Comparative Analysis of Behaviour of Horizontal and Vertical Irregular Buildings With and Without Using Shear Walls by ETABS Software

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Abstract

Modern residential structure are going higher and higher these days. The impact of lateral loads in the form of wind/Earthquakes affects the performance of these structures dramatically. It is often a common practice among structural engineers to use shear walls in place of columns. Shear walls are very common in high rise reinforced concrete building. In this study, comparative analysis of high-rise reinforced concrete irregular building with shear walls is present. The frame type of proposed building is used the special RC moment resisting frame. It belongs to seismic zone 2 This is why, seismic forces are essentially considered in the analysis of this building and shear walls are also provided to resist seismic forces. Structural members are designed according to IS456-2000. The structure is analyzed by using ETABS v 9.7.1 software. Load consideration is based on Indian code. All necessary load combinations are considered in shear walls analysis and frame analysis. In addition wind load, seismic load is considered as external lateral load in the dynamic analysis. In dynamic analysis; Response Spectrum method is used. For this purpose four multi storey building plans are considered that are horizontal irregular and vertical irregular models with and without shear walls .All the four buildings were analyzed for zone II. Modal Period with different configuration of building, Storey Displacement of structure with different configuration of building, Storey Drift with different configuration of building were studied and their comparison was done.

Keywords; *Compressive strength, fly ash, ordinary Portland cement, Recycled coarseaggregate, Splittensile strength.*

INTRODUCTION

General

In order to design a structure to resist wind and earthquake loads, the forces on the structure must be specified. The exact forces that will occur during the life of the structure cannot be anticipated. Most National Building Codes identify some factors according to the boundary conditions of each building considered in the analysis to provide for life safety. A realistic estimate for these factors is important; however the cost of construction and therefore the economic viability of the project are essential. Owing to lack of earthquake and wind forecasting centers the Egyptian Codes 1993 and 2003 give more concentration on calculating these lateral loads and the corresponding additional stresses to be taken into account in the design of the structures. During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as Irregular structures. Irregular structures contribute a large portion of urban infrastructure. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. For example structures with soft storey were the most notable structures which collapsed. So, the effect of vertically irregularities in the seismic performance of structures becomes really important. Height-wise changes in stiffness and mass render the dynamic characteristics of these buildings different from the “regular‘building. IS 1893 definition of Vertically Irregular structures:

The irregularity in the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of building. When such buildings are constructed in high seismic zones, the analysis and design becomes more complicated. There are two types of irregularities-

The component of the building, which resists the seismic forces, is known as lateral force resisting system (L.F.R.S). The L.F.R.S of the building may be of different types. The most common forms of these systems in a structure are special moment resisting frames, shear walls and frame-shear wall dual systems. The damage in a structure generally initiates at location of the structural weak planes present in the building systems. These weaknesses trigger further structural deterioration which leads to the structural collapse. These weaknesses often occur due to presence of the structural irregularities in stiffness, strength and mass in a building system. The structural irregularity can be broadly classified as plan and vertical irregularities. A structure can be classified as vertically irregular if it contains irregular distribution of mass, strength and stiffness along the building height. As per IS 1893:2002, a storey in a building is said to contain mass irregularity if its mass exceeds 200% than that of the adjacent storey. If stiffness of a storey is less than 60% of the adjacent storey, then a storey is termed as „weak storey". If stiffness of a storey is less than 70% or above as compared to the adjacent storey, then the storey is termed as „soft storey".

This difference in usage of a specific floor with respect to the adjacent floors results in irregular distributions of mass, stiffness and strength along the building height. In addition, many other buildings are accidentally rendered irregular due to variety of reasons like non-uniformity in construction practices and material used. The building can have irregular distributions of mass, strength and stiffness along plan also. In such a case it can be said that the building has a horizontal irregularity. The detailed classification of structural irregularity is presented in Figure 1.1 and code limits have been shown in Table 1.1 and Table 1.2. From review of code limits it can be clearly said that majority of the codes prescribe similar guidelines for the irregularities based on magnitude ignoring the aspect of irregularity location which is unrealistic Although irregular buildings are preferred due to their functional and aesthetic considerations is evident from examples of realistic existing irregular buildings is shown in Figures 1.2 to 1.4. The past earthquake records show poor seismic performance of these structures during earthquakes as discussed in the next section. The different types of irregularities are presented.

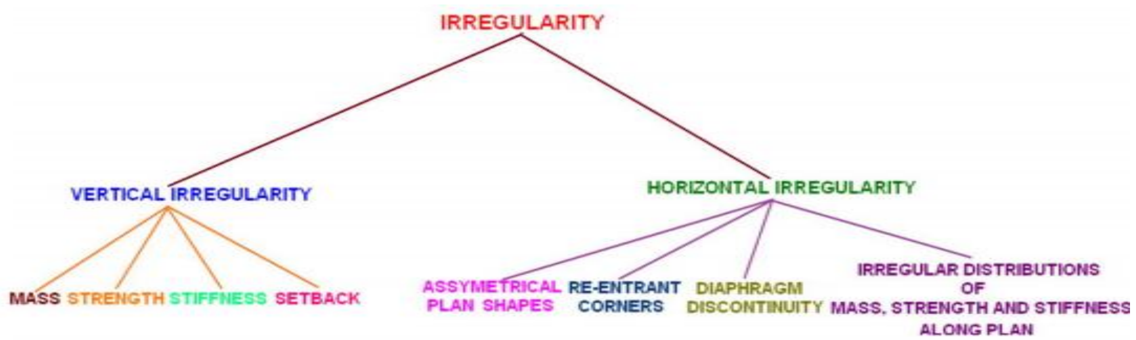


Figure 1

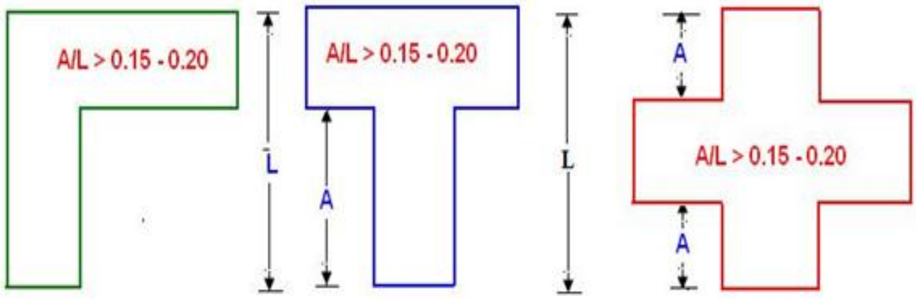


Figure 1.1 Re-entrant corner irregularity

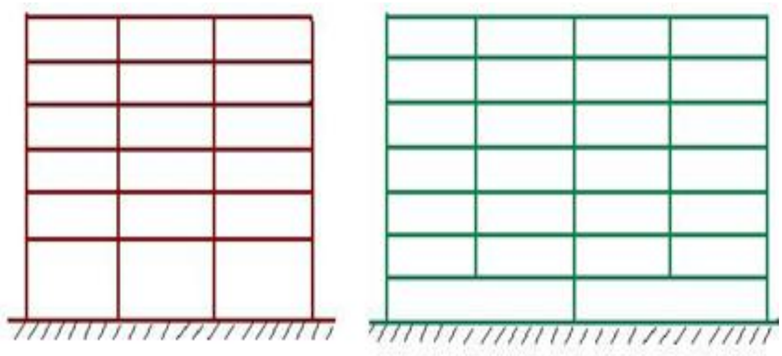


Figure 1.2 Irregular distribution of stiffness in the building system

Failures occurred during the past earthquakes

ETABS

The inventive and progressive new ETABS is a definitive coordinated programming bundle for the auxiliary investigation and outline of structures. Joining 40 years of persistent innovative work, this most recent ETABS offers unmatched 3D protest based demonstrating and representation instruments, blazingly quick straight and nonlinear explanatory power, complex and extensive plan capacities for an extensive variety of materials, and astute realistic showcases, reports, and schematic illustrations that enable clients to rapidly and effortlessly translate and comprehend examination and configuration comes about.

