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INFLUENCE OF WIND LOADING ON G+15 MULTISTORIED BUILDING WITH DIFFERENT BRACING PATTERN

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ABSTRACT

In the analysis and design of Multistoried building the effect of wind force is the major concern for the stability and effectiveness of the structure. In the Present paper the study deals with the comparison of Eccentric bracing and concentric bracing in case of wind loading. The calculation of wind load is done by the gust factor method as per the IS 875 –Part III for the precise results. The Structure is analyzed by the STAAD-Pro designing software. The parameters which considered for the comparison are Shear Force, Bending Moment, Displacement, Weight of structure, Torsion, Axial force and cost efficiency.

KEYWORDS: Stability, Eccentric, concentric, gust factor, torsion, efficient

INTRODUCTION

The structural components in a typical multi-storey building consist of a floor system which transfers the floor loads to a set of plane frames in one or both directions. The frames consist of beams and columns and in some cases braces or even reinforced concrete shear walls.

A building frame consists of number of bays and storey. A multi-storey multi-paneled frame is a complicated statically intermediate structure. A design of R.C building of G+15 storey frame work is taken up. The building in plan (48*36) consists of columns built monolithically forming a network. The size of building is 48x36m. The design is made using software on structural analysis design (STAAD-Pro). The building subjected to both the vertical loads as well as horizontal loads. The vertical load consists of dead load of structural components such as beams columns etc and live loads. The horizontal load consists of the wind forces thus building is designed for dead load, live load and wind load as per IS-875. The building is designed as two dimensional vertical frame and analyzed for the maximum and minimum bending moments and shear forces by trial and error methods as per IS 456-2000. The help is taken by software available in institute and the computations of loads, moments and shear forces and obtained from this software.

1.1 Braced frames

Braced Frames are usually designed with simple beam to column connections where only shear transfer takes place but may occasionally be combined with moment resisting frames. In braced frames, the beam and column system takes the gravity load such as dead and live loads. Lateral loads such as wind and earthquake loads are taken by a system of braces. Usually bracings are provided sloping in all four directions because they are effective only in tension and buckle easily in compression. Therefore in the analysis, only the tension brace is considered effective. Braced frames are quite stiff and have been used in very tall buildings.

1.1.1 Type of bracing

- x bracing
- v bracing
- k bracing
- Eccentric bracing

1.2 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.

The eccentric connection to the frame means an eccentric brace transfers lateral forces via shear either to another brace or to a vertical column. When properly proportioned, eccentric braced frames may exhibit a more

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ductile characteristic and greater energy dissipation capabilities than a concentric braced frame in the same material.

