"Effective Location of Shear Wall on Performance of Building Frame Subjected to Lateral Load"

Hussain Narayangarhwala[1], Prof. Sourabh Dashore[2]

[1]M.TECH. Student SIMS Indore (M.P.) INDIA
[2]M.TECH. Civil Head SIMS Indore (M.P.) INDIA

---***---

Abstract - - *The practice prior to the 1960s was to design buildings mainly for gravitational loads and to verify the adequacy of the safety structure against side loads It has been set up that the plan of a multi-story building is represented by side loads and ought to be the planner's principle worry to give sufficient security to the structure against side loads. Many existing RC buildings located in seismic areas are lacking to withstand earthquakes. Insufficient lateral resistance and poor reinforcement details are the main reasons for inadequate seismic performance. The shear wall system is one of the most commonly used side load resistance techniques for skyscrapers. The shear walls have a very high resistance and rigidity in the plane, which can be used simultaneously to withstand large horizontal loads and gravity. In tall buildings, it is very important to ensure adequate lateral rigidity to withstand lateral loading.*

The objective of this project is to determine the solution for the position of the shear wall in multi-storey buildings. To this end, four different models of buildings of eight floors each were considered, namely a model without a cutting wall and three others with walls cut in different areas. The models are studied in the four zones to compare the lateral displacement and the transfer of the load to various structural elements with different positions of the shear wall. The seismic load is calculated according to IS: 1893-2002 (Part 1), the various parameters such as the response reduction factor, the importance factor, the zone factor are taken from IS: 1893-2002.

(Part 1) and apply to a building located in Zone II, Zone III, Zone IV and Zone V. Buildings are modeled using the non-linear ETAB software v 17.0.1.

Providing shear walls in suitable positions substantially reduces displacements due to earthquakes. Therefore, the accounting separation wall in a building will form an efficient lateral force resistance system. Finally, I concluded that the small size of the shear wall is no more effective than the large size of the shear wall to control lateral movement in buildings with 10 or more than 10 floors

***Key Words*: Shear Wall, Optimization, Seismic Forces, Concrete Structures.**

1. INTRODUCTION -

A skyscraper is a tall building, unlike a low-rise building and is defined by its height differently in different jurisdictions. It is used as a residential building, offices or other functions, including hotels, retail stores or multiple combined purposes. Residential skyscrapers are also known as tower blocks and can be called "MDU", which means "multi-unit housing". A tall skyscraper is known as a skyscraper.

A building or bulding may be a structure with a roof and walls positioned additional or less for good in an exceedingly place, sort of a house or a manufactory. Buildings are available in a variety of sizes, shapes and functions and have been adapted throughout history by a large number of factors, from available building materials, weather conditions, land prices, soil conditions, to uses specific and aesthetic reasons. To all the more likely comprehend the term building, think about the rundown of structures without a structure. Structures meet different social needs, for the most part as an asylum from time, security, living space, protection, to safeguard belongings and to live and work serenely.

Resistance, rigidity and ductility are the essential requirements of the shear wall and must be evaluated for their structural performance (Law et al. 1979; Farvashany et al. 2008; IS 13920 1993; IS 4326 1993). Resistance limits damage and stiffness reduces deformation in the shear wall. Ductility, defined as the ability to withstand inelastic deformations without much degradation in strength and rigidity, has been considered an essential requirement, especially in conditions of high dynamic load. Therefore, the basic criteria that the designer must satisfy when designing the shear walls in anti-seismic structures are the following:

1.1 Problem Formulation -

G+10 storied buildings are modeled using conventional beams, columns & slabs. These buildings were given square geometry with plan dimensions of 18m x 18m. They are loaded with Dead, Live and Seismic Forces (according to IS:1893:2002). These models are analyzed victimization response spectrum methodology for earthquake zone V of India (Zone Factor = 0.36). The details of the modeled building are listed below. Modal damping of 5% is considered with OMRF having Shear Walls (Response Reduction Factor, R=3) and Importance Factor (I) =1. The performance of the models is recorded through ETABS to present a brief idea about the optimum shear wall positioning.

