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Analytical Approach in Stability Enhancement Techniques by Altering Beam Members at Different Levels

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Abstract— *Many cities need a space for its further development with a criterion to capture everything that would run it with ease without any difficulties. The future demand of each city will ultimately in the favor to attract the population and living demand. This demand leads to the progress of the multistoried building. To counteract the lateral forces and stand in its position, the tall structures need stability with or without any improvement in the same. The current work is going to show the stability criteria of changing the grades of beams without altering the size at various floor levels. Total 6 cases of the current theme created and analyzed with the help of software approach after then result is compared. Result shows that the increase of stability has seen in Case BS3 and Bs4 and would be recommended whenever this type of stability activity performed.*

Keywords— ***Dual supported system, Lateral load capacity, Optimum case, Shear wall, Stability enhancement.***

I. INTRODUCTION

Multistorey buildings are common now a day in metro cities. They are increasing rapidly because of their construction methods, modern equipment's, skilled labour, modern machineries used in construction and day night construction. The equipment's and new methods of construction made it easy therefore it is necessary to apply methods for increasing stability in each and every multistory building. Stability analysis is one of the best methods of increasing stability of multistory building, can be analyzed with software or by manual approach.

Factor Affecting Stability of Building

The stability plays an important role in any type of structure and in high-rise and tall structure buildings its importance increases. Its importance increases with increase in height of the building. There are some major factors which affect the stability of the building. They are as follows-

1. Earthquake generates Seismic waves.
2. Dead load (self-weight of the building)
3. Live load or imposed load
4. Height of the building
5. Shape of the building
6. Wind load at top of the building.'

II. OBJECTIVES OF THE CURRENT STUDY

Following heads shows the point of comparison of result parameters between various models during earthquake forces for building and its various cases. They are as follows:-

1) To determine Base shear response when seismic forces are applied in X and Z direction to the structure when conducting grade change of beams at different floor levels.
2) To find member Shear Forces values in Beam with efficient case between grade change and without grade change cases.
3) To examine Bending Moment values in Beam with efficient case between grade change and without grade change cases.
4) To determine and compare member Torsion values in Beam members.
5) To examine column Axial Forces for total 6 cases with efficient case to determine minimum axial force between grade change and without grade change cases in Beam members at different floor levels.
6) To find member Shear Forces values in Beam with efficient case between grade change and without grade

change cases in Beam members at different floor levels.

7) To examine Bending Moment values in Beam with efficient case between grade change and without grade change cases in Beam members at different floor levels.

8) To determine and compare member Torsion values in Beam with efficient case between grade change and without grade change cases in Beam members at different floor levels.

9) To analyze the maximum nodal displacement case in X direction with most efficient case that provides more stability among others.

10) To obtain the maximum nodal displacement values in Z direction with most efficient case between grade change and without grade change cases in Beam members at different floor levels.

To demonstrate and recommend the efficiency of the reduction of Base Shear by changing the size of beam member at top floors that increase stability of the structure.3.

III. PROCEDURE AND 3D MODELING OF STRUCTURE

As per criteria for earthquake resistance design of structures, a Residential Building (G+16) with plinth area 576 sq. m. has taken for analysis. Total six different cases have been chosen for parametric analysis, its description shown below. Various dimensions of structure are shown in Table 1, seismic parameters taken have shown in Table 2 respectively.

Dead loads, Live loads, Response spectrum loads are applied on the structure with various load combinations. M25 grade and M 40 grade of concrete used with Fe 415 grade of steel is used. After then six building cases described and each of them abbreviated as discussed below. Figure 1 shows typical floor plan as per selected grid system. After then, comparative results of various parameters shown with the help of graphs that has provided to compare each parameter figuratively.

