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DESIGN AND CALCULATION OF SOLAR POWER OPERATED SUGARCANE HARVESTING MACHINE

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Abstract - *In today's world there is a huge population due to this there is a need for large scale of production of agricultural products. Agriculture is the backbone of India. In India there is scarcity of labors in agriculture. Day by day labor wages are increasing and in the same way demand of agriculture products are also increasing and today's world need large scale of production of agriculture products due to huge population. This project aims to design and fabrication of small scale sugarcane harvesting machine for sugarcane harvesting. The main objective is to reduce farmer's effort and to increase production of agricultural products. The machine consists of Solar panel, Battery, Electric motor, Cutter and different mechanisms. When compare to manual harvesting by using this machine has a capacity to cut the sugar canes in faster rate and it is economical. The design and commercial manufacturing of small scale mechanical sugarcane harvesters have taken place firstly in Hawaii, Australia, Southern USA and Japan where the sugarcane production is fully mechanized from nearly 4 decades. Significant researches of mechanical cane harvesting have also done in Barbados, Brazil, Trinidad, Cuba, India and several other countries. Currently, companies belong to countries such as Cuba, UK, Germany and China fabricates types of sugarcane harvesters that represent variable levels of technology.*

Key Words: ***Agriculture, harvester, sugar cane, solar panel, DC motor, cutters, etc.***

1. INTRODUCTION

Harvesting is a process of cutting and gathering of mature crop from the field. Different types of harvesting machines are available all are available in small scale except sugarcane harvesting machine. In many countries, sugar cane harvesting is a very labour intensive activity. Hand knives, cutting blade or hand axes are used for manual harvesting. It requires skilled labours as improper harvest of cane leads to loss of cane. Aim behind this project is cutting this sugarcane at ground level. Because labour can't cut sugarcane properly at ground level.In many countries, sugar cane harvesting is a very labor-intensive activity in which workers usually become fatigued after manually cutting the cane for a few hours. They need frequent pauses for rest, and they experience sustained injuries from excessive stress on the joints and muscles of the body. The cutting tool and motion involved directly influence the stresses created. A cutting tool that has not been designed by taking into consideration occupational biomechanics can lead to unnecessary strains in the body's muscle system, resulting in injuries. India is a country which is dependent on Farming as a main source of income for many families. Farmers are thus primly important for us. In our state i.e. Maharashtra, crops like Rice, Wheat, sugarcane grow in majority. Sugarcanes are important part of it. Nearly 30 to 50 % of field is under Sugarcane only. Thus it is mostly needed to be focused on It. Hand knives, cutting blade or hand axes are used for manual harvesting. It requires skilled labors as improper harvest of cane leads to loss of cane and sugar yield, poor juice quality and problems in milling due to extraneous matter. Aim behind this project is cutting this sugarcane at ground level. Sugarcane above the ground level with distance 6" to avoid the strike of the knife with soil. Because of this, it required to cut remaining sugarcane steam after sugarcane harvesting/cutting. It requires extra labor. Cutting of the remaining sugarcane steam is necessary, because its affects the next crop generation.

1.1 METHODS OF HARVESING

There are two methods of sugarcane harvesting

1.1.1 Manual Method

In Manual Harvesting to cut one acre of sugarcane 16-17 labors are required they take 3days to cut one acre and involves harvesting of 70-80 tons per acre with labors being paid 500-550 Rupees per ton of harvest hence total cost of harvesting per acre comes up to 30,000-40,000 Rupees.

Fig -1: Manual Harvesting Method

1.1.2 Mechanized Method

In mechanization now by using large scale harvesting machine takes about 6-7 hours for harvesting one acre averaging about 70-80 tons with labor costing around 3,500-4,000 Rupees per hour hence the total cost of harvesting per acre comes up to 20,000-25,000 Rupees.

