International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Effect of Change in Shear Wall Location with Uniform and Varying Thickness in High Rise Building

G.S Hiremath[1], Md Saddam Hussain[2]

[1]Assistant Professor, Department of Civil Engineering, Basaveshwar Engineering College, Bagalkot, Karnataka, India

[2]Post Graduate Student in Structural Engineering, Department of Civil Engineering, Basaveshwar Engineering College, Bagalkot, Karnataka, India

Abstract: ***Shear wall are one of the excellent means of providing earthquake resistance to multistorey reinforced concrete building.They are usually provided in tall buildings and have been found to be immense use to avoid total collapse of building under seismic forces. It is very necessary to determine effective, efficient and ideal location of shear wall. In this paper, study of 25 storeys building in zone IV is presented with some preliminary investigation to reduce the effect of earthquake reinforced concrete shear walls are used in the building. These can be used for improving seismic response of buildings. The provision of shear wall in building to achieve rigidity has been found effective and economical. Shear walls are easy to construct and are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and non structural elements (like glass windows and building contents). This study aims to work on effect of addition of shear wall at different location and configuration, also study have been done with varying thickness of shear wall. The results are tabulated by performing pushover analysis using ETABS v 9.7.1 in the form of displacements and storey drift.***

Keywords: Shear Wall, Storey Displacement, Storey Drift, Lateral Loading, Nonlinear Static Analysis

1. Introduction

Shear wall may be defined as structural elements, which provide strength, stiffness and stability against lateral loads deriving strength and stiffness mainly their shape in many cases, high rise buildings are designed as a framed structure with shear walls that can effectively resist horizontal forces. Lateral forces generated either due to wind blowing against the building or due to the inertia forces induced by ground shaking tend to snap the building in shear and push it over in bending. This type of forces can be resisted by the use of a shear wall system which is one of the most efficient methods of ensuring the lateral stability of tall buildings [1]. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like *vertically-oriented* wide *beams* that carry earthquake loads downwards to the foundation. Shear walls in high seismic regions require special detailing [2].

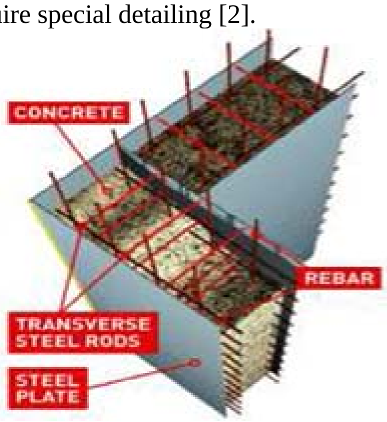

Figure 1: Illustration of Composite Shear Wall

1.1 Objectives of Study

The principal objectives of the study are as follows:

1) To study the Optimum location of shear wall having uniform thickness throughout the building.
2) To study the Performance of the building with shear wall having varying thickness at certain levels of building for different locations.

2. Methodology

This chapter explains the methodology used in the study. It explains the methodology in detail, various assumptions made, and details of the structures used in the study.

2.1 Description of Frame Buildings

The building consists of Twenty five stories. All columns in all models are assumed to be fixed at the base for simplicity. The floor to floor height is 3.5 m. Slab is modeled as rigid diaphragm element of 0.15m for all stories considered. Live load on floor is taken as 4 kN/m^2 and on roof is 1.5 kN/m^2. Floor finish on the floor is 1kN/m^2. Weathering course on roof is 1.5 kN/m^2. Wall thickness is of 230mm on all the beams. The seismic weight is calculated conforming to IS 1893-2002(part-I). The unit weight of concrete is taken as 24 kN/m^3. The grade of concrete for column is M-40 and for beam and slab M-30.The building is special moment resisting frame considered to be situated in seismic zone IV having medium soil and intended for residential use.

