ANALYSIS ON BICYCLE CRANK ARM USING TENSILE TEST

SHAIFATUL SHIMA BINTI SHAARI

This report is submitted in partial fulfillment of the requirement for the

Degree of Bachelor of Mechanical Engineering

(Design & Innovation)

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka

APRIL 2010

“I hereby declared that I have read through this report and found that is has comply the partial fulfillment for awarding the degree of Bachelor of Mechanical Engineering (Design & Innovation)

Signature : ……………………………………….

Supervisor’s I Name : ……………………………………….

Date : ………………………………………..

ACKNOWLEDGEMENT

Assalamualaikum, firstly I would like to thanks God because on his mercy I finally able to complete my final year project of Analysis on Bicycle Crank Arm Using Tensile Test. I would like to express my deepest appreciation to my supervisor Mr Asri Bin Yusuff, and also for his invaluable support, guidance, encouragement, criticism, and insight throughout the research. It was a great pleasure for me to work with him. And also to Miss Siti Nor Baya Binti Sahadan as my mentor for helped me to finished up this project.

For many valuable encouragements and discussions on my project, I am indebted to my colleagues at Universiti Teknikal Malaysia Melaka (UTeM), who has also involved during the project. I am also grateful to all technicians from structure department especially to Mr Rashdan Bin Seman who has been an indefatigable advisor; teach the procedure for my experiment which include to handling the machine and all the equipment in the laboratories for helping me in my final year project.

I would like thanks to UTeM for its facilities and resources mainly in the library, laboratory and their up-to-date equipment. It has indeed been a great help for me in reducing my expenses and obtaining precise reading and measurement for my research.

ABSTRACT

The mechanical properties of a material are directly related to the response of the material when it's subjected to mechanical stresses. The results of tensile tests are used in selecting materials for engineering applications. Tensile properties frequently are included in material specifications to ensure quality. Tensile properties often are measured during development of new materials and processes, so that different materials and processes can be compared. Since characteristic phenomena or behavior occur at discrete engineering stress and strain levels, the basic mechanical properties of a material are found by determining the stresses and corresponding strains for various critical occurrences. A wealth of information about a material's mechanical behavior can be determined by conducting a simple tensile test for bicycle crank arm of uniform cross-section is pulled until it ruptures or fractures into separate pieces. Finally, tensile properties often are used to predict the behavior of a material under forms of loading other than uniaxial tension. This mechanical testing was done by using Instron 8802 Dynamic Machine. Based on the initial geometry of the sample, the engineering stress-strain behavior (stress-strain curve) can be easily generated from which numerous mechanical properties, such as yield strength and elastic modulus, can be determined. The major parameters that describe the stress-strain curve obtained during the tension test are the tensile strength (UTS), yield strength or yield point (σy), and elastic modulus (E). By using the X-Ray Diffractormeter, it can determine the types of material which include in the bicycle crank arm.

.

ABSTRAK

Sifat-sifat mekanikal sesuatu bahan adalah berkaitan dengan terus untuk tindak balas bahan tersebut apabila ia di bawah beban mekanikal. Keputusan-keputusan ujian tegangan adalah digunakan sebagai pemilihan bahan-bahan untuk aplikasi kejuruteraan. Ciri-ciri tegangan sering didapati dalam setiap bahan yang terkandung bagi menentukan kualiti bahan tersebut. Ia juga kerap diukur semasa membuat sesuatu bahan baru dan proses supaya bahan dan proses yang berbeza dapat dibandingkan. Sejak fenomena tekanan kejuruteraan ini berlaku pada peringkat terikan, sifat-sifat mekanikal asas sesuatu bahan di temui bagi menentukan beban dan tegangan yang sesuai untuk pelbagai keadaan kritikal. Banyak maklumat tentang sifat-sifat mekanikal bahan boleh ditentukan dengan menjalankan satu ujian tegangan mudah terhadap lengan engkol basikal. Keratan rentas seragam di tarik sehingga ia pecah atau retak kepada keping-keping berasingan. Akhir nya, ciri-ciri tegangan di gunakan untuk meramalkan sifat sesuatu bahan. Ujian mekanik ini di lakukan dengan menggunakan Mesin Instron 8802 Dynamic. Berdasarkan geometri awal sampel tersebut, sifat mekanikal ketegangan tekanan (lengkung tegasan-terikan) boleh dibina dengan mudah di mana banyak sifat-sifat mekanikal boleh di perolehi , seperti kekuatan alah dan modulus kenyal boleh ditentukan. Parameter utama yang dapat di huraikan adalah lengkung tegasan-terikan yang diperolehi semasa ujian tegangan kekuatan tegangan (UTS), kekuatan alah atau takat alah (σy),dan modulus kenyal (E). Dengan menggunakan X-Ray Diffractormeter, ia dapat menentukan jenis bahan yang terkandung dalam lengan engkol basikal.