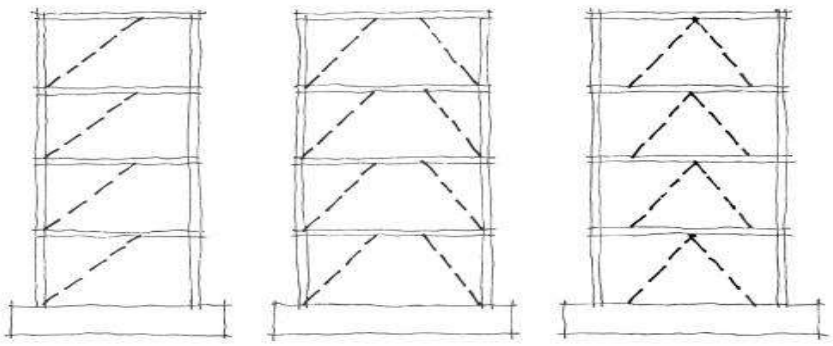


Fig: 1 Eccentric bracing and v bracing

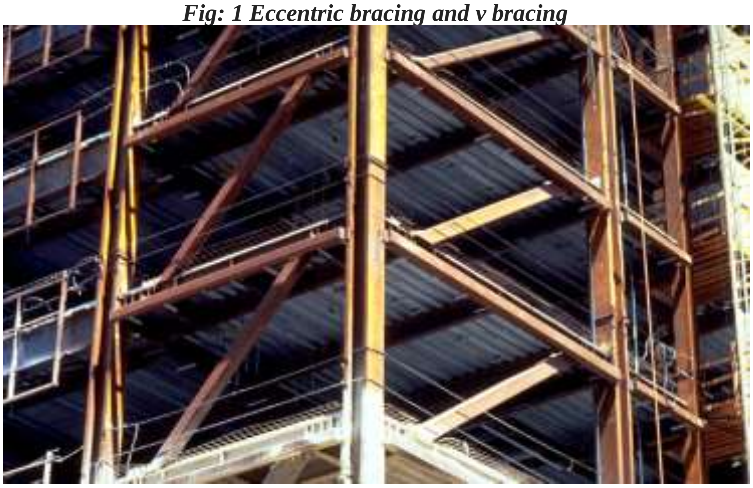


Fig: 2 Eccentric bracing in structure

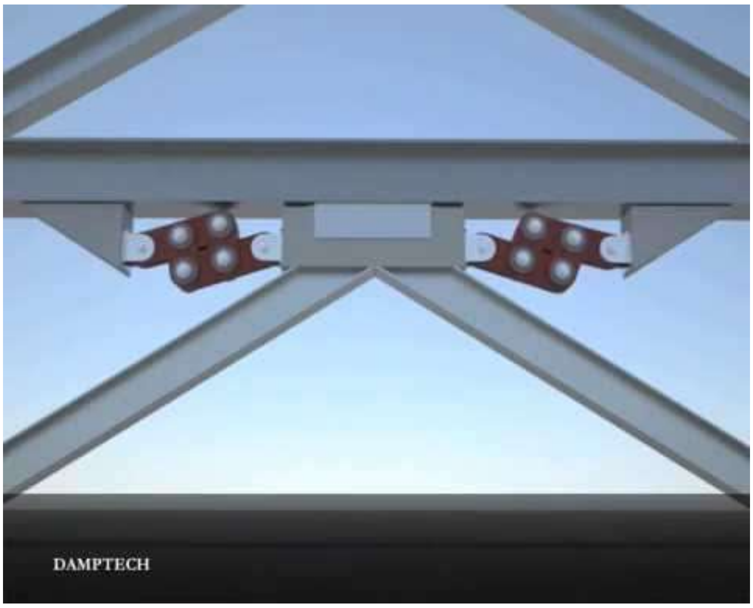


Fig: 3 V bracing in structure

METHODOLOGY

STAAD Pro

STAAD Pro V8i is the most popular structural engineering software product for 3D model generation, analysis and multi-material design. It has an intuitive, user-friendly GUI, visualization tools, powerful analysis and design facilities and seamless integration to several other modeling and design software products. The software is fully compatible with all Windows operating systems but is optimized for Windows XP.

For static or dynamic analysis of bridges, containment structures, embedded structures (tunnels and culverts), pipe racks, steel, concrete, aluminum or timber buildings, transmission towers, stadiums or any other simple or complex structure, Stadd.Pro has been the choice of design professionals around the world for their specific analysis needs.

Staad Pro is a general purpose program for performing the analysis and design of a wide variety of types of structures.

b) The calculations to obtain the analytical results

c) Result verification - are all facilitated by tools contained in the program's graphical environment.

The staad model is prepared to the scale in the working space of staad. The frame structure model is generated which consists of beams and columns and then the material with their cross-section properties are inputted to staad. The loads are then assigned and after that the structure is analyzed with the help of the staad program.

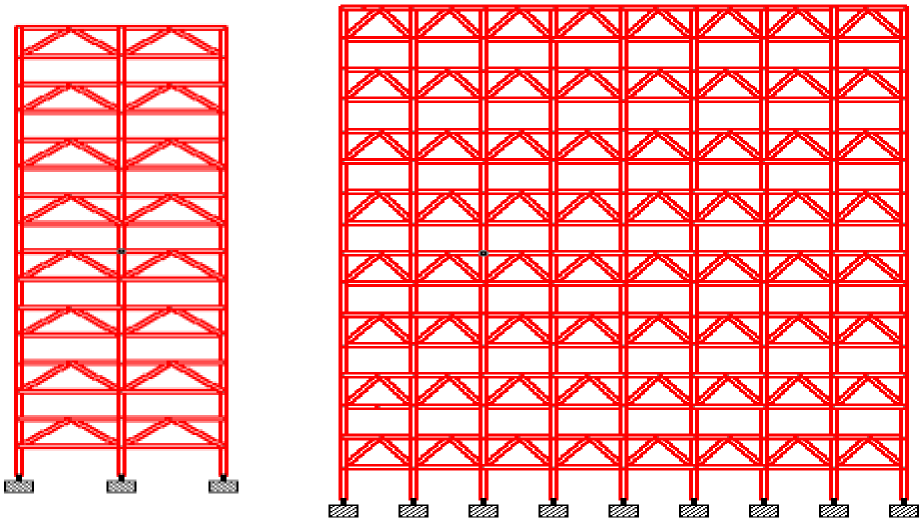
STAAD Pro is comprehensive structural engineering software that addresses all aspects of structural engineering including model development, verification, analysis, design and review of results. It includes advanced dynamic analysis and push over analysis for wind load and earthquake load.

PROJECT MODELS

For the analysis following two types of model has been taken.

Model: 1 V bracing in multistoried structure

Model: 2 Eccentric Bracing in multistoried structure



(A) *(B)*

Fig: 4 V bracing Model 1 (A) Side View (B) Front View

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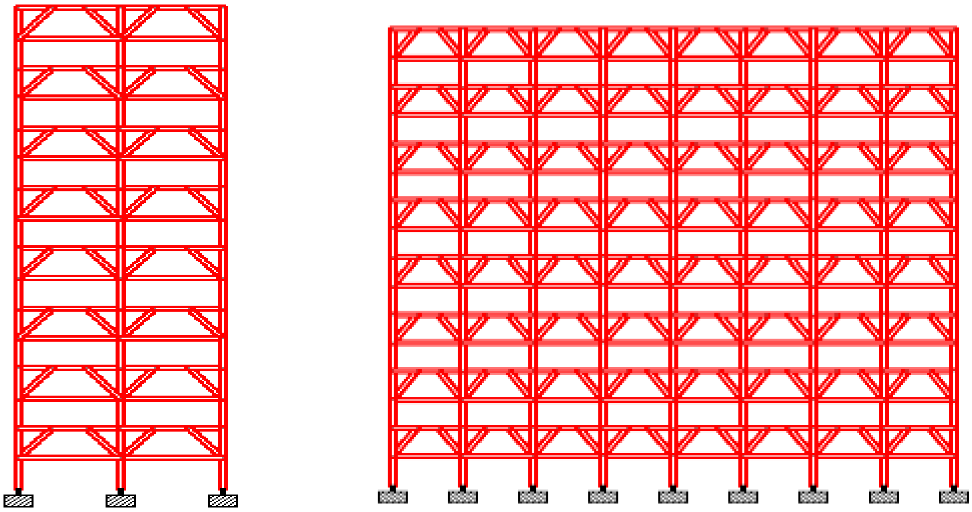

