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Optimization of Stability of Building by Changing Thickness of Shear Wall at Corners for Same Concrete Grade

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***Abstract*— *Stability is to ensure the safety of structures from collapsing. Stability theory is crucial for structural engineering, aerospace, nuclear engineering, coastal, ocean and arctic engineering. It plays an important role in certain problems of space structures, geotechnical structures, geophysics and materials science .The project deals with the Response Spectrum Analysis of G+20 storeys Residential Apartment for different models. Total 12 models are modeled under the variations in thickness Shear Wall Provided at Corners from 0.130m to 0.150m thickness. The structure consists of 5 m. spacing of grid with total 6 bays in both major directions. The plinth area is taken 30mx30m (900 m2). The earthquake structure analysis for zone III with the help of analysis software. The project concluded that stability of structure is increases with increment in the thickness of shear wall. The lateral load capacity is much more in shear wall structure and increment in it also increases. The optimum structures observed for the current project is OSW10 & 11 in terms of stability with respect to result parameters.*

***Keywords*—Concrete Grade, Dual System, Dimension Change, Shear wall, Stability.**

I. INTRODUCTION

A building is with stand under the lateral loads effect (earthquake) only when the building component is satisfying the lateral loads response. The shear wall is one of the important components in to it. Reinforced concrete (RC) buildings next to slabs, beams and columns often have vertical RC slab-like walls called shear walls. These walls usually start at the level of the foundation and are continuous throughout the height of the building. Their thickness can be up to 130 mm, or up to 450 mm high in tall buildings. Sliding walls are usually provided along the length and width of buildings. Shear walls are like vertically oriented wide beams that carry earthquake loads down to the foundation. The use of shear wall or their equivalents become mandatory in some high-rise building if inter storey deflection is controlled due to lateral loading. Shear walls also provides the solution against expensive non-structural harm during moderate seismic disturbance. The shear wall is actually a misnomer as far as tall buildings are concerned, when the lateral loads are applied to a tapered shear wall resulting in mainly momentary deflection and only very trivial shear deformation. Analysis of shear wall may appear as an important design element because high rise structures are continuously becoming taller and slender. More often than not, shear walls are pierced by multiple openings. This type of sliding walls is known as connected sliding walls. The walls on either side of the opening are interconnected by short, often deep beams that form part of the wall or floor slab, or both. If these walls are installed systematically, then an improvement in stability will be achieved in them.

II. SHEAR WALL

A structural component added to the multistoried building structure made up of stiff R. C. C. wall, is an additional member used to resist lateral effects on it. This R.C.C. vertical wall starts from foundation base to the top of the building. Ordinary RC structural walls and Ductile RC structural walls are classified by the Indian standardization. As per IS 13920, one doesn't meet the special detailing requirements for ductile behavior is considered as the former one meet the special detailing requirements for ductile behavior is considered as the later.

III. OBJECTIVES OF THE PROJECT

This research is based on the variation in thickness of shear wall in G+20 Storey building. The following objectives are taken for these project areas follows:-

- To Study about shear wall behavior with variation in different parameters.
- To Modeled a G+20 storey multistory Building by software approach.
- To find different results parameters such as Maximum displacement, Base shear, axial force, bending moment, Torsional moment & Stresses in required X Y and Z directions.
- To compare the OSW0 (regular model) with OSW1 to OSW11 model (1 to 11 is changing the thickness of shear wall from 0.130 m. to 0.150 m. in the interval added 0.002 m.).
- To find the optimum structure & thickness of shear wall structure in G+20 Storey model.

IV. MODELING AND ANALYSIS

The Different cases of G+20 Storey Residential Apartment with variation in Shear Wall thickness provided at corner are modeled by using fem based software. The Notations of cases are described in the table no. by OSWO to OSW11. Table 1 shows the Descriptions of model.

