Design and Fabrication of Crop Cutting and Collecting Machine

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Abstract-*Generally in India large scale as well as small scale farmers facing the problems of labor shortage for crop cutting as well as collecting it. It takes the extra efforts and becomes more expensive. So there is a scope of forming a machine of such kind which is having average cost and able to minimize required time as well as labor cost meanwhile the available machines in the market are expensive. As this machine providing both cutting and collecting facility, it will be helpful to minimize labor charges.*

Keywords: Power transmission, cutting mechanism , collecting mechanism, etc.

1. INTRODUCTION

Our country has an agricultural background. Most of the people in our country depend on agriculture. Generally farmer's doing farming by traditional methods. Thus it takes a lot of time and extra effort also required. The large scale as well as small scale farmers facing the problem of labor shortage. Crop cutting and sequentially collecting is a last stage in farming which takes maximum time of farmer among all farming process. In India crop cutting and collecting is done by manually. Thus our aim is to provide a crop cutting and sequentially collecting machine which reduces the human effort and time required for cutting as well as collecting.

2. METHODOLOGY

As the requirement for crop cutting as well as cutting, the objective was to fabricate reasonable crop cutting and collecting machine for small scale and large scale farmers. For the fulfillment of this objective, it is decided to follow the following steps :

- Consulting with the local peoples who have small scale and large scale farm about the traditional crop cutting methods and equipment.
- Consulting with agricultural equipment manufactures to know about available equipment and recently in demand equipment.
- Referring several research paper regarding crop cutting machine.

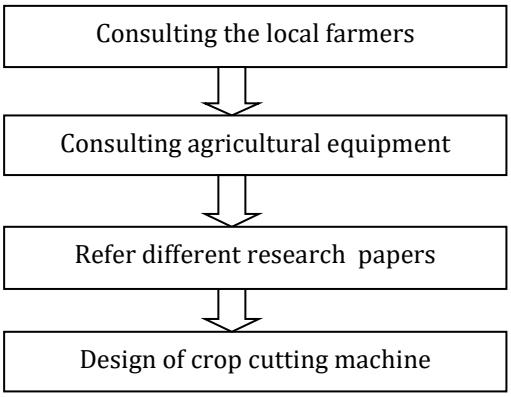


Fig-1: Flow chart of Methodology.

3. CONSTRUCTION AND WORKING

3.1Construction

3.1.1 Main frame:

The required frame must be in light weight and able to sustain weight of petrol engine. The crop cutting machine having dimension 700× 500 ×300 (l × b × h) mm^3 is fabricated. For fabrication purpose the mild steel angle section is use to built the frame.

Fig-2: Main Frame

3.1.2 Petrol Engine:

Petrol engine of 0.73Kw, 3200 rpm is used. And it is rope start type engine. Petrol engine is used because of it has good efficiency and easily available in rural areas.

Fig-3: Petrol Engine

3.1.3 Chain:

A motorcycle chain is used as a collecting belt. The collecting plates are welded to collecting chain. The metal strip which is welded to chain moves along with chain to carry cutted crops.

3.1.4 Chain sprocket:

Fig-4: Chain sprocket

A motorcycle chain sprocket is used for carrying a chain of collecting belt. In collecting mechanism two sprockets are used for collecting mechanism.

3.1.5 Cutter Assembly:

Cutter assembly consists of a sliding and stationary cutter plate. A 4 mm thick plate is used to give a support at teeth.

3.1.6 Bevel Gearbox:

Fig-5: Bevel gear

It is required to transmit a power to two mechanisms that is four bar mechanism and collecting mechanism. To divert the motion by 90^0 this type of gear box is used.

3.1.7 Ball Bearing

A bearing is a machine element that constraints relative motion to only the desired motion, and reduces friction between moving parts.

Fig-6:-Ball bearing

3.1.8 Assembly of cutting mechanism:

Cutting mechanism consists of two cutting blades namely sliding cutter blade and stationary cutter blade. Both cutter blades are supported by 4mm plate. Stationary cutter blades are directly welded to frame. Sliding cutter blades allows to sliding over stationary blade plate, so that cutting action takes place.

3.1.9 Collecting mechanism:

Collecting mechanism consists of motorcycle chain on which metal strips are welded for collecting crop. Chain sprocket used to carry chain. When cutting action takes place simultaneously collecting mechanism collects the crops.

3.2 Working

This machine consists of two mechanisms one is a four bar 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 sprocket and motorcycle chain.

This machine is powered by 1HP, 3200 rpm petrol engine. By using V-Belt power is transmitted to bevel gear box. Bevel gear box is used to change direction of drive by 90^0 in the gear system.

One end of this output shaft is connected to four bar 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. Collecting mechanism consist of motorcycle chain with collecting plates welded on it. Collecting belt simply carry cut crop sideways.

