

# Opening Area usage of Shear Wall Relating to Wall Area Used for Multistoried Building: A Review

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**Keywords—** Earthquake prone zone,  
Multistoried building, Optimum opening, Re-  
-Entrant corners, Shear wall

**Abstract** — In this present era of high-rise buildings and skyscrapers it is obligatory to work on overall shape, plan and structure of building. The building performance under seismic loading is a constraint of various factors comprises of geometry, location and the way of earthquake forces transferred to the ground. The affected zones of higher chances of occurrence of seismic effects with respect to other part of the country may leads to collapse of building under seismic load if they are not provided with and structural strengthening arrangement. However, safety has to be the main criteria when seismic hazard has taken into account in multistoried buildings. In the current study the solution for aforementioned problem is suggested by providing shear wall in a specified ratio with respect to wall area in plan irregularity which helps in resisting lateral load generated by seismic forces. This paper provides the review of research work previously presented by various researchers which shows the further research option.

## I. INTRODUCTION

To make building more appealing various modifications in the shape, size and height etc. are proposed. This will make the building more appealing with respect to the other buildings but sometimes they becomes vulnerable toward various loading conditions which results in either creep or fissure or sometimes collapse for heavier unexpected loading came into effect. The multistoried buildings having number of stories higher than 15 to 20 stories, a simple rigid framed structure is not viable as this does not provides the lateral stiffness required by the system and leads to excessive deflection of the building. To make seismic proof buildings, the architectural features should be minimized up to the desirable limits. This problem is sorted either by increasing the size of members but this have its own limitation for or by making the structure comparatively more stable and resist deformation. Also to overcome this problem various structural elements or are added in frame which will reduce the undesirable and destructive situation. One of these are shear wall which is a vertical RCC member

located in place of normal wall as infill of desired width so as to bear and transfer the seismic effect to foundation and ground. But now a days shear walls are also face some constrains like opening for natural lightening, ventilation, entry or exit, etc. This will affect the strength of shear wall also.

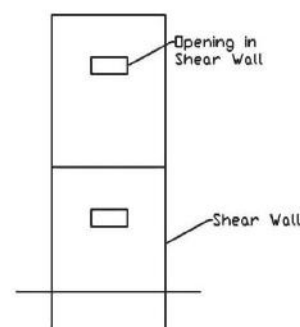


Fig. 1: Multistoried Frame having very small opening of Shear wall relating to Wall Area Used

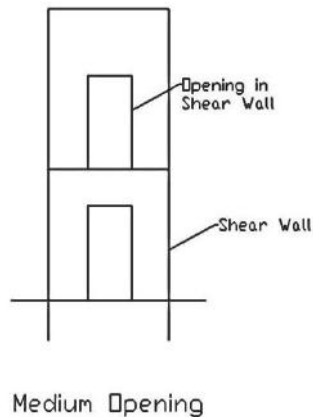


Fig. 2: Multistoried Frame having medium opening of Shear wall relating to Wall Area Used

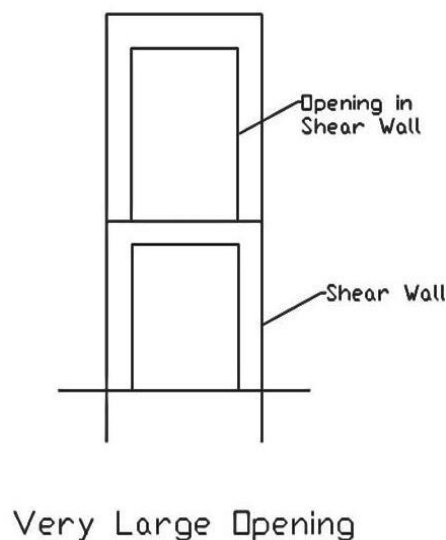


Fig. 3: Multistoried Frame having very large opening of Shear wall relating to Wall Area Used

## II. CONCEPT OF OPENING PROVIDED IN SHEAR WALL

Cantilever shear walls always act as coupled shear walls consist of openings and have connected with coupling beams. Multistoried buildings may have openings in rows which is essential for doors, ventilations, openings and windows in both internal and external walls. As per architectural point of view, the opening has provided. This opening has to be decided within the limit to secure the structural resisting components by adverse seismic effects. Shear walls are especially important in high-rise buildings subject to lateral wind and seismic forces. Generally, shear walls are either plane or flanged in section, while core walls consist of channel sections.

