

Design and Fabrication of Corn Shelling and Threshing Machine

Kedar Patil¹, Shamuvuel Pandit², Gajendra Pol³, Sunil Kadam⁴, Avdhut Jadhav⁵

Assistant Professor, Department of Mechanical Engineering, Bharati Vidyapeeth, Kolhapur, Maharashtra, India^{1,2,3,5}

Associate Professor, Department of Mechanical Engineering, Bharati Vidyapeeth, Kolhapur, Maharashtra, India⁴

ABSTRACT: In India, Corn is one of the most important crop and it has a source of a large number of industrial products besides its use as human food and animal feed. Every part of Corn has economic value as the grain, leaves, main crop stalk, tassel and cob can all be used to produce a large variety of food and non-food products. After harvesting with sickle and plucking of cob manually, dehusking of cob is done by hand to remove its outer sheath and further grain is obtained by shelling the cob traditionally, i.e. by beating the dehusked cobs with sticks or with fingers or sickle, etc. To overcome this problem of removing its outer sheath and dehusking the cobs this machine was developed. The machine basically comprises of separate shelling chamber, threshing chamber, collecting tray and motor (2HP). The arrangement of these parts is connected by belt and pulley mechanism. The weight was only 95 Kg. After testing the machine, the production rate for threshing operation was 300 kg/hr and for shelling 300 kg/hr. At last the germination test was carried out for corn seeds threshed by the machine and it were found that time required to grow from seed was about 48 hours.

KEYWORDS: Corn, shelling machine, threshing machine, design methodology, production rate, germination test, fabrication.

I. INTRODUCTION

In India, most of the farmers shell corn by mainly three methods namely shelling cob grain by hand; hand operated corn Sheller and beating by stick method were carried for removing corn kernel from the cob. For removal of corn shells and to deseeding of the corns with minimum damage to the corns, people uses various methods out of those two methods are described below:

I.I. Manual shelling and threshing:

In many regions of the India corn shelling and threshing is done manually, this method is conventional but productivity and output from that method is low and that's why there is a need to switch to mechanical motorised system for corn shelling and threshing.

I.II. Mechanical shelling and threshing:

Mechanical motorised corn sheller and thresher gives more desirable results than manual conventional method of corn shelling and threshing. It tends to saving of the time and also leads to save money. It is desirable to use low cost corn sheller and thresher for economical work and to increase the productivity.

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Table 1: Comparison of corn threshing methods

Type of Threshing	Technique Used	Time Required	Limitations	Labour Cost
Manual	Hands or Handheld Tools	More	Extensive amount of Labours required	more
Mechanical	Machine operated	Less	High machine cost and initial investment	Less

Along with this there are several electrical operated Corn shelling machines for mass shelling. Mostly farmers used to take their unshelled Corns to such industries where they get their final product that is shelled Corn and then they used to sell this product to the market. This incurred the cost of transportation between farms to machine industry increase the cost of product.

This research aimed at developing a portable, low cost, locally fabricated machine which can easily maintained by the peasant farmers. Also the machine can perform both shelling and threshing operations simultaneously.

II. OBJECTIVES

1. Motor selection - to choose proper electric motor for this application based on torque speed and power.
2. To reduce the power using belt drive and pulley system to form uniform shelling and threshing operation.
3. To construct a structure to fit all accessories to it with proper moving attachments.
4. Design of shelling shaft.
5. Retraction of shells from corn hubs.
6. To design threshing shaft.
7. To design separation zone for corn shells and seeds.

III. METHODOLOGY AND PROPOSED WORK

1. To construct working drawing of assembly by computer aided design procedure.
2. To select optimum motion for threshing and shelling operation.
3. To design a frame to sustain all these accessories and all loads developed by it.
4. To design shaft for shelling operation to run shelling operation smoothly.
5. To design belt drive and pulley system for threshing and shelling operation/
6. Design of shaft for threshing operation.
7. To perform test on corn having different moisture content from 20% to 75%.
8. To analyse results test conducted different moisture content and modification.
9. Analysis of results obtained.

IV. DESIGN FOR COMPONENTS OF CORN SHELLING AND THRESHING MACHINE

IV.I Belt, Pulley and Shaft Design for Shelling Operation:

A solid Shaft made up of mild steel 40C8 having yield strength as 380 Mpa was chosen. This shaft was coupled to electric motor rotating at 1440 rpm. The following design parameters are:

1. Permissible Shear Stress (τ):-

When the external force acting on the component tends to slide the adjacent planes with respect to each other, the resulting stresses in these planes are called shear stress.

$$\tau = S_{yt} / F.S. = 0.5 (S_{yt}) / F.S. = 0.5 (380) / 1.5 = 126.66 \text{ N/mm}^2.$$

2. Torsional Moment (M_t):-

$$M_t = 60 \times 10^6 (KW) / 2\pi N = 60 \times 10^6 (1.492) / 2\pi(710) = 20066.97 \text{ N-mm.}$$

3. Bending Moment:

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

For Pulley (1), $D = 130$.