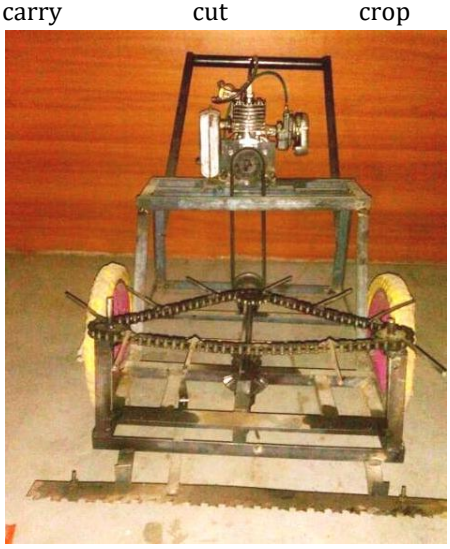


Fig-7: Crop cutting and Collecting Machine

4. DESIGN PROCEDURE

To prepare any machine part, the type of material should be properly selected, considering design, safety. The selection of material for agricultural equipment application is given by the following factors:-

1) Availability of materials
2) Accessibility of the materials
3) Machinability of the material
4) Cost of the material

As per the above factors mild steel is the most preferable material due to it's availability and machinability.

4.1 Engine Specification

Displacement	24.5cc
Engine power	0.73kW / 1.0HP
Fuel tank	0.4L
Spindle size	M8 x 1.25LH
Fuel mixture	50 : 1
Features	Waist cushion.
Maximum Horse Power	0.97 HP
Model No	EM2500U
Speed Controllable	-

Max. 3200 RPM

Reduction of speed during engine to pulley –Reduction ratio = 9 inch / 3 inch = 3

Speed of Intermediate shaft =

3200/3 = 1066.67 rpm

Bevel gear speed reduction = T2/T1= 16/10 =1.6

Speed of chain = 1066.67/1.6 =666.66

Oscillation of cutter are also same as chain =666.66. This is maximum speed of cutter. Therefore reduction can be obtain by controlling throttling.

5. DESIGN OF FRAME –

Design of frame structure-

A frame made up of structure steel

E = 210 GPa, $\gamma = 0.3$, Syt =335N/mm^2

A frame having Engine weight =15 kg distribute on four point. 3.75 kg at each point. 3.75 Kg=36.7875 N

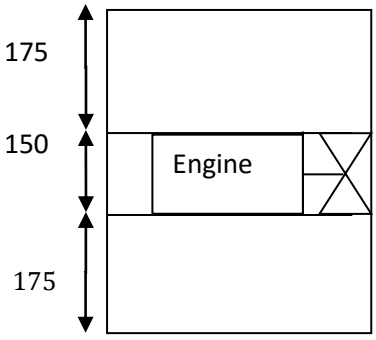
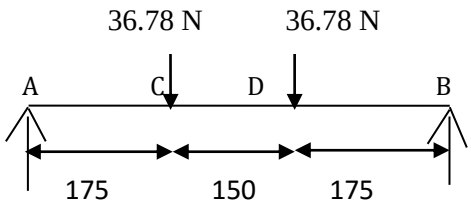


Fig-8: Engine base mounting frame structure design.



$\sum f = 0$

0= A + B- 36.78-36.78

A+B = 73.56

A= 36.78 N

B =36.78 N

B.M. calculation –

B.M. at A= 0

B.M. at B = 36.78*175 = 6436.5

B.M. at C= 36.78*325 -36.78* 150 = 6436.5 N-mm

B.M. at D= 0

MAX. B.M. = 6436.5 N -mm

Maximum Load on Column DG Check design for that

Frame made up of angle (L section 25 * 3) as shown in fig. –

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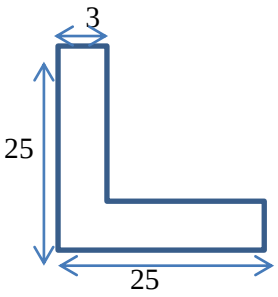
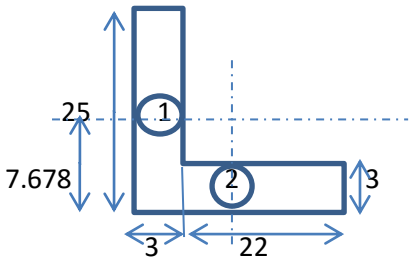


To determine position of neutral axis



At section 1 & 2 –

A_1= 25*3 =75 mm^2 y1 = 12.5 mm

A_2 =22*3 = 66 mm^2 y2 = 1.5 mm

$\bar{y} = \frac{A1y1+A2y2}{A} = \frac{75*12.5+66*1.5}{75+66}$ =7.67 mm

Moment of inertia of beam –

$$Ixx = Ixx_1 + Ixx_2$$

$$Ixx = \left[\frac{bd^3}{12} + A1h^2\right] + \left[\frac{bd^3}{12} + A2h^2\right]$$

$$\left[\frac{3*25^3}{12} + 75 * (7.67 - 12.5)^2\right] + \left[\frac{22*3^3}{12} + 66 * (7.67 - 1.5)^2\right] = 8217.9649 \text{ mm}^4$$

