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SEISMIC ANALYSIS FOR DIFFERENT RCC FRAME SYSTEMS

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ABSTRACT

The main use of shear walls and bracing systems in a structure enables the reduction in lateral forces. In Reinforced concrete buildings steel bracing and shear wall system are most effective measures for resisting the lateral forces like seismic and wind forces, since it increases the strength and stiffness of RC buildings. The present study is based on seismic analysis of reinforced concrete (RC) building frames with fixed base condition. Analysis for RC building frame of different shapes (C, L and Rectangle) with and without shear walls and bracing systems are carried out using response spectrum method. In this paper, a 13 storey building situated in zone V has been considered and modeled in E-Tabs software for the parameters like storey displacement, drift, base shear, time period and frequencies, storey forces etc.

Keywords: ETABS-2017, Shear Wall, Response Spectrum Method, Displacement, Drift, Time Period, Base Shear And Steel Bracing.

I. INTRODUCTION

In India due to increase in population, the demand of land for housing is increasing day by day. To fulfill the need of the land for housing and , offices and commercial buildings , vertical development that is multi-storey buildings are the only option. Today's high rise buildings become plenty and plenty of slender, leading to the plenty of sway as compared with earlier high-rise buildings. This type of development requires safety because these multi-storey buildings are highly susceptible to additional lateral loads due to earthquake and wind. It means, as the elevation of building increases, its reaction to lateral loads increases. Multi-storey reinforced concrete buildings are vulnerable to excessive deformation, which necessitate the introduction of special measures to decrease this deformation. This has brought more challenges for the engineers to take care of gravity masses along with lateral forces, Seismic zones play a role in the design of high rise buildings. Lateral force resisting system absorbs the lateral forces acting throughout the earthquake and can increase the stiffness of the structure and to make the structure earthquakes resistant. It is vital for the structure to possess adequate strength against vertical masses and also adequate stiffness to resist lateral masses. Hence the study on various forms of lateral force resisting system is implausibly necessary to understand and knowing which sort of system provides higher performance under wind and seismic activity.

Bracing system in a Multi-storey reinforced concrete building is one of the lateral load resisting system. Shear wall provides the best earth quake resistant design because of its higher seismic weight that increases the stiffness of the structure compared to other systems like braced system, outrigger, diagrid system. In this paper a comparative study of different lateral load resisting systems with shear wall and bracing system on different shapes of building, such as C, H, L, T, and Rectangular of 13 storey height is made using response spectrum analysis in ETABS software and parameters like fundamental time period, base shear, storey drift and storey displacement of the building and compared with the building with fixed base and with steel bracing/shear walls at the corners. The load and load combination are considered as per code IS 875(Part -2): 2015 (live load), part 3-for wind load, IS 1893 (Part -1):2016 for earth quake.

II. METHODOLOGY

The study is done comparing the different lateral load resisting systems; shear wall and bracing system on different shapes of building, such as C, L, Rectangular type, for 13 storey building using response spectrum analysis in ETABS software.

- Comparing the parameters like storey displacement, Storey drift, time period and frequencies, design lateral forces, base shear with different shape of building.

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- The study mainly focuses on determining the most effective shape which might resist both wind load and seismic load.
- Analysis will be for both wind and earth quake zone V as per code IS 875(Part -3): 2015 and IS 1893 (Part -1):2016.

The lateral systems adopted for the modeling are basically of 3 types namely,

1. Bare frame
2. With Shear wall at corners
3. With Steel bracings at corners.

Table 1: Details of the building

Plan Area	28 m × 21 m
Shape of Building	T, C, H, L, RECTANGULAR
Bay In X Direction Y Direction	4 m 3.5 m
No of Stories	13
Floor To Floor Height	3 m
Grade of Concrete	30 N/mm²
Grade of Steel	HYSD 415 N/mm²
Beam Size	300 mm × 450 mm
Column Sizes: GF –Story 4: C1 Story 5 – Story 9: C2 Story 10 –Story 12 :C3	 300 mm × 900 mm 300 mm × 600 mm 300 mm × 300 mm
Thickness of Shear Wall	230 mm
Steel bracing	ISMB 300
Slab Thickness	150 mm
Seismic Zone	V
Zone Factor	0.36
Importance Factor	1
Response Reduction Factor	5
Damping	5%
Live Load As Per Is 875 Part -2 LL Bellow Roof Live Load on	 2.5 kN/m² 3 kN/m²
Floor Finish	1.5 kN/m²
Soil Type	MEDIUM SOIL
Unit Weight of Concrete	25 kN/m³
Unit Weight Brick Masonry	20 kN/m³

