

# Analysis of Shear Wall in High Rise Unsymmetrical Building Using Etabs

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**ABSTRACT:** Recent days, structures are becoming more and more slender and susceptible to sway and hence dangerous in the earthquake. Researchers and engineers have worked out in the past to make the structures as earthquake resistant. After many practical studies it has shown that use of lateral load resisting systems in the building configuration has tremendously improved the performance of the structure in earthquake. Shear walls are mainly flexural members and usually provided in high rise buildings to avoid the total collapse of the high rise buildings under seismic forces.

In present study, an unsymmetrical building with 20 stories has been modeled using software Etabs. The study includes the seismic vulnerability of RC buildings without shear wall, shear wall at corners, shear wall at boundaries, shear wall at interior. These models has been analysed by using equivalent lateral force method for moderate and severe seismic zones for hard and soft soil conditions as per earthquake load IS 1893(PART1):2002. From the results it has to be found that which location of shear wall will give better performance in two zones for hard and soft soil condition. From the analysis by comparing the load combinations the shear wall location at corner sides of the building gives less displacement values and it is very much effective in moderate zone for hard soil condition.

**KEYWORDS:** Etabs, equivalent lateral force method, shear wall, base shear.

## I. INTRODUCTION

India at present is fast growing economy, which brings about demands in increase of infrastructure facilities along with the growth of population. The demand of land in urban regions is increasing day by day. It is imperative that land available for farming and agriculture remains intact. To cater the land demand in these regions, vertical development is the only option. This type of development brings challenges to counteract additional lateral loads due to wind and earthquake. This demands changes in the current structural system which needs to be implemented to resist these forces. Much research has been carried which describes the suitability of various lateral load resisting system against deformation and shear exerted due to the earthquake and wind forces. To resist these lateral forces, shear walls are specially designed structural walls included in the buildings to resist horizontal forces that are induced in the plane of the wall due to wind, earthquake and other forces. They are mainly flexural members and usually provided in high rise buildings to avoid the total collapse of the high rise buildings under seismic forces. Shear wall has high in-plane stiffness and strength which can be used to simultaneously resist large horizontal loads and support gravity loads. The major criteria now-a-days in designing RCC structures in seismic zones is control of lateral displacement resulting from lateral forces. The effort has been made for investigate the effective location of shear wall for lateral displacement and base shear in RCC Frames.

In this study we have to analyse and design for unsymmetrical building with G+19 storeys are considered. In this study we have to place the Shear walls at different locations to the structure. An earthquake load is calculated as per IS1893-2002(PART-1) applied to G+19 storey R.C building under consideration of moderate and severe seismic zones for hard and soft soil conditions by using equivalent lateral force method. Seismic loads are taken from the code IS1893(PART 1):2002, and also for dead and live loads are taken from the codes Is 875-1987(PART 1, 2). From this we determine the displacement and base shear values. A commercial package ETABS has been used for analysing high-rise buildings for different zones. After analysing the buildings the result has been compared using tables & graph to find out the most optimized solution.

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## II. LITERATURE REVIEW

In this study shear walls, is considered as major earthquake resisting member **Chandurkar et al.,2013** presented a study on the location of the shear wall in multi storey building. It is observed that changing the position of shear wall will affect the attraction of forces, so that wall must be in proper position. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake. Shear wall are one of the excellent means of providing earthquake resistance to multistory reinforced concrete building[1].**Hiremath et al., 2014**.has presented a study on effective, efficient and ideal location of shear wall are considered for 25 storey building in zone IV. From results by providing shear walls at adequate locations substantially reduces the displacements due to earthquake, percentage of lateral drift and displacement also depends on the location of shear wall and its thickness[2]. Location of Different shapes of shear Walls in Unsymmetrical High Rise Buildings is necessary to find out the effectiveness of building **Murali Krishna et al.,2014** has studied the optimum location of shear wall in Unsymmetrical High Rise Buildings. In this study different shapes of shear walls are considered for 30 storey building they are Box Section, L – Section, U – Section, W – Section, H – Section and T – Section. From the analysis results it is observed that the provision of T-SHAPED shear wall has significant effect on storey drift and shows good performance in both equivalent static method and response spectrum method[3].**Abhijeet Baikerikar et al.,2014** has presented a study on Lateral load resisting systems of variable heights in all soil types of high seismic zones and the analysis is done by comparing the bare frame and different locations of shear wall. From results it is observed that as the building height increases Lateral displacements and drift increases. Compared to all other cases Bare Frame produces larger lateral displacements and drifts. Lateral displacements and drift is significantly lower after inserting shear wall in the bare frame. One of the important conclusions that can be made from the above study soil changes from hard there is massive increase in base shear, lateral displacements and lateral drifts are less compared to soft soil condition [4]. **Manohar et al.,2014**.Has presented a study on the analysis of seismic performance on high rise building with fifteen storeys in zone V by changing the location of shear wall for different soil conditions. By using Etabs software four different models were studied with different positioning of shear wall in building and three different type of models were analysed by considering the masonry infill. The observation of results will gives that Shear wall shear wall at periphery and sides of building are effective in resisting the seismic force and Lateral load effects on high rise buildings are quite significant and increase rapidly with increase in height[5].**B.N.Sarath et al.,2015** has study on different types of lateral structural systems they are Shear wall system, Braced frame system, Framed tube system, Tube in tube system, Bundled tube system are considered for 30, 40, 50 and 60 story structures. The analysis has been carried out using software Etabs. From the results it is seen that the Shear wall system gives less displacement values and it is very much effective in resisting lateral loads and it is economical compared to the other structural systems[6].**Syed Ehtesham Ali et al.,2015**. has Study on Strength of RC shear wall at different Location of six storey multi-Storeyed residential building subjected to earthquake loading in zone-II is considered. The analysis was performed using Etabs. The lateral deflection of column for building with corner shear wall is reduced as compared to all models with and without shear wall. It has been observed that the top deflection is reduced after providing shear wall of the frame in X-direction as well as in Y-direction is more efficient at corner sides[7].**Pavani et al.,2015** presented a study on shear wall shear wall design and optimization is done by using the software Etabs, the building consists of a G+44+terrace R.C.C. residential cum commercial building. The plan of the building is irregular in nature but considered as it is regular for easy analysis; it is located in Seismic Zone III and is founded on medium type soil. From the results it is observed that the presence of shear wall at all possible deflection positions there is possible of controlling the damage that may occur due to seismic forces[8].

