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Computer Aided Design,Multibody dynamic analysis and Development of Low cost Solar Powered Maize corn Desheller

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ABSTRACT

In our country farmers are very poor, cannot afford engine operated maize shelling machine due to high initial and maintenance cost. Traditionally maize cob is deshelled with the help of bare fingers which causes injury to the grains and also requires long time. Hence a Low cost solar powered Maize corn Sheller is conceptually designed using CATIA V5 which mainly consists of deshelling unit, D.C motor, power transmission unit, bearings, base frame and Solar Panel. The CAD model of Maize Desheller was imported in ,stp or .igs format to ADAMS software and conducted the Multibody dynamic analysis. Simulation results are presented graphically on the graphs, which show the values of the measured torque and force parameters are given input to ANSYS work bench to do static stress analysis. The developed Maize desheller was tested in field as well as operations at load for short durations. The analysis of data collected during the short duration test revealed that the machine is stable and strong and its speed of operation 100 rpm was quite satisfactory. The deshelling capacity of the machine was 65 kg/hr with shelling efficiency of 99.50 %.

Keywords: *CAD, MBD, FEA, Solar Power, ADAMS, Maize corn, Desheller.*

1. INTRODUCTION

Deshelling operations of maize follow harvest and pre-drying processes. Maize corn after taking from the fields is dried and used for the many purposes. The grains on the cob is held in a systematic manner along its length and circumference rigidly. It is quite difficult to separate these grains from the cob. It is a very lengthy process to separate by hands only.

Manual labor has been an integral part of rural farming systems in India for hundreds of years and is still continuing. Because of the peculiar local conditions the lack of electricity on a large scale, and the immediate utility of implements, solar energy is effectively used.

This equipment has designed specially for poor farmers who are not able to carry the cost of large equipment and can not wear their operating expenses. Since the labour problem is rising day by day in the farming field hence the concept of "Solar powered Maize Desheller"has came into existence.

Commercial maize deshellers are more expensive, with a cost range of Rs.0.80 to 1.0 lakh [1] ; pedal-powered maize deshellers cost range of Rs.0.20 to 0.30 lakh which requires more than many families can afford. While industrial deshellers are highly productive, their energy infrastructure requirements can render them unusable in rural villages. Furthermore, mechanized equipment and stationary pedal-powered devices are difficult to transport to the users. As a consequence, farmers may be required to travel long distances to process their crops or the technology may not be able to reach the communities who need it most.

This equipment consists of maize desheller tubular unit with bearing mountings , Base frame , gear mechanism ,D.C motor and solar panel.

In the modern era where electricity is becoming the most important factor for development of any big nation like INDIA, but there are some rural places where electricity availability is the biggest problem. So we thought to make the project which operates using Solar Power which is environmentally friendly and low cost equipment.

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2. METHOD & MATERIAL

Moisture content seriously affects the shelling ability of maize corn. An average moisture content of 14% to 18% for maize that was to be deshelled was reported by [1]. Another factor that affect the thresh ability of maize in a mechanized system is the size of the maize cob. The mechanical shellers need to be adjusted to the various sizes of cobs. According to [2] the various sizes of maize cob ranges from 50mm to 85mm depending on variety. The base frame was made of mild steel square hollow tube for providing support to all other machine components. The GI tube of 75mm diameter was selected based on 15 to 20% larger then maximum diameter of maize cobs. In order to deshell the cob one end of the cob as inserted into GI pipe the inner surface of the pipe was welded by deshelling blades longitudinally 3 rows which helps to detach maze corns the height of the blade was designed depend on the length of the maize corns plus 5% extra length. The maize cob were inserted one by one to both Sheller blades by one operator and other is required for pedalling., the shearing action of the blades welded inside the pipe surface, the corn were separated from the cobs and then collected through the outlet 76mm PVC elbow fitted at the bottom of the pipe frame. Both the workers could be interchanged during operation to increase the productivity and continuity in operation.

