NON-LINEAR TIME HISTORY ANALYSIS OF G+12 HIGHRISE RCC STRUCTURE USING CSI ETABS

[1]Pyla Shanti Swaroop, [2]Dr. N.Victor Babu

[1]M.Tech Student, [2]Head of the Department
[1]CIVIL Department,
[1]BABA Institute of technology and sciences, Vishakapatnam, India.

***Abstract*: ETABS signify Extended three Dimensional Analysis of Building Systems. ETABS integrates every aspect for the engineering design process. Within the present situations of housing industry, the buildings that are being constructed are gaining significance, in general, those with the most effective possible outcomes which are brought up members such as beams and columns in multi storey's R.C structures. This software mainly used for structures such as high-rise structure, concrete and steel structures. The paper aims to investigate a high-rise building of (G+12) floors by considering seismic, dead, and live loads. The look criteria for high-rise buildings are strength, serviceability, and stability. The version of the software used is ETABS 2017.In the present study, we are mainly determining the results of a lateral loads on moments, shear force, base shear, axial force, maximum displacement and tensile forces on structural system is subjected and also comparing the results of seismic zones 3, 4 and 5**

***Keywords*: ETABS-2017, Seismic Analysis, High Rise Buildings Maximum displacement, High Rise Buildings, Storey drift, Base reactions, IS1893-2016.**

INTRODUCTION

The increases in population by which land deficit occurs and to overcome that, high-rise structure is opted. These types of high-rise structure are affected by the natural phenomena. Such as earthquakes are the most dangerous by means of the damage and effect caused to the structural components, , and that they can't be controlled. These natural calamities caused damage structure and interruptions in development of the normal lifecycle. Since it's a global concern, most of the analysis should be find out and provided with the results to prepare the structure to attain time period. With the technological advancement, man tried combating with these natural phenomena through various ways like developing early warning systems for disasters, adopting new prevention measures, proper relief and rescue measures. But however it's not true for all natural disasters. Hazard maps indicating seismic zones in seismic codes as per (IS 1893:2016) are revised from time to time which results in additional base shear demand on existing buildings. The collapse of a structure may be reduced if the subsequent points are taken into considerations. Majority of the building structures encompass structural elements like beams, Columns, braces, shear walls, and floor slabs. Floor slabs in multi storey buildings, which generally transmit gravity loads to the structural system, are required to transfer lateral inertia forces to the structural system.

1. The pattern of failure may be made ductile instead if brittle. If ductility is assured, dissipation of energy produced will show small deterioration.
2. Shear should not fail before flexure.
3. Columns failure comes after the failure of beams.
4. The joints should be hard as compared to the members
5. To perform dynamic analysis of the structure using response spectrum method

LITERATURE REVIEW

Patil A. S. (5) studied nonlinear dynamic analysis of 10 storied RCC building considering different seismi intensities and also studied seismic response of such building. The building under consideration is modeled with the help of SAP 2000-15 software and 5 different time histories have been used. The result of the study shows similar variations pattern in seismic response such as base shear and storey displacements and concluded that time history is realistic method used for seismic analysis. It provides a better check to the safety of structure analyzed and designed.

Bhagwat et al. (6) studied dynamic analysis of G+12 multistoried practiced RCC building considering for Koyna and Bhuj earthquake is carried out. The Time History Analysis and Response Spectrum Analysis and seismic responses of the building are comparatively studied. The modeled with the help of ETABS9.7.2 software. Two time histories (i.e. Koyna and Bhuj) have been used to develop different criteria (base shear, storey displacement, storey shear), and concluded that, the value of base shear for Bhuj earthquake is 49.11% more than the Koyna earthquake, and Response Spectrum method gives 50% more result than Time History Analysis.

Dubey et al. (7) presented design of multistoried irregular building with 20 stories and modeled it using software STAAD-PRO for seismic zone IV in India, dynamic response of building under actual earthquake, DELINA (ALASKA)2000 have been considered. This paper highlights the comparison of Time History Method and Response Spectrum Method. The story displacement result has been obtained by using both method of dynamic analysis, and Concluded that Time History Analysis is found to be 2 to 8% higher than that of Response Spectrum Analysis in both type of building i.e. regular and irregular, For high rise building it is necessary to provide dynamic analysis because of nonlinear distribution of force. Storey displacement is found greater in THM as compared to

RSM, and observed that the base shear is greater in RSM compared to THM. Thus it can be concluded that time history analysis is economically better for designing.