In the present study, the main objective is to determine the optimum location of shear wall by taking unsymmetrical model plan of the building in moderate and severe seismic zones for hard and soft soil conditions. By using equivalent lateral force method we have to determine the lateral forces for two zones in hard and soft soil condition. To determine parameters of shear wall in moderate and severe zones of building such as time period, base shear and displacements. The load combinations were taken as per IS1893-2002(Part1) and the resulting displacements were studied and compared for hard and soft soil located in two zones.

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## III. METHODOLOGY

The Etabs software is used to develop 3D model and to carry out the analysis. The lateral loads which are applied to the buildings are based on the Indian standards by using equivalent lateral force method. The study is performed for seismic zone moderate and severe, as per IS 1893:2002 (Earthquake load) for two soil conditions, the plan of the model as shown in figure1.

**Equivalent static force method:** Depending on the location of the building site, identify the seismic zone and assign Zone factor (Z). Compute the seismic weight of the building (W). After that to determine the natural period of the building ( $T_a$ ) by using code IS-1893 (2002), Using  $T_a$  and soil type (I / II / III), compute the average spectral acceleration ( $S_a/g$ ). knowing Z,  $S_a/g$ , R and I compute design horizontal acceleration coefficient ( $A_h$ ) using the relationship, From that we determine the seismic base shear ( $V_B$ ) by the following expression:

$$V_B = A_h W$$

Where,  $A_h$  = Design horizontal acceleration spectrum value using the fundamental natural period  $T_a$  in the considered direction of vibration. W = Seismic weight of the building The design horizontal seismic coefficient  $A_h$  shall be determined by the following expression:

$$A_h = \frac{ZIS_a}{2Rg}$$

Where Z = Zone factor as per table 2 of code; I = Importance factor as per table 6 of code ;R = Response reduction factors: R=3 for OMRF[ordinary RC moment-resisting frame]and R=5 for SMRF[special RC moment-resisting frame] are taken from code

### A. BUILDING PLAN AND DIMENSION DETAILS

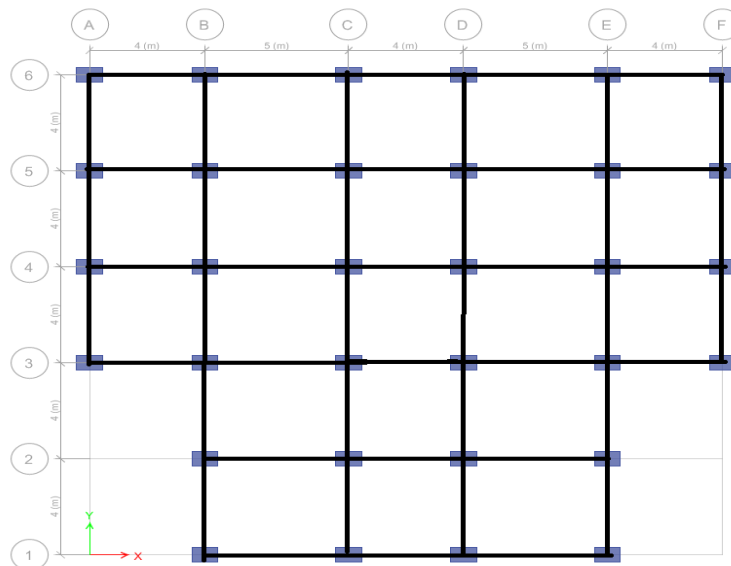


Figure 1. Plan of the model

### B. MODELLING

- Model 1: without shear wall as shown in figure 2
- Model 2: shear wall at corners as shown in figure3
- Model 3: shear wall parallel to x and y axis as shown in figure 4
- Model 4: shear wall at interior as shown in figure 5

