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# An Analytical Approach to Determine Base Shear Reduction Effects in Multistoried Building

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**Abstract:** The expansion in the current scenario leads to the scarcity of the living area and huge demand of the residential and commercial land. The solution of this particular problem again leads to the tall structures but again due to earthquake, it needs to be safe enough to resist the loads. The current work approaches to the safe living area with respect to seismic effects. As per the parametric point of view, it is necessary to evaluate the Base shear of the structure and criteria to lessening the weight of the structure. The current theme of the work based on the two base shear reduction techniques, the first approach is to lessening the beam size in top particular levels and the second one is to lessening the column approach in the top particular levels. Both the approaches are them compared among each four model cases. After deep analytical approach, it has been found and studied that base shear beam reduction case BCC4 observed and obtained as efficient case for both beam change cases and column change cases at different levels and should be recommended when this type of approach will be adopted in any earthquake zones.

**Keywords:** Base Shear Reduction, Beam cases, Bending Moments, Column cases, Concrete Grade, Displacement, Dual System, Multistoried Building, Shear Force, Shear Wall

## I. INTRODUCTION

As it has been predefined that column is the vertical stiffness component and it transfers the load from level to level of the floor and ultimately transfers the same to the ground. As this component generally made up of R.C.C., steel, timber, composite materials, etc. as per the requirement of the uniformity. In R.C.C. structure, concrete is basically a key component and an artificial stone, well modelled, transfer load as per its designed capacity.

R.C.C. column is the spinal cord when discussing specific on Multistoried building. Changing the size of the column member can reduce the weight of the structure but not sufficient to withstand the vertical loads and to bear the lateral load as well.

The same thing would happen with concrete beam specifications. Changing the size of the beam member in Multistoried building can reduce the weight of the structure but not sufficient to withstand the vertical loads and to bear the lateral load as well since the main work of this member is to transfer the loads to the subsequent downward members.

## II. OBJECTIVES OF THE CURRENT STUDY

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

- A. To determine Base shear response when seismic forces are applied in X and Z direction to the structure when size of beams and columns changes at different floor levels.
- B. To find member Shear Forces values in Beam with efficient case among all 4 beam and 4 column cases.
- C. To examine Bending Moment values in Beam with efficient case among all 4 beam and 4 column cases.
- D. To examine column Axial Forces for total 4 beam and 4 column cases with efficient case to determine minimum axial force.
- E. To find member Shear Forces values in Beam with efficient case among all 4 beam and 4 column cases.
- F. To examine Bending Moment values in Beam with efficient case among all 4 beam and 4 column cases.
- G. To analyze the maximum nodal displacement case in X and Z horizontal plane direction with most efficient case that provides more stability among beam and column size reduction cases.

The main theme of the current work is to demonstrate and recommend the efficiency of reduction of Base Shear by changing the size of beam member or column member at different floor levels.

### III. PROCEDURE AND 3D MODELING OF THE STRUCTURE

As per the objectives, the Response Spectrum Analysis has been performed on different models consist of various Base Shear Reduction Beam cases and various Base Shear Reduction Column cases. Total four cases for beams and four cases for columns have selected for the complete analysis.

Beam Change Case BCC1 made up of G+18 storey Residential cum commercial building with same sizes of beams at all levels. Beam Change Case BCC2 made up of G+ 18 storey Residential cum commercial building with beams size change above roof. Beam Change Case BCC3 made up of G+18 storey Residential cum commercial building with beams size change above Eighteenth floor. Beam Change Case BCC4 made up of G+ 18 storey Residential cum commercial building with beams size change above Seventeenth floor.

Column Change Case CC1 made up of G+18 storey Residential cum commercial building with same sizes of columns at all levels. Column Change Case CC2 made up of G+ 18 storey Residential cum commercial building with column size change above roof. Column Change Case CC3 made up of G+ 18 storey Residential cum commercial building with column size change above Eighteenth floor. Column Change Case CC4 made up of G+ 18 storey Residential cum commercial building with column size change above Seventeenth floor.

All the cases are situated in Earthquake Zone III.

