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Analysis and Design of Shear Wall to Retain Seismic Forcesby Using ETABS

[1]Prof.Subhashini Ramteke,[2]Pushkaraj Kale,[3] Kundan Singh Rathore, [4]Aniket Dhaigude and [5]Akshay Jadhav.s

[1]Assistant Professor, Department of Civil Engineering, D.Y Patil College of Engineering, Akurdi,Maharashtra,India.
[2345]Student , Department of Civil Engineering, D.Y Patil College of Engineering, Akurdi, Maharashtra,India.

ABSTRACT:
Shear walls are members of a structure used to maximize the power of the R.C.C. properties. These structure will be built at each level of the building, creating a efficient box structure.Shearwalls of equal length are placed horizontally on opposite sides of the outer walls of the building. Shear walls are added internally to the inside of the building to provide extra strength and durability in the building where the outer walls cannot provide sufficient strength and durability. It is necessary to provide these shear walls when the span-wide ratio of the floor or roof diaphragm is exceeded. The current project focuses on the study of improving the location of shear wall in unsymmetrical high-rise buildings. The shape of the shear walls in horizontal structures is a reasonable consideration. In horizontal structures, the center of gravity and the center of gravitymeet, so that the shear walls are placed evenly over the outer edges or inner edges (such as the shape box). Therefore, it is necessary to find an effective and convenient location of the shear walls in the corresponding structures to minimize the effect of torsion. In this work a high-rise building with various areas of shear walls is considered for analysis. The multi-storey building with G + 4 issues is analyzed for its removal, power and stability using ETABS software. Analysis of earthquake loading structure with Zone-V. Structural analysis was performed using the same static and dynamic methods.

KEYWORDS:ETABS, SHEAR WALL, IS 456-2000, IS1893-2002.

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I. INTRODUCTION

Adequate stifness should be ensured in high-rise structures to withstand side loads caused by wind or earthquake events. Reinforced concrete walls are designed for buildings in earthquake zones, due to their high carrying capacity, high ductility and durability. In very high-rise buildings, the column size and column size work out and the reinforcement in the column joints is quite heavy, so that there is a lot of closure in these joints and it is difficult to place and shake concrete in these areas to contribute to building safety. This functional complexity requires the introduction of shear walls in high-rise buildings.

1.1 Structural forms of buildings

Lateral loads can increase high stresses, produce more precise movements or cause vibrations. Therefore, it is very important to have sufficient structural strength against vertical load Earthquakes and strong winds are the only major forces affecting buildings. The function of lateral load resistance systems or structural form is to absorb the energy induced by these lateral forces by moving or determining without collapse. The determination of a high-rise building or a high-rise building can only involve entirely the arrangement of large building elements with excellent resistance to a variety of side loads and gravity loads. Internal planning

1) Materials and construction method
2) Type and magnitude of horizontal loading
3) External treatment of buildings
4) The height and ratio of the building as well
5) Scheduled location and delivery of service plans

The longer the height and the richer the material, the more architectural features that are present and the more necessary it is to select the appropriate building form or subsequent loading system for the building. In high-rise buildings designed for the same purpose and the same height and material, the efficiency of buildings can be compared to the weight of each floor area.

1.2 Factors affecting earthquake formation of a building

1) The natural frequency of the structure
2) The element of the structure of the structure
3) Type of foundation structure
4) The importance of structure
5) Ductility of structure

There are many methods available for seismic analysis of buildings; two of them are presented here:

a. Equivalent static lateral method(psuedo static mode).

b. Dynamic analysis.

-Response mode.

-Time history method.

1.3 General Indian Standard Codes

456: 2000 In terms of clause 32, wall structure means, horizontal shear structure in section 32.4 provided details on how to construct Shear walls

IS 1893-2002 Criteria of EarthQuake resistant Buildings Part (3) page23, sub-section 4.2 provides for seismic loads.

IS 13920: 1993 provides ductile profile of the shear wall in terms of clause9, whereas 9.1 provides standard requirements, 9.2 shear 9.3 provides flexural strength 9.6 provides openness to shear walls. Ductile specifications, according to code IS: 13920: 1993 are considered very important as ductile specifications provide the amount of reinforcement required and alignment of the bars.

