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COMPARTIVE STUDY OF SEISMIC PERFORMANCE OF REGULAR AND IRREGULAR PLAN BUILDING WITH DAMPERS,SHEAR WALLS AND INFILL WALLS.

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Abstract— **With the immense loss of life and property witnessed in the last couple of decades alone in India, due to failure of structures caused by earthquakes, attention is now being given 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+12 multi story building of regular and irregular configuration with five different structures such as bare frame, core wall, shear wall, dampers, and infill wall under seismic load. In this paper a G+12 multi story 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 two different methods such as Response Spectrum Analysis and Equivalent Static Analysis 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 infill 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 V was considered and properties of zone V were taken according to IS: 1893-2002 part 1 code.***

Keywords— Regular and Irregular, Fluid viscous dampers, shear wall, core wall, infill wall, displacement, drift, base shear, stiffness, time period, Equivalent static method, Response spectrum method.

I. INTRODUCTION

Human civilization required structures to live and their needs in all the aspects. But it is not only building structures but to build efficient structures so that it can fulfil the main 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 many classical methods to solve design problem, and with time new software's also coming into play. 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. A symmetric distribution of mass and stiffness should be provided in plan as well as in every storey of the structure to resist the lateral loads exerts by the earthquake and the buildings were considered to be as torsionally balanced structure. It is very difficult to get such a condition due to restrictions such architectural requirement and functional needs. From the past research it is observed that torsional oscillation cause many damages in the structure or buildings. The torsional motion in the elastic range exists due to the out of the centre of mass of the structure with non coincident centers of mass and rigidity which is called as asymmetric structure or may torsionally unbalanced structures, and it may be induced by asymmetry is called as natural torsion. 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 properties, such as the modulus of elasticity and it may exist due to the rotational motion of the ground towards the vertical axis. 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 keeping the limitations over 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 and Equivalent Static Analysis methods. 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 reinforced concrete buildings and to reduce the response of the structure effectively using Fluid viscous dampers, Shear walls and Infill 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:

- To study the different parameters like lateral story displacement, base shear, story drift, time period & story stiffness.
- To Study the effect of damper on structural behavior of high rise building.
- To study the behavior of building on influence of concrete shear wall & infill wall.
- To compare the behavior of regular & irregular building

II. 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, shear wall, core wall, infill wall etc..

Seismic codes give different methods to carry out lateral load analysis, while carrying out this analysis infill walls present in the structure are normally considered as non-structural elements and their presence is usually ignored while analysis and design. Most building codes prescribe the method of analysis based on whether the building is regular or irregular. Almost all the codes suggest the use of static analysis for symmetric and selected class of regular buildings. For buildings with irregular configurations, the codes suggest the use of dynamic analysis procedures such as response spectrum method or time history analysis.

In the present study the regular and irregular structures are considered for the analysis and the analysis were carried by different methods like Response Spectrum method and Equivalent Static Method. Then the various results are compared with different models. In this study different models are taken for the analysis such as bare frame, bare frame with core wall, bare frame with shear wall and bare frame with dampers.

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

Description of models for regular plan

1. Bare frame model
2. Bare frame with core wall.
3. Bare frame with L-Type Shear wall.
4. Bare frame with infill wall.
5. Bare frame with Fluid viscous dampers.

Description of models for irregular plan

6. Bare frame model
7. Bare frame with core wall.
8. Bare frame with L-Type Shear wall.
9. Bare frame with infill wall.
10. Bare frame with Fluid viscous damper.

REGULAR AND IRREGULAR MULTISTORY BUILDING (G+12)

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Modelling different models in etabs software

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1. Conventional building with beams and columns for regular plan (Bare frame model)
2. Bare frame model with core wall for regular plan
3. Bare frame model with L - Type Shear wall for regular plan
4. Bare frame model with Infill wall for regular plan
5. Bare frame model with fluid viscous dampers for regular plan
6. Conventional building with beams and columns for irregular plan (Bare frame model)
7. Bare frame model with core wall for irregular plan
8. Bare frame model with L - Type Shear wall for irregular plan
9. Bare frame model with Infill wall for irregular plan
10. Bare frame model with fluid viscous dampers for irregular plan.

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EQUIVALENT STATIC AND RESPONSE SPECTRUM ANALYSIS

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RESULTS AND COMPARISON

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CONCLUSION

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

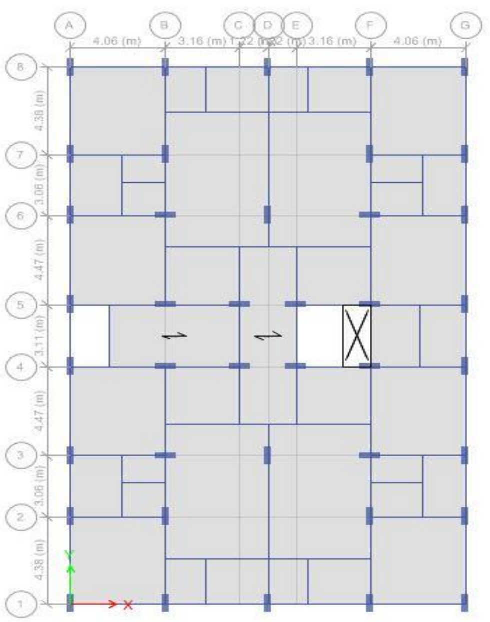


Fig 1 Plan of the regular building

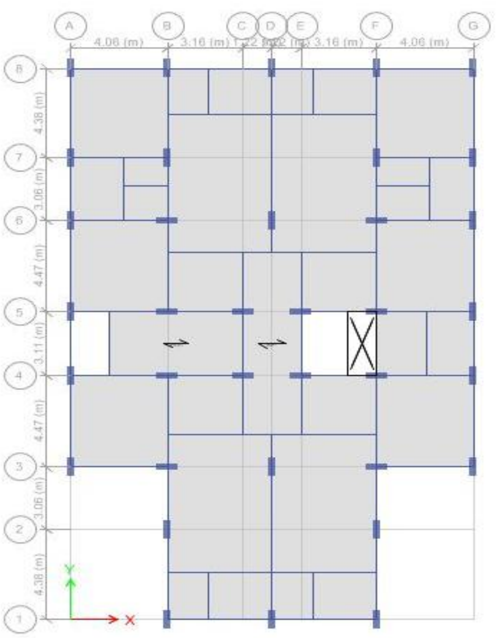


Fig 2 Plan of the irregular building

III. BUILDING DETAILS

Type of building	Residential Building (regular and irregular)
Type of frame	Moment Resisting Frame
No of stories Total height of building	12 stories 44.8m
Thickness of walls	230mm (main wall) and 115mm (inner wall)
Live load	3KN/m2 – Balcony , Corridor 2KN/m2 – All rooms
Grade of Concrete	M35
Grade of reinforcing Steel	HYSD500
Density of brick masonry	20KN/m3
Sizes of columns	C1=300mmX900mm C2=300mmX600mm
Sizes of beams Thickness of slab	B1=300X375mm B2=300X450mm 125mm
Zone	V
Soil type	III
Importance factor	1
Response reduction	5
Seismic zone factor	0.36 for zone V
Damping ratio	5%
Thickness of shear wall and infill wall	230mm
Type of damper	Fluid Viscous damper 250

