NOVEL GREEN COMPOSITE FOR APPLICATION OF PASSENGER AIRCRAFT INTERIOR

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ABSTRACT

In recent years, more emphasis was given to these developments, due to reflection over recyclability of aircraft components. Moreover, rising operating costs and increasing need for lighter components have caused a thorough rethink of almost every aspect of the aircraft cabin, with a strong focus on seats. Figure 1 indicates the increasing trend in the use of interior composites, which is mostly to be attributed to the Boeing 787 and Airbus A350 families. Despite the strict requirements enforced in aerospace regulation, a steady growth is foreseen, due to the fact that low weight and low fuel consumption are considered of paramount importance. Present study to reduce aircraft weight along with improving fuel efficiency and minimizing products' impact on climate change. This includes the development of fully recyclable aircraft cabin interiors. In this quest, natural fibres composites (NFCs) were analyzed in the present work to assessing their suitability for application into aircraft interiors.

Keyword: **-** *Composite1, Natural Fibers2, Characterized and Analyzed3, and Polymer matrix4*

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1 OVERVIEW

Composite is composed of two main components: the fiber as reinforcement and the matrix. The reinforcing element is able to support high tensile loads although the matrix imparts rigidity to the composite. The application of stress on the composite is results transfer of the loads from one fiber to another, via the matrix. The stiffness of the matrix is often accompanied by brittleness. Nevertheless, the combination of fiber and matrix makes for a tough material. The composites may fail by one or two mechanisms plastic flow or brittle cracking. Based on existing experience and knowledge of synthetic fiber composites, the mechanical behavior of plant fiber composites has been extensively characterized and analyzed. The work has mainly addressed measurements of pure tensile properties, as well as bending and impact properties. A considerable amount of literature has been published on composites containing lignocellulose fibers produced by the forest and paper industry such as cellulose, wood fiber and wood dust. Other studies have looked at agricultural fibers such as Kenaf, Pineapple, Sisal, Hemp, Coir and Rice Husks.

1.1 Natural Fibers

Natural fibers are subdivided based on their origins, whether they are derived from plants, animals, or minerals, Figure 2.1 shows a classification of natural fibers. [1] Plant fibers include bast (or stem or soft or sclerenchyma) fibers, Leaf or Hard Fibers, Seed, Fruit, Wood, Cereal straw, and other Grass Fibers [2]. Natural fibers are generally lignocelluloses in nature, consisting of helically wound cellulose micro fibrils in a matrix of lignin and hemicellulose [3]. The use of natural fibers composites matrices is highly beneficial because the strength and toughness of the resulting composites are greater than those of the un-reinforced matrix. Moreover, cellulose-based natural fibers are strong, light in weight, very cheap, abundant and renewable. Lignocellulose natural fibers like the pineapple leaf fiber come as a viable and abundant substitute for the expensive and nonrenewable synthetic fiber [4]. These fibers with high specific strength improve the mechanical properties of the polymer matrix. In tropical countries, like Malaysia, fibrous plants are available in abundance and at least some of them are agricultural crops. The properties of the single fibers depend on the crystallite content, size, shape, orientation, thickness of cell walls.

