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COMPARATIVE STUDY OF STATIC AND DYNAMIC SEISMIC ANALYSIS OF G+12 R.C.C BUILDING BY USING ETABS SOFTWARE

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ABSTRACT

Analysis of buildings for static forces is a routine affair these days because of availability of affordable computers and 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 dynamic 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 and dynamic forces due to earthquake. Here the present study describes the effect of earthquake load which is one of the most important dynamic loads along with its consideration during the analysis of the structure. In the present study a high rise framed structure is selected. Linear seismic analysis is done for the building by static method (Equivalent Static Analysis Method) and dynamic method (Response Spectrum Method) using ETABS as per the IS-1893-2016-Part1 for earthquake forces in different seismic zones of India. The principle objective of this project is the comparative study on design and analysis of G+12 building by ETABS software. A comparison is done between the Static (Equivalent Lateral) and Dynamic(Response Spectrum Analysis) analysis for G+12 building for various parameters like storey displacement, storey shear and storey drift.

I. INTRODUCTION

A natural calamity, an earthquake has taken toll of millions of lives through the ages, in the unrecorded and recorded history. A disruptive disturbance that causes shaking of the surface of the earth due to underground movement along a fault plane or from volcanic activity is called earthquake. The earthquake ranks as one of the most destructive events recorded so far in India in terms of death toll & damage to infrastructure last hundred years. All over the world, there is a high demand for construction of tall buildings due to increasing urbanization and spiralling population, and earthquakes have the potential for causing the greatest damage to tall structures. Since the earthquake forces are random in nature and unpredictable, the engineering tools need to be sharpened for analysing structures under the action of these forces. Structural analysis is mainly concerned with finding out the behaviour of a structure when subjected to some action. This action can be in the form of load due to weight of things such as people, furniture, wind, snow etc. or some other kind of excitation such as earthquake, shaking of the ground due to a blast nearby, etc. Structural design of buildings for seismic loads is primarily concerned with structural safety during major ground motions, but serviceability and the potential for economic loss are also of concern. Seismic loading requires an understanding of the structural performance under large inelastic deformations. Behaviour under this loading is fundamentally different from wind or gravity loading, requiring much more detailed analysis to assure acceptable seismic performance beyond the elastic range. Some structural damage can be expected when the building experiences design ground motions because almost all building codes allow inelastic energy dissipation in structural systems. The first step in dynamic analysis is to develop a mathematical model of the building, through which estimates of strength, stiffness, mass, and inelastic member properties are assigned. In general, for a multi storey building it is necessary to take into account contributions from more than one mode. have been carried out. In dynamic analysis; Response Spectrum method is used. ETABS stands for Extended Three-dimensional Analysis of Building Systems. ETABS is commonly used to analyse: Skyscrapers, parking garages, steel & concrete structures, low- and high-rise buildings, and portal frame structures.

II. MODELLING OF RCC FRAME

In this project, a G+12 Storey building was studied. The structure was modelled and analysed in ETABS V19. The seismic performance of the structure was carried out by linear static analysis and linear dynamic analysis. Further, the structure was analysed as per IS provisions.

An RCC framed structure is basically an assembly of slabs, beams, columns and foundation inter-connected to each other as a unit. The load transfer mechanism in these structures is from slabs to beams, from beams to columns, and then ultimately room columns to the foundation, which in turn passes the load to the soil. In this structural analysis study,

The building is 30m x 25m in plan.

Floor height of 3 m is assumed.

