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A Review paper on Design and Development of Manually Operated Crop Reaper

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Abstract -This machine targets the small scale farmers who have land area of less than 2 acres. This machine is compact and can cut up to two rows of plant. It has cutting blades which cut the crop in a scissoring type of motion. There are no is cutter on two metal strip (plate) upper cutter plate will be reciprocate by scotch yoke mechanism. It runs on engine with 7.5Hp capacity, this power from engine, is provided through pulley and gear box arrangement to the cutter. A collecting mechanism is provided for the collection of crops to one side after cutting. This mechanism is also powered by pulley arrangement, two sprockets and chain arrangements given for collection of crops. This compact harvester is manufactured using locally available spare parts and thus, it is easily maintainable. This harvester might be the solution to the problems faced by a small scale farmer regarding cost and labor implementation. After testing this machine in farm it is found that the cost of harvesting using this harvester is considerably less as compare to manual harvesting

***Key Words*:**Crop Reaper, Harvesting, Scissoring motion, Collecting mechanism.

1.INTRODUCTION*(Size 11, Times New roman)*

This Farming is most widely followed profession in India. Agricultural products contribute a major portion to our economy. Engineering science has brought tremendous changes in traditional methods of agriculture viz. sowing, planting, irrigation, fertilizer spraying, harvesting, etc. However to increase our economic condition, we must increase the productivity and quality of our farming activities. Nowadays very few skilled labors are available for agriculture. Because of this shortage the farmers prefer to use reaper harvesters. These reapers are costly and only available of very large scale farming. However, agriculture groups make these available for rent on an hourly basis. But the small holding farm owners generally do not require the full-featured combine harvesters. Also, these combine harvesters are not available in all parts of rural India due to financial or transportation reasons. Thus, there is a need for a smaller and efficient combine reaper which would be more accessible and also considerably cheaper. The mission is to create a portable, user-friendly and low cost mini harvester taking into account the requirements of current situation; the idea was created to prepare a machine which is cheap and will reduce the labor required to cut crops. This machine has the capability and the economic value for fulfilling the needs of farmers having small land holdings.

Effective and easy to maintain and repair for the farmers. The machine model is designed based on the demand for a compact and economical reaper. This demand is taken into consideration by consulting farmers in person, for their problems and requirements.

2.PROBLEM STATEMENT

1. Manual labour takes time and is not effective as they can work for 3-4 hours at a stretch.
2. Even if the land holding is small, it takes two or three days to completely harvest the crop.
3. High costs of machines and maintenance, non-availability of appropriate agricultural machines and equipment that cater to and suit the requirements of small-scale farms.

2.1 Objectives

1. To formulate an idea to suit our required functionality that is to reap the crops.
2. To develop the idea to suitable mechanical principles and to design the idea practice.
3. To fabricate the design with the knowledge and the selected material, which are cost effective.

2.3 Methodology

2.3.1Explanation of Methodology

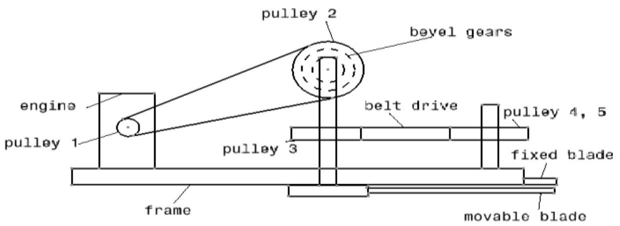
The overall project consists of following steps:

1. Selection of various composite materials
2. Study the characteristics properties of material
3. Design of gears
4. Design of blades
5. Design of belt pulley
6. Check the safety analytically and by various designing software

3. DESIGN STRUCTURE AND COMPONENTS OF MECHANISM

1. Shaft

A shaft is a rotating or stationary component which is normally circular in section. A shaft is normally designed to transfer torque from a driving device to a driven device. If the shaft is rotating, it is generally transferring power and if the shaft is operating without rotary motion it is simply transmitting torque and is probably resisting the transfer of power. A shaft which is not rotating and not transferring a torque is an axel. Mechanical components directly mounted on shafts include gears, couplings, pulleys, cams, sprockets, links and flywheels. A shaft is normally supported on bearings. The torque is normally transmitted to the mounted components using pins, splines, keys, clamping bushes; press fits, bonded joints and sometimes welded connections are used. These components can transfer torque to/from the shaft and they also affect the strength of the shaft a must therefore be considered in the design of the shaft. Shafts are subject to combined loading including torque (shear loading), bending (tensile & compressive loading), direct shear loading, tensile loading and compressive loading. The design of a shaft must include consideration of the combined effect of all these forms of loading. The design of shafts must include an assessment of increased torque when starting up, inertial loads, fatigue loading and unstable loading when the shaft is rotating at critical speeds



crop reaper

1. Ball Bearing

Pedestal bearing (Pillow blocks) is also known as housings which have a bearing fitted into them. Pillow blocks are usually mounted in cleaner environments and generally are meant for lesser loads of general industry. The fundamental application of the pedestal bearing is to mount bearings safely enabling their outer ring to be stationary while allowing rotation of the inner ring. The housing is bolted to a foundation through the holes in the base. Bearing housings are of two types. They are split type or un-split type. Split type housings are two piece housings where the cap and base can be detached, while certain series are one single piece housings. Various seals are provided to prevent dust and other contaminants from entering the housing. Thus the housing provides a clean environment for the expensive bearings to freely rotate, hence increasing their performance and duty cycle. Bearing housings are usually made of grey cast iron. However various grades of metals can be used to manufacture the same.

