Design And Develop Mold For EM 8 Standard Test Method For Tension Testing Of Metallic Material

MUHAMMAD SYAHIR BIN ISHAK

B091810483

BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Mechanical and Manufacturing Engineering Technology

Design And Develop Mold For EM 8 Standard Test Method For Tension Testing Of Metallic Material

Muhammad Syahir bin Ishak

Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

2021

Design And Develop Mold For EM 8 Standard Test Method For Tension Testing Of Metallic Material

MUHAMMAD SYAHIR BIN ISHAK

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this Choose an item. entitled “Design And Develop Mold For EM 8 Standard Test Method For Tension Testing Of Metallic Material” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : MUHAMMAD SYAHIR BIN ISHAK

Date : 18 JAN 2022

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 Manufacturing Engineering Technology (Process and Technology) with Honours.

Signature : .....

Supervisor Name : TS DR. HANIZAM BIN HASHIM

Date : 18 JAN 2022 .....

DEDICATION

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents that have support me mentally and most importantly financially to my many friends and who know me from UTeM or social media who have supported me throughout the process. I will always appreciate all they have done, especially my Supervisor Ts Dr Hanizam Bin Hashim for helping me develop my technology skills. I dedicate this work and give special thanks to my best friend. Thank you very much.

ABSTRACT

There are two types of casting processes, expendable mold and permanent mold. The purpose of this research is to make a permanent mold out of a metallic material. There are a few mold designs that can be compared between the old mold and the new mould design. Casting is an excellent method for mass production, and the design can include a variable number of cavities. The drawing is made with a solidwork programmed, and the design chosen must meet the improvement criteria. During the manufacturing process, a 3-axis conventional milling machine is used to machine the mold cavity to obtain squaring stock and datum side. Surface grinding machines are used to achieve flatness in order to prevent pouring leaks and for assembly. A solidwork design is exported to CATIA v5 in order to generate NC code and machining simulations. The cavity pattern is created using a 5 axis CNC milling machine. The cutting tool is the most important to obtain a precise design in order to avoid any defects in the mold pattern, which can affect the quality of the product while making it easier to assemble. Then, in order to achieve the goal, a casting process is used to perform testing. The material of the product is aluminium A356, which is appropriate for this study. In this study, a parameter important for avoiding product defects was investigated, such as a solidified, pouring speed, pre heated mold, and so on. To complete this study, the product's surface is evaluated using a surface roughness tester to obtain data. Based on this information, a t – test is run using Minitab software to compare the CNC method to direct casting. The graph will be generated by software, and evidence will be provided to support the probability expectation.

ABSTRAK

Dalam proses tuangan, acuan mempunyai dua jenis iaitu acuan boleh buang dan acuan kekal. Tujuan kajian ini adalah untuk menghasilkan acuan kekal menggunakan sederhana carbon aloi. Dalam mengahsilkan reka bentuk acuan yang baik, tiga reka bentuk dihasilkan dan membuat pilihan mengikut pengubahsuaian bentuk acuan. Reka bentuk acuan dilukis menggunakan Solidwork software . Semasa dalam proses pembuatan, mesin pengisar 3 paksi digunakan untuk membuang lebihan ukuran pada bahan dan membuat 90 darjah pada sisi bahan. Untuk mecapai kerataan, mesin mencanai digunakna bagi tujuan meratakan permukaan bahan, ini kerana ia mampu untuk mengahsilkan kecactan pada product dan menyukarkan untuk proses pemasangan. Seterusnya,untuk menghasilkan bentuk pada acuan, mesin yang digunakan adalah CNC milling 5 axis . Dalam pada ini, alat pemotongan amatlah penting bagi tujuan mencapai ketepatan pada acuan. Tambahan pula, dalam mencapai objektif, proses tuangan akan dijalankan dan bahan yang digunakan dalam proses tuangan adalah jenis aluminium A356. Pada proses ini, parameter adalah penting bagi menjamin kualiti pada produk. Permukaan pada produk tuangan akan dinilai dan direkod data memalui alat penilaian kekasaran permukaan. Untuk melenkapkan kajian ini, data yang direkod dianalisis menggunakan t- test Teknik. Nilai yang dihasilkan dapat memberi keterangan dalam menyokong kebrangkalian untuk menerima tanggapan pada keputusan.

