International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 05 | May - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Seismic Analysis of Multistorey RC Building by Using Staad.Pro V8i

Risent Kumar Dewangan[1], Dr. R.R.L. Birali[2], Mr. Akhand Pratap Singh[3] , Mr. Parmeshwar Sahu[4]

Mr. Shiva Verma[5]

[1]M.Tech Scholar,[2]Professor,[3]Assistant Professor,[4]Assistant Professor,[5]Assistant Professor

Department of Civil Engineering

Shri Rawatpura Sarkar University,Raipur

---***---

Abstract - The rapid increase in urban population has led to the vertical expansion of cities, resulting in the construction of high-rise buildings. As the height of buildings increases, their vulnerability to seismic forces also increases. In earthquake-prone regions, the structural stability of multistorey reinforced concrete (RC) buildings becomes a critical aspect of design. Seismic analysis, therefore, plays a pivotal role in ensuring that structures can withstand dynamic loads caused by earthquakes. This study focuses on the seismic analysis of a G+14 storey RC framed building using **STAAD Pro V8i**, a widely used software tool for structural analysis and design in the field of civil engineering.

The primary objective of this research is to analyze and understand the seismic behavior of a 15-storey (G+14) RC building, taking into consideration the dynamic effects of earthquake loading. The structure is assumed to be located in **Seismic Zone IV** (moderately to highly earthquake-prone), and the analysis is performed according to the seismic design provisions of the **Indian Standard IS 1893 (Part 1): 2016** and **IS 456:2000** for RC design. The modeling includes dead load, live load, and seismic load cases, with combinations formulated as per **IS 875 (Part 1 & 2)** and IS 1893 standards. The **Response Spectrum Method** is employed for the dynamic analysis as it provides more accurate results for taller buildings compared to the equivalent static method.

In this study, the building is modeled as a regular frame structure using M30 grade concrete and Fe500 steel. The seismic zone factor, response reduction factor, importance factor, and soil type are all input into the STAAD Pro V8i software to generate and apply dynamic seismic loads. Key response parameters analyzed include **storey displacement**, **storey drift**, **base shear**, and **natural time period**. The software enables visualization of deformation shapes, bending moments, and shear forces, which are essential for evaluating the structural performance during an earthquake.

This research concludes that STAAD Pro V8i is an effective tool for seismic analysis and offers valuable insights into the behavior of high-rise RC buildings under dynamic loading conditions. The analytical results assist engineers in designing structures that are both safe and compliant with current codes. Moreover, the findings emphasize the need for incorporating seismic considerations from the early stages of design, especially in regions with high earthquake risk.

Keywords: Seismic analysis, STAAD Pro V8i, G+14 building, multistorey RC frame, response spectrum method, base shear, storey drift, lateral displacement, IS 1893:2016, earthquake loading, reinforced concrete design, structural dynamics, dynamic analysis, Indian seismic code, high-rise buildings.

1. INTRODUCTION:

Earthquake refers to any form of seismic event developing seismic waves that may be either natural or human-initiated. Earthquakes are typically triggered by ruptures in geological fault, but they may also be caused by volcanic activities, mine blasts, land slides and nuclear explosions. Seismic waves are generated because of the earthquake and the developed waves are further referred to as seismic force or lateral loads. The sideways loads consequently decrease the stability of the structure by causing a sway moment and stresses in the frame. In a situation like this, the structure's tightness is more important than its capacity to withstand lateral loads.

In India, there have been a number of earthquakes that have seriously and significantly damaged the infrastructure for homes, businesses, and people. More than 60% of Indian land areas are concentrated in the top three seismic zones, III, IV, and V, while only around 3% of building spaceis adequately engineered, following the Indian seismic code IS 1893 (Part- 1):2016. With the increase in seismic activity around the world in recent years, seismic forces have drawn increased interest and have shown their effects to be more devastating during a significant earthquake, structures situated in seismically risky regions may sustain significant damage. As a result of ground motion, deformations happen throughout the load-bearing system of buildings. A building has a limit to resist displacement so, there is a need to increase the strength of the building. Strengthening techniques are then used to ensure that a building's displacement demandis maintained below the capacity of its displacement. This can primarily be accomplished by the enhancement of the structure's displacement capacity. In general, there is smaller horizontal displacement requirements for buildings with greater stiffness and lower density.

In recent decades, the devastating effects of earthquakes on structures, particularly in seismically active zones, have highlighted the critical importance of structural stability and safety. Reinforced Concrete (RC) buildings are widely used for both residential and commercial purposes due to their versatility, strength, and durability. However, their behavior under seismic loading can vary significantly depending on design, construction practices, and dynamic properties. Thus, it becomes imperative to analyze and design these structures to resist seismic forces effectively.

Seismic analysis refers to the evaluation of a building's response when subjected to earthquake-induced ground motion. This process ensures that the structure can withstand lateral forces, vertical displacements, and dynamic vibrations, thus minimizing structural damage and loss of life. With advancements in computational tools, the seismic behavior of complex multi-storey RC buildings can now be accurately modeled and analyzed using structural engineering software.

STAAD Pro V8i is one such powerful software widely adopted by structural engineers. Developed by Bentley Systems, it allows for comprehensive structural analysis and design, including static and dynamic loading conditions. Using STAAD Pro, one can model a building in three dimensions, assign material and geometric properties, apply seismic loads as per IS 1893 or other international codes, and interpret the results to ensure code compliance and structural integrity.

This project focuses on the seismic analysis of a multi-storey reinforced concrete (RC) building using STAAD Pro V8i. Through a methodical modeling and load application approach, the study aims to understand the building's performance under earthquake loading conditions and to identify potential vulnerabilities in the structural system.

The need for seismic analysis is reinforced by growing urbanization, population growth, and the increasing height and complexity of buildings in modern cities. As India is a seismically active region with zones of moderate to high hazard, it becomes essential to adopt accurate modeling techniques and reliable software tools for structural safety assessment.

This project serves as a practical exploration into the capabilities of STAAD Pro V8i in evaluating the seismic resilience of multi-storey RC structures, drawing on IS 456:2000 and IS 1893 (Part 1): 2016 for design criteria and loading specifications.

1.1 Objectives

The primary and secondary objectives of this study are outlined as follows:

Primary Objectives:

1. **To perform seismic analysis** of a multi-storey reinforced concrete (RC) building using STAAD Pro V8i, considering Indian Standard Codes for seismic loading.
2. **To evaluate the structural response** parameters such as displacement, base shear, storey drift, and member forces under seismic loading.

3. **To compare and verify** the obtained results against IS Code permissible limits to assess safety and compliance.
4. **To understand the influence of height** and configuration on seismic performance in RC buildings.

Secondary Objectives:

1. To familiarize with the modeling environment and features of STAAD Pro V8i specific to dynamic analysis.
2. To apply seismic load as per IS 1893:2016 using Response Spectrum Method or Equivalent Static Method.
3. To interpret output results including shear force, bending moment, axial force, and displacements for critical members.
4. To recommend possible design improvements or retrofitting suggestions based on the results.
5. To highlight the importance of dynamic analysis in structural design practices and promote earthquake-resistant construction.

