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Bio Caryota Fiber Reinforced Polyester Composites: A Study on Fracture Toughness Mode I

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Abstract:
The aim of the paper found the fracture toughness of caryota fiber loading with 35wt%, 40wt% and 45wt% having different fiber length of 10mm, 25mm, 50mm, 100mm and 125mm. The fiber have been used in many applications such as automotive, aircraft house hold, sports good etc. The natural fiber posses light weight, low cost and easily available. The stiffness and strength is high for the given weight. In this work caryota fiber reinforced composites were prepared by compression molding machine the chopped fiber varying length varying fiber loading ,the hardener used for the composites 10:1. The SEM analysis has conducted after the fractured specimen to found mode of failure of fractured specimen.

Keywords:*Reinforced polyester, composites, bio caryota fiber.*

I. INTRODUCTION

Recent scenario the natural fiber composites have been used in many applications such as automotive, aircraft house hold things, sports good etc.The natural fiber mainly focus on many filed ,it can be biodegradable,eco-friendly,easily available and low density.The natural fiber has high strength and stiffness for given light weight material.The natural fiber reinforced composites can be easily processing,cost reduction, increase the productivity and low environment pollution.This test can be conducted for valuable information about the toughness of material, which can be used in an engineering critical assessment. The design consideration the fracture toughness is important parameter to manufacturing the components.Santhanamet al.[1]. Banana fiber and glass fiber with varying volume fraction and 10mm chopped fiber and polyster resin used prepare the composites by hand lay- upprocess,they have reported mode one fracture toughness banana fiber reinforced polymer composites is in closeness for the glass fiber reinforced polymer composites and also banana fiber better alternative for future application.ParweenaliKhudhur et al.[2]investigated different orientation of treated and untreated sugar palm fiber reinforced epoxy composite fabricated ,they have found fracture toughness sea water treated better performance than untreated fiber.Silva et al.[3]reported fabricated the treated and untreated polyurethane composites,they have studied treated sisal fiber best performance tan the untreated composites.Venkateshwaranetal.[4] fabricated banana epoxy reinforced composites in three pattern weaving , found the tensile,flexural and impact properties plain weave pattern higher performance than other two pattern,also studied the dynamic characteristic of weaving pattern composites.Vasumathi[5] fabricated the hybrid laminate with natural fiber and with out natural fiber ,the results with natural fiber high performance of tensile and flexural modulus than the without natural fiber,but flexural strength high for without natural fiber.Also the result copare with the experimental and analytical both the results has close agreement.Palanikumar et al. [6]reported hand lay-up process used to fabricate the sandwich fiber reinforced polyester composites and added fot different nano clay loading ,they have found 4wt% nano-clay loading higher flexural,impact and physical properties,also investigated X-ray and SEManalysis.Anbusagar.NNR[7]investigated glass fiber withps foam sandwich with nano-clay loading and without nanoclay composite fabricated by hand lay-up process, they have studied vibration behavior 4wt% of nanoclay loading increase the performance,also studied SEM analysis increasing the nano clay upgrade the adhesion of fiber and matrix.Anbusagar[8]reported hand lay up process is used to fabricate the sandwich hybrid reinforced polyester composites with and with outnano clay for different loading condition,they have point out maximum flexural strength 2wt% of nano clay loadingwith hybrid polyester composites,impact strength maximum for 6wt% of nanoclay loading,alsoSEM analysis of sandwich composites shear deformation and bending load cary for core and skin were studied.Anbusagaretal[9]reported four different nano clay loading of glass fiber reinforced polymer composites fabricated by hand lay- uptechnique,they have studied 4wt% of nano-clay loading maximum tensile,flexural and deformation,also studied SEM image increasing the nano clay upgrade the adhesion of fiber and matrix.Jayapaul[10]investigated woven coir polyester composites with varying percentage of NaOH treated with varying hours and untreated woven coir polyester prepared by hand lay-uptechnique,they have reported improve mechanical and machinability characteristic such as tool wear torque and thrust force treated woven coir polyester composite, also compare the machinability behavior of treated woven coir polyester composites with mathematical model and regression model.Palanikumar et al. [11] prepare the glass fiber sandwich laminate the core material used for the Styrofoam and varying wt% nano clay by hand lay-up technique,they have list out flexural strength increase with 4wt% nanoclay glass fiber reinforcedcomposites,impact strength increase with 6wt% nanoclay glass fiber reinforced polyester composites.Venkateshwaran et al[12]fabricated the banana epoxy reinforced polymer composites,they have reported mechanical properties experimental values close agreement of modified rule of mixture.Vasumathi[13] studied replacement of carbon in the place of fiber(jute) fabricated FMLby compression mouldingprocess,they have reported orientation of fiber and stacking sequence best mechanical property used for alternative material replacement of aluminium and magnesium metal.Muralimohan Rao et al[14] investigated synthetic fiber replacement of conventional metal and also synthetic fiber welcomed to natural fiber composites to help create environmental effect.Sahariet al. [15] Biodegradable matrix are used to prepare the biocomposites they have found the modulus ratio,tensilemodulus,flexural modulus ,flexural and impact strength of different volume fraction of green composites.AbdulKhalil[16] impartment alternative to solve the problem is to used the agriculture residues as reinforcement to development of polymer composites.Rathika et al. [17]fabricated the six layers different natural fibers,glass with natural fiber reinforced polyester composites.They have investigated sisal-banana-palf hybrid reinforced polyester composites better tensile,flexural and impact strength than the composites. The naturalfiber used in this work replace the hybrid glass-natural fiber reinforced composites because of its low density, cost etc.