ACKNOWLEDGEMENTS

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

First of all, i would like to thank all of those who gave me the chance to complete this report. I would like to express my sincere appreciation for the valuable assistance and support that he has given me in the preparation of this report by Ts. Dr. Hanizam Bin Hashim, my final year project supervisor. Over these two semesters I am very grateful for his valuableguidance and support. I also want to thank all my friends who gave me suggestions and suggestions in the project and to express my appreciation. I also thank Mr. Ishak Bin Mukhtar and Norhashimah Binti Awang in. They always support mephysically and mentally. This enables me to concentrate without worry on my final year project. Finally, I extend my sincere thanks to all the lecturers and fellow students who offered me insights and lessons throughout my university life. I can acquire their expertise and become a better person with their advice and help. This can help me to be a professionalengineer and a future person.

TABLE OF CONTENTS

PAGE

DECLARATION

APPROVAL

DEDICATION

ABSTRACT **i**

ABSTRAK **ii**

ACKNOWLEDGEMENTS **iii**

TABLE OF CONTENTS **iv**

LIST OF TABLES **vi**

LIST OF FIGURES **vii**

LIST OF SYMBOLS AND ABBREVIATIONS **viii**

LIST OF APPENDICES **ix**

CHAPTER 1 INTRODUCTION **10**
1.1 Background 10
1.2 Problem Statement 12
1.3 Objective 12
1.4 Scope of Project 13

CHAPTER 2 LITERATURE REVIEW **14**
2.1 Introduction 14
2.2 Permanent mold 15
2.2.1 Top feeding 16
2.2.2 Side feeding 16
2.2.3 Filter 16
2.2.4 Sprue 17
2.2.5 Feeder 17
2.2.6 Sprue well 18
2.2.7 Ingate 18
2.2.8 Structure of cavity 19
2.2.9 Runner and gating system 19
2.2.10 Pattern and cavity 20
2.3 Design engineering 21
2.3.1 Conception design 22
2.3.2 Mold design and gating system 22
2.3.3 Solidwork software 23
2.3.4 CATIA v5 23

2.3.5 Application CAD/CAM 24
2.3.6 Selection of design cavity 24
2.4 Material selection 25
2.4.1 Mold properties 26
2.4.2 Product properties of Aluminium A356 26
2.5 Manufacturing process 27
2.5.1 Milling machine 27
2.5.2 Surface grinding machine 28
2.5.3 5 Axis CNC milling machine 28
2.5.4 Rough cutting 29
2.5.5 Finishing cutting 29
2.6 Casting application 30
2.6.1 Advantages and disadvantages of permanent mold 30
2.6.2 Pouring in casting 31
2.6.3 Phase of solidification 32
2.6.4 Defect of casting 33
2.7 Analysis of surface roughness 33
2.7.1 T-test analysis 34
2.7.2 Tensile testing 34
2.8 Conclusion 35

CHAPTER 3 METHODOLOGY 36
3.1 Introduction 36
3.2 Manufacturing flow chart 37
3.3 Material selection 38
3.3.1 Material of mold 38
3.3.2 Material of product 39
3.4 Mold design 39
3.4.1 Selected design of mold 40
3.5 Manufacturing process 42
3.5.1 3 Axis conventional milling machine 42
3.5.2 Surface grinding machine 43
3.5.3 Generate a simulation program 43
3.5.4 5 Axis milling machine 44
3.6 Casting process 45
3.7 Inspection of parameter casting 45
3.8 Characterization 47
3.8.1 Visual inspection 47
3.8.2 Effect of surface roughness to the tensile testing 48
3.8.3 Application of t-test analysis 49
3.8.4 Analysis the surface of CNC method versus direct casting 49
3.9 Procedure of fabrication 51
3.10 Conclusion 54

CHAPTER 4 RESULTS AND DISCUSSION 55
4.1 Introduction 55
4.2 design of sample 56
4.3 Advantage of the new mold design 57
4.4 Analysis of the surface roughness data 59
4.4.1 Probability 61
4.5 Conclusion 63

