Comprehensive Stability Enhancement Techniques of Multistoried Buildings through Altering Beam Structural components at Different Levels

Rajesh Chouhan, Sachin Sironiya, Chetan Gurjar
Assistant Professor, Department of Civil Engineering, School of Engineering & Technology,
Vikram University, Ujjain, Madhya Pradesh, India

Abstract— Living space at a particular location is now has been a main criterion of each and every home buyer Even they choose to live on their particular land or can live in a multistoried building. People need basic amenities around their residence. As per engineering point of view, the main approach is to shift and collect the people to a particular apartment so that they can live so the land use is very less. These multistoried building needs stability and for that there should be a criteria to make the structure stable. The current work is going to show the stability criteria of changing the grades of beams at particular floor levels without altering the size at various floor levels. After observing many research papers, none of the work is going on, so for that total 6 grade change cases of the current theme selected for different floor levels, created on software for fast and efficient parametric approach and analyzed after then result is compared. 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. Hence Beam grade change Case BS3 and BS4 observed and obtained as efficient case and should be recommended when this type of grade change approach will be adopted in earthquake zone III.

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

I. INTRODUCTION

The fast construction involves best 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. Multistorey buildings are increasing rapidly because of their construction methods, using modern equipment that are, modified and enhanced skilled labour, day – night construction activities and modern machineries used. Hence it is common now a day in metro cities. Stability analysis is one of the best methods of determination and finds stability of multistory building. Stability analysis can be done by using modern construction software's like Staad pro E-tabs etc. without doing the laborious hand written analysis work.

Factors Affecting Stability of Building

The stability plays an important role in any type of structure and in high-rised 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. Dead load (self-weight of the building),
2. Earthquake generates Seismic waves,
3. Height of the building,
4. Wind load at top of the building,
5. Shape of the building, and
6. Live load or imposed load

II. OBJECTIVES, PROCEDURE AND STRUCTURAL MODELING

To show and recommend the most efficient and effective grade change case at a particular floor level, following heads shows the point of comparison of result parameters between various grade change model cases when they are supposed to be at seismic prone area as per its soil condition and cases are as follows:-

1) To obtain the maximum nodal displacement values in X and Z direction with most efficient case between grade change and without grade change cases in Beam members at different floor levels.
2) 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.
3) To find member Shear Forces values in Beams and columns with efficient case between grade change and without grade change cases.
4) To examine Bending Moment values in Beam and columns with efficient case between grade change and without grade change cases.
5) To determine and compare member Torsion values in Beam and column members.
6) To examine column Axial Forces for total six grade change cases to determine the efficient case by comparing grade change and without grade change cases conducted in Beam members at different floor levels.

A G+16 residential building is assumed to be situated at seismic zone III with a projected plinth area of 576 sq. m. Length (6m @ 4 bays) and width (4m @ 6 bays)of the building is taken as 24 m because due to symmetrical approach, result obtained is good. Height of each floor is taken as 3m with 4m ground floor height. With 3m depth of footing, total height achieved from GL is 55m respectively.

For the analysis of stability improvement, we have created 6 cases varies according to the need of analysis. Response spectrum analysis has been applied and selected method of analysis to these 6 cases with combination of Dead loads, Live loads, Response spectrum loads and combinations as per Indian Standard 1893: 2016. Grade of concrete selected are M40 and M25. Steel Rebar used is Fe 500.

For Beams, total 2 grades are selected; they are 550 mm x 300 mm with M40 grade and M25 grade. For column, only M25 grade is selected for the analysis. Different thicknesses of plate member taken for analysis are 130mm for slab, 150 mm for staircase waist slab and last but not the least, 180 mm shear wall thickness are used.

Parameters for seismic analysis are taken as step by step, firstly damping ratio of 5 percent is selected with importance factor 1.2 and response reduction factor 4. Soil is taken as medium soil with seismic zone II having zone factor 0.16 respectively. Fundamental natural period of vibration equation if taken as $0.09*h/(d)^{0.5}$. Value obtained for both symmetrical X and Z directions are 1.0655 seconds respectively.

