



**COMPARATIVE STUDY ON THE EFFECTIVENESS OF  
CEMENTITIOUS AND ELASTOMERIC WATERPROOFING  
MATERIALS TO COMPLY WITH ASTM D5957**

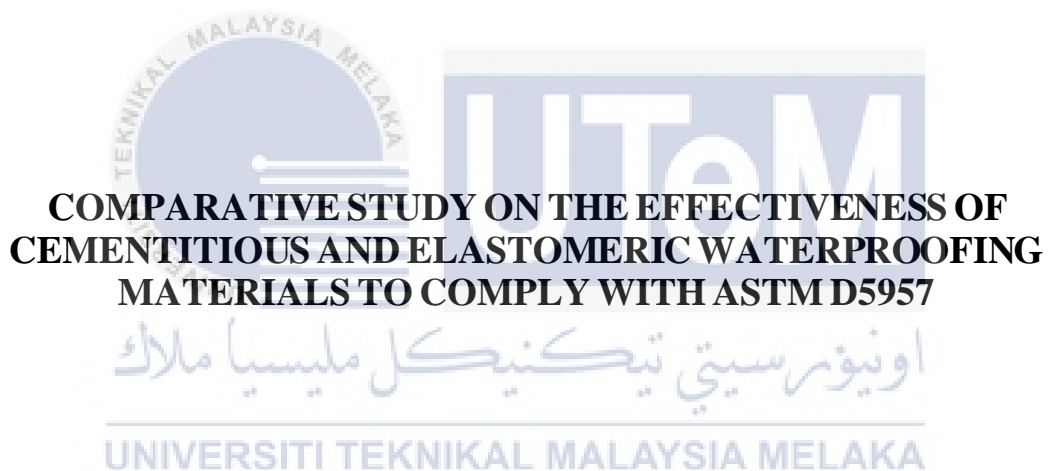


**BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY  
WITH HONOURS**

**2023**



**Faculty of Mechanical and Manufacturing Engineering Technology**



**Mohamad Nur Ikhmal bin Asmadi**

**Bachelor of Mechanical Engineering Technology with Honours**

**2023**

**COMPARATIVE STUDY ON THE EFFECTIVENESS OF CEMENTITIOUS AND  
ELASTOMERIC WATERPROOFING MATERIALS TO COMPLY WITH ASTM  
D5957**

**MOHAMAD NUR IKHMAL BIN ASMADI**



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2023**

## DECLARATION

I declare that this thesis entitled “Comparative Study On The Effectiveness Of Cementitious And Elastomeric Waterproofing Materials To Comply With ASTM D5957” is the result of my own research except as cited in the references. The result has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

:



Name

:

Mohamad Nur Ikhmal Bin Asmadi

Date

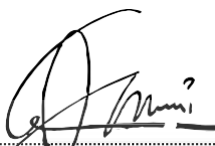
:

20 JANUARY 2023



## APPROVAL

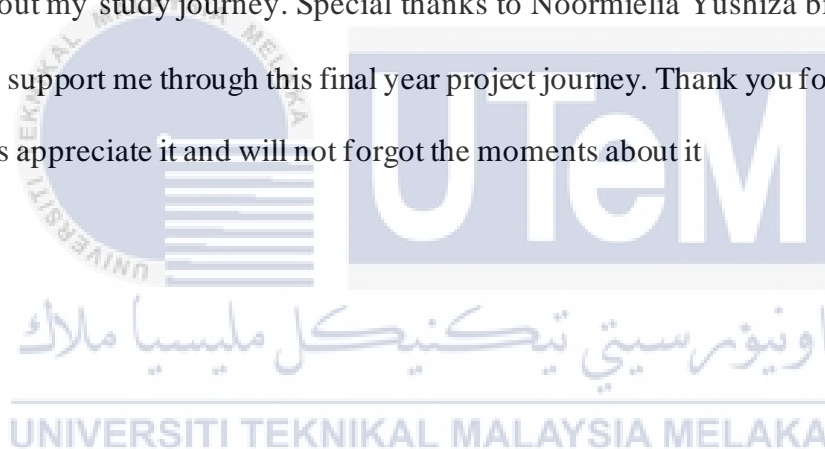
I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology with Honours.

