Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 2, Number 7; April-June, 2015 pp. 530-534

http://www.krishisanskriti.org/jbaer.html

Flexural Creep Studies on Banana-Pineapple Hybrid Natural Composites

P. Anusha[@], B. Lakshmi[+], S. Madhusudan[#] and Ch. Ramakrishna[$]

[@]*P.G.student, Mech. Engg. Dept, Sir C.R.Reddy College of Engg, Eluru-534007. India*
[+]*P.G. Student, Mech. Engg. Dept, NOVA college of engineering, Vijayawada India*
[#]*Mech. Engg.Dept, Sir C.R. Reddy College of Engg, Eluru-534007, India.*
$ Mech. Engg. Dept, Sir C.R.Reddy College of Engg, Eluru-534007. India

Abstract—*Flexural creep behavior of Banana/Pineapple hybrid composites is estimated in the present investigation. Hybrid composites are prepared using banana/pineapple fibers of 20:0, 15:5, 10:10, 5:15 and 0:20 ratios.Composites are manufactured using manual hand lay-up technique. All the specimens are subjected to different flexural loads ie 2.5, 5 and 7.5 kgs. A simple test set up has been designed to accommodate all the samples. Specimen deflections are periodically recorded with respect to time. Total experimentation is conducted at room temperature i.e at 25^{0}C. Glass fiber reinforced composite is also fabricated under similar processing conditions and comparison studies have been made with natural composites. Results show that both natural and hybrid natural composites has shown moderate to good flexural creep resistance behavior.*

Keywords*: Polymer matrix composites, Hybrid composites, Flexural creep, Deflection.*

1. INTRODUCTION

Composite materials consist of two or more distinct materials to get superior properties which cannot be obtained by any one individual material. Many of the composite materials composed of continuous and discontinuous phases. The continuous phase is known as matrix and discontinuous phase is known as reinforcement [1-2]. The reinforcement gives additional strength and stiffness and there by enhances the composite properties. The reinforcements are generally a fiber, particle and whisker. Based on availability fibers are of two types, namely synthetic and natural. Nylon, carbon and glass are some of the examples of synthetic fibers whereas jute, sisal, banana, cotton etc are few examples of natural fibers. Natural fibers as reinforcement have recently attracted the attention due to their own advantages. They include availability, economical, biodegradable, and environment friendly etc [3]. So far work has been carried out on the potential use of natural fibers such as sisal [4-7], bamboo [8-10], banana [11-14], coir [15-16]. Apart from the advantages stated, there are some disadvantages for example low thermal stability and moisture expansion etc. Hybridization approach is used to make cost effective composites. Hence in the present study an attempt has been made to fabricate banana/pineapple natural fiber hybrid composites and studying their flexural creep behavior.

2. EXPERIMENTAL

2.1 Fabrication of composite

Table 1: Properties of banana and pineapple fibers [17]

Properties	Banana	Pineapple
Density, kg/m3	1350	1440
Moisture content (%)	10-11	11-12
Lignin (%)	5	4.6
Cellulose (%)	63-64	81-120
Hemi cellulose (%)	19	19
Micro fibrillar angle	11	14
Lumen size, mm	5	2-3
Tensile strength, MPa	529-914	413-1627
Young's modulus, GPa	27-32	60-82

Table 1 shows various properties for banana and pineapple fibers. A teak mould of 350 x 330 x 5 mm was prepared for the fabrication of composites. All the composites are fabricated using hand layup technique.The moulds are cleaned and dried before applying epoxy. Remover is coated on the top and bottom surfaces of mould. Banana and pineapple fibers with varying proportions (20:0, 15:5, 10:10, 5:15, 0:20) were placed uniformly in the mould before applying epoxy or releasing agent. After placing fibers uniformly, they were compressed with the help of bottom and top plates for few minutes to ensure good quality of the composite. The epoxy mixed with hardener is then poured uniformly over the fibers and compressed. The curing time was maintained for 24 h. For comparison purpose pure banana and pure pineapple fiber reinforced composites are also fabricated under similar processing conditions.

