



**Faculty of Manufacturing Engineering**

**EVALUATION OF USED PLASTER OF PARIS  
RECYCLEBILITY FOR MOULD MAKING**

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**EVALUATION OF USED PLASTER OF PARIS RECYCLEBILITY FOR  
MOULD MAKING**

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**A thesis submitted  
in fulfillment of the requirements for the degree of Master of Manufacturing  
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## DECLARATION

I declare that this thesis entitled “Evaluation of Used Plaster of Paris Recyclebility for Mould Making” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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## APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering (Industrial Engineering)

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## **DEDICATION**

This thesis is dedicated to my beloved mother, father and wife. They have been a source of motivation and strength during moments of despair and discouragement, support has been shown in incredible ways recently.

## ABSTRACT

The use of plaster of Paris is widespread mainly in the manufacture of ceramic products, especially of clay using a plaster mold. Plaster molds used to produce cast products such as claypots, dishes, decorative lighting, tiles, sculpture and many more. However, the plaster mold has a particular life cycle of casting, usually useable for approximately hundred times or less depending on thier usage and then the unused mold needs to be disposed. Even so, the plaster should not be discarded because of an arbitrary chemical content that can cause pollution to the environment, eco-systems, health and cost. It is also should not be kept for long period because it requires a large storage area and dusty. As a solution, the used plaster mould can be recycled to produce a new mould. However, the method of recycling the used mould is still less known. In order to create new mould from recyceld plaster, the unused plaster need to mix with virgin plaster and conduct experiment to identify characteristic of new plaster mould. The criterias that need to be considered are the setting time, water absorption, strength and purity of the material. This study needs to be done is the technique of plaster mixing, determine the setting time, water absorption techniques, flexural by using 3 – points bending and using XRF to identify the purity of plaster . Meanwhile, the same experiment will be performed on the virgin plaster and the result is recorded as a benchmarking for comparison. At the end of this study, the results obtained from recycled plaster are able to meet the criteria as mentioned above and about 10% - 20% of plaster ca be reused in the process mould making development.

## ABSTRAK

*Penggunaan plaster of Paris amat meluas terutamanya didalam bidang pembuatan produk seramik khususnya produk berasaskan tanah liat yang menggunakan acuan plaster. Acuan plaster digunakan untuk menghasilkan produk tuangan tanah liat seperti pasu, pinggan mangkuk, lampu hiasan, jubin, barang perhiasan dan banyak lagi. Walaubagaimanapun, acuan plaster ini mempunyai tempoh hayat tertentu mungkin seratus kali tuangan atau lebih ataupun kurang bergantung kepada penggunaan dan acuan ini perlu dilupuskan. Walaupun begitu, plaster ini tidak boleh dibuang sebarangan sahaja kerana kandungan kimianya boleh menyebabkan pencemaran alam sekitar, eko-sistem, kesihatan dan kos. Ia juga tidak boleh disimpan terlalu lama kerana memerlukan kawasan simpanan yang besar dan berhabuk. Sebagai jalan penyelesaian, plaster tadi perlu dikitar semula sekurang – kurang 10% - 20% plaster boleh digunakan semula dalam proses membuat acuan. Kriteria yang perlu dititikberatkan ialah masa untuk mengeras, kadar serapan air, kekuatan dan ketulenan bahan. Antara kajian yang perlu dilakukan ialah teknik campuran aduan plaster dengan air, menentukan masa untuk mengeras, teknik rendaman serta kaedah 3 titik lentur dan menggunakan XRF. Sementara itu, ujikaji yang sama dilakukan terhadap plaster yang baru dan hasilnya direkodkan sebagai penanta aras. Di akhir kajian ini, beranggapan keputusan yang diperolehi daripada plaster yang dikitar semula itu dapat memenuhi kriteria – kriteria yang dinyatakan diatas.*

