Seismic Analysis of High-Rise Building by Response Spectrum Method Using Etabs

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Abstract- Reinforced Concrete Frames are the most commonly adopted buildings construction practices in India. With growing economy, urbanization and unavailability of horizontal space increasing cost of land and need for agricultural land, high-rise sprawling structures have become highly preferable in Indian buildings scenario, especially in urban. With high-rise structures, not only the building has to take up gravity loads, but as well as lateral forces. Many important Indian cities fall under high risk seismic zones, hence strengthening of buildings for lateral forces is a prerequisite. In this study the aim is to analyze the response of a high-rise structure to ground motion using Response Spectrum Analysis. Different models, that is, bare frame, brace frame and shear wall frame are considered in Staad Pro. and change in the time period, stiffness, base shear, storey drifts and top-storey deflection of the building is observed and compared

Keywords — Diaphragm Etabs. Response Spectrum, seismic zone, Reinforcement, Bending Moment Diagram

I. INTRODUCTION

Throughout human history, earthquakes represent constant danger to human settlements, wreaking havoc across environment and human-made infrastructure. In order to guarantee that buildings can resist seismic pressures, this unanticipated calamity must exist. Thus, there's ongoing research worldwide aimed at improving seismic performance via incorporation of new and improved approaches into buildings. Specially engineered structures that can withstand seismic activity obviously cost more to build than regular buildings, but they are essential for protecting people and property from disasters of this kind.

In every conceivable direction away from epicenter, earthquake generates haphazard ground motions. While earthquakes almost seldom cause ground to shift vertically, they do cause ground to shake horizontally. Inertial forces arise inside constructions that are laying upon ground as a result of ground vibration.

When an earthquake changes its direction, stresses in building's components might reverse, going from tension into compression before returning again. Severe stress from earthquake may produce structural deformation that in turn can make structure useless and unusable. Building's residents should not remain there due to potential for large-scale narrative drift. An ever-increasing number of skyscrapers are dotting the Indian landscape, & most prevalent building technique is use of reinforced concrete frames.

A. RESPONSE SPECTRUM ANALYSIS

In the year 1932, the RSM was announced. This method uses forms of vibrational modes & waves to determine how buildings will react in event of a seismic event. In middle of 20th century, several nations' building regulations began to include idea of reaction spectrum into their design criteria. Utilizing response spectrum approach of seismic analysis has computational benefits, one of which is ability to forecast moves & loads of building parts. Utilizing fine-design spectrum that is mean of several seismic movements, this technique only entails computing highest possible values of member shifts & forces for every mode.

B. NECESSITY OF SEISMIC ZONING INDIA:

Any choice about urban planning or seismic design in seismic zones is influenced by seismic zoning. Seismic zoning map, which shows numbers corresponding to anticipated amplitude & frequency of shaking induced by earthquakes, is principal source of zoning in theory. Primary source of seismic risk in India is country's fast urbanization, whichis result of its population expansion and rise of megacities in areas that might experience seismic activity.

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C. INFORMATION RELATED TO PLAN:

The building given be utilised for residential purpose. It has parking floor and 30 upper stories. The height of each floor is 3m and each floor of the building consists of four flats. The rooms in each flat are: Living and dining *hall*, three bedrooms, kitchen, study room, sit out, store room, toilets and a balcony.

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II. LITERATURE REVIEW

A. **Pardeshi Sameer et.al[1] (2016):** This paper discusses the influence of various longitudinal anomalies upon seismic response of a structure. The goal of the project is performing RSA of regular and irregular RC construction framework and Time History Analysis (THA) of conventional RC construction framework and realize the design based on ductility using IS 13920 standard for analysis of RSA. Comparison of irregular texture analysis results with regular texture is performed.

B. ***Balaji.U et.al[2] (2016):*** A multi-story structure was analysed & designed using ETABS, taking static & dynamic loads into consideration. In this study, seismic stresses on a G+13 storey residential structure were investigated utilising ETABS. After conducting static and dynamic analyses, they presupposed assuming material's characteristics would be linear. Non-linear analysis was conducted with severe seismic zones in mind, & behaviour was evaluated with type II soil condition in mind. We plotted and evaluated several outcomes, including displacements and base shear.

C. **Ali Kadhim Sallal et.al[3] (2018):** The main goal is to design and analyze multi-storey buildings in a systematic process. This paper presents a building designed and analyzed under the impact of earthquake and wind pressure using ETABS software. In this case, (18m x 18m) and eight-story structure were modeled utilising ETABS software. Ten floors are considered height (3m) and as the total height of building (31m).

D. **Jaswant N. Arlekar et.al[4] (2012):** Analysed 9 distinct construction models. It was thought that structures were in seismic zone III. Utilising ETAB's analysis program, building models underwent linear elastic analysis. Research's building models underwent two distinct analyses: a multi-model dynamic analysis & analogous static analysis. Lastly, it was proposed that, in aftermath of powerful earthquake, structures situated in zone III would demonstrate subpar performance.

E. **.** Guruprasad et.al[5] (2017): They performed a dynamic analysis of G+15 RC structure with L, C & rectangular shape in plan of ETABS software. Comparisons are made based on parameters such as soil drift, laminar shear force, support response, construction method and sectional shear strength. It can be said as largest earth shear value is observed for the L-shaped plan comparing with rectangular structure and C-shaped building

III. OBJECTIVE

i. To perform examination of structure utilizing RSA.

ii. To study irregularities in structural analysis of G+30 story's structure as per code(IS 1893:2002).

iii. To find out the bending moment and displacement of the building.

iv. To study the load combination

IV. METHODOLOGY

In this study, analysis of G+30 multi-story building for earthquake forces in seismic zone III is carried out.

Seismic analysis should be performed for buildings that lack resistance to seismic forces. Seismic analysis considers seismic effects, thus accurate.

A. IS: 1893-2002 provisions for zones:

Seismic zonation mapping of nation provides information upon seismic state and earthquake vulnerability of certain area in accordance with IS 1893 code. Intensity of earthquakes has led to the division of India in 4 zones.

Seismic Zone	II	III	IV	V
Intensity	Low	Moderate	Severe	Very Severe
Z	0.10	0.16	0.24	0.36

Table 1: Zone Factor

B. Building design data:

Building type	: Residential building
No. of story's	: Parking +30 floors
Building shape details:	: Rectangular Geometrical

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Ground floor height : 3m

Floors – floor height : 3m Material details:

Material details:

Grade of Concrete : M30

Grade of steel : HYSD reinforcement of Fe550

Bearing capacity of soil : 200 kN/mm^2

Type of concrete : R.C.C Framed structure

Wall : 230 mm, 100 mm thick

Live load : As per IS: 875 (part II)-1987 Size of the building = (80 x 100) feet

Size of each flat = 1800 sq. feet

C. 3BHK

LIVING HALL	- 26’9” X 19’4”
M BEDROOM	- 13’ X 13’11”
A.TOILET AND BATH	- 3’4” X 6’3”
BEDROOM 2	- 13’ X 11’9”
BEDROOM 3	- 9’9” X 12’
A.TOILET AND BATH	- 3’ X 5’11”
KITCHEN	-14’ X 8’
BALCONY	-12’ X 8’
STUDYROOM	-8’6” X 10’
SITOUT	-7’10” X 6’3”
STORE ROOM	- 3’ X 3’
BATHROOM	-3’ X 2’11”
WC	

