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STABILITY ENHANCEMENT OF MULTI STOREY STRUCTURE USING DIFFERENT BEAM GRADES UNDER SEISMIC LOADING

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ABSTRACT

There has been a growing demand for new structures to meet personal requirements and obligations. To fulfill these needs and ensure compliance with safety standards, it has become imperative to implement structural reforms. Numerous structural theories and solutions have been proposed to address this requirement while prioritizing the safety of buildings and their ability to withstand lateral forces. In this study, a need was generated by observing various literatures and their researchers conducted before. A need was generated to use different grade of concrete in beam member to observe the structural improvement by using M

45. Total 6 model cases have created in this regard with grade change at different floor levels. Result reveals that model case SIC 2 shows the better performance among all when compared with different result parameters that will be recommended for similar construction.

Keywords: Concrete Grade, Beam Member, Grade Change Levels, Shear Wall, Dual System.

1. INTRODUCTION

The grade of concrete plays a crucial role in the construction industry due to its significant importance. It determines the strength and durability of concrete structures, making it a vital factor in ensuring the safety and longevity of buildings, bridges, roads, and other infrastructure projects. The grade of concrete is determined by the ratio of cement, aggregates, and water used in the mixture, along with additional additives for specific requirements. Higher-grade concrete, such as M30, M40, or above, exhibits greater compressive strength and resistance to environmental factors like moisture, chemicals, and temperature fluctuations. This is particularly critical in structures subjected to heavy loads or harsh conditions. Conversely, lower-grade concrete may be suitable for non- structural applications or where lower strength requirements are sufficient. Therefore, understanding and implementing the appropriate grade of concrete is essential to guaranteeing the structural integrity and safety of construction projects.

As per Indian standards, the Bureau of Indian Standards (BIS) provides a classification system for concrete grades based on their compressive strength. Here are some commonly used grades of concrete in India:

M5 Grade	M15 Grade	M30 Grade
M7.5 Grade	M20 Grade	M40 Grade
M10 Grade	M25 Grade	M50 Grade and above

It's important to note that the specific grade of concrete to be used in a project depends on the structural requirements and the design specifications provided by the structural engineer.

2. IMPORTANCE OF HIGHER GRADE IN STRUCTURAL COMPONENT

The use of higher-grade concrete in structural components is of paramount importance due to several reasons:

1) Enhanced Strength: Higher-grade concrete possesses greater compressive strength, which is crucial for structural elements that need to bear heavy loads. It ensures the structural integrity and prevents premature failure of the components.

2) Improved Durability: Structures exposed to harsh environmental conditions or aggressive substances require higher-grade concrete. It offers increased resistance against factors like moisture, chemicals, and temperature variations, thereby enhancing the durability and longevity of the structural components.

3) Safety and Structural Integrity: High-strength concrete provides a higher margin of safety for structural components. It ensures that the structures can withstand anticipated loads, including dynamic loads, seismic forces, wind pressure, and other external forces, without compromising their integrity.

4) Slender and Efficient Designs: The use of higher-grade concrete allows for more slender and efficient structural designs. It enables the reduction of the cross-sectional area and volume of the members while maintaining the required strength, resulting in cost savings and aesthetic benefits.

5) Longer Spans and Greater Heights: Higher-grade concrete enables the construction of structures with longer spans

and greater heights. It offers the necessary strength and stiffness required for tall buildings, bridges, and other infrastructure projects, facilitating innovative and ambitious architectural designs.

6) Resistance to Structural Failures: Structures subjected to dynamic loads, vibrations, impact forces, such as bridges and industrial facilities, require higher-grade concrete. It improves the resistance against fatigue, cracking, and potential structural failures caused by these external factors.

7) Code and Standard Compliance: Many building codes and standards stipulate minimum requirements for concrete strength in structural components. Using higher-grade concrete ensures compliance with these regulations, ensuring that the structure meets the required safety standards.

3. PROCEDURE AND 3D MODELING OF THE STRUCTURE

Comprehensive input data and its descriptions about the model given below. The method used in this analysis to perform the work was response spectrum method.

