Case Studies onTimber Defects of Selected Traditional Houses in Malacca

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Abstract

The effect of adverse environmental conditions on building materials and the extent of damage caused depends on both the materials used and the environmental conditions. Although timber is a diminishing resource, it is still widely used in today's construction. In Malaysia, timber is one of the main components of many historic buildings. Appropriate maintenance of such buildings requires an understanding of timber defects and its related problems.

Timber defects are classified into two major groups: non-biological and biological deteriorations. Non-biological deterioration consists of physical decay, excessive moisture content, dimensional instability and chemical deterioration. These defects are mainly caused by the timber in service being subjected to environmental exposure. The most common and destructive timber biological deteriorations are those due to dry rot, wet rot as well as insect attacks.

A study based on seven selected houses was conducted to identify the most common building defects, specifically on timber components amongst traditional Malay houses in Malacca, Malaysia. A building condition survey was carried out to determine the effect of the environment towards timber buildings and their main components. Data collected were based on the investigation and visual observation of the selected case studies. Findings of this research will serve as an indicator towards maintaining the buildings' timber components in good condition in order that the buildings' life span could be extended and primarily to conserve the valuable traditional timber houses in a historical city.

Keywords: Building Defect; Timber Deterioration; Environmental Effect; Building Component and Building Condition Survey.

Introduction

Timber is still in demand as a building material in both the sub-urban and rural areas of Malaysia (Lim, 1987). Statistics on occupied living accommodations for Peninsular Malaysia in 1970 showed the importance of timber as a building material for houses with approximately two-thirds of homes built with timber walls, 7.8% used a combination of planks with bricks, and 9.9% used bricks, while 6.8% were constructed of concrete. These statistics also indicated the increasing use of bricks and concrete as building materials. According to Taylor (2000), the popularity of timber as a construction material has not diminished and it continues to be widely used in the construction industry primarily for houses and furniture. In larger public, commercial and industrial buildings the use of timber as trussed rafters and glued laminated sections are also gradually increasing.

According to Taylor (2000), timber is a durable material and would last indefinitely as it does not deteriorate spontaneously. Atmospheric conditions

such as rain, frost and acids that would normally affect other materials have little effect on it. Timber would only deteriorate if it was attacked by certain external forces. Although there are various causes for timber failure, repairs and replacements could be minimised if pre-emptive measures are taken prior to construction, during the construction and at the post-construction stage. Timber is still vastly demanded in today's construction due to its quality, flexibility and aesthetic values.

Malaysia's climate due to its location in the tropics between latitudes 1° and 7° North and longitudes 100° to 119° East can be classified as tropical with high temperatures, high humidity and heavy rainfall which will lead to timber defects and deterioration.

Defects and Deterioration of Timber Buildings

According to Richardson (2001), the effects of defects and deterioration or otherwise commonly referred to as damages and failures in the quality, function, use and beauty, in buildings are dependent on the surrounding conditions and time. Timber defects such as physical decay, excessive moisture content, dimensional instability and chemical deterioration, can be grouped into non-biological deterioration and biological deterioration which are caused by non-living and living organisms respectively. The amount of exposure to the environment that the particular timber is subjected to and to a smaller degree, the design as well as the physical use of the said timber play a role in causing these defects. Although the non-biological and biological deterioration groups are immensely different, they nevertheless subsist in an interconnected existence.

In general, the problems and failures in timber building elements are accredited to either defect or deterioration. While defects and may arise due to error or negligence, deterioration is an inevitable natural process that can be minimised through good design and choice of materials. The unsuitable choice and use of materials or the occurrence of a water leak that results in fungal decay may in some cases cause accelerated deterioration. Such defects may arise as a result of poor maintenance or the failure to execute timely repairs by the property owner or occupant upon unintentional or weather related damage. It could also result from a violation of the contract or carelessness during construction and repair by the contractor.

