# STRUCTURAL ANALYSIS OF A DEVELOPED COCONUT CRACKING AND SCRAPPING MACHINE

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**ABSTRACT**

Structural analysis is the process of calculating and determining the effects of loads and internal forces on a structure, building or object. It allows Engineers and Designers to ensure a piece of equipment or structure is safe for use under the estimated loads it is expected to withstand, this can be done either during design, testing or after fabrication and will generally account for the materials used, geometry of the structure and the applied loads. In this work, a coconut cracking and scrapping machine was developed and the structural components were subjected to some degree of stress analysis. The developed machine executes cracking and scrapping tasks in coconut processing. To achieve maximum efficiency and the output of the machine, the structural analysis of the machine was done on the cracking and scrapping units using Inventor Professional 2020 static. The safety factor of the machine was also determined. The result shows that the principal stresses of the machine at different degrees is between 90.9608MPa and 119.357MPa. Factor of safety is 15ul. This result shows that, the developed machine can operate under different stress loads and factors such as fatigue, impact, tension and compression.

**Keywords:** Coconut, Cracking, Scrapping, Analysis, Machine, Structure.

## 1.0 INTRODUCTION

Coconut is one of the most useful trees in the world. Tender coconut (7 to 8 months old maturity) is valued both for its sweet water, which is a refreshing drink and the delicious gelatinous meat. The water of tender coconut, technically the liquid endosperm, is the most nutritious wholesome beverage that nature has provided for people of the tropics and is consumed fresh, largely because, once exposed to air and warm temperatures, it rapidly deteriorates. In addition, sterilizing the water using high temperature and short-time pasteurization destroys some of the nutrients and the entire flavor (Jippu, 2014). Chemical composition and volume of the coconut water change during maturation. It indicates that quality and quantity of coconut water as well as consumer acceptability of tender nut is more after 7 months of maturity.

Coconut provides many necessities of life including food and shelter. Cultivation is done mostly for its nuts; its yield includes fiber, oil cake and oil. Tender coconut contain water which act as refreshing drink and are excellently used as isotonic in many tropical countries. The liquid in coconut is not only thirst-quenching but also mineral drink with enormous benefits to human health (Renata et al., 2006). Coconut is made up of traces of fats, protein and minerals like sodium (Na), potassium (K), calcium (Ca), iron (Fe), copper (Cu), phosphorus(P), sulfur (S), chlorine (Cl), Vitamin C, vitamin of the B group like pantothenic acid, biotin, nicotinic acid and riboflavin (Sylianco et al, 1992 and Jackson *et al*., 2004).

Coconut liquid comprises of some organic compounds having healthy growth enhancing properties. It also carries cells oxygen and nutrient, boost human immune system, increase the human metabolism, diabetes control, detoxify and fight against viruses and also, it's important in the human body in fighting against those viruses in human that causes herpes, flu and AIDS, (Poduval *et al.*, 1998) and (Pummer et al, 2001). Jackson *et al.,* (2004) described the presence of vitamins, sugar, organic acids, fatty acids, amino acids, fibers and minerals in coconut water.

Coconut plays a significant role in the economic, cultural and social life of over 80 tropical countries (Yong *et al.,* 2009). Over the years, the coconut palm has been referred to as "the tree of the Heavens" and "tree of a hundred uses" which indicates its remarkable usefulness and qualities. It is a major source of income for rural families and plays an important role in wealth generation and improving the quality of life in many tropical countries (Naveneethan, et al 2020).

Additionally, its shell is used for various fibers, charcoal and other products that are not yet fully commercialized (Jippu et al, 2016). This technical report addresses the description of the coconut plant, nursery operations required to produce high quality planting material, good production practices, pests and diseases and their control and, coconut intercropping and animal-based systems. If these approaches are implemented appropriately, it is hoped that the information will assist farmers to optimize their coconut production and quality of produce. Good agricultural practices can guide the efficient, safe, environmentally-sound production of food of acceptable quality (Alonge and Adetunji, 2011). The aim is to provide options and so assist farmers in their choice of the most appropriate management level for their particular circumstances

The major health benefits and medicinal properties of tender coconut are that it is good for feeding infants suffering from intestinal disturbances, oral rehydration medium, contains organic compounds possessing growth promoting properties (Malay et al., (2009). It keeps the body cool, application on the body prevents prickly heat and summer boils and subsides the rashes caused by small pox, chicken pox, measles, etc. It kills intestinal worms, presence of saline and albumen makes it a good drink in cholera cases, checks urinary infections (Stefan et al., 2001). It is a perfect tonic for both the sick and old, a perfect cure for malnourishment, diuretic effective in kidney treatment and urethral stones. It is intravenously injected during emergency cases, found as blood plasma substitute because it is sterile, does not destroy red blood cell, does not produce heat and is readily accepted by the body, urinary antiseptic and also eliminates poisons during cases of mineral poisoning. (Chikkasubbanna *et al.,* 1990).

In Nigeria, coconut production is about 9,072,55 Metric tons from 12,825 acres of land in 2004-2005 (Ovat and Odey, 2019). It is mostly grown in the southern part of the country. The liquid endosperm which is contained inside a young coconut is called coconut water. It is fat free and low in calories. Sodium, potassium, phosphorus, chloride and magnesium are the main minerals found in coconut water, besides vitamin C and sugars, (Nathan and Collins, 1999) and (Sreekanth, 1999).

According to Priya and Ramaswamy (2014), every part of the coconut and the tree has been used by different countries in different ways. The uses for coconut oil go way beyond just cooking. It can be used for health, skin, hair, weight loss and many others. Coconut is one of the most nutritious fruits commonly used as a kitchen ingredient. By now we understand that coconut is a versatile fruit which gives a range of products that can be used as both food consumption and beauty products.

Agricultural mechanization plays a significant role by increasing the production, reducing cost of cultivation and processing. Post-harvest mechanization implies the use of agricultural machinery in performing the operations fast and efficient. Mechanization helps in increasing and processing of agricultural commodities. It reduces the drudgery in performing various post-harvest operations and minimizes post-harvest losses. Traditional cutting method: The most widely practiced method of cutting the tender coconut is done manually by the use of large knives to produce thin wafers. A few entrepreneurs use manually operated different types of manual cutters.