Elevation of the building is shown in the following figure

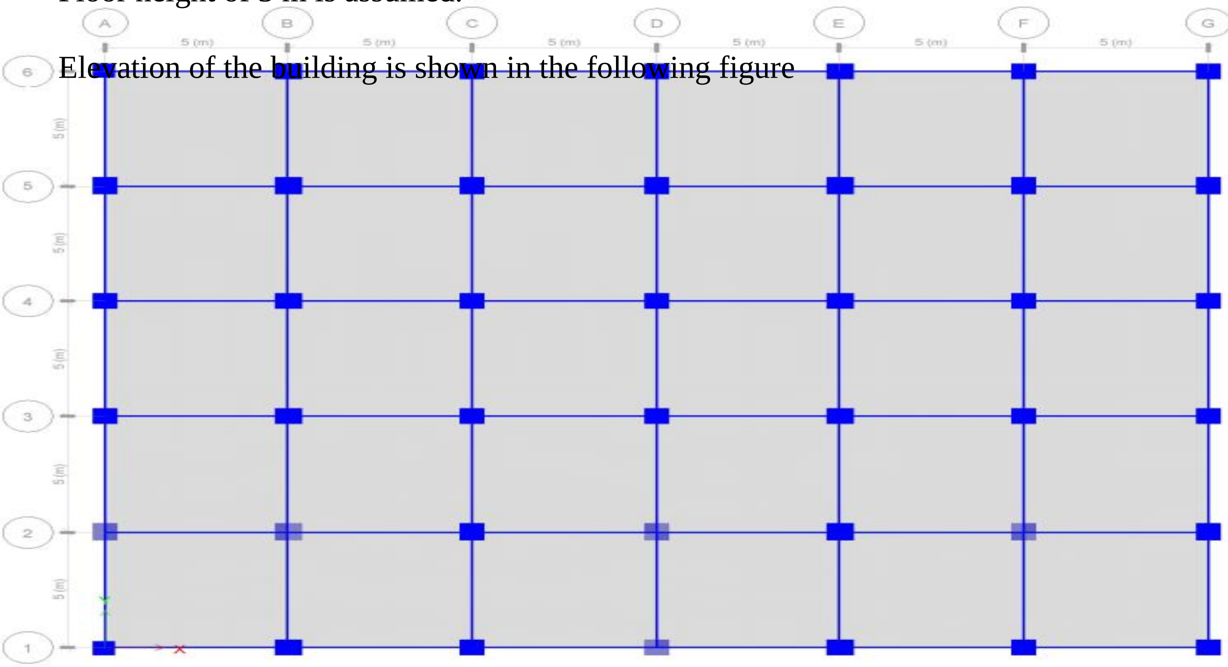

Fig:1 Plan of RCC Structure

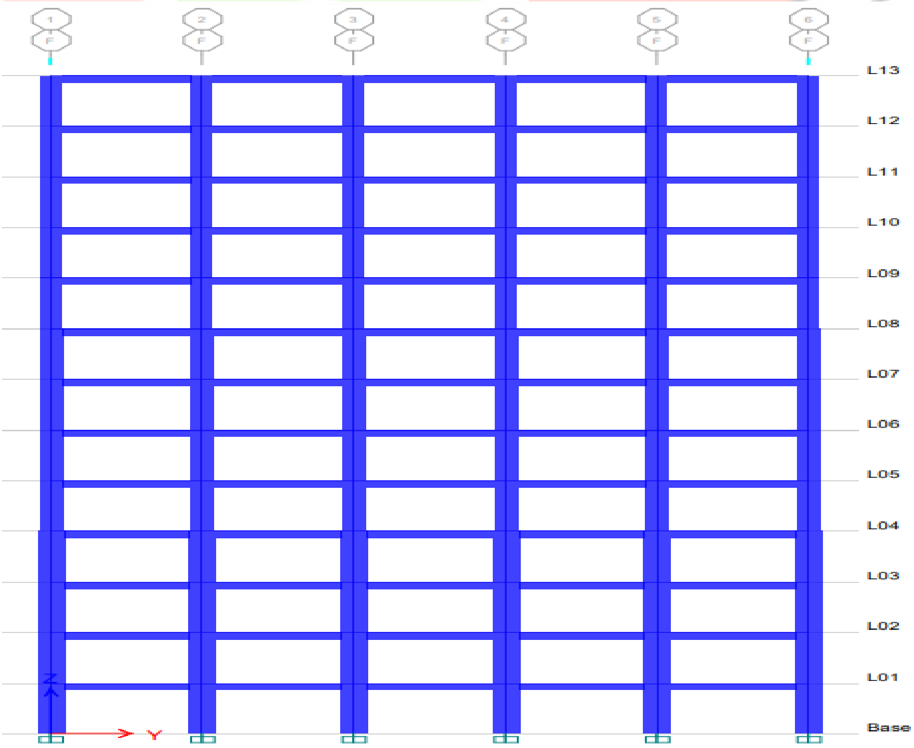

Fig:2 Elevation view of RCC Structure

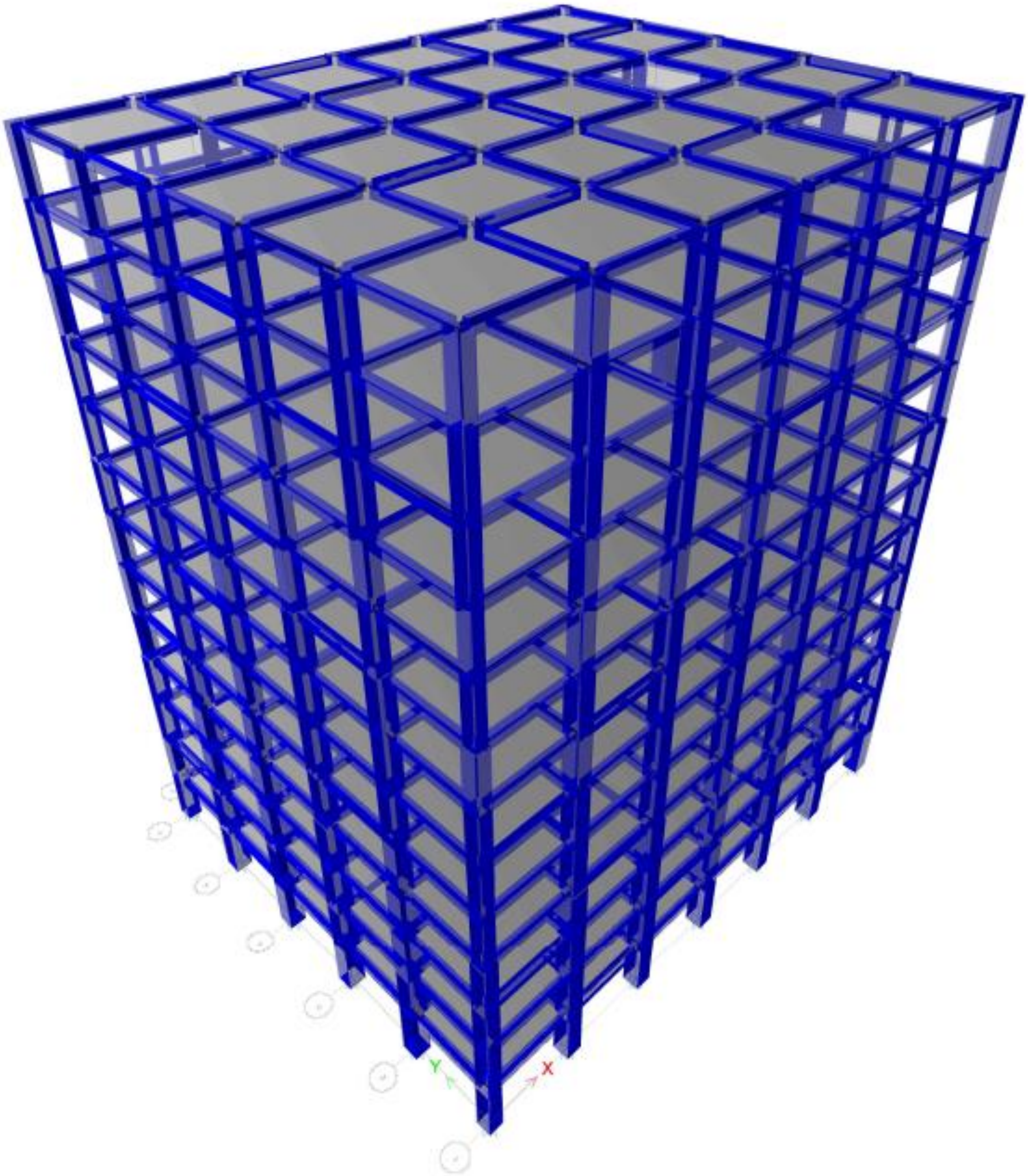

Fig:3 3D View of the RCC Structure

Table: 1 Design Data of RCC Frame Structures

S.NO	PARTICULARS	DIMENSION
1	Model	G+12
2	Floor Height	3m
3	Plan Size	30 X 25m
4	Size of Columns	
	i. For Stories 1 to 4	0.7m X 0.7m
	ii. For Stories 5 to 9	0.8m X 0.8m
	iii. For Stories 9 to 13	0.9m X 0.9m
5	Size of Beams	0.4m X 0.4m
6	Walls	0.25m
7	Thickness of Slab	0.15m
8	Type of Soil	Type I, Hard Soil as Per Is 1893
9	Seismic Zone	V
10	Material Used	Concrete M35 and Reinforcement F_e 415

III. LOADS APPLIED ON THE STRUCTURE

1 Dead Load: ETABS automatically calculates dead loads of beams, columns, slabs and shear wall.

2 Super Imposed Dead Load:

Super imposed Dead Loads on Beams: Super dead load on beams is due to external and internal walls load on the beam since it is framed structure so we didn't consider super imposed dead load on beams.

Super Dead Loads on Slabs: Super dead loads on slabs are due to floor finishes on slabs. Super dead load on slab = (2 times mortar + clay tiles)

As per IS 875 part 1, super dead loads on typical floors and roofs are as follows

Table:2 Super Dead Loads on Typical Floors Provided in this Structure

Material	Thickness (mm)	Unit Weight (kN/m^3)	Load (kN/m^2)
Tiles	10	23	0.230
Cement Mortar	10	21	0.210
Sand	10	18	0.180
Plaster	10	21	0.210
Total			**0.83**

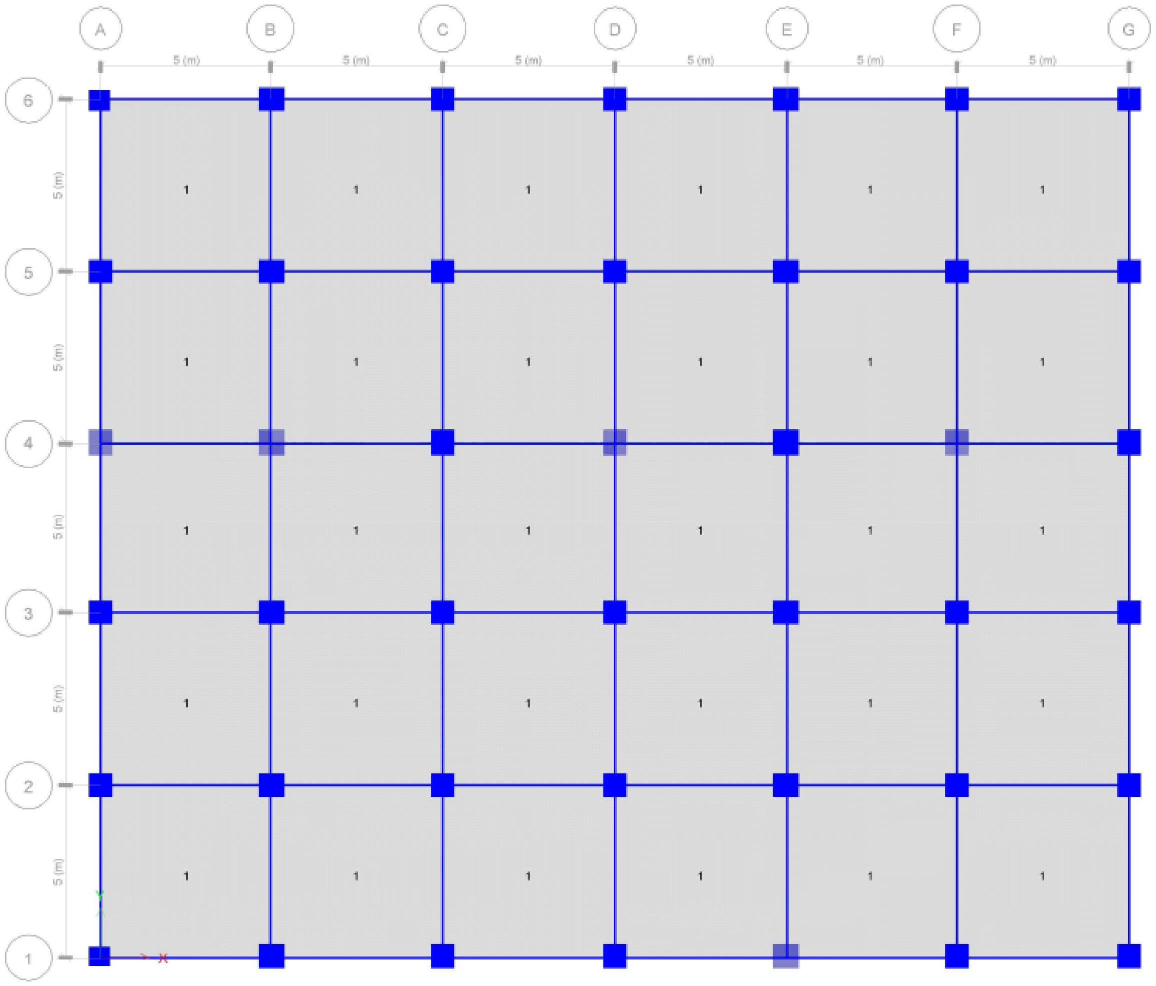

Fig:4 Super Imposed Dead Load

Table :3 Super Dead Loads on Roof Provided in this Structure

Material	Load (kN/m^2)
Floor Finishing with Water Proofing Coat	1

3 Live Load:

As per IS 875 Part 2, live loads on floors are shown

Table:4 Live Loads on Floors as per IS 875 Part 2

Live Loads On Floors	Load (kN/m^2)
Hall	2.5
Bed Room	2.5
Toilet	2.5
Corridors	2.5

