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Base Shear Reduction by Using Optimum Size of Beams in Top Floors with Different Grades in Multistoried Building at Different Levels

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***Abstract*— *The recent development shows that expansion is the key to enlarge the infrastructure not only in horizontal direction but in vertical direction too. For this, tall constructions are favored due to less consumption of the land region for living purpose. With this, the seismic disaster activities in this approach made it more complicated. Indian Standard code of practice 1893:2016 shows the seismic prone zones where the shakes are witnessed. On decreasing the load of the structure decreases the Base Shear on the foundation base without compromising the stiffness of the tall structures. To demonstrate and prove this, six tall structures are prepared using software approach, lessening the beam sizes with grade change in top floors, analyzed it and compared among them. After deep comparative analysis, it has been found out that Building with Base Shear reduction case F1 emerges and hence proved to be the best Base Shear reduction case.*

Keywords*— *Base Shear Reduction, Bending Moments, Concrete Grade, Displacement, Dual System, Multistoried Building, Shear Force, Shear Wall

I. INTRODUCTION

The introduction of lessening the weight of the structure is such a difficult task when construction is for high rise structures. This is only done with the help of changing the grade of concrete so that homogeneity of the components of concrete; or by reducing the components of the structures. The later one will compromise the architectural point of view.

Again the solution of this problem is to make the structural components slender, which will reduce the weight of the entire structure. But the lateral shakes of earthquake will not going to implement this. The last solution of this problem to use some special elements or to detect which part of the structure will be reduced to make it economical. This approach will need more case studies and the research will be useful in the growing infrastructure demand.

Similarly, the grade change of concrete in construction industry plays a vital role in terms of economy and providing the strength. The enactment of grade change will affect the presentation of the complete construction. Therefore it should not be unnoticed.

II. OBJECTIVES OF THE PRESENT STUDY

The objectives selection is a very tough task since what we have decided that has to be going to be proved. The use of this kind of system in which base shear will reduce without losing the concept of lateral load stiffening system by using the dual system in which Special Moment Resisting Frames are used in the combination of Ordinary Core Type Shear Wall around the lift area in multistoried building. The objectives of this work are as follows:

a. To show the base shear effect on dual structural system.
b. To make Base Shear reduction cases of same multistoried building and compare among each other under seismic loading.
c. To determine Base Shear in X and Z direction for all base shear reduction cases.
d. To show the seismic effect of lessening the sizes of beams in top floors.
e. To find member Shear Forces and Bending Moment values in Column for all Base Shear reduction cases.
f. To find out the Torsion values in Beam and Column members.

g. To determine Principal stresses, Von Mises Stresses and Shearing Stresses for all Base Shear reduction cases.

h. To examine column Axial Forces in column members for all Base Shear reduction cases.

i. To examine member Shear Forces and Bending Moment values in Beams for all Base Shear reduction cases.

j. To show the grade change effect in multistoried building under seismic loading.

k. To study and find the maximum nodal displacement in transitional X and transitional Z direction for all Base Shear reduction cases.

III. METHODOLOGY AND MODELING APPROACH

As per the objectives, the Response Spectrum Analysis has been performed on different models consist of Building Case A1 made up of G+17 storey Semi commercial building with all beams are of same sizes. Building Case B1 made up of G+ 17 storey Semi commercial building with all beams are not of same sizes and beam sizes changes above G+17. Building Case C1 made up of G+ 17 storey Semi commercial building with all beams are not of same sizes and beam sizes changes above G+16. Building Case D1 made up of G+ 17 storey Semi commercial building with all beams are not of same sizes and beam sizes changes above G+15. Building Case E1 made up of G+ 17 storey Semi commercial building with all beams are not of same sizes and beam sizes changes above G+14. Building Case F1 made up of G+ 17 storey Semi commercial building with all beams are not of same sizes and beam sizes changes above G+13. All the cases are situated in Earthquake Zone III.

