

PERPUSTAKAAN UMP



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BUILDING DESIGN

D ANALYSIS

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ABSTRACT

Building defects were used to describe imperfections in constructed buildings that can cause inadequacy or failure. This issue may occur due to problems during design stage or construction stage. Building defects not only occur in specific or certain place, but it involves from many different range which are from complex foundation and framing issues to aesthetic issues. The main purpose of this study is identifying types of the building defects, to determine the causes or factors of the building defects and also to analyze appropriate methods and techniques of building maintenance. In this study, the scope will be focusing in Peninsular Malaysia. Questionnaires are distributed to the selected company and also an interview session is conducted with related person on selected company. Data and information are gathered and analyzed using statistical method which is Average Index Percentage using Microsoft Excel. It is found that, twelve (12) defects are identified which are fungus stain and harmful growth, erosion of mortar joint, peeling paint, defective rendering plaster, cracking walls and leaning walls, defective rainwater goods, decayed floorboards, insect or termite attacks, roof defects, dampness penetration through walls, unstable foundations and poor installation of air-conditioning units. The factors that cause the defects are climate condition, location of the building, building type and change of use, maintenance approach to the building, building age, support and humidity. There are many methods to maintaining the building. For example, there are six (6) methods for peeling paint defect which are water washing, steam stripping, chemical paint removers, abrasive method, hot air paint stripper and burning off method. To identify those methods are very important so that proper maintenance of building can be made and also to avoid defects from repeating.

ABSTRAK

Kecacatan bangunan digunakan untuk menggambarkan ketidaksempurnaan pada bangunan yang dibina dimana boleh menyebabkan kekurangan atau kegagalan. Isu-isu ini berlaku kerana kesalahan semasa peringkat reka bentuk atau peringkat pembinaan. Kecacatan bangunan bukan sahaja berlaku di tempat yang khusus atau tertentu, tetapi ia melibatkan aspek yang berbeza dimana daripada tapak yang rumit dan merangkumi isu-isu estetik. Tujuan utama kajian ini adalah untuk mengenal pasti jenis-jenis kecacatan bangunan, untuk menentukan sebab-sebab atau faktor kecacatan bangunan dan juga untuk menganalisis kaedah dan teknik yang sesuai untuk penyelenggaraan bangunan. Dalam kajian ini, skop akan memberi lebih tumpuan di seluruh Semenanjung Malaysia. Soal selidik diagihkan kepada syarikat yang terpilih dan juga sesi temuduga dijalankan bersama orang yang berkaitan dengan syarikat yang terpilih. Data dan maklumat dikumpulkan dan dianalisis menggunakan kaedah statistik iaitu *Average Index Percentage* melalui *Microsoft Excel*. Sepanjang kajian ini, dua belas (12) kecacatan telah dikenalpasti iaitu *fungus stain and harmful growth, erosion of mortar joint, peeling paint, defective rendering plaster, cracking walls and leaning walls, defective rainwater goods, decayed floorboards, insect or termite attacks, roof defects, dampness penetration through walls, unstable foundations and poor installation of air-conditioning unit*. Faktor-faktor yang menyebabkan kecacatan ini ialah daripada keadaan cuaca, lokasi bangunan, jenis dan penggunaan bangunan, pendekatan penyelenggaraan bangunan, umur bangunan, sokongan dan kelembapan. Terdapat banyak kaedah untuk memulihara bangunan. Sebagai contoh, terdapat enam (6) kaedah untuk pengelupasan cat bangunan iaitu *water washing, stream stripping, chemical paint removers, abrasive method, hot air paint stripper and burning off method*. Mengenalpasti kaedah memulihara adalah sangat penting supaya penyelenggaraan boleh dibuat dan juga untuk mengelakkan kecacatan daripada berulang.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Defects are common construction-related issues in construction industry. It causes a dangerous condition. There are many types of defects can be found in building. Some defects are obvious (such as water seepage) but many are less obvious and do not become apparent until years after a building was constructed.