III. MODELING AND ANALYSIS

Modeling of RCC frames

1. C type frame building

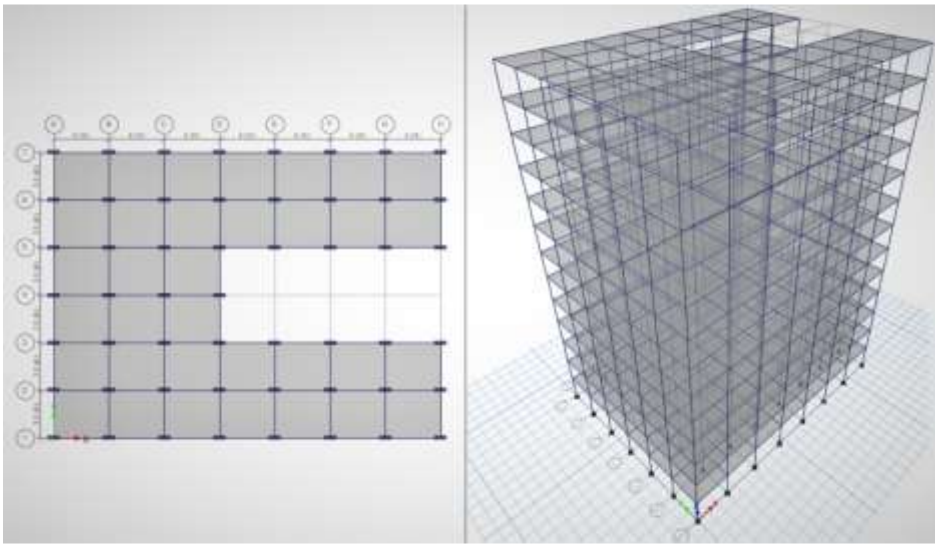

Fig 1: C Type bare frame

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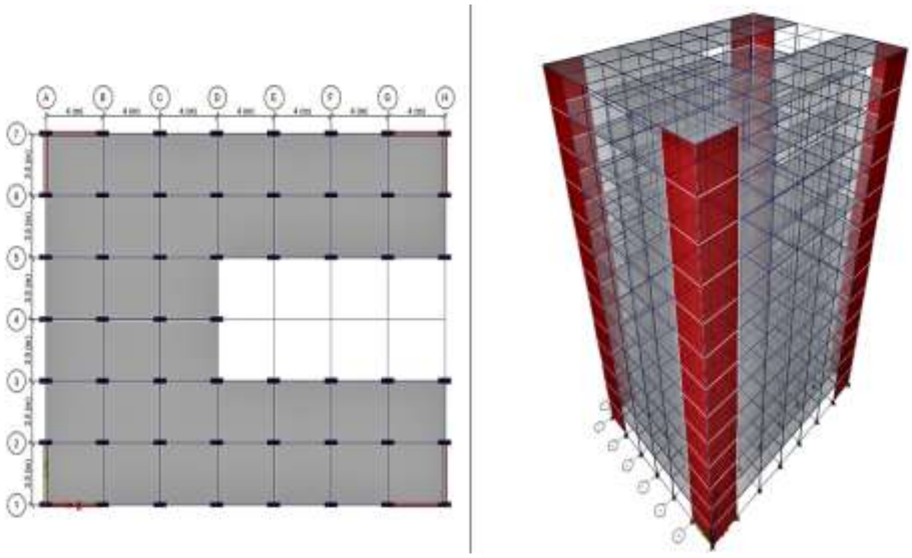

