Seismic Analysis of Multi Storied Building with Shear Walls of Different Shapes

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Abstract : **A shear wall is a wall that is used to resist the shear, produced due to lateral forces.Shear walls are added to the building interior to provide more strength and stiffness to the building when the exterior walls cannot provide sufficient strength and stiffness.It is necessary to find out the effective shape of shear wall.The present work deals with a study on the improvement shape of shear walls in symmetrical high rise building.In symmetrical buildings, the center of gravity and center of rigidity coincide, so that the shear walls are placed symmetrically.In this work a high rise building with different shapes of shear walls is considered for analysis. The multi storey building with G+14 and G+29 storeys are analyzed for its storey drift and base shear using ETABS software. For the analysis of the building for seismic loading with two different Zones (Zone-III & Zone-V) is considered. The analysis of the building is done by using dynamic method(Response spectrum analysis).**

Key words*: *Shear wall , ETABS

I. INTRODUCTION

Adequate stiffness is to be ensured in high rise buildings for resistance to lateral loads induced by wind or seismic events. Reinforced concrete shear walls are designed for buildings located in seismic areas, because of their high bearing capacity, high ductility and rigidity. In high rise buildings, beam and column dimensions work out large and reinforcement at the beam-column joins are quite heavy, so that, there is a lot of clogging at these joints and it is difficult to place and vibrate concrete at these places which does not contribute to the safety of buildings. These practical difficulties call for introduction of shear walls in High rise buildings.

Buildings engineered with structural walls are almost always stiffer than framed structures, reducing the possibility of excessive deformation and hence damage. RC multi storied buildings are adequate for resisting both the vertical and horizontal load. When such buildings are designed without shear walls, beams and column sizes are quite heavy. Shear walls may became imperative from the point of view of economical and control large deflection. Lateral forces, that is, the forces applied horizontally to a structure derived from winds or earthquakes cause shear and overturning moments in walls. The shear forces tend to tear the wall just as if you had a piece of paper attached to a frame and changed the frame's shape from a rectangle to a Parallelogram. The changing of shape from a rectangle to parallelogram is referred to as racking. At the end of shear walls, there is a tendency for the wall to be pushed down at the end away from the force. This action provides resistance to overturning moments.

Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important to have sufficient strength for the structure against vertical loads. Earthquake and wind forces are the only major lateral forces that affect the buildings. The function of lateral load resisting systems or structure form is to absorb the energy induced by these lateral forces by moving or deforming without collapse. The determination of structural form of a tall building or high rise building would perfectly involve only the arrangement of the major structural elements to resist most efficiently the various combinations of lateral loads and gravity loads.The taller and more the slender a structure, the more important the structural factors become and the more necessary it is to choose an appropriate structural form or the lateral loading system for the building. In high rise buildings which are designed for a similar purpose and of the same height and material, the efficiency of the structures can be compared by their weight per unit floor area.

1.1 Different Shapes Of Shear Walls

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

(a) U – Section
(b) W – Section
(c) H – Section
(d) T – Section

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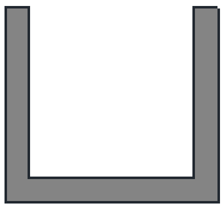

Figure 1.U – Section

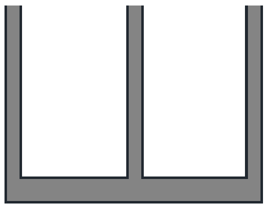

Figure 2.W – Section

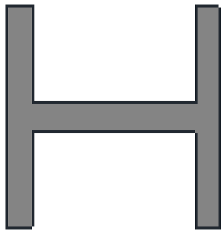

Figure 3.H – Section

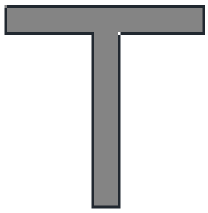

Figure 4.T – Section

II. OBJECTIVES

- To analyse seismic behaviour of symmetrical multi-storied building(G+14 and G+29) with shear walls of different shapes using dynamic analysis
- To find the effective shape of shear wall
- To compare the seismic analysis of multi storied building with shear wall in two different zone(zone III and zone V)

III. MODELLING OF BUILDING

Here the study is carried out for the behaviour of G+14 and G+29 building with shear walls of four different shape.The general software ETABS has been used for the modelling. It is more user friendly and versatile program that offers a wide scope of features like static and dynamic analysis, non- linear dynamic analysis and non-linear static pushover analysis, etc.

