Dynamic Analysis of Regular and Irregular Building using ETABS

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***Abstract*—This paper aims to describe the study of the time history analysis and response spectrum using ETABS. An earthquake is the result of a rapid release of strain energy storied in the earth crust that generates seismic waves. Structures are vulnerable to earthquake ground motion and damages the structures. In order to take precaution for the damage of structures due to ground motion, it is important to know the characteristics of the ground motion. The most important dynamic characteristics of earthquake are peak ground acceleration, frequency content, and duration. These characteristics play predominant rule studying the behavior of structures under the earthquake ground motion. The earthquake analysis of multistorey structure is done by linear and nonlinear methods. Response spectrum method of analysis is linear dynamic analysis. For nonlinear dynamic analysis time history method is used. In this paper, response spectrum method is used for linear analysis. For nonlinear analysis, time history method is used. For time history method Both theanalyses are done using ETABs software.**

Keywords:- Dyanamic analysis ; etabs; seismic analysis;time history

I. INTRODUCTION

All over world, there is huge demand for construction of high- rise buildings due to increasing population Earthquake resistant design of engineering structures is one of the most important methods of damage from future earthquake. The earthquake design of structure is based on the specification of ground motion of previous earthquake results. So earthquake resistant design of any important structure according to the seismic frequency is very important to overcome from damage. However, the earthquake forces are different and un predictable .so the software tools need to be used for analyzing structures under any seismic forces. Earthquake develops different intensities at different locations and the damage induced in buildings at these locations is also different according to the type of structure. Therefore, it is Necessary tostudy the seismic behavior of RC framed building for different seismic intensities. The seismic intensities in terms of various responses such as base shear, lateral displacement. Different types of analysis are used to identify the seismic resistance and behavior of building under applied seismic frequencies. The analysis can be performed on the basis of external applied loads, applied structural materials and type of structure, the analysis is classified as 1). Linear static Analysis 2) Nonlinear static analysis 3) Linear Dynamic Analysis 4) Nonlinear Dynamic Analysis. The Time history analysis is response of the structure including inertial effects, this is advanced to response spectrum analysis, and gives base acceleration, displacement, and duration. This is useful for very Highrise structures to know the behavior of structure under any seismic attacks. This analysis requires previous earthquake data toperform the analysis. It is a step-by-step analysis of response of structure under specified load that may vary with time.

II. SEISMIC METHOD OF ANALYSIS

For the determination of seismic responses there is necessaryto carry out seismic analysis of structure. The analysis can beperformed 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 andbehavior of structure, the analysis can be further classified as:

(1) Linear Static Analysis, (2) Nonlinear Static Analysis, (3) Linear Dynamic Analysis; and (4) Nonlinear 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 structure. Nonlinear static analysis is an improvement over linear static or dynamic analysis in the sense that it allows inelastic behavior of structure. A nonlinear dynamic analysis is the only method to describe the actual behavior of a structure during an earthquake. The method is based on the direct numerical integration of the differential equations of motion by considering the elasto-plastic deformation of the structural element.

Equivalent Static Analysis: - This procedure does not require dynamic analysis; however, it account for the dynamics of building in an approximate manner. The static method is the simplest one-it requires less computational efforts and is based on formulate given in the code of practice. First, the design base shear is computed for the whole building, and it is then distributed along the height of the building. The lateral forces at each floor levels thus obtained are distributed to individuals lateral load resisting elements.

Linear Dynamic Analysis: - Linear dynamic analysis can be performed in two ways either by mode superposition method or response spectrum method and elastic time history method. This analysis will produce

the effect of higher modes of vibration and the actual distribution of forces in the elastic range in a better way. They represent an improvement over linear static analysis. The significance difference between linear static and linear dynamic analysis is the level of force and their distribution along the height of the structure.

Nonlinear static analysis: - Nonlinear static analysis is an improvement over linear static or dynamic analysis as it allows the inelastic behavior of the structure. The method still assumes a set of static incremental lateral load over the height of the structure. The method is relatively simple to be implemented and provides information on the strength, deformation and ductility of the structure and the distribution of demands. This permit to identify critical members likely to reach limit states during the earthquake, for which attention should be given during the design and detailing process. But this method contains many limited assumptions, which neglects the behavior of loading patterns, the influence of higher modes, and the effect of resonance. Push over analysis has acquired a great deal of popularity nowadays in spite of these deficiencies this method provides reasonable estimation of the global deformation capacity, especially for structures which primarily respond according to the first mode.