Table 1: Dimensions of different components of building

Parameters	**Values**
Building configuration	G + 17
Building type	Semi-commercial building
Total plinth area	576m^2
Building Length	4m @ 6 bays
Building Width	6m @ 4 bays
Height of building from Ground level	61 m
Height of each floor	3 m
Depth of footing	3 m
Beam dimensions 1	450 mm x 350 mm with M30 grade
Beam dimensions 2	450 mm x 300 mm with M25 grade
Column dimensions	450 mm x 650 mm with M35 grade
Slab thickness	150 mm
Staircase waist slab	145 mm
Shear wall thickness	200 mm
Material properties	Concrete (M25), (M30), (M35), Steel (Fe 415)

Seismic parameters on the structure

1. Importance factor I = 1.2
2. Fundamental natural period of vibration (Ta) = 0.09*h/(d)0.5
3. For both the cases, Tax= Taz
4. Fundamental natural period (Tax) for X direction = 1.12064 seconds
5. Fundamental natural period (Taz) for Z direction = 1.12064 seconds
6. Response reduction factor R = 4
7. Damping ratio = 5% (0.005)
8. Zone factor = 0.16
9. Zone = III
10. Soil type = Medium soil

Different building model cases selected for analysis using ETABS software are as follows:-

1. **Case A1** = Base Shear Reduction Case – Beams of Same sizes
2. **Case B1** = Base Shear Reduction - Beams of Different sizes (size of beam changes above G+17)
3. **Case C1** = Base Shear Reduction - Beams of Different sizes (size of beam changes above G+16)
4. **Case D1** = Base Shear Reduction - Beams of Different sizes (size of beam changes above G+15)
5. **Case E1** = Base Shear Reduction - Beams of Different sizes (size of beam changes above G+14)
6. **Case F1** = Base Shear Reduction - Beams of Different sizes (size of beam changes above G+13)

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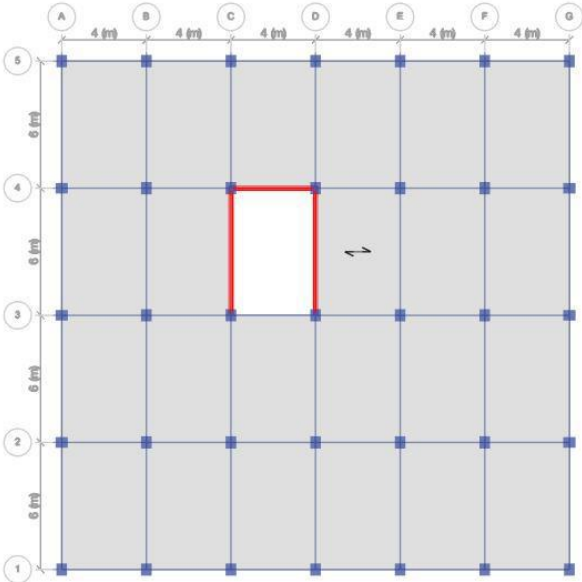

