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Different Bracing Configurations in Multi Storey RCC Buildings And Their Performance Analyses

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Abstract
When it comes to wind and earthquakes, high-rise building structural systems are often the most vulnerable. Reinforced concrete buildings may be made more resilient to lateral loads by using a steel bracing system. By making the structure more rigid and strong, bracing systems effectively decrease lateral displacements.
The purpose of this paper is to investigate the seismic and wind loading behaviour of high-rise building structures with various bracing configurations, and to propose a method to increase the stiffness and strength of these structures through the efficient and cost-effective use of steel bracing. A computer model represents the thirty-story R.C.C. tower. The location of the structure is said to be close to Mumbai. We use Finite Element Analysis to model and analyse the structures, and we use SAP2000 V21 to assess them.

Keywords:,SAP2000, wind load, displacement, diamond-shaped bracing, bracing position?

Introduction

One of the main goals of tall structures is to securely transmit the main gravity load. Dead load and live load are two typical types of gravity loads. In addition, the building must be able to resist the lateral forces of wind and earthquakes, which vary with the kind of terrain. Lateral loads cause sway moments and high stresses, which weaken the structure. Consequently, the ability to withstand lateral stresses is more dependent on stiffness than strength in these instances. A building's seismic performance may be enhanced in a number of ways by use of bracings.
Storey drift, caused by the lateral pressures pressing on the structure, becomes increasingly dangerous as the building's height grows. When designing tall structures, lateral stiffness is an important factor to consider in order to meet the strength and serviceability limit. Alterations to the structural design of skyscrapers may reduce the drift index and increase lateral stiffness. One device that multi-story buildings use to counteract lateral stresses is a steel braced frame. The steel bracing system increases the structure's stability and rigidity, making it more resistant to horizontal forces. It is common practice to use one of three distinct bracing configurations: diagonal, cross (X), or V. When compared to one another, different bracing layouts each have their advantages and disadvantages.

1.1 Objective of the Study

• To use response spectrum analysis in SAP2000 V21 software to determine the seismic

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reaction of the suggested models.
With the inclusion of a diamond bracing structure, we want to learn how seismic occurrences affect certain RC construction factors.
• To compare several diamond bracing configurations in the Mumbai area and choose the best one.
• Lessen the impact of earthquakes and cyclones on building stability by reducing story drift and displacement. • To find the ideal bracing system weight.

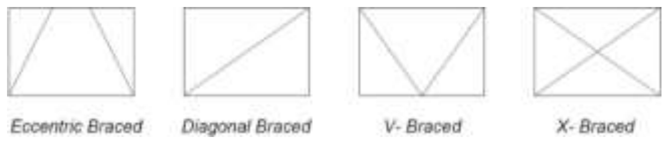

Figure1.TypesofBracing

2. LiteratureReview

A comparison of the seismic response of steel frames utilising various kinds of bracing systems is described in the study by Dia Eddin Nassani, Ali Khalid Hussein, and Abbas Haraj Mohammed. There are several bracing methods available, including X-braced, V-braced, inverted V-braced, knee-braced, and zipper-braced frames. Using metrics including plastification, storey displacements, base shear, drift ratio, global damage index, and capacity curve, we analyse the structural reactions of frames. Steel bracing in concrete-framed buildings is examined in the work of M. R. Maheri and A. Sahebi. The purpose of the experiments was to compare the performance of tension and compression braces and to find out how well various diagonal bracing configurations increased the concrete frame's in-plane shear strength. Also taken into account is the crucial issue of how the steel bracing should be fastened to the concrete frame.
Zasiah Tafheem, Md. Muhtadi Ratul, Md. Atik Masum, and Md. Ahasan-ul-Haque examine the structural performance of steel buildings using various bracing techniques. There has also been research on the effects of different bracing systems on the building. The purpose of this research is to examine the effects of lateral loading on a commercial steel structure that is 10 stories tall. Various bracing systems, including crossing, V-type, and eccentric bracing, have been used to study the steel building's structural performance.
K.K. Wijesundara a, R. Nascimbene b, and G.A. Rassati's research details a method for simulating concentrically braced building frames. Two beam-column elements based on inelastic forces are used to represent an inelastic beam-column brace. Each element has five integration points and a discretized fibre section. Integrating uniaxial stress-strain relations allows one to calculate the hysteretic response of such components.
A research comparing the static and response spectrum methods of analysing various bracing systems in an irregular G+7-story steel building was conducted by Farhat Aziz Sheen, Dr. Md. Monjur Hossain, Asma Ferdous, and Arifur Rahman. In fact, bracing is a crucial component of any lateral load resisting frame design. All of the following parameters were maintained constant during the course of the study: section characteristics, lateral loads, vertical loads, design parameters, support conditions, load combinations, and BNBC provisions. Numerous bracing types, including cross, single diagonal, knee, V, and chevron bracing, have been used to study the effects on various lateral displacements, storey drifts, and bracing weights.
L.Di Sarnoa and A.S. Elnashai's research evaluates the seismic performance of steel moment resistant frames (MRFs) that have been reinforced using various bracing schemes. There were three different structural configurations that were used: mega-braces, buckling-restrained braces, and unique concentrically braces. In areas with significant seismic risk, a 9-story steel perimeter MRF was built with lateral stiffness that did not meet code drift constraints. Then, SCBFs, BRBFs, and MBFs were retrofitted onto the frame. To measure how well the structure held up during earthquake ground vibrations, inelastic time-history analysis were performed.