Table 1: Dimensions of different components of building

Parameters	Values
Building configuration	G + 16
Building type	Residential building
Total plinth area	576m^2
Building Length	4m @ 6 bays
Building Width	6m @ 4 bays
Height of building from Ground level	55 m
Height of each floor and GF height	3 m and 4 m
Depth of footing	3 m
Beam dimensions 1	550 mm x 300 mm with M25 grade
Beam dimensions 2	550 mm x 300 mm with M40 grade
Column dimensions	500 mm x 550 mm with M25 grade
Slab thickness	130 mm
Staircase waist slab	150 mm
Shear wall thickness	180 mm
Material properties	Concrete (M25), (M40) Steel (Fe 415)

Table 2: Seismic parameters on the structure

Parameters	Values
Importance factor I	1.2
Fundamental natural period of vibration (T_a)	$0.09*h/(d)^{0.5}$ $Ta_x = Ta_z$
Fundamental natural period (Ta_x) for X direction	1.0655 seconds
Fundamental natural period (Ta_z) for Z direction	1.0655 seconds
Response reduction factor R	4
Damping ratio	5%
Zone factor	0.16
Soil type	Medium soil

Different building model cases selected for analysis using software approach

1. **CASE BS1** = Beam Stability Case - Beams of same sizes (All M25 grade beams)
2. **CASE BS2** = Beam Stability Case - Beams of different sizes (All M40 grade beams at plinth level)
3. **CASE BS3** = Beam Stability Case - Beams of different sizes (All M40 grade beams at fourth floor level)
4. **CASE BS4** = Beam Stability Case - Beams of different sizes (All M40 grade beams at eight floor level)

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5. **CASE BS5** = Beam Stability Case - Beams of different sizes (All M40 grade beams at twelfth floor level)
6. **CASE BS6** = Beam Stability Case - Beam Stability Case - Beams of different sizes (All M40 grade beams at sixteen floor level)

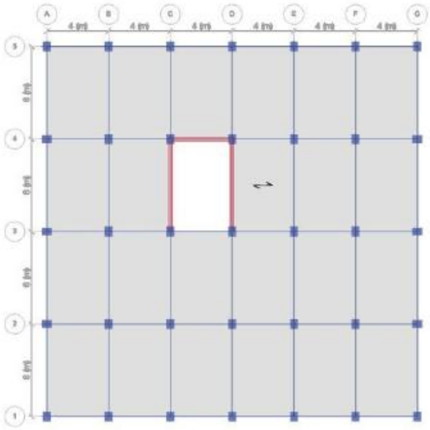


Fig. 1: Typical floor plan

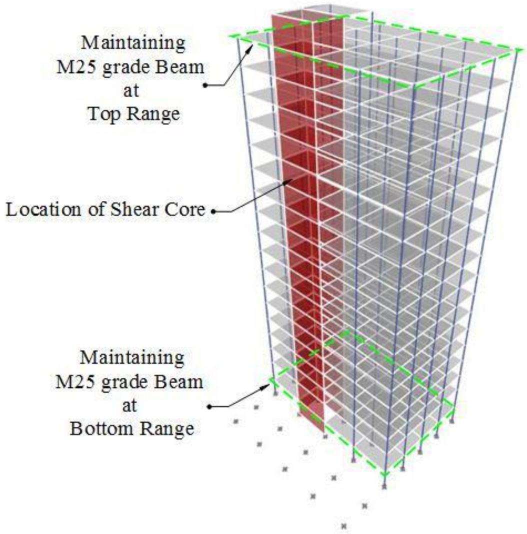


Fig. 2: Beam Stability Case - Beams of same sizes (All M25 grade beams): Case BS1

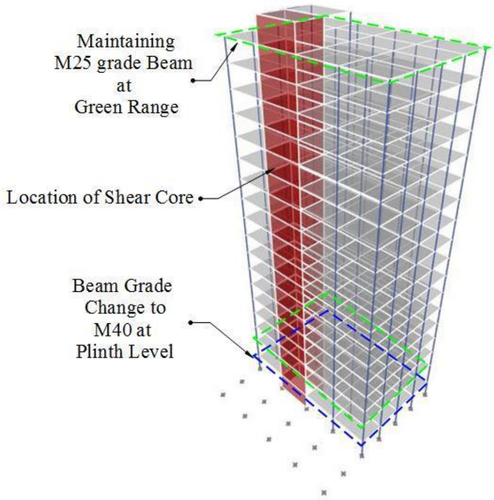


Fig. 3: Beam Stability Case - Beams of different sizes (All M40 grade beams at plinth level): Case BS2

