

Tribological Properties of Sisal Fiber Reinforced With Basalt and Glass Fiber for Composite Application

Mr. Gowtam JK¹, Dr. Raju BR², Naveen kumar R³

¹Associate Professor in Dept. of Mechanical Engineering, PESIT&M, Shimoga.

²Professor in Dept. of Automobile Engineering, TOCE, Bangalore

³Student of M.tech in Machine Design, SJBIT, Bangalore.

gowtam@pestrust.edu.in¹, rajusrujan@gmail.com², nvnmr206@gmail.com³

Article Info

Volume 83

Page Number: 5252 - 5257

Publication Issue:

March - April 2020

Abstract

In a creativity world man will be looking for a easiest method to find a life of daily used things like house hold utensils, construction purposes, moving vehicle purposes and other uses etc. like composite materials it has a long life, less price, easiest way of getting, high strength and so on. In this paper we research a fiber on easily get from nature ie sisal fiber that we can get from the sisal plant and with this two more will be added one is basalt fiber get from basalt rock, and other is glass fiber. The three fibers are using different streams with an epoxy resins like sisal and epoxy; basalt and epoxy; glass and epoxy; sisal, basalt and epoxy; sisal, glass and epoxy and finally glass, basalt and epoxy. For these combination use we can contrasting life of materials by conducting on wear test of two body (pin on disc) and three body abrasive wear test for calculating volume loss and wear rate. In two body wear test can be done by using 2 emery sheets at a grade of 150 & 320. Three body abrasive wear test can be done by varying a loads are 25kgs & 12.5kgs. what we get from the nature sisal and basalt fiber both are biodegradable and improving properties of composite material.

Article History

Article Received: 24 July 2019

Revised: 12 September 2019

Accepted: 15 February 2020

Publication: 27 March 2020

Keywords; Composite material, Sisal fiber, basalt fiber, glass fiber, tribological and epoxy.

I. INTRODUCTION

: In its most straightforward kind a stuff is one, that comprises of at least 2 segments working along to supply material properties that are totally unique to the properties of these components all alone. In follow, most composites incorporate a mass material (the 'grid'), and a support or some likeness thereof, valuable essentially to expand the quality and solidness of the lattice. This support is once in a while in fiber kind. Today, the preeminent basic incredible composites are frequently separated into 3 fundamental gatherings:

Polymer Matrix Composites (PMC's) – These are the main typical and can be dis-stiff-necked here.

moreover called FRP - Fiber bolstered Polymers (or Plastics) - these materials use a polymer-based resin considering the way that the structure, and a spread of strands like glass, carbon and aramid considering the way that the stronghold.

Metal Matrix Composites (MMC's) - progressively found inside the vehicle trade, these materials use a metal like atomic number 13 because the structure, and fortify it with strands, or particles, like carbide.

Aesthetic Matrix Composites (CMC's) - Used in awfully hot temperature circumstances, these materials use a terminated considering the way that the system and sustain it with short fibers, or stubbles like those made up of carbide and B

engineered compound.

II. MATERIALS AND METHODS

SISAL FIBER: Sisal fiber mats are made of natural fibres get from sisal plant that possess terribly sturdy properties, creating a wonderful quality mat. Sisal mats are infamous for his or her strength. As hostile some artificial mats, Sisal mats last for much longer and still manage to take care of that current look.

Sisal tangles likewise are earth well disposed, they're spun from present sisal filaments that are gathered ordinarily p.a. also, don't hurt the setting. the different hues, styles, weaves, and mixes are the makings of an irksome determination, as each is as dazzling on the grounds that the following.

In case you're attempting to discover huge amounts of steadiness in your Sisal Mat you may wish to go with a fiber blend. On the off chance that you might want that unmistakable tropical look, you may wish to mull over going with a sea grass weave. there's a scope of weaves, and each idea off an unmistakable environment. a few of the mats might be tweaked; you'll have the option to arrange explicit sizes that meet your wants.



Fig.1 shows sisal fiber mat type

BASALT FIBER: Basalt is standard as rock found in pretty much every nation round the world. Its principle use is as a stone used in development, modern and street building. yet, it's not unremarkably better-realized that volcanic stone are frequently used in delivering and made into fine, superfine and ultrafine strands. Included single

fixing staple mollify, volcanic stone strands are better than various filaments as far as warm dependability, warmth and sound protection properties, vibration obstruction and strength.

