Comparative Analysis Of RCC Building With Composite Column And Steel Column Building in Zone 3 and Zone 4 by using ETABS Software

MD KASHIF PARVEZ
Department of Civil Engineering
Poojya Doddappa Appa College of Engineering, Kalaburagi, Karnataka, India.

Dr. SHRUTI G
Department of Civil Engineering
Poojya Doddappa Appa College of Engineering, Kalaburagi, Karnataka, India.

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+13 multi-story building is studied for time history Analysis using ETABS is performed. These non-linear analysis are carried out and different parameters like displacement, base shear, bending, time period and frequency. 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: Time history Analysis, ETABS, Performance Point, Non-linear.

I. INTRODUCTION

1.1 General

When designing a building's framework, structural engineers often ignore fire as a potential load. When compared to other burdens they have to worry about, this is quite light. Modeling, risk assessment, and adjustments to structural stiffness are all integral parts of seismic design. Engineering for wind requires the use of wind tunnels and supplementary structural elements. As well as insulating the frame, extremely basic, single-element tests are used in fire design. In most cases, thermally generated forces are not planned for nor accounted for during development.

It's impossible to completely prevent natural catastrophes since they occur on a regular basis. Natural catastrophes such as floods, cyclones, earthquakes, and volcanic eruptions have disrupted regular living patterns, inflicted significant losses of life and property, and slowed down the progress of development at different points in human history. Man has responded to natural catastrophes in a number of ways, including the development of early warning systems, the adoption of new preventative measures, and the implementation of adequate relief and rescue efforts made possible by advances in technology. However, this is not always the case with natural calamities. One such calamity associated with ongoing tectonic processes is earthquakes, which may strike in a matter of seconds and inflict significant damage and loss of life. Because of this, developing effective methods of reducing the severity of earthquake disasters is a topic of international importance. Existing structures are subject to increased base shear demand whenever the hazard maps depicting seismic areas in seismic code are updated.

In the early period, people resided in caves, over bushes, or beneath bushes to protect themself from wild animals, rain, sun, etc. Building construction is engineering deals with advancement of constructing, such as residential buildings in a very simple constructing will be define as an enclose area via walls with roof, food, fabric, and correspondingly basic desires of members. At first, humans lived in huts made from tree branches, but as time went on, they shifted to more permanent structures. The caves of yore have been transformed into luxurious mansions for modern dwellers. Luxury homes are where the wealthy choose to call home.

Buildings are the most visible symbol of a country's progress in terms of its social infrastructure. On average, people spend around two-thirds of their lives at home, so it's no surprise that everyone wants a nice place to call their own. Few things are more responsible for a person exerting all of his or her labor and spending all of his or her savings on buying a home than the need for safety, a sense of civic duty, and pride of ownership.

Condominium construction is now a vital part of every county's effort to improve its citizens' standard of living. Engineers and designers conduct the seams work, design & layout, etc. of the projects, and they are always developing new strategies for developing homes in a cost-effective, time-efficient, and aesthetically beautiful manner. Skilled workers may be counted on to carry out architectural design tasks, following in the footsteps of designers and engineers. The skilled worker will know what he's doing, be able to follow directions from the engineer, and provide the necessary blueprints, site plans, and layout diagrams, among other things, for the project.

The framework of a structure has several different bays and levels. An intermediately difficult static challenge might be posed by a multi-story, multi-paneled body. Body work is being planned for a R.C building with a G+15 floor plan. The columns in the (40,28) arrangement of the building are all part of the same, monolithic structure, which was supposed to be a neighborhood. There will be a 40-by-28-meter building. There are 85 columns in all. It's technologically sophisticated in terms of housing.

ETABS is used to construct the design. This structure was hit by hundreds from above and masses from below. The vertical load is made up of the dead weight of structural parts such as beams, columns, slabs, etc. According to IS 875, a building must be designed to withstand three types of loads: the dead load, the live load, and the wind load. The building has been assessed in accordance with IS 456-2000 and is planned to have just two dimensions in the vertical plane. Hundreds, seconds, and shear forces are all calculated with the use of an institute-provided software.

Composite columns are widely utilized because of their strong performance in fire situations, simplicity of construction, and general usefulness. On-site fabrication of steel tubes which are then filled using reinforced concrete to create concrete-filled tubes. While the reinforced concrete core of the column does most of the heavy lifting under normal conditions, it takes over completely in the event of a fire. Numerous articles have been written on these columns, however they all make use of oversimplified approaches. In particular, when it comes to finding the neutral axis of circular columns. The column's shear resistance is also often overlooked.

1.2 Objective of the project

1. First, a comparative study of G+13 floors is performed in Zone III & Zone IV seismic condition in order to model and analyze composite column buildings and steel column buildings utilizing time history analysis. Both asymmetrical and conventional building patterns are present.

2. Investigate building characteristics including lateral displacement, age, and base shear

3. To contrast the modeled outcomes of composite column construction with those of steel column construction using modeling program Etabs

1.3 Introduction ToEtabs

ETABS is an advanced but user-friendly building systems analysis and design application. ETABS has an unparalleled graphical user interface with modeling, analysis, and design capabilities that are all seamlessly integrated into a single database. ETABS is the go-to program for structural engineers since it is fast and simple for basic buildings but can also handle very complicated models with a broad variety of geometric nonlinear behaviors (Computers and structures Inc. 2003).

The Structural Engineer has long worried about the precision of analytical modeling of complicated Wall Systems. Line elements, rather than continuum components, are often used in the idealized computer models of such systems. Cantilever models are used for single walls, whereas pier and spandrel models are used for walls with openings. These models can provide a satisfactory answer for basic systems in which stiffness lines may be established. However, a continuum model built using the finite element approach has traditionally been seen as superior. However, the use of such models in reality has proven difficult for Structural Engineer mainly because of the high costs associated with their development and, more crucially, the fact that they do not provide information immediately usable by Structural Engineer. Structural engineers formerly had little need to employ finite element models in practice, but recent advancements in ETABS's object-based modeling of basic and complicated wall systems in an integrated single-interface environment have changed that (Ashraf Habibullah, 2002).

II.LITERATURE REVIEW

1. Shweta A. Wagh*, Dr. U. P. Waghe (2014)

The use of steel-concrete composites as a cheaper alternative to traditional building materials like steel and concrete has seen widespread success across the globe. Steel is seldom used in India's building sector, especially when compared to other emerging nations.

