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SEISMIC ANALYSIS OF MULTI-STORIED RC AND COMPOSITE BARE FRAME BUILDING USING ETABS

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Abstract - *Composite constructions are used in both buildings and bridges. Comparing to RCC structure, steel concrete composite system are being more popular due to the various advantages. Both speed and economy can be achieved in case of composite systems. Equivalent static lateral force method and response spectrum method of analysis are explained in ETABS software and results are compared for different parameters. An attempt was made in this work to evaluate and compare the seismic performance of G+14 storey's made of RCC and composite structure and are located in the region of earthquake zone 5. Time period, displacement, base shear and acceleration are considered as parameters. Use of composite material is of particular interest. Due to its significant potential in improving the overall performance through rather modest changes in manufacturing and constructional technologies . Steel-Concrete composite columns are used extensively in modern buildings. Extensive researches on composite columns in which structural steel sections are encased in concrete have been carried out. In-filled composite columns, however have received limited attention compared to encased columns.*

Effort is done to reduces the quantity of steel required which results in economical design.

Key Words: Composite concrete filled steel tube columns, composite steel encased columns, base shear, time period, acceleration, displacement, ETAB software, equivalent static lateral force method, response spectrum method.

1. INTRODUCTION

In the past, structural engineers had the choice masonry buildings. Today multi-story buildings in India are constructed with RCC framed structure or steel framed structure. Recently the trend of going toward composite structure has started and growing up. Composite buildings were developed hundreds of years back not just for building they were additionally used to develop bridges in united states. They utilized steel and concrete for end joint individuals and they distinguished longitudinal slip between them. Later shear connecters was produced to forestall longitudinal sneak past a specialist from America.

There is Indian Standard Codal Provisions (IS 1893:2002) to construct earthquake resistant structures.

There are different methods of analysis, which provide different degree of accuracy. The analysis process can be categorized on the basis of three factors: the type of externally applied loads, the behaviour of structure / structural materials, and the type of structural model selected. Based on the type of externally applied load and behavior of structure the seismic methods of analysis can be classified as

a) Linear Static Analysis,
b) Linear Dynamic Analysis,
c) Non-Linear Static Analysis
d) Non-Linear Dynamic Analysis

The steel and concrete structures have wide applications in multi-story commercial buildings and factories as well as in case of bridges. Steel and concrete have almost the same thermal expansion. Concrete is efficient in taking compression loads and steel is subjected to tensile loads. Composite structures are becoming popular preferred choice of structural engineers. In composite construction initial construction loads will be carried out by steel frame sections including the self weight during construction and then concrete is cast around the section or concrete is poured inside the tubular section.

In this work, an attempt was made to compare the study of seismic performance of RCC and composite with G+14 story structure using ETABS. Time period, displacement, base shear, self weight acceleration are considered as parameters.

2. SEISMIC METHOD OF ANALYSIS

For the determination of seismic responses there is necessary to carry out seismic analysis of structure. The analysis can be performed on the basis of external action. The behavior of structure or structural materials and the type of structural model selected.

Based on the type of external action and behavior of structure, the analysis can be further classified as linear static analysis, non linear static analysis, linear dynamic

analysis and non linear dynamic analysis. Linear static analysis or equivalent static method can be used for regular structure with limited height. Linear dynamic analysis can be performed by response spectrum method. The significant difference between linear static and linear dynamic analysis is the level of the forces and their distribution along the height of the structure.

3. EQUIVALENT STATIC LATERAL FORCE METHOD

Equivalent static method of analysis is a linear static analysis. This methodology characterizes the best approach to speak to the effect of arrangement of force of tremor ground motion follow up on a building through a earthquake design response spectrum. This system expect that the building reacts in its fundamental mode. Application of this procedure is reached out in a several building standards by applying factor for higher structures with higher modes and similarly for low levels of twist. To account for impacts owing to yielding of the structure, a several codes apply modification factors that decrease the design force. In this technique the lateral force equivalent to the design fundamental earthquake is applied statically.

