IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Comparative Study Of Different Shapes Of Shear Wall In Asymmetrical Building On Different Slopping Ground

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Abstract: In seismic design of multistoried building, shear walls are most common structure adopted to make the structure earthquake resistant. These are constructed to counteract the lateral loads caused by wind load and seismic loads. Shear walls provide adequate stiffness to the structure. So that the lateral drift will be in limits. Generally shear walls are the vertical cantilever which acts as a column. This investigation presents the study and comparison of earthquake behaviour of buildings with and without shear wall of different shapes at sloping ground at different angle using STAAD Pro. In this study, reinforced concrete buildings are analyzed by changing the various position of shear wall with different locations considering various parameters such as Shear force, Bending Moment, Axial Force, Reaction, Displacement.

Index Terms - Seismic analysis, Shear wall, Sloping ground, STAAD Pro V8i.

I. INTRODUCTION

Shear wall is most commonly used lateral load resisting systems in high-rise multistoried structure. Shear walls have a efficient characteristics like in plane stiffness and strength, which can be used to resist large horizontal loads and support gravity loads, making them advantageous in structural engineering applications.
In this research work main focus is to determine effective positioning shear wall location in multistory asymmetrical building on the sloping ground nature.
A RCC Set-Step Back building of G+7 storey placed in 15°,30°,45° sloping terrain subjected to earthquake loading in zone-V is considered. An earthquake load is calculated by seismic coefficient method using IS 1893 (PART–I):2016. These analyses were performed using STAAD Pro.
A study has been carried out to determine the various parameters like storey shear, Displacement, Bending Moment, Shear force in the sloping ground G+7 storey building by Introducing various Configuration and locations of the shear wall. Different cases of shear wall position/Configuration for a G +7 storey building have been analyzed.

II. BUILDING MODELLING

In the present study, a RCC G+7 storied residential building with 3 meters height for each story is modeled. This residential building is designed as a plan of 15 m x 15 m. Sloping ground of angle 15°,30°,45°. Shear wall of Type 1. C-Type, 2. L-Type 3. T-Type. M25 grade of concrete and Fe 500 structural steel is used. The structure is supported as fixed at its base. The buildings are modeled and analyzed by using the software STAAD Pro V8i. Models are studied for zone V Seismic region The study of models is designed by placing the shear wall in different location with the thickness of 150 mm.

Physical Details

The preliminary data taken for the analysis is as follows:- All the dimensions in mm. • No of stories: G+7

- Storey height: 3 m
- Beam size in all direction: 230 x 380 *mm*
- Column size: 450 x 450 *mm*
- Thickness of the slab:150 mm
- Grade of concrete: M25
- Grade of steel: Fe500
- Density of concrete: 25 KN/*m*3
- Density of brick: 20 KN/*m*3

