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Optimum Location Of Shear Wall In G+9 Irregular Building

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Abstract – *The introduction of shear wall in a building is a structurally efficient solution to stiffen the building because they provide the necessary lateral strength and stiffness to resist horizontal forces .the shape and location of shear wall have significant effect on their structural behavior under lateral loads .The response of building with different positioning of shear wall by Dynamic analysis Method using IS 1893 (PART-1):2016 is analyzed Different location of Shear walls in a model and other models with different position of shear wall which is subjected to earthquake load in zone IV has been studied.*

Key Words: **shear wall, location, shape and earthquake.**

1. INTRODUCTION

Shear walls are constructed to counter the efforts of lateral loads which are acting on a structure. If shear walls are constructed properly they will have strength and stiffness to resist the horizontal forces. Shear walls are vertical stiffening elements designed to resist lateral forces exerted by wind or earthquake .The shape and location of shear wall have significant effect on their structural behavior under lateral loads. These shear wall resist horizontal force because of their high rigidity as deep beams are reacting to shear and flexure against overturning. Shear wall are much stiffer than horizontal rigid framed.

1.2.1 WHY SHEAR WALL IS PROVIDED?

- Improves the performance of buildings in high seismic areas
- Effective in reducing the cost of construction of buildings
- Resist the lateral loads imposes on the structure due to earthquake
- It reduces any damage on structure caused due to earthquake

1.2.2 Structural Requirements of Shear Wall:-

1. The thickness of shear wall should not be less than 150 mm to avoid unusually thin sections.

2. Effective flange width for the flanged wall sections from the face of web should be taken as least of half the distance to an adjacent shear wall web and one – tenth of total wall height.

3. The minimum reinforcement in the longitudinal and transverse directions in the plan of the wall should be taken as 0.0025 times the gross area in each direction and distributed uniformly across the cross section of the wall.

1.3 THERE ARE TWO TYPES OF FORCES THAT THE SHEAR WALL RESIST:

1.3.1 SHEAR FORCES: Shear forces are generated in buildings due to various ground movements due to external forces by winds and seismic waves. These actions are generate shear force.

1.3.2 UPLIFT FORCES:

Uplift forces are generated on shear walls due to the horizontal forces are applied to the top of the wall. These forces try to lift up one end and pushing the other end down. There are two methods for the seismic analysis of building:-

1).Equivalent static analysis.
2).Dynamic analysis.

According to IS 1893 (2016) Dynamic analysis is performed for the buildings:

1.Regular buildings – Those greater than 40m in height in zone IV and V and those greater than 90m in height in zone II and III.

2.Irregular buildings – All framed buildings higher than 12m in zone IV and V, and those greater than 40 m in height in zone II and III. For irregular buildings lesser than 40 m in height in zone II and III, dynamic analysis even though not mandatory, is recommended.

2. Literature review:

AshishS.Agrawal and S.D.Charkha (2012), Highlights the change in position and shapes of shear wall having different shapes for the member forces will increase as the shear wall is placed further away from the center of gravity .It shows that the rise in eccentricity, increases torsion and moment forces in the members.

P.P.Chandurkar,Dr.P.S.Pajgade(2013), It shows the unstable analysis of RCC Building with and while not shear wall. From this it may be ended that giant dimensions of shear wall isn't effective in ten stories or below ten stories buildings. It's discovered that the shear wall is economical and effective in high rise buildings.

H.Rahangdale,S.R.Satone(2013), In this paper study of G+9 construction of building in zone 4 is analyzed by changing the position of shear wall with different shapes for parameters like axial load and moments.This analysis is completed with the help of STAAD-pro software. By constructing shear walls damages due to lateral forces from earthquake are reduced.

R.Chittiprolu,R.Pradeep Kumar(2014), This paper shows that the high rise irregular buildings with or without shear wall subjected to high greater lateral, story drifts and torsional effects.

3.METHODOLOGY:

3.1 METHODS FOR SEISMIC ANALYSIS OF BUILDING USING IS1893(PART1):

In India, Indian standard criteria for Earthquake resistant Design of Structures IS1893(Part-I):2016 is the main code that provides outline for calculating seismic design force. These force depends on the mass of the structure and seismic coefficient of the structure and various properties such as the seismic zone in which the structure lies . The IS code recommends following method of analysis. 1-Equivalent static analysis. 2-Dynamic Analysis. Dynamic analysis is classified into two types :-

1) Time History Method:- Time history method of analysis is based on an appropriate ground motion and shall be performed using accepted principles of dynamics.

2).Response spectrum method:- According to IS 1893(2016) it is recommend to use dynamic analysis method for all irregular buildings above height 12m in zone 4 and 5 . When response spectrum analysis is performed the only the maximum displacements and member forces on the structure are calculated.

3.2 LOAD CALCULATION:

The structure is subjected to three types of primary load as per the provision of IS Code of practice .They are as follows:- Dead Load (From IS: 875-1987(Part I)) Live load (From IS: 875-1987(Part II)) Seismic Load (From IS: 1893-2016(part I) As per IS 1893 -2016(part1), load combinations considered when effects of earthquake in three directions are considered .

1) $1.2\,[DL + IL \pm (EL_X \pm 0.3\,EL_Y)]$ and
$1.2\,[DL + IL \pm (EL_Y \pm 0.3\,EL_X)]$;

2) $1.5\,[DL \pm (EL_X \pm 0.3\,EL_Y)]$ and
$1.5\,[DL \pm (EL_Y \pm 0.3\,EL_X)]$; and

3) $0.9\,DL \pm 1.5\,(EL_X \pm 0.3\,EL_Y)$ and
$0.9\,DL \pm 1.5\,(EL_Y \pm 0.3\,EL_X)$.

