SEISMIC PERFORMANCE OF REGULAR AND IRREGULAR PLAN BUILDINGS WITH SHEAR WALLS AND DAMPERS

ANJANADEVI PADASALI[1], PROF. B .K. KOLHAPURE[2]

[1]P.G Student, Department Of Civil Engineering, Poojya Doddappa Appa College Of Engineering, Kalaburgi, 585102
[2]Associate Professor, Department Of Civil Engineering, Poojya Doddappa Appa College Of Engineering, Kalaburgi, 585102

Abstract - With the massive loss of life and property experienced in the last several years**,** Due to the breakdown of constructions caused by earthquakes in India during the last few decades, the country is now paying attention. beinggiven to the evaluation of the adequacy of strength in framed RC structures to resist strong ground motions. In this paper we studied the behaviour of G+20 multi storey building of regular and irregular configuration with four different structures such as bare frame, dampers, shear wall, dampers and shear wall under seismic load. In this paper a G+20 multi storey building is studied for Seismic load using ETABS. Assuming the material properties, dimensions of beam and column for the analysis and the analysis are carried out by Response Spectrum method. After analysis the results such as Storey displacement, storey drift, storey stiffness, time period and base shear were compared with different models and also the effects of shear wall and dampers on the bare frame were studied. For the analysis the different loads are considered as per IS 875 code. The seismic Zone III and zone IV was considered and properties of these zones were taken according to IS: 1893-2002 part 1 code.

Key words: ***Regular and Irregular, Friction dampers, Shear wall, Displacement, Drift, Time Period, Shear, Stiffness, Response Spectrum Method.***

1. INTRODUCTION

Human civilization required structures to live and their needs in all the aspects. But It is not just about erecting structures, but also about erecting structures that are efficient in order to achieve the main goal. Purpose for what it was made for. Here comes the role of civil engineering and more precisely the role of analysis of structure. There are several traditional approaches for solving design problems, and new software is being developed all the time. In present many number of buildings or structures have irregular configuration in the plan and elevation. Structures or Buildings with irregular distribution in stiffness, mass and strength decreases due to which major damages occur during earthquakes.Which are commonly seen in past earthquakes which will be under torsional motion. To withstand lateral loads, a symmetric distribution of mass and stiffness should be given in plan as well as in each level of the structure, exerts by the earthquake and the buildings were considered to be as torsionally balanced structure. Itis very difficult to get such a condition due to restrictions such architectural requirement and functional needs.

According to previous study, torsional oscillation causes many damages in the torsional motion in the elastic range due to the out of the centre of gravity, mass of the structure with non coincident centers of mass and rigidity which is called as natural torsion. It can be induced by asymmetric structures or torsionally imbalanced structures. In finding the centers of mass and stiffness, in perfect in the measurement of dimension of building or structural element or lack of the correct data on material, Due to the rotating motion of the body, qualities such as the modulus of elasticity may exist. The accidental rotational exists due to the not finding the asymmetry and rotational motion of the ground. In generally heavier torsional effect is due to the distance between centre of rigidity to its mass. By maintaining the constraints on inelastic twist, the inelastic behaviour can be controlled. The effect of torsional motion is to be considered as one of the important consideration in the design of the building. Such factors are necessarily considered in the estimation of magnitude of asymmetry, point of centre of rigidity and mass, evaluation of accidental and design eccentricities.

1.1 Scope of study

The present work is to study the behavior and their responses of different models on the application of seismic forces. To study the inter relation between the models with different property by the results of Response Spectrum Analysis method. And also is to study the various parameters like story displacement, storey drift, storey stiffness, base shear and time period.

1.2 Need of study

The present study is an attempt in the state of art of seismic evaluation of multi-storeyed concrete buildings and to reduce the response of the structure effectively using friction dampers, shear walls and proving it as most efficient in the stability of the structure.

1.3 Objectives

The main aims of the present project work are as follows:

1. To study the story shear, story displacement, story drift, time period and story stiffness.
2. To study the effects of use of shear walls and dampers in both regular and irregular buildings.
3. To study the structural behavior of high rise buildings on influence of damper.
4. To analyze the regular and irregular buildings by using Response Spectrum Method.
5. To compare the behavior of regular and irregular building

2. DESCRIPTION OF THE MODELS

The Reinforced Concrete framed structure performance depend not only the particular specific members it also depends on the joints which are present in the frame. In many cases, the joints which are present in Reinforced Concrete framed structures are subjected to fully severe loads under earthquake load condition. In recent years the damaged caused due to earthquake in India and other countries are very severe. This damage is depends on the performance or load carrying capacity of the structure, specially the performance of beam- column joint. In order to increase the load carrying capacity of Reinforced Concrete framed structure many research are going by using different materials like dampers and shear wall.

Different methods for carrying out lateral load analysis are provided by seismic codes; nevertheless, infill walls present in the structure are typically deemed non-structural elements and their presence is ignored during analysis and design. Most building codes dictate the type of analysis to be used depending on whether the structure is regular or irregular. This is something that almost every code proposes. Dynamic analysis approaches such as the response spectrum method and time history analysis are used.

The regular and irregular structures were evaluated for examination in this study, and the analysis was carried out using the Response Spectrum Method. The varied outcomes are then compared to various models. Various models, such as bare frame, bare frame with damper, bare frame with shear wall, and bare frame with dampers and shear walls, are used in this study.

Here in this study we have considered sixteen models for the study.

Description of models for regular plan (ZONE III and ZONE IV)

1. Bare frame model
2. Bare frame with damper
3. Bare frame with Shear wall.
4. Bare frame with shear wall and damper.

Description of models for irregular plan (ZONE III and ZONE IV)

5. Bare frame model
6. Bare frame with damper
7. Bare frame with Shear wall.
8. Bare frame with shear wall and damper.

REGULAR AND IRREGULAR MULTISTORY BUILDING (G+20)

↓

Modelling different models in etabs software

↓

1. Conventional building with beams and columns for regular plan (Bare frame model)

2. Bare frame model with damper for regular plan
3. Bare frame model with Shear wall for regular plan
4. Bare frame model with shear wall and damper for regular plan
5. Conventional building with beams and columns for irregular plan (Bare frame model)
6. Bare frame model with damper for irregular plan
7. Bare frame model with Shear wall for irregular plan
8. Bare frame model with shear wall and damper for irregular plan

RESPONSE SPECTRUM ANALYSIS

↓

RESULTS AND COMPARISON

↓

CONCLUSION

The layout of the plan for all the models is shown in figures below

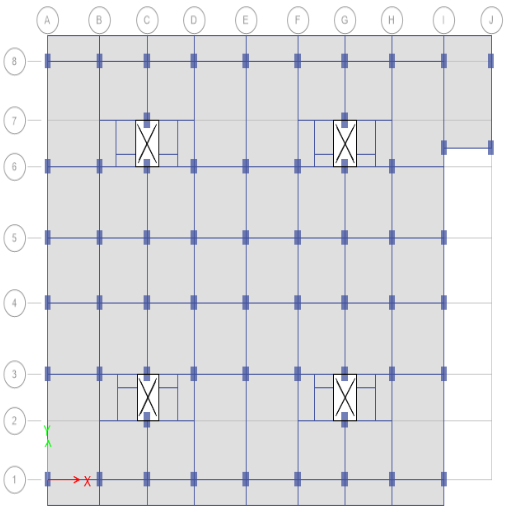


Fig 1 Plan of the regular building

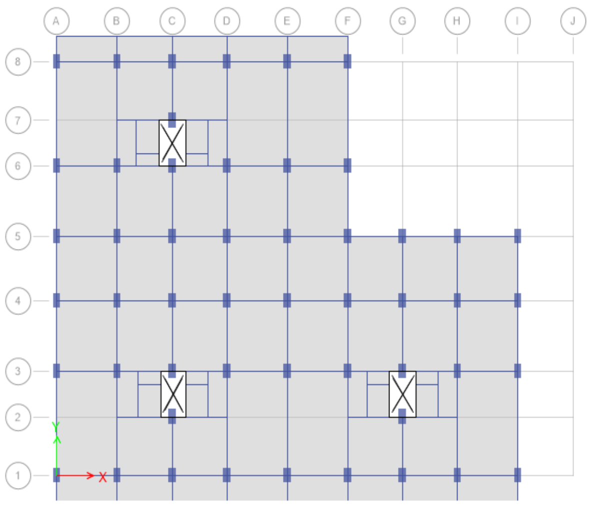


Fig 2 Plan of the irregular building

3. BUILDING DETAILS

Type of building	Residential Building (regular and irregular)
Type of frame	Moment Resisting Frame
No of stories Total height of building	21 stories 68 m
Thickness of walls	230mm (main wall)

