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A Review on Coconut Coir Composite Board Manufacturing Machine

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Abstract – *A More number of trees are cut yearly for making furniture, papers and construction of buildings. Therefore global warming is increases because of deforestation. There is need to be alternative to wood, which provides the function of wood. For that scientist made focus on the use of natural fibers such as bagasse, coir, sisal, jute etc. Which is resulted in production of natural fiber based materials mainly composites. Application areas of composites materials increased rapidly over a few decades. It is widely used in agriculture, packaging, insulation, sportswear, medicine etc.*

***Key Words*: -Coir fiber, composites, epoxy resin, coir reinforcement, polymer matrix.**

1. INTRODUCTION

In the early few years composites are widely used in several design materials. In the last few years there is continuous development in design and fabrication of light weighted, high strength material and which is available in comparatively low cost. Some researchers tried to create the composite material that having the properties like good strength, good mechanical and physical properties and which is in low cost [1]. Currently the big area of traditional material is being replaced by composite materials. Composites: it is a composition of two or more materials to gives combination of properties, one of which is made up of stiff long fiber and the other is a binder or polymer matrix which hold the fiber in place. [6] A composite material is a combination of two or more materials out of which some are load bearing members and others are holding members in proper orientation. Coir wood composites using coir as a reinforcing material impregnated with polymeric matrix materials like polymer, epoxy etc. The coir wood is substitute for wood. It is ecofriendly material used in building and furniture sector. By the combination of coir with resin and hardners and binders we gets our composite material which is replaces wood and which also preserves natural forests and saves the trees from cutting for wood. [11]

Coir board is made up of coco fiber and bonding agents and other materials incorporated in manufacturing processes. To increase the strength, resistance to moisture, fire or decay. Due to which the product has taken up an important position in construction and furniture industries. (27). In have to improve mechanical, physical and other properties carbon ,iron particles are added as per requirement.[2] CICT(central institute of coir technology, Bengluru) has developed a coir wood by mixing a coir and Phenol Formaldehyde(resin) which is economic and very effective in the case of replacement of traditional plywood. The board making from coir is very strong, because of its contents such as alpha cellulose and ligning. It having the properties like highly resistance to borer, termite water and other natural elements. [12] The properties of composites are depend on the material's nature and characteristics As increased in cellulose content of fiber flexural properties are decreases.[3] The materials used in composites should perform following functions 1) to stick/ bind together with the help of it's cohesive and adhesive property.

2) To protect them from environment and handling.

3) To dispense the fiber and maintain the desired fiber orientation and spacing.

4) To be chemically and thermally compatible with the reinforcing fibers.

5) To be compatible with manufacturing method. [6]

1.1 COMPOSITES CONSTITUENTS

1.1.1 Thermoset Polymer matrices;

Thermoset polymer matrices are resins such as unsaturated polyesters, epoxy resin, alkyds, vinyl esters, and alkyl resins, amino plastics, urethanes, silicon etc. [6]

1.1.2 Epoxy Resin:

Epoxy Resin is mainly used as a binding agents. It having certain advantages as follows 1) Low density 2) Good corrosion resistance 3) Low thermal conductivity 4) Low electrical conductivity etc.

Disadvantages-1) Low transverse strength, 2) Low operational temperature limits etc. [6]

1.1.3 Reinforcement:

Reinforcement meant the enhancement of mechanical properties of resin in composite material. [6]

1.2 Availability of natural fibers in INDIA and applications [11]

Item	Source	Qty. in Mt/Yr	Application
Rice Husk	Rice mills	20	As fuel, for manufacturing building materials and products for production of rice husk binder, fibrous building panels, bricks, acid proof cement
Banana leaves/stalk	Banana plants	0.20	In the manufacture of building boards, fire resistance fibre board
Coconut husk	Coir fibre industry	1.60	In the manufacture of building boards, roofing sheets, insulation boards, building panels, as a lightweight aggregate, coir fibre reinforced composite, cement board, geo-textile, rubberized coir
Rice/wheat straw	Agricultural farm	12	Manufacture of roofing units and walls panels/boards

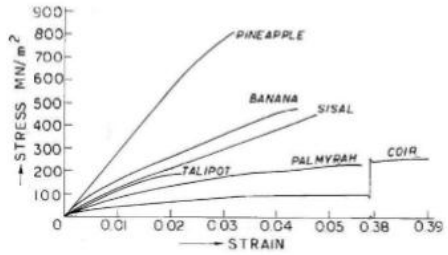
1.3 PROPERTIES:

1.3.1 Physical and mechanical properties of coco fiber.

There are variations in the properties of coco fiber due to which there is difficult to use these as a construction materials.

