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Performance Evaluation of Various Shapes of Shear Wall using Response Spectrum Analysis

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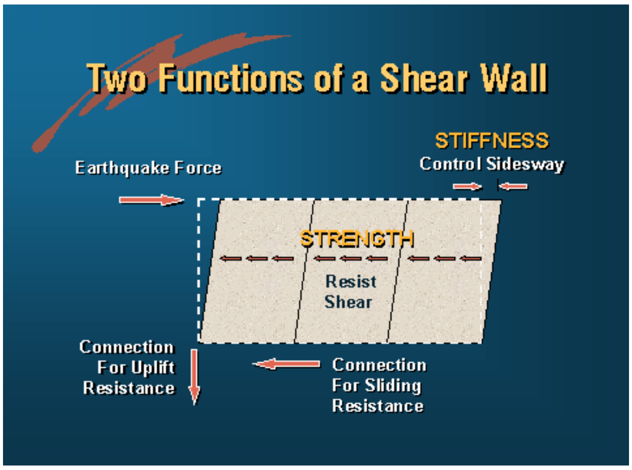
Abstract: ***In the present era, with the advancement of infrastructure, earthquake engineering has a vital role to play. As and when an earthquake occurs, we encounter something new and the profession grows to accommodate it. In researches as well as in practices designers are mostly concerned with structures that would be safe in the sense of surviving a seismic event along with minimum number of casualties. In2001, Bhuj earthquake most of the structures collapsed resulting in loss of lives and property. However, to minimise the effect of earthquake in structures, shear wall acts as a boon to safeguard the structure impacting greater stability. The work presented in this paper focuses on the performance of various shapes of shear wall in zone 5 namely: L-shaped, I-shaped, Rectangular-shaped & C-shaped. In this study G+6, G+16 and G+25 storeyed building is modelled and analysed for lateral displacement, storey stiffness, storey drift using ETABS-2016 software. The analysis of the building is done by using response spectrum method and the results obtained from this method are plotted graphically.***

Keywords: storey stiffness, storeydrift, response spectrum method.

I. INTRODUCTION:

Shear wall is a structural system composed of shear panels to counter the effects of lateral load acting on the structure. Depending upon the zone wind and seismic loads are the most common loads for which the shear walls are designed. The basic function of shear wall is to increase the rigidity for lateral load resistance along with providing adequate stiffness and strength to the structure. Reinforced concrete shear wall provide a significant amount of strength and stiffness to the building in the direction of their orientation which considerably reduces lateral sway of the building. However, if a building is designed in highly seismic prone areas without the use of shear wall, the beam and column sizes would be large along with this, it would be difficult to place and vibrate concrete which will lead to larger displacement inducing heavy forces on the structure therefore shear wall becomes an essential part in designing of tall buildings from both economy and stability point of view. With limiting space and fast pace construction of tall buildings, shear wall is gaining popularity day by day especially in construction of apartments and offices. In this paper the main is to study the various shapes of shear wall i.e. L-shaped, I-shaped, Rectangle shaped &C-shaped and its effectiveness for low rise(G+6), medium rise(G+16) & high rise(G+25) storeyed building. Variousshapes of shear wall are compared with the building without shear wall to observe the variation of various parameters like storey drift, storey stiffness & lateral displacement.



II. LITERATURE REVIEW:

YuZhang2017, (6) focused on optimisation for design of tall buildings with shear wall.The paper accelerate the use of optimisation using ground structure program formulation and developing algorithms leading to cost saving and economic design of shear wall

Fazal U Rahman Mehrabi.,2017 (7) focussed on building frame without bracing, shear wall and with bracing, shear wall is being designed as per IS 456:2000 & IS1893: 2002.The study was done to check the performance of a building when designed as per Indian standards and also to determine the effect of providing shear wall and bracing to building frame.

G.S. Hiremath 2016, (8) worked on effect of addition of shear wall at different location and configurationalong with varying thickness of shear wall using ETABS v9.7.1

Ali Kocak,BasakZengin 2015,(9) discusses the behaviour of frame -wall irregularity on the established reinforced concrete structures that were subjected to the 1999 Kocaeli Earthquake in Turkey.

