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A Design and Different components of Groundnut Separating Machine

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ABSTRACT

Groundnut is grown on small scale by farmers in developing countries like India. Lack of groundnut processing machines at affordable cost, especially groundnut Sheller, is a major problem of groundnut production. The groundnut Sheller machine available in the market are large in size & costly& not suitable for domestic purpose. The machine is fabricated by locally sourced material. The major part of machine are hipper, crushing chamber, separating chamber & blower. The processes involve in the project are like design, fabricating &assembly of different component

Keywords: Design & fabrication groundnut separating machine, locally sourced material

1. INTRODUCTION

India is an agricultural based country. Since last 50 year's lot of changes has been occurred in agriculture sector. Many new agricultural based industries have been started new varieties and species of plant have been discovered. In our country most of the people can be depend on the agriculture sector/field. The Groundnut is one of the product in the marathwada-nashik region. The product in the farming abundant quantity. There is lot of time waste in old method of groundnut pod separating. The time required for 1 Kg of groundnut pod separating from this groundnut is about 1 to 2 hours. So we have we have produces new machine for fast groundnut pod separating. In the Marathwada region people collect the groundnut from the groundnut plant directly for pod separating purpose. The ground spreads on the ground and the pod of groundnut can be separated manually. Because of this method lot of time waste takes place as well as due to striking process some ground nut can be brakes of damage. But by using the groundnut pod separating machine we separate the pod from groundnut efficiently and large quantity in very less time. So we increase the work capacity and saving the time efficiently & effectively. So our machine in very useful to separating the pod from groundnut.

2. LITERATURE SURVEY

Shelling is the removal of grains from their pod either by stripping, impact action and rubbing or any combination of these methods[4].the most popular method of groundnut shelling, which is still widely used in the method of crushing or pressing of pods in between the thumb and the first method has low efficiency, it is time consuming, and has high demand of energy [4]. Groundnut shelling machine is a machine used to remove the shell of groundnut so as to obtain the groundnut seed [3]. They are different machine have been fabrication and used to shell wide variety of groundnut pods [4].The machine are too costly and complex in operation and maintenance .The lowest price is 13000/- some of these machine have very high shelling capacity, shelling capacity varies from machine to machine ranging from 6kg speed/h to 60 kg speed/h same hand sheller machine are suitable are domestic application but they only do shelling operation. , separation of seeds we have to do manually by using traditional methods such as by using natural wind or by using sieve. A simple hand operated groundnut Sheller has a semi-cylindrical screen closed on both sides. A shaft carrying a lever at one end is fixed across the centre of the semi-cylinder as shown in the Fig.1 (a). On the lever is a pair of plate with shoes or beater bars, having blunts on their undersides. For successful operation of the machine, the operator stands by the side, then holding the operating lever (handle) and swinging it by pushing to and fro to provide shelling action on the shoes assembly [4]. The semi-rotary, action of the shoes shells the pods against the screen but this type of machines cannot do separation of shell and se

3. WORKING PRINCIPAL

By using electrical motor, the rotating moment transferred with the help of belt to the rotor shaft and fan shaft. The step pulley is maintained on the electrical motor shaft. When rotor rotating the groundnut falls in the hopper and then groundnut pressed between the rotor and grill. At that time groundnut seed and pod separated. The groundnut pod and groundnut seeds fall in the tray. Due to high fan speed the high velocity of air is created by using this high velocity air the light weight pod is thrown out from the machine and the groundnut seed falls in the tray due to this weight. We collect the seeds in the pot of bag.

Fig No -01groundnut Pod Separating Machine

4. DESIGN OF GROUNDNUTPOD SEPARATING MACHINE

In our attempt to design a GROUND NUT POD SEPARATING MACHINE we have adopted a very a very careful the total design has been divided into two parts mainly;

- System design
- Mechanical design

System design mainly concerns with the various physical constraints and ergonomics, space requirements, arrangement of various components on the main frame of machine no of controls position of these controls ease of maintenance scope of further improvement; height of m/c from ground etc.

