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# Categorization of General Problems and Defects in Historical Building

*Generally, there are numerous defects and problems which are common to historical building parts such as roofs, walls, floor, ceilings, toilets, door and window. Ever since the building boom of the 1970s, many of Malaysia's historic building had been demolished. Current large scale urban development continues to threaten pre-war buildings, while other historic buildings are merely declining owing to the age, abandon and high cost of maintenance. The above observation is the case with current situations found in the buildings designated in this study. Basically, it is very important to recognize and diagnose the defect that occurs at various locations with deferent types of causes and symptoms. Generally all existing structures of historical buildings are from stone, brickwork, plaster and timber. The problem, weakening and failure of the building are due to old age which gives rise to defects and faulty formation that had occurred since it was erected and aggravated by subsequent sloppy repairs or total ignorance. This paper will presents some general problems and defects occurred in historical building.*

***Keywords****: building defects, historical building, building problems, common defects*

## 1. Introduction

In the broadest sense, an acceptable building is one which is where it is needed, fits properly into its surroundings, and offers sufficient space and facilities, sheltered from adverse weather and other unwanted exterior conditions. Given that this shelter cannot readily be achieved with short-lived structures, buildings naturally outlive many other modern products, and, if built so that they can be tailored to changing requirements and simply repaired, can give adequate service for a long time. Much can be learnt from the condition of

the existing building stock about what mostly causes displeasure after completion.

Defect is the non-conformity of a section or component with a standard or specific feature. Defect is used sometimes as a synonym for 'failure', but the preferred meaning is to indicate only a deviation from some standard that may, but will not necessarily, result in failure [1]

The rigorousness of a building defect and the related levels of damage, deterioration or decay currently present or expected to affect the building and its occupant are similarly related to the perceptions and expectations of the owner and occupier. The defect or action required to reduce or remove its effect on the building, will typically be ranked according to a pre – determined set of priorities for repair.

## 2. Types of Building Defects

Studies carried out on historical buildings have highlighted a number of building problems and defects that are regularly found which will be thoroughly discuss in the following section which consists of cracking, spalling, salt, peeling paint, insect or termite attack, erosion of mortar joints, wood defects and dampness.

### a. Cracking

The cracks vary in width from fine hairline cracks to as much as 25 mm wide. Solid ground floors and foundations may also show cracks and walls may be out of plumb. The cracks sometimes appear suddenly, accompanied by some noise. They can appear long after the building was put up. There may be some outward movement of the walls. Apart from distributing from roofs and floor to foundations, external walls may be harmful to a building if they are structurally unsound. Cracks in wall, either vertical or diagonal, are common symptoms of structural instability [2]. The cracking is classified according to the causes. Among those are:

#### i. Shrinkage cracks

Concrete will shrink at first one hour it was mixed. This shrinkage process can occur interminably in a span of one month. There are two types of shrinkage cracks namely Drying Shrinkage Cracks and Plastic Shrinkage Cracks. Drying Shrinkage Cracks starts when the concrete mix started to lose the moisture and may continue for months. Usually this drying process causes fine line but this crack is not harmful to the structure. The size of this crack is less than 0.08 mm [3]. This cracking also not deep but occurs at the surface only. Plastic Shrinkage Cracks on the other hand is usually deep and its size is quite

big that sometime it can occur throughout the structure thickness. Concrete easily cracks during the shrinkage because of the load applied on them. This type of cracking can occur as early as after the concrete structure was build and sometimes it takes several months to form (Figure 1).

**Figure 1.** Shrinkage cracks appear on wall

**ii. Durability cracks**

This cracking occurs because the concrete expands and shrinks due to extreme and rapid exchange of the weather from cold to hot which makes the concrete expand and shrink rapidly. This situation weakens the structure of the concrete thereby triggering the crack. Besides that, it is also caused by the rusted internal steel reinforcement and the sulphate agent.

**iii. Cracks caused by structural distress**

The cracks at the structural component usually occur at the maximum point of the loading that the component supports. The over loaded of torque will cause cracking that are parallel to each other. The torque cracking and the shear cracking will form angled line. Furthermore the differences between these two cracking are the torque cracking align to the same direction with the component surface, while the shear cracking align opposite to the component's surface.

**iv. Cracks caused by settlement**

If the settlement happens at the same level, the defects if any are not to large extent but if the settlement is not at same level, half of the foundations

will stabilize while another half may cause fundamental concrete to crack or damage and the same effect goes to the upper building structure. The cracking defects of the building can further be divided into two types that is the first is small cracking and secondly is the active huge cracking [4]. Figure 2 shows a significant settlement crack.

**Figure 2.** A significant settlement crack

*- Small cracking*

This cracking must always be observed to determine whether or not it is active. The observation can be done by placing measuring equipment across the crack and record the reading from time to time. Cracking caused by the early settlement after construction is not active. If the cracking becomes active (that is becoming huge), further investigation must be conducted to determine its causes and appropriate repair. This type of cracking has the width of less than 1.5 mm.

*- Active huge cracking*

The huge and active cracking indicates that big movement happened. Likewise the contributing factors must first be determined before any remedial action is employed.

