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Lesson Learned from 27th May 2006 Yogyakarta Earthquake - Case of Building with Long Span of Roof Structure

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Abstract

Earthquake of Yogyakarta was occurred at 5.54 a.m. in 27th May 2006 with magnitude of 5.9 Richter Scale gave a lot of lesson to the people, government and experts to pay attention in constructing buildings in earthquake region. There were a lot of non engineered buildings and engineered buildings were collapse due to this earthquake. Some of the collapse engineered buildings were identified having long span of roof structures. The roof structures were made of steel structures. This paper will discuss the collapse of engineered buildings especially for the building with long span of roof steel structure to give awareness in the future for structural engineers who have responsibility of the safety of building. Therefore, the topic is discussed and highlighted in this paper.

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Keywords: lesson learned; Yogyakarta earthquake; collapse buildings; engineered buildings; long span of roof structure.

1. Introduction

Yogyakarta was hit by an earthquake in 27th May 2006 at 5.54 a.m. with magnitude of 5.9 Richter scale or M 6.3 according to United State Geological Survey (USGS). Chang et al. (2006) stated that although the intensity of the earthquake is Mw 6.3, however according to the level failure of building, it looks like the earthquake with the intensity of Mw 7.7.

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Kedaulatan Rakyat (2006) reported that in Yogyakarta Province there were 109,028 housings totally collapse, 96,009 housings categories as heavy and moderate failure, and 73,669 housings categories as light failure. It was also reported that more than 4,710 people were killed due to that earthquake. Moreover, in reconstruction and rehabilitation, Arfiadi et al. (2008) stated that there were 263,882 housings were categorized collapse and heavy failure in Yogyakarta Province including some part of Middle Java Province.

According to Raharjo et al. (2007) that the failure building mostly were non-engineered buildings where the buildings did not follow the building code and did not supervised by the expert when constructed. However, some of engineered buildings were also failure or collapse. Raharjo et al. (2007) also identified that some collapse engineered buildings were buildings which had long span of roof structure in the upper floor, especially roof structure made of steel structure.

In order to give reminder and attention to the structural engineers for the future, this topic is discussed and highlighted in this paper.

2. Failure of Engineered Buildings

The failure of engineered buildings can be divided into two failures, the first is non structural failure and the second is structural failure.

2.1 Non Structural Failure

Non structural failure of engineered building can be identified as the failure of following items :

a) Crack of wall
b) Falling of wall from the frame structure
c) Falling of roof
d) Falling of ceiling
e) The broken of door and window
f) The broken of tiles on the floor

2.2 Structural Failure

The failure of structural elements such as beams, columns, floor and roof structures can be categorized as structural failure. Generally, the meeting room or hall such as auditorium was designed on the upper floor below the roof structure. This design made the roof structure has a long span as shown in the Figure 1.

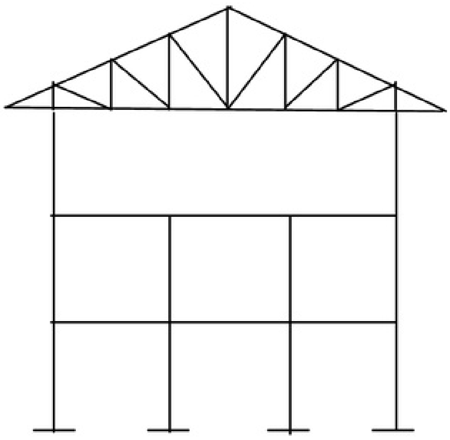

Figure 1. Long span roof structure.

Some of collapse of engineered buildings in Yogyakarta earthquake had long span roof structures. Figures 2, 3, and 4 show some collapse of engineered buildings which had long span of roof structures.

Figure 2. Among Rogo sport building.

Figure 3. UAD Janturan building.

Figure 4. STIE Kerjasama building.

The collapse of engineered buildings which had long span roof structures probably due to the collapse of roof structure itself or the stiffness of the upper column is not sufficient to support the roof structure when subjected to the earthquake loading (Raharjo et al. 2007).

3. Case Study and Discussion

In order to have clear information of the engineered building that had long span roof structure, it is better to see the case study of Auditorium of St. Thomas Aquinas Building of Universitas Atma Jaya Yogyakarta.

St. Thomas Aquinas Building of Universitas Atma Jaya Yogyakarta has three blocks of building, West wing, South wing and East wing. The West and the South wings are five stories building including basement. The East wing is four stories building including basement. The Auditorium room is in the East wing block of building and located at the fourth floor.

