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Concentric Bracing Frame in Earthquake-Resistant High-Rise Buildings

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Comparison; Concentric Bracing Frame (CBF); Earthquake Resistant

Abstract

Indonesia has regular earthquakes; thus, constructions must be designed to SNI 1726:2019. Building height based on SNI 1726:2012 table 9 and article 7.2.5.4 maximums. The survey says response-based damage models can assess ground vibrations. The earthquake damage was assessed and compared to the moment-resisting frame after the structure was rehabilitated with concentric bracing. 1) This study analyzes lateral forces on each level for moment-resisting and concentric-braced frames. CBF, 2) assessing displacements at each level for moment-resisting and concentric braced frames, and 3) counting narratives. The ETABS Structural Analysis Professional 2020 program measures structural element internal forces. Internal forces include shear, axial, bending, and twisting. Next, calculate level displacement, or vertical distance between levels. The pushover analysis on medium and high-rise structures shows 0.91% CBF lateral shear force. CBF stiffens elastically. CBF supports enhance CBF displacement by 70%, minimize floor structure displacement, and stiffen the steel frame laterally more than MRF. Maximum CBF deviation between floors is 85%; CBF and MRF weight differential is 1.530%. Thus, the CBF exceeds the frame weight. The designed structure is important, but seismic performance in static and dynamic nonlinear circumstances differs.

INTRODUCTION

Indonesia is geographically characterized by a heightened vulnerability to natural disasters, specifically seismic occurrences such as earthquakes (Hariadi, Sugiharti, & Wahiddin, 2019; Güler & Celep, 2020). Earthquakes occur due to interactions between tectonic plates in the earth's crust so that they experience collisions and horizontal displacement (Trutalli *et al.*, 2019; Aryo & Suangga, 2020; Hancilar, Sesetyan, & Cakti, 2020). The structural integrity of buildings located above ground level is disrupted, causing collapse due to the impact of seismic waves (Nur, 2010; Shen *et al.*, 2017; Ahmadi, Ricles, & Sause, 2018).

The cause of structural damage experienced by buildings during an earthquake is because the building is not strong enough to withstand seismic forces arising from its vulnerability to earthquakes caused by the interaction of the India-Australia tectonic plate with areas known to have it. In addition, the lack of effective hazard mitigation techniques increases the vulnerability of various regional building structures to earthquake events (Acharyya, Mohan, & Kujur, 2016; Bora & Pande, 2017; Syed *et al.*, 2017). The most important thing is to guarantee that building materials comply with strict quality standards. Apart from that, people must prioritize choosing quality materials (Sitota, Quezon, & Ararsa, 2021). Housing construction is arranged as a cohesive unit, including cohesive foundations, columns and walls, to maintain the connectivity and unity of its constituent elements even when seismic events occur (Trutalli *et al.*, 2019; Musthafa & Hindaryanto, 2021; Zulfiar & Zai, 2021).

Research conducted by Khan et al. (2015) entitled "Effect Of Concentric And Eccentric Type Of Bracings On " shows that 1) multilevel drift compared to the X bracing model was found to provide better results for the direction linear static analysis when compared to other models, 2) support is better for both linear and nonlinear static analysis, 4) concentric inverted V amplifier model better value for graded drift when compared to other models rendering to be better than the rest of the models (Khan, Naryana, & Raz, 2015; Formisano *et al.*, 2020).

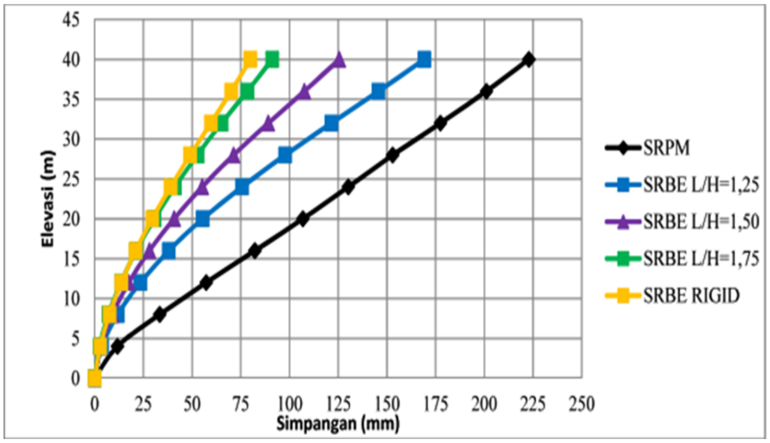


Figure 1. Deviation Between Floors (Sukrawa *et al.*, 2016)

Based on SNI 1726:2019 article 7.3.3, there are various kinds of earthquake-resisting systems, including the building frame system (single system). One of the developments in earthquake-resistant structural technology is stiffeners or bracing (Renaldi, Setiawan, & Tanojo, 2019). This stiffener aims to reduce the impact of lateral forces caused by earthquake forces. Currently, there are 2 (tow) earthquake-resistant steel structure systems known, namely the Moment Resisting Frame System (SRPM) and the Concentric Bracing Frame System (SRBC) (Tafheem & Khusru, 2013; Rahman, Teguh, & Saleh, 2021).