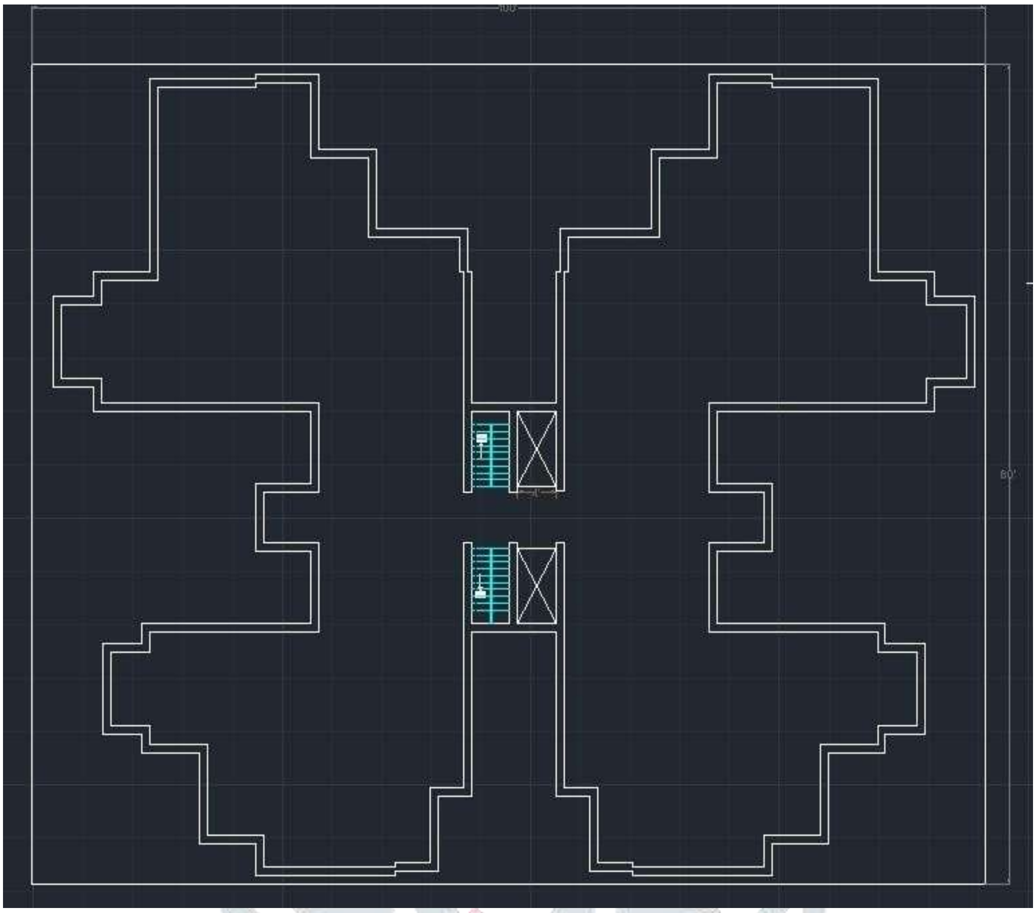

Fig. 3.2 Top view of structure

Table3.2 Structural details

S. No.	Particulars	Dimension/Size/Value
1	Number of storey	G+9
2	Seismic Zone	IV
3	Wall height	3m
4	Size of columns	0.4m x 0.4 m
5	Size of beams	0.5m x 0.5m
6	External wall Internal wall	0.3m 0.2m
7	Thickness of slab	150mm
8	Thickness of shear wall	200mm
9	Type of soil	Type II – Medium soil as per IS 1893 (Part I)
10	Materials used	M30 concrete, fe415

3.2.1 DEAD LOAD CALCULATION:

Dead loads consists of the weight of the whole structure and fixed elements of the structure before live loads are taken into account. Live loads are added to the dead load which gives the total load which is exerted on the structure.

1. Inner wall=0.2x19.1x(3-0.4) =9.93kN .
2. Parapet wall = 19.1x0.3x1= 5.73kN.
3. Slab = Density of concrete x thickness of slab = 25 x 0.15=3.75kN.
4. Thickness of floor finish x density of cement = 0.05x20 =1kN/m2.
5. So, the total load of slab = 3.75+ 1=4.75kN.

3.2.2 LIVE LOAD CALCULATION:

It is the load that change over a period of time .It includes the temporary weight such as weight of people, furniture ,vehicles and equipment , etc.

