SEISMIC ANALYSIS OF MULTI-STOREYED RCC AND COMPOSITE BUILDING

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Abstract: Composite Structure is quickly gaining acceptance in India's non-residential multi-story building sector. The reason for considering composite construction is simple: Steel is best in tension and concrete is best in compression. Combining these two materials strengthens their structural properties, which can be used to create a highly effective and lightweight design. Steel concrete composite building systems are formed by connecting the steel beams to the profiled deck slab using shear connectors so that they function as a single unit, and for columns steel section is encased in concrete. Comparing to RCC structures, steel concrete composite system are being more popular due to the various advantages they offer. Both speed and economy can be achieved in case of composite systems. An attempt was made in this work to evaluate and compare the seismic performance of G+ 25 storey's made of RCC and composite structures, ETABS 2018 software was used for the purpose. A total of six models were prepared, 3 models are RCC and 3 models are composite buildings. The buildings are located in seismic zone-V and soil is medium. Response spectrum method is used for analysis of RCC and Composite buildings. Comparative parameter includes storey displacement, base shear, storey drifts and time period. Composite building shows better performance compared to RCC.

1. INTRODUCTION

General: A building should have four main attributes, which are basically easy and regular layout, lateral strength, hardness and stiffness. As well as the layout of buildings with regular geometry in plan & elevation have suffered lesser damage over uneven layouts. A structure will be deliberated unorganized according to 1893-2002, if it is inconsistent and there is a discrepancy between geometry, mass or load-bearing elements. These irregularities can cause problems with the flow of force and the continuity of tension. Structural analysis is first anxious to find the nature of a building when it is targeted under different load & explosions. The balance of poor performance structure of buildings under severe seismic loading can be a major cause, disproportionate lateral growth, and increase in member forces and ultimately plays a significant role in building collapse. The project deals with seismic analysis & study of multi-storey symmetric building design. G + 25storey RCC symmetrical frame building and symmetrical composite building has been structurally analysed with help of Etabs software. These buildings are considered as multi-storey buildings. In this work, RSA of regular RC building results & composite building results are carried out.

BRACINGS: Earthquakes are a devastating natural hazard. Earthquakes are caused by the sudden temporary deformation or displacement of the earth as a result the elastic energy release in a matter of seconds. The impact of this incident can damage largely. Provide a wide range of livelihoods and essential services such as water supply, drainage systems, communications and electricity, transportation, etc. In Nation RC structures, reinforced concrete frames are used as part of earthquake-resistant systems designed to with stand earthquake resistance in buildings. Because of many displacement cycles caused by a powerful earthquake, joints of beams, columns, & beam columns in moment frames are proportionate & beneficial for resisting flexible, axial, & Shear functions. Required proportions and detail requirements result in a frame that can withstand with strong earthquake deformation s. the growth of the structure during the earthquake break is reduced. It works like restoring a structure. Based on this definition, the system shown in the following statistics can be considered as a bracing system. One of these systems maybe present inside the building. In this case, some systems are more efficient than others with horizontal loads, while others are ignored.

Kinds of Bracing:

1. Single diagonal racing
2. Cross diagonal bracing
3. K-bracing
4. V-bracing
5. X-bracing

Shear Wall:A shear wall is panel with sufficient structural integrity for resisting lateral forces. Forces acting perpendicular to the wall's plane include things like wind and earthquakes. Despite fact that shear walls are a great way to make multi-story buildings safer during earthquakes, damage is nevertheless common. The horizontal and vertical distribution of weight, stiffness, and strength in building significantly affect how it reacts to seismic motion. Shear walls are utilized in construction to mitigate destruction caused by earthquakes. One such use is enhancing a building's resistance to earthquakes. In tall buildings, it is especially crucial to maintain appropriate lateral stiffness to withstand lateral load, since structural safety during significant earthquakes is the primary issue of structural design for se for seismic loadings. Shear walls have shown to be a cost-effective and efficient way to increase a building's stiffness. The usage of shear walls is common in high-rise construction to prevent structural failure. Shear walls may be an effective lateral force resisting structure when placed in strategic locations inside building.

Types of Shear Wall: 1. Reinforced Concrete 2. Concrete Block 3. Steel 4. Plywood 5. Mid-Ply

2. LITERATURE REVIEW

2.1 General: The efficacy of RCC and composite structures is studied by the research papers. The following researcher's investigation gives the clear view of the performance of RCC and composite buildings with bracings.

2.2 Review:

2.2.1 Mahesh Suresh et.al: Analysis & designing of Multi-storey structure Utilising Composite Structure:

A shear wall is panel with sufficient structural integrity to resist lateral forces. Forces acting perpendicular to wall's plane include things like wind & earthquakes. Despite fact that shear walls are great way to make multi-story buildings safer in earthquakes, damage is nevertheless common. The horizontal & vertical distribution of weight, stiffness, & strength in building significantly affect how it reacts to seismic motion. Shear walls are utilized in construction to mitigate destruction caused by earthquakes. One such use is enhancing a building's resistance to earthquakes. In tall buildings, it's especially crucial to maintain appropriate lateral stiffness to withstand lateral load, since structural safety during significant earthquakes is the primary issue of structural design for se for seismic loadings. Shear walls have shown to be cost-effective and efficient way to increase a building's stiffness. The usage of shear walls is common in high-rise construction to prevent structural failure. Shear walls may be an effective lateral force resisting structure when placed in strategic locations inside building.