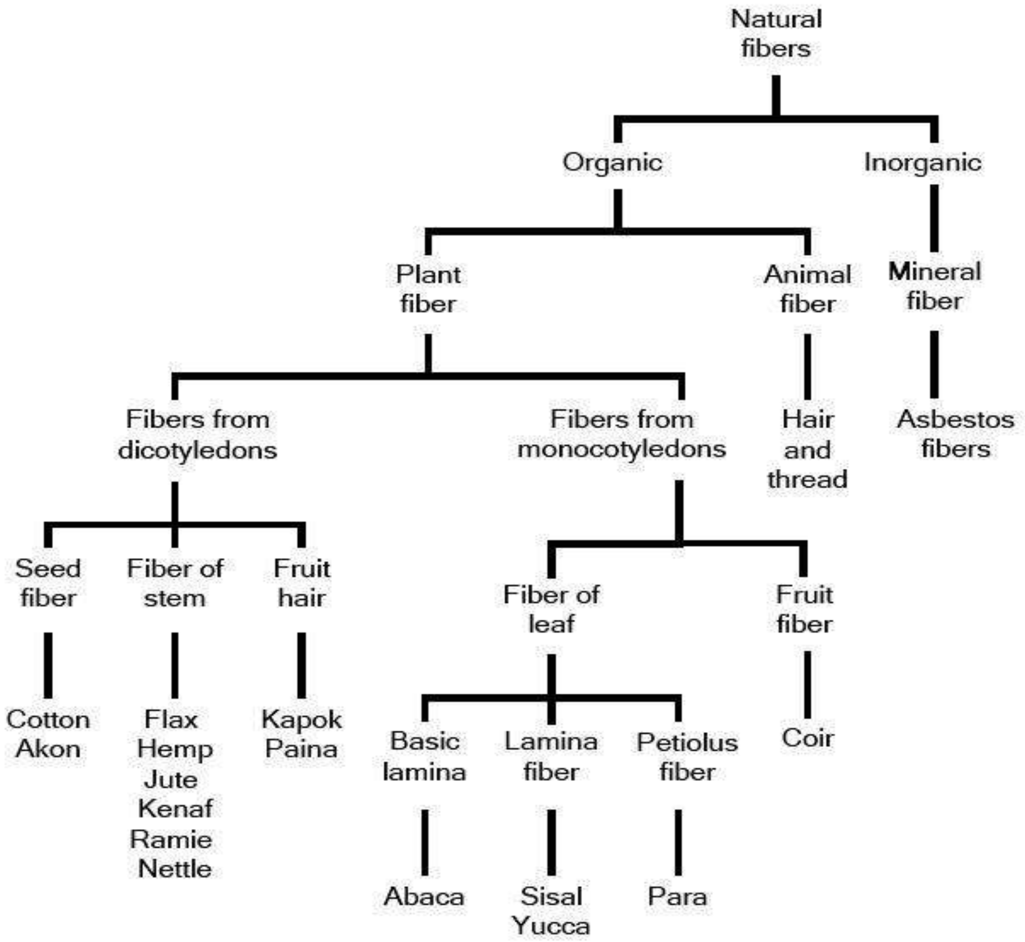


Figure 1.1: Classification of natural fibers [2]

Table 1.1: Properties of natural fibers and synthetic fibers [2]

Type of fiber	**Density g/cm3**	**Tensile Strength MPa**	**Young's Modulus GPs**	**Elongation at beark %**
Cotton	1.5-1.6	287-800	5.5-12	6 7.0-8.0
Jute	1.3-1.45	393-773	13-26.5	1.16-1.5
Flax	1.50	345-1100	27.6	2.7-3.2
Hemp		690		1.6
Sisal	1.45	468-640	9.4-22.0	3-7
Kenaf	1.4	930	53	1.6
Pineapple		413-1627	34.5-82.51	1.6
Coir	1.15	131-175	4-6	15-40
E-glass	2.5	2000-3500	70	2.5
Carbon	1.7	4000	230-240	1.4-1.8

1.2Comparisons of Natural Cellulose Fibers

Cellulose fibers have been used for long time in the manufacture of various products such as rope, string, clothing, carpets and other decorative products. Today, one of the major uses of Kenaf fiber is to make a range of paper and cardboard products as a substitute for wood fibers which are the most abundantly used cellulose fibers. The most efficient cellulose fibers are those with high cellulose content coupled with a low micro-fibril angle in the range of 7-12° to the fiber axis. It was determined that pulping Kenaf requires less energy and chemical inputs for processing than standard wood sources. Because of environmental problems (artificial fiber produce long-term pollution), this application of Kenaf fiber has drawn tremendous attention in the world, although the use of other fiber types is increasing. There are several physical properties that are significant to selecting suitable cellulose fibers for use in composites: fiber dimensions, structure, defects, crystallinity, variability, cost [7]. Mechanical properties are even more important when selecting a suitable fiber for composites reinforcement. To produce a strong composites material, it is important to utilize strong reinforcing fibers. Nevertheless, fiber strength is not the only promoting factor to composites strength, as excellent bonding between the fibers and matrix, good fiber orientation and good fiber dispersion are also demanded. Table 2.2 shows the composites of the Kenaf fiber whole stalk.

