UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN, SIMULATION AND ANALYSIS OF DISC ROTOR USING ANYCASTING SOFTWARE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Manufacturing Engineering Technology (Product Design) (Hons.)

by

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DECLARATION

I hereby, declare that this report entitled “Design, Simulation, and Analysis of Disc Rotor Using Anycasting Software” is the result of my own research except as cited in the references.

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Date : …….

APPROVAL

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

…….

(Project Supervisor)

…….

(Project Co-Supervisor)

ABSTRAK

Tujuan kajian ini adalah untuk mengkaji tentang kecacatan yang akan terhasil dalam proses tuangan pada cakera brek daripada bahan 'gray cast iron' melalui proses tuangan pasir. Kajian ini mengenai tuangan pasir dalam menghasilkan produk dimana di dalam industri pembuatan setiap produk yang dihasilkan mestilah mengikut spesifikasi dan kualiti yang ditentukan bagi mengelakkan produk itu tidak diterima. Pendekatan cuba jaya digantikan dengan teknologi moden dimana perisian simulasi digunakan dalam industri tuangan. Perisian Solidwork digunakan dalam memodel produk dan perisian simulasi AnyCasting digunakan dalam menjalankan proses tuangan pasir. Empat sifat kualiti yang akan dikaji iaitu masa pembekuan, rongga susut, mikro porositi dan isipadu penahan cairan. Hasil daripada ujikaji yang telah dilakukan, masa tuangan 100% kadar tuangan untuk rekabentuk 1 ialah 5.9865 saat, untuk rekabentuk 2 ialah 7.6648 saat dan untuk rekabentuk 3 sebanyak 1.5559 saat. Masa pembekuan pada 100% kadar pembekuan untuk rekabentuk 1 ialah 1172.8 saat, rekabentuk 2 selama 1452.6 saat dan rekabentuk 3 pula 1209.3 saat.

ABSTRACT

The aim of this study was to investigate the defects that will occur when designing a mould of disc brake by using gray cast iron as material through sand casting process. It is also study about sand casting to produce a product in the manufacturing of each product must be in accordance with specifications and quality in order to avoid products that have to be rejected. In this study, the trial and error approach has been replaced with modern technology, where simulation software is used instead to reduce the defects in casting. This project will focused on the simulation software that will run the sand casting process. Solidwork software is used in modelling and simulation software AnyCasting is used in simulating the sand casting process. The four quality characteristics that will be investigated in this study are the solidification time, shrinkage cavity, micro porosity and retained melt volume. The result of this study of the filling time at 100% filling rate for design 1 is 5.9865 seconds, for design 2 is 7.6648 seconds and for design 3 is 1.5559. The solidification time at 100% solidification rate for design 1 is 1172.8 seconds, for design 2 is 1452.6 seconds and for design 3 is 1209.3 seconds.

DEDICATION

Dedicated to my beloved parents, Jani Bin Isa and Mardiah Binti Gariman because of their loves, understanding and supporting. Special thanks to my supervisor, Ms. Nur Farah Bazilah Binti Wakhi Anuar, my co-supervisor, Mr. Mohamad Ridzuan Bin Mohamad Kamal, for the encouragement and patience in guiding to completing this project. To my friends, for all of their help and friendship.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

C	-	Carbon
CAD	-	Computer Aided Design
Fe	-	Iron
$FeCr_2O_4$	-	Chromite
Fe_2SiO_4	-	Fayalite
Mg_2SiO_4	-	Fosterite
Mn	-	Manganese
P	-	Phosphorus
S.G	-	Spheroidal Graphite
S	-	Sulphur
Si	-	Silicon
$ZrSiO_4$	-	Zirconium Silicate

CHAPTER 1
INTRODUCTION

1.1 Background

Foundry sand is often used in the industry to make parts consisting of iron, bronze, copper and aluminum as well. The metal is poured into the mould cavity that formed by the sand when the metal melted in the furnace. The process is relatively simple and inexpensive, and many industries use this process. However, the weakness of sand casting is commonly in parts of cast sand and it can affect the properties of casting materials (Merten, 2012).

