COMPARATIVE ANALYSIS OF G+23 BUILDING WITH VARIOUS SLENDERNESS RATIOS BY USING ETABS SOFTWARE

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Abstract *The behavior of a building during earthquakes depends critically on its overall shape, size and geometry. Earthquake resistant design of buildings depends upon providing the building with strength, stiffness and inelastic deformation capacity which are great enough to withstand a given level of earthquake generated force. This is generally accomplished through the selection of an appropriate building configuration and the careful detailing of structural members. Configuration is critical to good seismic performance of buildings. The important aspects affecting seismic configuration of buildings are overall geometry, structural systems, and load paths. The building slenderness ratio and the building core size are the key drivers for the efficient structural design.*

This paper focuses on the effect of Slenderness Ratio of the building frame, B is the Base width and L is the Length of the building frame with different Plan Configurations on the Seismic Analysis of Multistoried Regular R.C.C. Buildings. The slenderness ratios assumed are 3.00, 3.60, 4.80 and 7.20 with varying building widths as 25m, 20m, 15m and 10m.

The analysis results like storey drift, storey shear, storey bending, building torsion, time period, model stiffness values are compared with all the aspect ratios for G+23 building by using ETABS Software.

Key words: *Earthquake, slenderness ratio, storey drift, storey shear, storey bending, building torsion, time period, model stiffness.*

I. INTRODUCTION

Buildings oscillate during earthquake shaking and inertia forces are mobilized in them. sThen, these forces travel along different paths, called load paths, through different structural elements, until they are finally transferred to the soil through the foundation. The generation of forces based on basic oscillatory motion and final transfer of force through the foundation are significantly influenced by overall geometry of the building, which includes:

a) Plan shape,
b) Horizontal aspect ratio or plan aspect ratio and
c) Slenderness ratio of the building.

The length divided by width (both in plan) of a building is termed as its Aspect Ratio and the ratio of height to least lateral dimension of a building is termed as its Slenderness Ratio. Increase in length of a building increases the stresses in a floor working as a horizontal distribution diaphragm in a transverse direction. An increased length of the building increases efforts at a level that acts as a diaphragm horizontal distribution. The rigidity of the floor may be insufficient to redistribute the horizontal load caused by an earthquake.

In seismic design, the proportions of a building may be more important than its absolute size. For tall buildings the slenderness ratio of a building is one of the important considerations than just the height alone. The more slender the building is worse are the overturning effects of an earthquake and greater are the earthquake stresses in the outer columns, particularly the overturning compressive forces, which can be very difficult to deal with. Increasing the height of a building may be similar to increasing the span of a cantilever beam. As the building grows taller there is a change in the level of response to the seismic forces. Therefore, proportions of buildings length-wise and height-wise need to be considered carefully.

Slenderness Ratio

Slenderness ratio is an assessment of a structure that is able to withstand buckling pressures. Engineers can determine it by dividing the Height of the Building by width of the building. These calculations are important for supportive structure dimensions, to make sure they will not fail and put a structure at risk of serious damage or collapse.

To determine the slenderness ratio, the engineer needs a measurement of the height of the building and width of the building.

There are some additional considerations to take into account with slenderness ratio. One is the material used to make the building. Wood structural members are more likely to bend than steel or concrete. They need a slightly different ratio to build in a margin of safety. Likewise, the level of support available to the column is important.

Engineers developing design specifications can use this formula to make sure the planned buildings in a project will be adequate for the need. They can also check their math as a structure goes up, by sampling columns and calculating a slenderness ratio to determine if they are sufficient. If they are not, there is a risk the building could fall as it goes up. A building with inadequate supports may also fail to pass a building inspection. The builder might be required to retrofit or repair it and apply again for permission to start using the building.

