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Comparative Study of G+10 Storey RC Building with Different Types of Bracings Subjected to Wind Loads at Specified Basic Wind Speed Using ETABS

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ABSTRACT: In creating nation like India there is a shortage of land because of urbanization and industrialization. Structures built on bumpy zones are unique in relation to the structures developed on level grounds on account of their inconsistency and unsymmetrical structure in vertical and even plane. Wind loading is a typical dynamic load taken into account in the design of tall buildings. Interest in dynamic response and reliability analysis of wind-excited tall buildings has increased and many researches have been carried out on this topic (Benfratello et al., 1998). However, randomness and uncertainties, which are inherent in both wind loading and structural characteristics, will introduce variability in the dynamic response of wind-sensitive structures. Braced Frame Systems structural system consists of moment frames with specific bays provided with braces throughout the height of the building. Braces are provided in both plan directions such that no twisting is induced in the building owing to unsymmetrical stiffness in plan. The main objective of the present work is to investigate the seismic performance of a tall RCC frame building with X-Type bracing and inverted V-Type bracing, which give better performance against seismic responses. Analysis is performed by Response Spectrum Analysis using ETABS 17.0.1 software.

KEYWORDS: wind loads, bracings, displacements, storey shear, auto lateral loads.

I. INTRODUCTION

The concrete structure with Steel bracing is one amongst the structural system accustomed resist the earthquake masses within the multi-storey buildings, several existing bolstered cement concrete buildings must be retrofitting to beat deficiencies to resist tectonic masses. the employment of steel bracing systems for strengthening or retrofitting seismically light concrete frames could be a viable answer for enhancing tremor confrontation.

The primary purpose of every kind of operational systems employed in the building form of structures is to distribute gravity masses effectively. the foremost common masses ensuing from the result of gravity are loading, load and snow load. Besides these vertical masses, buildings also are subjected to lateral masses caused by wind, blasting or earthquake. Lateral masses will develop high stresses, turn out sway movement or cause vibration. Therefore, it's important for the building to own ample strength against vertical masses along with adequate stiffness to resist crosswise forces. Strengthening of structures proves to be a more robust choice business to the economic issues and immediate shelter issues instead of replacement of buildings. Hence, we all know this retrofitting and while not retrofitting structure within which economical as associated to every different structure.

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1.1 BRACING TYPES

Bracing can be classified into three types

1. Plan bracing
2. Torsional bracing
3. U-frame bracing

1.1.1 Plan bracing systems

Plan bracing is perhaps the most obvious way to prevent lateral buckling of a compression flange. This is because plan bracing provides lateral restraint, i.e. it stops the compression flanges of beams from moving sideways.
Plan bracing takes the form of diagonal members, usually angle sections, connecting the compression flanges of the main beams, to form a truss when viewed in plan. This makes a structure that is very stiff in response to lateral movement. With lateral movement of the compression flanges thus resisted, the half wave length for buckling is reduced to the length between bracings

1.1.2 Torsional bracing

Torsional bracing takes the form of a plane of bracing between a pair of beams. The principal advantage of this type of bracing is that a pair of beams is a stable unit. Beams can be braced in pairs in the fabrication shop prior to transportation to site, which means that pairs can be craned into place very quickly with the minimum of site connections. The bracing can take the form of a truss spanning laterally between the top and bottom flanges of the beams or can be a channel or I girder connecting the webs. In the case of ladder deck bridges, the bracing is provided by the transverse beams

1.1.3 U frame bracing

Structural action of U frame bracing where compression flanges are remote from a direct lateral restraint, such as a deck, and are restrained laterally by flexible frames comprising a transverse beam in a deck and stiffened webs of the main beam, this is said to be a U frame, and the restraint is given by U frame action. The stiffness of the frame is what provides resistance to buckling. U frame action is generally used to resist buckling in half-through girders, as is often the case in railway bridges. (Half-through girders are not often used for highway bridges because of the risk of collapse due to traffic collision with the main girders.)

