



IDENTIFICATION OF THE MAIN FACTORS
AFFECTING WATERPROOFING PROBLEMS OF
REINFORCED CONCRETE (RC) FLAT ROOF: A CASE
STUDY OF PERKESO BUILDINGS

BY

AHMAD SUFFIAN BIN SULAIMAN

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International Islamic University Malaysia

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ABSTRACT

In Malaysia, it is crucial to have a good waterproofing system as it receives frequent rainfall all the year round with an average rainfall of 250 centimetres. With a proliferation in popularity of flat roof system especially for high-rise buildings, waterproofing problems are considered critical to avoid damages to the building and its content. Ironically the failure of remedial works were also common. Current approaches address the problems were on ad hoc basis and merely corrective rather than preventive. As a result, more damages and costly repair become apparent in the maintenance budget. However, recent roof leakage incidents at numerous prestigious buildings such as Parliament House, high court and other government buildings has sparked awareness among the building owners and engineers to fully understand the importance of a good waterproofing system. The aim of this study is to identify the main factors affecting the performance of waterproofing system for flat roofs at selected buildings owned by Pertubuhan Keselamatan Sosial (PERKESO). Two objectives are set to achieve the aim. They are; (1) to identify the deficiency of waterproofing performance; (2) to identify ways to have the best performance of waterproofing system. This study involves three PERKESO buildings as case studies. Acquisition of primary data was carried out through investigation via interview, the records of maintenance and site observation. Secondary data involves the manoeuvre of factors found in the literature reviews such as application methods, weather elements, usage of the flat roof, substrate condition and budgetary constraint. Comparative analysis was carried out to gauge the significant cause of the waterproofing problems. Findings of this study indicate that the 'workmanship' as the main factor that contribute significantly to the problems. The outcome could be useful as guidance for better building maintenance management. With those factors determined, recommendations are presented to improve the performance of waterproofing system and thus could reduce the maintenance cost.

ملخص البحث

وجود نظام العزل المائي له أهمية قصوى للمباني في ماليزيا لغزارة و تكرار هطول الأمطار بها طوال العام بمتوسط 250سم. مع تعاظم شعبية السقوف المسطحة و خاصة في المباني العالية، فإن مشاكل العزل المائي قد اكتسبت وضعاً مفتاحياً في خطط حماية المباني و محتوياتها . و من المفارقات، أن عمليات إصلاحها هي الأخرى كثيراً ما تكون محفوفة بالفشل. فالأساليب المتبعة حالياً لحل هذه المشكلة عبارة عن معالجات تختلف من حالة لأخرى، و هي مجرد عمليات إصلاحية فضلاً عن كونها وقائية. كنتيجة لهذا فهناك المزيد من تكاليف ما يحدث من خراب و من عمليات الإصلاح و قد أصبحت تتصدر ميزانيات تكلفة صيانة المباني. فهناك بعض حوادث تسرب المياه المدمرة خلال السقف و التي حدثت بمباني حكومية شهيرة مثل مبنى البرلمان و مبنى المحكمة العليا و مباني أخرى، كان لها الأثر في توجيه الوعي لدى ملاك المباني و المهندسين لأهمية أنظمة العزل المائي الجيدة. غاية هذه الدراسة هي تحديد العوامل الرئيسية المؤثرة في أداء أنظمة العزل المائي بالسقوف المسطحة لمباني مختارة مملوكة لمجموعة بيركوسو (PERKESO) . تم تعيين هدفين لتحقيق الغاية المطلوبة، و هما: (1) تحديد قصور الأداء في العزل المائي (2) تحديد طرق الحصول على أفضل مستوى للأداء لأنظمة العزل المائي. هذه الدراسة شملت ثلاثة من مباني PERKESO كدراسة حالة كل على حده . تم الحصول على المعلومات الأولية بالاستقصاء عن طريق المعاينات، و من سجلات الصيانة و بالمراقبة الميدانية للمواقع. المعلومات الثانوية شملت تداول العوامل الواردة بالأدبيات السابقة في هذا الموضوع كطرق التطبيق، و عوامل الطقس، إستخدام السقوف المسطحة و حالة طبقات العزل و قيود الميزانية. تم أيضاً إجراء التحليل المقارن لقياس الأسباب المميزة لمشاكل العزل المائي. نتائج الدراسة توصلت لكون الصنعة اليدوية تشكل العامل الرئيسي الذي له مساهمة متميزة في وجود هذه المشاكل. يمكن إعتبار ثمرة الدراسة أن لها فائدة إرشادية في تحسين مستوى إدارة صيانة المباني. و بتحديد تلك العوامل، فقد تمت التوصيات بتحسين أداء أنظمة العزل المائي و من ثم خفض تكلفة الصيانة