Table 1.2: Details of the composites of the whole stalk Kenaf fiber [8]

Kenaf fiber	Ash (%)	A-Cellulose (%)	Semi-cellulose %	Lignin (%)
Bark	5.5-8.3	53.0-57.4	NA	5.9-9.3
Core	2.9-4.2	51.2	NA	17
Whole stalk	2.1-6.5	47.3-57.3	31.5-38.4	4.7-16.1

Kenaf was chosen for this research because it is a new fiber crop grown commercially in the world; other fibers isolated from annual growth crops have a potential as reinforcing fillers in plastics. The choice of the fiber for plastics applications depends on the availability of the fiber in the region and also on the ultimate composites properties needed for the specific application.

2. MECHANICAL STRENGTH

The tensile property study was conducted by using a universal Tensile testing machine. The results of the tests are as seen in Table 4.3. Figures 4.2 and 4.3 depict the results of the tensile test performed on the samples. Figure 4.2 (a,b,c) indicates the stress versus strain curves for the different samples and Figure 4.3 indicates the variations in the maximum displacement, tensile modulus and percentage elongation for the samples under study.

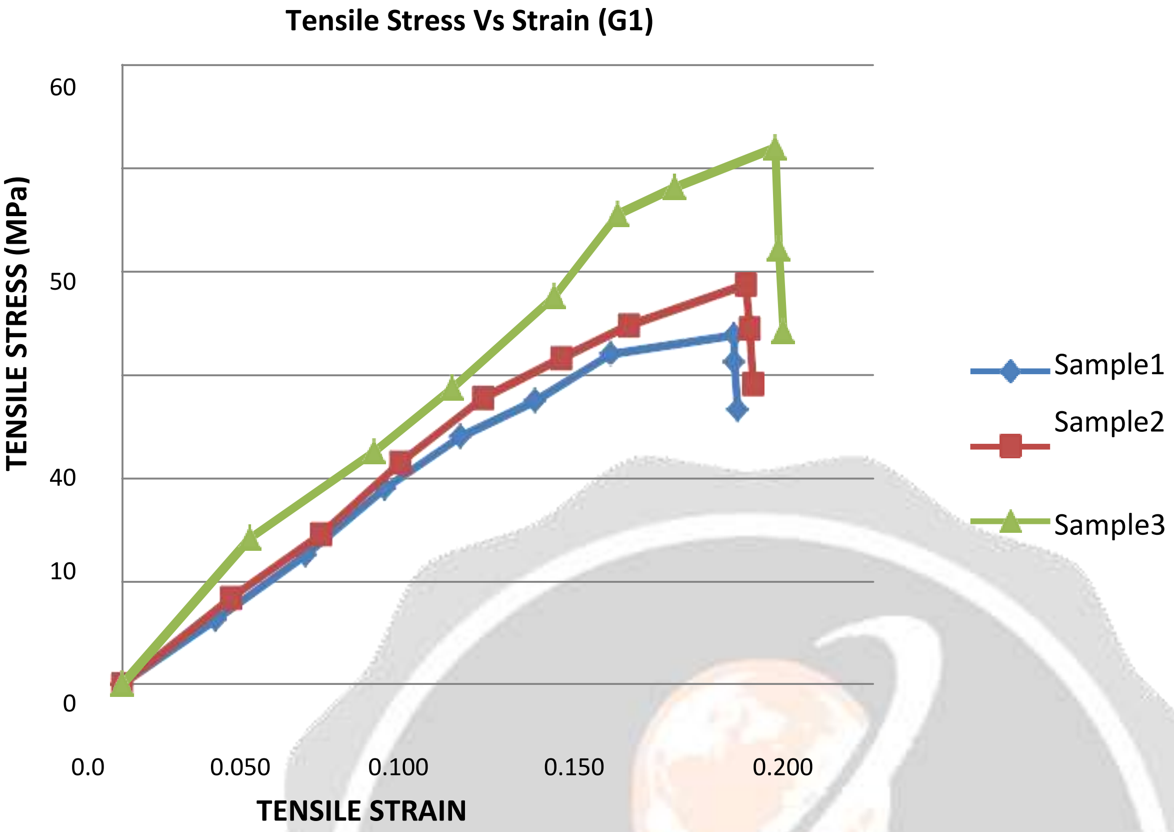
From the figures it is understood that G3 samples have provided better results compared to G1 and G2 samples. The inference is that the percentage of kenaf plays a significant role in the improvement of tensile strength of the said composites under discussion. The Ultimate Tensile Strength (UTS) value of S3 sample of G1 shows that it is 1.34 times stronger than S2 sample and 1.54 times stronger than S1. G2 and G3 samples, similarly, show the trend of increment of UTS values. This increase in strength can be attributed to the inclusion or increase in the kenaf percentage (Akil et al. 2011) in the composites and also the orientation of the fibers.

