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"Design and Fabrication of Pedal Operated Lawn Mower"

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ABSTRACT

The lawn mower is a device which is used to cut the grass in a lawn to even height. It is required to maintain the uniform level of grass as in the case of golf courses, party lawns, etc. At present grass cutters are operated by fuel and electrical energy, thereby exhausting the resources. The present project is to design & fabricate a grass cutter with reciprocating action of its cutting blade. In our project we fabricate the grass cutting machine for the use of Lawn and Golf Courses to cut the grass in the field. It can be operated manually through pedaling. It is simple in construction and its working is easy. The design objective is to come up with a mower that is portable, durable, easy to operate and maintain. It consists of a simple mechanism and the components such as chain and sprocket, sickle bar, single slider mechanism, wheel.

Keywords: Lawn mower, Tadpole, Manually Operated, Chain Sprocket mechanism

I. INTRODUCTION

A lawn mower (mower) is a machine utilizing one or more revolving blades to cut a grass surface to an even height. The height of the cut grass may be fixed by the design of the mower, but generally is adjustable by the operator, typically by a single master lever, or by a lever or nut and bolt on each of the machine's wheels. The blades may be powered by muscle, with wheels mechanically connected to the cutting blades so that when the mower is pushed forward, the blades spin, or the machine may have a battery-powered or plug-in electric motor. The most common power source for lawn mowers is a small (typically one cylinder) internal combustion engine. Smaller mowers often lack any form of propulsion, requiring human power to move over a surface; "walk-behind" mowers are self-propelled, requiring a human only to walk behind and guide them.

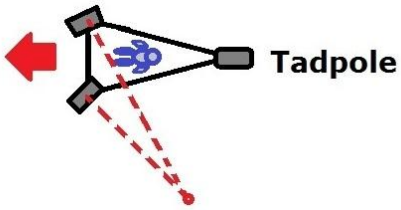
Larger lawn mowers are usually either self-propelled "walk-behind" types, or more often, are "ride-on" mowers, equipped so the operator can ride on the mower and control it. A robotic lawn mower ("lawn-mowing bot", "mowbot", etc.) is designed to operate either entirely on its own, or less commonly by an operator by remote control.

There are several types of mowers, each suited to a particular scale and purpose. The smallest types, unpowered push mowers, are suitable for small residential lawns and gardens. Electrical or piston engine-powered push-mowers are used for larger residential lawns (although there is some overlap).

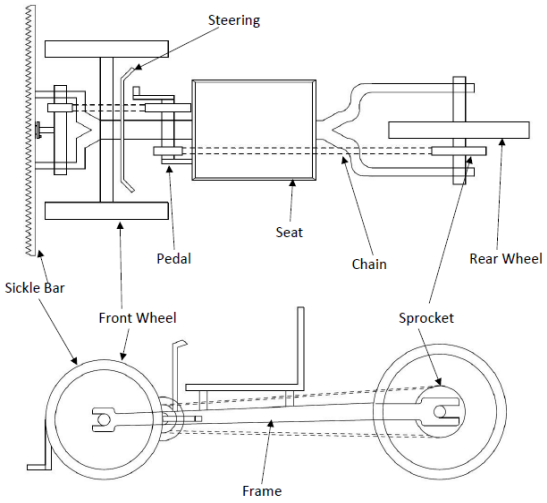
II. PROJECT DESCRIPTION

In our project we are using Tadpole type of frame which will be operated by a single person. Tadpole type structure has two front wheels & one rear wheel which is driven by the pedal. This frame is stable & comfortable at slow speed, also tadpole type of structure prevents over steering. In our project we are using the grass cutter for cutting the grass in the field. It consists of simple manner and the using components are chain and sprocket, sickle bar, single slider mechanism, wheel, cutter. Arrangement witches this project using two cutter one movable cutter another one fixed cutter the movable cutter is connecting to the single slider mechanism through links and slider is rotating help of pedal. Here the pedal is working using with the help of human power supply; When the pedal to start running the shaft is rotate and it's rotating the single slider mechanism is rotating with attach of cutting blade and the cutting process is carrying out by this machine. The grass cutter vehicle is moving help of human power .The pedal is connecting with the chain and sprocket arrangement with wheel shaft.

Tadpole- The first tadpole trikes were introduced in the year 1970. Even though it originated in Japan it was the United States where they were most prevalent. The original trikes work quit long compared to tadpole type of today. With its extremely low Centre of Gravity aerodynamic layout & light weight they are considered as highest performance frame. A configuration of two wheels in the front and one wheel at the back presents to advantages: it has improved aerodynamics, and that it readily enables small lightweight motorcycle power plant and rear wheel to be used. With a single driven rear wheel, all power is directed through a single wheel. The wheel must support acceleration loads, as well as lateral forces when in a turn, and loss of traction can be a challenge in some model type .With two wheels in the front (the "tadpole" form or "reverse trike") the vehicle is far more stable in braking turns, but remains more prone to overturning in normal turns compared to an equivalent four-wheeled vehicle, unless the centre of mass is lower and/or further forward.