Table 1: Model Descriptions

S. No	Model Cases	Descriptions
1	**OSW0**	G+20 storey with no Shear Wall (Regular Structure)
2	**OSW1**	G+20 storey with Shear Wall 0.130 thickness
3	**OSW2**	G+20 storey with Shear Wall 0.132 thickness
4	**OSW3**	G+20 storey with Shear Wall 0.134 thickness
5	**OSW4**	G+20 storey with Shear Wall 0.136 thickness
6	**OSW5**	G+20 storey with Shear Wall 0.138 thickness
7	**OSW6**	G+20 storey with Shear Wall 0.140 thickness
8	**OSW7**	G+20 storey with Shear Wall 0.142 thickness
9	**OSW8**	G+20 storey with Shear Wall 0.144 thickness
10	**OSW9**	G+20 storey with Shear Wall 0.146 thickness
11	**OSW10**	G+20 storey with Shear Wall 0.148 thickness
12	**OSW11**	G+20 storey with Shear Wall 0.150 thickness

Structural Parameters used in G+ 20 storey: Table 2 & Table 3 shows the basic parameters used in the analysis of building.

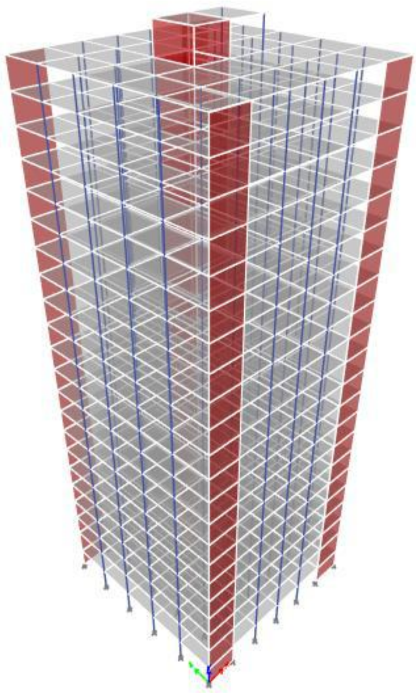

Fig.1: G+20 Storey 3D view

Table 2: Structural Parameters

S. No.	Element Name	Description
1	Building Types	Residential
2	No. of Storey	G+20
3	Plinth Area	900 m^2
4	Floor Height	4.5 GF & 3.66 each floor
5	Dimensions of Beam	0.50 m. x0.38 m.
6	Dimensions of Column	0.55 m. x 0.60 m.
7	Slab Thickness	0.150 m.
8	Shear wall	0.130 m. thick(around lift area) At Corners: 0.130m, 0.132m, 0.134m, 0.136m,

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		0.138m, 0.140m, 0.142m, 0.144m, 0.146m, 0.148m, 0.150m,
10	Grade of Concrete	M25
11	Steel Used	Fe 500
12	Grid Spacing in X-Direction	5 m.@ 6 bays
13	Grid Spacing in Y-Direction	5 m.@ 6 bays

Earthquake Parameters used:

Table 3: Earthquake Parameters

S. No.	Parameters	Description
1	Earthquake Code	IS 1893(Part 1):2016
2	Earthquake Zone	III
3	Response Factor(RF)	4
4	Importance Factor(IF)	1.2
5	Soil Types	Medium
6	Damping	0.05 (5%)
7	Time Period	1.3944 second.
8	Structural Type	RCC Framed Building
9	Earthquake method	Response Spectrum Method

V. RESULTS AND DISCUSSION

The Following results are to be obtained from the modeling and analysis of Multi storey building of G+20 Storey building in software. The results are as follows:

Table 4: Maximum Displacement for G+20 Storey for different Models

Shear Wall Stability Case	Maximum Displacement(mm)	
	For X Direction	For Z Direction
Case OSW0	268.583	349.03
Case OSW1	242.32	323.801
Case OSW2	242.174	323.925
Case OSW3	242.03	324.049
Case OSW4	241.888	324.174
Case OSW5	241.746	324.299
Case OSW6	241.607	324.425
Case OSW7	241.468	324.551
Case OSW8	241.468	324.551
Case OSW9	241.195	324.804
Case OSW10	241.06	324.931
Case OSW11	240.926	325.089

