**ABSTRACT**

*Earthquake is a very important parameter to be considered while designing structures. The seismic performance of both regular shape and irregular shape buildings depends on the height of the building along with other important structural parameters. As increasing the building height increases the base shear and base moment at the base of building. Vertical aspect ratio (H/L or H/B) affect the performance of structure for resisting lateral loading. The selection of structures configuration must be appropriate to withstand against seismic force. In the present work comparison of regular and irregular plan of commercial building for different vertical aspect ratio is carried out by using ETABS software for seismic zone II and V for different soil types.*

**Keywords:** ETABS Software, high rise building, seismic zone, soil type, vertical aspect ratio.

1. Introduction

The ratio of building height (h) to building width (b) is known as slenderness ratio of any building or structure. Increasing the building height increases the base shear and base moment at the base of building or any other structures. Higher slenderness buildings are more vulnerable than any other buildings during earthquake. Since base moment increases the axial forces in building components so it has become very important parameter to check whether the building is slender or not. It is not prohibited to build slender building at all but all the structure should have enough ductility to sustain during earthquake. Whether the building is slender or not the most important thing is buildings or any other structures should be construct earthquake resistive and stiff against seismic force. The symmetry and regularity are usually recommended for a sound design of earthquake resistant structure.

Building configuration refers to the indicators of shape and dimensions of a building as a unity, resulting from the project solution and related to the geometric proportion of the building contours. In a wider sense, the configuration includes the type, dimensions and position of structural elements, also emphasizing the

<table>
<thead>
<tr>
<th>MANISHA R. SINARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Civil Engineering, Shreyash College Of Engineering and Technology, Aurangabad, India, <a href="mailto:mrsinare@gmail.com">mrsinare@gmail.com</a>)</td>
</tr>
<tr>
<td>DR. P.S.BHALAGE</td>
</tr>
<tr>
<td>(Head of Civil Engineering, Shreyash College Of Engineering and Technology, Aurangabad, India, <a href="mailto:pradeep.bhalage@gmail.com">pradeep.bhalage@gmail.com</a>)</td>
</tr>
<tr>
<td>PROF. N.S. VAIDKAR</td>
</tr>
<tr>
<td>(Civil Engineering, Shreyash College Of Engineering and Technology, Aurangabad, India, <a href="mailto:nitinvaidkar@gmail.com">nitinvaidkar@gmail.com</a>)</td>
</tr>
<tr>
<td>PROF. A.B. VAWHALE</td>
</tr>
<tr>
<td>(Civil Engineering, Shreyash College Of Engineering and Technology, Aurangabad, India, <a href="mailto:avawhale@yahoo.in">avawhale@yahoo.in</a>)</td>
</tr>
</tbody>
</table>
significance of structural properties of a building.

1.1 Structural irregularities
There are different types of irregularities, IS Code 1893 (Part-1):2002 classifies irregularity in two parts: plan irregularities and vertical irregularities. In this study, vertical irregularities are considered and described as follows.

1.1.1 Plan Irregularities
Torsion Irregularity
Torsional irregularity to be considered to exist when the maximum storey drift, computed with design eccentricity, at one end of the structures transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure.

Re-entrant
Corners plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction.

Diaphragm Discontinuity
A diaphragm with sudden discontinuities or changes in stiffness. This includes more than 50% of cutouts or open areas of the entire enclosed diaphragm area, or those involving more than 50% of the effective diaphragm stiffness change from one floor to the next. Out-of-Plane Offsets. Discontinuities in the lateral force resistance path, such as out-of-plane offsets of vertical elements.

Non-parallel Systems
Vertical elements that resist lateral forces are not parallel or symmetrical to the main orthogonal axes or elements that resist lateral forces.

1.1.2 Vertical Stiffness irregularity
Soft storey:
Soft storeys are those whose lateral stiffness is less than 70% of the lateral stiffness of the upper floors, or less than 80% of the average lateral stiffness of the upper three storeys.

Extreme soft storey:
An extreme soft storey is one in which the lateral stiffness is less than 60% of that in the storey above or less than 70% of the average stiffness of three storeys above.

Mass irregularity:
They are considered to be present when the effective mass of any floor exceeds 150% of the effective mass of the adjacent floor. Effective mass is the actual mass consisting of the dead weight of the floor and the actual weight of the partition and equipment.