Table 2: Model Description

Building configuration	G + 16
Building type	Commercial Office building
Total plinth area	576m^2
Height of building from Ground level	55 m
Height of each floor and GF height	3 m and 4 m
Depth of footing	3 m
Beam dimensions 1	550 mm x 300 mm with M25 grade
Beam dimensions 2	550 mm x 300 mm with M45 grade
Column dimensions	500 mm x 550 mm with M25 grade
Slab thickness and Staircase waist slab	130 mm & 150 mm
Shear wall thickness	180 mm
Material properties	Concrete (M25), (M45) Rebar (Fe 550)

Table 2:

Models framed for analysis	Abbreviation
Beam of same sizes at all floor levels with M25 grade	SIC 1
Beams of M45 grade at plinth floor leve (All other beams are M25 grade)	SIC 2
Beams of M45 grade at fourth floor level (All other beams are M25 grade)	SIC 3
Beams of M45 grade at eight floor level (All other beams are M25 grade)	SIC 4
Beams of M45 grade at twelfth floor level (All other beams are M25 grade)	SIC 5
Beams of M45 grade at sixteenth floor level (All other beams are M25 grade)	SIC 6

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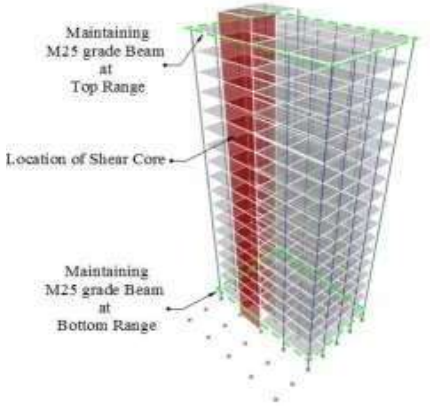

Fig 1: SIC 1: Beam of same sizes at all floor levels with M25 grade

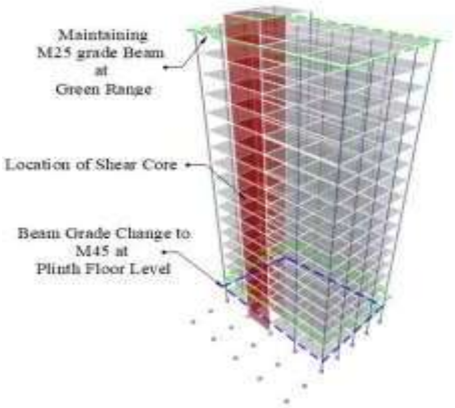

Fig 2: SIC 2: Beams of M45 grade at plinth floor level (All other beams are M25 grade)

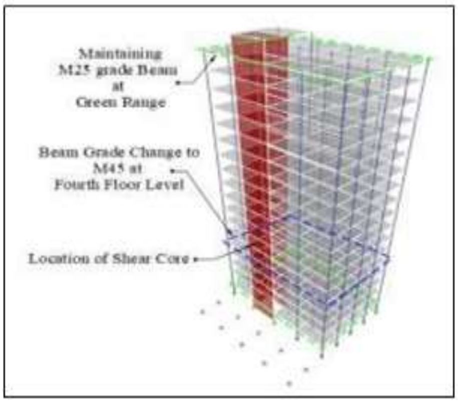

Fig 3: SIC 3: Beams of M45 grade at fourth floor level (All other beams are M25 grade)

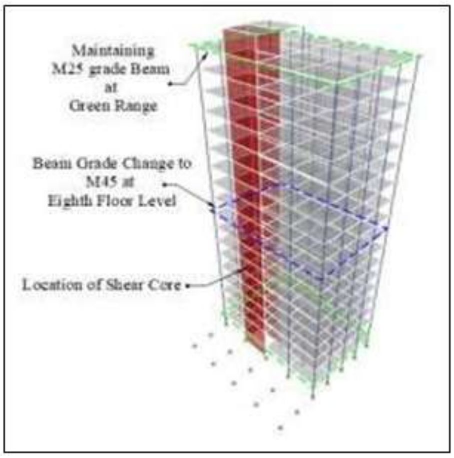

Fig 4: SIC 4: Beams of M45 grade at eighth floor level (All other beams are M25 grade)

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5) To observe all the three stresses in plates in all the cases against seismic parameters.

