RECENT TREND IN CIVIL ENGINEERING AND BUILT ENVIRONMENT
e-ISSN: 2773-5303

RTCEBE

Vol. 6 No. 1 (2025) 39-52
https://publisher.uthm.edu.my/periodicals/index.php/rtcebe

Building Conditions Assessment of Timber Mosques at Batu Pahat

Nursyahira Yahya[1], Nor Azizah Adnan[1]*

[1] *Faculty of Civil Engineering and Built Environment,*
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, MALAYSIA

*Corresponding Author: noraziza@uthm.edu.my
DOI: https://doi.org/10.30880/rtcebe.2025.06.01.005

Article Info

Received: 08 January 2024
Accepted: 15 April 2024
Available online: 6 May 2025

Keywords

Timber, Mosque, Crack, Crack width, BCA, Building Assessment, Timber Structure, Treatment Crack.

Abstract

This technical study is assessing the structural integrity of timber mosques in Malaysia, particularly Jamek An Nur Kampung Patah Pedang and Kampung Parit Lapis Bangas Mosques in Batu Pahat. A comprehensive evaluation is crucial to determine the extent of issues and devise targeted conservation strategies, ensuring the safeguarding of cultural heritage. The main goals to evaluate the quality and condition of the structure of the timber mosque based on a BCA checklist and to propose recommendations for repairs or replacements for any damaged components of the timber mosque identified based on a BCA checklist. Both primary and secondary data collection methods are employed, encompassing site visits, observations, crack measurements with crack meters as primary data, and reviewing journals and reports as secondary data. The severity index is computed using a formula, and compliance with the Australian standard specification 'Timber heavy structural visually' is considered to check allowable crack width limits. Condition surveys uncover timber defects in both mosques, with prevalent issues being cracks and insect attacks. Jamek An Nur Kampung Patah Pedang Mosque is categorized as fair, and the severity index is 40.55 which is not very severe. The most extensive cracks at C10 measure 4.3mm, while C21 exhibits a 7mm width, surpassing the allowable crack width limit for timber buildings, set at 3mm. In contrast, Kampung Parit Lapis Bangas Mosque is deemed to be in good condition and for severity index is 25.03 which is not severe, although monitoring, maintenance, and repairs are advised. For preserving timber against biological threats, it is imperative to apply preservatives using pressure-impregnation techniques, as mere brushing or spraying may be insufficient refer to JKR's standard specification. Widely used preservatives, including Copper, Chromium, and Arsenic (CCA), form a lasting chemical bond with the wood matrix. Additionally, addressing physical deterioration, such as cracks and warps, involves using Mouldable Epoxy Putty for spaces exceeding 5mm, while introducing dowels for cracks extending beyond 30% of the timber's thickness effectively 'stitches' the two halves together.

1. Introduction

Mosques are typically found in urban and rural locations where most residents are Muslims. As the environment changes and buildings get older, it's becoming more and more crucial to crack their condition for safety reasons, especially when it comes to wooden structures. The structural performance was evaluated using the collected data in the field which is at Masjid Jamek An Nur Kampung Patah Pedang and Kampung Parit Lapis Bangas Mosque at Batu Pahat. According to Branco, J. M. (2009), as of late, wood structures stand out because of their verifiable and social worth, and they have encountered huge natural changes over the most recent couple of hundreds of years. Typically, there are several issues and flaws that are present in all timber construction components, including roofs, walls, floors, ceilings, bathrooms, doors, and windows. Neglecting maintenance has allowed defects to mar the once-pristine timber elements, diminishing the buildings' visual appeal.

This research aims to assess the condition of the timber mosque at Masjid Jamek An Nur Kampung Patah Pedang and Kampung Parit Lapis Bangas Mosque, Batu Pahat. The study will use a Building Condition Assessment (BCA) checklist to identify any signs of structural damage or deterioration in the timber components of the mosque. The research will also evaluate the quality and condition of the structure of the mosque using the BCA checklist and propose recommendations for repairs or replacements for any deteriorated or damaged components of the timber mosque.

Jamek An Nur Kampung Patah Pedang and Kampung Parit Lapis Bangas Mosque, face a hidden threat which is timber degradation. According to Smith (2008), this lack of knowledge hinders proactive maintenance, leaving these architectural treasures vulnerable to decay and structural instability. Uncracked, this decay could cause irreparable damage and the tragic loss of our cultural heritage. A thorough assessment is crucial to identify the extent of the problem, understand the contributing factors, and develop targeted conservation strategies. By prioritizing preservation, it can ensure these mosques continue to stand as proud symbols of faith and history for generations to come.

A concerning incident occurred at the Haji Muhammad Mosque in Kampung Mengabang Tengah, Kuala Terengganu, where a dome tower collapsed. Four mosque attendees narrowly escaped harm, with three of them reciting the Quran and another folding prayer mats just 3 meters away from the collapse (Salleh, 2019). The 100-year-old private mosque was undergoing refurbishment due to significant issues, including rot in many parts of its wooden structure and a leaky roof (Wan Ngah, 2019). It's crucial to promptly address such defects as they pose a threat to the health and safety of individuals (Salgiya, 2019).

The aim of this research is to be assessing the condition of the timber mosque at Jamek An Nur Kampung Patah Pedang and Kampung Parit Lapis Bangas Mosque, Batu Pahat, which was built in 1953 and 1961. The objectives of this study are to evaluate the quality and condition of the structure of the timber mosque based on a BCA checklist and to propose recommendations for repairs or replacements for any damaged components of the timber mosque identified based on a BCA checklist.

