Behaviour of multistorey building with different shear wall arrangements with and without central cross shear wall

Vijit Sahu[1], Dr. G.P. Khare[2], Mr. Dushyant Kumar Sahu[3]

[1] *Student, M. Tech(Structural Engg.) GEC Jagdalpur*
[2] *Principal, GEC Jagdalpur*
[3] *Assistant Professor, GEC Jagdalpur*

Abstract - *Shear wall systems are one of the most commonly used lateral load resisting systems in high-rise buildings. Shear walls have very high in plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads, making them quite advantageous in many structural engineering applications. In this project, main focus is to determine the solution for shear wall location in multistory building. A RCC building of five storey subjected to earthquake loading in zone-IV is considered. An earthquake load is calculated by static method or equivalent lateral force method using IS 1893 (PART–I):2002. These analyses were performed using STAAD Pro. A study has been carried out to determine the strength of RC shear wall of a multistoried building with different arrangements, with or without central cross shear wall. Six different cases of shear wall position for a 5 storey building have been analyzed. In this project the aim is to analyze the response of structure using by static method or equivalent lateral force method. And base shear, storey drift, node displacement, and Maximum reactions of the building is observed and compared for both the cases with and without central cross shear walls.*

Key Words: **STAAD.Pro V8i, shear wall, *seismic analysis, IS 1893 (part-1)-2002,***

1.INTRODUCTION

Earthquake has always been a threat to human civilization from the day of its existence, devastating human lives, property and man-made structures. It is such an unpredictable calamity that it is very necessary for survival to ensure the strength of the structures against seismic forces. Therefore the continuous research works are going on around the world, revolving around for the development of new and better techniques that can be incorporated in structures for better seismic performance. Obviously, buildings designed with special techniques to resist damages during seismic activity have much higher cost of construction than normal buildings, but for safety against failures under seismic forces it is a prerequisite.

There are many different methods of seismic analysis like time history method, response spectrum method seismic coefficient method etc. in this project seismic coefficient method has been adopted. A study has been carried out to determine the strength of RC shear wall of a multistoried building by changing shear wall location. And parameters like base shear, storey drift, nodal displacement, maximum reaction are observed and compared. The seven different types of models are as follows.

1. Model of building without shear wall.
2. Shear wall along periphery
3. Shear wall at corners.
4. Shear wall at central frame.
5. Shear wall along periphery and in middle.
6. Shear wall at corners and in middle.
7. Shear wall at central frame and in middle.

The first model is without shear wall. Type 2,3 and 4 are without central cross shear wall and type 5,6,7 are with central cross shear wall.

1.1 Functions of shear wall

- Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them.
- Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side sway.
- When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage.
- Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large.

1.2 Objectives of present work

1) To analyze an R.C. building frame using staad pro. Software setup.

2) To judge the effect of an R.C. shear walls on structures when provided at different locations.

3) To study the results of base shear, storey drift, nodal displacement, maximum reaction for seven different models.

4) To understand the purpose of using shear walls using STAAD.pro. Through this work.

2. METHODOLOGY

In the present study the behavior of multistoried frame under seismic loads have been investigated for various location of shear walls. An analysis of multistoried frame of G+5 stories has been carried out. The buildings were assumed to be located in seismic zone IV. The shear walls were provided at different locations of the building. The analysis of the building has been carried out by static method or equivalent lateral force method approach using STAAD pro V8i SELECT series 4.

A G+5 multistory frame with six different locations of shear walls situated in seismic zone IV have been taken for the purpose of the study. The size of the building in plan is 12 m x 12 m. Height of each storey = 3m, Size of Column = 400mm x 400mm, Size of Beam = 500mm x 400mm, , Shear wall thickness = 200mm, Concrete Mix Used = M30,steel=Fe 415 All the supports are assumed to be fixed in nature.

All the structural properties of building and dimensions are shown in the table no.1. Damping ratio is 5% and soil type is taken as medium for all the 7 different models of different shear wall location.