METHODOLOGY

In the present study, analysis of G+12 multi-story building in all seismic zones for wind and earthquake forces is carried out.3D model is prepared for G+12 multi-story building using ETABS.

2.1 Methods of analysis of structure:

The seismic analysis should be carried out for the buildings that have lack of resistance to earthquake forces. Seismic analysis will consider seismic effects hence the exact analysis sometimes become building. However for simple regular structures equivalent linear static analysis is sufficient more. This type of analysis will be carried out for regular and high rise buildings and this method will give good results for this type of buildings. Dynamic analysis will be carried out for the building as specified by code IS 1893-2016 (part1). Dynamic analysis will be carried out either by site specific Time history method or Response spectrum method. Following methods are adopted to carry out the analysis procedure.

Equivalent Static Analysis

- Linear Dynamic Analysis
- Response Spectrum Method
- Time History Analysis
- Pushover Analysis
- Non Linear Static Analysis
- Non Linear Dynamic

2.2 Analysis Loads Acting on Multi-Storey G+12 Building: Loading on tall buildings is different from low-rise buildings in many ways such as large accumulation of gravity loads on the floors from bottom to top, increased significance of wind loading and greater importance of seismic effects. Thus, multistoried structures need correct assessment of loads for safe and economical design. Except dead loads, the assessment of loads cannot be done accurately. Live loads can be anticipated approximately from a combination of experience and the Previous field observations. Wind and earthquake loads are random in nature and it is difficult to predict them. They are estimated based on a probabilistic approach. The following discussion describes most of the some common types of loads on multi-storied structures.

1. Dead loads
2. Live loads
3. Earthquake loads

2.3 Methods of analysis of structure

In this study, the lateral design forces are determined by the response spectrum method as per the provisions of IS 1893 (Part -1): 2016, for the building models to be considered for the study. The buildings are analyzed by results of the building for different zones for the different load combinations to arrive at a conclusion regarding the importance of carrying out seismic analysis. The present work is expanded to study these effects on our building models by performing lateral load analysis. The present work the seismic effect of different zone on building models which are considered in Zone III, VI and V

Fast Nonlinear Analysis (FNA) is a modal analysis method useful for the static or dynamic evaluation of linear or nonlinear structural systems. Because of its computationally efficient formulation, FNA is wellsuite for time-history analysis, and often recommended over direct-integration applications. During dynamic-nonlinear FNA application, analytical models should

1-Be primarily linear-elastic.

2-Have a limited number of predefined nonlinear members.

3-Lump nonlinear behavior within link objects.

Here for analysis of the ten storey RC building the time function of linear case and Fast non linear modal analysis method has been chosen for the time history analysis.

GROUND MOTION EXCITATION

Selecting the seismic loading for design and/or assessment purposes is not an easy task due to the uncertainties involved in the very nature of seismic excitations. One possible approach for the treatment of the seismic loading is to assume that the structure is subjected to a set of records that are more likely to occur in the region where the structure is located.

ETABS SOFTWARE'S

ETABS offers a single user interface to perform modeling, analysis, design, and reporting. There is no limit to the number of model windows, model manipulation views, and data views.

Enhanced DirectX Graphics - DirectX graphics with hardware-accelerated graphics allow for navigation of models with fly-throughs and fast rotations.

Multiple Views

Users can view moment diagrams, load assignments, deflected shapes, design output and reports all in a single screen.

Quick Navigation and Data Management

The ETABS model explorer enhances your ability to manage data in your model. You can define, duplicate, and modify properties in groups and drag-and-drop properties right onto the models for assignment. User-defined displays can be set up easily in the model explorer for quick navigation.

