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Concept, Design, Analysis and Fabrication of Pesticide Sprayer for Rose Farming

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Abstract: ***Rose is one of the commercial plants which yield in better way of making profits for farmers. On the other hand maintaining the quality and quantity of Roses yielded plays an important role, hence expensive in maintenance of Rose farming becomes important. Since almost all types of Rose plants grows densely by nature and stems are of thorns, which is a problem/difficulty for farmers to enter the dense area for spraying pesticides, during which farmers may get hurt by thorns and flowers may get damage due to walking through denser path. Present project work involves in developing a concept and design for pesticide spraying and efforts to find solution for pesticide spraying for rose farming to provide cost effective and effortless spraying technique for farmers. Also the Analysis is been carried out for components involved in pesticide spraying mechanism. The pesticide spraying machine components are pulley and wire arrangement attached to two vertical arms on either side, each supported by four wheeled kart, while the wire provides travel path for sprayer head for spraying pesticides to Rose plants. Analysis study carried out to find stresses and strain acting on support (kart) wheels, Pulley and Sprayer head due to compression and tension loads acting on these, using ANSYS Workbench to provide further scope for design improvements. Finally the design of the model is fabricated and implemented at Rose farming plot.***

Keywords: Rose farming, ANSYS Workbench, farmers, pesticide spraying mechanism, cost effective

1. Introduction

Roses are one of the most popular garden shrubs in the world. Roses are predominantly hybrid roses that are grown as ornaments they are one of the most popular and widely cultivated groups of Flowering plants. In India the major rose flower cultivating states are Karnataka, Maharashtra, Tamilnadu, and West Bengal commercial varieties of roses cultivated in India. Rose is one of the commercial plants which yield in better way of making profits for farmers. On the other hand maintaining the quality and quantity of Roses yielded plays an important role hence maintenance of Rose farming becomes important. Current scenario in pesticide spraying for rose farming in India is through hand operated sprayer or motorized sprayer. Since almost all types of Rose plants grows densely by nature and stems are of thorns, which is a problem/difficulty for farmers to enter the dense area for spraying pesticides, during which farmers may get hurt by thorns and flowers may get damage due to walking through denser path for spraying pesticides. Hence this present project work provides a solution keeping in sense the difficulty faced by farmers in spraying pesticides. The pesticide spraying model consists of two small 4 wheels supporting kart, manually operated hand lever and sprayer which run on power source as a Diesel Engine. There are two vertical arms placed opposite each other on either ends of spray area connected through thick wire horizontally at top of the vertical arm.

Figure 1: Rose farming Plot

Three Nozzles is fitted to sprayer head and hooked to horizontal thick wire, so that it can spray pesticides following wire path. The wire path is provided through hand lever. Hence this spraying process helps to cover maximum spray area in minimum period of time and also it is cost effective.

2. Literature Survey

In this section, literature survey is conducted to understand the state of the art in different spraying methods.

Nitish Das, etc. al., [1], [April 2015], Paper comprises study on Agricultural Fertilizers and Pesticides Sprayers Spraying Methods. Also tells about different spraying methods 1) Backpack (Knapsack) Sprayer 2) Lite-Trac 3) Motorcycle

Driven Multi-Purpose Farming Device (Bullet Santi) 4) Aerial Sprayer.

Dhiraj N. Kumbhare et.al,[2],[April 2016], Study involves Fabrication of Automatic Pesticides Spraying Machine which uses a small 4 wheel kart or vehicle which is electronically operated by a wireless remote which runs on power source using DC battery.

M. A. Miller, et.al, [3], Study highlights the Effects of multi−mode four−wheel steering on sprayer machine performance.

Though there are other references available listed in the reference section, only few important papers are discussed under this section. These papers supported as a ready reckoner for developing the concept on pesticide spraying for Rose Farming.

