A Study based on combination of Coconut leaf fibre (MCLF) and human hair hybrid sandwich composites

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***Abstract* - Nowadays, Environmental issues has become a big concern in 2021 due to rapid industrialization. It becomes a big deal for scientists and engineers to find new solutions for waste management, which do not hamper to the environmental health, it brings three main objectives to deal waste management that is Reduce, Reuse and Recycle. This approach brings revolutionary development in eco-friendly composites for various applications mainly in automotive, marine, chemical, infrastructure, sporting goods etc. Almost there are various types of fibres kenaf, jute, oil palm, cotton, banana, hemp and sisal, coconut coir, coconut midrib. Among them, human hair and coconut leaves are most easily available and cheap fibres. On the whole much amount of human hair and coconut leaf is produced by India as a waste product. Due to present of cortex keratin the hair has elastic property. Whereas coconut midrib fibres is ductile and ability to carry 2-3 times more stress than other fibres So the proper approach should be utilize this waste as resources or raw material. Composites are very common and light weighted materials and so its applicable everywhere with different reinforce materials. Hence, the objective of this research is to make a review on mechanical properties of coconut leaf midrib-human hairs fibre reinforced polymer composites.**

***Index Terms* - Coconut leaf midrib fibre, human hair, fibre reinforced concrete, advanced fibres, natural fibre.**

I.INTRODUCTION

Composite material can be defined as the material which is compose of two or more distinct material on small scale with different properties to form a new product with a property that is entirely different from individual. The primary phase of composite material is called a matrix having a continuous character. In other words, matrix is a material which acts as a binder and holds the fibre in desired position there by transferring the external load to reinforcement. This matrix can be considered less hard and more ductile NFPCs (Natural Fibre Reinforced Polymer composites. provide a wide range of advantages over synthetic fibre best composites. This advantage includes high strength to weight ratio, high strength to elevated temperature, high creep resistance, high toughness also light weight, high durability design flexibility. So, this paper provides overview of natural Coconut midrib fibre and Human Hair fibre reinforced polymers.

A. Human Hair

Hair is an important part of our body, not only possesses aesthetic significance in our culture, but also offers. Hair fibres have a typical hierarchical structure similar to other α-keratin materials. Keratinous materials are differentiate as α-keratin if they exhibit a helical secondary structure or as β-keratin if they are in the shape of sheets. These cortical cells are composed of subcomponents called macrofibrils. they are composed of intermediate filaments (IF) embedded in a matrix with high-sulphide content. One IF has a diameter of ~7.5 nm and is formed by eight protofilaments. Every protofilament is contain on its turn of four right-handed α-helix chains; therefore, a total of thirty-two chains forms an IF. Hair fibres have 65–95 wt% of proteins depending on the humidity and up to 32% of water, some lipid pigments and remaining components. Therefore, chemically the properties of human hair are influence by the α-keratin. It has been demonstrated that the tensile properties of hair are mostly produced by the cortex, not the cuticle. It was also demonstrated that the tensile properties are mostly dependent on influences of other factors, a high relative humidity decreases the Young's modulus and increases the percentage of elongation.

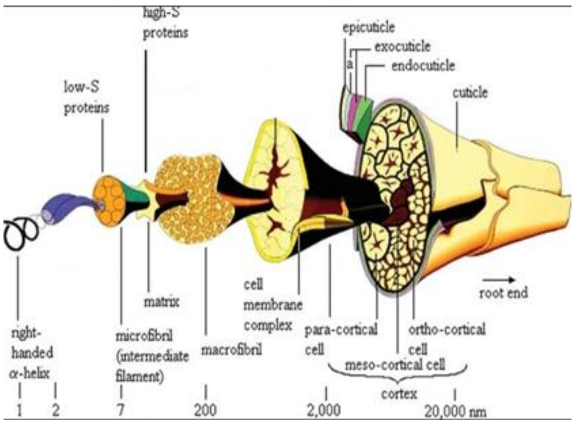

Fig 1. Detailed representation of hierarchical structure in human hair starting α-helix chains and progressing to the entire section.