From the begin of outline origination through the creation of schematic illustrations, ETABS incorporates each part of the building configuration process. Making of models has never been simpler - natural illustration charges take into consideration the fast age of floor and rise encircling. Computer aided design illustrations can be changed over straightforwardly into ETABS models or utilized as formats onto which ETABS items might be overlaid. The best in class SAPFire 64-bit solver enables greatly vast and complex models to be quickly dissected, and underpins nonlinear displaying procedures, for example, development sequencing and time impacts (e.g., crawl and shrinkage).

ETABS gives an unequaled suite of instruments for basic architects planning structures, regardless of whether they are taking a shot at one-story mechanical structures or the tallest business elevated structures. Massively competent, yet simple to-utilize has been the sign of ETABS since its presentation decades back, and this most recent discharge proceeds with that custom by giving architects the innovatively progressed, yet instinctive, programming they require to be their generally beneficial.

- Modeling of Structural Systems
- Loading, Analysis, and Design
- Output, Interoperability, and Versatility
- Editing and task highlights for plan, height, and 3D sees

FRAME

A rigid jointed R.C frame consists of Rectangular components, beams and columns connected together in the same plane by means of rigid joints. The lateral stiffness of such a frame depends upon the building stiffness of columns, beams, and connections in the plane. The frame may be in the with an interior wall of the building, or plane with the façade. The rigid frames principle advantage is its open rectangular arrangement, which allows freedom of planning and easy fitting of doors and windows. The rigid frame principle seems to be economical up to approximately 25stories for steel framing and up to 15 stories for concrete framing. Above these relatively low lateral flexibilities of frame calls for economical large numbers in order to control the drift.

The horizontal stiffness of a rigid frame is governed mainly by the bending resistance of the girders, the columns, and the connections, and in tall frame, by the axial rigidity of the columns. The accumulated horizontal shear above any story of riding frames resisted by shear in columns in that story the shear causes. The story-height columns to bend in double curvature with points of contraflexture at mid-story height levels. The moments applied to a joint from the column above and below are resisted by attached girders, which also bend in double curvature, with points of contraflexture at approximately mid span.

These deformations of the columns and girders allow racking of the frame and horizontal deflection in each story. The overall deflected shape of a rigid frame structure due to racking has a shear configuration with concavity upward. A maximum inclination near the base and a minimum inclination at the top.

Rigid frame construction is ideally suited for reinforced concrete buildings because of the inherent rigidity of reinforce concrete joints. The rigid frame form is also used for steel frame buildings, but moment resistant connections in steel tend to costly. The size of the columns and girders at any level of the rigid frame are become directly influenced by the magnitude of external shear at that level, and they therefore increase towards the base. Consequently the design of the floor framing cannot be repetitive as it is in the case of some braced frames.

MASONRY IN FILLED FRAMES

The lateral stiffness against forces due to wind or earthquake is primary consideration in the design of multistoried building. The one of the method to increase the lateral stiffness of a multistory frame is by using composite stiffness and strength of the structural framework and the infill walls. Brick masonry is the most commonly used material in construction of in filled frames. The behavior of an in filled frame depends upon the interaction of the frame and the infill. The guiding characters of behavior are panel proportion and the quality of an in fill work. The location of the infill also plays an important role in the behavior of the system Under lateral loads, the mortar cracks, causing sliding and separation at the interface between the frame and infill. This cracking of infill causes stiffness degradation results in the change in the structural behavior. Due to continuous cracking the moment of inertia and the stiffness reduces continuously results in failure.

SHEAR WALL

Shear walls are vertical stiffening elements designed to resist lateral forces exerted by wind or earthquake. The shape and location of shear wall have significant effect on their structural behavior under lateral loads. Lateral loads are distributed through the structure acting as a horizontal diaphragm, to the shear walls, parallel to the force of action. These shear wall resist horizontal forces because their high rigidity as deep beams, reacting to shear and flexure against overturning. A core eccentrically located with respect to the building shapes has to carry tension as well as bending and direct shear. However torsion may also develop in building symmetrical featuring of shear wall arrangements when wind acts on the facades of direct surface textures (i.e, roughness) or when wind does not act through the center of building's mass (schueller, 1977).

Shear walls are much stiffer than horizontal rigid frames. Therefore shear walls are economical up to 35 stories. If, in low to medium rise buildings, shear walls are combined with frames, it is reasonable to assume that the shear walls attract all the lateral loading so that frame may be designed for gravity loads only. Resistance of a shear wall increases linearly with its thickness. However, the effect of width is much higher.

A coupled shear wall structure is a particular, but very common, form of shear wall structure. It consists of two or more shear walls in the same plane, or almost the same plane, connected at floor levels by means of stiff beams or slabs. These results in a horizontal stiffness very much greater than if the walls acted as a set of separate uncoupled cantilevers.

SHEAR WALL COMPONENTS:

Reinforced concrete and reinforced masonry shear walls are seldom-simple walls. Whenever a wall has doors, windows, or other openings, the wall must be considered as an assemblage of relatively flexible components like column segments and wall piers and relatively stiff elements like wall segments

1. **Column segments:** A column segment is a vertical member whose height exceeds three times its thickness and whose width is less than two and one-half times its thickness. Its load is usually predominantly axial. Although it may contribute little to the lateral force resistance of the shear wall, its rigidity must be considered. When a column is built integral with a wall, the portion of the column that projects from the face of the wall is called a pilaster. Column segments shall be designed according to ACI 318 for concrete.
2. **Wall piers:** A wall pier is a segment of a wall whose horizontal length is between two and one-half and six times its thickness and whose clear height is at least two times its horizontal length.
3. **Wall segments:** Wall segments are components that are longer than wall piers. They are the primary resisting components in the shear wall.

NECESSITY, IMPORTANCE FEATURES IN PLANNING AND DESIGN OF SHEAR WALLS:

For all high rise buildings, the problem of providing adequate stiffness and preventing large displacements, are as important as providing adequate strength. Thus shear wall syatem has two distinct advantages over a frame system.

- It provides adequate strength to resist large lateral loads with-out excessive additional cost.
- It provides adequate stiffness to resist lateral displacements to permissible limits, thus reducing risk of non-structural damage.
- They should be located such a way they also act as functional walls. And do not interfere with the architecture of building. Enclosures around the lift are most commonly used system of shear cores.
- Shear walls should be placed along both the axis. So that lateral stiffness can be provided in both directions, particularly in the case of square buildings.
- To avoid torsion shear wall should be placed symmetrically about the axis.
- Shear walls should be continued up to foundation level.

SHEAR WALL WITH OPENING

Framed structures with shear walls are frequently adopted as the structural system for high rise buildings, the openings may be window, door type openings as described previously. To this opening in plane stiffness of the entire building decreases due to decrease of in plane stiffness. The behavior of wall will change, these changes will occur in deflection, bending moment, shear force, and the stress in walls. Openings may be small or large depending on the function of the building.

If the building is a residential building, openings like window, door, and corridor are sufficient whereas for special building like cinema theaters, function halls, hotels, community halls it requires large openings to meet the requirements. The parameters to be studied to decide weather the opening is small or large are given below.

1. Height of opening
2. Width of opening
3. Story level that contains opening

Opening parameter ( ) > 1 the opening size is called as small opening

> 1 opening will be called as large opening

Opening parameter is the ratio of area of opening to the area of part of wall surrounded by the centerlines of column.

FRAME- SHEAR WALL INTERACTION

The basic difference between the lateral load behaviors of a shear wall and frame is in their modes of deformation. Under lateral loads, a rigid frame deforms in shear mode. On the other hand a shear wall deflects in bending mode. The interaction of shear wall and frame is a special case of indeterminacy, in which basically two different components are tied together to produce one structure. Due to the different deformation characteristics of the frame and shear wall under lateral loads. The frame needs to pull back shear wall in upper portions of the building, and push it forward in lower portions of building. As a result, the frame participates more effectively in the upper portion of building where the lateral load stress are less and the shear wall carries most of the shear in lower portions of the building where frame generally cannot afford to carry high lateral loads.