Basalt persistent filaments give absolutely new change of composite materials and item. since it is eminent, volcanic stone is that the name given to a scope of molten stone renowned mainly for its protection from high temperatures, quality and toughness, wide unobtrusive all round the world, inside which SiO represents the most half, trailed by Al₂O₃, at that point Fe₂O₃, FeO, CaO and exclusively acidic kind basalts fulfill the conditions for fiber planning.

As a matter of fact volcanic stone likewise can be formed into endless fiber having particular compound and mechanical properties, so it's unmistakably fit to hard-to-satisfy applications requiring obstruction against high temperatures, protection properties, corrosive and dissolvable opposition, solidness, mechanical quality, tide assimilation, and so forth.



Fig.2 shows basalt fiber mat type

GLASS FIBER: Fiberglass alludes to a gaggle of item made up of individual glass strands consolidated into a scope of structures. Glass strands may be partitioned into 2 huge gatherings relentless with their geometry: ceaseless fibers used in yarns²and⁸materials, and thus the sporadic (short)fibers used as batts,¹covers⁷ or⁵sheets for insurance and²filtration. Fiberglass will be framed

into yarn on a very basic level equivalent to wool or cotton, and plain-woven into material that is typically used for draperies. covering material materials are regularly used as a fortress material for confined and overlaid plastics. covering material wool, a thick, down like material made up of unpredictable fibers, is used for warm insurance and sound maintenance. It is commonly found in ship and submarine bulkheads and structures; engine compartments and body board liners; in radiators and air con units; material science divider and rooftop sheets; and field of study portions.



Fig.3 shows glass fiber mat type

Planning OF LAMINATES: Laminates are prepared by hand b-ball shot strategy followed by sack procedure beginning cut the fiber into 220x220 metric direct unit measurement for preparing tractable, flexural and sway example for in step with ASTM principles. when cutting the filaments, wax are fixed for higher than referenced measurement for non-clingy then spot a fiber glue an epoxy and again a zone a fiber cover sort. the resulting subtleties contain what extent layer is put during a fiber for preparing a plates

Sl. No.	Composition	Layers
I	Sisal + epoxy	S+S+S+S+S (6 Layers)
II	Basalt + epoxy	B+B+B+B+B+B+B+B (10 Layers)
III	Glass + epoxy	G+G+G+G+G+G (6 Layers)
IV	Sisal + Basalt + epoxy	S+S+S+B+B+B+B (3+4) Layers
V	Sisal + Glass + epoxy	S+S+S+G+G+G (3+3) Layers
VI	Glass + Basalt + epoxy	G+G+G+G+B+B+B+B (4+5) Layers

Table 1.1 shows a composition with layer laminating

III. RESULTS & DISCUSSION

2.1 Wear test:

Wear test will be done by in step with ASTM standard G99, according to

this dimension of specimen is 6mm X 6mm. the test will be conducted by two types, one

is Two Body wear test (Pin On Disc) and other is Three body Abrasive wear test.

Wear rate: wear rate is defined as obtained value of the volume loss is divided by load applied in particular distances.

Wear rate= (Volume loss)/(Load X Distance)

Volume loss= (Initial weight-Final weight)/(Density)

Two Body wear test:

This test was conducted by with a distance of 90m, 180m, 360m, & 720m using of two different emery sheet of 320grade & 150grade.

320Grade:

Combination	Wear rate in mm ³ /Nm at a specified distance			
	90	180	360	720
Sisal	2.605	2.378	1.812	1.118
Basalt	2.265	1.472	0.906	0.523
Glass	2.038	1.189	0.736	0.424
Sisal + Basalt	1.529	0.86	0.523	0.3
Sisal + glass	1.642	1.036	0.639	0.478
Glass + Basalt	1.132	0.736	0.396	0.212

Table 2. shows Wear rate at specified distance of different combination at 320 grade

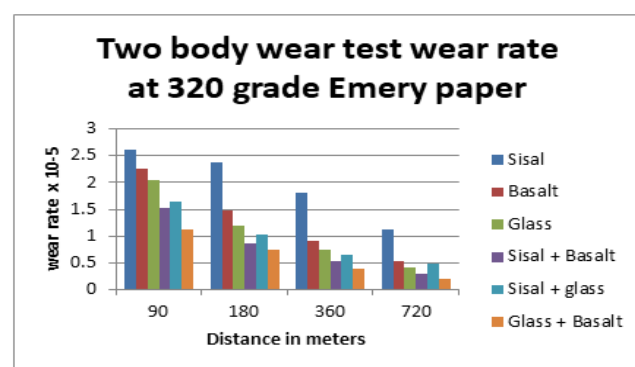


Fig.4 shows a graph of wear rate on 320 grade emery paper

Table 2 shows the value of two body wear test on wear rate of material at different combinations. The sisal composite has a maximum wear rate of at all the distances like 90m, 180m, 360m, 720m of 2.605mm³/Nm, 2.378mm³/Nm, 1.812mm³/Nm & 1.118mm³/Nm. The Glass & Basalt combination has minimum value of 1.132mm³/Nm, 0.736mm³/Nm, 0.396mm³/Nm & 0.212mm³/Nm respectively as shown in graph of fig. 4