Signature :   
Supervisor Name : Ts. Khairil Amri Bin Kamaruzzaman  
Date : 20 JANUARY 2023



## DEDICATION

First of all, Praise be to God that I am able to completed my thesis. I would like to thank Allah for giving me strength to complete this study and to see this thesis become reality. I am dedicated this project and research work to my beloved parents, Asmadi bin Ishak and Umi Salamah binti Osman who have always fully support and motivate me to finish my studies. Also to my supervisor Ts. Khairil Amri bin Kamaruzzaman and also my siblings, Nurshazereena binti Asmadi, Mohamad Nur Hakimi bin Asmadi and my friends who help me throughout my study journey. Special thanks to Noormielia Yushiza binti Md Yusoff who always support me through this final year project journey. Thank you for all the helping and I always appreciate it and will not forgot the moments about it



## ABSTRACT

One of the factors that make the infrastructure last longer is the waterproofing materials used. Weather factors that occur in Malaysia are the main cause in selection of a waterproof material to maintain the lifespan of a building or residential structure. Waterproofing is vital in humid tropical climatic regions such as Malaysia, and waterproofing chosen as the material will be determined by the extent of material exposure to rainwater. Furthermore, Universiti Teknikal Malaysia Melaka technology campus has encountered a few problems concerning bad waterproofing. Therefore, a comparative study on the effectiveness of cementitious and elastomeric waterproofing materials is conducted to help UTeM maintenance team on cost-effective strategy. Standard testing using ASTM D5957: Flood Testing Horizontal Waterproofing Installations will be the benchmark for this assessment to give an accurate testing analysis. Existing material data from an open literature study was used to determine the method, areas of application, and standards to analysis waterproofing. Testing of the specimen follow as per requirement of ASTM standard. Three tests will be performed on the specimens which are Water Penetration, Hardness Test and Water Absorption. The study findings show that the water penetration test resembles the ASTM D5957 standard. Other than that, Water Absorption ASTM D570 is applied to measure the quantity of water absorbed under specific conditions. Due to its high porosity, Cementitious waterproofing gained more weight compared to Elastomeric waterproofing. Based on the observations and analysis result, Elastomeric waterproofing material proves to be more effective compared to Cementitious waterproofing although both waterproofing materials comply with ASTM D5957 standards. It gives assurance that the ASTM D5957 standard used in this study may be used to testing the integrity of waterproofing material successfully.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## **ABSTRAK**

*Salah satu faktor yang menjadikan infrastruktur bertahan lebih lama adalah bahan kalis air yang digunakan. Faktor cuaca yang berlaku di Malaysia adalah penyebab utama pemilihan bahan kalis air untuk mengekalkan jangka hayat bangunan atau struktur kediaman. Bahan kalis air sangat penting di kawasan iklim tropika lembap seperti Malaysia, dan bahan kalis air yang dipilih sebagai bahan akan ditentukan oleh sejauh mana pendedahan bahan terhadap air hujan. Selanjutnya, kampus teknologi Universiti Teknikal Malaysia Melaka telah menghadapi beberapa masalah mengenai bahan kalis air yang teruk. Oleh itu, kajian perbandingan mengenai keberkesanan bahan kalis air simen dan elastomer dilakukan untuk membantu pasukan penyelenggaraan UTeM melakukan strategi kos efektif dalam memilih bahan kalis air. Piawai ujian menggunakan ASTM D5957: Pemasangan Kalis Air Mendatar Ujian Banjir akan menjadi penanda aras penilaian ini untuk memberikan analisis ujian yang tepat. Data bahan yang ada dari kajian literatur terbuka digunakan untuk menentukan kaedah, kawasan aplikasi, dan piawaian untuk menganalisis bahan kalis air. Pengujian spesimen akan mengikut keperluan standard ASTM. Tiga ujian akan dilakukan pada spesimen iaitu Penembusan Air, Ujian Kekerasan dan Penyerapan Air. Hasil kajian menunjukkan bahawa ujian penembusan air menyerupai piawai ujian ASTM D5957. Selain itu, ujian penyerapan air ASTM D570 digunakan untuk mengukur kuantiti air yang diserap dalam keadaan tertentu. Oleh kerana liangannya yang tinggi, berat bahan kalis air simen menambah berbanding dengan bahan kalis air elastomer. Berdasarkan hasil pemerhatian dan analisis, bahan kalis air elastomer terbukti lebih berkesan berbanding dengan bahan kalis air simen walaupun kedua-dua bahan kalis air mematuhi piawaian ASTM D5957. Ini memberi jaminan bahawa piawaian ASTM D5957 yang digunakan dalam kajian ini dapat digunakan untuk menguji integriti bahan kalis air dengan jayanya.*