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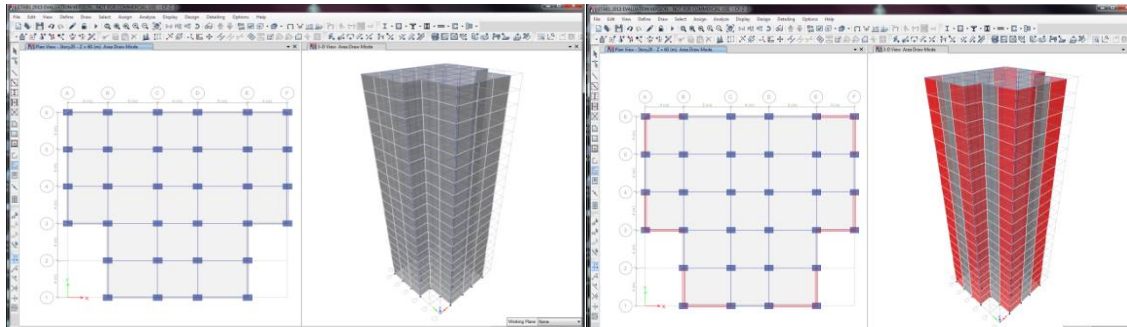


Figure 2: with out shear wall

Figure 3: shear wall at corners

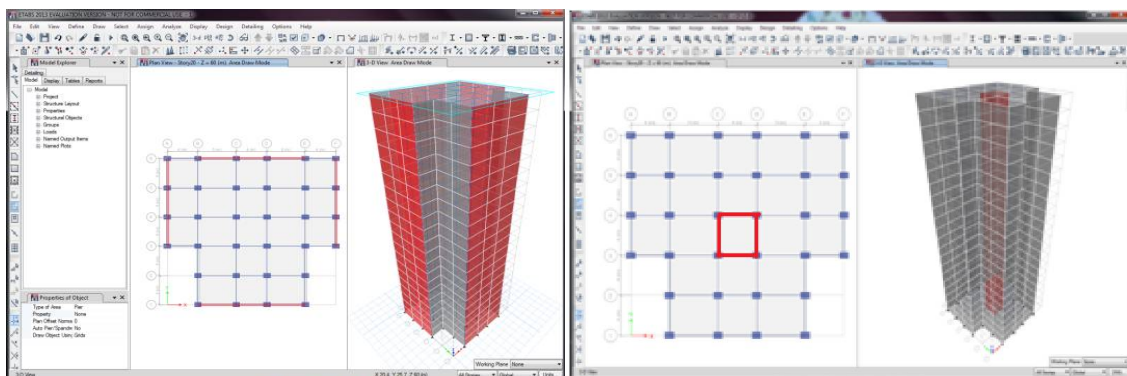


Figure 4: shear wall at parallel to x and y-axis

Figure 5: shear wall at interior

Table 1: Details and Dimension of the Building Models

Height of storey	3m
area of the building	376 m <sup>2</sup>
Height of the building	60m
Number of stories	20
Wall thickness	250mm
Slab Thickness	150mm
Grade of the concrete	M25
Grade of the steel	Fe 415
Thickness of shear wall	230mm
Support	FIXED
Column size	0.9X0.6m
Beam size	0.6x0.4m
Seismic zone(Z)	III&V
Type of soil	I&III
Importance factor (I)	1
Response reduction factor (R)	3&5

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**INPUT DATA:**

Loads have to be considered:

1. Dead load is taken as prescribe by the IS: 875 -1987 (Part-I)
2. Unit weight of R.C.C. = 25kN/m<sup>3</sup>  
Weight partitions = 2 kN/m<sup>2</sup>  
Wall load = 9kN/m<sup>2</sup>
3. Live load = 3 kN/m<sup>2</sup>

The effective weight at each floor will be =(Self weight +weight of partitions+0.25xL.L)  
=4+2+0.25x3  
=6.75kN/ m<sup>2</sup>

The analysis can be carried out on the basis of the external action, the behaviour of the structure or structural materials, and the type of structural model selected. Based on the height of the structure and zone to which it belongs to the type of analysis is pseudo static method or Equivalent static force analysis is selected in the soft ware. Depending on the location of the building site, identify the seismic zone and assign Zone factor (Z). Compute the seismic weight of the building (W).After that to determine the natural period of the building (T<sub>a</sub>) by using earth quake code. From analysis table 2: shows that the natural time periods (T<sub>a</sub>) for hard and soft soil conditions in moderate and severe seismic zones. From that we determine the base shear by knowing the seismic acceleration coefficient A<sub>s</sub> and the seismic weight of the building (W).