In Mechanical design the components are categories in two parts.

- Design parts
- Parts to be purchased.

For design parts detail design is done and dimensions thus obtained are compared to next highest dimension which are readily available in market this simplifies the assembly as well as post production servicing work. The various tolerances on work pieces are specified in the manufacturing drawings. The process charts are prepared & passed on to the manufacturing stage .The parts are to be purchased directly are specified &selected from standard catalogues.

5. DESIGN ANALYSIS AND CALCULATION

5.1Determination of Crushing Power to Break the Pod

The crushing power (P) to break the pod as computed by Okegbileet *al.*, (2014):

$$\text{Power} = \text{CLWF}$$

Where, C =Convey or Capacity (m^2/s),
L =Convey or Length (w),
W = bulk material weight (N/m^3),
F = material factor.

Taken Cc = 800kg/min

$\rightarrow c_c = \frac{800x10}{60} = 116.66$N/s.

But, C = $\frac{c_c}{w} = \frac{116.66}{199.3} = 0.59m^3/s$

By substitution, P = 40.83W.

Base on specification, 1hp motor was selected.

6.2Determination of the Pulley Diameters

The diameter, D of the auger pulley may be determined from the relation:

$N_1N_2 = N_1N_2$

Where,
N_1= speed of prime mover (1400rpm),
N_2= speed of driven pulley (auger),
D_1 = diameter of prime mover pulley = 0.125m,
D_2= diameter of the driven pulley (auger).

By substitution,

$$D_2 = \frac{N_1}{N_2} x\ D_1 = \frac{1440\ x\ 0.125}{1800} = 0.1m$$

The diameter, D of the fan pulley may be determined from the relation:

$N_3D_3 = N_4D_4$

Where,
N_3 =speed of auger pulley,
D_3 =diameter of auger pulley,
N_4 =speed of fan pulley,
D_4 =diameter of fan pulley.

$$D_4 \frac{N_3}{N_4} x\ N_3 = \frac{1800\ x\ 0.1}{900} = 0.2\text{m}$$

6.3Determination of the length of the belt

The length, $L_1$of thebelt between auger and motoris determined from the equation as given by Khurmi and Gupta

$$L_1 = 2c_1 + \frac{\pi(D_1 + D_2)}{2} + \frac{(D_2^2 - D_1^2)}{4c}$$

Where L_1= length of, c = distance between centres of pulley of motor and auger, D_1 = diameter of the motor pulley, D_2 = diameter of the auger pulley. Then, L_1 = 1640.47mm

The length, $L_2$of the belt between auger and fan is determined from the relation:

$$L_2 = 2c_{min} + \frac{\pi(D_3 + D_4)}{2} + \frac{(D_4^2 - D_3^2)}{4c}$$

Where,

c_{min} =distance between centres of pulleys of fan and auger, $= 2(D_4 + D_3) = 600mm$

D_3 = Diameter of the auger pulley,

D_4 =Diameter of the fan pulley.

L_2 = 1671.3mm.

Hence, a type B – standard V-belt of $1694mm$ pitch length was selected for each of the belts, L_1 and L_2 for maximum power transmission.

6.4 Determination of Tension in the Belt

The tensions, T in the belt of length L_1 is shown below:

The belt speed $V_b$is estimated as given by Khurmin and Gupta (2005) and Akerele and Ejiko (2015);

$$V_b = \pi\frac{DxN}{60}$$

Where,

N = Angular speed of motor (rpm),

D = Diameter of motor pulley $V_b = 9.426m/s$.

