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Seismic Analysis on Geometry of RCC Multi-Story Building with Same Plinth Area

Arvind Parmar[1], Dr. J.N. Vyas[2]

[1]PG Student, Department of Civil Engineering, Mahakal Institute of Technology & Management, Ujjain, MP, India
[2]Professor & Director, Department of Civil Engineering, Mahakal Institute of Technology & Management, Ujjain, MP, India
Email id:arvindparmar195@gmail.com, Jnvyas09@rediffmail.com

ABSTRACT

Seismicforces are irregular in nature and unpredictable hence the static and dynamic investigations of the structures have turned into essential necessities for a structural Engineer. The Multistoried building structures are in very fascinated use for almost all urban part of living areas such as in metro cities. In the view of this aspect the construction of irregular shape buildings has become more often now a days. In this study buildings of multistoried structure are taken for different cases. The main reason for the failure of the building is due to the irregularity in the plan of the RC multistory building. So, it is essential to discover the seismic response of the structure in high seismic zones to decrease the seismic harms in structures. The modelling part consist of modelling of G+14 Storey building on Staad.pro software. The total 5 models are created on the staad.pro. The model 1 having Square shaped building and from model 2 to 5 are modelled having building rectangular, L-Shaped T-shaped & H-shaped geometrical plans respectively.

Keywords: Concrete, G+ 14story's, STAAD Pro, Response spectrum method (RSA)

INTRODUCTION

The earthquake is major disaster for human civilization. It can harm structures, lives, property & many other similar things. To reduce the effects of earthquake many experimental works are carried out for making a harmless environment. Special techniques are used for facing the earthquake forces designing with the safety standards & providing proper checks.Due to unsystematic ground motions, in all possible directions coming from epicenter creates earthquake. These seismic effects which have horizontal shaking effects causing an inertia effect above the surface of the earth crust. These inertial forces then applied to structures causes setback of stresses in the components of the structure. From that compression forces changes to tension forces and vice versa. It then creates yielding of structures and ultimately unserviceable. A large amount of drift will then be generated which will ultimately fail from the joint of the building frame.

Regularity & Irregularity of Buildings:

Regularity of the structure deals with a symmetrical and compact shape of the structure. The importance of regularity of the building is for avoiding unpredictable stress concentration that can cause local collapses and modification of the dynamic behavior. Plan irregularity is further subdivided into Torsional irregularity, Re-entrant corners, Floor Slabs having Excessive Cut-Outs or Openings, Out-of-Plane Offsets in Vertical Elements, Non-Parallel Lateral Force System etc. And Non- Parallel Lateral Force System etc. And Vertical irregularities is further classified into Stiffness Irregularity, Mass Irregularity, Vertical Geometric Irregularity, In-Plane Discontinuity in Vertical Elements Resisting Lateral Force, Strength Irregularity etc. Irregular structures, like structures having a L-shaped plan, that can be defined "irregular" according to both perceptive criteria and irregularity rules provided by guidelines, show that, if the diaphragms are rigid and the columns are distributed according to the shape, the irregularity is "apparent".The disturbance to the response, induced by the irregularity consists of torsional effects, that can be accounted for, at design stage.

METHODOLOGY

The modelling part consist of modelling of G+14 Storey building on Staad.pro software. The total 5 models are created on the staad.pro. The model 1 having Square shaped building and from model 2 to 5 are modelled having building rectangular, L-Shaped T-shaped & H-shaped geometrical plans respectively. The analysis part consists the effect on building under the different loads such dead load, live load and lateral loads (earthquake) based on software mechanism. For analysis the response spectrum method of seismic load is used.

Table 1: Model Description

S. No.	Models	Descriptions
1.	Model 1	Building with square geometrical plan.
2.	Model 2	Building with rectangular geometrical plan.
3.	Model 3	Building with L-shaped geometrical plan.
4.	Model 4	Building with T-shaped geometrical plan.
5.	Model 5	Building with H-shaped geometrical plan.

MODELING AND ANALYSIS

G + 14 storey's building with different geometrical plans is taken into account for the analysis. Five various types of building models with bay width of 5m in X-direction, 5m in Z-direction and storey height of 3.5 m were taken into consideration for this analysis. The structure was modeled using STAAD.PRO V8i computer software. All the selected models were designed with M-30 grade of concrete being used and Fe-500 grade of reinforcing steel as per IS code of practice. The building with square, Rectangular-Shaped T-shaped & H-shaped geometrical plans respectively are modelled to study the various parameters. The model description is tabulated on table no 3.1 are as follows:

Model 1: Building with Square geometrical plan.