(A) *(B)*

Fig: 5 Eccentric bracing Model 2 (A) Side view (B) Front View

BUILDING DATA FOR ANALYSIS

Following data has been taken for the analysis of the Structure:

Table: 1 Building details

S.No.	**Type**	**Data**
1.	Type of building	Multi storey building
2.	Number of stories	G+15
3.	Floor Height	3 m
4.	Number of bays in length	8
5.	Number of Bays is Width	16
6.	Length of building	36 m
7.	Width of building	13 m
8.	Material	M-20 & Fe-415
9.	Length of one bay	4.5 m
10	Size of column	23.62 ft x 23.62 ft
11	Size Of beam	11.81 ft x 9.06 ft
12	Bracing	Eccentric and concentric
13	Dead Load	Self Weight -1 KN/cu. m
14	Live load	-8 KN/cu.m
15	Location	Jaipur

CALCULATION

Wind load calculation

Step: 1 Calculation of Basic Wind Pressure

V_b = 47 m/s (As per IS 875 Part III for Jaipur City)

Step: 2 Calculation of Design Wind Pressure

$\mathbf{V_z = k_1.k_2.k_3.V_b}$

Where k_1 = Risk coefficient

k_2 = Coefficient based on terrain, height and structure size.

k_3 = Topography factor

Table:2 Wind Calculation Table

S.No.	V_b (m/s)	Height	K_1	K_2	K_3	V_z (m/s)
1	47	48	1	1.125	1	52.875
2	47	45	1	1.1325	1	52.2275
3	47	42	1	1.14	1	53.58
4	47	39	1	1.1475	1	53.9325
5	47	36	1	1.155	1	54.285
6	47	33	1	1.1625	1	54.63
7	47	30	1	1.12	1	52.64
8	47	27	1	1.085	1	50.99
9	47	24	1	1.1	1	51.7
10	47	21	1	1.15	1	54.05
11	47	18	1	0.99	1	46.53
12	47	15	1	1.05	1	49.35
13	47	12	1	1.03	1	48.41

ANALYSIS

The project is analyzed in STAAD Pro and the following parameter is observed.

Table: 3 Comparisons of Shear Force and Bending Moment

S.No.	Fx (KN)	Fy (KN)	Fz (KN)	Mx (KN-m)	My(KN-m)	Mz(KN-m)
Concentric Bracing	3487.695	243.175	217.291	487.702	5127.22	2112.052
Eccentric Bracing	2157.962	152.93	38.851	162.484	5012.916	1813.867

Table: 4 Comparison of displacement

S.No.	X (mm)	Y(mm)	Z(mm)
Concentric Bracing	.097	.79	1.94
Eccentric Bracing	.071	1.447	1.97

Table: 5 Comparisons of Weight and Cost Efficiency

S.No.	Weight of structure	Cost Efficiency
Concentric Bracing	32.818 KN	High
Eccentric Bracing	19.201 KN	Less

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RESULTS AND DISCUSSION

After the comparison of various parameters following results have been observed from the study.