Factors considered for analysis

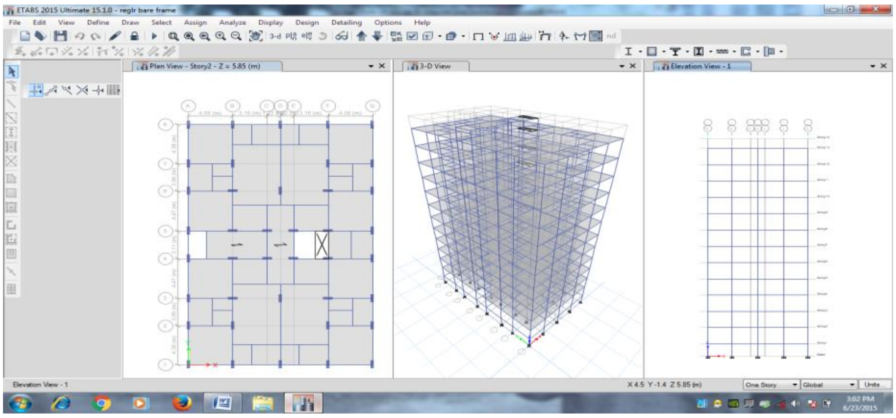
- Live load (As per IS 875 part I) - 3KN/m^2
- Floor finish (FF) load - 1KN/m^2
- Concrete grade - 35N/mm^2
- Steel grade - 500 N/mm^2
- Clear cover (CC) for beam and column - 30mm
- Concrete density - 25 KN/m^3
- Brick wall density - 19KN/m^3

Geometrical Details

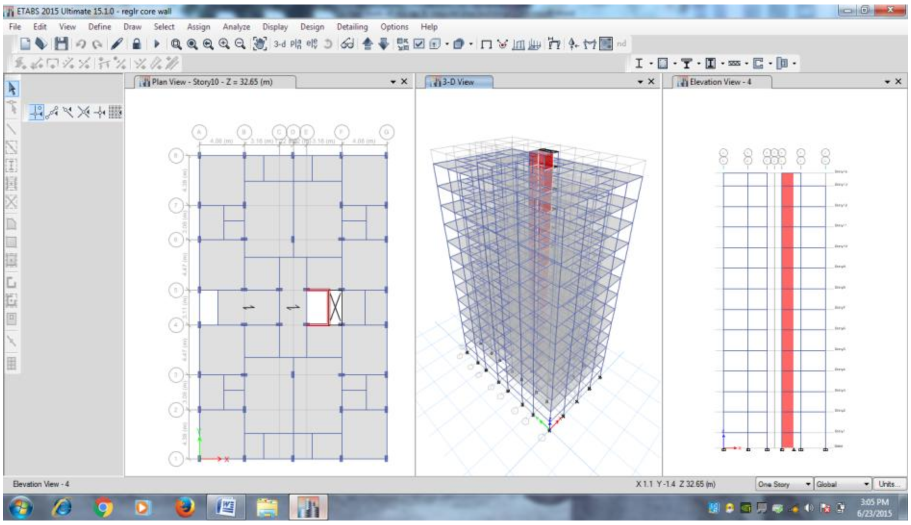
- Number of stories considered - 12
- Each height of storey - 3.35m
- Number of bays considered in x-direction - 7
- Number of bays considered in y-direction - 8
- Slab thickness considered - 125mm

IV. **Modeling different models in ETABS Software:**

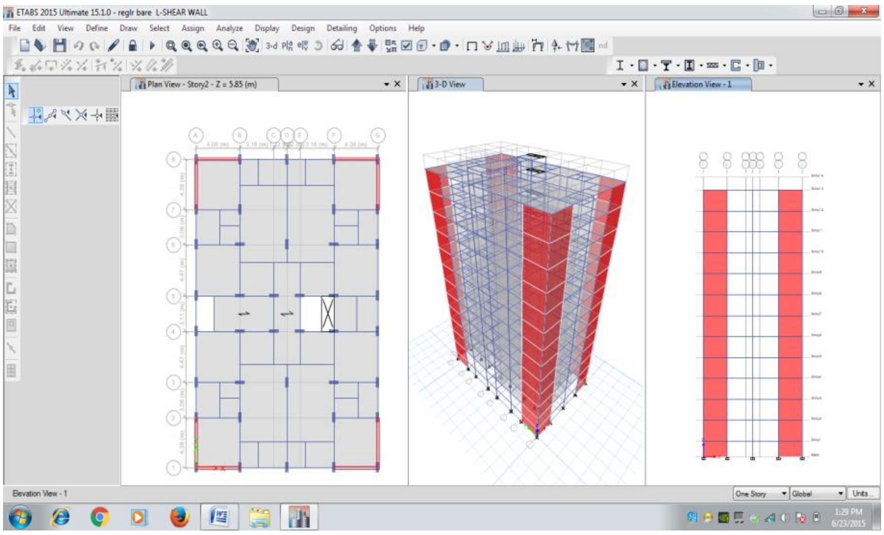
Regular Plan Models



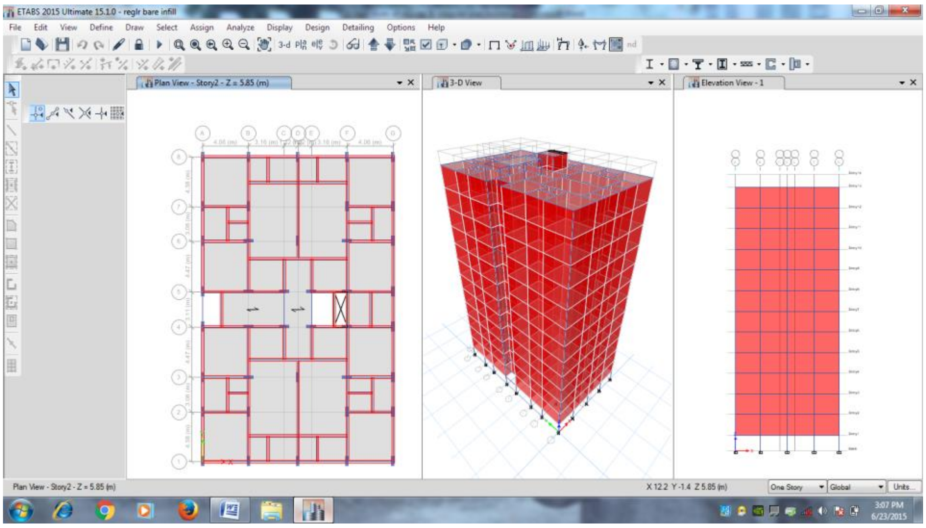
Plan, 3D model and Elevation of bare frame for regular plan



