



Factor Affecting Roof Leaking Focusing on Material Used for Concrete and Metal Roofing on Malaysia Heritage Buildings

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ARTICLE INFO

Article history:
Received 04 November 2014
Received in revised form 09 February 2015
Accepted 16 February 2015
Available online 17 February 2015

Keywords:

Leakage;
Building Maintenance;
Defects;
waterproof.

ABSTRACT

The paper shares the findings on the typical problems facing the heritage or old buildings in term of the problem pertaining to building leakage symptom scenario in Malaysia. Initialized from the problem finding, the paper highlight list of potential solutions best practiced by the local professional waterproofing implementer. By clearly identifying the possible factors that cause the leakage, one can take early steps to prevent the same defects form repeating thus savings can be achieved on the budget side. From the finding analysis, this paper gives the formulation ideas that can be used for creating a framework to prevent or minimize the building leakage syndrome focusing to concrete flat roof and metal roofing from re-happening.

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1. Introduction

According to Kamal and Harun (2002), it is believed that there are more than 37,000 historic buildings built between 1800 and 1948 throughout Malaysia which are worthy of preservation and conservation. Marshall et al. (2014) mentioned that proper and timely maintenance will help to extend the life of the buildings. Notwithstanding the fact that all materials will fail at some point, and require repair and replacement, early failure may occur for various reasons including poor maintenance, poor design, poor specification, poor construction, poor maintenance and inappropriate use. According to Rashid and Ahmad (2008), the conservation of heritage or historical buildings is a method on preserving structures which are historically and culturally important to the nation. Conservation involves works undertaken to preserve the condition of the building to its original state and this also includes the subsequent maintenance works.

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©2015. International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies. Volume 6 No.2 ISSN 2228-9860 eISSN 1906-9642. Online Available at <http://TUENGR.COM/V06/061.pdf>.

Maintenance is identified as a means on prolonging the lifespan of the historical structures. Without proper and systematic maintenance works, without doubt, the historical buildings will deteriorate and becoming dysfunctional as well as unfit to be used.

Addleson (1992) suggested that when dealing with the rectification works of the heritage buildings, the architects should understand the discipline that the combined use of the materials, especially in the recent modern multi-layer construction systems with modern construction materials and imposes them in design detail solutions or creatively use the discipline as a motivation in design. Kamal and Harun (2002) indicates that the present Malaysian legislation on historic buildings is not sufficient and suitable to protect such buildings from being demolished and destroyed. Under the Antiquities Act 1976, a historic building or monument aged must be at least 100 years old to be listed or gazette by the Government through the Museum Department to give protection and encouragement for preservation and conservation. However many important buildings have not yet reached this age, are not protected, others have been neglected or destroyed. According to Abdul Rahman et al. (2000), the enforcement of National Heritage Act 2005 has changed the landscape of national heritage, particularly in the development of preservation and conservation. Results of these changes have significantly increasing the demands of maintenance work in order to ensure the survival and functionality of the buildings.

Talib and Sulieman (2011) state that roof system is very important as it provides shelter for the interior spaces of the buildings. As part of an external envelope for a building, roof must be technically good and must perform aesthetically satisfactory. However, flat roof always cause problem in tropical climate country like Malaysia. Flat roofs should be designed to avoid the need for maintenance as far as this is possible; but inevitably some items of maintenance will occur. It is interesting to find out that the flat roof problems are numerous, diverse, complex, destructive and highly disruptive. The exposure of flat roofs to the extremes of the climate in tropical regions, give rise to the development of problems. Most of these however are avoidable by use of more appropriate design techniques, better quality construction workmanship and more regular inspection and maintenance. The details of the buildings selected for this research can be traced from <http://usm.academia.edu/RoslanTalib>.

2. Research Objectives & Methodologies

The objective of this research paper is to identify the typical factors that effects on the building leakage that happened focusing to the historical or heritage buildings in Malaysia as well as to the selected 'old' regular buildings with potentials. Among the objectives is to identify the building defects that start-up the water seepage mainly form the rain water or the piping leakage. The research intention also identify the most occurred leakage, so that the solution

method can be recommended to ensure the problem will not be repeated (the latter part will be presented into the next paper research). At the same time, the objective is intended to identify typical defects that always cause the water seepage into the interior of the building thus making problem to the occupier as well as its internal valuables. To improve the data quality, only the case studies that can contribute to establish the method to prevent roof leaking are being considered. The identification method to determine the type of leakages and the possible causes has been carefully categorized in order to improve data findings leading to the best possible solutions.

