

THE OPTIMUM LOCATION OF SHEAR WALL IN HIGH RISE R.C BULIDINGS UNDER LATERAL LOADING

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Abstract

Shear walls are the structural elements of the horizontal force resisting system .shear walls have high influence stiffness and strength and provided to resist gravity loads as well as lateral loads caused by seismic and wind. So many literatures are available to analyze and design of shear wall. However the optimum location and its effects in high rise r.c.buildings is not much discussed in any literatures. In this paper the main aim is to find the effective, efficient, and optimum location of shear walls in high rise irregular R.C building. In this present study the optimum location of shear wall has been investigated with the help of three different models. Model 1 is bare frame structural system and other two models are dual type structural system with central core wall and corner shear wall. An earthquake load is calculated as per IS 1893(PART-1)-2002 and applied to (G+20) storey R.C building in zone-2 and zone-5. The analysis is performed using ETABS 9.7.4 Software package.

Keywords: Shear wall, Irregular building, ETABS, analysis of structure, High rise building

1. INTRODUCTION

Shear walls are the structural system used to increase the strength of R.C.C Structure. In high rise buildings the shear wall are used to resist lateral loads that may be caused by wind and seismic motion. R.C. Shear wall provide large strength and stiffness to the building in the direction of their orientation which considerably reduces lateral sway of the building and there by reduces damage to the structure. If a high rise R.C. Structure is designed without shear wall the beam and column sizes are large and so many problems arises at the joints and due to this it is difficult to place and vibrate the concrete at such places and displacement is more which in turn induces heavy forces on the structure therefore shear wall become essential from the point of view of economy. By providing shear wall the structure become safe and durable and also more stable the function of shear wall is to increase rigidity for wind and seismic load resistance. The use of shear wall gains more popularity in the construction of service apartments or office. In this paper the main aim is to study the optimum location and its effectiveness of shear wall in irregular high rise R.C Building. In this paper we also considered irregular R.C. Building with twenty storey's and have been modeled using software package ETABS for earth quake Zone-2 and Zone-5 and wind Zone-2 and Zone-5. The effect of shear wall has been studied in this paper with the help of three different models. Model 1 is bare frame structural system and other two models are dual type structural system. The comparison of these models with different parameters like Storey displacement, Storey drift, and Storey shear has been presented by replacing the column with shear wall. In this Paper we also carried out work on both SMRF and OMRF Structure.

2. MAIN OBJECTIVES

1. The main objective is to determine the optimum position of shear wall by taking irregular plan of the building.
2. To find the optimum position of shear wall with the same cross sectional area on structural response under seismic and wind loading.
3. Equivalent static analysis is carried out for zone II & ZONE V to determine base shear.
4. To determine parameters such as base shear, displacement, storey drifts.
5. To provide guide lines for structural engineers on the serviceability and the economic aspects, that could be obtained by using shear wall.

2.1 Methodology

2.1.1 Model Data

Structure	OMRF&SMRF
No of storey	G+20
Storey height	3.0 m
Grade of concrete	M25
Grade of steel	Fe500
Thickness of slab	0.125m
Beam size	0.2x0.5m
Column size	0.2x0.75m
Seismic zone	II&V
Wind zone	II&V
Soil type	II
Importance factor	1
Response reduction factor	3&5
LL	2KN/m ²
FF	1.5KN/m ²
DL	1 KN/m ²

2.2.2 The model is an irregular plan, the analysis is Carried out using a three-dimensional of detailed finite element models

