COMPARATIVE STUDY OF RCC BUILDING WITH COMPOSITE COLUMN AND STEEL COLUMNS BY ETABS

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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 Pushover 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.

KEY WORDS: *Pushover, ETABS, Performance Point, Non-linear.*

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.

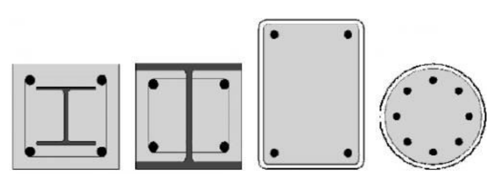
Natural disasters are inevitable and it is not possible to get full control over them. The history of human civilization reveals that man has been combating with natural disasters from its origin but natural disasters like floods, cyclones, earthquakes, volcanic eruptions have various times not only 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.

Building construction is that the engineering offers with the development of constructing akin to residential buildings in a really effortless constructing will probably be outline as an enclose area via partitions with roof, food, fabric and accordingly the basic desires of contributors. Inside the early earlier interval people lived in caves, over bushes or beneath bushes, to safeguard themselves from wild animals, rain, sun, etc. Because the occasions handed as people being started dwelling in huts created from trees branches. The shelters of these previous are developed at the moment into wonderful residences. Rich individuals reside in sophisticated houses.

Composite columns are often used in structures due to the ease and speed of erection, and high performance in fire situation. Concrete filled tubes are steel tubes that are in site filled with reinforced concrete. In normal situation column works as composite while in fire situation majority of the load is carried by the reinforced concrete core. There are numerous publications about this type of columns but all of them use very simplified methods. Especially regarding the calculation of the neutral axis of circular columns. Also the shear resistance of the column is often omitted.

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

Advantages of Composite Columns

In many cases of design, concrete or some other protective material is required around steel columns for reasons of fire-resistance and durability. It would seem appropriate, therefore, to develop composite action between the steel and concrete, thereby taking advantage of the inherent compressive strength of the concrete, increasing the compressive resistance of the section and leading to considerable savings in the cost of the steelwork. Even ignoring this composite action, the slenderness of the steel column in lateral buckling is reduced, thereby increasing the compressive stress that can be resisted by the steel section.

Much research has gone into the behavior of concrete filled tubular sections. Architecturally, tubular columns have many attractive features; concrete filling has no visual effect on their appeal. The advantages from a structural point of view are, first, the tri axial confinement of the concrete within the section, and second, the fire resistance of the column, which largely depends on the residual capacity of the concrete core.

Steel building

Steel building is a metal structure fabricated with steel for the internal support and for exterior cladding, as opposed to steel framed buildings which generally use other materials for floors, walls, and external envelope. Steel buildings are used for a variety of purposes including storage, work spaces and living accommodation. They are classified into specific types depending on how they are used.

Steel buildings first gained popularity in the early 20th century. Their use became more widespread during World War II and significantly expanded after the war when steel became more available. Steel buildings have been widely accepted, in part due to cost efficiency. The range of application has expanded with improved materials, products and design capabilities with the availability of computer aided design software.

Advantages of steel building

Steel provides several advantages over other building materials, such as wood. Steel is structurally sound and manufactured to strict specifications and tolerances. Any excess material is 100% recyclable. Steel does not easily warp, buckle, twist or bend, and is therefore easy to modify and offers design flexibility. Steel is also easy to install. Steel is cost effective and rarely fluctuates in price. Steel allows for improved quality of construction and less maintenance, while offering improved safety and resistance. With the propagation of mold and mildew in residential buildings, using steel minimizes these infestations. Mold needs moist, porous material to grow. Steel studs do not have those problems.

Objectives of the study

The following are the objectives of the study considered

1. To study the G+30 storied structure as per code (IS1893:2002) provision by using different columns like RCC, steel and composite columns.