UNIVERSITI TEKNIKAL MALAYSIA MELAKA



## ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform.

My utmost appreciation and sincere gratitude to my supervisor, Ts. Khairil Amri bin Kamaruzzaman for all his unwavering support and advice for me to complete my final year project successfully. I have gained so much information and experience to compete in my next step of career.

Last but not least, from the bottom of my heart a gratitude to my beloved parents, Asmadi bin Ishak and Umi Salamah binti Osman, for all encouragements and motivation since my first day being a student. My eternal gratitude also to my siblings, Nurshazereena binti Asmadi and Mohamad Nur Hakimi bin Asmadi. Not forget to mention, my housemates especially Daniel, Tinish, Izzul, Ammar, Syazwan and Amir who has helped me directly and indirectly in this Final Year Project journey. Special gratitude to Noormielia Yushiza who helped and motivate me through this degree journey. Finally, I am grateful for all of the help provided to me in completing my final year assignment.

## TABLE OF CONTENTS

	<b>PAGE</b>
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>DEDICATION</b>	
<b>ABSTRACT</b>	<b>i</b>
<b>ABSTRAK</b>	<b>ii</b>
<b>ACKNOWLEDGEMENTS</b>	<b>iii</b>
<b>LIST OF TABLES</b>	<b>vi</b>
<b>LIST OF FIGURES</b>	<b>vii</b>
<b>LIST OF APPENDICES</b>	<b>x</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Project Overview	1
1.2 Problem Statement	4
1.3 Research Objective	5
1.4 Scopes of Research	5
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>7</b>
2.1 Introduction	7
2.2 Building Envelope	7
2.3 Waterproofing Method	10
2.3.1 Cement based Waterproofing Method	11
2.3.2 Elastomeric Waterproofing Method	13
2.3.3 Bituminous Membrane Waterproofing Method	17
2.3.4 PVC Waterproofing Membrane Method	18
2.3.5 Polyurethane Waterproofing Method	22
2.4 Areas of Waterproofing	24
2.4.1 Basement	25
2.4.2 Wet Areas	27
2.4.3 Roof	30
2.5 Testing Standards	33

2.5.1	ASTM D5957-98 (2013)	33
2.5.2	ASTM D5385-93	34
2.5.3	ASTM D570-98	35
<b>CHAPTER 3 METHODOLOGY</b>		<b>37</b>
3.1	Introduction	37
3.2	Research Design	38
3.2.1	List Of Material	39
3.2.2	Sample Preparation	39
3.3	Flow Chart	46
3.3.1	Testing	46
3.3.2	Location	50
3.3.3	Observation	51
<b>CHAPTER 4 RESULT AND DISCUSSION</b>		<b>56</b>
4.1	Introduction	56
4.2	Water Penetration Observation Test Result	56
4.3	Water Absorption Test Result	61
4.4	Hardness Testing Result	64
4.5	Summary	65
<b>CHAPTER 5 CONCLUSION AND RECOMMENDATION</b>		<b>67</b>
5.1	Conclusion	67
5.2	Recommendation	68
<b>REFERENCES</b>		<b>69</b>
<b>APPENDICES</b>		<b>74</b>

## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 2.1	Cementitious Coating Properties	13
Table 2.2	Advantages and Disadvantages of Elastomeric Waterproofing	15
Table 2.3	Advantages and Disadvantages of Bituminous Waterproofing	18
Table 2.4	Advantages and Disadvantages of PVC Waterproofing Membrane	20
Table 2.5	Advantages and Disadvantages of Polyurethane Waterproofing	23
Table 2.6	Decision that effect on selecting system	26
Table 2.7	Criteria selection for Waterproofing system	28
Table 3.1	List of Material for Waterproofing Coating	39
Table 3.2	Material Price	39
Table 3.3	Application of Waterproofing on Sample	42
Table 4.1	Observation on Elastomeric Coating Sample	56
Table 4.2	Observation on Cementitious Coating Sample	57
Table 4.3:	Water Absorption for Cementitious Sample	61
Table 4.4:	Water Absorption for Elastomeric Sample	62
Table 4.5:	Properties of Cementitious Coating	63
Table 4.6:	Properties of Elastomeric Coating	64

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 2.1	Components of Building Envelope	10
Figure 2.2	Building system required for ongoing maintenance	11
Figure 2.3	Spray application of cementitious waterproofing	13
Figure 2.4	Wall waterproofing on masonry	14
Figure 2.5	Pentens Elastomeric Waterproofing	17
Figure 2.6	Elastomeric Waterproofing applied on roof	17
Figure 2.7	Bitumen Waterproofing Membrane System -Vproof 3mm & 4mm	19
Figure 2.8	Time to destruction dependent on stress at constant temperature	21
Figure 2.9	PVC Waterproofing Membrane	22
Figure 2.10	Water-spray analysis of a brick panel coated with 1:4 cement mortar	24
Figure 2.11	Polyurethane Waterproofing	24
Figure 2.12	Difference of Positive-side and Negative-side Waterproofing	26

Figure 2.13	Decision that effect on selecting system	26
Figure 2.14	Typical floor slab	28
Figure 2.15	Adequate drop in floor slab	29
Figure 2.16	Material for Wet Areas in Singapore Code of Practice	29
Figure 2.17	Waterproofing wet area floors	30
Figure 2.18	Waterproofing leakage on roof	31
Figure 2.19	Waterproofing of Inverted Roof	32
Figure 2.20	ASTM D570 Test Procedure for Different type of Immersions	36
Figure 3.1	Box to apply the Waterproofing	38
Figure 3.2	Container Used for Sample	40
Figure 3.3	1.5L of Water as Benchmark	40
Figure 3.4	Mark 1.5L of Water Using Masking Tape	40
Figure 3.5	Pentens T-200 Elastomeric Waterproofing Coating	41
Figure 3.6	Pentens AB-Bond Cementitious Waterproofing Coating	41
Figure 3.7	Wiped Container to Ensure Free from Any Material	43
Figure 3.8	Elastomeric Coating is Covered to Entire Benchmark Area	43
Figure 3.9	Recommended Mixing Ratio by Manufactured	44
Figure 3.10	Adjusted Mixing Ratio of Cementitious Coating	44

Figure 3.11	Applying Cementitious Coating Using Brush	45
Figure 3.12	Curing Process of Cementitious Coating	45
Figure 3.13	Flow Chart of Comparative Study	46
Figure 1.14	Water Absorption Test on Elastomeric Coating Sample	47
Figure 3.15	Rockwell Hardness Machine	48
Figure 3.16	Filled 1.5L of Clean Water into the Container Sample	49
Figure 3.17	1.5L of Clean Water in the Container Sample	49
Figure 3.18	Maps of Faculty of Mechanical & Manufacturing Engineering Technology (FTKMP)	50
Figure 3.19	Factory 3 of Technology Campus	51
Figure 3.20	Overall layout of Technology Campus	52
Figure 3.21	Layout of Factory 3	53
Figure 3.22	Mould Issue at Factory 3	54
Figure 3.23	Water Leaking at Factory 3 Toilet	54
Figure 3.24	Cracked Paint at Factory 3	55
Figure 2.1	Yellow Stains on Elastomeric Coating	59
Figure 4.2	Water Penetrate Cementitious Coating	60
Figure 4.3	Presence of Dew on the sample	60

