iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** VIII **Month of publication:** August 2024

DOI: https://doi.org/10.22214/ijraset.2024.64009

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VIII Aug 2024- Available at www.ijraset.com

Investigation on the Response of High-Rise Structures Subjected to Blast Loads and Earthquake Loads

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Abstract: ***In this research we have analyzed structure with the different floor numbers for blast & seismic loading to get relative results. In this study the blast parameters are obtained from IS Codes. The structure is analyzed using ETABS software & result obtained from this analysis. In this study we have compare different parameters such as storey displacement, storey shear, base shear, max moments and shear. The results help to get an understanding about the effects that would be caused by the loads acting such as, type of blast load and earthquake loads and their comparative results would help us to understand how a structure acts for same earthquake and blast loads and how will the structure behave for the case.***
Keywords: ETABS, Blast Load, Earthquake load, Base shear, displacement

I. INTRODUCTION

An explosive could be a in the form of a solid or liquid substance, or mixture of substances, which by the application of suitable impetus onto a small portion of explosive's mass, is converted in a very small interval of time into some other more stable substances which generally forms a largely or entirely gaseous, with some development of a high temperature and pressure. As we know that various types of the hazards can affect the building systems. These systems can be divided into two categories as manmade (blast impact) and natural (wind and earthquake etc.). So, it is important to understand the nature of the hazards. Blast loading and their effects on a structure fully depends on some different types of the factors which also includes in some charge weight (W), location of the blast (standoff distance) (R), and the geometrical configuration and direction of the blast. Structural response will depend according to the way these factors would combine and act upon.

Similarly the Seismic load is also a dynamic effect and is considered as a natural disaster, for past long times we have been designing our structures for the Earthquake loads and this are also very important for the consideration. The earthquake loads are assumed based on the previous occurrence and also all the zones are being divided on the basis of how earthquake effects in that area. The Earthquake can be of dynamic nature of any type and can be even sometimes be hazardous that other loads.

II. OBJECTIVE OF STUDY

1) The aim of the current study is to get some idea of blast and earthquake phenomenon and to understand how they affect a building.
2) For getting a judgment of what would be the possibility of occurrence of an explosion in the full lifetime of a building & the impact that would occur on the building due to this loads.
3) To get an understanding on the responses caused on a building due to the blast loads and earthquake loads using ETABS software as per IS Code 4991.
4) To get better understanding of the results for the analysis process and results of a building with different construction elements and techniques
5) Assessing of results obtained for high rise buildings subjected to load from the analysis.

III. POINT OF COMPARISON

1) The study would be giving us comparative results for the building subjected to this loads having different building heights i.e. building with different floor no.
2) The different aspects for the comparative results that are taken in this study are the lateral storey displacement, storey drift, base shear moments for same element and the moments.
3) These aspects would give us very clear results of the effects on the building for the comparative results.

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IV. METHODOLOGY & MODELLING APPROACH

A. Building Description

Material Properties: Density of concrete = 30kN/m3,
Density of steel = 78.5 kN/m3
Grade of concrete = M30,
Grade of rebar (steel) = Fe500
Sectional Properties:
Beam = 600mm × 400mm
Column=500*1000 (10 Storey)
Column=600*1200 (15 Storey)
Column=600*1200 (20 Storey)

B. Load Combination

Combination 1 = 1.2DL + 1.2LL + 1.2BL/EQ
Combination 2 = 1DL + 0.8LL + 0.8BL/EQ
Combination 3 = 1.5DL + 1.5LL