TEST Engineering & Management

January-February 2020
ISSN: 0193-4120 Page No. 7122 - 7130

II. MATERIALS USED FOR FABRICATE THE COMPOSITE SPECIMEN

Caryotafiber with 35wt%,40wt% and 45wt% loading with different fiber length 10mm,25mm,50mm,100mm and125mm.Matrixused Polyester resin 10:1 for the weight, Accelerator-Methyl ethyl ketone and Catalyst-Cobalt Naphthalene Unsaturated Polyester resin is one of the low cost resin compare to the other resin,Polyester resin are especially used for natural fiber composite fabrication.Unsaturated means that the resin is capable of being cured from a liquid to a solid state.

Caryota fiber extracted from flower stem of fish tail palm tree.First fish tail palm tree flower stem cut and dried in 24 hours in the sun light then remove the urens in the flower stem.The flower stem contains 3meter to 4meter long,then cut to the required length,the required length flower stem is immersed in the water for 3hours.The wet condition flower stem is punched in small force by using wooden mallet,soften the flower stem.By using manual isolation method the individual fiber collected and then used for composite preparation.

III. EXPERIMENTAL PROCEDURE

Caryota fiber with different length10mm,25mm,50mm,100mm and 125mm and varying wt% at random orientation were placed inside the lower part of die.The required Wt% polyester resin ,accelerator and catalyst poured in the lower part of the die, upper part of the die is placed .Finally the 55Kgf/cm2 hydraulic load is applied and set temperature of 600C and kept for30min at atmospheric temperature.The composites were produced for different wt% and different fiber length,all the composites the constant for overall weight.

Fig.1. 40Wt% of 10mm,25mm,50mm,100mm and 125mm length of fractured specimen

The fracture toughness was found using as per ASTM standard D638,the machine used for testing isInstron tensile testing machine. Thelength,width and thickness of specimen 100mm,100mm and3mmrespectively,8mm two holes and centrally cutting a notch, the surface

January-February 2020
ISSN: 0193-4120 Page No. 7122 - 7130

are finished by emery paper. For testing two bolts inserted in the hole thus the compact specimen is fixed in the machine then the pull load is applied the specimen is elongated .The machine encoder unit the digital graph is generated in load vselongation,the each five samples tested for varying fiber loading and varying fiberlength, the average loadvalue is used for the result and discussion [1-9].