Live load	2KN/m2 – All rooms
Grade of Concrete	M20
Grade of reinforcing Steel	HYSD415
Density of brick masonry	20KN/m3
Sizes of columns	C1=400mmX750mm
Sizes of beams Thickness of slab	B1=300X600mm 150mm
Zone	III and IV
Soil type	II
Importance factor	1
Response reduction	5
Seismic zone factor	0.16 and 0.24 for zone III and IV respectively
Damping ratio	5%
Thickness of shear wall	230mm
Type of damper	Friction damper

Factors considered for analysis

- Live load (As per IS 875 part I) - 2KN/m^2
- Floor finish (FF) load - 1KN/m^2
- Concrete grade - 20N/mm^2
- Steel grade - 415 N/mm^2
- Clear cover (CC) for beam and column - 30mm
- Concrete density - 25 KN/m^3
- Brick wall density - 20KN/m^3

Earthquake Details as per IS 1893-2002

- Importance Factor, I - 1

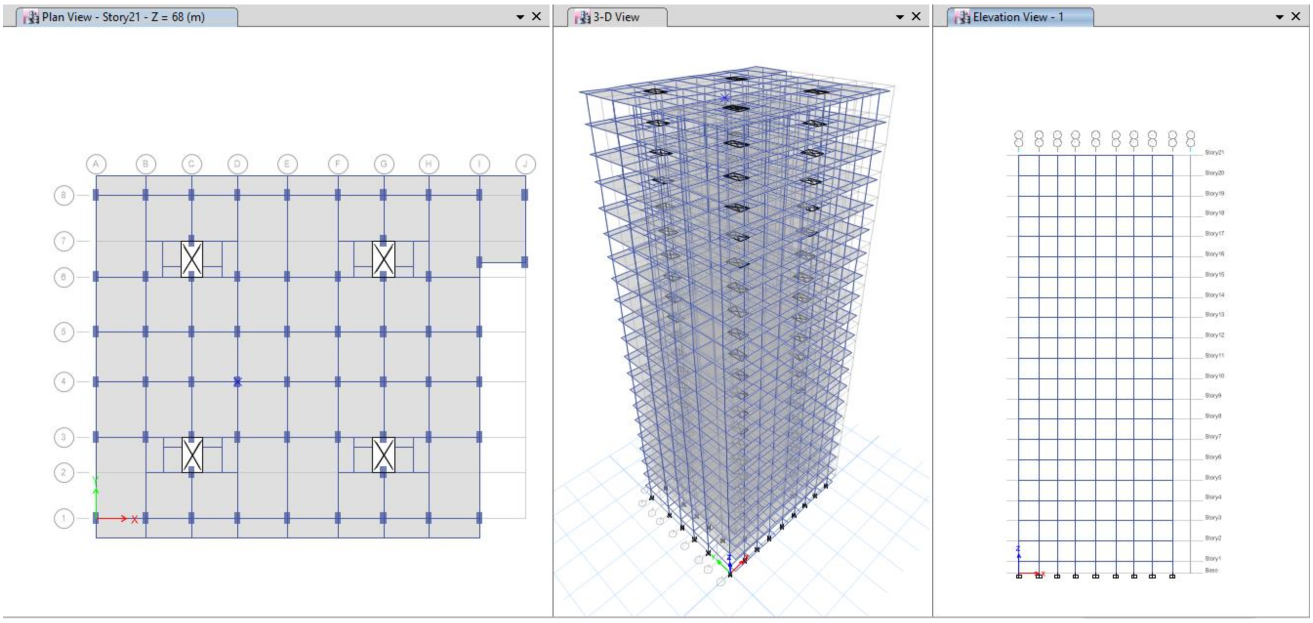
- Zone - III , IV
- Type of soil - Type II, Medium
- Seismic Zone Factor, Z - 0.16, 0.24
- Response Factor, R - 5
- Damping Ratio - 0.5
- Response Spectrum - As per code IS 1893-2002

Geometrical Details

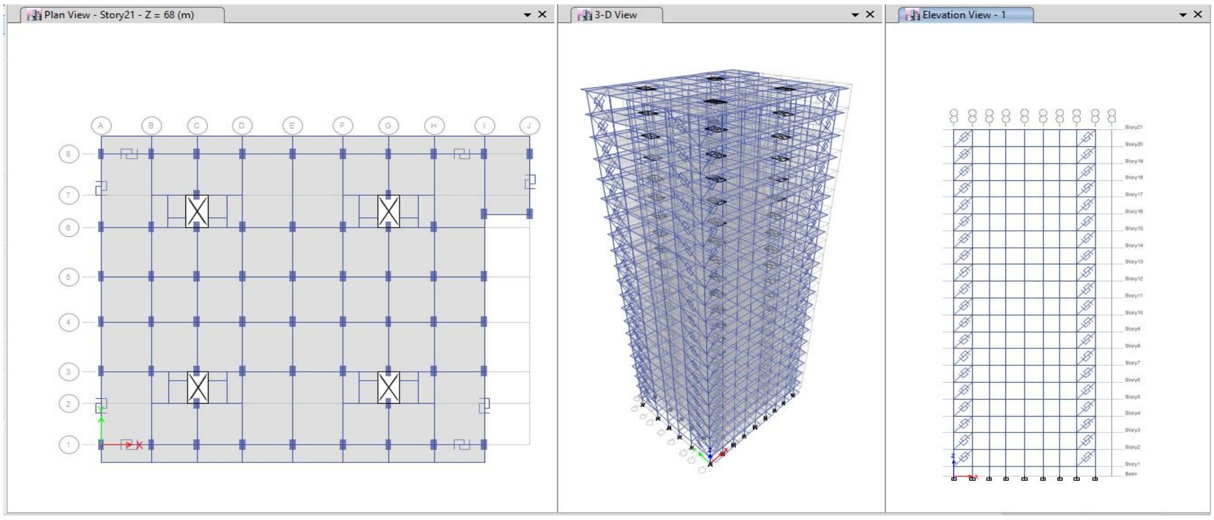
- Number of stories considered - G+20
- Each height of storey - 3.3m
- Number of bays considered in x-direction - 9
- Number of bays considered in y-direction - 5
- Slab thickness considered - 150mm