A remarkable improvement in the tensile strength was observed in sample 3 of G3 compared with S3 of G2. The strength has improved from 46.46 MPa for S3 of G2 to 59.71 MPa for S3 of G3. The value of tensile modulus of the samples in G3 is remarkably higher than the conforming samples in the other groups.

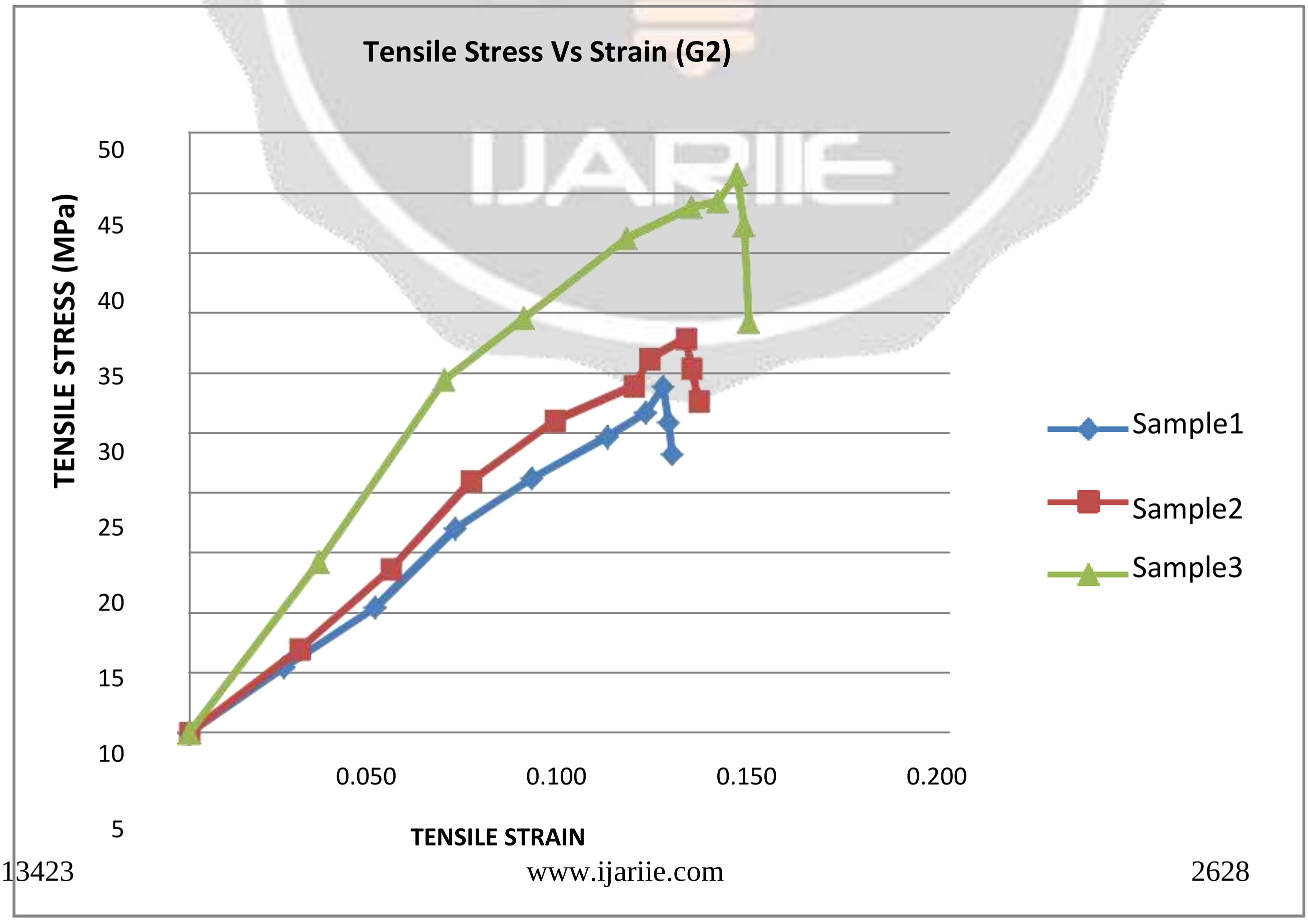
Table 2.1 Tensile test of samples S1, S2 and S3 of Group G1, G2 and G3