Timber is also subjected to biological deterioration caused by living organisms such as insect infestation, fungal decay and marine borers. The growth of fungus, the main cause of decay for timber is reliant on a combination of a suitable temperature, moisture, oxygen, and cellulose in timber (Richardson, 2001).

According to Seeley (1987), damp timber with moisture content of above 20% is required for fungus growth. Damp and still air conditions particularly in prolonged periods will augment the establishment and increase of fungus growth. Taylor (2000) maintains that the main source for destruction of timber by fungi and insect is brought about by enzymes which digest the cellulose fibres or lignin adhesive for food. According to Hickin (1972), organic substances like wood deteriorate. Time alone does not cause timber to deteriorate but rather it occurs due to deterioration agents such as vegetable, animal, mineral or physical factors. These factors can be summarised as fungi attack, wood-boring animals, mechanical wear, chemical degradation or decomposition of wood, heat and bacteria. Environmental factors from both above and below ground conditions can significantly influence a building's performance. Above ground conditions include climate, atmospheric conditions and pollution as well as amount of exposure to conditions; while nature, subsoil, drainage and site stability are included as below ground factors (Son and Yuen, 1993). The structure and technical properties of wood is

significantly influenced by such factors causing adverse affect to its strength. As a consequence of their excessive impact in particular to the traditional timber houses, a condition survey study was carried out to identify the most common timber defects and its effect on building deterioration.

Building Condition Survey on Traditional Timber Houses in Malacca

Traditional Malay houses in Malaysia, famous for their uniqueness in design and aesthetic value, are mainly constructed with timber materials. There is a pressing need to conserve this valuable heritage, as these timber building structures and elements are subjected to decay and deterioration caused by environmental factors. Civil laws and other protective measures are necessary to save these heritage buildings and important timber structures from destruction. Nevertheless, preventive treatment alone does not promise to restore the timber buildings and structure to their former condition, but will at least stop further deterioration.

The houses to be studied were selected from the Malacca Museum Corporation (PERZIM) conservation list. The scope of this study concentrates on the defects found on the timber components of traditional timber houses in the Malacca. Most of the selected houses have maintained their design originality. The study covers the various types of timber defects affecting these timber buildings and the potential hazards of decay and deterioration that they face. Data from seven selected houses was processed and analysed. The research then focused on the types of defects and their causes which led towards the deterioration of these traditional timber houses.

Research Objectives

The main objectives of this research are as follows:

a) to determine the types of timber defects in the traditional Malay timber houses,
b) to study the causes of the defects found on the timber components of these traditional timber houses, and
c) to analyze the most common timber defects and deterioration that occurred on the timber materials of these traditional timber houses.

Research Methodology

Building condition survey is one of the approaches that can be used in assessing a building's performance. In general, it is a survey that is carried out based on the investigation and visual observation of the selected case studies (traditional Malay houses). Surveying tools and instruments for non-destructive tests such as a decay detecting drill, ultra-sonic pulse velocity and proti-meter are used in detecting any unseen problems in the timber materials. The research methodology is divided into three stages namely: information gathering, data processing and analyzing, and data presentation, while the information gathering itself comprises four steps as shown in Table 1.0.

Table 1.0 : The Various Stages of Investigation Methods

Stage	Description
Step I	Determine building elements and spaces to strategize a coding system. In preparing the survey checklist, a complete building plan and floor layout is used to identify building elements in order for condition survey results to be obtained in a systematic manner.
Step II	Investigate building condition by visual observation. A methodical elemental survey is carried out from the ground level up to the highest point of the building. Use of surveying tools and equipments such as proti-meter, survey master, decay detecting drill, laser-tech dimension master, theodolite, measuring tapes, and callipers to provide near accurate to accurate information or data.
Step III	Record all defects and damages found from the case studies onto the checklist including its location, type of defect, element code and pictures. Sketches of defects that are made on site are also used to record the actual size and dimensions of the defects. For example, in the case of serious cracks, calliper and measuring tape are used to measure the width and length of the cracks.
Step IV	Analyze collected data by making comparative assessment with all types of defects recorded from the case studies. This is to identify the number of defects found and further translate the data into graphs and charts. From the analysis, the defects type that is recorded to have highest percentage will then be determined as the most common defects occurring in the timber elements located in the tropical climate.