Table 2: Time periods for hard and soft soil conditions in two seismic zones obtained from Etabs

TYPE OF SOIL →	HARD SOIL		SOFT SOIL	
	Time period in (sec)		Time period in (sec)	
LOCATION OF SHEAR WALL ↓	ZONE III	ZONE V	ZONE III	ZONE V
Without shear wall	1.579	1.465	1.353	1.303
Shear wall at corners	1.093	1.095	1.094	1.092
Shear wall parallel to x and y axis	1.267	1.303	1.465	1.425
Shear wall at interior	1.269	1.267	1.257	1.207

The design base shear computed above shall be distributed along the height of the building as per the following expression:

$$Q_i = \frac{w_i^2 h_i^2}{\sum_{j=1}^n w_j^2 h_j^2}$$

From the analysis the lateral forces at each floor for the four models as shown below for moderate and severe seismic zones for hard and soft soil conditions by using Etabs software. The lateral forces of moderate and severe zone for soil conditions will be determined by the above formulae(Q<sub>i</sub>) as shown for four models obtained from Etabs soft ware fig 6,7 shows the lateral forces acting in zone III &V for hard soil conditions and fig 8,9shows the lateral forces acting in zone III &V for soft soil conditions. From the lateral forces we have to calculate the total base for the four models located in moderate and severe seismic zones for two soil conditions.

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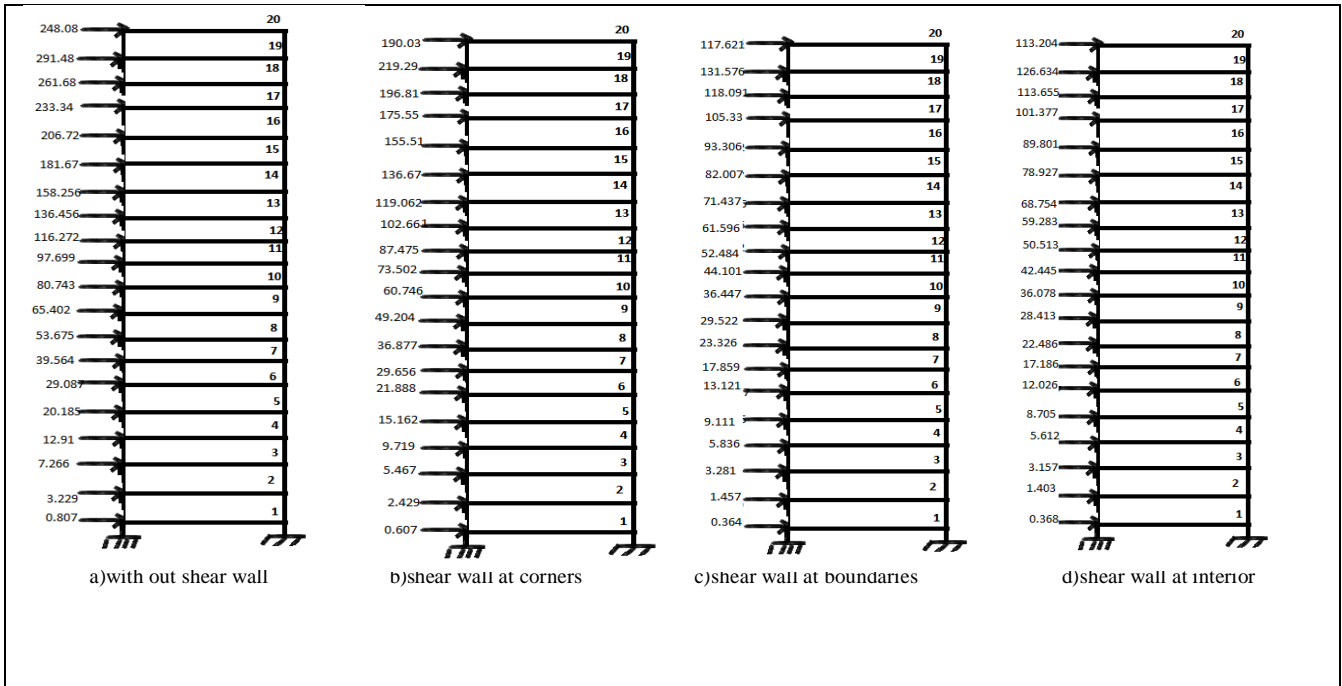