A) Building Plan And Dimension Details

Table below shows the details of building.

Table 1 Building deatails

Total height of building	45 m and 90 m
No. of stories	15 and 30
Height of each storey	3 m
Grade of concrete	M30
Grade of steel	Fe415
Depth of slab	150 mm
Size of beams	400 X 600 mm
Size of columns	800 X 800 mm
Shear wall thickness	230 mm
Plan area	720 m^2

This work include 8 models of G+14 and G+29 building with shear walls of four different shapes(UH,T and W shape)

B)Symmetrical Rc Building With U Shaped Shear Wall

The figure below shows the model of an I shaped RC symmetrical building with U shaped shear wall.

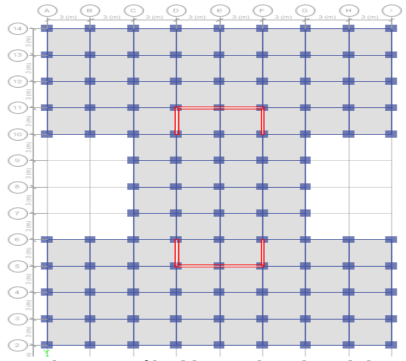

Figure 5. Plan view of building with U shaped shear wall

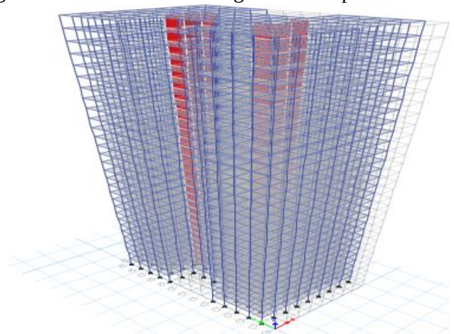

Figure 6. 3D view of building with U shaped shear wall

C) Symmetrical Rc Building With H Shaped Shear Wall

The figure below shows the model of an I shaped RC symmetrical building with H shaped shear wall.

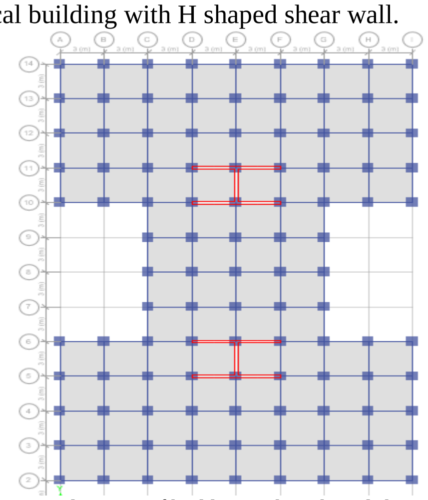

Figure 7. Plan view of building with H shaped shear wall

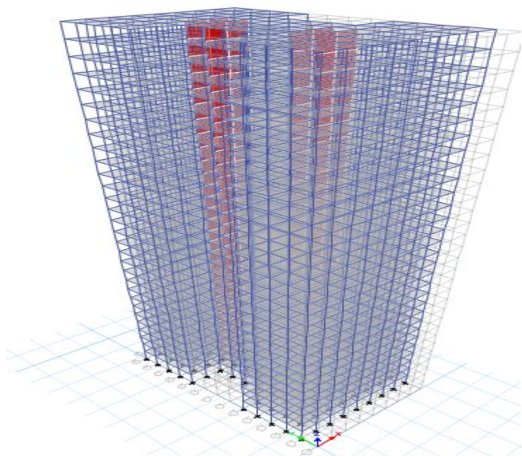

Figure 8. 3D view of building with H shaped shear wall

D) Symmetrical Rc Building With T Shaped Shear Wall

The figure below shows the model of an I shaped RC symmetrical building with T shaped shear wall.