3. TESTING

Fig. 1: Close view of sample under creep testing

Fig. 1 shows the sample under testing. Each sample is loaded with 2.5, 5 and 7.5 kgs as shown in fig 2. The deflection values are recorded periodically at an interval of two weeks. All the samples are tested at an average room temperature of 25^0C. A total of 3 samples are tested in each case and the average values are reported.

Fig. 2: A view of composites subjected to different loads

Table 2: Deflections obtained for banana and pineapple composites

Time	Load	Type of composite	
		PURE BANANA	PURE PINEAPPLE
INITIAL	2.5kg	0	0
	5kg	0.5	0.5
	7.5kg	1	1.5
15DAYS	2.5kg	1.46	3.08
	5kg	2.40	4.02
	7.5kg	4.02	4.64
30DAYS	2.5kg	1.58	3.44
	5kg	2.44	4.32
	7.5kg	5.92	f
45DAYS	2.5kg	2	3.72
	5kg	3.16	4.44
	7.5kg	6	f
60DAYS	2.5kg	2.3	3.9
	5kg	3.34	4.5
	7.5kg	6.04	f

Table 3: Deflections obtained for banana/ pineapple hybrid composites

Time	Load	Type of composite		
		15B-5P	10B-10P	5B-15P
INITIAL	2.5kg	0	0	0
	5kg	0	0	0.5
	7.5kg	1	1	1
15DAYS	2.5kg	0.06	1.36	0.1
	5kg	2.80	2.2	3.6
	7.5kg	5.2	2.4	5.02
30DAYS	2.5kg	1.28	1.5	0.3
	5kg	3.19	2.36	3.8
	7.5kg	5.5	2.96	f
45DAYS	2.5kg	1.4	1.76	0.5
	5kg	3.42	2.48	3.84
	7.5kg	6.2	3.24	f
60DAYS	2.5kg	1.9	1.8	0.6
	5kg	3.96	2.6	4.02
	7.5kg	f	3.3	f

4. RESULTS AND DISCUSSIONS

Table 2 and table 3 shows the summary deflections obtained for banana, pineapple and banana/pineapple hybrid composites at various loads.

Fig. 3 shows the trend for 8 weeks for banana composite under various loads. Creep is significant at higher time duration as compared to initial stages. For first week there is no remarkable deflection at 2.5 kg load. During second week at 7.5 kg load, the sample has failed. This may be due to manufacturing defects. It can be also observed that the flexural creep deflection is increasing with the increase in load. Fig. 4 shows the trend for 8 weeks for pineapple composite under various loads. At lower load i.e 2.5 kg, there is no initial deflection for the first week. However the creep deflection is reasonable during second week and also at 7.5 kg load. The samples were failed during 4^{th} week at higher load i.e 7.5 kg. This is due to lower load bearing capacity of pineapple fiber composite.

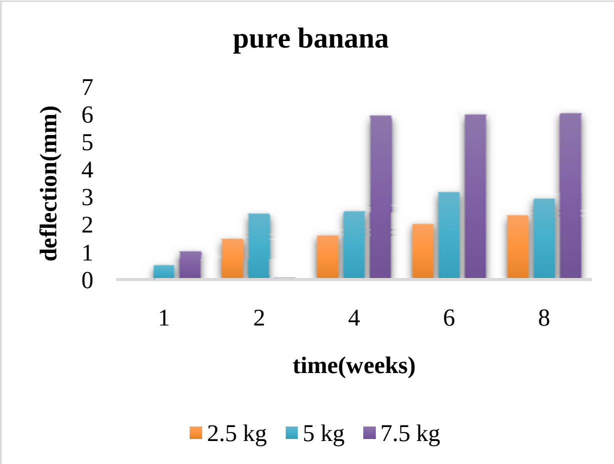

Fig. 3 : Creep behavior of Banana fiber composite under various loads.

