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Analysis of Seismic Behaviors of RC Frame Structure with and without bracing System

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Abstract - RC Building In recent decades, the building industry has relied heavily on RC structures for the most practical content. Seismic design is primarily used to provide strength, stability, and adaptability. It is necessary to build a structure that can withstand seismic loads. The system's structural bracing component has a significant impact on how the structure behaves during earthquakes. Massive steel-framed buildings' bracing patterns can alter how the worldwide seismic activity behaves.

In this study, a G+11-story RC frame building with a varied bracing system arrangement is subjected to linear static analysis. The dimensions of the beam (450 x 600 mm), the columns (450 x 700 mm), the thickness of the slab (180 mm), the density of RCC (25 KN/m3), the density of the masonry (20 KN/m3), the thickness of the wall (230 mm), the height of the parapet wall (1 m), the height of each floor (3.2 m), the live load on a typical floor (4.0 KN/m2), and the live load seismic calculation (0.75) are some of the parameters used in this work. Bracings are compared using different section types, such as ISMB350 sections. Steel buildings are analysed using the Staad Pro software program, which compares several parameters.

The section's properties are employed in accordance with IS: 456:2007 and IS 800:2007, which analysed several bracing types, such as X, V, and without bracing, and compare the performance of each frame using the linear static method.

In this research, a G+11 with a square building plan measuring 20 m by 28 m, with 3.2 m for each level, is modelled. The structure is constructed using the linear static method in Staad Pro software, and an earthquake analysis of the structure is conducted in seismic zones III with medium soil conditions.

Key Words**:** *Seismic zone, Soil type, G+11 Multistory Steel Building, different type Bracing, Software etc.*

1. INTRODUCTION

The earth's crust produces earthquakes, which are a natural occurrence. In typically, earthquakes last anywhere from a few seconds to a minute or longer. However, thousands of people are killed by earthquakes in various places of the world. A major loss would be the collapse of a building or damage from ground motion during an earthquake. Experience has shown that high frequency vibrations in the building cause inertial forces on the structure and its constituent parts during an earthquake. Even though the building is rising from the earth below, it is still in its original place because of the force of the tendency to stay at rest.

In order to accurately predict the seismic reactions of non-deterministic characteristics, it is necessary to assess the seismic sensitivity of structures and seismic activity levels beyond standard linear behavior. This is a very complex subject. Bracing systems are the primary determinant of stable performance. One more plastic deformation bracing system that can absorb more energy during an earthquake should be installed before it is destroyed. A subset of the earthquake response of a building's structure is determined via seismic and structural analysis. The procedure includes structural engineering, structural design, seismic assessment, and retrofit locations where earthquakes are common. Strengthening, stabilizing, and adapting are the main goals of seismic design.

Bracing System: The main purpose of a braced frame structural system is to withstand seismic and wind stresses. Like a truss, the members of a braced frame are made to function in both tension and compression. Steel members are nearly usually used to make braced frames. Moment resisting and concentrically braced frames, two popular lateral force resisting systems, typically offer cost-effective solutions for one of the two needs but not both. For example, while concentrically braced frames are stiff and have a limited capacity for energy dissipation, moment resisting frames are ductile and frequently too flexible to economically meet drift control requirements. Eccentrically braced frames have recently been promoted as a cost-effective way to address the seismic design issue. An eccentrically braced frame is a type of generalized framing system where shear and bending in a section of the beam transfer the axial forces generated in the braces to a column or another brace. The term "active link" or just "link" refers to this crucial beam portion, which will be identified in this context by its length e. Through material yielding, these linkages work to disperse the significant quantities of input energy from a strong seismic event.

1.1 Objective of study

The objective of the study comprises of the following:

1. Comparative study of the behavior of different type of bracing structures such as with and without braced, inverted V-braced.