Four different types of commercial multi-story buildings (G+12, G+16, G+20, and G+24) are analyzed in this work using STAAD-Pro. When the design and cost estimate is done in MS-Excel, the results may be compared to those of a composite structure and a reinforced concrete building.

Steel-concrete composite structures outperform R.C.C structures during earthquakes because of their superior ductility. When compared to other materials used in creating tall structures, steel-concrete composite design structures save money and time.

2. Mr. Anil S. Savadi ,Dr. Vinod Hosur (2019)

Steel-concrete composite building has become a popular alternative to reinforced concrete building across the globe. However, the building sector is only beginning to embrace this technique.

Concrete composite with RCC, Steel structure choices are examined for comparative research of G+2 story of Industrial building located in seismic zone-3 of IS 1893-2002 earth quake loading in the current work. Modeling composite, Steel, and RCC structures using the equivalent static technique of analysis

Since the dead load is less in a composite construction, the critical bending moment & Shear force values are larger. Composite structure, as opposed to RCC & Steel structure, is the optimal choice for multi-story buildings.

3. Siddalingaprasad Y. B, B. S. Sureshchandra (2018)

While steel excels in stress carrying and concrete shines at compression resistance, it is clear that composite components maximize the benefits of both materials.

Earthquake loads do the greatest damage to structures of all natural causes. Composite columns, used in earthquake-resistant building design, provide exceptional resilience to the stresses imposed by an earthquake.

In this study, we will examine the advantages and disadvantages of composite columns in relation to traditional concrete ones. Column types covered in this paper include those that are entirely enclosed, partly encased, as well as rectangular concrete filled tube sections, and their effects on the overall structure's behavior are the primary focus of this article.

In comparison to conventional concrete columns, the cross sectional area of partly enclosed and composite columns is much less.

4. ShanmugaPriya K, Karthick R, ChandrikkaV(2019)

Columns made of steel and concrete are commonplace in today's architecture. Many studies have been done on steel concrete composite columns, which consist of structural steel parts that are embedded in concrete. Composite columns with fillings

Review of the literature on concrete-filled steel columns is presented in this work. To strengthen the weld between the steel column and the concrete footing, wire mesh is welded to its inside surface. This study examines the structural differences between 3 composite columns and three RC columns of the same height. It is observed that columns have a high ultimate strength, flexibility, capacity for energy absorption and stiffness.

A superior structural behavior is shown in composite columns compared to RC columns.

5. AbhayGuleria 2014 Displayed were the results of an examination of several floor plans for multi-story RCC structures. The earthquake loads have been successfully analyzed. IS 1893 (Part 1)-2002 was used as the reference for the lateral load standard. ETABS, a finite-element analysis program, was used for the modeling and analysis. They conclude that form has a significant role according to their investigation and findings. The results of several building configurations are compared, including those with regards to story shear, overturning moment, story drift, story displacement, and mode shapes. Furthermore, the results of this research indicate that L-shape & I-shape structures react similarly to overturning moments, tale drift, & story displacement.

6. Baldev D. Prajapati, D. R. Panchal et., al. (2013) This article presents the analytical and design process used to assess the vulnerability of a symmetric 30-story high-rise to wind and quake forces. It is widely accepted that R.C.C., steel, and composite buildings with shear walls are the most effective against lateral forces. In this paper, we use ETABS to assess and design a G+30 story structure subject to the effects of wind and earthquake. The advantages of steel-concrete composite buildings are shown via the analysis and design of a total of twenty-one different models. The best economic and structural defense against side forces is determined by comparing analytical data.

Since composite steel-concrete is a novel idea in the Indian setting, there are no up-to-date rules to guide its development. The current approach not only avoids the need for expensive testing, but it also makes it possible to design with many possibilities for steel sections as well as shear connections, all while having their suitability checked. Composite construction calls for fewer structural steel sections than non-composite building does for the same span and loading. Because of how much lighter a composite building is compared to conventional buildings, the cost of the structure's base is lower.

7. AnirudhGottala, KintaliSai Nanda Kishore et., al. (2015) This research examines the hypothesis that, with the advent of cheap computers & specialized programs for doing the analysis, the assessment & design of structures for static forces has become a regular business. However, dynamic analysis is time-consuming and needs further information on the structure's mass and knowledge of structural dynamics in order to interpret analytical findings correctly. One of the most significant dynamic loads, earthquakes, are discussed here, along with how they should be accounted for in the analysis of the structure. An elaborate (G+9) framed building is chosen for this investigation. To ensure compliance with IS-1893-2002-Part-1, STAAD-Pro is used to perform a linear seismic analysis of the building utilizing the static and dynamic methods. Beams, columns, and the whole structure are compared and contrasted in terms of outcomes like bending moment, nodal displacements, and mode forms from static and dynamic analyses.

This research established that the tensile and compressive stresses in the examined beams were about equivalent. It was found that seismic stimulation caused much higher nodal displacements & bending moments in columns and beams than did static stresses. When comparing Static and Dynamic analyses, the Nodal Displacements in the Z-direction are 50% larger for the latter. Moment values derived from a Dynamic analysis are 35-45% more than those obtained from a Static analysis. For Static analysis, Torsion of columns has negative values, but for Dynamic analysis it has positive values.

8. Pardeshisameer, Prof. N. G. Gore et., al. (2016) In this research, symmetric and asymmetric G+15 storied building models were created in 3D and studied using the static structural tool ETABS software. The dynamic behavior of a structure may be characterized by a few primary factors, the most fundamental of which are its mass and stiffness. Different characteristics, including mass-stiffness distribution, foundation types, and soil conditions, affect how multi-story structures behave. In this work, we investigate how changes in the building's vertical orientation influence its reactivity to earthquakes. The project's goal is to perform RSA on regular and irregular RC building frames, THA on regular RC building frames, and RSA-based ductility-based design using IS 13920. The outcomes of analyses of irregular structures are compared to those of analyses of regular structures.

9. Syed KhasimMutwalli, Dr. Shaik KamalMohammed Azam In this research, the capacity spectrum idea is used to outline the steps necessary to estimate the seismic performance of tall structures. For symmetric building models, the 3D analytical modeling software ETABS was used to perform structural analysis. All relevant factors that affect the building's mass, strength, stiffness, and deformability have been accounted for in the analytical model.

