A DESIGN OF COMPACT PEELING-SHELLING MACHINE

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Abstract: *A corn peeling-shelling compact combo machine was designed, developed and built by using locally available material with overall dimensions of 890×40×108 cm. The machine involves 6 pulleys to vary the shaft speed as per requirement. The manually operated shelling machine gives low output and more damage to kernels. The machine is giving high peeling and shelling rate without damage to kernels. The overall peeling-shelling rate is 150kg/hr. The efficiency of peeling and shelling machine varies between 90%-97% with average efficiency of 94%.*

Keywords: Shelling, peeling, design, shaft, pulley, motor.

1. INTRODUCTION:

In today's industrial world man's innovative ideas has taken him towards all directions concerning about the production and safety in industrial establishments. Some instruments are of shear excellence where as others are the result of long research and persistent work, but it is not the amount of time and money spend in the invention of device or the sophistication of it operation is important, but its convenience, utility and operational efficiency that are important in considering the device. Shelling of high quantity of maize by hand typically takes weeks and the hardened dried maize can also be painful to shell thus leading to hand injuries. Existing alternatives to shelling maize by hand are often unaffordable or difficult to obtain for subsistence farmers. In industrialized countries, maize is largely used as livestock feeds and as raw material for industrial products, while in low income countries; it is mainly used for human consumption. Maize is a vital raw material in industry. Corn starch, corn oil, corn syrup and sugar are the chief industrial products obtained from maize. Corn starch is used for starching clothes. The starch is also employed in the manufacture of asbestos, ceramics, dykes, plastics, oil cloth and linoleum. Corn syrup is used in shoe polish, glassine paper and rayon in tobacco industries. Corn sugar finds their use in the manufacture of chemicals, leather preparation, dykes and explosives. The maize when cooked under acids produces furfural, a compound used in the production of adipontrile (nylon) in the restinging of diesel and lubricating oils. The stalks and leaves are sometimes used for making paper, paper board and wall board. Pulverised maize cobs are used extensively for removing carbon from airplane motors.

2. PART DETAILS AND MATERIALS:

Sr. No.	Part Name	Quantity
1	Feed Rollers	2
2	Spiked Rollers	2
3	Pedestal Bearings	12
4	Gears	2
5	Shaft	1
6	Pulleys	6
7	Belts	3
8	Motor	1

Table no. 1

Selection of proper material for machine components is one of most important step in process of machine design. The best material is one which will serve the desired objective at minimum cost. For our purpose the required material should have good properties which not give support to vibration and another problem. For this requirement following factor should be considered while selecting the material.

A) Availability material.

B) Suitability of material for working conditions in service.

C) The cost of material.

Materials selected for this machine,

2.1. Mild steel

Here is a compilation of mild steel properties and its uses in various fields of technology. It is often used when large quantities of steel are needed, for example as structural steel. The density of mild steel is approximately 7.85 g/cm^3 (7850 kg/m^3) and the Young's modulus is 200 GPa. Let us see, what make the mild steel composition other than maximum limit of 2% carbon in the manufacture of carbon steel, the properties of manganese (1.65%), copper (0.6%) and silicon (0.6%) are fixed, while the proportions of cobalt chromium, niobium, molybdenum, titanium, nickel, tungsten, vanadium and zirconium are not. A high amount of carbon makes mild steel different from other type of steel. Carbon makes mild steel stronger and stiffer than other type of steel. However the hardness comes at the price of a decrease in the ductility of this alloy.

What is called as mildest grade of carbon steel or mild steel is typically carbon steel, with a comparatively mild amount of carbon (0.16% to 0.19%). It has ferromagnetic properties, which make it ideal for manufacture of electrical devices and motors. Mild steel is cheapest and most versatile form of steel and serves every application which requires a bulk amount of steel. The high amount of carbon also makes mild steel vulnerable to trust. Naturally, people prefer stainless steel over mild steel.

