3D Modeling and Simulation of Coconut Dehusker Equipment

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Abstract: ***The process of removing the husk surrounding the coconut shell is still being carried out manually in rural sector. Even after various mechanized attempts by researchers, automatic and semi-automatic machines are not used by all farmers for this dehusking process. Irrespective of the reason behind this less utilization of automatic and semi-automatic machines, we are attempting for new equipment with minimum manual effort to improve the productivity which will be higher than the existing manual process. In order to reduce the manual work of a skilled operator, our equipment has been developed to satisfy this need. This manually operated coconut dehusker equipment was modeled using a 3D modeling tool and fabricated to withstand the load generated during dehusking process. After fabrication, the equipment was tested. Even the simulation studies were carried to ensure functional capabilities and predict limitations of the equipment under various working conditions. The critical element of the equipment was identified as the cutting tool, which is subjected to load required for dehusking, and is analyzed for determining the maximum von-mises stress, maximum principal strain and total deformation using ANSYS workbench. The load acting on main cutting tool has been experimentally predicted and analyzed.***

Keywords: Coconut dehusker, 3D modeling, Simulation

1. Introduction

Generally coconuts are dehusked manually using either a machete or a spike which requires minimum skill. But if the coconuts are in large numbers, it will be time-consuming, laborious and stressful to dehusk using the above two tools. Attempts have been made to develop automatic and semi-automatic dehusking machines [1], [2], [3], [4]. But still many are not using these machines.

In the light of the above observations, we attempted to design equipment, which is simple and would reduce human effort. In line with this, we modeled the equipment and simulated for extreme working conditions. After fabrication, we again simulated the behavior of main cutting tool element based on the experimental values and are discussed below.

2. 3D Modeling and Fabrication

The dehusking equipment has four parts namely a main frame, supporting base frame, handle and a cutting tool element. All the parts are of mild steel. Assembly drawing is shown in figure 1 and the isometric view is shown in figure 2. Figure 3 and figure 4 shows the pictorial view of the main frame and pictorial view of the equipment after assembly respectively. The equipment was then made to dehusk the coconut and then the load required to dehusk the coconut was examined. It was observed to be 12 kg, i.e. load being 117.72 N.

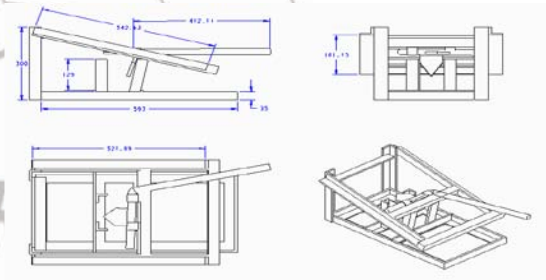

Figure 1: Assembly drawing of the coconut dehusking equipment.

Figure 2: Isometric view of the coconut dehusking equipment.

Figure 3: Pictorial view of the main frame of the coconut dehusking equipment.

Figure 4: Pictorial view of the assembled coconut dehusking equipment.

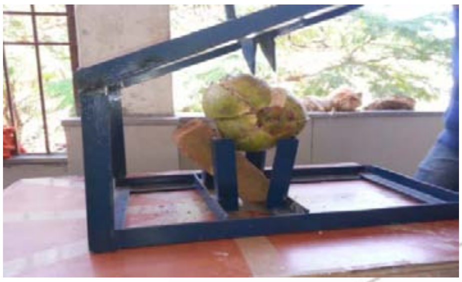

Figure 5: View of the coconut dehusking.

Figure 6: View of the coconut dehusking equipment during operation.

3. Simulation results and discussions

The elements used in mesh generation are tetrahedron, with element size of 2mm. The total elements were observed to be 16591 (figure 7). The load used for the analysis is 12 Kg x 9.81 i.e. 117.72N, it was observed that the load acting to the tool tip was at an angle of 20^0 vertically. Hence the forces were resolved along x and y axis with magnitudes of -20.44 N and 115.93 N. The boundary conditions are applied to the tool handle as fixed support (figure 8). In the static structural analysis, the stresses (Von Mises) observed are very minimal at magnitude of 133.16 MPa for the applied load of 12 Kg which is much less than the yield strength of mild steel of 250 MPa. Hence the applied load is safe to the tool operation (figure 9). Maximum Principle stresses were measured and the magnitude was observed at 93.385 MPa for the applied load of 12 Kg which is much less than the yield strength of mild steel of 250 MPa. Hence the applied load is safe to the tool operation (figure 10). The maximum elastic strains for the applied load were observed to be around 0.00056384 m/m, which is almost equal to zero strain. Hence the strains induced in the tool are almost negligible (figure 11). In this analysis, the maximum deformation observed is $2.9286e^{-5}$m for the applied load of 12 Kg. With this we can conclude that the deformation in the cutting tool member does not distort the members in the equipment (figure 12).

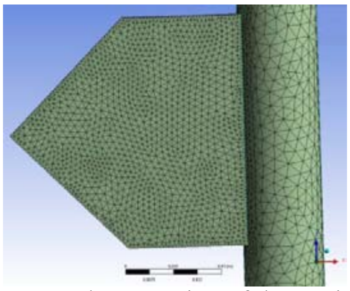

Figure 7: Mesh generation of the cutting tool

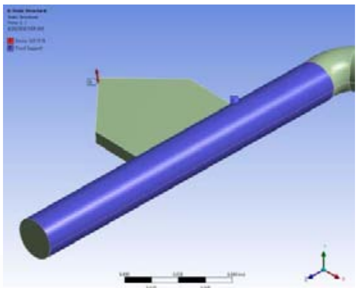

Figure 8: Boundary conditions on cutting tool handle

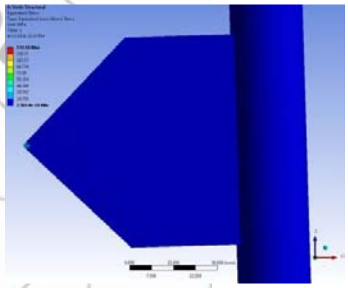

Figure 9: Von Mises Equivalent stress

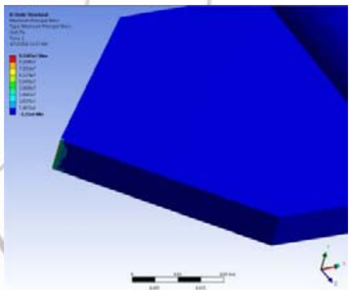

Figure 10: Maximum principal stress

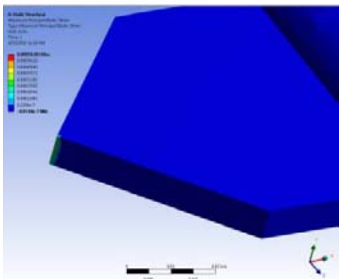

Figure 11: Maximum principal strain

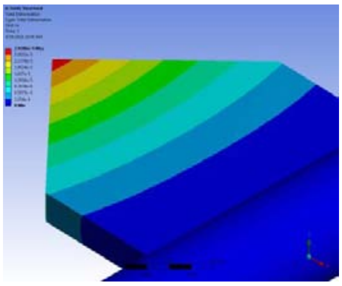

Figure 12: Total deformation

4. Conclusion

The fabricated coconut dehusking equipment is simple in its design and easy to operate, use and maintain. The simulation studies of the main cutting tool member indicate positive results to make the design a stable and sturdy one.

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Author Profile

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