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A Review of "Effect on Behaviour of Structure with types of opening at multiple locations with variation in the size of the shear wall”

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***Abstract*— over the past few years, there has been a significant increase in demand for high-rise structures due to changing trends such as the desire to own a home and the growing interest in investing in real estate. As a result, it has become crucial to ensure the safety of these buildings. This is particularly important in light of the recent disastrous earthquakes that some countries have experienced in 2023. To ensure earthquake resistance, shear walls are often used to provide strength and stability to the building, help to resist earthquake and wind forces and reduce the sway of the structure. However, functional requirements may necessitate the addition of openings in the shear walls, which can have an impact on the behaviour of the structure. This research paper aims to analyse the effects of different types of openings at multiple locations and with varying sizes of shear walls on the behaviour of an eight-story RCC residential building, using the ETABS software. The study considers shear walls with different opening arrangements, including horizontal, vertical, and zigzag configurations, with openings of varying sizes and positions. The analysis focuses on key parameters such as base shear, storey displacement, storey drift, storey acceleration, and time period, providing valuable insights into how different opening arrangements and sizes can impact the behaviour of the structure. By better understanding these effects, designers and engineers can make more informed decisions about the design and construction of high-rise structures, ensuring their safety and stability in the face of changing circumstances and potential natural disasters.**

***Keywords*— shear wall, Openings, Box shape, C shape, ETABS, High rise, storey drift, base shear.**

I. INTRODUCTION

Shear walls play an important part in enhancing the rigidity and lateral load resistance of buildings. Their primary function is to counteract horizontal forces, such as wind and seismic loads, effectively. These structural elements provide strength, stiffness, and stability, significantly reducing the lateral sway and displacement of tall buildings. By incorporating shear walls into the design, the sizes of beams and columns can be optimized, leading to both economic and stability benefits.

However, the presence of openings in shear walls, such as doors and windows, poses challenges to their structural behaviour. In many cases, the size and location of these openings are determined without considering their impact on the overall structural system. Therefore, understanding the effects of various opening sizes and configurations on shear wall stiffness and seismic response is crucial for obtaining suitable and efficient shear wall designs.

This research paper aims to probe the influence of openings in shear walls on their stiffness and seismic performance. Using Etabs software will be conducted on an 8-story frame shear wall building. The study will explore different opening sizes and configurations to determine their effects on structural behaviour. Including stiffness and seismic responses. By comparing the results with a shear wall with different openings, valuable insights will be gained to guide the optimal design of shear walls in terms of various parameters such as storey drift, storey stiffness, and lateral displacement. The paper will also bandy the significance of shear walls in high seismic prone areas, emphasizing their part in providing strength, stiffness, and stability against lateral loads. Different shapes of shear walls, including L-shaped, box-shaped, Rectangle-shaped, and C-shaped, will be examined for their effectiveness in high-rise buildings. The variations in storey drift, storey stiffness, and lateral displacement among different shear wall configurations will be analysed, highlighting the advantages of incorporating shear walls in modern construction, especially for apartments and office buildings.

Overall, this research aims to contribute to the understanding of shear wall behaviour and guide the design process for optimizing their configuration and performance. By evaluating the effects of openings and different shear wall shapes, this study will provide valuable insights for engineers and architects in constructing structurally efficient and stable buildings, considering both economic and safety aspects.

***A. Aim*:**

The project aims to probe the goods of openings in shear walls on the structural behaviour of a structure. This study will involve the perpetration of various types of openings at different locations within the shear wall and exploring the influence of different shear wall shapes on the overall structural response

***B. Objective*:**

1) Study the parameters includes the storey drift, storey acceleration and time period, base shear and storey displacement of the structure with an opening in the shear wall.
2) To study the parameter storey drift, storey acceleration and time period, base shear and storey displacement of the most optimal arrangement of openings within the shear wall, as we explore the effects of varying the percentage of opening and the shape of the shear wall.

II. LITERATURE REVIEW

Ashok Kankuntla, Prakarsh Sangave, Reshma Chavan [1]
A study on reinforced concrete buildings using direct finite element analysis was carried out by altering the placements of shear walls with an orifice for different story heights. The shear wall opening varies in size and shape, and the structure are examined for extremely high earthquake loads (seismic zone V). Various criteria, including column moment and axial force, are compared.

Pranav Patil1, Pro. A. S. Pat [2]
A study was conducted on G+10 structural analysis is conducted by the linear static response spectrum method by considering different combinations of openings and sizes using ETABS software. As per the studies, they concluded the size of openings plays a significant part in impacting the bending moment and axial forces within a structure. As the sizes of openings increase, both the bending moment and axial forces tend to increase. This can be attributed to the drop in the stiffness of the structure's stories. In the case of regular opening arrangements, the bending moment gets a notable increase of 25% compared to a column with a shear wall but no opening. This increase is observed when the openings are arranged in a regular pattern. Still, for irregular opening arrangements, the bending moment increases by roughly 30% compared to the column without an opening. Similarly, for regular opening arrangements, the axial force increases by around 38% compared to a column with a shear wall and no opening. This increase is calculated grounded on the axial force of the column without an opening. In the case of irregular opening arrangements, the axial force gets an advance increase of about 46% compared to the column without an opening. also, for a given irregularity, particularly in model 8 where the irregularity is maximized, there is no significant variation observed in the values of bending moments and axial forces between regular and irregular openings of the same sizes. The largest variation in bending moment values between regular and irregular openings of the same size is observed for the opening size of 450X900mm, which amounts to roughly 10%. Likewise, the maximum variation in axial force values between regular and irregular openings of the same size is observed for the opening size of 900X1200mm, which accounts for roughly 6%. Amongst all the models, except for the reference model (model 1), the structure or model with a shear wall containing an opening size of 600X600mm arranged regularly demonstrates superior performance.