Nonlinear Dynamic Analysis: A nonlinear dynamic analysis of inelastic time history analysis is the only method to describe the actual behavior of the structure during an earthquake. Time history analysis is a step-by step analysis of the dynamic response of a structure to a specified loading that may vary with time. Time history analysis is used to determine the seismic response of a structure under dynamic loading of representative earthquake.

III. TIME HISTORY ANALYSIS

In order to examine the exact nonlinear behavior of structures, nonlinear time history analysis has to be carried out. In this method, the structure is subjected to real ground motion records.[6] This makes this analysis method quite different from all of the other approximate analysis methods as the inertial forces are directly determined from these ground motions and the responses of the building either in deformations or in forces are calculated as a function of time, considering the dynamic properties of the structure.

The ground motion record is defined as a function of acceleration versus time. Here after, the analysis and the time history parameters are defined in order to perform a nonlinear time history analysis. The total time of the analysis is the number of output time steps multiplied by the output time-step size. To match time history to target response spectra, thereare two options in ETABS.

IV. RESPONSE SPECTRUM METHOD

Response spectrum analysis (RSA) is a method widely used for the design of buildings. Conceptually the method is a simplification of modal analysis, i.e., response history (or time history) analysis (RHA) using modal decomposition, that benefits from the properties of the response spectrum concept. The purpose of the method is to provide quick estimates of thepeak response without the need to carry out response history analysis. This is very important because response spectrum analysis (RSA) is based on a series of quick and simple calculations, while time history analysis requires the solution of the differential equation of motion over time. Despite its approximate nature, the method is very useful since it allows the use of response spectrum, a very convenient way to describe seismic hazard.

IV. OBJECTIVE

i. To investigate the behavior of re-entrant cornerbuildings under dynamic loading.
ii. To compare the behavior of RC regular and irregularframes in zone IV.
iii. To study the parameters such as displacement, drift, base shear and time period of both irregular and regular buildings.
iv. To carry out time history method for both regular andirregular models using ELCENTRO.

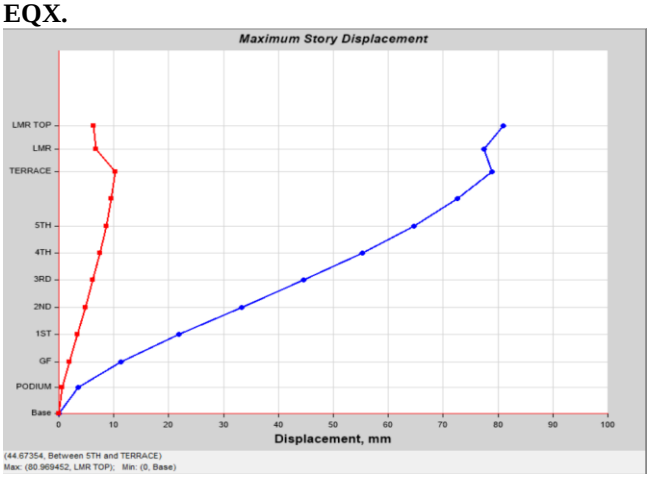
V. MODELING

The analysis of both regular and re-entrant structures (10storys) has been analyzed for both gravity and lateral loads. ETABS 18 has been used for the modelling and to carry out the analysis. The analysis results are obtained for seismic zone IV.

