International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Lateral Load Analysis of Multi- Storeyed Building with Different Types of Bracing.

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ABSTRACT

Now a days bracing in multi-storeyed building are commonly used because it can withstand lateral loads due to seismic or wind load. It is one of the best method for lateral load resisting system. This system provides to minimize the lateral deflection of structure. In the present work an attempt is made to analyse G+25 storey RC structure with different types of bracing such as X, V, Inverted V, K, Inverted K in seismic zone-III and zone-IV. The analysis was done by using Etabs software. Results are obtained by considering the different parameters like base shear, displacement, time period, storey drift

Keywords: ETABS, Base shear, displacement, time period, storey drift.

1. Introduction

All structures should be able to bear the loads placed on them over the course of the structure's service life in order to support varied activities. The structure should be able to withstand the weight of its own weight. The structure's rigidity and strength are determined by materials used in its construction, as well as its geometric and cross sectional qualities.

An earthquake occurs when the earth's surface vibrates as a result of an underground disturbance. These vibrations occur in all directions and are completely unpredictable. Unpredictability is a hallmark of earthquakes. Residents in earthquake-prone regions have an increased risk of earthquakes as a result of these geological factors.

Structures supported by the ground are susceptible to the vibrations caused by earthquakes. Consequently, there is no external force acting on the structure, but rather movement of support. Natural disasters such as earthquakes, which generate ground motion, are a threat to people's lives and property. The majority of these losses are attributable to building damage or collapse. Therefore, the building must be designed to withstand moderate to severe earthquakes.

Earthquakes cause structures to be damaged by seismic forces. The earthquake wave travels through the ground or rocky media to the building, causing it to shake. The structure's characteristic determines how these movements will be performed. As a consequence of the structure having for overcoming its own inertia, there is a reaction among structure and the earth. In the study of soil structure interaction, we look at how structures and soils interact. The term "Soil-Structure Interaction" refers to this kind of interdependent interaction among soil & structure that controls the overall reaction.

1.1 Objectives of Study

- Designing 3D model of building with and without bracings.
- Seismic study of various 3D building models utilizing E-TABS is required.
- For studying impact of provision of numerous kinds of bracing systems.
- To evaluate these 3D building models using EQUIVALENT STATIC METHOD of analysis for different load combinations as given in IS:1893-2002 (part 1)
- For studying Lateral Displacements, Base Shear, Time period, Storey Drift of the building model with and without bracing systems.

1.2 Scope Of the Study

Steel bracings are a cost-effective and efficient way to boost the seismic stiffness and stability of framed buildings. Usually steel bracings are used in framed structures shear walls are also been used in reinforced concrete structures.

Bhuj earthquake of 2001 and subsequent evaluation of many multistoried buildings into built-up zones of INDIA have exposed susceptibility of reinforced concrete framed buildings. This underscores the importance of strengthening the existing buildings to resist loads due to earthquake in high seismic zones. Use of steel bracings is amongst appropriate techniques to strengthen the existing reinforced concrete constructions.

Because of its light weight and high strength-to-weight ratio, steel bracings have recently been utilised in reinforced concrete buildings. Beam and column flexural and shear loads are reduced by bracing, whereas axial load mechanisms (such as truss mechanisms) transmit the stresses.

2. Literature Review

2.1 General

This literature evaluation will concentrate on current research relating with seismic performance of RC frame employing steel bracings and prior efforts most directly connected to the present topic. The evaluation of building design in earthquake risk estimate is generally conducted into light of earthquake resistance of structure, prior seismic hazard record, construction type, seismic zone of the region & construction of database and its statistical and qualitative approach. In employing steel bracing systems for RC frames, prior scientists concentrated on the retrofitting element of the bracing. In latest days the clear bracings of RC bracings has garnered more attention as it is affordable and may be used in addition to retrofit objective as well as a credible option to RC shear walls at pre-construction level of design. Several studies, experiments, and research works has been carried out in the seismic analysis of steel braced RC frames. Following are some of aspects of studies regarding seismic behavior of steel braced RC frames.

2.2 Literature Review

Youssef et. al (2007), study on braced steel frames' efficacy Two cyclic load tests were performed, one frame structure & other on a braced frame. Seismic codes are used in the design and construction of the moment frame. As a mechanism for resisting lateral stresses, steel bracings have been shown to be among the most effective. Despite the fact that it has been extensively studied and utilized to improve lateral load capability of existing RC frames, recommendations for its use in freshly built RC frames have yet to be created. The braced frame, as well as the interconnections among brace members & concrete frames, is designed using a logical technique. There is sufficient ductility and resistance to lateral loads in the braced frame, according to the results of the test. It's first step in developing design standards for these kinds of frames that the accepted technique for building a braced frame produced an appropriate seismic behavior.

Vishwanath et. al (2010),E-Tabs Software was used to assess a four-story structure for seismic zone IV compliance with IS 1893-2002. Rehabilitating a four-story building necessitated the use of numerous kinds of steel bracing. A structural technique utilized to withstand earthquake loads in multistory buildings is steel braced frames, according to the researchers. There are several advantages to using a steel bracing system, including its cost-effectiveness, ease of installation, and reduced space requirements. Peripheral columns receive bracings. Structural stiffness and maximum inter-storey drift were reduced dramatically by using X kind of steel bracings. They come to the conclusion that steel bracing is an excellent approach for strengthening or retrofitting existing buildings. In compared to other forms of bracing systems, building frames using X bracing systems would have least bending moment conceivable.

R.K. Gajjar, Dhaval P. Advani (2011), A multi-story building's lateral load resistant system and gravity load system were examined as part of design process. Bracing solutions for multi-story structures were shown to demonstrate their effectiveness. Different bracing techniques like X bracing & V bracing are used, as is a 20-story building model with same design. An E-tabs commercial software is used to do the analysis and design, with the various parameters being compared.

Kevadkar, Kodag et al (2013), concludes that the massive, lateral-force-prone structure is at risk of serious damage. While the frames can endure gravity, they also say that bracing systems help them resist high-stress lateral loads (such as those caused by earthquake or wind). They employ bracing systems to keep their structures safe from these kinds of high-stress lateral loads. Buildings are characterized as well as evaluated in E-Tabs, and results are evaluated based of deflections, storey shear, & storey drifts, according to author R.C.C.

Abhijeet Baikerikar (2014), The P-Delta effect may be minimized by using braced frames, which can withstand enormous lateral stresses and have decreased lateral deflection. E-Tabs 9.7.0 software was used in this study, and the author found that the braced frame significantly reduced lateral forces as well as drifting compared with the bare frame, thus effectively resisting earthquake forces. Zone V & soft soil were the focus of this investigation in accordance with IS 1893-2002. In comparison to other frames having bracing systems, the naked frame produced higher displacements and drifts, according to the investigation.

2.3 Summary Of Literature

There are many strengthening measures available for RC frames. The present structure's strength may be effectively improved by using steel bracing. An alternative or complement to shear walls in concrete-framed structures might be steel bracing. In order to reinforce & stiffen a structure for lateral stresses, diagonal bracing is great option. Bracing are of different types and their behavior during earthquake is different. Steel bracing are more economical compared to other retrofitting methods available, easy to erect, occupies less space. Steel bracings are a cost-effective and efficient way to boost seismic strength and rigidity of framed buildings.

