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Design the Development of an Agriculture Blade Machine

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Abstract

The reaper and binding machine is the focus of this research article. It does both cutting and binding at the same time. A reaper machine is a harvesting implement that winds rows of crop in the field after cutting it. The header, power source, gearbox, and frame are reaper's primary parts. The arm for the binder, which transfers motion from the base mechanism to the fingers that gather the grain, presents a challenge when operating in the field. As a consequence, harvesting machines techniques including combine harvesters, binders, and reapers are gaining traction. The paddy harvesting machine's design should be robust, dependable, straightforward, and simple to maintain. The carrier chain mechanism and harvesting gear box designs are explained in this research study. This research report describes the carrier chain system and reaping gear box concepts. The gear box is a crucial component of the reaping mechanism. This leads to the computation of bevel gear design calculations and the selection of appropriate gears and materials.

Retrieved Words: reaper, harvester come together, binder machine, bevel gears binders, reaping gear box

Introduction

Harvesting is a task completed as the crop reaches maturity. Crops are chopped and straws are bound as part of it. In India, there are four different kinds of technology accessible for cereal crops. Modern technology uses a combine harvester; traditional methods use hand instruments such a sickle, manual reapers, self-propelled reapers, and binder machines.\

BCS Company is the manufacturer of the reaper and binder machine. Three components make up the physical construction: the binder mechanism, the engine mounting and cutting mechanism, and the steering system operation.

When the time of harvest comes, a mechanical reaper can be used as an alternative to employing labourers to manually collect in crops by laying down the stems into little bundles. One of the most labour-intensive steps in the production cycle is harvesting. The issue of harvesting has grown due to the introduction of new, high-yielding rice varieties, as there are now more crops to manage. The majority of tropical rice-growing nations, as well as the entire world, harvest rice by hand with a scythe.

In Myanmar, rice is the most significant foodstuff and a staple diet. Currently, we are transitioning from the era of hand farming to the current era of power farming. Growing more food is necessary to feed the rapidly growing population. The only option to boost productivity now that there is more land under cultivation is to plant more than just one type of crop and raise yield. Since summer paddy farming began in 1992–1993, it has continued with the use of an irrigation plan over the summer.

In twice or three times cropping fields, the first crop corner is harvested quite close together. The majority of Myanmar farmers still employ traditional methods like sickle harvesting. Traditional harvesting requires between thirty and sixty man hours per acre, whereas cutting and laying alone require between twenty-five and thirty man hours per acre, with grain losses of as much as 6% for a week wait and 11% for a ten-day delay. Farmers have significant challenges in harvesting their crops on time during peak harvesting season, due to an increase in agricultural labor. Harvesting of crops must take place on time. As a result, farmers managed their operations well using machinery. The deployment of a mechanized reaper to improve labor productivity and rice yield could assist reduce this bottleneck.

The paddy reaper is powered by a five-cylinder horsepower petrol engine. The v-belt and pulleys carry power from the engine to an input shaft, which then passes through a set of bevel gears. The output shaft of the beveled gear is attached to the transmission bevel gear box by a couple of universal joints. The output of the transmission bevel gear box rotates the carrier chain system, causing reciprocating action on the cutter bar. After cutting, the star wheel directs the cut crop to the appropriate exit and drives the star spinners.

