PARAMETRIC STUDIES ON REALISTIC HIGH RISE BUILDING UNDER SEISMIC LOADING WITH SPECIAL EMPHASIS ON SHEAR WALL

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ABSTRACT: *Shear wall are one of the excellent means of providing earthquake resistance to multistorey reinforced concrete building. They have high plane stiffness and strength which can be utilized to simultaneously resist large seismic loads and support gravity loads. Buildings with shear walls which are properly designed and detailed have shown very good performance in past earthquakes. These can be used for improving seismic response of buildings. Shear walls are easy to construct and are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structure. It is very necessary to determine effective, efficient and ideal location of shear wall. In this project, a study has been carried out to determine the optimum structural configuration of a 17 storeys building in zone II by changing the shear wall locations. Three different cases of shear wall position are studied by computer application software ETABS. The structures were modelled with different configurations of shear walls such as L shape, core and rectangular shaped shear wall. Parameters such storey shear, storey drifts, and column displacement were considered. From the study conducted, it was observed that maximum reduction in seismic response was observed when an L shape wall is placed at four corners when compared to rectangular shear wall and core shaped wall. The outcome of the project clearly indicates that the structural designer must have knowledge of relevant codes, expertise on the software usage, he must place shear walls of precise dimensions at appropriate locations. Critical analysis considering all relevant load cases, comparison of parameters such as forces, column displacements, story drifts and especially shear forces in case of lateral loads is essential.*

Keyword: **Shear wall, Seismic load, storey drift, storey shear, column displacement and ETABS.**

1. INTRODUCTION

Shear walls are mainly flexural members and usually provided in high rise buildings. They are specially designed structural walls included in the buildings to resist horizontal forces such as wind and earthquake forces. If the structure is constructed to resist these horizontal forces then high amount of reinforcement and larger size of beams and columns should be provided which is uneconomical. Shear walls play prominent role in resisting the earthquake force and it is economical too. The structures can be made as earthquake resistant by the provision of shear walls at different locations within the structure since shear walls are very effective in resisting earthquake forces.

The principal objectives of the paper are

- To study the effect of storey drift, storey shear and column displacement in R.C.C building while changing shear wall position.
- To compare the effect of different configurations of shear walls (Core, L-shape, Rectangular) for effective reduction in seismic response parameters using ETABS software.

In this paper, G+17 storied building is analyzed for the critical load combinations (1.5D.L + 1.5 EQX), (1.5D.L - 1.5EQX), (1.5D.L + 1.5 EQY), (1.5D.L - 1.5 EQY) using ETABS. The effect of change in position of shear wall with respect to storey drift, storey shear and column displacements are analyzed.

Load combination recommended by IS 1893 (part1):2016 are:

1. 1.5 (D.L + L.L)
2. 1.5 (D.L + EQX)
3. 1.5 (D.L - EQX)

4. 1.5 (D.L + EQY)
5. 1.5 (D.L - EQY)
6. 1.2 (D.L + L.L + EQX)
7. 1.2 (D.L + L.L – EQX)
8. 1.2 (D.L + L.L + EQY)
9. 1.2 (D.L + L.L - EQY)
10. 0.9D.L + 1.5EQX
11. 0.9D.L - 1.5EQX
12. 0.9D.L + 1.5EQY
13. 0.9D.L -1.5EQY

1. PROJECT DETAILS

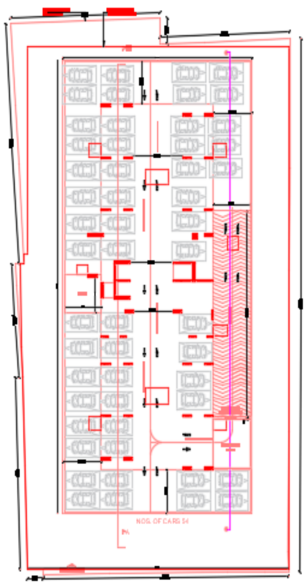

Fig 1 Architectural plan of building

A R.C.C. (G+17) residential building is considered having parking at basement. Floor to floor height is 3m and total height of building is 64m. The building is situated in earthquake zone II i.e., zone factor 0.10. Soil is of type II (medium) and Importance factor considered is 1.2. Grade of concrete is M35 and grade of steel is Fe 500.

