

# COMPARATIVE PUSHOVER ANALYSIS OF RCC AND COMPOSITE HIGH RISE BUILDING FRAME (G+15) BY USING ETABS

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**Abstract:** Reinforced concrete is the material of choice for the majority of building constructions. This choice is based on a number of factors, including the accessibility of the necessary components, the expertise of the builders, and the practicality of the design rules. Due to its dangerous formwork and high dead load, R.C.C. is no longer cost-effective. On the other hand, composite construction is an innovative idea in the building sector. It may be economically prohibitive to wait the building of each level while concrete columns are cast due to the usage of new composite techniques that enable the assembly of multi-story structural frames to continue at speed. Composite beam-columns have been widely employed for building in Japan due to their excellent earthquake resistant qualities, which have been known for a long time. In order to promote the adoption of this effective mixed-use building method, it was vital to establish seismic design requirements for commonly used structural systems in India. This project presents a comparison of several construction characteristics. This research examines the use of bracings and infill walls to mitigate the effects of seismic loading.

With the use of RCC and composite columns, ETABS was used to study a G+15 residential multi-story building's response spectrum, equivalent static technique, and push-over analysis. A total of twenty-four models are tested in a range of seismic zones and soil types. Values for variables such as base shear, time period, frequency, storey bending, and storey torsion are among the outcomes that are evaluated for these twenty-four models.

**Keywords:** Response spectrum analysis, ETABS, RCC column, Composite column, storey drift, storey shear

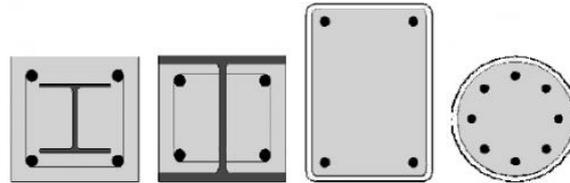
## I. INTRODUCTION

Engineers specialising in building structures often do not think about fire as a potential burden. This is different from other loads that need to be taken into account. Modelling, risk analysis, and structural stiffness modifications are the backbone of seismic design. Extra structural components and wind tunnel testing are essential in wind design. Simple, one-element testing and the addition of insulating material to the frame are the foundation of fire design. It is not common practice to compute or plan for thermally generated forces.

It is impossible to completely prevent natural catastrophes, and they will always happen. Disasters such as floods, cyclones, earthquakes, and volcanic eruptions have plagued human civilisation from its inception. These events have disrupted daily life, wreaked havoc on property and lives, and halted progress on multiple occasions. The development of early warning systems, innovative preventative measures, relief and rescue procedures, and other technologically advanced responses to natural disasters are examples of man's efforts to counteract catastrophic events. Regrettably, this does not hold true for every natural catastrophe. One kind of natural catastrophe associated with ongoing tectonic processes is the earthquake, which may strike at any moment and inflict significant damage and casualties. As a result, there is a pressing need for a worldwide plan to lessen the impact of earthquakes. Existing structures are subject to increased base shear demand as a result of periodic revisions to hazard maps that indicate seismic zones in seismic code. Construction engineering deals with the development of residential buildings. A simple building is an enclosed space with walls, a roof, food, and materials to meet the basic needs of its occupants. In the prehistoric era, people lived in caves, on top of or beneath bushes, to protect themselves from the elements. Because time passed and humans began to live in shacks built from branches. Wonderful new homes are being built on top of the old shelters of these people. People who are wealthy tend to live in mansions.

### Composite Columns

As you can see in the graphic below, composite columns may have many different shapes. Their allure stems from the fact that they, like other composite parts, take use of the advantages that steel and concrete have to offer. This may maximise the amount of usable floor space by creating a high resistance with a relatively small cross-sectional area. In the presence of fire, they function very well as well.



Typical composite column cross sections

British Standard 1994-1-1 specifies the requirements for the design of composite columns used in structural frames. Composite columns may have been underutilised up until now, but this is the first time the UK has ever had guidelines laid out in a code. Both completely and "partially encased" (web infill only) composite H sections, as well as hollow sections filled with concrete, have their own set of rules. The images show the typical cross sections. The British public does not often see composite columns that need formwork during construction as a cost-effective option.

Compression members with a concrete-filled hollow section utilise less material and don't need formwork compared to an equal H section. The bare steel section's compression resistance is greatly enhanced by concrete filling, which prevents local buckling and distributes the load more evenly. The improvement in fire resistance might be just as important, particularly if it allows the column to remain partially or completely exposed. Because of its ability to absorb and store latent heat of evaporation, infill concrete is able to considerably reduce the rate at which surface temperatures increase.

### Bracing systems

Structures that are vulnerable to lateral stresses, such as wind or seismic pressure, often use a braced frame as a structural solution. Typically, structural steel—which can be used efficiently in both tension and compression—makes up the members of a braced frame.

Vertical loads are supported by the frame's beams and columns, while lateral loads are taken up by the bracing system. On the other hand, bracing may be a pain to position since they mess with the façade's design and opening placement. In reaction, bracing has become a ubiquitous interior and exterior architectural element of high-tech and post-modernist buildings.

### Infill wall

A building's infill wall is the structurally sound wall that surrounds the outside of a three-dimensional framework construction, which is often composed of reinforced concrete or steel. Thus, the bearing function is guaranteed by the structural frame, while the infill wall fills in the outer frames' boxes and separates the inner and exterior spaces. The unique static purpose of the infill wall is to support its own weight. An exterior vertical opaque closure type is the infill wall. A load bearing wall and a non-load bearing partition that separates two interior areas are two types of walls that are different from infill walls. The second one is just like the infill wall in terms of hydrothermal and acoustical performance, but it also has static properties.

Masonry infill walls, and veneer walls to a lesser degree, are prevalent in many nations, particularly in reinforced concrete frame constructions. Actually, a long-lasting and cost-effective option is to build brick infill walls. They have a highly efficient cost-performance ratio, are aesthetically pleasing, and are simple to construct.

These days, clay units are still the most common, although autoclaved aerated concrete units, aggregate concrete units (both heavy and light aggregate), and masonry enclosures and partition walls also make an appearance. Industry has also been attempting to offer wood concrete blocks more lately. Approximately two-thirds of the market share is occupied by partition walls constructed from clay blocks that have perforations running vertically and horizontally.