Sl. No	Group and Fiber Orientation	Test Samples	Break Load(kN)	Maximum Displacement (mm)	% Elongation	Ultimate Tensile strength (MPa)	Tensile Modulus (Mpa)
1	G1 (90˚-0˚-90˚)	S1	3.3±0.754	9.3±0.563	16.3±0.143	33.85±0.712	170.51±0.235
2		S2	3.78±0.187	9.5±0.109	16.6±0.184	38.79±0.091	193.91±0.531
3		S3	5.07±0.234	9.9±0.654	17.40±0.172	51.98±0.743	254.48±0.801
4	G2 (0˚-90˚-0˚)	S1	2.81±0.341	7.1±0.390	12.5±0.121	28.81±0.191	197.17±0.712
5		S2	3.2±0.209	7.45±0.304	13.1±0.109	32.87±0.112	213.72±0.304
6		S3	4.53±0.089	8.2±0.109	14.4±0.149	46.46±0.340	274.10±0.290
7	G3 (45˚-45˚-45˚)	S1	3.96±0.117	8.9±0.724	15.7±0.454	40.66±0.072	219.76±0.723
8		S2	4.49±0.190	9.1±0.712	16±0.561	46.06±0.092	245.00±0.781
9		S3	5.82±0.167	9.1±0.173	16±0.702	59.71±0.110	318.75±0.310