Different building model cases selected for analysis using software approach

1. Beams of same grade (All M25 grade beams) = **CASE BS1**

2. Beams of different grade (All M40 grade beams at plinth level) = **CASE BS2**

3. Beams of different grades (All M40 grade beams at 4th floor level) = **CASE BS3**

4. Beams of different grades (All M40 grade beams at 8th floor level) = **CASE BS4**

5. Beams of different grades (All M40 grade beams at 12th floor level) = **CASE BS5**

6. Beams of different grades (All M40 grade beams at 16th floor level) = **CASE BS6**

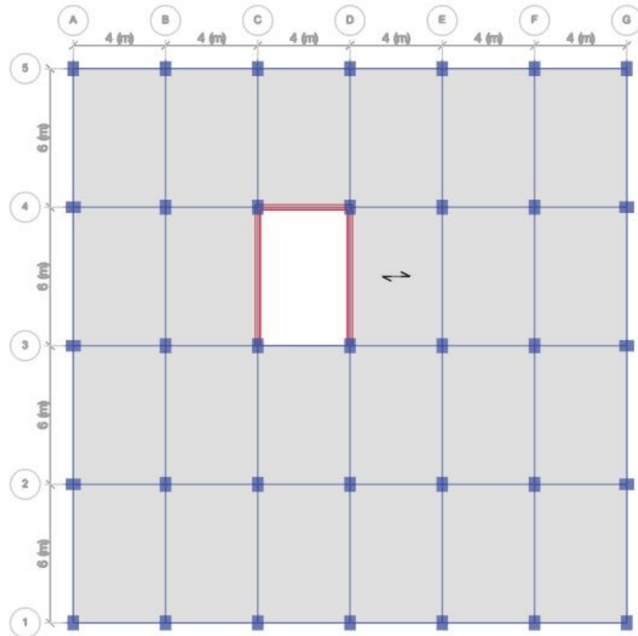

Figure 1: Typical floor plan

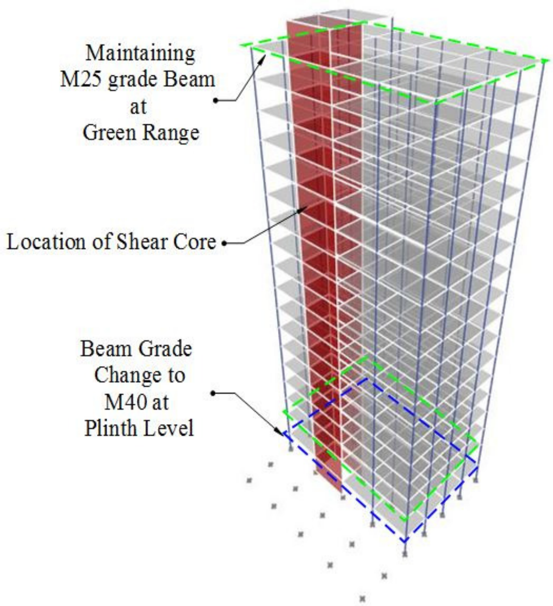

Figure 2: Beams of same grade (All M25 grade beams) = **CASE BS1**

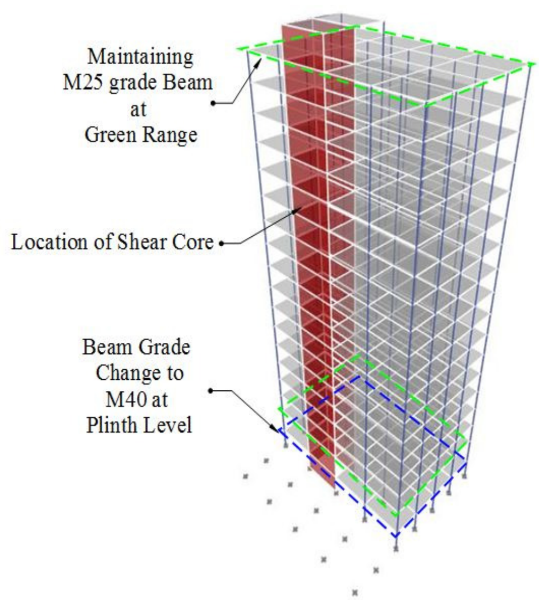

Figure 3: Beams of different grade (All M40 grade beams at plinth level) = **CASE BS2**

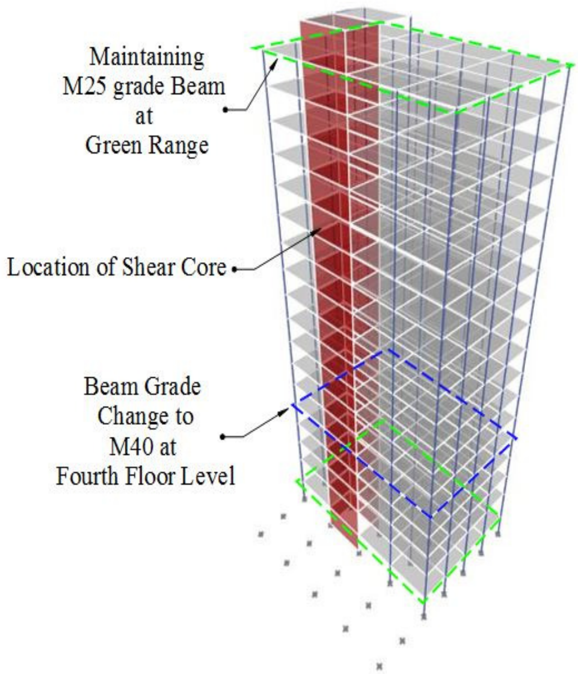

Figure 4: Beams of different grades (All M40 grade beams at 4th floor level) = **CASE BS3**