Building Plans

Plan Configuration

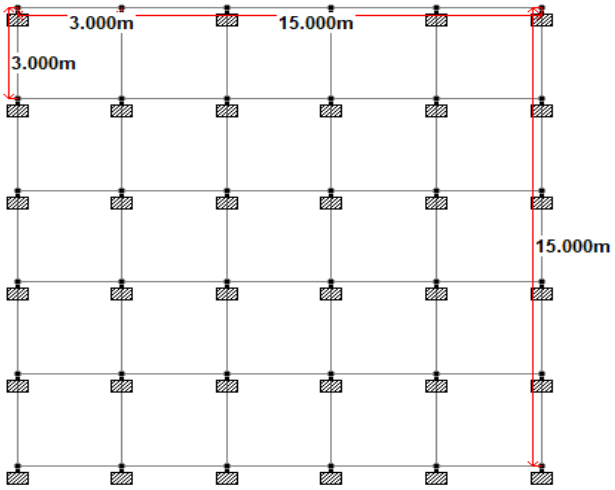

Fig 1:- Plan of Bare Frame Building

Shear wall Configuration

1. **15° Slope C Shape Shear Wall**

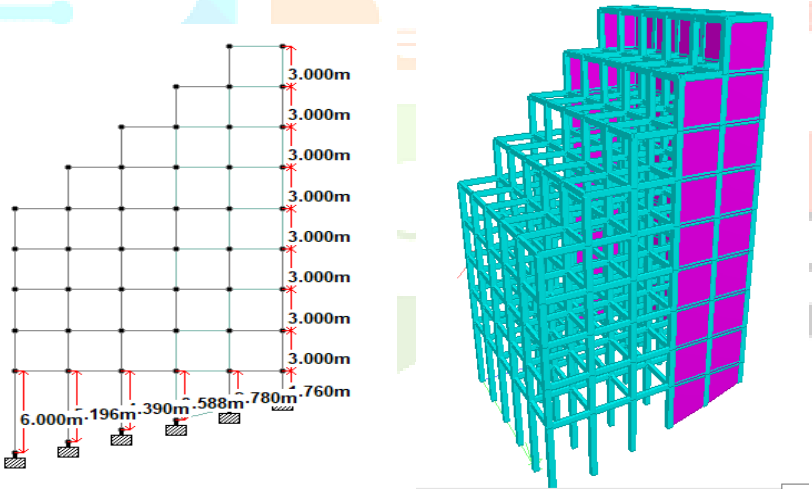

Fig 2:- Elevation of C Shape Shear Wall with 15° Slope

2. **15° Slope L Shape Shear Wall**

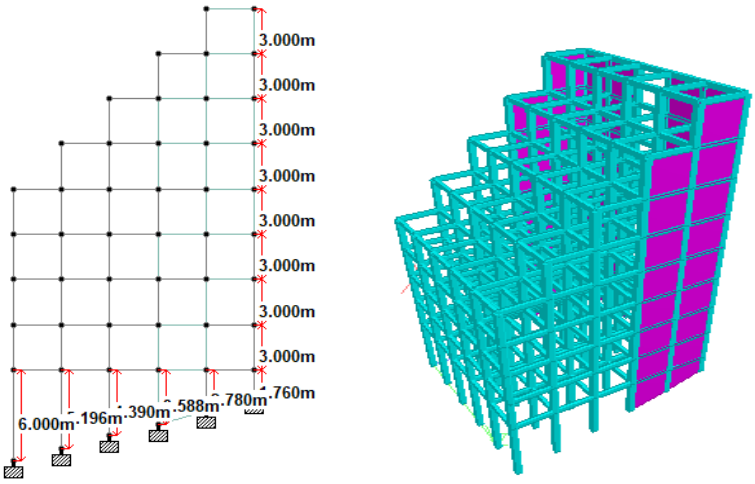

Fig 3:- Elevation of L Shape Shear Wall with 15° Slope

3. 15° Slope T Shape Shear Wall

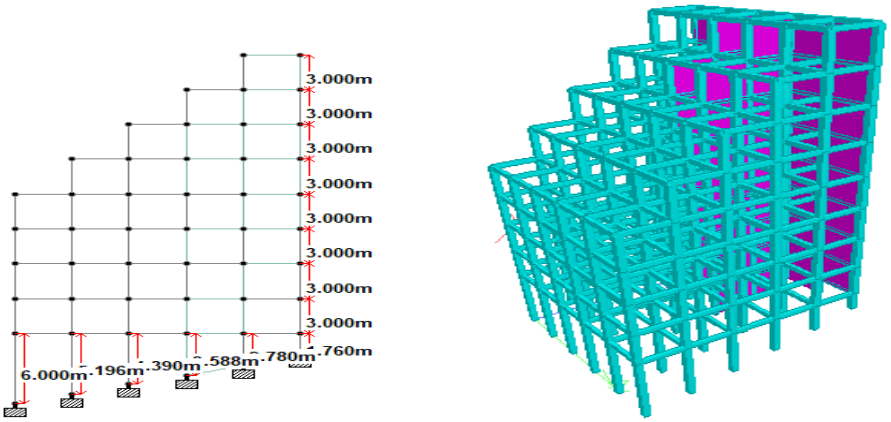

Fig 4:- Elevation of T Shape Shear Wall with 15° Slope

4. 30° Slope C Shape Shear Wall

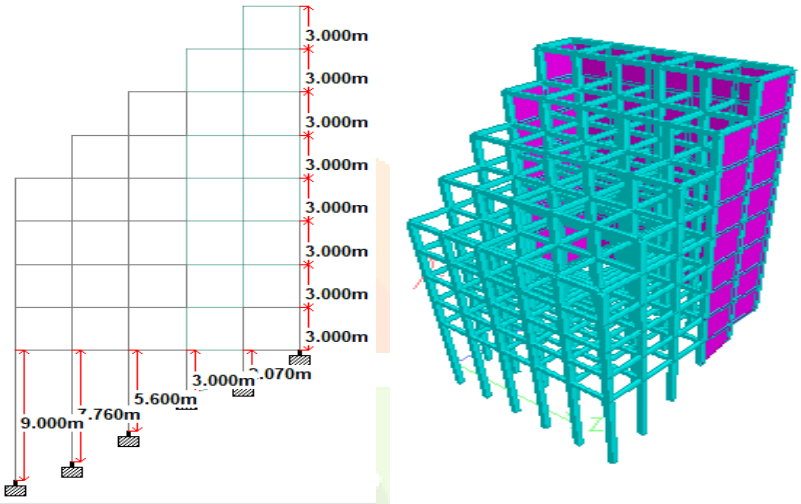

Fig 5:- Elevation of C Shape Shear Wall with 30° Slope

5. 30° Slope L Shape Shear Wall

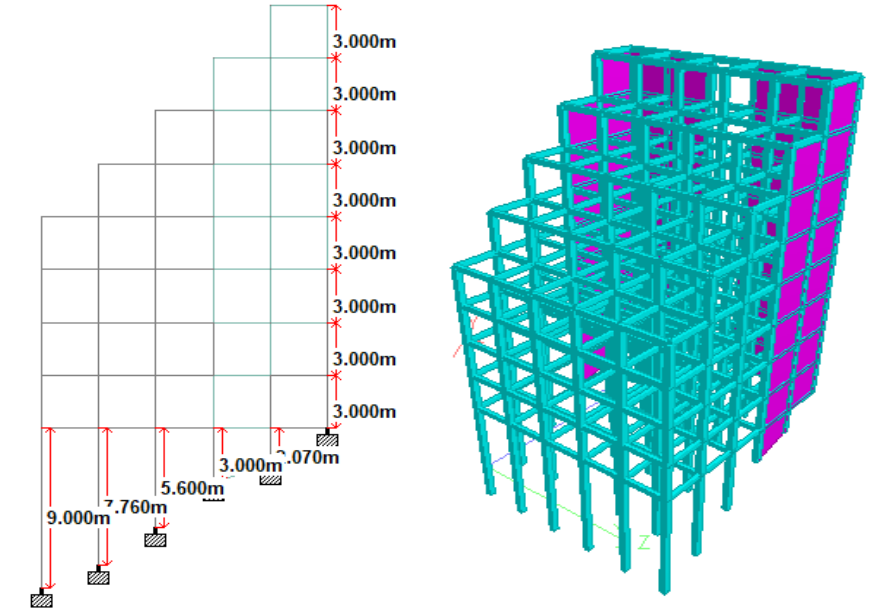

Fig 6:- Elevation of L Shape Shear Wall with 30° Slope

6. 30° Slope T Shape Shear Wall

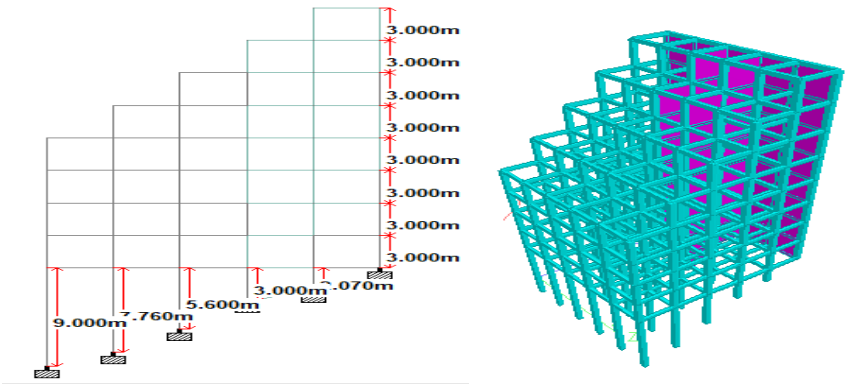

Fig 7:- Elevation of T Shape Shear Wall with 30° Slope

7. 45° Slope C Shape Shear Wall

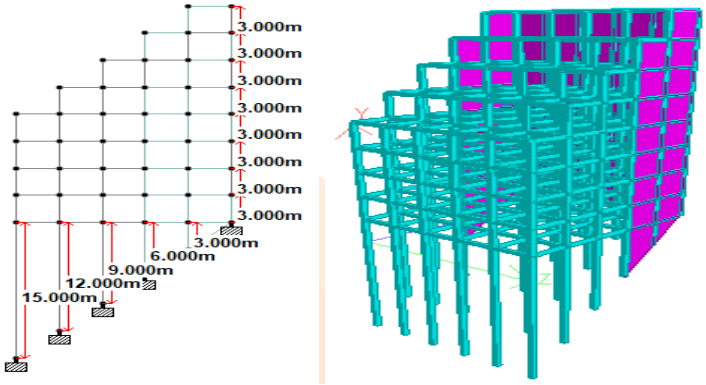

Fig 8:- Elevation of C Shape Shear Wall with 45° Slope

8. 45° Slope L Shape Shear Wall

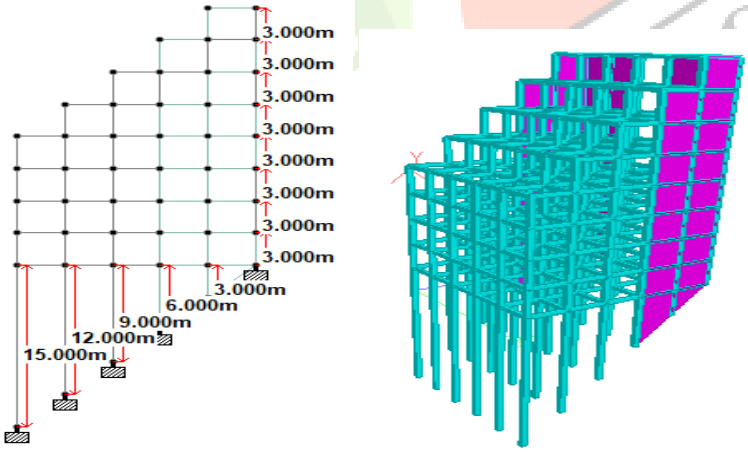

Fig 9:- Elevation of L Shape Shear Wall with 45° Slope

