UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CUTTING TECHNOLOGY AND SINTERING JIG DEVELOPMENT FOR MANUFACTURING OF HOLLOW STRUCTURE MAT

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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I hereby, declared this report entitled "Cutting Technology and Sintering Jig Development for Manufacturing of Hollow Structure Mat" 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:

……

(Engr. Dr. Mohd Hadzley Bin Abu Bakar)

ABSTRAK

Projek ini membincangkan teknologi pemotongan dengan penambahbaikan mesin gergaji menegak dan fabrikasi jig pensinteran untuk menghasilkan *hollow structure mat*. Mesin gergaji menegak dan jig pensinteran akan dibangunkan menggunakan beberapa proses pembuatan. Bahan diperuntukkan oleh pelajar-pelajar PhD dari Universiti Tun Hussein Onn (UTHM). Oleh itu, kertas kerja ini membentangkan teknik penambahbaikan dan pemasangan bahagian untuk mesin. Penyataan masalah dan objektif penyelidikan ini telah dikenalpasti. Selain itu, skop kajian, bersama dengan garis bentuk projek telah dikaji semula dan diperbincangkan. Bagi kajian literatur, ia mengandungi maklumat dan artikel akamedik daripada buku rujukan dan melalui internet, terutamanya yang berkaitan dengan tajuk dan ia mempunyai sejarah mereka, definisi, istilah dan teknik. Semua alat-alat yang moden dan teknologi tersedia bagi meningkatkan prestasi dan kecekapan. Prestasi mesin gergaji menegak akan diuji berdasarkan permukaan pemotongan. Sistem ini dijangka akan menambah baik pengeluaran dalam bidang proses pembuatan bagi menghasilkan *hollow structure mat.*

ABSTRACT

This project discusses the cutting technology by development of vertical bandsaw machine and fabrication of sintering jig for manufacturing of hollow structure mat. The vertical bandsaw machine and the sintering jig will be developed using several manufacturing processes. The material is provided by PhD students from Universiti Tun Hussein Onn (UTHM). Therefore, this paper presents the development technique of joining part for machine. The problem statement and the objectives of this research have been identified. Besides that, the scope of the study, along with the outline has been reviewed and discussed. As for literature review, it consist the information and the articles of academicals in the reference book and via internet, especially related to the title and it has their histories, definition, terminology and techniques. All the modern tools and technology are available to extend performance and efficiency. A complete processes are discussed on the methodology, the step used to develop the vertical bandsaw machine and sintering jig will consider the best. The component size will be selected to make the good design. The bandsaw performance will be tested based on surface cutting. The expected system enhances the productivity in manufacturing processes.

DEDICATION

To my beloved parents and family

ACKNOWLEDGEMENT

First and foremost, I would like to express my highest appreciation to my supportive academic supervisor, Dr. Hadzley B. Abu Bakar. His supervision and support that gave me truly helps during the period of conducting my thesis. His never-ending supply of valuable advice and guidance has enlightened me and deeply engraved in my mind.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AC	-	Alternate Current
DC	-	Direct Current
HP	-	Horse Power
Hz	-	Hertz
PP	-	Polypropylene
W	-	Watt

CHAPTER 1
INTRODUCTION

1.1 Background of project

The plastics and plastics products industry is one of the most dynamic and vibrant growth sectors within the Malaysian manufacturing sector. The Malaysian plastics industry has developed into a highly diversified sector producing an array of products including automotive components, electrical and electronic parts, construction materials, household goods, bottles, containers, toys, games and packaging materials. One of the plastic application is in the constructing of a structural support mat for load. The process that involves in the production of hollow structure mat is the sintering process. The sintering process is conducted in the large sintering chamber. Therefore, a special jig and clamping mechanism are needed in order to hold and press the customized plastic in the sintering chamber.