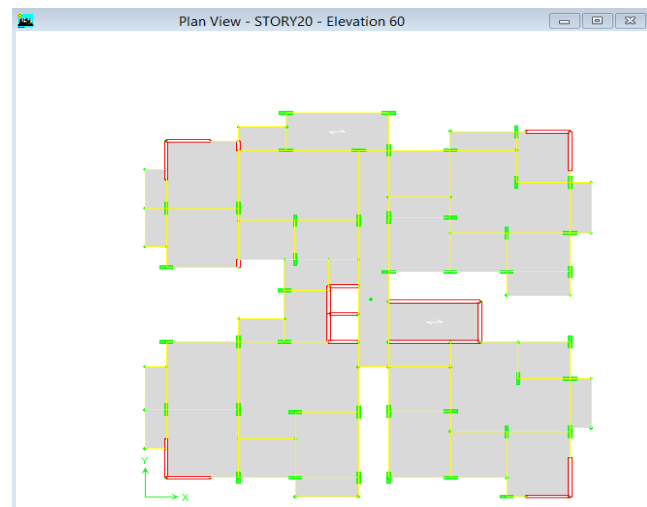


Fig -1: Plan with shear wall

2.2.3 Analysis of Structure

ETABS software is used for the analysis of structure by Equivalent static Lateral Force Method for Zone II& Zone V. And the results obtained are tabulated for the study of behavior of structure.

2.2.4 Load Calculations

The structure is subjected to three types of primary load as per the provision of IS Code of practice

They are:

- Dead Load (From IS: 875-1987(Part I))
- Live load (From IS: 875-1987(Part II))
- Seismic Load (From IS: 1893-2002(part I))

2.2.5 Method of analysis

In the study, the analysis of the high rise structure is carried out for lateral loads using Equivalent Static Force Method.

2.2.6 Assumptions

1. Material: Concrete is assumed to behave linearly elastic. The modulus of elasticity $E_c = 5000 f_c$ where the specified compressive strength of concrete f_c is assumed equal to $25 M_{pa}$.
2. Participating components: Only the primary structural components are assumed to participate in the overall behavior. The effects of secondary structural components and non structural components are assumed to be negligible: these include staircases, partitions, and openings.
3. Floor slabs: are assumed to be rigid diaphragm.
4. Constraints: Supporting bases of all structural models are fixed supports.
5. Loading:

- i. Gravity Loads: Dead load is taken as $1KN/m^2$, the building weight and its content is considered in the dead load while, the live load is taken as $2 KN/ m^2$.
 - ii. Wind loads: will be developed according to Indian standard.
6. Wind loading :

$$V_b = 33 \text{ \& } 50$$

Terrain category =2
 Structure class= B
 Risk co-efficient $K1=1$
 Topography $K3= 1$
 Sample calculations

Natural Time Period for Rigid System:

For 20 Storey building

$$T = 0.09h / \sqrt{d} = 1.069s \text{ In X-Direction}$$

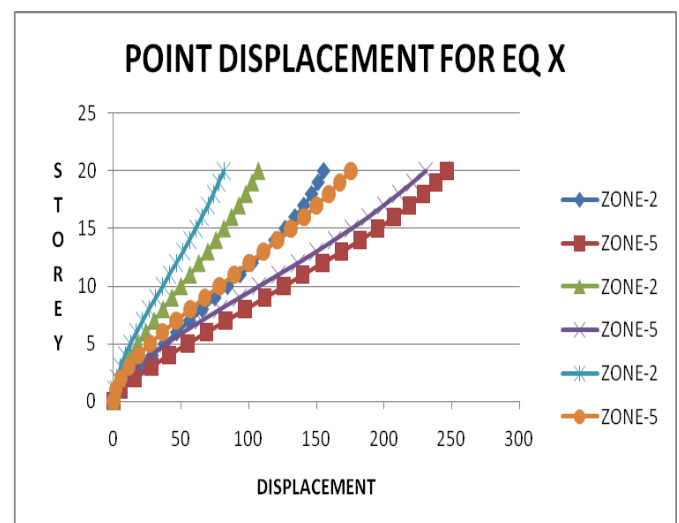
$$T = 0.09 \times 60 / (25.49)^{1/2} = 1.069s$$