9. 45° Slope T Shape Shear Wall

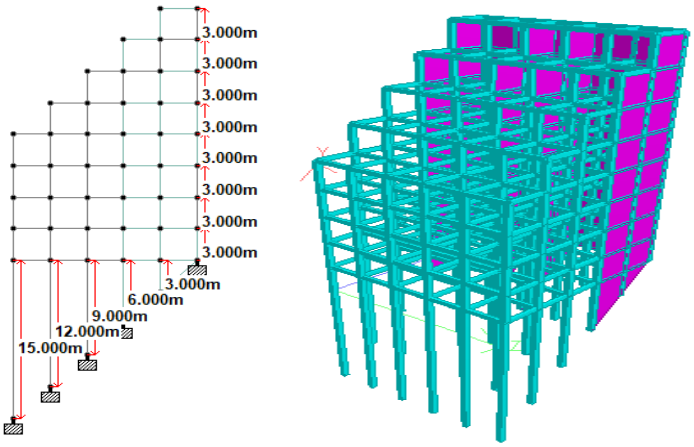

Fig 10:- Elevation of TShape Shear Wall with 45° Slope

2.3 Methodology

The loading of building is subjected to dead load and live load as per IS 875 (Part 1) (Part 2): 1987 respectively. As per Indian Code of Practice IS 1893 (Part 1): 2016, design the multistoried residential building against earthquake and wind loads. The member forces are calculated with load combination given in IS 456: 2000. Seismic provision for this building:

- Seismic zone : V
- Types of the frame : Special Moment Resisting Frame
- Response reduction factor (R) : 5.0
- Importance factor (I) : 1
- Soil type : Medium soil
- Damping ratio : 5%

Loading :-

Dead Load: Self-weight of slab= 25kN/m3×0.15 m= 3.75 kN/m2 . + 1kN/m2 (floor finish)=4.75kN/m2
Dead Load of 230 mm Brick wall = 0.23m x 20kN/m3 x(3-0.45)m=11.73 kN/m
Dead Load of 230 mm Brick wall = 0.15m x 20kN/m3 x(3-0.45)m=7.65 kN/m

Calculation of Dead Load:-
1. Wall Load= Thickness of Wall X Density of Brick X (Floor Height-Depth of Beam)
2. Slab Load (Floor Load)= Thickness of slab X Density of Concrete. …….(Density is considered from IS 875:2015 Part I)