10. Mohammed sameem afzal1, mohdfirasath ali2, syedfarrukh anwar3 2018 The purpose of this study is to investigate the unstable behavior of a composite column and a regular steel column in a moment resistant framed structure. In this work, we evaluate the instability of a typical G+12 stored framed structure using the analogous static approach specified by code IS 1893:2002 for moderate & unstable zone 3 exploitation in the commercial software package ETABS. In order to conduct this research, we used three distinct column materials (concrete, steel, and composite) in three distinct 3D space models of a conventional moment-resisting framed building. Important earthquake reaction metrics such storeyDrifts, bending moments, and storey overturning moments were included in the study, and the findings were compared using a standardized measurement system.

III. Problem statement

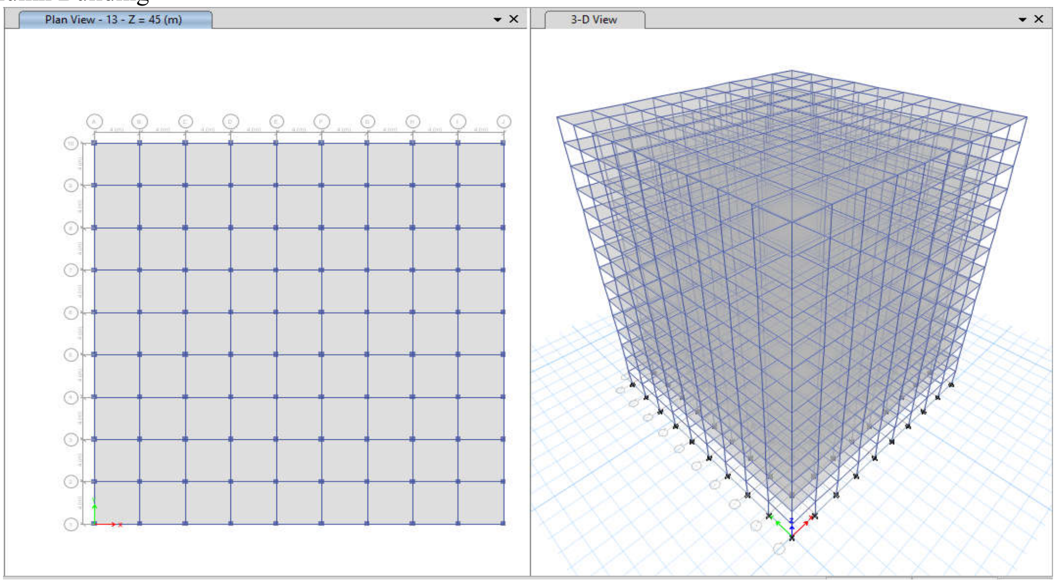
Basic parameters considered for the analysis are

1.	Grade of concrete	: M40
2.	Grade of Reinforcing steel	: HYSD Fe500
3.	Dimensions of beam	: 350mmX460mm
4.	Dimensions of column	: 460mmX460mm
5.	Thickness of slab	: 150mm
6.	Steel column	:ISMB450
7.	Composite column	:460mmX690 with angle section
8.	Height of bottom story	: 3m
9.	Height of Remaining story	: 3m
10.	Live load	: 3 KN/m^2
11.	Dead load	: 2 KN/m^2
12.	Density of concrete	: 25 KN/m^3
13.	Seismic Zone	: Zone III, Zone IV
14.	Site type	: II
15.	Importance factor	: 1.5
16.	Response reduction factor	: 5
17.	RCC design code	: IS 456:2000
18.	Steel design code	: IS 800: 2007
19.	Earth quake design code	: IS 1893 : 2016 (Part 1)

