INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 3)
Available online at: www.ijariit.com

Investigation on the influence of effective bracing system in multi-storeyed structure using CYPE

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ABSTRACT

A Bracing system is provided to reduce the lateral deflection of the structure. The use of braced frames has become more effective in high rise structure and also in the seismic design of the structure. The bracing system plays the vital role in structural behavior during the earthquake. So this paper aims to find out the effect of bracing on multi-storied of the steel building. In this paper, G+19 steel frames are modeled with the different type of bracing pattern and different combination of soft-story using CYPE software.

Keywords: *Bracing, Steel frame, Lateral deflection, Vertical truss*

1. INTRODUCTION

The majority of the tallest structures on the planet have concrete and steel framework, because of its high-quality to-weight proportion, the simplicity of getting together and field establishment, accessibility of different quality levels, and more extensive choice of segments. Inventive surrounding frameworks and present-day outline strategies, enhanced fire insurance, erosion resistance, creation, and erection systems joined with the progressed diagnostic methods are made conceivable by the utilization of PCs.

The floors of structures are commonly bolstered by beams and columns which at that point8are9upheld9by5sections.9Under1dead1and1live1loads8that9demonstration vertically Downwards (gravity stack), the segments are basically subjected to pivotal pressure strengths. Since segments convey pivotal loads proficiently in direct anxiety, at that point they would have moderately littler cross segments which are an alluring condition since proprietors need to expand usable floor space. At the point when parallel load, for example, wind stack follows up on a building, horizontal removals happen. These relocations are1zero1at the1base of the building1and increment with stature. Since slim segments have generally little cross areas, their bowing firmness is little. Subsequently, in a working with segments being the main supporting components, vast horizontal removals can happen. These parallel relocations can break parcel dividers, harm utility lines, and create movement disorder in inhabitants (especially in the upper floors of multi-Story structures where they have the best impact).

To Point of confinement horizontal removals, auxiliary creators regularly embed, at suitable areas inside the building, basic dividers of fortified stonework or strengthened solid (Shear Dividers) or include diverse sorts of bracings between segments to frame profound wind trusses which are firm in the plane of the truss.

These bracings, together with the joined areas and level floor columns in the plane of the bracings, shapes a significant constant, vertical truss that expands the full stature of the working (from the foundation to housetop) and produces a solidified, lightweight fundamental part to transmit sidelong bend powers into the foundation. It is basic to recognize domains of the building where floor loads, for instance, dead and live loads are lower (and economy of the material can be decreased) and runs where wind weights on the cladding are higher (and the structure prosperity and immovable quality can be extended) remembering the true objective to get perfect helper diagram and to arrange direct corner to corner people which are bracings, required for flat soundness on the structure of the building.

2. LITERATURE REVIEW

[1] Elnaz Nobahar, Mojtaba Farahi and Massood Mofid (2016): This paper presents Quantification of seismic performance factors of the buildings consisting of disposable knee bracing frames. In this review, a hypothetical examination was directed to survey the conduct of 3, 5, 7 and 9-stories expendable knee supporting steel outlines. In the first place, the nonlinear static examinations were directed to give measurable information on over-quality and period-based malleability of the expected prime example outlines. From now on a straightforward fall appraisal was performed utilizing nonlinear incremental dynamic examinations. At last, the adequacy of assumed seismic execution variables was checked in light of the seismic execution of the prime example outlines.The accompanying conclusions can be produced using the outcomes, The after effects of nonlinear static investigations (push-over) showed that the productivity of connection components to enhance the malleability of structures diminished by expanding the quantity of stories. As an occasion, in 3-stories space outlines, the estimation of pliability variable was approximately. In any case, that esteem is lessened to roughly 6 for the 9-stories outlines. It ought to be additionally noticed that the previously mentioned values got more prominent for fringe outlines than those of space frames. The aftereffects of incremental nonlinear static examinations uncovered that the measure of over-quality consider was for the most part diminished the space outlines by expanding the quantity of stories. For example, the over quality component took the estimation of 3.9 if there should arise an occurrence of the 3-stories outline with 2 ranges. Be that as it may, the estimation of this element come to 1.93 by expanding the quantity of stories. The consequences of non-direct unique examinations exhibited in this paper foregrounded the way that by expanding the quantity of stories, the measure of fall edge proportion decreased impressively in both space and fringe outlines. According to the aftereffects of this review and furthermore in light of the criteria specified in FEMA P695, the estimation of reaction alteration calculate for the working with dispensable knee propping casings was proposed equivalent to 8. It was likewise reasoned that the measure of avoidance intensification calculate, Cd, ought to be equivalent to the estimation of the reaction change figure. As a temperate thought, the use of connection components in steel outline structures is worthy. In addition, these components can assume a huge part in the restoration and repair of existing structures.