Live Loads: Live load as per IS 875 (Part 2):2015, (assumed) Live Load on typical floors = 3kN/m2

LOAD CASES & COMIBATIONS

LOAD CASE	DESCRIPTION
1 EQX+	Seismic in X direction
2 EQZ+	Seismic in Z direction
3 D.L	Dead Load
4 L.L	Imposed Load

NO. LOAD COMBINATIONS

LOAD COMB 101 1.5(DL+LL)
LOAD COMB 102 1.5(EQX+DL)
LOAD COMB 103 1.5(-EQX+DL)
LOAD COMB 104 1.5(EQZ+DL)
LOAD COMB 105 1.5(-EQZ+DL)
LOAD COMB 106 1.2EQX+1.2DL+1.2LL
LOAD COMB 107 -1.2EQX+1.2DL+1.2LL
LOAD COMB 108 1.2EQZ+1.2DL+1.2LL
LOAD COMB 109 -1.2EQZ+1.2DL+1.2LL
LOAD COMB 110 .9DL+1.5EQX
LOAD COMB 111 .9DL-1.5EQX
LOAD COMB 112 .9DL+1.5EQZ
LOAD COMB 113 .9DL-1.5EQZ
LOAD COMB 201 DL+.5LL
LOAD COMB 301 (DL+LL)
LOAD COMB 302 (EQX+DL)
LOAD COMB 303 (-EQX+DL)
LOAD COMB 304 (EQZ+DL)

LOAD COMB 305 (-EQZ+DL)

III. RESULTS

3.1 BASE REACTION

Table 3.1: Base Reaction Result.

Type of Structure	Base Reaction (kN)
15° Slope C Shape Shear Wall	1505.924
15° Slope L Shape Shear Wall	1505.501
15° Slope T Shape Shear Wall	1832.420
30° Slope C Shape Shear Wall	1233.911
30° Slope L Shape Shear Wall	2217.764
30° Slope T Shape Shear Wall	2542.980
45° Slope C Shape Shear Wall	3148.554
45° Slope L Shape Shear Wall	1643.625
45° Slope T Shape Shear Wall	1549.568

