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COMPARISON OF SEISMIC BEHAVIOUR OF TYPICAL MULTI STOREY STRUCTURE WITH COMPOSITE COLUMNS AND STEEL COLUMNS

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ABSTRACT

An extensive study has been carried out on the behavior of composite column in a structure. In composite column construction steel and concrete are united in such a manner that the advantages of the materials are employed in a efficient manner. By bonding and friction between steel and composite material these materials will accept the external loading in composite columns. In this study comparison of composite and conventional structure is carried out. Just varying the design of column i.e., by using composite and conventional column and keeping all other structural members same for both the structures. Composite column design is carried out according to Euro code 4 and conventional column design is by IS 456-2000. The buildings are taken to be true to be placed in II seismic zone. Seismic design is followed by IS 1893-2002. There are many different types of composite column from those we have taken concrete encased composite column for our analysis. Concrete encasement would increase the load resistance of steel column. During seismic activity the response of structure is also influenced by the material property which depends on the materials and also its configuration in the structural system. The base of the structure is assumed to be fixed. The building height is 36.8m which comes under low rise building. Modeling and analysis has been carried in ETABS software. The results are obtained of various parameters such as base shear, storey overturning, storey drift etc.., thus by obtaining those results graphs have been plotted. And comparison of two different type of structure has been done. Thus, we found that low rise conventional building is more suitable than low rise composite building.

Key Words: Composite columns, Seismic behavior, ETABS Software, roof displacement, Storey drift, Overturning moment etc.,

1. INTRODUCTION

In India most of the building structures fall under the category of low rise buildings. So, for these structures reinforced concrete members are used widely because the construction becomes quite convenient and economical in nature. But since the population in cities is growing exponentially and the land is limited, there is a need of vertical growth of buildings in these cities. So, for the fulfillment of this purpose a large number of medium to high rise buildings are coming up these days. For these high rise buildings it has been found out that use of composite members in construction is more effective and economic than using reinforced concrete members. The popularity of steel-concrete composite construction in cities can be owed to its advantage over the conventional reinforced concrete construction. Reinforced concretes frames are used in low rise buildings because loading is nominal. But in medium and high rise buildings, the conventional reinforced concrete construction cannot be adopted as there is increased dead load along with span restrictions, less stiffness and framework which is quite vulnerable to hazards.

In construction industry in India use of steel is very less as compared to other developing nations like China, Brazil etc. Seeing the development in India, there is a dire need to explore more in the field of construction and devise new improved techniques to use Steel as a construction material wherever it is economical to use it. Steel concrete composite frames use more steel and prove to be an economic approach to solving the problems faced in medium to high rise building structures.

Composite Structures

Composite Steel-Concrete Structures are used widely in modern bridge and building construction. A composite member is formed when a steel component, such as an I beam, is attached to a concrete component, such as a floor slab or bridge deck. In such a composite T-beam the comparatively high strength of the concrete in compression complements the high strength of the steel in tension. The fact that each material is used to the fullest advantage makes composite Steel-Concrete construction very efficient and economical. However, the real attraction of such construction is based on having an efficient connection of the Steel to the Concrete, and it is this connection that allows a transfer of forces and gives composite members their unique behavior.

Need of Steel - Concrete Composite Section

Steel concrete composite construction combines the compressive strength of concrete with the tensile strength of steel to evolve an effective and economic structural system. Over the years, this specialized field of construction has become more and more popular in the western world and developed into a multifaceted design and construction technique. Apart from composite beam, slab and column, options like composite truss, slim-floor etc., are also being explored in the field of composite construction.

2. COMPOSITE AND RCC MULTISTORIED BUILDING

Composite multistoried building consists of composite beams and composite columns. Composite beams are mainly subjected to bending, it means steel beams are connected to deck slab with shear connections, and the RCC structure consists of RCC beams and columns. Modeling of multistoried Steel-Concrete Composite and RCC 3-dimensional commercial building considering, to study various components of composite elements and RCC elements.

2.1 Shear Connectors

Shear connections are essential for steel concrete construction as they integrate the compression capacity of supported concrete slab with supporting steel beams / girders to improve the load carrying capacity as well as overall rigidity. The beams support a uniformly distributed load of w/unit length. For theoretical explanation, two extreme cases of no interaction and 100% (full) interaction are analyzed.

No Interaction Case

It first assumed that there is no shear connection between the beams, so that they are just seated on one another but act independently. The moment in inertia (I) of each beam is given by bh3/12. The load carried by each beam is w/2 per unit length, with mid span moment of wl2/16 and vertical compressive stress of w/2b at the interface.

Full (100%) interaction case

Let us now assume that the beams are joined together by infinitely stiff shear connection along the face. As slip strain are now zero everywhere, this case is called "full interaction". Inthis case, the depth of the composite beam is two h with a breadth b, so that $I=2bh^3/3$. The mid-span moment is $wl^2/8$.

