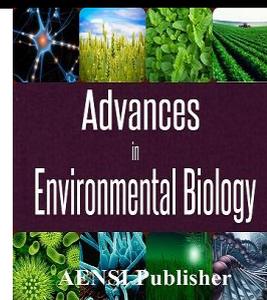




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Classification of factors contributing to roof leaking focusing on clay tile roof and asbestos roof on Malaysia heritage buildings

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ABSTRACT

The purpose of the paper is to share the findings on the typical problems facing the heritage or old buildings in terms of the problem leading to building leakage scenarios in Malaysia. The paper tabulates a list of potential solutions best practiced by the local waterproofing implementer with data on real case studies pertaining to the building leakage typically happened to the clay roof tile as well as the asbestos roof for heritage structures. The case studies are derived from the real selected projects done by the associated building maintenance contractor for the last 20 years. By identifying the possible factors that cause the leakages, one can take early steps to prevent the same defects from repeating thus saving on the financial side. The finding indicates the formulation ideas that can be used for creating a framework in preventing or minimizing the building leakage syndrome from happening again. As the old buildings or the buildings that are old enough to be considered worth to keep are becoming more valuable to either the central Government or the local council; the analysis from this paper may give some meaningful tabulation on how to maintain these heritage buildings from leaking especially from the roof seepage thus making the property much more valuable to the owner.

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INTRODUCTION

According to Kamal and Harun, 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 [1]. Marshall *et al.* mentioned that proper and timely maintenance will help to extend the life of the buildings [2]. 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, the conservation of heritage or historical buildings is a method on preserving structures which are historically and culturally important to the nation [3]. Addleson 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 [4].

Talib and Sulieman stated that roof system is very important as it provides shelter for the interior spaces of the buildings [5]. For convenience, the readers can do the cross reference on all the selected Malaysia building leakage cases detail at <http://usm.academia.edu/RoslanTalib> tabling information like failure causes as well as possible best solution suggestion.

Methodology:

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. With qualitative research approach, a total of 64 real project case studies as well as from personal

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observation has been identified and selected, accumulated since 1994. In the process accumulating the data, a series of unstructured interviews were made with the building owners, building maintenance representatives and of course the reparative contractors. 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.

RESULTS AND DISCUSSION

(i) Roof leakage rectifications procedures for clay or slate roof tile and asbestos roofing:

Table 1 shows 9 defects which list indicating the rectification frameworks to overcome the defects pertaining to the clay or slate roof tiles 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 as well the suggested waterproofing material or product can be used for each cases. Each of the 9 defective cases has been identified with the detail rectification works to overcome the tile or even slate roof seepage together with suggested waterproofing material together with the product brand to be used which are derived from the actual rectification works done. The list below 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.

Table 1: List of rectification frameworks to overcome the defects pertaining to the clay or slate roof tiles.

Clay/slate roof tile	Product sample	Rectification	Rectification
Cracked clay roof tile	Monier clay roof type or similar.	Ensure to replace with closer original resemblance. If repairable, apply sealant epoxy along cracked line.	Cracked may result from premature tile/shingles. Ensure quality selection of shingles.
Flashing between wall and roof failed	Sealant silicone brand BOSTIK or equivalent.	Expired sealant to replace with new one. Ensure metal flashing overlay in 2 layers.	Ensure metal flashing properly glued with epoxy sealant seal into the wall.
Roof ridge and hip moves allow gaps	Monier clay roof tile. Sealant silicone brand BOSTIK or equivalent.	Possible to lay sealant epoxy between joints to avoid leakage.	Defects require to make good i.e. rearrange manually. Also due to poor laying of tiles at first place.
Timber roof truss deteriorate	Setia Wood products/UAC steel truss	Deteriorate truss need to be replaced manually. If use timber, ensure use termite free type.	Option to replace timber truss with maintenance free metal one.
Moss accumulate deter water flow	Use Wagner moisture & damp meter detector or similar.	Ensure roof design min.12.5 degree low pitch.	Moss need to be removed periodically.
Strong wind allow tiles move	Plant tropical leave less Christmas or pine tree type nursery	Prefer design orientation with maximum wind resistant.	Typical problem is wind up-lift. To arrange tiles manually.
Human intervention	Use Wagner moisture & damp meter detector or similar.	Monitor human movement on roof location. Regular maintenance inspection required.	Installing new structures on roof top must be in waterproof condition.
Roof tile gap due to earthquake, building piling effect or soil movement.	GeoProfound Engineering provide micro piles services.	Must use micro piling/less vibrate type of piling for building next to site.	Ensure building having mechanically vibrate proof design feature. Monitor on soil movement near site.
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.

