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Behavior of Steel Plate Shear Wall in Framed Structure

Akash V. Lad[1], Saurabh S. Fartade[2]
Department of Civil Engineering, Swami Vivekanand Subharti University / Subharti Institute of Technology and Engineering, Meerut, India

Abstract: Steel plate shear walls have been used more and more in the steel structures to resist earthquake and wind forces. This system offers several advantages as compared to the other usual lateral load resisting systems. Steel saving, speed of erection, reduced foundation cost, and increased usable space in buildings are some apparent advantages of the steel plate shear walls. Steel plate shear walls also provide major stiffness against building drift for the hi-rise buildings. Our report describes the analysis and design of high-rise steel building frame with and without Steel plate shear wall (SPSW). In this report, equivalent static analysis is carried out for steel moment resisting building frame having (G+6) storey situated in zone III. The analysis of steel plate shear wall and the building are carried out using Software STAAD PRO. The main parameters consider in our report is to compare the seismic performance of buildings such as bending moment, base shear, deflection and storey drifts by varying the thickness of steel plate shear wall and position of steel plate shear wall in frame structure.

I. INTRODUCTION & OBJECTIVES

The shear wall can be describe as buildings having vertical plate-like walls called Shear Walls in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be varying according to height of buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation.

A. Main objective is to provide steel plate shear wall in framed structure instead of ordinary shear wall and analyze on the basis of deflection, bending moment ,base shear and storey drift occurred in steel frame under dynamic loading
B. To analyze the steel frame by varying thickness of steel plate shear wall and compare the result of steel plate shear wall with different thickness 8 mm, 12 mm and 16 mm.
C. To analyze the frame and compare the results by changing position of steel plate shear wall in steel frame like center position and corner position.

II. METHODOLOGY

A. Analysis methods and software used

For analysis of structure dynamic analysis method has been used**.** Dynamic analysis is classified into two types, namely, Time history method and Response spectrum method.

Software used- 3 D Spaced Frame Model is prepared in STAAD Pro. V8i (SELECT Series - 4) Version – 20.07.09.31.

B. Models

Model is prepared in STAAD Pro software for analysis purpose by providing steel plate shear wall in steel framed structure at different positions. Design is carried out as per the specification given in IS 800 – 2007. Following data is used to prepare the model for analysis purpose.

Specification of Model

Region	Pune Region
No. of Stories	G+6
Lateral Load Resisting System	Steel Plate Shear Wall
Height of each Storey	3 m
Support condition	Fixed Support
Section used for Steel Frame	
Columns	ISMB 450

Beams in X Direction	ISMB 450
Beams in Y Direction	ISMB 300
Plate Thickness	8 mm, 12mm, 16mm.
Type of Soil	Medium
Seismic analysis	Seismic coefficient method (IS1893-2002)
Design Philosophy	Limit state method IS 800-2007

C. Description of Frame

Frame having three bay and 7 storey building with fixed support the dimensions of frame are shown in figure.

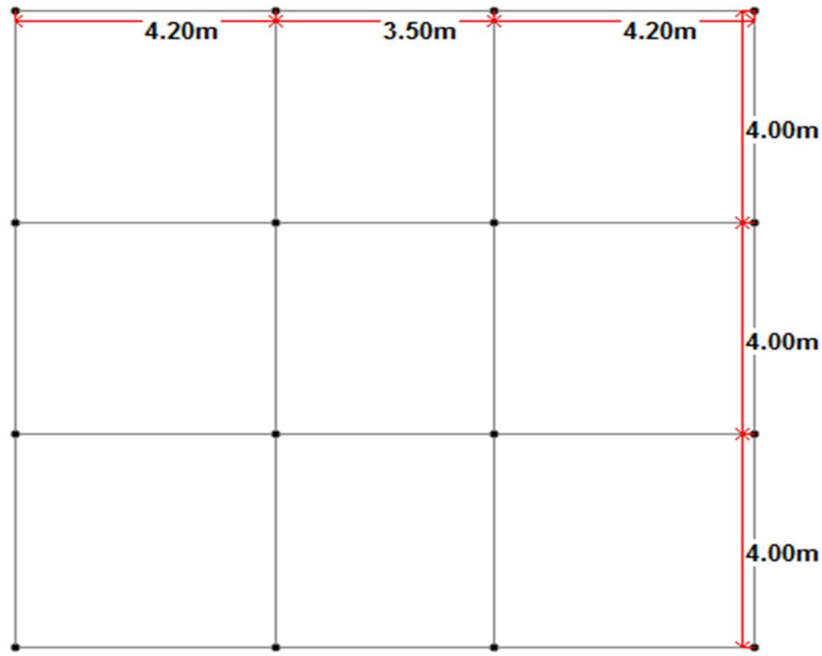

Figure 1. Plan with Dimensions of Steel Frame.

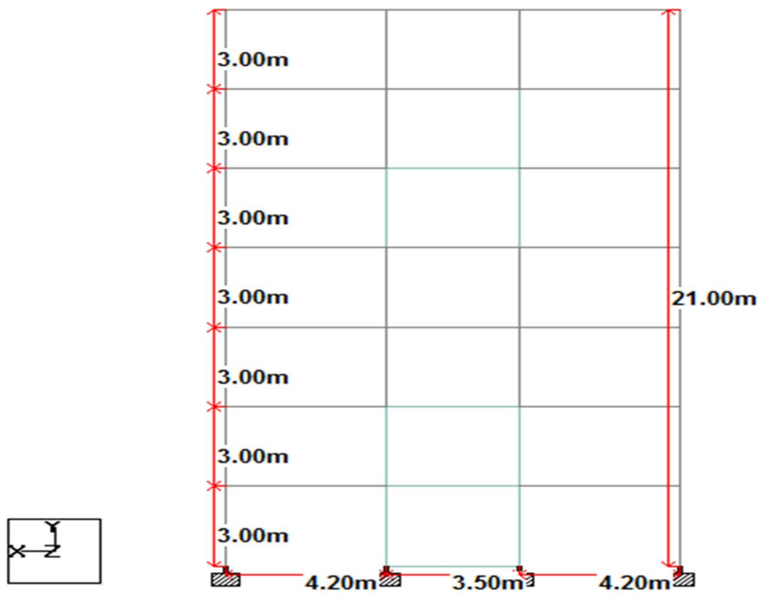

Figure 2. Elevation with Dimensions of Steel Frame

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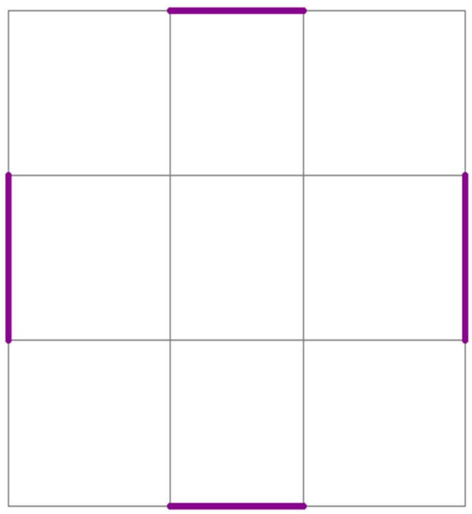
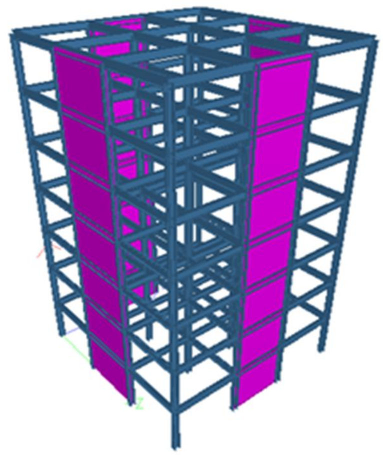
Model 1: Providing Steel Plate Shear Wall at centre bay of steel frame.