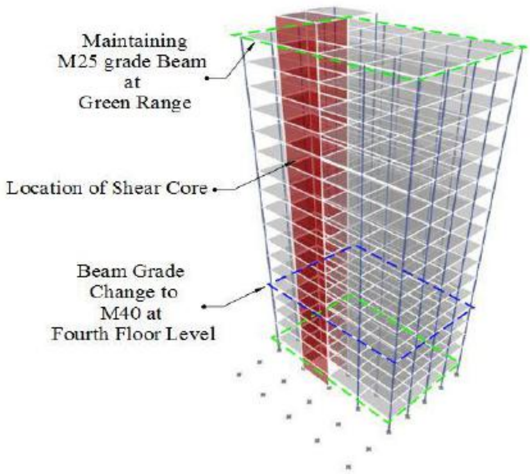


Fig. 4: Beam Stability Case - Beams of different sizes (All M40 grade beams at fourth floor level): Case BS3

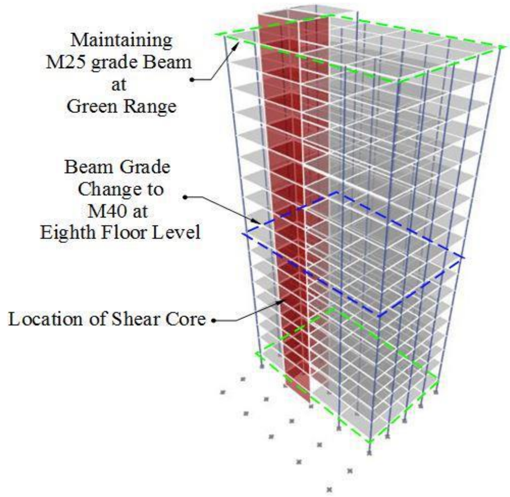


Fig. 5: Beam Stability Case - Beams of different sizes (All M40 grade beams at eight floor level): Case BS4

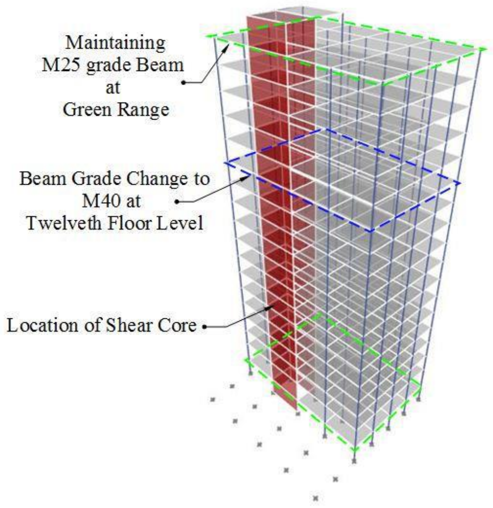


Fig. 6: Beam Stability Case - Beams of different sizes (All M40 grade beams at twelfth floor level): Case BS5

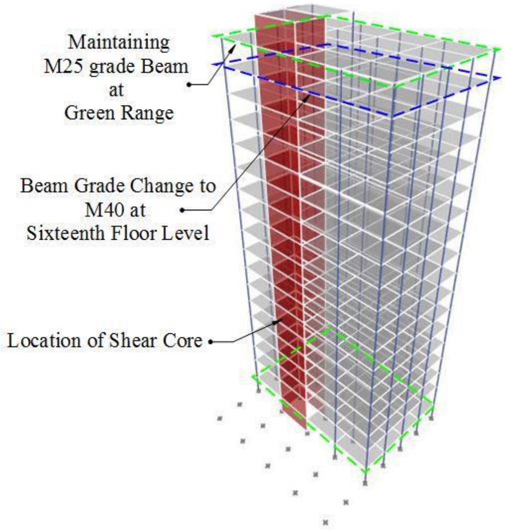
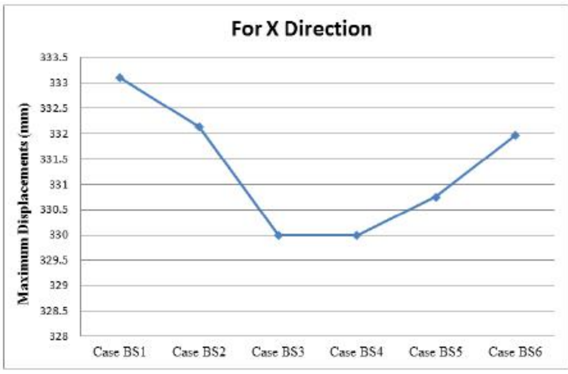


Fig. 7: Beam Stability Case - Beams of different sizes (All M40 grade beams at sixteen floor level): Case BS6

