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Design and Development of Paddy Harvester

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ABSTRACT - In this paper, the paddy harvester is designed and developed which helps the farmers holding small and large agricultural fields. The small rice combine harvester is mainly used for harvesting rice and wheat grain. It is specially suited for the hills and mountains or areas where general combined harvesters cannot enter where the compact harvester can be used and can be used by small agricultural land holding farmers. This harvester combining two separate operations comprising of harvesting and threshing into a one process. The waste pieces of paddy is left on the field the remaining stems and leaves of the crop which is chopped and spread on the field and can be fed to cattles and other animals. Harvesters are one of the most economically important machine which does labour saving and enabling a small population of people to be engaged in agriculture.

KEYWORDS – Paddy Harvester, Combined, Design

I. INTRODUCTION

Agriculture is the backbone of India. Farming is a science and art of cultivation on the soil. In many families agriculture is the only source of income 75% of Indian farmers own small agricultural land for farming . For harvesting purpose these farmers are renting harvesters or using manual labors. These harvesters also have lot of limitations to operate. The opportunities for other fields have increased and have higher wages than agriculture nowadays. Harvesting is a process of cutting and gathering of mature crops from the fields. Harvester is a machine which is used for harvesting . Different types of harvesters are available such as crop harvester ,onion harvester ,tea harvester, potato harvester, wheat harvester and sugarcane harvester. Due to high literacy rate a majority of population lost interest in traditional agriculture. By introducing new harvesters could grab the attention of people towards agriculture.

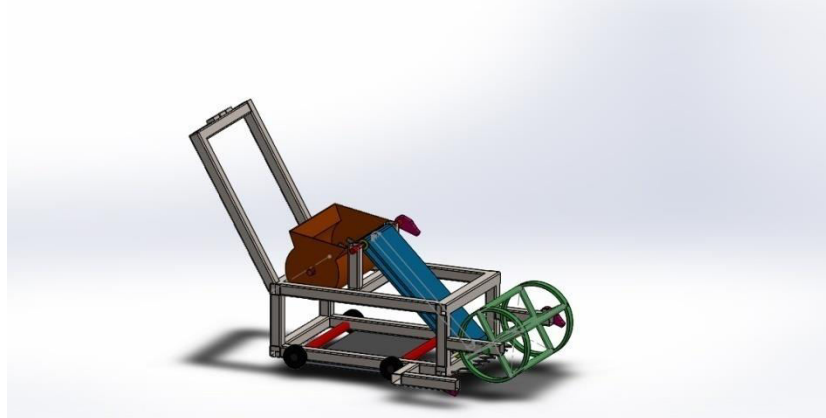


Fig1.1 Design of paddy harvester

II. FABRICATION DETAILS

DESIGN

The figure 1.1 shows the finalized design of the paddy harvester. The harvester is designed in a way to multitask. The header and thresher are designed based on the paddy. The crop is studied first and based on the requirement the parts are designed.

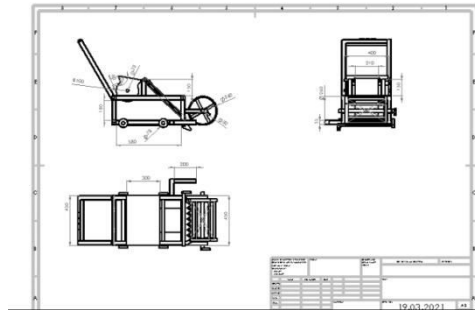


Fig 1.2 Dimension of paddy harvester

All the dimension details are provided in the figure 1.2.B based on the requirement alternate designs are also undertaken. Alternate design 1



Fig 1.3 alternate design 1

In this alternate the thresher and the conveyor belts are placed inside the frame to reduce usage of power for belt conveyor transmission.

Alternate design 2



Fig1.4 Alternate design 2

In this alternative the conveyor is eliminated and instead a double thresher system is introduced. The harvested paddy falls straight into the thresher and the seeds get loosened.

