THE EVALUATION OF BUILDING'S STRUCTURAL RELIABILITY OF MASJID TUHA INDRAPURI, ACEH BESAR

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Abstract: Masjid Tuha Indrapuri is one the ancient mosques in Aceh located in the district of Aceh Besar. The precise location of the mosque is in Indrapuri, Aceh Besar. Masjid Tuha Indrapuri exists right in the complex of the former temple. This mosque was built on an area of 33,875 square meters using the wooden material. The construction is supported by 4 (four) main pillars (that in terms of Javanese architecture known as "Soko Guru") with the shape of an octagonal cross section. Given the age of the mosque that is quite old, the structural reliability of the mosque structure has certainly been worn off, especially in the column and beam structure. The condition of several columns and beams is currently tilted. In this study, an assessment of the robustness of the buildings was performed using forensic engineering method. The purpose of this study is to evaluate the reliability of this old mosque so that the data related to every of its structural component can be obtained. Through this evaluation, it was expected that the strategy or treatment that needs to be planned to the building could be determined, therefore at the end, it can continuously stand as its ideal condition.

Keywords: Masjid Tuha Indrapuri, building performance, forensic engineering method.

Introduction

A mosque is a place of worship for Muslims that comes from the word Sajada which means a prostration place. A mosque is a representation of the Muslim community who prosper it. At the beginning of its development, the mosque was the center of the development of Islamic teachings. A number of social and religious activities such as holidays and deliberations are held in this place. A mosque is the main embodiment of Islamic architecture.

Masjid Tuha Indrapuri is one of the ancient mosques in Aceh located in the district of Aceh Besar. The precise location of the mosque is in Indrapuri, Aceh Besar. Masjid Tuha Indrapuri exists right in the complex of the former temple. The spread of Islam into Aceh at that time particularly has shifted the influence of Hinduism in the region of Aceh Besar and generally in Aceh. Masjid Tuha Indrapuri is one of the historic mosques because it was used as the coronation place for Tuanku Muhammad Daud Syah as the Sultan of Aceh in 1878. Masjid Tuha Indrapuri was chosen as the place of coronation for the Sultan

of Aceh because at that time the Baiturrahman Grand Mosque had been burned by the Dutch (Jalil, 2015).

This mosque was built on an area of 33,875 square meters using the wooden material. The construction is supported by 4 main pillars (that in terms of Javanese architecture known as "Soko Guru") with the shape of an octagonal cross section. The construction of these main pillars serves as the main support for the roof structure. This mosque uses three stacked roofs like pyramids which are getting smaller as getting to the top. This roof shape in terms of architecture certainly has a close connection with Hindu influences.

Figure 1. Masjid Tuha Indrapuri (sources: Putra, 2018)

Given the age of the mosque that is quite old, the structural reliability of the mosque structure has certainly been worn off, especially in the column and beam structure. The condition of several columns and beams is currently tilted. The purpose of this study is to evaluate the reliability of this old mosque so that the data related to every of its structural component can be obtained. Through this evaluation, it was expected that the strategy or treatment that needs to be planned to the building could be determined, therefore at the end, it can continuously stand as its ideal condition.

Research Methods

This research study was conducted at Masjid Tuha Indrapuri that located in Indrapuri, Aceh Besar. The research applied a quantitative methods that include several stages, which consist of collecting data and analyzing the primary data that have been obtained. The data are collected by direct observation or direct monitoring of Masjid Tuha Indrapuri that located in District of Indrapuri Aceh Besar and documenting the data acquired. The primary data which collected from observations were then analyzed by using the forensic engineering method.

In this study, an assessment of the robustness of the buildings was performed using forensic engineering method. According to Sulaiman, the forensic engineering is a method of engineering investigation to determine the

cause of failure of the building (Kurniyanti 2014). Weighting techniques in the construction section are presented in Table 1.

Table 1. Weighting technique for each component of construction

No.	Scope of Work	weight of interest (BK) %	BK x Sn (Maximum)	BK x Sn (Field)	Robustness Value (%)	Decrease in Robustness (%)
A	Roofs	27				
B	Ceiling	10				
C	Frames	19				
D	Walls	9				
E	Sills	6				
F	Floor	4				
G	Foundations	21				
H	Drainages	3				
I	Utilities	1				
	Total	**100**				
	Average (%)					

Source: Sulaiman, 2005

Meanwhile, the following method is used to obtain the robustness of the building value:

$$\text{Building Robustness Value} = \frac{\text{Total BK x Sn}}{500} \text{ x } 100\% \quad \text{.....(1)}$$

where **BK** is the weight of interest, **Sn** is value score (Kurniyanti, 2014).