$$T = 0.09h / \sqrt{d} = 1.083s \text{ In Y-Direction}$$

$$T = 0.09 \times 60 / (24.82)^{1/2} = 1.083s$$

2.2.7 Storey V/S Drift

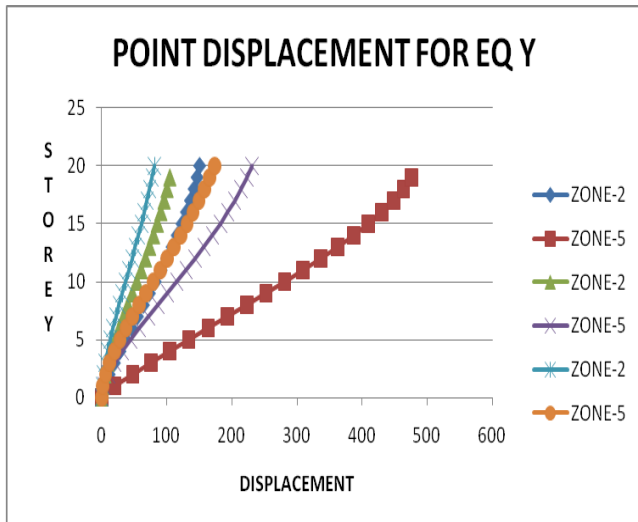
According to clause 7.11.1 of IS 1893-part1:2002 and clause IS 456:2000 the maximum allowable drift is $0.04h$ and allowable displacement is $(H/500)$ Where h is the storey height and H is the total height of the building.



Graph1: Storey v/s Displacement for G+20

Table1: Maximum storey displacement in x-direction and y-direction for earth quake(EQ X&EQ Y)

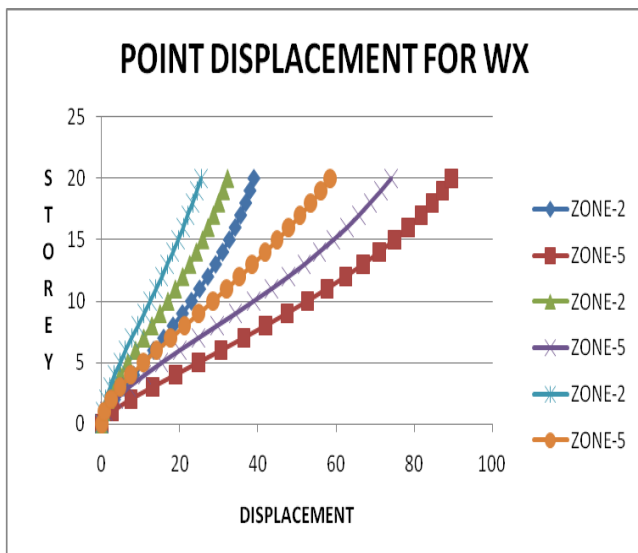
STOREY	WITH OUT SHEAR WALL		WITH CENTRAL CORE WALL		WITH CENTRAL CORE WALL AND CORNER SHEAR WALL	
	X	Y	X	Y	X	Y
20	155.6	151.1	107.3	108.3	81.6	81.4



Graph 2: Storey v/s Displacement for G+20

Table 2: Maximum storey displacement in x-direction and y-direction for earth quake (EQ X&EQ Y)

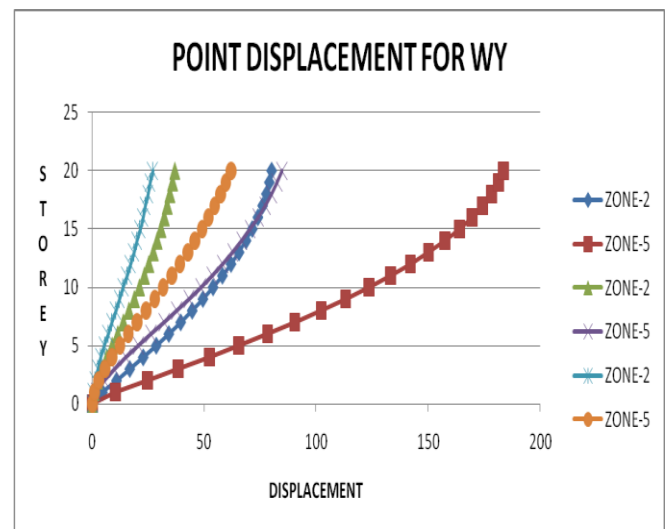
STOREY	WITH OUT SHEAR WALL		WITH CENTRAL CORE WALL		WITH CENTRAL CORE WALL AND CORNER SHEAR WALL	
	X	Y	X	Y	X	Y
20	246.9	485.7	231	231	175.7	173.7



Graph 3: Storey v/s Displacement for G+20

Table 3: Maximum storey displacement in x-direction and y-direction for Wind (WX& WY)

