Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 3, Issue 2, pp: (28-33), Month: May - August 2016, Available at: www.noveltyjournals.com

THE SIGNIFICANCE OF PROVIDING OF SHEAR WALLS IN TALL BUILDINGS

[1]V.Kalpana, [2]N.R.Sangeetha, [3]M.Sheik Mohamed

[1]Assistant Professor, Civil Engineering Department, AalimMuhammedSalegh College of Engineering, Muthapudupet, Avadi-IAF, Chennai, Tamil Nadu, India
[2]P.G Student (M.E Structural engineering),SreeSastha Institute of Engineering and Technology, Chennai, Tamil Nadu,India
[3]Assistant Engineer, Nabard& Rural Roads, Tamil Nadu Highways Department, Sankarankovil, Tirunelveli, TamilNadu,India

Abstract: **Tall buildings are the tall structures widely used all around the world. These tall structures eliminate the space required for buildings in the horizontal direction. The structural and construction features differ considerably when compared to low risestructures. Severe structural damage suffered by several modern buildings like tall structures during earthquakes, which loses its strength and stiffness of a building. To overcome from the lateral loading failures, strong and stiff load resisting system is essential in tall buildings. This paper deals with the importance of providing of shear walls in resisting lateral loads in tall buildings. Experimental and analytical studies are carried out to assess the uses of shear wall in structural safety, serviceability and stability. An effective lateral load resisting system like moment resisting frame, bracing frame and bracing with shear wall frame is used in this study. The lateral storey drift is noted and compared with the analytical results with the help of E-TABS.**

Keyword: **frame, lateral force, model, shear wall, stiffness, sway, x bracing, tall building.**

1. INTRODUCTION

Tall buildings or skyscrapers are the tallest structures which are having normally more than fourty floors which are meant to provision for mainly commercial and residential purpose. These tall structures are generally constructed at present with either composite or steel frame. The architectural and structural aspects vary considerably. The construction procedures also change due to its height and complexity. The design of tall buildings should be done with utmost care as compared with low rise buildings. In the design stage of tall buildings lateral loads nothing but horizontal loads occupy important role. The lateral forces commonly are wind and seismic force or earthquake force. The lateral loads lead to severe structural damage like gravity loads in tall buildings as compared with the low rise buildings. High rise buildings design involves complete understanding of structural components of tall buildings subjected to several factors architectural and other than civil works. Normally the tall structures usually get affected by lateral forces acting on it. Due to the lateral forces the entire tall building gets collapsed and forms more cracks etc.The shear wallsresist the damage caused by the lateral forces.

2. SHEAR WALLS

Shear walls or structural walls are frequently known for resisting lateral loads. The structural walls are made up of reinforced concrete to increase the strength of walls. These walls are particularly located lift and staircase regions to overcome vibration and horizontal shear force. These walls are constructed up to the entire height of structure. By its name the structural walls are also located in transverse or lateral directions of building to resist lateral forces namely wind and seismic forces. Some cases, if the location of building is of highly windy, the structural walls can be located in exterior as well as interior areas of building. The shear walls are very stiff in nature because of reinforced. They are firmly fixed with foundation and resist the horizontal loads by vertical bending in nature and behave as vertical cantilever walls. The wall thickness can be varied from 150 mm to 400mm.The lateral load resisting system is very much interacted with the vertical framing as this combined load resisting system provides better load carrying, resisting and safety. Due to its versatility shear wall is provided in tall structures.

3. LITERATURE REVIEW

Structural frames are usually filled with infilled walls named as partitions. Infills have been generally considered as non-structural elements. The presence of infills has been ignored in most of the current seismic codes except their weight. For finding the importance of the lateral load resisting systems extensive study is carried out. E.A Godinez-dominguez and Tenacolunga (2008) studied the Behaviour of moment resisting reinforced concrete concentric braced frames in seismic zones. RC Frame and Steel bracing Frame where experimentally studied. By the analysis they have proved that the percentage of the lateral shear strength provided for the steel bracing system is greater than the RC moment resisting framed. Only 50% of the lateral strength is provided by the columns of the RC moment resisting frames. H.S Jadhav et al (2014) had done seismic analysis of a Seven storey building with different bracings (Diagonal, V type, Inverted type and X type).Bracings are provided on the peripheral columns. This structure was analysed by using Staad proV$_{8i}$Software. It is found that X type steel bracing had reduced the lateral displacement when compared with the other types of bracing.