This study aims to assessing the condition and identify any signs of structural damage in the timber components of two timber mosque at Masjid Jamek An Nur Kampung Patah Pedang and Kampung Parit Lapis Bangas Mosque, Batu Pahat. BCA (building condition assessment) checklist have been used to Evaluate the quality and condition of the structure of the timber mosque at both mosque and propose recommendations for repairs or replacements for any damaged components of the timber mosque. This research will give an overview of the current state of the mosque, the type of damage and the width of the crack on the structure of the mosque and some maintenance methods that can be done to preserve and maintain the mosque for future generations. Methods that can be used to achieve the objective are observation/ visual inspection and use a crack meter to find out the crack width.

(a) **(b)**

Fig. 1 *(a) Jamek An Nur Kampung Patah Pedang Mosque; (b) Kampung Parit Lapis Bangas Mosque*

Recent Trend in Civil Engineering and Built Environment Vol. 6 No. 1 (2025) p. 39-52

2. Defects

Defects are common occurrences on any structure or building (Kartina, 2018; Mydin, 2015). This happens not just while the structure is being used, but also before and while it's being built. (Lateef et al, 2010; Kian, 2001). Failure to address faults could almost certainly result in higher costs for making corrections, disrupted building operations, and a shortened lifespan. Defects have the potential to lead to accidents and even disasters in the most extreme scenarios. (Groblier & Pretorius, 2002). Defects are defined as malfunctions or deficiencies in a building's operation, compliance with laws, or user demands.

2.1 Crack in Timber

Timber, a commonly used material in the construction industry, is prone to developing cracks, posing challenges to the structural stability and durability of timber structures. As outlined in the study by Hoadley (2000), the occurrence of cracks in timber is frequently linked to the stresses induced during the moisture reduction process. The process of drying shrinkage introduces internal tensions within the wood, resulting in observable separations or fractures running across the grain or along the length of the timber. This phenomenon, emphasized by Hoadley (2000), holds significant importance for construction professionals, influencing both the visual appeal and mechanical characteristics of timber. Beyond the impacts of drying stresses, external factors play a role in the initiation and spread of cracks within timber structures. Grasping the diverse origins of cracks is imperative for mitigating their effects on the enduring quality and dependability of timber constructions. The intricate nature of these cracks necessitates a comprehensive approach, encompassing considerations of both inherent material attributes and external influencers. To determine the allowable or limit width of cracks encountered and analyzed, reference is made to the Australian Standard Specification 'Timber heavy structural visually graded.

(a)

Fig. 1 *Australia Standard Specification*

3. Methodology

There are two (2) types of methods used in this study to gather information. The first is primary data, which is site visit or site observation and survey, including measuring work and measuring crack width. The second method is secondary data. The secondary data method is studying or researching journals, article reports and so on to get more detailed information related to this study. A survey in the form of a checklist was developed to systematically identify types of timber structure faults, potential causes, and the locations of defects. The inspection utilized Visual Inspection or Condition Survey to diagnose defects in the timber mosque. Several observations and procedures were implemented, and involved employing a method that began the inspection process from the uppermost part of the building, specifically focusing on the roof region. The survey was then systematically conducted, moving with care from the interior of the structure to the exterior facade. Valuable information about the building's history was gathered during this process, encompassing ownership details, the year of construction and completion, types of wood used, maintenance records, and other relevant information. Furthermore, the examination was conducted element by element, covering columns, beams, walls, floors, windows, doors, roof, plinth, and stairs, to diagnose construction defects and potential causes. The flow chart delineates the sequential phases undertaken in this study. Furthermore, the use of a crack meter is aimed at determining the width of cracks in timber structures. The crack meter comes with a magnifying lens and a lamp that is attached or connected to the device. The usage involves placing the tool in the location with cracks and inspecting them. Ten divisions represent 0.2mm.

(a) **(b)**

Fig. 2 *Crack meter.*

3.1 Layout Plan of Mosques

Figure 3 and Figure 4 below shows the layout drawing of the Jamek An Nur Kampung Patah Pedang Mosque and Kampung Parit Lapis Bangas Mosque that been used during the observation. This layout is utilized to determine the positions of beams and columns in the mosque. In this figure, directional indicators such as 'C' refer to Column, and 'RB' refers to Roof Beam.

