Ministry of Higher Education of Scientific

Research

University AMAR TELIDJI « LAGHOUAT »

Department: MECHANICAL ENGINEERING

Option: MECHANICAL AND PRODUCTIVE MANUFACTURING

DESIGN AND MANUFACTURING A WOOD CHIPPER MACHINE

Thesis for obtaining the Master's degree in Mechanical Engineering

Presented by:

Naceur YAGOUBI

Under the direction of:

Mr. Ahmed REZIG

Jury members:

Mr. Hadj A. BENHORMA	PR	President
Mr. Belkacem BENSMAIN	MCA	Examiner
Mr. Ahmida REZIG	MCB	Project Supervisor

Promotion :2023

Dedication

To the soul of my father, and to the present mother, who strongly supported me and I stand tall here because of her, to my brothers Abdul-Qadr, Abu Al-Qasim, Ahmed and Fathi , and to my sisters Saida, Arab and Fatima, and to the general who inspired them in this work and especially those who were the reason for its success.

To my friends at Ammar thaliji University and to the Department of Mechanical Engineering in particular, and especially the Department of mechanical industry and production.

To the best companions and all dear ones and all the special stations that came across me at the University.

NACEUR

Thanks, and gratitude

IN the beging thanks to allah Who has all the credit for completing this memo ,I also extend my sincere thanks to all those who contributed to the completion of this work and extended a helping hand to us, especially in this regard, the esteemed professor REZIG Ahmida, to whom I extend the highest appreciation and thanks and convey expressions of gratitude because he did not skimp on advice and guidance .

We would also like to thank the professors of Mechanical Engineering in general, and especially the discussion Committee that will oversee this research. Special thanks to the professors and students (mechanical industry and production)

abstract:

In my research, , where I touched on the definition of wood and what it is, and then we moved up to the definition of the history of the machine from its first use to the present day, and we also moved up to the speed and cutting power of the wood material, where I made a design for all aspects of the machine using SolidWorks .

In the last chapter, which we can call the "design application chapter", where in this chapter I mentioned all the machines that contributed to the installation and manufacture of this machine, where I photographed all the machines of the nation involved in the manufacture and installation, as well as signing, welding and riveting machine parts, as well as the final and experimental demonstration of the machine.

The process, i.e. the manufacturing process, was carried out according to three important stages, namely, study, design, and application, and finally the desired result was reached.

ملخص :

في بحثي ، ، حيث تطرقت إلى تعريف الخشب وما هو عليه ، ثم انتقلنا إلى تعريف تاريخ الآلة من أول استخدام لها حتى يومنا هذا ، كما انتقلنا إلى سرعة وقوة قطع المواد الخشبية ، حيث قمت بعمل تصميم لجميع جوانب الآلة باستخدام سوليدووركس.

في الفصل الأخير ، والذي يمكن أن نسميه "فصل تطبيق التصميم" ، حيث ذكرت في هذا الفصل جميع الآلات التي ساهمت في تركيب وتصنيع هذه الآلة ، حيث قمت بتصوير جميع آلات الأمة المشاركة في التصنيع والتركيب ، وكذلك التوقيع واللحام والتثبيت أجزاء الآلة ، وكذلك العرض التوضيحي النهائي والتجريبي للآلة.

تم تنفيذ العملية ، أي عملية التصنيع ، وفقا لثلاث مراحل مهمة ، وهي الدراسة والتصميم والتطبيق ، وأخيرا تم الوصول إلى النتيجة المرجوة

RESUME

Dans mes recherches,, où j'ai abordé la définition du bois et de ce que c'est, puis nous sommes passés à la définition de l'histoire de la machine depuis sa première utilisation jusqu'à nos jours, et nous sommes également passés à la vitesse et à la puissance de coupe du matériau bois, où j'ai réalisé une conception pour tous les aspects de la machine à l'aide de SolidWorks .

Dans le dernier chapitre, que nous pouvons appeler le "chapitre d'application de la conception", où dans ce chapitre j'ai mentionné toutes les machines qui ont contribué à l'installation et à la fabrication de cette machine, où j'ai photographié toutes les machines de la nation impliquées dans la fabrication et l'installation, ainsi que la signature, le soudage et le rivetage de pièces de machines, ainsi que la démonstration finale et expérimentale de la machine.

Le processus, c'est-à-dire le processus de fabrication, a été réalisé selon trois étapes importantes, à savoir l'étude, la conception et l'application, et enfin le résultat souhaité a été atteint..

Introduction

Introduction

For the recycling of organic waste there is a well-known and easily applied technique, which consists of the biological decomposition under controlled, aerobic and thermophilic conditions of the waste; This technique is called composting. The process allows to treat in a rational, economical and safe way, different organic residues and to conserve the nutrients present in them, for their later use in agriculture. Composting is a technique used for a long time, in which a pile of vegetable matter (branches, trunks, leaves), household waste, animal excrement and harvest remains is made; to break them down and transform them into an easily manageable product that can be used to improve the soil.

Compost fulfills important functions in the life of the earth, such as: delivering nutrients to the soil, improving its structure, texture, aeration and water retention capacity. For example, when mixing the compost with clayey soils, these increase their porosity and become light soils; On the other hand, in sandy soils, the water retention capacity increases. The compost also allows erosion control, soil fertility is increased and an increase in the rooting of plants is generated.

One of the determining conditions in the quality of the compost is the size of the matter that composes it; the smaller the residues, the sooner the organic decomposition of the matter takes place. For this reason, various machines have been built to "grind" or crush the vegetable product that will later be used as "raw material" for compost.

In our country, the composting technique has been little used and even less has been applied effectively. The methods used to generate the compost material and its subsequent stacking and turning are archaic and with little or no technology. In addition, there are very few manufacturers that commercially build in our country the machinery commonly used for compost production. For example, any subject that wishes to acquire a device for shredding branches or a compost turner in Algeria must obtain it through a distributor that imports said device from abroad, raising the sale price and, therefore, the production costs of the device. compost; discouraging people interested in dedicating themselves to this ecological practice. Therefore, to promote the habit of composting in our country, it is of vital importance to offer the main devices to carry out this practice in the Algerian market, including the machine that is the object of this study: a shredder.

Introduction

The availability of a low-cost vegetable matter shredding machine, capable of satisfying the basic needs of the average user, built with technology that is easily accessible and requires little maintenance, simple to manufacture with simple manufacturing processes so that it can be assembled in any workshop that has common machine tools; would significantly reduce the times and costs in the preparation of compost.

According to the previous exposition, the need to modernize a market with enormous potential, concerned with the problem of improving the fertility of the land and the conservation of the environment, is clearly justified. In this way, a device that assists people in the preparation of compost has an excellent area of opportunity to address a market that, despite only just emerging in our country, has magnificent possibilities of growing and developing in the future.

To achieve our goal, which is the design and manufacture of a machine to solve the problem of vegetable waste, this work is organized as follows:

-A general introduction

-The first chapter devoted to bibliographical research.

-The second chapter devoted to the design study and the calculation

-The third chapter is focused on the manufacturing steps of the machine.

- Finally, we end with a general conclusion.

General objective

• Design and build a crushing machine for vegetable matter to compost production.

Chapter I: Generalities about wood and wood chipper

In this chapter we will deal with generalities about what Wood is and the wood chopping machine, where we will touch on the knowledge of both, we will also get acquainted with its components and physical and mechanical properties, as well as the extent of its impact on the environment and the waste that we see and affect the environment in general and on the University neighborhood in particular, where we will try to how to calculate the cutting force, where this chapter will be to find out what it is and why it was made .

I- Generalities about wood

1- Deffinition of wood :

Wood is a natural material of plant origin. It consists of a plant tissue forming the largest part of the trunk of woody plants. The wood ensures, in the plant, the role of conduction of the raw sap from the roots to the leaves and the role of mechanical support of the tree or the shrub. It also sometimes serves as a reserve fabric.

The standard NF B 50-003 (defining the nomenclature of wood) defines it as "a set of secondary resistant tissues (support, conduction, and storage) that form the trunks, branches and roots of woody plants. Resulting from the functioning of the peripheral cambium, it is located between it and the medulla".

It is one of the most appreciated materials for its mechanical properties, for its calorific value and as a raw material for artistic production as well as in multiple industrial sectors. It has many uses in construction and industry (paper industries, chemical industries ...) and as a combustible1. Some plants (palm trees, bamboo ...) produce lignified tissues but not from a secondary cambium: it is therefore not wood.

The discipline that studies wood is xylology, a collection of wood samples is called a xylotheca. We use the adjective "xyloid" for what looks like itin 1. The fact of collecting wood or being passionate about this material is called xylophily. [6]

Its organic components: wood consists mainly of organic substances by 99% of its total mass, completely dry wood contains 49% of carbon, 44% of oxygen, 6% of hydrogen, and when burning wood, the inorganic part of it remains, which is Ash

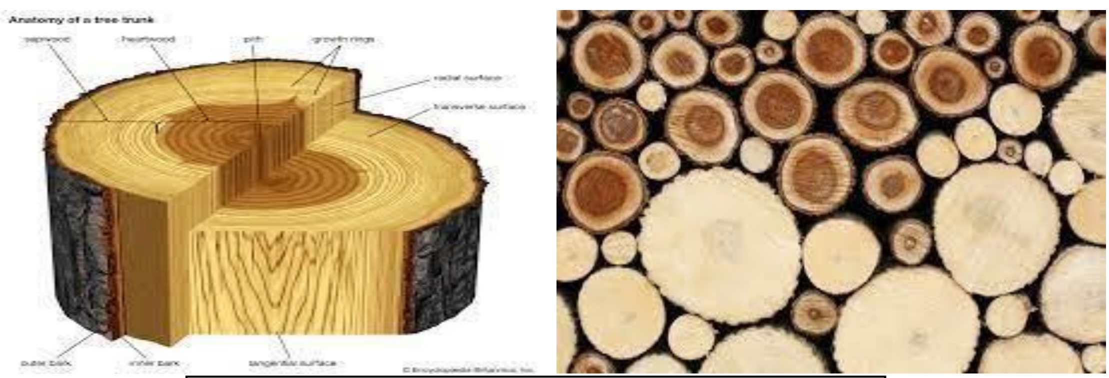


Figure 1.1: varios woods

There are many classes for wood, including: :

the **A-**class

corresponds to light woods including poplar, fir, pine and alder .

the **B-**class

includes beautiful woods for furniture such as walnut, teak or birch

the **C-**class

represents the most solid woods, classic woods such as oak, ash, elm and acacia

the **D-**class

among the most durable woods, there are dark acacia, wenge and azobe..7

2- Basic Components of Wood:

The elementary chemical composition of wood varies according to the species, but roughly the wood consists (by mass) of about 50% carbon, 42% oxygen, 6% hydrogen, 1% nitrogen and 1% minerals10 (mainly Ca, K, Na, Mg, Fe, Mn). There are also sulfur, chlorine, silicon, phosphorus, and other elements in small quantities.

Wood consists mainly of organic materials (cellulose and lignin) and a small percentage (from 1 to 1.5%) of mineral elements11. It also contains a variable share of humidity.

Cellulose (about 50%)

Lignin (20 to 30%)

Hemicellulose (15 to 25%)

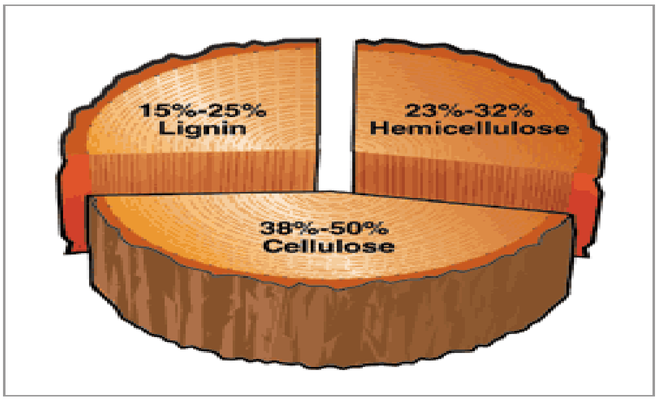


Figure1.2: Wood Component

3- Mechanical properties of solid wood:

subjected to low intensity mechanical stresses, solid wood is susceptible to reversible deformations which can be considered elastic (elasticity). However, compared to the elastic behavior of many other materials used, in particular in construction, that of solid wood has remarkable specificities. The mechanical behavior of solid wood is very strongly "anisotropic" and, as soon as the application time of the mechanical stresses becomes significant, the stressed part exhibits delayed deformations which can be described, when the imposed loads are less than 30% of the breaking load, within the framework of a model of behavior "anisotropic linear viscoelasticity"**.**

4- Physical properties

Hygroscopicity: for wood, it is generally a question of humidity levels denoted H%, called dry humidity (relative to anhydrous wood). Its calculation is as follows: H% = ((Wet mass minus Anhydrous mass)divided by the anhydrous mass)x100. says: H% = (Mass of pure water/Dry matter)x100. The moisture content varies from 50 to 120% (or more) for saturated wood (green wood), from 10 to 20% for air-dried wood (for drying it takes approx. 1an / cm of thickness of the board[ref. desired]), and 10% and less for artificially dried wood (by hot air conditioning, heat pump or vacuum mainly) (drying between 1 and 3 weeks). There are three types of water in the woods :

open water is the water present in the green wood. In a pictorial way, it is the water that comes out of the sponge when we press it. During the evacuation of this water, the wood does not shrink ;

bound water is the water that enters into the composition of the fibers. For our sponge, it is the water contained between the fibers of the material but that we cannot wring out.