2.2 Profiled Deck

Composite floors using profiled sheet decking have become very popular in the West for high-rise buildings. Composite deck slabs are generally competitive where the concrete floor has to be completed quickly and where medium level of fire protection to steel work is sufficient. There is presently no Indian standard covering the design of composite floor systems using profiled sheeting. In composite floors, the structural behavior is similar to a reinforced concrete slab, with the steel sheeting acting as the tension reinforcement.

The main structural and other benefits of using composite floors with profiled steel decking are:

Savings in steel weight are typically 30% to 50% over non-composite `construction Greater stiffness of composite beams results in shallower depths for the same span. Hence lower stored heights are adequate resulting in savings in classing costs, reduction in wind loading and savings in foundation costs Faster rate of construction

2.3 Composite Beams

Composite beams, subjected mainly to bending, consist of steel section acting compositely with flange of reinforced

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concrete. To act together, mechanical shear connectors are provided to transmit the horizontal shear between the steel beam and the concrete slab, ignoring theeffect of any bond between the two materials. These also resist uplift force acting at the steel concrete interface.

If there is no connection between concrete slab and steel beam at the interface, relative slip occurs between the steel section and the concrete slab when the beam is loaded. Thus each component will act independently, the slab on the extent to which slip is prevented. The degree of interaction depends mainly on the degree of shear connection used. Figure 3.1 shows that the composite beam.

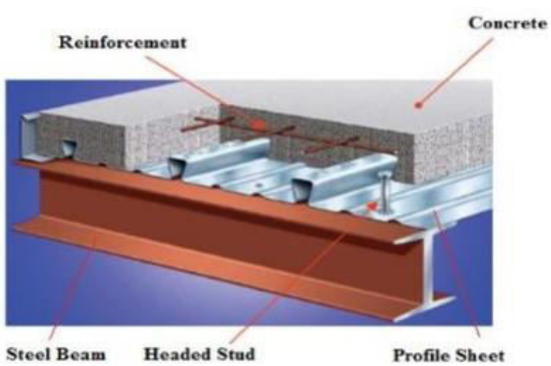


Figure 2.1: Composite beam and slab

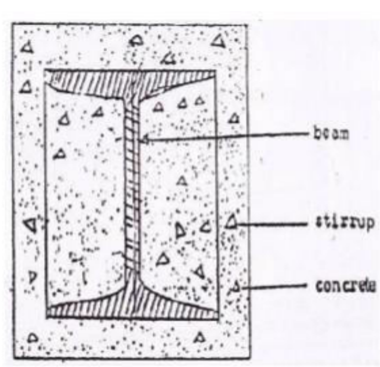
2.4 Encased Columns

A composite member subjected mainly to compression and bending is called as composite column. At present, there is no Indian Standard covering the design of composite columns. The method of design suggested in this chapter largely follows EC4, which incorporates the latest research on composite construction. Indian Standards for composite construction (IS: 11384-1985) does not make any specific reference to composite columns. The provisions contained in IS:456 – 2000 are often invoked for design of composite structures.

During construction, bare steel sections support the initial construction loads, including the weight of structure during construction. Concrete is later cast around the steel section, or filled inside the tubular sections. The lighter weight and higher strength of steel permit the use of smaller and lighter foundations. The subsequent concrete addition enables the building frame to easily limit the sway and lateral deflections. By employing composite columns, the speed of construction can be increased and it is possible to erect the structuresin most efficient manner with significant economic advantages over either pure structural steel/or reinforced concrete alternatives.

Apart from speed and economy, the following other important advantages can be achieved.

- Increased strength for a given cross sectional dimension.
- Increased stiffness, leading to reduced



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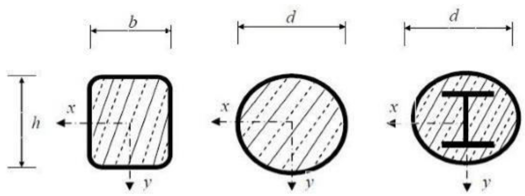
slenderness and increased buckling resistance.

- Fire resistance in the case of concrete encased columns in much better.

There is quite a vertical spread of construction activity carried out simultaneously at any one time, with numerous trades working simultaneously. For example

- One group of workers can be erecting the steel beams and columns for one or two storey at the top of frame.
- Two or three storey below, another group of workers may be fixing the metal decking for the floors.
- As we go down the building, another group may be tying the



column reinforcing bars in cases.
- Yet another group below them may be fixing the formwork, placing the concrete into the column moulds etc. Figure 2.2 shows that the encased composite column.

Figure 2.2: Concrete encased steel column

Composite columns of structural steel and concrete in which the steel forms a column by It self, should be designed with caution. To classify this type as a concrete column reinforced with structural steel is hardly permissible, as the steel will generally take the greater part of the load. When this type of column is used, the concrete should not be relied on to tie thesteel units together or to transmit stresses from one unit to another. The units should be adequately tied together by tie-plates or lattice bars, which, together with other details, such as splices, etc., should be designed in conformity with standard practice for structural steel.