2.2.2 **Anish N. et.al: Comparison of RCC & Composite Multi-storeyed Buildings:**

This research does a comparative analysis of the costs and benefits of using steel-concrete composite vs RCC for constructing a 15-story office building in seismic zone G. When modeling an RCC or composite structure, we use the equivalent static technique & utilize the staad pro program. In terms of cost, composite buildings are preferable.

Following conclusion was drawn:

1. Since composite structures are lighter than R.C.C. structures, they need less expensive foundations.
2. When it comes to building tall buildings, composite materials are your best bet.
3. When compared to composite structures, R.C.C. ones have more Axial Force and Shear Force.

2.2.3 **Umesh P. Patil, Suryanarayana M: Utilizing Etabs, we perform a RSA & equivalent static analysis on G+15 RCC & composite structure with soft storey on the ground floor-2013**

Steel-concrete composite systems are gaining favor over traditional RCC buildings because of their many benefits. Composite systems are able to simultaneously improve speed and efficiency. This study aimed to examine and contrast the seismic resistance of RCC & composite buildings at G+15 levels. For this, we utilized ETABS 2013. Structures had been placed in location of earth quake zone III upon medium soil, & both concrete & steel composite structures & RCC structures had a soft storey at ground level. The study utilizes of the equivalent static & response spectrum approach. Considerations include store drift, self-weight, bending moment, & shear force. Composite constructions outperform RCC in this comparison.

2.2.4 **Tobin Nainan, et.al (2022): Evaluation of Composite Elements in Laterally Loaded Buildings:**

For a 10-story structure with lateral loading, this research compares and contrasts the performance of two types of composite columns: C.E.S. & CFST alongside the performance of traditional R.C.C. columns. To counteract lateral forces, we utilize shear walls and bracings. Symmetric & asymmetric loads are both modeled and analyzed using ETABS. Part

3 of I.S. 875 (2015) governs wind forces, whereas Part 1 of I.S. 1893 (2016) governs seismic analysis. Eurocode-4 specifies the design requirements for all composite columns. When comparing composite columns to R.C.C. columns, it is clear that the former have a longer period while the latter have a significantly smaller base shear. When exposed to lateral stresses.

2.2.5 **Mr. Roshan Onkar et.al: Design & Analysis of Composite Structure, Steel Structure, RCC Structure & Comparison:**
India has traditionally favored low-growth buildings, but its population is expanding quickly, necessitating construction of medium- & high-rise structures. The frame system, which makes use of reinforced concrete elements, is cheapest and most practical choice for low-rise buildings, but is no longer cost-effective for medium- & high-rise structures because of their hazardous shape, reduced rigidity, flight restrictions, & increased dead load. It's possible that a composite structure might work well here.

2.2.6 **Siddhant D. et.al: A Comparison of Steel-Concrete Composite and Reinforced Concrete Buildings Through Analytical and Design Procedures:**
The use of Composite Structure for commercial high-rises in India is becoming more common. Composite building is being considered for one simple reason: steel excels under tension while concrete shines under compression. When employed together, these materials enhance one other's structural qualities, allowing for the development of a highly efficient and lightweight structure. This project uses the comparable Static Method of Analysis to compare a G+15 R.C.C to composite multi-story commercial structure in Earthquake Zone IV. We model the building and its systems using ETABS 2018 software. After comparing the outcomes, it becomes clear that the Composite structure is the clear winner.

2.2.7 **R.Aparna Shetty , R.Master Praveen Kumar(2018): Composite Column Analysis Utilizing Etabs for Lateral Load Systems:**
This study aims to investigate seismic behavior of high-rise buildings that use composite columns, as well as buildings that use shear walls and composite columns, and also those that use bracings and composite columns. These results are based on an evaluation of the equivalent static approach of research for zones III and V in 3 soils utilising ETABS.

2.2.8 **Prof. Swapnil B. Cholekar, Basavalingappa S. M: Mass Irregularity and the Performance of Multi-Story RCC and Composite Buildings:**
In order to maximize the benefits of steel and concrete and to create efficient and cost-effective buildings, steel-concrete composite construction has replaced R.C.C. The use of composites in building is rising quickly, making earthquake-resistant architecture more important than ever. Buildings with an irregular layout are more vulnerable to earthquake damage since their designers neglected to account for this feature. This research compares R.C.C. and Composite buildings of nine stories, taking into account impact of mass irregularity on these buildings. Using SAP 2000, we do an equivalent static & RSA of structure in accordance with IS 1893(Part 1):2002. It's important to think about mass irregularity at the second or third level. The results of the research indicate that Composite constructions with mass irregularity will fare over R.C.C.

