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The Influence of Variations in Shape and Placement Sliding Walls on The Behavior of Multi-Story Building Structures to Withstand Earthquake Loads (Case Study: Building Pasar Raya Inpres Block)

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ABSTRACT

System the structure of Building a Pasar Raya Inpres Padang Block IV, namely system double that uses wall shift as retainer lateral load and SRPMK as retainer style gravity, but cold sliding on the building the only there is on the 1st floor only if wall shifts No continuously until building roof floor so can influence behavior structure building the like mark style shift basis, displacement, deviation between the floor and p-delta influence. The study this aims to compare mark style shift basis, displacement, and deviation between which floor and p-delta later will compared against 4 variation models shape and placement wall shift. The method used that is method comparative with analysis uses response spectrum using ETABS software. Results of the study show model 2 structure has a mark base shear namely 3658,658 kN. Model 2 has a mark displacement the smallest in the x direction is 3,766 mm and Model 4 has a mark displacement the smallest in the y direction is 2,347 mm. Model 2 has a mark deviation atar floor smallest namely 8,019 mm for the X direction and 4,015 for the Y direction. All models are confirmed safe at the moment checking the P-Delta effect, with model 2 having the mark lowest for the X direction and Y direction.

Keywords: *Shear Wall; Base Shear; Displacement; Inter-Floor Deviations; P-delta.*

INTRODUCTION

West Sumatra is one of the most vulnerable provinces to earthquakes. The earthquake that hit West Sumatra on September 30 2009 measuring 7.6 on the Richter scale resulted in damage and loss in several regions in West Sumatra. Earthquakes also cause damage to office buildings, residential areas, health facilities, educational facilities, places of worship, roads, bridges and markets [1]. Therefore, it is necessary to provide structural reinforcement that can minimize damage to buildings due to earthquakes, especially in the city of Padang which has been made a provincial city and tourist attraction [2].

One of the reinforcements that can reduce damage caused by earthquakes is by adding shear walls. Wall shift is an element structure vertical that can be given prisoner moment, style slide, and style axial resulting from its existence burden gravity nor burden working earthquake [3]. When an earthquake occurs, a wall slide is designed effectively and naturally can reduce damage in non-structural parts of buildings like windows, doors, ceilings, and others [4]. In planning sliding walls there is a variety of possible shapes and placement use, shape and placement can influence the behavior of the building structure, namely the base force shear, displacement, deviation between floors, and p-delta influence [5].

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The object of research This namely Building A Pasar Raya Inpres Block IV. The building is located in Padang City which was founded in 2014 and completed built in 2016. Pasar Raya is the center economy and activities Padang people [6]. As the main market is always full and packed visitors fulfill their needs [7]. System the structure of Building A Pasar Raya Block IV, namely system double that uses wall shift as retainer lateral load and SRPMK as retainer style gravity. but in that building only own wall shifts in the floor one just and no continuously until the floor on the building, supposedly wall shifts no continuously until one can influence strength in the building, if the wall slides on the building no continuously until one can influence mark behavior structure his like style shift basis, displacement, deviation between floor, and p-delta influence.

Research purposes This For compare the results of behavior structure wall shift building existing with 4 variation models shape and placement wall shift by comparing the base force values shear, displacement, the deviation between levels, and the influence of p-delta. So it was found that the most effective shear wall placement in Building A Pasar Raya Inpres Block IV was obtained in withstanding earthquake loads. The results of this research will be the basis for further research regarding shear walls in structural reinforcement, thereby reducing the possibility of loss of life due to building collapse.

METHODS

This research is quantitative because the approach focuses on collecting and analyzing data that can be measured numerically. Quantitative research is research that uses numbers, starting with collecting numbers, interpreting the data, and looking at other results. The method in this research is a comparative study, namely research that is comparative to find similarities or differences in an object. This research compares the behavior of building structures with variations in shear wall placement.

