A Comparative Study of Behaviour of Structural Parameters Subjected to Lateral Forces by Shear Walls and Bracing Systems using Software

Dr. M.N. Bajad[#1], **Ravindra B. Gogawale**[#2]
[#]*Department of Civil Engineering, Savitribai Phule Pune University,*
Pune, Maharashtra, India.
[#1]*mnbajad@rediffmail.com*
[#2]*ravindragogawale097@gmail.com*

***Abstract*— In General, the structure in high seismic areas may be susceptible to the severe damage. Along with gravity load structure has to withstand to lateral load which can develop high stresses. Now a day, shear wall in R.C. structure and steel bracings in steel structure are most popular system to resist lateral load due to earthquake, wind, etc. Shear wall and Steel bracing systems are most widely used in medium to high rise buildings to provide stiffness, strength and energy dissipation required to resist lateral load imposed by earthquakes and wind. The shear wall is one of the best lateral load resisting systems which is widely used in construction industry but use of bracing will be the viable solution for enhancing earthquake resistance. So there is a need of precise and exact modelling and analysis using software to interpret relation between brace frame parameters and structural behaviour with respect to conventional lateral load resisting frame. There are various software's used for analysis of different type of lateral load resisting system such as, E-TABS, STAAD-PRO, SAP etc. In this paper comparative study of behaviour of structural parameters like displacement and shear forces subjected to lateral loads by changing the positions of shear walls and bracing systems has been discussed with their effective locations and their probable effects on the different structural parameters using ETABS software.**

***Keywords*— RC Frame, Shear walls , Bracing Systems, Lateral Displacement , story shear , Base shear, Response Structural Analysis etc.**

I. Introduction

The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads and to resist lateral forces effectively. In the past thirty years moderate to severe earthquakes have occurred in world at intervals of 5 to 10 years caused severe damages and suffering to humans by collapsing the structure, tsunamis, floods, landslides in loose slopes and liquefaction of sandy soils. Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Socio-economic losses have been increased significantly in the world due to establishment of new cities in earthquake prone areas. However, these developments in construction have not been followed by guidelines of seismic codes in the past. Existing RC buildings designed without considering seismic criteria and ductile detailing may undergo severe damage during earthquake ground motion. The effect of horizontal forces due to wind loads, earthquake loads and blast loads etc. are attaining increasing importance. Reinforced concrete shear walls have been used as most effective solution to provide resistance and stiffening to the buildings against the lateral loads imposed by the earthquakes and wind. Moreover these walls also provide sufficient ductility and lateral control drift in order to minimize the strong lateral load effect especially during earthquake. The use of steel bracing is also an effective solution for resisting the horizontal or lateral forces coming on the structure. It is highly efficient and economical method to increase the lateral resistant capacity of the building by increasing its lateral stiffness by effectively providing the different types of bracings systems like X Bracing, V Bracing, Inverted V Bracing, and Diagonal Bracing at different locations in building.

II OBJECTIVE OF THIS PAPER

The objective of this paper is the comparative study of the behaviour of structural parameters subjected to lateral forces by shear walls and bracing systems by using the software and to decide which one is more efficient in resisting the lateral forces.

III. DESCRIPTION OF BUILDING STRUCTURE

In this study, A G+9 storey reinforced concrete building of 4 bays have been considered with mass irregularity at 3rd floor considered for investigating the effect of X type, V type, inverted V type and Diagonal type bracings and there arrangements in various positions in the building.
Also the shear walls at various locations have been considered to study their effects on the structural parameters such as story shear and displacement.