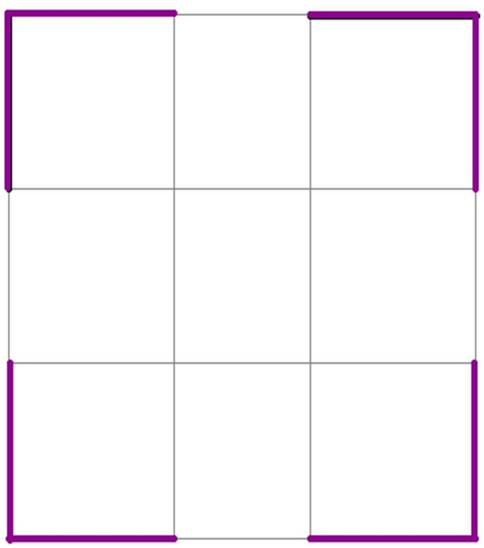


Plan

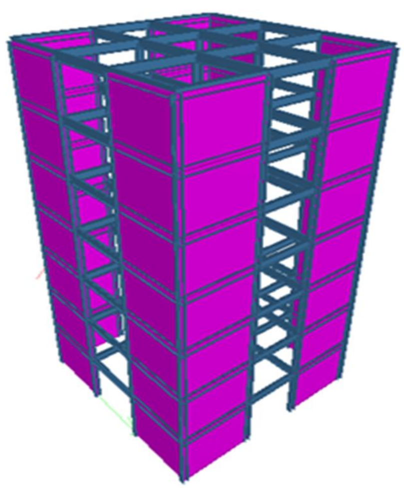


Elevation

Model 2: Providing Steel Plate Shear wall at corner bay of steel frame.



Plan



Elevation

D. Problem Statement

In the present study, the unsymmetrical steel framed structures having G+6 Storey with steel plate shear walls situated in seismic zone III is studied. Two models are constructed & analyzed using STADD PRO software.

Model 1- Steel plate at Centre bay of frame

Model2 - Steel plate at Corners of frame

These two models are analyzed by varying the thickness of steel plate as 8mm, 12mm, 16mm, respectively for each model. The result are calculated using software and compared amongst each other on the basis of four parameters viz. Displacement, Base shear, Bending moment & Storey drift. Results are plotted in the form of comparison graph. The main purpose of project is to determine the effect of changing position of steel plate shear wall on steel framed structure and also varying the thickness of steel plate. For analysis purpose the dynamic analysis method is used by applying general and seismic load along with various load combinations as per IS 1893-2002. This analyzed data could be useful to know effective position of steel plate shear wall in steel

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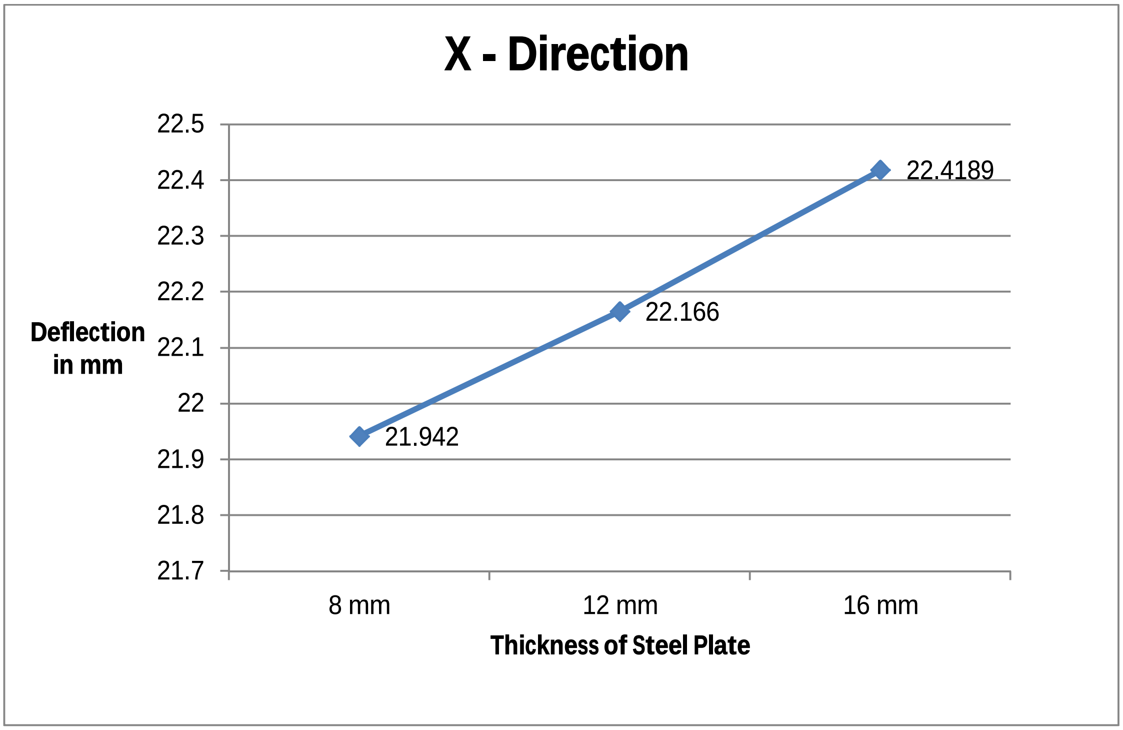
frame and also the effective thickness of steel plate to resist the seismic forces as well as lateral forces. The results and conclusion of study is described in further chapters.