Table -1: Structural properties of building

S.no.	Properties	Dimensions
1.	Shear wall thickness	200 mm
2.	Total depth of slab	150 mm
3.	External wall thickness	300 mm
4.	Internal wall thickness	200 mm
5.	Size of beam	500 mm x 400 mm
6.	Size of column	400 mm x 400 mm
7.	Height of parapet wall	0.7 m
8.	Zone factor (Z)	0.24
9.	Importance factor (I)	1
10.	Response reduction factor (R)	5
11.	Live load of the building at floor level	3KN/m^2
12.	Soil type	medium
13.	Damping	5%
14.	Grade of Concrete and steel	M30 and Fe 415
15.	Support condition	Fixed

In this project 7 types of structures in which shear walls at different locations are taken for comparison

Type 2,3and 4 are the structures without central cross shear wall and type 5,6and 7 are the structures in which central cross shear walls are provided at the center.

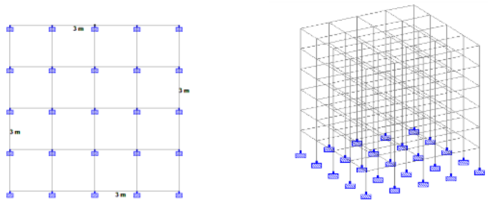

Fig -1 structure without shear wall

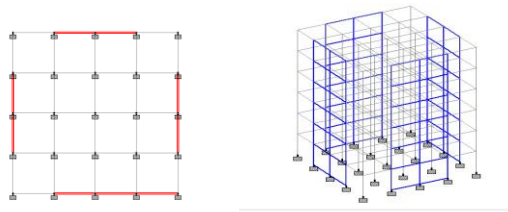

Fig -2 shear wall along periphery.

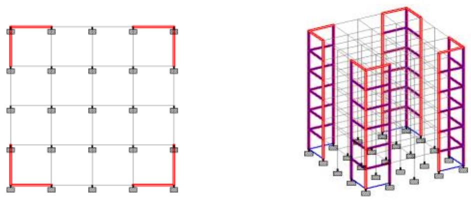

Fig -3 Shear wall at corners

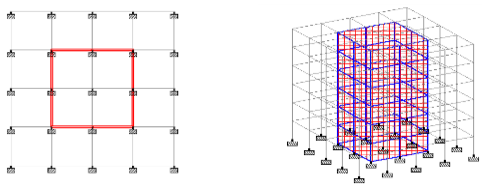

Fig -4 shear wall at central frame.

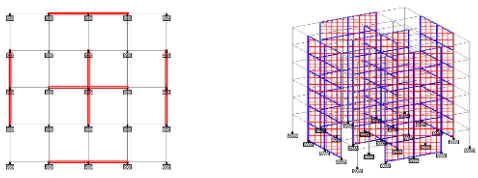

Fig -5: along periphery and in middle.

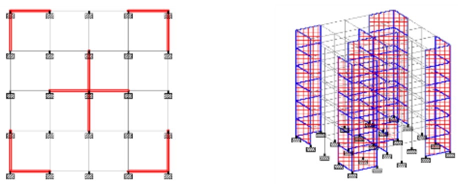

Fig -6: at corner and in middle.