STOREY	WITH OUT SHEAR WALL		WITH CENTRAL CORE WALL		WITH CENTRAL CORE WALL AND CORNER SHEAR WALL	
	X	Y	X	Y	X	Y
20	39	79.9	32.3	36.9	25.5	27

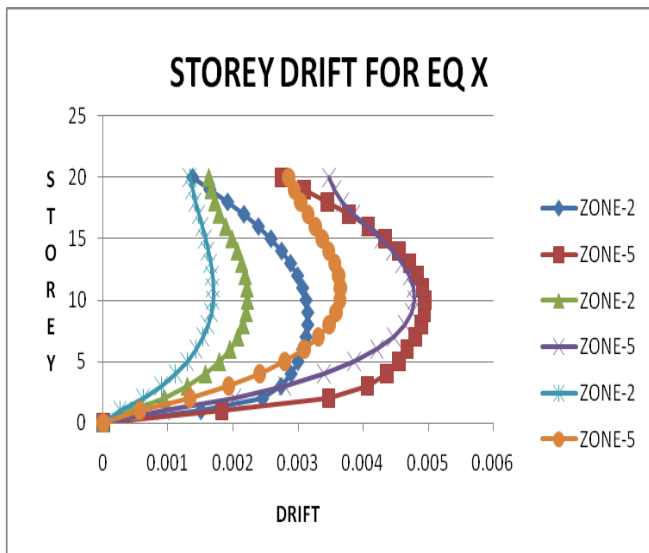


Graph 4: Storey v/s Displacement for G+20

Table 4: Maximum storey displacement in x-direction and y-direction for Wind (WX& WY)

STOREY	WITH OUT SHEAR WALL		WITH CENTRAL CORE WALL		WITH CENTRAL CORE WALL AND CORNER SHEAR WALL	
	X	Y	X	Y	X	Y
20	89.6	183.5	74.2	84.6	58.6	61.9

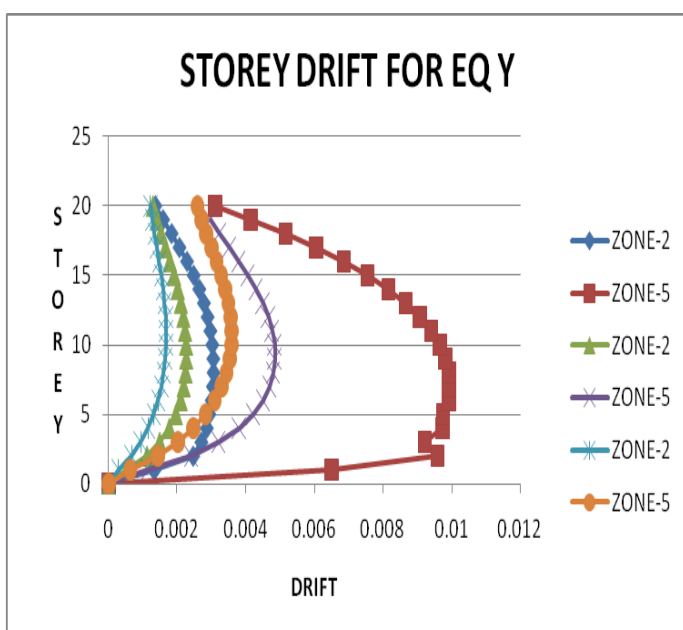
From this study we come to know that storey displacement is more in top storey compare to other storey.