The incorporation of stiffeners within the concentric bracing frame system (SRBC) results in a significant enhancement of its structural rigidity. This system's energy absorption is considered insufficient because of the limited inelastic capacity of the bracing members. The matter concerning the SRBK system's ability to absorb lateral loads effectively was effectively resolved with the use of the eccentrically bracing frame system (SRBE) (Issa & Alam, 2019; Kumar, Senthilkumar, & Sourabha, 2019).

Moreover, it is crucial to recognize that the application of bracing serves a pivotal function in mitigating the impact of bending moment and shear stresses exerted on columns (Ronagh, 2011; Alwaeli *et al.*, 2017; Ccahuana, Coronel, & Soto, 2020). However, it is imperative to acknowledge that this particular approach to bracing leads to a concomitant increase in the axial compression experienced by the columns that are connected to the braced columns (Kurniawan, Nurtanto, & Hayu, 2018; Gusella *et al.*, 2019; Yao *et al.*, 2020). The incorporation of eccentric reinforcement inside the system results in a decrease in its lateral stiffness while simultaneously enhancing its energy dissipation capabilities. The lateral stiffness of the design is contingent upon the bending stiffness of the shaft, which is influenced by the non-traditional connection between the bracing and the beam. The beam experiences an increase in lateral load due to the vertical component of the bracing forces generated by the seismic activity (Maizuar & Burhanuddin, 2016; Maida *et al.*, 2018; Gusella *et al.*, 2019).

Concentric Braced Frames (CBF) are a type of construction that resists lateral stresses by using a vertical concentric truss system with member axes aligning concentrically at the joints. Concentric ally braced frames have little restrictions for members or connections and are commonly utilized in low seismic risk zones. The majority of braced frames are concentric. This indicates that where members overlap at a node, each member's centroid passes through the same place (Khan et al., 2015).

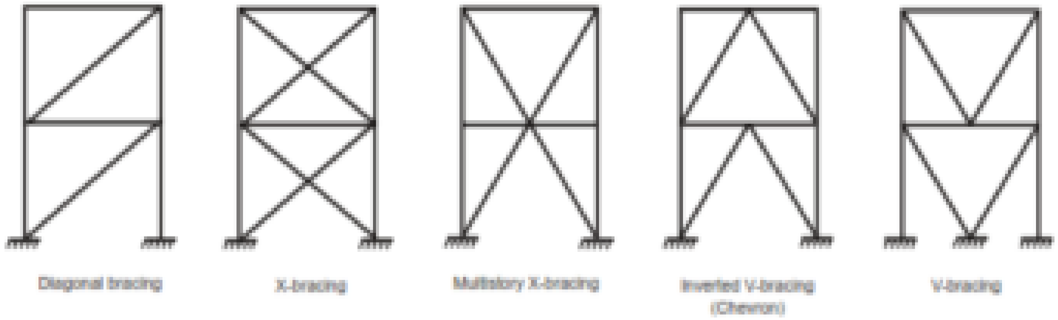


Figure 2. Concentric braced Frame Structures (CBF)
***Source*: (Tanijaya, 2021)**

A concentric bracing frame system, as defined by SNI 1726:2019, is a set of frame braces with structural elements that resist axial forces and can be divided into two categories: 1) Standard Concentric Braced Framework (SRBKB): In this system, it is anticipated that if the structure is loaded by seismic forces, the frame structure may undergo limited inelastic deformation. 2) Particular Concentric Braced Framework (SRBKK): When compared to SRBKB, the frame structure of this system is more ductile. The level must be calculated for her slenderness because the strength loss when buckling occurs in the compression brace is smaller in value.

The brewing process has been recognized as a technological advancement that has the potential to decrease concentricity and enhance structural stability. This observation indicates that eccentric-type bracing is more suited for buildings subjected to primary seismic pressures, but concentric bracing is more appropriate for structures exposed to wind loads (Alshamrani *et al.*, 2009; Salek Faramarzi & Taghikhany, 2020; Lingeshwaran *et al.*, 2021).

This prompted the researcher to analyze the position of the two braces in the earthquake-loaded building. The difference is in the working force; in previous research, the working load was wind load, but in this study, the working load was earthquake force. The study also stated that concentric bracing is more suitable for use in areas where earthquake loads dominate than wind (Sukrawa, Giri, & Tama, 2013; Formisano *et al.*, 2020).

Based on the problems above, this research aims to analyze the lateral forces on each floor for moment-bearing frames and concentric-braced frames. & CBF, displacement at each level for moment resisting frames and concentric braced frames, and the number of storylines in moment resisting concentrically braced frames. This research incorporates regulations officially acknowledged in Indonesia when doing structural analysis.

RESEARCH METHODS

The primary objective of this work is to examine and evaluate the modelling and analytic techniques employed in unbound structures. The building model used is the ETABS Structural Analysis Professional 2020 Program which can be used to determine the magnitude of internal forces in structural elements. Internal forces consist of shear force, axial force, bending moment, and twisting moment. Next, determine the vertical distance or displacement between various levels, also called level displacement. The building location described using ETABS is room AC of the Malang State Polytechnic Building. The structure is designed according to the seismic earthquake standard SNI 1726:2019. Building height based on SNI 1726:2012 table 9 and maximum limits in article 7.2.5.4.