The primary goal of this research is to examine the G+15 story building in accordance with the provisions of code (IS1893:2002) by using various types of columns, such as RCC and composite columns, in conjunction with bracings and infill walls. The purpose of this ETABS software study is to examine the structures using analogous static, push

over, and response spectrum methods. All all, 24 models are tested in diverse seismic zones and on different types of soil. Using pushover analysis, we can determine building torsion, storey bending, storey shear force, and storey drift.

## II. LITERATURE REVIEWS

**AnirudhGottala, Kintali Sai Nanda Kishore et., al. (2015)** Because of the widespread availability of reasonably priced computers and specialised software, this article explores the idea that analysing and designing structures for static forces is now a commonplace occurrence. Dynamic analysis, on the other hand, takes a long time and calls for further information on the structure's mass as well as knowledge of structural dynamics to decipher the findings. Approximately equal amounts of compressive and tensile stresses were determined to be present in the beams under investigation. Seismic stimulation caused much greater values for nodal displacements and bending moments in beams and columns than static loads.

**Pardeshisameer, Prof. N. G. Gore et., al. (2016)** This research makes use of the structural analysis program ETABS to create and examine three-dimensional models of G+15-story structures, both symmetric and asymmetric. In this research, we focus on how different types of vertical irregularities impact a building's seismic response. This project aims to conduct ductility-based design in accordance with IS 13920, as well as time history analysis (THA) on regular RC building frames and reaction spectrum analysis (RSA) on irregular RC building frames. The outcomes of analyses conducted on regular and irregular structures are compared.

**Mahmad saberet., al. (2015)** This study explores the design process of a multi-story concrete frame building using the software packages STAAD and ETAB. In terms of design software, the current market leaders are STAAD and ETAB. This ultimate encoding program is used by many design companies. Findings from this study indicate that when comparing STAAD PRO with ETAB, users encounter significant confusion and a lack of clarity when trying to apply loading parameters and designs. Beam design findings showed that ETABS reduced the amount of steel area needed compared to STAAD PRO.

## III. METHODOLOGY USED

### Push Over Analysis

Controlling structural deterioration is the goal of this performance-based study. Several houses that are built with hinges and meet the requirements of fema 356 for concrete persons are featured in this examination. Etabs 2013, a nonlinear program, will be used to do this assessment. This program can predict when the structure will first give, at the displacement stage, and at the base shear that corresponds to it. Finding the displacement vs. base shear graph is the main goal of this examination.

When it comes to natural disasters, earthquakes are the most destructive. The engineering tools need to be fine-tuned for analysing systems under the movement of seismic forces since these forces are erratic and unpredictable. It is important to predict earthquake loads accurately so that we can evaluate the shape's actual behaviour while being aware that damage is inevitable but should be controlled. As an alternative to conventional methods of assessment, iterative pushover analysis is considered here. To attain the preset performance stage, also known as target displacement, pushover analysis is performed on multi-tale RCCFrame structures that are exposed to increasing lateral stresses. The goal of performance-based seismic engineering is to ensure that buildings can withstand seismic events in a predictable manner.

## IV. MODELING AND SPECIFICATIONS OF BUILDING

### Basic parameters considered for the research

In the present study, analysis of G+ 15 stories building in all seismic zones carried out in ETABS.

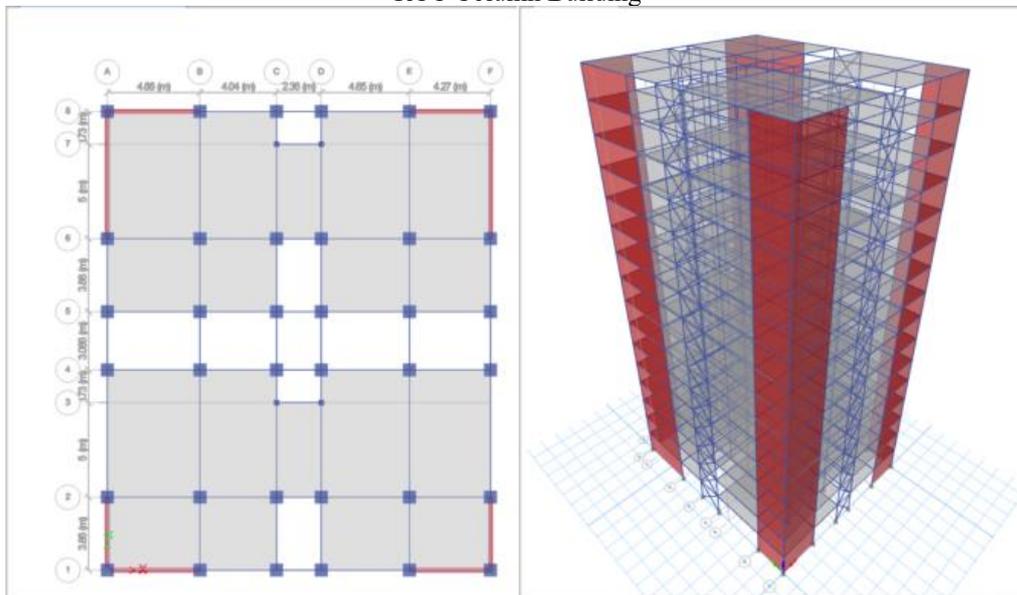
Basic parameters considered for the analysis are

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. Composite column :0.69X0.69 with angle section
7. Height of bottom story : 3m
8. Height of Remaining story : 3m
9. Live load : 5 KN/m<sup>2</sup>
10. Dead load : 2 KN/m<sup>2</sup>
11. Density of concrete : 25 KN/m<sup>3</sup>

