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DESIGN AND FABRICATION OF MINI WOOD CUTTER

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Abstract- **The design objective is to come up with a mower that is portable, durable, easy to operate and maintain. It also aims to design a self -powered mower of electric source. The heart of the machine is AC electric motor.**

It comprises of a system of speed reduction pulleys which drive the cutting blade for wood cutting. Thus the machine is considered highly efficient and is readily adaptable to different cutting materials. A fundamental understanding of wood cutting processes and the machining properties of wood can be obtained by investigating the interaction of wood properties, cutting tools and machining parameters. Such an understanding provides possibilities for improving product quality, increasing production efficiency, or otherwise improving the machining processes. The aim of this thesis was to find ways of improving the machining properties of some wood species, focusing on tool wear, cutting forces and the tensioning of circular sawblades.

The theoretical approach used for the prediction of the main cutting forces was based on surface response methodology. Among the studied variables, chip thickness and cutting direction had the greatest effect on the main cutting force level, while wood density, moisture and rake angle had the least effect.

I. INTRODUCTION

Cutting processes, in general, and wood cutting processes, in particular, are complex to explain and describe. The cutting process is extremely complex, with many influencing factors, such as material properties, cutting tool geometry and cutting parameters. The primary issue that confounds machining research is the considerable variability of physical and mechanical properties within and between wood species. Cutting tools during interaction with this anisotropic material are subjected to severe loads and transverse vibrations, thus, different wear characteristics and mechanisms are produced. Therefore, a fundamental understanding of wood machining properties, such as cutting tool wear, cutting forces, power consumption, and tensioning of cutting tools, gives the possibility of enhancing product quality, increasing production efficiency, or otherwise improving the machining process.

1.1 Objectives and limitations

The main objectives of this doctoral thesis were to:

- Increase knowledge of machining properties of some selected wood species.
- Identify suitable cutting tool materials for machining selected wood species.
- Evaluate cutting forces experimentally, and develop predictive models.
- Formulate a theoretical model of power consumption, and compare with experimental power consumption during resawing.
- Improve circular sawblades' dynamic stability through tensioning and levelling.

All experimental tests concerning Mozambique tropical species were made in Sweden, which limited the number of samples, owing to the transportation costs, and made it impossible to conduct industrial tests.

II. COMPONENTS OF MACHINE

2.1 Components of machine:

Functional components of machine:
A.C motor
Saw cutter
Moving jaw
V-belt pulley

2.1.1 A.C motor:

An AC motor is an electric motor driven by alternating current. It consist of two basic parts, an outside stationary stator having coil supplied with alternating current to produce an rotating magnetic field inside rotor attached to output shaft producing a second rotating magnetic field.

2.2.2 Saw cutter:

A saw blade with cutting edges(teeth)made from carbide. A circular saw blade is a metal disc with jagged teeth on edge. The disk fits into a machine which causes it to spin. Used to cut wood and other materials.

2.2.3 Pulley:

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable, supporting shell is referred to as a "block".

2.2.4 V-belt:

V-belt are specified by its type and nominal inside length. They are quite common within industry and in various items of machinery and are quite adaptable in many applications.

Advantage:

- Cutting speed is improved.
- Easy operation, even an unskilled labour can also operate.
- Mild steel can also be machined by this machine.

III. PURPOSE OF MECHANISM

Purpose of mechanism:
This mechanism is used for cutting the wood at any place easily.
Mechanism:

Wood cutting mechanism:

In wood machining there are three main cutting directions, namely: 90º–90º (rip sawing); 0º–90º (veneer cutting); and 90º–0º (planing); see Fig. 4. According to Kivimaa (1950), the first number indicates the orientation of the cutting edge with respect to the wood grain, and the second number indicates the direction of the movement of the cutting tool with respect to the wood grain. Also, two modes of cutting exist for each direction depending on annual ring direction.
Working process:
The induction motor is operated by using A.C power supply unit. The motor's power is transferred to the tool shaft with the help of an belt drive. The cutting tool shaft is guided on the two sides by the pair steel ball bearings. The cutting tool is fitted on the shaft. The circular saw is used to cut the work piece in both the direction so that the cutting operation is done.