Coding System

There are two types of codes used to ease the recording process and data analysis;

i) Code for building elements – used to differentiate the different types of elements.
ii) Code for building defects – used to show location of the defects on the building plan. The same codes are also used in the defects photos. The code refers to owner's name, spaces, elements, defect's location and photograph number.

An example of the coding system used is shown in Figure 2.

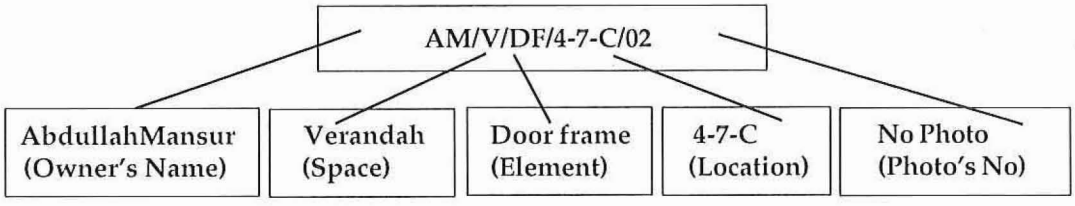

Figure 2.0 : Example of Coding System
Source : Field study (2005)

Research Analysis and Findings

The research is to identify damages and common defects affecting wood elements of the selected traditional timber houses. Analysis was made on the data gathered from seven traditional timber houses that were selected as samples for the case studies in this research and were correspondingly labelled as Case Study 1 to 7. The focus of this research is to identify and group the type and number of defects and damages that occurred on timber elements under specific defect factors. From the overall findings, the identified defects will be categorized under the building condition category and subsequently analysed.

i. Defects Factor Colour Coding System

The defects were identified and clustered into groups based on defect factors and given a colour code as shown in Table 3.1.

Table 3.1: Defect Factor Colour Coding System

Colour	Code	Defect Factor	Remarks
	ROT	Rot	Consist of Dry Rot, Rot (Weather) and Rot (Dampness)
	INSECT	Insect Attack, Termite Attack	Comprise of termite attack and pest attack
	DISCOLORATION	Discoloration	Occurred at unpainted timber element
	STAINING	Staining	Staining that creates an unpleasant sight for the timber surface
	PAINT	Paint	Bulging and discoloration-paint occurred on painted surfaces
	INSTALLATION	Installation	Occurred due to faulty installation
	OTHERS	Others factor	Comprises of four (4) categories: Spalling / Damage, Mould, Breaking Element and Dampness.

Source : Field study (2005)

ii. Defects Factor of Timber Elements

To identify damages and defects that frequently affects the timber of the traditional Malay houses, the result from the 'damaged & repaired elements' and 'damaged & replaced elements' groupings in the Building Condition Category were used. Tables 3.2 and 3.3 show the precise list of the damages and defect factors identified for the timber components from the site survey investigation under the 'damaged & repaired elements' and 'damaged & replaced elements' groupings in the Building Condition Category. The tabulations listed in table 3.1 show the total sum of the defects for each defect factor in the Defect Factor Colour Coding System.

Table 3.2 : Number of Damaged & Repaired Elements by Defect Factors
Source : Field study (2005)

DEFECTS FACTOR	CS 1	CS 2	CS 3	CS 4	CS 5	CS 6	CS 7	TOTAL
Bulging	1	4						5
Discoloration -Paint							8	8
Dampness						1		1
Installation	2				1	3	3	9
Dry Rot	25							25
Rot (Weather)	5		1					6
Rot (Dampness)					1		2	3
Mould			2	1				3
Discoloration -Paint	2		17		17	1	8	45
Cracking		1		1				2
Staining		1	2	30	1			34
Termite Attack	23	1				27	1	52
Insect Attack						1		1
TOTAL	**58**	**7**	**22**	**32**	**20**	**33**	**22**	**194**