The various properties are shown in below table .

Fig 1 shows the stress-strain relationship for coconut fiber. These fig shows that coconut fiber is most ductile fiber compared with other natural fibers. Coconut fiber is capable to take 4-6 times strain than other fibers.[8]



c. Stress-Strain Curves of Natural Fibres
[Satyanarayana, et al. (1990)]

figure no 01

1.3.2 Chemical properties

In the coconut fiber the major components are 1.cellulose, 2.hemi-cellulose and 3.lignin. Due to presence of these elements the chemical properties of fiber changes.

The chemical properties are given in below table.[8]

Fiber	Hemi-cellulose (%)	Cellulose (%)	Lignin (%)
	31.1 [a]	33.2[a]	20.5[a]
coir	15 – 28[b]	35-60[b]	20-48[b]
	16.8	68.9	32.1
	-	43	45
	0.15 – 0.25	43	41-45

a The compositions are % by weight of dry and powdered fibre sample

b Chemical compositions are % by mass and author took other researchers data

1.3.3 Mechanical properties:

Table below shows the mechanical properties. [8]

Fibre volume fraction (%)	Tensile Strength (MPa)	Modulus of Rupture (MPa)
2	1.9	3.6
3	2.5	4.9
4	2.8	5.49
5	2.2	5.4
6	1.5	4.6

1.3.4 Properties of Coconut Fibre Reinforced Concrete (CFRC) [8]

Fibre volume fraction (%)	Compressive Strength (MPa)	Split Tensile Strength (MPa)	Modulus of Rupture (MPa)	Shear Strength (MPa)	Toughness Index, I	Toughness Index , I10
-	21.42	2.88	3.25	6.18	1.934	1.93
0.5	21.70	3.02	3.38	6.47	2.165	2.27
1.0	22.74	3.18	3.68	6.81	2.109	2.77
1.5	25.10	3.37	4.07	8.18	2.706	4.27
2	24.35	3.54	4.16	8.21	2.345	3.45

1.3.5 Dynamic stability:

The dynamic stability is an important design consideration in polymer matrix composite structure.

The natural frequency and damping frequency forms a major impact on the composites. Various studies are carried out on vibration properties of composites.

The damping ratio is calculated by half power bandwidth method.

$$2\xi = \frac{F_1 - F_2}{F}$$

Where F_1 & F_2 are frequency corresponding to bandwidth at point $1/\sqrt{2}$ times the max amplitude of resonance frequency.[9]

Every chemical having distinct physical properties and structures can be impart fire resistant when used alone or in combination. Coir composites used in various application such as railway coaches, there is risk of fire in railway coaches could be fatal and strategy of fire control using construction materials motivates the use of fire retardant chemicals in composite by process or treatment for interior decoration /furnishing. Following are the types of fire retardants: 1) phosphorus based fire retardants, 2) Nitrogen based fire retardants, 3) halogen based fire retardants 4) inorganic based fire retardants. Methods of applying fire retardant treatment: 1) pressure impregnation process- full cell and empty cell processes, 2) Non pressure processes-soaking/cold soaking, brushing/spraying, hot and cold bath, diffusion processes (simple and double diffusion). [10]

1.4 Applications:

1) Coir wood for Panel Door Shutters.

2) Coir Composites in Packaging.

3) Bedroom furniture using Coir board.

4) Kitchen cabinet & drawing room furniture using coir wood.

5) Building and construction industry: panels for partition and false ceiling, partition boards, wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in times of natural calamities such as floods, cyclones, earthquakes, etc.

6) Storage devices: post-boxes, grain storage silos, bio-gas containers, etc.

7) Transportation: automobile and railway coach interior, boat, etc.

8) Electric devices: electrical appliances

2. DESIGN:

2.1 Material specification:

C-45

Properties of steel C-45 (carbon-0.45%, Mn-0.60-0.90%)

Weldability because of the medium-high carbon contain it can be welded with some precaution.

Hardenability- It has low hardenability in water or oil, fit for surface hardening that provides this steel grade a high hardness of the harden shell.

