Stress Analysis of Existing Sugarcane Crushing Machine using FEA
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Abstract— This paper describes analysis of existing sugarcane crushing machine. In the present machine all parts are made of iron so the machine is bulky and heavy. Machine is made of Cast iron. The advent of finite element simulation techniques and increases in computing power has provided new tools to simulate and optimize the machine. Stress analysis is done using hypermesh and values of force are taken from previous papers. Our results data shows that stress on all machine parts is very low compared to their strength.

Key words: Roller, Sugarcane, Juice, Extracts, FEA

I. INTRODUCTION
Sugarcane is the common name of a species of herb belonging to the grass family. For centuries it has been harvested by hand, because sugarcane was not easily harvested by Machine. It was formerly, mainly, harvested using large machete like blades. For this reason Sugarcane fields have very large amounts of farm hands, and are a major source of employment but the elimination of slave practices demanded the uprising of mechanical techniques to the harvesting of sugarcane. Sugarcane is highly adequate in the provision of energy for the nutritional requirement of both livestock and humans.

Sugarcane juice, over the years, has been successfully used in the production and manufacturing of the edible refined sugar; using machines which were fabricated and constructed to large scale production, industrialization and large capital requirements. This makes the extraction of sugarcane juice a fantasy to local or small-scale industrial establishments. Thus, this amputates the involvement of small-scale farmers in the business of sugarcane juice extraction and refined sugar production; at large. it is quite remote for those who are subsistent in agricultural practices to take part in sugar production practices in the scope of their practice.

The currently available sugarcane juice extractor require high energy and are application of more sophisticated mill driven mechanically. Some of the available cane crushers are of high capacity mainly for industrial applications. These are out of reach of small scale and rural farmers that are presently involved in processing of cane juice into ethanol, brown sugar and other related products at small scale level. The problems associated with processing of sugarcane include small size of farms and farm fragmentation as a result of land ownership by inheritance.

The main objectives of this study are to analyse a simple mechanical device for extraction of sugarcane juice. The stress analysis of operation of the machine was evaluated.

II. LITERATURE REVIEW
The review mainly focuses on existing sugarcane crushing machines available in market.
A. Makinde-Ojo, Ayoola Macjay
The improvement of the previously constructed sugarcane juice extractor is the main objective of this project work. Comparison of various sugarcane juicers and Safety improvement and material change are discussed in this paper.

B. V. Siva Prasad, Syed Altaf Hussain
This paper describes design and analysis of Spur gear. Replacement of Cast iron spur gears with the Nylon spur gear in the application of sugarcane juice machine.FEA analysis of CI and nylon material spur gear.

C. Mr. Tagare V.S, Mr. Patil V.B, and Mr. Talaskar
This project work is on the design and manufacturing of a sugarcane peeling machine. Design calculation and testing of machine with various sugarcane stalk. When sugar cane passing through the rotating hollow shaft due to blades and brushes inside the hollow shaft, upper surface of sugar cane is removed and peeled sugar cane is pulled by means of rollers.

D. Kehinde A. Adewole, Michael T. Adamolekun, Robinson Akinnusi
Performance tests carried out on the developed machine .Design parameters and calculations are done. A sugarcane crushing and squeezing machine with a capacity of 360 kg/hr was developed and tested.
E. C. J. Adam, J. G. Loughran

Extraction of juice from shredded sugarcane is commonly performed using sets of counter rotating rolls. Constant crushing rate simulations suggest that thinner blankets and higher roll speeds will reduce frictional sliding, roll load and torque, power requirements, and slightly improve juice extraction.

F. Joby bastin

The mechanical properties of sugarcane stalks viz., bending resistance, cutting resistance, penetration resistance and crushing resistance are measured in a Universal Testing Machine (UTM).

III. SPECIFICATION OF PROBLEM

In this project work it is proposed that existing machines which are made are heavy and bulky. The size of all machine parts is more than required and strength of material is not properly utilized. A virtual model of machine was created in Solid works. Model is imported in HYPERMESH for analysis by applying normal load conditions. After analysis stress is analyzed.

