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# A STUDY ON BEHAVIOR OF RC SHEAR WALL IN A MULTI-STOREY BUILDING USING ETABS

**Shaheena Parveen** PG Student,Department of civil engineering,Dr.K.V.Subba Reddy Institute of Technology, Kurnool, AP, India

**B.K.Vishwanath** Assistant Professor Department of civil engineering,Dr.K.V.Subba Reddy Institute of Technology, Kurnool, AP, India

**ABSTRACT** Besides, food and clothing, shelter is a basic human need. India has been successful in meeting the food and clothing requirements of its vast population; however the problem of providing shelter of all is defying solutions. While there has been an impressive growth in the total housing stock from 65 million in 1947 to 187.05 million in 2001, a large gap still exists between the demand and supply of housing units. Constructions made of shear walls are high in strength ,they majorly resist the seismic force, wind forces and even can be build on soils of weak bases by adopting various ground improvement techniques. In the present analysis a building with a height of 50 meters is analyzed in ZONE-2 & ZONE-5 with three different soils. Displacement, shears, moments is compared with different zones & soils in both Static & Dynamic analysis. We are verifying and designing this structure using Extended Three Dimension Analysis of Buildings (ETABS) 2013software

**KEYWORDS :** ETABS, SHEARWALLS, HIGH RISE BUILDING.

## INTRODUCTION

### 1.1 Shear wall structures:

Sufficient solidness is to be guaranteed in elevated structures for imperviousness to parallel burdens instigated by wind or seismic occasions. Fortified solid shear dividers are intended for structures situated in seismic zones, in view of their high bearing limit, high flexibility and unbending nature. In tall structures, pillar and segment sizes work out expansive and support at the bar segment intersections are very substantial, so that, there is a considerable measure of stopping up at these joints and it is hard to put and vibrate concrete at these spots which does not add to the wellbeing of structures. These reasonable troubles call for presentation of shear dividers in High ascent structures.

Cement or stone work persistent vertical dividers may serve both compositionally as segments and basically to convey gravity and parallel stacking. There will be no engineering trouble in broadening them through the tallness of the building; their high in plane firmness and quality had turned out to be in a perfect world suited for opposing parallel burdens. Contrasted with outline sort structures, shear-divider structures offer less bending and less harm to non auxiliary components. Care might be taken to have symmetrical setup of dividers in the building so torsion impact in plan could be stayed away from.

In a shear divider structure, shear dividers are completely in charge of the parallel load resistance of the working because of seismic and wind loadings. These shear dividers go about as vertical cantilevers as isolated planar dividers, and furthermore as non planar congregations of associated dividers around stair case, lifts and administration shafts. Shear dividers are substantially stiffer on a level plane than inflexible edges. Shear dividers are much efficient up to around 35 stories. As opposed to the inflexible casings, the shear dividers' strong frame has a tendency to limit open inside spaces where required. Be that as it may, they are appropriate to inns and private structures where the floor by floor dreary arranging permits the shear dividers to be vertically consistent. They additionally serve brilliant acoustic and fire encasings amongst rooms and flats.

### Shapes or geometry of shear walls:

Shear walls are rectangle in cross section, i.e. one dimension is much larger than the other. While rectangular cross-section is frequent, L- and U-shaped sections are also used. Thin-walled hollow RC shafts around the elevator core of the structure also act as shear walls, and should be taken advantage of to resist earthquake forces.

The Shear Wall sections are classified as six types.

(a) Box Section
(b) L – Section
(c) U - Section
(d) W – Section
(e) H - Section
(f) T – Section

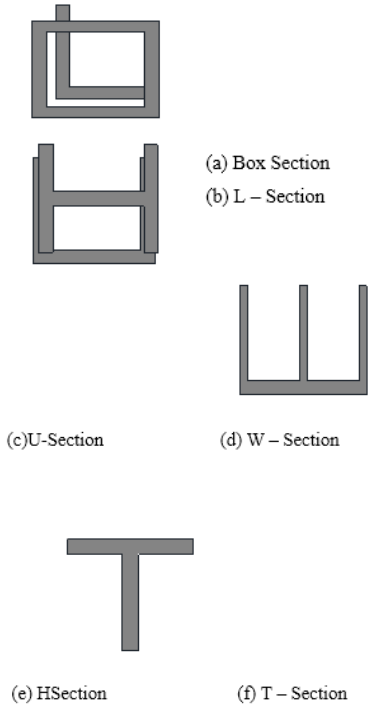



**Fig. Different shapes or geometries of shear walls**

The shape and location of shear wall have shown significant effect on their structural behaviour under lateral loads i.e. earthquake and wind loads. Lateral loads are distributed through the structure acting as a horizontal diaphragm, to the shear walls, parallel to the force of action. These shear wall oppose horizontal forces because their high rigidity as deep beams, reacting to shear and flexure against overturning effect. A core eccentrically located with respect to the building shapes has to carry torsion as well as bending and direct shear. However torsion may also develop in building symmetrical featuring of shear wall arrangements when wind acts on the facades of direct surface textures (i.e. roughness) or when wind does not act through the centre of building's mass.