Critical stress intensity (Kic)Santhanam et al[1]
Kic=F/D(W)0.5{f(a/w)}
Let K-fracture toughness it depends on load,depth of flow and geometry factor
F-load at which crack propagate
D-Depth of the test specimen
W-length of specimen
a-Creak length and f(a/w)-geometry factor

Table1 1. Average load obtained from machine caryotafiber composites

	Average load in N				
Wt%	**10mm**	**25mm**	**50mm**	**100mm**	**125mm**
35	9.23	10.1	8.56	8.12	7.90
40	13.56	14.93	12.58	11.32	10.98
45	8.83	9.86	8.01	7.85	7.23

Table2. Experimental fracture toughness values

	Experimental fracture toughness in kg/m^0.5 s2				
Wt%	**10mm**	**25mm**	**50mm**	**100mm**	**125mm**
35	4.17	4.51	3.868	3.669	3.569
40	6.123	6.746	5.684	5.115	4.96
45	3.990	4.455	3.619	3.547	3.267

IV. RESULT AND DISCUSSION

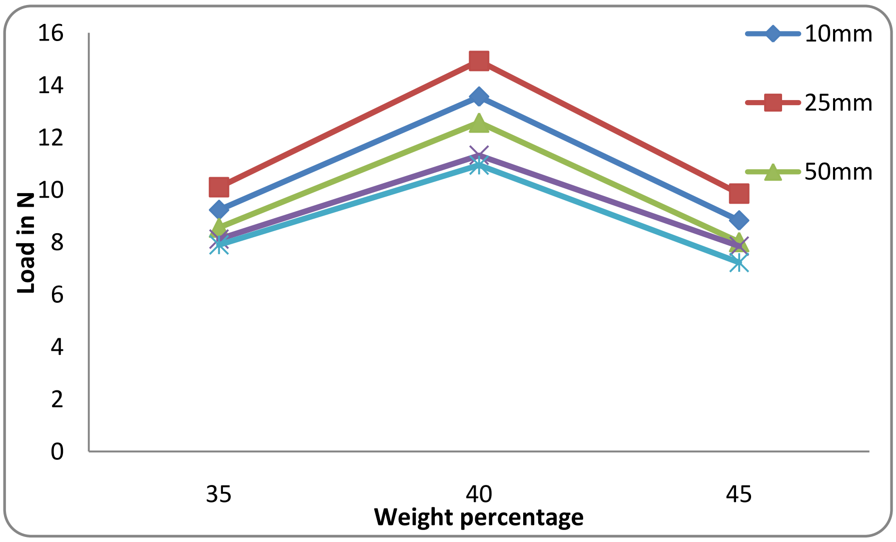

Fig.2. Load vs Wt% of varying length 10mm,25mm,50mm,100mm and 125mm Composites

January-February 2020
ISSN: 0193-4120 Page No. 7122 - 7130

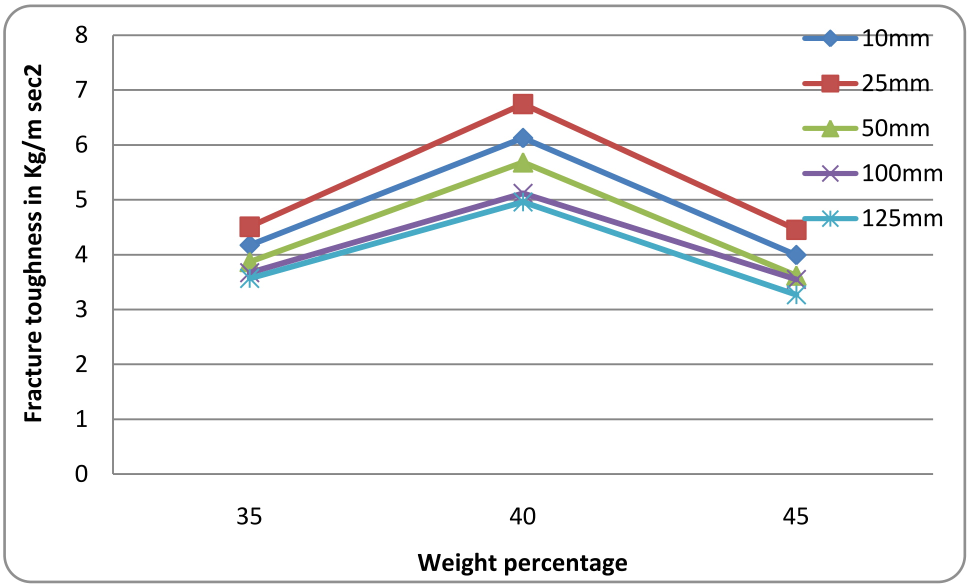

Fig.3.Fracture toughness vsWt% of varying length 10mm,25mm,50mm,100mm and 125mm Composite