2. Literature Review:

1. **Viswanath *et al.* (2010)** studied that for enhancing the earthquake resistance, increasing the strength and for retro fitting the concrete frames the use of steel braces is a very good solution. A 4-storey RC buildings with concentric steel bracing on peripheral columns were analysed for the seismic analysis. A computer based software named STAAD Pro was used for analysis and zone IV was considered. The performance of various steel bracing(X, K and Diagonal) were studied and the bracings were provided along the height for the building. Evaluation of the building was done by getting the storey drifts. The building's lateral displacement was found to be reduced when a bracing system was added when the findings were compared to the base frame and other steel braced frames. Due to the usage of bracings, shear forces and bending moments in the columns were also minimised. The usage of X (cross) type steel bracing was determined to be the most efficient when compared to other cases and increased structural rigidity. The studywas further increrased to more storied building in which percentage reduction in lateral displacement was studied and the steel bracing which reduced the inter-storey drift was theX type bracing system when used in theframes.

2. **Takey and Vidhale (2012)** They looked into how a steel building's linear bracing system might react to a seismic response using a computerised method. Steel Shares some crucial physical characteristics with reinforced cement concrete, such as maximal strength per unit weight and ductility. The analysis of asymmetrical structures with bracing systems to withstand seismic lateral loads was done using SAP, and the braced and unbraced structures that were submitted to seismic load were also compared. Response spectrum study was carried out on G+9 storeys in zone III using the steel bracings. The analysis made use of the X-type and inverted V-type bracing systems. In the study, factors taken into account to compare the seismic performance of the building were bending moment, shear force, storey drift, and axial force. Since story drift and displacement of braced structures were decreased when compared to unbraced buildings, it was determined that X bracing functioned better than another type of bracing

3. **Bajoria*et al.* (2012)** In their 2012 study, they looked at the steel construction both with and without bracing. A steel building (G+40) was used to test X, Diagonal, and K bracing. Bracing the structure boosted earthquake lateral resistance. This study described seismic analysis, or dynamic research, using the time history approach in line with IS 1893. (part1). The 40-metre-long, 22-metre-wide building had a 3.5- metre floor height. Seismic research included normal frequency, base shear, inter- storey drift, and mode forms. Bracing methods increased base shear by 38% and decreased to proof displacement by 65%, according to the research. Diagonal bracing proved very efficient and cost-effective.

4. **Kulkarni*et al.* (2013)** According to research by Kulkarniet al. (2013), braces expand the resistance to lateral forces experienced by inclined members while reducing the forces experienced by columns and beams. It behaves like a truss and is mainly stressed axially. Less moments are generated as a result when compared to moment resistant frames, and beam and column sizes can be reduced. The study focuses on the seismic analysis of RCC frames that had RC braced members installed in a V-braced arrangement. A 12- story structure with five bays in each direction is quantitatively analyzed. The V- bracing system was setup as follows:

5. bare and fully braced frames (ii) level wise and bay wise braced frames Out rigger, or partially braced frames, fall under category (iii). Following the development of these options, bracing may be placed in various locations throughout

the buildings to create various patterns and partially brace the structure. In buildings, this pattern would result in lesser forces for the worst load combinations. This set up was referred to as the ideal frame. Both braced and unbraced frames had their lateral displacement calculated, and comparisons were done. The conclusion drawn from the findings was that optimally braced frames were more rigid and powerful. Comparing this structural method to fully braced frames also led to the conclusion that it was more cost-effective. Additionally, it was claimed that optimally braced structures caused less displacement and induced fewer forces that exceeded the permitted level

6. **Kevadkar and Kodag (2013)** studied that severe damage was experienced . The structures in high seismic areas, so the structure should be able to resist the lateral loads which can develop considerable stresses. Therefore, use of steel bracings and shear wall in steel structure were considered in resisting lateral load due to seismic activities. In this study, G+12 storey building with three different kind of models were considered- I) Bare frame II) Frame which consisted of different bracing types III) Frame which consisted of different shear wall system. Further the shear wall and bracings were also of different types. For 3D modelling and to carry out the analysis a computer based software E-TABS was used. Zone III was considered for the study purpose and codal provisions used for analysis were IS-456:2000, IS- 1893:2002 and IS-875:1987. Parameters considered for the evaluation and comparison of the building were the base shear, storey drift, storey shear and lateral displacement. It was found that steel bracings reduced the BM and SF in columns and beams and thus these lateral loads were transferred through axis. Therefore, it was concluded that X bracing type was better as it increased the strength of the structure and reduced the storey drift and also the lateral displacement of the structure. Steel bracing was considered more safer against the collapse when compared with shear wall.

7. **Mohammed and Nazrul (2013)** looked into the performance of the multi-storey RCC braced constructions. A retrofitting method called a bracing systemis available to stiffen and strengthen the building so that it can with stand lateral stresses. A G+14 story SMRF (Resisting frame) was the subject of the study, which was then analysed using STAAD V8i software. The software is used to analyse the RCC frame both with and without bracing systems. Different types of bracing, including Cross (X), V, Diagonal, and K type bracings, were employed. Fully braced and unbraced framed structures are compared, and many metrics, including storey shear, bending moments in buildings, and shear forces, were computed. The conclusion drawn following the outcome was that the bracing built into the structure caused a decrease in the structure's displacement. Cross bracing assisted in lowering the shear stresses, bending moments, and lateral displacements in the columns. Because it produced superior outcomes than other bracing systems, the cross bracing system was regarded as the best of all bracing methods.

8. **Tafheem and Khusru (2013) :** The performance of steel buildings or models was evaluated using the concentric and eccentric bracing systems. The X-type and V type eccentric bracing were the two types of employed bracing. Storey drift and lateral displacement at various levels of the building were parameters that were assessed following the analysis. For the purposes of the investigation, the axial force and bending moment were also computed. Different bracings were employed for the same building characteristics to compare braced and unbraced frames. The results of the investigation demonstrated that concentric bracing increased the lateral stiffness of the building while eccentric V-type and concentric X-type bracing reduced lateral movement in the structure. The columns on the exterior face of the unbraced structure experienced the highest moments when compared to the braced structure, and itwas discovered that the columns at the corner and exterior face of the braced building were subjected to the highest axial forces when compared to the unbraced frames. As a result, after the analysis, the concentric X-type bracing was determined to be the optimal bracing method.

9. **Ibrahim, et.al (April 2019)**: Design and Analysis of Residential Building(G+4): After analyzing the G+4 story residential building structure, conducted that the structure is rate in loading like dead load, live load, wind load and seismic loads. Member dimensions (Beam, column, slab) are assigned by calculating the load type and its quantity applied on it. Auto CAD gives detailed information at the structure members length, height, depth, size and numbers, etc. STADD Pro. has a capability to calculate the program contains number of parameters which are designed as per IS 456: 2000. Beams were designed for flexure, shear and tension and it gives the detail number, position and spacing brief.