Then , Bending stress on beam is

$$\frac{M}{I} = \frac{\sigma}{Y}$$

$$\frac{6436.5}{8217.9649} = \frac{\sigma}{7.6709}$$

$$\sigma_{max} = 6\ N/mm^2$$

Structure steel having Syt = 335 N/mm^2

$$\sigma_{permisible} > \sigma_{max}$$

$$Therefore\ design\ is\ safe.$$

6. Design of Pulley

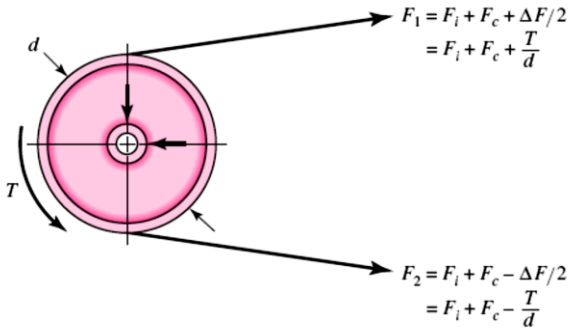


Fig.9: Diagram for Force Calculation

Diameter of first Pulley = 250 mm

Diameter of second Pulley = 65 mm

Centre distance = 400 mm

Power transmitted = 730 W

For sprocket 1 –

Diameter of first sprocket = 250 mm

$V_{max} = \frac{\pi dN}{60*1000} = \frac{\pi*.250*3200}{60}$ =41.86 m/sec

Power transmitted = Po

$$P_o = (T_{ft} - T_{fs})\ V$$

$$730 = (T_{ft} - T_{fs})41.86$$

$$T_{ft} - T_{fs} = 17.43$$

Now, $\propto = \sin^{-1}\left(\frac{D-d}{2C}\right)$

$\propto = \sin^{-1}$ [(250-65)/2*400]

$\alpha = 13.37^0$ i.e. 0.23336 rad.

Arc of contact $\theta = \pi - 2\alpha$

$= \pi - 2 * 0.23336$

= 2.6748 rad.

For chain friction losses is zero i.e. $\mu = 0.25$

Tensions on chain –

$$\frac{Tft}{Tts} = e^{\mu\theta}$$

$$\frac{Tft}{Tts} = e^{.25*2.67}$$

$$\frac{Tft}{Tts} = 1.94$$

$T_{ft} - T_{fs}$ =17.43

1.94 Tfs - T_{fs} =17.43

T_{fs} = 18.54

Tft = 35.97 N

Total force = T_{fs} +T_{ft}

= 18.54 +35.97

= 54.51 N

7. RESULT

By doing analysis of cutter blade in ANSYS software following results are obtained-

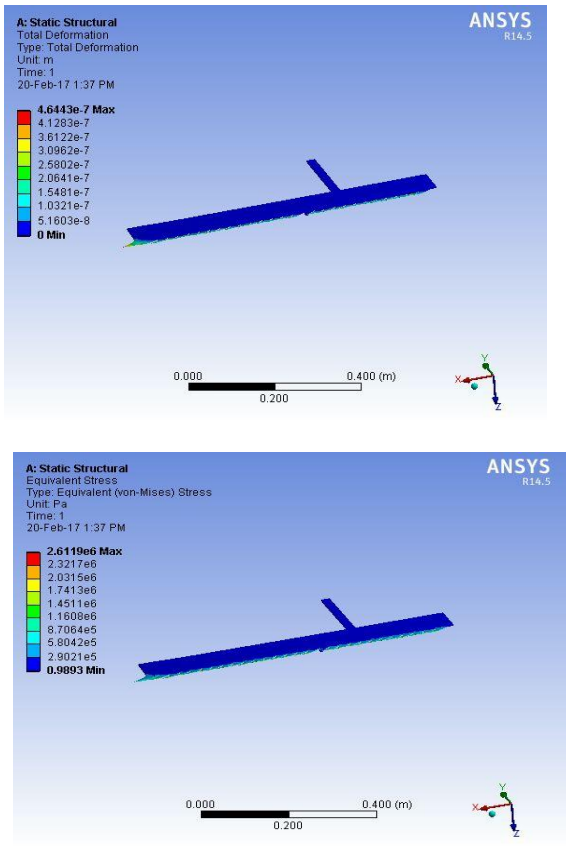


Fig-10: Force analysis on Cutter blade

The force analysis on the cutter blade is done. A uniformly distributed load of 220N is applied on the cutter blade. This force generated a Von Misses stress of 2.62 Mpa. The yield strength of the cutter blade is 386 MPa. This rendered the cutter safe from the cutting forces.

8. CONCLUSION

By doing all the study it is clear that the crop Cutter and collecting machine is very easy to construct and it's working is also very simple and cheap. This machine is able to run effortlessly thus using this machine efforts of farmers can be reduced. The cost of this machine considerably less as compare to manual grass cutter. The success of this machine depends on how the farmers use this machine.

ACKNOWLEDGEMENTS

We prepared the above paper with the help of research paper and also thankful of our guide **Prof.Dr.Borkar.B.R.**

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