Influence of Openings In Shear Wall In High Rise Building

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***Abstract*—In recent decades, shear wall structures are the most appropriate structural forms, which have caused the height of concrete buildings to be soared. In present work, sixteen storey buildings (49.2m) have been modeled using software package ETAB v 9.7.4 for earthquake zone III in India. Different positions and location of shear wall with opening conditions are considered for studying their effectiveness in resisting lateral forces. Study on different opening conditions for storey drift and diaphragm displacement concluded that provision of opening in shear wall ultimately helps to achieve the economy.**

***Index Terms*—Shear wall, lateral forces, storey drift, diaphragm displacement.**

I. INTRODUCTION

A shear wall building is in no way different from an ordinary framed building. However, it differs significantly when it comes to transference of lateral loads. Shear walls are vertical stiffening elements designed to resist lateral forces exerted on a building by wind or earthquakes .Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building.

In the last two decades, shear walls became an important part of mid and high-rise residential buildings. As part of an earthquake resistant building design, these walls are placed in building plans reducing lateral displacements under earthquake loads. So shear-wall frame structures are obtained.

Openings are used as architectural needs to have window or doors; besides, engineers want to design buildings without shear lag under negative shear.Shear walls are frequently pierced for doors, windows and corridor openings.

II. LITERATURE SURVEY

Lin and Kuo (1988), they stated that, had conducted finite element analysis and experimental work to study the ultimate strength of shear wall with openings under lateral load. In test program, the different amount and pattern of reinforcement were arranged around the openings.

Torki Harcheganiua et.al. (2011), has stated that, effect of openings dimensions on the relative flexural behavior of adjacent piers (independent or conjugate) in perforated shear walls is addressed. 384 designed models were made and exposed to lateral loads. For middle openings, in addition to the alpha parameter in the literature, the relative flexural behavior of piers in medium-rise buildings can be predicted as function of thickness-to-length ratio of the coupling beam and the ratio of the coupling beam length to the pier length; but in high-rise buildings, it is always conjugate. For corner openings, the alpha parameter must be modified with respect to the number of stories.

Rahangdale and Satone (2013), they stated that, shear wall system are one of the most commonly used lateral load resisting in high rise building Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal loads and support gravity loads. Incorporation of Shear wall has become inevitable in multi-storey building to resist lateral forces. According to them, efficient and ideal location of shear wall of G+5 Storey building in Zone IV is presented with some preliminary investigation which is analyzed by changing various position of shear wall with different shapes for determine parameter like axial load and moments. This analysis is done by using Standard package STADD-pro.

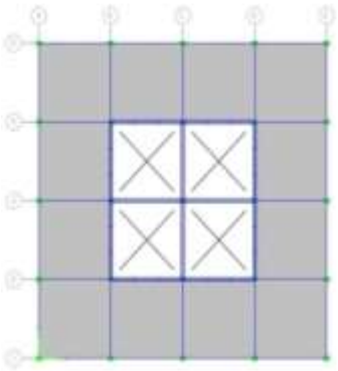
Sardar and Karadi (2013), they stated that, shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal loads and support gravity loads. Shear Walls are specially designed structural walls include in the buildings to resist horizontal forces that are induces 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. The study of 25 storeys building in zone V is presented with some investigation which is analyzed by changing various location of shear wall for determining parameters like storey drift, storey shear and displacement is done by using standard package ETAB. Creation of 3D building model for both linear static and linear dynamic method of analysis and influence of concrete core wall provided at the center of the building.

Awdy and Hassan (2013), has been focus on developed to assess the relative influences of various tensional resisting on the capacity of open rectangular shear walls. The stability is considered a four system of loads which produce zero distortion on cross section of shear wall. Finite element software ANSYS is used to perform the buckling analysis of open rectangular shear walls, also theoretical analysis will be presented for obtaining the critical buckling loads of open rectangular shear walls. An extensive set of parameters is investigated including dimensional parameters (walls thickness, shape factor, mono symmetry, and proportion factor) and discussions of the results are illustrated.

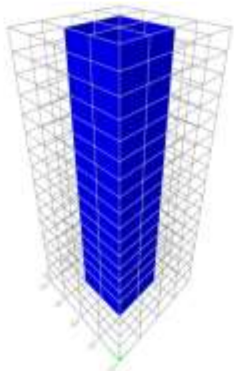
III. METHODOLOGY

Building models which are consider for analysis in ETAB v9.7.4 software are given below

Model 1 – Floor plan with the box type shear wall.