Fig 2: C frame with shear wall at corner

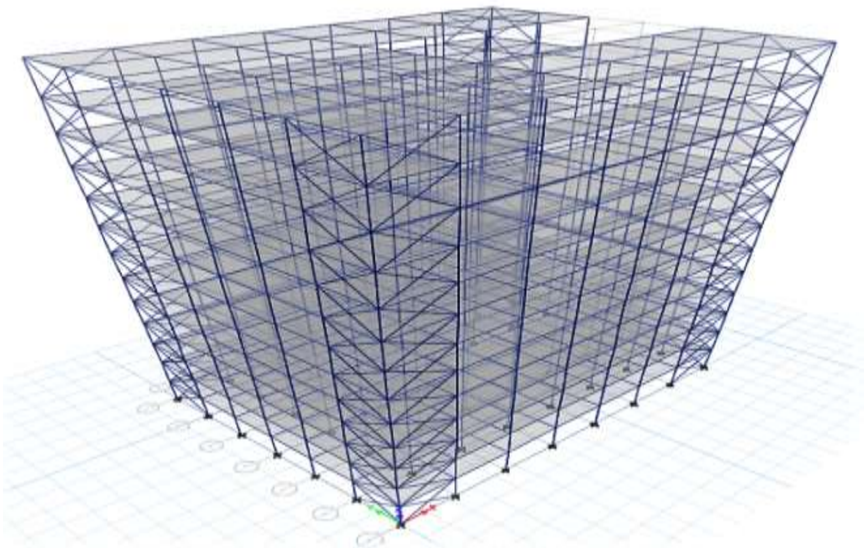

Fig 3: C - frame with steel bracings at corner

2. L -Type frame

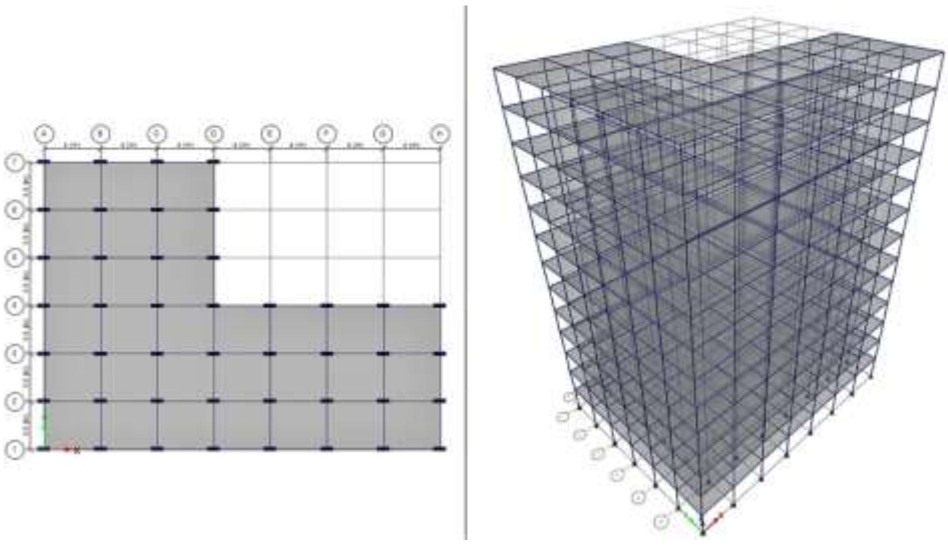

Fig 4: L Type bare frame

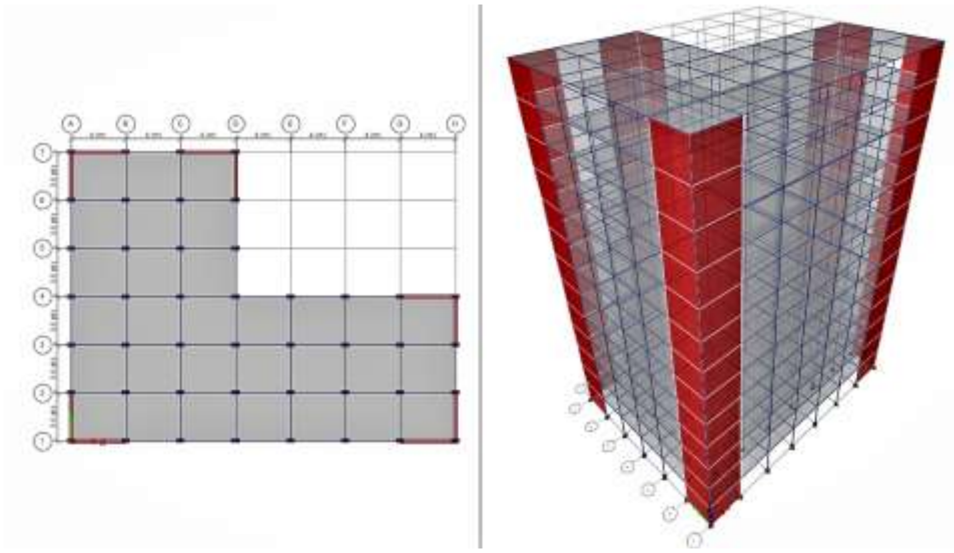

Fig 5: L Type with shear wall at corner

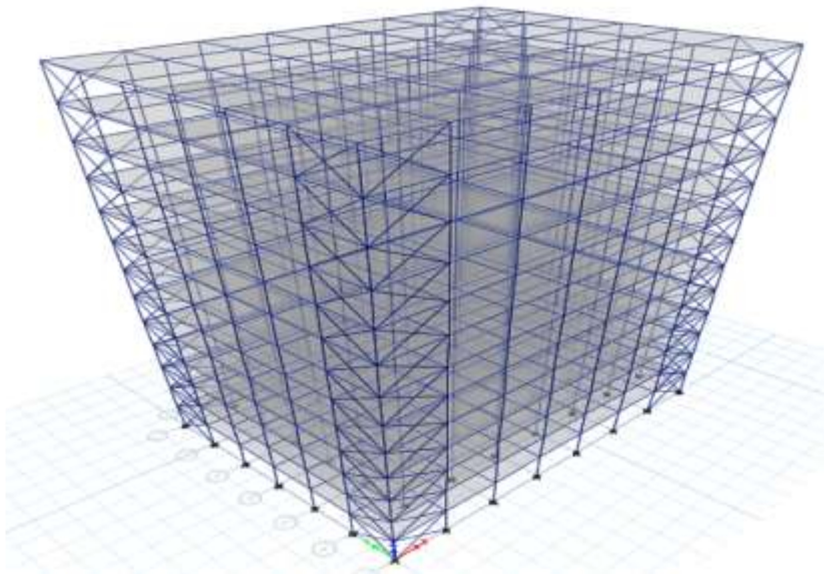

Fig 6: L - frame with steel bracings at corner

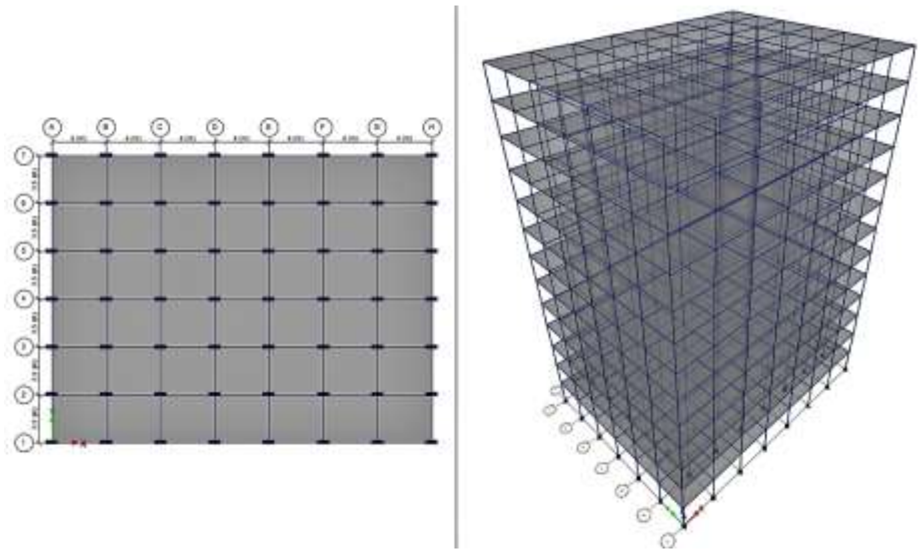

Fig 7: Rectangular bare frame

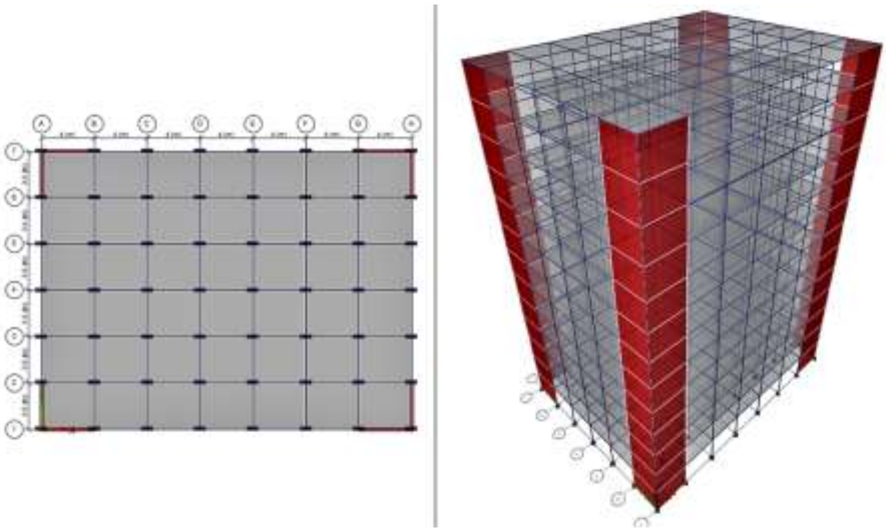

Fig 8: L Type with shear wall at corner

