International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 7, Issue 3, March 2017)

Effectiveness of Shear wall Orientation in RC Framed Structures under the action of Seismic Forces

Sagar L Belgaonkar[1], A.Amarnath[2], Shristi B Bevinakatti[3], Nikita S Pise[4], Chinmayee P[5], Kausar I Auti[6]

[1,2]Assistant Professor, Civil Engineering Department, S.G.B.I.T, Belgaum, India 590010
[3,4,5,6] Under Graduate Student, Civil Engineering Department, S.G.B.I.T, Belgaum, India 590010

***Abstract*—Shear walls are the structural members which are known to resist the lateral loads such as wind and earthquake etc. The main function of shear wall is to improve the lateral resistant of structure. From past 30 years history of earthquake, it has been estimated that, no building containing shear walls has undergone destructions during earthquake and heavy wind forces. The present study deals with the structural performance of RC framed building with shear walls at different locations. The analysis is compared for its parameters.**

The building is analysed with infill considerations with five different locations of shear walls.

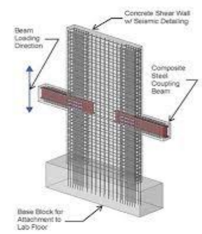
***Keywords*—Shear wall, Displacement, Time period, Stiffness.**

I. INTRODUCTION

An Earthquake is the sudden release of energy, caused due to eruption of molten magma from the earth's crust, collision of tectonic plates and it may also occur due to the continuous vibrations generated by the heavy machinery equipment. Earthquake leads to the dislocation of the earth's layer.

RCC frame structure is the combination of slabs, beams, walls and foundation which when connected to each other form a unit. In RCC structure, load is first transferred from beams to column and then column to foundation, which in turn transfers the load to soil.

Shear walls are the structural members which resists the lateral loads and gravity loads coming from other structural members. The provision of design of shear wall is done on the basis of their high bearing capacity, rigidity and ductility to resists the seismic loads. Shear walls are common requirements of lift wells and multi-storied buildings. However they are also adopted in the construction of towers, commercial buildings and apartments.



II. EFFECT OF SHEAR WALL

Shear walls are known for providing good strength and stiffness to buildings. By this the lateral sway of the building and damage to the structure is reduced. Therefore the construction of shear wall in earthquake prone regions is becoming more popular.

III. METHODOLOGY

3.1 Numerical Analysis

Description of framed building

RC framed building consists of, G+11 story building

Plan dimensions: 20x20m	Bay length: 5m
Typical story height: 3m	Bottom story height:3.5m
Slab thickness: 150mm	Wall thickness: 230mm
Beam size: 300x450mm	Column size: 300x450mm
Live load: $3kN/m^2$	

The grade of concrete is M20 and M25 (shear wall).

3.2 Methods for Seismic Analysis of buildings

3.2.1 Equivalent Static Analysis (Linear static)

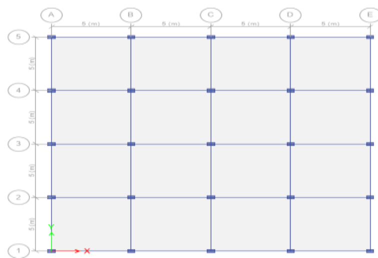
It is the study of forces on building which represents the effect of earthquake motion at the ground level. In this method it is considered that the building has its own fundamental mode of response when the vibrations due to earthquake are generated.

3.2.2 Response Spectrum Analysis (Dynamic Analysis)

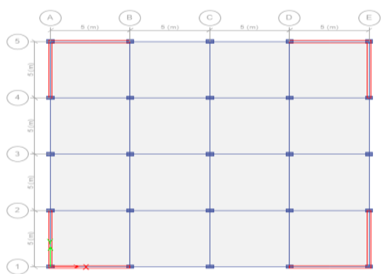
This method provides multiple modes of response of building during earthquake. The response of structure can be in any shape for each and every mode, responses read from the design spectrum based on the modal frequency and modal mass which in turn are combined to evaluate the total response of structure.

