International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

Seismic Analysis and Design of Regular and Irregular Framed Commercial Buildings

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Abstract - *Multi-storey structures construction by Reinforced Concrete are Subjected to most dangerous seismic waves during earthquakes .The main reason found that RCC commercial building failure is caused due to Irregularity in its plan dimension and lateral force distribution. In this paper study is made to find the Response of the Regular and Irregular Structures having plan Irregularity located in Seismic zone V. In the Present Study, Analysis has been made by taking 6 storey building by Response Spectrum Method using ETABS 2013 and IS Code 1893:2002 (part 1).Analysis can be performed for Regular and Irregular Buildings with a height of 21 m in zone V by using Response Spectrum Analysis method. Behavior of structures will be found by comparing the responses in the form of maximum storey displacement, storey drift, storey shear during earthquake. Presently there are Three models. One is Regular structure and remaining are Irregular structural models, all models have different shape but having same area. An attempt is made to study the structural behavior of 3Dimensional (3D) 6 storeys RC building considering the primary loads and their Combinations with appropriate load factor.*

Key Words: *Commercial building, Regular building, Irregular building, Earthquake, Wind load, seismic load, E-tabs.*

1. INTRODUCTION

Earthquake means the sudden vibration of earth which is caused by naturally or manually. We know that different types of vertical and horizontal irregularities buildings are used in modern infrastructure. During an earthquake, the building tends to collapse. This is mainly discontinuity is termed as irregular structures so vertical and horizontal regularities are one of the major reasons of failure of structures during earthquakes. The irregular buildings can not be avoided during the construction may due to space requirement and construction field so the tall structures more demand. the structure must withstand against lateral force acting on the structure due the wind load & earthquake load so in this project the comparative studies is done for the zone-V by providing the required size of columns and beams by following Indian standards(IS 456:2000).if this analysis is not proper means the effect of earthquake may cause the structural collapse and life of people may spoil. So structure should be designed in proper way. Earthquake causes different shaking intensities at different locations and the damage induced in buildings at these locations is also different. Thus, it is necessary to construct a structure which is earthquake resistant at a particular level of intensity of shaking and assimilate the effect of earthquake. Even though same magnitudes of earthquakes are occurring due to its varying intensity, it results into dissimilar damaging effects in different regions. Hence, it is necessary to study seismic behavior of multi- strayed RC framed building for different seismic intensities in terms of various responses such as lateral displacements, story drift and base shear. Hence the seismic behavior of buildings having similar layout needs to be understood under different intensities of wind and earthquake. For determination of seismic responses, it is necessary to carry out seismic analysis of the structure using different available methods.

The effects of non-structural infill walls are neglected by seismic codes during analysis. This neglects the of effect of infill stiffness by assuming that this would give some conservative results. Many codes(eg; IS 1893:2002) recommends a factor to take care for the magnification of bending moment and shear forces this factor is known as multiplication factor

1.1 Objectives of the Study:

1. To study the behavior of commercial building in different models.
    a) Story shear
    b) Story displacement
    c) Storey drift

2. To analyze the behavior of regular & irregular commercial buildings in different terrain categories.
3. In this study focus on the behavior of structures during earth quake having irregularities in plan and having same area.
4. To analyze the variations in parameters such as Bending moment, shear force, Displacement, percentage of steel reinforcement in different models at seismic zone-v.
5. To identify the best building configuration from this analysis.

2. METHODS OF ANALYSIS

The analysis can be performed 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 and behavior of structure, the analysis can be further classified as given below

Equivalent static analysis

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static analysis method is sufficient. This is permitted in most codes of practice for regular, low- to medium-rise buildings. 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 formulae 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 individual lateral load resisting elements.

Non-linear Static Analysis

It is a practical method in which analysis is carried out under permanent vertical loads and gradually increasing lateral loads to estimate deformation and damage pattern of structure. Nonlinear static analysis is the method of seismic analysis in which behaviour of the structure is characterized by capacity curve that represents the relation between the base shear force and the displacement of the roof. It is also known as Pushover Analysis.