PROPOSED DESIGN



DESIGN CALCULATION

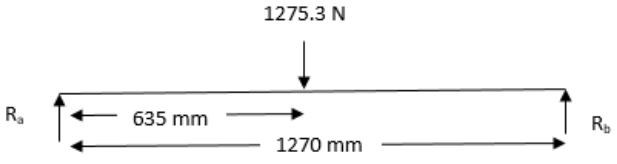
Considering SAE 1040 as the material of frame

Assuming maximum load 130 kg =130×9.18=1275.8N

Assuming total length of frame =50"=1270mm

1"=25.4mm

Factor of safety =1.5



Considering frame as simply supported beam

Considering forces system in Equilibrium

$R_a + R_b = 1275.8N$

Taking moment at point A

Ma=0

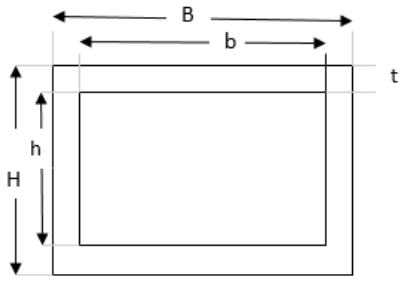
$1275.8 \times 635 - Rb \times 1270 = 0$

$R_b = 637.65N$

Ra=637.65N

Taking Bending moment

$BM = 410 \times 10^3$ N-mm



Considering Rectangular cross section of material

Bending stress =M/Z

$Z = BH^2/6 - bh^3/6H$

B=1.5"=38.1mm

H=1"=25.4mm

Thickness (t) =2mm

b=34.1mm

h=21.4mm

$Z = 38.12 \times 5.4^2/6 - 34.12 \times 1.4^3/6 \times 25.4$

$= 2 \times 10^3$ mm^3

Bending stress Induce $= 410 \times 10^3/2 \times 10^3$

=205Mpa

For SAE1040

S_{yt}=350Mpa

Bending stress Allowable $= S_{yt}/FOS$

=350/1.5

=233.33 Mpa

Induce Bending stress is less than Allowable Bending stress

Torque Calculation

Human Input Power

Assuming Weight of one healthy person is 50kg.

W=50kg (Weight is converted in to force)

F=50*9.81

F=490.5N

Length of Crank=17cm =170mm

Torque:

T=F*L

T= 490.5*170

T=83385N-mm

T=83.385N-m

Torque require to overcome the friction:-

Assuming Whole weight of measure of mower with a human is= 130kg

Let, Assume that weight is equally distributed among three tyres.

=130/3

=43.33 kg

Co-efficient of friction for Lawn=0.6

Traction Force:

Fr=uR

=0.6*(43.33*9.81)

Fr=235.45N

Maximum traction force is also equal to the

Fr=255.04N

Because Power is only supplied to rear single wheel.

Torque Required:

T=Fr*R

…Where, R-Radius of Wheel =30cm

=255.04*0.3

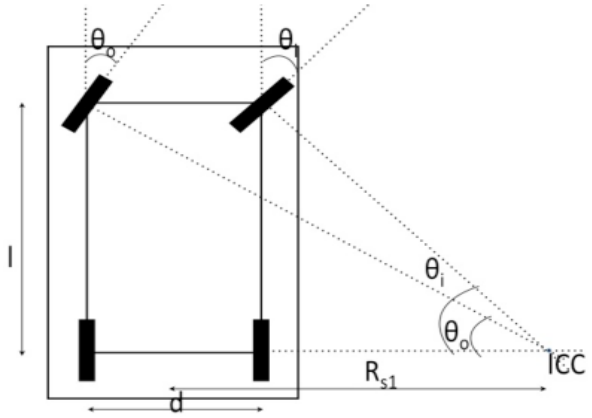
T=76.51 N-m

$T_{shaft} > T_{Fr}$

83.385N-m >76.51N-m

Steering Calculation

Ackermann geometry is to avoid the need for tyre to slip sideways when following the path around a curve. While going around a corner all the tires turn along the circle with a common center point. In this outer wheel has less angle than Inner wheel.



In fig. θo= Angle of outside Lock
θi= Angle of Inside Lock
d= Wheel Track
l= Wheel Base

Total length (L) = 120mm
Width (D) = 66mm
Assuming θi = 40˚

Formula:-

$\cot(\theta o) - \cot(\theta i) = D/L$
$\cot(\theta o) - \cot(40) = 66/12$
$\theta o = 30^{\circ}$

III. CONCLUSION

Thus we can conclude that tadpole type of manually operated lawn mower has been found suitable & requires less effort for very large lawns. A single person can operate the present setup & can cut the grass evenly in less time by harnessing human power only.

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