JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN MECHANICAL ENGINEERING
ISSN 0975 – 668X| NOV 16 TO OCT 17 , VOLUME –04, ISSUE – 02

DEVELOPMENT OF CROP CUTTER FOR VIBRATION REDUCTION

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ABSTRACT :*To integrate power electronic control technology into the most mechanical mechanism of conventional internal combustion engine type has made it possible to design and implement a new electric brush cutter with blade rotation speed control and electronic circuit protection functions. The mechanical power source of tradition mechanical grass cutter is based on a two or four strokes petrol engine. To obtain some very attracting advantages such as low vibration and acoustic noise, free of air pollution and low using cost, a DC motor is used as the mechanical power source of new electric type brush cutter. In addition, a Li-ion battery and electronic control board designed for DC motor speed control and circuit protection purposes were included as well. "Personal tools" refer to tools and instruments handled by humans. Today, with the increasing mechanization of work, requirements, and industrial applications, many types and uses of personal tools are available. However, personal tools suffer from the problem of vibration. Vibrations not only weaken their performance and reliability, but also harm the worker. In this paper, we propose a model the vibration reduction, and finally perform an experiment to evaluate its performance.*

KEY-WORDS*: - Electric brush cutter, DC motor, Electric battery*

1. Introduction

Agriculture is the most important sector in the Indian economy, so to increase productivity of agriculture mechanized agriculture is required. Mechanized agriculture is the process of using agricultural machinery to mechanize the work of agriculture, greatly increasing farm worker productivity. The history of agriculture contains many examples of tool use, such as the plough, cutter, harvester, etc. Mechanization involves the use of an intermediate device between the power source and the work. This intermediate device usually transforms motion, such as rotary to linear, or provides some sort of mechanical advantage, such as speed increase or decrease. The mechanization is used for different steps of crop production, such as in preparation of soil, sowing, irrigation, harvesting and storage, in which harvesting is less mechanized and time consuming process, where more labor force is required. The cutting of crop after it is mature is called harvesting. In harvesting, crops are pulled out or cut close to the ground.

Now a day's two stroke petrol engine operated brush cutter is mostly used to cut the grass. This machine may consist of two, three or four blades depending upon the machine. The grass cutting machine is known as lawn mower. The grass cutting machine is available in the various types like reel (cylinder) mower, rotary mower, idling mower, professional mower etc., but these are very costly and unaffordable, hence it was found necessary to have a grass cutter which can be operated by electricity (motor) with minimum initial cost and can be operated by unskilled labour. The conventional grass cutting machines that are employed for cutting the grass in the fields have the disadvantage that during the cutting of the grass the grass gets scattered around the machine due to the strong cutting forces hence requiring further labour to collect it. The two stroke petrol engine machines that collect the grass during cutting have the disadvantage that they can cut and collect only short grass not more than 8-10 inches long. Till date the long commercial grass which is usually more than 4 feet long is reaped manually like paddy using a sickle. This method is very labourious and unproductive and hence there was a need to

improve the scenario. New grass cutter is specially designed for the reaping of the commercial grass resulting in less fatigue to workers and increasing the productivity.

2. Drawbacks Of Conventional Tools

- Vibration

The total vibration level on the handle of grass cutter of 11.30 m/s^2 was measured, and it has reached the exposure limit value of 5.0 m/s^2 for daily vibration exposure. In this machine Hand–arm vibration syndrome is very common among the workers operating power tools and doing similar nature of work for long hours. Crop reaping is one of the operations that involves use of vibrating cutter, and results in hand–arm vibration among workers.

- Handling

Conventional grass cutter is not easy to handle because this machine weighs around 14kg and is placed on operators shoulder. To cut grass, operators have to swing the machine which is uncomfortable to operator. The traditional tools like sickles can make a serious injury to the labour operating it.

3. Problem Statement

The intricate steps involved in planting, cultivating, harvesting, and preparing crop requires an immense labour force. However, recently Maharashtra has seen a shortage of skilled labour available for agriculture. The machine which is used now a day to cut grass having high magnitude of vibration and also the labour have to take more effort to cut crop by using conventional machine. Because of this time consuming task and effort the farmers have transitioned to using combine harvesters. These harvesters are available for purchase but because of their high costs, they are not affordable. Thus, there is a need for a smaller and efficient cutter which would be more accessible and also considerably cheaper, hence key focus of this thesis is to design "automated grass cutter with holding mechanism".

4. Objectives

Design automated crop cutter machine for,

- Reducing vibration
- Easy handling
- Making it Eco-friendly

5. Scope

Two stroke grass cutter machine which mostly used now a day's having high magnitude of vibration and also having more weight, which directly affect on farm worker work efficiency. Harvesters are available with low magnitude of vibration and easy handling, but these harvesters are very costly. So here is scope to design a machine with low magnitude of vibration, easy to operate and with low cost.

