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Design and Fabrication of Multifunctional Agricultural Vehicle

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Abstract: ***The project is intended to help the farmers using a mechanical operated multifunctional agricultural vehicle which is able to perform functions such as Sowing, Weeding, Fertilizing and human powered. All these factors have been taken care of in this project along with being cost effective, light in weight and good in strength. The spraying pump traditionally available with farmers can be directly used in this mechanism. Using this vehicle effort required in carring the pump is reduced and pain in shoulders is also eliminated along with direct contact with this fertilizers is minimized.***
Keywords: Sowing, Weeding, Fertilizing, Human Powered, Cost effective, Pain in shoulder eliminated

I. INTRODUCTION

We all live in country which is having agriculture as main occupation, Indian farmers are not much wealthy they still rely on conventional methods with conventional equipment's. So we being responsible citizen and Engineers it is our duty to eliminate/reduce problems faced in agriculture practice. We saw Indian farmers using conventional fertilizing pump which is to be carried on the shoulders all along the field which causes fatigue and pain in shoulders along with this direct contact with fertilizers was of serious concern. Later we intending to resolve this problem went through number of research papers and again found some minor drawbacks in them. For example: Locking of vehicle and no provision to regulate the flow we tried to overcome this problem by making some changes and additions to arrangement as discussed below.

In this way we were able to design and manufacture a vehicle which could serve our purpose overcoming drawbacks and multipurpose vehicle capable of spraying fertilizer, sowing, weeding was manufactured which was free from any external modern power sources requirement at affordable price and maintenance cost.

II. PROBLEM STATEMENT

To study the properties, working of sprayer for designing the manual vehicle to empower multipurpose sprayer for its objective to minimize human exertion from carrying heavy pump and to avoid direct contact with chemicals with proper spraying action.

III. MAIN COMPONENTS OF MODEL

A. Frame

The frame is used to support the all parts and is made up of Mild Steel material. The main functions of a frame are: To support the stationary and mobile components of mechanism & to deal with static and dynamic loads, without undue deflection or distortion.

B. Connecting Link

Connecting link performs the function of converting rotary motion into oscillatory motion.

C. Nozzle

The nozzle is a critical part of any sprayer. Nozzles perform three functions:
Regulate flow, Atomize the mixture into droplets, Disperse the spray in a desirable pattern.

D. Fertilizing Pump

Fertilizing pump operate by using a reciprocating action from BDC to TDC by piston. The fluid enters a pumping cylinder via an inlet valve and is forced out via an outlet valve by the action of the piston. Reciprocating pumps are efficient and are perfect for very high heads at low flow rate. Storage tank provides fluid to pumping chamber.

E. Connecting Pipes

Connecting pipes provides closed conduit for flow of pressurised fluid from pump to nozzles.

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F. Chain and Sprocket

Chain and Sprocket is used to transmit motion from driving shaft to driven shaft. Chain is flexible in nature and is combination of small links. Sprocket is toothed wheel. It is able to obtain required speed ratio.

IV. CONSTRUCTION

In this model entire assembly is mounted on two wheels which are connected by one common shaft. On these shafts there is provision of sprocket where pinion is fixed and the sprocket wheel is located at upper part of body. Chain is mounted over pinion and sprocket wheel. This sprocket wheel and crank are mounted on same shaft, the pump piston and crank are connected by connecting rod. In the rear side of vehicle there is space for hopper for sowing of seeds. Hopper consist of rotating timing wheel which is rotated by chain and sprocket mechanism. This ensures proper seeding action.

At the rear bottom side of vehicle pair of weed cutters are installed.

V. WORKING

When the vehicle is moved in forward or reverse direction motion is transferred from movement of wheels to crank via chain and sprocket mechanism and further motion is passed by using I inversion of slider crank mechanism in which body is grounded this causes piston inside the fertilizing pump to reciprocate and pressurized fluid is obtained and can be sprayed at target site using connecting pipes and pairs of nozzle which atomizes the fluid and fine spray is obtained. Span of 2 meter wide and 1.5 meter height of area can be efficiently fertilized using this vehicle.

For seed sowing action again same chain and sprocket mechanism is used which rotates timing wheel; seeds get locked into pocket into it and are released to ground from hopper. In this way effectively seeds can be sown at constant distance. Separately weed cutter can be lowered and locked at suitable height using welded nut and driving screw arrangement and weeding action is performed.

Problems	Remedies
Locking of vehicle and no provision to regulate the flow	Excess pressure was developed leading to locking of piston and entire mechanism. Flow control valve with Bypass to storage tank is installed. Smooth movement of vehicle, desired flow rate is achieved.
Precisely continuous flow required (optional)	Spring loaded accumulator can be installed at the exit of pump to eliminate even small variation in pressure.

Table No.1 Post Fabrication problems faced and remedies over them

VI. DESIGNING

Design of multipurpose sprayer pump:

By Reverse Engineering–

Torque required to drive the pump = 1 kg of load from a length of 400mm

$$T = 1*9.81*400$$

$$T=3924Nmm$$

1) Selection of Material

Material of shaft- C30

2) From Design data Book

Syt=400 N/mm², Sut=620N/mm^2

A. Weight of Vehicle

Weight of empty pump= 1.8Kg~ 2Kg.

