Advanced Journal of Graduate Research
ISSN:2456-7108
Volume 3, Issue 1, pp. 34-40, January 2018

GRADUATE RESEARCH ARTICLE

Design and Analysis of Bamboo Stick Cutting Machine

Chetan Baseganni*, Syed Suhel, Hanumesha Pujar

Department of Mechanical Engineering, K.L.E.I.T. - Hubballi, Karnataka, India

doi: https://doi.org/10.21467/ajgr.3.1.34-40

*Corresponding Author email:
chetancb07@gmail.com

Article History
Received: 26 August 2017
Revised: 20 September 2017
Accepted: 02 October 2017
Published: 04 October 2017

Student(s)
- Chetan Baseganni
- Syed Suhel

Academic Year: 2016-17, 2nd Semester
Course Level: Bachelor Degree
Course Name: B. E. (Mechanical Engineering)
Course year: VIII Semester

Mentor(s)
- Hanumesha Pujar

ABSTRACT

As the modern trend is approaching more towards handcrafted art and natural artifacts, the demand for such hand-crafted arts has increased tremendously. To meet this increasing market demand there is always a need for advancement in the conventional production techniques to counterbalance the ever-increasing market demand for such handcrafted arts. India is known for many cottage industries and handicrafts designs but still, continuous efforts are required to design and produce unique handicrafts to satisfy the customer demands. In most of the large-scale industries, production is achieved with the help of machines but whereas in small-scale production, the man force is a must to carry out the entire production manually which results in the increased workload on workers which ultimately affect production rate as well as quality. To overcome this and to minimize the stress on the worker, an attempt has been made to design a bamboo stick making machine, which is simple in design and even can be handled by unskilled labor. The designed Bamboo cutting machine is mainly used to cut the bamboo into required shapes which are used in small-scale industries to prepare ice cream sticks or incense sticks. Our main concern is to avoid the manual operation of cutting bamboo which is time-consuming. The cutting operation is achieved by using a pair of spur gears and rollers.

Keywords: Artifacts, Handcrafted, Rollers, Spur gears.

1 Introduction

Bamboo splits making has been carried out manually for years using knives which is a very tedious, time consuming and risky method. Chopped bamboo sticks are mainly used in handcrafted furniture, ladders and for making various types of tool handles and scaff holding in large quantity. Bamboo cutting, slicing, splitting, removing the knot, stick length setting, and polishing are primary operations carried out through conventional method which are used to make various products such as basket, the core of incense sticks, kites, flutes and toys. Bamboo splits are also used to make poultry cages, drying, transport and packaging of grains. Bamboo splits are woven into mats and use to manufacture mat boards. [1]. The development of integrated bamboo processing machine was done and force evaluation with ability of performing multiple

operations in a single unit was carried out by P. G. Mehar [2]. Chopping of bamboo sticks into small pieces manually for their wide application in various fields leads to irregular size and shapes which would incur considerable loss for small scale production. The existing machine for this application incur heavy initial investment since the machines cost around 3-4 lakhs (INR). Since the profit of these industries is less, bamboo cutting industries must be set up with less investment. Our main objective is to design and develop a bamboo cutting machine to increase production rate, creating job opportunities for the people who are economically unstable. The usage of bamboo sticks and splits for various applications like making of furniture, ice cream sticks etc. is shown in Figure 1.

Figure 1: *Usage of bamboo splits and sticks for various applications*

2 Materials and Methods

2.1 Functional Analysis

Functional analysis composes of different techniques which help as tools to break down the functional objectives of the component. It is very necessary to ensure that the function structure is divided into smallest possible modules for easy flow of the process. The black box shown in Figure 2 gives a broad idea to achieve the cutting operations where in the inputs such as mechanical energy and bamboo is converted into bamboo pieces through bamboo cutting machine. Figure 3 illustrates the detailed working operations of the bamboo cutting machine such as inserting bamboo pieces, pressing bamboo pieces and cutting of bamboo pieces which converts raw bamboo into pieces of required shape and size.