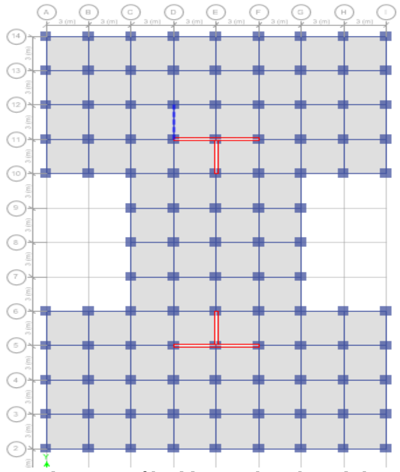

Figure 9. Plan view of building with T shaped shear wall

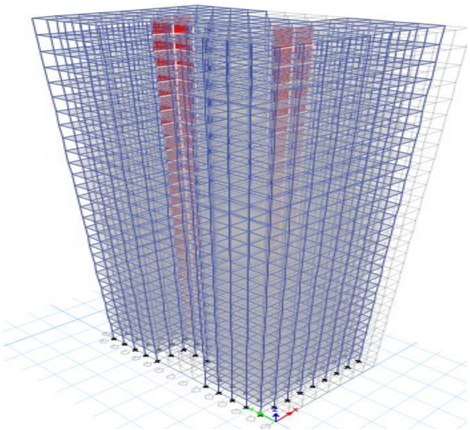

Figure 10. 3D view of building with T shaped shear wall

E) Symmetrical Rc Building With W Shaped Shear Wall

The figure below shows the model of an I shaped RC symmetrical building with W shaped shear wall.

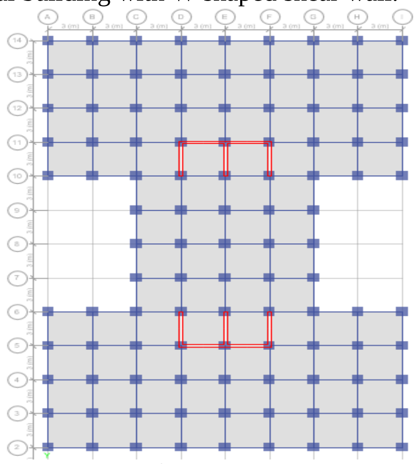

Figure 11. Plan view of building with W shaped shear wall

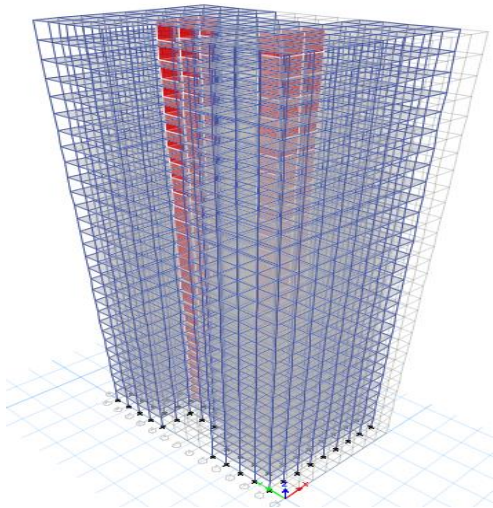

Figure 12. 3D view of building with W shaped shear wall

F) Load Formulation

In the present project works following loads are considered for analysis. Dead Loads (IS- 875 PART 1) and Live Loads (IS 875 PART 2). In addition to the above mentioned loads, dynamic loads in form of Response Spectrum method are also be assigned.