C. Modeling Approach

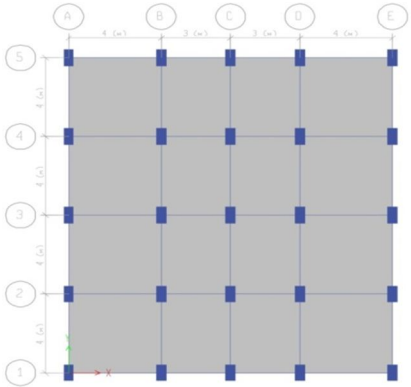

Fig 4.1 Plan of the Model

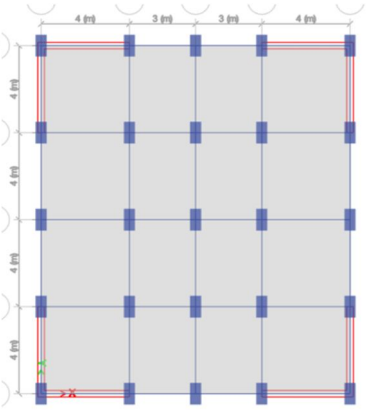

Fig 4.2 Plan of the Model With shear wall

10 FLOOR BUILDINNG

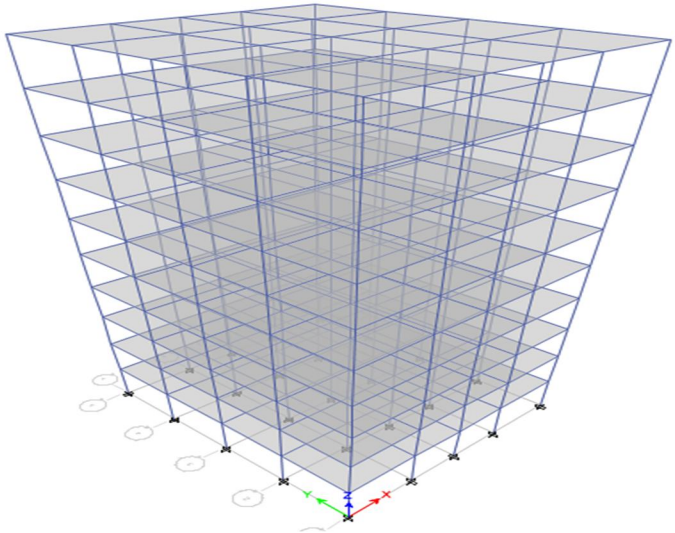

Fig 4.3 - 10 FLOOR BUILDINNG

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10 FLOOR BUILDINNG WITH SHEAR WALL