2. V-Belt Pulley

The pulleys are used to transmit power from one shaft to another by means of flat belts, V-belts or ropes. Since the velocity ratio is the inverse ratio of the diameters of driving and driven pulleys, therefore the pulley diameters should be carefully selected in order to have a desired velocity ratio. The pulleys must be in perfect alignment in order to allow the belt to travel in a line normal to the pulley faces. The pulleys may be made of cast iron, cast steel or pressed steel, wood and paper. The cast materials should have good friction and wear characteristics. The pulleys made of pressed steel are lighter than cast pulleys, but in many cases they have lower friction and may produce excessive wear. In this, I have used a Cast Iron Pulleys.

3. V-Belt

Generally, we know that a V-belt is mostly used in factories and workshops where a great amount of power is to be transmitted from one pulley to another when the two pulleys are very near to each other. The V-belts are made of fabric and cords moulded in rubber and covered with fabric and rubber as shown in Fig. below. These belts are moulded to a trapezoidal shape and are made endless. These are particularly suitable for short drives. The included angle for the V-belt is usually from 30° to 40°. The power is transmitted by the wedging action between the belt and the V-groove in the pulley or sheave. The wedging action of the V-belt in the groove of the pulley results in higher forces of friction. A little consideration will show that the wedging action and the transmitted torque will be more if the groove angle of the pulley is small. But a small groove angle will require more force to pull the belt out of the groove which will result in loss of power and excessive belt wear due to friction and heat. Hence the selected groove angle is a compromise between the two. Usually the groove angles of 32° to 38° are used. A clearance must be provided at the bottom of the groove as shown in Fig. below, in order to prevent touching of the bottom as it becomes narrower from wear. The V-belt drive may be inclined at any angle with tight side either at top or bottom. In order to increase the power output, several V-belts may be operated side by side.

4. Bevel Gear

Two important concepts in gearing are pitch surface and pitch angle. The pitch surface of a gear is the imaginary toothless surface that you would have by averaging out the peaks and valleys of the individual teeth. The pitch surface of an ordinary gear is the shape of a cylinder. The pitch angle of a gear is the angle between the face of the pitch surface and the axis.

The most familiar kinds of bevel gears have pitch angles of less than 90 degrees and therefore are cone-shaped. This type of bevel gear is called external because the gear teeth point outward. The pitch surfaces of meshed external bevel gears are coaxial with the gear shafts; the apexes of the two surfaces are at the point of intersection of the shaft axes.

Bevel gears that have pitch angles of greater than ninety degrees have teeth that point inward and are called internal bevel gears. Bevel gears that have pitch angles of exactly 90 degrees have teeth that point outward parallel with the axis and resemble the points on a crown. That's why this type of bevel gear is called a crown gear.

4. DESIGN OF CROP REAPER IN 3D

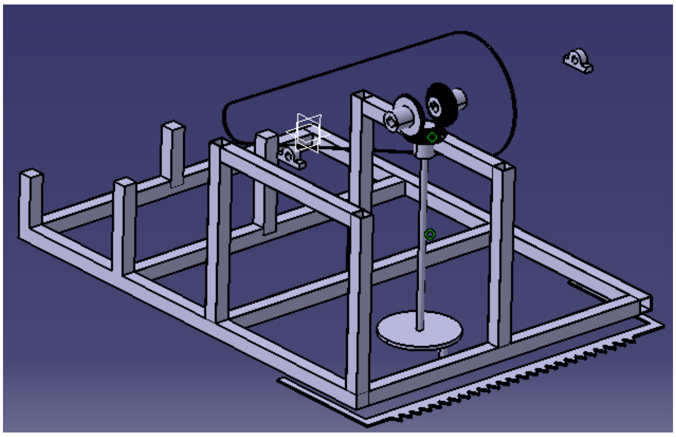


Fig -13D Design of crop reaper

5.DESIGN CLACULATIONS

ENGINE SPECIFICATIONS:

Maximum Power of engine = 7.5HP

Maximum Speed = 5600 RPM

Maximum Power = 7.5*746 = 5595 W

$$P = \frac{2*\pi*N*T}{60}$$

Torque = T = 9.5 Nm

BELT AND PULLEY:

From Design Data Book V.B.Bhandari, Z type of belt is selected.