## NUMERICAL MODELING AND ANALYSIS

### 5.1 Geometrical Properties:

Height of typical storey = 3.6 m
Height of ground storey = 3 m
Length of the building = 40 m
Width of the building = 30 m
Span in X- direction = 4 m
Span in Y-direction = 5 m
Height of the building = 107.4 m
Number of stores = 30
Wall thickness = 230 mm
Slab Thickness = 120 mm
Grade of the concrete = M40
Grade of the steel = Fe415
Thickness of shear wall = 230 mm
Support = fixed
Column sizes= 0.8 m X 1 m up to 8$^{th}$ story
0.9m X 0.8 m from 9$^{th}$ to 16$^{th}$ story
0.5 m X 0.7 m from 17$^{th}$ to 24$^{th}$ story
0.4 m X 0.5 m from 25$^{th}$ to 30$^{th}$
Beam sizes
0.4 m X 0.8 m up to 15$^{th}$ story
0.3 m X 0.6 m from 16$^{th}$ to 30$^{th}$ story

### Loads:

1. Live load

Live load from 1$^{st}$ floor to 30$^{th}$ floor =3 kN/m$^2$
Live load on 30$^{th}$ floor =1.5 kN/m$^2$

2. Dead load

Dead load is taken as prescribe by the IS: 875 -1987 (Part-I) [3] Code of Practice Design Loads (other than earthquake) for Buildings and structure.

Unit weight of R.C.C.= 25 kN/m$^3$
Unit weight of brick masonry=19 kN/m$^3$
Floor finish =1.5 kN/m$^2$
Water proofing=2 kN/m$^2$ on terrace roof
Wall load =13.8 kN/m on all floors expect terrace
Roof = 6.9 kN/m on terrace roof

### Wind load

The basic wind speed ($V_b$) for any site shall be obtained from IS 875(Part 3 -1987) [4] it is 44 m/sec and shall be modified to include the following effects to get design wind velocity at any height ($V_z$) for the chosen the structure.

Risk level Terrain roughness, height and size of structure, and Local topography It can be mathematically expressed as follows:

Vz = Vb K1.K2.K3 Eq. (4.1l) [5] Where,
Vz = design wind speed at any height **z**. in m/s
K1 = probability factor (risk coefficient) (Refer 5.3.1 of is 875(Part 3 - 1987))

K2 = terrain, height and structure size factor (Refer 5.3.2 of IS 875(Part 3 – 1987))

K3 = topography factor (Refer 5.3.3 of IS **875 (**Part 3 -1987))

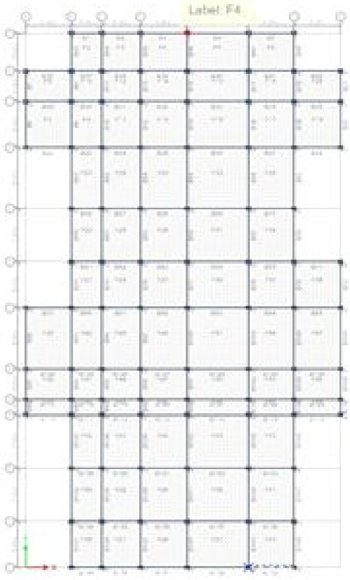
A) Wind Exposure parameters
Wind direction angle = 0 Degree
Windward coff. Cp = 0.8
Leeward coff Cp = 0.5
Wind coefficients
Wind speed = 39 m/s
Terrain category = 4
Structure class = C
Risk coefficient (k1) = 1
Topography (k3) = 1

### 3. Seismic loading

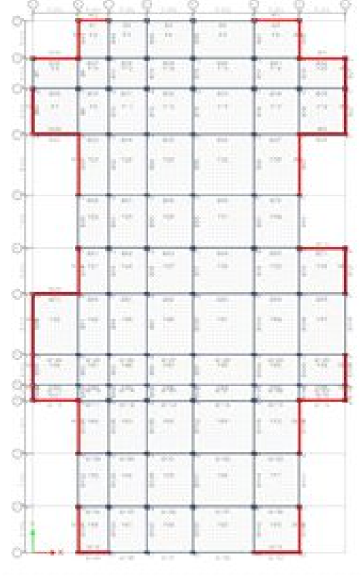
In the present work the building is located in Hyderabad which comes under –zone-II, using the IS 1893 (Part-I) – 2002(1) the following are the various values for the building considered.