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## TABLE OF CONTENTS

	PAGE
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF APPENDICES	x
CHAPTER	
1. INTRODUCTION	1
1.1 Background of study	1
1.2 Problem statement	8
1.3 Objectives of this research	9
1.4 Project scope	9
2. LITERATURE REVIEW	11
3. METHODOLOGY	17
3.0 Research flow	17
3.1 Raw material preparation	19
3.2 Data sheet for material preparation	21
3.3 Flexural test	22

3.4	Water absorption	24
3.5	Casting rate	25
3.6	Purity test	26
3.7	Expected result	28
3.8	Discussion and conclusion	28
3.9	Summary	29
<b>4.</b>	<b>RESULT</b>	<b>30</b>
4.0	Result	30
4.1	Material characteristic	30
4.2	Specimens	32
4.3	Flexural test	33
4.4	Water absorption	35
4.5	Casting rate	37
4.6	Setting time	39
4.7	Visual and surface	40
4.8	Test summary	41
<b>5.</b>	<b>DISCUSSION</b>	<b>42</b>
5.1	Material characteristic	42
5.2	Specimens	43
5.3	Strength	44
5.4	Water absorption	45
5.5	Casting rate	45
5.6	Setting time	46

5.7	Visual	47
5.8	Surface	48
<b>6.</b>	<b>SUMMARY AND CONCLUSION</b>	<b>49</b>
6.0	Summary and conclusion	49
	<b>REFERENCES</b>	<b>51</b>
	<b>APPENDICES</b>	<b>54</b>

## LIST OF TABLES

TABLE	TITTLE	PAGE
1	Types of mould and consistency of water	13
2	Material specimens composition	21
3	Flexural test result	22
4	Data sheet for water absorption	24
5	Casting rate	25
6	Comparison table for single batch	27
7	The composition of virgin POP (main mineral)	30
8	The composition of recycled POP (main mineral)	31
9	Material specimen composition	33
10	MOR test result	34
11	Result of water absorption of mixed POP specimens	36
12	Result of casting rate	38
13	Result of setting time	39
14	Result summary	40

## LIST OF FIGURE

FIGURE	TITTLE	PAGE
1	Plaster model and plaster mould	2
2	Unused plaster mould	3
3	Product student need to be disposed	3
4	Passed semester plaster mould	4
5	Old plaster mould and model	4
6	Waste of POP (balance POP from mould making)	5
7	Waste of POP in dustbin	5
8	Broken model block (for lathe purpose)	6
9	The red line will cause defect on ceramic product	7
10	Steel rack for mould	13
11	Flowchart of research	18
12	Process flow raw material preparation	20
13	Illustrate 3-point bending test	23
14	XRF machine	26
15	Example of XRF diagram	26
16	XRF spectra of virgin POP	31
17	XRF spectra of recycled POP	32
18	Relation between percentage of recycled POP and strength	34

19	Relation between percentage of recycled POP and porosity	36
20	Relation between percentage of recycled POP and casting rate	38
21	Relation in between percentage of recycled POP and setting time	40

## LIST OF APPENDICES

APPENDIX	TITTLE	PAGE
A	Gantt chart (activities planning)	54
B	Summary of analysis table	55
C	XRF Spectrum result (virgin POP)	56
D	XRF Spectrum result (recycled POP)	57

## CHAPTER 1

### INTRODUCTION

#### 1.0 Background study

Recently most of peoples do not know about the usage of ceramic in their life accept the common once such as vase, sanitary ware, table ware and pottery. However, ceramic field is a vast field that is needed to be explored. Basically, ceramics are divided into two major categories; traditional or conventional ceramics and advanced ceramics. The traditional ceramic commonly uses manual method to produce ceramic product such as throwing, peaching, slip casting and forming. In advanced ceramics, there are various ways to produce the products such as pressure casting, ram pressing, powder pressing, injection moulding, cold isotactic pressing, and fast firing. The example of the products for advanced ceramic are wall tiles, cutting tools, machinery equipment, space shuttle body, and so on. In this study the effect of recycled Plaster of Paris (POP) in order to reduce POP material wastage is investigated. Refer to Figure 1, 2, 3, 4 and 5 show examples of the student products that need to be disposed after end of the semester. The products are plaster model, plaster mould and plaster case mould that was produced by student. Meanwhile, Figure 6, 7, and 8 are showed another wasted of the POP during lab works. All these wasted need to be disposed to keep practical lab in clean condition and free from dust. In fact, during practical class the POP will be dumped into dustbin is not less than 10



kg due to failure of the products. Furthermore, this activity is running eighteen times per semester and total POP wastes are not less than 180 kg.



