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Design and Modification of Chaff Cutter Machine

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ABSTRACT : Chaff Cutter Machine is hay or straw cutting machine which is used for uniform chopping of fodder for livestock to agro industries. In this paper, design and development of Chaff Cutter Machine is presented. The machine is developed gradually from basic machines into commercial standard machine that can be electrical driven to achieve various length of cut of chaff as per the preference. The new chaff cutter machine is modified for its compactness and to avoid blockage of grass.

KEYWORDS: chaff, uniform chopping, fodder, cutter, machine.

I. INTRODUCTION

A Chaff cutter is mechanical device used to cut the straw or hay into small pieces so as to mix it together and fed to cattle. This improves animal digestion and prevents animal from rejecting any part of their food. As per today's scenario the population of buffalos is drastically increased. So to increase the productivity and reduce the physical effort required for running the machine the motorized machineries came into existence it is best for dairy farmers. Presently fodder cutting machines are electric driven as well as hand operated or engine driven.

Objectives:

- To ensure safety and make it compact.
- To provide good fodder for animal
- To save work time
- To save electricity consumption
- To provide pleasing/aesthetic look
- To get protection from dust
- To reduce noise
- To increase corrosion resistance of machine
- To Make It Portable easily

II. RELATED WORK

Literature Survey:

The literature survey reveals that several attempts have been already made to develop

1. Design of experimentation for establishing empirical relationship of chaff cutting phenomenon energized by human powered flywheel motor (HPFM) (P.B. Khope J.P. Modak 2013)

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2. Modak and his associates had developed Human powered process machines, which could energize process units needing 3 to 6 HP. These units had intermittent power requirement. In the present work human powered flywheel motor chaff cutting process has been studied.

3. Design & develop chaff cutter by using different types of blades (Sanjay Patil, Harshkumar Jain, Raut, Kalikat, Gandhi)

Need of new Chaff cutter machine :

The existing machines are observed and studied properly to detect the problems faced by the user are given below.

1. Less compact design
2. High voltage required such as 3 phase
3. Less safety while using by women
4. Noisy
5. Blockage of grass creates feed interference

Structure and working principle :

It is driven by motor and makes the driving of main shaft by belt. Under the high-speed rotation with cutter making the feed become filiform and powder, the feeds will be outflow from the material outlet through sieve. Chaff cutters are made up of feeding part, Cutting and throwing part, transmitting part, walking part and safety device, so it is reasonably structured safe and reliable.

- Feeding part is feed rollers.
- Cutting structure made up of motion knife and locking bolt.
- Transmitting structure mainly consist of belt, gears, pulleys
- Walking structure is made up of ground wheels

III. DESIGN AND CALCULATIONS

SELECTION OF MOTOR :-

From market survey known that the torque of the motor must be between 30-80Nm is sufficient for chaff cutter

∴ We selected net 50Nm and speed requirement 240rpm.

∴ Power requirement ,

$$P = \frac{2\pi NT}{60 \times 1000} = \frac{2\pi \times 240 \times 50}{60 \times 1000} = 1.25 \text{ kw}$$

2 HP = 2 × 0.746 = 1.5 kw is sufficient

SELECTION OF BELT

P= 1.5 kw and faster speed 240 rpm chart gives 'B' section belt. As losses in between pulley arrangement is considered, i.e. such that belt pulley power transmission efficiency is 85-95%

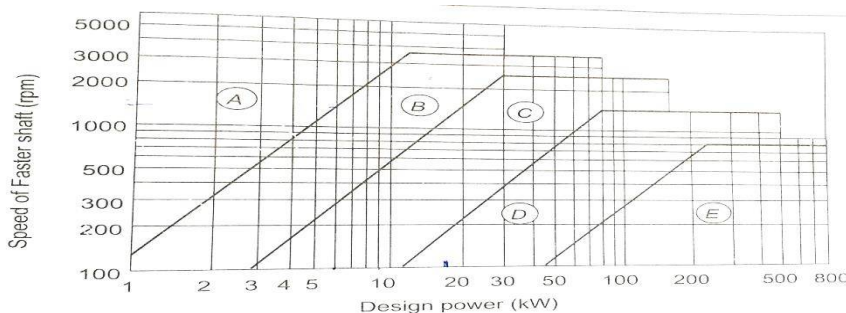


Fig1 . Selection of cross section of v- belt

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Length:

$$L_i = \frac{\pi}{2} \times [d_2 + d_1] + 2c_1 + (d_2 - d_1)^2 / 4c$$

$L_i = 1590.83 \text{ mm}$

For pulley (3) and (4) length of belt

$L_i = 958.19 \text{ mm}$

DESIGN OF GEAR

such that speed of lower roller is 55 rpm as discussed

1. Let power transmitted = 1.5 kw
2. i/p 240 rpm
3. o/p speed req. 55 rpm
(spur gear)

For EN9 Material

Let $s_{ut} = 700 \text{ N/mm}^2$

Let BHN = 255

Cal. Number of teeth on gears

$$Z_2 / Z_1 = N_1 / N_2$$

$$Z_2 = \frac{240}{55} \times Z_1, \text{ Assume } Z_1 = 22 \text{ teeth, } Z_2 = \frac{240}{55} \times 22, Z_2 = 96 \text{ teeth}$$

➤ Design of pair

Torque Produced

$$M_t = \frac{kw \times 60 \times 1000000}{2\pi N} = \frac{1.5 \times 60 \times 1000000}{2\pi \times 240} = 59683.10 \text{ N-mm}$$

$$d_p = m Z_p = m(22) = 22m$$

considering beam strength

$$S_b = mb\sigma_b y$$

y- lewis form factor

(Table no. 17.3 Bhandari)

$$Y = 0.330 \text{ for } Z = 22 \text{ (20}^\circ \text{ full depth) \& } b = 10m, \sigma_b = \frac{S_{ut}}{3} = \frac{700}{3}$$

$$S_b = m \times 10 \times m \times \frac{700}{3} \times 0.330, S_b = 770m^2$$

Tangential load

$$P_t = \frac{2mt}{dp} = \frac{2 \times 59683.10}{m(22)}$$

Wear strength

$$S_w = bQd_p K, \quad b = 10m \quad Z_g + Z_g$$

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$$Q = \frac{2Z_9}{Z_9 + Z_P} = \frac{2(96)}{96 + 22} = 1.6271$$

$$d_p = m (22)$$

$$K = 0.16 \left(\frac{BHN}{100}\right)^2 = 0.16 \left(\frac{255}{100}\right)^2 = 1.0404$$

$$S_w = 10m \times 1.6271 \times 22 \times m \times 1.0404, S_w = 372.4236 \dots\dots\dots(2)$$

$$P_t = \frac{2mt}{dp} = \frac{2 \times 59683.10}{m(22)} = \frac{5425.7363}{m}$$

$$372.42m^2 < 770 m^2$$

Hence beam strength is more and wear strength is less Hence it is consider for design purpose

$$S_w = P_{eff} \times FOS$$

$$372.4236 m^2 = P_{eff} \times 2 \dots\dots\dots FOS=2$$

$$P_{eff} = C_s P_t = 1.25 \times \frac{5425.7363}{m}$$

$$372.423 \times m^2 = 1.25 \times \frac{5425.7363}{m} \times 2$$

$$m^3 = 36.42$$

$$m = 3.31$$

$$m = 3$$

$$\text{width } b = 10 m = 30 \text{ mm}$$

$$d_p = mZ_p = 3 \times 22 = 66 \text{ mm}$$

$$d_g = m \times Z_g = 3 \times 96 = 288 \text{ mm}$$

$$h_p = \text{dedendum} = 1.25 m = 1.25 \times 3 = 3.75 \text{ mm}$$

$$h_a = \text{addendum} = m = 3 \text{ mm}$$

$$C = \text{clearance} = 0.25 = 0.25 \times 3 = 0.75 \text{ mm}$$

SELECTION OF BEARING

Let: 1. For shaft dia. = 30mm

$$n = 240 \text{ rpm}$$

$$L_{10} = \frac{60 \times n \times L}{1000000} = \frac{60 \times 240 \times 12000}{1000000}$$

$$= 172.8 \text{ millions of revolution}$$

$$C = P(L_{10})^{1/3}$$

$$= 2484.0901 (172.8)^{1/3}$$

$$C = 13814.76472 \text{ N}$$

This is load i.e. radial max load rating with speed 240 rpm.