Astaneh-Asl.A (2000) studied the behaviour of the steel plate shear wall. He had said the usage of steel plate shear wall in the tall building. Steel plate shear walls have been performing well in the past earth quakes that occurred in North America and Japan .This paper helped to develop the design office guidelines and code provisions by cyclic testing of steel shear wall.Korkmaz-et al had focused on the masonry infill walls .He made a study on the three storey RC structure with masonry infill walls. The earth quake response of the structure was determined by the non linear analysis of the SAP2000 Software. Push over curves are formed by the software analysis and storey displacement, plastic rotation, relative storeydisplacements are also obtained [3].

4. ANALYTICAL PROGRAM

Even though experimental work is essential in every research work, but at that same time analytical studies also play crucial role in studying a particular phenomenon. Apart from experimental work, analytical work is also deployed in this study. In order to simulate the results to tall buildings a three storey building is considered in this work. Three bays of building which has horizontal length of 12 m and vertical height of 9.6m.A suitable scale factor is provided to reduce the frame dimensions as 1.2mx0.96m.

4.1 Analysis

The analysis of this three story structure is done by E-tabs. Initially the model of the corresponding structure is created by assigning geometrical properties and material properties. The analysis is done for steel frame, X bracing steel frame and shear wall X bracing frame. After the completion of model, the load analysis carried out. The verticalloads nothing but dead and live loads are computed using IS 875 part 1 and part 2:1987.In this structure the wind load intensity compared with the seismic load intensity is low. For this the lateral seismic load is taken for analysis. In order to reduce the damage, the below load combinations have been made as per IS 1893 part 1:2002 1) 1.5(DL + LL),2) 1.2(DL + LL ± EL),3) 1.5(DL ± EL),4)0.9 DL ±1.5EL,5) 1.7(DL + LL),6) 1.7(DL ± EL),7) 1.3(DL + LL ± EL). The maximumdeflection result for worst loading case is given. In this work the analytical results are approximately simulated with the experimental results.

4.2 Analytical results

In this section the maximum sway of portal frames results for maximum loading condition in all cases are given. These results are indication of lateral storey drift of portal frames when they are subjected to lateral loads. The analytical deformationresults of portal frames are as much closer to experimental deformation. The results are tabulated in table 4.1.

Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 3, Issue 2, pp: (28-33), Month: May - August 2016, Available at: www.noveltyjournals.com

Table 4.1: Lateral Sway of the frames

Case	Maximum lateral sway in mm
Steel frame	8.5
X bracing frame	0.3
Shear wall frame	0.06

5. EXPERIMENTAL PROGRAM

The aim of this experimental work is to simulate the experimental results approximately to tall building. For this a three storey building is taken.The model of a three storey building with three bays is fabricated. The height of the model is 0.96m and the width is 1.2 m. The dimension of a single storey of model bay frame is 0.4m x 0.32m.

