ISSN 2347 - 3983
Volume 3, No.7, July 2015
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/ijeter/static/pdf/file/ijeter01372015.pdf

Practical building defect solutions; construction failures to be avoided- Real case studies selected from Malaysian buildings

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ABSTRACT

Building 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. Defects are generally caused by inadequacies in design, poor workmanship, building usage not in accordance with design and lack of or incorrect maintenance. Normally, dampness and cracks are common manifestations of defects affecting the exterior and the interior space. 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 design and design detailing. The paper however focusing more into the typical defects found within the construction industry in Malaysia with the highlight stressing more into the best potential technical solution to solve its problem as well as in economic term.

Key words: building defects, construction failures, building leakage, Malaysia.

1. INTRODUCTION

What is building defects? From the some recent research which has been carried out on the definition of building defect; as surveyors, some had always thought that they knew what are defects was but actually they are not! Anyway, 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"[3]. Defect is as the non- fulfillment of intended usage requirements. Therefore, based on these definitions, defect is inversely related to the construction industry. (ISO8402)[2]. 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.

This paper will focus on how the building failures occurred and how the defects can be avoided. It also stated on the practical solutions with technical detail to overcome the problem after the economic concern to use the most practical building construction materials.

1.1 Building Failure Cases Analysis I

A. Concrete Surface Damage/Spalling

Why did it fail? Corrosion growth leads to concrete damage (see Fig. 1). How it could have been avoided. Corrosion of reinforcing steel can be prevent by applying a surface coating or sealer that is intended to create a barrier to the incoming contaminated water during the construction. Solutions:

a. Electrochemical Technique such as cathode protection and chloride removal. Cathode protection is essentially the polarization of a metal to reduce the corrosion rate. An electrode is connected electrically with the reinforcement. This electrode becomes the anode, forcing the steel to become the cathode; halting the corrosion process.

b. Patch repairs consist of the following activities that are briefly described below:-

i. Removal of cracked and delaminated concrete to fully expose the corroded reinforcement.

ii. Cleaning of corroded reinforcement and the application of a protective coating to the steel surface (e.g. Anti-corrosion epoxy coating or zinc rich primer coat).

Figure 1: Concrete surface damage

iii. Application of repair mortar or micro-concrete to replace the damaged concrete

iv. Possible coating or sealant applied to the entire

concrete surface reduce moisture levels in the concrete

B. Honeycombing – voids in concrete caused by the mortar not filling the spaces between the coarse aggregate particles

Why did it fail?

a. Rebar Congestion

Rebar is placed too close together or too close to formwork it will trap the larger pieces of aggregate while the mortar in the mixture may or may not pass through.

b. Mix Design

A good mix design should take in consideration the issues noted for rebar congestion and lift depth.

d. Lift Depth

When single concrete placements or "lifts" are too deep, proper vibration can become very difficult or impossible. Also allow too much free-fall of the concrete that can create a separation of the cement mortar and aggregate.

e. Inadequate Vibration

When the concrete is properly vibrated it acts more like a liquid allowing it to better settle in the form, consolidate around the reinforcement and completely fill the forms (see Fig.2)

f. Form Leaks

Leaks in the formwork can allow the cement paste to escape out of the form leaving behind only un-bonded aggregate and rock pockets.

How it could have been avoided:

a. Ensure the mix has sufficient fines to fill the voids between the coarse aggregate.

b. Use a mix with appropriate workability for the situation in which it is to be placed.

c. Ensure the concrete is fully compacted and the placing methods minimize the risk of segregation.

d. Ensure the reinforcement layout and the section shape will permit the concrete to flow around the reinforcement and completely fill the forms.

e. Check that the formwork is rigid and well braced, the joints are watertight and any penetrations through the formwork e.g. form ties, are properly sealed

Figure 2: Honeycombing defect problem

Solutions:

a. If the honeycombed area is small in extent and depth does not significantly jeopardize the quality of the cover concrete protecting the reinforcement then, it can be repaired by patching with mortar of a similar color to the base concrete.

b. The extent and depth of the honeycombed area first needs to be defined. This can be done by chiseling out the affected area to expose sound concrete or by using non-destructive testing techniques such as impact-echo.

B. Corrosion on External Metal Trunking

Why did it fail? It caused by changing environment and ingress of chloride ions and carbon dioxide to the steel surface (see Fig. 3). How it could have been avoided: while the coatings on steel conduit provide excellent corrosion protection, supplementary corrosion protection may be necessary in very corrosive environments. Types of supplementary corrosion protection include paints; tape wraps, or shrinks wraps. A bitumastic coating, zinc-rich paints or acrylic, urethane or weather stable epoxy-based resins are frequently used. Surface preparation is important for proper adherence. The tube should be washed, rinsed and dried. It should not be abraded, scratched or blasted since these processes could compromise the protective zinc layer. A compatible paint primer or two coats of paint adds protection. Solutions - Rust contamination can be removed by adding one part of nitric acid to nine parts of warm water. Leave for 30 to 60 minutes, and then wash off with plenty of fresh water. Then apply applying zinc over steel to protect iron and steel from rusting.

