Research Paper on Design and Development of Paddy Harvester Machine

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Abstract - The aim of our project is to fabricate a crop harvester for farmers with land holding lesser than 2-3 acres or small scale farmers who cannot afford modern harvesting alternatives like combine or modern harvesters. The product will be capable of cutting various crops with cutter blades attachment and collecting mechanism. The projects focuses on giving the small scale farmers the best alternative for their hardships faced because of unavailability of labours & high expenses of harvesting.

Key Words : Portable Harvesters, Cutter Blade, Small scale farmers, Petrol engine, Collecting mechanism, Low cost fabrication.

1.INTRODUCTION

Agriculture being one of the major occupation in India, it is very essential to discover and implement new idea in this field. It is unfortunate that, these ideas are not been implemented properly in actual field. This is due to high cost and is complicated for rural people. Conventional method of planting and cultivating crops is a laborious process and hence for that reason there is a scarcity of labours, this result in delayed agriculture to overcome these difficulties, multipurpose agriculture equipment is designed. This machine targets the small scale farmers who have land area of less than 2 or 3 acres. This machine is compact and can cut up to two rows of wheat, millet, jowar & rice crops.

Rice is most important crop in the tropical region. Harvesting is mostly done manually in this region by using hand sickle. The farmers have to keep bend for cutting the plant, due to this the health related problems occurs. The crop cutting is important stage in agriculture field. The availability of human resources for critical operations in rice cultivation is decreasing and affordable technology is required to mechanization to increase the productivity. About 75% people are living in the rural area and are still dependent on agriculture. About 43% of geographical area is used for agricultural activity. Agriculture has been the backbone of the Indian economy. As Indian population is growing continuously, the demand for producing crop per hector is also increasing; this requires efficient and high-capacity machines. So mechanization in agricultural industry plays an important

2.PROBLEM DEFINATION

- The existing paddy transplanter involves the complex mechanism.
- Farmer cannot repair by their own.
- The small holding farms owners generally do not require the full featured combine harvesters.
- Available paddy harvester does not include height adjustment of cutter and also for collecting mechanism.
- The existing paddy harvester machine is costly.
- There is a need for a smaller and efficient combine harvester which would be more accessible and also considerably cheaper.

3. LITERATURE REVIEW

This chapter deals with research work done in past by various investigation on the performance,

Christopher Molica's [1] project was done by the students of Worchester Polytechnic Institute. They have created a small scale harvester which was combined reaper and binder. This machine was developed concerned to the small scale grain growers.

Yuming Guo's [2] paper describes the relation between the stalk strength and the cutting force that is required for cutting the soybean. The paper was helpful in guiding on the calculations front. This paper briefly describes the strength of various crops and compares it with the soybean. This relationship helps in giving a rough idea about the cutting speed required to cut the crop.

Asia and Pacific Commission [3] on Agricultural Statistics Twenty-Third Session Siem Reap, Cambodia, 26-30 April 2010 [3] was intended to discuss the characteristics of small scale farmers across Asia. This commission identifies the problems faced, the average land holdings and the average income of the small scale farmers.

N. S. L. Srivastava [4] checked in the interests of the farmers and the problems they face while harvesting and maintaining the agriculture field. This paper was an in depth study of the farming conditions of the farmers and their basic problems.

Fabrication of low-cost manual crop harvesting machine by **M.Rajya Lakshmi[5],SK.Mahaboobbasha,R.Sandeepkumar,V.Anusha,SK.Sharuk**developed a low cost manually operated reaper to cut different types of crops with in less time. They used different cutting mechanisms based on the crop type.

S. S. Kohli [6] in 2015 describes Mechanical cotton cutting tools or harvesters, i.e. strippers are commercially available, but these cannot be used for cotton harvesting from varieties presently grown in India due to design constraints and ergonomic practices. Higher initial cost and field capacity make cotton cutting tools or harvesters unsuitable and unaffordable for small & medium farms. Hence, a comprehensive review of cotton harvesting mechanisms developed is carried out.