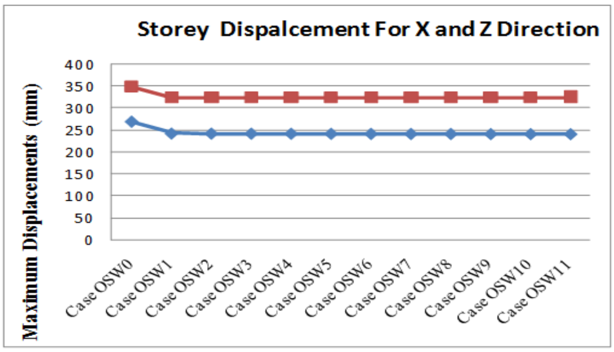

Fig.2: Bar char of Maximum Displacement for G+20 Storey for different Models

Table 5: Base Shear for all Optimum Shear Wall Stability Case

Shear Wall Stability Case	Base Shear (KN)	
	X direction	Z direction
Case OSW0	4957.557	4957.5451
Case OSW1	5146.7824	5146.7754
Case OSW2	5149.5729	5149.5649
Case OSW3	5152.3638	5152.3523
Case OSW4	5155.1486	5155.1414
Case OSW5	5157.9389	5157.9331
Case OSW6	5160.7287	5160.7212
Case OSW7	5163.5153	5163.5078
Case OSW8	5163.5153	5163.5074
Case OSW9	5169.0983	5169.0846
Case OSW10	5171.8813	5171.8750
Case OSW11	5174.6694	5174.6635

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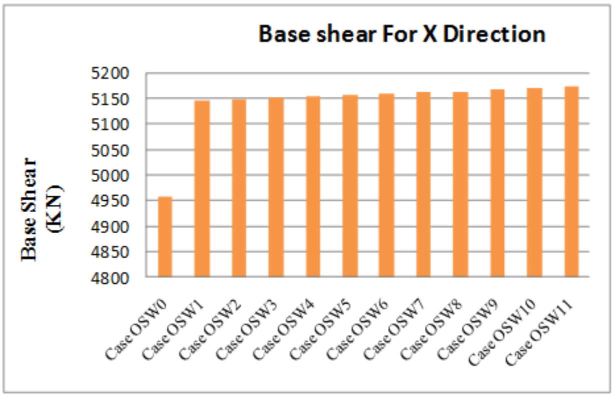

Fig.3: Base Shear in X direction for all Optimum Shear Wall Stability Case

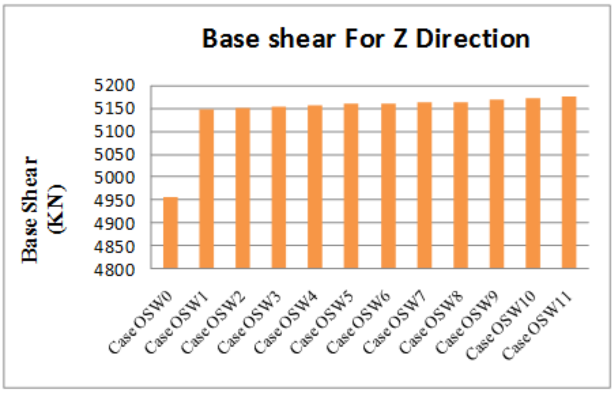

Fig.4: Base Shear in Z direction for all Optimum Shear Wall Stability Case

Table 6: Maximum Axial Forces in Column for all Optimum Shear Wall Stability Case

Shear Wall Stability Case	Column Axial Force (KN)
Case OSW0	9189.2016
Case OSW1	8854.1918
Case OSW2	8856.7936
Case OSW3	8859.4052
Case OSW4	8862.0302
Case OSW5	8864.6715
Case OSW6	8867.3191
Case OSW7	8869.9753
Case OSW8	8869.9753
Case OSW9	8875.3271
Case OSW10	8878.0194
Case OSW11	8880.7201