Figure 3: Corrosion on external metal trunking

C. Grouting of Tiles - the grout around the tiles is damaged

Why did it fail? It caused by poor workmanship in the application of grout (see Fig.4). How it could have been avoided:

a. Make sure to apply sealer on water-based grouts. The epoxy based grouts do not need to be sealed.

b. Use a waterproof grout for extra durability.

c. Never add water to make grout spread easily as this weakens the grouting.

d. Always clean the area thoroughly before applying the grout sealer.

e. Avoid sealing immediately after grouting and after sealing, let the sealer dry completely before starting to use that part of the house.

Solutions:

a. Install new grout.

b. Vacuum the grout lines, then scrape any protruding grout and vacuum again.

c. Mix the grout with a margin trowel until all the powder is dissolved.

d. Load the grout float.

e. Load the joints.

f. Clean off excess grout.

g. Sponge the surface.

h. Tool the grout lines.

i. Towel off the haze.

j. Caulk all inside corners.

k. Make sure that the tiles have sufficiently bonded to the thin set and the tiles will not move while grouting around it.

Figure 4: Tiles grouting improper

C. Uneven Tiles Lining

Why did it fail? The defect is due to human errors. The workers do not plan and estimate the tiles location properly during the lining of the tiles (see Fig.5). The tiles alignment between the wall and floor is not in a straight line. The alignment of the wall's tiles should be in a straight line with the floor's tiles.

How it could have been avoided - Plan and estimate properly the location of the tiles in order to make the alignment between the wall and floor is in an even lining. Solutions - Demolished the tiles and re-locate.

Figure 5: Uneven tile lining

D. Gap Between Floor Tiles & Columns (Fig.6)

Why did it fail? It caused by poor workmanship. How it could have been avoided- simply by installing a baseboard. Solutions - Improve workmanship's skill.

Figure 6: Gaps between floor base and column

E. False Ceiling - gap between ceiling and wall

Why did it fail? Poor workmanship, do not measure the size of ceiling accurately. How it could have been avoided -Measure the size of ceiling accurately. Solutions: Install crown molding.

Figure 7: Gap between wall and ceiling

F. Defective Plastered Rendering

Why did it fail? The plastered renderings are deteriorated and look unevenly (see Fig. 8) due to:

a. Poor workmanship.

b. Shrinkage or movement in the substrate.

How it could have been avoided:

a. Surfaces must be cleaned from dust, loose particles and grease, which may isolate the plastering coat to be stacked onto the surfaces.

b. Smooth concrete surface and walls must be roughened by firstly applying a *tartasha* coat or applying a bonding liquid.

c. In hot weather, wet the surfaces by cleaned water before application.

d. Leave surface flat and slightly roughened, to be ready for application of rendering material.

Solutions - Reapply the plastered rendering uniformly.

Figure 8: Defective plastered rendering

2 TYPICAL CONSTRUCTION FAILURES

2.1 Building Failures Analysis II

A. Leakage Flat Concrete Roof Slab

Why did it fail? Flat concrete roof leaking found at joints, steel staircase support and various concrete cracks (see Fig. 9). How it could have been avoided. To rectify this roof leakage from happening:

1. To do proper waterproofing rectification treatment to all the cracked leakage area. Typical effective procedure is to do the following steps (see photos on the right-Fig. 9):

2. Hacking the concrete floor.

3. Applying waterproofing cement with fiber.

4. Cement render until floor finish.

5. Applying waterproofing cementitious liquid on finish concrete (see Fig. 10).

Figure 9: Leaking on the surface of the concrete flat roof

Figure 10: Rectification done by applying cementitious epoxy coatings

B. Exterior Marble Floor Replacement

Why did it fail? Imported floor marble used at the front entrance cracked (Fig.11). How it could have been avoided- Require proper entrance cover to avoid rain water and direct sun heat; possible to get the marble cracked. To rectify this marble cracked from happening:

1. Having proper entrance cover.

2. Avoid using imported marble as it difficult to secure.

3. Successfully use local marble to match existing color.

Figure 11: Exterior marble floor replacement

C. Lower Portion Interior Wall Stained

Why did it fail? It happened when the opposite side of this brick wall having wet areas i.e. planters box and toilets (see

Fig. 12). How it could have been avoided- Ensure proper water proofing done right. If not, this ugly stained effect appears on bright color internal wall. Internal rectification works can be done as follows:

1. Smooth off the peeled surface completely.
2. Apply waterproofing special cement on the leak surface.
3. Apply water proofing paint coat with matching color.

