

Design of Special Purpose E-Power Tiller

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Abstract—Currently Power Tillers are working capacity is 4 to 5 hours and weighting up to 30 to 40 kg. The Power Tiller presented in this paper with design of machine and development of Chain and sprocket, bearing, electric motor, motor cycle wheel, wheel angles, lithium ion battery, electrical controller and wiring, mount and joints, supporting frames, screw and fitting.

This Power Tiller is meant for cultivator farms with minimum inter row this of machine is 3 hours in 100 meter distance are cover and changeable battery 54.6 volt are used, this battery charge in 2 to 3 hours and same motor would be used in the machine. Power tiller is designed mainly for tilling of seedbed in small farms and in hill farming and also for carrying out spraying operations in horticultural crops and food crops. The adoption of power tillers by the farmers for carrying out farming operations is low when compared to tractors.

Index Terms— Power Tiller, BLDC, Tractors, Farming, Agricultural.

I. INTRODUCTION

We have proposed E-POWER TILLER with fully equipped by battery and controller with BLDC (brushless direct current) motor. The system include sprocket chain mechanism the chain is rotating by motor, motor is connected to battery.

Design Specifications:

1. Battery 54.6V
2. Motor 48V
3. Welded wheel
4. Frame
5. Chain sprocket mechanism etc.

A. Problem Statement

Weed manage is one of the maximum difficult tasks on a agricultural farm. Three techniques of weed manage are typically recognized in agricultural. Those are mechanical, chemical and biological control. Because of chemical manage technique soil receives polluted and it's miles dangerous to our frame. Biological approach is less effective than different technique so those methods are not beneficial. Mechanical weed manipulate not best uproots the weeds among the plants rose but also maintains the soil surfers loose, making sure higher soil aeration and water intake capacity weeding by using energy tiller reduce the price of labor and additionally shop time. Various type of mechanical weed has been developed. In human operated weed muscular energy is required and so it can't be operated for long term. The traditional approach of hand weeding is time consuming. to be able to check the opportunity of mechanization of weeding operation, the power operated needs to be produced the energy produced via us is lesser in value much less time consumable smooth to perform.

B. Objectives

- To reduce human effort.
- To reduce cost on fuel.
- To increase profit of farmers.
- To save time.
- To increase efficiency work
- To reduce fuel consumption.

II. LITERATURE REVIEW

The concept of power tiller came to the world in the year 1920. The first country to use power tiller on large scale was Japan. The first successful model of power tiller was designed in the year 1947. During the year 1950 to 1965 the production of power tiller increased rapidly. Power tiller was introduced in India during 1963. Power tiller is a walking type tractor. The operator trails behind the power tiller, holding the two handles of tiller in his hands. Power tiller is also called as a single axle walking type tractor, though a seat is provided in some designs.

A. Framework Manufacturing



Fig 1. Framework

The manufacturing sector is closely connected with engineering and industrial design. Performed operations: We have performed some manufacturing operating operations and to perform those operations we have used following process, they are:

1. Cutting
2. Drilling
3. Grinding
4. Tapping
5. Welding
6. Finishing.
7. Hammering



Fig 2. Cutting operation



Fig 3. Drilling Operation

Grinding Operation



Fig 4. Grinding on welding joint

Welding



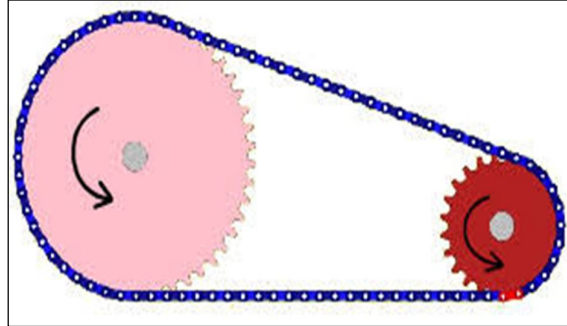
Fig 5. Welding the angles together

- Chain drive consists of three sections:
 - A. Chain section
 - B. Driver section
 - C. Driven section