Mechanical cutting method: Different Researchers have developed different coconut machines with unique features, among them are; Yuliat, (2019), Coconut shell breaker machine; Man et al, (2020), Performance Evaluation of Power Operated Coconut deshelling Machine for Different varieties of Coconut; Pranathi, et al, (2021) Designing the tender coconut punching tools. Jippu and Rajesh (2012), Design and invention of coconut dehusking machine Roshni et al, (2009), Development of a Household Coconut Punch-cum-Splitter; Jippu and Abi (2014), A study on the KAU coconut husking tool; Balachandar et al, (2018), Design and Fabrication of tender coconut cutting machine; Anil et al, (2016), Design and fabrication of green coconut cutting machine; Shamsudeen and Anitha, (1997), Development and testing of a tender coconut Punch and splitter; Amal et al, (2020), Design and fabrication of coconut dehusking machine; Vijay et al, (2017), Design and Fabrication of Pneumatic Operated Coconut Dehusking Machine; Sharanbasappa, (2017), Design and Development of Hydraulic Coconut Dehusking Machine and Azmi, (2015), Design and Development of a Coconut dehusking Machine (Machine Component Design) among others.

There are basically two type of coconut scrapping machine in terms of operation. There are the manually operated scrapping machine and automatic scrapping machine.
Today there are various method used for scrapping the coconut. These techniques have many limitations in process. These methods are widely used for scrapping. These techniques are,

- Manually scrapping method
- Automatic scrapping method

**Manually Scrapping Technique**

Any of the coconut scrapping, greater, shredder makes the job easier and much more efficient, so if you are planning on making fresh coconut a regular part of your diet, you may want to consider picking up one, there are rather inexpensive and do not take up much space unless you get the full bench model. Throughout Nigeria, Malaysia, the South Pacific Islands, India, Thailand and other growing coconut regions employ a traditional tool used to scrape the meat from inside of a split coconut shell is a low wooden bench with an iron grating tool or scrapping hook attached to one end. Sometimes called 'rabbit', many of these small, low benches were carved to resemble animals and rabbit was the most common design, (Shamsudeen et al, 1999) and Poduval and Chattapadhyay, 1998).

**Automatic Scrapping Technique**

The method of Hand-Arm Vibration (HAV) is vibrated and transmitted to the hand using hand-held power tools and hand-guided equipment, or holding material during machine operation. HAV mostly practiced by workers that use tools such as Jackhammer, Chainsaw, Grinders, Riveters, and Impact Wrenches (Senthil et al, 2018).

It has been predicted and initially proven that the biodynamic scenes such as stresses, vibration forces, and strains, power absorbed and dissolute in the system are connected closely with injuries vibration-encouraged and abnormality of the tissues or biological structures of the system (Sujaykumar et al, 2017). From the reviewed literature, research on a single machine that carries out cracking and scrapping of coconut simultaneously is scanty. The need for this work becomes imperative.

## 2.0 MATERIALS AND METHODS

Materials selected for the machine were mild steel and stainless steel. Mild steel was used in production of the frame and support components of the machine. For parts that were expected to have contact with the coconut shreds, such as the cutting blades, stainless steel was used. The machine was fabricated using standard engineering manufacturing processes.

**Design of the cracking unit**

Figure 1 shows a free-body diagram of the cracking mechanism. The movement of the cracking hammer is facilitated by the rotation of a crank relative to the impact portion of the hammer. $F_{TCR}$ is the total cracking force that is imposed on coconut in the cracking unit. This value is the sum of the weight of cracking mass, $W_{CM}$, spring force, $F_s$ and the force due to motion of the hammer. The relation is expressed in Equation 1.

$$F_{TCR} = W_{CM} + F_s + F_m \quad 1$$

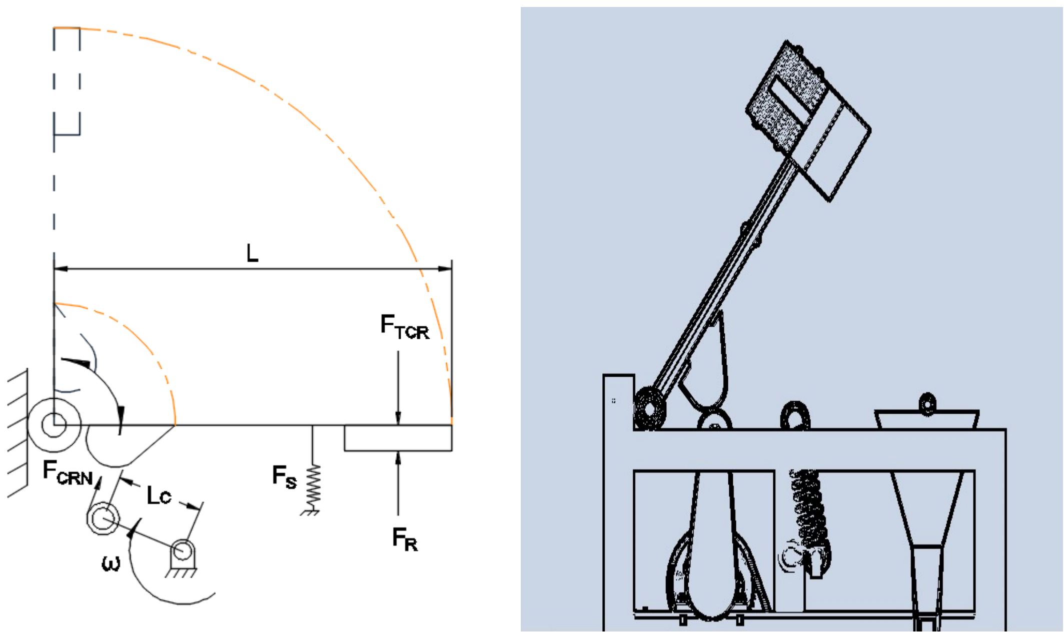



Figure 1: Mechanics of the Cracking Operation

The hammer is designed to return to a horizontal position after being deflected by the crank using an extension spring. The force on extension spring was calculated using Equation 2.

$$F_s = I_T + (D \times k) \quad 2$$

Where:
D is the distance the spring is deflected
$I_T$ is the initial tensile force on the spring
k is the stiffness of the spring

Furthermore, the force due to motion of the hammer, $F_m$ is computed because potential energy is stored in the hammer when it moves from the horizontal to vertical position. While the spring force returns the hammer, the stored energy, E is converted to kinetic energy on striking the coconut shell. This is best described mathematically as shown in Equation 3.

$$E = mgh = \frac{1}{2}mv^2 \quad 3$$

Where;
m = mass of the hammer

g = acceleration due to gravity
h = height of displacement of the hammer
v = the velocity of the hammer

But, according to Khurmi and Gupta (2005) and Budynas and Nisbett, 2011, the energy absorbed on impact is average work; thus,

$$E = \frac{F_m}{2} \times d \qquad 4$$

Where d is deformation of the coconut

Therefore, Force, $F_m = \frac{mv^2}{d}$ 5

$$F_{TCR} = W_{CM} + F_s + F_m \qquad 6$$

Force required to lift the hammer with the crank, $F_{CRN}$ was computed using the principle of moments. Referring to Figure 2, the free body diagram was used in the analysis.