Table 2 schedule out 9 typical problems dealing with the water seepage normally happened in regards to the use of asbestos as a covering material of roof structure. The list also come with the best possible rectification tasks in order to solve the leakage problem together with the suggested waterproofing material or product brand can be used to rectify the defects. The analysis found out that the nine typical scenarios always occurred in regards to the water seepage in relation to the asbestos roof of the selected old structures be able to the maintenance crew to schedule their maintenance tasks in order to ensure avoid future roof leak. The rectification works below are based on the real experience in handling the seepage problem on actual tasks of the old buildings. With the conservation works to ensure the original state of the physical appearance being conserve together with the 10 years warranty to be given to the building owner; the correct steps and procedure must be

done properly to avoid double cost in case the job need to redo if first attempt failed. However, due to proven health risk, do not maintain and use asbestos roof. Total replacement need to be done if required and use asbestos free roof type available on market.

Table 2: List of 9 typical problems dealing with the water seepage for asbestos roof.

*Asbestos roof	Product sample	Rectification	Rectification
Strong wind create gap between roof sheet	Plant tropical leaf-less Christmas or pine tree type nursery	To rearrange tiles manually. Prefer design orientation with maximum wind resistant.	Plant more trees to protect building from strong wind. Be selective on tree species.
Crack roof sheet	Sealant silicone brand BOSTIK or equivalent.	If sheet at repairable condition, use sealant epoxy along crack line.	Cracked may cause from defective sheet/lines. Quality selection or product required.
Roof flashing to wall not function	Sealant silicone brand BOSTIK or equivalent.	Expired sealant to be replaced with new one. Ensure metal flashing properly glued with epoxy sealant into the wall.	Long term: To install expansion joint with sealant at metal flashing/wall joint.
Timber roof truss deteriorate	Setia Wood products/UAC steel truss	Option to replace timber truss with maintenance free metal one.	Ensure use treated (termite free) timber for roof truss. Inject termite chemical inside site soil.
Roof sheet have gap due to building movement i.e. earthquake, piling, soil movement	GeoProfound Engineering provides micro pile services.	Must use micro piling/less vibrate type of piling for building next to site.	To make good insufficient depth and width of foundation. Ensure building having mechanically vibrate proof design feature.
Metal nail/screw/sealant not function	Lysaght metal screw/Sealant silicone brand BOSTIK© or equivalent.	Replace old sealant with new one ASAP. Replace missing screw or nail with new one. Installation must be in orderly manner.	Double protection: put sealant epoxy on top of screw/nail.
Human intervention	Use Wagner moisture & damp meter detector or similar.	Any installation of new structure on roof must be leak free with waterproof detail.	Monitor human movement on roof location. Workers must be fully supervised.
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.
Moss accumulate deter water flow	Use Wagner moisture & damp meter detector or similar.	Ensure roof design min. 10.0 or 12.5 degree low pitch.	Moss need to be removed periodically.
*due to health risk, do not maintain and use asbestos roof. Total replacement if required. Use asbestos free roof type.			

Summary:

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 for the asbestos roof and for the clay or slate tile 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 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 been maintain. Thus, the choice of the right waterproofing system together with the correct material is very important and has been considered when the tasks has been undertaken.

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 clay tile roof and asbestos 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.

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