The main function of jig is to hold, locate and support the workpiece for the various types of machining. A jig's primary purpose is to provide repeatability, accuracy, and interchangeability in the manufacturing of products. Usually, the jig is used for the operation of small parts. The special jig is needed to hold and press the plastic due to the large dimension of the product. The sintering process will be done by Department of Civil Engineering at the University Tun Hussein Onn Malaysia.

After the plastic is sintered, it must be cut into various sizes for the structural support platform. Usually, a plastic is cut by using laser cutting machine, however, it is only ideals for the thin part dimension because the thickness of material can affect the cutting quality. The vertical bandsaw machine is the most suitable machine to cut the large dimension of plastic with the minimum cost required.

1.2 Problem Statement

The hollow structure mat is produced by using a plastic. The material of the plastic comes in a tubular shape with a length of 1 meter, which will be sintered to create a dimension of 1m x 1m x 1m as shown in Figure 1.1. The structured of the hollow structure mat is honeycomb structure. In order to have a good joining between each plastic, it must be press uniformly during the sintering process. Therefore, a special jig and clamping mechanism are needed to hold and press the plastic to produce a structural mat.

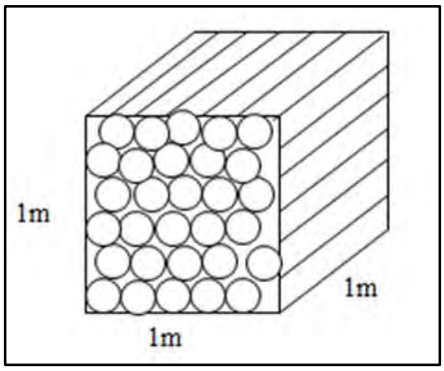

Figure 1.1: Illustration of Hollow Structure Mat

Occasionally, the structural support material is produced from the customized plastic, it is considered as a soft material and common techniques to cut this material is by using a vertical bandsaw machine. However, most commercial vertical bandsaw machine is too small and it is not suitable for cutting big material. Generally, machine operator loads the workpiece towards the cutting blade by using their hands and it is difficult to load a large size of workpiece. To load this plastic with a size of 1m x 1m x 1m, it will use a lot of energy and must be done at least by two people. To cut this hollow structure mat with a good surface finish, the machine has to be customized.

1.3 Objectives

The main objective of this research is:

i. To develop a vertical bandsaw machine for cutting process of hollow structure mat.

ii. To fabricate a sintering jig for sintering process of hollow structure mat.

1.4 Scope of Project

This research and development is focus on the functionality of jig for the sintering process of hollow structure mat and the surface finish analysis of vertical bandsaw machine to cut the hollow structure mat. The material of the hollow structure mat that will be sintering and cut is Polypropylene (PP) with the dimension of 1m x 1m x 1m. The performance measure to be evaluated is the cutting ability of vertical bandsaw machine and the clamping ability of the jig.

CHAPTER 2
LITERATURE REVIEW

2.1 Existing Product

Nowadays, users emphasize on the management of time, space for storage, safety and energy that need to do the work. Existing machine uses as example for research and to develop improvement based on user requirement. There are some products or machine that existing now in order to cut material but cannot cut big material.

2.2 Component of Vertical Bandsaw Machine

2.2.1 Electric Motor

A motor is nothing but an electro-mechanical device that converts electrical energy to mechanical energy. An electric motor is the most important part in the machine, especially for the vertical bandsaw machine. The main function of an electric motor in bandsaw machine is to rotate the bandsaw blade which is attached to the wheels. The blade must suitable to the bandsaw application so that the material being cut has a good surface properties. Besides that, the determination of electric motor also important in order to reduce the machining time, production cost and labor cost.

2.2.1.1 Motor Type

The motor-type classification on the information plate eludes to the kind of ventilation the engine employments. One sort is open sort, which gives course through ventilation from the fan mounted on the end of the rotor. In a few motor that are appraised for variable-speed obligation (utilized with variable-recurrence drives), the fan is particular motor that is incorporated with the end of the rotor. The fan motor is joined straightforwardly over the supply voltage, so it will keep up a consistent speed to give steady cooling paying little respect to the motor speed.