Following types of structural configuration is studied-
1. Reinforced concrete multistorey building with X type, V type, inverted V type and Diagonal type bracing systems.
2. Reinforced concrete multistorey building with RCC Shear wall
3. Other building details are given below:-
All RC Column sizes = 500mm x 500mm
All RC Beam sizes = 350mm x 450mm
Slab thickness = 200mm
Bracing details = ISHB 250
Grade of concrete = M-30
Grade of steel = Fe-500

IV. STRUCTURAL MODELLING AND ANALYSIS

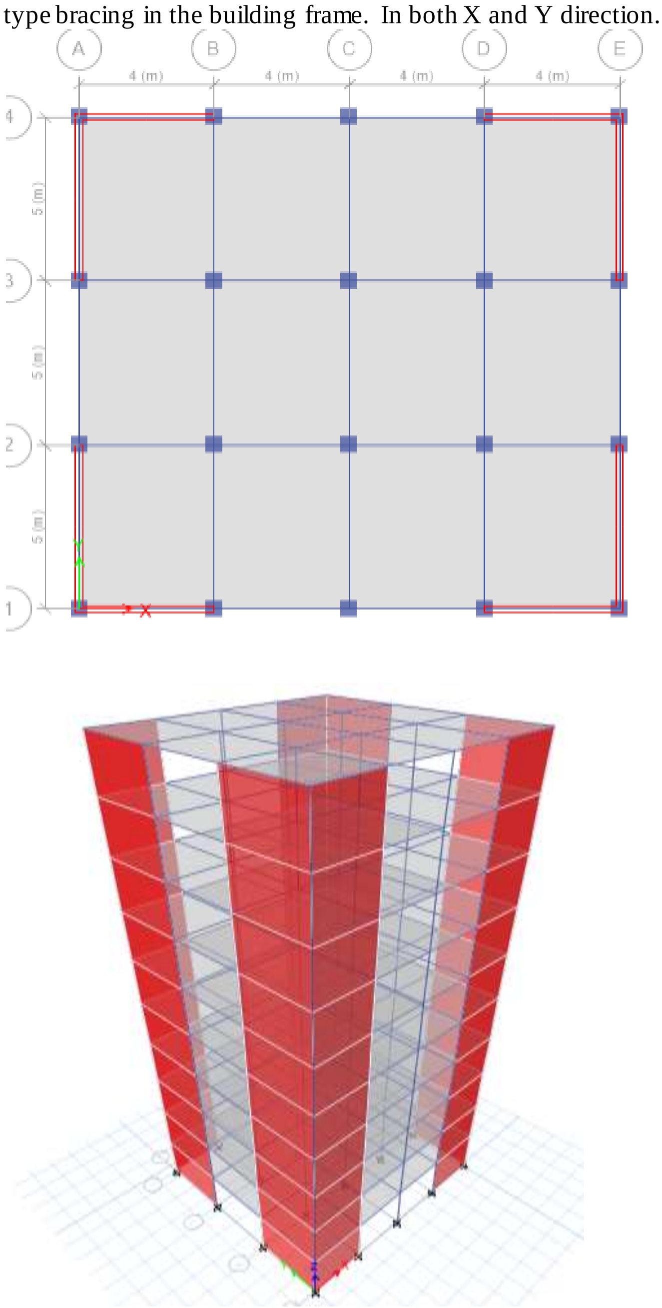
A G+9 storey reinforced concrete building with X type, V type, Inverted V type and Diagonal type bracing provided on various positions in the building are analysed for earthquake loading. The method of seismic analysis used in this present study is Response Spectrum method which is a linear dynamic approach. Earthquake loading is applied as per the recommendation of IS: 1893-2002. Building is assumed to be located in seismic zone IV of India and rest on medium soil condition.

A) Following seismic parameters considered for the present study.
1) Zone factor for seismic zone IV = 0.24
2) Soil site factor for medium soil condition = 2
3) For important building Importance factor = 1
4) Response reduction factor = 5
5) Damping ratio = 0.05

