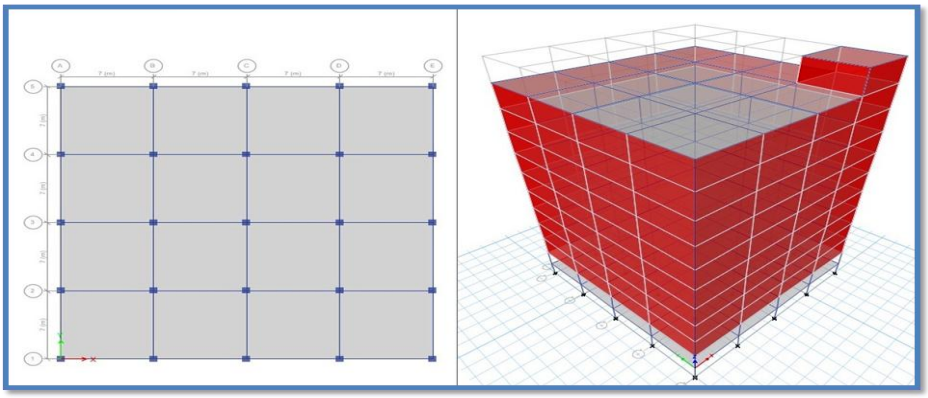

Fig 2: modelling of structure in ETAB

V. ANALYSIS RESULTS

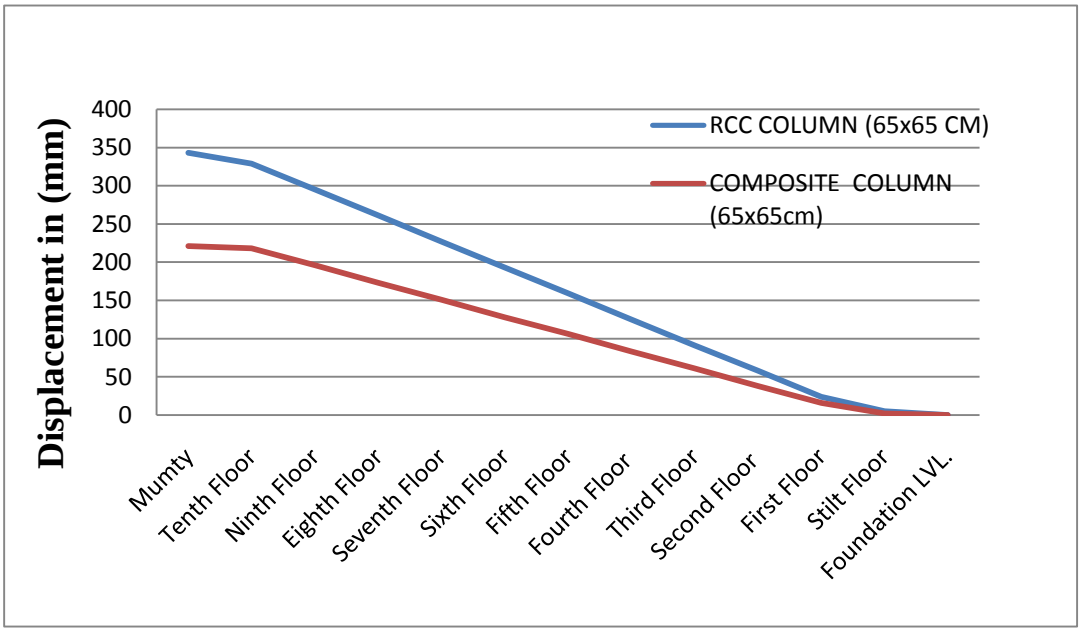

Fig 3: displacement

