DEVELOPMENT OF COIR SHEET MAKING MACHINE

Kathe Bhavik R.[1], Ghavare Kshitij R.[2], Kadam Rohit K.[3] Mhatre Aditya K.[4]

[1-4]*Student, Pillai HOC College of Engineering and Technology, University of Mumbai, Khalapur, Maharashtra, India*

Abstract - *Renewable natural fiber polymer composites include plant fibers could be extracted from best fibers, leaves fibers, leaflets, seed fibers, grass and reed fibers, and all other types. The recent advances in bio-composite development are genetic engineering. In recent years, there has been a remarkable increase in interest in biodegradable bio-composite material for application such as packaging, agriculture, medicine, sportswear, insulation, coating and other areas. This effort to develop the bio-composites materials will decrease the need for synthetic polymer production at a low cost. The natural fibers are alternately producing a positive effect on both environmental and economical. The availability of coconut shells is increasing every year worldwide, which is hard lignocelluloses Argo waste. But mostly the coconut shells are left out in the garbage or burn as waste and produce large quantity of CO2 and methane emission product after consumption water and meat from coconut. These coconut shell wastes can be used to fabricate fiber reinforced polymer composites for commercial purpose. Efforts to find utilization of this material have resulted mostly in low value. In this regard, coconut shell powder seems to be an interesting candidate due to its chemical composition. In present, review is carried out to evaluate development of coconut shell fibers reinforced polymer composites with its manufacturing processes, methodology and finding of mechanical properties, thermal analysis and its application.*

***Key Words*: Fibre, methane, CO2, coir, reinforced polymers.**

1. INTRODUCTION

In the latest years, composites fulfill optimal requirement criteria for several designers' materials. In the last 50 years, there have been major developments in the design and fabrication of lightweight, high strength materials, primarily due to the increase of polymer composite materials. Several researchers have aimed at their work towards defining abundant combinations of biodegradable matrix/natural fillers in order to promote new classes of biodegradable composites with enhanced mechanical properties, as well as to attain products with lower cost. Among several investigated natural fibers in this area, different fillers have the significant importance. For example, the development of wood flour composites has been actively pursued with the increasing consumption of wood-based raw materials. In their substitutions were inevitably needed. The Natural Fillers (NF) reinforced materials offer several environmental advantages, such as decrease dependence on non-renewable material sources, lower pollution and green house emission. Natural lignocelluloses fillers (flax, jute, hemp, etc.) represent an environmentally friendly alternative to conventional reinforcing fibers (glass, carbon). The Advantages of natural fillers over traditional ones are their low cost, high toughness, corrosion resistance, low density, good specific strength properties and reduced tool wear. However, there are several disadvantages in natural fillers, like low tensile strength, low melting point, not suitable for high temperature application, poor surface adhesion to hydrophobic polymers, non-uniform filler sizes, degradation by moisture. Therefore, chemical treatments are done to modify the fiber surface properties.

1.1 BACKGROUND

Renewable natural fibre polymer composites include plant fibres could be extracted from leaves fibres, grass and other types. Bio-composites materials will decrease the need for synthetic polymer production at a low cost. The natural fibres are alternately producing a positive effect on both environmental and economical. The availability of coconut shells is increasing every year worldwide. These coconut shell wastes can be used to fabricate fibre reinforced polymer composites for commercial purpose. Researchers have begun to focus attention on natural fibre composites (i.e. coir fibre), which are composed of natural or synthetic resins, reinforced with natural fibres. Natural fibres exhibit many advantageous properties, they are a low-density material yielding relatively lightweight composites with high specific properties. These fibres also have significant cost advantages and ease of processing along with being a highly renewable resource, in turn reducing the dependency on foreign and domestic petroleum Oliphant Air eddy et al Investigated coir dust reinforced epoxy matrix composites of different compositions. The abrasive wear property of the composites was examined in dry conditions on a pin-on-disc machine against 400µm grit size abrasive paper, with test speed of 0.540 m/sec and normal loads of 5,10,15,20, and 25N. The experimental results shown that, the abrasive wear resistance of the composite depends on the coir dust concentration, sliding distance and applied normal load. wear mechanism was dominated by reinforcement because of higher coir dust loading. The abrasive wear resistance decreased with increase in normal load and increased with increasing coir dust concentration. Simazine et all studied the viability of coir fiber reinforced composites in sound absorption panel. The composites are constructed as prescribed percentage of fillers and polyurethane as resin. Two microphone methods were used to investigate the acoustic the properties of the material. The result demonstrates good acoustic properties of the composites and highlight the potential of the coir fiber reinforced composites in sound absorption panel.