2.2. Cast iron:

It is used for manufacturing of pulleys as it is affordable price, easily available and good vibration absorber. Cast iron tends to be brittle, except for malleable cast irons. With its relatively low melting point, good fluidity, castability, excellent machinability, resistance to deformation and wear resistance, cast irons have become an engineering material with a wide range of applications and are used in pipes, machines and automotive industry parts, such as cylinder heads (declining usage), cylinder blocks and gearbox cases (declining usage). It is resistant to destruction and weakening by oxidation

2.3. Knife steel:

Good corrosion resistance, excellent for water sports applications. This alloy is a chromium-nickel-aluminum precipitation hardening stainless steel with good edge retention. Great corrosion resistance generally means a high chromium content, and this means knives made with this steel will be a little harder to sharpen than blades with a lower chromium content.

3. DESIGN:

3.1 Design of pulleys:

Design of pulley (5-6):

Diameter of pulley 5 (d) = 100 mm

Diameter of pulley 6 (D) = 300 mm

Centre distance (c) = 840 mm

To find out length of belt from given value,

$L = \pi (R + r) + 2c + \frac{(R-r)^2}{2c}$

$= \pi (150 + 50) + 2*840+\frac{(150-50)^2}{2*840}$

= 2320 mm.

Arc of contact for pulley (5-6):

$\Theta = 180\text{-}2*sin^{-1}(\frac{D-d}{2c})$

$= 180\text{-}2*sin^{-1}(\frac{300-100}{2*840})$

= **166**

Design of pulley (3-4):

Diameter of pulley 3 (d) = 65 mm

Diameter of pulley 4 (D) = 65 mm

Centre distance (c) = 200 mm

To find out length of belt from given value,

L = π (R + r) + 2c + $\frac{(R-r)^2}{2c}$

= π (32.5 + 32.5) + 2*200+$\frac{(32.5-32.5)^2}{2*200}$

= 620 mm.

Arc of contact for pulley (3-4):

ϴ = 180-2*$sin^{-1}(\frac{D-d}{2c})$

= 180-2*$sin^{-1}(\frac{65-65}{2*200})$

= 180

Design of pulley (1-2):

Diameter of pulley 1 (d) = 75 mm

Diameter of pulley 2 (D) = 250 mm

Centre distance (c) = 360 mm

To find out length of belt from given value,

L = π (R + r) + 2c + $\frac{(R-r)^2}{2c}$

= π (125 + 37.5) + 2*360+$\frac{(125-37.5)^2}{2*360}$

= 1250 mm.

Arc of contact for pulley (1-2):

ϴ = 180-2*$sin^{-1}(\frac{D-d}{2c})$

= 180-2*$sin^{-1}(\frac{250-75}{2*360})$

= 152

3.2 Design of shaft:

P = $\frac{2\pi NT}{60*10^3}$

= $\frac{60*10^6*0.95}{2\pi*1440}$

T = 6300 N-mm.

For pulley (1-2):

$\frac{T1}{T2} = e^{\mu\theta}$

Coefficient of friction (μ)

μ = 0.54 – $\frac{42.6}{152.6 + V}$

= 0.54 – $\frac{42.6}{152.6 + 0.245}$

= 0.26

$\frac{N1}{N2} = \frac{D2}{D1}$

$\frac{1440}{N2} = \frac{250}{75}$

N2 = 432 rpm.

V = $\frac{\pi DN}{60}$

= $\frac{\pi *250*432}{60*1000}$

V = $\frac{5.65}{60}$

V = 0.09m/min.

T1 = $e^{0.26*\left(\frac{\pi}{180}\right)*152}$

T1 = 1.99 T2

T = (T1-T2) R

= (1.99 T2-T2)*125

6300= 0.99 T2 *125

T2 = 51 N

T1 = 101 N

For pulley (3-4):

$\frac{T3}{T4} = e^{\mu\theta}$

Coefficient of friction (μ)

μ = 0.54 – $\frac{42.6}{152.6 + V}$

= 0.54 – $\frac{42.6}{152.6+0.0245}$

= 0.26

$\frac{N3}{N4} = \frac{D4}{D3}$

N3 = 432 rpm.