Some buildings in Malaysia are at risk from defects because these buildings are not being well cared for, due to lack of knowledge and high cost of repair and maintenance and also poor workmanship. Defect can occur at various locations with different types of causes and symptoms. Thus, it is very important to recognize and diagnose the defects at each building element so that building maintenances can be carried out.

The aim of this study is to identify the types of building defects, to determine the causes or factor of building defects and to analyze appropriate methods and techniques of building maintenances.

1.2 PROBLEM STATEMENT

In definition, defection means an imperfection that causes inadequacy or failure. Once the structural building failed because of defections, then conservation and maintenances survey is needed to protect our building.

Based on Construction Defect article, 22 May 2006, there has been much controversy within the construction industry with the respect to, “what is a construction defect?”

There are so many different viewpoints about this. For example, the viewers are from builder, developer, contractor, subcontractor, material supplier, product manufacturer, homeowner and also homeowner’s association.

Construction defects involves from many different range. It could range from complex foundation and framing issues to aesthetic issues such as improperly painted surfaces and deteriorating wood trim around windows and doors.

In this article, it stated that the trial courts have recognized that construction defects are tangible and can typically be grouped into the following four (4) major categories. The categories are design deficiencies, material deficiencies, construction deficiencies and subsurface or geotechnical problems.

According to this article, problems with design complexity may lead to defects. For example, problems are typically encountered with roof systems, which due to their design complexity, pitched or flat, are prone to leaks.

Defects problems have effects in our construction development. So, this study is conducted in order to find out the types and causes of defects so that in the future there will be precautions to avoid or minimize defects in building.

1.3 OBJECTIVES

There are three (3) objectives of this study which are:

- i. To identify the state of the building defects.
- ii. To determine the causes or factors of the building defects.
- iii. To analyze appropriate methods and techniques of building maintenances.

1.4 SCOPE OF STUDY

To achieve the objective of this study, the scopes of study are identifying the state of the building defects, determining the cause of the building defects, analyzing appropriate methods and techniques of building maintenances. A set of questionnaire are prepared and interview session are conducted with the related party which are the client, consultant, contractor and others. Location that involves in this study is in peninsular Malaysia. Statistical analysis method is used to analyze the questionnaire.

1.5 SIGNIFICANCE OF STUDY

Malaysia is a developed country that has many types of buildings. These buildings are very valuable in terms of manufacturing and historical values. It is believed that there are more than 37,000 historic buildings built between 1800 and 1948 throughout the country which are worthy for preservation and conservation (A. Ghafar Ahmad, 1994).

This survey includes identifying and recording building defects through the means of photographic and digital documentation prior to any conservation work. The survey requires analyses the state of the building defects, probable causes or factors of building defects and the proposed methods and technique of building maintenances (A. Ghafar Ahmad, 1994).

Basically, the common causes of defects in building are inappropriate methods of repair and lack of understanding of the behavior of the materials, and which in severe cases can lead to the destruction or loss of important historic elements. In order to achieve the objective effectively, building defect investigations are carried out seriously and precisely. In this study, an investigation of the building conditions, defects and their causes are necessary.

1.6 STRUCTURE OF THESIS

This study contains 5 chapters. Chapter 1 basically covers the idea of this study. Chapter 2 covers the studies by previous researchers which is literature review. Chapter 3 covers the methods that are used in this study. Chapter 4 shows the analysis of results and lastly chapter 5 will conclude the overall of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In designing a project or a building, there are lots of decision have to be made. Building designers' decisions affect long term quality and life cycle cost of buildings. Sometimes there are small errors made during the early stage of the construction which are designing stage. This will lead to defection. Designers' decisions are usually latent in nature and hard to detect at the early stage of construction. Insufficient considerations for these failures causes were found to be the key in preventing these defects (Chong et al., 1990).

Defects were used to describe imperfections in constructed buildings. A building defect may be considered to be a failing or shortcoming in the function, performance, statutory or user requirements of a building, and manifests itself within the structure, fabric, services or other facilities of the affected building (Ilozor et al., 2003).

