Wind Behavior of Buildings with and without Shear Wall

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ABSTRACT

Shear walls are specially designed structural walls which are incorporated in buildings to resist lateral forces that are produced in the plane of wall due to wind, earthquake and flexural members. This paper presents the study and comparison of the difference between the wind behavior of buildings with and without shear wall using Staad pro.

Keywords – Shear wall, STAAD PRO, Wind behavior

1. INTRODUCTION

Due to the interaction of the earth while rotating the majority of the heat falls up on the middle of the equator and only less towards the north and south pole of the earth. The warm air rises on the equator and the cold air is pulled in from the ice caps .This spreads warmth across the globe which results in moving air patterns. The characteristics of wind are galloping, gust, ovalling, flutter, eddies and buffeting.

he wind flow interacts only with the external shape of the structure for static structure. The deflections under the wind load will not be significant when the structure is very stiff. Hence the structure is said to be static. For dynamic structures there is an additional interaction with the motion of the structure. Due to the action of natural wind, gusts and other aerodynamic force which will affect the tall buildings continuously.

Shear wall mainly resists two types of forces: shear forces and uplift forces. To resist the horizontal earthquake forces, shear wall should provide the necessary lateral strength and to prevent the roof or floor above from excessive side-sway, shear walls also should provide lateral stiffness. Shear walls are classified into different types. They are coupled shear wall, core type shear wall, column support shear wall, frame wall with infill frame, rigid frame shear wall etc.

Anshuman. S, Dipendu Bhunia and Bhavin Ramjiyani (1) have discussed the solution of shear wall in multi storey building. By providing shear wall in some frames, the top deflection was reduced to permissible deflection. Also it has been observed that both bending moment and shear force in some frames were reduced after providing the shear wall.

P. S. Kumbhare and A. C. Saoji (2) have discussed the effectiveness of changing reinforced concrete shear wall location on multi-storeyed building. Shear wall frame interaction systems are very effective in resisting lateral forces. Abdur Rahman, Saiada Fuadi Fancy and Shamim Ara Bobby (3) have discussed the analysis of drift due to wind loads and earthquake loads on tall structures. The drift on high rise structures has to be considered as it has a notable magnitude. B. Dean Kumar and B.L.P. Swami (4) have discussed the wind effects on tall building frames. The wind pressures computed by the gust effectiveness factor method are rational and realistical. Hence it is an important and valid point to be considered for the design of very tall buildings. T. Kijewski and A. Kareem (5) have discussed the full-scale study of the behavior of tall buildings under winds. Figure 1 shows the two functions of shear wall.

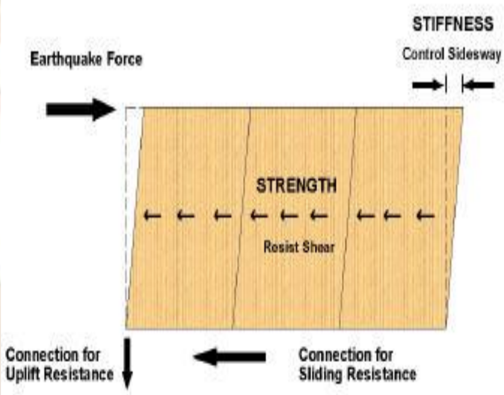

Fig.1.Functions of shear wall

The staad model of the 15 storey building without shear wall in figure 2 and with shear wall in figure 3 have been considered to carry out the study. Also 20 storey building without shear wall in figure 4 and with shear wall in figure 5 have been considered to carry out the study. STAAD PRO 2010 software has been considered for this study. The preliminary data for 15 storey building and 20 storey building are shown in table 1 and table 2 respectively.

Figure 2 shows the staad model of the 15 storey building without shear wall.