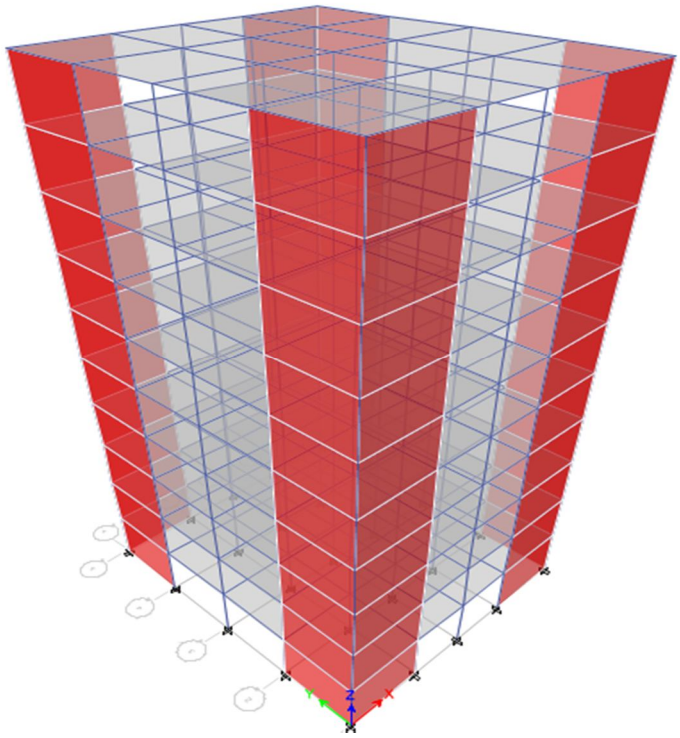

Fig 4.4 - 10 FLOOR BUILDINNG WITH SHEAR WALL

15 FLOOR BUILDINNG

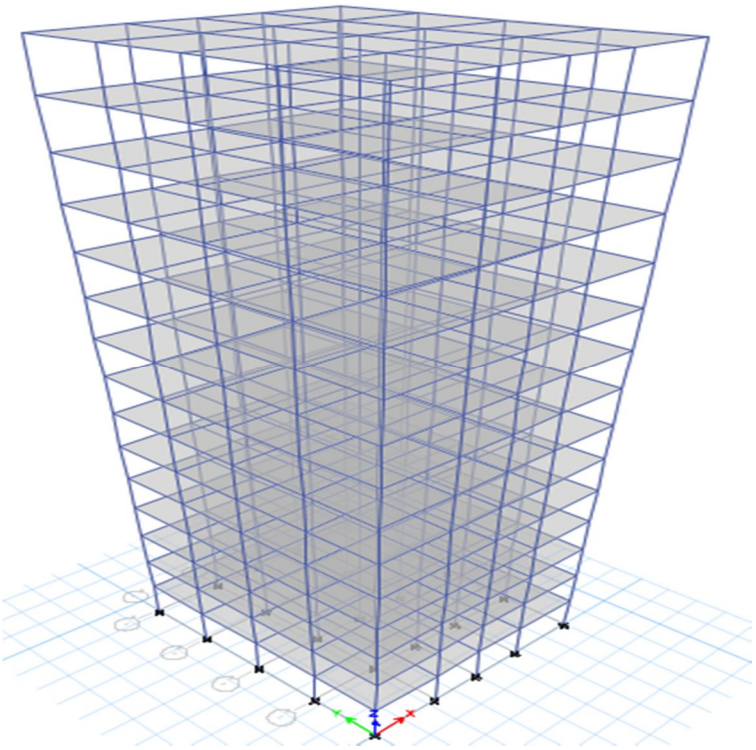

Fig 4.5 - 15 FLOOR BUILDINNG

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15 FLOOR BUILDINNG WITH SHEAR WALL