1.4 Shear Wall

The shear wall is a wall that is used to resist the shear, which is produced due to lateral forces. Many codes make the shear wall construction of high-rise buildings compulsory. Shear walls are provided when the center of gravity of the construction site and the loads operating on the building vary by more than 30%. To bring the center of gravity and strength to a level of 30%, concrete walls are provided which means that lateral forces will not grow much. These Shear wall start at the foundation level and extend throughout the building height. Shear walls are oriented in a vertical direction like wide beams which carry earthquake loads downwards to the foundation and are often provided with the width and length of the buildings. Shear walls in high-earthquake buildings require special details. The construction of shear walls is easy, because the reinforcement of the wall details is straightforward and easy to use on site. Shear walls are effective in both construction costs and efficiency in reducing earthquake damage in structural and non-structural materials.

1.4.1 Shapes or Geometry of Shear Walls

Shear walls are rectangular in cross sections, e.g. one size is much larger than the other. Whilethe section on the rectangular cross remains intact, L and U-shaped sections are used. RC shafts with walls around the elevator of the building also act as shear walls, and should be used to withstand the force of an earthquake. Section of the Shear Wall are divided into six types.

(a) Box-category

(b) L - category

(c) U-category

(d) W -category

(e) H - category

(f) T - category

1.5 Parts of Shear Walls

Reinforced concrete and reinforced masonry walls are rarly easy walls that fight side effects. Whenver a wall has doors, windows, or other openings, the wall should be considered a collection of flexible elements such as column sections and columns and stiff elements as part of the wall.

Segments of a column: A section of a column is a vertical member with a length greater than three times its diameter and less than two and a half times its width. Its load is usually axial. While it may contribute little to the lateral strength of the shear wall, durability should be considered. When a column is built and attached to a wall, the part of the column that emerges from the surface of the wall is called a pilaster. Column sections will be constructed according to ACI 318 concrete.

Wall piers: A wall block is part of a wall whose horizontal length is between two and a half and six times its apparent size twice that of its horizontal length.

Wall components: Wall parts are shear wall materials longer than wall columns. They are the key to resisting the shear wall.

Key Factors in the design and construction of shear walls: In all high-rise buildings, the problem of providing adequate durability and preventing mass removal, is as important as providing adequate energy. The shear wall system therefore has two benefit over the framework of the system

Method of operation Design Features

Earthquakes can occur on land and in water, anywhere on the surface of the earth where thereis a major Fault. When an earthquake hits the earth it affects a man-made structure around its origin which results in the loss of human resources. When a major earthquake occurs beneath the ocean or ocean, it not only affects nearby buildings but also produces huge tsunami waves, thus affecting areas farther away from their origin. All structures are designed for the combinedeffects of gravity and earthquake loads to ensure that the vertical strength and vertical strength and stability are obtained to satisfy the structural concert and acceptable deformation levels determined in the governing building code. Due to the natural safety feature used in the design specification, many buildings are often adequately protected from vertical vibrations. Vertical acceleration should also be considered in large multi-layered structures, where design stability, or complete structural stability analysis.

Serviceability limit state

The building is slightly damaged or there is no structure at all in this case. Important structures such as hospitals, atomic power stations, meeting places, etc., that affect the community, should be designed to stabilize under the expected earthquake power. These types of structures should be used even in the event of earthquakes or hurricanes.

Damage controlled limit state

In this case, in the event of an earthquake or hurricane, damage may be done to the building but may be repaired in the event of such an accident. Most permanent structures should fall under this category, therefore, the structure should be designed for a limited ductility response only.

Survival limit state

In this case, the building is permitted to be damaged in the event of an earthquake or disaster. However, the supports must stand and support the constant loads that come to them so that there are no structural cracks and no loss of life. Limited ductile response is cheaper and full ductile response is cheaper. A complete description of the ductile is achieved by observing thedesign of the plastic hinge and by carefully displaying the ductile details

The current building practice is to build buildings for the first two limit states as the other is under the development phase

1.6 Design approach to IS 1893 (2002)

The heading IS 1893-2002 states "Principles for Earthquake-Resistant Buildings" and part 1 of this code deals with General Provisions and buildings [1] According to this code we look at themagnitude of the following earthquakes:

a) Design Basic Earthquake (DBE): Earthquakes that occur at least during the lifespan of a building.

b) Maximum Considered Earthquakes (MCE): This is the largest earthquake possible in that region as determined by the code. It is divided into factor 2 to find the basic earthquake.

The Z value, the geographical area given in the code corresponds to the actual values of the earth's maximum acceleration

considering MCE and the service life of the structure. The following principles are the basis of the design method recommended by IS 1893-2002.