D. GROUND FLOOR PLAN (PARKING)

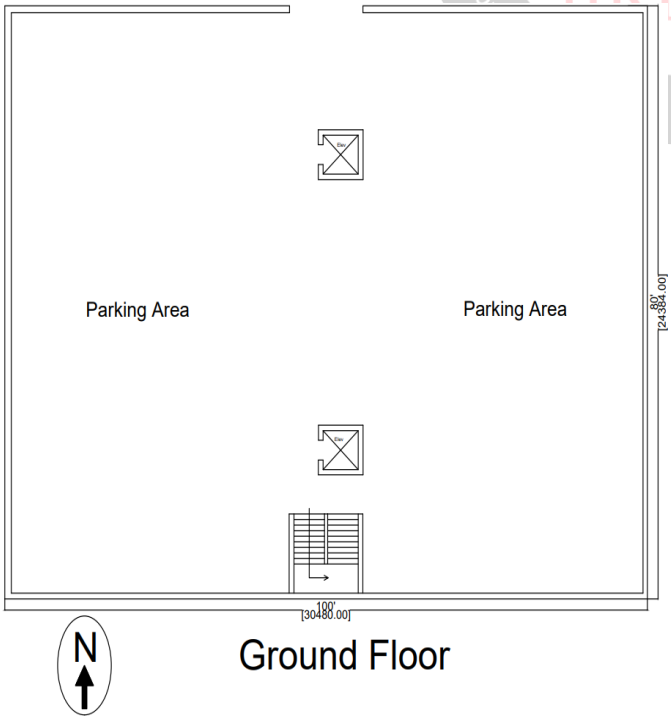

Fig.2 Ground Floor Plan (Parking)

E. FLOOR PLAN (1-30)

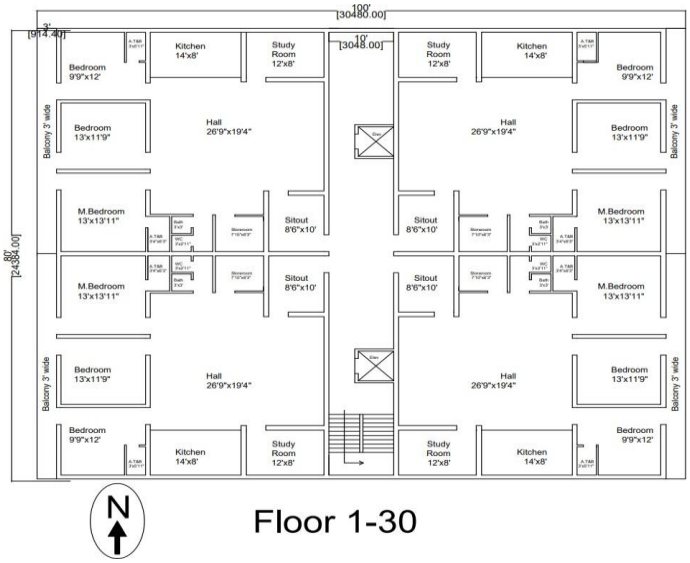

Fig.1 Floor Plan

F. Steps To Analyze Structure Utilizing ETABS

In this article, we will go over quick steps to create model of chosen plans and conductevaluation:

I. Launch program, ETABS.

II. Select built-in configuration according to the IS code after opening new model in file menu bar.

III. The next step is to draw grid lines.

IV. Determine material qualities that are relevant for the study of high-rise buildingsbased on grade we are using.

V. Next, use the room dimensions from floor plan to determine whether the slabportion will be one-way or two-way.

VI. Then, utilizing separate commands, sketch beam, column, and slab.

VII. The various static load scenarios, such as dead load (DL), live load (LL), wallload (WL), wind load (WL), earthquake load (EQ), etc., should be defined.

VIII. Assign the various loads specified in the static load scenarios in accordance withthe IS code.

IX. Allocate assistance (resolved).

X. To analyse the response spectrum, go to define, functions, and then response spectrum.

XI. A dead load, live load, wall load, etc., must have its mass source defined.

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XII. Choose seismic response spectrum in load cases menu.

XIII. We specify load combinations.

XIV. Say that diaphragm is stiff.

XV. Following this, do building analysis and design in accordance with IS456:2000; verify that chosen dimensions of frame section are safe; if not,adjust specifications.

G. Define Material Properties

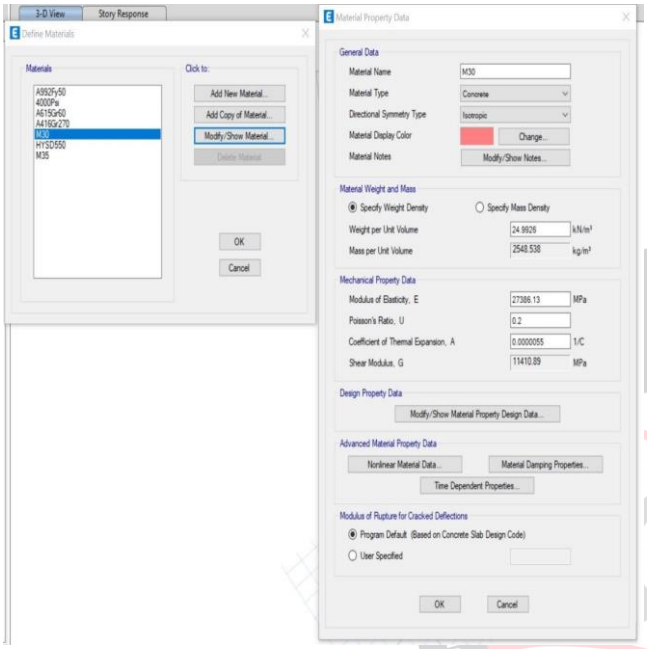

Fig 3. Material Property (Grade of concrete)

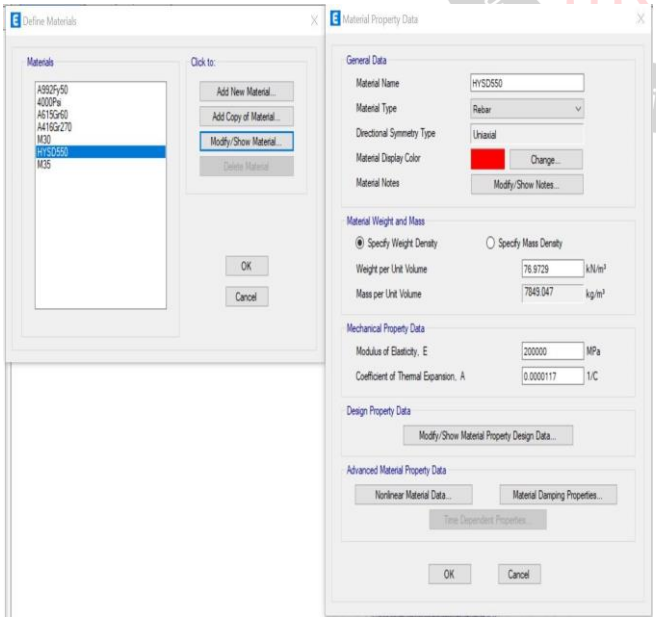

Fig 4. Material Property (Grade of steel)

