ENGINEERING AND TECHNOLOGY IN INDIA

Volume 5 | Issue 1&2 | Apr. & Oct., 2014 | 15-21
e ISSN-2230-9284 | Visit us : *www.researchjournal.co.in*
DOI : 10.15740/HAS/ETI/5.1and2/15-21

ARTICLE CHRONICLE :
Received : 07.08.2014;
Revised : 24.08.2014;
Accepted : 15.09.2014;

RESEARCH PAPER

Performance evaluation of bamboo sliver making machine

■ **S.P. KURHEKAR AND N.S. SHINDE**

ABSTRACT

The bamboo sliver making machine is electrically operated by a 3-phase, A.C induction motor. The readings were taken at no load condition and at load conditions for fresh as well as dry bamboo of different varieties. The power required at no load condition was 2.23 kW. At load condition for freshly cut bamboo energy consumed was 3.10 kW. Similarly, for dry bamboo energy consumption was 2.43 kW. The capacity for freshly cut bamboo was found to be 36 slivers per minute. Similarly, the capacity of machine for dry cut bamboo was found to be 42 slivers per minute. The cutting efficiency for freshly cut bamboo was found to be 76.19 % similarly, for the cutting efficiency for dry cut bamboo was found to be 77.82 %. The cutting efficiency increases with decrease in moisture content. The percentage damaged for freshly cut bamboo was found to be 23.79 %. Similarly, the percentage damaged for dry cut bamboo was found to be 24.05%. The percentage damage decreases with increase in moisture content.

KEY WORDS : Bamboo sliver, Moisture content, Efficiency

How to cite this Article : Kurhekar, S.P. and Shinde, N.S. (2014). Performance evaluation of bamboo sliver making machine. *Engg. & Tech. in India,* **5** (1&2) : 15-21.

INTRODUCTION

Bamboo is fast growing renewable forest based resource. It is single, most important forest produce used by mankind for diverse purpose. Some of the prominent uses are in house construction as structural material, agriculture implements, fishing industry, basket making horticulture and handicraft etc. besides extensive use in pulp and paper industry. The handicrafts are mould from fresh cut green bamboos, because they can be easily moulded into any shape (Abd and Khoo, 1992; Chancellor, 1993). But for structural purpose the fully matured, dry bamboos are used the bamboo has low natural durability so preservation is necessary (Bali, 2003). It can be done by traditional and chemical methods (Behera, 1996). The present day situation has necessitated the utilization of renewable and sustainable non-woody resources like bamboo for wood substitution. This is particularly important for developing countries like India where forests have been declining due to increase construction activities and increased demand of population (Hasnin *et al.*, 1997). Bamboo and its related industries provide income, food and housing to over 2.2 billion people worldwide (Lopez, 2003). Bamboo is used as an important raw material for various construction works and it has got a significant importance both at the urban and village levels. The global yield of bamboo is estimated to be about 16 million tons. Of this nonindustrial uses (such as farm implements, household articles, handicraft items, construction, etc.) account for about 70%. Only 30% of the yield goes for industrial use, mainly for pulp making (Haun-Ming, 2005). Bamboo's fast growth, good strength, straightness, lightness, hardness, varying sizes, easy workability, ease of propagation and quick maturity made it suitable for a variety of purposes (Haun-Ming, 2005; Yuming and Jian, 1994). The tensile strength of the fibers of a vascular bundle of bamboo could be up to 12,000 kg/cm^2, almost twice that of steel (Lopez, 2003). It is not unlikely that bamboo can be used satisfactorily to produce products with qualities equivalent to or better than those of wood (Yuming and Jian, 1994).