4. MODELING DIFFERENT MODELS IN ETABS SOFTWARE

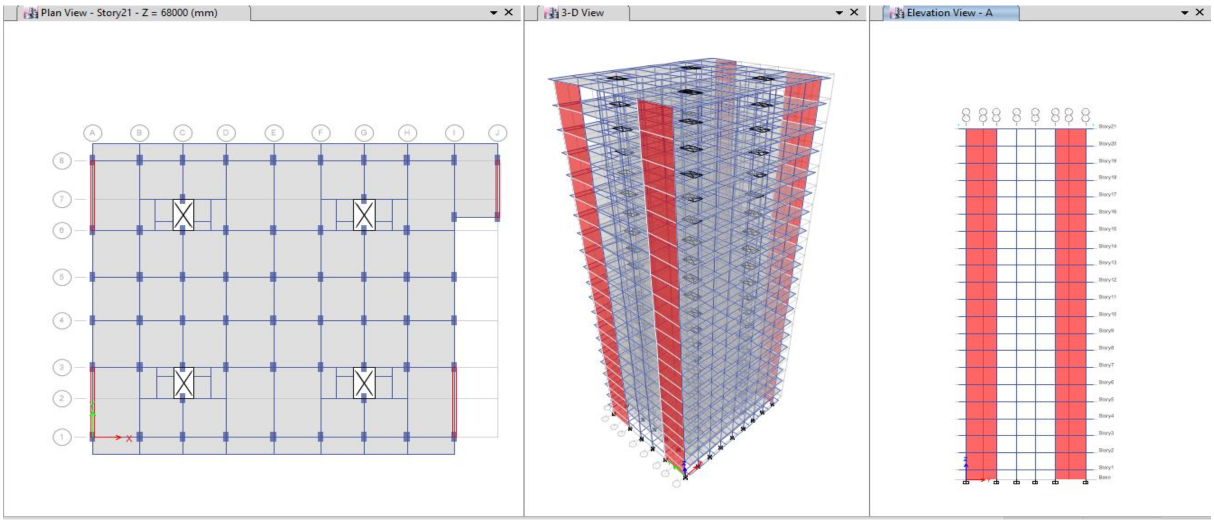
Regular Plan Models



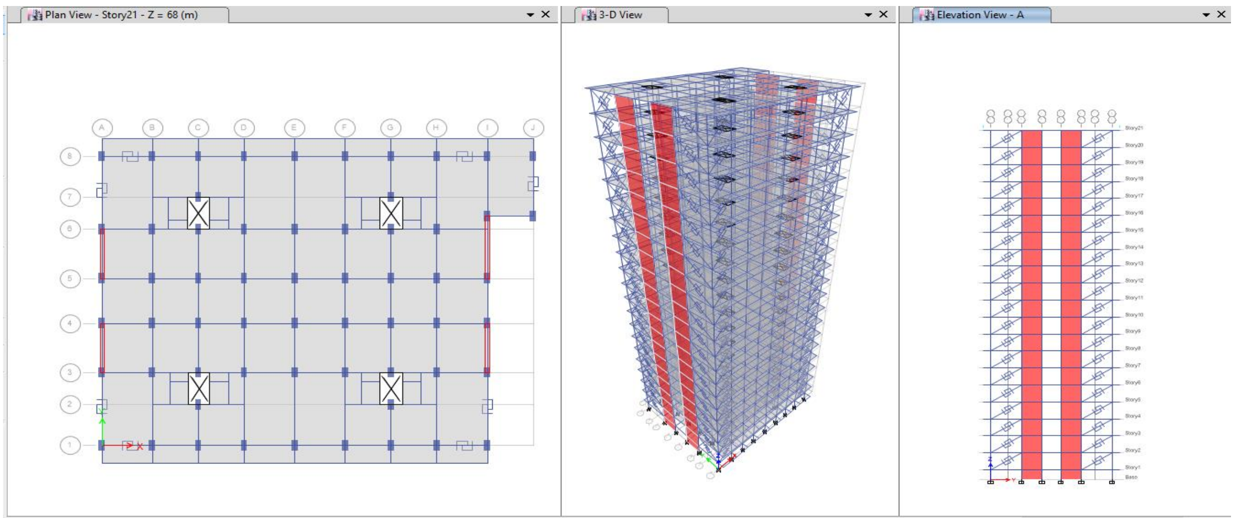
Plan, 3D model and Elevation of bare frame for regular plan



Plan, 3D model and Elevation of bare frame with damper for regular plan

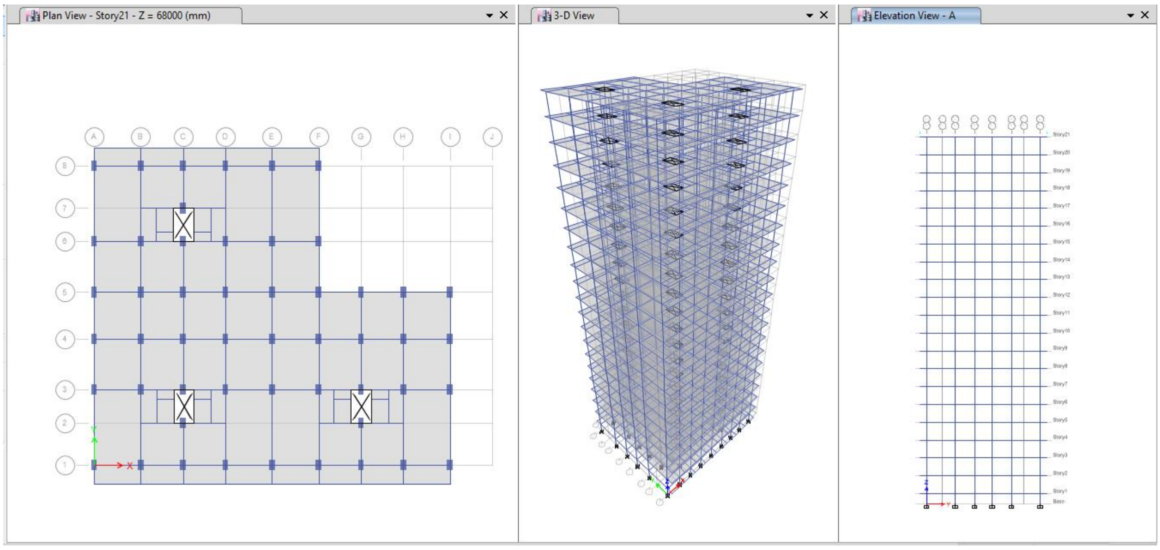


Plan, 3D model and Elevation of bare frame with shear wall for regular plan

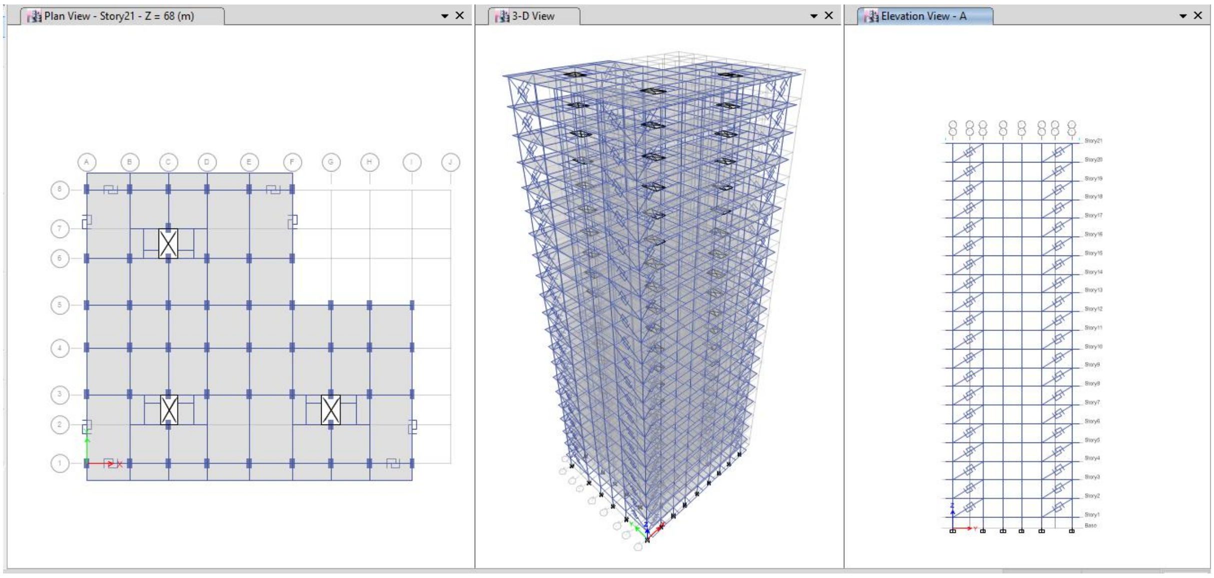


Plan, 3D model and Elevation of bare frame with dampers and shear wall for regular plan