- **Dead load**
  Dead load intensity = 1.5 kN/m^2
- **Live load**
  Live Load Intensity specified (Public building) = 4kN/m^2
- **Wall weight**
  Wall weight = 13.8 kN/m

G) Analysis

The three dimensional reinforced concrete structures were analyzed by Response Spectrum Analysis using ETABS software. It is a linear dynamic statistical analysis method to indicate the likely maximum seismic response of an elastic structure. A plot of the peak acceleration for the mixed vertical oscillators. A response spectrum is simply a plot of the peak or steady-state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency that are forced into motion by the same base vibration or shock.The analysis results will show the performance levels, behaviour of the structures.

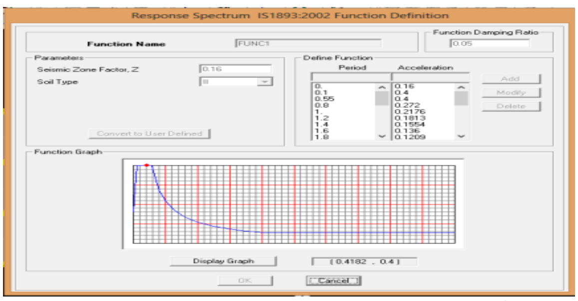

Figure 13.Response Spectrum IS 1893:2002 Function Definition

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IV. COMPARISON OF RESULTS

After analysing the results obtained then it will be compared and find the seismic performance of the building.

Graphical representation of storey drift and base shear values are shown in figure below. The results indicated that W and U shaped shear wall shows better performance than others based on storey drift and base shear values.In Y direction H shape is better according to storey drift and T shape is better according to base shear value.

A) STOREY DRIFT AND STOREY SHEAR OF G+14 BUILDING (ZONE V)

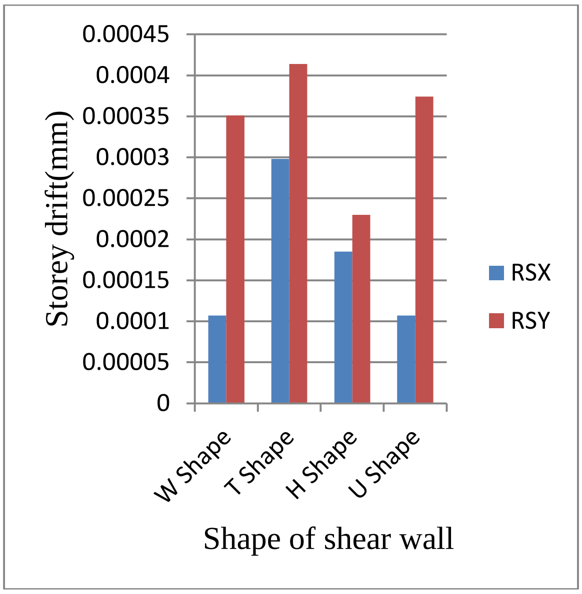

Figure 14. Variation of storey drift for G+14 building with different shape of shear wall(zone V)

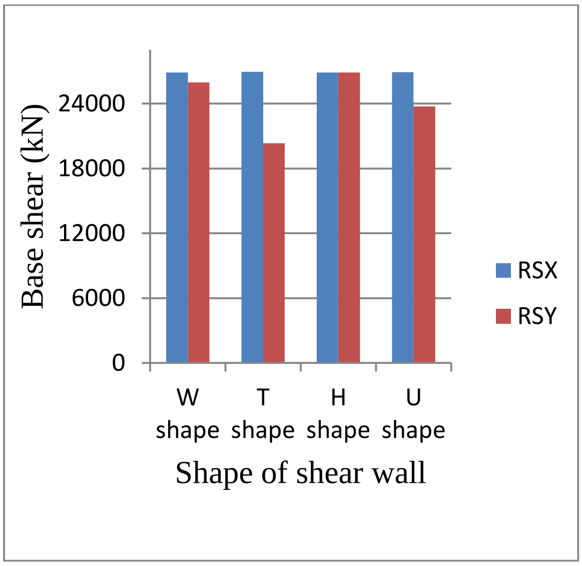

Figure 15.Variation of storey shear for G+14 building with different shape of shear wall(zone V)