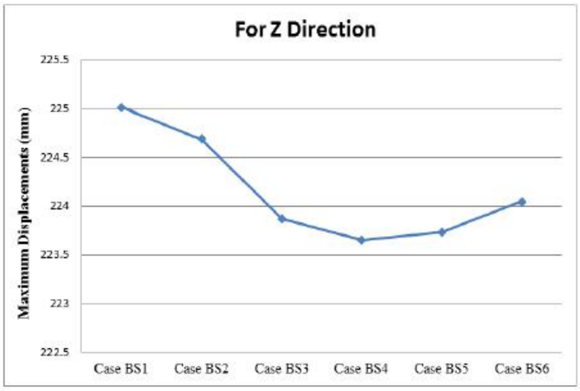
IV. RESULT ANALYSIS

As per the objectives, the Response Spectrum Analysis has been performed on different models consist of beam Stability Case BS1 made up of G+16 storey residential apartment with all beams of same sizes (All M25 grade beams). Beam Stability Case BS2 made up of G+16 storey residential apartment with all beams of different sizes (All M40 grade beams at plinth level). Beam Stability Case BS3 made up of G+16 storey residential apartment with all beams of different sizes (All M40 grade beams at fourth floor level). Beam Stability Case BS4 made up of G+16 storey residential apartment with all beams of different sizes (All M40 grade beams at eight floor level). Beam Stability Case BS5 made up of G+16 storey residential apartment with all beams of different sizes (All M40 grade beams at twelfth floor level). Beam Stability Case BS6 made up of G+16 storey residential apartment with all beams of different sizes (All M40 grade beams at sixteen floor level). All the cases are situated in Earthquake Zone III.

Since for the analysis of seismic effects, all the cases of the structures have been analyzed for seismic shake for longitudinal along with transverse direction. Various loads along with load combinations applied on all the cases and reflective result parameters have been analyzed with each other to determine the efficient case. Graphical Representation of each parameter has discussed with its graphical form below:-



Graph 1: Graphical Representation of Maximum Displacement in X direction for all Beam Stability Cases



Graph 2: Graphical Representation of Maximum Displacement in Z direction for all Beam Stability Cases

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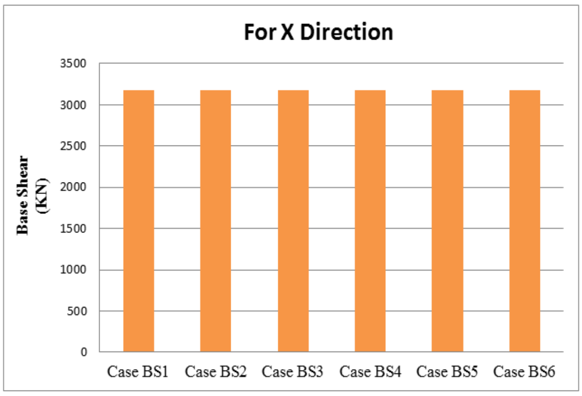
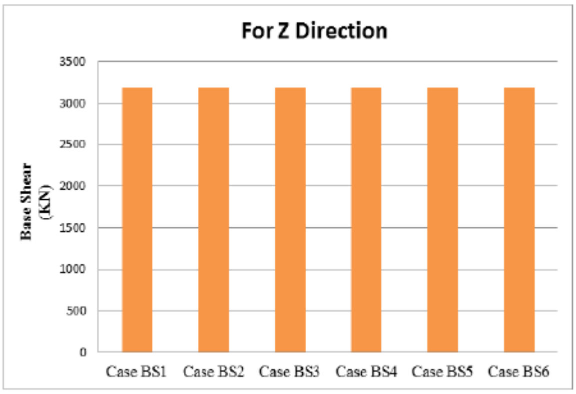
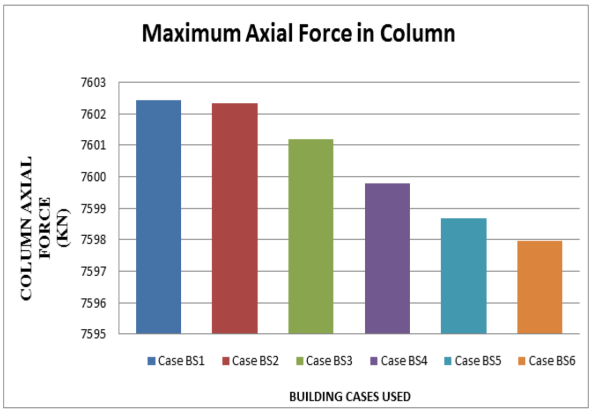