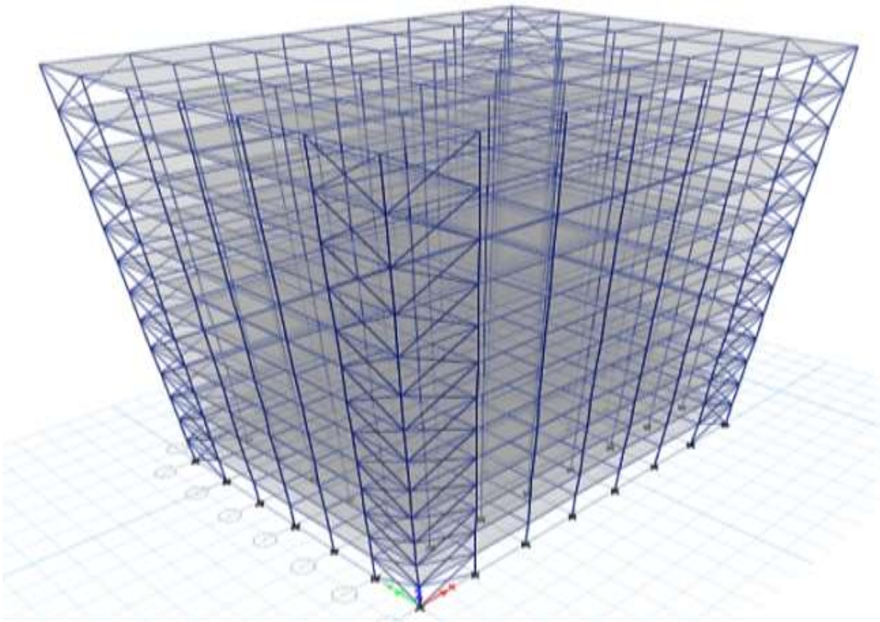

Fig 9: Rectangular frame with steel bracings at corner

IV. RESULT AND DISCUSSION

The fundamental time period for all models obtained from the modal analysis, which calculates the time period on the basis of mass and stiffness of the structure. IS 1893 (Part 1): 2002 gives the formulae for calculating the natural time period for RC frames without brick infill panels. i.e. $T_a=0.075h^{0.75}$

The loading due to earthquake shall be assessed based on the provisions of IS1893:2016(part1). Structural analysis shall be