Response Spectrum Method

Response spectrum method is the linear dynamic analysis method. In this method the peak responses of a structure during an earthquake is obtained directly from the earthquake responses. If the input used in calculating a response spectrum is steady-state periodic, then the steady-state result is recorded. Damping must be present, or else the response will be infinite. For transient input (such as seismic ground motion), the peak response is reported. Some level of damping is generally assumed, but a value will be obtained even with no damping.

Time History Method

It is the non-linear dynamic analysis & is the most complicated of all. Time History analysis is a step by step analysis of the dynamic response of the structure at each increment of time when its base is subjected to specific ground motion time history. To perform such an analysis, a representative earthquake time history is required for a structure being evaluated. It is used to determine the seismic response of a structure under dynamic loading of representative earthquake.

3.TYPES OF BUILDINGS

3.1 Regular building:

If a building is not a "Y ","T","L" or stepped elevations it is a regular shaped building so a rectangular building is a regualr shape building

3.2.Horizontal irregular building

Plan/Horizontal irregularities which refer to asymmetrical plan shape(L,T,U,F) or discontinuous in horizontal resisting elements (diaphragms) such as cut-outs, large openings, re-entrant corners etc resulting in torsion, diaphragm deformation and stress concentration.

3.3 vertical irregular building:

Vertical irregularities are characterized by vertical discontinuities in the distribution of mass, stiffness and strength.

4. MODELLING

ETABS features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification, ETABS is the professional's choice for steel, concrete design of low and high-rise buildings, ETABS consists of the following:

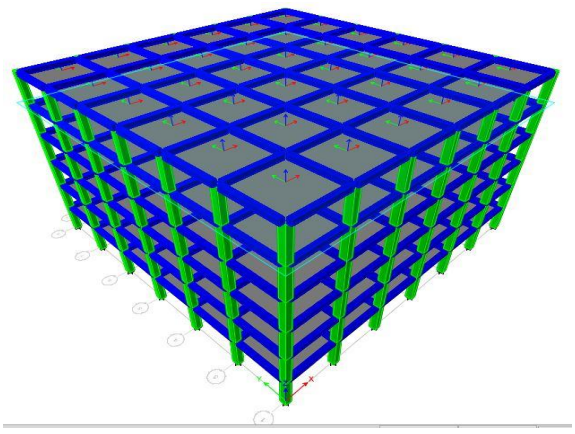
- The ETABS Graphical Interface: It is used to generate the model, which can then be analyzed. After analysis and design is completed. Once design completed graphs are plotted in storey response plots
- The ETABS Analysis and Design: It is a general- purpose calculation engine for structural analysis and integrated Steel, Concrete design.

To start with we have solved some sample problems using ETABS and checked the accuracy of the results with manual calculations. The results were to satisfaction and were accurate. In the initial phase of our project we have done calculations, regarding loadings on buildings and also considered seismic and wind loads. Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behaviour of structures. Structural analysis can be viewed more abstractly as a method to drive the engineering design process or prove the soundness of a design without a dependence on directly testing it.

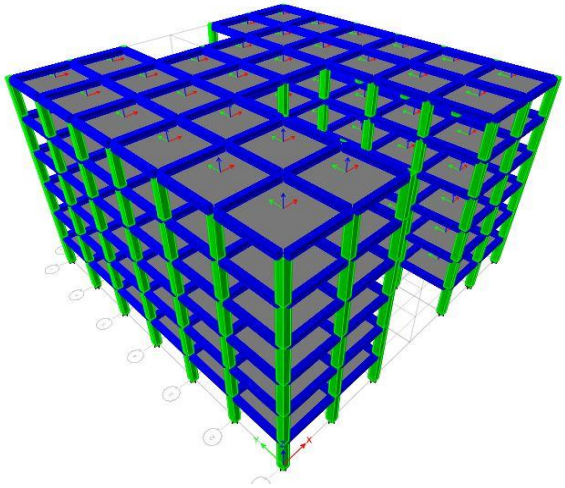
Project Statement

Commercial building with different shapes is taken for analysis. The salient feature of the building is:

