

Factor effecting typical interior defects (water based) found in Malaysian buildings. With real selected case samples

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ABSTRACT

Building's interior defects affect society at large due to possible danger posed; they also result in direct and indirect cost in repairs, abnormally high maintenance, disputes and possible loss of building use. Internal related defects are generally caused by inadequacies in design, poor workmanship, building usage not in accordance with design and lack of or incorrect maintenance. Dampness and cracks are common manifestations of defects. Interior dampness can however often lead to cracks; making it difficult to determine root cause and appropriate repair. Not all manifestations may be considered defects and not all defects are serious to the extent that it will affect building stability and occupant safety. Materials are often blamed for defects when the cause lies in the choice of unsuitable materials and/or when their limitations are recognized and taken into account in interior design and design detailing. A new Dutch standard NEN 2767, believed to be a world-first in Building Condition Assessment attempts to provide insight and uniformity in defect assessment and classification, translating the diagnosis in condition scores. The standard is expected to contribute towards improving communications for all involved including litigations relating to defects. This paper will give examples typically found during the building maintenance exercise. Also, the report focuses into the problem of the interior side of building defects which are having great impact to its occupant compare to the external one.

Key words : Interior defects, building defects, building maintenance, internal details, building survey

1. INTRODUCTION

What is building defects in relation to the interior? Recent research has been carried out on the definition of defect mentioned that as surveyors, some had always thought that they knew what an interior defect was. A defect may be considered to be failing or shortcoming in the function, performance, statutory or user requirement of a building and might manifest itself within the structure, fabric, services or other facilities of the affected building [1]. A comment as given by the Norwegian Building Research Institute stated

that defect is "unexpected expenditure incurred by the client following taking possession of a property" [2]. Defect is as the non-fulfillment of intended usage requirements.

Quality on the other hand is defined as the totality of features and characteristics of which a product or service that beat on its ability to satisfy stated or implied needs. Therefore, based on these definitions, defect and quality are inversely related (ISO8402)[4]. In principle, the words damage, defect, deficiency, mistake or failure mean the same, i.e. some sort of deviation from a given reference level. However, these words have negative connotations in the ordinary language use. Therefore, in recent terminology the concept quality deficiency is used as a collective term.

In structural perspective, there are two types of building defect which are structural defect and non-structural defect [3]. Structural defect define as serious or critical defects that effects to the building structure for examples settlement, cracks and bowing. While, non-structural defect is a non-serious/minor defect for instance detached, biological dampness and wear and tear [5]. Any decayed fabric should be analyzed prior to carry out the work repair and replacement. These will include an analysis of causes of defects, condition and nature of existing building materials and survey structural defects. The main purpose to carry such analysis is to make good and avoid any repetition of building problems to repeat previous design errors.

More related to this topic, a surveyor may be specifically instructed to carry out an investigation so that the causes of the internal defect can be identified and remedies allocated. Building interior related defects can be divided into five (5) major categories, which are dampness, cracks, detach, wear and tear and biological category.

2. RESEARCH ANALYSIS: CATEGORY 1-DAMPNESS

Dampness is inextricably linked to most building interior deterioration [6]. Water contributes to the oxidation of metal leading to the corrosion of steel reinforcement in concrete, in turn leading to the creation of circumstances where the propagation of fungal decay and of beetle infestation can affect timber. Water also facilitates chemical changes in the components of a building as well as being a source of damage where it penetrates into a building. Dampness in the building interior relates to the moisture content, which exists in any

element or construction material [10]. The percentage moisture content is the amount of water in material dividing by the weight of material resulting from $[(\text{wet weight} - \text{dry weight}) / \text{wet weight}] \times 100$. This means that a heavy material would have lower moisture content than a light material if they were both to contain the same amount of water.



Figure 1: Interior dampness rectification work been treated for this museum interior been treated by maintenance crew



Figure 2: The dampness effects clearly be seen at this beam due to minor leakage from the above wet area

Our analysis based on the maintenance projects done recently found out that the interior dampness contribute quite significant factor to interior defects problem. Fig. 1 shows the reparative work being done due to the museum feature wall reacting due to water leakage dampness. The solution for this defect is to apply cementitious water proofing repellent product from high quality product. As shown in Fig. 2, the typical dampness effect began to get worse due to leakage from wet area located above. For Fig. 3 the dampness of even double volume space (with expansive decorative lighting feature) allow minor leakage to the ceiling looks ugly and require immediate treatment. It may getting worse if the dampness effecting the electrol circuit of the internal space. You can notice the stain marked at the ceiling tile developed through time with the help of dampness.