3. Methodology

The steps in Analysis process consists of Creating Geometry, Meshing the Model and Analyse the Model by applying Boundary conditions as shown in Fig.2

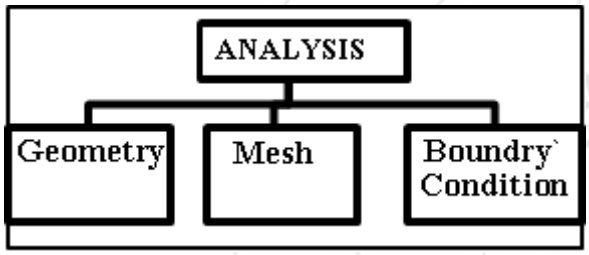


Figure 2: Steps in Analysis

Geometry is created using Unigraphics design tool which provides unique solution to design the model. Analysis is been carried out using ANSYS Workbench which is a combined tool for Geometry creation, Meshing and Analysis. The brief description on Geometry, Meshing and Analysis results carried out for present project work is discussed in the below following sections.

3.1 Geometry

The Isometric view of geometry model of pesticide sprayer is as shown in Fig 3. It consists of pulley (1), supporting wheel (2), nozzles connected to sprayer head (3) and Hand lever pulley (4). Horizontal wires connected to two vertical arms on either ends to provide the travel path for sprayer.

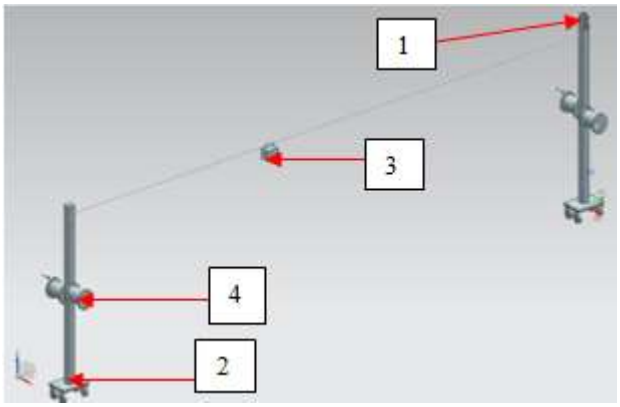


Figure 3: 3d Geometric model

The Zoomed view for pulley (1), supporting kart wheel (2), sprayer head (3) and hand lever pulley (4) is as shown in fig 4, fig 5, fig 6, and fig 7.

3.1.1 Pulley

Pulley is fixed to the vertical arm. It can be adjustable on vertical arm to required height. It helps in passing the sprayers pipe through it as the sprayer head travels on wire. A typical pulley is shown in fig 4.

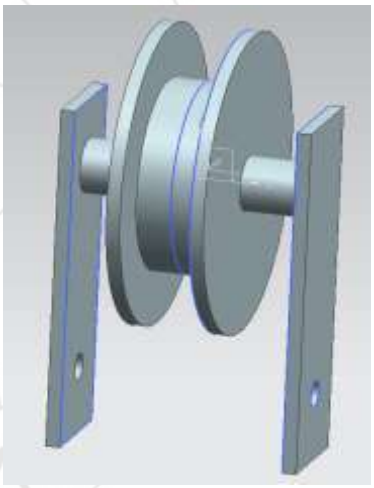


Figure 4: Pulley

3.1.2 Supporting kart wheels

It helps in moving the whole kart to require place. Whole setup consists of eight wheels and one of the wheels is as shown in fig 5.

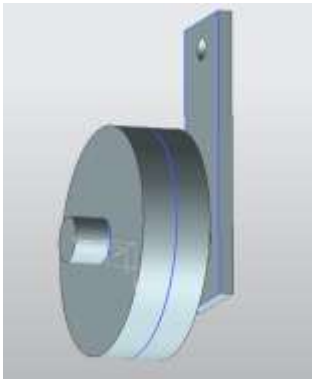


Figure 5: Supporting Wheel

3.1.3 Sprayer head

Sprayer head consist of three nozzles, two vertical hooks at the top and two horizontal hooks at the adjacent side as shown in fig 6. Sprayer head follow the wire path and nozzles spray the pesticide.