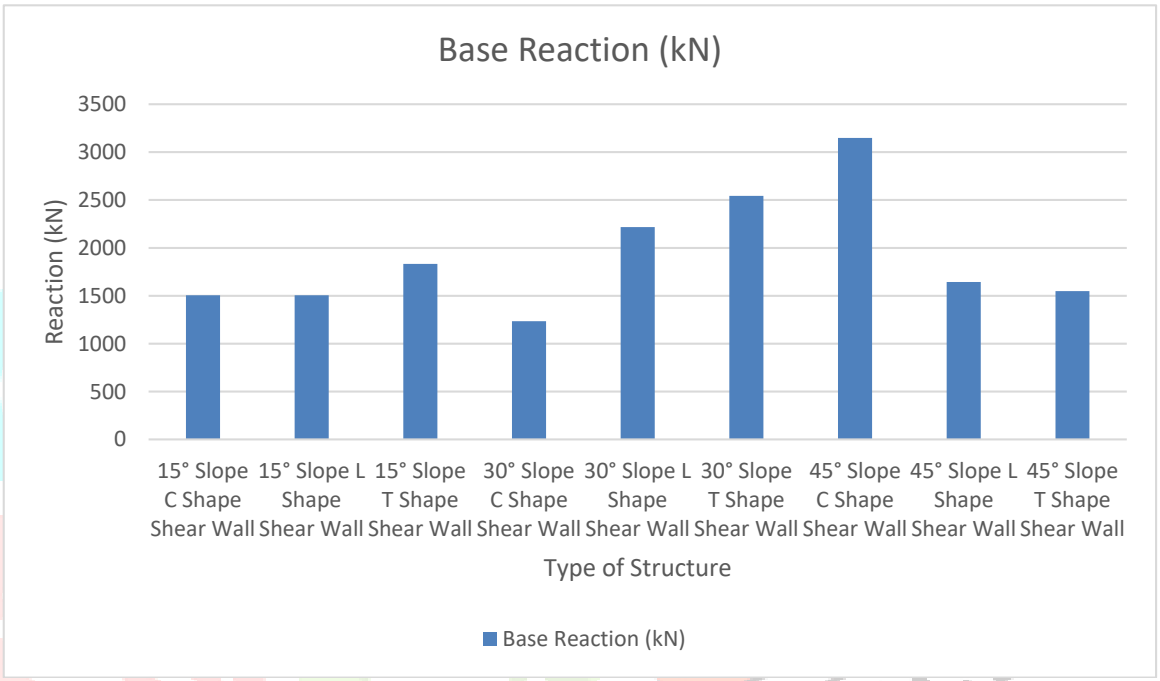

Fig 11:- Graph for Maximum Base Reaction

3.2 STOREY DISPLACEMENT

Storey Displacement for C shape Shear Wall (mm)

Table 3.2: Storey Displacement for C shape Shear Wall

Storey Displacement for C shape Shear Wall (mm)			
Storey	**15 Degree**	**30 Degree**	**45 Degree**
Terrace	34.339	26.157	19.318
Seventh	32.521	25.341	19.374
Sixth	29.072	22.939	18.511
Fifth	24.816	19.737	16.449
Fourth	20.319	16.234	13.996
Third	15.729	12.476	11.181
Second	11.131	8.425	8.072
First	6.572	4.495	5.004
Ground	2.675	2.247	3.418
Base	0	0	0

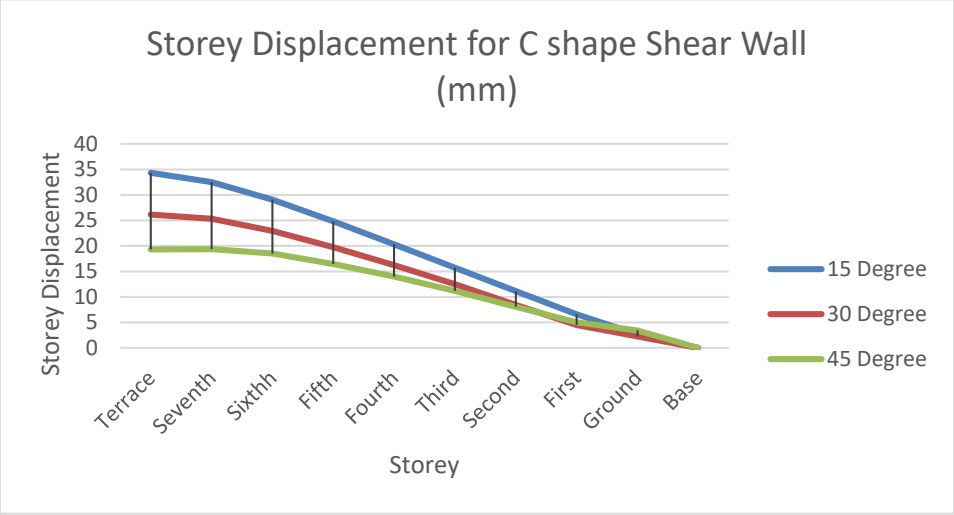

Fig 12:- Graph for Storey Displacement for C shaped shear wall

Storey Displacement for L shape Shear Wall (mm)

