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Analysis of Opening in Shear Wall in Tall Structures

Manish Bhoir¹, Dr. Vikram Patil²

¹PG Student, Dept. of Civil Engineering, B.R.Harne College of Engineering & Technology, Mumbai, Maharashtra, India

²Principal, B.R.Harne College of Engineering & Technology, Mumbai, Maharashtra, India

ABSTRACT: A Tall Structures with R.C.C framed type are becoming most popular in many of the metropolitan region in India. These Type of Structures are mostly provided with long shear walls to improve the lateral load resistance system against earth quack and wind loads. A shear wall may contain many openings as per architectural and functional requirements such as horizontal and vertical circulation purpose. These type of openings in shear walls may affect the overall behavior of the structure. Thus, it is necessary to study the effect of those on the various parameters such as story drift, columns shear and moments, deflections, stress within the shear walls etc.

A 3-D analysis of the frame shear wall structure using ETABS for three different heights of building, located in Mumbai terrain category 3 as per I.S 875 (Part3) - 2015 has been carried out. A Dynamic wind force (gust force) is adopted for the analysis purpose. The study covers the location and types of openings in shear walls.

KEYWORDS: Response Spectrum Method, ETABS version 20, R.C.C Shear Wall, Types of Openings, Base Moment, Shear Force, Deflections.

I. INTRODUCTION

Many multi-story apartment buildings are being constructed, in India, using shear walls frame system to provide earthquake resistance to reinforced concrete frames. Shear wall are vertical structural element that may induce to the lateral loads. These shear walls may have openings for the windows, doors and duct spaces for functional reasons. Framed structures with shear walls are mainly adopted as the structural system for high-rise buildings structures. Introduction of shear wall in a building is a structurally efficient solution to stiffen the building because they provide the necessary lateral the shear wall and frame respectively in the analysis of this kind of building. The size and location of shear wall is extremely critical. Otherwise, the bending moment at the end of a beam cannot be transferred to the shear wall. These openings seriously affect the efficiency and accuracy of the analysis.

A. Frames: A Rigid Jointed R.C frames of rectangular components, beams and columns connected together in the same plane by means of rigid joints. The lateral stiffness of such a frame depends upon the bending stiffness of the column, beams, and connections in the plane. The rigid frame principal advantage is its open rectangular arrangement, which allows freedom of planning and easy fitting of doors and windows.

B. Shear Wall: Shear wall are vertical stiffening elements designed to resist lateral forces exerted by wind or earthquake. The shape and location of shear wall have significant effect on their structural behavior under lateral loads. These shear wall resist horizontal force because their high rigidity as deep beams, reacting to shear and flexure against overturning. Shear walls are much stiffer than horizontal rigid frame. Types of shear wall i) Based on shape are Box Section, L- section, U- section, W- section, H- section, and T- section. ii) Based on elevation are Short: $H/D < 1$, Squat: $1 < H/D < 3$, Cantilever: $H/D > 3$. Where, H = Total Height of Shear Wall, D = Length of Wall in plan. iii) Based on behavior are Ordinary Shear wall and Special Shear wall.

C. Shear Wall with Openings: Framed structures with shear walls are frequently adopted as the structural system for high rise buildings, the openings may be window, door type openings as described previously. The behavior of wall will change, these changes will occur in deflection, bending moment, shear force, and the stress in walls. Openings may be small or large depending on the function of the building. If the building is a residential building, opening like window, door, and corridor are sufficient whereas for special building like cinema theaters, function hall, hotels, community halls it requires larger openings to meet the requirements.

D. Advantages of Shear Wall

1. It provides adequate strength to resist large lateral loads without excessive additional cost. 2. It provides adequate stiffness to resist lateral displacement to permissible limits, thus reducing risk of non-structural damage. 3. They should be located such a way they also act as functional walls. And do not interfere with the architectural of the building. 4. Shear wall should be placed along both the axis. So that lateral stiffness can be provided in both directions, particularly in the case of square buildings. 5) To avoid torsion shear wall should be placed symmetrically about the axis.