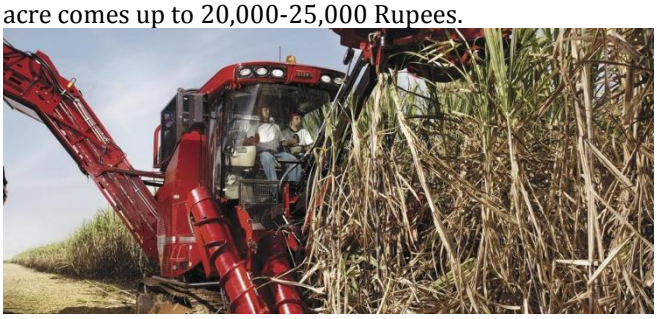

Fig -2: Mechanized Harvesting Method

2. OBJECTIVE

- The main and basic objective is to cut the sugarcane stem at ground level.
- Another thing is that the cutting must be very sharp cutting. The cane must be cut quickly and very sharply.
- The machine should not damage the crops near to the stem to be cut. The size should be according to this.
- The cost of a machine satisfying these objectives should be optimum. It should be affordable for a middle class Farmer.
- Space occupied by the machine should not be so large. It should be kept within the land.
- The machine should not have excessive weight. It should be such that a single man can operate it very easily.

3. DESIGN AND CALCUTATION

3.1 Design Of V-Belt And Pulley

$Pd=Pr*K_l$

K_l =1.10 for motor

Pd=275watts

Consider standard parameter for A type pulley

- Nominal thickness
  Width w=13mm
  Thickness t=8mm
- Pulley diameter= 75mm
- Suggested power range= 0.35-3.5KW
- Bending stress Kb=17.6*10^3
- Centrifugal tension Kc=2.52

Power rating per belt

Power/belt= $(Fw-Fc)*(e^{\theta\mu/\sin(\alpha/2)}-1)/(e^{\theta\mu/\sin(\alpha/2)})*Vp$

Fw= working load N

Fw=169N

Fc= centrifugal tension N

$Fc= Kc =(Vp/5)^2$

Where,

$Vp= (\pi DpN)/60$

Vp= 1.17 m/sec

μ=0.3

$\Theta=\pi+D2-D1/C$

We have both pulley of same direction

Θ=3.14

C=320mm

α=cone angle

Now, taking standard for A type

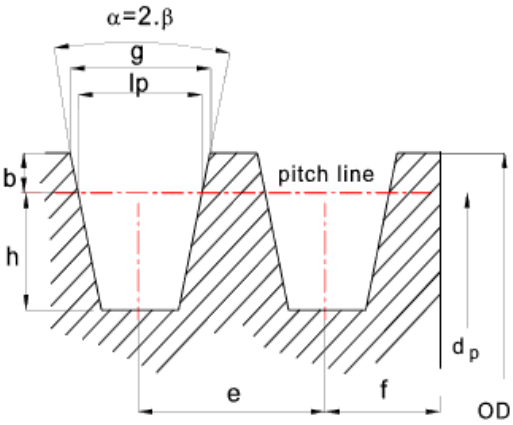

Fig -3: Pulley groove

Where,

lp=11

b=3.3mm

h=8.7mm

e=15mm

j=10mm

α=34° for Dp=75mm
Kc=centrifugal tension
$Fc=Kc(Vp/5)^2$
Fc=0.1379N
Now,
$Power/Belt= (Fw-Fc) *(e^{\theta\mu/\sin(\alpha/2)})-1)/(e^{\theta\mu/\sin(\alpha/2)})*Vp$
Power/belt=189.68watts

No of belts=power/belt/power
=180/250=0.72=1

Bending load
Fb=Kb/D
Where.
Kb= bending stress factor
$Kb=17.6*10^3$
D=pulley diameter
Fb=234.66N

3.2 DESIGN OF BEVEL GEAR

Design power=Pr*Ki
Pd=302.5watts

Tg/Tp=N1/N2
θ=angle between the gear and shaft
Tg/Tp=27/19=1.4
N1=426.31
For gear and pinion
$\theta p=\tan^{-1}(1/Vr)=35.15$
$\theta g=90-35.15=54.85^o$
θp=35.15
$\theta g=54.85^o$
For Pinion
Tan Yp= sinθ/(Tg/Tp)+cosθ
$Yp=14.22^o$
For Gear
Tan Yg= sinθ/(Tg/Tp)+cosθ
$Yg= \tan^{-1}(0.63)$
$Yg=32.58^o$

Dp=m+D
Assume module =2.5mm
Dp=48mm
Similarly,
Dg=76mm

Cone distance
$L=0.5\sqrt{Dg^2+Dp^2}$
L=44.94mm

Formative no of teeth on pinion
Tf=Tp/cos Yp
Tf=19

Formative no of teeth on gear
Tg=Tg/cos Yg
Tg=32

Tooth load
Ft=Pd/Vp
Where.
Vp=πDg N/60
Vp=1.1938m/sec
Ft=253.39N

Beam Strength
Fb=So*Cv*Y*m*b*(1-b/c)
Where.
So=196Mpa
Selecting cast steel 0.20% carbon heat treated
Cv=velocity factor
Cv=0.4
B=7-10mm for L>30mm
b= 8.5mm width
$Y=0.485-(2.87/tg)$ for 20^0 fuel depth
Y=0.3953
Fb=534N
Fb>Ft
Design is safe