DRIFT

One simple parameter that offers an estimation of the lateral stiffness of a building is the drift index, defined as the ratio of the maximum deflection at the top of the building to the total height. In addition the corresponding value of the single storey height, the inter story drift gives a measure of possible localized excessive deformation. The control of the lateral deflection is of particular importance for modern buildings, in which traditional reserves of stiffness due to heavy internal partitions and outer cladding have largely disappeared. The establishment of drift index limits is a major design decision, but unfortunately, there are no unambiguous or widely accepted values, or even in some of the national codes concerned, any firm guidance. The designer is then faced with having to decide on an approximate value, the figure adopted will reflect the building usage, the type of design criterion employed, the form of construction, the material employed, including and substantial in fills or cladding, type of lateral load considered and in particular past experience of similar building that have performed satisfactorily. Design drifts index limits that have been used in different index coefficients range from 0.001 to 0.005. As the height of the building increases, drift index coefficients should be decreased to the lower end of range to keep the story deflection to a suitable lower value.

IS: 1893-1984(Clause-4.2.3), puts the maximum limit to the ISD (Inter storey drift) due to Earthquake forces as 0.004 or 0.4%. In this study an attempt has been made to investigate how the drift is taking place both qualitatively and quantitatively, by considering shear wall with openings at different story levels of 15 storey building due to lateral load due to earthquake.

OBJECTIVE OF THE STUDY

The following are the main objectives of the project

1. To study the seismic behavior of multi story building by using IS 1893:2002
2. To compare the multi story buildings with and without shear wall for regular and irregular buildings.
3. To compare the results of Story Drift, Shear force, bending moment, Building torsion of buildings with and without shear wall for regular and irregular buildings.
4. To study the buildings in ETABS V9.7.4 in Time history analysis.

MODELLING OF SHEAR WALL

For the lateral load analysis of multistory buildings in the elastic zone, shear wall models that were created are provided in this chapter. Because building structure modeling techniques are examined individually. Both two and three dimensional methodologies can be used to study shear wall modeling research.

TWO DIMENSIONAL (PLANAR) SHEAR WALL MODELS

Several shear wall fashions that have been created for two-dimensional elastic analyses of multistory constructing systems are cited within side the literature. A evaluation of numerous fashions is supplied on this section.

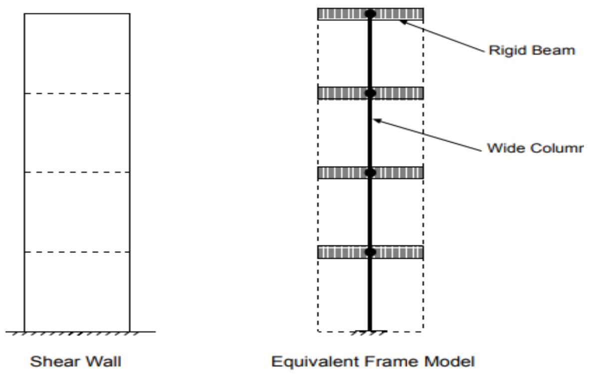


Fig2.1 Equivalent Frame Model of a Shear Wall

ANALOGOUS FRAME METHOD

This different approach was created for modelling both planar and no planar shear walls, according to Smith et a proposal.'s [53]. Their study's goal was to eliminate the false flexure and excessive shear deformations brought on by the current equivalent frame method's discontinuous modeling of continuous vertical connections between neighboring planar wall components. The braced broad column analogy and the braced frame analogy are the two different frame models that they suggested in their study for shear wall analysis.

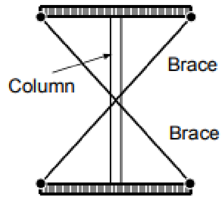


Fig 2.2 Braced Wide Column Module

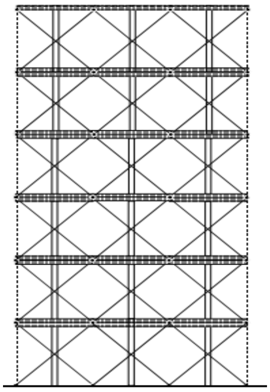


Fig 2.3 A Planar Shear Wall Modelled by Braced Wide Column Analogy wall,

In the analogy of the braced body, the module is asymmetrical and is made of diagonal braces, a column at the left related to the inflexible beams, a hinged cease at the right, and a right-facet column. While the right-hand cease of the beam and the hyperlink are rotationally liberated from the nodes, the left-hand cease of the beam and the ends of the column rotate with the nodes [53]. The stiffness traits of the column, braces, and hyperlink are decided the usage of equal equations.

The probability of having terrible stiffness values for the column and braces for particular component ratios of the framework modules is one of the shortcomings of the 2 analogies. These strategies may not paintings because the majority of body evaluation pc gear can not examine statistics with terrible vicinity and inertia values. For the 2 recommended analogies, Koulouris and Peppas [54] calculated the stiffness matrices. They suggest two-dimensional braced extensive column and braced body modules as changed three-d modules that can be delivered to numerous structural evaluation software program of their study. Then, a brand new shear wall geometry is made, wherein the preceding shear wall is break up into a chain of neighbouring horizontal shear partitions with fantastic stiffness values. This solves the trouble of terrible stiffness value.

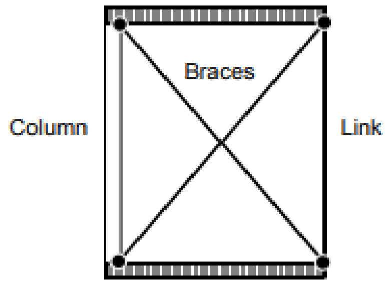


Fig:2.4 Braced Frame Module

FINITE ELEMENT MODELS

A two-dimensional shear wall is broken down into smaller components with limited size and number in the finite element modelling process. These components might be quadrilateral, rectangular, or triangle-shaped. The two-dimensional shell element is the most often used plane stress element for modelling shear walls. Each node has three degrees of freedom (two translation and one rotation). In addition to modelling multistorey structures, the finite element approach is frequently employed for various types of engineering issues. A connected shear wall's finite element model is shown in Figure 2.5. In Figure 2.6, a rectangular shell element is shown.

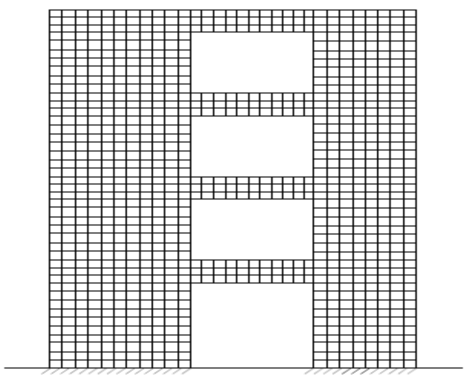


Fig:2.5 Finite Element Model of a Coupled Shear Wall

For the planar evaluation of shear wall-body systems, beams and columns are modelled the usage of two-dimensional body contributors with 3 ranges of freedom at every node (Figure 2.2), whilst shear partitions are modelled the usage of two-dimensional aircraft strain elements.