Fig. 1: Typical floor plan

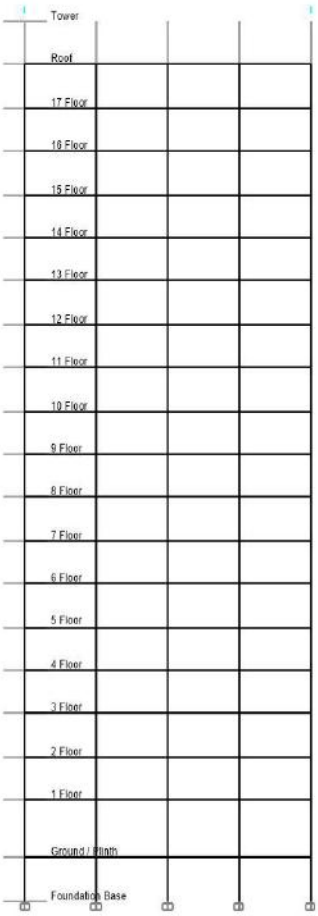

Fig. 2: Front View of the Structure

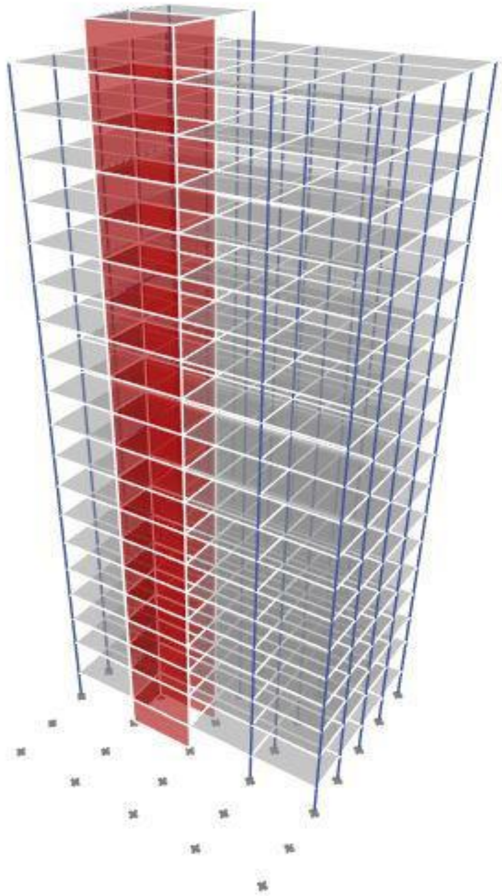

Fig. 3: Sectional 3D View of the Base Shear reduction case of the Structure

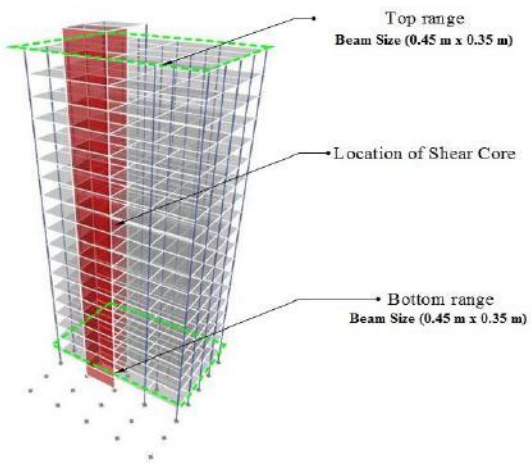

Fig. 4: Base Shear Reduction Case – Beams of Same sizes: Case A1

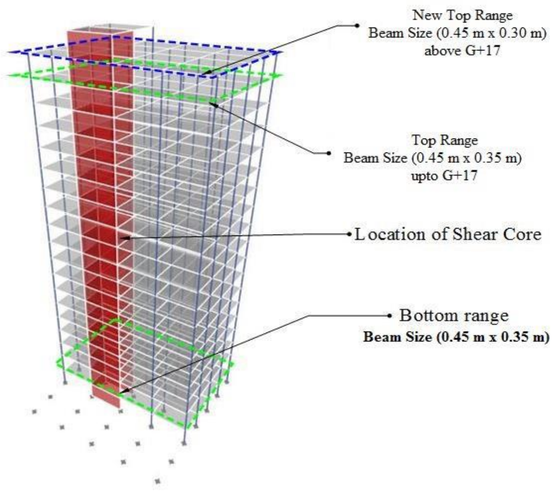

Fig. 5: Base Shear Reduction - Beams of Different sizes (size of beam changes above G+17): Case B1

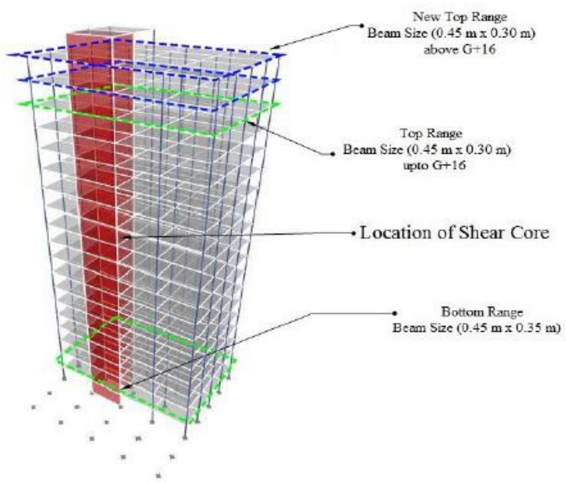

Fig. 6: Base Shear Reduction - Beams of Different sizes (size of beam changes above G+16): Case C1