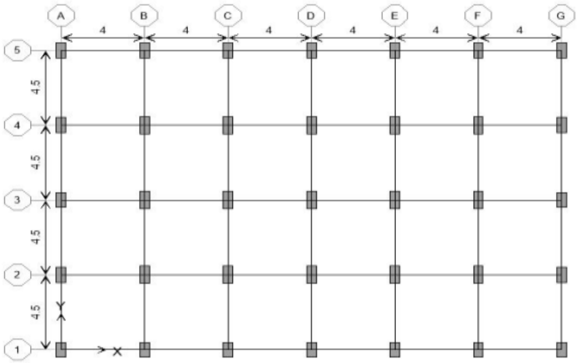

Figure 2: Plan of Twenty five storey building

2.2 Models Considered for the Analysis

2.2.1. Building with shear wall of uniform thickness

a) Building with shear wall at corner with uniform thickness.
b) Building with Shear wall at mid span with uniform thickness.
c) Building with Shear wall at middle mid span with uniform thickness.
d) Building with shear wall at middle mid span channel type with uniform thickness.

2.2.2 Building with shear wall of varying thickness

a) Building with shear wall at corner with varying thickness.
b) Building with Shear wall at mid span with varying thickness.
c) Building with Shear wall at middle mid span with varying thickness.
d) Building with shear wall at middle mid span channel type with varying thickness.

Table 1: shows the dimensions of beams and columns of buildings

Storeys	No of bays in X direction	No of bays in Y direction	X direction bays in m	Y direction bays in m	Outer Column sizes in mm	Inner Column sizes in mm	All Beam sizes in mm
25	6	4	4.0	4.50	450X900	450X1050	450X450

Shear wall thickness =300mm for uniform thickness models
Shear wall thickness for varying thickness models:
Base to storey 6=300mm
Storey 7 to storey 12=250mm
Storey 13 to storey 18=200mm
Storey 19 to storey 25=150mm

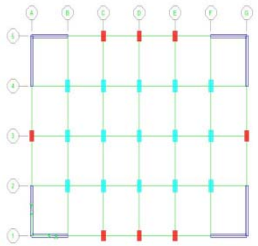

Figure 3: Building with shear wall at corner

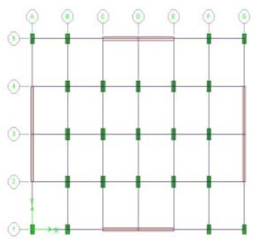

Figure 4: Building with Shear wall at mid span

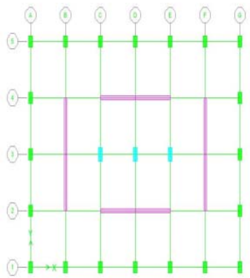

Figure 5: Building with shear wall

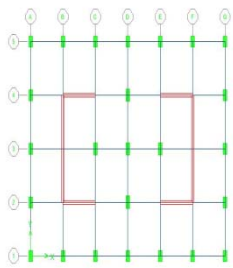

Figure 6: Building with shear at middle with mid span wall at middle mid span channel type

3. Results and Discussion

The results in the form of storey displacement and storey drift are presented in this chapter and variation of these results has been discussed. The analysis of buildings considered is carried out by nonlinear static method.

The variation of storey displacement and storey drift with respect to number of storey of the buildings with shear wall having uniform and varying thickness located in seismic zone IV are studied in this chapter.

The results obtained from analysis are tabulated as follows:

3.1Displacement

As it can be seen from below figures, the displacement of the stories of structures is reduced by developing a T2-B model. In addition to the results of all models the maximum displacement is in T2-A model and minimum displacement is in T2-B model. Furthermore the graph shows that there has been steady increase in the amount of displacement of stories over the height.

According to this work, the reduction of displacement of stories is due to increase of stiffness of structure as well as decrease of velocity and acceleration of structure. In other words by creating the T2-B model, the response of structure such as velocity and acceleration can be reduced and it is the cause of reduction of displacement.

On Observing, displacements at all the storey in the TYPE 2B model is less than those in TYPE 2A. Here as one can see displacements lowest in bottom stories, very high at the upper stories.

The displacement is of interest with regard to structural stability, strength and human comfort. The displacement of T2-B model is less than the other model. It means that the T2B, Structure is more stable Chance of Structural Strength reduction is less. Human comfort is good.