The choice of the total number of elements to be employed in modelling the shear walls is a crucial one in finite element analysis. A finer mesh can produce results that are more precise, but the overall running time may be longer. Analysis should have the ideal number of finite elements

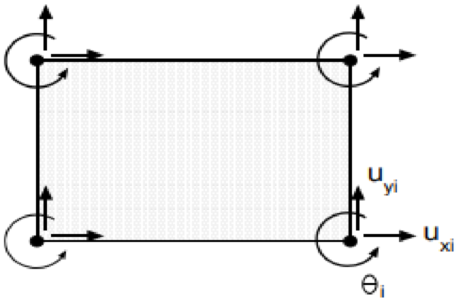


Fig:2.6 A Rectangular Shell Element with Three D.O.F. at Each Node

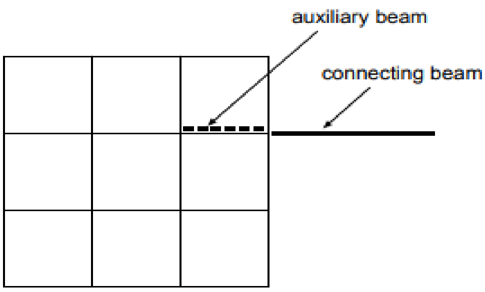


Fig:2.7 Plane Stress Elements with Horizontal Auxiliary Beam

SHEAR WALL MODELS FOR THREE DIMENSIONAL ANALYSIS

Shear wall fashions are regularly changed variations of dimensional fashions used withinside the 3 dimensional have a look at of structures. The maximum famous of those fashions is reviewed withinside the pages that follow.

BRACED FRAME ANALOGY

Smith et alb raced.'s frame analogy was used by them to analyse core structures in three dimensions. A coarse mesh of wall width storey height modules divides each wall into its component parts. To illustrate the torsional behaviour of the core structure in three dimensions, they used a torsional column. Figure 3.12 shows the braced frame model of an elevator core. This approach prevents parasitic moments from affecting column elements.

This particular model was created for the analysis of open, partially open, and closed cores. There hasn't been any research on the model's applicability to three-dimensional shear wall-frame buildings. This can be because the method's lengthy and difficult process.

TWO – COLUMN ANALOGY

Smith and Jesien [70] endorsed the usage of a -column analogy to examine unmarried center partitions or cores, that are additives of large surrounding systems which might be uncovered to lateral loading. The version includes columns, one on both facet of the primary bending axis of the center, which constitute the warping and St. Venant torsional modes. The columns percentage the traits of the center. Figure 3.thirteen illustrates this idea for a U-fashioned center. When as compared to the findings received the usage of shell elements, it became said that [70] the deflections and stresses produced through the cautioned technique had been inside 10% and 20%, respectively.

This technique, which is typically employed to comprehend the overall behaviour of the structural system, is restricted in its analysis of single core walls.

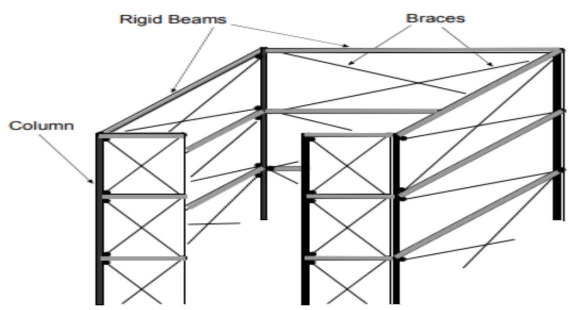
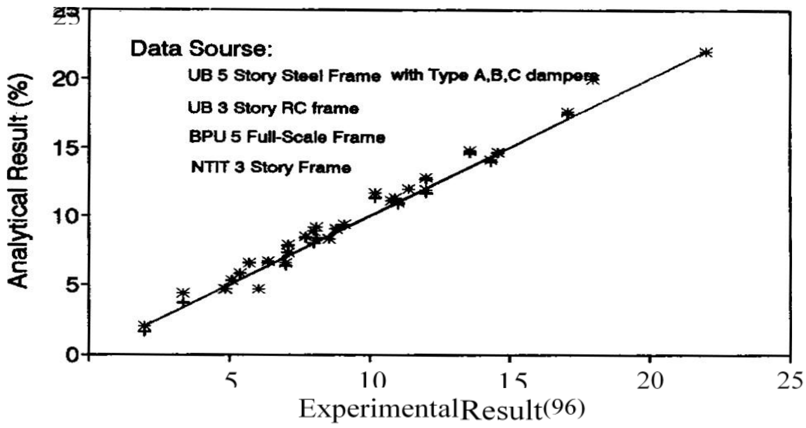


Fig 2.8 Two Column Analogy

METHODOLOGY

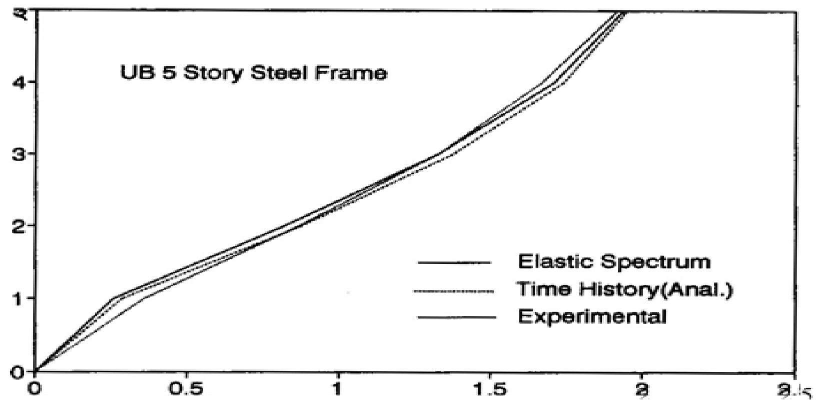
Time History Analysis

Once the visco elastically damped structure's damping ratios have been determined, seismic response assessments may be performed utilising the available dynamic analysis software. Figure 6 displays the test results for a five-story model's average time history response prediction under the 0.6g Hachinohe earthquake (Chang et al. 1995). In this work, the VE damper assemblies are modelled as truss components using the modal strain energy approach in the modified version of the computer software ETABS. Numerous such research have been conducted, and the findings show that if the structure's damping ratios can first be precisely anticipated, the elastic time-history response of visco elastically damped structures can be predicted with good accuracy.



Graph:1 Experimental analysis

Demonstrates the time-records responses of a three-tale metallic shape with superior VE dampers to a 0.8g El earthquake as derived experimentally and computationally (Chang et al. 1996). Drain2D+ fashions the structural individuals and VE damper assemblies as bi-linear beam and column and truss components, respectively. It is obvious that the analytical end result usually predicts



Graph.2: Lateral Displ.(cm) Response spectrum analysis, 0.6g El Centro, 15% damping, lateral displacement

DIFFERENT TYPES OF LOADS ACTING ON THE STRUCTURE

Vertical burdens, level burdens, and longitudinal burdens are the three sorts of burdens that work on structures for buildings and different constructions. Dead loads, live loads, and effect loads make up the upward loads. Wind and earthquake loads are utilized in the flat loads. The longitudinal anxieties, for example, tractive and slowing down powers, are considered in the development of extensions, gantry supports, and different constructions.

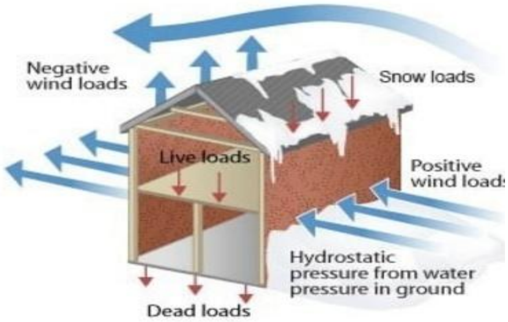


Fig 3.1 Types of Loads on the Structure

Wellbeing and economy are number one contemplations of constructing layout. The financial system might be affected if the hundreds are adjusted and brought higher. As price is taken into consideration and stacks are decreased, safety is risked. Therefore, the estimation of diverse burdens appearing have to be precise. Different layout hundreds for homes and structures are characterized in Indian Standard Code IS: 875-1987 and American Standard Code ASCE 7: Minimum Design Loads for Buildings and Other Structures.

Types of loads acting on the structure are:

1. Dead loads
2. Imposed loads
3. Wind loads
4. Snow loads
5. 5Earthquake loads
6. Special loads

Dead loads (DL)

The dead burden is the main vertical burden to be thought of. The expression "dead loads" alludes to loads that stay steady or stable over the existence of a framework. Oneself load of primary individuals, lasting part dividers, fixed perpetual hardware, and the heaviness of different materials are the fundamental wellsprings of dead burden. It for the most part comprises of the heaviness of floors, bars, dividers, and segments, which are generally the building's perpetual segments.

