

## EXPERIMENTAL INVESTIGATION BIO REINFORCED MATERIALS AND ITS MECHANICAL PROPERTIES

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### 1. Abstract

In the present study, the effect of stacking sequence on mechanical, physical, and biodegradability properties of treated coconut leaf sheath fabric with vinyl ester resin hybrid composites were studied. The hybrid composite laminates were fabricated by using hand lay-up technique. The specimen preparation and testing were conducted as per ASTM standards. Obtained results indicated that the incorporation of coconut leaf sheath with the same coconut leaf sheath of hybrid composites has greater effect on tensile and hardness properties. Coconut leaf sheath fibers treated with NaOH solution shows significant improvement for adhesion between fiber and matrix. Water absorption plots for different periods of immersion indicated that coconut leaf sheath with hybrid composites offer better resistance to water absorption than pure natural fiber reinforced composites. Thickness swelling of the hybrid composites increases due to increase in the percentage of water absorption of the composites. From SEM analysis of the tensile fractured surface of hybrid composites, it is found that the failure of composite is due to poor interfacial bonding between fiber and matrix. An overall comparison of all the laminates revealed that the hybrid laminates of coconut leaf sheath with extreme fibers plies as skin layer is the optimum combination with a good balance between the properties. So they may be suited in manufacturing of doors, roofs, windows and other oriented materials.

### 2. Introduction

The major constituent of the matrix is reinforcing fiber and epoxy. The matrix acts as binder. The other constituents are fillers, coatings and coupling agents. Fillers are used to enhance the dimensional stability and the fillers are the low-cost material. The coatings and coupling agents are employed to the fibers for better binding of the fibers to the matrix.

Natural fibers reinforced composites have a good physical and mechanical characteristic as a replacement for wood-based material in various applications. Composites, because of their ability to combine good properties from different materials to attain the desired physical and mechanical characteristics such as low- weight, reasonable strength-to- weight ratio and high stiffness properties have been main reason for replacing the commonly used materials like woods and metals. Hence there is an increased number research works made by scientists aimed at natural composite reinforced with jute, banana, coconut shell, cotton, silk etc.

Fabricating of the composite material is done by fibers in the form of layer called as 'lamina' or

‘ply’. The combinations of the number of laminas are used to form a thick layer called as ‘laminate’. The thickness of the lamina is of the range from 0.1 to 1 mm. The orientation or configuration of the glass fiber may be unidirectional, bidirectional or multidirectional. The unidirectional may be continuous or discontinuous fibers (random fibers). Sometimes to form hybrid laminate, the several types of laminate can be incorporated. The hybrid laminate is of two types namely interply hybrid laminate and intraply hybrid laminate. The interply laminate consists of different types of laminas with different varieties of fibers. The intraply laminate consists of two or more fibers are arranged with interspace to form laminates.

Sometimes the laminates can be made using thin sheets such as aluminum or other metal sheets. These laminates are called as ‘fiber metal laminates’. The commercially available aluminum composite are arall and glare. The arall consists of aluminum sheet with aramid fiber/epoxy composites, whereas glare consists of aluminum sheet with S-glass fiber/epoxy composites.

### **3.Literature review**

**Sheleme Mosisa, Temesgen Batu** (2021) the hybrid bamboo/ sisal fiber reinforced epoxy matrix composite material has significantly good mechanical strength, along with the inherent importance being cost-effectiveness, low specific to weight ratio.

**Owonubi J. Shesan, Agwuncha C. Stephen, Anusionwu G. Chioma, Revaprasadu Neerish** (2019). Improving the Mechanical Properties of Natural Fiber Composites for Structural and Biomedical Applications, Renewable and Sustainable Composites.

**Naveen Arasu A, Soundharya R,** (2020) addition of steel slag increases compressive strength of concrete. Addition of steel slag in the concrete mix significantly influenced the cracking behaviour and ultimate strength.

**Arao Y et. al.,** (2014) investigated the mechanical characteristics of green- composites based on polylactic acid (PLA) with jute fibers.

**P.T.R. and Biswas.S** (2014) studied the jute fiber reinforced epoxy composites filled with Al<sub>2</sub>O<sub>3</sub> particulate as fillers and observed that the incorporation of Al<sub>2</sub>O<sub>3</sub> content notably impacts the physical and mechanical characteristics of composites

**Alavudeen A et. al.,** (2015) studied the mechanical properties of banana fiber, kenaf fiber and their hybrid composites and concluded that the hybridization of kenaf with banana fibers increases the mechanical strength of the composite. Chokchai et. al., (2015) incorporated bioactive glass in hydroxyapatite and observed that this addition increased the flexural strength and also increased the % crystallinity and relative density with no changes in hardness.