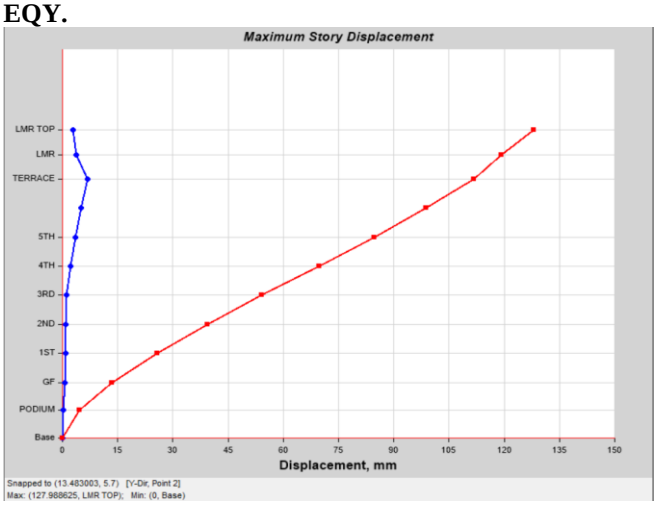
V.I MODEL

Type of frame	Regular and irregular	
Dimension of beamAnd column(mm)	Irregular B 150*400 B 250*400 C 300*600 C 400*700	Regular B 400*650C 450*700
Materials property	HYSD500 HYSD415 M25	HYSD 415M25
SLAB	S130 S175 Stair S200	S 150 S150oneway
WALL	Wall 230 lift	
Diaphragm	Rigid (D1, D2)	
Shell Uniform load	D=1.5, l=2.5 parking D=1.5, L=3 CorridorD=2, l=1.5 terrace D=3, l=3 staircase D=7, l=2 WC SIDl=1.5, l=2 general	
Seismic zone and factor	IV,0.24	
Importance factor	**1**	
Site type	**II**	
Damping ratio	**5%**	

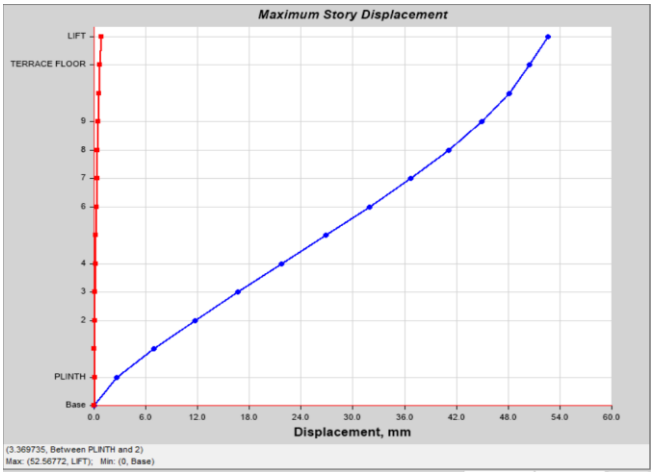
A. Story displacement of irregular building in EQX.



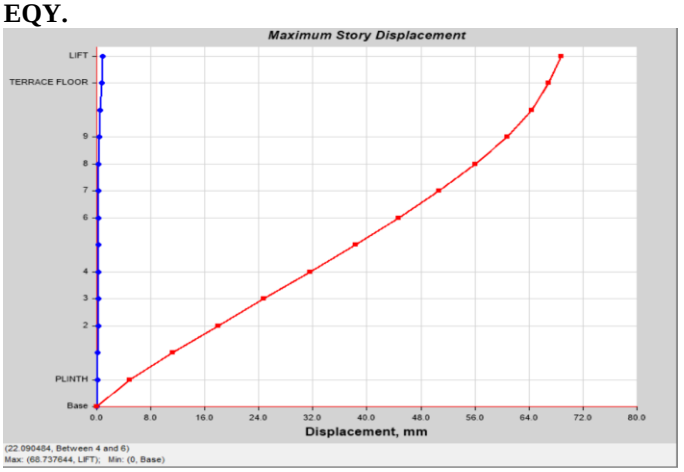
B. Story displacement of Irregular building in EQY.



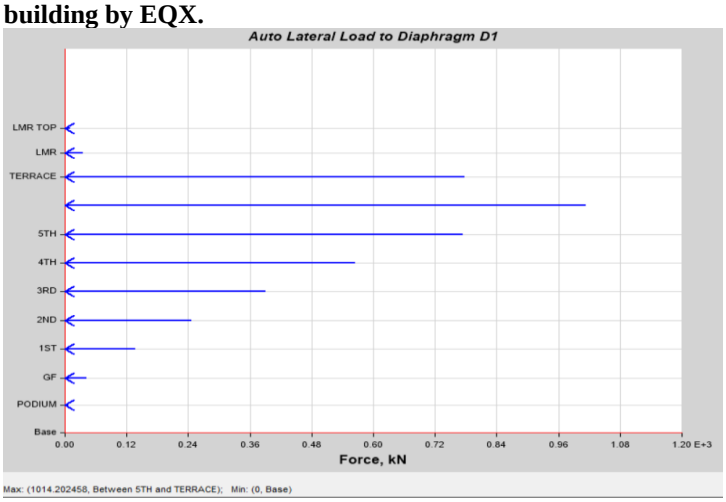
C. Story displacement of regular building inEQX