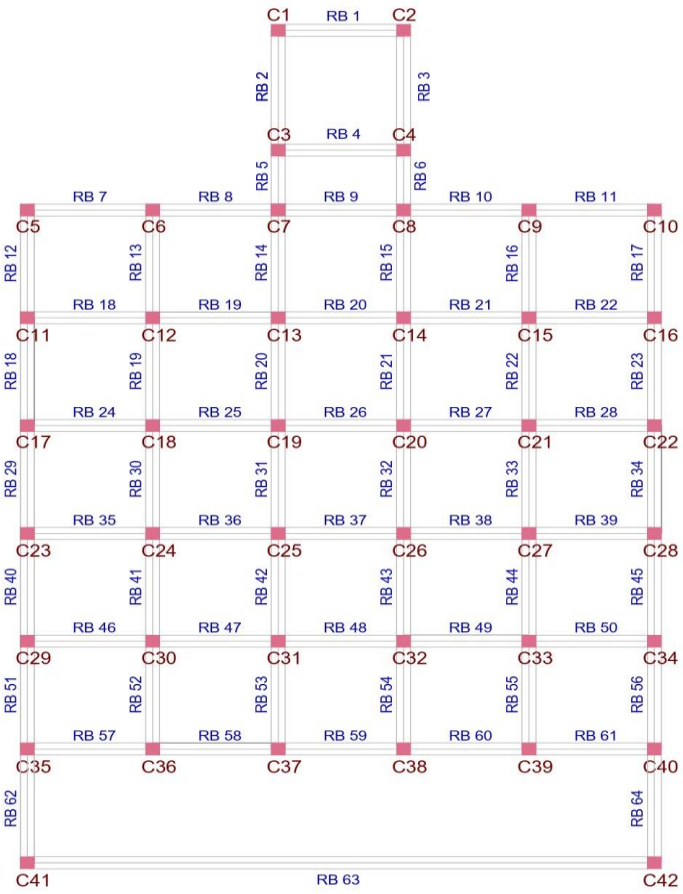


Fig. 3 *Layout Jamek An Nur Kampung Patah Pedang mosque.*

Recent Trend in Civil Engineering and Built Environment Vol. 6 No. 1 (2025) p. 39-52

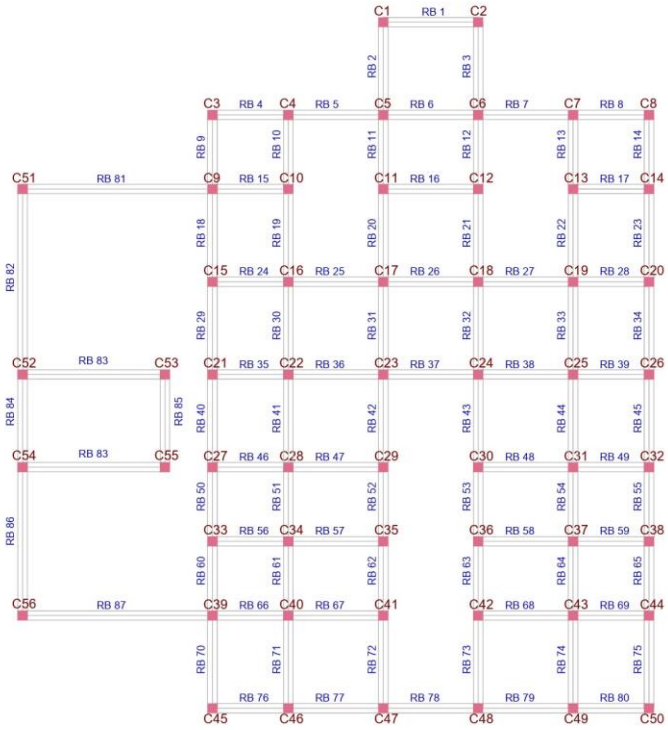


Fig. 4 *Layout Plan Kampung Parit Lapis Bangas Mosque.*

3.2 Data Collection Method.

Table 1 and table 2 below is a Building Checklist Assessment that have been used during monitoring to collect data. This table contains several columns, for example the first column is a construction element. This construction element explains the position of the defect, for example in the column, slab, wall and so on. in the second column is building survey which is contain two categories, first is defects diagnosis that explain about crack or knot and other and second is description of defect that explain about the width of the crack. Followed by the priorities ranking which contain A, B, C, D, and E and lastly is total of the Priorities ranking. Table 3 below Show the condition assessment of the building either dilapidate, fair or poor based on the average mark. Table 4 and 5 show the multiplier value and analysis of severity index and lastly table 6 is Percentage of severity index.

Table 1 *Building Checklist Assessment*

No	Construction Element	Building Survey		Priorities Ranking					
		Defect Diagnosis	Description of Defect	A	B	C	D	E	Total
1									
2									

Table 2 *Reference terms for timber defects, priority ranking system.*

No	Type of data	Scale value	Chronology value	Linguistic value
1	Physical condition	0	Repair or replacement is needed the period of 1 month	Element/structure not functional at all
		1	Repair or replacement is needed the period of 1-6 months	Serious defect, cannot be functional to an acceptable standard
		2	Repair or replacement is needed the period of 6-12 month	Functional sound, but need an urgency repair or replacement
		3	Repair or replacement is needed the period of 1-2 years	Structurally functional, only minor defects
		4	No need for repair or replacement	Free from any visible defects
2	Fabric effects	1	Significant effect	If one element/structure
		2	Have effect	is malfunction, what is the possible effect to the other
		3	Minor or no effect at all	element/structure member
3	User effect	1	Significant effect	If one element/structure
		2	Have effect	is malfunction, what is the possible effect to the other
		3	Minor or no effect at all	element/structure member
4	Potential risk	1	Most possible	Risk for structural damage, which in turn can lead to death or
		2	possible	injury (if the scale value is 3, the 'risk effect 'should have the score
		3	Not possible	value of '4')
5	Risk effects	1	Death or serious injury	Risk for structural damage, which in turn can lead to death or
		2	Injury	injury
		3	Minor injury	
		4	No risk associated	

Table 3 *Condition assessment of the building.*

Condition	Linguistic Value	Average Marks
Condition 1: Dilapidated	✓ Not safe for occupancy	04-09
Condition 2: Fair	✓ Sign of detect in structural member (no effect on building stability)	10-13
	✓Needs repair or replacement	
Condition 3: Poor	✓ Main Structural member is strong and stable.	14-17
	✓Defects that influence aesthetic value only	

Table 4 *Multiplier Value.*

Score	Multiplier	Accumulate multiplier
1	0.25	1.00
2	0.25	0.75
3	0.25	0.50
4	0.25	0.25