III. COMPONENTS AND DESCRIPTION

The physical setup of this project are given below and it is been explained as follows

- 1.Frame
- 2.Bearing
- 3.Motor
- 4.Rolling Shaft
- 5.Threshing Shaft
- 6.Wheels

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

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. Such bearings cannot be used without a careful study of the loads and operating conditions. The bearing must be provided with adequate mounting, lubrication

TYPES OF BALL BEARING

A ball bearing usually consists of four parts, an inner ring, an outer ring, the balls and the cage or separator. To increase the contact area and allow larger loads to be carried, the balls run in curvilinear grooves in the rings. The radius of the groove is slightly larger than the radius of the ball, and a very slight amount of radial play must be provided. The bearing is thus permitted to adjust itself to small amounts of angular misalignment between the assembled shaft and mounting. The separator keeps the balls evenly spaced and prevents them from touching each other on the sides where their relative velocities are the greatest. Ball bearings are made in a wide variety of types and sizes. Single-row radial bearings are made in four series, extra light, light, medium, and heavy, for each bore,

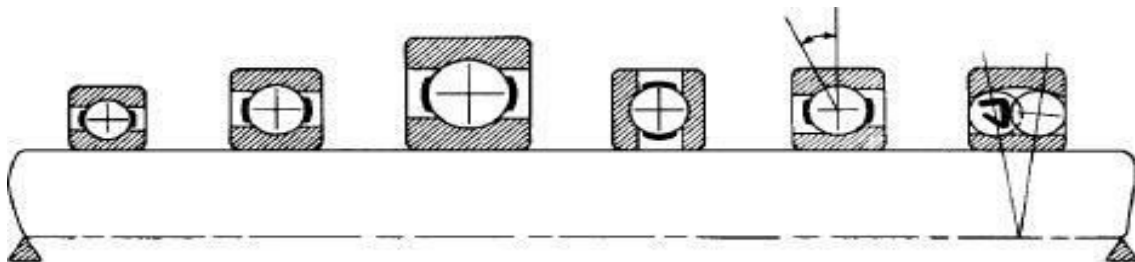


Fig 2.1 Types of Ball Bearings

The heavy series of bearings is designated by 400. Most, but not all, manufacturers use a numbering system so devised that if the last two digits are multiplied by 5, the result will be the bore in millimetre. The digit in the third place from the right indicates the series number. Thus, bearing 307 signifies a medium-series bearing of 35-mm bore. For additional digits, which may be present in the catalogue number of a bearing, refer to manufacturer's details. Some makers list deep groove bearings and bearings with two rows of balls. For bearing designations of Quality Bearings & Components, see special pages devoted to this purpose. The radial bearing is able to carry a considerable amount of axial thrust.

3.BELT

A belt is a loop of flexible material used to mechanically link two or more rotating shafts, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys and the shafts need not be parallel. In a two pulley system, the belt can either drive the pulleys normally in one direction or the belt may be crossed so that the direction of the driven shaft is reversed. As a source of motion, a conveyor belt is one application where the belt is adapted to continuously carry a load between two points.

Power Transmission

Belts are the cheapest utility for power transmission between shafts that may not be axially aligned. Power transmission is achieved by specially designed belts and pulleys. The demands on a belt drive transmission system are large and this has led to many variations on the theme. They run smoothly and with little noise, and cushion motor and bearings against load changes with less strength than gears or chains. However, improvements in belt engineering allow use of belts in systems that only formerly allowed chains or gears.