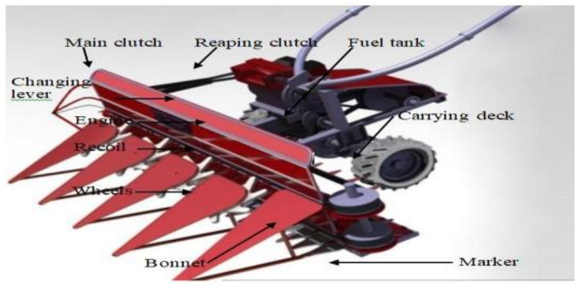

Figure 1: Assembly of paddy reaper

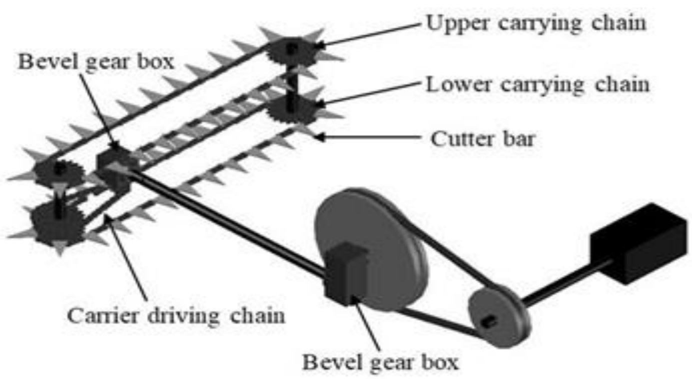

Figure 2: Assembly of reaping mechanism

There are two gear sets in reaper: the main gear box and the reaping gear box. The main gearbox is powered by a gasoline engine through a belt and clutch pulley system. Power is transferred from the main drive mechanism to the harvesting gear box, crank arm, and cutter bar. The cutter bar [4] cuts rice stalks that follow four guidance patterns. Bevel gears are used to transfer motion between non-parallel shafts, typically at a 90˚ angle, as seen in Figure 3.

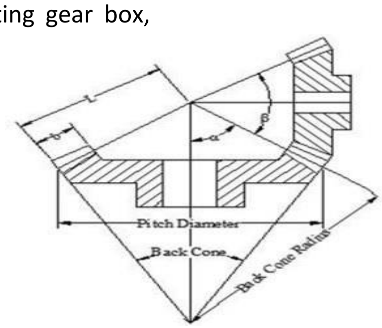

Figure 3: Bevel gear geometry [1]

Mounting bevel gear is crucial for achieving optimum performance. Most commercial gear has a set mounting distance. If the gear is installed closer than the recommended distance, the teeth will most certainly bind. If placed at a higher distance, there will be considerable backlash, resulting in noisy and harsh operation.

A) Force on Straight Bevel Gear

The transmitted load acts tangential to the pitch cone and is the force that generates torque on the pinion and gear. The torque (Mt) can be calculated using the known power transferred and the rotating speed (rpm).

$$M_t = \frac{9550 * kw}{rpm} \tag{1}$$

Considering the pinion as an example, the transferred load is

$$F = \frac{M_t}{r_m} \tag{2}$$

Where rm represents the mean radius of the pinion. The pitch diameter (Dp) is measured between the pitch cone and its big end. The radial load acts orthogonal to the pinion axis, causing the pinion shaft to bend.

$$F_{rp} = F_t tan\alpha \cos\beta \tag{3}$$

The axial force acts parallel to the axis of the pinion Fap, pushing it away from the mating gear. It applies a thrust load to the shaft bearings. It causes a bending moment on the shaft because it acts at the same distance from the axis as the gear.

F_{ap}□ $F_t tan$□ $sin\beta$ *(4)*

To calculate the forces on the gear, use the same equations as for the pinion, substituting the gear geometries for the pinions.

B) Stress in Straight Bevel Gear Teeth

This could have been based on the Lewis equation. It should be noted that the tooth tapers and shrinks in cross section as it approaches the apex of the cone. To account for this, the Lewis equation is adjusted as shown below.

$$F = sby\pi \left(\frac{L-b}{L}\right) m \tag{5}$$

Where

S = allowable bending stress, N/m^2
y = form factor based on the formative number ofteeth and the type of tooth profile
L = the cone distance, m
b = the face width of the gear, m
m = the module based on the largest tooth crosssection