The research flow described outlines the various stages of concentric bracing frames in earthquake-resistant high-rise buildings. Here's an explanation of each stage: 1) Start:This likely represents the beginning of the research process, where define the research problem and establish research objectives. 2) Data Collection:Involves gathering relevant data, which could include literature review findings, structural data of buildings, and seismic data for analysis. 3) Study of Literature:A comprehensive review of existing literature on concentric bracing frames, earthquake resistance, high-rise buildings, and other relevant topics to establish the background and context for research. 4) Preliminary Design: Based on the literature review and data collected, developing initial designs or concepts for the concentric bracing frames. 5) Building Modeling: Creating computer models of high-rise buildings to simulate their behaviour under seismic loads. 6) Loading Analysis: Applying seismic loads to the building models to analyze their response and evaluate the performance of the preliminary designs. 7) Internal Force Analysis: Analyzing the internal forces and stresses within the building components, such as beams and columns, under seismic loads. 8) Control: Ensuring the modelling and analysis are accurate and meet the required standards and specifications. 9) Structural Modeling with Concentric Bracing using ETABS20: Specifically modelling the structural behaviour of the building using concentric bracing frames in the ETABS20 software, which is commonly used for structural analysis and design. 10) Structural Modeling with Moment Resistance using ETABS20: Similarly, modelling the structural behaviour with moment resistance frames, is likely for comparison with the concentric bracing frames. 11) Comparison MRF&CBF: Comparing the performance of Moment Resistance Frames (MRF) and concentric Bracing Frames (CBF) to evaluate their effectiveness in earthquake resistance. 12) Discussion: Analyzing and interpreting the results of the comparison and discussing their implications for the design of earthquake-resistant high-rise buildings. 13) Conclusion: Summarize the key findings of research and state conclusions regarding the effectiveness of concentric bracing frames in earthquake-resistant high-rise buildings.

Planning Material Data

Preliminary drawing foundation of Beams, Columns AC polyneme

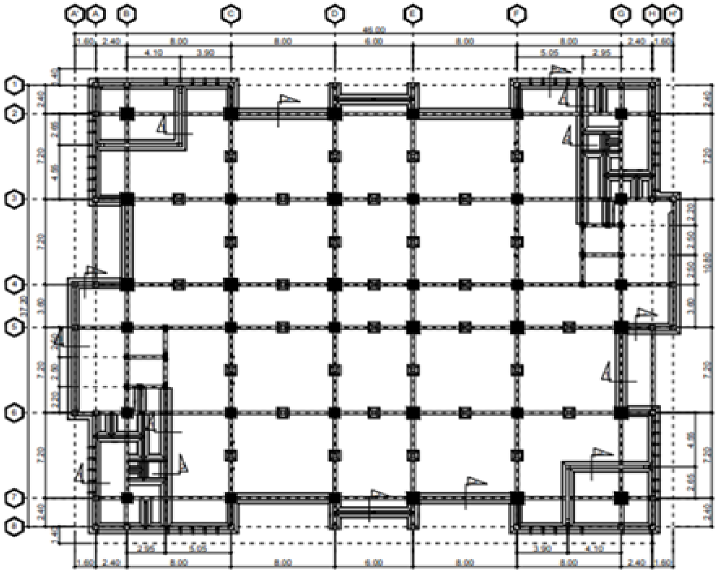


Figure3. Foundation

The structure of the A.C. Building Polytechnic State of Malang Building was planned using the material with details shown in Table 1.

Table 1. Structure of the building

No	**Composite Plate**	
1	The modulus of elasticity, E	200000 MPa
2	Fy floor deck	550 MPa
3	Fy steel reinforcement	240 MPa
4	Fu shear studs	450 MPa
No	**WF Hot Rolled Profile**	
1	Column profile quality (WF500x300x16x22)	BJ 50 (f_y= 290 MPa; f_u= 500 MPa)
2	Bracing profile quality (WF200x100x5.5x8)	BJ 50 (f_y= 290 MPa; f_u= 500 MPa)
3	Profile quality of cross main beam (WF450x250x10x16)	BJ 50 (f_y= 290 MPa; f_u= 500 MPa)
4	Profile quality of Secondary Column profile (WF350x350x12x19)	BJ 50 (f_y= 290 MPa; f_u= 500 MPa)
5	Quality of joist profile (WF400x200x8x13)	BJ 41 (f_y= 250 MPa; f_u= 410 MPa)

1. Main Beam Dimensions :

Main Beam Dimensions for direction of X &Y axis (8.00 m)

$$1/22 \times L \leq H \leq 1/18 \times L = 363.6 \leq H \leq 444.4 \text{ mm}$$

Table 2. Main Beam Dimensions For Direction of X &Y axis (8.00m)

