DESIGN AND FABRICATION OF COCOA POD SPLITTING AND BEAN EXTRACTION MACHINE

Arivu. Y[1], Manikandan S[2], Sivakarthi T[3], Gowtham M M[4]

[1]*Assistant Professor, Mechanical Engineering, Bannari Amman Institute of Technology, Erode, Tamilnadu.*
[2,3,4] *Student ,Mechanical Engineering, Bannari Amman Institute of Technology, Erode, Tamilnadu.*

Abstract - *As India is agriculture based country and 70% people do farming and related work. Agriculture is required to be boomed to enhance the Gross Domestic Product of the country by improving the productivity. The productivity of the cocoa fruit can be increased with the help of simplify the bean removing process. Bean removing from cocoa pod is the necessary procedure in cultivation of the fruit. For doing fieldwork maximum human power is used, but some present year's needs of workers are necessary but availability of workers are less for field work. So reduce the need of workers for removing bean from its pod. This project suggest a model of manually operated cocoa pod splitting and bean extraction machine which will gives optimum results in less time.*

***Key Words*: Cocoa fruit ;Bean ; cocoa pod splitting**.

1. INTRODUCTION

This study outlines the design of a very efficient, highly productive, cost-effective, ergonomic and environmentally friendly cocoa splitting machine that will be used by cocoa Farmers world - wide to increase and boost productivity and enhance the quality of coca products to the highest possible level devoid of any hazards, dangers or perils. This machine can be manufactured from locally available scraps and assembled and maintained at a relatively low cost. The knives which do the splitting are actuated by handle. The machine can be assembled and/or disassembled easily and quickly, and, therefore can be owned patronized by a group of cocoa farmers who can easily bear the low cost of maintenance of the already relative cheap machine.

2. Literature Review

[1]. S.K. Adzimah and E.K. Asiam (2010), This study has intensively and extensively dilated on the dire need to have an efficient, cost-effective, highly ergonomic, environmentally friendly cocoa splitting machine that will be used by cocoa farmers to increase and boost productivity and enhance the quality of cocoa products to the highest possible level, devoid of any hazards, dangers, perils or risks.

[2] B.O.Akinnuli1, O.S.Bekunmi and C.O.Osueke (2015), Cocoa beans processing for human consumption is growing into different products from time to time. Demand for it's processing equipment is also at increase and costly to purchase. One of the processing workstations that needs urgent attention is the winnowing section, where the shell (seed coat) is removed from the cocoa beans and retains the broken cotyledons(Nibs). The mechanization of this process is capital intensive and all cocoa processing industries in Nigeria have no local substitute that can render same service at lower cost. Hence, the design of a winnower that can be produced locally at low cost and capable of producing high quality products. The required components were identified, each of these components was designed and the designed values were used for the proposed machine drawings.

[3] Ndukwu MacManus Chinenye (2010),Cocoa (Theobroma cacao L.) is widely produced in West Africa and South America and is a great economic tree crop, with so many industrial uses. In this work, the experimental drying kinetics of foreign species was investigated, and the experiments were carried out under isothermal conditions, using heated batch drier at 55, 70 and 81 ºC. The moisture ratio data obtained from change of moisture content with the drying time was fit to two thin layer drying model with good results. A faster drying process was observed at a higher drying temperature resulting in higher drying rates which is advantageous when evaluating costs.

[4] Akinnuli B. O, Ayodeji S.P ,Omeiza A. J (2014) Ability of Cocoa Beans Processing Industries to predict the yield of Cocoa Beans before processing will be a great advantage. This knowledge will aid: proper planning as per resources allocation, predicting profit margin and decision making on acceptability of contract (by considering cost of production and profit margin). The approach taken in this research was to identify the parameters needed for processing Cocoa Beans yield such as: actual mass of Cocoa Beans to process; mass of foreign material; mass of shell removed; quantity of Cocoa nibs to be processed; mass of butter and mass of Cake from Cocoa Liquor obtained from ground nibs; consideration was also given to material wastes at each processing stage. These identified parameters were used to develop mathematical

models, from which computer algorithm and software were also developed.

[5] B. Adewumi and A. Fatusin (2006). Design, Fabrication and Testing of an Impact-Type Hand Operated Cocoa Pod Breaker The machine developed during the study is simple and easy to maintain. It was fabricated using materials sourced locally. It is cheap and affordable. The drudgery and much time involved in the process of breaking the cocoa pod with hands could be overcome with the help of the machine.

3. Modelling of Cocoas Pod Machine

The Individual components are modelled separately and assembled using Autodesk Inventor software.

Fig. 1: Isometric View

4.1 Bearing:

Bearings are used to reduce the friction between moving parts. Ball Bearing is used to reduce the wear and tear of the wheel shaft. The bearing is used within the pinion and gear to connect the shaft with these gears.