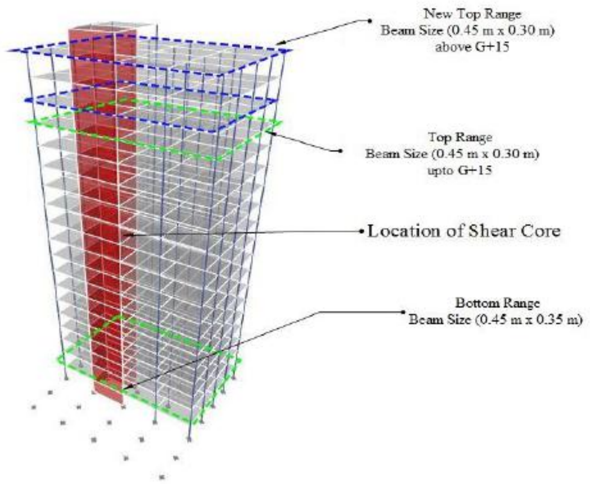

Fig. 7: Base Shear Reduction - Beams of Different sizes (size of beam changes above G+15): Case D1

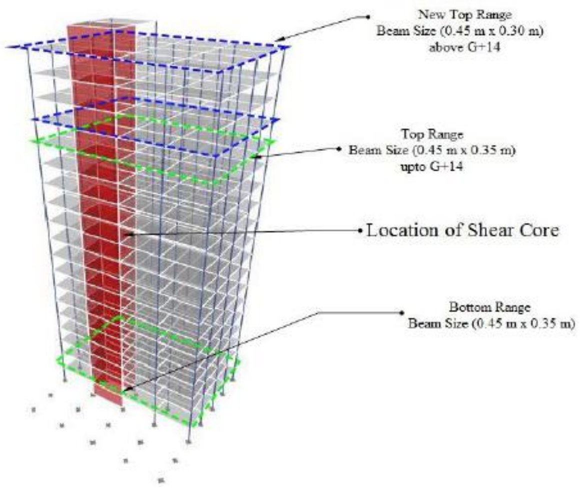

Fig. 8: Base Shear Reduction - Beams of Different sizes (size of beam changes above G+14): Case E1

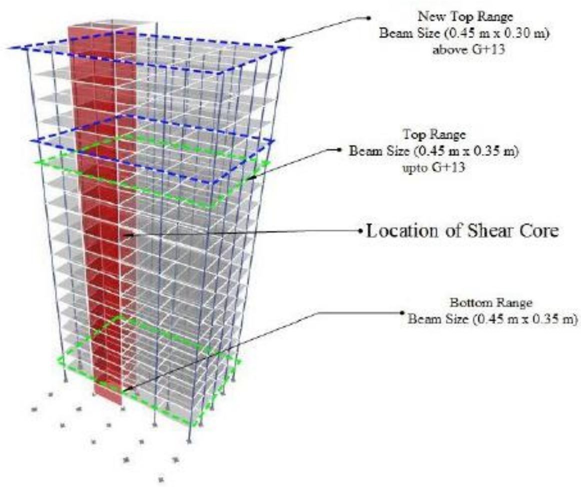

Fig. 9: Base Shear Reduction - Beams of Different sizes (size of beam changes above G+13): Case F1