3. Aim and Scope of Present Study

3.1 Introduction

The study carried out in using the steel bracings for RC frames is focused upon retrofit feature of the brace. Steel bracing for RC frames has been increasingly popular in recent years due to its higher cost-effective and may be used for retrofitting as well as an alternative to conventional retrofitting methods.

3.2 Aim Of The Present Study

- To carryout seismic study on RC framed structure braced having steel members.
- To investigate analytically and conceptually utilization of steel braces schemes for seismic retrofitting of RC structures and to investigate result of such use of steel braces.
- For studying several kind of braces and behavior of RC frame braced having steel members during an earthquake for different load cases and to find out the structural behavior under various load cases and load combinations.
- The objective of this research is determining efficacy level of several braces types for increasing reliability of reinforced concrete frame against an earthquake.
- Change in force into structural members of the RC frame & other related parameters are studied.
- For studying behavior of RC building with both static and dynamic situations.

3.3 Scope Of The Present Study

Purpose of our research is presenting results of analytical study carried out on the reinforced concrete frame and to investigating seismic behavior of RC frame with steel bracing systems as one of the retrofitting schemes available. The performance of the building is compared for the different bracing system arrangements. Benefits and inadequacies of each system are presented.

4. Method Of Analysis

4.1 Introduction

Several old RC building framed structures which are high, medium to low rise, were not design for resisting the earthquakes. Those buildings usually were designed by considering gravity loads without considering the effect of earthquake load. This makes the unsafe during the earthquake, and may be damaged if earthquake occurs. Consider effects of earthquakes in designing the structures in order to limit the effects of large earthquakes.

When it comes to analyzing lateral loads, seismic codes use a variety of methodologies. Infill walls are often regarded as non-structural components of a building. Analysis and design do not take into account infill walls. When constructions are exposed to seismic stresses, infill walls may interact with the frame, even though they are deemed non-structural.

Analysis of the gravitational and lateral loads on reinforced concrete frame including steel bracings according to norms for zones III, IV, & V is carried out. Equivalent Static and Response Spectrum methods are used to conduct the investigation. The R.C. frame is being tested to see how it holds up under earthquake stresses.

4.2 Method Of Modelling

The building's 3D model & assessment is done using E-TABS software. Geometric nonlinearity and material elasticity are taken into account in software's ability to forecast space frame behavior under various loading circumstances. Static and dynamic analysis may be performed using the program.

4.3 Model Description

Load resisting elements are used to model the building. Buildings in India are subjected to lateral loads, according to the Indian standard code. According to IS 1893 (part 1): 2002, seismic zones III and IV are the focus of this investigation. Reinforced concrete & brick masonry components make up the under consideration building's structure. The ground floor of the building is presumed to be solidly fastened.

- It is determined that15th-story structure is subject to gravity and seismic stresses.
- Models for various bracing systems including X Bracing, V Bracings, K- Bracings, Inverted V and Inverted K Braces have been evaluated.
- Zone III & Zone IV have been subjected to the same static study.

5. Seismic Analysis Of Steel Braced Reinforced Concrete Frame

5.1 Introduction

The review of the technical documentation reveals that moment resistant frames are the most common types of structures. The moment resisting frames are poor in stiffness. Based on the above discussion the 16 storey framed building chosen for the study.

5.2 Analysis Of R.C Framed Building

The plan and elevation of the RC moment resistivity of 16 storey building chosen for study is shown in Fig 1 and 2. The 3D models of the building with and without bracing systems considered are shown in fig. 3 to 8. The storey height is kept constant as 3.5m. In seismic weight calculations as per IS 1893:2002, just 50% of live loading is deliberated. Detailed data set specified of building is given in Table 1

5.3 Detailed Data for the Building:

Table 1 Elaborated dataset for Structure

Sl no	Description	Parameter
1	Depth of foundation	2.5 m
2	Floor to floor height	3.5 m
3	Grade of concrete	M 30
4	Grade of steel	HYSD-500
5	Column size (bottom 3 storey's)	0.6 m x 0.80 m
6	Column size (top 12 storey's)	0.5 m x 0.70 m
7	Beam size in X	0.3 m x 0.70 m
8	Beam size in Y	0.3 m x 0.50 m
9	Slab thickness	150 mm
10	Unit weight of masonry wall	20 KN/m

Load

Wall loading X-direction 11.8 KN/m Wall loading Y-direction 12.6 KN/m Floor finish – 1 KN/m^2