In this chapter, several types of defects, causes or factors of defects and technique and methods of building maintaining were explained further with the support of previous researchers.

2.2 DEFINITION OF DEFECTS

Defects problems occur during design or construction that damage the integrity of the building or structure. For example, it is caused by inaccurate calculations, incomplete drawings or specifications, or poor designing. It can also cause by

misunderstanding of the design, cutting corners, carelessness, or not following the design. Defects can be detected by comparing a design to standard conventions and codes and then by comparing the constructed building to design. Professional inspections are required to determine the actual defect and to find the cause of the problem and to provide the right information for remedial works. Lack of expertise at time of construction and lack of adequate maintenance may be a result to defect.

Defect investigation will usually involve diagnosing the cause of the defect and propose suitable work to rectify it. By investigating, issues or problems related to the building defect can be identified. Once the issues or problems are identified, then a strategy to perform the repair can be developed as well as possibly determine who is responsible to the matter or problems arise.

Building is defined in many aspects. Building can be defined as permanent or temporary structure enclosed within exterior walls and a roof, and including all attached apparatus, equipment, and fixtures that cannot be removed without cutting into ceiling, floors, or walls.

2.3 TYPES OF DEFECT

A house of building is basically owners' most valuable financial investment and one of the most important emotional investments. It is actually more than bricks and mortar because it is a place where people live, rest, business and a shelter for family. There are several types of defects that are listed below.

2.3.1 Fungus Stain and Harmful Growth

Fungal stains occur in situation when there is moisture content in the walls. It happens in an environment of high humidity and with poor ventilation. Harmful growth occurs on walls, roofs or gutters. This includes creeping and ivy plants. It will happens when dirt penetrate small openings in the walls and mortar joints, creating suitable grounds for seeds to grow. Roots can go deep into the existing holes causing further cracks and water penetration (A. Ghafar Ahmad et al., 1994).

2.3.2 Erosion of Mortar Joints

Function of a mortar joint is to even out the irregularities of individual blocks either stones or bricks. Causes of this factor includes salt crystallization, scouring action of winds, then disintegrating effects of wall-growing plant, and water penetration resulting in dampness. Ways or methods to remove decayed mortar is either with a mechanical disc or manually raked out using a knife or spike (A. Ghafar Ahmad et al., 1994).

2.3.3 Peeling Paint

Peeling paint occurs on building facades, which is on plastered walls, columns and other areas that are exposed to excessive rain and dampness. Buildings that are nearer to sea may face a greater risk. Factors that can turn the surfaces of the paint to become chalky and wrinkled or blistered are the amount of constant wind, rain and sun received. Several layers of paint have been applied. For example lime wash, emulsion, oil-based, tar, bituminous and oil-bound water paint. Different types of paints give different methods of removal (A. Ghafar Ahmad et al., 1994).

2.3.4 Defective Plastered Renderings

Defective plastered rendering occurs on the extreme walls, columns and ceiling. Defective rendering are caused by biological attacks arising from penetrating rain, evaporation, condensation, air pollution, dehydration and thermal stress, harmful growth, insects, animals and traffic vibration (A. Ghafar Ahmad et al., 1994).

2.3.5 Cracking of Walls and Leaning Walls

Cracks in the wall are common symptoms of defects. This symptom should be investigated promptly and the causes diagnosed whether the foundations, weak materials and joints or any shrinkage or thermal movements such as those of timber window frame. Diagonal cracks, usually widest at foundation and may terminate at the

corner of a building, often occur when shallow foundations are laid on shrinkable sub-soil which is drier than normal or when there is a physical uplifting action of a large tree's main roots close to the walls. Basically, causes of leaning walls are spreading roof which forces the weight of a roof down towards the walls, sagging due to soil movement, weak foundation due to the presence of dampness, shrinkable clay soil or decayed building materials and disturbance of nearby mature trees with roots expanding to the local settlement (A. Ghafar Ahmad et al., 1994).