Graph 5: Storey v/s Drift for G+20

Table 5: Maximum storey drift

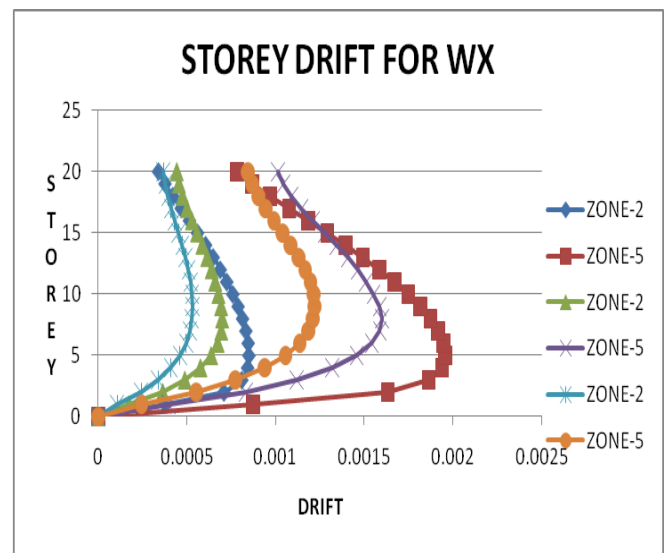
STORE Y	ZON E	WITHO UT SHEAR WALL	WITH CENTR AL CORE WALL	WITH CENTRA L CORE WALL AND CORNER SHEAR WALL
08	2	0.003143	0.002158	0.001613
08	2	0.003069	0.002247	0.001607
09	2	0.003143	0.002207	0.001662
09	2	0.003062	0.002269	0.001651
10	2	0.003117	0.002227	0.001689
10	2	0.003033	0.002265	0.001674
11	2	0.003065	0.002222	0.001695
11	2	0.002977	0.002235	0.001678



Graph 6: Storey v/s Drift for G+20

Table 6: Maximum storey drift

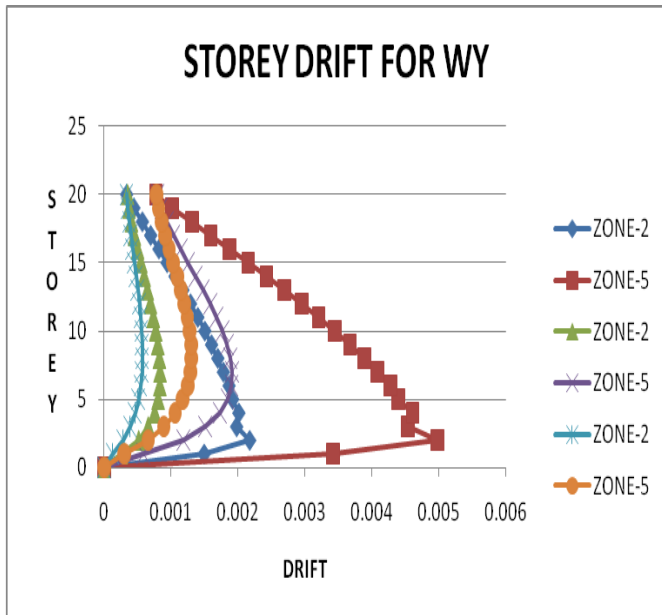
STORE Y	ZON E	WITHO UT SHEAR WALL	WITH CENTR AL CORE WALL	WITH CENTR AL CORE WALL AND CORNE R SHEAR WALL
07	5	0.001827	0.000926	0.000565
07	5	0.00993	0.002414	0.001434
09	5	0.004945	0.004753	0.003581
09	5	0.009817	0.004849	0.003534
10	5	0.004952	0.004796	0.003638
10	5	0.009652	0.004836	0.003581
11	5	0.004917	0.004783	0.00365
11	5	0.009404	0.00477	0.003587