Building Data

This research reviews the building A of Pasar Raya Inpres Block IV with the following description.

a. Building name : Building A Pasar Raya Inpres Block IV
b. Building function : Market
c. Building location : Jl. Pasar Baru, Jao Village, West Padang District, Padang City, West Sumatra
d. Building height : 15 meters
e. Number of floors : 4 floors
f. Building length : 20 meters
g. Building width : 40 meters
h. Type of structure : Reinforced concrete
i. Column dimensions : K1 (700 x 700) mm
K2 (700 x 700) mm
j. Beam Dimensions : B1 (150 x 600) mm
B2 (300 x 600) mm
B3 (250 x 600) mm
k. Plate thickness : Floor Plate 1 (200) mm
Floor Plates 2-4 (130) mm

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Research Stages
Stages study this is displayed in a chart flow research that can seen in the picture following.

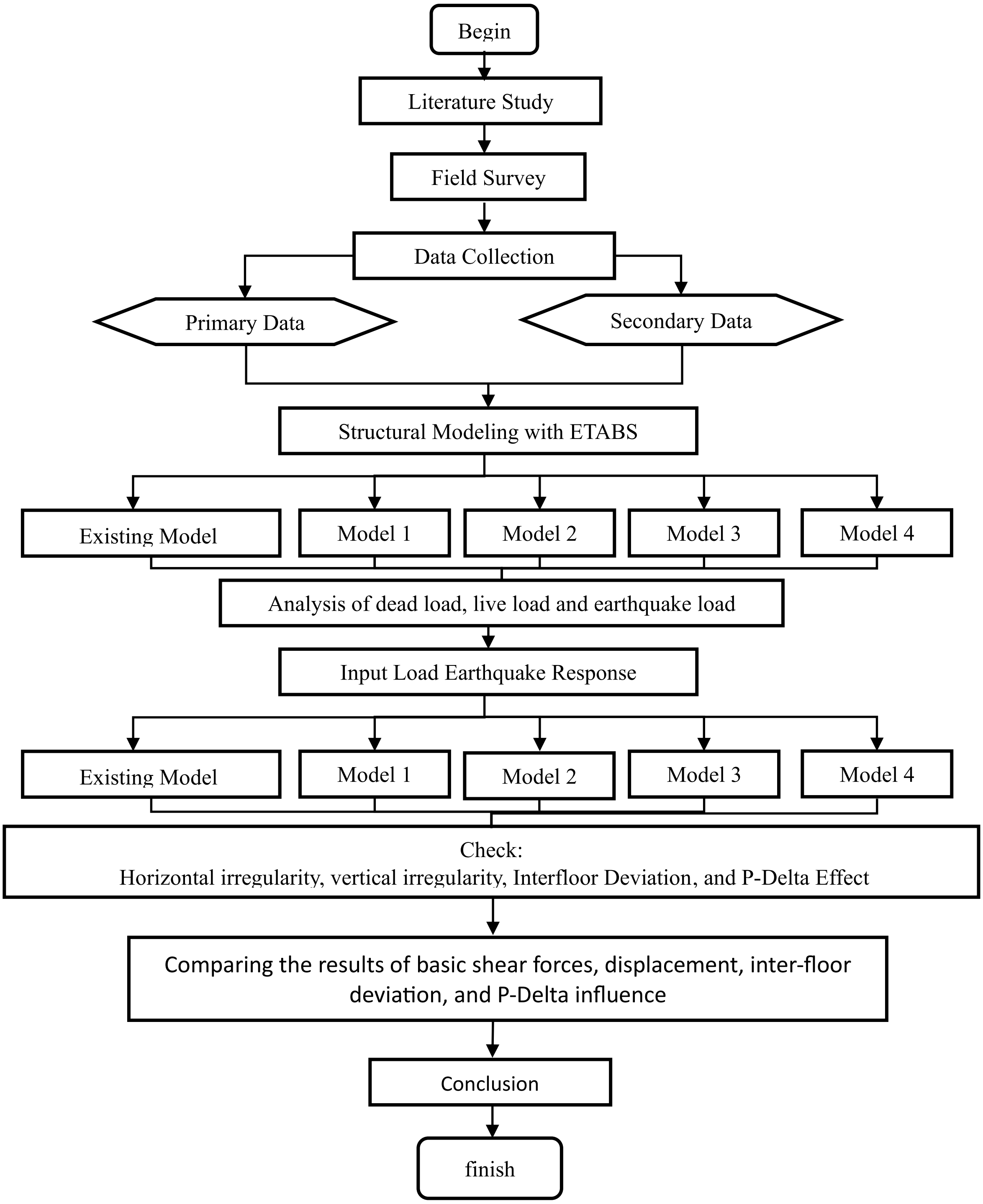

Figure 1. Research Flow Chart

Structural Modeling
There are 3 types of sliding walls used in this study, the existing model and model 2 use the L-shape sliding wall type, Model 1 uses an I-shape sliding wall, Model 3 uses a Couple Shear Wall sliding wall, and model 4 uses a C-shape sliding wall. The shape of structural modeling using the help of ETABS software with the shape and variation of sliding wall placement can be seen in the picture as follows.

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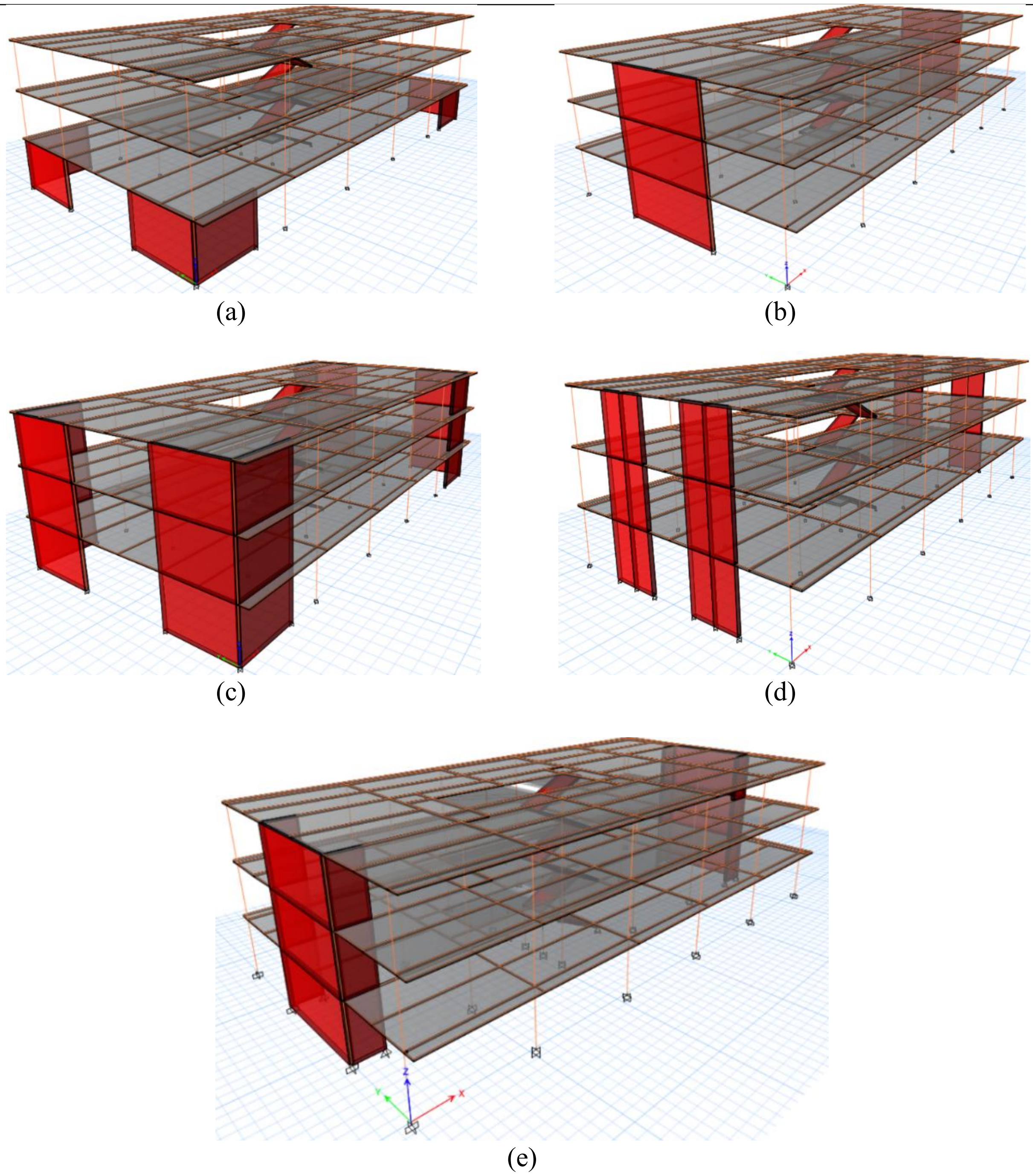