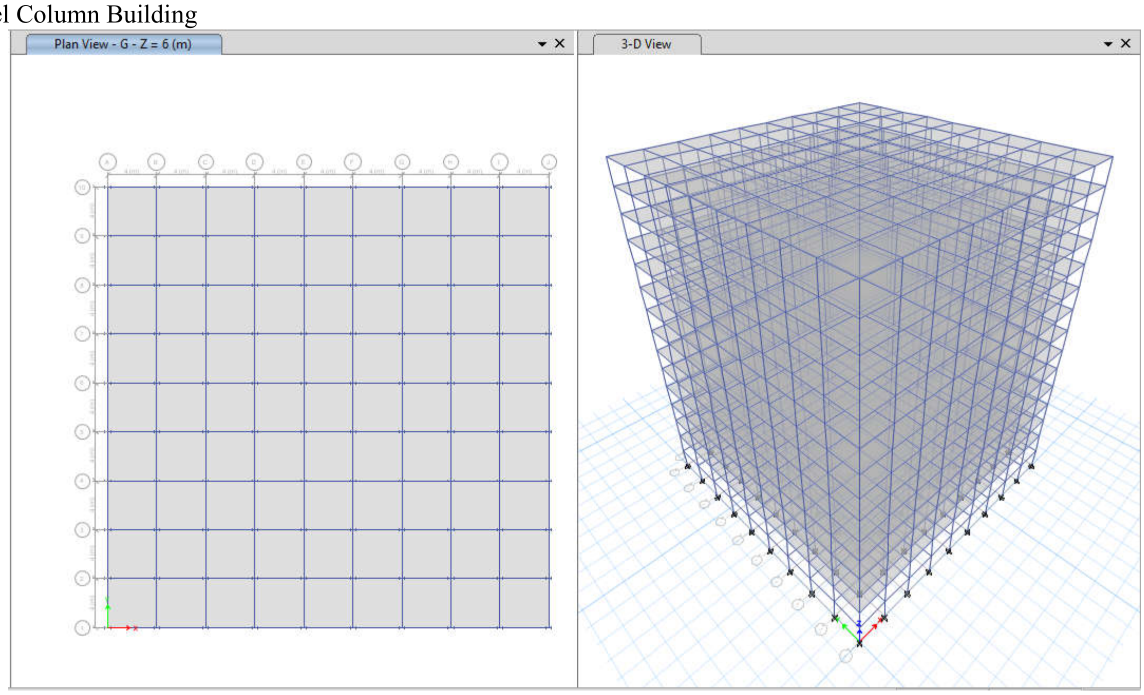
3.1 Models in ETABS

3.1.1 Regular building

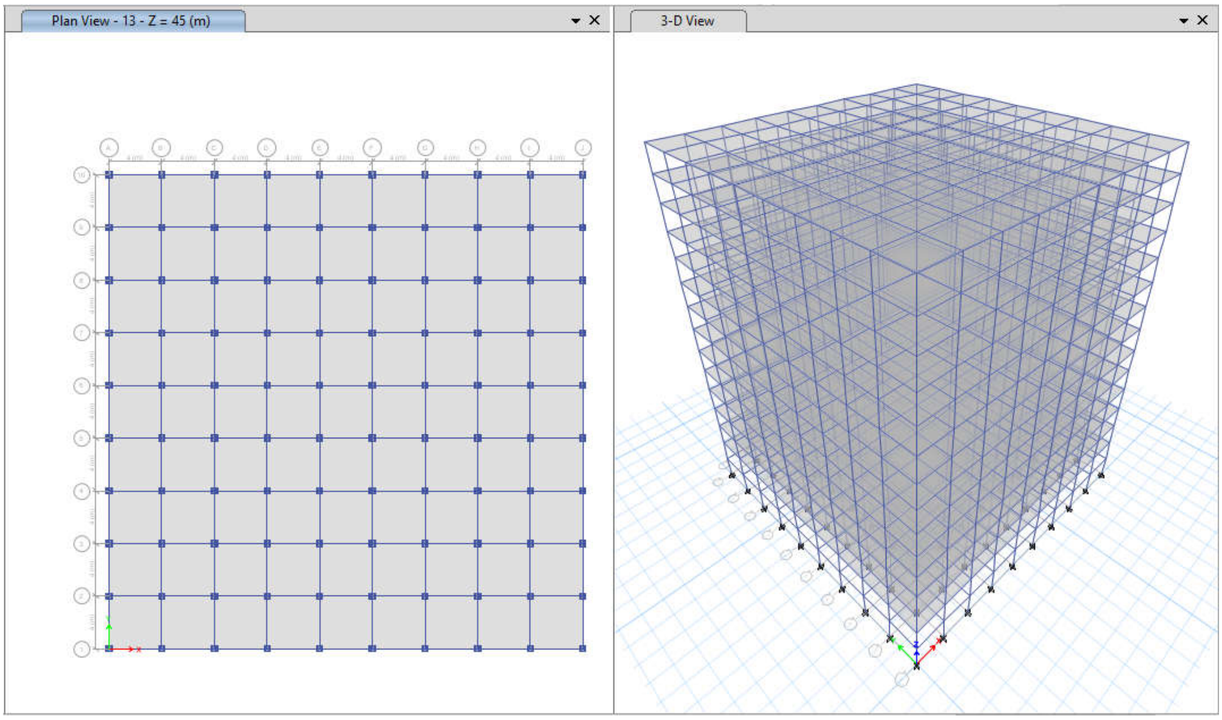
RCC Column Building



Steel Column Building

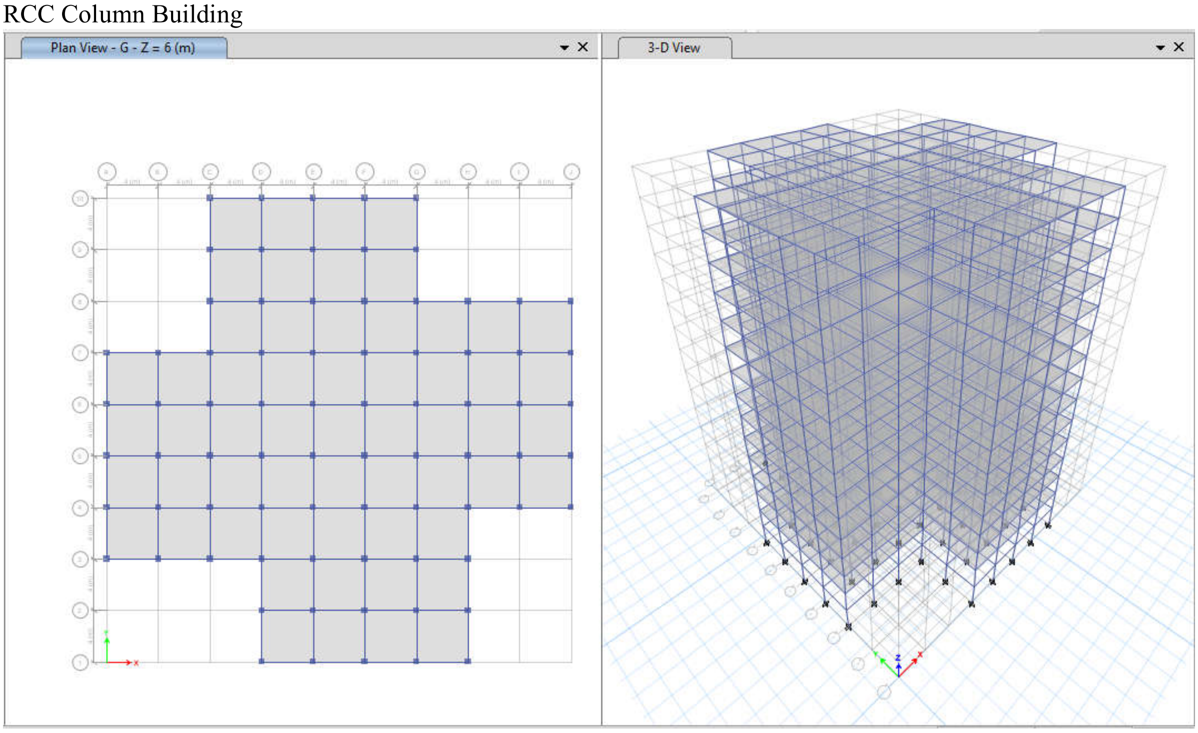


Composite column Building

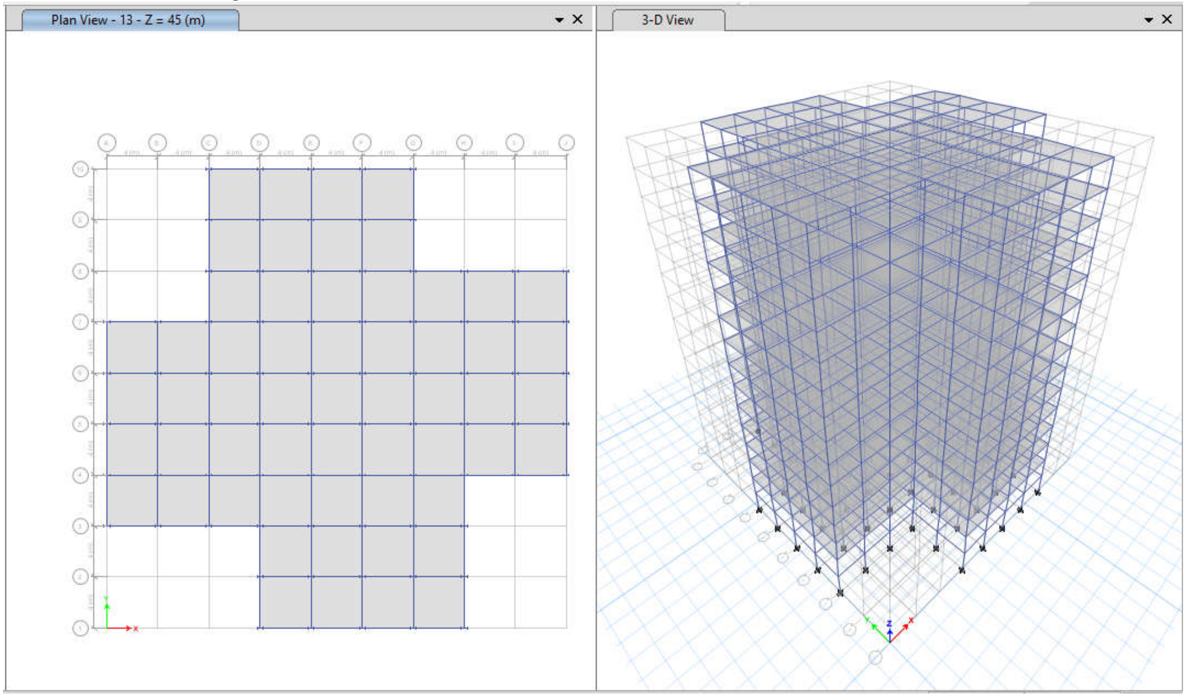


3.1.2 Irregular building

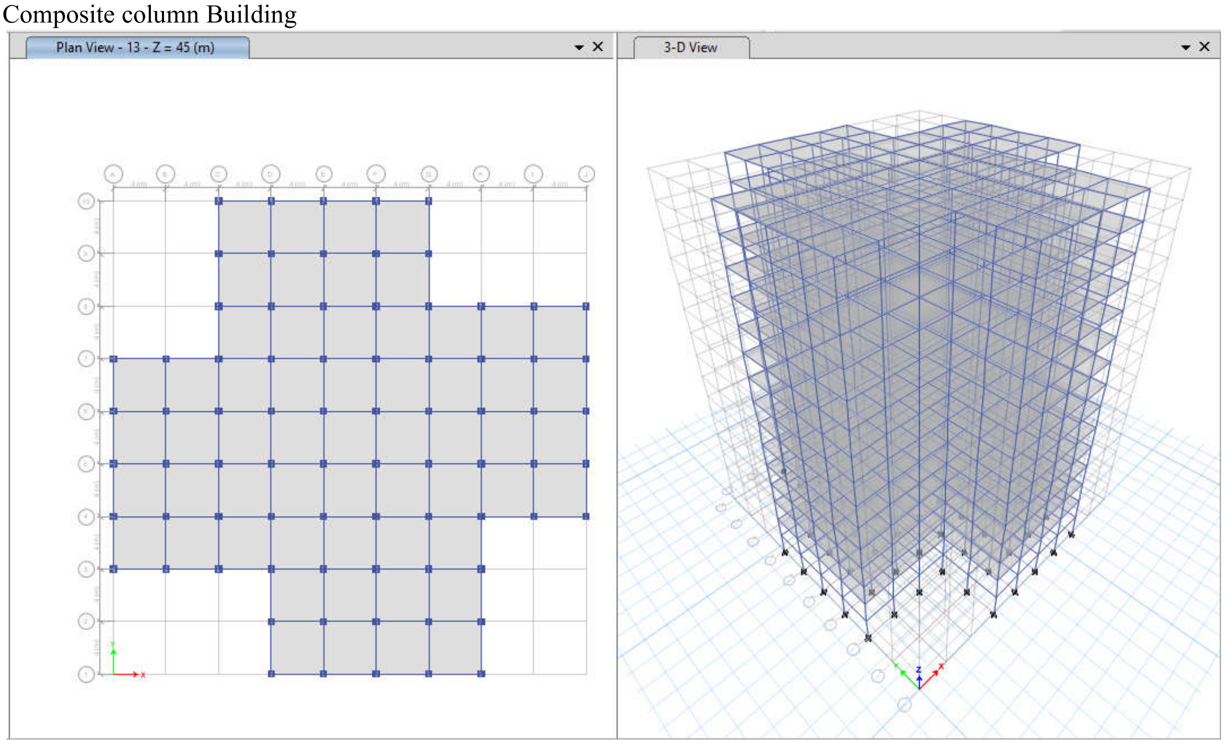
RCC Column Building



Steel Column Building



Composite column Building

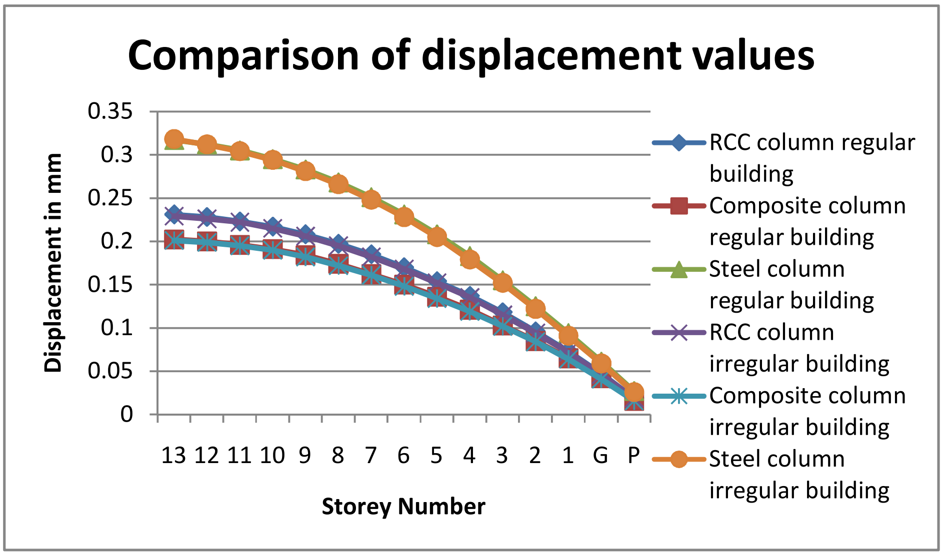


IV.RESULTS AND ANALYSIS

