DEVELOPMENT OF CUTTING TECHNOLOGY FOR CUTTING POLYMER FOAM MATERIAL

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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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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 memberi tumpuan untuk membangunkan teknologi dalam bentuk mesin gergaji menegak untuk pembuatan *polymer foam*. Fungsi utama teknologi pemotongan adalah untuk mengurangkan saiz *polymer foam* seperti 2m (panjang) x 1m (tinggi) x 0.0254m (ketebalan). Pembangunan awal teknologi pemotongan dengan menyatakan masalah untuk mengurangkan ketebalan kerana tidak ada mesin yang sesuai untuk mengurangkan ketebalan *polymer foam*. Oleh itu, teknologi pemotongan telah dibangunkan dengan melibatkan beberapa kaedah kejuruteraan seperti reka bentuk, proses dan penilaian produk. Dari segi reka bentuk, proses yang terlibat adalah penentuan spesifikasi mesin, memilih dan menganalisis konsep reka bentuk berdasarkan Kaedah Pugh dan membangunkan lukisan sebenar berdasarkan konsep dan spesifikasi yang dipilih. Di samping itu, teknologi pemotongan telah dihasilkan dengan beberapa proses seperti pemesinan, memotong, kimpalan dan pemasangan. Setelah teknologi pemotongan keseluruhan selesai, ia telah dinilai berdasarkan keupayaan fungsi, prestasi *belting* dan *Finite Element Analysis (FEA).* Untuk keupayaan fungsi, sistem menunjukkan prestasi yang mencukupi untuk mengurangkan ketebalan. Untuk prestasi *belting*, pemerhatian pada permukaan baru dan dipakai menekankan mekanisme kegagalan *belting* dalam bentuk kerosakan, haus dan kemerosotan *belting* struktur. Untuk analisis FEA, simulasi menggunakan Solidwork menunjukkan struktur teknologi pemotongan boleh menahan daya sehingga 1000N dan sesaran. Secara keseluruhan, teknologi pemotongan yang dibangunkan dalam kajian ini berjaya melaksanakan mengikut bertujuan objektif dan sedia digunakan untuk pengeluaran industri sebenar.

ABSTRACT

This project focused to develop cutting technology in the form of vertical bandsaw machine for manufacturing polymer foam. The main function of the cutting technology is to cut large size of foam expected minimum of 2m (length) x1m (high) x 0.0254m (thickness). Early development of the cutting technology expressed the problem to cut the foam due to unavailable machine that suit to reduce the thickness of the foam. Therefore, the cutting technology has been developed involving with several engineering methods such as design, process and evaluation of the product. In term of design, the process involved with determination of machine specifications, select and analyse the design concept based on Pugh Method and develop the real drawing of the cutting technology based on the selected concept and specifications. Further, the cutting technology has been manufactured by machining, cutting, welding and assembly. As the whole cutting technology completed, the newly fabricated produce were evaluated based on function ability, belting performance and Finite Element Analysis (FEA). For function ability, the systems demonstrated adequate performance to cut the foam into reasonable thickness. For belting performance, observation of new and worn surface highlighted the mechanism of belting failure in the form of breakage, burr and deterioration of belting structure. For FEA analysis, the simulation using Solidwork shows the cutting technology enable to retain force up to 1000N with minimum stress and displacement. Overall, the cutting technology developed in this study manage to perform according to the intended objective and ready to be applied for real industry production.