3.3 Models considered for the Analysis

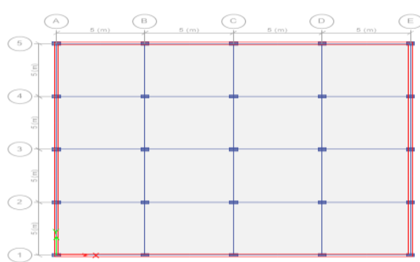
3.3.1 Model 1: Plan of building without shear wall



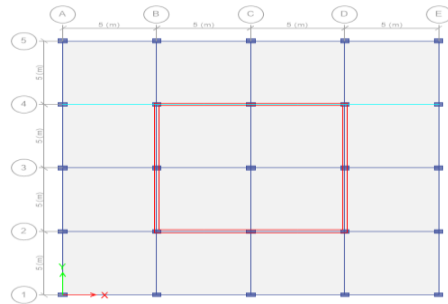
3.3.2 Model 2: Plan of building with shear wall located at Corner.



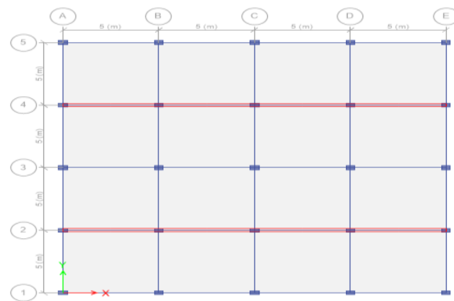
3.3.3 Model 3: Plan of building with shear wall located at Periphery.



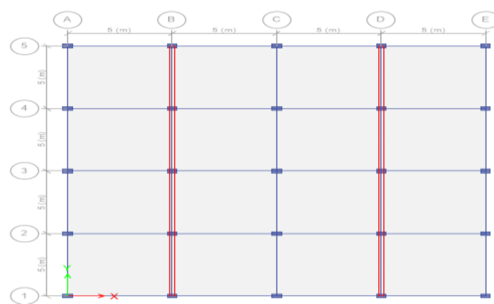
3.3.4 Model 4: Plan of building with shear wall located at Core.



3.3.5 Model 5: Plan of building with shear wall located in the X direction



3.3.6 Model 6: Plan of building with shear wall located in the Y direction



International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 7, Issue 3, March 2017)

Table I:
DISPLACEMENT FOR STATIC ANALYSIS MODEL 1

Storey	Displacement (mm)
Terrace	53.1
storey 11	52.7
storey 10	51.2
storey 9	48.6
storey 8	44.9
storey 7	40.4
storey 6	35.3
storey 5	29.7
storey 4	23.7
storey 3	17.6
storey 2	11.5
storey 1	5.4
Base	0.0

TABLE 2:
displacement in mm for static analysis

Storey	Model2	Model3	Model4	Model5	Model6
Terrace	0.02730	0.002050	0.00797	0.00392	0.20000
Storey11	0.02654	0.002010	0.00787	0.00383	0.20000
Storey10	0.02379	0.001890	0.00717	0.00349	0.20000
Storey9	0.02097	0.001760	0.00644	0.00313	0.20000
Storey8	0.01812	0.001610	0.00568	0.00276	0.20000
Storey7	0.01524	0.001450	0.00489	0.00238	0.20000
Storey6	0.01237	0.001260	0.0041	0.00199	0.10000
Storey5	0.00958	0.001070	0.0033	0.0016	0.10000
Storey4	0.00694	0.000860	0.00252	0.00123	0.10000
Storey3	0.00453	0.000650	0.00178	0.00087	0.10000
Storey2	0.00249	0.000430	0.0011	0.00054	0.10000
Storey1	0.00093	0.000220	0.00051	0.00025	0.02791
Base	0.00000	0.00000	0.00000	0.00000	0.0000

Table 3:
story stiffness for static analysis (model 1)

