Conceptualization Design, Analysis and Development Cotton Harvesting Machine

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Abstract: It is hoped that this research would provide farmers with a substitute harvesting technique that is ergonomically light and that will allow them to pick cotton bolls in less time while retaining accuracy. Cotton is used for a variety of purposes, including medicinal and industrial applications. Because of a labour scarcity on farms, the harvesting of the cotton crop has been delayed, resulting in a reduction in cotton output overall. Commercially accessible cotton harvesters were used to harvest Indian kinds of cotton, although there have been various challenges with cotton harvesting, including lengthier harvesting periods and excessive power consumption due to the large size of the operation. In India, we are cognizant of our surroundings. Because India is a developing nation, we are familiar with the circumstances on Indian farms. Cotton harvesting devices are widely accessible in India; however, the expenses of these equipment are prohibitively expensive. Using a finger-type cotton harvesting equipment, the cotton is delicately collected in a cotton bale. The stripping finger is linked to a section of the machine that is ahead of it. The finger is a hinge joint that may be rotated in both the upward (45 degrees) and downward (45 degrees) directions (-45). The paddle has deteriorated in a clockwise direction since its construction. The paddle is connected to the stripping finger and the collecting tank by a rubber band. The cotton stripping finger is coupled to a collecting tank, which is located behind it.

Keywords: cotton crop, cotton stripper, crop attributes, machine performance attributes, boll crusher, seed- cotton output.

1. Introduction

Cotton is the most fundamental necessity on the planet, and it is used in hospitals, as a textile fiber, and as sewing thread. As a result, cotton is the most beneficial and significant crop in terms of economic and social activities, and cotton fiber is referred to as "king fiber" [2]. Large numbers of cotton harvesters, also known as cotton pickers, are easily available on the market [1], but since this equipment is very expensive, it should not be purchased by small and medium-scale farmers. Cotton is still hand-picked in India, which results in higher quality cotton but also needs more time for picking, resulting in a higher cost [3]. It is a finger-type cotton harvesting equipment, as the name suggests. With a spinning paddle mounted above the stripping fingers, which are hinge joints that form an angle of +45 upwards to -45 downwards with the machine vertical line, the stripping fingers were able to remove more material faster. At this point, the time machine wheels are paused for a few of seconds, and the time stripping fingers are oriented upward at an angle of +45 degrees, with cotton being caught by a spinning paddle. And this cotton is gathered in a cotton collection tank for further processing. The cotton fibre is wrapped around the spindle and then removed by a specific instrument known as a doffer before being collected in a storage tank for later use.

2. Materials and Methods

A belt drive must be used in order for the prime mover (1.64 KW, 10,000 rpm) fitted with the aspirator to be connected to the pulley. A circular paddle cotton collector with an 8cm diameter shaft and four wind attachments is affixed to the shaft. The wind has a length of 48cm and a width of 15cm. Nylon 101 is the material used to make the paddle. The Stripping Finger's dimensions are as follows: 70cm in length, 1.79cm in width, and 1.80cm in height. The Stripping Finger is made of Alloy Steel, and there are a total of 20 stripping fingers. The Natural Rubber material is used on the large wheels, which have a 45cm diameter. The diameter of the pulleys is 7cm for the large pulleys and 4cm for the tiny pulleys; the material of the pulleys is Cast Carbon Steel. The volume of the collecting tank is between 20kg and 25kg. These are the sources of the information provided above: Machine Design Data Book by P.C. Sharma & D.K. Agrawal; Machine Design Data Book by V.B. Bhandari; Data Book of Engineering by PSG.

3. Prototype Working

As seen in the figure (1 - 2), the prime mover, which is the internal combustion engine, is connected with a shaft that is attached to a pulley. With the 10,000 RPM, the engine began to rust. And the pulley rotated at a speed of 50 RPM; the pulley is attached to the paddle with the assistance of a belt; the paddle's speed is 40 RPM; and the pulley is also attached to the huge wheels, which rotate at a speed of 20 RPM. The machine is moved in the forward direction at which time cotton is gathered in the stripping fingers, and the stripping finger is rotated at a 45-degree angle in the upward direction at which time cotton is collected in the collecting tank with the use of a paddle. The paddle is rotated in a clockwise manner, and the cotton is transported to the collection tank. Approximately 20kg to 25kg of cotton is stored in a collecting tank with a capacity of 20kg to 25kg.
4. Design Analysis of Cotton Harvesting Machine

**FIGURE 1:** Prototype model of cotton harvesting machine with the stripping finger angle are +45 upward

**FIGURE 2:** Prototype model of cotton harvesting machine with the stripping finger angle are -45 downward

**FIGURE 3:** Drafting assembly of cotton harvesting machine
5. Part Design and Analysis

Design of Stripping Finger:

- Force: 50N
- Material: Alloy Steel
- Elastic Modulus: $2.1 \times 10^{11}$ N/m$^2$
- Poisson’s Ratio: 0.28 N/A
- Shear Modulus: $7.9 \times 10^{10}$ N/m$^2$
- Mass Density: 7700 Kg/m$^3$
- Tensile Strength: 723825600 N/m$^2$
- Yield Strength: 620422000 N/m$^2$
- Thermal Expansion Coefficient: $1.3 \times 10^{-5}$ 1/K
- Thermal Conductivity: 50 W/(m*K)
- Specific Heat: 460 J/(kg*K)

**FIGURE 4:** Design of stress analysis of stripping finger

**FIGURE 5:** Design of displacement analysis of stripping finger
FIGURE 6: Design of strain analysis of stripping finger by solid work software

**Design of Paddle:**

- Torque: 40 Nm
- Material: Plastic (Nylon 101)
- Elastic Modulus: 1000000000 N/m^2
- Poisson’s Ratio: 0.3 N/A
- Mass Density: 1150 Kg/m^3
- Tensile Strength: 79289709 N/m^2
- Yield Strength: 60000000 N/m^2
- Thermal Expansion Coefficient: 1e-06 1/K
- Thermal Conductivity: 0.53 W/(m*k)
- Specific Heat: 1500 J/(kg*K)

FIGURE 7: Design of stress analysis of paddle by solid work software
Design of Pulley:

- Torque: 50 Nm
- Material: Cast Carbon Steel
- Elastic Modulus: 2e+11 N/m²
- Poisson’s Ration: 0.32 N/A
- Shear Modulus: 7.6e+10 N/m²
- Mass Density: 7800 Kg/m³
- Tensile Strength: 482549000 N/m²
- Yield Strength: 248168000 N/m²
- Thermal Expansion Coefficient: 1.2e-05 1/K
- Thermal Conductivity: 30 W/(m*K)
- Specific Heat: 500 J/(kg*K)
FIGURE 10: Design of stress analysis of pulley

FIGURE 11: Design of displacement analysis of pulley
- Torque: 20 Nm

Design of Wheel:
- Material: Rubber (Natural Rubber)
- Elastic Modulus: 10000 N/m²
- Poisson’s Ratio: 0.45 N/A
- Mass Density: 960 Kg/m³
- Tensile Strength: 20000000 N/m²

FIGURE 12: Design of strain analysis of pulley

FIGURE 13: Design of stress analysis of wheel
Conclusion:

1. The labour demand for cotton picking by stripper was between 8.30 and 8.75 man-hours per hectare of cotton harvested, and the labour savings from mechanical cotton picking were 90.9 percent when compared to manual picking.

2. When compared to the pneumatic type cotton harvesting machine, this cotton harvesting equipment will produce cotton of higher grade.

3. It would take less time to operate this machine compared to the pneumatic one.

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