Zone factor (Z): It is a factor to obtain the design spectrum depending on (lie perceived maximum seismic risk characterized by Maximum considered Earthquake (MCE) in the zone in which the structure is located. The basic zone factors included in this standard are reasonable estimate of effective peak ground acceleration. Zone factor = 0.24 (Zone-IV) (from IS 1893 (Part-I)-2002, Table.- 2).

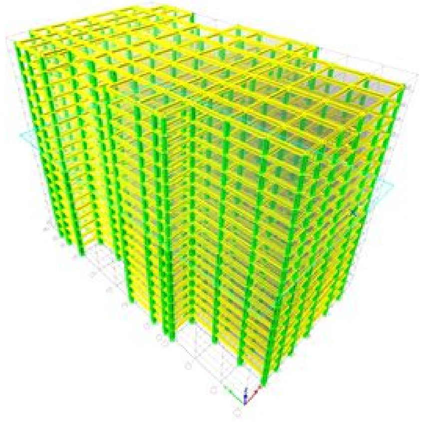
### Building models in E-tabs



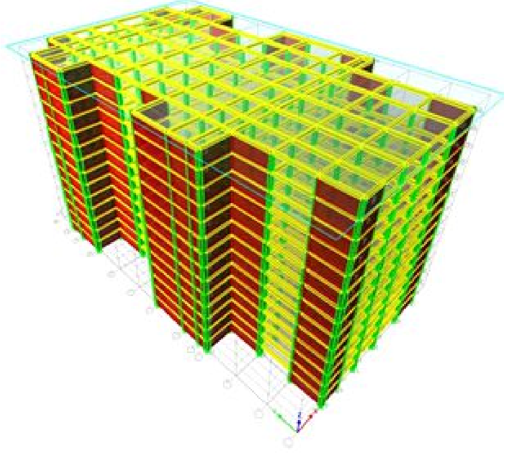
Plan view of residential building



Plan view of high rise building with SHEARWALL



3D view of high rise building with out SHEARWALL



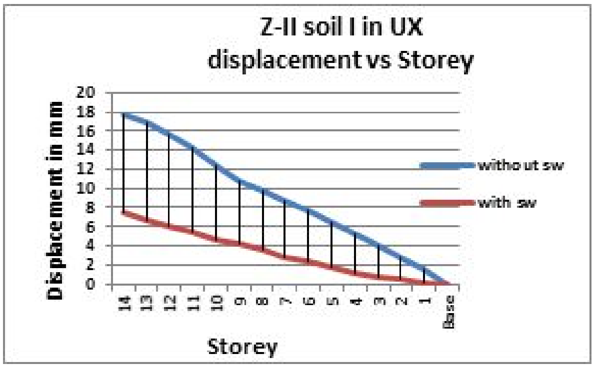
3D view of high rise building with SHEARWALL

**Results & discussions**

*Comparative study on displacement values for without shear wall & with shear wall*

**Table 1: Displacements of zone II soil-I under X-direction**

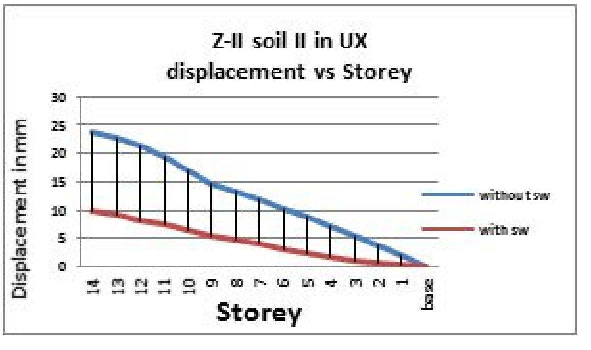
| zone II soil I | | |
|---|---|---|
| Storey | 1.2(dd+ll+eqx) | |
| | without sw | with sw |
| 14 | 17.6 | 7.4 |
| 13 | 16.9 | 6.7 |
| 12 | 15.7 | 6.1 |
| 11 | 14.2 | 5.4 |
| 10 | 12.4 | 4.7 |
| 9 | 10.8 | 4.1 |
| 8 | 9.8 | 3.5 |
| 7 | 8.7 | 2.8 |
| 6 | 7.6 | 2.3 |
| 5 | 6.4 | 1.7 |
| 4 | 5.2 | 1.2 |
| 3 | 3.9 | 0.8 |
| 2 | 2.7 | 0.5 |
| 1 | 1.5 | 0.2 |
| Base | 0 | 0 |