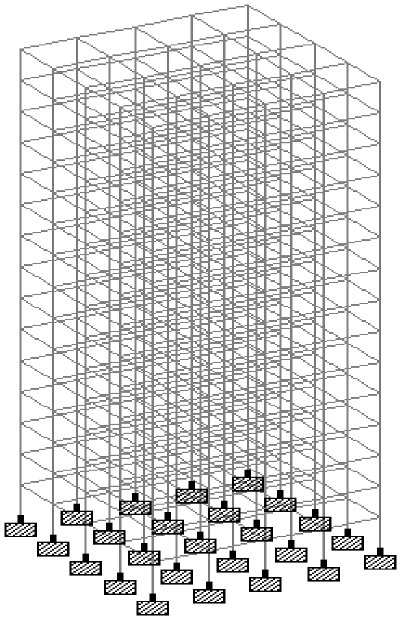

Fig.2. Staad model of the 15 storey building without shear wall

Figure 3 shows the staad model of the 15 storey building with shear wall.

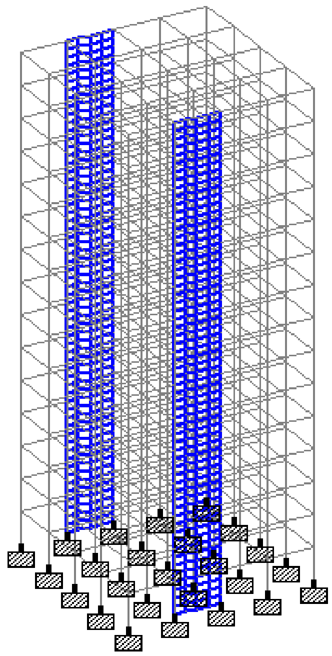

Fig.3.Staad model of the 15 storey building with shear wall

Table 1 gives the preliminary details of the 15 storey building.

Table 1: Preliminary Data

Height of each storey	4.0 m
Number of storey	Fifteen (G+14)
Shear wall thickness	200 mm
Grade of concrete and steel	M20 and Fe 415
Size of beam	300 x 400 mm^2
Size of column	600 x 800 mm^2
Location	Coimbatore

The 15 storey building is located in Coimbatore. Therefore the wind velocity of the building is 39 m/s. Figure 4 shows the staad model of the 20 storey building without shear wall.

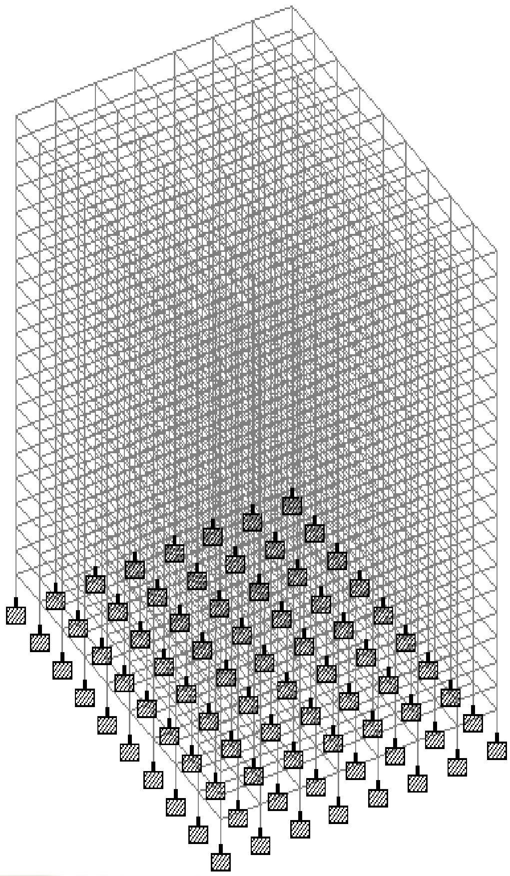

Fig.4. Staad model of the 20 storey building without shear wall

Figure 5 shows the staad model of the 20 storey building with shear wall.

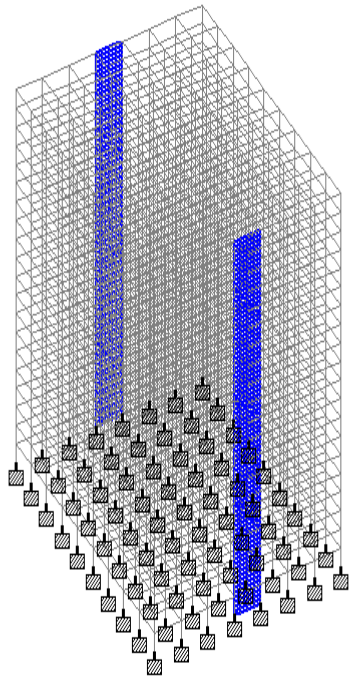

Fig.5.Staad model of the 20 storey building with shear wall

Table 2 gives the preliminary details of the 20 storey building.

