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Comparative Study Of High Rise Building With And Without Shear Wall In Different Seismic Zones

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Abstract: The majority of metropolitan India's buildings are made on Reinforced Concrete (RC) frames. Throughout their service lives, these are subjected to a variety of stresses, including static forces from dead and live loads and dynamic forces from earthquakes. This research compares the Response Spectrum analysis of two different earthquake-damaged reinforced concrete buildings. In this research, an ETABS (Extended Three-Dimensional Analysis of Building System)-based Response Spectrum analysis was performed on a G+8-story reinforced concrete building. The Indian Building Codes (IS 875 parts 1, 2, 3, 5, and 1893) are used to calculate the allowable load.

Dynamic (response spectrum) analysis outcomes are presented in this study, including displacement, storey shear, and overturning moment.

Index Terms - ETABS, Response Spectrum analysis

I. Introduction

An earthquake is a jarring disturbance that generates surface shaking due to underlying movement along a fault line or from volcanic activity. Millions of people throughout history have lost their lives due to earthquakes. When considering the number of lives lost and the amount of property destroyed, the earthquake is among India's most catastrophic earthquakes on record. Bhuj, Gandhidham, Rajkot, etc., are only few of the major cities that have been hit hard by the earthquake. Death and damage are inevitable results of each earthquake. In the Bhuj earthquake, India's first reinforced concrete multi-story structures experienced severe ground motion shaking. Failure can occur for a variety of reasons, including but not limited to: soft stories, floating columns, mass irregularities, low quality construction materials and defective construction practises, inconsistent seismic response, soil and foundation, influence of pounding of nearby structures, etc. The history of earthquakes is littered with examples of reinforced concrete (RC) structures collapsing or being severely damaged. Numerous inquiries have been made into earthquake-damaged or -destroyed structures. Some of the major flaws in the structure included poor quality concrete, end areas, weak column-strong beam behaviour, short column behaviour, inadequate splice lengths, and inappropriate hooks on the stirrups. The vast majority of those structures were built before the advent of stringent safety regulations. In most cases, they are unable to meet the demands of current building codes due to a lack of ductility, lateral stiffness, and strength. Vulnerable structures have poor lateral stiffness and strength, making them susceptible to large displacement demands that they cannot meet properly due to their lack of ductility.

ETABS is the go-to programme for engineers everywhere. Design companies rely heavily on the software for conceptualising new projects. The revolutionary new ETABS is unparalleled in the realms of structural analysis and building design. The latest version of ETABS is the result of 40 years of development, and it offers users state-of-the-art 3D object-based modelling and visualisation tools, lightning-fast linear and nonlinear analytical power, advanced and comprehensive design capabilities for a wide variety of materials, and insightful graphic displays, reports, and schematic drawings that facilitate rapid comprehension of analysis and design outcomes.

II. METHODOLOGY

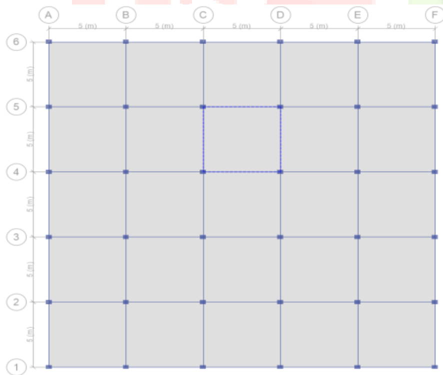
To calculate how a building will react in the event of an earthquake is the focus of seismic analysis, often known as earthquake analysis. The lowest frequency of a structure's response is its basic mode, which can cause it to sway back and forth during an earthquake. Higher kinds of response in buildings, however, are uniquely triggered by an earthquake. After a structural model has been chosen, seismic analysis can be performed to ascertain the forces acting on the structure as a result of the earthquake. There is a wide range of precision possible using these various approaches to analysis. The analysis process can be broken down into three distinct groups dependant on the external loads considered, the structure's or material's behavior, and the modal analysis technique chosen. The analysis can be further broken down into linear static analysis, linear dynamic analysis, and nonlinear dynamic analysis based on the nature of the external action and the structure's behaviour.