B. Coconut Leaf Fibres (MCLF)

The Coconut midrib fiber is extracted from the leaf stalk (rachis) of the coconut leaf. The midrib of coconut leaf (MCL) is larger, center, a main vein which support the leaf and facing the sun. In India coconut palm are grown on the entire coastal belt. Major shares go to kerala, Kernataka and Tamil Nadu followed by Goa, Maharashtra, Andra Pradesh and Orissa. Coconut palm leaf midrib content 30% of cellulose and 16 % lignin which use for reinforcement of the different structural parts where moderate strength is required like door, panel, roof, sheets, packaging etc. The extraction of fiber done by soaking of Coconut leaves in water about 3 days, which loosen and are separated from the leaf by using metal wise brush and fibers are dried in room temperature, these fibres are known as untreated fibres. these fibres we are using for reinforcement of composite materials.

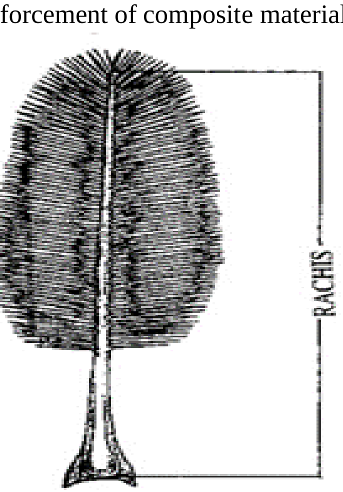

Fig.2.1 Coconut leaf midrib (rachis)

Fig 2.2 Coconut fibre obtain from midrib(rachis)

TABLE 1

Chemical composition of coconut leaf midrib fibre

Cellulose (%)	Lignin (%)	Cellulose lignin ratio	Nitrogen (%)	Phenol (%)	Moisture content(%)
31.73	25.08	1.31	0.31	2.84	10-15

TABLE 2

Comparative Mechanical properties of coconut leaf fibre with other natural fibres.

properties	Coconut Midrib fibres	Vakka	Harakeke	Oil palm	Jute	Sisal	Bamboo
Density (g/cm^3)	1.3	0.00081	1.3	0.7-1.55	1.3-1.46	1.33-1.5	0.6-1.1
Elongation (%)	2	3.46	4.2-5.8	25	1.5-1.8	2.0-14	-
Tensile strength (Mpa)	177.5	549	440-990	248	393-800	400-700	140-800

TABLE 3

Comparative Mechanical properties of pure thermoset composite and respective midrib coconut leaf fibres reinforced composites.

Properties	Epoxy	MCL FIBRES/EPOXY	POLYESTER	MCL Fibres/POLYESTER
Tensile Strength(MPa)	33.86	153.7	31.5	177.5
Tensile Modulus (GPa)	0.712	12.20	0.63	14.85
Flexural Strength (GPa)	118.75	136.8	55.08	316.04

Flexural Modulus (GPa)	5.67	8.56	1.535	23.54
Impact Strength (Kj/m^2)	5.67	3	--	8.23

C. Epoxy and polyester resins.

The epoxy resin (LY556) and hardener (HY951) is taken in the propertion of 10:1 (i.e.100ml for 1 lit. of resin) for the bounding of the composite material, And polyester resin and hardener was taken in propertion of 100:3 (i.e. 30ml for 1 lit. of resin).

II. METHODOLOGY

A. FOR WATER TREATMENT:

We took both the natural fibres approximately 250gm of Hair and MCL FIBRES immersed into the distilled water for 24 hours in about 5 liters of tub in measured quantity. After 24 hours taking both the fibres out and then putting for drying naturally in the Sun so that all the moisture content present in it should be completely removed or evaporated.

Fig.3: human hair in water

Fig. 4: MCL fibres in water

fig.5: human hair with 10% NaOH

Fig.6: MCL fibres with 10% of NaOH

B. FOR NaOH TREATMENT

Same for NaOH treatment, taking 5 liters of water and adding 50gm of NaOH in it in measured quantity. Then dipping both fibres in different tubs and keeping for 24 hours. After 24hrs taking both fibres outside of tub and for washing these fibres with distilled water 3-5 times with the Acetic Acid (CH3 COOH) to neutralize the NaOH content present in Coconut fibres and human hair. we used phenolphthalein indicator to get NaOH content free fibers. now washing it with fresh water and putting it for drying naturally till its moisture gets evaporated.