The angle of contact,$\o_1$for the belt around auger and motor (Hall *et al.*, 1983):

$$\o 1 = (180^0 - 2sin^{-1}(\frac{r_2 - r_1}{c})x\frac{\pi}{180}$$

Where,

r_2 = radius of motor pulley,

r_1 =radius of auger pulley,

c =centre to centre distance between auger and motor, $\o 1 = 3.103rad$

For a v-belt, the relationship between the tensions T_1 and T_2 in the belt is given by (Khurmi and Gupta, 2005):

$$2.3log\frac{T_1}{T_2} = \mu\,\O_1 cosec\beta$$

Whereμ = coefficient of friction = 0.3,

$\O_1$ = angle of contact on smaller pulley,

β = half of groove angle = 19^0.

By substitution,

$$T_1 = 17.507T_2$$

Recall,

power, $P = (T_1 - T_2)V_b$,

where $P = 3.7285KW$,

V_b =belt velocity = 9.426.

Then,

$$T_1 - T_2 = 395.55N$$

By simplifying the equation2 9 and 10:

$T_1 = 419.506N$and$T_2 = 23.9621N$ Initial tension in the belt,

$$T_1 = (T_2 + T_1)/2 = 221.73N$$

The tensions, T in the belt of length L_1 is shown below:

The angle of contact,$\o_2$for the belt around auger and fan is given in equation 11 by Hall *et al.*, (1983) andAkerele and Ejiko, (2015)

$$\o 1 = (180^0 - 2sin^{-1}(\frac{r_4 - r_3}{c})x\frac{\pi}{180}$$

Where r_4 = radius of fan pulley, r_3 = radius of anger pulley, c_2 = centre distance of fan and auger pulleys.

$$\O 2 = 2.9751rad \ .$$

$$2.3log\frac{T_3}{T_4} = \mu\,\O_2 cosec\beta$$

$$T_3 = 15.5574T_4 \quad 13$$

Also,

$$power = (T_3 - T_4)\,V_b$$

$$\rightarrow T_3 - T_4 = 395.55$$

By simplifying equations 13 and 14:

$T_3 = 422.7217N$ And $T_4 = 27.1717N$

Initial tension in the belt,

$$T_1 = (T_3 + T_4)/2 = 224.95N.$$

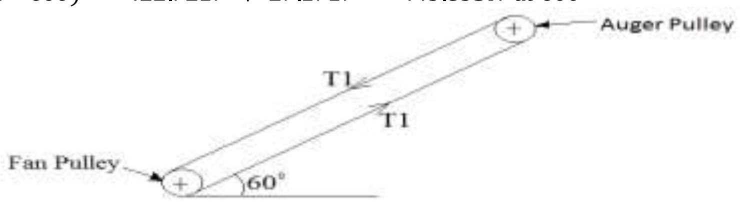
6.5 Determination of the bending moments acting on the shaft

The resultant of the tensions on belt 1,F_{r1};

$$F_{r1} = T_1 + T_2 = 419.506 + 23.9621 = 443.4681N$$

The resultant of the tensions on belt 2, F_{r2};

$F_{r2} = T_3 + T_4(at \ 600) = 422.7217 + 27.1717 = 449.893N$ at 600



By resolving the forces into its vertical and horizontal components;

$$F_{v2} = F_r 2\sin \quad ø = 449.8934\sin \quad 600 = 389.6191N$$

F_{H2}Vertical weight of the pulley, $wp = 9.81N$.
So, resultant vertical head of the pulley is given as:

$$F_{r1} + F_{v2} + Wp = 443.4681 + 389.6191 + 9.81 = 842.8972N$$

Wt. of auger, $w_1 = 0.15KN/m$,
Vol. capacity of hopper, $V = 0.5(a + b)hl = (0.25 + 0.15)\,0.25 \times 0.42 = 0.021m^3$
By experiment, the specific weight of dry groundnut is 199.3N/m^3.
Therefore the hopper capacity = $0.021 \times 199.3 = 4.1853N$.
Weight of the handle disc = volume of disc x specific weight of steel