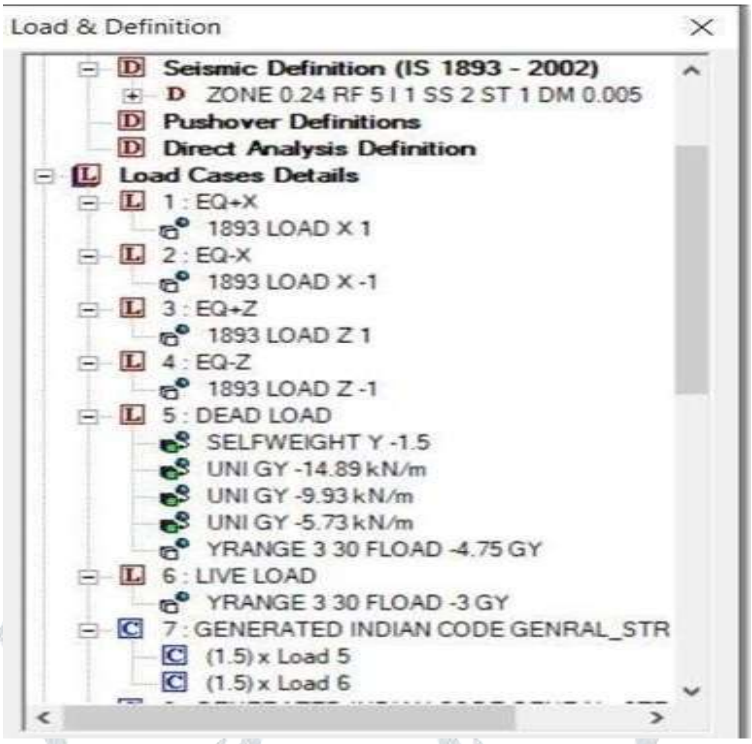

Fig 3.2.2 Loads and Defintion.

3.2.3 SEISMIC LOADS:

For the analysis of earthquake resistant structure we have used the following seismic parameters on STAAD PRO according to IS code 1893 part 1 (2016). According to IS 1893(2016) seismic weight taken in consideration of each floor is it's full dead load plus a specific percent of imposed load as specified in table 10 (clause 7.3.1) where for floor loads upto 3kN/m² , 25% of imposed load is considered in calculation of seismic weight.

Table No. 3.2.3 Seismic Parameters.

S. No.	Parameters	Value
1	Zone	IV
2	Zone factor	0.24
3	Damping ratio	0.005
4	Importance factor	1
5	Response reduction factor(RF)	5

4. MODELLING AND ANALYSIS:

CASE 1:
Case 1 model is a STAAD PRO of an unsymmetrical G+9 building where shear walls are not placed but seismic loads are considered.

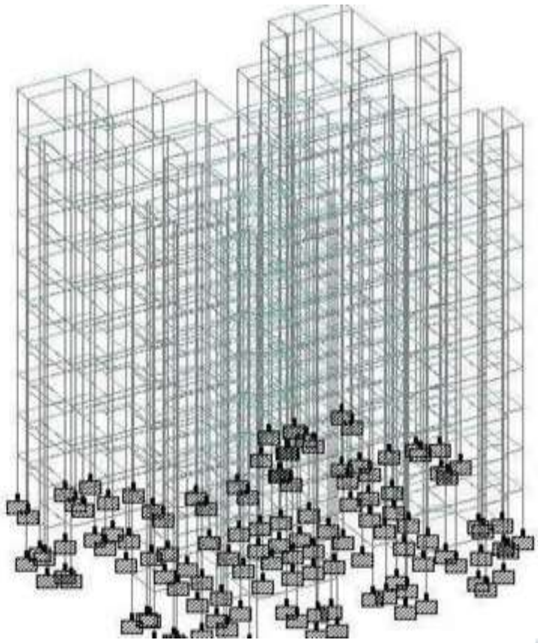

Fig.4.1 CASE I without shear wall.

CASE 2: Case 2 is a model in STADD pro, C- shaped shear walls are placed at the center of the structure.

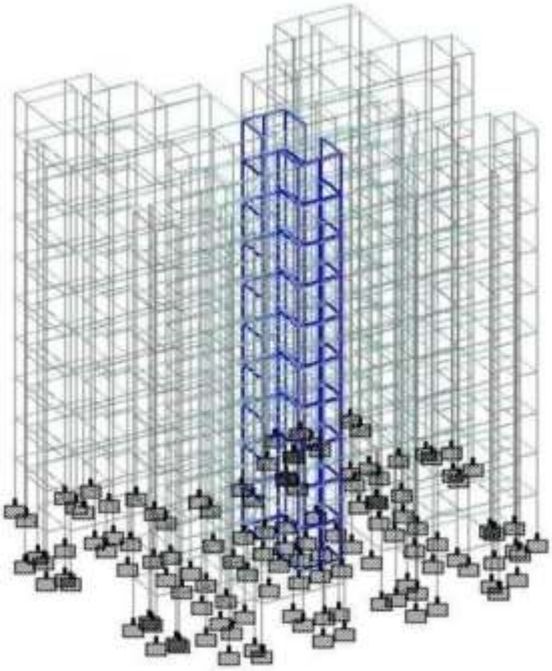

Fig.4.2 CASE II shear wall at center.