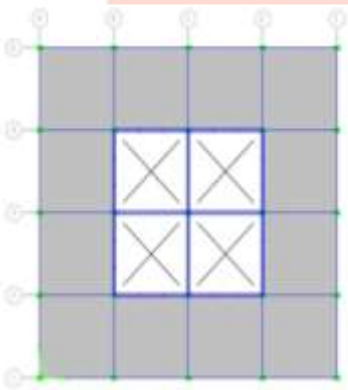


Plan



Elevation

Model 1(a) - Floor plan with the box type shear wall with center window openings.



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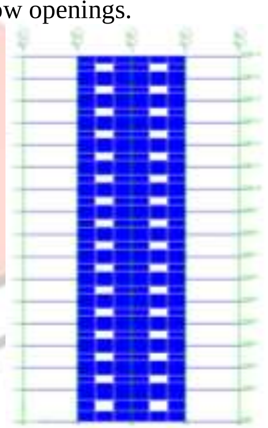
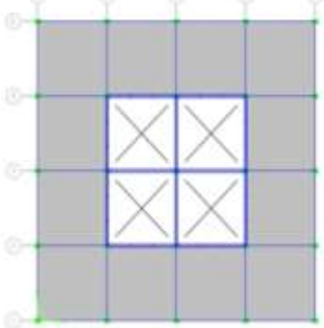
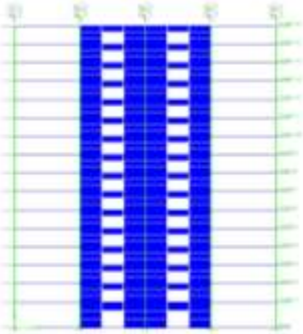


Elevation

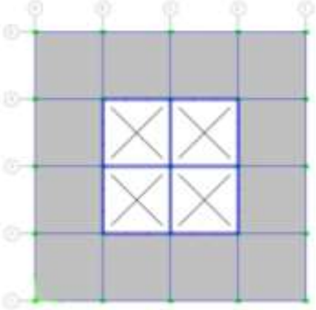
Model 1 (b) - Floor plan with the box type shear wall with door opening

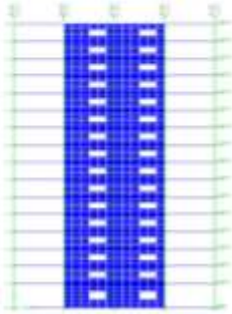




Plan Elevation

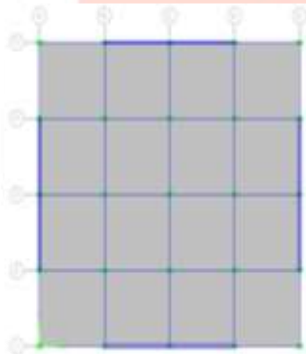
Model 1 (c) - Floor plan with the box type shear wall with eccentric window openings.

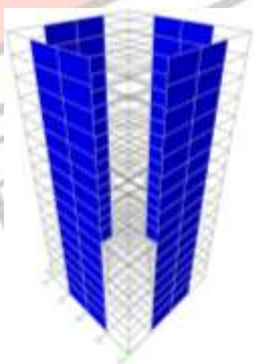




Plan Elevation

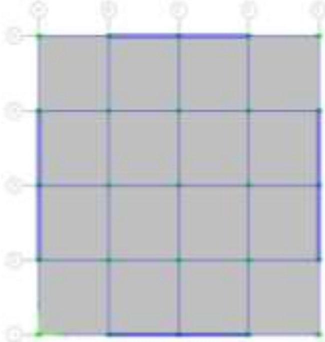
Model 2 – Floor plan with the center shear wall.

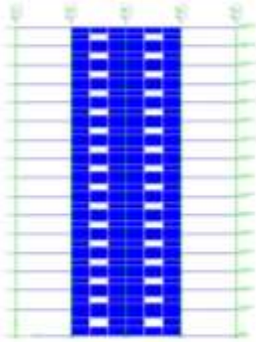




Plan Elevation

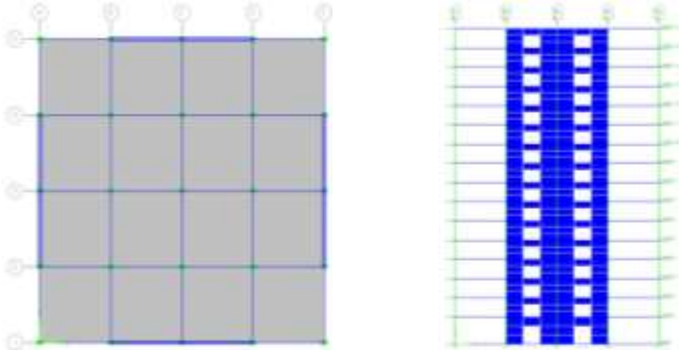
Model 2(a) –Floor plan with the center shear wall with center window openings.





