EFFECT OF BRACING AND SHARE WALL POSITION ON THE SEISMIC PERFORMANCE OF A G+30 RCC BUILDING

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Abstract: Earthquake resistant structures are designed to protect buildings from earthquakes. While no structure can be entirely immune to damage from earthquakes, the goal of earthquake-resistant construction is to erect structures that fare better during seismic activity than their conventional counterparts. According to building codes, earthquakeresistant structures are intended to withstand the largest earthquake of a certain probability that is likely to occur at their location. This means the loss of life should be minimized by preventing collapse of the buildings for rare earthquakes while the loss of the functionality should be limited for more frequent ones. Now a day's steel bracings technique and shear wall systems are generally using for designing of earth quake resistant structure due to simple construction methods, easy to install and they are reduces the deflection and shear in past studies the earth quack resistant structure is designed by using steel bracings or shear wall systems in present study a comparison made between these two systems along with general building in high seismic zone. In the present study a G+30 story is modeled by using ETABS software and analyzed in Response spectrum analysis in various seismic zones and the comparison is made between the general building, steel building and shear wall buildings to design the earth quake resistant structures design. The results like story drift, story shear, story moment, building torsion, time period, and frequency values are compared. The analysis revealed that Introducing lateral load-resisting elements significantly improved seismic performance. The bare frame model showed the highest story drift and displacement, indicating inadequate stiffness. Structures with shear walls and bracings at corners achieved substantial reductions in drift (up to 40%) and displacement (up to 35%), along with increased storey stiffness and base shear capacity. The combined systems demonstrated superior resistance to lateral loads and better torsional stability compared to individual systems.

Key words: Earthquake, Response spectrum analysis, story drift, story shear, story moment, building torsion, time period, model frequency.

I. INTRODUCTION

Earthquakes are considered one in all nature's most high-quality risks to life within the international and function decimated incalculable urban regions and cities on for all intents and purposes every landmass. They are one in every of guy's maximum dreaded regular marvels due to real seismic tremors delivering tremendously instantaneous pulverization of systems and great structures. Furthermore, the damage due to Earthquakes is on the complete connected with synthetic structures. As in the times of avalanches, seismic tremors likewise cause passing with the aid of the harm they instigate in structures, for instance, structures, dams, spans and top notch works of guy. Sadly massive numbers of Earthquakes supply nearly no or no note before taking region and that is one reason why Earthquake constructing is complex.

Nowadays the townhouse constructing is number one paintings of the social enhance of the province. Everyday new strategies are being produced for the development of living preparations financially, unexpectedly and pleasant the situations of the collection experts and creators do the crease work, arranging and format, and so forth, of the tendencies.

Prepared representatives are honest for doing the example works of running with appreciate to the manner of architects and fashioners. The organized laborer should secure his interest and could likewise be successful to conform with the guideline of the architect and may likewise pull inside the coveted example of the building, website designs and layout designs and several others, with recognize to the requirements.

Earthquake-resistant structures:

Earthquake-resistant systems are structures designed to protect buildings from earthquakes. While no structure may be absolutely proof against harm from earthquakes, the goal of earthquake-resistant production is to erect systems that fare better throughout seismic interest than their conventional counterparts. According to building codes, earthquake-resistant systems are meant to resist the most important earthquake of a sure possibility that is possibly to occur at their region. This approach the lack of existence should be minimized by way of preventing crumble of the buildings for rare earthquakes even as the lack of the functionality has to be confined for greater common ones.

Bracing system:

A braced frame is a structural machine normally utilized in systems concern to lateral masses which includes wind and seismic stress. The members in a braced body are typically made from structural metal, that can work correctly each in tension and compression. The beams and columns that shape the body deliver vertical masses, and the bracing gadget incorporates the lateral masses. The positioning of braces, however, may be complicated asthey are able to intrude with the layout of the facade and the location of openings. Buildings adopting high-tech or submit-modernist patterns have replied to this through expressing bracing as an inner or outside design characteristic.