Figure 2. Modeling Model Existing (a), Modeling Model Structure 1 (b), Modeling Model Structure 2 (c), Modeling Model Structure 3 (d), Modeling Model Structure 4 (e)

Loading Structure

The loads calculated in this study are gravity load and earthquake load. The calculated gravity load is the dead load which is the building's own weight and live load [8]. Dead loads are divided into 2 groups, namely the weight of building materials themselves and the weight of building structural elements [9]. In this study, the building material for structural elements is reinforced concrete with a specific gravity of 2400 kg/m^3. The live load calculated in this study was taken according to SNI 1727 (2020) live load working on the floor of 600 kg/m^2 and live load working on the roof of 96 kg/m^2 [10]. Earthquake Load is taken based on SNI 1726 (2019), and structural analysis of earthquake load on buildings is carried out using the Dynamic Analysis Method of Spectrum Response.

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Combination Loading
[11] Based on SNI regarding the latest earthquake SNI 1726 (2019), some of the combinations used in this study are:
a. 1.4 D
b. 1.2 D + 1.6 L + 0.5 (Lr or S or R)
c. 1.2 D + 1.6 (Lr or S or R) + (L or 0.5 W)
d. 1.2 D + 1.0 W + L + 0.5 (Lr or S or R)
e. 0.9 D + 1.0 W
The loading combinations for the loads used are as follows.
f. 1.2 D + Ev + Eh + L
g. 0.9 D – Ev + Eh

RESULTS AND DISCUSSION

Base Shear
The additional wall shifts continuously until building on the structure can add lateral stiffness to the structure that can cause increasing style shift base consequence lateral load received by the structure [12]. The size style shift basis accepted by the fifth modeling structure is shown in the graph following.

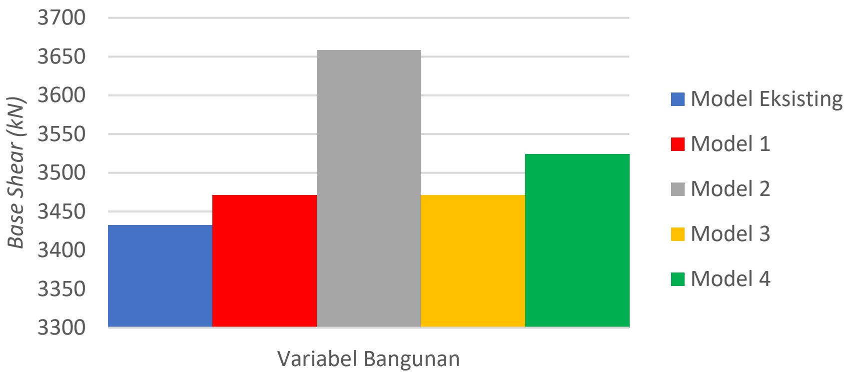

Figure 1. Comparison of Base Shear

Displacement
A comparison of displacement that occurs due to differences in building structure models can be seen in the following figure.

