Design and Fabrication of Mini Rice Harvesting and Threshing Machine

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Abstract - *The small rice combine harvester is mainly used for harvesting rice grain and wheat grain. It is special suit for areas where general combined harvesters cannot enter in, very convenience for the farming. The name derives from its combining three separate operations comprising harvesting reaping, threshing, and winnowing into a single process. among the crops harvested with a combine are wheat, oats, rice, barely, corn, soybeans and flax .The waste straw left behind on the field is the remaining dried stems and leaves of the crop with limited nutrients which is either chopped and spread on the field or baled for feed and bedding for livestock. Harvesters are one of the most economically important labour saving inventions, enabling a small fraction of the population to be engaged in agriculture*.

***Key Words*: Manual Method, Combine Harvester, Crop Cutting.**

1. INTRODUCTION

The power of combine harvester is usually 9-10 kW, so the machine model should be matched with the field area. If the field is flat and vast, the large combine type is good choice; on the contrary, a small one is better. The whole-feeding combine harvester involves both rice ears and straw into threshing device, after the straw are crushed, they will be discharged in the land field.

1.1 Need for harvesting machine

In conventional harvesting process, the crop is cut manually by labour and then this crop is get threshed by Thresher. It takes time and it is not effective as they can work only 5-6 hours in a day. Even though the small scale farmers who having land less than 5 acres, it takes two to three days to cut and harvest the crops. After plantation of crops, if proper care is not taken then non-required plants also grows with crop. So, to separate this unwanted plant while harvesting is tedious work. Aim of our project is to target small scale farmers who’s having land less than 5 acres.

1.2 Small Rice Harvester Features

This motor operated rice harvester integrates the functions of reaping and threshing. Made of high quality steel, sturdy and durable. Compact design and structure, safe to operate with high legerity and climbing ability High threshing rate and low seeds losing rate with reasonable price. Wide applicability, suitable for mountainous areas, hills and muddy farmland.

2. AIM AND OBJECTIVE

Aim of this project is to design and develop small scale low cost compact harvester which reduce the overall cost of grain harvesting in the form of labour cost and harvesting cost. To provide proper utilization of wastage which is useful for cattle. To reduce overall harvesting time as that of traditional harvesting time.

3. MACHINE COMPONENTS

The main components of small scale harvester are as follows:

1. Frame
2. Bearing
3. Rolling Shaft
4. Threshing Shaft
5. Cutting Blade
6. Screw conveyor
7. DC Motor
8. Battery

3.1 FRAME

Frame is back bone of the equipment. It is made of mild steel. All the sub-parts in the equipment are mounted in the shaft. It is the rigid structure that forms a skeleton to hold all the major parts together. At the bottom end of the frame wheel with seed container assembly is mounted. In the frame, fertilizer container assembly is mounted and in the top of the frame handle and stand is mounted.

Fig -1: Frame

3.2 BEARING

The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks. Bearing is made up of steel material and bearing cap is mild steel.A ball bearing usually consists of four parts: an inner ring, an outer ring, the balls and the cage or separator. The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks. Bearing is made up of steel material and bearing cap is mild steel. Ball and roller bearings are used widely in instruments and machines in order to minimizefriction and power loss. While the concept of the ball bearing dates back at least to Leonardo da Vinci, their design and manufacture has become remarkably sophisticated.

Fig -2: ball bearing

3.3 ROLLING SHAFT

Rolling is a type of motion that combines rotation (commonly, of an axially symmetric object) and translation of that object with respect to a surface (either one or the other moves), such that, if ideal conditions exist, the two are in contact with each other without sliding.Rolling is achieved by a rotational speed at the line or point of contact which is equal to the translational speed.

Fig -3: Rolling Shaft

3.4 THRESHING SHAFT

Threshing is the process of loosening the edible part of cereal grain (or other crop) from the scaly, inedible chaff that surrounds it. It is the step in grain preparation after harvesting and before winnowing, which separates the loosened chaff from the grain. Threshing may be done by beating the grain using a flail on a threshing floor. A modern version of this in some areas is to spread the grain on the surface of a country road so the grain may be threshed by the wheels of passing vehicles.

