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# ANALYSIS AND OPTIMIZATION OF MOTORIZED AGRICULTURE WEEDER TOOL

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**ABSTRACT**

Weed control is one of the most time-consuming aspects of vegetable production. Manual weeding is inconvenient due to labor costs, time, and tedium. A mechanical weeding actuation system was designed and built as a prototype. This actuator was designed to control intra-row weed plants mechanically. A belt drive system powered by an integrated engine and a rotating tine weeding mechanism powered by engine power comprised the mechanical weeding actuator. One of the most difficult tasks on an agricultural farm is weed control. In agriculture, three weed control methods are widely used. Mechanical, chemical, and biological control are examples of these. Farmers readily adopt mechanical weed control once they are convinced of its benefits. Mechanical weed control not only removes weeds between crop rows, but it also keeps the soil surface loose, allowing for better soil aeration and water intake capacity. Mechanical weeders of various types have been developed. Because muscle power is required in human-operated weeders, they cannot be operated for an extended period of time. The traditional method of hand weeding takes time. The power operated single row active weeder will be designed and developed to assess the feasibility of mechanization of the weeding operation.

## INTRODUCTION

The plant prefers well-drained soil with moderate rainfall, but it can survive in wet soils. Tapioca roots do not tolerate freezing temperatures, and the best growth occurs in areas with more sunlight. This is a drought-resistant crop that can also grow in extremely dry areas. Tapioca is also largely unaffected by pests, insects, and other animals because the edible parts are below ground. The plant is grown for its tubers, which contain a high concentration of starch.

**Figure 1manual weeder**

These tubers are a source of carbohydrate all over the world, and they are also used to make a variety of medicinal products. This crop is important to the economies of developing countries around the world, including India, South Africa, and others. The reason for this is that this crop grows well even in low-fertile soils with low moisture content and an arid climate. Furthermore, tapioca is a popular staple food in many parts of the world. It is also a significant source of livestock food supplement.It is also used to make biofuels like alcohol blended fuels and biodiesel. Tapioca is grown in thirteen states in India, out of the thirty-two states in the country. Because the climate in these regions is favorable for cultivation, the south Indian states play a significant role in tapioca production.

Weeds are plants that are classified as undesirable or undesirable. These plants are small herbs that have a negative impact on farmland productivity. These weeds or unwanted plants tend to absorb the nutrients supplied to the crops, drastically affecting the growth of the main crops. As a result, controlling the growth of these unwanted plants in farmlands becomes a necessary activity.Weeds, in other words, are plants that grow when we want other plants or crops to grow in the desired location and at the desired time. It is a well-known fact that all weed plants are undesirable plants, but not all undesirable plants are weeds. These plants have a tendency to reduce the utilization of farm lands and water resources, which has a negative impact on agricultural welfare.

**EVOLUTION OF WEED CUTTER MACHINE**

A weed can be thought of as any plant growing in the wrong place at the wrong time and doing more harm than good. Weed waste excessive proportion of farmer time, there by acting as a brake on development. Weeding is one of the most important farm operations in crop production system. Weeding is an important but equally labor incentive agricultural unit operation. Weeding accounts for about 25% of the total labor requirement (900-1200 man h/ha) during a cultivation season. The labor requirements for weeding depend upon on weed flora, weed intensity, time of weeding and efficiency of worker. Delay and negligence in weeding operation affect the crop yield up to 30 to 60 percent. In India about 4.2 billion rupees are spent every year for controlling weeds in the production of major crops.

**MECHANISM**

All the parts are assembled as per the concepts of our project. Vehicle moves in a forward direction and the blades enter into the soil between rows of crops. Firstly we start the engine manually, the power of the engine is transferred from the engine shaft to the main shaft on which the cutter blades is mounted through the belt and pulley arrangement in this way the cutter is start to rotate in the agriculture crop and remove the unwanted weeder from the crop and removing of weeds takes place. By this a huge amount of labor effort can be reduced and within less time more weeds can be removed with less cost and easy operation. Then finally one labor is required to remove the weeds which are not removed by weeder around the plants.

**WORKING**

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**ADVANTAGES**

- It does not cause any damage to the crops.
- It reduces the time consumption in the weeding process.
- The equipment is light weighted and portable.
- The materials used are easily available and can be purchased easily.
- The weeder is low cost and affordable.
- The labor costs in the tapioca farm are reduced.

