Design And Fabrication Of Ergonomic Hedge Trimming Machine With Angle Adjustment

C.M. Vivek, J. Kesavan, S.P. Manikandan

Abstract: Garden maintenance in public and private sectors involves day- by day care and endures great cost and labor. In addition to this the labors are subjected to Hand arm vibration (HAV) due to vibrating machines. HAVs cause musculoskeletal disorders, numbness and reduce hand grip strength. Noise induced hearing loss and ocular disorders are some of the issues associated with motorized vibrating garden trimmers. Hence it is necessary to design garden maintenance equipment by considering the problems associated with it. This paper proposes an optimized model of hedge trimmers capable of angle adjustment in blade projection. Furthermore, the paper investigates the performance of proposed trimming machine to conventional hedge trimmer in terms of uniformity in cutting, time taken for trimming operation, temperature of the equipment and vibration associated with it.

Index Terms: Garden maintenance, Hand- arm vibrations. Shrub trimming, Trimmers

1. INTRODUCTION

Maintenance of gardens in public in today's life is much needed. Shrubs are common in open area and different types of grass cutting machines are available in market for cutting grass such as lawn mowers, strimmers, hedge trimmers etc. However, these vibration machines cause vibrations and contribute risk for workers health. Mechanical vibration in industrial sectors such as construction, manufacturing, engineering maintenance etc can be considered as occupational disease for Human workers associated with it. To overcome vibration associated with garden maintenance equipment, it is important to have significant knowledge in state of art in vibration causing machines.

For activities related to garden maintenance the commonly used machines are strimmers and hedge trimmers. These hand held machines account the Hand arm vibration (HAV) in most cases. In an investigation, 204 male workers were analyzed by questionnaire and direct observations. About 90 % of workers undergoes vascular and sensori neural disorders. Majority of the workers also experience problems in hand grip strength, numbness and finger blanching. Among garden maintenance workers, the study reveals grass cut workers are the most suffer due to vibrations. [1] In another study, the exposure time for HAV and whole body were analyzed for 469 vibration tool workers from numerous environments. The study was based on questionnaire survey, daily worker interviews and direct workplace observation. Among the gardening tools, strimmers has largest median factor observed for extensive vibration measured by HAV prometer. [2] Grass trimming activity is extensively done using petrol engines and electric motors and it cause HAV to the operators. HAV is categorized under industrial disease and a greater number of workers associated towards garden maintenance experiences issues related to vibrations. Hence an approach is required to overcome the existing problems associated with vibrating machines. One of the approaches is done by installing tuned vibration absorber (TVA) to handle of the vibrating machines. Tuned vibration absorber minimizes the vibrations in the handle remarkably. [3] In another study, imposing nodal technique when applied to shaft of the trimming machine can reduce vibration at the handle. In these techniques two cantilevered TVAs were used for repress the handle vibration. [4] Optimizing the design of vibration machines can be noticeably shortened by using Analytic hierarchy process (AHP). These techniques are primarily used in industries producing portable vibrating machines for garden maintenance by establishing a standard between safety and productivity. [5] Lifting of the vibrating machine while carrying out trimming activity also affects the human health. The cutting force is directly transmitted to hands of the operator and the exhaust of the engine is also very near to the operator's nose. Noise can define as sound that is disagreeable or unpleasant. Noise induced hearing loss (NHIL) is observed commonly among the garden maintenance workers. In a study of 18 workers noise level range of 84.3 dbA to 92.3 dbA were observed with 27 % of workers suffering from hearing impairment. [6] In another study of 75 grass trimming workers, due to increase in ceaseless noise due to motorized machines noise level ranging 91.3 dbA to 100.7 dbA was observed and contributed to NHIL. [7] Line nylon trimmers are extensively used trimmers in garden maintenance activity. However, more studies related to trimmer accidents ocular trauma were associated with these trimmers. These issues are mainly due to lack of proper eyewear and risk associated with it cannot be exaggerate. [8] Ocular hazards are been observed in lawn trimmers with rigid blades. In a particular study it is found that ocular trauma in operator when the motor switch was in off. While cleaning of the rigid blades, particles during trimming were accumulated and cause ocular trauma. [9] Fugal keratitis was also observed due to trimming activity carried out by nylon line lawn trimmer. These nylon line trimmers were considered to be safe due to the absence of blade however studies reveal that ocular injury occur with these trimmers. [10]

2. OBJECTIVE

The following are the major factors considered while designing ergonomic trimming machines.