Used steel profile WF 400.250.10.16

Figure 2. Main Beam follows

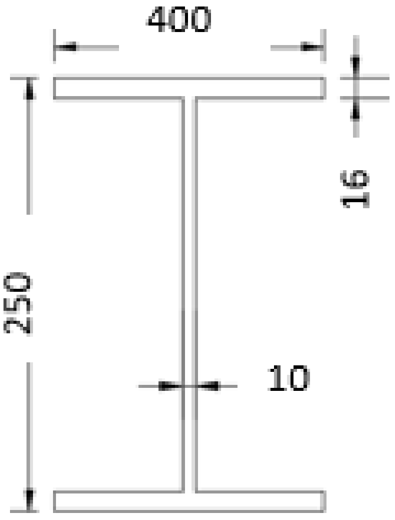


Figure 4. Main Beam

2. Column Dimensions

Used steel profile WF 500 x 300 x 16 x 22

Table 3. Main Column follows

WF 500.300.16.22							
d(H)	=	500	mm	r_x	=	20.77	cm
b(B)	=	300	mm	r_y	=	6.96	cm
t_w	=	16	mm	Z_x	=	3986.5	mm^3
t_f	=	22	mm	Z_y	=	1019.2	mm^3
r	=	24	mm	F_y	=	290	Mpa
A	=	205	cm^2	E	=	200000	Mpa
I_x	=	88095.5	cm^4	h	=	$d - 2(t_f+r)$	
I_y	=	9915.6	cm^4		=	208	mm

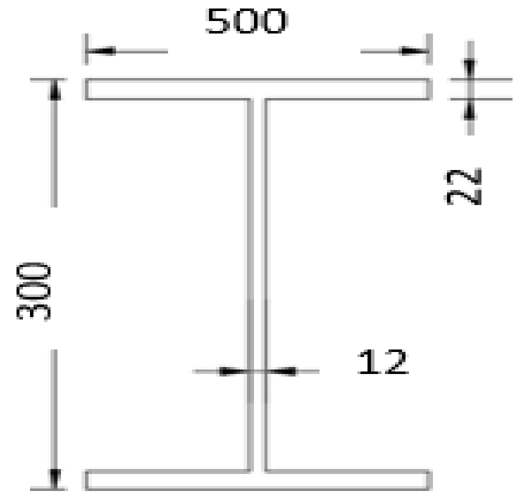


Figure 5. Main Column

3. Bracing Dimensions

Planned steel profile WF 200 x 100 x 5.5 x 8.

Table 4. Main Column follows

h	= 200	mm	A	= 27.16	cm^2	i_x	= 8.24 cm	r	= 11mm
b	= 100	mm	W	= 21.30	kg/m	i_y	= 2.22 cm		
t_f	= 8	mm	I_x	= 1840	cm^4	Z_x	= 184 cm^3		
t_w	= 5.5	mm	I_y	= 134	cm^4	Z_y	= 26.8 cm^3		

Earthquake Parameters According to SNI1726-2019.

1. Building Structure Risk Categories

The specific utilization of the facility notably impacts the classification of building risk. The AC Polinema building has been officially classified for educational purposes, categorizing it under risk category IV. The seismic hazard categorization was Category IV, leading to an earthquake priority factor (Ie) of 1.5.

2. Site Class Classification

Based on the available data, it can be observed that the soil found on building sites in the Malang area is classified as medium soil (S.D.).

Table 5. Site Class Classification

	Site Class Classification			**=**	**elementary school**
Variable	Sign	Variable	Sign	Variable	Sign
PGA (g)	0.3997	FPGAs	1,104	PSAs	0.441
SS(g)	0.865	F.A	1,154	LDK	0.67
S1(g)	0.4044	FV	1.8956	SD1(g)	0.51
CRS	0.96	SMS	0.99821	T0	0.15
CR1	0.93	SM1	0.581	Ts	0.76

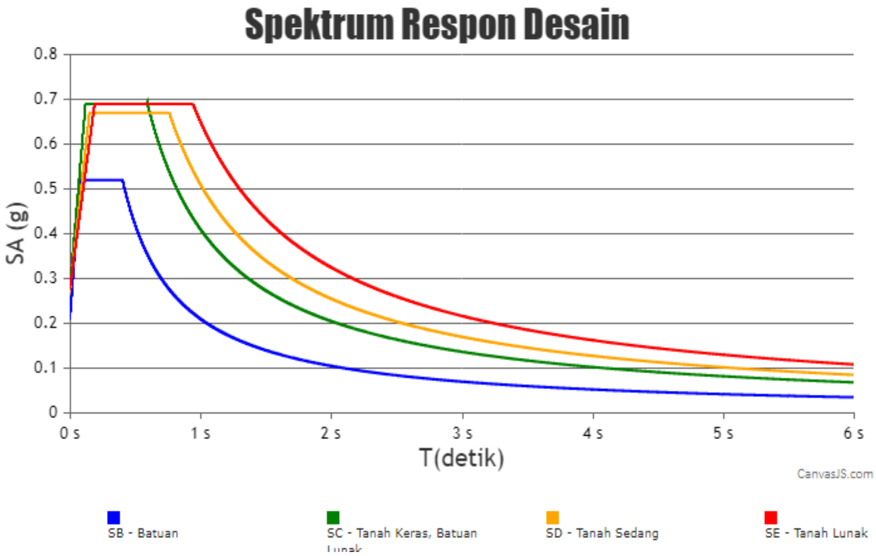


Figure 6. Response spectrum design

3. Site coefficient factors (Fa, Fv).

The table presents the Fv coefficients associated with various locations. The above image depicts the Maximum Considered Earthquake Acceleration Spectral Response Parameter (MCER) over a T = 1-second duration, denoted as S1. The current temporal epoch is characterized by identifying the footprint coefficients Fa and Fv, which have been determined to be 1.12 and 1.895, respectively.

