UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF HOLDING JIG FOR CUTTING OF POLYMER FOAM MATERIAL

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

by

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DECLARATION

I hereby, declared this report entitled “Development of Holding Jig for Cutting of Polymer Foam Material” is the results of my own research except as cited in references.

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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 Process) (Hons.). The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Projek ini membentangkan hasil kajian yang dibuat untuk menghasilkan sebuah jig yang berupaya untuk memegang bahan kerja semasa proses pemotongan. Bahan kerja yang dipotong adalah untuk kegunanaan kilang DK Composite Sdn Bhd. Bahan tersebut merupakan bahan yang akan diletakkan di antara dinding luar kapal terbang dengan dinding dalamannya. Menurut pihak DK Composite, tiada mesin yang berupaya untuk memotong bahan kerja yang mereka hasilkan. Bahan kerja tersebut mempunyai ukuran saiz yang besar dimana ukurannya bersaiz 2m x 1m x 0.0254m dan diperbuat daripada sejenis busa polimer. Oleh yang demikian, sebuah jig khas perlu dibina dan jig tersebut perlu mengikut saiz bahan kerja. Bagi membina jig tersebut, beberapa langkah perlu diambil diantaranya reka bentuk jig, bahan untuk membuatnya dan juga proses yang terlibat dalam penghasilan jig tersebut. Selain daripada itu, selepas jig tersebut siap dihasilkan, ianya perlu diuji bagi mengetahui kemampuan jig tersebut untuk beroperasi. Antara ujian yang dikenakan ialah ujian terhadap fungsi jig dan juga ketahanan struktur jig itu sendiri. Untuk mendapatkan hasil analisis tentang struktur jig tersebut, “Finite Element Method” digunakan sebagai alat untuk mendapatkan nilai tekanan maksimum dan jugak nilai anjakan bahagian struktur tertentu. Hasil daripada ujian tersebut mendapati struktur yang dihasilkan berupaya untuk menahan tekanan yang diuji sebanyak 1000N. Oleh itu, jig ini boleh digunakan bagi memotong beban bahan kerja yang lebih berat dari bahan busa polimer itu sendiri.

ABSTRACT

This project is about a development of holding jig that has an ability to hold a workpiece during cutting process. The workpiece that will be cut is belong to DK Composite Sdn Bhd. The workpiece is used as a material to fill an empty space between the aircraft body panel and the inner wall of it. As referred to DK Composite, there is no machine that able to cut the material that has been produced by them. The material has a dimension of 2m x 1m x 0.0254m and it made from polymer foam. So that, a jig need to be develop which is able to cut the required size. To develop this jig, a several steps are needed which are consist of jig design, material and process that involves for fabrication. Hence, after the jig is fabricated, it need to be tested to analyze the performance of the jig to be operated. On the same time, the functionality of the jig and the strength of the structure will be analyzed. To get the analysis on the jig structure, Finite Element Method (FEM) is used to determine the maximum stress and maximum displacement for specific side. The result from the analysis shows that the structure could withstand for load 1000N. Therefore, the jig is assuring to cut the material that is heavy than the polymer foam itself.

DEDICATION

Special dedication to my beloved family, final year project supervisor and all my friends that supporting me throughout my journey of education.

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CHAPTER 1
INTRODUCTION

This chapter are describing the introduction of the project. In this project, a polymer foam material need to be cut to fit the specific place for aircraft body. So that, a holding jig is required to hold the material during the cutting process. In this chapter, it includes of project background, problem statement, objective and scope of study.

1.1 Background of Study

A polymer foam is a material that comprised of soft structure of polymer interconnected with linkage materials form embedded with bubbles. This material normally applied as wall structure for damper for sound and vibration absorber since it has soft properties and lightweight. Such materials prepared in various size according to the application. For instance, this material applied inside aerospace structure that may available from the range of 1-10 meters. Normally, this material attached as a sandwich structure between two main body panels for a large aerospace body. Since it requires variety shapes, polymer foam normally produced by the industry with large size, before trimmed or cut into required dimension. Such process requires special jig and bandsaw to reduce the size. (Hadzley, 2015)

A bandsaw contains of a continuing band of metal with sharp tooth varied one edge being a power tool to cut a variety workpiece. The band typically rides on two rotating

rolling wheels within the exact plane to generates uniform cutting performance resulting a uniformly distributed tooth load. Normal bandsaw as shown in Figure 1.1 has limitation which can cut to a certain dimension depending on the machine ability. Besides, it has limited table to place and hold the workpiece to be cut. In addition, it's difficult to control the stability of product if it held by manual manpower. Therefore, jig is needed to support the workpiece during the cutting process to produce better result.