done using response spectrum method by giving input for different time periods and acceleration.

Earth quake zone =	5.0	// FIG : 1 IS : 1893 (PART -I) - 2016 //
Seismic intensity =**Z** =	0.36	// TABLE - 2 IS : 1893 (PART -I) - 2016 //
Response reduction factor = RF=	5.0	// TABLE - 7 IS : 1893 (PART -I) - 2016 //
Importance factor -(I) -	1	// TABLE - 6 IS : 1893 (PART -I) - 2016 //
Damping percent - (DM) -	0.05	// TABLE - 3 IS : 1893 (PART -I) - 2016 //

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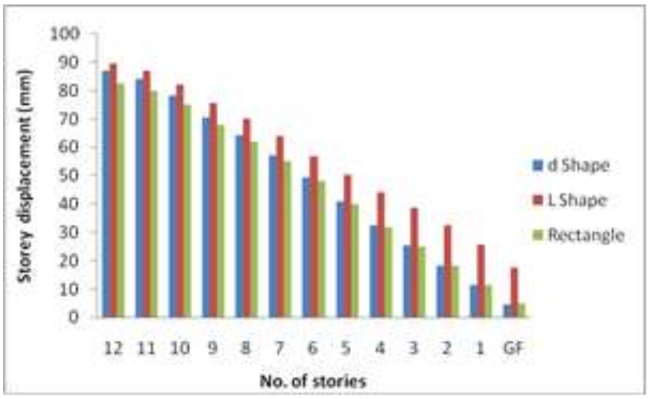