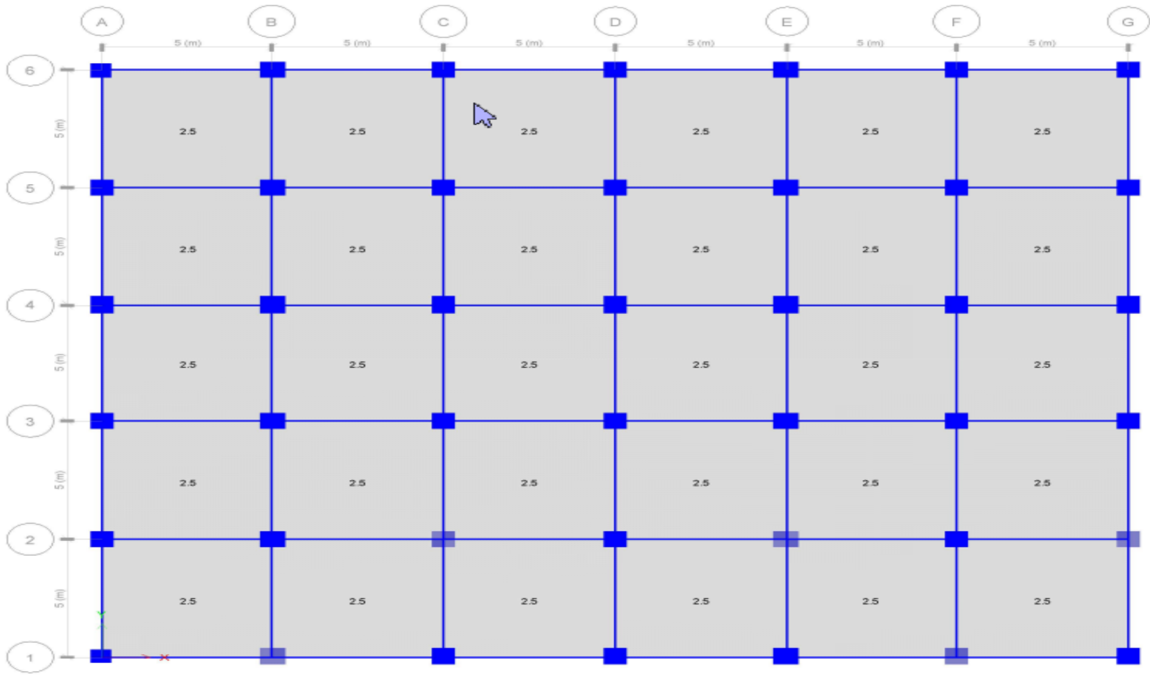

Fig:5 live load on Floor

As per IS 875 Part 2, live loads on the roof and headroom as shown in Table 3.5

Table:5 Live Loads on Roof and Head Room as per IS 875 part 2

Live Loads on Roof & Head Room		Load (kN/m^2)
Roof	With Access	2.5

4 Earthquake Load:

As Per IS 1893-2016, Earthquake Loads are as shown

Table:6 Earthquake Loads

Zone Factor (Z)	V
Importance Factor (I)	1
Response Reduction (R)	5
Soil Type	I
Height Of Building (m)	39
Base Dimension In X-Direction (m)	30
Base Dimension In Y-Direction (m)	25

5 Time Period (Ta):

Table:7 Time Periods in X and Y directions

Time Period (Ta)	Brick with Infill
X-Direction (sec)	0.6408
Y-Direction (sec)	0.7020

IV. RESULTS AND DISCUSSIONS

1 GENERAL

Linear static and dynamic analysis is performed on the model. Loads are calculated and distributed as per Indian code IS 1893:2016 (Seismic loads). The results obtained from the analysis are compared with respect to the following parameters such as storey Shear, Lateral Displacement, and Storey Drift.

In this Thesis, the building was modelled for two models.

Model 1: G+12 Storey buildingconsidered EQX

Model 2: G+12 Storey building considered RSX

2 STOREY DISPLACEMENTS

Table :8 Story Displacementsin X-direction

STORY	Elevation(m)	EQX	RSX
BASE	0	0	0
1	3	1.84443	1.61912
2	6	6.4756	5.57574
3	9	12.9044	10.8819
4	12	20.4227	16.8627
5	15	28.7148	23.1672
6	18	37.3384	29.4314
7	21	45.8924	35.4323
8	24	54.1061	41.0516
9	27	61.7526	46.1478
10	30	68.3641	50.4552
11	33	73.8155	53.9886
12	36	78.0788	56.7866
13	39	81.3238	58.9725