DEDICATION

To my beloved parents

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AC	-	Alternative Current
C	-	Center Distance
D	-	Diameter
DC	-	Direct Current
FEA	-	Finite Element Analysis
FHP	-	Fractional Horsepower
Hz	-	Hertz
HP	-	Horse Power
kW	-	Kilowatts
L	-	Pitch Length
Mm	-	Millimeter
mhp	-	Milihorsepower
N	-	Newton
NEMA	-	National Electrical Manufacturers Association
Pa	-	Pascal
R	-	Radius
tpi	-	Teeth per inch
W	-	Watts
ω	-	Angular Velocity
θ	-	Angle

CHAPTER 1
INTRODUCTION

1.1 Background of Project

Polymer foam is made up from solid and gas phase mixed together to form a foam. The polymer foam is found virtually everywhere in modem world and are used in a wide of application such as producing automotive components, aerospace part, construction material, the cushioning furniture, toys, games, packaging and decoration. Most of the polymer foam prepared with the size around 1m (length) x 2m (high) 0.0254m (thickness). Certain this polymer foam thickness need to reduce for specific propose. In this manner, the vertical band saw machine is the most suitable machine to cut the thickness of polymer foam with the minimum expense required. Figure 1.1 shows the example of polymer foam material.

Figure 1.1: Polymer foam material
(Source: Okolieocha et al,2015)

The bandsaw machine is the machine that produces continuous cutting process with teeth along one edge to cut many types of workpiece. The band saw blade is underpinned and determined by a drive wheel and an idler wheel. The bandsaw machines are divided into two classifications which are horizontal and vertical machines. On vertical machines, the position of cutting edge is vertical and cut into the side of the workpiece. The blade is rotated on the fixed track between the idler wheel mounted over the worktable while the drive wheel mounted underneath the worktable. The workpiece is moved by manually against the blade to make the cut.

Two major components that controlled the performance of bandsaw in blade and belting. The function of blade is to cut the material according to the shape and precision required. There are many blades available for the bandsaw, consisted of high speed steel and coated high speed steel. The performance of the blade depended on the wear resistance of the tooth of blade. On the other hand, the belting of the bandsaw control the movement of the blade according to the ratio of motor belting rotation. The belting normally made from leather, available of various size according to the motor. Performance of belting influence by the strength of tooth that engage with the pulley form motor. Low performance of belting will reduce the durability of bandsaw. Figure 1.2 shows example of commercial vertical bandsaw machine.

Figure 1.2: Commercial vertical bandsaw machine
(Source: Yandles, 2015)

1.2 Problems Statement

The polymer foam with the size 2m (length) x 1m (high) x 0.0254m (thickness) is supplied by the DK composite company. The material is used as the damper for the body aerospace part and for other thickness components. So, one machine must be produced to cut this thickness of material from 0.0254 m to 0.02 m and the machine that provide this process is Vertical Bandsaw. This type of machine does not exist at any industrial and it must be done by custom made. Commercial Vertical Bandsaw Machine is too small and it's not suitable to cut this thickness of material. Bandsaw blade in the market also small and the space between the blade guides for cutting is too short. Usually the operator load the workpiece through the cutting blade by manual using their hands and it very difficult to load a bigger size of workpiece.

On the other hand, there are no analysis of belting performance the available bandsaw. Normally failure will occur when one of the belting tooth distort. Such situation affected the bandsaw process as the cutting process will be interfered when the belting damaged. Figure 1.3 and Figure 1.4 shows the possible failure of bandsaw blade and belting that normally occurred. This project will fabricate a new bandsaw for polymer foam cutting, evaluate the function ability of machine in term of belting performance and demonstrate the structure performance of the machine by applying FEA analysis.

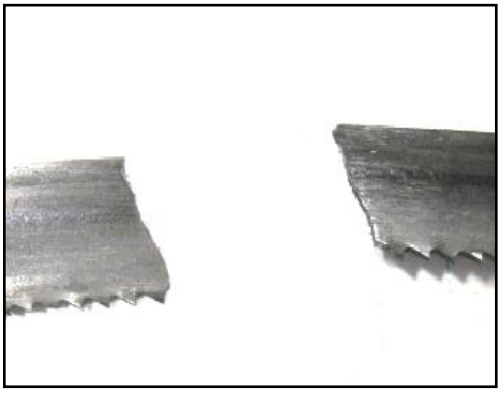

Figure 1.3: The possible failure of bandsaw blade
(Source: Soediono, 1989)