FINDINGS FROM LITERATURE REVIEW:

After studying about the research and experiments done on various things, the followings are the things which we are going to conduct in our project:

In the present Scenario due to the gradual increase in population, there is too much of demands in the farm sector due to the scarcity of daily labors. The output from these labors is less productive due to manual or hand operations adopted by them. Since heavy machines cannot be introduced due to affordability and limited area of cultivation, it is very essential to bring in a machine which is cost effective, compact and easy to use for low end farmers. So there is the need to make a machine which can perform the following operations

- Easy harvesting of grains
- Less manual efforts
- Low cost and less maintenance

4. DESIGN METHODOLOGY

The machine is a walk behind type of harvester which can be used for harvesting crops especially fodder crops such wheat, bajra etc. There are two cutter blades; one is moving and another is stationary. The slider crank mechanism was used to convert rotary motion to linear sliding motion. Scissoring action is obtained due to reciprocating movement of cutter blade over stationery blade was used to cut the crops. The frame of the harvester with the dimensions 610 X 260 X800 (l X b X h) mm was fabricated. The mild steel angle section was used to build the frame. Mild steel angle was used because they are light weighted and can be easily welded. The frame was fitted with 2 pair of wheels. Front pair is smaller in size whereas other one is bigger in size. Two pair of wheels was used for easy movement of harvester in the field. Two handles were provided at the end of the frame for pushing the harvester forward. We use 2-stroke petrol engine of 2650 rpm.

Cutter assembly consists of two cutter blade plates. One of the cutter plates is stationary and other is sliding in nature. The cutters used are of triangular shape. The stationary cutter plate was directly welded and fixed on frame. Sliding cutter blade was provided with 4 slots of 80 mm on its ends; it allowed sliding motion to be in straight line. The bottom of the sliding cutter plate was connected to the slider crank mechanism. The blades were made up of Mild steel.

5.WORKING

The machine performs mainly two operation cutting and collecting of the crop. This machine consists of two mechanisms one is a Crank and Slotted Lever Mechanism for reciprocation of cutter blade over stationary cutter blade and this mechanism is used to convert rotary motion into linear motion.

Second is collecting mechanism which consist chain belt and pulley. By using V-Belt power is transmitted to bevel gear box. Bevel gear box is used to change direction of drive by 90 degree in the gear system. One end of this output shaft is connected to Crank and slotted lever Mechanism which converts rotary motion of shaft into reciprocating motion of cutter blade. Reciprocating cutter blade slides over fixed blade and creates scissoring action responsible for cutting the crop and other end is connected to the collecting mechanism.

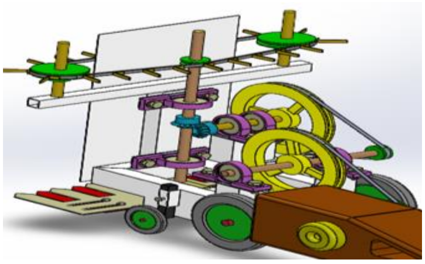


Figure 1 cad model

6.MODEL

6.1 Part List

Sr no	Part name	Material	Size	Qty
1.	PLATE	MS	450X210MM	2
2.	CHASIS FRAME TUBE	MS	60X40 MM	15 FT
3.	SHAFT	BRIGHT	20MM	5KG
4.	PULLEY	CI	100MM	2 NOS
5.	PULLEY	CI	50 MM	2 NOS
6.	ENGINE 50CC	STD		1 NO
7.	BELT	SYNTHETIC RUBBER	A- 51	1 NO
8.	BELT	SYNTHETIC	A-41	2 NO
9.	FLAT	MS	15X3MM	7 FT
10.	BEARING	STD	8MM	1 NO
11.	PEDESTAL BEARING	CI	P-204	6 NO
12.	SQUARE TUBE	MS	30X30 MM	7 FT
13.	NUT BOLT	MS	3/8 INCH	20 NOS
14.	SHEET METAL	MS	310X540MM	1 NO
15.	FUEL	STD	-	0.5 L
16.	WHEELS	PLASTIC	8 INCHES	2 NOS
17.	WHEELS	PLASTIC	4 INCHES	2 NOS
18.	SQUARE TUBE	MS	30X30 MM	7 FT
19.	PULLEY	CI	250MM	2 NOS
20.	PULLEY	CI	75 MM	1 NOS
21.	BELT	SYNTHETIC	A-40	2 NO
22.	BUSH	MS	20X40MM	30 NOS
23.	PAINT	STD	-	0.5L

