DESIGN AND FABRICATION OF TWO WHEELER OPERATED SICKLE BAR MOWER

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Abstract - This present paper deals with design and fabrication of two wheeler operated sickle bar mover which is mechanical device used for cutting grass and shrubs. It is simple in construction and working. This project is more related to the engineering design field, so all the criteria in the design specification must be followed to get the best result. In present work, we collect data related to our project, so that it can be help full for taking correct decision while performing design calculation and cad modeling etc. The main components are Bevel Gear, bearings, shaft, wheel, cam, frame made by M.S rectangular pipe and the flat cutting blade called sickle bar. There are two cutting blade one is rigidly fixed to the frame and other is movable (reciprocate over fixed blade). When two-wheeler move forward then mower wheel rotates shaft, gear, cam arrangement and cam convert rotary motion into reciprocating motion and finally cutting force obtained on blade edges.

Key Words: Sickle bar, bevel gear, shaft, frame, wheel.

1. INTRODUCTION

A lawn mower is an important equipment to maintain the beauty of the lawn. Land cleaning involves the removal of vegetation such as tree, bushes, shrubs, etc. Different types of mowers are available in market, but they are classified in three types as Walk-Behind Mower, Riding Mower and Tow-Behind Mower.

The first actual mower was invented in 1830 by Edwin Beard Budding [1][3]. Budding was an engineer from England who first discovers the idea of mower from a cylindrical machine used for cutting in mill. The mower that he developed was composed of a large roller which provides power t cutting cylinder using gear. The cutting cylinder contains several blades connected in series around the cylinder [1] [3]. There are three main methods of harvesting using manual labor, harvesting by mowers, and harvesting by silage machines. Scythe is mostly used in manual cutting of grass, but this is suitable for small lawns. In second method we observed that for large are ie. (>200m2 area) tractor two behind mower or riding mower is used, but the biggest disadvantage of the tractor-mounted type mower is dependency and availability of a tractor [4].

For these reasons, a tow-behind Sickle bar mower was selected for exploring its adaptability to overcome problems in terms of cost and versatility on various small-scale enterprises. In this project we designed and fabricate tow-behind type mover. Tow-behind mowers are used for much larger areas, like massive fields, large lawn, yards, play ground and are used much more in agriculture and road sides [1][2]. Two-wheeler tows these sickle bar mechanism and provide power to mechanism. And cut the hay (grass) shrubs. Basic components are sickle bar, cutting blades; drive system, cam, wheels, etc.

2. DESIGN AND CALCULATION

2.1Data accumulation

Two wheeler specification:

Table-1: Specification

Parameter	value
Displacement	109cc
Maximum Power	8 bhp@ 7500 rpm
Maximum Torque	8.7Nm@5500rpm
Number of Cylinders	1
Number of Gears	Automatic
Fuel Tank Capacity	5.5 liters
Ground Clearance	155mm
Top Speed	80 mph

The minimum cutting force on the blade: In literature survey it is found the shearing force of most annual and

perennial grasses found on most lawns is usually between 9.2N ~ 11.51N (Yong and Chow, 1991) [11].

2.2 Components

1. Bevel Gears
2. shaft
3. Blade
4. Frame
5. Bearing
6. Wheels

Design: Standard tables referred from design data book [9]

2.2.1 Bevel gear

Design data available.

Speed of pinion Np= 150 rpm (speed 10 kmph) as t_p=12 and $\frac{t_g}{t_p}$= 2 Therefore Ng

Fig-2: Straight Bevel gear

Table-1: Bevel gear dimension

Parameter	Formulae	Value
Pitch angle for pinion γ_p	$\tan\gamma_p = \frac{\sin\theta}{\frac{t_g}{t_p}+\cos\theta}$	26.56°
Pitch angle for gear γ_g	$\tan\gamma p = \frac{\sin\theta}{\frac{t_p}{t_g}+\cos\theta}$	63.43°
Cone distance, (L)	$0.5\sqrt{Dg^2+Dp^2}$	62.08mm
Formative no of tooth of pinion (t_{fp})	$\frac{t_p}{\cos\gamma_p}$	13.40
Formative no of tooth of pinion (t_{fp})	$\frac{t_g}{\cos\gamma_g}$	53.63
Tooth load F_t	$\frac{(P_d)}{V_p}$	2879N
Beam strength F_b	$\sigma_b C_v Y b m (1+\frac{b}{L})$	2468N
Dynamic load factor, F_d	$F_t + \frac{21V_p(Ceb+F_t)}{21V_p+\sqrt{Ceb+F_t}}$	3215N
Limiting wear load,F_w	$\frac{KbD_pQ}{\cos\gamma_p}$	3354.75N

2.2.2 Shaft

Taking SAE 1030 steel having S_{us}= 183Mpa and factor of safety 3.

$$T = \frac{P_d \times 60 \times Kl}{2\pi Ng} = 175.70 \text{ Nm}$$

$$\text{Also, } T = \frac{\pi}{16} \times d^3 \times \tau$$

$$d = 24.479\text{mm} \sim 25\text{mm}$$

2.2.3 Blade

The cutting blade typically made up of steel having trapezoidal shape and having 3mm thickness. The greased tight contact between the two members is maintained. Lower and upper blades have 17 &15 blades.

