

DIAGNOSING TIMBER DEFECTS IN TRADITIONAL MALAY HOUSE: A CASE STUDY OF TOK ABU BAKAR ALANG KETAK (TABAK) Nature of Building Defects in Tok Abu Bakar Alang Ketak House (TABAK)

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ABSTRACT

Timber traditional houses can bring a significant image of Malaysian built environment heritage. Indeed, it is one of the most valuable treasures that must be sustained for future global reference thus, the building owner and the professional must undertake the responsibility to ensure that these assets are in good condition and safe for its occupants. This paper aims to identify the nature of timber defects that occurred in Tok Abu Bakar Alang Ketak House. Two research objectives had been established (i) to identify the types of timber defects and (ii) to determine the causes of the occurrence of the defects. A mixed-method approach was adopted. The building inspection was carried out from the external to the internal of the building through a grid number from the building plan. All timber defects for each building element were recorded in the conditional survey form. The data were analysed using frequency analysis to measure the frequency of the defects occurring. The findings suggest that with a proper methodology in place, there is much that can be learned from studying the cause of the defect. It



will provide some insights to the owner/caretaker in planning to repair for replacement work in order to sustain the house.

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Keywords: *Timber traditional house, Timber defects, Building inspection, Insights*

INTRODUCTION

There are many traditional Malay houses scattered around Malaysia. Although it had been built from decades to centuries, these houses created significant images of Malaysian built environment heritage. According to M. Nurfaizal et al (2020), a traditional Malay house portrays the uniqueness of Malay architecture and cultural value to the society. Indeed, it is one of the most valuable treasures which are sustained for future reference universally. Nevertheless, Seo et al (2009) reported recently, the traditional Malay house has been affected by the rapid modern development and faces the threat of being demolished or transformed into a brick house. Thus, the house owner and the professional must ensure that these assets are in good condition and safe for their occupants (C. Ani et al., 2009). One of the methods is via conducting a building condition survey. It is used to identify the type of defects, location of the defects and causes of the defects so that an appropriate solution can be made. This paper aims to identify the nature of timber defects that occurred in one of the traditional Perak Limas House i.e Tok Abu Bakar Alang Ketak House (TABAK). To address this study, two research objectives had been established (i) to identify the types of timber defects and (ii) to determine the causes of the defect's occurrence.

LITERATURE REVIEW



Defects are common phenomena which occur on any structure or building (Kartina et al, 2018) and (Mydin, 2015). It occurs not only in the building operational phase but also before and during the construction stage (Lateef et al, 2010; Kian, 2001). Failure to address defects would most likely contribute to additional rectification costs, hamper the smooth operation of








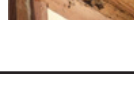


the building, and reduce its service life. In extreme cases, defects may even lead to accidents and disasters (Groblrier & Pretorius, 2002).




Defects can be defined as a failure or shortcoming in the building’s function, performance, statutory or user requirements, and this may occur in its structure, fabric, services or other facilities (Carillo, 2006; Peng & Wee, 2001). This can be classified as patent and latent defects. Patent defects can be recognized during inspection throughout the construction phase. Meanwhile, latent defects usually appear over time when the building is occupied. Hidden or latent defects are not apparent and can only be detected during the occupancy stage. However, Chong and Low (2005) state that getting access into occupied buildings to acquire information on the defects can be difficult. Most of these defects rarely surfaced to the public, unless the defects are serious enough to cause the occupants to complain to the authorities.

Under proper conditions, timber provides excellent, lasting performance. However, it also faces several potential threats to service life, including fungal activity and insect damage which can be avoided in numerous ways. Mydin (2016) explained that timber buildings are also exposed to several potential threats to service life, including fungus, insect damage and wear and tear process. In addition, M. Nurfaizal et al, 2020 highlighted other typical timber defects such as timber shakes, twisted, cup, bow, split, peeling off paint and unwanted plant growth.