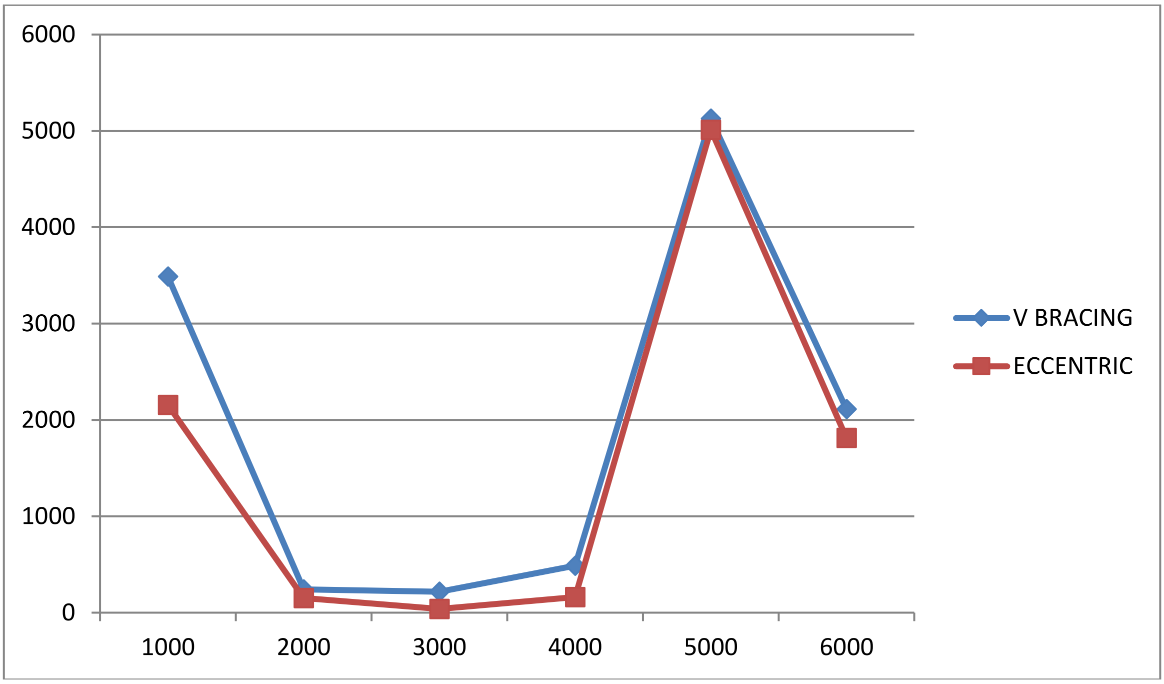

Fig: 6 Maximum shear force graph of Model 1 & Model 2

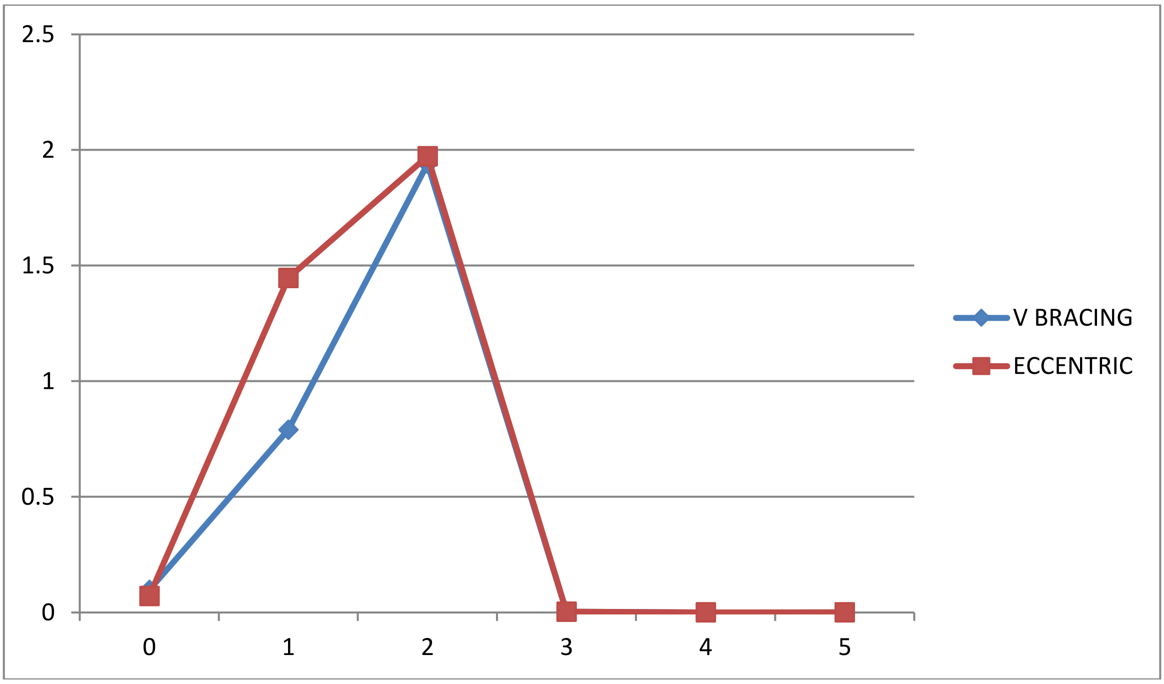

Fig: 7 Maximum displacement graph of Model 1 & Model 2

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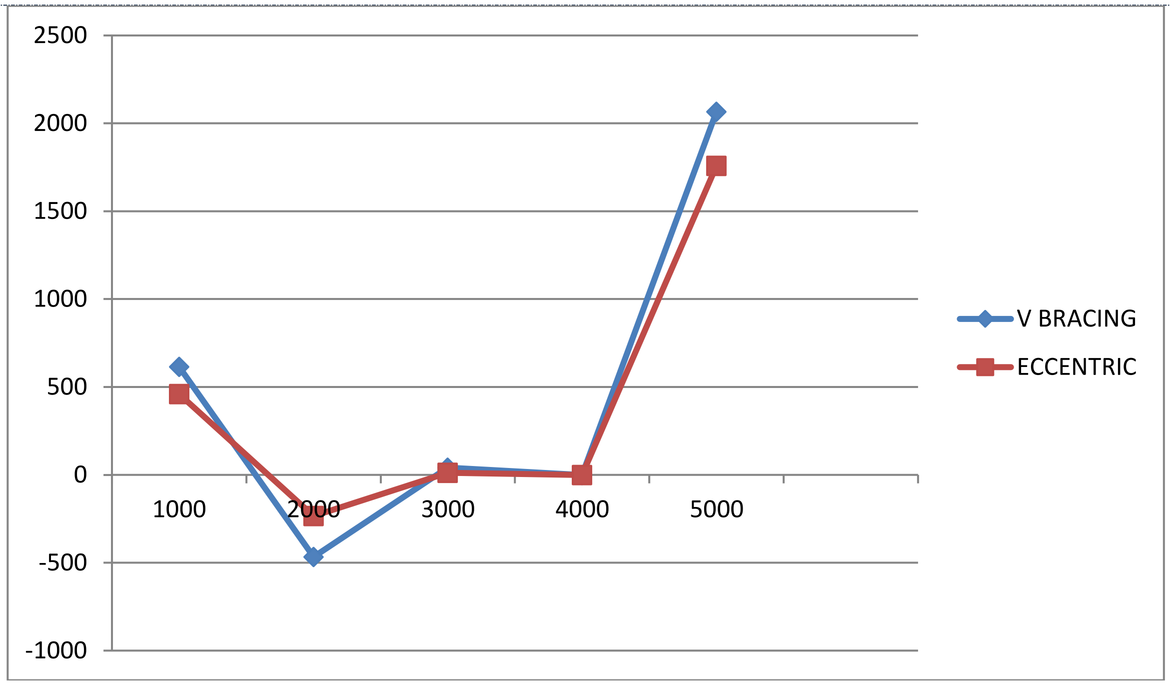