[2] G Navya and Pankaj Agarwal, (2016): This paper presents the Seismic Retrofitting of Structures by Steel Bracings. In this paper, Pushover examination of the building composed according to IS 1893 (Part 1): 2002 on the premise of kept plastic pivot districts performs much palatably when contrasted with the un-bound condition. Delicacy bends likewise demonstrate that routinely outlined building is more helpless when contrasted with building composed with seismic arrangements identified with control at the conceivable area of plastic pivots. Fragility examination shows that the routinely composed working under MCE condition comparing to Zone IV demonstrates that the most astounding likelihood (97.68%) is under the classification of broad harm. Be that as it may, building composed according to IS 1893 (Part 1): 2002 endures direct harm under a similar level of seismic risk. There is a critical diminishment in the seismic helplessness of the working in the wake of retrofitting of working with steel propping. The delicacy investigation shows that the likelihood of harm under crumple and broad condition of harm diminishes impressively in the wake of retrofitting of the building.

[3] Ali Imanpour, Karl Auger and Robert Tremblay (2016): This paper presents, Seismic design and performance of multi-tiered steel braced frames including the contribution from gravity columns under in-plane seismic demand. This paper analyzes the likelihood of activating gravity sections in the resistance of in-plane bowing minutes forced on the segments of multi-layered steel propped outlines subjected to seismic stacking. This would be the situation when even struts are utilized to associate gravity sections to supported edges at each level, as is regularly observed along outside dividers. A seismic outline methodology in view of the AISC Seismic Provisions is introduced for four-layered model steel concentrically supported casings. Three diverse methodologies are proposed for the outline of the propped edge and gravity segments. An arrangement of 12 4-layered X-propped outlines, running from 15 to 30 m in tallness and situated in a high seismic region were composed in light of the proposed configuration approaches. The seismic conduct of the edges is assessed utilizing non-linear reaction history investigation. The outcomes demonstrate that the seismic execution of the propped casings is enhanced as a non-linear seismic request on the supporting individuals is decreased while assembling the gravity sections for horizontal resistance. Moreover, gravity sections bowing minute requests are appropriated between the supported edge and gravity segments in the extent of their relative flexural firmness. Sufficient seismic execution and financially savvy configuration can be accomplished when sections of both sorts are intended to oppose their separate offer of the flexural request. On the other hand, the agreeable reaction was accomplished when the gravity segments are confirmed for the seismic prompted bowing minute's acting together with attendant pivotal burdens.