Table 1. Typical Defects Table

Typical defects of timber house	Type of defects	Photos	Defects explanation
Crack	Star Shakes		Cracks which extend from the bark towards the sap wood that usually confined up to the plane of the sap wood. These are wider on the outside ends. It is usually formed due to the extreme heat or severe frost during the growth of the tree.
	Cup Shakes		Appears as curved split which partly or wholly separates the annual rings from one another which is caused due to the excessive frost action on sap present in the tree especially when the tree is young.

	Heart Shakes		This crack occurs in the centre of the crosssection of the tree and it extends from the pith to sap wood in the direction of medul.
	Ring Shakes		This crack happens when the cup shakes cover the entire circle of the timber, which is known as the ring shakes.
Shrinkage	Twisted		Occurs when the wood is drying and if it is too severe, the wood may not be valuable. However, this defect can also occur due to uneven perforation rate as there is a density difference in a board
	Cup		Indicated by curvature formed in transverse direction of timber. This type of defect can be reduced by practicing wood arrangement efectly.
	Bow		Indicated by curvature formed in direction of length of timber
	Check		A crack which separates fibres of timber and doesnot extend from one end to the other.
	Split		The split defect can be defined when the check extends from one end to other.
Insects Attack	Termites		Termites are an essential member of the soil ecosystem and are found throughout the world and their presence is particularly noticeable in tropical and sub-tropical regions where they represent a significant portion (10%) of the animal biomass
	Beetles		According to Kyru (2015), beetles are the small insects and they cause the rapid decay towards the timber structure. It forms the pin-holes of size about 2mm diameter in the timber and it attacks the sap wood of all species of hard woods. The tunnels are formed in all directions in sap wood by the larvae of these beetles, which caused the timber being converted into the fine flour like powder and they usually do not disturb the outer shell of timber
Fungal Growth	Dry rot		Dry rot is the conversion of the wood into the dry powder form that could be brown in colour and will easily crumble in your hand. It will weaken the strength of the timber structures

	Wet rot		Wet rot caused by black fungus growing and chemical decomposition of timber and it converts to the brown powder easily, later crack and crumble into fine pieces
Peeling of Paint	loss of the adhesion between the paint film and the surface		Peel off paint is the defect that occurs due to the paint film and gets lifted from the underlying surface. The air bubble is created in that tiny lifted space. It is basically the loss of the adhesion between the paint film and the surface which is usually caused by heat, moisture or a combination of both.
Unwanted Plant Growth			Unwanted plant growth can affect the strength of the strong structure because the roof from the plant can strongly grip on the particular structure of the house.

(Source: Author, 2021)

According to Ridout (2000), S. Johar et al (2013) and Mydin (2016), these defects can be divided into four main wood deterioration agents such as:-

- a. Biological agents are well known for their catastrophic attacks. This deterioration agent can be classified into two namely fungi and insects/ small animals. Soft , brown and white rot are typically grouped into fungi. Meanwhile, beetles, termites, ants, bees and birds are an example of insects/small animals
- b. Physical agents are imperfections and aesthetical defects in the wood itself. It was naturally born, known for its hollow, knots and cracked features before being consumed by users
- c. Chemical agents are acids that make the wood brittle and wood fibers become separated resulting in a mass of sharpened filaments detectable on the surface. These defects can usually be found in industrial areas with high pollution
- d. Mechanical agents are commonly due to mechanical friction during handling and processing, such as cutting and drying. The combined effects of light, wind and water movement produce stresses resulting in small surface checks and cracks

Some of the agents are significantly less damaging and usually affected only the aesthetic value. However, biological agents and moisture problems are the two most common defects that occurred and caused serious wood deterioration (S. Johar et al, 2013). Visual inspection is the easiest and the

most fundamental method to use in order to inspect the existing structure. However, this method may not be applicable on the defects that do not appear on the surface. Hence, a non-destructive test will be used to assess the properties of material, component or system.

Since most of the traditional timber houses use famous local hardwood with fine carpentry skills that are rarely seen today, thus, conserving timber houses are as important as conserving other heritage buildings. According to S. Johar et al (2013), Harun (2011), Fielden (2000), conservation is a practice that highlights the importance of preserving cultural properties and safeguards the object from destruction, decay and unintentional changes to prolong the life span of the existing cultural and natural importance.