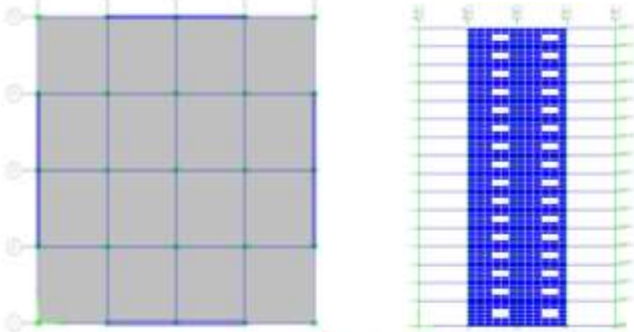
Plan Elevation

Model 2(b) – Floor plan with the center shear wall with door openings.



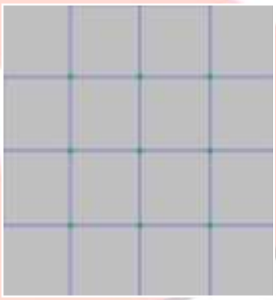
Plan Elevation

Model 2(c) – Floor plan with the center shear wall with eccentric window openings.



Plan Elevation

Model 3 – Floor plan without shear wall



Plan

Shear wall locations –

Shear walls are used as the main lateral force resisting system in N-S and E-W directions. In this research 10” thick ordinary concrete shear walls are used in two locations, at the ends and at the mid-region of the buildings and their effect on lateral load distribution and displacement examined.

Analysis data for all the models –

- Type of frame: Special RC moment resisting frame fixed at the base
- Seismic zone: III
- Number of storey: G + 15
- Floor height: 3.0 m
- Depth of Slab: 150 mm
- Size of beam: (300x 450) mm
- Size of column (exterior): (300x 450) mm
- Size of column (interior): (300x 450) mm
- Spacing between frames: 6 m along x and 6m along y- directions
- Live load on floor: 3 KN/m^2
- Dead load: 3.75 KN/m^2
- Floor finish: 1.0 KN/m^2
- Materials: M 30 concrete, Fe 415 steel Material
- Thickness of wall: 230 mm
- Thickness of shear wall: 250mm
- Density of concrete: 25 KN/m^3

- Density of infill wall : 20 KN/m^3
- Type of soil: Medium

Table 1 - Loading combination

SR NO.	LOAD COMBINATION
1	1.5 (D.L + L.L)
2	1.2(D.L + L.L + E.Q.X.)
3	1.2(D.L + L.L - E.Q.X.)
4	1.2(D.L + L.L + E.Q.Y.)
5	1.2(D.L + L.L - E.Q.Y.)
6	1.5 (D.L + E.Q.X)
7	1.5 (D.L - E.Q.X)
8	1.5 (D.L + E.Q.Y)
9	1.5 (D.L - E.Q.Y)
10	0.9 D.L + 1.5 E.Q.X
11	0.9 D.L - 1.5 E.Q.X
12	0.9 D.L + 1.5 E.Q.Y
13	0.9 D.L - 1.5 E.Q.Y

IV. RESULT AND DISCUSSION

Storey Drift -

Storey drift is the displacement of one level relative to the other level above or below. As per Indian standard, Criteria for earthquake resistant design of structures, IS 1893 (Part 1) : 2002, the storey drift in any storey due to service load shall not exceed 0.004 times the storey height.

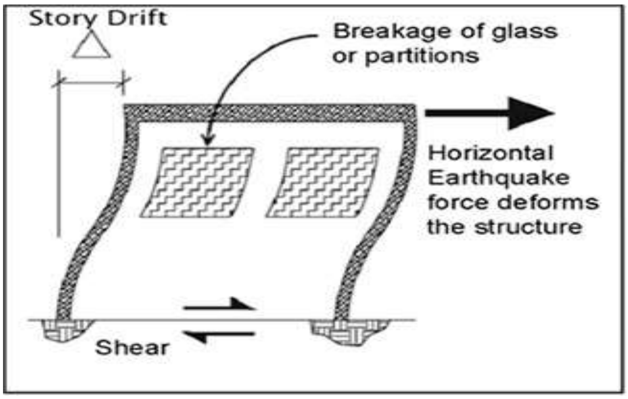


Figure 1 – Storey drift

Diaphragm displacement -

Diaphragm displacement is the displacement of the diaphragm with its original position under the lateral effect.