Fig: 8 Maximum bending moment graph of Model 1 & Model 2

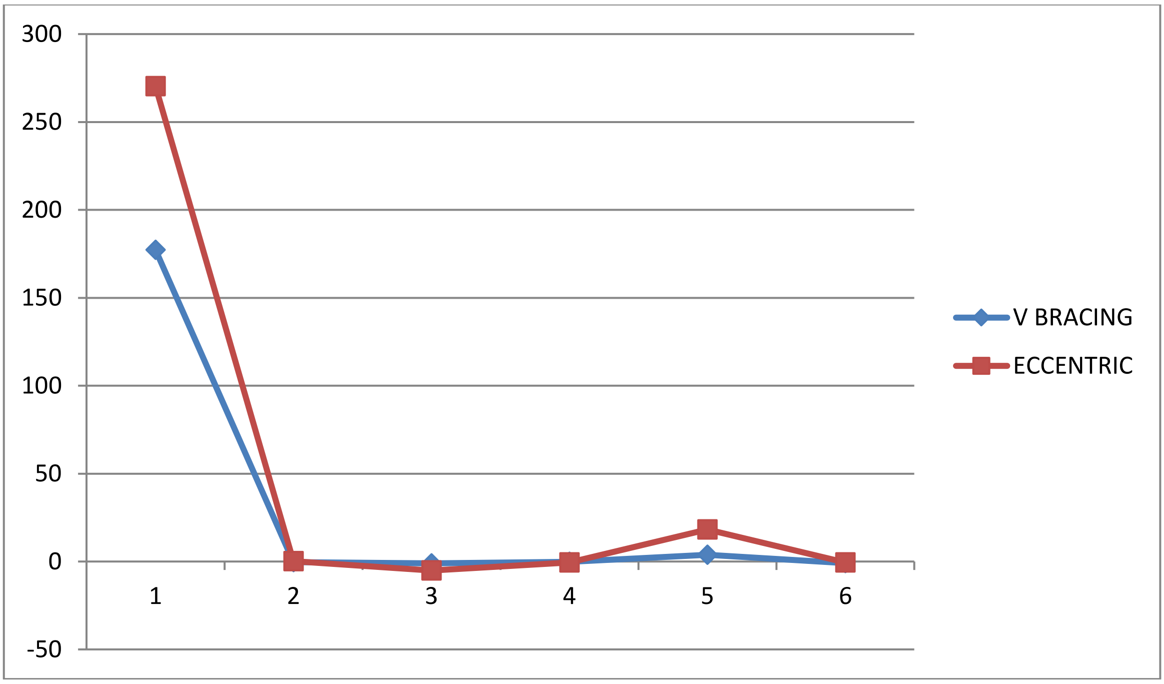

Fig: 9 Maximum shear force graph on beam 673

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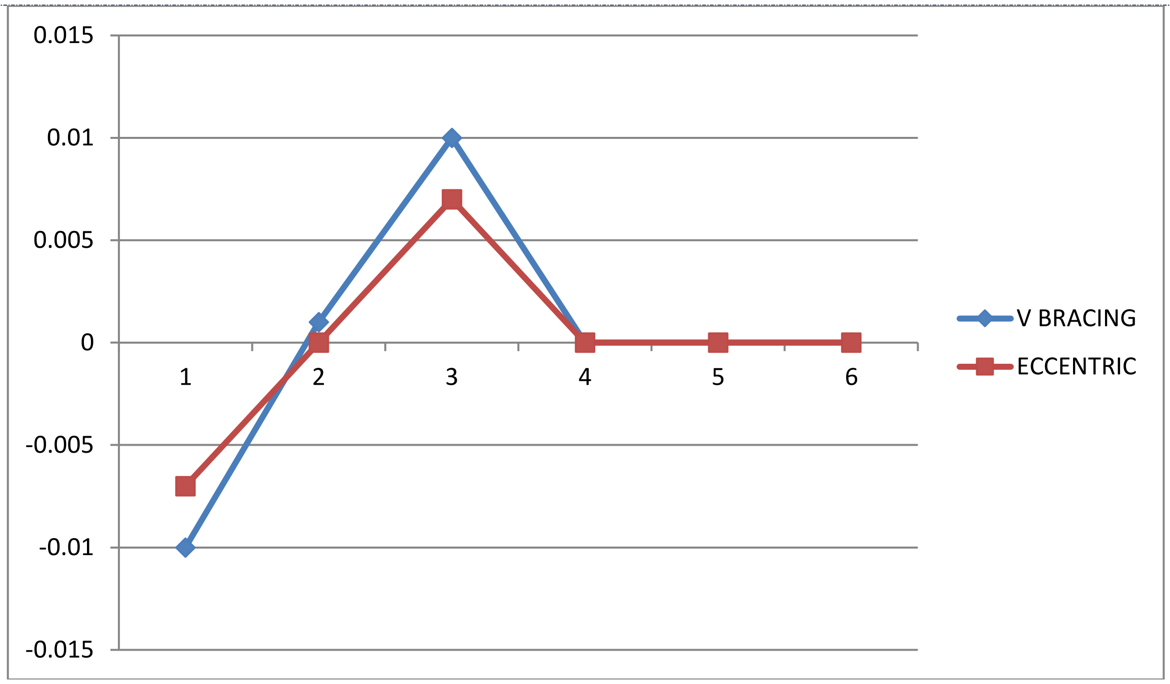