Different building model cases selected for analysis using software approach

Table 1: List of models framed with assigned abbreviation

| S. No. | Models framed for analysis                  | Abbreviation |
|--------|---|--------------|
| 1.     | Same sizes of beams at all levels           | Case BCC1    |
| 2.     | Beams size change above roof                | Case BCC2    |
| 3.     | Beams size change above Eighteenth floor    | Case BCC3    |
| 4.     | Beams size change above Seventeenth floor   | Case BCC4    |
| 5.     | Same sizes of columns at all levels         | Case CC1     |
| 6.     | Columns size change above roof              | Case CC2     |
| 7.     | Columns size change above Eighteenth floor  | Case CC3     |
| 8.     | Columns size change above Seventeenth floor | Case CC4     |

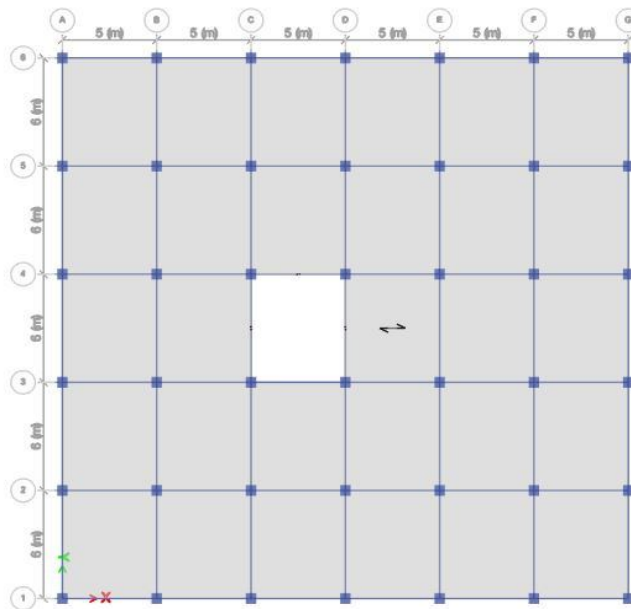


Fig. 1: Typical floor plan