II. OBJECTIVE AND SCOPE

The main objective of this work is to analyses the behavior of tall Structure due to inappropriate location of opening.

For satisfying the above-mentioned objectives following points were studied.

- 1) Detailed analytical study on opening in shear wall of high-rise buildings using ETABS version 20.
- 2) The present study is limited to analysis of 70 story of R.C.C. Buildings.
- 3) To determine the effect on structure by providing dual system.
- 4) To understand effect of opening of two different sizes.
- 5) To understand the P – Delta effect in tall structures.
- 6) To perform dynamic wind analysis.

The Scope of work is limited to

1. To understand the behavior of high-rise structure analytically having openings in shear wall.
2. Comparative study of Structure with and without opening in Shear wall.
3. To understand the behavior of Structure with various types of openings.
4. Comparative study of Linear Dynamic analysis on structure with and without opening.
5. To calculate the percentage, change in the values of various structural parameters like Deflection, Bending Moments, Shear Force, using wind load as a lateral load.

III. PROBLEM STATEMENT

The present study involves the study of structures with and without openings at centrally located and at corners as shown above. The opening size for door and window is 1.4m*2.1m and 1.5m*1.5m respectively. The height considered for study purpose is 70 floors. The aim of study is to find out the differences in various parameters of structures of an irregular shaped high-rise building using Etabs software is used for analytical study and dynamic wind force are considered as lateral load for study purpose. In this present study various models will be modeled with different two types of openings and a without opening and the results are compared. The plan dimension is 50m X 50m, and floor to floor height will be 3.0m having varying grade of concrete with Fe 500 and Fe415.

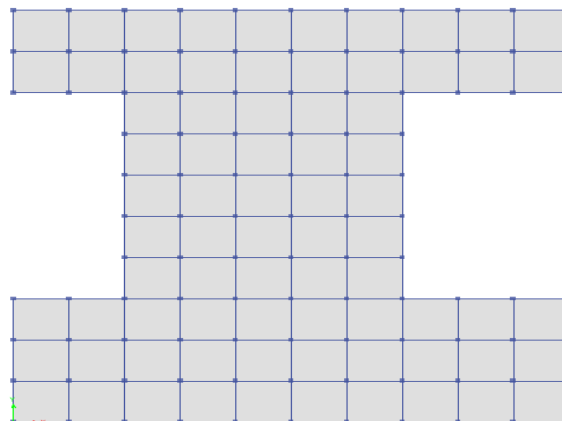


Figure 1. Floor plan

IV. METHODOLOGY

For the structural analysis there are few methods which is used to understand the behavior of structure. Some of the methods are explain below.

Equivalent Static Method: This approach defines a series of forces acting on a building to represent the effect of earthquake ground motion. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when the ground moves. As per this method first the design base shear shall be computed for the building as a whole. Then the base shear shall be distributed to the various floor levels at the corresponding centers of mass. And finally, the design seismic force at act level shall be distributed to individual lateral load resisting elements trough structural analysis considering the floor diaphragm action. This method is applicable for regular building with height less than 15m in seismic zone 2 as per IS code 1893-2016.

Response Spectrum Method: The response spectrum represents an envelope of upper bound responses, based on several different ground motion records. For the purpose of seismic analysis, the design spectrum given in figure 1 of IS: 1893 (Part 1): 2016 is used. This spectrum is based on strong motion records of eight Indian earthquakes. This method is an elastic dynamic analysis approach that relies on the assumption that dynamic response of the structure may be found by considering the independent response of each natural mode of vibration and then combining the response of each in same way. This is advantageous in the fact that generally only few of the lowest modes of vibration have significance while calculating moments, shear and deflections at different levels of the building.

