

Potential Coir Fibre Composite for Small Wind Turbine Blade Application

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Abstract— Natural fibers have been developed as reinforcement of composite to shift synthetic fibers. One of potential natural fibers developed is coir fiber. This paper aims to describe potential coir fiber as reinforcement of composite for small wind turbine blade application. The research shows that mechanical properties (tensile, impact, shear, flexural and compression strengths) of coir fiber composite have really similar to wood properties for small wind turbine blade material, but inferior to glass fiber composite properties. The effect of weathering was also evaluated to coir fiber composite in this paper.

Index Terms—Coir fibers, composites, wind turbine blade.

I. INTRODUCTION

Natural fibers have been applied in composite materials. Related to this, natural fibers have beneficial properties over synthetic fibers like high specific strength and modulus, low density, low cost and abundant in many countries [1, 2, 3]. Some natural fibers used as reinforcement composite are coir, flax, jute, and ramie fibers.

Coir fiber is a natural fiber which has been used for reinforcement of composite. Coir fiber composite has been developed in India and Brazil. Some researches of mechanical properties of coir fiber composite were done. Flexural strength was obtained for coir fiber/polyester composite really similar to the conventional materials [4]. Meanwhile, impact strength of coir fiber composites is higher than jute and kenaf composites. Alkali treatment of coir fiber increases its bonding with polyester matrix. Coir fiber composites show tensile strength improves when fibers is soaked in 2% alkali prior to mixing polyester and flexural strength improves when 5% alkali [5]. This result was supported by another reseacher that states tensile strength of coir fiber composites increased when fibers are soaked with alkali prior to binding with matrix. This is because good adhesive between fibers and matrix after alkali treatment [6]. Tensile, impact and flexural strengths of coir/epoxy composites were evaluated with the average values of 17.86 MPa, 11.49 kJ/m² and 31.08 MPa respectively. These values have lower than glass reinforced composite laminate [7]. The tensile strength of coir reinforced composites was also tested and found lower its value. But, their impact strength was found higher which have potential for application in automotive that require impact resistance [8]. The impact strength of coir fiber composites was also reported that its value is higher than other natural fiber composites [9].

Coir fiber composite have been developed to some applications like automotive and structure. In this paper, the potential application of this composite was presented for small wind turbine blade and it was also evaluated effect of weathering time to the mechanical properties.

Using of fiber composites in wind turbine blade was applied with glass fiber as reinforcement [10]. Glass fiber composite for small wind blade have been applied and compared to flax fiber composite. Flax fiber as natural fiber can replace possibly glass fiber for reinforcement composite [11]. The designed small blades will be subjected to load when operation, therefore they need good strength, stiffness and tip deflection.

For application in wind blade, weathering will affect to the materials of wind blade. Some literatures explained the effect of weathering to the natural fiber composites. Kenaf high density polyethylene (K-HDPE) composite has been tested for durable behavior towards weather effect. The result shows that composite obtained brittleness proportional to the amount of weathering time [12]. Then, outdoor weathering affected tensile and moduli of the banana/phenol formaldehyde composite, and alkali treatment of fiber can improve tensile strength if exposure to outdoor weathering [13]. Mechanical properties (including impact, tensile and shear strengths) of coir/epoxy composites were influenced by weathering when composites were placed in outdoor for 10 days, 20 days and 30 days [14] [15]. These effect can be seen in Table 1 where we were published.

TABLE 1. THE EFFECT OF WEATHERING TIME ON IMPACT,TENSILE AND SHEAR STRENGTH OF COIR FIBER COMPOSITES

Specimens Treatment Time	Tensile Strength (MPa)	Shear Strength (MPa)	Impact Strength (kJ/m ²)
Without treatment (WT)	17.56	14.57	384.99
10 days	17.37	14.42	328.13
20 days	16.38	13.83	307.22
30 days	16.40	13.63	296.00

II. METHODOLOGY

Coir fibers were extracted from the husk of coconut shell. Prior to mixing with matrix, fibers were soaked in 5% NaOH and water during 24 hours. Epoxy resin was used as matrix. Coir fiber composites were made with 17% volume fraction of fiber by pressing molding for 24 hours. Molded composite is shown in Fig.1. Then, specimens were divided into two types including without treatment (WT) and treatment to weathering. Specimens with treatment time to the environmental effect (outdoor weathering) were 10 days, 20 days and 30 days. Mechanical properties of coir fiber composites were tested in this paper including compression and flexural strength with specimens as shown in Fig. 1 and Fig.2. Flexural testing used three point bending and compression used compressive testing. For impact, tensile and shear strength have been published [14],[15].