1.2 OBJECTIVES OF THIS STUDIES -

The main objectives of the thesis are to perform dynamic analyzes and obtain seismic yields of different forms of structures located in the area of severe earthquake (V) with intermediate ground conditions in India and to evaluate shear forces, overturning moment, lateral displacement and moving the floor.

1. Concentrate the exhibition of high rises with various places of shear dividers.

2. It studies the effect of shear walls in skyscrapers geometric with and without a shear wall.

3. Study this effect on the parameters of lateral displacement and drift of the floor.

4. Compare the skyscrapers with the above parameters for the medium soil condition in Zone IV.

5. Study the performance of skyscrapers with geometric shape and also study on different location with and without Shear wall.

6. To calculate the maximum bending moment, the maximum shear force, the maximum axial force on the beam and on the column.

2. GEOMETRY & DETAILING OF SHEAR WALLS

In structural engineering, a shear wall is a vertical element of a system of resistance to seismic force designed to withstand lateral forces in the plane, typically wind and seismic loads. In many jurisdictions, the International Building Code and the International Residential Code regulate the design of shear walls.

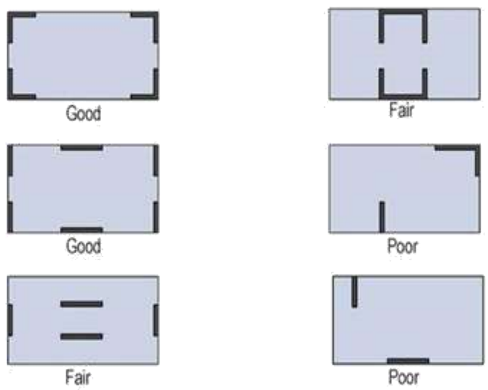

Chart -1: Different Location of Shear Wall.

A shear wall resists masses parallel to the plane of the wall. Collectors also known as drag members; transfer the cut of the diaphragm to the cutting walls and to other vertical elements of the seismic resistance system. The cutting walls are generally wooden walls with light frames or reinforcements with cutting panels, walls in reinforced concrete, walls in reinforced masonry or steel plates.

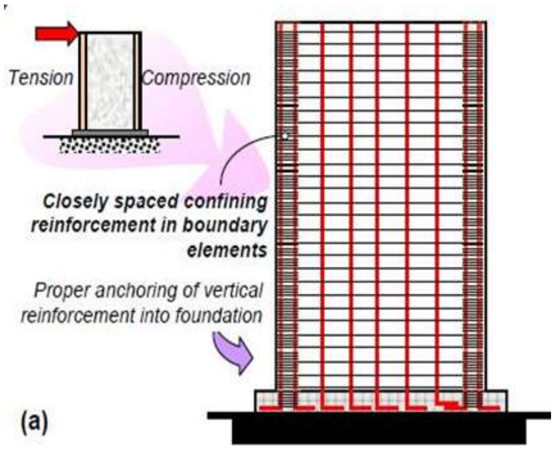

Fig -1: : Layout of Main Reinforcement in Shear Wall as per IS:13920:1993

2.1 Loading and Failure Mechanism. –

A shear wall is more rigid in its main axis than in the other axis. It is considered a primary structure that provides a relatively rigid resistance to the vertical and horizontal forces acting on its plane. In this condition of combined loading, a cutting wall develops axial, shear, tension and flexion compatible deformations, with the consequent complicated distribution of the internal forces. In this way, the loads are transferred vertically to the building foundations.