The area of Auditorium is 898.56 m^2 or (46.8 meter x 19.2 meter). There are no column in the middle of space of Auditorium, so the column only at the edge of the Auditorium. Therefore, the span of the roof structure was 19.2 meter. The original roof structure of the Auditorium before earthquake is shown in the Figure 5. The roof structure was made of steel structure and used Wide Flange steel shape (IWF300x150x6.5x9).

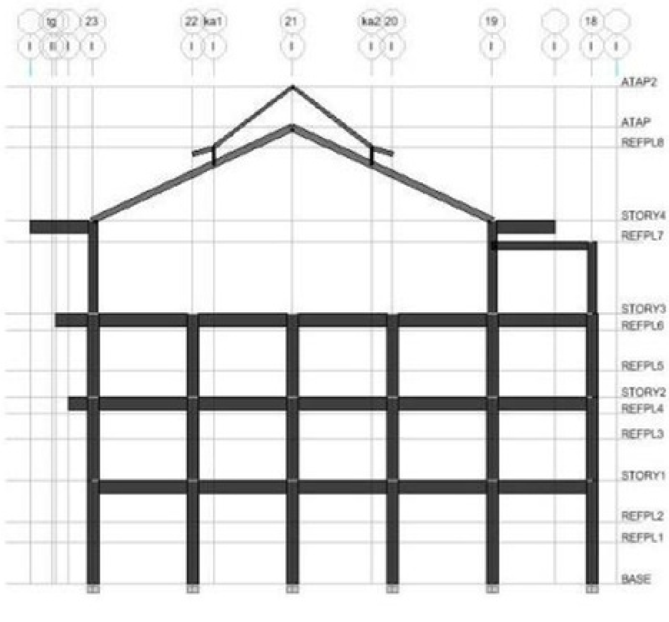

Figure 5. Originally roof structure of Auditorium.

After the earthquake, some columns of the Auditorium which support the roof structures were cracks and declined (see Figure 6).

Figure 6. Columns of Auditorium were declined

Wibowo et al. (2007) stated that the failure columns in the Auditorium due to the capacity columns were not adequate to resist the combine loading including the earthquake loading. Wibowo et al. (2007) proposed two items for repairing the problem. First improving the stiffness of roof structure by adding truss elements into the original roof structure using steel shape of U 75x40x5x7 (see Figure 7).

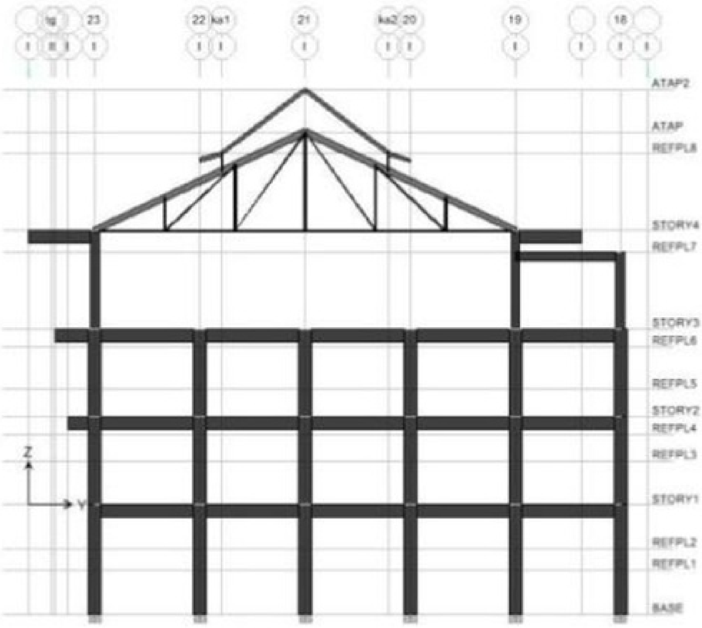

Figure 7. Modified roof structure of Auditorium (Wibowo et al. 2007)

Second for repairing the declined columns, they proposed to repair the columns by using jacketing methods with steel structure (see Figure 8).

Figure 8. Jacketing method for declined column (Wibowo et al. 2007)

By adding stiffness of the roof structures and repairing the declined columns, now the roof structures and columns of the Auditorium of St. Thomas Aquinas Building of Universitas Atma Jaya Yogyakarta become adequate and stable to resist combine loading including the earthquake loading.

4. Conclusion

Regarding to the discussion above some conclusion can be drawn are as follow :

1) Meeting room or auditorium when located at the top floor has consequence that the roof structure will have long span structure.
2) Needs special attention for designing the long span roof structure, especially for the adequate stiffness of the roof structure and the adequate of the columns that resist the roof structure.
3) If the long span roof structure has heavy weight, it needs special attention for the columns which support the roof structure when subjected to the earthquake loading.

Acknowledgement

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