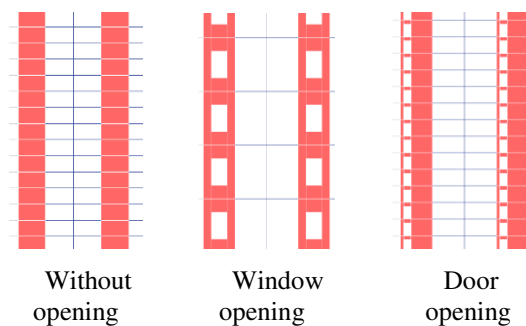


Figure 2. Part plan elevation.

Details of building load configurations as per IS 875, IS 1893 (PART 1) :2016, shown in Table

Table 1. Load Configuration

Description	Loadings
Self-weight	As per Etabs
Floor Finish	1 kN/sq.m
Water proofing on Terrace	3 kN/sq.m
Live loads	2 kN/sq.m
Non-Structural wall load	8.7 kN/m
Live load on Staircase	3 kN/sq.m
Live load on Terrace	3 kN/sq.m
Importance factor	1.2
Type of Soil	I (HARD)

Response Reduction Factor	4
Seismic zone	III
Zone factor	0.16
Wind speed V_b	44 m/sec
Terrain Category	3
Risk coefficient k_1	1
K_2	1
K_3	1

V. RESULTS

The structure has been studied for parameters like bending moment, shear force and deflection for without openings and two different types of openings i.e. door and window on sample model for different height. As in tall building wind load is governed, so wind load is considered as

lateral load for analysis purpose and the result is compared for along X any Y direction. The models are,

Model 1 is without opening.

Model 2 is with window opening.

Model 3 is with door opening.

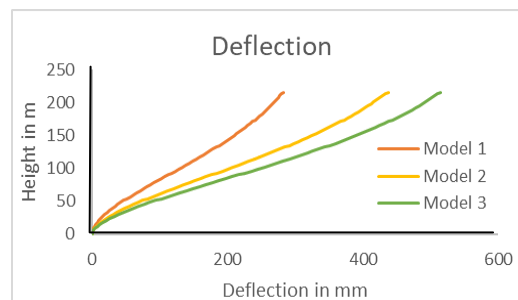


Figure 3: Deflection for wind Along X for G+70

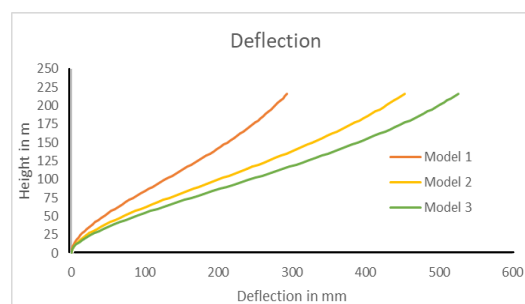


Figure 4: Deflection for wind Across X for G+70

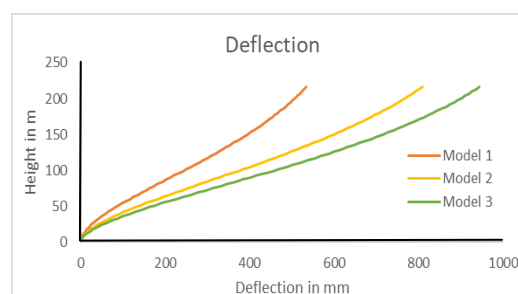


Figure 5: Deflection for wind Along Y for G+70

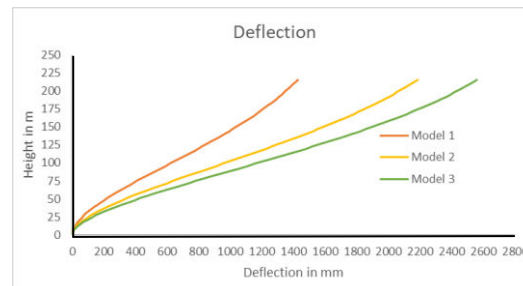


Figure 6: Deflection for wind Across Y for G+70

In 70 story building the deflection is more in across than in along direction. Due to opening of different sizes the percentage increasing in along X is 54.61% in model 2 and 82.19 % in model 3 as compared to model 1. Similarly, for across X the percentage increase in deflection is 54.20% in model 2 and 79.12% in model 3 as compared to model 1 and the percentage increasing in along Y is 51.32% in model 2 and 76.63 % in model 3 as compared to model 1. Similarly, for across Y the percentage increase in deflection is 53.11% in model 2 and 79.50% in model 3 as compared to model 1.