1.2 NEED AND SCOPE

With the on-going development of technology and economy, new industrial requirements such as high precision, good quality, high production rates and low production costs are increasingly demanded. Use of coir-based products leads to avoid the deforestation and save the environment. The availability of coconut shells is increasing every year worldwide, which is Argo waste. But mostly the coconut shells are left out in the garbage or burn as waste and produce large quantity of CO2 and methane emission product after consumption water and meat from coconut. Efforts to find utilization of this material have resulted mostly in low value. The versatility of coconut fibres and its applications in different branches of engineering particularly in civil engineering as a construction material is good. Coconut fibre is one of the natural fibres abundantly available in tropical regions and is extracted from the husk of coconut fruit. Not only the physical, chemical and mechanical properties of coconut fibres are shown; but also, properties of composites (cement pastes, mortar and/or concrete etc), in which coconut fibres are used as reinforcement, are discussed. The primary advantage of the coir wood composites is due to the coir, which is natural, eco-friendly and abundantly available material. Coir is very strong due to its high content of crystalline alpha cellulose (40%) and highly resistance to borer, termite, water and other natural elements due to high lignin content (45%). The coir fibre being very strong and flexible, it can easily replace the glass fibre or can be hybridised in required ratio with the glass fibre. One unit of coir ply with a production capacity of 40 cubic metres day would be able to save about 22 trees per day which means 6,600 trees per year. If one such tree requires 40 sq. meter, then it would be 25 trees in one acre so that a coir ply unit could save about 264 acres of tropical forest in every year. If 10 % of coir fibre produced is utilized in the manufacture of coir ply, it would save about 8, 80,000 tropical trees per year which corresponds to 8,800 acres of tropical forests per year. The Advantages of natural fillers over traditional ones are their low cost, high toughness, corrosion resistance, low density, good specific strength properties and reduced tool wear.

2. MATERIAL SELECTION

(a) General Criteria for Selection

Materials are selected based on four general criteria:

- Performance characteristics (properties)
- Processing (manufacturing) characteristics
- Environmental profile
- Business considerations

The science of the metal is a specialized and although it overflows into realms of knowledge it tends to shut away from the general reader. The knowledge of materials and their properties is of great significance for a design engineer. The machine elements should be made of such a material which has properties suitable for the conditions of operations. In addition to this a design engineer must be familiar with the manufacturing processes and the heat treatments have on the properties of the materials. In designing the various part of the machine, it is necessary to know how the material will function in service. For this certain characteristics or mechanical properties mostly used in mechanical engineering practice are commonly determined from standard tensile tests. In engineering practice, the machine parts are subjected to various forces, which may be due to either one or more of the following.

1. Energy transmitted
2. Weight of machine
3. Frictional resistance
4. Inertia of reciprocating parts
5. Change of temperature
6. Lack of balance of moving parts

The selection of the materials depends upon the various types of stresses that are set up during operation. The material selected should withstand it. The type of load because a machine part resist load more easily than a live load and live load more easily than a shock load.

Selection of the material depends upon factor of safety, which in turn depends upon the following factors.

1. Reliabilities of properties
2. Reliability of applied load
3. The certainty as to exact mode of failure
4. The extent of simplifying assumptions
5. The extent of localized
6. The extent of initial stresses set up during manufacturing
7. The extent loss of life if failure occurs
8. The extent of loss of property if failure occurs

(b) Materials selected in Machine -

1. Base plate, motor support, sleeve and shaft: -

Material used: **- Mild steel**

Reasons:

1. Mild steel is readily available in market
2. It is economical to use
3. It is available in standard sizes
4. It has good mechanical properties i.e. it is easily machinable
5. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure
6. It has high tensile strength
7. Low co-efficient of thermal expansion.