Regarding ease of manufacture and satisfactory operation of bevel gears, the face width b should be limited to between L/3 and L/4, where L represents the cone distance. In general, we shall keep the face width close to, but never exceeding, L/3. When the diameter is known, it is convenient to utilize the modified Lewis equation as follows:

$$\frac{sb\pi}{myF} \left(\frac{L-b}{L}\right) \tag{6}$$

When the diameter is uncertain, it is convenient to use the following variant of the Lewis equation:

$$S = S_0 \frac{2M_t}{mb\pi ym}\left(\frac{L}{L-b}\right) \qquad (7)$$

This equation will produce a number for the real stress in terms of m after making the following substitutions:

The allowed stresses, S, for the average conditions can be calculated as

$$S = S_0\left(\frac{5.6}{5.6+\sqrt{V}}\right) \; for\ generated\ teeth \qquad (8)$$

Where S0 is the gear material's endurance limit for released loads, corrected for average concentration. An approximate value for S0 is 1/3 of ultimate strength, based on an average stress concentration. V represents the pitch line velocity in m/s.

The limiting wear load, F_w, may be approximated from

$$F = F + \frac{21V(L-b)}{21V+\sqrt{(bc}+F_t)} \qquad (9)$$

The dynamic load, Fd, which is the transmitted load plus an incremental load due to dynamic effects, can be estimated using

$$F_d = F_t + \frac{21V(bc+F_t)}{21V+\sqrt{(bc}+F_t)} \qquad (10)$$

Note that F_0 and F_w are allowed values which must not be exceeded by the dynamic load. F_d must be £F_w. F_d must be £F_0.

The cutter bar consists of two fundamental components. A mobile bar with riveted knives is known as a reaping cutter, while a stationary bar with rivets is known as a corresponding cutter bar. The corresponding cutter divides the chopped crops into parts, which are then cut by the reaping cutter using reciprocating motion powered by a carrier chain system [3].

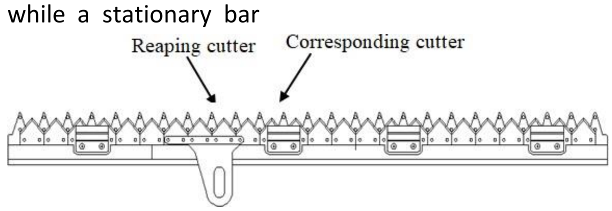

Figure 4: Cutter bar assembly

The purpose of the carrier chain system is to chop rice sticks using a chain and a star wheel. The reaping gearbox sprocket powers the vertical shaft, which is made up of three sprockets. One is used to rotate the shaft, while the other is for the two carrying chains. Chains are classified into three types: carrier driving chains, lower carrying chains, and upper carrying chains. The most popular type of chain is roller chain, which has a roller on each pin to produce extremely minimal friction between the chain and sprockets. The carrier driving chain incorporates a typical single-strand roller chain. Upper and lower carrying chains both use double pitch roller chains [3].

The chain length *L*¢ in pitch numbers, for a given distance *C*¢ in pitch numbers, is exactly.

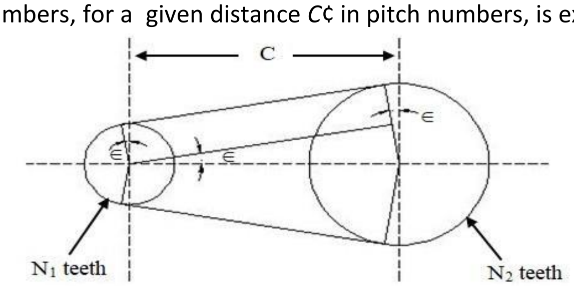

Figure 5: A typical chain drive

$$L' = 2C' cos \in + \left(\frac{N_1 + N_2}{2}\right) + (\frac{N_2 - N_1}{\pi})$$

Where

$$\in = arcsin \frac{\frac{1}{sin\propto_2} - \frac{1}{sin\propto_1}}{2C'}$$

Since, Î is generally small, it is sufficient in most casesto use the approximation.

$$L' = 2C' + \left(\frac{N_1 + N_2}{2}\right) + \frac{S}{C'}$$

Where, $S = \left(\frac{N_2 - N_1}{2\pi}\right) * \left(\frac{N_2 - N_1}{2\pi}\right)$

The actual chain length is

$$L = L'p$$

And the actual sprocket center distance

$$C = C'p$$

It is recommended that *C*¢ lie between 30 and 50 pitches. If the center distance is not given, the designer is free to fix *C*¢ and to actuate *L*¢.

