

Dynamic analysis of residential Building with and without Bracing for Zone IV (G+10)

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Abstract: Earth is the one of the planet where all types of creatures are easily survive. But earthquake is most destructive phenomena of nature and destroy the earth. So we have to know the about earthquake and their effect on the residential Building. And research for prevention of the building due to earthquake. In this paper we are analyzed building for zone iv and see the result how much affected building by earthquake, and for reduce the effect of earthquake provide X bracing in the different arrangement in building. And analyzed dynamic analysis by Staad Pro vi 8i.

1. Introduction

All bodies having mass and elasticity are capable to vibrate. The mass is inherent in the body and elasticity causes relative motion among its parts.

The body's internal forces, which take the form of elastic energy, attempt to return the body to its initial position when external forces cause displacement of its particles. Because of Lit, the body continued to move in the opposite direction at equilibrium, converting all of the elastic energy into kinetic energy. The body returns to its equilibrium position as a result of the complete conversion of kinetic energy into elastic or strain energy. In this manner, energy is exchanged and vibratory motion is repeatedly repeated. Therefore, vibration or oscillation refers to any motion that repeats itself after a certain amount of time.

While conventional seismic design aims to create structures that do not collapse when subjected to intense seismic shaking, it may cause damage to both structural and non-structural elements, such as beams, columns, and occasionally entire buildings. Furniture, equipment, partitions, curtain wall systems, pipes, electrical equipment, and many other items might be considered non-structural components. This could make the building inoperable following the earthquake, which could be problematic for certain structures, such as residential buildings, hospitals, and important institutions like museums, etc., that must continue to function during an earthquake.

This study discusses the use of X bracing to maintain structure stability during seismic events like earthquakes and windstorms. It also lessens the possibility of damage by limiting the building's lateral movement.

Various Zones of Earthquake in India:-Based on data from previous earthquakes, the tectonic structure of the areas, and other scientific information pertaining to seismicity, earthquake-prone locations in India have been identified. The nation is separated into four seismic zones, II, III, IV, and V, according to BIS.

Zone IV :- This area is known as the severe intensity zone . It includes parts of ladakh. remaining portions of Jammu and Kashmir, Himachal Pradesh, and Uttarakhand, some parts of Haryana, parts of Punjab, Delhi, and Sikkim, the northern parts of Uttar Pradesh, a small portion of Bihar, West Bengal, parts of Gujarat, small parts of Maharashtra near the west coast, and small portions of western Rajasthan are all included in Zone IV, also known as the severe intensity zone

