UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF VERTICAL BANDSAW MACHINE AND JIG FOR CUSTOMIZED PLASTIC PRODUCTION

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 "Development of Vertical Bandsaw Machine and Jig for Customized Plastic Production" 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 (Process) (Hons.). The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Projek ini membincangkan mengenai pembangunan dan aplikasi mesin ‘bandsaw’ menegak dan jig pemanasan. Pembinaan mesin dan jig di ambil kira dari segi fungsinya. Mesin ‘bandsaw’ menegak difabrikasi dengan menggunakan beberapa proses pembuatan yang terlibat. Kejayaan membangunkan mesin ‘bandsaw’ menegak untuk memotong plastik yang diubahsuai membolehkannya beroperasi secara berulangan untuk tempoh yang berpanjangan tanpa kompromi. Penggunaan peralatan moden dan teknologi sedia ada amat penting bertujuan untuk meningkatkan lagi prestasi serta kecekapan mesin dan jig. Semua kenyataan yang dibincangkan dipertimbangkan sebagai yang sesuai dengan pembangunan dan pembuatan sesuatu produk. Selain itu, komponen yang dipilih adalah sesuai untuk membangunkan rekaan yang terbaik. Pandangan dan cadangan dijelaskan setelah mesin dan jig dibangunkan. Sistem ini dijangka akan menambah baikkan pengeluaran dalam bidang proses pembuatan.

ABSTRACT

This project discusses the development and application of the vertical bandsaw machine and sintering jig. It will be measured by the functionality. The vertical bandsaw machine and the sintering jig will be developed using several manufacturing process involves. The successful vertical bandsaw machine for cutting various type of customized plastic will be able to repeatedly perform its required task for many years without compromise. Yet for all the modern tools and technology available is to extend performance and efficiency. All sentences 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 machine development was comment once the machine is completed. The expected system enhances the productivity in manufacturing processes.

DEDICATION

To my beloved parents.

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Last but not least, I would like to state my appreciation to the staff – Faculty of Manufacturing Engineering, FKP, my friend and colleagues for supporting me and administration department for their help in the project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AC	-	Alternate Current
AISI	-	American Iron and Steel Institute
ASB	-	Acrylonitrile-butadiene-styrene
DC	-	Direct Current
HB	-	Brinell Hardness
HR	-	Rockwell Hardness
PP	-	Polypro
PET	-	Polyethylene Terephthalate
W	-	Weights

CHAPTER 1
INTRODUCTION

1.1 Background of project

In Malaysia, the technology of polymer processing is improved drastically and one type of the polymer is the recycle plastic. The recycle plastic is widely used in the various applications. One of the recycle plastic application is in the constructing the structural support for load. The process that involve in production of customized plastic is the sintering process. The sintering process is conducted in the large sintering chamber. Therefore, the jig is needed in order to hold and press the customized plastic in the sintering chamber.

The main function of jig and fixture is to hold and locate the work piece for the various type of machining. Usually, the jig and fixture is used for the operation of small parts. The special jig is needed to hold and press the customized plastic due to large dimension of the structural support. The sintering process will be done by Department of Civil Engineering at the University Tun Hussein Onn Malaysia.

After the customized plastic is sintered, it must be cut into various sizes for the structural support platform. Usually, a plastic is cut by using laser cutting and water jet abrasive particle, however it is only ideals for the thin part dimension because the thickness of material can affected the cutting quality. The vertical band saw machine is the most suitable machine to cut the large dimension of recycles plastic with the minimum cost required.

1.2 Problem Statement

The structural support for load is produced by using the customized plastic. The raw material of the customized plastic comes in a tubular shape with a length of 1 meter, and then it is sintered to create a dimension 1m x 1m x 1m (Figure 1.1). The structured of the structural support is honeycomb structure. In order to have a good joining between each customized plastic, it must be press uniformly during sintering process. Therefore, the special jig is needed to hold and press the customized plastic to produce a structural support.

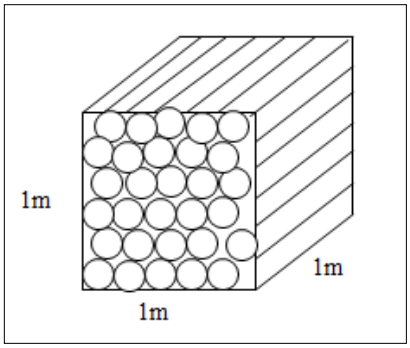

Figure 1.1: Structural support (Hasanah, 2013)

Occasionally, structural support material is produced from the customized plastic, it is considered as a soft material and common technique to cut this material is by using a vertical bandsaw machine. However, most vertical bandsaw just enable to cut about 20-30cm height (Figure 1.2). To cut 1m x 1m x 1m height of product with the good surface finish, the machine have to be customized.

Figure 1.2: Vertical Bandsaw Machine with feeding Table (www.directindustry.com)

1.3 Objectives

The main objective of this research is:

i. To develop a vertical bandsaw machine.
ii. To fabricate a jig for sintering process of customized plastic.

1.4 Scope of Project

This research and development is focus on the functionality of jig for the sintering process of customized plastic and the surface finish analysis of vertical bandsaw machine to cut the customized plastic plastic. The customize plastic 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 clamping ability of the jig and the cutting ability of vertical bandsaw machine.

1.5 Importance of Study

The importance of the study is to develop and analyze or improve the already made product that is available in the market. Base from the research and the analysis, the best part is select and the design built to make a jig and vertical bandsaw. The mounting of bandsaw machine also is one of the researches because the cutting operation will performed repeatedly. Base of all these, an ideal jig and bandsaw machine for the customized plastic production is developed, thus will reduce work-related injuries, improve quality and productivity, and provide a good machining process.