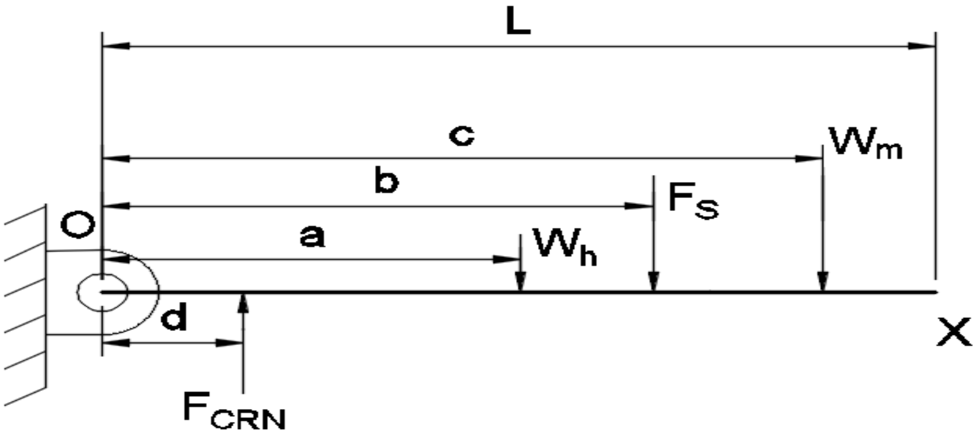



Figure 2: Free-body diagram of the hammer lifting mechanism

Taking moments about O,

$$(F_{CRN} \times d) = (W_h \times a) + (F_s \times b) + (W_m \times c) \qquad 7$$

$$F_{CRN} = \frac{(W_h \times a) + (F_s \times b) + (W_m \times c)}{d} \qquad 8$$

The force thus computed was generated by the rotation of a crank with length, $L_c$. With the minimum required force to operate the hammer, $F_{CRN}$ and crank length, $L_c$, the torque developed by the motor was calculated using Equation 9.

$$T = F_{CRN} \times L_c \qquad 9$$

An electric motor was selected to provide the required torque. Chain drive was used to facilitate power transmission from the electric motor to the drive shaft. Velocity ratio, r of the chain drives was computed using Equation 10.

$$r = \frac{number\ of\ teeth\ on\ the\ smaller\ sprocket}{number\ of\ teeth\ on\ the\ larger\ sprocket} \qquad 10$$

Also, power transmitted by the drive shaft was computed using Equation 11.

$$P = \frac{2\pi NT}{60} \qquad 11$$

Where;
T = torque transmitted (in N-m)
N = shaft speed (rpm)

The main drive shaft provides the torque required to operate the cracking hammer as well as the coconut holder. Although the two chambers are not operated simultaneously, the shaft is subjected to torsional stresses (Mahadevan and Balaveera, 2018).

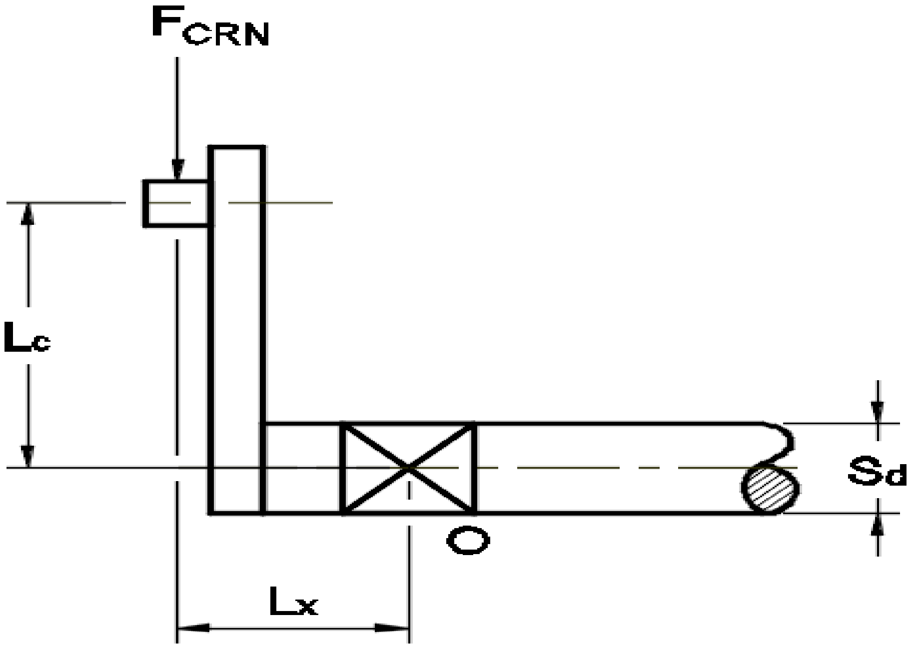



Figure 3: Stresses due to loading of the crank

Bending moment at the centre of the bearings of the main drive shaft.
Taking moments about the bearing at O,

$$M = (F_{CRN} \times l_x) \qquad 12$$

But, bending stress, $\sigma_b$ due to the bending moment is given by:

$$\sigma_b = \frac{M}{Z} \qquad 13$$

Where Z = section modulus of the shaft

$$Z = \frac{\pi}{32} \times {S_d}^3 \qquad 14$$

$$\therefore \sigma_b = \frac{32M}{\pi {S_d}^3} \qquad 15$$

Furthermore, shear stress due to the torque transmitted was computed using Equation 16.

$$\tau = \frac{16T}{\pi {S_d}^3} \qquad 16$$

The efficiency of the cracking unit was determined based on the length of crack that develops on the coconut along the cracking axis (the shorter dimension of the coconut) using the Equation 17.

$$Cracking\ Efficiency, \eta_{cr} = \frac{length\ of\ observable\ crack}{diameter\ of\ coconut\ along\ the\ crack\ axis} \times 100\% \qquad 17$$

**Design of the Scrapper Assembly**

The scrapper unit is the part of the machine that facilitates shredding of the coconut endosperm. For reasons of evaluation, three scrapper rotors were produced; each having blades with serrated edges. Each rotor had different number of blades: two, three and four. Before using the scrapper part of the machine, the cracking hammer is locked in position. A half-split coconut is installed firmly in the holder, then the scrapper blade is moved into position for the scrapping process. The main drive motor is turned on as well as the scrapper motor. While the coconut is rotated in its locked-in position, the user moves the scrapper towards the walls of the endosperm for scrapping. The speed of operation of the scrapper was variable. This was done to observe the performance of the machine at various speed settings. The scrapping speed, $V_c$ was computed mathematically using Equation 18.

