Banana Fiber Extraction Machine

Yash Mutha[1], Rushikesh Mishra[2], Adarsh Patil[3], Hemant Chaudhary[4], Rajvardhan Pawar[5], Rajkumar Bhagat[6]

[1,2,3,4,5]B.Tech Students, Mechanical Engineering Department, VIT, Pune, MAHARASHTRA, INDIA
[6]Professor, Dept. of Mechanical Engineering, Vishwakarma Institute of Technology, Pune, MH, INDIA

Abstract - *Bananas are one of the most popular in the world. Almost all parts of this plant can be used, which includes fruit, leaves, flower bud, stem, and artificial stem. Morphological, physiological, and mechanical properties of Banana pseudostem fiber, with its toughness, corrosion,and chemical properties. Many possible requests for this fiber are also indicated, including cord, local mats, paper cardboard, yarn, tea bags, and high quality fabrics building materials.*

***Key Words*: — pseudo-stem, firmness, deterioration**

1.INTRODUCTION

Natural plants are an underutilised resource in the textile industry for the manufacture of fibres. Natural plant stems/stalks/leaves fibres have been used extensively in the last decade for handicraft, ropes, and other applications. The abundance of natural plant stems, stalks, and leaves makes it highly enticing to use them for clothing. Because natural plant stems, stalks, and leaves are discarded once the fruit is taken, their supply is abundant. Hand scraping and hand retting are the most fundamental methods for extracting natural plant stems/stalks/leaves fibres. Then machines were invented that produced low-quality fibres with increased damage. As a result, fibres were not used in big amounts. Fiber qualities such as strength, fineness, and fastness were moderate to good in the fibres extracted. Fibres can be used to make shirts, ladies' and children's dress fabrics, and other items. Fibres can also be utilised to make composites (natural fibre reinforced composites for automobile, building construction, furniture etc). Fibres can be blended with other fibres like cotton, polyester, and viscose to create high-end fancy textile textiles. The created equipment was perfect for producing high-quality fibres. It can also be used to remove the fibres from Agave family plants. The designed machine is a low-cost, high-output machine that is well-suited to small-scale industries. Bananas are a well-known fruit crop that is widely farmed in the Indian peninsula. India is the world's largest producer of this perennial crop. After fruit harvest, a large quantity of biomass residues (60t/ha – 80t/ha) is projected to be left behind as waste, consisting of pseudo stem, leaves, sucker, and other items. The banana pseudo stem has a lot of potential for extracting fibres. It is predicted that 17,000 tonnes of fibres worth Rs.85 crores can be recovered annually from this garbage. Apart from its frequent use in handicrafts and utility goods, these vast amounts of natural treasure can be exploited in the fibre sector for the manufacturing of technical and non-technical textiles. It entails a sequence of unit processes, starting with the extraction of fibre and ending with the creation of a final product from this natural resource. Though the manual extraction procedure produces high-quality fibre, it is uneconomical due to its labor-intensive nature and low output (200gm/person/day). As a result, automation is the only way to remove banana fibre efficiently. However, depending on the many characteristics, the design and execution of energy conservation drives at various processes of banana fibre extraction and processing may be done one at a time or all at once as possible. Synthetic fibre has taken the globe by storm due to its low cost and ease of use. Synthetic fibres, on the other hand, have a negative impact on the environment since they pollute the environment and are not biodegradable. As a result, natural fibres must be investigated. Several alternative natural fibres, such as ramie, mesta, sisal, and roselle, are already well-established. However, the primary goal of these plants' cultivation is to produce fibre. Banana (Musa sp.) is a well-known major fruit crop that is grown all over the world and can also be used as a substitute for high-quality fibres.

The main source of income is fruit bunches and leaves, which are also used as bio plates for serving food in homes and gatherings. Despite the availability of methods for extracting fibres and producing paper from pseudo-stem, companies have yet to utilise them, owing to high transportation costs. However, the potential for extracting fibres from pseudo-stem is enormous. It is predicted that 17,000 tonnes of fibre worth Rs. 85 crore may be recovered annually from the trash portion of the banana factory (Rs. 50,000 per tonne). Due to its limited usage in cottage industries, the fibre derived from banana pseudo-stem was unable to find a market. This fibre appears to have a lot of potential for commercial usage in the textile and paper sectors. Not only that, but banana pseudo-stem may also be used to make a variety of high-value products such as rugs, coasters, bags, and various forms of handicrafts. In conclusion, banana fibre has a promising future and a wide range of applications in the next years.

1.1Microstructural Characteristics:

A. Banana Fibre Extraction by Mechanical Means:

Manual (or semi-mechanical) banana fibre extraction was arduous, time-consuming, and damaging to the fibre. So, following extensive research and development, the CTRI Banana Fibre Extractor machine was created and developed for mechanically extracting banana fibre from banana pseudostems, leaf stalks, and flower stalks. The procedure is straightforward, and the machine is adequate for extracting fibre from banana stems. It's incredibly simple to use. With only 30 minutes of training, anyone can operate it. This equipment eliminates the drudgery of manual fibre extraction and creates a sanitary working environment. It will enable workers to create more fibres and earn more money.

B. Banana fibre characteristics:

The following are the physical and chemical properties of banana fibre:

A. The chemical makeup of banana fibre is cellulose (50-60%), hemicelluloses (25-30%), pectin (3-5%), lignin (12-18%), water soluble compounds (2-3%), fat and wax (3-5%), and ash (3-5%). (1-1.5 percent).