Fig 10: Storey displacement with bare frame in Y-direction

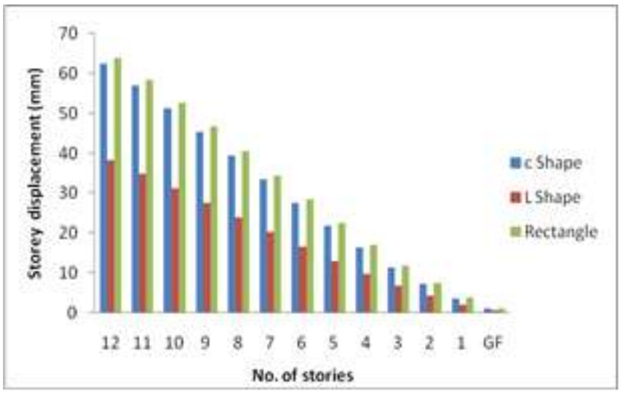

Fig 11: Storey displacement with shear wall in Y-direction

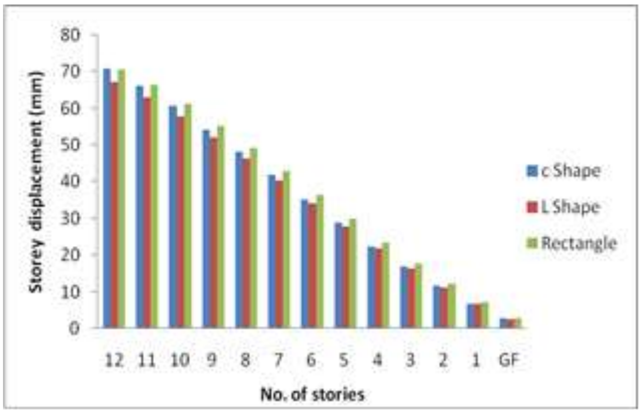

Fig 12: Storey displacement with steel bracings in Y-direction

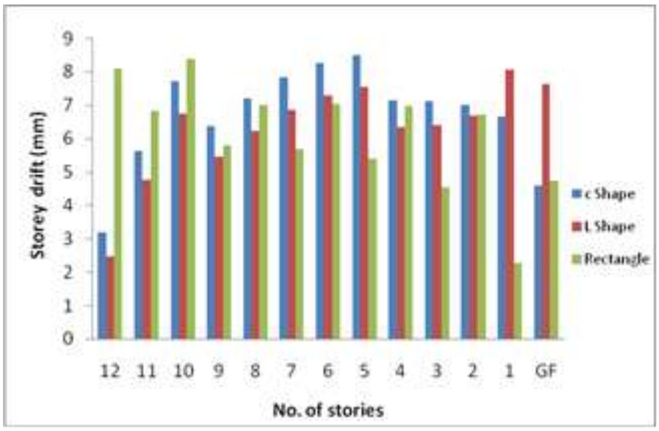

Fig 13: Storey drift with bare frame in Y-direction

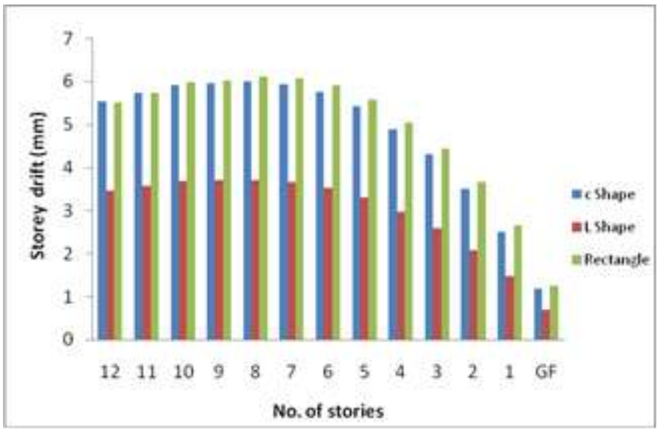

Fig 14: Storey drift with shear wall in Y-direction

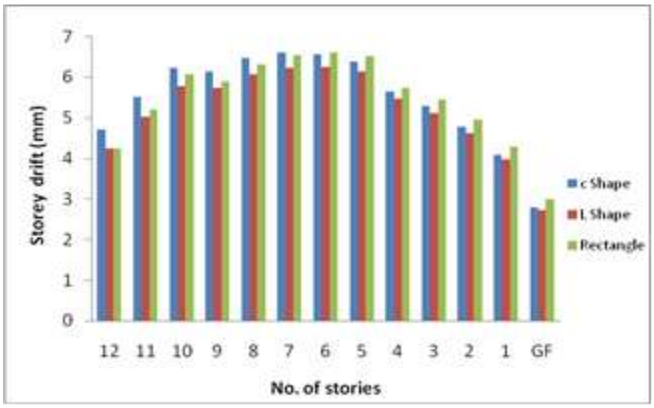

Fig 15: Storey drift with steel bracings in Y-direction

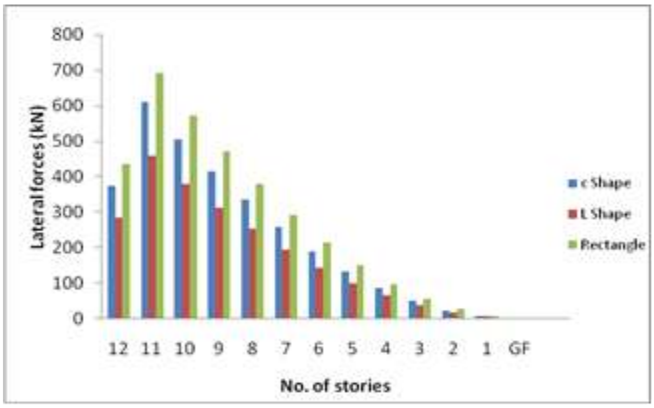

Fig 16: Lateral forces with bare frame in Y-direction

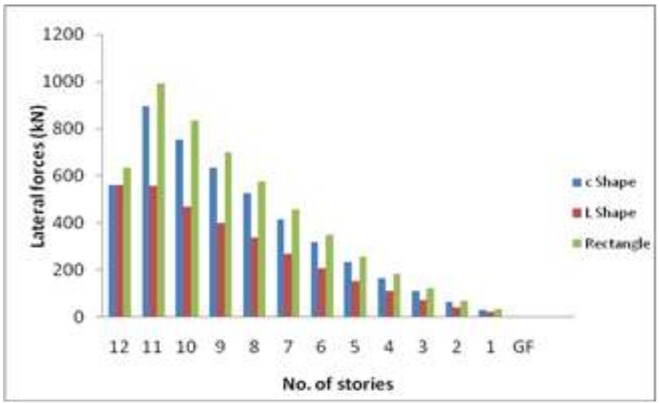

Fig 17: Lateral forces with shear wall in Y-direction

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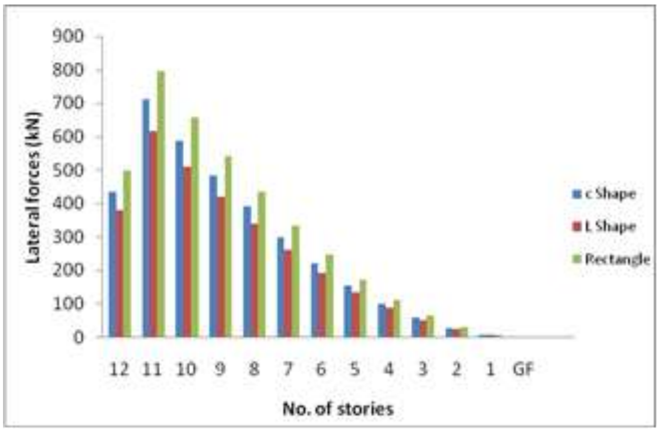

Fig 18: Lateral forces with steel bracings in Y-direction

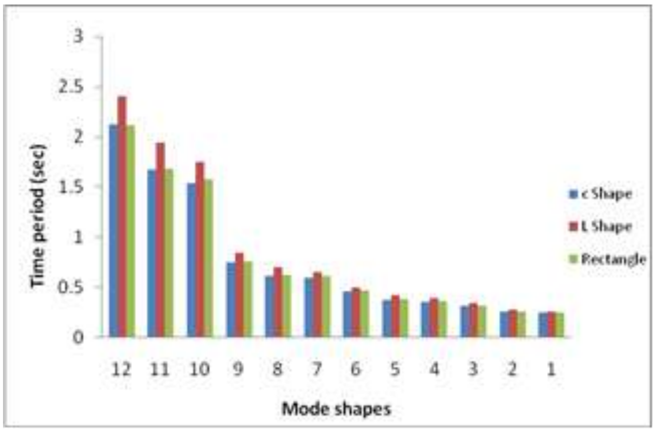