## LIST OF SYMBOL AND ABBREVIATIONS

**PVC** - Polyvinyl Chloride

**mm** - Millimeter

**%** - Percent

**kg** - Kilogram

**C** - Celcius

**g** - Gram

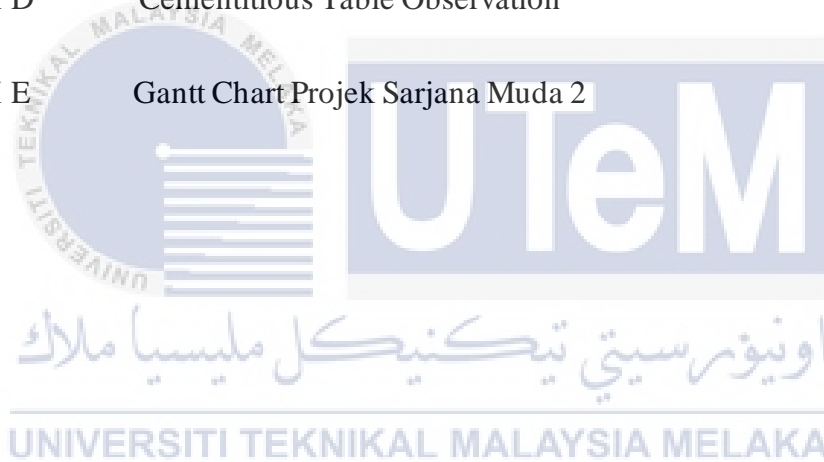
**cm** - Centimeter





## LIST OF APPENDICES

APPENDIX	TITLE	PAGE
APPENDIX A	Gantt Chart	74
APPENDIX B	Turn-it-in	75
APPENDIX C	Elastomeric Table Observation	77
APPENDIX D	Cementitious Table Observation	86
APPENDIX E	Gantt Chart Projek Sarjana Muda 2	95



# CHAPTER 1

## INTRODUCTION

### 1.1 Project Overview

Malaysia's economy is among the fastest expanding in Southeast Asia. Growth infrastructure is responsible for a substantial proportion of the country's economic investment, due to first-rate infrastructure. It is consequently crucial that these facilities, which include public structures, are kept in good condition so that they can fulfil both architectural and aesthetic purposes for which they were intended. One of the factors that make the infrastructure last longer is the waterproofing materials used. Across the year, Malaysia has warm and humid weather. The average annual temperature in Malaysia ranges from 21 to 32 degrees Celsius. Malaysia's weather is typically affected by winds from the Indian Ocean (Southwest Monsoon Winds - May to September) as well as the South China Sea (Northeast Monsoon Winds - November to March). The average rainfall is approximately 80%, ranging from 2000 mm to 2500 mm (Malaysian Meteorological Department, 2017). Weather factors that occur in Malaysia are the main cause in selection of a waterproof material to maintain the lifespan of a building or residential structure. Waterproofing is vital in humid tropical climatic regions such as Malaysia, and waterproofing chosen as the material will be determined by the extent of material exposure to rainwater (Talib et al, 2015).

Waterproofing is a basic requirement of any construction project. It is essentially a process that prohibits water from entering a structure. Waterproofing is usually performed in layers and phases to generate different barriers preventing water from penetrating the