**b. Spalling**

According to Philip H. Perkins [2] Spalling occurs subsequent to cracking. When cracking goes unchecked, it will become huge and the concrete on which account, becomes spalled (Figure 3). Spalling can occur due to the following:

i. Rusted steel reinforcement

ii. When the steel reinforcement in the component structure is rusting, it will crack along that reinforcement. When this cracking continues, the concrete spalling follows suit.
iii. Extreme weather exchange
iv. Weather is the main factor to concrete spalling. This is because when the weather is hot, concrete expands and when the weather is cold, concrete shrinks. The extreme weather exchange causes the concrete to expand and shrink rapidly and eventually causing the concrete to spall if left unchecked.
v. Chemical reaction
vi. The concrete building that is exposed to the chemical agent/material is more easily to decay. This is because most chemical matters have high erosion factor. The slow erosion will contribute to the concrete spalling if not remedied.
vii. The inferior quality of concrete
viii. The quality of the concrete would be compromised if the ratio of the concrete mixture does not comply with the standards. The strengths of the concrete will become weak if the component of the structure is damaged.
ix. Unsuitable reinforcement or over loaded
x. Concrete is weak at the tension load. The use of the steel reinforcement can support the load but the use of unsuitable steel reinforcement can make concrete crack and spall. It is because if the reinforcement cannot support the tension load resulting in the concrete structure cracking and spalling.

**Figure 3.** Concrete spall exposing the rebar

**c. Salt Attack**

Various types of soluble salts are known to cause damage to building masonry, including sodium chloride, carbonates, nitrates and sulphates of calcium, magnesium, potassium, sodium sulphate and magnesium chloride. Acording to A. Ghafar Ahmad and Haris Fadzilah Abdul Rahman [5] there are two types of salt attack that will depend on which building area the salt penetrates (Figure 4). When salt penetrates the surface and white powder is formed, this phenomenon is known as efflorescence and is harmless to the masonry (apart from creating an unsightly visual appearance).

Salt may also attack by penetrating from below the surface; this is a more serious condition as the salt will become crystallized, a phenomenon known as sub-florescence. Pressure from the growth of the crystallization process will cause building materials to crumble, resulting in serious damage to the buildings. Salt-induced weathering is due to three factors, namely geographical location, type of sandstone (building materials) and cleaning regime (maintenance of the building).

Environmental factors also contribute to accelerating process of decay [6]. Salt weathering occurs most often during the hot season (the summer months of November to April in the southern hemisphere) due to lower relative humidity and stronger sunlight. Large temperature changes and increasing rates of evaporation trigger more upward water movement in the building walls, resulting in the process of salt crystallization [3].

Ground water contains chlorides and nitrates, which are hygroscopic. Both soluble salts can cause visual signs of dampness and decorative spoiling on the wall when present in large amounts

**Figure 4.** Salt attach to brickwork

**d. Peeling Paint**

Peeling paint (Figure 5) usually occurs on building facades, mainly on plastered walls, columns and other areas which are exposed to excessive rain and dampness. Some building located near the sea may face a much greater risk once the signs of peeling paints are visible on the exterior walls [1].

**Figure 5.** Peeling paint from wall surface

**e. Insect or Termite Infestation**

Timber can deteriorate easily if left exposed to water penetration or high moisture content and loading beyond its capacity. Insect or termite infestation poses a threat to damp and digestible timber found in wall plates, the feet of rafters, bearing ends of beam and trusses, as well as in the timbers which are placed against or built into damp walling (Figure 6). It is unwise to ignore timber that is lined with insect or termite holes because it may soften the timber and form further cracks [7].

**Figure 6.** Extensive termite damage

**f. Wooden Defect**

The main factor of the wooden structure defects is dampness. Moisture from the ground can diffuse up through the floor due to failure of damp proofing. Moisture can also diffuse through roof and wall from leakage. Apart from that, the dampness or moisture is naturally produced from evaporation resulting from living activities in the building. This situation will be aggravated by lack of ventilation.

The damage to the wooden structures is more evident at the dampest most part. The environmental effects such as rain, sun radiation and wind blow are the catalysts. Another factor of the decays is because of fungal invasion, wear and tear and effect of the weather [4].

The faulty formation and the defects of the building occur because of the many factors such as:

- The inappropriate use of components or materials.
- The use of a material adjacent to or in combination with another that adversely affects it.
- Lack of knowledge by the designer regarding the potential deterioration of materials/building components.
- The building being subject to forces or agents not considered in the design.
- Inaccurate information from manufacturers.
- Poor manufacturing quality.
- Poor workmanship coupled with lack of adequate supervision during the construction period.
- The failure to carry out necessary routine maintenance at the appropriate time.

### g. Dampness

Dampness can be a serious matter, particularly to building located near water sources [8]. The main cause of dampness is water entering building through different routes. Water penetration occurs commonly through walls exposed to prevailing wet wind or rain.

For this situation 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. Dampness also occurs in walls due to other factors such as leaking gutters or down pipes, defective drains, burst plumbing and condensation due to inadequate ventilation. Figure 7 shows the dampness problem occured on interior walll surface.

**Figure 7.** Dampness problem on interior wall surface

## 3. Conclusion

This paper has discussed thoroughly some general problems and defects occurred in historical building cracking, spalling, salt, peeling paint, insect or termite attack, erosion of mortar joints, wood defects and dampness. It is vital to recognize and diagnose the defect that occurs at various locations with deferent types of causes and symptoms. In general all existing structures of historical buildings are from stone, brickwork, plaster and timber. The problem, weakening and failure of the building are due to old age which gives rise to defects and faulty formation that had occurred since it was erected and aggravated by subsequent sloppy repairs or total neglect.

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