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DESIGN AND ANALYSIS OF ATTACHMENT OF SUGARCANE HARVESTER FOR A TRACTOR

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ABSTRACT

In today's world of competition, there is a need for faster rate of production of agricultural products as the agriculture is the backbone of India. In India, farmers are facing problems of labour shortage.Therefore, there is a need of mechanization in the Indian agricultural sector as the agriculture sector is still dependent on labours & hence it is labour intensive. The need for mechanization is increased by the scarcity of workers on account of urbanization and the consequent rise in labour costs. Also, speed is the major factor in the faster rate of production which helps to improve the quality of agriculture products like sugarcane. Sugarcane harvesting by a machine has a more capacity to cut the sugarcane faster compared to the manual one. Hence, need of using sugarcane harvester in India is necessary for faster rate of production of sugarcane products as well as harvesters take less time to cut the cane and cuts cane in smaller parts so that it becomes easy to transport with larger amount of quantity in one trolley. This project aims to design and analyze small scale sugarcane cutting machine harvester as an attachment for tractor for sugarcane harvesting to reduce farmers' effort and to increase production of agricultural products of sugarcane at the lower cost which can be affordable to Indian farmers or a group of farmers. The cost of an attachments goes up to Rs.35000/-.The design is done analytically, drawn in Pro-Engineer Wildfire 4.0 & results are analyzed in Ansys 11.The project also aims to design and analyze a Cutting, Conveying and collecting methodology of a sugarcane harvester as an attachment to the tractor which takes the power from tractor only through its Power Take off (PTO) point.

KEYWORDS: Sugarcane harvester, cutting, conveying, Power Take Off point, agriculture

INTRODUCTION

India is one of the major agricultural countries in the world. Maharashtra being a major sugarcane cultivating state had majority of labours for harvesting of sugarcane manually, but that was the situation of 10-20 years back. Today, as the demand of sugarcane products like sugar has increased, the cultivation of sugarcane is also increased. But as there has been a shortage of labours for the sugarcane harvesting process, due to which sugarcane which is ready for harvesting is left as it is in the field and dried which affects its quality & quantity of sugar content in it due to delay in supplying to the sugarcane industry. The process of harvesting consists of cutting the cane from bottom, then cutting off its top leaves, making a bundle which consists of 10 to 15 canes each and then carrying it to the trucks and loading it. This entire process is time consuming and requires a lot of hard work and is tedious as it is done manually by labours.

When we look at the world scenario, it is found that the fields of sugarcane are extremely huge compared to the Indian farms and hence they use machines for harvesting instead of labours as it is not possible by the labours to harvest the farm quickly. Therefore, labours for harvesting are very rare case. Therefore it is seen that machines specially for sugarcane harvesting have been built & used and they have worked out to be quite successful. There have been attempts made to make use of these harvesters in India, however, the attempts turned out to be unfavorable to the small size farms and also land quality of our farms. Hence, till today also very few sugarcane harvesters are used for helping in the process even though a need is arising due to scarcity of labourers and an increase in demand for a faster and more profitable output of farmers .

RESEARCH METHOLOGY

The aim of the project is to design and analyze a cutting front attachment & rear Conveying attachment to be appended to a tractor (Mahindra Yuvraj 215) which will cut the sugarcane and convey it to a trolley which will follow the tractor. This attachments will work as a sugarcane harvester which can be used for a smaller area of farms especially in India where the area of farms are smaller unlike the developed countries where huge price & cost cane harvesters are affordable to the farmers . Also the main aim of project is to design a smaller sugarcane harvester at lower price so that it can be affordable to the farmers or group of farmers of India.

The parts of cutting & conveying attachments are designed for tractor to which trolley which is attached for collecting the cane. Cutting attachment is fixed to the front side of a tractor which cuts the sugarcane with the help of two rotary blade cutters. The power required for working for the attachments is supplied by the Power Take off (PTO) point of tractor only. The power is transmitted to the cutting & conveying attachments simultaneously. In cutting part power is supplied by the shaft which is connected to the belt. The required enough tension to sugarcane is given by knockdown roller which is in rotary motion & pushes the cane in forward direction. This creates tension in stalk of cane which helps to cut the cane easily by rotary disc cutters. After cutting the cane, the cane remains lied on the ground & tractor moves forward. The lied cane is collected by the conveying part attachment with the help of lifters & cane is passed through rollers. These rollers help to drag the cane in trolley through number of rollers attached to the frame. In this process the cane is compressed between the rollers but juice of cane does not come out. The leaves of the cane are removed with the help of trash removals which are connected to the end of conveying attachment. Finally the cut cane is thrown in the trolley which is attached to the tractor.

Power of tractor is 15 hp out of which 12 hp is supplied to the PTO (Power Take Off) Point. At PTO gives 540 rpm with a standard 6 splines shaft having length 76 mm and diameter 11/8 inches.

FOR CUTTER

The required amount of force to cut the cane = 413 N[4]

Amount of Torque required to cut the cane considering disc radius of 100 mm

$$T = \text{Force} \times \text{radius}$$

$$T = 413 \times 0.1$$

$$T = 41.3 \text{ Nm}$$

$$T \approx 42 \text{ Nm}$$

Power getting at PTO in 12 hp, dividing the power for cutting & conveying equally, the power for cutting & conveying 6 hp respectively with speed 540 rpm.