The following loads are considered / applied on the building:

- Dead load of the building i.e., Self weight of all R.C.C. members and brickwork as per IS 875 part1
- Live load for all the floors = 2KN/m2 as per IS 875 part 2
- Earthquake load as per IS 1893 (part 1) 2016

The plan of the building model are given below

Case1 – Shear wall at lift.

Case 2 – Corner Shear wall.

Case 3 – L shape shear wall.

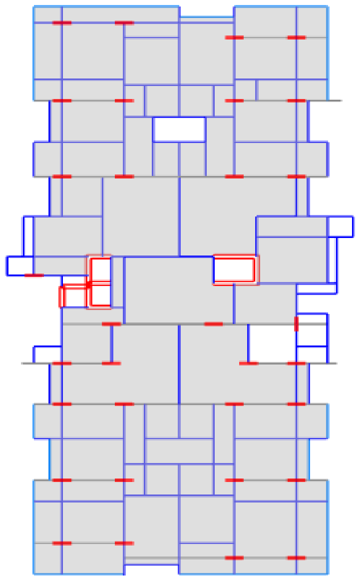

Fig 2 Shear wall at lift

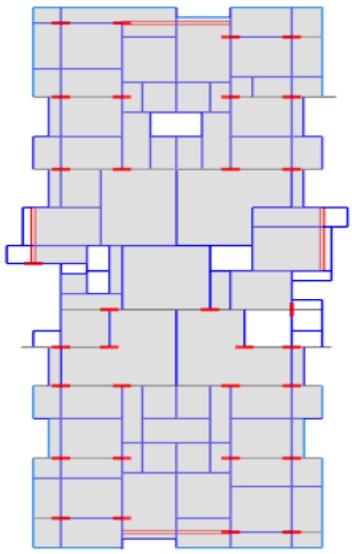

Fig 3 Corner shear wall

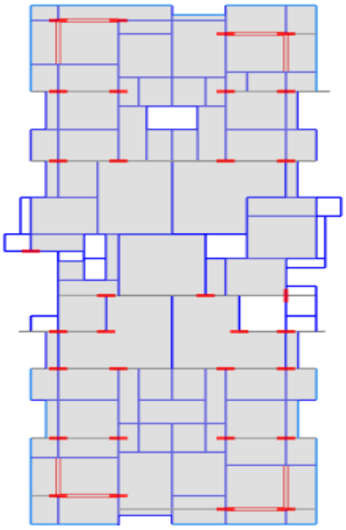

Fig 4 L shape shear wall

2. ANALYSIS OF DATA GENERATED

Critical load combinations for Earthquake are: (1.5D.L + 1.5 EQX), (1.5D.L - 1.5EQX), (1.5D.L + 1.5 EQY), (1.5D.L - 1.5 EQY)

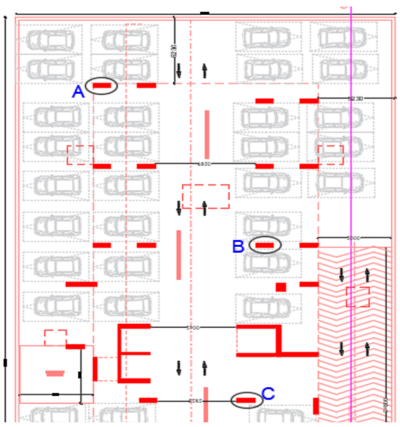

Fig 5 Different column location

3 columns are selected from different locations in the building for detailed study Column A Position: Corner Column B Position: Middle, Column C Position: Inner