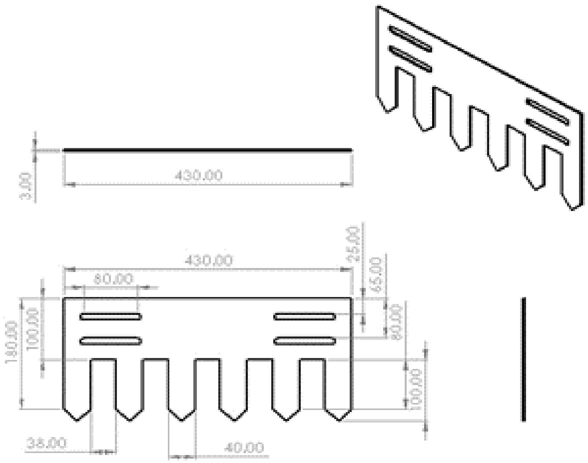


Figure 2 blade

6.2Drawing

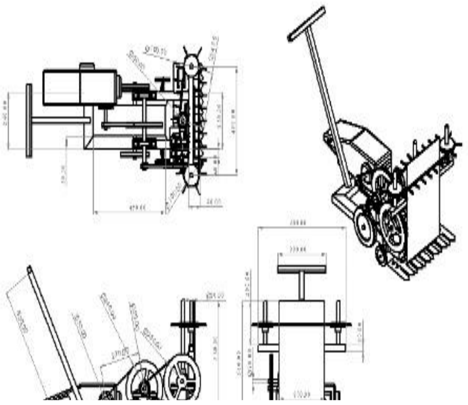


Figure 3 assembly drawing

7.Stress Analysis

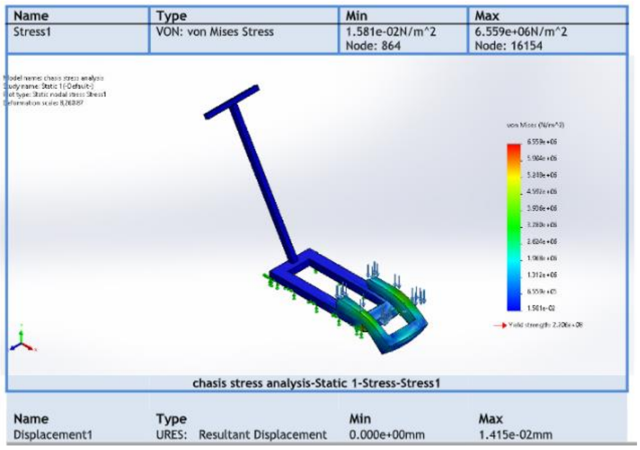


Figure 4 stress analysis of chassis

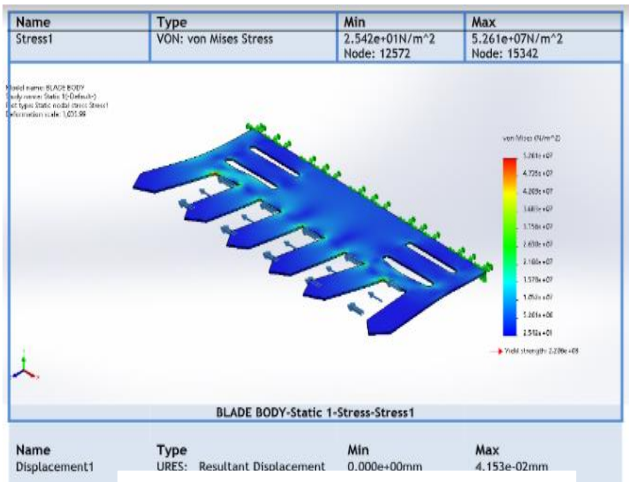


Figure 5 stress analysis of blade

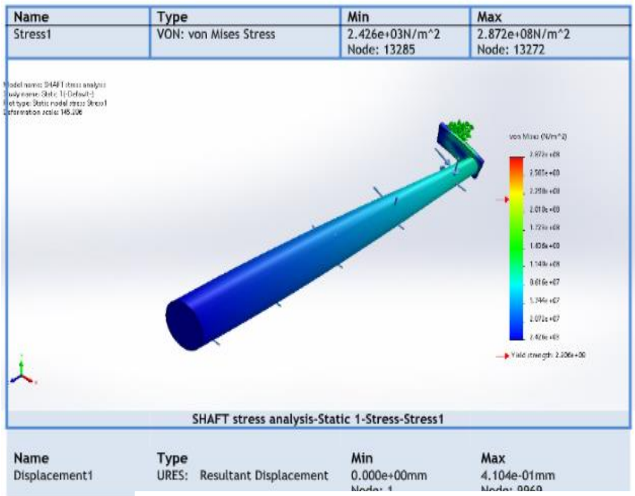


Figure 6 stress analysis of shaft

8. Calculation

8.1 Design of motor

Power of motor = 1 kw= 1000 watt

Rpm of motor = 2650 rpm

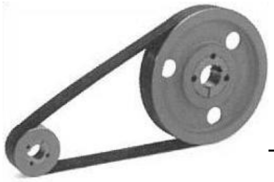
Calculation for final speed & torque

Power of motor= P = 1000 watt.

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

Were,

N→ Rpm of motor = 2650 rpm