A. List of Components

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1HP Motor</td>
<td></td>
</tr>
<tr>
<td>2 Rollers</td>
<td></td>
</tr>
<tr>
<td>Belt and pulley</td>
<td></td>
</tr>
<tr>
<td>Gears</td>
<td></td>
</tr>
<tr>
<td>Shaft</td>
<td></td>
</tr>
<tr>
<td>Frame</td>
<td></td>
</tr>
<tr>
<td>Adjusting block</td>
<td></td>
</tr>
<tr>
<td>Side plates</td>
<td></td>
</tr>
</tbody>
</table>

Table 1:

IV. SPECIFICATION OF MACHINE

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of upper body</td>
<td>90 kg</td>
</tr>
<tr>
<td>Weight of frame</td>
<td>35 kg</td>
</tr>
<tr>
<td>Material used</td>
<td>Cast iron</td>
</tr>
<tr>
<td>Diameter of roller</td>
<td>140 mm</td>
</tr>
<tr>
<td>Length of roller</td>
<td>170 mm</td>
</tr>
<tr>
<td>Diameter of pulley</td>
<td>505 mm</td>
</tr>
<tr>
<td>Frame</td>
<td>640*535mm</td>
</tr>
<tr>
<td>Adjusting block</td>
<td>14.40*212mm</td>
</tr>
</tbody>
</table>

Table 2:

Power (P) = 1 kW = 1000 watt
Speed (N) = 1440 RPM
MAX FORCE OF FAILURE = 137.5
FACTOR OF SAFETY = 1.7


CRUSHING FORCE (Fc)
Fc = Mf*FOS = 137.5*1.7 = 233.75N

V. CAD MODEL OF MACHINE

CAD modeling is done on SOLIDWORKS.

VI. FINITE ELEMENT ANALYSIS OF SUGARCANE CRUSHING MACHINE

Finite element modeling is described as the representation of the geometric model in terms of a finite number of element and nodes. It is actually a numerical method employed for the solution of structures or a complex region defining a continuum. Solutions obtained by this method are rarely exact. However, errors in the approximate solution can be minimized by increasing the number of equations till the desired accuracy obtained. This is an alternative to analytical methods that are used for getting exact solution of analysis problems. HYPERMESH is used for meshing, while the results are obtained from NASTRUM.
A. Meshing

4 Node Quadrilateral element - 26830
3 Node Triangular element – 0
4 Node Tetrahedral element – 163194
6 Node Pentahedral element – 944
8 Node Hexahedral element – 17868
Total- 208836

Boundary condition is applied on frame, which are fixed. Crushing force is applied of the rollers.

Motor Torque of 4954 N-mm
Crushing Force of 234 N

VII. RESULTS OBTAINED

From the static analysis using hypermesh (Nastrum) the deflections and vonmisse stress and strain values for the sugarcane crushing machine are obtained as following below table.

<table>
<thead>
<tr>
<th>Component</th>
<th>Crushing force</th>
<th>Vonmisse Stress</th>
<th>Deflection (mm)</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>roller</td>
<td>234N</td>
<td>4.86Mpa</td>
<td>0.0034mm</td>
<td>3.05e-03</td>
</tr>
<tr>
<td>frame</td>
<td>234N</td>
<td>1.36Mpa</td>
<td></td>
<td>1.21e+00</td>
</tr>
<tr>
<td>Side plates</td>
<td>234N</td>
<td>0.23Mpa</td>
<td>2.83E-00</td>
<td></td>
</tr>
<tr>
<td>Large gear</td>
<td>234n</td>
<td>1.16Mpa</td>
<td>1.16e-01</td>
<td></td>
</tr>
<tr>
<td>Small gear</td>
<td>234N</td>
<td>0.19Mpa</td>
<td>1.97e-01</td>
<td></td>
</tr>
<tr>
<td>Adjusting lever</td>
<td>234N</td>
<td>1.6Mpa</td>
<td>1.60e+00</td>
<td></td>
</tr>
</tbody>
</table>

Table 3:
VIII. CONCLUSION

From the above results it shows that the stress on all machine parts is very low as compared to their strength. Thus machine can be manufactured in small sizes. This will reduce the weight of machine thus making it user friendly and can be transported from one place to another with ease.

REFERENCES


[7] Sirichai Songsermpong and Weerachet Jittanit comparison of peeling, squeezing and concentration methods for the sugarcane juice production’ Nov 24, 2009; Revised: Mar 5, 2010;