2.2.9 **Nitish A. Mohite (2015): “Comparative Analysis of Building" RCC & Steel-Concrete-Composite (B+G+11Storey):**
This paper employs a straightforward technique using a composite slab, a beam, and some software written in CP 2000.The document explains how to design composite slabs, beams,

and columns, as well as pre- and post-processing techniques. There are a lot of tools to assist you develop models quicker and more precisely, and SAP 2000 is a restricted structural program for the study of sophisticated analytics approaches for completing exceedingly difficult tasks. Using SAP 2000's section designer, we investigated composite columns, beams, and slabs.

2.2.10 **Athira K B, Linda Ann Mathew: Analyzing the Differences between R.C.C. & Composite Columns in GFRG Infilled G+15 Stories:**
Composites have found widespread acceptance and application in building. Composite buildings are superior than R.C.C. ones in terms of seismic resistance because of their less seismic weight. The composite structure combines the superior qualities of steel and concrete. Aim was to analyse seismic efficacy of a G+15-story structure in seismic zone V using R.C.C columns, composite columns, and GFRG infill, respectively. We have decided to analyze both completely concrete-encased composite columns and partly concrete-encased composite columns. Only the columns will be composite, while the rest of the building will use regular concrete. For modeling purposes, GFRG infill is similar to a single strut model. Response Spectrum analysis using ETABS software assesses the seismic behavior of the study frames.

3. OBJECTIVES OF THE STUDY

3.1 OBJECTIVES:

1. For studying seismic behaviour of RCC multi-storey building and Composite Building.
2. For studying effect of providing single diagonal encased forward -bracings in RC framed building and Composite building
3. For studying impact of providing shear wall in RC framed building & Composite building.
4. Displacement, drift, base shear, and time period comparison between RCC and Composite Building Seismic Behavior.

3.2 SCOPE OF PRESENT STUDY:

The goal of the research is to learn how to maximize seismic quality and building firmness with the use of a single diagonal enclosed forward-bracing, damper, and shear wall system.. For RCC and composite buildings single diagonal encased forward -bracings, shear wall system is used individually to resist seismic forces. The main aim is to find out behaviour of RCC and composite structure having addition of single diagonal encased forward –bracings, shear wall.

4. METHODOLOGY

This study used a composite building model and a multi-story reinforced concrete structure to examine the impact of chaotic planning. The primary emphasis of the study is an investigation of a 26-story, R.C.C. standard multi-story skyscraper (G + 25). In order to analyze RCC and composite construction, we shall use ETABS. Post-structure comparisons included things like maximum narrative displacement, base share, tale drift, and Time duration.
Here, we investigate the performance of a G+25 structure with R.C.C columns, composite columns, and both completely and partly concrete-encased steel sections. The specified floor height is 3.3m. We construct three RCC models and three composite models. ETABS was

used to produce the 3D models of the buildings. In this investigation, we focus on soil type - II in seismic zone 5. To find out how much of a base may be displaced, an analysis is performed. Then, we have a graphical representation of the data from which we may extrapolate the essential information.

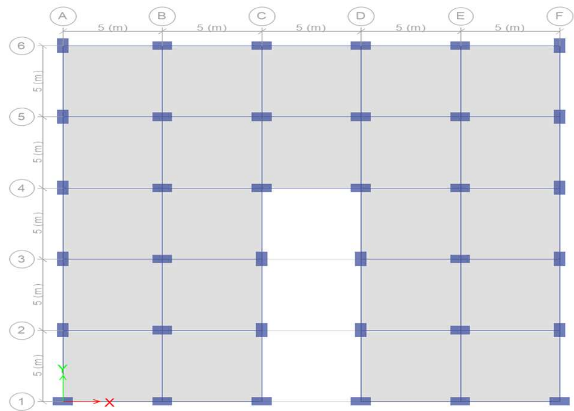


Fig 1.Floor Plan of the Structure

4.1 ANALYTICAL MODELLING:

- This research aims to examine the effects of earthquakes on reinforced concrete (RC) frames and composite buildings reinforced with bracing & shear walls.
- To analyze a G+25 RC framed building, we use Etabs.
- Various building types undergo lateral load analysis.
- For this study, we are using a sample of medium soil.
- Zone-V is where the analysis happens.
- Parameters such as lateral displacements, base shear, Time period, and inter-storey drifts are recorded after analysis of various models in Etabs software.
- Finally, we compare outcomes between models.

4.2 Description of Models:

Total 06 models were prepared for seismic study of RC framed building and composite building.

1. Model-01: A RC Multi-storeyed building of G+ 25 storeys.
2. Model-02: A RC Multi-storeyed building of G+ 25 with bracing.
3. Model-03: A RC Multi-storeyed building of G+ 25 with shear wall.
4. Model-04: A Composite building of G+ 25 storey.
5. Model-05: A Composite building of G+ 25 storey with bracing.
6. Model-06: A Composite building of G+ 25 storeys with shear wall.