Gray cast iron is one of the most important casting materials and has many industrial applications because of its good castability properties and large variation in mechanical properties. The variation of mechanical properties depends on the microstructure. The quality of the casting parts is depend on the percentage of the porosity in the product (Kumar & Kumar, 2012).

Disc brake or disc rotor is a device for slowing or stopping the rotation of the tire wheels. It is usually made of cast iron or ceramic, and connected to the wheels. Friction material on the brake pads are forced to stop the wheels mechanically, hydraulically or pneumatically against both sides of the disk and the resulting friction causes the disc and wheel to slow or stop the vehicle. Most of brake discs are produced with sand casting process. Casting defects such as shrinkage porosity and hot tear often occurs in sand casting process. This defect is influenced by the geometry of the casting, also from the runner and gating system that will lead to the formation and distribution of the defect. Gating system could lead to incomplete filling, insufficient feed volume shrinkage,

inclusions trapped and the dissolved gas as running with poorly designed. Design a proper running and gating system is the most importance to take into account to solve this problems. However, the translucent of the mould and high temperature molten metal during the casting process makes it difficult to be observed. Trial and error practices to get optimum design are expensive and time consuming. Casting process simulation is to help engineers to optimize the design foundry through a better understanding of the history of the solidified casting temperature. Simulation results can be used to obtain a defect free casting a systematic way (Yeh, Hwang, & Lin, 2008).

1.2 Problem Statement

The major problem in casting was defect. To detect the defect in the casting are by using a simulation because it is more simple and easy to detect the problem. In this simulation, we can know the problem about the solidification defect in casting. It is because, by using this simulation, we can see in three dimensional views. From that, we can see clearly at which part the defect on the cast occurs. In this project the result were simulate by the AnyCasting software. AnyCasting software simulation designed for casting process. It will help the foundry to produce better casting with forecast the defect through a simulation.

1.3 Objectives

The objectives of this project are:

i. To design the mould sand casting using Solidworks.
ii. To simulate the casting simulation of Gray Cast Iron disc brake in AnyCasting software.
iii. To analyze the casting defects on Gray Cast Iron disc brake in AnyCasting software.

1.4 Scope of Project

This project will be limited to this aspect:

i. This project is focusing on the defects of gray cast iron disc brake.

ii. This project also focusing on the defect casting parameter in AnyCasting software.

iii. AnyCasting simulation method will be used to complete the project.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Most brake rotor was made from gray cast iron is produced by many industrial foundry in this era. The cast iron material vary from the steel materials were higher in carbon (C) content and silicon (Si). Heavy steel have weight less than 1.2 percent (wt.%) carbon and a little or no silicon, where the carbon content in a cast iron usually range from 2.5 to 4.5 wt.% C and 1 to 3 wt.5 Si. It have a higher Sulphur (S) and Phosphorus (P) contents meanwhile the manganese is an important additive in the both metals. To lower the melting point of the metal, it must be added some extra carbon and silicon in cast iron. Cast iron material is easy to cast the complex shapes such as fittings and pipe. It will tend to form a brittle iron sulphide at the boundaries of the grains if it is without the Manganese even it is with Sulphur. This will cause the inclusion form and cause the crack during rolling and other forming and it would be a problem in steels (Iraqi, For, & Engineering, 2010).

2.2 Cast iron

It is primarily composed of iron (Fe), carbon (C) and silicon (Si), but may also contain of Sulphur (S), Manganese (Mn) and Phosporus (P) and it is the one of the oldest ferrous metals that use in foundry. The structure of the cast iron was crystalline and it is easy to brittle and weak in tension and the mechanical properties cast iron is hard, brittle, non-malleable than steel. Even though it is brittle, it is very good in compression. To determining the characteristic of cast iron, the methods to

manufacture itself will affect and the composition of the cast iron are must be taken very seriously.

Cast iron is commonly used in variety of structural and a decorative application because of it is reasonably inexpensive, durable and easy to cast into several of shapes and the most typical that are used:

i. Hardware such as hinges, latches
ii. Stairs
iii. Fences
iv. Tools and utensils
v. Stoves
vi. Structural connectors in buildings and monuments.