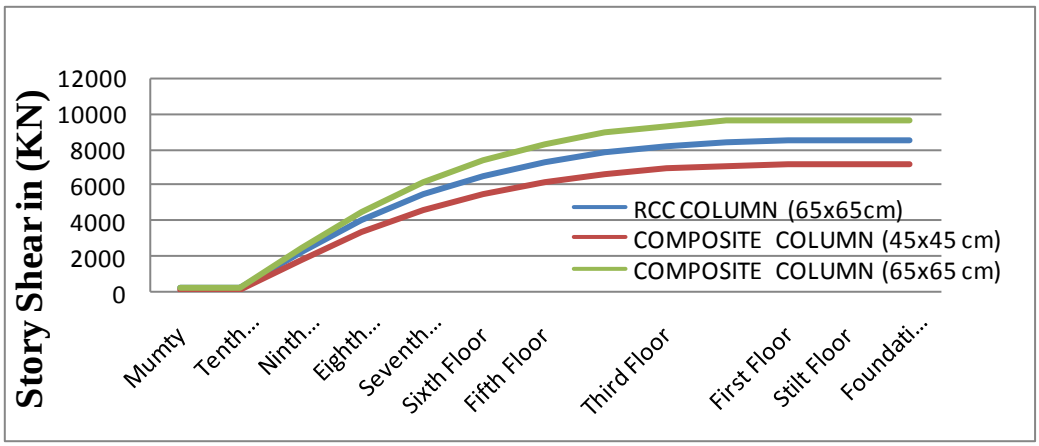

Fig 4: Story Shear

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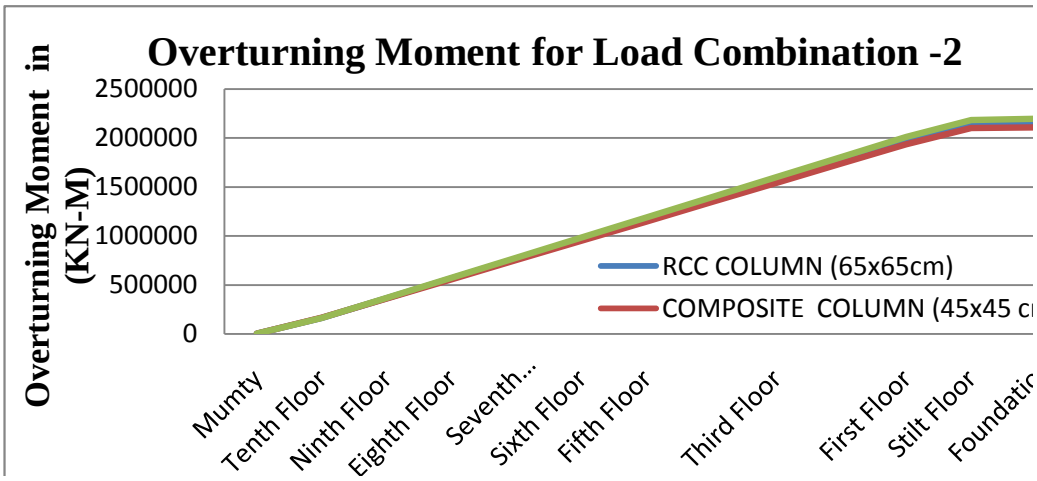