For the current study the following slenderness ratios are used

S. No	Length of building	Height of building	Width of building	Slenderness Ratio
1	24m	72m	25m	3.00
2	24m	72m	20m	3.60
3	24m	72m	15m	4.88
4	24m	72m	10m	7.20

Objectives of the study

1. To examine abnormalities in structures dissect and plan of G+23 storied structure according to code (IS1893:2002) arrangement.
2. Investigate the structures in ETABS programming to complete the story avoidance, story float, story shear power and base shear of standard and sporadic structures utilizing reaction range examination and think about the aftereffects of various structure.

3. To analyze the building by using Response spectrum analysis.
4. To study the building with 3.00, 3.60, 4.88 and 7.20 slenderness ratios.

II LITERATURE REVIEW

Arnold and Reitherman (1982) discussed a number of seismic design configuration problems, and explanations of architectural reasons for why they often arise in their research paper, Building configuration and seismic design.

C.V.R.Murty (2005) discussed in Importance of Architectural Features,that the behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground.

Snigdha A. Sanyal (2008) focused in Multi Dimensional Building Planning For Safer Tomorrow, that the seismic performance of a building will benefit greatly from timely interaction between architects and structural engineers. A building that is poorly configured will never perform well in a damaging earthquake.

Pawan Pandey & Dilip Kumar (2014) studied in Seismic load Effect on Building Configuration, that the behavior of building during Earthquake depends critically on its overall shape, size and geometry. The Seismic performance of building is available and new design methods should account for the building ability to dissipate energy and the effect of the lateral deformation. These aspects involve both plan and structural configuration of building. Dileshwar Rana, Prof.

Juned Raheem (2015) shows the performance & behavior of regular & vertical geometric irregular RCC framed structure under seismic motion. Five types of building geometry are taken in this project: one regular frame & four irregular frames. A comparative study is made between all these building configurations height- wise and bay-wise. The change in the different seismic response is observed along different height.

III METHODOLOGY OF THE PROJECT

Response spectrum analysis

The representation of most response of idealized single degree freedom device having sure length and damping, at some point of earthquake floor motions. This evaluation is performed in line with the code IS 1893-2002 (part1). here kind of soil, seismic zone component ought to be entered from IS 1893-2002(part1). the same old response spectra for type of soil considered is carried out to building for the analysis in ETABS 2013 software program. Following diagram shows the usual reaction spectrum for medium soil type and that may be given within the shape of time period as opposed to spectral acceleration coefficient (Sa/g).

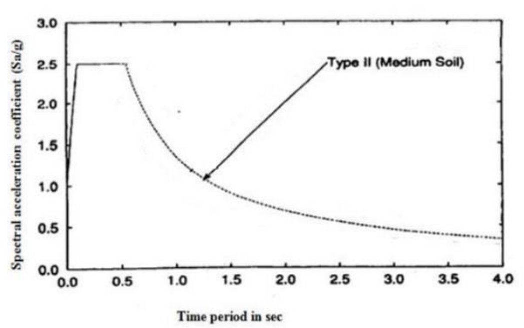


Fig 3. 1 : Response spectrum for medium soil type for 5% damping

This approach permits the multiple modes of response of a building to be taken in to account (inside the frequency domain). this is required in many constructing codes for all besides very simple or very complicated structures. The reaction of a structure can be described as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonic" laptop analysis may be used to decide these modes for a shape. For every mode, a reaction is read from the layout spectrum, based totally on the modal frequency and the modal mass, and they may be then mixed to offer an estimate of the overall response of the shape. on this we need to calculate the significance of forces in all directions i.e. X, Y & Z after which see the consequences at the building. combination techniques consist of the subsequent:

1. absolute - peak values are added together
2. square root of the sum of the squares (SRSS)
3. complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes

The end result of a reaction spectrum analysis the use of the response spectrum from a ground motion is normally specific from that which could be calculated directly from a linear dynamic analysis the use of that floor motion directly, considering that section records is lost within the process of generating the reaction spectrum.