4. RESPONSE SPECTRUM METHOD

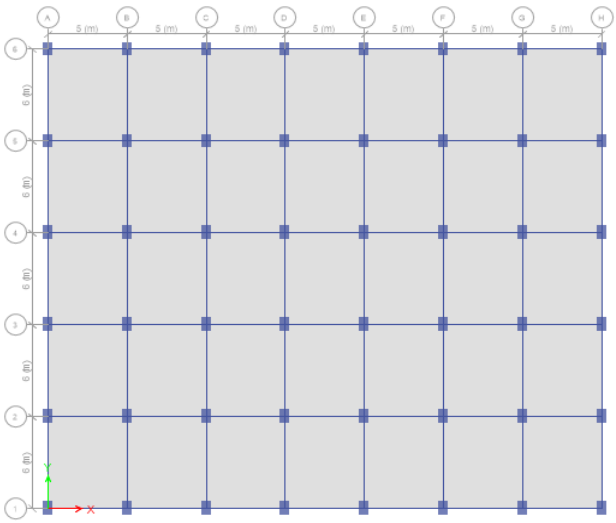
Response spectrum is linear dynamic analysis which is a tool to analyze the behavior of existing structure. It is a plot of maximum response corresponding to natural frequency or time period which is directly obtained by earthquake response spectrum during earthquake and this method gives approximate peak response which is almost accurate for structural design application and in this approach multi modes are taken into consideration and for each mode a response is read from design spectrum based on modal frequency and modal mass. These modes are combined to provide total response using modal combination such as complete quadratic combination, square root of sum of square or absolute sum method

5. LINEAR STATIC ANALYSIS

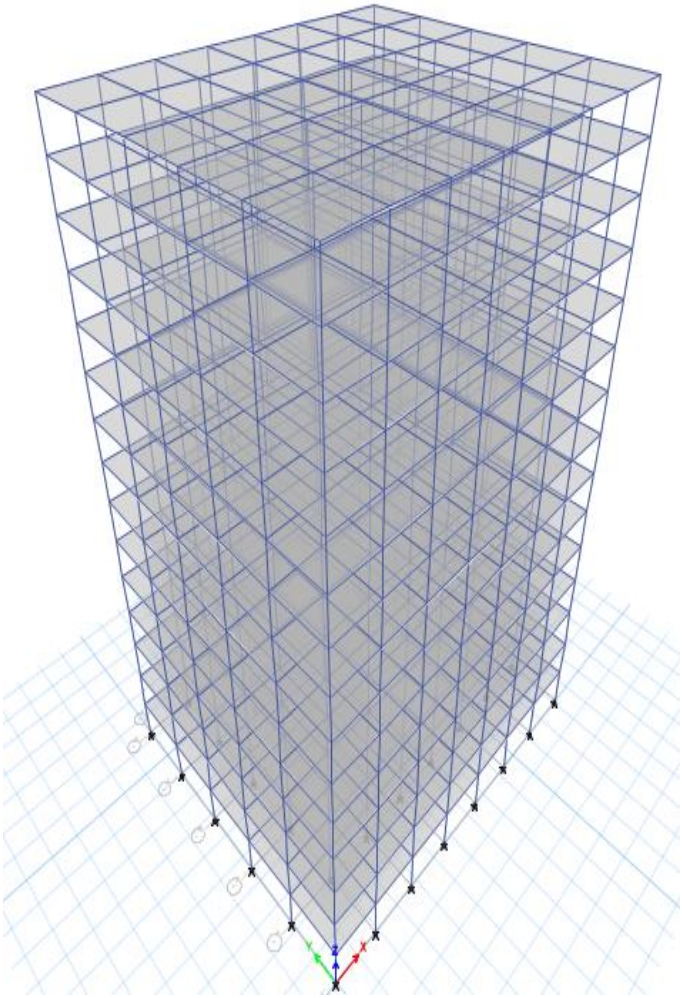
Linear static analysis can be performed by equivalent static lateral force method. This method can be applied for regular structure with limited height i.e. for low and medium height buildings.

The horizontal seismic co-efficient and total seismic weight of the structure is determined and hence base shear is found.

6. STRUCTURAL PLAN LAYOUT OF RCC BARE FRAME



7. 3 D MODEL OF RCC BARE FRAME



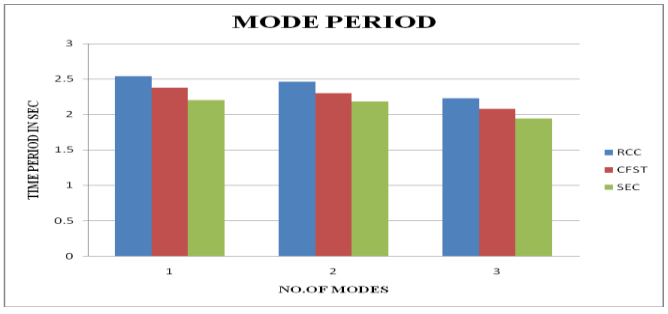
In the present work comparative study of RCC and composite bare frame building with G+14 floors are modeled by utilizing ETABS 2015 and these structures are subjected to linear static and dynamic analysis involving equivalent static lateral force and response spectrum analysis.