From the above the considerations we have considered following materials for each of the parts of the machine: -

SR NO	PART NAME	MAT	QTY
1	Hydraulic cylinder	CI	1
2	Chain	STEEL	1 pack
3	OIL	SERVO 38	500 ML
4	Moving Die	MS	1
5	FIX Die	MS	1
6	Sprocket	MS	2
7	Frame Stand	MS	20 KG
8	3 phase gear motor	Std	1
9	Motor starter	Std	1
10	Coco pit	Coir	5 KG

Table: 1 – Parts and material

3. OBJECTIVE

With the on-going development of technology and economy, new industrial requirements such as high precision, good quality, high production rates and low production costs are increasingly demanded. Use of coir-based products leads to avoid the deforestation and save the environment. The availability of coconut shells is increasing every year worldwide, which is Argo waste. But mostly the coconut shells are left out in the garbage or burn as waste and produce large quantity of CO2 and methane emission product after consumption water and meat from coconut. Efforts to find utilization of this material have resulted mostly in low value. The versatility of coconut fibres and its applications in different branches of engineering particularly in civil engineering as a construction material is good. Coconut fibre is one of the natural fibres abundantly available in tropical regions and is extracted from the husk of coconut fruit. Not only the physical, chemical and mechanical properties of coconut fibres are shown; but also, properties of composites (cement pastes, mortar and/or concrete etc), in which coconut fibres are used as reinforcement, are discussed. The primary advantage of the coir wood composites is due to the coir, which is natural, eco-friendly and abundantly available material. Coir is very strong due to its high content of crystalline alpha cellulose (40%) and highly resistance to borer, termite, water and other natural elements due to high lignin content (45%). The coir fibre being very strong and flexible, it can easily replace the glass fibre or can be hybridised in required ratio with the glass fibre. One unit of coir ply with a production capacity of 40 cubic metres day would be able to save about 22 trees per day which means 6,600 trees per year. If one such tree requires 40 sq. meter, then it would be 25 trees in one acre so that a coir ply unit could save about 264 acres of tropical forest in every year. If 10 % of coir fibre produced is utilized in the manufacture of coir ply, it would save about 8, 80,000 tropical trees per year which corresponds to 8,800 acres of tropical forests per year. The Advantages of natural fillers over traditional ones are their low cost, high toughness, corrosion resistance, low density, good specific strength properties and reduced tool wear.

4. METHODOLOGY

Standard coir available in the market was purchased, coir sheets were cut in specific size. The chopped sheet was mixed with chemical and hardener. The mixture was put in desired shape die, and then it was pressed under hydraulic press. The hydraulic press pressed the material under high pressure and removed the excessive binder. The pressed material was removed and allowed to dry. Here 70x130x250 mm rectangular block of coir board will be made, the size of construction brick is taken for reference. The coir board made will be tested for impact test. So, for testing which coir board is having maximum strength we will use three different binding materials

1. Phenol formaldehyde

2. Urea formaldehyde

3. Araldite

The strength of board was compared with Plywood and we check its replacement with coir board.

5. MACHINE DESIGN

The subject of MACHINE DESIGN deals with the art of designing machine of structure. A machine is a combination of resistance bodies with successfully constrained relative motions which is used for transforming other forms of energy into mechanical energy or transmitting and modifying available design is to create new and better machines or structures and improving the existing ones such that it will convert and control motions either with or without transmitting power. It is the practical application of machinery to the design and construction of machine and structure. In order to design simple component satisfactorily, a sound knowledge of applied science is essential. In addition, strength and properties of materials including some metrological are of prime importance. Knowledge of theory of machine and other branch of applied mechanics is also required in order to know the velocity. Acceleration and inertia force of the various links in motion, mechanics of machinery involve the design.