Table 3.3 : Number of Damaged & Replaced Elements by Defect Factors
Source : Field study (2005)

DEFECTS FACTOR	CS 1	CS 2	CS 3	CS 4	CS 5	CS 6	CS 7	TOTAL
Dry Rot	13	10	4		20	24	32	103
Rot (Weather)	5		3		4	3		15
Rot (Dampness)	1				7	1	1	10
Discoloration	7							7
Spalling		1	1					2
Termite Attack						5		5
Insect Attack						1		1
Erode Element						1		1
Broken Element						1		1
Installation							2	2
TOTAL	**26**	**11**	**8**	**0**	**31**	**36**	**35**	**147**

iii. Building Condition Category

Any defects found in the timber elements were recorded and categorized into four (4) categories. The categories are sustained, damaged & repaired, damaged & replaced and no access. These categories as shown in Table 3.4, describe the condition and assessment of the defects and damages to the buildings found during the site survey.

Table 3.4: Building Condition Category
Source : Field study (2005)

Building Condition Category	Description
Sustained	• All building element at best condition. • Minor stage of defects and damages • Building is safe for inhabitant • Repairing work – not immediate
Damaged & Repaired	• Some parts of building element have damages. • Defects and damages varied of major and minor. • Building is safe for inhabitant. • Repairing work – immediate
Damaged & Replaced	• Building element has damages almost entirely • Defects and damages are serious. • Building is unsafe for inhabitant. • Repairing work – immediate.
No Access	• Some of the area of the house are not accessible

Table 3.0 shows the total number of defects according to the defects factor. From the analysis, the highest number of defects occurred due to rot defect factor (162 nos.) followed by insect factor (59 nos.) and discoloration (52 nos.). From the analysis, rot defect is found as the most common defect identified in this study.

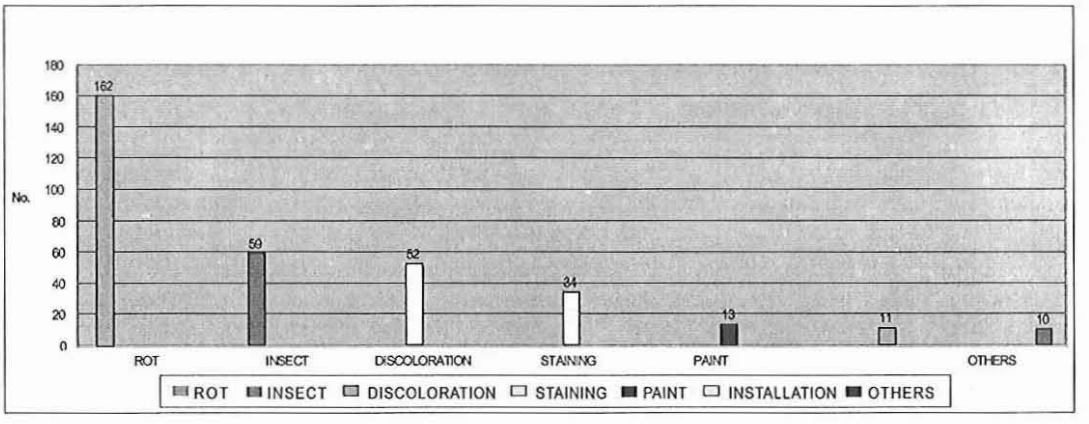

Figure 3.0: Number of Defects Based on Defects Factor in Coding System
Source : Field study (2005)

The pie chart in Figure 3.1 indicates that the most common defect that have affected the timber performance on the selected case studies is caused by rot factor (48%), followed by pest factor (17%) and discoloration factor (15%). Pest and discoloration factors are considered a normal phenomenon and occur due to the lack of regular maintenance. Staining factor (10%), paint factor (4%), installation factor (3%) and others factor (3%) are external factors that are considered as defect problems to the buildings.