**LITERATURE REVIEW**

1. The time period accessible for weeding is limited, enhanced mechanical weeders are to be used to complete the weeding operation in due time at less cost. At present, more than fifteen different designs of hoes and weeders are available in market. All these designs are region specific to meet the requirements of soil type, crop grown, cropping form and availability of resident possessions. Therefore, effort has been made to develop a weeder for dry land crops.
   Its performance was compared with other available weeders in the state namely wheel finger weeder, wheel hoe and traditional method of weeding by trench hoe for groundnut crop at different soil moisture content. The plant damage increased with decrease in moisture content. This may be due to the reason that with decrease in moisture content soil hardness increased and as a result weeding element could not penetrate to desired depth and sometimes slide over hard surface and strikes the plant.

2. The force required to evacuate some weeds determined by using rope was by pulling through a spring balance and the force at the point of weed removal will be noted. The machine was designed based on the principle of weed stem failure due to shear, and soil or root failure due to impact and abrasion. The design process can be viewed as an optimization process to find structures, mechanical systems, and structural parts that fulfill certain expectations towards their economy, functionality, and appearance using simulation-based design process.

3. Weeding is an important agricultural unit operation. Delay and carelessness in weeding operation affect the crop yield up to 30 to 60 percent. Various parameters such as speed of travel, time of operation, field capacity, weeding efficiency and horse power requirements were considered during the design of the weeder.
   Kharif crops are most affected due to weeds. Weeding accounts for about 25 % of the total labour requirement (900–1200 manhours/hectare) during a cultivation season. Delay and negligence in weeding operation affect the crop yield up to 30 to 60 percent. Though many manually operated weeders are available they are not popular because farmers feel it to be heavy as compared to conventional hoes. For mechanical control of weeds, mostly human and animal powers are utilized. Mechanical weed control not only uproots the weeds between the crop rows but also keeps the soil surface loose, ensuring better soil ventilation and water intake capacity. Manual weeding can give a clean weeding, but it is a slow process.

4. Manual weeders are not available for vegetables and other crops like tapioca planted at row layout of 30 cm to 50 cm. The control methods for weeds are mechanical, chemical, biological and cultural methods. Mechanical weeding is favored as compared to chemical weeding because weedicides are generally expensive, hazardous and selective. Moreover, mechanical weeding keeps the soil surface loose which results in better aeration and moisture conservation.
   Battling one of the major problems (weed control) in crop production, different types of weeder have been developed for weeding in wet and dry upland flat beds which will best suited to a specific soil type. The material for making the weeder can be mild steel. Mild steel is used in the production of agricultural tools for a long period. The mild steel is used because it has the sufficient strength to withstand the loads that act on the weeder in the working farm lands.

5. The effectiveness or the efficiency with which the machine performs its envisioned function is considered in evaluating the performance of an implement. The machine should be adapted to the soil and environmental conditions of the farm. All machines are designed to perform a given task at a specified time. If this designed objective is not met it means that the machine and the power unit is not correct. The rotary blade was made of mild steel to withstand the wearing condition during its contact with the soil and other external material.

## OVERVIEW OF PROJECT

Weeding is a time-consuming process in agriculture. Weeds have been shown to reduce crop productivity by 40%. There are numerous methods for controlling weeds in farmlands, including manual, chemical, and mechanical methods. The mechanical method is preferred over the other two because of its advantages.

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## PROBLEM IDENTIFICATION&OBJECTIVES:

A farm the productivity of the crops is affected by the unwanted weed plants and it is tedious to control the weeds by the traditional and general weeding equipment's. There is a need of a specific design of a weeder for the tapioca farm causing only less or no damage to the crop.

- To reduce the costs associated with weed control on tapioca farm lands.
- To reduce the amount of time spent weeding.
- To design equipment that reduces human effort in tapioca production, thereby reducing the need for labor.
- Develop a mechanical equipment to remove weed plants in farms without harming the crop, particularly tubers.
- To reduce the number of additional or additional labors required for the weeding process in the job.
- Move the equipment at the most cost-effective and affordable price.
- To make a weeder for the tapioca farm that will not only remove the unwanted plants but also losses the soil and increases the porosity to help the water percolation in order to maintain the moisture content.

## METHODOLOGY

The project begins with a literature review and concludes with a result evaluation. The diagram depicts the design and fabrication project methodology.