Fig -4: Threshing Shaft

3.5 CUTTING BLADE

Cutter blade assembly consist of a sliding cutter blade and a stationery cutter blade. The cutters used are of triangular shape. In sliding cutter blade, cutter blade is riveted on 3 mm MS plate and in stationery cutter plate; cutter blade is riveted on 5 mm plate. The stationary cutter plate can be directly bolted and fixed on frame.

Fig -5: Cutting Blade

3.6 SCREW CONVEYOR

When the dry crop cut by cutter blade then these crops get transfers with the help of guider to the screw conveyor. Screw conveyor collects the crops and transfers it for the further operation.

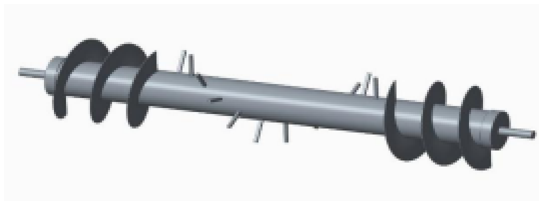

Fig -6: Screw Conveyor

3.7 DC MOTOR

An electric motor is a machine which converts electrical energy to mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a magnetic force whose direction given by Fleming's left hand rule.

When a motor is in operation, it develops torque. This torque can produce mechanical rotation. DC motors are also like generators classified into shunt wound or series wound or compound wound.

Fig -7: DC Motor

3.8 BATTERY

A battery is a self-contained, chemical power pack that can produce a limited amount of electrical energy wherever it's needed. The basic power unit inside a battery is called a cell. There are two electrodes (electrical terminals) and a chemical called an electrolyte in between them.

Fig -8: Battery

4. WORKING

It is combining three separate operations comprising harvesting threshing, into a single process. A mechanical reaper or reaping machine is a mechanical, semi-automated device that harvests crops. Mechanical reapers are an important part of mechanized agriculture and a main feature of agricultural productivity.

Threshing is the process of loosening the edible part of cereal grain (or other crop) from the scaly, inedible chaff that surrounds it. It is the step in grain preparation after harvesting and before winnowing, which separates the loosened chaff from the grain.

5. DESIGN AND MODELLING

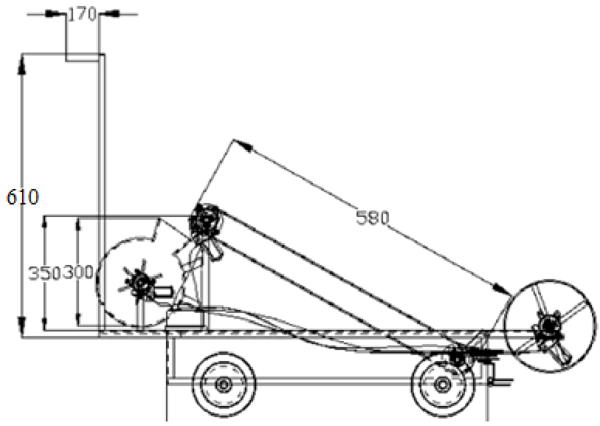

Fig -9: 2D Design

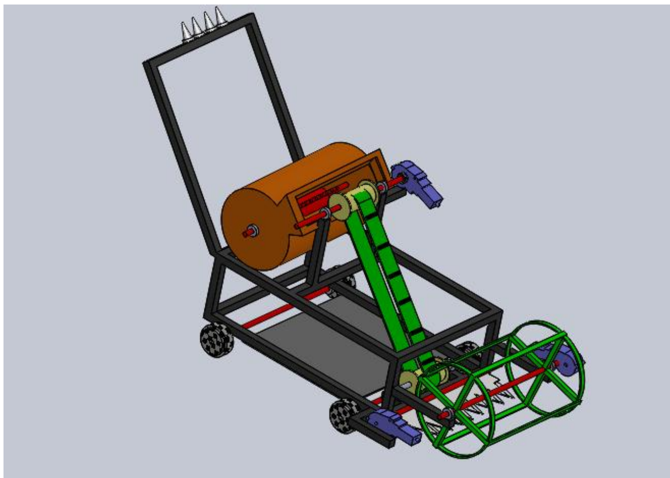

Fig -10: 3D Design

Fig -11: Manufacturing process

6. CALCULATIONS

DESIGN OF SHAFT

Volume, V = L * B * H

= 9* 0.025* 0.025

$V = 0.05625\ m^3$.

mass = volume * density

Density of Mild steel, $\rho = 7850\ Kg / m^3$.

mass = 0.005625 * 7850

mass = 44.15* 9.81 + (7 * 9.81)

weight = 501.84 N

Reactions at D ,

$R_D * 560 = (125* 510) + (125* 50)$

$R_D = 125$ N .