$$V_c = \frac{\pi d n}{12} \qquad 18$$

Where;
d = diameter of the scrapper
n = revolutions per minute of the scrapper spindle
Cutting power, $P_s$ at the spindle is related to the tangential cutting force, $F_t$ and the scrapping speed as shown in Equation 19.

$$P_s = \frac{F_t \times V_c}{60000}\ (kW) \quad 19$$

$$F_t = \frac{T_s}{R} = \frac{2T_s}{d} \quad 20$$

Where;
$T_s$ = torque of the cutting spindle
R = radius of the spindle

$$\text{But, } T_s = \frac{60P_s}{2\pi n} \quad 21$$

Thus, substituting Equation 21 in Equation 20,

$$F_t = \frac{60P_s}{\pi dn} \quad 22$$

The scraping efficiency, $\eta_{scr}$ was determined based on how long it took to completely remove the edible portion of the coconut (endosperm). This was assessed using the three different blades configuration and coconuts of roughly the same size. Mathematically,

$$\eta_{scr} = \frac{Volume\ of\ coconut\ grits\ produced,\ V_{GT}}{Grain\ volume, V_G} \times 100\% \quad 23$$

According to Mahadevan and Balaveera, (2018), grain volume is given by:

$$V_G = \frac{\pi b^2 a^2}{6(2a-b)} \quad 24$$

Where;
a = length of the coconut along the major axis (mm)
b = width of the coconut along the minor axis (mm)
$V_{GT}$ Was obtained by physical measurement.

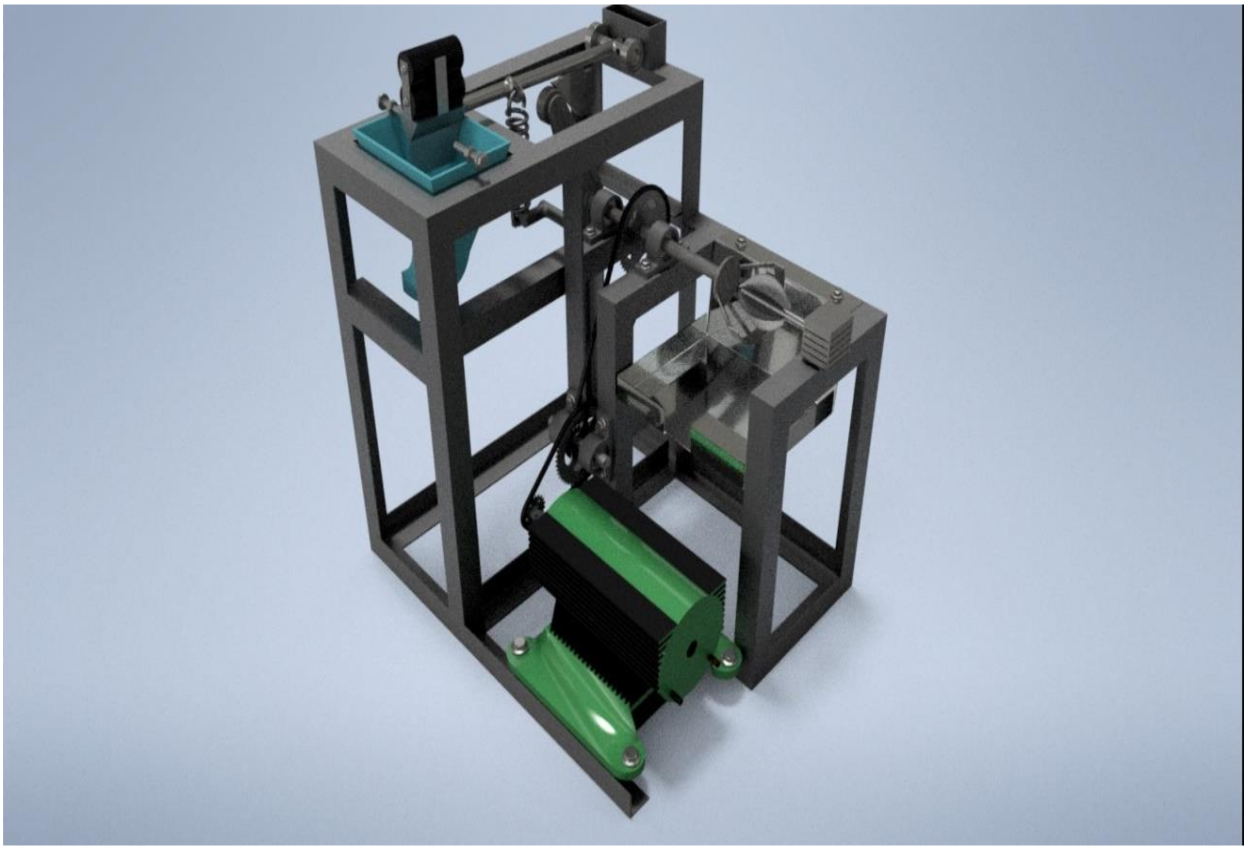
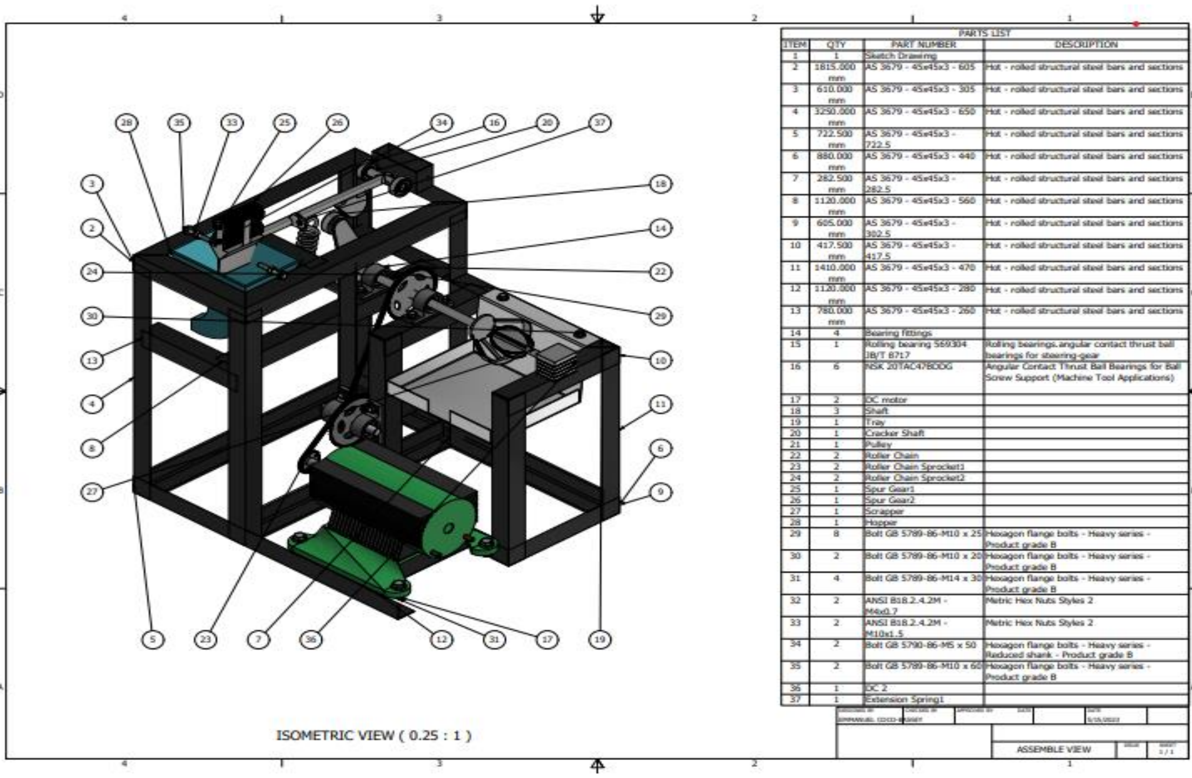
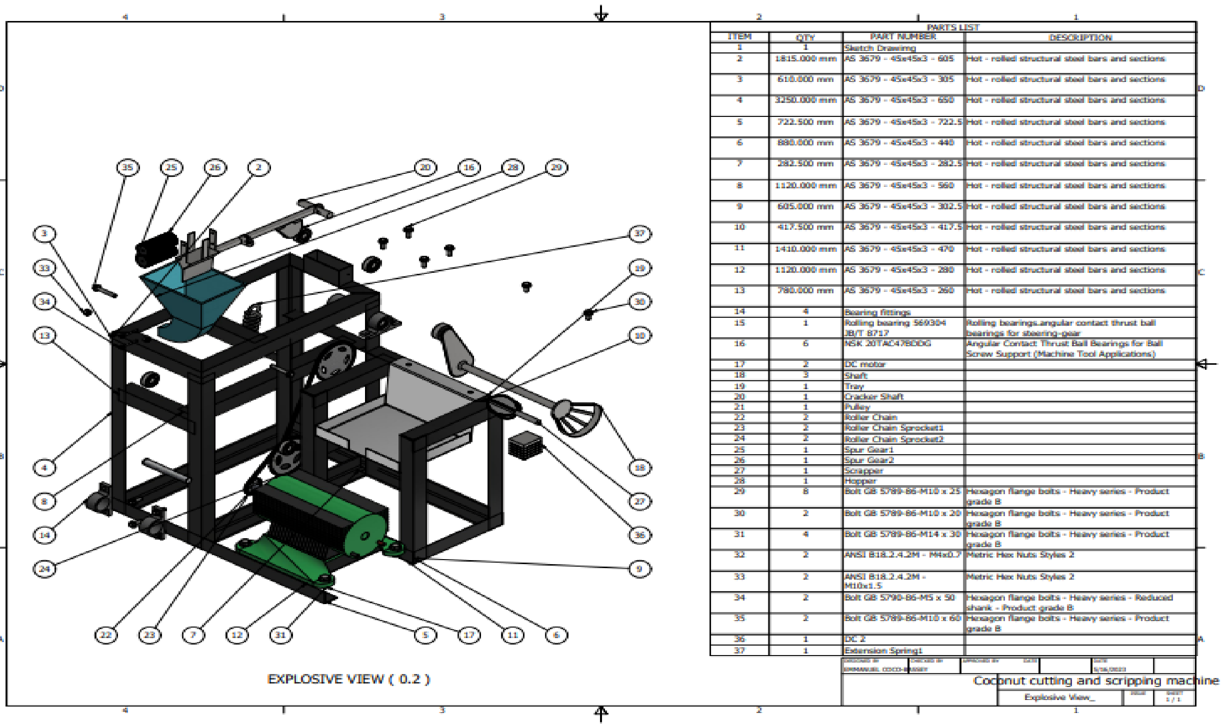