V = $\frac{\pi DN}{60}$

= $\frac{\pi * 65 * 432}{60 * 1000}$

V = $\frac{1.47}{60}$

V = 0.0245 m/min.

T3 = $e^{0.26*\left(\frac{\pi}{180}\right)*180}$

T3 = 2.26 T4

T = (T3-T4) R

= (1.26 T4-T4)* 32.5

6300= 1.26 T4 *32.5

T4 = 155 N

T3 = 350 N

For pulley (5-6):

$\frac{T5}{T6} = e^{\mu\theta}$

Coefficient of friction (μ)

μ = 0.54 – $\frac{42.6}{152.6 + V}$

= 0.54 – $\frac{42.6}{152.6 + 0.0376}$

= 0.26

N6 = 220 rpm.

V = $\frac{\pi DN}{60}$

= $\frac{\pi * 300 * 220}{60 * 1000}$

V = $\frac{3.45}{60}$

V = 0.0575 m/min.

T5 = $e^{0.26*\left(\frac{\pi}{180}\right)*166}$

T5 = 2.12 T6

T = (T5-T6) R

= (2.12 T5 – T5)* 150

6300= 1.26 T5 * 150

T5 = 113 N

T6 = 239 N

3.3 Design of peeling shaft:

For vertical loading dig.

