RESEARCH PAPER

# COMPARISON OF SEISMIC BEHAVIOR OF A STRUCTURE WITH COMPOSITE COLUMNS AND STEEL COLUMNS BY USING ETABS SOFTWARE

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**ABSTRACT-**
The majority of building structures are designed and constructed in reinforced concrete which is mainly depends upon availability of the constituent materials and the level of skill required in construction, as well as the practicality of design codes. R.C.C is no longer economical because of their increased dead load, hazardous formwork. However composite construction is a new concept for construction industry. The use of modern composite systems, allowing the erection of multi-story structural frames to proceed at pace, can make it economically prohibitive to delay the construction of each floor while concrete columns are cast. In Japan, however, the superior earthquake resistant properties of composite beam-columns have been long recognized and have become a commonly used for construction in that region. It was therefore necessary to develop seismic design criteria for typically used Indian structural systems, to advance the use of this efficient type of mixed construction. This Project shows comparison of various aspects of building.
In this project a residential of G+30 multi-story building is studied for Response Spectrum Analysis using ETABS, assuming that material property linear, static and dynamic analysis is performed. These non-linear analysis are carried out and different parameters like displacement, storey drift, Performance point, base shear are plotted. Now it is the demand of time that every structure must be analyzed and designed for lateral forces such as earthquake and wind forces. But generally it is found that the cross sectional area of RCC structural member comes out very heavy with large amount of constituent material such as steel & concrete, which takes large space in construction of multistory building. Under such circumstances composite structure is one of the best options, which not only takes care for earthquake forces but also gives less cross sectional area of structural member and provides large space for utilization in economical way.

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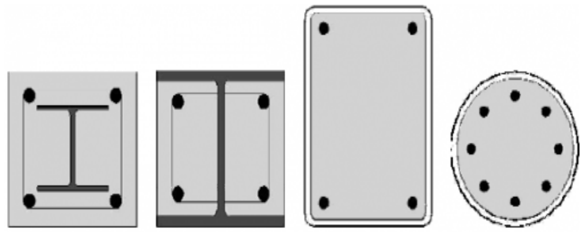
## 1. INTRODUCTION

Structural engineers do not traditionally consider fire as a load on the structural frame. This is in contrast to other loads they must consider. Seismic design relies on modeling, risk analysis and changes to the structural stiffness. Wind design relies on additional structural members and wind tunnel tests. Fire design relies on very simple, single element tests and adding insulating material to the frame. Thermal induced forces are generally not calculated or designed.

Natural disasters are inevitable and it is not possible to get full control over them. The history of human civilization reveals that man has been combating with natural disasters from its origin but natural disasters like floods, cyclones, earthquakes, volcanic eruptions have various times not only disturbed the normal life pattern but also caused huge losses to life and property and interrupted the process of development. With the technological advancement, man tried to combat with these natural disasters through various ways like developing early warning systems for disasters, adopting new prevention measures, proper relief and rescue measures. But unfortunately it is not true for all natural disasters. Earthquakes are one in all such disasters that's connected with in progress tectonic process; it suddenly comes for seconds and causes nice loss of life and property. So earthquake disaster prevention and reduction strategy is a global concern today. Hazard maps indicating seismic zones in seismic code are revised from time to time which leads to additional base shear demand on existing buildings.

**Composite columns**

Composite columns may take a range of forms, as shown in the figure below. As with all composite elements they are attractive because they play to the relative strengths of both steel and concrete. This can result in a high resistance for a relatively small cross sectional area, thereby maximising useable floor space. They also exhibit particularly good performance in fire conditions.



Typical composite column cross sections

Design rules for composite columns in structural frames are given in BS EN 1994-1-1[4]. This is the first time that guidance has been given in a code for use in the UK, which may explain why composite columns have been rarely used to date. Rules are provided for composite H sections, either fully or 'partially encased' (web infill only), and for concrete filled hollow sections. Typical cross sections are shown. Composite columns requiring formwork during execution tend not to be viewed as cost-effective in the UK.

**Objectives of the study**

1) To study irregularities in structures analyze and design of G+300 storied structure as per code (IS1893:2016) provision by using different cross sections of the columns (rectangular, circular, I sections)
2) To analyze the buildings in Etabs and Staad pro V8i SS6 softwares to carry out the storey deflection, storey drift, storey shear force and base shear of structures using response spectrum analysis and compare the results.
3) Time history analysis subjected to intermediate frequency ground motion for the response of regular buildings and compare with response spectrum analysis.
4) Ductility-based earthquake-resistant design as per IS 13920

## 2. LITERATURE REVIEW

**Abhay Guleria** Presented the analysis of multi story RCC building for different plan configuration. The analysis has performed for the earthquake loads. The specification of lateral loads has been taken from IS 1893 (Part 1)-2002. In addition, this study suggests that L-shape and I-shape structure gives almost similar response against overturning moment, story drift, and Story displacement.

**Mahmad saber et., al. (2015)** This paper is investigates that the design of concrete frame multi-story structure when designed using STAAD and ETAB software's. STAAD and ETAB are the present day leading design software's in the market.