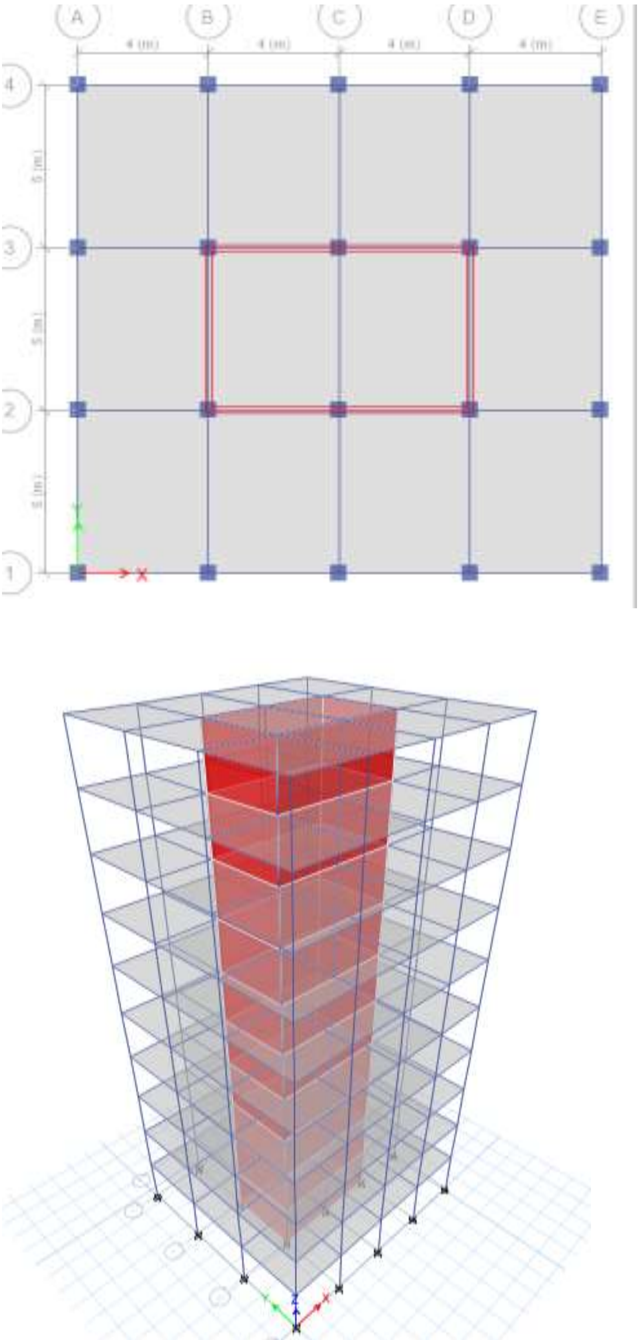
B) The structures are demonstrated by utilizing computer programming ETABS.
1) The floor load is taken as 5 kN/m2
2) Floor finishing load as 1 kN/m2.
3) Water proofing load as 2 kN/m2.
4) The live load is taken as 5 kN/m2.
5) Additional load taken for mass irregularity 10kN/m2

Note: - Load combinations are applied as per the recommendation of Indian standard codes.
A) Total 10 models are analysed in this study.
B) Two models of mass irregularity at 3rd and 8th floor without providing lateral steel bracing system.
C) Four models of mass irregularity at 3rd floor which include X, V, Inverted V, Diagonal bracing (In X and Y direction)
D) Four models of mass irregularity at 8th floor which include X, V, Inverted V, Diagonal bracing (In X and Y direction)

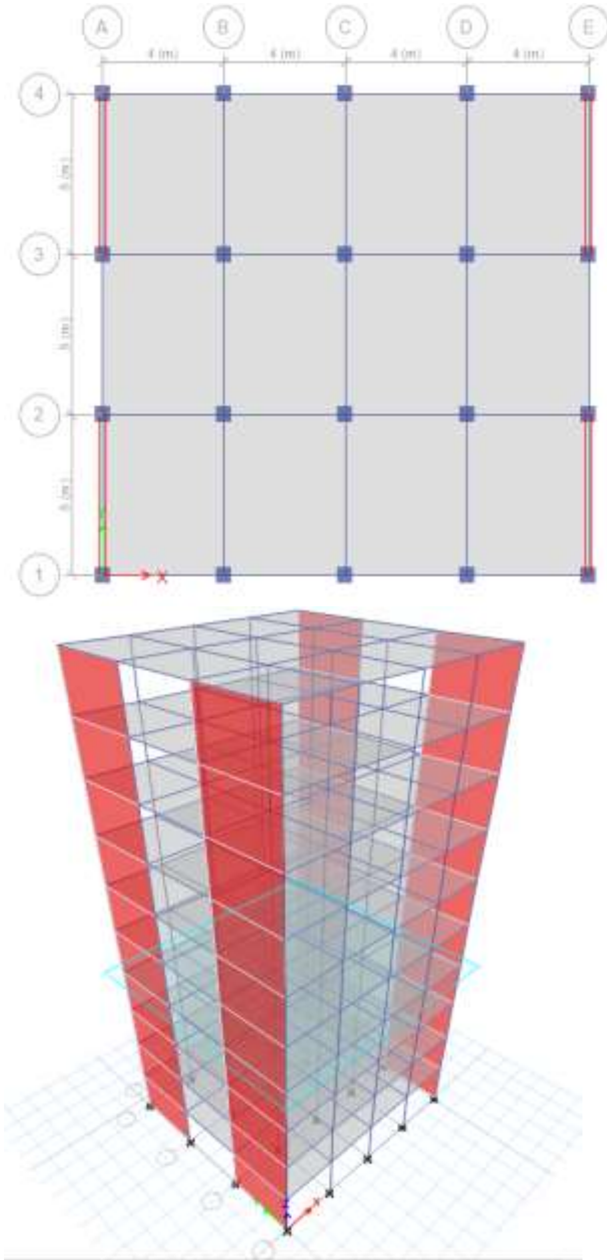
Figures given below shows the plan and various arrangements of X type, V type, Inverted V type and Diagonal type bracing in the building frame. In both X and Y direction.