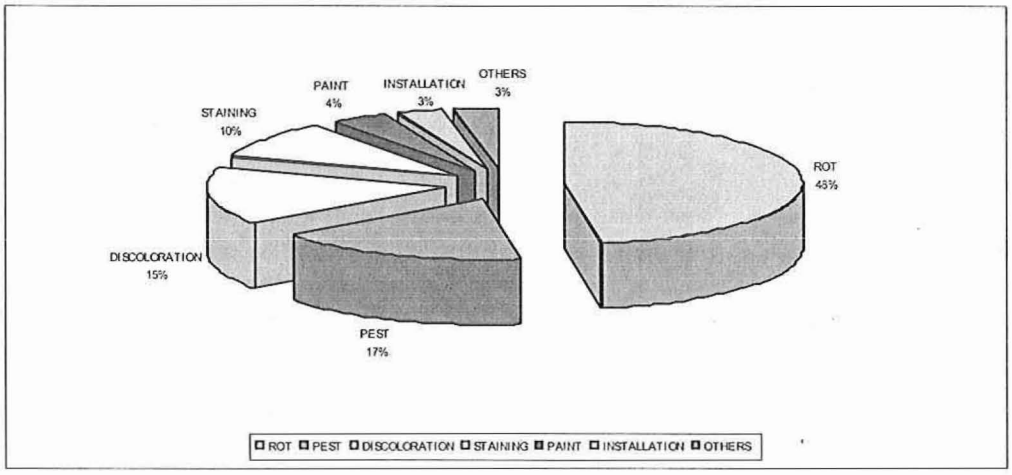

Figure 3.1: Defect factors of timber components pie chart
Source : Field study (2005)

iv. Cumulative Defect List of Case Studies

After the research and inspection done, an analysis was carried out on the data in the Building Condition Category. Figure 3.2 shows the number of identified defects that were taken and categorized during the inspection.

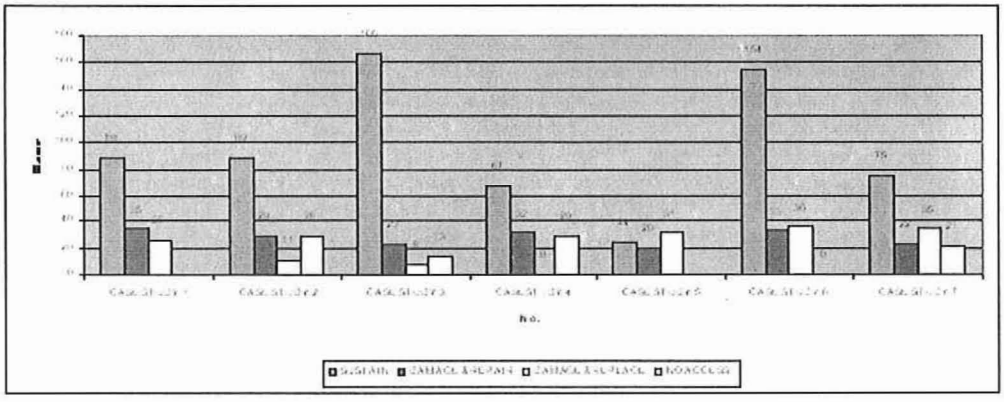

Figure 3.2: Accumulated defects according to building condition category
Source : Field study (2005)

Figure 3.3 indicates that 61% of the total amounts of defects identified fall within the 'sustained' category, i.e. defects that do not require serious repairing work. About 8% was identified as 'no access', in which the research cannot be conducted in certain areas due to inevitable factors such as limited ceiling height and others. Analysis found that only 18% of the defects fall under the 'damaged & repaired' category and 13% under 'damaged & replaced' category; categories that showed defects of a severe level.