Power = Torque * Angular velocity

$$P = T\,\omega$$

$$6 \times 746 = T \times (2\,\pi\,540/\,60) \ldots\ldots \text{ (1 hp= 746 watt)}$$

$$\text{Torque} = 79.13 \text{ Nm}$$

Torque actually supplied (79.13 Nm) by the PTO is greater than required torque (42 Nm). Hence it is possible to cut the cane with available power supplied by the tractor.

FOR ROLLER

Assuming the diameter of cane = 38 mm

Distance between the bearings on which shaft is supported is equal to the distance through which canes are moving upwards = 290 mm

Therefore maximum number of canes that can be accommodated in this space = $\frac{290}{38}$

= 7.63

= 8 canes

Weight of one cane = 2 kg = 20 N

Therefore, weight of 8 canes = 20 × 8 = 160 N

The total weight of 8 canes is supported on three rollers in the conveying attachment.

Therefore, force one roller can be calculated as

$$(W_C) = \frac{160}{3}$$

$$(W_C) = 53.33 \text{ N}$$

Combined weight of shaft and roller can be given by,

$$(W_{SR}) = 2 \text{ kg} = 20 \text{ N}$$

Maximum compressive force applied by rollers on one cane = 25 kg = 250 N

Therefore total compressive resistance force applied by 8 canes on the roller = 250 × 8 = 2000 N
Therefore, frictional force on the roller due to this reaction is given by,

$$(F) = \mu \times N$$

Assuming co efficient of friction, μ= 0.5

$$(F) = 0.5 \times 2000$$
$$(F) = 1000 \text{ N}$$

Therefore, frictional torque is given by,

$$M_t = F \times r$$
$$M_t = 1000 \times 0.05$$
$$M_t = 50 \text{ Nm}$$

Now, vertical reaction on bearings are calculated as follows,

$$V_A = V_B = W_C + W_{SR} + N = 743.77 \text{ N}$$

Therefore, vertical bending moment is given by,

$$(M_V) = 743.77 \times 0.145 = 107.84 \text{ Nm}$$

Horizontal reaction on bearings is

$$H_A = H_B = \frac{N \text{ Sin}45}{2}$$
$$H_A = H_B = \frac{2000 \times \text{Sin}45}{2}$$
$$H_A = H_B = 707.11 \text{ N}$$

Therefore, horizontal bending moment can be calculated as,

$$(M_H) = H_A \times 0.145$$
$$(M_H) = 707.11 \times 0.145$$
$$(M_H) = 102.53 \text{ Nm}$$

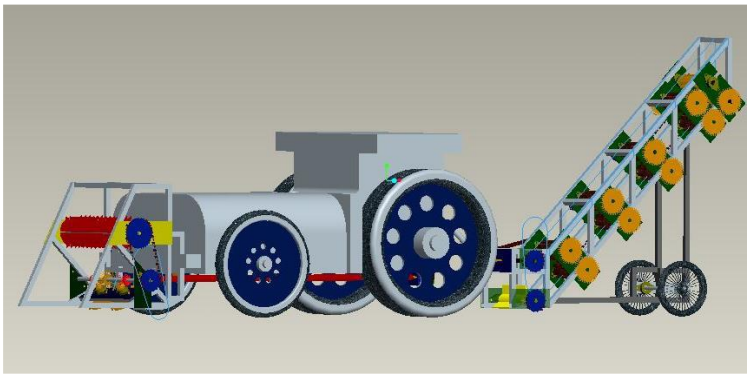
Therefore, Total Bending Moment is calculated as,

$$M_B = \sqrt{M_H{}^2 + M_v{}^2}$$
$$M_B = \sqrt{102.53^2 + 107.84^2}$$
$$M_B = 148.8 \text{ Nm}$$

Induced shear stress can be calculated as,

$$(\tau) = \frac{16 \times \sqrt{M_t{}^2 + M_B{}^2}}{\pi d^3}$$
$$(\tau) = \frac{16 \times \sqrt{50^2 + 148.8^2}}{\pi \times 0.038^3}$$
$$(\tau) = 14.56 \text{ MPa}$$

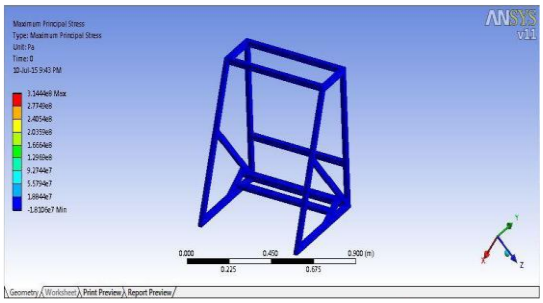
As induced shear stress is lesser than allowable shear stress, hence design is safe for the bending failure of shaft.