It is easily available in market.

It has sensible machinability.

Cheapest in all other material.

2.2 Chemicals used:

a) Epoxy resins –Epoxy resins are characterized by the presence of more than one1, 2- epoxide groups per molecule. Crosslinking is achieved by introducing curatives that react with epoxy and hydroxyl groups located on adjacent chains.

Advantages

Low Densities. Good Corrosion Resistance, Low Thermal Conductivities, Low Electrical Conductivities,

Aesthetic Color Effects

Limitations-

Low transverse Strength.

Low Operational Temperature Limits

b) Cobalt-{cobalt\metallic element\metal} is a chemical element with a symbol Co and atomic no 27.

Density-8.86 g/cm3

Melting point -1768 0K

Boiling point-3200 Kelvin

c) Araldite:- it is referring to their range of engineering and structural epoxy, acrylic, and polyurethane adhesive. Araldite adhesive sets by the interaction of a resin with a hardener. Heat isn't necessary although warming will reduce the curing time and improve the strength of the bond. After curing, the joint is claimed to be impervious to boiling water and all common organic solvents. It is available in many various forms of packs, the most common containing 2 completely different tubes, one each for the resin and the hardener.

D) Silica Gel;-Silica gel is an amorphous form of silicon dioxide (silica), consisting of an irregular tridimentional framework of alternative silicon and oxygen atoms with nanometer scale voids and pores. The voids could contain water or another liquids, or may be filled by gas or vacuum. In the latter case, the material

2.3 components:

a) Linear Actuator-The basic working principle of electric linear actuators is to convert the rotary motion into a linear motion. This conversion of motion is done with the assistance of a gearbox and a lead screw

b) Battery:- A battery is a source of energy that provides a push - a voltage - of energy to get the current flowing in a circuit. A bulb uses the electrical energy provided by the battery, but doesn't use current.

c) Die :- A die is a specialized tool to cut producing industries to cut or shape material mostly using a press like molds, dies are typically customized to the item they are used to produce. Products created with dies range from simple paper clips to complicated items used in advanced technology.

d) Press plate:- a press plate is employed to use load at equal pressure on coir sheet inside the die

e) Main body:-All accessories ar mounted on body

2.4 design Calculations:

Material selection c-45 (mild steel)

Take fos = 3

Syt =340 N/mm2 .(psg 1.12)

$\sigma t = \sigma b = 340/fos = 113.33$ N/mm2

$\tau = 0.5\ \sigma t$

$= 0.5 \times 113.3$

$= 56.65$ N/mm2

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

Square pipe of 30x30 section is employed as a column, is used check for its bending load.

Let the most load applied by linear actuator be 68 kilogram

So load on column is = 68 kilogram = 680N

W = 680 N

M = W L / 4 = 680 X 335/ 4 =56950 N/mm ....(psg 5.65)

Z = B3 – b3 / 6 = 303 - 263 / 6 = 1570.6 mm3

σ b = M / Z

σ b = 56950 / 1570.6 = 36.25 N/mm2

σ b induced < σ b ALLOWED

36.25 N/mm2 < 114 N/mm2

Hence design is safe.

Design of bolt:- shearing

Bolt is to be fastened tightly also it should fail under shearing load when we rotate the arm. Std nominal diameter of bolt is 5.8 mm. From table in design data book (psg 5.42) diameter corresponding to M 6 bolt is 5.35 mm

Let us check the strength:-

For M6 Bolt

dc= 5.35 mm

D = 6 mm

P = 1 mm

$\tau = 58$ N/mm2

Also,

$P = \pi /4 dc^{2x} \tau$

$$58 = \frac{P}{\text{----------}}$$

3.14/4 x (5.35)^2

P= 1304 N = 130.4 kg

The single M6 bolt will sustain can.4 kilogram load under shearing and which is far more than 68kg, thus bolt is safe.

Design of transverse fillet welded joint.