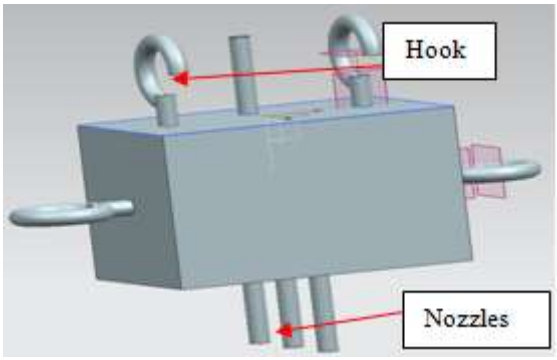


Figure 6: sprayer head

3.1.4 Hand lever pulley

It consists of flexible hand lever as shown in Fig 7. Through manual rotation of it, gives horizontal linear motion to wire, (on which sprayer is hooked) by continuously wounding wire on it on every manual rotation.

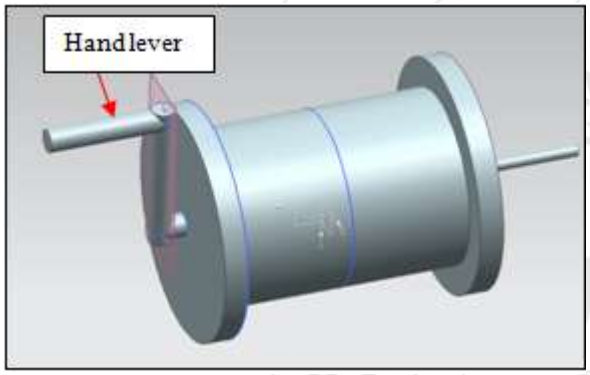


Figure 7: Hand lever pulley

3.2 Mesh

The Analysis is been carried out for following parts.
1) Pulley
2) Supporting wheel
3) Sprayer head
Meshing is the important criteria as the part of analysis considered. The 3D Mesh models is as shown in Fig. below

3.2.1 Pulley

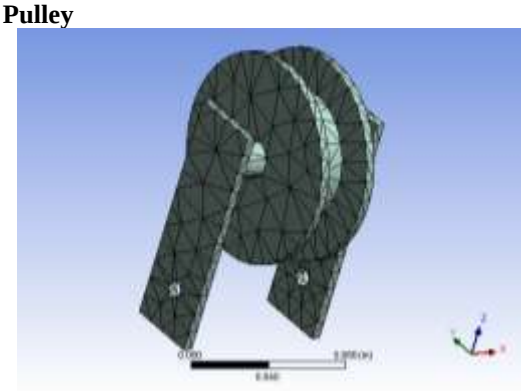


Figure 8: meshed pulley

The fig 8 shows the typical view of unstructured meshed pulley, having Nodes and Elements as shown in the table-1.

Table 1: Nodes and Elements of meshed pulley

Nodes	2835
Elements	1301

3.2.2 Supporting wheel

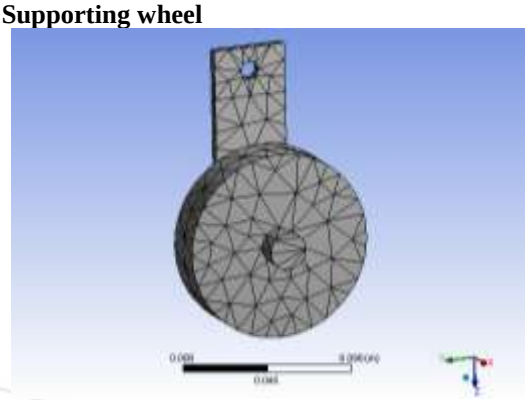


Figure 9: Meshed wheel

The fig 9 shows the typical view of unstructured meshed wheel, having Nodes and Elements as shown in the table-2.