1.2 LOAD DISTRIBUTION

Since bracing connects beams, it can be used to distribute the vertical bending effects between the main beams, and to ensure that lateral effects such as wind loading and collision loading are shared between all the beams. This sharing is particularly important at lines of support, where the effects of the lateral loads are often resisted at one fixed or guided bearing (depending on the chosen articulation system). In steel composite bridges during the "steel only" condition during construction, the main beams are particularly susceptible to wind loading. Bracing can be used to share loading between the beams so that the windward beam is not carrying the entire wind load. In bridges curved in plan, bracing can provide the 'radial' component of force that is consequence of the changing direction of the curved flange. The effective couple of the forces at tension and compression flanges is resisted by additional vertical bending effects in the connected beams

II. RELATED WORK

Viswanath, Prakash KB, and Anant Desai. "Seismic analysis of steel braced reinforced concrete frames." International Journal of Civil & Structural Engineering 1.1 (2010): 114-122. with 4 bayous in Y heading and 6 straights in X bearing. The slant of the ground is taken between 0o to 30o. ETABS 2015 programming is utilized to break down and plan the model for various soil compose and for the seismic zone V. They inferred that diminishing in seismic weight is seen when the incline at the base is expanded and the execution of the building is expanded when the firmness of the dirt is more. Sandip Doijad and Surekha Bhalchandra (2015) In this paper, they considered the seismic conduct of RC structures with various arrangement of Shear dividers on plain and slanting ground.

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Patil, Dhanaraj M., and Keshav K. Sangle. "Seismic behaviour of different bracing systems in high rise 2-D steel buildings." bracing system of G+9 storey building in seismic zone V with soft soil as per IS code. They are used square grid of 20 meters with 5-meter bay in each direction and results compared RC bare framed structure without and with braced (ISHB 500) system by using Etabs software. He found that the bare framed structure and braced structure significantly lower the lateral displacements and also drifts as compared to bare framed structure.

Safarizki, Hendramawat A., S. A. Kristiawan, and A. Basuki. "Evaluation of the use of steel bracing to improve seismic performance of reinforced concrete building." RC structure with V type bracing system and provided the different thickness 2.5mm, 4mm, 6mm, 8mm, 10mm, 14mm and 20mm of steel bracing. They worked that seismic effect of the structure in the term of storey displacements, inter storey drift, base shear, fundamental time periods, capacity curve and also the failure of the structure by dynamic analysis and nonlinear static analysis in Etabs software. He observed that V bracing system improved the seismic performance of the RC structure as well as improved the strength capacity and stiffness of the buildings and when using bracing in RC frames decreased the top storey displacements and inter storey drift of the buildings.

Rai, D. C., and S. C. Goel. "Seismic evaluation and upgrading of chevron braced frames." storey RC building framed structure with different bracing system like X bracing, K bracing, V and inverted V bracing system and compared the these structures output to the RC bared frame structures and they work done all these models on Staad Pro software to evaluate the structure of a particular type braced system in order to control the lateral displacement , forces and also observed that inverted V braced system is more economical as compared to the other braced structures.performed to label each object separately. Finally, the set of selection criteria is applied to filter out non text regions. After text detection, text inpainting is accomplished by using exemplar based Inpainting algorithm.

III. METHODOLOGY

loads considered for the structure design process are as follows,

1. dead load
2. live load
3. seismic load
4. wind load

1. COMBINATION OF LOADS

The combination given below are to be taken measure when the structures are in seismic forces. These are considered asper the limit state design of reinf0rced concrete structures As per IS 1893(2002)

1. 1.5(DL+IL)
2. 1.2(DL+IL±EL)
3. 1.5(DL±EL)\
4. 0.9DL±1.5LL
5. 1.2(DL+IL±WLx)
6. 1.2(DL+IL±WLy)
7. 1.5(DL±WLx)
8. 1.5(DL±WLy)

Where the terms DL,LL,WL and IL stands for the response quantity of dead load,wind load imposed load and designed earthquake load.

Response spectrum analysis

In this method, for obtaining the dynamic nature of the structure it uses the time history analysis and damping level to measure pseudo acceleration, displacement and velocity. The smooth curve for each period of structure gives the peak response in response spectrum and for dynamic response, this method is selected based on the structure selected, This method constrains numerous building codes except for the simpler or complex structure. Response 0f a structure is usually defined as the combination of modes that vibrates according to harmonic correspondence. So c0mputer

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software can be used for specific structure to determine these methods. The response is based on the modal mass and frequency, reads from each of the design's spectrum for each mode. So, x, y and z directions and then the effect on the structure should be studied. The combination method include followings,

- Adding together the absolute-peak values
- Square root of the sum of the squares
- Combination of complete quadratic.