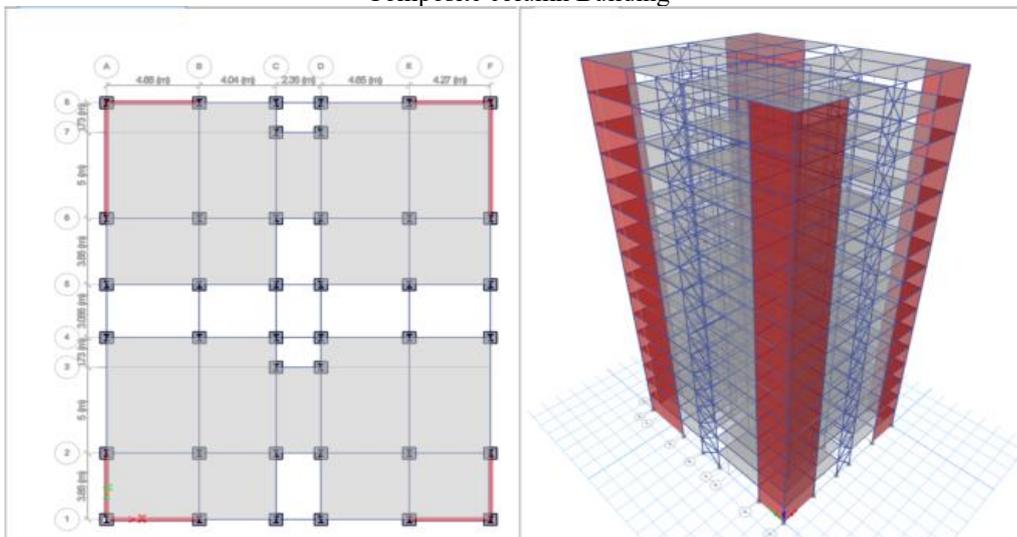
12. Seismic Zone : All seismic Zones
13. Site type : All soil conditions
14. Importance factor : 1.5
15. Response reduction factor : 5
16. Damping Ratio : 5%
17. Structure class : B
18. Basic wind speed : 44m/s
19. Risk coefficient (K1) : 1.08
20. Terrain size coefficient (K2) : 1.14
21. Topography factor (K3) : 1.36
22. Wind design code : IS 875: 1987 (Part 3)
23. RCC design code : IS 456:2000
24. Steel design code : IS 800: 2007
25. Earth quake design code : IS 1893 : 2002 (Part 1)