Although building defects cannot be avoided, Haryati (2016) argued that it needs to be learned in providing valuable insights to the industry. These significant data can be used to provide lesson-learnt to assist the project team in identifying what went wrong and how to better manage future projects (Wardhana & Hadipriono, 2003; Ilozor et al. 2004; Samuel and Isaac, 2018). Findings from the survey will provide some insights to the owner/caretaker in planning the repair for replacement work to be undertaken to sustain the building. By systematically recording and tracking defects, the types, causes and categories of each defect can be identified. Moreover, recurring defects can also be traced.

Brief description of Tok Abu Bakar Alang Ketak House (TABAK)

Tok Abu Bakar Alang Ketak House is located on the banks of the Perak River in Bota Kiri, Perak. It was built by Tok Abu Bakar Alang Ketak together with several other craftsmen in the 1920s. This house was built based on the architectural style of Rumah Limas Bumbung Perak and the front of the house faces the Perak River. The structure of TABAK's house such as pillars and beams were originally built using Cengal timber. The floorboard used Kempas and the walls are from Meranti timber.



Figure 1. Location Plan and Front Elevation of TABAK House

(Source: M.Nurfaisal et al, 2019)

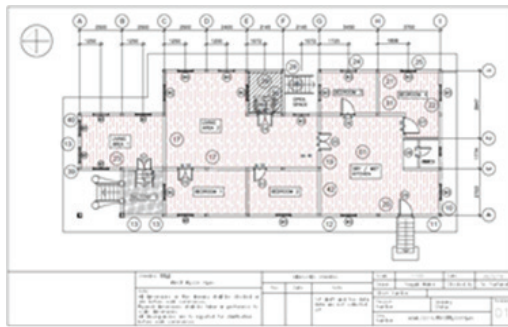


Figure 2. Floor Plan of TABAK House

(Source: M.Nurfaisal et al, 2019)

In 1960 when the road began to be built along the Perak River, this house was renovated by changing its front facing the road and turning its back to the river. This TABAK house is built with several main basic spaces such as foyer space, porch space, motherhouse, interval house and kitchen.

METHODOLOGY

A qualitative research approach was adopted. The crucial stage in this research is to assess the existing condition of the building through a building condition survey. A pro-forma survey was established as a checklist and being used to identify the types of timber building defects, the possible causes and the location of defects. The inspection was carried out using Visual Inspection or Condition Survey Protocol 1 as to diagnose a building defect for the Malay's traditional house.

A few observations and procedures needed to be followed such as a

top to down approach, which starts the inspection from the highest level of the house i.e roof space. Then, the survey will be moved from the internal building to the external façade with reasonable care. Several significant information on the building background was taken into consideration such as the property belongs to whom, year of built and completed, timber types, any maintenance information regarding the property and any related information were gathered during that inspection. At the time of the survey, the weather condition was a sunny day.

The approval to conduct this research was obtained with the permission from the owner of the particular building. The study was conducted in early July and ended at the end of August 2019. Furthermore, the analysis was made based on element by element; the column, beams, walls, floors, windows, doors, roof, plinth and stairs, diagnosing the building defect and defect possible causes. The data recorded were then analysed using frequency analysis to measure the frequency of the defect occurrence.

RESULTS AND DISCUSSIONS

Based on the analysis of building defects obtained from the conditional survey, it was found that TABAK house involved several defective works. The types and causes of the defect's occurrence are illustrated in Table 2 and 3 below.