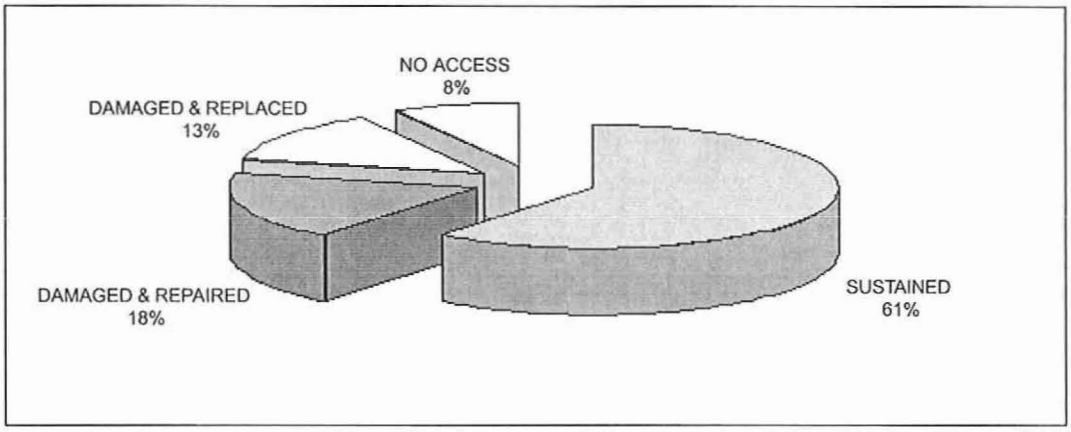

Figure 3.3 : Percentage of Defects Sum According to Building Condition Category
Source : Field study (2005)

Conclusion

The built environment is the product of a complex interaction between external environment, building materials, design, contents, activities in buildings and occupants. To try manipulating any one of these factors without giving due consideration for the possible effects on the others can be at worst ineffective and at best inefficient and costly.

Timber is a very flexible material for building structure, can decay easily if no remedial action is taken to protect and prevent it from deterioration. The occurrences of defects in timber houses are becoming more common due to the effects of biological agents, temperature and the poor standard of workmanship. A timber defect can only be repaired satisfactorily if its cause has been correctly diagnosed and identified. Correct diagnosis depends upon the collection and analysis of all information, knowledge of the characteristics and behaviour of building materials and methods of construction.

By using the five-stage investigation method, the research has identified the types of timber defects in the traditional timber houses and their causes. Data collected is subsequently analysed to determine the most common timber defects and the deterioration that occurred for the timber components of the traditional timber houses. The results of the case studies showed that rot was the most common defect problem followed by insect attack and discoloration problems.

Timber decaying organisms cannot be eradicated by pesticide treatments. However, they can only flourish in buildings if the environmental conditions are suitable. Even with the loss of traditional skills and the complexities introduced in buildings by new materials and uses, these conditions can easily be avoided with a little thought and scientific understanding. New materials and techniques can often be used to the advantage of the building

owners if their properties are analysed to facilitate environmental controls.

Good maintenance is advisable to prevent the failure of building components especially for timber materials in traditional timber houses. This is a more rational approach to the treatment of timber decay and should be promoted in the interest of sound building and public health. In maintaining Malaysia's valuable heritage, the principles of conserving traditional timber buildings should be considered when approaching repairs to these historical buildings.

References

Richardson, B. A. (2001). *Defects and Deterioration in Buildings*, 2nd Edition, Spon Press, London and New York.

Taylor, G.D. (2000). *Materials in Construction - An Introduction*, 3rd Edition, Pearson Education Ltd, England.

Hickin, N.E.(1972). *The Dry Rot Problem*, 2nd Edition. Hutchison & Co, London.

Seeley, I.H. (1987). *Building Maintenance*, 2nd Edition, Palgrave, New York.

J.Y.Lim (1987).*The Malay House-Rediscovering Malaysia's Indigenous Shelter System*, Institut Masyarakat, Malaysia.

Son, L.H. and Yuen, G.C.S. (1993). *Building Maintenance Technology*, MacMillan Press Ltd., London.