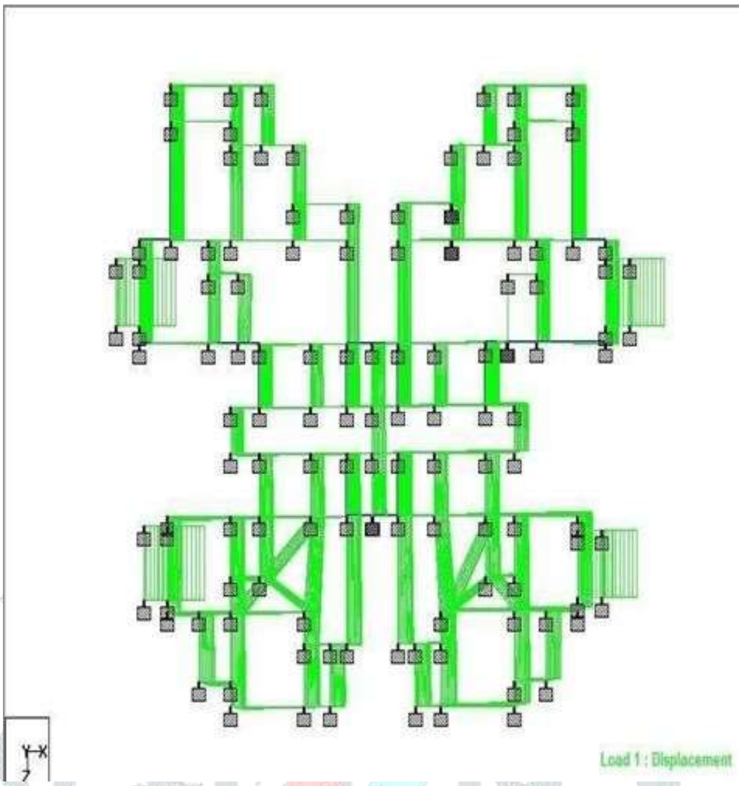

Fig.4.3 CASE2 Displacement top view diagram in the case when no shear wall is provided.

CASE 3: Case3 is a model in STAAD pro, the L - shaped shear walls are placed at the two corners of the building in addition to the C - shaped shear walls in the center of the building.

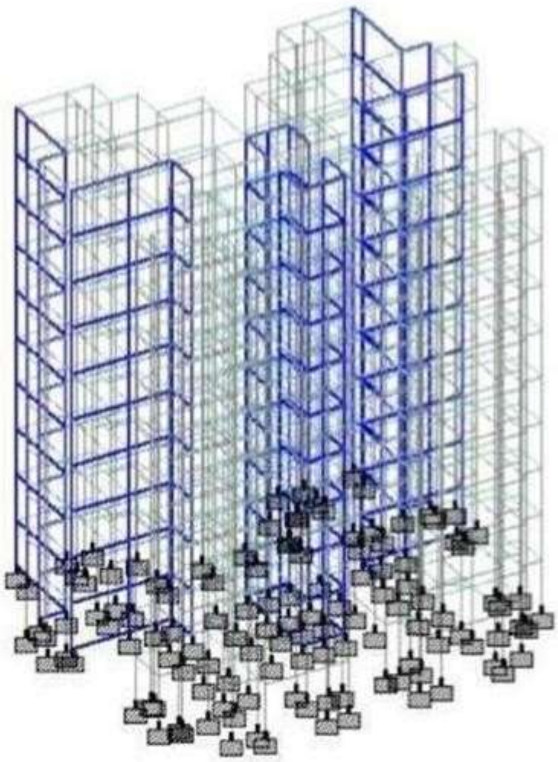

Fig.4.4 CASE III shear wall at centre and Corner

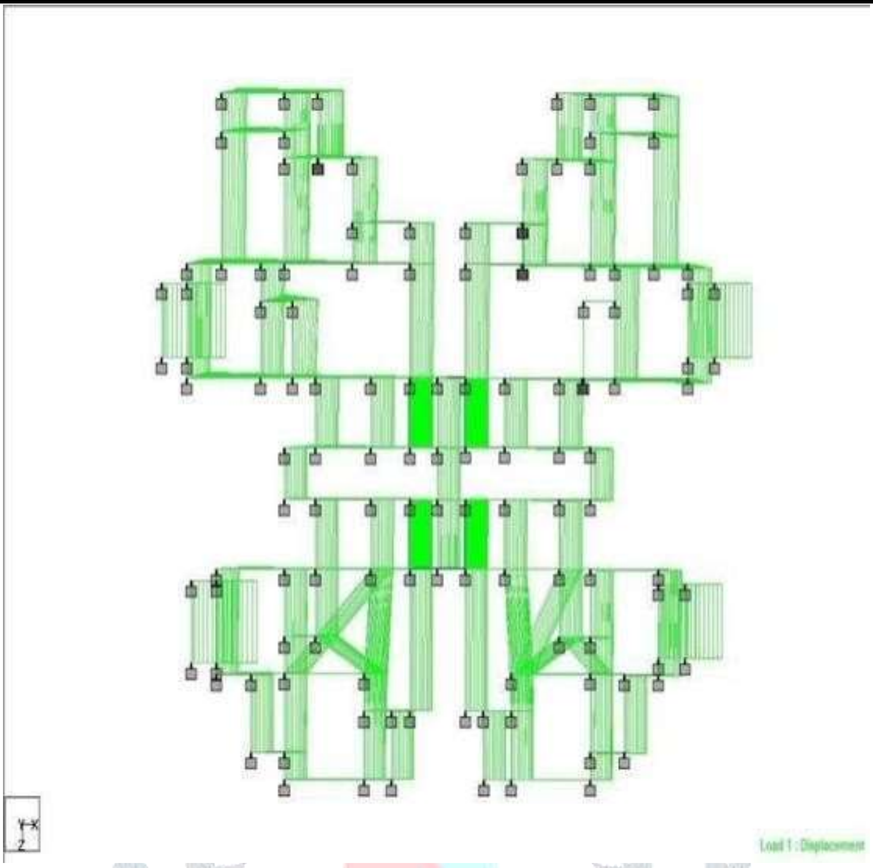

Fig.4.5 Displacement top view diagram in the case when shear wall is provided at the centre.