H. Define Slab Sections

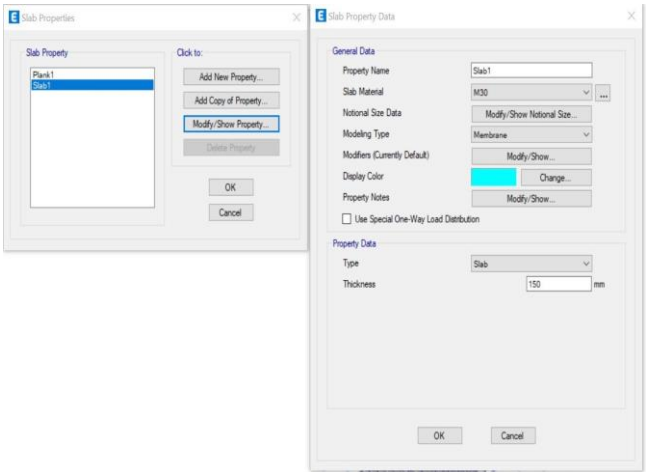

Fig 5. Defining Slab

I. Define Load Patterns

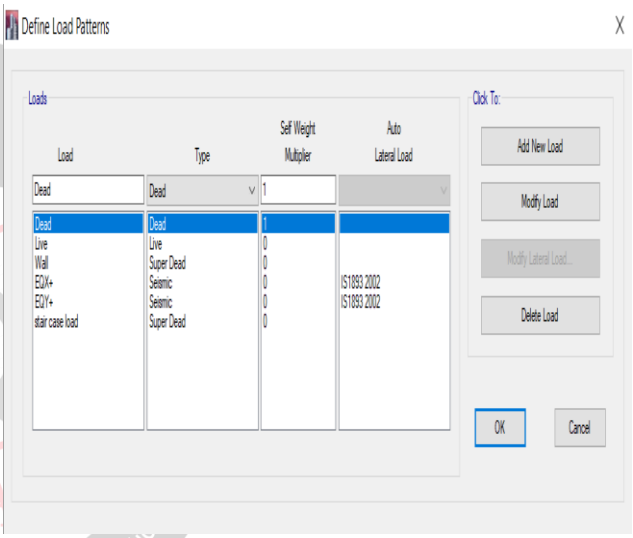

Fig 6. Defining Load Patterns

J. Assign Load Patterns

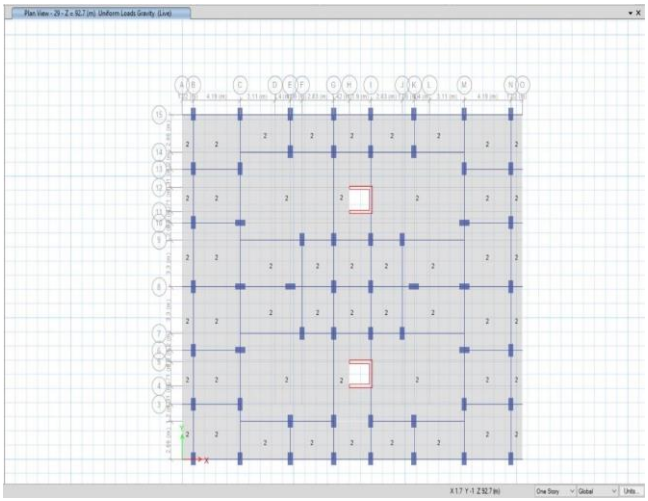

Fig 7. Live Load Assigned

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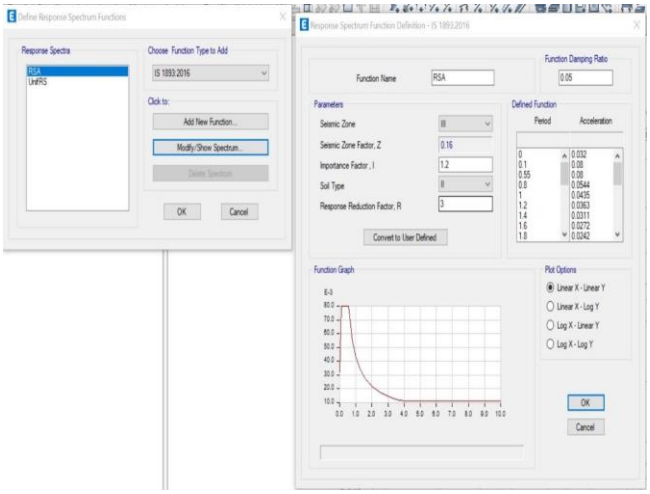


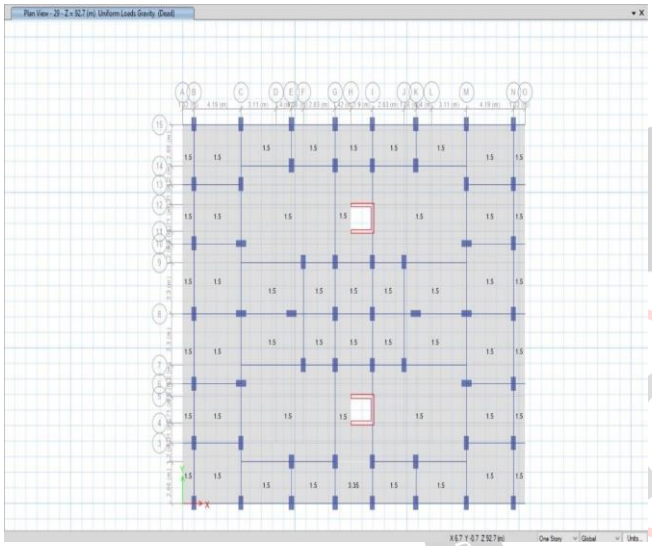
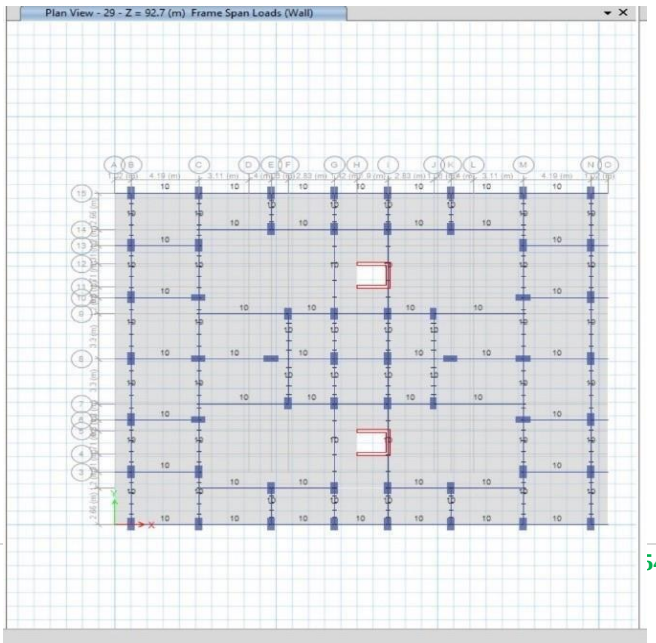