Modelling different models in Etabs

1. Model-01: A RC Multi-storeyed building of G+ 25 storeys

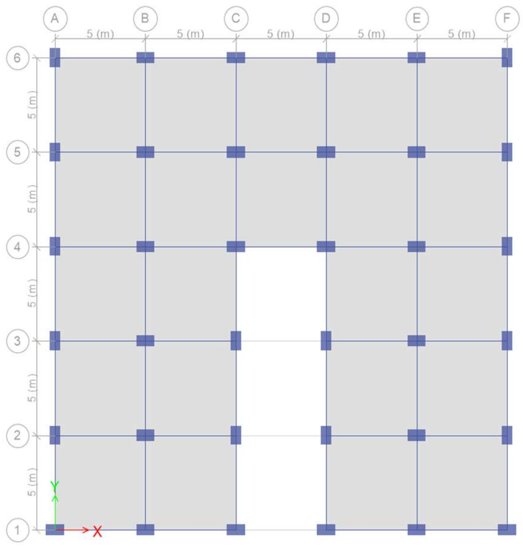


Fig-1: Plan of Model-1

Model-02: A RC Multi-storeyed of G+ 25 with bracing.

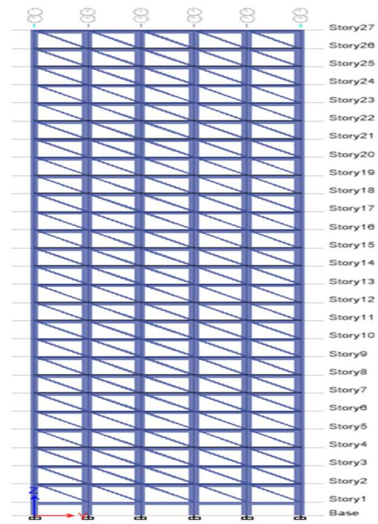
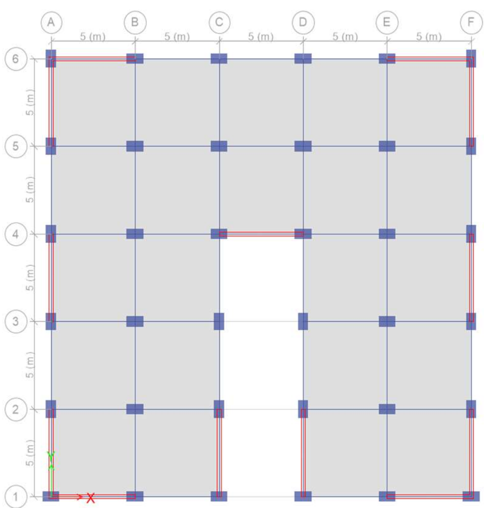


Fig-2: Elevation of Model-2

3. Model-03: A RC Multi-storeyed building of G+ 25 with shear wall.



4.3 Details of Structures:

	RCC Building	Composite Building
No of Storey	26 (G+25)	26 (G+25)
Grade of concrete	M30	M30
Grade of Steel	Fe500	Fe500
Storey height	3.6m	3.6m
Beam size	300mmx600mm	B1-ISWB600-1
Column size	600mmx1000mm	C1-400x800mm Encased With–ISWB600-1
Slab thickness	150mm	Deck slab with concrete 100mm
Wall thickness	230mm	230mm
Shear wall thickness	230mm	230mm
Density of Brick masonry	20 KN/m^3	20 KN/m^3
Live load	3 KN/m^2	3 KN/m^2
Floor Finish	$1KN/m^2$	$1KN/m^2$
Building Type	SMRF	SMRF
Soil type	Medium	Medium
Seismic zone	5	5
Importance factor	1.0	1.0

5. METHODS OF SEISMIC ANALYSIS

5.1 General: During a seismic study, engineers measure the components of a building to determine how much force and deformation they can withstand. Linear processes include static analysis & RSA, whereas NLSPA & NLTHA.

1. Equivalent static analysis
2. Response spectrum analysis
3. Push over analysis
4. Time history analysis

5.2 LINEAR STATIC ANALYSIS (Equivalent Static Method):

When it comes to doing an earthquake analysis, this is perhaps the easiest process available to a structural engineer. Widely utilized, particularly for buildings and other common structures fulfilling specific regularity standards, it is required in any applicable code for earthquake analysis. Due to the assumption that earthquake impacts are similar to those coming from statically transverse loadings, this technique is also known as the "Lateral Forces Method." It is reasonable to suppose that with an appropriate set of inertia forces one may reach a satisfactory approximation for the response if the structural reaction is not significantly affected by aid from higher mode of vibrations. Essentially, this is what the "Equivalent Static Method" is all about.

5.3 LINEAR DYNAMIC ANALYSIS (Response Spectrum Analysis):

With the development of software for computers, the acceleration of technological progress, and the proliferation of typographic research, more reliable resources for architectural planning have become available. If you're looking for a reliable technique for structural analysis, go no further than linear dynamic analysis, often regarded as the gold standard.

When the linear dynamic analysis is used, an inelastic response experiment is planned. Engineers often use elastic-dynamic analysis because of its ease of use and familiarity. While each mode exhibits a unique deformation pattern, in a multi-story building it is crucial to enlist the aid of many.

