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THE POTENTIAL OF POLYURETHANE FOAM INSULATION IN ROOF MAINTENANCE

Nur Amirah Damia binti Md Nasser

Department of Building, Faculty of Architecture, Planning and surveying, Seri Iskandar Campus, University Technology MARA, 32610 Seri Iskandar, Perak, Malaysia *Email: nadmdnasser@gmail.com*

Abstract:

Malaysia has a tropical climate which receives a lot of rainfall throughout the year. Heavy rainfall increases the dampness to roof and causes leakage. Even though numerous solutions are available in the market, this has not stem the tide of these occurrences. Hence, this paper presents the potential of polyurethane foam insulation in roof maintenance. Polyurethane foam insulation insulates and eliminates thermal bridging through fasteners or gaps in decking while providing a long-lasting roofing system. A study has been conducted to identify the issue and problem according to the use of conventional roof insulation. The objective of this study is to evaluate the function of polyurethane foam insulation that can contribute to roof protection. Some of theprevious studies are from the relevant research articles and journals. Based on the data, there are many challenges regarding the arising of building defect and leakages. Service and maintenance after the equipment break down also increases the usage of maintenance cost. Expected outcome will benefit for preventive maintenance.

Keywords: Polyurethane foam insulation; Foam insulation; Building maintenance; Roof; Waterproofing system

1.0 INTRODUCTION

A safe and hygienic living environment depends very much on the timely maintenance of your buildings' common areas and estate facilities. A building lacking in maintenance is like a time bomb which endangers life and limbs and may bring about serious consequences to the owners. It is therefore vital for owners to carry out maintenance works without delay. Equally important is upholding integrity and implementing best practices in the tendering and monitoring of building maintenance works, which are essential to help keep at bay corruption and fraud that may inflate the maintenance costs or even jeopardise the safety of the occupants (ICAC, 2013).

The increasing complexity of homes, the use of innovative materials and technologies, and the increased population in high-hazard areas have introduced many challenges to the building industry and design profession. These challenges call for the development and continual improvement of efficient engineering methods for housing applications as well as for the education of designers in the uniqueness of housing as a structural design problem (NAHB Research Center 2000).

Exposed membrane roofs (i.e., roofs with exposed roofing membrane on top of the roof insulation and structure—also called conventional roofs) make up most of low-slope roofing assemblies in North America. Membrane colors from dark to light are chosen based on product availability, aesthetics, building type/use, energy efficiency, and standard practices, which vary from southern to northern latitudes. Lighter, more-reflective membrane colors or finishes (high solar reflectivity index [SRI]) are common in the southern U.S. where it is required by energy code (AShRAE 90.1); though with Leadership in Energy and Environmental Design® (LEED®) projects and some other energy-rating programs, light- or white-colored roofs are often used regardless of geography. In northern climates, the benefit of using white membrane roofs to achieve cooling savings is often small and can be offset by higher wintertime heating loads (Dell & Finch, 2013).

Weatherization is the process of modifying a building envelope to reduce energy consumption. Weatherization can significantly reduce heating and cooling costs, improve building durability, and create a healthier indoor environment. Spray foam and one-component foams are ideal for weatherization because they provide two key elements in one product: insulation and air-sealing. Weatherization typically involves air-sealing seams, cracks and openings to the exterior of the house with spray foam or one-component foam. If necessary, additional spray foam insulation can be applied to attics, ceilings, exterior walls, basement walls, floors, and crawl spaces (Karamagi, 2009).

Spray Polyurethane Foam (SPF) insulation is ideal for roofs because it can be sprayed onto existing roofing material as a re-cover, or applied onto new substrates. SPF roofs are weather-proof, light-weight, durable, and require less maintenance compared to traditional roofing systems. SPF is very compatible with highly reflective coatings for 'cool roofs' with improved thermal performance (Karamagi, 2009).

The technique used in Polyurethane foam insulation for the waterproofing system for the roof and waterproofing system is a spraying system by using a spray gun. It is a liquid spray applied seamless waterproofing system that have been developed specifically for roof tiles and flat roof refurbishment for surfaces such as timber, asphalt, and concrete. This insulation makes it ideal for consolidating, waterproofing and protecting existing systems to the roof truss which was attacked by termites. Therefore, it is essential to provide building maintenance for residential and commercial buildings to minimize the effect to building and indirectly it will prolong the life span of the building.

2.0 LITERATURE REVIEW

Polyurethane is a plastic material (a polymer) which wouldn't exist without diisocyanates and polyols. Methylene diphenyl diisocyanate (MDI) and Toluene diisocyanate (TDI) are aromatic diisocyanates, while hexamethylene diisocyanate (HDI), methylene dicyclohexyl diisocyanate or hydrogenated MDI (HMDI) and isophorone diisocyanate (IPDI) are aliphatic diisocyanates. Along with polyols, which are long alcoxyether chains, these chemicals form the building blocks of polyurethane (Polyols, 2017).

Effectively polyurethane is derived from the chemical reaction between diisocyanates and polyols; when mixed together they react to a polymer and foam. For polyurethane to live up to quality expectations and products' technical specifications, pigments and additives are added to ensure the exact formulation of the foam (Polyols, 2017).

The varieties in density are endless and all blocks of foam are tested for conformity to meet the EU's safety standards. As the molecule is adapted to provide different properties, polyurethane foam can either be more rigid or more flexible. For example, a comfortable sofa requires the use of carbon dioxide as a blowing agent to produce soft foam (Polyols, 2017).