### Models in ETABS

RCC Column Building



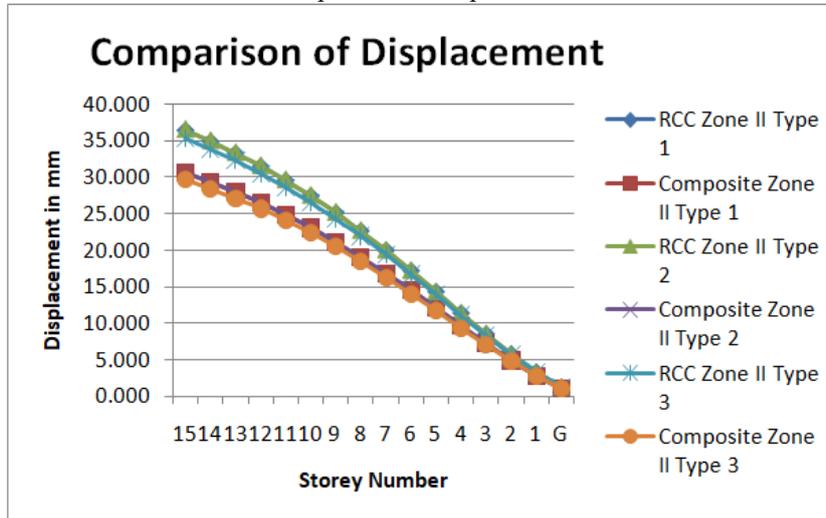
Composite column Building



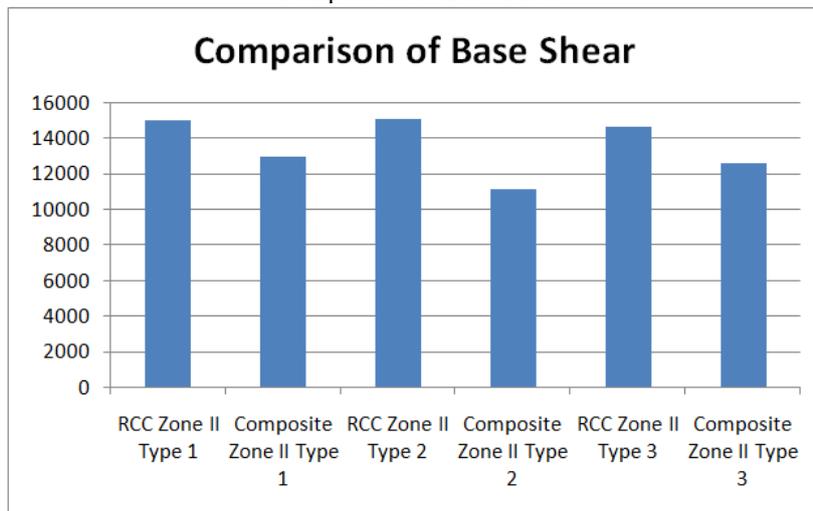
V. RESULTS AND ANALYSIS

Zone II

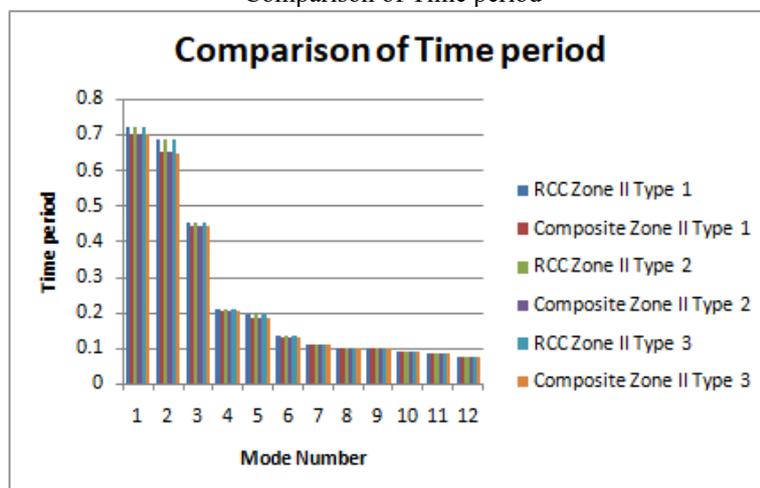
Comparison of Displacement



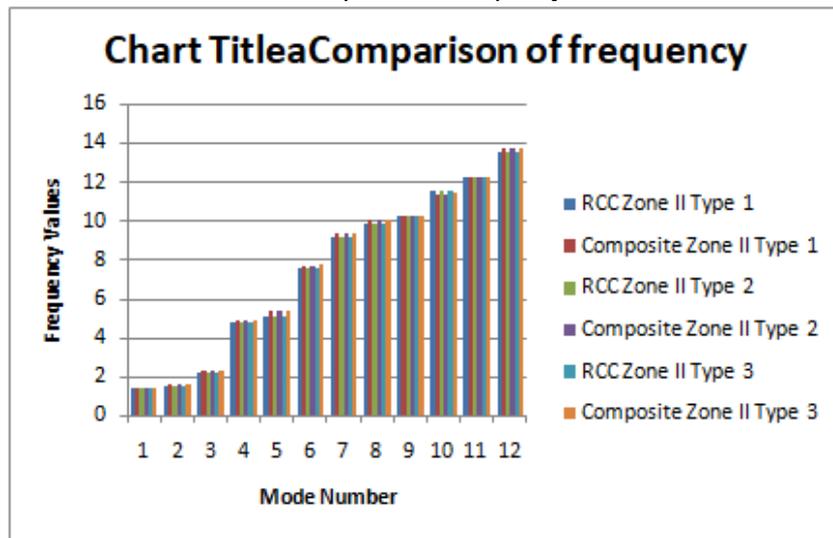
Comparison of Base Shear



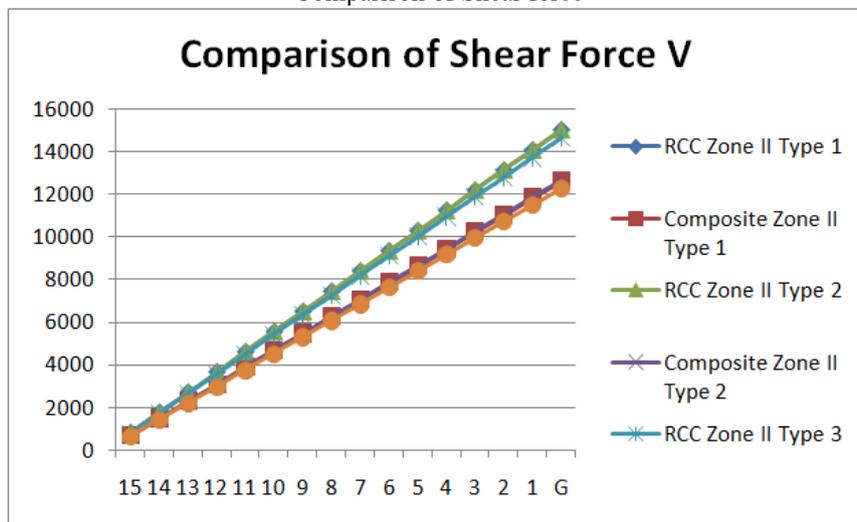
Comparison of Time period



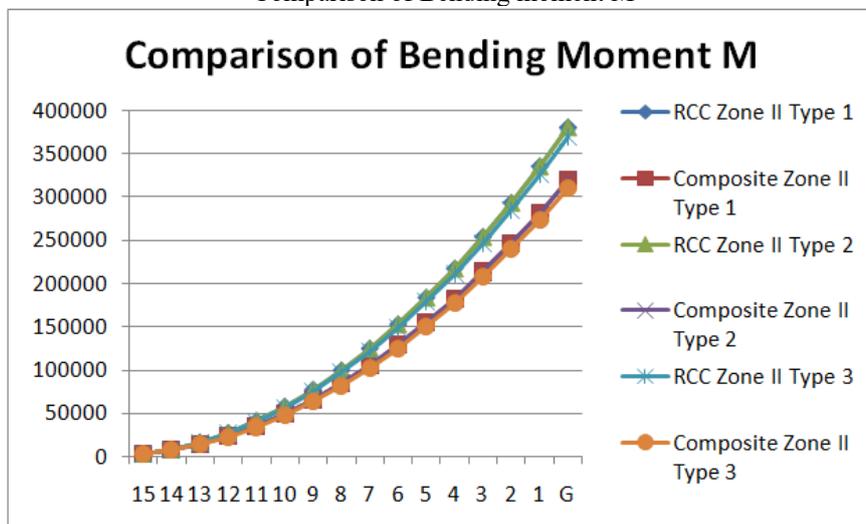
Comparison of frequency



Comparison of Shear force

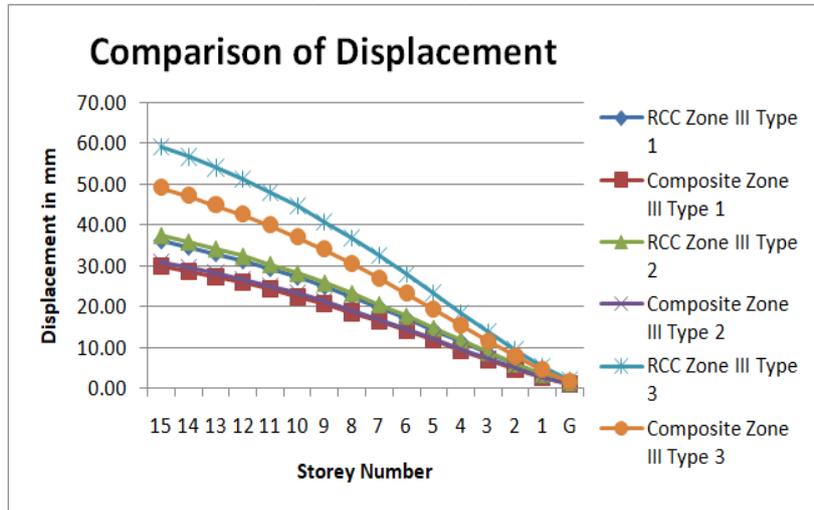


Comparison of Bending moment M

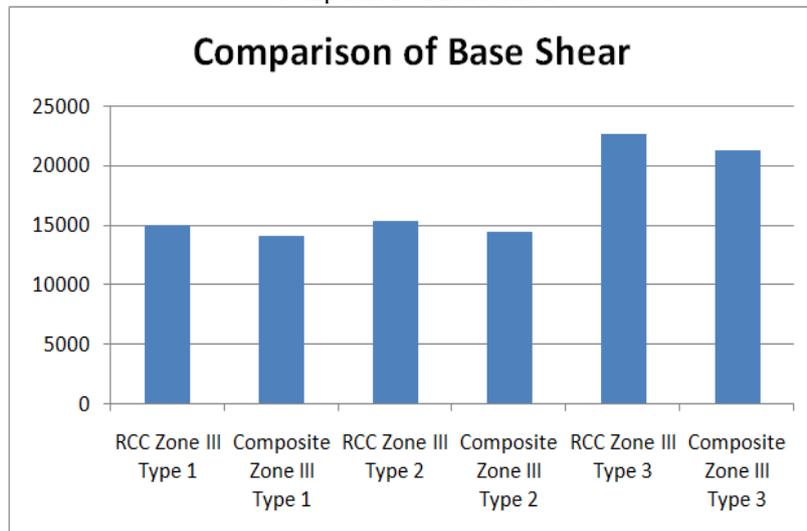


Zone III

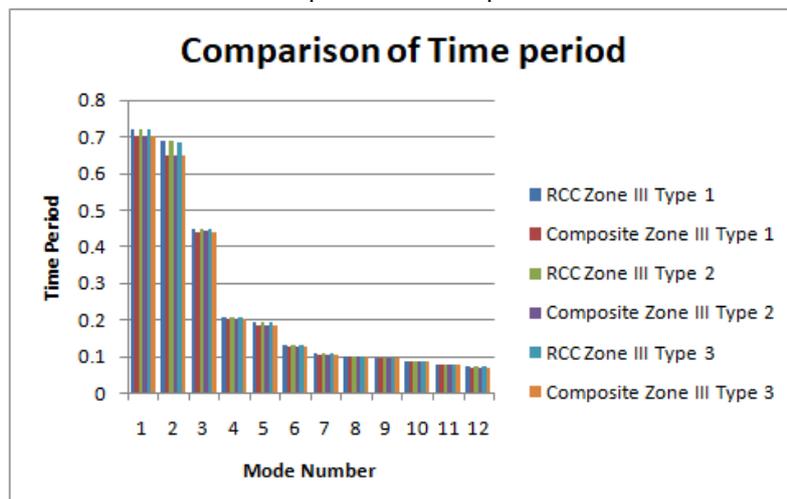