Weight of capacity of pump=16 Kg.

Weight of wheel = 2 Kg (for single wheel)

=4 Kg (for both wheels)

Weight of frame= 5Kg.

Therefore, total weight of v

ehicle=2+16+4+5

=27Kg

Hence, for safety we consider weight 30Kg.

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B. Design of Shaft

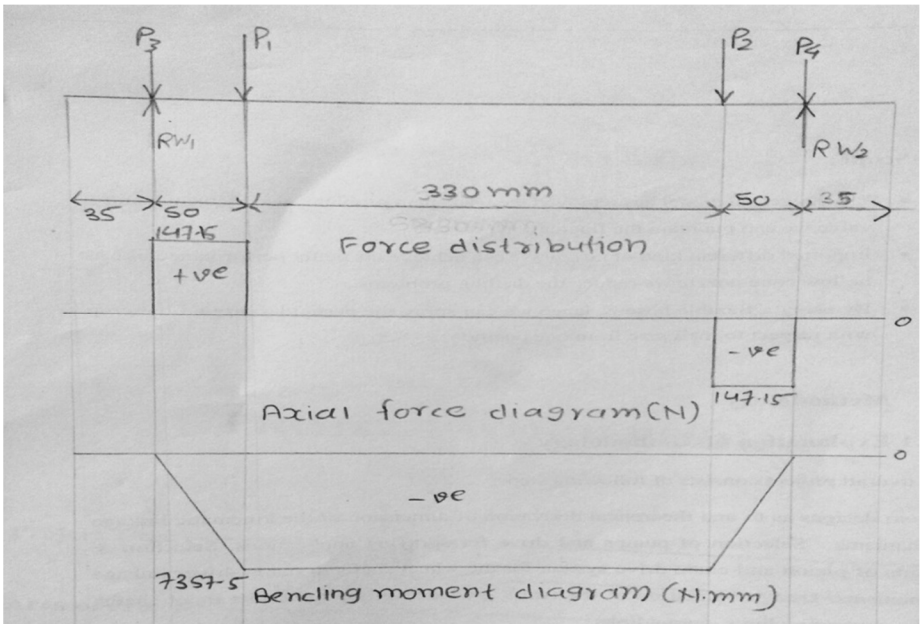

Fig.3 Loading diagram, Shear force diagram and Bending moment diagram.

Therefore Moment (M)= 7357.5Nmm

1) T=F*D/2

2) Te=√(KbM)^2+(KtT) ^2

3) τ=16*Te/πd^3

4) τ_{per}=0.33syt

5) τ_{per}=0.18sut

Torque available at the shaft T=force(F)*radius of shaft

Let's assume dia. of shaft(d) = 10 mm

Therefore T=F*d/2

3924=F*10/2

F=784.8N

Equivalent torque (Te)=√(Kb*M) ^2+(Kt*T) ^2

=√7375^2+(784.8*Ds/2) ^2

Shear stress=(16*Te) /(π*d^3)

By ASME code

τ_{per}= 0.33 Syt = 0.33*400=132N/mm^2

τ_{per}=0.18 Sut = 0.18*620N/mm^2 =111.6N/mm^2

selecting smaller values

τ_{per}= 111.6 N/mm^2

therefore 111.6 = (16*√7357.5^2+784.8^2*Ds^2/4) / π*Ds^3

Ds=7.10 mm

=10mm(approx.)

Therefore, the dia. of design shaft is 10mm

D= 8.77mm ~ 10mm

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C. Selection of Bearing

1) Pe=Fr*Ka

Pe= 200.124 N

2) L10=Lh10*60*n/10^6

L10=15.912

3) L10=(C/Pe) ^3

C=503.354 N

Equivalent force (Pe)=radial force (Fr)*load factor (Ka)

=17*9.81*1.2 (for safest Assume load factor as 1.2)

=200.124N

$L10=(Lh10*60*n)/10^6$

$=15000*60*17.68/10^6$

=15.912 million rev.

$L10=(C/Pe)^3$

15.912 =C/200.124

C=503.35 N

From SKF manufacturers catalogue 61800 is selected

d=10mm

D= 19mm

b=5mm

D. Design of Chain Drive for Pumping

Let us assume pinion has 18 teeth having dia. 60mm

Length covered by wheel in one rotation = (Dia. of wheel) *π

=0.6*π

=1.888mm

So, for proper spraying we need at least 2.5 positive strokes of piston

i.e. gear ratio G=2.55

No of teeth on sprocket =G*Zp

=2.55*18

=46 teeth

Dia. of sprocket =G*dp

=2.55*46

=117mm

Distance between two sprockets=radius of sprocket + radius of pinion + clearance

=58 + 30 + 122

=210mm

Length of chain=2C+(Zg/4+Zp/4+1)