Live loading – 4 KN/m^2

Earthquake Loads

Earthquake Zone – III, IV, Response reducing Factor: 5 Importance factor: 1

Soil kind: Medium soil

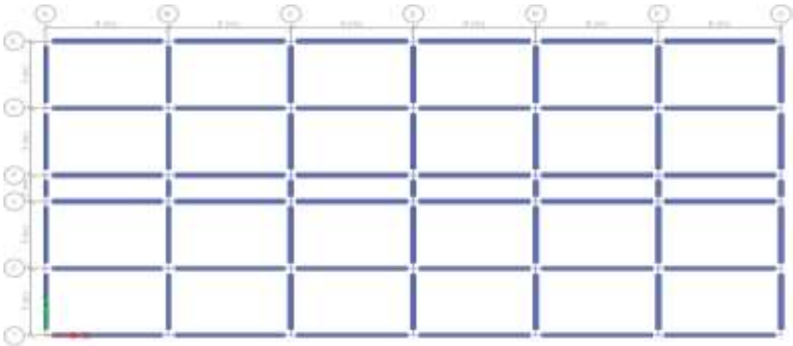


Fig 1 Plot of Projected Structure Framework

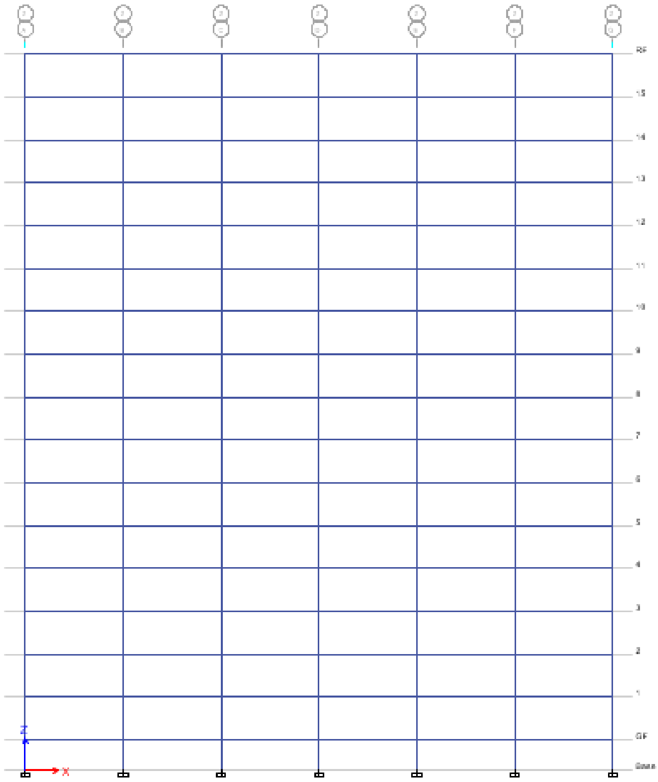


Fig 2 Elevation of Projected Structure Framework

Fig 3 Bare frame

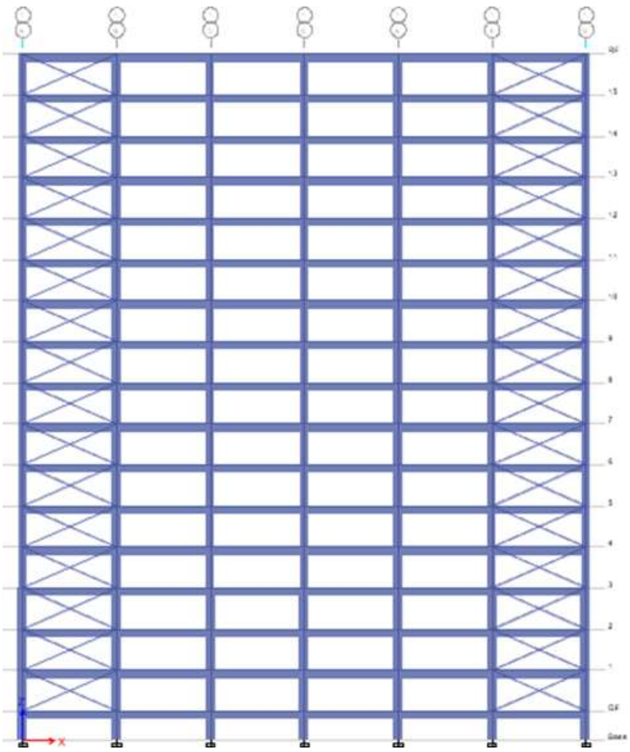


Fig 4 X-Braces

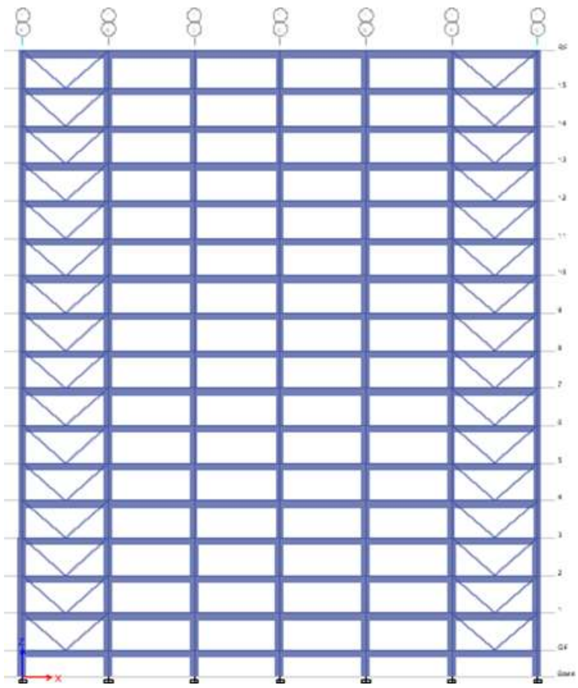


Fig 5 V-Bracings

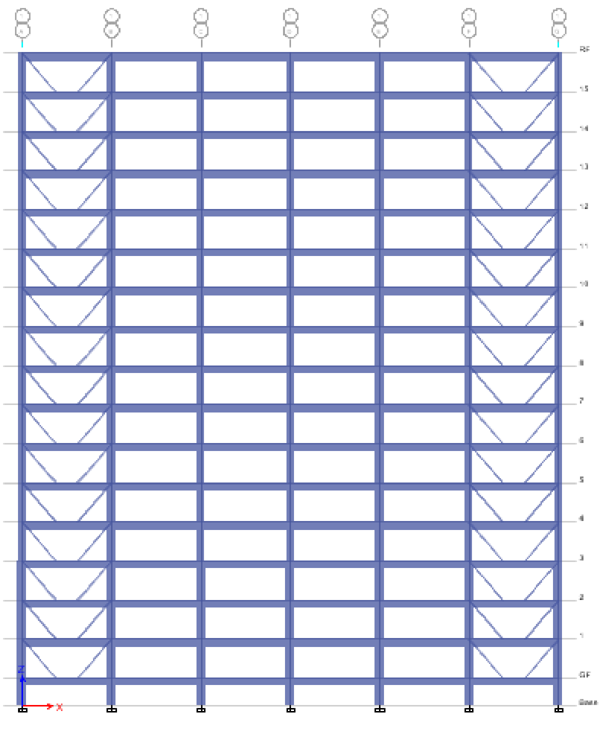


Fig 6 K-Bracings

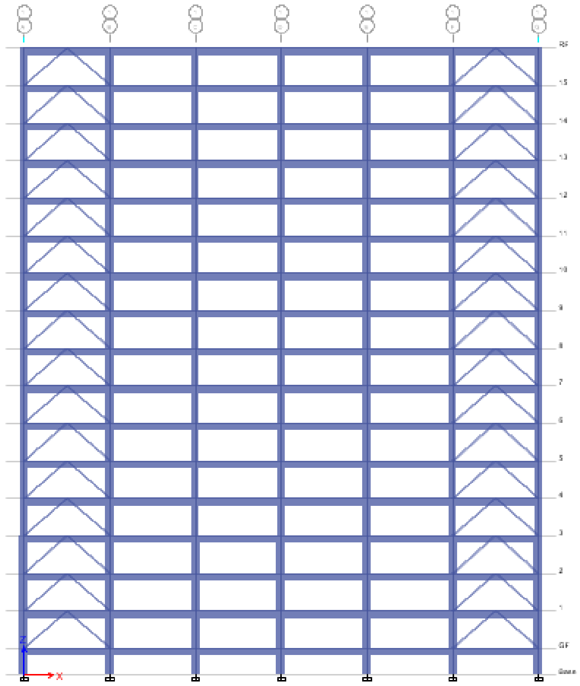


Fig 7 Inverted V-Bracings

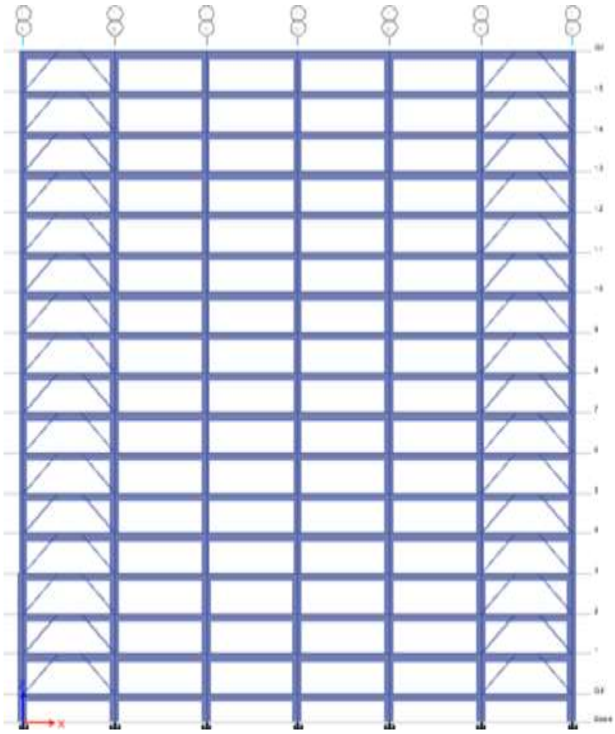


Fig 8 Invert K-Braces

6. Results and Discussion

6.1 General

All models preliminarily and conservatively designed for load cases according to IS 1893-2002. The outcomes have been detailed for each of structure model, with several types of bracings analyzed using ETABS Software. Reinforced concrete building frame without bracing and R.C frame with numerous kinds of bracings are specified for assessment.