Fig 8. Dead Load Assigned

Fig 9. Wall Load Assigned

K. Define Response Spectrum

Fig 10.Defining Response Spectrum



L. Define Mass Sources

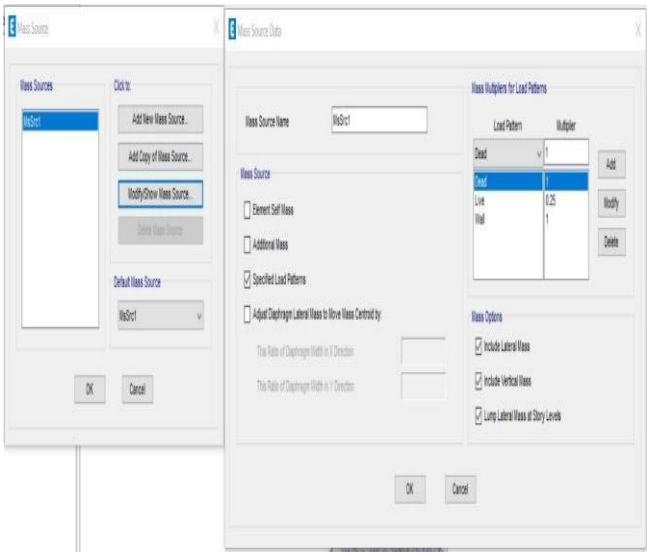


Fig 11.Defining Mass Sources

M. Define Load Cases

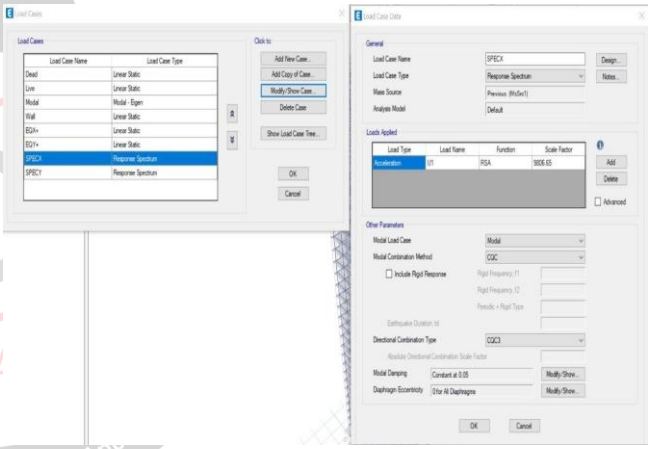


Fig 11 Defining Load Cases

N. Define Load Combinations

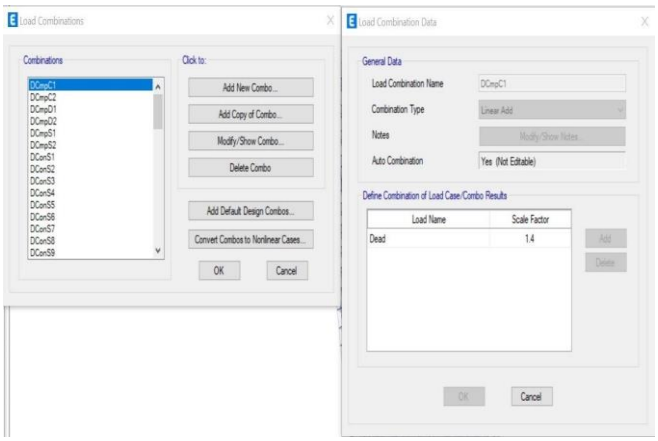


Fig 12. Defining Load Combination

O. Define Diaphrag

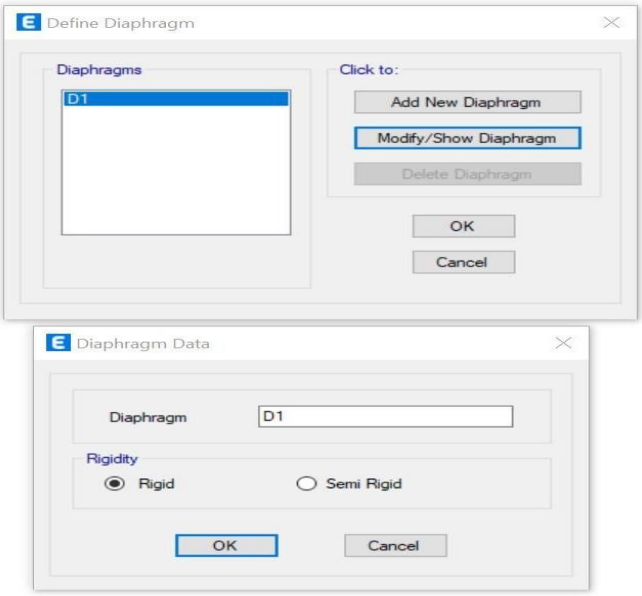


Fig 13. Defining of Diaphragm

P. Assign Diaphragm

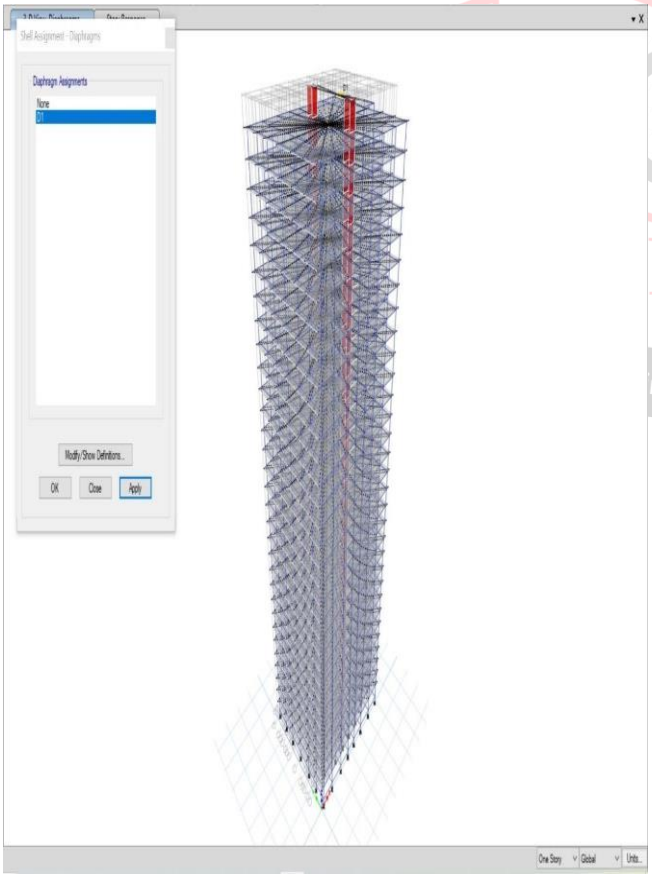


Fig 14.Assigning of Diaphragm