***(Average of three samples)**



a. Tensile Stress Vs. Tensile Strain for the samples of Group G2



b. **Tensile Stress Vs. Tensile Strain for the samples of Group G3**

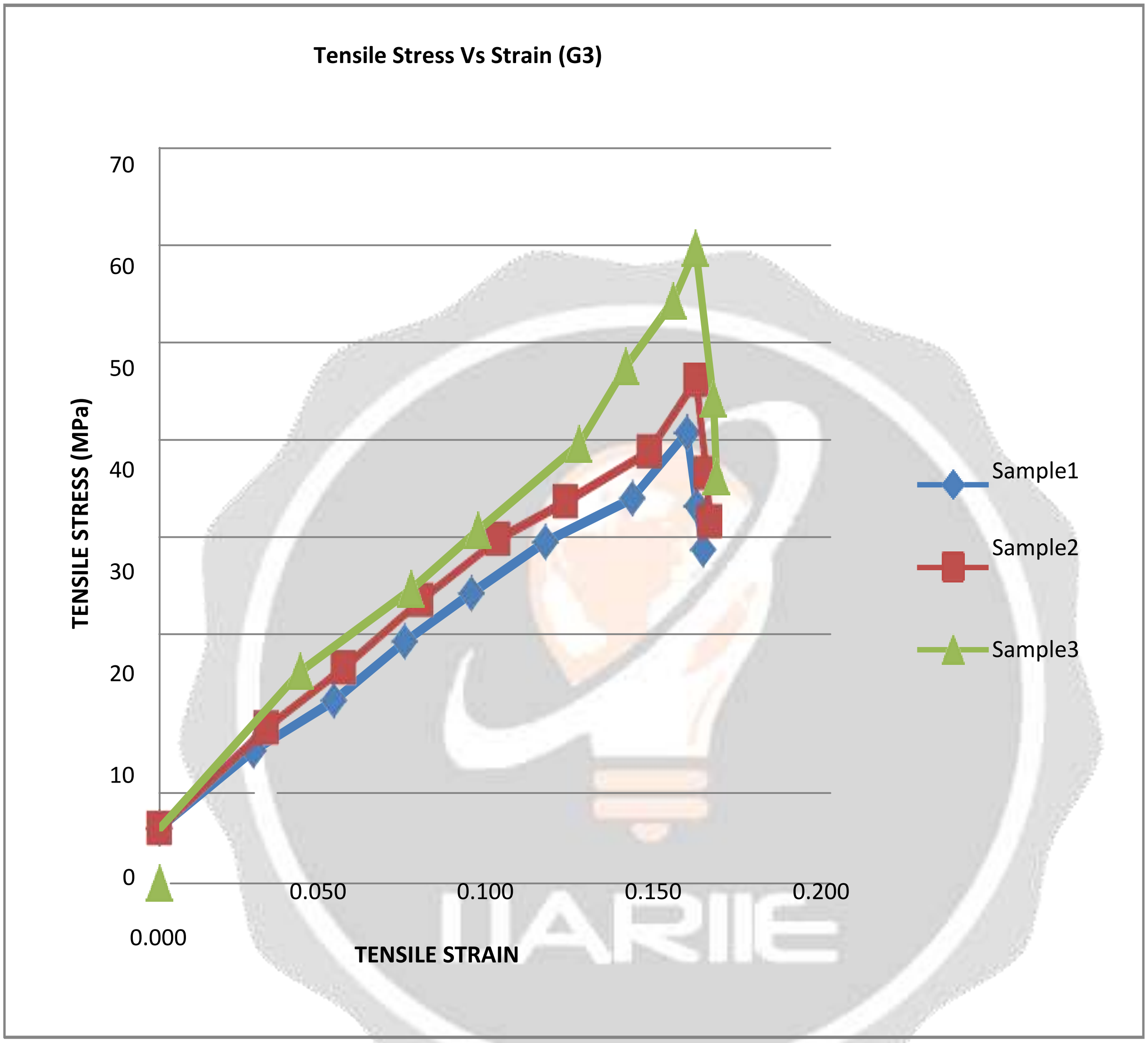
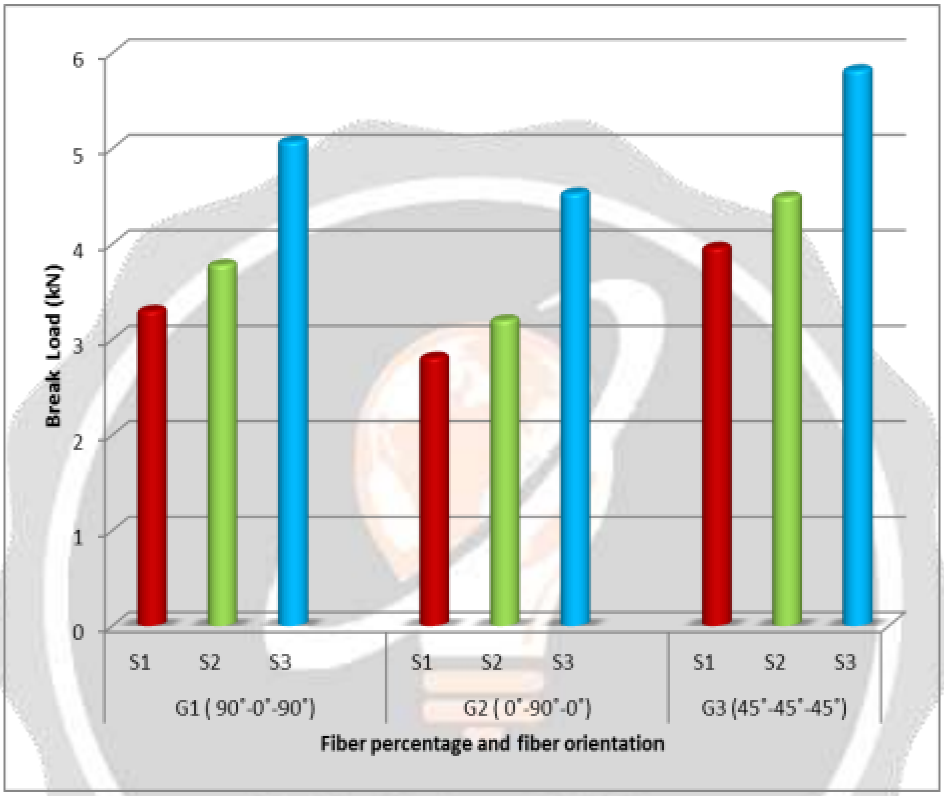
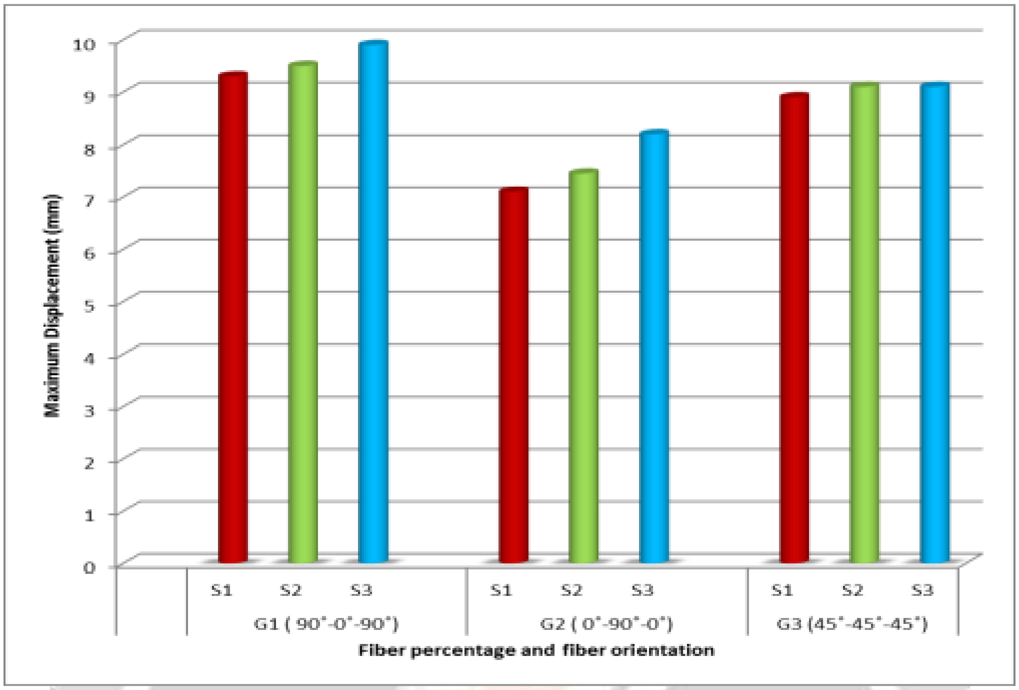