2. To analyze the buildings in ETABS software with the help of seismic analysis.
3. The results like storey drift, storey shear force, story bending, building torsion of structures using pushover analysis is carried out.
4. Ductility-based earthquake-resistant design as per IS 13920

II LITERATURE STUDIES

Sonia Longjam, S. Aravindan The 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 and to find a detailing strategy which will ensure a sufficient level of safety for various levels of loading demands.

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. The modeling and analysis has done by using finite element based software ETABS. From the analysis and results, they conclude that the effect of shape is very important. And also they compare the result of different plan configuration buildings such as story shear, overturning moment, story drift, story displacement and mode shapes. In addition, this study suggests that L-shape and I-shape structure gives almost similar response against overturning moment, story drift, and Story displacement.

Syed Khasim Mutwalli, Dr. Shaik Kamal Mohammed Azam This study presents the procedure for seismic performance estimation of high-rise buildings based on a concept of the capacity spectrum method. In 3D analytical model of thirty storied buildings have been generated for symmetric buildings Models and analyzed using structural analysis tool ETABS. The analytical model of the building includes all important components that influence the mass, strength, stiffness and deformability of the structure. To study the effect of concrete core wall & shear wall at different positions during earthquake, seismic analysis using both linear static, linear dynamic and non- linear static procedure has been performed.

III METHODOLOGY USED

Response Spectrum Analysis

This method is also known as modal method or mode superposition method. It is based on the idea that the response of a building is the superposition of the responses of individual modes of vibration, each mode responding with its own particular deformed shape, its own frequency, and with its own modal damping.

According to IS-1893(Part-l):2002, high rise and irregular buildings must be analysed by response spectrum method using design spectra shown in Figure 4.1. There are significant computational advantages using response spectra method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves only the calculation of the maximum values of the displacements and member forces in each mode using smooth spectra that are the average of several earthquake motions. Sufficient modes to capture such that at least 90% of the participating mass of the building (in each of two orthogonal principle horizontal directions) have to be considered for the analysis. The analysis is performed to determine the base shear for each mode using given building characteristics and ground motion spectra. And then the storey forces, accelerations, and displacements are calculated for each mode, and are combined statistically using the SRSS combination.

However, in this method, the design base shear (VB) shall be compared with a base shear (Vb) calculated using a fundamental period T. If V_B is less than Vb response quantities are (for example member forces, displacements, storey forces, storey shears and base reactions) multiplied by VB/Vb Response spectrum method of analysis shall be performed using design spectrum. In case design spectrum is specifically prepared for a structure at a particular project site, the same may be used for design at the discretion of the project authorities. Figure 4.1 shows the proposed 5% spectra for rocky and soils sites**.**

For structures with VE dampers, the seismic response envelopes of the structure can be also carried by response spectrum analysis using the response spectra of the input ground motions with damping ratios calculated from Equation (3). Figures 8a and 8b show typical results of the floor lateral displacement and story shear envelopes of a 5. story steel frame with added VE dampers (4 = 15 0/0) under 0.62 El Centro earthquake using the CQC method (Kiureghian 1981). The structure remained elastic during the earthquake. Also included in these figures are the envelopes of experimental and analytical time history analysis results. It can be seen that the tæsponse spectrum analysis gives reliable predictions on the lateral displacement and story shear envelopes of the visco elastically damped structure.

IV SPECIFICATIONS AND MODELS USED

Problem statement

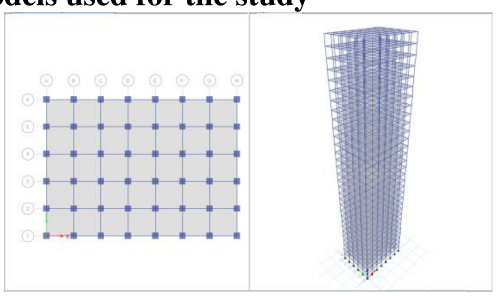
In the present study, analysis of G+ 30 stories building in Zone V is carried out in ETABS.