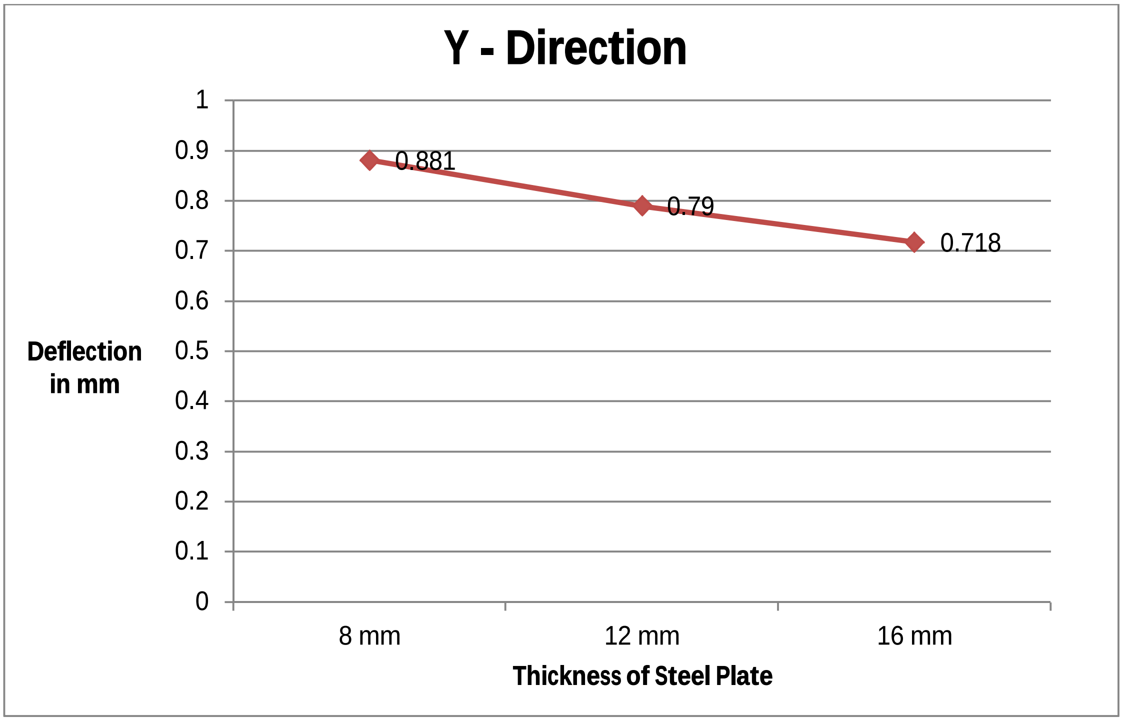
III. RESULTS

A. Maximum Deflection at Different Direction

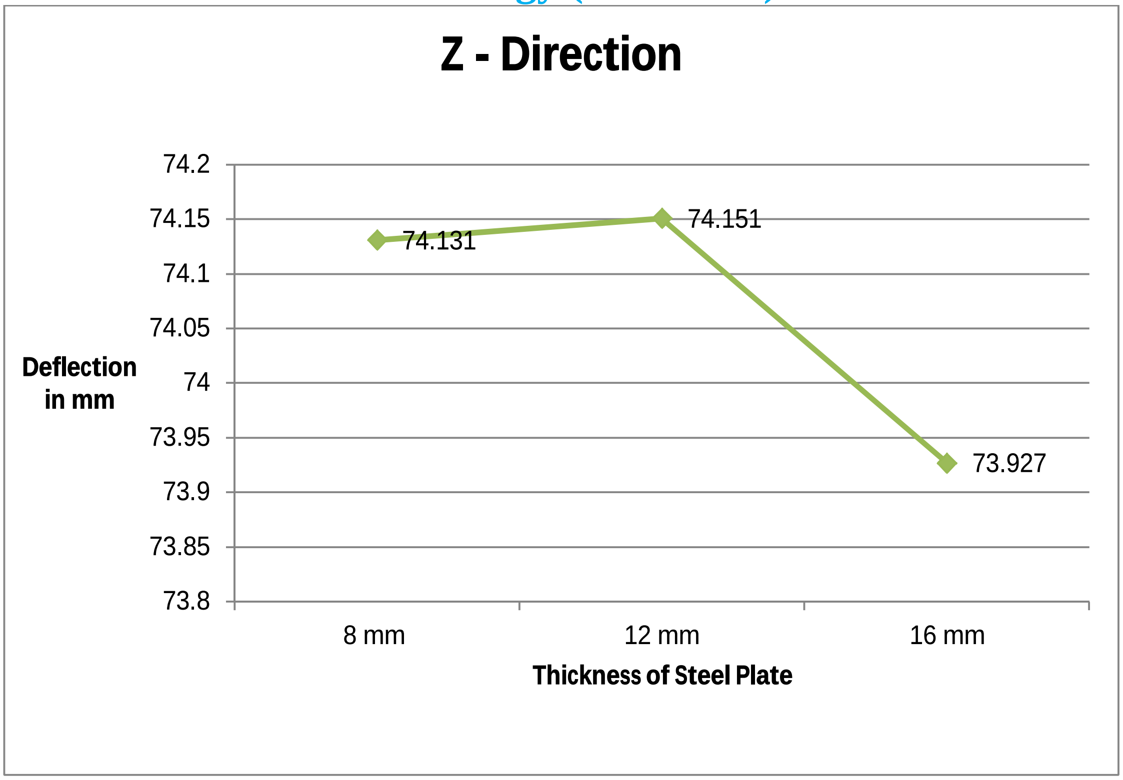
Model 1: Steel Frame Building with Steel Plate at Centre Bay.



