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Research Article

Stability Enhancement in Wall Belt Supported Dual Structural System using Different Grades of Concrete

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Abstract

The tall structures are preferred due to less consumption of the land area for living purpose. The earthquake activities in this approach made it more complicated. The I.S. 1893 shows the seismic zones where the shakes are observed. The shear wall belt system so introduced to make the tall structure stiff and the lateral movement of the same will reduced. To demonstrate this, total 10 tall structures are prepared and analyze it by applying the wall belt of different thickness of different grades. After deep comparative analysis, it has been found out that Building case B7 emerges as the best wall belt grade stability case.

Keywords: *Bending Moments, Concrete Grade, Displacement, Dual System, Multistoried Building, Shear Force, Shear Wall, Wall Belt*

1. Introduction

The lateral effects on the structures made it less stiff and for the tall structures, the main criteria to make it less displaced. The solution for this problem is to construct buildings as per growing demand with the usage of something that is required and now essential to earthquake.

The introduction of wall belt supported system makes an additional effort to make the structures stiffer than before. The lateral displacement again a major parameter, obtained as less as compared without usage of the same.

Again, the concrete grade plays a major role in construction field, since it is the backbone of the civil engineering industry. The performance of grade will affect the performance of the entire structure. Therefore it should not be ignored.

2. Objectives of the present study

To use this kind of lateral load stiffening system by using shear wall belt around the multistoried building, for both basic and seismic parameters the main objectives are selected for analysis. The objectives of this work are as follows:

a. Determination of effective case among general and wall belt supported system.
b. To determine Base Shear in X and Z direction for all Wall Belt Stability Cases.
c. To find member Shear Forces values in Column with efficient case among all 10 cases.
d. To examine Bending Moment values in Column with efficient case among all 10 cases.
e. To determine Von Mises Stresses for all Wall Belt Stability Cases.
f. To compare Shearing Stresses for all Wall Belt Stability Cases
g. To examine column Axial Forces for total 10 cases with efficient case to determine minimum axial force.
h. To find member Shear Forces values in Beam with efficient case among all 10 cases.
i. To examine Bending Moment values in Beam with efficient case among all 10 cases.
j. To determine and compare member Torsion values in Beams and Columns.
k. To analyze and obtain the maximum nodal displacement in X and Z direction with most efficient case that provides more stability among others.

3. Methodology and modeling approach

As per the objectives, the Response Spectrum Analysis has been performed on different models consist of Building Case B0 made up of G+18 story Semi commercial building without shear wall belt. Building Case B1 made up of G+18 story Semi commercial building with shear wall belt of thickness 140 mm with M25 grade at 8th floor. Building Case B2 made up of G+18 story Semi commercial building with shear wall

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belt of thickness 160 mm with M25 grade at 8th floor. Building Case B3 made up of G+18 story Semi commercial building with shear wall belt of thickness 180 mm with M25 grade at 8th floor. Building Case B4 made up of G+18 story Semi commercial building with shear wall belt of thickness 140 mm with M30 grade at 8th floor. Building Case B5 made up of G+18 story Semi commercial building with shear wall belt of thickness 160 mm with M30 grade at 8th floor. Building Case B6 made up of G+18 story Semi commercial building with shear wall belt of thickness 180 mm with M30 grade at 8th floor. Building Case B7 made up of G+18 story Semi commercial building with shear wall belt of thickness 140 mm with M35 grade at 8th floor. Building Case B8 made up of G+18 story Semi commercial building with shear wall belt of thickness 160 mm with M35 grade at 8th floor. Building Case B9 made up of G+18 story Semi commercial building with shear wall belt of thickness 180 mm with M35 grade at 8th floor. All the cases are situated in Earthquake Zone III.