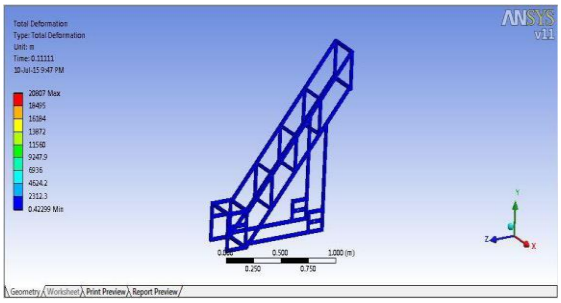
Assembly of sugarcane harvester with tractor

RESULTS AND DISCUSSION

Analytically the results are showing safe in case of stress failure & negligible deformation for cutting & conveying attachment. Similarly comparing these with Ansys 11 result, it shows that the results are safe.
The diagrams given below shows that after applying a load on frames i.e. front & rear frames, the values of the stresses which are obtained from the analysis are safe. It shows that frame is stable for stresses.



Result of front attachment



Result of rear attachment

CONCLUSION

The various experiments were performed by the researchers for minimizing the force required for the cutting of sugarcane for the harvesters which helps to increase the rate of harvesting. The changes made in cutting angle, type of blade like serrated or normal blade, angle of blade affect the quality of the cut of cane. From the research it is concluded that at 45° angle, the required amount of force is minimum & hence the blades were placed at the angle of 45°.

The main objective is to design of small scale sugarcane harvester i.e. Compact in size, which is designed in Pro-Engineer Wildfire 4.0 & analyzed in Ansys 11. The harvester has lower price i.e. Rs.35000 /- which is comparatively much lesser than any other existing sugarcane harvester. As the price of harvester is lower therefore, it is affordable & Economical in terms of money for Indian farmers. There are two attachments which are attached to the tractor and then from taking power from PTO, it works as sugarcane harvester. The harvester is easy to operate & assemble as there is no need of skilled worker. The maintenance & operating cost of harvester is much lesser as it is used as an attachment for a tractor & takes the power from tractor only. Design of harvester is smaller and hence it can be used for smaller as well as larger area farms easily.

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REFERENCES

[1] Rasoul Hematian, Ebrahim Fayyazi, Bahram Hosseinzadeh, Gholamhassan Najafi and Barat Ghobadian, (2013), "Study of shearing strength of sugarcane stem using Nano-coated knifes", TJEAS Journal-2013-3-3/249-258.

[2] Adarsh J Jain, Shashank Karne, Srinivas Rathod L, Vinay N, Thotad and Kiran P (2013), "Design And Fabrication Of Small Scale Sugarcane Harvesting Machine", ISSN 2278 –0149,Vol. 2, No. 3/204-210.

[3] R. Hemmatian1, G. Najafi, B. Hosseinzadeh, T. Tavakoli Hashjin and M. H. Khoshtaghaza (2012), "Experimental and Theoretical Investigation of the Effects of Moisture Content and Internodes Position on Shearing Characteristics of Sugar Cane Stems", J. Agr. Sci. Tech. (2012) 14: 963-974.

[4] Javad Taghinezhad Reza Alimardani, Ali Jafari (2012), "Effect of Sugarcane Stalks Cutting Orientation on Required Energy for Biomass Products", Internatıonal Journal of Natural and Engineering Sciences 6 (3): 47-53, 2012, ISSN: 1307-1149, E-ISSN: 2146-0086.

[5] H. Taghijarah, H. Ahmadi, M. Ghahderijani, M. Tavakoli (2011), "Shearing characteristics of sugar cane (Saccharum officinarum L.) Stalks as a function of the rate of the applied force", AJCS 5(6):630-634(2011) ISSN: 1835-2707.

[6] E.Meyer and L.J. Fenwick (2003), 'Manual Sugarcane Cutter Performances in the Southern African Region", Proc S Afr Sug Technol Association (2003) 7:150-157.

[7] Roberta Da Cunha Mello & Harry D. Harris (2001), "Angled And Serrated Blades Reduce Damage, Force And Energy For A Harvester Base cutter", Proc. Aust. Soc. Sugar Cane Technol., 23: 212-218.
[8] Harry D. Harris and Roberto Da Cunha Mello (1999), "Kinematics, blade shapes and edges for alternative base cutter configurations", Proc. Aust. Soc. Sugar Cane Technol., 21:185-190.
[9] S. Kroes & Harry D. Harris (1997), "The Optimum Harvester Forward Speed By Sugar Research Institute", Mackay, University of Southern Queensland, Toowoomba, 147-154.
[10] S. Kroes, and Harry D. Harris (1995) "A kinematic model of the dual basecutter of a sugarcane harvester", J. Agric. Engin. Res., 62: 163-172.
[11] S. Kroes and Harry D. Harris (1994), "Effects of cane harvester base cutter parameters on the quality of cut", Proc. Aust. Soc. Sugar Cane Technol., 16:169-177.
[12] Indian Sugar Mills Association (2012), Sugarcane Harvester & Mills observation on harvester Wednesday, July 04, 2012.
[13] A Textbook of Machine Design by R.S.Khurmi & J.K.Gupta, edition 2005.
[14] PSG Design Data Book by PSG College of technology, Coimbatore, Tamilnadu, Revised Edition 1978.

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