The fracture toughness of the caryotafiber reinforced polyester composites with the various weight percentage for the various fiberlength.The Fig.3shows the variation of fracture toughness over the percentage increase in weight fractions for the various fiberlength.Thefracture toughness decrease from 4.51 to 3.569 for the 34wt% of the fiber when the fiber length increase from10mm to 125mm for 34wt% of the fiber accumulation is less in the composites,so the percentage increase between the fracture toughness is 20.8% similar increasing trend in the fracture toughness for the 40wt% of fiber is 26.47%. The maximum fracture toughness of the caryotafiber reinforced composites lies in between 10mm and 25mm fiber length are 34.8% and 33.9% respectively.It is absorbed that the fracture toughness of the composites increases in wt% fibereloading.The load transfer is good in between fiber and the matrix.Further increase in the fiber length and increase in weight percentage of fiber loading reduce the fracture toughness,thefiber and matrix cannot be significant.The polyester resin converts the brittleness into ductile so the fracture toughness is maximum for the 40wt% of fiber,the 45wt% of fiber loading the ductility is more the brittleness is less ,so the fracture toughness is minimum.The increasing trend continuous up to 40wt% fiber, which has the maximum fracture toughness [10-20].

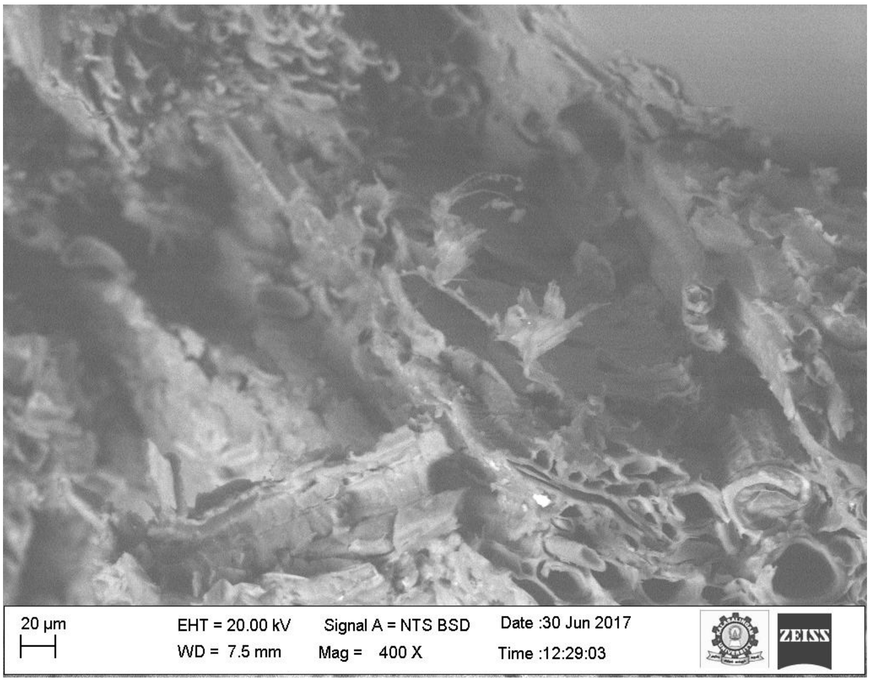

Fig.4.Fractograpy analysis of 25mm 40Wt.% of caryotafiber reinforced composites

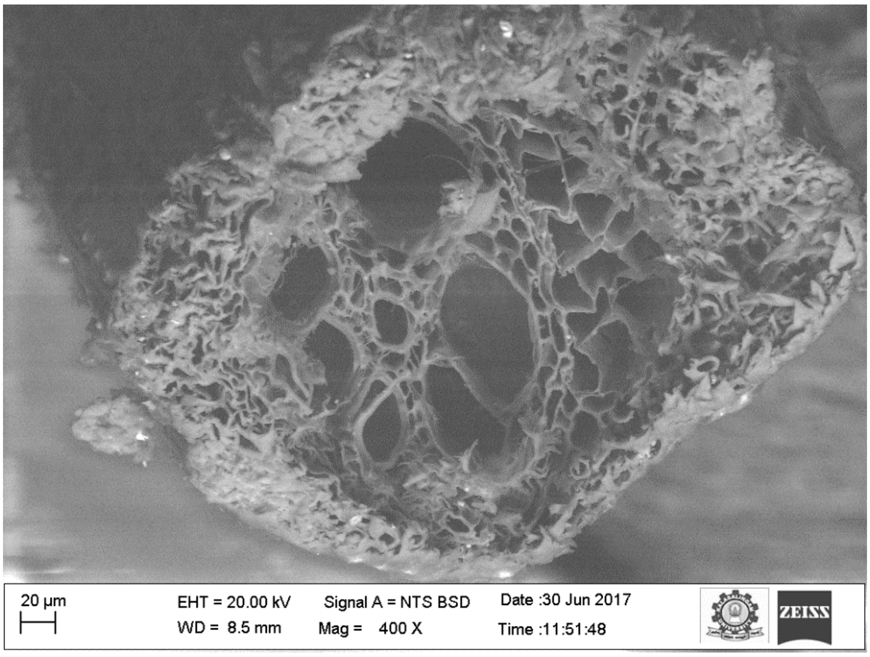

Fig.5 .Fractograpy image of 25mm ,45Wt.% of caryotafiber reinforced composites

January-February 2020
ISSN: 0193-4120 Page No. 7122 - 7130

Fig. 6.Fractograpy image of 25mm, 35Wt.% of caryotafiber reinforced composites

The fractography analysis of fractured specimen was studied using SEM analysis.SEM analysis utilized for performing one half of the fractured specimen.Thefractograpy analysis of the fracture toughness of the specimen of 40wt.% is shown in Fig.3.The fractography analysis the fiber pull out is minimum for the 40wt.