Comparison of Displacement



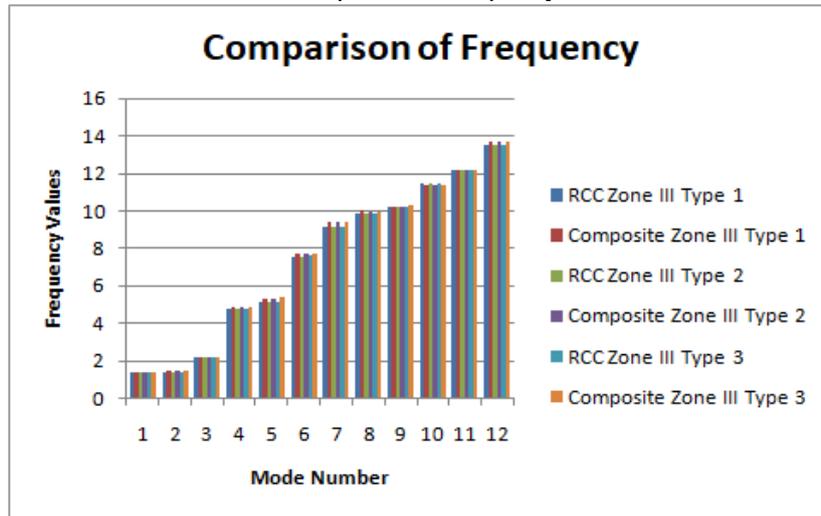
Comparison of Base Shear



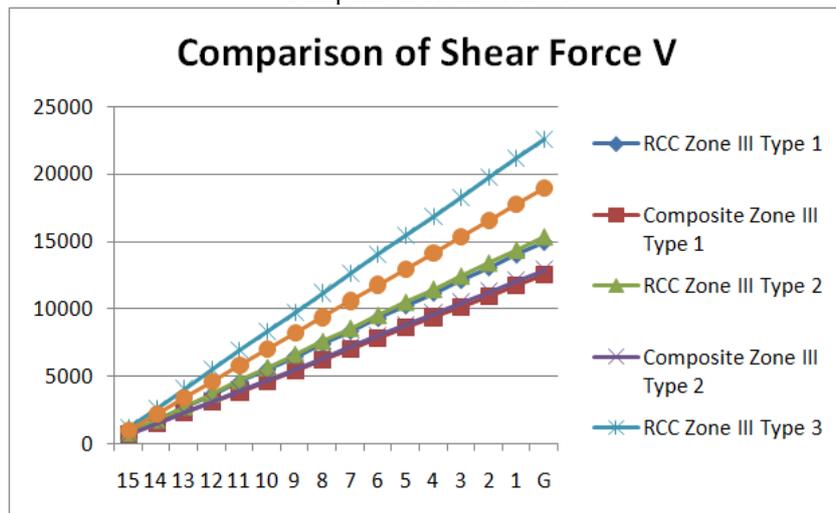
Comparison of Time period



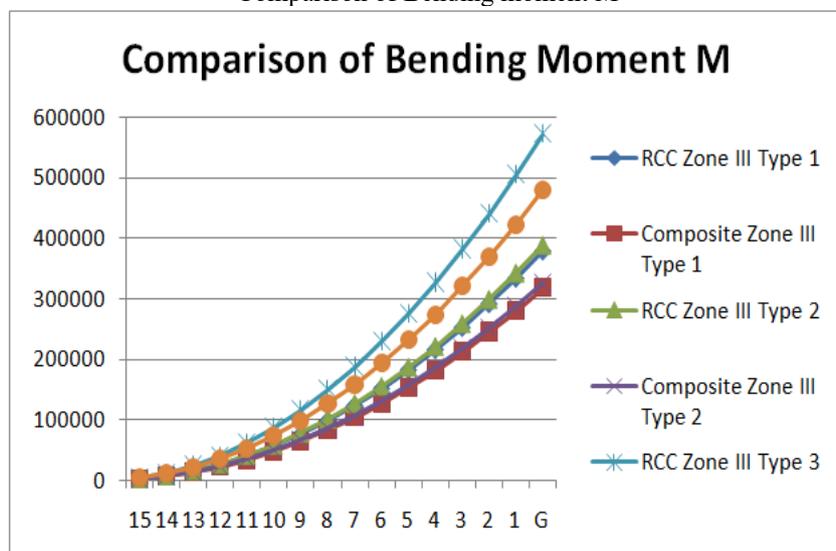
Comparison of frequency



Comparison of Shear force

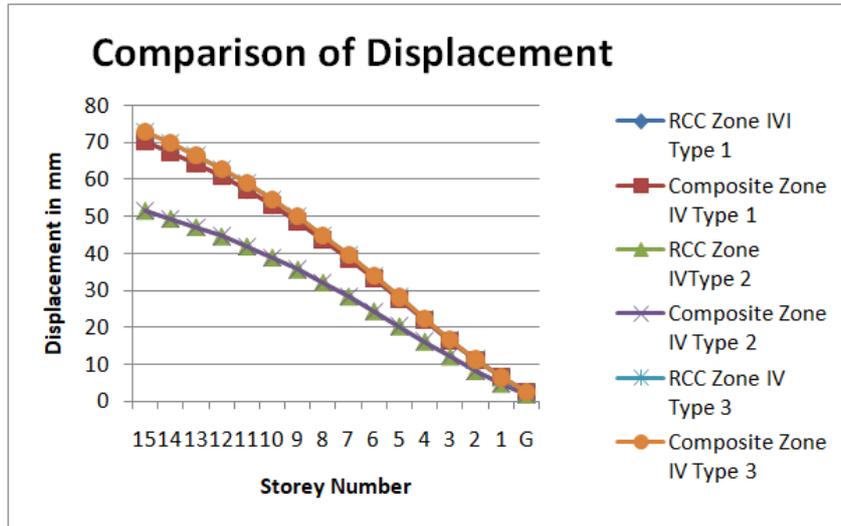


Comparison of Bending moment M

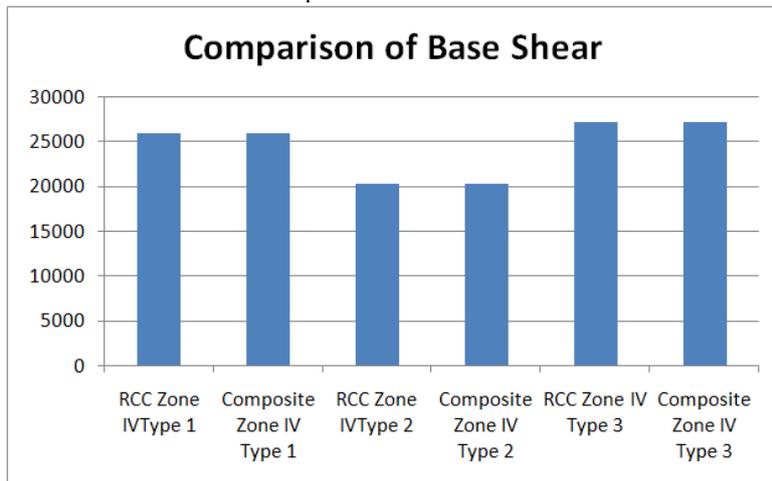


Zone IV Results

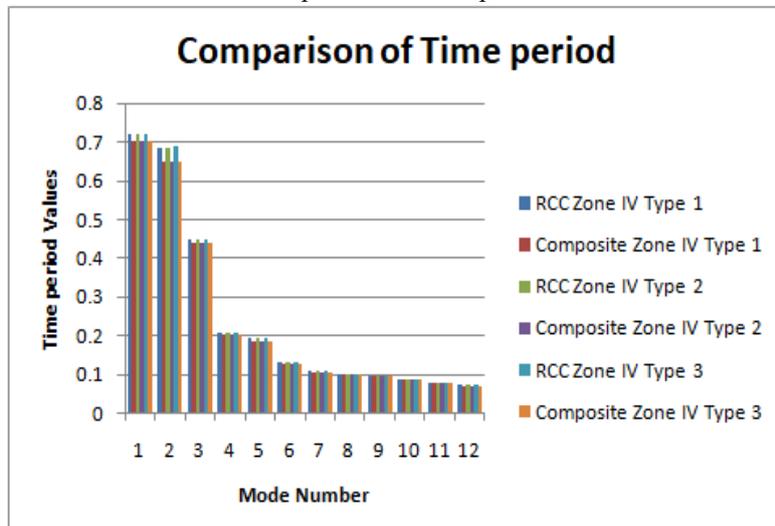
Comparison of Displacement



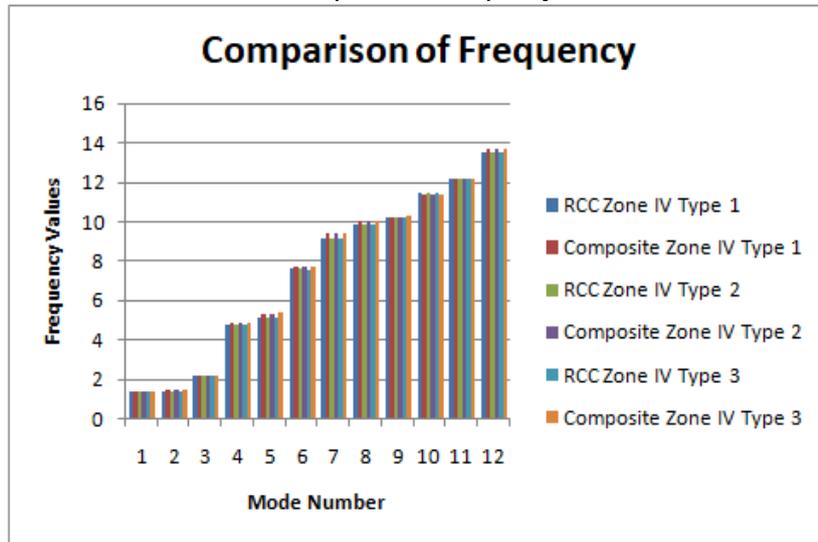
Comparison of Base Shear



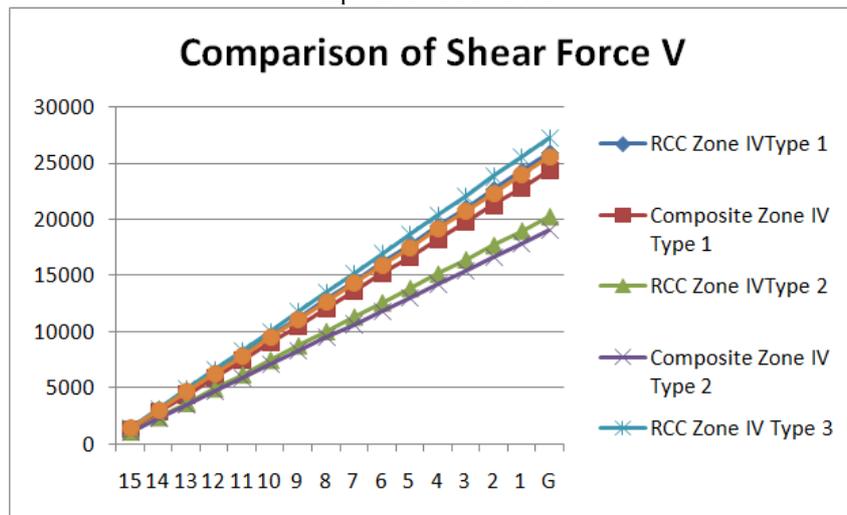
Comparison of Time period



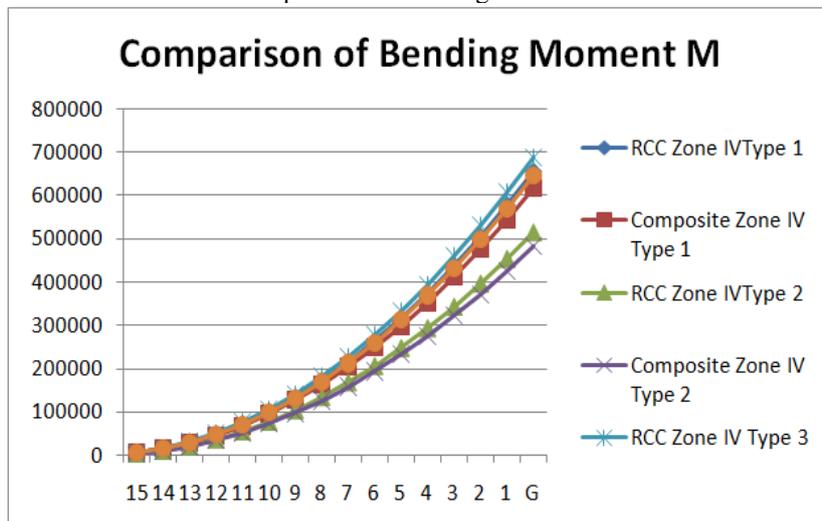
Comparison of frequency