Keyvan Ramin's research wants to find out how effective it is to use off-diagonal steel bracing on reinforced concrete frames. This was accomplished by modelling three different types of structures using SAP2000 software: 2-story, 6-story, and 15-story. The models included and did not include X-bracing and off-center bracing systems. For micro modelling, ANSYS software was employed to achieve finite element results, allowing for an accurate comparison of the different retrofitting systems.
In their research, M. N. Chimeh and P. Homami evaluated two steel buildings that had undergone seismic rehabilitation using six distinct bracing techniques. Both static and dynamic non-linear analyses were used to evaluate the structures, which were built with performance based methods in mind. X braced frames, Chevron braced frames (Inverted-V braced frames and V braced frames), Zipper columns, and EBF with long and short link beams were all tested to see how they affected the behaviour of rehabilitated structures. The results revealed that the EBF system was the most efficient, while the Zipper columns bracing system and short linked EBF were the most ductile.

Methodology

This numerical study aims to minimise the effect of wind and earthquake loads on tall structures by analysing their behaviour when braced differently for different parameters, such as storey drift, base shear, and lateral displacements. Using Indian codes IS456:2000, IS 875(Part1,2,3)-1987, and IS1893:2016, as well as a bare frame and three distinct bracing placement models, this research takes into account a 30-story structure with a 4-meter height at each level. There are two sets of four-meter bays, one running in the X-and one in the Y-axes. It is believed that all buildings are situated in Mumbai. It is believed that the columns are fastened at the base. Frame components, such as beams and columns, are represented by connecting nodes. The structural components have been analytically modelled using Finite Element Analysis in SAP2000 V21.

3. ModellingDetails

Asmentioned earlier, themodel considered for analysisisa30 storey high rise building. The total height of the building is 120 m, and floor to floor height is 4m.

Table1.InputParameter

Sr.No	PARAMETER	VALUE
1	Plansize	64mx24m
2	Storeyheight	4m
3	Heightofbuilding	120m
4	Columnsize	900x600mm
5	Beamsize	300x600mm
6	Slabthickness	150mm
7	Liftductwallthickness	200mm
8	Gradeofconcrete	M50
9	Gradeofsteel	Fe500
10	HollowSquarebracing	(250x250x10)mm
11	Gradeofsteelforbracing	Fe250

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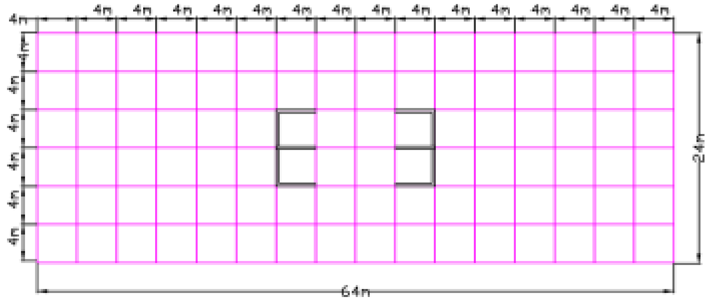
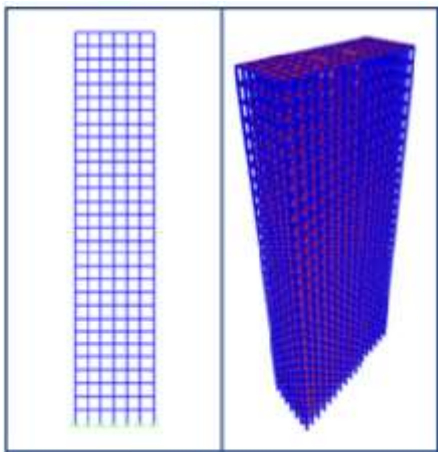