**Sonia Longjam, S. Aravindan** This paper presents the plan, model, analyze and design of a vertical irregular shopping mall structure of G+10storey and investigate its performance under various lateral loading conditions. The main goal is to assess current Indian Standard design practice and to provide design guidelines using ETABS.

## 3. METHODOLOGY

**Response spectrum analysis**

The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2002 (part1).

The standard response spectra for type of soil considered is applied to building for the analysis in ETABS 2013 software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g).

**Types of loads on building**

- Dead load
- Live load
- Floor load
- Seismic load
- Wind load

## 4. MODELING OF THE BUILDING IN ETABS

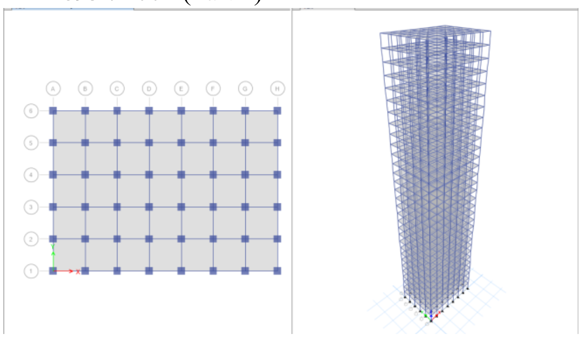
**Problem statement**

In the present study, analysis of G+ 30 stories building in Zone V is carried out in ETABS.

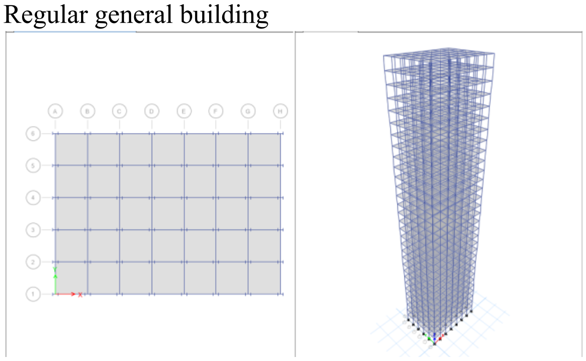
Basic parameters considered for the analysis are

1. Grade of concrete : M40
2. Grade of Reinforcing steel : HYSD Fe500
3. Dimensions of beam : 230mmX460mm
4. Dimensions of column : 690mmX690mm
5. Thickness of slab : 180mm
6. Steel column :ISWB500
7. Composite column :0.69X0.69 with angle section
8. Height of bottom story : 3m
9. Height of Remaining story : 3m
10. Live load : 5 $KN/m^2$
11. Dead load : 2 $KN/m^2$
12. Density of concrete : 25 $KN/m^3$
13. Seismic Zone : Zone IV
14. Site type : II
15. Importance factor : 1.5
16. Response reduction factor : 5
17. Damping Ratio : 5%
18. Structure class : B
19. Basic wind speed : 44m/s
20. Risk coefficient (K1) : 1.08
21. Terrain size coefficient (K2) : 1.14

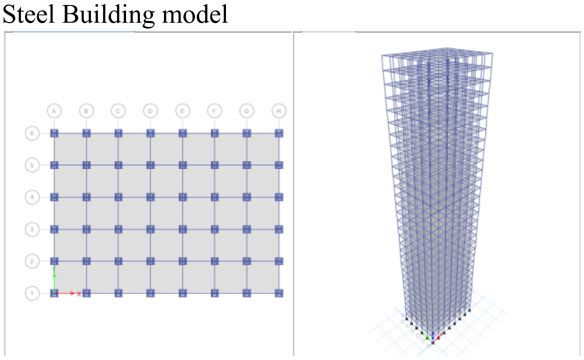
22. Topography factor (K3) : 1.36
23. Wind design code : IS 875: 1987 (Part 3)
24. RCC design code : IS 456:2000
25. Steel design code : IS 800: 2007
26. Earth quake design code : IS 1893 : 2002 (Part 1)