4. Earthquake Design Category, KDS

The determination of the earthquake design category depends on the values of the short-period design spectral acceleration (SDS) and the 1-second spectral acceleration (SD1), as specified in the following table: The subject of inquiry pertains to the Earthquake Design Category. The primary objective of this study is to analyze the acceleration response parameters during the brief term. Based on the provided figures of SDS (0.63433) and SD1 (0.511), it can be deduced that the earthquake design category utilized for the design is classified as D. Based on the categorization of earthquake design category D, the level of earthquake risk is classified as high, hence requiring the development of specific structures that are resistant to seismic activity(Zhang, 2023).

5. CenterPeriod (T)

The AC Polinema building showcases a structural arrangement consisting of eight levels and a lower level that is partially buried, adhering to the specified criteria defined in SNI 1726-2019. According to the given standards, the fundamental period of vibration (T) must be less than 3.5 times the natural period of the structure (Ts), as prescribed by the pertinent equation. To mitigate the heightened seismic risk associated with earthquake design category D, earthquake-resistant construction employs a Steel Frame and Composite Concrete System incorporating a moment-resisting steel frame. The factors that have been obtained consist of the values.

6. Equivalent Lateral Force:

The design spectral response for the equivalent lateral force corresponds to equation 2.6 as follows:

V = Cs x W

Where Cs = 0,044 SDS Ie< SDs /(R/Ie) < SD1 /T(R/Ie)
Ie = 1.5
R = 8
CS = SDs /(R/Ie)
CS = SDs /(R/Ie)
= 0.1189375
CS max = SD1 /T(R/Ie)
= 2.913186274
CS min = 0.044 x S.D.s x Ie
= 0.041866

CS min	CS	CS max
0.042	0.119	2.240

RESULTS AND DISCUSSION

a. AC building design with ETABS 20

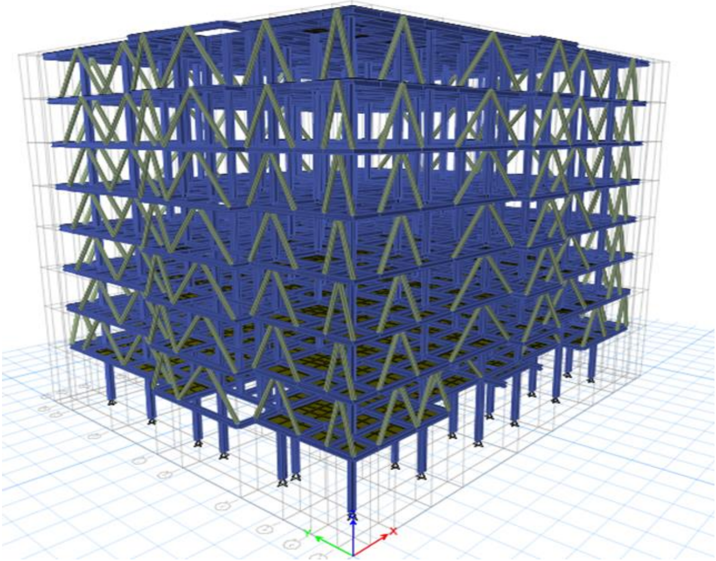


Figure 7. Bracing CBF AC building

Braces are additional structural elements that are used when desired making the portal structure more rigid (not swaying). Brewing is planned to carry axial loads that can cause tension and compression. When happened to earthquakes braced has two possible behaviors, namely due to buckling behavior compression and yielding or tensile fracture

Bracing Dimensions

Planned steel profile WF 200 x 100 x 5.5 x 8

Table 6. Bracing Dimensions

H	=	200 mm	A	=	27.16 cm^2	Ix	=	8.24 cm	r	=	11 mm
B	=	100 mm	W	=	21.30 kg/m	Iy	=	2.22 cm			
Tf	=	8 mm	Ix	=	1840 cm^4	Zx	=	184 cm^3			
Tw	=	5.5 mm	Iy	=	134 cm^4	Zy	=	26.8 cm^3			

b. Comparison of Story Lateral Force between MRF and CBF

Table 7. Story Power Comparison between MRF and CBF:

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN	kN
Story8	42.5	Top	3793.4951	0
Story7	37.5	Top	3194.8554	0
Story6	32.5	Top	2586.1225	0
Story5	27.5	Top	2020.6007	0
Story4	22.5	Top	1502.2636	0
Story3	17.5	Top	1036.389	0
Story2	12.5	Top	632.4571	0
Story1	7.5	Top	279.749	0
Base	0	Top	0	0

