International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 04, April-2021

A Review on Performance of Shear Walls and Cost Optimization of the Structures based on Different Shear Walls Position

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Abstract-[4]**Modern trends towards high rise buildings increases recently due to the high increase in the number of tall buildings, both residential and commercial. In comparison with earlier high-rise buildings, today's tall buildings are becoming more and more slender and leading to the possibility of more sway. Thus, shear walls come into play, shear wall is a structural member designed to counteract the lateral forces acting on a structure. The present study is on the factors which helps in optimizing the cost of the structure with minimum lateral deflection and total cost of the structure by the help of shear walls at different positions.**

Keywords-High rise, Lateral deflection, Optimizing cost, Slender, Shear walls, Sway and Tall buildings.

I. INTRODUCTION

[2]Reinforced concrete (RC) buildings often have vertical plate-like RC walls called Shear Walls in addition to slabs, beams and columns. 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.

The simple and most general definition of optimization is 'making the things best', Structural optimization is the subject of making an assemblage of materials sustain loads in the best way. Here in this paper, we tried to optimize the cost of the structure in accordance with the minimum serviceability requirement as per IS code specification such that we don't focus on minimizing the deflection but to make the structure come within serviceable deflection limits and the overall cost stays within limit.

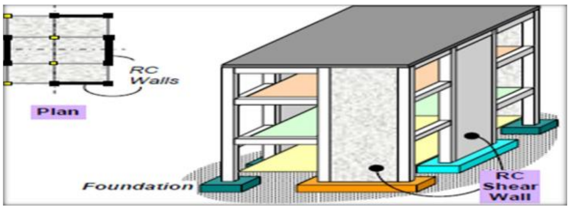


Fig.1. Shear Wall.

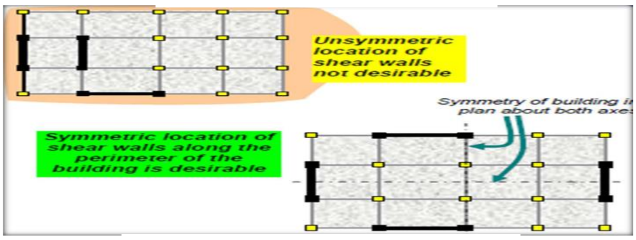


Fig.2. Effective Position of Shear Wall.

II. LITERATURE REVIEW

A. Mr. K. LovaRaju et.al

[3]Conducted non-linear analysis of frames to identify effective position of shear wall in multi storey building.

An earthquake load was applied to an eight-storey structure of four models with shear wall at different location in all seismic zones using ETABS. Push over curves were developed and has been found the structure with shear wall at appropriate location is more important while considering displacement and base shear.

B. Syed.M. Katami et.al

[3]Presented the results of time history analysis which addressed the effect of openings in shear walls near- fault ground motions. A Complete shear walls, shear walls with square opening in the center and shear wall with opening at right end side were considered. From the results it was observed that shear walls with openings experienced a decrease in terms of strength.

C. Dr. B. Kameshwari et.al

[3]Analysed the influence of drift and inter storey drift of the structure on various configuration of shear wall panels on high rise structures. The bare frame was compared with various configurations like i) Conventional shear wall ii) Alternate arrangement of shear wall iii) Diagonal arrangement of shear wall iv) Zig Zag arrangement of shear wall v) Influence of lift core shear wall. From the study it was found that Zig Zag shear wall enhanced the strength and stiffness of structure compared to other types. In earthquake prone areas diagonal shear wall was found to be effective for structures.

D. Nanjma Nainan et.al

[3]Conducted analytical study on dynamic response of seismo resistant building frames. The effects of change in height of shear wall on storey displacement in the dynamic response of building frames were obtained. From the study it was concluded that it is sufficient to raise the shear wall up to mid height of building frames instead of raising up to entire height of the building.

E. Shahzad Jamil Sardar et.al

[3]Modelled a 25-storey building zone V and analysed by changing the location of shear wall to determine various

parameters like storey drift, storey shear and displacement using ETABS. Both static and dynamic analysis was done to determine and compare the base shear. Compared to other models, when shear wall placed at center and four shear walls placed at outer edge parallel to X and Y direction model showed lesser displacement.