Imposed loads or Live loads (IL or LL)

Forced burdens, in any other case referred to as stay masses, are the second one type of vertical burden this is taken into consideration while designing a framework. Live masses are flexible or strolling burdens that do not accelerate or impact the climate. These thousands are concept to be created with the aid of using the building's organized usage or inhabitance, together with the masses of transportable allotments or furniture, similarly to different things.The stay burden varies now and again. The producer ought to definitely anticipate those thousands. It is one of the design's precept masses. IS 875 (segment 2) – 1987 shows the bottom stay burden esteems to be accepted. It is reliant upon the building's organized use.

The code gives the values of live loads for the following occupancy classification:

a. **Residential buildings -** dwelling houses, hotels, hostels, boiler rooms and plant rooms, garages.
b. Educational buildings
c. Assembly buildings
d. Business and office buildings
e. Mercantile buildings
f. Industrial buildings and
g. Storage rooms.

The code produces both uniformly scattered and grouped burdens. The floor chunks should be worked to bear either uniformly divided loads or bunched loads, contingent upon which causes more prominent anxieties in the segment being referred to. Since it is uncommon that all floors will hold full loads simultaneously, the code considers any heap alleviation when building segments, load bearing dividers, docks supports, and establishments.

Wind loads

The flat burden created through the access of air comparative with the earth is called wind load. At the factor whilst the stature of the constructing arrives at more than one instances the measurements go over to the exposed breeze surface, wind load ought to be remembered for underlying layout.

The breeze load isn't always considerable for low-ascent homes of 4 to 5 tales because the photograph of competition given through the congruity of the ground framework to section connection and the dividers gave among sections is excellent to oblige the impact of those powers. Besides, whilst wind is taken into consideration withinside the breaking factor nation measure, the thing for layout load is dwindled to 1.2 (DL+LL+WL) as opposed to 1.5 (DL+LL) whilst wind isn't always idea of.

The degree powers implemented through wind additives ought to be considered as even as growing the layout. The evaluation of wind masses is challenge to 2 variables: wind velocity and constructing scale. The IS-875 (Part 3) - 1987 offers overall information on estimating wind load on structures.

Earthquake loads (EL)

The construction is exposed to both vertical and level earthquake impacts. The general vibration prompted by an earthquake can be separated into three commonly opposite tomahawks, which are frequently alluded to as vertical and flat.

Sidelong loads or flat loads following up on the design is appeared in the Figure

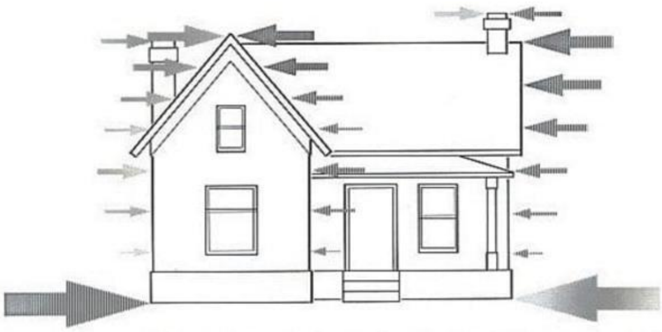


Fig3.2: Lateral loads acting on the building

Other loads and effects acting on structures

As according to the clause 19.6 of IS 456 – 2000, further to above load discussed, account will be taken of the subsequent forces and outcomes if they may be susceptible to have an effect on the protection and serviceability of the structure.

a. Foundation movement (see IS 1904)
b. Elastic axial shortening
c. Soil and fluid pressure (see IS 875, element 5)
d. Vibration
e. Fatigue
f. Impact (see IS 875, part5)
g. Impact (see IS 875, element 5)
h. Erection loads (see IS 875, element 2) and
i. Stress attention impact because of factor load and the like.

Problem Statement

In the present study, analysis of G+12 multi-story commercial building in zone 2 is considered in ETABS. Building has a typical size of Basic parameters considered for the analysis are:

1. Utility of building : Residential building
2. Number of stories : G+12
3. Shape of building : Regular and irregular
4. Geometric details
    a. Ground floor : 3 m
    b. floor to floor height : 3m
    c. Height of the building : 36m
5. Material details
    a. Concrete Grade : M40 (COLUMNS AND BEAMS)
    b. All Steel Grades : HYSD reinforcement of Grade Fe600
    c. Bearing Capacity of Soil : 200 KN/m^2
6. Type Of Construction : R.C.C FRAMED structure
7. Column : 0.5m X 0.3m
8. Beams : 0.3m X 0.3m
9. Slab : 0.150m
10. Special considerations
    - Shear wall : Thickness 125mm
11. Concrete code : IS 456-2000

12. Seismic code : IS 1893:2015
13. Wind code : IS 875:1987

MODELING OF BUILDING IN ETABS

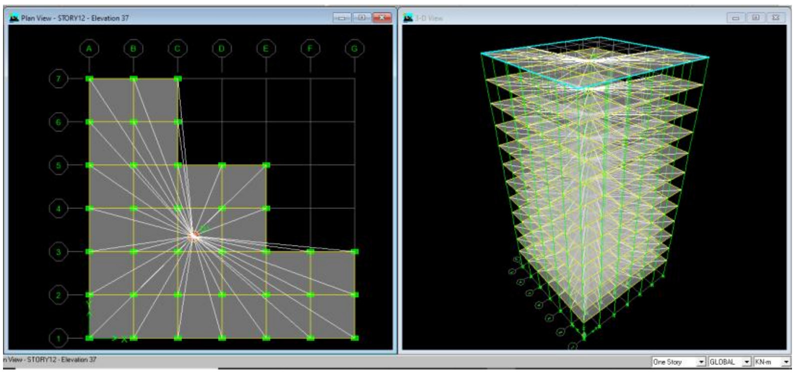
1. Open ETABS program.
2. Check the units of the model in the drop-down box in the lower right-hand corner of the ETABS window, click the drop-down box to set units to Kn-m.
3. Click the File menu > New model command
4. The next form of Building Plan Grid System and Story Data Definition will be displayed after you select NO button.Set the grid line and spacing between two grid lines. Set the story height data using Edit Story Data command
5. Define the design code using Options > Preferences > Concrete Frame Design command .This will Display the Concrete Frame Design Preference form as shown in the figure.
6. Click the Define menu > Material Properties Add New Material or Modify/Show Material used to define material properties
7. Define section columns and beams using Define > Frame section
8. Define wall/slab To define a slab as membrane element and one way slab define using special one way load distribution
9. Generate the model Draw beam using Create Line Command and draw column using Create Column command
10. Slab is created using 3 options in which 1st draw any shape area, 2nd draw rectangular area and 3rd create area in between grid line
11. Above creating option used to generate the model as shown in below figure
12. Define various loads (Dead load, live load, wind load, Earthquake load)
13. Dead Load: self weight multiplier is used 1 to calculate dead load as default. Live load or any other define load 1st select the member where assign this load than click the assign button.
14. Assign point load and uniform distributed load Select assigning point or member element than click the assign button
15. Assign support condition Drop-down box in the lower right-hand corner of the ETABS window, Select only bottom single storey level to assign fixed support using assign > Joint/Point>Restrain (Support) command
16. In building, slab is considered as a single rigid member during earthquake analysis. For

that, all slabs are selected first and apply diaphragm action for rigid or semi rigid condition.