An alternate type of motor is the encased type. The encased motor is not air-cooled with a fan; rather it is made to permit high temperature to disseminate rapidly to and from within the motor outward of the edge. As a rule the edge has fins based into it on the outside to give more zones to cooling air to reach. (Kissell, 1999)

2.2.1.2 Motor Selection Factors

According to Mott (1999), as a minimum, the following items must be specified for motors:

i. Motor type: DC, AC, single-phase, three-phase and so on.
ii. Power rating and speed.
iii. Operating voltage and frequency.
iv. Type of enclosure.
v. Frame size.
vi. Mounting details.

In addition, there may be special requirements that must be communicated to the vendor. The primary factors to be considered in selecting a motor include the following:

- Operation torque, operating speed and power rating. Note that these are related by the equation:

$$\text{Power} = \text{torque} \times \text{speed}$$

- Starting torque.
- Load variations expected and corresponding speed variations that can be tolerated.
- Current limitations during the running and starting phase operation.
- Duty cycle: how frequently the motor is to be started and stopped.
- Environmental factors: temperature, presence of corrosive or explosive atmospheres, exposure to weather or to liquids, availability of cooling air and so on.
- Voltage variations expected: most motors will tolerate up to (+-10%) variation from the rated voltage. Beyond this, special designs are required.
- Shaft loading, particularly side loads and thrust loads which can affect the life of the shaft bearings.

2.2.1.3 Motor Size

A rough classification of motors by size is used to group motors of similar design. Horse-power (hp) is currently used most frequently, with the metric unit of watts or kilowatts also used at times. The conversion is:

$$1.0 \text{ hp} = 0.746\text{kW} = 746 \text{ W}$$

The classifications are as follows:

- Subfractional horsepower: 1 to 40 milihorsepower (mhp), where 1mhp = 0.001hp, thus, this range includes 0.001 to 0.040 hp (0.75 to 30 W approximately).
- Fractional horsepower: 1/20 to 1.0 hp (37 to 746 W, approximately).
- Integral horsepower: 1.0 hp (0.75 kW) and larger.

2.2.1.4 AC Motor and General Information of AC Power

Alternating current (AC) motors utilize an electrical current, which reverses its direction at regular intervals. An AC motor has two basic electrical components, a 'stator' and a 'rotor' as depicted in Figure 2.1. The stator is in the stationary electrical component. The rotor is the rotating electrical component, which in turn rotates the motor shaft.

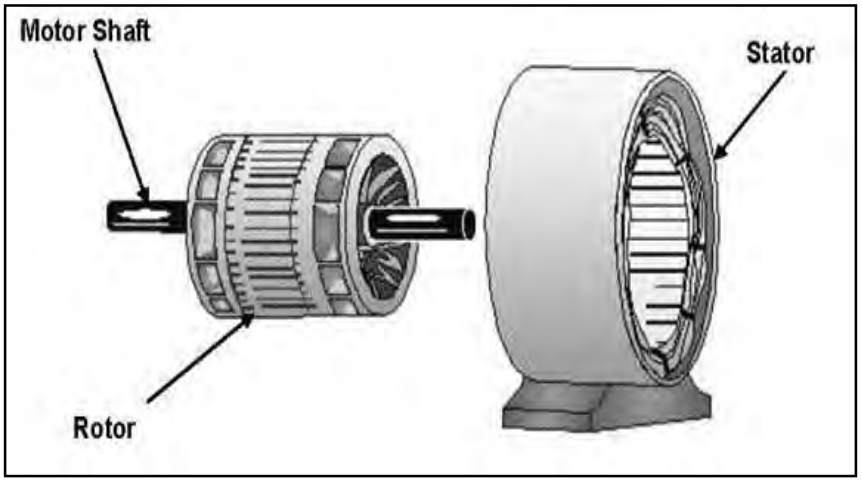

Figure 2.1: AC Motor
(Source: http://www.jconsultingonline.com)

