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# A Review Paper on Seismic Performance Evaluation of an Irregular Building with Lateral Force Resisting System

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**Abstract:** Shear walls are strong vertical diaphragms that are used in building construction to transfer lateral stresses from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. A reinforced concrete wall is an example. The most frequent loads that shear walls are designed to support are wind and earthquake loads. We will learn about shear walls and their numerous openings in this assignment. The previously reviewed materials indicate that a shear wall with a particular type of opening behaves in another manner. The opening can vary in size, proportion to the size of the wall that it occupies, form, and position.Shear wall variation will be based on thickness. Additionally, we'll research variables including earthquake stresses, storey drift, storey displacement, and lateral stiffness.The behaviour of the shear wall can be deduced after taking into account all these factors in relation to the wall's opening.

**Keywords—** Shear wall openings, shape of openings, seismic loads ultimate strength, economy.

## I. INTRODUCTION

A structural component created to withstand lateral forces is the shear wall. From a structural standpoint, the shear wall is a structural element that transmits both lateral and horizontal loads. Column and shear walls differ primarily in how they react to applied loads and how they operate. It will typically be offered when the structure is subject to wind and seismic forces. They are constructed from of correctional facilities (concrete masonry units), wood, and concrete. The more stable structural systems are shear walls. Due to the fact that their supporting area (the combined cross-sectional area of all shear walls) is greater than the building's overall plan area compared to RCC framed constructions, it is considerably more.

**Need of shear wall:**

Shear walls are made to withstand vertical loads and gravity in addition to its own weight and the weight of other people.

They are made to withstand movement loads as well as lateral loads from cyclones and earthquakes. The walls are structurally interwoven with the roofs, floors, and other lateral walls that cross at right angles to give the building structures three-dimensional stability. Systems with shear walls are more stable. Due to the fact that, in contrast to RCC-framed buildings, their supporting area (total cross-sectional area of all shear walls) is considerably more than the entire building designs area. The uplift forces generated by the pull of the wind must be resisted by walls. Walls must withstand the shear stresses that attempt to collapse them. The wind's lateral force, which tries to push the walls in and pull them away from the building, must be resisted by the walls. Shear walls give buildings incredible strength and stiffness in the direction of their orientation, which significantly reduces the building's lateral sway and, as a result, prevents damage to the building's structure and contents. Shear walls are subject to significant overturning effects because they are subject to substantial horizontal earthquake stresses.

**Function of shear wall:**

1. It significantly reduces lateral displacement/story displacement/story drift.

2. Reduces the time period of vibration of the building.

3. Reduces moments and induced torsion during earthquakes.

4. Increases stiffness of the building

5. Strength and Stiffness

**Forces acting on shear wall:** Shear walls withstand two kinds of pressure: bending forces uplift forces, etc. Horizontal forces are transferred to the shear wall by connections to the structure above. This Transfer generates shear forces between the top and bottom shear wall connectors that extend the length of the wall. The wall will break or "shear" apart if the strength of the lumber, sheathing, and fasteners cannot withstand these shear forces. Because the horizontal forces are applied to the top of shear walls, uplift forces are present. These uplift forces aim to drive one end of the wall down while lifting the other. The uplift force might be so strong that it knocks a wall over. Tall short walls experience stronger uplift forces than low long walls. Because shear walls are helped by gravity stresses to resist uplift, bearing walls experience less uplift than non-bearing walls. When the gravity loads are not sufficient to withstand the entire uplift, shear walls require holdown devices at each end. The required uplift resistance is subsequently provided by the holdown device.

## II. LOADS ACTING ON SHEAR WALL

1) **Wind Load:** Wind pressures occurring on the building surfaces during a wind event are what actually cause wind load. Because the pressure or load develops with the square of the wind velocity (i.e., doubling the wind speed results in a four-fold increase in wind load or pressure), this wind pressure is essentially a function of the wind speed.

2) **Earthquake Load:** Ground motions (accelerations), which are similarly variable or dynamic in nature—indeed, they reverse direction somewhat chaotically—are what cause earthquake forces to be felt by a building.

## III. LITERATURE REVIEW

- **Sharmin Reza Chowdhury, M.A.Rahaman, M.J.Islam, A.K.Das (2012):** This paper makes an attempt to use finite element modelling to analyse and investigate the behaviour of a shear wall with an opening under seismic load actions. This research is being conducted on 6-story frame-shear wall buildings using linear elastic analysis with finite element software, ETABS, under earthquake loads in equivalent static analysis. Using the finite element approach and ETABS software, this study reveals that the size of the openings as well as their locations in the shear wall affect the stiffness and seismic responses of structures. It is prudent to state that proper analysis should be performed prior to introducing openings in shear walls.