Hence Pillow Bearing with designation **UCP205 Series Bearing** can be selected Having=1761.0314N

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III .DETAILS OF COMPONENTSDRAFTINGSSAMPLES

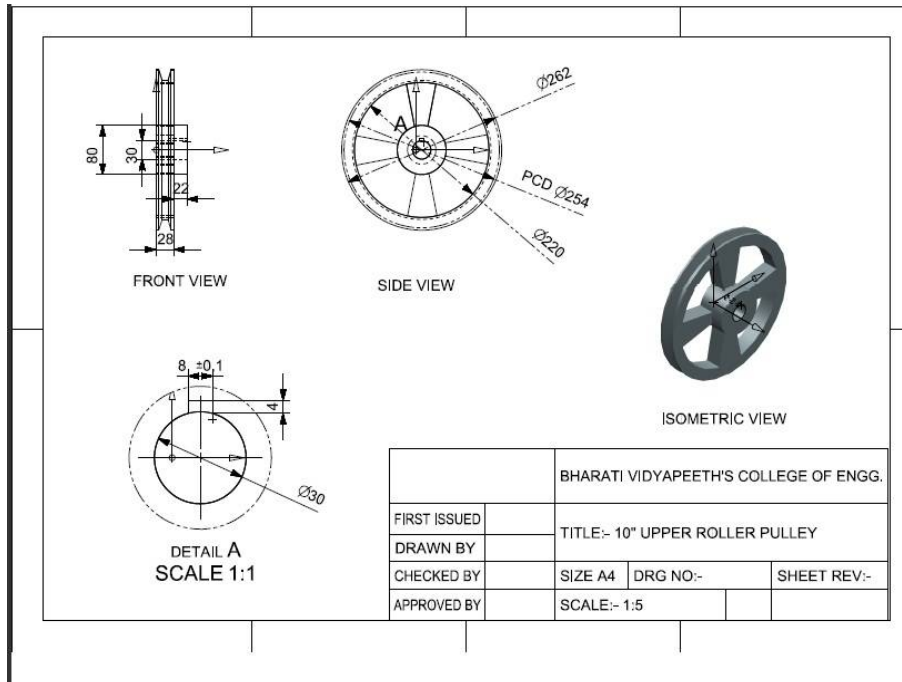


Fig2.Drafting Of Pulley

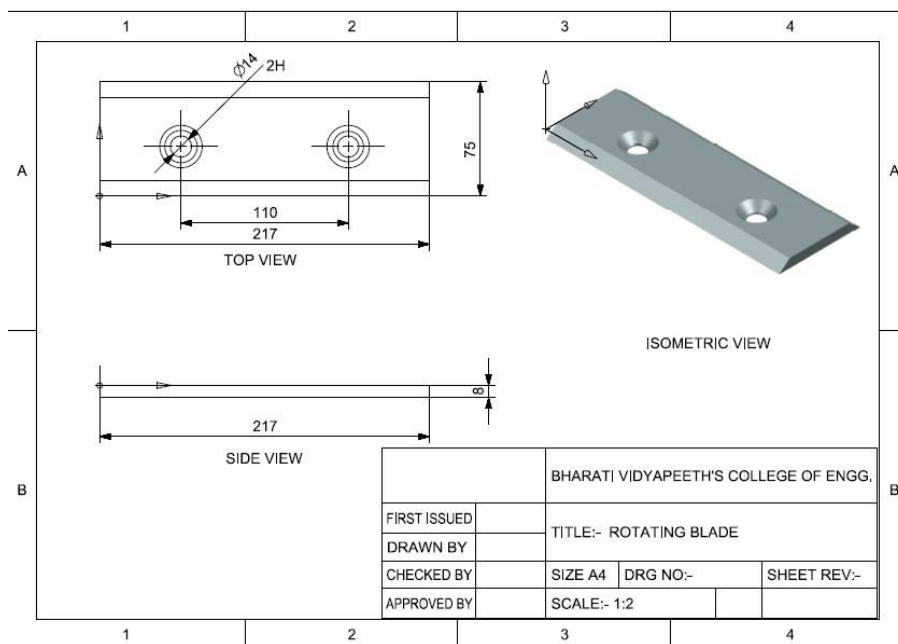


Fig 3. Drafting Of Blade

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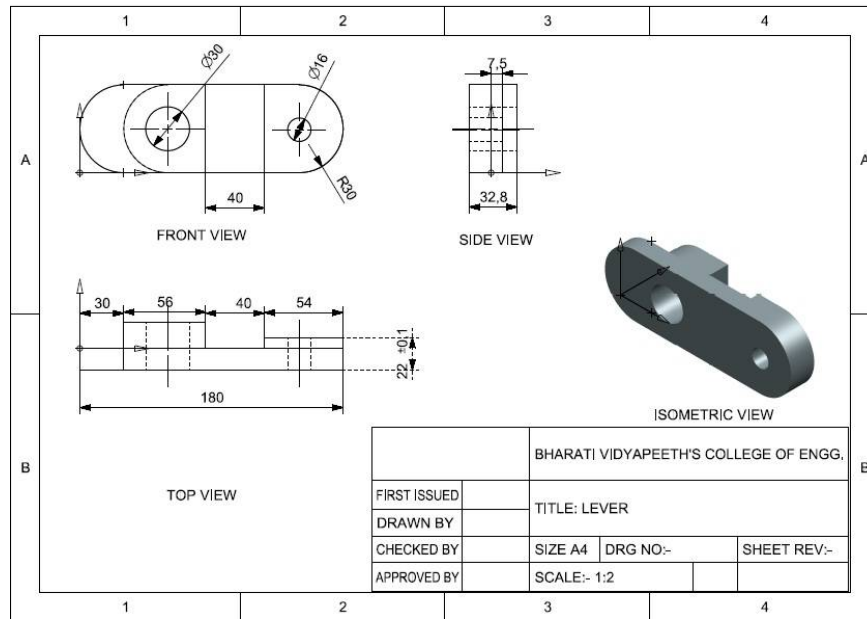


Fig.4 Drafting Of Lever