Following analysis is done by using ETABS software:

- Floor wise displacements for critical combinations of earthquake for different model.
- Storey shear along various heights for critical combinations of earthquake for different model.
- Storey drift along various heights for critical combinations of earthquake for different model

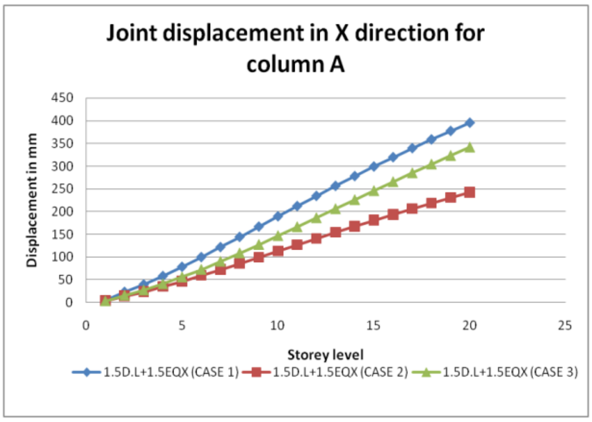

Fig 6: Joint displacement in X direction of column A for load case (1.5D.L+1.5EQX)

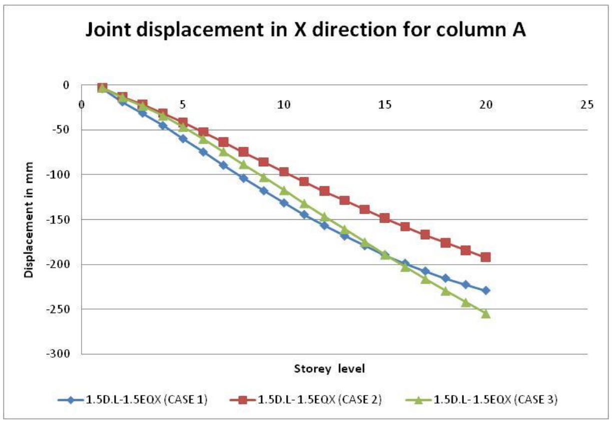

Fig 7: Joint displacement in X direction of column A for load case (1.5D.L-1.5EQX)

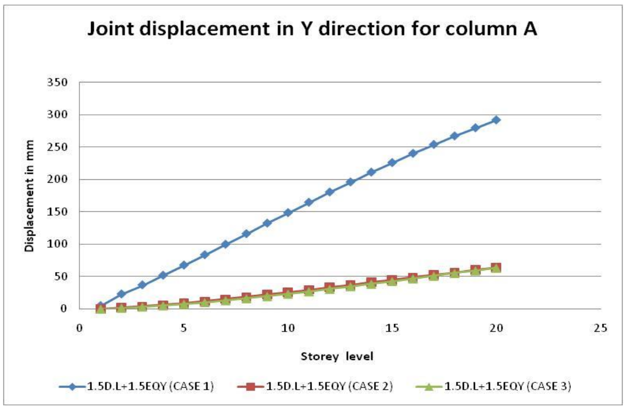

Fig 8: Joint displacement in Y direction of column A for load case (1.5D.L+1.5EQY)

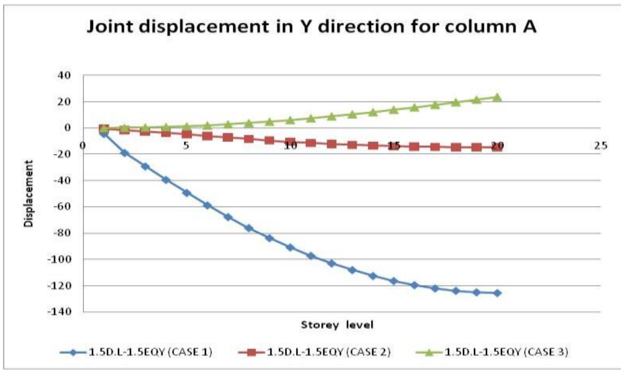

Fig 9: Joint displacement in Y direction of column A for load case (1.5D.L-1.5EQY)