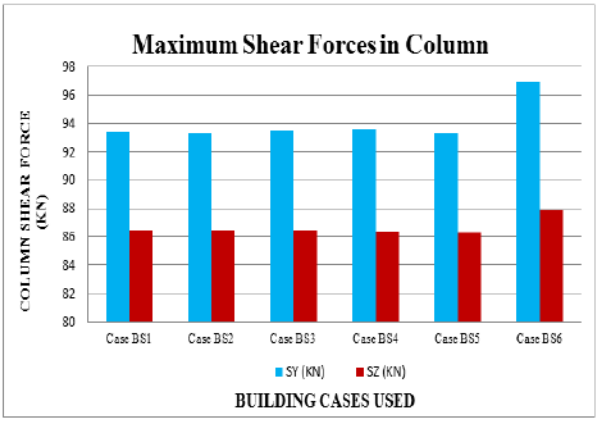
Graph 3: Graphical Representation of Base Shear in X direction for all Beam Stability Cases



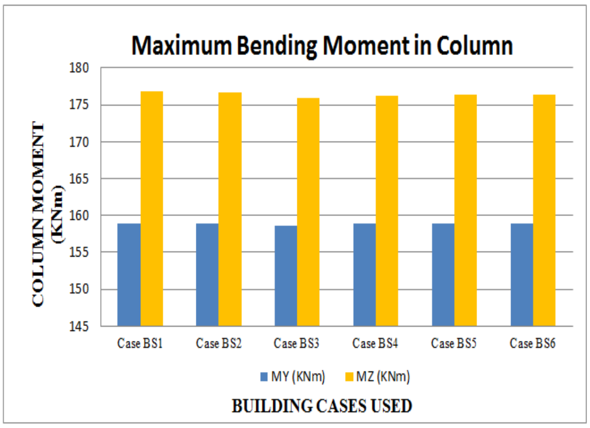
Graph 4: Graphical Representation of Base Shear in Z direction for all Beam Stability Cases



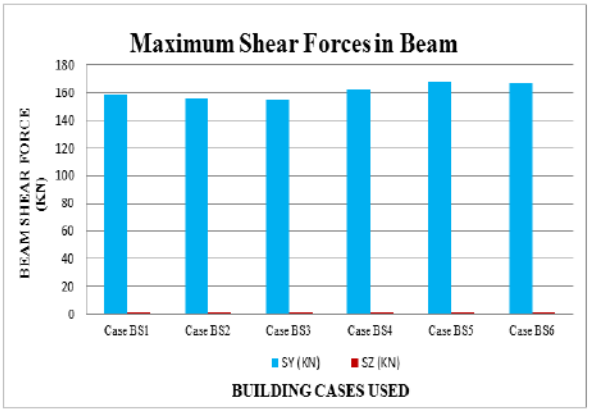
Graph 5: Graphical Representation of Maximum Axial Forces in Column for all Beam Stability Cases



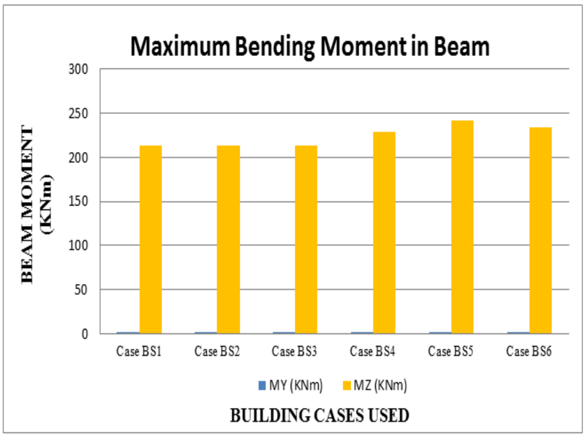
Graph 6: Graphical Representation of Maximum Shear Force in Column for all Beam Stability Cases