5.4 PUSHOVER ANALYSIS:

For this approximation, we apply lateral pressures to the structure that increase monotonically with height, until we achieve the desired displacement, a technique known as pushover analysis. In order to get the worldwide capacity curve, we plot the roof displacement vs the base shear. There are two types of pushover analysis: force-controlled and displacement-controlled. The force-controlled pushover process applies the whole load combination as requested, hence it is ideal for situations when the load is known (such as gravity loading). Since the evolution of mechanisms and P-delta effects may cause target displacement to be linked with a very tiny positive or even a negative lateral stiffness, various numerical issues arise in the force-controlled push over technique that impair the accuracy of findings.

Due to its conceptual and computational simplicity, pushover analysis has been the technique of choice by the main rehabilitation standards and codes for evaluating the seismic performance of buildings. By doing a pushover study, one may track the onset and development of yielding and failure at the level of individual members and the whole structure.

5.5 TIME HISTORY ANALYSIS:

In order to determine the true reaction of a building, time history analysis methods must solve multi-degree-of-freedom equations of motion step by step in the time domain. As far as structural engineers are concerned, this is the pinnacle of analytical sophistication. The answer depends directly on the seismic ground motion chosen for a given structure. Instead of being used as a means of allocating lateral pressures, this analytical approach is often used to verify the validity of assumptions established during the design of crucial structures.

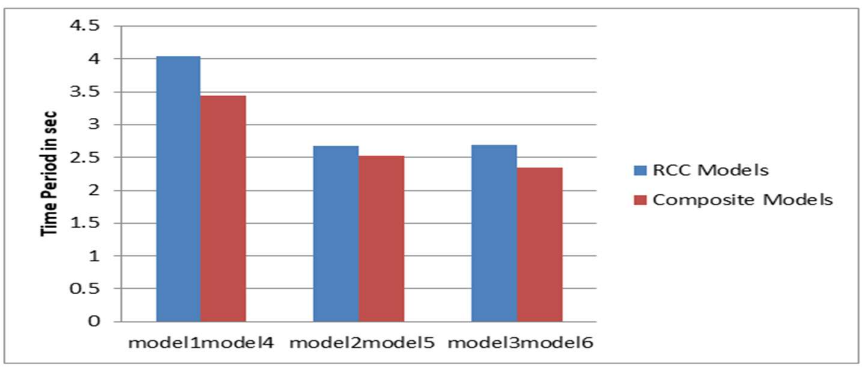
6. RESULTS AND DISCUSSION

6.1 GENERAL: Three different building models undergo earthquake analysis with use of applied loads. ETABs 2020 is used to do analysis upon all various building models. In this section, we provide a summary of findings of our analyses, including displacements, storey drifts, & base shear for all of models we used.

6.2 Time Period: It's defined as amount of time required to complete one full cycle of vibration in order to advance a certain distance.

Table 6.2.1: Time period of all models

Model	Time Period in sec	
Model-1	4.038	RCC Models
Model-2	2.673	
Model-3	2.685	
Model-4	3.444	Composite Models
Model-5	2.53	
Model-6	2.34	



Graph 6.1: Time Period in sec of various models due to Response spectrum method.

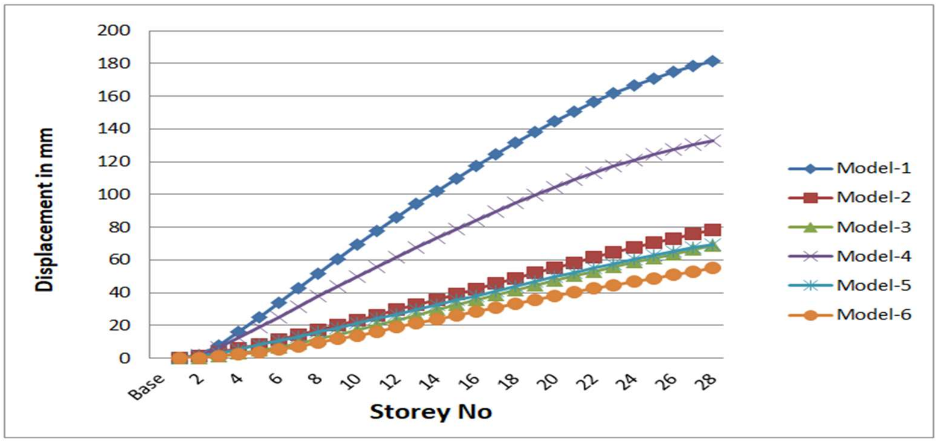
From graph, we can see as time period for model-1 is 4.038 seconds, that it drops by 33.08% when we switch to model-2, and that it lowers by 33.50% when we switch to model-3, all relative to model-1 for RCC models.

Now in composite models the time period is maximum in model-4 i.e 3.444 seconds. The time required to complete a project lowers by 26.53% when going from Model 4 to Model 5 with bracing and by 32.05% when going from Model 4 to Model 6 with a shear wall.