Findings for separations, base shear, storey displacement, bending moment, & shear force in columns & beams for a variety of building types are discussed. The best sort of bracing for structure is recommended based on the findings. By doing a seismic study, the effects of various kinds of bracing systems may be evaluated.

6.2 Analysis

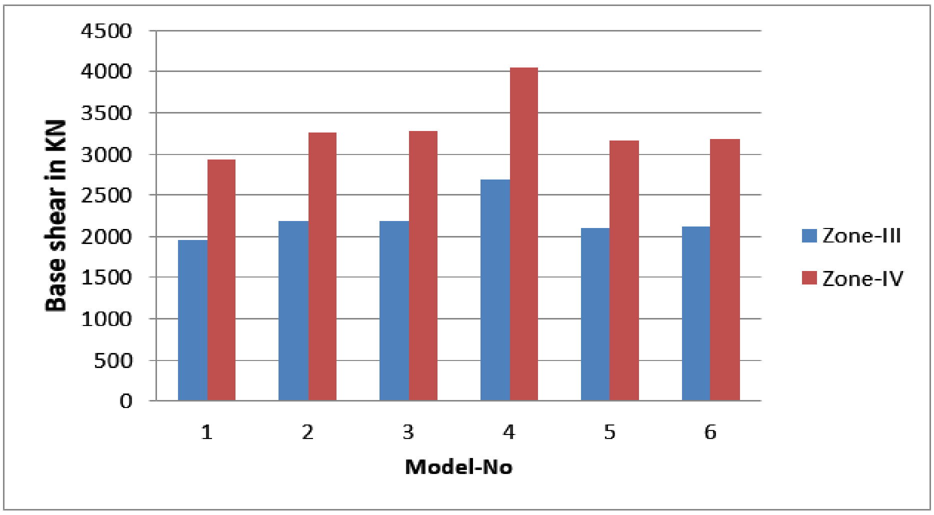
The results of analysis using E-TABS are presented in the tables below. The analysis is carried out in different seismic zones with different bracings systems were provided to the building frame. The outcomes of Base shear, Time period, max Displacement, Storey Drifting, have been illustrated in the tables

6.3 Base Shear

The overall horizontal force acting upon structure is known as base shear force. A building's base shear might be dispersed across its height since the structure does not stay rigid after an earthquake but instead deflects. Different bracing solutions for base shear of bare frame & for seismic zones III & IV have been discovered. provide the results of the investigation.

Table 2 BASE SHEAR EQX (KN)

Structure Kind	Zone III	Zone IV
Bare Frame	1952.99	2929.49
X Bracing	2178.86	3268.29
V Bracing	2188.00	3282.00
Inverted V Bracing	2694.49	4041.74
K Bracing	2104.72	3157.08
Inverted K Bracing	2120.18	3180.28

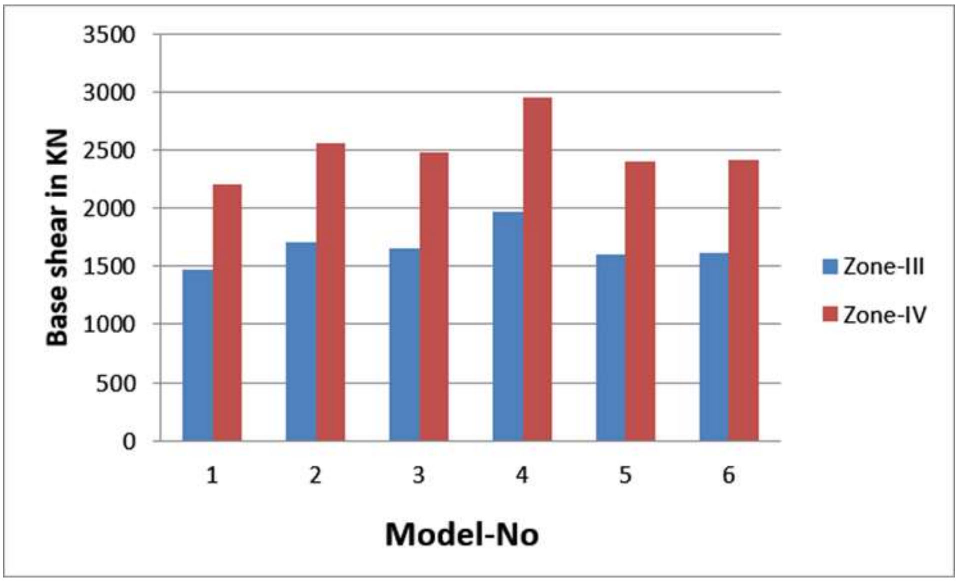


Graph 1: Comparison of base shear between zone-III and zone-IV along-X

Table 3 BASE SHEAR EQY (KN)

Structure Kind	ZoneIII	ZoneIV
Bare Frame	1473.21	2209.81

X Bracing	1707.9	2561.86
V Bracing	1657.34	2486.01
Inverted V Bracing	1964.42	2946.63
K Bracing	1597.76	2396.65
Inverted K Bracing	1613.19	2419.78



Graph 2: Comparison of base shear between zone-III and zone-IV along-Y

From table 2 & 3 interpretations noticed as.

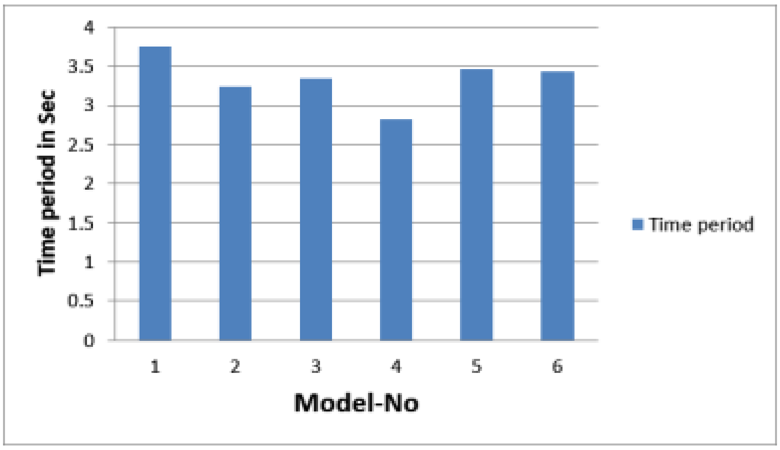
- Bare frames have been shown to have the lowest EQX and EQY base shear in both zones under consideration when compared to other bracing techniques.
- Inverted V-Bracings have the highest base shear EQX for both seismic zones..
- The base shear is minimum for bare frame, as the bracing are added in other models the base shear increases.
- When we add X-bracing the base shear increases by 13.74% , and with V-bracing the base shear increases by 11.10% and with inverted bracing the base shear increases by 25% compared to model-1

6.4 Time Period:

Its described as time it takes for completing cycle of vibration to move to a very particular point.