Figure 4: Rendered Assembled view




| ITEM | QTY | PART NUMBER | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | Sketch Drawing | |
| 2 | 1815.000 mm | AS 3679 - 45x45x3 - 605 | Hot - rolled structural steel bars and sections |
| 3 | 610.000 mm | AS 3679 - 45x45x3 - 305 | Hot - rolled structural steel bars and sections |
| 4 | 3250.000 mm | AS 3679 - 45x45x3 - 650 | Hot - rolled structural steel bars and sections |
| 5 | 722.500 mm | AS 3679 - 45x45x3 - 722.5 | Hot - rolled structural steel bars and sections |
| 6 | 880.000 mm | AS 3679 - 45x45x3 - 440 | Hot - rolled structural steel bars and sections |
| 7 | 282.500 mm | AS 3679 - 45x45x3 - 282.5 | Hot - rolled structural steel bars and sections |
| 8 | 1120.000 mm | AS 3679 - 45x45x3 - 560 | Hot - rolled structural steel bars and sections |
| 9 | 605.000 mm | AS 3679 - 45x45x3 - 302.5 | Hot - rolled structural steel bars and sections |
| 10 | 417.500 mm | AS 3679 - 45x45x3 - 417.5 | Hot - rolled structural steel bars and sections |
| 11 | 1410.000 mm | AS 3679 - 45x45x3 - 470 | Hot - rolled structural steel bars and sections |
| 12 | 1120.000 mm | AS 3679 - 45x45x3 - 280 | Hot - rolled structural steel bars and sections |
| 13 | 780.000 mm | AS 3679 - 45x45x3 - 260 | Hot - rolled structural steel bars and sections |
| 14 | 4 | Bearing fittings | |
| 15 | 1 | Rolling bearing 569304 JB/T 8717 | Rolling bearings.angular contact thrust ball bearings for steering-gear |
| 16 | 6 | NSK 20TAC47BDDG | Angular Contact Thrust Ball Bearings for Ball Screw Support (Machine Tool Applications) |
| 17 | 2 | DC motor | |
| 18 | 3 | Shaft | |
| 19 | 1 | Tray | |
| 20 | 1 | Cracker Shaft | |
| 21 | 1 | Pulley | |
| 22 | 2 | Roller Chain | |
| 23 | 2 | Roller Chain Sprocket1 | |
| 24 | 2 | Roller Chain Sprocket2 | |
| 25 | 1 | Spur Gear1 | |
| 26 | 1 | Spur Gear2 | |
| 27 | 1 | Scrapper | |
| 28 | 1 | Hopper | |
| 29 | 8 | Bolt GB 5789-86-M10 x 25 | Hexagon flange bolts - Heavy series - Product grade B |
| 30 | 2 | Bolt GB 5789-86-M10 x 20 | Hexagon flange bolts - Heavy series - Product grade B |
| 31 | 4 | Bolt GB 5789-86-M14 x 30 | Hexagon flange bolts - Heavy series - Product grade B |
| 32 | 2 | ANSI B18.2.4.2M - M4x0.7 | Metric Hex Nuts Styles 2 |
| 33 | 2 | ANSI B18.2.4.2M - M10x1.5 | Metric Hex Nuts Styles 2 |
| 34 | 2 | Bolt GB 5790-86-M5 x 50 | Hexagon flange bolts - Heavy series - Reduced shank - Product grade B |
| 35 | 2 | Bolt GB 5789-86-M10 x 60 | Hexagon flange bolts - Heavy series - Product grade B |
| 36 | 1 | DC 2 | |
| 37 | 1 | Extension Spring1 | |