**Khan J A and Khan M A** (2015) studied the physico-mechanical properties of jute-reinforced polymer composites and the applications of jute composites in different areas. Abdellaoui H et. al., (2015) studied the manufacturing technique and mechanical properties of natural jute fibers reinforced with epoxy resin and observed that the use of different staking orientation had changed the anisotropic behaviour of the composites.

**Udhayasankar R et. al.,** (2015), evaluated the manufacturing processes, methodology. Mechanical properties, thermal analysis and development of coconut shell fibers reinforced

polymer.

**Aymerich F. and Francesconi L.** (2014) examined the structural characteristics of stitching on carbon/epoxy [02/902]s laminates subjected to impact at low velocity and concluded that stitches improved the impact damage resistance. **Gopinath A et. al.**, (2014) experimentally investigated the jute fiber reinforced composites with polyester and epoxy resin matrices and concluded that the jute reinforced epoxy composite exhibited excellent mechanical properties than jute- polyester composite.

**Berhanu T et. al.**, (2014) investigated the effect of the weight percentage of the Jute fiber reinforcement on the mechanical behaviour of the Jute fiber- polypropylene reinforced composites and concluded that the incorporation of the Jute fiber reinforcement relatively enhanced the composite properties. **Pujari S et. al.**, (2014) studied and investigated the uses & applications of jute and banana fiber composites.

#### **4. Material Properties**

##### **a) Matrix Material**

Vinyl Ester Resin (VBR-4508), Catalyst (MEKP), Cobalt Octoate 6%, Promotor-VBR. This is a type of polyester resin. Polyester resin is also known as a thermosetting plastic, which implies the plastic sets at high temperatures as opposed to thermoplastics which can be formed at high temperatures. Polyester resin can attach things to itself by creating a strong bond. Polyester resins are the most economical and widely used resin in major industries. Their advantages include low viscosity, low cost, and fast cure time. In addition, polyester resins have long been considered least toxic.

##### **b) Fibre Material**

In the present work, Coconut Sheath (CS) is used for studying the effect of hybridization along with coconut sheath fibre.

**Table 1. Chemical properties of fibre**

Cellulose content (Wt %)	68.36
Lignin content (Wt %)	20.63
Wax content (Wt %)	0.4062
Moisture content (Wt %)	8.79

##### **c) Fine Aggregate**

Ordinary Portland Cement (53 grade) conforming to IS: 12269 -1987 and specific gravity of cement was determined as 3.15 was used for casting all the specimens. Fineness of cement test was conducted by sieve analysis (using 90 μ sieve), specific gravity using Le-chatlier's apparatus, initial setting time and final setting time using vicat apparatus.

**Table 2. Properties of cement**

Property of Cement	Values
Fineness Of Cement	8 %
Grade Of Cement	53
Specific Gravity	3.15
Initial Setting time	45 minutes
Final Setting Time	456 minutes

**d) Fine Aggregate**

Sand is naturally occurring material from rocks in the river banks. Different types of sand are used in construction but nothing can replace the properties of river sand. Sand passing through 2.36mm sieve size is used for casting the specimens.

**Table 3. Properties of Fine Aggregate**

Properties	Values
Specific Gravity	2.467
Fineness Modulus	2.22

**e) Coarse aggregate**

Aggregate passing 20mm sieve and retained in 12.5mm is considered as coarse aggregate which is mixed up with cement and sand and used in concrete.

**Table 4. Properties of Coarse Aggregate**

Properties	Values
Specific Gravity	2.792
Fineness Modulus	2.63

**f) Water**

Casting and curing of specimens were done with the potable water as per IS 456:2000.

**Table 5.pH Value Test**

WATER	pH VALUE
Sample 1	7
Sample 2	7
Sample 3	7

**5. Mixture Preparation for Cube Casting**

**Table 6. Mix Proportion (M25)**

<b>Coconut Sheath with Resin treated (%)</b>	<b>0</b>	<b>10</b>	<b>20</b>	<b>30</b>
Cement (kg/m <sup>3</sup> )	370	370	370	370
FA (kg/m <sup>3</sup> )	964.72	868.32	771.85	675.31
CA (kg/m <sup>3</sup> )	893.30	893.3	893.3	893.3
Water (kg/m <sup>3</sup> )	166.4	166.4	166.4	166.4
<b>Coconut Sheath with Resin treated (kg/m<sup>3</sup>)</b>	0	96.47	193.48	289.41

**6. Experimental methodology**

**i) Casting of Cubes**

Cubes were made using concrete mixture without Coconut Sheath with Resin treated and concrete mixture Containing Coconut Sheath with Resin treated as partial replacement of fine aggregate with various percentages ( 10%, 20% and 30%).