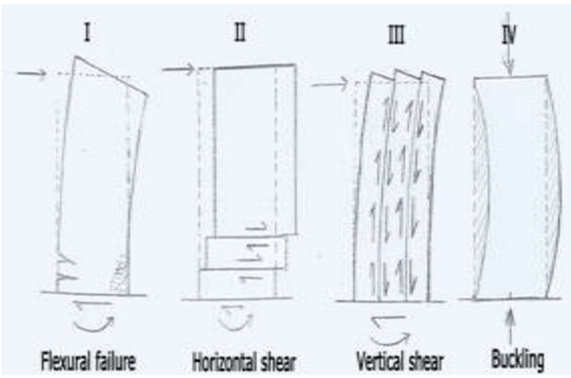

Fig -2: Failure Mechanism Of Shear Wall

2.2 MODELLING IN ETABS –

Exact seismic analysis of the structure is highly complex and to tackle this complexity, numbers of researches have been done with an aim to counter the complex dynamic effect of seismic induced forces in structures, for the design of earthquake resistant structures in a refined and easy manner. For this project, four models were made. Their description is as follows:

Case [1] Conventional Frame (Fig. 2)

Case [2] Building with Shear Walls on Periphery at Corners (Fig. 3)

Case [3] Building with Shear Walls on Periphery at Centers (Fig. 4)

Case [4] Building with Box-type Shear Wall at the center of the geometry (Fig. 5)

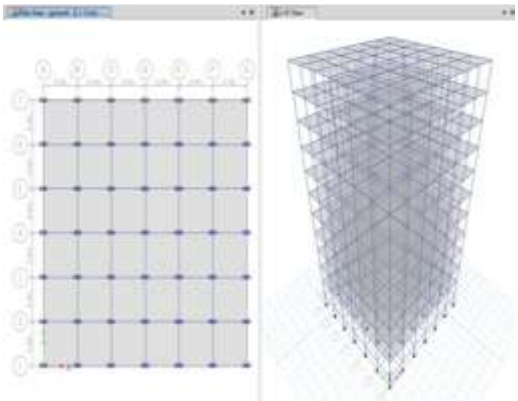

Fig: 2 Conventional Frame

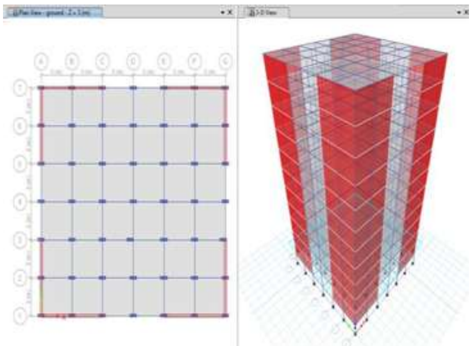

Fig: 3 Shear Walls on Periphery at Corner

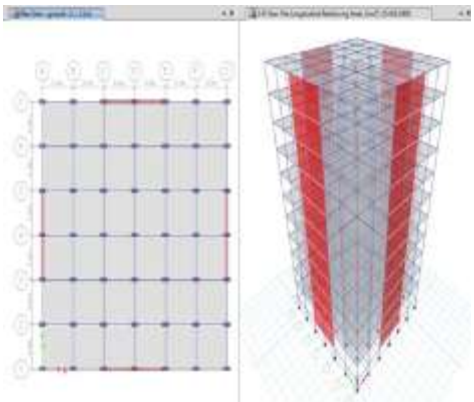

Fig: 4 Shear Walls on Periphery at Center

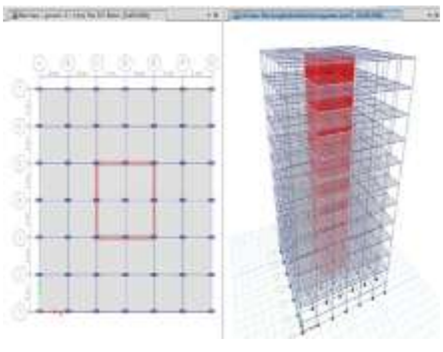

Fig: 5 Shear Wall At The Center Of The Geometry

2.2 Model Analysis –

The behavior of all the framing systems is taken as a basic study on the modeled structure. The lateral drift/deflection ratio is checked against the clause 7.11.1 of IS-1893:2002 i.e. under transient seismic loads. The following parameters were considered to present a comparison between the different frames: 1.5 DL + 1.5 LL