The resistance to horizontal forces is provided by two bracing systems:

Vertical bracing and Horizontal bracing NoBracings used in Project (Cross Bracings) :

In production, cross bracing is a device applied to reinforce building systems in which diagonal helps intersect. Cross bracing can increase a building's functionality to withstand seismic pastime. Bracing is important in earthquake resistant homes because it allows hold a structure standing. Cross bracing is normally visible with diagonal helps positioned in an X formed way; those support compression and tension forces. With Different forces, one brace can be beneath tension whilst the alternative is being compressed. It facilitates make structures stand sturdier and face up to lateral forces. Cross bracing may be carried out to any square frame shape, including chairs and bookshelves. In metallic creation, steel cables may be used because of their splendid resistance to anxiety (although no longer resistant in any respect to compression). The common uses for go bracing consists of bridge (facet) supports, along with structural foundations. This method of construction maximizes the burden of the burden a shape is capable of aid. It is a usual application while constructing earthquake-secure buildings.

Figure 1. 1 Cross Bracings

Shear wall system

Shear wall, In building development, an inflexible vertical stomach equipped for moving horizontal forces from outside walls, floors, and rooftops to the ground establishment toward a path corresponding to their planes. Models are the reinforced-substantial wall or vertical bracket. Parallel forces brought about by wind, quake, and lopsided settlement loads, notwithstanding the heaviness of structure and tenants, make amazing bending (tensional) forces. These forces can in a real sense tear (shear) a building separated. Supporting a casing by appending or putting an unbending wall inside it keeps up with the state of the casing and forestalls pivot at the joints. Shear walls are particularly significant in elevated structures subject to sidelong wind and seismic forces.

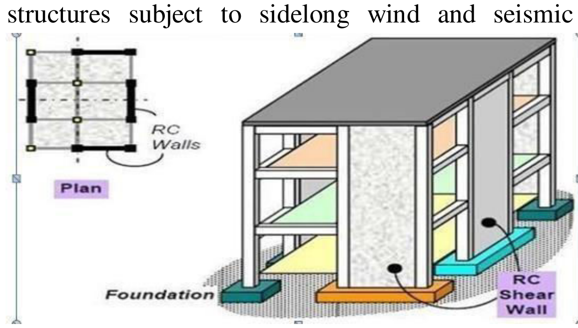


Figure 1. 2 Shear Wall Building

Objectives of the study :

The following are the main objectives of the project

1. To analyze the seismic behavior of a G+30 RCC building with bracing and shear wall configurations.
2. To evaluate the influence of bracing and shear wall positions on key seismic parameters such as base shear, storey drift, displacement, and time period.
3. To compare the structural performance of models with different lateral load–resisting systems under earthquake loading conditions.
4. To identify the most effective configuration and placement of bracing and shear walls for improving the overall seismic stability of tall buildings.

II. LITERATURE REVIEW

Kum. K Navyasri et al. (2025): In this study, a G+19 storey important service and community building with re-entrant corners has been analyzed and designed with shear wall with openings and cross bracings. Significance of shear walls and bracings has been studied with the help of nine models. This analysis and design was made as per IS 1893:2016 codal provision by using ETABS 20 software. The building models are analyzed by response spectrum method using ETABS software. The main parameters compared in this study are lateral displacement, storey drift, base shear, overturning moment and storey stiffness. Shear wall without openings shows better performance when compared to all models. From this study it was concluded that shear walls and bracings are placed in such a way that the symmetry of the structure is maintained. From the comparison of the results it is found that the optimum location of shear wall with openings, without openings and bracings is found at the corners of the building. The performance of building without any lateral force resisting member is poor. For serviceability criteria, the maximum displacement for bare frame is 145.66 mm which exceeds maximum limit and stiffness for the bare frame is $6.7x10^6$ kN/m which is less compared to the building with shear walls and bracings. For strength criteria, the maximum displacement for bare frame is 171.98 mm and stiffness is $4.4x10^6$ kN/m. Shear wall with openings shows better performance. For serviceability criteria, after comparing to bare frame displacement is reduced by 33.8%, drift reduced by 31.7%, storey shear increased by 87% and storey stiffness increased to $20.5x10^6$ kN/m. For strength criteria, after comparing to bare frame displacement is reduced by 40.3%, drift reduced by 45.2%, storey shear increased by 108.1% and storey stiffness increased to $16.6x10^6$ kN/m.

Irpan et al. (2023): An irregular structure refers to buildings or other structures that deviate from standard design principles and geometric shapes. Based on previous studies, one of the factors that causes failure of an irregular structure is the asymmetrical shape, which causes uneven load distribution in the structure. Therefore, this study aims to evaluate an irregular-structure building and bracing type X on this structure. The evaluated parameters were the period, modal participating mass ratio, base shear, story drift, and DCR. The modelling process was performed using ETABS, an element-based structural modelling software.