Figure 3: Defect found with stained ceiling tile at this double height space with elaborate lighting invites problem



Figure 4: Dampness being created from the expired sealant of the skylight and can be tracked from the stained wall of this interior of an office building

Furthermore, huge skylight space may also give a dampness problem due to uncontrollable amount of light penetrating in. It is worsen with the small leakage of water seeping through the expired sealant between the polycarbonate skylight materials as shown in Fig. 4. Defect example as shown in Fig. 5 however shows the early rectification works found due to water leak making the dampness of the ceiling tiles. Brown spots clearly be seen from this office interior due to the reaction of internal ceiling dampness. For Fig. 6 the dampness reaction of the plaster ceiling clearly be seen at the aluminum curtain railing require attention before getting worse. The worse scenario of the internal dampness due to the water leakage can be seen in Fig. 7 affecting the wall, the freestanding cabinet wardrobe as well as for the parquet timber flooring.



Figure 5: Workers checking the dampness space between the ceiling interior and the underneath concrete slab

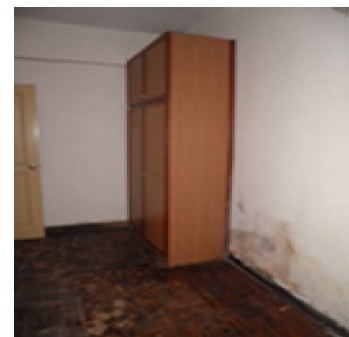


Figure 6: The dampness creating worse scenario of this bedroom with stained wall affecting the wardrobe and floor parquet timber material

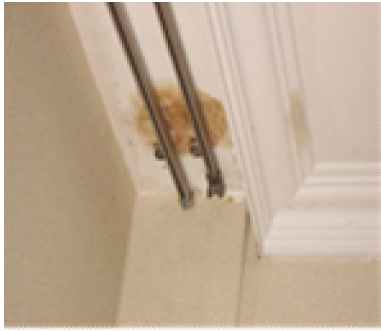


Figure 7: The chalking content of the plaster ceiling speeding-up the dampness effect at this curtain railing spots of this luxury hotel room. It is known that water seepage through plaster ceiling easily can create unwanted holes and the damage outlook

3. CATEGORY 2 -CRACKS

All buildings are subjected, both during construction and throughout their lifetime to continual slight movement. This may be due to expansion and contraction as the temperature change or materials dry out or decay. Superimposed loads such as furniture or moving occupants and wind may also have this effect. Because of many building materials may anticipated movement, some cracking may be inevitable. Sometimes, cracks either on wall or roof top caused by many factors including settlement, water pressure and microorganism growth as well as factors mentioned above. All cracks including the interior cracks should be critically examined so that the cause can be identified and dealt with before any attempt is made to make the damage good [9]. The correct diagnosis may require careful observation over a period of time, during which time remedies can be considered for this damage or defect. The width of cracks can most easily measured either by the use of a card on the edge of which different widths of cracks are drawn out accurately or by using calipers. Without some help, there is tendency to overestimate the width of cracks. There are now several different types of caliper available and the most accurate uses electronics to provide a digital reading.

As shown in Fig. 8, the cracking evidence seems allowing water to seeping through from the above concrete slab hence having large pool of water accumulation. This water ponding effect letting the water penetration to the public interior of this important public space as shown in Fig. 9 and Fig.10. Next, Fig. 11 clearly shows the huge crack cutting



Figure 8: A rare view of the internal part of an enclosed space having the water ponding effect letting seepage to the public interior space below



Figure 9: The photograph shows plastic pail has to be located at the spots where the water leakage, this one next to walkalator linking parking to terminal building

