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Investigation for Base Shear and Roof Displacement for Multi-Storey Building with Different Location of Shear Wall Using STAAD Pro

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***Abstract*—**Shear wall systems 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 .It is very necessary to determine effective, efficient and ideal location of shear wall.

In this paper, study of 25 storey building in zone V is presented with some preliminary investigation which is analyzed by changing various position of shear wall with for determining parameters like bending moment ,base shear and roof displacement. This analysis is done by using standard package STAAD. Pro

Keywords- *Shear Wall, Lateral Loading, , Displacements, Forces, Moments*

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I. INTRODUCTION

RC multi-storey buildings are adequate for resisting both the vertical and horizontal load. When such building is designed without shear wall , beam and column sizes are quite heavy and there is lot of congestion at these joint and it is difficult to place and vibrate concrete at these places and displacement is quite heavy which induces heavy forces in member. Shear wall may become imperative from the point of view of economy and control of lateral deflection.

In RC multi-storey building lift well or shear wall are usual requirement. Centre of mass and stiffness of the building is ideal for a structure. However, on many occasions the design has to be based on the off centre position of lift and stair case wall with respect to centre of mass which results into an excessive forces in most of the structural members, unwanted torsional moment and deflection.

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II. STRUCTURAL DATA

Building consists of 7 bays of 7.5M in X- direction and 5 bays of 6.5M in Y- direction.

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Table 1: Shows the Structural Data of Building

Zone	V
Height of storey	3.35 m
Number of storeys	25
Shear wall thickness	600mm from base to storey Level 10 400 mm from storey level 10 to 20 230 mm from storey level 20 to 25
Grade of concrete and steel	M20 and Fe 415
Depth of slab	175 mm
Size of beam in longitudinal and transverse direction	400 x 600 mm
Size of Column	850 x 850 mm From Base to Storey level 13 750 x 750 mm From Storey level 13 to 16 650 x 650 mm From Storey level 16 to 19 550 x 550 mm From Storey level 19 to 22 450 x 450 mm From Storey Level 22 to 25 Column around periphery 600 x 600 mm

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III. GRAVITY LOADING

A. Gravity loading consists of dead load due to structural self-weight Abbreviations and Acronyms

i. Live load is considered as 3 KN per Square meter.

IV. LATERAL LOADING

Lateral loading consist of earthquake loading which has been calculated by program and it has been applied to the mass centre of the building.

ii. Period Calculation: Users defined

iii. Response Reduction factor (R): 5

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V RESULTS AND DISCUSSION

Results obtained from the analysis are recorded in tabular form for the five cases of the building separately for comparison of base shear and displacement.

A.

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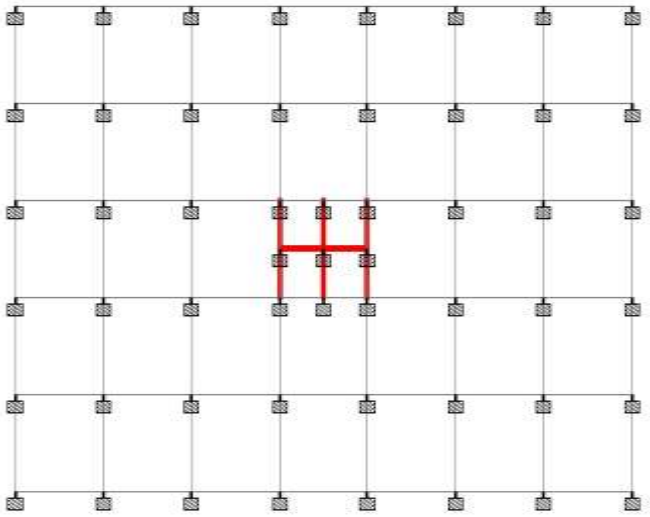
i Case no. 1 When Shear wall (Lift core) is placed at centre of building

ii. Case no. 2 When Shear wall (Lift core) is displaced 7.5m from the centroid in X-direction

iii. Case no. 3 When Shear wall (Lift core) is displaced 15 m from the centroid in X-direction.

iv. Case No 4. When shear wall (Lift core is displaced 22.5m from the centroid X – direction.