III. OBJECTIVE

- To model a structure using STAAD.PRO with all the loads acting on it like Dead, Live, Wind and Earthquake Loads as per IS code.
- To analyse the deflection for the bare frame G+10 and G+15 structures.
- To compare the deflections due to provision of shear walls at different positions in both G+10 and G+15 structure and compare the results with the bare frame and check with the serviceability requirement.
- To optimize the structure cost with minimum deflection, i.e., choosing the best possible shear wall position such that deflections are within limits as per IS code and cost is minimal for shear wall construction.

IV. METHODOLOGY

In this chapter a multi-storey building has been modelled and analysed considering all loads like Dead load, Live load, Wind Load as per as IS standard and Seismic load as per as IS standard. The structure details taken from reference is given in table 1.

[1]STAAD or (STAAD.Pro® V8i) is a structural analysis and design computer program originally developed by Research Engineers International in Yorba Linda, CA. In late 2005, Research Engineers International was bought by Bentley Systems. It is the World's #1 Structural Analysis and Design Software. The analysis is done in a numerical way by the STAND.PRO program, a finite element package, which enables us to solve the linear and the nonlinear PDE"s and thus the modulus of elasticity of the beam material is obtained. STAND.PRO is modelling and analysis software which helps in the modelling and analysis of required models, a FEM tool. It is used to analyse complex problems in mechanical structures, thermal processes, electrical fields, magnetics, and computational fluid dynamics. STAAD.PRO provides a rich graphics environment, which is used to display results of analysis that re performed.

TABLE 1 BUILDING PROPERTIES

INDEX	DESCRIPTION
Density of Reinforced Concrete	25 kN/m^3
Density of Brick Masonry	19.1 kN/m^3
No. of Storey	G+10 & G+15
Beam Dimensions	300 mm * 300 mm
Column Dimensions	400 mm * 400 mm
Slab Thickness	130 mm
Shear Wall Thickness	170 mm
Floor Height	3.5 m

V. MODELLING

A. *Time History Analysis Models*

Time History Analysis was performed on the G+10 structures and G+15 structures for the Bhuj Earthquake of January 26, 2001 at Ahmedabad having:
Initial Velocity = -0.1411E-02 m/s
Initial Displacement = 3.970 mm
Peak Acceleration = -1.0382 m/s/s at 34.95 sec

It was observed that for Time History Analysis the deflection was in order of 5 - 20 mm and thus we performed Equivalent Static Method with Earthquake and Wind Loads of that region acting simultaneously to analyse and come to the conclusion of how we could optimize the structure.

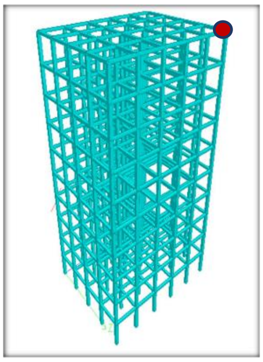


Fig. 3a. (G+ 10, Deflection of 5.90 mm at Node 330)

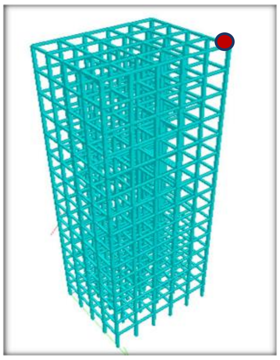


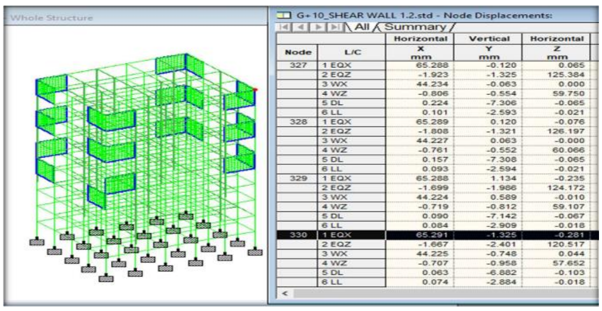
Fig. 3b. (G+ 15, Deflection of 19.70 mm at Node 480)