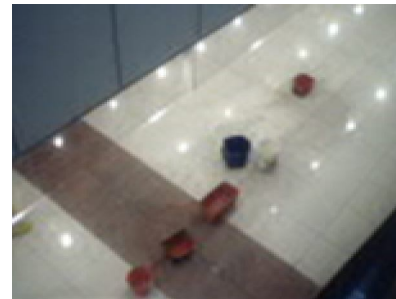


Figure 10: The photograph shows numbers of plastic pails have to be located at the spots where the water leakage happened due to the cracks allowing water seepage at this important public area

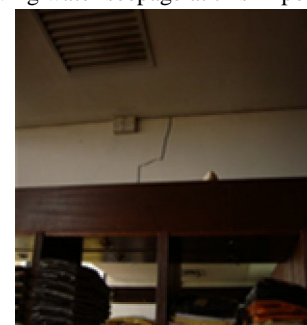


Figure 11: Crack appears at the beam possible due to building movement and requires immediate attention.

through the concrete beam at this room interior. Typical restoration can be done by hacking the crack to its weak point and doing the structural repair. For this case, the water from the wet area above is seeping through the concrete beam and the reaction of water-steel cause the rusty effect. The rust then began the concrete start cracking and weakens the beam structure as shown in Fig. 12, 13 and 14; these area the typical leakage scenario when the water proofing layers run out of order and permit the water seepage through its cracks or weak points. The figures shows the brown patches marks showing the water leak and getting worse when the stalactites began to forms as seen in Fig. 14. The internal defect on Fig. 17 showing the typical crack problem with water leakage image at the concrete slab. The problem normally been tackled by treating the mess with polyurethane (p.u.) sealant to seal out

the cracks as shown in Fig. 15 and Fig. 16. Normally the procedure is using high pressure grouting machine to get the best result.



Figure 12: Typical problem due to the under slab concrete leakage with clear stained marked on it possible due to building movement.



Figure 13: Another spot with typical problem due to the under slab concrete leakage with clear stained marked on it possible due to building movement.

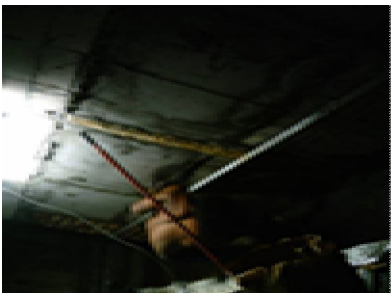


Figure 14: Under slab concrete leakage with clear stained marked on it possible due to building movement. It also shows stalactites beginning to form and create problem to the interior users

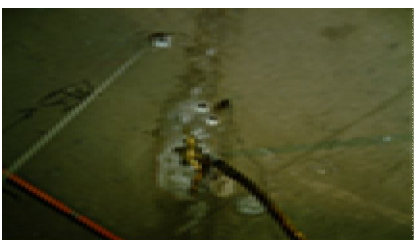


Figure 15: The photograph shows the worker using the packer to inject the p.u. grout into the crack



Figure16: This one shows the worker using the packer to inject the p.u. grout into the crack. This tedious rectification works must be handled with professional building pathology agent



Figure 17: (right) show a typical stained appears once you removed the stained ceiling tile.

4. CATEGORY 3 - DETACH

Detach means that each element of building had been split from the head or major building. These defects normally happen to wall finishes and floor finishes. Sometimes it caused by weather or vandalism. When the material is fully exposed to weather, especially on external envelop, the probability of detachment is higher [7]. In other word, the elements become detach or hang up or displace from the original position and may be still in its position but not stick or attached to the building or internal element of the building. For example, most of the internal materials facing this problem are tiles, marbles and mosaics.

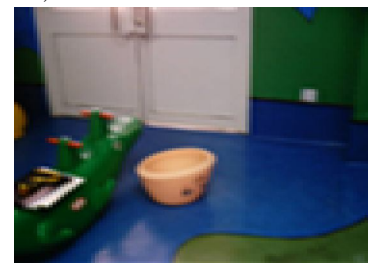


Figure 18: Notice the linoleum flooring found at this hospital's children playground detaching itself due to water seepage



Figure 19: Closure look on the linoleum flooring found at this hospital's children playground detaching itself due to water seepage



Figure 20: Structural repair required for this concrete spalling task due to detachment defects found at this internal part of the room

Fig. 17 and Fig. 18 show the linoleum flooring material detaching itself from the concrete floor due to the water seepage from the existing door. Rectification work has to be done by elevate the concrete slab outside the door preventing rain water penetrate through this hospital internal playground of the Children Ward. Normally, it is suggested to use non-shrink cement to get better result in doing this spalling concrete task (refer Fig. 20 photograph). Fig. 20 shows part of the concrete slab beginning to be separated from the concrete beam due to the b.r.c. steel reinforcement material reacting with seeping water. Hence, the spalling concrete treatment needs to be done immediately to prevent worse event.