[4] Dhanaraj M. Patil and Keshav K. Sangle, (2015): This paper presents Seismic Behaviour of Different Bracing Systems in High Rise 2-D Steel Buildings. In this review an endeavor is made to evaluate the seismic reaction parameters of various basic frameworks to analyze seismic conduct of every framework. For this reason, contrastingly propped structures are considered for various stories; and the execution is analyzed. A broad logical examination of the seismic reaction of various propped outlines has been embraced by nonlinear static sucker investigation. The finishes of this review can be outlined as follows.1. In elevated structures quality and firmness are more imperative, so it is conceivable to choose a supporting framework in order to increment both the drive conveying limit and solidness. MRF structures demonstrate higher story uprooting and between story float proportion showing that MRF structures are more adaptable (flexible) than other propped structures, so inclined to over the top harm in seismic event.2. CBF and VBF demonstrate bring down story dislodging and between story float proportion showing that these frameworks have quality and solidness. ZBF likewise demonstrates almost comparable story uprooting and between story float ratio.3. Seismic reaction of CBF and VBF is almost comparable as far as base shear with sufficient rooftop dislodging for all story structures. Seismic reaction of these two is impressively higher than MRF and XBF. Likewise, ZBF indicates higher seismic reaction as far as base shear with satisfactory rooftop uprooting than different frameworks for all story buildings.4. In MRF, a greater number of bars experience plastic pivot arrangement than the propped structures. In supported structures the grouping of pivot arrangement is that first in the prop, after that in the bar and afterward in the section, though in MRF, it is first in the shaft and afterward the column.5. The pattern in the similitudes or potentially in the varieties of the in variation parallel load examples is thought about seismic reaction of the structure. Multi-modular sidelong load design overestimates the base shear and belittles the story removal, float proportion; subsequently it predicts unconservative outcomes, though codal and versatile first mode parallel load designs foresee more conservative results.6. Seismic execution of various structures regarding execution point demonstrates that ZBF structures have higher limit than different structures, while MRF structures have least capacity.7. ZBF, VBF and CBF have higher seismic reaction relying upon various seismic parameters, for example, basic day and age, base shear, rooftop relocation, story uprooting, between story float proportion and execution point than XBF and MRF. The exploration displayed here basically concentrates on the seismic conduct of various propping frameworks in tall structure 2-D steel structures. Nonetheless, future reviews ought to consider the seismic conduct of various propping frameworks in tall structure 3-D steel structures.

[5] Wenwu Lan, Jiaxing Ma, and Bing Li, (2015): This paper presents a Seismic performance of steel-concrete composite structural walls with internal bracings. This paper presents test and systematic examinations of steel-concrete composite auxiliary dividers with interior bracings. In the test think about, four full-scale divider examples were tried under cyclic load inversions. The execution of the divider examples as far as load–deformation reaction and breaking examples is depicted. Nonetheless, because of the innate many-sided quality of shear dividers and special components of the installed slanting supporting, the exploratory examination was not adequate to completely clarify the impact of a few parameters. Along these lines, a diagnostic examination in light of the FE models utilizing DIANA is introduced. Approval of the FE models against the test comes about has demonstrated a decent understanding. Basic parameters affecting the shear divider's conduct, for example, shear traverse proportion, pivotal load, the size and thickness of molded steel fluctuate, and their impacts on the dividers' seismic conduct are talked about. The seismic conduct of steel-concrete composite auxiliary dividers with corner to corner bracings was explored utilizing the exploratory and the FE numerical models. In light of the perceptions and results from these reviews, the accompanying conclusions can be drawn. Trial perceptions demonstrated that the "X" molded steel supporting shad a helpful impact on the shear limit, firmness corruption and vitality dispersing limit of steel-concrete composite basic dividers. By including more "X" formed steel bracings and level molded steel, steel-concrete composite auxiliary dividers could withstand more shear drive under cyclic stacking, in this way slanting the disappointment mode towards flexural disappointment. Test and FE numerical examinations demonstrated that the expansion of level formed steel in inserted sections could clearly enhance the execution concerning firmness corruption of steel-concrete composite auxiliary dividers with a vast shear traverse proportion (1.8).