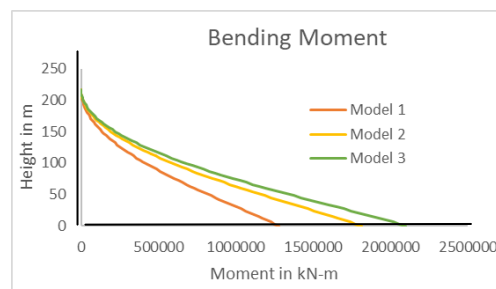


Figure 7: B.M for wind Along X for G+70

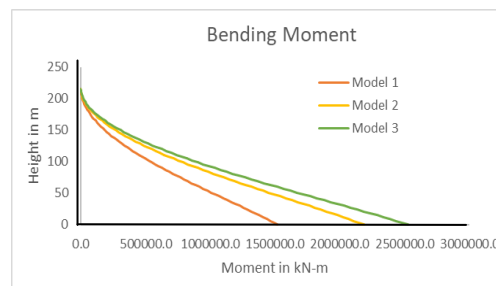


Figure 8: B.M for wind Across X for G+70

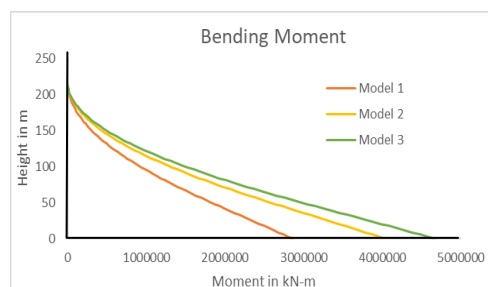


Figure 9: B.M for wind Along Y for G+70

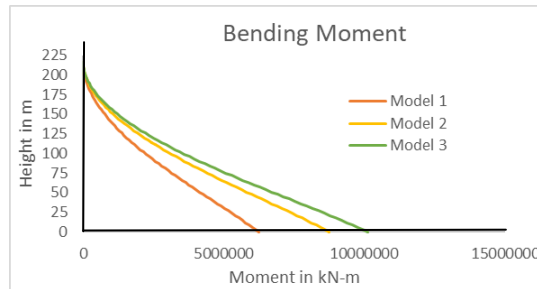


Figure 10: B.M for wind Across Y for G+70

In 70 story building the bending moment is more in across than in along direction. Due to opening of different sizes the percentage increasing in along X is 29.42% in model 2 and 39.11% in model 3 as compared to model 1. Similarly, for across X the percentage increase in bending moment is 30.56% in model 2 and 39.80% in model 3 as compared to model 1 and the percentage increasing in along Y is 29.21% in model 2 and 38.81% in model 3 as compared to model 1. Similarly, for across Y the percentage increase in bending moment is 28.76% in model 2 and 38.33% in model 3 as compared to model 1.