Table 2: Storey wise displacement of type1 model

STOREY	*T1AUX*	*T1BUX*	*T1CUX*	*T1DUX*
STORY1-24	853.5247	729.4923	678.8967	813.0584
STORY1-23	813.605	694.9698	644.9246	776.4814
STORY1-22	773.3026	660.1017	610.7234	739.4351
STORY1-21	732.5454	624.865	576.3125	701.8339
STORY1-20	691.2504	589.1949	541.6675	663.5825
STORY1-19	649.398	553.0885	506.8151	624.6544
STORY1-18	607.0139	516.5876	471.8105	585.0707
STORY1-17	564.1682	479.7782	436.7386	544.9033
STORY1-16	520.971	442.7754	401.71	504.2648
STORY1-15	477.5823	405.7243	366.8603	463.3127
STORY1-14	434.2087	368.7959	332.3418	422.2469
STORY1-13	391.087	332.1899	298.3203	381.2979
STORY1-12	348.4865	296.1197	264.9806	340.7259
STORY1-11	306.7082	260.8087	232.5229	300.8083
STORY1-10	266.0676	226.5011	201.1604	261.8379
STORY1-9	226.8931	193.4565	171.1196	224.1314
STORY1-8	189.5373	161.9496	142.6381	188.0247
STORY1-7	154.3711	132.2696	115.9639	153.8726
STORY1-6	121.7812	104.719	91.354	122.0484
STORY1-5	92.1664	79.6143	69.0741	92.945
STORY1-4	65.9342	57.2865	49.397	66.9729
STORY1-3	43.4972	38.0812	32.603	44.5614
STORY1-2	25.2695	22.3616	18.9793	26.162
STORY1-1	11.6642	10.5082	8.8154	12.2516
STORY1	3.1041	2.9181	2.3994	3.3423