Graph 1. Deflection in Model 1 at X Direction

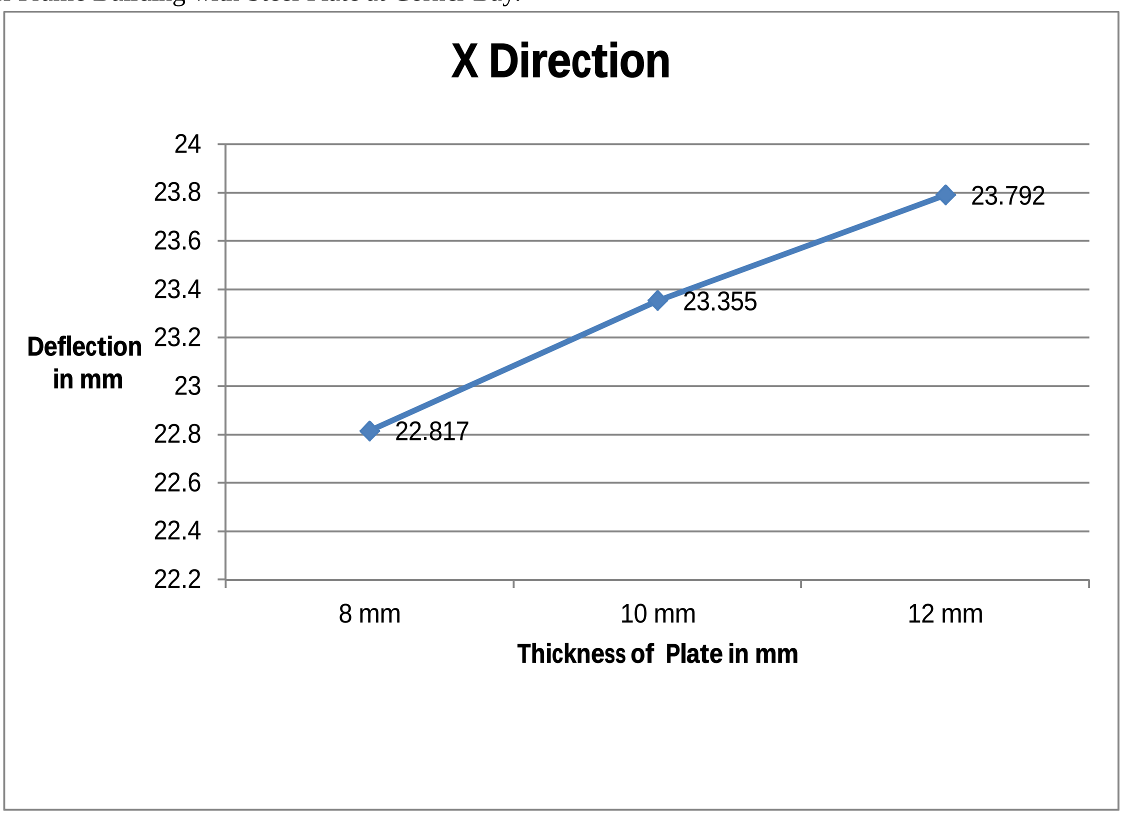


Graph 2 Deflections in Model 1 at Y Direction

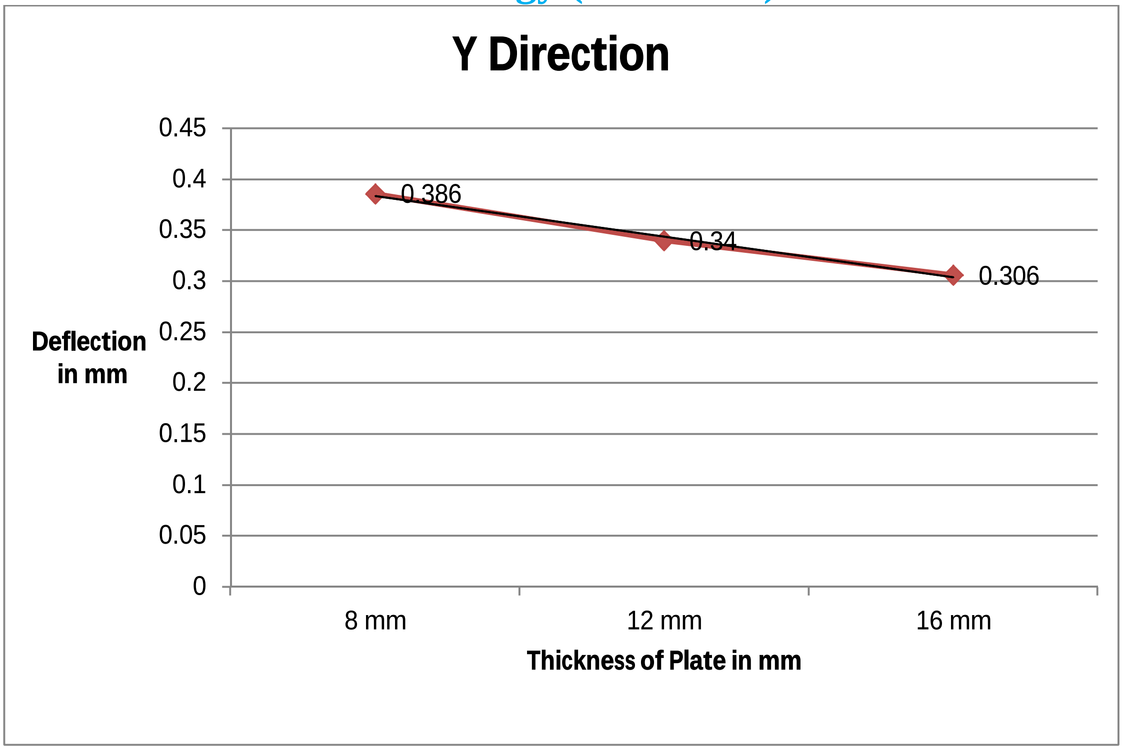


Graph 3 Deflections in Model 1 at Z Direction

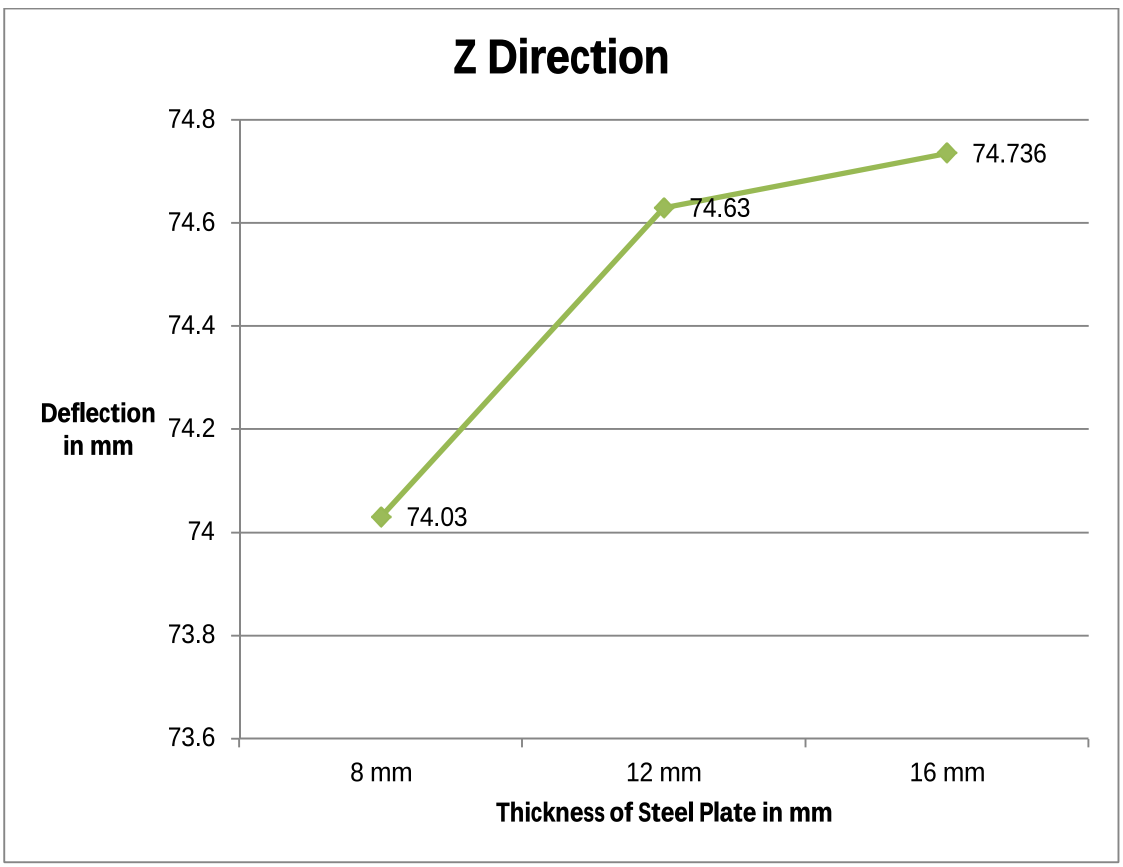
Model 2: Steel Frame Building with Steel Plate at Corner Bay.