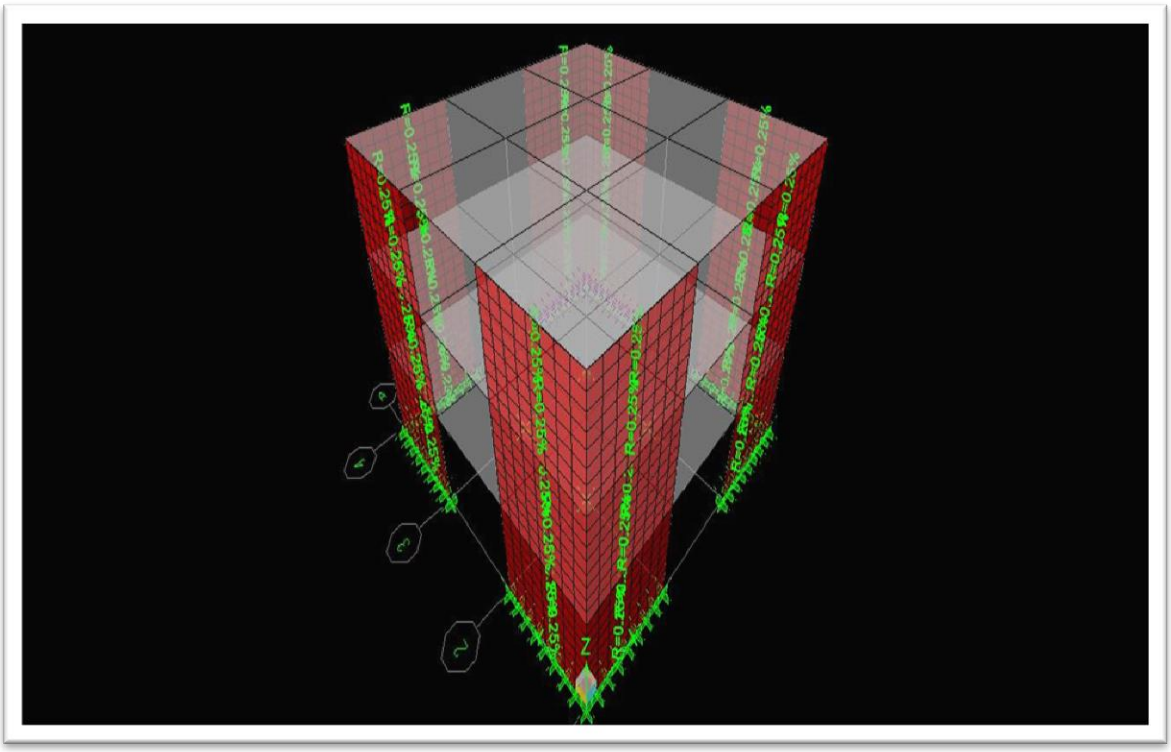

Fig.5: Modeling of shear wall frame in E-tabs

5.1 Foundation setup

The floor is well cleaned for the structural frame foundation. The setting out or foundation marking of the frame is established with the assist of chalk powder. Then the marked areas are dug at a depth of 1.5m and the width is of 1m and the length is of 2.5m. The dug surface is very well cleaned by pouring water.The mild steel bar of 12 mm diameter is used for making vertical frame. In the same way, for making horizontal frame 10 mm diameter mild steel bar is used. Mild steel 8mmdiameter bar is used for making bracing frame. The frame is connected by means of welding to a base plate. The top base plate is well anchored by bolts. This top corner anchor bolts which in turn resting on the bottom base plate. The bottom base plate is directly resting on soil. A suitable leveling course of plain cement concrete of 1:5:10 is provided below bottom base plate. The level of base plateis provided by the spirit level and the foundation concrete of M 20 is used.

5.2 Loading setup

The portal frame is loaded with a pulley setup which is fixed at the right side of the frame with the help of brick pillars .To fix the dial gauges, brick pillar is also constructed. In this brick pedestal dial gauge is fixed to measure lateral sway for each storey.

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 3, Issue 2, pp: (28-33), Month: May - August 2016, Available at: www.noveltyjournals.com

6. TEST RESULTS

Once the loading arrangements completed, the portal frames are tested for lateral loads as well as vertical loads. In this three portal frames such as for steel frame, X bracing steel frame and shear wall X bracing frame are tested. The frames are tested for gravity load nothing but their self weights. The portal frames are subjected to gradual increments of horizontal loads, i.e 10 kg, 20kg, 30 kg, 40kg, 50kg.The corresponding lateral sway is calculated.

6.1 Model frame without x bracing and shear wall

The steel frame is shown in figure 6.1.For calculating lateral storey drift, dial gauges namely, A.B and C is used for bottom storey, middle storey and top storey.For every 10 Kg load increment, sway is computed in all dial gauges for both loading and unloading conditions. Table6.1 shows the test results of steel frame. Due to gradual increment of load lateral deflection is also increased. It is noted that top floor swayed more when compared to middle and bottom floor. Even after the unloading residual deformation is observed in all dial gauges.

Table 6.1: Steel frame test results

	Sway in loading(mm)			**Sway in unloading(mm)**		
loads kg	**gauge a**	**gauge b**	**gauge c**	**gauge a**	**gauge b**	**gauge c**
10	0.53	1.23	2.80	0.49	1.18	2.65
20	0.64	2.50	4.96	0.61	2.45	4.87
30	0.92	3.53	6.24	0.89	3.48	6.20
40	1.65	5.54	7.70	1.59	5.50	7.73
50	1.52	7.23	9.70	1.50	7.20	9.70

Fig.6.1: Steel portal frame

6.2 Frames with x- bracing

Figure 6.2 shows the steel frame strengthen with x frame. The x frame is provided for first and third bay of portal frame. Table 6.2 shows the test results of x bracing portal frame. Even in this x bracing frame also lateral sway is increased due to rise in loads. But the magnitude of lateral sway is highly decreased due to provision of x bracing. In this case also plastic or residual deformation is existed in portal frame. The maximum deformation of top storey is less than one mm.