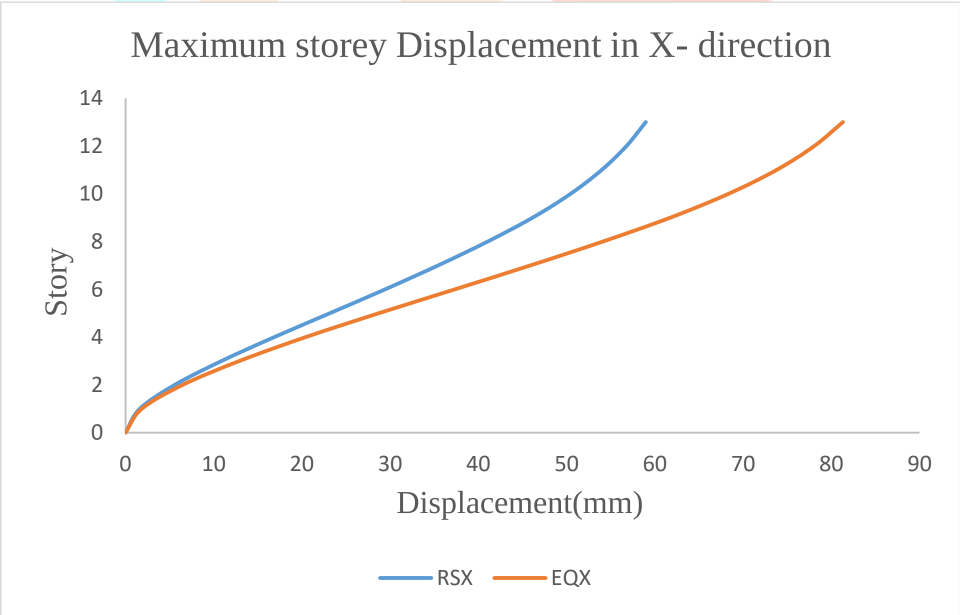

Fig 6: Graph showing comparison of Displacements in Equivalent static and response spectrum analysis method in X-Direction

Table:9 Story Displacements in Y-Direction

STORY	Elevation(m)	EQY	RSY
BASE	0	0	0
1	3	1.880517	1.656771
2	6	6.601953	5.701857
3	9	13.15563	11.12154
4	12	20.8199	17.22566
5	15	29.2749	23.65736
6	18	38.06959	30.04675
7	21	46.79458	36.16853
8	24	55.1738	41.90318
9	27	62.97704	47.10668
10	30	69.72516	51.50679
11	33	75.29043	55.11974
12	36	79.64349	57.98486
13	39	82.95617	60.22627

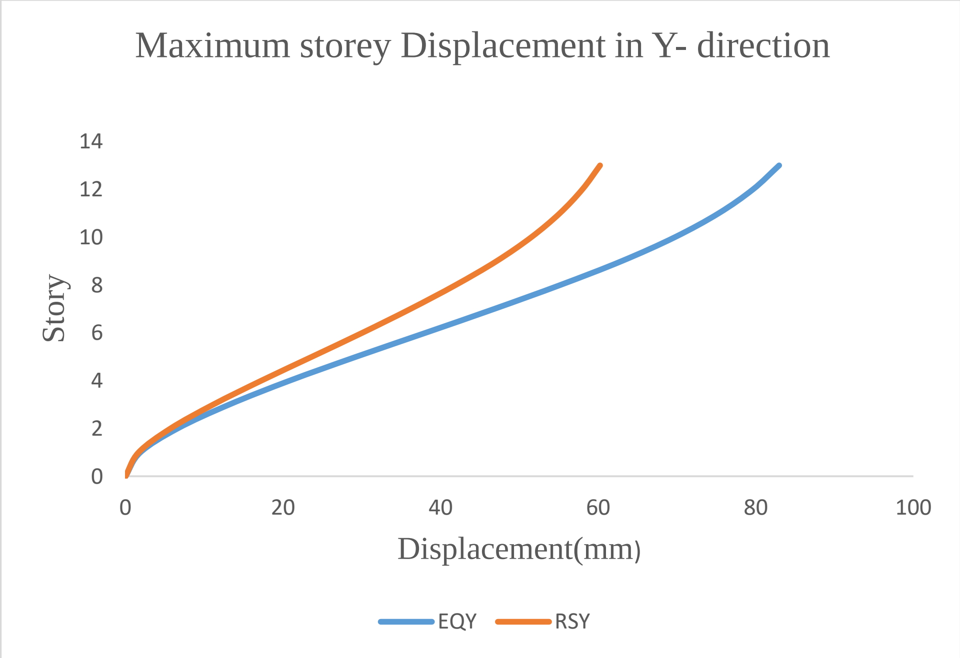

Fig:7 Graph showing comparison of Displacements in Equivalent static and response spectrum analysis method in Y-Direction

Fig 6 and Fig 7 shows the graphs of **Displacement vs Story's** for Equivalent Static Analysis and Response spectrum Analysis.The displacement is higher at the top story and lesser in bottom story for both X&YDirection. However,the displacement inYdirections seems to be higher than X Direction. This is due to more stiffness in X Direction.

3 STOREY DRIFTS

Table :10 Story Drifts in X-Direction

STORY	Elevation(m)	EQX	RSX
BASE	0	0	0
1	3	0.000615	0.00054
2	6	0.001544	0.00132
3	9	0.002143	0.001773
4	12	0.002506	0.002008
5	15	0.002764	0.00214
6	18	0.002875	0.002168
7	21	0.002851	0.00212
8	24	0.002738	0.002027
9	27	0.002549	0.001903
10	30	0.002204	0.001703
11	33	0.001817	0.001494
12	36	0.001421	0.001262
13	39	0.001082	0.00102