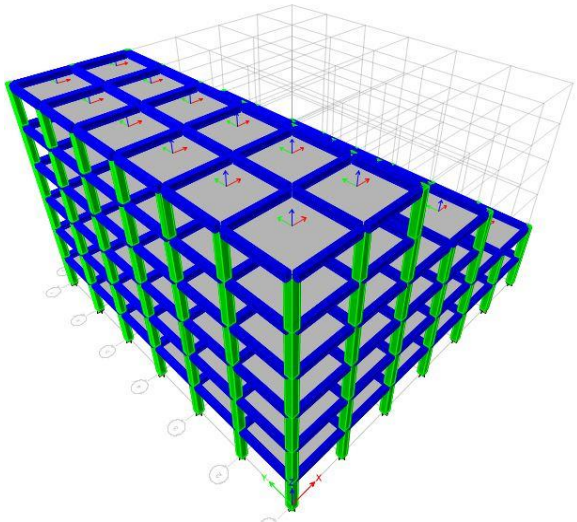
No. of stories	G+6
Shape of the building	Asymmetrical
Depth of the slab	125 mm
Seismic zone	V
Imposed load	4.5 kN/m^2
Floor finishes	1.5 kN/m^2
Grade of concrete	M25,M40
Grade of steel	Fe 415
Unit weight of RCC	25 kN/
Beam	300x500mm
Column	500 x 500 mm
Wall thickness	230 mm for ordinary wall 115 mm for parapet wall
Total height	21m
Floor height	3.5m
Base height	3.5m



3d View of building (model-1)



3D view of building (model-2)



3D view of building (model-3)

Seismic zones and z factor

Seismic Zone	Z
II	0.10
III	0.16
IV	0.24
V	0.36

Type of soil

Type	Soil
I	Hard or Rocky
II	Medium
III	Soft

Wind Terrain Categories

Category	Height in meters
I	< 3
II	3 - 10
III	> 10
IV	> 40

Important Terminology:

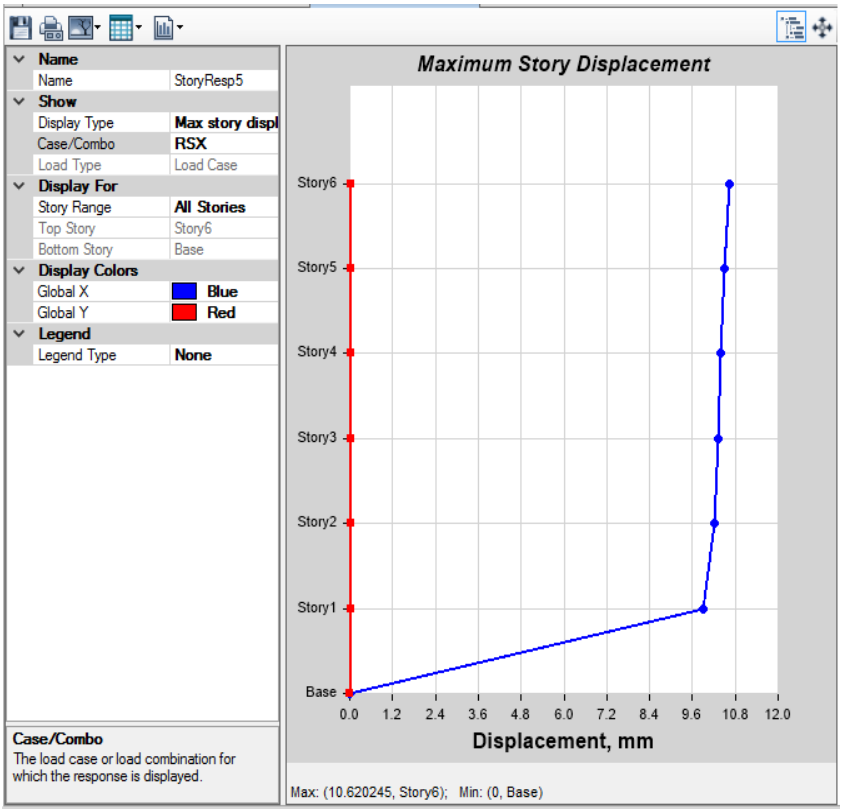
Storey displacement: It is total displacement of the storey with respect to ground and there is maximum permissible limit prescribed in IS codes for buildings.