ABSTRAK

Di Malaysia, adalah penting untuk mempunyai sistem kalis air yang baik kerana negara ini menerima hujan yang kerap sepanjang tahun dengan purata 250 sentimeter. Selari dengan populariti sistem bumbung rata yang semakin meningkat terutamanya bagi bangunan tinggi, keberkesanan sistem kalis air dianggap kritikal bagi menghindarkan kerosakan pada bangunan dan harta benda di dalamnya. Ironinya kegagalan sistem kalis air masih dianggap perkara biasa. Pendekatan sediada yang konvensional dalam menangani kegagalan lapisan kalis air adalah bersifat membaiki sesudah berlakunya kerosakan dan bukannya bersifat pencegahan. Akibatnya, lebih banyak kerosakan dan kos pembaikan yang tinggi perlu diambil kira dalam peruntukan bagi kerja penyelenggaraan. Namun baru-baru ini insiden kebocoran bumbung di beberapa bangunan berprestij seperti bangunan Parlimen, mahkamah tinggi, lapangan terbang dan bangunan kerajaan yang lain telah mencetuskan kesedaran di kalangan pemilik bangunan dan jurutera untuk memahami betapa pentingnya sistem kalis air yang baik. Tujuan kajian ini adalah untuk mengenal pasti faktor-faktor utama yang menjejaskan prestasi sistem kalis air untuk bumbung rata di bangunan milik Pertubuhan Keselamatan Sosial (PERKESO). Dua matlamat telah ditetapkan bagi kajian ini iaitu (1) untuk mengenal pasti kelemahan sistem kalis air di bangunan terpilih; (2) untuk mengenal pasti cara untuk memperolehi prestasi yang baik bagi sistem kalis air. Kajian ini melibatkan tiga buah bangunan PERKESO sebagai kajian kes. Pencerapan data primer diperolehi melalui temuramah, rekod penyelenggaraan dan pemeriksaan tapak. Data sekunder pula melibatkan penerokaan faktor-faktor yang diperolehi melalui bahan rujukan ilmiah melibatkan kaedah pemasangan sistem, faktor cuaca, kegunaan bumbung rata, keadaan permukaan lantai konkrit dan kekangan belanjawan. Analisis perbandingan telah dijalankan untuk menilai punca sebenar masalah sistem kalis air. Hasil kajian ini menunjukkan mutu kerja sebagai faktor utama yang menyumbang kepada masalah sistem kalis air di bumbung bangunan berkenaan. Hasil kajian ini mungkin berguna sebagai rujukan demi pengurusan bangunan yang lebih baik. Dengan faktor penyebab yang dikenalpasti, beberapa cadangan juga dikemukakan bagi menambahbaik prestasi sistem kalis air dan diharap dapat mengurangkan kos penyelenggaraan.

APPROVAL PAGE

I certify that I have supervised and read this study and in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Building Services Engineering.

.....
Norwina Mohd Nawawi
Supervisor

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Building Services Engineering.

.....
Nurul Hamiruddin Salleh
Internal Examiner

This dissertation was submitted to the Kulliyah of Architecture & Environmental Design and is accepted as a fulfilment of the requirement for the degree of Master of Science in Building Services Engineering.