Modeling

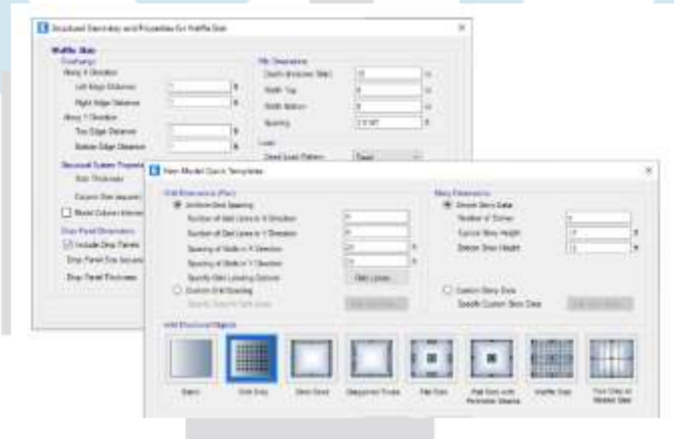
Wide array of templates for quick model generation.

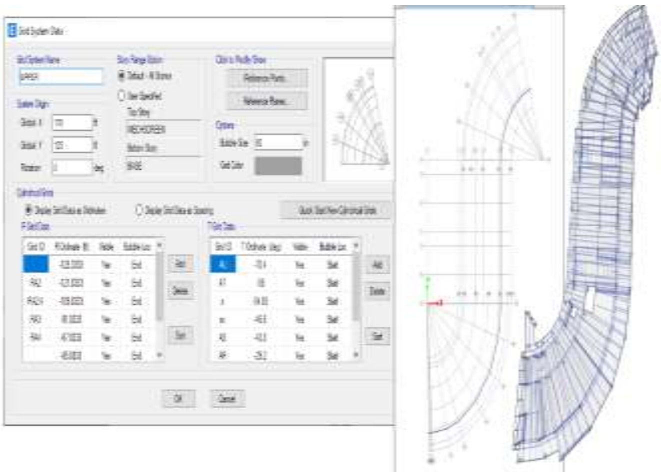
ETABS has a wide selection of templates for starting a new model quickly. At this model template stage, you have the ability to define grid and grid spacing, the number of stories, the default structural system sections, default slab and drop panel sections, and uniform loads (specifically dead and live loads).