Table 5 *Analysis of severity index.*

Types of defects	Frequency	Frequency %	Average score of risk effect	Accumulate multiplier	Severity index	Severity index

Recent Trend in Civil Engineering and Built Environment Vol. 6 No. 1 (2025) p. 39-52

Table 6 *Percentage of severity index.*

Percentage	Severity Index
0 – 25	Not severe
26 – 50	Not very Severe
51 – 75	Severe
76 - 100	Very severe

The severity level of each timber defect is assessed by calculating the severity index, requiring two types of data which is frequency and accumulate multiplier of risk effect for each defect. The frequency is converted into a percentage and need to look at the average score risk effect column to determine the multiplier value. The severity index is then calculated using a specified formula based on formula (1) below and converted into a percentage. The severity index is further categorized into four escalating numerical values 0-25% (not severe), 26-50% (not very severe), 51-75% (severe), and 76-100% (very severe) based on Table 6.

$$Severity\ index = Frequency\ (\%) \times Accumulate\ multiplier\ of\ risk\ effect \quad (1)$$

4. Result and Discussion

This section presents the defects of the 2 selected mosques in Batu Pahat which are Kampung Parit Lapis Bangas Mosque and Jamek An Nur Kampung Patah Pedang mosque.

4.1 Jamek An Nur Kampung Patah Pedang mosque

NO	CONSTRUCTION ELEMENT	BUILDING SURVEY		PRIORITISE RANKING (REFER TOR)					
		DEFECT DIAGNOSIS CAUSES	DESCRIPTION OF DEFECT	A	B	C	D	E	TOTAL
1	C 2	Beetles (Woodworm)		3	3	2	3	4	15
2	C 10	Crack Average = 1.6mm	1. 2.45mm 2. 0.75mm	3	2	2	3	4	14
3	C 11	Knot		4	3	3	3	4	17
4	C 15	Crack Average = 0.5mm	Length = 0.9m 1. 0.6mm 2. 0.4mm	4	3	3	3	4	17
5	C 18	Beetles		4	3	3	3	4	17
6	C 19	Termites / Crack Average = 2.27mm	Length = 6.1m 1. 5mm 2. 1mm 3. 0.8mm	4	3	3	3	4	17
7	C 20	Crack	1. 2.65mm	4	3	3	3	4	17
8	C 21	Decay/ Crack Average = 7mm	Length = 7.62m 1. 10mm 2. 5mm 3. 6mm	2	2	2	2	3	11
9	C 23	Dry Rot	45mm X 70mm	2	2	2	2	3	11
10	C 25	Crack Average = 0.38 mm	Length = 9m 1. 0.2mm 2. 0.45mm 3. 0.5mm	3	3	3	3	4	16
11	C 26	Cracks/ Beetles	1. 1.4mm	4	3	3	3	4	17
12	C 27	Cracks Average = 0.33 mm	1. 0.2mm 2. 0.3mm 3. 0.5mm	4	3	3	3	4	17
13	C 28	Beetles		4	3	3	3	4	17
14	C 30	Cracks	1. 0.8mm	4	3	3	3	4	17
15	C 32	Fungi		4	3	3	3	4	17
16	C 34	Dry Rot	40mm X 4.5mm X 3.5mm	3	3	3	3	4	16
17	C 42	Dry Rot		3	2	2	2	3	12
18	Wall (C1/C3)	Peeling Of Paint		4	3	3	3	4	17
19	Wall (C3/C7)	Wane		4	3	3	3	4	17
20	Wall (C9/C10)	Knot		4	3	3	3	4	17
21	Wall (C1/C3)	Peeling Of Paint		4	3	3	3	4	17
22	Frame external (C1/C2)	Dry Rot		3	3	3	3	4	16
23	Wall & Door (C3)	Fungi		3	3	3	3	4	16
24	Roof (C8)	Termites		3	3	3	3	4	16
25	Roof (C8)	Termites		3	3	3	3	4	16
26	Settlement (At the Door)	Settlement		3	2	2	2	3	12
									362

CONDITION ASSESMENT = 362 / 26
= 13 (Condition 2: Fair)

Fig. 5 *Analysis of building survey and priority timber defects.*

TYPES OF DEFECTS	FREQUENCY	FREQUENCY %	AVERAGE SCORE OF RISK EFFECT	ACCUMULATE MULTIPLIER	SEVERITY INDEX	SEVERITY INDEX %
Beetles	4	13.79	4	0.25	3.45	8.51
Peeling Of Paint	2	6.90	4	0.25	1.73	4.27
Fungi	2	6.90	4	0.25	1.73	4.27
Wane	1	3.45	4	0.25	0.86	2.12
Knot	2	6.90	4	0.25	1.73	4.27
Check	9	31.03	4	0.5	15.52	38.27
Decay	5	17.24	3.4	0.5	8.62	21.26
Termites	3	10.35	3	0.5	5.18	12.77
Settlement	1	3.45	3	0.5	1.73	4.27
Total	29				40.55	

Fig. 6 *Analysis of severity index for Jamek An Nur Kampung Patah Pedang mosque*

Figure 5 above present the outcomes of the assessment conducted on Jamek An Nur Kampung Patah Pedang Mosque, focusing on timber defects. The survey identified 26 timber defects with cracks/split and insect attacks, specifically beetles, being most prevalent, followed by various types of rot. Figure 6 shows the analysis of severity index for Jamek An Nur Kampung Patah Pedang. Table 4.3 is referred together with Table 4.2 which is the percentage of severity index.