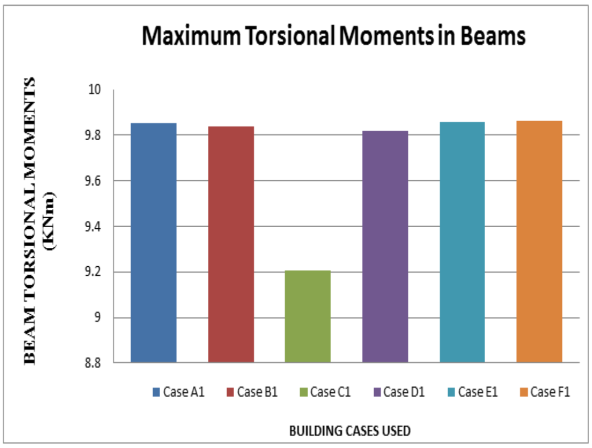
Graph 7: Graphical Representation of Maximum Bending Moment in Column for all Beam Stability Cases



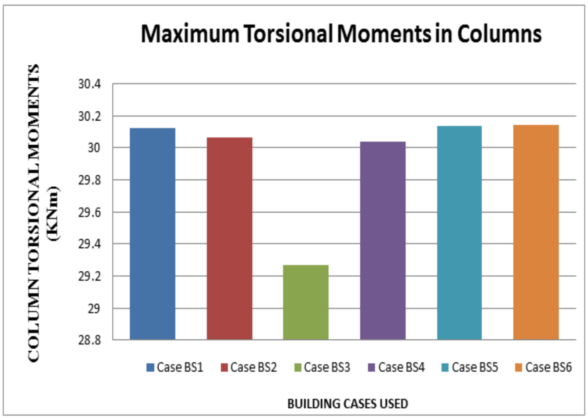
Graph 8: Graphical Representation of Maximum Shear Force in Beam for all Beam Stability Cases



Graph 9: Graphical Representation of Maximum Bending Moment in Beam for all Beam Stability Cases



Graph 10: Graphical Representation of Maximum Torsional Moments in Beam for all Beam Stability Cases



Graph 11: Graphical Representation of Maximum Torsional Moments in Columns for all Beam Stability Cases

V. CONCLUSION

The conclusion can be pointed out are as follows:-

1. Maximum displacement in X direction has a minimum value of around 329 mm for Beam Stability Case BS3 and BS4 since the values keep on decreasing to Beam Stability Case BS3 when beam grade level changes. No special displacement reducing components are implemented in these buildings.
2. Again, the maximum displacement in Z direction behaves same as the X direction when no special displacement reducing components are implemented in these buildings. Case BS3 and BS4 shows good results.
3. Base Shear in X direction for all Beam Stability Cases shows equal values, since no additional mechanisms were added.
4. Again, no additional mechanisms were added, the Base Shear in Z direction behaves same as the trend obtained in X direction. Here, also, no value change has been observed in any Beam Stability Case.
5. The maximum Axial forces in Column keep on decreases to BS6. Observing the least parameter, Beam Stability Case BS6 obtained as an efficient case with a parametric value of 7597.9567 KN.
6. The sectional Shear Forces along both Y-Y axis and Z-Z axis in column members shows least values in Beam Stability Case nearly same in all.
7. The Bending Moment along both Y-Y axis and Z-Z axis in column decreases gradually to Beam Stability Case BS3 and proves to be an efficient case with values of 158.5923 KNm and 175.9371 KNm respectively.
8. For beams in the structures, the minimum value of Shear Forces along both Y-Y axis and Z-Z decreases gradually to Beam Stability Case BS3 and BS4 and proves to be an efficient case with values of 155.0516 KN and 0.1268 KN respectively.
9. Bending Moments in beams Shows least value in Beam Stability Case BS3 along both in Y-Y axis and in Z-Z axis.
10. The main criterion has seen in torsion effects in beams. The values keep on decreasing when grade change done on fourth floor beams. For this parameter, Beam Stability Case BS3 seems to be efficient among all.
11. Similarly, the same trend has seen in Torsional Moments in columns. The values gradually decrease to

a minimum value of 29.2705 KNm for Beam Stability Case BS3 and hence prove to be an economical case.

Observing all the parameters, the main theme of this work has achieved with increasing stability by changing grades of concrete in beam member in both X and Z direction in Residential Apartment, (G+16) multistoried building under seismic loading. Beam Stability Case BS3 and BS4 observed and obtained as efficient case and should be recommended when this type of approach will be adopted in earthquake zone III.

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