After than comparison has performed among different model cases under different parametric heads to show the behaviour of structure under grade change of beam members under actual soil condition and its use to optimize the building will be suggested.

4. RESULTS ANALYSIS

The application of loads and their combinations on different cases as per the Indian Standard 1893:2016 code of practice yield result parameters:-

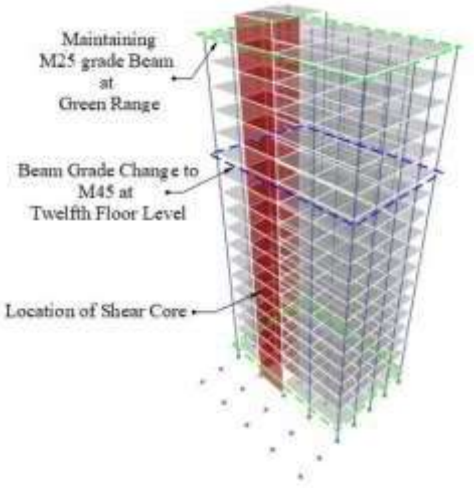

Fig 5: SIC 5: Beams of M45 grade at twelfth floor level (All other beams are M25 grade)

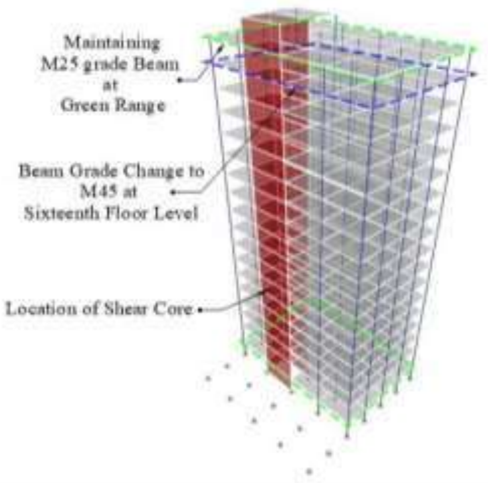

Fig 6: SIC 6: Beams of M45 grade at sixteenth floor level (All other beams are M25 grade)

5. RESEARCH OBJECTIVES

There are not many papers that have been presented in the area of stability increment with behavior of structure under grade change of beam members and its use to optimize the building. The objective of this study is to examine the various models against several seismic parameters comprises of-

1) The observation of the above-mentioned problem with inspection of the earthquake response of various model cases of G + 16 commercial office building constructed with change in beam size at different floors situations that act as cost-effective and effectual for Seismic Zone III and building rested on actual soil.

2) Comparison and examination of the maximum displacement and base shear in both directions to contact the adverse effects of various building components.

3) To examine and compare all the beam parameters in all the cases against numerous earthquake zonal parameters to obtain the optimum case among all cases.

4) To examine and compare all the column parameters in all the cases against seismic parameters to identify the optimum case among all cases.

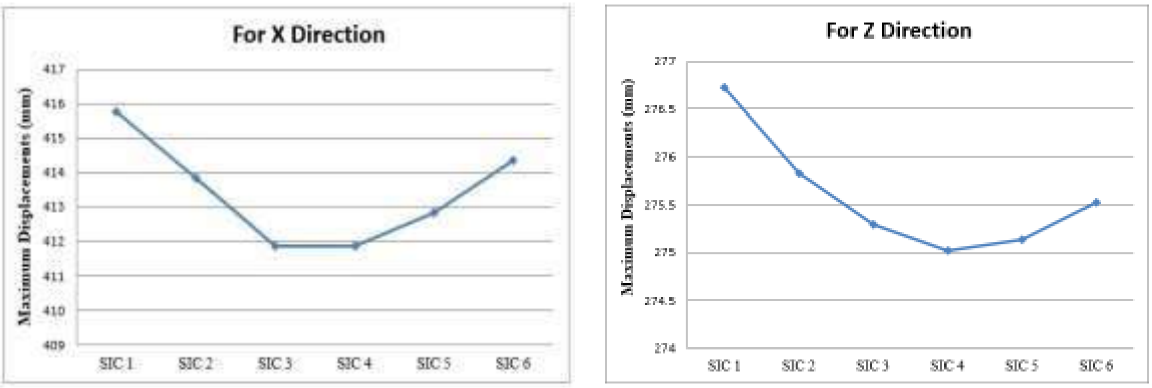

Fig 7: Maximum Displacement in X and Z direction for all Stability Improving Cases