Table 4: Time period for all models

Structure Type	**Time period** **Zone III and Zone-V**
Bare Frame	3.753
X-Bracing	3.241
V-Bracing	3.339
Inverted V Bracing	2.828
K Bracing	3.463
Inverted K Bracing	3.43



Graph 3: Time period for all models

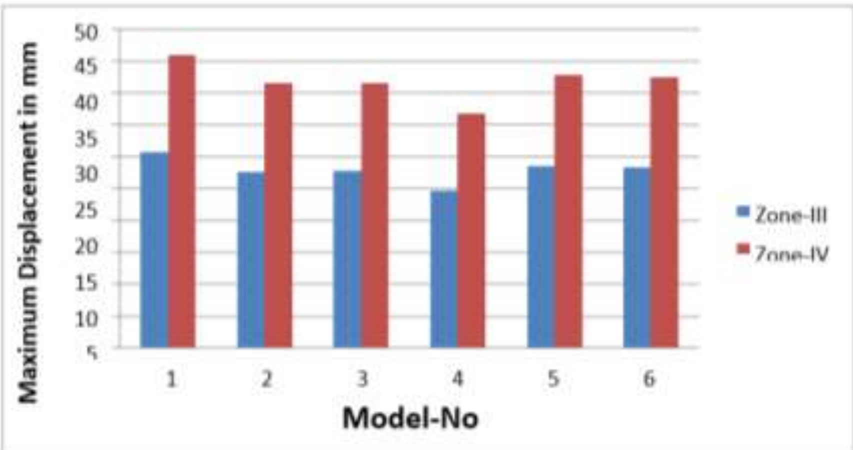
From the above graph it is noticed that the time period is maximum for bare frame, as we add X-bracing in model-02 the time period decreases, the time period is minimum when the frame with inverted bracing are provided.

6.5 Lateral Displacements

Equivalent Static Method tables 4 to 5 give maximal lateral displacements for various braced methods in zones III & zone IV. These lateral deflections on every storey with all bracing systems should be compared for improved comparison. Analysis of the Equivalent Static Method includes the bare frame, X, V, Inverted V, K & Inverted K bracing systems in the seismic zones III & IV. The lateral displacements along the two directions X-transverse direction, Y-transverse direction are plotted in the graph 6-11

Table 5 Maximal lateral displacing into Frame along-X

Displacing(mm) into X (Longitudinal) orientation		
Structure Kind	ZoneIII	ZoneIV
Bare Frame	30.7	46
X Bracing	27.6	41.5
V Bracing	27.7	41.5
Inverted V Bracing	24.6	36.8
K Bracing	28.5	42.8
Inverted K Bracing	28.3	42.4

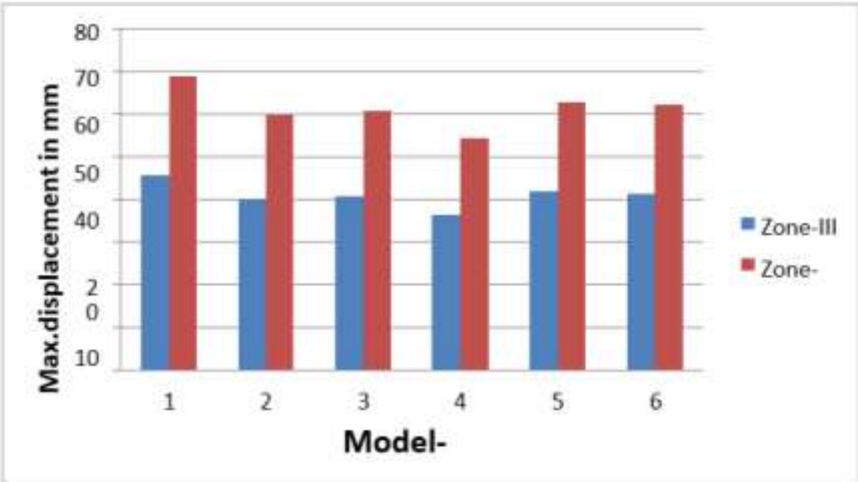


Graph 4: Comparison of Maximum displacement in mm along-X

From the above graph it is noticed as displacing is maximal with bare frame model-1, and is minimum when we are providing inverted bracing in model-4, hence the displacement reduction is 19.86% with inverted V-bracing in Zone-III and 20% reduction in Zone-IV compared to model-1.

Table 6 Maximal lateral displacing into Frame along-Y

Displacements (mm) in Y (Transverse) Direction		
Structure Kind	ZoneIII	ZoneIV
Bare Frame	45.8	68.7
X Bracing	39.8	59.7
V Bracing	40.6	60.9
Inverted V Bracing	36.4	54.5
K Bracing	41.9	62.8
Inverted K Bracing	41.4	62.1



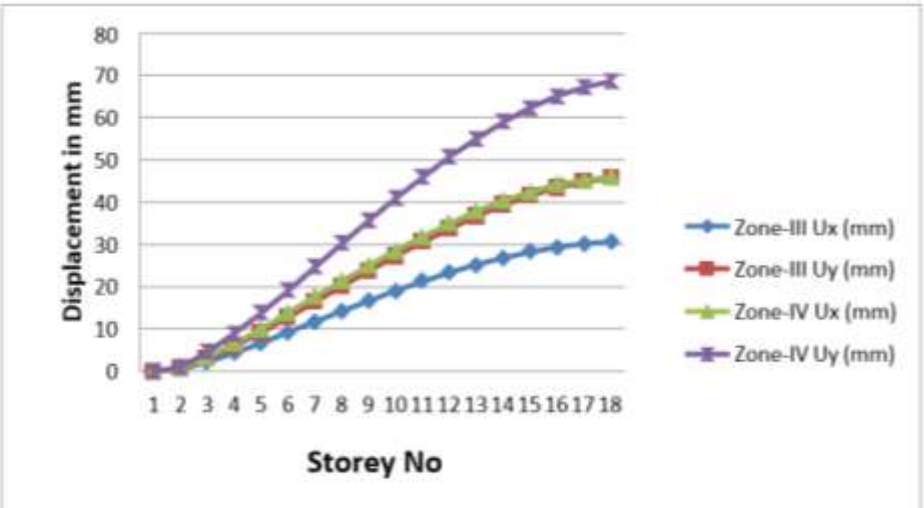
Graph 5: Comparison of Maximum displacement in mm along-Y

From the above graph it is noticed that the displacement is maximal for bare frame and is minimal in model-4 with inverted-V bracing. The reduction of displacement for model-04 in zone-III is 20.52% and in zone-IV is 20.66% compared to model-01 and all the storey drift values are within the permissible limit.