Figure 7 below shows the frequency of defects occurring at Jamek An Nur Kampung Patah Pedang mosque. As seen in the chart, the highest frequency is for cracks, accounting for 32%, followed by decay with a frequency of 17%. The third-highest frequency is for beetles, amounting to 14%, and termites account for 10%. The remaining three defects, namely peeling of paint, fungi, and knots, make up 7%, while wane and settlement each contribute 3%.

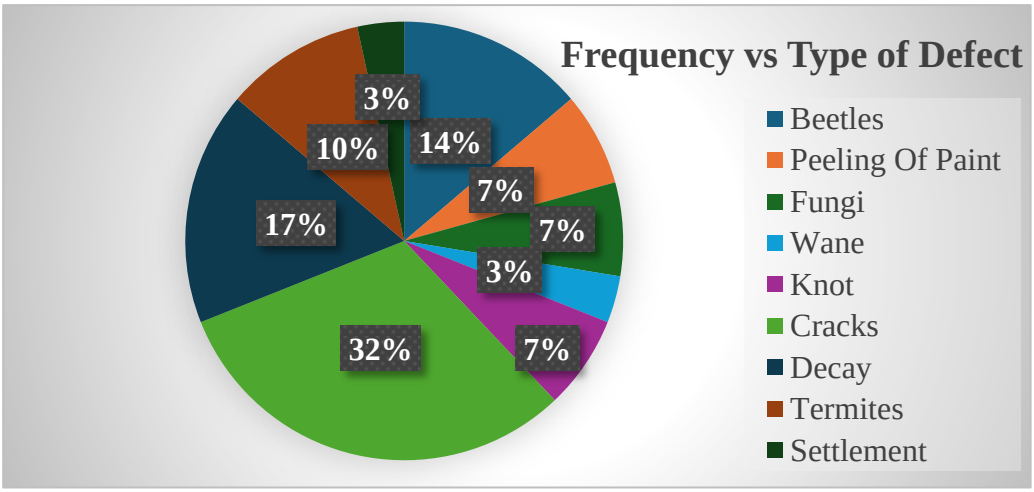


Fig. 7 *Frequency vs Type of Defect.*

Figure 8 below illustrates the width of cracks at the mosque. The lines on the chart indicate that the highest width of cracks is at the C10 position, measuring 4.3mm, and C21 has a width of 7mm, exceeding the allowable crack line permitted for timber building, which is 3mm. The dark blue represents C10, yellow corresponds to C20, blue-black indicates C27, orange represents C15, maroon is for C30, grey corresponds to C19, green is C25, and finally, red represents the allowable crack based on the Australia Standard

Recent Trend in Civil Engineering and Built Environment Vol. 6 No. 1 (2025) p. 39-52

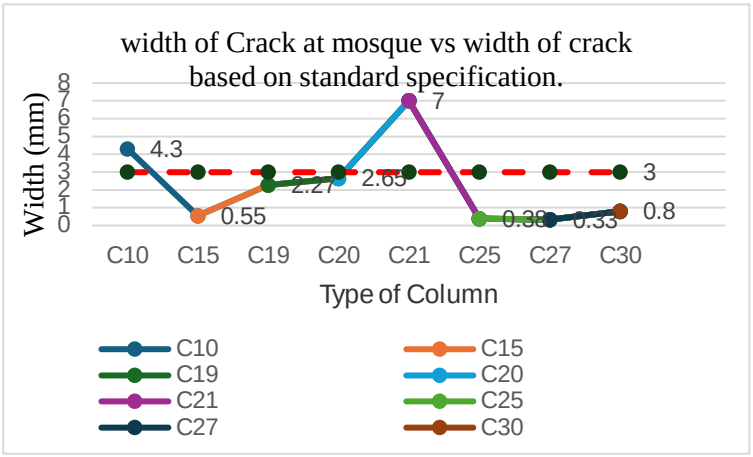


Fig. 8 *Frequency vs Type of Defect.*

Figure 9 and Figure 10 below shows the picture of timber crack that exceed the allowable crack which is 3mm at C10 (4.3mm) and C21(7mm) at Jamek An Nur Kampung Patah Pedang mosque.

Fig. 9 *C10*

(a) **(b)** **(c)**

Fig. 10 *(a)C21 below; (b) C21 Middle; (c) C21 above.*

4.2 Kampung Parit Lapis Bangas Mosque

No	Construction Element	Building Survey: Defect Diagnosis Causes	Building Survey: Description Of Defect		Prioritise Ranking (Refer Tor): A	B	C	D	E	TOTAL
1	Rb 40	Termites			4	3	3	3	4	17
2	Rb 55	Decay			4	3	3	3	4	17
3	Beam & Roof Rb 7	Leakage			4	3	3	3	4	17
4	C 2	Decay			4	3	3	3	4	17
5	C 5	Termites			4	3	3	3	4	17
6	C 10	Termites			4	3	3	3	4	17
7	C 11	Beetles			4	3	3	3	4	17
8	C 13	Termites			4	3	3	3	4	17
	C 17	Cracks	Length 1.10m	Width 0.4mm						
9		Average = 0.4mm	1.25m	0.7mm 0.2mm 0.12mm	3	3	3	3	4	16
			Length	Width						
10	C 18	Cracks Average = 0.5mm	0.7m 1.07m 1.03m	0.4mm 0.7mm 0.3mm	3	3	3	3	4	16
11	C 19	Termites Cracks		Length Width	4	3	3	3	4	17
12	C 23	Average = 1.1mm	0.4m 2.85m	0.8mm 1.4mm	3	2	3	3	4	15
13	C 24	Cracks	Length = 2.90m Width = 0.6mm		3	3	3	3	4	16
14	C 28	Peeling Of Paint			4	3	3	3	4	17
15	C 29	Peeling Of Paint / Beetles			4	3	3	3	4	17
16	C 55	Crack	Length = 1.03m Width = 0.8mm		4	3	3	3	4	17
										284
CONDITION ASSESMENT = 284 / 16 = 17 (Condition 3: Good)										