Storey	Stiffness (kN/m)
Terrace	5279.065
storey 11	116936.698
storey 10	151596.214
storey 9	158479.01
storey 8	161316.607
storey 7	163039.068
storey 6	164351.19
storey 5	165537.741
storey 4	166782.973
storey 3	168534.883
storey 2	172918.283
storey 1	194196.197
Base	0.0000

Table 4:
displacement in mm for dynamic analysis

Storey	Model2	Model3	Model4	Model5	Model6
Terrace	0.02794	0.0021320	0.008217	0.004039	0.20000
Storey11	0.02712	0.0020860	0.008101	0.003939	0.20000
Storey10	0.02415	0.0019520	0.007328	0.003563	0.20000
Storey9	0.02111	0.0017960	0.006512	0.003166	0.20000
Storey8	0.01803	0.0016200	0.005665	0.002753	0.20000
Storey7	0.01497	0.0014260	0.004801	0.002331	0.20000
Storey6	0.01196	0.0012200	0.003938	0.00191	0.10000
Storey5	0.00909	0.0010060	0.003096	0.001499	0.10000
Storey4	0.00644	0.0007890	0.002296	0.00111	0.10000
Storey3	0.00410	0.0005750	0.001563	0.000753	0.10000
Storey2	0.00217	0.0003700	0.000923	0.000443	0.04997
Storey1	0.00077	0.0001810	0.000401	0.000192	0.0238
Base	0.0000	0.0000	0.0000	0.0000	0.0000

Table 5:
displacement for dynamic analysis model 1

Storey	Displacement (mm)
Terrace	0.20000
storey 11	0.20000
storey 10	0.20000
storey 9	0.20000
storey 8	0.20000
storey 7	0.20000
storey 6	0.10000
storey 5	0.10000
storey 4	0.10000
storey 3	0.10000
storey 2	0.04688
storey 1	0.02234
Base	0.00000

Table 6:
story stiffness for dynamic analysis model 1

Storey	Stiffness (kN/m)
Terrace	4454.67
storey 11	107152.859
storey 10	146295.367
storey 9	155548.684
storey 8	159755.37
storey 7	162420.869
storey 6	164396.442
storey 5	166081.272
storey 4	167688.103
storey 3	169668.205
storey 2	174172.761
storey 1	195511.239
Base	0.0000

IJETAE
EXPLORING RESEARCH AND INNOVATIONS

International Journal of Emerging Technology and Advanced Engineering

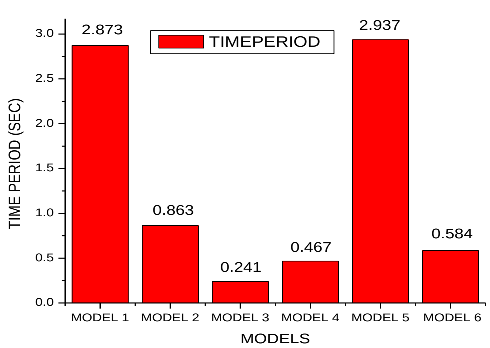
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 7, Issue 3, March 2017)

TABLE 7:
STOREY STIFFNESS IN KN/M FOR STATIC ANALYSIS

Storey	Model2	Model3	Model4	Model5	Model6
Terrace	3649.699	69391.36	26391.836	30655.802	3392.470
Storey11	118618.209	2902365.72	506502.230	1022754.48	104488.998
Storey10	299564.356	6617653.42	1188431.832	2400229.216	140624.279
Storey9	475278.564	9468061.36	1820935.627	3678179.712	151528.198
Storey8	650438.839	11785405.00	2426213.159	4905772.633	156982.155
Storey7	834220.322	13791400.00	3034702.421	6143127.656	160459.925
Storey6	1040881.600	15650548.00	3683679.061	7465338.048	163010.524
Storey5	1294107.896	17498968.00	4424359.444	897533.359	165084.485
Storey4	1638368.607	19472478.00	5336380.073	10833026.00	166948.985
Storey3	2173684.666	21758075.00	6566732.619	13331676.00	169171.071
Storey2	3194545.068	24583819.00	8422844.120	17077369.00	174216.901
Storey1	5918127.590	26033407.00	10958318.000	22008790.00	199535.94