LIST OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

LIST OF SYMBOLS

ϵ	=	True Strain
σ	=	True Stress, Pa
S	=	Engineering Stress, Pa
e	=	Engineering Strain
P	=	Load, N
A	=	Area, m^2
L	=	Length, m
l_0	=	Original Gage Length, m
l_f	=	Final Gage Length, m
t_f	=	Final Thickness, m
E	=	Modulus Elasticity
σ_{UTS}	=	Ultimate Tensile Strength

CHAPTER 1

INTRODUCTION

1.1 Introduction

Failure of material means the progressive or sudden deterioration of their mechanical strength because of loadings or thermal or chemical effect.All materials have different properties that result in advantages and disadvantages. Study and understanding of these properties is critical to the design of a mechanical system and the selection of the correct materials for a given part. One crucial failure mode is fatigue. Fatigue is the weakening or failure of a material resulting from prolonged stress. The strength of a material is its ability to withstand an applied stress without failure. Yield strength refers to the point on the engineering stress-strain curve (as opposed to true stress-strain curve) beyond which the material begins deformation that cannot be reversed upon removal of the loading. Ultimate strength refers to the point on the engineering stress-strain curve corresponding to the maximum stress. The applied stress may be tensile, compressive, or shear.

The selected material was choosing is crank arm for paddle bicycle. This material is structural material which consists of combining two or more constituents. Normally, cranks are constructed of an aluminum alloy, titanium, carbon fiber, chromoly steel, or some less expensive steel.This crank arm is the component of the bicycle that transfers the force exerted on the pedals to the crank set. Crank arms can crack in a number of places. Sometimes a crack will develop between the pedal mounting hole and the end of the arm. A crack also will develop at the crotch of the chaining-mounting arms (spider arms) and the crank arm.

The effects of dynamic loading are probably the most important practical part of the strength of bicycle crank arm, especially the problem of fatigue. Repeated loading often initiates brittle cracks, which grow slowly until failure occurs. However, the term strength of materials most often refers to various methods of calculating stresses in structural members. The methods that can be employed to predict the response of a structure under loading and its susceptibility to various failure modes may take into account various properties of the materials other than material (yield or ultimate) strength.

In basic, tensile stress is the stress state caused by an applied load that tends to elongate the material which is bicycle crank arm in the axis of the applied load, in other words the stress caused by pulling the material. The strength of structures of equal cross sectional area loaded in tension is independent of cross section geometry. Materials loaded in tension are susceptible to stress concentrations such as material defects or abrupt changes in geometry. However, materials exhibiting ductile behavior (metals for example) can tolerate some defects while brittle materials (such as ceramics) can fail well below their ultimate stress.

Most crucial structures subjected to fatigue failures in metallic structure are a well-known technical problem. It is of great importance for engineers the time a fatigue crack will take to grow from initial size to the critical value in designing structures and determining inspection intervals. Failures apparently occurred without any previous warning.

Fatigue of materials is a well known situation whereby rupture can be caused by a large number of stress variations at a point even though the maximum stress is less than the proof or yield stress. The fracture is initiated by tensile stress at a macro or microscopic flaw. Once started the edge of the crack acts as a stress raiser and thus assists in propagation of the crack until the reduced section can no longer carry the imposed load. While it appears that fatigue failure may occur in all materials, there are marked differences in the incidence of fatigue.

The total fatigue life of a component can be divided into three phases which is crack initiation, crack propagation and fracture.After a certain number of fluctuations, the accumulated damage cause the initiation and subsequent propagation of crack in the plastically damage regions. This process can many cases does cause the fracture of components. The more severe the stress concentration, the shorter the time to initiate the fatigue crack.