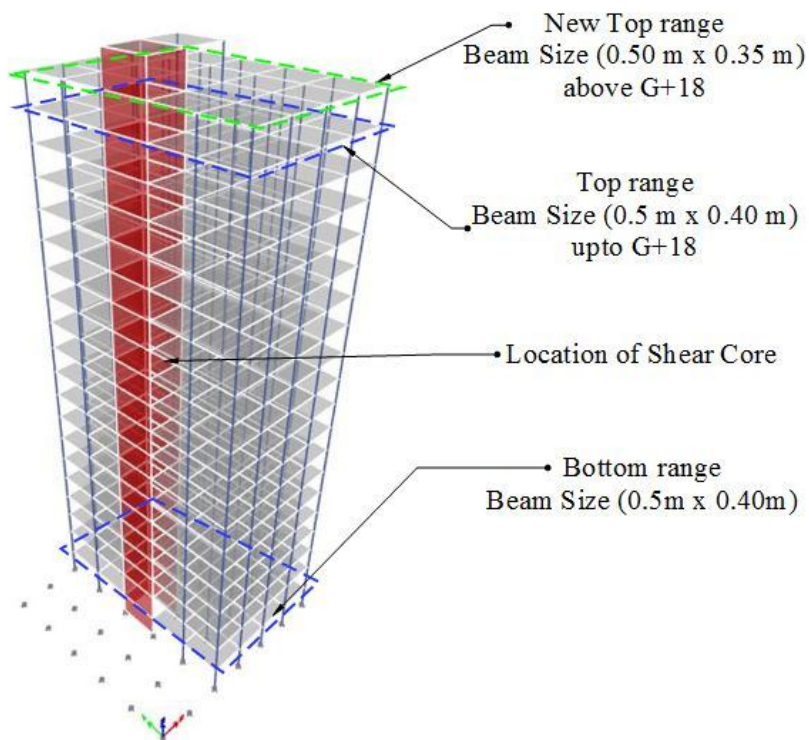


Fig. 2: Base Shear Reduction - Beams size change above roof: Case BCC2

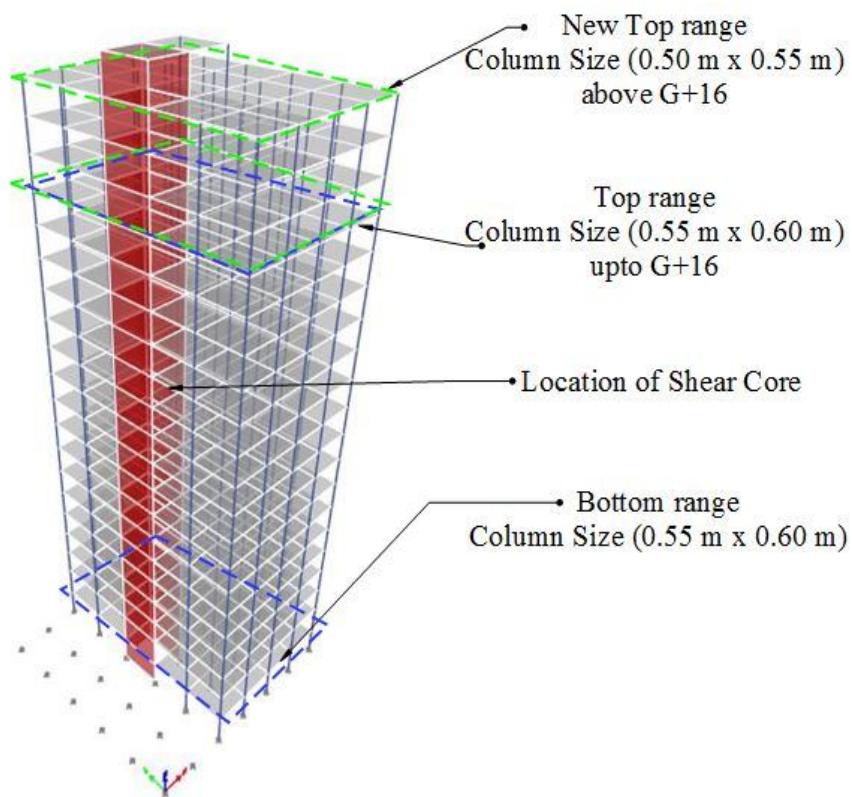


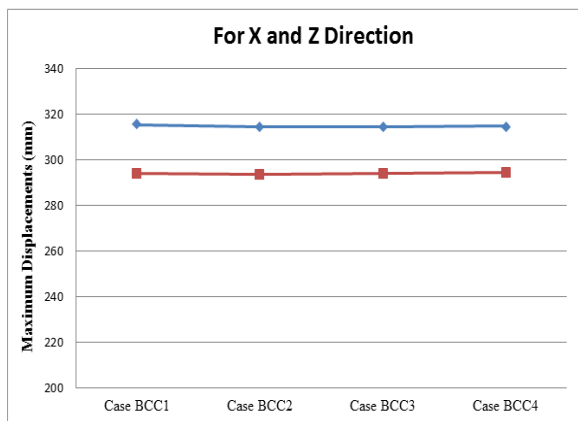
Fig. 3: Base Shear Reduction - Columns size change above Seventeenth floor: Case CC4

#### IV. RESULTS ANALYSIS

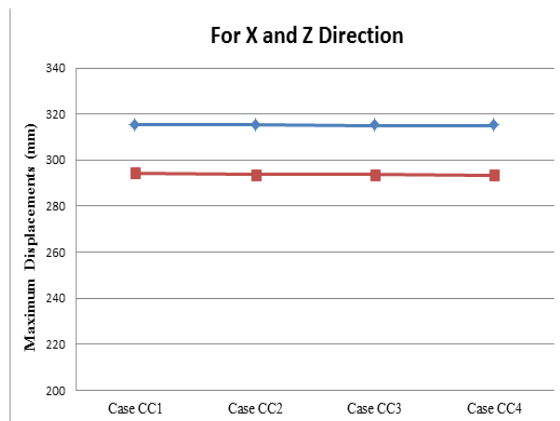
For the stability of the structure by changing the section of beam and column members at various particular level cases. After analysis, various comparative results have been drawn for all four beam cases and four all column base reduction cases.

The above parameters obtained by the application of loads and their combinations on various cases of the multistorey building as per Indian Standard 1893: 2016 code of practice.

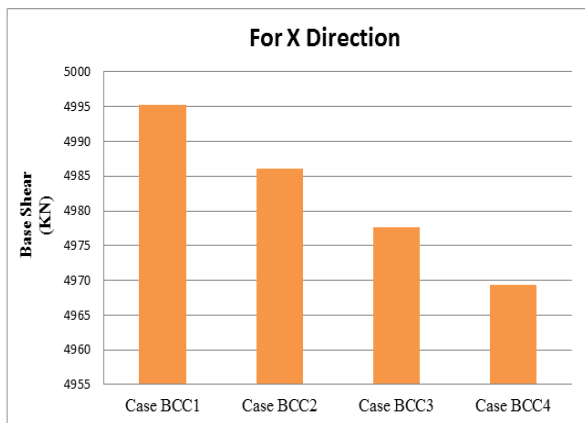
Graphical result of each parameter has discussed below:-