Figure 21: This concrete beam running through-out the toilet showing its detachment process in the making due to water leakage from the top wet area.

For Fig. 21, the process of detachment is in the making due to the water seepage running through the whole length of the beam. Through time, the beam can become weak and require fast treatment. The concrete repair exercise must be done by treating the rusty internal concrete b.r.c steel and patches of high strength concrete to be done to cover the beam with correct form work. Fig. 22, Fig. 23 and Fig. 24 show how water has done a job as detachment agent by separating the carpet material from the concrete base. The photographs also show how the timber material i.e. the timber skirting as well as the timber door become ready to undetached from its main component due to the water penetration.



Figure 22: Having carpet material easily over run the glue and making the detachment process easily been done from the concrete floor slab of this office space

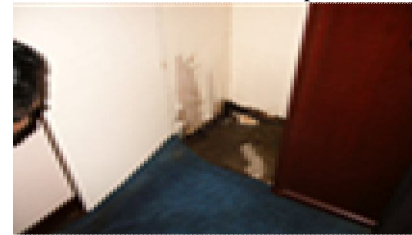


Figure 23: This case happened at the corner spot inside this hotel suite



Figure 24: The detachment is found inside the prayer space of an office

5. CATEGORY 4 – WEAR AND TEAR

The defects in this group can be found in materials, component or in the building interior elements where these things will fade, diffuse, peel off, deteriorate, blocked and others. Normally the areas affected are:

- At certain parts of building interior which are exposed to adverse weather (internal courtyard, window sealant or sky light space)
- Access area (i.e. along the internal circulation area, entrance internal space etc.)
- Public area (public waiting area or public toilet)

For example, the internal-external wall with windows, door, handrail, steps and floor surface. Wear and tear also occurs on paint finishes. External paint is fully exposed to weather and if the paint used is not weather proof, then the color easily fade. Somehow this effect also can be found for the internal part of the building with much adverse effect as well.

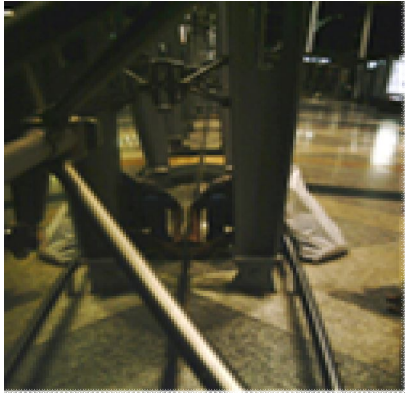


Figure 25: Maintenance crew replacing expired sealant using high quality GE brand building sealant between the marble floor and glass wall. It is found out that the same brand of sealant used for NASA space shuttle as specify on the product brochure

Fig. 25 showing where it is required to change the sealant located between the glass wall material and the marble floor slab. The internal space of this public building is air-conditioning 24 hours in relation to the rain-shine weather on the outside. No replacement of expired joints may result in cracking effect of the glass or marble materials. The non-functional sealant also may let the air-conditioned space may not work efficiently and require more energy to cool-off.