Design of machine is not an easy task. Over a period of time, design of different machines was done by using the paper and drafting tools, but now most of the designing work is done by using CAD tools.
Structural analysis calculates the effects of steady loadings on a structure, while ignoring inertia and damping effects, such as those caused by time varying loads. A static analysis can, however, include study inertia load, and time-varying loads that can be approximated as static equivalent loads. Static analysis determines the displacements, stresses, strain and forces in structures or components caused by loads that do not

For design of each component a lot of survey has been done by meeting the farmers and getting the information and various field data. This project was designed by using high end modeling and simulation tool CATIA V5 software and results are verified by using analysis software ANSYS 14.

Maize desheller unit

The various size of maize is observed and an average dimensions is considered for blade design. In this equipment two size of blade is used one set of blade is used for smaller diameter and another set of blade is used for larger diameter maize. Three blades and four blades are placed at 120^0 and 90^0 to each other inside a hollow pipe of 75mm diameter having190 mm length . The blades are kept at inclined position as the maize corn are placed. The blade shape is also tapered which gives a tapered shape inside the pipe.

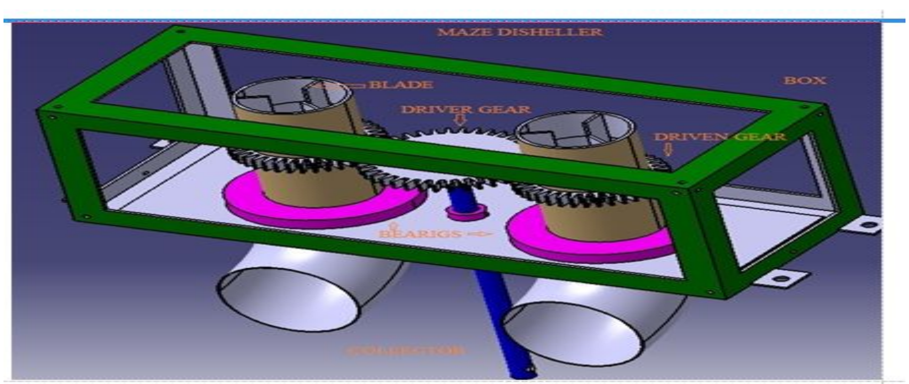

Figure*: 1 CATIA 3D Desheller Mechanism*

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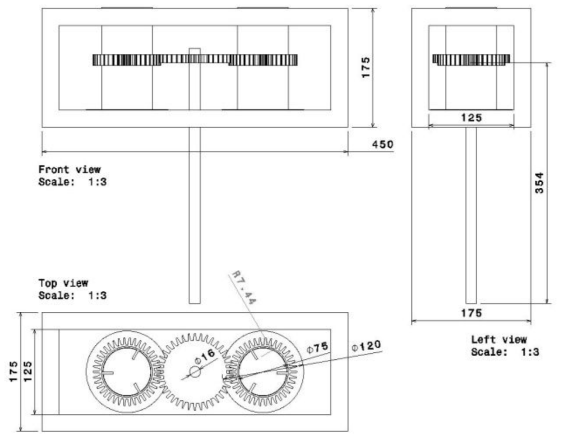