Graph 4 Deflections in Model 2 at X Direction



Graph 5 Deflections in Model 2 at Y Direction



Graph 6. Deflection in Model 2 at Z Direction

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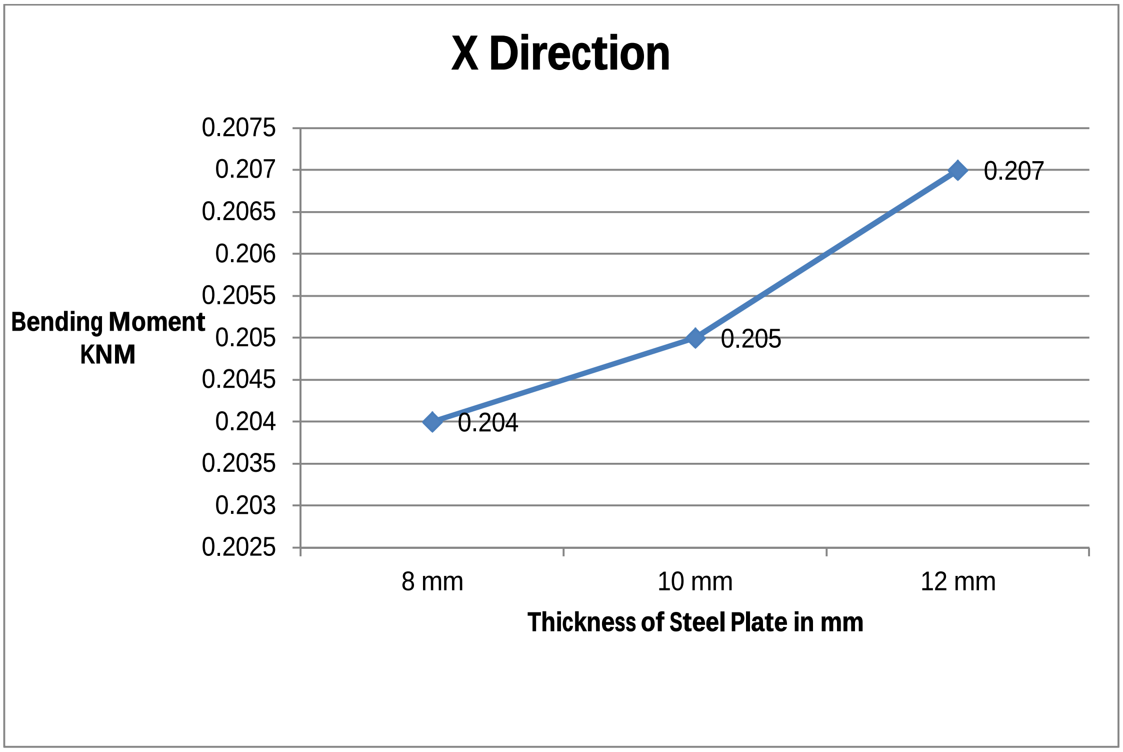
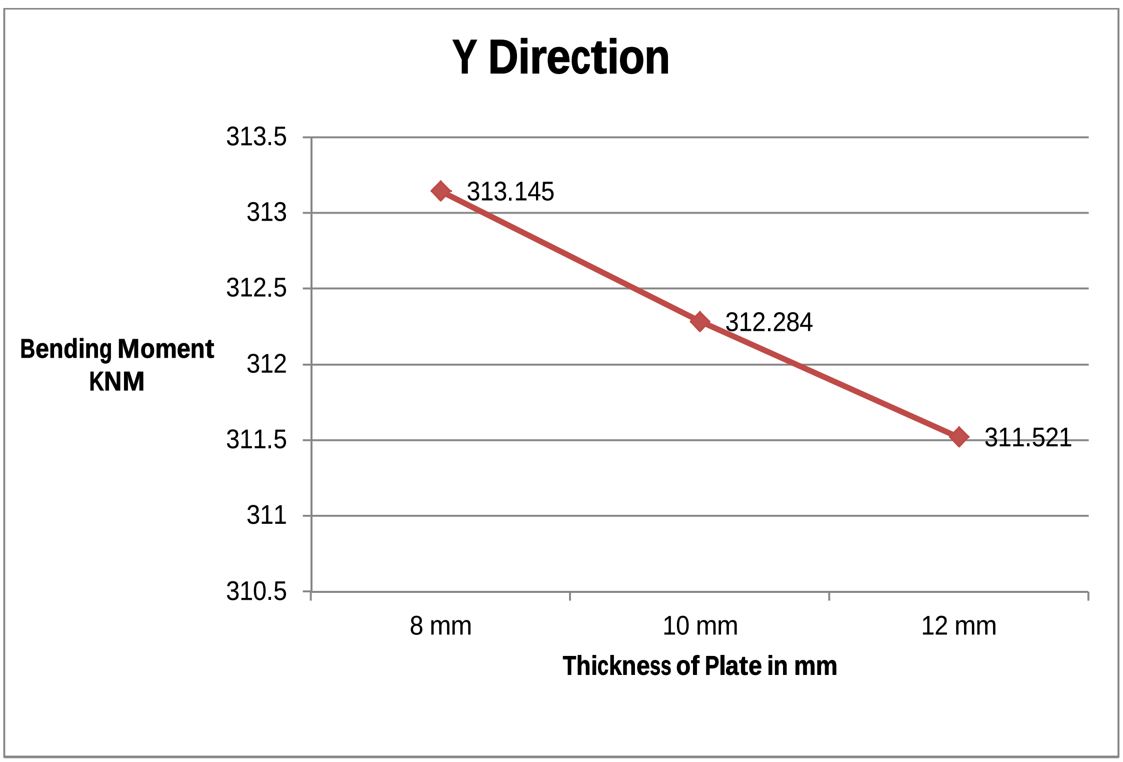
B. Maximum Bending Moment at Different Direction