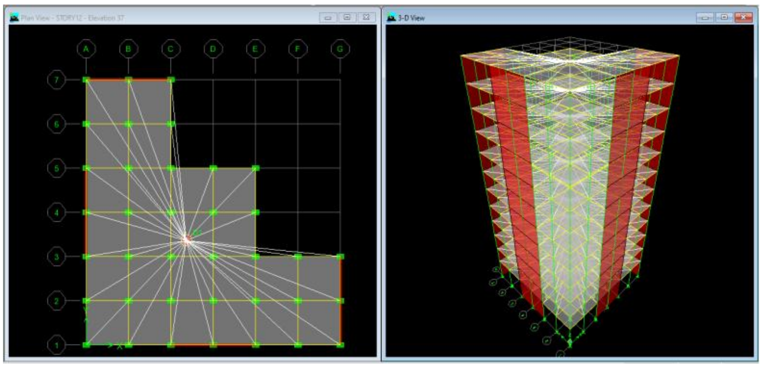
17. Mass source is defined from Define > mass source command
18. Run analysis from Analysis > Run Analysis command

MODELS IN ETABS V 9.7.4

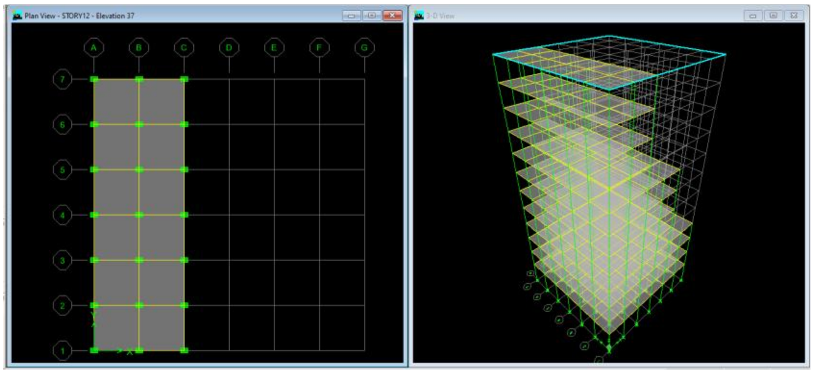
A. Horizontal irregular without shear wall



B. Horizontal irregular with shear wall



C. Vertical irregular without shear wall



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D. Vertical irregular with shear wall

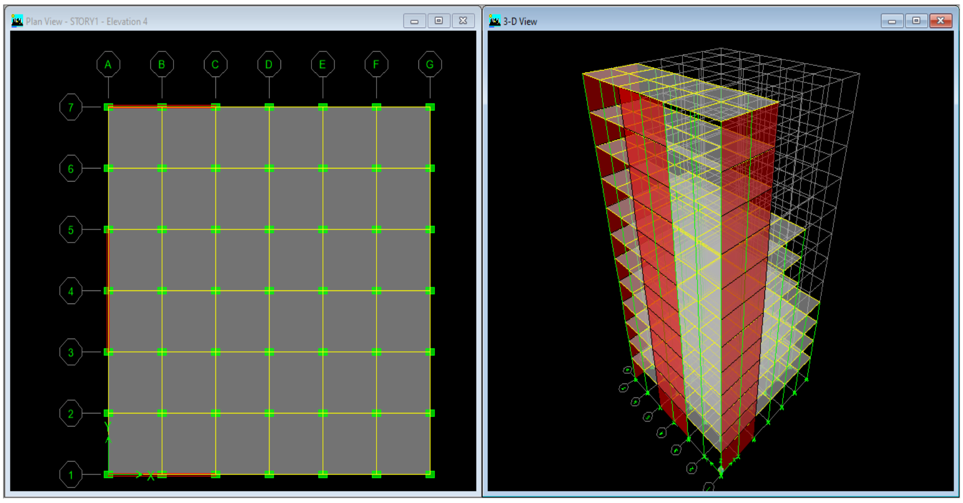


Fig3.3 A,C horizontal irregularity &vertical irregularity without shear walls

Fig B, D horizontal irregularity &vertical irregularity shear walls

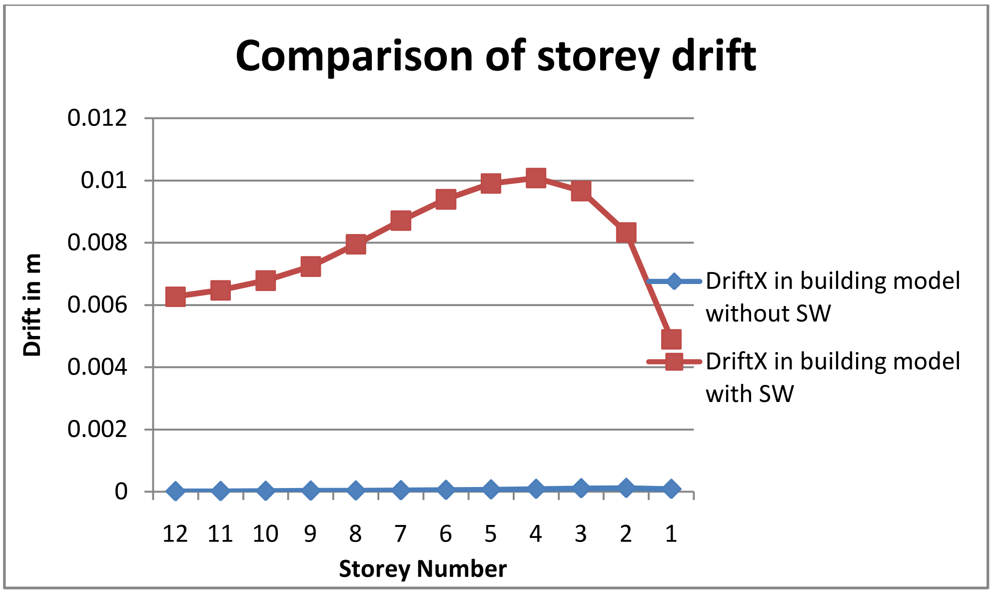
RESULTS AND DISCUSSION

Horizontal irregularity

Storey drift

Table 1 Story Drift of a Horizontal Building With and Without Shear Walls

Storey Number	**Load**	**Drift X in building model without SW**	**Drift X in building model with SW**
12	TH	0.000011	0.006268
11	TH	0.000016	0.006472
10	TH	0.000022	0.006786
9	TH	0.000028	0.007236
8	TH	0.000034	0.007948
7	TH	0.000042	0.008711
6	TH	0.000053	0.009396
5	TH	0.000068	0.009903
4	TH	0.000087	0.010076
3	TH	0.000106	0.009662
2	TH	0.000116	0.008329
1	TH	0.000085	0.004901

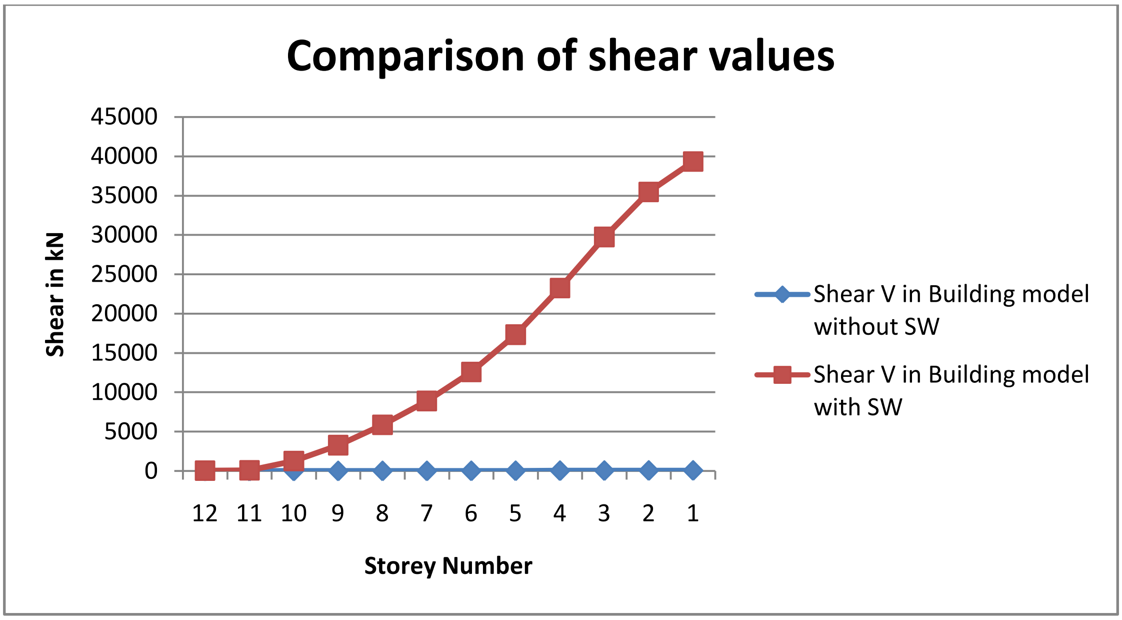


Graph 3 Comparision of Storey Drift Between Horizontal Buildings With and Without shearwalls