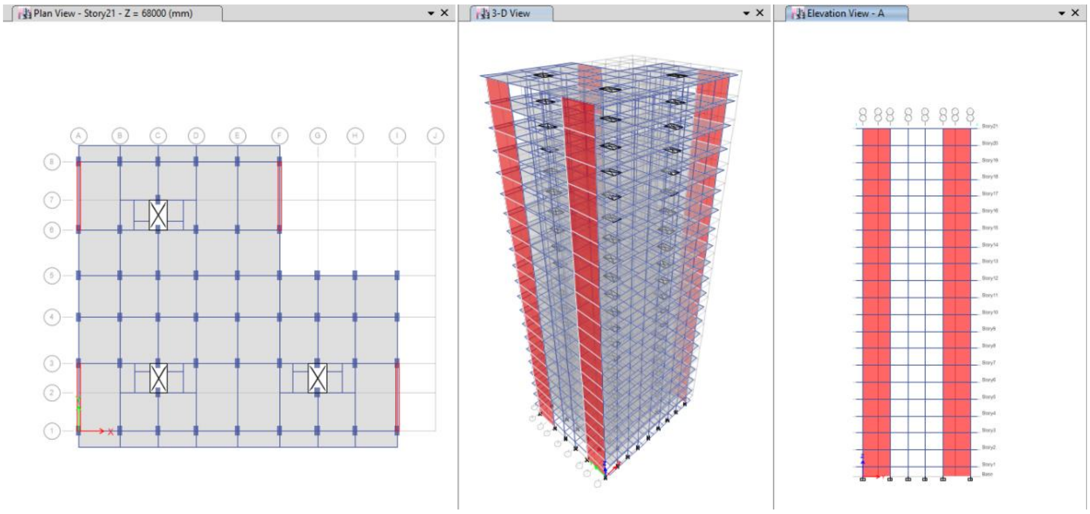
IRREGULAR PLAN MODELS



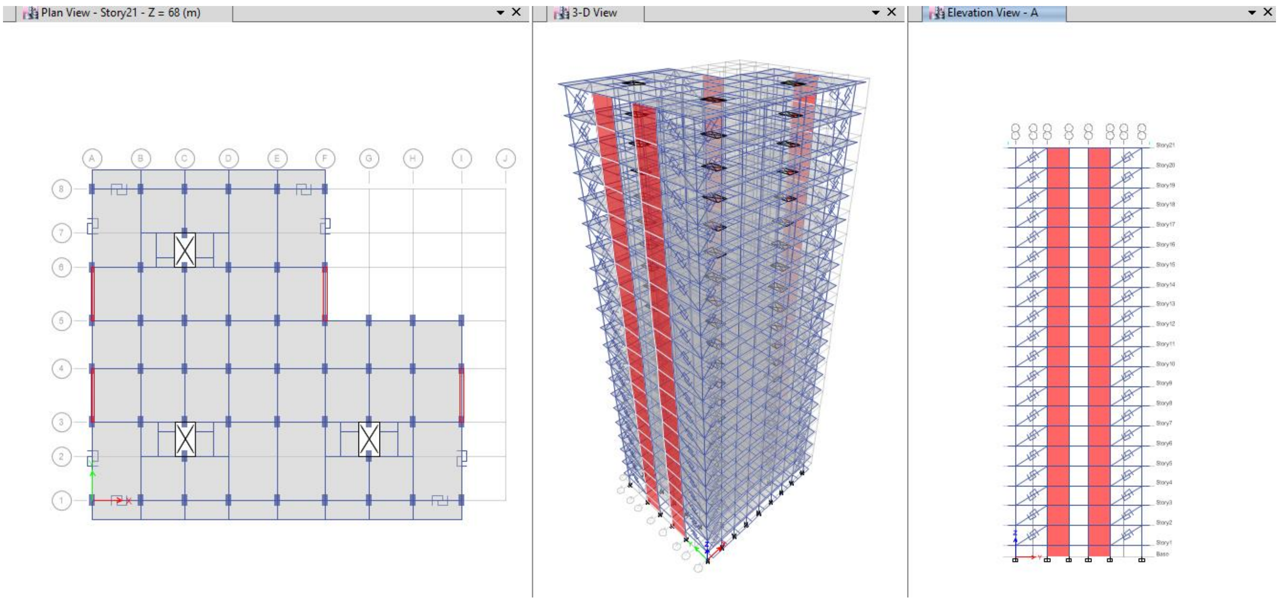
Plan, 3D model and Elevation of bare frame for irregular plan



Plan, 3D model and Elevation of bare frame with damper for irregular plan



Plan, 3D model and Elevation of bare frame with shear wall for irregular plan



Plan, 3D model and Elevation of bare frame with dampers and shear wall for irregular plan

5. ANALYSIS RESULTS AND DISCUSSION

Time period

It is defined as the time required to complete one cycle of vibration to pass in a given point.

Table 1: Time period of various regular and irregular plan models for zone III and IV

MODEL NO.	NATURAL TIME PERIOD IN SEC (REGULAR)	NATURAL TIME PERIOD IN SEC (IRREGULAR)
1	3.046	3.013
2	2.883	2.837
3	2.962	2.918
4	2.794	2.749

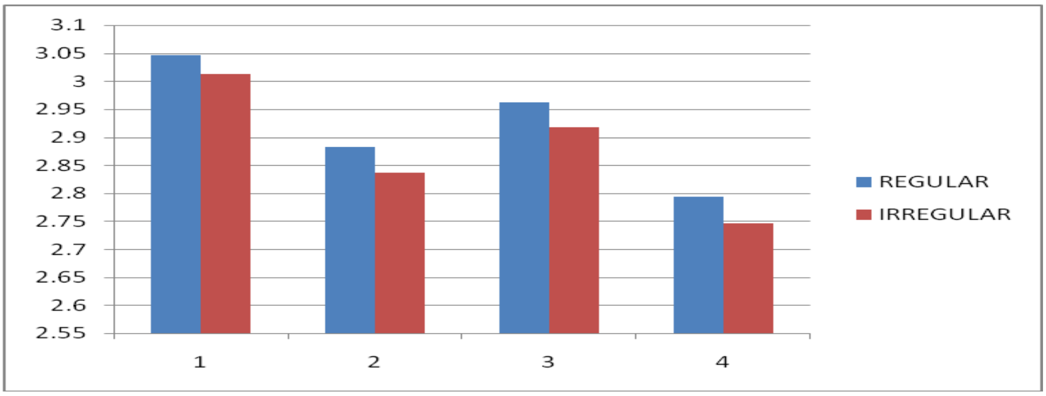


Chart 1: Time period of various regular and irregular plan models for zone III and IV

Storey displacement

It is defined as total displacement of ith storey with respect to ground.

Table 2: Max Storey displacement in mm for regular plan models in zone III.

MODEL NO	RSX	RSY
1	28.334	31.946
2	25.817	28.024
3	25.274	29.638
4	24.824	20.655

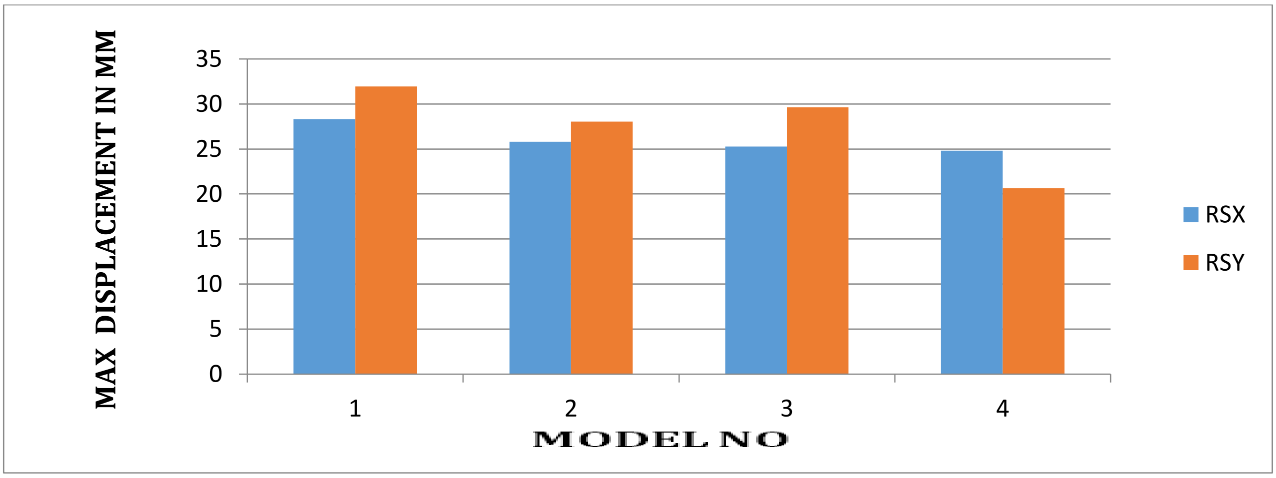


Chart 2: Max displacement in mm for various models of regular plan for RSA along X and Y direction in zone III.

Table 3: Max Storey displacement in mm for regular plan models in zone IV

MODEL NO	RSX	RSY
1	42.378	47.762
2	25.817	28.024
3	37.792	44.443
4	24.824	20.655

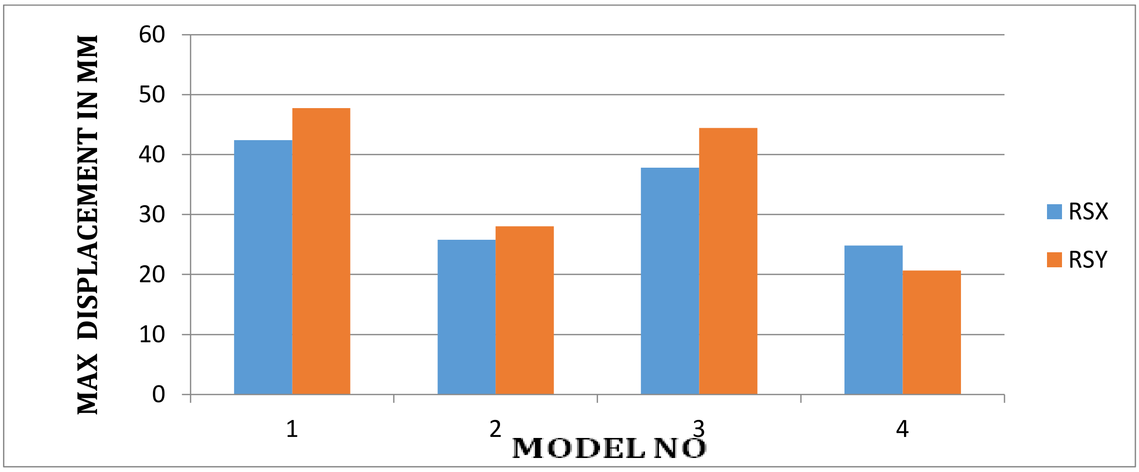


Chart 3: Max displacement in mm for various models of regular plan for RSA along X and Y direction in zone IV.