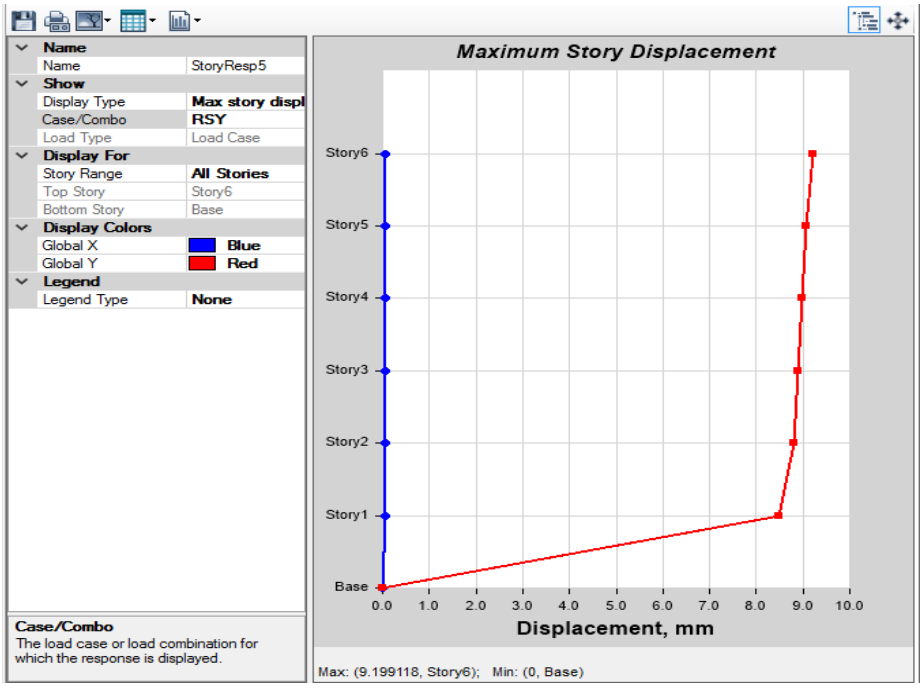
Storey drift: Storey drift is the drift of one level of a multi-storey building relative to the level below. Inter story drift is the difference between the roof and floor displacements of any given story as the building sways during the earthquake, normalized by the story height.

Storey shear: It is the lateral force acting on a storey, dueto the forces such as seismic and wind force. It is calculated for each storey, changes from minimum at the top to maximum at the bottom of the building.