Fig 5: Overturning moment

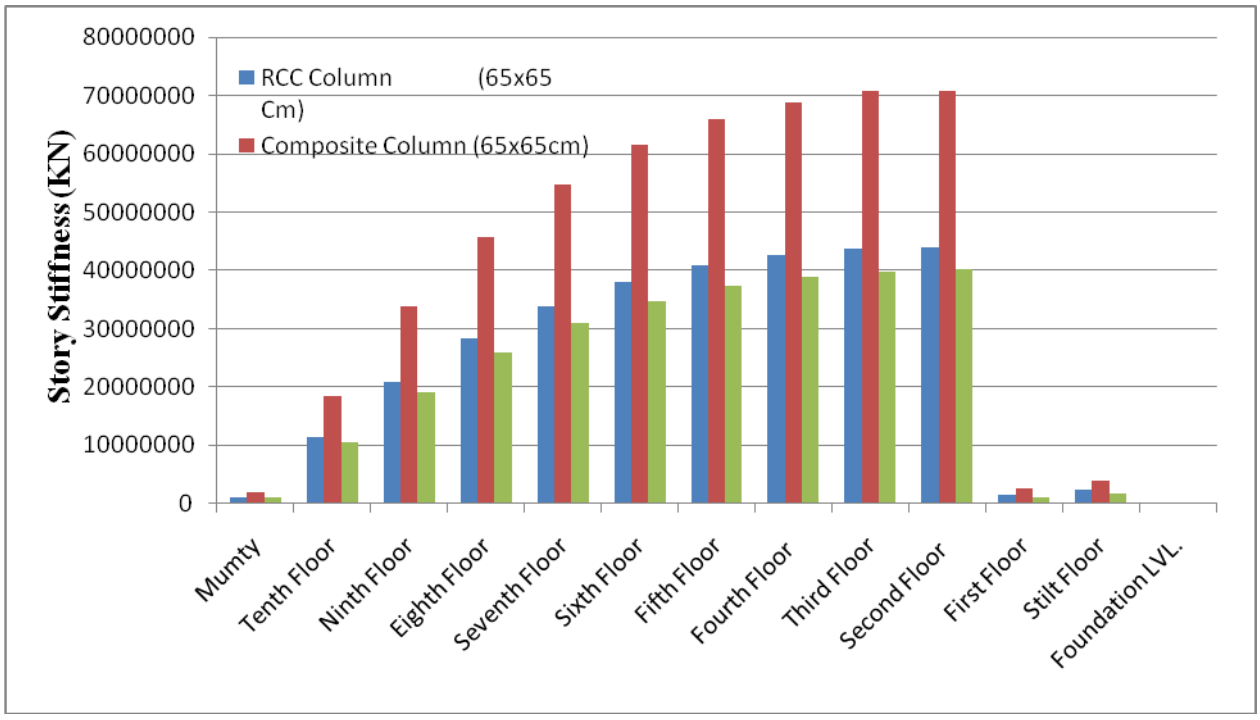

Fig 6: Story Stiffness

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VI. COST ANALYSIS

Table 4: Cost Analysis

S.N.	Description	Unit	Qty.	Rate	Amount
For RCC Columns					
1.	P/L M-25 Grade R.C.C.	Cum	433.696	7749	3360797.04
2.	P/D shuttering	Sqm	2566.25	467.9	1200620.06
3.	Cutting, Binding R/f Steel	Kg.	128661.66	58	7462376.28
4.	P/L 12.0 m thick cement plaster	Sqm	2566.25	186.90	479503.80
Total Cost of RCC Column (Rs.)					12503297.20
For Composite Columns					
1.	P/L M-25 Grade R.C.C.	Cum	189.799	7749	1470790.411
2.	Cutting, Binding R/f Steel	Kg.	13468.34	58	781163.72
3.	P/f structural steel	Kg.	145044.50	67.2	9746987.04
Total Cost of Composite Column (Rs.)					11998941.17

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VII. CONCLUSION

1. Due to repression of cement in CFST sections, its heap conveying limit has been expanded. For this model segment area required in RCC is 650x650 mm while on planning same model with composite segments segment size diminished to 450x450 mm.
2. Maximum story dislodging in RCC segments is 49% to 55 % higher than the composite segments of same area size. The area size required in composite segments is less so on decrease of segment size most extreme story dislodging of composite segments is 6% to 12% higher than RCC segments.
3. Maximum story shear for edge with RCC sections (65x65 CM) is 17% to 19% higher than the casing with composite segments (45x45cm). Story shear in composite segments are less because of diminished load of structure with composite sections.
4. Overturning minutes in composite segments of size 45x45 cm is hardly higher than the RCC segments of size 65x65 cm.
5. Story Stiffness in RCC segments of Size 65x65 CM is 8% to 26% higher than the composite sections of size 45x45 CM.
6. It is seen that damping in RCC Column is 4 % to 18 % higher so composite segments ought to be progressively favored for the structure intended for seismic burdens and wind loads.
7. Due to decrease in segment size, the expense of composite section is 4 % not exactly the expense of RCC segments. Establishment size and plan for composite sections is likewise light because of decrease in dead weight of structure.

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