Table 4: Max Storey displacement in mm for irregular plan models in zone III.

MODEL NO	RSX	RSY
1	26.397	32.061
2	25.346	23.552
3	25.134	27.526
4	24.15	23.032

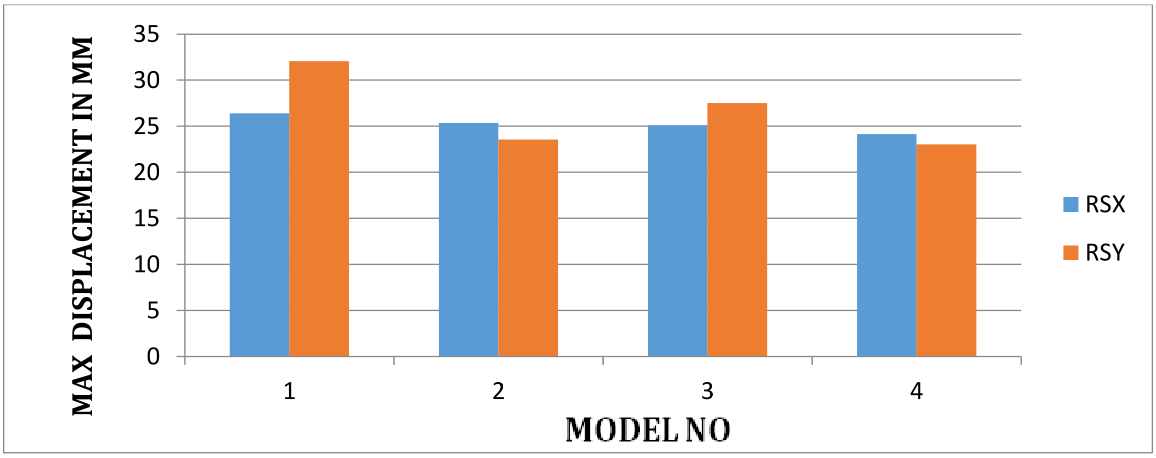


Chart 4: Max displacement in mm for various models of irregular plan for RSA along X and Y direction in zone III.

Table 5: Max Storey displacement in mm for irregular plan models in zone IV.

MODEL NO	RSX	RSY
1	39.94	48.982
2	32.422	28.311

3	25.134	27.526
4	36.002	34.568

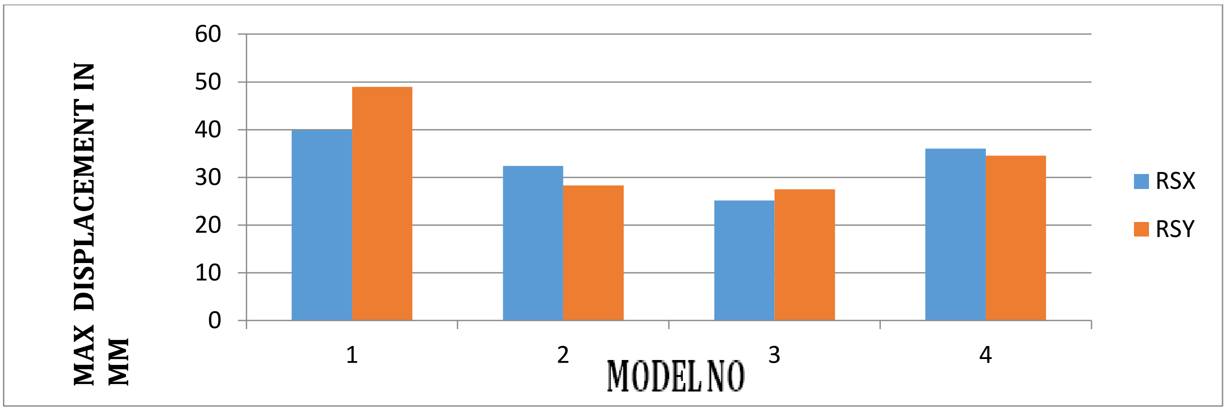


Chart 5: Max displacement in mm for various models of irregular plan for RSA along X and Y direction in zone IV.

Storey drift

It is defined as the ratio of displacement of two consecutive floor to height of that floor.

Table 6: Max storey drift in m for regular plan models in zone III.

MODEL NO	RSX	RSY
1	0.00014	0.00064
2	0.00046	0.000534
3	0.00056	0.0004
4	0.0005	0.00028

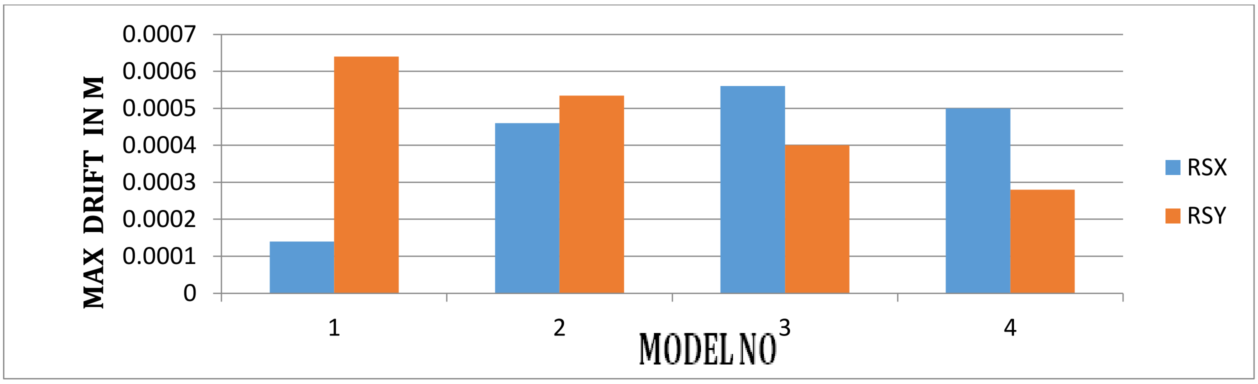


Chart 6: Max storey dtift in m for various models of regular plan RSA along X and Y direction in zone III.

Table 7: Max storey drift in m for regular plan models in zone IV.

MODEL NO	RSX	RSY
1	0.00087	0.000962
2	0.00046	0.000534
3	0.00078	0.00078

4	0.0005	0.00028

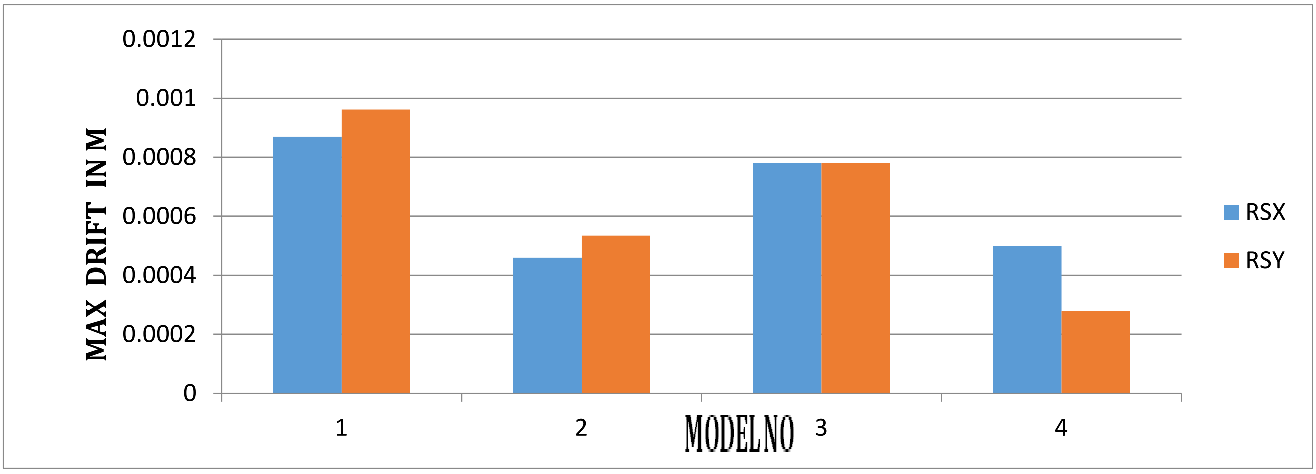


Chart 7: Max storey dtift in m for various models of regular plan RSA along X and Y direction in zone IV.