10. **Dunnala Lakshmi Anuja, et.al (2019)**: Planning, Analysis and Design of Residential Building(G+5) By using STAAD Pro: Frame analysis was by STAAD-Pro. Slab, Beams, Footing and stair-case were design as per the IS Code 456-2000 by LSM. The properties such as share deflection torsion, development length is with the IS code provisions. Design of column and footing were done as per the IS 456-2000 along with the SP-16 design charts. The check like oneway shear or two-way shear within IS Code provision. Design of slab, beam, column, rectangular footing and staircase are done with limit state method. On comparison with drawing, manual design and the geometrical model using STADD Pro.

11. **Mr K. Prabin Kumar, et.al (2018)**: A Study on Design of Multi-Storey Residential Building: They used STADD Pro. to analysis and designing all structure member and calculate quantity of reinforcement needed for concrete

section. Various structure action is considered as members such as axial, flexure, shear and tension. Pillar are delineated for axial forces and biaxial ends at the ends. The building was planned as per IS: 456- 2000.

12. **Deevi Krishna Chaitanya, et.al (January, 2017)**: Analysis and Design of a (G+6) Multi-Storey Building Using STAAD Pro: They used static indeterminacy methods to calculate numbers of unknown forces. Distributing known fixed and moments to satisfy the condition of compatibility by Iteration method. Kanis method was used to distribute moments at sucessire joints in frame and continues beam for stability of members of building structure. They used the designing software STADD Pro. which reduced lot of time in design, gives accuracy.

3. METHODOLOGY:

3.1 General

A braced frame is a type of structural structure that was primarily developed to with stand the forces caused by earthquakes. Bracings function as inclined components to sustain lateral load. By applying forces to the associated beams and columns, they axially stress the entire structure, making it resemble a truss. This axial tension reduces the moment, which in turn leads to the sections of the columns being compressed. To sustain either tension alone or alternately supporting tension and compression, the bracing elements may be placed in a variety of ways. The bracing consists of crossed diagonals and serves only as a tension reliever. Ones lanting is thought to be active while the other diagonal is thought to be passive depending on the wind direction. Cross bracing is a layout that is very common. By transferring horizontal loads to the ground, bracings keep the structure stable. Additionally, they are used to counteract lateral forces, which prevents the building from wobbling.

The study's purpose and literature review are discussed in the earlier chapters. By using various bracing techniques at various locations throughout the structure, the current research compares the seismic impact on high rise, multi-story RC buildings. The numerous loads and their combinations as per IS norms are therefore depicted in this chapter, along with a full description of the structure as it is made up of both braced and unbraced RC frame models. The plan, elevation, position of the bracing systems inside the structure, and a 3D representation of the RC frame with andwithout bracing systems are used to illustrate the geometry in this.

3.2 Loading Description

The structure should be constructed in such a manner that the load system applied to the structure verity life time will withstand it. The load application leads to the development of stress and also leads to displacement of a structure, leading to the structure's collapse. Gravity loads and seismic loads are the types of loads used in the methodology.

The codes of the Indian Standard (IS) provide information on all types of loads for structural design. For the study of the building, the following loads were considered:

3.2.1 Dead Load (DL)

Permanent loads act vertically downward and dead loads are primarily brought on by the weight of the floor slab, beams, columns, walls, and floor finish, as well as the structure's own weight. To determine a building's dead load, one can calculate and sum the self-weight of each structural component. The following formula is used to determine each structural element's self-weight in kN/m:

$DL = \gamma_m \times d \times b$

where, γ_m = unit weight of material (kN/m^3) d = element depth b = element width

For ordinary concrete and reinforced concrete, the unit weights are 24 kN/m3 and 25 kN/m3, respectively. Dead loads for different materials are extracted from the IS 875 (Part1) for analysis and design. A dead load of 3 kN/m2 on the floor and roofis used in the current study.

3.2.2 Live Load/Imposed Load (IL)

The term "live loads" refers to loads that might alter in size and location. The term "living load" was changed to "imposed load" to account for factors such as the type of occupancy, furniture, and other equipment that shape the character of the occupancy in addition to the physical contribution that people are accountable for. The loads placed on residential buildings are determined in line with IS 875 (Part 2), as detailed below.

Live load is used as 4 kN/m^2 in the present study. The codal provision which has been used for live load is given in IS 875 (part2). Live load that is to be considered for calculation of seismic effect of building as per IS 1893-2016 load upto and including 3 kN/m^2 is 25% of the imposed load is and above 3 kN/m^2 percentage of imposed load used is 50%.

3.2.3 Earthquake Load

Large areas of India's north and north east, which are classified as seismic zones IV and V, have mountainous topography. In such places, buildings are particularly susceptible to earthquakes. The epicentre of earthquakes is typically found at fault lines because earthquakes are caused by the interaction of tectonic plates.

The intensity of earthquakes involves both vertical and horizontal forces in the structure. The cumulative vibration induced by an earthquake is registered in three mutually perpendicular directions, one in vertical and two in horizontal directions. Earthquake forces in the vertical direction do not cause any major damage to buildings, where as the impact of horizontal earthquake forces on structures is

Catastrophic thus is taken into consideration for the seismic analysis. The structural stability due to ground vibration depends on the quality of the soil of the foundation, the size of the foundation, the design mode and the speed of the ground motion. The calculation of earthquake forces is based on IS1893:2016.

3.3.4 Load Combination

A load combination is provided when the structure is subjected to more than one kind of load. Building regulations often provide a variety of load combinations along with load factors for each load type to assure the safety of the structure under varied maximum load circumstances. For the investigation, a variety of loads that have a negative impact on the structure are combined.

The following load circumstances must be taken into consideration for analysis in accordance with IS 1893 (part 1): 2016 clause no. 6.3.2.2.

(Dead load plus Impose load) i.1.5

Earthquake load = Dead load+ Imposed load+Earthquake load = ii.1.2 +

iii.1.5

Dead load = 0.9 and earthquake load = 1.5

EL = Earthquake load, IL = Imposed load, & DL = Dead load

3.4 Detail of the Model

A G+14 storey RC frame building is selected for the seismic study and its performance is being checked when exposed to the seismic forces. It has been compared with thedifferent bracing systems with the same configuration. A G+14 storey building is modeled and analyzed using a computer aided software STAAD. Pro V8i. The elevation and plan of a building's bare (unbraced) RC frame are depicted in Figs. 3.2 and 3.3 (a), respectively. It is a square-plan building with a plan dimension of 12 m by 12 m, and the structural plan of the RC frame model of the construction has a total of 5 grid lines in both the X and Z directions and 4 bays each in each direction at a spacing of 3m. The structure is 45 metres tall overall, with a 3 metre height difference between each story.

Figures 3.2 to 3.9 display the structural models of RC frames with various bracing systems and bracing locations as well as the building's design and elevation (b). The building's bracing positions are shown on the plan, and a 3D rendered version of that plan is shown on the elevation. The RC frame models that were used for the analysis and are described in detail are:

STAAD cartesian coordinate directions. Fig. 3.1 displays Pro V8i for the analysis of the RC multi-story building. All of the elevations, floor plans, and 3D rendered views are depicted in accordance with the x, y, and z directions provided in fig. 3.1 of the three coordinates.