- **Dr. Suresh Borra1, P.M.B. Rajkiran, Nanduri2, Sk. Naga Raju3 Dr. Suresh Borra, P.M.B. Rajkiran Nanduri, Sk. Naga Raju3:** The primary goal of this paper is to believe that structural engineers working in the analysis and design of high-rise buildings will benefit from the design shear wall using EBCS:2-1995 and EBCS:8-1995 codes and its results. The preliminary sizes are analysed to see if the design criteria are met. If not, an analysis of the modified structure is performed to improve its agreement with the requirements, and the process is repeated until a design within acceptable limits is obtained. Starting the process with the best possible selection of members results in the iterative process quickly converge to the desired solution.

- **P. P. Chandurkar and Dr. P. S. Pajgade (2013):** This paper presented an investigation into the location of shear walls in multi-story buildings. The effectiveness of the shear wall had been determined. four different models were used to conduct research. The first model was a bare frame structural system, and the other three were dual type structural systems. An earthquake load was applied to a ten-story building located in zones II, III, IV, and V. Parameters such as lateral displacement and story drift. In both cases, the total cost for the ground floor was calculated by replacing the column with a shear wall.

- **B. Karnale and Dr. D. N. Shinde:** 'In this paper, researchers presented the results for various shear wall configurations for 6 (Low Rise) and 14 storeys (High Rise) buildings. They are also RCC shear wall functions and advantages are defined. Using ETABs software, a comparative analytical study was conducted in which 6 models for 6 and 14-story buildings were analysed, each with different combinations of shear wall placement. The results were compared based on the effect observed due to the height of the structure with a shear wall. The analysis for lateral loading was performed in this dissertation. The loads used were equivalent static and earthquake loads. The results of an analysis that provides topically base shear, deflection, and storey drift are plotted to compare and understand the behaviour of RCC.

- **Varsha Patil, Devikrishna P.M (2014):** Review of relevant literature to learn about the history of shear walls. The research contributions that are directly relevant are discussed in greater detail. Some historical works that have greatly contributed to the understanding of shear wall design are also described. literature from books, codes and research papers gives proper designing, positioning and introducing the shear wall in building. A building is made more strong to resist earthquake. Even though there are many methods for dissipating earthquake energy, shear walls are observed to be simple, efficient, economical and long lasting.

- **G. Muthukumar and Manoj Kumar, (2014):** The dynamic behaviour of shear is studied in this paper. Nonlinear finite element analysis (using) was used to study the wall at various opening locations. Degenerated shell element) using the assumed strain method. Using the plasticity approach, only material nonlinearity has been considered. The time history responses have been plotted for all opening cases with and without ductile detailing. The analysis has been done for different damping ratios.

- **K. Marsono and S. Hatam:** This paper evaluated the behaviour of coupling beams in a concrete shear wall with rectangular and octagonal openings. To increase the strength of coupling beams, this study suggests adding haunches to the corners of rectangular openings and forming octagonal openings. In terms of coupling beam behaviour under cyclic load, the experimental results of a shear wall with a single band of rectangular and octagonal openings were compared. The findings show that coupling beams in shear walls with octagonal openings are stronger than coupling beams in shear walls with rectangular openings.

- **T. Dadayan and E. Roudi (2014):** FEM (Finite Element Method) models were used in this study to investigate the stress-strain state of RC wall-frame buildings with various openings in the walls under the action of seismic forces. The paper took the Building Code of Armenia (BCA) into account when limiting the size and location of openings. During practise, eight different schemes for openings in shear walls were considered. Some numerical analysis was performed to demonstrate that in RC walls where the length of the openings exceeds their length by more than 50%, significant increases in stresses occur in both the walls and the columns.

- **L. Gong, J. Chen and Y. Su (2014):** The research findings on shear walls with opening at home and abroad were summarised, and seismic behaviours were induced and analysed. The researchers discovered some issues that need to be addressed, such as (1) shear capacity and lateral stiffness of the shear wall are reduced due to the openings, and ductility and energy dissipation capacity can be improved. The seismic behaviour of the shear wall will also be influenced by the frame constraint, opening size, and location. (2) When compared to conventional shear walls, research on prefabricated composite shear walls with boundary frames and openings has become in short supply.

- **S. K. Mutwalli and Dr. S, Azam ( 2014):** This study presented a procedure for estimating seismic performance of high-rise buildings using the capacity spectrum method. Buildings with thirty stories in three dimensions ETABS, a structural analysis tool, was used to model and analyse the structure. The building's analytical model includes all important components that influence the structure's mass, strength, stiffness, and deformability. Seismic analysis was performed using both linear static, linear dynamic, and non-linear static procedures to study the effect of concrete core wall and shear wall at different positions during earthquake. The deflections at each storey level were compared using the Equivalent static response spectrum method, as well as the pushover method, to determine the capacity, demand, and performance level of the considered building models.

- **M. Mosoarca (2015):** In terms of seismic response, the paper presented the results of theoretical and experimental tests on the failure modes of three types of reinforced concrete shear walls with staggered openings, which were compared to those obtained from walls with vertical ordered openings. Using a calculus programme, the failure modes of the structural walls under seismic stress were identified.

