DESIGN AND ANALYSIS OF MULTI STOREYED BUILDING UNDER STATIC AND DYNAMIC LOADING CONDITIONS USING WITH E-TABS

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ABSTRACT
Analysis of buildings for static forces is a routine affair these days because of availability of specialized programs which can be used for the analysis. On the other hand, dynamic analysis is a time-consuming process and requires additional input related to mass of the structure, and an understanding of structural dynamics for interpretation of analytical results. Reinforced concrete (RC) frame buildings are most common type of constructions in urban India, which are subjected to several types of forces during their lifetime, such as static forces due to dead and live loads, wind and dynamic forces due to the wind and earthquake. In this project a residential of G+7 multi-story building is studied for earth quake loads using ETABS. Assuming that material property is linear, under static and dynamic loads analysis is performed. Non-linear analysis is carried out by considering severe seismic zones III and V and the behavior is assessed by taking type II soil condition. Different response like storey displacements, storey drifts and storey shear are plotted to study the behaviour of the building.
Keywords: Multi-storey building, static loads, dynamic loads, ETABS, storey displacements, storey drifts and storey shears.

1.0 INTRODUCTION
These days earthquakes have become very frequent in the nature due to several reasons, here we don't discuss about the reasons of earthquake rather our subject is how to with stand the earthquake loads on the structures or buildings. This becomes the major criteria for us, as the earthquakes are becoming quite common to us designing the building or analyzing the buildings in general regular format using the static loads such as live load, dead load etc., we can't design a safer building especially in the case of high raised building it is because in high raised building there will be wind pressure on the building at greater magnitude which varies time to time depending upon the intensity, velocity and direction of wind i.e., dynamic in nature similarly to earth quake loads so as to withstand these type of loads, static methods are not enough and hence we go for dynamic analysis and we model the required structure using ETABS software and analyse the structure in the ETABS using the response spectra method.

Dynamic Analysis
Structures on the earth are generally subjected to two types of loads i.e. static and dynamic. Static loads are constant with time while dynamic loads are time varying. In general, the majority of the civil structures we design assuming only the static loads. The effect of dynamic load is not actually considered in many cases it is because, in India the structures are rarely affected by the earthquake and more over its considerations in the analysis makes the solution more complicated and time consuming.

Need for the work
Tall building developments have been rapidly increasing worldwide. The growth of multi-storey building in the last several decades is seen as the part of necessity for vertical expansion for business as well as residence in major cities. As the height of the building increases the lateral resisting system becomes more important than the structural system that resists the gravitational loads. From the research papers it is observed the response of the structures subjected to Earthquake excitation. They are found to be increasing in the Natural time period, reduction in lateral displacement and reduction in story drift of the building. In this present study, it is proposed to compare between the performances of conventional structure and geo-polymer concrete structure in the high-rise buildings

Scope of the work
The study focuses on comparison of seismic analysis of conventional concrete structure and geo-polymer concrete structure. For the analysis, the model of RC building G+7storey is considered. The performance of the building is analyzed in Zone III. Modeling and analyzation of the structure is done in ETABS 2016 software. The model of the building with conventional concrete structure and geo-polymer concrete will be implemented in the software and it would be analyzed for response spectrum. Time period of the structures are retrieving from the software and as per IS 1893(part 1):2002 seismic analysis has undergone and storey displacements, storey drifts, storey shear will be compared.

2.0 LITERATURE REVIEW

The chapter involves the discussion of various research papers reviewed for achieving the aim of the project. The following research papers have discussed about the dynamic analysis, response spectra analysis and design of different multi-storey structures in different loading conditions such as static forces and dynamic forces using software's such as E-tabs, Stadd Pro etc. This in turn helps us in archiving our aim of the project.

Alhamd Farqaleet [1] In this case we can observe that storey drift increases from base to top floor. Maximum storey drift is found to be within the permissible storey drift range as per IS 1893:2002. The max drift obtained at 10^{th} storey is 0.106m while permissible drift is approximately 0.124m. The max base shear in x and y direction are 2528.2 KN and 184.59 KN hence we can conclude that time history analysis should be performed as it predicts the structural response more accurately than response spectrum analysis.

Gouse Peera, [2] In this journal he gives importance to the shape Irregular shaped are severely affected during earthquakes especially in high seismic zones Base shear is calculated for different kinds of structures we get lowest base shear for L shaped building and highest for rectangular shaped. Irregular shape building undergoes more deformation than the regular shape building C shape building is more vulnerable than other shaped building

T. Pranay Kumar [3] There is no much difference in the magnitude of axial forces in the static and dynamic analysis of the steel structures Magnitude of moments are higher in the case of static analysis when compared with the dynamic analysis We can observe the values of torsion in the static analysis are negative and the values are positive in the case of dynamic analysis the values of displacements at the different points in the beam are higher for static analysis and lesser for dynamic analysis.