2. To perform the Linear Static Analysis on steel structures.

3. To compare the different bracing steel structures such as with & without bracing.

2. LITERATURE SURVEY

1. Anila S, Safvana P {9} (2018):- Using Etabs software, he examined the RCC structure and steel structure with and without bracing systems under seismic loads. He thought of several bracing systems, such as zipper bracing and X bracing. In order to test the efficacy of different types of bracing systems in steel and RCC structures, bracing is installed at

each corner of various multistory buildings, such as G+6, G+12, and G+18 storey with 6x3 bays along X and Y directions. When it comes to RCC structures, he found that SBS with a double spring bracing system reduces lateral displacement, deformation, and base shear by a smaller percentage. For steel structures, he found that SBS with a double spring bracing system reduces deformation and base shear by a smaller percentage.

2. B. Ravali, P. Poluraju {46} (2019):- He researched the industrial structure's seismic analysis both with and without bracing. In the development industry, opposing tremor-prone constructions is a vast task. Using SAP2000 and Etabs software, he took into account a number of characteristics, including the importance factor, I 1.0 reduction factor, R 5, zone factor, Z 0.36 (for Zone v), and 0.16 (for Zone III). Solidity, stability, and pliability are necessary for a structure to support both level and vertical loads. The development of influence and additional results in vibration and story float are prompted by flat stacking. Two important factors that help any construction resist gravity and parallel loads are quality and stiffness. Any structure can be made more sidelong reliable by adding bracings or dampers. After distributing bracings or dampers,

The horizontal burden opposing framework (LLRS) replaces the general framework. In any case, this includes high economy, which is only suitable for skyscrapers and other important structures that are thought to be impacted by parallel burden and horizontal burden. The current task consists of preparing to control seismic movement on modern structures, namely in seismic zones III and V of India, or suggesting an appropriate type of damper. Because they house large, well-built people, modern structures also contribute to a high death toll. In order to regulate vibration, parallel uprooting, and story float, it is crucial to investigate the seismic response of structures using various bracings and dampers. The important parameters taken into consideration for watching are regularity, frequency, and rooftop removals.

Using SAP 2000 and ETABS, a reaction range analysis of a 3D modern structure with specific concentric bracings and dampers is conducted in this investigation under independent base shear. The results themselves demonstrate how PEB behaves under parallel stacking with bracings and dampers as well as an exposed casing. In this case, a model number is assigned to each model that has a certain type of propping and damper, such as Zone III (I), Zone V (II), Slanting propping (III), X-supporting (IV), Knee-propping (V), Contact damper (VI), and Material damper, respectively. The behaviour of stories such as Story Firmness, Base Shear, and Most Extreme Sidelong Removal is taken into consideration using ETABS, and the variation in Timespan, Increasing Speed, and Recurrence is investigated using SAP2000.

3. Chhavi Gupta, Ashiru Muhammad, etc al{41} [2015]- Using Staad Pro, he investigated the comparative seismic analysis of multistory G+5, G+8, and G+11 story buildings with RCC and steel frames. He chose the building geometry of three bays facing X and five bays facing Z, each having a height of 19.6 m, 29.2 m, and 38.8 m above ground level. All floors have a height of 3.2 m, with the exception of the lowest floor, which has a height of 3.6 m. The RCC structure's beam and column section properties were 230 x 450 mm with a slab thickness of 150 mm, whereas the ISWB 500 steel building frame's column and the ISHB 450 steel beam had a slab thickness of 150 mm. The length of time increases as building height increases, which indicates that regardless of the type of building frames, such as composite and traditional type structure. He found that the average response reduction coefficient for conventional and composite frames decreased as building height increased, and he also noticed that the conventional structure had a longer time period than the composite structure.

4. Dr. Prakash M R, Jagdeesh B N {18} (2016): - He researched the massive bracing system's seismic analysis of the steel-framed building. Among the several horizontal burden opposing frameworks, the propping stands out and will be the best solution for improving earthquake obstruction. The purpose of a supporting framework is to prevent sidelong avoidance of structure. With the intention of using these abilities as support, the people from a propped outline are subjected to pressure and strain. Steel persons are continuously used to structure supported edges. The use of propped outlines in skyscraper construction and earthquake planning has become very well-known. Investigation and demonstration using ETABS programming to determine the relationship between views with and without support outlines and focused on assessing the seismic response of steel structures with