Figure 12: Part of the internal wall (lower side) stained

D. Stalactite Appearance

Why did it fail? Timely water leakage through concrete floor due to the above wet area not having proper water proofing installed. In this case it fails inside a motor room located next to the light spot (Fig.13). How it could have been avoided - Avoiding having potential wet area such as the flat roof, planter's box, concrete gutter or toilet located above the mechanical or electrical room of a building. To rectify this leakage from happening again:

1. Do the below of concrete floor treatment by first cleaning-up the work surface.
2. Injecting water proofing epoxy grouting using high pressure injecting machine (Fig.14).
3. After the grouting exercise, ensure to paste-on the water proofing cement.

Figure 13: Stalactite appearance

Figure 14: Grouting process method being done

E. Concrete Gutter Clogging

Why did it fail? It caused by clogging off the concrete roof gutter resulting rain water leak to internal as well as to the external of the building (see Fig.15). How it could have been avoided - First, the planting of the trees located quite closely with the flat roof building. The leaves from these tree easily clogging the RWDP. Next, the small size of water outlet/RWDP unable to cater the rain water flow from the big size of the concrete gutter. To rectify this marble cracked from happening:

1. Having bigger size of water outlet/RWDP to cater water flow.
2. Avoid plants big tree species with a lot of leaves near a flat roof building.
3. Good point for this building having comfortable size of concrete gutter for maintenance worker to fit-in doing the maintenance work.

Figure 15: Clogging off concrete gutter

F. Metal Gutter Leakage from not-functioned epoxy

Why did it fail? Metal gutter require more maintenance as it's rubberized/epoxy joint not expanding and contracting vice-versa hence letting leakage to occur (Fig. 16). How it could have been avoided - Require proper maintenance and regular cleaning and replacing the epoxy and peeled-off rivet.

To rectify this problem from happening:

1. Ensure to water-jet the existing gutter, having super clean surface.
2. Take-off the old epoxy and replace with new one. Application better in clear weather to ensure epoxy properly fit and function (Fig.17).
3. Successfully replace peeled-off river with new one at the joints.

Figure 16: Leakage at joints of metal gutter

Figure 17: Replacing the epoxy at the joint being done

G. High Ground Water Table level at Lift Pit

Why did it fail? Unable to use the lift as it is leaked/fill with water due to the leakage high ground water table pressure (see Fig.19). How it could have been avoided - Require to exercise total specialize water proofing rectification work on the leakage wall area. Water normally seeping through the cracked/weak spots on concrete wall. To rectify this problem from happening:

1. Require to drill and hacking the leakage cracked area.
2. To drill-in water plug to stop water leak (see Fig.18).
3. Also to use waterproofing cement to render the crack area.

Figure 18: Water seepage at the lift pit wall due to high water table

Figure 19: External view of the lift pit- to be closed for rectification work

3. PRELIMINARY CONCLUSION

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 triggered building defects naturally[4][6]. 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 thus further deteriorate the construction details and starts to fail [5][7].However, proper building maintenance as well as correct rectification works seldom been done correctly to rectify building defects[8]. If the maintenance crew know to choose the correct method and right building materials to be used; thus importantly saves some time and bucks.

ACKNOWLEDGEMENT

We extend our gratitude to the Universiti Sains Malaysia's RCMO office for approving the funding in publishing this paper through RU grant (no. 1001/PPBGN/816247). The author also would like to thank research assistant Mr Khairul Anuar Abd Rasib for the involvement in this study.

REFERENCES

1. D. Marshall, D. Worthing, R. Heath and N. Dann, 'Understanding housing defects', Routledge, London & New York. 2014

2. ISO 8402:1994. Australian/New Zealand Standard. Quality management and quality assurance.

3. M. Hollis. "Introduction to dilapidation", 4th edition. Cem,UK. 2003

4. R. Talib, M.Z., Sulieman, "Case studies: applying waterproofing systems for the university building's flat roof.", Bulletin of Research and Comm. Engagement (BRACE),HBP USM, vol.2 (2), 2012, 42-44.

5. R. Talib, M.Z. Sulieman, "Conserving concrete dome in the tropic.", Bulletin of Research and Comm. Engagement (BRACE).HBP USM, vol.1 (1), 2011, 13-17.

6. R. Talib, "The problem of flat roofing system in tropical climate: case study - a high-rise building in Kuala Lumpur, Malaysia.", Iconda®ciblibrary, Fraunhofer, Rotterdam, 2008, pp.177-84.

7. R. Talib, M.Z. Sulieman, " Choosing the right waterproofing system: case study of the epf building, Malaysia.", Proceeding for 5th Int. Conf. on Built Env. in Dev. Countries (ICBEDC 2011).Vistana,Penang, 2011.

8. Vistaprint co. (n.d). citing websites. Building waterproofing specialist applicator. retrieved June 27, 2013 from http:///www.jumpatech.webs.com/apps/photos/