4.RESULTS

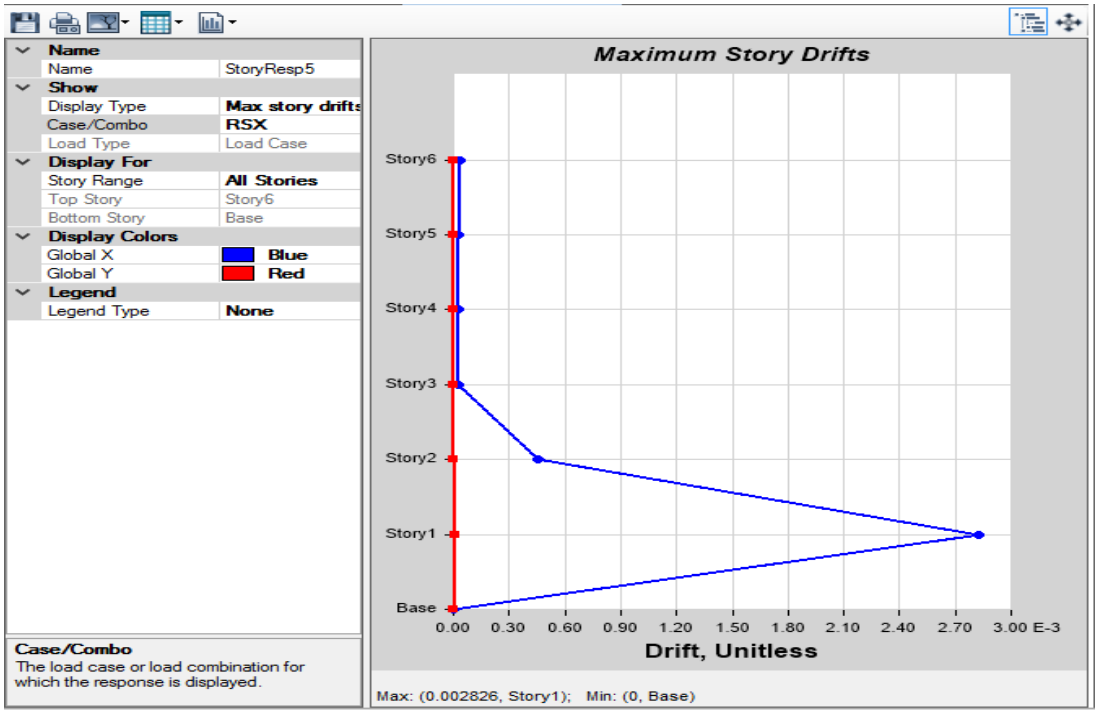
Maximum Story Displacement (mm)

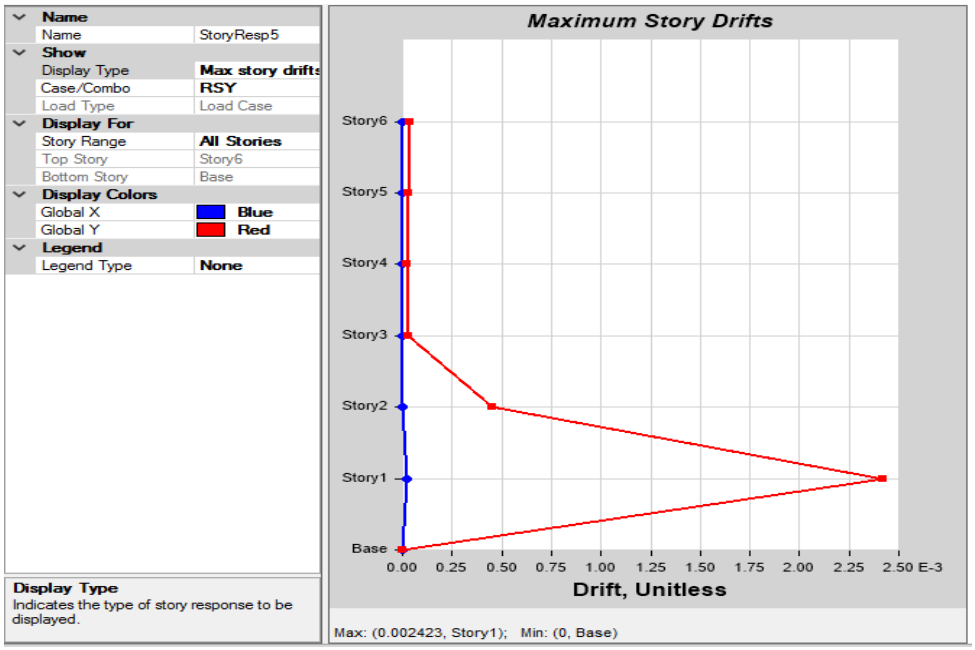




Maximum Story Displacement (mm)			
Direction	Model-1	Model-2	Model-3
X	10.6	10.5	5.8
Y	9.2	8.4	7.6

