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Design and Structural Analysis of Weed Removing Machine Fitted With Rotovator Blade in Glory Lily Plant (Gloriosa Superba Linn)

C.Manivelprabhu¹, A.Subramoniam², N.Dhamodharan³

^{1,2,3}Dept. of Mechanical Engineering, Kumarguru College of Technology, Coimbatore, India

Abstract- Glory Lily (Gloriosa superba linn) is a medicinal plant, used to manufacture medicines for eye defects. In the cultivation of this plant, weed removal is one of the main problem. There is no weed remover that is conventionally available in the market for removing weeds. So the weed removing process for this plant is mostly carried out manually. But manual weed removing process takes more time and it is not an economical one. To overcome this problem we have planned to design and fabricate a machine for removing weeds for the plant Glory Lily (Gloriosa superba linn). This machine will reduce the manual work in weed removal process with less time and reduced man power. The weed removing machine was modelled and analyzing the performance of the cutter in the weed removal machine. To analyze the cutter in the weed removing machine the various software's used are Modelling of the cutter in (Pro-E) for meshing (Hyper mesh 9.0) and for taking analysis results Ansys 12.0 is used. The results are obtained using hyper view.9.0. The various stresses acting on the cutter can be calculated from the above procedures. Finally the efficient cutter is obtained with optimum design and the balanced in the correct position.

Keywords- Pro-E, Hyper mesh, Ansys, stress.

I. INTRODUCTION

The process of removing unwanted plants in the field crops is called weeding. Mechanical weed control helps to reduce drudgery involved in manual weeding because of its high effectiveness. It kills the weeds and also keeps the soil surface loose ensuring soil aeration and water intake capacity. This project aims in the design and fabrication of a machine which is used to remove the weed formation in Glory Lily (*Gloriosa superba linn*).

The Lely weeder is an effective weed eradication alternative to some spraying methods and chemical applications. This Mechanical weed eradication allows users to avoid potential environmental issues surrounding traditional chemical application processes. Vibration of spring tines through the upper layer of soil, thus removes all the weeds. Hence hard surface crust gets disturbed assisting with surface drainage. The weeder consists of a rugged frame with four rows of tines.

II. DESIGN DETAILS

Design a blade of thickness 15mm

Design a shaft of diameter 30mm

Assembling of first blade over the cutter

Assembling of second blade with an angle 120deg

Assembling of third blade with 240deg

Similar steps are followed for another two sets

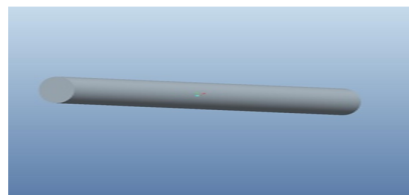


Fig.1. Shaft

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Fig.2. Blade

A. Cutter Description

The blade arrangement in the cutter is mounted depends upon the weed present in field. The various dimensions of the cutter are given below.



Fig.3. Cutter

Number of blades: 9blades

Number of rows: 3 rows

Shaft length: 460 mm

Shaft diameter: 30 mm

Blade thickness: 15 mm

Distance between two blades: 25 mm

Angle between two blades : 120 deg

B. Mesh Generation

The meshing of the designed Pro -E model is carried out using Hyper Mesh 9.0.

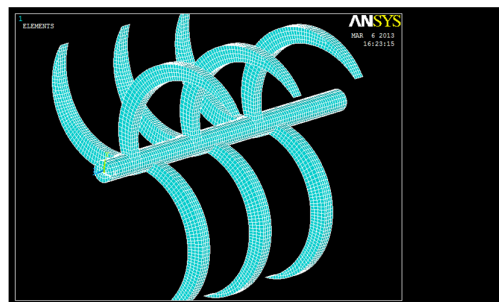


Fig.4. Assembled component

Steps involved in meshing of components are

First import the STEP file of pro-E model to hyper mesh

The next step is to split enter component into number of sub component by using split command.

Then tetra mesh is selected for the meshing process

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Blend and Jacobean limits are fixed

To avoid length failure percentage of Jacobeans are eliminated

Maximum and minimum angles are fixed

C. Material Properties

The materials are taken from the manufacturing database of rotavator production system specification drawn by Industry. The material properties for different types of materials are given below.

TABLE.I. MATERIAL PROPERTIES

S.NO	Material Name	Elastic Modulus (N/mm ²)	Poisson Ratio	Density (tone/mm ³)
1.	High carbon steel	1.97x10 ¹¹	0.29	7.48 x10 ⁻⁹
2.	Cast iron	1.20x10 ⁵	0.28	7.20x10 ⁻⁹
3.	Mild steel	2.10x10 ⁵	0.3	7.89x10 ⁻⁹

D. Soil Properties

The soil properties relevant to the design of cutter were identified as bulk density, cone index, soil type and moisture. The type of soil was heavy loam type soil. Moisture content of soil plays an important factor in weed removing process.

TABLE.II. SOIL PROPERTIES

S.No	Type of soil	Soil resistance (kg/cm ²)	Optimum moisture content (%)
1	Sandy soil	0.2	3.5
2	Sandy loam	0.3	5.8
3	Slit loam	0.35-0.5	5.8
4	Clay	0.4-0.56	7.18
5	Heavy loam	0.5-0.7	13.30

This chapter deals with the results taken for the various types of analysis in ANSYS 12.0.it gives clear information about stresses acting on the cutter.

III. LOAD CALCULATION

The soil force acting on each blade [K_e] is calculated by using the following equation

$$K_e = K_s \frac{C_p}{i z e} n \quad [9] \quad (1)$$

Then [K_s], the tangential force acting along the blade

$$K_s = 75 c_s N c \eta c \frac{n z}{u m i} n \quad (2)$$

$$K_s = 2 \times 40 \times 0.9 \times 0.8 \times \frac{75}{1.7}$$

$$K_s = 2542 \text{ kg} \quad K_s = 2542 \times 9.81$$

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Staggered to allow trash through but provide close working space of 3.81mm. With the unique tine/holder design, adjustment of individual tines can be done to fit the contours of the ground or the crop. Hence working of remaining tines takes place aggressively between the rows of crops. This makes the Weeder extremely flexible for a variety of row crop applications regardless of row spacing.

Weed removing is an important agricultural operation. Delay and negligence in weed removing operation affect the crop yield up to 30 to 60 percent. With regard this, a manually operated weeder was developed and tested ergonomically. The weeding efficiency of the developed weeder was satisfactory and it was easy to operate. The developed weeder could work up to 30 mm depth with field capacity of 0.048 ha/hr. and higher weeding efficiency was obtained up to 92.5%. During weeding operation, the peak heart rate of the subjects was found to range from 142 to 150 rpm. In case of heavy work and dense grass infested field, the subjects requires the rest pause of 14 min to come to the normal heart rate. The weeder's overall performance was promising.

V. CONCLUSION

The various analyses were made on the cutter to determine the various stresses acting on it. The cutter is analyzed for three modes of operation. Three modes are rotational analysis; self weight analysis and rotational and soil resistance combination. Because of the three modes the cutter failure occurs whenever the weed removal is carried out. So the analyses were carried out for all these modes. Based on the results obtained from the various analyses, it is found that the design of cutter is safe. Hence the factor of safety is 2-3 times better. The deformation produced in all the analysis shows the values is acceptable. This proposed design gives better results when compared to existing design. The new design enables ease of operation and reduced vibration. The effectiveness and efficiency also gets improved. The fuel consumption also gets decreased for a considered weed removal land.

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