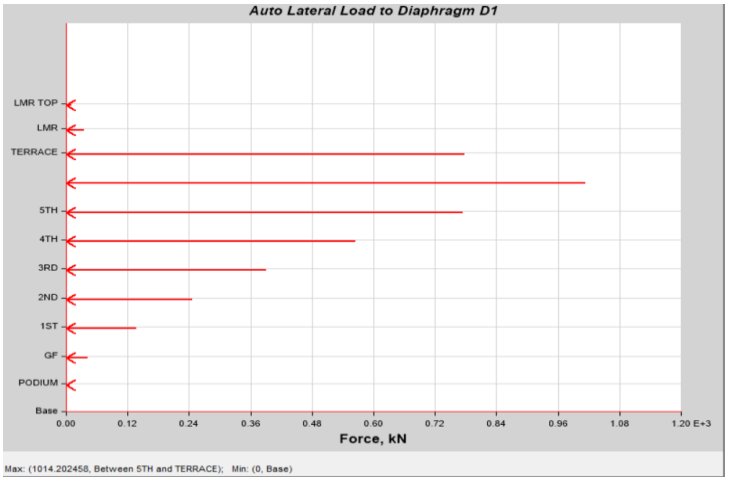
D. Story displacement of regular building in EQY.



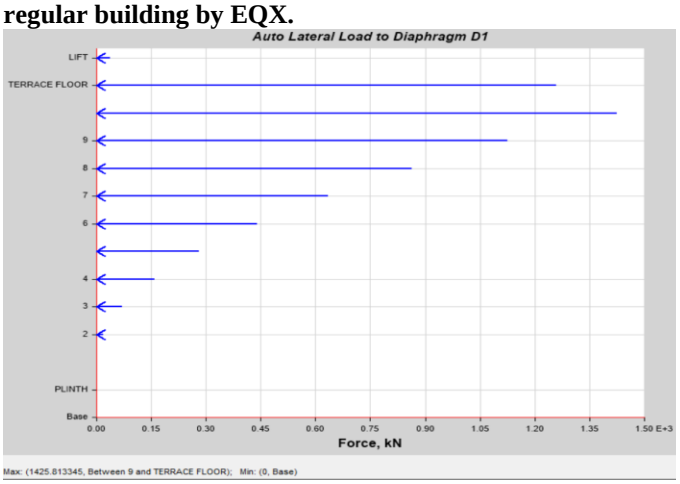
E. Story Response-Auto Lateral Load to Diaphragm of irregular building by EQX.



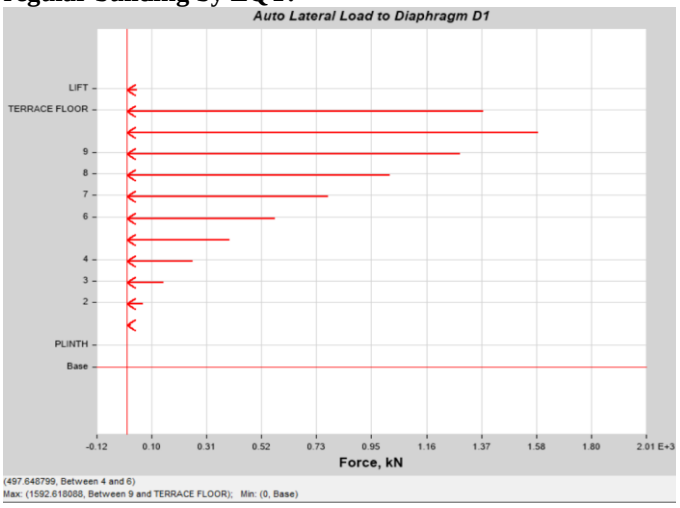
F. Story response-auto lateral load to Diaphragmof Irregular building by EQY



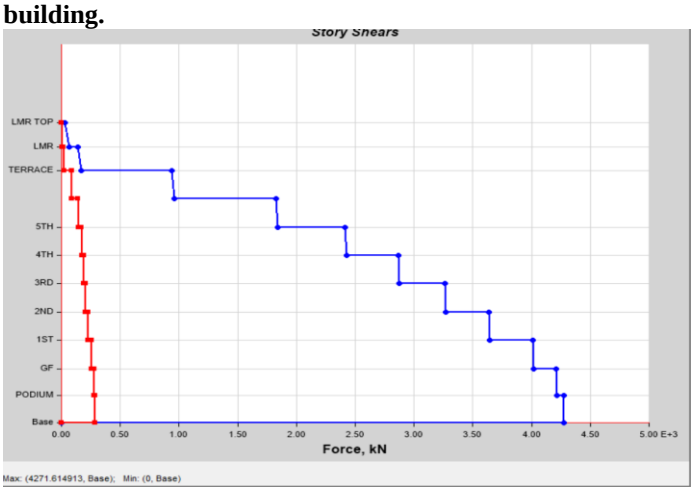
G. Story response-auto lateral load to Diaphragmof regular building by EQX.