To ascertain the response of G+14 floor RCC and composite bare frame building with parameters such as displacement, time period, acceleration, base shear is determined by equivalent static lateral force method and response spectrum method.

8. MATERIALS AND SECTION PROPERTIES OF RCC AND CFST STRUCTURE

	CFST STRUCTURE	RCC STRUCTURE
GRADE OF CONCRETE	M-40	M-40
GRADE OF REINFORCING STEEL	Fe-415	Fe-415
GRADE OF STRUCTURAL STEEL	250 N/mm^2	
UNIT WEIGHT OF CONCRETE	25 KN/mm^3	25 KN/mm^3
SECTION PROPERTIES		
COLUMN SIZE	300X450X18 mm	600X900 mm
BEAM SIZE	ISMB-500	200X500
SLAB THICKNESS	150 mm	150 mm
BUILDING PLAN		
NUMBER OF BAYS IN X DIRECTION	7 m	7 m
NUMBER OF BAYS IN Y DIRECTION	5 m	5 m
WIDTH OF BAYS IN X DIRECTION	5 m	5 m
WIDTH OF BAYS IN Y DIRECTION	6 m	6 m
HEIGHT OF STORY	3.5 m	3.5 m
LOAD ASSIGNMENT		
LIVE LOAD ON ROOF SLAB	2 KN/m^2	2 KN/m^2
LIVE LOAD ON FLOOR SLAB	2 KN/m^2	2 KN/m^2
FLOOR FINISH	1 KN/m^2	1 KN/m^2
SEISMIC DATA		
SEISMIC ZONE	5	5
IMPORTANCE FACTOR	1	1
RESPONSE REDUCTION FACTOR	5	5
SOIL TYPE	TYPE-2	TYPE-2
FUNCTION DAMPING RATIO	5 %	5 %

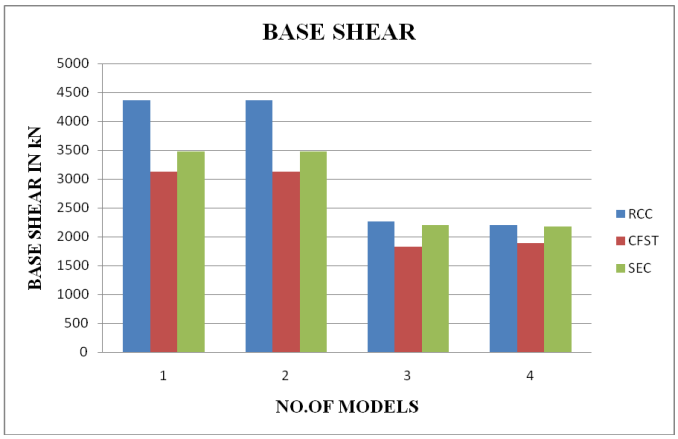
9. TIME PERIOD



It was observed that, the mode period is more in RCC building when compared with composite building and also mode period decreases with increase in number of modes in all other models.

The modal analysis is conducted to understand mode period and mode shapes. Response spectrum analysis and equivalent static lateral force method are administered for zone 5, as per Indian standard code 1893:2002 for medium soil.

10. BASE SHEAR



It was cleared that, base shear is increased by 29 % and 21 % in RCC model when compared with CFST and SEC structure along X and Y direction respectively for equivalent static lateral force method.

Similarly it was increased by 19 % and 3 %in RCC structure when compared with CFST and SEC along X direction and 15 % and 2 % along Y direction in response spectrum method.

11. CONCLUSIONS

RCC building is having maximum mode period because mass acts more in this building. This shows that time period is directly proportional to the mass of the building and SEC building is having lesser time period because steel quantity is more in this building.

Base shear is more in RCC building when compared with CFST and SEC because concrete weight will be more when compared with steel.

Displacement increases with increase in height of the building and RCC building is having more displacement when compared with CFST and SEC because stiffness is less in this building.

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