B) STOREY DRIFT AND STOREY SHEAR OF G+14 BUILDING (ZONE III)

Graphical representation of storey drift and base shear values are shown in figure below. The results indicated that W and U shaped shear wall shows better performance than others based on storey drift and base shear values.In Y direction H shape is better according to storey drift and T shape is better according to base shear value.

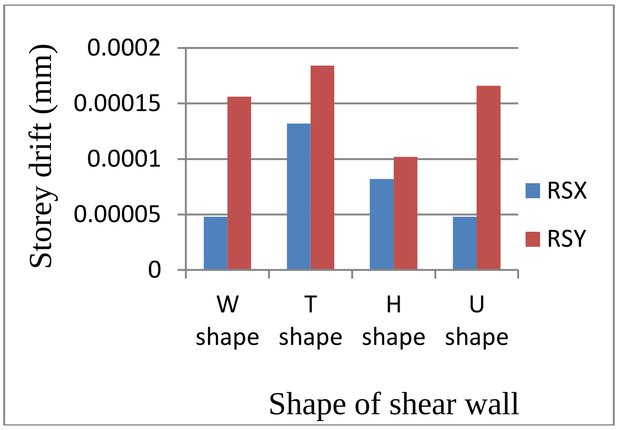

Figure 16.Variation of storey drift for G+14 building with different shape of shear wall(zone III)

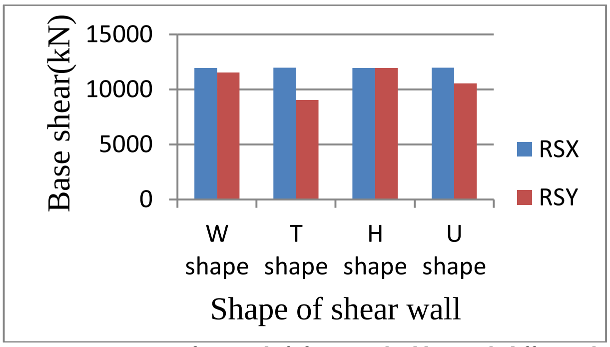

Figure 17.Variation of storey drift for G+14 building with different shape of shear wall(zone III)

C) STOREY DRIFT AND STOREY SHEAR OF G+29 BUILDING(ZONE V)

Graphical representation of storey drift and base shear values are shown in figure below. The results indicated that , in terms of storey drift W and H shaped shear wall is good in X and Y direction.According to base shear values T shaped shear wall is good in both X and Y direction.

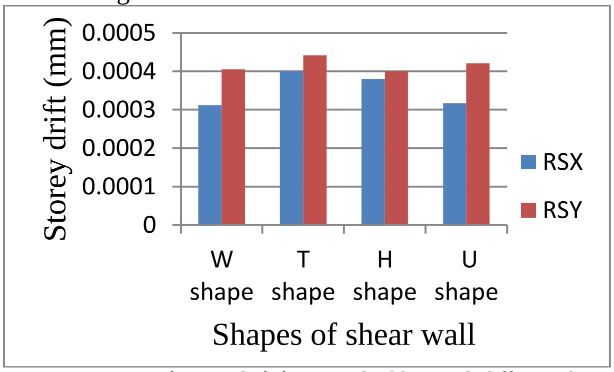

Figure 18.Variation of storey drift for G+29 building with different shape of shear wall(zone V)