- Uniformity in cutting operation
- Reduced Hand arm vibration
- Increased Productivity
- Height adjustment of cutting blade
- Angle adjustment of Cutting blade

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3D model of the proposed ergonomic hedge trimming machine is shown in fig.1

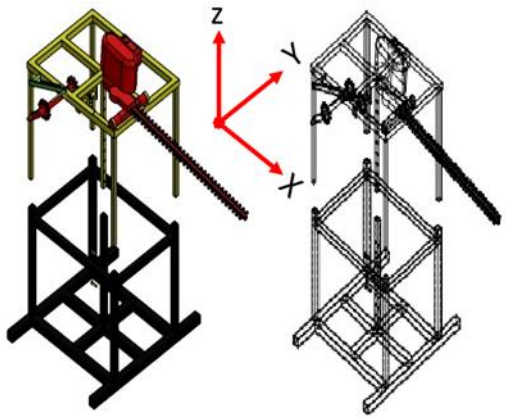

Fig.1. *Isometric view model of Ergonomic hedge trimming machine*

3 EXPERIMENTAL SETUP

The machine consists of the following parts

(i) Fixed frame structure with lawn mower wheels (ii) Vertically movable frame structure (Z axis) along with lock pin arrangement (iii) Two stroke petrol engine (iv) cutting blade and other components are shown in figure.2The fixed frame structure is made up of 16MnCr5-low alloy steel which possess good weldability and low density. [11] The size of base structure is 36 X 30 X 30 inch (LBH) At the bottom of the frame structure Lawn mower rolling wheels are attached which is used to move the machine in X and Y direction of horizontal platform. At the top of the fixed frame structure a vertically

(ii) movable frame structure is attached. This attachment helps to lift the machine in the Z direction from the platform with aide of lock pin arrangement.

The maximum and minimum working height of this machine is 51inch and 36inch respectively from horizontal datum.

A two stroke 25cubic capacity petrol engine is mounted on the vertically movable frame structure. The engine is seated over the rolling shaft. The two ends of the rolling shaft are mounted in the ball bearing, which is fixed on the vertically movable frame structure. This kind of arrangement helps the operator to position the blade in required angle. The cutting blade can travel 80^0 above and 80^0 below about Y axis shown in figure.3 and figure.4. The angle position can be controlled by weight balance, chain and sprocket mechanism.The Non corrosive high strength nickel-based blades are attached to engine with the help of special attachment. [12] There are two kind of blades are used. One is fixed blade and another one is movable blade. Here the rotary motion of the engine output us converted into reciprocating motion, which is input to the blade. Hence the cutting operations can be performed.