- **Vishal A. Itwar, Dr. Uttam B. Kalwane (2015):** For the parametric study, 6 and 12 storied 7x3 bay apartment buildings with a typical floor plan of 35mx15m and a floor height of 3m with various layouts were used. STAAD pro was used to model the size and location of openings in shear walls. IS 1893 (part 1): 2002 equivalent static analysis was performed on three-dimensional building models. The seismic responses of the investigated structures were compared. According to the findings, for opening areas of 20% of shear wall area, the stiffness of the shear-wall structure is more affected by the size of the openings than their arrangement in the shear walls. The stiffness of the system is significantly affected by the arrangement of openings in shear walls when the opening area exceeds 20% of the shear wall area.

- **J. Ali, A. Bhatti, M. Khalid, J. Waheed and S. Zuberi (2015):** Important aspects of shear wall design discussed in this paper included their placement in the structure and the cross section (i.e. width to thickness ratio) while keeping torsional stresses, economy, and structure ductility in mind. A comparative study was carried out for the Stock Exchange Building in Islamabad using ETABS software by varying the location and cross section of the shear wall.Maximum lateral drift, storey drift, base shear forces, and structure time period were all important parameters to consider. Response spectrum analysis was performed on four cases based on the location of the shear wall, and the best possible case was chosen and compared to the actual building. It was determined that the original location with a 6 inch thick shear wall could have been more economical and ductile than the existing 12 inch thick shear wall.

- **M. Surana, Y. Singh and D. H. Lang, (2015):** The current study employs nonlinear pushover analysis to estimate the seismic performance of shear-walls and shear-wall core buildings designed in accordance with Indian codes. The wide column model and shell element model were validated using experimental results from other reviews of literature. The stiffness obtained from moment-curvature analysis was also found to be in close agreement with the experimental results, whereas the shell element model predicts a high initial stiffness that decreases after cracking and matches the experimental results.

- **S. M. Yarnal, S. S. Allagi, P. M. Topalakatti and A. A. Mulla (2015):** Seismic analysis of shear wall building in zone III (IS 1893: Part 1, 2002) and study for shear walls with various percentages of openings were performed in this research paper. Analytical results for fundamental frequency, base shear, storey drift, shear forces, and stiffness were obtained. The performance of the shear wall was compared to various percentages of shear wall openings. The ETABS 2013 tool was used to analyse the structure in this project. The results show that the storey drift of a building with openings in the shear wall is greater than that of a shear wall without openings.

- **Karthick S, Udaya Kumar S, Geetha G (2016):** The structural aspects of a R.C building with G+32 stories will be studied for lateral forces using structural components such as R.C shear walls and bracings. Non-linear analysis was performed in ETABS 9.7.4 to evaluate component lateral force resistance. The lateral forces are resisted by structural components with increased stiffness, deformability, and decreased drift by providing a shear wall and bracing. Buildings use reinforced concrete shear walls to mitigate the effects of earthquakes. Buildings with shear walls that have been properly designed and detailed have performed admirably in previous earthquakes. For this reason, they are known as braced wall lines in some areas. This type of effective wall is stiff and strong.

- **Swetha K , Akhil P (2017):** The zigzag pattern of openings in shear walls is to be used in The location of openings in the shear wall affects the time period, displacement, drift, base shear, and overall seismic response of the structure, according to this study. practise, because it provides a 4% better performance than other opening arrangements. Shear wall with zigzag openings exhibited 1.35% higher value of time period and storey acceleration when compared to shear wall with vertical and horizontal openings and approximately 3% higher value of time period and storey acceleration when compared to shear wall without opening.

- **Pooja R. Gupta and A.M. Pande (2018):** Study the effect of shear wall location and openings on structural frame behaviour. Shear walls must be placed in both directions because shear walls in one direction can increase moment in the transverse direction. Shear walls at the periphery have been found to be advantageous in terms of displacement reduction. Additional shear walls above the optimum requirement may not be useful in limiting displacements, but they may result in higher costs and unwanted gravity forces. If the shear walls are extended beyond the plinth level up to the foundation level, there is a marginal reduction in lateral displacement.

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## IV. CONCLUSION

The capacity spectrum method was used in this study to estimate the seismic performance of high-rise buildings. Three-dimensional buildings with thirty stories The structure was modelled and analyzed using ETABS, a structural analysis tool. The analytical model of the building includes all significant components that influence the structure's mass, strength, stiffness, and deformability. To study the effect of concrete core wall and shear wall at different positions during an earthquake, seismic analysis was performed using both linear static, linear dynamic, and non-linear static procedures. To determine the capacity, demand, and performance level of the considered building models, the deflections at each storey level were compared using the Equivalent static response spectrum method as well as the pushover method.

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