Gangisetty2015(10) presented optimisation techniques which are used to solve problems related to structural engineering involving both size and topological optimisation by considering stability,safety,response to different types of loading

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III.METHOD OF ANALYSIS:

In the study, the analysis of the high-rise structure is carried out for lateral loads using Response Spectrum Method

A. Load Combination:

The structure is subjected primary load as per the provision of IS Code of practice:

(1) 1.5DL+1.5LL

(2) 1.2DL+1.2LL+1.2EX

(3) 1.2DL+1.2LL-1.2EX

(4) 1.2DL+1.2LL+1.2EY

(5) 1.2DL+1.2LL-1.2EY

(6) 1.5DL+1.5EX

(7) 1.5DL-1.5EX

(8) 1.5DL+1.5EY

(9) 1.5DL-1.5EY

(10) 0.9DL+1.5EX

(11) 0.9DL-1.5EX

(12) 0.9DL+1.5EY

(13) 0.9DL-1.5EY

(14) 1.2DL+1.2LL+1.2WLX

(15) 1.2DL+1.2LL-1.2WLX

(16) 1.2DL+1.2LL+1.2WLY

(17) 1.2DL+1.2LL-1.2WLY

(18)1.5DL+1.5WLX

(19) 1.5DL-1.5WLX

(20) 1.5DL+1.5WLY

(21) 1.5DL-1.5WLY

(22) 0.9DL+1.5WLX

(23) 0.9DL-1.5WLX

(24) 0.9DL+1.5WLY

(25) 0.9DL-1.5WLY

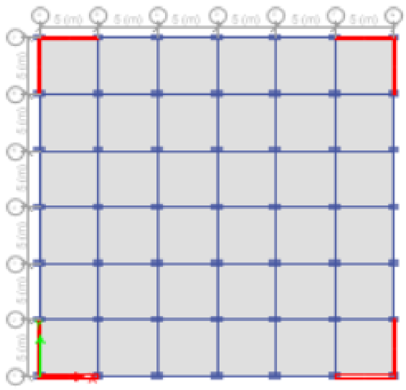
B .Modelling of Structure:

Salient features of the structure modelled:

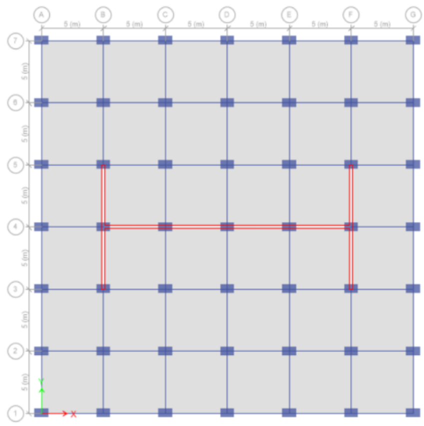
S/No.	Description	Specifications
1	Building frame system	SMRF
2	Ground storey height	3.5m
3	Typical storey height	3.5m
4	Type of soil	Medium (II)
5	Support condition	Fixed
6	Grade of concrete	M30
7	Grade of steel	Fe 415
8	Live load	2 kN/m^2
9	Floor finish	1 kN/m^2
10	Importance factor	1
11	Response reduction factor	5
12	Zone	V
13	Slab thickness	150mm
14	Thickness of brick wall	230mm
15	Wind Zone	V
16	Basic wind speed	50m/s
17	Terrain Category	III

IV.BUILDING MODELLED:

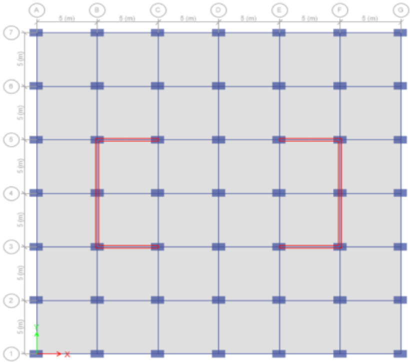
1. Model 1: Building with L shaped geometry of shear wall
2. Model 2: Building with I shaped geometry of shear wall
3. Model 3: Building with rectangular shaped geometry of shear wall
4. Model 4: Building with C shaped geometry of shear wall
5. Model 5: Building without shear wall