A. Storey Drift -

Table 1- Storey Drift for Zone V

Story	Elevation	Case 1	Case 2	Case 3	Case 4
Ten	35 m	0.000403	0.000416	0.000492	0.000374
Nine	32 m	0.000572	0.000426	0.000534	0.000402
Eight	29 m	0.000737	0.000442	0.000570	0.000421
Seven	26 m	0.000874	0.000451	0.000601	0.000436
Six	23 m	0.000981	0.000455	0.000623	0.000443
Five	20 m	0.00105	0.000451	0.000634	0.000446
Four	17 m	0.001112	0.000437	0.000624	0.000437
Third	14 m	0.001142	0.000413	0.000596	0.000418
Second	11 m	0.001154	0.000376	0.000546	0.00038
First	8 m	0.001161	0.000343	0.000490	0.000372
Ground	5 m	0.001185	0.000415	0.000543	0.000454
Plinth	2 m	0.000606	0.000497	0.000563	0.000493
Base	0 m	0	0	0	0

1. 1.2 DL + 1.2 LL
2. DL + 1.2 LL + 1.2 EQX
3. 1.2 DL + 1.2 LL - 1.2 EQX
4. 1.2 DL + 1.2 EQX
5. 1.2 DL - 1.2 EQX

2.3 Observation And Interpretation Of Result -

A. Maximum Storey Drift

B. Maximum Storey Displacement

C. Storey Shears

D. Storey Overturning Moment

The following load combinations are considered during the analysis of the model:

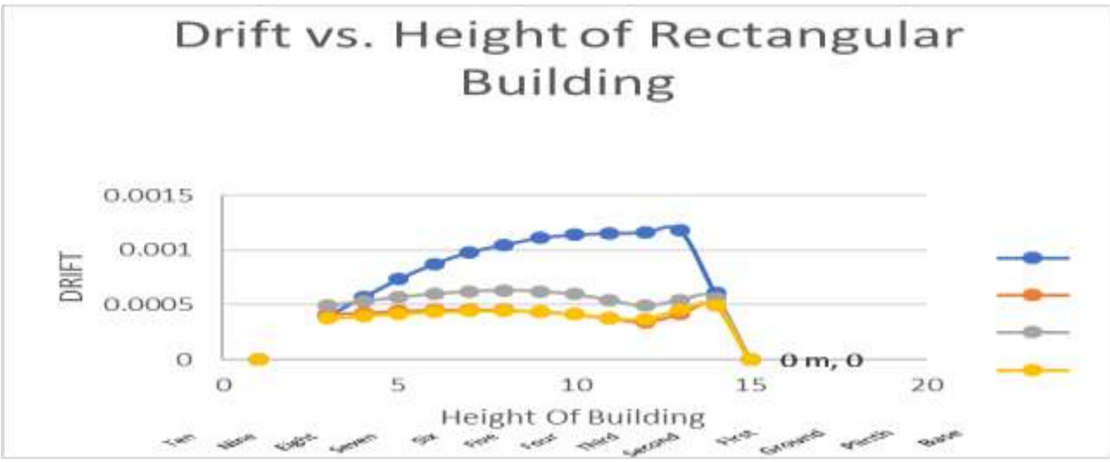

Figure 5 Drift vs. Height of Rectangular Building

B. Storey Displacement (in mm) :-

Story	Elevation	Case 1	Case 2	Case 3	Case 4
Ten	35 m	30.3	14.1	18.2	14.2
Nine	32 m	29.1	13.0	17.3	13.2
Eight	29 m	28.4	11.5	16.1	11.6
Seven	26 m	26.2	10.3	14.4	10.2
Six	23 m	23.6	9.2	12.6	9.1
Five	20 m	21.6	7.6	10.3	8.0
Four	17 m	18.4	6.3	8.2	6.6
Third	14 m	14.1	5.2	7.0	5.3
Second	11 m	11.7	3.8	5.1	4.2
First	8 m	8.2	2.6	3.5	2.9
Ground	5 m	4.7	1.7	2.3	1.8
Plinth	2 m	1.3	1	1.2	1
Base	0 m	0	0	0	0