Table 2.Type of Defects

No.	Types of Defects	Frequency	Percentage (%)	Rank
1	White spot	3	8.1	3
2	Decay / Rotten	12	32.4	1
3	Deformation of timber	6	16.3	2
4	Floor crack	1	2.7	5
5	Faded of paint	3	8.1	3
6	Missing element	2	5.4	4
7	Stain mark	2	5.4	4
8	Detachment	1	2.7	5
9	Peeling off paint	3	8.1	3
10	Mould growth	1	2.7	5
11	Wide gap	1	2.7	5

12	Rusting	2	5.4	4
	Total	37	100	

(Source: Author, 2021)

Table 2 shows that there are 12 types of defects occurred in this house namely white spot, decay/rotten timber, deformation of timber, floor crack, faded of paint, missing element, stain mark, detachment, peeling off paint, mold growth, wide gap and rusting. Decay/rotten and deformation of timber structure are recorded as the most frequent types of defects that occurred. Meanwhile, floor crack, detachment, mold growth and wide gap are the four least types of defects recorded at TABAK house.

Table 3 indicates the causes of the defect’s occurrence at this house. There are 12 causes of defects recorded in the survey form. These are due to fungus, termite attack, exposure to weather, soil settlement, biological factors, human factors, aging, leakage, dampness, climatic condition, insect attack and lack of maintenance.

Table 3. Causes of Defects

No.	Causes of Defects	Frequency	Percentage (%)	Rank
1	Fungus	3	9.1	3
2	Termite attack	6	18.2	1
3	Exposed to weather	3	9.1	3
4	Soil settlement	2	6.1	4
5	Biological factor	3	9.1	3
6	Human factor	3	9.1	3
7	Ageing	3	9.1	3
8	Leakage	3	9.1	3
9	Dampness	1	3.0	5
10	Climatic condition	4	12.1	2
11	Insect attack	1	3.0	5
12	Lack of maintenance	1	3.0	5
	Total	33	100	

(Source: Author, 2021)






The most frequent causes of defects occurred are due to termite attack and climatic condition, while dampness, insect attack and lack of maintenance are the three least causes of defects occurring at TABAK house.







The nature of these defects is further analysed based on elements/components involved and was divided into structural members and non-structural members. These are illustrated in Table 4 and 5 below.

Structural Members Defective Elements and Components

Defects for structural members of TABAK house cover four main elements namely roof, timber structure, floor and stairs. Table 4 illustrates the type and causes of defects observed in each element and component of this building.

Table 4. Type and Causes of Structural Members Defects According to Element/component

No: 1	Photos	Element: Roof
		Component: Truss
		Types of defect: A white spot at roof truss
		Causes of Defects: Fungus at timber roof frame
No: 2	Photos	Element: Timber structure
		Component: Column
		Types of defect: Decay/ rotten column
		Causes of Defects: Termite attack
No: 3	Photos	Element: Timber structure
		Component: Column
		Types of defect: Decay/rotten and deformation of timber column
		Causes of Defects: Termite attack
No: 4	Photos	Element: Timber structure
		Component: Column
		Types of defect: Decay/rotten and deformation of timber column
		Causes of Defects: Exposed to weather
No: 5	Photos	Element: Timber structure
		Component: Column and beam
		Types of defect: A white spot at timber column and beam
		Causes of Defects: Fungus due to high moisture

No: 6	Photos	Element: Floor
		Component: Timber floor
		Types of defect: Decay/rotten of timber beam
		Causes of Defects: Fungus at timber roof frame
No: 7	Photos	Element: Floor
		Component: Timber beam
		Types of defect: A white spot at roof truss
		Causes of Defects: Termite attack
No: 8	Photos	Element: Floor
		Component: Cement floor
		Types of defect: Uneven floor crack
		Causes of Defects: Ununiform soil settlement
No: 9	Photos	Element: Stairs
		Component: Tread and risers
		Types of defect: a) Decay/rotten timber tread and risers, b) Deformation of timber c) Faded paint
		Causes of Defects: Biological factor
No: 10	Photos	Element: Stairs
		Component: Timber stairs
		Types of defect: a) Decay/rotten timber stairs b) White spots at timber
		Causes of Defects: Biological factor and fungus
No: 11	Photos	Element: Stairs
		Component: Baluster
		Types of defect: Missing baluster
		Causes of Defects: Human factors /aging

(Source: Author, 2021)

- Findings from Table 4 depicts the following: -
- a) Roof truss – A thorough and detailed inspection to find out the current condition of the roof frame is not feasible due to limited access to the roof space. Only the roof space in the kitchen area could be observed since it is not covered with ceiling covering. The roof truss had been thoroughly inspected to identify the degree of damage to the component. It is observed that there is a white spot at the timber roof







truss due to the fungal effect. It is suggested that treating work must use appropriate methods without damaging the original wood components. The zinc roof finish is in good condition as roof replacement work had just been carried out. However, further inspections can be carried out to ensure that there is no defect such as leaks that can affect the current condition of the building.