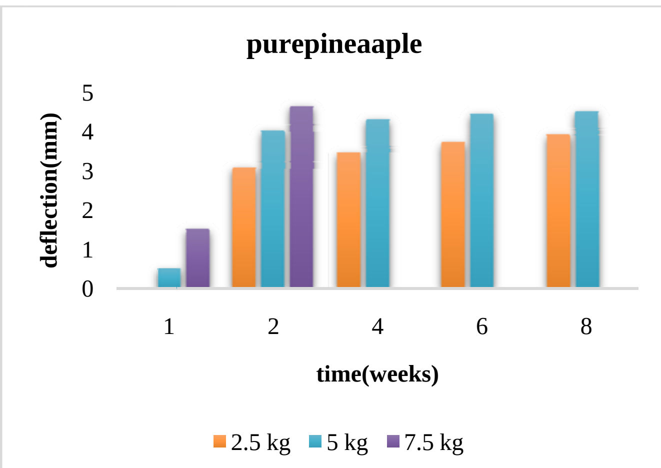

Fig. 4 : Creep behavior of Pineapple fiber composite under various loads.

Fig. 5 shows the trend for 8 weeks for 15 Banana-5 Pineapple fiber composite under various loads. The creep deflection is negligeble for the first week at lower loads, i.e 2.5 kg and 5 kg. During second week also there is no variation in deflection at lower load. There is gradual variation in creep with respect to time as well as with respect to increase load. The trend values are also same as compared to pure case of pineapple composite. After 8^{th} weeks the samples were failed at 7.5 kg.

Fig. 6 shows the trend for 8 weeks for 10 Banana-10 Pineapple fiber composite under various loads. At lower loads and initial time interval the deflections are negligeble.However reasonable variations can be observed at loads with respect to time. The deflection values are lower as compare to 15B-5P composites. Even after 8^{th} week the samples have sustained with out failure. This may be due to hybridization effect.

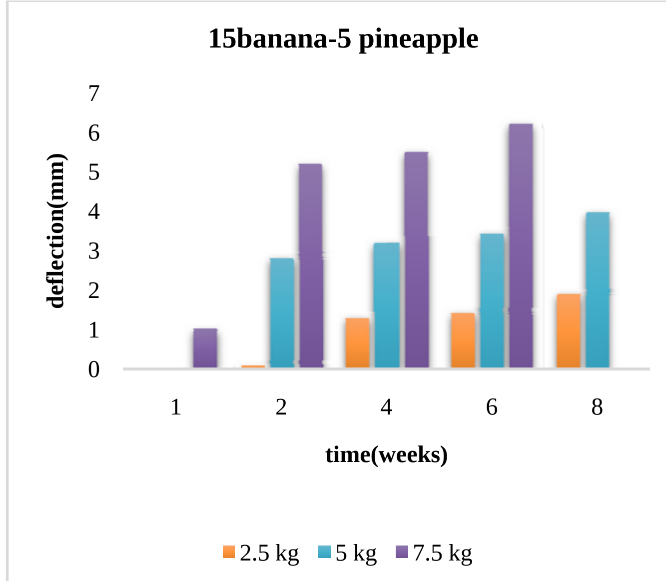

Fig. 5 : Creep behavior of 15 Banana-5 Pineapple fiber composite under various loads.

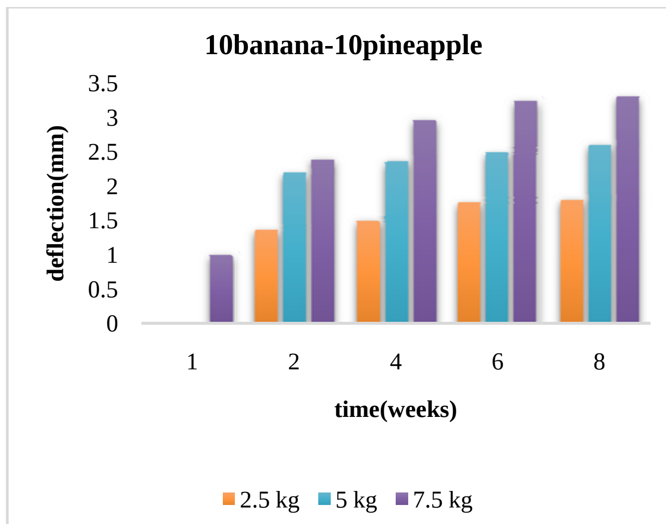

Fig. 6 : Creep behavior of 10 Banana-10 Pineapple fiber composite under various loads.