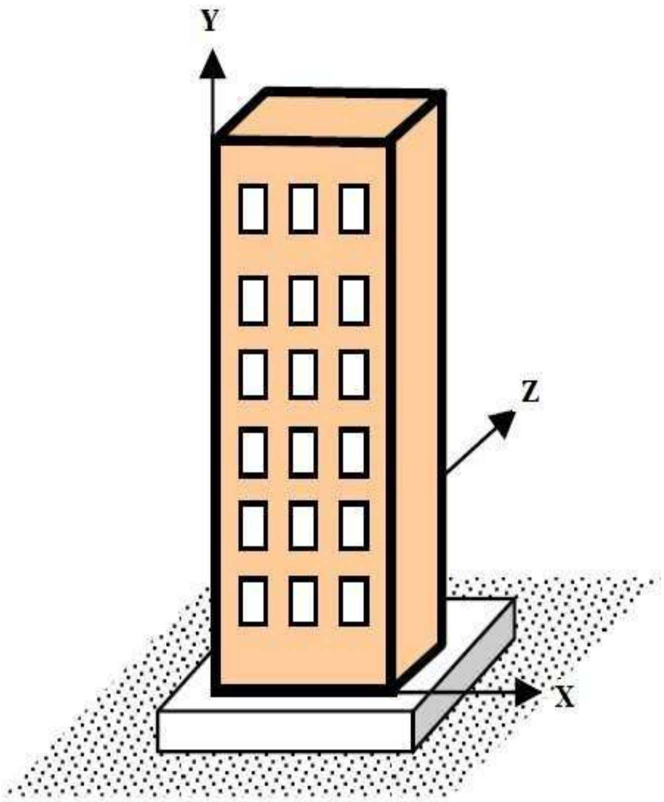


Fig 3.1 Cartesian coordinates directions in building

The basic data details of the selected building frame for analysis are listed in Table 3.1. To study the seismic analysis of frames, the basic values are selected form IS 1893: 2016 (part1) to meet the basic requirement of the structure. Moreover, various IS code has been used to calculate the DL, LL, etc. and all are explained in detail.

Table 3.1 RC Frame Data Details Considered for the Analysis

The geometry of the structure	**Detail/value**
Grids in the direction-X	5
Grids in the direction-Z	5
Gridline space of line in X-direction	3 meter
Spacing of Gridline in Z-direction	3 meter
Number of Storey	G+14
Height of each storey	3m
Height of the ground-floor	3m
Beam dimension	450mm x 450mm
Column size	600mm x 600mm
Steel bracing	ISMB 200
Soil Type	Medium

Response Reduction Factor	5
Seismic Zone	IV
Dead Load	3 kN/m^2
Importance Factor (I)	1
Combination Method	CQC
Support type	Fixed
Live Load	4 kN/m^2
Damping Ratio	5%

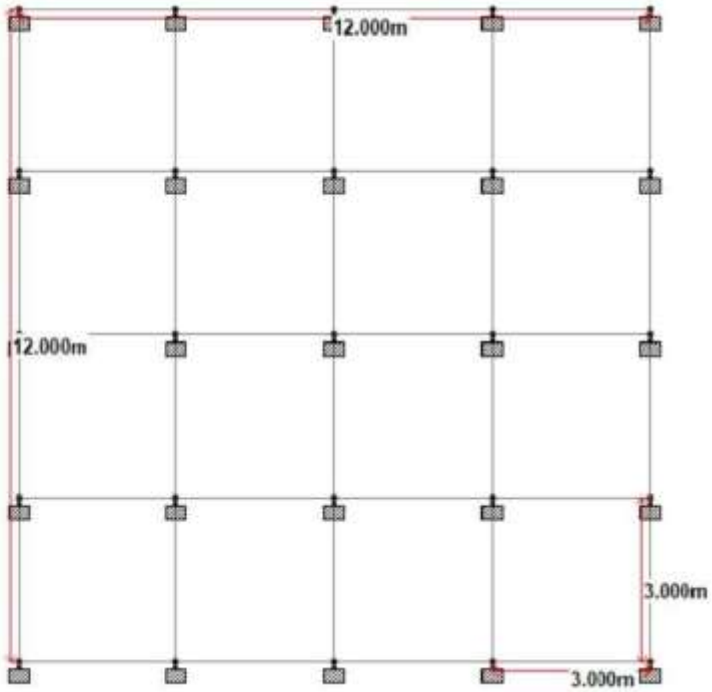
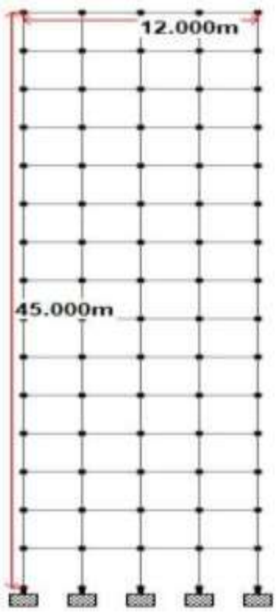


Fig.3.2StructuralLayoutofRCFrame Prototype



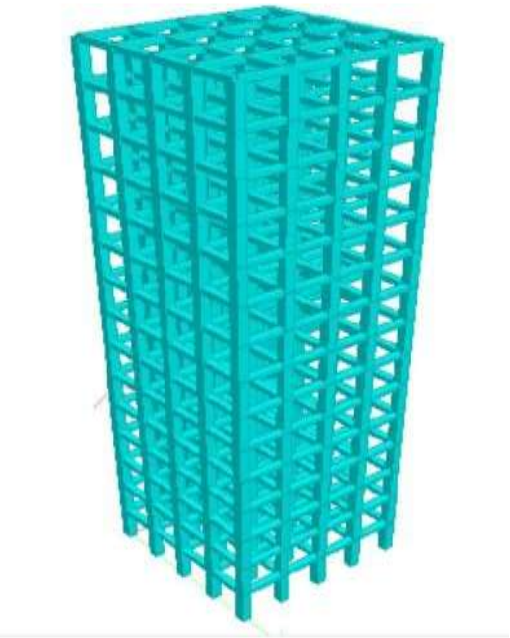


Fig. 3.3 (a) Structural Elevation of RC Frame Model

Fig. 3.3(b) Rendered view of unbraced RC Frame (Model-1)

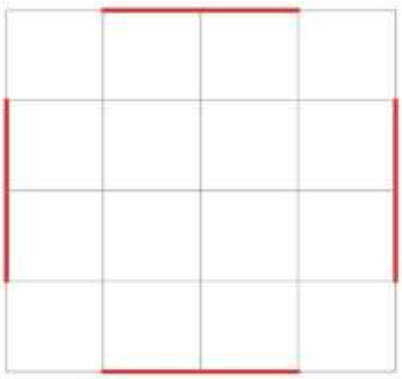


Fig. 3.4(a) Structural Plan for X-braced RC Frame (Model-2)