Table 2: Nodes and Elements of meshed pulley

Nodes	1814
Elements	852

3.2.3 Sprayer head

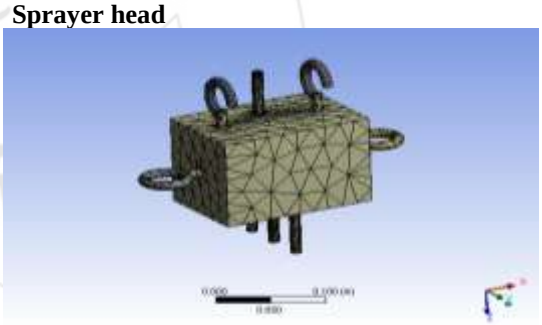


Figure 10: Meshed sprayer head

The fig 10 shows the typical view of unstructured meshed sprayer head, having Nodes and Elements as shown in table-3.

Table 3: Nodes and Elements of meshed sprayer head

Nodes	18229
Elements	8809

3.3 Boundary conditions

By fixing any one of the supports in the given components and applying forces, the necessary boundary conditions are obtained. The boundary condition for pulley, supporting wheel and sprayer head are shown in fig11, fig12, and fig13.

3.3.1 Pulley

The mounted ends of the pulley are fixed and tangential load of 15N is applied on surface of pulley due to tension of pipe. The load applied region (2) and fixed region (1) are shown in fig 11 and table-4.

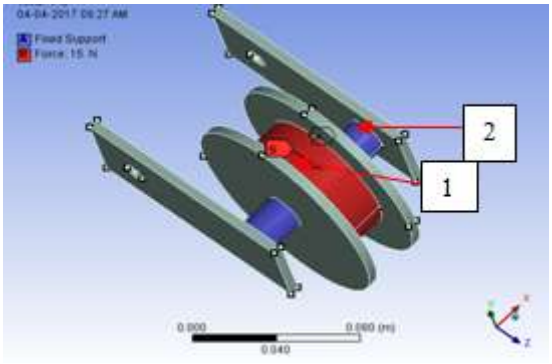


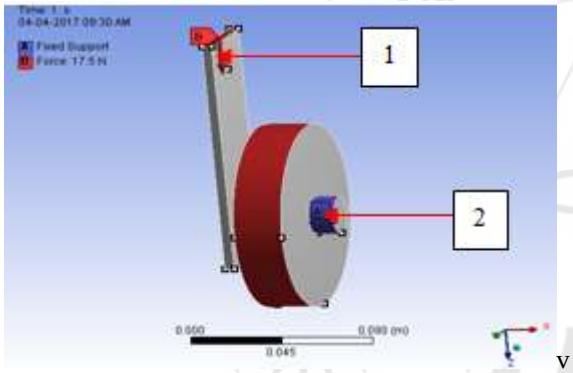
Figure 11: Tangential load on pulley

Table 4: Boundary conditions for pulley

Red color(1)	Tangential load
Blue color(2)	Fixed support

3.3.2 Supporting wheel

The compression load of 17.5N applied on the top most portion of the rectangular support of wheel (1) and axle of the wheel is fixed (2). The load applied region and fixed region are as shown in Fig. 12 and table-5.



v

Figure 12: load on wheel

Table 5: Boundary condition for wheel

Red color(1)	Compression load
Blue color(2)	Fixed support

3.3.3 Sprayer head

Sprayer head consist of two hooks on top which are at fixed condition (2) and the tensile load is given to the side hooks (1). The load applied region and fixed region are as shown in fig 13 and table-6.

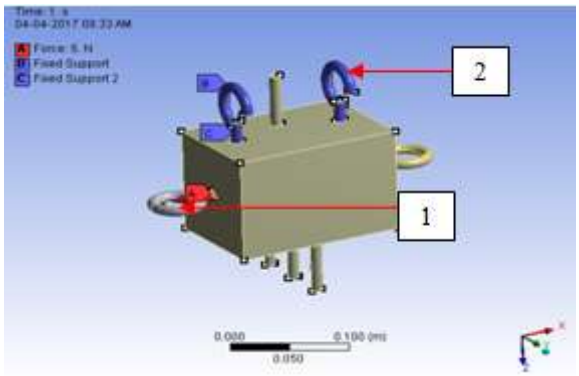


Figure 13: sprayer head

Table 6: Boundary condition for sprayer head

Red color(1)	Tensile load
Blue color(2)	Fixed support

4. Results and Discussion

The total deformation results obtained through analysis is as discussed below and as shown in fig 14, fig 15, and fig 16.