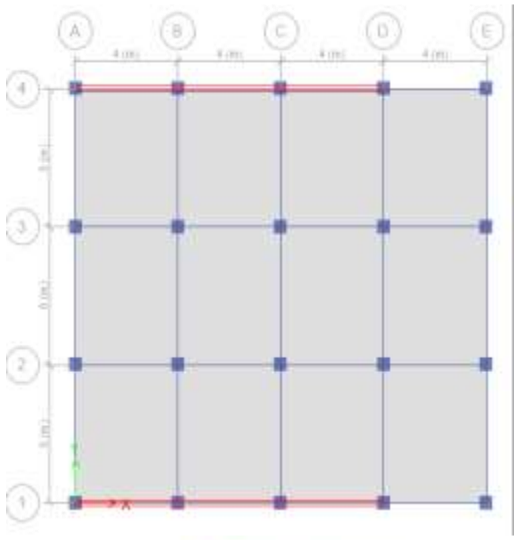
Model1: plan and elevation of building showing Shear walls at corners of building

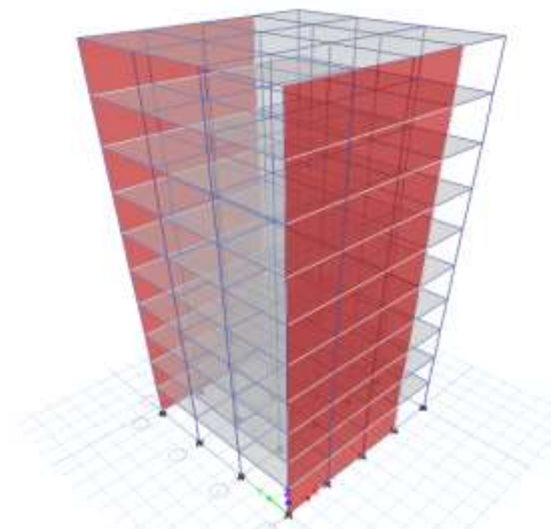


Model 2: plan and elevation of building showing Shear walls placed at core of building.



Model 3: plan and elevation of building showing Shear walls placed symmetrically.





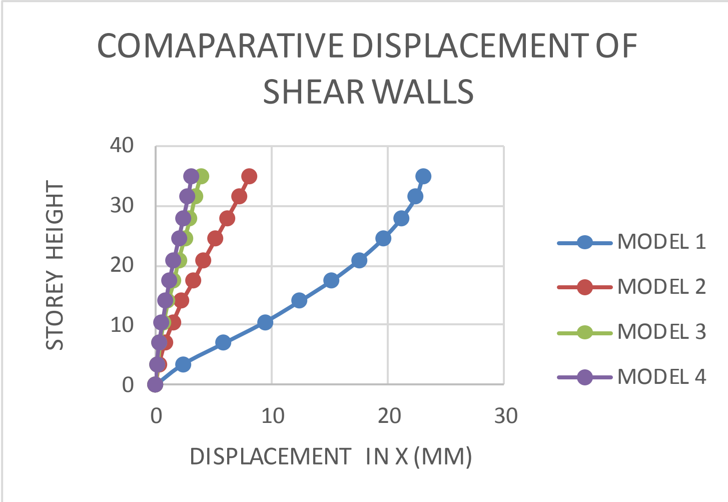
Model 4: plan and elevation of building showing Shear walls placed symmetrically.