Fig. 7 shows the trend for 8 weeks for 15 Banana-5 Pineapple fiber composite under various loads. There is no initial deflection for 2.5 kg load. With respect to time the flexural creep is increasing at the same load. During second week increased deflections are noted. After 2^{nd} week the samples are observed to be failed with respect to time as well as increasing load. It may be due to higher concentration of pineapple fiber which might have lead to the failure. This can also be attributed to incompatability between matrix and reinforcement as well as with in the reifocement combination.

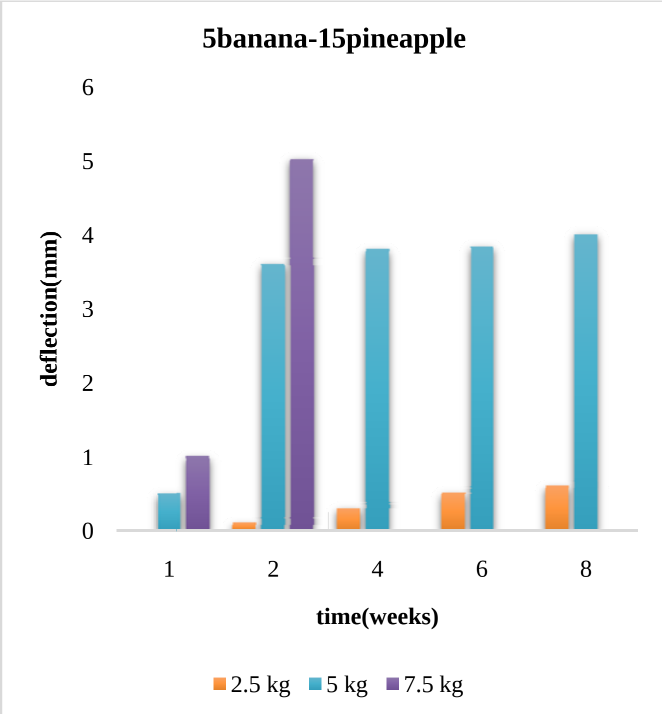

Fig. 7 : shows the trend for 8 weeks for 15 Banana-5 Pineapple fiber composite under various loads.

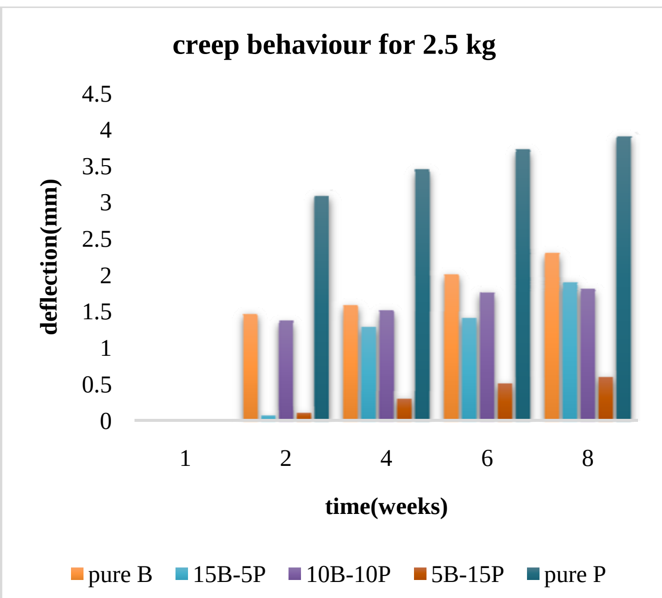

Fig. 8 : Creep behavior of all composites at 2.5 kg load.