Figure1.PlanOfStructure



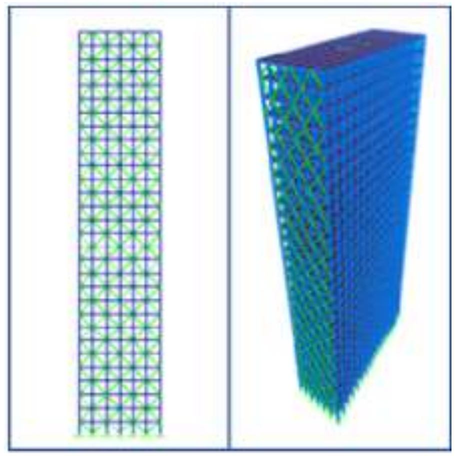
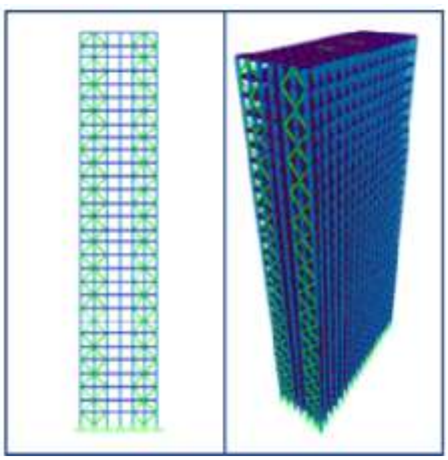


Figure2.ModelA (without Bracing)



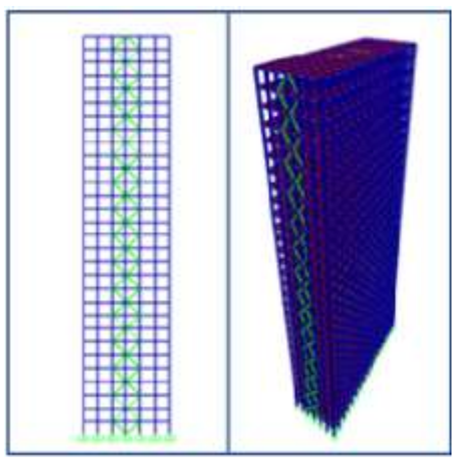


Figure4.ModelC

(TwobandsofSideBracings)Figure3.ModelB (Fully Braced)

Figure5.ModelD

(OnebandofcentralBracings)

Table2.WindLoadParameter's

Sr.No	Parameters	Value	IS875(part3)–1987.
1	Terrain category	II	Clause5.3.2.1
2	Windspeed	55m/s	Clause5.3.2.2,AppendixA-Clause5.2
3	ProbabilityFactor,k1	1	Clause 5.3.2.2,Table1
4	TopographyFactor,k3	1	Clause5.3.3,Table3

Table 3.SeismicParameter's

Sr.No.	Parameters	Value	IS1893(Part1):2016
1	SeismicZoneFactor(Z)	0.16(III)	ANNEXE
2	ImportanceFactor(I)	1.2	Table8(Clause7.2.3)
3	ResponseReductionFactor(R)	5	Table9(Clause7.2.6)
4	SoilType	Medium(ii)	Clause6.4.2.1
5	Damping	5%	Clause7.2.4

4. ResultsandDiscussion

Results are shown for comparisons of all four Models A, B, C and D for 30 storey structures.Resultsareshownforthebuilding'sY-axisonlybecauseithaslessstiffnessin the Y direction.

Figure9.BaseShearInYDirection

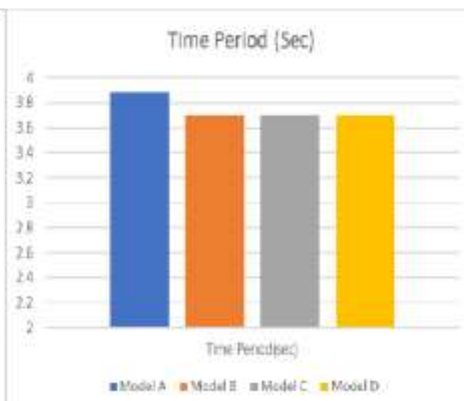


Figure10.TimePeriod

Figure9 showsthecomparisonofallresultsgotfromSAP2000forthebaseshearinthe Y direction. Figure 10 shows the comparison of all results got from SAP2000 for the time period in mode 1.