By using the INSTRON machine it is to determine the mechanical properties of bicycle crank arm by mechanical testing which is tensile test. From this method to measure the strength of crank arm. This is to obtain the yield strength of each specimen. The data will be collected using software BLUEHILL. From the graph, it also can determine the yield point, % elongation, maximum load, strength of the material, and also can develop the stress and strain graph. In this research, the tensile test with constant load is utilized use to discuss the affect of the structure and the strength of the bicycle crank arm.

1.2 Objectives

The objectives of this research are:

a) Learn to conduct an experiment related with tensile test.

b) To analyze the effect of constant load to the bicycle crank arm structure.

c) To study and analyze the material properties of the bicycle crank arms.

1.3 Problem Statement

This research has been carried out due to the strength of material for the selected material which is bicycle crank arm. The bicycle crank arm is one of the bicycle parts which received high load. Analysis need to be done to figure out the maximum load capacity that the crank arm could stand. The tensile test was conducted to measure the strength of this material under constant load. Due to the matters set out above, this study will analyze the strength of bicycle crank arm structure under constant loading.

1.4 Scope of the Research

This research comprises of the following scope:-

a) To do literature study on metal structure.
b) To carry out tensile test on bicycle crank arm.
c) To anaylize affect to the structure
d) To carry out analyze the experiment data analysis after tensile test.
e) Conclusion and suggestion for future study.

TABLE 1.1: GANTT CHART FOR PSM 2

FINAL YEAR PROJECT TITLE:

ANALYSIS OF BICYCLE CRANK ARM USING TENSILE TEST

RESEARCH ACTIVITY/TIME	JANUARY 2010				FEBRUARY 2010				MARCH 2010				APRIL 2010	
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1) Mechanical Testing														
2) Result and Analysis														
3) Discussions														
4) Report Writing for PSM 2														
5) Preparation for Seminar 2														
6) Submission of Report and Log Book														

CHAPTER 2

LITERATURE REVIEW

2.1 An Overview of Metal Structure.

Material can be anything a finished product in its own right or an unprocessed raw material. Raw materials are first extracted or harvested from the earth and divided into a form that can be easily transported and stored, then processed to produce semi-finished materials. These can be input into a new cycle of production and finishing processes to create finished materials, ready for distribution, construction, and consumption. In chemistry materials can be divided into two which is metals and non metals. [1]

All elements of the world, based on their physical and chemical properties, are divided into solids, liquids, and gases. Solids can be of two types which is metals and non metals. This grouping is done mainly on the basis of their physical properties. Metals are usually elements in solid form that have a shiny body surface. They are tough, and some are malleable while others are ductile. Most metals are good conductors of heat. Most of them are also good conductors of electricity. [1]

2.1.1 Types of Metal

This is one of the three groups of elements in materials. Some metals and metal alloys possess high structural strength per unit mass, making them useful materials for carrying large loads or resisting impact damage. Metal be divided into three which is ferrous, non ferrous and alloys. [2] In this research the main objective is to analyze the metal structure.