The sprocket diameters are

$$D_i = \frac{p}{sina_i}$$

The plucking device design process is divided into two steps. First, calculate the power transfer from the engine to the bevel gearbox. The second step is to determine the chain length for the carrier chain system. The bevel gear module, diameters, face width, and number of teeth are determined for two bevel gear boxes. The carrier chain system's chain number, the amount of teeth, center distance, and speed serve as input data, and the diameter of sprockets and chain length are computed.

Design Thoughts and Result

This document calculates the design of a power reaper using 3.727 kW engine power and 3600 rpm engine speed, as well as all components of the reaping gear box and carrier chain system. Engine power equals 3.31 kW. Losses equal 10%. Gear Material:

AISI 5160 OQT 400, so: 740 MN/m2
BHN = 627
Ep(Eg) = 207×109 N/m2.
ϕ = 20 degree full depth.

MATHLAB CODE FOR GRAPH

```
% Data points (replace with actual values)
numTeeth = [0, 10, 20, 30, 40, 50, 60];
pinionA = [0, 10, 30, 20, 10, 0, 20];
gearB = [0, 20, 40, 30, 20, 0, 10];
pinionC = [0, 30, 60, 40, 30, 0, 20];
gearD = [0, 20, 40, 30, 20, 0, 10];
% Create the plot
plot(numTeeth, pinionA, 'b-', ...
```

```
    numTeeth, gearB, 'r-', ...
    numTeeth, pinionC, 'g-', ...
    numTeeth, gearD, 'm-');
% Add labels and title
xlabel('Number of Teeth');
ylabel('Pressure (N/m²)');
title('Pressure vs. Number of Teeth');
% Add legend
legend('Pinion A', 'Gear B', 'Pinion C', 'Gear D');
% Gridlines
grid on;
```

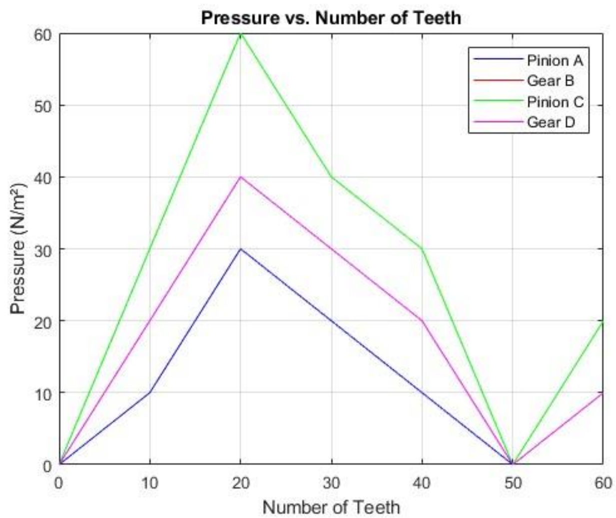

Figure 6: Result Data of in reaping gear box

Conclusion

This study presents the development and evaluation of a paddy reaper powered by a 3.729 kW motor and a 3600 rpm input speed. Key design factors, such as gearbox and carrier chain system calculations, were addressed to assure peak performance.

The developed paddy reaper outperformed manual harvesting methods. It greatly decreased harvesting time, enhanced production, and provided a more sustainable alternative for agricultural operations. Future research could concentrate on greater optimization, sophisticated features, and environmental impact assessments to improve the machine's capabilities and contribute to sustainable agriculture.

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