Table 7: BARE FRAME:

STOREY	Zone-III		Zone-IV	
	Ux	Uy	Ux	Uy
ROOF	30.7	45.8	46	68.7
15th	30.2	44.9	45.3	67.3
14th	29.4	43.5	44.2	65.2
13th	28.3	41.6	42.5	62.4
12th	26.9	39.4	40.4	59.1
11th	25.3	36.8	37.9	55.1
10th	23.4	33.8	35	50.8
9th	21.3	30.7	31.9	46
8th	19.1	27.3	28.6	41
7th	16.7	23.8	25.1	35.7

6th	14.3	20.2	21.4	30.3
5th	11.8	16.5	17.7	24.7
4th	9.3	12.8	13.9	19.2
3rd	6.7	9.2	10.1	13.8
2nd	4.4	6	6.6	9
1st	2.3	3.1	3.4	4.6
GROUND	0.5	0.7	0.8	1.1
BASE	0	0	0	0

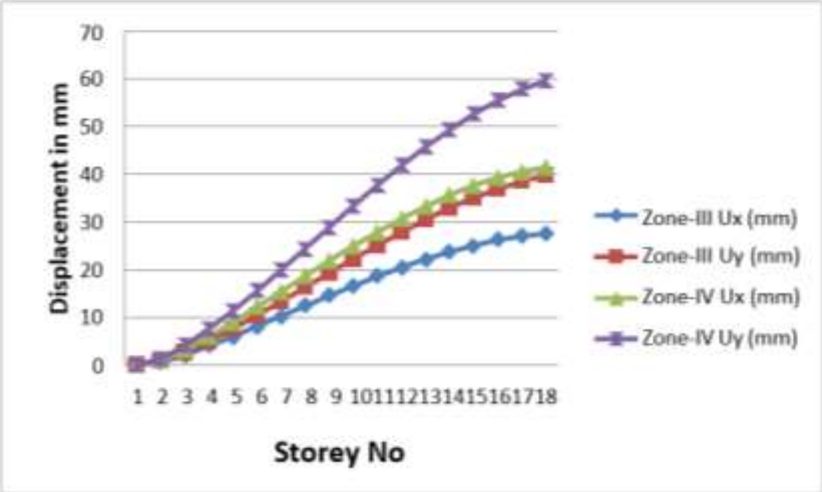


Graph 6: Displacement of BARE FRAME for zone- III and zone-IV

Table 8 X-BRACINGS

STOREY	Zone-III		Zone-IV	
	Ux	Uy	Ux	Uy
ROOF	27.6	39.8	41.5	59.7
15th	27.1	38.6	40.6	57.9
14th	26.3	37	39.4	55.6
13th	25.1	35.1	37.7	52.7
12th	23.8	33	35.7	49.4
11th	22.2	30.5	33.3	45.8
10th	20.5	27.9	30.7	41.9
9th	18.6	25.1	27.9	37.7
8th	16.6	22.2	25	33.4
7th	14.6	19.3	21.9	28.9
6th	12.4	16.3	18.7	24.4
5th	10.3	13.3	15.4	19.9
4th	8.1	10.4	12.2	15.5
3rd	5.9	7.5	8.9	11.3
2nd	4	5	6	7.5

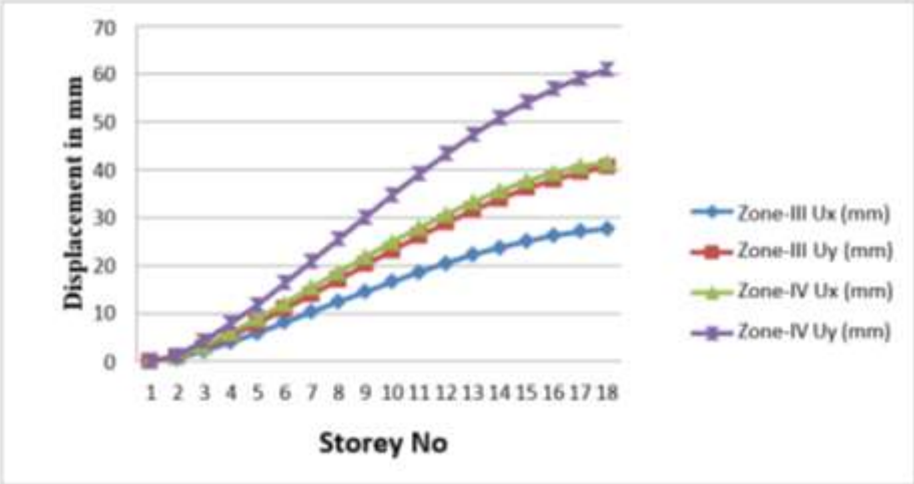
1st	2.1	2.7	3.1	4
GROUND	0.6	0.8	0.9	1.2
BASE	0	0	0	0



Graph 7: Displacement of FRAME with X-bracing for zone-III and zone-IV

Table 9 V-BRACING

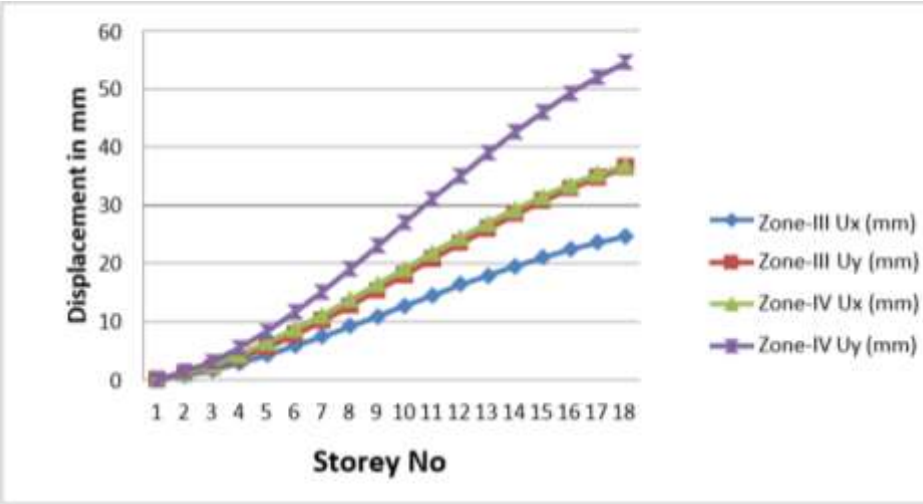
STOREY	Zone-III		Zone-IV	
	Ux	Uy	Ux	Uy
ROOF	27.7	40.6	41.5	60.9
15th	27.1	39.4	40.7	59.2
14th	26.3	37.9	39.4	56.9
13th	25.1	36.1	37.7	54.1
12th	23.8	33.9	35.6	50.9
11th	22.2	31.5	33.3	47.3
10th	20.5	28.9	30.7	43.3
9th	18.6	26.1	27.9	39.1
8th	16.6	23.1	24.9	34.7
7th	14.5	20.1	21.8	30.1
6th	12.4	17	18.6	25.5
5th	10.3	13.9	15.4	20.9
4th	8.1	10.9	12.1	16.3
3rd	5.9	7.9	8.9	11.8
2nd	4	5.2	6	7.9
1st	2.1	2.8	3.1	4.2
GROUND	0.6	0.8	0.9	1.2
BASE	0	0	0	0