B. It has a similar appearance to bamboo and ramie fibre, but banana fibre is finer and spins more easily.

C. Depending on the extraction and spinning procedure, it has a gleaming aspect.

D. It has a highly strong fibre with a 3% elongation and is quite light in weight.

E. It has a fineness of 2386 Nm, a strength of 3.93 cN/dtex, and a length of 50-60 mm on average (or 38mm).

F. It easily absorbs and releases moisture.

G. It can be spun using ring spinning, open-end spinning, best fibre spinning, and semi-worsted spinning techniques.

H. It is biodegradable and has no detrimental impact on the environment, making it an environmentally friendly fibre.

***C.* Natural fibers**

Natural fibres are derived from natural sources. It offers a number of advantages over synthetic fibres that are created artificially. These fibres have a low density and high specific characteristics. Because they are biodegradable and non-abrasive, they are more environmentally friendly than synthetic fibres. Natural fibre composites are simple to dispose of, as they may be easily combusted or degraded at the end of their product lifecycle. Natural fibres, when compared to the economic advantages of synthetic fibres, offer comparable levels of security when employed in automotive applications Banana fibre has been used for textile purposes since before written history. This can be seen in epics such as the Ramayana, where Sita and Rama wore "Naravastra" clothing made of banana fibres. Banana fibre cloth was manufactured around the 13th century in Japan, according to historical texts. The Yen, Japan's money, is constructed of banana fibre. They used to make fibres of various softnesses and finenesses that provide yarn and textiles of various qualities for specialised applications. In the past, extracted fibre was used to make rugs, ropes, and flower tying. Philippines and Japan are the two countries that export banana fibre on a considerable scale to Japan, Singapore, and other East Asian countries. India's demand for textiles and readymade clothing is growing in tandem with its population and purchasing power. According to the article's study, a billion tonnes of banana plant stems are thrown away each year. Banana farms in the Philippines alone can produce more than 3,00,000 tonnes of fibre, according to the Philippine Textile Research Institute.

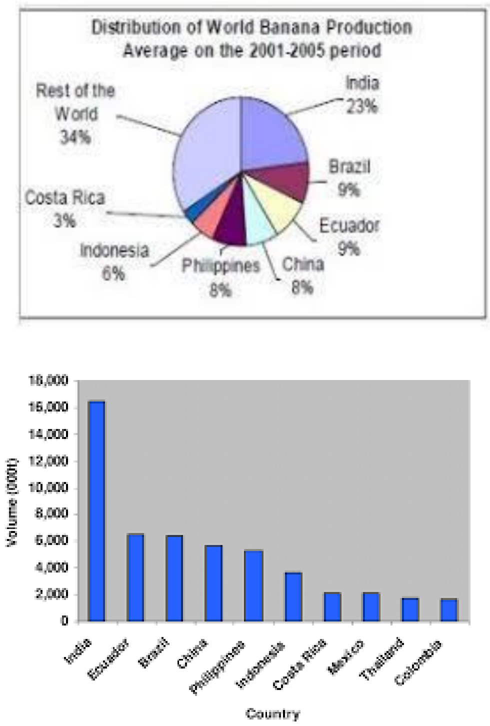

Fig .1. Banana Production worldwide

I. Origin of Banana Fibre:

According to historical records, the banana fibre textile was created in Japan about the 13th century. Bashôfu is a Japanese word that literally translates to "banana-fibre cloth." The fabric, as well as the garments fashioned from it, are now key components of Okinawan identity. The Japanese Folk Craft Movement in the 1930s brought this unique feature of Okinawan material culture to light. With a period of decline following WWII, bashôfu weaving and use experienced a resurgence that intensified after the restoration of Okinawa to Japan in 1972 and continues to this day. Despite the fact that its roots and history were unknown.

Fig.2. Map of Japan and Okinawa Islands.

A. Extraction of banana fiber.

The methods for spinning banana fibres into yarn differ from one region to the next. The most widely used approaches are those used in Japan and Nepal.

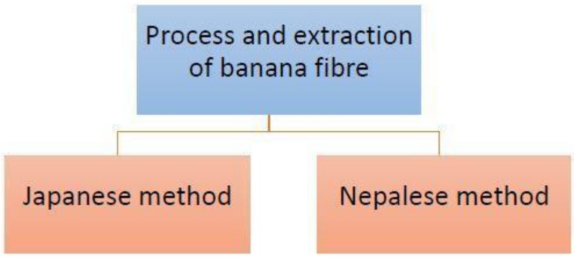

Fig.3. Process and extraction of banana fibre.

Japanese Method:

Banana planting for clothes and other domestic use dates back to the 13th century in Japan. Care is given right from the stage of plant cultivation in the Japanese method of manufacturing banana fibre. The banana plant's leaves and shoots are clipped on a regular basis to maintain their suppleness. To prepare the fibres for manufacturing yarn, the gathered shoots are first cooked in lye. Banana shoots emit soft fibres in varied degrees of softness. As a result, different kinds of yarns and textiles are produced, which can be utilised for different purposes. The coarsest fibres in the shoots are those on the outside. As a result, they're more suited to home furnishings like tablecloths. The softest section is the innermost part, which produces delicate fibres that are commonly utilised in traditional Japanese clothing such as kimono and kamishimo. The process of manufacturing banana cloth is extensive, and each stage is completed by hand.

Nepalese Method:

In Nepal, the banana plant's trunk is plucked rather than the shoots. Small sections of these trunks go through a softening process to extract the fibres mechanically, followed by bleaching and drying. The resulting fibre has a similar appearance to silk and has become known as banana silk fibre yarn. Nepalese women are primarily responsible for refining, processing, and skeining this fibre. To speed up the natural process, just the aged bark or rotting outer layers of the banana plant are plucked and immersed in water. Only the cellulose fibres remain after all the chlorophyll has been dissolved. They're extruded into pulp in order to make them suitable for spinning into yarn. After then, the yarn is hand-dyed They have a high texture quality, similar to silk, and are used to make high-end rugs as a result. Hand-knotted methods are used to weave these traditional rugs by Nepalese women.

Fig.4. Scraping the Banana pseudo-stem.