G. B. Bhaskar [4] There is remarkable increase in axial force for static state as compared to dynamic state. increase in shear force for static state as compared to dynamic state. the bending moments for dynamic state is more as compared to static state. As the floor height increases, the bending moment in beam decreases.

The research papers above have discussed about the about the studies on dynamic analysis, response spectrum analysis, design of a multi-story building in different seismic zones and by considering different criteria and using different software this study has helped to choose the parameters on which seismic analysis depends and best methodology to get the accurate results as per our requirement.

3.0 MATERIALS AND METHODS

The chapter involves in material collection and the laboratory testing of the samples. This involves the collection of samples and various test procedures conducted at the lab. The laboratory testing of the samples is explained in detail along with the procedures and results. These works play an important role in assessing the properties of the samples. The evaluation of the properties by conducting various tests provides the opportunity to determine whether the material is used for construction or not by considering the Indian standard code.

Fine Aggregate

The material which passes through 4.75 mm sieve and retains on 75 microns sieve such a material is known as fine aggregate this is the important material in the concrete preparation, the strength of the concrete depends up on the type of the fine aggregate used and also quality of the material used if at all low grade material is used then in such case the slump value varies, water absorption varies along with this strength of the material also will also be effected hence always fine aggregate is selected in such a way that all the material properties of such material should satisfy the is code requirements.

Coarse Aggregate

Material which passes through 4.75mm sieve and retained on 80mm sieve such material is known as coarse aggregate the major part of the concrete is of coarse aggregate out of all the aggregate used in concrete about 60 - 70% of the material is of coarse aggregate hence it is the deciding factor to attain the calculated strength hence the quantity and quality this type of materials is to be taken according to Indian standard only.

Grain Size Analysis

This test is performed to determine the percentage of different grain sizes contained. The mechanical or sieve analysis is performed to determine the distribution of the course, larger-sized particles. Grain size analysis provides the grain size distribution, The equipment required are Balance, Set of sieves, Cleaning brush.Prepare a stack of sieves. Sieves having larger opening sizes (i.e. lower numbers) are placed above the ones having smaller opening sizes (i.e. higher numbers). To sieves are arranged in the order of 4.75mm, 2mm, 425microns and 75microns from top to bottom respectively.

Cement

Cement is the binder material, a substance that sets and hardens and can bind other materials together. The word "cement" traces to the Romans, who used the term opus cementatim to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick supplements that were added to the burnt lime, to obtain a hydraulic binder, were later referred to as cementum, and cement.

Recycled Coarse Aggregate

Materials which are dismantled are collected from the respective site and then the physical properties of their materials are found using the below test procedure, if the values of these materials (properties such are as specific gravity, density etc…) are in the range of Indian standards then in such a case these materials are allowed to use in the preparing the cube for finding the compressive strength of the cube.

CURING

The test specimens are stored in moist air for 24hours and after this period the specimens are marked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.

Linear static analysis

This method of finding lateral force is also known as the static method or equivalent static method or seismic coefficient method. The static method is the simplest one and it required less computational effort and it is based on formula given in the code of practice IS 1893:2002 (part-1). The design against seismic loads must consider the equivalent linear static methods. It is to be done with an estimation of base shear load and its distribution on each story calculated by using formula given in the code.

Linear dynamic analysis

Response spectrum method is the linear dynamic analysis method. In that method the peak response of structure during an earthquake is obtained directly from the earthquake response, but this is quite accurate for structural design applications.

In **linear time history analysis** overcomes all the disadvantages of modal response spectrum analysis, provide non-linear behavior is not involved, the support points of the model are oscillated back and forth in accordance to a recoded ground motion of an actually occurred earthquake (as recorded by a seismograph and available in tabular form of time vs acceleration).

Response spectrum method

The response spectrum method (RSM) was introduced in 1932 in the doctoral dissertation of Maurice Anthony Biot at Caltech. It is an approach to finding earthquake response of structures using waves or vibrational mode shapes. The mathematical principles of oscillations in n-degree-of-freedom systems were taken largely from the theories of acoustics developed by Rayleigh.

MODELING AND ANALYSIS

This chapter deals with the modeling and analysis of the structure under various loads. The finite element package ETABS V16.2.1.0 has been used for the analysis. A three-dimensional model of the structure has been created to undertake static and dynamic analysis. The model ideally represents the complete three dimensions (3D) characterizes of the building, including its mass distribution, strength, stiffness deformability. Modeling of the material properties, structural elements, load patterns, load cases and combinations and response spectrum and time history functions are discussed in this chapter.

Problem Formulation

The building considered in the present study is G+7 storied R.C framed building of symmetrical rectangular plan with configuration of buildings having a plan area of 48m x 24m with a storey height 4.5 m each and total height of chosen building including depth of foundation is 40.5 m. Complete analysis is carried out for dead load, live load, wind and seismic load using E-tabs Response spectra method for dynamic analysis is used. Loading combinations are considered as per IS 1893:2002.