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concentric propping frameworks. Two fundamental configurations were employed: the vertical sporadic model with super supporting (VIRM_MB) and the vertical unpredictable model (VIRM). For every zone of soil type-II (medium), a 15-story steel second opposing edge was disassembled. The tests were conducted to assess the fundamental performance during seismic ground movements. These models are examined from many perspectives, such as base shear, tale float, and story uprooting. The drop in narrative floats in mega supported casing is assumed to occur similarly to the unsupported outline. Using a user-propping framework reduces the story relocation of the vertical unexpected structure by 77.64% as compared to not using a supporting framework. Therefore, it is possible to argue that, in comparison to floor removal, the propping structure has a greater impact on the limitation. When compared to VIRM without supporting casing, the most extreme base shear for mega (VIRM_MB) propping outline is reduced by 23.42%.

3. METHODOLOGY

The seismic performance i.e., analysis of steel structures is attempt in the current project. For this, the proposed methodology is as follows:

1. An extensive survey of the literature on the response of steel structures to seismic loading is performed.
2. Different type of steel structure are taken and analyzed by Linear Static Analysis.
3. Different type of steel bracing system of RC structures are taken and analyzed by different ground motion with the help of Staad Pro Software.
4. Calculate the different results of RC structure i.e. without bracing and with Steel bracing.

The current effort attempts to analyze steel constructions' seismic performance. The following is the suggested methodology for this:

- ➢ The literature on how steel structures react to seismic loads is thoroughly reviewed.
- ➢ Linear Static Analysis is used to examine various steel construction types.
- ➢ Using Staad Pro software, several steel bracing systems for RC constructions are taken and examined by various ground motions.
- ➢ Determine the differences between the RC structure's outcomes with and without steel bracing.

1. Making use of Staad Pro.
2. Developing the structure's building plan.
3. Using structural properties such as beam, column, slab dimension, and support.
4. Using loads such as dead, live, seismic, and combination loads in accordance with IS code.
5. Obtaining outcomes in the form of maximum axial force, maximum story displacement, maximum bending moments, maximum story shears, etc.
6. Results Analysis: A visual analysis using Max Story Shears and Max Bending Moments. Maximum Axial Force, Maximum Story Displacement, etc.
7. Discussion of the Conclusion and Future Prospects.

3.1 Building Geometry:

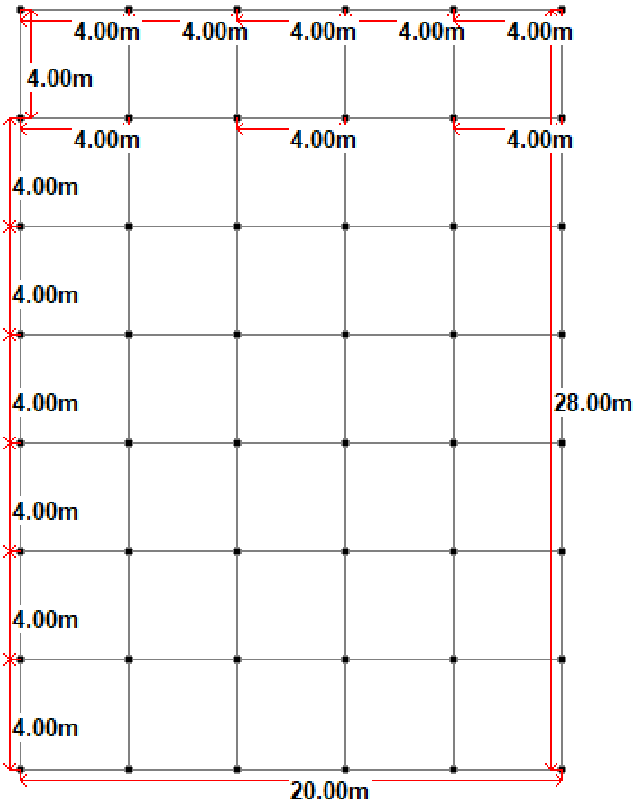

Fig.3.1 Building Plan configuration

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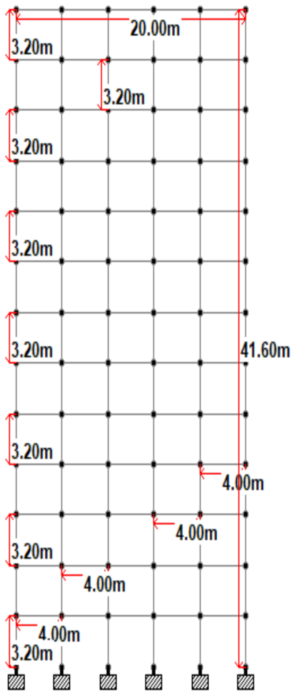