2.3.6 Defective Rainwater Goods

Defective rainwater goods creates problems such as sagging or missing eaves, gutters, corroded or broken downpipes, and leaking rainwater heads, undersized gutters or downpipes. Undersized gutters or downpipes cause an overflow of water during heavy rain, and improper disposal of water at ground level. Iron rainwater goods can rust and fracture due to improper painting. Lack of proper wall fixings, particularly by projecting leads ears or lugs can cause instability to the downpipes. Rainwater goods can be easily exposed to all sorts of defects if the building inspections and maintenance have been neglected (A. Ghafar Ahmad et al., 1994).

2.3.7 Decayed Floorboards

Timber floorboards deteriorated leads to structural and public safety problems. Causes of decayed floorboards are pest attacks, careless lifting or weakened boards by occupants, electricians or plumbers. Other causes are lack of natural preservatives and corroded nails (A. Ghafar Ahmad et al., 1994).

2.3.8 Insect of Termite Attacks

Insects of termite attacks usually involve timber. Timber can deteriorate if left exposed to water penetration, high moisture content and loading beyond its capacity. Insect or termite attacks pose threats to damp and digestible timber found in wall plates, the feet of rafters, bearing ends of beams and trusses, as well as in timbers which are placed against or build into damp walling. When timber is lines with insects or termite

holes, the timber will get soften and form further and dangerous cracks (A. Ghafar Ahmad et al., 1994).

2.3.9 Roof Defects

Roof acts as a weather shield. Thus, it is important to treat aging roof tiles. Clay roof tiles have been widely used buildings. Roof tiles defects include corrosion of nails that fix the tiles to battens and rafters, the decay of battens, and the cracking of tiles caused by harmful growth. Harmful growth poses a danger to the tiles because it may lift tiles and create leaks. Not forgotten is the mortar applied for ridge tiles which tends to decay or flake off over the years (A. Ghafar Ahmad et al., 1994).

2.3.10 Dampness Penetration through Walls.

Dampness penetration through walls is a serious matter for buildings located near water sources because it can deteriorate building structures and damages the furnishings. Causes of dampness are water entering a building through different routes. Water penetration occurs commonly through walls exposed to prevailing wet wind or rain. With the existence of gravity, water may penetrate through capillaries or cracks between mortar joints, and bricks or blocks before building up trap moisture behind hard renders. Water may also drive further up the wall to emerge at a higher level. Dampness also occurs in walls due to other factors such as leaking gutters or downpipes, defectives drains, burst plumbing and condensation due to an inadequate ventilation. Dampness may also enter a building from the ground through cracks or mortar joints in the foundation walls (A. Ghafar Ahmad et al., 1994).

2.3.11 Unstable Foundations

Foundations are the main distributing loads starts from roofs, walls and floors onto the earth below. They are structurally important to the permanence of a building and should this be lacking, it is pointless investing on superficial restoration work. Common problems associated with the foundations depend on the geology of the ground upon which a building stands structural failures as well as presence and height

of a water table. Failures may also happen in a building in which has to cope and carry any unsettled problem of the foundations. Problems of the foundation may lead to an unstable building structure, which is unsafe to users and occupants. Unstable foundations may occur because of shrinking clay soil, penetration of dampness and water that may decay walls and foundations; presence of large trees nears the building and the undertaking of excavations nearby. They may also occur due to traffic vibrations, deteriorating of building materials and the increased loads, particularly with a change in building function (A. Ghafar Ahmad et al., 1994).

2.3.12 Poor Installation of Air-conditioning Units

In olden days, most buildings were built without air-conditioning systems, where people have to content with warm temperatures. The need to install air conditioning systems to meet modern building requirements seems necessary. Subject to the building function, structures and the effects on building fabric, one should consider several factors before installing air-conditioning units in buildings. The cooler and drier air produced by the air-conditioning systems may cause shrinkage of building materials. There may also be a possibility of condensation either on the surfaces or within the structure of the fabric, eventually allowing the build-up of mould. Moreover, it may be difficult installing the air conditioners as evidenced by how units were haphazardly placed on windows or the front facade of some buildings. Such poor practices have gravely affected the appearance of these heritage buildings (A. Ghafar Ahmad et al., 1994).