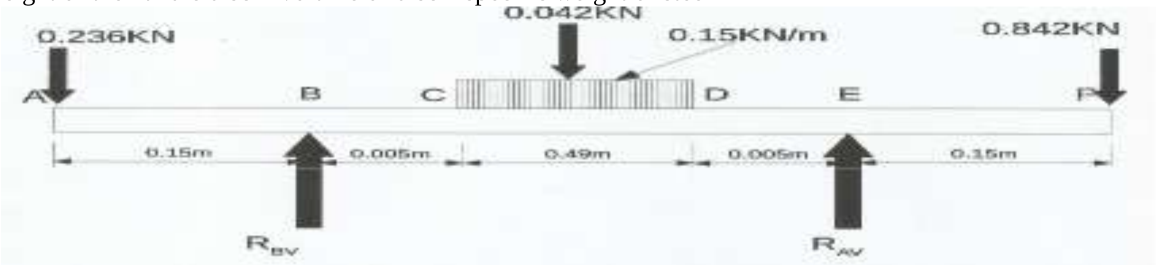


Figure 2: vertical load diagram

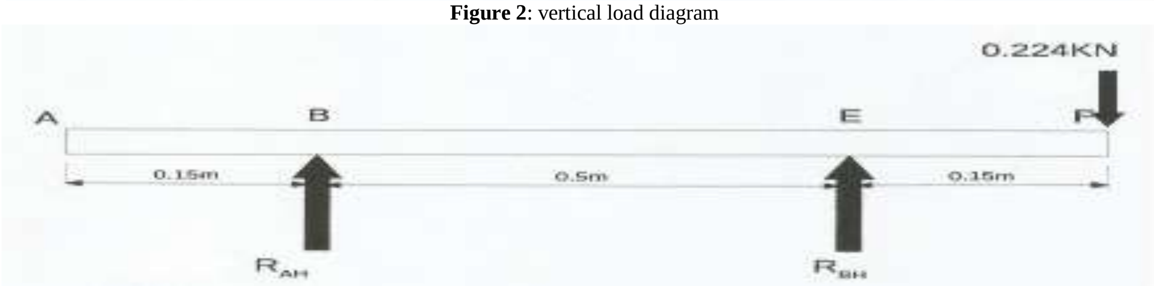


Figure 3: Horizontal load diagram

Considering Fig 1: $\sum F_V = 0$,
$\sum F_V = 0$; $R_{Av} + R_{Bv} = 0.236 + 0.042 + 0.15\,(0.49) + 0.842$
$\sum M_E = 0$; $0.236\,(0.65) + 0.042\,(0.25) + 0.15\,(0.49)\,(0.25) = 0.5R_{Av} + 0.842(0.15)$
By simplifying, $R_{Av} = 0.112KN$ and $R_{Bv} = 1.0815KN$
Using bending moment diagram; maximum bending moment, $M_{bmax} = 0.1263KNm$ at 0.15m from point F.
Considering Fig 2: $\sum F_V = 0$; $R_{AH} + R_{BH} = 0.224$ and $\sum M_E = 0$ $0.5R_{AH} = 0.15 \times 0.224$
By simplifying equation 17; $R_{AV} = 0.0672KN$ and $R_{BH} = 0.1568KN$

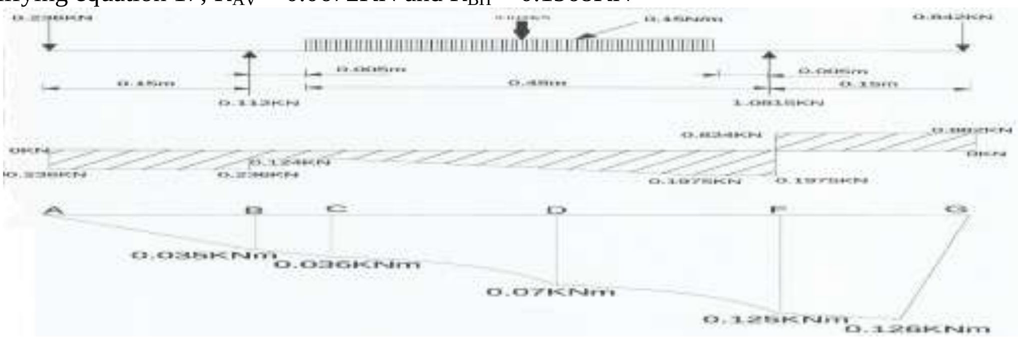


Fig 4: Free Body Diagram, Share Force Diagram and Bending Moment Diagram for Vertical Loading