Table 2: Preliminary Data

Height of each storey	4.0m
Number of storey	Twenty(G+19)
Shear wall thickness	200 mm
Grade of concrete and steel	M20 and Fe 415
Size of beam	400 x 600 mm^2
Size of column	600 x 800 mm^2
Location	Coimbatore

The 20 storey building is located in Coimbatore. Therefore the wind velocity of the building is 39 m/s.

2. LOADING CONSIDERATION

Dead load and live load have been taken as per IS 875 (Part 1) (1987) and IS 875 (Part 2)(1987) respectively. Wind load calculation has been done based on the IS 875 (Part 3) (1987).

3. DEFLECTION DIAGRAM

Figure 6 shows the deflection diagram of 15 storey building without shear wall.

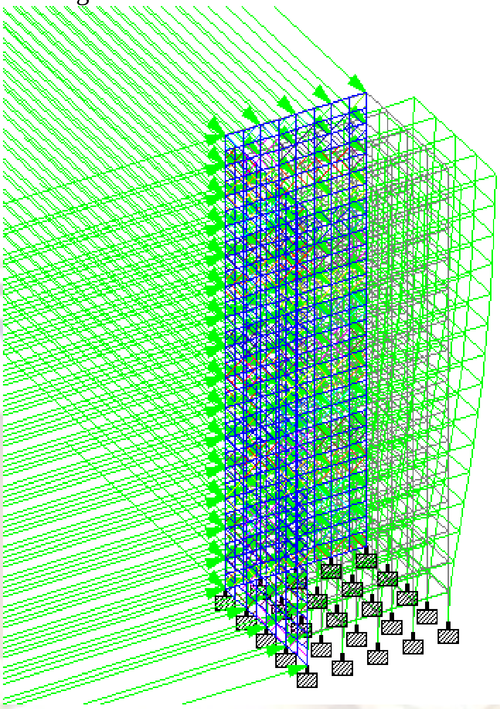

Fig.6. Deflection diagram of 15 storey building without shear wall

Figure 7 shows the deflection diagram of 15 storey building with shear wall.

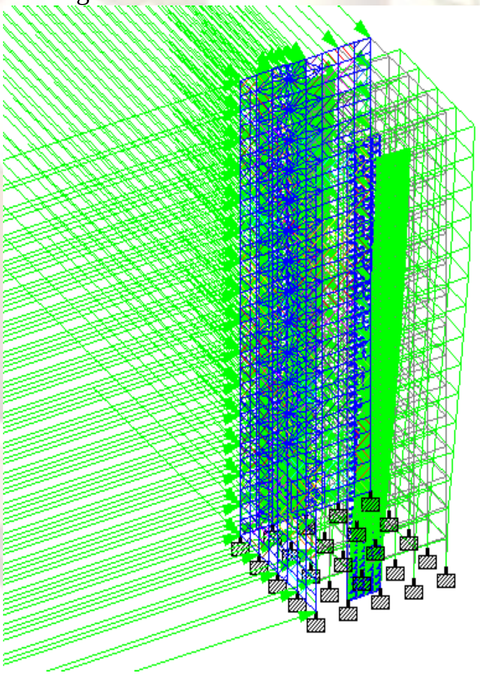

Fig.7. Deflection diagram of 15 storey building with shear wall

Figure 8 shows the deflection diagram of 20 storey building without shear wall.