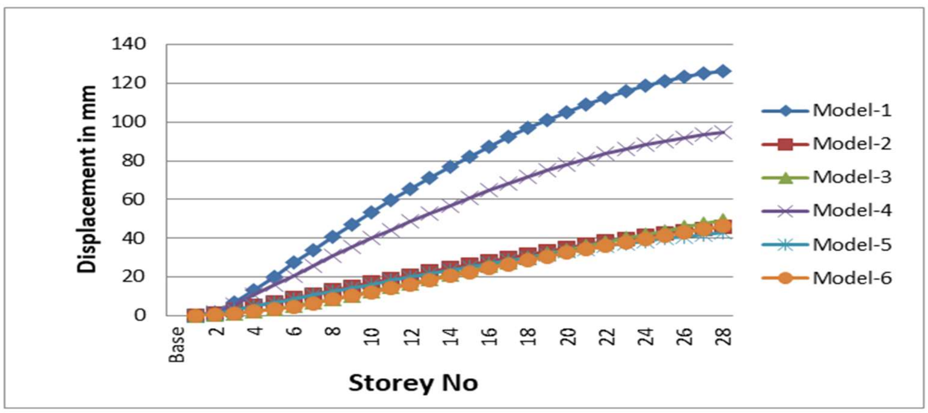
6.3 Displacement: The performance of the models under the application of lateral loads is studied to understand the effect of seismic loads. The displacements for each model which are likely to occur due to various lateral loads are obtained and tabulated.

As per the Indian standards the maximum allowable displacement in any multi-storey building is hs/500,

Where hs =height of building.
For the models used in the investigation the maximum allowable displacement
= 88.30/500 =0.1766 m=176.6mm

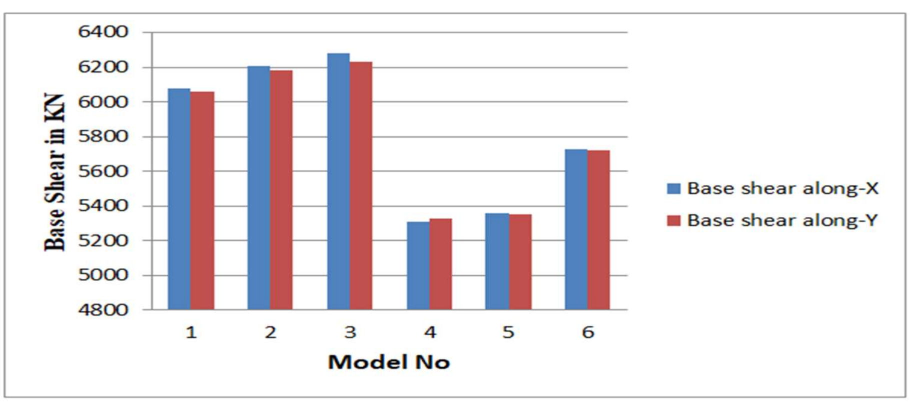


Graph 6.2: Displacement in mm of various models due to Response spectrum method along X-direction.



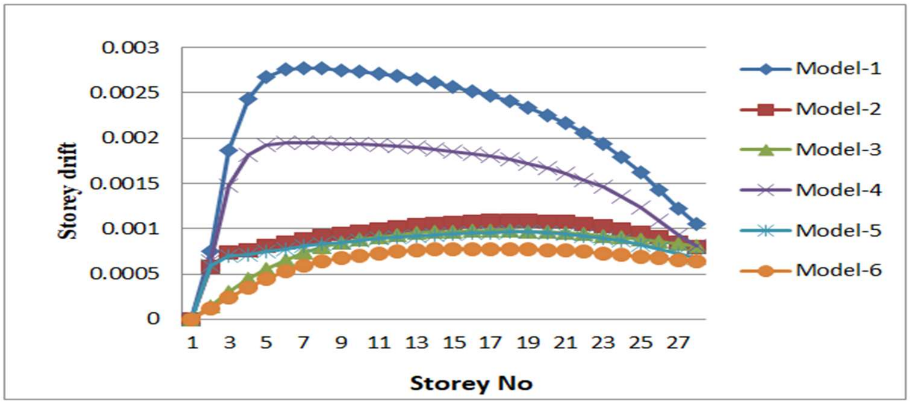
Graph 6.3: Displacement in mm of various models due to Response Spectrum method along Y-direction.

6.4 Base Shear: It's a prediction of greatest lateral pressures that will develop at foundation of building as result of seismic floor movement.

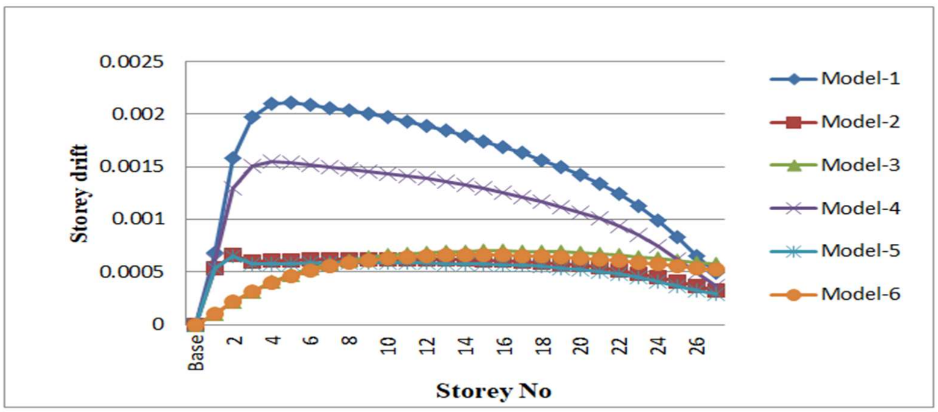


Graph 6.4: Base shear of various models due to Response spectrum method along X and Y-direction

6.5 Storey Drift: Quantitative relationship between heights of two succeeding levels & amount of movement between them is described.