The determination of building condition categories are grouped into five class conditions, depending on the percentage of the final robustness value that has obtained. The value of the robustness of the building and its predicate are presented in Table 2.

Table 2. The building condition value category and its predicate

No.	Robustness Value (%)	Predicate Categories	Description of Building Conditions
1.	81-100	Very Good	If the condition of the component is still functioning properly and there is routine maintenance.
2.	61-80	Good	If the condition of the component is still functioning there is no routine maintenance.
3.	41-60	Lightly Damaged	If damage to non-structural components is more often seen as damage to finishing work, such as roof coverings, ceiling pairs, cremation pairs, masonry, plastering etc.

4.	21-40	Moderately Damaged	If damage occurs in some non-structural components as well as roof structure, ceiling structure, concrete structures, floors and others. At utility facilities damage that has disrupted the functionality of the facility.
5.	0-20	Heavily Damaged	Damage that occurs in most components of the building, both structural and non-structural which if after repairing can still function properly as it should, even though the financing is quite expensive

Source: Sulaiman, 2005

Results and Discussion

The building condition assessment of Masjid Tuha Indrapuri includes the work of roofs, wall frames, walls, doors and windows, foundations, floors, drainages, and utilities. The assessment activities involve visual identification of structural and non-structural components. After the observations, the next phase is to rank the outcomes of the observation. The observations on the condition of Masjid Tuha Indrapuri and reliability ratings are presented in Table 3.

Table 3. The results of observation of Masjid Tuha Indrapuri

No.	Scope of Work	weight of interest (BK) %	BK x Sn (Maximum)	BK x Sn (Field)	Robustness Value (%)	Decrease in Robustness (%)
A	Roofs	27	135	119,5	23,9	11,5
B	Ceiling	10	0	0	0	0
C	Frames	19	95	86	17,2	9,5
D	Walls	9	45	36	7,2	20,0
E	Sills	6	30	30	6	0,0
F	Floor	4	20	20	4	0,0
G	Foundations	21	105	105	21	0,0
H	Drainages	3	15	12	2,4	20,0
I	Utilities	1	5	5	1	0,0
Total		**100**	**450**	**413,5**	**82,7**	
Average (%)						**8,11**

Based on Table 1, it shows that the robustness value of the entire building is 82.7%, this means that the condition of Masjid Tuha Indrapuri construction is in a good condition. The roof has a decrease in robustness of 11.5%, this is because the roof cover looks mossy and poorly maintained. While the roof frame appears in good condition and can not be repaired.

Figure 2. The Roof Condition of The Mosque (source: Putra, 2018)

At the same time, the utilities section which consists of lighting, air conditioning, and water availability appear to be in excellent shape. The existence of utilities, even though they are small in weight, yet are very supportive for the convenience of the users, most of all because this is a mosque building that have always been used for the implementation of five daily prayers. Therefore, there is no decrease in robustness for the utilities part.

In addition, the scope of work which has the lowest decrease in robustness is the foundations that is equal to 0%. This is because the identification of building foundations in the research can not be done directly due to the foundations being covered by the floor. And based on historical facts, Masjid Tuha Indrapuri foundations is a former foundation that was once a temple which later the mosque was constructed on top of it. Floor works also does not encounter a decrease in robustness. From the results of observations in the field, the floors of the mosque do not have any cracks or fractures.

Furthermore, the state of the frames of Masjid Tuha Indrapuri construction from the field observation has decreased in robustness by 9.5%. This is due to the building pillars that have slopes although it is in a very small measure, as seen in figure 5.1, the protractor reading meter shows the number 87.8 °, this means that one of the pillars has a slope of 2.2 °.

Figure 3. The Slope Measurement of The Mosque's Pillar (source: Putra, 2018)

However, the overall robustness of the building frames is 17.2%, while the maximum value for the frame is 19%. Thus, the condition of the frames of the mosque in general is still in a good condition.