5.1 CONCEPT IN MACHINE DESIGN

5.1.1 Consideration in Machine Design: -

1. When a machine is to be designed the following points to be considered: -
2. Types of load and stresses caused by the load.
3. Motion of the parts and kinematics of machine. This deals with the
4. iii) Type of motion i.e. reciprocating. Rotary and oscillatory.
5. Selection of material & factors like strength, durability, weight, corrosion resistant, weld ability, machine ability is considered.
6. Form and size of the components.
7. Frictional resistances and ease of lubrication.
8. Convenience and economy in operation.

1. Use of standard parts.
2. Facilities available for manufacturing.
3. Cost of making the machine.
4. Number of machine or product to be manufactured.

5.2 GENERAL PROCEDURE IN MACHINE DESIGN

1. The general steps to be followed in designing the machine are as followed.
2. Preparation of a statement of the problem indicating the purpose of the machine.
3. Selection of groups of mechanism for the desire motion.
4. Calculation of the force and energy on each machine member.
5. Selection of material.
6. Determining the size of component drawing and sending for manufacture.
7. Preparation of component drawing and sending for manufacture.
8. Manufacturing and assembling the machine.
9. Testing of the machine and for functioning.

5.3 CAD MODEL DESIGN

5.3.1 PROCEDURE

1. The entire model has been designed with the help of designing software solid works.
2. With the help of color feature, the colors are given to the entire model.

5.3.2 SOLID MODELING

The entire model has been designed with the help of designing software solid works.

5.3.3 CAD MODELS

I. **Base Plate**

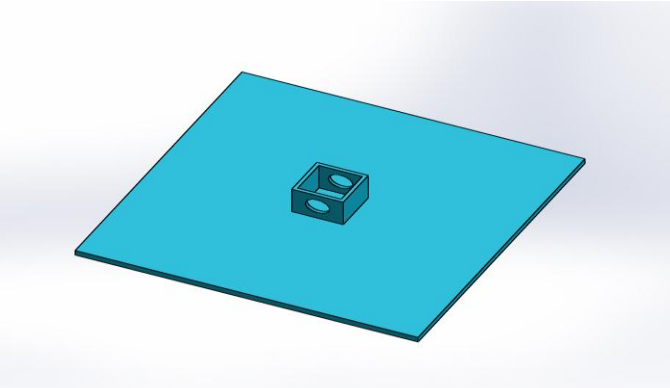

Fig: 1 – Base plate (CAD model)

II. **Frame**

Fig: 2 – Frame (CAD model)

III. Needle Mechanism

Fig: 3 – Needle Mechanism (CAD Model)

IV. Dimensions and views of final project

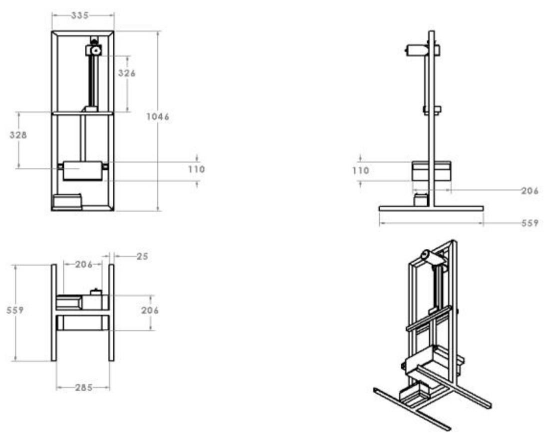

Fig: 4 – Dimensions and views of final project

V. Die Assembly

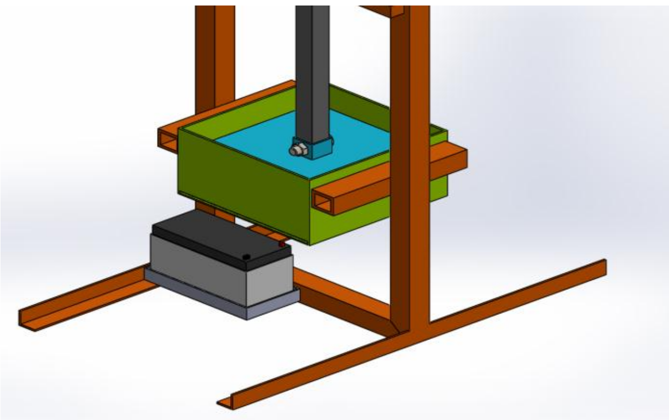

Fig: 5 – Die assembly (CAD model)