Graph 6.5: Storey Drift of various models due to Response spectrum method along X-direction

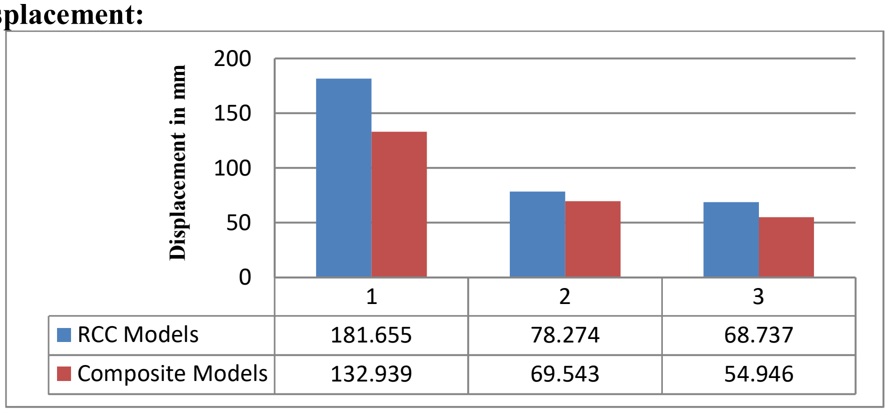


Graph 6.6: Storey Drift of various models due to Response spectrum method along Y-direction

7. COMPARISON

Comparison between RCC and Composite models.

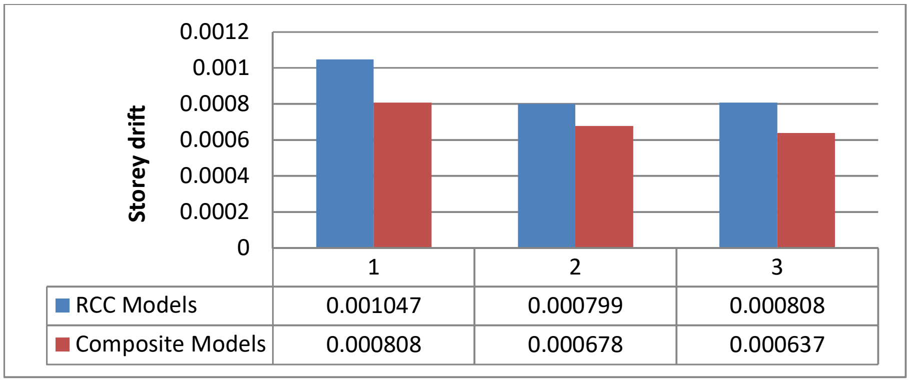
7.1 Displacement:



	1	2	3
RCC Models	181.655	78.274	68.737
Composite Models	132.939	69.543	54.946

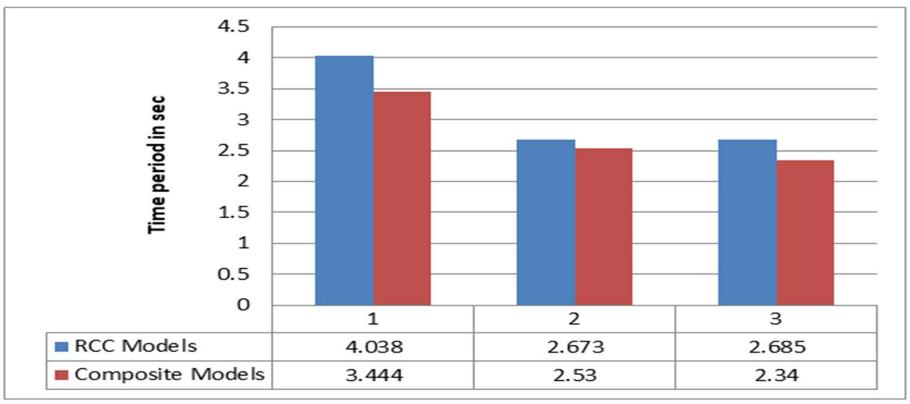
Graph 6.7: Comparison of maximum displacements of all models along X- direction