Both Fig. 26 and Fig. 27 giving example of the harsh usage of the entrance space of the buildings. The floor material



Figure 26: The wear and tear of the floor material pays its toll due to the heavy vehicle load as well due to frequent traffic usage at airport hangar building

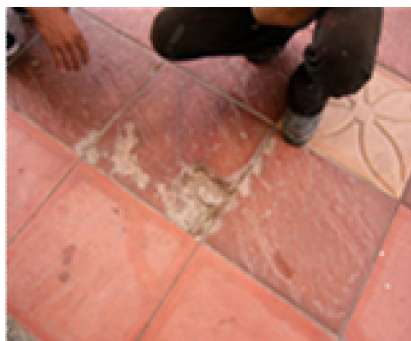


Figure 27: The wear and tear of the floor material pays its toll due to the heavy vehicle load as well due to frequent traffic usage found at drop-off part of the building



Figure 28: Wear and tear usage for disable toilet folding door inside the male handicapped toilet



Figure 29: Wear and tear usage for the expired window sealant found at an office building



Figure 30: The maintenance crew squeezing himself in making rectification work repairing the hole using the fiber mat and antirust paint for this internal part of the metal roof material.

began to have cracks and holes and require rectification work due heavy vehicle loading occurring regularly to the surfaces.

For the defects shown in Fig. 28 and Fig. 29; the disable toilet cannot stand the wearing and tearing of the handicapped users during many events created by the building owners. For Fig. 29; the non-functional sealant in relation to harsh tropical climate letting rain water to seep through the interior form the bare window. With the hot and humid tropical weather, Fig. 30 show how the internal part of this academic building permit holes at its metal roof material and begin flooding the interior working area with high value machines inside. The building manager no needs to wait until

the rusty effect appears on top or below the metal roof material before make does the maintenance work for the affected area.



Figure 31: The wearing and tearing of this linoleum let the peeling-off and unwanted bubbles appear and started to look ugly



Figure 32: Wear and tear of the timber skirting and parquet floor with the help of the humidity of the internal space creating this mess



Figure 33: Wear and tear of the timber skirting and parquet floor with the help of the humidity of the internal space creating this mess



Figure 34: Rectification work is being done to replace the peel-off ceramic wall tile due to harsh usage and sink leakage of this toilet area. Water proofing material need to be done on the effected wall as well as sink plumbing's pipe connection must be done correctly.

Next, for this green floor material, the peeling-off effect and bubbles appear due to the high traffic usage of the floor need to be replaced. This linoleum floor material found as earth-friendly internal material used for this hospital building (Fig. 31). The next photographs show how weather including unwanted water may helping the detachment exercise of the timber material been peeled-off from its intended place. For this case, the wear and tear of the timber skirting and the timber parquet floor need rectification to get back its purpose (see Fig. 32 and Fig. 33). The last wear and tear defect can be found in this Fig. 34 showing the peeling-off of these toilet's wall ceramic tiles. It is found that the improper usage of the sink letting the water to defecting the wall underneath the sinks.

6. CATEGORY 5 – BIOLOGICAL

The internal defects in this category are caused either by insects, termites, molds, lichens and other growths; dry rot, wet rot, climatic factor and pollution. Insects such as beetles, like to infest in timber because the organic nature of the materials is favorable to the grub's life cycle of hatching, growing and emerging. The effect is to reduce the cross sectional area of the timber and this will reduce its strength. Eggs are laid in cracks and crevices in the timber, hatching out as larvae or grub which tunnel through the timber for the whole of their growth period; the larvae develop into pupae and then into beetles which emerge through flight holes to fly off and perpetuate the cycle.

Termites are commonly erroneously called white ant. There are about 2,500 species and found mainly in the tropical area. There were broadly classified as dry wood termites and subterranean termites. Although molds, lichens and other growths are seldom destructive, nevertheless they tend to disfigure and stain the brickwork. In addition, climbing plants and creepers can cause damage to wall as their root penetrate into cracks and crevices of mortar joints.

The fungus producing dry rot is known as *sepula lacrymans* and the ideal internal condition for the growth is in moisture content of 30%-40% and the temperature of 23°C. Partially seasoned wood fixed in a warm, damp and poorly ventilated internal condition is therefore susceptible to dry rot attack. Wet rot occurs in timber, which is extremely wet, whether located inside or outside of the building. The cellar fungus, *coniophora puteana* is perhaps the most widely encountered wet rot fungus. It appears on timber as a very dark brown, vein like pattern and destroys the cell structure of the timber by consuming only the cellulose.



Figure 35: Possible fungus formation seen at this ceiling tile may hazard the occupant of this space and also can become an ideal breeding space for termites to make a colony.