In the below Figure 2.3 shows that the different types of steel encased concrete column sections, steel-concrete composite column is a compression member, comprising either a concrete encased hot-rolled steel section or a concrete filled tubular section of hot-rolled steel and is generally used as a load-bearing member in a composite framed structure. Typical cross-sections of composite columns with fully and partially concrete encased steel sections are illustrated using figures shows three typical cross-sections of concrete filled tubular sections.

Figure 2.3: Steel encased concrete column sections

2.5 Elements of RCC Building

Concrete is one of the most popular materials for buildings because it has high compressive strength, flexibility in its form and it is widely available. The history of concrete usage dates back for over a thousand years. Contemporary cement concrete has been used since the early nineteenth century with the development of Portland cement. Despite the high compressive strength, concrete has limited tensile strength, only about ten percent of its compressive strength and zero strength after cracks develop.Concrete consists of a cement and stone aggregate mixture that forms a rigid structure with the addition of water. When steel that has a high tensile strength is embedded in concrete, the composite material withstands compression, bending, and tensile stresses. In the late nineteenth century, reinforcing materials, such as iron or steel rods, began to be used to increase the tensile strength of concrete. Today steel bars are used as common reinforcing material. Usually steel bars have over 100 times the tensile strength of concrete; but the cost is higher than concrete. Therefore, it is most economical that concrete resists compression and steel provides tensile strength. Also it is essential that concrete and steel deform together and deformed reinforcing bars are being used to increase the capacity to resist bond stresses.

Advantages of reinforced concrete can be summarized as follows (Hassoun, 1998).

- It has a relatively high compressive strength.
- It has better resistance to fire than steel or wood
- It has a long service life with low maintenance cost.
- In some types of structures, such as dams, piers, and footing, it is the most economical structural material.
- It can be cast to take any shape required, making it widely used in precast structural components.

2.5.1 Beams

Concrete is a poor material for tensile strength and it is not suitable for flexure member by itself. The tension side of the beam would fail before compression side failure when beam is subjected a bending moment without the reinforcement. For this reason, steel reinforcement is placed on the tension side. The steel reinforcement resists all tensile bending stress because tensile strength of concrete is zero when cracks develop The design of beam is initiated by the calculation of moment strengths controlled by concrete and steel.

2.5.2 Types of Beams

Figure.2.5 shows the most common shapes of concrete beams: single reinforced rectangular beams, doubly reinforced rectangular beams, T-shape beams, spandrel beams, and joists.

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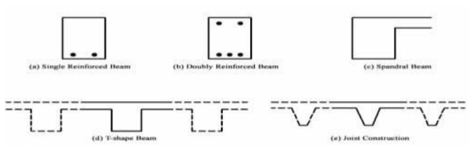
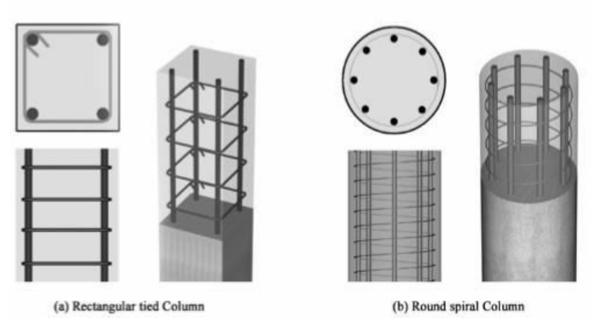


Figure 2.5: Common shapes of concrete beam (Spiegel, 1998)

In cast–in-place construction, the single reinforced rectangular beam is uncommon. The T shape and L-shape beams are typical types of beam because the beams are built monolithically with the slab. When slab and beams are poured together, the slab on the beam serves as the flange of a T-beam and the supporting beam below slab is the stem or web. For positive applied bending moment, the bottom of section produces the tension and the slab acts as compression flange. But negative bending on a rectangular beam puts the stem in compression and the flange is ineffective in tension. Joists consist of spaced ribs and a top flange.

2.5.3 Columns

Columns support primarily axial load but usually also some bending moments. The combination of axial load and bending moment defines the characteristic of column and calculation method. A column subjected to large axial force and minor moment is design mainly for axial load and the moment has little effect. A column subjected to significant bending moment is designed for the combined effect. The ACI Code assumes a minimal bending moment in its design procedure, although the column is subjected to compression force only. Compression force may cause lateral bursting because of the low-tension stress resistance. To resist shear, ties or spirals are used as column reinforcement to confine vertical bars. The complexity and many



variables make hand calculations tedious which makes the computer-aided design very useful.

2.5.4 Types of Columns

Reinforced concrete columns are categorized into five main types; rectangular tied column, rectangular spiral column, round tied column, round spiral column, and columns of other geometry (Hexagonal, L-shaped, T-Shaped, etc).

Figure 2.6: different types of Columns

Figure:2.6 shows the rectangular tied and round spiral concrete column. Tied columns have horizontal ties to enclose and hold in place longitudinal bars. Ties are commonly No. 3 or No.4 steel bars. Tie spacing should be calculated with ACI Code.