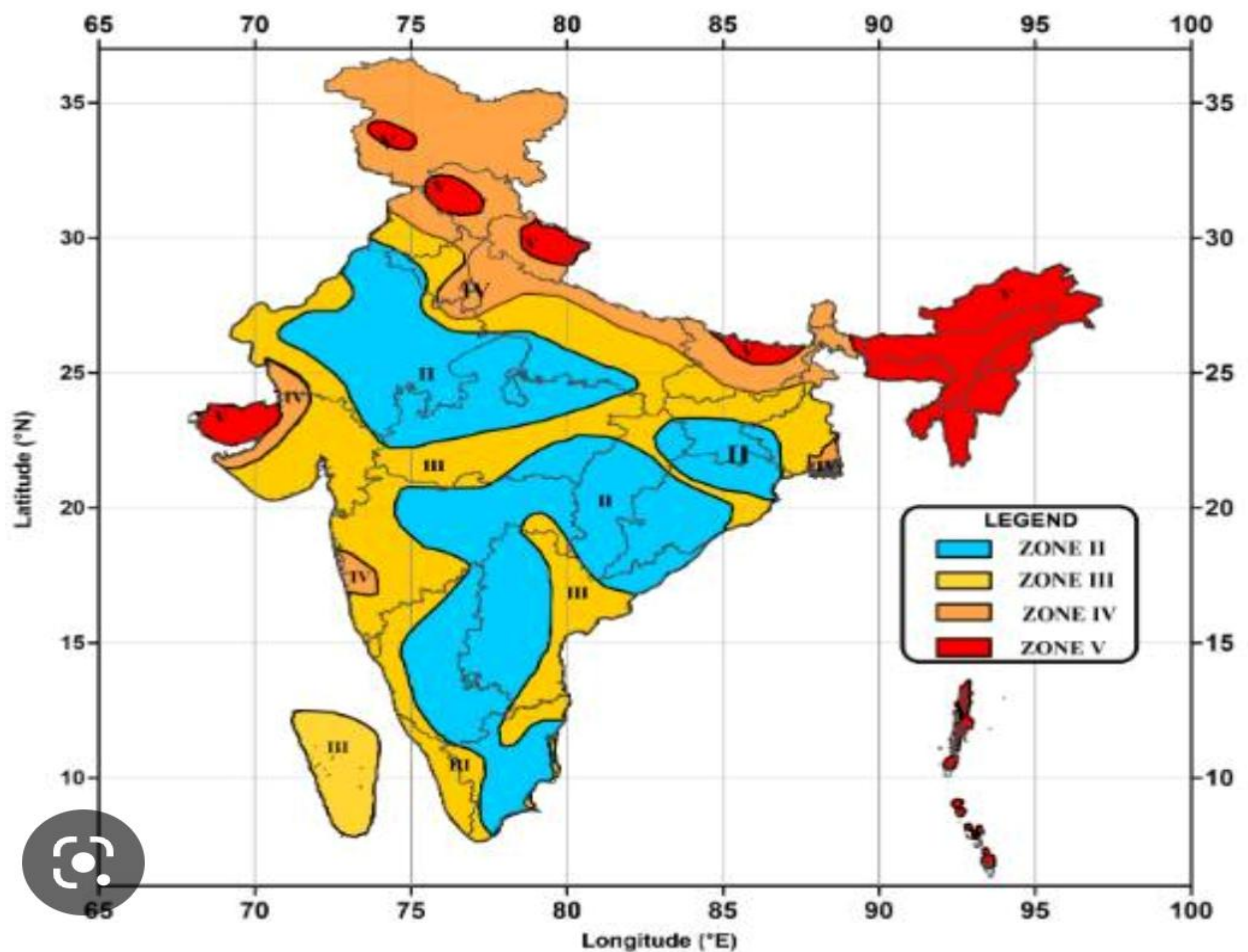


Figure 1.1 - Map of India of different seismic zone
(Source - Internet)

<https://images.app.goo.gl/QgJMkce7Mi7KqXPn7>

Types of Bracing:-

For modern buildings to be stable and secure, bracing systems are essential. In order to withstand lateral forces such as wind, seismic activity, and other loads that cause a building to sway or collapse, a bracing system is a structural component. Building stability to withstand these stresses and reduce damage to the structure and its inhabitants can be enhanced by well-designed bracing during construction. Columns, beams, and frames support vertical loads, while bracing supports lateral loads.

K-Bracing

V-Bracing

X Bracing

Single Diagonal Bracing

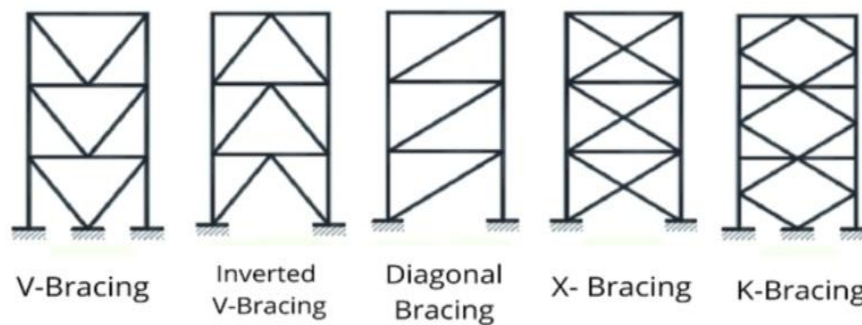


Figure 1.2 – Different type of bracing
(Source – Internet)

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Advantage of X Bracing:-

Structural stability:- cross bracing can help maintain a building's stability under significant seismic activity. Winds can lessen the possibility that the structure will sustain damage.

Load distribution: Cross bracing allows beams to share lateral impacts like wind and collision stress as well as vertical bending effects.

Buckling control: Cross bracing can help keep main beams from buckling, particularly during construction when steel beams may be stressed by wet concrete.

Economy: Compared to other options, cross bracing may be more cost-effective. For instance, sheeting can be utilized to reinforce the building in short spans.

Problem And Statement

Building is a one of the important structure which is stand on the surface of the earth. Due to increasing the population and shortage of land we have to develop vertical structure storey vice. Earthquake is a problem this effect to structure and damage. So for prevention by earthquake and reducing the effect of this problem provide the X bracing in different way of arrangement and compare to their result which one of the arrangement is more suitable and effective for the structure this analysis is done for zone IV by staad pro software which allows for a more accurate result of seismic force acting on building. STAAD pro offers advance features for calculating the frequency mode, dynamic behavior of structure due to seismic effect. The software will helpful for calculating the various result of building such that displacement, peak storey shear, shear force etc. The study and analyzing to building with and without X bracing we know the effect of seismic in building and how to reduce this effect by providing seismic resistant X bracing in different way of arrangement in building and which arrangement is more effective.

Objective and Scope

The objective of this project is reduce the affect of lateral force in building which produces during the earth quake and affected to structure, reduce the reduce the lateral effect by providing X Bracing in building in different ways of arrangement in structure. Provide X Bracing for IV zone and compare their results.

The main objective of this project is reduce the effect of seismic vibration which is produce during the and affected to structure. So for this this problem in the building provide better strength than normal building. By provision of X bracing in the structure in different way of arrangement and see the result which way is more effective with and without bracing and compare their deflection, maximum bending. This analyzed done for zone iv. Scope of seismic analysis is provide to knowledge about earthquake and effect of it in the structure. How to prevent structure by provide bracing and reduce the effected from earthquake.

It is calculated as the distance from the point. A Bending moment is simply the bend that occurs in a beam due to a moment.