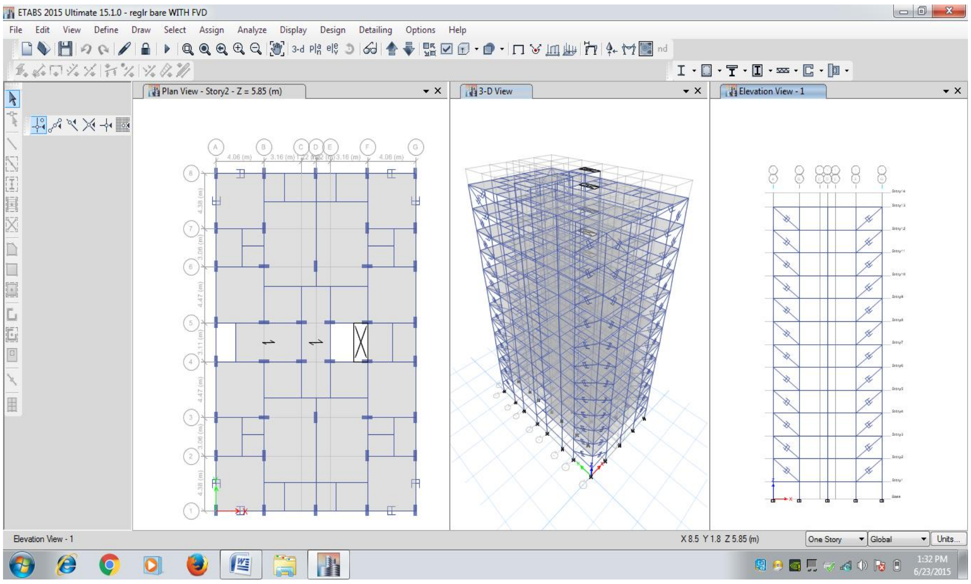
Plan, 3D model and Elevation of bare frame with core wall for regular plan



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

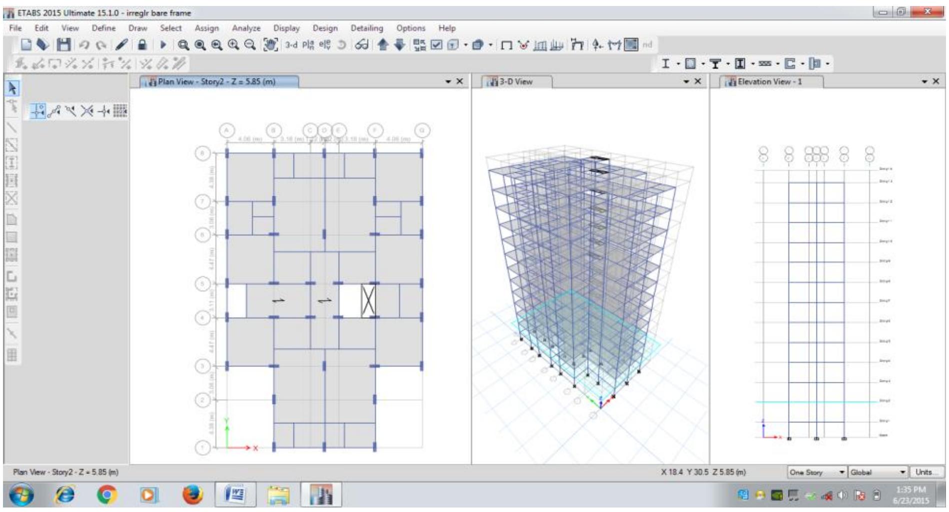


Plan, 3D model and Elevation of bare frame with infill wall for regular plan

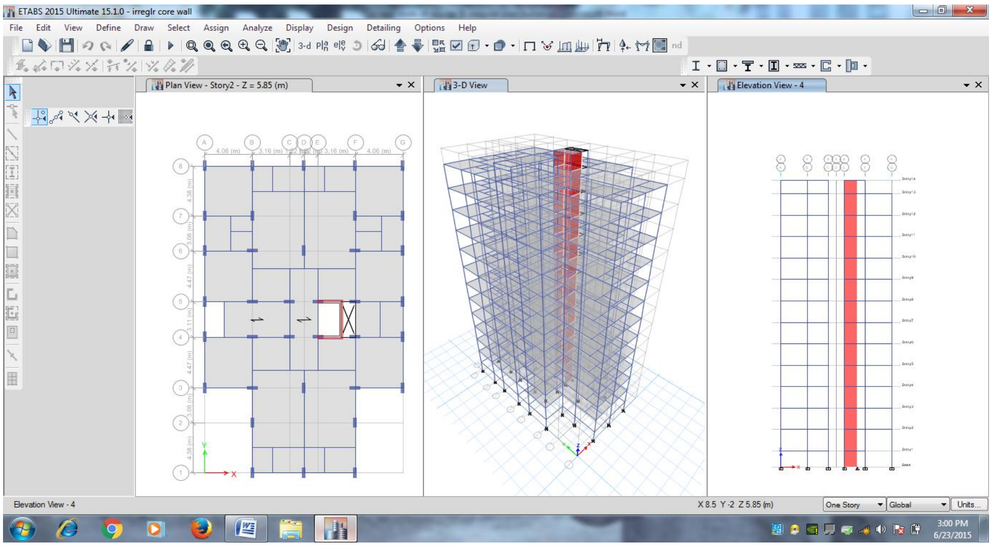


Plan, 3D model and Elevation of bare frame with fluid viscous dampers for regular plan