Figure 1: Comparison of Tensile Stress vs. Tensile Strain

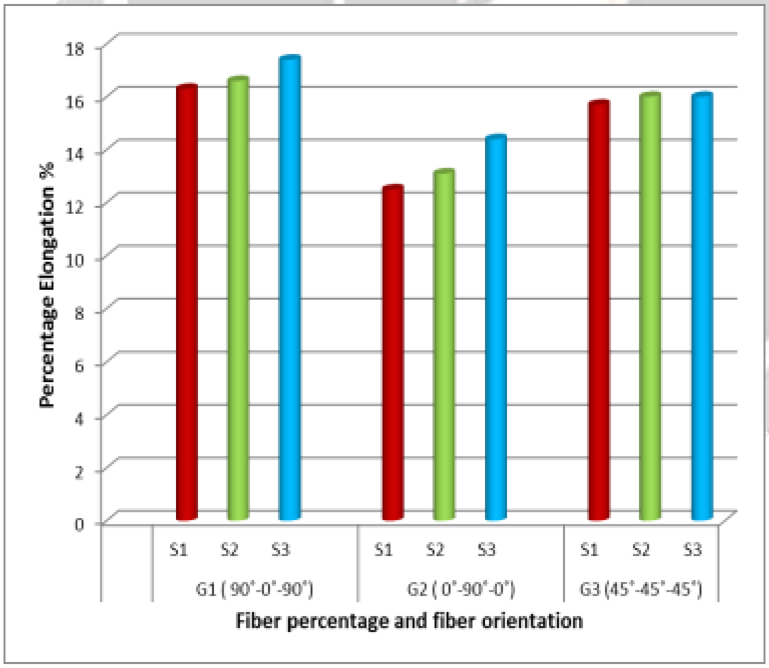
a. Break Load of Group G1, G2, G3 – Tensile test