Plan of the Building (a)

Table 2: Case No. 01 Deflection at Roof when Shear Wall (Lift Core) at Centre

Load combination	Deflection in mm (X direction)	Deflection in mm (Z direction)
1.2(DL+LL+EQx)	65.75	0.00
1.2(DL+LL+EQz)	0.051	74.873
1.5(DL+EQx)	83.629	0.00
1.5(DL+EQz)	0.00	94.858

Table 3: Case No. 01 Base Shear when Shear Wall (Lift Core) at Centre.

Direction	Base Shear (KN)
In X Direction	4284.12
In Z Direction	3866.19

Table 4: Case No. 02 Base Shear when Shear Wall (Lift Core) Placed at Second Position

Direction	Base Shear (KN)
In X Direction	3677.22
In Z Direction	3303.44

Table 5: Case No. 02 Deflection at Roof when Shear Wall (Lift Core) at Second Position

Load combination	Deflection In mm (X direction)	Deflection in mm (Z direction)
1.2(DL+LL+EQx)	83.521	0
1.2(DL+LL+EQz)	1.692	74.605
1.5DL+1.5EQx	108.621	0
1.5DL+1.5EQz	44.783	136.13

Table 6: Case No. 03 Base Shear when Shear Wall (Lift Core) Placed at Third Position

Direction	Base Shear (KN)
In X Direction	3961.11
In Z Direction	3046.55

Table 7: Case No. 03 Deflection at Roof when Shear Wall (Lift Core) at Third Position

Load combination	Deflection In mm (X direction)	Deflection In mm (Z direction)
1.2(DL+LL+EQx) 1.2(DL+LL+EQz)	56.118 -16.753	0 68.851
1.5DL+1.5EQx	75.777	0.00
1.5DL+1.5EQz	31.587	138.509

Table 8: Case No. 04 Base Shear when Shear Wall (Lift Core) Placed at Fourth Position

Direction	Base Shear (KN)
In X Direction	3692.09
In Z Direction	3168.54

Table 9: Case No. 04 Deflection at Roof when Shear Wall (Lift core) at Fourth Position

Load combination	Deflection in mm X direction	Deflection in mm Z direction
1.2(DL+LL+EQx)	69.709	0.00
1.2(DL+LL+EQz)	-4.762	57.613
0.9DL+1.5EQx	92.575	0.00
0.9DL+1.5EQz	39.092	138.788

B]

i . Case no. 1 When Shear wall (Lift core) is placed at centre of building & Shear wall (I type) is placed at corner of building in Y direction.

ii. Case no. 2 When Shear wall (Lift core) is displaced 7.5m from the centroid in X-direction & Shear wall

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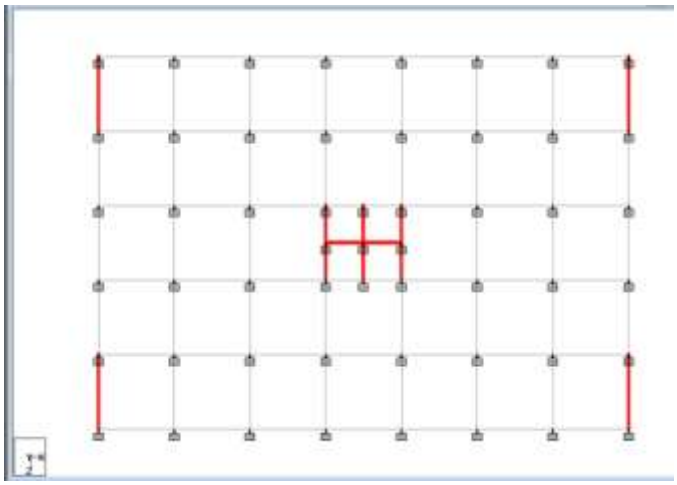
(I type) is placed at corner of building in Y direction.

iii. Case no. 3 When Shear wall (Lift core) is displaced 15 m from the centroid in X-direction & Shear wall (I type) is placed at corner of building in Y direction.

iv. Case no. 4 When Shear wall (Lift core) is displaced 22.5 from the centroid in X-direction & Shear wall (I type) is placed at corner of building in Y.



Plan of Building (b)

Table 10: Case No. 01 Deflection at Roof when Shear Wall (Lift Core) at Centre.