Reactions at A ,

$R_A * 560 = (125 * 510) + (125 * 50)$

$R_A = 125$ N .

Bending moment at B ,

$B_{MB} = R_A$ * Near by support

= 125* 50

$B_{MB} = 6250$ N-mm

$B_{MC} = R_D$ * Near by support

= 125* 50

$B_{MC} = 6250$ N-mm

$M_{(max)} = 6250$ N-mm

From PSG Data book Pg no. 1.9,

Depends upon carbon composition (C – 45)

$\sigma_u = 630\ N/mm^2$

$\sigma_y = 360\ N/mm^2$.

Deflection of shaft,

Point load on Simply supported beam,

$\delta = (W * l^3) / (48 * E * I)$

$= (501.84 * (560)^3) / (48 * 210 * 10^9 * 2485.04)$

$\delta = 0.00351$m .

Bending Equation

$(M / I) = (\sigma_b / y) = (E / R)$

$M_{(max)} = 6250$N-mm

$I = 2485.04mm^4$

y = D / 2 = 15 / 2 = 7.5 mm

$(M / I) = (\sigma_b / y)$

$(6250/ 2485.04) = (\sigma_b / 7.5)$

$\sigma_b = 18.86\ N / mm^2$

Bending stress for taken material can be assumed to be

$\sigma_b = 0.66 * \sigma_y$

= 0.66 * 360

$\sigma_b = 237.6N / mm^2$

$\sigma_b < \sigma_{b\ allowable}$

Design is safe

DESIGN OF BEARING

Outer Diameter of Bearing (D) = 35 mm

Inner Diameter of the Bearing (d) = 15 mm

Static load , $C_o = 3350$ N

C = 6100 N

Speed , N = 16000 rpm (max)

N = 100 (min)

$P_r = 879.58$N

$L_h = 100$ (from databook)

$L = (60 * N * L_h) / (10^6)$

$= (60 * 16000* 100) / 10^6$

L = 72 million revolution

$L = (C / P_r)^{b}$

b = 3 for ball bearing

72 = (C / 879.58) ^3

C_a = 3659.20 N

C_a< C ,

Hence Design is safe

DESIGN OF SPUR GEAR

N1/N2 = D2/D1

Where,

N1 = Motor speed in RPM---60 RPM

N2 = Output speed

D2 = Diameter of the roller gear wheel

= 88 mm

D1 = Diameter of the motor gear wheel

= 35 mm

N2 = (D1/D2) x N1

= (35 / 88) x60

= 24 rpm

CUTTING SPEED CALCULATION

Cutter speed = RPS* (distance travelled in left + distance travelled in right)

RPS = (120/60) = 2

Cutter speed = 2 *(distance travelled in left + distance travelled in right)

= 2*(35+35) = 140mm/sec

P.M.D.C MOTOR

Power = 90 Watts

Voltage = 12 Volt

Output Speed = 60 RPM

Speed in rotor = 2800 RPM

TORQUE CALCULATION

Torque (T) = ½ (Ia / A) BDC Z Newton meters

Using the relation,

B = φ / a

= φ / (Π D / P) ł

= φ x P / (ΠDł)

T = ½ x (Ia / A) x Z x φ x {P/ (ΠDł)} x Dł

= φ Z P Ia / (2ΠA) Newton meters

= 0.159 x φ x Z x Ia X (P/A) Newton meters

= 0.162 x φ x Z x Ia x (P/A) Kg-m

7. CONCLUSIONS

Thus project is to design and develop small scale low cost compact harvester which reduce the overall cost of grain harvesting in the form of labour cost and harvesting cost.

We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institutions and the industries.

We are proud that we have completed the work with the limited time successfully. The “MINI RICE HARVESTING AND THRESHING MACHINE”is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities.

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