RAV + RBV = 608.47 N

∑MB = 0

-100 × 330 -157.49×630 -350.98×720 + 660 RAV = 0

∴ RAV = 583.21 N

∴ RBV = 25.26 N

∴ MCV = MBV = 0

∴ MAV = -350.98 × 60

= -21058.8 N.mm

∴ MDV = -350.98×90 + 583.21 ×30

= -14091.9 N.mm

∴ MEV = 25.26 × 330

= 8335.8 N.mm

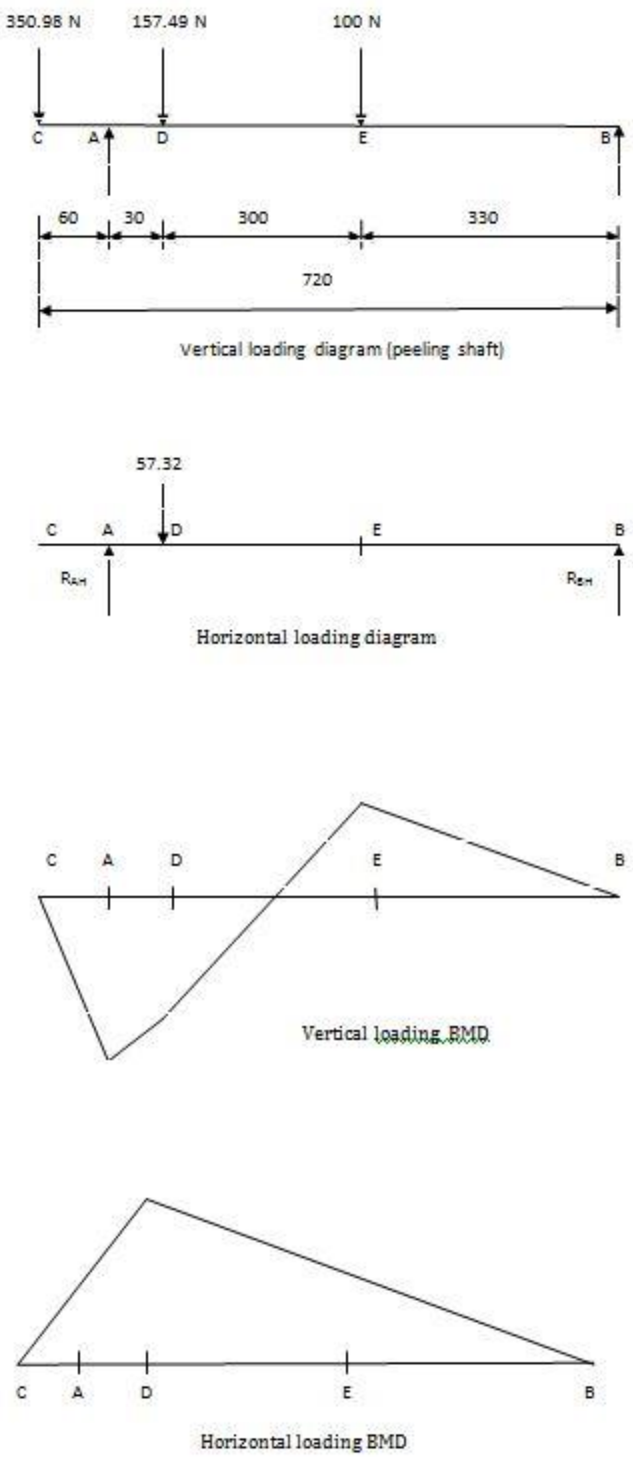


Fig. 1 Loading and BMD dig. For Peeling shaft.

For horizontal loading dig.

RAH + RBH = 57.32 N

$\sum MB = 0$

∴ RAH × 660 -57.32×630 = 0

∴ RAH = 54.71 N

∴ RBH = 2.60 N

∴ MAH = MBH = 0

∴ MDH = 54.71 × 30

= 1641.3 N.mm

Hence now finding the resultant moments at each point

∴ MC = MB = 0

∴ MD = $\sqrt{MDV^2 + MDH^2}$

= $\sqrt{(-114091.9)^2 + (1641.3)^2}$

= 14187.16 N.mm

∴ ME = MEV = 8335.8 N.mm

Hence maximum bending moment is at point D which is 14187.16 N.mm

∴ TE = $\sqrt{kb * M^2 + Kt * T^2}$

= $\sqrt{1.5(14187.16)^2 + 1.5(6299.88)^2}$

= 15523.01 N.mm

We also know,

TE = $\frac{\pi}{16} \times \tau \times D^3$

15523.01 = $\frac{\pi}{16} \times 40 \times D^3$

∴ D = 16.23 ≅ 19 mm

3.4 Design of transmission Shaft:

For vertical loading dig.