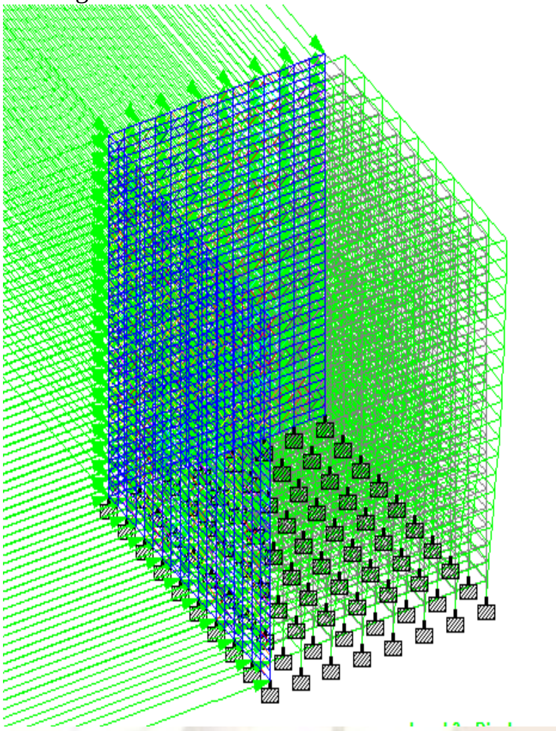

Fig.8. Deflection diagram of 20 storey building without shear wall

Figure 9 shows the deflection diagram of 20 storey building with shear wall.

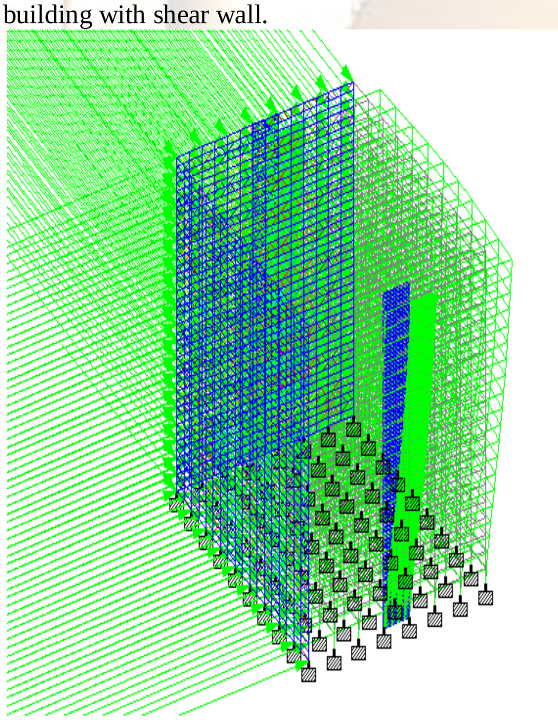

Fig.9. Deflection diagram of 20 storey building with shear wall

4. RESULT AND DISCUSSION

4.1. 15 STOREY BUILDING

Comparison between displacement of 15 storey building without shear wall and with shear wall at each floor level are shown in table 3.

Table 3: Displacement of 15 storey building with and without shear wall

Storey Numbers	Displacement of 15 Storey Building without Shear Wall (mm)	Displacement of 15 Storey Building with Shear Wall (mm)
Storey 15	145.012	115.751
Storey 14	142.332	112.820
Storey 13	138.939	109.411
Storey 12	134.266	105.124
Storey 11	128.200	99.883
Storey 10	120.709	93.663
Storey 9	111.796	86.464
Storey 8	101.491	78.311
Storey 7	89.849	69.241
Storey 6	76.958	59.312
Storey 5	62.961	48.614
Storey 4	48.108	37.303
Storey 3	32.868	25.676
Storey 2	18.160	14.366
Storey 1	5.842	4.730

Table 3 gives the displacement of 15 storey building with and without shear wall for each storey level.

4.2. 20 STOREY BUILDING

Comparison between displacement of 20 storey building without shear wall and with shear wall at each floor level are shown in table 4.

Table 4: Displacement of 20 storey building with and without shear wall

Storey Numbers	Displacement of 20 Storey Building without Shear Wall (mm)	Displacement of 20 Storey Building with Shear Wall (mm)
Storey 20	133.650	114.130
Storey 19	130.986	110.642
Storey 18	129.435	108.048
Storey 17	127.342	105.083
Storey 16	124.492	101.669
Storey 15	120.907	97.803
Storey 14	116.610	93.497

Storey 13	111.609	88.747
Storey 12	105.916	83.564
Storey 11	99.543	77.958
Storey 10	92.505	71.949
Storey 9	84.823	65.558
Storey 8	76.518	58.812
Storey 7	67.615	51.738
Storey 6	58.144	44.370
Storey 5	48.147	36.744
Storey 4	37.690	28.908
Storey 3	26.901	20.925
Storey 2	16.096	12.927
Storey 1	6.155	5.325

Table 4 gives the displacement of 20 storey building with and without shear wall for each storey level.