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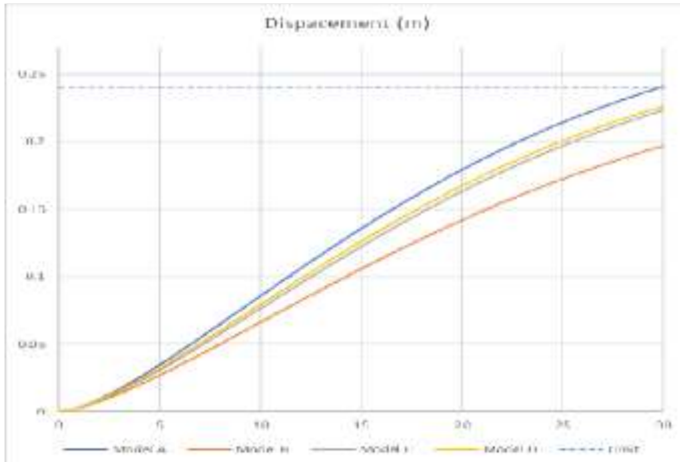

Figure11.StoreyDisplacement

Figure11showsthecomparisonofallfourmodelsresultsgotfromSAP2000for displacementateachleveldue towindintheY direction.Permissible limitaccordingto I.S.1893:2016.

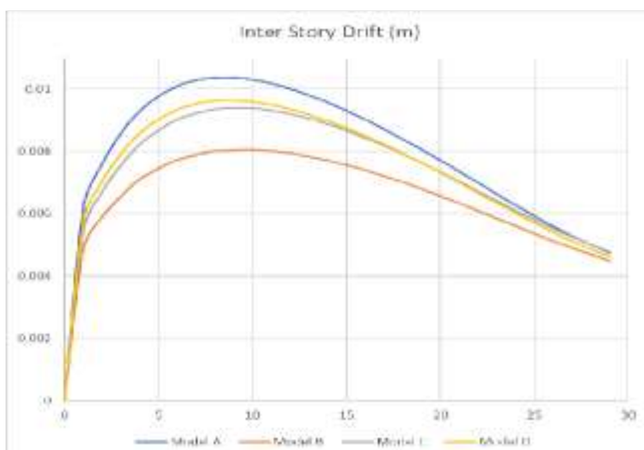

Figure12.InterStoryDrift

Figure12showsthecomparisonofallfourmodelsresultsgotfromSAP2000forthe storeydisplacement in the Y direction due to the wind load in Y direction.

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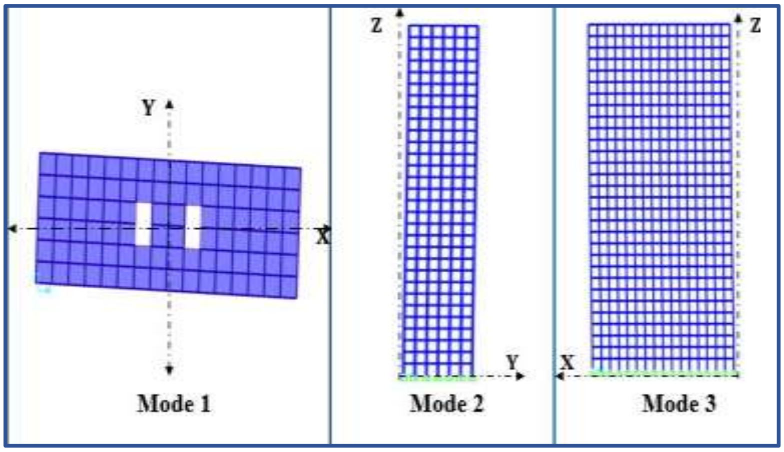