Scope:-

The scope of analysis of residential building without bracing and with X bracing in different way of arrangement is that it's provide knowledge about for zone IV and which type arrangement of bracing is more effective for structure. So it is very important to know the about that in this zone which type arrangement of bracing is useful and reduce the lateral force, displacement, peak storey shear which is produce by earthquake, so how to design the structure and check the result which is safe or not safe for future.

2. Literature Review

[1] Pravin S. Kamble, Satyajeet H. Chavan, Saurabh S. Kadam, Dada S Malve ,(2016), Lateral load analysis of a building with & without knee bracing.

In this research paper author used different type of bracing (X,V,K)and knee bracing. And analysis by computer software SAP 2000 and pushover analysis. Result get satisfying. This analysis comparision between siesmic parameter such as roof displacement, time period storeydrift, base shear analysis by steel bare frame with different bracing pattern are studied. And found that the X type of bracing significantly contributes to the structure stiffness and it proved for use to reduce the maximum interstates drift of steel in comparision of other bracing system.

[2] Sk Muiz Sk Abd Razak, T.C. Kong , N.Z. Zainao, A. Adzan ,and ,M. Azimi (2018),A Review of influence of various type of structural bracing to the structure performance of building

This paper examines the effects of different building structural performance types. The outcome against excessive lateral drift was found in this. Structural bracing, which increases the stiffness and stability of the structure, is a common technique used to control lateral drift. Excessive latral drift within the building may cause cracks to grow and cause structural damage. Researchers examined the history of structural bracing, the variations among various structural bracings in terms of suitability for various building types and loading, technical specifics of the mechanism, and the overall effect behavior performance of the advantages and disadvantages.

[3] Kartik Prashar, Jagdeep Singh Gahir, (2018), A Review paper on a seismic behavior of RC Frame structure with Different type of bracing.

This study examines how bracing systems in high-rise RC buildings are designed to withstand latent loads by providing stiffness, strength, and energy dissipation. Additionally, an examination of various bracing systems for high-rise buildings is conducted in order to reduce seismic hazards and ensure that the structure has sufficient lateral resistance. Column members are provided by the bracing system to withstand lateral loads. Installing a bracing system is cost-effective and takes up less room. Using ETAB software, the structure is analyzed for seismic zone V with various bracing options and compared to the brae frame.

[4] Maddigari Venkata Raja, K. Venkata Krishna, (2018) , Pushover analysis of High rise building with and without bracing By using SAP 2000. During an earthquake, buildings that seemed sturdy enough can collapse like houses of cards, exposing flaws.This research examines the 2001 Bhuj earthquake, which was the most catastrophic pushover in history.SAP 2000 v16 software was used to analyze the G+10 structure in order to improve the results. A comparison is made between the base of shear, displacement, time period, hinge location, and pushover curve results. According to the analysis, bracing in the center of the building is more advantageous than other bracing arrangements.

[5] Megha Chauhan, Pratiksha malviya, Nitesh Kushwaha, (2019), Analysis of A High Rise building frame with bracing and shear links at the external member using Analysis tool Staad : A review.

A high-rise building frames with bracing and shear linkages at the external member were examined in this publication. Since the vertical shear links in the characteristic bracing system are different from those in the structure and are easily adjustable, the frame structure can continue to function normally after seismic effects as long as the other frame elements are kept elastic. In contrast to knee braces, vertical shear links are simple to design and implement. An X-type bracing system will be highly accurately fitted, and minor changes to its characteristics will decrease its ductility without increasing its stiffness.The analysis was finished using the Staad: Review tool.

[6] Shivani B. Dasare, Mrs. Karriappa M.S. (2022), Analysis and Comparative study of steel Bracing in reinforced concrete building under seismic and wind load.

The author of this journal examined the seismic resistance of unbraced and X&V braced multistory buildings. India is currently a rapidly growing country, and as its population increases, more

infrastructure will be needed. The expansion of India's infrastructure is driving up demand for homes. We can use vertical construction to meet the demand for more residential and commercial land. Because reinforced concrete buildings are primarily designed to withstand the gravity loads acting on the structure, they are not designed with the seismic load in mind, which leads to building collapse. The author provides a bracing mechanism for earthquake-resistant structures.

[7] Nandona, Goshwami, (2022), A review on the analysis of building with the different types of bracings.

Bracing is one of the most common ways to resist lateral loads in multi-story frame structures, and the author used it in this review. It aids in preventing damage or collapse caused by earthquakes. The purpose of this study is to determine how bracing in high-rise buildings is received. It is required for bracing analysis, design, and post-event effects during the building's seismic event. The tools ETAB, SAP, and Stataad Pro are used to analyze this review both with and without bracing.

[8] Shivam Prajapati, Siddharth Deb, Satyendra Dubey, (2022), Analysis of seismic behavior of RC frame structure with bracing system and without bracing, An analysis of a G+23-story steel frame building with a varied bracing system layout is done in this article. Researchers employ ISLB 50 sections and the member properties of beams measuring 300 x 400 mm and 300 x 500 mm to compare the identical pattern of bracing, columns, and beams. ETAB Software was the technology used to accomplish this analysis. According to IS 800:2007 and IS 456:2016, the section's attribute is utilized for analysis of various bracing types, including X, V, and inverted. Each level in the research model G+23, which has a 52 x 52 m square construction layout, is 3.2 m high.