Graph 8: Displacement of FRAME with V-bracing for zone-III and zone-IV

Table 10 Inverted V-BRACING

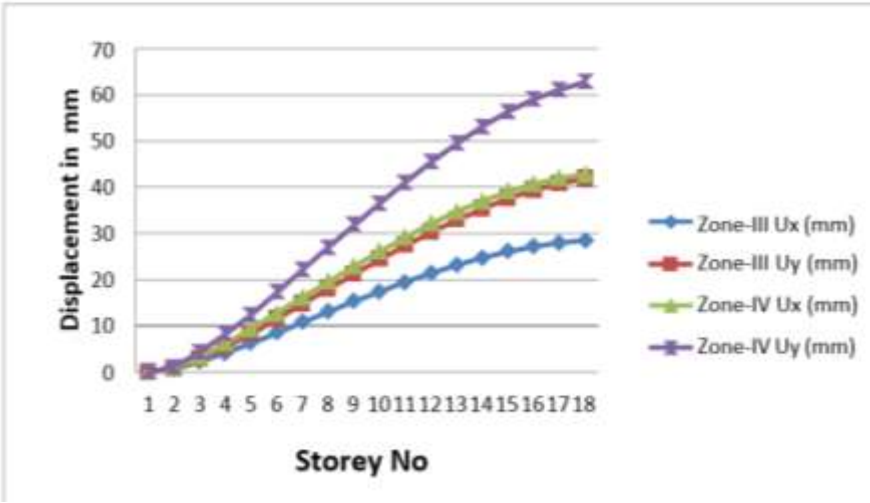
STOREY	Zone-III		Zone-IV	
	Ux	Uy	Ux	Uy
ROOF	24.6	36.4	36.8	54.5
15th	23.6	34.7	35.3	52
14th	22.4	32.8	33.5	49.2
13th	21	30.7	31.5	46
12th	19.5	28.4	29.3	42.6
11th	17.9	25.9	26.9	38.9
10th	16.3	23.4	24.4	35
9th	14.5	20.7	21.8	31.1
8th	12.7	18	19.1	27
7th	10.9	15.3	16.4	22.9
6th	9.1	12.6	13.7	19
5th	7.4	10.1	11.1	15.1
4th	5.8	7.7	8.7	11.6
3rd	4.2	5.5	6.4	8.3
2nd	2.9	3.7	4.3	5.5
1st	1.6	2.1	2.4	3.1
GROUND	0.7	0.9	1.1	1.4
BASE	0	0	0	0



Graph 9: Displacement of FRAME with Inverted V-bracing for zone-III and zone-IV

Table 11 K- BRACING

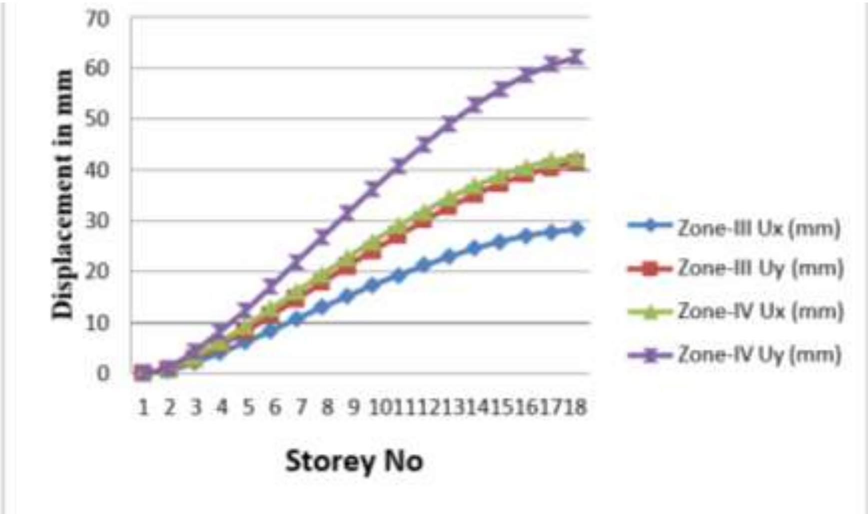
STOREY	**Zone-III**		**Zone-IV**	
	Ux	Uy	Ux	Uy
ROOF	28.5	41.9	42.8	62.8
15th	28	40.8	42	61.2
14th	27.2	39.4	40.8	59.1
13th	26.1	37.6	39.1	56.4
12th	24.7	35.4	37.1	53.2
11th	23.2	33	34.7	49.5
10th	21.4	30.3	32.1	45.5
9th	19.5	27.4	29.2	41.1
8th	17.4	24.4	26.1	36.6
7th	15.3	21.2	22.9	31.9
6th	13.1	18	19.6	27
5th	10.8	14.8	16.2	22.2
4th	8.5	11.5	12.8	17.3
3rd	6.2	8.4	9.4	12.5
2nd	4.2	5.5	6.2	8.3
1st	2.2	2.9	3.2	4.3
GROUND	0.6	0.8	0.9	1.2
BASE	0	0	0	0



Graph 10: Displacement of FRAME with K-bracing for zone-III and zone-IV

Table 12 INVERTED-K BRACING

STOREY	**Zone-III**		**Zone-IV**	
	Ux	Uy	Ux	Uy
ROOF	28.3	41.4	42.4	62.1
15th	27.8	40.4	41.7	60.6
14th	27	39	40.5	58.5
13th	25.9	37.2	38.8	55.8
12th	24.6	35.1	36.8	52.6
11th	23	32.7	34.5	49
10th	21.2	30	31.8	45
9th	19.3	27.1	29	40.7
8th	17.3	24.1	25.9	36.2
7th	15.2	21	22.7	31.5
6th	13	17.8	19.4	26.7
5th	10.7	14.6	16.1	21.9
4th	8.4	11.4	12.7	17.1
3rd	6.2	8.2	9.3	12.4
2nd	4.1	5.5	6.2	8.2
1st	2.1	2.8	3.2	4.3
GROUND	0.6	0.8	0.8	1.1
BASE	0	0	0	0