It is the water that is withdrawn between 30% and 0% of humidity, and it is its evaporation that causes the withdrawal during drying ;

the water of constitution is the water that enters into the chemical composition of the molecules of the wood. Its elimination leads to the destruction of the wood (by fire, for example).

5- Properties of wood

Natural wood is composed of cellulose, semi-cellulose, lignin (organic cement that binds the fibers) and on average from 5% to 10% of external materials contained in the cell structure. Variations in the characteristics and the volume of these components, and small differences in the cellular structure make the wood heavier or lighter, rigid or flexible, hard or soft. The properties of the same species are relatively the same within certain limits.

The structure of a tree (Figure 1.1) contains several layers: the bark protects the trunk of the tree; the cambium contains new growing cells; the sapwood contains living cells that store nutrients; and the heartwood, or heart, contains only dead cells that provide mechanical support.

Many factors influence the behavior of wood, for example, the strength increases when the humidity is reduced. In addition, the wood is very anisotropic due to the orientation of the fibers; the resistance in the longitudinal direction can be 25 to 50 times greater than the resistance in the radial or tangential directions.

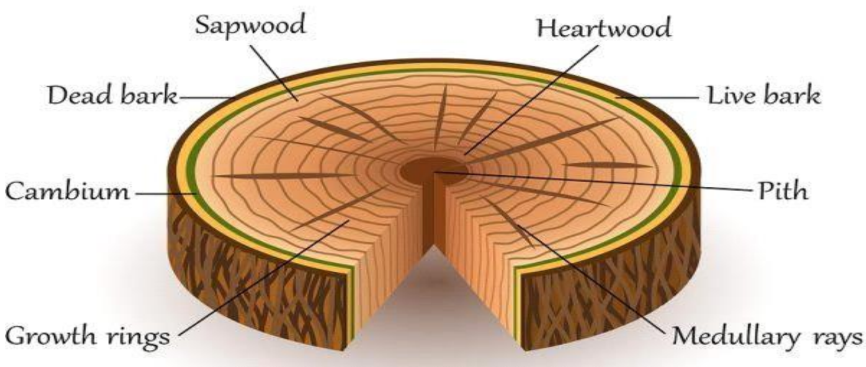


Figure 1.3: Wood structure.

Fibers have a higher tensile strength than compression or shear strength. In compression the fibers buckle; when cut, the lignin is brittle and cannot prevent the fibers from slipping over each other. The wood has good toughness due to the low disorientation of the cellulose; and under load, the fibers straighten allowing some ductility and energy absorption. The density of typical dry hardwoods varies from 300 Kg/m^3 to 800 Kg/m^3, while in softwoods it is 300 Kg/m^3 to 500 Kg/m^3 [1].

The engineer has digital calculation means allowing him to size complex mechanical structures taking into account the anisotropic nature of the materials used. The classical data of the longitudinal modulus of elasticity are supplemented by the associated anisotropic properties. The data bank[Which one?] is based on the characteristics measured over more than half a century by numerous laboratories. It has made it possible to establish a predictive model of the anisotropic elastic behavior of a wood, parameterized by the leafy or resinous nature of the species.

a. **density:**

The woody material resulting from the log of the tree is technically used in multiple forms, more and more destructured, obtained through the Primary Processing industries: sawing, unwinding, slicing, shredding (wafers, particles) and mechanical or chemical defibrating. The fibers find their outlets in the paper and cardboard industry as well as that of fiber panels (MDF, etc.); wafers and particles feed the structural panel factories, while unrolled and sliced are assembled in plywood factories. The noble form of the woody material, supposed to be sawn timber, feeds the carpentry and cabinetmaking industries, but especially the carpentry for the building and more generally the interior design companies of the habitat

The design engineer, equipped with modern means of calculating structures, likely to implement an extremely varied woody resource, needs to supply the codes made available to him, with realistic material data. Data relating to the anisotropic elastic behavior of wood are presented here, they complement the traditional characterizations generally limited to a longitudinal modulus of elasticity (E = 10,000 MPa).

Other organic substances: polysaccharides, pentosans, hexosans, resins, tannins, dyes, waxes, alkaloids, volatile aromatic compounds.

The density of the wood is usually less than 1 (the wood floats) due to the voids in its structure. This density varies greatly according to a number of parameters: the species, its degree of humidity, the geographical location and its climate, the situation of the sampling in the tree. This density is normally expressed for a moisture content equal to 15% (the average is between the anhydrous state and the saturation state)13. The density at 15% is generally between 0.5 and 0.7, but can vary considerably, from 0.1 for balsa, 0.4 for light woods (fir, spruce, poplar), 0.8 to 1 for hard woods (yew, teak, olive), 1.0-1.15 for ebony, 1.1-1.2 for azobé and 1.3-1.4 for guaiac (ironwood)14.

The density influences the buoyancy of the wood**.**

b- **Durability:**

Although it is a biodegradable material, wood can last under certain conditions for several centuries, as evidenced by many frames of ancient monuments. The parameters favorable to the durability of the wood are the maintenance in a dry **atmosphere, the high** density, the chemical composition, (the cutting period), linked to the essence (presence of resins, oleo-resins, tannins). Heartwood is more durable than sapwood, richer in fermentable materials. Among the most sustainable species, we classify cedar, sequoia, acacia robinia, larch, oak, chestnut ... and among the least sustainable: fir, spruce, beech, poplar, linden…ect.

c- Flexibility (Elasticity)

- It is the ability of a material to form as a result of the loads on it, its ability to compress when the loads affect it, causing bending, and then returning to its original shape when these loads disappear again, and the relative hardness is directly proportional to the modulus of elasticity, and it is a material .

Wood has a greater modulus of elasticity than many other structural materials, which makes it suitable for use as a load-bearing material-it has the ability to absorb shock forces, which qualifies it to withstand wind and earthquake forces.

d- Resilience

is the ability of a material to absorb the energy of a shock by deforming (rapid deformation).

In the case of fragile materials, resilience is characterized by the energy necessary to deform and break the material during an impact by a striking object. In the case of elastomeric materials, the test piece is not ruptured, the resilience is characterized by the proportion of energy restored to the striking object which bounces as a result of the impact.

e- Retractibility

Wood shrinkage is the phenomenon according to which the dimensions of a piece of wood vary with its humidity level. We talk about shrinkage because the fresh wood has maximum dimensions.

With regard to lumber, this phenomenon results in the need to dry the wood.

6- Impact load on wood

In this section the impact load necessary to cause fracture in the wood will be calculated. This is the starting point to develop the engineering analysis of the vegetable matter crusher machine.

Cutting of wood-based materials is one of the most widespread technologies in wood processing. A circular saw is used for cross-cutting or longitudinal cutting of materials, especially in the production of elements of timber structures or joinery products. Crosscutting of wood in the production of final products is usually carried out as accurate cutting to the required dimensions using mitre or transverse saws ([2]; [3]).

The fixed speed during the machine feed of the workpiece determines the constant feed per tooth and the thickness of the layer cut.

It is also common knowledge that with an increasing tooth count, the feed per tooth decreases evenly as well as the thickness of the uncut chip removed with a tooth. On the other hand, the total cutting force and the force required to feed the workpiece grow proportionally with the number of teeth in contact. When cross-cutting wood using transverse or mitre saws, the saw blade feed is most often done manually. If such saws are used, it is necessary to select the geometry, the tooth count and a chip thickness limiter so that the blade tooth is able to remove a chip and make a quality cut with minimal energy demands for the application of an average feed force. Similar issues have been addressed in, for example, [4], [5], who sought to clarify this process from an energy point of view based on an assessment of the general cutting power.

The cross-cutting of spruce and oak samples took place in a enclosed cutting mode. The main cutting edge of a WZ tooth with the set of cutting edges $\kappa_r = 10°$ cut in the tangential-transversal model with angles $\varphi_1 = 10°$ (angle between the tooth main cutting edge and the direction of wood fibres), $\varphi_2 = 10°$ (angle between the direction of wood fibres and the cut plane), $\varphi_3 = 90°$ (angle between the cutting force vector and the direction of wood fibres).

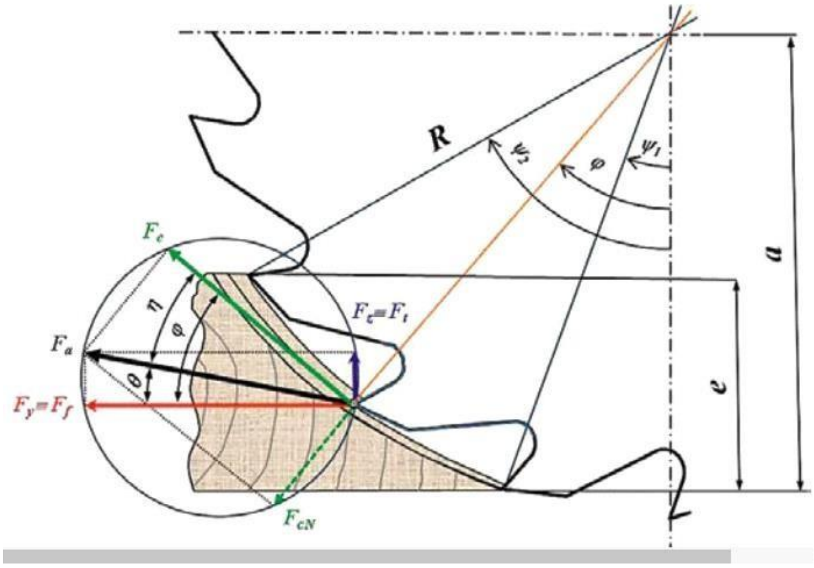


Figure 1.4: Circular sawing machine cutting force model [5].

The measurement of forces by the Kistler dynamometer was carried out on two axes, Y and Z. Force F_y, which is directly equal to the feed force F_f, was measured on Y axis. Force F_z, which equals the thrust force F_t, was measured in Z direction. This force can push the workpiece to the table or even away from it, in dependence on the current cutting conditions and resistances. The diagram of the saw blade and workpiece interaction captured by Ernst-Merchant circle is shown in Figure 1.2. Although this is not an orthogonal cutting for the main cutting edge ($\kappa_r = 10°$), it is possible to use an Ernst-Merchant circle for decomposition and force analysis

The geometry of the saw blade and the Ernst Merchant circle (Figure 1.2) yields a simple mathematical apparatus for calculating additional forces that classify the entire cutting process.

As the radius of the saw blade (R), the position of the table (workpiece) to the axis of the saw blade rotation (a) and the cutting height - thickness of the cut material (e) are known, it is possible to express the technological angles and tooth path in the workpiece:

Tooth angle when entering the workpiece

$$\psi_1 = \cos^{-1}\frac{a}{R} \qquad (1)$$

Tooth angle when getting out of the workpiece

$$\psi_2 = \cos^{-1}\frac{a-e}{R} \qquad (2)$$

$$\psi_2 = \cos^{-1}\frac{a-e}{R} \qquad (2)$$

Tooth position angle at the point of the mean uncut chip thickness

$$\varphi = \frac{\psi_1 + \psi_2}{2} \qquad (3)$$

Angle of cut

$$\psi = \psi_2 - \psi_1 \qquad (4)$$

Length of tooth path in workpiece

$$l = \frac{\pi \cdot D}{360}\psi \qquad (5)$$

Active force

$$F_a = \sqrt{F_y^2 + F_z^2} \qquad (6)$$

Cutting force

$$F_c = F_a \cdot \cos\eta \qquad (7)$$

Angle between active force Fa vector and cutting force Fc vector

$$\eta = \varphi - \theta \qquad (8)$$

Angle between active force Fa vector and feed force Ff

$$\theta = \tan^{-1}\frac{F_z}{F_y} \qquad (9)$$

Number of teeth, zl , which simultaneously remove a chip from the workpiece

$$z^1 = \frac{l}{t_p} \qquad (10)$$

Where tooth pitch

$$t_p = \frac{\pi \cdot D}{z} \qquad (11)$$

Cutting force per tooth of the saw blade

$$F_c^1 = \frac{F_c}{z^1} \qquad (12)$$

Calculation of kinematic technological parameters:

Feed speed

$$v_f = f_z \cdot n \cdot z = L / t \qquad (13)$$

Feed per tooth

$$f_z = \frac{L}{\frac{n}{60} \cdot t \cdot z} \tag{14}$$

Mean thickness of the cutting layer

$$h_m = \sin \varphi \cdot f_z \tag{15}$$

Where L : cut length (mm), n : revolution (rpm), t : time of cutting (s) - (Table 1), z : number of teeth.