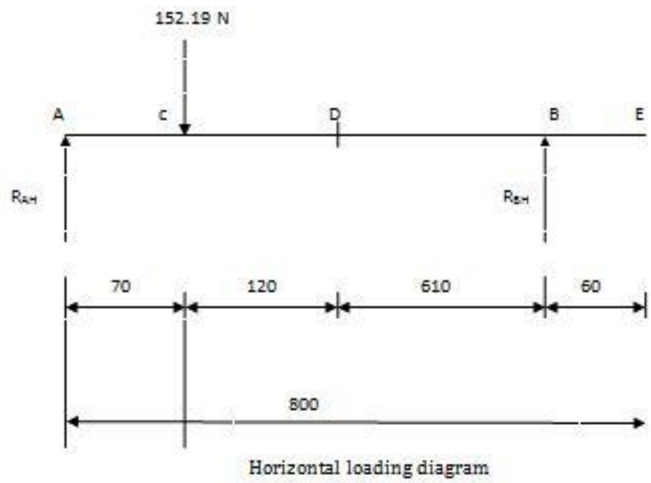
RAV + RBV = -856.2 N

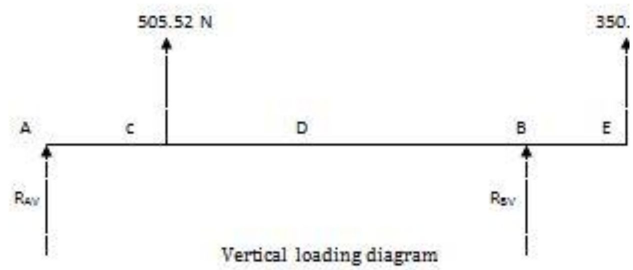
$\sum MA = 0$

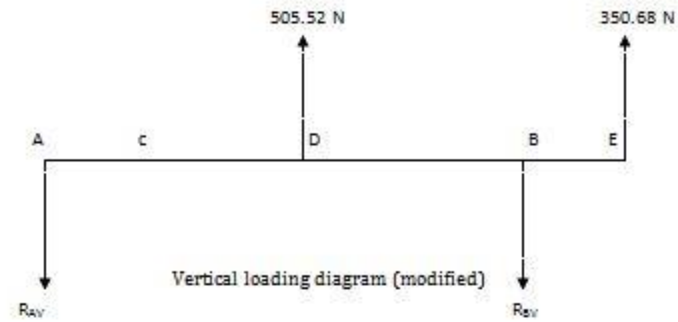
∴ 505.52 × 190 + 800RBV + 350.68 × 860 = 0

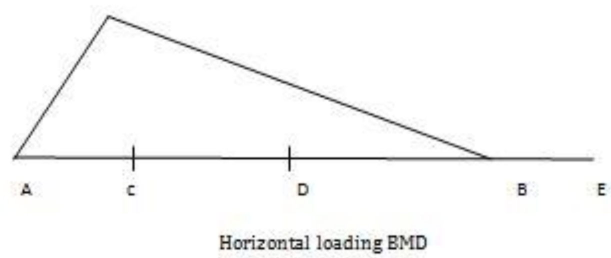
∴ RBV = -497.04 N

∴ RAV = -359.18 N









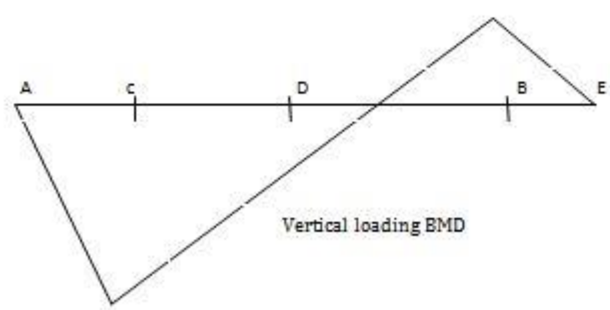


Fig. 2 Loading and BMD dig. For peeling transmission shaft.

As the support reactions are negative then the supports are in opposite direction.

∴ MAV = MEV = 0

∴ MDV = -359.18 × 190 = -68244.2 N.mm

∴ MBV = 350.68 × 60 = 21040.8 N.mm

For horizontal loading dig.

RAH + RBH = 152.19 N

∑MA = 0

-152.19 × 70 + 800RBH = 0

∴ RBH = 13.32 N

∴ RAH = 138.87 N

Now moments about all the points,

∴ MAH = MBH = 0

∴ MCH = 138.87 × 70

= 9720.9 N.mm

Hence now finding resultant bending moments at each point,

MA = ME = 0

MC = MCH = 9720.9 N.mm

MD = MDH = -68244.2 N.mm

MB = MBH = 21040.8 N.mm

Hence here MB is bigger among all,

∴ M = MB = 21040.8 N.mm

∴ TE = $\sqrt{kb * M^2 + kt * T^2}$

= $\sqrt{1.5(21040.8)^2 + 1.5(6299.88)^2}$

= 32945.53 N.mm

∴ TE = $\frac{\pi}{16} \times \tau \times D^3$

∴ 21040.8 = $\frac{\pi}{16} \times 40 \times D^3$

∴ D = 19 mm

3.5 design of bearings:

The Pedestal bearings are used in this machine as per the requirement.

3.6 Creo Model:

Fig. 1 3-D Model of Corn Peeling-Shelling Machine.

4. RESULTS:

4.1 Peeling-Shelling Rate:

The Peeling and Shelling rate of the machine was observed to be 150 kg/hr in ideal conditions. The shelling efficiency was more than other hand operated or pedal operated shelling machines.

4.2 Peeling-Shelling Efficiency:

The efficiency of peeling and shelling machine varies between 90%-97% with average efficiency of 94%.

4.3 Kernel Damage:

During the shelling operation the kernels were detached from the cobs without any damage to the kernels.

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