B. Banana Varieties grown in different states of India.

- **Nendran**-Kerala, Tamil Nadu
- **Ney Poovan**-Kerala, Tamil Nadu and Karnataka
- **Red Banana**-Gujarat, Madhya Pradesh,

  Chhattisgarh, Kerala, Karnataka and Tamil Nadu
- **Robusta**-Tamil Nadu, Karnataka, Bihar, Jharkhand,

  Kerala and Maharashtra
- **Karpuravalli**-Assam, Andhra Pradesh, Tamil Nadu
- **Virupakshi**-Himachal Pradesh, Andhra Pradesh,

  Kerala and Tamil Nadu
- **Rasthali**-Kerala, Tamil Nadu, Andhra Pradesh, West

  Bengal, Assam and Mizoram

C. Banana Fiber Textile Types.

The quality of the stem's fibre varies:

Inner fibres (fine, smooth, and natural shine) - the smoothest textiles, such as kimonos and saris.

Outer strands (coarse) for basket weaving and handbag creation.

Fig.5. Coarse Fibre.

Fig.6. Fine and smooth fibre.

Fig.7.Banana fibre fabric silk lookalike.

A. Banana Fibre Characteristics:

Banana fibre has its unique physical and chemical traits, as well as a variety of additional characteristics that distinguish it as a high-quality fibre.

1. Banana fibre has a similar appearance to bamboo and ramie fibres, but its fineness and spinability are superior to both.

2. Cellulose, hemicellulose, and lignin make up the chemical makeup of banana fibre.

3. It's a really strong fibre.

4. The elongation is shorter.

5. Depending on the extraction and spinning procedure, it has a lustrous appearance.

6. It's not too heavy.

7. It has excellent moisture absorption properties. It absorbs and releases moisture at a rapid rate.

8. It is biodegradable and has no detrimental impact on the environment, making it environmentally friendly.

9. It has a fineness of 2400 Nm on average.

10. It can be spun using practically any method, including ring spinning, open-end spinning, bast fibre spinning, and semi-worsted spinning, to name a few.

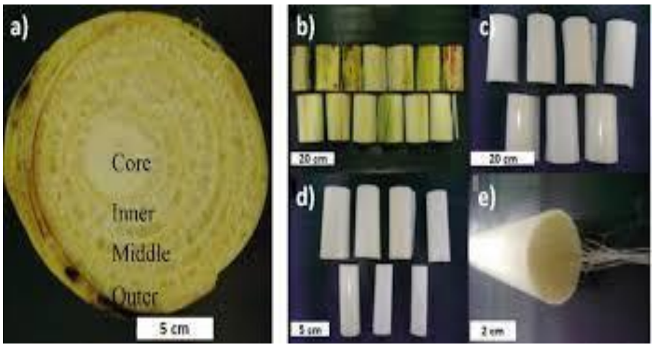

Fig.8.Sectional view of Fibre.

BANANA FIBRE USES:-

• Banana leaves are used as bio-plates for serving food, and the fruit and spadix are edible. • The innermost part of the stem, which is also edible, is utilised for medical purposes.

• These fibres are more sustainable and are entirely biodegradable and do not need chemicals or pesticides to nurture them, according to article study. • According to article research, a billion tonnes of banana plant stems are discarded every year.

• According to the Philippine Textile Research Institute, banana plantations alone may produce over 3,00,000 tonnes of fibre in the Philippines.

II. BANANA FIBRE EXTRACTION PROCESSING, YARN SPINNING & WEAVING:

The National Institute for Interdisciplinary Science and Technology (NIIST) in India devised an anaerobic (oxygen-free) technique for extracting banana fibre. The fibres are separated using enzymes produced in an anaerobic reactor. The fibres are then washed and dried in the sunlight when the separating procedure is completed. The resulting fibre is pure white in colour. This procedure, according to NIIST, is low-cost, pollution-free, and does not harm fibres. To avoid damage, the natural fibre from the plant has to be extracted with caution. The banana plant portions were cut from the main stem of the plant and softly rolled to eliminate excess moisture in the current studies Impurities in the rolled fibres, such as pigments, broken fibres, cellulose coating, and so on, were manually removed with a comb, and the fibres were then cleaned and dried. The extraction of banana fibres by mechanical and manual means proved arduous, time-consuming, and damaging to the fibre. As a result, this method cannot be suggested for use in the industrial setting. specific machine was conceived and constructed for the mechanically automated extraction of banana fibres. It was primarily made up of two horizontal beams that allowed a carriage to travel back and forth with a connected and specially constructed comb.

The fibre extraction may be done easily by placing a cleaned segment of the banana stem on the machine's fixed platform and clamping it at the ends with jaws. This prevented early fibre breakdown by eliminating relative stem movement. This comes after three hours of cleaning and drying the fibres in a chamber at 200 degrees Celsius. After that, the fibres were labelled and prepared for the lamination process. Following the collection of fibre, the procedure progresses to yarn spinning. Poor farmers and small rural entrepreneurs will be encouraged to use the banana fibre extracting machine. One of the most fascinating aspects of this machine is that it provides significant assistance to the handicraft and textile industries. Agricultural waste is now being used to make high-quality silk-like yarn. The researcher looked at the traditional method of weaving banana fabric with filament threads. The findings revealed that the convention process was extremely time-consuming, making it unsuitable for modern use. As a result, this study looked into the open-ended spinning process for yarn development. For the spinning process, the fibre was chopped into 3-centimeter lengths. After yarn spinning, weaving takes place on looms in the same manner as any other material. According to the experts, if the cloth is mass-produced, it can be less expensive than cotton and linen. Fabrics manufactured from these fibres have a high sheen, are light in weight, absorb moisture quickly, and have a linen-like appearance. It can be used as an environmentally friendly alternative to a variety of popular fabrics.

