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Modification and Performance Evaluation of Lawn Mower

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Abstract: *The main objective of the work is to develop the manually operated rotary lawn mower to clean the lawn. Rotary mower has a set of three wheels, one front wheel and two rear wheels. The shaft between the two rear wheels is connected to the compound gear train system. The wheels are rotated in forward motion and bevel gear system convert the forward motion to the vertical motion. The bevel gear system is connected to the blade and the blade is a low lift blade used for low speed. This lawn mower is used to minimize the cost and power requirement for domestic purpose. Since heavy machine cannot be introduced in domestic purpose due to the limited space of lawn. From the above points it found necessary to give a better lawn mower operated by power (motor) with minimum cost so there is no need of skilled labour. The lawn mower was fabricated and operated at an average speed 1.5 km/hr without disturbance in operation. The effective field capacity of machine is 0.04 ha/hr i.e. it can cover / move the lawn mower in 22.54 hrs. The field efficiency of grass cutter was found to be 70%. 1 Hp single phase electric motor is sufficient to operate the working width of 390 mm cutter bar.*

Keywords: *Lawn Mower, Field capacity, and Field Efficiency.*

INTRODUCTION

In India ever since human being first attempted the cultivation of plants. They have not to fight the invasion by weeds into areas chosen for lawn. Some unwanted plants lateral were found so have virtues not originally suspected and so were removed from category of weeds and takes under cutting. But still thousands of plants were categorized under pastureland due to lack of cheaper mechanical weed control techniques or grass cutting techniques. The first lawn mower was invented by Edwin Budding in 1827 in Throop, just outside Stroud, in Gloucestershire. Budding's mower was designed primarily to cut the lawn on sports grounds and extensive gardens, as a superior alternative to the scythe, and was granted a British patent on August 31, 1830. It looks ten more years and further innovations to create a machine that could be worked by animals, and sixty years before a steam-powered lawn mower was built. The first machine produced was 19 inches wide with a frame made of wrought iron. Two of the earliest Budding machines sold went to Regent's park zoological gardens in London and the oxford colleges. A cylinder (reel) mower from 1888 showing a fixed cutting blade in front of the rear roller and wheel-driven rotary blades.

A lawn 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 internal combustion engine, particularly for larger, self-propelled mowers. Smaller mowers often lack any form of propulsion, requiring human power to move over a surface; "walk-behind" mowers are self-propelled, requiring

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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. Arobotic lawn mower is designed to operate either entirely on its own, or less commonly by an operator by remote control.

MATERIAL AND METHODS

Design Considerations

The principle and working of lawn mower was to cut the lawn by shearing action of the blades above the ground surface without damaging the blades when it strikes on immovable objects such as rock, stone. The cutting of grass takes place due to impact and shearing action. Following are the various parts of lawn mower designed carefully.

Cutting unit

The straight shaped cutting edge had been sharpened for easy cutting fixed at an angle of 180^0 to its horizontal axis. The cutting blade had been used as a horizontal plane to perform cutting the grass efficiently. Design aspects of cutting unit consist of following consideration.

In order to cut the grass the peripheral speed of the blade was calculated by the formula,

$$V = \frac{\pi DN}{60}$$

Where,

V = Peripheral speed of blade, m/s.

D = Dia. of cutting coverage area, m.

N = Shaft speed, rpm.

Power requirement for cutting

The horse power required to cut the grass can found out with the help of formula,

$$P = \frac{2\pi NT}{4500}$$

Where,

P = Power requirement, hp

T = Torque, Kg-m

Design of Lawn Mower

Design of machine was carried out and the material required for its fabrication used as per the availability in the market. The available material was used as per the requirement concerning the function of machine and the life of the components. Mild steel was known as soft metal, having less than 0.25 % of carbon, able to with stand with the load stand will occur against machine elements, lower cost, easy availability, machinability it was mostly used in order to reduce the cost of agricultural machine. For fabrication of the machine mild steel was used.

Fabrication of the Lawn Mower or Grass Cutter

Due attention was provided on the following design aspects while designing and fabrication of the lawn mower. Viz.

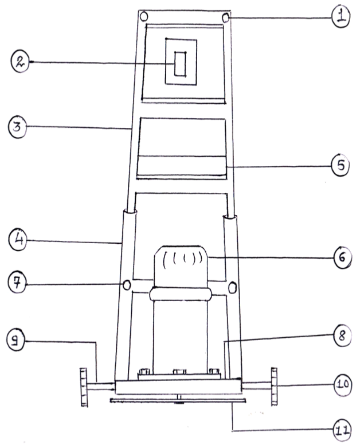
1. Cutting unit
2. Supporting frame
3. Power unit
4. Handle
5. Transporting unit

Cutting unit

Cutting unit of lawn mower was consisting of cutter blade. Cutter blade used, was straight with sharpened edges. The cutter blade was made of high carbon steel. The cutter blade was hardened and tempered to suitable hardness for longer service life of the cutting edge. The blade was rotated by the motor shaft which was operated electrically. The grass was cut by the shearing action of blade revolving at 1420 rpm. Other details of blade were shown in fig.