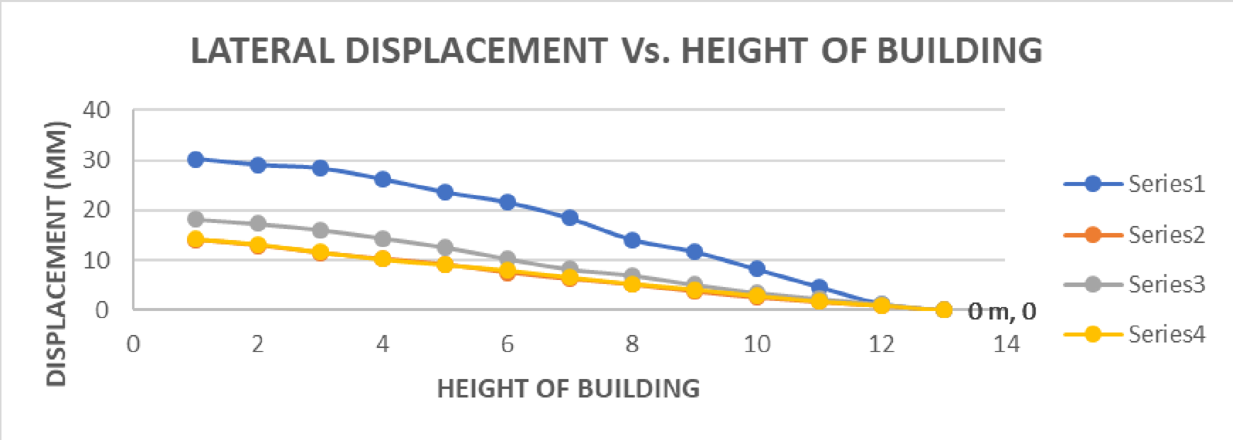

Fig 6- Storey Displacement vs. Height of Rectangular Building:-

C. Storey Shear (in Kn) :-

Story	Elevation	Case 1	Case 2	Case 3	Case 4
Ten	35 m	-520.365	-576.3636	-493.0089	-465.2851
Nine	32 m	-978.284	-1162.7927	-976.2461	-931.1237
Eight	29 m	-1370.7846	-1638.6714	-1363.7678	-1289.5982
Seven	26 m	-1686.2748	-2021.1831	-1695.1034	-1613.8321
Six	23 m	-1953.1684	-2331.1415	-1934.7768	-1851.890
Five	20 m	-2139.8685	-2527.9532	-2144.3233	-2031.9046
Four	17 m	-2254.7369	-2711.4834	-2281.2727	-2141.9434
Third	14 m	-2346.2246	-2822.3918	-2354.1595	-2247.170
Second	11 m	-2422.6865	-2870.8485	-2431.4883	-2284.6231
First	8 m	-2442.5654	-2927.0718	-2441.8138	-2313.4363
Ground	5 m	-2464.2342	-2921.229	-2462.6625	-2332.6761
Plinth	2 m	-2474.7356	-2932.9253	-2465.2016	-2336.2785
Base	0 m	0	0	0	0