[6] Krishnaraj R. Chavan, Jadhav H.S, (2014): This paper presents, Seismic Response of R C Building With Different Arrangement of Steel Bracing System. In this review, the seismic investigation of fortified cement (RC) structures with various sorts of propping (Diagonal, V sort, upset V sort, X sort) is contemplated. The supporting is accommodated fringe sections. A seven-Story (G+6) building is arranged at seismic zone III. The building models are dissected by equal static investigation according to IS 1893:2002 utilizing Staad Pro V8i programming. The principle parameters consider in this paper to look at the seismic examination of structures are parallel relocation, Story float, hub drive, base shear. It is discovered that the X kind of steel propping fundamentally adds to the auxiliary firmness and decreases the most extreme interStorey float of R.C.C working than another supporting framework.

[7] Siddiqi Z.A, Rashid Hameed, Usman Akmal, (2014): This paper presents, Seismic Protection of R/C Structures by a New Dissipative Bracing System. In their review they have talked about five distinct sorts of supporting frameworks have been explored for the utilization in tall working keeping in mind the end goal to give parallel firmness lastly the advanced plan as far as lesser basic weight and lesser sidelong dislodging has been uncovered. For this reason, a sixty Story customary molded building is chosen and broke down for wind and gravity stack blends along both major and minor tomahawks. Single Diagonal, Double corner to corner, K/Chevron, V, Knee props are utilized. Lesser auxiliary tall building steel weight is acquired when it is supported along the minor pivot of bowing of sections in the examination of the circumstance when the same building is propped along the real hub of bowing. Among five diverse explored supporting frameworks, twofold propping framework yields the least weight of auxiliary steel. Additionally, least weight is gotten when focal two narrows of the tall building are supported against sidelong loads (fourth and fifth straights in the present review).

[8] Jesumi A, Rajendran M.G, (2013): This paper presents, Optimal Bracing System for Steel Towers. They have examined distinctive sorts of propping frameworks for steel cross-section towers. The statures of these towers differ from 20 to 500 meters, in light of the commonsense prerequisites. This review has concentrated on distinguishing the practical propping framework for a given scope of tower statures. Towers of tallness 40m and 50m have been broke down with various sorts of propping frameworks under wind loads. The inclining wind has been observed to be the most extreme for towers. Investigative reviews have been introduced to locate the most suitable game plan and savvy supporting arrangement of steel cross-section towers for the powerful resistance against sidelong powers.

[9] Qing Quan Lian, Yi Min Xie and Grant P. Steven, (2012): This paper presents, Optimal Topology Design of Bracing Systems for Multistory Steel Frames.:In this review, they have examined about the distinctive propping frameworks and utilizing of ideal outline procedure for steel outlines utilized as a part of multi-Story structure with general firmness requirements under various stacking limitations. Material evacuation criteria are inferred by undertaking an affectability investigation on the mean consistency of a structure as for component expulsion. An execution file is proposed to assess the execution of coming about supporting frameworks in the enhancement procedure. In the proposed technique, unbraced systems are at first planned under quality imperatives utilizing business standard steel segment from databases. The ideal topology of a propping framework for the multi-story steel building structure is then created by slowly expelling wasteful materials from a continuum outline area that is utilized to harden the structure until the execution of the supporting framework is amplified. Two plan cases are given to delineate the adequacy of execution based outline improvement technique proposed for the reasonable format plan of horizontal propping frameworks for multi-story steel building systems.

3. AIM OF THE STUDY

The aim of the Present work is to evaluate the different sorts of Bracing frameworks utilized as a part of Tall Buildings to oppose the sidelong loads. Tall structures are worked with different basic frameworks; we are thinking about steel and concrete structures with supported casings for this work. Rule goal of this work is to touch base at the best arrangement of bracing individuals in a tall building.