III-LOAD CALCULATIONS

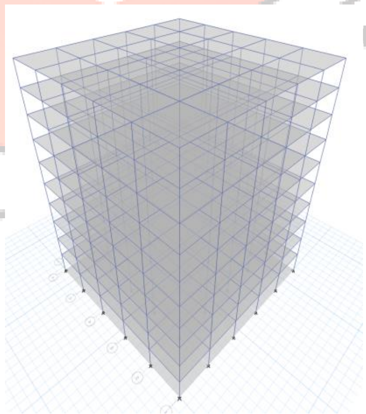
Case 1:

- Plan area =25(m)*25(m)
- Beam size =300(mm)*400 (mm)
- Column size =300(mm)*500 (mm)
- Slab =125 mm
- ‘eam length and column c/c spacing =5m
- Typical storey height = 3m
- Live load =4kN/m²
- Wall load =18 kN/m in all beams
- Beam clear cover =25 mm
- Column clear cover =40 mm
- M25, Fe550 ,Zone V,IV,III, Soil Type (III)

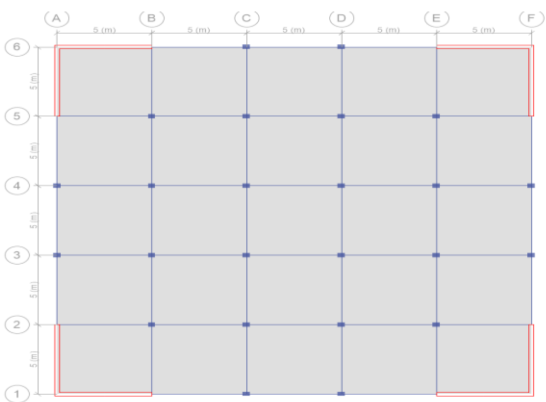
PLAN WITH OUT SHEAR WALL



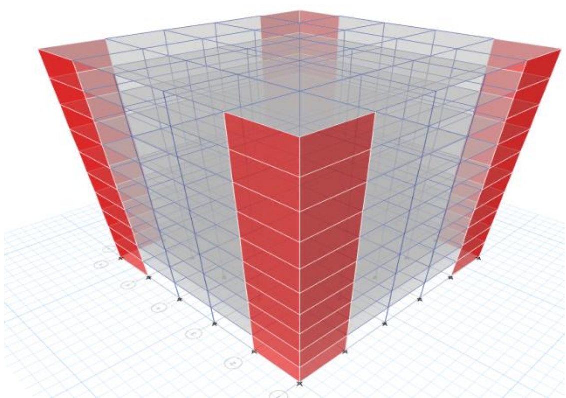
3D View



PLAN WITH SHEAR WALL



3D View



IV-LOADING

Dead Loads (DL)

Sl. No	Material	Weight
1	Brick Masonry	18.8 kN/m^3
2	Stone Masonry	20.5-26.5kN/m^3
3	Plain Cement Concrete	25kN/m^3
5	reinforced concret	25kN/m^3
5	timber	5-8kN/m^3

Load calculation

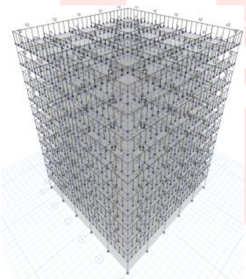
Dead load calculation

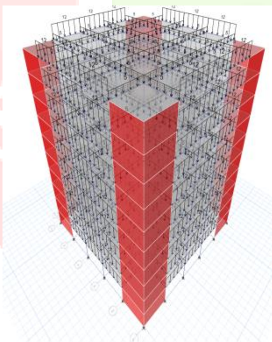
Weight=Volume x Density

Self weight floor finish=0.1270*25+1=4.175kn/m^2

The above example shows a sample calculation of dead load.

Dead load is calculated as per IS 875 part 1





more than twice the dimensions transverse to the exposed wind surface, it must be designed to withstand the force of the wind. The moment of resistance supplied by the continuity of the floor system to the column connection and the walls provided between the columns is adequate to handle the influence of these forces, making the wind load unimportant for low rise buildings of up to four or five storeys. In addition, when wind is taken into account, the design load factor in the limit state technique drops from 1.5(DL+LL)to1.2(DL+LL+WL).