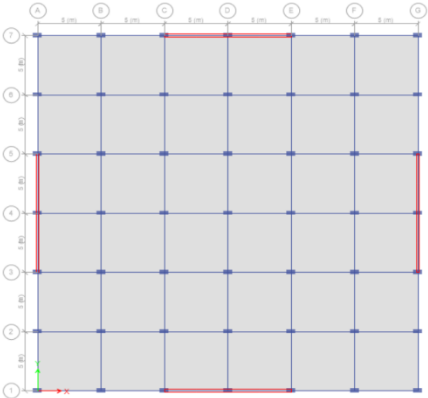
(a) Model 1



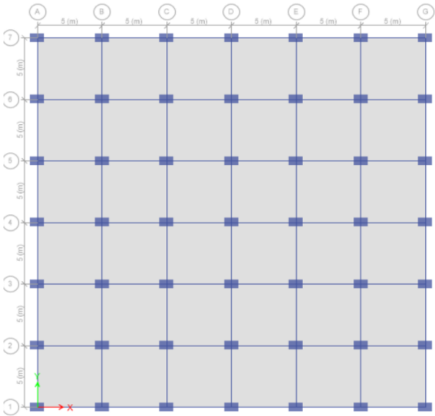
(b) Model 2



(c) Model 3

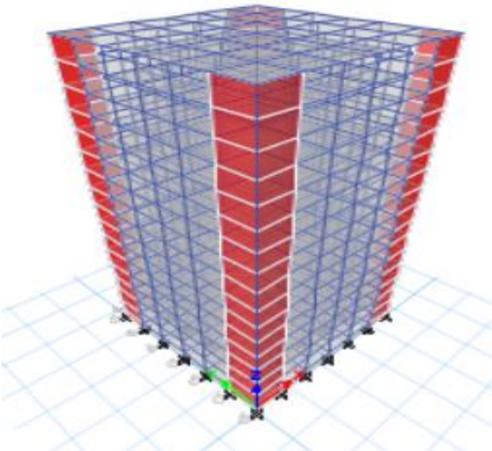


(d) Model 4

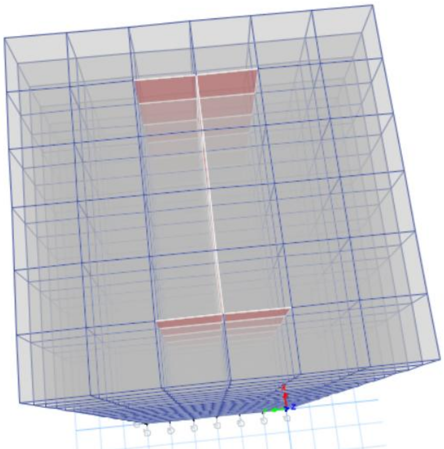


(e) Model 5

Fig 1:Plan of Building with various shapes of shear wall



(a) Model 1



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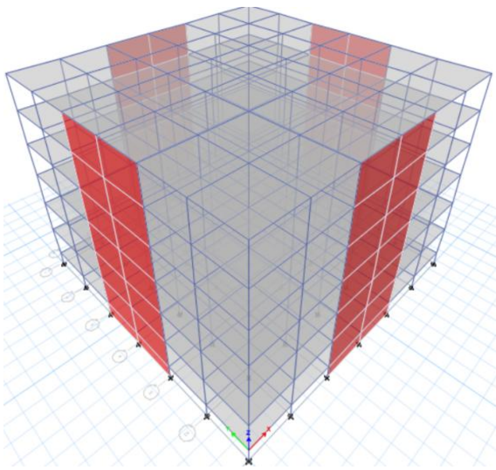
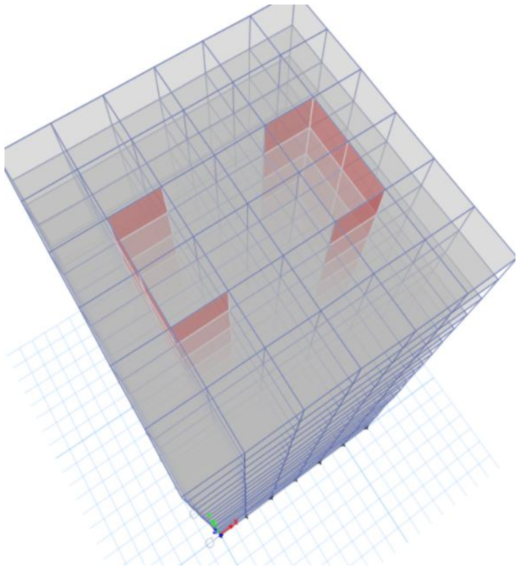
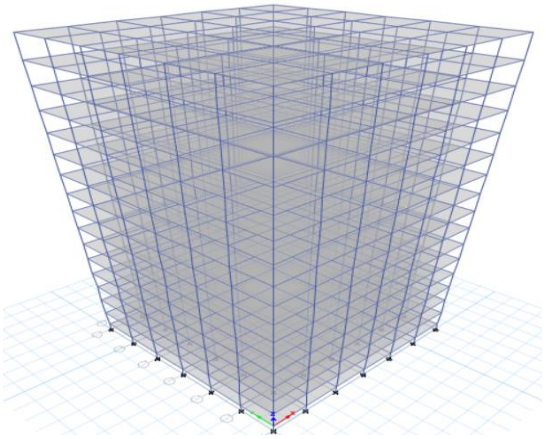


(c) Model 3



(d) Model 4



(e) Model 5

Figure 2: 3D view of RC Building with various shapes of shear wall

MEMBER SIZES OF G+6 STOREY

SALIENT FEATURES OF G+6 STOREY

SNo.	Description	Specifications
1	Column size (Ground level)	300mm x 600mm
2	Column size (other stories)	350mm x 500mm
3	Plinth beam	400mm x 500mm
4	Beam size	300mm x 500mm

MEMBER SIZES OF G+16 STOREY