T →Torque transmitted

$1000 = \frac{2\pi \times 2650 \times T}{60}$

T = 3.603 N-m

T = 3603 N-mm

T_1 = 3603 N-mm

Now, pulley of 250 and 50 diameter is mounted.

Figure 7a pulley

Figure 7a pulley

So,ratio 5 : 1

T_2 = 18015 N-mm

N_2 = 530 rpm

Now, pulley of 250 and 50 diameter is mounted.

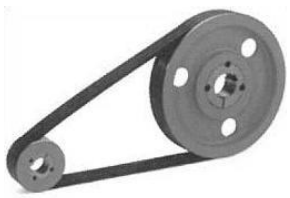


Figure 7b pulley

So, ratio 5 : 1

T_3 = 90075 N-mm

N_3 = 106 rp

Now, T_3 is the maximum torque among all shafts, so we will check shaft for failure here

8.2 Design of shaft

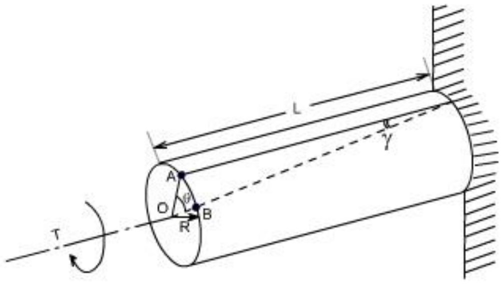


Figure 8 shaft

T3=π/16 x135xd3
d3=90075 x 16/ 3.1.42 x 135
d= 15.03 = 16 mm
but we are using- 20 mm shaft so design is safe.