4. OBJECTIVES

1. Inspecting the usually utilized supporting examples for the tall structures and to condense the regular frameworks of bracings for elevated structures.
2. To build up a three-dimensional limited component model for the impacts of various supporting examples utilizing CYPECAD programming. Taking after sorts of supports are utilized as a part of the present review :
3. Single inclining bracings unusual in reverse.
4. Single corner to corner supports unconventional forward.
5. V-Bracing framework.
6. X-Bracing framework/Cross-Bracing framework.
7. 3. Assessing the outcomes from the investigation, Comparison is made concerning unbraced model to have the greatest lessening of bury Story float and float record for propping arrangement which enhances the sidelong load resistance of the structure effectively.
8. 4. Assessing the models with the most extreme diminishment of entomb Story float and float record per unit amount of steel devoured for bracings in light of the ideas of direct compel way and uniform drive circulation.

5. MODELING USING FINITE ELEMENT SOFTWARE CYPECAD

Different types of supporting frameworks that can be utilized as a part of an encircled structure are demonstrated utilizing a limited component bundle CYPECAD. A three dimensional encircled structure with 4 narrows along flat tomahawks and 20 quantities of stories is chosen for the review. The profundity of the story is 3 meters and narrows width of 4 meters is accommodated the structure considered. The segments and bars are intended to withstand the dead load and live load satisfactorily. The supports are furnished with same basic properties as that of the shafts for the present study. The horizontal burdens to be connected on the building depend on the Indian benchmarks. The review is performed for earthquake zone V according to IS - 1893:2002 and wind speed of 50 m/s according to Seems to be IS 875-1987. The edges are thought to be immovably settled and soil structure communication is ignored. The heap blends and other outline parameters related with steel structure are according to IS 800:2007.

5.1 Basic data for modeling:

Table 1: Basic Data for Modelling

Structure	Reinforced Concrete frame
Number of stories	G+19
Height of story	3.00 m
Building type	Residential
Seismic3zone	V
Basic Wind Speed	50 m/s

5.2 Material properties:

Table 2: Properties for Concrete

Mass per unit volume	2.5 KN/m^3
Weight per unit volume	25 KN/m^3
Modulus of elasticity	$25x10^6$
Poisson's ratio	0.2
Co-efficient of thermal expansion	$9.900x10^{-6}$
Shear Modulus	10416666.7
Concrete Cube compressive Strength	30 N/mm^2
Bending Reinforced Yield Stress Fy	415 N/mm^2
Shear reinforced yield stress, Fys	415 N/mm^2

Table 3: Properties of Steel

Mass per unit volume	800.2019 Kg/m^3
Weight per unit volume	7850 Kg/m^3
Modulus of elasticity	$2x10^8$
Poisson's ratio	0.3
Co-efficient of thermal expansion	$1.2x 10^{-5}$
Shear Modulus	76923077
Minimum Yield Stress Fy	240 N/mm^2
Minimum tensile strength Fu	410N/mm^2

5.3 Frame section properties:

Columns

Column 1: Width = 0.8 m
Depth = 0.8 m

Column 2: Width = 0.6 m
Depth = 0.6 m

Beams

Beam-X: Width = 0.3 m
Depth = 0.9 m

Beam-Y: Width = 0.3 m
Depth = 0.5 m

Braces

I section - ISHB-450 @ 92.5kg/m
The width of Flange – 250 mm, Thickness of Flange–13.7mm Thickness of Web–11.30mm,
The height of the section – 450mm

5.4 Loads Considered:

The loads considered for the analysis of the high rise steel buildings are:

1. Dead load
2. Live load
3. Wall load
4. Seismic/Earth Quake load
5. Wind load

Table 4: Wall Loads

The density of brick masonry	20 KN/m³
Thickness of wall	0.230 m
A load of the parapet wall	4.6 KN/mm²
Wall load on beams	13.8 KN/mm²

Table 5: Earthquake Loads

Zone factor, Z	0.36
Importance Factor, I	1.0
Soil type	II
Response reduction factor R for unbraced reference model	5
Time period	1.866
Percentage of imposed load considered during seismic load calculations	25 %