structure. Regardless of the scale, size, area, or layout of the structure, waterproofing materials are a critical component for ensuring the structural integrity and safety of the building's occupants. Its area of application includes basements, flat roof, retaining wall, balconies, and banded areas. There are several steps to apply the waterproofing material such as using a paintbrush, sprayer, or rollers. Also, the paint thickness varies according to the type of paints, coating, and waterproofing material used. Creating a "Building Envelope" is the result of a series of such stages which will enclosures all contribute to a building's performance. This performance is hampered mostly by outside weather conditions, the most significant of which are rainwater and site drainage. Thus, the correct application of a waterproofing system can protect a structure from climate, seepage from the ground, and vertical water travel. As a result, a waterproofing system is useful not only to the entire building envelope but also to a particular element of the building. The consequences of selecting unsuitable material and method of application of a waterproof material will cause damage to your home's structural integrity and it also will affect physical and medical health of the occupant. According to (Abdul Malik, 2021), a tenant said that they had to live a full life in the living room and even facing the risk of electric shock following the electrical lines of the three rooms entering the water due to a waterproofing failure in his apartment.

Waterproofing should ideally be durable, stretchable, tear-resistant, and elastic so it can fill cracks and move with the structure. If the membrane will be exposed to sunlight, it must be UV resistant. The membrane must be flexible enough to conform to any surface it is applied to, as well as capable of rotating up and over walls as well as other structural elements. There are five waterproofing methods that are commonly used which is Cementitious Waterproofing, Liquid Waterproofing Membrane, Bituminous Membrane, Bituminous Coating, and Polyurethane Liquid Membrane. Cementitious waterproof coatings are two-component, permeable, seamless coatings that are used to offer advantages and

disadvantages side waterproofing protections on concrete building surfaces. It protects against water ingress and mould and mildew growth. It is utilized behind the tile, on masonry repairs, and concrete. Due to their cementitious nature, these above- and below-grade waterproofing coats have a great bonding strength to concrete and masonry substrates. This coating protects the cement or other substrates from the impacts of strong acid gases, moisture, and chlorides, as well as chemical attacks (Constro Facilitator, 2021).

Meanwhile, elastomeric coating is a thicker-than-paint, above-grade external wall or roof finish. It generates an extremely thick yet flexible covering that aids in the waterproofing of a structure's exterior. It could bridge hairline cracks to create an airtight waterproof seal, unlike other forms of coatings or paints. It can be applied to a variety of surfaces, including stucco, concrete, brick, and more. Elastomeric coatings are suitable for both walls and roofs. So, when elastomeric coating is sprayed in liquid form, it entirely dries, hardens, and attaches to the structure while remaining flexible, moving, bending, and flexing in tandem with the structure beneath it. It helps preserve a structure from damage in and provide a waterproof protective layer. It may be tinted in a variety of hues and keeps its colour for a long time. Thus, it aids in maintaining the desirable appearance of the building's façade while preventing the less appealing appearance of damage, wear, and tear. These two materials have their own advantages, so this analysis is to investigate the effectiveness of cementitious or elastomeric waterproofing materials to fulfil the cost-effective strategy on the selection of materials and coatings.

## 1.2 Problem Statement

Tropical countries like Malaysia experience rain and sunshine all year, which is good for the people, but it can cause structural and water damage to structures. It also encourages microbial growth in areas where moisture is retained. Fungi and other invisible airborne pests can have a negative impact on the health of those who live in the building by causing respiratory disorders such as respiratory problems and other discomforts and infections, particularly in more vulnerable populations such as children and the elderly. Malaysia's rainfall is likewise consistently high throughout the year, averaging 3085.5 millimetres on an annual average basis (mm). Precipitation averages roughly 200 millimetres every month throughout the year, ranging from 200 millimetres in June and July to 350 millimetres in November and December. There are two monsoon seasons: Southwest Monsoon (April-September) and Northeast Monsoon (October-December) (October-March) ([www.climateknowledgeportal.worldbank.org](http://www.climateknowledgeportal.worldbank.org), 2021). Due to prolonged rains that occur in Malaysia, it can cause water leakage which will give significant damage to buildings, first aesthetically and then structurally, if instant measures are not taken. Also, the technology campus has encountered a few problems concerning bad waterproofing. Therefore, a comparative study on the effectiveness of cementitious and elastomeric waterproofing materials is conducted to help Universiti Teknikal Malaysia Melaka (UTeM) maintenance team on cost-effective strategy.

