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

Bhagwat Mahajan¹, Sagar Jamle²

¹M Tech Scholar, Department of Civil Engineering, Oriental University, Indore, India  
²Assistant Professor, Department of Civil Engineering, Oriental University, Indore, India

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.

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.

| Parameters                              | Values                           |
|-----------------------------------------|----------------------------------|
| Building configuration                  | G + 16                           |
| Building type                          | Residential building             |
| Total plinth area                       | 576m²                            |
| Building Length                         | 4m @ 6 bays                      |

| Parameters                              | Values                           |
|-----------------------------------------|----------------------------------|
| Importance factor I                     | 1.2                              |
| Fundamental natural period of vibration | $0.09 \times h/(d)^{0.5}$        |
| ($T_a$) for X direction                  | $T_{ax} = T_{az}$                |
| Fundamental natural period              | $1.0655$ seconds                  |
| ($T_a$) 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)
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 eighth floor level): Case BS4
VENKATESWARA V. et al.

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
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
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.

ACKNOWLEDGEMENTS

I extend my deepest gratitude to Mr. Sagar Jamle, Assistant Professor, Department of Civil Engineering, Oriental University, Indore, (M.P.) for his continuous support and guidance for the completion of this entire work. I am glad that he simultaneously works with 12 research scholars and do support individual scholars intensively.

REFERENCES

[1] Suyash Malviya, Sagar Jamle, (2019), “Response of Multistoried Building with Rooftop Telecommunication Tower in Different Positions: An Approach to Efficient Case”. International Research Journal of Engineering and Technology, (ISSN: 2395-0072(P), 2395-0056(O)), vol. 6, no. 4, pp. 3783-3790.

[2] Yash Joshi, Sagar Jamle, (2019), “Effect of Curtailed Shear Wall on Dynamic Analysis of RC Building”, International Journal of Management, Technology And Engineering, (ISSN: 2249-7455(O)), vol. 9, no. 7, pp. 223-230.

[3] Sagar Jamle, Dr. M.P. Verma, Vinay Dhakad, (2017), “Flat Slab Shear Wall Interaction for Multistoried Building under Seismic Forces”, International Journal of Software & Hardware Research in Engineering (IJSHE), ISSN: 2347-4890 Vol.-05, Issue-3, pp. 14-31.

[4] Romesh Malviya, Sagar Jamle, (2020), "Increasing Stability of Multistoried Building using Different Grades of Concrete in Column Member Sets at Different Locations", International Journal of Current Engineering and Technology, (ISSN: 2277-4106 (O), 2347-5161(P)), vol. 10, no. 2, pp. 208-213. https://doi.org/10.14741/ijcet/v.10.2.3

[5] Mohit Kumar Prajapati, Sagar Jamle, (2020), "Strength irregularities in multistoried building using base isolation and damper in high Seismic zone: A theoretical Review", International Journal of Advanced Engineering Research and Science, (ISSN: 2456-1908 (O), 2349-6495(P)), vol. 7, no. 3, pp. 235-238. https://dx.doi.org/10.22161/ijaers.73.37

[6] Gagan Yadav, Sagar Jamle, (2020), "Opening Effect of Core Type Shear Wall Used in Multistoried Structures: A Technical Approach in Structural Engineering", International Journal of Advanced Engineering Research and Science, (ISSN: 2456-1908 (O), 2349-6495(P)), vol. 7, no. 3, pp. 344-351. https://dx.doi.org/10.22161/ijaers.73.50

[7] Durgesh Kumar Upadhayay, Sagar Jamle, (2020), "A Review on Stability Improvement with Wall Belt Supported Dual Structural System Using Different Grades of Concrete", International Journal of Advanced Engineering Research and Science, (ISSN: 2456-1908 (O), 2349-6495(P)), vol. 7, no. 3, pp. 293-296. https://dx.doi.org/10.22161/ijaers.73.43

[8] Gagan Yadav, Sagar Jamle, (2020), “Use of Shear Wall with Opening in Multistoried Building: A Factual Review”, International Journal of Current Engineering and Technology, (ISSN: 2277-4106 (O), 2347-5161(P)), vol. 10, no. 2, pp. 243-246. https://doi.org/10.14741/ijcet/v.10.2.9

[9] Sagar Jamle and Roshan Patel, (2020), “Analysis and Design of Box Culvert- A Manual Approach in Structural Engineering”, LAP LAMBERT Academic Publishing, Mauritius, ISBN: 978-620-0-78760-6.

[10] Gaurav Pandey, Sagar Jamle, (2018), “Optimum Location of Floating Column in Multistoried Building with Seismic Loading”, International Research Journal of Engineering and Technology, (ISSN: 2395-0072(P), 2395-0056(O)), vol. 5, no. 10, pp. 971-976.

[11] Sachin Sironiya, Sagar Jamle, M. P. Verma, (2017), “Experimental Investigation On Fly Ash & Glass Powder As Partial Replacement Of Cement For M-25 Grade Concrete”, IJSART - Volume 3 Issue 5, ISSN- 2395-1052, pp. 322-324.

[12] Surendra Chaurasiya, Sagar Jamle, (2018), “Determination of Efficient Twin Tower High Rise Building Subjected to Seismic Loading”, International Journal of Current Engineering and Technology, INPRESSCO, E-ISSN 2277 – 4106, P-ISSN 2347 – 5161, Vol. 8, No. 5, pp. 1200 – 1203, DOI: https://doi.org/10.14741/ijcet/v.8.5.1.

[13] Archit Dangi, Sagar Jamle, (2018), “Determination of Seismic parameters of R.C.C Building Using Shear Core Outrigger, Wall Belt and Truss Belt Systems”. International Journal of Advanced Engineering Research and Science(ISSN : 2349-6495(P) | 2456-1908(O)), vol. 5, no. 9, pp.305-309 AI Publications, https://dx.doi.org/10.22161/ijaers.5.9.36

[14] Mohd. Arif Lahori, Sagar Jamle, (2018), “Investigation of Seismic Parameters of R.C. Building on Sloping Ground”, International Journal of Advanced Engineering Research and Science, (ISSN: 2349-6495(P), 2456-1908(O)), vol. 5, no. 8, pp.285-290 AI Publications, https://dx.doi.org/10.22161/ijaers.5.8.35

[15] Suyash Malviya, Sagar Jamle, (2019), “Determination of Optimum Location of Rooftop Telecommunication Tower over Multistory Building under Seismic Loading”, International Journal of Advanced Engineering Research and Science(ISSN : 2349-6495(P) | 2456-1908(O)), vol. 6, no. 2, 2019, pp. 65-73, AI Publications, https://dx.doi.org/10.22161/ijaers.6.2.9

[16] Neeraj Patel, Sagar Jamle, (2019), “Use of Shear Wall Belt at Optimum Height to Increase Lateral Load Handling Capacity in Multistory Building”, International Journal for Research in Engineering Application & Management (ISSN