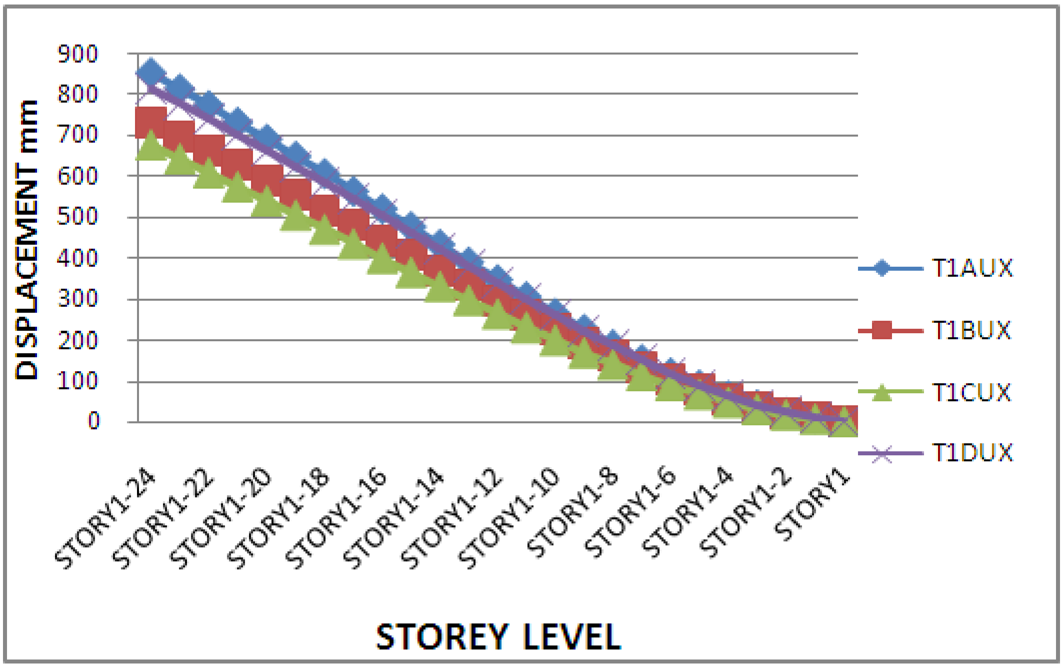

Figure 7: storey wise displacement of Type1 Model

Table 3: Storey wise displacement of type 2 model

STOREY	*T2AUX*	*T2BUX*	*T2CUX*	*T2DUX*
STORY1-24	891.6637	654.9044	734.9133	758.6951
STORY1-23	850.9832	622.0237	698.9862	725.0115
STORY1-22	809.5321	588.7207	662.4956	690.6097
STORY1-21	767.193	555.0188	625.4359	655.3589
STORY1-20	723.8406	520.8793	587.7572	619.1219
STORY1-19	679.4758	486.3515	549.5401	581.8812
STORY1-18	634.186	451.5279	510.9222	543.6996
STORY1-17	588.1431	416.5681	472.1014	504.7251
STORY1-16	541.7327	381.7457	433.4237	465.3003
STORY1-15	495.1849	347.1562	394.9524	425.6303
STORY1-14	448.781	313.0081	356.8988	385.9824
STORY1-13	402.851	279.5312	319.4987	346.6611
STORY1-12	357.7742	246.9694	283.02	307.9947
STORY1-11	313.9539	215.5895	247.7467	270.3259
STORY1-10	271.7042	185.5945	213.9412	233.9564
STORY1-9	231.145	157.0162	181.6168	199.0065
STORY1-8	192.6465	130.1062	151.0603	165.813
STORY1-7	156.6125	105.1305	122.5711	134.7365
STORY1-6	123.4733	82.367	96.4686	106.1597
STORY1-5	93.6865	62.098	73.0839	80.4846
STORY1-4	67.4694	44.4496	52.5898	57.9043
STORY1-3	44.8741	29.3799	34.9671	38.4621
STORY1-2	26.337	17.1286	20.5442	22.5353
STORY1-1	12.3276	7.9754	9.6678	10.5256
STORY1	3.3589	2.182	2.6949	2.8603

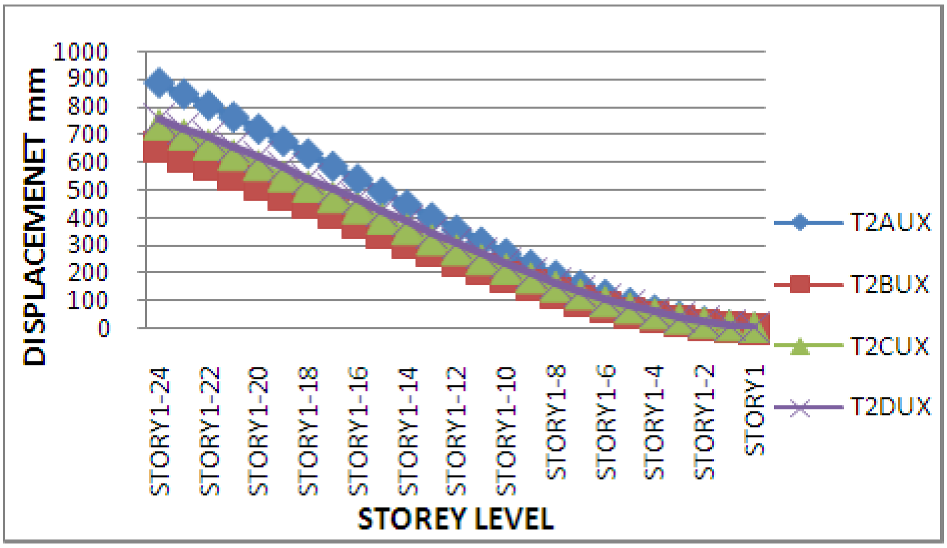

Figure 8: storey wise displacement of Type 2 Model

3.2 Storey Drift Ratio

Story drift is the displacement of one level relative to the other level above or below. In Software value of story drift is given in ratio.

Storey drift ratio =difference between displacement of two stories /height of one story

The building may collapse due to different response quantities. For example at local levels such as strains, curvatures, rotations and at global levels such as interior story drifts.

Individual stories may exhibit excessive lateral displacement. Therefore it can be concluded that by decreasing the story drifts of structure, the probability of collapse of the building can be reduced. To do that, as it is mentioned, T2-B model can play a significant role to reduce response of structure.