CODE BASED WIND ANALYSIS

Designed based on IS 875-part III, it is very important to analyse the structure against horizontal loads. The present study has been carried out to check the stability of wind loads against the structure height, the checking has been done using ETABS

- Design wind speed(Vz) : Vb*K1*K2*K3
- Design wind pressure(Pz) : $0.6Vz^2$

2. BUILDING PLAN AND LAYOUT

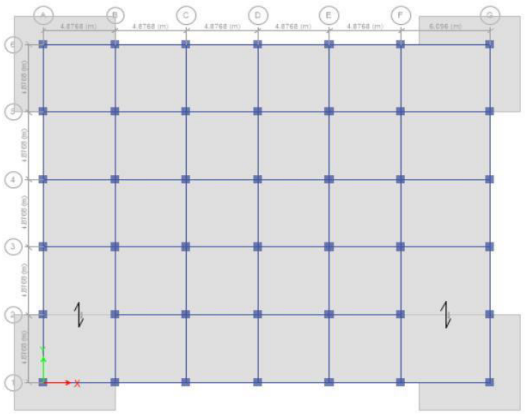

Figure 3.1 : column layout

The study is done on ten storey building all the models of the building has same plan of floor. Building data taken for the analysis is as follows

Grade of concrete	: M45
Grade of steel	: Fe550
Beam	: 600×450mm
Column	: 600×600 mm.
One way slab	: 200mm
Storey Height	: 3m

3. SEISMIC LOADS

Seismic design shall be done in accordance with IS: 1893:2002. The building is situated in earthquake zone V. The parameters to be used for analysis and design are given below (As per IS: 1893:2002 (Part I).

Zone factor	:	0.16 (Refer Table 2)
Importance factor	:	1.5(Refer Table 6)
Response reduction Factor	:	5.0(Refer Table 7)
Soil Type	:	Medium
Structure Type	:	RC Frame Structure

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4. WIND LOADS:

CATEGORY	VALUES	UNIT
WIND SPEED	39	M/S
TERRAIN	3	
K1	1	
K2	1	
HEIGHT	30	M
LENGTH	30.48	M
WIDTH OR BREADTH	24.384	M

COEFFICIENT(CP)	VALUE	
H/W	1.230314961	>1.5
L/W	1.25	>1.5

WIND ANGLE	DX WINDWARD	DX LEEWARD	DY WINDWARD	DY LEEWARD
0 DEG	0.7	-0.25	-0.6	-0.6
90 DEG	-0.6	-0.6	0.7	-0.25

5. NUMERICAL SIMULATION OF THE BUILDINGS

The examination is done between the structures and made comparision, so we can get the difference between the results. There are 3 types of models as follows,

- Model 1 : structure with X bracing
- Model 2 : structure with V bracing
- Model 3 : structure with inverted V bracing

IV. RESULTS AND DISCUSSION

4.1 BASE REACTION:

Scale Factor=1428

MODEL	RSMAX	EQX	BS>84%
X BRACINGS	2850.0308	3394.1784	83.968208
V BRACINGS	2760.1087	3253.657	84.830967
INVERTED V BRACINGS	2872.6422	3415.9847	84.094117

Table 4.1 : base reaction values

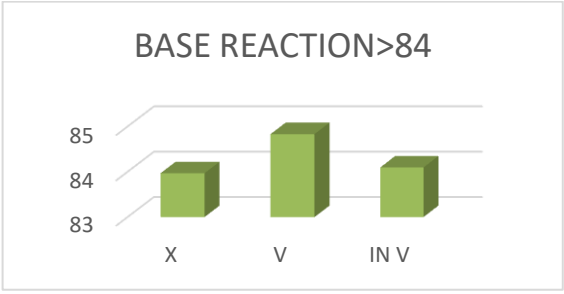

Figure 4.1 : graphical representation of base reaction

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As per IS code book 1893 2002, we found the scale factor 1428 by calculating the base reaction with respect to maximum response spectrum and the values of EQX or EQY model is found to be is greater than 84% as per under guidance which is mentioned in code book enhance the model is safe to which stand all the best reactions as per code book. the base reaction for expressing is found to be 83.96 which is nearly equal to 84 percentage, and the same base reaction for We bring is phone to be 84.83 percentage and similarly for the inverted V bracing the base reaction is found to be 84.09 percentage considering all the ratio the we bring is found to be very good when compared to all other models.