Fig. 2: Bearings

4.2 Spring (open coil):

A spring is a mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces.

Open-coil-spring force production from continuous load-deflection curves, thereby assisting the clinician in the selection of the ideal spring for a given application.

Fig. 3: Spring (open coil)

4.3 Frame pipes:

1. Grinding:

Grinding Machine using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the work piece via shear deformation.

2. Welding:

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal joining techniques such as brazing and soldering, which do not melt the base metal. In this product it is used for the joining of rod and disc.

Fig. 4: Frame Pipes **Fig.5:Fabricated Project**

5. Working

The project consists of handle, spring, knife, coco holder, seed removing tool. Coco holder is to hold the coco pod, handle is use to operate the seed removing tool and the knife in this setup. Here spring is used for the suspension to retract the handle and the entire setup is mounted on the base frame. Initially we have to place the cocoa pod on the coco holder and we have to adjust the width of the knife according to the coco pod distance, then we have to use the handle to cut both the end of coco pod with knife. Then we have to place the coco pod below the seed removing tool when we press the handle seed removing tool will come down and the seeds inside the pod will be extracted. This is simple method to extract the coco beans and use it for chocolate manufacturing process.

6. Design of Spring:

Parameters known:

Spring Outer diameter Do =30 mm

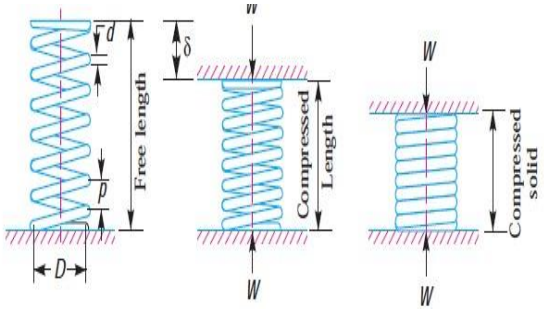
Wire diameter (d) = 2 mm

Number of coils in the spring=15

Free length of the spring = 50 mm

Axial Load = 5kg = 5 x 9.81 = 49.05 N

To find:



Mean diameter of the spring:

$D = D_O - d = 30 - 2 = 28$ mm

Spring index:

$C = D / d = 28 / 2 = 14$

Solid length of the spring:

$L_S = n \times d = 15 \times 2 = 30$ mm

Shear stress factor:

$K = 1 + (1 / 2C) = 1 + (1 / 2 \times 14) = 1.036$

Maximum Shear Stress occurs on the spring:

$$\tau = K \times \frac{8\,W.D}{\pi\,d^3}$$

$\zeta = (1.036 \times 8 \times 49.05 \times 28) / (3.14 \times (2)^3)$

$= 453.13$ N/mm^2

Let us assume modulus of Rigidity = 82×10^3 N/mm^2

Deflection of the spring

$$\delta = \frac{8\,W.D^3.n}{G.d^4}$$

$\gamma = [8 \times 49.05 \times (28)^3 \times 15] / [(82 \times 10^3)(2)^4]$

$= 98.48$ mm (Deflection active per turn)

Pitch of the coil

= Free length / (n-1)

= 50/(15-1) = 3.6 mm

Spring Rate (or) Stiffness of the spring

$K = W / \gamma = 49.05 / 3.6 = 13.63$ N/mm

Buckling of compression Spring

$W_{CR} = K \times K_B \times L_F$

K = Spring Rate

K_B = Buckling Factor = $L_F / D = 50/28 = 1.8$

W_{CR} = Critical Load

$W_{CR} = K \times K_B \times L_F$

$= 13.63 \times 1.8 \times 50 = 1226.7$ N

Energy stored in helical spring of Circular Wire U

$$\frac{\tau^2}{4\,K^2.G} \times V$$

Volume of the Spring V

$V = (\pi \times D \times n) \times (\pi/4 \times d^2)$

$= (3.14 \times 28 \times 15) \times (3.14/4 \times 2^2)$

$= 4141.032$ mm^3

Energy Stored U

$U = (453.13)^2 \times 4141.0.32 / (4 \times 1.05^2 \times 82 \times 10^3)$

$= 2351.27$ N – mm

7. Conclusion

By using this method the farmers work such as cocoa pod splitting and bean extraction can be reduced to some extent. The entire design is manually operated pod splitter and bean extractor is upgraded which will be helpful for small land farmers. This project consumes less time and saves the money .With conventional cocoa pod splitting and bean extraction covers more amount of fruit than manual method. This project also highly ergonomic, environmentally friendly cocoa splitting machine that will be used by cocoa farmers to increase and boost productivity and enhance the quality of cocoa products to the highest possible level, devoid of any hazards, dangers, perils or risks.

8. References:

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