4.SHAFT

Rolling is a motion that combines rotation and translation of that object with respect to a surface 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. When no sliding takes place the rolling motion is referred to as 'pure rolling'. In practice, due to small deformations at the contact area, some sliding does occur. Nevertheless, rolling resistance is much lower than sliding friction, and thus, rolling objects, typically require much less energy to be moved than sliding ones. As a result, such objects will more easily move, if they experience a force with a component along the surface, for instance gravity on a tilted surface; wind; pushing; pulling; an engine. Unlike most axially symmetrical objects, the rolling motion of a cone is such that while rolling on a flat surface, its center of gravity performs a circular motion, rather than a linear one. Rolling objects are not necessarily axially-symmetrical. Two well-known non-axially-symmetrical rollers are the Reuleaux triangle and the Meissner bodies. Objects with corners, such as dice, roll by successive rotations about the edge or corner which is in contact with the surface.

5.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 is given by Fleming's left hand rule. When a motor is in operation, it develops torque. This torque can produce mechanical rotation. 12v DC motors are also like generators classified into shunt wound or series wound or compound wound motors.

6.THRESHING SHAFT:-

Threshing is the process of loosening the edible part of crop from the scaly. It is the step in grain preparation after harvesting and before winnowing, which separates the loosened chaff from the grain. Threshing does not remove the bran from the grain. Threshing may be done by beating the grain using a flail on a threshing floor. Another traditional method of threshing is to make donkeys or oxen walk in circles on the grain on a hard surface. 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. Hand threshing was laborious, with a bushel of wheat taking about an hour. In the late 18th century before threshing was mechanized, it took about one-quarter of agricultural labor. Industrialization of threshing began in 1784 with the invention of the threshing machine by Scotsman Andrew Meikle. Today, in developed areas, it is now mostly done by machine, usually by a combine harvester, which harvests, threshes, and winnows the grain while it is still in the field. The cereal may be stored in a threshing barn or silos.

7.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, and it consists of three main bits. There are two electrodes and a chemical called an electrolyte in between them. For our convenience and safety, these things are usually packed inside a metal or plastic outer case. There are two more handy electrical terminals, marked with a plus and minus, on the outside connected to the electrodes that are inside. The difference between a battery and a cell is simply that a battery consists of two or more cells hooked up so their power adds together.

IV .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 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 does not remove the bran from the grain. Threshing may be done by beating the grain using a flail on a threshing floor. Another traditional method of threshing is to make donkeys or oxen walk in circles on the grain on a hard surface. 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. A header is attached to the front end of the frame which acts as a collector. This collects the paddy and pushes it backwards by rotating motion. A trimmer type blade is attached to the frame behind the header which cuts the paddy which comes out from the header. The harvested paddy falls behind on the conveyor belt. The conveyor belt moves and takes the paddy to the threshing cylinder. the threshing cylinder consist of peg type thresher which threshes the paddy which enters the cylinder and let the remaining out through a opening. This is hoe the paddy harvester works

V. DESIGN CALCULATIONS

Design of frame

$$\text{Volume} = L \times B \times H$$

$$= 9 \times 0.025 \times 0.025$$

$$V = 0.05625 \text{ m}^3$$

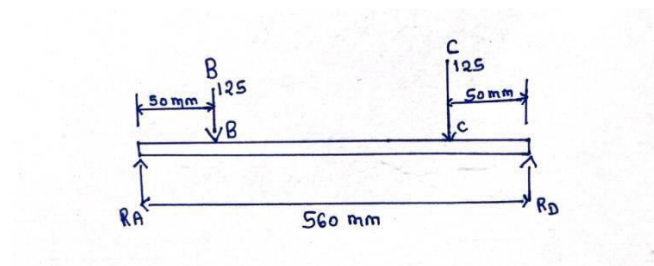
$$\text{mass} = \text{Volume} \times \text{Density}$$