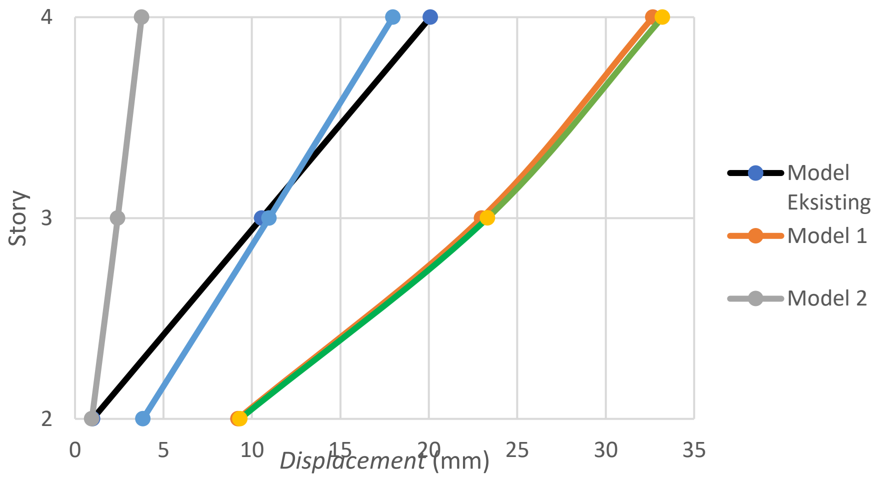

Figure 2. Chart Displacement Value in X Direction for Each Model

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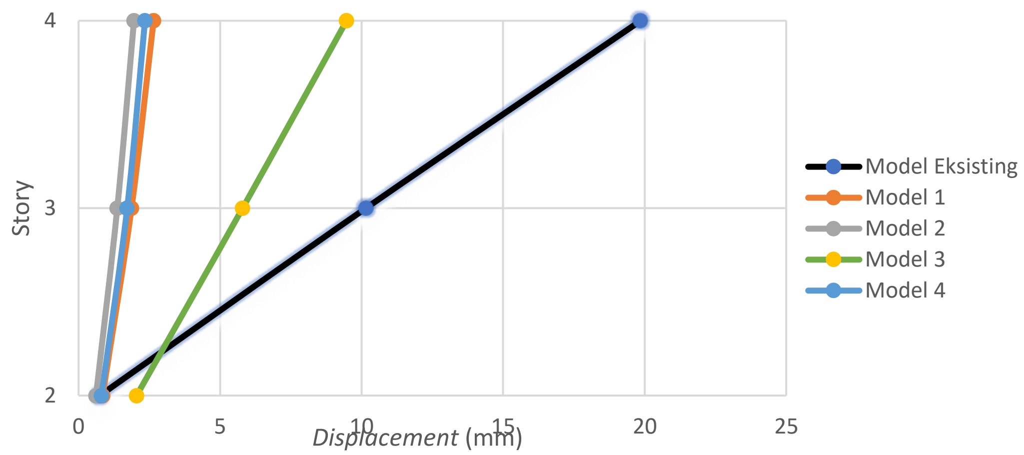

Figure 3. Chart Y Direction Displacement Value for Each Model

The displacement value taken from the analysis of the ETABS software above shows that the structure of model 1 has increased the displacement value by 105% from the existing model from 20,094 mm to 32,672 mm in the X direction and a decrease of 83% from 19,859 mm to 2,651 mm in the Y direction. For the 2-way X model increased by 77% to 3,766 mm and in the Y direction decreased by 87% to 1,959 mm. For the 3-way model, the X increased by 108% to 33.22 mm and the Y-direction decreased by 44% to 9,469 mm. For the 4-way model, X increased by 4% to 17,977 mm and in the Y direction decreased by 84% to 2,347 mm. The increase and decrease in displacement value occur due to the placement of sliding walls in each variation differently. Model 2 has the lowest displacement values for the X direction and the Y direction.

Interchange Between Floors

In determining the deviation between floors, the value of the deviation between floors must be calculated not to exceed the value of the deviation between permit levels which has been regulated in SNI 1726:2019 [13]. The function of the building in this study is a market that is in the seismic design category D, so according to SNI 1726:2019 article 7.3.4.2 for the seismic design category D that does not have torque irregularities in the redundancy factor (ρ) must be 1.3 [14]. The results of the deviation between floors of the design level in the five models of the structure of the x direction and y direction are more informatively presented in the following graph.