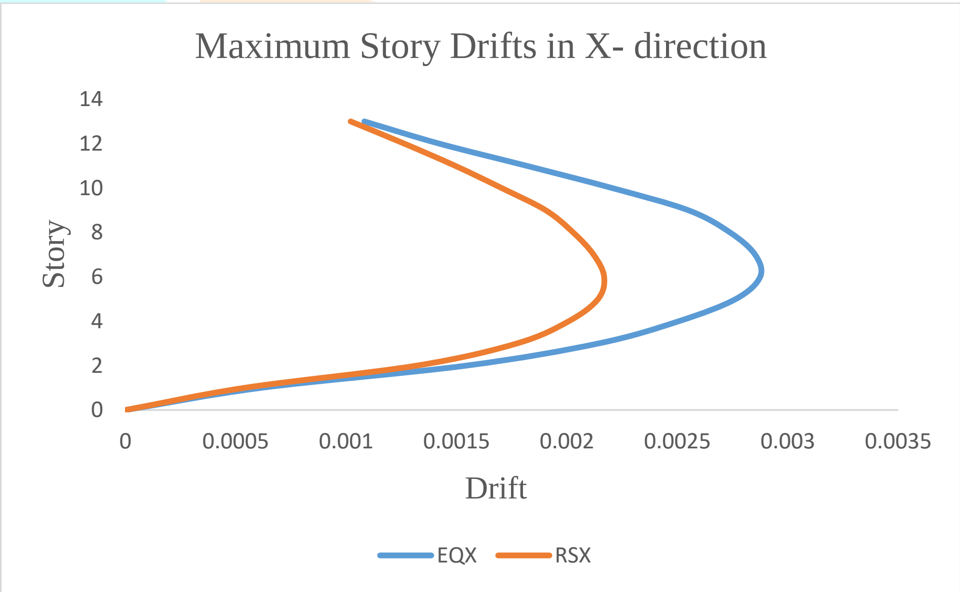

Fig:8 Graph showing comparison of Drifts in Equivalent static and response spectrum analysis method in X-Direction

Table :11 story Drifts in Y-Direction

STORY	Elevation(m)	EQY	RSY
BASE	0	0	0
1	3	0.000627	0.000552
2	6	0.001574	0.001349
3	9	0.002185	0.001811
4	12	0.002555	0.00205
5	15	0.002818	0.002185
6	18	0.002932	0.002214
7	21	0.002908	0.002166
8	24	0.002793	0.002073
9	27	0.002603	0.001948
10	30	0.002255	0.001746
11	33	0.001865	0.001535
12	36	0.001466	0.001301
13	39	0.001125	0.001053

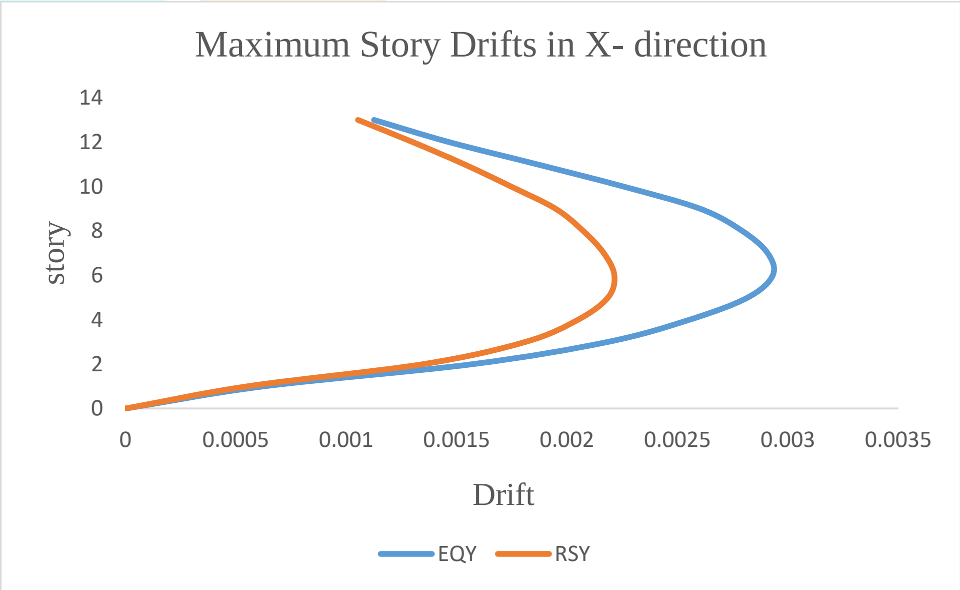

Fig:9 Graph showing comparison of Drifts in Equivalent static and response spectrum analysis method in Y-Direction

The **Story drift** is the difference of the displacement of successive story. However, the drift values are increasing with increase in story level. It keeps on increases up to some height and later it reduces again. The drift values are slightly higher in Y direction compared with X Direction

4 STOREY SHEARS

Table:12 Story shears X-Direction

STORY	Elevation(m)	EQX	RSX
BASE	0	0	0
1	3	2840.827	2840.816
2	6	2836.844	2769.075
3	9	2820.911	2583.97
4	12	2785.062	2367.745
5	15	2723.528	2212.527
6	18	2630.448	2098.424
7	21	2496.412	1969.566
8	24	2313.975	1832.023
9	27	2083.438	1695.083
10	30	1800.286	1539.279
11	33	1450.716	1377.489
12	36	1027.735	1166.185
13	39	524.3539	720.8874