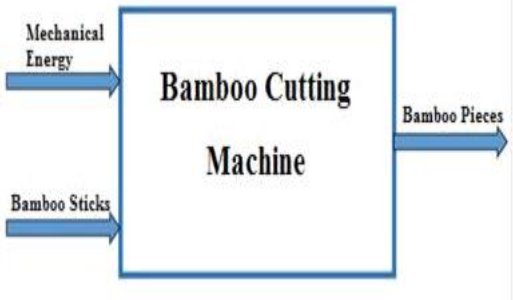

Figure 2: *Black Box*

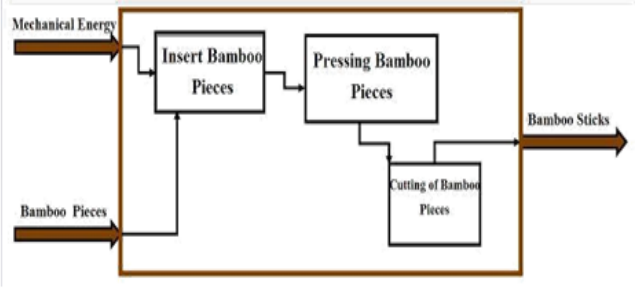

Figure 3: *White Box*

2.2 Conceptual Designs

Conceptual Design is an early phase of the design process, in which the broad outlines of function and form of something are articulated. It contains the design of interactions, strategies, processes and experiences. It includes an understanding of people's demands,needs and solution to meet those with products, services and processes. Concept sketches and models are common artifacts of conceptual design.

Three conceptual designs (Figure 4 - 6) were selected and evaluated for different criterias such as safety, cost effectiveness, efficient, maintenance, portable, user friendly and eco friendliness using morphological chart (Figure 7). All the three conceptual designs are evaluated for their best suitability for the project requirement as well as for various mechanical criteria. The conceptual design 1 is found to be safer in design, cost effective, high efficient, easily portable due to its less weight. Considering this result obtained from the morphological chart, conceptual design 1 is selected for the design of Bamboo cutting machine.

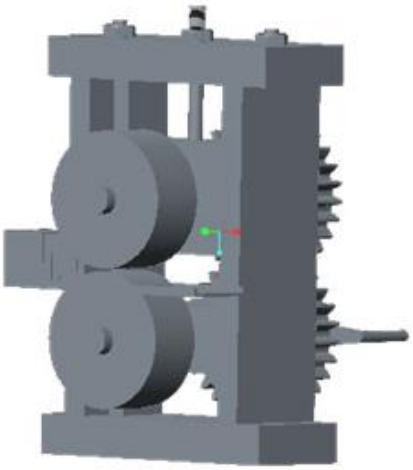

Figure 4: *Conceptual Design 1*

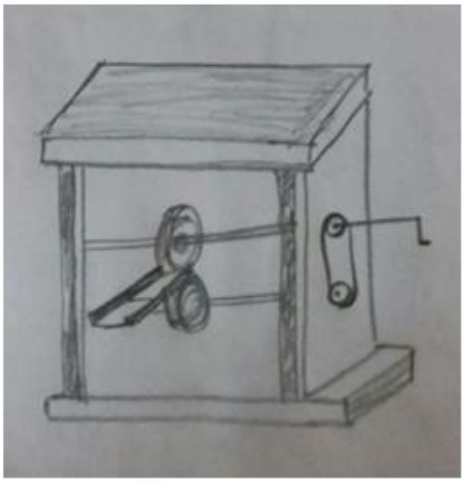

Figure 5: *Conceptual Design 2*

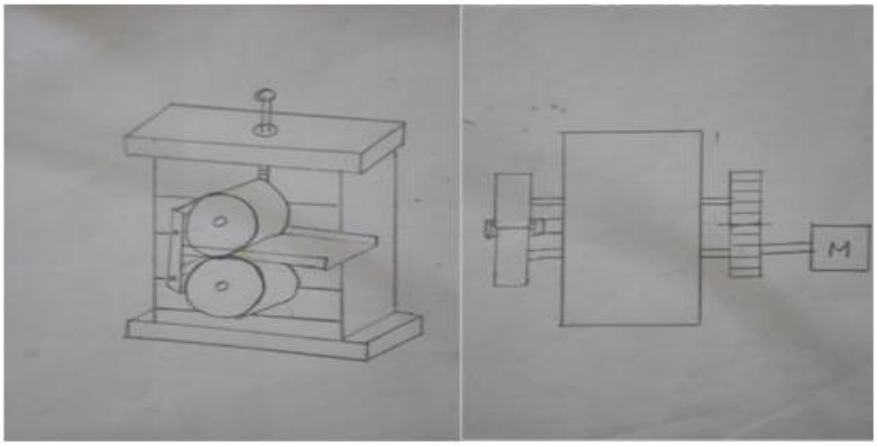

Figure 6: *Conceptual Design 3*

Criteria	Concept 1 (Datum)	Concept 2	Concept 3
Safety	0	0	0
Cost Effectiveness	0	-	-
Efficient	0	-	+
Maintenance	0	0	-
Portable	0	0	-
User Friendly	0	0	0
Eco Friendly	0	0	0
Total +	0	0	1
Total -	0	2	3
Final	0	-2	-2