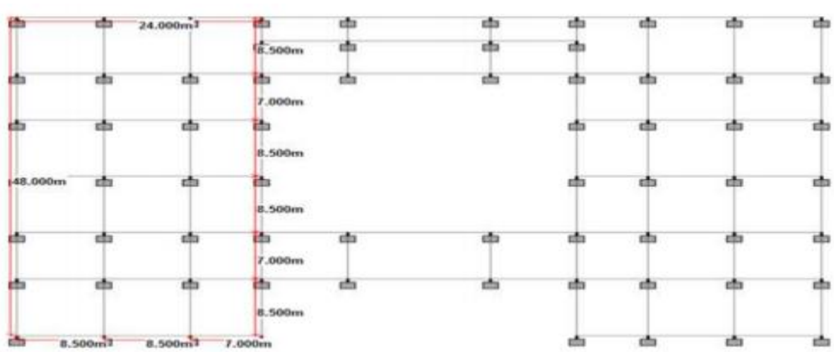

Figure 1.1: Plan of G+7 Building

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Building properties

Site Properties:

- Details of building: G+7 RC structure
- Outer and inner wall thickness: 200 mm
- Floor height: 4.5 m
- Height of the building: 40.5 m

Seismic Properties:

- Seismic zone: V
- Zone factor: 0.36
- Importance factor: 1
- Response Reduction factor R: 5
- Soil Type: Hard soil

Material Properties

- Material grade of M30 used for the analysis.
- Loading on structure
- Dead load: self-weight of structure including infill.
- Live load: 4 KN/m²
- Wind load: As per IS 875(Part 3) 1987
- Seismic load: Seismic Zone -V

Preliminary Sizes of members:

- Column sizes: 750mm x 750mm
- Number of columns: 64 nos. at each floor
- Column sizes: 1000mm x 1200mm
- Number of columns: 4 nos. at each floor
- Beam sizes: 750mm x 350mm
- Beam sizes: 1000mm x 500mm
- Slab thickness: 250mm

Description of Loads All moving loads come under live loads:

- Live load (on floors): 2kN/m2, (IS 875:1987 – Part -2)
- Live load (on roof): 1kN/m2, (IS 875:1987 – Part -2) Floor finishes are the super imposed dead loads.
- Floor Finishes (on floors): 1.5kN/m2
- Floor Finishes (on roof): 2kN/m2 Wall loads are the loads of bricks used in construction.
- For 9” wall (outer wall):12.45kN/m2 (wall thickness * height of the floor*density of brick = 0.23*3*18)

For 4.5” wall (inner wall): 6.21kN/m2 (wall thickness *height of the floor*density of brick = 0.115*3*18) Earthquake loads are given so that the building shall be earthquake resistant. Zone: IV (According to the present zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity.)

Zone factor: 0.24 Soil type: II (medium stiff soil) Importance factor, I: 1.0 (as residential building) The building is proposed to have ordinary moment resisting frame.

Factors and Coefficients: Risk Coefficient, [IS 5.3.1] k1=1

Topography Factor, [IS 5.3.3] k3=1

Lateral Loading:

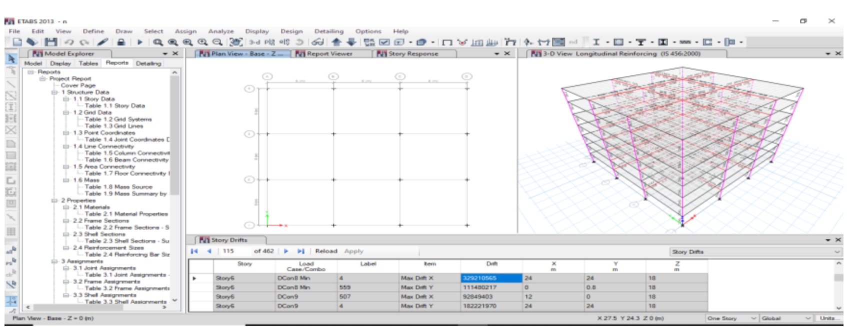

Figure: 3.2 Plan and 3D view of the structure

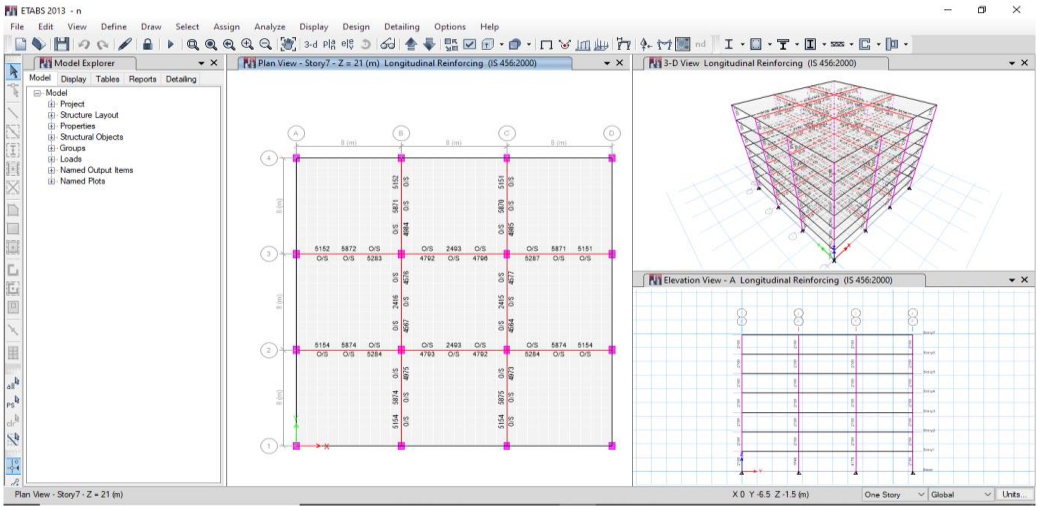

Figure: 3.3 Plan, Elevation and 3D view of the structure

After completing the modeling we need to define materials such as concrete, steel etc. which are required in defining the structural members such as beams, columns, stair case etc.,

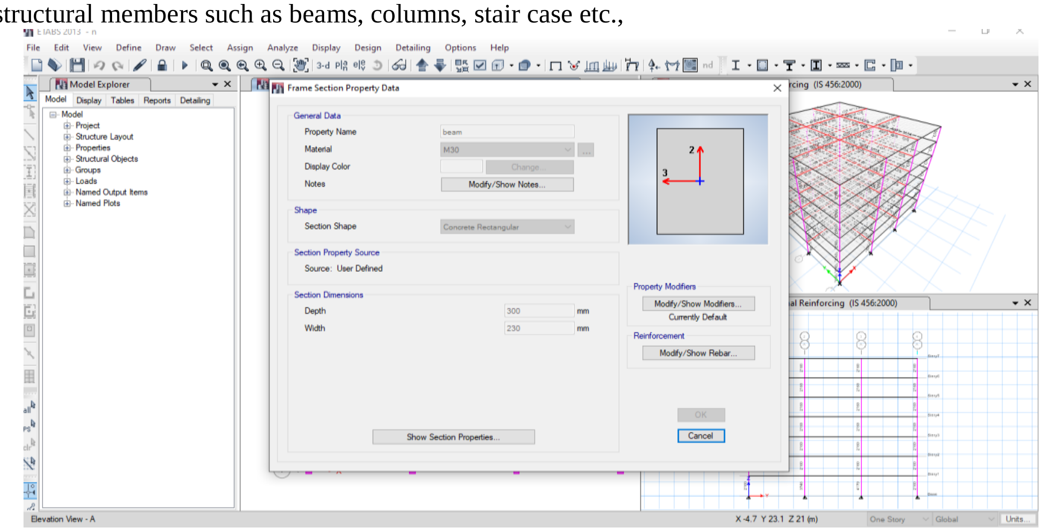

Figure 3.4 Defining of beam

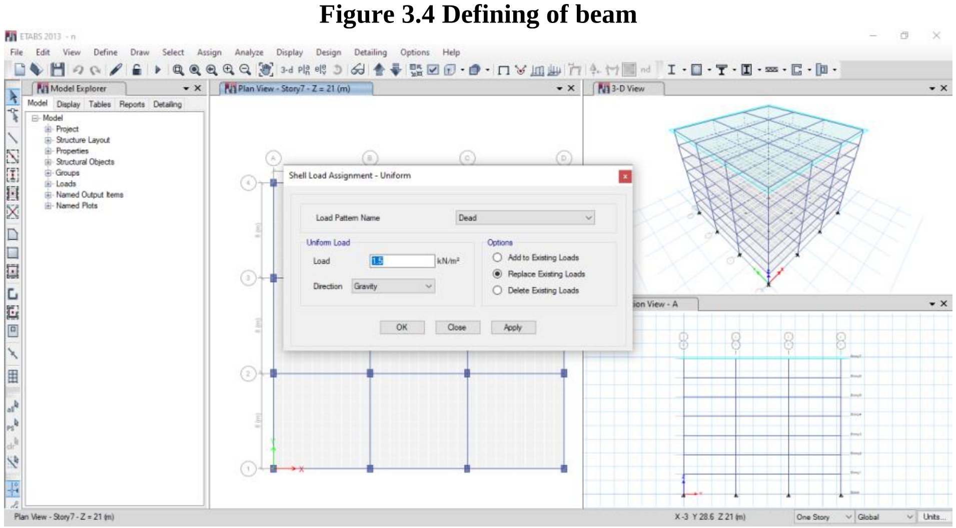

Figure 3.5 Defining Floor Finish load (DEAD LOAD)