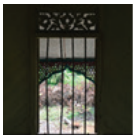



- b) Timber column and beam – Timber column and beams are damaged by decay and termite or insect attacks which is very worrying as it is likely to spread to other wood components if prompt action is not taken. Some of the timber columns at several grids are also being deformed due to termite attacks. The defective structural components need to be rectified or replaced urgently. It is found that the termite attacks have spread to the central and upper parts of the building. Furthermore, in some parts, there are fungal spots occurring on the timber surface due to high moisture because the columns are exposed to the weather. It is also recorded that the concrete plinth of the timber column had dirty marks as well as moss on its surface that requires cleaning work.
- c) Timber floor and beam - The timber floorboards and joists were at an unsatisfactory level due to termite attacks on the joists. Replacement of damaged joists is essential to prevent damage to other components. There are also effects of decay and breakage on the floorboards due to the aging factor of the material and termite attacks. Furthermore, through the observation conducted, it is also found that the floorboards in some parts have been replaced with new boards.
- d) Cement floor – There are uneven floor crack found at the ground floor due to uneven soil settlement
- e) Timber stairs - There is timber decay, deformation of timber, faded paint and white spots observed at the entrance stairs due to biological factors. In addition, the timber baluster is also missing due to aging since the building is more than 100 years old. Therefore, the baluster is missing and need to be replaced with a new baluster but with similar design





Non-structural Members Defective Elements and Components

Defects for non-structural members of TABAK house cover seven main elements namely ceiling, external and internal wall, windows, doors, decorative elements and services. Table 5 illustrates the type and causes of defects observed in each element and component of this building.

Table 5. Type and Causes of Non-structural Members Defects According to Element/component

No: 1	Photos	Element: Ceiling
		Component: Timber strip ceiling
		Types of defect: Water stain mark
		Causes of Defects: Leakage at the roof area
No: 2	Photos	Element: Ceiling
		Component: Asbestos sheet
		Types of defect: Broken/Detached and missing
		Causes of Defects: Lack of Maintenance
No: 3	Photos	Element: External wall
		Component: Wall panel
		Types of defect: a)Peeling off paint b)Faded of paint
		Causes of Defects: Climatic condition
No: 4	Photos	Element: External wall
		Component: Wall panel
		Types of defect: Missing of timber panel wall
		Causes of Defects: Aging / Lack of maintenance
No: 5	Photos	Element: External wall
		Component: Brickwall
		Types of defect: a)Peeling off paint b)Mould growth
		Causes of Defects: High dampness at the toilet
No: 6	Photos	Element: Internal wall
		Component: Brickwall
		Types of defect: a)Peeling off paint b)Mould growth
		Causes of Defects: Leakage from the upper toilet
No: 7	Photos	Element: Internal wall

		Component: Timber party wall Types of defect: a)Decay/rotten timber b)Deformation of timber Causes of Defects: Climatic factor / Lack of maintenance
No: 8	Photos	Element: Windows
		Component: Window leaves Types of defect: a)Decay/rotten timber b)Deformation of timber c)Faded of paint Causes of Defects: Aging / Lack of Maintenance
No: 9	Photos	Element: Windows
		Component: Window grill Types of defect: a)Rusting grill b)Deformation of steel Causes of Defects: Climatic and human factors
No: 10	Photos	Element: Doors
		Component: Timber door leaves panel Types of defect: a)Decay/rotten timber panel door b)Deformation of timber panel door c)Faded of paint Causes of Defects: Climatic factor / Lack of Maintenance
No: 11	Photos	Element: Doors
		Component: Door fittings Types of defect: a)Rusting ironmongery Causes of Defects: Climatic factor / Lack of Maintenance
No: 12	Photos	Element: Decorative elements
		Component: Motifs Types of defect: Decay of timber decorative elements Causes of Defects: Climatic factor / Lack of Maintenance
No: 13	Photos	Element: Decorative elements

