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Coconut fiber reinforced polymer composite for partition wall

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ABSTRACT

The increase in consumption of coconut usage every year leads to the production of the fiber of it, presently a very less quantity of coconut husk is used in domestic application mainly as a fuel and remaining as waste which is directly proportional to the quantity of coconut cultivated. The main thrust of present research work is to explore the possibility of utilizing coconut husk fibers as reinforcement for composites with the appropriate matrix material. The fiber reinforced plastic composites made of areca fibers extracted from areca were prepared with used plastics. The composite material prepared with different proportion of reinforcement and matrix material. The required dimensions of the die were prepared using mild steel. The matrix material is placed layer by layer with reinforcement in the die. The die is designed to heat the material to its semi-liquid state with the help of heater at the bottom of the die. The material is compacted by an applying a force 500 kgf and soaked in a die for 2 hours at 115 ℃. Then the composite is allowed to cool to room temperature. The resulted composite is cut into required dimensions to carry out mechanical properties of it; they are Tensile strength, bending strength, and compression strength and impact tests. The results of the mechanical properties of composites are quite competitive with existing plywood planks. The composite is also tested for threading operation by tapping and it shows tapping is obtained successfully in the composites.

Keywords— *Composite, Coconut husk, Polyethylene, Plywood plank.*

1. INTRODUCTION

The coir fibers use as reinforcement in polymer-matrix composites and it is an abundant, versatile, renewable, cheap and biodegradable lingo-cellulosic fiber used for making a wide variety of products. Furthermore, it represents an additional agro-industrial non-food feedstock (agro-industrial and food industry waste) that should be considered as feed stack for the formulation of echo compatible composite material. Coconut coir is the most interesting products as it has the lowest thermal conductivity and bulk density. The addition of coconut coir reduced the thermal conductivity of the composite specimens and yielded the lightweight product. Development of composite material for buildings using natural fibre as coconut coir with low thermal conductivity is an interesting alternative which would solve environment and energy concern.

Polyethene or name polyurethane is the common plastic. The annual production is approximately 80 million metric tons. Its primary use is in packaging (plastic bag, plastic films, geomembranes, containers including bottles etc.). Many kinds of polyethene are known, with most having the chemical formula $(C2H4)_n$ H2. Polyethene is a thermoplastic polymer consisting of the long hydrocarbon chain. Depending on the crystallinity and molecular weight, a melting point and glass transition may or may not be observable. The temperature at which these occur varies strongly with the type of polyethylene. For common commercial grades of medium-and high-density polyethylene. The melting point is typically in the range 120 to 130 degree Celsius (248 to 266 degree F). The melting point for average, commercial, low-density polyethene is typically 105-115 DC (221-239 DF).

2. LITERATURE SURVEY

The reinforced composites showed increased strength with increase in fiber content. This makes them good resources in the production of everyday materials such as ceilings, partition boards and automobile interiors. Such waste materials which are causing havoc to our environment, therefore, have the potential to be put to good use, and the negative effect on the environment avoided (George Amoako and Patrick Mensah-Amoah, 2018).

They can be easily moulded into varied shapes and as such, perfect for packaging food, drinks and virtually all products. Plastics used for food storage preserve freshness and flavor as a result of their ability to seal out contaminants. They are also useful over a wide range of temperature, being used in the storage of frozen foods and in microwavable packages. Plastics are also widely used due to their chemically inert nature (Callister Jr., 2007).

According to (Geethamma, Kalaprasad, Gabriel, and Sabu, 2005), several groups have successfully tested coir fiber polyester composites being used in the fabrication of helmet, roofing sheets and post boxes eer.ccsenet.org Energy and Environment Research Vol. 8, No. 1; 2018 2 while others have developed composite materials for building using natural fibers. The preparation of composite materials, which involves the combination of two or more conventional materials, have been the result of many engineering activities.