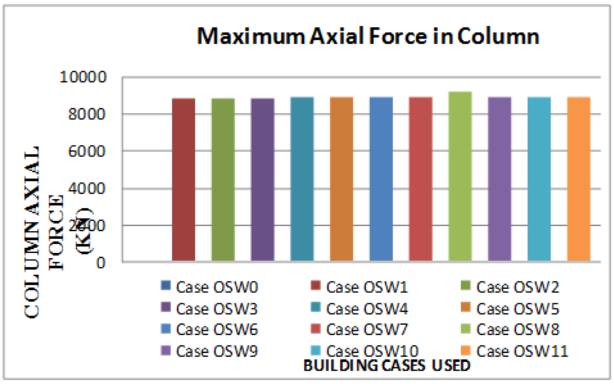

Fig.5: Maximum Axial Forces in Column for all Optimum Shear Wall Stability Case

Table 7: Maximum Shear Force in Column for all Shear Wall Stability Cases

Shear Wall Stability Case	Column Shear Force (KN)	
	Shear along Y	Shear along Z
Case OSW0	121.1855	122.829
Case OSW1	122.7198	121.8681
Case OSW2	122.9672	121.8993
Case OSW3	123.2112	121.9307
Case OSW4	123.4517	121.9623
Case OSW5	123.689	121.8142
Case OSW6	123.923	122.0263
Case OSW7	124.1539	122.0585
Case OSW8	124.1539	121.883
Case OSW9	124.6065	122.1238
Case OSW10	124.8282	122.1567
Case OSW11	125.0471	122.1898

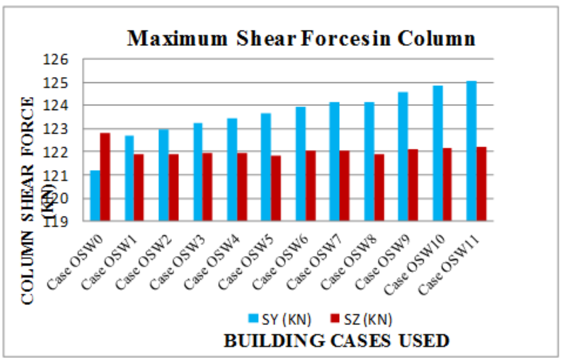

Fig.6: Maximum Shear Force in Column for all Optimum Shear Wall Stability Case

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Table 8: Maximum Bending Moment in Column

Shear Wall Stability Case	Column Bending Moment (KN.m)	
	Moment along Y	Moment along Z
Case OSW0	208.5969	220.4408
Case OSW1	207.521	202.4762
Case OSW2	207.8065	202.8719
Case OSW3	207.8612	203.2622
Case OSW4	207.9163	203.6469
Case OSW5	207.9719	204.0266
Case OSW6	208.0278	204.4011
Case OSW7	208.0839	204.7706
Case OSW8	208.0839	204.7706
Case OSW9	208.1974	205.4952
Case OSW10	208.2547	205.8502
Case OSW11	208.3124	206.2007

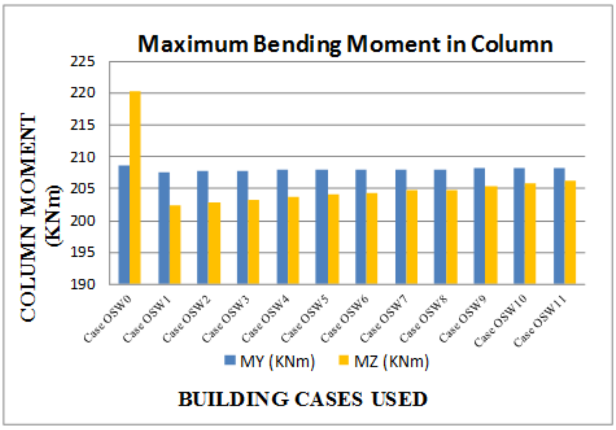

Fig.7: Maximum Bending Moment in Column

Table 9: Maximum Shear Force in Beam for all Optimum Shear Wall Stability Case

Shear Wall Stability Case	Beam Shear Force (KN)	
	Shear along Y	Shear along Z
Case OSW0	155.6581	1.1827
Case OSW1	147.4593	0.2535
Case OSW2	147.5962	0.2526
Case OSW3	147.7309	0.2517
Case OSW4	147.8633	0.2508
Case OSW5	147.9938	0.25
Case OSW6	147.1222	0.2492
Case OSW7	148.2485	0.2484
Case OSW8	148.2485	0.2485
Case OSW9	148.4955	0.2469
Case OSW10	148.616	0.2461
Case OSW11	148.7347	0.2454