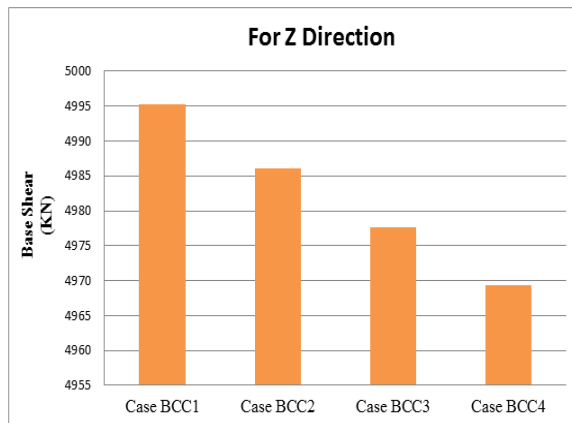
Graph 1: Maximum Displacement in X and Z direction for all Base Shear Reduction Beam Cases



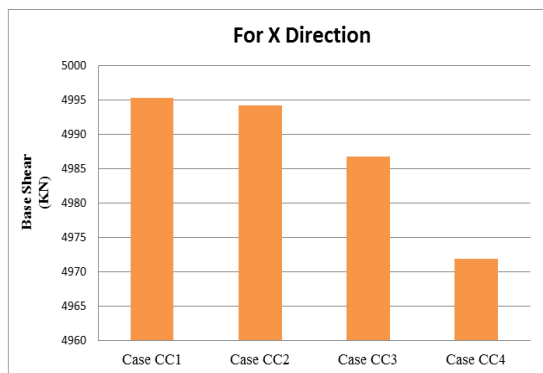
Graph 2: Maximum Displacement in X and Z direction for all Base Shear Reduction Column Cases



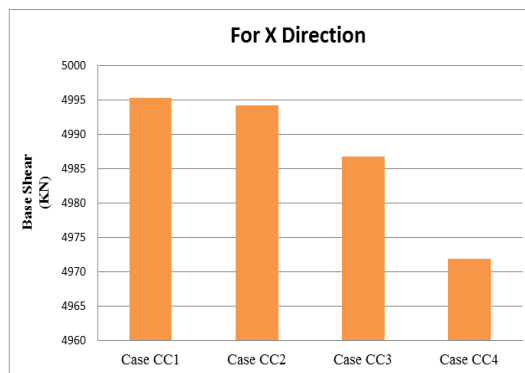
Graph 3: Base Shear in X direction for all Base Shear Reduction Beam Cases



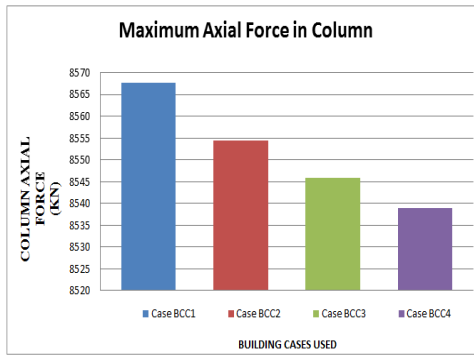
Graph 4: Base Shear in Z direction for all Base Shear Reduction Beam Cases



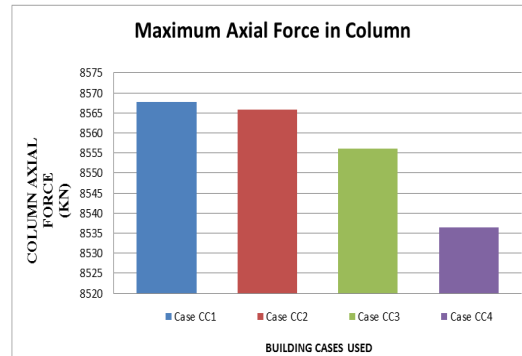
Graph 5: Base Shear in X direction for all Base Shear Reduction Column Cases



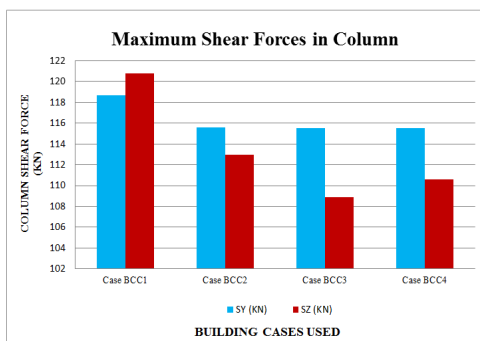
Graph 6: Base Shear in Z direction for all Base Shear Reduction Column Cases