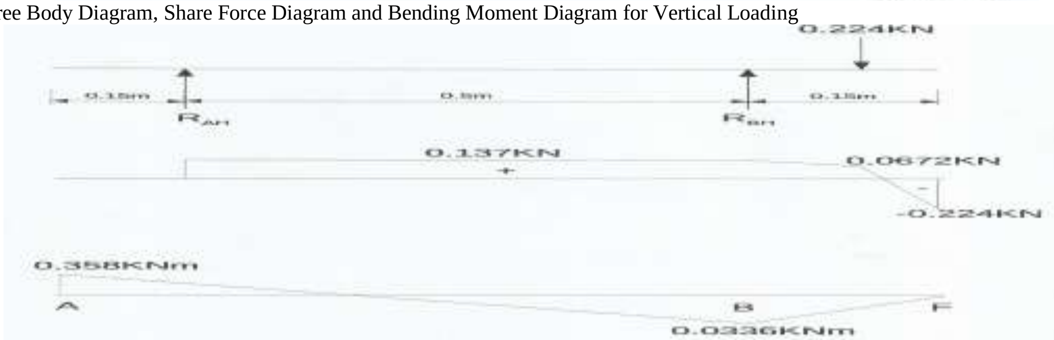


Fig 5: Free Body Diagram, Share Force Diagram and Bending Moment Diagram for Horizontal Loading
Considering points E for maximum resultant moment;

At E; $M_E = \sqrt{M_V{}^2 + M_H{}^2} = \sqrt{0.0336^2 + 0.1263^2} = 0.1307KNm$
Therefore, the maximum BM = 0.1307KNm which occurs at E

6.7 Determination of the shaft material
The selection of suitable material for the auger shaft is done as computed by Benham*et al.*, (1998):
Bending stress, $\sigma_b = \frac{My}{I}$(Where M = bending moment, y = centroid of the shaft, I = moment of initial)The critical part of the shaft is at $E.M = 0.1307KNm, y = 0.05m$, I $= \frac{\pi d^4}{64} = 4.909 \times 10^{-6} m^4$. Then, σ_b = 1331.2kpa
Torsional stress, $\tau_s = \frac{Tr}{j}$
Where T = torque, r = radius of shaft, j = polar moment of inertia. T = 19.77Nm, r = 0.05,
$j = \frac{\pi d^4}{32} = 100.67kpa$
The shear stress, $\tau_v = \frac{4V}{3A}$
(Where v = shear force, A = area of the shaft).

$$v = 0.842^2 + 0.224^2$$
$$\rightarrow v = 0.8713KN.$$

So, $\tau_v = \left(\frac{4x0.8713}{3x7.855x10^{-6}}\right) = 147.9kpa$. In order to estimate the principal stresses, we use the relation:
$\sigma_{1,2} = \frac{\sigma_x+\sigma_y}{2} \pm \left(\frac{\sigma_x-\sigma_y}{2} + \tau_{xy}{}^2\right)^{0.5}$
Where, $\sigma_x = \sigma_b$, $\tau_{xy} = \tau_v + \tau_s$. Then, σ_1 = 1639.07kpa, σ_2 = 0 kpa and σ_3= -307.95kpa
Von mises equation is used to design against material failure as shown below (Rajput, 2006):
$s_y = \sqrt[2]{\frac{((\sigma_1-\sigma_2)^2)+((\sigma_2-\sigma_3)^2)+((\sigma_1-\sigma_3)^2)}{2}}$
By substitution, Sy = 1.8128Mpa. A standard shaft made from mild steel is selected.