=2*210+46/4+18/4+1

=437mm

E. Design of Chain Drive for Sowing

Let us assume pinion has 18 teeth having dia. 60mm

Length covered by wheel in one rotation = (Dia. of wheel) *π

=0.6*π

=1.888mm

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So, for proper sowing we need at least 2 positive rotation of shaft
i.e. gear ratio G=2
No of teeth on sprocket =G*Zp
=2*18
=36 teeth
Dia. of sprocket =G*dp
=2*36
=72mm
Distance between two sprockets=radius of sprocket + radius of pinion + clearance
=36 + 30 + 934
=1010mm
Length of chain=2C+(Zg/4+Zp/4+1)
=2*934+36/4+18/4+1
=1882.5mm

VII. ACTUAL MODEL

VIII. CONCLUSION

Hence it can be concluded that the multifunctional vehicle designed is far better than using the conventional method of using a backpack fertilizing pump which is human powered i.e. free from any external energy requirement and problems such as pain in shoulder, Contact with pesticides is significantly reduced. Moreover large area of field can be fertilizer with much less effort, time and fatigueness being caused. Large span of area can be fertilized 2m wide and 1.5 m height effectively in a single go of vehicle.
In addition, Weeding operation and Sowing seeds at intermittent distance is efficiently carried away.

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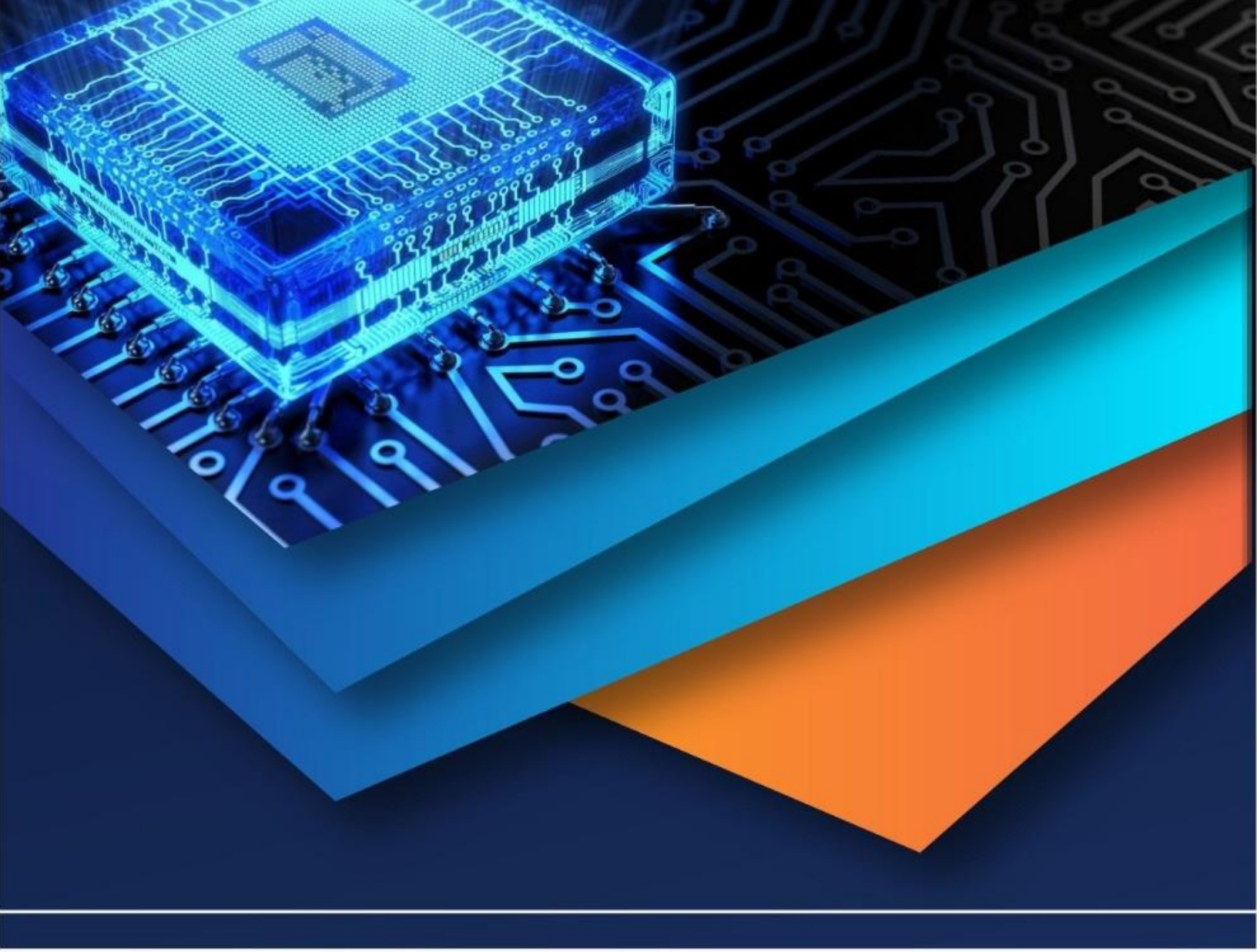

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