Basic parameters considered for the analysis are

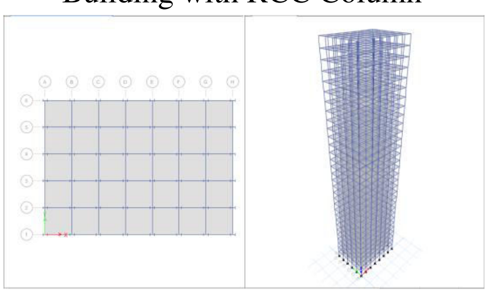
1. Grade of concrete : M40
2. Grade of Reinforcing steel : HYSD Fe500
3. Dimensions of beam : 230mmX460mm
4. Dimensions of column : 690mmX690mm
5. Thickness of slab : 180mm
6. Steel column :ISWB500
7. Composite column :0.69X0.69 with angle section
8. Height of bottom story : 3m
9. Height of Remaining 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
24. RCC design code : IS 456:2000
25. Steel design code : IS 800: 2007
26. Earth quake code : IS 1893 : 2002

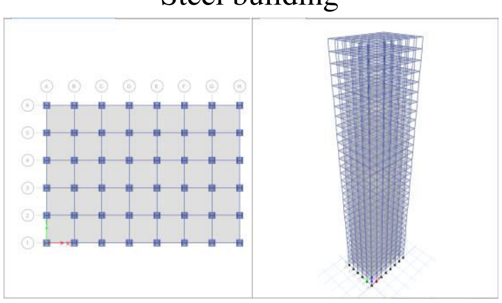
Models used for the study



Building with RCC Column