Model Specifications

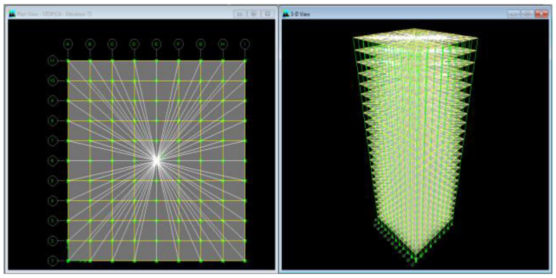
In the present study, analysis of G+ 23 stories building in Zone V seismic zones is carried out in ETABS.

Basic parameters considered for the analysis are

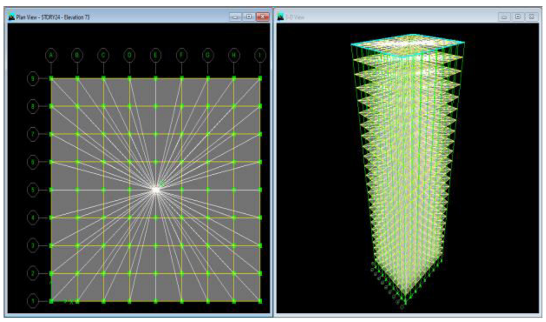
1. Grade of concrete : M40
2. Grade of Reinforcing steel: HYSD Fe600
3. Dimensions of beam
   a. Floor 1 to Floor 6 : 500mmX230mm
   b. Floor 7 to Floor 12 : 450mmX230mm
   c. Floor 13 to Floor 18 : 400mmX230mm
   d. Floor 19 to Floor 24 : 350mmX230mm
4. Dimensions of column
   a. Floor 1 to Floor 6 : 500mmX500mm
   b. Floor 7 to Floor 12 : 450mmX450mm
   c. Floor 13 to Floor 18 : 400mmX400mm
   d. Floor 19 to Floor 24 : 350mmX350mm
5. Thickness of slab
   a. Floor 1 to Floor 12 : 150mm
   b. Floor 1 to Floor 12 : 120mm
6. Height of bottom story : 3m
7. Height of Remaining story : 3m
8. Methodology Used : Response Spectrum Analysis
9. Live load : 5 KN/m^2
10. Dead load : 2 KN/m^2
11. Density of concrete : 25 KN/m^3
12. Seismic Zone : Zone 5
13. Site type : II
14. Importance factor : 1.5
15. Response reduction factor : 5
16. Damping Ratio : 5%
17. Structure class : B
18. Basic wind speed : 44m/s
19. Risk coefficient (K1) : 1.08
20. Terrain size coefficient (K2) : 1.14
21. Topography factor (K3) : 1.36
22. Wind design code : IS 875: 1987 (Part 3)
23. RCC design code : IS 456:2000
24. Steel design code : IS 800: 2007
25. Earth quake design code : IS 1893 : 2002 (Part 1)