The quest to produce biodegradable and eco-friendly materials has brought about the inclusion of natural reinforcement materials into the many composites being produced (George, Sreekala, & Thomas, 2001). The use of composites has several applications which include the manufacturing of aircraft parts, sporting equipment, marine equipment, in the construction industry and transportation industry (Mohammed, Ansari, Pua, Jawaid, and Islam, 2015).

This work seeks to report on the possibility of producing a polymer reinforced composite from polyethene (polymer) and a natural fiber (reinforcement). Specifically, this involves used polythene covers and milk packets and coconut fibers. In India, these are both wastes, and therefore pose a lot of problems when it comes to their disposal. Plastic covers like milk cover, for instance, can be found littered virtually in every corner of our environment, while the accumulation of coconut husks principally along our water area has turned into fertile breeding spots for mosquitoes. The useful application of these wastes is the motivation behind this work.

3. MATERIALS AND EXPERIMENTAL SETUP

In the present research, the matrix material is polyethene (used polyethene covers and milk packets) and reinforcement material (Coconut fiber). After preparation of composite material different test is performed on specimens and mechanical properties are obtained.

3.1 Raw materials

Fig. 1: **Polyethylene and coconut fiber**

3.2 Composition

- Coconut fiber : 280gms
- Polyethylene(matrix) : 190gms
- Temperature : 89 degree centigrade
- The 500kg load is applied by UTM on the press which in turn presses the material in the fabricated mould.

3.3 Experimental setup

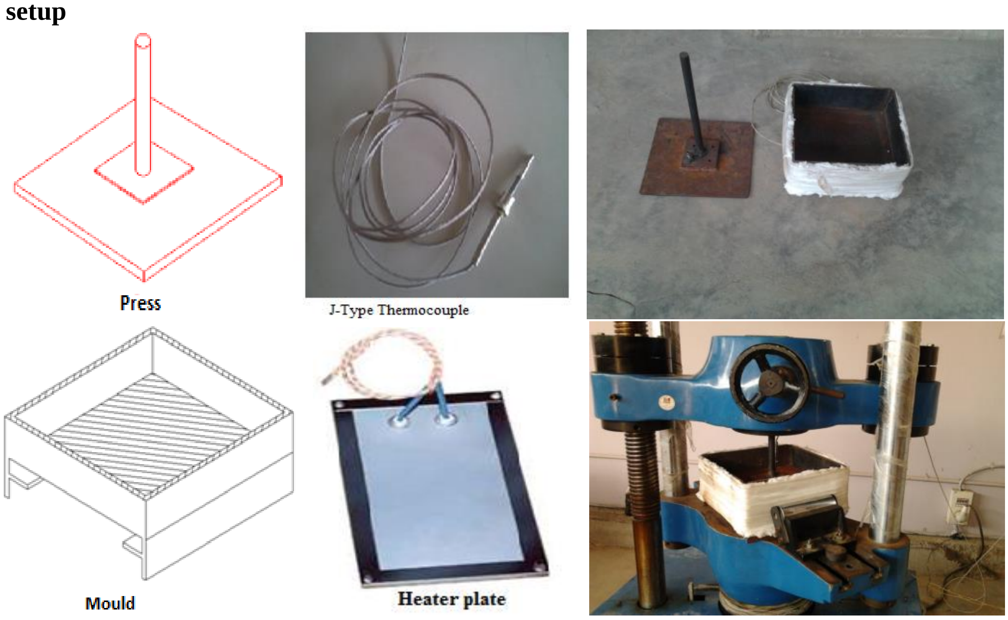

Fig. 2: **Experimental setup**

Mild steel is used as the material and thickness from 6mm to 15mm for the fabrication of the furnace. The Heater plate is made up of nichrome wire, mica insulated with stainless steel plated cover. Heater plate is of 750W capacity and can heat up to 150 degree Celsius of heating value. The size of the plate is 285*280*10 mm. J type thermocouples are attached to fixture at four faces to monitor the heating of the fixture during the preparation of composite material.

