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Evaluation of seismic analysis in diverse effect position of shear wall for reinforced concrete frame building

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ABSTRACT

Shear wall is important and suitable part in high-rise building to carry (support) dead loads and resist lateral loads (wind and seismic), shear wall's position in the building influences on the all analysis and design's behavior of the building. This paper presents the different positions of shear walls in the building as well as effects of different position of shear wall on the building's behavior of analysis including; displacement, shear force and bending moment. Considering this case the results in different effect positions of shear wall for a building which represent G+17 storey separated into four different models. The analysis of different position of shear wall, which is using equivalent lateral load method in the building, have been performed by using ETABS 2016 Structural analysis software.

Content

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1. Introduction

In structural engineering, a shear wall is a structural system that composed of braced panels (also known as shear panels) in order to counter the effects of lateral load acting on a structure. Wind, seismic and supporting gravity loads [1, 2] are the most common loads that shear walls are designed to carry. Under several building codes, including the International Building Code (where it is called a braced wall line) and Uniform Building Code [3, 4].

A structure of shear walls in the center of a large building—often encasing an elevator shaft or stairwell form a shear core. Shear walls resist in-plane loads that are applied along its height. The applied load is generally transferred to the wall by a diaphragm or collector or drag member. They are built in wood, concrete, and CMU (masonry).[5-8]

P-Δ effect, or P-"big-delta", is associated with displacements relative to member ends. Unlike P-δ, this type of P-Delta effect is critical to nonlinear modeling and analysis. As indicated intuitively by Figure 2a, gravity loading will influence structural response under significant lateral displacement. P-Δ may contribute to loss of lateral resistance, ratcheting of residual deformations and dynamic instability (Deierlein et al. 2010) [9-11], effective lateral stiffness decreases, reducing strength capacity in all phases of the force-deformation relationship (PEER/ATC 2010) [12-15]. To consider P-Δ effect directly, gravity load should be present during nonlinear analysis. Application will cause minimal increase to computational time, and will remain accurate for drift levels up to 10%. [16]

P-δ effect, or P-"small-delta", is associated with local deformation relative to the element chord between end nodes. Typically, P-δ only becomes significant at unreasonably large displacement values, or in especially slender columns. So long as a structure adheres to the slenderness requirements pertinent to earthquake engineering, it is not advisable to model P-δ, since it may significantly increase computational time without providing the benefit of useful information. An easier way to capture this behavior is to subdivide critical elements into multiple segments, transferring behavior into P-Δ effect Fig. 2b [17-21].

2. Objective

The objective in this paper demonstrates different positions of shear in the building and influence behavior on overall behavior of analysis from building against gravity loads and seismic load and choose correct location for desired shear wall in multi-storey building as well as compression between results of analysis in different positions of shear wall which illustrates the point that shear wall is crucial for buildings especially high-rise buildings.

3. Descriptions of building

Analysis incorporates G+17 storyes and dimensions of building 20*20 m, 5 bays in both X and Y directions, the height of ground floor is 3m and height of each storeys including ground floor is 3m, total height is 54 m, building's location in Zone B, Size of Column 500*500 mm, Size of beam 400*400 mm, Thickness of slab 180 mm and Thickness of shear wall 30 mm.

4-Modeling description or Methodology

The results of analysis and different effect position of shear wall on the building have been deduced with applied equivalent lateral load method in order to derive deflection, displacement, shear, drift story and moment that 4 models are considered for analysis, all models are shown in below:

Model 1: Building without shear wall

Model 2: Building with shear wall on corners at each side

Model 3: Building with shear wall in center of the building

Model 4: Building with shear wall on each side on middle

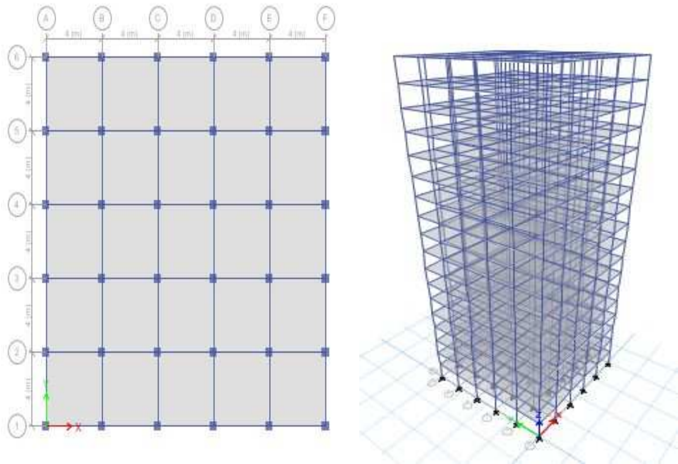

Figure 1. Model 1

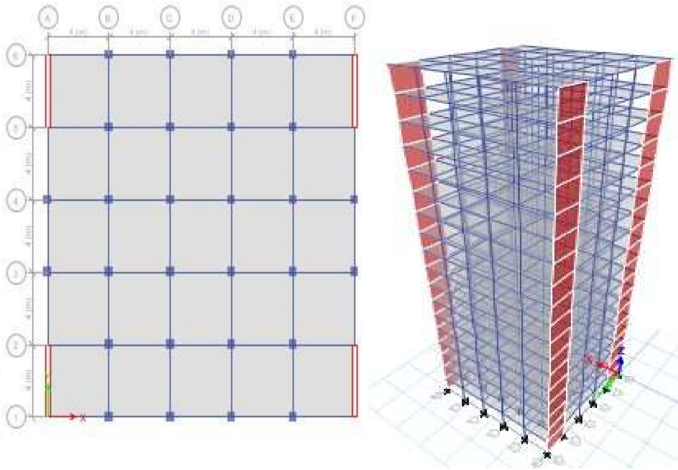

Figure 2. Model 2

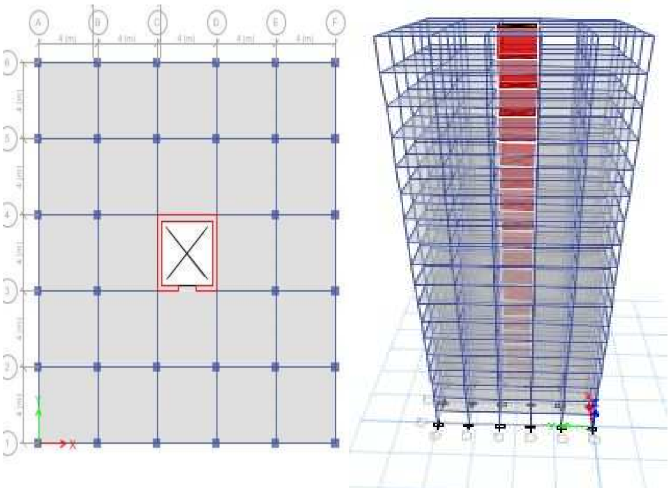

Figure 3. Model 3

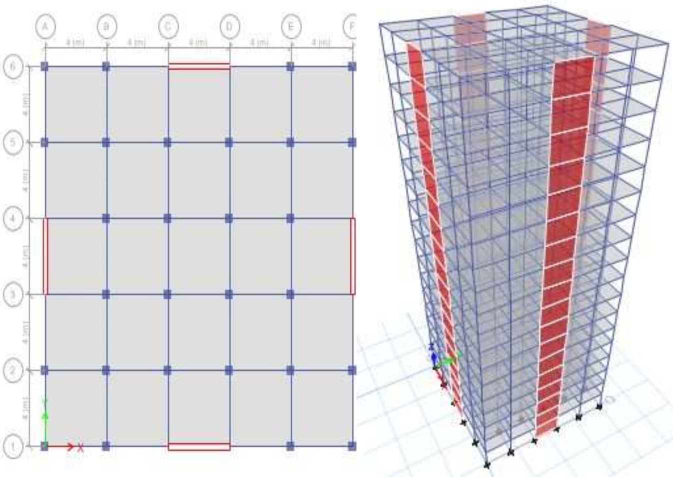

Figure 4. Model 4

4. Result and discussion

4.1. Lateral displacement

Lateral displacement of top storey (storey 18) from different models is shown in table below, the maximum value obtained from all the Load Combinations.

Table1: displacement in X-direction

Load combination	Top storey displacement in X- direction (mm)			
	Model 1	Model 2	Model 3	Model 4
1.3D.L+ L.L+ Eq	136.83	121.66	115.31	109.63

Table 2. Displacement in Y-direction

Load combination	Top storey displacement in Y- direction (mm)			
	Model 1	Model 2	Model 3	Model 4
1.3D.L+ L.L+ Eq	136.83	109.74	107.82	109.63

4.2. Vertical displacement

Maximum Vertical displacement occurs in the top storey that is shown in table 3 that indicates the maximum value obtained from all the Load combinations.

Table 3. Vertical displacement

Load combination	Top storey vertical displacement (mm)			
	Model 1	Model 2	Model 3	Model 4
1.2D.L+1.6 L.L	18.83	17.33	14.63	17.34

4.3. Storey Drift

Storey drift is displacement of one level relative to other level above or below. The storey drift of all the four models in X and Y direction is shown in figure 5, 6, 7 and 8.

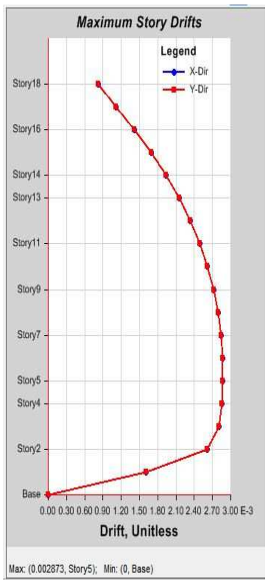

Fig.5 Model 1 Drift.