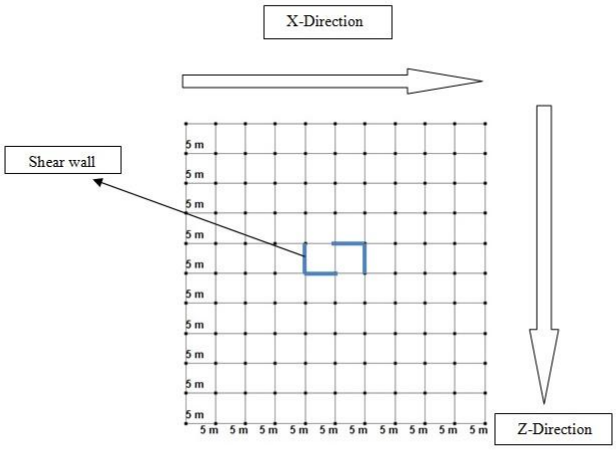
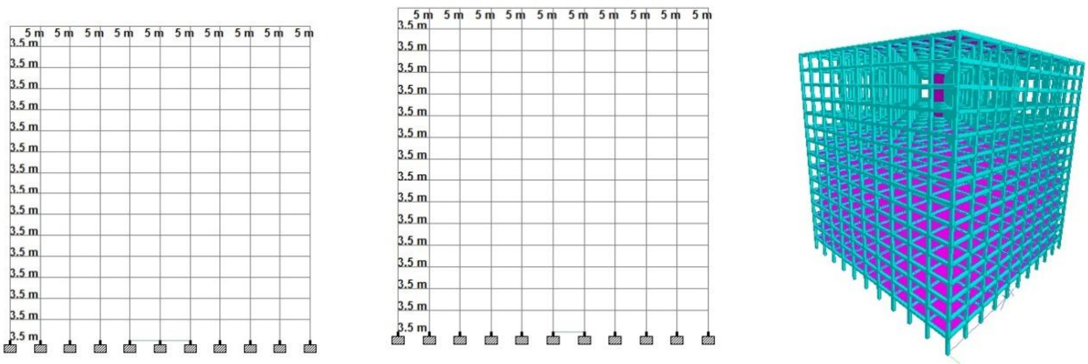


Fig. 1:Plan View with the position of shear wall



a) Elevation@ X direction **b) Elevation @ Z direction** **c) 3D view**

Fig. 2:Model 1- G+14 Storey Building with Square geometrical plan

Model 2: Building with rectangular geometrical plan.

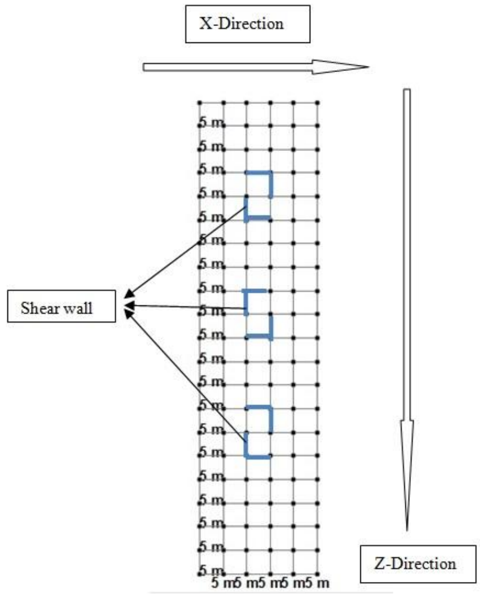
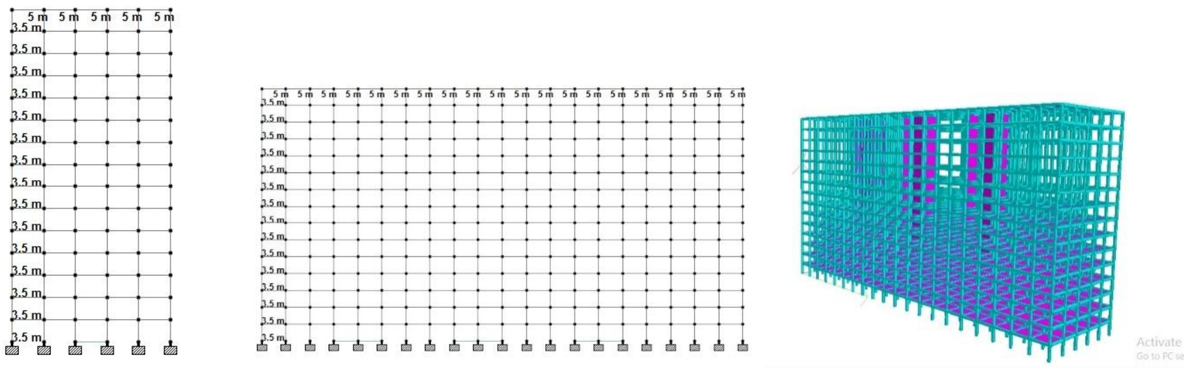


Fig. 3: Plan View with the position of shear wall



a) Elevation@ X direction **b) Elevation@ Z direction** **c) 3D view**

Fig.4: Model 2- G+14 Storey Building with rectangular geometrical plan.

Model 3: Building with L-shaped geometrical plan.