Q. Beam and Column Reinforcement

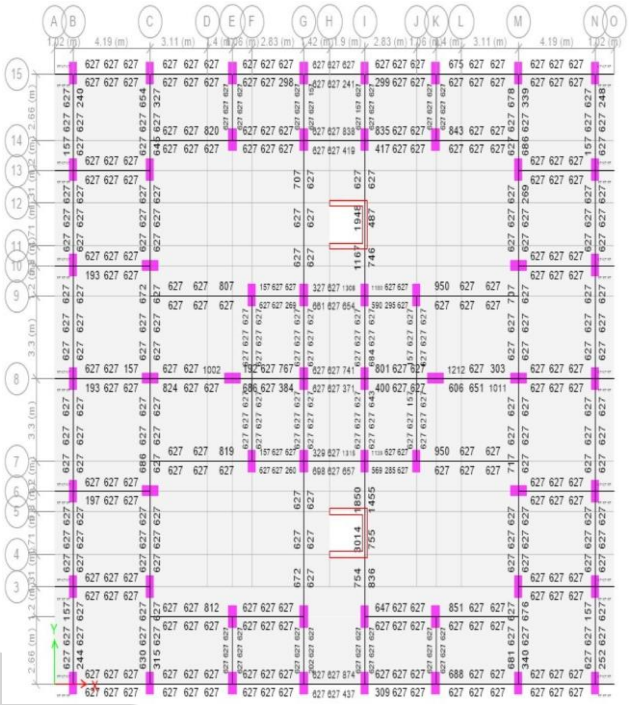


Fig 13. Beam Reinforcement

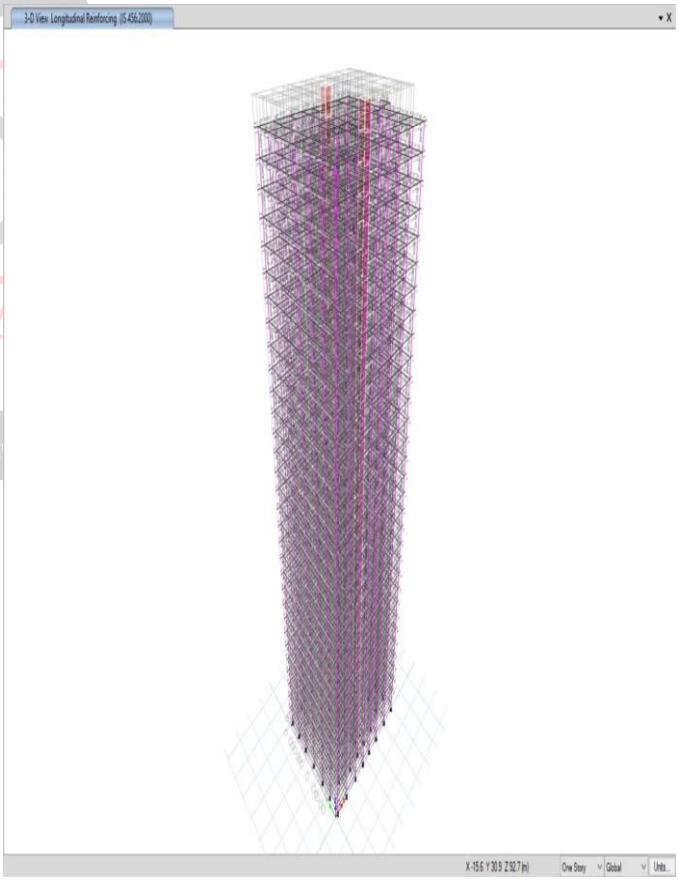


Fig 14 Beam and Column Reinforcement in 3D

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R. Bending Moment Diagram

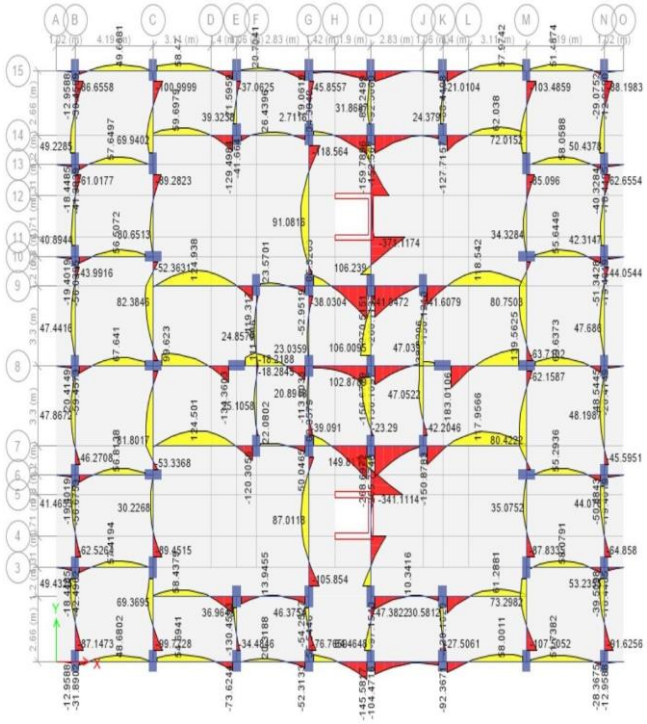


Fig 15.Bending Moment Diagram

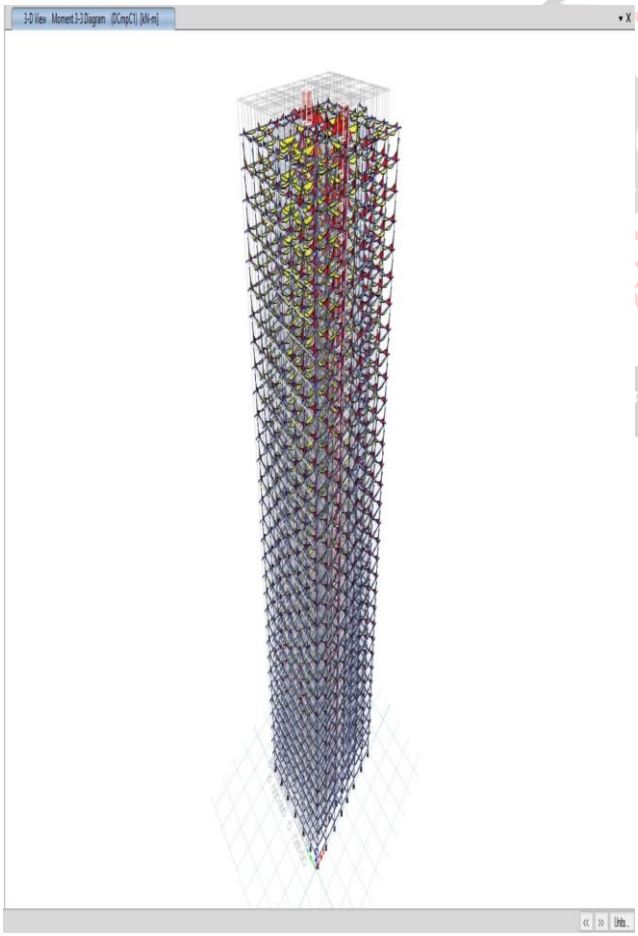


Fig 16.Bending Moment Diagram in 3D

V. RESULTS

A. Story Displacement

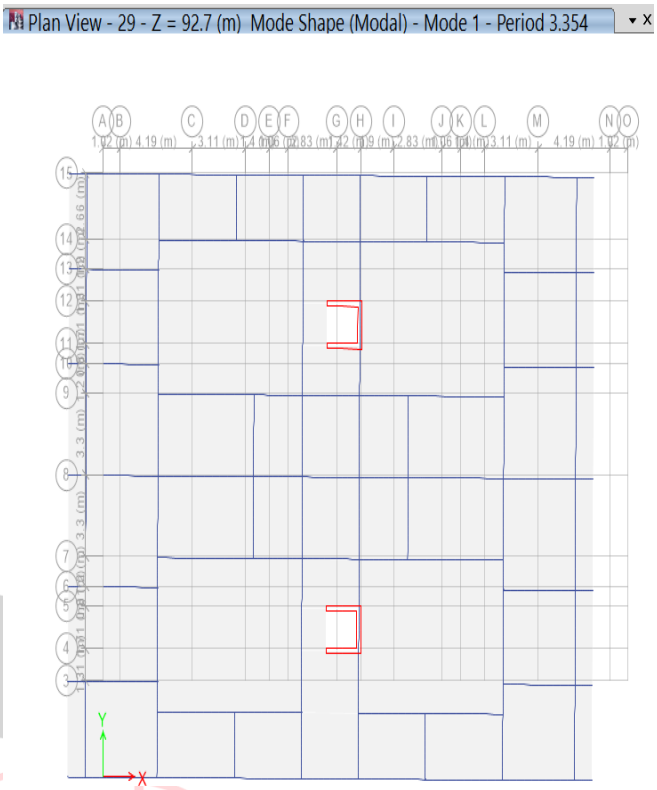
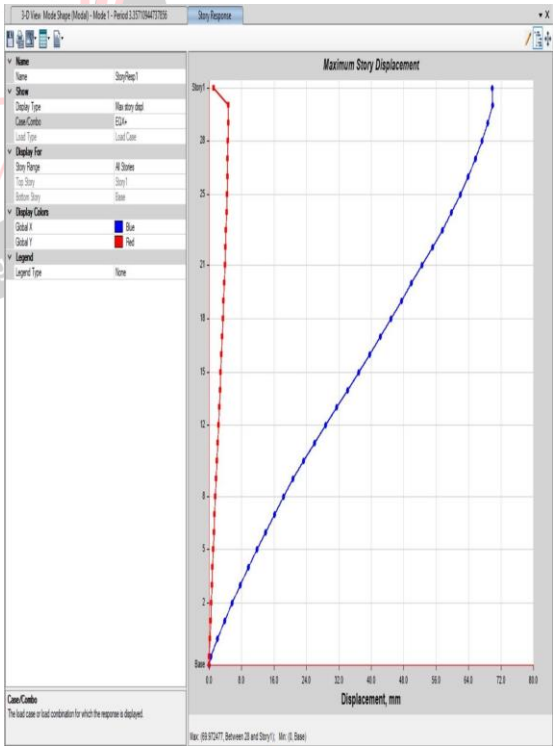


Fig 17 Story displacement (period)