**Graph 1: Zone II soil-I displacement vs Storey under X-direction**

**Displacements of zone II soil-II under X-direction**

| zone II soil II | | |
|---|---|---|
| Storey | 1.2(dd+ll+eqx) | |
| | without sw | with sw |
| 14 | 23.9 | 10 |
| 13 | 22.9 | 9.1 |
| 12 | 21.4 | 8.2 |
| 11 | 19.3 | 7.3 |
| 10 | 16.9 | 6.4 |
| 9 | 14.7 | 5.5 |
| 8 | 13.3 | 4.7 |
| 7 | 11.8 | 3.9 |
| 6 | 10.3 | 3.1 |
| 5 | 8.7 | 2.3 |
| 4 | 7 | 1.7 |
| 3 | 5.3 | 1.1 |
| 2 | 3.7 | 0.6 |
| 1 | 2 | 0.3 |
| base | 0 | 0 |

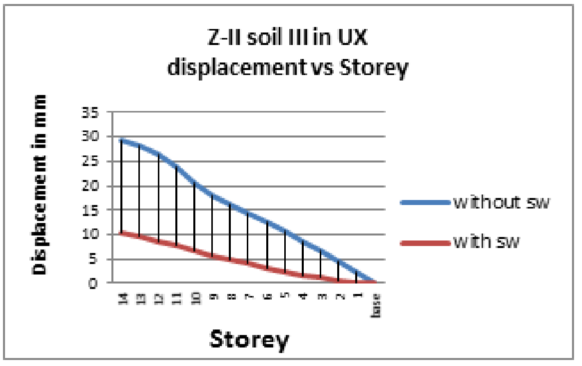



**Graph 3: Zone II soil-II displacement vs Storey under X-direction**

**Displacements of zone II soil-III under X-direction**

| zone II soil III | | |
|---|---|---|
| Storey | 1.2(dd+ll+eqx) | |
| | without sw | with sw |
| 14 | 29.3 | 10.5 |
| 13 | 28.2 | 9.6 |
| 12 | 26.3 | 8.6 |
| 11 | 23.7 | 7.7 |
| 10 | 20.7 | 6.7 |
| 9 | 18.1 | 5.8 |
| 8 | 16.3 | 4.9 |
| 7 | 14.5 | 4 |
| 6 | 12.6 | 3.2 |
| 5 | 10.6 | 2.4 |
| 4 | 8.6 | 1.8 |

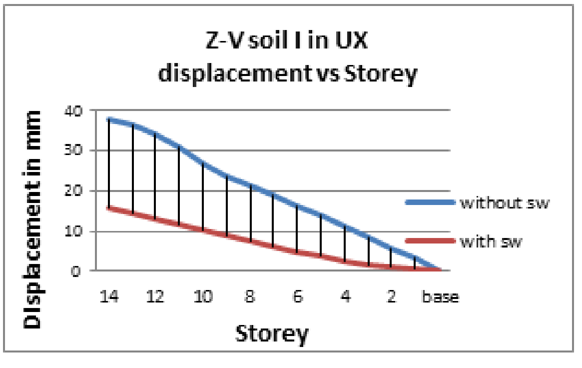
| | | |
|---|---|---|
| 3 | 6.6 | 1.2 |
| 2 | 4.5 | 0.7 |
| 1 | 2.5 | 0.3 |
| base | 0 | 0 |