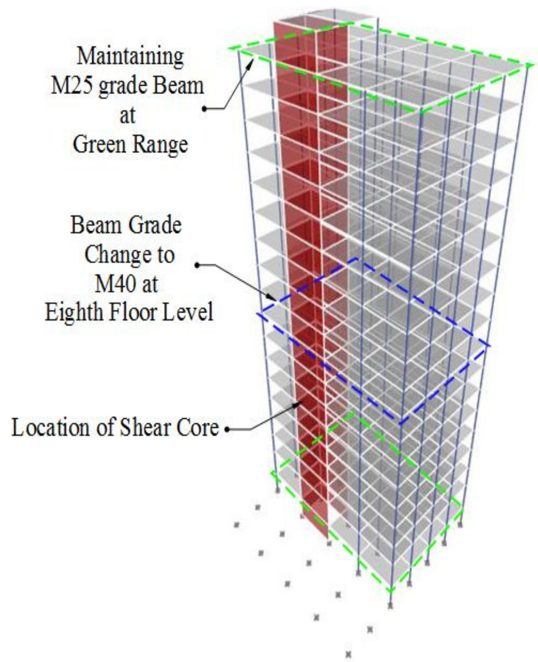

Figure 5: Beams of different grades (All M40 grade beams at 8th floor level) = **CASE BS4**

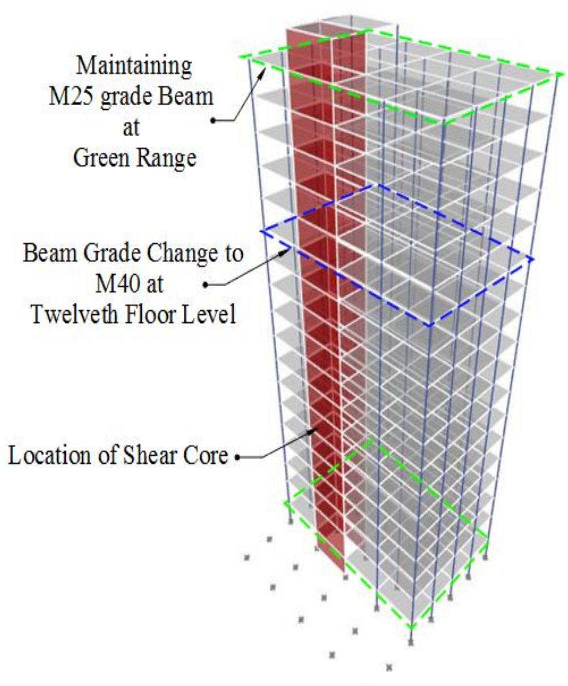

Figure 6: Beams of different grades (All M40 grade beams at 12th floor level) = **CASE BS5**

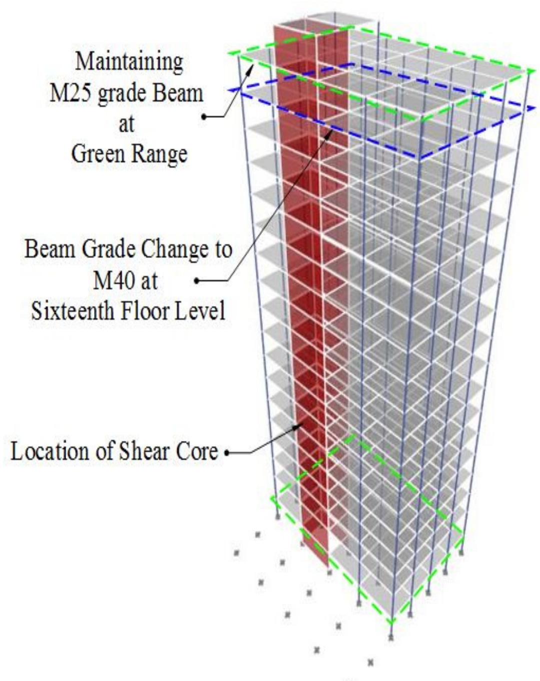

Figure 7: Beams of different grades (All M40 grade beams at 16th floor level) = **CASE BS6**

ISSN No : 1006-7930

III. RESULT ANALYSIS

As per the objectives, the various models are analyzed as per the cases decided. They are assumed to be situated at seismic prone area and the seismic shake is applied to it on the base of it. The grade change criteria implement on it and we have selected some result parameters such as displacement in X and Z horizontal direction, base shear in X and Z horizontal direction, Axial forces in columns, Shear forces in columns, bending moments in column, shear forces in beam members, bending moment in beam members and Torsional moment in both beam and column members.