2.1 Data Collection Methodologies

All the Malaysian cases data are based on the collection of real rectification works on selected building leakage projects as well as from author and research assistant personal observations. The reparative tasks were done by the local waterproofing specialist contractor implemented mostly at the cities located within the western part of Malaysia's Malay peninsula; cities like Kuala Lumpur, Petaling Jaya, Jasin, City of Melaka, Taiping and Penang. A total of 64 real project case studies as well as from personal observation has been identified and selected, accumulated since 1994. According to Kamal and Harun (2002), it is believed that there are more than 37,000 historic buildings built between 1800 and 1948 throughout Malaysia which are worthy of preservation and conservation. In the process accumulating the data, a series of interview were made with the building owner, building maintenance representative and of course the reparative contractor. It is quite interesting to note that all the Malaysian cases are the real maintenance rectification works and has been given 10 years warranty or even up to 15 years depending on the type of material used for the said work. Thus the standard of work must be in performed within the highest quality and using the best product standard for each job. Other than that, the redo waterproofing work must be done within the budget to make business profit thus the detail rectification works step must be done at the best as well as within the stipulated time frame given by the building owner.

2.2 Strategies Grouping Identification

To ease-up reader for reference from the charts, the author had done several grouping identifications ensuring each factor related to the point discussed. All the charts are based on the information found from the collected data. The categories include the type of defects, type of roofs and types of material used for rectification works. Ratings were given to show the frequency of activities.

3. Data Analysis on Products

3.1 Discussion

Table 1: Sample of waterproofing selected products list: Use in UK/Europe/International

No	Logo	Company	HQ	Est.	Most applied product	4 seasons climate	Tropical all year	Sold
1		Axter	Paris, France	1922	Torch applied membrane; anti root with bituminous membrane.	Yes	Yes	World
2		Sika AG Group	Baar, Switzerland	1910	Epoxy coating (outdoor) and cementitious (indoor wet areas/for outdoor use to be rendered on top)	Yes	Yes	World
3		Fosroc Ltd.	London, UK and Dubai UAE	1940	Construction sealants and wet areas cementitious.	Yes	Yes	World
4		Soprema	Strasbourg, France	1908	Liquid membrane.	Yes	Yes	World
5		GE Sealants	Huntsville, NC, USA	1940	Construction sealants. Silicone sealants.	Yes	Yes	World
6		Bostik	Paris, France	1889	Sealants and adhesive.	Yes	Yes	World
7		Bitumat	Dammam, KSA	1975	Bitumen's torch membrane.	No	Yes	Mid-east, Africa, Asia, South America.

Note: All trademarks, trade names, product names and logos are the property of their respective owners.

Table 1 shows the list of waterproofing products found from the website search as well as the products being used in actual rectification works done by the specialist contractor in most of the project in Malaysia. It is interesting to note that all of these products originally being produced in Europe except Bitumat© which is from the Kingdom of Saudi Arabia. Even though most of the products above have its main plant in Europe and being exported to Asia however some products have its own plant locally in Malaysia; for example Sika© having its plant in Nilai, Negeri Sembilan to cater for the Malaysian market. It is interesting also to point out that these products has been used for the European market which having totally different weather

pattern with the tropical hot and humid climate of Malaysia as Europe having from hot and dry Mediterranean to Continental extreme winter seasons. Marshall et al. (2014) pointed the importance of understanding how the building particularly a house being inspected was built, in general and in detail, and the products or materials used to do so, applies not only to older historic heritage buildings. It is interesting to note that the Bostik© sealant and adhesive product was first established in Europe as early as in 1889 the same year Eifel Tower was finished constructed by France engineer-architect Alexandre Gustave Eifel.

Table 2: Sample of waterproofing selected products list: Use in Malaysia.