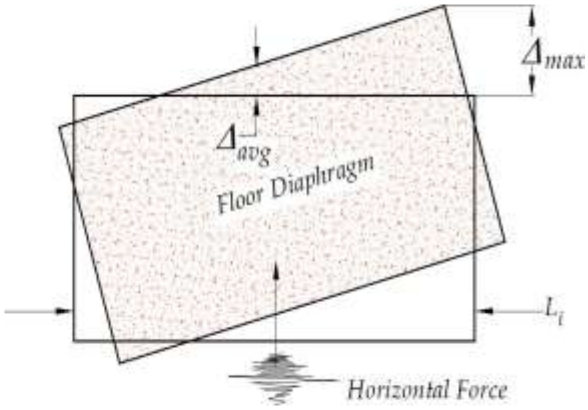


Figure 2 – Diaphragm displacement

a) The following graph showing the diaphragm displacement of box type shear wall among model 1, 1(a), 1(b), 1(c) and model 3.

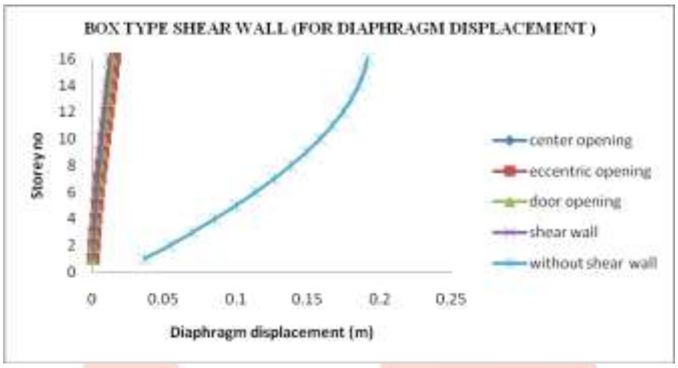


Figure 3- Comparative study for diaphragm displacement of box type shear wall against storey height.

b) The following graph showing the diaphragm displacement of center type shear wall among model 2, 2(a), 2(b), 2(c) and model 3.

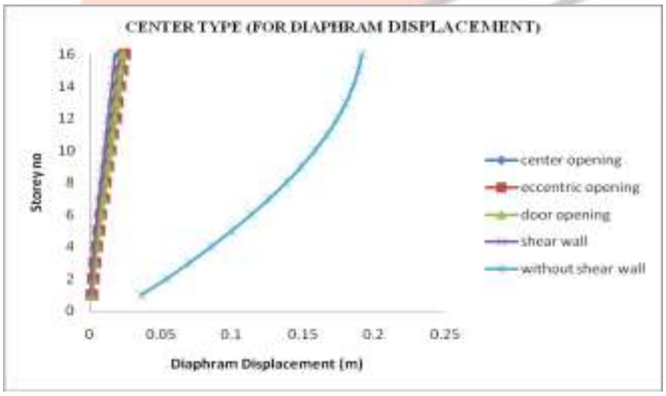


Figure 4 - Comparative study for diaphragm displacement of center type shear wall against storey height.

With the reference of Figure 3 and Figure 4, for box and centre type shear wall, the diaphragm displacement is approximately same.(For all types of opening in shear wall and with the shear wall without opening.) But, the same comparison with the building without shear wall shows the importance of the shear wall in a building.

c) The following graph showing the storey drift of corner type shear wall among model 1, 1(a), 1(b), 1(c) and model 3

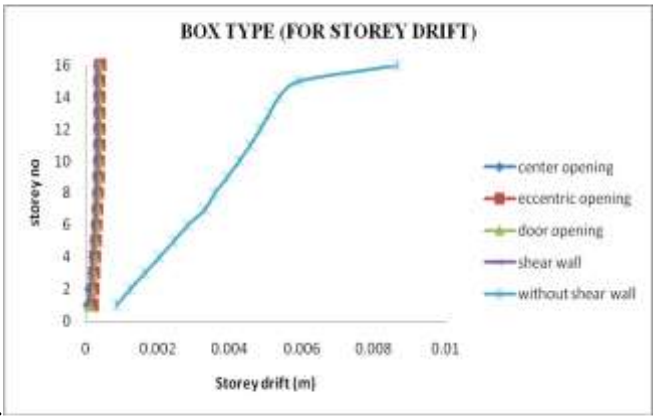


Figure 5- Comparative study for story drift of box type shear wall against storey height.

d) The following graph showing the storey drift of center type shear wall among model 2, 2(a), 2(b), 2(c) and model 3.