.....
Rosniza Othman
Head, Department of Architecture
Kulliyah of Architecture &
Environmental Design

This dissertation was submitted to the Kulliyah of Architecture & Environmental Design and is accepted as fulfilment of the requirement for the degree of Master of Science in Building Services Engineering.

.....
Alias Abdullah
Dean, Kulliyah of Architecture &
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To my wife, Halmi Ramly for being supportive and encouraging

To my children Irdina, Irfan, Imran, Irsalina and Irina for their laughs and smiles

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LIST OF ABBREVIATIONS

PERKESO	Pertubuhan Keselamatan Sosial
SOCISO	Social Security Organization
Bernamea	Pertubuhan Berita Nasional
BS	British Standard
MySET	Malaysian Society for Engineering And Technology
LCC	Life-Cycle Cost
NAFAM	National Asset and Facilities Management
UBBL	Uniform Building By-Laws
RC	Reinforced Concrete
AHU	Air Conditioning Unit
PWD	Public Works Department
UV	Ultra Violet
RWDP	Rain Water Down Pipe
CCTV	Close Circuit Television
VOC	Volatile Organic Compound

CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

Recent years saw many roof leak incidents occurred at some prestigious government buildings such as Parliament House, new High Court Building (At Jalan Duta) and Terminal Building of Kuala Lumpur International Airport. Since Malaysia receives high precipitation, the durability and functionality of waterproofing system are crucial and interesting to study. This research will study the factors affecting the performance of waterproofing system for flat roofs at the selected PERKESO buildings. The key factors in selecting those buildings are merely the factor of accessibility of important data such as the history of the buildings, area of the flat roofs, variant waterproofing materials and maintenance records.

The roof provides protection to the building users from the effect of weather such as rain, sun radiation and thunderstorm. It also gives an aesthetic value to the building and may represent certain cultural elements through its design. However for the reinforced concrete flat roof, waterproofing component must be included as a ‘must’ element to make sure the roof will function effectively. In this research, a flat roof is referred to as a top most reinforced concrete slab that functions as a roof for the building.

In Malaysia, two types of roof structures are commonly used namely pitched roof and flat roof. Pitched roof is popular for residential buildings and relatively conventional in terms of design while the flat roof is widely used for commercial buildings as it gives a modern look. However pitched roofs are presumed to have a

better performance in the sense of flowing out surface water thus does not warrant any waterproofing system. This factor makes the pitched roof is popular amongst designers.

The flat roof design has been gradually increasing in Malaysia in line with the advancement in materials and design choices. For certain types of building, a flat roof is considered more cost-efficient compares to triangle-shape pitched roof as it can be multi-functions such as recreational, roof gardens and helipad purposes. On the other hand, flat roofs are subject to human rough activity, punching force and stagnant water which possibly causing cracks or punctures to the waterproofing membranes. Activities like placing of equipment such as Air Conditioning Unit (AHU) or installation of through-roof service pipes/cables are the examples of human rough activities while the uneven concrete surface is an example of a puddle-causing factor.

1.2 PROBLEM STATEMENT

Roof leakages occur due to many factors. Some of the commonly cited factors are the failure of waterproofing systems including lacks of maintenance, low-quality material, inappropriate use of material, workmanship problem and weather issue. The scope of this research is to study the main factors at the selected buildings in order against the real factors that affect their performance of waterproofing systems. It involves the study of the substrate condition, maintenance routine, weather condition and properties of the waterproofing material used.

1.3 BACKGROUND OF STUDY

PERKESO or in its English abbreviation, SOCSO is an acronym for Social Security Organization. It was established in 1971 under the Ministry of Human Resources (formerly known as Ministry of Labor) with the aim to administer, enforce and

implement the social security schemes under the Employee Social Security Act 1969. According to PERKESO Annual Report 2011, as of December 2011 there were approximately 5.76 million active employees and 820,000 employers registered with PERKESO. To cope with the increment, PERKESO has to have satisfactory numbers of staff and offices as well. By the 31st of December 2011, PERKESO has approximately 2,051 employees working in 48 offices across Malaysia.