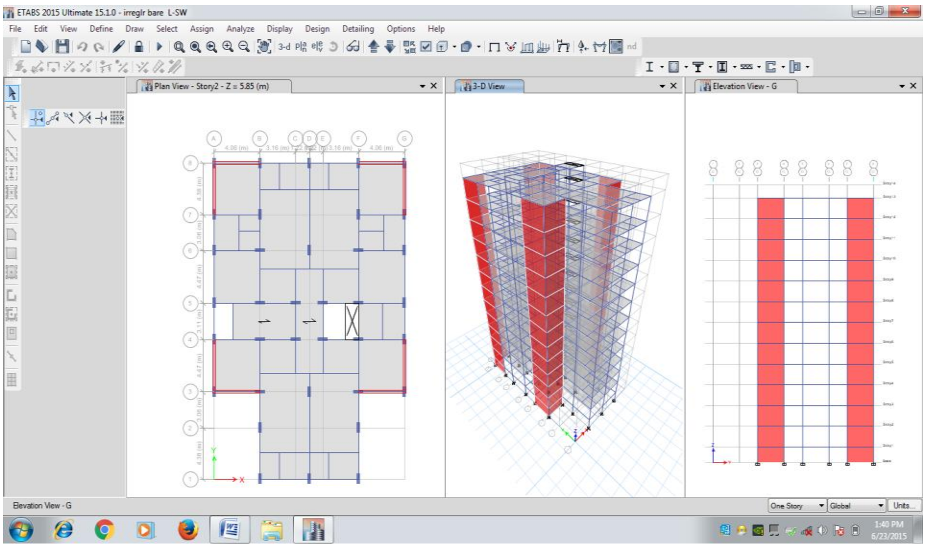
IRREGULAR PLAN MODELS



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



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



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

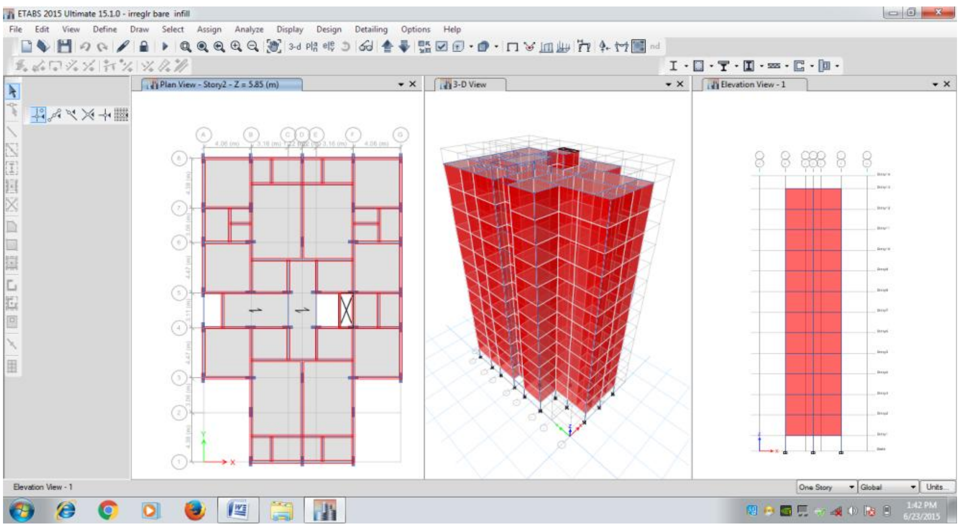


Fig 5.9 Plan, 3D model and Elevation of bare frame with infill wall for irregular plan

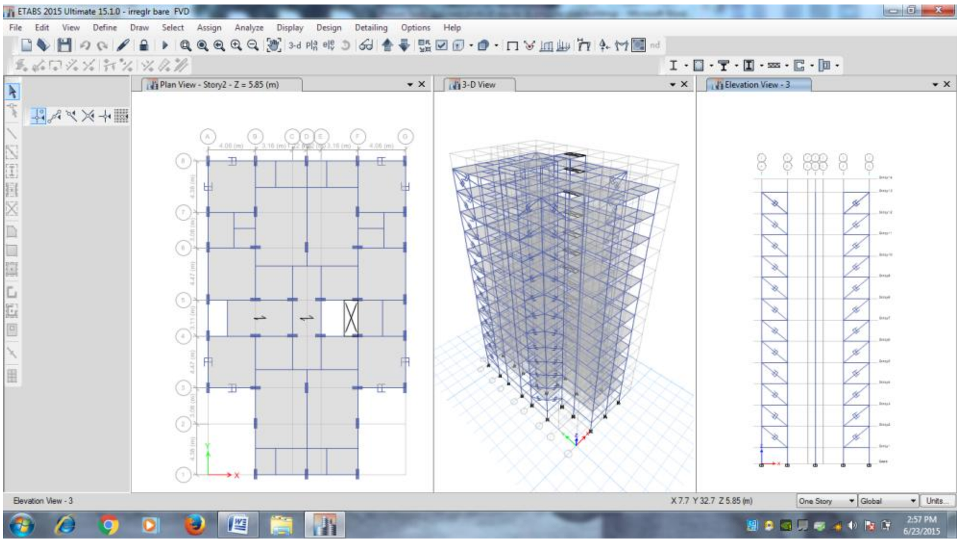


Fig 5.10 Plan, 3D model and Elevation of bare frame with fluid viscous dampers for irregular plan

V. ANALYSIS RESULTS AND DISCUSSION

Time Period

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

Table 1: Time period of various regular and irregular plan models.

MODEL NO.	NATURAL TIME PERIOD IN SEC (REGULAR)	NATURAL TIME PERIOD IN SEC (IRREGULAR)
1	2.409	2.418
2	2.071	2.083
3	1.298	1.285
4	0.692	0.693
5	1.82	1.868