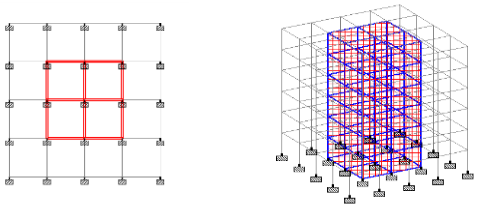

Fig -7: at central frame and in middle

2.1 Result and discussion

2.1.1Storey drift

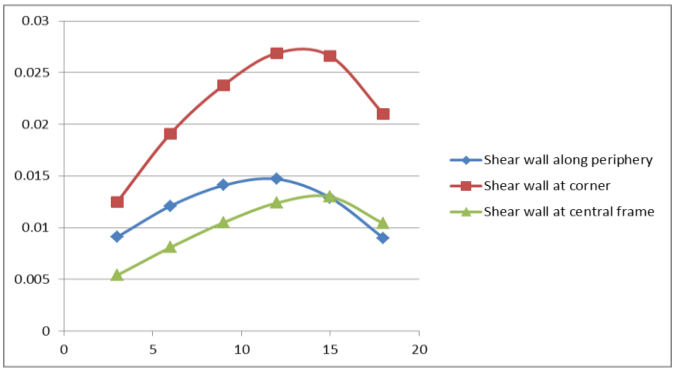

Chart -1: storey drift without central cross shear wall

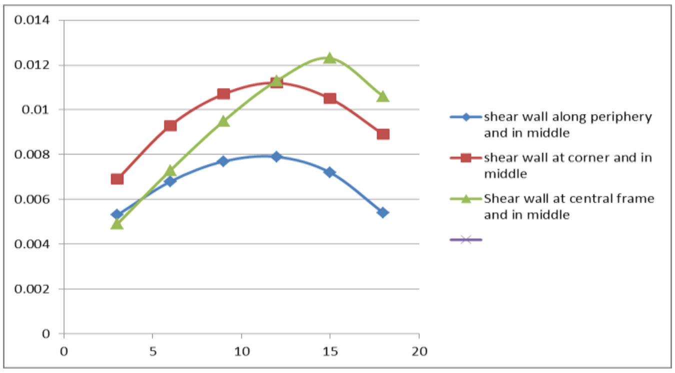

Chart -2: storey drift with central cross shear wall

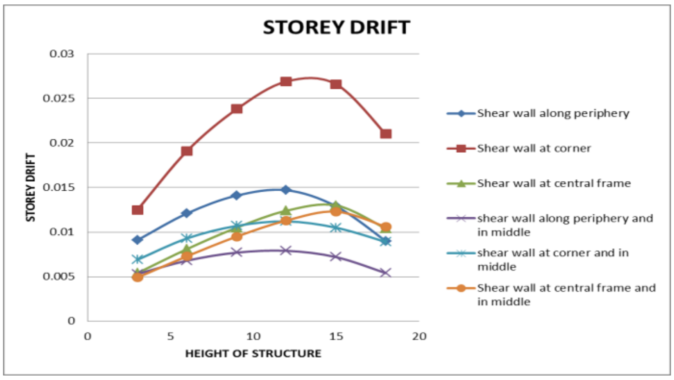

Chart -3: storey drift for all structures with shear wall at different height

Above graph shows the value of storey drift for all types of structures in which shear wall is provided. From the graph it is observed that the maximum value of storey drift is for the structure type 4 which is shear wall at corners and the minimum value is for the model type 5 which is shear wall along periphery and in the middle

2.1.2 Base shear

TABLE-2: Value of base shear for all types of structure

Type	Structure type	Base shear	% increase
1.	Structure without shear wall	918.567 KN	-
2.	Shear wall along periphery	1019.966 KN	11.03 %
3.	Shear wall at corner	1028.931 KN	12.01 %
4.	Shear wall at central frame	1042.377 KN	13.47 %
5.	Shear wall along periphery and in middle	1079.62 KN	17.53 %
6.	Shear wall at corner and in middle	1115.479 KN	21.43 %
7.	Shear wall at central frame and in middle	1088.59 KN	18.51 %

Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure If shear wall is not provided in the structure the value of base shear is minimum. It means shear wall increases the base shear From the above table it is clear that if we provide shear wall at corner in middle the value of base shear will maximum and if we provide shear wall along periphery the value of base shear is minimum

From the graph it is clear that value of base shear increases with the provision of shear wall it means shear walls provide more safety to resist lateral loads. The maximum value of the base shear is for structure type 6 which is shear wall at corner and in middle, and minimum for type 2 which is shear wall along periphery.