No	Logo	Company	HQ	Est.	Most applied product	4 seasons climate	Tropical all year	Sold
1		Bina Paint Marketing Sdn Bhd	Selangor, Malaysia	1992	Elastomeric waterproofing coating.	No	Yes	Malaysia only
2		PLC Laboratory Sdn Bhd	Selangor, Malaysia	1995	Roof coatings. Epoxy and p.u. grout. Acrylic elastomeric coating.	No	Yes	Malaysia only
3		Atlas Industry Sdn Bhd (under Taiko Group)	Selangor, Malaysia	1968	Coating primer. Modified bituminous compound emulsions. Synthetics resin.	No	Yes	Malaysia only
4		Axel Chemie Sdn Bhd	Kuala Lumpur, Malaysia	1986	Roof coating for metal, clay and concrete flat roof.	No	Yes	Malaysia only
5		Polycell Sdn Bhd (under TYGA Coop.)	Selangor, Malaysia	1980	Foam grout.	No	Yes	Malaysia only
6		Quicseal Pte Ltd	Singapore	1988	Liquid applied waterproofing system. Silicone sealant.	Yes	Yes	Malaysia China Philippine South Korea
7		Shell Malaysia	Kuala Lumpur, Malaysia	1964	Shell Flintkote is for internal wet areas waterproofing system as well as for flat concrete roof and metal roof.	No	Yes	Malaysia only

Note: All trademarks, trade names, product names and logos are the property of their respective owners.

Table 2 shows the list of selected waterproofing products which are being offer in the Malaysian market today. Other than the products being imported from Europe, Saudi Arabia or even Australia; the Malaysian based waterproofing products has been used regularly for the local

Table 3: Rectifications analysis schedule tabulated for the concrete flat roof identified for this case studies

CONCRETE FLAT ROOF			
	Product sample	Rectification	Rectification
A/C drainage piping/joint leakage	Bina Plastic/Dunlop Ecobond solvent based PVC pipe adhesive glue.	Replace leaking drainage pipe/joints	A/C regular maintenance must be done.
Water tank leakage	Atlascote petro based primer. PLC epoxy coating/ BINA epoxy coating	Paint anti-rust coating at rust surfaces.	Paint epoxy coating at joints
Metal flashing detail at roof top wall failed	GE sealant epoxy/Sealant BOSTIK/MOHM Chemie sealant	Flashing location must be at easy accessible area for maintenance.	Ensure metal flashing properly glued with epoxy sealant seal into the wall.
Metal flashing's sealant failed	GE/MOHM Chemie epoxy sealant.	Replace expired sealant	Ensure metal flashing overlay in two layers.
Drilled holes to screw object on top concrete roof	Fosroq non-shrink cement.	Seal holes with new sealant. Render holes with non-shrink cement.	Or paint epoxy coating with fibre matte on holes
Expired waterproofing hard membrane failed	Atlascote primer. AXTER torched hard membrane/ Bitumat torched hard membrane	Lay coat of petro based primer before torch membrane	Membrane lapping must be in orderly. Have membrane skirting min. 0.5 metre height
Roof top epoxy coating failed	PLC epoxy coating/ Axel Chemie coating/ Bina Integrated epoxy coating.	Ensure coating been applied in hot and dry weather with clean surface.	Ensure liquid membrane thickness 1.5mm. To lay coating in intersecting direction with 3 layers
Roof slab cracked due to building movement from earthquake etc.	GeoProfound Engineering	Must use micro piling/less vibrate type of piling for building next to the site.	Ensure building having mechanically vibrate proof design feature. Monitor on soil movement near site.
Human intervention on concrete slab	Use Wagner moisture & damp meter detector or similar.	Installing new structures on roof top must be in waterproof condition.	Regular maintenance inspection required.
RWDP size not sufficient	Bina Plastic.	To cut concrete making new bigger hole to fit larger uPVC RWDP. Suggest use uPVC type for easy maintenance.	RWDP and roof joint piece must be sealed properly to ensure leak free.
Building expansion joint expired	SIKA backer rod.	Also possible to install new backer rod at joints.	Replace old joint sealant with new flexible sealant epoxy.
Plant root penetration	Bina Int. (Jiangsu China made) fibre-matte	Remove vegetation until root gone. Put fibre-matte at the spot, then paint epoxy coating on it.	This may sign of inefficient run of rainwater. Rerender of flat top required.
Dried leaves accumulate on outlet/ concrete gutter	Plant tropical leave less Christmas or pine tree type nursery	Install metal netting at gutter drain outlet.	Long term: distance planting leafy tree. Suggest plant evergreen trees.
Concrete defects with cracks on top due to weather	Polycell Tyga epoxy liquid epoxy grout chemical.	Short term: Inject pressure grouting. Long term: top surfaces treatment required i.e., install new waterproofing system	New waterproofing i.e. liquid membrane coating, hard torch membrane.