Fig. 3.4(b) Rendered view for X-braced RC Frame (Model-2)

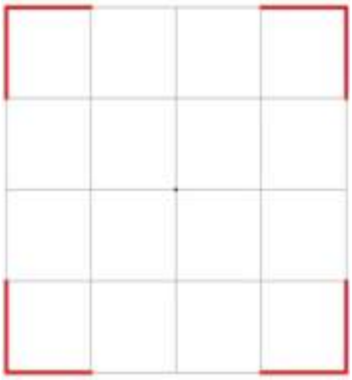
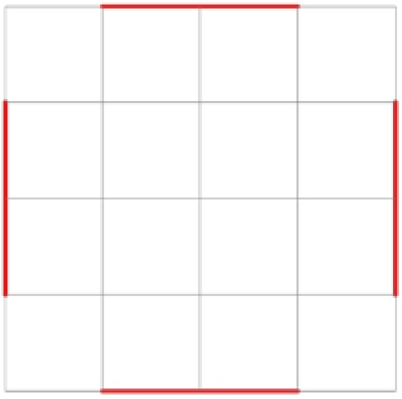


Fig. 3.5(a) Structural Plan for X-braced RC Frame (Model-3)

Fig. 3.5(b) Rendered view for X-braced RC Frame (Model-3)



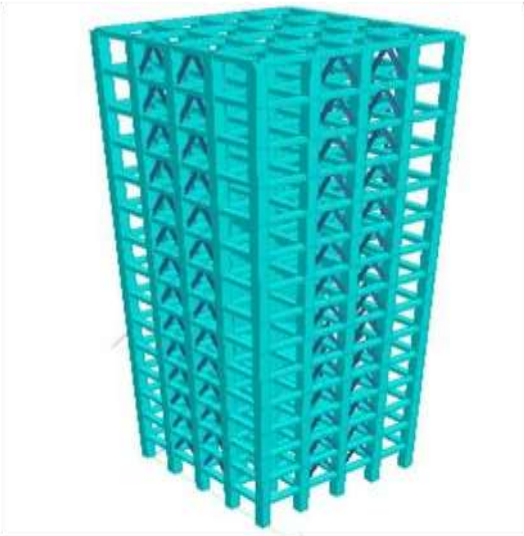


Fig. 3.6(a) Structural Plan for Inverted V-braced RC Frame (Model-4)

Fig. 3.6(b) Rendered view for Inverted V-braced RC Frame (Model-4)

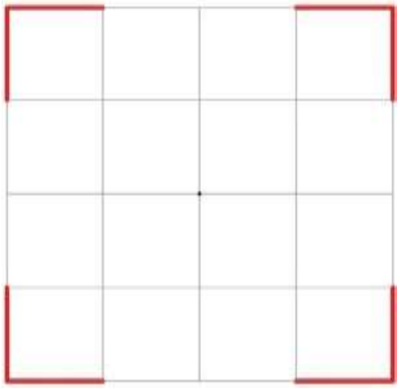


Fig. 3.7(a) Structural Plan for Inverted V-Braced RC Frame (Model-5)

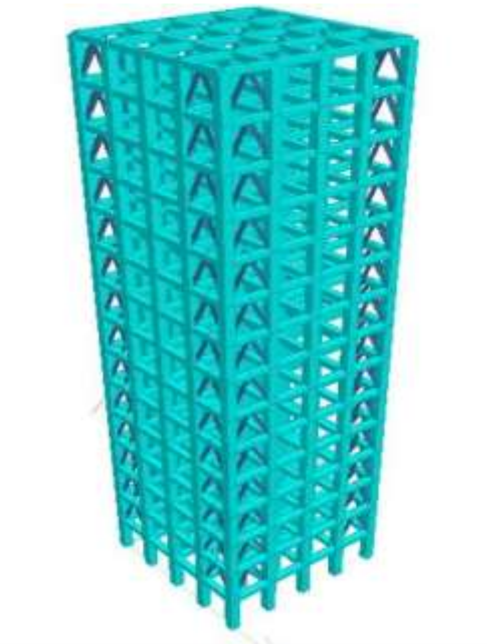


Fig. 3.7(b) Rendered view for Inverted V-braced RC Frame (Model-5)

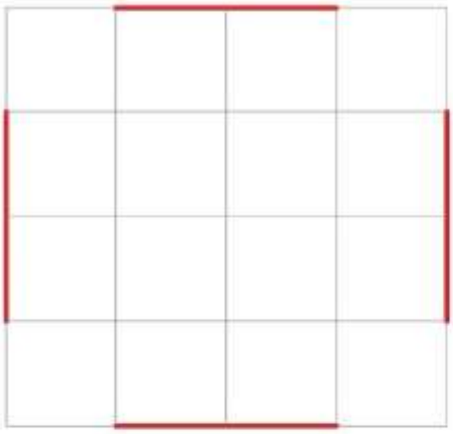


Fig. 3.8(a) Structural Plan for V-braced RC Frame (Model-6)

Fig. 3.8(b) Rendered view for V-braced RC Frame (Model-6)

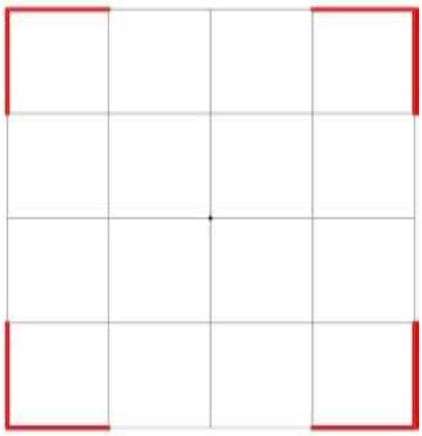


Fig. 3.9(a) Structural Plan for V-braced RC Frame (Model-7)

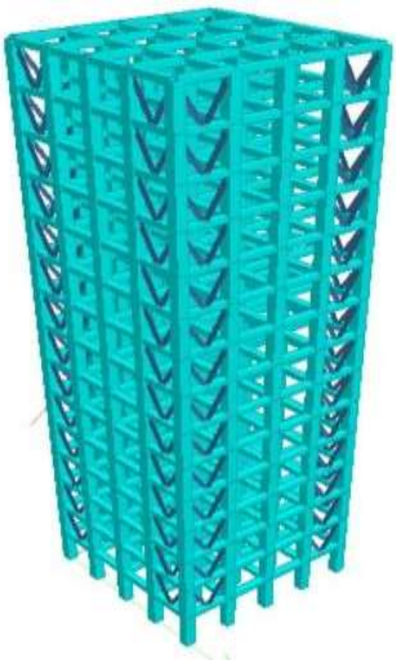


Fig. 3.9(b) Rendered view for V-braced RC Frame (Model-7)

3.5 Parameters for Analysis

Comparing the seismic behavior of an unbraced and braced RC frame in seismic zone IV is the major goal of the current research. The study took into account the following elements in order to meet the goals.