**Graph 5: Zone II soil-III displacement vs Storey under X-direction**

**Displacements of zone V soil-I under X-direction**

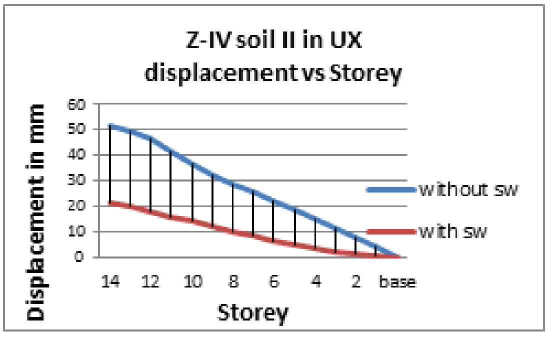
| zone V soil I | | |
|---|---|---|
| Storey | 1.2(dd+ll+eqx) | |
| | without sw | with sw |
| 14 | 38 | 15.9 |
| 13 | 36.4 | 14.5 |
| 12 | 34 | 13.1 |
| 11 | 30.7 | 11.7 |
| 10 | 26.8 | 10.2 |
| 9 | 23.4 | 8.8 |
| 8 | 21.1 | 7.5 |
| 7 | 18.8 | 6.1 |
| 6 | 16.3 | 4.9 |
| 5 | 13.8 | 3.7 |
| 4 | 11.1 | 2.6 |
| 3 | 8.5 | 1.7 |
| 2 | 5.8 | 1 |
| 1 | 3.2 | 0.5 |
| base | 0 | 0 |




**Graph 7: Zone V soil-I displacement vs Storey under X-direction**

**Displacements of zone V soil-II under X-direction**

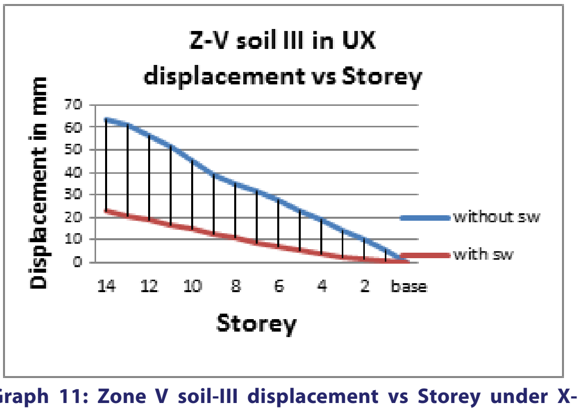
| zone v soil II | | |
|---|---|---|
| Storey | 1.2(dd+ll+eqx) | |
| | without sw | with sw |
| 14 | 51.6 | 21.6 |
| 13 | 49.5 | 19.7 |
| 12 | 46.2 | 17.8 |
| 11 | 41.7 | 15.9 |
| 10 | 36.5 | 13.9 |
| 9 | 31.8 | 12 |
| 8 | 28.7 | 10.1 |
| 7 | 25.5 | 8.3 |
| 6 | 22.2 | 6.6 |
| 5 | 18.7 | 5 |
| 4 | 15.2 | 3.6 |
| 3 | 11.5 | 2.3 |
| 2 | 7.9 | 1.3 |
| 1 | 4.4 | 0.6 |
| base | 0 | 0 |




**Graph 9: Zone V soil-II displacement vs Storey under X-direction**

**Displacements of zone V soil-III under X-direction**

| zone V soil III | | |
|---|---|---|
| Storey | 1.2(dd+ll+eqx) | |
| | without sw | with sw |
| 14 | 63.4 | 22.6 |
| 13 | 60.8 | 20.6 |
| 12 | 56.7 | 18.6 |
| 11 | 51.2 | 16.6 |
| 10 | 44.8 | 14.6 |
| 9 | 39 | 12.5 |
| 8 | 35.2 | 10.6 |
| 7 | 31.3 | 8.7 |
| 6 | 27.3 | 6.9 |
| 5 | 23 | 5.2 |
| 4 | 18.6 | 3.7 |
| 3 | 14.2 | 2.4 |
| 2 | 9.7 | 1.4 |
| 1 | 5.4 | 0.6 |
| base | 0 | 0 |




**Graph 11: Zone V soil-III displacement vs Storey under X-direction**

## CONCLUSIONS

1- The center of mass and center of rigidity is influenced by adding and positioning of shear wall. It can be concluded that all models are symmetric about x-direction and there is no effect of torsion due to center of mass and center of rigidity in x-direction. The performance of structure with shear wall is better than structure without shear wall because center of mass and center of rigidity become closer.

2- Provision of shear wall generally results in reducing the displacement because the shear wall increases the stiffness of building and sustains the lateral forces. The better performance is observed and displacement is reduced in both x and y directions and shows better performances with respect to displacement when analysis is carried out by using response spectrum method.

3- The shear force resisted by the column frame is decreasing by placing the shear wall and the shear force resisted by the shear wall is increasing. This can be concluded indirectly by observing the maximum column shear force and moment in both directions.

The moment resisting frame with shear walls are very good in lateral force such as earthquake and wind force. The shear walls provide lateral load distribution by transferring the wind and earthquake loads to the foundation. And also impact on the lateral stiffness of system and also carry gravity loads.

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