Table 6: Wind Loads

Basic wind speed	50 m/s
Terrain Category	3
Class of structure	B
Risk coefficient	1
Topography	1
Windward coefficient	0.8 for wind direction angle 0° 0.8 for wind direction angle90°
Leeward coefficient	0.25 for wind direction angle0° 0.8 for wind direction angle90°

5.5 Structural modeling:

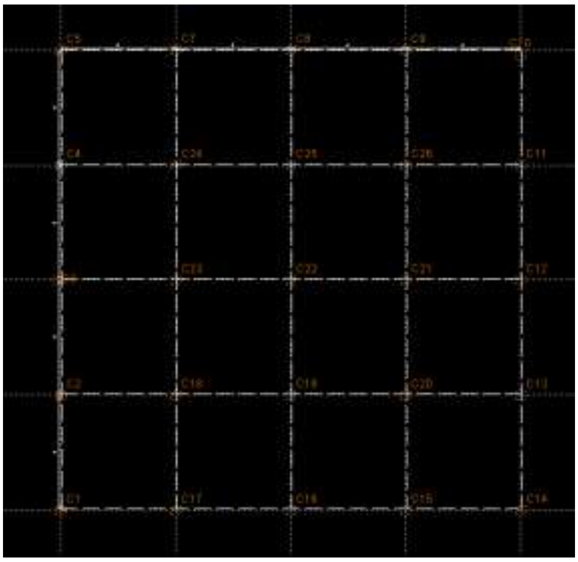

Fig. 1: Plan of the Unbraced Reference Model.

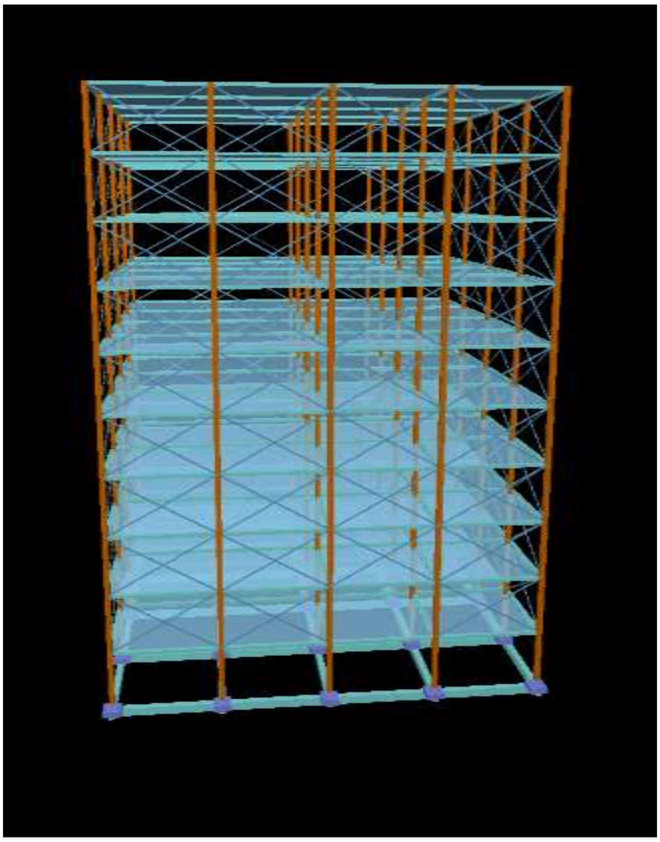

Fig.2: 3D view of the Braced Structural Model.