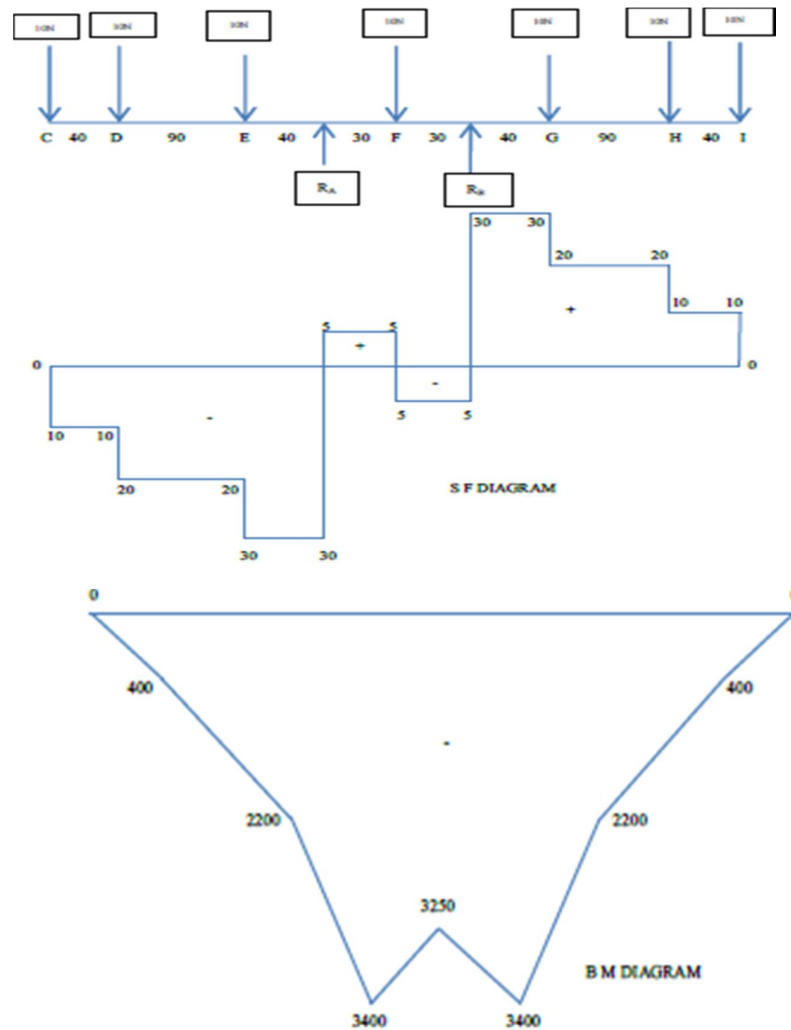
Design of E-Power Tiller

Following are the calculation for the designing of the electric power tiller and similarly gets validate with numerical analysis.

Transmission System - Chain Transmission



Forces Distribution on the Shaft



Reaction Calculation $R_A + R_B = 70 \text{ N}$

Taking $\sum M@ = 0 \text{ N}$

$$- (10 \times 170) - (10 \times 130) - (10 \times 40) + (10 \times 30) + (10 \times 100)$$

$$+ (10 \times 190) + (10 \times 230) = 60 R_B$$

$$R_B = 35 \text{ N}$$

$$R_A = 35 \text{ N}$$

Shear Force Calculation SF C = - 10 N

SF D = - 10 - 10 = - 20 N SF E = - 20 - 10 = - 30 N SF A = - 30
 + 35 = 5 N SF F = 5 - 10 = - 5 N
 SF B = - 5 + 35 = 30 N SF G = 30 - 10 = 20 N
 SF H = 20 - 10 = 10 N
 SF I = 10 - 10 = 0 N

Bending Moment Calculation At C = 0 N-mm

At D = - (10×40) = - 400 N-mm
 At E = - (10×130) - (10×90) = - 2200 N-mm
 At A = - (10×170) - (10×130) - (10×40) = - 3400 N-mm
 At F = - (10×200) - (10×160) - (10×70) + (35×30)
 = - 3250 N-mm
 At B = - (10×230) - (10×190) - (10×100) + (35×60)
 - (10×30) = - 3400 N-mm
 At G = - (10×270) - (10×230) - (10×140) + (35×100)
 - (10×70) + (35×40) = -2200 N-mm
 At H = - (10×360) - (10×320) - (10×230) + (35×190)
 - (10×160) + (35×130) - (10×90) = - 400 N-mm
 At I = 0 N-mm

Maximum bending at point A and B Maximum bending is 3400

Mild Steel Shaft

1) Design Of Shaft

TABLE I. PROPERTIES OF MILD STEEL SHAFT

Property	Symbol	value
Tensile Strength	σ_t	345 – 525 Mpa
Ultimate Shear Stress	τ	200 – 300 Mpa
Stress/Strength	σ_{ut}	800 – 840 Mpa
Yield Strength	σ_{yt}	250 Mpa
Bending Stress	σ_b	248 Mpa