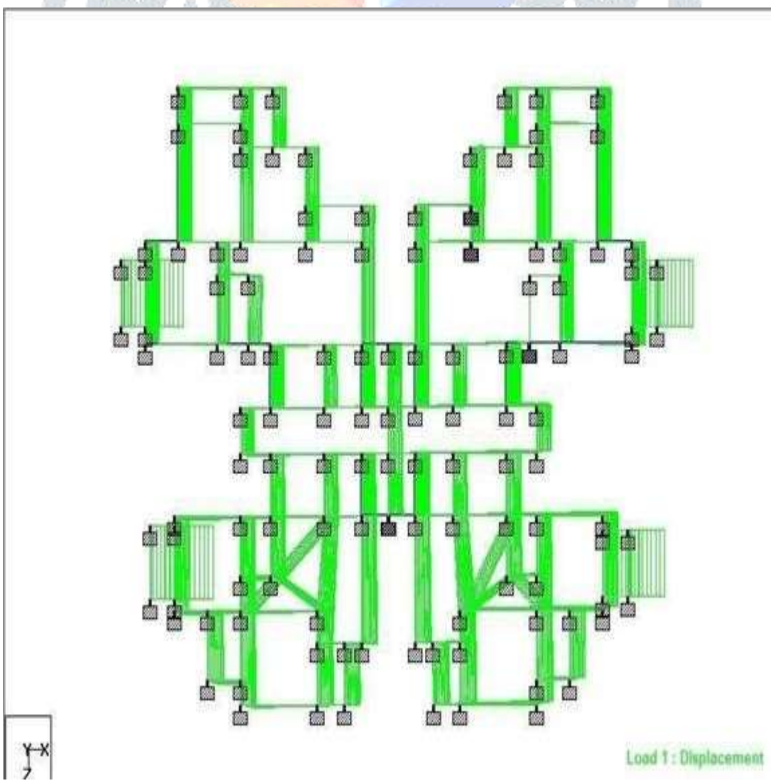

Fig.4.6 CASE 2 Displacement top view diagram in the case when shear walls are provided at the centre as well as the corners.

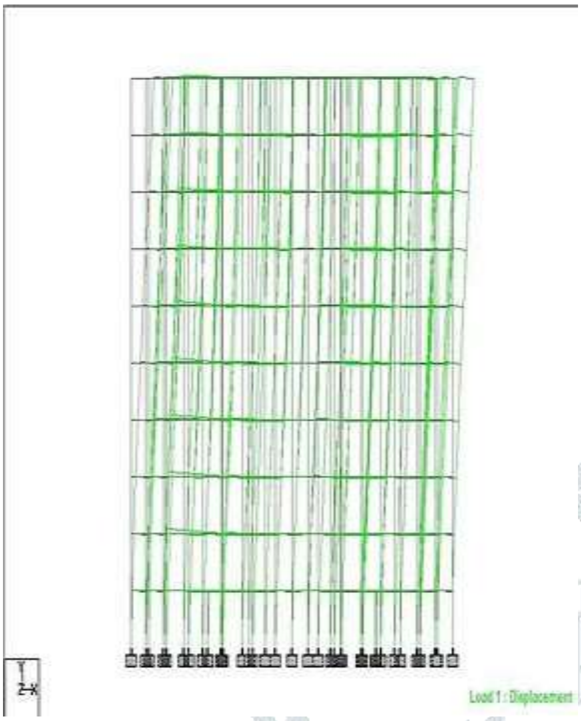

Fig.4.7 Displacement in the case when no shear wall isprovided.

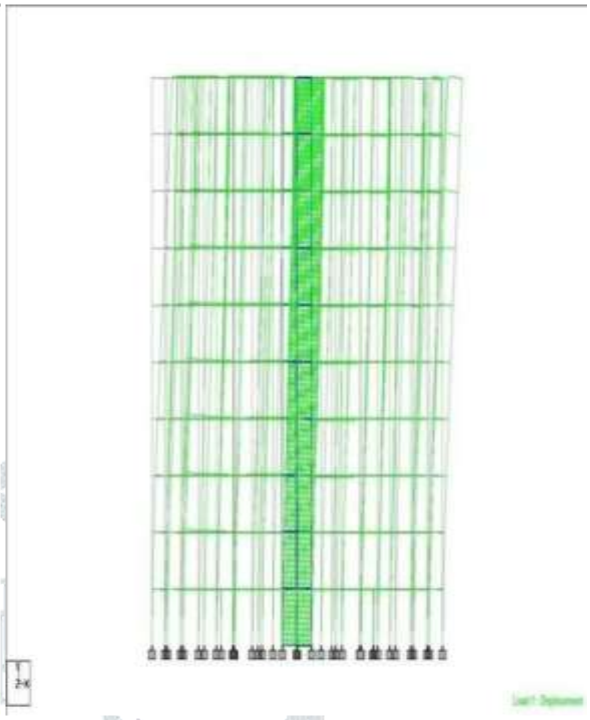

Fig.4.8 Displacement diagram in the case when shearwall is provided at centre.