Fig. 8 shows the trend for 8 weeks for all composites at 2.5 kg load. During first week there are no response to creep. It can be also seen from the above fig that pineapple fiber reinforced composite has dominating creep deflection as compared to banana fiber reinfroced composite. With the addition of pineapple fiber to the banana fiber the flexural creep deflections are dropped (15B-5P). Upon further addition of pineapple fiber the deflections are much higher.

How ever at dominating pineapple fiber hybrid composite the deflections are dropped. This may be due to some manufacturing process variations.

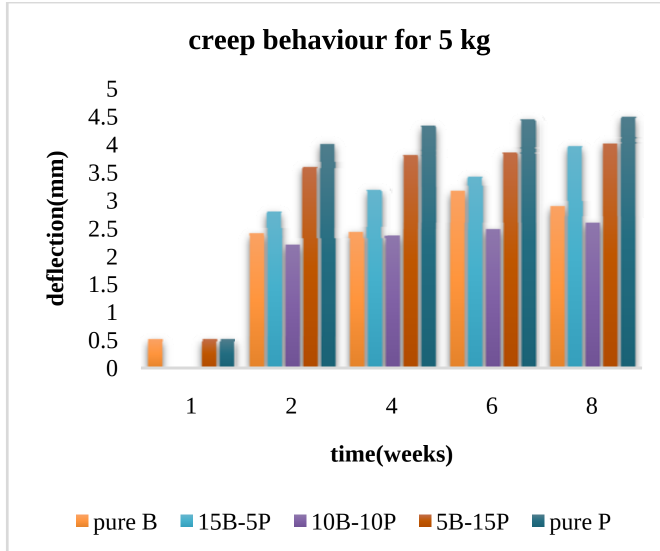

Fig. 9 : Creep behavior of all composites at 5 kg load.

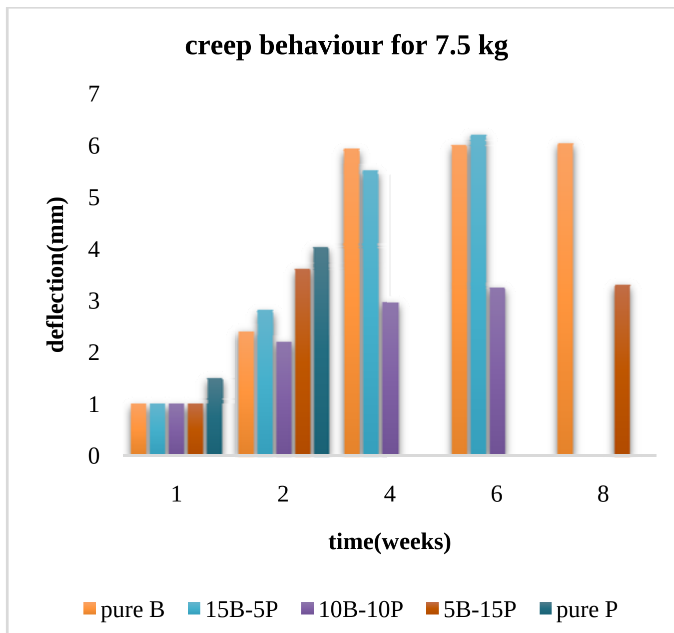

Fig. 10 : Creep behavior of all composites at 7.5 kg load.

Fig. 9 shows the trend for 8 weeks for all composites at 5 kg load. The fluxural creep values are increasing with respect to time. 10B-10P hybrid composite has shown moderate to less flexural creep deflections as compared to other hybrid composites. This may be due to proper hybridization concept. Pure pineapple and pure banana composites has shown highest and lowest deflctions for the reasons explained in earlier paragraphs.

Fig. 10 shows the trend for 8 weeks for all composites at 7.5 kg load. Initial deflectios are negligeble for all composites. However stady increment deflection can be seen with respect to time. Interestingly pure pineapple composite has failed after 4th week . The reason can be explained in two ways. One may be due to less load bearing capacity of pineapple fiber and second may be due to due higher load application as compared to earlier loads, i.e 2.5 and 5 kgs.