The other construction components which also experience a decrease in robustness are walls, namely 20%. The walls of the mosque are made of concrete, from the observations in the field, the condition of the walls is not too well maintained, many parts of the wall shows that the paint has peeled off and covered by moss. The wall plastering also seems rough, although there are no cracks that can affect the strength of the structure.

Figure 4. The View of The Mosque (left) and The Condition of The Mosque Walls (Right) (source: Putra, 2018)

The comparison between the weight of interest and the existing condition of the mosque is shown in the following figure 5:

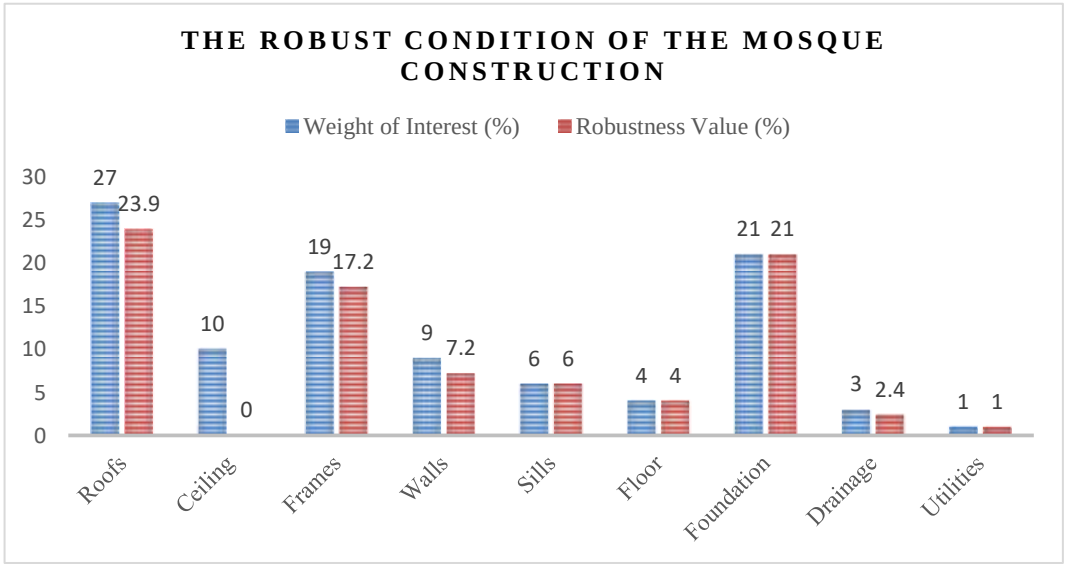

Figure 5. The comparison between weight of interest and the existing condition (source: Analysis)

Conclusions and Suggestions

Conclusions

From the results of study conducted on the Masjid Tuha Indrapuri shows the value of the reliability / robustness of the building on the mosque at 82.7%, and the average decrease in robustness at 8.11%. This figure proves that the condition of Masjid Tuha Indrapuri building is in a 'good' condition. This state indicates that each building component still has a decent level of reliability and is still functioning properly as it should be.

Despite the 'good' condition of Tuha Indrapuri Mosque, based on observations in the field, there is a decrease in the robustness of the building by 9.5% in this mosque construction. This is due to the presence of several pillars which have a slope of 2.2°, also a decrease in the robustness of the walls by 20% that caused by the large number of peeling walls and the plaster that looks rough.

However, the overall robustness of the building frame is 17.2%, while the maximum value for the frame is 19%. Thus, the condition of the mosque building frame in general is still in a good condition.

Suggestions

From the results of the study, Masjid Tuha Indrapuri building still has the reliability / robustness of the 'good' building even though it is hundreds of years old. Maintaining and taking care of this historic building is the forms of effort that needed so that this building can still stand firm and become a historical artifact for the people of Aceh.

The main structure of Masjid Tuha Indrapuri uses wood construction. Therefore, it is necessary to do a routine maintenance so that each component of the wood structure can be maintained properly. Every component of wood structure needs to be examined from various aspects that can reduce its strength, such as the water content in it, the conditions of the influence of termites and so on. In addition, the lower structure of the mosque which includes the foundation wall also needs to be treated so that the robustness does not decrease.

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