Load combination	Deflection in mm (X direction)	Deflection in mm (Z direction)
1.2(DL+LL+EQx)	64.925	0.00
1.2(DL+LL+EQz)	0.919	70.265
1.5(DL+EQx)	84.009	0.00
1.5(DL+EQz)	0.00	89.530

Table 11: Case No. 01 Base Shear when Shear Wall (Lift Core) at Centre.

Direction	Base Shear (KN)
In X Direction	4353.34
In Z Direction	4045.94

Table 12: Case No. 02 Deflection at Roof when Shear Wall (Lift Core) Placed at Second Position

Load combination	Deflection (mm) X direction	Deflection (mm) Z direction
1.2(DL+LL+EQx)	114.92	0.00
1.2(DL+LL+EQz)	2.979	108.453
1.5DL+1.5EQx	148.944	0.00
1.5DL+1.5EQz	16.579	142.952

Table 13: Case No. 02 Base shear when Shear Wall (Lift Core) at Second Position

Direction	Base Shear (KN)
In X Direction	5043.58
In Z Direction	5313.02

Table 14: Case No. 03 Base Shear when Shear Wall (Lift Core) Placed at Third Position

Direction	Base Shear (KN)
In X Direction	5043.58
In Z Direction	5313.02

Table 15: Case No. 03 Deflection at Roof when Shear Wall (Lift Core) at Third Position

Load combination	Deflection In mm (X direction)	Deflection In mm (Z direction)
1.2(DL+LL+EQ)	56.636	0
1.2(DL+LL+EQ)	-18.763	82.439
1.5DL+1.5EQ	76.263	0
1.5DL+1.5EQ	0.38	124.982

Table 16: Case No. 04 Deflection at roof when Shear Wall (Lift Core) Placed at Fourth Position

Load combination	Deflection In mm (X direction)	Deflection In mm (Z direction)
1.2(DL+LL+EQx)	67.812	0
1.2(DL+LL+EQz)	7.498	89.402
1.5DL+1.5EQx	87.451	0
1.5DL+1.5EQz	4.892	112.459

Table 17: Case No. 04 Base Shear when Shear Wall) Lift core at fourth position.

Direction	Base Shear (KN)
In X Direction	3987.59
In Z Direction	3866.11

C]

i . Case no. 1 When Shear wall (Lift core) is placed at centre of building & Shear wall (L type) is placed . at corner of building.

ii. Case no. 2 When Shear wall (Lift core) is displaced 7.5m from the centroid in X-direction & Shear wall (L type) is placed at corner of building.

iii. Case no. 3 When Shear wall (Lift core) is 15 m from the centroid in X-direction & Shear wall (L type) is placed at corner of building.

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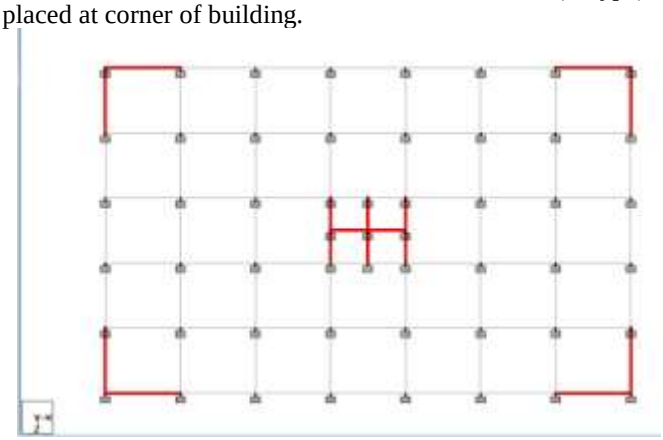
iv. Case no. 4 When Shear wall (Lift core) is displaced 22.5 from the centroid in X-direction & Shear wall (L type) is placed at corner of building.



Plan of the Building (c)

Table 18: Case No. 01 Deflection at Roof when Shear Wall (Lift Core) at Centre

Load combination	Deflection in mm (X direction)	Deflection in mm (Z direction)
1.2(DL+LL+EQx)	59.133	0.00
1.2(DL+LL+EQz)	1.296	65.47
1.5(DL+EQx)	74.600	0.00
1.5(DL+EQz)	0.00	86.845

Table 19: Case No. 01 Base Shear when Shear Wall (Lift Core) at Centre

Direction	Base Shear (KN)
In X Direction	4925.58
In Z Direction	5258.58

Table 20: Case No. 02 Base Shear when Shear Wall (Lift Core) Placed at Second Position