Fig: 10 Maximum displacement graphs on Node 145

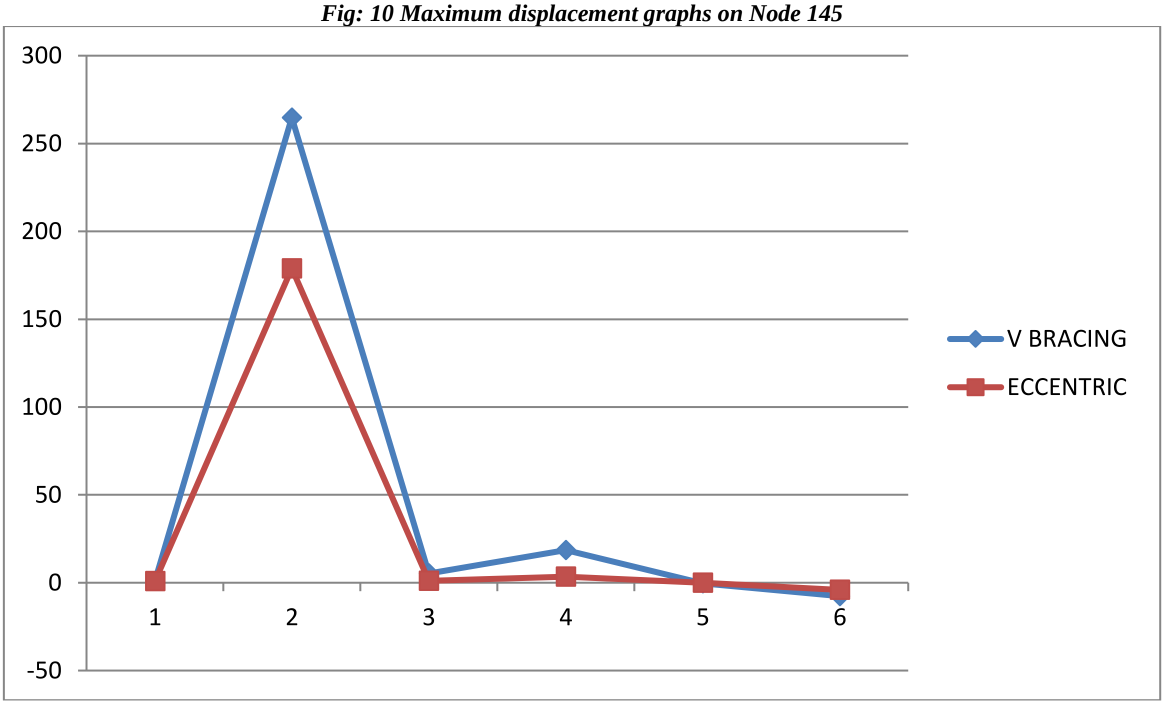

Fig: 11 Maximum reaction graphs on Node 1

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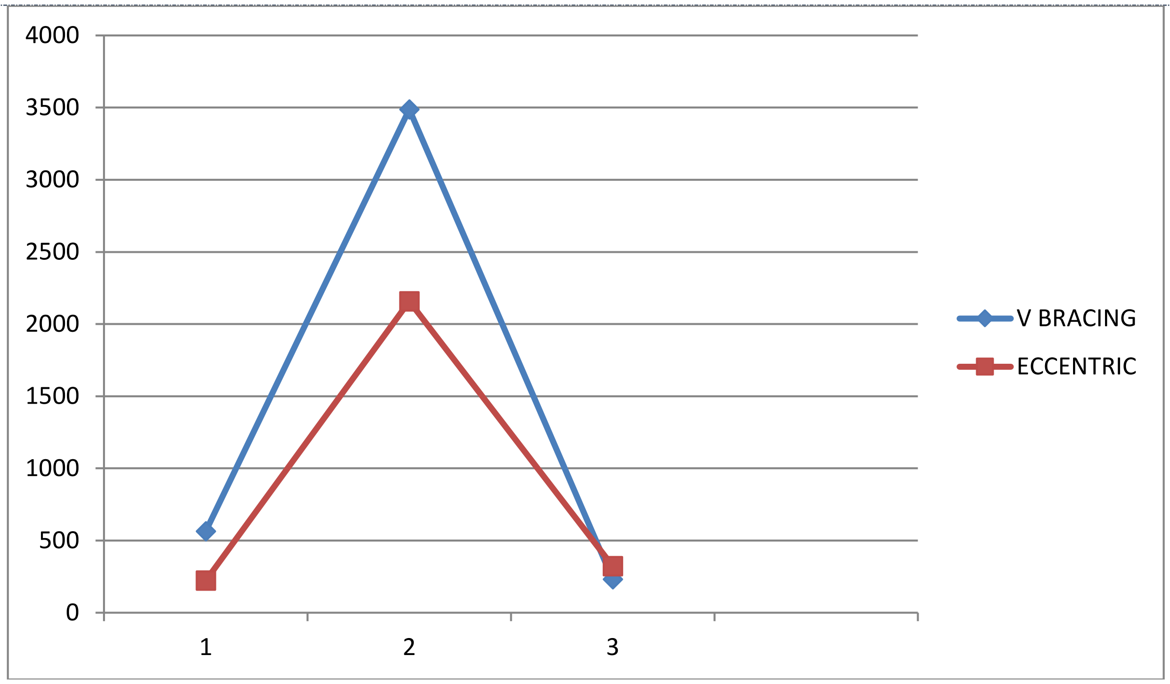