The cutting force F on a tooth of a circular saw acts on chips of width b and thickness h regarding to the cutting resistance for disintegrated material K:

$$F = \frac{K.b.h.v_f}{60.v_c} \tag{16}$$

The cutting power Pc is defined as the product of cutting force F and cutting speed:

$$P_c = \frac{F \cdot v_C}{1000} \tag{17}$$

It is also possible to calculate the cutting power Pc via torque Mk, and the diameter of a circular saw D as:

$$P_c = \frac{2 \cdot M_k \cdot v_c}{D} \tag{18}$$

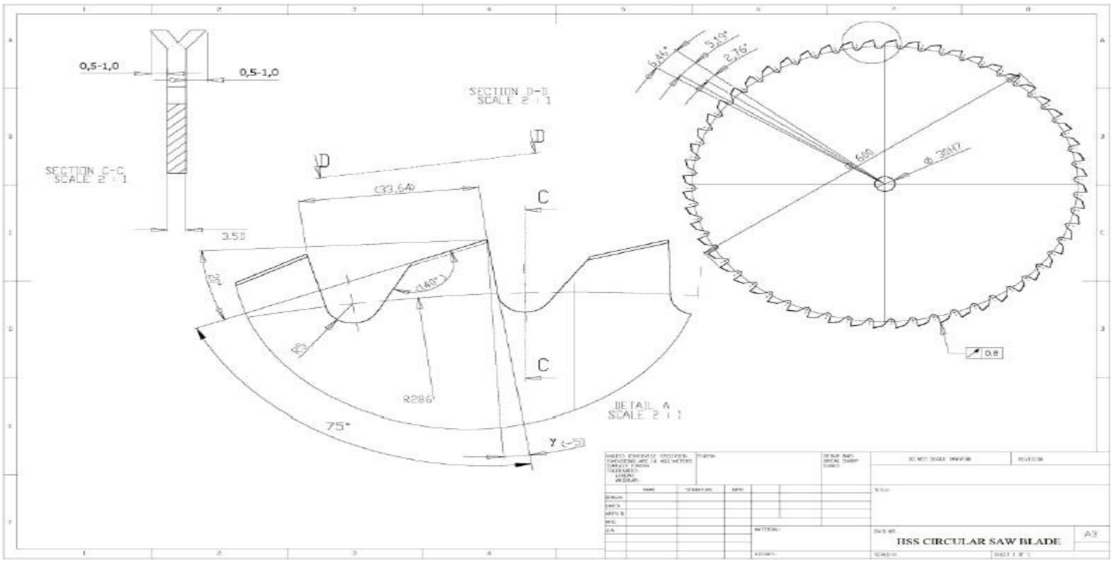


Figure 1.5: draw of disk

II- Wood chipper (crusher of wood):

1- Définition of wood chipper :

A tree shredder or wood chipper[8] is a machine used to reduce wood (generally tree limbs or trunks) into smaller wood chips. Most often they are portable, mounted on wheels on tires suitable for towing behind a truck or truck.Power is generally provided by an internal combustion engine from 2 to 700 kilowatts (3 to 1000 hp), or it is placed and the pieces are brought to it (as in this study will be done). There are also high-power shredder models that are installed on trucks and work with a separate engine. Usually such models also have a hydraulic jack.

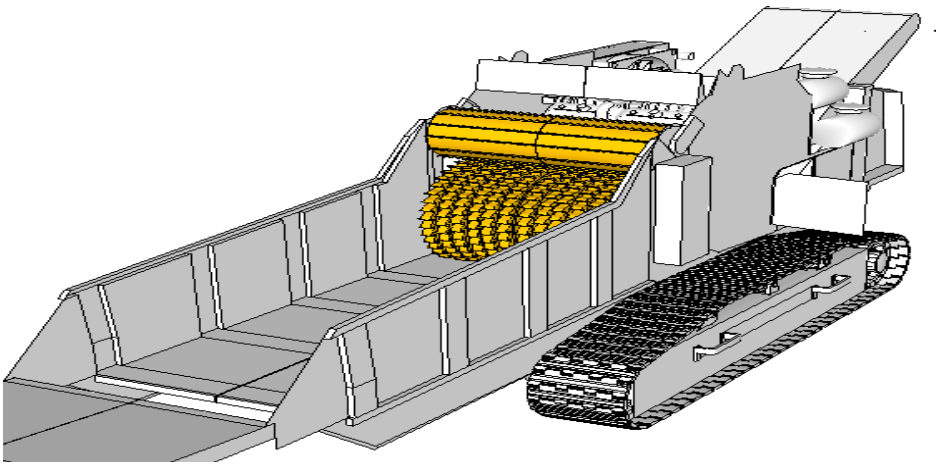


Figure 1.1: model Wood chipper.

Tree shredders are usually made from a Hopper with a collar, the shredder mechanism itself, and an optional collection box for chips. The tip of a tree is inserted into the hopper (the hoop serves as a partial safety mechanism to keep human body parts away from the chopping blades) and starts the chopping mechanism. The chips come out through a chute and can be directed to a truck-mounted container or to the ground. The typical output is 25-50 mm (1-2 in)or less than that from 5 to 10 mm (0.2 to 0.5 in)in size. The resulting wood chips have various uses such as spreading as a groundcover or being introduced into digestion during papermaking.

Figure 1.2: Wood chipper models

2- History of wod chipper

when the wood chipper was invented by Peter Jensen (Maasbüll, Germany) in 1884, the "Markehorn" quickly became the core business of his company, which already produced and repaired municipal and woodworking machines...

The first recorded use of wooden twigs dates back to the late 19th century when Peter Jensen invented drum twigs in 1884. Jensen's invention was used in the linseed oil business of Jensen and Nicholson in the state of Washington, USA. The primary purpose of the Jensen wood chipper was to process wood waste from the linseed oil industry.

At that time, the linseed oil industry produced large volumes of wood waste, including branches, trunks and other wood waste. These by-products are often burned or left to decompose, which is inefficient and wasteful. Jensen's roller shredder has revolutionized the disposal of wood waste by cutting it into smaller pieces that can be used for different purposes.

Over time, the use of wood chippers has expanded to residential applications, such as yard waste management and landscaping projects. Today, wood chipping machines are widely used in both commercial and domestic environments for processing wood waste, creating sawdust, biomass production, and other purposes related to Wood Recycling and use..

a- wood crusher between 1886and 1950

Between 1886 and 1950, wood crushers were an important development in wood processing and use. While wood chippers and wood crushers are similar in their purpose of reducing wood waste, crushers typically focus on reducing large pieces of wood to smaller, more manageable sizes. The following are some of the main developments and developments in wood crushers during that time period:

- **Patent for a wood crushing machine**:

In 1886, Edward N.Wooster, a resident of Lowell, Massachusetts, patented a wood crushing machine. His invention is aimed at crushing or crushing wood into smaller pieces, especially for use as fuel.

- **Steam-powered wood crushers:**

During the late 19th and early 20th centuries, steam power was widely used in various industries. Steam-powered wood crushers have been developed and used in sawmills and wood processing facilities. These crushers used steam engines to drive heavy-duty mechanisms that crushed wood or ground it into smaller particles.

- **Industrial applications**:

wood crushers have become an integral part of the sawmill industry and other wood processing facilities. They were used for crushing and processing large logs, wood waste and wood waste, which facilitates the handling and transportation of materials. Crushed wood can be used for various purposes, including fuel, pulp production or the manufacture of wood products.

- **Advances in crushing technology**:

over time, advances in engineering and technology have led to improvements in wood crushers. These included more efficient cracking mechanisms, improved safety features, and increased automation. Hydraulic systems have been introduced to provide better control and strength in crushing operations.

- **Portable wood crushers:**

in the early 20th century, portable wood crushers became popular for on-site wood processing. These machines are designed to be mobile and can be transported to logging sites or construction projects to process wood waste directly on site.

Electric-powered crushers: in the middle of the 20th century, electric motors began to replace steam engines in many industries, including wood processing. Electric-powered wood crushers are becoming more widespread, providing quieter operation,

easier maintenance and improved efficiency compared to their steam-powered counterparts.

During the period from 1886 to 1950, wood crushers played a decisive role in the timber industry, helping to maximize the utilization of wood resources and improve efficiency in wood processing operations. They contributed to the development of various industries that relied on wood as a raw material and facilitated the recycling and reuse of wood waste

b- wood crusher between 1950 and 1980:

Wood Crusher model late 90's

Wood Crusher late 80's

Between 1950 and 1980, wood crushers continued to develop and improve, driven by developments in technology and increasing demand for efficient wood processing. The following are some of the main developments in wood crushers during this period:

❖ **Automated wood crushers**:

electric motors became the standard power source for wood crushers during this time. The transition from steam-powered or belt-driven machines to electric motors has increased efficiency, ease of operation and reduced maintenance requirements.

❖ **Mobile wood Crushers:**

the concept of mobile wood crushers gained popularity during the mid-20th century. These portable units are designed to be easily transported to various locations, such as logging sites or construction projects. Mobile wood crushers provided on-site processing capabilities, reducing the need to transport large volumes of wood waste.

❖ **Increase capacity and efficiency:**

wood crushers have been continuously improved to enhance their capacity and efficiency. This included developments in crushing mechanisms, such as the use of sharp blades, hammers or grinding discs, to achieve a faster and more effective reduction of wood. The integration of screening systems allowed to separate fine particles or contaminants from the crushed wood material.

- **Industrial wood crushers:**

wood crushers have been widely used in large-scale industrial environments, such as sawmills, plywood factories, pulp and Paper Mills. These facilities relied on wood crushers to process various types of wood waste, including logs, boards, bark and trimmings. Pulverized wood material is often used for fuel, pulp production or as a raw material for wood products.

- **Automation and control systems:**

with the advancement of technology, wood crushers have begun to integrate automation and control systems. These systems made it possible to better monitor and regulate the crushing process, improve performance and ensure consistent production quality. Safety features, such as emergency stop buttons and protection guards, have also been improved to enhance operator safety.

- **Research and development:**

the period from 1950 to 1980 witnessed great research and development in wood crusher technology. Manufacturers invested in the design and engineering of wood crushers that were more efficient, durable and cost-effective. This led to the introduction of innovative features, including adjustable settings for particle size control, improved feeding mechanisms, noise reduction measures.

c- wood crusher between 1980 to today:

Between 1980 and the present day, wood crushers have continued to evolve with advances in technology and an increased focus on sustainability and environmental conservation. The following are some notable developments in wood crushers during this period:

Wood crusher 2023

Wood crusher 2000's

❖ **High-power and efficient crushers**:

wood crushers have become more powerful and efficient, thanks to advances in motor technology, cutting mechanisms and overall design. These improvements have resulted in higher productivity rates, lower energy consumption, and enhanced crushing capabilities.

❖ **Chopping and grinding functions:**

modern wood crushers often combine chopping and grinding functions in one machine. They can process different sizes and types of wood waste, including logs, branches, stumps, wood waste. This variety allows more efficient use of various wood materials.

❖ **Mobile and compact designs:**

portable wood crushers have become more compact, lightweight and maneuverable. This allows easy transportation to work sites and increased accessibility in difficult environments. Compact designs have also made wood crushers more suitable for residential use and small operations.

Advanced feeding systems: wood crushers now feature improved feeding systems to enhance efficiency and safety. Automatic or hydraulic feeding mechanisms help regulate the flow of wood waste to the crusher, ensuring a stable supply while minimizing the risk of bottlenecks and operator fatigue.

❖ **Versatile output**:

today Wood crushers offer versatile output options , such as different chip sizes, mulch, sawdust or biomass pellets. This flexibility allows the use of treated wood materials for a wide range of applications, including landscaping, animal bedding, energy production, manufacturing.

❖ **Automation and control:**

automation and advanced control systems are becoming more and more widespread in wood crushers. Such systems allow for better monitoring, fine adjustments and increased safety. Built-in sensors, computerized controls and user-friendly interfaces simplify operation and provide real-time feedback on performance.

❖ **Environmental considerations:**

with an increasing focus on sustainability and environmental conservation, wood crushers are now prioritizing features that reduce emissions, noise pollution and waste generation. Improved filtration systems and noise mitigation technologies help to reduce the environmental impact of wood crushing operations.

❖ **Safety improvements:**

safety features have been further improved in modern wood crushers. Emergency stop mechanisms, interlocking locks, reinforced safety guards ensure operator protection during operation and maintenance.

❖ **Digital communication and monitoring**:

some wood crushers now include digital communication and monitoring capabilities. This allows remote access, data collection and performance analysis, enabling operators to improve productivity and troubleshoot problems more efficiently.

3- The impact of wood waste on the environment:

Wood waste, like any other form of waste, can have various effects on the environment. Here are some key points related to the impact of wood waste:

a. Greenhouse gas emissions:

when wood waste decomposes in landfills, it produces methane, one of the powerful greenhouse gases. Methane contributes to climate change and global warming. In addition, burning wood waste as a disposal method releases carbon dioxide (CO2) into the atmosphere, which also contributes to climate change.

b. Air pollution:

burning wood waste can release various pollutants into the air, including particulate matter, carbon monoxide, nitrogen oxides and volatile organic compounds. These pollutants can have adverse effects on air quality and human health, contributing to respiratory problems and other diseases.

d- **Water pollution**:

improper disposal of wood waste can lead to water pollution. When wood waste is dumped or left near water bodies, rainwater can wash pollutants from the waste into rivers, lakes, or groundwater. This pollution can harm aquatic ecosystems, affect water quality and harm marine life.

e- Landfill space:

wood waste occupies valuable landfill space, which may lead to the need for more landfills or expansion of existing landfills. This can lead to the destruction of natural habitats and increase the pressure on the Earth's resources.

We can mention that our environment suffers from the problem of accumulation of waste, which negatively affects the view and cleanliness of the University neighborhood, as the random breakage of tree branches leaves many accumulations of tree waste and leaves that distort the general view of the University Institution, and in order to protect our environment from harm and random distortions, we had to find solutions that

4- Wood waste recycling:

is the process of turning waste wood into usable products. Products generated from scrap wood recycling are used in paper production, panel board production, wood pellets, energy production, and more.