Supporting frame

Supporting frame comprises of rectangular frame made of M.S angle (490 x 350, 40 mm) from the economic point of view, to reduce cost of machine, a rectangular wooden plank 470 x 330, 30 mm size which was support the motor weight. The motor shaft was mounted on the frame with the help of



1. Grip
2. Main switch
3. Conduit pipe (20.75 mm dia.)
4. Conduit pipe (27.5 mm dia)
5. Tool box
6. Motor
7. Adjustment of handle
8. Supporting frame
9. Wheel axle
10. Wheel
11. Blade

Figure 1: Front view of lawn mower

bushing at the centre of frame and conduit pipe handle was attached to the frame for easy operation of lawn mower. Reel shaft of 20.75mm outer dia. and 220 mm length was attached to frame for supporting the reel. The reel was used for winding the cable.

Power unit

The Power unit was consisting of motor and on-off lever. Power to the machine was provided with the help of single phase electrical motor of 1 Hp to rotate the blade for cutting of grass. The blade was attached on shaft of motor. The height of shaft 80 mm from the frame. There were two holes on the shaft made for adjustment of blades. The first hole was 40 mm from ground level and other was 60 mm from ground level. Washer, nuts and quarter pin were used for supporting the blade. On-off levers (switch) were used to cut and start the electric supply. There were two switches provided. Main switch was fixed at the front side of handle for easy operation. Adjustable switch was fixed on the grip of the handle to reduce the losses during the turning of the machine.

Handle

A standard light weight M.S 27.5 mm outside dia. of outer pipe and 20.75 mm outside dia. of inner pipe were used for the easy operation of machine. Length of handle was calculated based on the average standing elbow height of operator. Average standing elbow height of operator was 100 cm. The height of handle adjusted from 88 cm to 118 cm. from the ground level. A rubber hand grip of 20.75 mm outer dia. and 170 mm long fitted at the end of conduit pipe for easy grip. A tool box (410 x 120 x 130 mm) was attached to the back side of handle for safely keeping the tools. Also the electric board (230 x 200 x 10 mm) was used for supplying the current to the motor and where the main switch was attached.

Transporting unit

Transporting unit consist of ground wheel and axle. Two front and two rear wheels of 150 mm diameter and 50 mm width made of rubber which support and carry the machine. The dia. of wheel was mainly based on the machine height. The width of wheel was depending upon the type of soil and wheel sink-age. The four wheels were axle by 25 mm dia. M.S. bar. Washer and quarter pin were used for wheel supporting.

Specification of lawn mower

Table 1
Specification of Lawn Mower

Measurement of cutting unit	
A] Cutter blades specifications	
Width, mm	50
Length of single blade, mm	390
Thickness, mm	5
Total number of blades	1
Weight of each blade, gm	350
Width of coverage, mm	390
Blade speed, m/s	29
Mean cutting height of grass, mm	40
B] Motor shaft	
Diameter of transmission (motor) shaft, mm	15
Length of transmission shaft, mm	150
Measurement of support frame	
A] Supporting frame specifications	
Overall length, mm	490
Width, mm	350
Thickness, mm	40
B] Wooden plank specifications	
Overall length, mm	470
Width, mm	330
Thickness, mm	30

cond. table 1

Measurement of transporting unit

A] Specifications of wheels		
Diameter, mm		150
Width, mm		50
Measurement of power unit		
Electrical motor		
Make	Batlibal and Company Ltd.	
Brand	Batlibal	
Model	Jet centrifugal pump combination	
Rated rpm	1420	
Hp	1 (single phase)	

Lawn Mower Tested in the Field

Field test was carried out in order to confirm the adaptability of the grass cutter to the practical conditions in the field for different field capacities.

The field test was conducted for the plot of 20x10 m area as per recommended by RNAM Test Codes (1983).

Field parameters

For the performance test the Field parameters were observed and listed in following table.

Table 2
Field Parameters

Particulars	*Observations*
Test plot size, m	20 X 10
Area of test plot, m^2	200
Average height of grass, mm	100
Required cutting height of grass, mm	40
Total no of strips (0.5X20m) to cover area	26
Time taken to cover one strip, sec	48
Time taken to cover total strips of test plot, sec	1248
Total number of turns	25
Time lost to one turning , sec	15
Time lost to total turning, sec	375
Speed of operation, km/h	1.5

Measurement of average height and thickness of grass

The height and thickness of grass from ground in the test plot was measured by selecting the grass throughout the test plot.

Measurement of field efficiency

During measurement field efficiency some parameters were calculated by the following formulae.