The results indicate that failure occurred in the structure under the existing conditions in terms of the modal participating mass ratio, story drift, and DCR. The model with bracing type X indicates a reduction in the period and rotation Z (RZ) of the participating mass. The story drift on the model with bracing type X also indicates a significant reduction; however, in model 1,3, and 5, the story drift value did not meet the story drift requirement. The DCR values of the column and beam in the model with bracing type X also indicate a reduction; however, there are some elements in the structure that do not meet the requirements of model 1,3, and 5. Bracing placement at the corner of the structure has a more significant effect on the structure.

Ajay kumar et al. (2023): In this study a two different G+8 and G+10 storey building is analysed for different bracing system under seismic load in ETABs software. Building islocated in seismic Zone-V.Four configuration of bracing (X, V, diagonal and Inverted-V bracing) is used. The parameters obtained in terms of Storey displacement and Storey drift. Compared these parameters for these two different Zone .It is seen that Inverted-V bracing system gives better result as compare to other two. From this results it was concluded that after analyzing both building G+8 and G+10 storey building in seismic ZONEV in ETABS software with different shape of bracing. Following are the conclusion comes out: Steel bracings can be used to strengthening of structure. Steel bracing is also used as retrofitting purpose. Steel bracing is an advantageous concept for strengthening or retrofitting existing structures. The concept of using steel bracing in reinforced building to resist seismic forces is helpful. After providing Steel bracing in RCC building, building drift less as compare to un braced frame. Building drift less in case of inverted V bracing.

Khaja et al. (2020):Earthquake happens all around the globe and it is a natural calamity and can occur across the world. It affects the structure by producing tough ground signals.

To overwhelmed the Earthquake there is establishment of Shear wall and Bracing to increase the crosswise stiffness, ductility of the structure. To plan a building storey drift and crosswise displacement are crucial. The building is analyzed by Linear static and Linear dynamic method by E-tab software. In present paper G+25 multistoried building is analyzed by insertion of Shear wall and bracing at Corners, End and central core of the structure. The responses like Displacement, Storey drift, Time period and Base shear is calculated and

equated. From this study it was concluded that the Displacement, Storey drift, Time Period and Base

Shear of regular building and L- shape building models are compared. The variation is less in these models because of the same stiffeness and corresponding loads. L- shape models are considered with shear wall and bracing at different location, the models without shear wall and bracing has the higher displacement value because of absence of stiffeners. The shear wall and bracing (combination) plays a important role in reducing the lateral load.

Among all the models the shear wall with bracing corners proves to be more effective than shear wall with bracing at other location

III. METHODOLOGY

Earthquake loading :

Earthquake loading consists of the internal forces of the building mass that result from the shaking of its foundation by a seismic disturbance. Earthquake resistant design concentrates mainly on the translational inertial forces. These translational inertial pressures have a greater impact on a structure than vertical or rotational shaking components. Other strong earthquake forces exist, such as land slide, subsidence, and liquefaction of the local subgrade due to vibration, among others. The frequency of earthquakes is inversely proportional to their magnitude. Although a structure may be designed to withstand the most severe earthquake without substantial damage, the requirement for such strength throughout the project's lifetime would not justify the high additional expense. Two main techniques are used to assess seismic loading. These methods take into account the structure's characteristics as well as the region's previous earthquake history. The comparable lateral force process is the first method. The maximum base shear is calculated using a basic calculation of the structure's fundamental period and the expected maximum ground acceleration, as well as other pertinent parameters.

The second technique is a modal analysis, which involves analysing the structure's modal frequencies and combining them with earthquake design spectra to determine the maximum modal response.

Response spectrum analysis

This technique is often referred to as the modal approach or the mode superposition technique. It's founded on the notion that a building's reaction is a superposition of the responses of several modes of vibration, each of which has its own distorted shape, frequency, and modal damping.

According to IS-1893(Part-l):2002, the response spectrum approach must be used to assess high rise and irregular structures, as illustrated in Figure 3.1. The response spectra technique

of seismic analysis offers considerable computing benefits for structure drift and force predictions. In this approach, the maximum values of drifts and member forces in each mode are simply calculated by averaging numerous seismic movements' smooth spectral peaks. At least 90 percent of the building's total mass must be taken into account for the analysis (in each of two orthogonal principal horizontal directions). Based on the supplied building features and ground motion spectra, the analysis is carried out to estimate the base shear for each mode. For each of these modes, the Storey forces are computed, and the SRSS combination is used to combine them statistically.