[9] Shree Lakshmi K. A. Donna Sunny, (2022), Comparative study of X type of bracing and V type of bracing in multi storey building.

The author of this research examined the differences between V and X type bracing. In multistory buildings, bracing is a structural element that resists lateral loads. The author of this paper used tool staad pro to implement V type bracing and X type bracing for eight stories. And compared the results.

[10] Amer Alnajjar, (2023), Seismic Bracing For Earthquake resistant design: Architectural functioning and enhancing building safety and esthetics suggestion case of Istanbul.

This research paper examines the integration of seismic bracing in building design to enhance both safety and aesthetics, focusing specifically on Istanbul. In this paper researcher present a case study of 40 year .Old apartment building with three stories above ground and two basement floors , measuring 19 meters in length ,14 meters in width and approximately 11 meters height . Seismic bracing is essential technique .

[11] Swapnil Suresh Maindre, S.B. Salve, (2023), Seismic analysis of (G+10) building with and without zipper base frame.

The seismic study of a G+10 building with and without a zipper brace frame is presented by the review authors in this work. Two analytical models are developed, and the author of this research presented the zipper brace frame as a novel method that has demonstrated encouraging outcomes in improving seismic performance while preserving architectural aesthetics. A zipper brace was incorporated into one model, but another model did not. The author covers a number of important topics in this work. base shear, lateral displacement, and storey drift.

[12] Rangraj B., Nallina K. Ashok kumar M., deepa lakshmi P., Rishika S. Vaishnavi devi M.S., (2023), Comparative analysis of unbraced and chevron braced steel building of different stories.

The author compares unbraced and chevron-braced steel buildings of varying floors in this review paper. As more steel buildings are being built, they are quickly being deemed unbraced if the structural element is able to withstand lateral loads. A braced structure is one in which the braced frame provides lateral resistance. In their study, the author employed chevron bracing, also referred to as inverted V bracing. The behavior of G+3, G+7, and G+10 story steel buildings with and without chevron bracing is investigated using linear static and dynamic analysis. The Staad pro used.

[13] Prateek Raushan, Rahul Kumar Meena, Indrajeet Singh, (2023), Analyzing the Effectiveness of Bracing Pattern in high rise Building.

The impact of many bracing systems in a multi-story steel building is examined by the researcher in this work. Given that the majority of multi-story The effectiveness of the bracing design in high-rise buildings is examined by the researcher in this work. In addition to the gravity load system, multi-story buildings must be able to withstand lateral loads since these factors influence the design and service life performance. The purpose of the study is to illustrate how various bracing systems affect multi-story steel buildings. This study compares the maximum lateral displacement, shear force, and bending

moment observed for different types of bracing (V, X, K, and diagonal bracing) by structural system using Staad pro software.

3. Objective and Scope

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4. Software used for analysis:-

STAAD or STAAD Pro is a structural analysis and design software application originally developed by Research Engineers International in 1997. In late 2005 Research Engineers International was bought by Bentley system.

STAAD Pro is one of the most widely used structural analysis and design software products world wide. It can apply more than 90 international steel, concrete timber, and aluminium design codes.

It can make use of various forms of analysis from the traditional Static analysis to more recent analysis method like P-delta analysis, geometric non linear analysis, pushover analysis (static non linear analysis) or a buckling analysis. It can also make use of various form of dynamic analysis method from time history analysis to response spectrum analysis features is supported for both defined spectra as well as several international code specified spectra.

STAAD pro offers a range of tools and calculation, including the ability analyze for time dependent effects, check designs for cold formed section and comply with seismic requirements.

STAAD pro has an intuitive interface that can help user learn quickly. It provides a flexible environments for modeling structures. It support international codes and offer a wide range of design code to help determine deflection, drift, and depth. Users can also learn to use the appropriate code for a structure through online courses or certification programs.

BUILDING DECRPTION

Table 4.1- Description of building

1.	Types of building	G+10 storey (Residential)
2.	Seismic zone	IV
3.	Zone factor	0.24 (IS code 1893:2002)
4.	Floor Height	3m
5.	Base floor height	3m
6.	Size of column	0.45X0.45
7.	Size of beam	0.30X0.45
8.	Slab thickness	0.125
9.	Bracing	I800
10.	Length of building	15m
11.	Height of building	33m
12.	Width of building	18m

SEISMIC PARAMETER

Table 4.2 –Seismic parameter

1.	Indian code	IS 1893:2002
2.	Zone factor	0.24 (IS 1893:2002)
3.	Response reduction factor	5
4.	Importance factor	1
5.	Damping ratio	0.05