Wood recycling can also help to reduce the amount of waste sent to landfills, where it can take decades or even centuries to decompose. By recycling wood, the material is given a new life as a fuel source, a landscaping product, or a building material, which can help to extend its useful life and reduce waste.

Resource conservation: wood waste represents a missed opportunity to conserve resources. Instead of being discarded, wood waste can be reused, recycled or reused for other purposes. Recycling wood waste into products such as composite panels or mulch reduces the demand for virgin wood and helps preserve forests.

To mitigate the environmental impact of wood waste, it is critical to prioritize sustainable forestry practices, promote responsible wood waste management, encourage recycling and reuse initiatives, and explore alternative energy options that reduce the need to burn wood waste. In addition, promoting awareness and encouraging individuals and industries to reduce the generation of wood waste in general can have a positive impact on the environment.

5- Wood disc and cutting force:

HSS saw blade also called cold saw, which is designed to cut wood. High speed steel (HSS) saw blade is a kind of blade composed of a certain amount of carbon (C), tungsten (W), molybdenum (Mo), chromium (Cr), vanadium (V), etc. High speed steel blanks, the semi-finished products have high hardness after cutting, forging, annealing, quenching and grinding procedures. Due to the high cutting temperature, however, hardness is still not significantly reduced when it reaches 600 °C or above. The cutting speed can reach more than 60 meters per minute. That the reasons why named high speed steel (HSS) saw blade.

a- Cutting force:

For a transverse cut (worst case) in beech at 12% humidity, a chip 0.2 mm thick, a rake angle of 30°, we have a cutting force of approximately

$$F = K \times b \times f = 16.8 \text{ N.}$$

With:

K: specific wood pressure

b: chip width

f: feed per tooth.

If you want to switch to another species, there is a correction coefficient to apply depending on the density:

Solid wood:

- Balsa: 0.5

- Poplar: 0.7

- Tree: 0.8

- Beech: 1 (reference)

- Oak: 1.4

Derivatives:

- Plywood: 1.2 to 1.5

- Particle board: 1.2

- Fibreboard: 2.5

- Laminated compact panel: 2.7

Compared to my specifications, the cutting force to be taken into account is therefore:

Reference effort: 16.8 N

Maximum correction factor for derivatives: 2.7

Safety factor: 1.4

$$F = 16.8 \times 2.7 \times 1.4 = 63.5 \text{ N}$$

Essence de bois	Densité [kg/m³]	Résistance [N/mm²] Pression	Flexion	Cisaillement
Feuillus				
Afzelia	750 - 950	65 - 79	90 - 120	7,5 - 15,0
Erable	530 - 790	29 - 72	50 - 72	9,0 - 15,0
Balsa	90 - 260	5 - 15	12 - 23	1,1 - 2,0
Bangkirai	900 - 1100	68 - 80	125 - 140	10,0 - 15,0
Bouleau	510 - 830	38 - 100	147 - 155	12,0 - 14,5
Hêtre (Hêtre rouge)	540 - 910	41 - 99	74 - 210	6,5 - 19,0
Chêne améri.	550 - 980	39 - 61	89 - 130	9,0 - 14,6
Chêne europ.	430 - 960	54 - 67	74 - 105	12,0
Aulne	490 - 640	31 - 77	44 - 172	3,0 - 6,5
Frêne	450 - 860	23 - 80	58 - 210	9,0 - 14,6
Eucalyptus	720 - 790	37 - 51	75 - 104	9,5
Iroko	550 - 850	52 - 81	70 - 158	9,5 - 12,5
Merisier américain	525 - 615	33 - 59	59 - 98	15,0
Mahagoni	450 - 620	36 - 70	50 - 130	6,0 - 9,5
Meranti, Dark Red	550 - 890	53 - 74	66 - 222	7,1 - 10,6
Meranti, Light Red	390 - 760	21 - 50	32 - 80	4,0 - 8,0
Merbau	760 - 830	60 - 85	140	13 - 17,5
Peuplier	410 - 560	26 - 56	43 - 94	4,0 - 8,0
Sipo	550 - 750	43 - 73	47 - 155	5,5 - 15
Teck	520 - 700	42 - 59	58 - 109	8,3 - 9,5
Résineux				
Douglas	640 - 800	43 - 68	68 - 89	7,8 - 10,2
Epicéa	330 - 680	33 - 79	49 - 172	3,0 - 6,5
Pin	330 - 890	35 - 94	59 - 98	6,1 - 14,6
Mélèze	440 - 850	64 - 132	107	4,5 - 10,9
Radiata Pine	450 - 580	36 - 65	60 - 91	6,8 - 7,6
Sapin	350 - 750	31 - 59	47 - 118	3,7 - 6,3

Tableau : Densité et résistance (Humidité 12%) pour les bois courants
(Source : Atlas du bois, Wagenführ, 2007)

Conclusion

Finally, we can say that the environment may be affected by everything that is around, and trees play a prominent role in maintaining hygiene requirements, as we can also say The environment around us, which has been negatively affected by our waste and the lack of dedicated cleaning mechanisms for waste materials such as wood and plastic, while in this project we will try to conduct an experiment aimed at reducing the waste of pruning and breaking trees, which will be the starting point in this project.

Refrences

[1] A. Dietenberger, B. Miller, et al, Wood Handbook, United States Department of Agriculture, pp. 4-1-44, USA, March 1999.

[2]. Sandak, J.; Negri, M., 2005: Wood surface roughness – What is it? In: Procedings of the 17th International Wood Machining Seminar (IWMS 17). Rosenheim, Germany, pp. 242-250.

[3]. Orlowski, K. A.;Ochrymiuk, T.; Hlásková, L.; Chuchala, D.; Kopecký, Z., 2020: Revisiting the estimation of cutting power with different energetic methods while sawing soft and hard woods on the circular sawing machine: a Central European case. Wood Science and Technology, 54 (2): 457-477.

[4]. Wasilewski, R.; Orlowski, K. A., 2012: Economical wood sawing with circular saws blades of a new design. Drvna industrija, 63 (1): 27-32.

[5]. Kminiak, K., 2016: Cuttnig power during cross-cutting of selected wood species with a circular saw. BioResources, 11 (4): 10528-10539.

[6]. « xylophilie » [archive], sur *Universalis.fr* (consulté le 10 mai 2023 – 13h21).

[7]. https://www.vallon-faure.com/toutes-les-breves/tendance-bois/les-differents-/types-de-bois

[8] Denny Lee (February 24, 2002). "RIVERDALE; After Much To and Fro, an Oak Falls". The New York Times. Retrieved January 16, 2023.

CHAPTER II: Wood chipper design Strategy

From this chapter we can understand the machine in an illustrative way what we will do is to make a detailed design of all parts of the machine, as well as study the main pieces in this installation, where we will design the disk, tape, load and other pieces, as well as we will make a study explaining the factors, forces and effects that occur on the disk , And also define and clarify some of the pieces

I- Wood chipper design Strategy

1- Wood chipper design Strategy

Most of the specialized bibliography establishes that the first stage in the design process of a mechanical device is to define a plan that establishes the necessary tasks that must be carried out during the development of the project. For each task, the plan must establish at least: the purpose, the personnel requirements and the time needed to perform the task [3].

In the case of the crusher design, the following general tasks were established:

- Develop engineering specifications.
- Generate a wood chipper concept.
- Analyze the concept.
- Build the prototype.
- Test and evaluate the prototype.
- Correct and/or improve the product.
- Generate product documentation.
- Develop engineering specifications:

The objective of this task is to achieve an adequate understanding of the problem by generating customer requirements and evaluating other existing products in the market using the Quality Function Deployment (QFD) method. The estimated duration to complete this task is four weeks with a full-time person.

- **Design a wood chipper concept:**

Based on the clear understanding of the required functions, a wood chipper machine concept will be proposed that meets the requirements specified by the customer. A full-time person will be needed working for five weeks.

- **Analyze concept:**

Through techniques of resistance of materials, mechanical design, mechanical vibrations, computer-aided engineering, etc.; Carry out a complete engineering analysis that includes the calculation of the loads, stresses and deformations to which the chipper will be subjected. A period of six weeks is estimated to carry out said analysis.

- **Build a prototype**:

Develop the concept proposed in task two to the point where the prototype can be physically materialized. This requires previously carrying out engineering drawings and establishing a bill of materials. It will take twelve weeks to complete this task.

- **Test and evaluate the prototype:**

Field test a first version of the wood chipper to assess its ability to meet engineering objectives. Any new requirements that arise during this test will be added to the original list of specifications. The duration of the product evaluation will be set at four weeks.

- **Generate product documentation:**

To finish the work, the documentation of the same will be carried out, including: the digital capture of all the stages of the project, cost estimation of the crushing machine, the conclusions and the respective recommendations. The time to complete this last stage is four weeks.

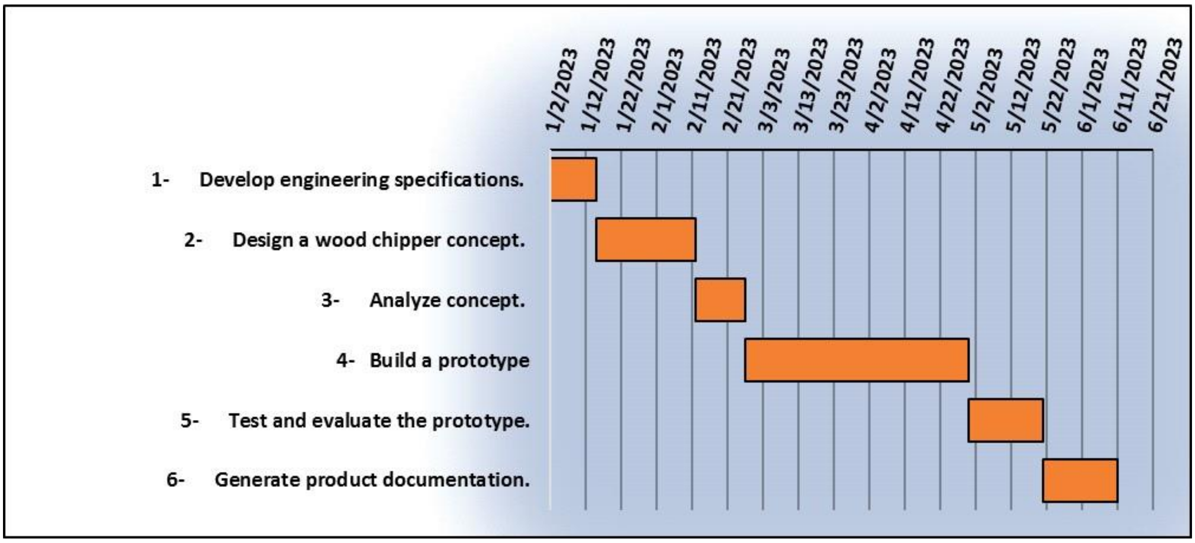


Figure 1.1 Gantt chart for the wood chipper machine project

2- Prototype construction

The main parts of the machine were purchased from the local market, namely:

1- Two Angles grinders (small model);

2- Four Proper Bearings Alignment

3- Twenty circular saw blades

Finally, all of the remaining Chipper Machine components can be made from virtually any type of steel without any special processing or heat treatment.

3- Chipper detail drawings

In this section, 3D images and the work plans necessary for the manufacture of the Chipper Shredder Machine unit are presented. These plans refer only to the elements that must be specially manufactured for the construction of the machine and, therefore, do not include the drawings of other important components of the same (bearing, screws, etc.).

Below is a series of images made using **solid works** software, of **the machine device**:

4- Machine engine design:

Through this semi-detailed design, we can know most of the parts that are included in the installation of the engine, gears, charbonnets and others, as we note the presence of two electrical and mechanical parts that generate sufficient power to ensure the success of the proper operation of the machine.

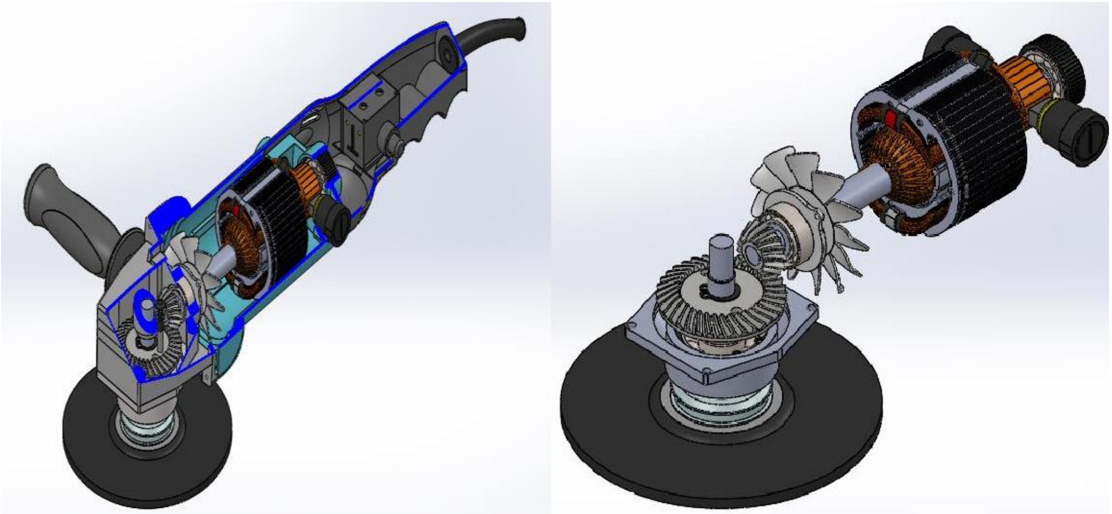


Figure 1.2 Machine engine interior design.