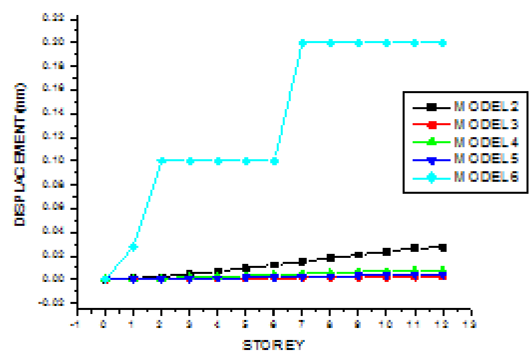
TABLE 8:
STOREY STIFFNESS IN KN/M FOR DYNAMIC ANALYSIS

Storey	Model2	Model3	Model4	Model5	Model6
Terrace	6254.608	97416.93	40356.6200	42029.148	3945.420
Storey11	192147.991	3913171.11	760137.783	1372624.106	114479.878
Storey10	426775.855	8157810.84	1067548.517	3014152.239	147279.153
Storey9	611138.001	10898529.00	2254294.253	4362914.133	155775.663
Storey8	768400.598	12876353.00	2786743.414	5520098.83	159820.460
Storey7	917472.459	14481513.00	3274217.442	6577742.228	162410.614
Storey6	1076157.370	15940206.00	3773257.464	7627985.27	164373.130
Storey5	1268052.718	17420525.00	4345823.909	8780061.596	166051.966
Storey4	1530556.423	19073279.00	5073246.921	10194286.00	167654.681
Storey3	1945340.208	21096364.00	6099358.289	12166878.00	169645.509
Storey2	2760476.423	23793189.00	7752207.595	15370783.00	174148.181
Storey1	5078344.821	25446772.00	10297260.00	20350085.00	195495.934