Fig. 11 *Analysis of building survey and priority timber defects*

TYPES OF DEFECTS	FREQUENCY	FREQUENCY %	AVERAGE SCORE OF RISK EFFECT	ACCUMULATE MULTIPLIER	SEVERITY INDEX	SEVERITY INDEX %
DECAY	2	11.8	4	0.25	2.95	11.8
TERMITES	5	29.4	4	0.25	7.35	29.4
LEAKAGE	1	5.9	4	0.25	1.48	5.9
CRACKS	5	29.4	4	0.25	7.35	29.4
BEETLES	2	11.8	4	0.25	2.95	11.8
PEELING OF PAINT	2	11.8	4	0.25	2.95	11.8
TOTAL	17				25.03	

Fig. 12 *Analysis of severity index for Kampung Parit Lapis Bangas Mosque.*

The assessment of Kampung Parit Lapis Bangas Mosque, as detailed in figure 11, should be cross-referenced with Figure 4 for easier defect localization. Sixteen timber defects were identified, with cracks/split and insect attacks, particularly termites, being the most prevalent, followed by various types of rot, peeling paint, knots, and others. Figure 12 shows the analysis of severity index for Kampung Parit Lapis Bangas Mosque.

Figure 13 below depicts the occurrence frequency of defects at Kampung Parit Lapis Bangas Mosque. As observed in the chart, the most prevalent occurrences are cracks and termites, constituting 29%, followed by decay, peeling of paint, and beetles with a frequency of 12%. The least frequent occurrence is leakage, accounting for 6%.

Recent Trend in Civil Engineering and Built Environment Vol. 6 No. 1 (2025) p. 39-52

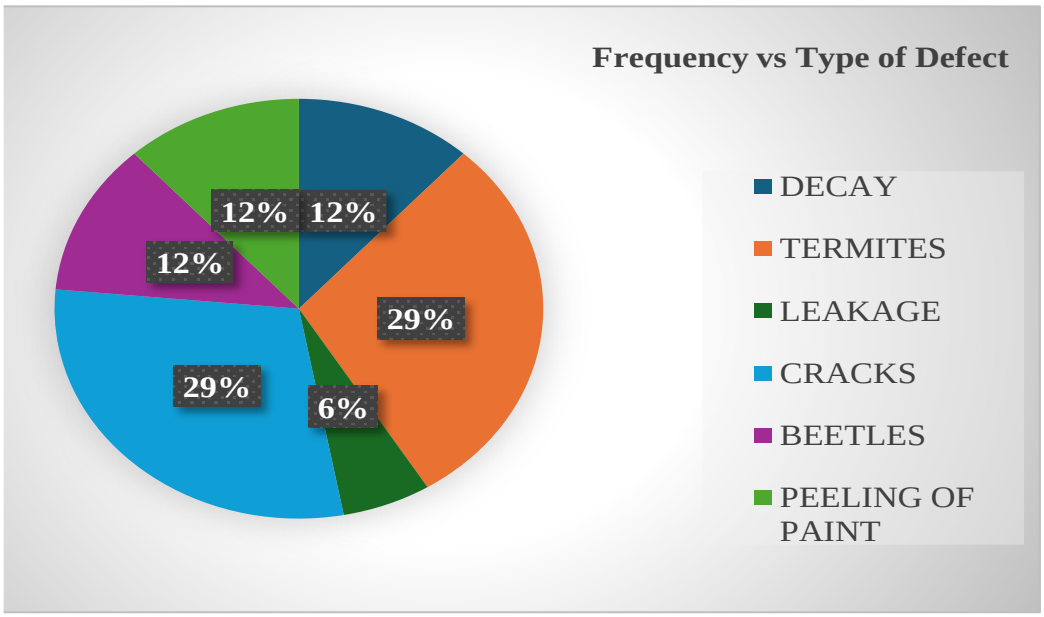


Fig. 13 *Frequency vs Type of Defect.*

The following Figure 14 below provides an overview of the width of cracks at the mosque. Upon examining the line chart, the width for all columns 'C' does not exceed the allowable cracks based on the Australian standard which is 3mm. The highest width of cracks is only 1.1mm, followed by 0.8mm at positions C23 and C55. Therefore, for this mosque, the condition of the wood remains safe for use and does not require replacement in the near future.