6.	Period in X direction	1 sec
7.	Period in Z direction	1 sec
8.	Spectral acceleration	1.32

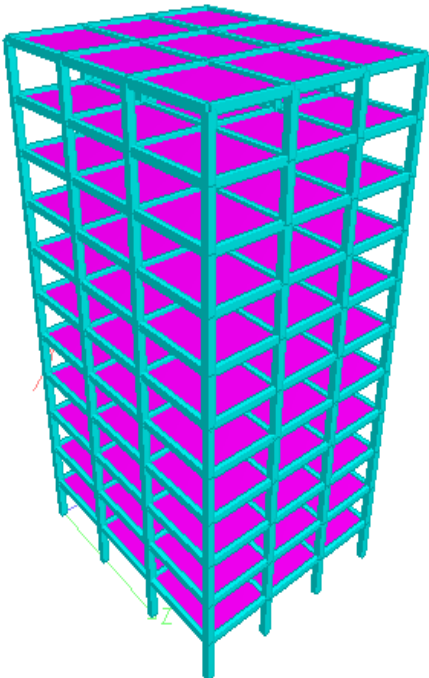


Figure- 4.2 3D Rendering view of without bracing

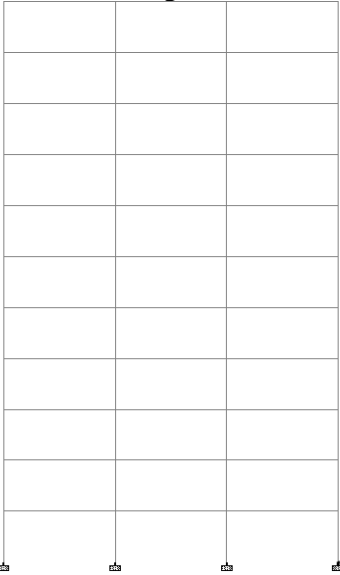


Figure 4.1- Front view of without bracing

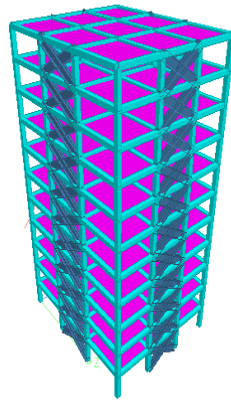


Figure 4.4 – 3D Rendering view of With continuous bracing

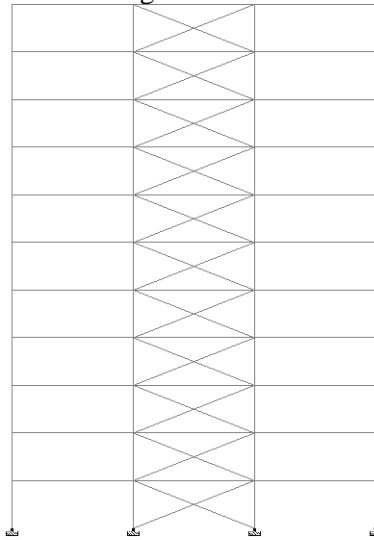


Figure 4.3 –Front view of with continuous bracing

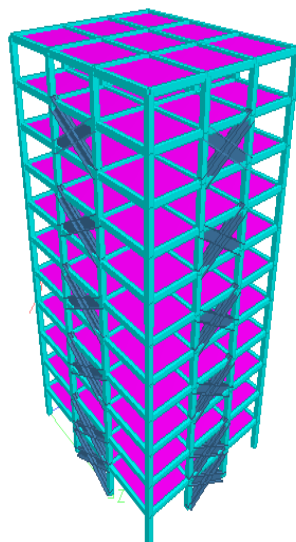


Figure 4.6 – 3D Rendering view of with alternate arrangement of bracing

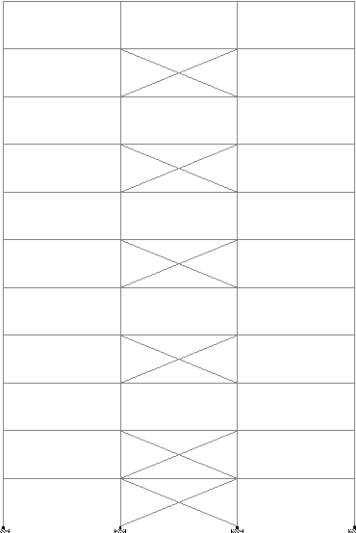


Figure 4.5 – Front view of with Alternate arrangement of bracing

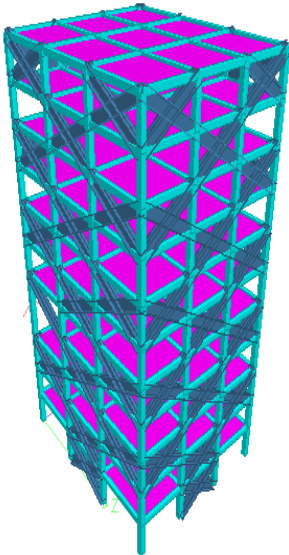


Figure 4.8- 3D Rendering view of with diagonal arrangement of X bracing

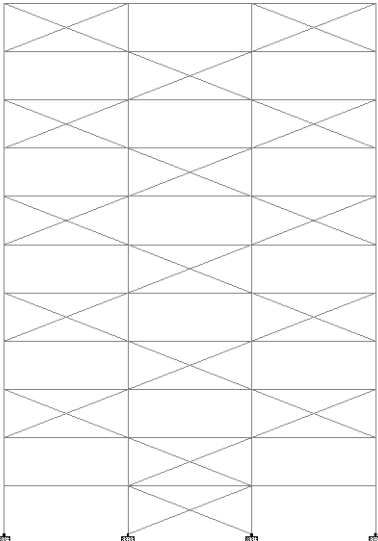
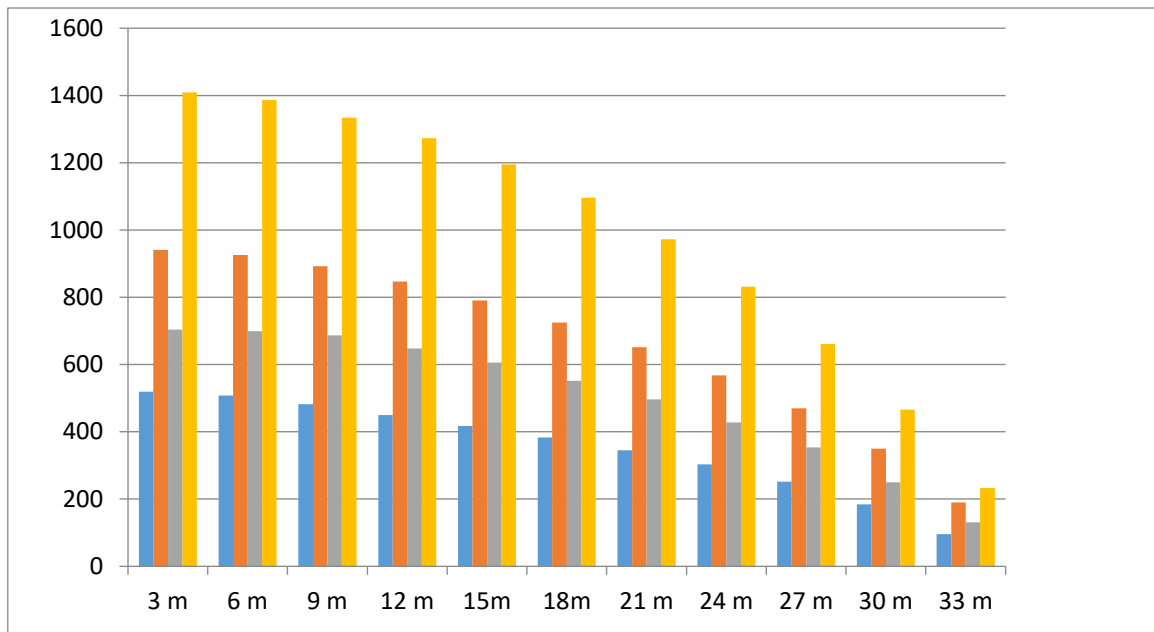