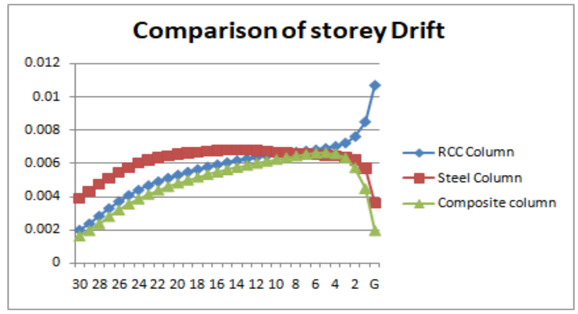
Steel building



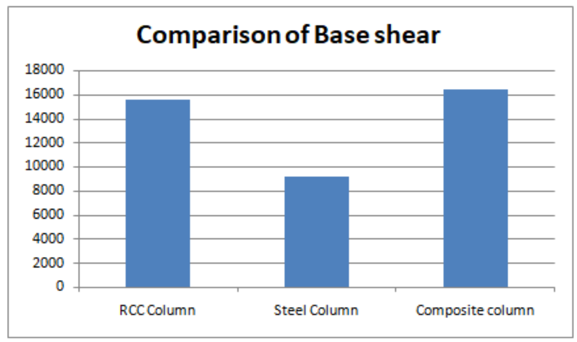
Composite column Building

V RESULTS AND ANALYSIS

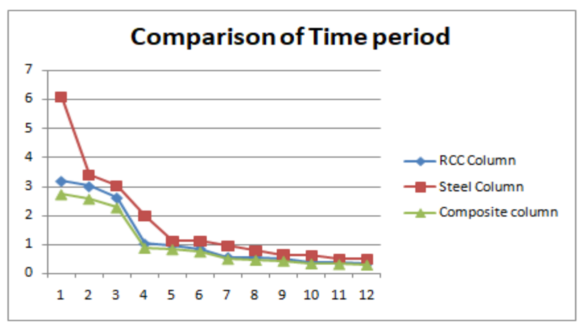
Seismic load in X Direction Results



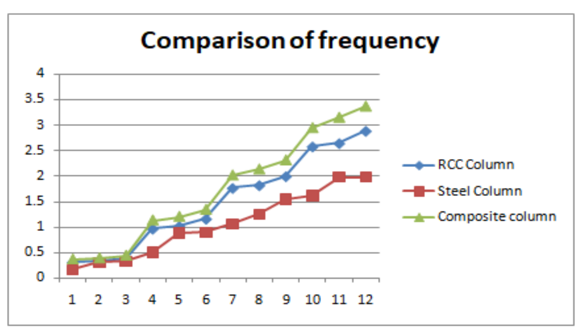
Comparison of storey drift



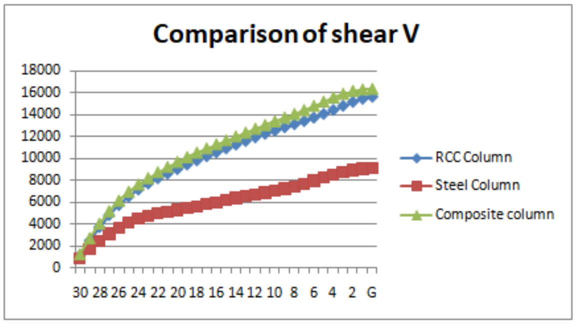
Comparison of base shear



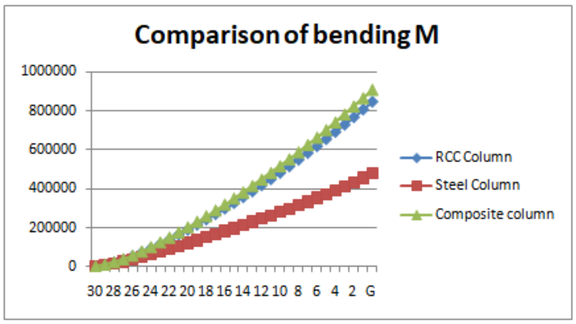
Comparison of time period



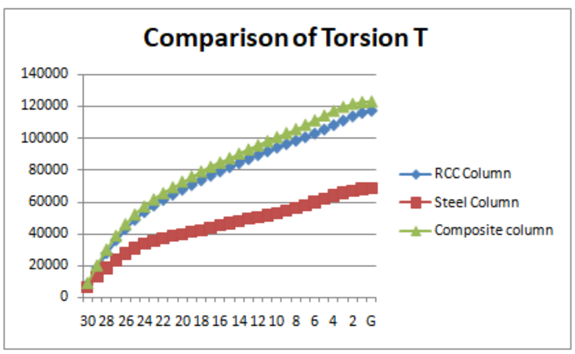
Comparison of frequency



Comparison of shear V values

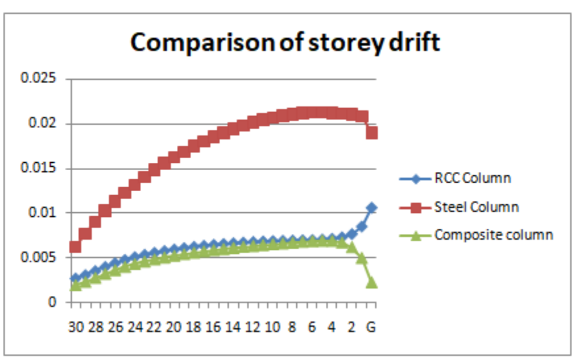


Comparison of bending M values

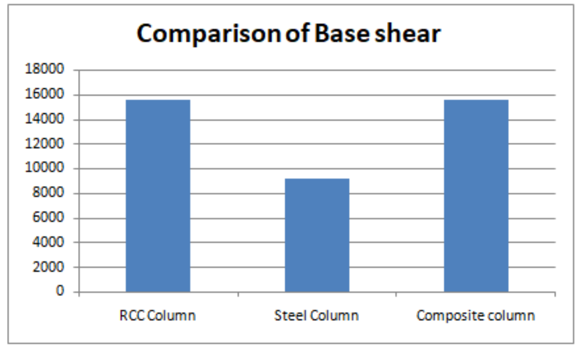