Graph 1 Showing Maximum Story Displacement in EQX+

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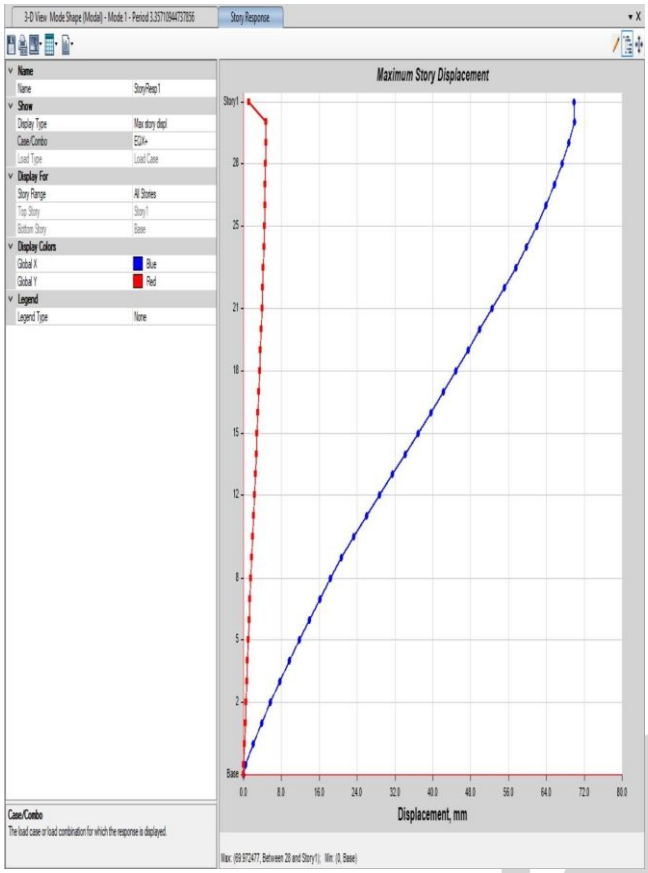
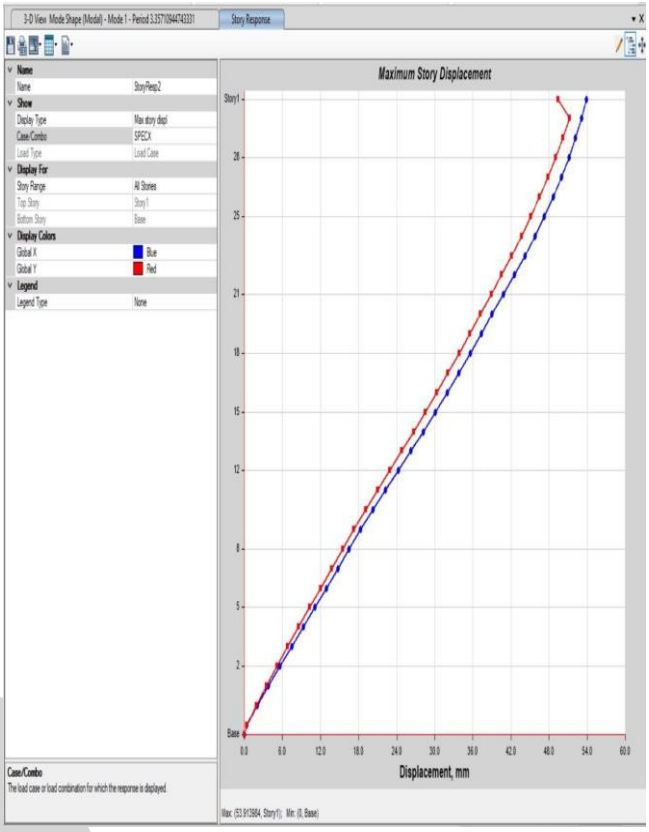
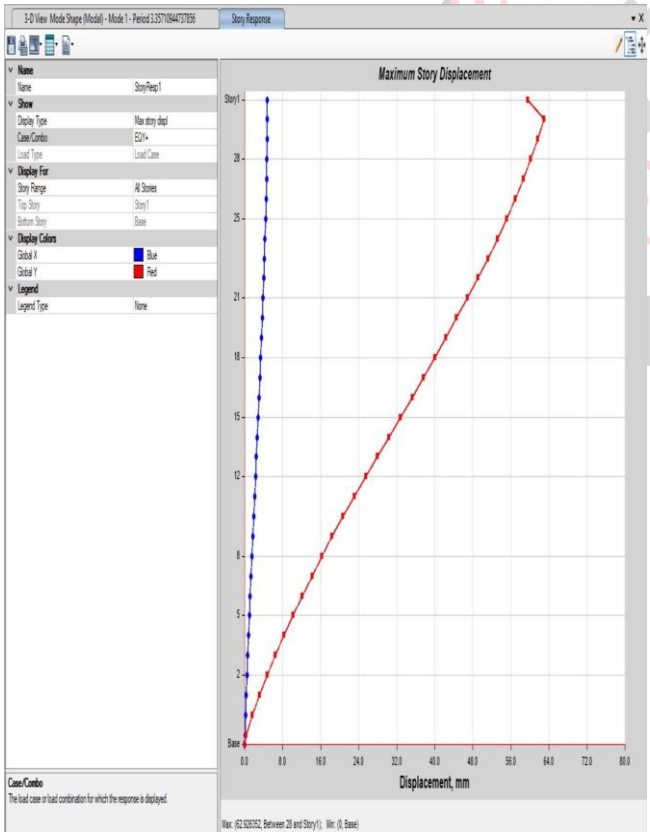


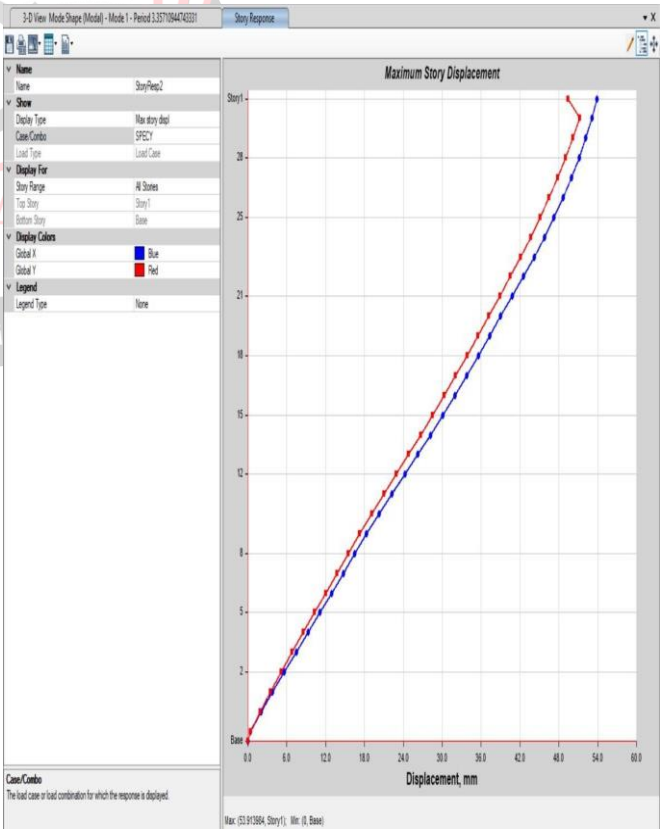
Graph.2 Showing Maximum Story Displacement in EQX+