$$\rho = 7850 \text{ Kg/m}^3$$

$$= 0.05625 \times 7850$$

$$\text{mass} = 44.15 \times 9.81 + (7 \times 9.81)$$

$$\text{mass} = 501.84 \text{ N bending moment of shaft}$$



Reaction at D

$$(R_A \times 0) + (R_D \times 560) = (125 \times 510) + (125 \times 50)$$

$$= 63780 + 70000$$

$$R_D = 125 \text{ N}$$

Reaction at A

$$R_A + R_D = 125 + 125$$

$$R_A = 250 - 125$$

$$R_A = 125 \text{ KN}$$



Bending Moment B

BMB = RA × Nearby support

$$= 125 \times 50$$

BMB = 6250 N-mm

Bending Moment C

BMC = RD × Nearby support

$$= 125 \times 50$$

$$BMC = 6250 \text{ N-mm}$$

From Data Book

$$\sigma_u = 630 \text{ N/mm}^2$$

$$\sigma_y = 360 \text{ N/mm}^2$$

Deflection of shaft (simply supported Beam point load)

$$\delta = \frac{(w \times L^3)}{48 \times E \times I}$$

$$I = \frac{3.14 \times D^4}{64}$$

$$D = 15 \text{ mm}$$

$$I = 2484 \text{ mm}^4$$

$$\delta = 0.00351 \text{ m}$$

Design of Shaft (conveyor)

$$T = \tau \times \frac{\pi}{16} D^3$$

$$1.76 = 200 \times 10^6 \times \frac{\pi}{16} D^3$$

$$D = 3.5 \text{ mm} < 15 \text{ mm}$$

Design is safe.

Design of Shaft (cutter)

$$T = \tau \times \frac{\pi}{16} D^3$$

$$3.1 = 200 \times 10^6 \times \frac{\pi}{16} D^3$$

$$D = 4.2 \text{ mm} < 15 \text{ mm}$$

Design is safe

Design of Spur Gear

$$\frac{N_1}{N_2} = \frac{D_2}{D_1}$$

Cutting speed = RPS × (move left + move right)

$$= 22 \times (50 + 50)$$

$$= 2200 \text{ m/s}$$

$$\text{Cutting speed} = 2.2 \text{ m/s}$$

$$N_1 = \frac{880}{350} \times 1320$$

$$N_1 = 3300 \text{ rpm}$$

Power = weight × velocity × gravity

$$= \frac{50 \times 2.2 \times 9.81}{1000}$$

$$\text{Power} = 1.0791 \text{ K watt}$$

$$= 1079 \text{ watts}$$

$$\text{Torque} = \frac{9550 \times P \text{ in Kw}}{RPM}$$

$$= \frac{9550 \times 1.0791}{3300}$$

$$\text{Torque} = 3.122560 \text{ N-m}$$



CUTTING SPEED CALCULATIONS

For 120 rpm motor

cutting speed = $rps * (\text{distance travelled to left} + \text{distance travelled to right})$

$$rps = 120/60 = 2$$

$$\begin{aligned} \text{cutting speed} &= 2 * (35 + 35) \\ &= 140 \text{ mm/sec} \end{aligned}$$

For 1 HP 3000rpm motor

cutting speed = $rps * (\text{distance travelled to left} + \text{distance travelled to right})$

$$rps = 3000/60 = 50$$

$$\begin{aligned} \text{cutting speed} &= 50 * (35 + 35) \\ &= 3500 \text{ mm/sec} \end{aligned}$$

Cutting speed required to cut paddy = 1.8m/s

Cutting speed of 1 HP motor = 3.5m/s > 1.8

Cutting force = torque/diameter

$$= 3.122560/0.005$$

$$= 625 \text{ N}$$

Harvest rate

Blade size = 45cm

Distance travelled left to right = 35mm

Harvest rate per second = 2 square feet/second

Harvest rate = 7200 square feet/hour

BATTERY REQUIREMENT CALCULATION

1HP = 745.7W

Amps = Watts/Volts

$$= 745.7/220$$

$$= 3.39 \text{ A}$$

For 8 working hours = $3.39 * 8$

$$= 27.12 \text{ A}$$

VI. CONCLUSION



Providing a compact and effective paddy harvester that can be employed in both smaller and bigger paddy fields. Farmers can use the paddy harvester in low cost instead of renting bigger expensive harvesting machines which can harvest 7200square feet per hour.

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