Design and Fabrication of Multipurpose Self-Propelled Electric Weeding Machine

Prof. Mhaske Milind S.[1] Mr. Thombre Somesh Dayanand[2] Mr. Rasane Sagar Bharat[3] Mr. Tambe Rushikeh Ganpat[4] Mr. Maniyar Sarfaraj Rajjak[5]

[1]Associate Professor [2,3,4,5]B. E Student

[1,2,3,4,5]Department of Mechanical Engineering

[1]PREC Loni, India [2,3,4,5]Pravara Rural Engineering College, Loni, India

Abstract— The paper presents analysis of study of method of weed control for development of self-propelled Electric Weeding Machine. The paper further deals with the detailed design of various component and parts for implementation of weeding technology. The paper gives literature on weed control management. Paper explains failure mode analysis of mechanism which are best suited for weeding by using ANSYS, paper also gives more information about main subsystems of the weeding machine like Digging Mechanism, Conveyor, spraying unit, Drive system and collecting system.

Keywords: self-propelled, ANSYS, subsystem, Digging, Conveyor, drive

I. INTRODUCTION

In the todays agriculture scenario it is always observed that requirement of labours for seasonal work is in demand but there is always shortage for the labours in farm during the weeding and insecticides spraying operations. Which is the main cause to decrease the productivity of crop.

As per the general observation it is proven that 50-60% of productivity of crop is decreased as because of different weeds. By this machine we are capable to do the weeding operation within less time and less man power as compared to the conventional method of weeding. Also conventional method has a disadvantage that the seeds of the weed are dropped on the field which tends to further growth of the weeds. To eliminate such uneven conditions we are providing a weed collecting mechanism in machine. The machine is electrically driven using the solar power for the recharging of battery pack.

In addition to the weed ploughing operation there is a spray arrangement is provided which sprays the insecticides to kill the insects harming to crop.

II. PROBLEM STATEMENT

From survey we found that the productivity of the crops is affected by weeds in large extent. Weed ploughing is the seasonal process and it should be done in the period of intermediate crop period. But during the season of the weeding there is always shortage of labours which affects the productivity of crop. And in conventional weeding process seeds of weed are dropped causing again growth of weeds.

So to reduce this two measure problem we are designing and fabricating the multipurpose weeding machine.

III. OBJECTIVES

1) To reduce the man power in agricultural sector.
2) To reduce the power consumption during weeding.
3) To maintain the accuracy during weeding.
4) This type of weeding m/c provides work practically at low cost, low maintenance, low capital investment in less space.
5) To perform the most rigid operation with high speed weeding & to reduce time in Weeding.

IV. CONSTRUCTION

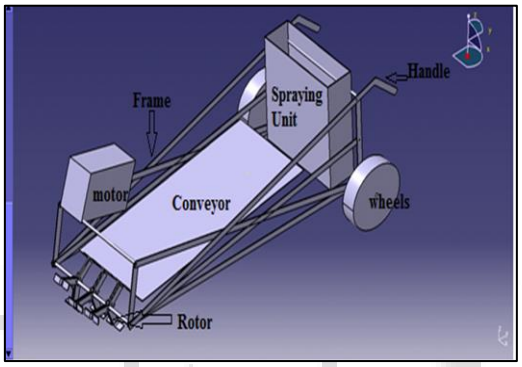

Fig. 1: Catia model of Weeding Machine

As its name indicates that it is used for multiple operations like weeding, spraying crops, etc. to achieve this multipurpose ability we have two power driven systems,

1) Weeder Assembly Rotor and conveyor assembly
2) Spraying unit assembly

The weeder assembly has a motor connected to the constant supply battery of 48 volts, the two groove pulley is mounted on the motor shaft which is used to drive rotor and conveyor assembly separately at a same time.

The electric spraying pump is mounted for spraying assembly.

V. WORKING

Here rotor blade is rotated by using belt and pulley arrangement from the motor which is connected to the constant battery supply of 48 volts. The speed variation is achieved by different pulley diameters. The conveyor is driven by same arrangement as of rotating shaft. The spraying pump shall be used for the purpose of spraying pesticides.

When the battery supply is given to the motor then the rotor blades rotates due to which digging operation is carried out. With the digging of the soil the grass and weed is plough out with roots this ploughed weed is thrown on belt due to centrifugal force exerted by blades. Then the conveyor conveys this weed to container (collecting box) which has trainer arrangement to separate soil from the weed. The weeder machine has to rare wheel to support system and give the rigidity to structure. The weeder

machines handle is designed ergonomically to ease in operation by considering each of operator between 18-40 years.