2.4 FACTORS OR CAUSES OF BUILDING DEFECTS

High demand for housing construction leads to a number of construction-defect cases in recent years. This is because many general inexperience contractors are hired. The combination of these factors makes people wondering what the causes to these defects are.

2.4.1 Climate Conditions

Malaysia has heavily rainfall and warm sunshine all year round. Thus, buildings in this country tend to weather rapidly, particularly in respect to external building material which are exposed to external causes such as rain, wind, solar radiation and atmospheric pollution (A. Ghafar Ahmad et al., 1994).

2.4.2 Location Of Building

Usually, buildings that is located near the sea or rivers tend to have common building defects. This is because the water coming from the ground causes dampness penetration and structural instability. Soluble salt which comes from the sea and together with the presence of a polluted atmosphere can also cause damage to the exterior surface of the building (A. Ghafar Ahmad et al., 1994).

2.4.3 Building Type and Change of Use

Buildings or other constructed building were built to only hold certain loads and sometimes may not withstand additional loads on the existing structure. Mostly, building that have fewer problems maintained their originality such as its functions or uses appear and did not change their use. (A. Ghafar Ahmad et al., 1994).

2.4.4 Maintenance Approach To The Building

Buildings maintenance plays an important role in preventing building defects. Historic buildings or other constructed building that neglect building maintenance may leads to several defects and cause failure. It is important to regularly inspect not only the main structural elements like roof structure, beams and columns but also other common building parts (A. Ghafar Ahmad et al., 1994).

2.4.5 Building Age

Elements of buildings tend to deteriorate at a lesser or greater rate depending upon their location and function. Aging building materials, particularly timber should be checked frequently. The proper treatment of building repair and maintenance should be given full considerations (A. Ghafar Ahmad et al., 1994).

2.4.6 Support

Factors that contribute are excessive weight loadings, additional and eccentric loads, wind loads, creep and shrinkage movements of the structure, heat and moisture movement of the masonry, lack of wall ties, lack of technological knowledge and poor workmanship skills (R.Da Silva Vicente et al., 2006)

2.4.7 Humidity

Building structure, the finishing and furnishing materials can be damaged due to moisture and can increase the heat transfer through the envelope and thus the overall building energy consumption. Normally, this problem can be more severe in residential building due to the absence of air conditioning and presence of more intensive moisture sources. Moisture problems are also intensified when there is a deficient (or lack of) insulation of the envelope and when no heating is provided on a regular basis (Paulo B. Lourenco et al., 2005)

2.5 METHODS AND TECHNIQUES OF BUILDING MAINTENANCE

Identifying common building problems and understanding of building materials are part of the process of building maintaining that are damaged. Parties that should be involved in a conservation are architect, engineer, surveyor, planner or anyone who has the interest in saving our building. This will ensure that our buildings are handed to the next generation in good conditions (A. Ghafar Ahmad et al., 1994).

2.5.1 Fungal Stain or Harmful Growth

For fungal stain or mould on wall surfaces, the problem can be handled by low pressure washing. Water spray, at low pressure, is used to soften fungal stain or mould on the wall surfaces. Then, bristle brushes are applied to remove the stain. Chemical products containing caustic soda should not be used because they contain soluble salts which likely can cause serious damage to walls, particularly of stone. Instead, a chemical cleaner such as hydrofluoric acid is recommended, for it leaves no soluble salts in masonry. If there are open joints or holes in the masonry walls, it is important to avoid the water from penetrating through the structures. This is because it may cause decay in other building materials such as timber and iron fixing.

Harmful growth should be removed from the walls surfaces as quickly as possible. This is due to the fact that the roots can go deep into the existing holes causing further cracks and water penetration. Removal of harmful growth can be done by cutting the thick roots and applying an ammonium sulphamate paste on the root. This will gradually wither and kill the plants. Once the plants are drying out or shrinking, they can be removed by carefully pulling them out from the walls (A. Ghafar Ahmad et al., 1994).