A. Weaving Preparatory process

Pre treatment bleaching

To increase the whiteness of the fabric, a bleaching process is performed. The procedure of bleaching is used to achieve this. The natural colourants in bananas are degraded into colourless compounds during bleaching. The removal of these colourants aids in the improvement of banana fabric's whiteness.

Purpose of bleaching:

1. To generate white fabric with little fibre deterioration by removing colouring substances.

2. To increase the colour brightness after dyeing or printing

3. When the cloth is to be marketed as white, further improvement in whiteness can be achieved by using optical brightening chemicals.

Purpose of preparatory processes:

• To eliminate natural and added impurities

• To eliminate natural and added impurities

• To impart specific desirable attributes (water absorbency)

• To improve the appearance of the fabric (whiteness)

• To prepare it for later procedures such as dyeing and printing finishing When it comes While removing impurities from cotton, a series of chemical processes are involved.

• oxidation

• hydrolysis

Sizing and Starching:

Sizing is a safeguarding procedure. Sizing is the process of adding a protective adhesive covering on the surface of yarns. This is the most crucial procedure for achieving maximum weaving efficiency, particularly with blended yarns.

Purpose of Sizing:

Sizing is done during beam preparation to get a weaving advantage. There are a number of things to consider when it comes to sizing.

a To improve the warp yarn's weave ability by making it more resistant to weaving actions such as absorption, friction, and stress.

b. Maintaining good fabric quality by minimising hairiness, frailty, and boosting yarn smoothness and absorbency.

c The yarn's elasticity is improved.

Fig. 9. Brushing the yarn before starching .

***B*.Dyeing of banana fibres.**

• Dyeing is done using the extracted fibre after it has been spliced with basic colours. Hibiscus, pomegranate, henna, and harifra plants provide natural dyes. To boiling water, add the appropriate dye in the required quantity.

• After that, the fibre is added and the mixture is cooked for 15 to 1 hour, depending on the requirements. It is then moved, rinsed, and dried.

Fig.10.Sizing and starching of fibre.

• A cluster of fibres is mounted or clamped on a stick to allow segregation once the fibres are ready for knotting.

• Each fibre is split into several groups based on its size.

• To knot the fibres, each one is hand tied to the end of another.

• The separation and knotting process is repeated until the bunches of unknotted fibres are completed to produce a long and continuous thread.

Fig.11. Dyed banana coarse fibre.

***C.* Raw Materials.**

Bananas, also known as plantains, are tropical plants that thrive in hot climates. The tropical jungles of Asia are considered to have been their initial home. Musa Paradisiaca, Musa Sapientum, Musa Cavendishii, and Musa Chinensis are the botanical names for these plants. Banana trees come in a variety of fibres. In fact, practically every section of this plant produces fibres of varying strength, colour, attractiveness, and staple length, making it suitable for a variety of applications. The outermost leaf sheaths have coarse and strong fibres, the innermost ones have fine and silky fibres, and the intermediate ones have intermediate quality fibres. A white fine fibre runs through the core from the roots to the point where it emerges from the false stem's covering. When correctly processed, the fruit stems contain rough fibres, while the midribs of the leaves yield a fibre of extraordinary strength and durability. Banana fibre is a medium-quality fibre that works well in combination with other fibres to create beautiful goods like as handicrafts, money, and so on. Banana fibre is mostly employed in the handicraft industry, where it is braided, crocheted, and handwoven into a variety of products such as purses, accessories, mats, and pillow coverings. Banana fibre is also utilised in the manufacturing of furniture, such as sofa sets, as well as in the creation of plywood surfaces and the textile sector.

In Banana, two kinds of fibres are used:

1. Banana bark fibre (the layers of the banana stem)
2. Banana pith fibre (the fibre extracted from the bark)

These banana shoots create a variety of soft fibres, resulting in yarns and textiles with different characteristics for different applications. The coarse outermost threads of the shoots, for example, are suitable for tablecloths, but the softest core fibres are preferred for fine garments.

(IV) **Modelling in solidworks:**

***(1)*Frame**

The machine consist of various components. All this components are mounted on a frame. The frame is made of cast iron and bore holes are drilled in correspondence to the bearings. Also proper lubrication is provided for smooth functioning. Fig() shows the structure of the frame. The height of the frame is 1100mm and the width of the frame is 480 mm. The thickness of individual poles used is 75mm.

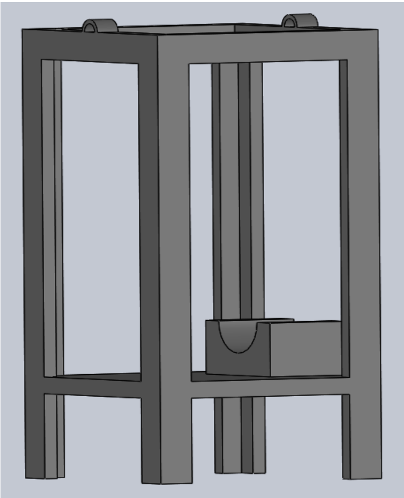

Fig.12. Frame

***(2)*Belt:-**

Belt provides a mechanical link between two rotating shafts. The shaft which is attached to the roller drum and the one which is connected to the motor. The belt is chosen such that it does not slip very easily. The A32 power loom belt is used in the machine due to its strength and capabilities.

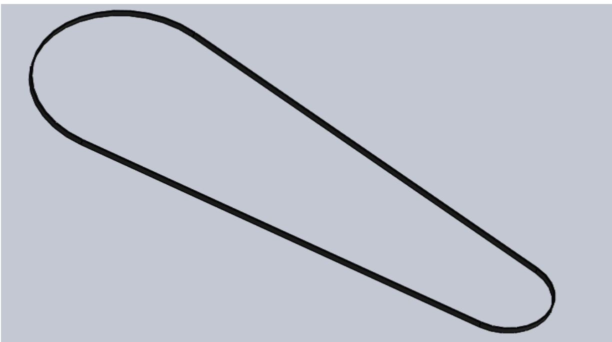

Fig.13.Belt

***(3)* Roller drum**

Roller drum is the most important component of the entire machine. Its specifications are very important. Type of blades used and the no. of belts taken are important. Its type mainly affects the quality of fiber. The roller design can easily separate a finer quality of banana leaf sheath. The diameter of the roller drum is 60mm and consists of 12 baldes.