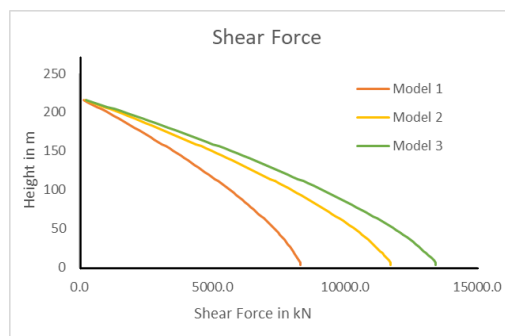


Figure 11: Shear force for wind Along X for G+70

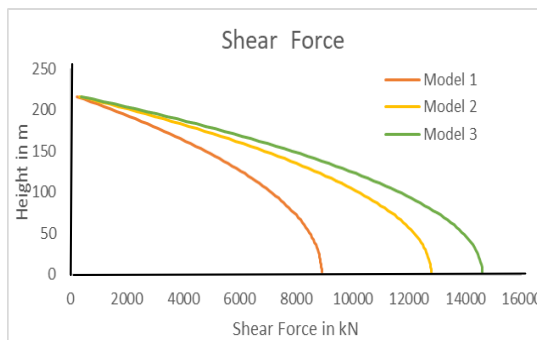


Figure 12: Shear force for wind Across X for G+70

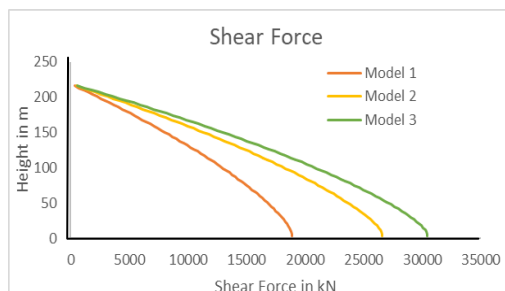
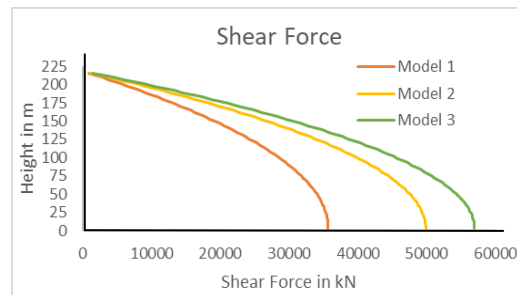


Figure 13: Shear force for wind Along Y for G+70

**Figure 14: Shear force for wind Across Y for G+70**

In 70 story building the shear force is more in across than in along direction. Due to opening of different sizes the percentage increasing in along X is 29.051% in model 2 and 38.05% in model 3 as compared to model 1. Similarly, for across X the percentage increase in Shear force is 30.36% in model 2 and 39.02% in model 3 as compared to model 1 and the percentage increasing in along Y is 28.98% in model 2 and 37.97% in model 3 as compared to model 1. Similarly, for across Y the percentage increase in Shear force is 28.41% in model 2 and 37.31% in model 3 as compared to model 1.

VI. CONCLUSIONS

Based on the results it can be concluded that

1. It is observed that deflection, bending moment, and shear force increases as the opening in shear wall increases.
2. The presence of openings in shear wall decreases the strength and rigidity of the shear wall depending on the sizes and shapes of opening.
3. Deflection, bending moment, and shear force is observed more in model 3 having more area of openings.
4. It is observed that as the height of building goes on increasing forces in Across direction becomes more critical than in Along direction and therefore shear force, bending moment and deflection found more in G+70 in across direction.
5. The deflection for G+70 exceeds the permissible limits for wind in across and along direction.
6. Hence it can be concluded that the opening in shear wall should be avoided or it should be of minimum in size and numbers as the height of buildings goes on increasing.