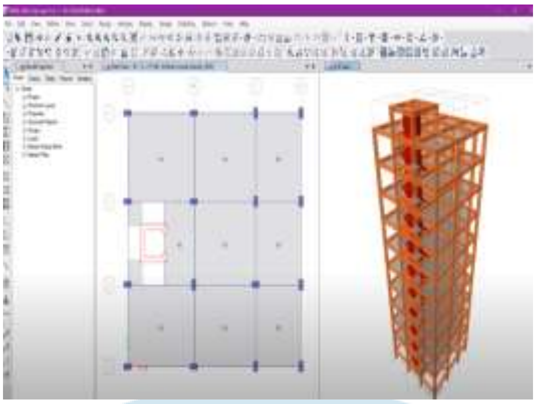
MODELING AND ANALYSIS

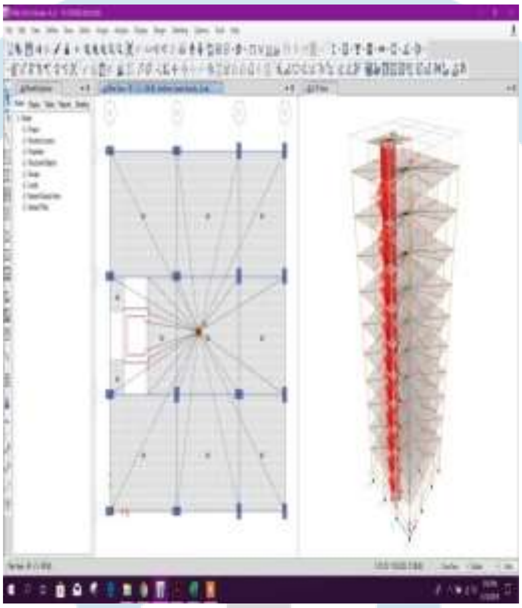
MODEL DESIGN

There is a resurgence of construction of high rise structure and ultra-high rise structure around the world. The design of these high rise buildings in seismically active regions varies dramatically from region to region where as rigorous performance-based assessments is required in many countries, including nepal and China, some other countries do not require anything beyond a traditional design based on force reduction factors. Recent trends in high-rise commercial construction have resulted in a variety of unusual configurations, innovative structural systems, and high performance materials that challenge current design practice one of the objectives of this model designing is to ensure that the models represent the characteristics of apartment structure. These days, high-rise structure is different in shape, height and functions. This makes each building characteristics different from each other's. There are some standards for each kind of highrise buildings, such as residential, official, commercials. The seismic design of modern tall buildings, defined as buildings exceeding 170 feet in height, introduces a series of challenges that need to be met through consideration of scientific, engineering, issues specific to the modeling, analysis, and acceptance criteria appropriate for these unique structural systems. there, for model designing, main factors such as floor shape, grid spacing, and floor height and column and beam considered. Three buildings with equal number of storey's, with (G+12) storey having same floor plan of 30 m x 20 m dimensions were considered for this study. The floor plans were divided into 6 x 4 bays in such a way that center to center distance between two grids is 5 meters on both the sides respectively as Plan and elevation & plane shown in Figure 5.1 and 5.2. The floor height of the building was assumed as 3.2 meters for all floors and Elevation was shown in Figure 5.3. The following two distinct building models are used in the study: high rise building (G+12) The modeling of the structure has been done using the structural software ETABS as per the data.









DESCRIPTION OF BUILDING

Type of structure: Multi-storey RC frame Structure
Number of stories: (G+12)
Ground storey height: 3.6 m
Intermediate storey height: 3.2 m
Type of soil: Hard soil

Materials

Grade of concrete: M25
Density of concrete: 25kN/m2
Modulus of elasticity of concrete: 5000√fck As per IS 456:2000.

Member dimensions

Beam Size: 230mm x 500 mm
Column Size: 230mm x 500 mm
Slab Thickness: 125 mm

LOAD CALCULATION

1. Dead Load

The self-wt. of the structural members is taken care in the software
Floor Finish load: 1 kN/m2

2. Live Load

Live load on roof: 1.5kN/m2

2. Seismic Load

- Seismic zone: Zone-III,IV,•& V As per IS 1893 (Part 1) 2016
- Height of Building: 32.4 m
- Damping ratio: 5% for RC frame structure Seismic zone factor (Z): 0.16,0.24 and 0.36• (Table 2 of IS 1893(Part-1):2016
- Importance factor (I): 1.0 as per IS• 1893(Part-1): 2016
- Response reduction factor (R): 5.0 as per IS• 1893(Part-1): 2016,
- Foundation Soil type = Type-1(Hard Soil) (As• per IS 1893(Part-1): 2016,
- Design horizontal seismic coefficient (As per• IS 1893(Part-1): 2016) For all Models Ah = 0.0267 sec

- Design Seismic Base Shear:

V B =Ah x W

RESULT AND DISCUSION

GENERAL

For every seismic zone the software gives six possible seismic load cases and two combination load cases i.e., maximum and minimum. The six possible load cases depend upon the loads acting on the structure their behavior will be analyzed and compared in terms of following parameters of tables:

1. Maximum displacement
2. Story Drift
3. Base Reactions

The comparison of results in terms of the above parameters will be given in terms of graphs andtables. Below discussed in details.

ZONE 5 RESULTS

Maximum Displacemen

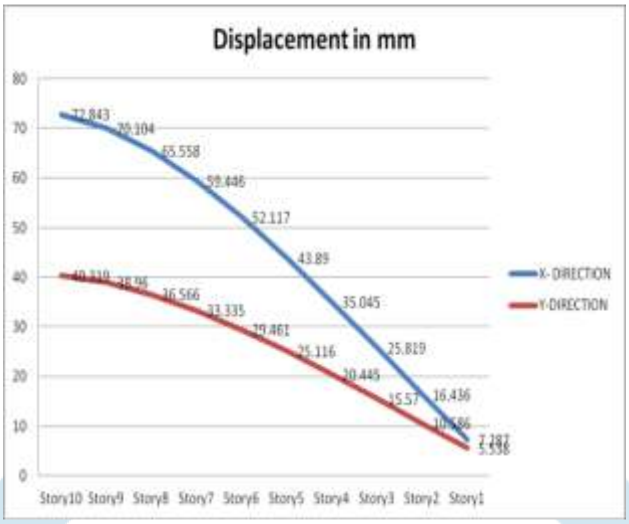
DISPLACEMENT IN X DIRECTION FOR (G+12) STORY