VI. Final Machine Assembly

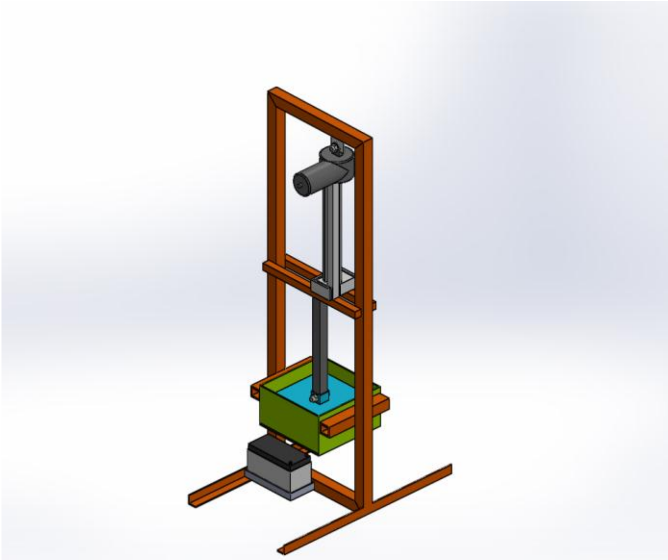

Fig: 6 – Final machine assembly (CAD model)

5.4 DESIGN CALCULATIONS

5.4.1 DESIGN OF FRAME

C45 steel sheet Physic-chemical testing items for products of the plant include tensile test, hardness test, impact test, flattening test, and chemical composition analysis. C20, C45 steel pipes are manufactured by cold drawn process.

C45 is a medium carbon steel is used when greater strength and hardness is desired than in the "as rolled" condition. Extreme size accuracy, straightness and concentricity combine to minimize wear in high speed applications. Turned, ground and polished.

1. Soft Annealing: -

Heat to 680-710oC, cool slowly in furnace. This will produce a maximum Brinell hardness of 207.

2. Normalizing: -

Normalizing temperature: 840-880oC/air.

3. Hardening Harden from a temperature of 820-860oC followed by water or oil quenching.

4. Tempering temperature: 550-660oC/air.

C45 steel plate, EN 10083 C45 steel plate, under EN 10083 standard, we can regard C45 steel plate as high carbon steel.

C45 steel plate is one mainly of high carbon Steelman 10083 C45 steel plate is for quenching and tempering. Technical delivery conditions for non-alloy steels, these steels are for general engineering purposes.

Grade	C (%) min-max	Si (%) min-max	Mn (%) min-max	P (%) max	S (%) max	Cr (%) min-max
C45	0.42-0.50	0.15-0.35	0.50-0.80	0.025	0.025	0.20-0.40

Table: 2 - Chemical Composition of EN C45 steel.

Grade	Condition	Yield Strength R°(Mpa)	Tensile Strength Rm(Mpa)	Elon-gation A5(%)	Hardness HRC	Quenching Temperature (°C)	Benda-bility	Nominal Thickness 1.95mm≤t≤10.0mm	
								Rolled	Annealed
C45	Rolled Annealed Water-quenched Oil quenched	460 330	750 540 2270 1980	18 30	58 55	820 860	Min.reco-mmended Bending radius (≤90°)	2.0 ×t	1.0×t

Table: 3 - Mechanical Properties of EN C45 steel

- Material = C 45 (mild steel)

∴ $\sigma_t = \sigma_b = 540\ N/mm^2$

∴ $\sigma_s = 0.5\ \sigma_t$

$= 0.5 \times 540$

$= 270\ N/mm^2$

5.4.2 DESIGN OF ELECTRIC ACTUATOR MOTOR

This simple electrical actuator system will ensure consistent operation in both directions. It will also give you added features such as end of stroke limit switches, mid stroke protection and manual override operation in case of power failure. Optional features such as analog or digital position feedback and adjustable end of stroke limit switches are also available. Another advantage is that a system like this is easy to integrate with other control systems normally found in industrial systems or vehicles such as PLC's, micro-controllers, computers or simple relay-based systems.

