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JUDUL: **Design Rules for Casting Process Using CAD Tool.**

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UNIVERSITI TEKNIKAL MALAYSIA, MELAKA

DESIGN RULES FOR CASTING PROCESS USING CAD TOOL

This report submitted in accordance of with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) with Honours.

by

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FACULTY OF MANUFACTURING ENGINEERING
2010

DECLARATION

I hereby, declared this report entitled "Design Rules for Casting Process using CAD Tool" is the results of my own research except as cited in references.

Signature	:	…….
Author's Name	:	MOHD FIRDAUS BIN IBRAHIM
Date	:	12TH APRIL 2010

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design). The member of the supervisory committee is as follow:

……

(Mr. Taufik)

(Supervisor)

ABSTRACT

This project was highlighted on design rules of casting process. The design rules was focused on the part that will influence the casting product, unorthodoxly with current researches as many of researchers more concentrate on general casting process design guidelines. This project was to analyses of the product and it will be fabricated by using one of casting methods which is investment casting. Investment casting is a typical one among casting methods and it is also called lost-wax casting. This project was used the casting technology that can produce parts with high in accuracy and precise in dimension and parameters. The part that had been gone through analysis was spherical bracket for pneumatic bar. Spherical bracket had been designed using one Computer Aided Design (CAD) tool which was CATIA V5R19. Then, it had been analyzed by using ANSYS V12. Hence, the analyses will determined the design rules for the spherical bracket using investment casting.

ABSTRAK

Projek ini adalah khusus kepada garis panduan untuk proses tuangan. Garis-garis panduan proses tuangan ini difokuskan kepada bahagian yang akan mempengaruhi produk yang dihasilkan melalui proses tuangan kelak, berbanding dengan kajian-kajian yang dilakukan oleh para kajiselidik ketika ini yang lebih tertumpu kepada garis-garis panduan untuk proses tuangan sahaja. Projek ini adalah untuk menganalisis produk dan akan dihasilkan menggunakan salah satu teknik tuangan iaitu tuangan pelaburan. Tuangan pelaburan juga disebut sebagai tuangan lilil hilang. Projek ini menggunakan teknik tuangan pelaburan kerana ia boleh menghasilkan bahagian-bahagian yang mempunyai ukuran dan parameter yang tepat dan jitu. Analisis akan dilakukan terhadap penyangga yang digunakan untuk silinder pneumatik. Penyangga tersebut akan direkabentuk dengan menggunakan salah satu daripada alat CAD iaitu CATIA V5R19. Kemudian, ia akan melalui analisis yang dilakukan dengan menggunakan ANSYS V12. Melalui analisis-analisis tersebut, ia akan menentukan garis-garis panduan untuk penyangga dengan menggunakan tuangan pelaburan.

DEDICATION

Here, I would like to dedicate my love to my parents, Mr. Ibrahim Bin Omar and Mrs. Aishah Binti Awang for their supports, helps and cares while completing this project. Special thanks to my supervisor, Mr. Taufik for his encouragements, advices, and motivational supports for me to finish PSM 2.Thanks a lot to my colleagues for giving supports and their keenness helping me during completing my project for the whole smester.

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Alhamdulillah, with the guidance and support I received, my PSM 2 has completed by right time following to faculty's requirement. I would like to express my special greatest gratitude to my supervisor, Mr. Taufik for his valuable guidance and continuously support throughout the entire course of my work.

Finally, do not forget also my friends who have helped provide guidance and moral support to me in the success of this project.

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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

This report described a project on identifying the design rules for casting process using CAD Tool.

In manufacturing operations, certain guidelines and design principles pertaining to casting have been developed over many years. Although these principles have been established primarily through experience, analytical methods, process simulation and modelling, and computer-aided design and manufacturing techniques have all come into wide use as well, thus improving productivity and the quality of castings and resulting in significant cost savings.

Malaysia has grown up as of developing country in the world. Malaysia has made it clear as their Gross National Product (GDP) is 6% to 7% per year. As consequence, there are lot of Malaysian manufacturers have been setup in years. There are 2% of Malaysian manufacturers who are applying casting technology for their businesses out of over 2000 manufacturers registered at Federation of Malaysian Manufacturers. This shown that there is plenty company who make use of casting technology.

Casting is made from metal which is melted, poured into the mould, cooled and solidified. To make casting, the process of melting metals, moulding, pouring, shakeout and cleaning must to be carried out. Various furnaces are used to melt metals. Some castings are easy and others are difficult to make depending upon their shapes, sizes and dimensions.

All casting operations share some characteristics, such as phase and thermal shrinkage during the casting cycle. Consequently, a number of design considerations apply equally to, for example, sand casting and die casting. However, each process will have its own particular design considerations; sand casting will require the consideration of mould erosion and associated sand inclusions in the casting, whereas die casting will not have this concern (although it has its own problems, such as heat checking of dies which reduce die life).

1.1.1 General Design Considerations for Casting

Kalpakjian and Schmid (2006) classify that there are two types of design issues in casting: (a) geometric features, tolerances, etc. that should be incorporated into the part and (b) mould features that are needed to produce the desired casting. Robust design of castings usually involves the following steps:

a) Design the part so that the shape is cast easily.
b) Select a casting process and a material suitable for the part, size, mechanical properties, and so on. Often, the design of the part will not be independent of the first step, and the part, material and process have to be specified simultaneously.
c) Locate the parting line of the mould in the part.
d) Locate and design the gates to allow uniform feeding of the mould cavity with molten metal.
e) Select appropriate runner geometry for the systems.
f) Locate mould features such as sprue, screens, and risers, as appropriate.
g) Make sure proper controls and good practices are in place.