Calculation of P_1 and P_2 .

$$M_t = (P_1 - P_2) \times (D / 2).$$

$$20066.97 = (P_1 - P_2) \times 65.$$

$$(P_1 - P_2) = 308.72 . \quad \dots\dots\dots(1)$$

$$P_1 / P_2 = e^{0.3\pi} = 2.566. \quad \dots\dots\dots(a)$$

$$P_1 = 2.566 \times P_2. \quad \dots\dots\dots(b)$$

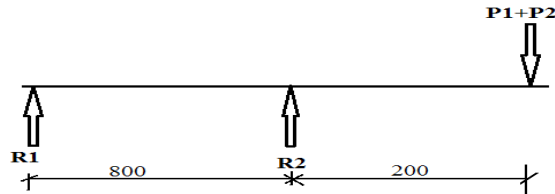
Put value (b) into equation (1).

$$2.566P_2 - P_2 = 308.72$$

$$P_2 = 197.14N \quad \dots\dots\dots(c)$$

From equation (b) and (c).

$$P_1 = 2.566 \times 197.14 = 505.86 N$$



Let, $R_1 + R_2 = 703 \quad \dots\dots\dots(d)$

Taking moment at R_1 ,

$$R_2 \times 800 = 703 \times 1000$$

$$\therefore R_2 = 878.75 N$$

from equation (d).

$$R_1 = 175.75 N$$

Now, bending moment is given by,

$$M_b = (878.5 \times 200) + (175.75 \times 1000) = 351.45 N\cdot m$$

4. Shaft Diameter On Strength Basis:

Transmission shafts are subjected to axial tensile force, bending moment or torsional moment or their combinations. Most of the transmission shafts are subjected to combined bending and torsional moments.

We know,

$$d^3 = \{ [16 / (\tau \times \pi)] \times (M_b^2 + T_2^2)^{0.5} \} = \{ [16 / (126.66 \times \pi)] \times (351450^2 + 15830^2)^{0.5} \}$$

$$d = 24.18 \approx 25 \text{ mm}$$

- Length of belt :-

$$L = 2C + \frac{\pi(D + d)}{2} + \frac{(D - d)^2}{4C}$$

$$= 2 \times 600 + \frac{\pi(130 + 63)}{2} + \frac{(130 - 63)^2}{4 \times 600}$$

$$\therefore L = 1505.03 \text{ m m}$$

from std. table, $L = 1600 \text{ m m}$

- Corrected centre distance:-

$$L = 2C + \frac{\pi(D + d)}{2} + \frac{(D - d)^2}{4C}$$

$$\therefore 1600 = 2C + \frac{\pi(130 + 63)}{2} + \frac{(130 - 63)^2}{4C}$$

$$\therefore C = 645 \text{ m m}$$

IV.II BELT, PULLEY AND SHAFT DESIGN FOR THRESHING OPERATION

Speed (N) = 600 rpm, P = 0.746 KW, $S_{yt} = 380N/mm^2$, Θ = Angle of wrap, $P_1 / P_2 = e^{\mu\theta}$, $P_1 / P_2 = 2.566$

1. Permissible Shear Stress (τ):-

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

$$\tau = 0.5 (S_{yt}) / F.S = 0.5 (380) / 1.5 = 126.66 \text{ N/mm}^2$$

2. Torsional Moment (M_t):-

$$M_t = 60 \times 10^6 \text{ (KW)} / 2\pi N = 60 \times 10^6 (1.492) / 2\pi(600) = 23745.92 \text{ N-mm.}$$

3. Bending Moment:

For Pulley, $D = 125\text{mm}$.

Calculation of P_1 and P_2 .

$$M_t = (P_1 - P_2) \times (D / 2).$$

$$18996 = (P_1 - P_2) \times 62.5$$

$$(P_1 - P_2) = 303.936 \quad \dots\dots\dots(1)$$

$$P_1 / P_2 = e^{0.24\pi}$$

$$P_1 / P_2 = 2.566 \quad \dots\dots\dots(a)$$

$$P_1 = 2.566 \times P_2 \quad \dots\dots\dots(b)$$

Put value (b) into equation (1).

$$2.125P_2 - P_2 = 368.15$$

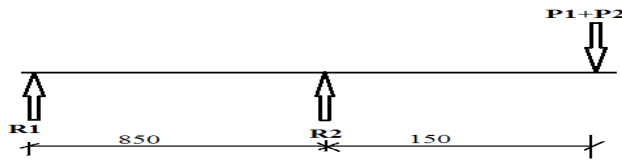
$$P_2 = 194.08 \text{ N} \quad \dots\dots\dots(c)$$

From equation (b) and (c).

$$P_1 = 2.566 \times P_2$$

$$P_1 = 2.566 (194.08)$$

$$P_1 = 498.02 \text{ N}$$



$$\text{Let, } R_1 + R_2 = 692.1 \quad \dots\dots\dots(d)$$

Taking moment at R_1 ,

$$R_2 * 850 = 692.1 * 1000$$

$$\therefore R_2 = 814.23 \text{ N}$$

from equation (d).