Vishal A. Itware, Dr.Uttam B. Kalwane [3]
By comparing the exploration, it can be concluded that the size and placement of openings in reinforced shear walls have an impact on the seismic responses and stiffness of structures. The strength of the wall decreases more snappily the closer the openings are to the wall's edge. In addition, as a structure height rises, openings in the shear wall should be avoided or maintained to a minimum in size and volume.

Ehsan Borbory [4]
The effectiveness and responsibility of the steel plate shear wall system in various seismic zones and under varied loading Circumstances should be validated through further exploration and testing. It is important to look into how various opening types, such as their shape and exposure, affect the system stiffness and seismic performance. In addition, it is important to assess how well the system will work in actual construction system from a cost and practicality perspective. To fully comprehend and improve the design and performance of reinforced shear walls with orifice, more thorough exploration is needed.

Binitha Gopal, Aiswarya [5]
Further exploration and testing should be conducted to validate the effectiveness and trustability of the steel plate shear wall system in various seismic regions and under different loading conditions. The impact of different types of openings, such as shape and exposure, on the stiffness and seismic performance of the system should also be delved. Also, the cost-effectiveness and practicality of enforcing the system in real-world construction system should be estimated. Overall, more comprehensive studies are demanded to completely understand and optimize the design and performance of reinforced shear walls with openings.

Seyed M. Khatami, Alireza Mortezaei, Rui C. Barros [6]
The full shear wall of the 3D structure was able to absorb more energy when compared to before delved performance of shear walls with openings. The results of the alternate exploration showed that, although openings dwindle the side carrying capabilities of shear walls and panels, there was a detention between the panel with the opening and the entire panel at the yielding cargo position. These specifics demonstrate how shear walls and panels with orifice bear and serve, which lessens their capability to support side loads.

AlfiaBano [7]
In the analysis conducted using ETABS, considering different structure shapes such as L-shaped, I-shaped, Rectangle-shaped, and C-shaped, it was noted that the performance of the I-shaped shear wall surpasses that of all other shear wall shapes.

Ankit Dane, Umesh Pendharkar [8]
Grounded on the study findings, it can be inferred that the optimal effectiveness of shear walls is achieved when they are placed on the upward pitch side.

Ashwini A. Gadling, Dr P. S. Pajgade [9]
The positioning of the shear wall has a direct impact on the distribution of forces, making it crucial to place the wall appropriately. When the dimensions of the shear wall are larger, it absorbs a significant portion of the horizontal forces. By strategically locating shear walls, the displacements caused by earthquakes can be substantially reduced. Buildings that incorporate openings in shear walls experience greater storey drift compared to those without openings. The presence of openings in shear walls directly affects the time period of the structure, with an increase in the area of openings leading to a longer time period.

Kajal Patil, Dr. T. G. Shende [10]
Comparing the various issues they observed that the c and l shape is optimal placement for shear walls. As much as the angle increases axial and shear force, and bending moment also increases Shear walls contribute significantly to the structural integrity, particularly as the pitch angle rises, as they effectively offset seismic forces and minimize overall structural deviation. Incorporating shear walls enhances the seismic performance of the structure. In terms of results, the C and L shapes, specifically with 15 and 30-degree angles for shear walls, demonstrate superior performance when compared to the 45-degree T-shaped shear wall. Shear walls fortify the fringe of the structure, offering protection against pitches.

Mr. Amey Dhondopant Kulkarni [11]
Upon analyzing all the structure of blockish shape and different story heights, it was observed that the R/40/20/2 combination yields the most stable and optimal results for the structure. Also, when considering all the C-shaped structure, it was set up that the C/40/20/2 combination provides the most stable outcomes in terms of top-storey displacement and base shear. The attained results indicate that, as the height of the structure increases, incorporating confined plan shapes with a moderate percentage of shear walls yields superior results compared to other plan shapes. Confined plan shapes contribute to higher stability against top storey displacement, while not significantly impacting the base shear.

Kashyap Shukla, Nallasivam .K. [12]
The study does not support the notion that walls placed at the centre position constantly parade superior performance. Model-8, for ex, demonstrated comparatively poor performance when subordinate to lateral loads in the X-direction. This finding highlights the significance of wall arrangement direction in impacting the structural response. The study also reveals that structure with corner-located walls are more susceptible to wind and earthquake loads compared to buildings with properly positioned central walls or walls situated at the edges. Structure with walls at the centre and edges prove to be more effective as compared with walls solely located at the edges.

