# COMPARATIVE STUDY OF BEHAVIOR OF SHEAR WALL WITH DIFFERENT PERCENTAGE OF OPENING FOR DIFFERENT ASPECT RATIOS

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**Abstract**

**Shear walls are provided in high rise structures and structures located in higher seismic areas. The primary purpose of shear wall is to resist lateral forces arising due to earthquake or wind. Usually, architectural design leads to the existence of doors and windows within shear walls. This project is to study the effect of openings in shear wall on behavior of structural frames. A RCC medium rise building of 12 stories with floor height 3m subjected to earthquake loading in V Zone has been considered. Such building modeled with different type of lateral resisting system: complete shear wall, shear wall with opening. Results of the analyses showed a substantial decrease in terms of strength of the wall for shear walls with openings. Also to study the displacement at various levels with the different percentage of opening provide in shear wall. This study verified large lateral displacements and ductility for shear walls with openings in comparison with complete shear wall. The displacement increases gradually from ground floor to top floor with increase in percentage of openings. By comparing the stiffness of single story rectangular shear wall of size 4m x3m with different opening size, the simplified method to calculate the stiffness of shear walls with maximum opening area of 15% in shear wall is preferable, regardless of the aspect ratio of openings. If openings are required in shear wall detailed analysis of structure is essential as it may lead to erratic increase in forces on columns.**

**Key Words*:* Shear walls ; High Rise Structures; Opening Area.**

## I. INTRODUCTION

The primary purpose of all kinds of structural systems used in the building type of structures is to support gravity loads. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces.

Buildings are designed primarily to serve the needs of an intended occupancy. One of the dominant design requirements is therefore the provision of an appropriate internal layout of buildings. Once the functional layout is established, one must develop a structural system that will satisfy the established design criteria as efficiently and economically as possible, while fitting into the architectural layout. The vital structural criteria are an adequate reserve of strength against failure, adequate lateral stiffness and an efficient performance during the service life of the buildings.

In India, a considerable number of buildings have reinforced concrete structural systems. This is due to economic reasons. Reinforced concrete building structures can be classified as:

1. **Structural Frame Systems:** The structural systems consist of frames. Floor slabs, beams and columns are the basic elements of the structural system. Such frames can

carry gravity loads while providing adequate stiffness.

2. **Structural Wall Systems:** In this type of structures, all the vertical members are made of structural walls, generally called shear walls.
3. **Shear Wall–Frame Systems (Dual Systems):**

The system consists of reinforced concrete frames interacting with reinforced concrete shear walls.

Most of the residential reinforced concrete buildings structures in India have shear wall-frame systems. A typical floor plan of a shear wall-frame building structure is given in Figure 1.1. It is a fact that shear walls have high lateral resistance. In a shear wall-frame system, this advantage can be used by placing shear walls at convenient locations in the plan of the building

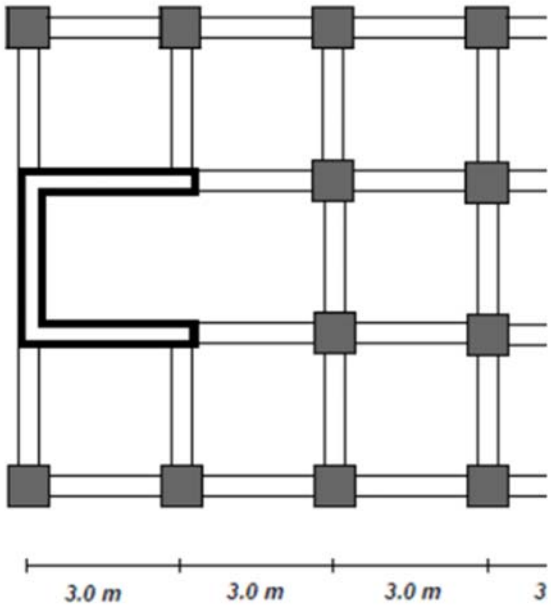
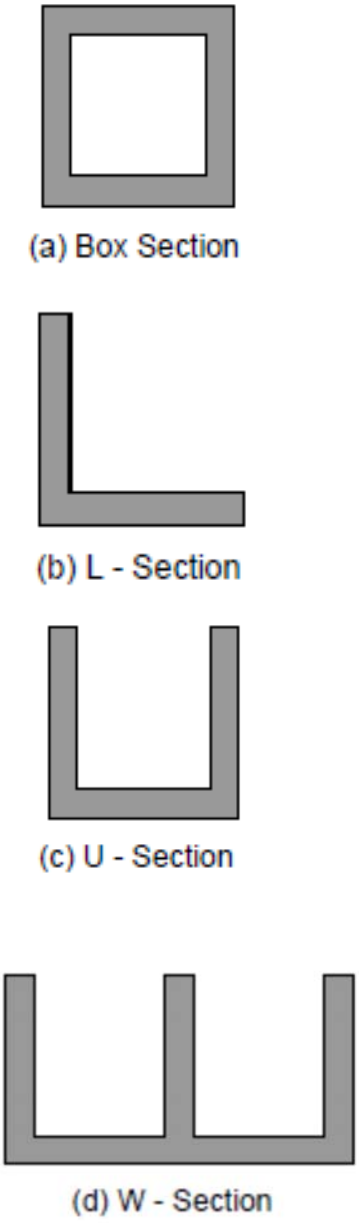
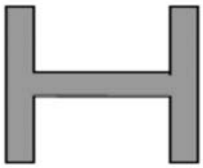