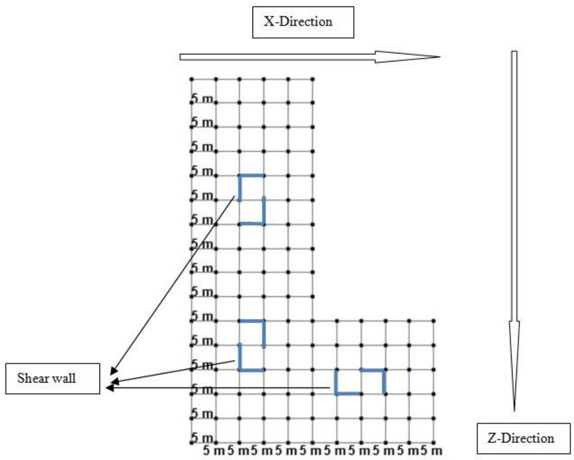
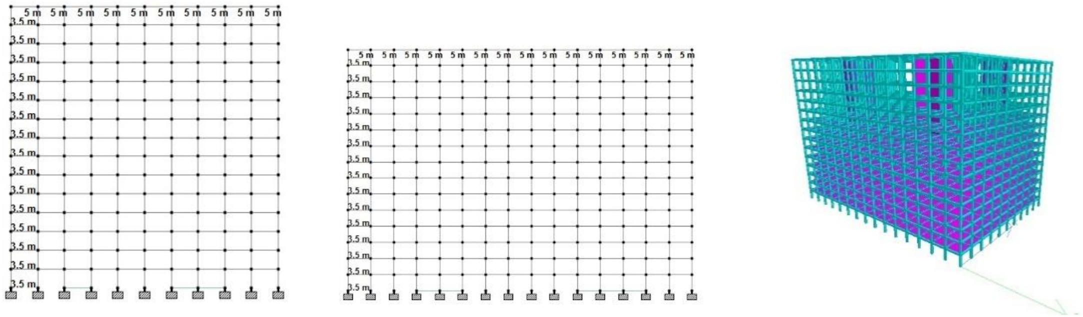


Fig. 5: Plan View with the position of shear wall.



a) Elevation@ X direction **b) Elevation@ Z direction** **c) 3D view**

Fig. 6: Model 3: G+14 StoreyBuilding with L-shaped geometrical plan

Model 4: Building with T-shaped geometrical plan

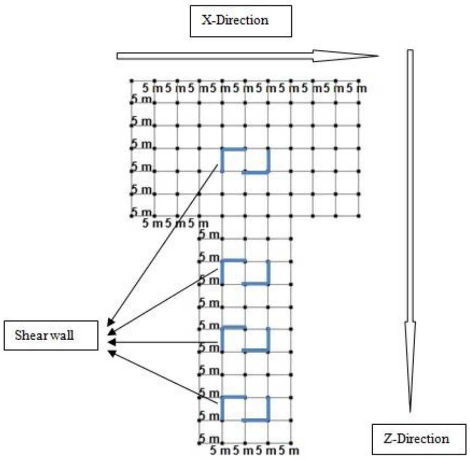
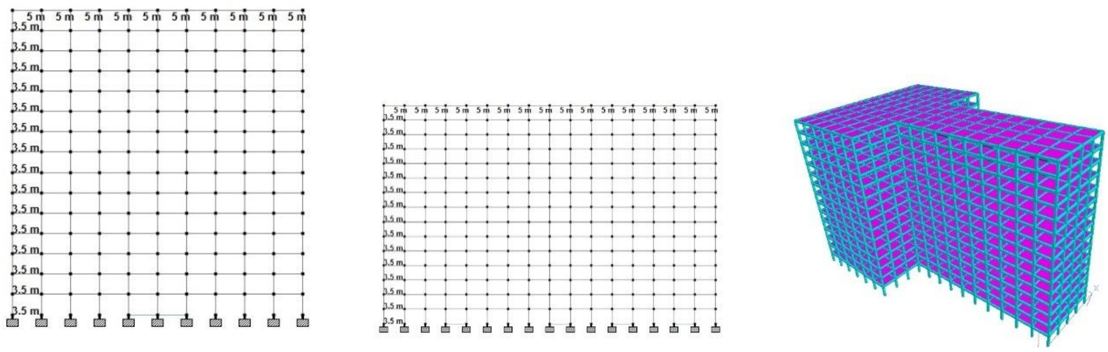


Fig. 7: Plan View with the position of shear wall



a) Elevation @ X direction **b) Elevation@ Z direction** **c) 3D view**

Fig. 8: Model 4- G+14 Storey Building with T-shaped geometrical plan

Model 5: Building with H-shaped geometrical plan.

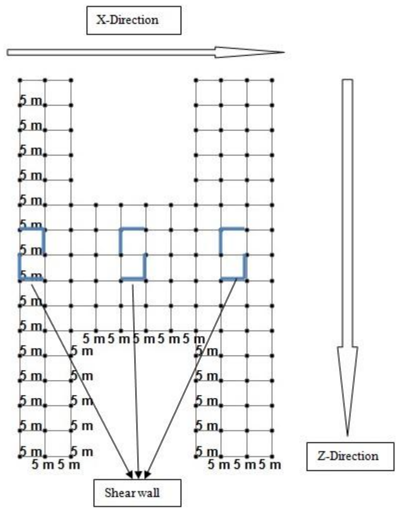
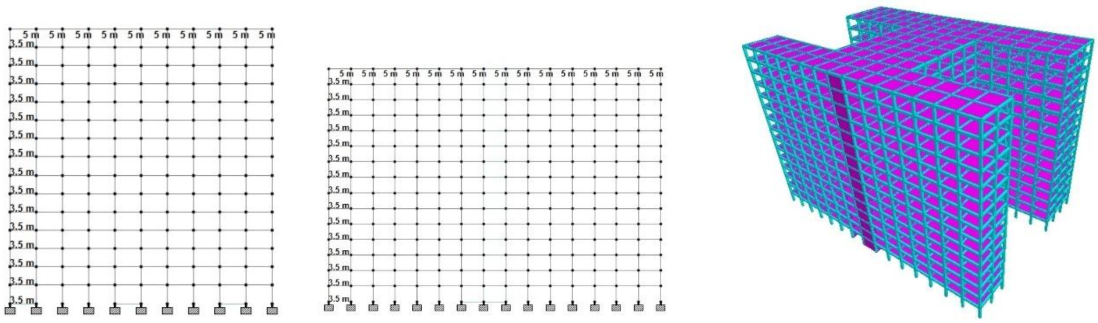


Fig. 9: Plan View with the position of shear wall



a) **Elevation @ Xdirection** b) **Elevation@ Z direction** c) **3D view**

Fig. 10: Model 5- G+14 Storey Building with H-shaped geometrical plan.

