DESIGN AND ANALYSIS OF BENDING AND STRETCHABLE TESTING APPARATUS FOR CONDUCTIVE INK

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS OF BENDING AND STRETCHABLE TESTING APPARATUS FOR CONDUCTIVE INK

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REKA BENTUK DAN ANALISIS PADA RADAS UJIAN REGANGAN DAN LENTURAN DAKWAT KONDUKTIF

IFFAH SYAKIRAH KAMARUL'ARIFIN

**Laporan ini dikemukan sebagai
memenuhi sebahagian daripada syarat penganugerahan
Ijazah Sarjana Muda Kejuruteraan Mekanikal**

Fakulti Kejuruteraan Mekanikal

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2020

DECLARATION

I declare that this project report entitled "Design And Analysis of Bending and Stretchable Testing Apparatus for Conductive Ink" is the result of my own work except as cited in the references.

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PENGAKUAN

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PENGESAHAN PENYELIA

Saya akui bahawa telah membaca laporan ini dan pada pandangan saya laporan ini adalah memadai dari segi skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Mekanikal.

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Tarikh : JULAI 2020

DEDICATION

I dedicate my dissertation work to my parents, Kamarul'Arifin and Salmiah as they have given me a lot of support along this journey. They encourage me on every step and decision that I made. They also provided me everything that I needed to make sure that I am able to accomplish my degree in Bachelor of Mechanical Engineering. My parents always believe in me and give me opportunity to do the best. I would also dedicate to all my fellow friends who helped me a lot during the completion of this project. A lot of new information and skills that I gained from them. They are very willing to give me advice on every problem that I facing. They also give me great advice and encourage me to do my best until this day.

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Saya mendedikasikan laporan saya kepada ibu bapa saya, Kamarul'Arifin dan Salmiah kerana mereka telah banyak memberi sokongan kepada saya sepanjang perjalanan ini. Mereka sentiasa menyokong kepada setiap perkaran dan keputusan yang saya buat. Mereka juga telah menyediakan segala keperluan yang saya perlukan untuk memastikan saya dapat mencapai Ijazah Sarjana Muda Kejuruteraan Mekanikal. Ibu bapa saya memberi kepercayaan sepenuhnya kepada saya dan memberi ruang kepada saya untuk melakukan yang terbaik. Saya juga ingin berterima kasih kepada rakan-rakan saya yang telah banyak membantu saya sepanjang penyiapan projek ini. Banyak maklumat dan ilmu baru yang dapat saya pelajari daripada mereka. Mereke sentiasa berbuka hati untuk memberi tunjuk ajar tentang permasalahan yang saya lalui. Mereka juga sering memberi nasihat dan sentiasa mendorong saya untuk berusaha sebaik mungkin hingga ke hari ini.

ABSTRACT

Conductive ink have being widely use in many industry area lately because of the new growing of its technology. The technology have capture many attention from the researchers and company. It have being use widely in most electronic devices such as smart phones and Light Emitting Diodes (LED). The study of this conductive ink is important for further application in the production of various types of electronic devices. Currently, there is no perfect test apparatus for studying conductive ink at the Universiti Teknikal Malaysia Melaka (UTeM). Therefore, the project will focus on the design and analysis of the conductive ink testing apparatus. The reverse engineering and simulation analysis method will be done on the product design, according to the objectives of the project. The method of reverse engineering is to reconstruct the existing product design. In the reverse engineering, it included with the process of finding the customer requirements, engineering characteristics, house of quality (HOQ), preliminary design (PDS), morphological chart, concept design, pugh method and embodiment design. Meanwhile, to find the stress analysis on the product design, two method will be done which are theoretical method and experimental method. It is performed to identify the result of stress produced when a load is imposed on the product. In theoretical method, formula to find out the Von Mises stress will be used while in experimental method, there are two types of Computer-Aided Software (CAD) used in this project. The software is CATIA V5 and Workbench Ansys. The results of the Von Mises stress then will be compared between both of the method to find out the probability of error in the results gained. Based on the study, the percentage error for four parts of the product design is below the expected results, which is 10%. There is one part of the product design is over the expected value. The setting of meshing size may become the effect of the high percentage error on that part.