Since, we have to take some of the parameters for concluding the objective statement. For the same, results obtained and from that combined comparative graphs are obtained are as follows:-

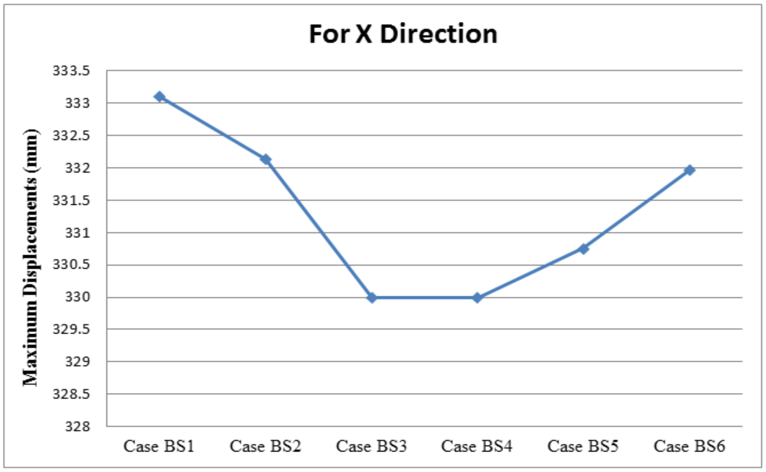

Figure 8: Maximum Displacement Obtained in X direction

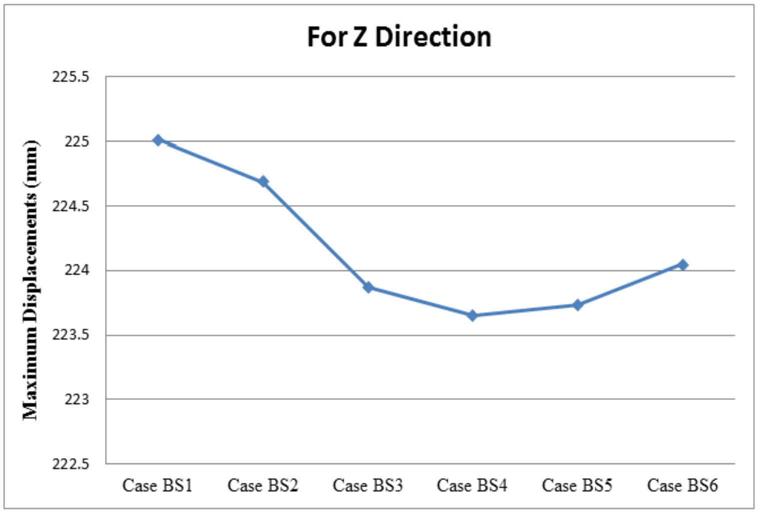

Figure 9: Maximum Displacement Obtained in Z direction

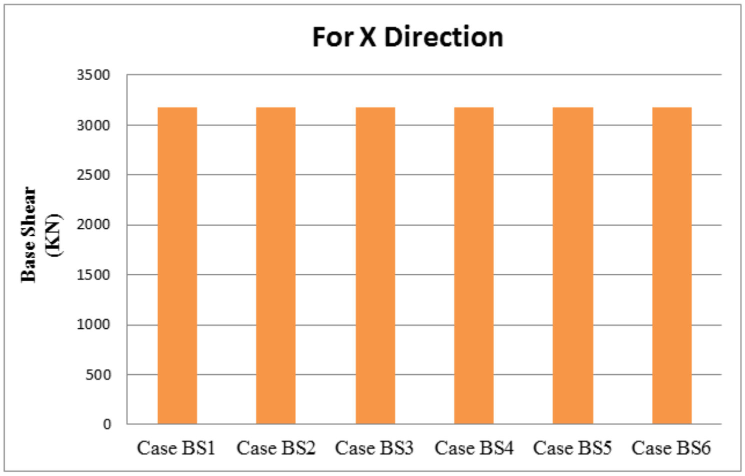

Figure 10: Maximum Base Shear Obtained in X direction

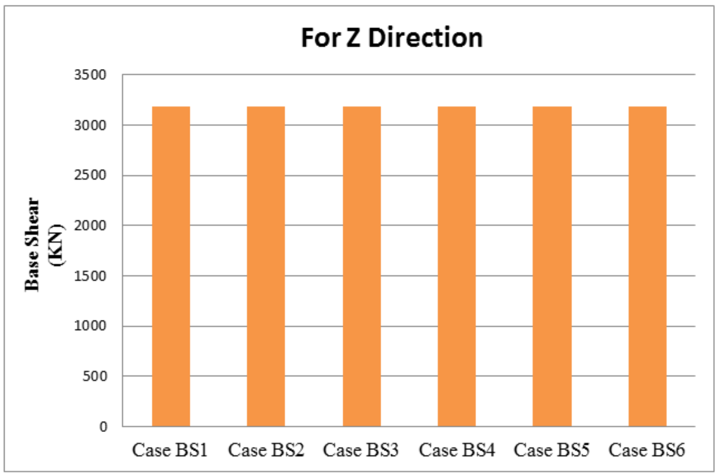

Figure 11: Maximum Base Shear Obtained in Z direction

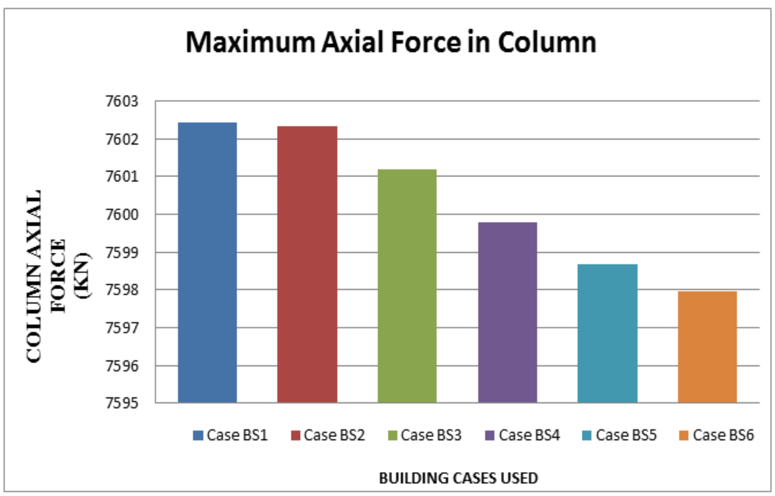

Figure 12: Maximum Axial Forces obtained in Column

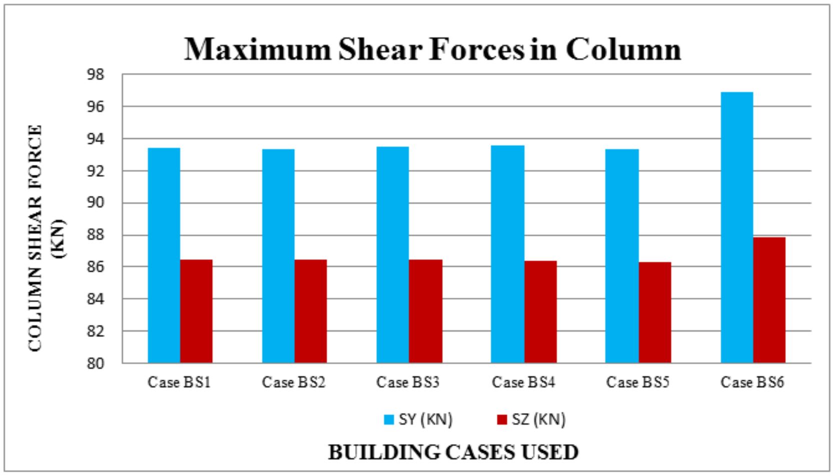

Figure 13: Maximum Shear Forces obtained in Column

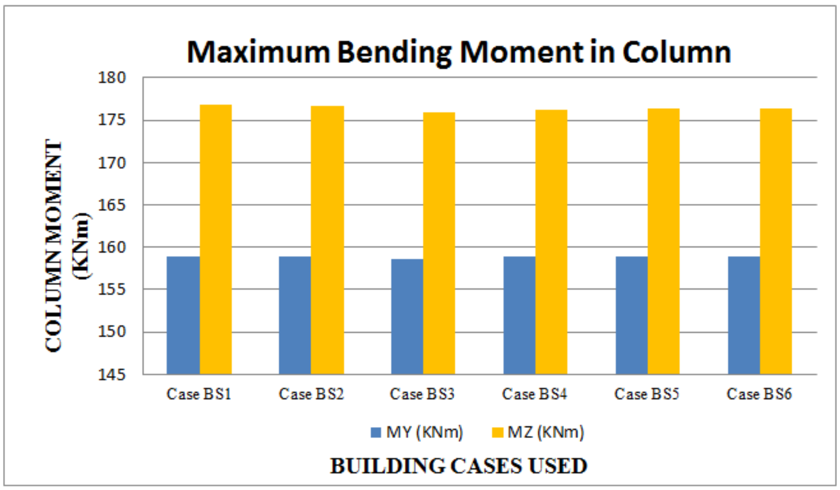

Figure 14: Maximum Bending Moment obtained in Column

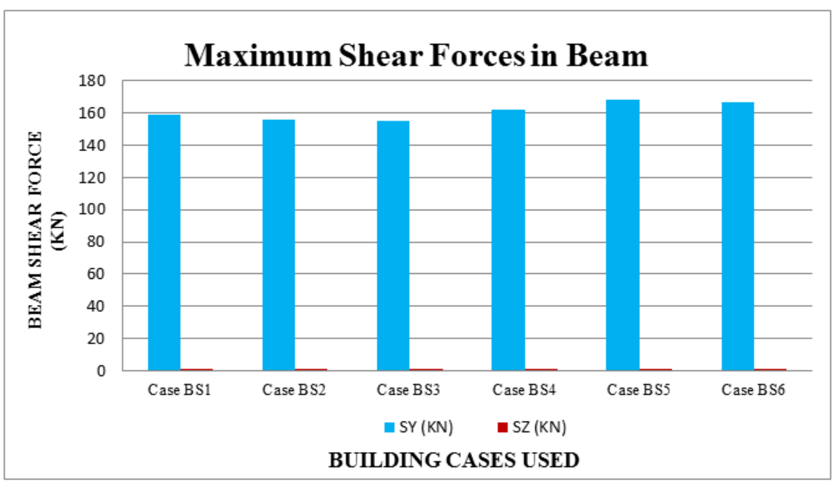

Figure 15: Maximum Shear Forces obtained in Beam

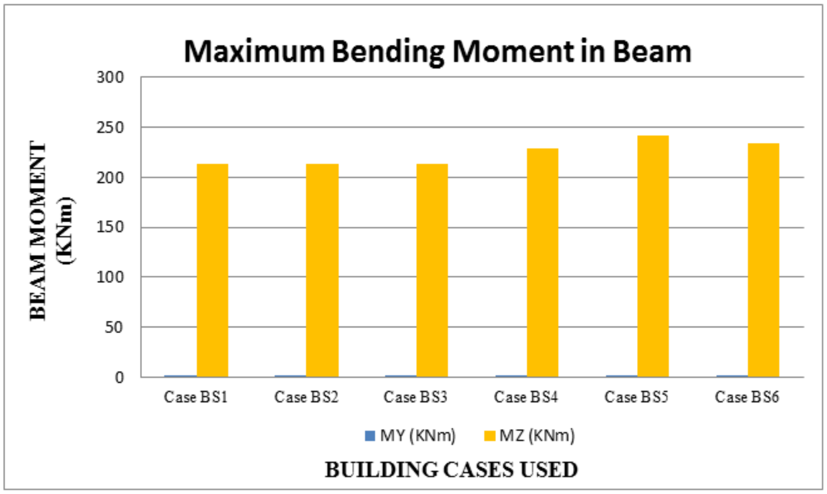

Figure 16: Maximum Bending Moment obtained in Beam

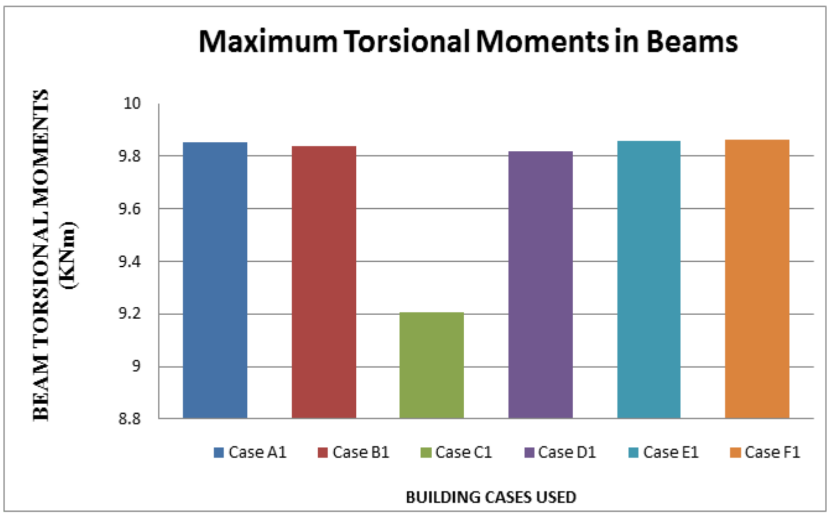

Figure 17: Maximum Torsional Moment obtained in Beam