Alternating current power is produced by the electric utility and delivered to the industrial, commercial or residential consumer in a variety of forms. AC power is classified as a single-phase or three-phase. In the United States, AC power has a frequency of 60 Hertz (Hz) or 60 cycles/s. In many other countries, 50 Hz is used. Most residential units and light commercial installations have only single-phase power, carried by two conductor plug ground. The waveform of the power would appear as shown in Figure 2.2, a solitary persistent sine wave in the system frequency whose amplitude is evaluated voltage of the force. Three-stage force is carried on three-wire system and is made out of three different waves of the same amplitude and frequency, with each one stage counterbalance from the following by 120 degree, as illustrated in Figure 2.3.

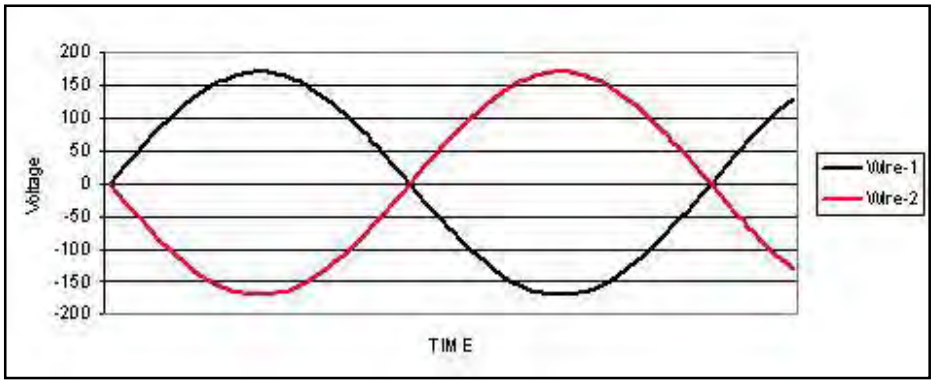

Figure 2.2: Single-phase AC Power
(Source: http://www.esubnet.com)

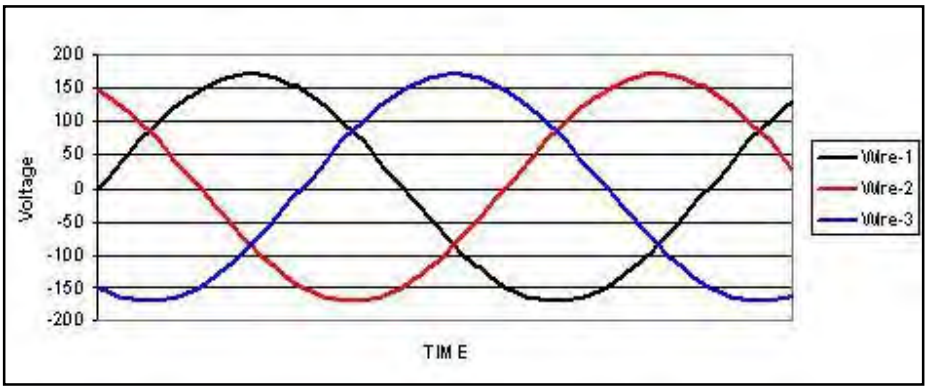

Figure 2.3: Three-phase AC Power
(Source: http://www.esubnet.com)

2.2.1.5 AC Induction Motor Application and Operation

The AC induction motor is the most commonly used AC motor in industrial applications because of its simplicity, rugged construction, and relatively low manufacturing costs. The reason that the AC induction motor has these characteristics is because the rotor is a self-contained unit, with no external connections. This type of motor derives its name from the fact that AC currents are induced into the rotor by a rotating magnetic field. The AC induction motor's rotor as shown in Figure 2.4 is made of a laminated cylinder with slots in its surface. The windings in the slots are one of two types.

The most commonly used is the 'squirrel-cage' rotor. This rotor is built of heavy copper bars that are joined at each end by a metal ring made of copper or brass. No insulation is required between the core and the bars because of the low voltages