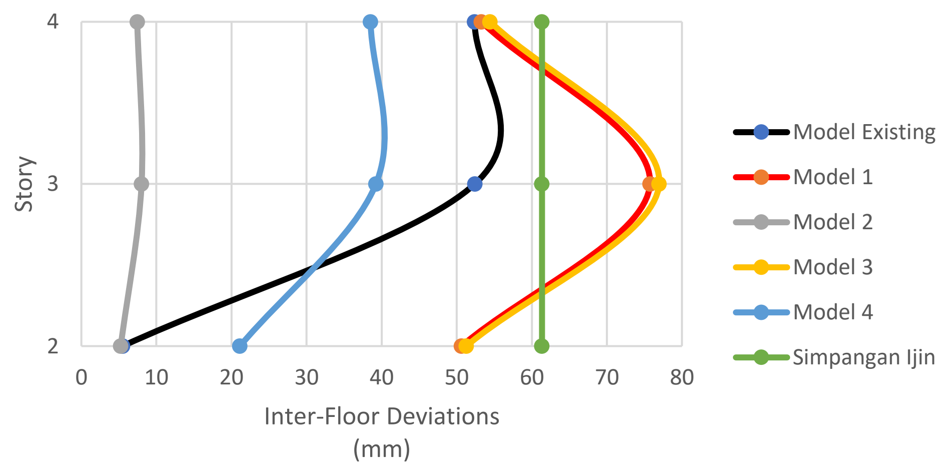

Figure 4. Graph of Comparison of Deviation Values Between Design Floors in X Direction

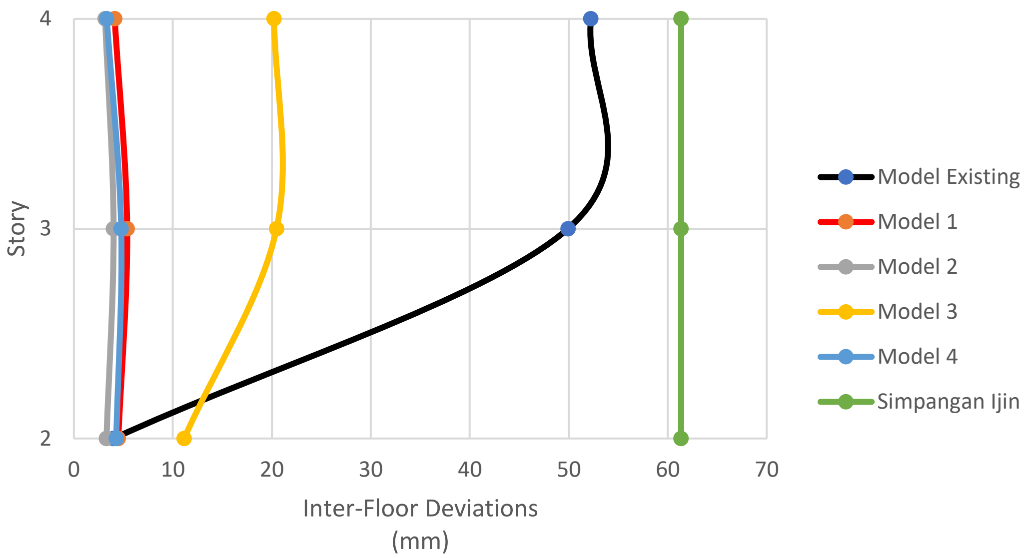

Figure 5. Graph of Comparison Value of Deviations Between Design Floors in Y Direction

From the graph the can be concluded that the deviation between floor level design on existing models, model 2 and model 4 has fulfilled the condition while model 1 and model 3 do not fulfill the condition because the resulting deviation is bigger than the deviation floor permission. On analysis, This is the x direction and y direction of model 2 structure own mark deviation more smaller compared to other model structures with a mark maximum as big as 8.019 mm in the x direction and 4.015 mm in the y direction.

P-Delta Influence

The influence of P-Delta is regulated in SNI regulations 03-1726-2019 the article arranges that the influence of P-Delta does not need to be taken into account when mark coefficient stability (θ) is the same with or not enough of 0.1. Structure said Still in condition stable If θ< θmax [15].