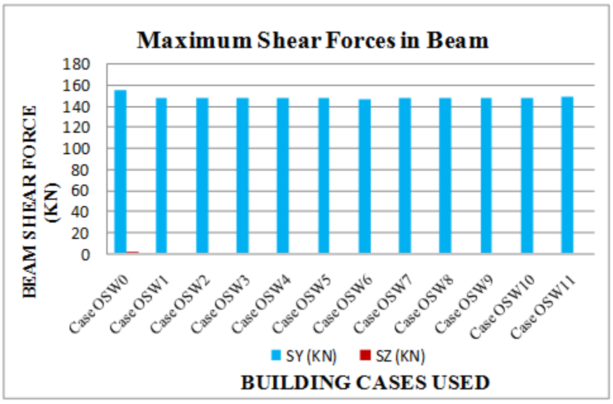

Fig.8: Representation of Maximum Shear Force in Beam

Table 10: Maximum Bending Moment in Beam for all Optimum Shear Wall Stability Case

Shear Wall Stability Case	Beam Bending Moment (KN.m)	
	Moment along Y	Moment along Z
Case OSW0	2.6776	277.2208
Case OSW1	0.6344	269.5813
Case OSW2	0.6324	269.646
Case OSW3	0.6304	269.7109
Case OSW4	0.6285	269.7759
Case OSW5	0.6266	269.8414
Case OSW6	0.6248	269.9069
Case OSW7	0.623	269.9725
Case OSW8	0.623	269.9725
Case OSW9	0.6196	270.1046
Case OSW10	0.6179	270.171
Case OSW11	0.6163	270.2375

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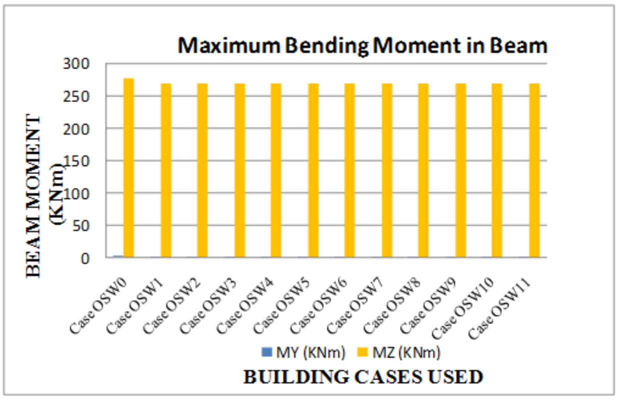

Fig.9: Representation of Maximum Bending Moment in Beam

Table 11: Maximum Torsional Moments in Beam & Column Results

Shear Wall Stability Case	Beam Torsional Moments (KN.m)	Column Torsional Moments (KN.m)
Case OSW0	8.7148	19.8112
Case OSW1	9.5852	4.5013
Case OSW2	9.5909	4.4919
Case OSW3	9.7109	4.4826
Case OSW4	9.6023	4.4734
Case OSW5	9.6079	4.4642
Case OSW6	9.6136	4.4551
Case OSW7	9.6192	4.446
Case OSW8	9.6192	4.446
Case OSW9	9.6304	4.4281
Case OSW10	9.6359	4.4193
Case OSW11	9.6415	4.4105