This comparative study is conducted to provide a good waterproofing material. This is because the harsh climate and other environmental factors in Malaysia have continuously induced the damage rate in the wet areas. In addition, it was also conducted to provide effectiveness analysis on the selection of materials and coatings.

The comparative study that was conducted is difficult to analysis because the material is not the same with each other. Therefore, standard testing using ASTM D5957: Flood

Testing Horizontal Waterproofing Installations will be the benchmark for this assessment to give an accurate testing analysis. This standard is a method for testing the watertightness of waterproofing installations that applied to horizontal surfaces with a maximum slope of 20 mm/m (2% slope) (1/4" per foot). It is applied to completely attached or bonded sheet membranes, liquid or fluid applied membranes, and loose laid sheet membranes placed on parking garages and plaza deck types above inhabited areas or elevated structures.

### 1.3 Research Objective

The main aim of this research is to analyse and evaluate of a waterproofing material. Specifically, the objectives are as follows:

- a) To test the effectiveness of the waterproofing material using ASTM D5957: Flood Testing Horizontal Waterproofing Installations.
- b) To compare the cost-effective waterproofing material based on data analysis.

### 1.4 Scopes of Research

The aim of this project is to compare on the effectiveness of cementitious and elastomeric waterproofing materials to comply with ASTM D5957 at Faculty of Mechanical and Manufacturing Engineering Technology (FTKMP) wet areas. Faculty of Mechanical and Manufacturing Engineering Technology (FTKMP) was established on 1 July 2018 after the Faculty of Engineering Technology was restructured into two new faculties which is Faculty of Mechanical and Manufacturing Engineering Technology and Faculty of Electrical and Electronic Engineering Technology. There are three faculties which is Department of Mechanical Engineering Technology (JTKM), Department of Manufacturing Engineering Technology (JTKP), and the new one is the Department of Industrial Technology (JTI).

Therefore, the structural strength, durability and resistance of the building material are decreasing from year to year it is built.

Faculty of Mechanical and Manufacturing Engineering Technology (FTKMP) wet area were chosen as the area to carry out the project because it is an area that is easily exposed to water which will cause the occurrence of dampness and deterioration in a building element. Cementitious and elastomeric waterproofing materials were chosen for this project because they are materials that are readily available in stores. The procedures outlined for designation and guidance of this testing uses temporary contention accumulation of pond water on level surfaces to determine the compact of the waterproofing installations. The initial procedure of the project will be starting with study of previous experimental project, and then continued with testing the effectiveness of the waterproofing material using ASTM D5957: Flood Testing Horizontal Waterproofing Installations. Then, after conducting overall process will begin to choose the cost-effective waterproofing material depends on the testing result data analysis. Lastly, the analysis on the effectiveness of the waterproofing material will benefit UTem maintenance team on choosing cost-effective strategies in selection of materials and coatings.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

In this chapter, research from journal, internet, books, and other resources have been used to get information and facts regarding to this research project. The aim of this study is to create a basic knowledge and information from previous knowledge and ideas to complete this project.

#### 2.2 Building Envelope

The building envelope is comprised of all building components that serve to divide the interior from the exterior. The outer wall, foundation, roof, windows, and doors comprise the building envelope. Some subsystems, including heating, cooling, and ventilation equipment, plumbing, and electrical systems, effect the performance of building envelope. The interaction between subsystems and building envelope components, as well as other occupant actions, can alter the performance of building envelope.

A building's envelope is a complex and vital element. However, it is frequently the most overlooked part of a structure. The building envelope should be designed, built, and maintained appropriately to avoid air and water infiltration through envelope and condensation of moisture within the envelope system (Seaverson, 2006). A building envelope is typically described as "tight" or "loose." A structure with a loose envelope allows the air to travel more freely throughout, whereas a building with a tight enclosure provides for more comfort control, fewer moisture issues, and greater energy efficiency. Obviously, a tighter seal reduces natural ventilation, necessitating increased mechanical ventilation. These three essential components must be present for a building envelope to work correctly