Spiral columns have reinforced longitudinal bars that are enclosed by continuous steel spiral. The spiral is made up of either large diameter steel wire or steel rod and formed in the shape of helix. The spiral columns are slightly stronger than tied columns.

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The columns are also categorized into three types by the applied load types; The column with small eccentricity, the column with large eccentricity (also called eccentric column) and biaxial bending column. Figure: 3.7 shows the different column types depending on applied load.

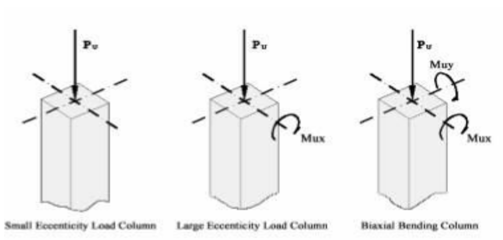


Figure 2.7: The column types depending on applied load.

Eccentricity is usually defined by location:

- Interior columns usually have
- Exterior columns usually have large eccentricity
- Corner column usually has biaxial eccentricity.

3. METHODOLOGY AND MODELING

3.1 Static Linear Analysis

Linear static analysis represents the most basic type of analysis. The term "linear" means that the computed response displacement or stress, for example is linearly related to the applied force. The term "static" means that the forces do not vary with time or, that the time variation is insignificant and can therefore be safely ignored. An example of a static force is a building's dead load, which is comprised of the building's weight plus the weight of offices, equipment, and furniture. This dead load is often expressed in terms of lb/ft^2 or N/m^2. Such loads are often defined using a maximum expected load with some factor of safety applied for conservatism.

In addition to the time invariant dead load described above, another example of a static load is an enforced displacement. For example, in a building part of the foundation may settle somewhat, inducing static loads. Another example of a static load is a steady-state temperature field. The applied temperatures cause thermal expansion which, in turn, causes induced forces.

The static analysis equation is: $[K]\{u\} = \{f\}$

In linear static analysis displacements, strains, stresses and reaction forces under the effect of applied loads are calculated.

3.2 Dynamic Linear Analysis

Dynamic linear analysis is discussed with seismic analysis of the structure and dynamic analysis can be used to find natural frequency, dynamic displacements, time history results, modal analysis.

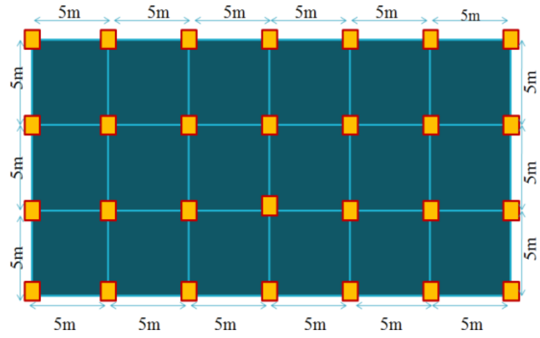
3.2.1 Time history analysis

Linear time history analysis is the study of the dynamic response of the structure at every addition of time, when its base is exposed to a particular ground motion. Static techniques are applicable when higher mode effects are not important. This is for the most part valid for short, regular structures. The seismic input is modeled utilizing time history analysis, the displacements and internal forces are found using linear elastic analysis. The playing point of linear dynamic procedure as for linear static procedure is that higher modes could be taken into account.

In linear dynamic analysis, the response of the building to the ground motion is computed in the time domain, and all phase information is thus preserved. Just linear properties are considered. In order to study the seismic behavior of structures subjected to low, intermediate, and high frequency content ground motions, dynamic analysis is required. E-tabs 2015 software is used to perform linear time history analysis.

3.2.2 Response spectrum analysis

This approach permits the multiple modes of response of a building to be taken into account (in the frequency domain). This is required in many building codes for all except very simple or very complex structures. The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonics". Computer analysis can be used to determine these modes for a structure. For each mode, a response is read from the design spectrum,



based on the modal frequency and the modal mass, and they are then combined to provide an estimate of the total response of the structure. In this we have to calculate the magnitude of forces in all directions i.e. X, Y & Z and then see the effects on the building.. Combination methods include the following:

- absolute - peak values are added together
- square root of the sum of the squares (SRSS)
- complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes

The result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum., the response spectrum approach is no longer appropriate, and more complex analysis is often required, such as non-linear static analysis or dynamic analysis.

3.3 Modeling of RCC Structure

The RCC structure is consist of columns, beams and slab. The distance between the column to column is 6m in x-direction and 5m in y-direction. The overall dimensions of the structure is 30m*15m.column dimensions are 400*300mm, beam dimensions are 500*300mm and thickness of slab is 125mm.

