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

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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 conventially 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 over come 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

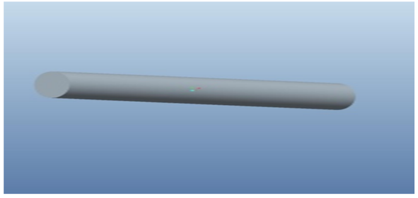

Fig.1. Shaft

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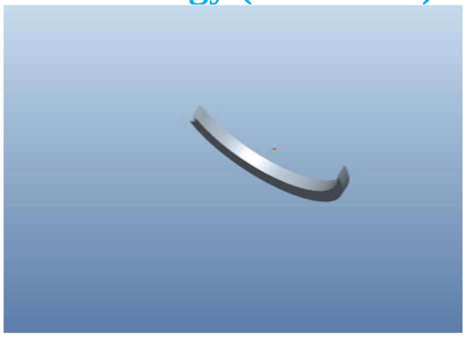

Fig.2. Blade

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.

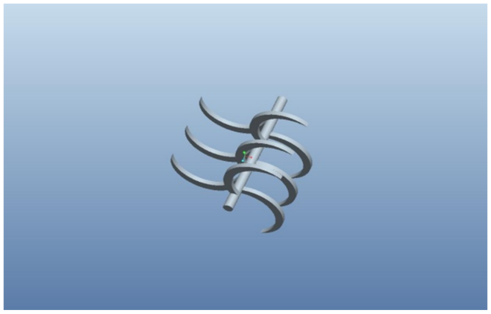

Fig.3. Cutter

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.

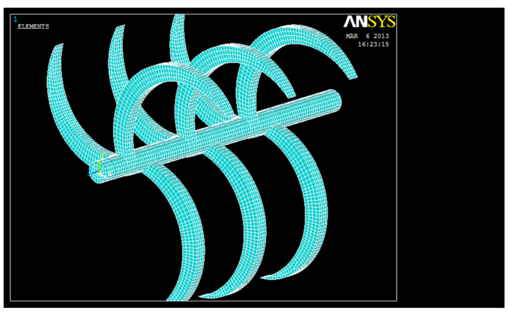

Fig.4. Assembled component

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

$$Ke = Ks\frac{Cp}{iZe}n \quad [9] \quad (1)$$

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

$$Ks = 75cs\, Nc\, \eta c \frac{\eta z}{umi} n \quad (2)$$

$$Ks = 2\, x\, 40\;\; 0.9\, x\, 0.8\, x \frac{75}{1.7}$$

K_s = 2542 kg $\quad$ K_s=2542 x 9.81

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$$Ke = Ks\frac{Cp}{iZe}n$$

$$Ke = 2542 \ x \ 2.7/10 \ x 11 \ x \ 0.167$$

K_e= 374 x9.81

K_e = 3700 N

The load acting on the blade is found out Then the load is given to the cutting edges of the blade as an impact force.

By using various numerical formulas, the approximate load values are calculated. We have chosen the boundary condition corresponding to the above calculated load (3700N).

IV. RESULTS AND DISCUSSIONS

A. Self Weight Analysis Results

This chapter gives the results taken for the self weight analysis from Ansys 12.0. Here various stresses acting on the cutter is shown in the figure.\

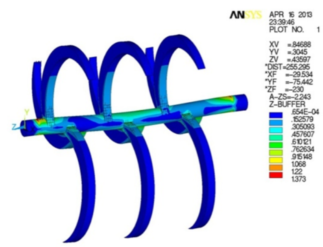

Fig.5. Von mises stress

B. Rotational Analysis Results

The results from figure 6.1 give the deformation of the cutter under the self weight. From the results we could see that the failure mode of the cutter is very less. Because the red marked values shows very small deformation.

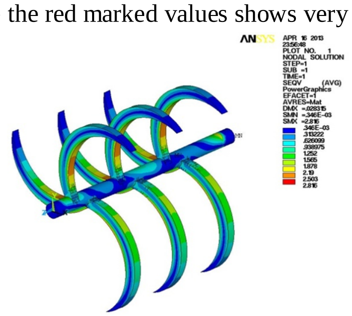

Fig.6. Von mises stress

The deformation produced under the various rpm levels are given in the figures. That shows the maximum value of deformation is 2.854mm .this value is very low .so the cutter is in the safe region only.

C. Analysis of Soil Resistance & Rpm Results

The results from figure 6.9 give the deformation of the cutter under the rotation and soil resistance is included. From the results we could see that the failure mode of the cutter is very less. Because the red marked values shows very small deformation.