Direction	Base Shear (KN)
In X Direction	6706.05
In Z Direction	5736.71

Table 21: Case No. 02 Deflection at Roof when Shear Wall (Lift Core) at Second Position

Load combination	Deflection In mm (X direction)	Deflection in mm (Z direction)
1.2(DL+LL+EQx)	62.109	0.00
1.2(DL+LL+EQz)	-2.1	68.837
1.5DL+1.5EQx	81.683	0.00
1.5DL+1.5EQz	3.884	89.456

Table 22: Case No. 03 Base Shear when Shear Wall (Lift Core) Placed at Third Position

Direction	Base Shear (KN)
In X Direction	4883.68
In Z Direction	4617.01

Table 23: Case No. 03 Deflection at Roof when Shear Wall (Lift Core) at Third Position

Load combination	Deflection In mm (X direction)	Deflection In mm (Z direction)
1.2(DL+LL+EQx)	64.199	0
1.2(DL+LL+EQz)	-2.782	73.212
1.5DL+1.5EQx	81.854	0
1.5DL+1.5EQz	13.303	91.711

Table 24: Case No. 04 Deflection at Roof when Shear Wall (Lift Core) Placed at Fourth Position

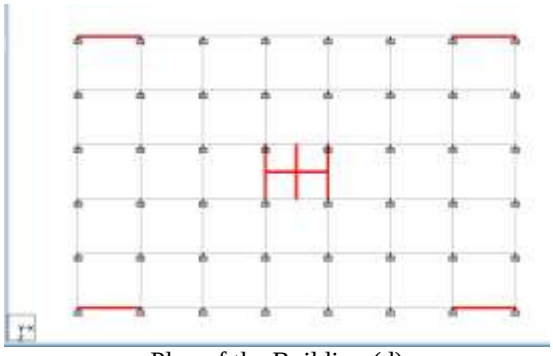
Load combination	Deflection In mm (X direction)	Deflection In mm (Z direction)
1.2(DL+LL+EQx)	59.721	0
1.2(DL+LL+EQz)	-2.474	70.906
1.5DL+1.5EQx	75.763	0
1.5DL+1.5EQz	4.877	93.015

Table 25: Case No. 04 Base Shear when Shear Wall Lift core at fourth position.

Direction	Base Shear (KN)
In X Direction	5047.41
In Z Direction	4647.17

D]

i. Case no. 1 When Shear wall (Lift core) is placed at centre of building & Shear wall (I type) is placed at corner of building in X direction
ii. Case no. 2 When Shear wall (Lift core) is displaced 7.5m from the centroid in X-direction & Shear wall (I type) is placed at corner of building in X direction
iii. Case no. 3 When Shear wall (Lift core) is displaced 15 m from the centroid in X-direction & Shear wall (I type) is placed at corner of building in x direction
iv. Case no. 4 When Shear wall (Lift core) is displaced 22.5 from the centroid in X-direction & Shear wall (I type) is placed at corner of building in x direction



Plan of the Building (d)

Table 26: Case No. 01 Deflection at Roof when Shear Wall (Lift Core) at Centre

Load combination	Deflection in mm (X direction)	Deflection in mm (Z direction)
1.2(DL+LL+EQx)	62.499	0.00
1.2(DL+LL+EQz)	0.051	78.932
1.5(DL+EQx)	79.199	0.00
1.5(DL+EQz)	0.025	99.249

Table 27: Case No. 01 Base Shear when Shear Wall (Lift Core) at Centre

Direction	Base Shear (KN)
In X Direction	4825.28
In Z Direction	4173.78

Table 28: Case No. 02 Base Shear when Shear Wall (Lift Core) Placed at Second Position

Direction	Base Shear (KN)
In X Direction	4300.27
In Z Direction	3959.86

Table 29: Case No. 02 Deflection at Roof when Shear Wall (Lift Core) at Second Position

Load combination	Deflection In mm (X direction)	Deflection in mm (Z direction)
1.2(DL+LL+EQx)	70.952	0.00
1.2(DL+LL+EQz)	-3.177	90.634
1.5DL+1.5EQx	88.373	0.00
1.5DL+1.5EQz	6.287	113.306

Table 30: Case No. 03 Base Shear when Shear Wall (Lift Core) Placed at Third Position