150 Grade:

Combination	Wear rate in mm ³ /Nm at a specified distance			
	90	180	360	720
Sisal	1.359	0.849	0.622	0.339
Basalt	0.974	0.566	0.339	0.226
Glass	1.132	0.996	0.506	0.28
Sisal + Basalt	1.72	1.3	0.792	0.495
Sisal + glass	1.721	1.183	0.741	0.453
Glass + Basalt	0.804	0.497	0.453	0.325

Table 3. shows Wear rate at specified distance of different combination at 150 grade

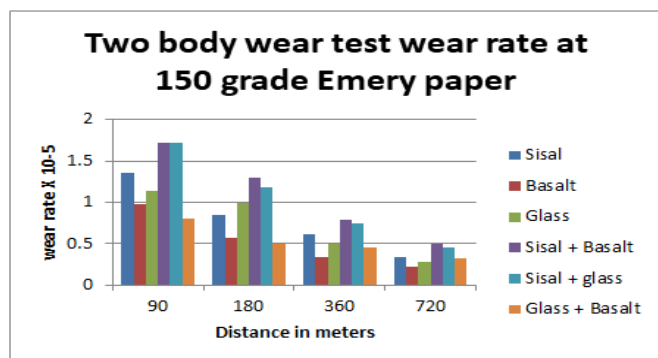


Fig.4 shows a graph of wear rate on 150 grade emery paper

Table 3 and fig.4 shows result of two body wear test on wear rate at 150 grade emery paper with mentioned material combination. In this also clearly shows that sisal+Basalt fiber has maximum wear rate of 1.72mm³/min at 90m, 1.3mm³/min at 180m, 0.792mm³/min at 360m & 0.495mm³/min at 720m. The glass + basalt fiber has minimum wear rate of 0.804mm³/min at 90m, 0.497mm³/min at 180m, 0.453mm³/min at 360m & 0.32572mm³/min at 720m respectively.

Three body abrasive wear test: This test can be done

by abrasive wear testing machine at load of 25kgs & 12.5kgs respectively

Load at 25 kgs

Combination	Wear rate in mm ³ /Nm at a specified distance			
	225	450	675	900
Sisal	3.062	3.225	3.745	4.059
Basalt	2.084	2.383	2.277	2.491
Glass	2.011	1.957	2.222	2.401
Sisal + Basalt	1.757	1.83	2.053	2.21
Sisal + glass	1.902	2.011	2.18	2.496
Glass + Basalt	0.072	1.35	1.57	1.726

Table 4. shows three body abrasive wear test of wear rate at load of 25 kgs

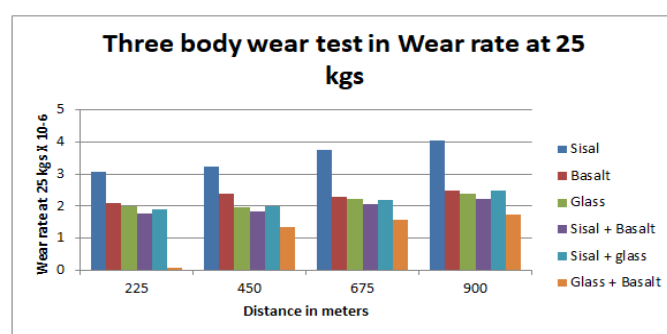


Fig.5 shows a graph of wear rate on load of 25kgs

Table 4 and fig.5 shows result of three body wear test on wear rate at load of 25kgs with mentioned material combination. In this also clearly shows that sisal fiber has maximum wear rate of 3.062mm³/min at 225m, 3.225mm³/min at 450m, 3.745mm³/min at 675m & 4.059mm³/min at 900m. The glass + basalt fiber has minimum wear rate of 0.072mm³/min at 225m, 1.35mm³/min at 450m, 1.57mm³/min at 675m & 1.726mm³/min at 900m respectively.