It's important to consider the horizontal forces exerted by the wind components as you plan the building's layout. Wind loads are determined by the wind speed and the dimensions of the building. The following provides comprehensive information for determining wind load on structures (as per the IS-875 (Part 3) -1987). India's basic wind pressure (Vb) is represented on a color-coded map. The value of Vb can be determined by the designer based on the location of the structure.

To get the design wind velocity V_z the following expression shall be used:

$$V_z = k_1.k_2.k_3.V_b$$

Where k_1 = Risk coefficient

k_2 = Coefficient based on terrain, height and structure size.

k_3 = Topography factor

The design wind pressure is given by

$$p_z = 0.6\, V^2_z$$

wherep_z is in N/m^2 at height Z and V_z is in m/sec. Up to a height of 30 m, the wind pressure is considered to act uniformly. Above 30 m height, the wind pressure increases.

5.5 Snow Loads (SL):

Snow loads constitute to the vertical loads in the building. But these types of loads are considered only in the snow fall places. The IS 875 (part 5) – 1987 deals with snow loads on roofs of the building.

The minimum snow load on a roof area or any other area above ground which is subjected to snow accumulation is obtained by the expression

$$S = \mu S_0$$

Where S = Design snow load on plan area of roof.

μ = Shape coefficient, and

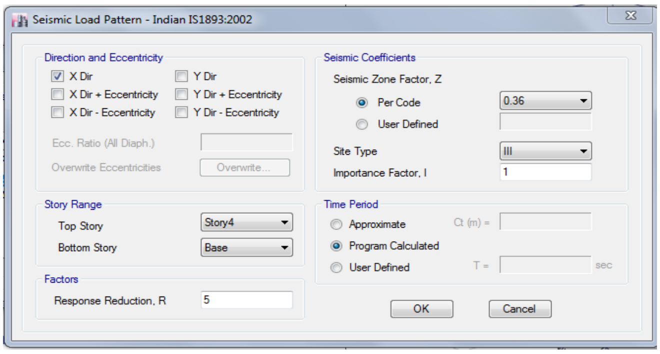
S_0 = Ground snow load.

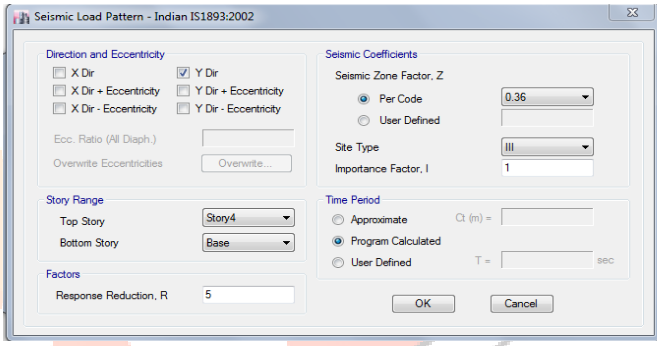
V-Earthquake Loads (Linear Static Analysis):

The building will be subjected to horizontal and vertical forces during an earthquake. An earthquake's entire vibration can be broken down into three orthogonal components—typically the vertical and the two horizontal components.

There is little to no effect on the superstructure from vertical motion. However, designers must account for the building's horizontal movement during an earthquake.

The size, kind of construction, and duration and magnitude of ground motion all play a role in how

