STUDY OF BEHAVIOUR OF STRUCTURE USING BRACING SYSTEM CONSIDERING LATERAL LOAD

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Abstract: A study on performance of high rise steel building with bracings, carried out on a residential building by considering the gravity loads and lateral loads in the form of earthquake loads and wind loads incorporating the bracing to reduce lateral load on structure element in this study. A steel frame structure has been selected to be idealized as multistory steel building model. The model is analyzed by using STAAD PRO 2008 structural analysis software with consideration of wind and earthquake loads at the same time the influence of the different types of bracing has been investigated. Different types of bracing systems have been investigated for the use in tall building in order to provide lateral stiffness. The use of bracings has potential advantage over other scheme, the bracings are provided for peripheral columns. A multi storey situated at a different seismic zone is subjected to lateral loads. The analysis and design as per IS:800-2007,the wind load analysis IS 875 (Part 3)–2015 and seismic or earthquake load according IS 1893 (Part 1) – 2016.

Keywords: High rise building, Bracing system, Lateral force, Nodal displacement, Storey drift, Axial force, Bending moment.

I. INTRODUCTION

Structural engineer's point of view the tall building or multi-storey building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. Buildings and structures are considered stable with lateral supports by using either bracing systems or shear system or both such as wall to ensure the stability of the building. Moreover, the important thing to consider are the software to be used for the analysis of tall building structure and wind speed at construction area to avoid any problems in future. In this, study is conducted for braced frame structures. Bracing is a highly efficient and economical method to laterally stiffen the frame structures against wind loads.

II. BRACING SYSTEM

A **braced frame** is a structural system designed to resist wind and earthquake forces. Members in a braced frame are not allowed to sway laterally.

TYPES OF BRACING

Concentric bracing

Concentric bracing consists of diagonal braces located in the plane of the frame. Both ends of the brace join at the end points of other framing members to form a truss, creating a stiff frame.Efficient energy dissipation is difficult to achieve in concentrically braced frames.

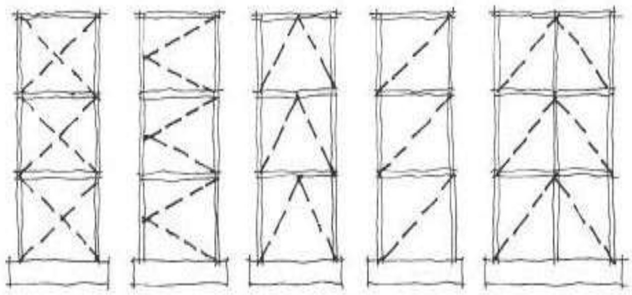

Fig1.concentric bracing

Eccentric bracing

Eccentric bracing consists of diagonal braces located in the plane of the frame where one or both ends of the brace do not join at the end points of other framing members. The system essentially combines the features of a moment frame and a concentrically braced frame, while minimizing the disadvantages of each system.

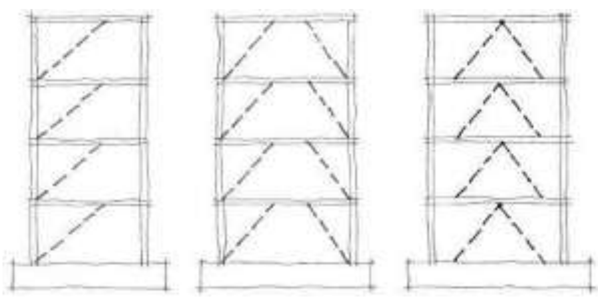

Fig 2. Eccentric bracing

Types of bracing based on their shape:

Following are the five types of bracings:

1. Diagonal bracing
2. Cross bracing
3. Chevron bracing
4. V – bracing
5. K - bracing

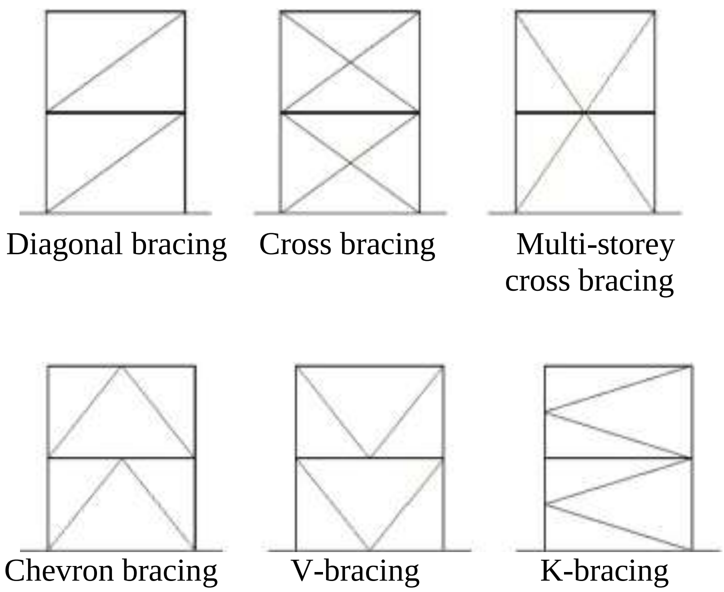

Fig3.Types of bracing

III. OBJECTIVE OF STUDY

The primary objective of this study is to evaluate the response of braced structure arranged at the different locations that are subjected to seismic loads and to identify the effective bracing system to effectively resist seismic load and wind load.

The objectives have been indicated as follows:
Generation of structural model on STAAD. Pro.
Load calculation because of various loading conditions.
Application of loads on STAAD. Pro model.
Analysis of the structural model on STAAD. Pro.
Study of the reaction forces, shear force, bending moment and nodal displacement.
Design of the structure.

IV. METHODOLOGY OF STUDY

This study is based on STAAD PRO 2008.The model is analyzed and design by using STAAD PRO 2008.
A symmetrical framed structure with 30m × 30m plan size and G + 20 is selected for the study.This study is performed as per IS:456-2000 and IS:800-2007, wind load analysis IS 875 (Part 3) – 2015 and seismic or earthquake load according IS 1893 (Part 1) – 2016.

Following steps to be taken for analysis and design of building on STAAD.Pro :

Step-1:Generation of nodal points

Step-2: Representation of beams and columns

Step-3: Assignment of support and property

Step-4: Three-dimensional view

Step-5: allocation of the dead load

Step-6: allocation of the live load

Step-7: allocation of the seismic load

Step-8: allocation of the wind load

Step-9: Assignment of the load combination

Step-10: Analysis of the structure on STAAD. Pro

Step-11: Structural design on STADD.pro and Generation of output

V. MODELLING INFORMATION

Building Specification:

Table 1. Modelling Data

No. of storey	G + 20
Plan size	30m×30m
Storey height	3.5m
Total height	73.5m
Spacing of frame along length	5m
Spacing of frame along width	5m
Beam size	ISMB 500
Column size	I80012B50012
Bracing size	ISMC 200
Slab thickness	0.15m
Grade of steel	FE415
Grade of concrete	M 25

These values are provided as a input to the STAAD-Pro software for analysis and designing purposes. The base supports of the structure are assigned as fixed.

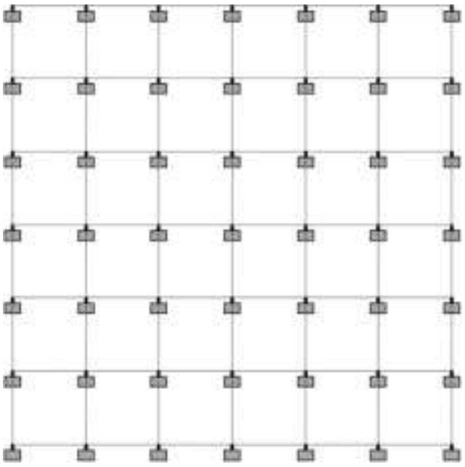

Fig 4. Plan- Un-braced reference model

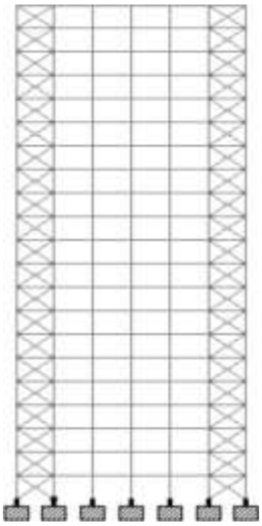

Fig 5. X bracing system at periphery (Model 1)