Regular general building



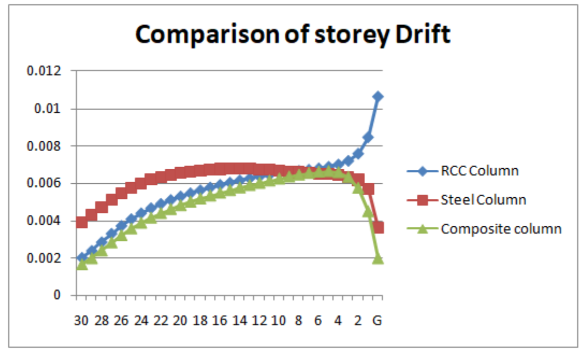
Steel Building model



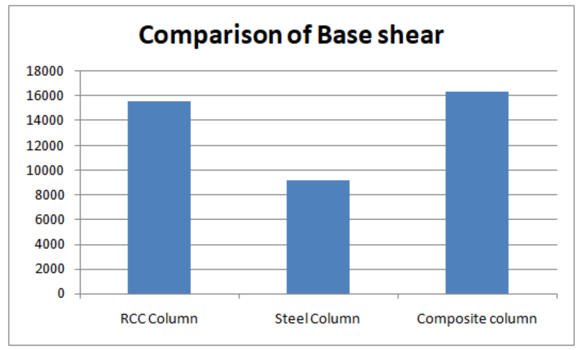
Composite Building model

## 5. RESULTS AND ANALYSIS

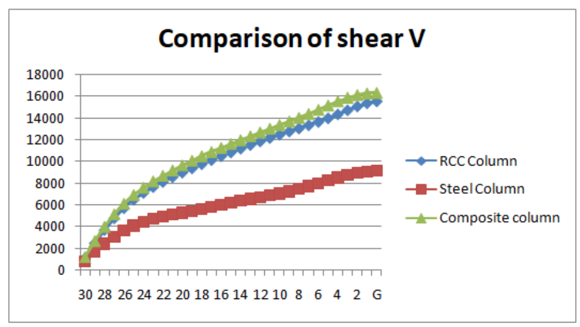
**Drift X**



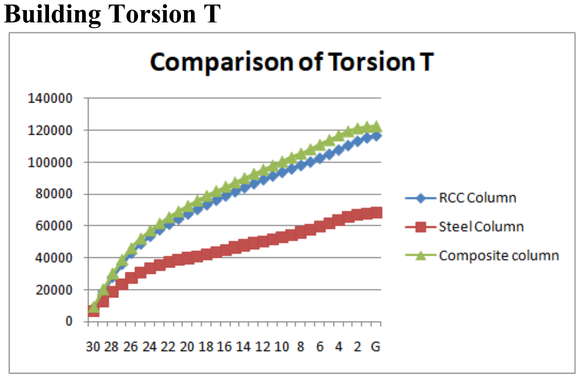

**Base shear Values**



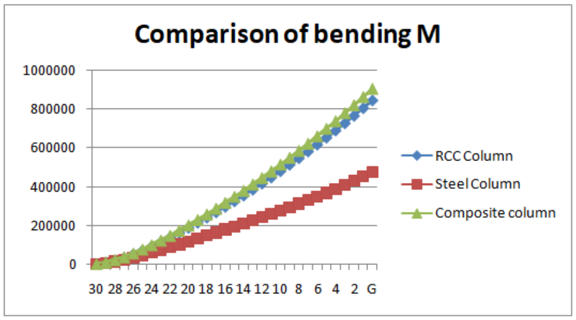

**Shear V values**



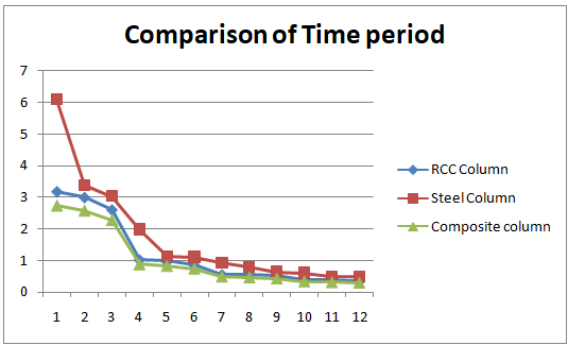

**Building Torsion T**



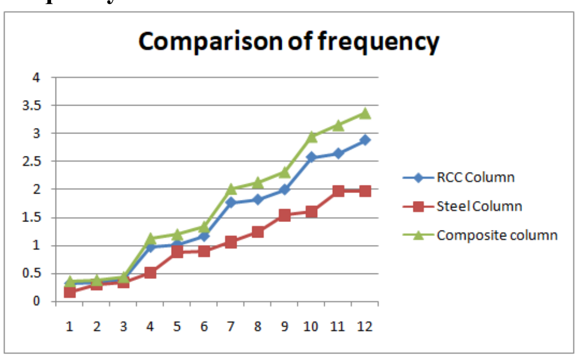

**Bending moment**




**Time period**




**Frequency**




## 6. CONCLUSIONS

The following are the conclusions were made
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1. The values of story Drift in both X and Y load case is observed as less values for the steel building model than other models (RCC Building and Composite column Building). And the maximum values are obtained from composite column buildings.
2. The values of shear and bending moment and building twist are increases for 30th to bottom story. For the steel column building has less shear and bending values are obtained than the RCC buildings and composite column structures.
3. The maximum values of Base shear is obtained for composite column building than the RCC column and Composite column models in both X direction and Y Direction push over load.
4. For the above points the steel column building has less values of Shear, Bending, Torsion, Story Drift and other factors than the RCC column building, Composite column building..
5. Storey drift in Analysis in X-direction is more for Steel frame as compared to Composite and RCC frames.
6. The differences in storey drift for different stories along X and Y direction are owing to orientation of column sections. Moment of inertia of column sections are different in both directions.
7. Base Shear for RCC frame is maximum because the weight of the RCC frame is more than the steel and the composite frame. Base shear gets reduced by 40% for Composite frame and 45% for Steel frame in comparison to the RCC frame.
8. Reduction in cost of Composite frame is 33% and Steel frame is 27% compared with cost of RCC frame. This involves material cost only and doesn't include fabrication cost, transportation cost, labour cost etc.

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