Stiffness analysis comparison of masonry full infills frame and masonry open middle span frame using Lubuk Pakam Bricks with pushover analysis

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Abstract. Local brick in Lubukpakam Indonesia has mechanical and physical characteristics that are different from the developed countries that have always been used as references, since a different behavior with other countries and the low power of local bricks, it widely needs research to get the stiffness of the structure factor of earthquake-resistant buildings. This research was conducted with the use of modeling in the Frame masonry full infills with Frame masonry opens on the Middle span of powerful data with the use of modulus of elasticity and press bricks with pushover analysis. Obtained values of elastic rigidity and stiffness of elastic post. The results obtained on the rigidity of walled portal bigger than an open portal on elastic Stiffness of Central and spans larger than the elastic stiffness of the post.

Keywords: Frame masonry full infills, Frame masonry Middle span open, pushover analysis, stiffness

1. Introduction
Reinforced concrete (RC) framed buildings with infill walls are usually analyzed and designed as bare frames, without considering the strength and stiffness contributions of the infills [1]-[2]. However, during earthquakes, these infill walls contribute to the response of the structure, and the behavior of infilled framed buildings is different from that predicted for bare frame structures. Therefore, based on the understanding of the actual response, design provisions need to be developed. Fortunately, a few countries already have codal provisions for seismic design of RC framed buildings with brick masonry infills. The present study evaluates these available provisions with a view to identifying design methodologies that exploit the benefits of infills in a rational manner, for improving the contribution of these infills and for reducing the detrimental effects. local bricks of Lubukpakam tested from Laboratory and by modeling the structures examined. On a wall full of middle walls open. The purpose of the experimental and analytical studies reported in the literature that attempts to understand the behavior of wall [2]-[4].

Studies show that the walls increase the stiffness and strength of the structure compared to a structure without walls. Elastic response during this phase, the presence of brick wall filler increases the lateral stiffness of the aircraft's structure and reduces fundamental, and as a result of the styles of the slide [1].
2. Review of Literature

2.1. Concept of the Planning Reinforced Concrete Frame

Reinforced Concrete Frame which is modeling a structure divided into two open frames and frame content. In the portal content, wall fillers are generally used as partitions or cover the outside of the structure of reinforced concrete frames. Installation will be done after the main structure is completed is done and is considered a non-component structure in essence, wall charger is a component of a non-structure that does not provide a meaningful contribution toward rigidity and the power structure, but in fact the wall charger provides a major influence on the collapse of the building so that it behaves differently with the frame open [2].

2.2. Brick Masonry Infills

Brick Masonry Infills used in this research is a red brick wall because it is very widely used in almost all the buildings on the territory of the country of Indonesia. This is because red brick has an economical price, easily obtainable, and impervious to weather. The behavior of a portal with a brick wall against lateral loading has been investigated, due to lateral loads that occur resulting in the onset of interaction between a wall charger with portal [5]-[7]. Whereas in the event of an earthquake the wall charger can affect the stiffness and strength of the structure that the effect is not profitable in the structure so that it can cause damage [8]-[9].

2.3. The Basic Concept Of Pushover Analysis Method

The method of static analysis is not linear (pushover analysis) is not a linear method is very popular used in planning or assessment of buildings located in areas prone to earthquakes[9]. As described, the underlying idea of this method is to explain the State of earthquake load acting on the order of the structure. The response order structure of the dynamic load is a combination of the dynamic range of vibrating system that vibrates[10]. So this method is also based on the fundamental concepts of analysis of spectrum of vibration on the structure. Explanation of the underlying theory of static analysis is not linear here is based on[10]–[11]

2.4. Concept planning of earthquake-resistant

Structure earthquake-resistant Building was designed based on the earthquake zone, the character of location, soil type, occupation building, the building uses factors, the natural period of the structure, and others. The entire structure of the elements designed with a prisoner who according to withstand lateral displacement occurs due to ground motion having regard to the response of inelastic structure, redundant factors, more powerful and dactylitis structures [7].

The response of a building due to earthquake loads is happening is very complex, so new methods continue to evolve in order to know the behavior of the structure due to the earthquake which occurred [9]. Structure with soft-storey will enlarge the lateral deformation and sliding on a column style The collapse of the building due to the earthquake, one of which can also be caused by the selection of the structure of the soft-storey [10].

3. Method

In this research, the analysis used to obtain good results is a Pushover Analysis. The method used is the method of a numeric approach. The purpose of the analysis was a pushover for estimating maximum style and deformations that occur as well as to obtain information, which is the critical part. The next, identifiable parts that require special attention to acid etching or stability.

3.1. Modeling Structure

On the research on the structure of the buildings are modeled as 2 dimensional frame and consists of 6 grid model but analyzed only 2 grid model in the model and model masonry infills frame the masonry
opens on the Middle span, all the models structure consisting of 3 floors and 3 landscape including the structure of the portal, Figure 1.