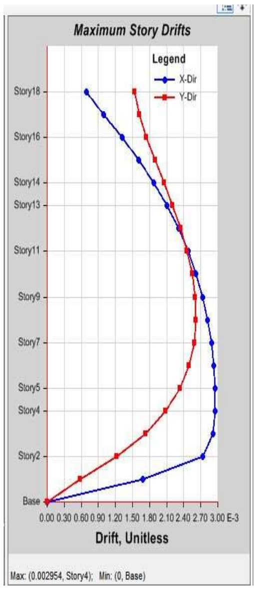

Fig.6 model 2 Drift

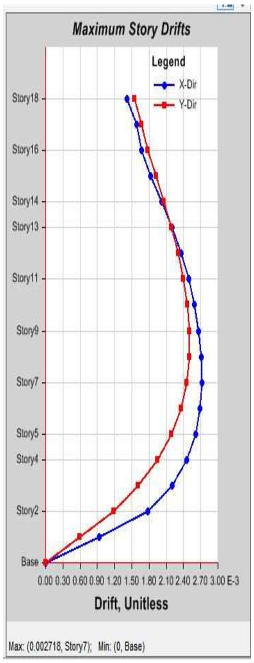

Fig.7 Model 3 Drift.

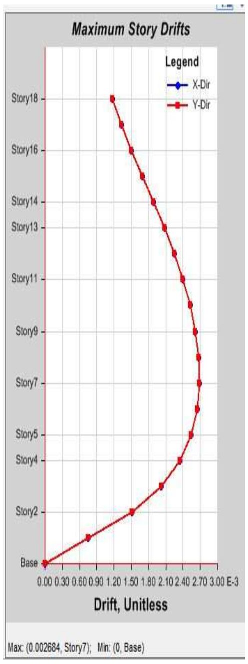

Fig.8Model 4 Drift

The maximum storey drift took place in model 1 which depicts building structure with no shear wall as compared to other models, the minimum storey drift appeared in model 4 which depicts building has shear wall on middle side apiece.

4.4. Axial Load

The maximum value of axial load obtained from all the Load Combinations, all different models are shown in table 4.

Table 4. Axial force

Storey No.	Column	Axial load in Column Kg			
		Model 1	Model 2	Model 3	Model 4
1	C27	363708	346024	342891	342236
2	C27	339594	319140	318752	318138
3	C27	316513	299559	295814	295259
4	C27	294165	277962	273785	273298
17	C27	38279	34848	34766	34492
18	C27	20047	18639	18459	18318

4.5. Bending moment

Regarding changing the position of shear wall in bending moment, B37, B38, B39, B40 and B41 are considered in X-direction for all different models are shown in table 5.

Table 5. Bending moment

Model No.	Bending moment	Bending Moment for Beam at top storey (Kg.m)				
		B37	B38	B39	B40	B41
Model 1	(+ve)	2337	2180	2019	2180	2337
	(-ve)	4815	2664	1812	2664	4815
Model 2	(+ve)	4293	2589	2203	2589	4293
	(-ve)	5109	3034	1907	3034	5109
Model3	(+ve)	436	2100	885	2100	2436
	(-ve)	4197	2538	1740	2538	4197
Model 4	(+ve)	4672	2885	2491	2885	4672
	(-ve)	5281	3187	2137	3187	5281

4.6. Shear force

Table 6. Shear force

Model No.	Shear force for Beam at top storey (kg)				
	B37	B38	B39	B40	B41
Model 1	77.58	88.05	89.69	88.05	77.58
Model 2	135.27	110.81	92.90	110.81	135.27
Model 3	75.40	123.93	48.32	123.85	75.46
Model 4	151.53	184.52	154.95	184.52	151.53

Regarding changing the position of shear wall in shear force on top storey B37, B38, B39, B40 and B41 are taken into account. All different models are shown in table 6.

5. Conclusion

In this paper studied four models containing: one without shear wall and three models use shear wall in different positions, Maximum horizontal displacement and vertical displacement has been obtained in model 1 and minimum displacement occurred in model 4. When earthquake happens, the displacements in three models with shear wall is lower than model 1, which has no shear wall. it means three shear wall models are more stable than model 1, moreover, minimum drift storey occurred in model 4 as compression to other models, it refers position of shear wall in model 4 better than other, although, model 2 obtained minimum drift storey but only in Y-direction, Minimum value of axial load obtained in column C27 at storey 1, 2, 3, 4, 17 and 18 in model 3 and higher value obtained in Beams 37, 38, 39, 40 and 41 in top storey in model 3 building as compared with other models.

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Оценка сейсмического анализа в различных положениях воздействия сдвиговой стенки для железобетонного каркасного здания

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АННОТАЦИЯ

Сдвиговая стена является важной и подходящей частью высотного здания для перевозки (поддержки) мертвых грузов и сопротивления боковым нагрузкам (ветер и сейсмика), положение сдвиговой стены в здании влияет на весь анализ и конструктивное поведение здания. В данной статье представлены различные положения сдвиговых стенок в здании, а также влияние различного положения сдвиговой стенки на поведение здания при анализе, в том числе: Смещения, поперечной силы и изгибающего момента. Рассматривая этот случай, результаты в различных положениях эффекта сдвиговой стенки для здания, которые представляют собой этаж G + 17, разделены на четыре разные модели. Анализ разного положения сдвиговой стенки, которое использует метод эквивалентной боковой нагрузки в здании, был выполнен с использованием программного обеспечения ETABS 2016 Structural analysis.

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