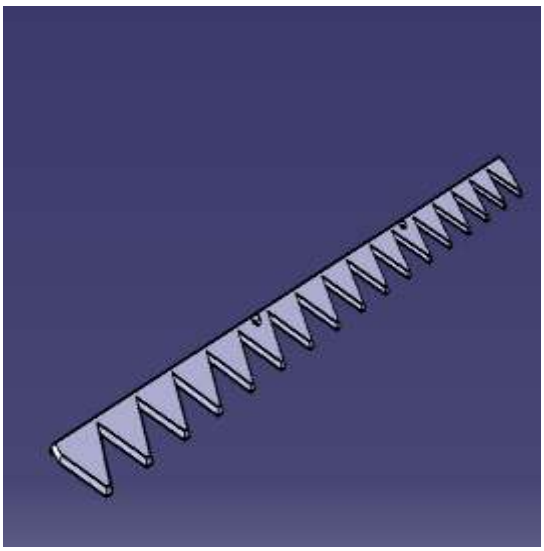

Fig-2: Lower fixed blade.

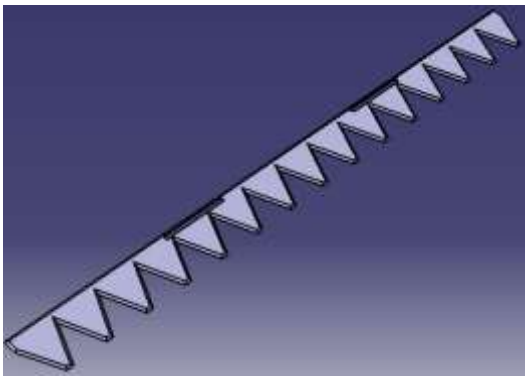

Fig-3: Upper movable blade

2.2.4 Frame

Frame is fabricated with MS rectangle pipe of 1.5"x1" cross section and thickness of 1.2 mm (16 gauges). On which wheels shaft and bearing is mounted. Overall frame dimension are 40" x 26" two rectangle pipe are welded in frame at 15" and 7.5" from right side to left as shown in figure for support.

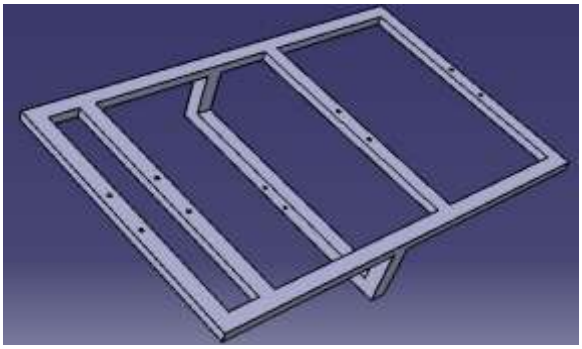

Fig-4: Frame

2.2.5 Bearing

Bearing is a mechanical element which locates two machine parts relative to each other and permits relative motion between them. Here pedestal bearings are used and selected from manufacturer's catalogue.

Table-1: bearing dimensions

Bearing No.	Principal dimension			Permissible RPM	
	Bore diameter 'd' mm	Outer diameter 'D' mm	Width 'B' mm	Grease lubrication	Oil lubrication
6205	25	52	15	12000	15000

2.2.6 Wheels

Two wheels are used having diameter of 14'' are mounted on shaft by hub arrangement.

3. FABRICATION IMAGES

Fig-5: Fabrication image-1

Fig-6: Fabrication image-2

Fig-7: Fabrication image-3

4. WORKING PRINCIPAL

Lawn mower is an essential device for the maintenance of yard/garden. They basically classified on the basis of sizes, mode of operations, and power source. Human aesthetics and ergonomics also considered in designing mower. The MS rectangular pipe is used as material for frame. The power source for lawn mower is

taken from two-wheeler. Whole arrangement is designed for tow behind two-wheeler. The cutting unit i.e. blades are attached to the main frame which consist of two-knife bar sections; the upper blade reciprocates over fixed blade. The crank converts rotary motion into reciprocating motion. The width of each blade teeth is 50mm. Diameter of crank is determined according to stroke length of blades 100 mm i.e. travel over two teeth's (2 x 50 mm) in one rotation. Reciprocating motion of the blades produces shearing force on cutting edges which is sufficient for cutting shrubs/hay/grass.