IV. RESULT ANALYSIS

Graphical representation of each objective is mentioned below:-

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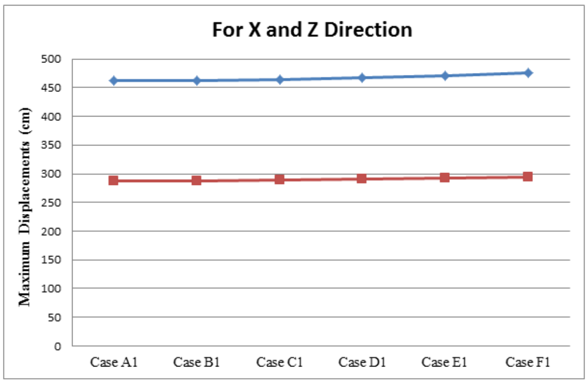
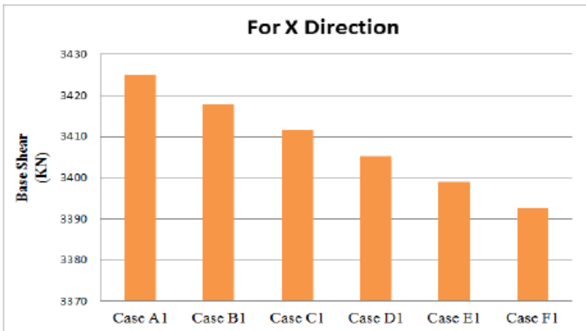
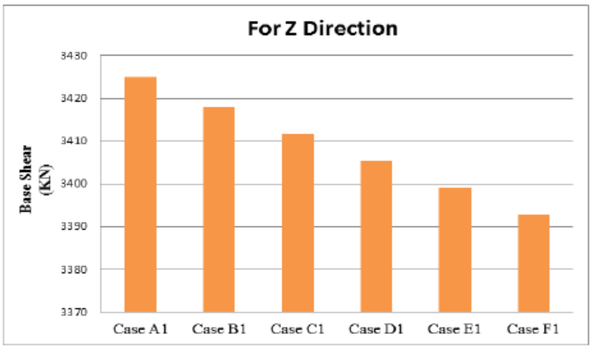


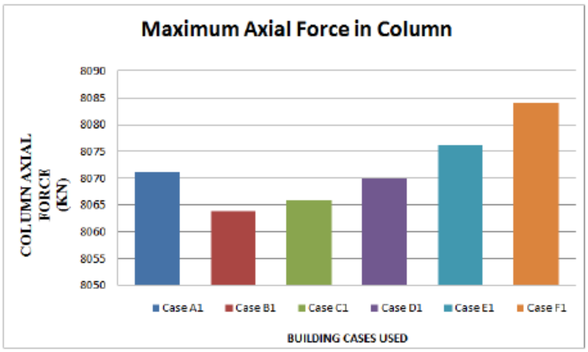
Graph 1: Maximum nodal displacement in X and Z direction



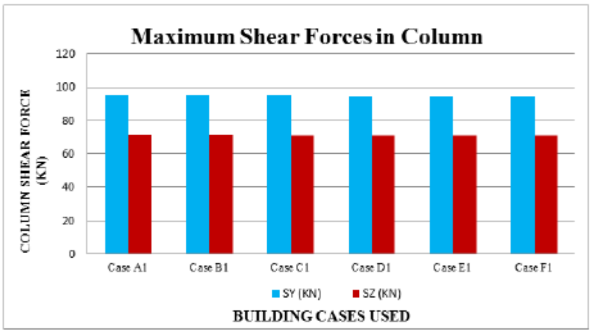
Graph 2: Base Shear in X direction for all Wall Belt Stability Cases



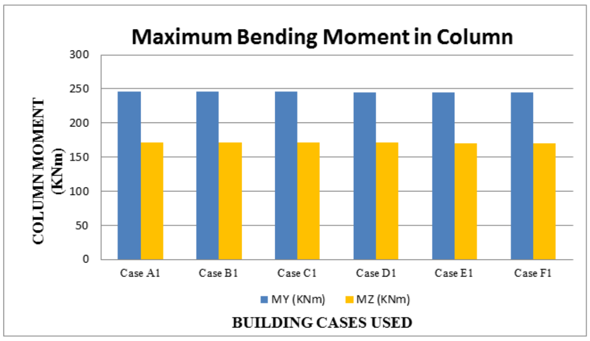
Graph 3: Base Shear in Z direction for all Wall Belt Stability Cases