Methodology (Response spectrum method)

The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2016 (part1). Here type of soil, seismic zone factor should be entered from IS 1893-2016 (part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABS software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g).

For each mode, a response is read from the design spectrum, based on the modal frequency and the modal

mass, and they are then combined to provide an estimate of the total response of thestructure. In this we have to calculate the magnitude of forces in all directions i.e. X, Y & Z

and then see the effects on the building. Combination methods include the following:

 absolute - peak values are added together

 square root of the sum of the squares (SRSS)

 complete quadratic combination (CQC) - a method that is an improvement on SRSS for

closely spaced modesThe result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum

Statement of the project

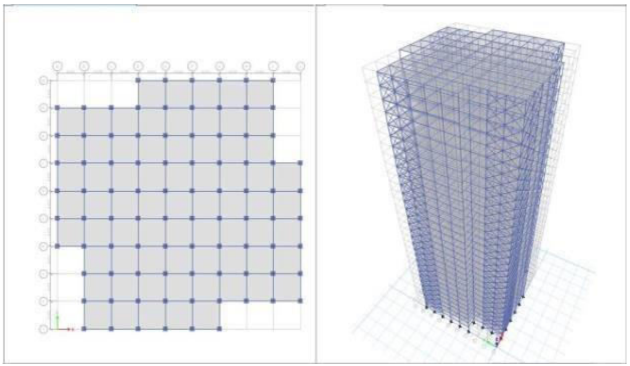
In the present study, analysis of G+ 30 stories building in various seismic zones is carried out in ETABS.

Basic parameters considered for the analysis are computer analysis can be used to determine these modes for a structure.

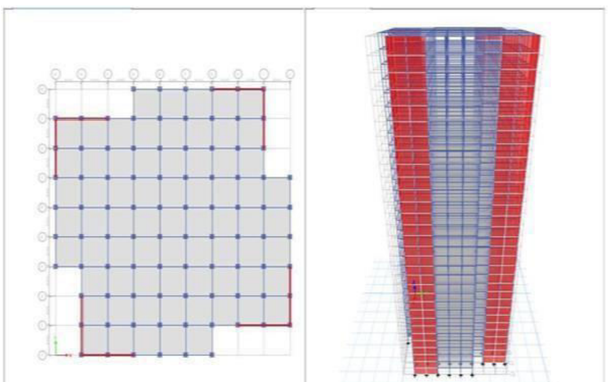
1. Utility of Buildings : Residential Building
2. No of Storey : 31 Stories (G+30 Building)
3. Grade of concrete : M40
4. Grade of Reinforcing steel : HYSD Fe500
5. Type of construction : RCC framed structure
6. Dimensions of beam
   a. 1st storey to 10th storey : 690mmX500mm
   b. 11th storey to 20th storey :500mmX460mm
   c. 21st storey to 31st storey :460mmX300mm
7. Dimensions of column
   a. 1st storey to 10th storey : 690mmX690mm
   b. 11th storey to 20th storey :500mmX500mm
   c. 21st storey to 31st storey :460mmX460mm
8. Thickness of slab
   a 1st storey to 10th storey : 180mm
   b. 1th storey to 20th storey :150mm
   c. 1st storey to 31st storey :125mm
9. Thickness of Shear wall : 180mm
10. Height of bottom story : 4m
11. Height of Remaining story : 3m
12. Building height :94m