III.MODELLING

We prepared the residential building structural plan and the detailing of the structural plan is shown below

TABLE I

DETAILS OF THE STRUCTURAL PLAN

Sr. No	Model description	Dimensions (mm)
1	Plan dimension	15230x15230
2	The thickness of the shear wall core	300
3	The thickness of the shear wall normal	250
4	Thickness of wall	150
		200
5	Size of beam	230x450
		300x600
6	Size of column	230x450
		300x600
7	Floor-to-floor height	3000

TABLE 2

PROPOSED OPENING SIZES

Sr. No	Dimensions of openings	Percentage of opening (m)
1	0.9X1.2	7.2%

2	1.2X1.2	9.6%
3	2X2	26.66%
4	0.8X2	6.4%
5	1.2X2	16%
6	1.2X2.2	17.6%

TABLE 3

TYPES OF SHEAR WALL

Sr. No	Shapes of shear wall
1	Rectangular shape type
2	L Shape type
3	C Shape type
4	Box shape type

IV. ANALYSIS

The structural building will be analysed using ETABS software. The required inputs are provided below.

Seismic data –
Seismic Zone- II
Zone factor- 0.16
Soil type- 2
Importance factor- 1
Response reduction factor- 5

Loads-
SDL= Floor finish- 1.5kn/m2
Staircase load- 5.5kn/m2
Live load = for room floors- 2kn/m2
Unit Wt. of concrete- 25kn/m3
Unit Wt. of Brick material- 20kn/m3
Concrete grade – Beam M 20, Column M25
Steel grade – Fe415 and Fe 500
Poisons ratio-0.2

V. CONCLUSIONS

Grounded on the study conducted on structures with shear walls having openings using ETABS software and conclusions can be drawn. The strength and severity of shear walls drop with the presence of openings, and the size and shape of the openings affect this reduction. Larger openings affect in increased column moment and axial force due to the dropped stiffness of shear walls. The length of the shear wall has a diminishing effect on the opening's influence, while the height and width of the openings do have an impact. The stiffness and response of structures with openings are more affected due to the size of the openings rather than their locations when the opening area is less than or equal to 15% of the solid shear wall area. However, when the opening area exceeds 15% of the solid wall area, the opening locations in shear walls significantly impact the structure's behavior. The presence of shear walls, both external and internal, with openings, reduce the column moment and axial force compared to structures without shear walls or with core walls alone. The Response Spectrum Method shows lower forces in comparison to the Seismic Coefficient Method.

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REFERENCES

[1] Ashok Kankuntla, Prakash Sangave, Reshma Chavan Jan. - Feb. 2016, ' Effects of Openings in Shear Wall', IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 13, Issue 1 Ver. II (Jan. - Feb. 2016), PP 01-06.

[2] Pranav Patil1, Pro. A. S. Patil2, June 2021, 'effect of the opening of shear wall on the column of building', International Research Journal of Engineering and Technology IRJET.

[3] Vishal A. Itware, Dr Uttam B. Kalwane, 2015, "Effects of Openings inShear Wall on Seismic Response of Structure", International Journal ofEngineering Research and Applications, Vol. 7, 2015, pp. 41-45.

[4] Ehsan Borbory, February 2020, 'Openings effects in reinforced concrete shear walls; a literature review on experimental and finite element studies', International Journal of Engineering and Applied Sciences (IJEAS) ISSN: 2394-3661, Volume-7, Issue-2.

[5] Binitha Gopal, Aiswarya, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

[6] Seyed M. Khatami, Alireza Mortezaei, Rui C. Barros, Comparing Effects of Openings in Concrete Shear Walls under Near-Fault Ground Motions

[7] Alfia Bano April 2019, International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8, Issue- 6S4, of Engineering Research and Applications ISSN: 2248-9622, Vol. 5, Issue 7, (Part - 1), pp.41-45.

[8] Ankit Dane, Umesh Pendharkar December 2019, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249-8958 (Online), Volume-9 Issue-2.

[9] Ashwini A. Gadling. December 2016,' Review on Analysis and Design of RCC Shear Walls with and Without Openings', Int.Journal of Engineering Research and Application ISSN: 2248-9622, Vol. 6, Issue12,(Part-2) December 2016, pp. 69-72

[10] Kajal Patil, Dr T. G. Shende, June 2022, 'A Comparative Study Of Different Shapes Of Shear Wall In Asymmetrical Building On Different Slopping Ground', a Volume 10, Issue 6 June 2022, IJCRT, ISSN: 2320-2882

[11] *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification*, IEEE Std. 802.11, 1997. Mr Amey Dhondopant Kulkarni,2016, 'Assessment of location and optimum percentage of the shear wall for typical plans' IJEDR, Volume 4, Issue 3,| ISSN: 2321-9939.

[12] Kashyap Shukla, Nallasivam .K., Effective Location of Shear Walls in High-Rise RCC Buildings Subjected to Lateral Loads.