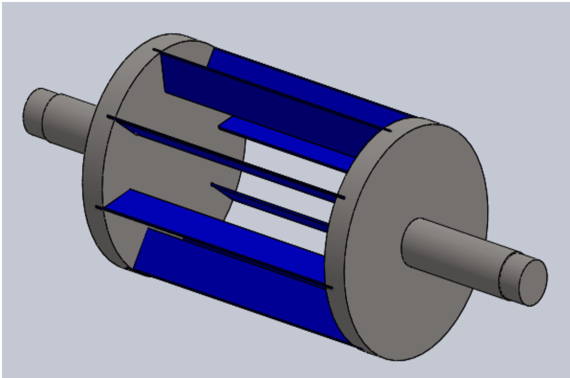

Fig.14. Roller Drum.

***(4)*Blade**:- Type of material chosen for the blade is very important. EN 8 carbon steel is used which is very strong , long lasting and effectively sperate out the fibers.

Length of the blade is 304mm and the width of the blade is 37mm

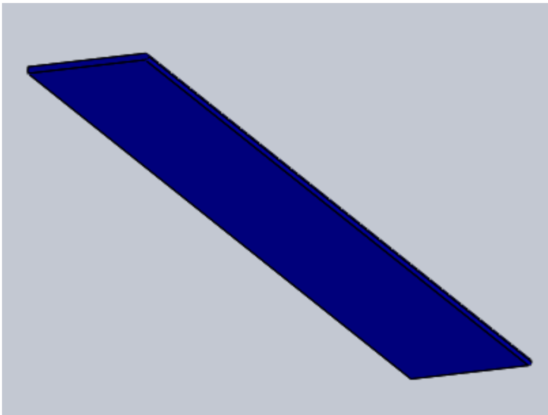

Fig.15.Blade

***(5)*Motor**:- motor provides initial motion required to move the drum roller. An AC motor is connected to the shaft which drives the shaft connected to the roller drum.

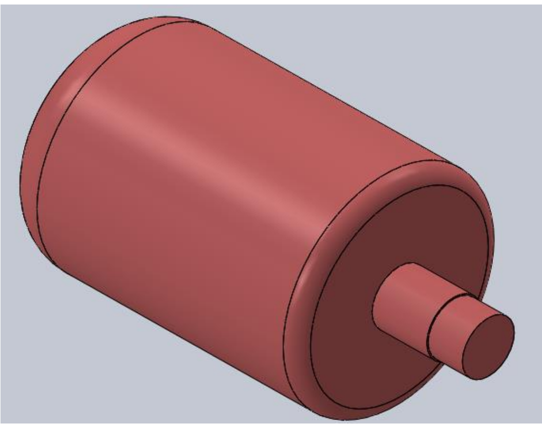

Fig.16.Motor.

***(6)*Pulley**:- pulley transmits the power of the motor to the roller drum with the help of a belt attached to it. Two pulley i.e. one with the motor and other with roller drum are used. The pulley with the motor is fixed which provides deviation for the rope, the force on the belt moving on its circumference. The second pulley is movable which offers a greater mechanical advantage when passing over the circumference. The pulley with the roller drum has diameter of 315 mm and the one with the motor has the diameter of 170 mm.

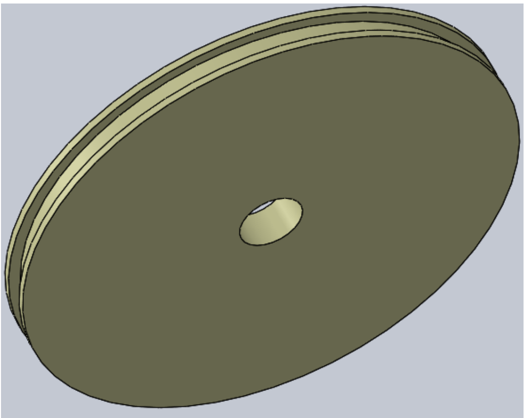

Fig.17.Pulley

***(7)*Feed roller**:- The feed roller is the part where the stem and leaf enters the machine. It consist of teeth that helps in creating marks on the stem. Also it provides an angle for the stem to get in contact with the roller drum. There are total of 3 roller in the entire machine.

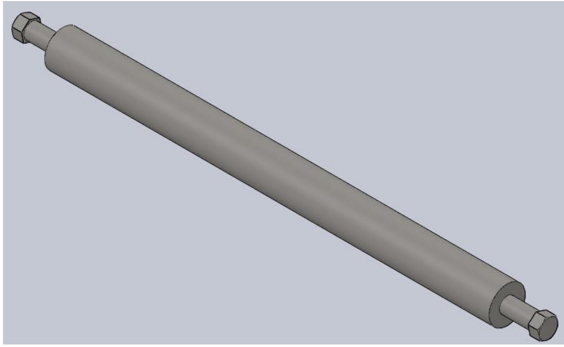

Fig.18.Feed Roller

***(8)*Supporter:-** supporter provides support to the motor when it is mounted on the frame. It is fixed on the frame.

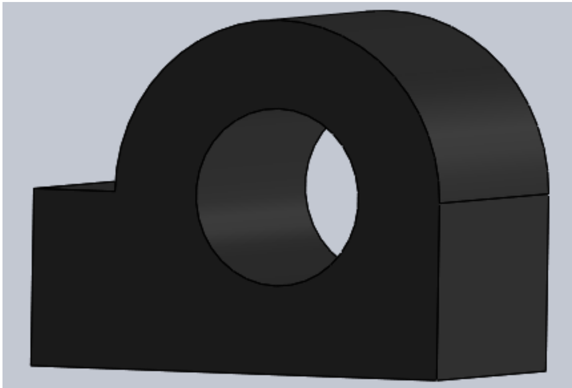

Fig.19.Supporter

***(9)*Slope and Cap** :- the slope is a metal sheet his is welded to the frame that provides a platform where the fibers will fall after separating. Cap it the apart which is kept closed when the machine is not used so that no. insects or dust can entre the machine.