Table 1: Dimensions of different components of building

Parameters	Values
Type of Structure	Semi- Commercial Building
Configuration	G+18
Plinth Area	576 m^2
Foundation depth	3 meters
Floor height	4m for G.F. 3m for all floors
Beam size	0.50 m x 0.35 m
Column size	0.50 m x 0.58 m
Thickness of Slab	160 mm
Thickness of Staircase Waist Slab	150 mm
Thickness of Shear Wall	180 mm

Table 2: Wall belt parameters

Grade of Concrete	Wall Belt Thickness
M25	Wall Belt Thickness - 140 mm
M25	Wall Belt Thickness - 160 mm
M25	Wall Belt Thickness - 180 mm
M30	Wall Belt Thickness - 140 mm
M30	Wall Belt Thickness - 160 mm
M30	Wall Belt Thickness - 180 mm
M35	Wall Belt Thickness - 140 mm
M35	Wall Belt Thickness - 160 mm
M35	Wall Belt Thickness - 180 mm

Table 3: Seismic parameters on the structure

Parameters	Values
Zone	III
Type of Soil selected	Medium Soil
Fundamental Natural Period (Ta)	In X direction 1.1757 seconds In Z direction 1.1757 seconds
Importance Factor of the selected structure	1.2
Zone Factor	0.16
Response Reduction Factor R	4 (Ordinary Shear Wall with Special Moment Resisting Frames)

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

1. **Case B0** = Wall Belt Stability Case – Building without wall belt.
2. **Case B1** = Wall Belt Stability Case – Building with wall belt (M25_0.140 m thickness)
3. **Case B2** = Wall Belt Stability Case – Building with wall belt (M25_0.160 m thickness)
4. **Case B3** = Wall Belt Stability Case – Building with wall belt (M25_0.180 m thickness)
5. **Case B4** = Wall Belt Stability Case – Building with wall belt (M30_0.140 m thickness)
6. **Case B5** = Wall Belt Stability Case – Building with wall belt (M30_0.160 m thickness)
7. **Case B6** = Wall Belt Stability Case – Building with wall belt (M30_0.180 m thickness)
8. **Case B7** = Wall Belt Stability Case – Building with wall belt (M35_0.140 m thickness)
9. **Case B8** = Wall Belt Stability Case – Building with wall belt (M35_0.160 m thickness)
10. **Case B9** = Wall Belt Stability Case – Building with wall belt (M35_0.180 m thickness)