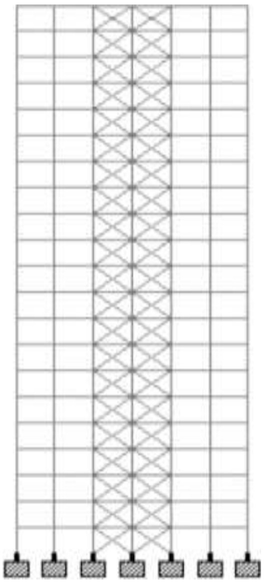

Fig 6. X bracing system at centre (Model 2)

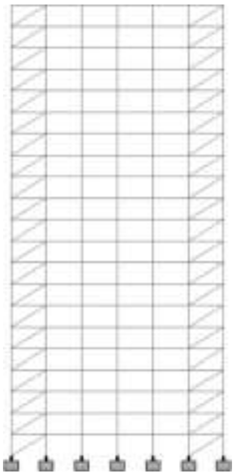

Fig 7. Diagonal bracing system at periphery (Model 3)

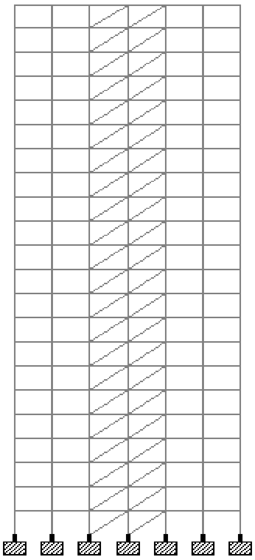

Fig 8. Diagonal bracing system at centre (Model 4)

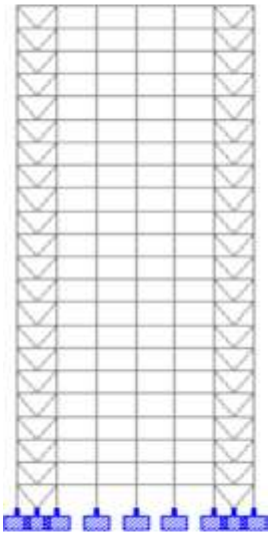

Fig 9. V bracing system at periphery (Model 5)

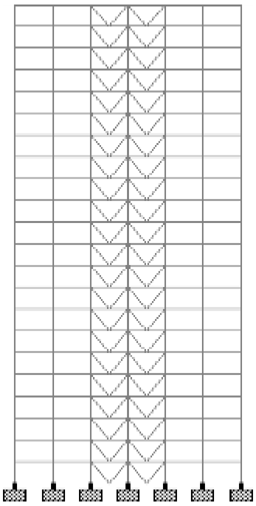

Fig 10. V bracing system at centre (Model 6)

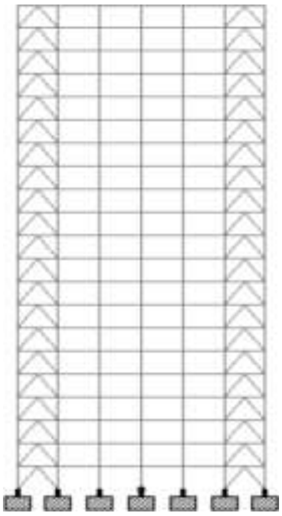

Fig 11. Chevron bracing system at periphery (Model 7)

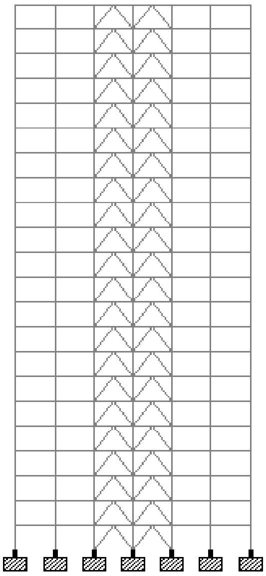

Fig 12. Chevron bracing system at centre (Model 8)

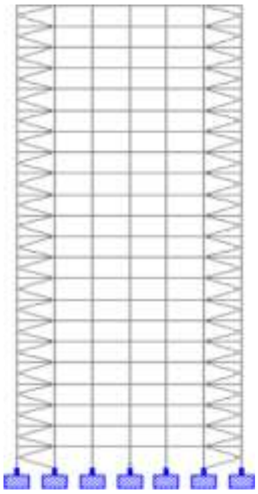

Fig 13. K bracing system at periphery (Model 9)