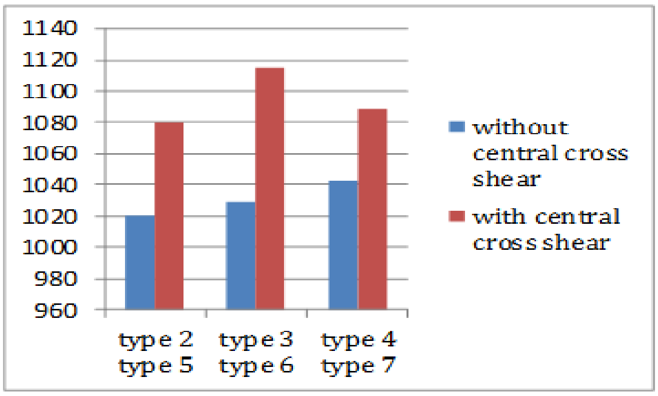

Chart -4: base shear of structure with and without central cross shear wall

2.1.3 Maximum nodal displacement due to earthquake load.

TABLE-3: Maximum nodal displacement of structure

s.no.	Type of structure	Nodal displacement (cm/radian)	% decrease with respect to type 1
1.	Type 1	1.48	-
2.	Type 2	0.47	68.24%
3.	Type 3	0.59	60.13%
4.	Type 4	0.27	81.75%
5.	Type 5	0.30	79.72%
6.	Type 6	0.37	75%
7.	Type 7	0.25	83.10%

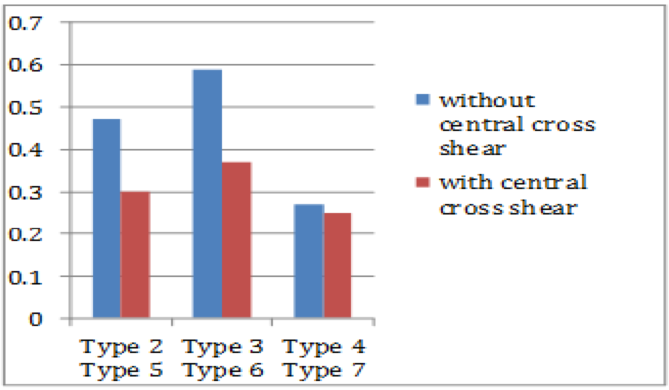

Chart -5: nodal displacement for structures with and without central cross shear wall

2.1.4 Maximum nodal reaction

TABLE-4: maximum nodal reaction

S.No.	Type of model	Maximum reaction (KN)
1	Type 1	61.069 (at node 107)
2	Type 2	560.404 (at node 142)
3	Type 3	469.793 (at node 144)
4	Type 4	512.385 (at node 107)
5	Type 5	542.170 (at node 72)
6	Type 6	470.594 (at node 72)
7	Type 7	362.510 (at node 107)

The reaction at supports implies that the rigidness of support and to ensure that the capability of a column to transfer the load without settlement of support.

From the above table it has been observed that maximum nodal reaction for type 1 which is structure without shear wall is minimum. And nodal reaction is maximum for type 2 which is shear wall along periphery.

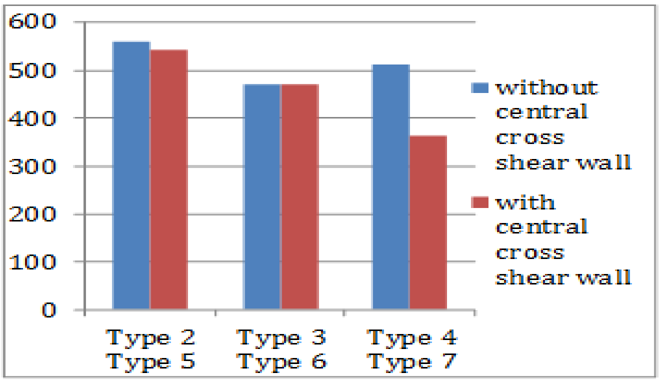

Chart -6: maximum nodal reaction for structure with and without central cross shear wall

3. CONCLUSIONS

In this project main aim was to compare the effect of shear wall at different location of multistory frame. and the parameters for the comparison were storey drift, base shear, maximum nodal displacement and maximum nodal reaction.