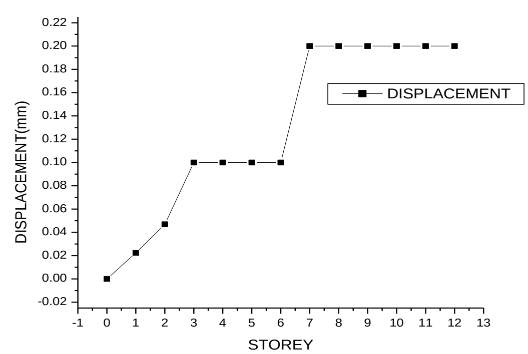


GRAPH 1: TIME PERIOD IN SECONDS

Graph 2 : displacement for static analysis model 1

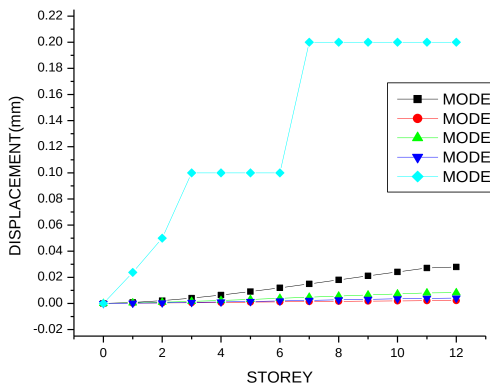


GRAPH 3: DISPLACEMENT FOR STATIC ANALYSIS

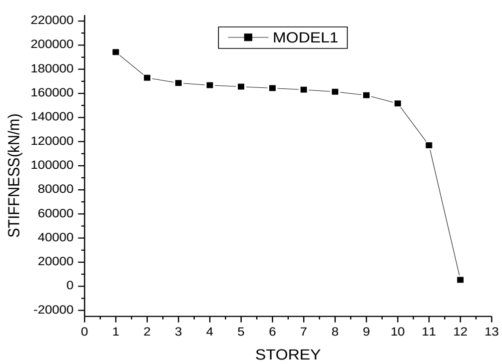


GRAPH 4: DISPLACEMENT FOR DYNAMIC ANALYSIS MODEL 1

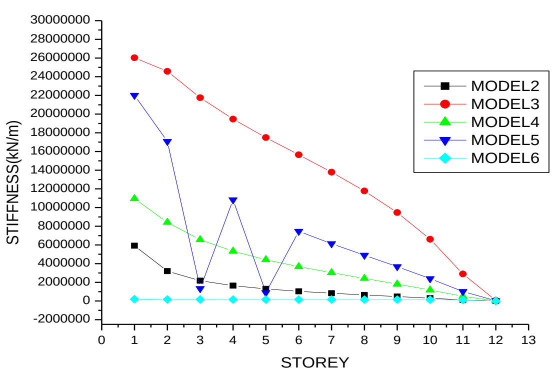
International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 7, Issue 3, March 2017)



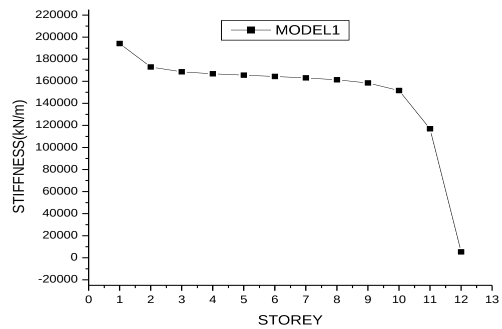
GRAPH 5: DISPLACEMENT FOR DYNAMIC ANALYSIS



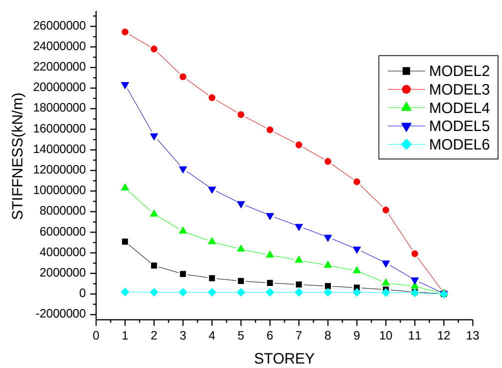
GRAPH 6: STIFFNESS FOR STATIC ANALYSIS MODEL 1



GRAPH 7: STIFFNESS FOR STATIC ANALYSIS



GRAPH 8: STIFFNESS FOR DYNAMIC ANALYSIS MODEL1



GRAPH 9: STIFFNESS FOR DYNAMIC ANALYSIS

IV. RESULTS AND DISCUSSION

4.1 Comparison with Time Period

From Graph 1 it is seen that the time period for model with shear wall in X direction is 2.937 secs , which is almost more than 2 times when compared to other models. It is increasing because seismic waves are acting in the same direction as that of shear wall.

We know that,

$$T = \frac{2\pi}{p}$$

Where, T- time period in sec

p- frequency in rad/sec

Since time period and frequency are inversely proportional, lesser is the frequency more will be the time period.

Because shear wall is in the direction of earthquake force. Corner shear wall model is having a time period of 0.863 secs which is more when compared to periphery shear wall model, central core shear wall model and model with shear wall along Y direction .Because there is no connectivity between the shear wall. Greater time period is found for model with shear wall in X direction because the shear walls are located in the direction of force, where as corner shear wall model has comparatively less time period as the shear wall is along two direction.

While comparing the periphery shear wall model and core shear wall model, less time period is found for periphery shear wall model as its all external walls are shear wall. Where as in core shear wall model, shear walls are located only at central core. Time period for periphery shear wall model is 0.241 secs and model without shear wall is 2.873 secs which is 12 times more the former case.

4.2 Comparison with Displacement

From graph 3 it is seen that the maximum displacement is taken by model with shear wall along Y direction from storey 7 to storey 11, it is due to lesser stiffness for that particular storey. There is no much variation in displacement observed for the other shear wall models. Corner shear wall model is having greater displacement than model with shear wall at core, periphery and shear wall along X direction, as there is no connectivity between the shear walls.