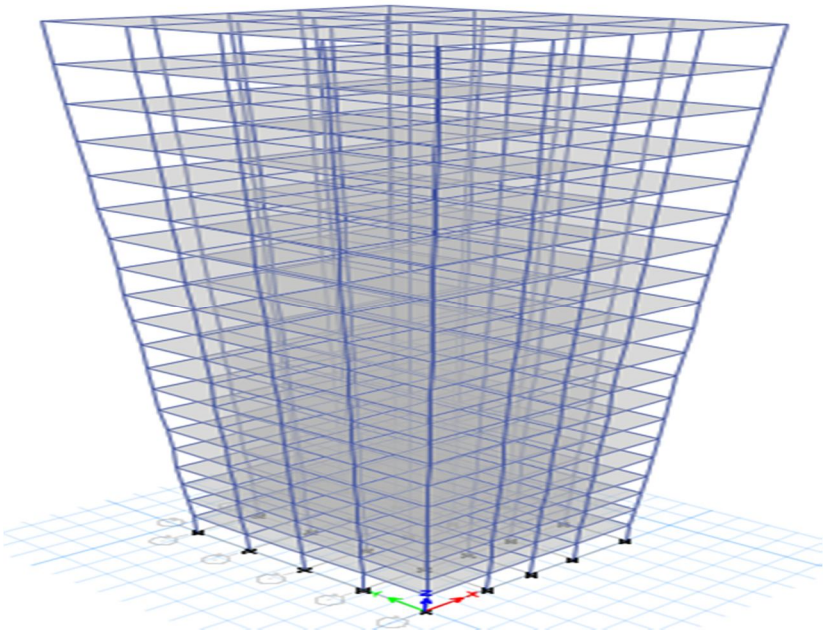


Fig 4.6 - 20 FLOOR BUILDINNG

20 FLOOR BUILDINNG WITH A SHEAR WALL

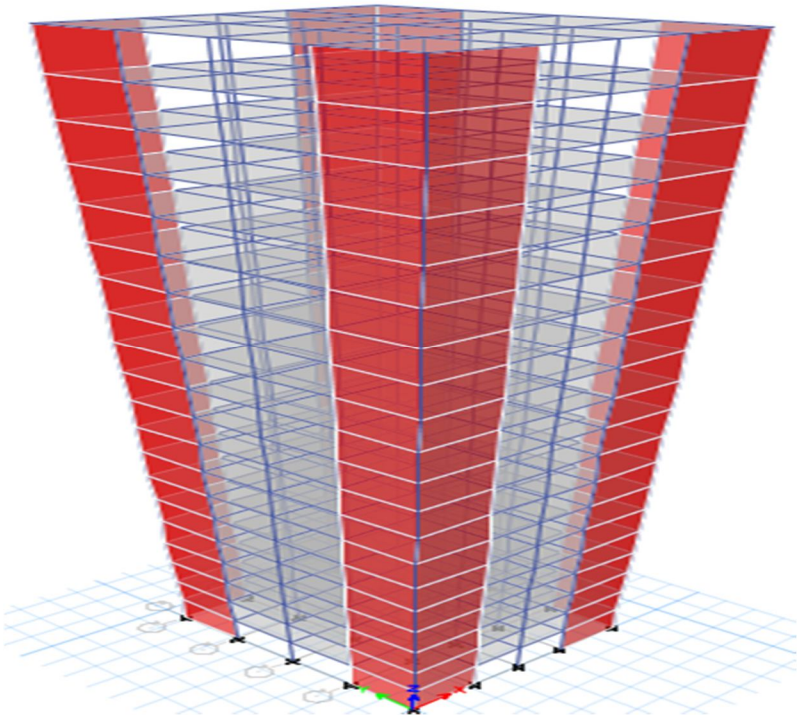


Fig 4.7 - 20 FLOOR BUILDINNG WITH SHEAR WALL

V. RESULTS & DISCUSSION

A. Results

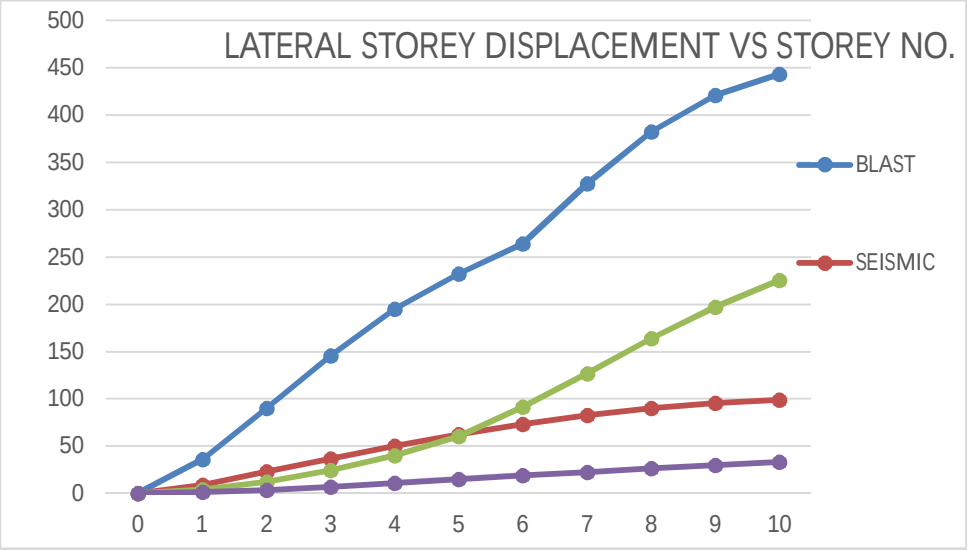
The analysis results are obtained and the different aspects are obtained in the form of tables and graphs. The results are tabulated for the three models and their all the cases are obtained and given.