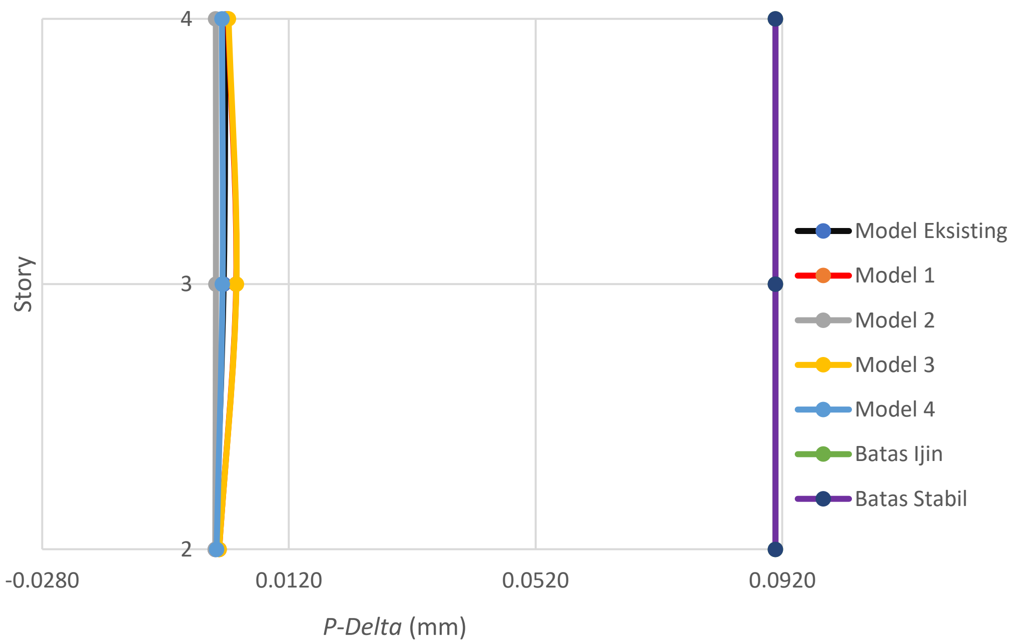

Figure 6. Comparison Chart of P-Delta Influence in X Direction

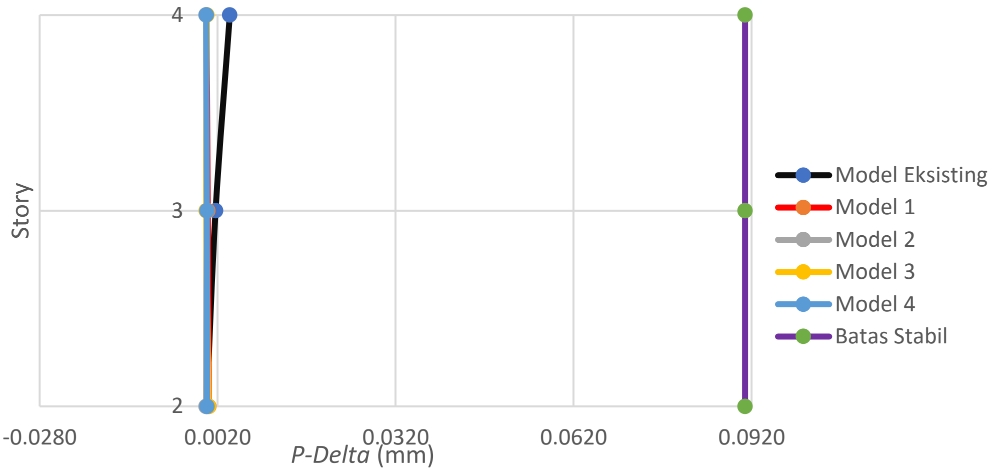

Figure 7. Comparison Chart of P-Delta Influence in X Direction

Based on the graph above, it is found that all models do not have a value of stability coefficient (θ) that does not exceed the value of the maximum coefficient (θmax) in both the X direction and the Y direction.

CONCLUSION

The conclusions that can be drawn based on the results of the analysis of variations in the placement of shear walls are as follows.

1. The result obtained from the structural analysis is that model 2 has the largest base shear value of 3658.658 kN.
2. The displacement with the smallest value in the x direction is the model 2 sliding wall structure model with a maximum displacement value of 3.766 mm, while in the y direction is the model 4 sliding wall structure model with a maximum displacement value of 2.347 mm.
3. The smallest deviation value is found in the sliding wall structure of model 2 with a maximum value of inter-floor deviation in the x direction of 8.019 mm with a percentage decrease of 81%. In the sliding wall structure of model 2, the maximum value of the deviation between floors in the y direction is 4.015 mm with a percentage decrease of 90%.
4. All models on P-Delta effect checking are ensured to be safe because none of the stability coefficient values exceed the maximum coefficient value.

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