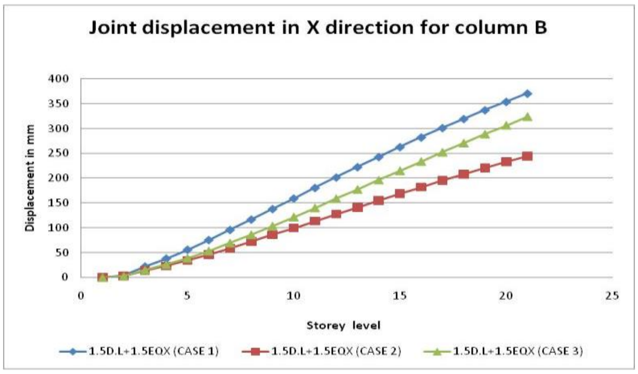

Fig 10: Joint displacement in X direction of column B for load case (1.5D.L+1.5EQX)

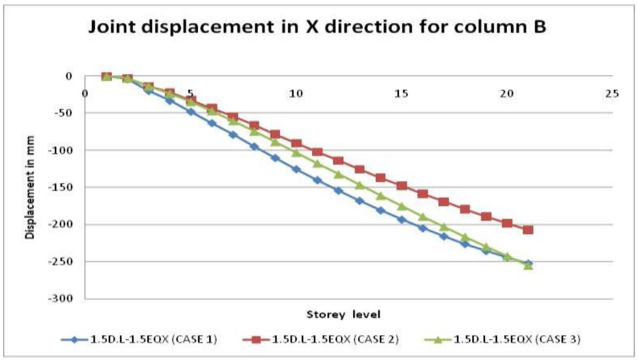

Fig 11: Joint displacement in X direction of column B for load case (1.5D.L-1.5EQX)

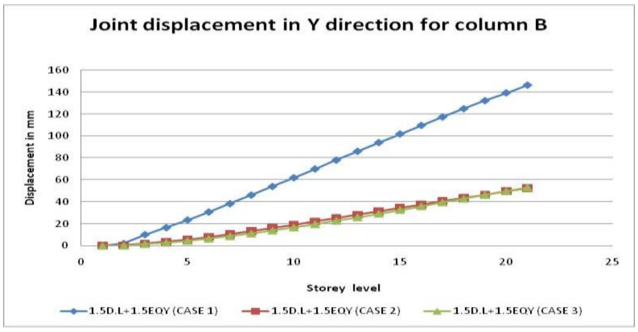

Fig 12: Joint displacement in Y direction of column B for load case (1.5D.L+1.5EQY)

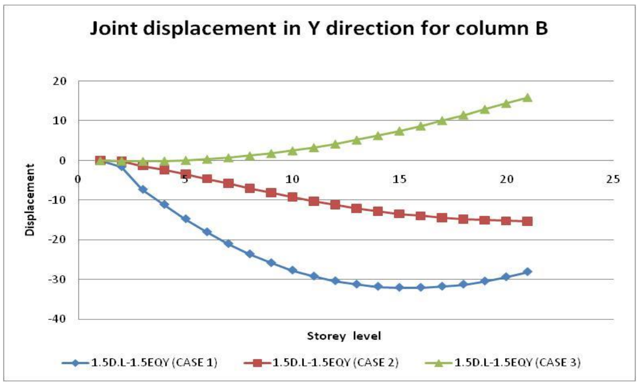

Fig 13: Joint displacement in Y direction of column B for load case (1.5D.L-1.5EQY)