Figure*: 2 CATIA 3 blades Desheller Mechanism*

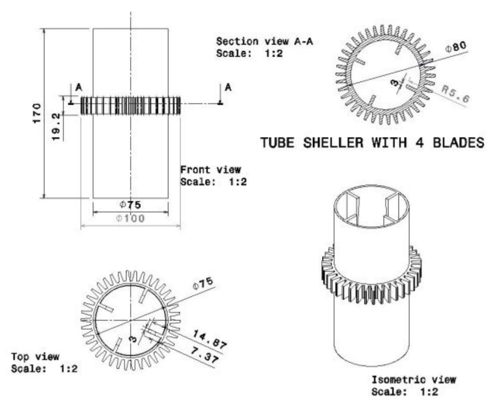

Figure*: 3 CATIA 4 blades Desheller Mechanism*

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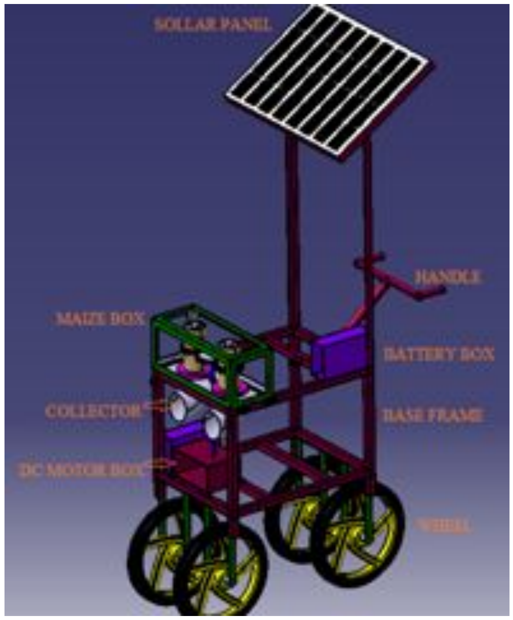

Table 3.1 Structural Steel Properties

Density	7850 kg m^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Thermal Conductivity	60.5 W m^-1 C^-1
Resistivity	1.7e-007 ohm m
Young's Modulus	2.e+011 Pa
Poisson's Ratio	0.3

Figure*: CATIA Solar powered Maize Desheller*

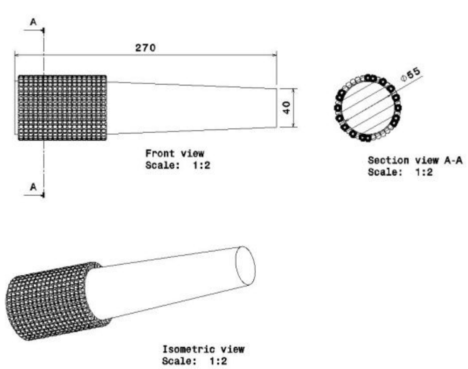

Figure*: Maize corn model*

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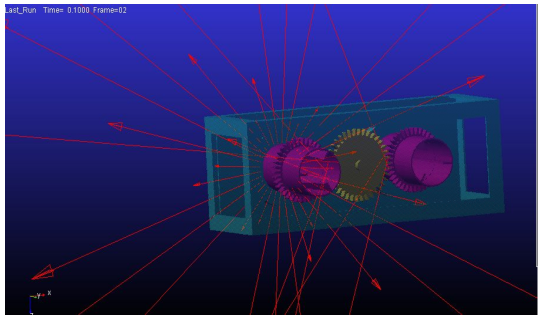

Figure*: 1Adams Desheller Simulation*

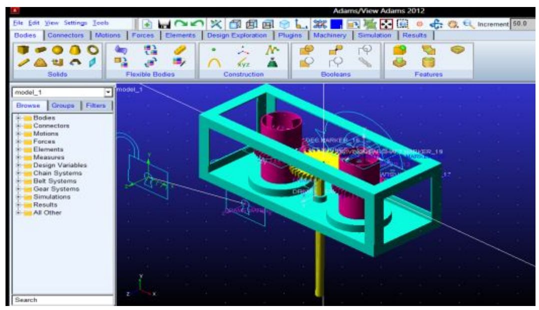

Figure*: 1 ADAMS Model with Materials Properties*

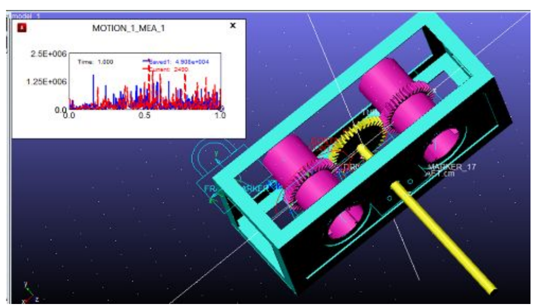

Figure*: 1Adams Desheller Simulation Motion plot*

3. DESIGN ANALYSIS

In this component the blade is designed according to the various shape and size of the maize available in the field. The blades are mounted inside a pipe. Two pipes of same size is used here . Both the pipes are connected to gear mechanism and a shaft rotates both the pipe. The required power is developed by a 100 rpm dc motor .both the pipes are supported with ball bearing.