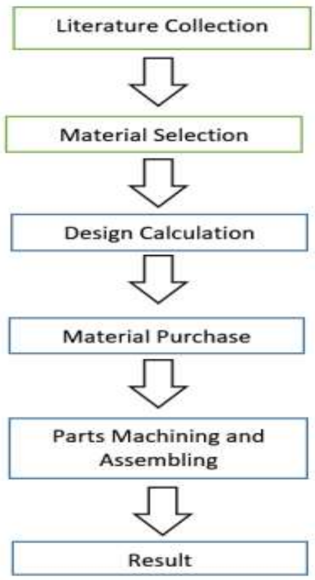


**Figure 2 METHODOGY of project**

## MATERIALS USED

The equipment moveable a standard bicycle wheel available in the market is purchased and used. The bicycle wheel is chosen because it has a large diameter and it is less weight. As it has a large diameter only a small amount of effort is to be given by the worker to move the equipment. The light weight of the wheel also helps us to reduce the overall weight of the machine. The wheel is made up of stainless steel which is weightless and has the sufficient strength to withstand the stresses and loads induced during the working time. The stainless steel and CFRP are also corrosion resistant and it is very favorable to use it in the farm lands. The farm lands has enormous amount of moisture content in the environment and it favors the formation of rust in the equipments. In our equipment, the wheel will be in contact with the soil surface where there will be more amount of moisture.

- STRUCTURAL STEEL
- CFRP
- ASTM A36 STEEL

## VALIDATION OF WEEDER TOOL:

Calculation is by far the most important stage lies after the data acquisition. In this stage the required magnitude of torque needed to perform desired weeding operation is calculated. There are various assumptions and considerations taken into account during calculation, which are found to be appropriate on the various field conditions during operation.

Determination of required motor torque Considerations:

1. Depth of tool = 6.739 mm

2. Contact area of a blade = 68.79 mm^2 3.

Soil resistance = 0.5

Now, from the value of contact area of a single blade, the total area of contact for all blades is given by,

Total contact area = 4 x 68.79 mm^2 = 275.16 mm^2

Total force required is calculated by using the following equation.

Force required = total blade contact area x soil resistance

Now, putting the values in the above equation we get,

F = 2.7516 x 0.5 = 1.375 kg f

**F = 1.375 x 9.98 = 13.722 N**

Required torque can be determined by using following equation.

Torque = Force x Radius In our case the radius of rotor is considered while calculating the torque, which is, 20 cm or 0.2 m.

T = 13.722 x 0.2 = 2.744 N m

Hence, the required torque is 2.744 N m.

| | BASE PAPER | VALIDATION | PERCENTAGE ERROR (%) |
|---|---|---|---|
| EQUIVALENT STRESS (MPA) | 2.50 E8 | 2.07 E8 | 0.005 |

## DESIGNING OF THE MODEL:

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The weeding tool proposed here consists of two major components: the blade and the mounting rotor. The blade's design and analysis have been completed. Although the rotor is exempt from analysis because it has little or no direct contact with soil during the operation under normal conditions, the blade is constantly subjected to impact and wear during the weeding operation.

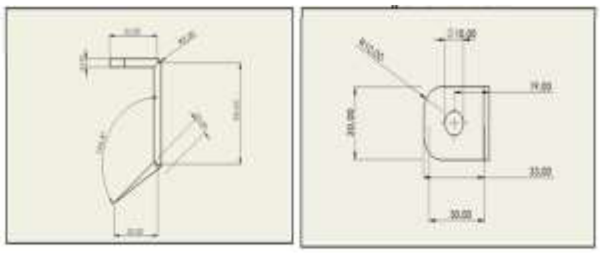

**Figure 3 front views and top view of weeder blade**

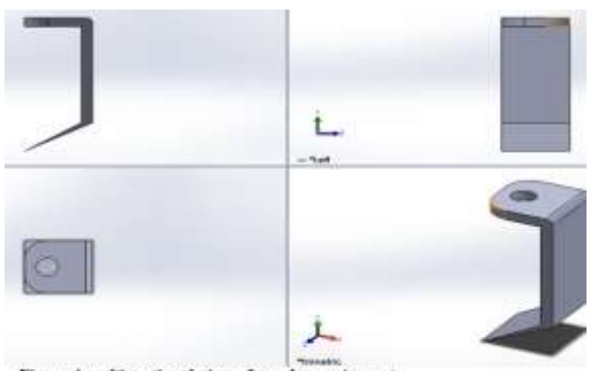

**Figure 4 multi sectional view of weeder equipment**

**THE BASIC STEPS INVOLVED IN FEA**

Mathematically, the structure to be analyzed is subdivided into a mesh of finite sized elements of simple shape. Within each element, the variation of displacement is assumed to be determined by simple polynomial shape functions and nodal displacements. Equations for the strains and stresses are developed in terms of the unknown nodal displacements. From this, the equations of equilibrium are assembled in a matrix form which can be easily be programmed and solved on a computer. After applying the appropriate boundary conditions, the nodal displacements are found by solving the matrix stiffness equation. Once the nodal displacements are known, element stresses and strains can be calculated.