8.3 Design of bearing

Figure 9 bearing

For 20mm Shaft diameter we take standard breaking no. P204
P=pedestal bearing
2=spherical ball or deep groove ball bearing
=04=5 * 4 = 20mm
Bore diameter of bearing.

8.4 Design of V- belt:

We know that the power transmitted per belt
P = (T1-T2) x V

As we know maximum torque on shaft = Tmax = T3 = 90075 N-mm
Were,

T1 = Tension in tight side
T2 = Tension in slack side
O1,O2 = center distance between two shaft

From fig.

$$\sin\alpha = \frac{R1 - R2}{O1O2}$$

$$\sin\alpha = \frac{125 - 25}{270}$$

Sin α = 0.370

α = 21.7

TO FIND θ

θ = (180 –2α) X 3.14/180

θ = (180 –2*21.7) X 3.14/180

θ =1.62 rad

we know that,

$T1/T2 = e^{\mu\theta}$ Cosec β

T1/T2 = e0.25 x 1.62 cosec 20

T1 = 1.615 T2

We have,

T = (T1 – T2) X R

90075 = (1.615T2 – T2) X 125

T2 = 1171.7 N

T1 = 1892.30 N

So tension in tight side = T1= 1892.30

V = πDN/60

= 3.142 x 0.250 x106 /60

V =1.38 m/sec.

P = (T1-T2) x V

P = (1892.3 – 1171.7) x 1.38

P = 994.428 W (N-m/s)

Number of V-Belts: -

$$N = \frac{\text{Total Power transmitted}}{\text{Power transmitted per belt}}$$

$$= \frac{994.428}{1000}$$ (power of engine 1000 watt)

= 0.99

Say 1 belt

So, 1 belt is sufficient for transmission of power

Calculation of length of belt: -

We know that radius of pulley on shaft

r1 = 125 mm

Radius of pulley on motor shaft

r2 = 25 mm

Center distance between two pulley = 270mm

We know length of belt

L = Π (r2+r1) + 2 x X + (r2-r1)2/x

= Π (25 + 125) + (2 x270) + (25 125)2/270

L = 1048.27 mm = 41.27 inch

So standard A-41inch belt is used

8.5 Force

Force generated by motor for cutting crops

T = Force × length of eccentricity

90075 = F × 45

F = 2001.67 N

$$F = \frac{2001.67\ N}{9.81}$$

F = 203.93 Kg

This is the force by blades to cut crop in sheering

8.6 Design of transverse fillet welded joint.

Figure 10 transverse fillet welded joint

Hence, selecting weld size = 3.2mm

Area of Weld = 0.707 x Weld Size x l
= 0.707 x 3.2 x 50
= 113.12 mm^2

Force Exerted = 2001 N
Stress induced = Force Exerted / Area of Weld
= 2001 / 113.12
= 17.68 N/mm^2

For filler weld:
Maximum Allowable Stress for Welded Joints
= 210 Kgf/ cm^2
= 21 N/mm^2
Hence welding is safe.

9. Result

The mini Paddy Harvester is built to be compact and efficient to cut the paddy crop. The machine was tested to check its cutting capability and efficiency. The test results as shown that the machine is capable of performing according to the design specification. The cost of harvesting by this machine is considerably less compared to that of manual harvesting. It is found that engine is capable to deliver the required power to run a harvester. Speed reduction of gear box for the working, Reciprocating action and cutting capability of the blades is found to be satisfactory.

10.Conclusion

The harvester we have designed is with a new concept of power transmission mechanism. We aimed to design the harvester for the small-scale land farmers. The design is compact, easy to operate low cost and efficient working. The small-scale farmers can use this machine if it further upgraded with small change in the type of cutters used. The cutter we have placed are to be upgraded with design and analysis process. So the final cutting process can be achieved with better performance. This conceptual design is very helpful for the farmers for better productivity. This machine can be operated by the single labour. This is very useful in the areas where labour scarcity is there, and more over skilled labour is not essential for operating the machine.so everyone can use and operate it easily.

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