Model in ETABS V

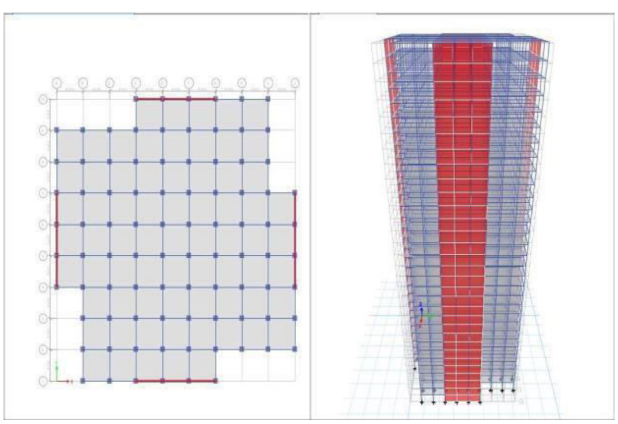
General Building



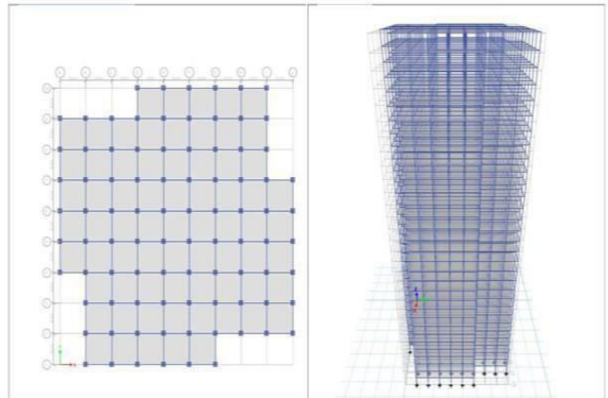
Building with Shear wall Corner



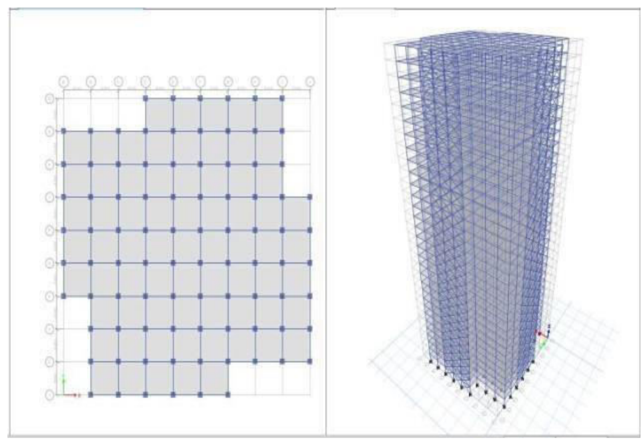
Building with Shear wall Center



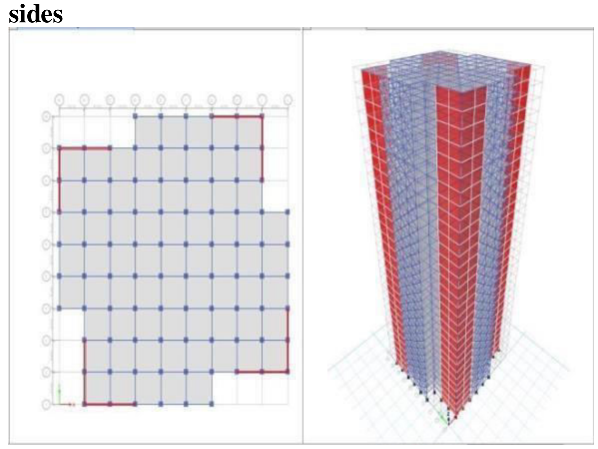
Building with steel bracings Corner



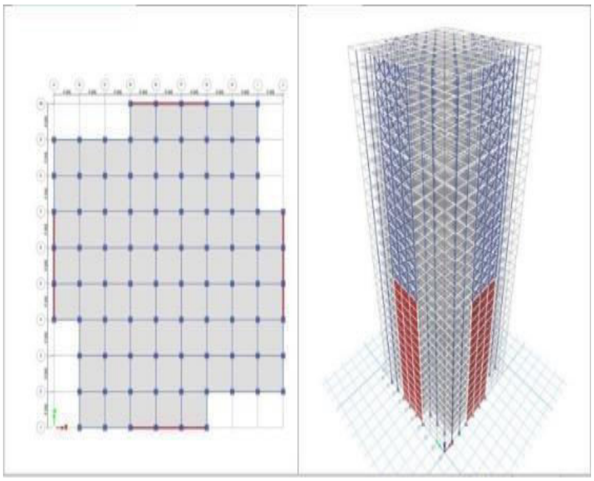
Building with steel bracings Center



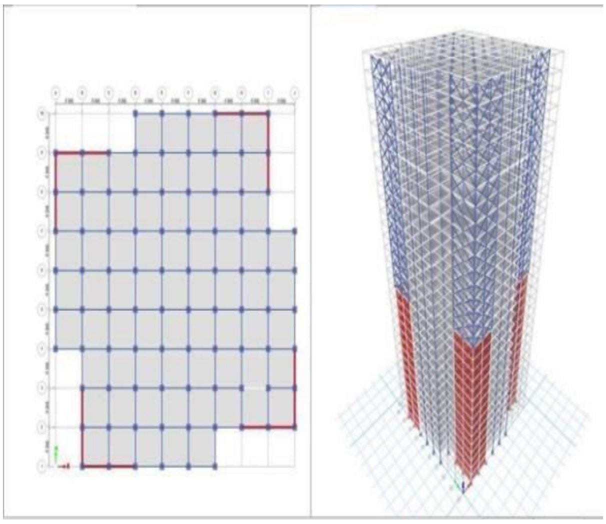
Building with steel bracings and Shear wall at opposite sides



Building with steel bracings and Shear wall Corner



Building with steel bracings and Shear wall Center



IV. RESULT

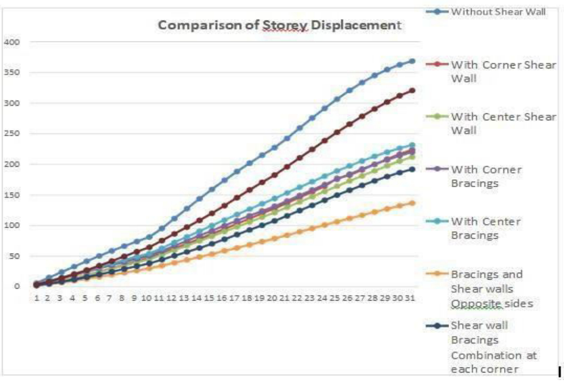


Fig. 4.1 Comparison of story Displacement

The bare frame experiences the highest drift, making it unsafe for high-rise construction.Shear walls significantly reduce displacement due to their high stiffness.Bracings improve displacement values but are less effective than shear walls.Combined systems (shear wall + bracing) provide the best performance, with the "Opposite Sides" arrangement showing the maximum reduction in displacement.This confirms that hybrid lateral systems deliver optimal control over seismic movements in tall buildings.