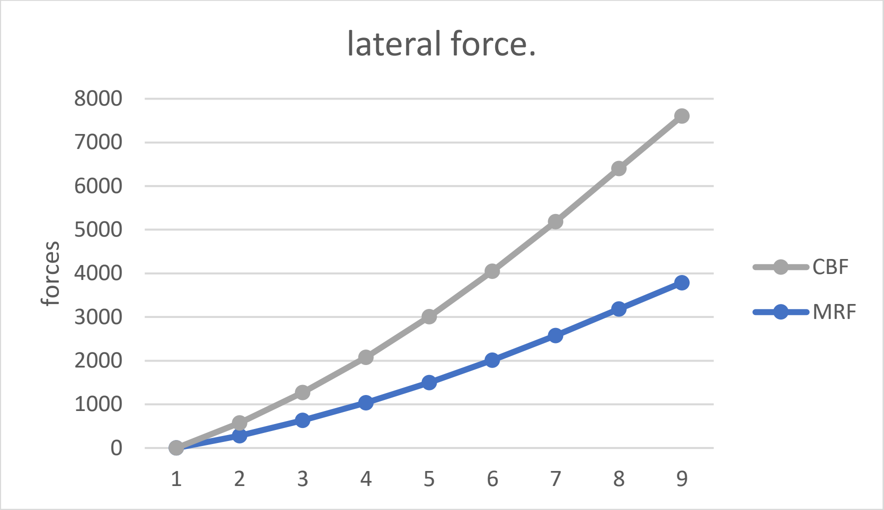


Figure 8. Story Force between MRF, CBF

The results reported in this study suggest that the CBF model demonstrates enhanced structural resilience when subjected to seismic pressures compared to previous models that employ moment-resisting frames (MRF). Determining the maximum shear force sustained by a Concrete Beam Flexure (CBF) structure yields a value of 195,672 kg. The shear energy for CBF exhibited a substantial increase of around 94.0% compared to MRF. The research suggests that a positive link exists between the connection length and the shear force amount. The shear force resistance of the Concentrically Braced Frame (CBF) demonstrates a substantial enhancement of 92% in comparison to the Moment Resisting Frame (MRF) (Kapoor and Setia, 2020; Jalali, Amiri, and Shakouri, 2021). Therefore, it can be demonstrated that CBF has a higher elastic rigidity, resulting in results similar to Tanijaya's. The CBF model presents enhanced structural robustness in its ability to withstand seismic forces when compared to competing models such as MRF.

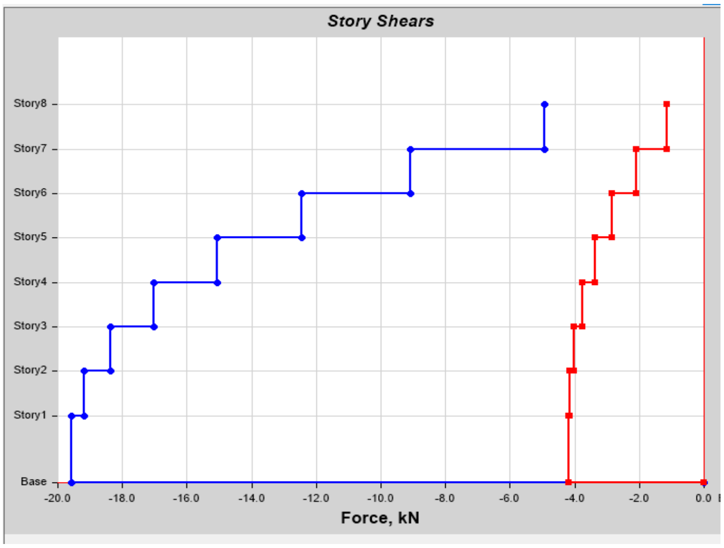


Figure 9. Story shears force kN

The calculated value for the maximum shear force experienced by a concrete beam with fiber reinforcing (CBF) is 234210.48 kilograms. The shear energy for CBF exhibited a percentage increase of approximately 74.0% compared to MRF. Based on the data mentioned above, it can be deduced that there exists a positive association between the length of the link and the magnitude of the shear force (Ahmadi, Ricles, and Sause, 2018; Kurniawan, Nurtanto and Hayu, 2018; Tanijaya, 2021).

c. Comparison of Maximum Level Displacement between MRF and CBF:

Elastic displacement:

For the Elastic displacement corresponds to the equation:

$\delta ex = \delta x- \delta x\text{-}1$

δex = Elatic displacement

δx = displacement for story

Table 8. Displacement between MRF and CBF:

Story	Elevation	displacement	Elatic	Story Drift	Allowable	check
	mm	(mm)	displacement (mm)	Δx	Δa	
		δx	δex	mm	mm	
Story8	5000	178.181	386.06	26.97	75	OK
Story7	5000	165.735	359.09	41.83	75	OK
Story6	5000	146.43	317.27	53.99	75	OK
Story5	5000	121.512	263.28	63.05	75	OK
Story4	5000	92.411	200.22	68.90	75	OK
Story3	5000	60.609	131.32	69.42	75	OK
Story2	5000	28.571	61.90	54.83	75	OK
Story1	7500	3.263	7.07	7.07	112.5	OK