Vertical geometric irregularity:
Geometric irregularity exists when the horizontal dimension of the lateral force resisting system in any storey is more than 150% of that in an adjacent storey.

Discontinuity in capacity–weak storey:
Weak floors are floors whose lateral strength is less than 80% of that of the floor above. The lateral strength of a storey is the total strength of all seismic force resistance elements sharing the story shear in the considered direction.
1.2 Overview of earthquake effect
Earthquakes are occasional forces on structures that can occur infrequently during the life of a building. Also, the structure may not be exposed to severe seismic forces during the design life. Reinforced concrete multi-storey buildings are considered to be designed structures in the sense that they may have been analyzed and designed to meet the provisions of the relevant codes of practice, which structures are supervised by skilled personnel need to do it. In such cases, the structure has sufficient built-in strength and ductility to provide some seismic strength, even if seismic forces are not considered.

1.2.1. Type of Analysis
Seismic analysis
Seismic analysis is a major tool in earthquake engineering and is used to understand the response of buildings to seismic excitation. In the past, buildings were designed solely for gravity loading, and seismic analysis is a recent development. It is part of structural analysis and part of structural design where earthquakes exist. There are various types of seismic analysis methods. Below those used in the project are:
I. Equivalent Static Analysis II. Response Spectrum Analysis

I Equivalent static analysis
The equivalent static analysis procedure is the elastic design method. It is easier to apply than the multi-model response method, and the absolute simplification assumption is consistent with other absolute assumptions elsewhere in the design procedure. The equivalent static analysis procedure consists of the following steps:
1. Estimate the first mode response period of the building from the design response spectra.
2. Use the specific design response spectra to determine that the lateral base shear of the complete building is consistent with the level of post-elastic (ductility) response assumed.
3. Distribute the base shear between the various lumped mass levels usually based on an inverted triangular shear distribution of 90% of the base shear commonly, with 10% of the base shear being imposed at the top level to allow for higher mode effects.

II. Response spectrum analysis
This approach allows for multiple response modes of the building. This is required by many building codes, except for very simple or very complex structures. Structural response can be defined as a combination of many modes. Computer analysis can be used to determine these modes of structure. For each mode, the response corresponding to the modal frequency and modal mass is obtained from the design spectrum and combined to estimate the total response of the structure. Now the magnitude of the force in all directions is calculated and the effect on the building is observed.

1.3 Need for the present study:
• From various experimental observations, it is observed that dimensions of buildings significantly affect the earthquake forces.
This study will give an interest on the use of Aspect ratio to earthquake force. It would be useful in showing the importance of Aspect ratio to earthquake force in earthquake zone II & V and soil conditions.

1.4 Objectives of the present study:
- To study the behaviour of regular and irregular structure when subjected to Earthquake force in earthquake zone II&V and different soil types.
- To study the effect of shape and size of the building in plan on the behaviour of the structure for various soil conditions.
- To study same floor area of the building with different Vertical Aspect ratio.
- To define the most efficient Vertical Aspect ratio for different story height which can provide seismic force by observing the comparative studies for various soil conditions.

2. Literature review
Arnold and Reitherman (1982).
Discussed a variety of seismic design configuration problems and explanations of architectural reasons for why they often arise in their research paper, Building configuration and seismic design.

Jasmina Drazic a, Nikolai Vatin b.
The author investigated the composition of a building conditioned by the needs of the urban project and the style of the designer and conditioned by the building's function (interior design), so the choice of structural system was based on the behavior of the building during an earthquake. Affect normal building structures perform well under the influence of earthquakes and perform relatively well in seismic analysis, which means that the seismic performance represents the best economic solution. The behavior of irregular structures during an earthquake is very complex, often unpredictable, and it is very difficult to accurately determine the seismic response of a building.

Mahendra Balasaheb Shelke, V. A. Kuwar.
Wind force and seismic force for different aspect ratios of the building are observed. All types of effects of wind and seismic forces are taken into account. His work is forced to consider building aspect ratio as an important parameter when designing. Below are the expected conclusions of the author's influence of increasing wind and seismic forces at high aspect ratios. Skyscrapers should have a small aspect ratio. That is, the sides of the building should be about the same size.