Building models in ETABS Software

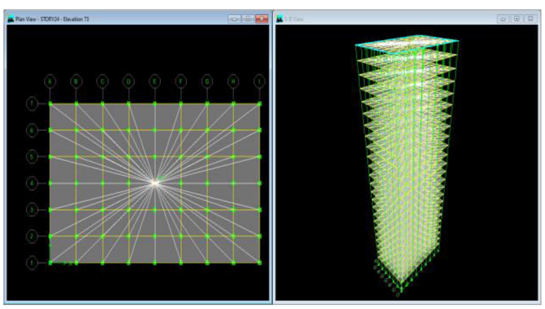
3.00 Slenderness Ratio



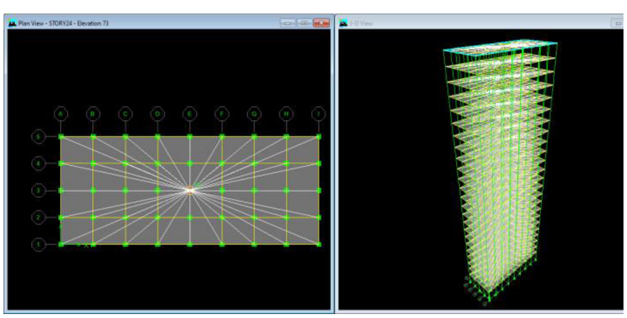
3.60 Slenderness Ratio



4.80 Slenderness Ratio

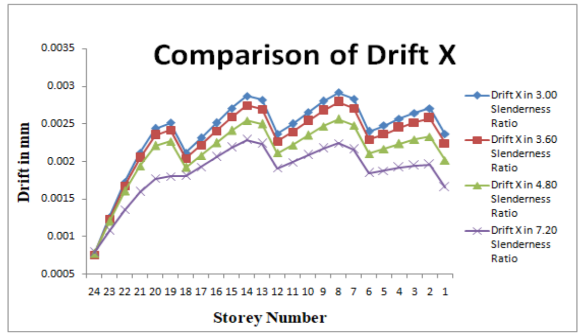


7.20 Slenderness Ratio

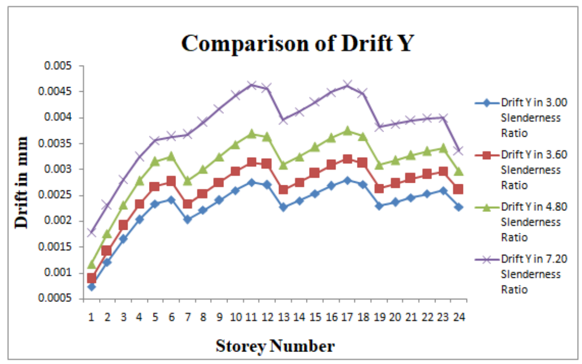


IV RESULTS AND ANALYSIS

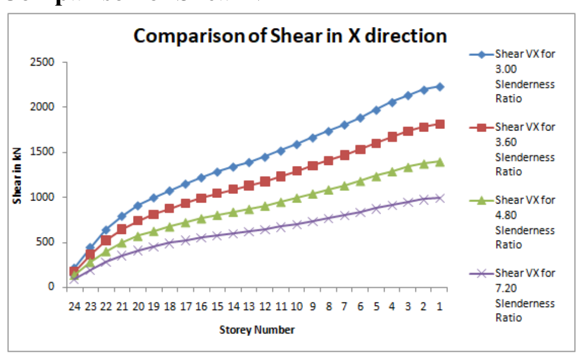
Comparison of Drift in X direction



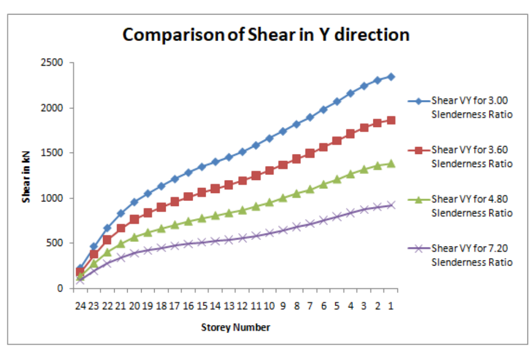
Comparison of Drift in Y direction



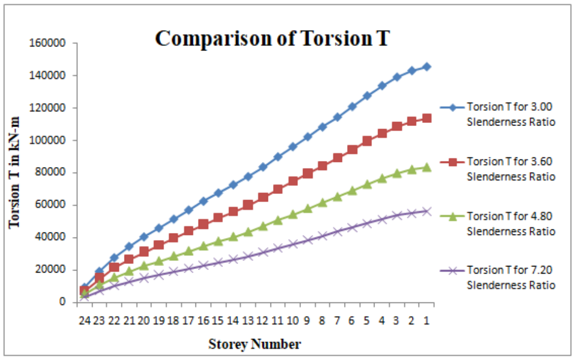
Comparison of Shear Vx



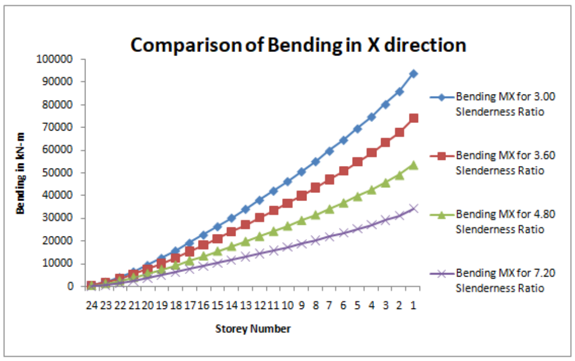
Comparison of Shear Vy



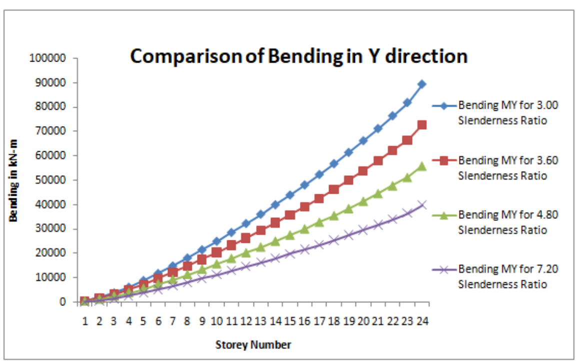
Comparison of Building Torsion T



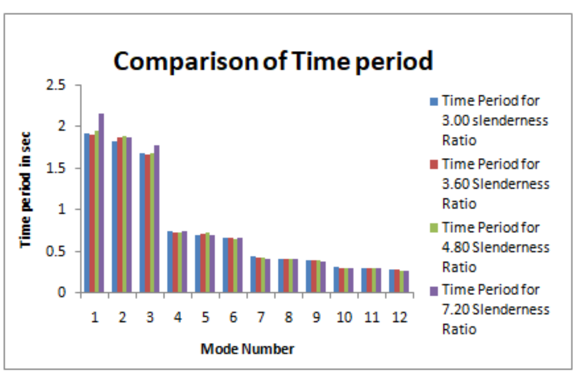
Comparison of Bending Mx



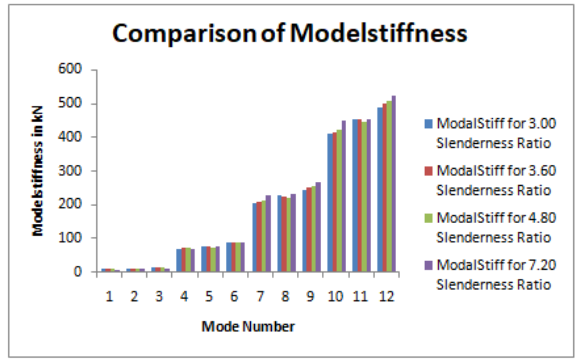
Comparison of Bending My



Comparison of Time period



Comparison of model stiffness



V CONCLUSIONS

From this analysis the following conclusions were made

1. The building slenderness ratio is one of the most significant factors affecting the structural behavior of high rise buildings.
2. Building 1 of slenderness ratio 3.00, Building 2 of slenderness ratio 3.60, Building 3 of slenderness ratio 4.80 and Building 4 of slenderness ratio 7.20 is analyzed by using Response spectrum analysis for G+23 building.
3. Due to the effect of seismic loading action the storey drift value is less in X direction for 7.20 slenderness ratio than reaming cases like 3.00, 3.60, 4.80. where in case of Y direction the storey drift has less values for 3.00 slenderness ratio than reaming cases like 3.60, 4.80 and 7.20 ratios.
4. The storey shear values, storey bending, building torsion has less values for 7.20 slenderness ratio that reaming cases like 3.00, 3.60, 4.80 from this observation it was clearly observed that by increasing the width of the building the values of shear, bending, torsion decreases for G+23 building structure.
5. The time period values decreases from mode 1 to mode 12 and it has almost same values for all the building models.
6. The model stiffness values increases from mode 1 to mode 12 and it has almost same values for all the building models.

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