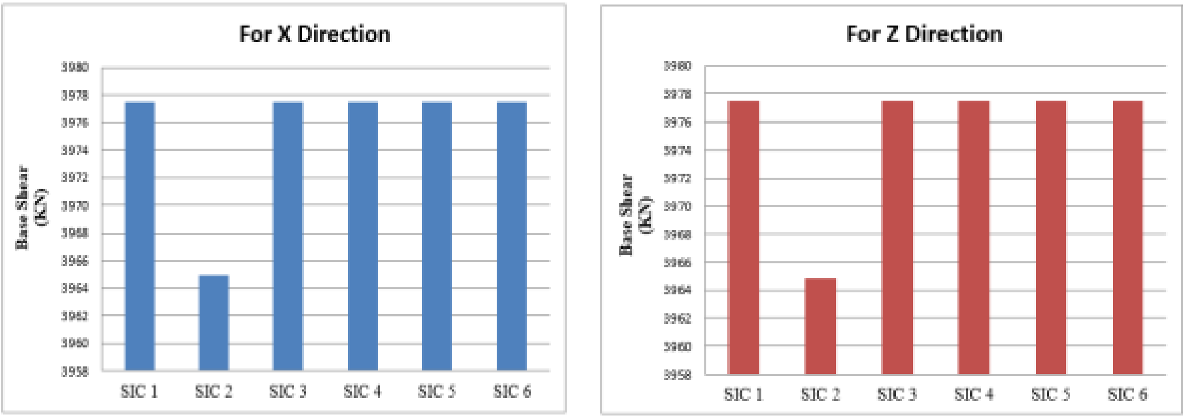

Fig 8: Base Shear in X and Z direction for all Stability Improving Case

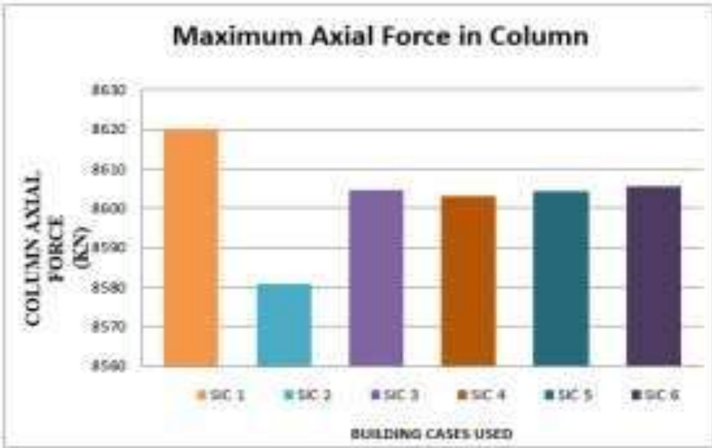

Fig 9: Maximum Axial Forces in Column for all Stability Improving Cases

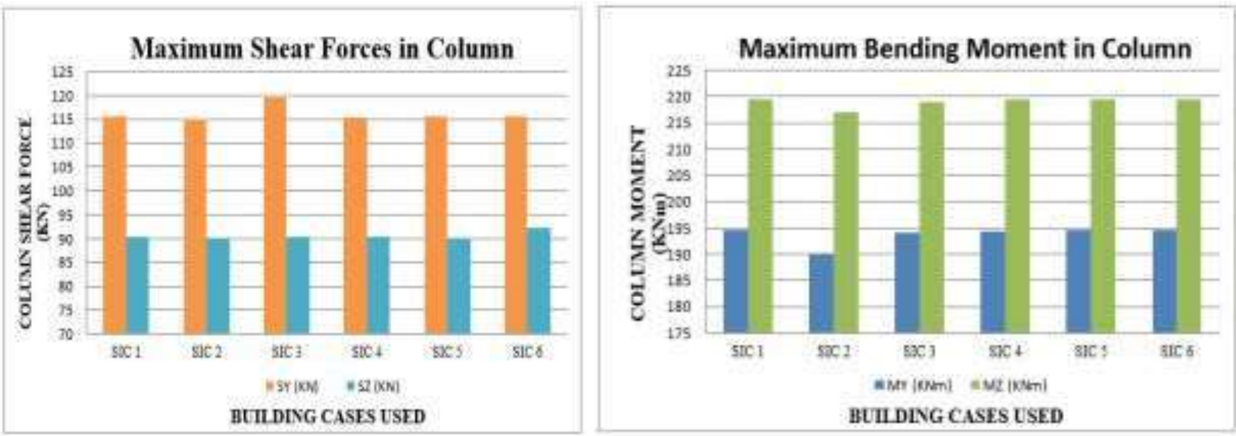