3.3.1 Plan of Asymmetry RCC Structure

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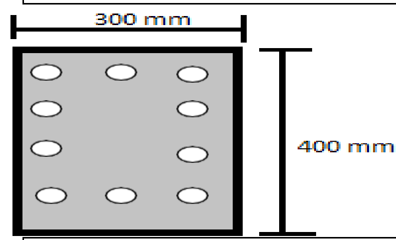
Figure 3.1: Plan of RCC Structure

3.3.2 Building Details

The building considered here is commercial building having G + 3 storied located in seismic zone III and for earthquake loading, the provisions of the IS: 1893(Part1)2002 is considered. The plan of building is shown in above figure 3.1. the building is planned to facilitate the basic requirements of commercial building. The plan dimension of the building is 18 x 15 m. Height of each storey for composite and RCC is 3m. The floor plans were divided into three by three bays in such a way that center to center distance between two grids is 6 meters by 5 meters respectively. The study is carried out on the same building plan for RCC and composite construction with some basic assumptions made for deciding preliminary sections of both the structures. The basic loading on both types of structures are kept same, other relevant data is tabulated in Table 3.1

Table.4.1: RCC structure properties

Section properties	30m*15m
Beam dimensions	500*300 mm
Column dimensions	400*300 mm
Thickness of slab	125 mm
Grade of concrete	M30
Grade of reinforcement	Fe415
Live load	3 KN/m^2
Dead load	3 KN/m^2
Floor finishes	1 KN/m^2
Seismic zone	III
Importance factor	1
Zone factor	0.16
Density of concrete	25 KN/m^3



3.3.3 RCC Column Modeling

In the below Figure 3.2 shows that the Rcc column modeling by using E-tabs software. Here the modeling of Rcc column is a rectangular column.Columns support primarily axial loadbut usually also some bending moments. The combination of axial load and bending moment defines the characteristic of column and calculation method.

Figure 3.2 RCC Column

3.3.4 RCC Beam Modeling

In the below Figure 3.3 shows that the Rcc beams modeling by using E-tabs software. Here the modeling of Rcc beam is a rectangular beam. Beams can be described as members that are mainly subjected to flexure and it is essential to focus on the analysis of bending moment, shear, and deflection.

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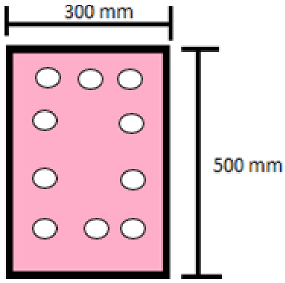

Figure 3.3: RCC beam

3.3.5 RCC 3D Model

In the below Figure 3.4 shows that the Rcc 3D model by using E-tabs software

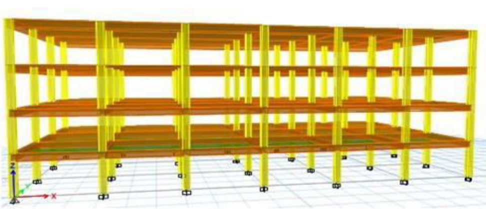

Figure 3.4: 3D model generated by E-tabs

3.4 Modeling of Composite structure

The composite structure is consisting of composite columns, composite beams and deck slab. The distance between the column to column is 6m in x-direction and 5m in y-direction.the overall dimensions of the structure is 30m*15m.Column dimensions are 400*300mm, beam is ISLB600 and thickness of slab is 125mm.

3.4.1 Plan of Asymmetry Composite Structure

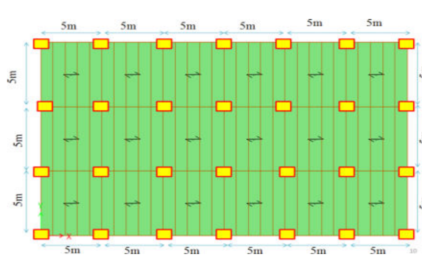

Figure 3.5: Plan of Composite Structure

3.4.2 Building Details

The building considered here is commercial building having G + 3 storied located in seismic zone III and for earthquake loading, the provisions of the IS:1893(Part1)2002 is considered. The plan of building is shown in fig. the building is planned to facilitate the basic requirements of commercial building. The plan dimension of the building is 18 x 15 m. Height of each storey for composite and RCC is 3m. The floor plans were divided into three by three bays in such a way that center to center distance between two grids is 6 meters by 5 meters respectively. The study is carried out on the same building plan for RCC and composite construction with some basic assumptions made for deciding preliminary sections of both the structures.

The basic loading on both types of structures are kept same, other relevant data is tabulated in table 4.2.

Table 4.2: Composite structure properties

Section properties	18 m*15 m
Beam dimensions	ISLB600
Column dimensions	400*300 mm
Thickness of slab	125 mm
Grade of concrete	M 30
Grade of steel	Fe 250

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Live load	3 KN/m^2
dead load	3 KN/m^2
Floor finishes	1 KN/m^2
Seismic zone	III
Importance factor	1
Zone factor	0.16
Density of concrete	25 KN/m^3

3.4.3 Composite Column Modeling

In the below Figure 4.6 shows that the composite column modelinbg by using E-tabs software.the composite column consist of rectangular steel tube is filled with concrete.and the thickness of steel tube is 13mm.