Table 7: Percentage Reduction of Drift Index for Various Models in Comparison With Unbraced Reference Model

Model Number	Response spectrum along x-direction RSX			Response spectrum along y-direction RSY		
	DISPLACEMENT (m)	DRIFT INDEX	% REDUCTION	DISPLACEMENT (m)	DRIFT INDEX	% REDUCTION
0	0.0485	0.001415		0.0823	0.002468	
1	0.0094	0.000184	86.996	0.0098	0.000193	92.180
2	0.0094	0.000184	86.996	0.0098	0.000193	92.180
3	0.0093	0.00018	87.279	0.0098	0.00019	92.301
4	0.0086	0.000169	88.057	0.009	0.000178	92.788
5	0.0089	0.000175	87.633	0.0094	0.000184	92.545
6	0.0089	0.000175	87.633	0.0094	0.000184	92.545
7	0.0173	0.000358	74.700	0.0199	0.000413	83.266
8	0.0173	0.000358	74.700	0.0199	0.000413	83.266
9	0.0142	0.000298	78.940	0.0175	0.000369	85.049
10	0.0154	0.000328	76.820	0.0195	0.000417	83.104
11	0.0168	0.000354	74.982	0.021	0.000442	82.091
12	0.0111	0.000224	84.170	0.0208	0.000421	82.942
13	0.009	0.00018	87.279	0.0095	0.00019	92.301
14	0.009	0.000179	87.350	0.0095	0.00019	92.301
15	0.0088	0.000173	87.774	0.0093	0.000183	92.585
16	0.0123	0.000248	82.473	0.0142	0.000288	88.331
17	0.0124	0.00025	82.332	0.0143	0.000289	88.290
18	0.0124	0.00025	82.332	0.0143	0.000289	88.290
19	0.0126	0.000271	80.848	0.0141	0.000314	87.277
20	0.0127	0.000273	80.707	0.0143	0.000313	87.318
21	0.0261	0.000545	2466.77	2466.77	0.0289	0.000603
22	0.0239	0.000496	2726.15	2726.16	0.0259	0.00054
23	0.021	0.000425	3089.08	3089.08	0.0216	0.000441

Table 8: Percentage Reduction of Drift Index for Various Models in Comparison With Unbraced Reference Model

MODEL NUMBER	QUANTITY OF STEEL CONSUMED IN BRACING	% Reduction of DRIFT INDEX in X direction	% Reduction/Unit Quantity of Steel	% Reduction of DRIFT INDEX in Y direction	% Reduction/Unit Quantity of Steel
0	-	-	-	-	-
1	1786.112	86.996	0.478	92.180	0.506
2	1786.112	86.996	0.478	92.180	0.506
3	1786.112	87.279	0.479	92.301	0.507
4	1786.112	88.057	0.484	92.788	0.510
5	1786.112	87.633	0.481	92.545	0.508
6	1786.112	87.633	0.481	92.545	0.508
7	1428.889	74.700	0.513	83.266	0.572
8	1428.889	74.700	0.513	83.266	0.572
9	2143.334	78.940	0.361	85.049	0.389
10	1428.889	76.820	0.527	83.104	0.571
11	1428.889	74.982	0.515	82.091	0.564
12	2143.334	84.170	0.385	82.942	0.380
13	1786.112	87.279	0.479	92.301	0.507
14	1786.112	87.350	0.480	92.301	0.507
15	1786.112	87.774	0.482	92.585	0.509
16	1428.889	82.473	0.566	88.331	0.606
17	1428.889	82.332	0.565	88.290	0.606
18	1428.889	82.332	0.565	88.290	0.606
19	714.445	80.848	1.110	87.277	1.198
20	714.445	80.707	1.108	87.318	1.199
21	1428.889	61.484	0.422	75.567	0.519
22	1428.889	64.947	0.446	78.120	0.536
23	1428.889	69.965	0.480	82.131	0.564

Table 9: Percentage Reduction of Inter Storey Drift for Various Models in Comparison with Unbraced Reference Model.