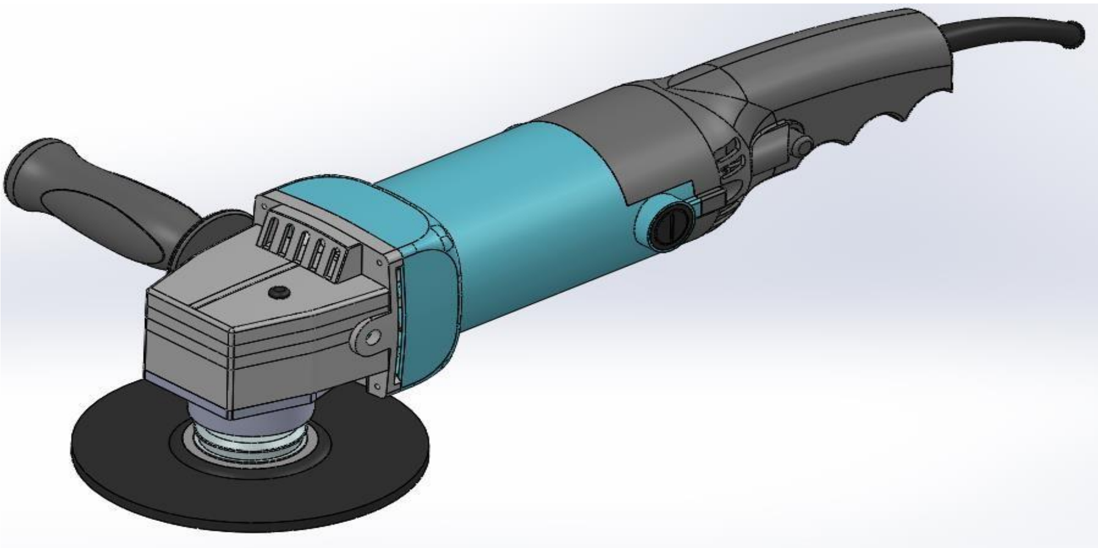


Figure 1.2 External design of the machine engine

5- Design for various parts of the machine:

The machine is composed of many pieces, some of which were previewed and studied on the solidworks program and designed as well ,where this is what the following photos and designs will illustrate.

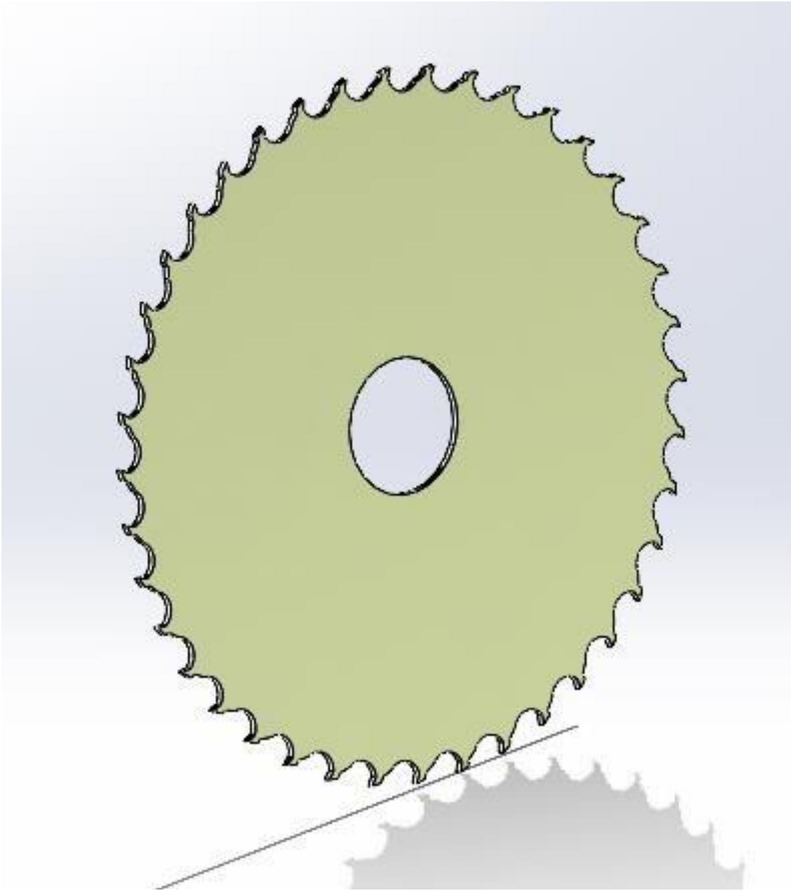
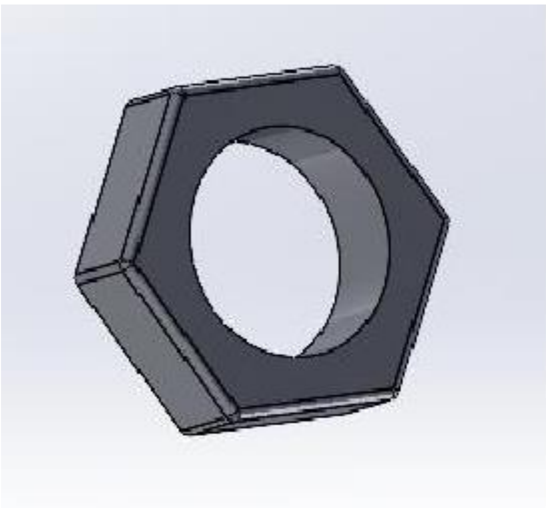
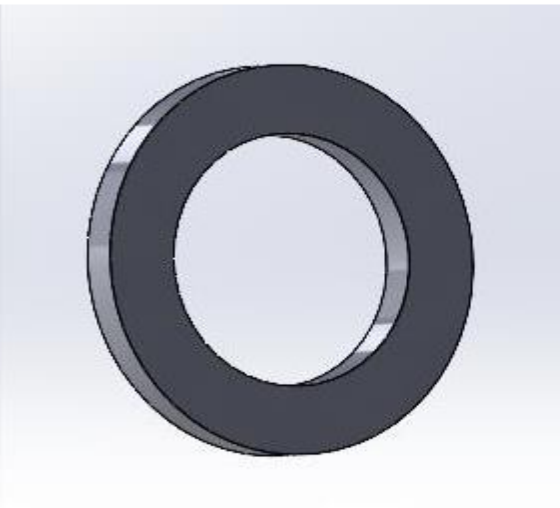


Figure 2.1 Disck



Nut design



Design of ring

Figure 2.2design of ring and nut

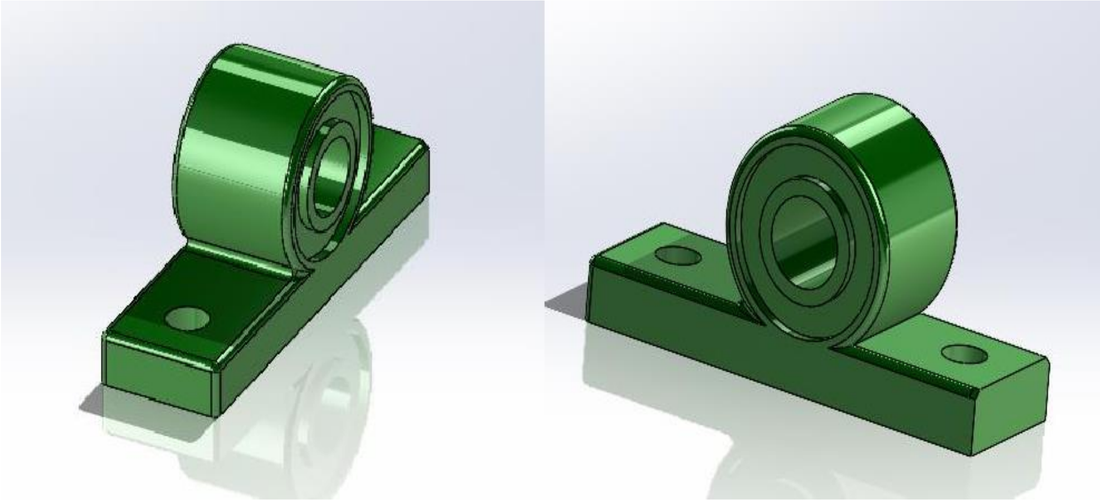


Figure 2.3 design of bearing

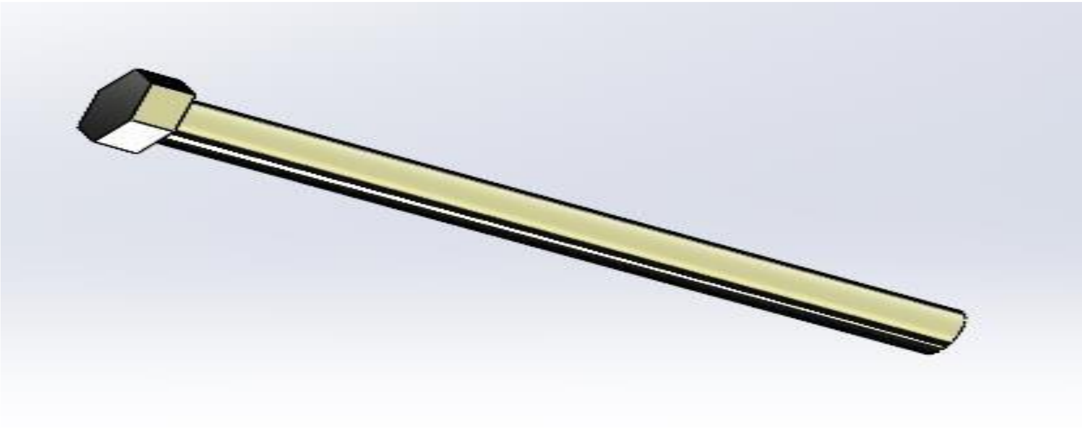


Figure 2.3 design of rod

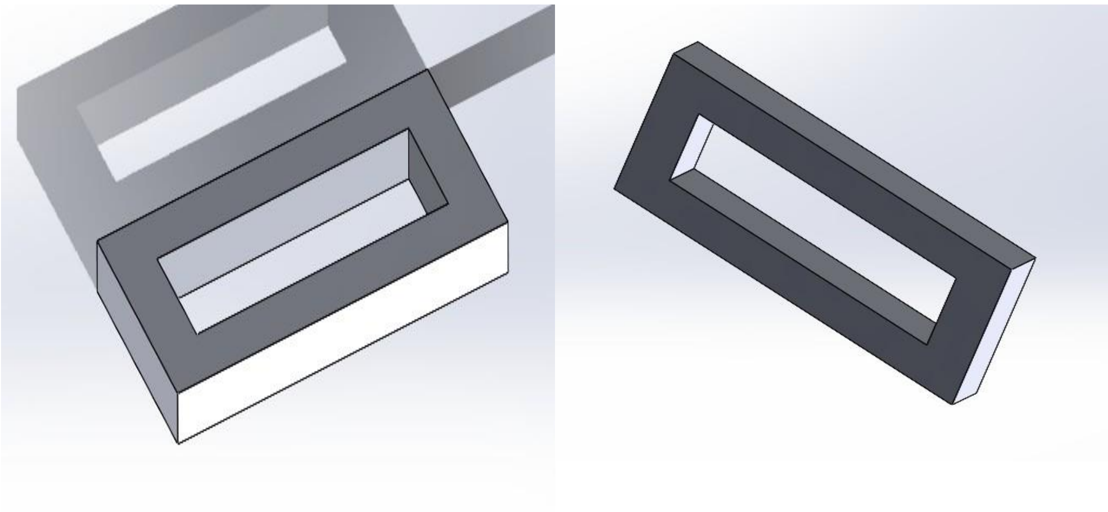


Figure 2.4 front and side deisgn of the holder (support)