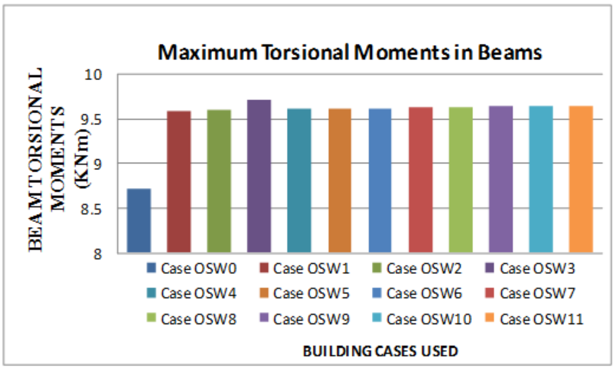

Fig.10: Bar chart of Maximum Torsional Moments in Beams

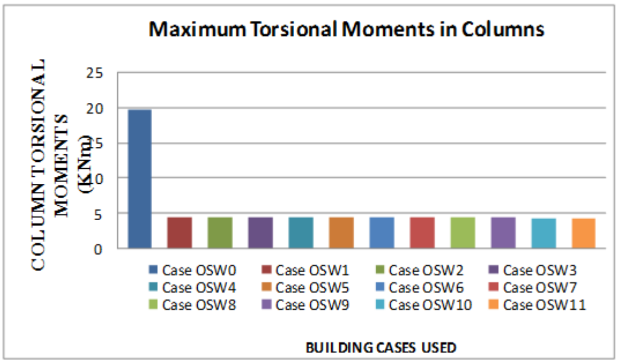

Fig.11: Bar chart of Maximum Torsional Moments in Columns

Table 12: Maximum Principal Stresses for all Optimum Shear Wall Stability Case

Shear Wall Stability Case	Maximum Principal Stresses (Smax Top) (N/sq. mm)	Maximum Von Mises Stresses (SVM Top) (N/sq. mm)	Maximum Shearing Stresses (S12) (N/sq. mm)
Case OSW0	20.66	25.75	8.2
Case OSW1	18.75	24.18	4.46
Case OSW2	18.76	24.19	4.47
Case OSW3	18.77	24.2	4.47
Case OSW4	18.78	24.2	4.47
Case OSW5	18.79	24.21	4.47
Case OSW6	18.8	24.22	4.47
Case OSW7	18.8	24.23	4.48
Case OSW8	18.8	24.23	4.48
Case OSW9	18.8	24.24	4.48
Case OSW10	18.83	24.25	4.48
Case OSW11	18.84	24.26	4.48