Load at 12.5 kgs

Combination	Wear rate in mm ³ /Nm at a specified distance			
	225	450	675	900
Sisal	4.965	4.965	5.979	5.642
Basalt	3.75	2.83	3.49	3.988
Glass	2.827	2.845	4.288	3.57
Sisal + Basalt	2.102	2.102	2.853	3.126
Sisal + glass	2.355	2.355	3.322	3.461
Glass + Basalt	1.377	1.449	1.933	2.428

Table 5. shows three body abrasive wear test of wear rate at load of 12.5 kgs

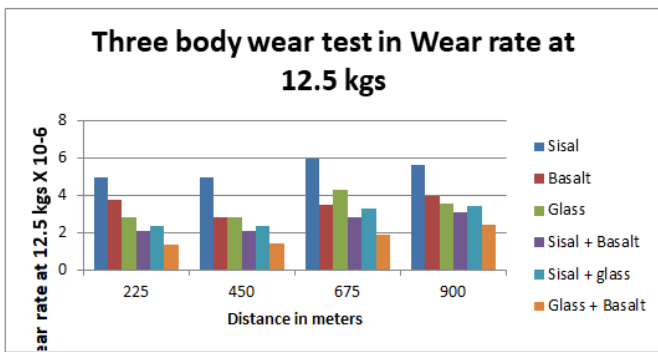


Fig.6 shows a graph of wear rate on load of 12.5kgs

Table 4 and fig.5 shows result of three body wear test on wear rate at load of 25kgs with mentioned material combination. In this also clearly shows that sisal fiber has maximum wear rate of 4.965mm³/min at 225m, 4.965mm³/min at 450m, 5.979mm³/min at 675m & 5.642mm³/min at 900m. The glass + basalt fiber has minimum wear rate of 1.377mm³/min at 225m, 1.449mm³/min at 450m, 1.933mm³/min at 675m & 2.428mm³/min at 900m respectively.

IV. SEM ANALYSIS

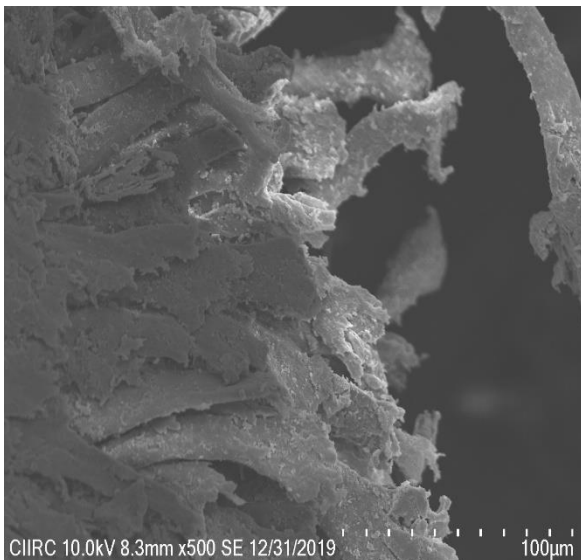


Fig. 7 shows SEM analysis on three body wear test specimen of sisal fiber

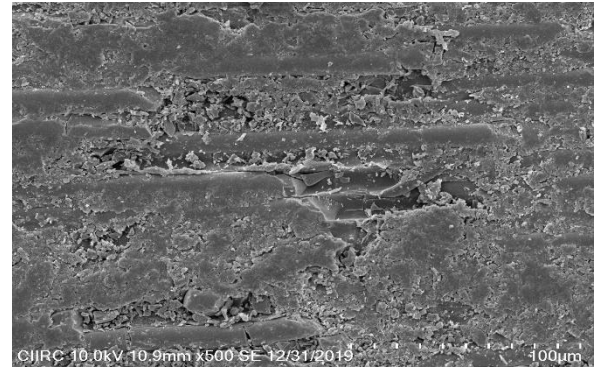


Fig. 8 shows SEM analysis on three body wear test specimen of basalt fiber

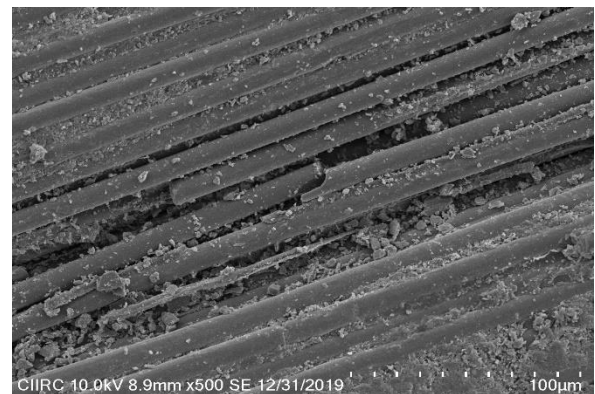


Fig. 9 shows SEM analysis on three body wear test specimen of sisal+basalt fiber



Fig. 10 shows SEM analysis on three body wear test specimen of sisal+glass fiber

Fig. 7 shows SEM analysis on three body wear test specimen of sisal fiber, it clearly says that the loss of material is high, resulting is very less strength. Fig. 8 shows SEM analysis of basalt fiber has loss of material is little high, not more than sisal fiber, but also maximum wear rate. When sisal is added with