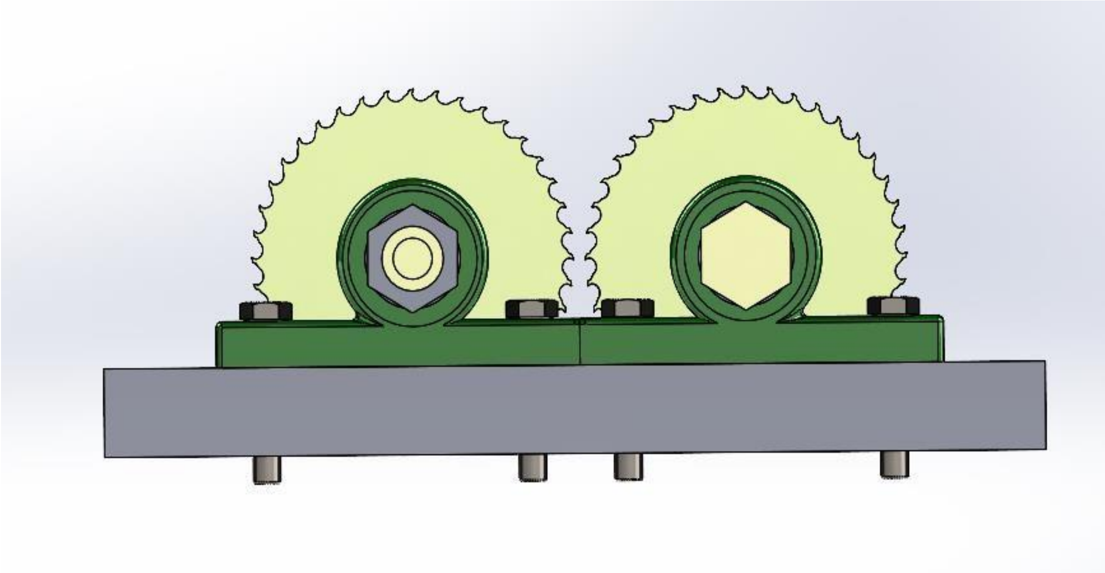


Figure 2.5 the side design of the final assembly of the machine

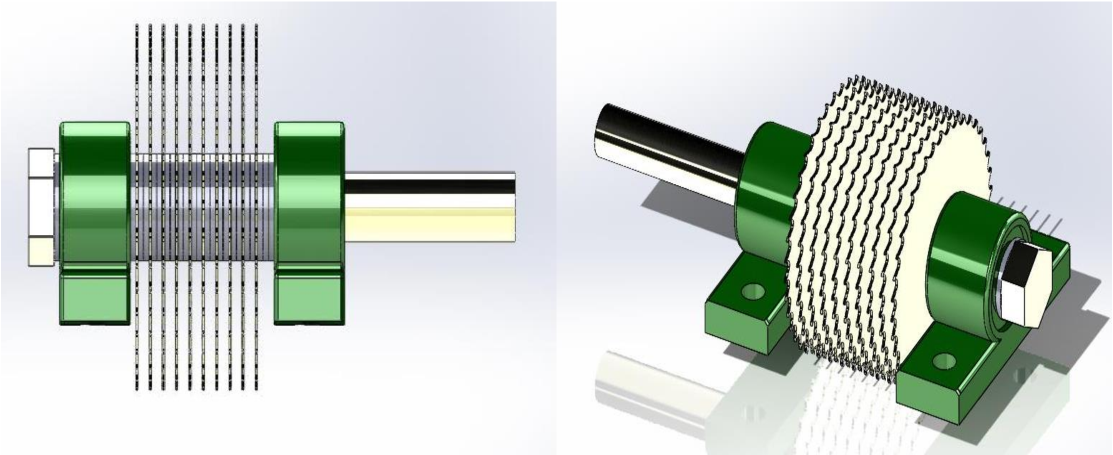


Figure 2.5 the tow main pieces of the machine

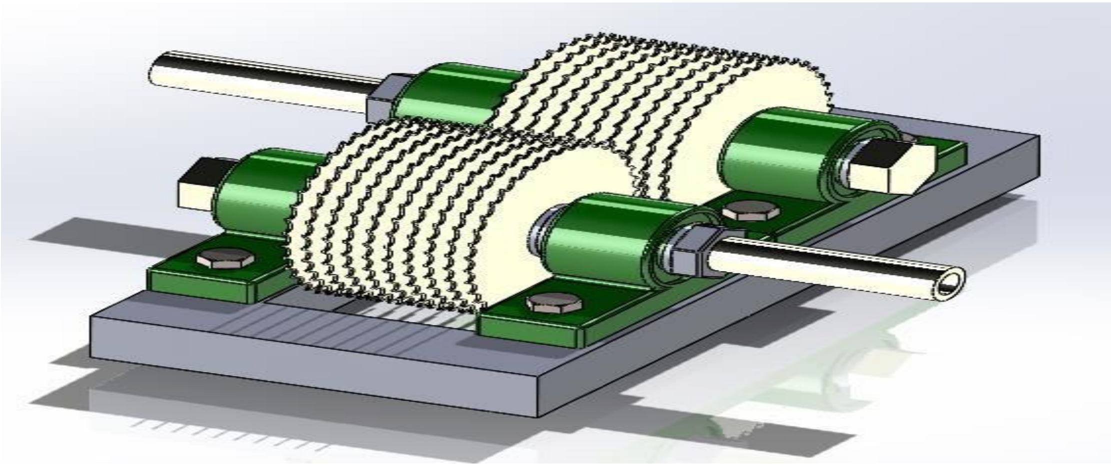


Figure 2.6 the final assembly of the machine

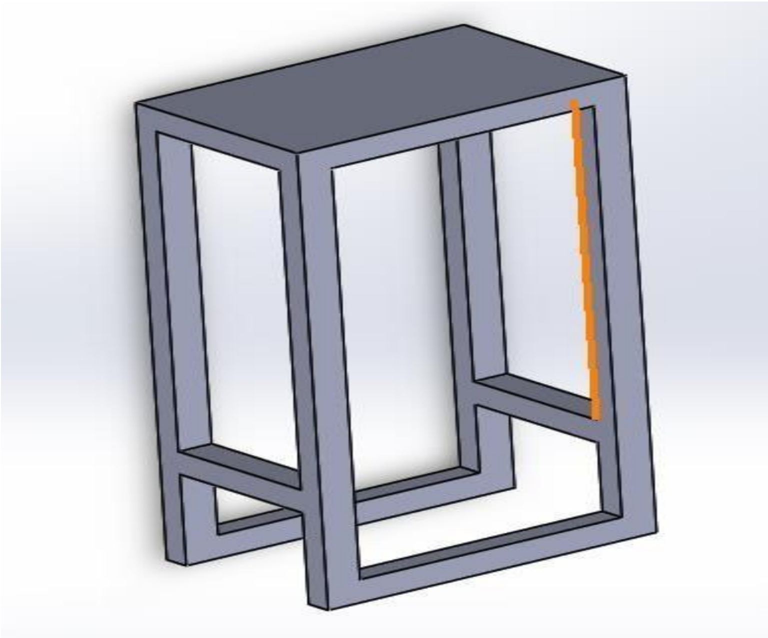


Figure 2.6 design of support

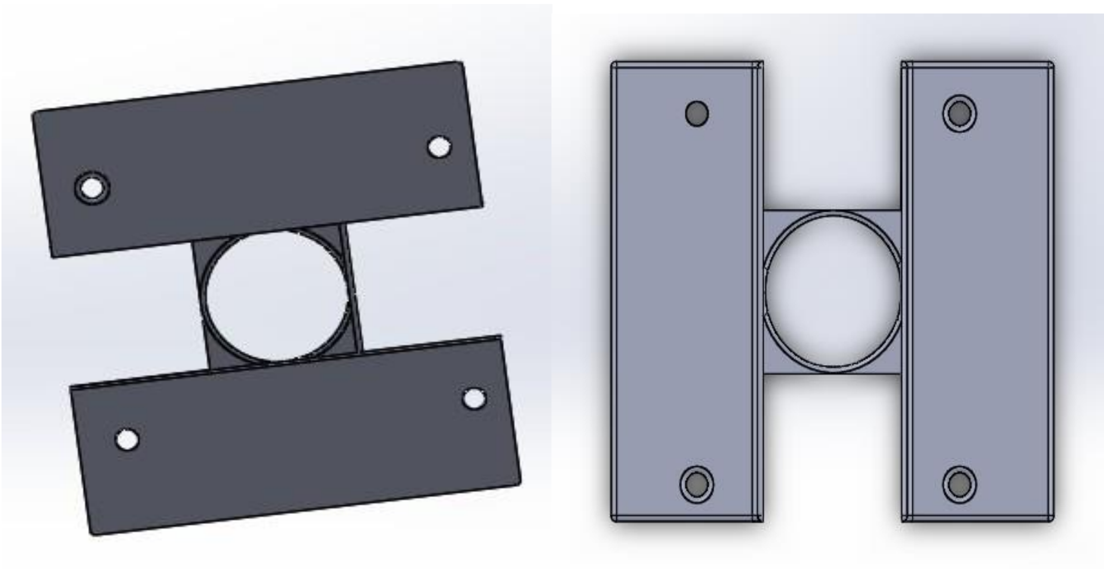
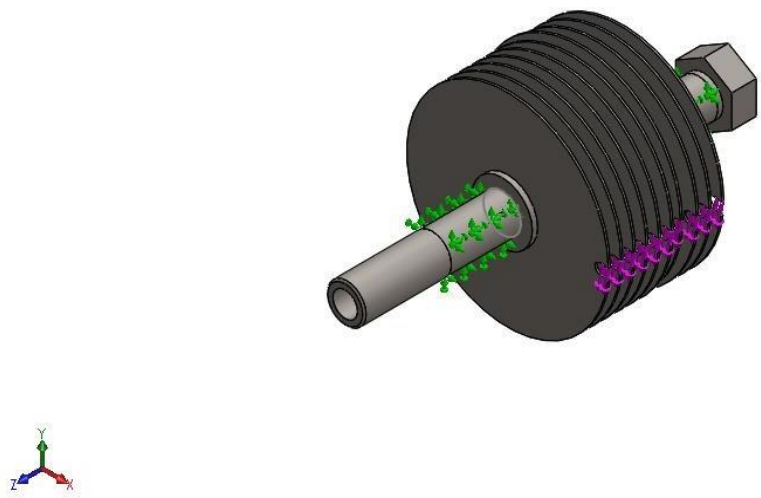


Figure 2.6:

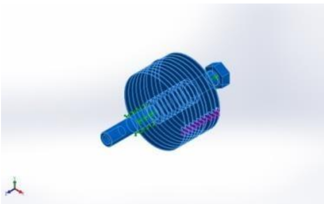
II- Rod study :

1- Assumptions:

The strong rotation of the discs can lead to some breaks, splits and stresses, but this does not affect the disc alone, it will affect the bar and bearings, so assumptions must be made to provide assistance in the design and installation of machine parts, perhaps the machine is affected by the heat generated by the rotation speed and friction forces caused by cutting, perhaps the strength of the wood is greater than the strength of the machine, perhaps the torque of the machine should be determined, as well as the cutting force.



Model Name: Rod – Study
Current configuration: Default

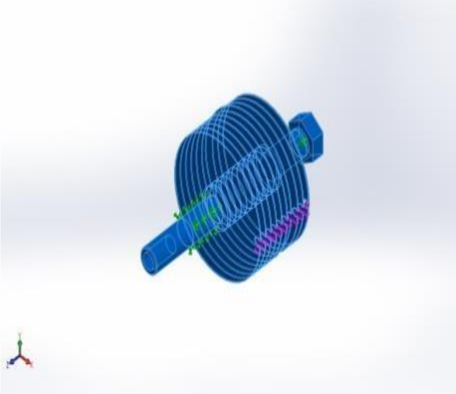
Volumetric bodies			
<L_MdInf_SldBd_Nm/>	Treated as	Volumetric properties	Path/Date of modification of the document
Enlèv. mat.-Extru.4 	Volumetric bodies	Mass:1.8274 kg Volume:0.000237324 m^3 Density:7700 kg/m^3 Weight:17.9085 N	D:\ End of Study project \Yagoubi\Rod - Study.SLDPRT Jun 17 21:45:09 2023
<L_MdInf_ShlBd_Nm/>	<L_MdIn_ShlBd_Fr/>	<L_MdInf_ShlBd_VolProp/>	<L_MdIn_ShlBd_DtMd/>
<L_MdInf_CpBd_Nm/>	<L_MdInf_CompBd_Props/>		
<L_MdInf_BmBd_Nm/>	<L_MdIn_BmBd_Fr/>	<L_MdInf_BmBd_VolProp/>	<L_MdIn_BmBd_DtMd/>

2- Properties of the study:

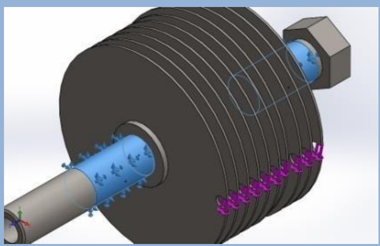
Study name	Static analysis 1
Type of analysis	Static analysis
Type of mesh	Volume mesh
Thermal effects:	Activated
Thermal option	Include thermal loads
Zero deformation temperature	298 Kelvin
Include the fluid pressure calculated by SolidWorks Flow Simulation	Disabled
Type of solver	FFEPlus
Stress Stiffening:	Disabled
Low stiffness:	Disabled
Inertial relaxation:	Disabled
Incompatible solidary contact options	Automatic
Grand déplacement	Disabled
Check the external forces	Activated
Friction	Disabled
Adaptive method:	Disabled
Disabled	Document SolidWorks (D:\Projet de Fin d'Edude\Yagoubi)

3- Units:

System of units:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular speed	Rad/sec
Pressure/Stress	N/m^2

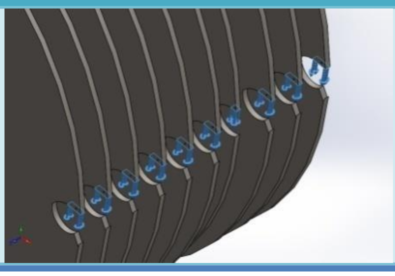
Model reference	Properties		Components
	**Name:**	Acier allié (SS)	**Volume body 1(Enlèv. mat.-Extru.4)(Rod - Study)**
	Type of model:	Isotropic elastic linear	
	Default ruin criterion:	Von Mises constraint max	
	Yield strength:	6.20422e+008 N/m^2	
	Tensile limit:	7.23826e+008 N/m^2	
	Modulus of elasticity:	2.1e+011 N/m^2	
	Poisson's ratio:	0.28	
	Density:	7700 kg/m^3	
	Shear modulus:	7.9e+010 N/m^2	
	Coefficient of thermal expansion:	1.3e-005 /Kelvin	