Figure 1: Plaster model and plaster mould



Figure 2: Unused plaster mould



Figure 3: Product student need to be disposed



Figure 4: Passed semester plaster mould



Figure 5: Old plaster mould and model





Figure 6: Waste of POP (balance POP from mould making)



Figure 7: Waste of POP in dustbin



Figure 8: Broken model block (for lathe purpose)

Recently, there are lot of POP wastes in ceramic production area especially in mould making developments and slip casting production. In mould making development, product student as known as plaster mould and model will be removed from temporary storage after finished 2<sup>nd</sup> semester. This will be routing cycle, cause give way to new batch student for participant mould making development class. For the slip casting production, after a curtain cycle, plaster mould must be disposed due to lack of efficiency on casting rate and obtaining defect at the product, refer to Figure 1.9. At the same time, this activity will become waste and affecting the environment. So, one of the solution is to recycle POP by adding percentage into fresh POP and make study on effect of recycled POP material.



Figure 9: The red line will cause defect on ceramic product.

In order to recycle, waste POP will be used as an additive in fresh or virgin POP. This condition will create new mixed POP body for mould making development. However, this activity may change properties or characteristics of virgin POP. To verify it, some experiments need to be conducted on the new mixed POP and virgin POP. The experiments that may consist water absorption testing, setting time testing, flexural testing



and purity of POP testing. All these testing more related to the properties of plaster mould requirement in mould making development. The data from testing and experiment need to be recorded and at the same time, experiment data from virgin POP is highly required for optimum value to make it as a benchmarking. So, result from new mixed POP can be compared against virgin POP results. If the value from new mixed POP are similarly with optimum value that mean, the new mixed POP are acceptable as a raw material in mould making development. Otherwise, the new mixed POP can be done in other applications.

### **1.1 Problem statement**

Currently KKTm Masjid Tanah having a lot of waste material due to unused plasters mould. This happened because every end of semester student products will be disposed especially plasters mould and model. Today, there are no alternative ways to manage the wastage of plaster mould and model. At the same time, plaster of Paris is already registered as a schedule waste and need to pay for disposal material in dumping area in order to keep environment clean and free space in storage area. Furthermore, the cost of buying virgin POP is cheaper than paying to disposal site agency and need to meet the requirement of Department of Environment (DOE). On the other hand, the POP also will harm ecosystem and hazardous to health. Another problem is there is a limited reading material to make a reference according to recycle POP. In this opportunity, new mixed plaster will be produced by adding percentage recycled of plaster especially from used plaster mould and model into virgin POP. However, some challenges are need to be faced for example; binding system in the body, strength, setting time, and water absorption.

Besides that, another problem faced is data comparison in between virgin plaster and new mixed body plaster.

## **1.2 Aim and objectives**

- i. To prepare material and specimen by mixing recycled POP with virgin POP.
- ii. To study the effect of mixing recycled POP with virgin POP on various parameters such as; setting time, water absorption, strength and purity.
- iii. To evaluate recycled POP performance compare with virgin POP

## **1.3 Project scope**

To produce new mixed POP body for slip casting mould in mould making development. This new body is produced by adding recycled POP into virgin POP with a different ratio. The recycled POP will crushing into powder and dries under temperature 60 degrees Celsius. Dried powder will mix with virgin POP in certain ratio and prepare specimens for testing. The testing that may conduct are water absorption, setting time, flexural and purity of the new mixed POP. Result from the testing need to be recorded and evaluate by comparing the current value with the optimum value. Optimum value gathered from testing result on virgin POP. After comparison is complete that may conclude that new mixed POP whatever may use or not in mould making development for slip casting