4.3. TOP STOREY DISPLACEMENTS OF BUILDING WITH AND WITHOUT SHEAR WALL

Comparison between top storey displacement of 15 storey building and 20 storey building without shear wall and with shear wall are shown in table 5.

Table 5: Top storey displacement of building with and without shear wall

Building Model	Top Storey Displacement of Building without Shear Wall (mm)	Top Storey Displacement of Building with Shear Wall(mm)
15 Storey Building	145.012	115.751
20 Storey Building	133.650	114.130

Table 5 gives the top storey displacement of both 15 storey and 20 storey building with and without shear wall.

The top storey displacement of 15 storey building without shear wall and with shear wall are shown in figure 10.

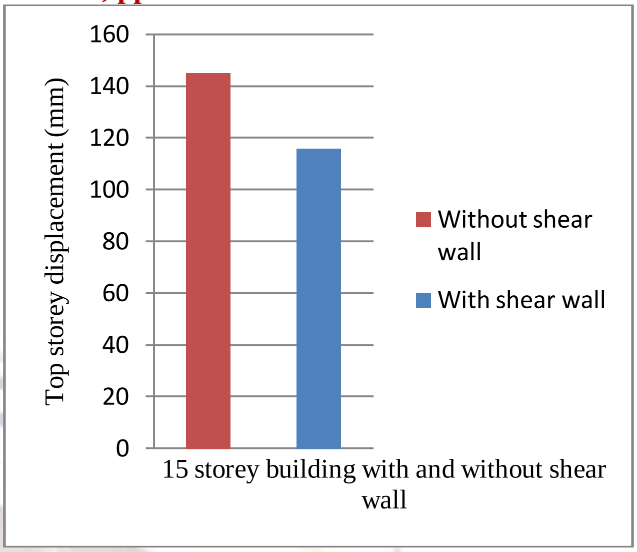

Fig.10. Top storey displacement of 15 storey building with and without shear wall

Figure 10 shows that 15 storey building without shear wall results higher top storey displacement when compared to 15 storey building with shear wall.

The top storey displacements of 20 storey building without shear wall and with shear wall are shown in figure 11.

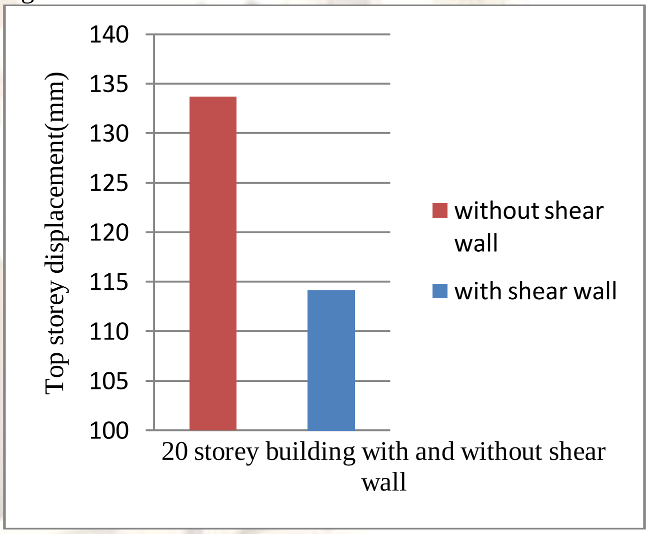

Fig.11. Top storey displacement of 15 storey building with and without shear wall

Figure 11 shows that 20 storey building without shear wall results higher top storey displacement when compared to 20 storey building with shear wall.

5. CONCLUSION

A 15 storey building and 20 storey building were analysed with shear wall and without shear wall and the displacements of the buildings with shear wall and without shear wall were compared. From the above results it is seen that the displacement for a 15 storey building with shear wall was 20.18% less than the 15 storey building without shear wall and the displacement for 20 storey building with shear wall was 14.6% less than the 20 storey building without shear wall. Hence it is found that building with shear wall resists wind load effectively.

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