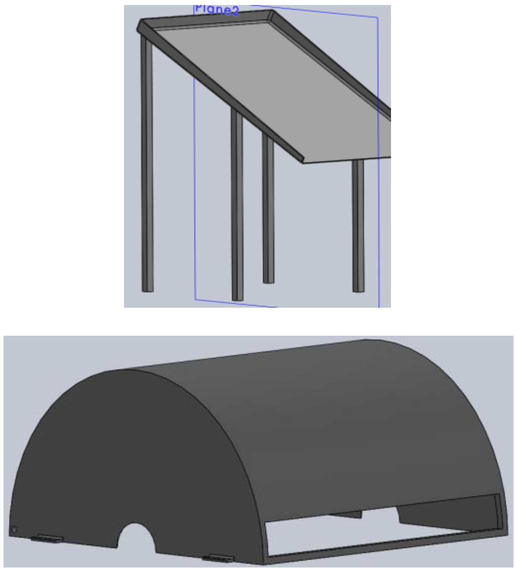

Fig.20.Slope and Cap

Solid Works model for the entire machine :

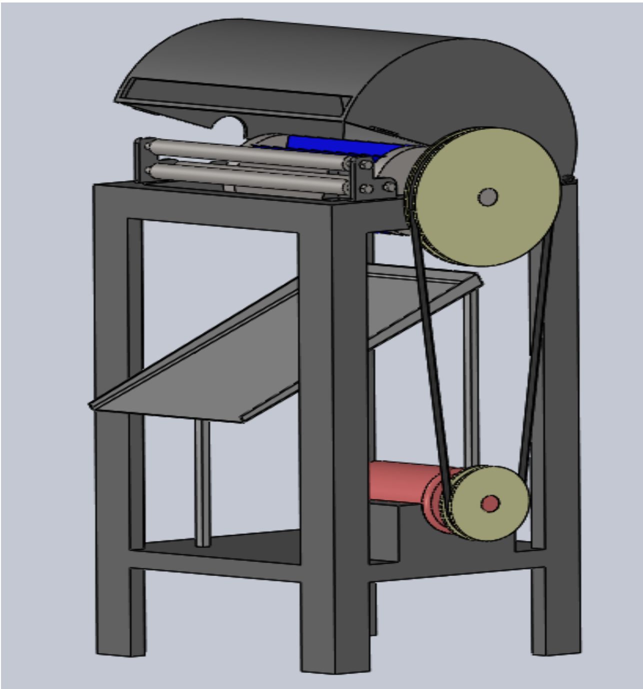

Fig.21.Assembled model

Draft of the machine

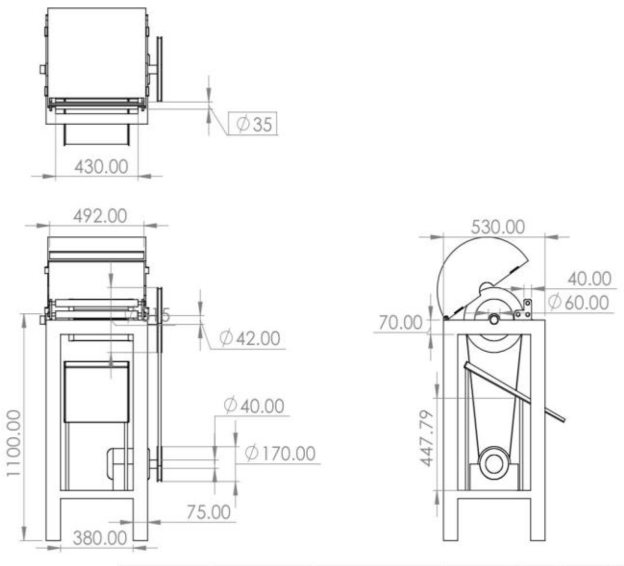

Fig.22.Draft of machine.

*B.***Working Principle :**

The feeding device feeds the raw material, which is plant stems, stalks, and leaves, to the blade drum. The fixed blades and high-speed rotating blade drum shatter the raw material and separate the fibres and residue. The machine's settings are kept to a minimum in order to preserve the extracted fibres' vital qualities. Due to the inclination of the slope the pulp generated falls away from the fibre.

B. **Working Principle :**

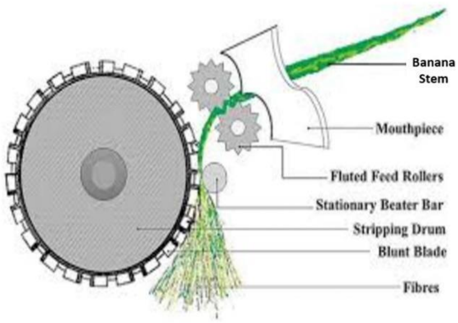

Fig.23.Working Mechanism

***C*.Design Calculations**

The following specifications for the banana fibre extraction machine are considered:

- Banana stem width = 150 mm maximum
- Banana stem maximum thickness = 10 mm
- Driving means = electric motor
- Motor operating voltage = 220 V
- Feeding method = Manual
- Coupling method = belt method
- Belt type: V belt

Determination of the force/torque needed to pulp the banana stem:

For banana stem at: L = 400 mm
B = 100 mm

Thickness – H = 8 mm y = 4 mm
Using the modulus of elasticity (Eb) of banana fibre- Eb= 29 GPa = $29*10^3$ N/mm^2

Now modulus of elasticity E could be expressed as = $E = fL^3/48yI$ ....(1)
Where,
E = Modulus of elasticity

Y = Deflection in mm

f = pulping force in N

I = Moment of inertia

Therefore, EI = $fL^3/48y$ .... (2)

Here, EI is a flexural rigidity of the banana stem. Also, I = $BH^3/12$ ....(3)

Therefore,
I = $100*8^3$ /12 = 4267 mm^2
E I = $29*10^3 * 4267 = 124*10^6$ N/mm^2

The force required to fibre out the stem is

f = EI*48 *y/ l^3 = 384 N
Torque required from rolling drum to banana stem: r = radius of drum
L = distance between two blades

= length of arc 1 & 2
No. of blades = 12
L = 26 mm
Drum diameter = 315mm

Drum thickness = 4 mm

Stem width = 100 mm
Now,
Blade thickness = 3mm flat bar Hence,
Torque = force*radius

= 150*157.5 mm

= 23.625 Nm

Velocity ratio of belt drive:

d1 = 0.315m
d2 = 0.17m

N2/N1 = d1/d2

As, N1 = 1440 rpm of motor

N2/1440 = 0.317/0.17 N2 = 2668 rpm

P= = 2πTN/6 P= 3 Hp motor

Design of shaft

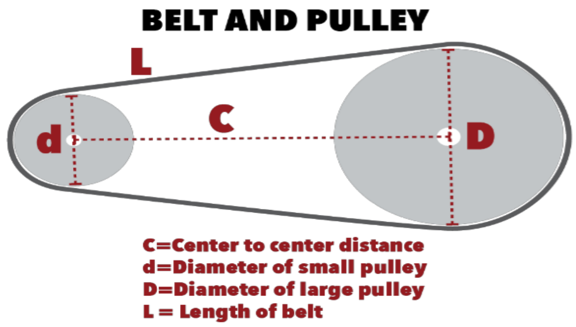

Fig.24.Shaft design.

$\alpha = 180-2\sin^{-1}(D-d/2c)$

$\alpha = 180-2\sin^{-1}(315-170/2*630)$=3.14radian

Length of belt

$L = 2C+ (D + d)/2 +(D+d)^2/4C$

$L = 2*630 + \pi(315+170)/2+(170+315)^2 /4*630$

L= 1616.2mm

$T_1 - T_2 = _v{}^P$

Here, μ = 0.2 and α = 3.14 rad.

T1 = T2 * $e^{0.2*3.14}$ = 1.873 * T2
V = πdN/60 = (π* 0.070 * 2800)/60 = 10.2625 m/s P = 3 hp = 2238 W

$T - T = {}^{2238}$,$1.8566T_2 - T_2 = {}^{2238}$ 10.2625

T2 = 254.5826 N and T1 = 472.6581 N. $\sum F=0$

Ra + Rb = 96.525 + 218.0755 = 314.6005 N $\sum M=0$

Rb = 281.9148 N

Mb = 11439.995 N-mm and Mt = 10800 N-mm.

$d^3 = {}^{16}\sqrt{(kb*Mb)^2 + (kt*Mt)^2}\, \pi*\tau$

Kb = 1.5, Kt = 1 and τ = Syt /2*FOS = 200 /2*2 = 50 N/mm^2

$d^3 = {}^{16}\sqrt{(1.5 * 11439.995)^2 + (1 * 10800)^2}\, \pi * 50$

d = 17.7348 mm ≈ 17 mm.

Design of shaft motor

We are using same diameter for Motor shaft. So,

$\tau = {}^{16Mt} = {}^{16*7560} = 7.8128\ N/mm2\ \pi d^3\ \pi * 20^3$

Therefore, τ < τ allowable = 50 N/mm^2

(D) Analysis of blade present on the roller drum

Structural analysis of the blade present in the roller drum are done as it is the part that has to bear the maximum stress and strain during working. Loads are applied on the blade at different speeds and analysis is carried out on ANSYS workbench. The factor of safety and the length of the blade along with the type of material used are considered. EN8 carbon steel is used as it has good strength which is required of the job.

Total Meshing

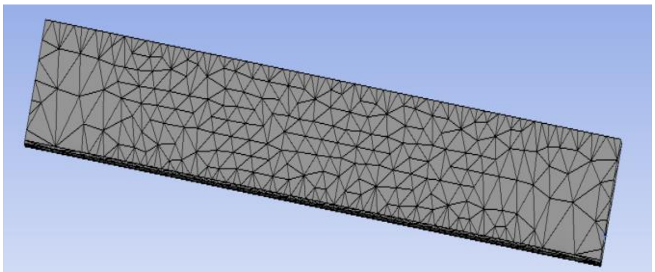

Fig.25.Total Meshing

Total deformation

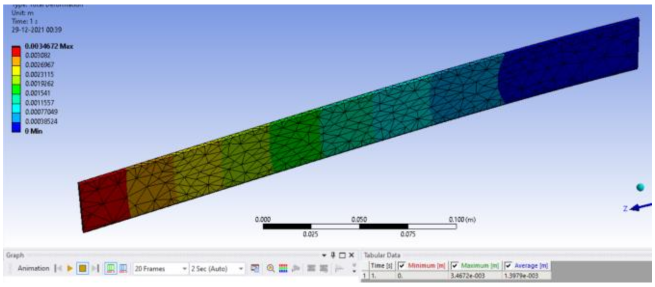

Fig.26.Total Deformation.