Figure 4.7- Front view of with diagonal arrangement of X bracing

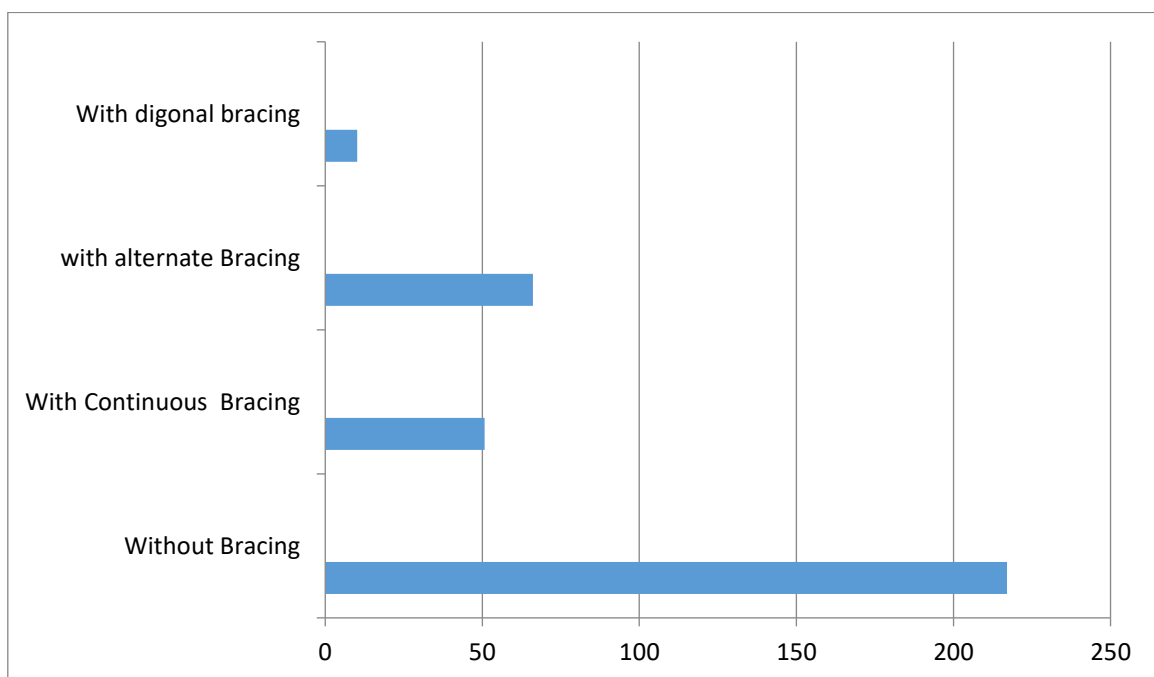


Graph 5.1 – Peak storey V/s height of building