6. Literature Review

This section includes the literature survey of earlier research work made by various researchers on grass cutter machine. Many researchers focus on effect of vibration on hand. The various researchers have carried out vibration analysis & noise analysis of cutter machine.

Tengku H., et al. 2013 [1]studied noise exposure among grass cutters. Eighteen grass cutters were monitored for 8 hours each, using the Noise dose meter. The workers were exposed to noise levels ranging from 84.3dB to 92.3dB. Audiometric test for both ears showed some evidence of mild to moderate hearing impairment in some workers. This study revealed that some workers were exposed to excessive noise level and were at risk of acquiring noise induced hearing loss. From the 8-hr exposure monitoring on all subjects, results indicate that that five out of 27.8% of the workers exceeded the permissible level 90dB & 83.3% exceeded the action level 85dB.

Ko Ying Hao., et al. 2011 [2]they explained suspended handle design approach to minimize vibration transmissibility within the operating frequency range of the machine based on the machine vibration spectra. From the study, it was observed the reduction of vibration depended on the handle dynamics; handle material and distance installed between rubber mount which influences the vibration transmissibility of handle-isolation system. Handles were made of different materials, and the distance of rubber mounts were varied. From prototype testing of handle model they conclude that heavier material results in the lowest hand-arm vibration of 2.69m/s^2. With modified handle they significantly reduced the vibration level value by 76% compare with the existing commercial handle.

Ko Ying Hao, et al. 2011 [3]they studied approach for the suppression of hand-arm vibration in electric grass trimmer was explained. The proposed system was a tuned vibration absorber (TVA). Modal analysis and operating deflection shape analysis of the electric grass trimmer were carried out and a TVA was designed and fabricated for testing. The results indicated that minimum vibration level was related to the position of the TVA on the shaft of electric grass trimmer. The TVA was found to have best performance with 95% reduction on the

acceleration level at position 0.025L. The results from modal analysis and operating deflection shape revealed that the presence of TVA has successfully reduced the large deformations of the handle where the node was shifted nearer to the handle location.

Chieh-Tsung Chi,2012 [7]explained the integrate power electronic control technology into the most mechanical mechanism of conventional internal combustion engine type which has made it possible to design and implement a new electric brush cutter with blade rotation speed control and electronic circuit protection functions. They observed that mechanical power source of tradition mechanical grass cutter is based on a two or *four* strokes petrol engine. To obtain some very attracting advantages such as low vibration and acoustic noise, free of air pollution and low using cost, a DC motor is used as the mechanical power source of new electric type brush cutter. In addition, a Li-ion battery and electronic control board designed for DC motor speed control and circuit protection purposes were included as well.

Magar A. P., et al. 2010[8]they observed that the grass cutting machine is available in the various types like reel (cylinder) mower, rotary and mulching mower, hover mower, riding mower, professional mower etc. but these are very costly and unaffordable. It required a skilled person to operate. Hence, it was found necessary to have a grass cutter which can be operated by electricity (motor) with minimum initial cost and can be operated by unskilled labour. The newly developed grass cutter was able to operate at an average speed of 2km/hr without disturbance in operation. The effective field capacity of the machine was 0.07 ha/hr (i.e. to move one hectare in 14.30hr) with an efficiency of 70 per cent. 1 hp single phase electric motor was sufficient to operate at working width of 500mm cutter bar.

7. Methodology

- Preparation of concept model drawing.
- Design components of machine by using different failure theories.
- Modeling: The modeling of system components will be done in CATIA V5R19.
- Analysis and validation: The analysis of critical component like slotted lever, crank, crank pin and frame will be done by using ANSYS 15.0 and obtained results will be compared with analytical solution.
- Manufacturing of cutting machine.
- Experimental validation: Experimental validation of vibration level of this grass cutter machine will compared with two stroke petrol engine operated brush cutter machine

Sr. No	Section/ Area of model		Von-misses stress(N/ mm^2)	Deformation(mm)
1	Base frame	Slotted lever at extreme left position	57.81	1.620
		Slotted lever at centre position	59.14	1.756
2	Crank motor support beam		191.83	2.541
3	Slotted lever		19.58	0.500

8. Result And Discussion

In the present study, the grass cutter model is developed by using crank and slotted lever mechanism for optimization vibration level and to increase work durability of worker. The best suitable dimensions for the model are found out by analytical method and accordingly stress analysis results are also plotted.