projects. Even though the local products have been competing with the imported products, the quality standards of the products are at par with the European products with having the Malaysian quality standard monitoring label on them. It is interesting to note that some products having its parent company outside Malaysia i.e. Singapore and South Korea but having its main distribution offices in Malaysia to cater the local market. There is no research so far has been done to prove that the local waterproofing products perform much better compare to the imported one which may ideally being formulated for the harsh cold climate of the European continent. It is understandable to feels that the local Malaysian waterproofing product may be more suitable to be applied for the hot and humid tropical Malaysian weather. For record, all the above local products has been used for the real rectification works in Kuala Lumpur, Melaka Ipoh and Pulau Pinang with projects ranging from schools, office buildings, hospitals and university buildings with minimum 10-15 years warranty being given to the building's owner.

For the 14 defects given in Table 3, the list indicates the rectification frameworks to overcome the defects pertaining to the concrete flat roof on the said heritage buildings of the research paper study. The above table indicating on the best possible rectification works that can be done for each identified leakage problem pertaining to the concrete flat roof including the best possible use of the waterproofing products for each case. Each of the 14 defective cases has been identified with the detail rectification works to overcome the flat concrete slab roof seepage together with suggested waterproofing material to be used which are derived from the actual rectification works done. The list above helps the maintenance crew to identify each of the possible leakage scenario on the heritage buildings and also indicating on the step by step rectification works and it can become as a guideline framework for the crew. It is the intention of this paper to list up the possible rectification works to ease-up the maintenance management team in doing the maintenance works for the heritage building. It can become as an initial guidelines to be used for the leakage work pertaining to the clay tile roof. It is interesting to note that the all the rectification steps identified are based on the real experience from the actual task done by an experience waterproofing implementer. The method of works are to ensure works done in proper steps and using the right and best waterproofing materials in order to ensure the tasks not be repeated as the warranty been given for 10 years and any repeated works are not economical to waterproofing business as well as to the owner.

The schedule in Table 4 indicates 12 rectification actions taken for the 12 identified defects always happened for the metal corrugated roofing sheet or zinc roofing sheet. For this schedule, the author has indicated the specific brand of waterproofing materials done for the specific

Table 4: Rectifications analysis schedule tabulated for the metal sheet roof including zinc roof identified for this case studies