Comparison of torsion T Values

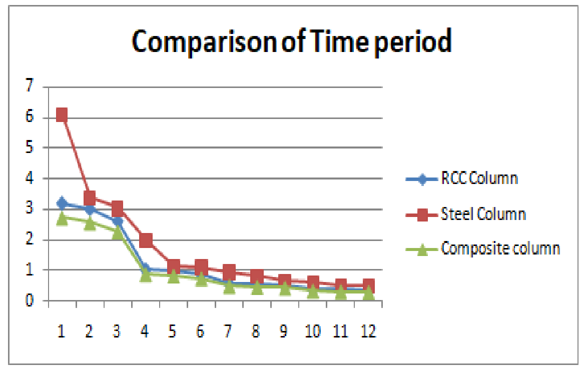
Seismic load in Y Direction Results



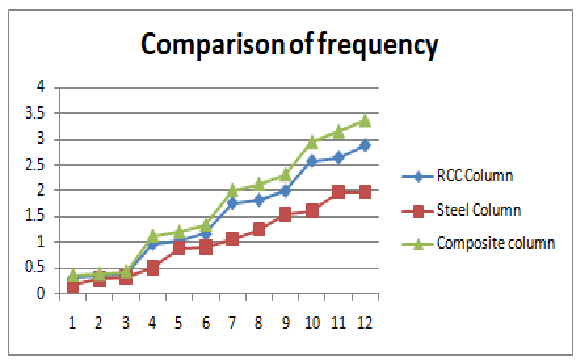
Comparison of storey drift



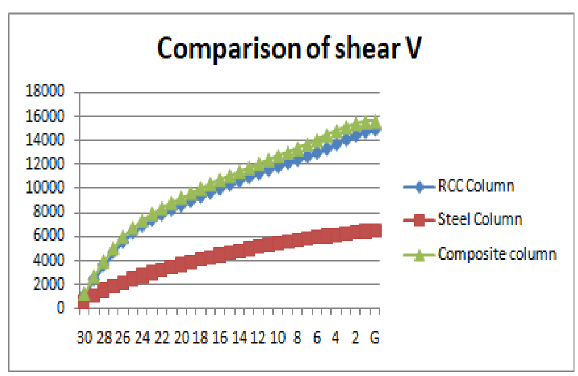
Comparison of base shear



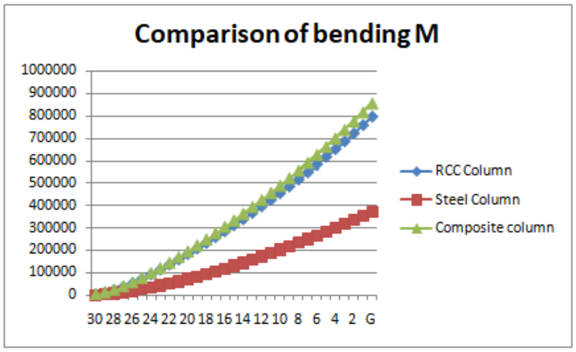
Comparison of time period



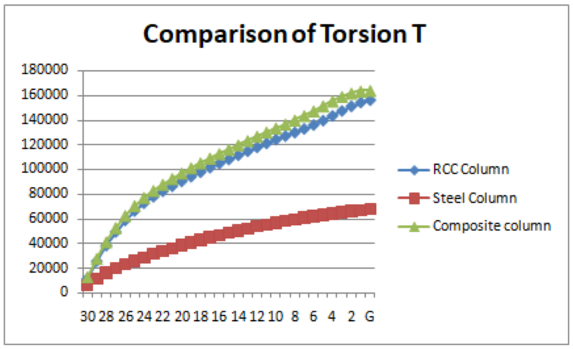
Comparison of frequency



Comparison of shear V values



Comparison of bending M values



Comparison of torsion T Values

VI CONCLUSIONS

The following are the conclusions were made

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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