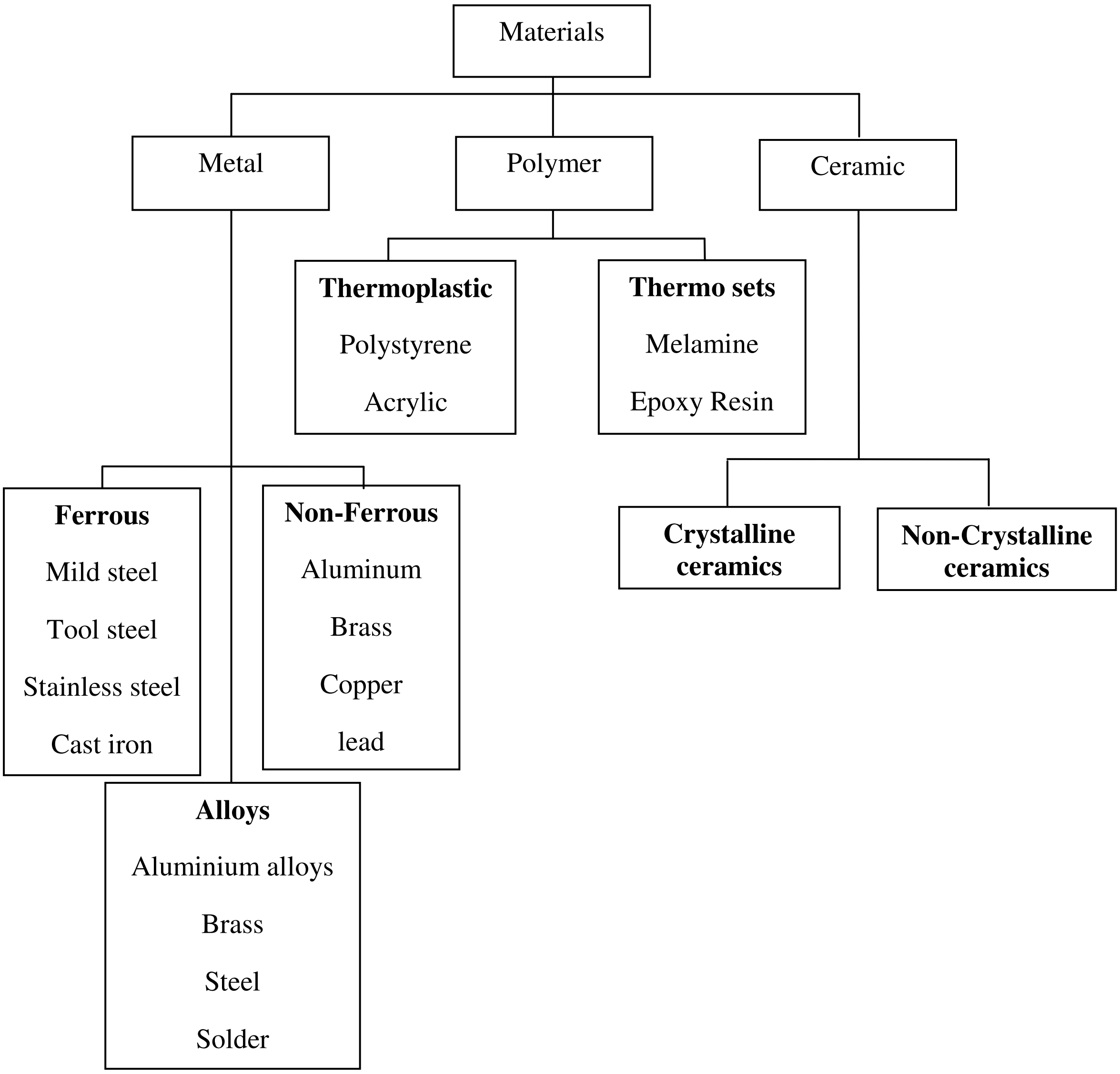

Figure 2.1: Flow for different types of material

(Source: Mortimer (1975))

2.1.1.1 Ferrous

Ferrous metals are those metals which contain iron. They may have small amounts of other metals or other elements added, to give the required properties. All ferrous metals are magnetic and give little resistance to corrosion. Most commonly used ferrous metals are mild steel, high speed steel, stainless steel, high tensile steel and cast iron. [1]

2.1.1.2 Non-Ferrous

Non ferrous metals are those metals which does not contain iron. They are not magnetic and are usually more resistant to corrosion than ferrous metals. Most commonly used non ferrous metals are aluminium, copper, brass, lead, tin, gilding metal and zinc. [1]

2.1.1.3 Alloys

An alloy is a mixture of two or more metals. When a material is needed which requires certain properties and this does not exist in a pure metal we combine metals. Pure white aluminium is very soft and ductile. Other elements can be added to create an aluminium alloy. This can produce a metal which is stronger than mild steel has improved hardness and is resistant to corrosion while still remaining light in weight. By changing the properties to form alloys, metals can be easily bent, twisted, welded and also stretched. [1]

2.1.2 Metallic Properties.

Metals are usually shiny solids with high melting points and are very good conductors of heat and electricity. They are malleable, so they can be beaten into sheets, and ductile, which means they can be drawn into wires. Most are strong and cannot be broken easily. Mercury, for example, is a metal that has a low boiling point and is liquid at room temperature. [1] In general metal have:

1. Density
2. Ductility
3. Thermal Conductivity
4. High electric

2.1.2.1 Density

The high density of most metals is due to the tightly-packed crystal lattice of the metallic structure. The strength of metallic bonds for different metals reaches a maximum around the centre of the transition series, as those elements have large amounts of delocalized electrons in a metallic bond. [1]