Figure 1.1: Vertical Bandsaw (Source: comprehensivebandsaw, 2015)

The important element of jig and fixture is often to hold and locate the work piece for the various sorts of machining. Regularly, the jig and fixture is designed to suit working on small parts. The special jig is essential to hold and clamp the polymer foam since it has large dimension of the structural support.

To produce the jig, the design and drawing for the respected jig need to be developed. The design of the jig will consider the load, the size, the expected dimension, the technique of clamp and the working mechanism need to be determined. On the other

hand, the available resource to fabricate this machine, the area of operation and manpower require to operate the system should be also considered. (Hadzley, 2015)

There are many materials, components and process need to be identified. The most suitable material for initial jig development would be hollow steel as main structure as it not only lightweight but it has ability to be processed and assembled in precision. Some components including L-bar steel, wood, wheel and screw is needed in this jig fabrication. In addition, the process to be involved are cutting, fitting, welding and drilling. On top of that, the structure of the jig need to be analyzed in terms of strength, stress and deflection in order to make sure this jig will not be collapsed during cutting implementation.

In this project, a special jig has been designed and fabricated to cater the process to cut or trim polymer foam. Since the polymer foam is prepared by industry with customize size, the jig has been designed according to the requirement form respected polymer foam. Since there is no jig available in the market to assist the process, this jig will be the first to be produced to cater the process.

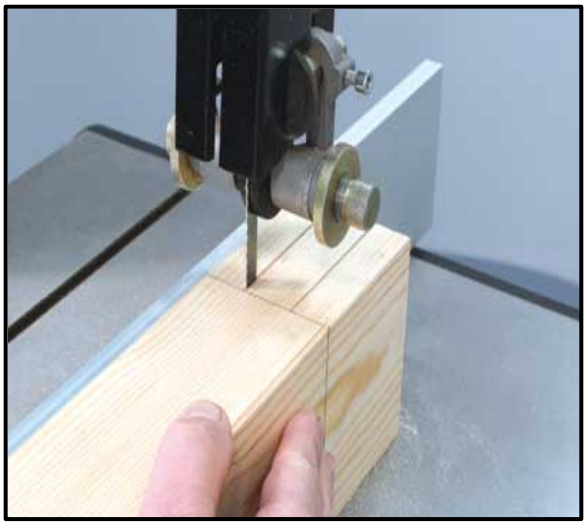

Figure 1.2: Example of jig during cutting process (Source: woodworkingcrafts, 2008)

1.2 Problem Statement

Company has to produce a specialized industrial polymer foam with specific dimension for aerospace part uses. The existing conventional machine could only produce thicker dimension which is the dimension of 2m x 1m x 0.0254m. They need to cut half of the thickness to get the accurate dimension needed. Based on a survey that has been made by the company, there is no machine that can cut the dimension needed. This material can be cut using bandsaw machine. However, due to the oversize of the machine, it could be very difficult to hold the product on certain period, it needs manpower to hold the big material during the cutting process for a period of time that can lead to human mistake. Hence, this project aims to develop a jig to hold the product during cutting process to produce the product according to the size required. Figure 1.3 is shows the same concept of cutting process with an existing of jig to help the process.

Figure 1.3: Example of jig on another similar process (Source: dcwwoodworks, 2014)

1.3 Objective

The main objective of this research is

i) To develop a holding jig to cut flat polymer foam material.

ii) To evaluate the functionality of the newly fabricated machine.

iii) To analyze the strength of body structure based on FEM analysis.

1.4 Scope

The project focused on design and fabrication of jig to hold the large polymer structure. It consisted of planning and real fabrication of jig. In the planning stage, the project involved with the concept design of possible jig that can hold the structure, followed by the analysis of Pugh method to determine which concept provide the optimum function ability according to the criterion required. The criterion that been assessed based on the knowledge shared by the respected technical expertise.

Subsequently, the jig was designed by Solidwork software, which involved with real dimension, assembly drawing and isometric drawing. Analysis have been made in terms of strength of the component by using specialized FEM software. Further process of fabrication have been implemented by determining the suitable material for the main structure such as hollow steels and wood. On top of that, small components for assembly also have been identified to support the building of the jig.