Fig 6: Lateral forces in zone III for hard soil condition for four models

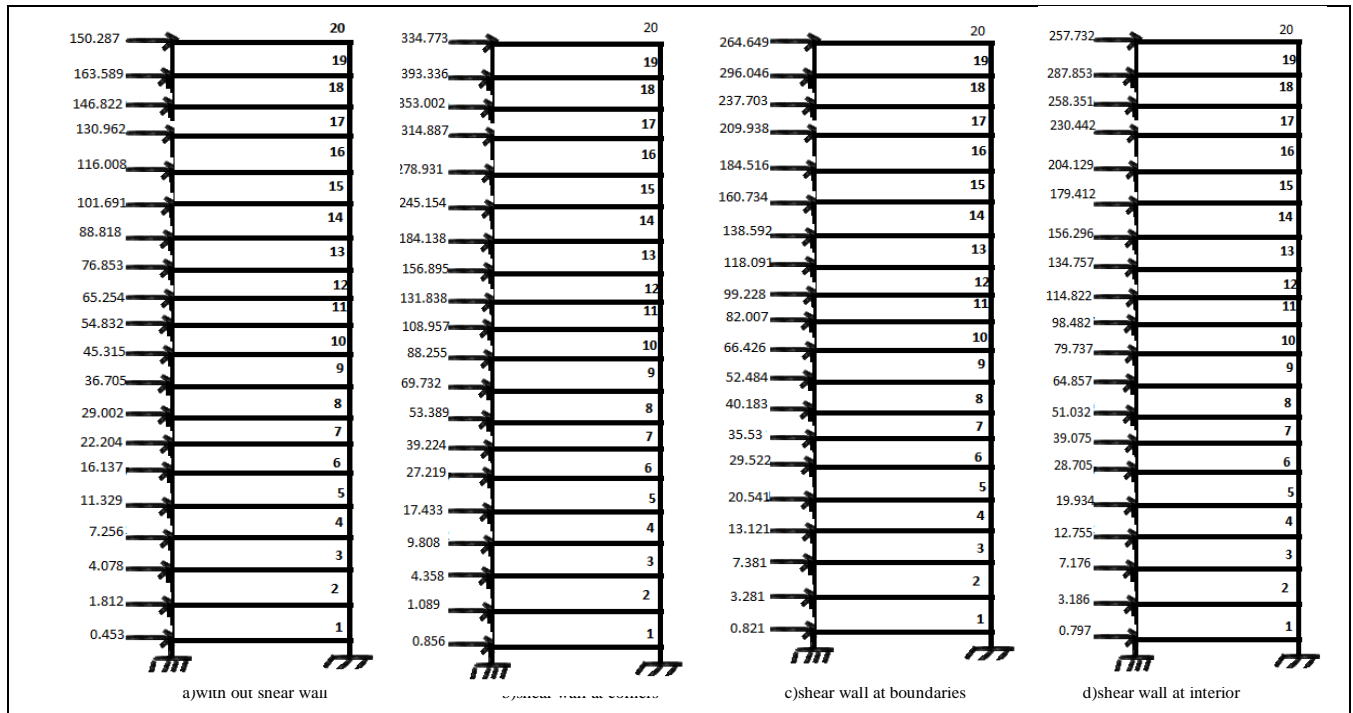


Fig 7: Lateral forces in zone V for hard soil condition for four models

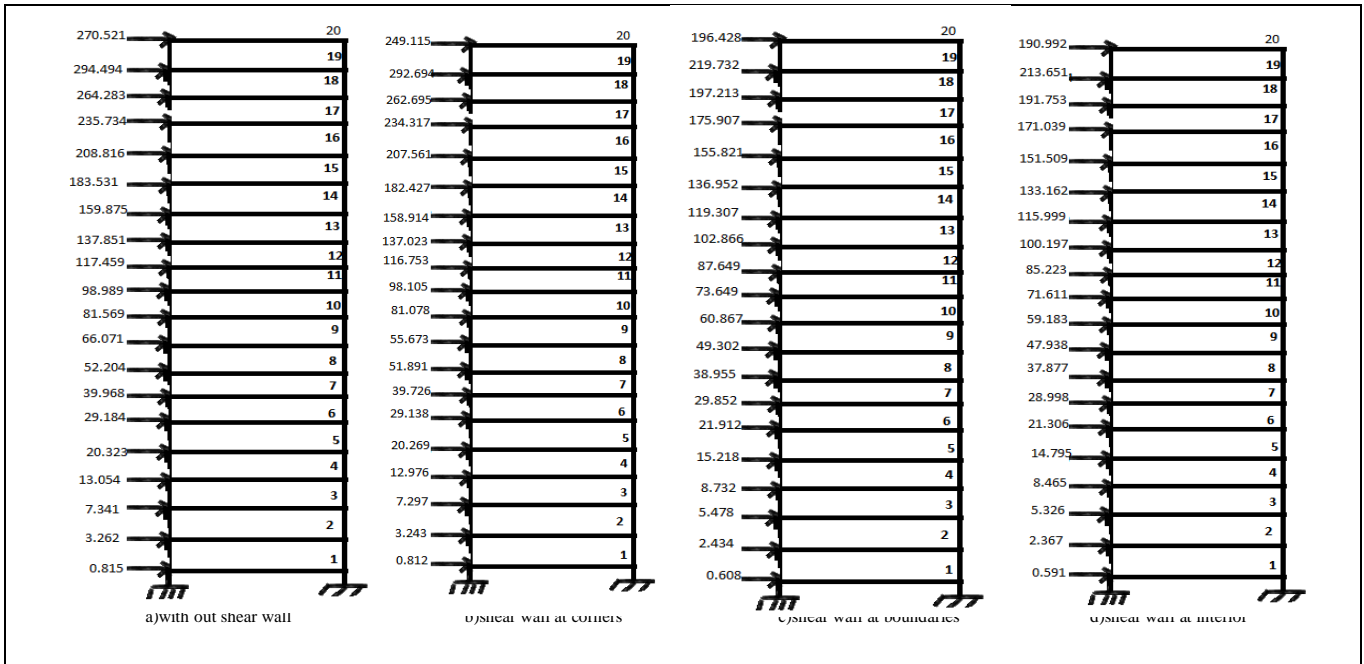


Fig 8:Lateral forces in zone III for soft soil condition for models

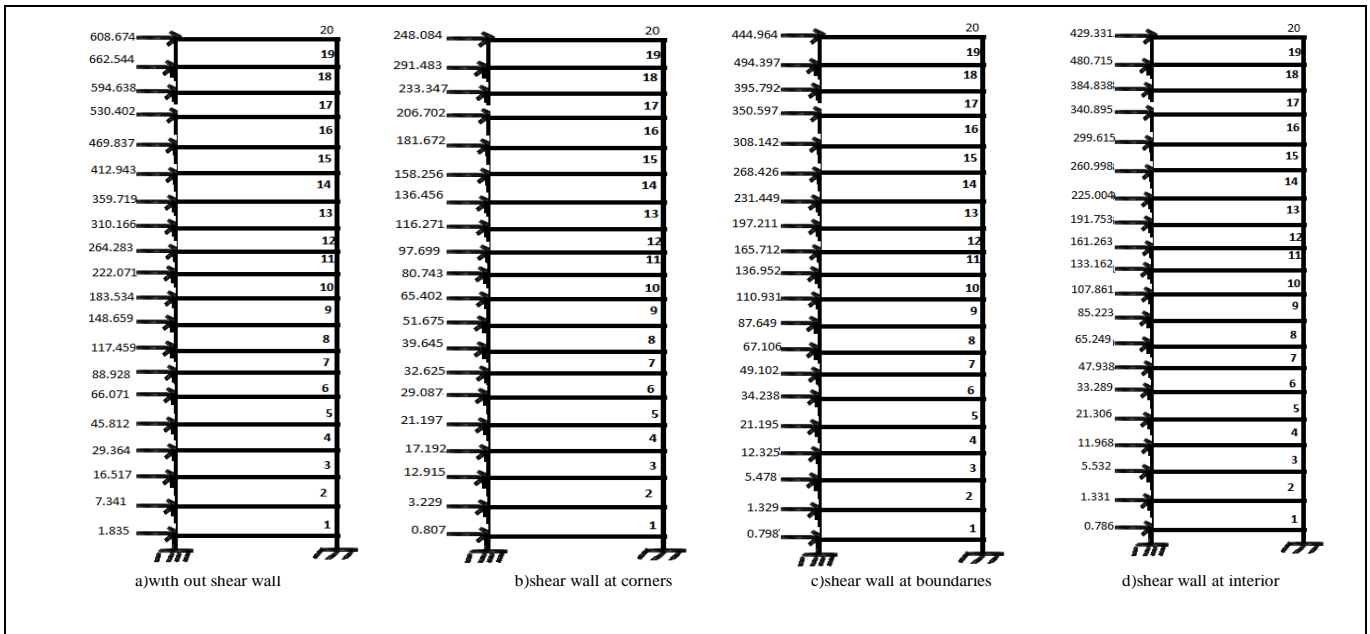


Fig 9: Lateral forces in zone V for soft soil condition for four models

By using the code IS 1893 (Part-I) –2002 The following load combinations have been considered for the analysis of building is located in Zone III &V by using Etabs software.

1. 1.2(DL+LL±EQX) 2. 1.2(DL+LL±EQY) 3. 1.5(DL ± EQX)
4. 1.5(DL±EQY) 5. 0.9DL±1.5EQX 6. 0.9DL±1.5EQY

**IV. RESULTS AND DISCUSSIONS**

Table 3: Base shear for hard and soft soil conditions in two seismic zones

TYPE OF SOIL→	HARD SOIL		SOFT SOIL	
	BASE SHEAR(kN)		BASE SHEAR(kN)	
LOCATION OF SHEAR WALL↓	ZONE III	ZONE V	ZONE III	ZONE V
Without shear wall	1676.4852	1699.5888	1752.8182	3141.8722
Shear wall at corners	2242.4416	3026.0261	2251.7633	4066.4874
Shear wall parallel to x and y axis	1779.8999	2296.8509	2395.2759	3718.8415
Shear wall at interior	1718.8804	2225.2308	1899.8602	3824.6855

The seismic base shear, it has been found that maximum base shear is occurred in the case of shear wall at corners along longitudinal and transverse direction, compared to without shear wall, shear wall at boundaries, shear wall at interior. For moderate and severe seismic zones the time period decreases with increase in base shear and coming to hard and soft soil condition base shear increases in soft soil condition subjected to seismic loads.