Graph 11: Displacement of FRAME with Inverted K-bracing for zone-III and zone-IV

From Table 8 to 12 interpretations can be given as:-

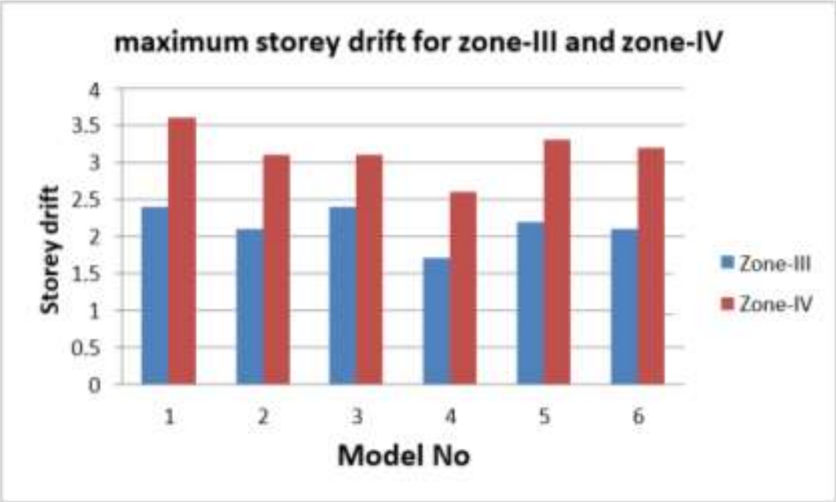
- Zone IV is shown to have most lateral displacement, compared to building in Zone III. Zone IV has a high level of seismic activity.
- The greatest lateral displacement occurs at roof level and progressively reduces as one descends through the structure.
- It has been shown that in both seismic zones, bare frames exhibit larger lateral displacements than frames with alternative bracing methods.
- Inverted V-Bracing systems have been proven to be more successful in decreasing lateral deformation in earthquake regions III & IV.
- Compared to other forms of bracing systems, Inverted V-Bracing systems feature the lowest potential lateral displacement.
- In case of bare frame the displacement for zone-IV is higher about 33.26% related to zone-III.
- As with frame with X-bracing displacement for zone-IV is higher about 33.49% with respect to zone-III.
- As with frame with V-braces displacing for zone-IV is high about 33.25% with respect to zone-III.
- In case of frame with inverted V-bracing the displacement for zone-IV is higher about 33.15 % with respect to zone-III

6.6 Lateral storey drift:

It is the difference in height or distance between two levels. IS 1893 (Part 1): 2002 states that any storey drift owing to the minimum required designing lateral force, having partial loading factor 1, should not exceed 0.04 times height of storey.

Table 13 Max Storey Drift in Frame along-X

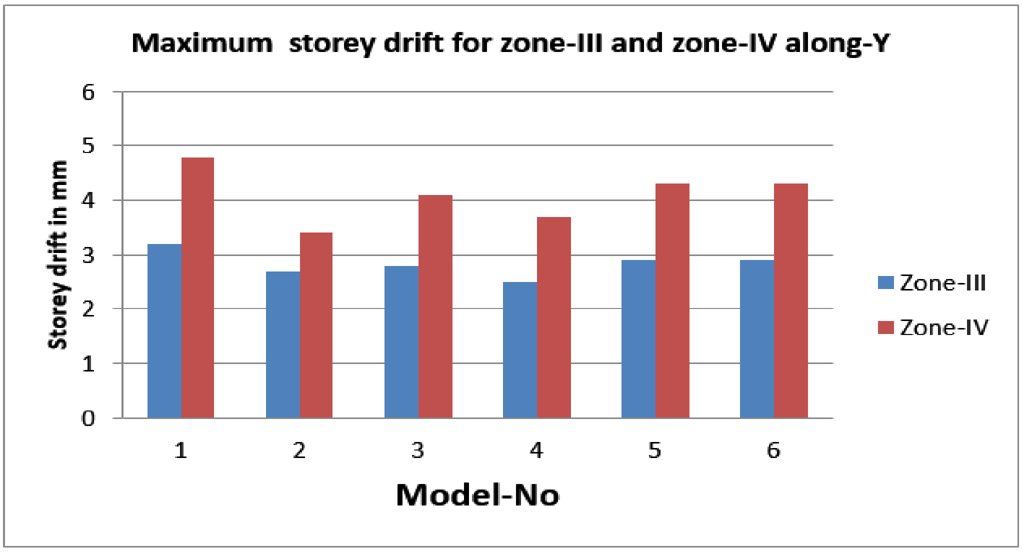
Displacements (mm) in X (Longitudinal) Direction		
Structure Kind	Zone III	Zone IV
Bare Frame	2.4	3.6
X Bracing	2.1	3.1
V Bracing	2.4	3.1
Inverted V Bracing	1.7	2.6
K Bracing	2.2	3.3
Inverted K Bracing	2.1	3.2



Graph 12: Storey drift of all models for zone-III and zone-IV along-X

Table 14 Max Storey Drift in Frame along-Y

Displacing(mm) into Y orientation		
Structure Kind	Zone-III	Zone-IV
Bare Frame	3.2	4.8
X Bracing	2.7	3.4
V Bracing	2.8	4.1
Inverted V Bracing	2.5	3.7
K Bracing	2.9	4.3
Inverted K Bracing	2.9	4.3



Graph 13: Storey drift of all models for zone-III and zone-IV along-Y

From Table 13 to 14 the following observations are made

1. The storey drift for bare frame is maximum in both zone III and zone-IV
2. The storey drift is minimum for frame with inverted-V bracing i.e model-04
3. All storey drift values are within the permissible limit in both longitudinal and transverse direction.

4. When we go with X-bracing in model-2 the storey drift is reduced by 12.5% in zone-III and 13.88% in zone-IV compared to model-01.
5. When we go with inverted-V bracing in model-04, the storey drift is reduced by 29.16% in zone-III and 27.77% in zone-IV compared to model-01

7. Conclusion and Scope for Further Studies

7.1 Conclusion

Analytical experiments have been used to investigate the braced RC frame's behavior in this study. A bare frame model of an RC building frame was examined, as were several bracing techniques. After doing this research, these are findings.-

1. 1. The idea of employing steel bracing to withstand earthquake pressures is a good one.
2. When compared to a frame without bracings, lateral movement is much minimized.
3. Bracing lowers the stresses on the frame members.
4. As an option for retrofitting, steel bracings might be employed.
5. Structure safety has been improved by adding steel bracing as a stress resistant part.
6. Bracing is more effective than a bare frame in reducing story drift.
7. This bracing method exhibits the lowest lateral displacement both in seismic zones compared to other bracing systems.
8. Primary RC structure system for resisting lateral loads is comprised of steel bracings.
9. The time period for bare frame is highest compare to other frame with different types of bracing.
10. The time period for frame with inverted-V bracing is least compared to other frame with other type of bracing.
11. The base shear for bare frame is least compare to other frame with different type of bracing system in both zones.
12. The base shear for frame with Inverted-V bracing is highest compared to other frame with different types of bracing system.

7.2 Scope For Future Study

- ❖ Seismic analysis of asymmetric building frame can be studied by providing steel bracings.
- ❖ Into current analysis, Equivalent Static Method is utilized for the analysis. Time history analysis and Push Over analysis can also be performed.
- ❖ The building frame can be studied by considering different soil conditions.
- ❖ The present study has been done by considering plain ground, further study may be undertaken by considering the building to be resting on Sloping ground.
- ❖ In this study foundation is considered as fixed, auxiliary analysis can be done with consideration of soil’s structural response.

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