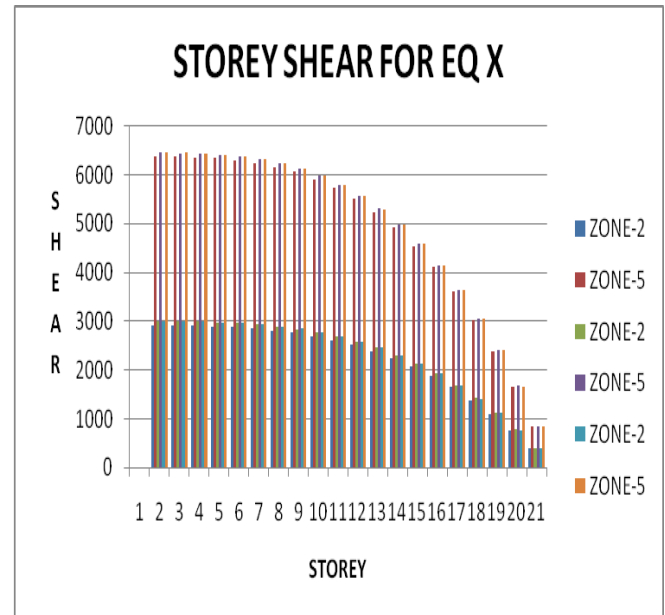
Graph 7: Storey v/s Drift for G+20

Table 7: Maximum storey drift

STORE Y	ZON E	WITHO UT SHEAR WALL	WITH CENTRA L CORE WALL	WITH CENTRA L CORE WALL AND CORNER SHEAR WALL
02	2	0.000711	0.000363	0.000241
02	2	0.00217	0.000514	0.000287
05	2	0.000852	0.000635	0.00046
05	2	0.001915	0.000802	0.000513
07	2	0.000835	0.000692	0.000516
07	2	0.001778	0.000831	0.000564
08	2	0.000816	0.000697	0.000526
08	2	0.001695	0.000821	0.00057
09	2	0.000791	0.000691	0.000532
09	2	0.001601	0.000798	0.000568



Graph 8: Storey v/s Drift for G+20



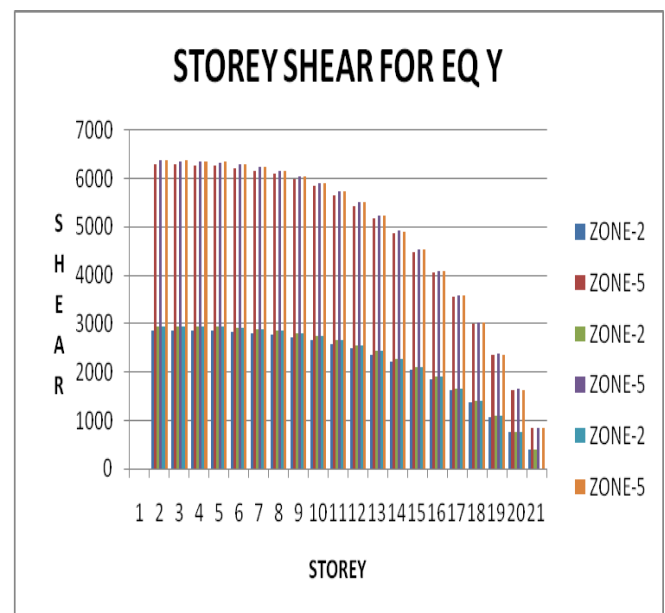
Graph 9: Shear v/s Storey for G+20

Table 8: Maximum storey drift

STOREY	ZONE	WITH OUT SHEAR WALL	WITH CENTRAL CORE WALL	WITH CENTRAL CORE WALL AND CORNER SHEAR WALL
02	5	0.001632	0.000834	0.000552
02	5	0.004983	0.00118	0.000659
05	5	0.001957	0.001457	0.001057
05	5	0.004396	0.001842	0.001179
07	5	0.001917	0.001588	0.001184
07	5	0.004081	0.001909	0.001294
08	5	0.001873	0.001601	0.001208
08	5	0.003892	0.001884	0.00131
09	5	0.001816	0.001587	0.00122
09	5	0.003675	0.001832	0.001305

Table 9: Maximum storey Shear in x-direction and y-direction for Earth Quake (EQX& EQY)

STO REY	WITH OUT SHEAR WALL		WITH CENTRAL CORE WALL		WITH CENTRAL CORE WALL AND CORNER SHEAR WALL	
	X	Y	X	Y	X	Y
01	2903.1	2865.58	2988.57	2949.94	2990	2951.35



Graph 10: Shear v/s Storey for G+20

Table 10: Maximum storey Shear in x-direction and y-direction for Earth Quake (EQX& EQY)

STOR EY	WITH OUT SHEAR WALL		WITH CENTRAL CORE WALL		WITH CENTRAL CORE WALL AND CORNER SHEAR WALL	
	X	Y	X	Y	X	Y
01	6375 .5	6293. 09	6454. 05	6370. 62	6457. 14	6373. 67

Table 12: Maximum storey Shear in x-direction and y-direction for Wind (WX& WY)

STOR EY	WITH OUT SHEAR WALL		WITH CENTRAL CORE WALL		WITH CENTRAL CORE WALL AND CORNER SHEAR WALL	
	X	Y	X	Y	X	Y
01	1438 .7	1478. 15	1438 .7	1478. 15	1438 .7	1478. 15

From this study we concluded that storey shear is more at the bottom storey compare to other storey.