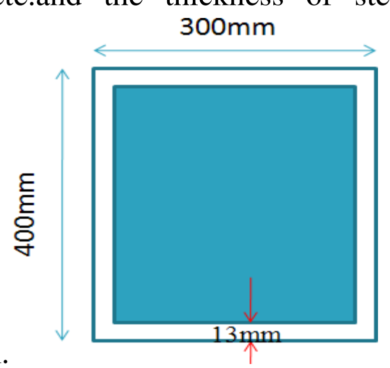

Figure 3.6: Composite Column

3.4.4 Composite Beam and Slab Modeling

In the Below Figure 4.7 shows that the composite beam and slab modelinbg by using E-tabs software.height of the each storey is 3m, and the dimensions of the structure is 30m X 15m.for modeling of composite structure composite columns and composite beams are developed.figures 4.8 and 4.9 are symmetry structures of composite and RCC.

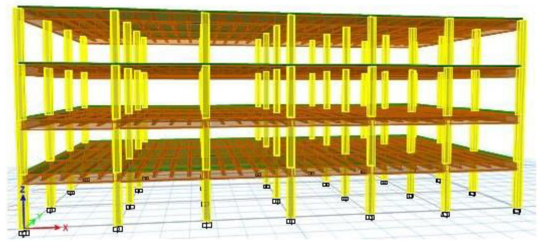

Figure 3.7: 3D Model generated using E-tabs

Plan of Symmetry RCC structure

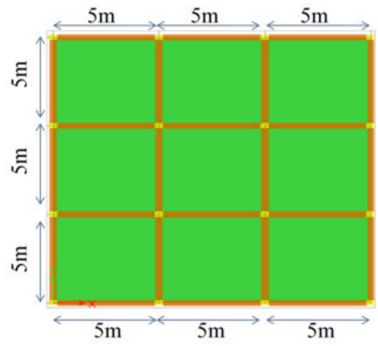

Figure 3.8: Plan of RCC (Symmetry)

3.4.5 Plan of Symmetry RCC structure

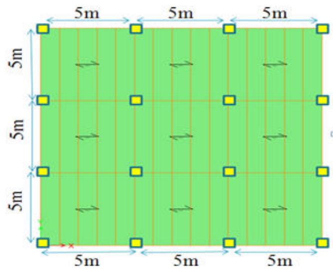

Figure 3.9: Plan of Composite (Symmetry)

4. RESULTS

4.1 Static Linear Analysis

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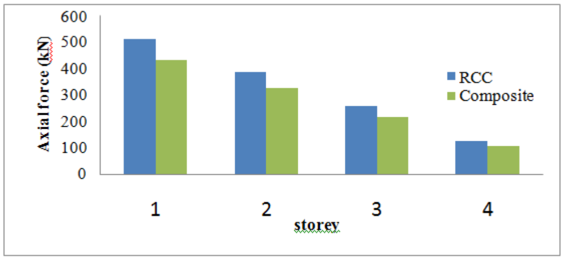

Figure 4.1: Graph for Axial force of symmetry structure

4.1.1 Axial force (symmetry)

Figure 4.1shows that comparison of axial force between composite and RCC structure and observed that axial force of composite column is less as compared to RCC column in different stories. Table 5.1 shows that the axial force values of both the structures i.e composite and RCC structure.

Table 4.1: Axial Force symmetry (KN)

Storey No	RCC	Composite
1	514.1	432.1
2	387.2	326.2
3	258.9	216.8
4	127.3	105.4

4.1.2 Axial force Asymmetry

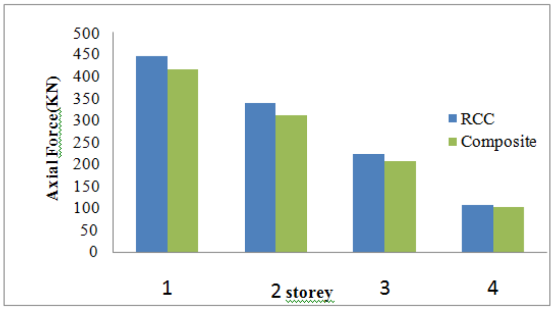

Figure 4.2: Graph for Axial force of Asymmetry structure

Figure 4.2 shows that comparison of axial force between composite and RCC structure and observed that axial force of composite column is less as compared to RCC column in different stories. Table 5.2 shows that the axial force values of both the structures i.e composite and RCC structure.

Table 5.2: Axial Force Asymmetry (KN)

Storey no	RCC	Composite
1	446.9	414.8
2	338.5	312.2
3	224.1	207.6
4	106.9	101.5

4.2 Mode shapes

A mode shape is a specific pattern of vibration executed by a mechanical system at a specific frequency. Different mode shapes will be associated with different frequencies. The experimental technique of modal analysis discovers these mode shapes and the frequencies.

The following below Figures 5.3 and 5.4 are shows that the mode shapes of RCC symmetry and composite symmetry structures. And Figures 5.5 and 5.6 are shows that the mode shapes of RCC and Composite Asymmetry structures.