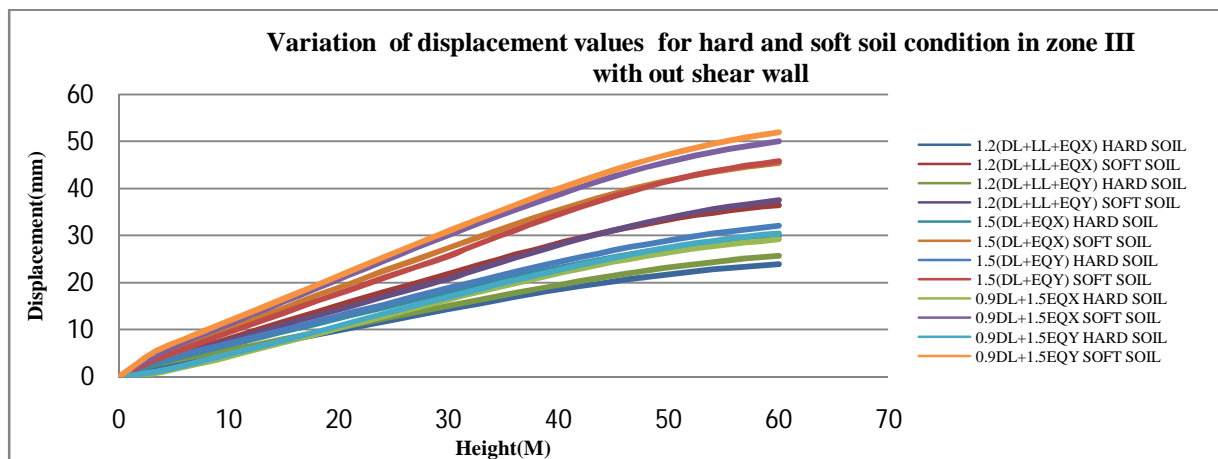


Fig 10: Displacement values for hard and soft soil conditions in zone III without shear wall

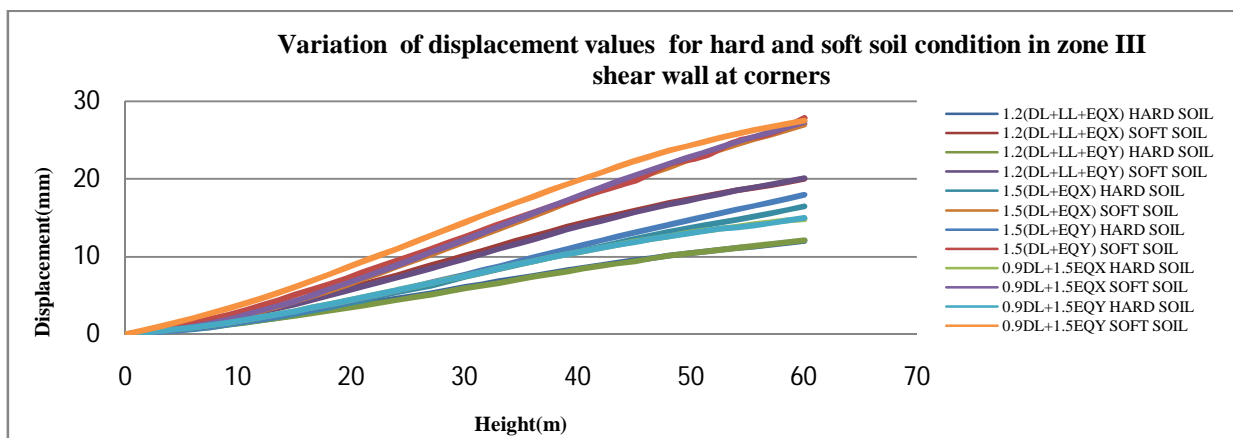


Fig 11: Displacement values for hard and soft soil conditions in zone III shear wall at corners