Fig: 12 Maximum Axial Force graph of Model 1 & Model 2

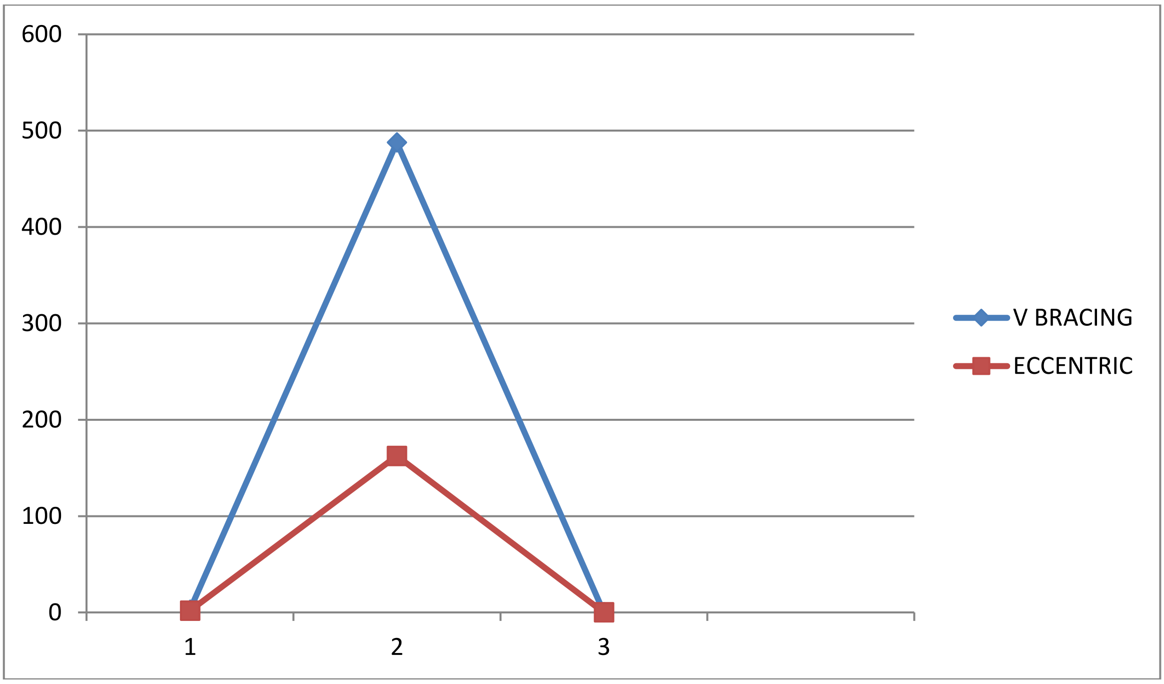

Fig: 13 Maximum Torsion graph of Model 1 & Model 2

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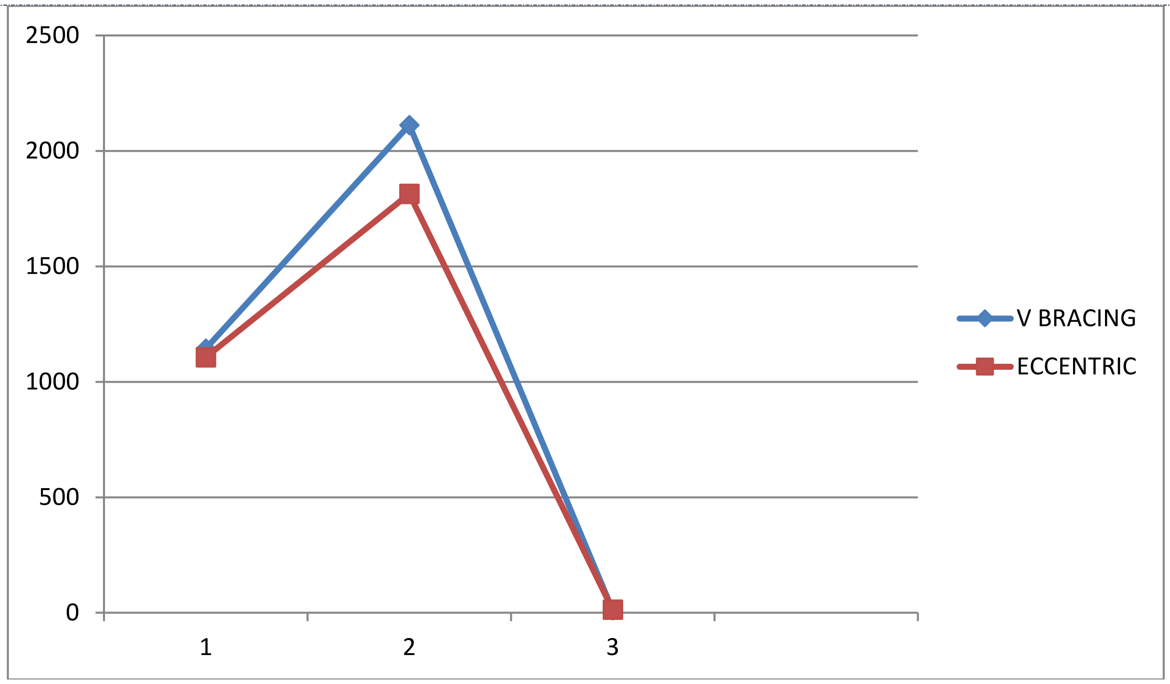