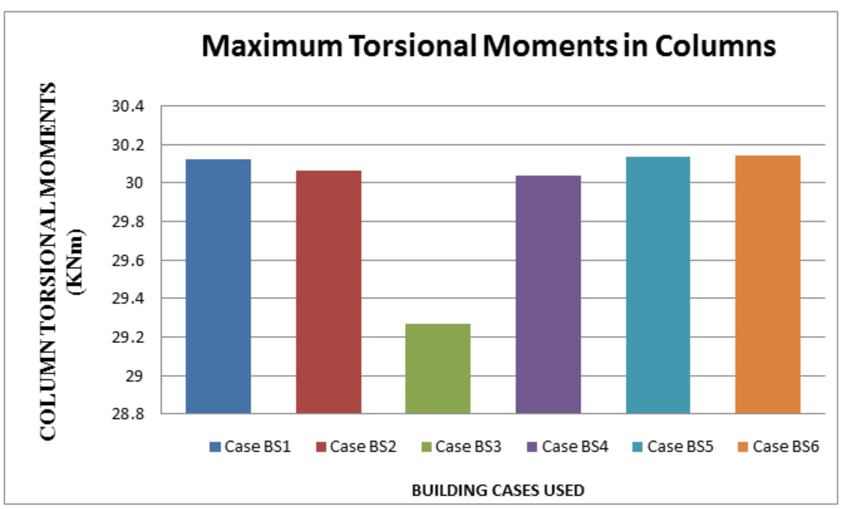

Figure 18: Maximum Torsional Moment obtained in Columns

IV. CONCLUSION OF THE WORK

The conclusion of current work has been pointed out are as follows:-

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

Since we have achieved the stability increment by changing the grade of beam members and this minor change is done at a particular level instead. Hence beam grade change Case BS3 and BS4 observed and obtained as efficient case and should be recommended when this type of grade change approach will be adopted in earthquake zone III

REFERENCES

1. Suyash Malviya, et. al, (2019), “Response of Multistorey 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, et. al, (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 (IJSHRE), ISSN: 2347-4890 Vol.-05, Issue-3, pp. 14-31.
4. Romesh Malviya, et. al, (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. Gagan Yadav, et. al, (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

6. Durgesh Kumar Upadhyay, et. al, (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
7. Gagan Yadav, et. al, (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