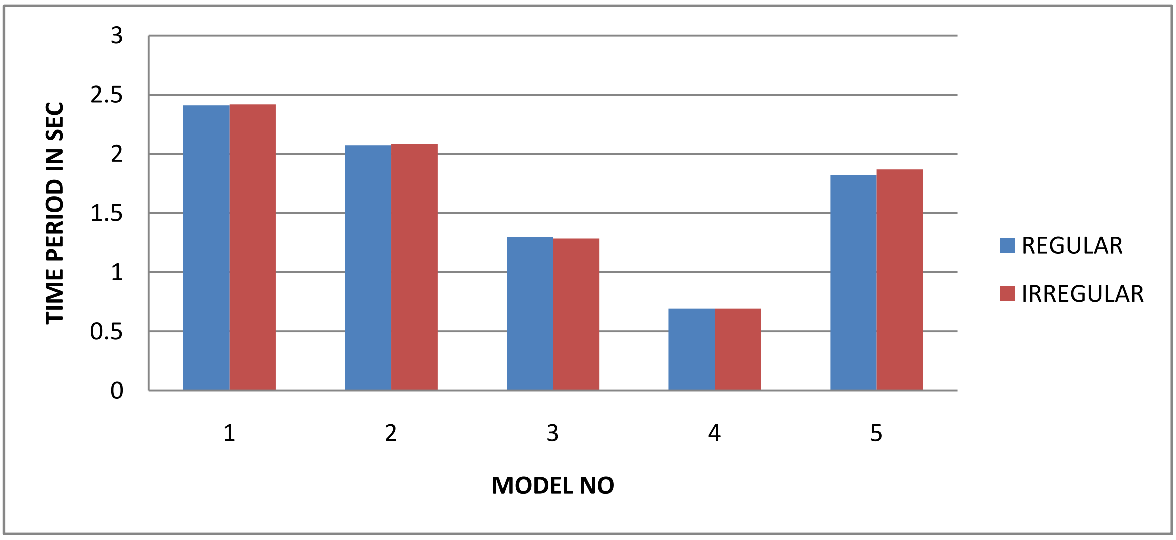


Chart 1: Time period of various regular and irregular plan models

Storey displacement.

Table 2:Max Storey Displacement in mm for regular plan models

MODEL NO	EQX	EQY	RSX	RSY
1	133.1	78.8	119.1	70.3
2	108.9	68.1	94.3	66.2
3	47.2	31.3	39.6	27.7
4	14.4	11.5	12.4	11.9
5	88.9	53.9	64.8	44.5

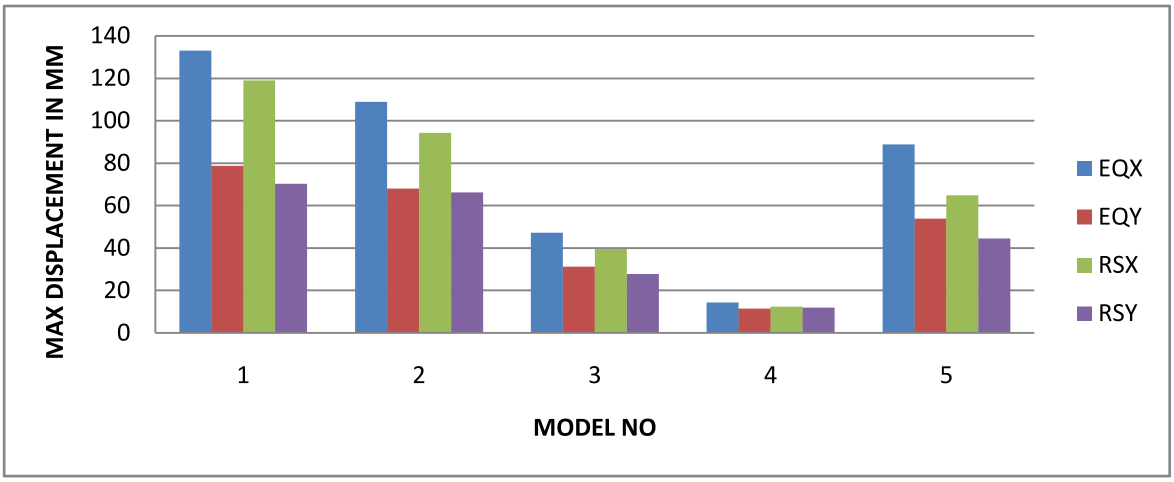


Chart 2:Max Storey Displacement in mm for various models of regular plan for ESA and RSA along X and Y direction.

Table 3:Max Storey Displacement in mm for irregular plan models

MODEL NO	EQX	EQY	RSX	RSY
1	135.9	81.7	131.3	73.7
2	108.7	70.5	125.3	68.2
3	49.2	28	46.2	25.1
4	15	11.9	12.9	12.5
5	95.1	51	70.9	42.5

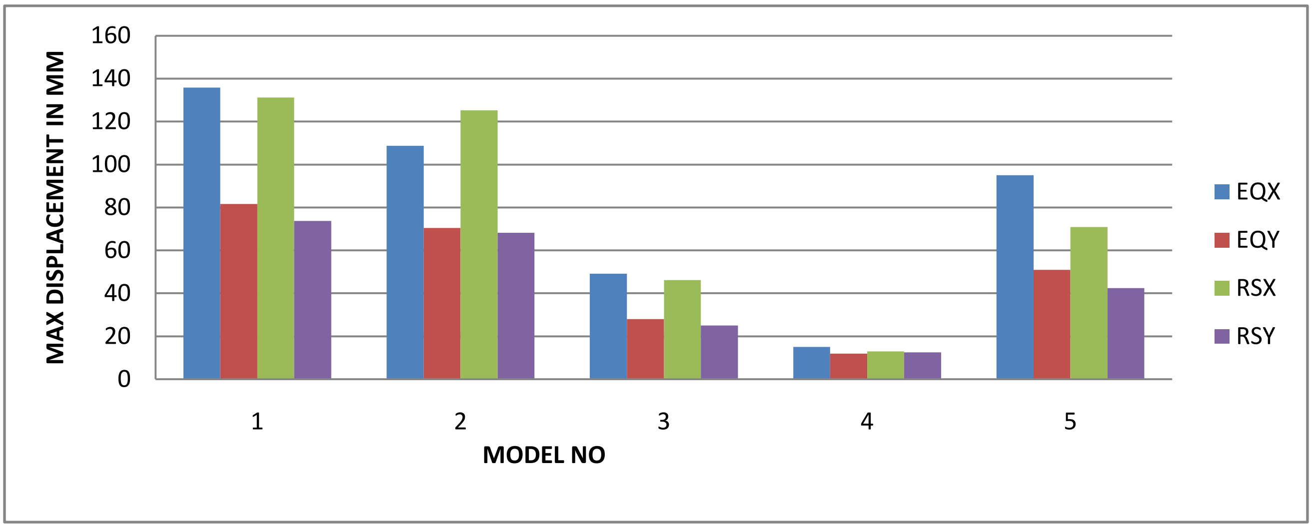


Chart 3:Max Storey Displacement in mm for various models of irregular plan for ESA and RSA along X and Y direction.

Storey Drift.