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 3, Issue 2, pp: (28-33), Month: May - August 2016, Available at: www.noveltyjournals.com

Table 6.2: X-bracing portal frame test results

	Sway in loading(mm)			Sway in unloading(mm)		
loads kg	**gauge a**	**gauge b**	**gauge c**	**gauge a**	**gauge b**	**gauge c**
10	0.09	0.15	0.20	0.07	0.13	0.19
20	0.20	0.25	0.30	0.19	0.21	0.29
30	0.38	0.32	0.39	0.36	0.31	0.37
40	0.49	0.41	0.45	0.46	0.39	0.43
50	0.50	0.54	0.65	0.48	0.51	0.63

Fig.6.2: X bracing portal frame

6.3 Model frame with x bracing and shear wall

Figure 6.3 shows the shear wall frame. In this case, the portion of x bracing is closed with the shear wall. The shear wall is made up with cement mortar 1:3. The shear wall is built with cement mortar 1:3 and chicken mesh. Initially the chicken mesh is placed over the x bracing and cement mortar is placed over this arrangement. Table 6.3 shows the test results of shear wall frame. In this case, lateral sway of portal frame is very less when compared with plain frame and x bracing frame. For the first two loadings there is hardly any deformation in both loading and unloading cases.

Table 6.3: Shear wall frame test results

	Sway in loading(mm)			Sway in unloading(mm)		
loads kg	**gauge a**	**gauge b**	**gauge c**	**gauge a**	**gauge b**	**gauge c**
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.03	0.00	0.00	0.02
30	0.00	0.00	0.05	0.00	0.01	0.04
40	0.00	0.01	0.07	0.00	0.01	0.06
50	0.00	0.02	0.08	0.00	0.02	0.08

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 3, Issue 2, pp: (28-33), Month: May - August 2016, Available at: www.noveltyjournals.com

Fig.6.3: Shear wall portal frame

7. CONCLUSION

From the analytical and experimental studies, the lateral sway of portal frames is less when they are strengthened with lateral load resisting systems subjected to lateral loads. The higher deformation is observed in steel portal frame where as in x bracing and shear wall portal frames the lateral deflection is very small. It is also to be noted that the portal frames are subjected to less sway in bottom floors in all three cases. It is due to the rigidity provided by the supports. The lateral story drift rate is more in top storey when compared with middle and bottom storeys. The lateral sway is gradually increased as the load increased from 10 kg to 50 kg. It is also observed that the difference of lateral sway values between in dial gauge A and in dial gauge B is less but at the same time difference of lateral sway values in dial gauge A and in dial gauge C is more in all three cases. Even after the removal of applied horizontal loads, the plastic or residual deformation is still observed in storeys of portal frames. It is also clearly noticed from experiment that once the portal frame is strengthened with adequate systems, it led to reduction in sway, of portal frames. The lateral load resisting systems tend to observe the effects caused by horizontal loads. The E-tabs software analytical program are yielded results lesser than experimental results. Out of three types of portal frames shear wall x bracing steel portal frame showed very much less deformation. The shear wall portal frame showed lesser sway for the gradual load increment. It is concluded that for lateral loads like wind and earthquake forces, the provision of shear walls strengthens the structure which is clearly seen from the reduced lateral deflections. So the shear walls are the best lateral load resisting systems as they can provide an efficient and safe high rise structures.

REFERENCES

[1] A.Astaneh-Asl, “Steel plate shear walls,” U.S Japan workshop on seismic fracture issues in steel structures, Sanfrancisco, Feb.2000.

[2] A. Godinez-Dominguez and A. Tena-Colunga, “Behavior ofMoment Resisting Reinforced ConcreteConcentric Braced Frames (Rc-Mrcbfs) in Seismic Zones,”The 14th World Conference of Earthquake Engineering,Bejing,2008.

[3] KasimArmaganKormaz, FuatDemir and Mustafa Sivri, “Earthquake Assessment of R/C Structures with Masonry infill walls, International Journal of Science &Technology, Vol.2, No.2, pp.154-164.

[4] Krishnaraj R. Chavan, H.S.Jadhav, “Seismic Response of R C Building with Different Arrangement of Steel Bracing System,”International Journal of Engineering Research and Applications, Vol.4, No.7, pp.218-222, July.2014.

[5] Murthy C.V.R, “Earthquake Tips,” Department of Civil Engineering, Indian Institute of Technology, Kanpur,March 2005.