1) The building must be able to withstand a small earthquake under the DBE without damage.

2) The building must be able to withstand a magnitude DBE earthquake without significant damage even though there may be irregular damage.

3) The building must be able to withstand an earthquake equivalent to the MCE without collapse so that there is no loss of life.

1.6.1 Equivalent Static Method

A continuous vertical method of obtaining lateral force is also known as the vertical or horizontal axis. This method is the simplest and requires little calculation and is based on the formulas given in the operating code. In all methods of analyzing the multi-storey structures recommended in the code, the structure is considered to be an unambiguous system with low-level masses containing the weight of columns and walls in each floor should be evenly distributed below and below the floor.

In addition, the fair value of the load on the ground is alsodetermined. It is also assumed that the structure is flexible and will deviate in relation to the condition of the foundation; the lumped mass system reduces the solution of the second-order separation system. These equations are formed by the distribution of the weight and stiffness of the structure, as well as its indications of a dumping in ground motion.

The seismic weight of the earthquake

The seismic weight of a building is the sum of the seismic mass of all the elements in a building. The seismic weight of each floor is the sum of its total dead load and the appropriate amount of load, the last of which is the load that can be expected to be attached to the building during an earthquake. Includes the weight of the permanent and movable partition, the permanent equipment, part of the living load, etc. When using a computer the seismic weight of the walls and columns in any storage will be distributed equally to the floor and below the storage.

Distribution of Design Force

Computed base shear is now distributed over the height of the building. The strength of the shear wall, at any level depends on the quantity of that level and tends to impair the structure of the structure. Seismic forces deflect a building into many known types of natural mode shapes and a number of natural state conditions depending on the degree of freedom of the system.

The building usually has a continuous system with infinite degree of freedom. The magnitude of the lateral force on a particular floor depends on the hardness of the node, the distribution of rigidity above the height of the structure and the displacement of the nodal in a given mode.The lateral force induced at any level h_i as per clause 7.7.1, IS1893-2002,can be determined by,:

$$Qi = VB \frac{Wihi^2}{\sum_{j=1}^{n} Wjhj^2}$$

Where,
Qi- Design side forces floor i
Wi-Seismic weight is low
hi- The height of the floor I measured from the base
n-Number of stores in a building, ie, the number of levels where the masses are located.

The proposed distribution in this code provides for the distribution of earthquake forces high upnear the top storey of the same base shear. The assumptions involved in the static process shown in this statement

a) The basic structure of the structure makes the most significant contribution to the base shear, and the total weight is considered to be the opposite of the size of the methods to be used in the dynamic process.

b) Mass and stiffness are evenly distributed throughout the building.

1.7 Dynamic Analysis

Dynamic analysis will be done to determine the strength of the earthquake, as well as its distribution at different levels of the building's height, and at various rear loads.

Typical buildings: Those above 40m high in zone IV and V, those above 90m high in zone II and III.

Irregular buildings:All buildings with frames higher than 12m in zones IV and V, and those larger than 40m hight in zone II and III.

Model analysis with a dynamic analysis of structures with irregular configurations should be such that there are sufficient models of the types of defects present in the configuration of the structure. Structures with structural flaws, as defined in Table 4 of the IS code: 1893-2002 cannot be modeled by dynamic analysis. Strong analysis may be made by TIME HISTORY METHOD or RESPONSE SPECTRUM METHOD

II. NUMERICAL MODELING AND ANALYSIS

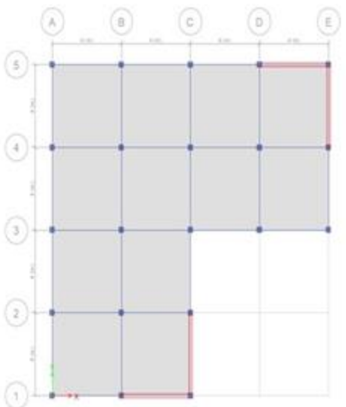
Table 1 Dimension of shear structural member.