V. RESULTS

TABLE 1

TABLE 1 BELOW SHOWS THE DISPLACEMENTS FOR THE MODELS 1,2,3,4 IN X- DIRECTION

STORY	FLOOR HEIGHT	DISPLACEMENT			
		MODEL 1	MODEL 2	MODEL 3	MODEL 4
Storey 10	35	28.9	9.5	4.5	3.4
Storey 9	31.5	27.9	8.4	4	3
Storey 8	28	26.1	7.3	3.4	2.6
Storey 7	24.5	23.6	6.1	2.9	2.2
Storey 6	21	20.7	4.9	2.3	1.7
Storey 5	17.5	17.3	3.7	1.8	1.3
Storey 4	14	13.7	2.7	1.3	0.9
Storey 3	10.5	10	1.7	0.8	0.6
Storey 2	7	6.1	0.9	0.4	0.3
Storey 1	3.5	2.4	0.3	0.2	0.1
Base	0	0	0	0	0



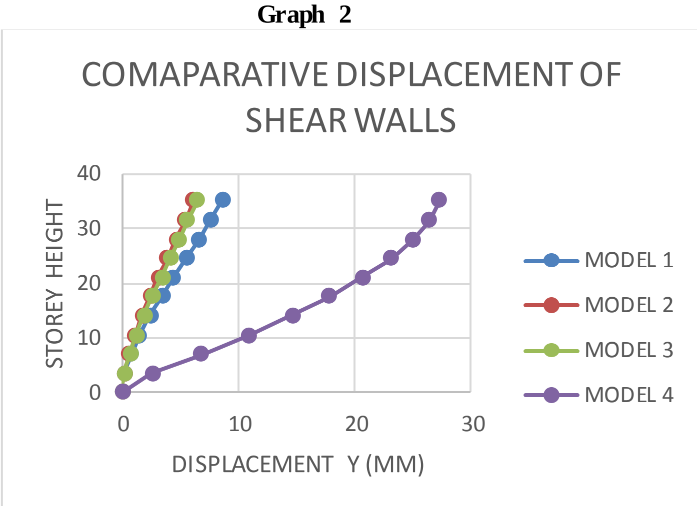
Graph 1: Graphical representation of story height Vs Displacement

TABLE II

TABLE II SHOWS DISPLACEMENT FOR MODLS 1, 2, 3, 4 IN Y-DIRECTION

STORY	FLOOR HEIGHT	DISPLACEMENT (Y-DIRECTION)			
		MODEL1	MODEL2	MODEL3	MODEL4
Storey 10	35	9.5	7.1	7.5	34.4
Storey 9	31.5	8.3	6.2	6.6	33.2
Storey 8	28	7.2	5.4	5.7	31
Storey 7	24.5	6	4.5	4.8	28.1
Storey 6	21	4.8	3.6	3.9	24.5
Storey 5	17.5	3.6	2.7	3	20.5
Storey 4	14	2.6	1.9	2.1	16.2
Storey 3	10.5	1.6	1.2	1.4	11.7
Storey 2	7	0.8	0.6	0.7	7
Storey 1	3.5	0.2	0.2	0.3	2.7
Base	0	0	0	0	0

Graph 2



Graph2: Graphical representation of the displacement Vs story height

DISCUSSION

The results found were plotted to get actual behaviour of structure and to judge the objectives of study. The results and their significance discussed here briefly.

The graph of displacement in x- direction shows that the displacement is maximum for model 1 where shear walls are provided at corners of the building and least for the model 4 where the shear walls are provided symmetrical configuration in plan.