Storey shear

Table 2 Storey Shear of Horizontal Building With and Without Shear Walls

Storey Number	**Load**	**Shear V in Building model without SW**	**Shear V in Building model with SW**
12	TH	2.3	46.06
11	TH	5.44	66.86
10	TH	8.92	1248.31
9	TH	12.31	3276.04
8	TH	15.39	5865.01
7	TH	18.76	8899.19
6	TH	23.77	12588.19
5	TH	31.82	17328.82
4	TH	43.16	23251.46
3	TH	56.18	29751.94
2	TH	67.68	35465.43
1	TH	74.63	39342.2

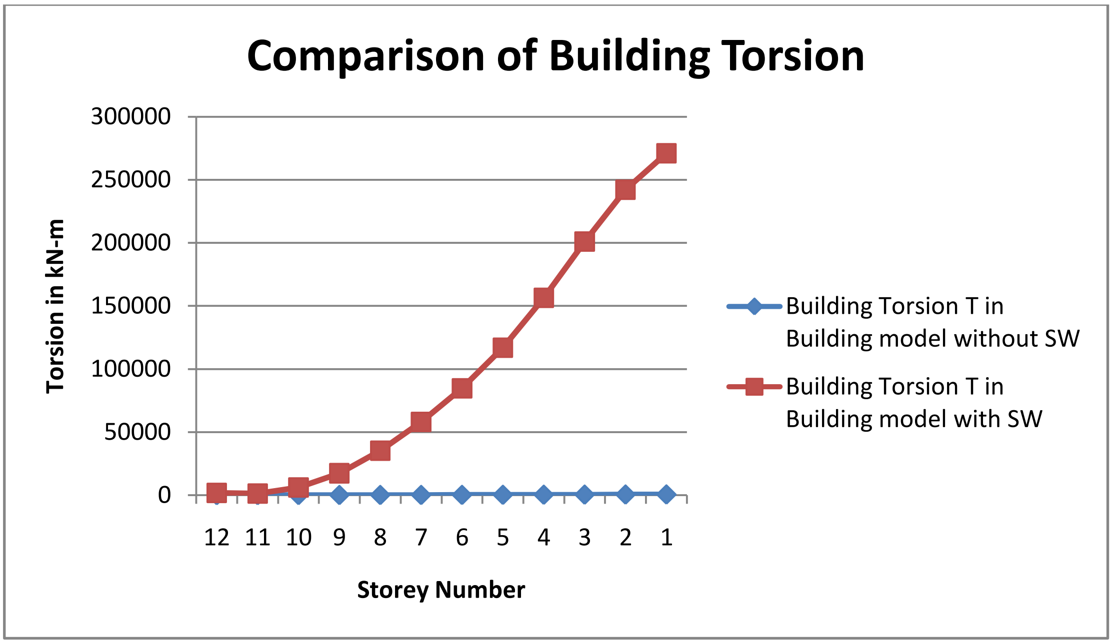


Graph 4 Comparison of shear values of Horizontal Building With ana Without Shear Walls

Storey bending

Table 3 Storey Bending of Horizontal Building With and Without Shear wall

Storey Number	Load	Building Torsion T in Building model without SW	Building Torsion T in Building model with SW
12	TH	12.927	1825.724
11	TH	32.292	1311.517
10	TH	55.578	6044.313
9	TH	79.729	17393.08
8	TH	102.861	35247.04
7	TH	128.371	57986.004
6	TH	165.2	84707.543
5	TH	222.716	116859.202
4	TH	302.69	156352.379
3	TH	393.846	200991.439
2	TH	473.853	241977.704
1	TH	521.755	270892.993

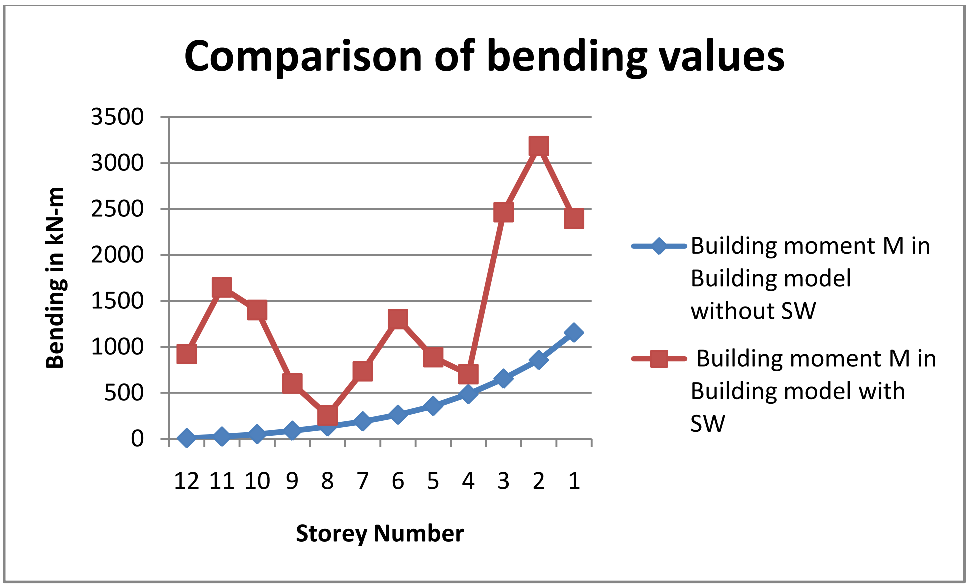


Graph 5 Comparison of Building Torsion of Horizontal Building With and Without Shear wall

Story moment

Table 4 Storey Moment of Horizontal Building With and Without Shear wall

Storey Number	Load	Building moment M in Building model without SW	Building moment M in Building model with SW
12	TH	6.914	921.884
11	TH	23.243	1646.243
10	TH	50.005	1400.799
9	TH	86.922	602.239
8	TH	133.1	254.339
7	TH	189.382	734.579
6	TH	260.704	1302.741
5	TH	356.164	886.691
4	TH	485.647	702.744
3	TH	654.196	2465.554
2	TH	857.242	3184.758
1	TH	1155.748	2396.963