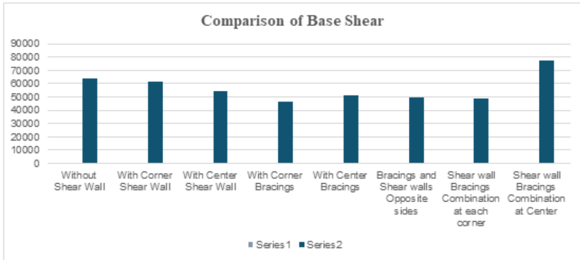


Fig4.2 Comparison of Base Shear

A higher base shear value indicates greater stiffness and force-resisting capacity. The bare frame shows low base shear because of its flexibility, which attracts smaller forces but experiences higher displacements.When shear walls or bracings are introduced, stiffness increases, thereby mobilizing higher base shear forces in accordance with the response spectrum method. The corner configurations show slightly higher base shear than centre configurations, reflecting better lateral load distribution

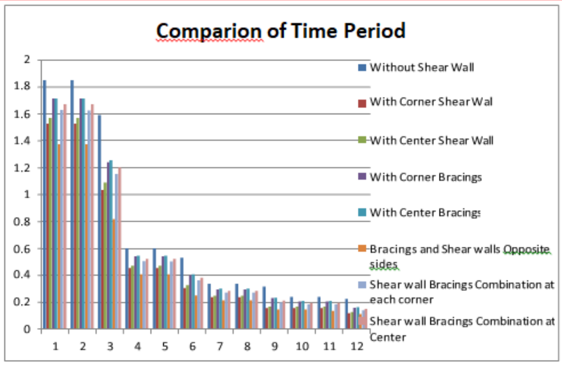


Fig. 4.3 Comparion of Time Period

A longer time period indicates a flexible structure; a shorter one signifies higherstiffness. The reduction in natural period after introducing bracings and shear walls demonstrates an improvement in lateral stiffness and overall rigidity