SALIENT FEATURES OF G+16 STOREY

SNo.	Description	Specifications
1	Column size (Ground level)	500mm x 450mm
2	Column size (other stories)	300mm x 600mm
3	Plinth beam	400mm x 650mm
4	Beam size	350mm x 600mm

MEMBER SIZES OF G+25 STOREY

SALIENT FEATURES OF G+25 STOREY

SNo.	Description	Specifications
1	Column size (Ground level)	500mm x900mm
2	Column size (other stories)	400mm x 800mm
3	Plinth beam	550mm x 800mm
4	Beam size	450mm x 700mm

V. OBSERVATIONS & RESULTS

1. G+6 building

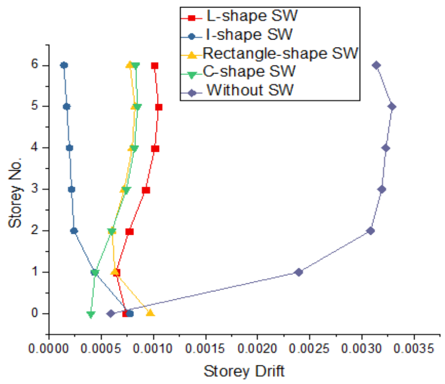


Fig 3: Storey Drift vs Storey No

The above graph shows the variation of storey drift with Storey No. Here, for the various shapes of shear wall it has been observed that storey drift i.e.the displacement of one storey with respect to the other in I-shape shear wall is significantly low as compared to other shapes of shear wall.