CHAPTER 5 **CONCLUSION AND RECOMENDED** 64
5.1 Conclusion 65
5.2 Recommendation

REFERENCES **66**

APPENDICES **70**

LIST OF TABLES

TABLE	TITLE	PAGE
Table 1	The composition of mild carbon steel	38
Table 2	Composition of aluminium alloy	39
Table 3	Selection design of mold	41
Table 4	Methadology of project.	51
Table 5	New cavity of mold.	57
Table 6	Old mold and product.	58

LIST OF DIAGRAM

TABLE	TITLE	PAGE
Diagram 1	Flowchart of process	37

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1	Schematic of mold component	15
Figure 2	A single cavity (a) and multicavity (b)	20
Figure 3	Graph cooling curves of pure metal or eutectic alloy	32
Figure 4	3 Axis conventional machine	42
Figure 5 & 6	Surface grinding semi auto machine	43
Figure 7	CAD/CAM process	44
Figure 8	Generate NC code	44
Figure 9	5 Axis CNC milling machine	44
Figure 10	Drilling process	44
Figure 11	Temperature is increased to 700-degree Celsius	45
Figure 12	Defect from short pour	47
Figure 13	Surface roughness testing	48
Figure 14	A sampe design is refered to standart ASTM.	56
Figure 15	Standard of specimen based on standard ASTM.	56
Figure 16	The specimen of testing.	58
Figure 17	Statistic of data CNC and casting.	59
Figure 18	Estimation for difference	60
Figure 19	Result of *p* - value	60
Figure 20	Graph of individual value plot	61
Figure 21	Graph of boxplot.	62

LIST OF SYMBOLS AND ABBREVIATIONS

CAD	-	Computer Aided Design
CAM	-	Computer Aided Machine
CNC	-	Computer Numerical Control
EM	-	Standard testing
P	-	Lower basin pressure
c	-	Celcius
etc	-	etcetera
i.e	-	Example
g	-	Gravity
H	-	Height of ladle
T	-	Time of pouring
V	-	Pouring speed
m/s2	-	Meter/ second square
VT	-	Vibration Treatment
TST	-	Total solidification time
C_M	-	Mold constant
A	-	Area surface of casting
mm	-	Milometer
ASTM	-	American Society for Testing Materials
°	-	Degree
%	-	Percentages
V	-	Volume of casting

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
APPENDIX	Data of surface roughness	68
	Gantt chart PSM 1	59
	Gantt chart PSM 2	70
	Drawing of mold	71
	Surface roughness testing data	78

CHAPTER 1

INTRODUCTION

1.1 Background

Casting is a smart way to go because it is a cost-effective way to obtain raw materials while still reducing discarded metal scrap. The new method of casting metal and the method used 100 years ago are vastly different. The precision and resistance of a component can be archived in modern technology during the design process, and modern machine technology can also be used to produce precise cores and mold.

Casting is a process of manufacture where a molten material usually flows to a mold containing a hollow cavity, which can be solidified in the desired form. Also known as a cast, in this process solidification has begun in heat transfer from liquid hot temperature cast to the mold and the metal has shrink due to which air gap is formed in between cast and the mold. The cooling curves are the major influence on the quality of a cast. The cooling rate that affects the microstructure and properties is the most important part of the cooling curve. Generally speaking, a casting area that is quickly cooled will be finely grained and will have a coarse grain structure, slowly cooling (Al-luaibi, 2015). Most of die castings are made from non-ferrous metals, particularly zinc, copper, aluminium, magnesium, plumbs, pewter,and tin-based alloys. The die casting method is particularly suited for applications in whichgreat detailed, fine surface quality, and dimensional consistency are required to produce large numbers of small to medium-sized parts.

This project begins with identifying suitable products for designing a die casting mold. The product has been decided according to title EM 8 standard test method for

tension testing of metallic material, it knows as a dog-bone. Tensile testing is commonly used in engineering application for selecting the material. The strength might be measured the stress are appreciable plastic deformation with the maximum stress can be withstand. Furthermore, tensile testing is performed to measure the ductility, and how much the measure of material can be deformed before fracture.