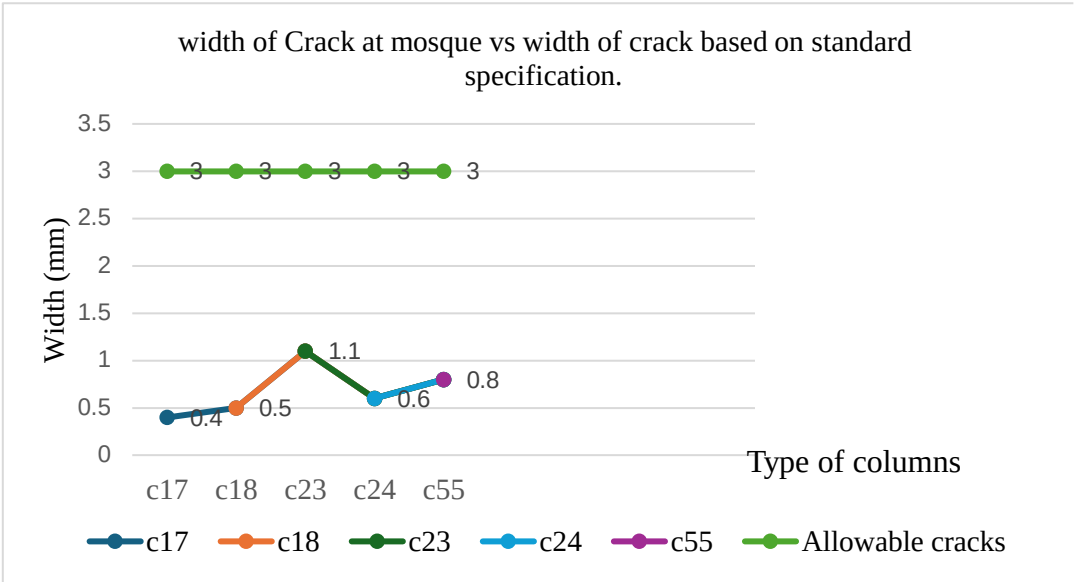
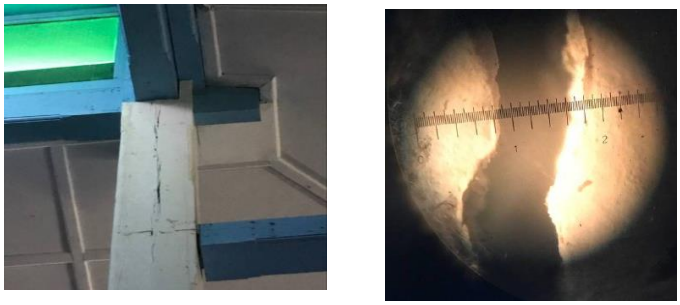


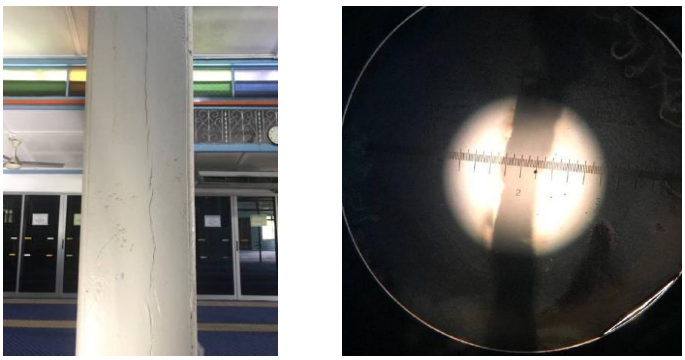
Fig. 14 *width of Crack at mosque vs width of crack based on standard specification.*

Figure 15 and Figure 16 below show the picture of timber crack among the highest crack width but not exceed the allowable crack which is 3mm at Kampung Parit Lapis Bangas Mosque.



(a) **(b)**

Fig. 15 *(a)C23; (b) Crack Meter Reading.*



(a) **(b)**

Fig. 16 *(a)C24; (b) Crack Meter Reading.*

4.3 Summary of timber defects for case study of mosque

The condition survey of Jamek An Nur Kampung Patah Pedang Mosque revealed the presence of twenty-six timber defects. The most common issues were cracks/split and insect attacks, particularly by beetles, followed by various types of rot. Termite attacks were found once. The defects were predominantly located in the interior parts of the mosque. Notably, C21 and 23 show serious defects due to weathering, specifically cracks and dry. After prioritizing each timber defect, the overall condition of the mosque was deemed fair based on the figure 4, with an average mark are 13. The severity index analysis indicated that cracks were the most severe defect, with a frequency of 38.27%. Other defects were considered non-severe, supporting the overall fair condition assessment of the mosque.

A condition survey of Kampung Parit Lapis Bangas Mosque identified sixteen timber defects. The most common issues were cracks/split and termite attacks, followed by various types of rot, peeling paint, and knots. Beetle attacks were found once. The defects were mostly concentrated in the interior parts of the mosque. C23 Show serious defects due to weathering, specifically cracks, with a score at total priorities ranking are 15. After prioritizing the defects, the overall condition of the mosque was assessed as good based on figure 11, with an average mark of 17. The severity index analysis indicated that cracks were the most severe defect, with a frequency of 38.27%. Other defects were considered non-severe, supporting the overall good condition assessment of the mosque.

In conclusion, both Jamek An Nur Kampung Patah Pedang Mosque and Kampung Parit Lapis Bangas Mosque experienced timber defects, with cracks and insect attacks being common issues. However, the severity index analysis indicated that cracks were the most severe defect in both cases, requiring particular attention. Overall, Jamek An Nur Kampung Patah Pedang Mosque was assessed to be in fair condition, emphasizing the importance of addressing the identified defects to ensure the safety of the occupants. On the other hand, Kampung Parit Lapis Bangas Mosque was assessed to be in good condition, indicating a satisfactory and safe condition for use. In addition, the line chart shows the width of cracks in An Nur Kampung Patah Pedang Mosque exceeding the Australian standard of 3mm. This can be seen on C10 and C21 where the crack width is 4.3mm and 7mm.