The linear actuator we will purchase will be of 150 lbs. = 68 kg

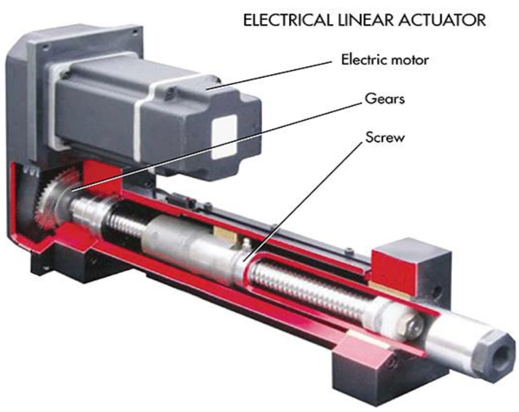

Fig: 7 - Electric Linear Actuator

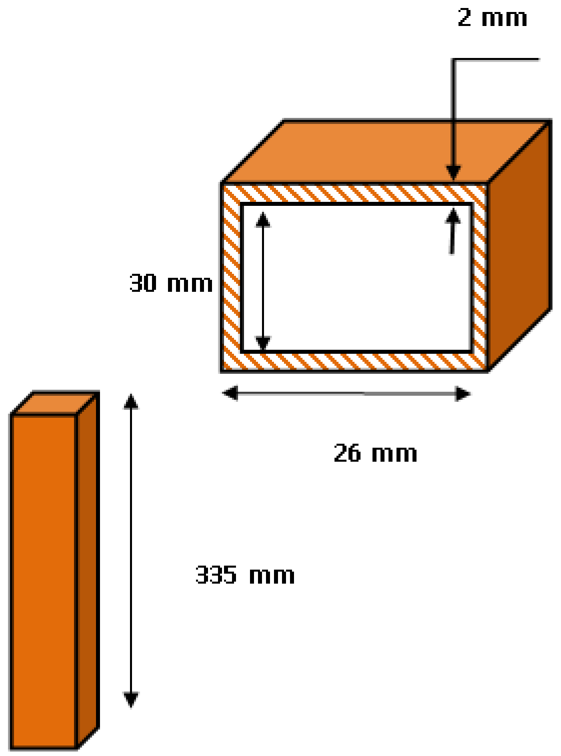

Fig: 8 – Dimensions

- **Square pipe of 30x30 section is used as a column, we will check for its bending load.**

Let the maximum load applied by linear actuator be 68 kg

∴ So, load on column is = 68 kg = 680 N

∴ W = 680 N

∴ M = W L / 4 = 680 X 335/ 4 =56950 N-mm

∴ $Z = B^3 - b^3 / 6 = 30^3 - 26^3 / 6 = 1575.6\ mm^3$

∴ $\sigma_b = M / Z$

∴ $\sigma_b = 56950 / 1575.6 = 36.14\ N/mm^2$

∴ $\sigma_{b\ INDUCED} < \sigma_{b\ ALLOWED}$

∴ $36.14\ N/mm^2 < 270\ N/mm^2$

Hence our design is safe.

Induced stress is less then allowable, so design is safe.