4- External actions

Name of the imposed displacement	Image of the imposed displacement	Details of the imposed displacement	
Fixe-1		**Entities:**	2 face(s)
		Type:	Fixed geometry

Forces resultants

Components	X	Y	Z	h
Reaction Force(N)	**30.3752**	**164.916**	**-0.660109**	**167.692**
Reaction Moment(N.m)	**0**	**0**	**0**	**0**

Name of the load	Loading image	Loading details	
Force-2		**Entities:**	**10 face(s)**
		Type:	**Force normale**
		Value:	**-16.8 N**

5- **Definitions of connectors**:

A type of connector in which the main conductor and the branch conductor connected to earth or to a live device are held in place by tightening a bolt[1]

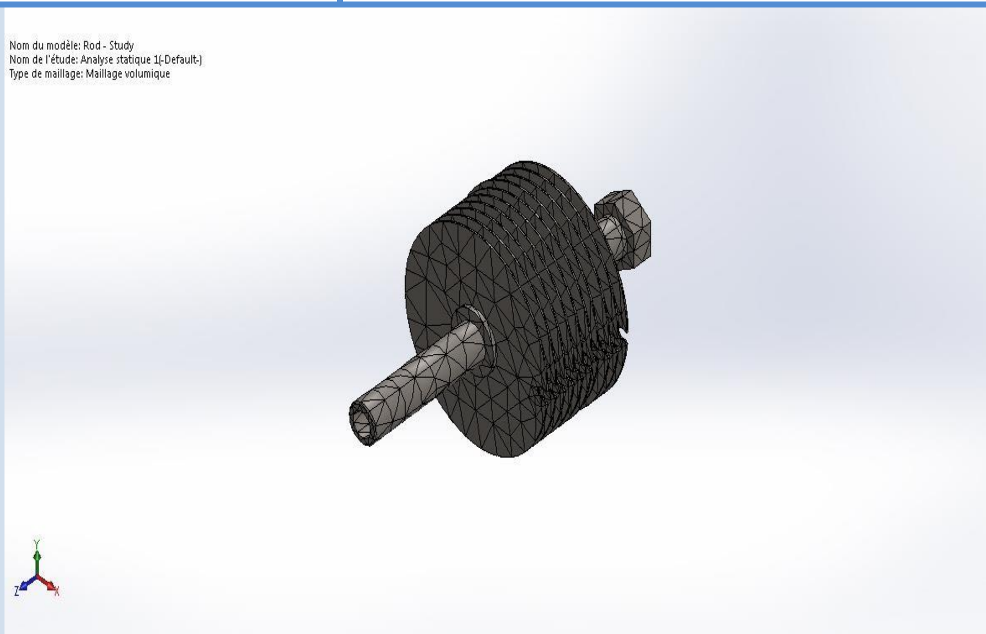
Or, It is the process of assembling two or more mechanical parts into one of the mechanical elements for the purpose of forming a structure for a machine, for example, we mention (bolts , nuts , anchors, welding, lathes, elastic rings, metal rings and rivets,and some machines such as bearing…etc. [1]

6- Information about the mesh:

Type of mesh	Volume mesh
Used mallet:	Standard mesh
Automatic transition:	Disabled
Automatic mesh loops:	Disabled
Jacobian points	4 Points
Element size	13.1861 mm
Tolerance	0.659303 mm
Mesh quality	HIGH

7- Information about the mesh – Details

Total number of nodes	11077
Total number of elements	5212
Aspect ratio maximum	38.346
of elements having an aspect ratio < 3%	16.8
of elements having an aspect ratio > 10%	45.1
of distorted elements (Jacobian%)	0
Duration of creation of the mesh (hh;mm;ss:)	00:00:04
Computer name:	AHMIDA-PC



8- Sensor details :

a- Resultant forces:

❖ **Reaction forces**

Set of selections	Unités	Somme X	Somme Y	Somme Z	Resultant
Modèle entier	N	30.3752	164.916	-0.660109	167.692

❖ **Moments of reaction**

Set of selections	UnitS	Somme X	Somme Y	Somme Z	Resultant
Modèle entire	N.m	0	0	0	0

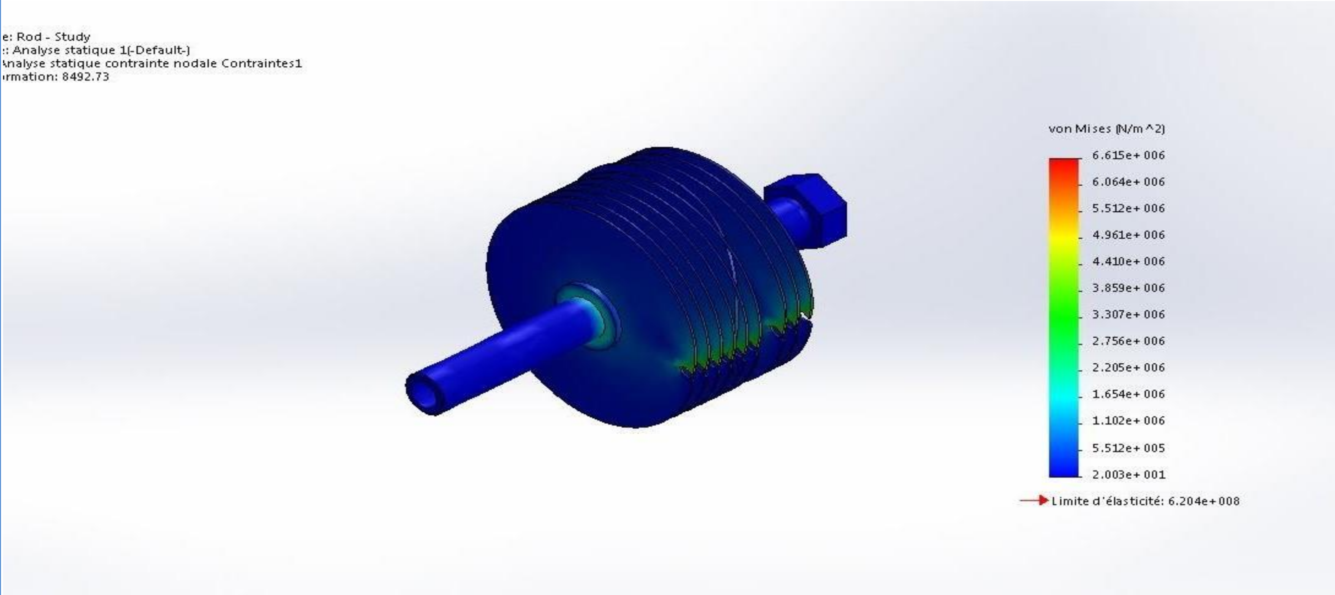
9- Beams :

The term "beam" designates an object whose length is large compared to the transverse dimensions (thin section). Strictly speaking, a beam is a structural element used for construction in buildings, ships and other vehicles, and in the manufacture of machinery. However, the model of the beams can be used for very diverse rooms provided that they comply with certain conditions.

- The theory of beams is a model used in the field of material strength. We use two models :
- the Euler-Bernoulli theory, which neglects the influence of shear.
  Timoshenko's theory that takes into account the effect of shearing.[2]

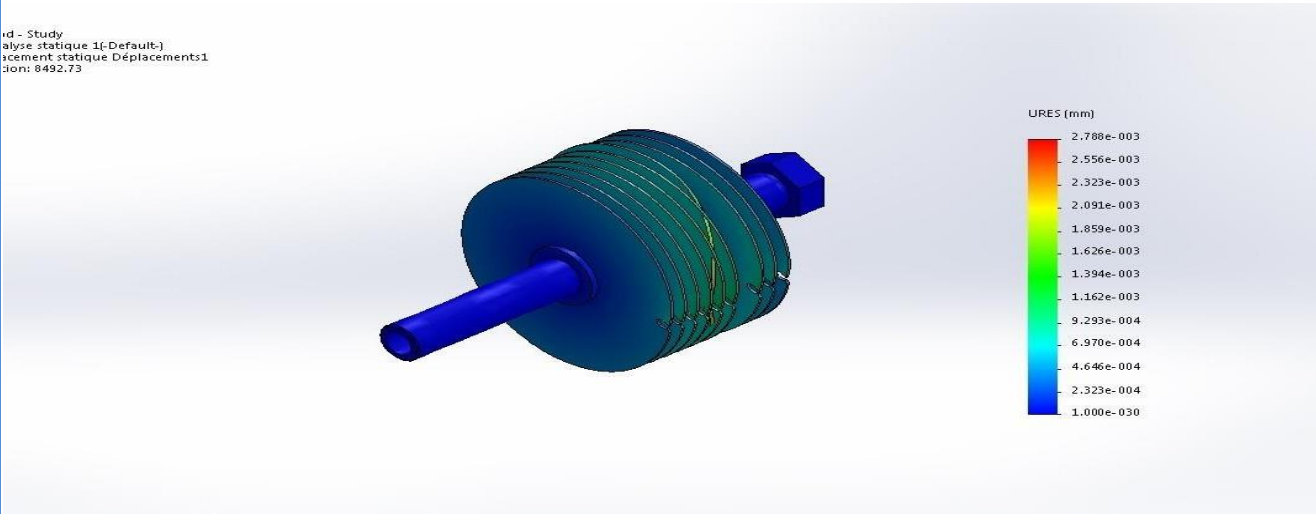
10- Results of the study:

NAME	Type	Min	Max
Contraintes 1	VON: von Mise constraints	20.0276 N/m^2 Noeud: 3608	6.61477e+006 N/m^2 Noeud: 1052



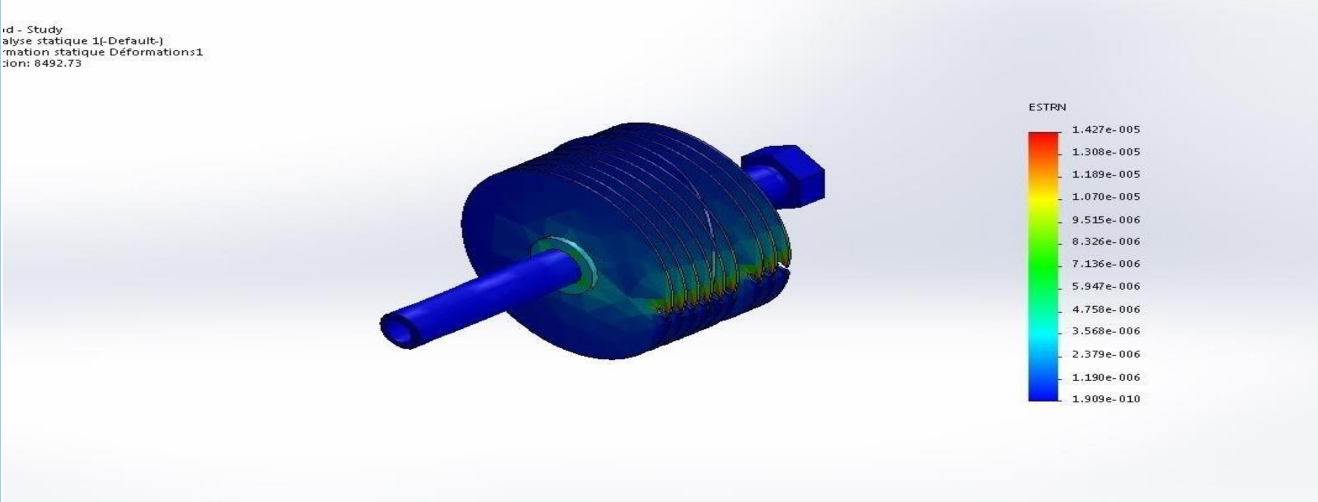
Rod - Study-Analyse statique 1-Contraintes-Contraintes1

NAME	Type	Min	Max
Displacements 1	URES: Resulting displacement	0 mm Noeud: 106	0.00278783 mm Noeud: 1489



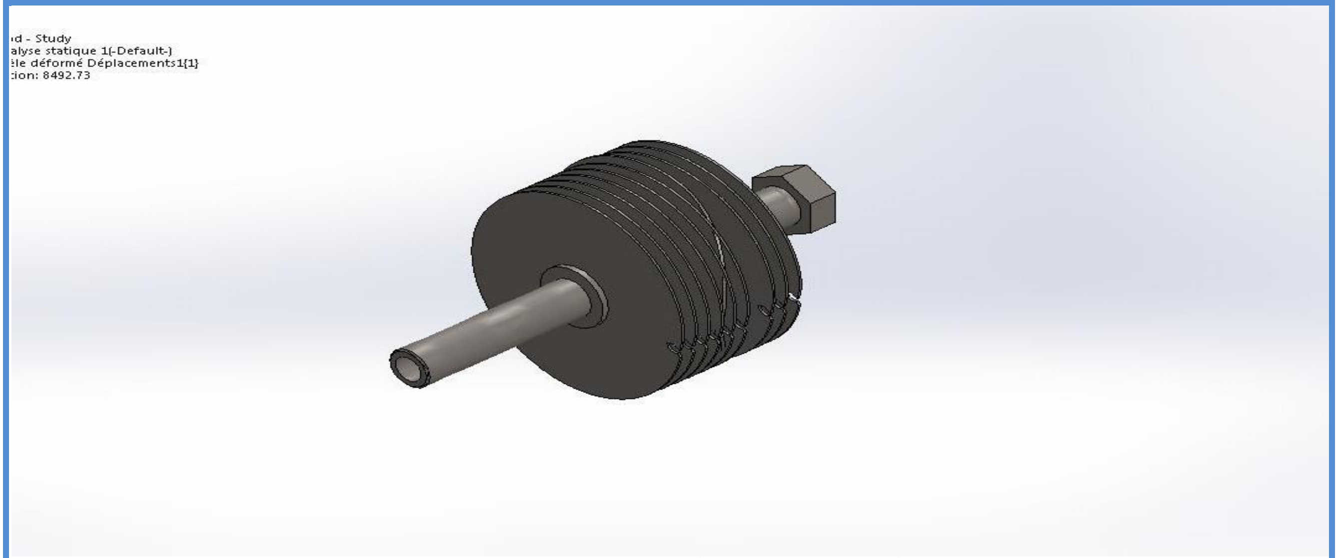
Rod - Study-Analyse statique 1-Déplacements-Déplacements1