Computer aided design (CAD) and simulation using Computer Aided Manufacturing (CAM) software will be used to design the mold die casting. Furthermore, the machining process is performed with a CNC milling machine, followed by the die casting process. The products will then be analyzed in terms of shape and tension testing. All the process methods will be combined at the end of the project to study and investigate the defects, structure, mechanical properties, mold design, and material selection in the die casting process.

The project background and scope were discussed in this section. The problem declaration and goals are included. It is important to make the declaration of the problem. We have already made use of the scope for this project to guide the entire of project.

1.2 Problem statement

Die casting is one of the economic processes for precise formed piece production. A precision casting method is used to inject the molten metal into the diving cavity. When the molten metal fills the cavity, it reinforces with rapid refreshments. Die-cast components are increasingly employees their high quality, low cost, and low weight in automotive, aerospace, electronics, and other industries.

However, casting products still have defective products. No defective parts and some very hard parts can produce a mold. A few defects can be seen in products primarily due to solidification, pouring, raising size, etc. However, this kind of thinking is difficult to control, as the casting process involves the melted metal in the mold cave as a practical process by humans instead of the machine. Thus, the casting system for this project has been designed and calculated to reduce part defects concerning the casting gating system and risers. CNC milling and CNC lathe machines are commonly used to produce tension specimens. The casting process is the best method is used to save the cost and time. As a result, it can produce more product at once.

1.3 Objective

The main purpose of this study is to design and fabricate the mold for EM 8 standard test method for tension testing of metallic material. Specially, the objective are as follows:

1. To design a permanent mold for aluminium alloy according to the EM8 standard using Solid Work/ CATIA software.
2. To fabricate the selected design of steel permanent mold using CNC machine.
3. Analyze the surface of sample CNC method and sample direct casting using T -test analysis.

1.4 Scope of Project

The project's scope is to design tension testing specimens in accordance with EM 8 standards. A design is created with specialized software such as Solidworks. The purpose of this engineering design software is to create a product that includes a tension testing specimen and a permanent mold. To improve on the old mold, a design for a few types is created. The design is chosen based on machine capability, time, and cost. The raw material is machined using a 3-axis milling machine to fabricate the mold. This is known as squaring stock. Surface grinding is used to machine a stock to achieve a good surface. The materials used in this project are limited to aluminium A356 as a casted material and mild steel as a permanent mold. Furthermore, CATIA v5 software is used to simulate the mold fabrication process and generate NC code prior to entering the manufacturing process. The machine is used to make the cavity part, and it is a 5 axis CNC milling machine. As a result, assemble all the cavity plate parts before beginning the casting process. The casting process is currently underway at FKP on the Utem campus. The casting product is measured with a vernier caliper, and the measurement is checked to ensure that it meets the EM 8 standard as well as the drawing. To obtain data, a sample of the product is evaluated by a surface roughness machine. The purpose of the data collection is to examine and analyses it to find a comparison a greater surface roughness between the CNC method and direct casting.

.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides with the detail description literature review done according to title of “Design and develop mold for EM 8 standard test method for tension testing of metallic material”. Because the purpose of this project is to design the die casting mold and produce tensile testing specimen using Solidwork and the suitable software such as CATIA V5 and software associated with that. Thus, literature reviews related to the definition of metal casting, the fundamental principles of casting, and other projects related to the design engineering. This review of the literature gives an overview or a brief introduction of the appropriate techniques for this project.

2.2 Permanent mold

Permanent mold has two type open and closed molds. Molten metal will be simply poured into an open mold until the cavity is filled, while molten metal is poured into a gatedsystem until the cavity is filled up. The door controls the molten metal flow into the center and cavity. For the process to be completed, cooling and solidification are necessary. After sufficient cooling of the cast can be removed from the cavity. (Adeoti et al., 2019). In permanent casting, there are no external pressure is applied in the continuous casting of molds, but the main responsibility of the metal casting is hydrostatic pressure created by therisers. This process is also called a gravitational die casting because no external pressure is applied. The main advantage here is a permanent mold that is used repeatedly for multiple castings. This solidification takes place much faster than in sand casting (Bhardwaj et al., 2014).