Table 3.3: Storey Displacement for L shape Shear Wall

Storey Displacement for L shape Shear Wall (mm)			
Storey	**15 Degree**	**30 Degree**	**45 Degree**
Terrace	34.189	25.638	18.568
Seventh	31.865	25.129	18.624
Sixth	28.426	21.624	17.761
Fifth	24.238	19.125	15.699
Fourth	20.319	15.38	13.246
Third	20.13	11.726	10.431
Second	14.984	7.675	7.322
First	10.826	3.745	4.254
Ground	2.548	1.497	2.668
Base	0	0	0

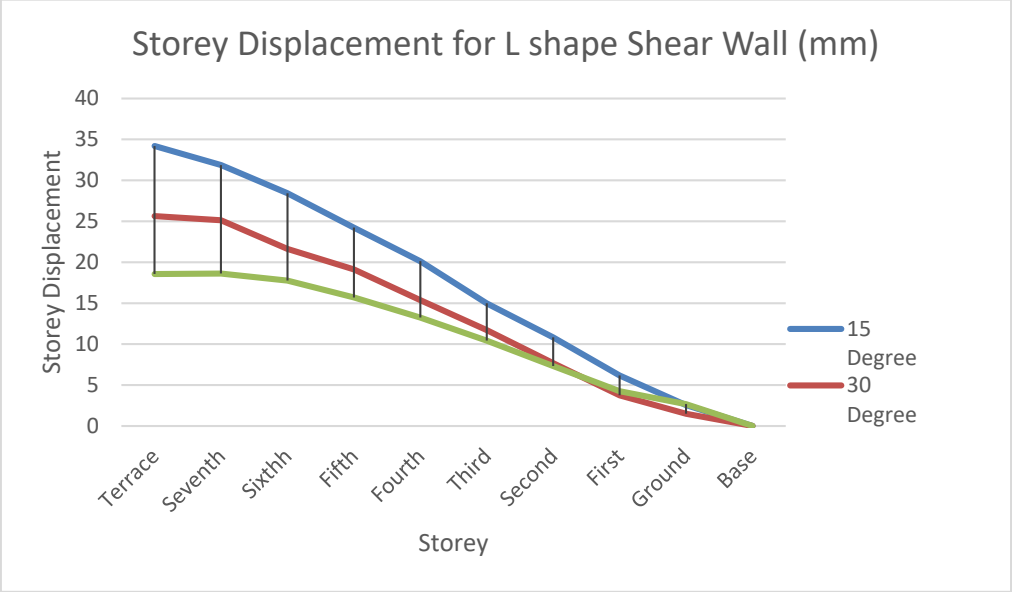

Fig 13:- Graph for Storey Displacement for L shaped shear wall

Storey Displacement for T shape Shear Wall (mm)

Table 3.4: Storey Displacement for L shape Shear Wall

Storey Displacement for T shape Shear Wall (mm)			
Storey	**15 Degree**	**30 Degree**	**45 Degree**
Terrace	34.257	25.689	18.605
Seventh	31.929	25.179	18.661
Sixth	28.483	21.667	17.797
Fifth	24.286	19.163	15.730
Fourth	20.360	15.411	13.272
Third	20.170	11.749	10.452
Second	15.014	7.690	7.337
First	10.848	3.752	4.263
Ground	2.553	1.500	2.673
Base	0	0	0