The characteristic of cast iron is extremely strong and durable when it is used correctly and confined from adverse exposure. It is commonly found in columns, rather than in structural beams because of, it is much stronger in compression than in tension. However, it is disposed to corrosion when it is exposed to moisture and has several regular problems which usually can be identified by visual inspection (Pulkit Bajaj, 2010).

2.2.1 White cast iron

White cast iron contains more than 2.11% carbon and all the carbon that present were combined in cementite form which is, it makes the fracture of these alloys have white and dull colour. Typical white cast iron contains 2.5 until 3.5% C, 0.4 until 1.5% Si, 0.4 until 0.6% Mn, 0.1 until 0.4% P, 0.15% S, and the balance are Fe. The figure below show the changes occur on cooling in hypoeutectic white cast iron (Pulkit Bajaj, 2010).

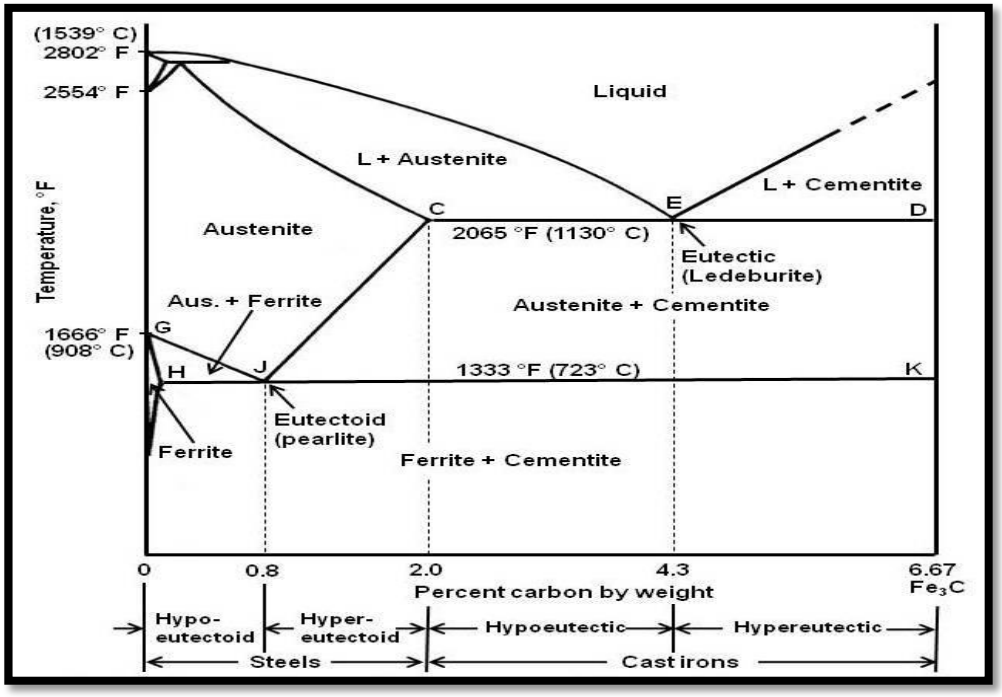

Figure 2.1: The changes occur on cooling in hypoeutectic white cast iron

The typical microstructure of white cast ironis consisting of dendrites of changed of austenite (Pearlite) in a white interdendritic network of cementite as shown in Figure 2.2 below.

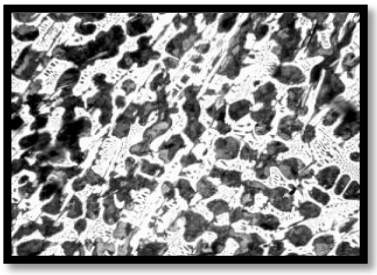

Figure 2.2: Microstructure of white cast iron

White irons find inadequate in engineering applications because of the extreme brittleness and lack of machinability. The parts where resistance to wear is the most important requirement such as liners of cement mixers, ball mills, pumps, wearing plates. Parts of sand slingers, certain type of drawing dies, extrusion nozzles, grinding balls. Most parts are sand-cast and do not require much machining, which