Story	Load Case/Combo	Direction	Maximum
Story10	Seismic	X	72.843
Story9	Seismic	X	70.104
Story8	Seismic	X	65.558
Story7	Seismic	X	59.446
Story6	Seismic	X	52.117
Story5	Seismic	X	43.89
Story4	Seismic	X	35.045
Story3	Seismic	X	25.819
Story2	Seismic	X	16.436
Story1	Seismic	X	7.287

TABLE 4.2

Story	Load Case/Combo	Direction	Maximum
Story10	Seismic	Y	40.319
Story9	Seismic	Y	38.96
Story8	Seismic	Y	36.566
Story7	Seismic	Y	33.335
Story6	Seismic	Y	29.461
Story5	Seismic	Y	25.116
Story4	Seismic	Y	20.445
Story3	Seismic	Y	15.57
Story2	Seismic	Y	10.586
Story1	Seismic	Y	5.538

DISPLACEMENT IN Y DIRECTION FOR (G+12) STORY



Displacement X and Y Direction of thestructure in zone 5

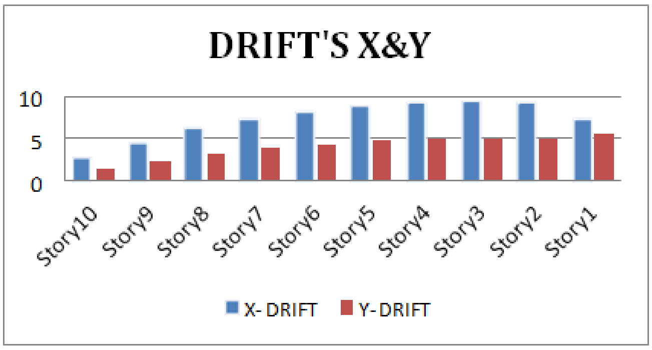
STORY DRIFT

Story Drift In X Direction for G+12 Story’

Story	Load Case/Combo	Direction	Max Drift
Story10	Seismic	X	2.74
Story9	Seismic	X	4.546
Story8	Seismic	X	6.111
Story7	Seismic	X	7.329
Story6	Seismic	X	8.227
Story5	Seismic	X	8.845
Story4	Seismic	X	9.227
Story3	Seismic	X	9.383
Story2	Seismic	X	9.149
Story1	Seismic	X	7.287

STORY DRIFT IN Y DIRECTION FOR 10 FLOORS

Story	Load Case/Combo	Direction	Max Drift
Story10	Seismic	Y	1.359
Story9	Seismic	Y	2.394
Story8	Seismic	Y	3.232
Story7	Seismic	Y	3.874
Story6	Seismic	Y	4.345
Story5	Seismic	Y	4.671
Story4	Seismic	Y	4.875
Story3	Seismic	Y	4.984
Story2	Seismic	Y	5.047
Story1	Seismic	Y	5.538



Comparison Of Drifts X And Y In Zone 5

Base Reactions of Zone 5

zLoad Case	Fx kN	FykN	Fz kN	Mx kN m	My kN m	Mz kN m
Dead	0.0	0.0	24937.8	249378.1	-311722.6	0.0
Live	0.0	0.0	7500.0	75000.0	-93750.0	0.0
FLOOR FINISH	0.0	0.0	5000.0	50000.0	-62500.0	0.0
EQ-X	-1183.1	0.0	0.0	0.0	-29999.2	11831.3
EQ-Y	0.0	-301.4	0.0	7642.3	0.0	-3767.5
RS-X Max	946.8	644.4	0.0	12962.2	19047.8	9599.9
RS-Y Max	354.1	241.0	0.0	4848.1	7124.2	3590.5