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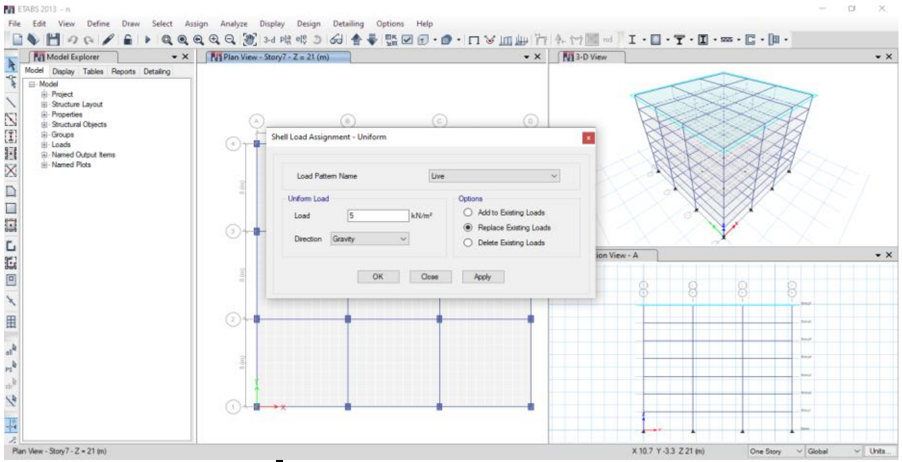


Figure 3.6 Defining Live Load

After assigning the loads which are defined above, we also define the earth quake loads, wind loads as per our requirements, the figures below will explain the way we define the lateral loads such as both earth quake and wind loads and in the below figures we can observe the structure after we apply all the loads.

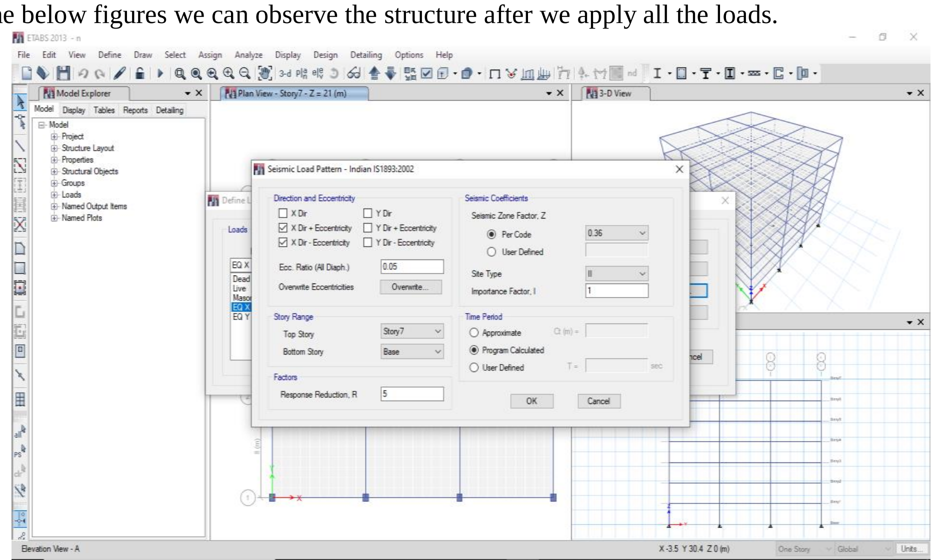


Figure 3.7 Defining the Earth Quake Load X

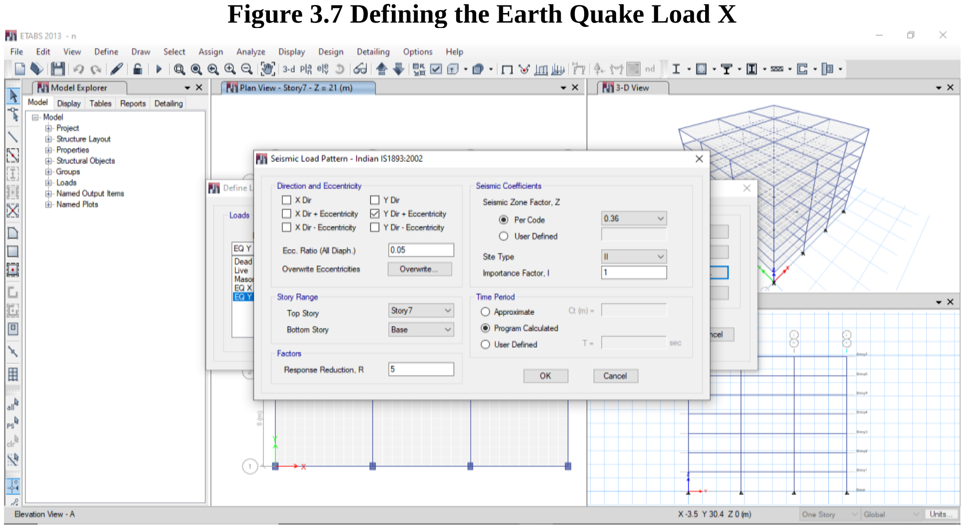


Figure 3.8 Defining the Earth Quake Load Y

In the following Fig. definitions of loading are shown. Several loads are applied on both the structure such as dead load which is self-weight, super dead load which is applied dead load, live load which is imposed load, wind load at two directions X and Y which is imposed load, earthquake load at two directions applied X and Y direction which is imposed load, Load combination is done as per IS: 1893-2002.