Material & Geometrical properties

Table 2: Material properties of elements of Structural

Descriptions of Elements used	**Material Grade**
Column	M-30
Beam	M-30
Equivalentshearwall	M-30
Slab Thickness	M-30
Reinforcement	HYSD-500

Table 3 Structural elements Details of Building.

Particulars	Details
Plinth Area (m^2)	2500m^2
No. of bay in X- direction in G+14 building	5m c/c different in no. for each model
No. of bay in Z - direction in G+14 building	5m c/c different in no. for each model
No. of floors	G+14
Storey height	3.5 m each
Beam Size n X direction	500 mm x 450 mm
Beam Size n Z direction	450 mm x 500 mm
Column Size	450 mm x 500 mm
Slab Thickness	180 mm
shear wall Thickness	180 mm

Earthquake Data

Table 4:Earthquake Data

Earthquake Zone	III
Importance Factor	1
Types of Soil	Medium Soil
Response Reduction Factor	4
Time period both X & Z Direction	1.53533
Damping	0.05
Method of Analysis	Response Spectrum Analysis

CONCLUSION

The results are evaluated based on modeling and analysis of the G+14 Storey Building having five different models. The model 1 to model 5 is based on different geometry with same plinth area. The details of modeling are as follows:

Maximum Storey Displacement: - The maximum displacement value will be taken for all 5 models which is obtained on the top storey of each model. Table 4.1 tabulated the results of maximum storey displacements. The fig. 4.1 shows the bar chart representation of maximum displacement of all models.

Table 5 Maximum Storey Displacement Results

Maximum Storey Displacement (mm)			
S.No.	**Models**	**X - Direction**	**Z -Direction**
1	**Model 1**	94.564	90.601
2	**Model 2**	101.338	92.652
3	**Model 3**	104.345	97.682
4	**Model 4**	106.356	95.354
5	**Model 5**	102.933	94.618

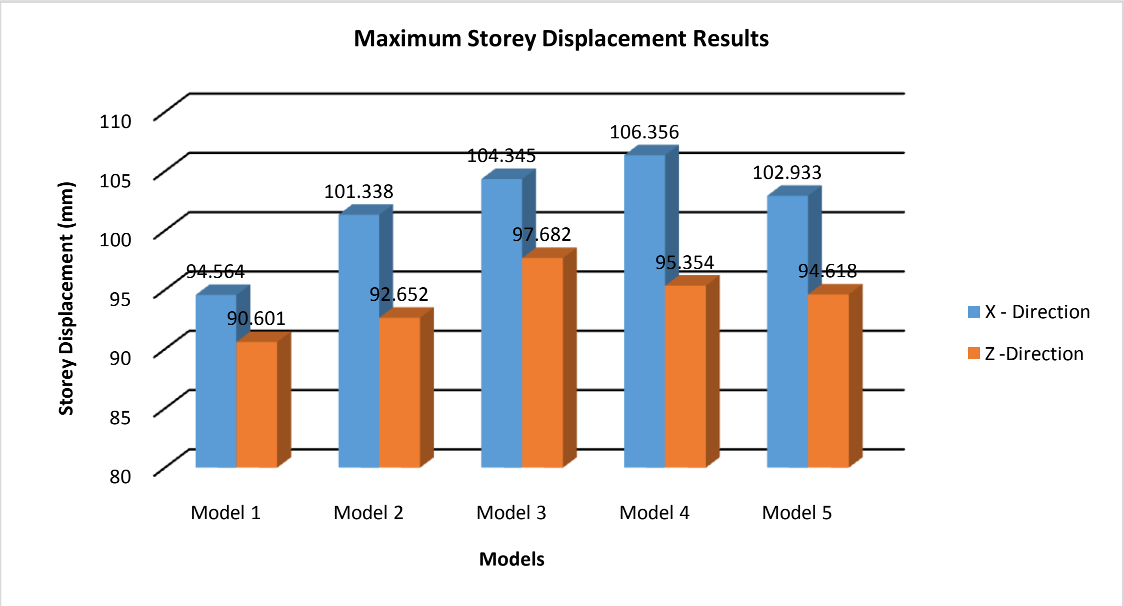


Fig. 11: Bar chart Representations of Max. Storey Displacement Results

Maximum Shear Force in Building: The Maximum Shear Force in Building value will be taken for all 5 models, one by one for each model. Table 4.2 tabulated the results of Maximum Shear Force in Building. The fig. 4.2 shows the bar chart representation of Maximum Shear Force in Building of all models.