Zone III Results

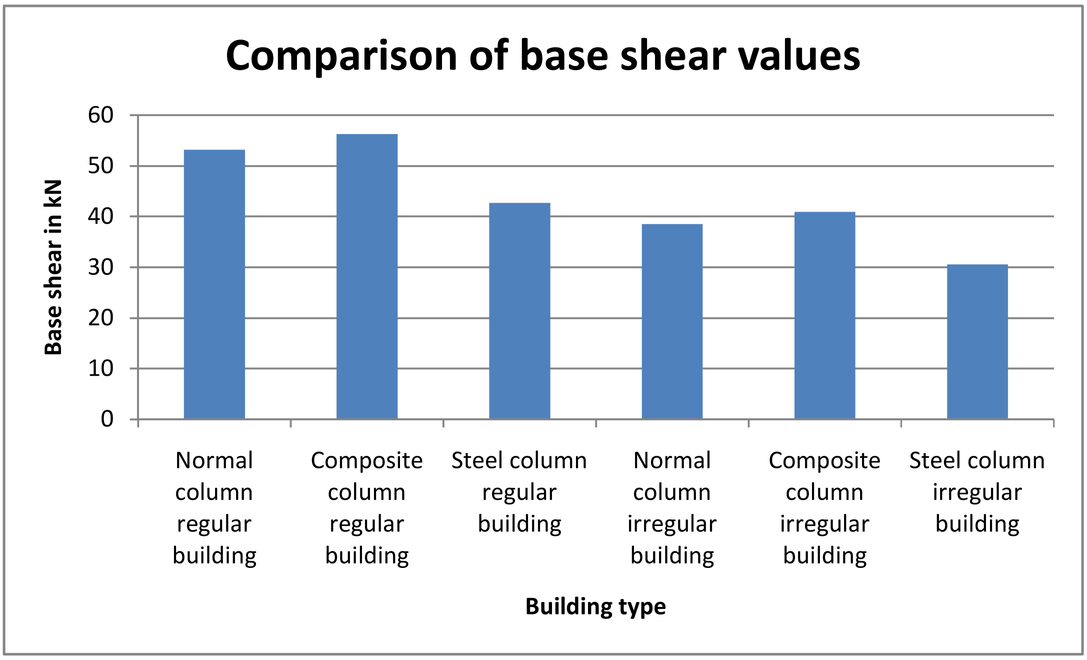
Displacement

Storey number	Regular building			Irregular building		
	RCC column	Composite column	Steel column	RCC column	Composite column	Steel column
13	0.231	0.202	0.317	0.229	0.201	0.318
12	0.228	0.2	0.312	0.226	0.199	0.312
11	0.223	0.196	0.305	0.222	0.195	0.304
10	0.217	0.191	0.295	0.215	0.19	0.294
9	0.208	0.184	0.283	0.206	0.182	0.281
8	0.197	0.174	0.268	0.195	0.172	0.266
7	0.185	0.162	0.251	0.182	0.161	0.248
6	0.17	0.15	0.231	0.168	0.148	0.228