Load combinations as per IS codes

When earthquake forces are considered on a structure, load combinations shall be combined of partial safety factors for limit state design of reinforced concrete structures where terms like DL, LL, EQX and EQY, RSX and RSY, THX and THY stands for response quantities due to dead load, live load, earthquake loads in X and Y direction, response spectrum in X and Y direction and time history in X and Y direction respectively. Load combinations are considered according to IS 1893-2002 part 1 is tabulated in Table 5.2

Table 3.2 Load combination as per Indian standards

Load Combination	Load Factors
Gravity Analysis	1.5(DL + LL)
Equivalent Static Analysis	1.2(DL + LL $\pm$ EQX)
	1.2(DL + LL $\pm$ EQY)
	1.5(DL $\pm$ EQX)
	1.5(DL $\pm$ EQY)
	0.9(DL $\pm$ EQX)
	0.9(DL $\pm$ EQY)
	0.9DL $\pm$ 1.5EQX
	0.9DL $\pm$ 1.5EQY

4.0 RESULTS AND DISCUSSIONS

The seismic analysis of the modeled structures with shear walls and diagrids spanning in two directions are carried out by using ETABS software and the results are given in the following sections. The parameters studied are story displacement, story drifts, base shear and storey stiffness in seismic zones III. Comparison of seismic behavior is made between the structures with conventional concrete and geo-polymer concrete. The comparison has done in Response Spectrum method.

Table 4.1 Story drifts of the structures in zone III in X-direction

Drift(mm) in Zone III in X-direction			
Story	**Elevation (m)**	**X**	**Y**
		Drift(mm)	Drift(mm)
Story7	21	-1.745	-0.5297
Story6	18	-1.063	-0.3476
Story5	15	-3.732	-0.0515
Story4	12	-0.8604	-0.2058
Story3	9	-1.442	-0.1479
Story2	6	-0.2711	-0.05726
Story1	3	-0.1195	-0.01442
Base	0	0	0

4.1 Result comparison of static and dynamic results:

Columns = 0.75 x 0.75m & 1 x 1.2 m

Beams = 0.75 x 0.35 m& 1 x 0.5 m

Live load on the floors is 4 KN/m2

Grade of concrete: Used M25 concrete

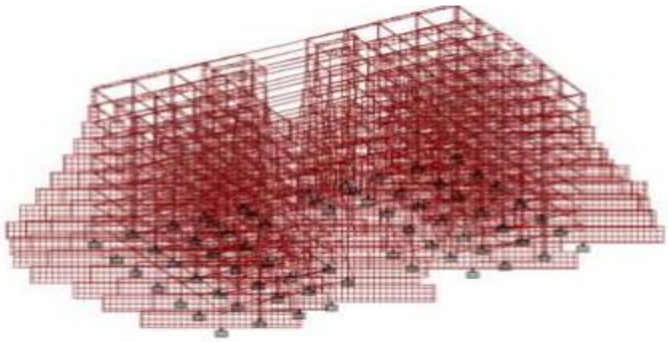


Figure: 4.1 Axial Force Diagram (Static)

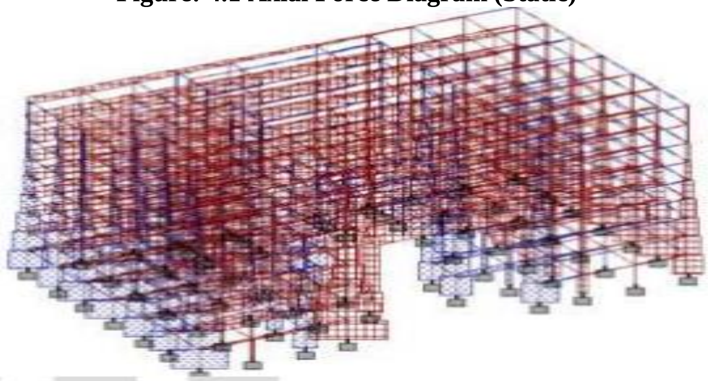


Figure: 4.2 Axial Force Diagram (Dynamic)