5. ANALYSIS OF PARTS

5.1 Frame

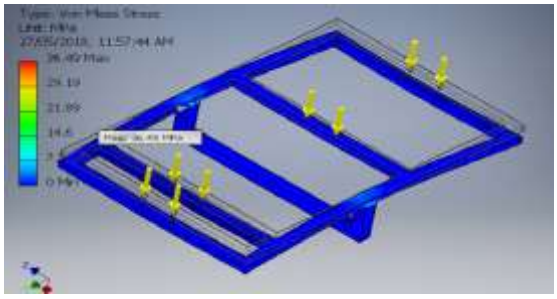

Fig.9 Max. Vonmises stress =36.488 N/mm^2

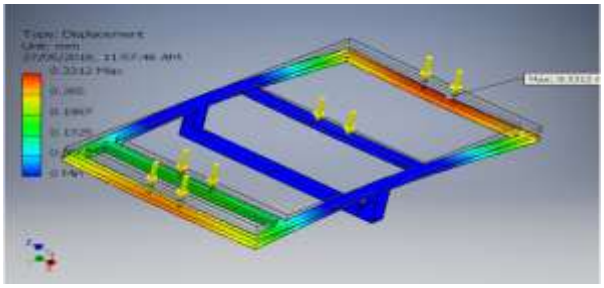

Fig.10 Max. Displacement =0.331mm

5.2 Blade

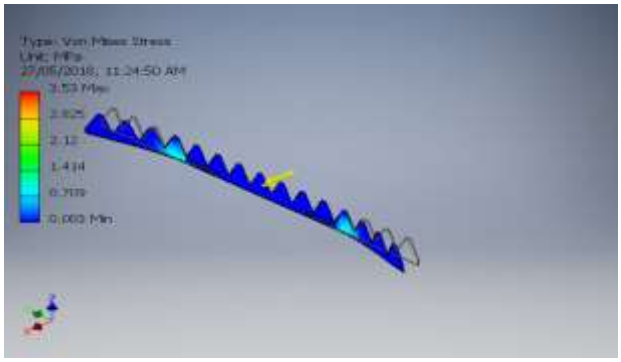

Fig.11 Max.Vonmises stress =3.530 N/mm^2

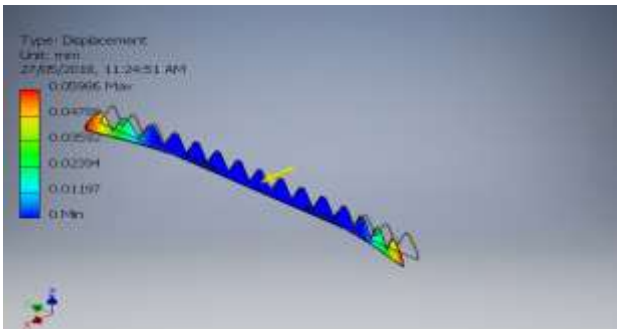

Fig.12 Max. Displacement =0.55mm

5.3 Gear

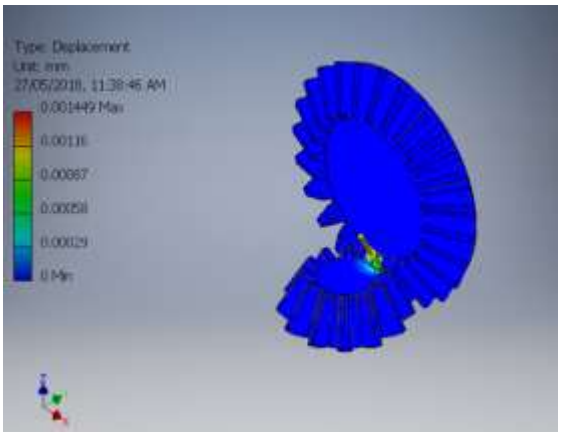

Fig.13 Max. Displacement =0.0014mm

6. CONCLUSION

Lawn mowers are an important part and used many different places throughout the world. They play big role in agriculture field. In literature survey we found that there are so many different types of lawns movers available. Also various concept and design are introduced on lawn mower by different researchers. The sickle bar lawn mower was designed, fabricated and analyzed. The machine is simply powered by two-wheeler. Therefore, it can be used by both rural as well as urban dwellers. It is also affordable since the cost of production is low. The bevel gear is selected of hardened steel materials to prevent any damage to teeth face. Minimum numbers of parts are used for minimizing weight as well as transmission losses. All the components of the machine, especially the parts used in the transmission unit are simple, strong, and inexpensive. Test revealed that, higher grass cutting efficiency is obtained when the lawn is dry. It is also affordable since the cost of production is low. So this project is designed with the hope that it is very much economical and help full to many agricultural areas. This project helped us to know the periodic steps in completing

a project work. Thus we have completed the project successfully.

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