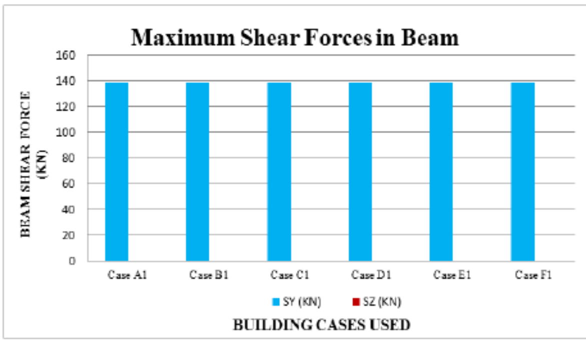
Graph 4: Maximum Axial Forces in Column for all Wall Belt Stability Cases



Graph 5: Maximum Shear Force in Column for all Wall Belt Stability Cases



Graph 6: Maximum Bending Moment in Column for all Wall Belt Stability Cases



Graph 7: Maximum Shear Force in Beam for all Wall Belt Stability Cases

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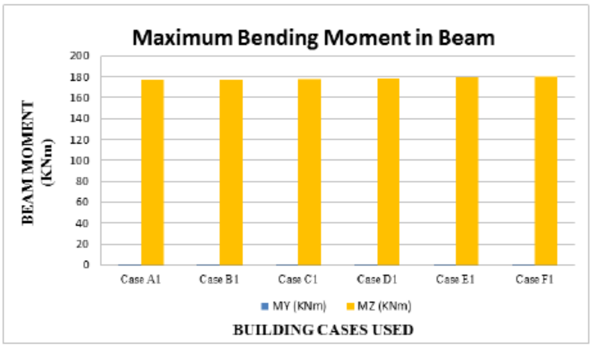
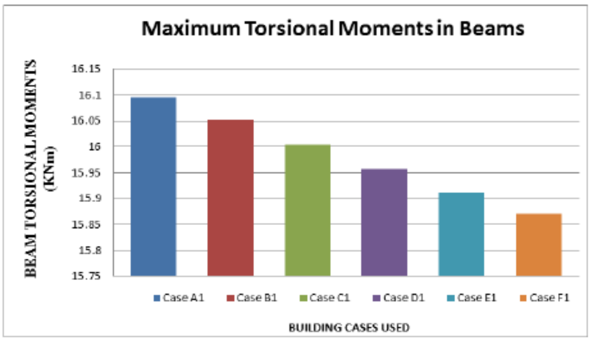
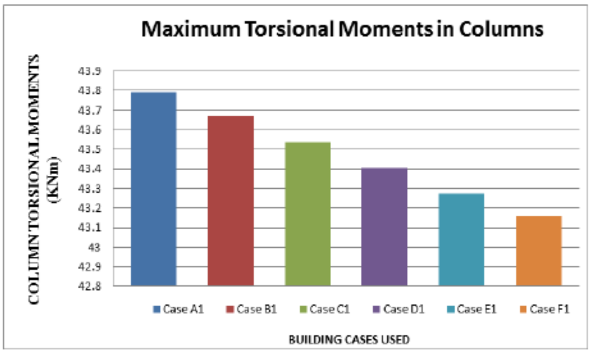


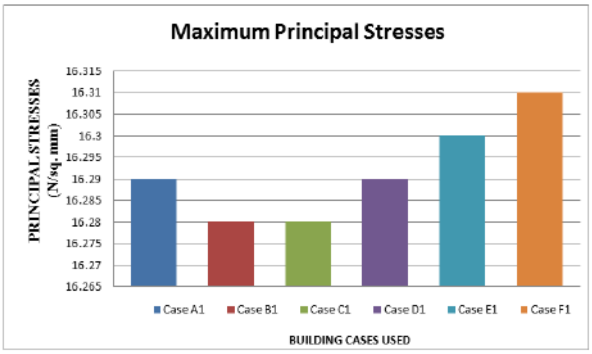
Graph 8: Maximum Bending Moment in Beam for all Wall Belt Stability Cases