ZONE 4 RESULTS MAXIMUM DISPLACEMENT

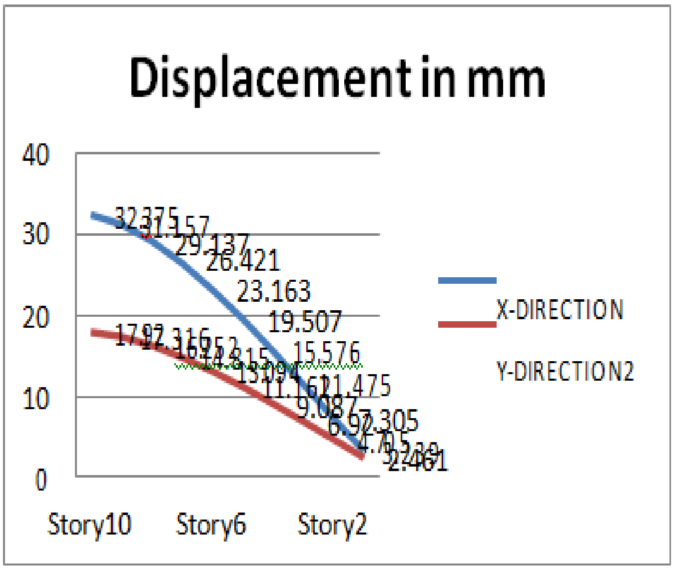
DISPLACEMENT IN X DIRECTION FOR (G+12) STORY

Story	Load Case/Combo	Direction	Maximum
Story10	Seismic	X	32.375
Story9	Seismic	X	31.157
Story8	Seismic	X	29.137
Story7	Seismic	X	26.421
Story6	Seismic	X	23.163
Story5	Seismic	X	19.507
Story4	Seismic	X	15.576
Story3	Seismic	X	11.475
Story2	Seismic	X	7.305
Story1	Seismic	X	3.239

DISPLACEMENT IN Y DIRECTION FOR (G+12) STORY

Story	Load Case/Combo	Direction	Maximum
Story10	Seismic	Y	17.92
Story9	Seismic	Y	17.316
Story8	Seismic	Y	16.252
Story7	Seismic	Y	14.815
Story6	Seismic	Y	13.094
Story5	Seismic	Y	11.162
Story4	Seismic	Y	9.087
Story3	Seismic	Y	6.92
Story2	Seismic	Y	4.705
Story1	Seismic	Y	2.461

Displacement X and Y Direction of thestructure in zone 3



STORY DRIFT

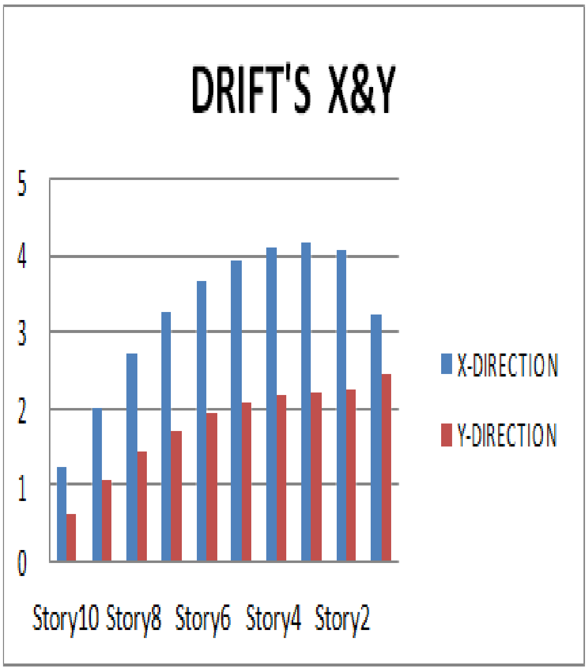
Story Drift In X Direction for G+12 Story