## III. REVIEW OF LITERATURE

The researchers presented the effect of opening in shear wall with variable size and shape in the various seismic parameters of the buildings. For analysis a fifteen storey building is chosen for study with variable location of shear wall with the size of opening. Various models are framed with variable location from internal to external shear wall and also core shear wall and in combination. Opening with rectangular and square shape is also analyzed for windows of different sizes and also doors of different sizes. The results of the study shows that column moment and axial force are reduced for both internal and external shear wall as compared to core type and core with internal type. Forces are predicted lesser by seismic coefficient method as compared to response spectrum method. Strength and rigidity of shear wall is decreases with opening extent (Ashok kankuntla, Prakarsg Sangave, Reshma Chavan).

Authors made an effort for seismic analysis with shear wall at center core and periphery of each side in the center of shear wall. Behavior of Multistorey building is analyzed for dynamic analysis by Etabs software. A forty storey building is taken for analysis with variable position of shear wall from center core to periphery of building with an opening size of 2m x 1.2m. The conclusions of the study are effects of displacement and drift are considerably lesser in case of outermost perimeter shear wall. Concentrations in stresses are increased by providing opening. Also performances are better in case of building with shear wall at the center core and at the center of periphery for the parameters storey drift and storey displacement also in this case base shear and stiffness is highest (Mahdi Hosseini, N. V. Ramana Rao).

Numerous studies are carried out on a static loading test of RC shear wall with openings carried out to check the variable number and layout of openings. The entire specimen has the same equivalent perimeter ration of openings that is 0.4. The specimens are designed to simulate the lower two storey of multistorey shear wall in multistorey building and scaled to one third of the prototype walls. The analyses are carried out with Finite element method and various models are compared against different constraints. The results of the study are the shear strength for RC shear wall with opening is within the safety limit, but its predictive accuracy is not so accurate. The axial deformation and stress distribution at the bottom of shear wall with openings were variable at columns, wing wall (Masoto Sakurai, Hiroshi Kuramoto, Tomoya Matsui, Tomofusa akita).

The aim of this study is to examine the effect of opening area to wall area ratio against various seismic parameters and yield resistance of the system. The

experimental study is done for multistorey building for various loading systems with various modes framed with opening of variable size and shape. The analyses were performed by ANSYS software and the non-linear static analysis known as hysteresis. The result of the study shows better performance by decreasing the area so that the system's final energy absorption is increased in cyclic and collateral hardness. Also by analyzing the surrender the decrease in opening area and the way in which succession begins enhance the system's performance and at some specific point stress concentrations are prevented (Peyman Ghaderi, Allaedin Behraves).

The studies in the paper are carried out on a 30 storey building with regular square shaped structure having shear walls are placed at all four sides at the periphery. Two cases are taken for analysis under this in first case models are compared for with and without opening with variable size without incorporating the volume of shear wall and in the second case various models are compared with variable size of openings provided in the center of the shear wall by incorporating the volume of shear wall by increasing the boundary element dimensions. Analyses for various parameters are done by both response spectrum method and time history analysis method. The results of the study reveals that without considering the volume of shear wall and providing opening decreases the stiffness in lateral dimensions and so increases the lateral displacement and inter storey drift of the building. Also for second case as compared to first one the stiffness is increases (Ruchi Sharma, Jignesh A. Amin).

The work of the author in his study is to analyze the symmetric multistorey building with and without shear wall in a bare frame structure. Total 12 cases has taken for analysis and from that 10 cases are only for different types of shear wall location position and comparing all along with static seismic analysis. Shear wall has used in core of the building and periphery of the building. Figure 4 describes the best way to show how the seismic base shear of all the 12 frames behaves comparatively. It has been proved that the core location of the shear wall has been the best location for the stiffness requirement of the multistoried building that has been discussed in the paper for seismic Zone V (Sagar Jamle).