4.3 Comparison with Stiffness

Periphery shear wall model is having maximum stiffness at storey 1 when compared to model with shear wall along Y direction. As Displacement and Stiffness are inversely proportional, lesser the displacement more is the stiffness. Stiffness for periphery shear wall model at storey 1 is 26033407 kN/m and model with shear wall along Y direction at storey 1 is 199535.94 kN/m which is 0.766 times more than model with shear wall along Y direction.

4.4 Comparison with Storey Shear

From the analysis, greater force is found for the base storey and the force is found to be gradually decreasing as the storey increases. This is due to the fact that the earthquake waves are generated from the ground and the storey which is very near to ground will be affected by greater force. This intensity of force goes on reducing as the building height increases.

V. CONCLUSION

1. From the analysis and discussion, shear walls are preferred in high rise buildings as it has good resistance towards lateral forces.
2. It is found that the behaviour of the shear wall is good when they are provided in Box shape structure. But from the analysis, model with shear wall at periphery has better resistance for lateral forces as compared to model with core shear wall.
3. The resistance of periphery shear wall model is almost 26% more than the core shear wall model.
4. The provision of shear wall results in decrease of time period, maximum decrease of 91.61% is observed for periphery shear wall model, 83.74% for core shear wall model and 69.96% for corner shear wall model.
5. The time period is increasing by 2% for model with shear wall along X direction.
6. Shear wall construction results in the reduction of displacement as the shear wall increases the stiffness of building and thereby sustain the lateral forces.
7. The percentage reduction is found to be 92% for periphery shear wall model, 85.64% for model with shear wall along X direction and 70.80% for core shear wall model, When compared with corner shear wall model. On the other hand displacement for shear wall along Y direction is 8 times more than the corner shear wall model.
8. Storey stiffness for periphery shear wall model is having an increased stiffness of about 91.67%, model with shear wall along X direction by about 81.15% and core shear wall model by 78.10%. The stiffness is reducing for corner shear wall model and the model with shear wall along Y direction.

Hence we can conclude that shear wall placed in box shape structure works out to be well. However irrespective of shape shear wall placed on the exterior part of the structure have better resistance for lateral forces than locating it on the other locations. Because shear wall placed on the periphery acts like a shell, reduces displacement, storey shear and thereby increasing the stiffness. Thus better resistance for the lateral forces.

REFERENCES

[1] Lakshmi K.O., Prof. Jayasree Ramanujan, Mrs. Bindu Sunil, Dr. Laju Kottallil, Prof. Mercy Joseph Poweth "Effect of shear wall location in buildings subjected to seismic loads",Vol.1 Issue 1,Dec 2014, pp.07-17.

[2] G.S Hiremath, Md Saddam Hussain ,"Effects of Change in Shear Wall Location with Uniform and Varying Thickness in High Rise Building ",Vol.3 Issue 10, Oct. 2014, pp.284-288.

[3] Er. Raman Kumar, Er Shagunveer Singh Sidhu, Er. Shweta Sidhu, Er. Harjot Singh Gill "Seismic Behavior Of Shear Wall Framed Buildings", Vol. 2 Issue 1, July 2014, pp. 28-38.

[4] Ehsan Salimi Firoozabad, Dr. K. Rama Mohan Rao, Bahador Bagheri, "Effect of Shear Wall Configuration on Seismic Performance of Building" , 2012,pp.121-125.

[5] IS 1893 (Part 1) :2002, Criteria for Earthquake Resistant Design of Structures part 1 general provisions and buildings (fifth Revision)

[6] IS : 875 (Part 5) - 1997 , code of practice for design loads (other than earthquake) for buildings and structures part 5 special loads and combinations (Second Revision)

[7] IS 456 : 2000, Indian Standard Plain and reinforced concrete - code of practice (Fourth Revision)

[8] Pankaj Agarwal and Manish Shrikhande, " Earthquake Resistant Design of Structures ", PHI Learning Private Limited, Delhi-110092,2014.

[9] S.K.Duggal, " Earthquake Resistant Design of Structures (second edition)" ,Oxford University Press YMCA Library Building, 1 Jai Singh Road, New Delhi -110001, India,2013.