Equivalent stress

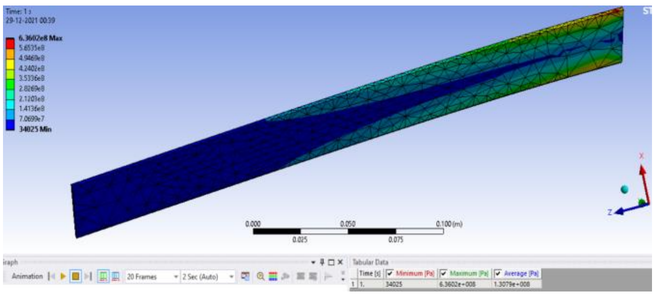

Fig.27.Equivalent Stress.

Equivalent strain

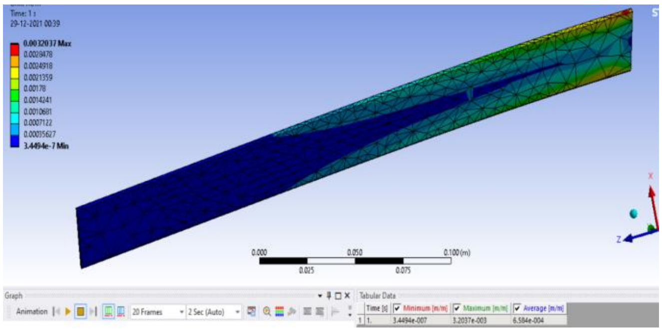

Fig.28.Equivalent Strain.

*(V)A.*Factors determine the Selection of materials for the machine.

The different elements that influence material selection are outlined below.

*(1)*PROPERTIES

The material used must have the qualities required for the planned application. Weight, surface finish, rigidity, ability to withstand chemical attack in the environment, service life, and reliability are some of the parameters that must be met.

The four categories of material's primary qualities have a significant impact on their choosing.

- Physical
- Mechanicals
- From manufacturing point of view
- Chemical

Melting point, thermal conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purposes, and other physical properties are all involved. Strength in tensile, compressive shear, bending, torsion, and buckling load, fatigue resistance, impact resistance, elastic limit, endurance limit, and modulus of elasticity, hardness, wear resistance, and sliding characteristics are among the mechanical qualities concerned. From a manufacturing standpoint, the following features are important:

From a manufacturing standpoint, the following features are important:

- Cast ability
- Weld ability
- Surface properties

• Shrinkage

• Deep drawing, and so on.

***(2)*QUALITY REQUIRED:**

This usually has an impact on the production process and, as a result, the material. For example, casting a small number of components that may be made far more affordably by welding or hand forging steel is never a good idea.

***(3)*AVAILABILITY OF MATERIAL:**

Because some materials are scarce or in low supply, the designer is forced to choose a different material, which may or may not be a perfect alternative for the material designed. It's also important to consider the delivery of supplies and the product's delivery date.

SPACE CONSIDERATION:

Because the forces involved are strong and space is limited, high-strength materials must sometimes be chosen.

TYPES OF COST ESTIMATION:

1. Material cost

2. Machining cost

MATERIAL COST ESTIMATION (factors considered) :

The total amount required to acquire the raw material, which must then be processed or produced to the desired size and functionality of the components, is calculated using material cost estimation. There are two types of materials in this collection.

1. **Fabrication material**: This is material that is obtained in its raw state and is made or treated to a completed size in order for the component to work properly.

2. **Purchased standard parts**: This category contains items that are easily available in the market, such as allen screws. The estimation forecasts a list describing the quality, size, and standard parts, as well as the weight of raw material and the cost per kilogramme. For the parts that have been fabricated.

This cost estimate attempts to forecast overall expenses, which may include manufacturing costs in addition to material costs. Manufacturing component cost estimation can be thought of as a judgement based on and after careful consideration of the labour, materials, and factory services required to produce the desired part.

3. **Total the cost of the basic materials purchased.**

COST OF THE MATERIALS

Sr no.	Component	Quantity	Cost (RS)
1	V-BELT	1	700
2	ROLLER PIPE	3	1500
3	CIRCULAR DISC	2	800
4	SLOT SHEET MILD STEEL	-	1500
5	FRAME	-	1200
6	BEARING	2	200
7	SHAFT	1	1000
8	MILD STEEL SHEET	1	1000
9	MOTOR	1	3000
10	BELT PULLEY	2	1500
11	Total		**20200**

Table.1. Cost of the materials.

SAFETY PRECAUTIONS:

L = length of banana stem

For safe machine use and to avoid accidents, keep the following considerations in mind:-

1. Make sure that all of the machine's parts are perfectly aligned.

2. Make sure that all of the nuts and bolts are securely fastened.

3. To control the machine easily, the operational switch should be placed at a suitable distance from the operator.

4. Inspection and maintenance of the machine should be performed on a regular basis.

***B.*APPLICATIONS**

• Banana fibre offers a lot of promise for papermaking, especially if you want to make handcrafted papers.

• It's even used to make currency paper in some nations.

• Rope, matting, and other composite materials are made with it.

• Banana fibre is well-known for its use in clothing and home goods.

• Banana fibre composite materials are utilised in building and fire-resistant boards.

• Automobile manufacturers employ polypropylene reinforced with banana fibre to make underfloor protection panels in high-end vehicles such as Mercedes-Benz.

• Banana fibre is commonly used in handicrafts and home décor.

***C.*SCOPE AND FUTURE WORK.**

• It can be altered to work with other fibres, such as bamboo.

• Variable-speed microprocessor controllers can be used.

• Feed sensors can be utilised to adjust the spacing between feed rollers based on the thickness of the fibre.

• All rollers can be anchored with positive driving systems.

• Pneumatic pressure devices can be used to guarantee greater pressure control for quality fibre extraction, but dye uptake must be thoroughly investigated.

• FTIR and X-ray techniques can be used to investigate the structure of fibres.

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