Fig 19: Time period with bare frame in Y-direction

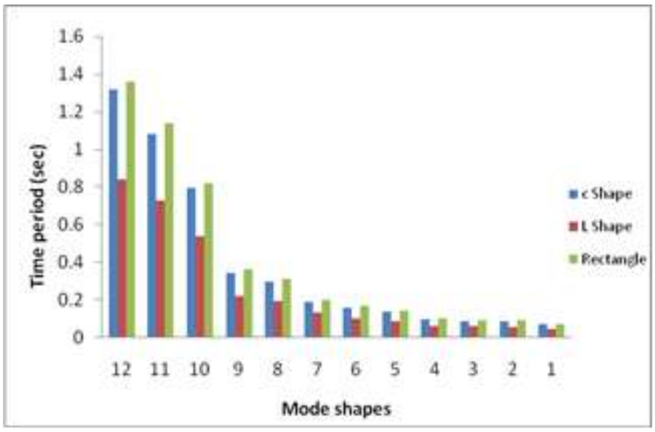

Fig 20: Time period with shear wall in Y-direction

1. **Storey Displacement**

- Building without shear wall and bracing system show a maximum storey displacement in L shape that is 73.73 mm in horizontal x and 89.46 mm in vertical y with minimum storey displacement in C shape i.e. 65.58 mm in horizontal X direction and 87.11 mm in vertical y.
- Building with shear wall at corner show a maximum storey displacement in Rectangular shape i.e. 53.53 mm in horizontal X and 63.87 mm in vertical y and minimum storey displacement in L shape i.e. 32.47 mm in x direction and 38.34 mm in vertical y.
- Building with X bracing at corner show a maximum storey displacement in Rectangular shape i.e. 58.351 mm in horizontal X and 70.706 mm in vertical y and minimum storey displacement in T shape i.e. 55.5 mm in x direction and 64.401 mm in vertical y.