3.4 Composite material

The composite material is manufactured using the fixture and heater plates which are fabricated. The heater plate is placed in the fixture such a way that heat loss is minimal. Before placing the matrix material in the fixture the aluminum foil is provided and above the aluminum foil, the matrix material is laid one layer. Above that matrix material, the coconut fibers are spread evenly. Then layers of areca fibers to hold the fibers in arranged place in a proper manner. Similar way alternate layers of matrix and reinforcement are arranged as per. A single layer aluminum foil is used in the bottom and the top layer of the composite to avoid sticking of material to fixture. After arranging the entire required composite in the furnace is covered with a top cover and loading using crossbar of the UTM. A load of range 400kg to 600kg is applied from beginning to end of heating the furnace.

Fig. 3: **Final product-composite**

4. MECHANICAL TESTS

- **Impact Test:** Test specimen fabricated according to the standard and determine the impact energy of composite material and plywood with the help of Charpy Impact Instrument.

- **Tensile test:** Test samples are manufactured according to the standard and the universal testing machine, Model: UTES (SERVO) used to measure the maximum tensile stress & Young's modulus of the material at elastic points and compared with plywood values.

- **Bending test:** Test samples are prepared according to the standard and determine the behaviour of the composite material under bending and the modulus of elasticity. (4) Compression test: Test specimens are prepared according to standard and measure its values. Mechanical tests are conducted on plywood and comparison has done with composite material values are tabulated in the tabular column.

5. RESULTS AND DISCUSSION

5.1 Tensile test

Table 1: Tensile strength for composite material

Load F (N)	Deflection ΔL(MM)	Stress σ = F/A1 N/mm2	Strain e = ΔL/L1	Young's modulus, E = σ/e N/mm2
2160	0.01	24.742	0.000087	284390.8
6600	1.43	75.601	0.0125	6048.08
8850	1.5	101.374	0.0131	7738.47
13290	1.56	152.233	0.0136	11193.6
13380	1.66	153.264	0.0145	10569.93
13440	1.86	153.951	0.0162	9503.14
13320	2	152.577	0.0174	8768.79
13050	**4**	**149.484**	**0.0349**	**4283.20**(Crack)
13080	5	149.828	0.0437	3428.55
13050	**5.5**	**149.484**	**0.0481**	**3107.77**(Break)

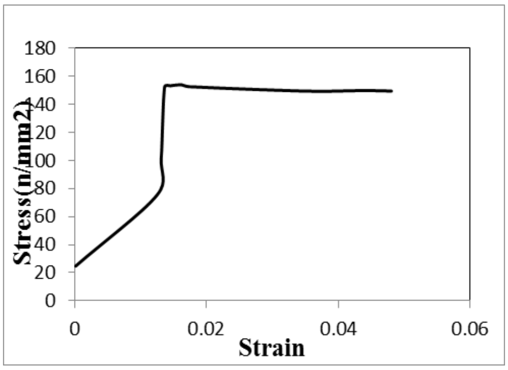

Fig. 4: Stress- strain curve for composite material

Table 2: Tensile strength for the plywood

Load F (N)	Deflection ΔL(MM)	Stress σ = F/A1 N/mm2	Strain e = ΔL/L1	Young's modulus , E = σ/e N/mm2
7890	0.01	90.378	0.000087	1291114.20
9090	4	104.12	0.0349	2983.38
9780	8	112.02	0.0699	1602.57
9930	**9**	**113.74**	**0.0787**	**1445.23**(Crack)
10050	10	115.12	0.0874	1317.16
8850	11	101.37	0.0962	1054.88
8880	13	101.71	0.1137	894.54
8910	14	102.06	0.1224	833.82
8910	**15**	**102.06**	**0.1312**	**777.89**(Break)