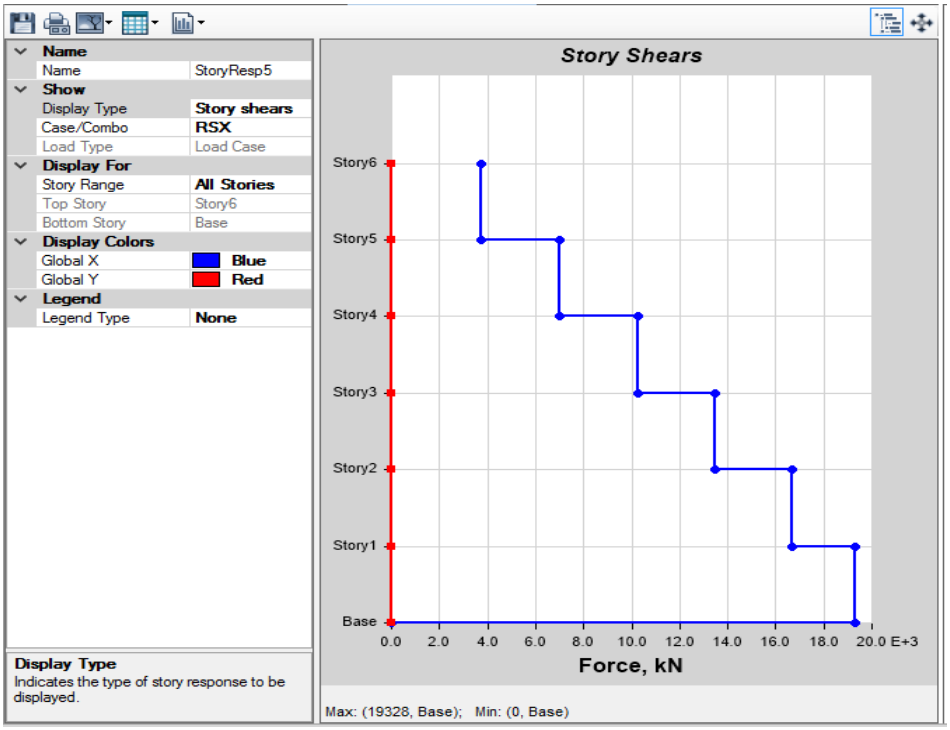
Maximum Drift

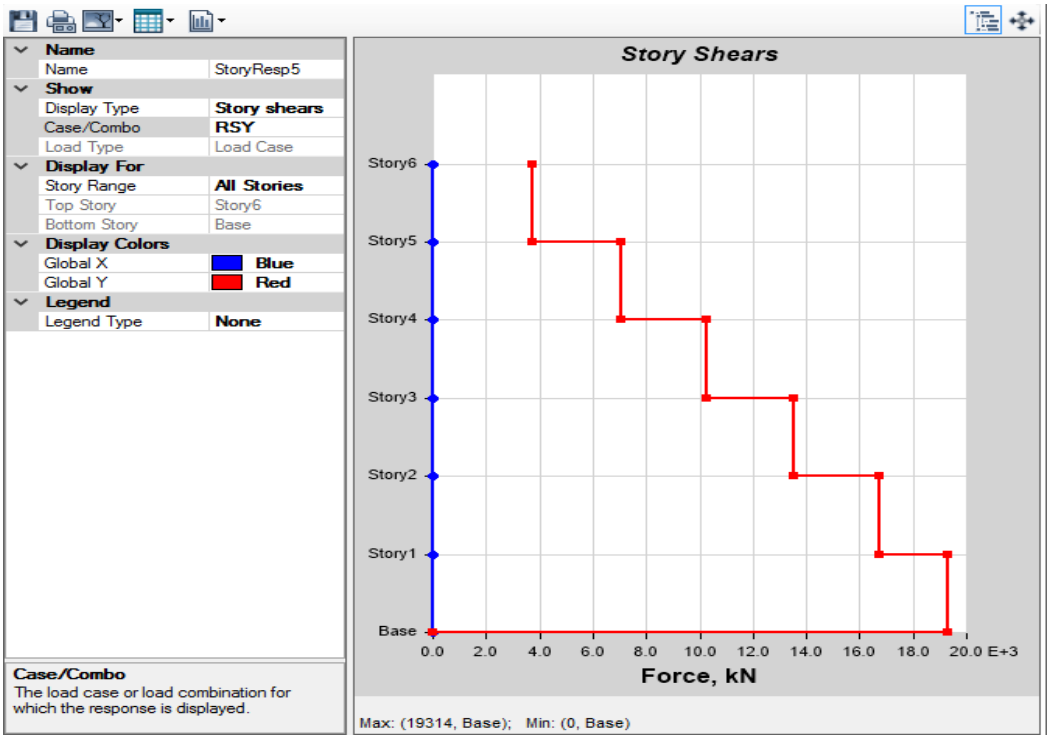




Maximum Story Drift			