2.5.2 Erosion of Mortar Joints

Erosion of mortar joints occurs once there is a presence of salt crystalization, scouring action of winds, disintegrating effects of plant growing on wall or water penetration leading to the concentrations of moisture and dampness. Where mortar has weathered out or become soft and crumbly, repointing should be undertaken which is an operation of raking out decayed mortar from the joints of masonry or brickwork to a depth of between 25mm and 40mm (or at least to twice the height of the joint); and refilling the joint with suitable mortar.

Decayed mortar can be removed forcibly by the use of a mechanical disc or carefully raked out by using a knife or spike manually. Many buildings used lime-based mortar for the bedding. In such a case, repointing should be carried out using a lime-

sand mortar in a proportion of 1:3. For the mixing of a new mortar, it is advisable to match it in mix and finish with the original mortar. In addition, sound old pointing or mortar joints should be left undisturbed (A. Ghafar Ahmad et al., 1994).

2.5.3 Peeling Paint

There are layers of paints being applied on walls, mainly of plaster. Paint can be removed by six main methods depending on the nature, condition and type. It is important to analyze the surface of damaged paints and possible side effects to other building materials before choosing any appropriate method of paint removal. Consultations with various paint manufacturers are essential and helpful. The six (6) main methods of removing paint are discussed as follows:

2.5.3.1 Water Washing

Water washing can be helpful in removing paints, particularly those which are of water-thinned. This is because adhesion in the coatings is likely to be loosened when thoroughly wetted. When appropriate, the use of warm or hot water is necessary for softening limes, whitening and soft distemper or copolymer emulsion paints before sponging, scrubbing or scrapping off the resultant form. Never use soda, soft soap or other highly alkaline soap in the washing, for it may leave harmful residues which later attack new paintwork. Instead, mild liquid detergents are more suitable (A. Ghafar Ahmad et al., 1994).

2.5.3.2 Steam Stripping

The method is a process in which steam at low pressure is applied to the paint through a hose capped with a perforated metal concentrator. The appliance used is similar to that of stripping wallpaper. It is useful for removing water-thinned paints including the emulsions because the combination of heat and moisture from the steam can soften the paint which is removed with a sponge and water. Steam stripping is more effective and can be faster over large areas compared to water washing (A. Ghafar Ahmad et al., 1994).

2.5.3.3 Chemical Paint Removers

Solvent (non caustic) and alkaline (caustic) are two main types of chemical paint removers. Both of which contain toxic ingredients which are flammable and health risk. The method should be handled by a competent and experienced person. Application of the removers should be with a brush and when appropriate, should be used in well-ventilated rooms. The solvent remover, usually based on methylene chloride, is very effective in removing only oil-based paints. The alkaline remover is not only used on the oil-based paint but other tough paints that cannot be removed by other means. Once the chemical paint removers are applied, the paint layers are softened. The use of hard brush and water is helpful in scrapping or scrubbing off the softened paint. These removers are not suitable for plywood, veneers or hardwood. They can also be harmful to brickwork, stonework and metal (A. Ghafar Ahmad et al., 1994).

2.5.3.4 Abrasive Methods

Paints can be removed by hand scrapping, sanding and mechanical methods. For the hand scrapping and sanding, a wetted medium-coarse glass paper wrapped round a wood block is used, particularly in removing a thin layer of paint. However, the mechanical method uses hand-powered tools applied with standing attachment such a disc, flap wheel or rotary stripper. It is practically suitable for flat surfaces, mainly to remove multiple layers of old paintwork. Blast cleaning by using controlled pressure of air or water is helpful in the abrasive methods (A. Ghafar Ahmad et al., 1994).

2.5.3.5 Hot Air Paint Stripper

Hot air paint stripper, an electrical tool with heat adjustable, is designed to soften and blister oil-based paints and varnishes on wood surfaces before the paints are scrapped away with a stripping knife or scraper. This method is not suitable for the removal of water-based paints or any type of paint on metal or plaster but fast and effective (A. Ghafar Ahmad et al., 1994).