Table 8: Max Storey drift in m for irregular plan models in zone III.

MODEL NO	RSX	RSY
1	0.00043	0.000635
2	0.00047	0.00019
3	0.00054	0.00051
4	0.00048	0.000425

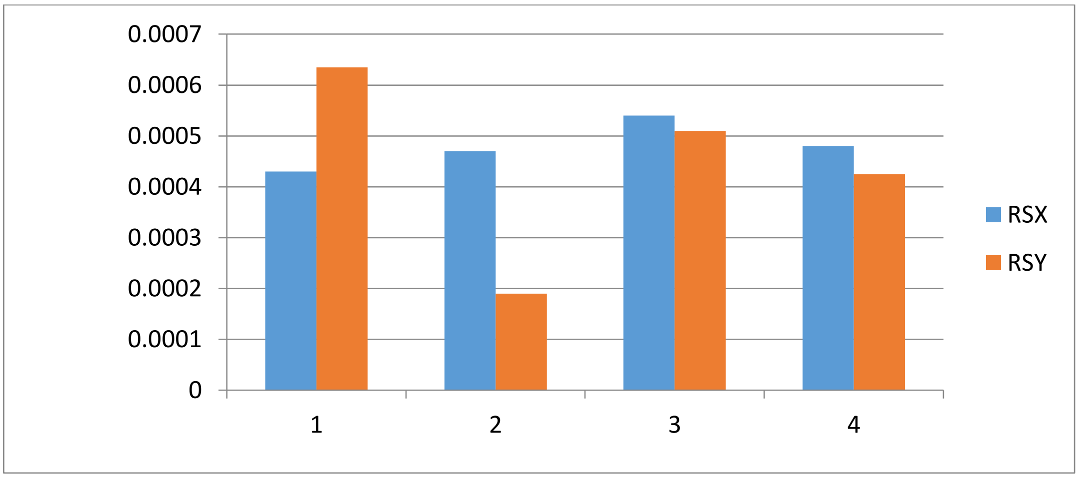


Chart 8: Max storey drift in m for various models of irregular plan RSA along X and Y direction in zone III.

Table 9: Max Storey drift in m for irregular plan models in zone IV.

MODEL NO	RSX	RSY
1	0.00068	0.0009
2	0.00062	0.00051
3	0.00054	0.00051
4	0.00069	0.00063

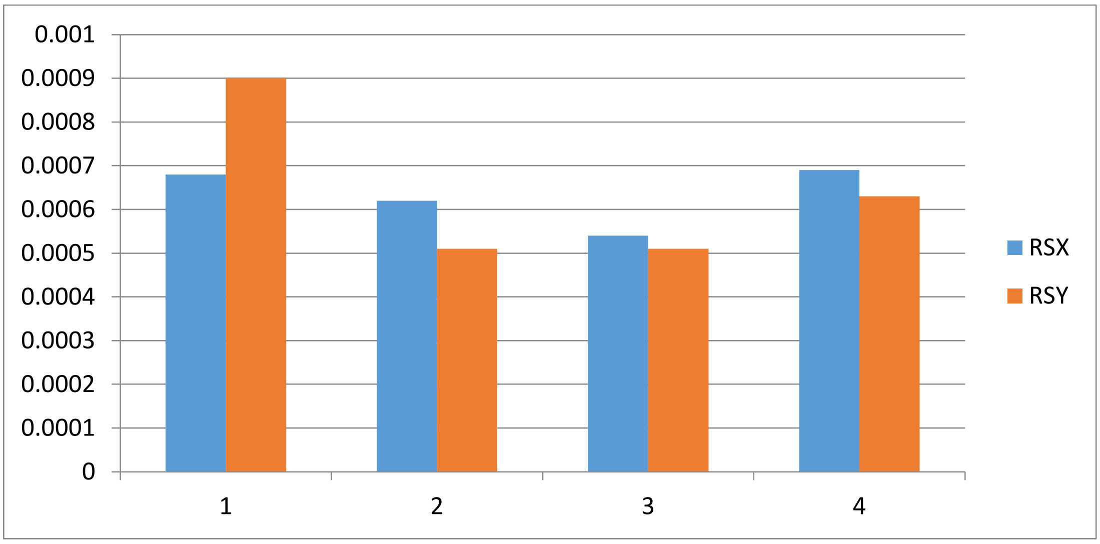


Chart 9: Max storey dtift in m for various models of irregular plan RSA along X and Y direction in zone IV.

Storey shear

Table 10: Max storey shear in KN for regular plan models in zone III.

MODEL NO	RSX	RSY
1	1571.2198	1714.0196
2	1687.003	1948.391
3	1635.348	2143.8673
4	1764.0867	2497.0092

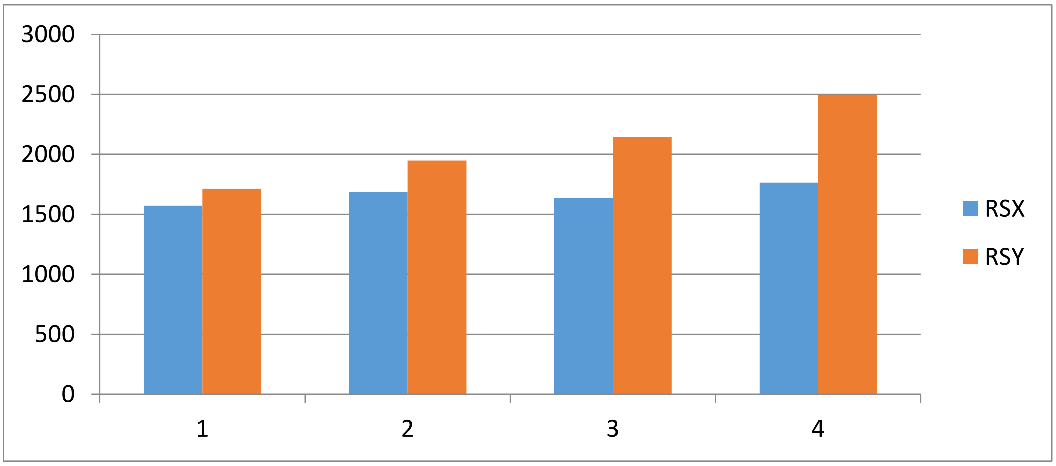


Chart 10: Max storey shear in KN for various models of regular plan RSA along X and Y direction in zone III.

Table 11: Max storey shear in KN for regular plan models in zone IV.

MODEL NO	RSX	RSY
1	2349.9982	2562.6273
2	1687.003	1948.391
3	2445.3264	3214.7469
4	1764.0867	2497.0092

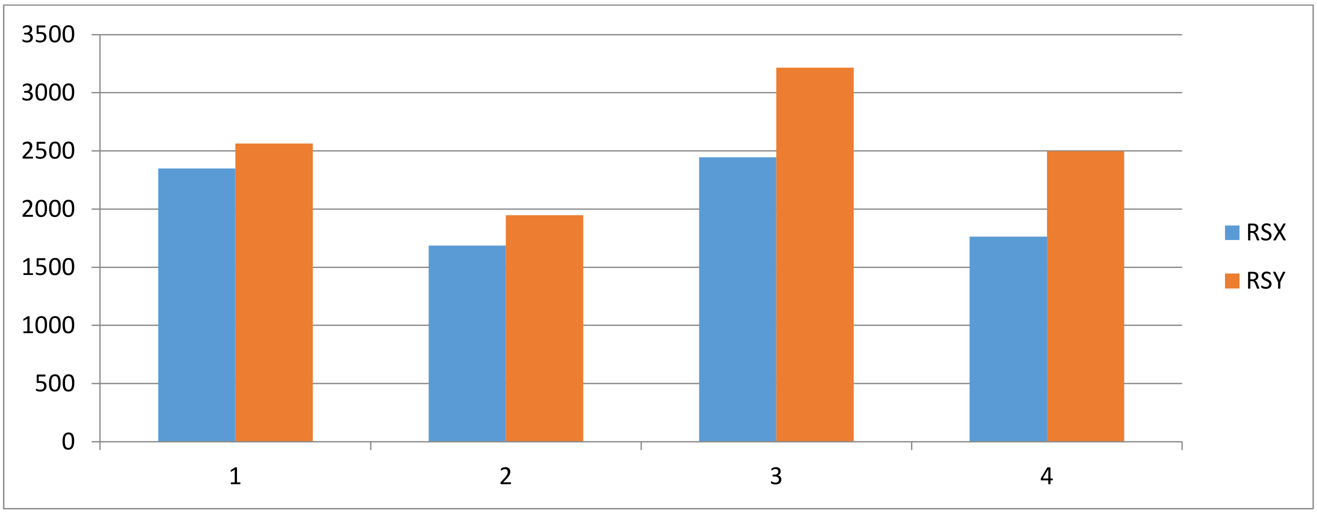


Chart 11: Max storey shear in KN for various models of regular plan RSA along X and Y direction in zone IV.