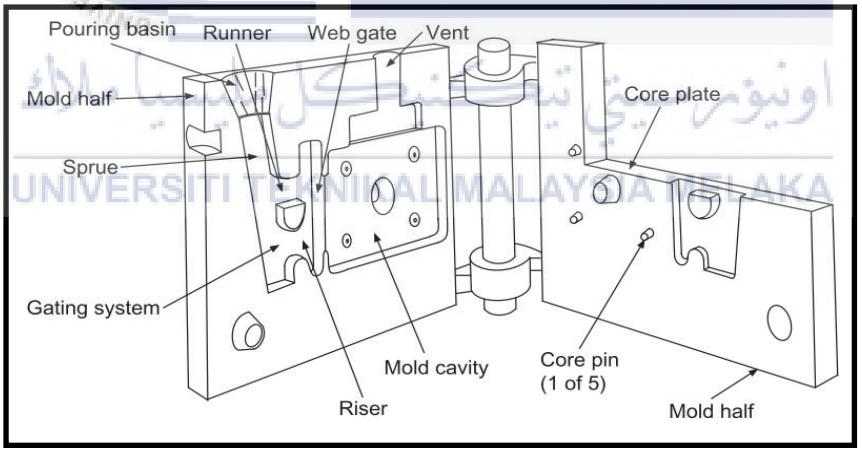

Figure 1 : Schematic of mold component

2.2.1 Top feeding

The molten metal enters the mold cavity from the base of the casting in the top feeding system in this situation, the process of slow metal filling and higher temperatures can be required. The fused metal enters the mold cavity without jetting, helping to produce a sound casting, gradually when the design is correct. However, the longer time it was solidified was due to the slower filling process (Schwam & Wallace, 2004).

2.2.2 Side feeding

Using a large slope positioned on the side of the casting, the side feeding method is commonly called a web gating. This gating system in which the riser is connected via a small input section to the whole casting height. This design is located at the top of the raising of the molten metal known as a feeder. The thin ingest force provides adequate resistance to the metal flow in this process to the slow flow rate. In this case, the metal entering the mold cavity provides less turbulence. If the flow rate is lowered, it can eliminate filtering by reducing the flow rate (Schwam & Wallace, 2004).

2.2.3 Filter

In a gating system, the filter has two functions. They are inserted to help reduce or remove slag and dross from the metal as it entered to the cavity. The filter's efficiency is the biggest surface area, and the filter lowers the metal speed. The filter adds to reduce metal flows as metal flows through the pores system and decrease turbulent in the gate. The metal flow is less turbulent if metal is exiting the filter (Schwam & Wallace, 2004).

2.2.4 Sprue

The molten aluminium enters the mold via a sprue in a vertical permanent mold. Sometimes the molten aluminium is poured into a pot above the sprue. The metal's height presses the system head-on. The equation of pressure is calculated with P = μgh. P stands for lower basin pressure.¨is the aluminium density, g is the weight (9.8 m/s2). The force is fed into the mold by this pressure. The metal flows sprue down, the velocity is accelerating. The mold is expected to cause most turbulence due to the increase in speed. This turbulence is allowed large surface areas of metal to encounter the reactive ambient air and form oxides. A sprue design is tapered to be narrower at the base. The taper has several functionsto prevent aspiration and air entanglement from the molten metal flux. This process causes the air to be trapped into the casting and forms porosity relatively fast solidification rates inthe permanent mold system. The minimum length of the taper must be 0,008 cm per cm. Thesprue can also be used for the installation of a fixed height and diameter flow rate of metal.Sprue design is the most important part of the gating (Schwam & Wallace, 2004).

2.2.5 Feeder

During solidification process, the feeder of a gate system is used to supply the metal into cavity. When a metal starts freezing in the chambers, the metal shrinks and depends on the casting geometry, shrinkage may take shape. The warmest metal is stored on the feeder and provided through the gate, if necessary, to the cavity. The feeder height should be somewhat higher than the actual casting then. This process enables a small excess pressure against capillary forces (Schwam & Wallace, 2004).