1. Time Period
2. Shear at base
3. Displacement of building storeys
4. Storey drift
5. Maximum Bending Moment for Column
6. Peak Storey Shear

Method of Seismic Analysis

The several seismic analysis techniques may be broadly divided into:

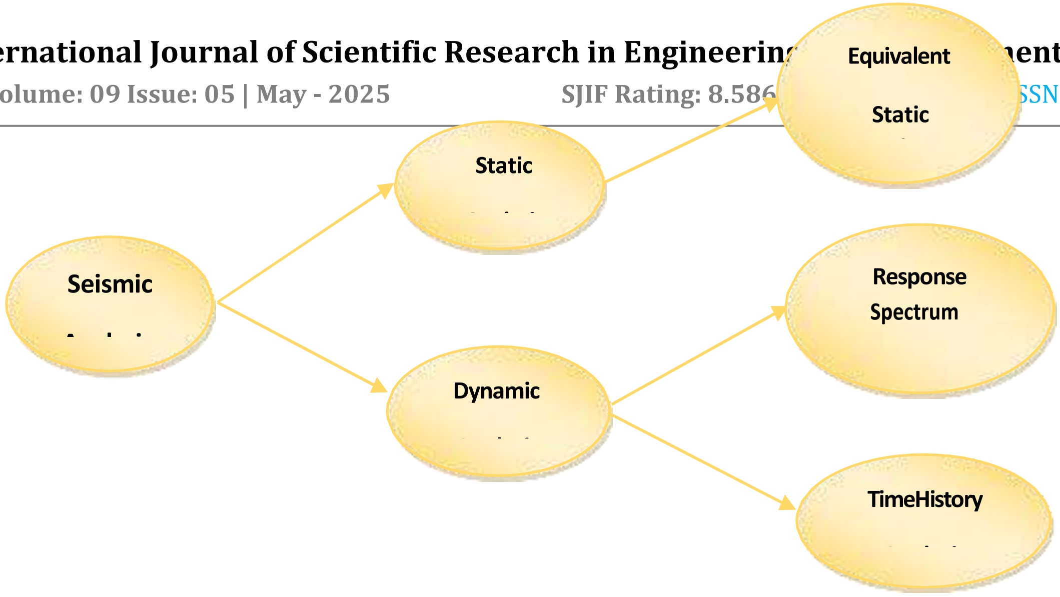


Fig. 3.13 Classification of seismic analysis

Several analytical methodologies (static and dynamic) may be employed for seismic analysis of RCC frames depending on the building height and seismic zone to which it belongs. The sectiont hat follows provides a brief introduction of static analysis and dynamic methodologies of analysis.

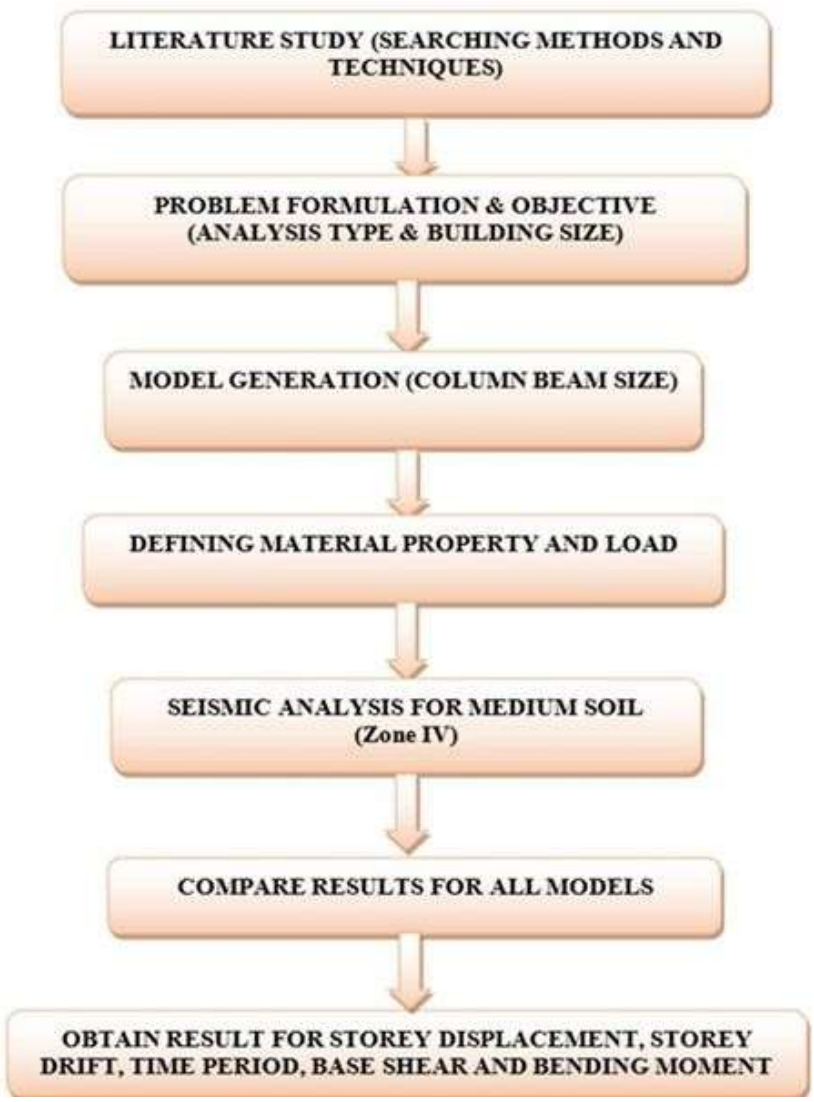


Fig. 3.17 Flow chart of the analysis procedure

4. Results and Conclusions

Storey Drift

The relative movement between the floors that are either above or below the storey. Maximum storey drift values have been determined using STAAD.Pro. The table below lists the maximum values of storey drift determined by the analysis at each storey level for the different models. To examine the effectiveness of various bracing systems at various places, the storey drift values, which are reported in Table 4.6, are also plotted against the storey height. This plot is shown in Fig.4.10.

The graph has been shown to display the comparable trend for the decrease in

Storey drift value per storey height. Initially, the storey drift reduction rate was found to be very low in all braced structures upto2- 3 storey level and then it has been observed that the decrease in storey drift value serises rapidly upto the level of 5-7th storey and there is a drop in storey drift values again after that.