6.8 Determination of the size of power to drive the fan
The required power, P (watt) is obtained from the relation below:
Efficiency, e = $\frac{\text{power output } (P_o)}{\text{power input } (P_i)}$
Where p_o= fan flow rate (Q) x static pressure (P_s). Taken Q = $0.59m^3/s$, P_s= $400N/m^2$, e= 0.80
Then, Power input, $p_i = \frac{0.59x400}{0.80}$= 295W

7. FABRICATION PROCESS

The fabrication was done at mechanical workshop located at Department of Mechanical Engineering, Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria. It involved purchase of needed materials after thorough understanding of the design involved in the research. Several operations, such as marking out and cutting of components, bending and folding of sheet metals, welding, drilling, disbursing by grinding, assembling and painting were done. There is re-designing and modification at certain stages of the fabrication until the whole machine was complete

8. SYSTEM DESIGN

In system design we mainly concentrate on the following parameter

8.1 System selection based on physical constraints:-
While selecting any m/c it must be checked whether it is going to be used in large scale or smallscale industry in our case it is to be used in small scale industry so space is a major constrain .The system is to be very compact. The mechanical design has direct norms with the system design hence the foremost job is to control the physical parameters.

8.2 Arrangement of various components
Keeping into view the space restriction the components should be laid such that their easy removal or servicing is possible moreover every component should be easily seen & none should be hidden every possible space is utilized in component arrangement.

8.3Components of system:-
As already stated system should be compact enough so that it can be accommodated at a corner of a room. All the moving parts should be well closed & compact A compact system gives a better look & structure.

Following are some example of this section

- Design of machine height
- Energy expenditure in hand operation
- Lighting condition of m/c

8.4 Chances of failure:-

The losses incurred by owner in case of failure of a component are important criteria of design. Factor of safety while doing the mechanical design is kept high so that there are less chances of failure. Periodic maintenance is required to keep the m/c trouble free.

8.5 Servicing facility:-

The layout of components should be such that easy servicing is possible especially those components which required frequent servicing can be easily dismantled.

8.6 Height of m/c from ground:-

Fore ease and comfort of operator the height of m/c should be properly decided so that he may not get tired during operation .The m/c should be slightly higher than that the level also enough clearance be provided from ground for cleaning purpose.

9. FUTURE SCOPE

- The agriculture is the basic profession of vast of population world-wide .Some modifications can be done in this machine and it will be used over long scale.
- This machine provides better help to farmers so that they can get proper income of their crop. The scope in agricultural field is tremendous.
- It will definitely be a vast sector to work on to minimise man power and improve efficiency of operation, decrease cost of operation, decrease efforts.
- Use of solar energy instead of electrical energy to operate machine

10. RESULT AND DISCUSSION

The data collected for the shelling efficiency of the machine. the calculated average shelling efficiency. The result of test conducted on the percentage dryness is presented on table 3. It was deduced from the test data that the groundnut seeds used are 86.5% dry. The machine is having a shelling efficiency of 84% and material damage of 14%. The assembled machine is shown in Figure 5 and the exploded view is shown in Figure 6.

11. CONCLUSION ANDRECOMMENDATIONS

A groundnut shelling machine has been designed, fabricated and tested in this research. A preliminary test evaluation in terms of shelling efficiency and material damaged has indicated that it has a higher potential in substituting manual methods. Also, the machine exceeded the previously designed and fabricated shelling machine in terms of efficiency and time. This is because the design involves material strength and rigidity. The following recommendations are required for effective utilization of the machine; these include making sure the groundnut moisture content is not more than 16%, running the machine for a maximum of 10 hours daily, installing the machine in a well ventilated area, using engine grade lubrication oil and running daily maintenance after operation to prolong the machine life span.

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