Table 6 Maximum Shear Force in Building

Maximum Shear Force inBuilding (KN)			
S.No.	**Model Description**	**X-Direction**	**Z-Direction**
1	Model 1	356.25	328.72
2	Model 2	301.749	266.064
3	Model 3	297.469	265.152
4	Model 4	285.82	274.005
5	Model 5	290.057	270.936

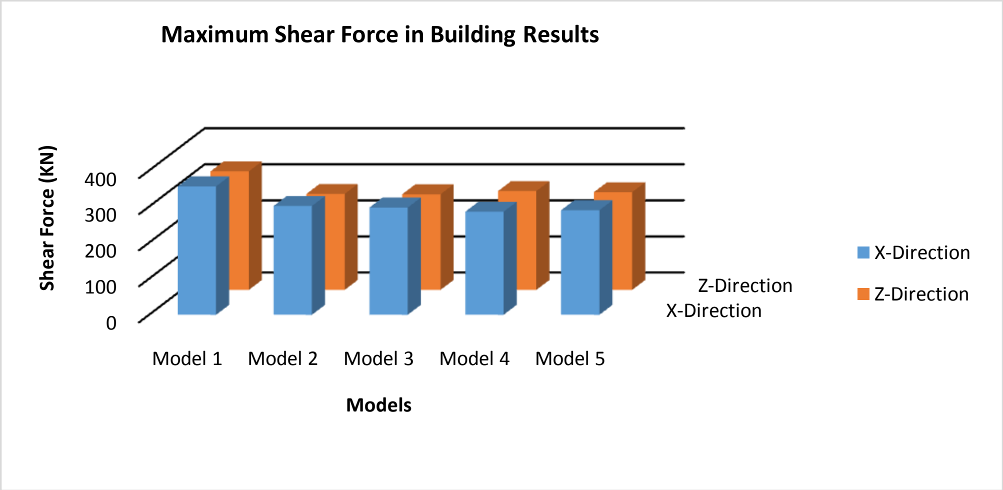


Fig. 12: Bar chart Representation of Maximum Shear Force in Building

Maximum Bending Moment in Building: The Maximum Bending Moment in Building value will be taken for all 5 models, one by one for each model. Table 4.3 tabulated the results of Maximum Bending Moment in Building. The fig. 4.3 shows the bar chart representation of Maximum Bending Moment in Building of all models.

Table 7: Maximum Bending Moment in Building

Maximum Bending Moment in Building(KN)			
S.No.	**Model Description**	**X-Direction**	**Z-Direction**
1	**Model 1**	615.204	774.92
2	**Model 2**	447.552	605.524
3	**Model 3**	440.517	614.642
4	**Model 4**	410.682	635.51
5	**Model 5**	428.341	625.717

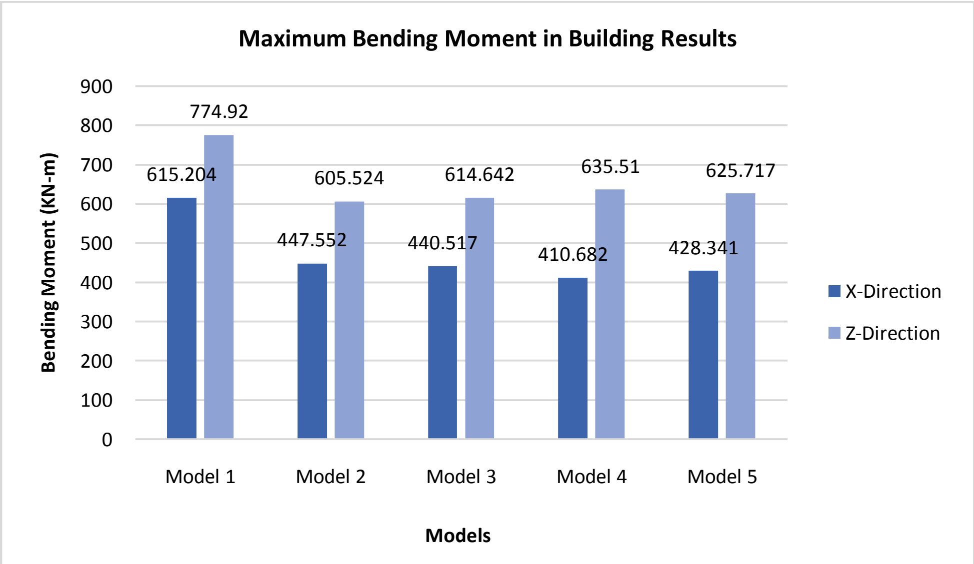


Fig. 13: Bar chart Representations of Maximum Bending Moment in Building

Column Axial Force Results

Table 8: Column Axial Force Results

Column Axial Force (KN)		
S.No.	**Model Description**	**Axial Force(KN)**
1	**Model 1**	11277.818
2	**Model 2**	10883.517
3	**Model 3**	10794.154
4	**Model 4**	10808.232
5	**Model 5**	10374.598