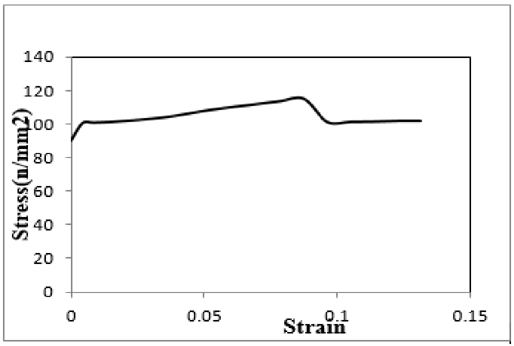

Fig. 5: Stress- strain curve for plywood

5.2 Flexural/Bending test

Table 3: Bending strength of the composite and plywood

For composite material			For plywood		
Load F (N)	Deflection ΔL(MM)	Young's modulus E=FL^3/48YI	Load F (N)	Deflection ΔL(MM)	Young's modulus E=FL^3/48YI
30	0.05	192001.2	8340	0.01	154444444
60	3.5	5485.74	8360	0.05	30962962.96
120	5.1	7529.45	8370	0.2	7750000
180	7.18	8022.33	8370	0.8	1937500
240	9.6	8000.05	8370	2	775000
300	10.2	9411.82	8400	3	518518.5
330	11.1	9513.57	8430	4	390277.77
390	13	9600.06	8460	6	261111.11
420	14.5	9269.02	8550	8	197916.66
450	**33**	**4363.66**	**8610**	**10**	**159444.44**
600	**53**	**3622.66**	**8550**	**11**	**143939.39**

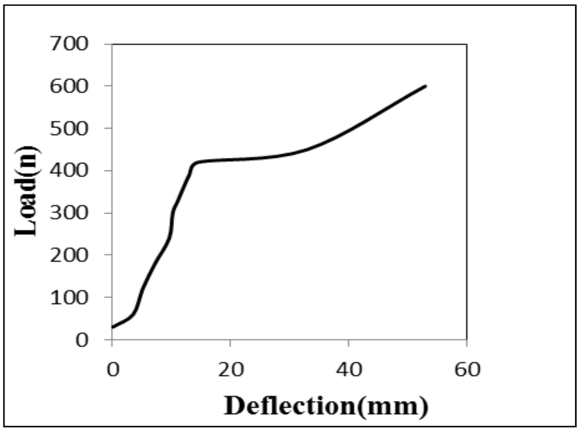

Fig. 6: stress-strain curve for composite

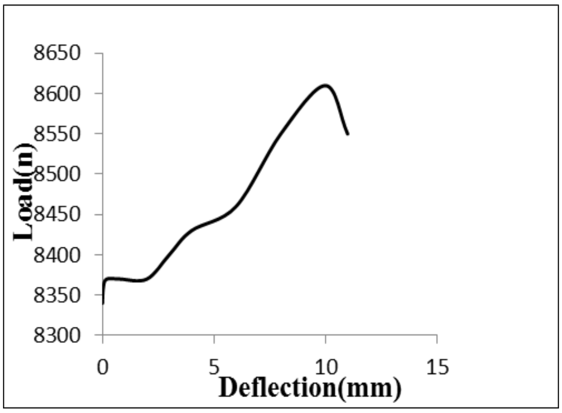

Fig. 7: stress-strain curve for plywood

5.3 Compression test

Table 4: Compression strength of the composite

Load F (N)	Deflection ΔL(MM)	Stress σ = F/A1 N/mm2	Strain e = ΔL/L1	Young's modulus E = σ/e N/mm2
5400	0.10	2.16	0.002	1080
6660	0.20	2.64	0.004	660
6720	0.30	2.68	0.006	446.66
7500	0.40	3.00	0.008	375
10750	0.50	4.30	0.010	430
12400	0.60	4.96	0.012	413.33
26000	1.00	10.40	0.02	520
41400	1.50	16.56	0.03	552
56600	2.00	22.64	0.04	566
58900	2.10	23.56	0.042	560.95
62000	2.50	24.80	0.05	496