From Page No. 529, Table no. 13.13, Minimum diameter of pulley is 50mm

minimum diameter d = 50mm

Speed = n = 5600 RPM

BEVEL GEAR DESIGN:

n_1= 1400 rpm Z_1= 24 Z_2= 12 d_1= 100mm d_2= 50mm

Material of Bevel Gear = M.S.

Ultimate Tensile Strength = 841MPa

Module $m = \frac{d_1}{Z_1} m = 4.17$ assume m=4

Pitch angle $\gamma_{1} = \tan^{-1}\left(\frac{d_1}{d_2}\right) \gamma_{1} = \tan^{-1}\left(\frac{100}{50}\right)$

$$\gamma_1 = 63.43 \approx 63°$$

$$\gamma_2 = \tan^{-1}\left(\frac{d_2}{d_1}\right)$$

$$\gamma_2 = \tan^{-1}\left(\frac{50}{100}\right)$$

$$\gamma_2 = 26.56 \approx 26.5°$$

$$d_{av} = d_1 - b \sin \gamma_1$$

$$d_{av} = 100 - 20 \sin(63)$$

$$d_{av} = 82.17mm$$

Pitch line velocity correspond to the average pitch radius is

$$V_{av} = \frac{\pi \times d_1 \times n_1}{60000}$$

$$V_{av} = \frac{\pi \times 100 \times 1400}{60000}$$

$$V_{av} = 7.33 \frac{m}{s}$$

Transmitted tangential force

$$F_t = \frac{1000 \times \omega}{v} F_t = \frac{1000 \times 146.6}{7.33}$$

$$F_t = 20000N$$

Radial force

$$F_r = F_t \times \tan \varphi \cos \gamma_2$$

$$F_r = 2000 \times \tan(20) \cos(26.5)$$

$$F_r = 6514.58N$$

Axial force

$$F_a = F_t \times \tan \varphi \sin \gamma_2$$

$$F_a = 20000 \times \tan(20) \sin(26.5)$$

$$F_a = 3248.05N$$

Shaft angle

$$\theta = \gamma_1 + \gamma_2$$

$$\theta = 63 + 26.5$$

$$\theta = 89.99 \approx 90°$$

Dynamic Load

$$P_d = \frac{21V(Ceb+Ft)}{21V+(Ceb+ft)0.5}$$

Where, Pd = Dynamic Load (N)

V = Pitch line velocity = 7.33m/sec

C = Deformation Factor (N/mm^2) = 11,400 N/mm^2 From Design Data Book V.B.Bhandari, page no.663

e = Maximum expected error between two meshing teeth(mm)

From Design Data Book V.B.Bhandari, page no.19.4, Table no. 19.8 e = 0.05

b = Face width = 10*m or A_0 / 3 (whichever is minimum) = 18.33mm =20

$$P_d = \frac{21*7.33(11400*0.05*20+20000)}{21*7.33+(11400*0.05*20+20000)0.5}$$

Pd = 14596.67 N

Beam Strength of Gear**:**

$S_b = m*b*\sigma_b*Y[1-b/A0]$

Where, S_b = Beam Strength (N)

A_0 = 55.90= 60mm

b = Face width = 10*m or A_0 / 3 (whichever is minimum) = 20mm

σ_b = Permissible Bending Stress (N/mm^2) = Ultimate tensile strength/3 = 280.33

(for M.S UTS=841MPa)

Y = Lewis Form Factor = 0.33

fromV.B.Bhandari Design data book, page no. 660

S_b = 4*20*0.33*280.33 (1-20/60) = 4933.81N

S_b = 4933.81N

Wear Strength of Gear:

$$S_w = \frac{0.75*b*Q*Dp*K}{Cos\Upsilon}$$

Where, Sw = Wear Strength of Gear (N)

b = Face width = 10*m or A_0 / 3 (whichever is minimum) = 20mm

$$Q = \text{Ratio Factor} = \frac{2*z1}{z1+z2*tan\Upsilon} = \frac{2*24}{24+12*tan26.5} = 1.6$$

Dp = Pitch circle diameter of pinion (mm) = 50mm

$$K = \text{Load Stress Factor (MPa)} = 0.16*(\frac{BHN}{100})^2 = 0.16*(\frac{1200}{100})^2 = 23.04\text{MPa}$$

BHN = 1200MPa

Υ = Pitch angle of pinion = 26.5

$$S_w = \frac{0.75*20*1.6*50*23.04}{Cos(26.5)}$$

Sw = 30893.88 N

Dynamic load is less than the Wear load so, design is safe (Pd = 14596.67 <Sw = 30893.88)

6. CONCLUSIONS

1. The This machine can be used to trim heavy crops like corn and sugarcane.
2. Machine also can be automatically driven with the help of engine so can be used in vast trimming.
3. The cost of harvesting using this machine is considerably less as compare to manual harvesting.
4. Poor farmers can easily afford this economical crop reaper.

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