Direction	Base Shear (KN)
In X Direction	4314.14
In Z Direction	3731.20

Table 31: Case No. 03 Deflection at Roof when Shear Wall (Lift Core) at Third Position

Load combination	Deflection In mm (X direction)	Deflection In mm (Z direction)
1.2(DL+LL+EQx)	71.403	0
1.2(DL+LL+EQz)	-0.523	81.88
1.5DL+1.5EQx	89.974	0
1.5DL+1.5EQz	17.643	115.841

Table 32: Case No. 04 Deflection at Roof when Shear Wall (Lift Core) Placed at Fourth Position

Load combination	Deflection In mm (X direction)	Deflection In mm (Z direction)
1.2(DL+LL+EQx)	62.728	0
1.2(DL+LL+EQz)	-0.434	74.278
1.5DL+1.5EQx	78.827	0
1.5DL+1.5EQz	17.079	121.367

Table 33: Case No. 04 Base Shear when Shear Wall Lift core at fourth position.

Direction	Base Shear (KN)
In X Direction	4481.55
In Z Direction	3720.12

CONCLUSION

Study has been carried out on 16 models with different locations of shear wall. From the above observations and study, following conclusion has been drawn.

1. For all load Combinations. From it is observed that the roof displacement is minimum for model no. 5.
2. For all load Combinations it is observed that the roof displacement is maximum for plan of building (b)
3. There is reduction in roof displacement in member in plan of building (c) due to occurrence of lateral forces.
4. Lower roof displacement helps in reduction of P-Δ Effect.
5. Response quantity like storey drift, torsional irregularity etc should be calculated from actual displacement of each mode considered during analysis.
6. The response quantity from each mode should be combined using modal combination to get the maximum magnitude of that response quantity.

7. Storey Drift will not be calculated corresponding to response spectrum load cases.
8. Response Spectrum computes joint displacements that represents maximum magnitude of the response quantity that is likely to occur during seismic loading.
9. Multistory building subjected to lateral loads by changing shear wall location using Software STAAD. Pro gives lower displacement, base shear and base moment value as compare to other software.
10. Using STAAD.Pro Structure becomes more rigid and hence it gives concrete quantity more.

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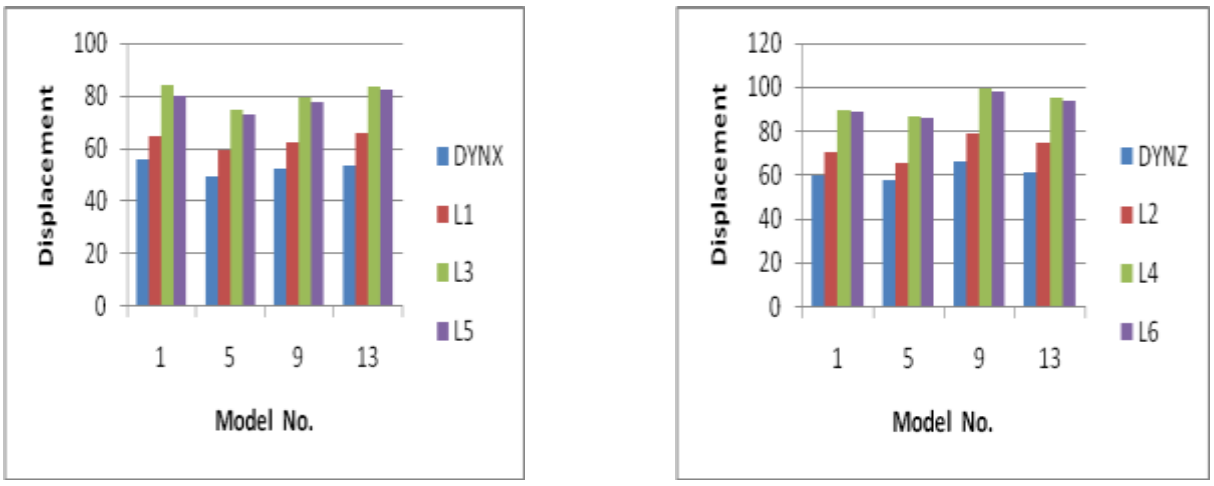

Fig. a): Roof displacement (in mm) Vs. model no. for seismic forces in x- direction & seismic forces in z- direction