1.1.2 Locating and Designing Gates

For locating and designing gates for casting process, Kalpakjian and Schmid (2006) explain that:

a) Multiple gates often are preferable and are necessary for large parts.

b) Gates should feed into thick sections of castings.
c) A fillet should be used where a gate meets a casting; this feature produces less turbulence than abrupt junctions.
d) The gate closest to the sprue should be placed sufficiently far away so that the gate can be easily removed.
    i. The minimum gate length should be three to five times the gate diameter, depending on the metal being cast.
    ii. Curved gates should be avoided, but when necessary, a straight section in the gate should be located immediately adjacent to the casting.

1.1.3 Riser Design

Another important part is riser. Kalpakjian and Schmid (2006) have explained that:

a) The riser must not solidify before the casting.
b) The riser volume must be large enough to provide a sufficient amount of liquid metal to compensate for shrinkage in the cavity.
c) Junctions between casting and feeder should not develop a hot spot where shrinkage porosity can occur.
d) Risers must be placed so that the liquid metal can be delivered to locations where it is most needed.
e) There must be sufficient pressure to drive the liquid metal into locations in the mold where it is most needed.
f) The pressure head from the riser should suppress cavity formation and encourage complete cavity filling.

Basically people always concentrate on general design for casting, risers design, and gates design. However, there are some criteria that never been emphasized or underlined in any casting process. The need of another rules or criteria is for the product that will be cast.

1.2 PROBLEM STATEMENT

S. Guleyupoglu (1997) has explained that the design parameters such as thickness for mould and gating system are important in casting technology. There are a lot of parameters which also important likewise tolerance, allowance, and angle. If the parameters are slacked, the result will lead to a modest product. At the moment, there is a lack between designer and manufacturing department at industry. Many products produced by investment casting technology have been rejected or in other word turn to scraps due to lack of design rules. Manufacturing department have to spend more times and cost to produce good finished product. Hence, the parameters that have been constraint in this project were chamfer, fillet, and hole. The design rules were developed by using tolerance as its variance.

1.3 OBJECTIVE

The objectives of project are:

a) To investigate the design parameters for a casting product.
b) To analyze the structural and fluid flow using ANSYS V12.
c) To develop design rules in investment casting.

1.4 SCOPE OF PROJECT

This project was divided in two parts. First, investigate the parameters of the product and second identify the design rules for casting process using CAD Tool. This project has focused on main product only which is spherical bracket for pneumatic cylinder. The 3D modeling or design process was used CATIA V5R19 while simulations were using ANSYS CFX. At last, the design rules for Investment Casting have been developed and also the design of spherical bracket has been improved by referring the design rules.

1.5 PROJECT OUTLINES

Based on the thesis for Projek Sarjana Muda (PSM) I, an organization has been constructed for the process flow of completion in order to fulfill course of Degree in Universiti Teknikal Malaysia Melaka (UTeM). Below shows the format of the organization:

I. Chapter 1 represents the introduction of the project conducted which is background, problem statement, objectives, scope and project outlines. In this chapter, it explains clearly how the subtopics influence each other in this project.

II. Chapter 2 represents the literature review on the background and basic information about the design rules for investment casting. By understand the basic concept and method of the investment casting; it may enhance the progress of this project.

III. Chapter 3 represents the methodology used for conduct this project. This chapter included the planning of the research, flowchart, and the sources of data.

IV. Chapter 4 shows the data results and presentation of data that have been collected in the production processes. The current state map is show in this chapter.

V. Chapter 5 represents the design improvement and discussion on the result of the study. It focused on the significance and implementations of the findings of this project.

VI. Chapter 6 presents the conclusion of the whole project and recommendation for future research.

1.6 Gantt Chart

Table 1.1: Gantt Chart of PSM 1.

No.	Tasks	Semester 01-2009/10																			
		July				August				September				October				November			
		W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
1	Select / Propose Project Title																				
2	Brainstorming of project title																				
3	**Preparation of Chapter 1**																				
4	Project Background																				
5	Problem Statement																				
6	Project Objective																				
7	Scope of Project																				
8	Submission and Discussion 1																				
9	**Preparation of Chapter 2**																				
10	Articles and Journals Finding																				
11	Highlighted Issues																				

12	Summarizing																					
13	Literature Review																					
14	Submission and Discussion 2																					
15	**Preparation of Chapter 3**																					
16	Introduction																					
17	Project Flowchart																					
18	Design and Analysis Tools																					
19	Submission and Discussion 3																					
20	Compiling Report																					
21	Submission of Report																					
22	Preparation of Presentation																					
23	Project Presentation																					

Table 1.2: Gantt Chart of PSM 2.

No.	Tasks	Semester 02-2009/10																			
		January				February				March				April				May			
		W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
1	**Preparation of Chapter 4**																				
2	Introduction																				
3	Design and Development																				
4	Preaparation of Analysis																				
5	Conduct Analysis																				
7	**Preparation of Chapter 5**																				
8	Analyze Results																				
9	Result Explanations																				
10	Result Optimization																				
11	Summarizing																				
13	**Preparation of Chapter 6**																				
14	Conclude Project																				
15	Suggestion and Recommendation																				
18	Compiling Report																				