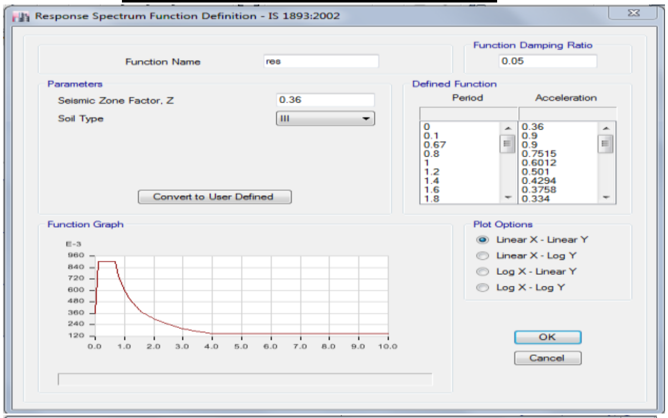


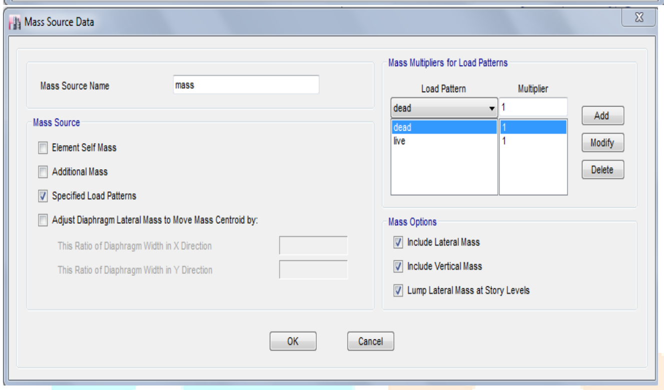


the building reacts to vibrations below. For buildings on stable ground that won't shift or slide too much during an earthquake, the formula for making these estimations can be found in IS 1893-2015.

In order to calculate the necessary seismic accelerations for the design, the seismic coefficient can be used. This coefficient is the ratio of the acceleration caused by the earthquake to the acceleration caused by gravity. Monolithic reinforced concrete buildings in seismic zones 2 and 3 that are no more than 5 storeys tall and have an importance factor of less than 1 are not particularly vulnerable to seismic pressures

Response spectrum method





Other Loads and Effects acting on Structures

As per the clause 19.6 of IS 556 – 2000, in addition to above load discussed, account shall be taken of the following forces and effects if they are liable to affect materially the safety and serviceability of the structure:

(a) Foundation movement (See IS 1905)

(b) Elastic axial shortening
(c) Soil and fluid pressure (See IS 875, Part 5)
(d) Vibration
(e) Fatigue
(f) Impact (See IS 875, Part 5)
(g) Erection loads (See IS 875, Part 2) and
(h) Stress concentration effect due to point load and the like.

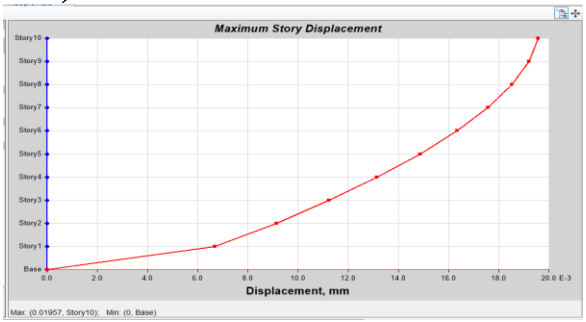
VI-RESULT AND DISCUSSION

1. DISPLACEMENT:

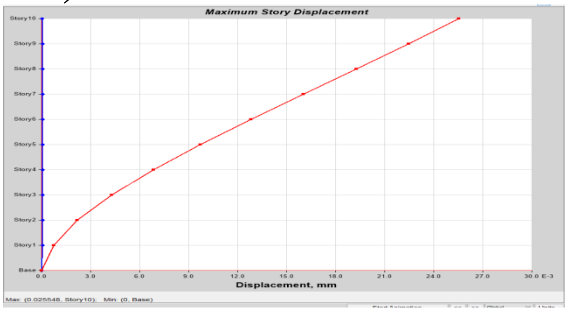
When evaluating the lateral stability and stiffness of a tall building's lateral force resisting systems, displacement is a crucial measure. "Wind causes lateral displacement, which compromises the stability and durability of tall buildings. Because of the building's relocation, the residents are uneasy.