Story	Load Case/Combo	Direction	Max Drift
Story10	Seismic	X	1.218
Story9	Seismic	X	2.02
Story8	Seismic	X	2.716
Story7	Seismic	X	3.257
Story6	Seismic	X	3.656
Story5	Seismic	X	3.931
Story4	Seismic	X	4.101
Story3	Seismic	X	4.17
Story2	Seismic	X	4.066
Story1	Seismic	X	3.239

Story Drift In Y Direction for G+12 Story

Story	Load Case/Combo	Direction	MAX DRIFT
Story10	Seismic	Y	0.604
Story9	Seismic	Y	1.064
Story8	Seismic	Y	1.436
Story7	Seismic	Y	1.722
Story6	Seismic	Y	1.931
Story5	Seismic	Y	2.076
Story4	Seismic	Y	2.167
Story3	Seismic	Y	2.215
Story2	Seismic	Y	2.243
Story1	Seismic	Y	2.461

COMPARISON OF DRIFTS X AND Y IN ZONE 3



BASE REACTIONS

Base Reactions of Zone 3

Load Case	Fx kN	Fy kN	Fz kN	Mx kN m	My kN m	Mz kN m
Dead	0	0	24937	249378	-311723	0
Live	0	0	7500	75000	-93750	0
FLOOR FINISH	0	0	5000	50000	-62500	0
EQ-X	-525.8	0	0	0	-13333	5258.3
EQ-Y	0	-133.9	0	3396.5	0	-1674.4
RS-X Max	420.8	286.4	0	5760.9	8465.6	4266.6
RS-Y Max	157.3	107.1	0	2154.6	3166.2	1595.7

CONCLUSIONS

1. A high-rise building of (G+12) floors subjected to seismic, wind and live loads were analyzed using ETABS 2017 software.
2. The behavior of high-rise building is clearly shown using graphs and lateral displacement It is found that the lateral displacements or drifts are more in zone 5 when compared to the zones 4&3.
3. It is also found that from the base reactions of structure obtained in zone 5, the story shear is higher in zone 5 than in zone 3.
4. All members were designed using ETABS" .The members which aren't appropriate will be obtained and suitable sections are recommended by the software.
5. Better accuracy of the analysis can be obtained by using ETABS software

SCOPE FOR FUTURE STUDY

1. To analyze the building as per code IS 1893- 2016 part I criteria for earthquake resistant structure
2. Reanalyze the frame structure with different seismic zone.
3. Building with different lateral stiffness systems
4. The study may further be carried out by providing openings in slabs.
5. Development of a city
6. get economical and efficient lateral stiffness system
7. To deal with energy and environmental challenges.

REFERENCES

[1] Bhalchandra p. Alone," Seismic Analysis in software of STAAD pro v8i (Ground +3 Basements + 50 storey's) Volume 2, Issue 8

[2] Mahdi Hosseini "Earthquakes Analysis of High Rise Buildings with Effect of Box Shape RC Shear Walls at the Center" Volume-7 Issue-2, Dec 2017

[3] Mr. Nikhil Shingade "Seismic Analysis of Concentric Bracing In High Rise Steel Structure" Vol. 3, No.4, 2018

[4] Sang-Kyoung Ahn "An Efficient Model for Seismic Analysis of Building Structures with The Effect of Floor Slabs"

[5] K. G. Patwari "Comparative study of RC Flat Slab & Shear wall with Conventional Framed Structure in High Rise Building" Volume No.5 Issue: Special 3, pp: 612-616

[6] Dinesh Sen, "Analysis of building on sloping ground considering seismic forces"

[7] Dr.H.J.Shah and Dr.S.K.Jain, Seismic Analysis of six Storey Building, Document no: IITK-GSDMA-EQ-V3.0 final report: A-earthquake Codes.

[8] IS: 1893-2016, Indian Standard Criteria for Earthquake Resistant design of Structures Part 1-General provisions and buildings,(Sixth Revision), Bureau of Indian standards, New Delhi, India

[9] IS: 456:2000, Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standard, New Delhi, India.,

[10] Agarwal .P and Shirkhandez. M., Earthquake Resistant design of Structures Prentice hall of India private ltd. New Delhi, India..