Figure 5: Assembled View

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| 29 | 8 | Bolt GB 5789-86-M10 x 25 | Hexagon flange bolts - Heavy series - Product grade B |
| 30 | 2 | Bolt GB 5789-86-M10 x 20 | Hexagon flange bolts - Heavy series - Product grade B |
| 31 | 4 | Bolt GB 5789-86-M14 x 30 | Hexagon flange bolts - Heavy series - Product grade B |
| 32 | 2 | ANSI B18.2.4.2M - M4x0.7 | Metric Hex Nuts Styles 2 |
| 33 | 2 | ANSI B18.2.4.2M - M10x1.5 | Metric Hex Nuts Styles 2 |
| 34 | 2 | Bolt GB 5790-86-M5 x 50 | Hexagon flange bolts - Heavy series - Reduced shank - Product grade B |
| 35 | 2 | Bolt GB 5789-86-M10 x 60 | Hexagon flange bolts - Heavy series - Product grade B |
| 36 | 1 | DC 2 | |
| 37 | 1 | Extension Spring1 | |

Figure 6: Exploded View

Figure 7: Developed cracking and scrapping machine

**3.0 STRUCTURAL ANALYSIS**

The structural analysis of the designed and developed cracking and scrapping machine was carried out on the cracking unit. This was done to determine the maximum angle of swing that is sufficient to crack the coconut and make it ready for scrapping. Also determined was the principal stress required for the same action as well as the duration through which the machine will operate.

The performance and analysis done on the developed machine is as discussed below;

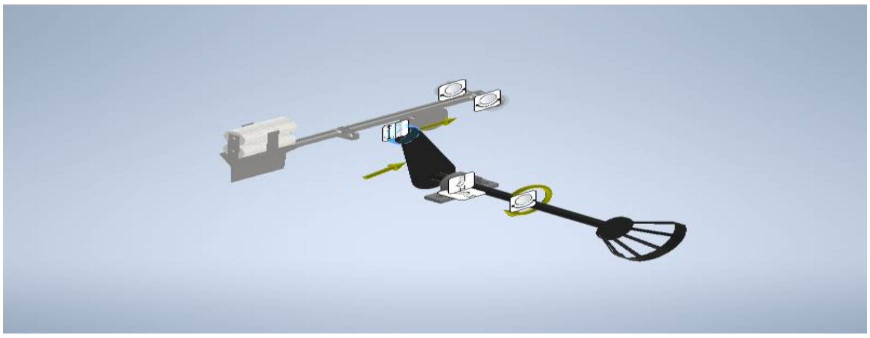
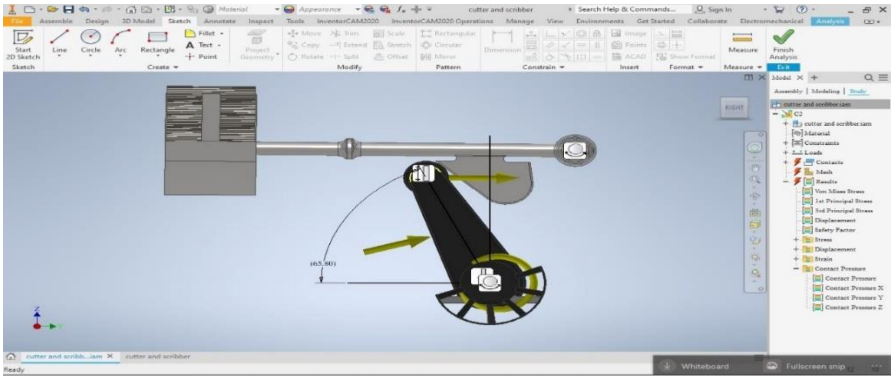


Figure 8: Boundary condition setup on the Components

After the simulation of the structure using Inventor Professional 2020 static structural with a force load of 2000N and Moment force of 2000N, the results obtained are presented in the following sections. The analysis was carried out at different angles of impact 65.8, 74 and 90 degrees.



**At 65.8 degrees,**
Figure 9: Front View at Angle 65.8

## TOTAL DEFORMATION

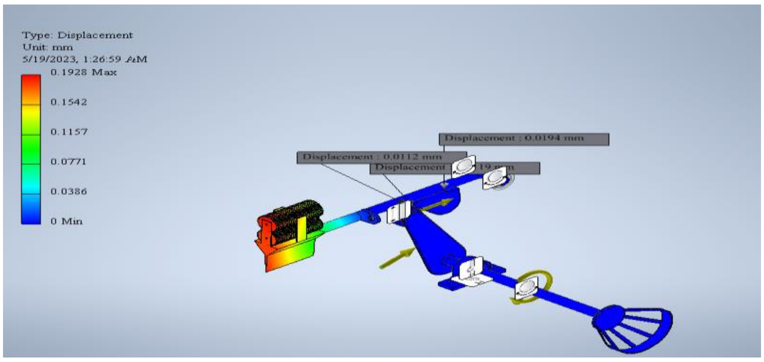



Figure 10: Isometric View of the Total Deformation that Occurs on the machine Part.

The minimum and maximum deformation in the analysis depicted in Figure 10 above are 0 mm and 0.1923 mm. The overall deformation that occurs when a force and moment of 2,000 N is applied at the point of contact. The Von-Misses stresses affecting the components are depicted in the figure below.