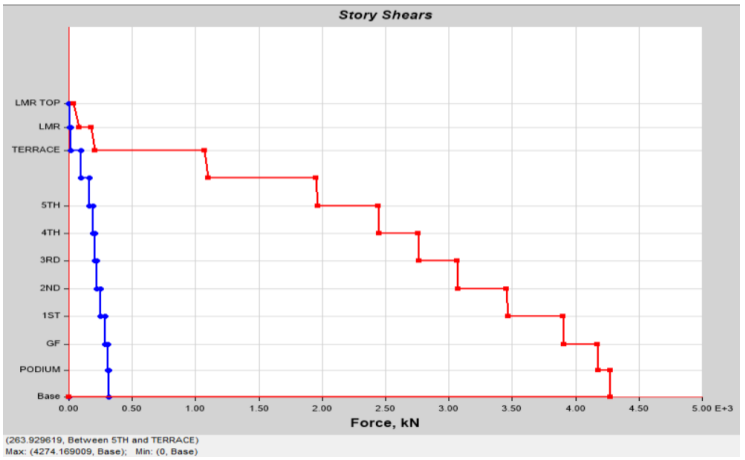
H. Story response-auto lateral load to Diaphragm of regular building by EQY.



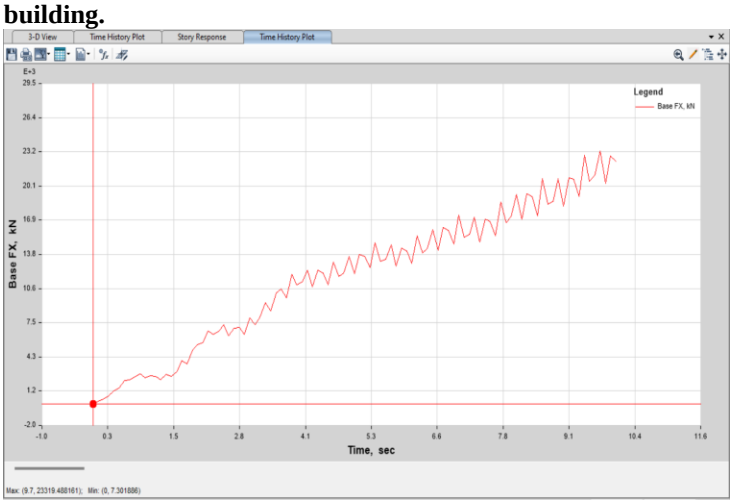
I. Story shear in load case RS in irregular building.



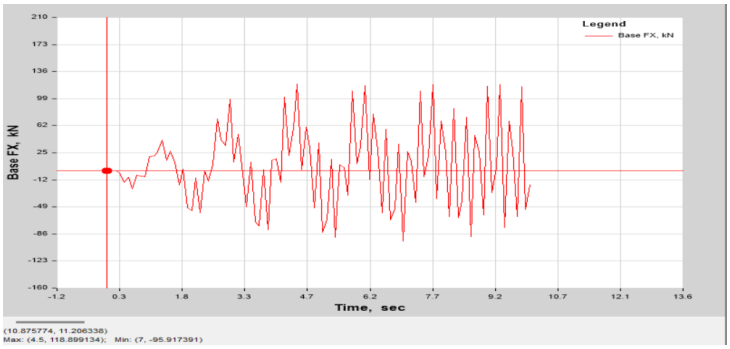
J. Story shear in load case RS in regular building