Fig 1. Molded coir fiber composite



Fig 2. Specimens of compression testing (standar ASTM D695)

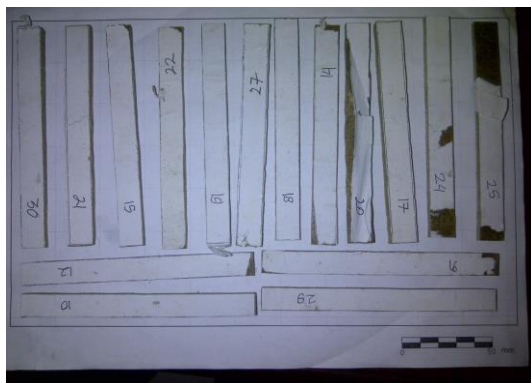


Fig 2. Specimens of flexural testing (standar ASTM D 790 – 02)

III. RESULTS AND DISCUSSION

Coir fiber composites were tested the mechanical properties including compression, flexural, tensile, shear and impact strength. These properties can be seen in Table 2. Impact, tensile and shear strength results were published previously. In this paper, flexural and compression strengths of coir fiber composite were described. Flexural and compression strengths were presented in Table 2 with values of 44.89 MPa and 26.27 MPa respectively.

TABLE 2. MECHANICAL PROPERTIES OF COIR FIBER COMPOSITES

Properties		Sources
Tensile Strength (MPa)	17.56	[15]
Shear strength (MPa)	14.57	[15]
Impact strength (kJ/m ²)	384.99	[14]
Flexural strength (MPa)	44.89	
Compression strength (MPa)	26.27	

From mechanical properties of coir fiber composite as explained before, it can be seen that for application of small wind turbine blade can be compared with other composites and wood in Table 2. Mechanical properties of wood for small wind turbine blade have similar to the coir fiber composites. This indicated that coir reinforced composites have potential for using of wind blade material. But, mechanical properties of coir fiber composite are lower than glass fiber composite. For development of application in wind turbine blade therefore coir fiber composites need hybridization to other fibers for improving strength and stiffness.

TABLE 2. MECHANICAL PROPERTIES OF GLASS FIBER COMPOSITES AND WOOD

Materials	Tensile Stre. (MPa)	Shear Stre. (MPa)	Flex. Stre. (MPa)	Compr Stre. (MPa)	Sources
GFRP	826	90.9		14.04	[11][16]
Laminated veneer lumber	19.1		28.7		[17]
Timberstran wood		5.1			[17]

Related to weathering time effect, the relationship between compression strength and treatment time of specimens is demonstrated in Fig.1. Compression strength was not change significantly on the treatment (weathering) time. When testing of coBut, flexural strength decreased when specimens were exposed during 20 days and 30 days (Fig.2). The decreasing of flexural strength are about 9.71% for 20 days and 20,4% for 30

days. The possible cause of decreasing its strength was due to solar radiation and high humidity.

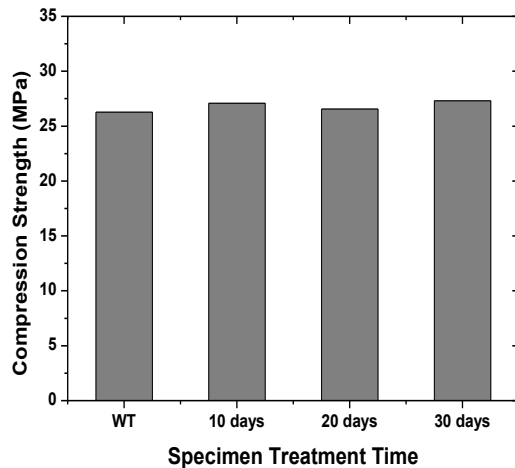


Fig 1. Relation between compression strength and specimen treatment time

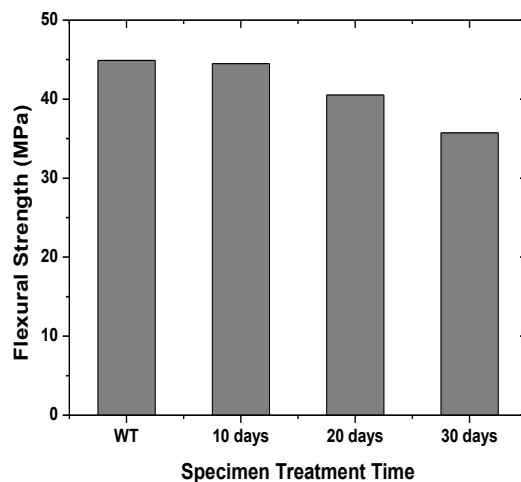


Fig 2. Relation between flexural strength and specimen treatment time

IV. SUMMARY

Coir fiber composite is one of natural fiber composites having potential for small wind turbine blade application because their mechanical properties were found competitive with wood properties for wind blade materials. Although, it has inferior to glass fiber composites. Related to treatment (weathering) time of specimens, mechanical properties of coir fiber composites were tend to decreasing but it is not significant.

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