## EQUIVALENT STRESS (VON-MISSES STRESS)

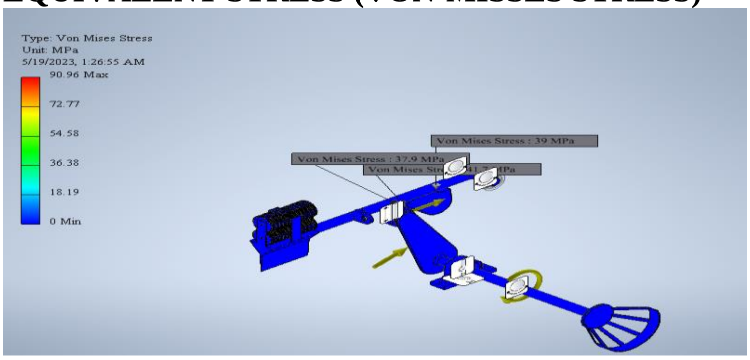



Figure 11: Isometric View of the Equivalent stress that Occurs on the machine Part.

The maximum Von-Misses Stress (vm) that emerges on these components according to the analysis indicated in Figure 11 above is 90.96 MPa. This frame's construction material has a yield strength of 207 MPa. This led to the conclusion that on these components are within safe bounds because the yield strength is larger than the maximum Von-Misses Stress (vm).

**SAFETY FACTOR**

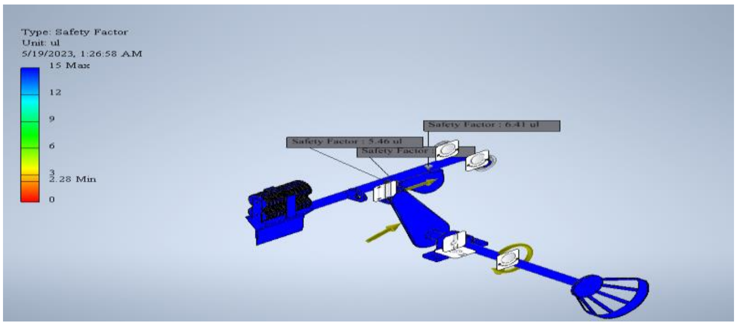



Figure 12: View of the Equivalent Safety Factor Occurs on the machine Part.

The factor of safety for the frame has a minimum and maximum value of 0.84179 and 15, as shown in Figure 12. According to the minimal values, failure will occur with a load that is 0.8 times the applied pressure for highly stressed sections. While the maximum value indicates that the structure will break with a load 15 times the applied load for locations where there is less stress concentration.

**At 74 degrees,**
**TOTAL DEFORMATION**

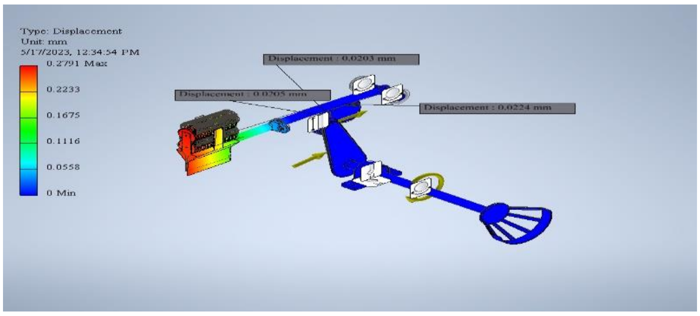



Figure 13: Isometric View of the Total Deformation that Occurs on the machine Part.

The maximum deformation in the analysis depicted in Figure 13 above are 0.0205mm mm, 0.0203 mm and 0.0224 mm on the probed parts of the components. the overall deformation (0.2791 mm) that happens when a force load and moment of 2000 N is applied at the point of contact. The Von-Misses stresses affecting the components are depicted in the following figures.

**EQUIVALENT STRESS (VON-MISSES STRESS)**

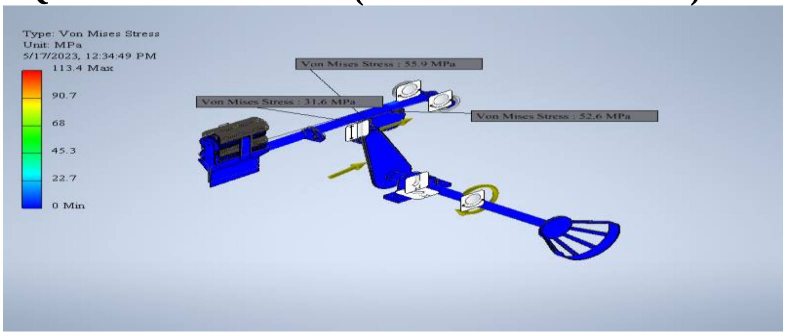



Figure 14: Isometric View of the Equivalent stress that Occurs on the machine Part.

The maximum Von-Misses Stress (vm) that emerges on these components according to the analysis indicated in Figure 14 above is 0 MPa on the probed parts of the components.

These components construction material has a yield strength of 207 MPa. This led to the conclusion that on these components are within safe bounds because the yield strength is larger than the maximum Von-Misses Stress (vm).

## SAFETY FACTOR

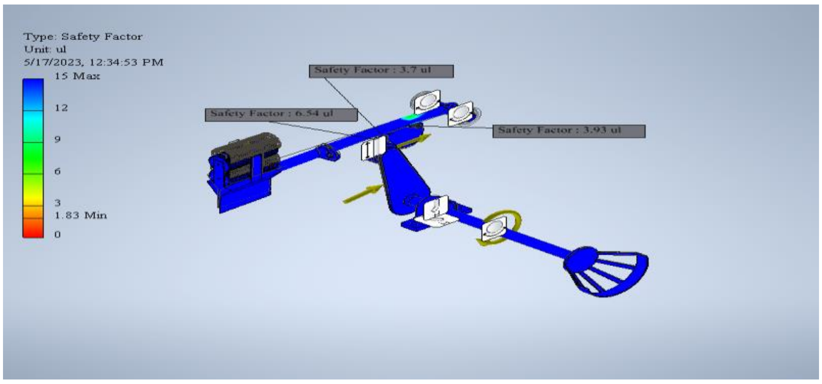



Figure 15: View of the Equivalent Safety Factor Occurs on the machine Part.

The factor of safety for the frame has a minimum and maximum value of 1.83 and 15, as shown in Figure 15. According to the minimal values, failure will happen with a load that is 0.8 times the applied pressure for highly stressed sections.