The jig have been fabricated by suitable process such as cutting, fitting, drilling and welding. On this time, machineries involved was prepared to make sure the process can be run effectively. As the jig completed, the jig have been evaluated by trimming the respected polymer foam into required shape and analyzed the surface finished and flatness of the polymer foam.

In addition, Finite Element Method (FEM) have been used to analyze the structure of the holding jig. This analysis is important to checked the strength of the structure which is proposed during the design step. The maximum load that can be applied onto the holding jig have been determined by using this software. Software that have been used is Solidwork simulation.

The project is implemented through chapters as follow:

1) In chapter 1, introduction of the whole project that have been done including of the material that has been cut, machine to cut the material, function of jig and evaluation of the fabricated jig.
2) For literature review in chapter 2, all related information and previous study is stated. It is including of vertical bandsaw, jigs and fixtures, geometrical dimensioning and tolerance and finite element method(FEM).

3) The flow of the project is explained detailed in methodology in chapter 3 that consist of conceptual design selection, process that have been involves to fabricate the jig and component of the jig itself.

4) In chapter 4, results for this project has been explained as it meets the objective. Then, results have been analyzed thoroughly. It includes fabrication and assembly of the holding jig, functionality of the holding jig, and analysis of holding jig structure.

5) Finally, the summary of overall study for this project is conclude in chapter 5. It will include of conclusion, recommendation and also sustainable development.

CHAPTER 2
LITERATURE REVIEW

Basically, one of the scope studied is this chapter which is literature review. It serves as a guide to conduct the project analysis. It consists of a variety of information that related to the holding jig development. In addition, it also provides information to fabricate the holding jig. Various references are gathered to gain the information, which are from journals, articles, handbooks and conference online.

2.1 Vertical Bandsaw

2.1.1 Component of Vertical Bandsaw Machine

2.1.1.1 Electric Motor

A motor isn't anything but an electro-mechanical device that transforms electrical energy to mechanical energy. An electrical motor (Figure 2.1) is an essential part in the machine, especially for the vertical bandsaw machine. The main objectives of an electric motor in bandsaw machine is usually to rotate the bandsaw blade that's connected to the wheels. The blade must appropriate to the bandsaw application to ensure that the material that is cut has good surface properties. Other than that, the persistence of electric motor also essential in order to diminish the machining time, production cost and labor cost. (Kissell, 1999)

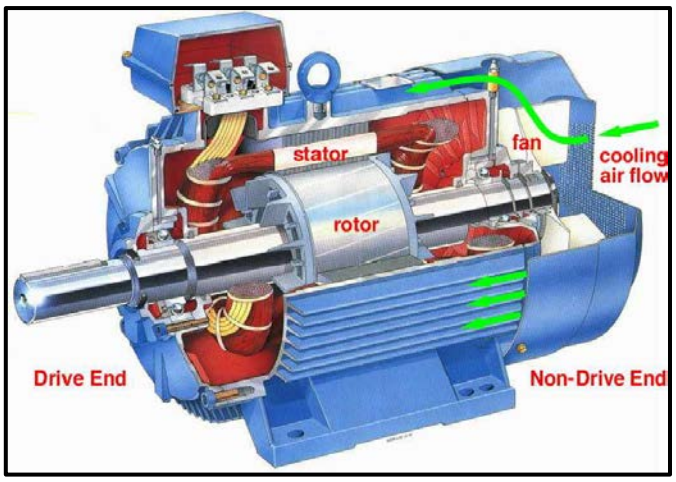

Figure 2.1: Electric motor (Source: Y. Masli, 2015)

2.1.1.2 Gear System

As stated by Damir (2012), gear is known as a toothed member created to disperse motion to or receive motion from a different toothed member, by way of uninterruptedly engaged teeth. The two gears are rotatable close to axes whose relative position are fixed, and this form a gear pair. The torque originating from driving shaft towards the driven one in a gear drive is transferred because of the pressure of the teeth of the pinion (the gear in a pair that have the smaller number of teeth) on those along the wheel (the gear in a pair which has the better number of teeth). To retain a continuous transmission ration, the teeth of both pinion and wheel ought to have conjugate profiles. This condition is seen if the teeth of the mating gears are properly meshed using the standard basic rack teeth, which could be used as an intention of defining the tooth dimension. Figure 2.2 shows an example of gear system.