basalt fiber is resulting is material loss is very low as shown in fig. 9 causes less wear rate compared to fig. 7 & fig. 8. The same sisal fiber has mixing with glass fiber material loss is low not that much of sisal+basalt fiber as shown in SEM images at fig. 10 resulting is better wear rate.

REFERENCES

- [1]. Goulart S.A.S., Oliveira T.A., Teixeira A., Mileo P.C., Mulinari D.R., Mechanical behaviour of polypropylene reinforced palm fibers composites, *Procedia Engineering*;2011;10:2034-2039.
- [1]. Flavio de Andrade Silva, Romildo Dias Toledo Filho, Joao de Almeida MeloFilho, Eduardo de MoraesRego Fairbairn, Physical and mechanical properties of durable sisal fiber-cement composites, *Construction and Building Materials*;2010;24:777785.
- [2]. K.Sabeel Ahmed and S.Vijayarangan, Tensile, flexural and interlaminar shear properties of woven jute and jute-glass fabric reinforced polyester composites, *Material Processing Technology*;2008;207:330-335.
- Maries Idicula, S.K. Malhotra, Kuruvilla Joseph, Sabu Thomas, Dynamic mechanical analysis of randomly oriented intimately mixed short banana/sisal hybrid fiber reinforced polyester composites, *Composites Science and Technology*;2005;65: 1077-1087.
- [3]. K.Sabeel Ahmed, S. Vijayarangan, A.C.B. Naidu, Elastic properties, notched strength and fracture criterion in untreated woven jute-glass fabric reinforced polyester hybrid composites, *Materials and Design*;2007;28:2287 2294.
- [4]. Yan Li, Yiu-Wing Mai, Lin Ye, Sisal fiber and its composites: A review of recent developments, *Composites science and technology*;2000;60:2037-2055.
- [5]. M. Jawaaid , H.P.S. Abdul Khalil, A. Abu Bakar, P. NoorunnisaKhanam, Chemical resistance, void content and tensile properties of oil palm/jute fiber reinforced polymer hybrid composites, *Materials and Design*;2011;12: 1014-1019.
- [6]. M. Jawaaid, H.P.S. Abdul Khalil, Azman Hassan, Rudi Dungani, A. Hadiyane, Effect of jute fibre loading on tensile and dynamic mechanical properties of oil palm epoxy composites.
- [7]. KasamaJarukumjorn, NitinatSuppakarn, Effect of glass fiber hybridization on properties of sisal fiber polypropylene composites, *Composites: Part B*;2009;40:623627.
- [8]. Maries Idicula, S.K. Malhotra, Kuruvilla Joseph, Sabu Thomas, Dynamic mechanical analysis of randomly oriented intimately mixed short banana/sisal hybrid fiber reinforced polyester composites, *Composites Science and Technology*; 2005;65:1077 1087.
- [9]. N. Venkateshwaran, A. Elayaperumal, G.K. Sathiya, Prediction of tensile properties of hybrid.
- [10]. K. Murali Mohan Rao, K. MohanaRao, A.V. Ratna Prasad, Fabrication and testing of natural fiber composites: Vakka, sisal, bamboo and banana, *Materials and Design* ;2010;31: 508513.
- [11]. N.Venkateshwaran, A. ElayaPerumal, A. Alavudeen, M. Thiruchitrambalam, Mechanical and water absorption behaviour of banana/sisal reinforced hybrid composites, *Materials and Design*;2011;32:40174021.
- [12]. BledzkiAK,GassanJ.Compositesreinforced with cellulose based.bres. *ProgPolymSci* 1999;24:221–74.
- [13]. Mwaikambo LY, Ansell MP. Chemical modification of hemp, sisal,jute, and kapok .bers by alkalisation. *J ApplPolymSci* 2002;84(12):2222–34. 3.
- [14]. JochenGassan. A study of .bre and interface parameters a.ectingthe fatigue behavior of natural.brereinforced biodegradable polyester amide composites – fabrication and properties evaluation. *J ReinfPlastComp* 2002;21(1):55–70