% of fiber reinforced composites. It shows the bonding between the fiber and matrix is very good,due to the fiber have undergone the less breakage of the predominance of fiber pullout .The fracture toughness indicate that the elongation is more due to the load transfer between the fiber and matrix at the interphase region of the composites.The effective load transfer between the fiber and matrix proven due to the higher fracture toughness .At 40wt.% of fiber build up more due to the interfacial bonding better and matrix bonding is highly increased and causes the increase in fracture toughness, considering all the factors the optimized the fracture toughness for 40wt.% fiber loading in 25mm caryotafiber have good interfacial ,less fiber pull out and poor intra fiber delamination.

Fig.4.shows the fractured specimen for the 45wt.% and 25mm length of specimen.The fractography resut indicate the fiber pull out is maximum for the fiber reinforced composites. It shows the bonding between the fiber and matrix is less, due to the fiber undergone the more breakage it will cause more pull out.The fracture toughness indicate that the elongnation is less due to the load transfer between the fiber and matrix at the interphase region of the composites.Fig.5.shows the fractured specimen for the 35wt% and 25mm length of specimen.The 35wt.%fiber loading the fiber accumulation is less due to the minimum interfacial bonding it will causes the decrease the fracture toughness[21-23].

V. CONCLUSION

- In this experimental work the effect of newly developed chopped caryotafiber randomly oriented with varying fiber loading and different length 10mm,25mm,50mm,100mm and 125mm the load vs elongation is generated on the encoder unit of the machine. The average load was tabulated by using stress intensity factor formula the fracture toughness was calculated and tabulated.

- The experiment indicates the fracture toughness maximum value6.746kg/m^0.5 s2for the25 mm length of 40wt.%fiber loading of caryotafiber reinforced polyester composites.
- It is found that the increase in the fiberwt% increase the fracture toughness. The maximum fracture toughness of the chopped fiber reinforced composites 40wt% of fiber loading for the 25mm length of fiber is 6.746.
- This value 33.9% higher than the other wt% of composites in a 25mm fiberlength.In general the short fibers have higher fracture toughness and higher fiber ends which is accumulated in the composites.

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