**Figure 1.1: Typical Floor Plan of a Shear Wall-Frame Building Structure**

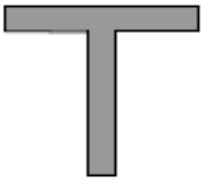
An introduction of shear wall represents a structurally efficient solution to stiffen a building structural system because the main function of a shear wall is to increase the rigidity for lateral load resistance. In modern tall buildings, Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. Behavior of structure during earthquake motion depends on distribution of weight, stiffness and strength in both horizontal and planes of building. To reduce the effect of earthquake reinforced concrete shear walls are used in the building. These can be used for improving seismic response of buildings.

In general, shear walls are in planar form in the plan of the building. However, some combinations of planar walls are also used in the structural systems. Typical non-planar shear wall sections used in the building structures are given in Figure below,





(e) H - Section



(f) T - Section

**Typical Shear Wall Sections**

When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces. In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) force. Shear walls are usually provided along both length and width of building plans reducing lateral displacement under earthquake loads. Shear walls became an important part of mid and high-rise residential buildings.

Shear walls, which are quite common in Earthquake resisting structural systems, may have openings for doors, windows and building services or other functional reasons. Such openings create regions of disturbed stress flow. Such small openings in the shear wall will yield minor effect on the load capacity of shear walls, cracking pattern and maximum drift. The size and location of openings may vary from architectural and functional point of view therefore proper Size of opening is very important for the structure to behave safe.

## II. METHODOLOGY

i) A thorough literature reviews the existing literature and Indian design code provision for designing the Shear wall building.
ii) To understand the seismic evaluation of building structures and application of Equivalent static method.
iii) Select an proposed models of buildings with different size of opening provided in shear wall for the study.
iv) Design the building as per prevailing Indian Standard for dead load, live load, wind load and Earthquake load.
v) Analyze the building using linear/nonlinear static/dynamic analysis methods.
vi) Analyze the results and arrive at conclusions

## III. RESULTS AND DISCUSSION

Shear wall structure having G+ 12 storeys is analyzed for gravity and lateral loads. The effect of Displacement and storey drift are observed for different stories. The analysis is carried out using ETABS and data base is prepared for different storey levels as follows.

**Software Based Modeling And Analysis Of Building**

Manually analyzing a building with lateral forces is a very tedious process and almost practically not possible. There are various finite element software which has a capacity to simulate the exact behavior of building subjected to different loadings including lateral load. One of the finite element software tool specifically designed for building was ETABS which has a capacity to analyze a three dimensional model of a building subjected to various loading. Some of the important features of EATBS are highlighted here for the purpose of better understanding the software interface and implementation in the analysis.

**Modelling of the Structures**

The model of the frame structure is made in ETAB 2013 with accurate dimensions.

Detailing of the structure is done like floor name, floor height, dimensions etc. The codes IS: 875 (Part 2) – 1987, IS: 13920:1993 and IS 1893(Part 1), 2002 are used for applying earthquake and wind loading.

**Analysis**

All type of frame is analyzed by ETAB software. The analysis is conducted for IS 1893(Part 1), 2002 specified combinations of loadings.

## CONCLUSIONS

In this study seismic analysis of RC Frame models has been studied that includes different percentage of opening in shear wall. From the above results and discussions, following conclusion are drawn from present work:

1) Introduction of shear wall greatly reduces lateral displacements in structures due to application of earthquake forces. The presence of shear wall can affect the seismic behaviour of frame structure to large extent and the shear wall increases the strength and stiffness of the structure.
2) With the increase in openings in shear wall lateral displacement increases to greater extent. But reducing the opening in shear wall by 50% then the displacement is save up to 44.7%.
3) Solid shear wall should be preferred in seismic regions than the opening in shear wall, because the storey drift with opening in shear wall is very large than the than solid shear wall, this may probably cause the collapse of structure. Variation of storey drift with storey is non-linear.
4) A very good control over displacement, drift, can be achieved by keeping the minimum possible opening provided in shear wall which is upto 15% is preferable.
5) It is advisable to limit the simplified method to calculate the stiffness of shear walls with maximum opening area of 15% in shear wall, regardless of the aspect ratio of openings.
6) If openings are required in shear wall detailed analysis of structure is essential as it may lead to erratic increase in forces on columns. Careful analysis of structures is necessary, if shear wall is provided with opening as it may result in unnecessary increase of forces in various columns.

In case of openings that are required for windows in external walls or for doors ways is essential. As a designer, it is necessary to know the effects of openings sizes and configurations in shear wall on stiffness as well as on seismic responses and behavior of structural system so that a suitable configuration of openings in shear walls. Therefore on basic of the above result and conclusion upto 15% opening in shear wall will be the better option preferred in the seismic regions.

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