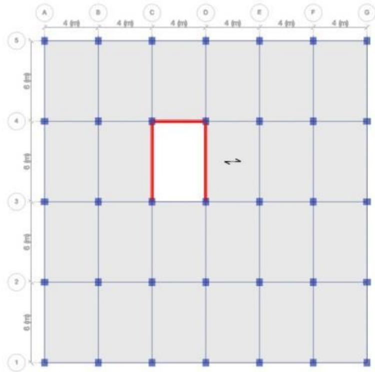


Fig. 1: Typical floor plan

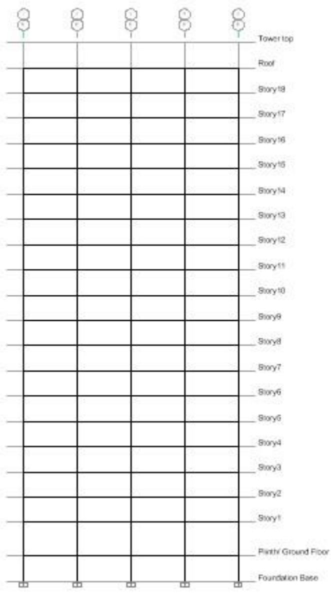


Fig. 2: Front View of the Structure

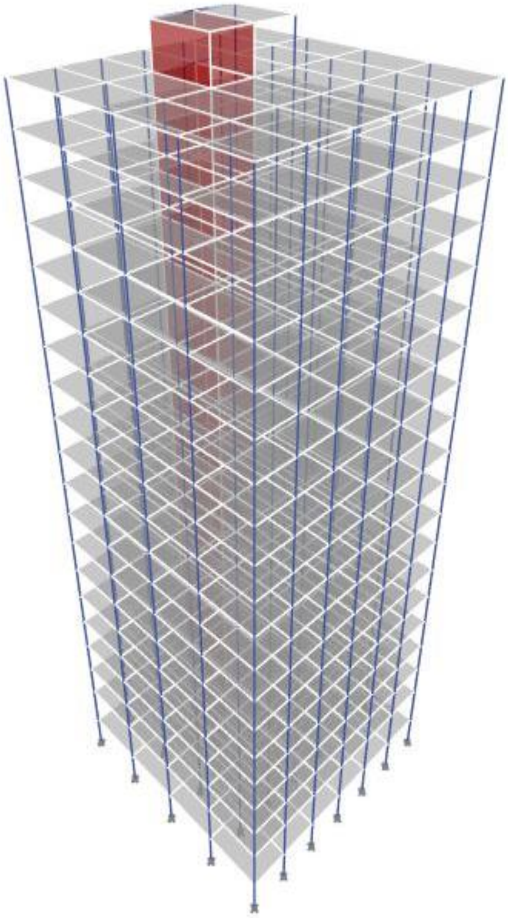


Fig. 3: 3D View of the Structure without wall belt

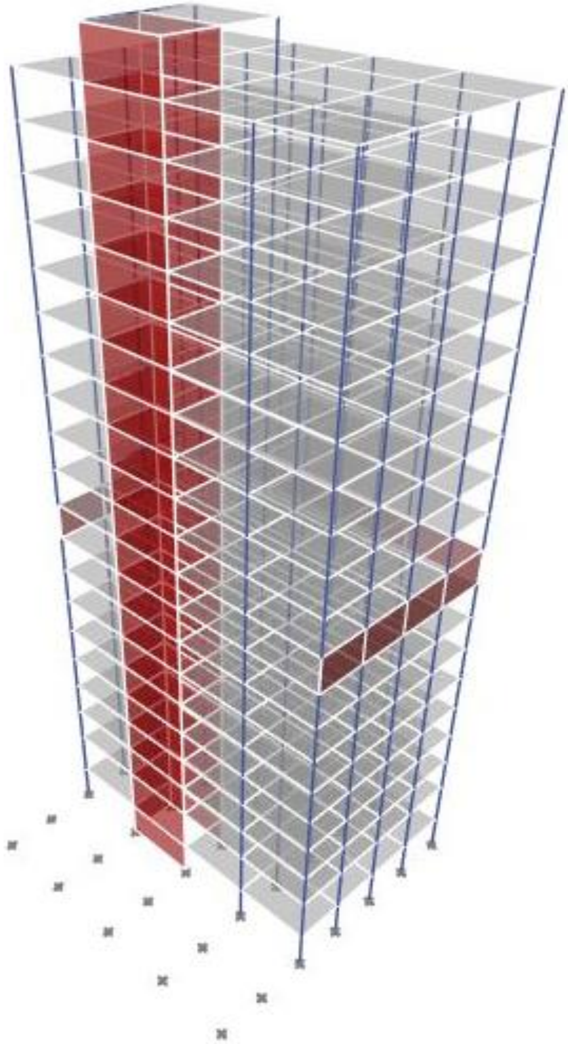


Fig. 5: Sectional 3D View of the Structure with Wall Belt at corners

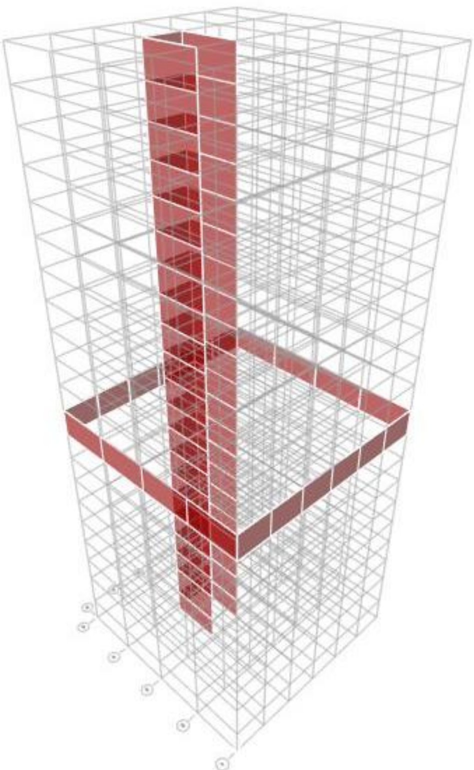
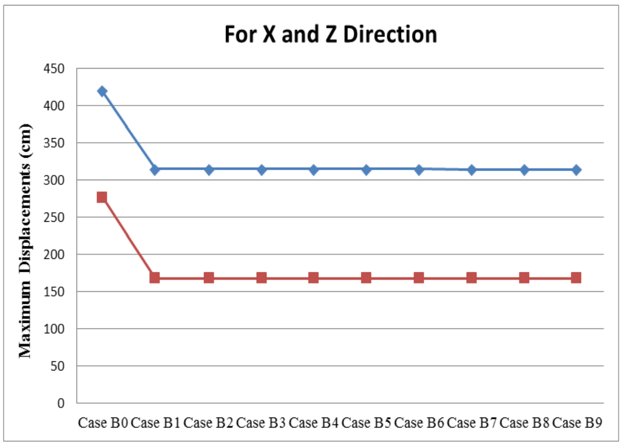


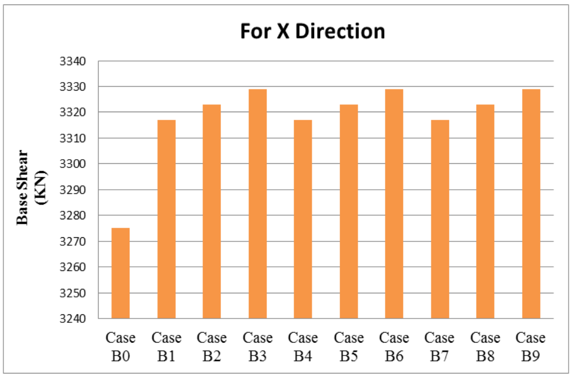
Fig. 4: View of Shear Wall and Shear Belt applied to the structure

4. Results analysis

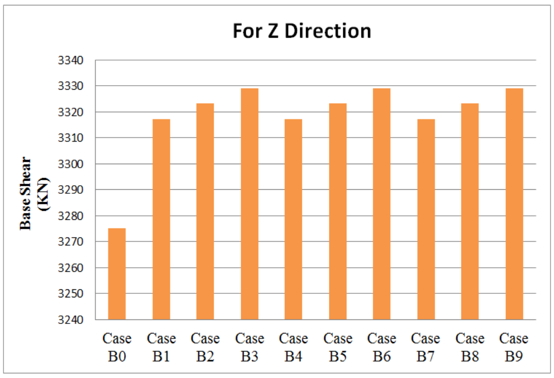
Graphical representation of each objective is mentioned below:-



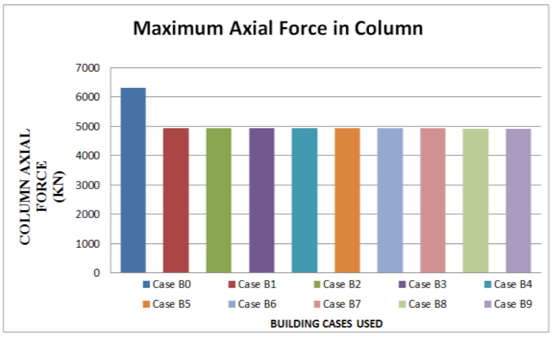
Graph 1: Maximum nodal displacement in X and Z direction