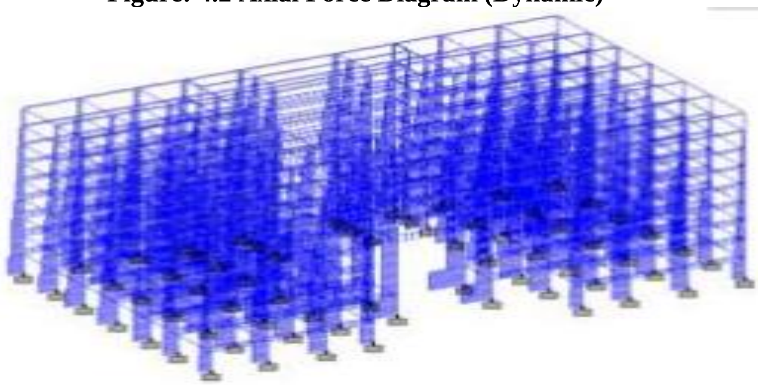


Figure: 4.3 Shear Force Diagram (Static)

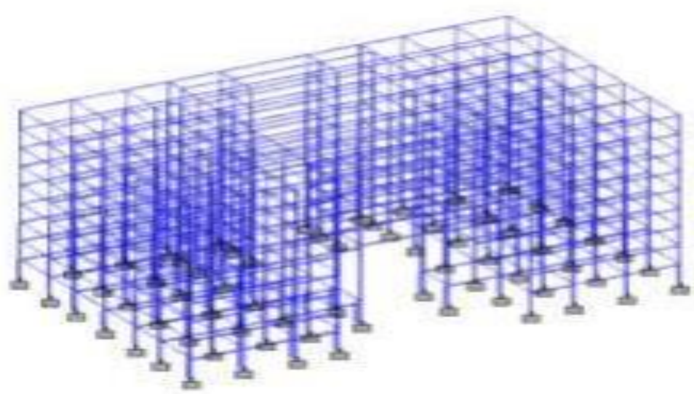


Figure: 4.4 Shear Force Diagram (Dynamic)

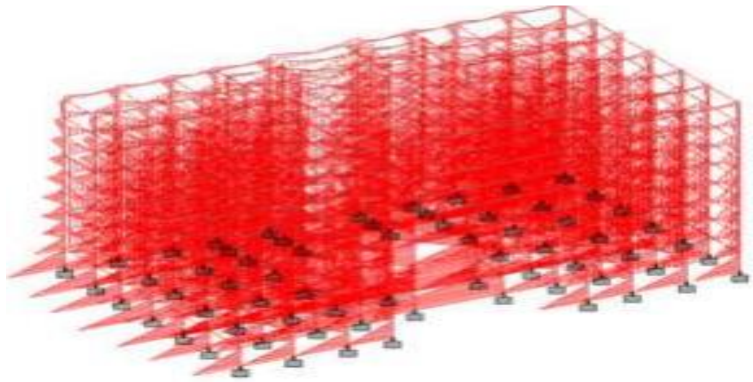


Figure: 4.5 Bending moment (Static)

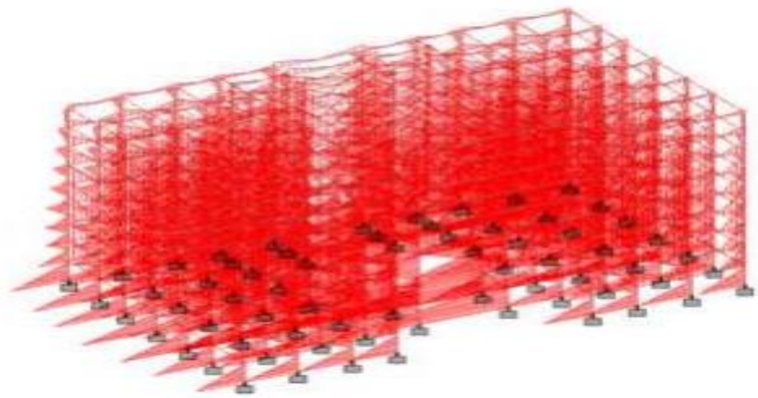
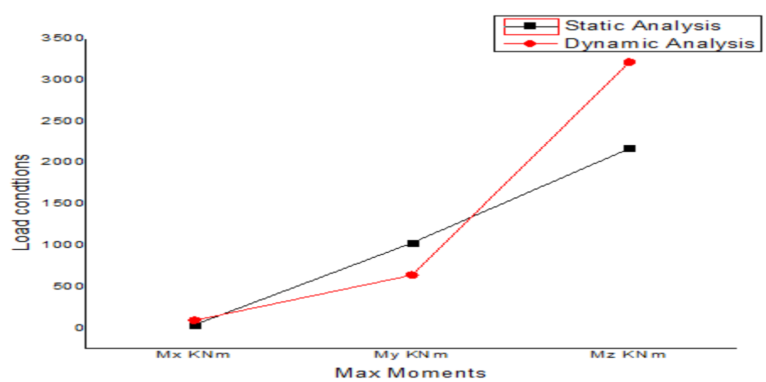