		Component: Motifs
		Types of defect: Decay of timber decorative elements
		Causes of Defects: Climatic factor /Lack of Maintenance
No: 14	Photos	Element: Decorative elements
		Component: Motifs
		Types of defect: Decay of timber decorative elements
		Causes of Defects: Climatic factor / Lack of Maintenance
No: 15	Photos	Element: Services
		Component: Water tank
		Types of defect: Unwanted plant growth
		Causes of Defects: Lack of routine maintenance
No: 16	Photos	Element: Services
		Component: Perimeter drain
		Types of defect: a)Unaligned perimeter drains b)Broken of drain
		Causes of Defects: Ununiform soil settlement

(Source: Author, 2021)

Findings from Table 5 illustrates the following: -

- a)Ceiling – There were some stain marks found on the ceiling and some of the asbestos ceilings were detached and missing. The stain marks were due to leakage and the missing/detached asbestos due to the ageing factor.
- b)External and internal wall - Based on the survey it was found that a few of the wall timber boards are missing due to the age factor of the building as well as the natural deformation of the material. In addition, the exterior paint has problems with fading and peeling of paint due to climatic conditions and exposure to the weather. There is also a problem with the decay of wall timber boards observed in the house.
- c)There is mold growth, water stain, faded and peeling off paint observed at the brick wall of the toilet due to dampness and leakage from the

- upper toilet.
- d) Windows - Overall the current condition of the window is in good condition and satisfactory. However, there are some windows that are damaged, deformed and faded paint. There is also rusting and deformation of the grill in a certain window.
- e) Doors - The condition of the doors throughout the house is in good condition and satisfactory. Defects to the door involve the finishing of paint that begins to fade, flake off and the fittings are damaged and rusty. The door at the store has also decayed and rotten due to the climatic factor.
- f) Decorative elements – The timber decorative elements of the house are found to be decayed also due to climatic factors. In addition, there are carvings on the door head that have been damaged and broken due to aging since the building is more than 100 years old.
- g) Services - The plumbing and sanitary systems are in an unsatisfactory condition due to a leak in the main water tank located at the rear of the building. As a result, there are leakage problems and the growth of wild plants around the water tank. The existing sewage tanks are also surrounded by wild plants and drain pipes are broken and unaligned.

From Table 4 and 5, it is observed that the TABAK house required immediate action against termite attacks on the main wooden structure which is very alarming. Most of the poles and beams have been affected due to termite attacks. Immediate action should be taken as these termite attacks can spread and affect other wooden components on the building. In addition, observations at the site found that the main areas where termites have been concentrated are such as poles, beams, beams and floorboards. This is very worrying as there are some parts that have spread to the middle part of the building. It is advised that the process of re-treatment of land can be implemented using appropriate methods to ensure that termite problems can be handled well.

CONCLUSION

Overall, the present study achieved in addressing the mentioned objectives, namely, (i) to identify the types of timber defects and (ii) to determine the causes of the occurrence of the defects.

The main building defects that occurred at the TABAK house is decay/rotten resulting from termite attacks, particularly the main timber structure elements, which are in critical stage, since it will adversely affect in the context of safety and health issues. Therefore, it is suggested for essential repair practice, particularly in the context of conservation of historic buildings, the restoration work should be carried out by using a ‘minimal intervention’ approach.

Thus, much more can be learned if the defective data can be exploited using more advanced statistical tools. Further investigations to study the “ripple effect” of the causal relationships of the process that led to the defects to better track the root cause of the defects, particularly for traditional Malay houses will be considered for the next stage of the study.

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