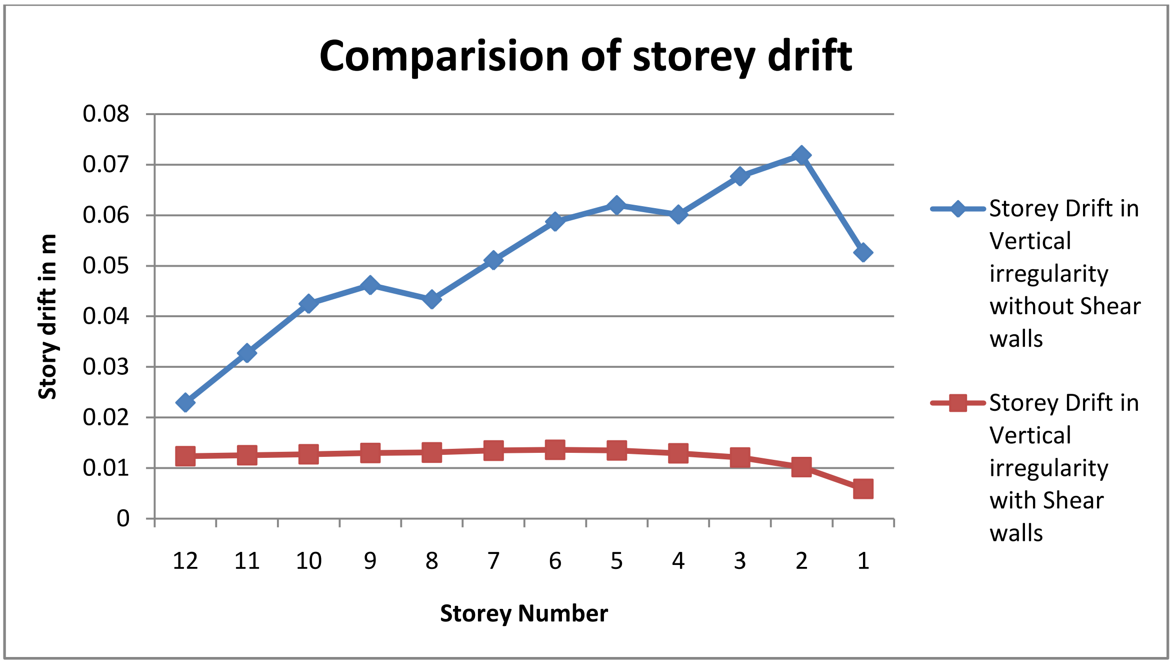
Graph 6 Comparison of Bending Values of Horizontal Building With and Without Shear wall

Vertical irregularity

Storey drift

Table 5 Storey Moment Of Vertical Building With and Without Shear wall

Storey Number	Load	Storey Drift in Vertical irregularity without Shear walls	Storey Drift in Vertical irregularity with Shear walls
12	TH	0.022942	0.012343
11	TH	0.032737	0.012535
10	TH	0.042502	0.012767
9	TH	0.046185	0.012997
8	TH	0.043353	0.013095
7	TH	0.051102	0.013468
6	TH	0.058736	0.013626
5	TH	0.061992	0.0135
4	TH	0.060137	0.012925
3	TH	0.067701	0.012087
2	TH	0.071903	0.010207
1	TH	0.052636	0.005895

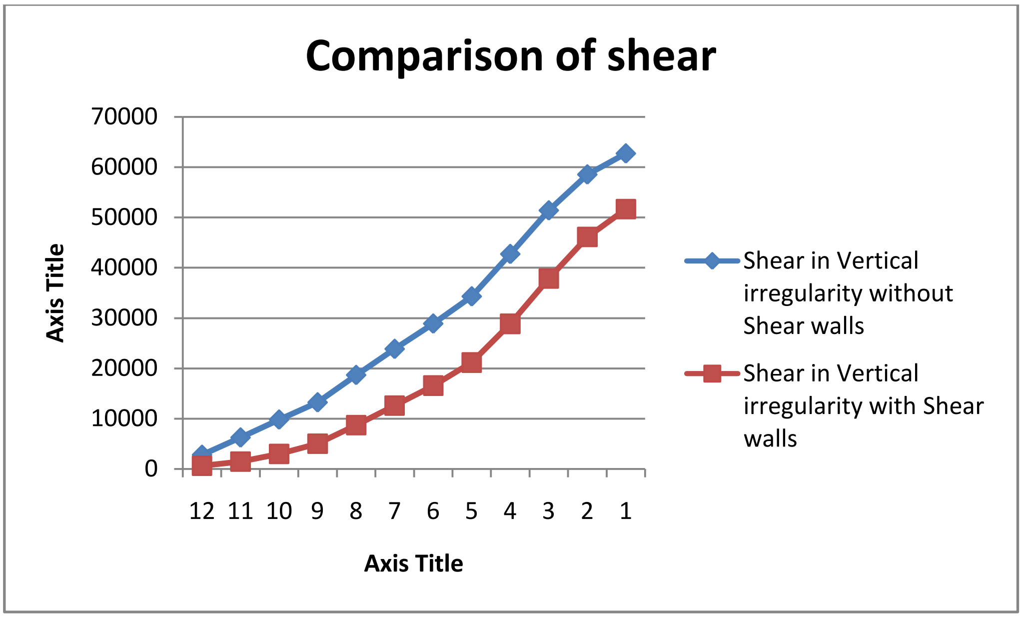


Graph 7 Comparision of Storey Drift Between Vertical Buildings With and Without shearwalls

Storey shear

Table 7 Storey Shear of Vertical Building With and Without Shear wall

Storey Number	Load	Shear in Vertical irregularity without Shear walls	Shear in Vertical irregularity with Shear walls
12	TH	2779.43	629.3
11	TH	6222.38	1455.45
10	TH	9785.98	2987.23
9	TH	13212.85	5017.3
8	TH	18651.78	8710.02
7	TH	23842.16	12579.7
6	TH	28872.63	16560.35
5	TH	34287.45	21157.44
4	TH	42712.94	28856.48
3	TH	51384.47	37870.09
2	TH	58528.24	46126.27
1	TH	62710.44	51664.41

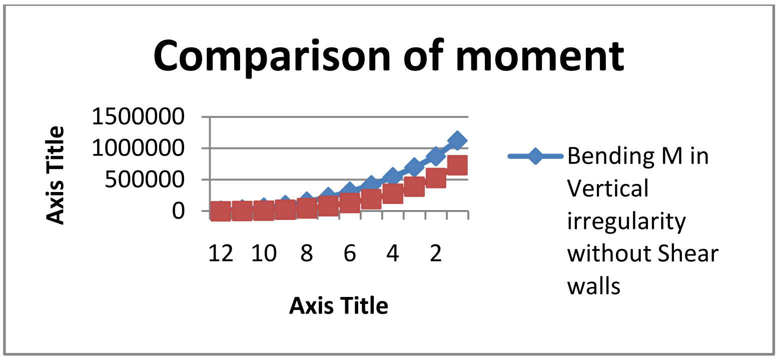


Graph 8 Comparision of Storey Shear Between Vertical Buildings With and Without shear Walls

Story moment

Table 8 Storey Moment of Vertical Building With and Without Shear wall

Storey Number	Load	Bending M in Vertical irregularity without Shear walls	Bending M in Vertical irregularity with Shear walls
12	TH	8338.275	188.615
11	TH	27005.419	2855.667
10	TH	56363.354	10118.069
9	TH	96001.889	23470.677
8	TH	151957.232	47901.445
7	TH	223483.701	83941.236
6	TH	310101.581	131922.975
5	TH	412963.921	193696.003
4	TH	541102.755	278566.146
3	TH	695256.161	390477.116
2	TH	870840.894	527156.64
1	TH	1121682.648	730793.305



Graph 9 Comparision of Storey Moment Between Vertical Buildings With and Without shear Wall

CONCLUSION

From this study the following conclusions were made

1. Earth quake resistant building design is carried out in this study for the both plan as well as vertical irregularities by considering shear walls.
2. Shear walls are the vertical members which are generally used to reduce the intensity of the lateral loading conditions related to the seismic loads and wind loads.
3. The storey drift values are observed high in case of building with shear wall condition in case of horizontal irregularity building.
4. The values related to the shear bending torsion in Horizontal irregularity buildings is high for the with shear wall case than without shear wall case.
5. Time period vales decrease from node 1 to node 12 and it has higher values in without shear wall model than with shear wall model.
6. Model stiffness increases from node 1 to node 12 and it has higher values for building without shear wall case than with shear wall case.
7. The story drift values has higher intensities for without shear walls than with shear walls in case of vertical irregular structures.
8. The values related to the shear bending torsion in vertical irregularity buildings is high for the without shear wall case than with shear wall case.
9. Time decreases from node 1 to node 12 and it has higher values for without shear wall condition than with shear wall case.
10. Model stiffness increases from node 1 to node 12 and it has higher values for building with shear wall case than without shear wall case.
11. The vertical stiffness building is more earth quake resistant than the horizontal

irregularity buildings

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