Fig.a without bracing

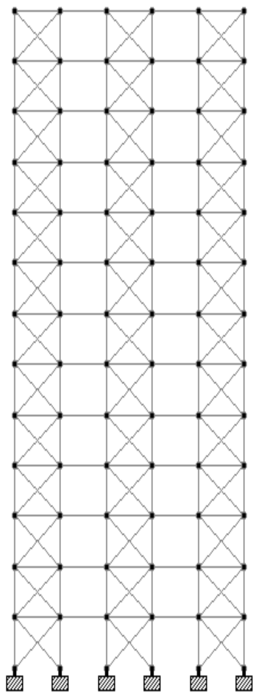

fig. b Cross Bracing

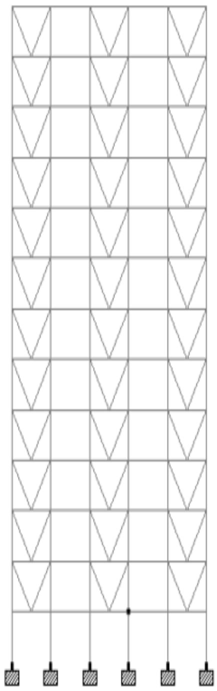

Fig. (c) V-Bracing

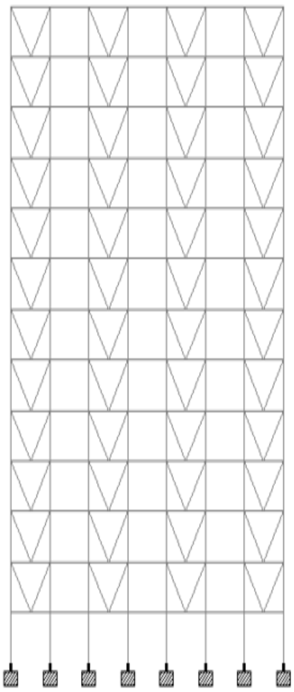

Fig. (d) V- Bracing

4.MODELLING AND PROBLEM FORMULATION

MODELLING OF BUILDING FRAMES

Etabs is a general-purpose application used to analysed structures in seismic zone III and medium soil conditions. To accomplish that purpose, the following three tasks must be completed:

a. creating a model with Staad Pro software.

b. The computations used to get the analytical findings

c. The tools in the system's graphical environment all encourage result checking.

Parameter Using:

Type of Building: RC Framed Structure with & Without bracing System

Number of Floor: G+11 (Rectangular Shape Building)

Section Property: ISMB

Seismic Parameter:

Seismic Zone- III

Soil Type- Medium Soil

Damping = 5% (as per table-3 clause 6.4.2), Zone factor for zone III, Z=0.24)

Importance Factor I=1.5 (Important structure as per Table-6)

Response Reduction Factor R=5 for Special steel moment resisting frame Table-7)

Sa/g= Average acceleration coefficient (depend on Natural fundamental period)

GEOMETRY AND MODELLING

Grade of concrete is considered M25

Grade of Rebar is considered Fe-415

Grade of Steel –Fe-345

Description:

Table: Structural modeling specification of G+11 Buildings

Type of Structure	Without bracing	With bracing
Bay Width in longitudinal direction	20m	20m
Bay Width in Transverse direction	28m	28m
Total Height	41.60 m	41.60 m
Live Load	3.0 KN/m2	3.0 KN/m2
Floor Finishing	$0.75KN/m^2$	$0.75KN/m^2$
Wall Load	14.75 KN/m	14.75 KN/m
Grade of concrete	M-25	M-25
Type of Rebar	Fe-415	Fe-415
Type of steel	Fe-345	Fe-345
Each column height	3.2 m	3.2m
Support condition	Fixed	Fixed