3. CONCLUSION

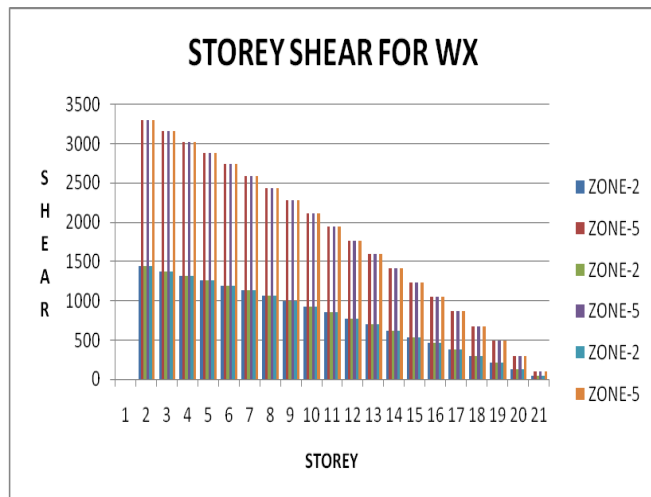
In this paper the study is carried out according to earthquake code book IS 1893[PART-I] 2002 and wind code book IS 875 [PART-I]-1987 and analysis is carried out by taking irregular plan of building [G+20] on medium [ZONE-II] and severe [ZONE-V] and soil [TYPE-II] and also in this paper the seismic analysis of irregular plan of building is done by both static earthquake and static wind analysis and also in this paper we also done comparison by providing shear wall at four edges with without shear wall in the irregular plan to determine the optimum position of shear wall.

The following are the conclusion taken in this paper

1. The plan without shear wall gives more displacement and more drift compare to plan with shear wall along four edges.
2. Hence by providing shear wall along four edges we can reduce storey displacement, storey drift, storey shear and also we can increase strength and stiffness of the structure.
3. Hence we concluded that by providing shear wall along four edges is found to be optimum position of shear wall

REFERENCES

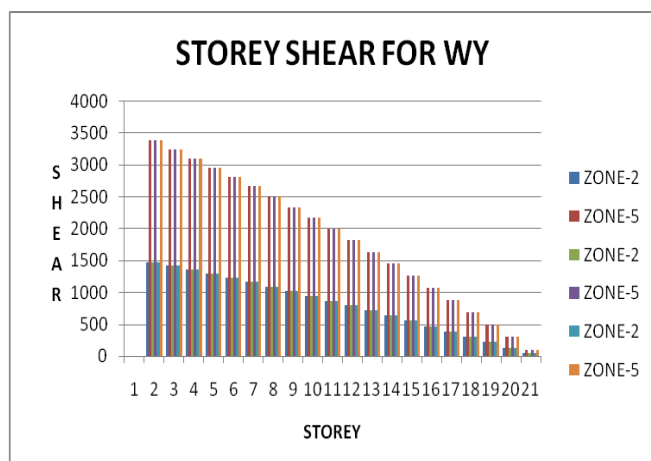
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 [2]. IS 875[PART-I]-1987, "Code of practice for design loads (other than earthquake) for buildings and structures. Dead loads unit weights of building materials and stored materials, Bureau of Indian standard, New Delhi.
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 [6]. ETABS Nonlinear ver.9, Extended Three Dimensional analysis of building systems, computers and structures Inc. Berkeley, CAUSA,2006.



Graph 11: Shear v/s Storey for G+20

Table 11: Maximum storey Shear in x-direction and y-direction for Wind (WX& WY)

STOR EY	WITH OUT SHEAR WALL		WITH CENTRAL CORE WALL		WITH CENTRAL CORE WALL AND CORNER SHEAR WALL	
	X	Y	X	Y	X	Y
01	1438 .7	1478. 15	1438 .7	1478. 15	1438 .7	1478. 15



Graph 12: Shear v/s Storey for G+20

BIOGRAPHIES



Associate professor, Civil Engineering Department, has an working experience of 30yrs in Dr Ambedkar Institute of Tecnology Bengaluru



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