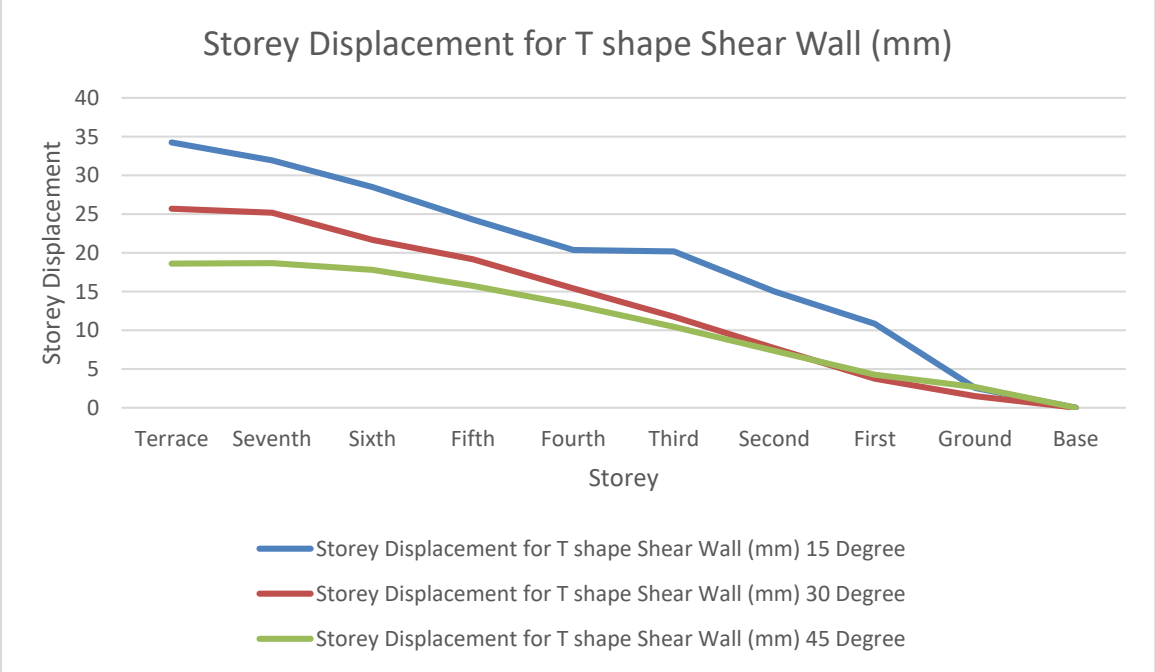

Fig 14:- Graph for Storey Displacement for T shaped shear wall

3.3 BENDING MOMENT IN COLUMN

Table 3.5: Bending Moment In Column

Type of Structure	Bending Moment (kN-m)
15° Slope C Shape Shear Wall	13.587
15° Slope L Shape Shear Wall	22.804
15° Slope T Shape Shear Wall	24.684
30° Slope C Shape Shear Wall	27.271
30° Slope L Shape Shear Wall	31.962
30° Slope T Shape Shear Wall	34.854
45° Slope C Shape Shear Wall	27.284
45° Slope L Shape Shear Wall	32.483
45° Slope T Shape Shear Wall	36.495

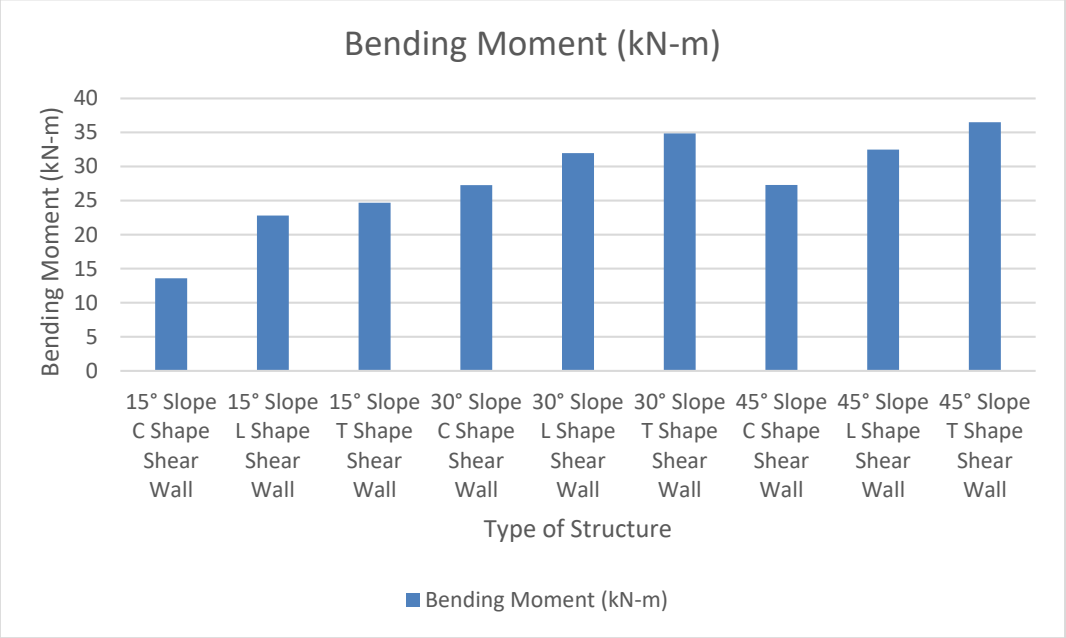

Fig 15:- Graph for Bending Moment in Column.

3.4 SHEAR FORCE IN COLUMN

Table 3.6: Shear Force In Column

Type of Structure	Shear Force (kN)
15° Slope C Shape Shear Wall	7.500
15° Slope L Shape Shear Wall	12.146
15° Slope T Shape Shear Wall	14.192
30° Slope C Shape Shear Wall	16.338
30° Slope L Shape Shear Wall	15.184
30° Slope T Shape Shear Wall	18.481
45° Slope C Shape Shear Wall	16.737
45° Slope L Shape Shear Wall	15.638
45° Slope T Shape Shear Wall	19.273