**Basic Steps in FEA**

- Discretization of the domain
- Application of Boundary conditions
- Assembling the system equations
- Solution for system equations
- Post processing the results.

**STATIC STRUCTURAL ANALYSIS**

The static structural analysis calculates the stresses, displacements, strains, and forces in structures caused by a load that does not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that the loads and the structure's response are assumed to change slowly with respect to time. A static structural load can be performed using the ANSYS WORKBENCH solver. The types of loading that can be applied in a static analysis include:

**RESULTS AND DISCUSSION**

This analysis is performed to find structural parameters such as stresses, strain and deformation of farm tiller equipment using two materials namely structural steel and CFRP along with the exisisting ASTM A36 Steel finally observed results as shown below figures.

**VON-MISES STRESS:**

Here we have the final von misses stress results of structural steel and CFRP along with the exisisting ASTM A36 Steel. Here we get maximum von misses stress value of 2.1348e8 Pa for the Structural steel material and favorable lowest stress value for the advanced CFRP material value of 1.985e7 Pa.

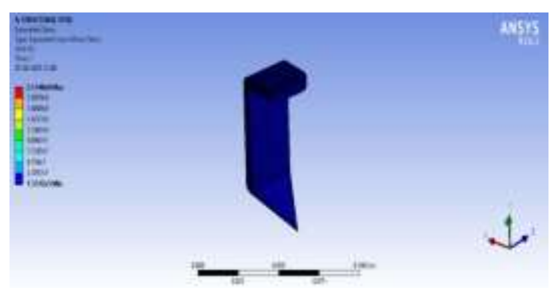


**Figure 5 von-misses stress on structural steel**


**Figure 6 von-misses stress on CFRP**

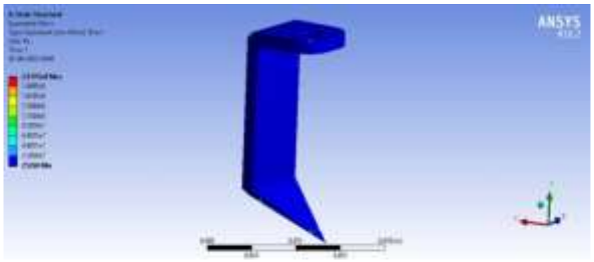


**Figure 7 von-misses stress on ASTM A36 STEEL**

**TOTAL DEFORMATION:**

In this analysis point of view we are getting the final total deformation results of structural steel and CFRP along with the existing ASTM A36 Steel. Here we get maximum total deformation value of 189.49 m for the Structural steel material and favorable lowest stress value for the advanced CFRP material value of 81.341 m.

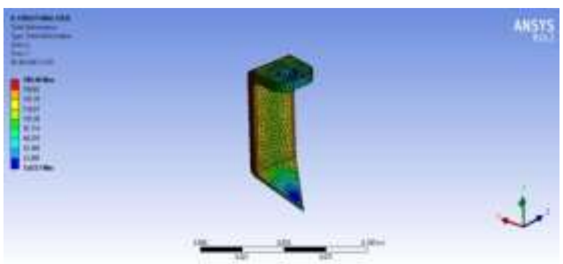


**Figure 8 total deformations on structural steel**

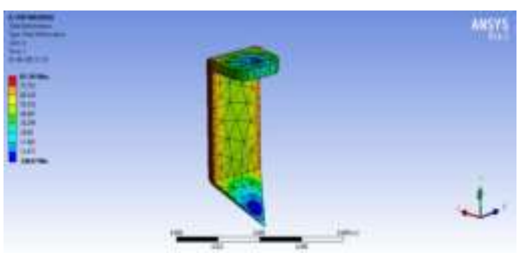


**Figure 9 total deformations on CFRP**

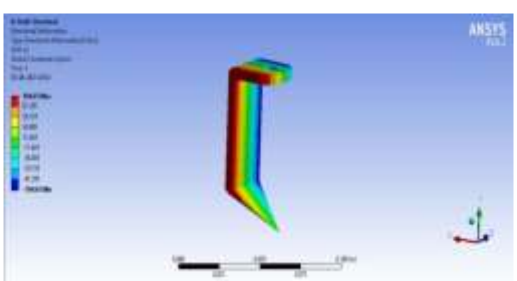


**Figure 10 total deformations on ASTM A36 STEEL**

**STRAIN:**

In this analysis point of view we are getting the final Strain results of structural steel and CFRP along with the existing ASTM A36 Steel. Here we get maximum total deformation value of 0.0013904 for the Structural steel material and favorable lowest stress value for the advanced CFRP material value of 0.0001289.