Fig 10: Maximum Shear Forces and Bending Moments in Column for all Stability Improving Cases

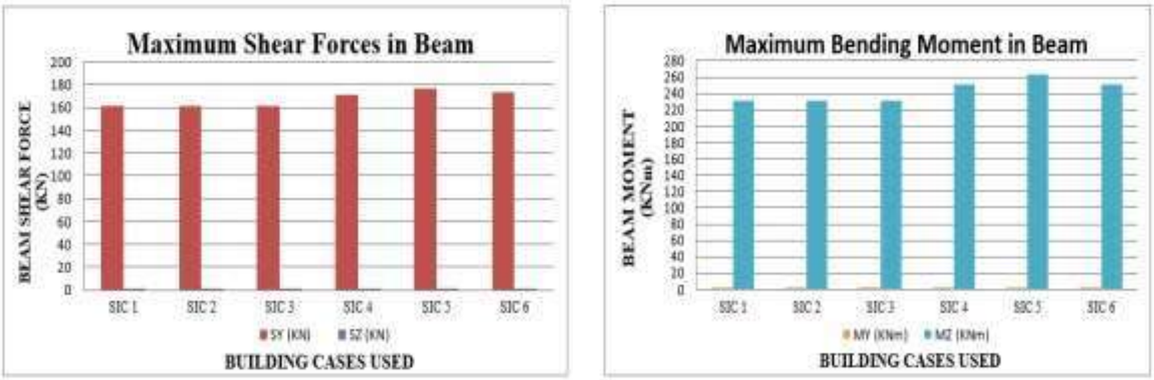

Fig 11: Maximum Shear Forces and Bending Moments in Beam for all Stability Improving Cases

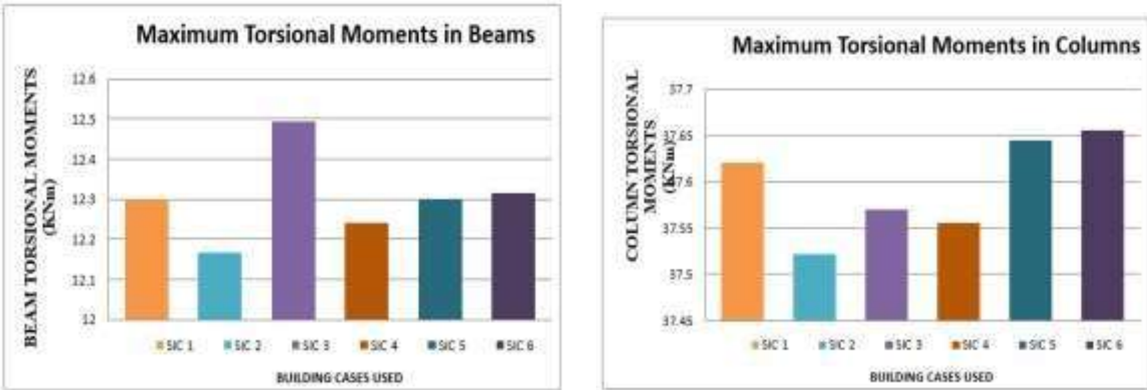

Fig 12: Maximum Torsional Moments in Beams and Columns for all Stability Improving Cases