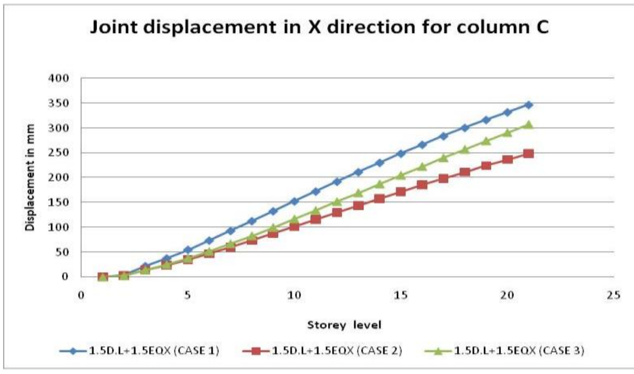

Fig 14: Joint displacement in X direction of column C for load case (1.5D.L+1.5EQX)

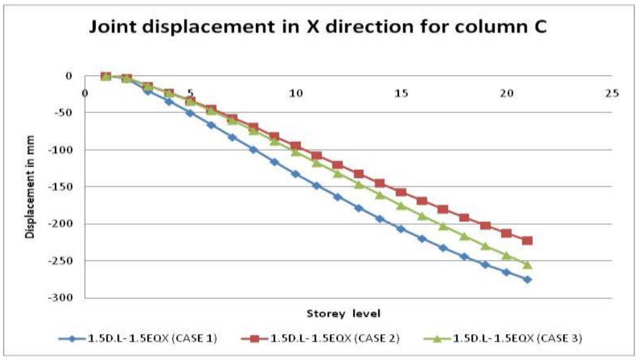

Fig 15: Joint displacement in X direction of column C for load case (1.5D.L-1.5EQX)

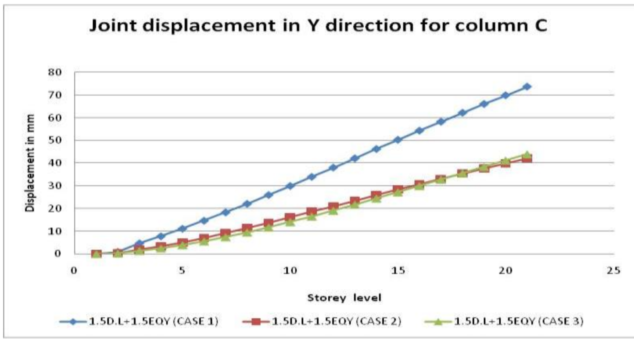

Fig 16: Joint displacement in Y direction of column C for load case (1.5D.L+1.5EQY)

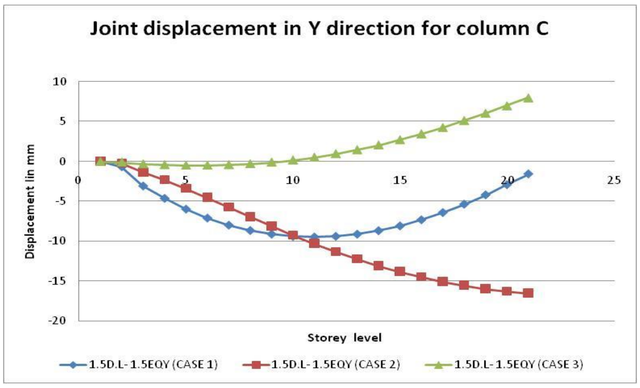

Fig 17: Joint displacement in Y direction of column C for load case (1.5D.L-1.5EQY)