5	0.154	0.136	0.208	0.152	0.134	0.205
4	0.137	0.121	0.183	0.135	0.119	0.179
3	0.118	0.103	0.155	0.115	0.102	0.152
2	0.096	0.085	0.125	0.094	0.084	0.122
1	0.073	0.065	0.094	0.072	0.064	0.091
G	0.047	0.042	0.061	0.046	0.041	0.059
P	0.019	0.016	0.027	0.019	0.016	0.026



Base shear

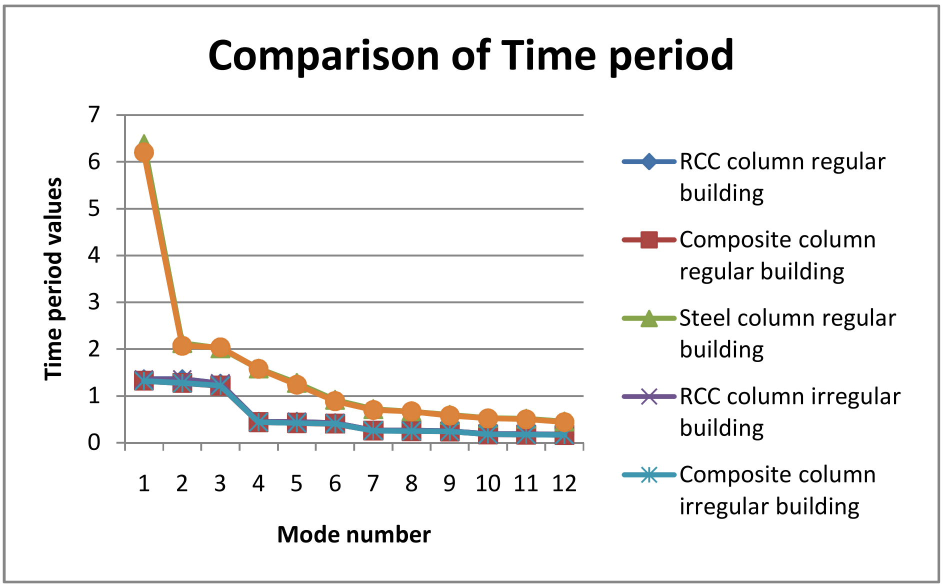
S. No	Regular building			Irregular building		
	RCC column	Composite column	Steel column	RCC column	Composite column	Steel column
1	53.1871	56.2752	42.6477	38.5426	40.9701	30.5425