Source – staad pro

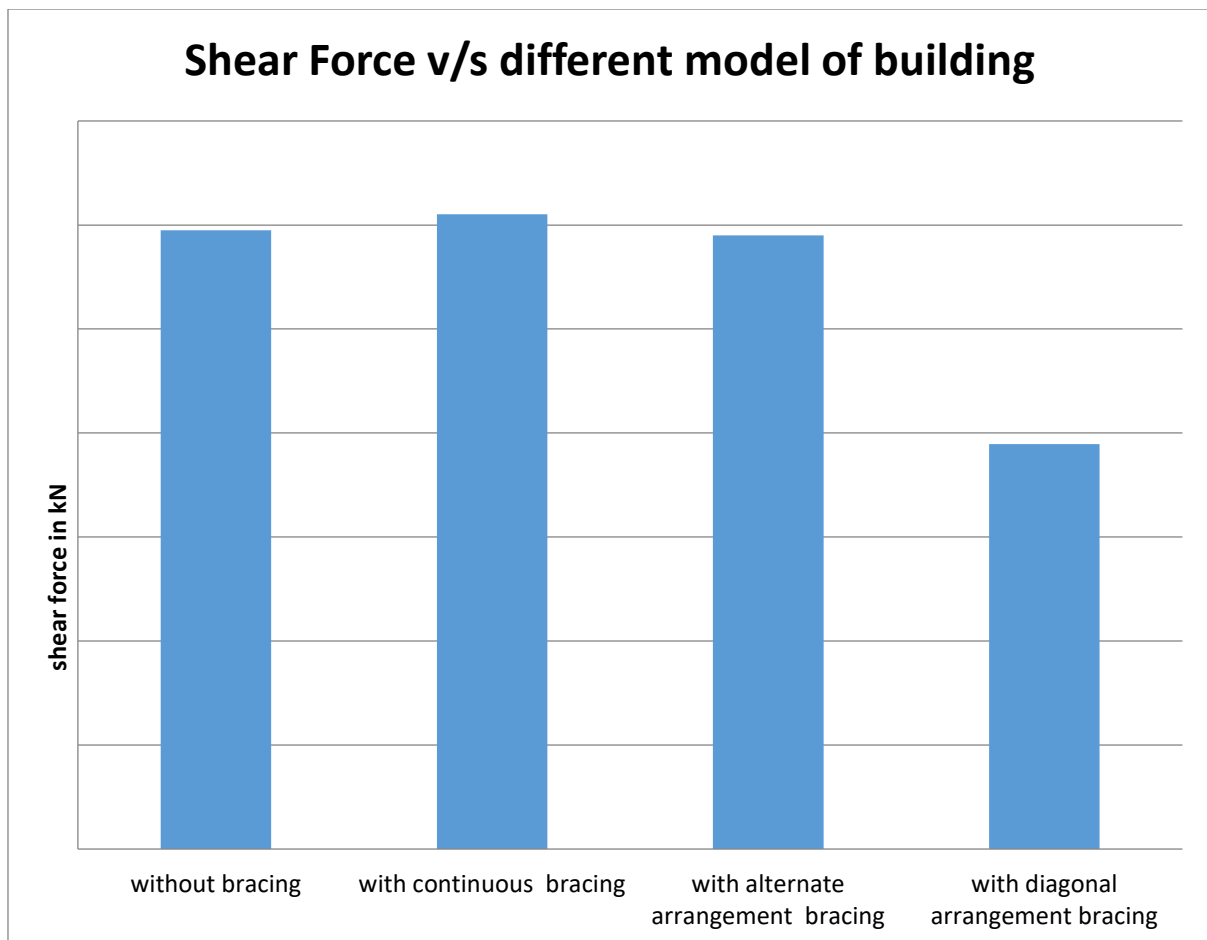
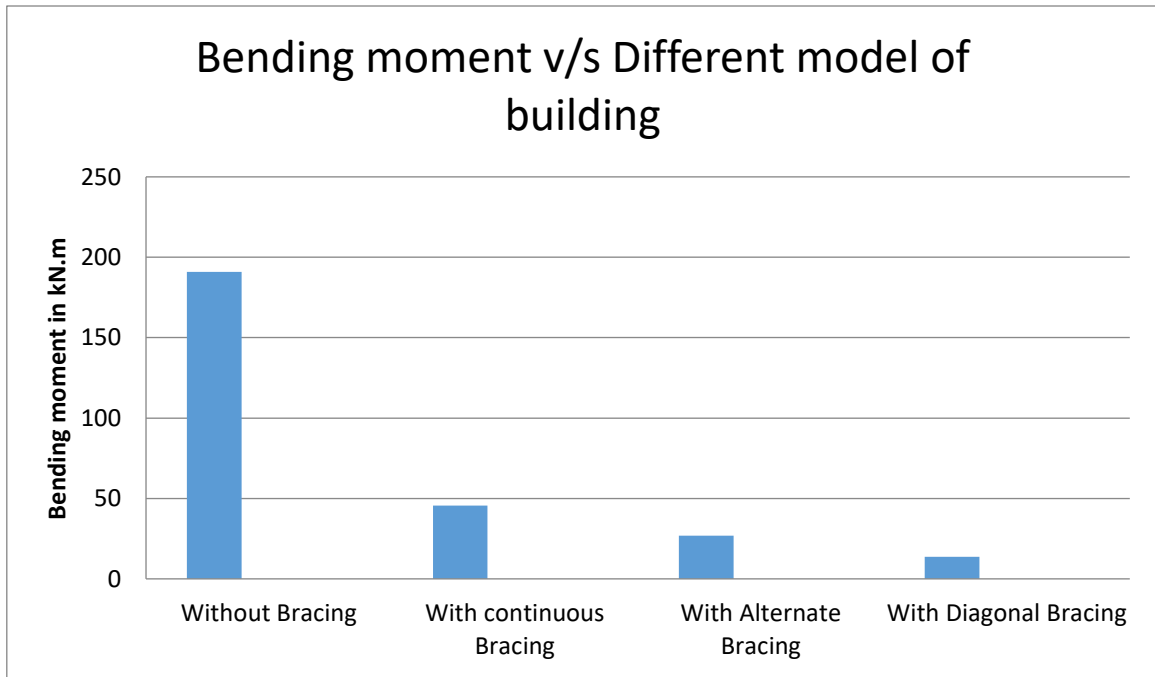
X direction is indicate to height of the building in M