Hence, choosing weld size = 3 mm .. Psg 11.4

area of Weld = 0.707 x Weld Size x L

= 0.707 x 3x 18

= 38.178 mm2

Force Exertred = 68kg

= 680 N

Stress induced = Force Exerted / area of Weld

= 680 / 38.178

= 17. 8 N/mm2

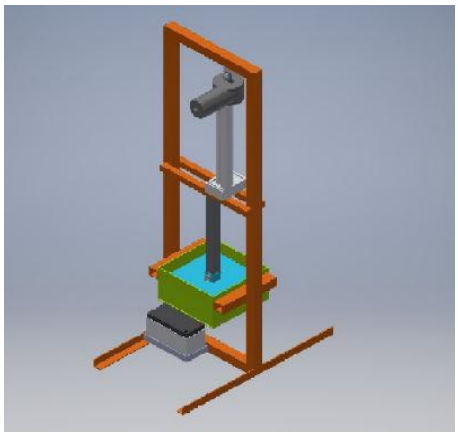
For filler weld :

maximum Allowable Stress for Welded Joints = 210 Kgf/ cm2 . Psg 11.4

= 21 N/mm2

hence design is safe.

2.5 Design model:



ACTUAL MODEL

3. RESULTS AND DISCUSSION

For substitute or alternative of wood, analysis have begun to focus on natural fiber composites that which composed of natural or synthetic resins and reinforced with natural fibre. natural fibre composites used in several applications like construction and furniture sector. Coir fiber composites having different properties than of coir. The natural fibers are extensively used in Various kind of application e.g. furniture, packaging etc [6].Chary investigated regarding analysis of natural frequencies and damping ratio of composite which is consist of dried coconut shell particles of sizes 0.25mm,0.5mm, 1mm and 2mm as reinforcement material and epoxy resin LY556 and hardener HY951 in the quantitative relation of 10:1 as matrix and also 5-hitter melamine added for higher surface finishing. The composite fabricated in several volume fraction of 400th, 50%, hr using different particle sizes of 0.25,0.5, 1, 2mm by open mold process and the densities of those composites are 933, 884 and 842 kg/m3 to respective particle volume fraction. [9]

While making of coir board there is major roles of chemicals used. Chemicals suitable for medium density composites. Medium density coir boards are usually panel boards created from coir and jute fibers combined with binding materials like phenol formaldehyde are processed to a specific gravity 0.5 t0 0.9 using press by applying heat and pressure for definite period[10].There are so many small and large machines available for extraction of husk from coconut. The machine works on gear mechanism having two barrels rotate in opposite direction for removing fiber from coconut husk[7].Coir fiber shows different mechanical properties to the various length 5mm, 10mm, 15mm as reinforcement with epoxy resin as polymer matrix. The composite made which is tested on UTM (Universal Testing Machine) [14].Moisture is also main factor which plays major role in coir fiber.K. N. Bharath investigated adhesive tensile and moisture absorption characteristics of natural fiber areca (areca husk) and maize powder reinforced urea

formaldehyde composites. Adhesive tensile test of specimen (composite board) is carried out on Hounsfield universal testing machine. UF400 (400gm formaldehyde) composite having 0.1476 Mpa tensile strength. Conclusion made is fabricated composite absorbs 6-7% moisture of its weight whereas the particle board absorbs more than 400th of moisture.[13].The correct quantity of chemicals and adhesives is necessary to get better mechanical and physical properties. S. K. Pradhan studied on the composites about to improves the properties like mechanical, physical by the using correct quantity of ultrahigh molecular weight polythene (UHMWPE) powder and coconut shell powder(CSP).The composite material remains tough when the CSP content was 20-30 volume unit. Compressive strength decreases when the composite contains below 20 the volume of CSP.[2]

Organic fibre is available in many types. R. Udhaysankar did the detail study about the classification of organic as well as inorganic fibers. The organic fiber extracted from grass, seeds, leaf, fruits and from animals also(hair and wool).The detail knowledge of composition of natural fibre is given in these paper. He studied the mechanical properties fibers and therefore the applications of that fiber in various fields.[1]

4. CONCLUSIONS

From this review we tend to ended that Coconut shell waste is used as various alternative reinforcement. It can be reused as natural material. the product made of coir board making machine having good mechanical, thermal, physical properties and which is available in economic cost. coir board having large no of applications like kitchen cabinet & drawing room furniture using coir wood. Building and construction industry, panels for partition and false ceiling, partition boards, wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in times of natural calamities like floods, cyclones, earthquakes, etc. Storage devices: post-boxes, grain storage silos, bio-gas containers etc. Transportation: automobile and railway coach interior, boat, etc. electrical devices: electrical appliances etc.

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