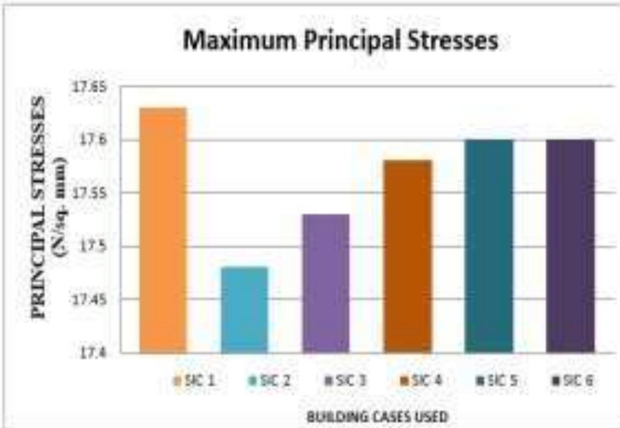

Fig 13: Maximum Principal Stresses for all Stability Improving Cases

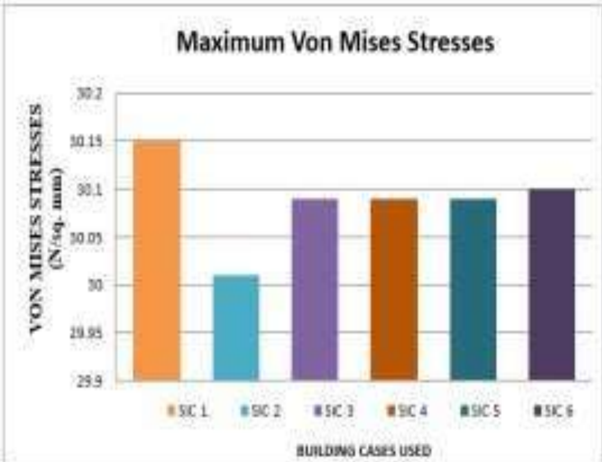

Fig 14: Maximum Von Mises Stresses for all Stability Improving Cases

Fig 15: Maximum Shearing Stresses for all Stability Improving Cases

6. CONCLUSION

The conclusion can be pointed out are as follows:-

1) Maximum displacement values in X direction keep on decreasing upto a minimum value of around 411 mm for Case SIC and SIC 4 then the values keep on increasing to Case SIC 6.

2) Again, the maximum displacement in Z direction behaves same as the X direction with a minimum value in SIC 4.

3) Base Shear in X direction for all cases shows equal values but less in SIC 2. These results are identical with Base Shear in Z direction due to length and width of building is same.

4) Observing the least parameter, case SIC 2 obtained as an efficient case with least value of 8580.643 KN for maximum Axial Forces in column.

5) On comparing the values of Shear Forces along both Y- Y axis and Z-Z axis in column members least values in case SIC 2 has observed.

6) The Bending Moment values along both Y-Y axis and Z- Z axis in column shows least values at case SIC 2 and proves to be an efficient case.

7) For beams members, the minimum value of Shear Forces along both Y-Y axis and Z-Z shows least values in SIC 3.

8) Bending Moments in beams shows least value in case SIC 2 along both in Y-Y axis and in Z-Z axis with a value of 0.241 KNm and 230.712 KNm respectively.

9) The values of maximum Torsional Moments in beam member's shows minimum values when grade change done on plinth floor beams i.e. case SIC 2.

10) Similarly, the same trend has observed in Torsional Moments in columns. The values shows minimum values when grade change done on plinth floor beams i.e. case SIC 2.

11) The principal stresses in plates shows least values in case SIC 2 then values increases gradually.

12) Von Mises stresses in plates least values in case SIC 2. No such major differences have observed.

13) Maximum Shearing Stresses seems same for all Stability Improving Cases.

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 Commercial Office Building (G+16) configuration under seismic effects. Stability Improving Case SIC 2 observed and obtained as efficient case and should be recommended when this type of approach will be adopted in earthquake zone III under the same soil parameters wherever obtained which have been selected in this research.

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