VI. DESIGN

Design of pulley

$$v = \frac{\pi d1 n1}{60 \times 1000}$$

Consider, Belt velocity 18 m/s

$$d1 = \frac{60 \times 1000 \times 18}{\pi \times 3000}$$

d1=111.59 mm

d1=112 mm

D= 2×d1

D= 2×112

D=224 mm

$$v = \frac{\pi d1 n1}{60 \times 1000}$$

v = 18.06 m/s

Maximum power = 1.3×0.746

Maximum power =0.9698 kW

$$\alpha = 180 - 2\sin^{-1}\left\{\frac{D - d1}{2c}\right\}$$

α = 153.40º

$$\alpha = 153.40º \times \frac{\pi}{180} = 2.67$$

4.4 Design of Belt

Arc of Contact factor

$$fd = \frac{(1.04 - 1.0) \times (180 - 153.40)}{(180 - 170)}$$

Fd = 1.1064

Corrected Power

= 1.1064×0.9698

=1.0729 kW

Corrected Belt Rating

$$= \frac{0.0118 \times (18.85)}{5.08}$$

= 0.0437 kW

Width of Belt × No. of plies = $\frac{\text{Corrected.Power}}{\text{Corrected.Belt.Rating}}$

Consider No. of plies of Belt are 5

Width of Belt = $\frac{1.0729}{0.0437}$

= 6.13 mm

Width of Belt = 7mm

Length of Belt

$$L = 2C + \frac{\pi(D + d1)}{2} + \frac{(D - d1)^2}{4C}$$

L = 1055.14 mm

Tension in Pulley Belt

$P = (T_1 - T_2) \times v$

$1072.9 = (T_1 - T_2) \times 18.06$

$(T_1 - T_2) = 59.4075$

We have,

$$\frac{T1}{T2} = e^{\mu\alpha}$$

$$\frac{T1}{T2} = 2.2294$$

T1=2.2294×T2

T1 = 48.32 N

T2 = 107.72 N

Design of Shaft

Selection of Material

50C4

Sut = 700 N/mm^2

Syt = 460 N/mm^2

Maximum Shear stress = 0.3×460 = 138 N/mm^2

Or $Ƭ_{max} = .01 \times 700 = 126$ N/mm^2

Selecting minimum maximum Shear stress

$Ƭ_{max} = 126$ N/mm^2

Torsional Moment,

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

M_t = 51227.20 N-mm

Bending Moment

Ra + Rb = 312.08+70+70+70

Ra+Rb = 522.08

$$\sum Mb = (70 \times 100) + (70 \times 175) + (70 \times 250) - (Ra \times 350) + (312.08 \times 375)$$

$$0 = (70 \times 100) + (70 \times 175) + (70 \times 250) - (Ra \times 350) + (312.08 \times 375)$$

Ra= 439.37 N

Rb= 82.71 N

Wp = mp × g

Pulley Weight = 312.08+30=342.08 N

Bending Moment at A,

$Mb_a = 50 \times 342.08$

$Mb_a = 17104$ N-mm

$$Ƭmax = \frac{16}{\pi d^3} \times \sqrt{KbMb^2 + KtMt^2}$$

Kb=1.5 and Kt=2

$d^3 = 9576.38$

d= 21.23 mm

d= 25 mm

Bearing Selection

N = 200 rpm

D = 25 mm

L_{10h} = 8000 Hrs

Load Factor = 2.5

R1 = 439.37 N

R2 = 82.32 N

$$L10 = \frac{60 \times 200 \times 8000}{10^6}$$

L_{10} = 96 million revolutions

$$C = R \times L10^{\frac{1}{3}}$$

C_1 = 1968.99 N

C_2 = 605.94 N

Selecting 61805 Bearing from Manufacturers Catalogue.

Specifications of 61805 Bearing

d = 25 mm

D = 37 mm

B = 7 mm

C = 2700 N

4.7 Selection of Motor

The motor provides the drive necessary for the displacement of the machine. Motor is mounted on the front of the machine which is placed on the mainframe. The motor used is a “Brushed DC motor”, with following Ratings

P= 1HP

N_s = 2880 rpm

V = 24 volts

Selection of Battery

The battery is of constant 12V. The amps rating selected is 50AH. A total of 2 batteries are used for power supply. Batteries are mounted on the tray, which is placed on the mainframe with the help of welding. The batteries are connected in series to build a voltage of 24V that is suitable to drive the motor with more power and torque.

4.8 Overall Dimensions of Frame

Length = 2000 mm
Width = 450 mm
Height = 1500 mm

VII. CONCLUSION

Agricultural development plays important role as a driver of rural poverty reduction. The effort require to develop a weeder will meet the demand of farmers. The efficiency of weeder should be satisfactory and it's easy to operate. It was faster than the traditional method of removing weed. Less labour needed and it is more economical than hand weeding. Here do not use any fuel and power, Hence maintenance cost is very less. Cost of weeding by this machine comes to only one-third of the corresponding cost by manual labourers.

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