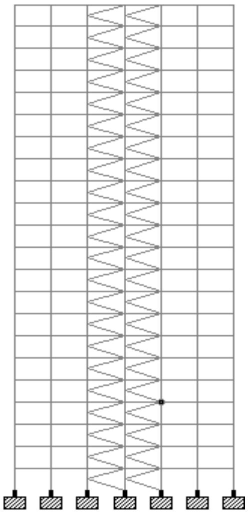

Fig 14. K bracing system at centre (Model 10)

VI. RESULT

Table 2. Maximum nodal displacement in X direction

Model number	Nodal displacement	Model number	Nodal displacement
Model 1	124.62	Model 6	104.877
Model 2	117.06	Model 7	54.200
Model 3	144.3	Model 8	182.75
Model 4	491.0	Model 9	70.73
Model 5	131.30	Model10	355.00

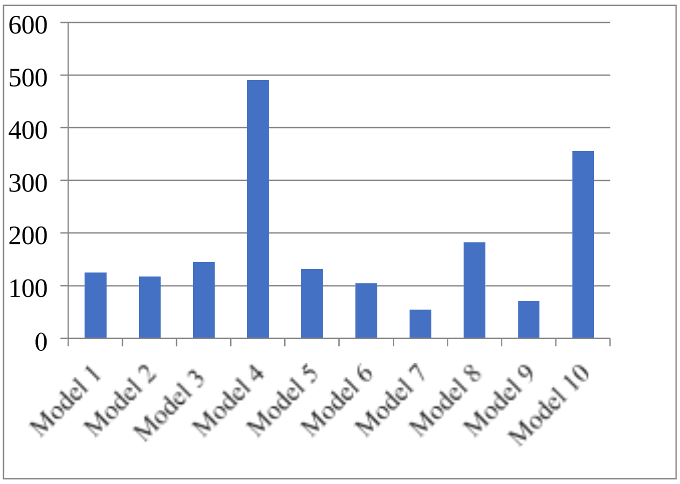

Fig 15. Maximum nodal displacement in X direction

Table 3. Maximum nodal displacement in Z direction

Model number	Nodal displacement	Model number	Nodal displacement
Model 1	123.77	Model 6	104.96
Model 2	116.17	Model 7	55.9
Model 3	208.6	Model 8	493
Model 4	52.33	Model 9	264
Model 5	131.34	Model 10	118

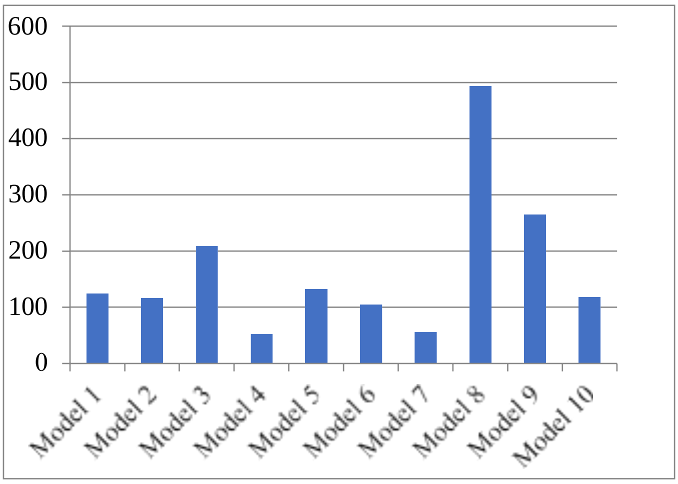

Fig 16. Maximum nodal displacement in Z direction

Table 4. Maximum axial force

Model number	Axial force	Model number	Axial force
Model 1	4812.9324	Model 6	3808.4327
Model 2	4523.2885	Model 7	3588.997
Model 3	6387.866	Model 8	3807.795
Model 4	3582.9094	Model 9	2423.0135
Model 5	3680.5972	Model 10	3586.7045