Fig: 14 Maximum bending graph of Model 1 & Model 2

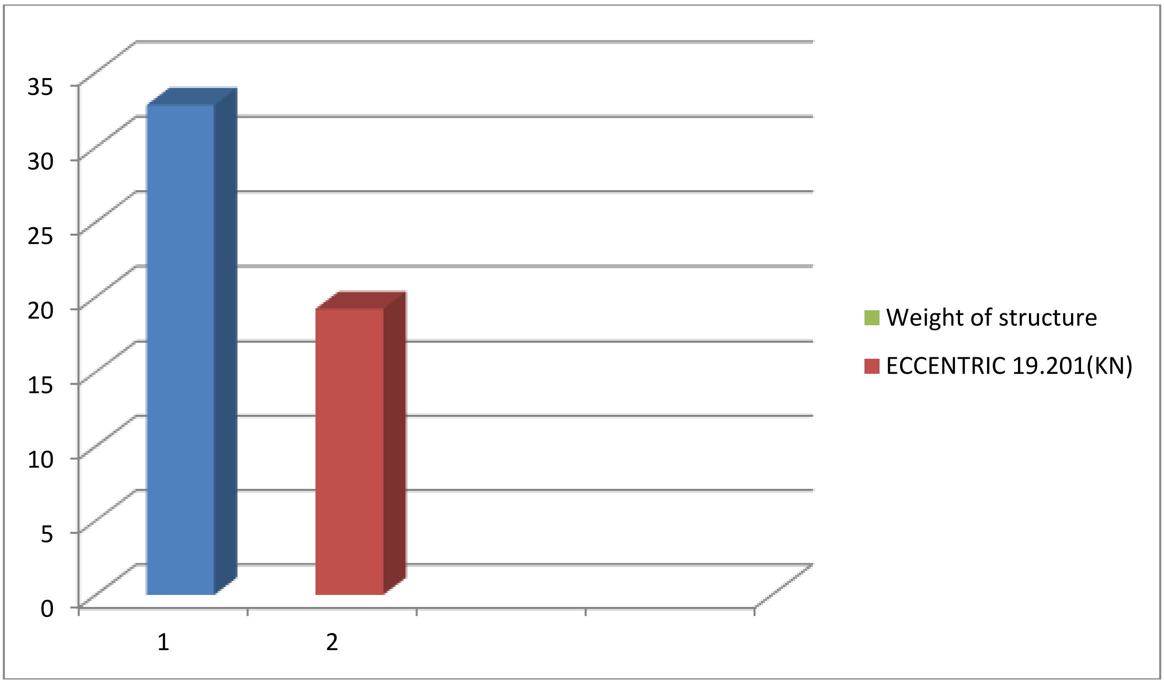

Fig: 15 Weight of structure graph of Model 1 & Model 2

By the comparison of various parameters following table is the final result table of the paper.

Table: 6 Final Result Table

S no	Comparative Parameter	V bracing	Eccentric Bracing
1	Weight Of structure	32.818 (KN)	19.201(KN)
2	Cost Of structure	HIGH	LOW
3	Shear Force	HIGH	LOW
4	Bending Moment	HIGH	LOW
5	Deflection	HIGH	LOW
6	Axial Force	High	Low
7	Reaction	LESS	HIGH
8	Torsion	HIGH	LESS

CONCLUSION

The following conclusion may be drawn based on the analysis carried out

1. Figure 12 Shows that axial force in v bracing is high when compared with eccentric bracing.
2. Figure 6 shows that the shear-force is higher in V bracing model as compared to Eccentric bracing model.
3. Figure 8 Shows that the Maximum bending moment is more than 2000 KN-m in V bracing model and bending moment in Eccentric bracing model is approximate 1700 KN-m.
4. Figure 7 Shows that the displacement in V bracing structure is more than as compared with eccentric bracing model.
5. Figure 13 shows that the torsion in V bracing model is high as compared with the Eccentric bracing model.
6. Table 6 and figure 12 shows the comparison of weight and cost efficiency between Model 1 and model 2.
7. In high rise structure the stability can be achieved by suitably adding the eccentruic bracing as analyze in the final result table 6.

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