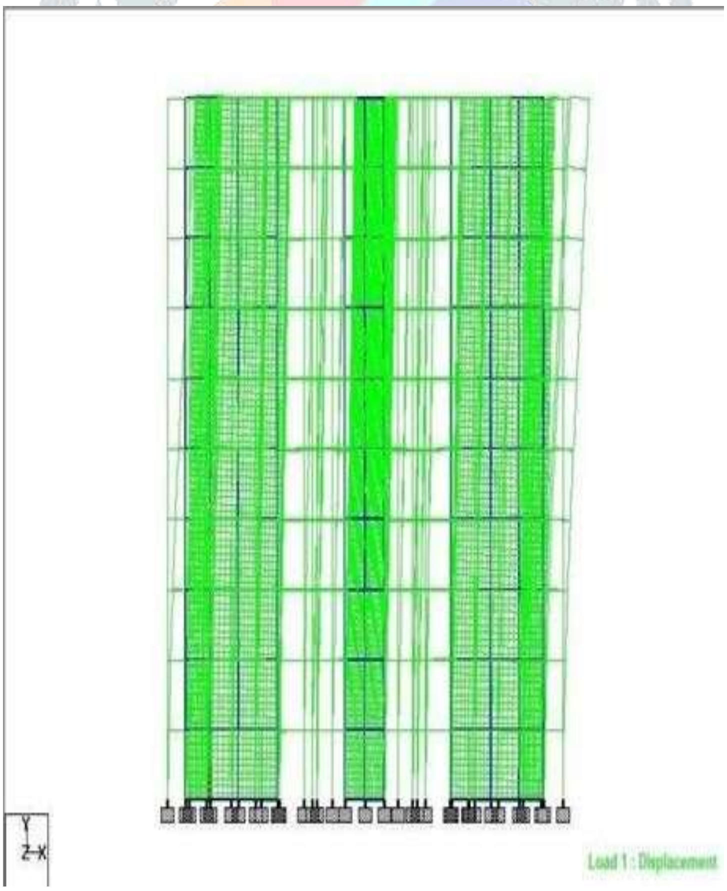

Fig. 4.9 Displacement diagram in the case when shear wall is provided at the center and corner.

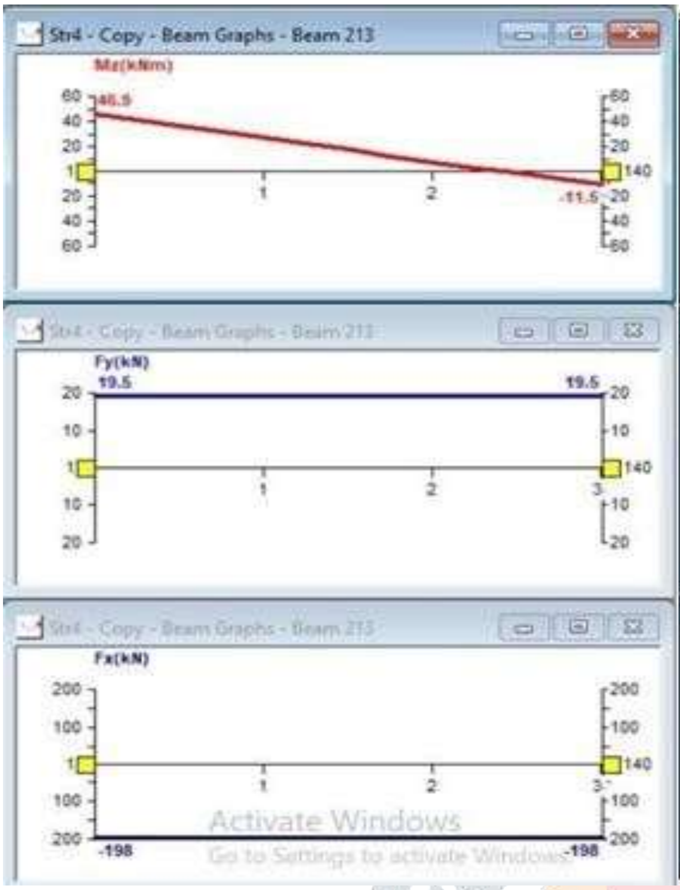

Fig.4.10 Beam related graph for model with no shear wall.

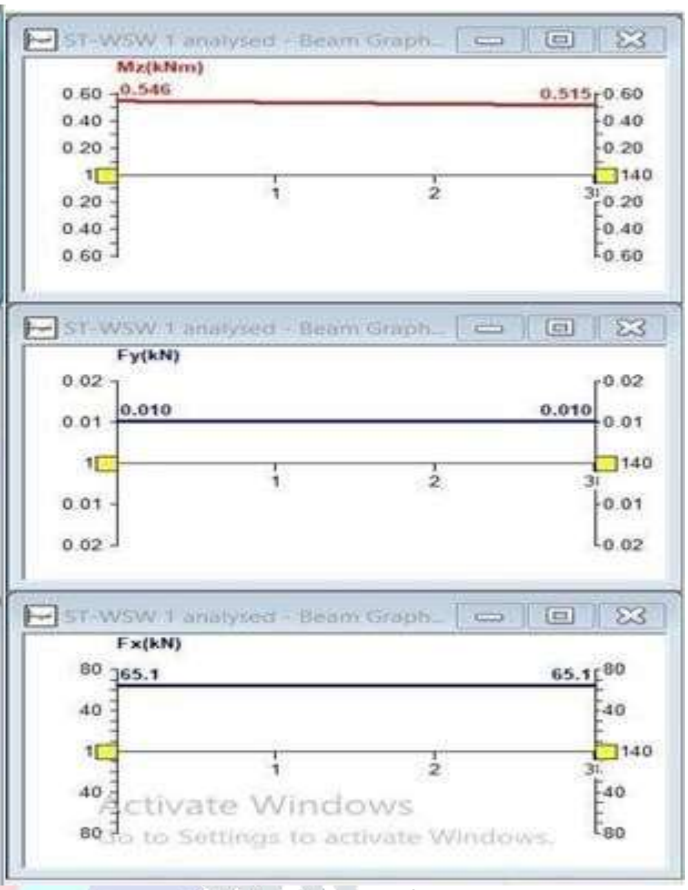

Fig.4.11 Beam related graph for model with shear walls at centre.