Table 4: Max Storey Drift in m for regular plan models

MODEL NO	EQX	EQY	RSX	RSY
1	0.003689	0.00229	0.003603	0.002293
2	0.003014	0.001911	0.00271	0.001906
3	0.001359	0.000898	0.001181	0.000794
4	0.001098	0.000751	0.001193	0.000966
5	0.002626	0.001544	0.002778	0.001272

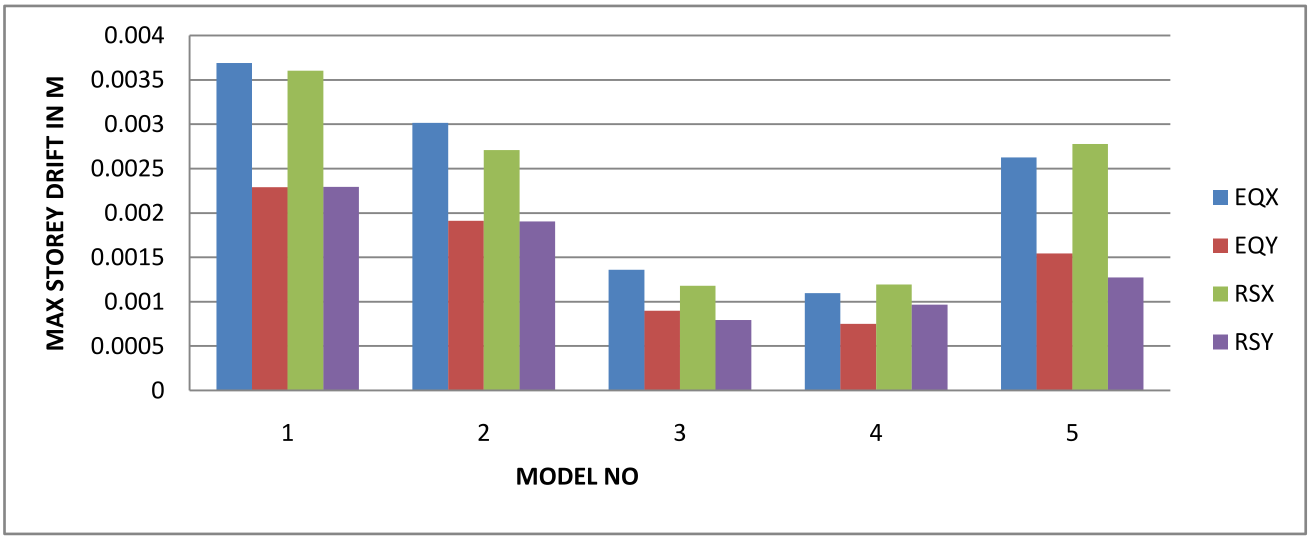


Chart 4:Max Storey Drift in m for various models of regular plan for ESA and RSA along X and Y direction.

Table 5: Max Storey Drift in m for irregular plan models

MODEL NO	EQX	EQY	RSX	RSY
1	0.00392	0.002379	0.003979	0.002406
2	0.003016	0.001979	0.003758	0.001959
3	0.001479	0.000806	0.001383	0.000921
4	0.00109	0.000702	0.002383	0.000921
5	0.002796	0.001465	0.002383	0.00122

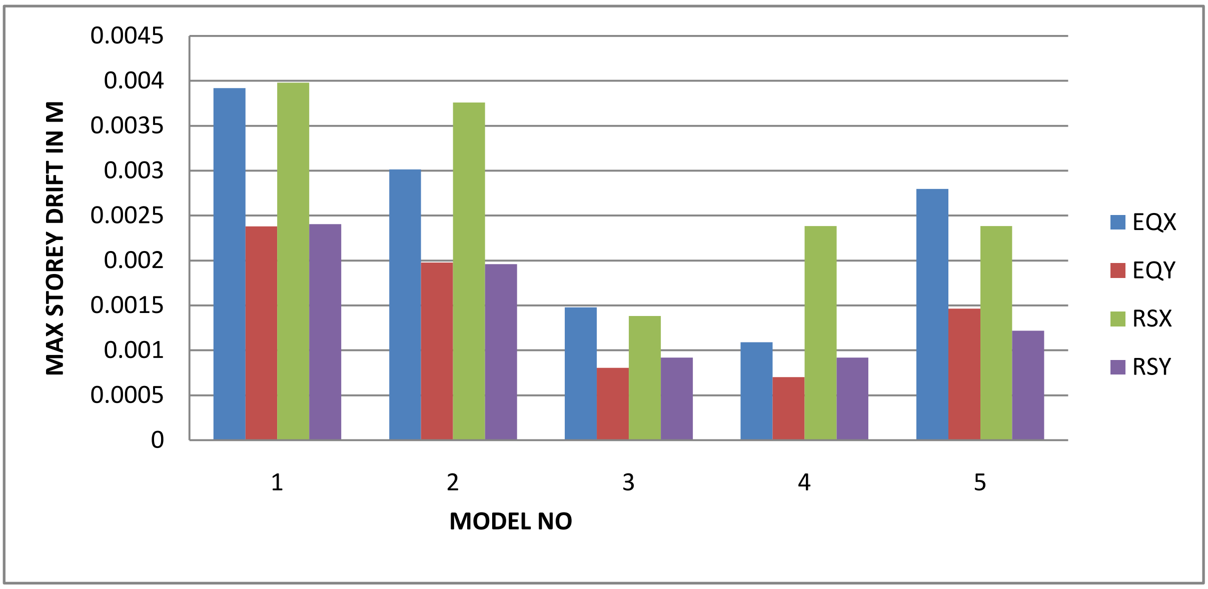


Chart 5:Max Storey Drift in m for various models of irregular plan for ESA and RSA along X and Y direction.

Storey stiffness

Table 6: Max Storey Stiffness in kN/m for regular plan models.