Sr.no	Component	Property(mm)
1	Main beam	250*300
2	Main Column	300*300
3	Slab	150

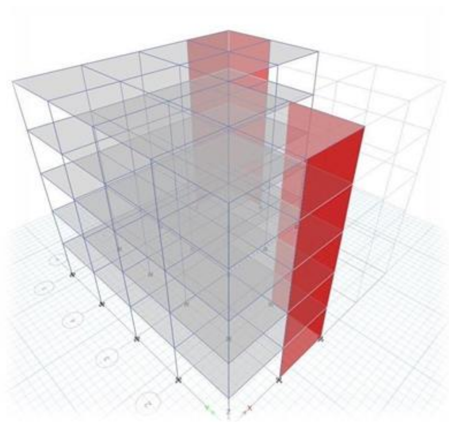
Table 2 General dimension of frame structure

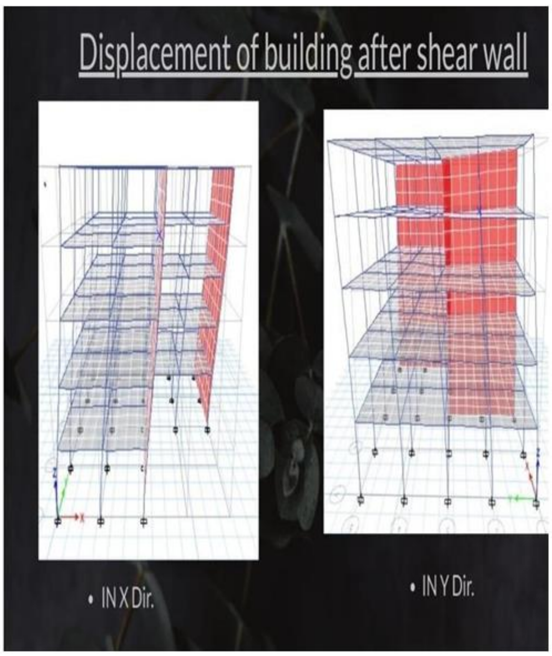
Sr no.	Particular	Dimension	Sr no.	Particular	Dimension
1	Length of building	16m	9	Thickness of Floor finishing	30mm
2	Width of building	8m	10	Thickness of Ceiling plaster	5mm
3	Height of building	15m	11	Density of concrete	25kN/m ^{2}
4	Typical storey height	3m	12	Thickness of slab	150mm
5	Top story height	3m	13	Grade of concrete	M25
6	Bottom story height	3.5m	14	Grade ofsteel	HYSD 415
7	Wall load	15kN/m^2	15	Importance factor	1.5
8	Live loadon roof	2kN/m^2	16	Zone 5	Z.F.=0.36