In contrast, for Kampung Parit Lapis Bangas Mosque, the highest recorded crack width was a safe 1.1mm, with other positions like C23 and C55 measuring 0.8mm. Therefore, the wood at Kampung Parit Lapis Bangas Mosque remains in a satisfactory and safe condition. However, monitoring, maintenance, and repairs are necessary for Jamek An Nur Kampung Patah Pedang Mosque to address the identified timber defects.

5. Suggestion and Recommendations for Repairs Crack in Timber.

1. Biological agencies

According to standard specification JKR, (2014) Preservatives refer to chemical substances added to wood to ward off biological threats. To guarantee the effective safeguarding of the timber, it is crucial that these chemicals are thoroughly infused into the wood. The optimal method to achieve this is through the application of pressure-impregnation techniques during the wood treatment process. Mere actions such as brushing, spraying, or dipping the timber with preservatives are insufficient to provide the timber with a reliable and efficient level of protection. The primary preservative chemical extensively employed for wood worldwide is CCA, an acronym for a combination of water-based inorganic salts containing Copper, Chromium, and Arsenic. CCA is advantageous because, upon impregnation into the wood, it forms a chemical bond with the wood matrix, preventing any leaching and providing lasting protection to the timber. Commercially, CCA is applied to wood through pressure impregnation. However, the drawback of using CCA is its recognition as environmentally detrimental by numerous countries.

2.Physical agents

Cracks, shakes, warps, and fissures develop when wood loses moisture and contracts. This can occur during the initial drying process or subsequent environmental changes, while in use, corresponding to the Equilibrium Moisture Content (EMC). The EMC of wood within structures can vary between 9% and 14%. Fiber saturation is achieved in softwoods used in construction at approximately 28 to 32%. If cracks or splits exceed a width of 5mm, the space can be filled with a Mouldable Epoxy Putty. However, when a crack extends beyond 30% of the timber's thickness, it becomes necessary to introduce dowels (Epoxy-Glass Bars) across the filled area to effectively 'stitch' the two halves together.

6. Conclusion.

Mosques are significant for the people of the Muslim population. Two Mosque were selected for a case study. it carried out a building condition survey to develop a timber defect priority ranking system. The system also provides an assessment of the overall building condition in terms of building stability, as well as a determination of the severity index for every type of defect. These two mosques in the past were developed by the villagers themselves. The building condition survey reveals that both mosques are still in good condition and are classified as Fair, which means safe for occupancy. Nevertheless, repair or replacement is needed to ensure that the defective elements do not become worse over time, which may result in loss or injury. For maintenance purposes, the mosque authorities Jamek An Nur Kampung Patah Pedang should give priority to repairing the column that has highest severity index, same goes to Kampung Parit Lapis Bangas Mosque. In terms of the severity level, which represents total number of defect occurrences, both houses are cracks. The level of crack is considered not very severe since the percentage of the severity index is within 26-50 % for both mosques. The other types of defects, that is, termites and rot, are found to be not severe at all.

Acknowledgement

The Author would like to thank the Supervisor, family, friends and Faculty of Civil Engineering and Built Environment, University Tun Hussein Onn Malaysia for its support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

References

Branco, Jorge M (2009) Portuguese traditional timber structures: survey, analysis and strengthening, *Protection of Historical Buildings, PROHITECH 09 – Mazzolani (ed); https://hdl.handle.net/1822/15973*

Grobler, K., & Pretorius, L. (2002). An evaluation of design-build as procurement method for building a civil engineering project in South Africa. Journal of South African Institution of Civil Engineering, 44(1), 13-19.

Kartina, A., M. Fisal, I., & M. Azim, M. W. (2018). Perak Heritage Mosques: Evaluating The Defects of Building Elements*. Malaysian Journal of Sustainable Environment, 4(1), 77-93. https://doi.org/10.24191/MYSE.V4I1.5608*

Kian, P. S. (2001). A review of factors affecting building defects in Singapore. *Dimensi Teknik Sipil, 3(2), 64-68. Petra Christian University; https://doi.org/10.9744/ced.3.2.pp.%2064-68*

Lateef, O. A., Mohd Faris, K., & Arazi, I. (2010). Sustainability in the context of maintenance: Building Defects in the Malaysian university campuses. Journal of retails and leisure property, 9(2), 137-149 Learning Academic Resource Center, Mason, OH, 265; https://www.academia.edu/31203260/Sustainability_in_the_Context_of_Maintenance_Building_Defects_in_the_Malaysian_University_Campuses.

Salgiya, D., Jain, U., & Tongiya, S. (2019). General Building Defects and Cracks. International Journal of Research in Engineering, Science and Management Volume-2, Issue-10, October-2019; https://www.ijresm.com/Vol.2_2019/Vol2_Iss10_October19/IJRESM_V2_I10_172.pdf

Smith, I., & Snow, M. A. (2008). Timber: An ancient construction material with a bright future, *he Forestry Chronicle, 84(4), 504-510.; https://doi.org/10.5558/TFC84504-4*

Hoadley, R. B. (2000). Understanding Wood: A Craftsman's Guide to Wood Technology. Library of congress cataloging in publication data. https://books.google.com.my/books?id=5HBH2ibu-ZwC&lpg=PA3&ots=cqKLbFthAe&dq=Hoadley%2C%20R.%20B.%20(2000).%20Understanding%20Wood%3A%20A%20Craftsman's%20Guide%20to%20Wood%20%09Technology&lr&pg=PP10#v=onepage&q&f=false

Salleh,A.(2019, May 8). Mosque Dome Tower Collapses. *The Sun Daily*

Wan Ngah, W. I. (2019, May 8). Mosque Dome Tower Collapses four escape death. *The Sun Daily*