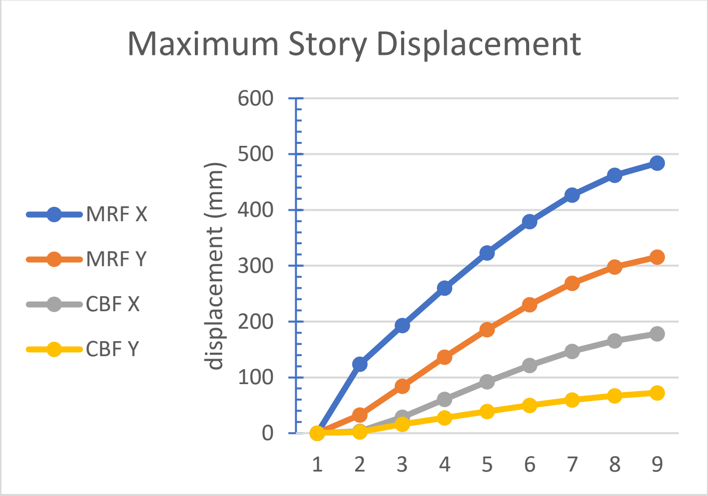
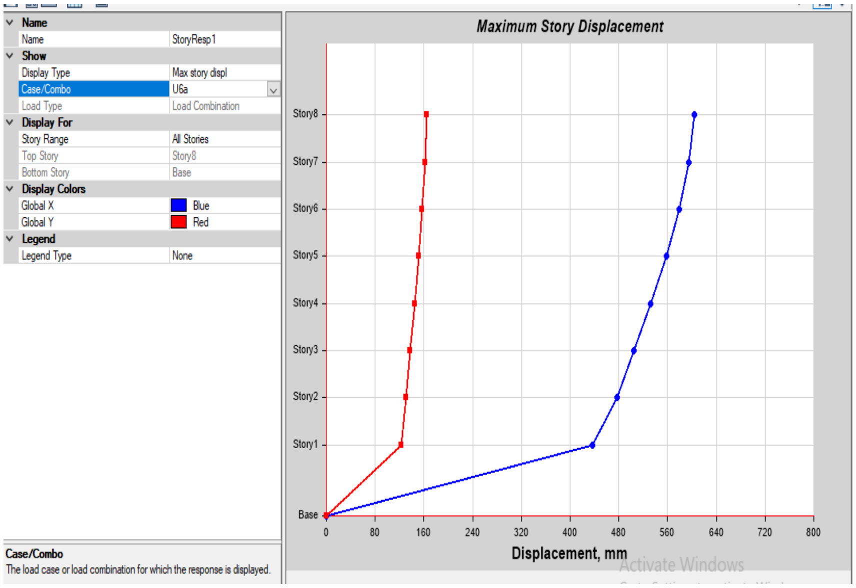


Figure 10. Comparison of Maximum Displacement between MRF, CBF

It is imperative to acknowledge that the maximum displacement of a structure's story, as determined by the Maximum Resisting Force (MRF) system, is contingent upon the bending capacity of the column and beam. Hence, it is justifiable to propose that the moment-resisting frame (MRF) system could demonstrate a greater level of tale drift than a braced frame.



Name	
Name	StoryResp1
Show	
Display Type	Max story displ
Case/Combo	U6a
Load Type	Load Combination
Display For	
Story Range	All Stories
Top Story	Story8
Bottom Story	Base
Display Colors	
Global X	🟦 Blue
Global Y	🟥 Red
Legend	
Legend Type	None

Case/Combo
The load case or load combination for which the response is displayed.

Figure 11. Displacement for EITABS

Nevertheless, it is crucial to recognize that moment-resisting frames (MRFs) utilized in multi-story buildings may encounter more significant displacements during intense seismic events than braced structures. The primary factor contributing to this occurrence might be the possible creation of plastic hinges inside the beams, resulting in further deformation following the onset of yielding. Concrete-filled steel columns (CBF) tend to undergo substantial deformation when subjected to intense seismic events, resulting in structural impairment and necessitating subsequent support maintenance or replacement.

The initialism MRF denotes a particular concept or thing within a specific contextual framework. Please provide additional details or explanations. Implementing suitable design methodologies can significantly improve the rigidity and durability of a structure, hence reducing variations in its vertical alignment to acceptable levels. Applying bracing with eccentricity allows for the intentional dissipation and energy distribution in a controlled manner. Including diagonal bracing in a Concentrically Braced Frame (CBF) system enhances its overall rigidity and resilience, allowing it to efficiently endure horizontal forces and limit the magnitude of structural displacement. This specific characteristic facilitates the assessment of the uppermost extent of displacement through efficient absorption and dissipation of seismic energy. The efficient load path of CBF can be credited for the effectiveness of force distribution and the decrease of narrative displacement. The main goal of CBF is to provide increased flexibility and enhanced energy dissipation compared to CBF. This aligns with Karsaz & Razavi Tose's (2018) research on average. The seismic performance of the retrofitted 8-story structure was primarily impacted by the incorporation of the inverted V bracing system, leading to a notable enhancement of 96%. The following ranking methods include concentric V and concentric inverted V, which result in significant gains in the seismic performance of a 15-story building, with enhancements of 92% and 88%, respectively.

d. Comparison of Maximum Story Drift between MRF and CBF:

The deviations between levels must be uniform to avoid drift jumps between groups. The calculation of story drift uses the formula: Based on SNI 1726:2019 Chapter 7.12.1, the distance between floor designs (Story drift) is not allowed to exceed the limit on the interchange permit level.