Graph 4. Showing Maximum Story Displacement in SPECX



Graph 3. Showing Maximum Story Displacement in EQY+



Graph 5.Showing Maximum Story Displacement in SPECY

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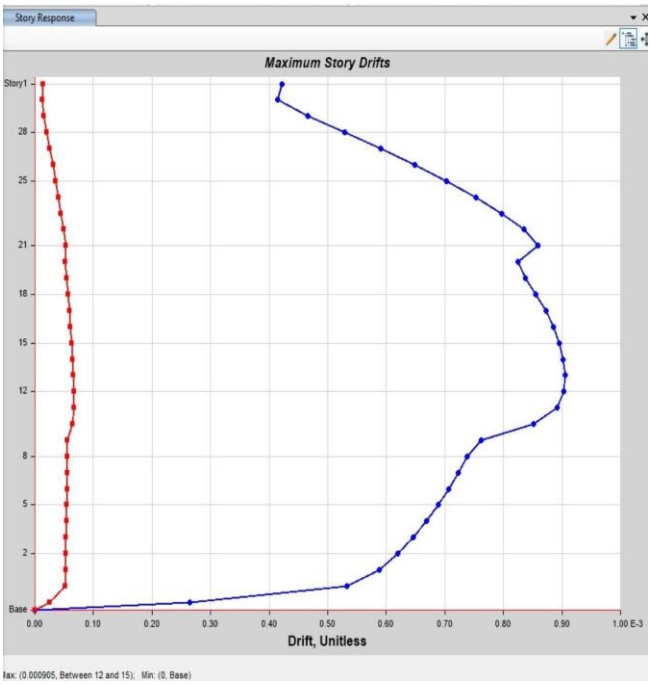
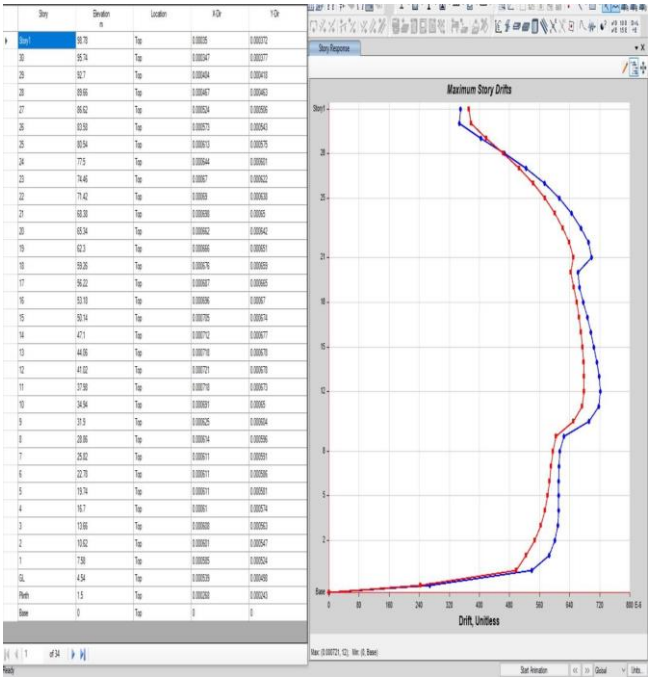
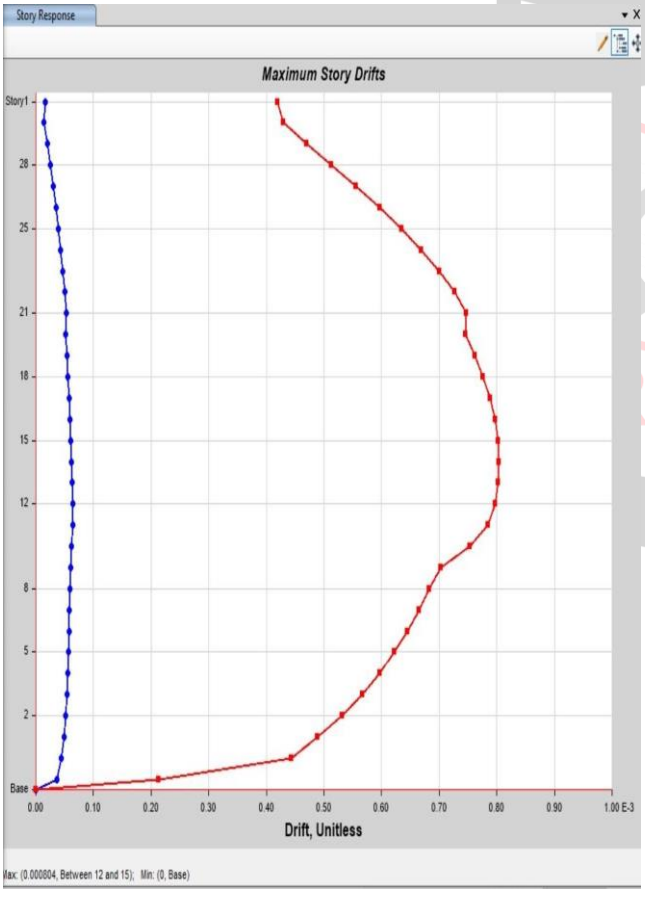
B. Story Drift



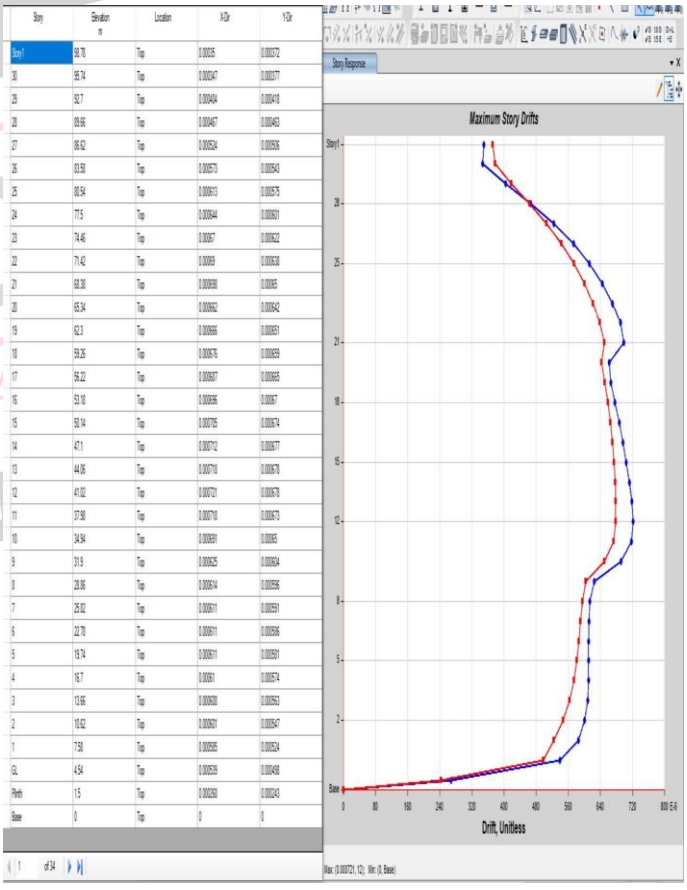
Graph 6. Showing Maximum Story Drift in EQX+