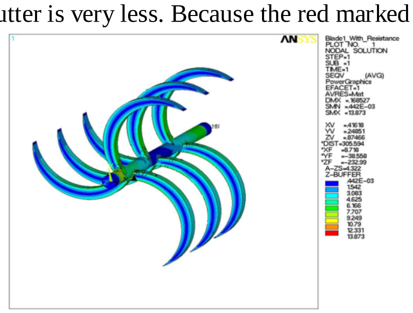

Fig.7. Von mises stress

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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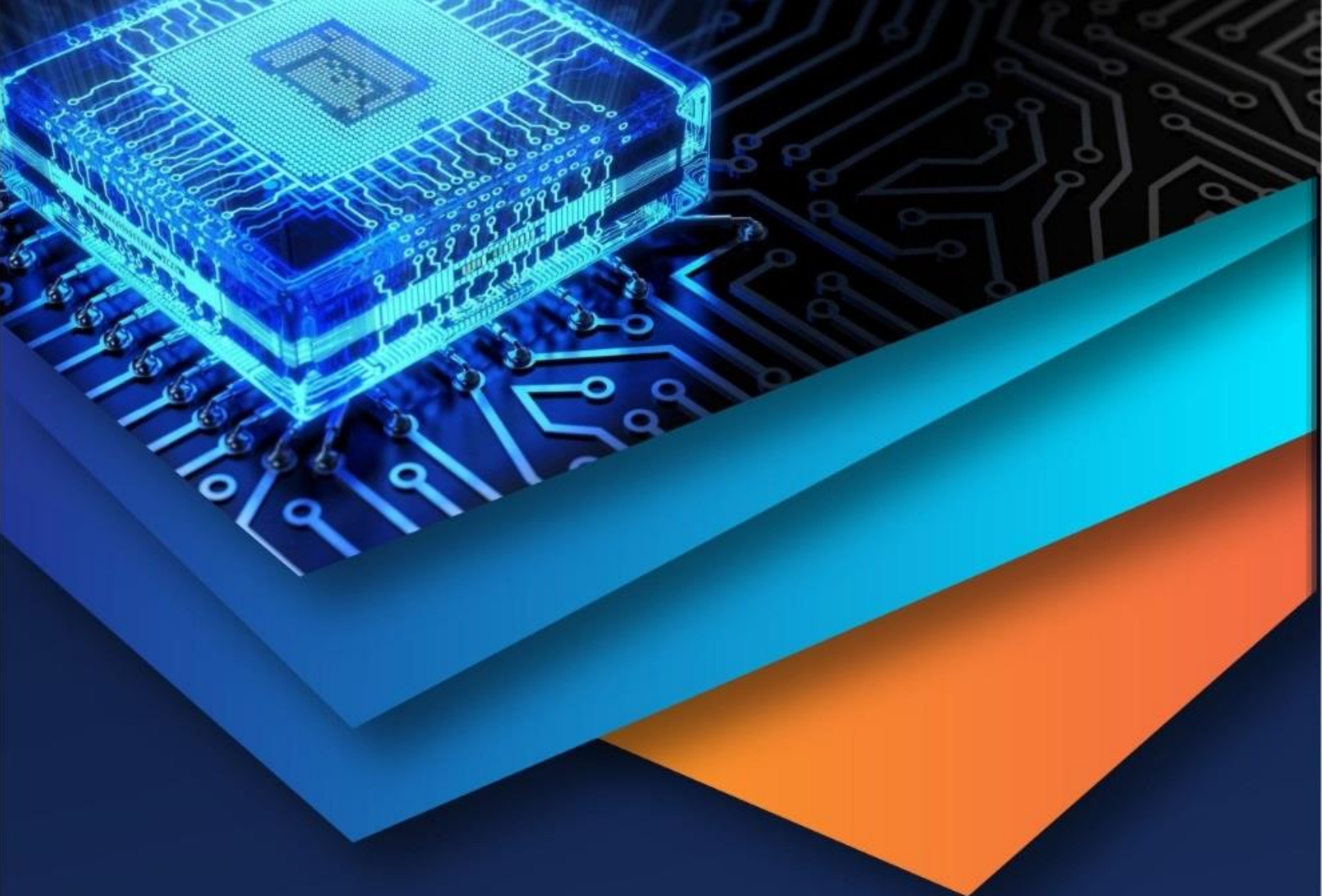

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