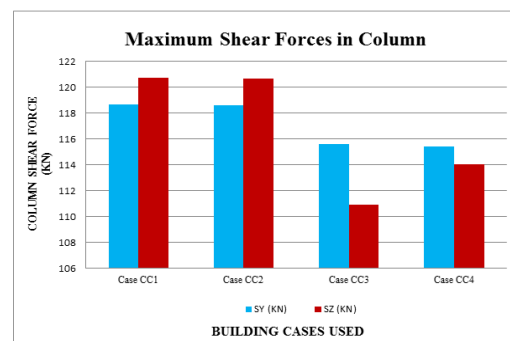
Graph 7: Maximum Axial force in column all Base Shear Reduction Beam Cases



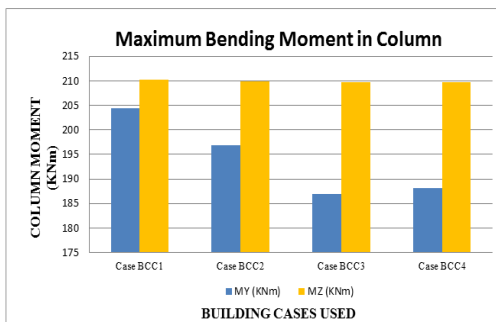
Graph 8: Maximum Axial force in column all Base Shear Reduction Column Cases



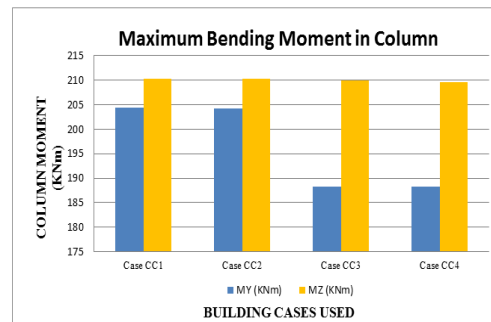
Graph 9: Maximum Shear Force in Column for all Base Shear Reduction Beam Cases



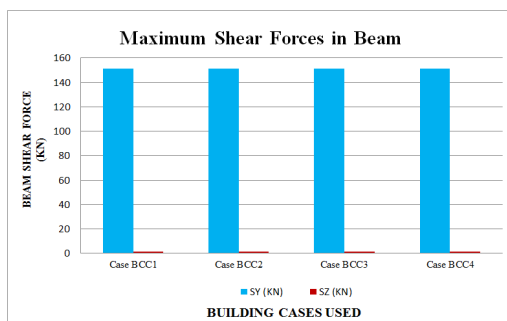
Graph 10: Maximum Shear Force in Column for all Base Shear Reduction Column Cases



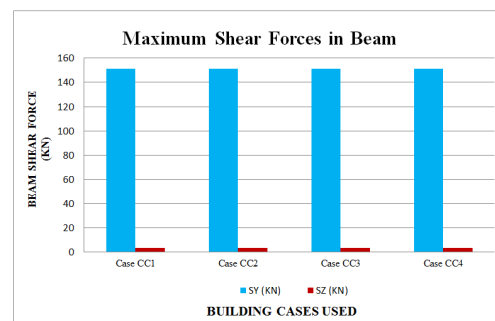
Graph 11: Maximum Bending Moment in Column for all Base Shear Reduction Beam Cases



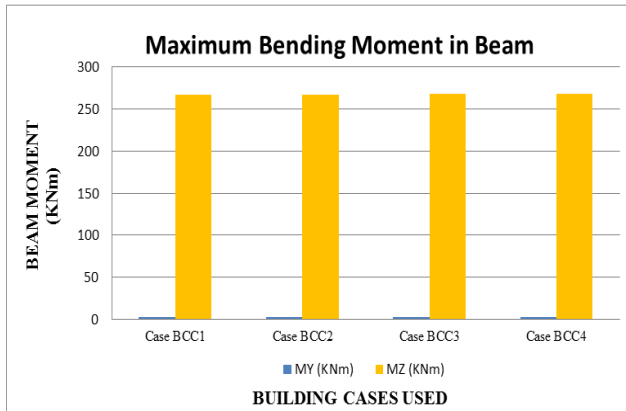
Graph 12: Maximum Bending Moment in Column for all Base Shear Reduction Column Cases