Theoretical field capacity

Theoretical field capacity was calculated by using the following formula,

$$\text{T.F.C (ha/hr)} = \frac{Width\,(m) \times Speed\,(km/hr)}{10}$$

Effective field capacity

Grass cutter was operated in the test plot continuously for the specified time. The area covered during test was calculated. The Effective field capacity was then calculated by formula,

$$\text{E.F.C (ha/hr)} = \frac{Area\,covered\,(ha)}{Time\,required\,(hr)}$$

Field efficiency

Field efficiency was calculated by formula,

$$\text{F.E. (\%)} = \frac{Effective\ field\ capacity}{Theoretical\ field\ capacity} \times 100$$

Machine parameters

The following machine parameters were considered to evaluate the performance of lawn mower.

Speed of operation

Two poles A and B that were placed at the outside corners, 20 m apart to the long boundary of the test plot. On the opposite side, two poles C and D were also placed in a similar position, 20 m apart. So that all four poles form corners of rectangle, parallel to at least one long side of the test plot. The speed would be calculated from the time required for the machine to travel the distance of 20 m between the poles A and B.

Time of turning

Time required to turn the machine was calculated when it completes the distance of 20 m and when it begins the other end of the 20 m.

Actual operating time

Actual operating time was the time required to complete the cutting of grass of 20mX10m test plot including speed of operation and time required to turn the machine.

Effective cutting width

The effective cutting width of the machine was the actual width of cut of the blade. It was measured with the help of measuring tape.

RESULTS AND DISCUSSION

Working of Lawn Mower

The 1hp motor started by supplying electricity. The power was transmitted to the blade shaft from the motor. The cutting blades were attached to the motor shaft which revolved horizontally parallel to the ground surface leaving 40 mm height of grass after cutting. The machine was operated move forward by the man walking behind the machine with the help of handle. When the shaft rotates, the blades are also rotates with respect to motor shaft and cutting of grass takes place.

Experimental Details

The performance evaluation of lawn mower was tested on plot. During working observations were taken for each strip of (20 x 10m) test plot. The detail calculations were described in Appendices.

Machine parameters

Machine parameters that were taken into considerations to evaluate the field performance of lawn mower are presented in table 2.

Field conditions of test plots

The field performance of lawn mower and details of test plot are discussed in table 3.

Table 3
Field Condition of Test Plot

Particulars	*Observations*
Test plot size, m	20 X10
Area of test plot, m^2	200
Kind of plot	Flat
Typ-e of soil	Black cotton soil
Height of grass, mm	100

From Table 3, the plot having size of 20 X 10 m as per RNAM Test Codes 1983. The plot was flat having average height 100 mm of grass before test.

Performance and Evaluation of Lawn Mower

Table 4
Performance and Evaluation of Lawn Mower

Particulars	*Observations*
Operating width of machine, mm	390
Test plot size, m	20 X10
Area of test plot, m^2	200
Average height of grass, mm	100
Required cutting height of grass, mm	40
Total no of strips (0.5X20m) to cover area	26
Time taken to cover total strips of test plot, sec	1248 (20.8 min)
Total no of turns	25
Time lost to owing to turning, sec	375 (6.25 min)
Speed of operation, km/hr	1.5
Total time required to cover the plot including time losses, sec	1623 (27.05 min)
Theoretical field capacity, ha/hr	0.058
Effective field capacity	0.04
Field efficiency, %	70

The summary of the performance of field test of the lawn mower for given plot is presented in table 4. Following observations regarding the different performance parameters of lawn mower are discussed below.

Height of grass

From the table 4 it was found that the average height of grass was found to be 100 mm before cut.

Height of grass after cut

The height of cutting grass was varies with height of grass before cut because the lawn mower was adjustable. The height of cut grass was same for the ground level throughout the testing which was 40 mm after cut (table 4).

Speed of operation

The speed of operation was totally depending on operator speed. The speed of operation was found to be 1.5 km/hr. It was calculated by taking the average time required to cover 20 m length of plot.

It was found that the intensity of grass affects the speed of operation. For less intensity, the speed of operation was maximum and vice versa.

Time requirement

It was found that the time required to cover the test plot (20 x 10 m) was inversely proportional to the speed of operation. As the speed of operation was more, the time required to cover the test plot was less. The total time required to cover the plot was found to be 1623 min at average speed of 1.5 km/hr.

Field capacity

It was found that (from table 4) theoretical field capacity 0.058 ha/hr and effective field capacity 0.04 ha/hr. From this calculations it can be say that to cover 1 ha with the help of machine requires 22.54hrs.

Field efficiency

It was found that the value of field efficiency for test plot was 70%. The field efficiency decreases as the speed of operation increase. The field efficiency was 70% obtained at speed of 1.5 km/hr which found satisfactory.

CONCLUSION

(1) The lawn mower is able to cut grass of height 40 mm above ground level.
(2) The effective field capacity of machine is 0.04 ha/hr i.e. it can cover / move the lawn mower in 22.54 hrs.
(3) Field efficiency of lawn mower is 70%.
(4) Lawn mower is operated at an average speed 1.5 km/hr without disturbance in operation.
(5) 1 Hp single phase electric motor is sufficient to operate for the width of 390 mm.

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