Metal Sheet Roof Including Zinc Roof	Product sample	Rectification	Rectification
Rusty roof	Nippon paint anti-rust. Bina Integrated epoxy coating.	Paint anti-corrosion epoxy. Lay fibre-matte on stain spot.	Paint 3 layers (intersect pattern) with epoxy coating
Expired sealant on metal flashing	Sealant silicone brand BOSTIK or equivalent.	Ensure to apply new sealant during hot and dry weather.	Replace old sealant with new silicone sealant.
Metal flashing design failed	Lysaght metal screws/GE sealant epoxy.	Ensure metal flashing overlay in 2 layers. Use of copper flashing due to its strength.	Ensure metal flashing properly glued with epoxy sealant seal into the wall.
Screw or metal roof nail not in place	BOSTIK silicone sealant.	Replace missing screw or nail with new one. Installation must be in orderly manner.	Double protection: put sealant epoxy on top of screw/nail. Ensure new nail has anti-corrosion feature.
Gap between metal sheet deck	Plant tropical leave less Christmas or pine tree type nursery as barrier.	Gap may cause from strong wind.	Metal sheet to redo/refit manually orderly.
Expired metal coating	PLC epoxy coating/ Axel Chemie coating/ Bina Integrated epoxy coating.	Ensure coating act as corrosion resistant surface coating for metal roof.	To scrap off peeled coating and paint 2 layers new epoxy coating.
Building movement allow sheet gap	GeoProfound Engineering has micro pile services.	Rearrange metal sheet orderly manually. Ensure design movement/wind resistant.	Urge use micro piling for building next to existing.
Human intervention on sheet metal	Use Wagner moisture & damp meter detector or similar.	To redo defects done manually.	Ensure movement monitored by management.
Holes drilled on metal sheet due to other task	Bostik epoxy silicone sealant.	Avoid installing new item/gadget right on top metal roof.	Cover holes with sealant epoxy.
RWDP size not sufficient	Bina Plastic uPVC products or similar. Ensure with SIRIM label.	Replace new sufficient size RWDP with new one. Prefer to use uPVC type.	RWDP and roof joint piece must be sealed properly to ensure leak free.
Dried leaves accumulate on outlet/metal gutter	Tropical Christmas or pine tree type nursery	Install metal netting at gutter drain outlet.	Long term: distance planting leafy tree. Suggest plant evergreen trees.
Grown unwanted plants blocked water flow	Bina Int. (Jiangsu China made) fibre-matte. Bina int. epoxy coating.	Put fibre-matte at the spot, then paint epoxy coating on it.	Remove manually unwanted plants.

leakage cases. By specifying specific brands, it is hope that the specification writer can be able to identify the said products and beginning to find similar type of material to be used in order to ensure the rectification works done in orderly fashion. It is important to note that based on the writer experience that these are the best waterproofing products has been used on the real project situation for the real job to ensure the leakage issues totally been solved. However, another important aspect for the rectification works is that the jobs must be done with the qualified experience personnel. This is to ensure the works has been done according to the method of

works submitted to the client. Most of the cases, improper supervision of the waterproofing rectification works always leak to the fail aspect of the said work and need to be done repeatedly for the same type of leakage cases.

4. Conclusion

This subtopic elaborates information pertinent to Table 3 and Table 4. Having an initial guidelines or initial frameworks dedicated to specific roofing or covering material for the heritage or old buildings for this case are a good thing to benefit building maintenance team. The paper focusing on the suggested best possible rectification works including the suggested products or waterproofing materials to be applied for the concrete flat roof and for the metal or zinc corrugated roofing. The rectification works must be done in proper steps and to use the correct method and choosing the right material in order not to repeat the same process hence become not economical in term of business aspect of the waterproofing company. Normally, the rectification works come along with at least 10 years warranty period as demanded by the building owner thus all the step and procedure must be right to avoid repeating reparative works. It is important to ensure that all the rectification works done maintaining the physical appearance of the historical building; the look as what it should have been before it was been maintained. Thus, the choice of the right waterproofing system together with the correct material is very important and has been considered when the tasks have been undertaken. Stringer (1977) stressed that there must be a work programme to survey the main structure of the buildings especially the roofing part during the first year of the post construction stage to ensure the repairs to the main structure can be planned if required.

While the finding determined that even though asbestos roof surprisingly the most numbers of the old building undertaken in this research, flat concrete roof as well as the metal roof are the two types of roof that mostly being as roof covering structure of the analysis. As a conclusion, by determining and identifying the factors always leading to the concrete flat roof and metal decking's water leakage, the predicted defects can be obtained and some money can be saved by having periodical maintenance check-up. After all, it is the objective of the research at least to put some savings on the maintenance aspect hence be able the Government to spend more money on other useful matter.

5. Acknowledgements

The author would like to thank Universiti Sains Malaysia (through RUI grant account no: 1001/PPBGN/816247) to enable the research to goes on smoothly.

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Note: The original of this article was accepted and presented at the **2nd International Workshop on Livable City 2014 (IWLC2014)**, a Joint Conference with **International Conference on Engineering, Innovation, and Technology (EIT)**, held at Tabung Haji Hotel, Alor Star, Malaysia, during December 9-11, 2014.