Y direction is indicate peak storey shear in KN

- This colour is indicate to graph without bracing structure
- This colour is indicate to graph with continuous bracing
- This colour is indicate to graph with alternate bracing
- This colour is indicate to graph with diagonal arrangement bracing



Graph 5.2 -Maximum displacement in X direction in mm V/S different model of building



Graph 5.4 –shear force v/s different model of building

5. Result and Discussion

Several modal are analyzed and outcomes are presented in this chapter. In thesis model 4 model of (G+10) residential building are analyzed and compare their result. First model is analyzed without bracing for zone IV second model is analyzed with continuous bracing, third model is analyzed with apply alternate way of bracing, and forth modal is analyzed with alternate diagonal way of bracing. Peak storey shear, bending moment, and displacement are analyzed and get the result.

Description of building is (G+10) storey residential building, seismic zone IV, base floor height is taken 3 m, size of column 0.45X0.45 m, size of beam 0.30X0.45 m, slab thickness 0.125m, bracing 1800 ,length of building 15 m, Height of building 33 m, Width of building 18 m.

Result of the building check and found difference in result. Bending moment, peak storey shear, displacement, in building. Differentiate their result how to work bracing if it arrange the different way in building and give the result different.

The result of the diagonal arrangement of bracing is better than as compare to other arrangement of bracing and without bracing structure. Below show the comparison chart of result and graphical representation of result.

Comparison Table of Result

S. No	Result	Without bracing	With continuous bracing	With Alternate Bracing	With Diagonal arrangement bracing
1	Peak Storey Shear at the Top in kN.m	95.80	189.49	130.50	232.22
2	Peak Storey Shear at the Bottom in kN.m	519.52	940.49	703.47	1409.01
3	Bending Moment in kN	5948.387	6104.43	5900.068	3892.309
4	Displacement in vertical direction in mm	5.085	3.944	-1.954	0.253
5	Displacement	217.053	50.743	66.111	10.136

6. Conclusion

Peak storey shear is analyzed in building without bracing and with bracing different arrangement in building. Peak storey shear is indicates the intensity of lateral forces. Less stiffness of building having less peak storey shear, we found the less peak storey shear in without bracing building 519.52 kN in bottom of building and 95.80 kN in top of the building and with continuous bracing in building get 940.49 in the bottom and 189.49 in the top. In third model building with alternate bracing result found 703.47 in the bottom and 130.50 in the top. The value of peak storey shear in diagonal arrangement in building 1409.01 kN in bottom of the building and 232.22 kN in top of the building. The diagonal arrangement of bracing in building is more effective as compare to other arrangement type of bracing in building.

Displacement of building is the distance between the original position of a point and its final position after deformation we have found the less displacement in diagonal arrangement in building 10.136 mm and 217.053 mm in without bracing building. While 50.743 mm in with continuous arrangement of bracing and 66.111 mm in with alternate arrangement of bracing Diagonal arrangement of bracing in building is more stable as compare to other arrangement of bracing in building.

Bending moment is the forces that cause a structural element to bend when an external force is applied to it. We are found the result 191.002 kN-m in without bracing structure, 45.646 kN-m in with continuous bracing in building, 26.962 kN-m in with alternate arrangement of bracing, 13.791 kN-m in with diagonal arrangement of bracing. Analysis the building without bracing and different arrangement of bracing in building, we get the better result in diagonal way of arrangement as compare to other way of arrangement.

Shear force is an internal force that acts parallel to structure member's cross section and can cause it to deform or fail. In without bracing building 5948.387 kN and with continuous bracing 6104.43 kN with alternate bracing 5900.068 and with diagonal arrangement of X bracing 3892.309 kN.

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