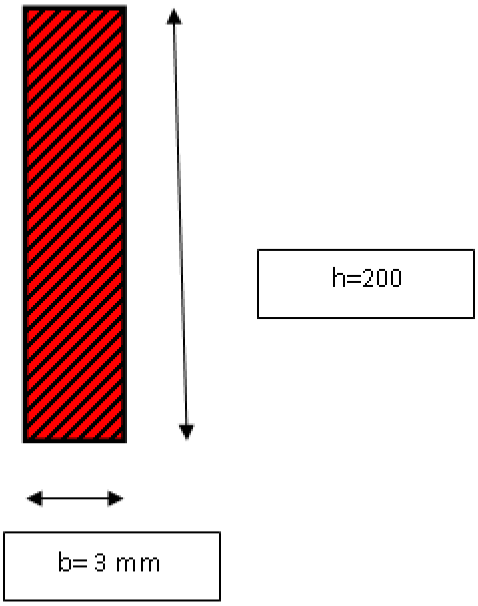

Fig: 9 – Dimensions

NOW,

This die may fail under bending 200x200x3

∴ F = maximum force applied = 680 N

∴ M = W L / 4 = 680 X 200/ 4 =34000 N-mm

And section moulus = $Z = 1/6\ bh^2$

∴ $Z = 1/6 \times 5 \times 200^2$

∴ $Z = 1/6 \times 3125$

∴ $Z = 33333\ mm^3$.

Now using the relation,

∴ Fb = M / Z

∴ Fb= 34000/ 33333 = 1.02 N/mm^2

Induced stress is less then allowable 260 N/mm^2 so design is safe

5.4.3 DESIGN OF BOLT

Bolt is to be fastened tightly also it may fail under shearing load when we rotate the arm. Std nominal diameter of bolt is 5.8 mm. From table in design data book, diameter corresponding to M 6 bolt is 5.2 mm

∴ Let us check the strength: -

∴ $\sigma_s = 90\ N/mm^2$

Also,

∴ $P = \Pi /4\ dc^2 x\ \sigma$ shear

$$90 = \frac{P}{3.14/4 \times (5.2)^2}$$

∴ P= 90 x 21.23= 1911.3 N = 198 kg

The single M6 bolt can sustain 198 kg load under shearing and which is far more than 68 kg, so nut is safe.

5.4.4 DESIGN OF TRANSFER FILLET WELDED JOINT

Checking the strength of the welded joints for the safety. The transverse fillet weld welds the side plate and stiffness plates, the maximum load which the plate can carry for transverse fillet weld is,

P = 0.707 x S x L x fs

Where, S = size of weld, L= contact length =25mm

The load of shear along with the friction is 30kg = 300N Hence, eqn becomes

300 = 0.707 x 3.4 x 25 x fs

So, fs = 300

0.707 x 3.4 x 25

Fs = 5 N /mm2

Since the above calculated are smaller so permissible value fs is taken as 21 N /mm2 which is very safe.

6. CONCLUSIONS

The use of Natural fiber polymer composites filled with natural-organic fillers, in alternate of mineral in organic fillers. It is of great interest in the view of the reduction in the use of petroleum-based, nonrenewable resources and in general it is the more intelligent utilization of environmental and financial resources. These "Natural fiber" composites can find some industrial applications, although some limitations occur regarding mainly ductility, process ability and dimensional stability. Worldwide research has spent much effort in order developing suitable solutions through chemical modification of the Filler, Fiber dispersion, Fiber aspect ratio, Fiber orientation, Fiber volume fraction, use of adhesion promoters and additives. However, a full biodegradability and thus a really improved environmental impact can be obtained only by biodegradable ones instead of traditional polymers (coming from non-renewable resources). In these cases, however, new limitations arise, and current scientific investigation has been focusing on the selection of the most suitable biodegradable matrix and the optimization of all the preparation and processing parameters. The utilization of coconut shell fibers in various applications has opened new avenues for both academicians as well as industries to design a sustainable module for future use of coconut shell fibers. Coconut shell fibers have been extensively used in composite industries for socioeconomic empowerment of peoples. The fabrication of coconut shell fibers-based composites using different matrixes has developed cost effective and eco-friendly bio composites which directly affecting the market values of coconut shell.

The conclusions of the designed machine were –

- The machine was able to perfectly press the coir and hardeners/adhesives into a sheet
- According to the shape of die, various products were made from the machine
- Machine was able to sustain the load for the pressing operation
- The material produced had desirable tensile and bending stress
- The coir material can be effectively used as a substitute of wood or processed wood
- Machining operations can be further carried out on the produced coir material

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