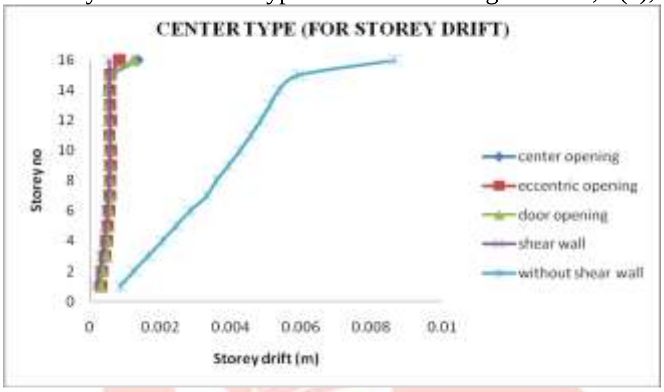


Figure 6- Comparative study for story drift of center type shear wall against storey height.

e) The following graph showing the diaphragm displacement of box type shear wall with opening among model1(a),1(b),1(c)

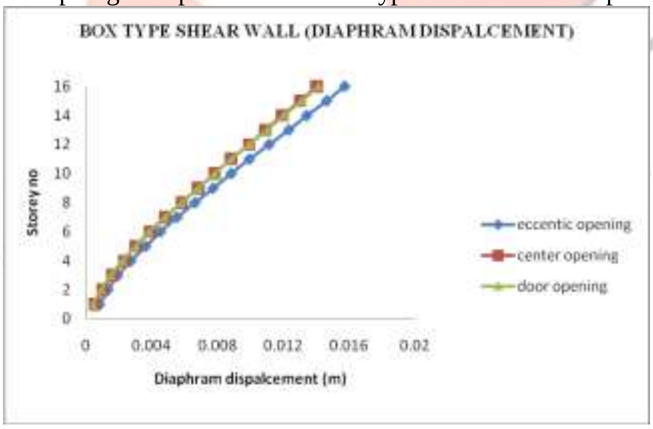


Figure 7- Comparative study for diaphragm displacement of box type shear wall with opening against storey height.

f) The following graph showing the diaphragm displacement of center type shear wall with opening among model 2(a), 2(b), 2(c)

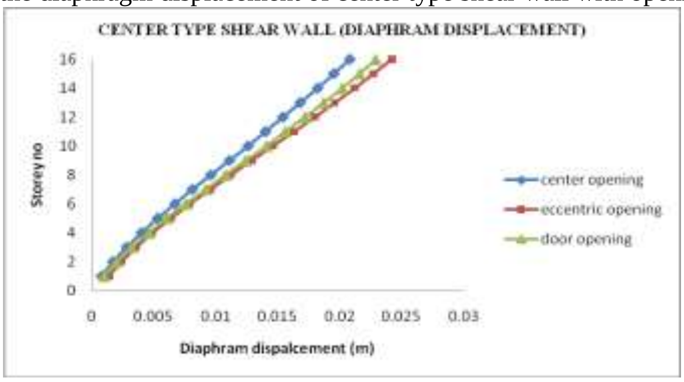


Figure 8 - Comparative study for diaphragm displacement of center type shear wall with opening against storey height.

V. CONCNLUSIONS

- The presence of shear wall can affect the seismic behavior of frame structure to large extent, and the shear wall increases the strength and stiffness of the structure.

- For box and centre type shear wall, the diaphragm displacement is approximately same.(For all types of opening in shear wall and with the shear wall without opening.) But, the same comparison with the building without shear wall shows the importance of the shear wall in a building.

- The presence of opening in shear wall give approximately same result as that of the shear wall without opening. So provision of opening in shear wall ultimately helps to achieve the economy.

- In the comparisons among door opening, center window opening and eccentric window opening, it is found that eccentric opening in shear wall gives more displacement within the study of diaphragm displacement and storey drift.

- When we provide 22.22% door opening as against 11.11% center window opening, the diaphragm displacement for box type shear wall and centre type shear wall remain approximately same.

- In case of box type shear wall, When we provide 22.22% door opening as against 11.11% eccentric window opening, the diaphragm displacement is more for eccentric window opening even opening percentage is twice.

- In case of centre type shear wall, 22.22% of door opening and 11.11% of eccentric window opening shows more displacement as against 11.11% of centre window opening.

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