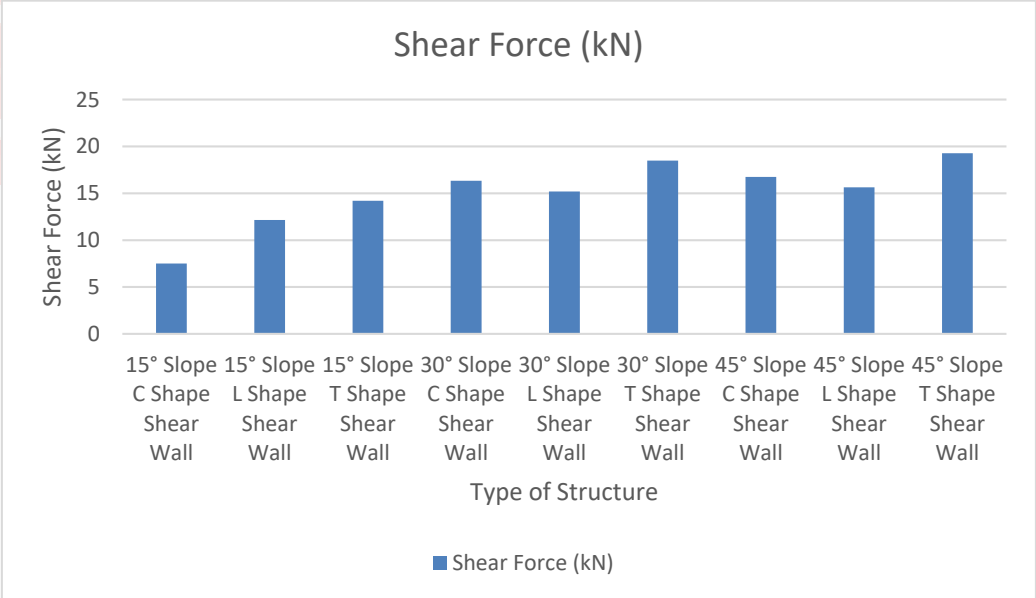

Fig 16:- Graph for Shear Force in Column.

3.5 AXIAL FORCE IN COLUMN

Table 3.5: Axial Force In Column

Type of Structure	Axial Force (kN)
15° Slope C Shape Shear Wall	652
15° Slope L Shape Shear Wall	698
15° Slope T Shape Shear Wall	758
30° Slope C Shape Shear Wall	686
30° Slope L Shape Shear Wall	724
30° Slope T Shape Shear Wall	783
45° Slope C Shape Shear Wall	670
45° Slope L Shape Shear Wall	736
45° Slope T Shape Shear Wall	754

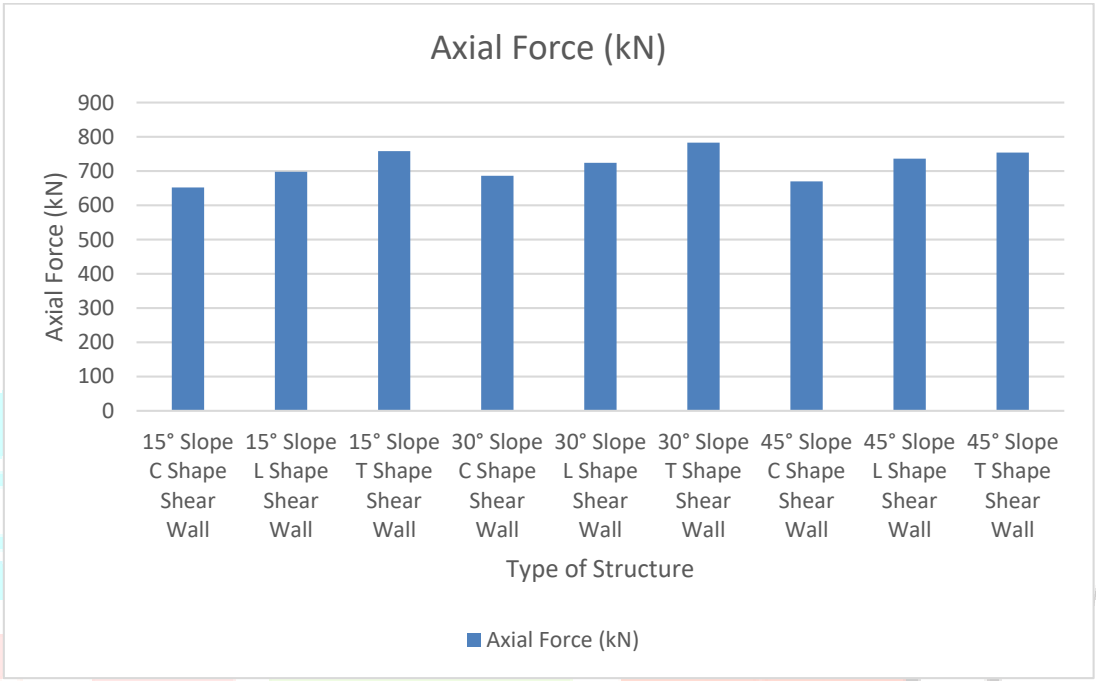

Fig 17:- Graph for Axial Force in Column.

CONCLUSION

- From the comparison of the result it is found that the effective location of shear wall is found in the C and L Shape in the building.
- As the angles of increases the shear force, bending moment and Axial Force increases.
- The shear wall Provide a good strength to the structure as the Slope angle increases the sear wall resist the seismic forces thus reducing the overall deflection of the structure.
- To provide shear wall increase the seismic performance of the structure.
- Overall the C and L shaped with 15 and 30 degree angle shear wall shows the better result as compared to the 45 degree T shaped shear wall. As the Shearwall provide a strength to the periphery of the structure and prevent against the slope.

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