Model 1 Steel Frame Building with Steel Plate at Centre Bay



Graph 7. Maximum Bending Moment in model 1 at X Direction



Graph 8. Maximum Bending Moment in model 1 at Y Direction

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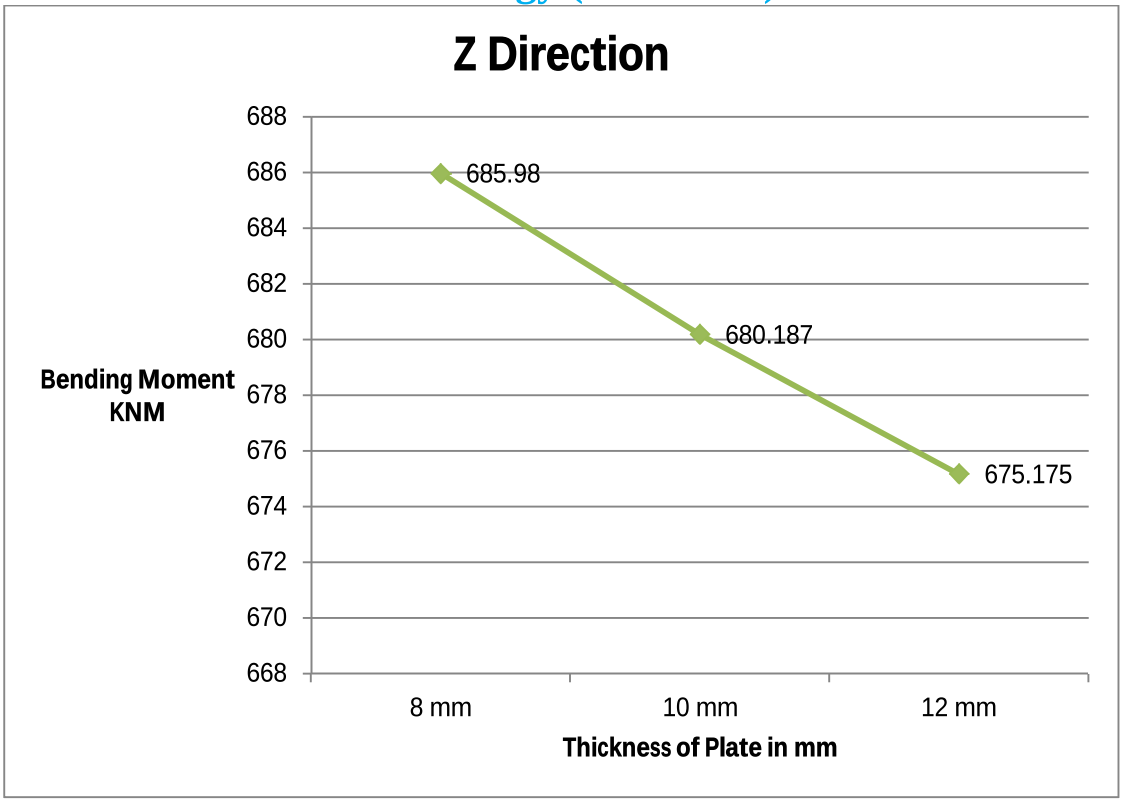
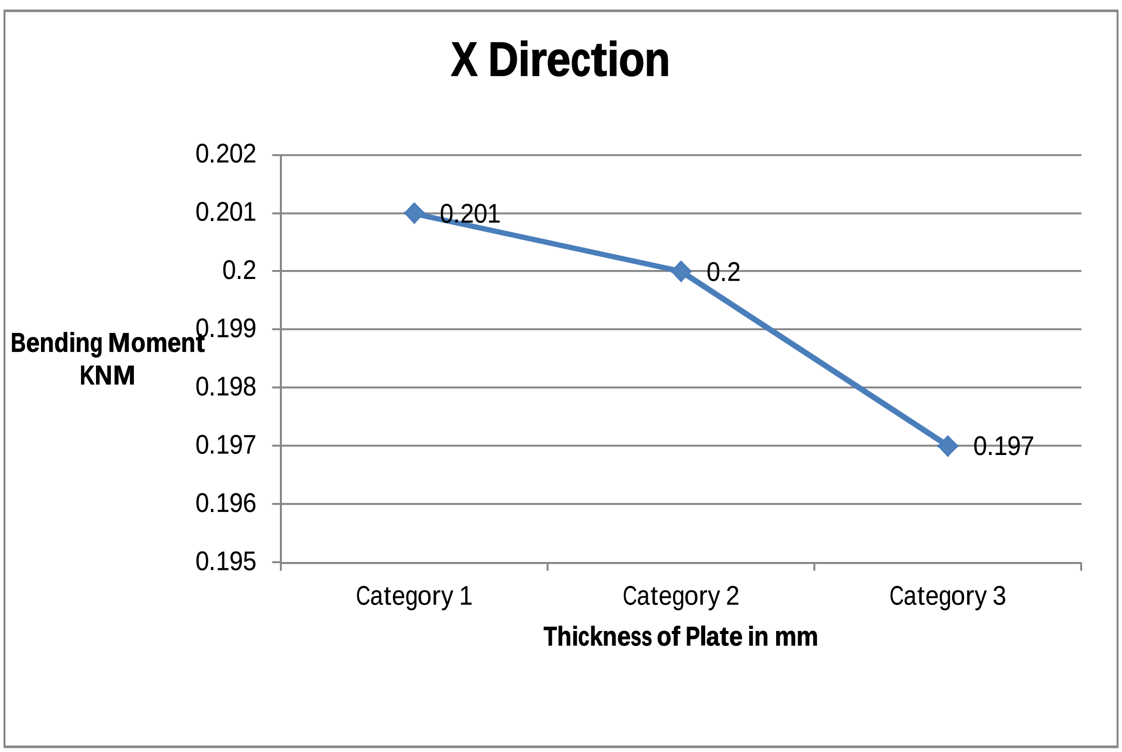
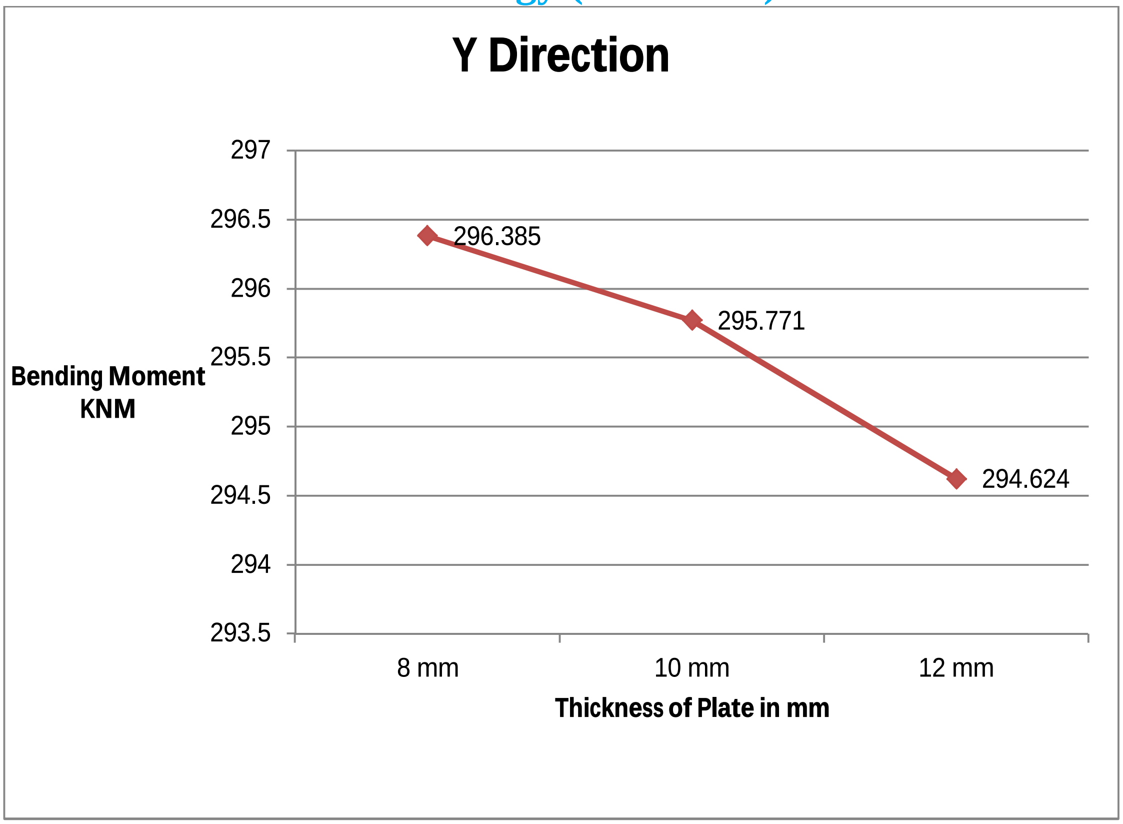