Time period

Mode number	Regular building			Irregular building		
	RCC column	Composite column	Steel column	RCC column	Composite column	Steel column
1	1.354	1.318	6.377	1.348	1.312	6.199
2	1.354	1.274	2.125	1.348	1.269	2.065
3	1.26	1.212	2.011	1.261	1.215	2.035
4	0.446	0.434	1.581	0.444	0.432	1.576
5	0.446	0.419	1.272	0.444	0.417	1.236
6	0.416	0.4	0.912	0.415	0.4	0.886
7	0.26	0.254	0.714	0.257	0.251	0.694
8	0.26	0.244	0.664	0.257	0.242	0.666
9	0.245	0.234	0.591	0.242	0.233	0.574

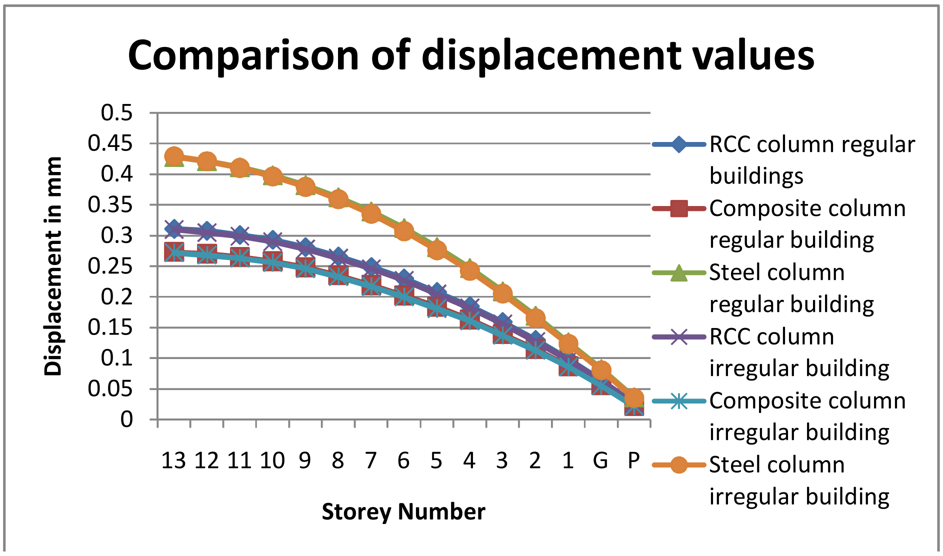
10	0.182	0.177	0.52	0.18	0.175	0.517
11	0.182	0.169	0.509	0.18	0.168	0.494
12	0.171	0.163	0.45	0.169	0.162	0.437



Zone IV Results

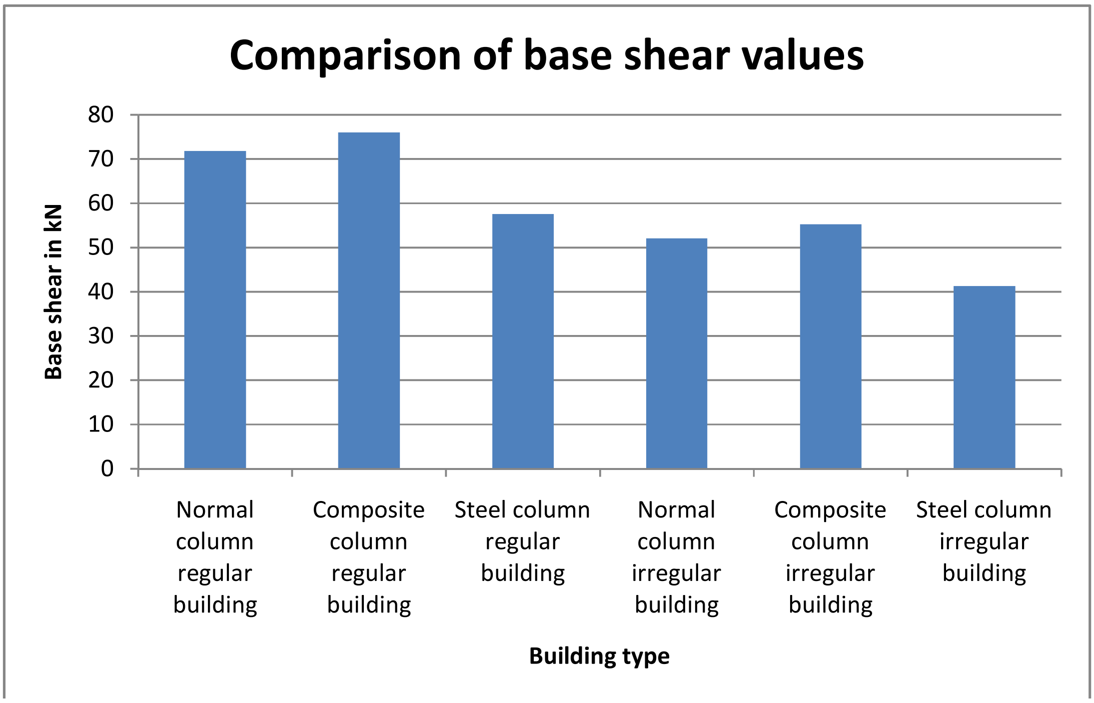
Displacement

Storey number	Regular building			Irregular building		
	RCC column	Composite column	Steel column	RCC column	Composite column	Steel column
13	0.311	0.273	0.428	0.31	0.272	0.429
12	0.308	0.27	0.421	0.305	0.268	0.421
11	0.301	0.265	0.411	0.299	0.263	0.41
10	0.293	0.258	0.398	0.29	0.256	0.396
9	0.281	0.248	0.382	0.278	0.246	0.379
8	0.266	0.235	0.362	0.263	0.233	0.359
7	0.249	0.219	0.339	0.246	0.217	0.335
6	0.23	0.202	0.312	0.227	0.2	0.307
5	0.208	0.184	0.281	0.205	0.181	0.276
4	0.185	0.163	0.247	0.182	0.161	0.242
3	0.159	0.139	0.209	0.156	0.137	0.205
2	0.13	0.115	0.169	0.127	0.113	0.165
1	0.099	0.087	0.126	0.097	0.086	0.123
G	0.064	0.056	0.082	0.063	0.055	0.08
P	0.026	0.022	0.036	0.026	0.022	0.035