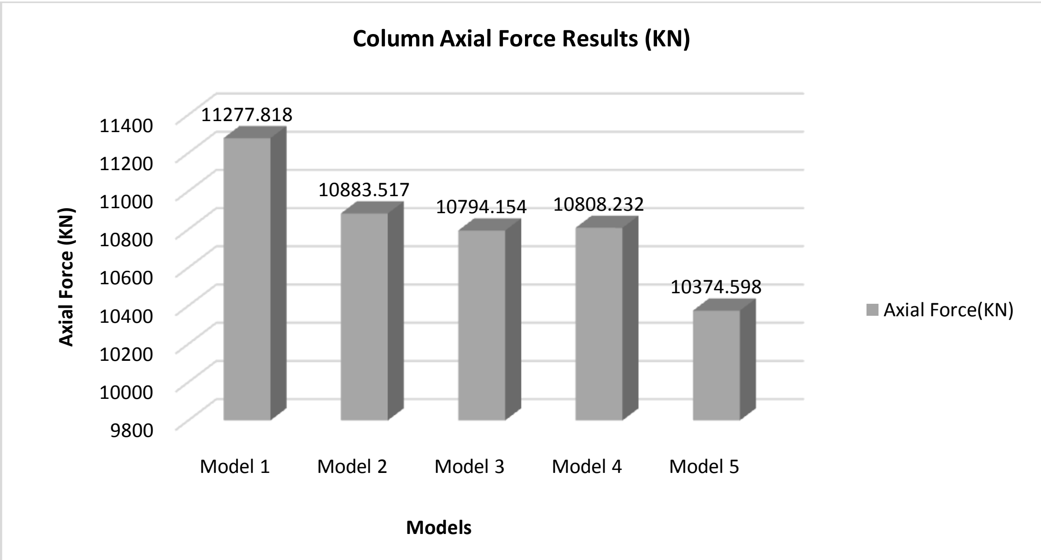


Fig. 14 Bar chart Representations of Column Axial Force

Base Shear Result

Table 9:Base Shear Results

Base Shear Result (KN)			
S.No.	**Model Description**	**X-Direction**	**Z-Direction**
1	**Model 1**	15254.86	15213.99
2	**Model 2**	14650.02	14575.07
3	**Model 3**	12805.25	11602.75
4	**Model 4**	11702.35	12502.85
5	**Model 5**	13900.15	13754.01

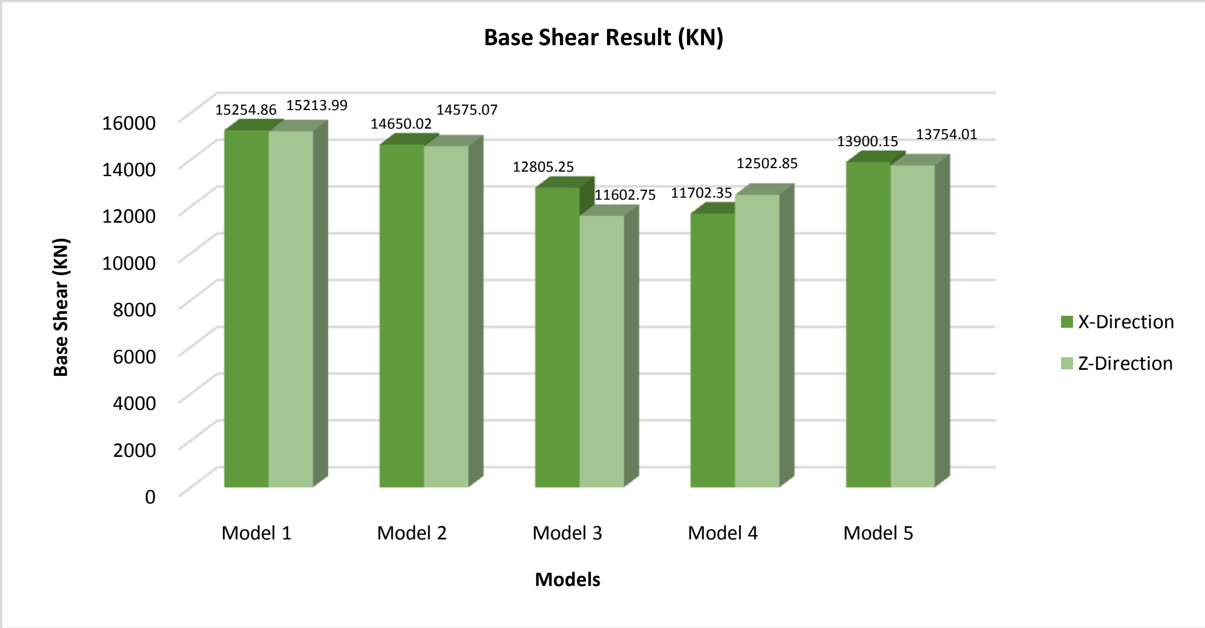


Fig. 15 Bar chart Representations of Base Shear Results

Maximum Beam Torsion

Table 10: Maximum Beam Torsion Results

Maximum Beam Torsion (KN)		
S.No.	**Model Description**	**Torsion (KN)**
1	**Model 1**	30.992
2	**Model 2**	28.629
3	**Model 3**	27.652
4	**Model 4**	28.015
5	**Model 5**	25.335