Story	Elevation	CASE 1	CASE 2	CASE 3
BASE	0	0	0	0
GROUND	3	0.000979	0.00073	0.000714
PODIUM	7.67	0.002536	0.001624	0.001673
FIRST	10.67	0.003364	0.002172	0.002347
SECOND	13.67	0.003709	0.002508	0.002771
THIRD	16.67	0.003921	0.00276	0.003103
FOURTH	19.67	0.004082	0.00295	0.003364
FIFTH	22.67	0.004184	0.003091	0.003566
SIXTH	25.67	0.004236	0.003195	0.003722
SEVENTH	28.67	0.004252	0.00327	0.003842
EIGHT	31.67	0.00424	0.003322	0.003933
NINTH	34.67	0.004206	0.003354	0.004
TENTH	37.67	0.004151	0.003367	0.004046
ELEVENTH	40.67	0.004075	0.003361	0.00407
TWELVE	43.67	0.003977	0.003334	0.004073
THIRTEEN	46.67	0.00386	0.003287	0.004053
FOURTEEN	49.67	0.00371	0.003219	0.004012
FIFTEEN	52.67	0.003538	0.003132	0.00395
SIXTEEN	55.67	0.003346	0.003032	0.00387
SEVENTEEN	58.67	0.003149	0.002928	0.00378
TERRACE	61.67	0.002991	0.002806	0.003672
LWT	64.52	0.003	0.00219	0.002876
TOP WT	66.32	0.003021	0.002031	0.002677

Table 1: Storey drift in X direction

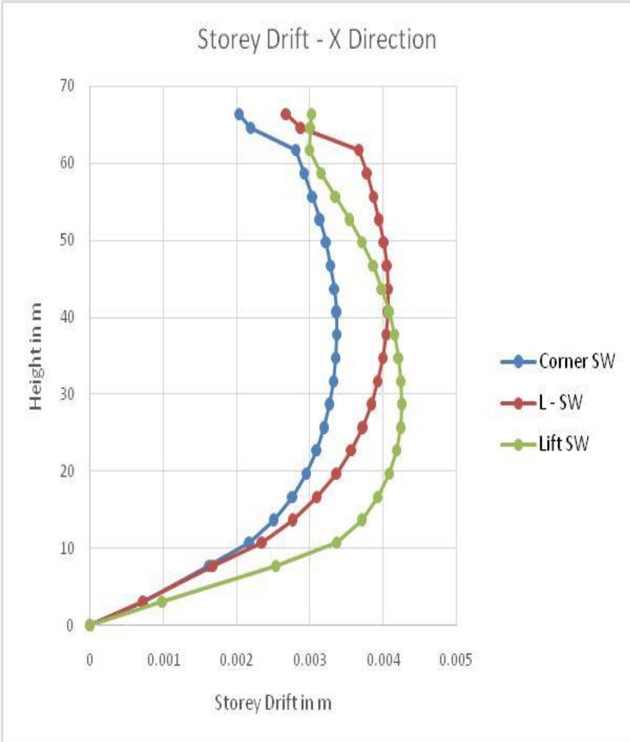

Fig 18: Storey drift along height in X direction

Story	Elevation	CASE 1	CASE 2	CASE 3
BASE	0	0	0	0
GROUND	3	0.000136	0.000112	0.000174
PODIUM	7.67	0.000296	0.000137	0.000331
FIRST	10.67	0.000362	0.000171	0.000372
SECOND	13.67	0.000403	0.000199	0.000375
THIRD	16.67	0.000429	0.00022	0.000372
FOURTH	19.67	0.000445	0.000237	0.000374
FIFTH	22.67	0.000452	0.00025	0.000383
SIXTH	25.67	0.000453	0.000259	0.000397
SEVENTH	28.67	0.00045	0.000266	0.000411
EIGHT	31.67	0.000442	0.000269	0.000425
NINTH	34.67	0.000431	0.000271	0.000436
TENTH	37.67	0.000417	0.00027	0.000447
ELEVENTH	40.67	0.0004	0.000268	0.000457
TWELVE	43.67	0.000381	0.000264	0.000468
THIRTEEN	46.67	0.000361	0.000259	0.000478
FOURTEEN	49.67	0.000338	0.000252	0.000487
FIFTEEN	52.67	0.000316	0.000246	0.00049
SIXTEEN	55.67	0.000294	0.000241	0.000486
SEVENTEEN	58.67	0.000273	0.000237	0.00047
TERRACE	61.67	0.000255	0.000235	0.000446
LWT	64.52	0.000873	0.000601	0.000429
TOP WT	66.32	0.000769	0.000571	0.000476