Figure13.First3ModeShapeOfModelA

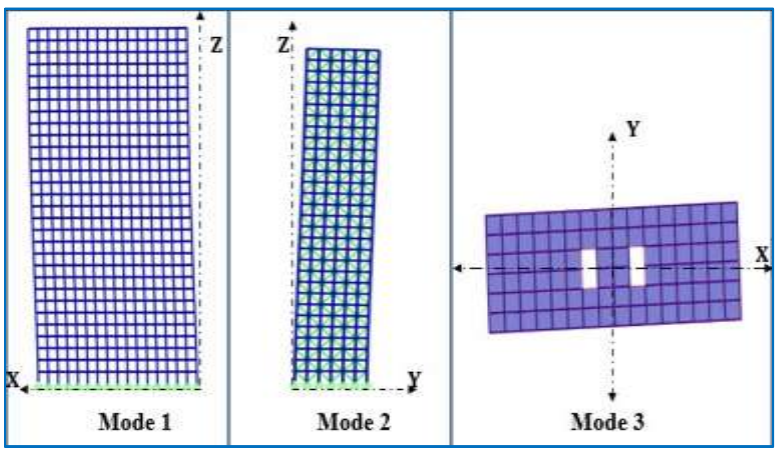

Figure14.First3ModeShapeOfModelB

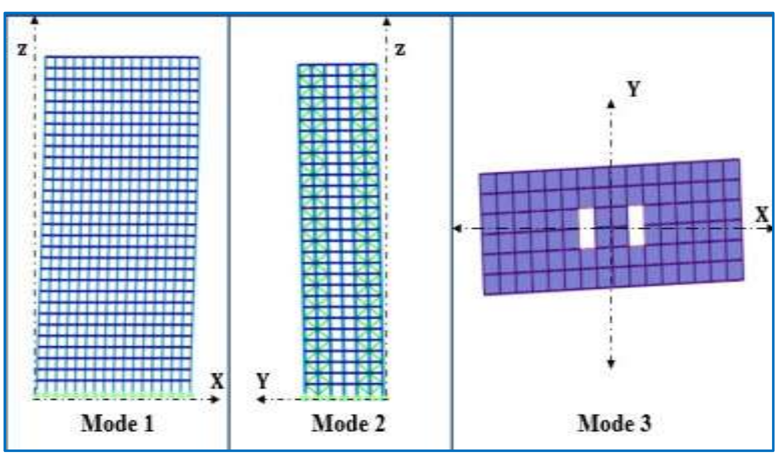

Figure15.First3ModeShapeOfModelC

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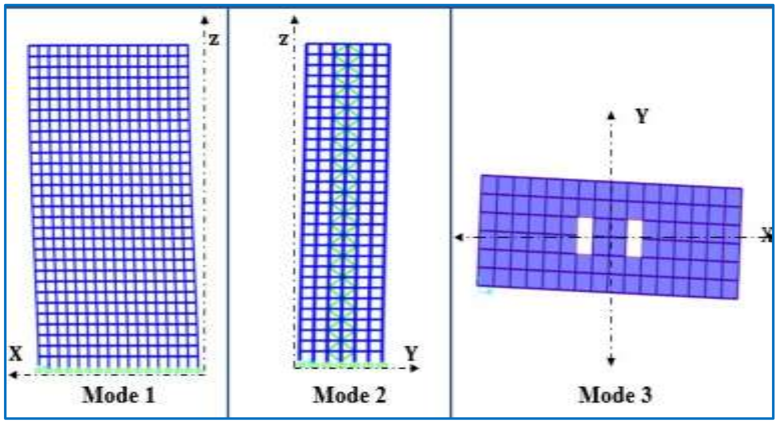

Figure16.First3ModeShapeOfModelD

Figure13,14,15&16showsthefirst3modeshapesforthatstructureandmodeshape direction. Mode shape diagrams of that model are taken from SAP2000 software.

Figure17.WeightofBracing

Figure 17 showsthecomparisonof weightof bracingprovided in each configuration of structures.

Table4.SummaryofDifferentParametersforWindLoad

TypesOf Structure	Wt. Of Bracing (KG)	Base Shear (KN)	Top Storey Displacement (m)	Time Period (SEC)	FirstMode Shape Direction
ModelA	0	7213.426	0.240984	3.879046	Torsional
ModelB	153468.193	8055.086	0.197034	3.697168	Translational
ModelC	102312.12	7532.138	0.223437	3.697106	Translational
ModelD	51156.06	7459.213	0.226409	3.697049	Translational

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5. Conclusion

The results of the aforementioned numerical analysis allow us to conclude:
1. 'Torsion' is the initial mode shape seen in the numerical model of the multi-story building in this research, which is often not acceptable. The first mode of "torsion" transforms into the third mode with implementation of the suggested bracings.
2. To lessen the duration of vibration caused by wind and seismic pressures, bracing systems similar to Model D are useful.
3. Model D's bracing systems effectively mitigate the displacement of upper stories caused by wind and seismic activity.
4. When subjected to wind and seismic stresses, the base shear is somewhat increased by the bracing systems described in Model D.
Model D makes the most efficient use of bracing material when compared with versions B and C. 15.
Models B, C, and D have very identical time periods. 6.

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