The graph of displacement in y-direction reflects that for structure having core shear wall i.e. model 2 the displacement is least. The maximum structural displacement for 10 storey building is 0.0231m for bare frame structure model 4 and least value is 0.0071m for structure with shear wall at core location. The displacement observed is within the limits specified in IS 1893:2002 (Part I).

fig below shows that the different types of bracing systems.

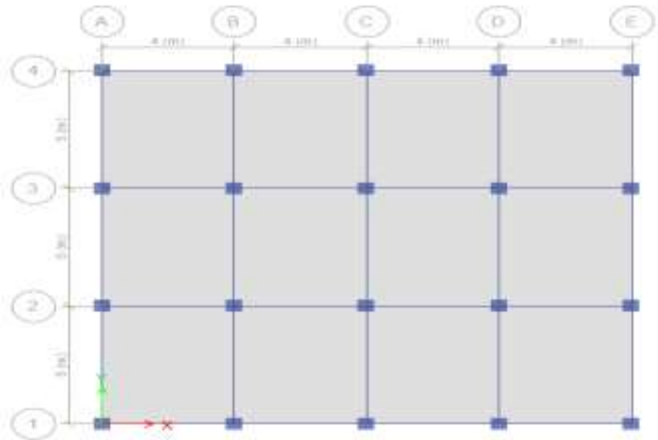


Fig: Plan of building

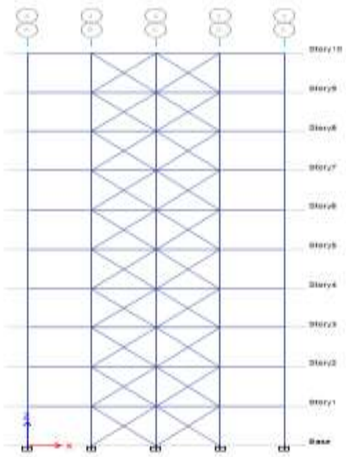


Fig: X- type Bracing

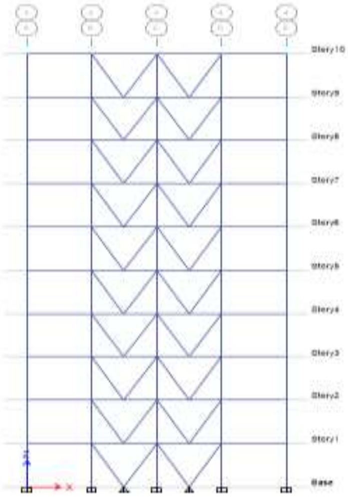


fig: V - type Bracing

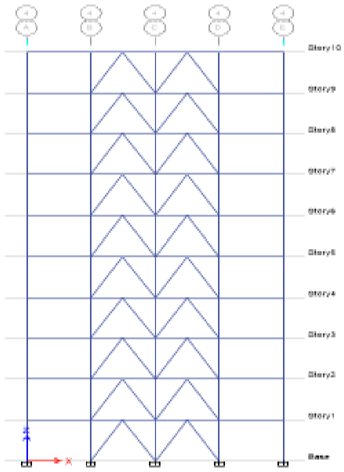


Fig: Inverted v- type Bracing

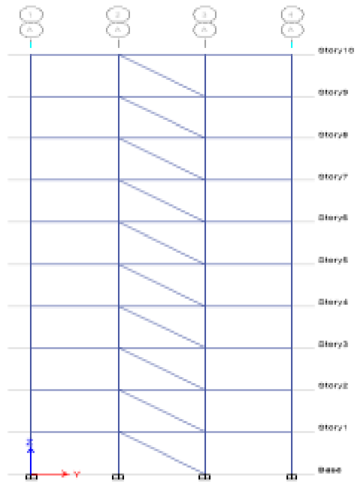


fig: Diagonal bracing

TABLE III

Table III below shows displacements for x -bracing, v -bracing, inverted v bracing, diagonal type bracings in x-direction.