Direction	Model-1	Model-2	Model-3
X	0.002826	0.002811	0.001523
Y	0.002423	0.02159	0.002086

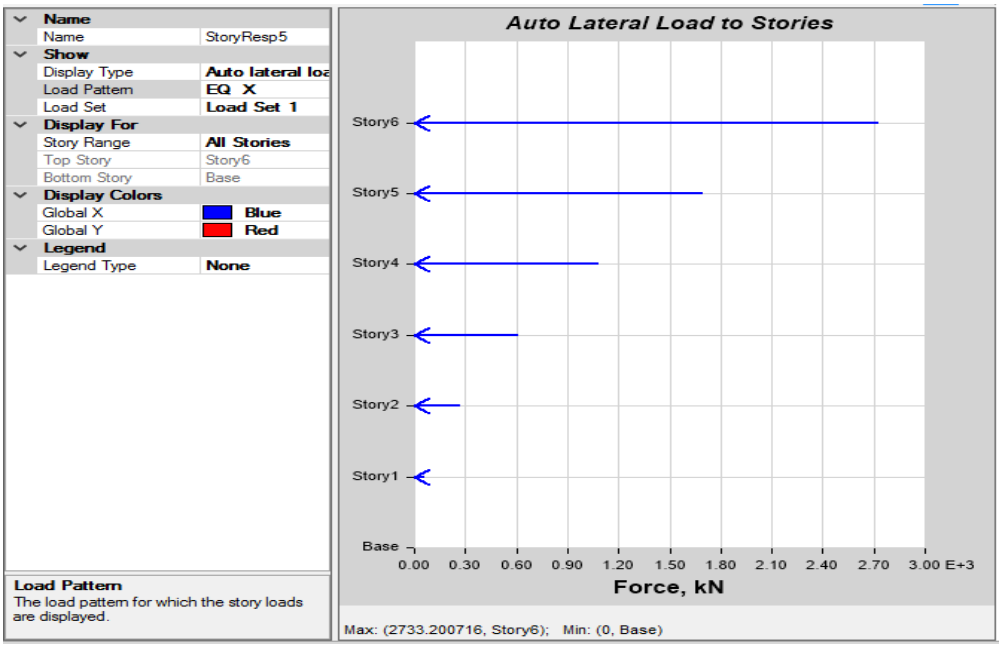
Maximum Storyshear (kN)