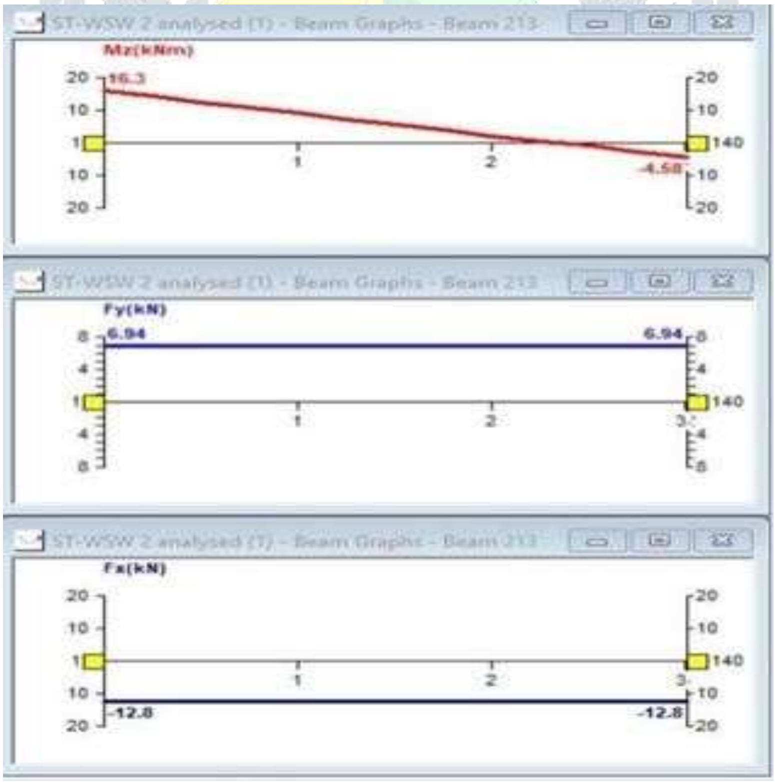

Fig.4.12 Beam related graphs for model with shear wall at centre and corner.

Table No.4.1 Case 1 Beam displacement table

STOREY	BEAM	LOAD COMBINATION	HEIGHT	MAX DISPLACEMENT IN MM
Ground	301	5 1.5 1 1.5	3	2.273
Storey 1	633	5 1.5 1 1.5	3	5.623
Storey 2	724	5 1.5 1 1.5	3	8.517
Storey 3	979	5 1.5 1 1.5	3	11.774
Storey 4	1178	5 1.5 1 1.5	3	16.918
Storey 5	1323	5 1.5 1 1.5	3	22.063
Storey 6	1522	5 1.5 1 1.5	3	27.996
Storey 7	1667	5 1.5 1 1.5	3	33.534
Storey 8	1867	5 1.5 1 1.5	3	39.467
Storey 9	2038	5 1.5 1 1.5	3	45.004

Table No.4.2 Case 2 Beam displacement table

STOREY	BEAM	LOAD COMBINATION	HEIGHT	MAX DISPLACEMENT IN MM
Ground	307	5 1.5 1 1.5	3	1.944
Storey 1	549	5 1.5 1 1.5	3	3.971
Storey 2	807	5 1.5 1 1.5	3	7.416
Storey 3	979	5 1.5 1 1.5	3	10.652
Storey 4	1178	5 1.5 1 1.5	3	15.367
Storey 5	1323	5 1.5 1 1.5	3	21.004
Storey 6	1522	5 1.5 1 1.5	3	26.897
Storey 7	1667	5 1.5 1 1.5	3	31.244
Storey 8	1867	5 1.5 1 1.5	3	38.652
Storey 9	2038	5 1.5 1 1.5	3	44.061

Table No.4.3 Case 3 Beam displacement table

STOREY	BEAM	LOAD COMBINATION	HEIGHT	MAX DISPLACEMENT IN MM
Ground	340	5 1.5 1 1.5	3	1.407
Storey 1	662	5 1.5 1 1.5	3	3.842
Storey 2	807	5 1.5 1 1.5	3	7.113
Storey 3	979	5 1.5 1 1.5	3	9.365
Storey 4	1178	5 1.5 1 1.5	3	14.857
Storey 5	1323	5 1.5 1 1.5	3	20.246
Storey 6	1522	5 1.5 1 1.5	3	25.369
Storey 7	1667	5 1.5 1 1.5	3	30.254
Storey 8	1867	5 1.5 1 1.5	3	37.216
Storey 9	2038	5 1.5 1 1.5	3	42.221

Table No. 4.4 Storey displacement comparison table

Storey	Height	Case 1	Case 2	Case 3
Ground	3	0	0	0
Storey 1	3	5.623	3.971	3.842
Storey 2	3	8.517	7.416	7.113
Storey 3	3	11.774	10.652	9.365
Storey 4	3	16.918	15.367	14.857
Storey 5	3	22.063	21.004	20.246
Storey 6	3	27.996	26.897	25.369
Storey 7	3	33.534	31.244	30.254
Storey 8	3	39.467	38.652	37.216
Storey 9	3	45.004	44.061	42.221