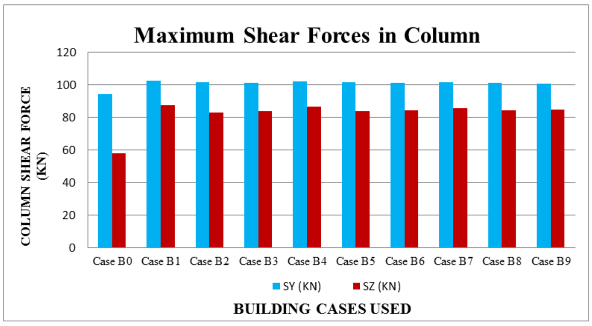
Graph 2: Base Shear in X direction for all Wall Belt Stability Cases



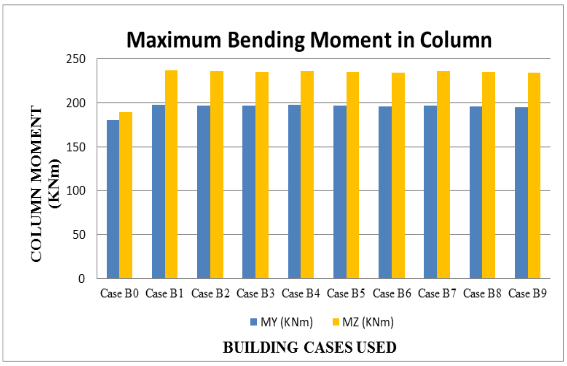
Graph 3: Base Shear in Z direction for all Wall Belt Stability Cases



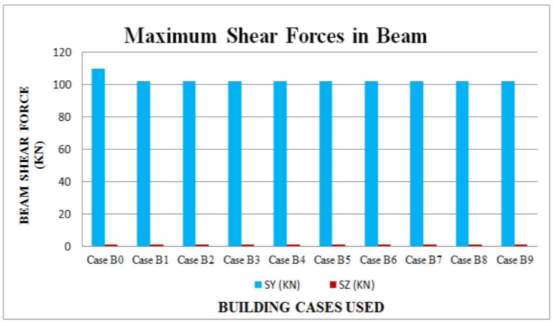
Graph 4: Maximum Axial Forces in Column for all Wall Belt Stability Cases



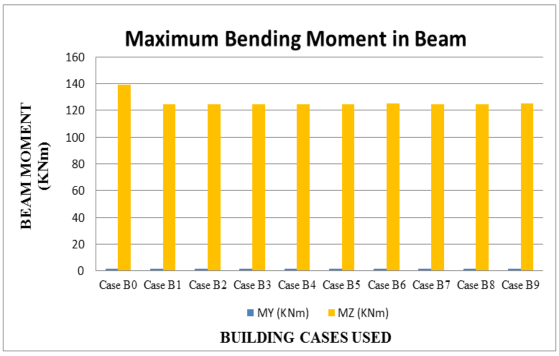
Graph 5: Maximum Shear Force in Column for all Wall Belt Stability Cases



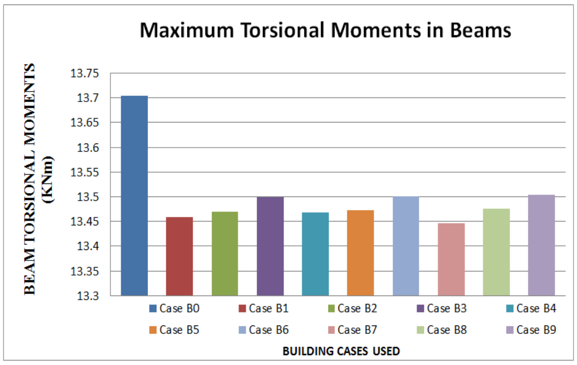
Graph 6: Maximum Bending Moment in Column for all Wall Belt Stability Cases