On Observing, storey drift ratios at all the stories in the TYPE 2B model are less than those in TYPE 2A model. Here as one can see the storey drift ratio is very low in bottom stories, very high at the middle stories and finally decreases towards the upper stories.

After observing all the graphs ,it can be generally said that drift ratio in upper storey is generally more , less in lower stories and maximum being middle storey.

Table 4: storey drift ratio of type 1 model

STOREY	*Drift-T1A-X*	*Drift-T1B-X*	*Drift-T1C-X*	*Drift-T1D-X*
STORY1-24	0.010589	0.009864	0.01036	0.010604
STORY1-23	0.010714	0.009962	0.010457	0.010746
STORY1-22	0.010811	0.010068	0.010555	0.010914
STORY1-21	0.010927	0.010191	0.010669	0.011111
STORY1-20	0.011039	0.010316	0.010778	0.011317
STORY1-19	0.011138	0.010429	0.010874	0.011517
STORY1-18	0.011214	0.010517	0.010946	0.011695
STORY1-17	0.011258	0.010572	0.010983	0.011841
STORY1-16	0.011264	0.010586	0.010979	0.011942
STORY1-15	0.011226	0.010551	0.010927	0.011986
STORY1-14	0.011137	0.010459	0.010819	0.011962
STORY1-13	0.010992	0.010306	0.01065	0.01186
STORY1-12	0.010788	0.010089	0.010416	0.011676
STORY1-11	0.010525	0.009802	0.01011	0.011407
STORY1-10	0.010194	0.009441	0.009729	0.011045
STORY1-9	0.009783	0.009002	0.009268	0.010586
STORY1-8	0.009268	0.00848	0.008725	0.010022
STORY1-7	0.008645	0.007872	0.008093	0.009348
STORY1-6	0.007909	0.007173	0.00737	0.008558
STORY1-5	0.007057	0.006379	0.006552	0.007647
STORY1-4	0.006086	0.005487	0.005633	0.006609
STORY1-3	0.004993	0.004491	0.004609	0.005435
STORY1-2	0.003781	0.003387	0.003474	0.004118
STORY1-1	0.002435	0.002169	0.002224	0.002645
STORY1	0.001021	0.000834	0.000856	0.000998

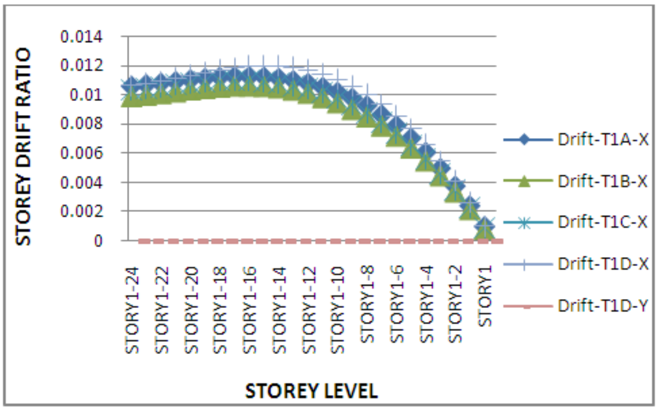

Figure 9: Storey drift ratio of type 1 Model

Table 5 Storey drift ratio of type 2 Model

STOREY	*Drift-T2A-X*	*Drift-T2B-X*	*Drift-T2C-X*	*Drift-T2D-X*
STORY1-24	0.011623	0.009795	0.010265	0.009964
STORY1-23	0.011843	0.009943	0.010426	0.010199
STORY1-22	0.012097	0.010087	0.010588	0.010478
STORY1-21	0.012386	0.010247	0.010765	0.010802
STORY1-20	0.012676	0.010395	0.010919	0.011132
STORY1-19	0.01294	0.010517	0.011034	0.011444
STORY1-18	0.013155	0.010592	0.011092	0.011712
STORY1-17	0.01326	0.010578	0.011051	0.011871
STORY1-16	0.013299	0.010534	0.011	0.011968
STORY1-15	0.013258	0.010427	0.010902	0.011986
STORY1-14	0.013123	0.01025	0.010733	0.011913
STORY1-13	0.012879	0.009998	0.010483	0.011741