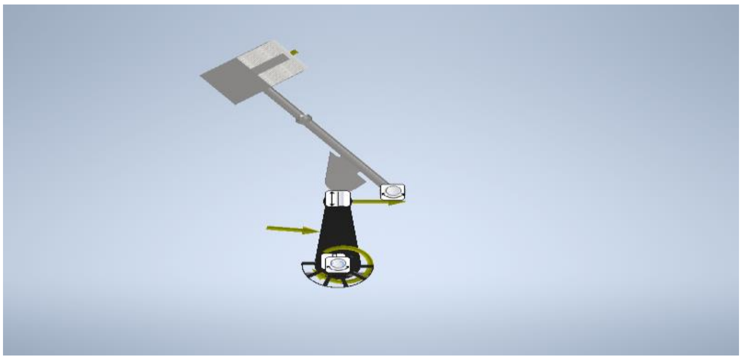


Figure 16: Front View at Angle 90

## TOTAL DEFORMATION

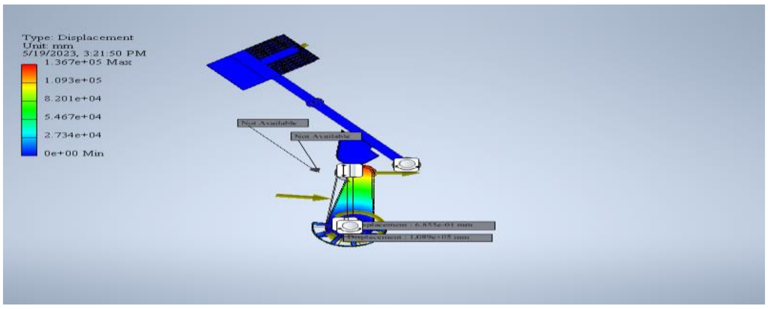



Figure 17: Isometric View of the Total Deformation that Occurs on the machine Part.

The maximum deformations in the analysis depicted in Figure 17 above are 6.855e-01mm mm and 1.089e+05 mm on the probed parts of the components. the overall deformation that happens when a force load and moment of 2,000 N is applied at the point of contact. The Von-Misses stresses affecting the components are depicted in the following figure.

**EQUIVALENT STRESS (VON-MISSES STRESS)**

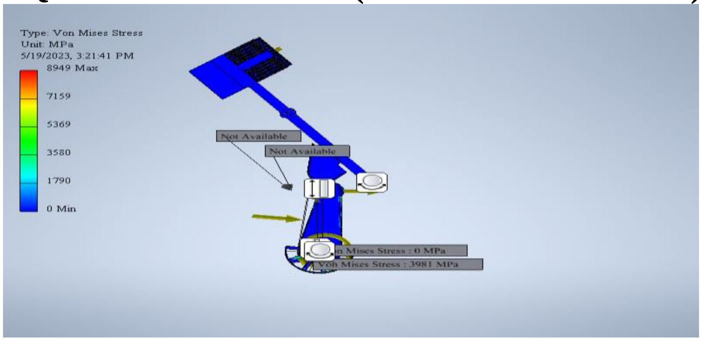



Figure 18: Isometric View of the Equivalent stress that Occurs on the machine Part.

The maximum Von-Misses Stress (vm) that emerges on these components according to the analysis indicated in Figure 18 above is 0 MPa on the probed parts of the components. These components construction material has a yield strength of 207 MPa. This led to the conclusion that on these components are within safe bounds because the yield strength is larger than the maximum Von-Misses Stress (vm).

## 4.0 FATIGUE ANALYSIS ON THE CRACKER

The minimal fatigue life indicates how long these structures will endure before beginning to deteriorate in any way, at which time the structure is no longer functional. whereas the maximum fatigue life depicts how long the material will survive before the structure completely fails.

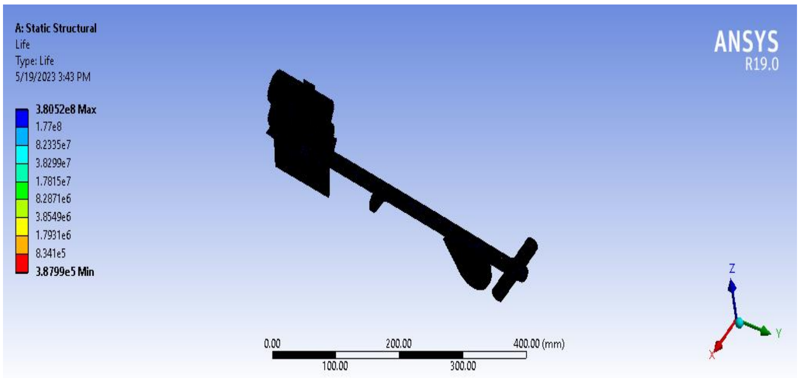



Figure 19: Isometric View indicating the fatigue life of the chassis.

According to the estimates provided above in Figure 19, the structure's fatigue life will last for a maximum of 380,520,000 months.

Table 1: Analyzing overall results with Inventor Professional 2020

| | | |
|---|---|---|
| **64 Degrees** | | |
| Name | Minimum | Maximum |
| Volume | 808429 mm^3 | |
| Mass | 6.31071 kg | |
| Von Mises Stress | 0.0000529594 MPa | 90.9603 MPa |
| 1st Principal Stress | -33.0861 MPa | 103.77 MPa |
| 3rd Principal Stress | -99.4417 MPa | 28.9226 MPa |
| Displacement | 0 mm | 0.192791 mm |
| Safety Factor | 2.27572 ul | 15 ul |
| **74 Degrees** | | |
| Name | Minimum | Maximum |
| Volume | 808429 mm^3 | |
| Mass | 6.31071 kg | |
| Von Mises Stress | 0.0000730432 MPa | 113.363 MPa |
| 1st Principal Stress | -28.2141 MPa | 119.357 MPa |
| 3rd Principal Stress | -108.62 MPa | 40.9673 MPa |
| Displacement | 0 mm | 0.279116 mm |
| Safety Factor | 1.826 ul | 15 ul |
| **90 Degrees** | | |
| Name | Minimum | Maximum |
| Volume | 808429 mm^3 | |
| Mass | 6.31071 kg | |
| Von Mises Stress | 0.0000956386 MPa | 0 MPa |
| 1st Principal Stress | -2492.59 MPa | 0 MPa |
| 3rd Principal Stress | -8290.59 MPa | 0 MPa |
| Displacement | 0 mm | 0 mm |
| Safety Factor | 0.0231316 ul | 15 ul |

## CONCLUSION

A coconut cracking and scrapping machine was developed and the structural components were subjected to some degree of stress analysis. The developed machine executed cracking and scrapping task in coconut processing. To achieve maximum efficiency and the output of the machine, the structural analysis of the machine was done on the cracking and scrapping units using Inventor Professional 2020 static. The safety factor of the machine was also determined. The result showed that the principal stress of the machine at different degrees is between 90.9608MPa and 119.357MPa. Factor of safety is 15ul. This result shows that, the developed machine can operate under different stress loads and factors such as fatigue, impact, tension and compression.

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