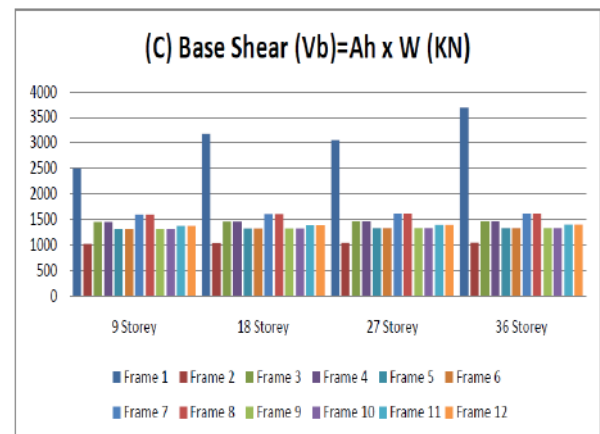


Fig. 4: Base Shear analysis

The aim of the researchers is to analyze the asymmetric shear wall system influenced by non-linear static behavior. The study is carried out for six models of 12 storied building with variable percentage of opening of shear wall with 10%, 20%, 30% and 40% opening. The study is carried out for the building located in North Karnataka zone III. Several seismic parameters are analyzed against various types of loading and constraints. The outcomes of the study shows that base shear for variable opening percentage is lesser as compared to model without any opening. Frequency is decreases with increase in opening but the time period is increases with increase in opening. Storey drift for models with opening in shear wall is higher as compared to the modes without any opening (Saleem Malik Yarnal, Sagar S Allagi, Prashant M Topalakatti, Arif Ahmed Mulla).

The author compared multistorey building with and without opening by non-linear methods. These methods are differ in terms of accuracy and transparency and are developed to rectify the limitations of linear methods without adding any complication to the working and analyzing procedure. Ten storied building is taken for analysis having shear wall provided in the center of periphery by SAP 2000 software. For analysis various models are framed with different opening percentage comprises of 0%, 14%, 25%, 33% & 42% at the center of the shear wall. The result of the study concludes that with the increase in percentage of opening displacement are also increases. Various seismic parameters like base shear and storey drift increases with the increases in percentage of opening. The results of capacity spectrum method shows capacity curve is intersected by demand curve at immediate occupation which leads to the stability of plastic hinges in the structure (Satpute S G, D B Kulkarni).

Author focuses the attention in studying the effect configuration and opening in shear wall system of the

building under seismic response. The model G + 10 storied taken during study with the objective is the building with different shaped opening and without opening comprises of rectangular and square shape and varied arrangement under reversed cyclic loadings. Various seismic parameters are analyzed for load combination applied as per IS 1893:2002. The analysis is performed by Etabs software. The results of the study shows that stiffness of the building is not depended on horizontal location of shear wall but depended on size of opening. This study also reveals that opening is very advantageous and useful (Shivangi Gupta, Rohit Rai, Smiriti Mishra).

The studies of the effect of opening in reinforced concrete shear wall are discussed by the author in this work. The objective this study is to frame a finite element model without shear wall and some finite models with reinforced coupled shear wall with opening for doors and window at centric and eccentric locations. Also an effort is made to optimize the thickness of coupling plate to achieve full wall capacity in reinforced concrete shear wall. The outcomes of the study are effect of opening is insignificant for opening area less than 20%. With the increase in opening area a non-linear variation is observed. There will be drastic increase for door opening in deformation variable from 15% to 25%. Eccentricity is insignificant while increasing for door opening more than 35% and window opening more than 30% (Sruthy K S, Dr. C Justine Jose).

The aim of the present study proves that the stiffness of the building influencing with the variation in percentage of opening area with respect to the wall area has been revealed. Study is carried out for two models of 6 and 12 stories with variable location of shear wall and size of openings. Openings are provided to accommodate doors and windows whose dimensions are initially fixed but are increased considerably at a rate of 14% to 35%. The results of the study shows that for opening provided in shear wall is less than 20% of shear wall area, since the main thing in terms of stiffness of shear wall system, size of the opening is major criteria. They concluded that when opening provided is beyond twenty percent, stiffness of the building is affected. Horizontal door opening location may not cause any considerable effect but the windows vertical locations will significantly affect the stiffness of the system (Vishal A Itware, Dr Uttam B. Kalwane).

#### IV. CONCLUSIONS

From the earlier review it was observed that several papers are presented in shear wall opening against various constraints such as location of shear wall, size and shape of the shear wall etc. In most of the papers presented major portions of work is done toward the seismic parameters

and are modeled for regular shaped building with rectangular plan only. Nowhere the analysis is done for opening in shear wall in Re - Entrant corners of the building along the height of building to accommodate the current population fit with appealing architecture and with safety.

1. A multistorey building with various irregular shapes comprises of "I" and "L" is taken for analysis with opening in shear wall system in all stories one by one at various locations within the stories to understand better the effect of opening ratio to wall area of the building and several seismic parameters in such case of high rise building. The analysis is done for Seismic zone III to observe the values of result parameters.
2. In this study various seismic parameters like nodal displacement, storey drift and modal participation factors are analyzed at various stories to examine the effective variation.
3. Some other deciding parameters like maximum of bending moment, shear force and axial force is needed to be analyzed for better optimization and conclusion for various cases.
4. Re – Entrant corner building condition is checked as per IS 1893 – 2016.

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