4.1 Pulley

The fig 14 shows analysis result for the total deformation in the pulley.

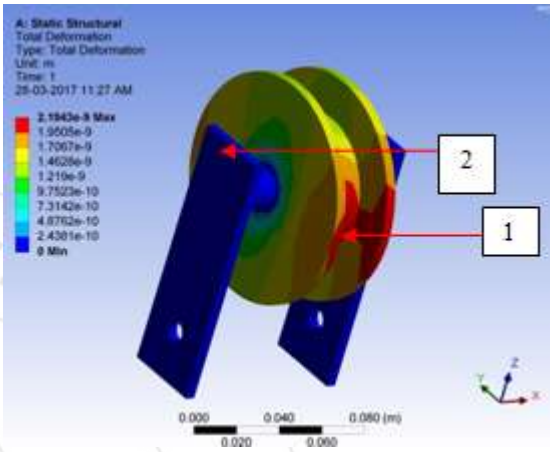


Figure 14: pulley- analysis result

The maximum deformation is found at front portion of pulley (1) due to tangential load of pipe and its value found to be 2.1943e-9 and Minimum deformation is at fixed supported (2), as it is at no load condition.

4.2 Supporting Wheel

The fig 15 shows analysis result for the total deformation in supporting wheel.

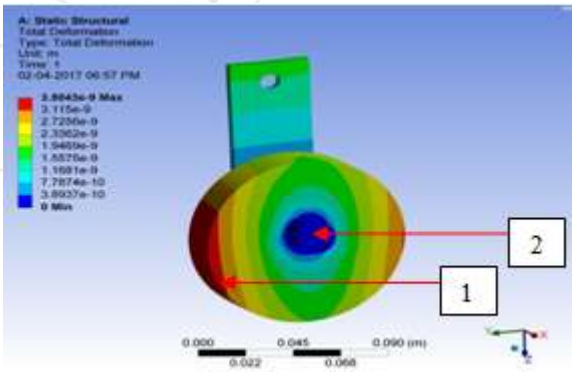


Figure 15: supporting wheel

The maximum deformation is found at adjacent portion (1), due to compression load and its value found to be 3.5043e-9 and Minimum deformation is at fixed supported (2), as it is at no load condition.

4.3 Sprayer head

The fig 16 shows analysis result for the total deformation in sprayer head

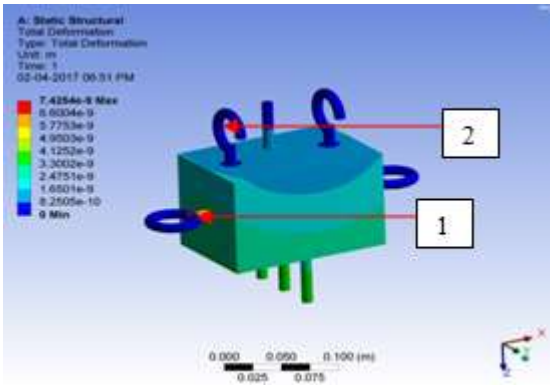


Figure 16: sprayer head

The maximum deformation is found at side hooks (1), due to tensile load and its value found to be 7.425e-9 and Minimum deformation is at fixed supported (2), as it is at no load condition.

5. Fabrication

Based on the Design and Analysis results obtained, the model is fabricated and the details of components, materials used and cost are as table 7.