STORY1-12	0.01252	0.009665	0.010149	0.011466
STORY1-11	0.012071	0.009266	0.009736	0.011094
STORY1-10	0.011588	0.008858	0.009317	0.010686
STORY1-9	0.011	0.00837	0.008814	0.010175
STORY1-8	0.010295	0.007798	0.008223	0.009554
STORY1-7	0.009468	0.007138	0.007539	0.008815
STORY1-6	0.008511	0.006386	0.006759	0.007951
STORY1-5	0.007491	0.005588	0.005927	0.00702
STORY1-4	0.006456	0.004795	0.0051	0.00607
STORY1-3	0.005297	0.003919	0.004177	0.004998
STORY1-2	0.004005	0.002947	0.003153	0.003793
STORY1-1	0.002565	0.001883	0.002023	0.002442
STORY1	0.000961	0.000722	0.000784	0.000925

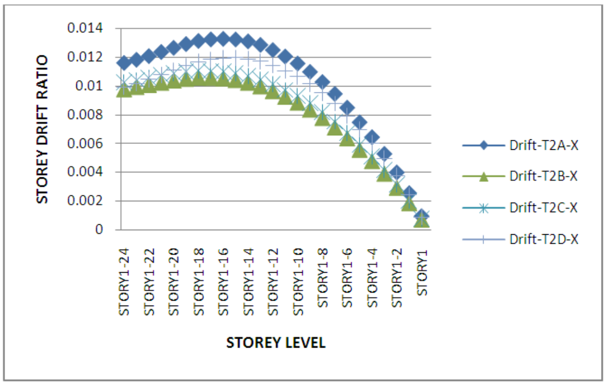

Figure 10: Storey drift ratio of type 2 Model

4. Conclusions

The present study has been carried out the earthquake response of tall building by using varying thickness shear wall and its position. The main objectives of the study are stated in the chapter one. The purpose of the study is to investigate whether the TYPE 2 model provides adequate performance. The following conclusions were drawn from the analysis:

1. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake, percentage of lateral drift and displacement also depends on the location of shear wall and its thickness.
2. Model with shear wall at mid span having varying thickness achieves highest reduction in displacement with base shear in elastic region, so that the building acts well within the elastic region.
3. On Observing, storey drift ratios at all the stories in the TYPE 2 model are less than those in TYPE 1 model. Here the storey drift ratio is very low in bottom stories, very high at the middle stories and finally decreases towards the upper stories.

5. Recommendations for further work

It is recommended that further research be undertaken in following areas;

1. Determining the earthquake response of tall building structures by doing non linear dynamic analysis to assess the exact response of TYPE 2 model.
2. Study of foundation for various systems taking shear wall as major element.
3. Performance of building taking different heights of shear wall.

References

[1] Anuj Chandiwala, *"Earthquake Analysis of Building Configuration with Different Position of Shear Wall"*, International Journal of Emerging Technology and Advanced Engineering ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 2, Issue 12, December 2012, Adhoc Lecturer in Sarvajanik College of Engineering & Technology, Athvalines, Surat, Gujarat, India.

[2] S.K.Duggal 2007 *"Earthquake resistant design of structures"* Oxford university press 2, New Delhi ISBN-13:978-0-19-568817-7.

[3] Himalee Rahangdale , S.R.Satone , *"Design and Analysis of Multistoried Building with Effect of Shear Wall"*, International Journal of Engineering Research and Applications, Vol. 3, Issue 3, May-Jun 2013, pp.223-232

[4] P. S. Kumbhare, A. C. Saoji, *"Effectiveness of changing of RC shear wall location in multi-storey building"*, International Journal of Engineering Research and Applications Vol. 2, Issue 5, pp.1072-1076 Sant Gadge Baba Amravati University, Amravati, Maharashtra

[5] P.C.Verghese 2005 *"Advanced Reinforced Concrete Design"* 2nd edition by prentice-Hall of India private limited New Delhi ISBN-81-203-2787-X

[6] www.iitk.ac.in/.../SeismicBehaviour_Design & Detailing of ShearWalls.