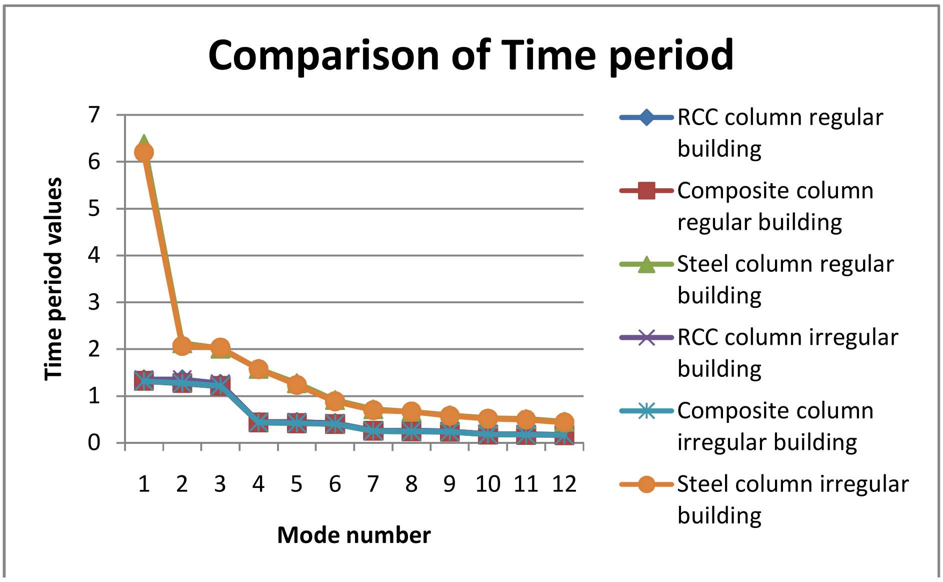
Base shear

S. No	Regular building			Irregular building		
	RCC column	Composite column	Steel column	RCC column	Composite column	Steel column
1	71.8026	75.9715	57.5743	52.0326	55.3096	41.2324



Time period

Mode number	Regular building			Irregular building		
	RCC column	Composite column	Steel column	RCC column	Composite column	Steel column
1	1.354	1.318	6.377	1.348	1.312	6.199
2	1.354	1.274	2.125	1.348	1.269	2.065
3	1.26	1.212	2.011	1.261	1.215	2.035
4	0.446	0.434	1.581	0.444	0.432	1.576
5	0.446	0.419	1.272	0.444	0.417	1.236
6	0.416	0.4	0.912	0.415	0.4	0.886
7	0.26	0.254	0.714	0.257	0.251	0.694
8	0.26	0.244	0.664	0.257	0.242	0.666
9	0.245	0.234	0.591	0.242	0.233	0.574
10	0.182	0.177	0.52	0.18	0.175	0.517
11	0.182	0.169	0.509	0.18	0.168	0.494
12	0.171	0.163	0.45	0.169	0.162	0.437



V.CONCLUSION

1. Time period of steel column building is more than that of composite column building.
2. Base shear of steel column building is 24% less than that of composite column building
3. The values of displacement in load case is observed as less values for the composite column building model in case of regular and irregular structures than other models (RCC Building and steel column Building). And the maximum values are obtained from steel column buildings.
4. The maximum values of Base shear is obtained for composite column regular building than the RCC column and steel column models in time history analysis case.
5. For the above points the steel column building has less values of Shear, Bending, and other factors than the RCC column building, Composite column building..
6. displacement Analysis is more for Steel frame as compared to Composite and RCC frames.
7. The weight of RCC frame is more than that of the steel, which causes the base shear to be greater for the RCC frame. The composite frame reduces base shear by 40%, while the steel frame reduces it by 45% compared to the RCC frame.

REFERENCES

1. IS 1893 (Part 1): (2002), "Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions and Buildings", Bureau of Indian Standards.
2. CSI Computers and Structures INC. "Introductory Tutorial for E-TABS: Linear and Nonlinear Static and Dynamic Analysis and Design of Three- Dimensional Structures" 2011
3. IS :11384-1985 Indian code for composite column
4. Shweta A. Wagh*, Dr. U. P. Waghe (2014) Comparative Study of R.C.C and Steel Concrete Composite Structures
5. Mr. Anil S. Savadi , Dr. Vinod Hosur (2019) COMPARATIVE STUDY OF RCC, STEEL AND COMPOSITE STRUCTURES FOR INDUSTRIAL BUILDING
6. Siddalingaprasad Y. B, B. S. Sureshchandra (2018) Comparative Analysis of Composite and Regular Column Buildings under Seismic Loads
7. ShanmugaPriya K, Karthick R, Chandrikka V(2019)REVIEW ON STEEL CONCRETE COMPOSITE COLUMN
8. Pardeshisameer, Prof. N. G. Gore et., al. (2016) Seismic AnalysisandComparative StudyofRegularandIrregular Building usingETABS

9. Mohammed sameem afzal1, mohdfirasath ali2, syedfarrukh anwar3, "comparasion of multi stored structure with Composite column and steel column by using etabs", international journal of management, technology and engineering Volume 8, issue xii, december/2018 Issnno : 2249-7455
10. Baldev D. Prajapati, D. R. Panchal et., al. (2013) STUDY OF SEISMIC AND WIND EFFECT ON MULTI STOREY R.C.C., STEEL AND COMPOSITE BUILDING
11. AbhayGuleria, "Structural Analysis of a Multi-Storeyed Building using ETABS for different Plan Configurations", International Journal of Engineering Research & Technology (IJERT)IJERTIJERTISSN: 2278-0181IJERTV3IS051552 www.ijert.org, Vol. 3 Issue 5, May – 2014
12. AnirudhGottala, KintaliSai Nanda Kishore et., al. (2015), "Comparative Study of Static and Dynamic Seismic Analysis of a Multistoried Building" IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 01 | July 2015.
13. Syed KhasimMutwalli, Dr. Shaik Kamal Mohammed Azam, "Dynamic Response of High Rise Structures Under The Influence of Shear Walls", Syed KhasimMutwalli Int. Journal of Engineering Research and Applications www.ijera.com ISSN : 2248-9622, Vol. 4, Issue 9(Version 6), September 2014, pp.87-96.
14. Dnyaneshkumar H. Lanjewar1, Prof. AmeyaKhedikar, "Seismic Analysis of Unsymmetrical RCC Structures" International Journal of Innovative Research in Science, Engineering and Technology *(An ISO 3297: 2007 Certified Organization)* Vol. 6, Special Issue 11, May 2017