**Fig. 1. Casting of Concrete Cubes (M25)**

**ii) Curing of Concrete Cubes and Beams**

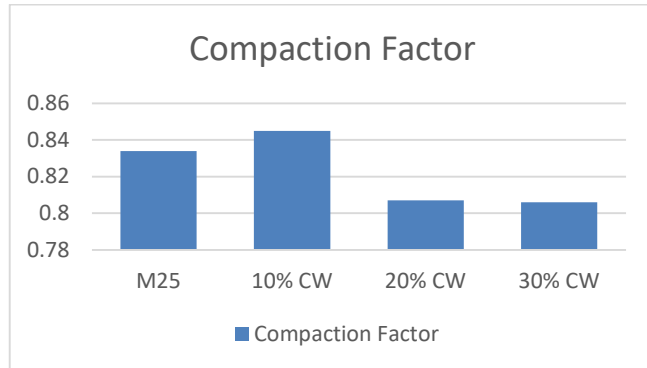
After casting, all the test specimens were stored at room temperature in the casting room. They were de-moulded after 24 hours, and were put into a water-curing tank for 28 days at room temperature.

**7. Test on concrete**

**Table 7. Compaction Factor Test**

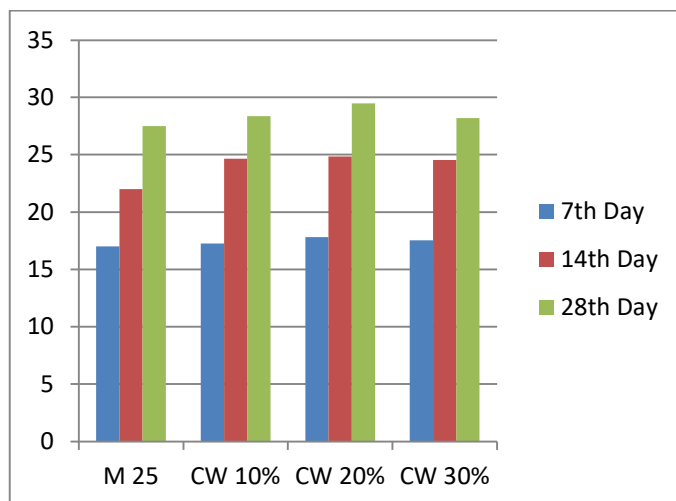
<b>Concrete Mix</b>	<b>Partially compacted concrete (kg)</b>	<b>Fully compacted concrete (kg)</b>	<b>Compaction factor</b>

M25	11.50	13.80	0.834
10% CSHT	12.82	15.16	0.845
20 % CSHT	12.87	15.93	0.807
30% CSHT	12.31	15.261	0.806



**Table 8. Compressive strength test (N/mm<sup>2</sup>)**

Concrete Mix	7 <sup>th</sup> Day	14 <sup>th</sup> Day	28 <sup>th</sup> Day
M25	17	22	27.5
10% CSHT	17.25	24.66	28.35
20 % CSHT	17.8	24.85	29.49
30% CSHT	17.52	24.53	28.20



## 8. CONCLUSIONS

From the results of this investigation, the following conclusions are made:

- High modulus composites can be prepared using chemically treated fibres under optimum curing temperature conditions.
- Higher tensile modulus is exhibited by  $\text{KMnO}_4$  treated composites and higher flexural modulus is shown by  $\text{Ca}(\text{OH})_2$  treated composites.
- In the aspect of wear, the varying load is found to influence the specific wear rate with respect to sliding distance. The change in the magnitude of specific wear rate is observed in all the chemical treatments which could happen due to the improved adhesion and change in the morphology of fibre surface.
- The vibration properties of the SCS pattern appear good in natural frequency and damping among the pure and hybrid composites.
- The overall observation is, inclusion of the *Sansevieria* cylindrical fibre in to the polyester matrix greatly enhances the strength of the polymer composite and significant enhancements in both mechanical and vibrational properties are noted at a higher curing temperature

## 9. REFERENCES

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