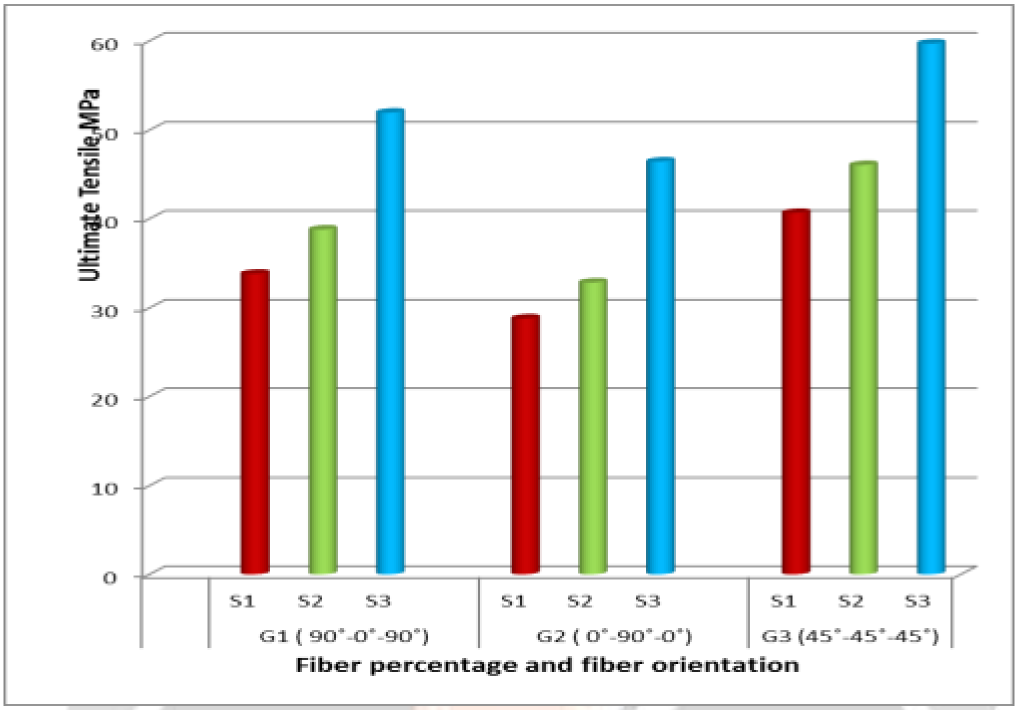
b. Maximum Displacement of Group G1, G2, G3 – Tensile test



c. **Percentage Elongation of Group G1, G2, G3 – Tensile test**



d. **Ultimate Tensile Strength of Group G1, G2, G3.**



e. Tensile Modulus of Group G1, G2, G3.

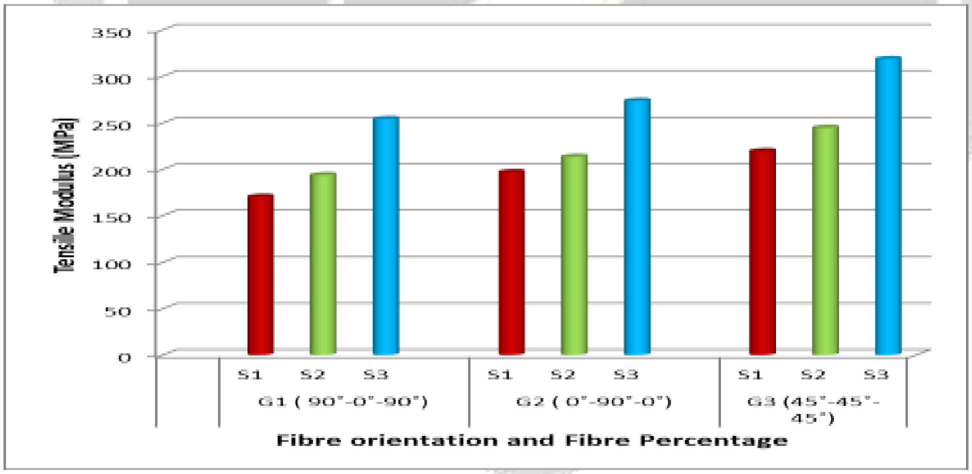


Figure 2: Comparison of Results of Tensile Test

3. CONCLUSION

Traditionally natural fibers like sisal, hemp, coir etc., are used to make high strength ropes in South India. Hemp fibers are available in large quantities and are renewable. Similarly, around the world many works were carried out using kenaf fibers as reinforcement in polymer matrices. Especially there are no reports available to the best of the researches knowledge, the hybridization of hemp fiber using Kenaf fiber as a reinforcing agent with polyester matrix. In this research, kenaf fiber, hemp fiber and kenaf/ hemp polyester composites have been fabricated in two forms i.e., woven (plain and twill) and randomly oriented. These fabricated composites were tested for the mechanical properties according to ASTM standards. However, as a novel attempt, the tribological behavior of kenaf/hemp hybrid polyester composites is studied.

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