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2. Storey Drift

- Building without shear wall and bracing system show a maximum storey drift in Rectangular shape i.e. 9.063 in horizontal X and 7.275 in vertical y and minimum storey drift in T shape i.e. 6.385 in x direction and 8.384 in y direction.
- Building with shear wall at corner show a maximum storey drift in Rectangular shape i.e. 5.187 in x direction and 5.965 in vertical y and T shape i.e. 5.097 in horizontal X and 5.948 in y direction for minimum storey drift in L shape i.e. 3.175 in x direction and 3.677 in y direction.
- Building with X bracing at corner show a maximum storey drift in Rectangular shape i.e. 5.925 in horizontal X and 6.064 in vertical y and minimum storey drift in L shape i.e. 5.546 in x direction and 5.769 in y direction.

3. Design Lateral Forces

- Building without shear wall and bracing system show a maximum Design Lateral Forces in Rectangular shape i.e. 691.05 kN in horizontal X and 514.18 kN in y direction and minimum Design Lateral Forces in L shape i.e. 458.55 kN in x direction 334.68 kN in vertical y.
- Building with shear wall at corner show a maximum show a maximum Design Lateral Forces in H shape i.e. 1464.50 kN in horizontal X and 1365.68 kN in y direction and minimum Design Lateral Forces in L shape i.e. 554..92 kN in x direction and 468.34 kN in vertical y.
- Building with X bracing at corner show a maximum show a maximum Design Lateral Forces in Rectangular shape i.e. 794.57 kN in horizontal X and 634.72 kN in y direction and minimum Design Lateral Forces in L shape i.e. 616.39 kN in x direction and 500.83 kN in vertical y.

4. Time Period

- Building without shear wall and bracing system show a maximum Time period in L shape is 2.40 sec and minimum time period in H shape is 2.02 sec.
- Building with shear wall at corner show a maximum Time period in Rectangular shape is 1.358 sec and minimum Storey Time period in L shape is 0.838 sec.
- Building with X bracing at corner show a maximum Time period in Rectangular shape is 1.715 sec and for L shape is 1.613 sec and minimum Time period in H shape is 1.588 sec.

V. CONCLUSION

On comparing the results of storey displacement, storey drift, design lateral forces, time period and frequencies of all the shapes of building such as C, L and Rectangular for all three cases such as case-1 (building without shear wall and bracing system), case-2 (building with shear wall at corner), case-3 (building with X bracing at corner) the following conclusions were drawn:

- Storey displacement of L shape building shows a maximum storey displacement in case-1 i.e. 73.73 mm in x direction and 89.46 mm in y direction. After providing shear wall at corner it will reduces storey displacement i.e. 55.96% in x direction and 57.14% in y direction. After providing bracing system at corner of building it reduces storey displacement up to 23.06% in x direction and 24.98 % in y direction.
- Storey displacement of Rectangular shape building shows a maximum storey displacement in case-1 i.e. 67.91 mm in x and 82.41 mm in y direction. After providing shear wall at corner it will reduces storey displacement i.e. 21.17% in x direction and 22.5% in y direction. After providing bracing system at corner of building it reduces storey displacement up to 14.07% in x direction and 17.50% in y direction.
- Storey drift of L and rectangular shape building shows a maximum storey drift in case-1 i.e. for L shape 8.197 in x and 6.739 in y direction and for rectangular shape building 9.063 in x and 7.275 in y direction. On comparing the above results L shape building with shear wall at corner shows maximum percentage of reduction in storey drift i.e. 61.26% in x and 45.43% in y direction. For bracing system, it will reduce storey drift of 32.34% in x and 14.4% in y direction.
- Storey drift for rectangular shape building with shear wall at corner shows maximum percentage of reduction in storey drift i.e. 42.76% in x and 18% in y direction. For bracing system, it will reduce storey drift of 34.62% in x and 16.64% in y direction.

- Design lateral forces for rectangular, L shape building shows a maximum design lateral forces i.e. for rectangular shape 691.05 kN in x and 514.18 kN in y direction and minimum for L shape building is 458.55 kN in x and 334.68 kN in y direction. Design lateral forces for rectangular shape building shows a less percentage reduction in case 2 i.e. 30% in x and 36.67% in y direction and for case 3 i.e. 19.73% in x and 36.67% in y direction Design lateral forces for L shape building shows a less percentage reduction in case 2 i.e. 17.36% in x and 28.54% in y direction and for case 3 i.e. 25.60% in x and 33.17% in y direction.
- Time period in case 1 has a maximum value in L shape, case 2 has a maximum value in H shape , case 3 has a maximum value in rectangular shape building. Providing shear wall at corner shows a maximum percentage reduction in L shape i.e. 65.08% comparing with rectangular shape i.e. 35.64%.
- On comparing the results obtain for different lateral load resisting system shear wall at corner is more effective in resisting lateral loads. And L shape building is more effective is more effective in comparing with other shapes of building.

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