8. 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.
9. Gaurav Pandey, et. al, (2018), "Optimum Location of Floating Column in Multistorey 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.
10. Surendra Chaurasiya, et. al, (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.
11. Archit Dangi, et. al, (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***
12. Mohd. Arif Lahori, et. al, (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***
13. Suyash Malviya, et. al, (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***
14. Neeraj Patel, et. al, (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 : 2454-9150),vol. 4, no. 10, pp. 596-603, doi: 10.18231/2454-9150.2018.1372.
15. Neeraj Patel, et. al, (2019), "Use of Shear Wall Belt at Optimum Height to Increase Lateral Load Handling Capacity in Multistory Building: A Review", International Journal of Advanced Engineering Research and Science(ISSN : 2349-6495(P) | 2456-1908(O)),vol. 6, no. 4, pp. 310-314, AI Publications, ***https://dx.doi.org/10.22161/ijaers.6.4.36***
16. Taha A. Ansari, et. al, (2019), " Performance Based Analysis of RC Buildings with Underground Storey Considering Soil Structure Interaction", International Journal of Advanced Engineering Research and Science (ISSN: 2349-6495(P) | 2456-1908(O)),vol. 6, no. 6, pp. 767-771, AI Publications, ***https://dx.doi.org/10.22161/ijaers.6.6.89***
17. Sagar Jamle and Shirish Kumar Kanungo, (2020), "Determination of Stable Underground Storage Reservoir System- Recent Advancements in Structural Engineering Volume 1", *LAP LAMBERT Academic Publishing, Mauritius*, ISBN: 978-620-2-51435-4.
18. Prakash Mandiwal, et. al, (2019), "Tensile Strength & Durability Study on Self-Curing Concrete as a Partial Replacement of Cement by PEG-400", International Journal for Research in Engineering Application & Management(ISSN : 2454-9150),vol. 4, no. 10, pp. 244-248, doi: 10.18231/2454-9150.2018.1314
19. Surendra Chaurasiya, et. al, (2019), "Twin Tower High Rise Building Subjected To Seismic Loading: A Review". International Journal of Advanced Engineering Research and Science (ISSN : 2349-6495(P) | 2456-1908(O)), vol. 6, no. 4, pp. 324-328, AI Publications, ***https://dx.doi.org/10.22161/ijaers.6.4.38***