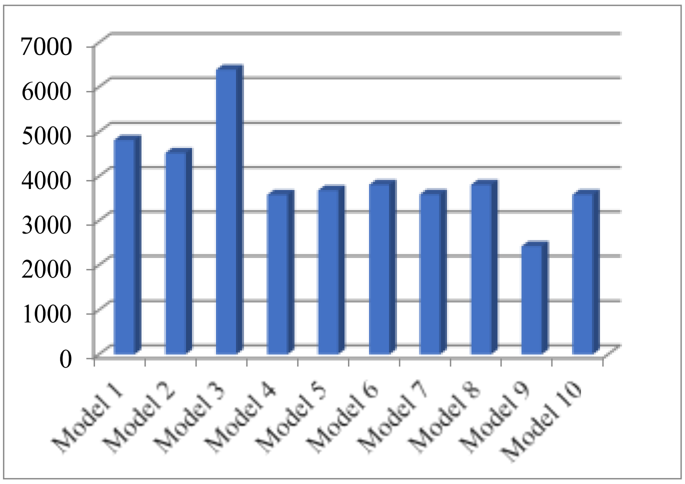

Fig 17. Maximum axial force

Table 5. Maximum bending moment

Model number	BM	Model number	BM
Model 1	409.18602	Model 6	190.249
Model 2	479.26324	Model 7	392.9832
Model 3	166.4020	Model 8	560.01258
Model 4	142.139	Model 9	225.09033
Model 5	136.699	Model 10	660.39102

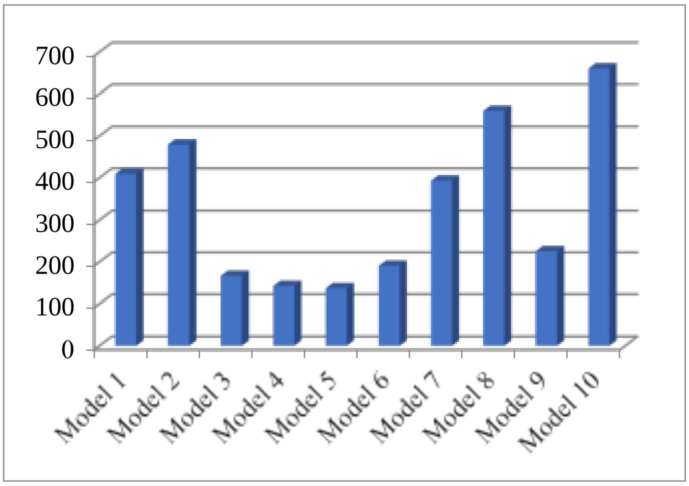

Fig 18. Maximum bending moment

Table 6. Maximum shear force

Model number	SF	Model number	SF
Model 1	7730.841	Model 6	11469.310
Model 2	9021.093	Model 7	1115.868
Model 3	3008.656	Model 8	6436.857
Model 4	3063.51	Model 9	4135.177
Model 5	9247.667	Model 10	8640.326

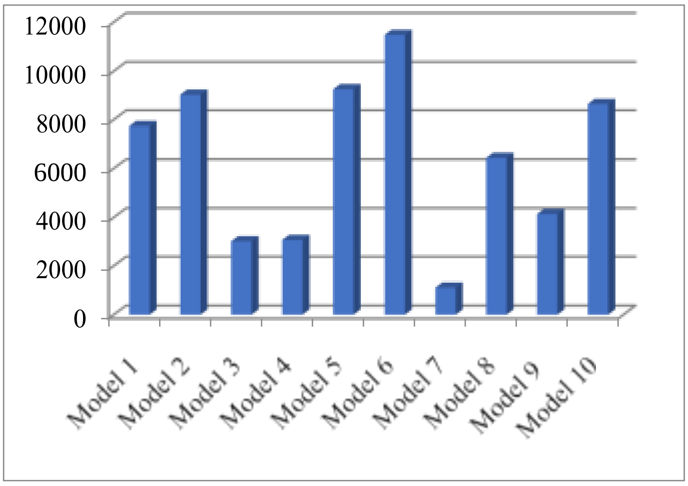

Fig 19. Maximum shear force

VII. CONCLUSION

Based on the result, following conclusion are drawn:

1. In model 4, Diagonal Bracing at centre have lowest nodal displacement in x direction, and z direction compared to other models.
2. Result also shows that Maximum axial force in diagonal bracing at periphery (Model 1).
3. Maximum bending moment is more in centre bracing than periphery bracing for X, V, inverted V and K bracing except for diagonal bracing in which periphery bracing have maximum bending moment than centre bracing.
4. Maximum shear force is more in centre bracing than periphery bracing.
5. The steel braced building of base shear increase compared to without steel bracing which indicates that stiffness of building is increases.

   From the result shows that model 4 consisting of diagonal bracing at centre is the effective bracing systems among different types of bracing arrangements considered for the present study.

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