MATERIALS OF MACHINE PARTS

NAME OF PART	MATERIAL	NAME OF PART	MATERIAL
FRAME	MILD STEEL(M.S)	ALL SHAFTS	EN9
PULLEY 1	C.I	18 TEETH GEAR	EN9
PULLEY 2	C.I	96 TEETH GEAR	C.I
PULLEY 3	C.I	STATIONARY BLADE	HIGH CARBON STEEL
PULLEY 4	C.I	ROTATING BLADES	WPS, Tool Steel
BEARING	CHROME STEEL	HOPPER	M.S
Ele. Switch	Std. FWD & REV. Type	CASINGS	M.S

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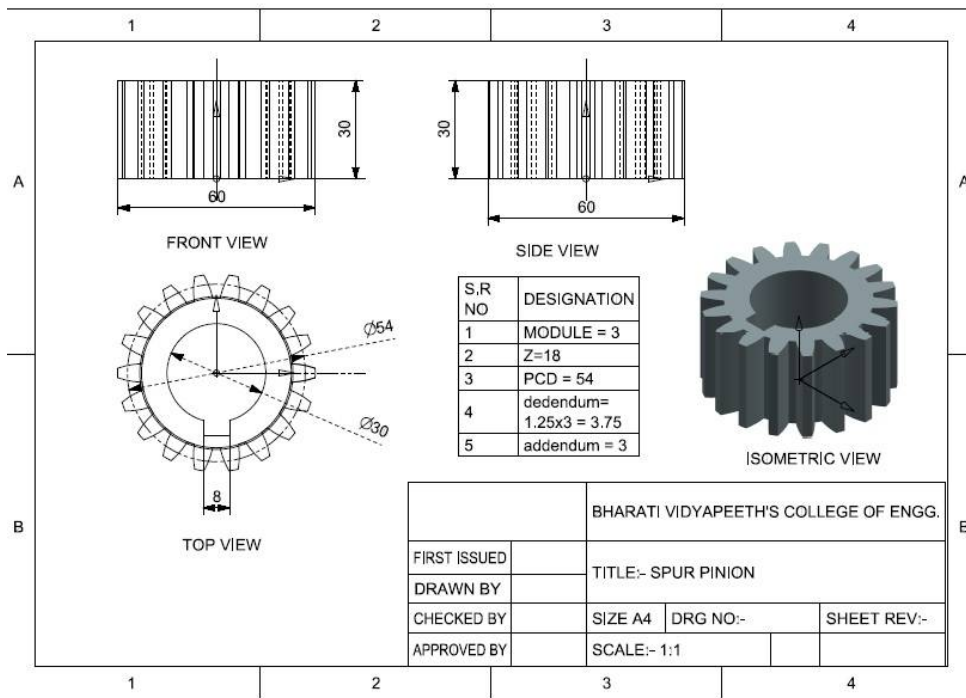