Comparison of Shear force

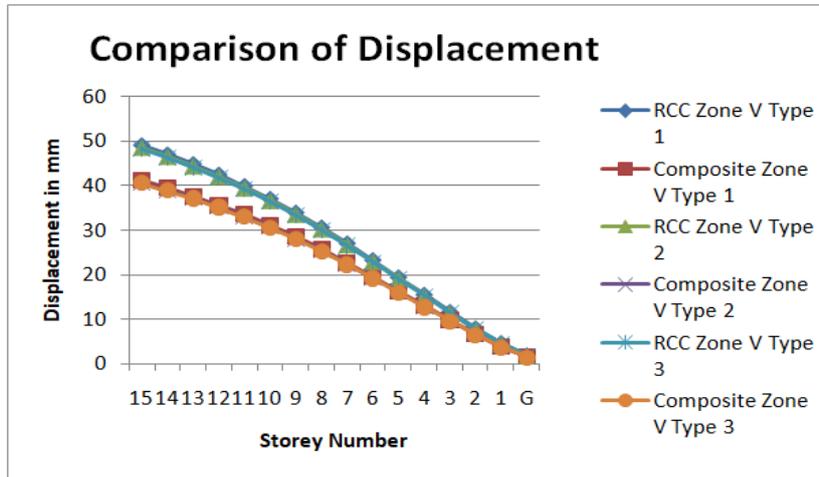


Comparison of Bending moment M

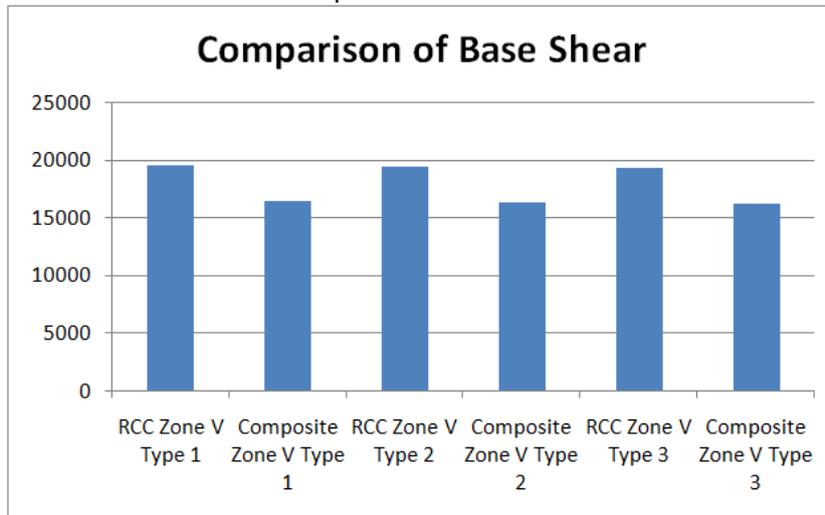


Zone V Results

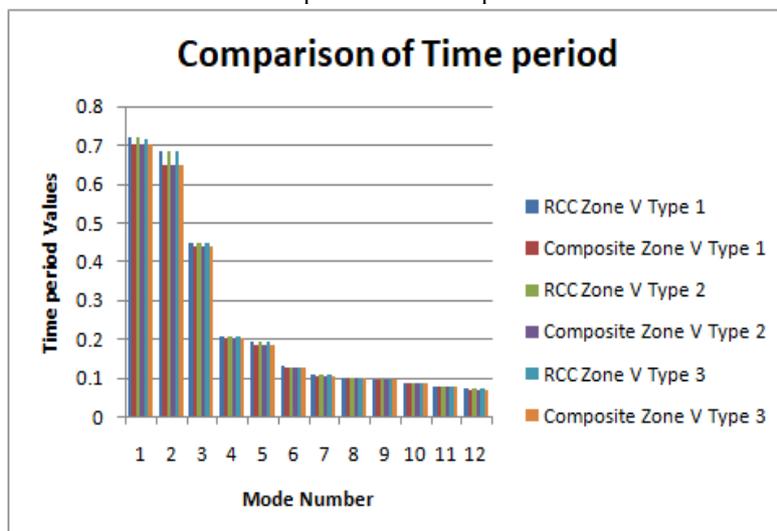
Comparison of Displacement



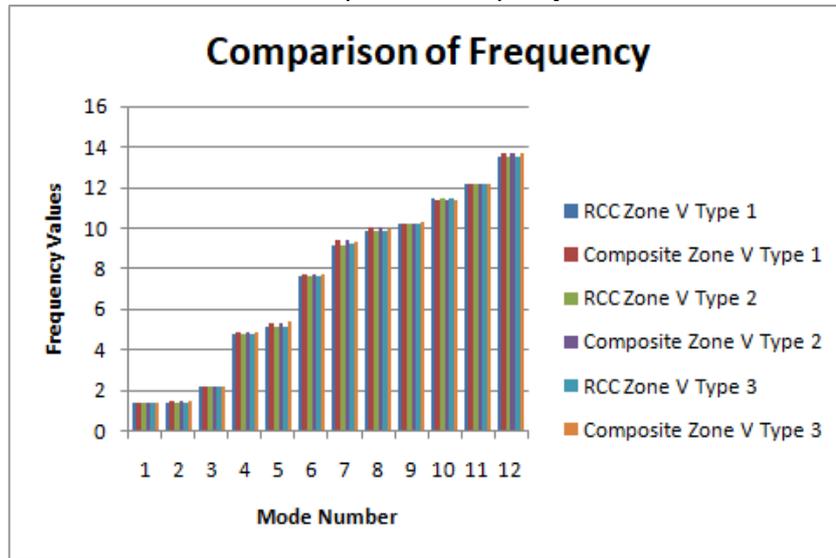
Comparison of Base Shear



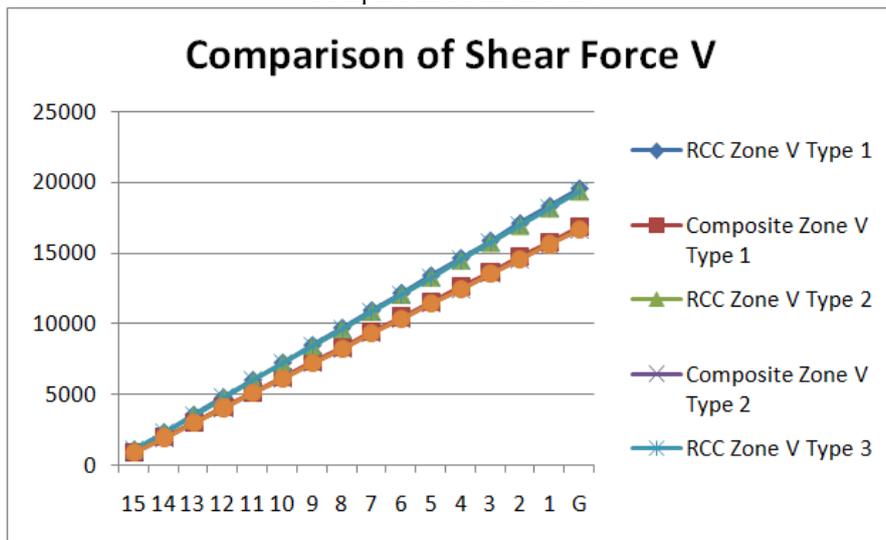
Comparison of Time period



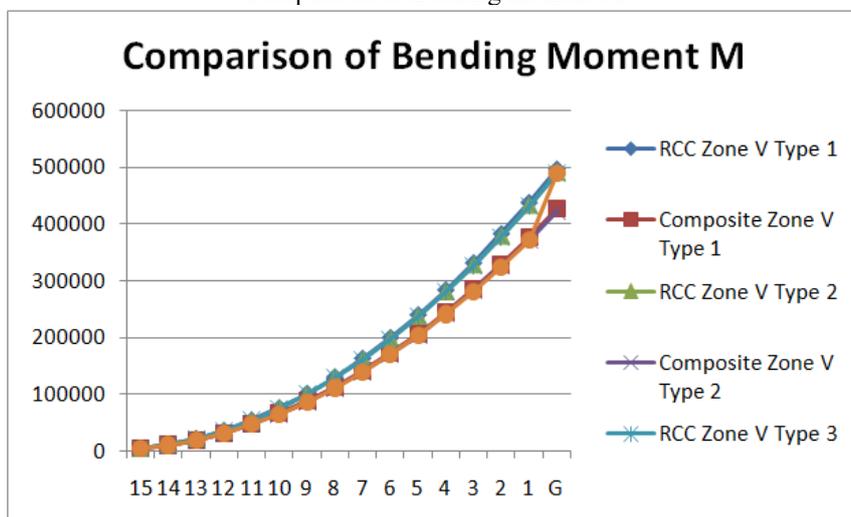
Comparison of frequency



Comparison of Shear force



Comparison of Bending moment M



**VI. CONCLUSION**

The following findings were drawn from the aforementioned analytical study:

1. Composite columns are often used in construction projects because they are quick to install, have excellent fire resistance, and are easy to maintain.
2. Steel tubes that have been filled with reinforced concrete are known as concrete filled tubes. The reinforced concrete core bears the brunt of the stress in a fire, while in a normal circumstance, the column acts as a composite.
3. Compared to other types of structures, composite column buildings have lower deflection values, which is their main benefit.
4. In comparison to RCC columns, building models constructed with composite columns show lower values for story displacement in all seismic zones. This is especially true for hard soil conditions.
5. Composite column structures have lower shear, bending, and torsion values than RCC buildings in all seismic zones.
6. All building models built in different seismic zones will have their time period values decreased from mode 1 to mode 12.
7. For building models created in different seismic zones, the model stiffness values will rise from mode 1 to mode 12.
8. The RCC building has higher values for SF, BM, Twist, and Story Displacement, whereas the Composite column building has lower values for these and other parameters.
9. The composite column section is more robust than the RCC construction model because the displacement values of the former are lower.

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