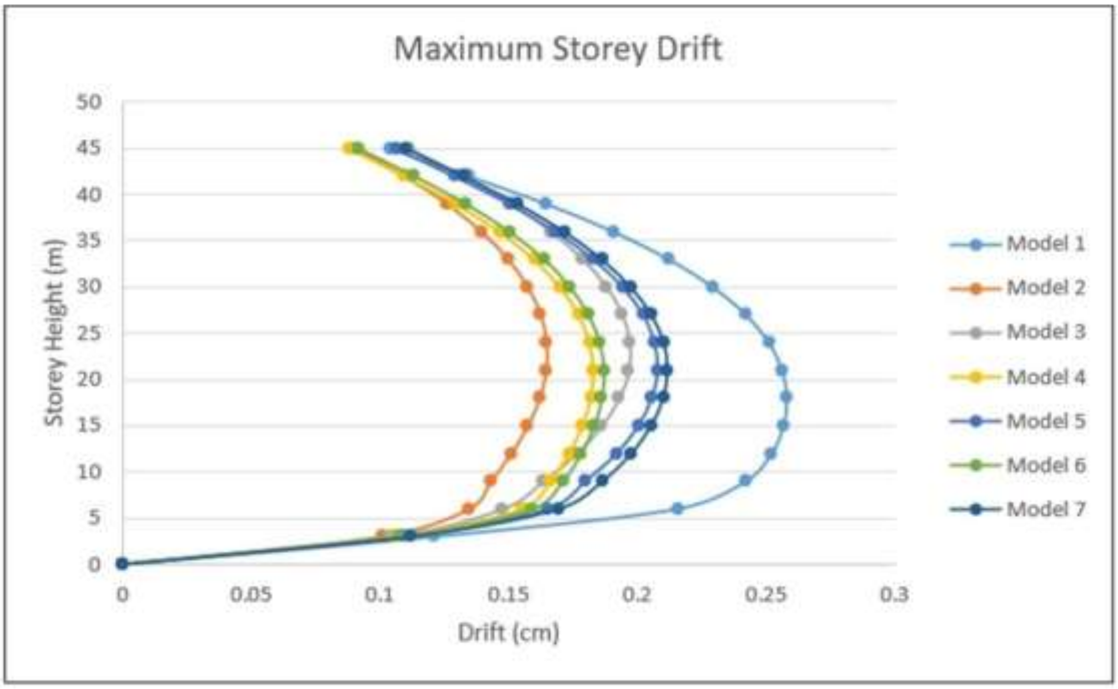


Fig. 4.10 Maximum Storey Drift for Different models for different storey level

However, the maximum storey drift value at various storey levels is displayed by different bracing systems provided at different locations. In the case of Model- 2, relative to other braced and unbraced systems, the percentage decrease in storey drift is very high and is seen in the graph Fig.4.10.

Table 4.7 Percentage Reduction in the Storey Drift w.r.t Model-1

		Types of Models with Bracings					
	Storey Height (m)	**2**	**3**	**4**	**5**	**6**	**7**
Percentage Reduction	24	42.41	21.58	25.88	17.64	26.20	16.20
	45	13.17	7.02	15.28	2.11	11.82	6.15

Table.4.7. shows a percentage reduction in storey drift at floor height of 24 m and 42 m for the various models with braces in zone IV relative to the unbraced model.

Bending Moment

From the analysis, the bending moment values are obtained for the columns at the center of the frame and the values are shown in Table 4.8. The corresponding

obtained result values of the bending moment are arranged in the form of the bar chart as shown in Fig.4.11.

Table 4.8 Maximum Bending Moment for Different Models

Model	Bending Moment (kNm)
1	72.567
2	54.560
3	57.159
4	59.283
5	61.064
6	60.092
7	62.233

It has been found that when the bracing system is applied, the bending moment is decreased and it is good for the structure. Compared to other types of bracing system, the building construction with the X bracing system provided in the middle outer bays would have the least possible bending moment.