Force required to thresh the maize is given by

$F = m\omega^2 r$ (1)

$\omega = 2\pi N/60$ (2)

$P = F\omega r.$ (3)

Energy Requirements:

The battery 12.8v, 7.5 Amp can power a 20 watt for a theoretical maximum of 5-6 hours. The 30 Watt solar panel will be able to fully charge the battery in about 3-4 hours, which means it should be capable of charging the battery fully on a regular basis. Our system can probably meet our needs most of the time, but just barely. We recommend a slightly larger solar panel such as the 40 Watt ensures required power transfer from the battery to run the D.C. motor, whilst the solar panel power to continuously recharge the battery while in operation.

Figure 3: Solar Plate 40 Watt

Figure 4: D.C Motor 12V

Figure 5: Battery 12.V 7.5Ah

Electrical energy of the battery is converted to mechanical energy through a set of blades designed to achieve cutting operation.

The motor torque **T** is related to the armature current, **i,** by a torque constant **K**;

$T=Ki$ (4)

The back electromotive force (emf), *Vb*, is related to the angular velocity by:

$V_b = K\omega = Kd\theta/dt$ (5)

Power consumed by motor=40 watts,

Speed N = 100 rpm, rotor inertia J is assumed to be 0.01 and supply voltage Vi=12 volts

Using the following equation=]n we will calculate the value of K , $\omega_m = V_t/K = 2\pi N/60$ then We get K= 1.146 and ω=10.47 rad/sec

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4. RESULT & DISCUSSION

It was observed that, the maximum and minimum principal stresses for base frame were found to be 1.55e6Pa and 1.9e-10Pa respectively with a total deformation of 3.25e-2 mm. The stress values were within the limits of the yield stress of the material.