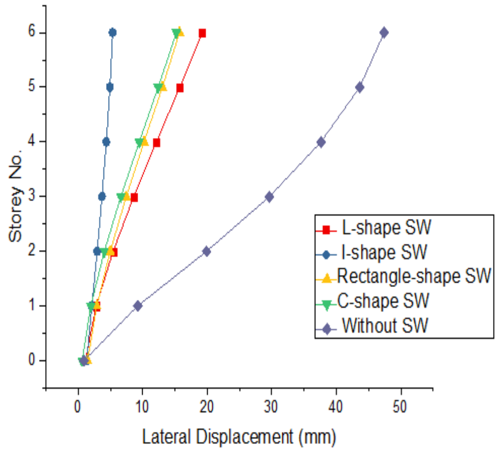


Fig 4: Lateral Displacement vs Storey No

The graph above shows the variation of lateral displacement with Storey No. The lateral displacement increases with increase in the storey No. However, the amount of displacement observed in I-shape shear wall is minimum as compared to other shapes of shear wall. It has also been observed that RC building without shear wall has a larger amount of displacement as compared to any shapes of shear wall.

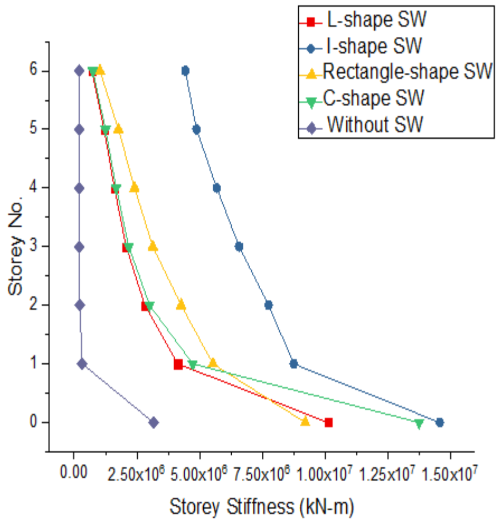


Fig5: Storey Stiffness vs Storey No

The above graph plots the variation of Storey Stiffness with Storey No..Storey stiffness indicates the resistance offered during the occurrence of earthquake. From the graph, it is very much clear that storey stiffness is significantly higher for I-shaped shear wall and very much lower for normal RC building.

2. G+16 Building

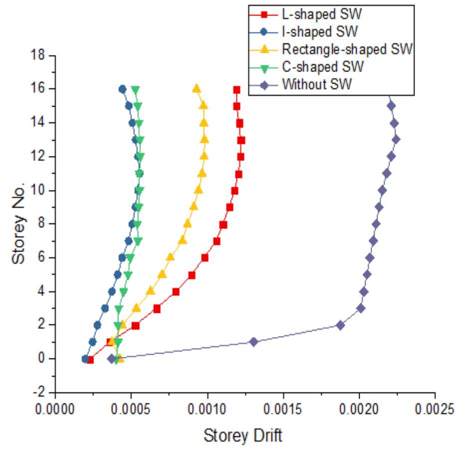


Fig 6: Storey Drift vs Storey No.

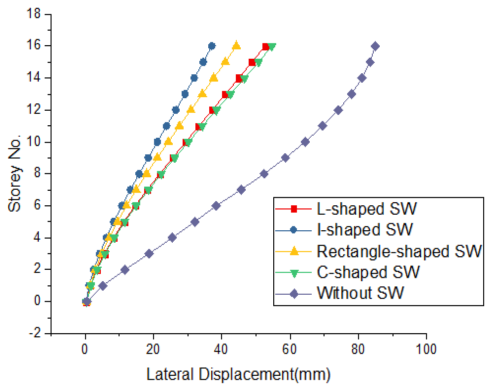


Fig 7: Lateral Displacement vs Storey No.

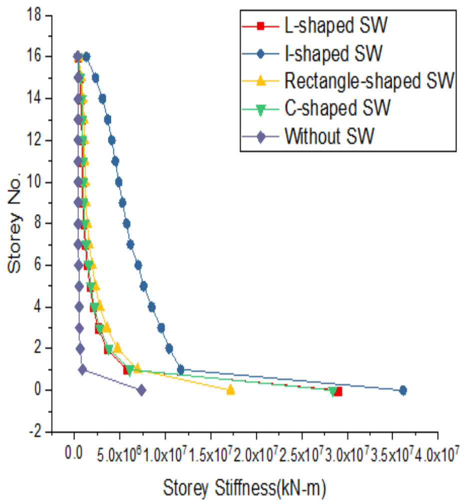


Fig8: Storey Stiffness vs Storey No.