IV. CALCULATION

Shear force and bending moment acting on Shaft:
Taking moment about A

$R_D \times 0.350 = 5 \times 0.110 + 5 \times 0.240 + (65.94 \times 0.35 \times 0.35/2)$

$0.350R_D = 5.788$

$\mathbf{R_D = 16.5395}$

$R_D + R_A = 5 + 5 + 65.94 + 0.35$

$R_D + R_A = 33.079$

$R_A = 33.079 - R_D$

$R_A = 33.079 - 16.5395$

$\mathbf{R_A = 16.54}$

Shear force calculation

SF at D = $-R_D = -16.5395$N

SF at C (without point load)

$= -R_D + 65.94 \times 0.110$

$= -9.2861$N

SF at C(with point load)

$= -9.281+5$

$= -4.2861$N

SF at B (without point load)

$= -4.2861+65.94\times0.130$

$=4.8861$N

SF at B (with point load)

$=4.2861+5$

$=9.2861$N

Bending moment Calculation

BM at D = $-R_D \times 0 = 0$

BM at C= $R_D \times 0.110 - 65.94 \times 0.110 \times 0.110/2$

$=1.4193$N-m

BM at B = R_D × 0. 240 - 65.94 × 0.240 × 0.240/2 (- 5 × 0.110)

=1.5182N-m

BM at A = R_D × 0.350 - (0.350 × 0.350/2 × 65.94)-5 × 0.240 – 5

=-0.003 N-m

(bending moment dia want to draw)

$$\frac{M}{I} = \sigma\frac{b}{y}$$

I=π/64 d^2

Power(P)=0.375 kw

Speed(N)=1440rpm

$$P = \frac{2\pi NT}{60}$$

$$T = 2.4867N - m$$

Bending moment = 1.5182 N-m

Equivalent torque $T_{eq}=\sqrt{(T^2 + BM^2)}$

T_{eq}=2.656 N-m

$T_{eq}=\frac{\pi}{16}\times T_s\times D^3$

D=9.05 mm

Selected shaft diameter=15mm

Design is safe

$$I = \frac{\pi}{64}d^2$$

I=$11.04\times10^{-5}mm^2$

$\sigma_b = \frac{M}{I} * y$

σ_b =3477.7N/mm

σ_b material=4000 N/mm

σ_b material is greater than the σ_b induced

Design is safe

Selection of Shaft Diameter (Shaft material C10):

Torque = Force ×Radius

Maximum manual force =600 N

Torque (T) = 600×0.175 =105 N-m

Bending moment M =1.1857 N-m

$T_{eq} = \sqrt{M^2 + T^2}$

Equivalent Torque = $\frac{\pi}{16}\tau_S d^3$

Maximum shear stress for C 10 = 105 N/mm^2

$d^3 = (105\times10^3\times16) / (\pi\times105)$

d = 17.20 mm

Selected diameter of shaft =20 mm

Calculated diameter of shaft < Selected diameter of shaft

17.20 mm < 20 mm

Design is safe and satisfactory.

Design of V-belt:

Motor Power =1 hp

Diameter of the driving wheel=40mm

Speed of the motor drive=1440rpm

Speed of the driven wheel=850rpm

Step 1:Selection of smaller pulley diameter (d_1 ,d_2).

d_1=40mm

Recommended standard pulley dia,d_1=40mm.

$d_2 = d_1 * N_1 / N_2$

d_2 =71mm(Recommended standard dia)

Step 2:Selection of belt.

“A” belt is selected based on power

Step 3:Selection of center distance.

C=200 mm

Step 4:Determination of nominal pitch length(L)

$L=2C+3.14(D+d)+(D-d)^2/4C$

L=645(Recommended standard nominal pitch length)

Step 5:Selection of various modification factor.

$f_c=0.8$

$f_a=1.01$

Arc of contact=171

$f_d=0.77$

Step 6:Calculation of Max power capacity(KW).

$d_0=d_p*f_b$

$d_0=44.8mm$

S=3.0144m/s

KW=0.82788

Step 7:Determination of no of belt.

Number of belt=1

Design is safe and satisfactory.

V.CONCLUSION

The machinability of different minor wood species was assessed by visual grading and by three dimensional surface reconstruction. The machining of the sample as well as the three dimensional grading were done according to recently presented original method.

A tendency to produce higher smoothness, also with different grain orientations, was observed in Deodar cedar and Italian alder comparedtoblackpoplarandblackpinethathasshownamuchlowerfinalsurfacequality. Both visual and three dimensional reconstruction methods has driven to the same conclusions. The machinability of thermally modified samples was also assessed and compared with the surface quality of control samples. The thermally modified samples have shown to produce a higher smoothness if compared to controls for deodar cedar, black pine and black poplar. The surface improvement is very clear especially where early wood defects are present in the control samples. This was explained with a loss of ductility of the modified material. Modified Italian alder has shown e slightly higher tendency to form torn grain compared to control and resulted in a worse surface rating also if the difference is very small.

Control samples have shown a higher smoothness when machined with sharp tool instead than with dull tool. The difference in smoothness between thermally modified wood when machining with dull and sharp tools is much lower. It shows when machining thermally modified wood, the sharpness of the tool has a lower importance for the final surface smoothness.

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