Combine Twisting and Bending Moment

Transmitting Power (P) = 750 W

Speed = 300 rpm

Ultimate shear stress (τ) = 300 Mpa

Ultimate bending stress (σ_b) = 248 Mpa

Factor of safety = 8

Maximum shear stress (τ_b) = $\frac{\text{Ultimate shear stress}}{\text{Factor of safety}}$

$$= \frac{300}{8}$$

$$= 37.5 \text{ Mpa}$$

Maximum bending stress (σ_{max}) = $\frac{\text{Ultimate bending stress}}{\text{factor of safety}}$

$$= \frac{248}{8}$$

$$= 31 \text{ Mpa}$$

a) To calculate torque transmitted by shaft

$$\text{Power Transmitted (P)} = \frac{2\pi NT}{60}$$

$$T = \frac{P \times 60}{2\pi N}$$

$$T = \frac{750 \times 60}{2 \times 3.14 \times 300}$$

$$T = 23.87 \times 10^3 \text{ N-mm}$$

To calculate Maximum bending moment $M = 3400 \text{ N-mm}$

To calculate diameter of shaft -

$$T_e = \frac{\pi}{16} \tau_{\max} d^3 = \sqrt{M^2} + \sqrt{T^2}$$

$$\frac{\pi}{16} \times 37.5 \times d^3 = \sqrt{3400^2 + (23.87 \times 10^3)^2}$$

$$d^3 = \frac{24.11 \times 10^3}{7.363}$$

$$d = 14.84 \text{ mm}$$

Equivalent bending moment is given by,

$$M_e = \frac{1}{2} [M + \sqrt{M^2 + T^2}] = \frac{\pi}{32} \sigma_{\max} d^3$$

$$\frac{1}{2} [3400 + \sqrt{3400^2 + (23.87 \times 10^3)^2}] = \frac{\pi}{32} \times 31 \times d^3$$

$$d^3 = \frac{13755.46}{31\pi/32}$$

$$d = 16.53 \approx 18 \text{ mm}$$

Diameter of shaft is 18 mm

5.2 Velocity Ration of Chain Drive

N_1 = Rated speed of motor = 300 rpm

N_2 = Speed of shaft

T_1 = Teeth on small sprocket = 9

T_3 = Teeth on big sprocket = 28

$$\frac{N_1}{N_2} = \frac{T_2}{T_1}$$

$$\frac{300}{N_2} = \frac{28}{9}$$

$$N_2 = 96.42 \text{ rpm}$$

Battery Specifications:

Max. Charging voltage: 54.6 V

Std. Charge Current: 5 A

Max. Discharge Current: 20 A

Salient Technical Competing Features:

- Low capital cost, Low operational cost compared to Tractor
- Consume less power relative to tractor
- Suited for Indian Soils, rugged terrain
- Can be operated by single men even women can operate which is a big plus



Photo: Final Designed and Developed E-Power Tiller

- Advantages E-Power Tiller:
 - Reduced labor cost for weed removing.
 - Less maintenance because machine is compact.
 - Structure are simple and better
 - No fuel cost.
 - Multipurpose for farming operations.
 - Less charging cost.
 - Woman and gents both are operate very easily.
- Disadvantages E-Power Tiller:
 - It is investment of high costs but can be used for all farming operation including cultivating of agriculture products.
 - It is not suitable for rocky field.
 - It is not suitable for muddy area.
 - Depends upon battery charging.

III. CONCLUSIONS

As per the overall performance of the machine, this project will satisfy the need of small scale farmer, because they cannot afford high cost agricultural equipment's. The machine will need less man to work with and will also save time as compared to the ancient and traditional methods. So if we make this available on a large scale, its cost significantly reduce and we hope this will help our farmers and contribute to our Indian agriculture. Our team has successfully combined many ideas from various fields of mechanical engineering and agricultural knowledge to improve the yield and by reducing the labour effort and expenses.

REFERENCES

- [1] Sonu Yadav , Harshal Deshmukh , Chetan Dhapodkar , Ashish Singh Parihar , Guman Viridi , Prof. Prashant Rahate, "Portable Electric Tiller Machine," International Journal of Advanced Research in Science, Communication and Technology (IJARSCT) Volume 7, Issue 1, July 2021.
- [2] J R Murray, J N Tullberg and B Bbasnet, "Planters and their Components" School of Agronomy and Horticulture, University of Queensland, Australia.
- [3] "Hand Book of Agriculture", Indian Council for Agricultural Research, New Delhi.
- [4] Chhidda Singh, 1983, "Modern Techniques of Raising Field Crops", Oxford & IBH Publ. Co., New Delhi
- [5] Gopal Chandra DE, 2008, "Fundamentals of Agronomy", Oxford & IBH Publ. Co., New Delhi
- [6] Rathore, P.S., 2002, "Techniques and Management of Field Crop Production", Agro bios (India), Jodhpur.
- [7] Meheta S.K and MaitHli A. 2011. Development and Performance Evaluation of Portable Electric Power Tiller.In Proc. Of Conference on Machines and Mechanism, NaCoMM 2011. IIT Madras, India, pp 319-325
- [8] Technical committee education design of portable tiller machine Co1991.
- [9] Yoshinori Mechanical manufacturing and control of electric tiller, journal of Asian electric vehicles, Vol .4 no.2 ,697-752-2006.