	Storey Height	X BRACING	V BRACING	INVERTED V	DIAGONAL
Storey 9	28	6.6	7.5	6.8	8.6
Storey 8	25	6.2	7.1	6.5	8.2
Storey 7	22	5.7	6.5	5.9	7.7
Storey 6	19	5	5.8	5.3	6.9
Storey 5	16	4.3	5	4.6	6
Storey 4	13	3.5	4.2	3.8	5
Storey 3	10	2.6	3.2	2.9	3.9
Storey 2	7	1.8	2.3	2.1	2.7
Storey 1	4	0.9	1.3	1.2	1.5
Base	0	0	0	0	0

Graph3: Graphical representation of story height Vs Displacement

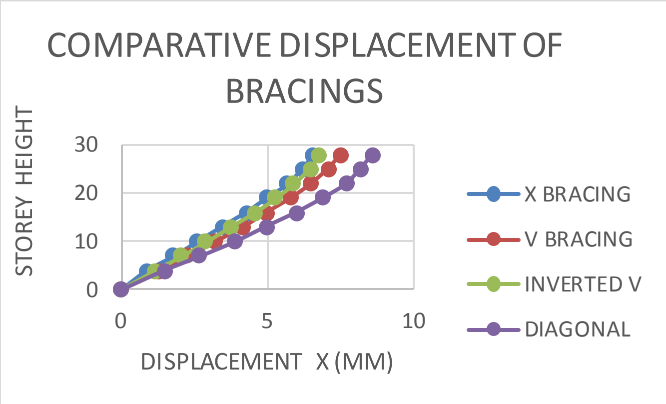
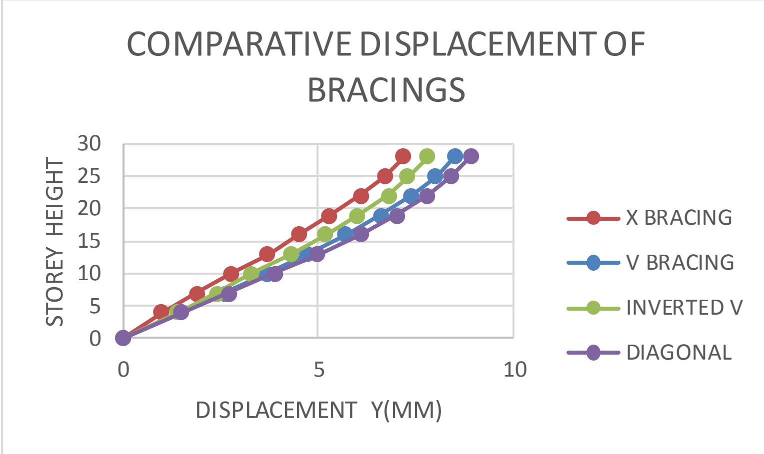


TABLE IV

Table IV below shows displacements for x -bracing, v -bracing, inverted v bracing, diagonal type bracings in y-direction.

STORY	Storey Height	X BRACING	V BRACING	INVERTED V	DIAGONAL
Storey 9	28	7.2	8.5	7.8	8.9
Storey 8	25	6.7	8	7.3	8.4
Storey 7	22	6.1	7.4	6.8	7.8
Storey 6	19	5.3	6.6	6	7
Storey 5	16	4.5	5.7	5.2	6.1
Storey 4	13	3.7	4.7	4.3	5
Storey 3	10	2.8	3.7	3.3	3.9
Storey 2	7	1.9	2.6	2.4	2.7
Storey 1	4	1	1.5	1.4	1.5
Base	0	0	0	0	0

Graph 4: Graphical representation of story height Vs Displacement



The results found were plotted to get actual behaviour of structure and to judge the objectives of study. The results and their significance discussed here briefly.

From the above graphs it can be inferred that the displacement in x direction for the X – TYPE of bracing is very less as compared with the other types of bracings i.e. V bracing, inverted V-type bracing and diagonal bracing and it is near about 6.6 mm.

If we considered the displacement in y – direction then also the displacement is very less so it can be concluded that the X-type of bracing is more effective in resisting the lateral forces.

VI . CONCLUSION

So from the above study it can be clearly seen that the displacement in shear wall when provided at core of the section is very less as compared to other locations of shear walls as well as the types of bracings. So providing shear wall for the lateral resistance is most viable solution than providing the bracing for resisting lateral forces coming on the structures.

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