III. PROCEDURE

After human hair and Coconut fibre get treated with water and NaOH Coconut fibres are cut in 175mm and human hair are cut randomly in very fine length about

10mm. then Coconut fibre and human hair are arranged in 180mm ×180mm cavity alternately. Firstly, we arranged Coconut fibre and after that human hair layer. We arranged alternate 5 layers (I.e. 2 layers of human hair and 3 layers of MCL FIBRES) of it and after every layer we use resin as a binder. succeeding layers are sequenced in cavity then we apply pressure on it by using C-clamp and after 24hrs we remove the pressure from the cavity and we get the 50mm thick layer of composite material. at last, we cut the strips by using grinding machine.

Fig 7: Final products cutted into strips

IV. RESULT AND DISCUSSION

A. Tensile Test

The tensile strength of the composite material is calculated by using universal testing machine. The dimension of strip material 170mm×25mm×5mm. After testing the material average value is observed.

B. Flexural Test

The flexural strength of the composite product were calculated by using universal testing machine.

Table 4: With Epoxy resin

Serial No	Sample identification	Ultimate tensile strength(N/mm^2)	Flexural Load (Kg)
1	A1	15.44	45.1
2	B1	12.69	35.5
3	C1	16.79	30.2
4	D1	28.99	58.3
5	E1	18.00	13.9
6	F1	19.84	36.8

Where,
A1 - Parallel matrix with NaOH.
B1 - Perpendicular matrix with NaOH.
C1 - Inclined matrix with NaOH.
D1 - Parallel matrix with water.
E1 - Perpendicular matrix with water.
F1 - Inclined matrix with water.

Table 5: With Polyester Resins

Sr. No.	Sample Identification	Identification Ultimate Tensile strength(N/mm2)	Flexural load (Kg)
1	A2	15.57	69.6
2	B2	11.22	41.9
3	C2	24.95	30.2
4	D2	24.77	61.7
5	E2	21.29	38.5
6	F2	14.69	33.5

Where,
A2 - Parallel matrix with NaOH, B2 - Perpendicular matrix with NaOH, C2 - Inclined matrix with NaOH, D2 - Parallel matrix with water, E2- Perpendicular matrix with water, F2 - Inclined matrix with water,

C. Water Absorption Test

In this test the strips of materials are soaked into the distilled water for the duration of 24 hrs. and water absorption capacity observed by formula % of water absorption= [(W2-W1/W1)] ×100

Table 6: With Epoxy resin

Sr. No.	Sample Identification	Weight before dipped into water (W1 in gm)	Weight after 24 hrs (W2 in gm)	Water absorption capacity (%)
1	A1	44	45	2.272
2	B1	38	39	2.631
3	C1	32	33	3.125
4	D1	33	34	3.030
5	E1	31	32	3.225
6	F1	34	35	2.941

Where,
A1 - Parallel matrix with NaOH, B1 - Perpendicular matrix with NaOH, C1 - Inclined matrix with NaOH, D1 - Parallel matrix with water, E1 - Perpendicular matrix with water, F1 - Inclined matrix with water.

Table 7: with polyester resin

Sr no	Sample identification	Weight before dipped into water (W1) in gram	Weight after 24 hours (W2) in gm	Water absoption capacity %

1	A2	33	33	0
2	B2	35	35	0
3	C2	33	34	3.030
4	D2	32	32	0
5	E2	34	34	0
6	F2	34	34	0

Where,
A2 - Parallel matrix with NaOH, B2 - Perpendicular matrix with NaOH, C2 - Inclined matrix with NaOH, D2 - Parallel matrix with water, E2- Perpendicular matrix with water, F2 - Inclined matrix with water.

V. CONCLUSION

- Mechanical properties such as flexural as well as tensile are found to be increasing with different structure of sandwich structure pattern.
- The Polyester resin (NaOH) average value for tensile and flexural test is 18.69 N/mm2 and 45.9 Kg which is comparatively greater than Epoxy resin (NaOH) samples i.e. 18.62 N/mm2 and 36.63 Kg.
- Water absorption capacity of Polyester resine is lower than that of Epoxy resins.
- Natural fibres composites have good mechanical properties, and they are slowly substituting synthetic fibres and are helping to decrease the environmental impact caused by synthetic fibres.
- Mechanical properties can be achieved by using treated fibres and correct method of fabrication.

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