ZONE 5

a) WITH SHEAR WALL

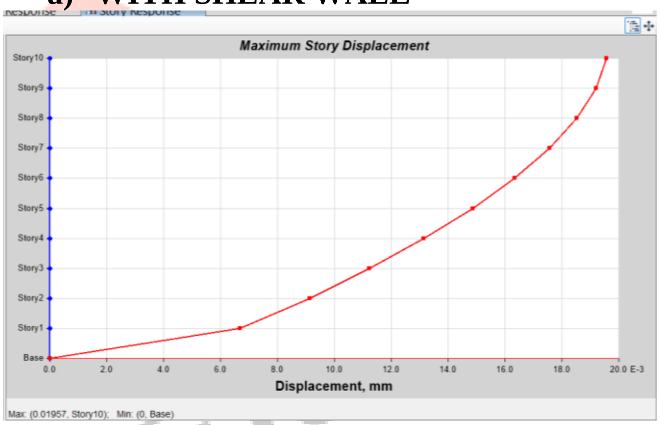


b) WITHOUT SHEAR WALL



2) ZONE 4

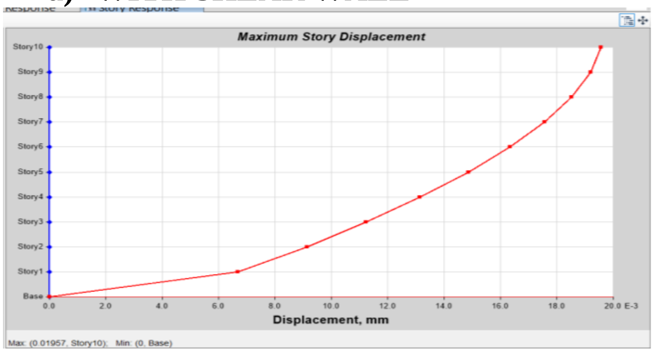
a) WITH SHEAR WALL



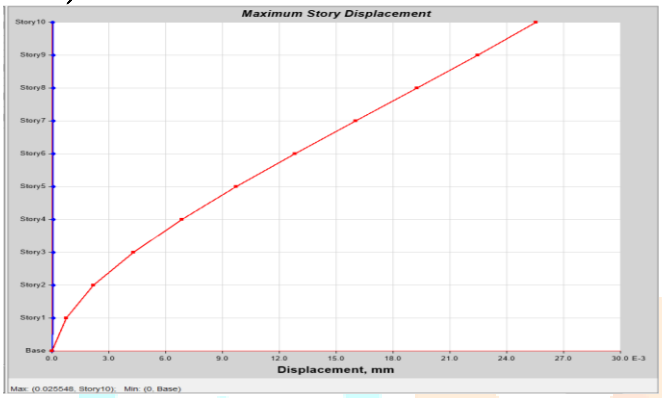
b) WITHOUT SHEAR WALL

2) ZONE 3

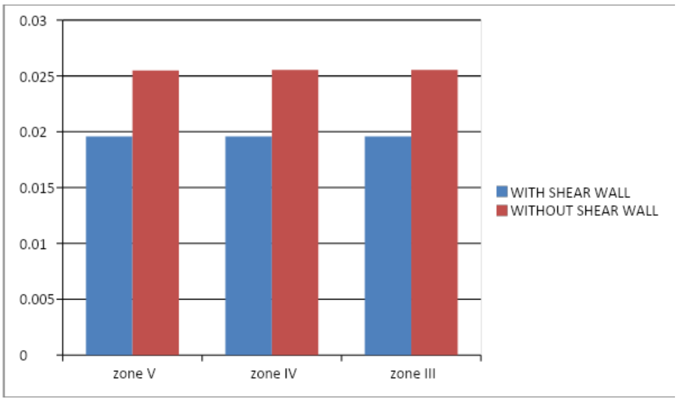
a) WITH SHEAR WALL



b) WITHOUT SHEAR WALL



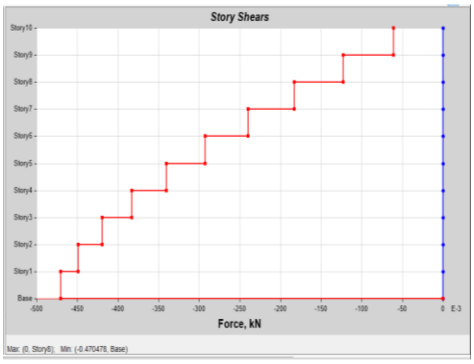
DISPLACEMENT COMARISION GRAPHS:

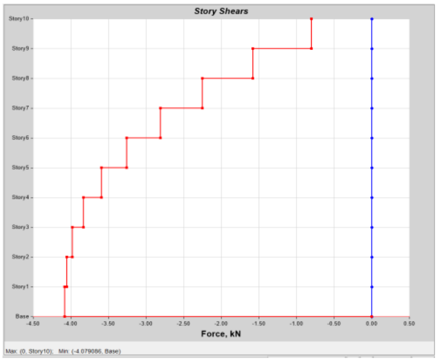


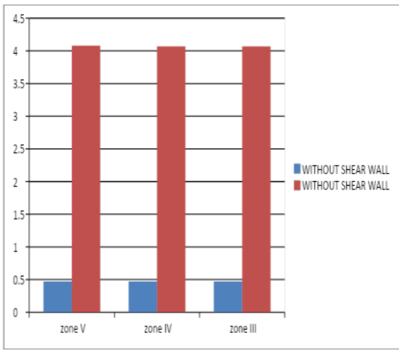
STOREY SHEAR

ZONE 5

a) WITH SHEAR WALL b) WITHOUT SHEAR WALL C) STOREY SHEAR COMPARISON



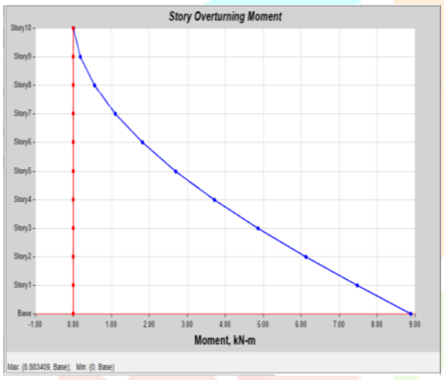


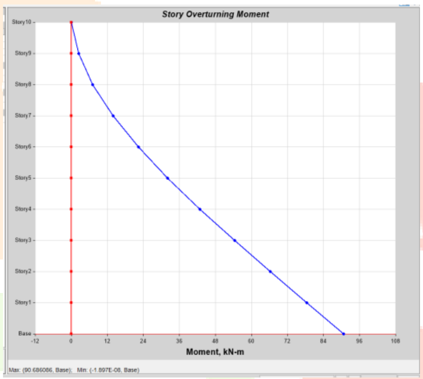


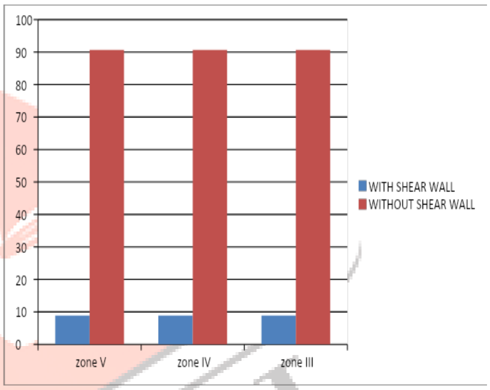
Overturning Of The Structure

ZONE 5

a) WITH SHEAR WALL b) WITHOUT SHEAR WALL C) OVERTURNING COMPARISON







VII-CONCLUSION

Displacement is a critical factor to consider when assessing the lateral stability and stiffness of a tall building's lateral force resisting systems. The stability and durability of tall buildings are compromised by lateral displacement brought on by wind. The residents are uneasy as a result of the building's relocation. The sum of all design lateral forces acting on floors above the contested floor results in the total lateral force. Due to the uniformity of building areas across all models, storey shear caused by seismic and wind loads will be equal. The shear in the top levels won't be impacted by the wind and seismic loads until the building itself changes. The storey shear of a building is greatest at the base and lowest at the top. The lateral pressures lead the building to topple over. Wind loads, earthquake loads, seismic loads, etc. are all examples of lateral forces. Lateral force refers to the pressure that soil puts on a retaining wall. Earth pressure refers to the force exerted by the soil or backfill against the retaining wall

Deflection in the lateral direction and lateral sway in one direction are both exhibited in constructions subjected to lateral forces like wind force and seismic effects. Because of this, the structure topples over Large lateral forces are exerted on tall structures. Therefore, they are built so that the structure itself can prevent them from toppling over. The stability of the structure improves considerably when the overturning impact is taken into account during the design analysis". A structural collapse may occur if the building is overturned without protection.

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