Ayush Agrahari1, Prof. Sonal Pawar2, Prof Atul Pujari3.
Author researched that it is essential to identify the seismic response of structures even in high seismic zones in order to reduce the damage of buildings due to earthquakes. In his work, a dynamic analysis and comparison of different building geometries is performed using ETABS 2013 software. The authors concluded that the design and analysis of the G+15 building is safe with maximum displacement, Story drift. The building is safe in all respects, as the calculated value is less than the tolerance. Irregular shapes
are severely affected during earthquakes in high seismic zones.

**Abhay Guleria.**
His paper focuses mainly on the structural behavior of multi-storey buildings of various plan configurations, such as rectangles, C, L, and I shapes. Modeling of a 15-story R.C.C. framed construction is done in ETABS software for analysis. Post-analysis of the structure, maximum shear forces, bending moments, and maximum rank displacements are calculated and compared in all analyzed cases.

**C.V.R.Murty (2005).**
The behavior of buildings during an earthquake was discussed, as well as how the seismic forces are transferred to the ground, as well as the importance of architectural features that are highly dependent on overall shape, size, and shape.

**Pandey & Dilip Kumar (2014).**
Author investigated the effect of seismic loading on the shape of a building, where the behavior of the building during an earthquake is highly dependent on the overall shape, size, and shape of the building. Seismic performance of the building is available and new design methods need to account for the building's ability to dissipate energy and the effects of lateral deformation.

**Dileshwar Rana, Prof. Juned Raheem (2015).**
Author investigated the effect of seismic loading on the shape of a building, where the behavior demonstrate the performance and behavior of regular and vertical geometric and irregular RCC frame structures under seismic action. The project uses five different building geometries, one standard frame and four irregular frames. Weigh all these building configurations in height and bay direction. Different seismic response changes are observed along different heights.

**Sadh, Pendharkar (2016).**
Author studied the behavior of buildings during an earthquake show that they are highly dependent on the overall shape, size and shape of the building. Seismic design of a building relies on providing the building with sufficient strength, stiffness, and inelastic deformation capacity to withstand a given level of seismic force. This is done by choosing the proper building configuration and careful attention to structural member details. Important aspects that affect the seismic composition of a building are the overall shape, structural system, and load path. Building slenderness ratio and building core size are important factors in efficient structural design. In this paper, the vertical aspect ratio (H/B ratio or slenderness ratio) and the horizontal or plan aspect ratio (L/B) the focus is on both effects. H is the total height of the building frame, B is the base width, and L is the length of the building frame in various plan configurations for seismic analysis of multi-story normal RCC building. Test structures are regularly maintained at elevation and floor plan. Here, the height of the building and the reference dimensions vary depending on the aspect ratio. Aspect ratio values have been assigned to provide different configurations for low-
rise, medium-rise, and high-rise building models. In his study, four building models with different horizontal aspect ratios, namely lengths of 1, 4, 6, 8 with different vertical aspect ratios from 12 m to 96 m. Various 4, 16, 24, and 32 floors, 1, 4, 6, and 8 floors are considered, IS-1893-2002 - Seismic Zone Part 1-3. Linear elastic dynamics using ETABS-2015 software. The analysis (response spectrum analysis) analyzes a total of 16 building models for various load combinations.

Md. Mohiuddin Ahmed*, Sumsunnaher Tonny2, Maqsuda Haque3, Subrata Roy4, Nazmus Sakib Ahmed5 (2019). The authors studied that the seismic performance of both regular and irregularly shaped buildings depends on the height of the building along with other important structural parameters. Increasing the building height increases the base shear forces and base moments at the building base. Vertical aspect ratio (H/L or H/B) affects the efficiency of the structure to resist lateral loads. The choice of structural configuration must be appropriate to withstand seismic forces. His study considers seven building models with different vertical aspect ratios, including 1.875, 3, 3.75, 4.5, 5, 6.25, 6.75 and 7.5 of 5, 8, 10, 12, 15, 18, 20 storeys. The effects of RCC on multi-storey buildings have been demonstrated using seismic zone BNBC-1993 based design parameters. 2. ETABS software is used throughout his analysis.

3. Conclusion

1. Many analytical, performance and comparative works have been done by many researchers related to plan configuration, geometry and irregularity of structure. In some of the papers, it is studied that square or rectangular shape building give better results than irregular shapes.
2. As the aspect ratio increase the building becomes more critical.
3. In this present study comparative study on actual commercial building plan is done for various seismic zones and different soil condition. So behaviour of structure is analysed and suitable soil type also observed.

4. References

Journal Papers:


Books:

