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Design and analysis of Grass mower

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Abstract: **- Grass mower is an equipment used to chop up grass or weed which grows on farm land or other ground surfaces. In the present work, a prototype model of grass mower has been designed and analyzed for its performance. This equipment consists of rotating sharp edged cutting blade, which is powered by an internal combustion engine. Cutting blade unit and engine are mounted on rigid base frame which in turn moves on ground surfaces with wheels. While in action, blade which is rotating at high speed will shear the grass or weeds. In comparison with manual cutting of grass, this mechanized setup is having many merits like chopped surface is more uniform in appearance, completion of work in less time with less manual effort.**

Index Terms— Grass mower, cutting blade, cutting stress analysis.

INTRODUCTION

Grass is a plant which grows on farm land or other ground surfaces, this grass has to be cut frequently as it grows to maintain the ground surface clean or for aesthetic beauty. To do this task, we make use of grass mower. Grass mower is a machine that uses one or more rotating blades to cut the grass to an even height. Cutting blades are powered either by hand through pushing the mower forward to operate the mechanical blades or an internal combustion engine to rotate their blades. Grass mowers using a single blade that rotates about a vertical axis are known as rotary mowers, while those using a multiple blade assembly that rotates about a horizontal axis are known as cylinder or reel mowers. Grass mower works on the principle that, when the blade rotates, it imparts impact and shearing stress on grass, due to this grass is cut. Blades are made of carbon or stainless steel and cutting edges of it are hardened and tempered to suitable hardness for longer service life.

LITERATURE REVIEW

Venkatesh.K, et al. [1], have designed and fabricated the grass cutting machine to cut grass as well as crop in the field. It consists of electric motor, gear arrangement, cam, chain and sprocket, lead screw, wheel, control unit. Below the gear arrangement cutting blade is fixed. When the motor starts running, shaft and gears also rotates, this in turn actuate the cam arrangement and then the sickle bar which tends to cut the grass or crops. Sickle bar has one of its fixed cutters and another one is movable cutter which is placed on it. Whole set up is placed on a movable base which has a wheel arrangement. Ibe , et al. [2], have developed a hand-held grass mowing machine. It is a petrol powered machine with rotary blades for cutting the grass on lawn. Good Strength, durability, light weight, shorter times of work completion are the merits of this machine. Vivek. P. Ravi, et al. [3], have designed the cutter of rotary lawn mower. Static Structural analysis of cutter is done with the help of ANSYS workbench. Deepak.A.R, et al. [4], have designed a solar operated grass cutting device. It harnesses the solar power using solar panel and supplies the power to electric motor. Motor in turn drive the cutting blade and causes it to cut the grass. It helps in building of eco-friendly system and reduces the cost of fuel required to run blades. In our present work, a grass mower consist of rotary cutting blade run by an Internal combustion engine is designed. This machine accomplish many benefits like shorter grass cutting time, less manual fatigue, more uniform and good aesthetic appearance of cut lawn surface.

Problem statement and the set up: Objective of the present study is to develop a prototype model of a grass mower, which consist of a steel blade which rotates at high speed and cut the grass or crop when it is directed on it. Power required to rotate the blade is supplied by an internal combustion engine which along with cutter blade is mounted on a base frame. Base frame in turn moves on ground surface with wheels. The set up is shown in figure 1.Based on power required to cut the grass, blade of mower is designed and proper rated engine will be chosen.

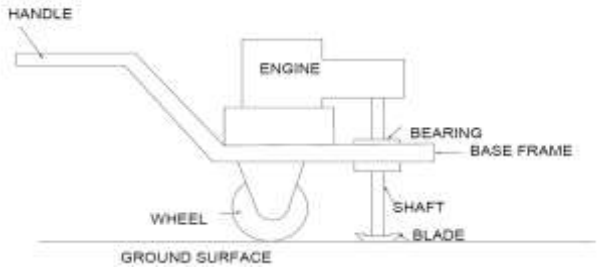

Figure 1. Grass mower setup.

Design and analysis of grass mower: shear energy of most annual and perennial grasses found on most lawns is 3.9 mJ / mm^2. Average stem diameter of such grass is 2.6 mm. so shear energy required per stem to shear is 20.6 mJ. Figure 2 shows the cutter blade and its dimension. It is having two

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cutting edges of 100 mm length on each side of its centre along its length. One cutting edge can cut 38 numbers of stems of grass at once. So shear energy required is 20.6*38 = 782.8 mJ. Further, this shear energy is spend as work in shearing the grass through its cross section of 2.6 mm diameter. Therefore shear force on one cutting edge F= 782.8/2.6= 301.07 N. Speed of rotation of blade can be regulated and if normal operating speed is 500 rpm, at this rated speed, power required to cut grass P.

$P = 2 \pi NT/60 = 2*\pi *500*301.07 *0.1/60=1575.2$ watts.

Since blade is having two cutting edges on either side of its centre along its length, total power required =1575.2*2=3150.4 watts= 4.2 hp. Hence for smooth cutting of grass at the rated speed, an engine power of not less than 4.2 hp is needed.

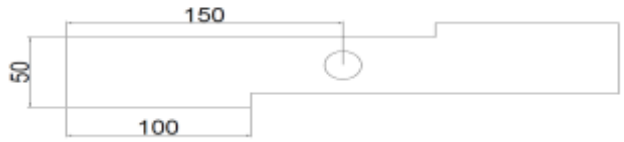

Figure 2. Cutter blade and its dimension.

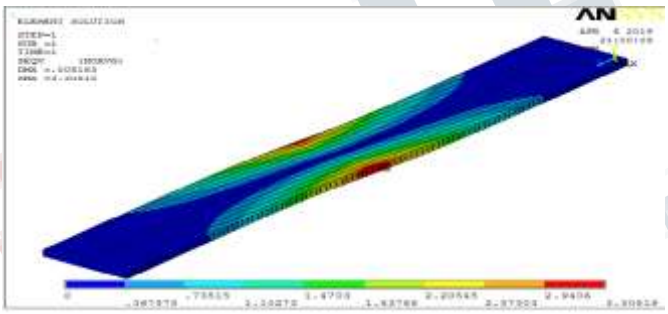

Figure 3. Von mises stress developed on cutting blade.

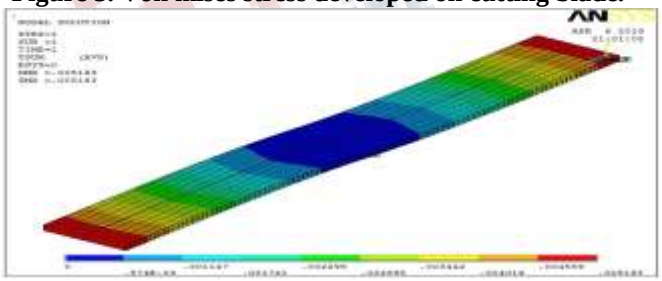

Figure 4. Displacement of blade section due to cutting force.

Blade of the mower has been designed using ansys software. Results of the ansys showing von mises stress and displacement of blade during cutting is shown in figure 3 and figure 4. Maximum stress developed is near the center of blade and it is 3.3 N/mm2 .Material of the blade is chosen based on this stress level. Blade made of mild or low carbon steel having tensile yield strength of 370 Mpa can best suit this purpose.

CONCLUSION

In the present work, a grass mower has been designed and analysed for its performance. Cutting blade of mower is designed using Ansys software considering strength required to cut the grass at rated speed. Since, the internal combustion engine is used to supply power to the cutting blade; proposed mower can cut the grass with less manual effort and in less time in comparison with manual grass cutting operation.

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