Fig 5. 18 Teeth Spur Gear



Fig.6 Actual MACHINE VIEW

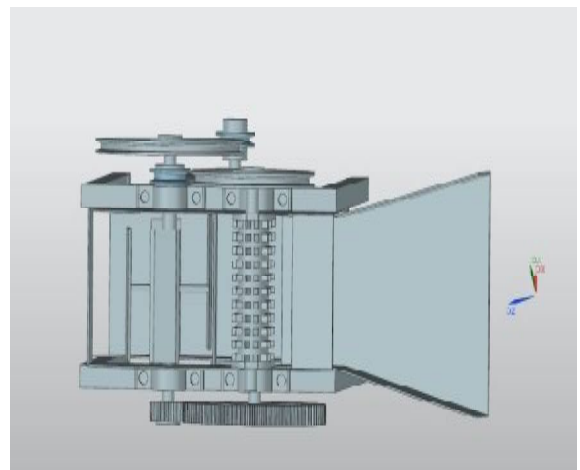


Fig 7.TOP VIEW OF MACHINE(UG NX)

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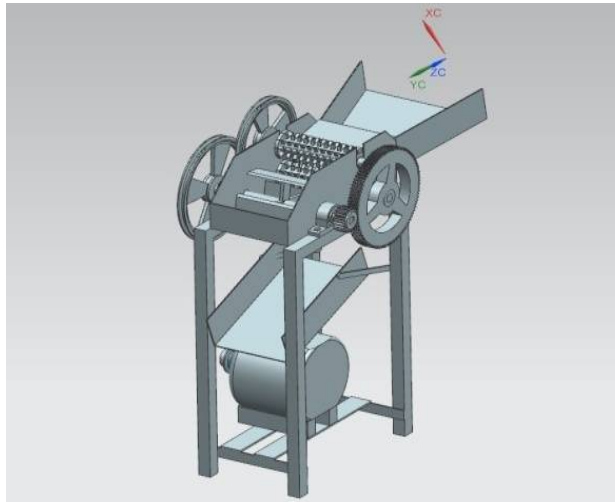


Fig 8.UG NX Drawing Model



Fig 9. Actual Model

IV. CONCLUSION AND RESULTS

1. The machine is simple in construction as there is not so much complication in design. It is also important that velocity ratio can easily be determine measuring number of teeth on gears ,p.c.d of pulleys.
2. The machine is designed in such a way that it will require minimum space to install. As the motor is placed inside the machine stand not outside the machine, the space is considerably saved
3. As there are no sharp edges in the m/c for m/c frame and machine stand , it can be handled safley without injury. Blades are provided with double sharpening edges.
4. The m/c is provided with motor sliding arrangement and the cutting blades can be easily detached by operaotor for sharpening purpose.
5. We provided the powder Scoating casing to whole assembly of m/c for safety and aesthetic look. And for corrosion resistance.
6. Machine has reduced noise and weight due to gears arrangement and compact design.
7. Machine has casters for portability.
8. Machine has 300kg/hr fodder cutting rate
9. Fodder size is 20mm in length
10. Forward and reversed rotation arrangements for blades

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