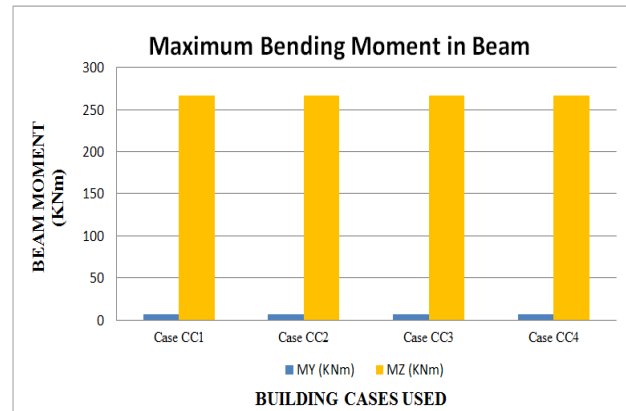
Graph 13: Maximum Shear Force in Beam for all Base Shear Reduction Beam Cases



Graph 14: Maximum Shear Force in Beam for all Base Shear Reduction Column Cases



Graph 15: Maximum Bending Moment in Beam for all Base Shear Reduction Beam Cases



Graph 16: Maximum Bending Moment in Beam for all Base Shear Reduction Column Cases

## V. CONCLUSIONS

### A. Conclusions evolved for all Base Shear Reduction Beam Cases

- 1) Maximum displacement in X direction has a minimum value observed at Case BCC3 and for Y direction minimum value observed at again Case BCC3 with a parametric value of 294.037 mm respectively. No special displacement reducing components are implemented in these buildings. Hence Case BCC3 shows economical among all base shear reduction beam cases.
- 2) Base Shear in both X and Z direction has gradually reduced by implementing lesser size of beams in top floors subsequently decreases the weight of the structure. For this parameter, Case BCC4 proves to be an efficient parametric case.
- 3) As the weight of the structure reducing, the Maximum Axial Forces in Column decreases gradually to Case BCC4. Observing the least parameter, Case BCC4 obtained as an efficient Case with a parametric value of 8538.8876 KN among all base shear reduction beam cases.
- 4) The Shear Forces along both Y-Y axis and Z-Z axis in column section decreases gradually and hence case BCC3 with a minimum value among all beam cases and proves to be an efficient case with values of 115.5225 KN and 108.8726 KN respectively.
- 5) Similarly, the Bending Moment along both Y-Y axis and Z-Z axis in column decreases gradually to case BCC3 and proves to be an efficient case among all base shear reduction beam cases.
- 6) Shear forces for beams in the structures, no drastic change has observed and again among all base shear reduction beam cases Case BCC3 and BCC4 proves to be an efficient case.
- 7) Again in Bending Moments in beams no major change has observed for beam base shear reduction cases.

### B. Conclusions Evolved For All Base Shear Reduction Column Cases

- 1) Maximum displacement in X direction has a minimum value observed at Case CC4 and for Y direction minimum value observed at again Case CC4 with a parametric value of 293.263 mm respectively. No special displacement reducing components are implemented in these buildings. Hence Case CC4 shows economical among all base shear reduction column cases.
- 2) Base Shear in both X and Z direction has gradually reduced by implementing lesser size of column in top floors subsequently decreases the weight of the structure. For this parameter, Case CC4 proves to be an efficient parametric case.
- 3) As the weight of the structure reducing, the Maximum Axial Forces in Column decreases gradually to Case CC4. Observing the least parameter, Case CC4 obtained as an efficient Case with a parametric value of 8536.4212 KN among all base shear reduction column cases.
- 4) The Shear Forces along both Y-Y axis and Z-Z axis in column section decreases gradually and hence case CC3 with a minimum value among all beam cases and proves to be an efficient case with values of 115.5985 KN and 110.9522 KN respectively.

- 5) Similarly, the Bending Moment along both Y-Y axis and Z-Z axis in column decreases gradually to case CC3 and CC4 and hence proved to be an efficient case among all base shear reduction column cases.
- 6) Shear forces for beams in the structures, no drastic change has observed and again among all base shear reduction column cases BCC4 proves to be an efficient case.
- 7) Again in Bending Moments in beams no major change has observed for column base shear reduction cases.

## VI. RECOMMENDATIONS

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 residential cum commercial (G+18) multistoried building under seismic loading. Building beam case BCC4 observed and obtained as efficient case for beam change cases at different levels and should be recommended when this type of approach will be adopted in any earthquake zones.

On other hand, Building column case CC4 observed and obtained as efficient case for column change cases at different levels and should be recommended when this type of approach will be adopted in any earthquake zones.

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