5. RESULTS & ANALYSIS

5.1 STOREY DISPLACEMENTS

5.1.1 MAXIMUM STOREY DISPLACEMENTS IN MODEL-I

Table: 5.1.1 Storey Displacements in MODEL-I

MODEL-I (Without Bracing)		
Maxiumum Node Dispacement (mm)		
Storey	X- Direction	Z -Direction
13	111.054	176.06
12	107.693	171.797
11	102.667	164.62
10	96.113	154.879
9	88.295	143.025
8	79.47	129.474
7	69.876	114.603
6	59.726	98.747
5	49.212	82.203
4	38.502	65.226
3	27.741	48.03
2	17.083	30.795
1	6.912	13.768
0	0	0

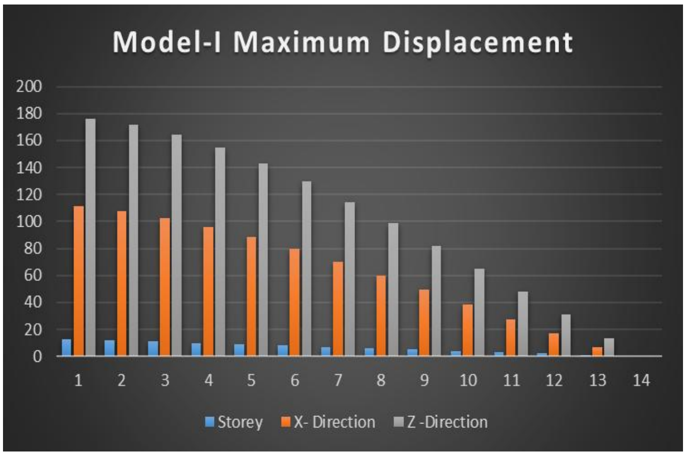

Fig. 5.1.1 Storey Displacements in MODEL-I

5.1.2 MAXIMUM STOREY DISPLACEMENTS IN MODEL-II

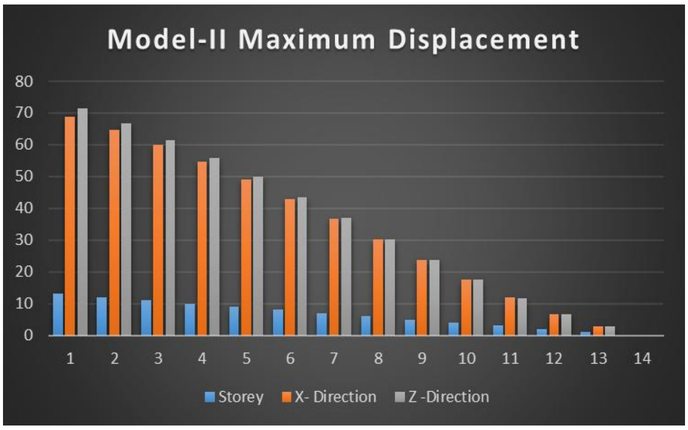

Fig. 5.1.2 Storey Displacements in MODEL-II

Table: 5.1.2 Storey Displacements in MODEL-II

MODEL-II (With X-Type Bracing)		
Maxiumum Node Dispacement (mm)		
Storey	X- Direction	Z -Direction
13	68.923	71.408
12	64.678	66.646
11	59.965	61.532
10	54.746	55.954
9	49.059	49.942
8	42.988	43.58
7	36.652	36.989
6	30.191	30.316
5	23.771	23.736
4	17.579	17.448
3	11.836	11.681
2	6.809	6.69
1	2.861	2.757
0	0	0

5.1.3 MAXIMUM STOREY DISPLACEMENTS IN MODEL-III

Table: 5.1.3 Storey Displacements in MODEL-III

MODEL-III (With V-Type Bracing)		
Maxiumum Node Dispacement (mm)		
Storey	X- Direction	Z -Direction
13	79.073	90.684
12	75	85.906
11	70.06	80.363
10	64.508	74.256
9	58.415	67.631
8	51.883	60.586
7	45.04	53.251
6	38.029	45.778
5	31.01	38.341
4	24.167	31.122
3	17.692	24.385
2	11.809	18.358
1	6.67	13.227
0	0	0