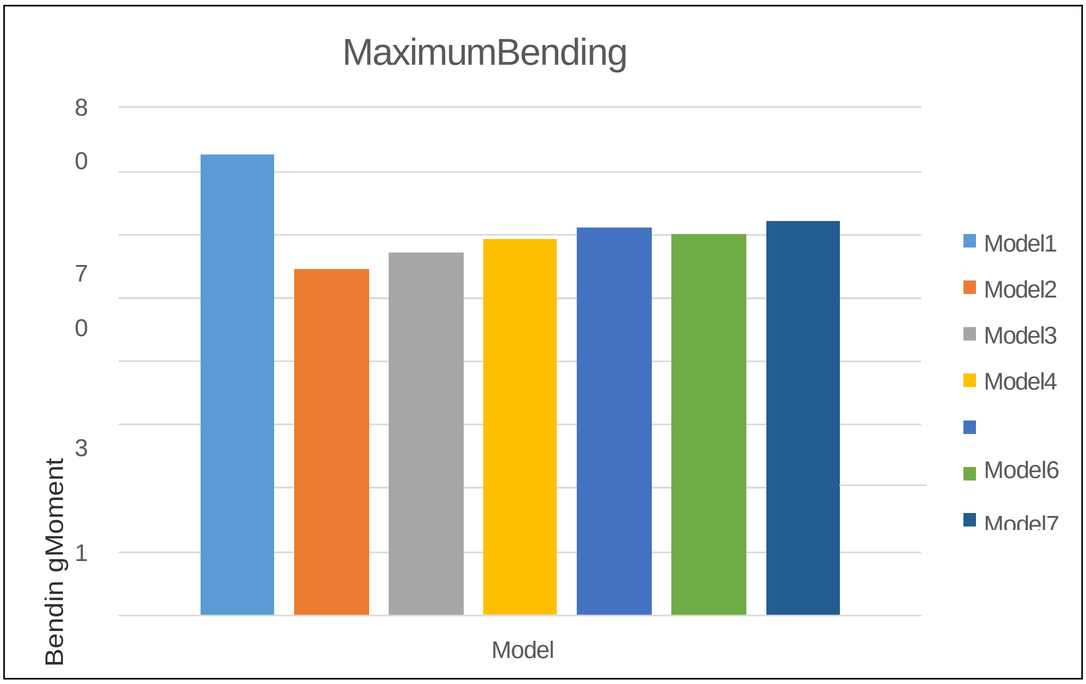


Fig. 4.11 Maximum Bending Moment for Different models

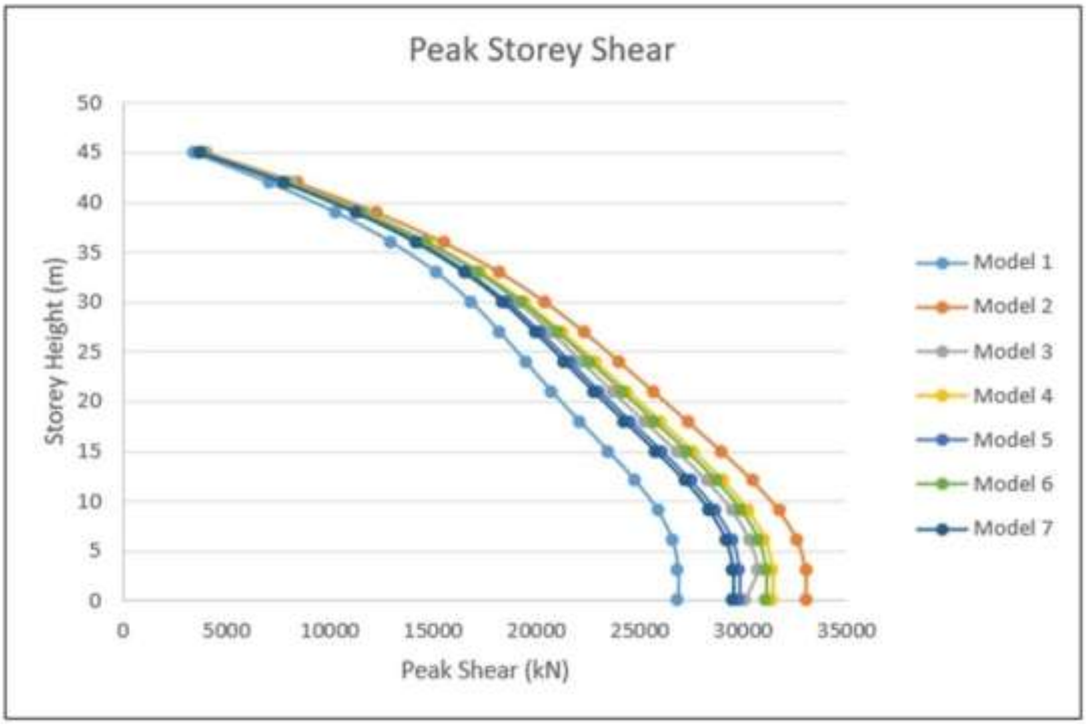


Fig. 5.12 Peak storey shear for Different models

The graph has been shown to display the comparable trend for the decrease in storey shear value per storey from the bottom to the top of the building. In general, it has been observed that the storey shear values at the base was maximum and the decreased as we moved up to the next storey level. Storey shear is minimum at the top most floor. The comparison of the values shows the structure which can be ar the maximum storey shear is most feasible and effective.

In the case of Model-2, relative to other braced and unbraced systems, it can with stand with high shear values at different storey level so it the most case suitable case braced frame and is seen in the graph Fig.4.12.

5. CONCLUSIONS:

STAAD.Pro V8i software was used to conduct reaction spectrum analyses on all braced frame models for all the required parameters, including peak storey shear, base shear, maximum bending force, and storey displacement. Braced structures demonstrated greater seismic resistance than unbraced structures in the specific seismic zone under consideration, i.e., zone IV, according to the analysis of braced models. In order to provide better results, a better place for providing the various bracing was also identified. Comparatively speaking, it was discovered that model-2, or the model with X-Bracing offered on the exterior of the building and on the mid bays, is the greatest option among all models taken into consideration from astructural standpoint. As a result, only the values of model-2 are shown in the results that follow.

1. Building's response during earthquake is known as time period, which means greater the time period greater is the response and lesser the time period, lessis the response. As the time period of model- 2 is less it means it is stiffer or it has more stiffness. Time period for the unbraced structure is 1.393 seconds which when compared with braced structure is more. In braced buildings, model-2 shows the lowest time period which is 1.125 thus it is the most effective compared to others. By comparing model- 2 with the bare frame (model- 1), time period is reduced by19.24%.

2. As compared to the bare frame, the lateral displacement of the bracing system decreases with an increase in the building height. Compared to the other structural models of other bracing (inverted-V bracing and V-bracing) and

unbraced structures in zone IV, the structural model- 2 displays less lateral displacement. The reductionin lateral displacement values for model-2 in zone IV at a storey height of 24 m and 45 m is 35.98% and 32.29% respectively.

3. The overall base shear correlation reveals that in the case of model-2 and model-3, the base shear value is high relative to other models. As compared to the unbraced RC frame model, the base shear of the braced models increases.

4. By using various forms of bracing in the model, the storey drift is minimized. Compared to the braced and unbraced structures, a structural model with X- bracing provided on the exterior of the structure and on the middle bays (model-2) shows less floor drift. The reduction in storey drift values for the model- 2, compared with bare frame at storey height of 24 m and 45 m is 42.41% and 13.17% respectively.

5. Compared to the unbraced frame, bending moment values for the column provided at the center are lower in the braced frame. In contrast to the other models, the braced model with the X-bracing provided in the mid bays has the least possible bending moment. Therefore, the X- bracing provided in the middle two bays of the structure is more efficient.

6. Peak storey shear values rose in the braced frame model compared to the unbracedframe model at various levels of the structure. As it could withstand more shear than the other models, the frame model-2 produced the superior results. At the top of the building, it is minimum, and at the bottom, it is maximum. Model 2 is thus superior than other models in terms of benefits.

References:

1 **Katte, Aniket, and D. B. Kulkarn**i. "Seismic Analysis of Multi-Storey Steel Structure with Steel Bracing at Different Location."*International Research Journal of Engineering and Technology (IRJET), ISSN* (2019):2395-0056.

2 **Smita, Juhi Nigam** (2020). "Study of irregular multi-storey RC frame subjected to seismic condition analysis with STAAD Pro V8i software." *International Journal of Advance Research, Ideas and Innovations in Technology*, 6(5).

3 **Bollaraki, S., Gudela, S., Shaik, M. S., & Bollaraki, S.** (2020). "Analysis of Multi-Storied Building in Different Seismic Zones using STAAD Pro." *IOP Conference Series: Materials Science and Engineering*, 982(1), 012074.

4 **Armo, P., & Jha, B. K.** (2022). "Seismic Analysis and Design of Multi–Storey Building in STAAD Pro for Zone II." *International Journal of Engineering Research & Technology*, 11(5).

5 **Azam, M. S., & Sharma, R.** (2023). "Comparative Study on Seismic Analysis of Multistory Building Resting on a Sloping Ground and Flat Ground." *International Journal of Engineering Research & Technology*, 12(7).

6 **Manzoor, N., Murari, K., Islam, J. U., & Kumar, M.** (2020). "Seismic Analysis Of Multi Story RC Building With Shear Wall Using Staad Pro." *Solid State Technology*, 63(6).

7 **Sharma, A., Nirmal, P. K., & Singh, L.** (2021). "Health Monitoring of an Existing RC Structure Considering Seismic Analysis Using Analysis Tools Staad." *International Journal of Scientific Research in Civil Engineering*, 5(1).

8 **Nisar, A., & Kumar, A.** (2023). "Seismic Analysis (Zone V) of RCC Building (G+5) with Shear Walls Using Staad. Pro Software." *International Journal of Innovative Research in Engineering & Management*, 10(4).

9 **Singh, H. S., & Kumar, P.** (2019). "Seismic Analysis and Design of Vertically Irregular Multistoried RC Concrete Building using Staad Pro V8i." *International Journal of Trend in Scientific Research and Development*, 4(1), 237-242.

10 **Smita, Juhi Nigam** (2020). "Study of irregular multi-storey RC frame subjected to seismic condition analysis with STAAD Pro V8i software." *International Journal of Advance Research, Ideas and Innovations in Technology*, 6(5).

11 **B Ramakrishna, G Swetha, SK Amreen Shazia, K Kiran Sai, S Durga Venkata Dinesh** (2022). "Analysis of Multi-Storied Building in Different Seismic Zones using STAAD Pro." *IOP Conference Series: Earth and Environmental Science*, 982(1), 012074.