$$R_1 = 122.13 \text{ N}$$

Now, bending moment is given by,

$$M_b = (814.23 * 150) + (122.13 * 1000)$$

$$= 244.264 \text{ N-m}$$

4. Shaft Diameter On Strength Basis:

$$d^3 = \{ [16 / (\tau \times \pi)] \times (M_b^2 + T_2^2)^{0.5} \} = \{ [16 / (126.66 \times \pi)] \times (244264.5^2 + 18996^2)^{0.5} \}$$

$$d = 21.44 \approx 25 \text{ mm.}$$

- Length of belt :-

$$L = 2C + \frac{\pi (D + d)}{2} + \frac{(D - d)^2}{4C}$$

$$\therefore L = 1297.23 \text{ m m}$$

from std. table, $L = 1250 \text{ m m}$

- Corrected centre distance (C):-

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

$$L = 2C + \frac{\pi (D + d)}{2} + \frac{(D - d)^2}{4C}$$

$$1250 = 2C + \frac{\pi (125 + 63)}{2} + \frac{(125 - 63)^2}{4C}$$

$$\therefore C = 476 \text{ mm}$$

IV.III Bearing Selection:-

Bearing must be selected based on its load carrying capacity, life expectancy and reliability (PSG Tech 1989). The relationship between the basic rating life, the basic dynamic rating and the bearing load is:

$$L = 60n/10^6 \text{ million revolutions, therefore, } L_{10} = (106/60n) \times [C/P]^K,$$

From calculations select standard bearing for 25 mm diameter shaft is 6205.

V. ASSEMBLY OF MACHINE

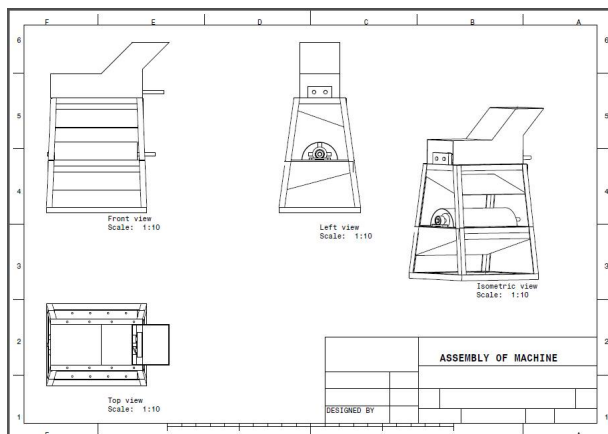


Figure 1. Drafting of assembly

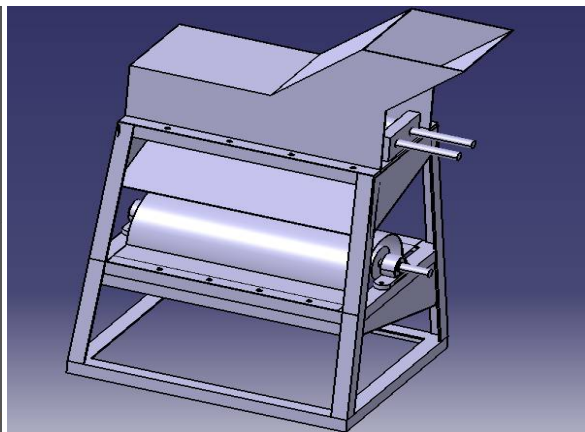


Figure 2. 3-D drawing of assembly

VI. TESTING OF CORN SHELLING AND THRESHING MACHINE

1. Time required to Shelling and threshing of 100kg maize is 20minutes.
2. The average shelling and threshing capacity of machine is 300 kg/hrs.
3. Machine can remain in working position as long as electricity gets supplied to motor.
4. Shelling and threshing efficiency of this machine is 90%
5. As load increases, speed decreases.

The effect of load on threshing speed is given as,

Load	0 kg	10 kg
Speed	600rpm	560rpm

VII. CONCLUSION

- 1) Corn shelling and threshing machine add the modernization in the agricultural field. This machine will make the farmers becomes independent and not rely on the labours for removing covers of maize and for deseeding.
- 2) A single person can efficiently operate this Corn shelling and threshing machine.
- 3) It takes less weeding time compared to manual shelling and threshing of maize.
- 4) Controlled feed rate and from working as per directions on can achieve greater productivity.
- 5) It is portable Corn shelling and threshing machine with collecting system which can be driven by automatically.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

6) Production rate

OPERATION	PRODUCTION RATE PER HOUR	RATE FOR 8 HOURS
SHELLING	300 kg	2400 kg
THRESHING	300 kg	2400 kg

7) **Germination test** :- Germination is process by which a plant grows from seed. Several factors influences if, and how, seed germinate. The most important factors are water availability, temperature and sun light. The seed must go through imbibitions to activate root growth.

Moisture content in corn	25%
Time required for germination	48 hours



Figure 3. Final assembly of the machine.

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