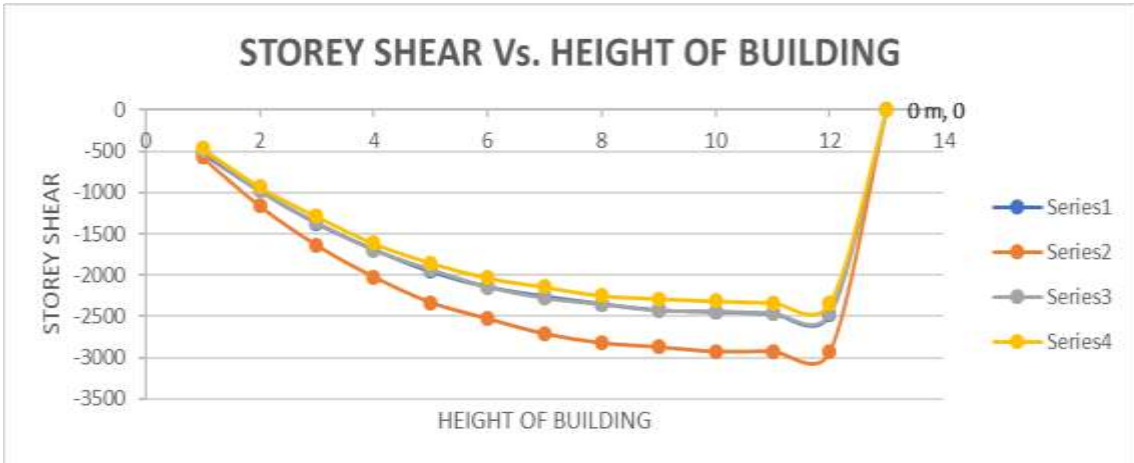

Fig 7- Storey Shear vs. Height of Rectangular Building:-

D. STOREY OVERTURNING MOMENT -

Story	Elevation	Case 1	Case 2	Case 3	Case 4
Ten	35 m	37058.847	37055.7912	37048.847	37038.847
Nine	32 m	82411.1138	90187.7239	86286.9637	86296.9657
Eight	29 m	127771.3876	143359.6566	135545.0914	135555.0914
Seven	26 m	173142.6654	196511.5874	184823.2211	184813.2211
Six	23 m	218533.9412	249643.5221	234081.3468	234071.3488
Five	20 m	263885.2169	302815.4548	283339.4744	283329.4744
Four	17 m	309256.4927	355967.3855	332577.6041	332587.6041
Third	14 m	354627.7665	409119.3183	381855.7318	381845.7318
Second	11 m	400019.0443	462251.2502	431113.8575	431103.8575
First	8 m	445370.3181	515423.1837	480371.9852	480361.9852
Ground	5 m	490761.5959	568555.1164	529610.1148	529620.1148
Plinth	2 m	502572.3363	588182.8944	544112.5925	545337.7052
Base	0 m	508237.2955	593717.8535	549647.5517	550892.6643