Table 2: Storey drift in Y direction

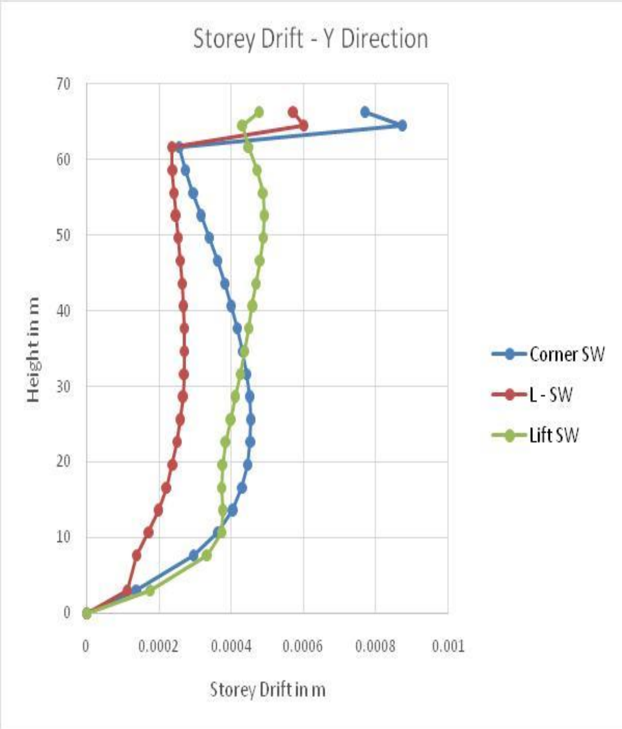

Fig 19: Storey drift along height in Y direction

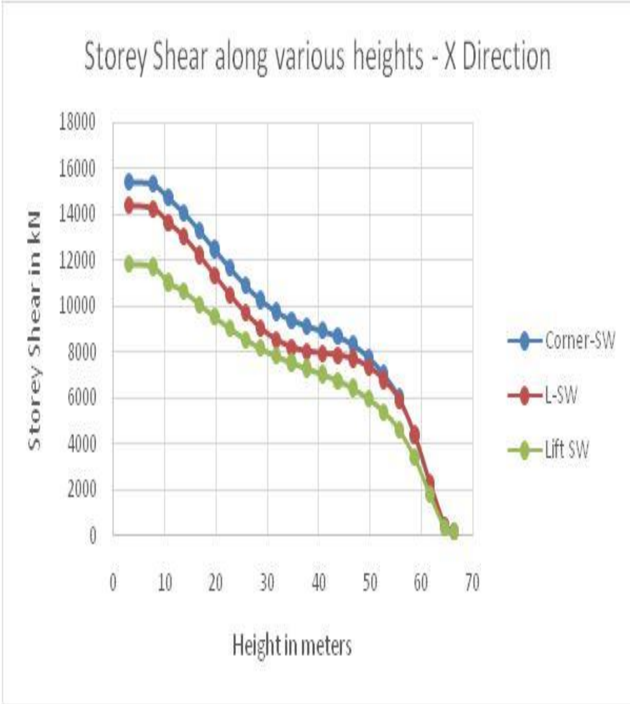

Fig 20: Storey shear along height in X direction

Story	Elevation	CASE 1	CASE 2	CASE 3
	m	kN	kN	kN
BASE	0	0	0	0
GROUND	3	15402.116	14362.975	11810.83
PODIUM	7.67	15305.798	14229.286	11690.58
FIRST	10.67	14709.473	13628.426	11013.34
SECOND	13.67	14074.984	13009.344	10621.98
THIRD	16.67	13292.497	12199.133	10058.46
FOURTH	19.67	12463.762	11333.907	9504.028
FIFTH	22.67	11647.876	10475.273	8984.558
SIXTH	25.67	10900.599	9691.1568	8523.619
SEVENTH	28.67	10262.205	9031.1337	8125.19
EIGHT	31.67	9757.6538	8529.9682	7789.016
NINTH	34.67	9391.4953	8204.0913	7504.204
TENTH	37.67	9132.4562	8030.0006	7250.54
ELEVENTH	40.67	8917.7622	7943.6915	7003.676
TWELVE	43.67	8672.4792	7862.7292	6731.154
THIRTEEN	46.67	8318.4221	7697.8598	6391.446
FOURTEEN	49.67	7766.5018	7346.0962	5937.874
FIFTEEN	52.67	7020.1858	6786.2073	5365.357
SIXTEEN	55.67	5987.6038	5890.0078	4575.248
SEVENTEEN	58.67	4360.3047	4390.9109	3358.382
TERRACE	61.67	2209.5677	2288.1935	1735.501
LWT	64.52	395.0416	461.6474	324.1592
TOP WT	66.32	171.0788	207.2429	142.592

Table 3: Storey shear in X direction

Story	Elevation	CASE 1	CASE 2	CASE 3
	m	kN	kN	kN
BASE	0	0	0	0
GROUND	3	1322.3046	717.0014	1604.9431
PODIUM	7.67	1315.7859	714.7686	1567.8501
FIRST	10.67	1261.375	697.0547	1362.6156
SECOND	13.67	1204.738	680.885	1171.0499
THIRD	16.67	1141.388	663.0189	1031.9119
FOURTH	19.67	1078.1344	640.6944	960.5624
FIFTH	22.67	1019.2848	613.7517	948.7731
SIXTH	25.67	967.4458	586.8936	970.291
SEVENTH	28.67	922.1118	562.2987	990.2578
EIGHT	31.67	881.2956	537.2126	998.516
NINTH	34.67	843.9679	510.3027	997.6988
TENTH	37.67	808.3844	484.7326	983.1686