Model no.	Inter storey Drift	% Reduction
0	0.0019	
1	0.0002	90.29
2	0.0002	90.29
3	0.0002	90.47
4	0.0002	91.06
5	0.0002	90.75
6	0.0002	90.75
7	0.0004	80.14
8	0.0004	80.14
9	0.0003	82.82
10	0.0004	80.81
11	0.0004	79.50
12	0.0003	83.39
13	0.0002	90.47
14	0.0002	90.50
15	0.0002	90.83
16	0.0003	86.20
17	0.0003	86.12
18	0.0003	86.12
19	0.0003	84.93
20	0.0003	84.91
21	0.0006	70.44
22	0.0005	73.32
23	0.0004	77.70

6. OUTCOMES

From the results obtained, following inferences have has been made:

1. Table 7 shows the percentage reduction in drift index for different models in comparison with the unbraced reference model. Model no. 4, the bracing consists of backward bracing in bays 3 and 4 and forward eccentric bracing on bays 1 and 2 has maximum percentage reduction of drift index of in x-direction 88.057% and in y-direction 92.78%.
2. Table 9 shows the percentage reduction in inter-storey drift for different models in comparison with unbraced reference model. Model no.4 also has the maximum percentage reduction of inter Storey drift of 91.06 %.
3. Table 8 shows the percentage reduction in drift index per unit quantity of steel used for bracing for different models. Model no.20 consisting of single bracings in diagonal form of forming diamond shape has a maximum percentage of drift index per unit quantity of steel used for bracings in x-direction 1.108% and in the y-direction 1.199%.

Table 10: Results of all parameters studied for models 04 and 20.

Model Number	Percentage reduction in drift index	Percentage reduction in drift index per unit quantity of steel consumed for bracing	Percentage reduction in inter storey drift	Percentage reduction in inter storey drift per quantity of steel consumed for bracing
Model 04	88.057	0.484	91.064	0.500
Model 20	80.707	1.108	84.909	1.166

Apart from reducing the inter storey drift and storey index, an effective bracing system should transfer the lateral forces to the columns in the frame such that there is no stress concentration in a particular column and thus equally distributing the internal forces in each of its individual member resulting in effective load transfer down to the substructure and thus reduce the flexure and shear demands on columns.

7. CONCLUSIONS

From the analysis of the results obtained, following conclusions were derived:

1. Model consists of backward bracing in bays 4 and 5 and forward eccentric bracing on bays 1, 2 and 3has maximum percentage reduction of drift index of in x-direction 88.057% and in y-direction 92.78%.
2. Model consists of backward bracing in bays 4 and 5 and forward eccentric bracing on bays 1, 2 and 3 also has maximum percentage reduction of inter Storey drift of 91.06 %.
3. Model consisting of single diagonal bracings forming diamond shape has maximum percentage of drift index per unit quantity of steel consumed for bracings in x-direction1.108%and in the y-direction1.199%.
4. Model consisting of single diagonal bracings forming diamond shape has maximum percentage of reduction of inter-storey drift per unit quantity of steel consumed for bracings of 1.166%.
5. With financial perspective the Model consists of single diagonal bracings arranged in diamond shape has most extreme decrease of drift index per unit quantity of steel consumed and greatest reduction of inter-storey drift per unit amount of steel consumed for bracing and slightest flexural and sheer demand in columns, in this manner enhancing its basic effectiveness, circulation of inside strengths and the base flexural and demands in columns.
6. Based on the design concepts of inter-storey drift, drift index and criteria on internal forces, we can evidently say that model no. 20 consisting of single diagonal braces arranged to form a diamond shape such that, the braces are providing all the five bays, starting from the exterior columns is the best type of bracing system among the 23 sorts of bracing arrangements considered in this study.

8. SCOPE FOR FURTHER WORK

1. The effective bracing system can be found out by comparing the behaviour of bracing systems in buildings of different storeys.
2. The effective bracing system can be found by varying the plan of the buildings.
3. The effective bracing system can be found by varying the load cases
4. Effectiveness of the bracing systems can also be compared by varying the magnitude of the lateral load.
5. The effectiveness of the bracing system can be found out by comparing different seismic zones.

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