Figure 7: *Morphological Chart*

3 Experimental Setup

The experimental setup of a bamboo cutting machine is shown in Figure 8. The main structure of framework is constructed using channel section of mild steel. These sections were cut into required length using gas cutter and joined together by welding. Two columns made up of channel section of mild steel are mounted vertically on the frame and are welded to the base. Supports are provided to the columns of the channel section at top ends. A base plate is made up of mild steel and is attached to the lower end of the frame on which the cylinder is mounted and fixed by using nut bolts. Two rollers made up of mild steel are connected to the two different shafts by means of bearings. The rollers rotating in opposite direction are used for feeding purpose. Handle is provided for manual rotation of gears which rotates the rollers. These rollers help to hold the bamboos rigidly and help to feed the bamboos through the blades without any misalignment. The blades cut the fed bamboos into required shapes for end use application. Specifications of the blade are decided based on the size and shape of the bamboo chips required for various applications.

Figure 8: *Experimental Setup*

3.1 Working

The working principle of bamboo cutting machine is similar to the principle followed in sugarcane juice making machine. The circular raw bamboos are cut into pieces of short lengths for easy handling. The shortened bamboo pieces are fed into rollers manually. The gears are driven by rotating the handle manually.

The rollers are driven by gear mechanism and hold the bamboo pieces firmly and force bamboo to pass through a set of blades. The rollers force the bamboo pieces into set of pre-adjusted blades which cut the bamboos into definite shapes and sizes. The blades are made up of MS material with sharp edges which results in smooth operation. The alignment of blades can be adjusted based on the size and shape of bamboo strips for end user application. The production rate of bamboo strips can be varied by varying the mechanical force applied manually on the handle. CAMD Model of the Assembly is shown in Figure 9.

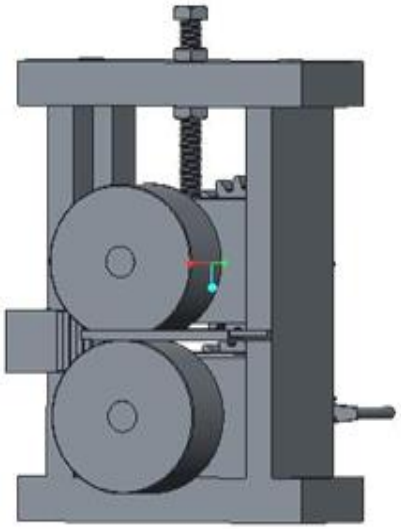

Figure 9: *CAMD Model of the Assembly*

3.2 Design of Blades

Cutting blades are made from special heat-treated steel. In this research, special carbon tool steel with a standard number of 1.1744 is used. The blades were made with the dimension of 10×2×0.5 cm, and are changed to special heat-treated steel with hard surface and soft pith under solid carburetion procedure. The carbon from carbon monoxide gas enters steel surface only up to 22% of profile surface. Finally, series of blades are made with the angles of 30° and 45°.

3.3 Calculations

The formulae and the equations used for calculations are obtained from reference **[**3]- [4]. Calculations are the primary basis for developing the proposed model. The selected dimensions suit better for all kind of parameters that are considered for the selection of model such as cost estimation, load sustainability and floor space consideration. These calculations are done to design the components for maximum safety and to prevent run time failure.

3.3.1 Cutting Force Calculations

Cutting strength of bamboo = 6.9MPa
Area of contact = 10x1=10mm^2
Therefore, required cutting force (F) = σ x A x n
F = 345N

3.3.2 Torque and Power Calculations

Handle arm length (L) = 0.15 m
Then, torque applied on the shaft (T) = F x L
T = 51.75 N-m.
Therefore, required power (P) = 86.70 W

3.4 Spur Gear Design

No of teeth on pinion (Z_1) = 25
No of teeth on gear (Z_2) = 25
Module (m) = 5mm
Addendum = 1 x m = 5mm
Dedendum= 1.25 x m = 6.25mm
Tip clearance (c) = 0.25 x m = 1.25mm
Total tooth height (h) = 11.25mm
Pitch diameter (d) = m x Z = 125mm
Base circle diameter = 117.5mm
Outside diameter = m x (Z+2) =135mm
Root diameter = m x (Z-2.5) = 112.5mm