Name	Type	Min	Max
Deformations1	ESTRN: Equivalent deformation	1.90853e-010 Elément: 3879	1.42722e-005 Elément: 3914



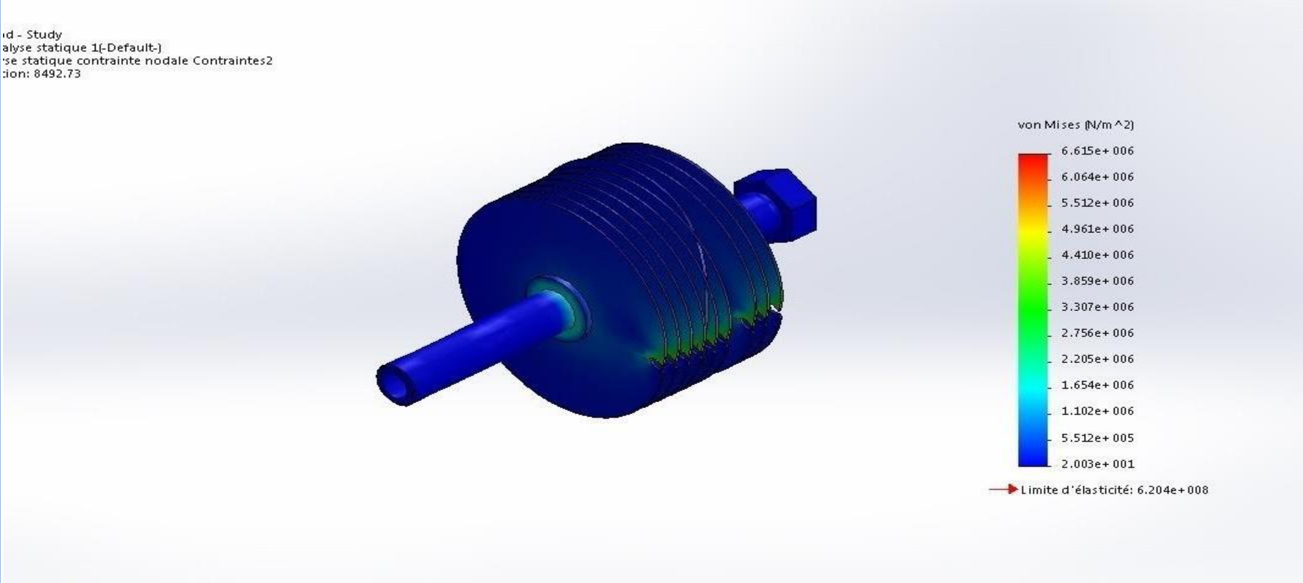
Rod - Study-Analyse statique 1-Deformations-Deformations1

Nom	Type
Displacements 1{1}	Distorted model



Rod - Study-Analyse statique 1-Déplacements-Déplacements1{1}

Name	Type	Min	Max
Contraintes2	VON: contrainte von Mises	20.0276 N/m^2 Noeud: 3608	6.61477e+006 N/m^2 Noeud: 1052



Rod - Study-Analyse statique 1-Contraintes-Contraintes2

Cost of components from third-party providers

The following table summarizes the approximate budget of the commercial pieces that are purchased "prefabricated" and that are ready for assembly:

Table 1.1 Budget for parts from external suppliers.

Subtotal	Quantity	Description	Concept
9000 DA	2	Crown Model (dia,115mm)	Angles grinders
5600 DA	4	Dia, 25 mm	Proper Bearings Alignment
4600 DA	20	Dia, 115 mm	circular saw blades
950 DA	1	Dia, 22 mm et L= 1 000m	Threaded shaft
2500 DA	1	e = 1mm	Sheet iron
500 DA	1	3 positions	Electrical power strip
600 DA	1	Simple	Circuit breaker
600 DA	2	2 colors, 2 L	Paint
300 DA		different size	Assembly screws
250 DA			Overs
24650 DA	**Total**		

Refrences

[1] https://fr.wikipedia.org/wiki/Connecteur_(linguistique[(consulté le 14 Fevrier 2023 à 18h51)

[2] https://fr.wiktionary.org/wiki/poutre#:~:text=(M%C3%A9canique)%20Mod%C3%A8le%20de%20pi%C3%A8ce%20permettant,une%20section%20perpendiculaire%20%C3%A0%20cette

[3] G. Pahl, W Beitz et al, Engineering design, Springer, pp. 3-19, Germany, 2006

CHAPTER III: Stages and tools of wood chipper manufacturing

I- Stages and tools of wood crusher manufacturing

In this chapter, the machines and tools that contributed to the manufacture of the wood crushing machine will be mentioned, as most of the machine parts will be manufactured and assembled step by step using various tools.

1- tools and machines used in the manufacturing process:

In order to ensure the final installation of the machine, many other machines were used for cutting and welding..ect , as well as connecting the pieces with each other, we can mention lathe machine ,wealding machine ..ect .

a. Machines

Figure 3.1: column drill machine

Figure 3.2: lathe machine

Figure3.3: sheet metal bending machine

Figure3.4: hydraulic press 25T

Figure3.5: Spot welding

Figure3.6: soldering station

Figure 3.7: cutting machine

Figure 3.7: DRILLING MACHINE

1- Tools :

Figure 3.9: riveter

Figure 3.10: drilling tools

Figure 3.11: clamping vise

Figure 3.12: manual guillotine shearing machine

Figure 3.13: Tarau

Figure 3.14: **square**and Manual molding

Figure 3.15: keys

Figure 3.16: vernier caliper

Figure 3.17:

I- Manufacturing part

First, we brought and brought all the pieces and all the necessary equipment in order to complete the work , where we cut pieces with different dimensions and consistent taking into account and trying to pass all the difficulties and try to minimize the error rate to the maximum possible

Figure 3.18: Iron cutting and cutting forming

Secondly, we cut two equal pieces of the rod ,and then Where we made a hole with the lathe machine , Then by means of a tapping we made a felting of the hole

Figure 3.19: made hole and felting the bar

And then we started installation the pieces , install the bar between tow bearings the disck in the bar ,between each tow disck we put tow rings , each bar contains 10 disck As shown in the pictures below

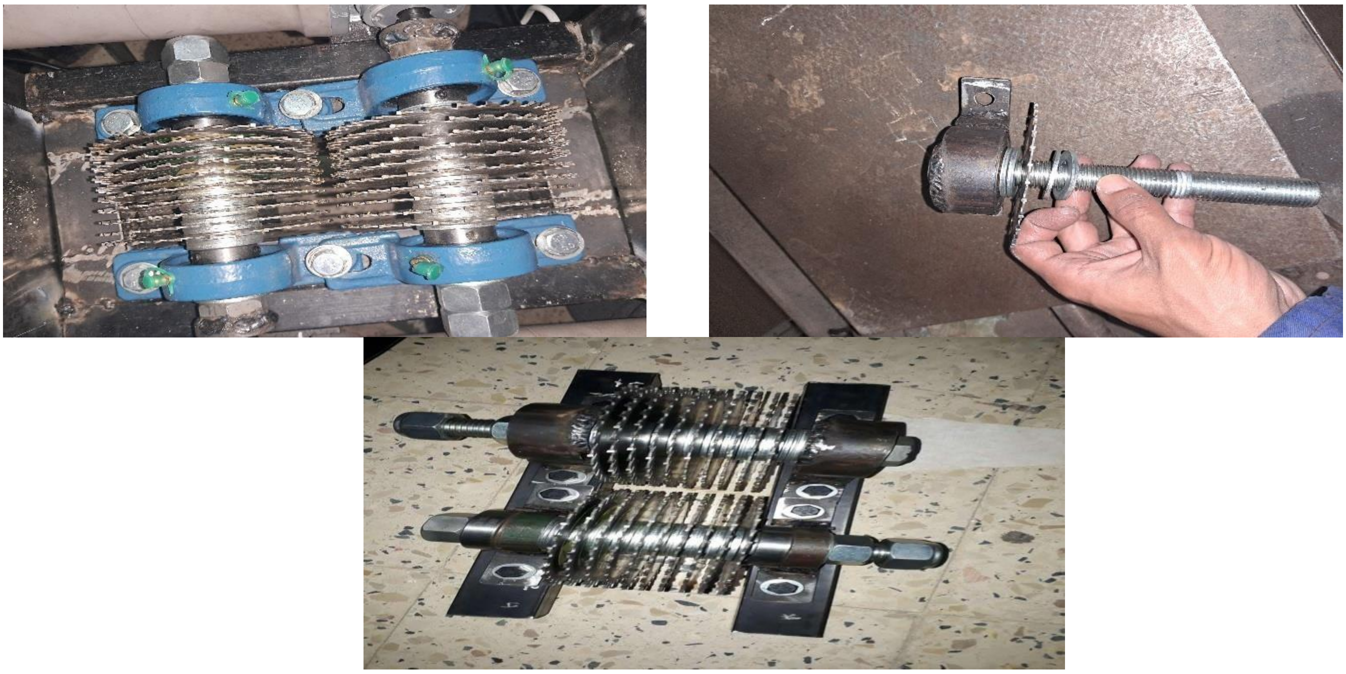


Figure 3.20: instal(the bar on th bearing ,the disks in the bar)the machine in the support

Thirdly, we made accessories or other pieces by cutting, welding, as well as folding with each other according to the measurements studied by the machines mentioned above, we secured the pieces and we made a hole on some of the pieces that need this, which will be shown by the following pictures:

Figure 3.21: Folding, welding and perforation of shaped parts

Later, Later we installed the preformed pieces to form the final pieces , and from there the final installation of the various machine pieces where they were finally installed and bolted and welded Later we installed the preformed pieces to form the final pieces , and from there the final installation of the various machine pieces where they were finally installed by bolt and welding and rivter as the following pictures will show:

Figure 3.22: the final result for various pieces

Then after that, install the two motors and install them by bolts with a diameter of MM8 and with a step of 1.25 as shown

Figure 3.23: the final result of the machine

Figure 3.24:machine wood chipper

After assembling the pieces we can get the final shape of the wood cutting machine and install it by bolts as the following pictures will illustrate After assembling the pieces we can get the final shape of the wood cutting machine and install it by bolts as the following pictures will illustrate

The wood chipper final forme After a lot of hard work and a lot of effort and fatigue, the last Shape of the wood chipper was finally obtained, where we completed it and painted it and we tried it, where it was successful and works smoothly

Figure 3.25: machine wood chipper

Conclusion

In conclusion, we can say that the wood chopping machine is to turn the design into a prototype or final model and the embodiment of studies and calculations on reality, and this is what we tried to reach, and this has been done, as several stages have been moved to the final stage, which embodies the conclusion and the general picture of the machine

we can say that the wood chopping machine has been worked in a short time, where it was installed, where we did our best to reduce the error rate and manufacture a model as described in the study , and finally this is the machine after all those studies, work, planning and error correction.

Conclusions

Conclusions

When a novice engineer is faced with a new design problem, his first hope is that the developed device will behave as planned in the design process. That is to say, that the mechanical component performs the task for which it was conceived in an adequate and efficient manner. In addition, the designer also expects to deliver the project on the specified date meeting the cost proposed in initial planning. Unfortunately, in reality, things can be very different than initially thought in the early stages of the design process. For example: the operation of the mechanism may differ from the desired behavior, the materials may not resist the loads to which they are going to be subjected, delays in the delivery dates, substantial increase in the budget, or all of these situations together.

In the case of our machine, the problems were not unrelated to the design. It has already been commented that the machine was less heavy due to a poor choice of materials that make up the body and therefore the machine vibrates during its operation. Also, the efficiency of the machine was a bit low, which caused the waste to not have the desired quality; this situation has been partially corrected by adding an edge to the hopper a guide for the trenches in order to locate the cutting area; this means that a slight design modification is required. Perhaps the biggest problem in the design of the machine was the discrepancy in the delivery time of the final prototype; a delay of a month and a half can be reason enough to ruin the best of ideas (because of the spring holidays and the month of Ramadan).

As for the successes of the project, it should be noted that the cost of the design was very low. In fact, the total investment made in the machine was really low, even compared to similar machines. It is estimated that if the errors mentioned before are corrected, the money needed to manufacture the machine could decrease further.

On the other hand, the assembly quality of the prototype built is, without a doubt, superior to that of other machines available on the net.

Moreover, the manufacture of this type of product in Algeria makes it possible to generate sources of employment which are so essential in a developing country.

Finally, it is considered that despite the shortcomings committed during the design process, the objectives set at the beginning of the project have been achieved.

Contents

Contents