B. Building Displacements and storey drift 10 Floors

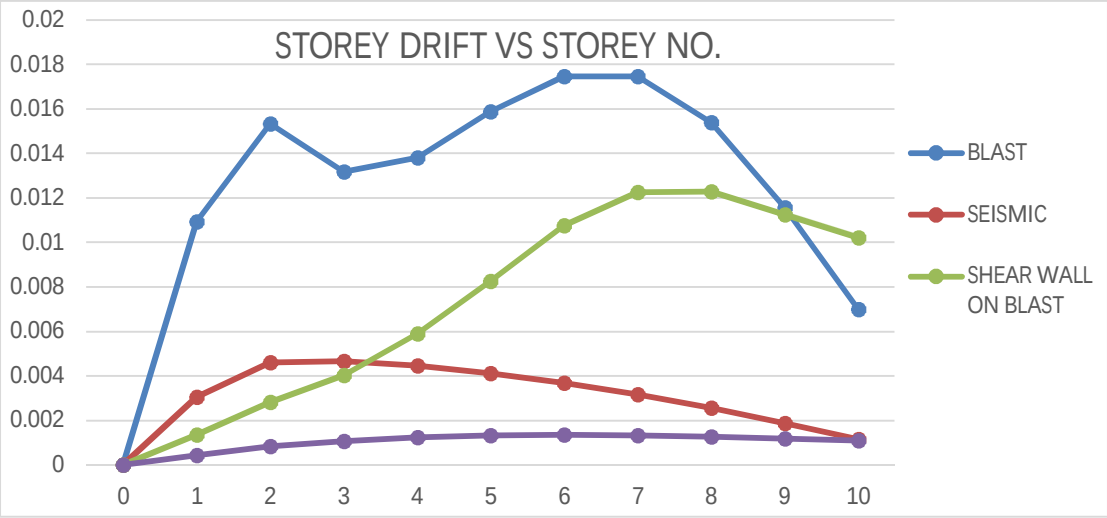
Table 5.1: Model 1- Building Displacements and storey drift

S.NO	LOAD CASE	MAX STOREY DISPLACEMENT	MAX STOREY DRIFT
1	BLAST LOAD	443.60	0.0213
2	BLAST LOAD WITH SHEAR WALL	225.20	0.0122
3	EARTHQUAKE LOAD	98.96	0.00467
4	EARTQUAKE LOAD WITH SHEAR WALL	33.2	0.00135

For 10 floors



Graph 5.1- Lateral Storey Displacement Vs Storey No.



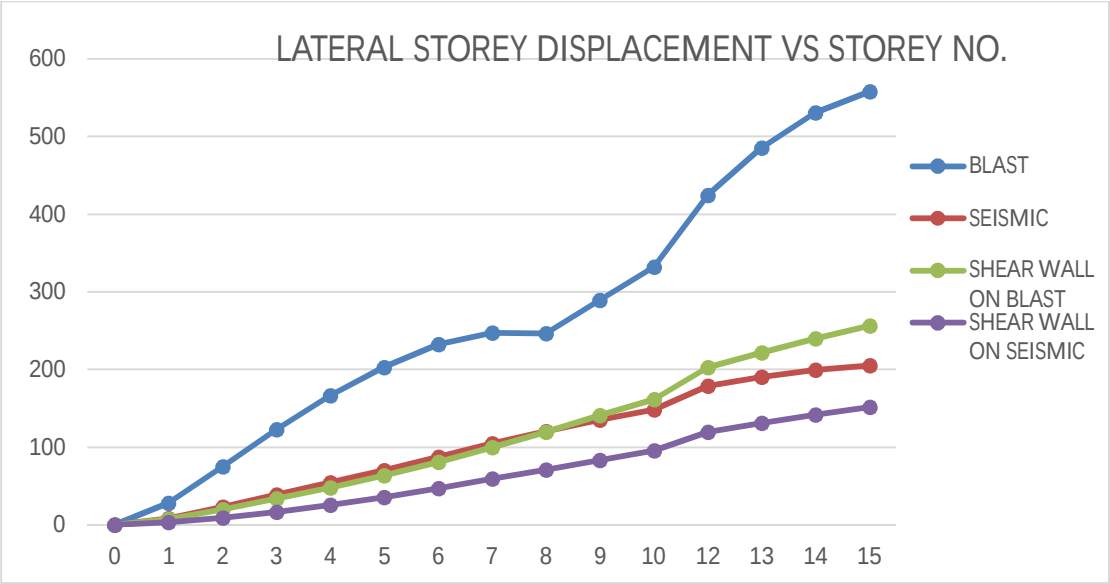
Graph 5.2 - Storey Drift Vs Storey No.