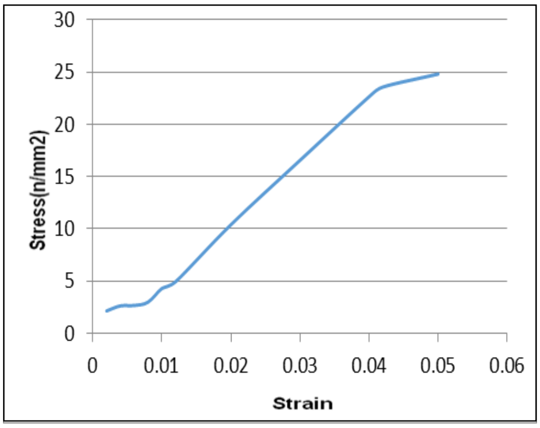

Fig. 8: **Stress-strain curve for the composite**

Table 5: Compression strength of the composite

Load F (N)	Deflection ΔL(MM)	Stress σ = F/A1 N/mm2	Strain e = ΔL/L1	Young's modulus E = σ/e N/mm2
15180	0.01	6.072	0.0002	30360
16700	0.02	6.68	0.0004	16700
17280	0.06	6.912	0.0012	5760
18090	0.12	7.236	0.0024	3015
19320	0.25	7.728	0.005	1545.6
20850	0.50	8.34	0.001	8340
23220	0.80	9.288	0.016	580.5
26100	1.00	10.44	0.02	522
30660	1.40	12.264	0.028	438
39360	2.00	15.744	0.04	393.6
46140	2.40	18.456	0.048	384.5
55410	2.80	22.164	0.056	395.78
78800	3.30	31.52	0.066	477.57
98280	3.55	39.312	0.071	553.69

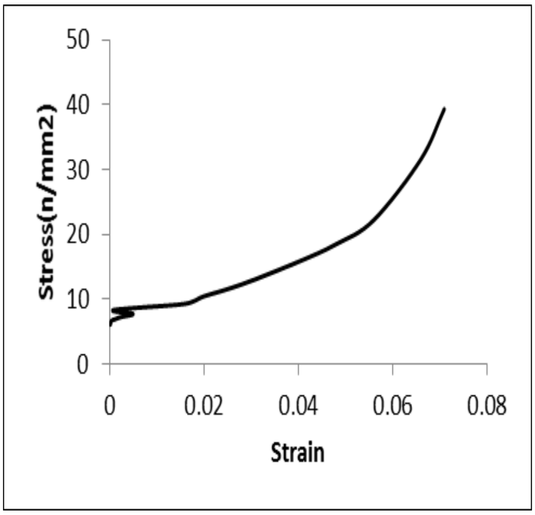

Fig. 9: Stress- strain curve for ply wood

5.4 Impact test

Table 6: Results of the Charpy test

Material	Width (b) in mm	The depth of notch (d) in mm	C/S area (b*a) in mm2	Fracture energy E1 in Joules	Fracture energy E2 in Joules	Impact energy U=E2-E1	Impact strength U/A (J/mm2)
Composite material	26	6	126	0	30	30	0.23
Plywood	26	6	126	0	22	22	0.174

5.5 Discussion on results

Results are showing that load carrying capacity is more in these composites than ply wood. Bending and compression strength is higher than the ply wood and tensile strength is near to ply wood. The composite material developed seems to be more flexible when compared to plywood. Repeatability trails need to be carried out for further confirmation of the performance of the composite material.

6. CONCLUSION

A polymer jute composite material has been successfully developed using coconut husk and polyethylene. All The mechanical test such as tensile, flexural, compression and impact test are carried out on the prepared composite. Results of mechanical tests are compared with plywood. The composite is economical and alternative to plywood. This composite material is water proof.

The present trial on the composite has been done in semi liquid state. Hence there is a scope for carrying out further work by liquid metallurgy methodology. By varying the quality and volume fraction of jute fiber, it is possible to develop a composite with properties superior to plywood. However, there is to be supported by conducting extensive trails, followed by characterization applications in various fields.

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