ABSTRAK

Dakwat konduktif sedang aktif digunakan secara meluas dikebanyakan bidang industri hasil daripada pertumbuhan teknologinya yang semakin pesat. Teknologi ini telah menarik perhatian ramai terutamanya daripada kalangan para penyelidik dan syarikat pembuatan. Dakwat konduktif kebanyakkannya digunakan di peranti elektronik seperti telefon pintar dan diod pemancar cahaya (LED). Kajian mengenai dakwat konduktif ini amatlah penting untuk diterapkan lebih dalam pengeluaran pelbagai jenis peranti elektronik. Pada masa kini, tiada radas ujian yang sempurna untuk mengkaji dakwat konduktif di Universiti Teknikal Malaysia Melaka (UTeM). Oleh itu, projek ini akan menumpukan kepada reka bentuk dan analisis radas ujian dakwat konduktif. Kejuruteraan semula dan analisis simulasi akan dilakukan pada reka bentuk produk, mengikut kepada matlamat projek ini. Kaedah kejuruteraan semula dilakukan adalah untuk menganalisa reka bentuk yang sedia ada. Dalam kaedah kejuruteraan semula, ia merangkumi proses mencari keperluan pelanggan, ciri-ciri kejuruteraan, rumah kualiti (HOQ), reka bentuk awal (PDS), carta morfologi,reka bentuk kosep, kaedah pugh dan reka bentuk perwujudan. Sementara itu, untuk mengetahui analisis tekanan pada reka bentuk produk, dua kaedah akan dilakukan iaitu kaedah teori dan kaedah eksperimen. Ia dilakukan untuk mengenal pasti hasil tekanan jika terdapat beban yang dikenakan ke atas produk tersebut.Dalam kaedah teori, formula untuk mengetahui tekanan Von Mises akan digunakan sementara dalam kaedah eksperimen, terdapat dua jenis perisian lukisan (CAD) yang digunakan dalam projek ini. Perisiannya adalah CATIA V5 dan Workbench Ansys. Kemudian, hasil tekanan Von Mises akan dibandingkan antara kedua-dua kaedah untuk mengetahui kebarangkalian kesalahan pada hasil yang diperoleh. Berdasarkan kajian, peratusan kesalahan bagi empat bahagian reka bentuk produk berada di bawah hasil yang dijangkakan, iaitu 10%. Terdapat satu bahagian dari reka bentuk produk melebihi nilai yang dijangkakan. Penetapan ukuran meshing boleh menjadi kesan kepada kesalahan peratusan tinggi pada bahagian tersebut.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This section consists of an explanation about background, problem statement, objectives and scope of study of the design and analysis of bending and stretchable testing apparatus for conductive ink. In this study, the testing apparatus is a product design that consists of the function of bending testing, tensile testing and torsion testing.

1.1 Background

Conductive ink is a new technology of ink that can conduct electricity. It is an ink which has been saturated with some type of conductive materials. The conductive materials are such as graphene, silver and copper. According to research by "What is Electric Paint: The Composition and Application of Conductive Paints" (n.d), conductive inks is first been developed to be used in the printed electronics. It is used for the purpose to print the printed circuit boards, that is located in any electronic devices. It help the devices to function very well by conducting electricity through it.

The printed electronics is been used widely in the technology nowadays. It have attracted the technology and scientific industry to use and study about it. The uses of printed electronics can give many benefits, such as low in costs and productive in mass production (Liu et al., 2019). Based on the research by Mou et al., (2019), the applications of printed electronics can be found in such as flexible electrodes, photovoltaic cells and light emiting diodes (LEDs).

Besides, there are also a lot of study that involve the conductive inks. The study made to find out the properties and characteristics of the conductive inks. The properties are important to be known so that it can help to understand more on the behavior of the conductor. All of the information about the behaviour can be used to be implement in any applications. In many applications, graphene is one of the conductive materials that have been used widely. The infusion of graphene and inks results on a good conductive ink as graphene have many good properties as the conductor.

The great and unique mechanical properties of the graphene have attracted many researchers to do some studies about it. There are many types of research about the graphene conductive ink reported for the past 10 years, where it is used for printing on flexible substrates and for electronic applications uses (Saidina et al, 2019). The good mechanical properties and characteristics of the graphene have made it perform great in mechanical and electrical uses.

This study is purposed to focus on the development of the bending and stretchable test machine for the conductive ink such as graphene conductive inks. To test for the conductive ink, machine of bending testing, tensile testing and torsion testing are needed to be used. Bending testing is a process where it can deform any material surfaces to determine the resistance to fracture of the material. For this study, the bending testing is used to test the ductility of the conductive ink from fracture or cracking on any elastic materials such as thermoplastic polyurethane (TPU).

Other than that, the tensile test is a process where it is used to determine the tensile strength of a material. The purpose of doing the tensile test in this study is to know the responses of the conductive ink towards the stress and how much of the elongation can it be towards the tensile test. While torsion test is a process where it is used to determine the torsional properties of the material. The test is conducted in this study to know the behavior of the conductive ink when twisted or under torsional forces.

The design of the testing apparatus to test on the conductive ink is separated into three types of testing, which are for bending testing, tensile testing and torsion testing. The product design will be study by using reverse engineering method to find out the process of product design and analysis result.

1.2 Problem Statement

The researches and experiments that related to the conductive ink is currently being done in AMCHAL lab, located in UTeM. It is a research on testing the stretchable and bending motion of the conductive ink material. The problem statement is there are no proper test rig that can be use for the testing. Thus, this study are about to do analysis and reverse engineering on the design of testing apparatus for the conductive ink.

1.3 Objective

Objectives are very important elements that need to be considered through this study of the design and analysis for the stretchable and bending testing apparatus for conductive ink. There are two objectives that have been determined to be achieved. The objectives are

1) To do reverse engineering on design of testing apparatus of conductive ink

2) To make analysis on testing apparatus for conductive ink

1.4 Scope of Study

The scope of this study is to make a reverse engineering on the product design of the testing apparatus of conductive ink. All of the method use in reverse engineering will be done through this study. The analysis on the design of testing apparatus will also be conducting. It is needed to focus on analyzing the possible result of testing simulation for the product design. Computer aided design (CAD) is been used in order to do the analysis. The analysis is done to look at the weaknesses of the design, so that it can be improvised before being manufactured.