Table 12: Max storey shear in KN for irregular plan models in zone III.

MODEL NO	RSX	RSY
1	1301.4648	1388.6799
2	1395.7919	1555.0392
3	1383.5988	1885.8883
4	1469.7797	1898.0764

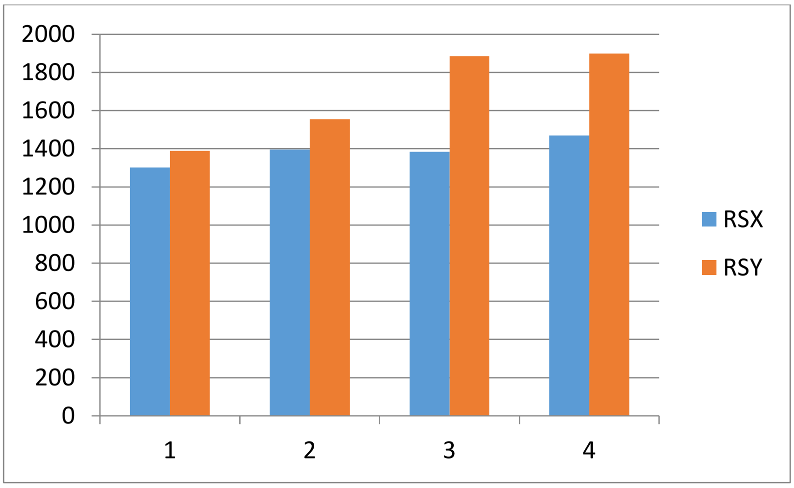


Chart 12: Max storey shear in KN for various models of irregular plan RSA along X and Y direction in zone III.

Table 13: Max storey shear in KN for irregular plan models in zone IV.

MODEL NO	RSX	RSY
1	1969.1729	2121.5944
2	1785.4862	1869.298

3	1383.5988	1885.8883
4	2191.1202	2848.7679

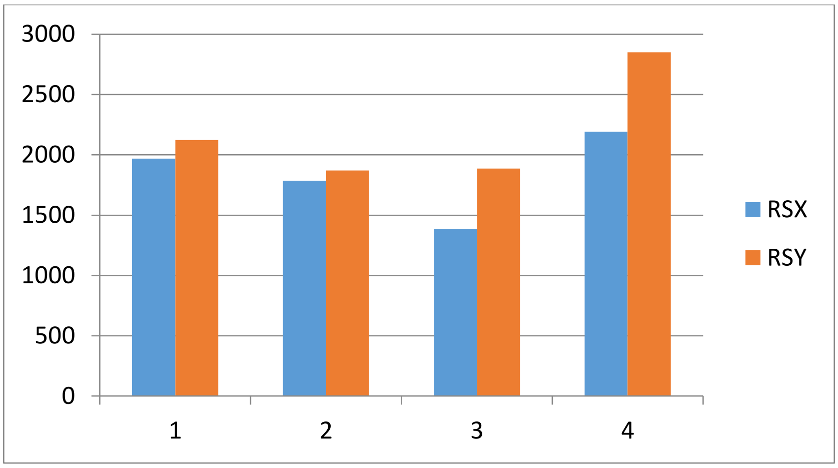


Chart 13: Max storey shear in KN for various models of irregular plan RSA along X and Y direction in zone IV.

Storey stiffness

Table 14: Max storey stiffness in KN/m for regular plan models in zone III.

MODEL NO	RSX	RSY
1	3783575.5	4989055.4
2	3524893.6	5245288.1
3	3922551.8	14903213
4	3692290.6	13262674

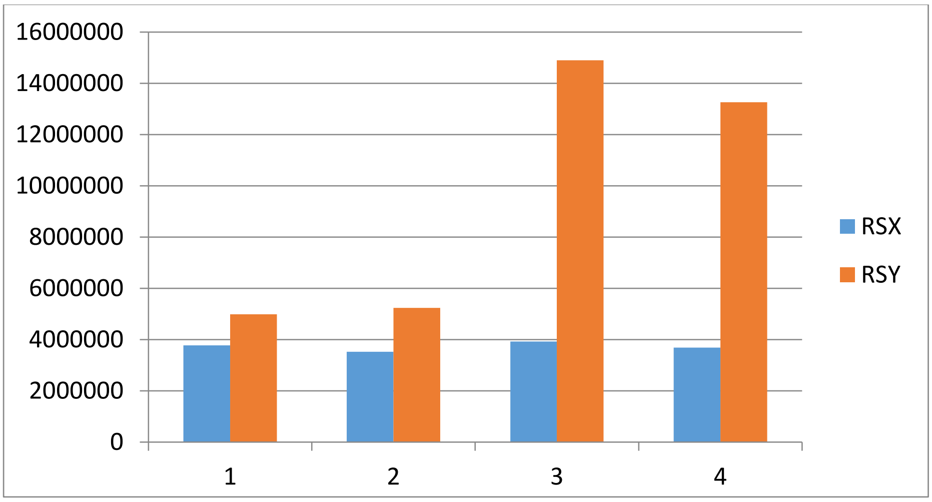


Chart 14: Max storey stiffness in KN/m for various models of regular plan RSA along X and Y direction in zone III.

Table 15: Max storey stiffness in KN/m for regular plan models in zone IV.

MODEL NO	RSX	RSY
1	3783575.5	4989055.4
2	3524893.6	5245288.1
3	3922551.8	14903213
4	3692290.6	13262674

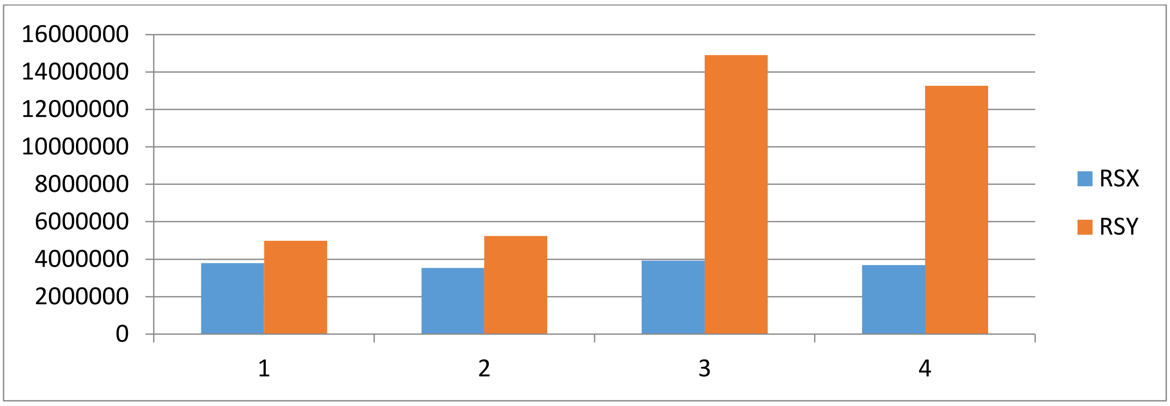


Chart 15: Max storey stiffness in KN/m for various models of regular plan RSA along X and Y direction in zone IV.

Table 16: Max storey stiffness in KN/m for irregular plan models in zone III.