MODEL NO	EQX	EQY	RSX	RSY
1	952586.656	1449612.503	923665.124	1442989.715
2	1975529.991	2687750.03	1960367.899	2763085.648
3	7413637.027	8848226.082	8245032.784	9538367.906
4	7550186.935	11070521	7857694.569	10987371
5	1012032.359	3241047.296	992018.305	3228265.679

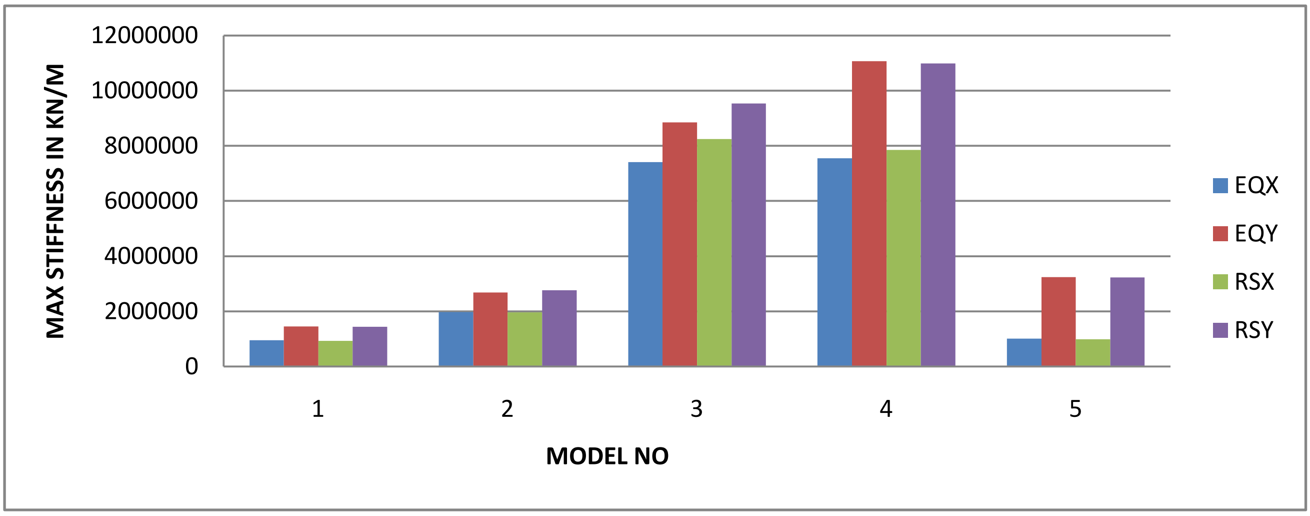


Chart 6:Max Storey Stiffness in kN/m for various models of regular plan for ESA and RSA along X and Y direction.

Table 7: Max Storey Stiffness in kN/m for irregular plan models.

MODEL NO	EQX	EQY	RSX	RSY
1	906780.8	1276897	861958.7	1266406
2	1927588	2460223	1258081	2563631
3	7188980	8816960	7574420	9439936
4	6202361	9690536	6336284	9217474
5	1148229	2937490	1133420	2907366

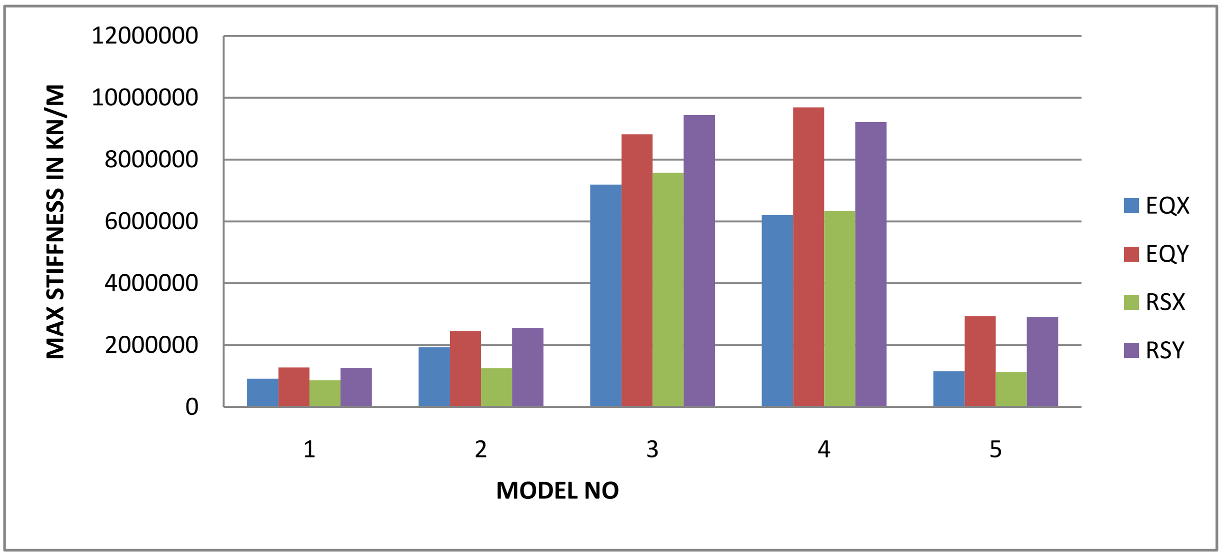
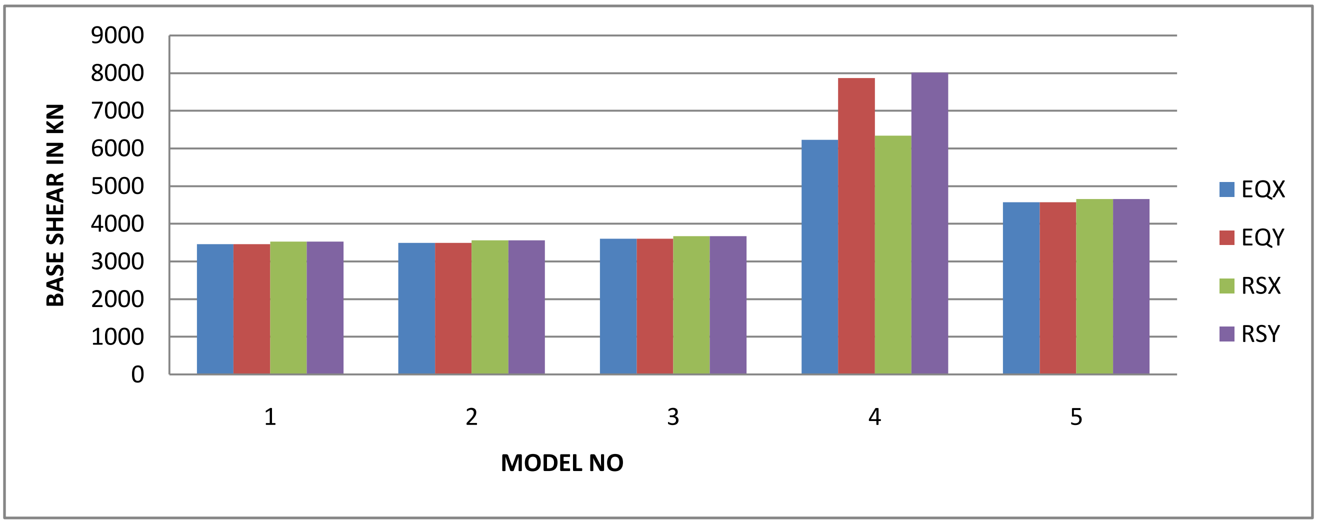


Chart 7:Max Storey Stiffness in kN/m for various models of irregular plan for ESA and RSA along X and Y direction.