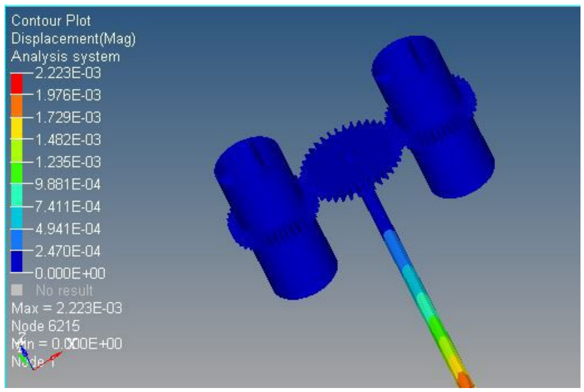

Figure:*1 Displacement Plot Gear Mechanism*

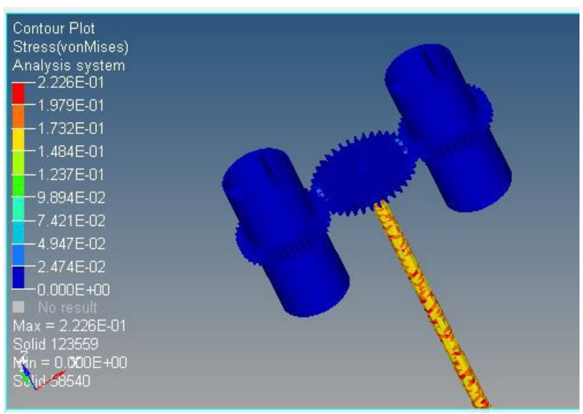

Figure: ***1Von misses Stress Plot of Gear Mechanism***

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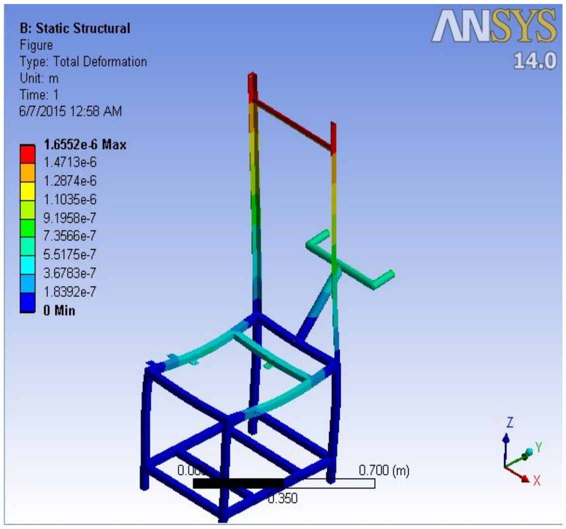

Figure*: 1Total Deformation of Base frame*

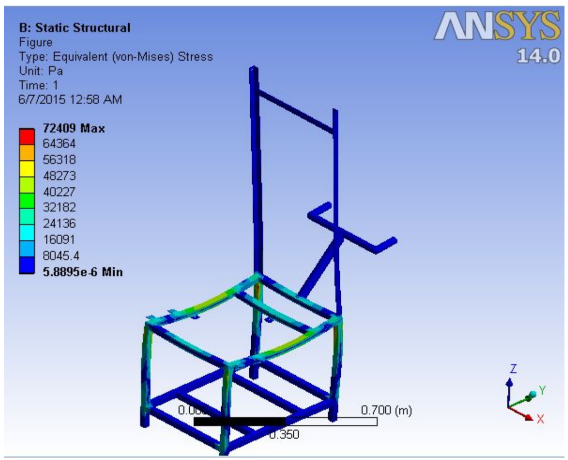

Figure*: 1Von misses Stress of Base frame*

Table 9. Comparison table for motoring mode

	PI	PID	FUZZY
SPEED(rpm)	1500	1500	1500
Settling time of speed	0.8	1.8	0.4
Speed fluctuations	±20rpm	±10rpm	-
Torque ripples	±6	±0.5	±0.05

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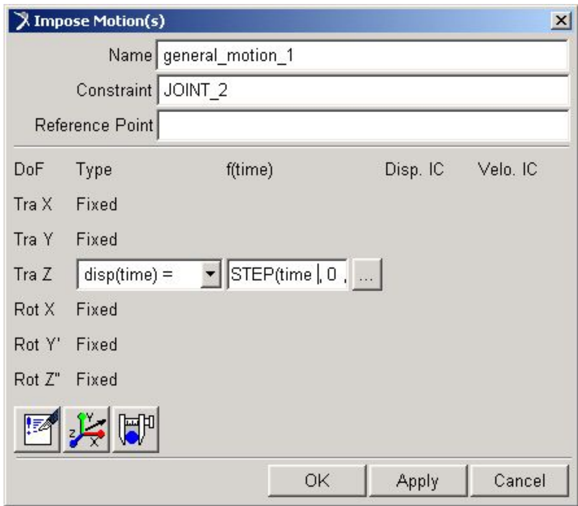

Figure: ***1***

Figure: ***1***

5. CONCLUSION

The output capacity of pedal operated desheller was only 60-65 kg/h but solar operated maize desheller gives 75-85 kg kg/h for the same threshing efficiency. And the cleaning efficiency is 99 percent. This requires only one labour and very less maintenance cost with large saving. The number of blades component can be increased to improve the

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productivity of the equipment.This can be done by increasing the blade component 2-3. The total cost of fabrication of the prototype is affordable to poor farmers compared to the cumulative costs of service hiring or purchase of industrial shellers. The Desheller can help to substantially reduce the human labour involved in deshelling at an affordable cost and also reduces the time used for operation on small farms. The machine designed here utilizes the solar energy in place of conventional fuel. In villages peoples are facing fuel shortage and also unavailability of required power supply.

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