Graph 9. Maximum Bending Moment in model 1 at Z Direction

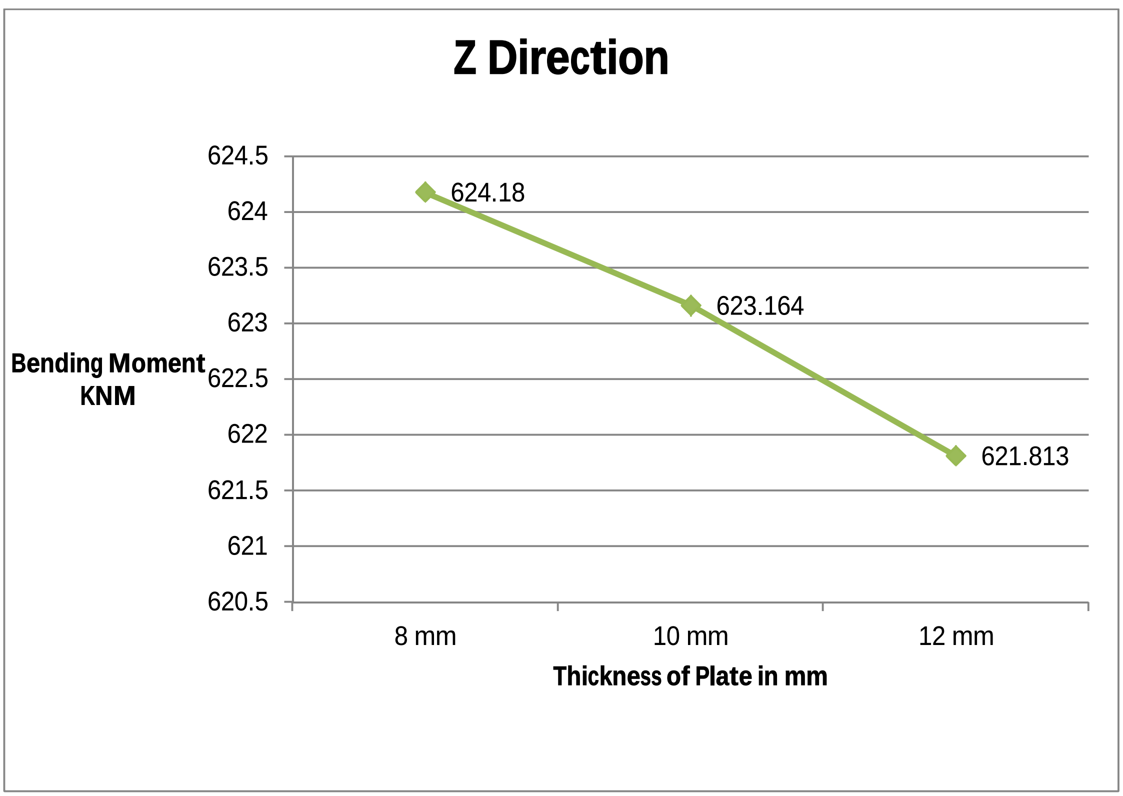
Model 2: Steel Frame Building with Steel Plate at Corner Bay.



Graph 10. Maximum Bending Moment in model 2 at X Direction.



Graph 11. Maximum Bending Moment in model 2 at Y Direction.



Graph 12. Maximum Bending Moment in model 2 at Z Direction.

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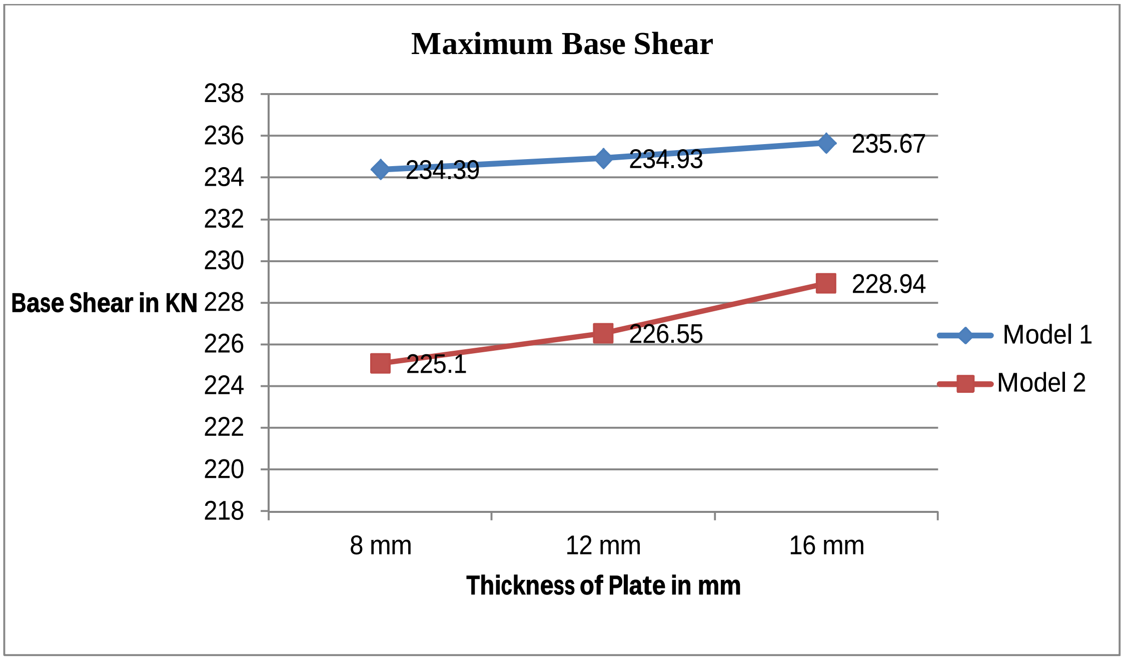
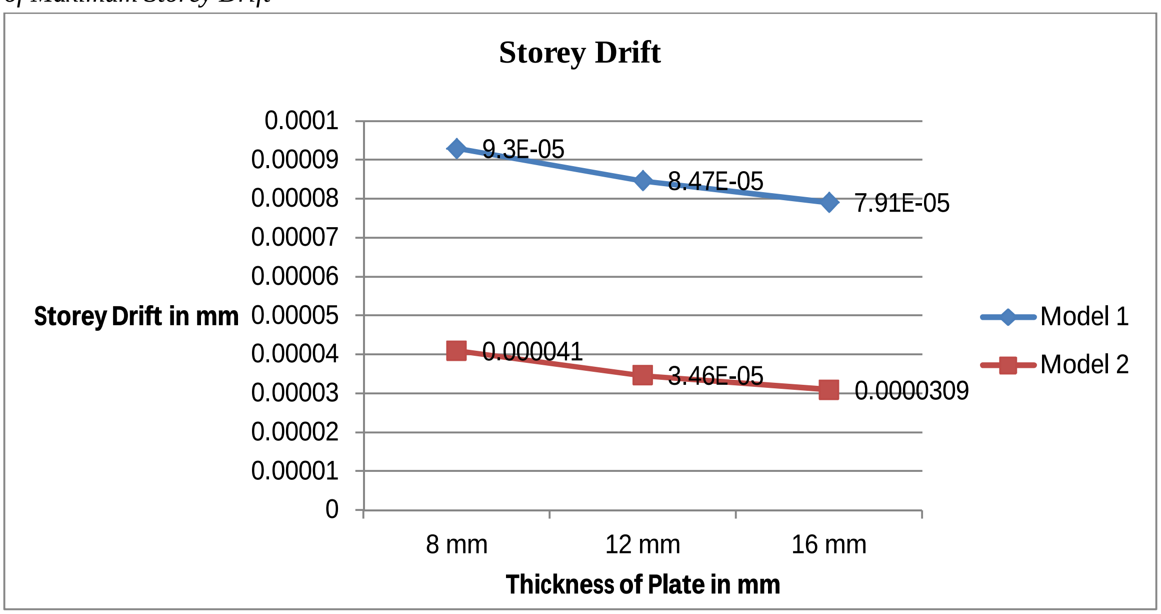
C. Results of Maximum Base Shear