The results obtained for G+16 building follow the same trend as that of G+6 building. However, the storey stiffness is comparatively higher for G+16 buildings with respect to G+6 building. The amount of lateral displacement is also large for G+16 sized building while the storey drift is lower for G+16 storeyed building.

3. G+25 Building

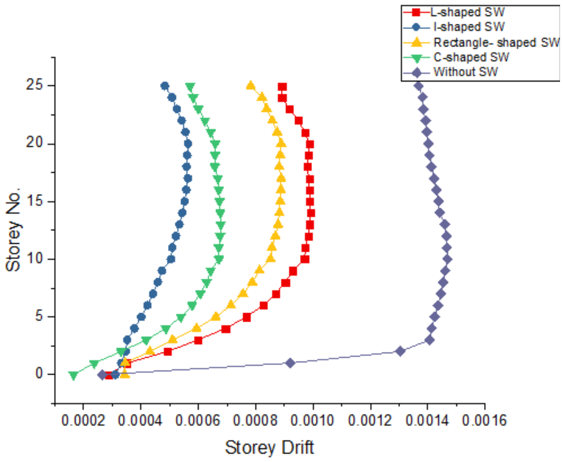


Fig 9: Storey Drift vs Storey No.

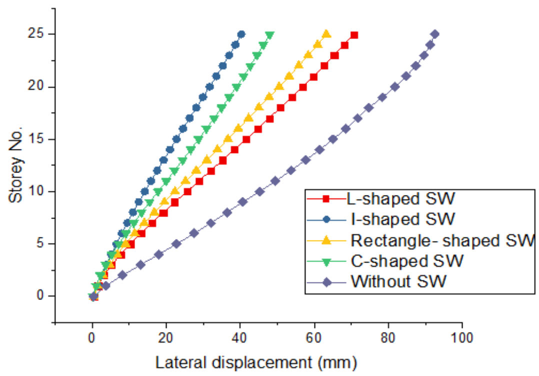


Fig 10: Lateral Displacement vs Storey No.

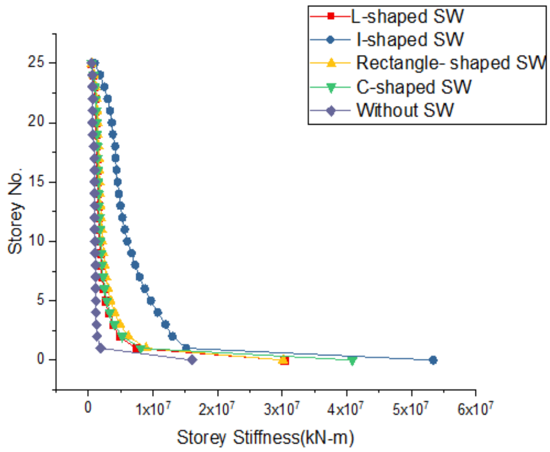


Fig11: Storey Stiffness vs Storey No.

The results obtained for G+25 storeyed is similar to that of G+6 & G+16 storeyed building. But the storey stiffness is comparatively higher in G+25 storeyed building as compared to other storeyed building.It has also been observed that RC building without shear wall seems to perform vulnerable,being more susceptible to earthquake.

VI.DISCUSSION

1.For the various shapes of building considered for analysis in ETABS i.e. L-shaped,I-shaped,Rectangle-shaped &C-shaped,it has been observed that I-shaped shear wall performs significantly well as compared to all other shapes of shear wall .

2.For the 3 different types of building considered i.e. G+6, G+16 &G+25, it has been observed that there is decrease in lateral displacement &storey drift for buildings with shear wall as compared to the normal RC buildings without embedding shear wall.

3.The parameter storey stiffness play a considerable role during the occurrence of earthquake and it is observed to be higher for G+25 storey building for I-shaped shear wall. However, every other shape of shear wall also performs better in comparison with buildings without shear wall

4. Wind doesn't dominate the analysis in zone 5 and didn't alter any results which clearly defines wind has no contribution in the analysis of building in zone 5.

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