Base shear

Table 8: Base shear in kN for regular plan models.

MODEL NO	EQX	EQY	RSX	RSY
1	3457.687	3457.687	3523.489	3523.489
2	3495.554	3495.554	3562.684	3561.829
3	3600.018	3600.018	3667.41	3667.73
4	6226.281	7871.112	6340.966	8015.838
5	4569.305	4569.305	4656.372	4656.81



. Chart 8:Base Shear in kN for various models of regular plan for ESA and RSA along X and Y direction.

Table 9: Base shear in kN for irregular plan models.

MODEL NO	EQX	EQY	RSX	RSY
1	3053.339	3053.339	3111.835	3111.039
2	3091.207	3091.207	3150.636	3150.667
3	3196.429	3196.429	3256.561	3253.507
4	5405.641	6833.678	5508.992	6964.81
5	4257.592	4257.592	4339.782	4339.461

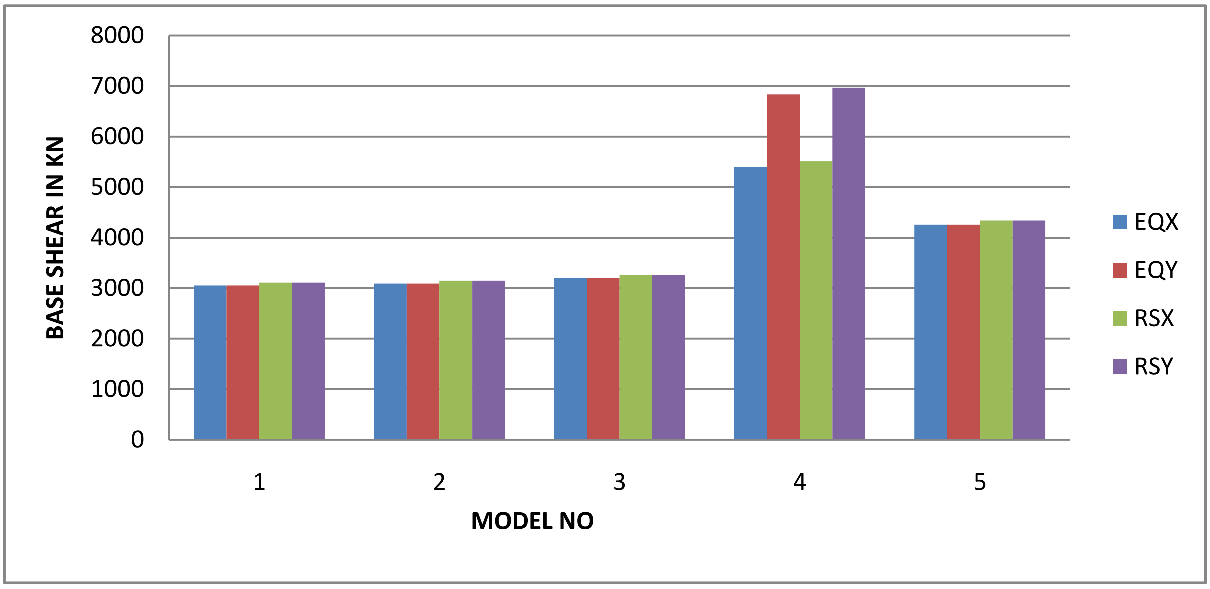


Chart 9:Base Shear in kN for various models of irregular plan for ESA and RSA along X and Y direction.

VI. OBSERVATION & CONCLUSIONS

Observations

The following observations were made from the present study.

1. The time period in regular and irregular (infill wall model) is get reduced by 71.27% and 71.33% respectively when compared to bare frame model.
2. When the shear wall is added to the bare frame the storey displacement is decreases by 66.75% and 60.59% in X-and Y-direction respectively, if infill wall is added then the displacement is reduced by 89.58% and 83.07% in X and Y-direction respectively for regular building.
3. When the shear wall is added to the bare frame the storey displacement is decreases by 64.81% and 65.94% in X-and Y-direction respectively, if infill wall is added then the displacement is reduced by 90.17% and 83.03% in X and Y-direction respectively for irregular building.
4. When the damper is added to bare frame the drift is reduced by 22.89% and 44.52% in X and Y-direction respectively, if infill wall is added then the drift is reduced by 66.88% and 57.87 % in X and Y-direction respectively for regular building.
5. When the damper is added to bare frame the drift is reduced by 40.11% and 49.29% in X and Y-direction respectively, if infill wall is added then the drift is reduced by 69.48% and 61.72 % in X and Y-direction respectively for irregular building.
6. When the damper is added to bare frame the base shear is increased by 32.15% in X and Y-direction respectively for regular building.
7. When the damper is added to bare frame the base shear is increased by 28.29% in X and Y-direction respectively for irregular building.
8. The stiffness is increased by 88.24% and 86.86% in X and Y –direction respectively if infill wall is added to the bare frame for regular building.
9. The stiffness is increased by 86.39% and 86.26% in X and Y –direction respectively if infill wall is added to the bare frame for irregular building.
10. The base shear is increased by 44.43% in X and 56.04% in Y- direction in the infill wall regular model .
11. The base shear is increased by 43.51% in X and 55.33% in Y- direction in the infill wall irregular model

Conclusions

The following conclusions were made from the present study.

- This study shows that the use of infill wall to bare frame will increases the strength and stiffness of the building and also the base shear will be increase by adding the infill wall to the bare frame model in both regular and irregular models.
- From this study it is concluded that the use of dampers in bare frame will effectively decreases the time period, drift and displacement by increasing the stiffness in both regular & irregular models. Hence viscous 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 displacement point of view it is concluded that infill wall is having less displacement value as compared to the models with shear walls and dampers.
- From base shear point of view it is concluded that model with dampers is having greater base shear as compared to models with shear wall. 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.

- Due to lesser area and mass, irregular models are having the lesser base shear and the regular models are having higher base shear indicating the greater stiffness.
- Irregular models are having greater value of time period hence are less stiff compared to the regular models.
- From the study it can be concluded regular building performs well as compared to irregular building under the seismic load.

- From the study it can be concluded regular building performs well as compared to irregular building under the seismic load.

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