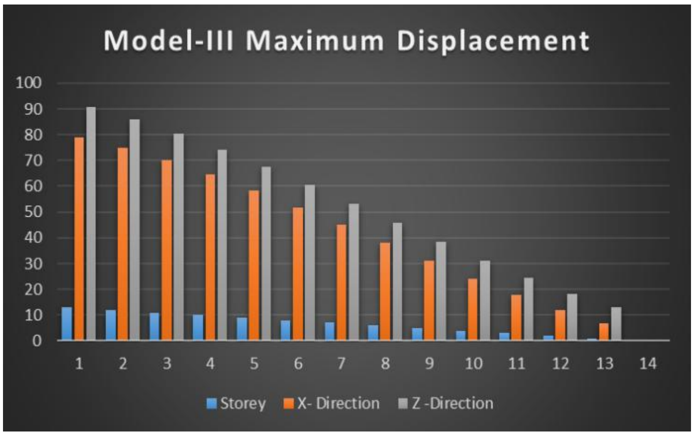

Fig. 5.1.3 Storey Displacements in MODEL-III

5.1.4 MAXIMUM STOREY DISPLACEMENTS IN X-DIRECTION

Table: 5.1.4 Storey Displacements in X-Direction

Maxiumum Node Dispacement in X-Direction (mm)			
Storey	Model-I	Model-II	Model-III
13	111.054	68.923	79.073
12	107.693	64.678	75
11	102.667	59.965	70.06
10	96.113	54.746	64.508
9	88.295	49.059	58.415
8	79.47	42.988	51.883
7	69.876	36.652	45.04
6	59.726	30.191	38.029
5	49.212	23.771	31.01
4	38.502	17.579	24.167
3	27.741	11.836	17.692
2	17.083	6.809	11.809
1	6.912	2.861	6.67
0	0	0	0

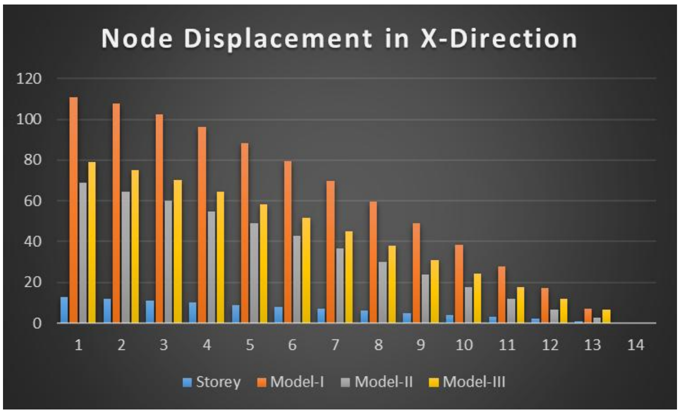

Fig. 5.1.4 Storey Displacements in X-Direction

5.1.5 MAXIMUM STOREY DISPLACEMENTS IN Z-DIRECTION

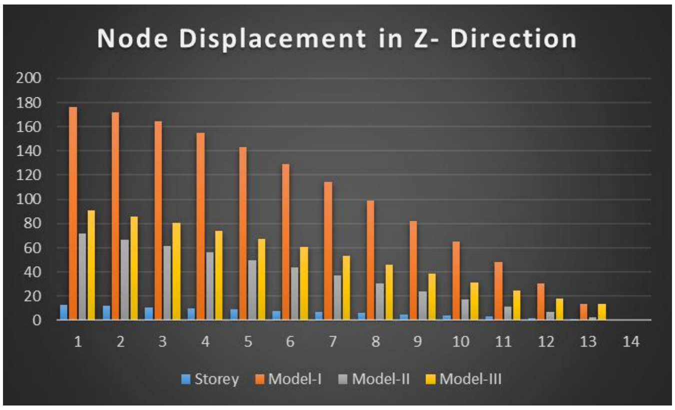

Fig. 5.1.5 Storey Displacements in Z-Direction

Table: 5.1.5 Storey Displacements in Z-Direction

Maxiumum Node Dispacement in Z-Direction (mm)			
Storey	Model-I	Model-II	Model-III
13	176.06	71.408	90.684
12	171.797	66.646	85.906
11	164.62	61.532	80.363
10	154.879	55.954	74.256
9	143.025	49.942	67.631
8	129.474	43.58	60.586
7	114.603	36.989	53.251
6	98.747	30.316	45.778
5	82.203	23.736	38.341
4	65.226	17.448	31.122
3	48.03	11.681	24.385
2	30.795	6.69	18.358
1	13.768	2.757	13.227
0	0	0	0