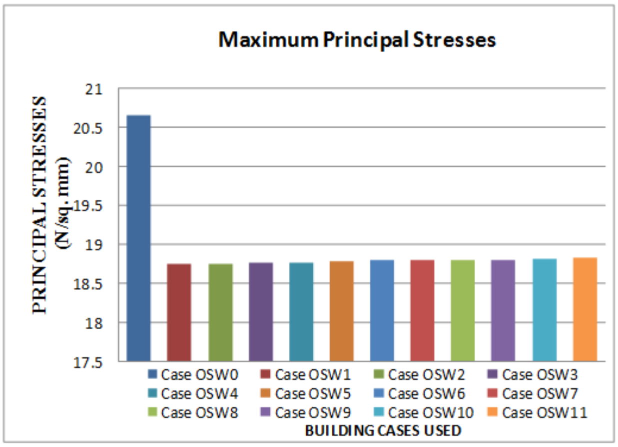

Fig.12: Maximum Principal Stresses for all Optimum Shear Wall Stability Case

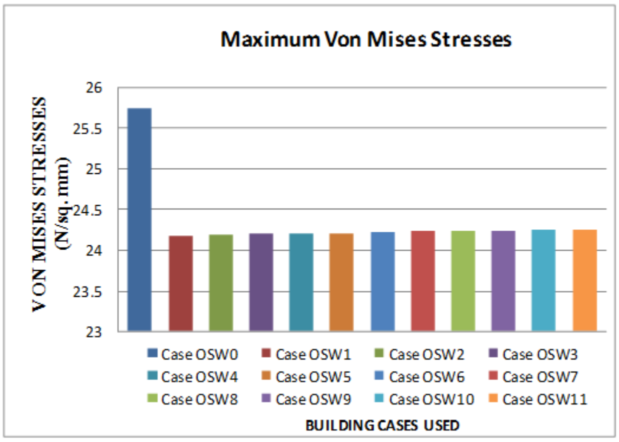

Fig.13: Maximum Von Mises Stresses for all Optimum Shear Wall Stability Case

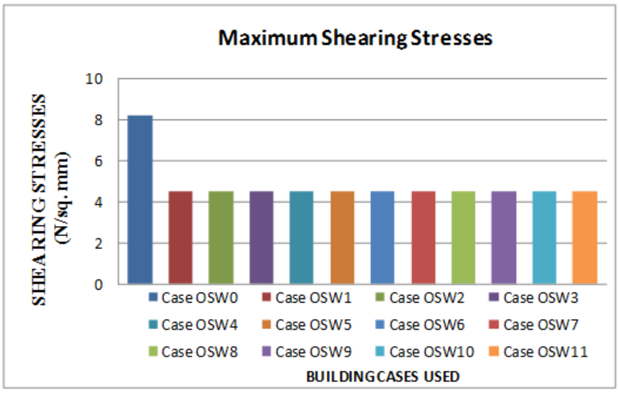

Fig.14: Maximum Shearing Stresses for all Optimum Shear Wall Stability Case

VI. CONCLUSIONS

The following conclusions are obtained based the different results obtained of model OSW0 to model OSW11.

The Response spectrum approach is adopted in it. The entire conclusion are valid only and only for this project. The conclusions are as follows:

1. There is decrement in storey displacement of 9.78%, 9.83%. 9.89% 9.94%. 9.99%, 10.04%, 10.10%, 10.10%, 10.20%, 10.30% is observed in model OSW1 to OSW11 with respect to OSW0(reference model) in X direction. Similarly 7.23%, 7.19%, 7.16%, 7.12%, 7.09%, 7.055, 7.01%, 7.01%, 6.94%, 6.90%, 6.86% with respect to OSW0 (reference model) in Z-direction.
2. There is increment is observed in base shear which is 3.82%, 3.87%, 3.93%, 3.99%, 4.04%, 4.10% ,4.15% 4.15% 4.27%,4.32%, 4.38% in OSW1 to OSW11 models with reference to basic model in both major direction.
3. The axial forces value is also reduces in OSW1 to OSW11 which is 3.65%,3.62%,3.59%,3.56%,3.53%,3.50%,3.47%,3.47 %,3.42%,3.39%,3.36% with references to OSW0.
4. There is increment in column shear force in OSW1 to OSW11 which is 1.27%,1.47%,1.67%,1.87%,2.07%2.26%,2.45%,2.45% ,2.82%,3.01%,3.19%, with respect to basic structure in X direction. Similarly in Z direction decrement is observed 0.78%, 0.76%, 0.73%, 0.71%, 0.83%, 0.65%, 0.63%, 0.77%, 0.57%, 0.55%, 0.52%.
5. There is minute reduction of 0.14% to 0.50% observed in bending moment in column in the models having shear wall variation with thickness in x Direction. But in case of z direction decrement value is observed in between 6 to 8 % with respect to normal model.
6. There is reduction in beam shear force is observed. The average 5% & 78 % reduction in Y & Z direction respectively in shear wall models with reference to regular model.
7. There is reduction in bending moment in beam is observed. The average 76.50 % & 2.65 % reduction in Y & Z direction respectively in shear wall models with reference to regular model.
8. The increment in value of Torsional moment in beam is observed which is 9.99%,10.05%,11.43%,10.18%,10.25%,10.31%,10.38 %,10.38%,10.51%,10.57%,10.63%, in OSW1 to OSW 11 models with respect to basic model.
9. The decrement in value of Torsional moment in column is observed which is 77.28%,77.33%,77.37%,77.42%,77.47%,77.51%,77.56 %,77.56%,77.65%,77.69%,77.74% in OSW1 to OSW 11 models with respect to regular model(OSW).
10. The reduction is observed in stresses when increment in shear wall thickness in models. The avg. 9%, 6%, 45 % reduction in stresses i.e. Maximum Principal Stresses

Maximum, Von Mises Stresses, Maximum Shearing Stresses respectively with reference to regular model stresses.

The final concluded that there is decrement is observed on affected parameters on the structure with increment in shear wall thickness. The lateral loads resisting capacity is improved with increment in thickness in shear wall. The optimum structure is observed is OSW10 & 11.

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