C. Building Displacements and Storey drift 15 Floors

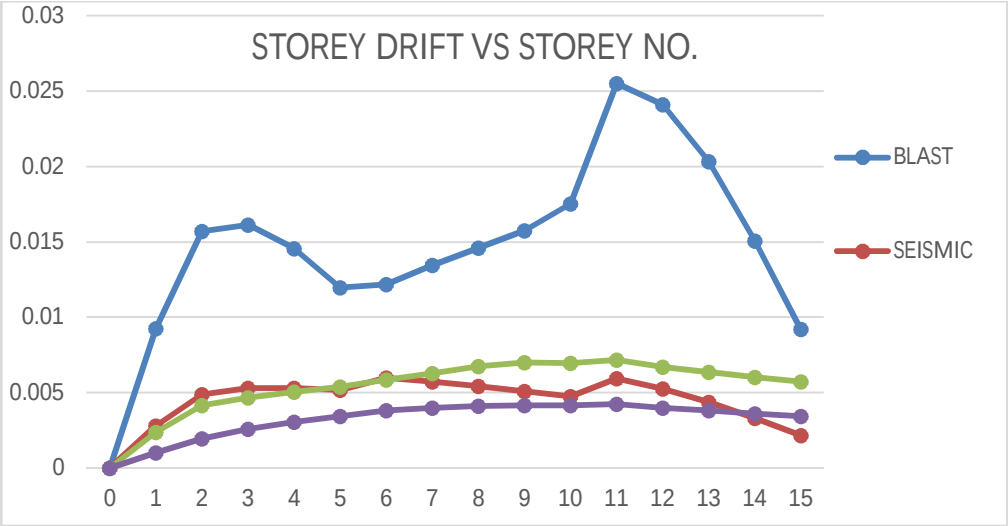
TABLE –5.2: Model 2- Building Displacement and storey drift

S.NO	LOAD CASE	MAX STOREY DISPLACEMENT	MAX STOREY DRIFT
1	BLAST LOAD	558	0.0251
2	EARTHQUAKE LOAD	256.8	0.00715
3	BLAST LOAD WITH SHEAR WALL	205.21	0.00597
4	EARTQUAKE LOAD WITH SHEAR WALL	151.3	0.00423

15 floors



Graph 5.3 - Lateral Storey Displacement Vs Storey No.



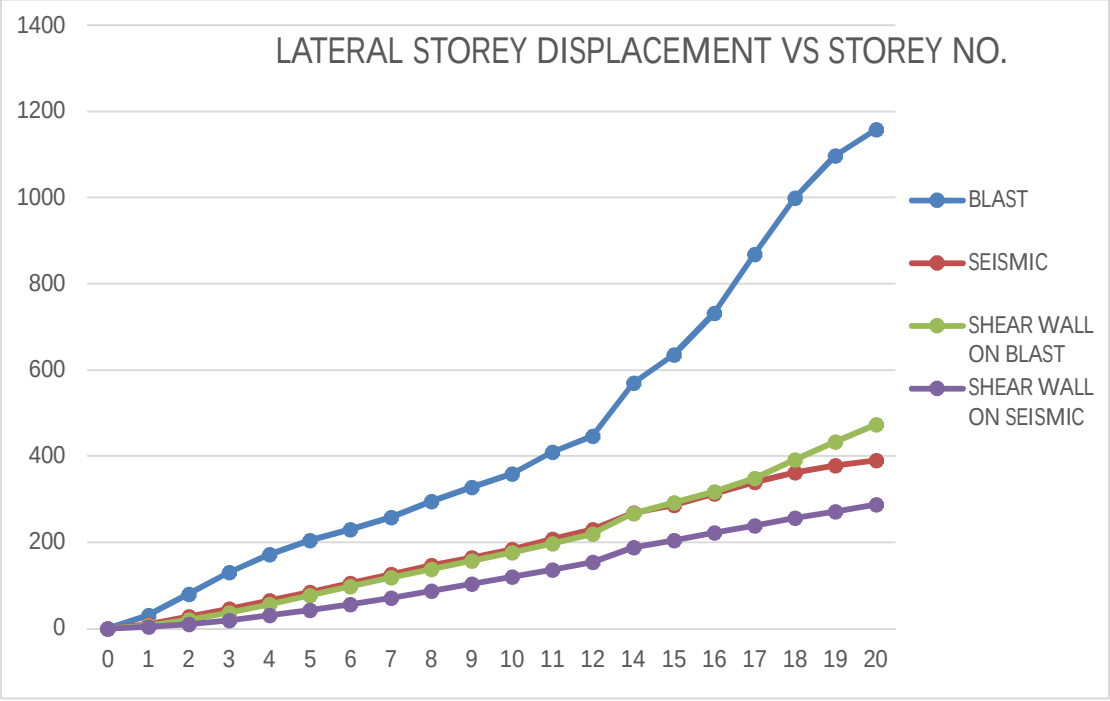
Graph 5.4 - Storey Drift Vs Storey No.