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4.2 RESPONSE SPECTRUM

MODEL	RSMAX	EQX	BS>84%
X BRACINGS	0.99	0.9951	99
V BRACINGS	0.9903	0.9955	99.03
IN V BRACINGS	0.9903	0.9955	99.03

Table 4.2 : base reaction values

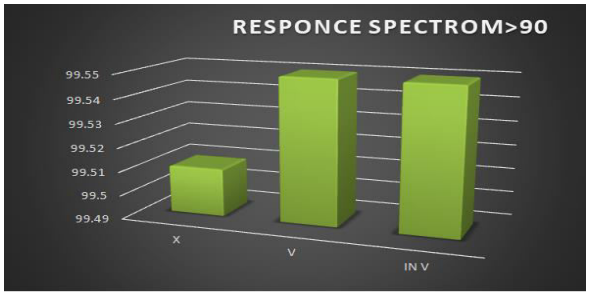

Figure 4.2 : graphical representation of response spectrum

The response spectrum modal participating mass ratio as per IS code book 1893 2002 the value must be greater than about 90% for all the sum of values along x and y axis enhance we found that for the expressing the valley is found to be 99.51 percentage, the modal participating mass ratio for the we bring is 99.5%, and finally coming to the inverted we bracings the value is almost same as 99.5% since all the values as cross the 90% required value the model is completely validated and save for considering the results

4.3 DISPLACEMENT

4.3.1 X Direction:

MODEL	X in mm
X BRACING	7.493
V BRACING	7.73
INVERTED V	7.357

Table 4.3 : displacement values in X direction

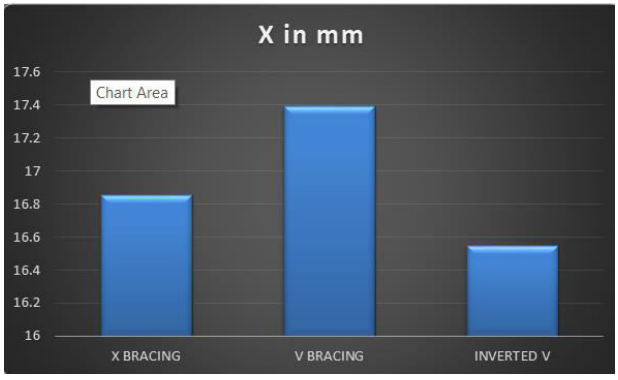

Figure 4.3.: graphical representation of displacement in X direction

Considering the Displacement, we can clearly see that the displacement for the V bracing is more when compared the inverted V bracing is less when compared to all other model also in Final comparison with all bracing in X direction , the displacement for the inverted V bracing which is very good for the final consideration.

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4.3.2 Y Direction:

MODEL	Y n mm
X BRACING	7.627
V BRACING	7.879
INVERTED V	7.507

Table 4.4 : displacement values in Y direction

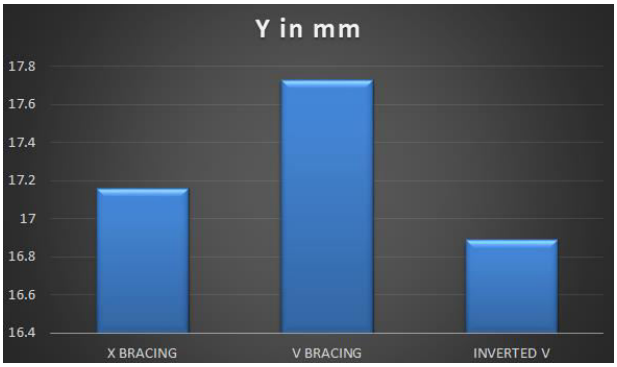

Figure 4.4 : graphical representation of displacements in Y direction

4.4 STORY SHEAR

4.4.1 X Direction:

MODEL	X In kN
X BRACING	472.02
V BRACING	452.3927
INVERTED V	472.1288

Table 4.5 :story shear values in X direction

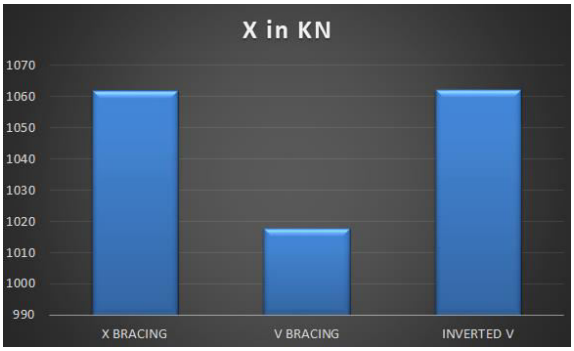

Figure 4.5 : graphical representation of story shear in X direction

4.4.2 Y Direction

MODEL	Y n mm
X BRACING	469.497
V BRACING	441.419
INVERTED V	463.097

Table 4.6 :story shear values in Y direction

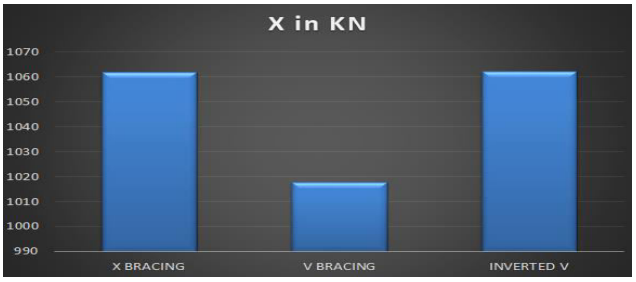

Figure 4.6 : graphical representation of story shear in Y direction

Considering the Story Shear in Y Direction, we can clearly see that the story shear for the Inverted V bracing and X Bracing is more when compared the V bracing is less when compared to all other model also in Final comparison with all bracing in Y direction , the Story Shear for the V bracing which is very good for the final consideration.

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4.5 AUTO LATERAL LOADS

4.5.1 X direction

MODEL	X In kN
X BRACING	821.5056
V BRACING	788.8955
INVERTED V	828.2542

Table 4.7: autolateral loads values in X direction

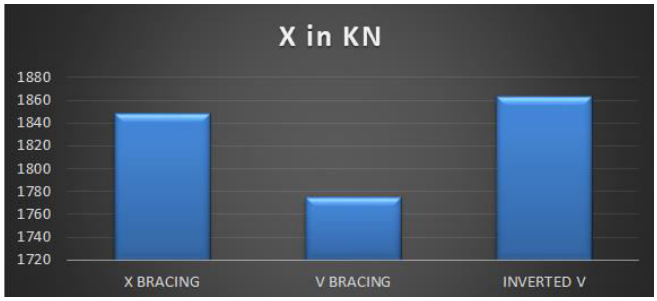

Figure 4.7 : graphical representation of auto lateral loads in X direction

Considering the Autolateral in X Direction, we can clearly see that the Autolateral for the Inverted V bracing and X Bracing is more when compared the V bracing is less when compared to all other model also in Final comparison with all bracing in X direction , the Autolateral for the V bracing which is very good for the final consideration.

4.5.2 Y Direction :

MODEL	X In kN
X BRACING	804.91
V BRACING	763.141
INVERTED V	802.587

Table 4.8 :auto lateral load values in Y direction

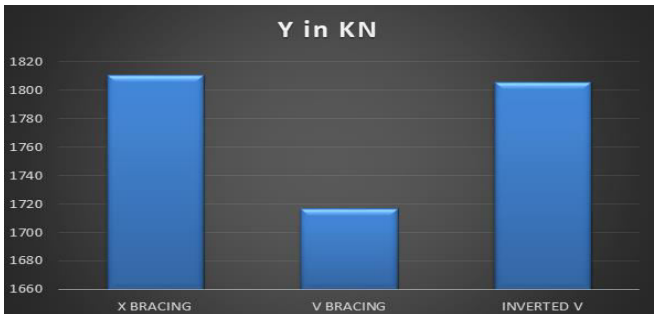

Figure 4.8 : graphical representation of story shear in X direction

Considering the Autolateral in Y Direction, we can clearly see that the Autolateral for the Inverted V bracing and X Bracing is more when compared the V bracing is less when compared to all other model also in Final comparison with all bracing in Y direction , the Autolateral for the V bracing which is very good for the final consideration

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4.6 WIND LOAD COMPARISON:

4.6.1 Wind Load DX in X Direction:

MODEL	X In mm
X BRACING	0.681
V BRACING	0.734
INVERTED V	0.665

Table 4.9 :values of displacements in Y direction

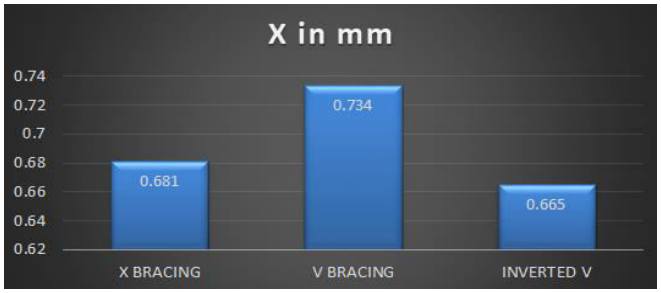

Figure 4.9 : graphical representation of displacements in X direction

Inverted V bracing can be an effective bracing system for resisting lateral loads, including wind loads, in certain structural configurations.