6. CONCLUSIONS

It is evident that the 13th storey top of the structure has the largest storey displacement, measuring 111.054 mm in the X direction and 176.060 mm in the Z direction. Additionally, the displacement decreases in order as the structure's storey height decreases, while the base of the structure has zero displacement.
The 13th storey of the structure has the largest storey displacement, measuring 68.923 mm in the X direction and 71.408 mm in the Z direction. When comparing the two directions, the Z direction shows the largest displacement, and it is also noted that the displacement decreases in order as the structure's storey height decreases, with zero displacement at the base.

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The top storey of the structure shows a maximum storey displacement of 176.060 mm without bracing and a minimum of 71.408 mm with X type bracing along to X direction. This indicates that the X type bracing is superior to the V type bracing and the structure without bracing. Additionally, it was noted that there was zero displacement at the base of the structure and that the displacement decreased in order as the structure's storey height decreased. It indicates that when we raised the floor of the constructions, the displacement progressively grew as a result of the structure's growing forces.

REFERENCES

[1] Manish S. Takey and S.S.Vidhale,"Seismic response of steel building with linear bracing system (A software approach)", International Journal of Electronics, Communication and Soft Computing Science and Engineering, 2(1), pp 17-25, 2012.

[2] Ms Deepika C. Hiwrale , Prof. P.S. Pajgade: Analysis and Design of Steel Framed Buildings with and without Steel Plate Shear Walls- International Journal of Scientific & Engineering Research Volume 3, Issue 6, June-2012, ISSN 2229-5518.

[3] Kevadkar M.D. and Kodag P.B., (2013) "Lateral load analysis of R.C.C. building" International Journal of Modern Engineering Research (IJMER) Vol.3, Issue.3, pp. 1428-1434

[4] I.Anusha* , U.Arun Kumar: Analysis Of A Steel Building Against Earthquake Loads- International Journal Of Engineering Sciences & Research Technology, ISSN: 2277-9655 [Anusha* et al., 5(12): December, 2016] Impact Factor: 4.116 IC™ Value: 3.00 CODEN: IJESS7.

[5] K. S. K. Karthik Reddy, Sai Kala Kondepudi: A Comparative Study on Behavior of Multistoried Building with Different Types and Arrangements of Bracing Systems- IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 2 | August 2015 ISSN (online): 2349-784X.

[6] Avani Mandlik , S K Sharma , Shahjad Mohammad: Behaviour of Symmetrical RCC and Steel Framed Structures Under Seismic and Wind Loading-International Journal of Research and Scientific Innovation (IJRSI) |Volume III, Issue VIII, August 2016|ISSN 2321–2705.

[7] Kartik prashar , Jagdeep Singh Gahir: Review Paper on Seismic Behaviour of RC Frame Structure With Different Types of Bracing System- International Journal of Engineering and Techniques - Volume 4 Issue 2, Mar-Apr 2018.

[8] SALEM R.S GHDOURA , VIKAS SRIVASTAVA: Analysis of Steel Framed Structure using STAAD Pro and ROBOT Software- International Journal of Scientific Engineering and Technology Research, ISSN 2319-8885 Vol.05,Issue.07, March-2016, Pages:1442-1449.

[9] Safvana P and Anila S: Seismic Analysis Of Braced Rccand Steel Structures Using Etabs Software- International Journal of Recent Scientific Research Vol. 9, Issue, 4(C), pp. 25689-25691, April, 2018.

[10] Thorburn J.L., Kulak G.L., and Montgomery C.J. (1983). "Analysis of steel plate shear walls", Structural Engineering Report No.107, Department of Civil Engineering, The University of Alberta Edmonton, Alberta, pp 1-167.