Graph 13 Maximum Base Shear Result for Both Model

D. Results of Maximum Storey Drift



Graph 14 Maximum Storey Drift for Both Model

E. Results According To Graph

Model 1:- Steel plate at center position

Plate thickness	8 mm	12 mm	16 mm
Maximum deflection(Z direction)	Less	More	Moderate
Maximum BM(Z direction)	Less	Moderate	More
Maximum Base Shear(X direction)	Less	Moderate	More
Storey Drift	More	Moderate	More

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Model 2 :- Steel plate at corner position

Plate Thickness	8 mm	12 mm	16 mm
Maximum deflection(Z direction)	Less	More	Moderate
Maximum BM(Z direction)	Less	Moderate	More
Maximum Base Shear(X direction)	Less	Moderate	More
Storey Drift	More	Moderate	Less

IV. CONCLUSION

A. When steel plate shear walls are in Centre position deflection in X direction increases due to increase in thickness of steel plate, but deflection in Y and Z direction decreases. It can be concluded that the increase in thickness of steel plate is not effective to resist deflection in X direction but it is effective in resisting deflection in Z direction which is maximum.

B. In second model the maximum deflection is in Z direction but increasing thickness of steel plate is not effective to reduce the deflection due to lateral load.

C. Bending moment of steel frame is reduce in both model condition but when steel plate is situated on corner of external face of frame the bending moment produced is much less than of first model. So it is effective to provide steel plate shear wall at corner position to reduce the bending moment.

D. Base shear produced in steel frame increases with respect to increase in thickness of steel plate for both models. Adopting second model with 12 mm thickness is effective to reduce the base shear.

E. Storey drift in steel frame reduced when thickness of steel plate is more. And storey drift is less in case of second model.

F. Also by comparing both the models simultaneously it is observed that base shear, storey drift and bending moment is more in case of model one than that of model two but deflection is more in second model with respect to increase the thickness of steel plate.

G. On the basis of analyzed result and all above conclusions, adopting second model frame and more thick steel plate is proved more effective than that of model one.

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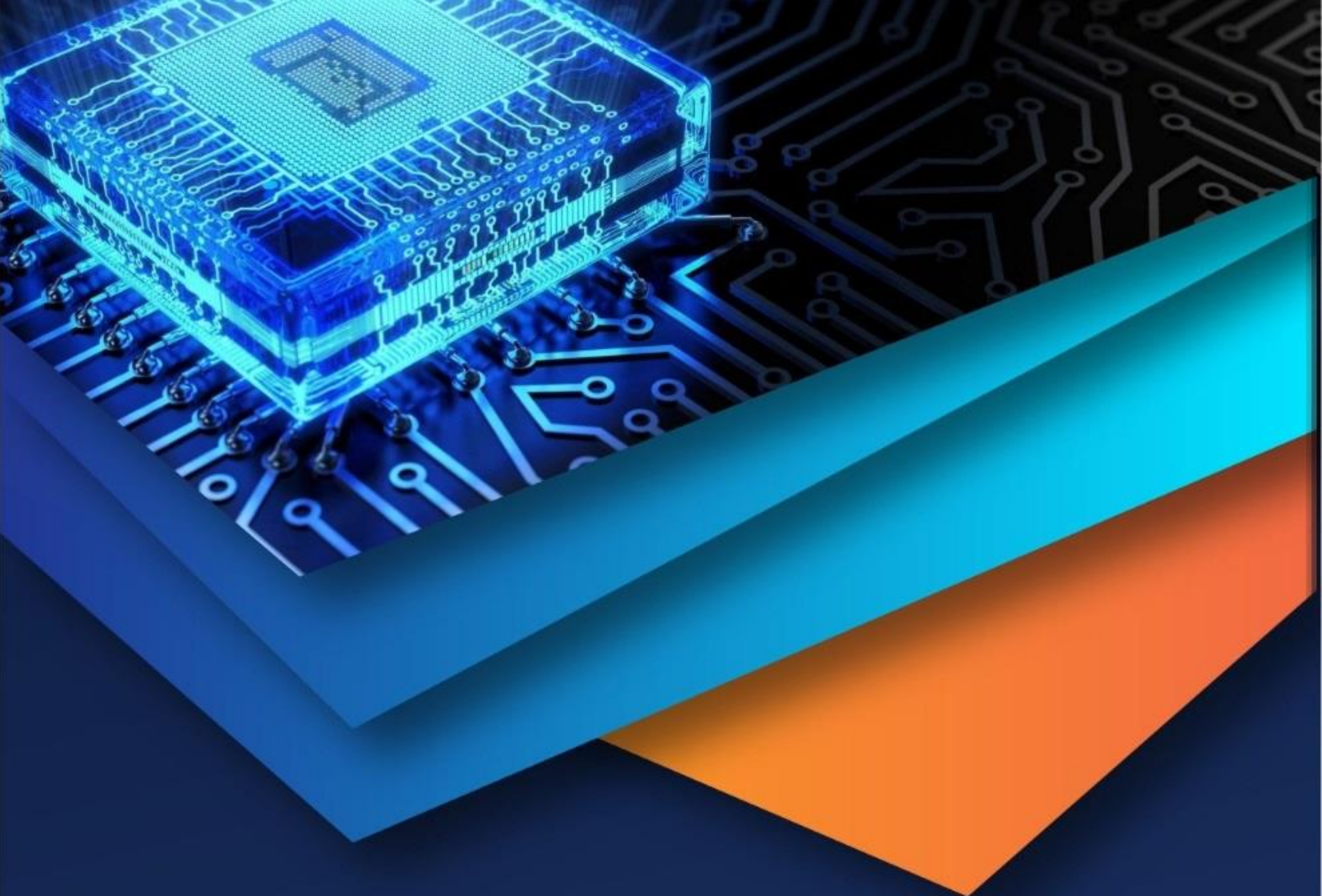

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