It has been found that the storey drift increases with increase in number of storeys. Storey drift decreases with the provision of shear walls. In this project storey drift is compared for the models with and without central cross shear walls. And for each cases different results are observed.

Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. Value of base shear is observed minimum for the case in which no shear walls are provided in the structure. The value of base shear increases with the provision of shear wall. In this project the maximum base shear is observed in the model no. 6 which is Shear wall at corner and in middle, it means that it provides maximum safety against the earthquake load.

Provision of shear wall results in reduction of average displacements.it means if shear wall is provided in the structure the displacement should be minimum. In this project the nodal displacement for structures with and without shear wall are compared. For the safety purpose the nodal displacement should be minimum.in this project the minimum nodal displacement is observed in the model type 7 which is Shear wall at central frame and in middle.

The reaction at supports implies that the rigidness of support and to ensure that the capability of a column to transfer the load without settlement of support. Maximum nodal reaction is observed in model type 2 which is Shear wall along periphery. And maximum nodal reaction also compared for structure with and without central cross shear walls and in this case also the different results are observed. If shear wall is not provided the reaction is minimum and the value increase with the provision of the shear wall at different location of the buildings.

REFERENCES

[1] Anshuman, Dipendu Bhunia, Bhavin Ramjiyani, " Solution of shear wall in multi-storey building" International journal of civil and structural engineering, Volume 2, no.2, 2011.

[2] Vipin V. Halde, Aditi H. Deshmukh, "Review on Behaviour of Soft Storey Effect in Building" International Journal of Innovative Research in Science,Engineering and TechnologyVol. 4, Issue 12, December 2015R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[3] Deepak Kumar Bandewar, Mr. Praveen Singh Tomar, Dr. Prakash Porey,"Seismic analysis of an R.C. multistorey building frame with varying sizes of openings in shear wall", International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 07 July-2016.

[4] Himalee Rahangdale , S.R.Satone, "Design And Analysis Of Multistoreied Building With Effect Of Shear Wall", International Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 3, May-Jun 2013

[5] G.Amar, V.Sanjay Gokul, K.Vamsi Krishna, D.Rakesh, "analysis and design of reinforced concrete rectangular shear wall" IJIRT ,Volume2, Issue 12,May 2016.

[6] V.ABHINAV, Seismic Analysis of Multi Story RC Building with Shear Wall Using STAAD.pro .international journal of innovative technology and research volume no.4, issue no.5, august – September 2016, 3776 – 3779

[7] Alkesh Bhalerao , S.B. Shinde , " effect of structural shape on wind analysis of multistoried rcc structures" ,5th international conference on recent trends in engineering, science and management.9-10 december 2016.

[8] Prashanth.P, Anshuman.S, Pandey.R.K, Arpan Herbert, " Comparison of design results of a Structure designed using STAAD and ETABS Software", international journal of civil and structural engineering volume 2, no 3, 2012.

[9] Vinay Sanjeevkumar Damam "comparative study on multistoried rcc structure with and without shear wall by using sap2000 v17" , International Research Journal of Engineering and Technology (IRJET) , Volume: 02 Issue: 07 | Oct-2015.

[10] Ashishs.agrawal, s.d.charkha, "effect of change in shear wall location on storey drift of multistorey building subjected to lateral loads", International Journal of Engineering Research and Applications (IJERA) ,Vol. 2, Issue 3, May-Jun 2012.

[11] Bureau of Indian Standards: IS-875, part 1 (1987), dead loads on buildings and Structures, New Delhi, India.

[12] Bureau of Indian Standards: IS-875, part 2 (1987), live loads on buildings and Structures, New Delhi, India.

[13] Bureau of Indian Standards: IS-1893, part 1 (2002), "Criteria for Earthquake Resistant Design of Structures: Part 1 General provisions and Buildings", New Delhi, India.

[14] Bureau of Indian Standard, IS-456(2000), "Plain and Reinforced Concrete Code of Practice".