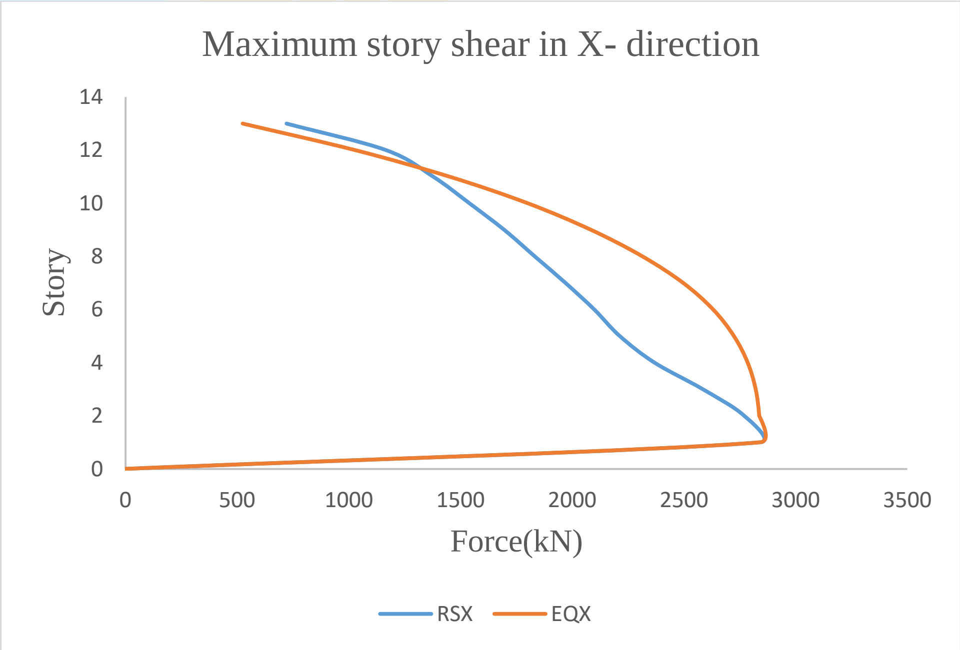

Fig 10: Graph showing comparison of shears in Equivalent static and response spectrum analysis method in X-Direction

Table :13 Story shears in Y-Direction

STORY	Elevation(m)	EQY	RSY
BASE	0	0	0
1	3	2840.827	2840.828
2	6	2836.844	2768.502
3	9	2820.911	2581.806
4	12	2785.062	2363.911
5	15	2723.528	2208.417
6	18	2630.448	2095.296
7	21	2496.412	1967.32
8	24	2313.975	1830.109
9	27	2083.438	1693.395
10	30	1800.286	1538.206
11	33	1450.716	1378.142
12	36	1027.735	1169.38
13	39	524.3539	724.6235

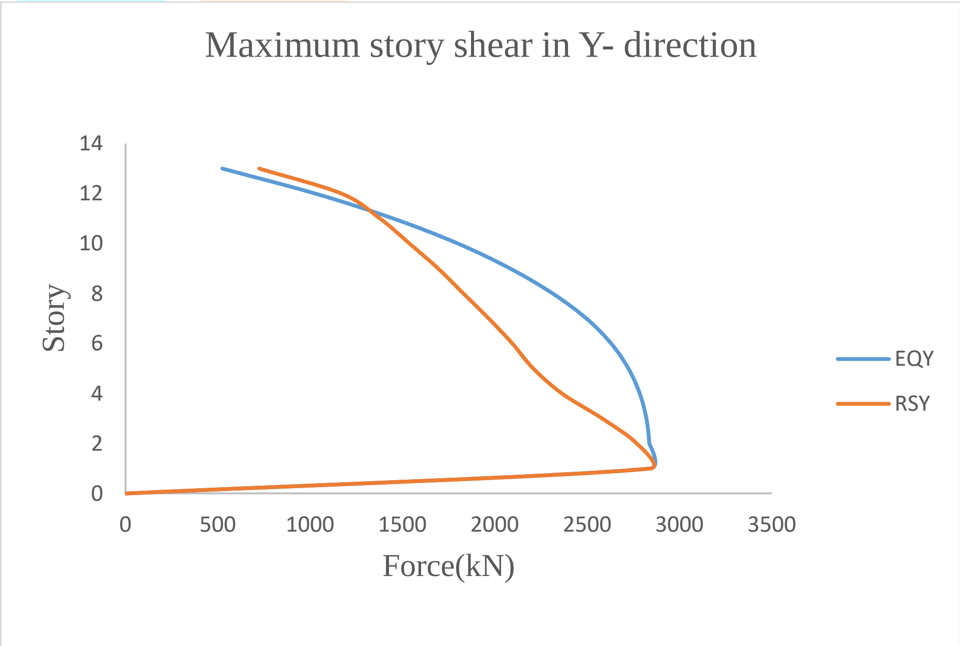

Fig 11 Graph showing comparison of shears in Equivalent static and response spectrum analysis method in Y-Direction

The **Story shear** is the shear force acting at the support level of the structure. It is the sum of equivalent shear acting at particular floors. More the stiffness more will be the bases hear attracted.

5 TIME PERIOD

Table:14 Time period for different modes

Mode	Period (sec)
1	2.273
2	2.253
3	1.905
4	0.686
5	0.681
6	0.596
7	0.351
8	0.349
9	0.31
10	0.206
11	0.205
12	0.185

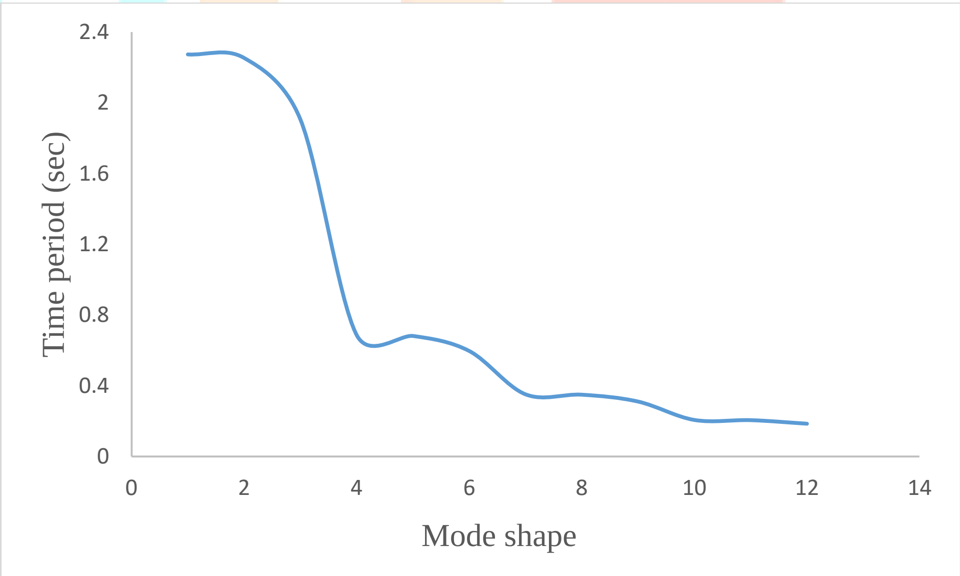

Fig 12: Mode shape Vs Time period Graph

Time period seems to be more in first three modes compared to other modes. However, after three modes it decreases suddenly.