B. *Loading Details*

TABLE 2 APPLIED LOAD

INDEX	DESCRIPTION
Dead Wall Load on Outer Perimeter	14 kN/m^2
Dead Wall Load on Inner Perimeter	7 kN/m^2
Dead Floor Load	4.25 kN/m^2
Live Floor Load	3 kN/m^2

C. *Equivalent Static Method Models*



Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm
327	1 EQX	65.288	-0.120	0.065
	2 EQZ	-1.923	-1.325	125.384
	3 WX	44.234	-0.063	0.000
	4 WZ	-0.806	-0.554	59.750
	5 DL	0.224	-7.306	-0.065
	6 LL	0.101	-2.593	-0.021
328	1 EQX	65.289	0.120	-0.076
	2 EQZ	-1.808	-1.321	126.197
	3 WX	44.227	0.063	-0.000
	4 WZ	-0.761	-0.552	60.066
	5 DL	0.157	-7.308	-0.065
	6 LL	0.093	-2.594	-0.021
329	1 EQX	65.288	1.134	-0.235
	2 EQZ	-1.699	-1.986	124.172
	3 WX	44.224	0.589	-0.010
	4 WZ	-0.719	-0.812	59.107
	5 DL	0.090	-7.142	-0.067
	6 LL	0.084	-2.909	-0.018
330	1 EQX	65.291	-1.325	-0.281
	2 EQZ	-1.667	-2.401	120.517
	3 WX	44.225	-0.748	0.044
	4 WZ	-0.707	-0.958	57.652
	5 DL	0.063	-6.882	-0.103
	6 LL	0.074	-2.884	-0.018

Fig. 4a. (G+10 – Without Shear Wall, Max. Deflection of 78.304 mm at Node 330)

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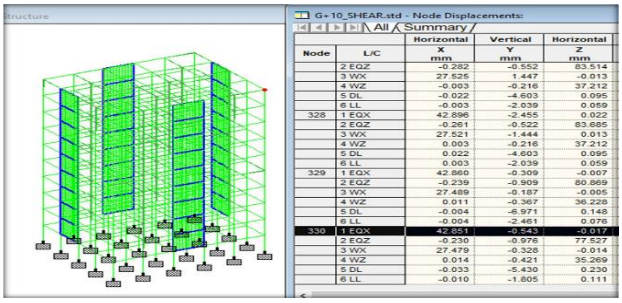

Fig. 4b. (G+10 – With Shear Wall @ Position 1, Max. Deflection of 42.851 mm at Node 330)

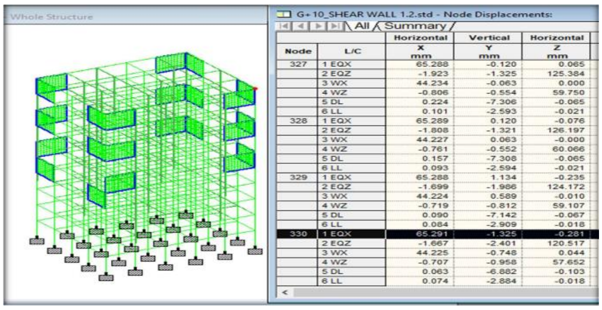

Fig.4c. (G+10 – With Shear Wall @ Position 2, Max. Deflection of 65.291 mm at Node 330)

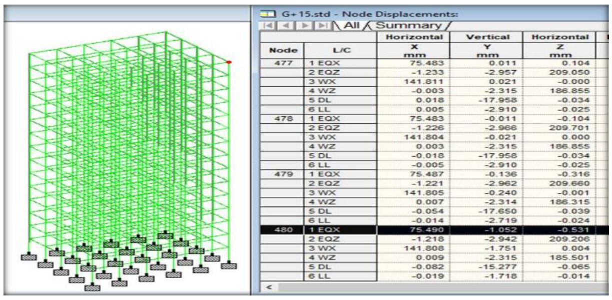

Fig.4.d. (G+15 – Without Shear Wall, Max. Deflection of 75.490 mm at Node 480)