D. Building Displacements and Storey Drift 20 FLOORS

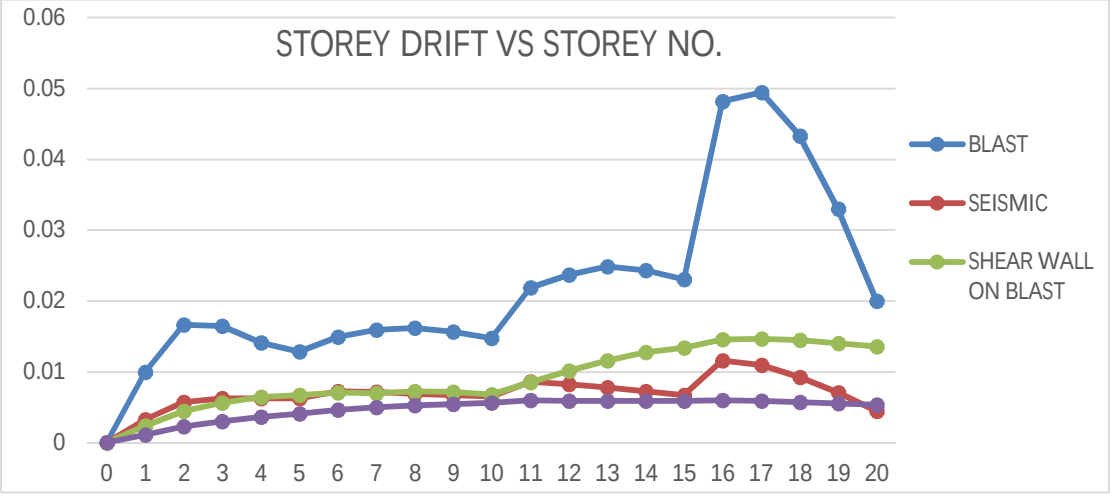
TABLE –5.3:Model 3- Building Displacement and storey drift

S.NO	LOAD CASE	MAXSTOREY DISPLACEMENT	MAX STOREY DRIFT
1	BLAST LOAD	1157.08	0.04948
2	EARTHQUAKE LOAD	473.71	0.01464
3	BLAST LOAD WITH SHEAR WALL	390.54	0.01156
4	EARTQUAKE LOAD WITH SHEAR WALL	288.11	0.00608

E. Building Displacements and storey drift 20 floors



Graph 5.5 Lateral Storey Displacement Vs Storey No.



Graph 5.6 Storey Drift Vs Storey No.

VI. CONCLUSION

From the above results following conclusion has been drawn.

1) The magnitude for both the types of dynamic loads are same the building is more dangerous in a blast loads case in all the terms as, storey displacement, storey drift, moments and shear.

2) The effect of the blast waves reduces as the distance and magnitude of the blast load reduces such as a higher floor is less affected when a blast explosion occurs at the ground level

3) Shear wall works as a very effective addition to the building and highly reduces the effect of any kind of dynamic load and an approx. 45 percent of reduction in the displacement occurs due to shear walls.