4.2.1 Mode Shapes RCC (symmetry)

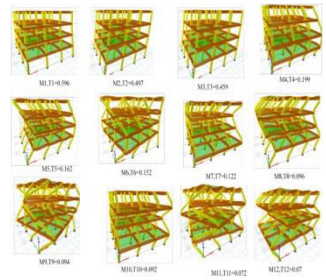

Figure 4.3: Mode shapes of Symmetry (RCC)

4.2.2 Mode Shapes Composite (Symmetry)

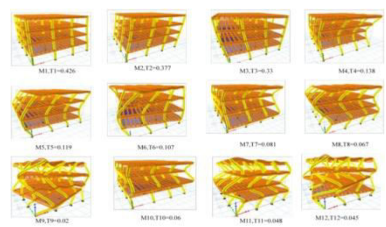

Figure 4.4: Mode Shapes of Symmetry (Composite)

4.2.3 Mode Shapes RCC (Asymmetry)

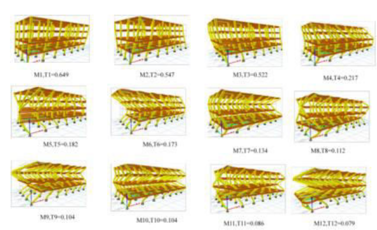

Figure 4.5: Mode shapes of Asymmetry (RCC)

4.2.4 Mode Shapes Composite (Asymmetry)

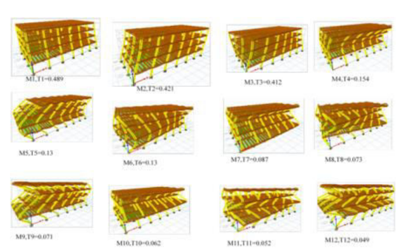

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Figure 4.6: Mode Shapes of Asymmetry (Composite)

4.2.5 Time Period

5. In any structure the stresses are basically calculated from the net displacement of each and every node in various directions. Once we calculated the displacements The building will oscillate back-and-forth horizontally and after some time come back to the original position, these oscillations are periodic. The time taken (in seconds) for each complete cycle of oscillation (i.e. one complete back-and-forth motion) is the same and is called Fundamental Natural Period T of the building. Value of T depends on the building flexibility and mass; more the flexibility, the longer is the T, and more the mass, the longer is the T.Table 4.3 shows that symmetry and asymmetry structures of time period values are compared for both the structures composite and RCC, observed that time period values of composite structure is less as compared to RCC structure.

Mode No	**Symmetry**		**Asymmetry**	
	RCC	Composite	RCC	Composite
1	0.596	0.426	0.649	0.489
2	0.497	0.377	0.547	0.421
3	0.459	0.334	0.522	0.412
4	0.199	0.138	0.217	0.154
5	0.162	0.119	0.182	0.13
6	0.152	0.107	0.173	0.13
7	0.122	0.081	0.134	0.087
8	0.096	0.067	0.112	0.073
9	0.094	0.062	0.104	0.071
10	0.092	0.06	0.104	0.062
11	0.072	0.048	0.086	0.052
12	0.07	0.045	0.079	0.049

Table: 4.3 Time Period

5.1 Dynamic Analysis Results

Dynamic linear analysis is discussed with seismic analysis of the structure and dynamic analysis can be used to find natural frequency, dynamic displacements, time history results, modal analysis.

5.1.1 Time History Analysis Results

- Here we analyzing the seismic analysis of the composite and RCC structure with time history analysis and Response spectrum analysis by using E -tabs software For time history analysis bhuj earthquake data is collected, with that earthquake data we applying ground motion for both the structures composite and RCC.
- The ground motion is applying in both directions i.e X and Y. The Displacement is compared for both the structures RCC and composite, as shown in below figures.

Bhuj earthquake

Bhuj earthquake occurred on 26th January 2001 on the India's 51 republic day. It has very huge and disastrous and cause many deaths. People today also remember that as it has leavedvey big impact on them. About 20000 people were died and 40000 homes were destroyed. The earth quake was 6.9 on Richter scale.

Bhuj Earthquake ground motion

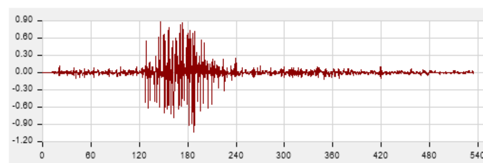

Figure 4.7: bhuj earth quake ground motion Earth Quake (EQ) in X–direction (Asymmetry):

In the below Figure 5.8 shows that the Displacement is compared in x-direction for both the structures RCC and composite. For better comparability the displacement for both the model along the x-direction of ground motion are plotted in as shown in Graph.

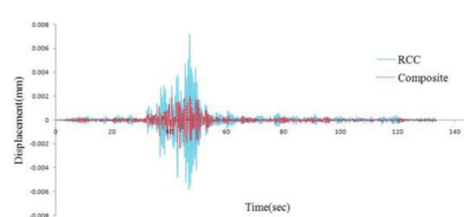

Figure 4.8 displacement in X-Direction

Table: 4.4 Displacement values (mm)

Type of structure	Max Displacement	Min Displacement
RCC	0.007	-0.005
Composite	0.002	-0.002

Earth Quake (EQ) -Y direction:

The below Figure 5.9 shows that the Displacement is compared in y-direction for both the structures RCC and composite. For better comparability the displacement for the model along the y-directions of ground motion are plotted in as shown in Graph.