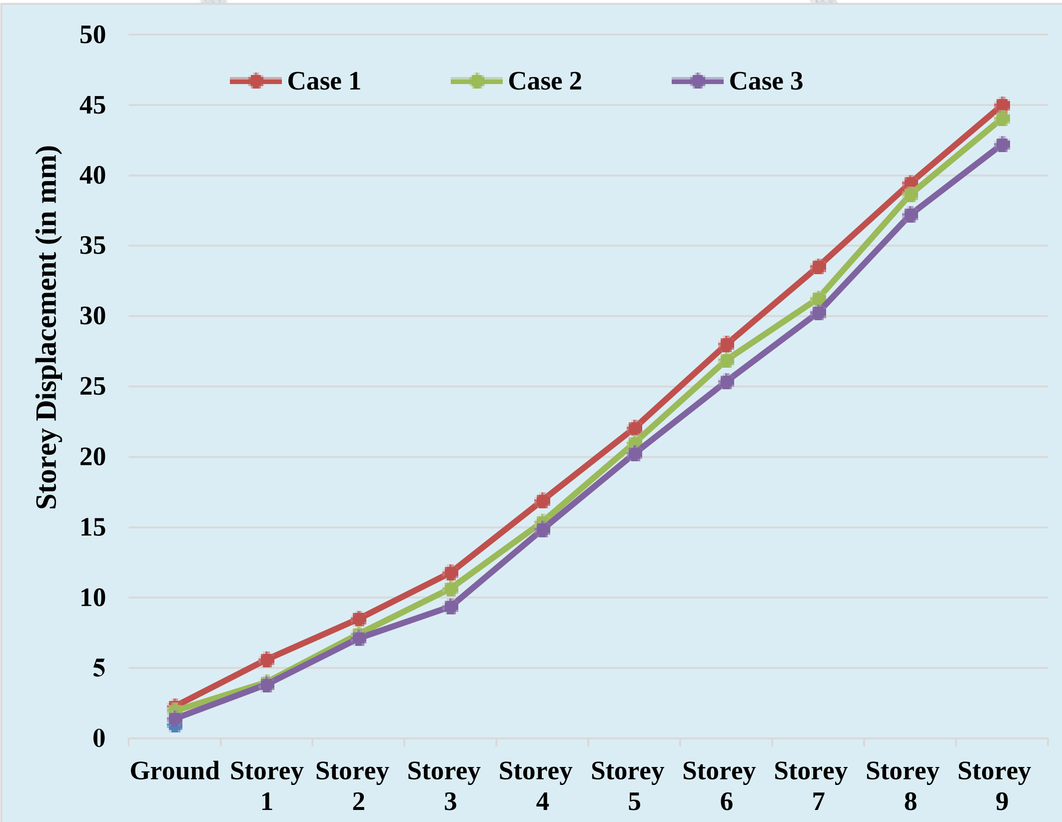

Fig. 4.13 Maximum displacement graph

Table No.4.5 Maximum storey drift

Results	Maximum storey drift
Case 1	0.016
Case 2	0.004
Case 3	0.0027

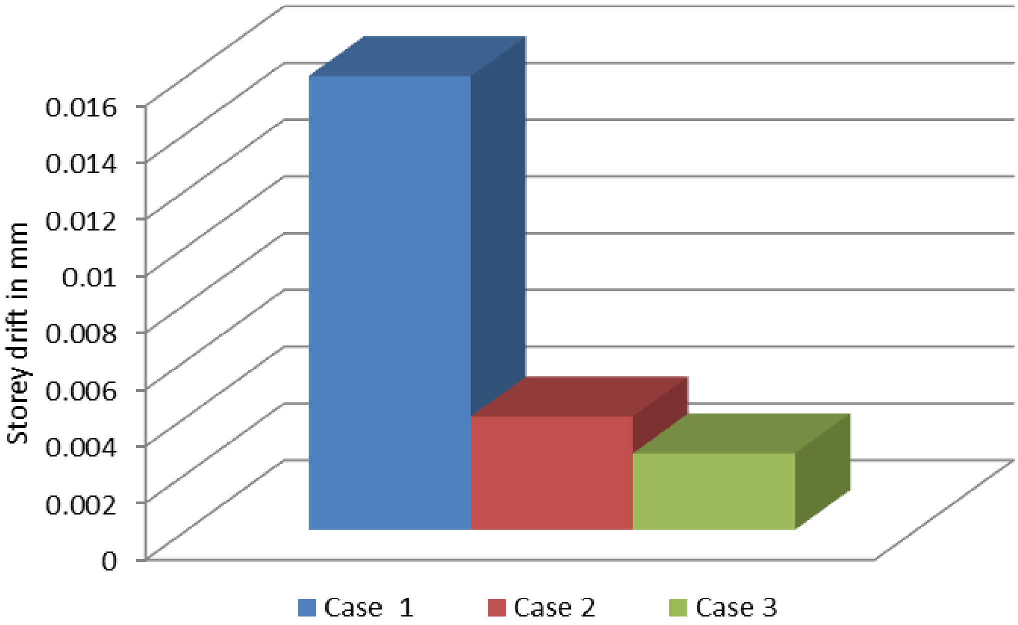

Fig.4.14 Maximum story drift

5. CONCLUSION:

1. In this analysis , we conclude that the maximum lateral displacement increases as storey height increases in all the 3 cases.
2. Lateral displacement of a building has been reduced due to the presence of shear wall in the centre as well as corner as compare to other cases.
3. The moment is minimum for model 3 as compared to other cases.
4. The maximum displacement is seen in the top storey in case I maximum displacement is 45.004mm , in case I maximum displacement is 44.061mm and in case III maximum displacement is 42.221mm.
5. The maximum displacement in case III is 2.12% less than in case I and 0.775% less than in case II. Hence, it can be said that building with type 3 shear wall is more efficient than all other type of shear wall..

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