We can conclude that building subjected to blast and earthquake load of same magnitude would have more effect of blast load on to the lateral storey displacement, storey drift, moments, shear and other aspects.

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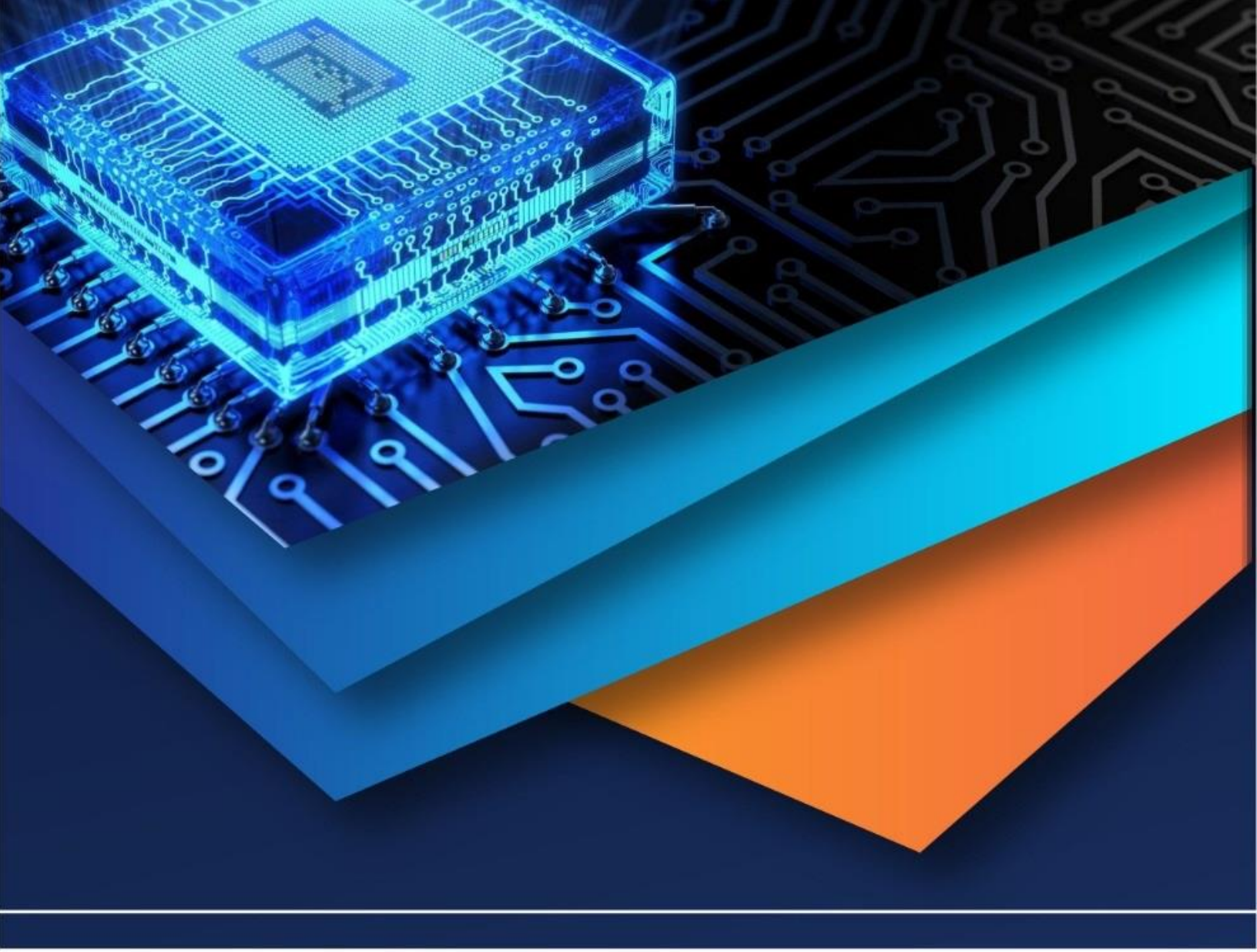

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