Table: 4.5 Displacement values (mm)

Type of structure	Max Displacement	Min Displacement
RCC	0.005	-0.004
Composite	0.002	-0.002

Table 4.5 shows that the maximum and minimum displacement of composite and RCC structure and from the table observed that the displacement of composite structure is less as compared to RCC structure.

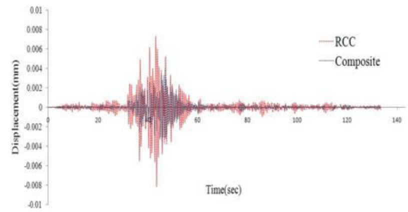

Figure 4.9: displacement in Y-direction

Earth Quake (EQ) in X–direction (Symmetry):

In the below Figure 5.10 shows that the Displacement is compared in x-direction for both the structures symmetry RCC and composite. For better comparability the displacement for both the model along the x-direction of ground motion are plotted in as shown in Graph.

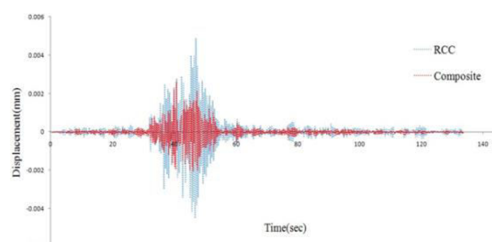

Figure 4.10: displacement in X-Direction

Earth Quake (EQ) in Y–direction (Symmetry):

The below Figure 4.11 shows that the Displacement is compared in y-direction for both the structures RCC and composite. For better comparability the displacement for the model along the y-directions of ground motion are plotted in as shown in Graph.

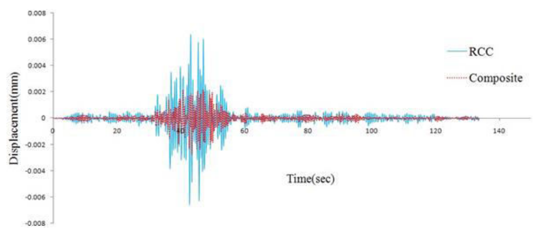

Figure 4.11: displacement in Y-Direction

Table: 4.6 Displacement values (mm)

Type of structure	Max Displacement	Min Displacement
RCC	0.006	-0.006
Composite	0.002	-0.002

Table 4.6 shows that the maximum and minimum displacement of composite and RCC structure and from the table observed that the displacement of composite structure is less as compared to RCC structure.

5.1.2 Base shear in Z-direction

The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonics". For response spectrum analysis the building considered here is commercial building having G + 3 storied located in seismic zone III and for earthquake loading, the provisions of the IS:1893(Part1)2002 is considered. The zone factor value is 0.16 and soil type is medium soil. Response spectrum analysis done in both the directions i.e x and y. from Response spectrum analysis the base shear results are taken for both the structures i.e composite and RCC.

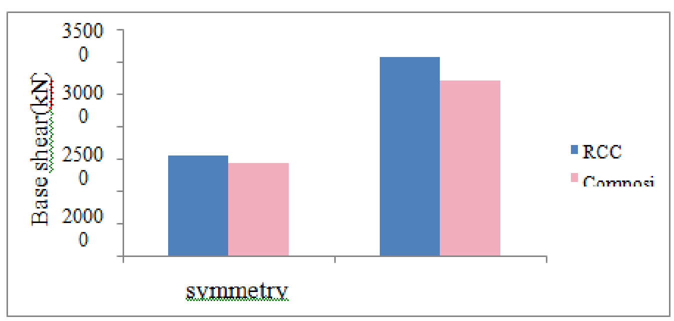

Figure 4.12 Base Shear in Z- direction

6. CONCLUSION

In this study, the comparative study of RCC and Composite multistoried building (G+3) is presented. Parameter considered are, beam deflection, maximum shear force, and maximum bending moment, time period and displacement, base shear is considered.

- The axial force in composite column is 7.45% less compared to RCC column.
- The displacement of composite structure is less than the RCC structure.
- The time period of composite structure is also less than the RCC structure.
- The composite structure will perform well in earthquake condition than the RCC structure this will be decided by the comparative of displacement for both the structures i.e composite structure and RCC structure.
- Base shear is less in composite building compared to RCC building.

The data mentioned above is clearly said that composite section is always a better choice against R.C.C. Composite Structure provides efficient and better option than R.C.C. structures.

FUTURE SCOPE

- The use of fully and partially encased steel sections in reinforced concrete is particularly beneficial for earthquake-resistant design. A further study on the suitability of other types of composite structural systems for earthquake-resistant design is highly recommended.
- The wind analysis of multi-storied composite structure can be carried out and charts can be prepared for various wind pressure.
- Non-linear dynamic analysis can be carried out of various types of composite and RCC structures.

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