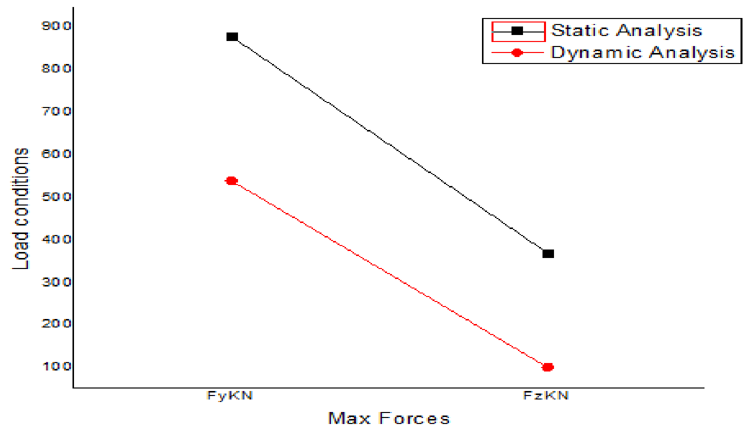
Figure: 4.6 Bending moment (Dynamic)

Table: Result comparison of static and dynamic results

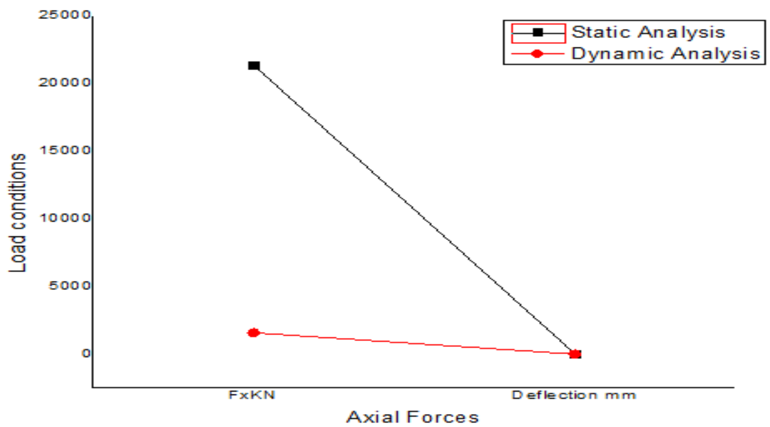
Particulars	Static Analysis	Dynamic Analysis
Max Moments		
Mx KNm	38.635	92.934
My KNm	1029.329	640.199
Mz KNm	2169.87	3213.101
Max Forces		
FyKN	877.562	538.36
FzKN	368.041	99.638
Axial Forces		
FxKN	21311.26	1570.604
Deflection mm	22.343	0.91



Graph: 4.1 Load conditions vs Max Moments



Graph: 4.2 Load conditions vs Max forces



Graph: 4.3 Load conditions vs Axial forces

DISCUSSIONS:

The behavior of the buildings in Zone V are analyzed for Static and Dynamic condition. The parameters such as maximum deflection, maximum moments, maximum shear forces and axial forces are studied and comparison between these parameters are given between the Static and Dynamic state for Zone V.

There is remarkable increase in axial force for Static state as compared to Dynamic state.

There is remarkable increase in Shear force for Static state as compared to Dynamic state.

In beam the bending moments for Dynamic state is more as compared to Static state. As the floor height increases, the bending moment in beam decreases.

- As a result, the comparison between both the analysis it is observed that the deflection obtained by Static analysis is higher than Dynamic analysis.
- As the effect of earthquake is more in bending moment in column, footing and beam displacement in column joint, if structure is designed for Static case it will not sustain earthquake load (Dynamic). So, we have to consider the earthquake load for the analysis and design.
- The bending moment due to earthquake load in column is highly increasing with the storey height. So, if earthquake load is not considered for the analysis there will be possibilities for overturning.
- The result of Static analysis are approximately uneconomical as the values of deflection are higher for Dynamic analysis.

CONCLUSIONS

The dynamic response of structures is applicable to the analysis of this method. In their linear range behavior, the areas of geometrical discontinuity or irregularity. Modeling and Analyze the buildings in ETABS software to carry out the storey deflection, displacement, storey drift, storey shear force and base shear of regular using equivalent static method and response spectrum method to compare the results. The dimensions of the members and the material properties were assigned in the previous chapter, the seismic behavior of the modeled structures i.e. story displacement, story drifts, base shear and natural time period in seismic zones are discussed concrete structure in response spectrum method. In this chapter, the conclusions of the obtained results are discussed in detail. The maximum displacement is increased from first storey to last storey. Base shear reverence is more in the storey 7 and that in the delicate soil in unpredictable setup. Unpredictable shapes are seriously influenced amid quakes particularly in high seismic zones. The unpredictable shape working under go more misshapening and subsequently normal shape must be favored. Because of high flexible nature of steel, it prompts expanded seismic opposition of the composite segment in composite structure

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