3.3 Design Of Bearing

3.3.1 Bearing 1

Diameter of bearing = 15 mm
Bore number = 02
Series No. =0203

D = 42 mm
B = 13 mm
C = 8800

Assume,
L_{10} =5000 hrs
N = 639 RPM
N = 38340 RPhr

L_{10} = 38340*5000
(L_{10})=191.7 million rev.

$L_{10} =(C/Fe)^n*1$
n = 3
C= 8800
Fe = 1526.19

3.3.2 Bearing 2

Diameter of bearing = 20 mm
Bore diameter = 04 mm
Series No. = 0204

D = 47 mm
B = 14 mm
N = 895 RPM
L_{10} = 5000 hr

$(L_{10})_{rev}$ =53700*5000
$(L_{10})_{rev}$ = 268.5 million of rev

$L_{10} = (C/Fe)^n*1$
n = 3
C = 10000
Fe = 1550.07 N

3.4 Design of Cutter

Cutting force
Fc = k*b*h
Where;
b = 25.4 mm
h = 2.6 mm
k = 1
Fc = 66.04 N

Cutting speed
P = Fc * Vc

Vc = 7.95 m/sec

Cutting torque
Torque = Fc * Radius
Torque = 8.25 N.mm

4. COMPONENTS AND SPECIFICATIONS

- Solar plate
- D.C. Electric motor
- Battery
- Cutters
- Pulley
- Bevel gears

4.1 Solar Plate:

Solar plate is used to charge the battery, by using sun rays. Which reduce the cost of charging the battery manually.
Power = 50 watt
Celle = 6*10 Photovoltaic cell

Fig -4: Solar panel

4.2 D.C. Electric Motor:

For getting maxing torque output brushless D.C. motor used. This motor produce sufficient amount of torque to cut the sugarcane.
Output = 24 volt
Current =10.4 amp
Power = Voltage * Current
= 24* 10.5
=250 watt

Fig -5: Brushless D.C. motor

4,3 Battery:

Battery is electric energy storage device, which store the electric energy generated from the solar panel. Battery is then provided the electric energy to the motor and used to run the electric motor.
Dry battery
Voltage = 24 volt
Current = 50 amp

Fig -6: 12 Volt battery

4.4 Cutter:

Two cutters place at the bottom side to cut the sugarcanes from the stem level. Depending upon the sharpness of the cutters the machine efficiency depends.

Fig -7: Cutter

4.5 Pulley:

Pulley is used to transmit the torque of motor to the cutter. One pulley is directly mounted over the motor shaft and another pulley mounted on the shaft where the motion is to be transferred. And both the pulleys are connected with the help of V-belt.

Fig -8: Pulley

4.6 Bevel Gear:

A pair of bevel gear used to change the motion to 90^0 angle. Bevel gear is used because it can transmit maximum amount of torque through it.

Fig -9: Bevel gear

5. WORKING

The machine is operated with help of the Electric Motor which is connected with battery. The machine is taken out in sun rays to generate electric current and to charge the battery. The Motor is transmitted power to the cutting shaft through Belt and bevel gear and thus cutter will rotated. The rotating Bevel gears are in turn connected to the cutters through vertical rods which rotates the cutters. To cut the sugarcane stem then we select a row of sugarcane stems and machine move on this row. After cutting of canes they are taken by worker and leaf are separated with the help of knife. By this way the small scale sugarcane harvesting machine works.

6. ADVANTAGES

- Harvesting time will be less
- Efficient work is done by using machine harvester
- Limited number of labours are required
- Cost of harvesting is comparably less as manual harvesting
- Running cost is negligible

7. CONCLUSION

The cost of the machine is less and if the farmer buys this machine, farmer can recover the invested money back. By using this machine problem of the labor crises can be reduced. Comparing with manual harvesting only 20% of labors are required. It makes the process faster hence reduces most of the harvesting time and labor required to operate the machine is also less. This machine is helpful for both small and big farms.

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