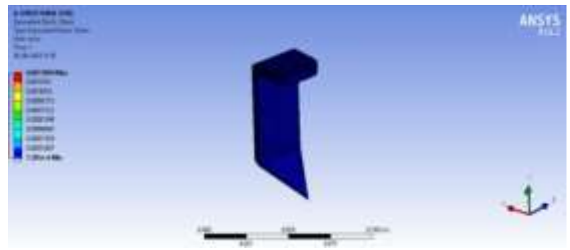


**Figure 11 strain on structural steel**

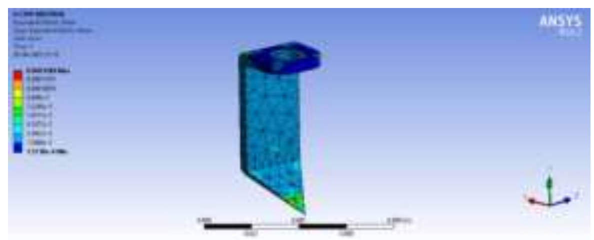


**Figure 12 strain on CFRP**


**Figure 13 strain ASTM A36 STEEL**

**VON MISSESE STRESS GRAPH**

The below graph shows that with variation of von misses stress in three different materials structural steel, CFRP materials along with exisisted ASTM a36 steel . In these simulations are posse's highest value of von misses stress for the structural steel as 2.1348 MPA and lesser deformation to CFRP material as 1.9856 MPA.

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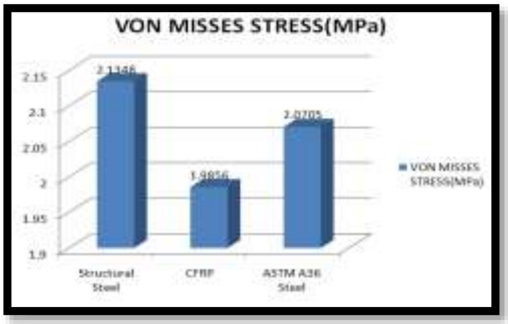
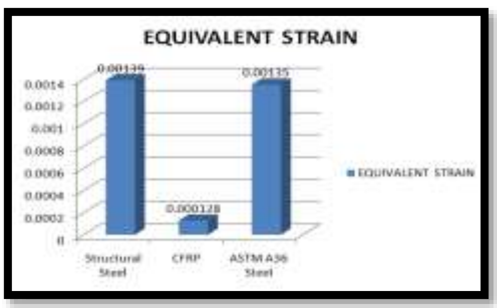



**Graph 1 maximum von misses stresses**

**STRAIN GRAPH**

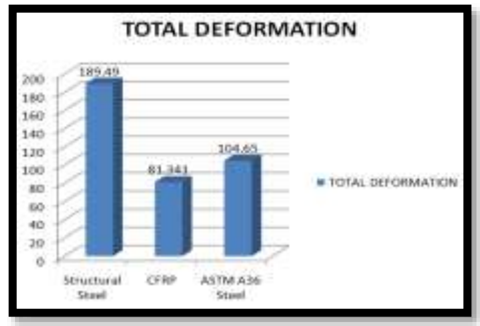
The below graph shows that with Variation of strainin three different materials Structural steel, CFRP materials along with exisisted ASTM A36 Steel . In these simulations are posse's highest value of strainfor the Structural steel as 0.00139 and lesser deformation to CFRP material as 0.000128.




**Graph 2 equivalent strains acting on 3 materials**

**TOTAL DEFORMATION GRAPH:**

The below graph shows that with Variation of Total deformations in three different materials Structural steel, CFRP materials along with exisisted ASTM A36 Steel . In these simulations are posse's highest value of Total deformations for the Structural steel as 189.49 mm and lesser deformation to CFRP material as 81.341 mm.




**Graph 3total deformation acting on 3 materials**

**CONCLUSION**

Designing of weeder equipment tool is done by using SOLIDWORKS Software and then the model is imported into ANSYS Software for Structural analysis on the weeder to check the quality of materials such as existing ASTM A36 Steel along with structural steeland advanced CFRP. From the obtained Von-misses stresses, deformation andstrain for these threematerials,respectively Compared these materials with CFRP material posses have less stresses, deformations and strain values proven through maximum values with graphical representation.Finallyamong the existing ASTM A36 Steel and structural steel analysis based on results it is concluded that CFRP material is suitable material for weeder equipment.

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