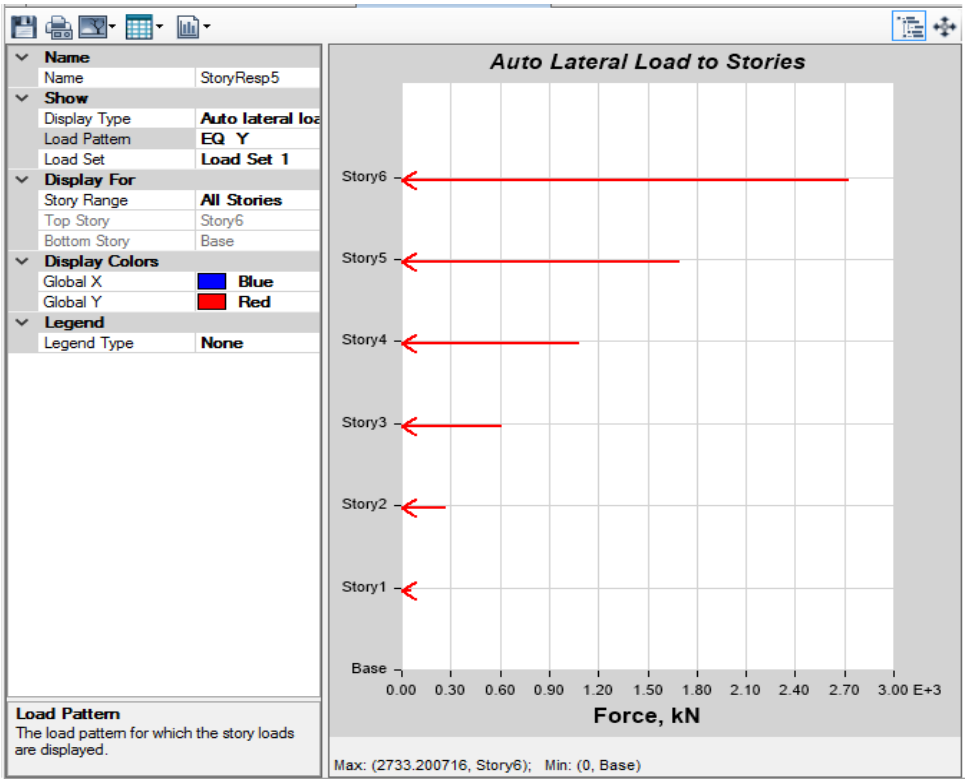




Maximum StoryShear (kN)			
Direction	*Model-1*	*Model-2*	*Model-3*
X	*19328.3826*	*8781.9609*	*8781.9609*
Y	*19313.5022*	*7462.5507*	*17693.6291*

Auto Lateral Loads(kN)





Maximum Auto lateral loads (kN)			
Direction	Model-1	Model-2	Model-3
X	2733.2007	2430.5961	814.2585
Y	2733.2007	2430.5961	814.2585

5. CONCLUSIONS

Form the data revealed by the software analysis for the structure using various load combinations tried following conclusions are drawn:

1. Seismic analysis was done by using ETABS software as per IS 1893 – 2002.
2. There is a gradual increase in the values of lateral forces from bottom floor to top floor in three models.
3. The maximum story displacement is occurred in Regular building compared to Horizontal and Vertical irregular buildindgs.
4. The maximum story drift comes at 1st floor in all the three models.
5. The maximum story drift get in regular building.
6. The maximum story shear occurred in regualar building.
7. Results are compared for all models we observed minimum displacement,drift,story shear in vertical irregular building.
8. Hence the vertical irregular building is more resistant to against the earthquake in zone-V and the regular is less resistant.

SCOPE FOR FUTURE STUDY

The present study is limited to response spectrum analysis this commercial building for 3 different models.This can be further continued for analysis through another three different models even with time history analysis.

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