4.6.2 Wind Load DX in Y Direction:

MODEL	Y in mm
X BRACING	0.004
V BRACING	0.003
INVERTED V	0.004

Table 4.10 :values of displacements in Y direction

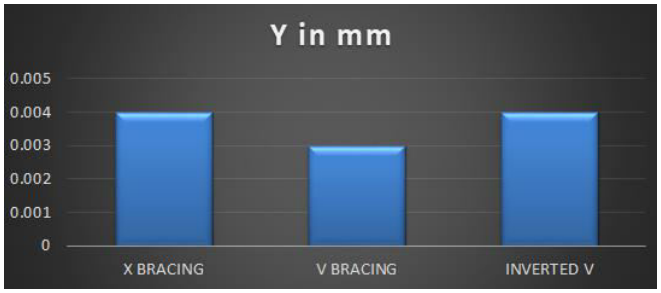

Figure 4.10 : graphical representation of direction in Y direction

V bracing can be an effective bracing system for resisting lateral loads, including wind loads, in certain structural configurations.

4.6.3 Wind Load DY in X direction :

MODEL	X in mm
X BRACING	0.001
V BRACING	0.001
INVERTED V	0.001

Table 4.11 :values of displacements in Y direction

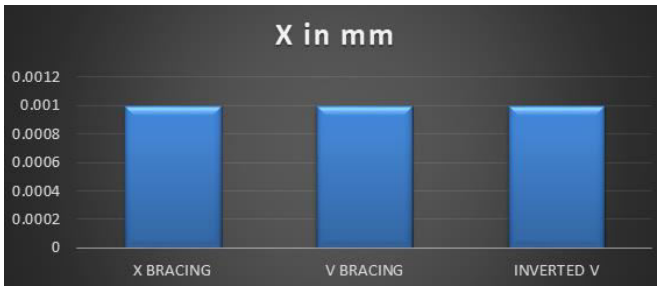

Figure 4.11 : graphical representation of direction in X direction

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4.6.4 Wind Load DY in Y Direction:

MODEL	Y in mm
X BRACING	0.001
V BRACING	0.001
INVERTED V	0.001

Table 4.12 :values of displacements in Y direction

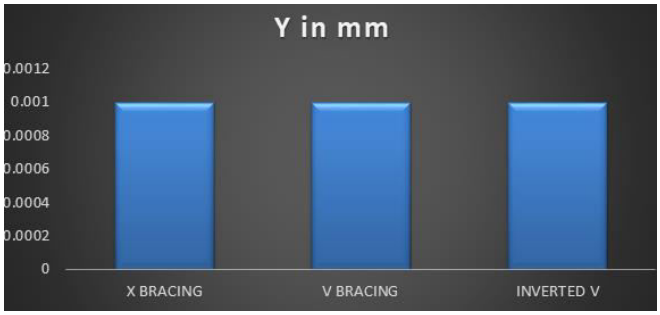

Figure 4.12 : graphical representation of direction in Y direction

When designing for wind loads in both the X and Y directions, you need to consider the overall lateral stability and stiffness of the structure. All three bracing systems can generally provide effective resistance to wind loads.

V. CONCLUSION

1. By comparing all the final results we can conclude that the V type bracing holds good for displacements
2. In story shear X direction the V bracings holds good for the final consideration.
3. In story shear Y direction the V bracings holds good for the final consideration.
4. Considering auto lateral loads in X direction, V bracings holds good for the final consideration comparing to inverted V and X bracing.
5. Considering auto lateral loads in Y direction, V bracings holds good for the final consideration comparing to inverted V and X bracing.
6. when considering wind loads in both the X and Y directions and comparing the performance of different bracing systems (X-bracing, V-bracing, and inverted V-bracing), it's important to note that all three systems can generally provide effective resistance to wind loads.
7. There is no one-size-fits-all answer as to which bracing system is universally better in all scenarios. Each system has its advantages and considerations. X-bracing and inverted V-bracing tend to distribute loads more evenly between the X and Y directions, while V-bracing primarily resists loads in the Y direction.

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