5. CONCLUSIONS

1. Pure banana, pure pineapple and banana/pineapple hybrid composites are successfully fabricated through hand layup technique.
2. Failure due to flexural creep is high in case of pure pineapple composite as compared to pure banana composite.
3. Flexural creep failure is decreasing at a proper combination of banana-pineapple fibers due to hybridization effect.
4. Flexural creep behavior for pineapple rich is close to pure pineapple composite whereas banana rich composite behavior is close to pure banana composite.
5. Overall, the natural hybrid composites can be an alternative replacement in place of artificial fiber reinforcements.

REFERENCES

[1] K.John, S.Venkata Naidu, "Chemical resistance studies of sisal/glass., fiber hybrid composites", J. Rein. Plast.Comp. 26(4) (2007) 373–376.
[2] H. P. S. Abdul Khalil, S. Hanida, C. W. Kang, N.A.Nikfuaad, Agrohybrid composite: "the effects on mechanical and physical properties of oil palm fiber(efb)/glass hybrid reinforced polyester composites", J. Rein. Plast. Comp. 26(2) (2007) 203–218.
[3] N. Venkateshwaran , A. Elayaperumal, G.K. Sathiya "Prediction of tensile properties of hybrid-natural fiber composites", composites: part B, 43, 2012, pp793-796.
[4] Joseph Kuruvilla, Tolêdo Filho Romildo Dias, James Beena, Thomas Sabu, de Carvalho Laura Hecker. A review of sisal fiber reinforced polymer composites. Revista Brasileira de Engenharia Agrícola Ambiental 1999;3(3):367–79.
[5] Paramasivam T, Abdul Kalam APJ. On the study of indigenous natural fiber composites. Fiber Sci Technol 1974; 7:85–8.
[6] Bai SL, Li RKY, Wu LCM, Zeng HM, Mai YW. Tensile failure mechanisms of sisal fibers in composites. J Mater Sci Lett 1998;17(21):1805–7.
[7] Kalaprasad GK, Joseph K, Thomas S, Pavithran C. Theoretical modelling of tensile properties of short sisal fiber–reinforced low-density polyethylene composites. J Mater Sci 1997;32(16):4261–7.
[8] Vardarajulu A, Ganga Devi L, Babu Rao G, Lakshmi Narayana Reddy R. Chemical resistance and tensile properties of epoxy/unsaturated polyester blend coated bamboo fibers. J Reinf Plast Compos 2003; 22(11):1029–34.
[9] Jindal UC. Development and testing of bamboo fibers reinforced plastic composites. J Compos Mater 1986; 20(1):19–29.
[10] Yong CAO, Yi Qiang WU. Evaluation of statistical strength of bamboo fiber and mechanical properties of fiber reinforced green composites. J Cent South Univer Technol 2008; 15:564–7.
[11] Venkateshwaran N, Elayaperumal A. Banana fiber reinforced polymer composites – A. Rev J Reinf Plast Compos 2010; 29(15):2387–96.
[12] Pothan Laly A, George Jayamol, Thomas Sabu. Effect of fiber surface treatment on the fiber matrix interaction in banana fiber reinforced with polyester composites. Compos Interfaces 2002;9(4):335–53.
[13] Venkateshwaran N, Elayaperumal A, Jagadesshwaran MS. Effect of fiber length and volume fraction on mechanical properties of natural fiber composites. In: Proceeding of APM-2010 conference, CIPET, Bhubaneswar, India; February 2010. p. 323–6.
[14] Sapuan SM, Leenie A, Harimi M, Beng YK. Mechanical properties of woven banana fiber reinforced, epoxy composites. Mater Des 2006; 27(8):689–93.
[15] Rout J, Misra M, Mohanty AK, Nayak SK, Tripathy SS. SEM observations of fractures surfaces of coir composites. J Reinf Plast Compos 2003; 22(12):1083–100.
[16] Varma DS, Varma M, Varma IK. Coir fibers-II. Evaluation as reinforcement in unsaturated polyester resin composites. J Reinf Plast Compos 1985;4(4):419–31.
[17] Mukherjee KG, Satyanarayana KG. "Structure and properties of some vegetable fibers." J Mater Sci 1984; 19:3925–34.