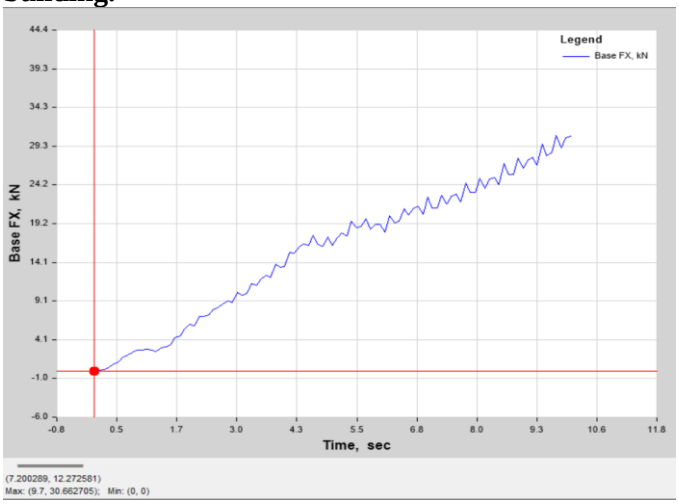
K. Time history method in thx in irregular building.



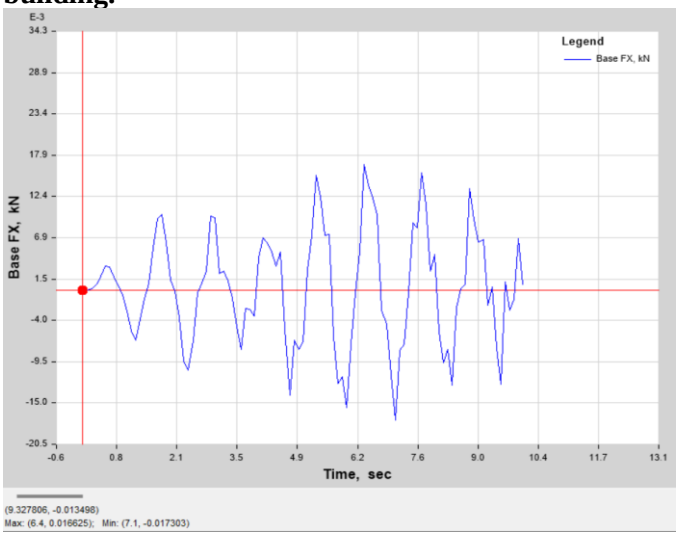
L.Time history method in thy in irregular building.



M. Time history method in thx in regular building.



N. Time history method in thy in regular building.



CONCLUSION

The following are the major conclusions that can be made based on present work carried Up on the RC buildings with different types regular and Irregular building (taken in dimensions shown above) analyzed in Time history method, Earthquake forces in the seismic zone ii using ETABS Software 2018.

1) The base shear in regular building in X&Y dir. is 380.67 KN where as in irregular type its value in x direction is 968.67KN and in y direction is 802.0 KN.

2) Here from the Base Shear curves that the magnitude of Base Shear decreases in regular type building.

3) In irregular building, the maximum story displacement in EQX obtained and the maximum displacement is X direction is 80.969 mm and Y direction 6.268mm.and the maximum displacement in EQY is x direction is 2.963mm mm and y direction 127.989mm**.**

4) In regular building, the maximum story displacement in EQX is obtained at story g +10 and the maximum displacement is X direction is 52.568 mm and y direction 0.842mm.and the maximum displacement in EQY is X direction is 0.866 mm and Y direction is 68.738mm.

5) Here from the story displacement in EQX and EQY that the Displacement of Shear decreases in regular type building.

6) In irregular building, the maximum Lateral Load in EQX is x direction 1014.20 KN and Y direction 0 and the maximum Lateral Load In EQY is x direction 0 KN and y direction 1014.20kN.

7) In regular building, the maximum Lateral Load is X direction 1425.81kN and Y direction 0 KN, the maximum Lateral Load in EQY is X direction 0 and Y direction 1592.61KN.

8) In irregular building the maximum story shear in RS valuein is obtained at story in X direction is 4271.61 KN and Y direction 289.03 KN.

9)In regular building, the maximum story shear value in RS isobtained at story in X direction is 318.56 KN and Y direction 4274.16 KN.

10) Time History in Irregular building in THX maximum 9.7 sec in base 23319.488 KN and min 0 in base 7.30kN and THYin maximum 4.5 sec in base 118.89kN and min 7sec in base in95.91kN.

11) Time History in regular building in THX maximum 9.7 sec in base 30.66kN and THY in maximum 6.4 sec in base 0.01kN.

The major conclusions that can be made based on present work carried upon the RC buildings with different types Regular and Irregular building (taken in dimension) analysesin Time history method, Earthquake forces, Response spectrum in the seismic zone using ETABS Software 2018 is that there will be increase in the bases shear, story displacement and story drift in irregular building than in regular building.

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