3.0 METHODOLOGY

3.1 Conceptualization

Before starting researches on the building that was chosen, I had several discussions with my academic supervisor and supervisor in charge in a brainstorming session to determine relevant matter that needs to be selected before completing the analysis. This purpose of conceptualization is to list all matters that should be completed and rensure the proposed paper has all the purposes that I needed.

3.2 Review Article from Website

Several of the literature studies are article reviews from various relevant websites regarding the Polyurethane foam insulation and roof maintenance.

4.0 ANALYSIS AND FINDINGS

4.1 Identification of issue and problem according to the use of conventional roof insulation

Maintaining a building involves a process of reservation and restoration activity of the structure and components of a building. It covers the whole building which includes toilets, rooms, walls, roofs, drains, doors, windows, floors and the fixed furniture. The issue of building maintenance is a universal issue and is of high significance in the early process of the construction and the design to ensure the quality of the building.

4.1.1 Expanded Polystyrene

It is usually in white with low density and low thermal conductivity, which is another type of polystyrene that should be installed, below the roofing membrane. It is introduced in BSI standard number BS 3837. It is also used in packaging industry (Nafici, 2012).

4.1.2 Fesco Board

Fesco Board is a homogeneous insulation board that is usually used as fire resistant. It can resist damages that come from construction and maintenance (Nafici, 2012).

4.1.3 Roofing Membranes

Roofing membrane is a type of roofing system, which is used on flat or nearly flat roofs to prevent leaks and move water off the roof. Most of them are made from thermoplastic or synthetic rubber modified bitumen. They are replacements for asphalt roof systems. Most well-known membranes are EPDM (ethylene propylene diene Monomer (M-class) rubber), TPO (thermoplastic polyolefin), PVC (Poly vinyl chloride), BUR (Built-Up Roofing), Modified Bitumen and Liquid-Applied Membrane and Metal roofing (Nafici, 2012).

4.1.4 TPO and PVC Membranes

TPO and PVC membranes are thermoplastic membranes with good chemical and oil resistant. Their surfaces are white, and they are durable membranes (Nafici, 2012).

4.2 Evalution of the function of Polyurethane foam insulation that can contribute to roof protection

Table 1: Evalution of the function of Polyurethane foam insulation that can contribute to roof protection

SPF as an Air	SPF as a Moisture	SPF as a Sound	SPF as a Thermal
Barrier	Barrier	Barrier	Insulant
Low air presence	Prevents moisture penetration	Air seals to absorb sound at varying frequencies	High R-value
Completely seals wall penetrations	Eliminates dew points in the wall cavity	Dampens sound vibrations transmitted through solid materials	Does not settle or sag with time
Prevents drafts and hot-spots	Controls mold problems	۶_ -	ReducesoreliminatesthermalbridgingeffectSPFasaInsulantthermal

4.2.1 Conduction

Conduction is the transfer of heat within an object or between two objects in contact.

The SPF Advantage: The predominant heat transfer mechanism is conduction. Because the polymer matrix and the gas contained within the cells are both poor conductors of heat, closed-cell spray polyurethane foam has a very high R-value and effectively blocks heat transfer by conduction (Covestro, 2015).

4.2.2 Convection

Convective heat transfer occurs when air moves within the walls. Natural convection currents occur when temperature differences in different locations (for example, walls) create air movement that transfers heat.

The SPF Advantage: Both open-cell and closed-cell polyurethane spray foam helps reduce air movement within and through the walls, thereby reducing convection as a heat transfer mechanism within the insulation mass (Covestro, 2015).

4.2.3 Radiation

Radiation is the transfer of heat from one object to another by means of electromagnetic waves. Heat transfer by radiation is reduced by spray polyurethane foam because of the cell structure. Minimizing radiant heat loss/gain can lead to greater comfort (Covestro, 2015).

4.2.4 Air Infiltration

Air Infiltration transfers heat by the gross flow of air between the exterior and interior. SPF applied at a minimal thickness of 3/4" for closed-cell SPF1 and 3.5" for open-cell SPF 2 is considered air-impermeable insulation based on testing in accordance with ASTM 283 (Covestro, 2015).

4.2.5 Moisture Accumulation

Moisture Accumulation within insulation materials will reduce it's R-value, contributing to heat loss/gain. Closed-cell spray foam is a water-resistive barrier. It also helps stop moisture accumulation due to air infiltration and air intrusion (Covestro, 2015).

5.0 CONCLUSION

Overall. after studying the problem and solution, Polyurethane foam insulation is really important as one of the main building maintenance in roof and waterproofing system. All actions are needed to retain material in a serviceable condition or to restore it to serviceability. This is because residential buildings are one of the important facilities for getting basic protection in everyday life. Based on the data, there are many problems regarding increase inbuilding defects and serviceability break down. Preventive maintenance has been proposed because worn out equipment can damage the other parts and cause multiple damages. Moreover, service and maintenance after the equipment break down will also increase the usage of maintenance cost.

There are many other issues involving equipment break down even though a residential building has taken all possible safety measures. When the equipment breakdown, main contractor's solution is by using corrective maintenance to avoid equipment failures, unnecessary production loss and safety violations.

Therefore, it is recommended to all parties to take safety measures regarding the building maintenance to minimize other contributing factors to building defects and failures.

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