ELEVENTH	40.67	769.3688	461.3301	962.0739
TWELVE	43.67	720.0729	433.6006	948.792
THIRTEEN	46.67	658.0761	394.8945	956.0031
FOURTEEN	49.67	583.7884	346.9288	984.1122
FIFTEEN	52.67	516.7964	295.6772	1009.5406
SIXTEEN	55.67	447.4883	241.1039	988.2911
SEVENTEEN	58.67	326.216	175.1911	844.0035
TERRACE	61.67	167.7177	100.6107	508.8558
LWT	64.52	69.3658	82.5535	110.4085
TOP WT	66.32	35.4964	43.0672	49.3928

Table 4: Storey shear in Y direction

Fig 21: Storey shear along height in Y direction

3. OBSERVATIONS

Following observations are drawn from the tables and graphs:

- Critical load combinations for Earthquake are: (1.5D.L + 1.5 EQX), (1.5D.L - 1.5EQX), (1.5D.L + 1.5 EQY), (1.5D.L - 1.5 EQY).
- By providing different shape of shear walls there is reduction in column displacement.

4. CONCLUSIONS

From the results of this project, the following conclusions are drawn

- Providing shear walls at adequate locations substantially reduces the displacements in column.
- The presence of shear wall can increase the strength and stiffness of the structure.
- Building with L shape Shear Wall showed better performance in terms of storey drifts and storey shear.
- Structural designer must critically understand provisions of IS 1893 :(Part-1) 2016 and IS13920 for appropriate seismic analysis and design of high rise structures.
- It is essential to decide the locations of shear walls at planning stage, there relevance in resisting lateral forces and displacements need to be worked out.

5. ACKNOWLEDGEMENTS

I would like to express my deep sense of gratitude to my professor Dr. A. M. Pande for his patient guidance, enthusiastic encouragement and useful critiques of this research work.

6. REFERANCES

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