Graph 8. Showing Maximum Story Drift SPECX



Graph 7.Showing Maximum Story Drift in EQY+



Graph 5.2.4 Showing Maximum Story Drift in SPECY

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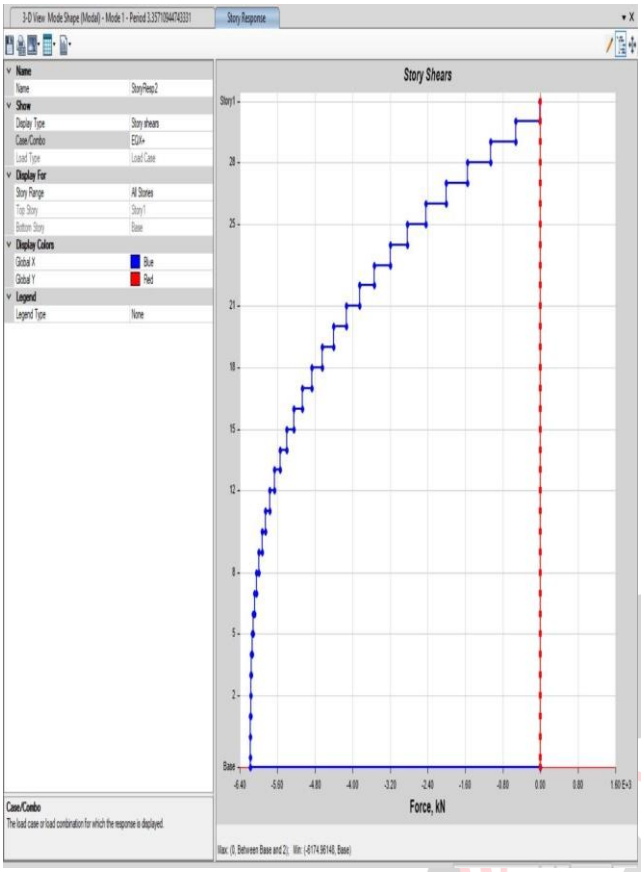
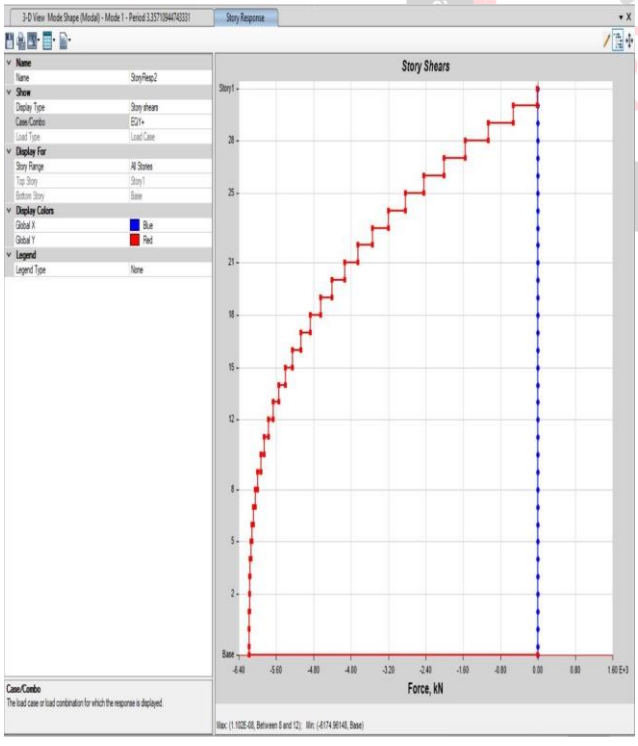
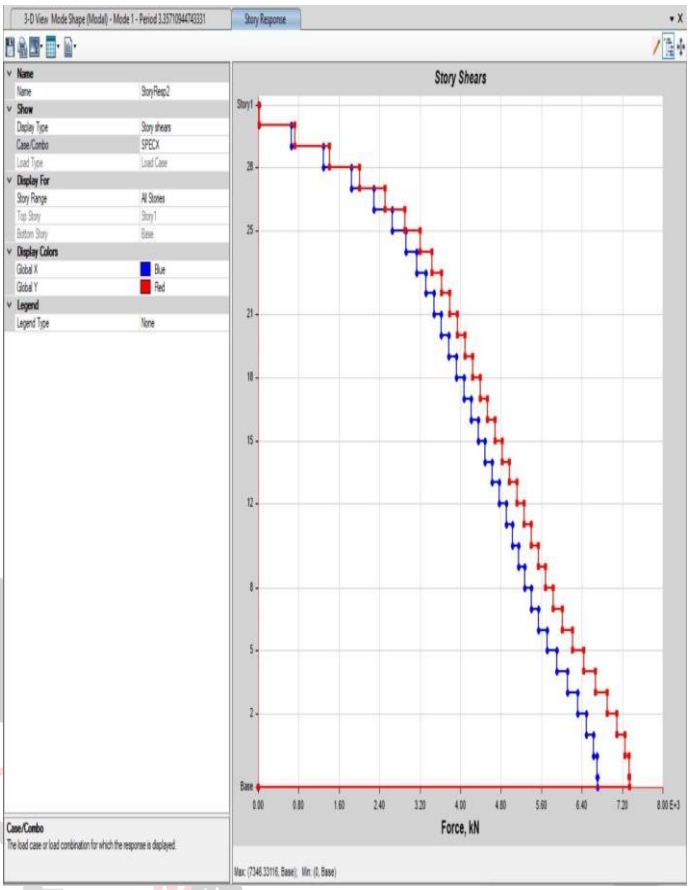
C. Story Shear



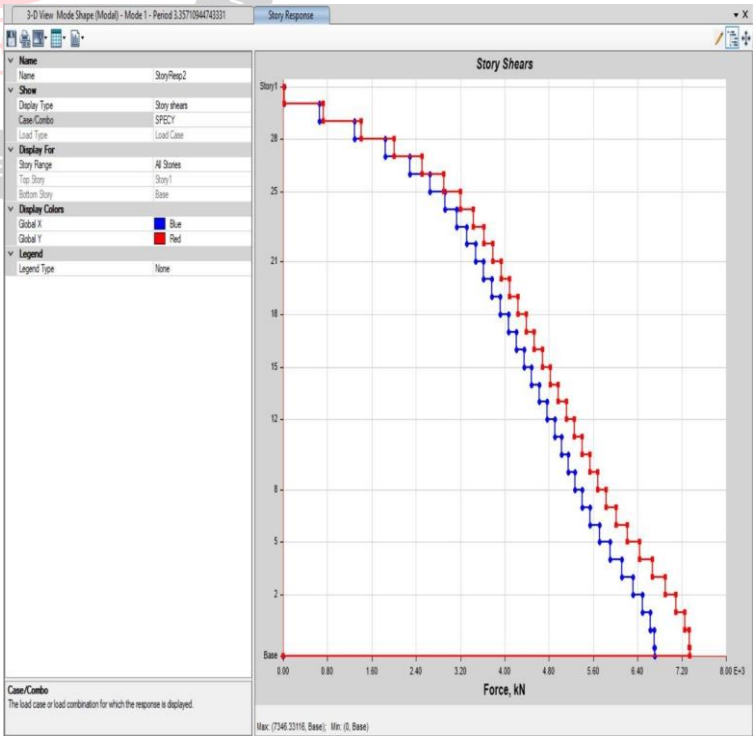
Graph 5.3.1 Showing Maximum Story Shear in EQX+



Graph 5.3.2 Showing Maximum Story Shear in EQY+



Graph 5.3.3 Showing Maximum Story Shear in SPECX



Graph 5.3.4 Showing Maximum Story Shear in SPECY

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VI. CONCLUSION FUTURE SCOPE

A. CONCLUSION

- The structural components of structure are safe.
- Construction process may make advantage of specified element sizes.
- Lateral displacements & graphs demonstrated clearly behaviour of high-risestructure.
- With this program, you may receive more precise results from your analyses.

B. FUTURE SCOPE

- Structure analysis with different software
- Comparing with different seismic zones
- Design of the building structure
- Considering different soil type and comparing

.

References

[1] Pardeshi Sameer and Prof. N. G. Gore (2016): "Comparative study on Response spectrum analysis (RSA) of regular and irregular RC building frames and Time History Analysis (THA) of regular RC building frames using ETABS", Volume 03; Issue 01.

[2] Balaji.U and Selvarasan M.E (2016): "Analysis and design of multi-storied building under static and dynamic loading conditions using ETABS", International Journal of Technical Research and Applications e-ISSN: 2320-8163, www.ijtra.com Volume 4, Issue 4, PP. 1-5.

[3] Ali Kadhim Sallal (2018): "Design and analysis multi-Storeyed building under effect of earthquake and wind pressure by using ETABS software 2016", Volume 4; Issue 2; May 2018 Page No. 21-27.

[4] Jaswant N. Arlekar, Sudhir K. Jain et al. (2012): "Studied nine different models of the buildings located in seismic zone III using Linear elastic analysis using ETABS", Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi.

[5] G. Guruprasad et al. (2017): "Comparative study on dynamic analysis of G+15 storied RC frame building with L, C & rectangular shape using ETABS software".

[6] Pushkar Rathod, Rahul Chandrashekar "seismic analysis of multistoried building for different plans using ETABS 2015" Volume: 04 Issue: 10 | Oct - 2017

[7] S. Vijaya Bhaskar Reddy, Jagath Chandra. P, Srinivas Vasam, P Srinivasa Rao "Analysis Of Multistoried Structures Using ETABS" Vol. 3, Issue 1, pp: (151- 158), Month: April 2015 - September 2015

[8] IS 1893-2002 for earthquake load

[9] IS 456-2000 for RC structure

[10] SP-16 for column.

[11] IS 875 part III for wind load.

[12] G. W. Juette and L. E. Zeffanella, "Radio noise currents n short sections on bundle conductors (Presented Conference Paper style)," presented at the IJREAM Summer power Meeting, Dallas, TX, Jun. 22–27, 1990, Paper 90 SM 690-0 PWRS.

[13] J. G. Kreifeldt, "An analysis of surface-detected EMG as an amplitude-modulated noise," presented at the 1989 Int. Conf. Medicine and Biological Engineering, Chicago, IL.

[14] J. Williams, "Narrow-band analyzer (Thesis or Dissertation style)," Ph.D. dissertation, Dept. Elect. Eng., Harvard Univ., Cambridge, MA, 1993.

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