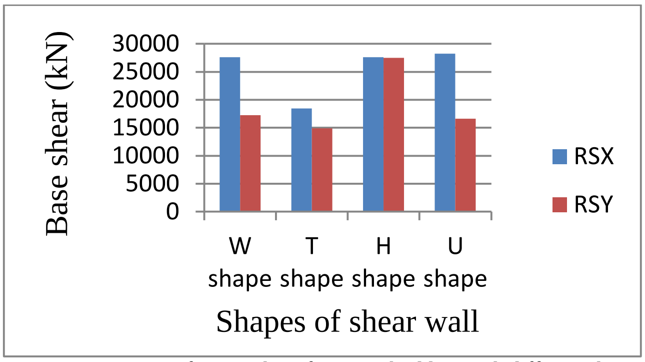

Figure 19.Variation of storey shear for G+29 building with different shape of shear wall(zone V)

D) STOREY DRIFT AND STOREY SHEAR OF G+29 BUILDING(ZONE III)

Graphical representation of storey drift and base shear values are shown in figure below. The results indicated that , in terms of storey drift W and H shaped shear wall is good in X and Y direction.According to base shear values T shaped shear wall is good in both X and Y direction.

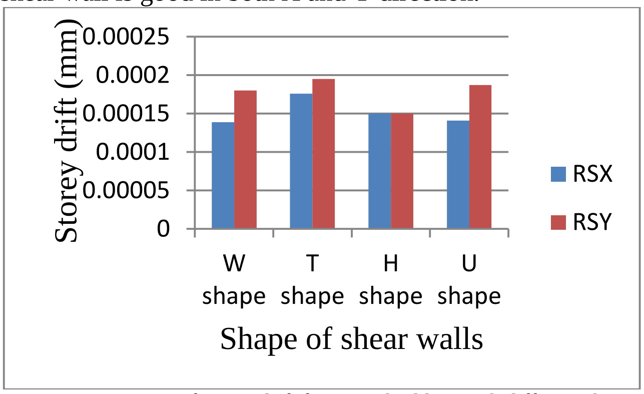

Figure 20.Variation of storey drift for G+29 building with different shape of shear wall(zone III)

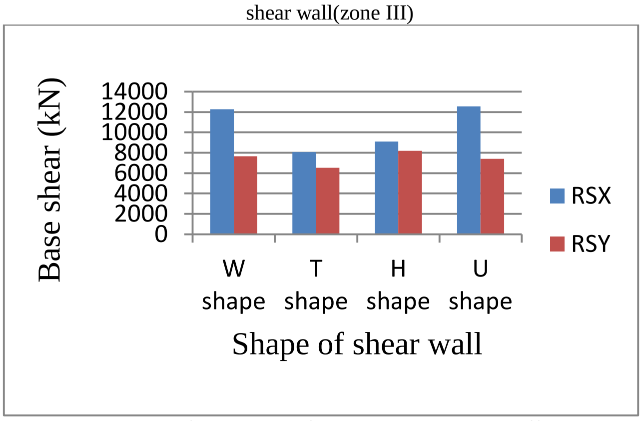

Figure 21.Variation of storey shear for G+29 building with different shape of shear wall(zone III)

V. CONCLUSIONS

In the present study, an attempt is made to study the seismic behavior of building with shear walls of four different shapes.First part of study included the dynamic analysis of building. The storey drift and base shear were obtained. A comparative table of these results for all the shapes of shear wall has also been presented. In the next section conclusions obtained from the study is presented.

- On the basis of storey drift and base shear value G+14 building with W and U shaped shear wall shows better performance (X - direction) in both zone V and III.
- G+14 building with H shaped shear wall is good in terms of storey drift (Y – direction) in zone V and III.
- G+14 building with T shaped shear wall is good in terms of base shear (Y – direction) in zone and III.
- On the basis of storey drift and base shear value G+29 building with W and H shaped shear wall shows better performance (X and Y direction) in both zone V and III.
- G+29 building with T shaped shear wall is good in terms of storey drift and base shear value (both X and Y direction) in zone V and III.
- There is no change in the better shape of shear wall in both zones.

VI. FUTURE SCOPE

Further study can be carried out by changing the position of shear wall.

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