Figure 36: The possible fungus colony here at the mosaic wall is created from the water seepage from the edge of the floor and concrete wall as found at this academic building.

Fungus appearance as shown in this Fig. 35 is starting with minor leakage and clearly be seen within this office space. The circle stained spot grow from small to big through time if no treatment done.

This mosaic wall tiles as in Fig. 36 letting rain water stained appear direct from the concrete under slab and beginning to create permanent fungus effect. Both photographs show the fungus building on top of the underneath interior concrete slab and getting worse thus require immediate rectification works. Normally, it is suggested to use the grouting technique for short term solution (see Fig. 37 and Fig. 38).



Figure 37: The formation of hazard like condition may let fungus to grow even on top of the paint layers of these concrete floor slabs. The interior become unhealthy due to tiny particle trapped inside the room



Figure 38: The formation of hazard like condition may let fungus to grow even on top of the paint layers of these concrete floor slabs. The interior become unhealthy due to tiny particle trapped inside the room



Figure 39: These are another example of the hazardous fungus effects particles found within the interior space of this leakage concrete. This defect found within the internal part of the parking basement area and getting worse affecting the parked cars



Figure 40: These are another example of the hazardous fungus effects particles found within the interior space of this leakage concrete. This defect found within the internal part of the parking basement area and getting worse affecting the parked cars.

The photographs (Fig. 39 and Fig. 40) show much adverse effect of the internal defect leakage as these interior space began to look like Venus surface with white or brown fungus. The internal defects require water proofing treatment as the maintenance crew applying cementitious water proofing cement by rendering the material to ensure no fungus can regrow on the surface (see Fig. 41 and Fig. 42). These building ‘doctor’ ensuring proper treatment has been done to the affected area.



Figure 41: Anti-fungus coating is being applied for this rectification work of an interior space. The task requires expert personnel to ensure the space back to its original condition and in reusable state



Figure 42: Anti-fungus coating is being applied for this rectification work of an interior space. The task requires expert personnel to ensure the space back to its original condition and in reusable state

7. INITIAL SUMMARY

The process of weathering by tropical sun, wind and monsoon rain is defined as the breakdown and alteration of material by mechanical and chemical processes such as even the humid subtle temperature changes [8]. This will include the pollution which may produce acid rain if the air is polluted with toxic gas and also if the air is polluted, it will give effect to the exterior and interior of the building when the air bring along tiny dust and other small particle alongside annually smelly haze problem.

The summary graph as shown in Fig. 43 tells that all the identified internal defects are caused by the only one main treat which is water. The five categories from the graph are derive from the 5 main internal defects which are dampness, cracks, detach, wear & tear and biological (from top to bottom). Most point getting 5 marks showing the most defect

impact from the related category and the lowest get 1. With the condition of haze is getting worse during the time of the article been written, it is an important to us to have an ideal internal detail design with very minimum defects as we may have to spend more time inside of a building than be on the outside.

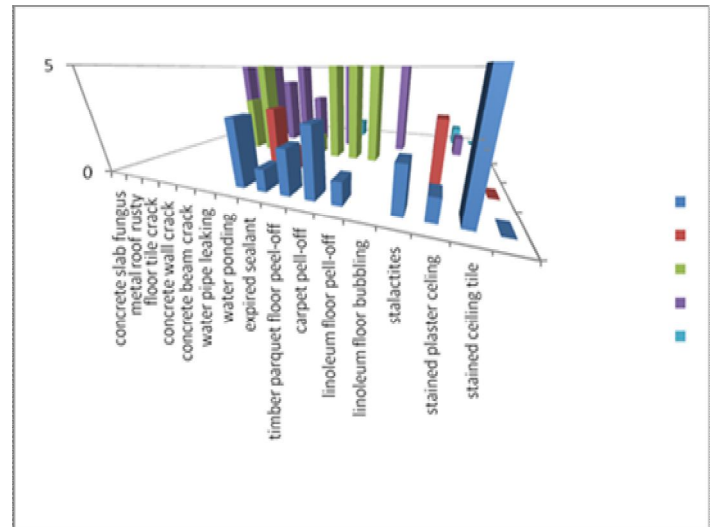


Figure 43: Summary graphs showing the factors of internal defects awarded point quick survey analysis

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