Fig.3. *Ergonomic hedge trimmer- blade below Y axis*

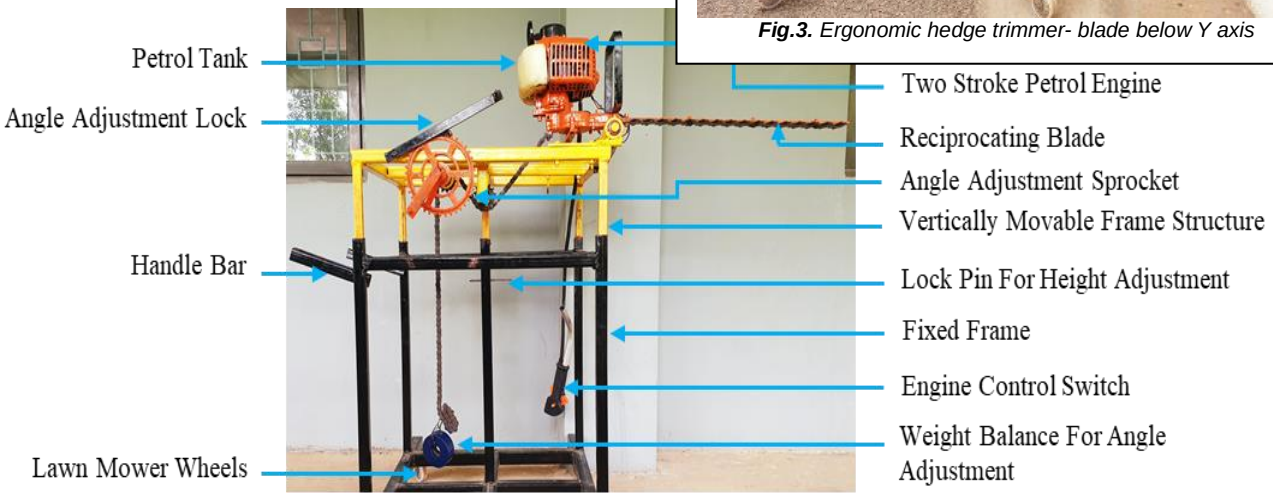

Fig. 2. *Fabricated Ergonomic hedge trimming machine*

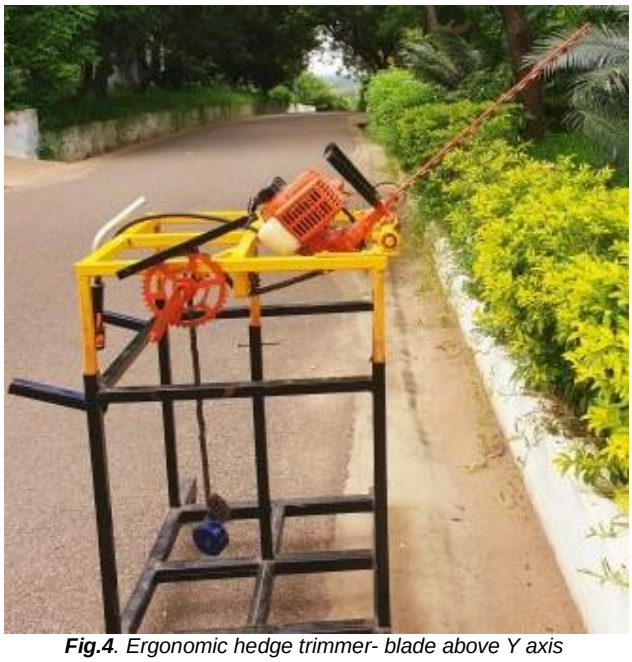

***Fig.4**. Ergonomic hedge trimmer- blade above Y axis*

4 RESULT AND DISCUSSION

The ergonomic hedge trimmer with blades were tested in both horizontal and vertical position. The thickness of shrub ranges between 10mm to 18mm.

4.1 Time taken

Fig.5 shows the comparison of time taken for conventional and ergonomic shrub trimming machine. Based on the result

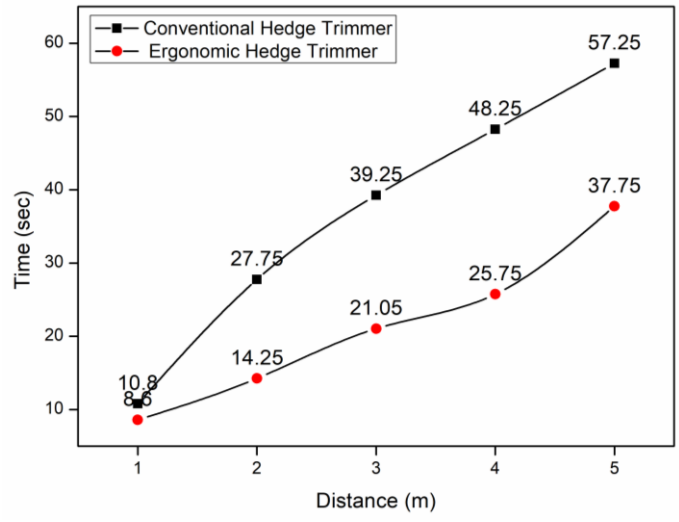

***Fig.5.** Time taken – Ergonomic hedge trimmer vs. conventional hedge trimmer*

it is evident that the ergonomic shrub trimmers reduce the time taken for trimming activity incrementally. The operator while operating the conventional machines carries the machine causes fatigue and time taken for reaching areas may quite high.

4.2 Temperature analysis

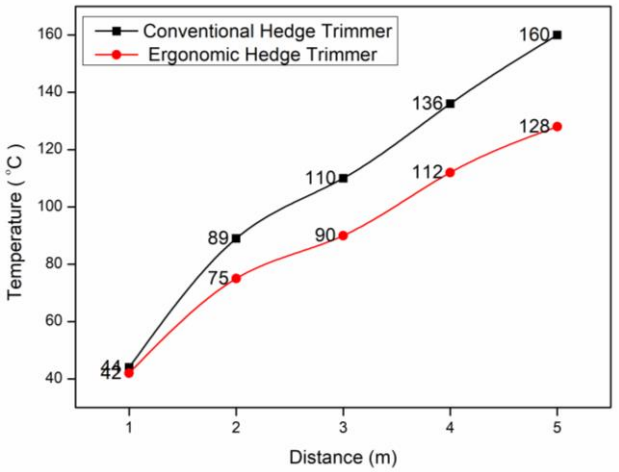

***Fig.6**. Temperature analysis – Ergonomic hedge trimmer vs. conventional hedge trimmer*

Fig.6 shows the comparison of the engine's temperature between the conventional and ergonomic shrub trimming machines. It is evident that the temperature of engine increase with increase in time. From the comparison made above on time taken conventional trimmers take more time comparing to ergonomic trimmers. Hence ergonomic trimmers travel more distance with less temperature. Moreover, the engine is not carried but fixed to the frame. Hence the operator will not be affected the increase of temperature.

5 CONCLUSION

Optimizing the design parameters of the shrub trimming machines provides better uniformity in trimming operation. This is due to the attachment of the reciprocating blades to the frames. It is also evident that time taken for trimming operation was reduced up to 34 % comparing to conventional shrub trimming machine. The operating time is directly proportional to the engine temperature, therefore 20% of the engine temperature was reduced due to the reduction in operating time. The provision of angle adjustment mechanism also facilitates the blade movement at angle 80^0 above and 80^0 below about y axis. Hence a uniform trimming with different angles can be made possible. Problems associated with HAV are significantly reduced with aid of vibration arrested mounting pads. Hence the garden workers experience reduced vibration comparing to conventional shrub trimming machine. Traumas and accidents associated with trimmers also can be significantly reduced by the provision of frames which facilitates a greater distance between reciprocating blades and garden workers.

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