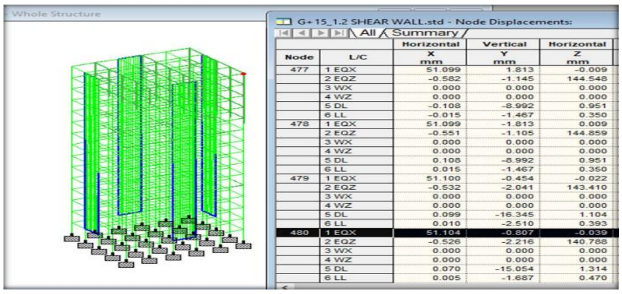

Fig.4.e. (G+15 –With Shear Wall @ Position 1, Max. Deflection of 51.104 mm at Node 480)

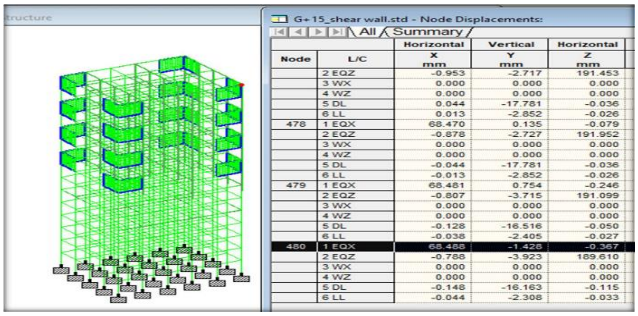

Fig.4.f. (G+15 –With Shear Wall @ Position 2, Max. Deflection of 68.488 mm at Node 480)

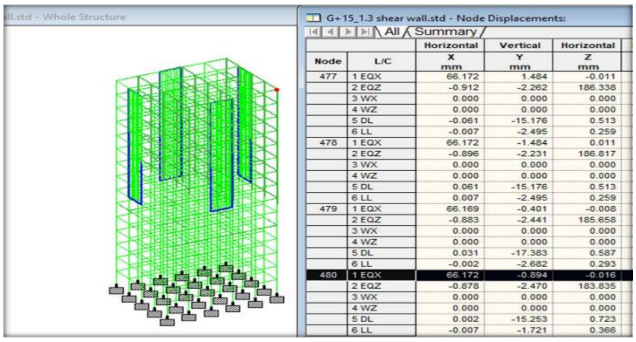

Fig.4.g. (G+15 – With Shear Wall @ Position 3, Max. Deflection of 66.172 mm at Node 480)

VI. RESULT

Comparison Chart For G+10 Structure						
Deflection without shear wall @ 330	Shear Wall Model Number	Deflection with shear wall @ 330	Shear Wall Area	Cost per sq. m of 170 mm thick Shear Wall	Total Cost of Shear Wall	Difference
78.304 mm	1	42.851 mm	504 m^2	Rs. 7400	3729600	1243200
	2	65.291 mm	336 m^2	Rs. 7400	2486400	
Comparison Chart For G+15 Structure						
Deflection without shear wall @ 480	Shear Wall Model Number	Deflection with shear wall @ 480	Shear Wall Area	Cost per sq. m of 170 mm thick Shear Wall	Total Cost of Shear Wall	Difference
75.490 mm	1	51.104 mm	784 m^2	Rs. 7400	5801600	2486400
	2	68.488 mm	448 m^2	Rs. 7400	3315200	
	3	66.172 mm	448 m^2	Rs. 7400	3315200	

VII. CONCLUSION

Thus, from the above comparison table we find that both G+10 and G+15 structures without shear walls deflects by approximately 76mm and so we have used shear walls to reduce the deflections. Now, the best possible shear wall position i.e. (position 1) would lead to reduction in deflections to 42 mm and 51 mm respectively but they would cost a total of Rs.1243200 and Rs.2486400 in G+10 and G+15 structures respectively.

But, by analysis we have come to the conclusion that by providing shear walls at position 1 in G+10 structure and at position 3 in G+15 structure we have fulfilled the serviceability requirement as per IS codes i.e., the deflection is within limits and that had eventually led to a total cost saving of Rs.12.5 lacs and Rs.25 lacs in G+10 and G+15 structures respectively.

VIII. REFERENCES

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