These numbers are expecting to soar in line with the steady economic growth. Out of forty-eight offices, thirty-four are owned by PERKESO while the remaining is shop-lot premises being rented from the private owners. Thirteen of the PERKESO owned-building are stand-alone buildings known as MENARA PERKESO or WISMA PERKESO and located in major cities while the rest is a shop lot premise. Table 1.1 shows the locations and ownerships of PERKESO buildings.

Table 1.1
Location and Ownership Status of PERKESO Buildings

NO	STATE	OFFICE LOCATION	OWNERSHIP	
			OWN	RENTED
1	TERENGGANU	Wisma PERKESO Kuala Terengganu	/	
2		Dungun		/
3		Kemaman		/
4	SABAH	Wisma PERKESO Kota Kinabalu	/	
5		Lahad Datu	/	
6		Sandakan	/	
7		Tawau	/	
8		Keningau		/
9	SARAWAK	Wisma PERKESO Kuching	/	
10		Miri	/	
11		Bintulu	/	

NO	STATE	OFFICE LOCATION	OWNERSHIP	
			OWN	RENTED
12		Sibu		/
13		Sri Aman		/
14		Kapit		/
15		Sarikei		/
16	LABUAN	Labuan		/
17	SELANGOR	Wisma PERKESO Petaling Jaya	/	
18		Klang	/	
19		Rawang	/	
20		Kajang		/
21	MELAKA	Wisma PERKESO Melaka	/	
22	NEGERI SEMBILAN	Wisma PERKESO Seremban	/	
23		Kuala Pilah	/	
24	JOHOR	Wisma PERKESO Johor Bahru	/	
25		Batu Pahat	/	
26		Muar	/	
27		Segamat	/	
28		Kluang		/
29	PAHANG	Wisma PERKESO Kuantan	/	
30		Temerloh	/	
31		Bentong	/	
32	KELANTAN	WISMA PERKESO Kota Bahru	/	
33		Kuala Krai		/
34	KUALA LUMPUR	Menara PERKESO, Jalan Ampang	/	
35		Wisma PERKESO W.P Kuala Lumpur	/	
36	PERLIS	Kangar (1 Lot)	/	
37		Kangar (1 Lot)		/
38	KEDAH	Wisma PERKESO Alor Setar	/	
39		Langkawi	/	
40		Kulim	/	

NO	STATE	OFFICE LOCATION	OWNERSHIP	
			OWN	RENTED
41		Sungai Petani	/	
42	PULAU PINANG	Wisma PERKESO Seberang Jaya	/	
43		Wisma PERKESO Pulau Pinang (Blok A & Block B)	/	
44	PERAK	Wisma PERKESO Ipoh	/	
45		Taiping	/	
46		Teluk Intan	/	
47		Kuala Kangsar		/13
48		Tapah		/
		TOTAL	34	14

Source: PERKESO's Property Division (2013)

In this research, three PERKESO buildings with the flat roof from different states were chosen as case studies so that the results could be taken to represent the overall flat-roofed PERKESO buildings. The height of the buildings varies from 18m (6-storey) to 60m (19-storey). They were selected because of the factor of high rise, flat roof and accessibility of data. Table 2 lists the buildings, the regions and the type of waterproofing system used.

Table 1.2
Type of Waterproofing System for Case Study

NO	PERKESO BUILDINGS	YEAR OF BUILT	TYPE OF WATERPROOFING SYSTEM
1.0	WISMA PERKESO KUALA LUMPUR	2008	LIQUID
2.0	WISMA PERKESO ALOR SETAR	2009	LIQUID
3.0	WISMA PERKESO KUANTAN	2009	TORCH MEMBRANE LIQUID

Source: PERKESO's As-Build Documents (2013)

1.4 RESEARCH AIM AND OBJECTIVES

The aim of this study is to identify the main factors affecting the performance of waterproofing system for the flat roof of the selected buildings. It involves the study of workmanship, the quality of waterproofing materials, weather, cost, usage of flat roof area and maintenance.