III. RESULTS

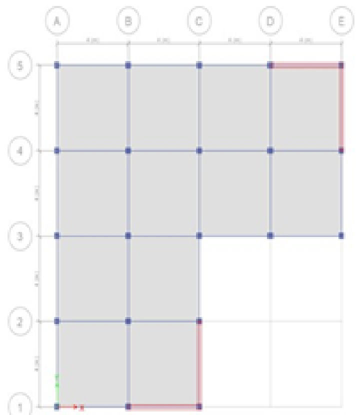


D View of the building



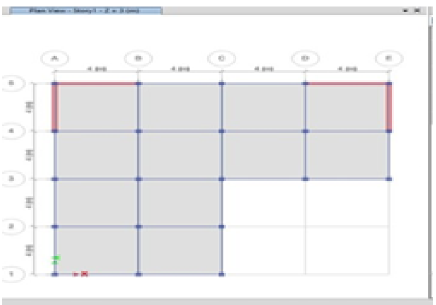


Different Positions of Shear Wall



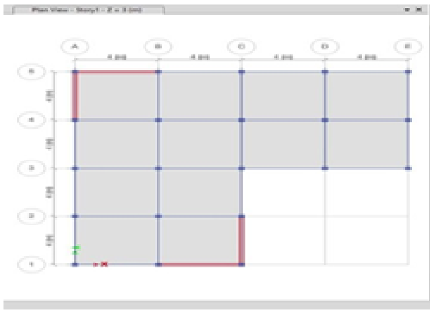
Position 1

Position 2



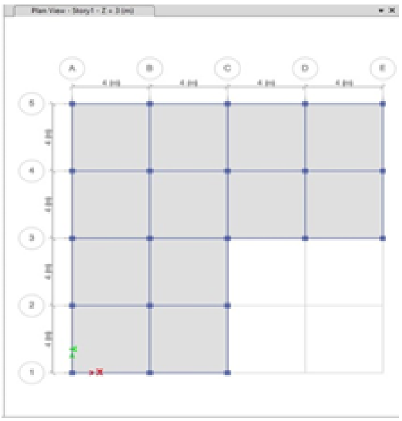
Position 3

Position 4



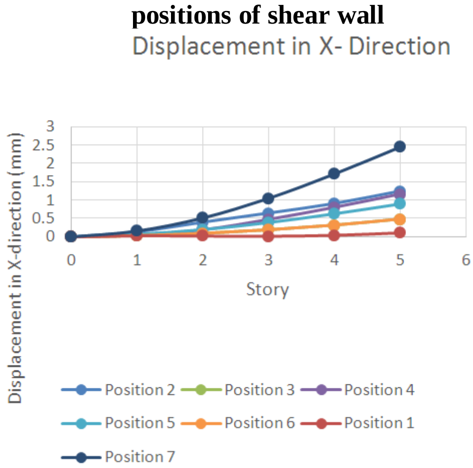
Position 5

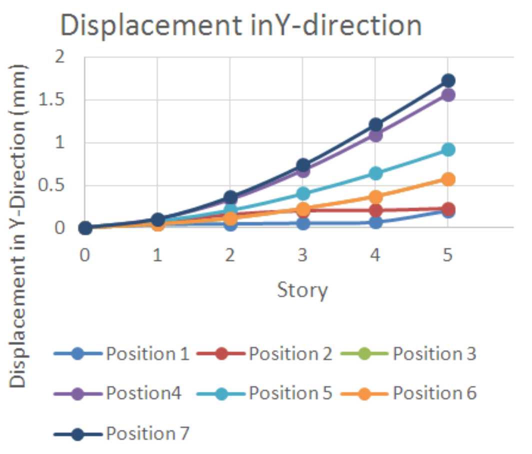
Position 6



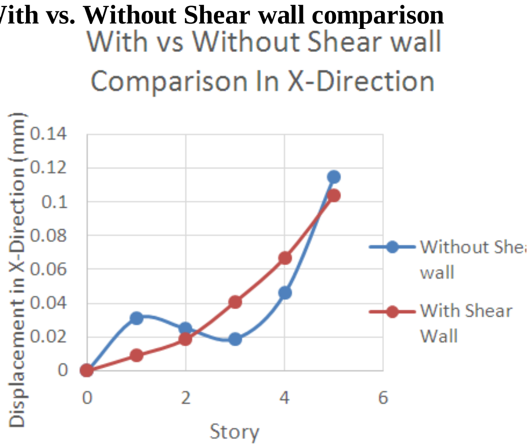
Position 7

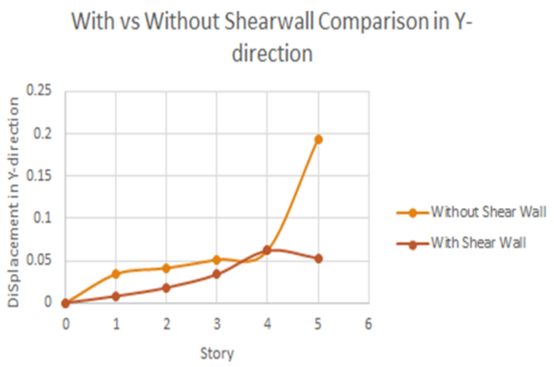
Displacement in X & Y direction of different positions of shear wall





With vs. Without Shear wall comparison





☐ We have compared all the possible positions of shear wall and Herby conclude that **Position 1** is best suited for location of shear wall. We compared position 1 of shear wall with building without shear walls and hereby concluded that the displacement of buildingwithout shear wall is more than position1.

IV. CONCLUSION:

1. Shear walls are therefore one of the most effective building materials for resisting lateral forces during an earthquake.
2. By building a wall of shear damage due to the lateral force effect due to earthquakes and high winds can be improved.
3. The construction of Shear walls will provide greater stiffness in the buildings thus reducing damage to the structure and its contents.
4. Not only by its strength but also by accommodating a large number of people in a small area tall buildings with shear walls are considered very useful.
5. ETABS is a state-of-the-art software used to analyze any type of architecture. Its speed and accuracy can easily analyze buildings up to 40 floors. Shear wall design is made differently from this software with various load combinations.
6. ETABS can analyze any predetermined load-bearing structure and the combination of shear load load relative to IS codes.
7. Therefore, to design or cut a wall structure, if we use ETABS software then analyze the structure easily and provide quick results with accurate data.
8. In India the population growth rate is very high so most of them suffer from homelessness. With this shear wall construction for a small area we can increase the number of floors and increase the quality of life.
9. So in a developing nation like India shear wall construction is considered a backbone in the construction industry.

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