V. CONCLUSIONS

The performance of the G+12 building model have been studied using ETABS 19 software for analysis.This structure is analysed for seismic analysis under two different analysis methods. Seismic analysis is carried out for linear static and linear dynamic analysis.

The Model is analysed forboth static and dynamicanalysis. The results are extracted and compared; from theoverallcomparison followingconclusionsarelisted.

1. For X- direction it is observed that the maximum displacement in Equivalent Static Analysis (EQX) is 27.46% more than Response Spectrum Analysis (RSX). Similarly, for Y- direction it is observed that the maximum displacement in Equivalent Static Analysis (EQY) is 27.4% more than Response Spectrum Analysis (RSY).
2. For X- direction it is observed that the maximum drift in Equivalent Static Analysis (EQX) is 5.73% more than Response Spectrum Analysis (RSX). Similarly, for Y- direction it is observed that the maximum drift in Equivalent Static Analysis (EQY) is 6.4% more than Response Spectrum Analysis (RSY).
3. The time period for static and dynamic analysis issame. This is due to the fact that, time period onlydepends on modelgeometry other than type ofanalysis.
4. The base shear values should be same for static and dynamic analysis and is almost same as perIS:1893 Seismic Code, however, it is again proved from the results.
5. From the overall analysis, it can be easily concluded that, for high rise structure, the static analysis gives higher results comparatively. And hence dynamic analysis should be carried out to design the structure effectively and economically.

VI. ACKNWOLEDGMENT

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VII. REFERENCES

1. Bhagwat Mayuri D, Comparative study of performance of multistoried building for Konya and Bhuj earthquake by THM and RSM, International journal of Advanced Technology in engineering and Science, vol.no.02, Issue -07,ISSN:2348- 7550,July 2014
2. Kalyan Chowdary et al., comparative study of seismic performances of high rise 30 story building with beam slab, flat slab and alternate flat beam slab systems in zone V. eISSN: 23191163, pISSN: 23217308
3. Panchal, D R, and Marathe, P M, comparative study of R.C.C, steel and Composite (G+30) building, international conference 2 on current trends in technology –Nuicone 2011. Institute of technology, NirmaUniversity, Ahmedabad
4. Chandurkar, PP &Pajgade, PS 2013, Seismic Analysis RCC building with without shear wall, international journal of modern engineering research (IJMER), Vol.3 no. 3 pp. 805-1810.

5. Can Balkaya and Schnobrich W.C,Non- linear 3D behavior of shear wall dominant RC building structures, journal of structural engineering and mechanics. Vol.1; no. 1,pp 1-16
6. Payam Tehrani and ShahroMaalek, comparison of non-linear static and non- linear dynamic analysis in the estimation of maximum displacement for structures equipped with various damping device, 4th International Conference on Earthquake Engineering, Taipei, Taiwan, October 12-13. 2006, paper no. 129
7. A.R. Touqan, a scrutiny of the equivalent static lateral load method of design for multistory masonry structures, American Institute of Physics, AIP conference proceedings vol. 1020, pp 161-1158, 7/8/2008
8. Dr. Qaiseruz Zaman Khan (2010), Evaluation of effects of response spectrum analysis on height of building, International Conference on sustainable built environment (ICSBE-2010) kandy, 13-14 December 2010
9. Romy Mohan, C Prabha (2011), Dynamic Analysis of RCC buildings with Shear wall, International Journal of Earth Science and Engineering ISSN 0974-5904, Volume 04, no 06 S P L, October 2011, pp 659-662.
10. Mohele J.P, Hopper J.D (2008), Seismic design of reinforced concrete special moment frames: A Guide for Practicing Engineers, National Institute of Standards andTechnologyGaithersburg, MD20899-8600
11. Balaji.U and Selvarasan M.E, Design and Analysis of Multi Storied Building UnderStatic and Dynamic Loading Condition Using ETABS. International Journal of Technical Research and Applications Volume 4, Issue 4. (July-Aug, 2016)
12. Anirudh Gottala, Dr.shaikYajdhani, Comparative Study of Static and Dynamic seismic Analysis of Multistoried Building. IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 01 | July 2015.
13. Mahesh N. Patil, Yogesh N. Sonawane, Seismic Analysis of Multistoried Building, International Journal of Engineering and Innovative Technology (IJEIT), Volume 4, Issue 9, March 2015.
14. Mohammed Rizwan Sultan, D. GousePeera, Dynamic Analysis Of Multi-storey building for different shapes, International Journal of Innovative Research in Advanced Engineering (IJIRAE), Issue 8, Volume 2 (August 2015).
15. Mohit Sharma, Dr. Savita Maru Dynamic Analysis of Multistoried Regular Building. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278- 1684,p-ISSN: 2320-334X, Volume 11, Issue 1 Ver. II (Jan. 2014).
16. Mr. S.Mahesh, Mr. Dr.B.Panduranga Rao, Comparison of analysis and design of regular and irregular configuration of multi-Story building in various seismic zones and various types of soils using ETABS and STAAD ,Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 11, Issue 6 (Nov- Dec. 2014).
17. NI NI WIN, KYAM LIN HTAT, Comparative Study of Static and Dynamic Analysis of Irregular Reinforced Concrete Building due to Earthquake, International journal of scientific engineering and technology research, Volume3, Issue7, May- 2014.
18. E.PavanKumar,A.Naresh, Earthquake Analysis of Multi Storied Residential Building - A Case Study E. Pavan Kumar et al Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 11(Version 1), November 2014, pp.59-64