The objectives of this study are as follows:

- a) To identify the deficiency of waterproofing system and its root causes.
- b) To identify ways in order to have the best performance of waterproofing system

1.5 SIGNIFICANCE OF THE RESEARCH

The identified problems as described in this study will be useful to all interested parties to understand waterproofing system for the flat roof at PERKESO buildings which is in some aspects represents typical government buildings. With that, it is hoped that the performance of waterproofing issue could be improved.

1.6 RESEARCH PROCESS AND WORK FLOW

The research adopts a mixed mode that combines quantitative and qualitative method. It starts with a problem statement on the studied issue. It was followed by literature review to find out the relevant studies and information on the topic. Interviews were conducted with some parties including the technical staff of PERKESO's Property Division, maintenance personnel, consultants, contractors and building users. Field inspections were made to the buildings for case study to observe the real condition of the flat roof and its waterproofing system. The results and finding from the literature review and case studies was analysed and concluded with the recommendations. The complete workflow for this research is illustrated in Figure 1.1.

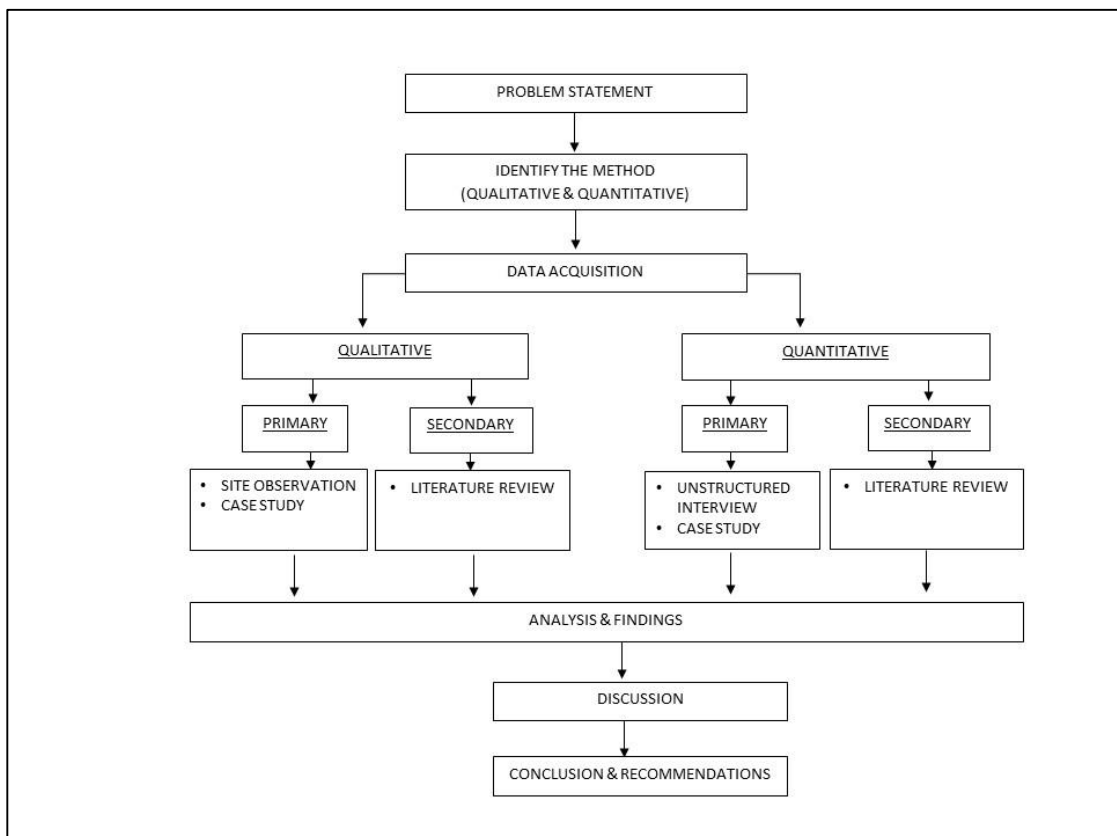


Figure 1.1: Flow Chart of Research Process