REFERENCES

Research paper

- 1] M. Shariq, H. Abbas, H. Irtaza, M. Qamaruddin, "Influence of openings on seismic performance of masonry building walls, Journal of Building and Environment Engg, Vol 43, March 2007, PP. 1232–1240
- 2.] G. Ozpalkanlar, "Evaluation of Earthquake Response Analysis Methods for Low-Rise Base Isolated Buildings" World Conference on Earthquake Engineering, oct.2008.
- 3] Hamdy H. A. Abd-el-rahim, "Influence of Requisite Architectural Openings in Shear Walls Efficiency" Journal of Engineering Sciences, Vol. 38, March, 2010. PP. 421-435
- 4] Vinayak Kulkarni, Swapnil Cholekar, Hemant Sonawadekar, "Effect of openings of shear wall in high rise buildings" Int. Journal of Applied Sciences and Engineering Research, Vol. 3, May2014, PP. 776- 781
- 5] Pooja Hegde, "Effect of Base Opening in Reinforced Concrete Shear Wall" The International Institute for Science Technology and Education" Vol. 6 2014.
- 6] Vishal A. Itware, Dr. Uttam B. Kalwane "Effects of Openings in Shear Wall on Seismic Response of Structure" Int. Journal of Engineering Research and Applications, Vol. 5, Issue 7 (Part - 1) July 2015, 41-45
- 7] Bhargulgi H. Gandhi, "Effect Of Opening On Behavior Of Shear Wall" International Journal For Technological Research In Engineering, Vol. 3, Dec-2015, 875-878
- 8] Ruchi Sharma, Jignesh A. Amin, "Effects of opening in shear walls of 30- storey building" Journal of Materials and Engineering Structures, March 2015, 44-55
- 9] Aarthi Harini, G. Senthil Kumar, "Behavior of R.C. Shear Wall with Staggered Openings under Seismic Loads" International Journal For Research And Technology, Vol 2, March 2015, 91-96
- 10] Ashwani Singh, "Effect of Shear Wall on Seismic Performance of RC Open Ground Storey Frame Building" May2015.



- 11] Anand S. Attal, Jyoti P. Bhusari "Effect of Opening in Shear Wall " International Journal of Engineering Research, Vol 5, Feb. 2016 , 572-577.
- 12] Reshma Chavan, " Effects Of opening in Shear Wall" IORS Journal of Mechanical and Civil Engineering, Vol. 13, Feb-2016, PP. 1-6
- 13] Aniket . T. Patil, Sachin B. Kadam, "Behaviour of Multi-storey Building under the effect of Wind and Earthquake for Different Configuration of Shear Wall" Journal of Civil Engineering and Environmental Technology, Vol. 3, June-2016, PP. 558-563.
- 14] S. H. Jagadle, "Analysis of Various Thickness of Shear Wall with Openings and Without Openings and their Percentage Reinforcement" International Journal of Research in Engineering, Science and Technologies, Vol. 2 March 2016, PP. 212-218.
- 15] Swetha K. S, "Effects of Openings in Shear Wall, International Research Journal of Engineering and Technology, Vol. 4, May 2017.
- 16] Mohamed Safeer Kodappana, "Study on Dynamic Behaviour of Shear Wall with Staggered Openings in Irregular R.C. Framed Structures" International Journal of Scientific Research in Science, Engineering and Technology, Vol. 3, April 2017, PP. 561-567.
- 17] Sruthy K.S., "Effect of Opening On Reinforced Concrete Coupled Shear Wall" International Journal of Science and Scientific and Engineering Research, Vol.8, Nov. 2017, PP.42-51.

I.S. Codes

- 18] IS456 (2000) - "Plain and Reinforced Concrete – Code of Practice".
- 19] IS1893 (2016) Part I, 'Criteria For Earthquake Resistant Design of Structures', Bureau of Indian Standards, New Delhi, India.
- 20] IS 875 Part 1 (2015) - "Code of Practice for Design Loads (Other than Earthquake) for buildings and Structures ", Part 1- Dead Loads
- 21] IS 875 Part 2 (2015) - "Code of Practice for Design Loads (Other than Earthquake) for buildings and Structures ", Part 2– Imposed Loads.
- 22] IS 875 Part 3 (2015)- "Code of Practice for Design Loads (Other than Earthquake) for buildings and Structures ", Part 3- Wind Loads
- 21] IS 13920-2016-Ductile Design and detailing of reinforced concrete structures subjected to seismic forces.

url links

https://www.google.co.in/search?q=shear+wall+system&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjFsfG5NDcAhXMWysKHRwiDbYQ_AUICigB&biw=1242&bih=602#imgrc=0aW_XQ6Y-feYIM:



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