![Figure 1](image)

Figure 1. Floor plans and Look at Modeling and outdoor Walled Portal Diftesh Das and CVR CONTENT Murty (2004)[2]

3.2. Analysis of Testing Properties of Bricks

In this study used red bricks as wall material filler. Characteristics of the brick walls that will be used in this study are based on the characteristics of the brick wall on how to test the elasticity modulus of bricks[3] with single-axis pressure test objects, the bricks using 10 samples of the bricks from the region of LubukPakam, Deli Serdang, North Sumatera, Indonesia. From the results of Experiments Testing Powerful press Bricks obtained as in Table 1.

| Table 1. Test results of Strong Brick Press |
|--------------------------------------------|
| **TEST RESULT DATA STRONG BRICK PRESS**     |
| NO. TEST OBJECTS | SIZE OF THE BRICKS | ACCEPTED LOAD (KN) |
|                | P (cm) | L (cm) | A (cm²) |
| **TYPE 1**     |        |        |         |
| 1              | 19.6   | 9.7    | 190.12  | 580    |
| 2              | 19.7   | 9.7    | 191.09  | 590    |
| 3              | 19.7   | 9.5    | 187.15  | 575    |
| **TYPE 2**     |        |        |         |
| 4              | 19.6   | 9.5    | 186.2   | 460    |
| 5              | 19.4   | 9.6    | 186.24  | 378    |
| 6              | 19.5   | 9.6    | 187.2   | 377    |
| 7              | 19.3   | 9.5    | 183.35  | 368    |
| **TYPE 3**     |        |        |         |
| 8              | 19.4   | 9.5    | 184.3   | 355    |
| 9              | 19.6   | 9.6    | 188.16  | 350    |
| 10             | 19.6   | 9.7    | 190.12  | 350    |

Table 2 shows the physical properties of brick were used.

| Table 2. Physical Properties average brick red |
|-----------------------------------------------|
| Properties | Brick Red | Unit |
|------------|-----------|------|
| Length     | 195.23    | Mm   |
| High       | 52.28     | Mm   |
| Thick      | 95.29     | Mm   |
| Heavy Type | 1373.55   | kg/m³|

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3.3. Research Stages
Stages are implemented so that the achieved the goals and purpose of the research. To achieve these goals then done stages, namely:
1) The First stage: This stage is done is to model a structure with its own modeling and determining technical data used in the analysis.
2) The Second stage: This stage is done the calculation of loading structures consisting of gravity load (dead load and live load) and earthquake load and done to determine the horizontal earthquake load takes shakes the building.
3) The Third stage: This stage is carried out to determine the horizontal load due to the earthquake needed to vibrate the building.
4) The Fourth stage: This stage is carried out to determine the occurrence of plastic joints on beams, columns and brick walls.
5) The five-stage: At this stage, do the procedure for calculating a pushover analysis
6) The sixth stage: At this stage, the pushover analysis of the output obtained i.e. the capacity curve shows the relationship of the basic styles of sliding towards the junction, showing the change in behavior of linear structure into a nonlinear, a decreased stiffness.

4. Results and Discussion
A study on modeling the structure in question is modeling the structure of 3-dimensional reinforced concrete building in comparison with the existing building (actual) and with the model design based on SNI 2012. After the run was completed analysis, the next step to control the results of the analysis, i.e. the natural period of vibration, slide style (base shear), and displacement.

4.1. Frame masonry full infills
Figure 2 shows and compares that to the third model Frame masonry full infills on a Grid of 1 to several types of brick fully infilled wall frames. Image shows value style slide base and the junction of the largest rooftop capacity in receiving the brunt of the earthquake or the styles there are lateral on a brick type 1 (M1-G1-B1).

![Figure 2](image)

**Figure 2.** Comparison of the curves on the Grid Capacity Combined with 1 Some types of Bricks (type 1, 2, 3)

4.2. Frame masonry opens on the Middle span
The following described some of the capacity curves is the relationship between Frame masonry full infills structure of some brick that is type 1, type 2 and type 3 as shown in Figure 3.
Figure 3. Capacity Curves on a Grid with combined several types of Bricks (type 1, 2, 3)

Figure 3 shows that the third model of Frame masonry opens on the Middle span on the Grid 3 (G3) for some types of bricks that have the largest capacity in receiving the brunt of the earthquake or the lateral style present on the portal open brick type 1 (M1-G1-B1). Comparison of the capacity curve for compared to the open portal as shown in Figure 4.

4.3. Stiffness

4.3.1. Stiffness  Frame masonry full infills.

On types 1, 2, 3 the following comparison chart of elastic rigidity, stiffness of elastic post. Elastic stiffness is calculated based on the sliding base style that caused the first melting on structure element with a displacement of the roof when melting occurs at the first element of the structure. Based on Figure 5, it can be analyzed that:

1) In brick-walled portals of type 1 have greater elastic stiffness than type 2 bricks and type 3 bricks.
2) The biggest percentage difference in elastic stiffness in the portal with brick walls in type 3 is reaching 24.43% less than the portal with a brick wall in type 1.
3) In brick-walled portals of type 1, the post-elastic stiffness is greater than that of type 2 bricks and type 3 bricks.
4) The biggest percentage difference in elastic stiffness in the portal with brick wall in type 3 is 28.57% smaller than the Port with a brick wall in type 1.
4.3.2. Stiffness Frame masonry opens on the Middle span in type 1, 2, 3
Figure 6 shows the comparison of the elastic stiffness and rigidity of post for brick elastic type 1, type 2 and type 3. The following comparison chart of elastic rigidity, stiffness of elastic post. Elastic stiffness is calculated based on the sliding base style that caused the first melting on structure element with a displacement of the roof when melting occurs at the first element of the structure in Figure 6.

5. Conclusion
Based on the results of the analysis and discussion in accordance with the problems that have been raised against the walls of the Portal model is Frame masonry full infills and Frame masonry opens on the Middle span. The results of the study showed that the stiffness of brick walls,
a. Stiffness of elastic. From the results of the analysis of stiffness of elastic then it can be inferred that the elastic stiffness values larger Frame masonry full infills on the model is compared to Frame masonry open on the Middle span and brick larger than type 1 type 2 and type 3.
b. Post Stiffness elastic. From the results of the analysis of the elastic stiffness of the post then elastic stiffness values can be summed up the larger Frame masonry full infills on the model is compared to the Frame masonry opens on the Middle span and brick larger than type 1 type 2 and type 3.

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Acknowledgment
Submission of this paper is supported by the University of Muhammadiyah Sumatera Utara.