MODEL NO	RSX	RSY
1	3274143	4164076.9
2	3048320	4762089.7
3	3402964.9	13808638
4	3160331.4	10624825

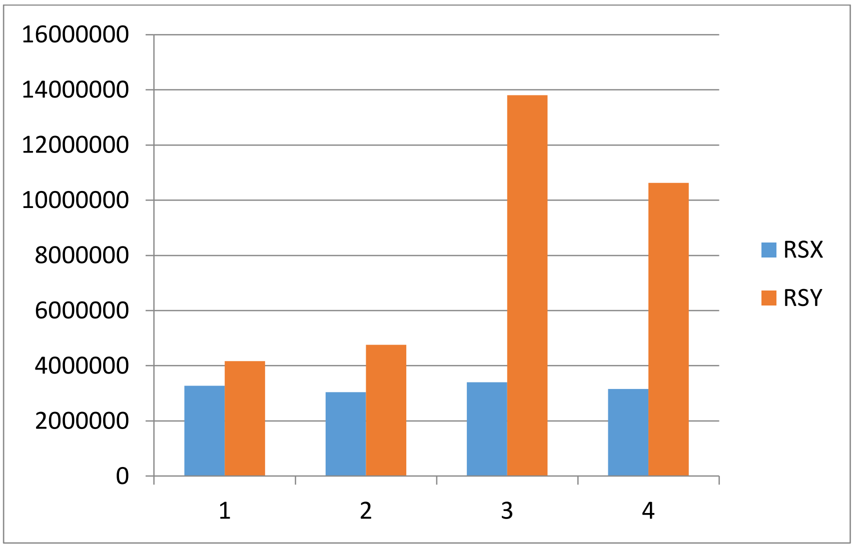


Chart 16: Max storey stiffness in KN/m for various models of irregular plan RSA along X and Y direction in zone III.

Table 17: Max storey stiffness in KN/m for irregular plan models in zone IV.

MODEL NO	RSX	RSY
1	3274143	4164076.9
2	3048320	4762089.7
3	3402964.9	13808638
4	3160331.4	10624825

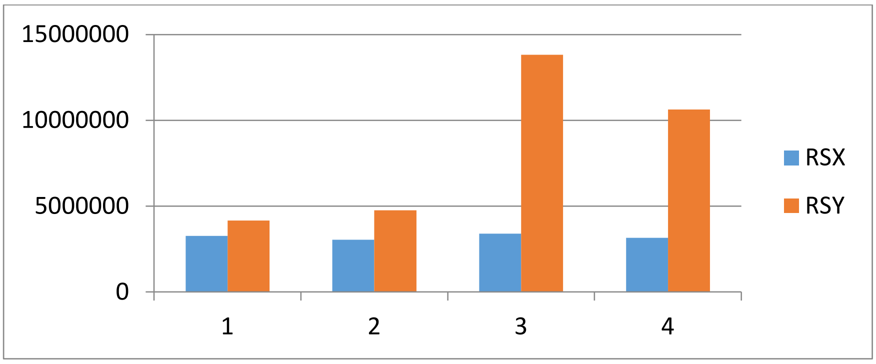


Chart 17: Max storey stiffness in KN/m for various models of irregular plan RSA along X and Y direction in zone IV.

6. OBSERVATIONS AND CONCLUSIONS

Observations

The following observations were made from the present study.

1. The time period in regular and irregular model is get reduced by 1.083% when compared to bare frame model. When the damper is added to bare frame the time period is reduced by 5.35%, if shear wall and damper is added then the time period is reduced by 8.27%, compared to bare frame model.
2. When the damper is added to the bare frame the storey displacement is decreases by 8.88% and 12.27% in X-and Y-direction respectively, if shear wall is added then the displacement is reduced by 10.79% and 7.22% in X and Y- direction respectively compared to bare frame model, if damper & shear wall is added then the displacement is reduced by 12.38 % and 35.34 % in X and Y- direction respectively compared to bare frame model for regular building **zone-III**
3. When the damper is added to the bare frame the storey displacement is decreases by 39.07% and 41.32% in X-and Y-direction respectively, if shear wall is added then the displacement is reduced by 10.82% and 6.94% in X and Y- direction respectively compared to bare frame model, if damper & shear wall is added then the displacement is reduced by 41.42% and 56.75% in X and Y- direction respectively compared to bare frame model for regular building **zone-IV**
4. When the damper is added to bare frame the drift is increases by 14.11% and 14.93 % in X and Y-direction respectively, if shear wall is added then the drift is reduced by 22.85 % in X-direction and 49.73 % increases in Y-direction respectively for regular building.

5. When the damper is added to bare frame the drift is increases by 16.18% in X-direction and decreases by 10.38% in Y-direction respectively, if shear wall is added then the drift is reduced by 19.31% in X-direction and 37.56 % increases in Y-direction for irregular building zone-III.
6. When the damper is added to bare frame the Storey stiffness is reduced by 8.66% in X-direction & 5.32% increases in Y-direction for regular building, if shear wall is added then the Storey stiffness is increases by 29.08 % in X-direction and 6.43 % reduced in Y-direction for regular building zone-III and zone-IV, if shear wall and damper is added then the Storey stiffness is increases by 16.41 % in X and 15.43 % in Y-direction for regular building zone-III and zone-IV.
7. When the damper is added to bare frame the Storey shear is increased by 6.86 % in X-direction respectively for regular building.
8. When the damper is added to bare frame the Storey shear is increased by 9.27 % in X-direction respectively for Irregular building.

Conclusions

The following conclusions were made from the present study.

- From this study it is concluded that the use of friction dampers in bare frame will effectively decreases the time period, drift and displacement by increasing the stiffness in both regular & irregular models. Hence friction damper devices perform a vital role in reducing and controlling the seismic response of the structure.
- It is concluded that the use of shear wall in bare frame is performing very well by reducing the storey displacement and storey drift in both regular and irregular models.
- From storey shear point of view it is concluded that model with dampers and shear wall is having greater storey shear as compared to models with shear walls.
- Irregular models undergo the maximum displacement and drift compared to the regular models. This means buildings with irregularity appears to be more susceptible to large deformation and damage when they are subjected to strong ground motion than those with regular plan.
- From the study it can be concluded regular building performs well as compared to irregular building under the seismic load.

REFERENCES

1.Mohammed Arshad Hussin Aamir, Prof.Amaresh.S.Patil **"Comparitive study of seismic performance of regular and irregular plan buildings with dampers, shear walls and infill walls".**International Journal of Technical Innovation in Modern Engineering and Science(IJTIMES), Volume 4, Issue 7,July-2018, e-IISN:2455-2585.

2. Deepna U, Arjun S Menon,S.Balamurugan **"A comparative study on shear wall concept in accordance its seismic behavior".** International Journal of Engineering and Technology, Volume 7,Issue 4.5, 2018,e-182-187.
3. Puneet Sajjan , Praveen Biradar **"Study on the effect of viscous damper for RCC frame structure".**International Journal Research in Engineering and Technology(IJRET), Volume:05, Issue:09,eISSN:2319-1163,pISSN:2321-7308.

4. Sanjay Sengupta **"Study of shear walls in multistoried buildings with different thickness and reinforcement percentage for all seismic zones in India".** International Journal Research of Enginerring and Technology(IJRET),Volume:03,Issue:11,eISSN:2319-7308.
5. S K Abid Sharief, M Shiva Rama Krishna, S V Surendhar **"A Case Study on Seismic Analysis of an Irregular Structure".** International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-6, April 2019 .
6. Chaitra H N, Dr B Shivakumara Swamy **"Study On Performance Of Regular And Vertically Irregular Structure With Dampers, Shear Wall And Infill Wall".** International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 10 | Oct -2016, p-ISSN: 2395-0072.
7. Kapil P. Gunjal , Prof. Sanket S. Sanghai " **Seismic Analysis of Building Using Dampers In Shear Walls".**International Journal of Innovations in Engineering and Science, Volume: 4,Issue No:6, 2019,e-ISSN:2456-3463.
8. Rakhimol. S and Ms. Smrithi Cheriyath **"Seismic Response Control of Irregular Shaped RCC Buildings by using Nonlinear Viscous Damper".** International Journal of Engineering Research & Technology (IJERT), Volume 6, Issue 06, ISSN: 2278-0181**.**
9. Mayuri M. Baviskar and Prof. L. G. Kalurkar **"Storey Response of G+40 Horizontally Connected Buildings with Dampers".** International Journal of Engineering Research and Technology(IJERT), Volume:09, Issue:07,July-2020, ISSN: 2278-0181.
10. Ankit Jain **"Performance of High Rise Structure with Dampers at Different Location".** International Journal of Engineering Research and Technology(IJERT), Volume:05, Issue:07, July-2016, ISSN: 2278-0181.