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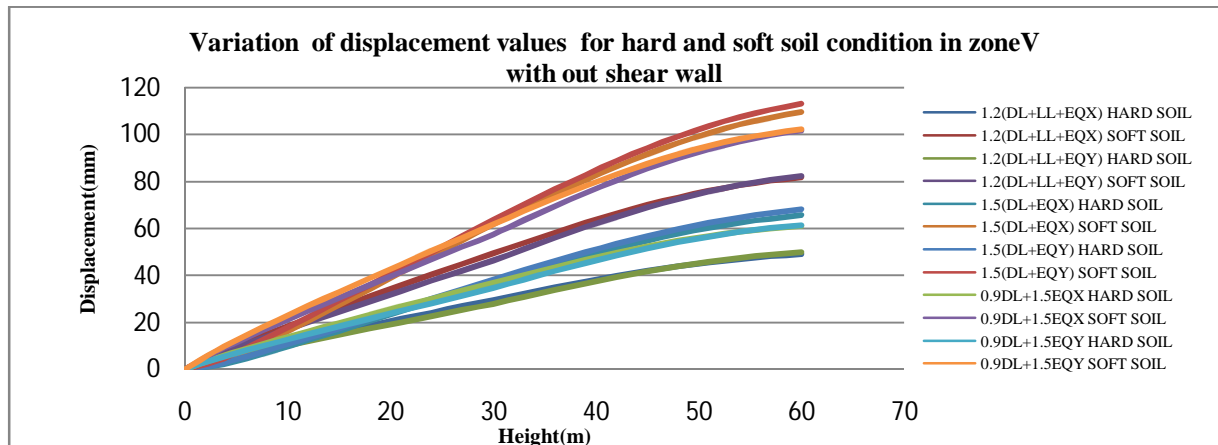


Fig:12 Displacement values for hard and soft soil conditions in zone V without shear wall

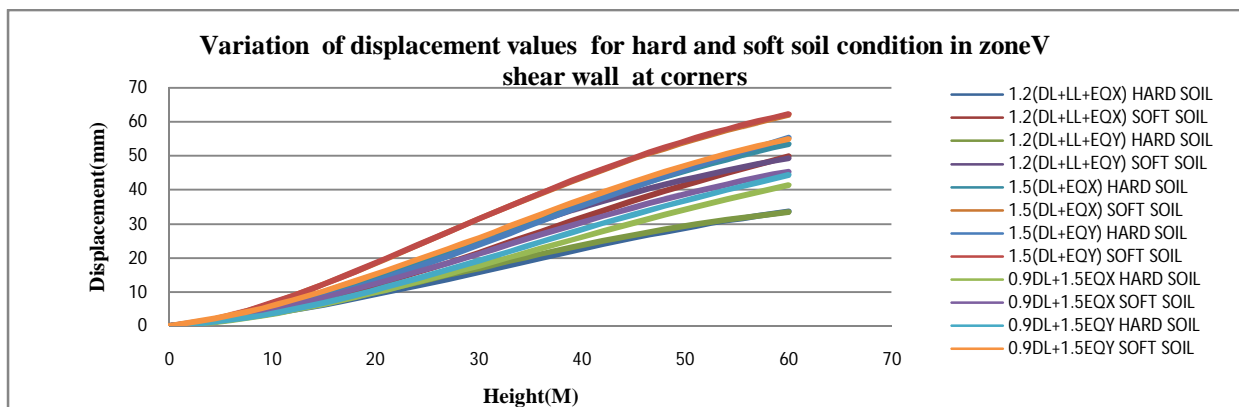


Fig 13: Displacement values for hard and soft soil conditions in zone V shear wall at corners

After the analysis of four models the displacement values are plotted for hard and soft soil condition in Zone III & V for the load combinations as per code IS 1893 (Part-I) – 2002. The present study makes an effort to evaluate the effect of shear wall at different location of building in zone III & V for hard and soft soil condition subjected to earthquake loads and imposed loads. From the above graphs it is observed that the maximum displacement values is increasing from first storey to last one for four models from this it is clear that the displacement values increases in two zones for two soil conditions in model1. Comparing to other three models by providing shear walls at corners gives less displacement values. From the results it is found to be that the load combination of 1.2(DL+LL± EQX) gives less displacement values by Comparing to other load combinations for soft and hard soil conditions in moderate and severe seismic zones in model 2. It has also been observed that combination of 1.5(DL±EQX) is more critical in both cases of two zones for hard and soft soil conditions. The maximum storey displacement is reduced when shear wall provided at corners gives better results in zone III&V for hard and soft soil conditions.

## V. CONCLUSION

In the present work the lateral structural system i.e., shear wall system considered for 20 story structure. Conclusions that can be made from the above study is by comparing the earth quake zones III&V for hard and soft soil conditions. From software analysis comparing to hard and soft soil conditions, there is a massive increase in base shear in soft soil condition. From the study it is clear that (shear wall at corners) gives less displacement values in hard soil condition for moderate and severe seismic zones. Providing shear wall at corners performing better and more efficient than all other

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cases. The provision of shear wall position in an appropriate location is advantageous and the structure performs better for an existing or a new structure.

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## INDIAN STANDARD CODES OF PRACTICE

- [1]IS: 875(part 1) -1987 Dead Loads on Buildings and Structures, New Delhi, India.
- [2]IS: 875(part 2) -1987 Live Loads on Buildings and Structures, New Delhi, India.
- [3] IS-1893(part 1):2002, Criteria for Earthquake Resistant Design of Structures

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