20. Archit Dangi, et. al, (2019), Stability Enhancement of Optimum Outriggers and Belt Truss Structural System", International Research Journal of Engineering and Technology, (ISSN: 2395-0072(P), 2395-0056(O)), vol. 6, no. 2, pp. 772-780.
21. Mohd. Arif Lahori, et. al, (2019), "Response of Multistory Building Located on 20 degree and 30 degree Sloping Ground under Seismic Loading", International Research Journal of Engineering and Technology, (ISSN: 2395-0072(P), 2395-0056(O)), vol. 6, no. 1, pp. 1063-1069.
22. Mariyam and Sagar Jamle (2020), "Wind Analysis of Flat Slab Multistoried Building Construction: "Recent Advancements in Structural Engineering": Volume II, *LAP LAMBERT Academic Publishing, Mauritius*.
23. Durgesh Kumar Upadhyay, et. al, (2020), "Stability Enhancement in Wall Belt Supported Dual Structural System using Different Grades of Concrete", International Journal of Current Engineering and Technology, (ISSN: 2277-4106 (O), 2347-5161(P)), vol. 10, no. 2, pp. 237-242. https://doi.org/10.14741/ijcet/v.10.2.8
24. Pankaj Kumar Dhakad, et. al, (2020), "Base Shear Reduction by using Optimum Size of Beams with same Grade of Concrete: An Informative Review", International Journal of Current Engineering and Technology, (ISSN: 2277-4106 (O), 2347-5161(P)), vol. 10, no. 2, pp. 259-262. https://doi.org/10.14741/ijcet/v.10.2.12
25. Manoj Patidar, et. al, (2020), "Optimization of Stability of Multistoried Structure by Changing Grades of Concrete in Shear Wall Member", Journal of Xi'an University of Architecture & Technology, ISSN: 1006-7930, vol. 12, no. 4, pp. 2479-2497. https://doi.org/10.37896/JXAT12.04/979
26. Sagar Jamle, Dr. M.P. Verma, Vinay Dhakad, (2017), "Flat Slab Shear Wall Interaction for Multistoried Building Analysis When Structure Length is greater than width under seismic Forces", International Journal of Software & Hardware Research in Engineering (IJSHRE), ISSN: 2347-4890 Vol.-05, Issue-3, pp. 32-53.
27. Pankaj Kumar Dhakad, et. al, (2020), "Base Shear Reduction by Using Optimum Size of Beams in Top Floors with Different Grades in Multistoried Building at Different Levels", International Journal of Advanced Engineering Research and Science, (ISSN: 2456-1908 (O), 2349-6495(P)), vol. 7, no. 4, pp. 293-296. https://dx.doi.org/10.22161/ijaers.74.20
28. Sagar Jamle, Nirmal Delmiya, Rahul Singh, (2020), "Efficient Use of UPV Meter: A Non Destructive Test of Concrete by Fragmentation Analysis", Journal of Xi'an University of Architecture & Technology, ISSN: 1006-7930, vol. 12, no. 4, pp. 3385-3394. https://doi.org/10.37896/JXAT12.04/1078
29. Manoj Patidar, et. al, (2020), "Use of different Grades of Concrete in Shear Wall: A Comprehensive Review", International Journal of Advanced Engineering Research and Science, (ISSN: 2456-1908 (O), 2349-6495(P)), vol. 7, no. 4, pp. 355-359. https://dx.doi.org/10.22161/ijaers.74.44
30. Mohammad Bilal Rasheed, et. al, (2020), "Conceptual Approach on Effect of Various Concrete Grade in Outrigger and Wall Belt Supported System: A Perceptional Review", International Journal of Advanced Engineering Research and Science, (ISSN: 2456-1908 (O), 2349-6495(P)), vol. 7, no. 5, pp. 100-104. https://dx.doi.org/10.22161/ijaers.75.14
31. Shahdab Khan, et. al, (2020), "Use of Shear Wall Member at Corners to Enhance the Stability Using Different Grades: An Immense Review", International Journal of Advanced Engineering Research and Science, (ISSN: 2456-1908 (O), 2349-6495(P)), vol. 7, no. 5, pp. 396-400. https://dx.doi.org/10.22161/ijaers.75.47
32. Ankush Nagar, et. al, (2020), "Base Shear Reduction Techniques: A Review", International Journal of Advanced Engineering Research and Science, (ISSN: 2456-1908 (O), 2349-6495(P)), vol. 7, no. 5, pp. 466-471. https://dx.doi.org/10.22161/ijaers.75.57