Explanation:

δxe = elastic deflection results analysis structure on x direction

δze = Elastic deflection results analysis structure on z direction
Δz = Deflection consequence factor enlargement deflection on axis x

$\text{Drift} - \text{Story} = (\delta i{+}1 - \delta i) / h$
Where:
δi+ = deviation at the (i+1) level
δi = deviation at the i-level
h = height between floors
Requirements: Δplan ≤ Δpermit

Table 9. Drift between MRF and CBF

Story	Elevation	displacement	Elatic	Story Drift	Allowable	check
	mm	(mm) δy	displacement δey	Δy mm	Δa mm	
Story8	5000	72.412	156.89	11.48	75	OK
Story7	5000	67.112	145.41	16.60	75	OK
Story6	5000	59.451	128.81	20.58	75	OK
Story5	5000	49.952	108.23	23.36	75	OK
Story4	5000	39.169	84.87	24.92	75	OK
Story3	5000	27.669	59.95	25.20	75	OK
Story2	5000	16.04	34.75	30.09	75	OK
Story1	7500	2.153	4.66	4.66	112.5	OK

Story drift Intersection Floor portal X Direction

- **Drive Ratio:**

$$\boldsymbol{Drift - Ratio} = \frac{\Delta_{\text{top}}}{\boldsymbol{H}}$$

Where:
Δ_{top} = top displacement of a building (m)
H = building height (m)
Building height = 45.9 m
= 45900
Δ_{top} = 11.73
With a drift-ratio limit < 0.0025

$$Drift - Ratio = \frac{11.73}{45900} = 0.000255468$$

0.000255468 < 0.0025 ……. ok

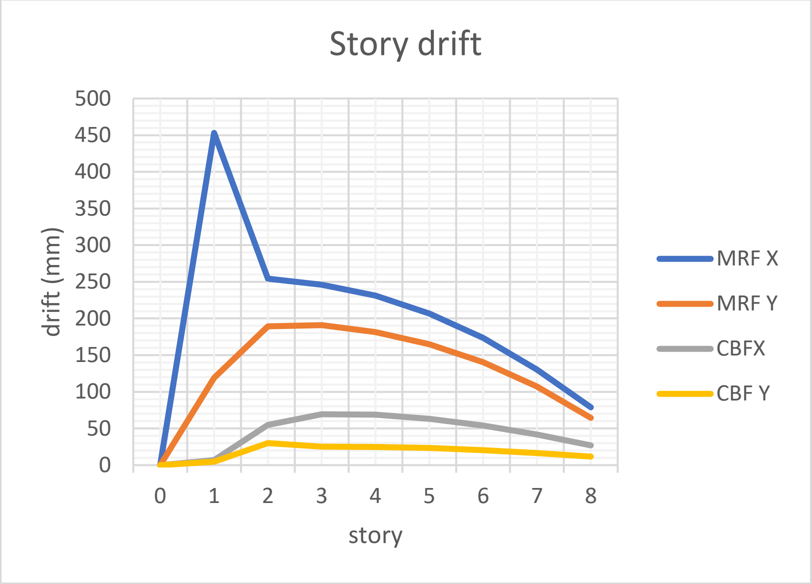


Figure 13. Comparison of Maximum Drift between MRF, CBF

Based on the presented graphical representation, it can be inferred that the difference in floor levels within the moment-resisting frame (MRF) design, in the absence of bracing, exceeds the allowable limit. Based on the empirical findings obtained from the investigation conducted on the research building, it is advisable to incorporate a stiffening mechanism to maintain the permissible level of deflection between the various floors. As a result, this architectural structure exemplifies implementing a stiffening system, such as a moment-resisting frame (CBF) or bracing (Tanijaya, 2021; Susanti and Wijaya, 2022).

The CBF model demonstrates compliance with the prescribed standards for inter-floor variations since the deviations observed fall within the permissible thresholds. The disparity in floor deflection between the CBF Model and the Model is relatively reduced when considering the CBF 85% system. Therefore, the data above offer empirical support for the proposition that the CBF model demonstrates enhanced strength and stiffness compared to the MRF model. Moreover, identifying the maximum relative deformation between levels is crucial for discerning different production procedures (Karsaz and Razavi Tosee, 2018; Pachideh, Kafi, and Gholhaki, 2020).

CONCLUSION

The following conclusions can be drawn from the structural planning alternatives: (1) The lateral shear force for CBF is 0.91 %, compared to MRF. Therefore, CBF has higher elastic stiffness than MRF. (2) The maximum displacement of the amplifier increases the removal for the CBF by70 compared to MRF because CBF bracing greatly reduces structural floor displacement. Therefore, (3) Drift must meet limit requirements based on the lateral resisting elements used. The maximum inter-story drift results for MRF are 453,035 mm, CBF 69,416mm, the ultimate implication between levels of CBF is 85%, (4) Heavy the difference is 1.530% for CBF compared to MRF. Therefore, CBF has a higher weight than CBF. That weight of the frame in question There is little difference in the importance of the planned structure but a difference between its seismic performance under static and dynamic nonlinearity.

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