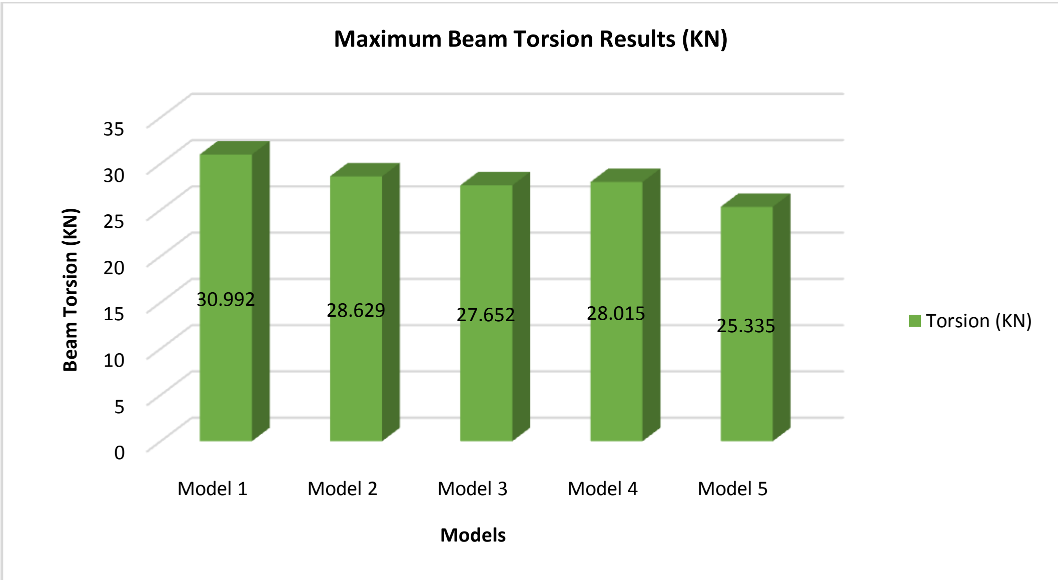


Fig. 16:Bar chart Representations of Maximum Beam Torsion

Maximum Stresses developed

Three types of stresses are be considered in this project. The stresses are VON MIS TOP, TRESCA TOP and Max.TOP, the obtained results are tabulated by table 4.7 and bar chart plot are shown on fig. 4.7.

Table 11Maximum Stresses developed Results

Maximum Stresses developed (N/mm2)				
S.No.	Models	VON MIS TOP (N/mm2)	TRESCA TOP (N/mm2)	Max. Absolute (N/mm2)
1	**Model 1**	24.2254	26.2821	6.7153
2	**Model 2**	22.7113	24.6514	4.57763
3	**Model 3**	23.6649	25.7525	5.64193
4	**Model 4**	23.9556	26.0082	5.98024
5	**Model 5**	23.401	25.3988	4.96915

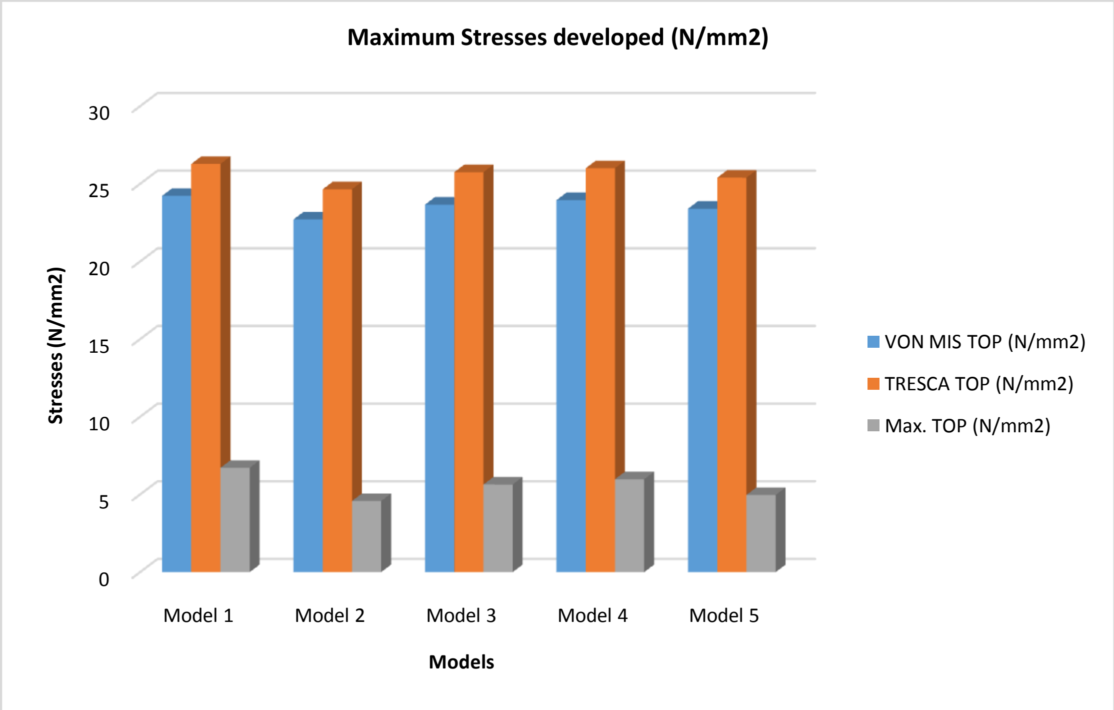


Fig. 17:Bar chart Representations of Maximum Stresses developed

CONCLUSIONS

The following conclusions are to made which are as follows:

- The Storey displacement will be increased when shapes are changed from square plan to different types of geometrical plans. The maximum storey displacement occurs in T-shape building and minimum storey displacement occur in Square-shaped building in X-direction. While the maximum storey displacement occurs in L-shape building and minimum storey displacement occur in Square-shaped building in Z-direction.
- Theshearforce of all models shows decrement in value when their geometrical plan is changed from square to different irregular plans. There is decrement of 15.3%, 16.5%,19.77% & 18.58% being observed in shear force from model 2 to model 5 with respect to model 1(Building with Square Plan) in X- Direction. Similarly in Z direction the decrement of 19.06%, 19.34%, 16.64% & 17.58 being observed in shear force from model 2 to model 5 with respect to model 1(Building with Square Plan).
- There is decrement in bending moment value also being observed in all Irregular building models. In X direction 27.25%, 28.35%, 33.24% & 30.37% decrement is being observed in bending moment from model 2 to model 5 with reference to model 1(Building with Square Plan). In Z direction 21.86%, 20.68%,17.99% & 19.25% decrement being observed in bending moment from model 2 to model 5 with reference to model 1(Building with Square Plan).
- The column axial forces value from model 2 to model 5 with reference to model 1 shows decrement of 3.50%, 4.29%, 4.16% & 8.01% respectively.
- The use of irregular plan building shows decrement in base shear value with respect to Model 1(Building with Square Plan). The maximum Base shear occurs in Square-shaped building and minimum Base shear occur in T-shaped building in X-direction. While the maximum Base shear occurs in Square-shape building and minimum Base shear occur in L-shaped building in Z-direction.
- The Irregular Building Plans also reduces the beam Torsion in the building. The decrement of 7.64%, 10.57%, 9.40% & 18.07% is being observed from model 2 to model 5 with respect to model 1(Building with Square Plan).

- There is Decrement in stresses being observed within the range of 1 to 32 % with irregular plan buildings with respect to Square Plan building.

As overall it concluded that by taking irregular building plan deformation is increased as compared to regular Geometrical plans. Thus, building with regular Plan should be preferred. In G+14 Storey Building the Model 1 with square plan performs very well as compared to other remaining models. Also, it is being observed that as overall comparison the L- shaped Building is very much susceptible to seismic forces than all the other building models.

REFRENCES

[1]. Moehle, J. P. (1984), “Seismic response of vertically irregular structures’, *Journal of Structural Engineering*, *110*(9), 2002- 2014.

[2]. Sultan, M. R., Peera, D. G. (2014), “Dynamic Analysis of Multi-story building for different shapes”, *International Journal of Innovative Research in Advanced Engineering (IJIRAE)*.

[3]. Reddy, K. U., Arunakanthi,” DYNAMIC ANALYSIS OF MULTI STORY STRUCTURE FOR DIFFERENT SHAPES.”

[4]. Rajesh, B., Khan, M. S. A., Kandan, M,Babu, D. S. S. (2015), “Comparison of both linear static and dynamic analysis ofmultistoriedbuildingswithplanirregularities”,*International Journal of Scientific Engineering and Applied Science (IJSEAS)*.

[5]. Yousuf, M., Shimpale, P.M. (2013). “Dynamic analysis of reinforced concrete building with plan irregularities”.

[6]. Tejaswini, M. L., & Naik, S. (2018), “COMPARATIVE STUDY OF ZONE II AND ZONE III FOR EQUIVALENT STATIC METHOD, RESPONSE SPECTRUM METHOD AND TIME HISTORY METHOD OF ANALYSIS FOR SINGLE MULTI-STORY BUILDING”.

[7]. Monish, S., & Karuna, S. (2015), “A study on seismic performance of high-rise irregular RC framed buildings”, *International Journal of Research in Engineering and Technology (IJRET)*, *4*(5), 340-346.

[8]. WIN, N., & KYAM, L. H. (2014), “Comparative study of static and dynamic analysis of irregular reinforced concrete building due to earthquake”, *International journal of scientific engineering and technology. Research, Volume3, Issue7*.

[9]. Banginwar, R. S., Vyawahare, M. R., & Modani, P. O. (2012), “Effect of plans configurations on the seismic behavior of the structure by response spectrum method”, *International Journal of Engineering Research and Applications (IJERA)*, *2*(3), 1439-1443.

[10]. Gottala A, shaikYajdhani, D. (2015), “Comparative Study of Static and Dynamic seismic Analysis of Multistoried Building”, *IJSTE-InternationalJournal of Science Technology & Engineering*, *2*(01July2015).

[11]. Lalit Balhar, Dr. J.N. Vyas, “Comparative Analysis of Flat slabs & Conventional RC slabs with and without Shear wall”,*InternationalResearch Journal of Engineering and Technology (IRJET) Issue 01, Vol 6 (January 2019).*

[12]. Lalit Balhar, Dr. J.N. Vyas, “Review paper on Comparative Analysis of Flat slabs & Conventional RC slabs with and without Shear wall”,*International Journal of Engineering and Technology (IRJET) Issue 02, Vol 6 (February 2019).*

[13]. Dhiraj Kaul, SagarJamle, Lalit Balhar, “An Immense Review on Comparative Analysis between Regular & Irregular Multistoried Building Under Seismic loading “,”,International Journal of Advanced Engineering Research and*Science* Vol-7, Issue-11, Nov- 2020, ISSN:2349-6495(P),2456-1908(O), PP-305-309. https://dx.doi.org/10.22161/ijaers.711.25

[14]. Standard, I. (1893). Criteria for earthquake resistant design of structures. *Bureau of Indian Standards, Part, 1*.

[15]. IS-875-1987. "Indian Standard code of practice for structural safety loadings standards part-1,2 " Bureau of Indian Standards, New –Delhi

[16]. IS-456-1978 and IS-456-2000."Indian Standard of code and practice for plain and Reinforced concrete "Bureau of Indian Standards, New Delhi-2002.