CHAPTER 2
LITERATURE REVIEW

2.1 Developing the bandsaw machine application

Band sawing uses a continuous band, welded to form a loop. The band sawing process is continuous. The band is tensioned between two pulleys-known as bandwheels-mounted on a bow (the nomenclature is derived from hack sawing). One of the band wheels is the "lay" or nondriven wheel. Generally, this wheel is arranged in an assembly which allows the band to be tensioned either mechanically or-more usually in modern machinery-via a hydraulic cylinder. The other wheel is driven by an electric motor and gearbox configuration. The band runs through a system of guides-usually roller bearings and preloaded carbide pads-to keep it running true through the material, mechanical variators arranged between motor and gearbox were employed to provide variable band speed. More recently, frequency-regulated motors feeding directly into the gearbox have become the normal.

Although a different design exist, bandsaws split into two basic configurations which are vertical and horizontal, it is based on the attitude of the band. Vertical machines are commonly used in tool room applications and in lighter structural applications. Heavy-duty billet sawing and the heavier structural applications favor the horizontal arrangement since this allows a closed, "box" type construction whereby the bow assembly runs in a gantry straddling the material and rigidly attached to the base of the machine. This setup allows maximum band tension and counteracts bow/blade deflection. Lighter-weight horizontal machines often employ a pivot-mounted bow which arcs in a similar fashion to the hack saw. (Manufacturing Engineering Handbook, 2004)

When developing a new design of vertical bandsaw machine for machining application, many of the time-tested classic design philosophies still apply. In addition, with the advent of new technologies, particularly in motor and hydraulic controls, many improvements and innovations are possible.

When embarking on a new design, one must consider many parameters which define the problem to be solved. Many of these parameters are dependent on each other and the design becomes an iterative process. First, one must consider the maximum live load to be deployed by the bandsaw mounting and the desired cutting speed.

2.1.2 Materials of Choice

At this point, the material for the bandsaw machine and feeding table must be decided. For most applications, steel is appropriate. If the bandsaw machine is meant to be transportable, aluminium may be the material of choice. For some rare applications such as a bandsaw machine is built to cut a high temperature workpiece, selected and expensive materials such as titanium may be considered. Each of these materials has their own unique characteristics and requires certain manufacturing techniques. Although some end-users may feel that steels would have a superior strength properties compared to aluminum, with a good method of machine development and minimal maintenance, an aluminum bandsaw's structure can provide a good dimension stability of the machined work piece.

If ones decide that aluminum is required, manufacturing techniques become very important. Due to the high distortion that can result, special techniques must be utilized to control and correct this distortion. In addition, improper welding of aluminum can result in weak joints with defects that can also reduce the machine's stability.

2.2 Components on Vertical Bandsaw Machine

2.2.1 Electric Motor

Basically, an electric motor is the most important part in the machine especially vertical bandsaw machine. The 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 good surface properties. Besides that, the determination of electric motor also important in order to reduce the machining time, production cost and labor cost. There is various type of electric motor in the market which is depending on its application.

2.2.1.1 Sizing Electric Motor for Motion Control

To size an electric motor for a particular drive application the designer must first analyze the mechanics of the drive application. The following must be determined: (Edge Engineering, 2006)

a) Friction of the bearings, or other mechanical elements.
b) The weight or load to be driven by the electric motor.
c) Inertia of the mass to be moved or controlled. Acceleration and deceleration forces should be analyzed.
d) Mechanical system type and number of linkages.

Friction – The friction may be determined by estimation, component specification or by measuring by the use of a torque reading device or mechanism.

Weight or Mass – The mass may be calculated using 3D CAD, specific or direct measurement.

Inertia – Inertia is the force required to accelerate of decelerate a mass. Inertia is used to calculate the motor torque required to operate the mechanical system.

Mechanical System – There are roughly four categories of mechanical drive systems.

a) Direct drive
b) Gear drive
c) Tangential drive
d) Lead-screw or worm-gear

2.2.1.2 Start and Running Torque Requirements, and Calculations.

When determining the torque requirements for an electric motor, consideration should be given to the load and start time demands during the start duration, operating torque, and peak load torque. The starting torque is dependant on the number of times an electric motor will have to start in a given time, as well as, the duration of the start cycle. The actual start torque applied should be many times greater than the actual start torque required by the application. The greater difference in torque applied by the motor and the start torque required by the application, the faster the applied acceleration of the electric motor. The time duration required to accelerate an application from a dead stop to operating speed is given by the following:

$$T = (N \times WR^2) / (T_a \times 308)$$

Where:
T = Time (seconds)
N = Velocity at load (rpm)
T_a = Average torque during start (ft-lbs)
WR^2 = Rotating inertia (lbs-ft^3)
W = Weight (lbs)
R = Radius of gyration (ft^2)
308 = Constant derived converting minutes to seconds, mass from weight, and radius to circumference

2.2.1.3 Running or operating torque equation:

$T_o = (5250 \times HP) / N$

Where:

T_o = Operating or running torque (ft-lbs)
HP = Horse power delivered by electric motor
N = Rotational velocity (rpm)
5250 = Constant converting horse power to ft-lbs

Use the peak horse power to determine the maximum operating torque.

2.2.1.4 Electric Motor Application and Operation

(i) Synchronous Motors

Synchronous motors are like induction motors in that they both have stator windings that produce a rotating magnetic field. Unlike an induction motor, the synchronous motor is excited by an external DC source and, therefore requires skip rings and brushes to provide current to the rotor.