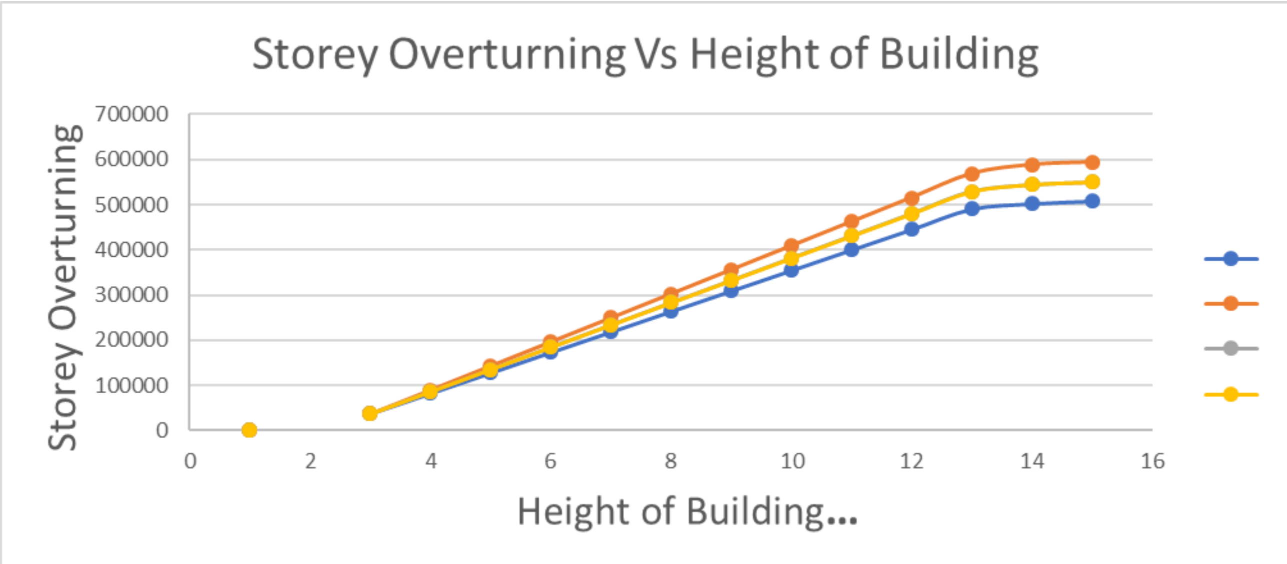

Figure 8 Storey Overturning vs. Height of Rectangular Building

3. CONCLUSIONS

It is clear to all that the seismic hazard has to be carefully evaluated before the construction of important and high-rise structures. Based on the above analytical study carried out on 4 models, it is evident that buildings with shear walls behave more effectively than conventional frames when subjected to seismic loads. The following deductions are made from the obtained results:

1. The framework with Shear Walls clearly offers more safety to designers and, although it is a bit expensive, they are extremely effective in terms of structural stability.

2. Due to the fall of the area, the danger of earthquake will also increase. In such cases, the use of shear walls is mandatory to achieve design security

3. On all systems, Storey Drift is inside allowed limits according to IS: 1893 (Part 1). However, CASE 4, closely followed by CASE 2, showed better results than other models. This leads us to believe that when the shear walls are positioned at the center of the box-shaped geometry or at the corners, the structures behave in a more stable manner. This practice of supplying Box shear walls is now becoming more popular, as multi-storey structures generally have a lifting system and these box shear walls have the dual purpose of shear walls and also as a conduit or vertical passage for the movement of the elevators.

4. The storey displacement also follows a pattern similar to the storey drifts, The best results are obtained for CASE 4, followed closely by CASE 2, which once again demonstrates that the optimal position of the Shear walls is in the center of the building or at the corners.

5. The main difference in the behavior of CASE 4 and CASE 2 can be noticed when comparing the cut of the floor. CASE 2 showed very high floor cutting values compared to the other models. Even in this case, CASE 4 proved to be the best.

6. Overturning moments are minimal in conventional buildings. However, the lower performance of CASE 1 in terms of Storey Drift, Storey Displacement and Lateral Loading indicate that it is not suitable for use in areas with greater seismic activity.

7. To further increase the effectiveness of the structure, it is possible to use earthquake resistance techniques such as seismic Dampers and Base Isolation. Therefore, it is safe to conclude that, among all the other possibilities, CASE 4 (Building with a Box-shaped Shear wall at the center of the geometry) is the ideal framing technique for skyscrapers.

ACKNOWLEDGEMENT:

I want to convey most sincere gratitude to **Prof. Sourabh Dashore** Department of Civil Engineering, SIMS for taking out time from the hectic schedule and guiding us-all so in the most warm and friendly manner.

REFERENCES:-

[1] Anshumn. S, Dipendu Bhunia, Bhavin Rmjiyani (2011), "Solution of the position of a shear wall in a multi-storey building". International civil engineering magazine. Vol.9, No.2, pages 493-506.

[2] H.S. Kim, D.-G. Read "Analysis of the shear wall with openings by superelements" Engineering structures 25 (2003), pages 981–991.

[3] Duggal S. K. (2010), "Anti-seismic design structures". YMCA Library Building of Oxfored University, Jai Singh Road, New Delhi.

[4] G. Vimalanandan and Dr. S. Senthilselvan [2017] “ANALYTICAL STUDY ON EFFECT OF CURTAILED SHEAR WALL ON SEISMIC PERFORMANCE OF HIGHRISE BUILDING”

[5] Patil S.S. and Sagare S.D. [2018] “Seismic Analysis of Multistorey Building with and Without Soft Storey” International Journal of Research in Advent Technology, Vol.6, No.8, August 2018

[6] Bureau of India Standard, IS-1893, Part 1 (2002), “Criteria for earthquake resistant design of structures.”

[7] Bureau of Indian Standard, IS-456(2000), “Plain and Reinforce Concrete Code of Practice”.