3.4.1 Check for Design of Gear

Tangential force due to applied torque $(M_t) = \frac{60*10^6*P}{2\pi N}$

$M_t = 51745.250$ N-mm

$P_t = \frac{2Mt}{Dp}$

$P_t = 827.924$N

3.4.2 Effective Load

Velocity (V) $= \frac{\pi DN}{60*10^3}$

$V = 0.1047$m/sec

$C_v = \frac{3}{3+V}$

$C_v = 0.9663$

$F_s = \frac{Sb}{P_{eff}}$

$F_s = 4.34$ *Hence design of gear is safe*

4 Analysis of Cutting Blades

During cutting operation large force acts on the blades, hence at most care should be taken since majority of the breakdown occurs due to the failure of blades. Therefore, analysis of cutting blades is carried out in ANSYS 15 as shown in Figure 10. The maximum stress induced on the blade is 13.005MPa which is less than the tensile stress. So, the design of the blade is safe.

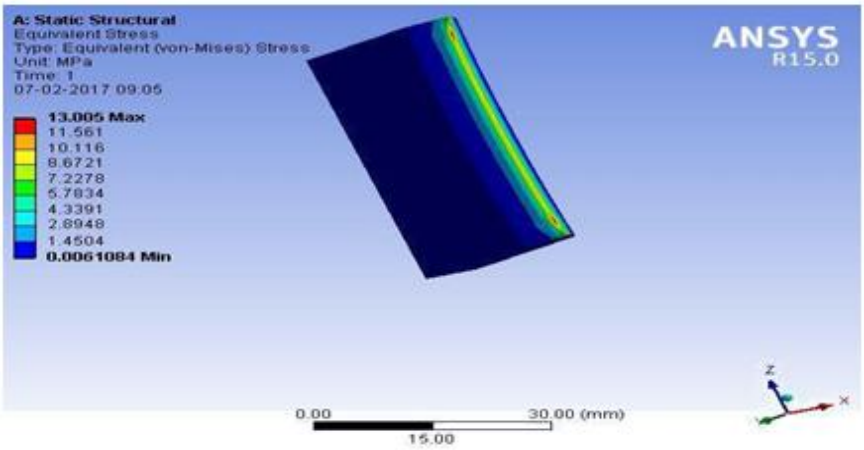

Figure 10: *Analysis of cutting blades in ANSYS 15*

5 Conclusion

The Bamboo stick cutting machine is successfully fabricated and tested. The various cross-sectional shapes and quality of sticks that can be produced by this machine cannot be achieved by traditional manual methods. The machine can cut bamboo strips with minimum human effort with high productivity. Machine can be easily operated by unskilled labor with negligible maintenance cost. For different shape and size of bamboo strips, blades can be placed at different angles with the help of adjustable slides. The provision for collection of cut bamboo pieces can be provided by placing collecting box below the cutting blades. Automation of this machine by incorporating motor instead of manual operation for gear rotation can be a boon in large scale industries.

Acknowledgement

We are thankful to Dr. S. N. Mathad, Head & Prof. Department of Physics, KLEIT Hubballi. For his encouragement, effective guidance and valuable suggestions right from the beginning of the project, without which this project work would not have been accomplished. We are greatly indebted to him. We would like to express our heart full thanks to all the lecturers and staff members of the department of mechanical engineering for constructive suggestion and constant encouragement. We also thank to our parents and all our friends wholeheartedly who have rendered their help, motivation and support to accomplish this project.

How to Cite this Article:

C. Baseganni, S. Suhel, and H. Pujar, "Design and Analysis of Bamboo Stick Cutting Machine", *Advanced Journal of Graduate Research*, vol. 3, no. 1, pp. 34-40, Oct. 2017. doi: 10.21467/ajgr.3.1.34-40

References

[1] Er. Ulhas N. Sonkusre, "Design and fabrication of improved bamboo processing machine," *International Journal of Application or Innovation in Engineering & Management*, vol.3, ISSN: 2319-4847,2013.

[2] P. G. Mehar Das, "Design and fabrication of improved bamboo processing machine," 1st International and 16th National Conference on Machines and Mechanisms, pp. 896-903, Dec 2013.

[3] V B Bhandari, "Design of machine elements," Tata McGraw-Hill Education, 3rd edition: 648-680.

[4] Central Machine Tool Institute, "Machine Tool Design Handbook," McGraw Hill Education, 1st edition:232-240, 1982.