Table 7: Material Cost Details

Fig. no	*Components*	*Material used*	*Cost*
18	Vertical arms	Steel	2000
18	Hand lever	Polymer	50
18	Pulley	Cast Iron	200
21	Sprayer head	Steel	500
20	Nozzles	Brass	850
20	Pipes	Polymer	400
-	Cable Wire	-	500
Total			**4500/-**

Since the Project cost is just ₹4500 which is affordable for the low class and middle class farmers

Nozzle flow rate [2] can be calculated using eqn.1

$$Q_n = 28.9 * D^2 * \sqrt{P} \quad \ldots\ldots\ldots\ldots \text{ eqn. 1}$$

Where,

Q_n = flow rate of water from nozzle (gpm), D = Nozzle diameter (inch), P = Pressure at nozzle (Psi)

6. Project Implementation

The project is implemented in Rose farming plot which is of three Acres near kumbena agrahara, kadugodi post, Bengaluru. The Rose farming plot is as shown in Fig. 17.

Figure 17: Rose Farming Plot

The photography of components as shown in Fig. 18, Fig. 19, Fig. 20 and Fig. 21

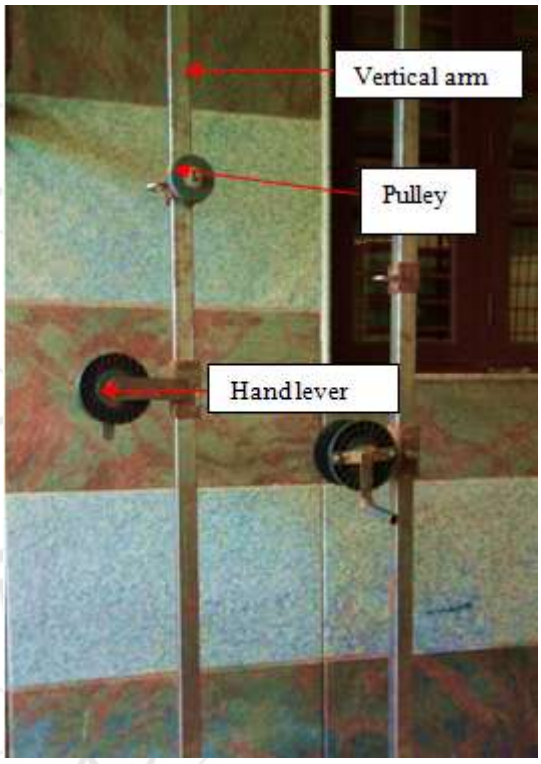


Figure 18: Vertical arms with hand levers

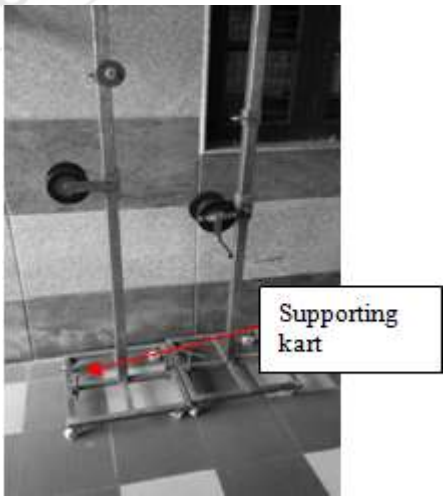


Figure 19: Supporting kart

Figure 20: Spraying Nozzles

Figure 21: Sprayer head

The complete project setup implemented as shown in Fig. 22.

Figure 22: complete project setup

7. Conclusion

The following conclusion can be drawn from the design, analysis and fabrication of pesticide sprayer for Rose farming are:

1) ANSYS is a powerful tool in determining the deformation in the components based on the load applied.
2) Cost effective project which can be affordable by low and middle level farmers through Government subsidies. Initial investment and maintenance cost is very low.
3) Provides flexible way of spraying method for farmers without damaging the flowers and getting them hurt from thorns present in flowers stems.
4) Project implementation eliminates the labour charges

It can be concluded that the present project work is no more exhaustive and it can be developed as future scope of project. The results obtained through ANSYS become a ready reckoner for the engineers for future project development and helps in making decision faster.

8. Acknowledgment

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