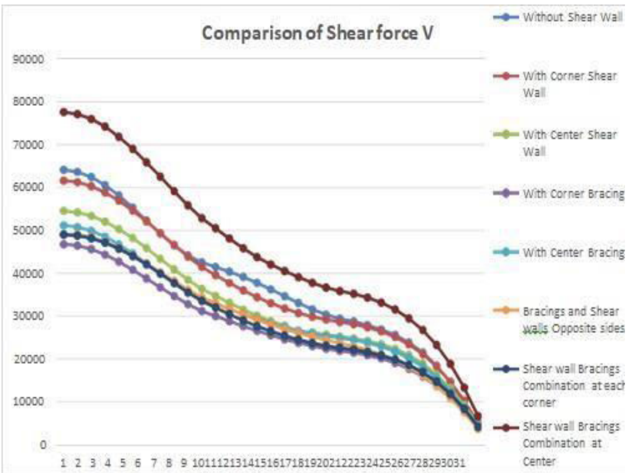


Fig. 4.4: Comparison of Shear force V

The tablenncomparison of shear force shows that the combined system of shear wall and bracing placed at the corners provides the most effective seismic performance, resulting in the highest shear capacity and minimum deformation. Although this configuration attracts greater lateral forces, it ensures maximum stability and structural safety under seismic loading.

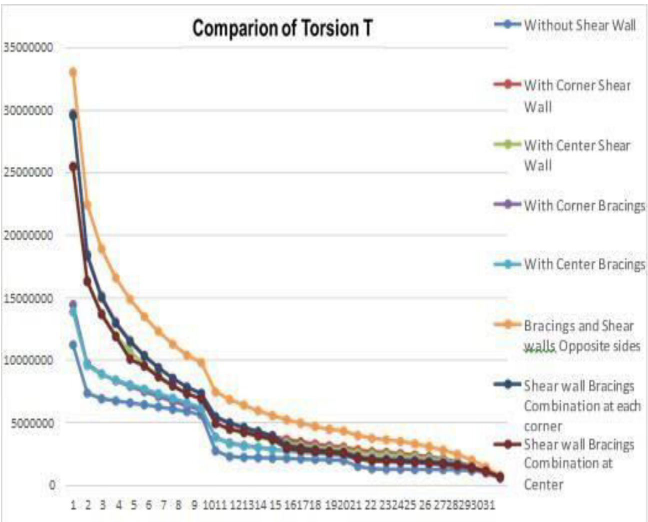


Fig 4.5:Comparison of Torsion

The bare frame model experiences the maximum torsion, caused by uneven stiffness distribution and the absence of lateral load-resisting elements.

The torsional response significantly decreases after the inclusion of shear walls and bracings, with the combined system (shear wall + bracing at corners) showing the lowest torsion values. The corner placement of lateral resisting elements provides more uniform stiffness in both directions, minimizing eccentricity between the center of mass (CM) and center of rigidity (CR).

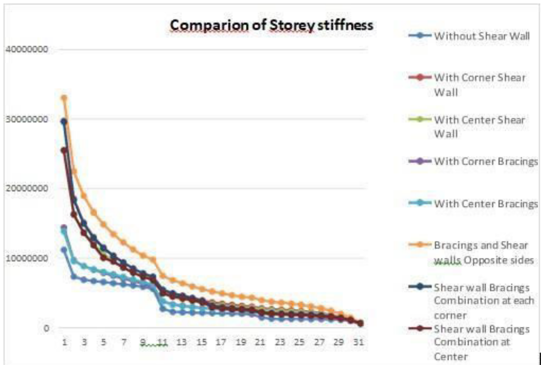


Fig.4.6: Comparison of Storey stiffness

The storey stiffness values increase progressively with the introduction of shear walls and bracings.The bare frame model shows the lowest stiffness, confirming its flexibility and susceptibility to lateral deflection.

V. CONCLUSION

From this study the following conclusions were made 1.The rate of storey drift decreases from the top to the bottom of the building. A reduction of nearly 30% in storey drift was observed in structures with the inclusion of shear walls and bracings, showing improved resistance to lateral loads. 2.Among all configurations, the combination of shear walls and bracings exhibited the highest values of shear force, bending moment, and torsion. About a 35% increase in these parameters was noted compared to other models, indicating better stiffness and strength. 3.It was observed that the arrangement of bracings and shear walls in opposite positions provided better overall performance compared to other placements, enhancing the structural stability and stiffness. 4.With an increase in the mode number from 1 to 12, the time period values showed a gradual reduction. Around 10% variation in time period and frequency was observed for models with bracings and shear walls, showing improved stiffness characteristics

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