A. Stress & deformation results for base frame model when slotted lever at extreme left position:

From static analysis of model maximum Stress value for base frame is 57.81 N/mm^2 which is well below the critical value. Hence, design is safe. The observed maximum deformation value for trolley is 1.620 mm.

B. Stress & deformation results for base frame model when slotted lever at centre position:

From static analysis of model maximum Stress value for base frame is 59.14 N/mm^2 which is well below the critical value. Hence, design is safe. The observed maximum deformation value for base frame is 1.756 mm.

C. Stress & deformation results for crank motor support beam:

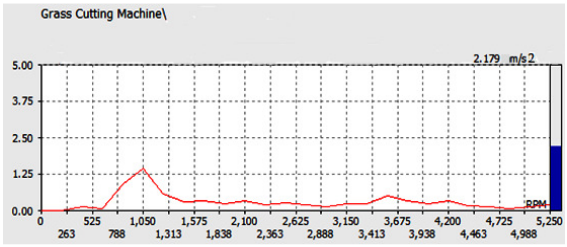
From static analysis of model maximum Stress value for crank motor support beamis 191.83 N/mm^2 which is well below the critical value. Hence, design is safe. The observed maximum deformation value for crank motor support beam is 2.541 mm.

D. Stress & deformation results for slotted lever:

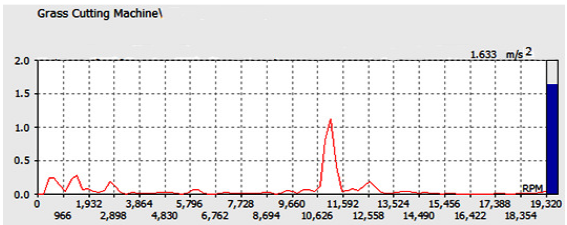
From static analysis of model maximum Stress value for slotted leveris 19.58 N/mm^2 which is well below the critical value. Hence, design is safe. The observed maximum deformation value for slotted lever is 0.500 mm.

9. Vibration Analysis Results

From vibration analysis of model acceleration amplitude obtain for the speed of motor 3200 rpm, 2800 rpm and 2400 rpm are 2.179 m/s^2, 1.633 m/s^2, 1.416 m/s^2 respectively, which are well below the daily vibration exposure according to European union has defined value that is 2.5 m/s^2

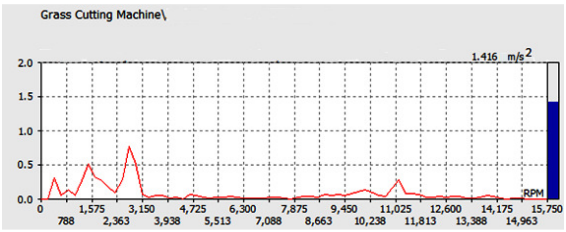


The above fig 7.9 shows the acceleration amplitude for the cutter speed 3200. The amplitude is 2.179 m/s^2



The above fig7.10 shows the amplitude of vibration for the cutter speed 2800 rpm. The amplitude of vibration is 1.633 m/s^2.

The following fig7.11 shows the amplitude for the cutter speed 2400 rpm. The amplitude of vibration is 1.416 m/s^2.



The following table 7.2 shows the acceleration level for different cutter speed, which is well below the daily exposure limit as well the vibration level is reduced as compare to the existing grass cutter.

Table 7.2 Acceleration at three different speeds of cutter speed

Sr.no	Cutter/Machine Speed (rpm)	Acceleration (m/s^2)
1	3200	2.179
2	2800	1.633
3	2400	1.416

10. CONCLUSION

In the present study grass cutter machine is design and fabricated for grass cutting. The experiment was carried out by using FFT analyzer and analysis of model was done by using ANSYS software. In this study the vibration level was measured at three different speeds of cutter. On the basis of experimental results the following conclusions are drawn.

Concluding remarks:

- From vibration analysis of model acceleration amplitude obtain for the speed of motor 3200 rpm, 2800 rpm and 2400 rpm are 2.179 m/s^2, 1.633 m/s^2, 1.416 m/s^2 respectively, which are well below the daily vibration exposure according to European union has defined value that is 2.5 m/s^2.
- The maximum Stress value for base frame is 57.81 N/mm^2, for crank motor support beamis 191.83 N/mm^2 and for crank motor support beamis 191.83 N/mm^2, which is well below the critical value. Hence, design is safe.

- The observed maximum deformation value for base frame is 1.620 mm, for crank motor support beam is 2.541 mm and for slotted lever is 0.500 mm, which is well below the critical value. Hence, design is safe.

11. FUTURE SCOPE:

- In this machine manpower is required to push the vehicle, so here is scope to make it fully automatic by using switch or wireless remote control.
- It's difficult to carry this machine to long distance, so here is scope to make it foldable.

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