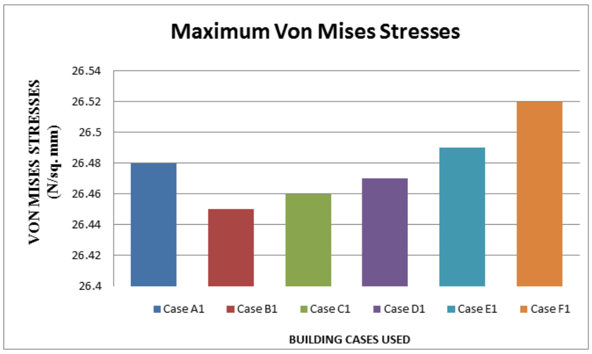
Graph 9: Maximum Torsional Moments in Beam for all Wall Belt Stability Cases



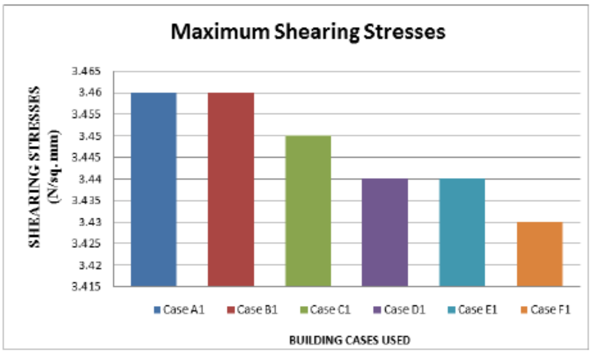
Graph 10: Maximum Torsional Moments in Columns for all Wall Belt Stability Cases



Graph 11: Maximum Principal Stresses for all Wall Belt Stability Cases



Graph 12: Maximum Von Mises Stresses for all Wall Belt Stability Cases



Graph 13: Maximum Shearing Stresses for all Wall Belt Stability Cases

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V. CONCLUSION

On investigating the result data of various parameters for all six Base Shear reduction cases, conclusions developed are as follows:-

1. Maximum displacement in X direction has a minimum value of 462.225 mm for Building case A1 since the values keep on increasing up to Case F1 when beam

size is less. 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.
3. Base Shear in X direction has gradually reduced by implementing lesser size of beams in top floors, subsequently decreases the weight of the structure. For this parameter, Case F1 proves to be an efficient parametric case.
4. Again, the Base Shear in behaves same as the trend obtained in X direction. Here, due to reducing the beam size in top floors; subsequently decreases the weight of the structure with Base Shear values. Case F1 proves to be efficient case.
5. The maximum Axial forces in Column first decreases to Case B1 and then it increases gradually up to Case F1. Observing the least parameter, Case B1 obtained as an efficient Case with a parametric value of 8063.884 KN.
6. The sectional Shear Forces along both Y-Y axis and Z-Z axis in column decreases gradually to case F1 and proves to be an efficient case with values of 94.6674 KN and 71.1444 KN respectively.
7. Similarly, the Bending Moment along both Y-Y axis and Z-Z axis in column decreases gradually to case F1 and proves to be an efficient case with values of 244.4088 KNm and 170.3592 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 case F1 and proves to be an efficient case with values of 94.6674 KN and 71.1444 KN respectively.
9. Bending Moments in beams slightly increases just because of the size is reduced in top floors and due to lateral effects, the displacing effects slightly increases its values 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 on lessening the sizes of beams in top floors. For this parameter, again Case F1 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 43.4109 KNm for Case F1 and hence prove to be an economical case.
12. The principal stresses and Von Mises stresses in plates increases when lateral effects were there along with combination of the vertical loads.
13. Maximum Shearing Stresses seems less in Base Shear stability Case F1 with a minimum value among all and this parameter links with the theme of the current work.

Observing all the parameters, the main aim of this work has achieved with lessening the Base Shear parameter in both X and Z direction in Semi-Commercial (G+17) multistoried building under seismic loading. Building Case F1 observed and obtained as efficient case and should be recommended when this type of approach will be adopted in any earthquake zones.

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