7.2 Storey drifts:



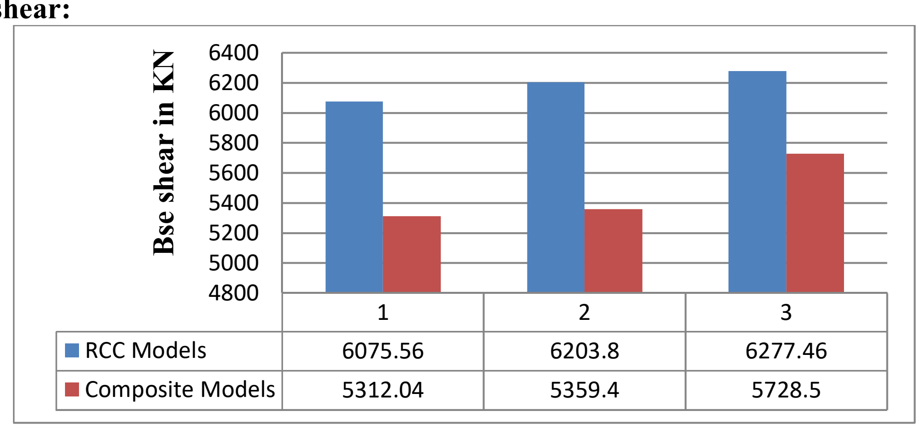
Graph 6.8: Comparison of maximum drift of all models along X- direction

7.3 Time period:



Graph 6.9: Comparison of time period of all models

7.4 Base shear:



Graph 6.10: Comparison of base shear of all models along X- direction

8. OBSERVATION AND CONCLUSION

8.1 Observations:

1. It's noticed as time period for RCC model is highest comparing with composite model.
2. It's noticed as displacement for RCC model is more compared to composite model.
3. It's noticed as RCC model with respect to bracing and shear wall the displacement is decreases with respect to bare frame model.
4. It's noticed as storey drift for RCC model is more compared to composite model.
5. It's noticed as base shear for composite model is lesser comparing with RCC model.
6. It's noticed as RCC or Composite models as the bracing and shear wall is added the base shear is increases because of increase in weight of building.

8.2 Conclusion:

- Because composite constructions are stiffer than RCC, they are better at preventing storey drift.
- Storey drift is within the allowable limit of 0.004 times the storey height in both RCC and composite constructions.
- Because the column sections have varying moments of inertia, storey drift in the X and Y directions is distinct.
- Composite structures, in general, have a better reaction than reinforced concrete ones, meaning they cause less displacement.
- Composite structures have a lower self-weight than their RCC counterparts.
- Composite structures experience less displacement than reinforced concrete ones.
- Composite buildings have superior overall responsiveness than reinforced concrete (RCC) buildings.
- Faster construction times and greater durability make composite constructions ideal for tall buildings.
- Composite's lower base shear compares well to that of RCC.

8.3: Scope for further study:

1. The present work is carried out on seismic forces further it may extend on wind forces.
2. The present work is carried out on response spectrum method. Further the work may carry out by considering push over analysis method and time history method.
3. The present work may be able to extend for vertical irregularity.
4. The present work is carried out with bracing and shear wall further it may extend with addition of dampers.

REFERENCES

1. **Tobin Nainan, Snehal V. Mevada, Sumant B. Patel, Abhay Gupta:** Performance of Building with Composite Structural Elements Subjected to Lateral Loads SSRG International Journal of Civil Engineering Volume 9 Issue 6, 1-14, June 2022.
2. **Umesh P. Patil, Suryanarayana M:** Analysis of G+15 RCC and Composite Structure having a Soft Storey at Ground Level by Response Spectrum and Equivalent Static Methods Using Etabs 2013 International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 03 | June-2015.
3. **Siddhant D. Shirsath, Dr. V. R. Rathi:** Analysis and Design of Steel Concrete Composite Structure and Its Comparison with RCC Structure, International Journal

for Research in Applied Science & Engineering Technology (IJRASET), Volume 10 Issue VI June 2022.

4. **Mahesh Suresh Kumawat and L G Kalurkar:** Analysis and design of Multi-storey Building Using Composite Structure, international journal of structural and civil engineering research Vol. 3, No. 2, May 2014.
5. **Mr. Roshan Onkar Gathekar and Prof. Hemant B Dahake:** Design and Analysis of Composite Structure, Steel Structure, RCC Structure & Comparison, International Journal of Advanced Research in Science, Communication and Technology (IJARSCT) Volume 2, Issue 1, July 2022.
6. **R.Aparna Shetty , R.Master Praveen Kumar(2018):** Analysis of Composite Column Building with Lateral Load Resisting Systems using Etabs, International Journal of Innovative Research in Science, Engineering and Technology.
7. **Nitish A. Mohite (2015): "**Comparative Analysis of Building" RCC and Steel-Concrete-Composite (B+G+11Storey), International Journal of Scientific and Research Publications, Volume 5, Issue 10, October 2015.
8. **Prof. Swapnil B. Cholekar, Basavalingappa S. M:** Comparative Analysis of Multi-storeyed RCC and composite building due to mass Irregularity, International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 04 | July-2015
9. **Athira K B, Linda Ann Mathew:** Contrast of Seismic Behaviour of R.C.C. and Composite Columns in G+15 Storied Buildings with GFRG Infill, International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 06, June – 2017.
10. **Anish N.Shah, Dr.P.S.Pajgade:** Comparison of R.C.C. and Composite Multi-storeyed Buildings, International Journal of Engineering Research and Applications (IJERA) Vol. 3, Issue 2, March -April 2013.