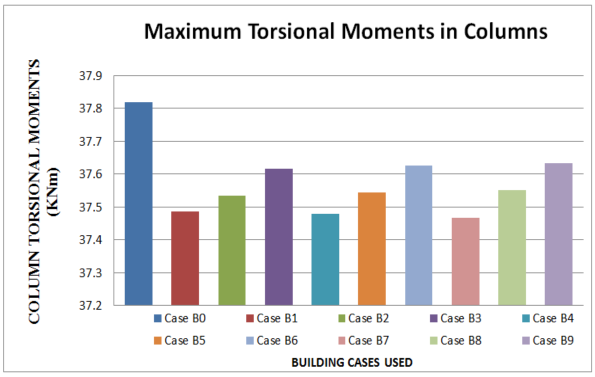
Graph 7: Maximum Shear Force in Beam for all Wall Belt Stability Cases



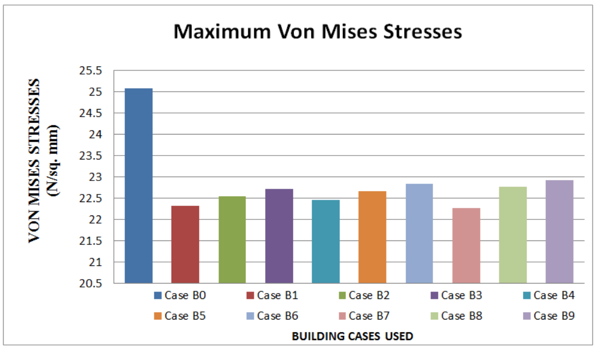
Graph 8: Maximum Bending Moment in Beam for all Wall Belt Stability Cases



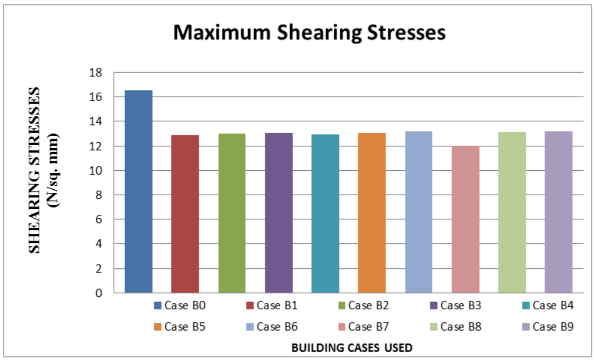
Graph 9: Maximum Torsional Moments in Beam for all Wall Belt Stability Cases



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



Graph 11: Maximum Von Mises Stresses for all Wall Belt Stability Cases



Graph 12: Maximum Shearing Stresses for all Wall Belt Stability Cases

Conclusions

On analyzing the result data of various parameters for all ten wall belt cases, conclusions evolved are as follows:

1) Maximum displacement in X direction has a minimum value of 314.063 mm for Building case B7 and value of 166.992 mm obtained same in Building B7. The values are more in Building case B0 when shear belt is not used then it drastically decreases since stiffness is more when shear belt is used.
2) Base shear values increases with increase in additional member in a structure. Building case B0 seems lesser value of base shear. Building case B4 and B7 seems lesser value of shear forces with a value of 3317.0919 KN.
3) Maximum Axial Forces in Column for all Wall Belt Stability Cases seems lesser in Building case B7 with a minimum value of 4922.3212 KN.
4) Shear forces in column increases with increase in additional member in a structure and behaves same as base shear parametric value.
5) The same pattern again follows in Bending Moment in column for both My and Mz.
6) Values of Shear forces in beams seem lesser in Building case B7 for both Sy and Sz.
7) The pattern that created in shear forces in beam follows same in Bending Moment in Beam for both My and Mz. The values decreases to Building case B7 then it increases.
8) Torsion in beams seems less in Building case B7 with a minimum value of 13.446 KNm.
9) Torsion in columns seems less in Building case B7 with a minimum value of 37.4671 KNm.
10) The Von Mises Stresses seems less in Building case B7.
11) Maximum Shearing Stresses seems less in Building case B7 with a minimum value among all.

Under seismic activities observed, observing all the parameters, Building case B7 observed and obtained as efficient case and should be recommended when this type of stability in building will be provided.

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