Muli bamboo (*Melocanna baccifera*) is distributed in India, Bangladesh, Myanmar and cultivated in many Asian countries

(Sattar *et al.,* 1990). It is the most common forest grown bamboo species in Bangladesh with small culm diameter and thin wall. This species constitutes 70-90 percent of total bamboo forests of the country (Banik, 1980; Drigo *et al.,* 1988; Hansin *et al.,* 1997).The bamboo sliver making machine is designed to sliver the bamboo slivers to required thickness. The sliver has varied usage depending on the finished product. It can be used for making mats and various handicraft items. The sliver serve as raw material for the stick manufacturing machines and can be used for making round, square and oval slivers for blinds, handicrafts and toothpick sticks etc. the machine uses hardened chisel for the operation. The chisel has three axes of motion for setting providing a lot of flexibility in the operation. The fully matured dull green bamboo contains the 12.80 percent moisture and freshly harvested bamboo contains 44.32 percent moisture contain. All the handicrafts and furniture are made manually. But it is a time consuming and laborious work. Also, due to the fibrous nature of the bamboo woodworking machines cannot be used (Bining, 1985). Thus it is necessary to develop some specific machines to work with bamboo. Looking at the vast vacuum for industrialization in bamboo processing machines, some of the industry forayed into developing of these machines in India.

EXPERIMENTAL PROCEDURE

Bamboo sliver making machine :

The bamboo slivers have fibrous structure thus it cannot produce by any wood working machine. The machine having dimensions as 0.6×0.95×1.3 m, power consumption is 2.25 or 3 hp motor.

Bamboo variety :

Three varieties of bamboo were used for the study *viz., Pseudoxytenanthera stocksii* (Mes), *Pseudoxytenanthera ritcheyi* (Manga), *Dendrocalamus strictus* (Manvel).

The moisture content of the bamboo was determined with the help of hot air oven at temperature of $103+2^0$ C. The specimen has a thickness of 1 to 1.5 cm and taken at least 30 cm from one end, knot should be avoided. The specimen was weighted and then placed in oven at $103+2^0$ C until its weight become constant. Multi meter was used to measure the line voltage across. The AC voltage measurement has five-measurement position on the rotary switch: 400MV, 4V, 40V, 400V and 750 V. Tong tester was used to measure the line current through each wire R, Y, B in three phase four wire induction motor. The measurement of power of 3-phase AC induction motor was by measuring line current and line voltage. Three phase, four-wire system has red, yellow, blue and neutral wires indicated by letter R, Y, B and N, respectively. Hold each wire R, Y and B in the tong tester and the current passing through each wire shown on display. Power required was calculated as :

$$P = V \times I \times \cos$$

where,
P = power, kW
V= voltage, volt
I= current, ampere
Cos= power factor taken as 0.85
The energy is work done per unit time. It was calculated as :

$$E = p\frac{t}{60}$$

where,
E=energy consumed kWh
P=power required, kW
t=time, min.

The capacity of bamboo sliver making machine expressed in terms on number of slivers produce per minute. After each replication the number of slivers produce was counted manually. Cutting efficiency of the bamboo sliver making machine is expressed as broken slivers over the total quantity of slivers produced. The percentage damaged of sliver making machine is expressed as number of damaged slivers after cutting to total number of slivers produced.

EXPERIMENTAL FINDINGS AND ANALYSIS

The result obtained from the resent investigation have been discussed in the following points :

Moisture content of fresh and dry cut bamboo :

The data from Table 1 shows that fresh fully matured; dull green bamboo contains the average moisture content of 44.32 per cent. The Table 2 shows that the dry, yellowish bamboo contains average 12.80 per cent moisture.

Table 1 : Moisture content of fresh cut bamboo

Sr. No.	Sample number	Initial weight (g)	Final weight (g)	Moisture content (%)	Average moisture content (%)
1.	V_1R_1F	114	78	46.15	
2.	V_1R_2F	151	99	52.52	
3.	V_1R_3F	106	71	49.29	
4.	V_2R_1F	160	103	55.33	
5.	V_2R_2F	152	110	38.38	44.32
6.	V_2R_3F	62	42	47.61	
7.	V_3R_1F	126	91	38.46	
8.	V_3R_2F	92	55	67.27	
9.	V_3R_3F	81	56	44.04	

Table 2 : Moisture content of dry bamboo

Sr. No.	Sample number	Initial weight (g)	Final weight (g)	Moisture content (%)	Average M.C. (%)
1.	V_1R_1D	70	62	12	12.80
2.	V_1R_2D	85	74	14	
3.	V_1R_3D	91	80	13	
4.	V_2R_1D	121	107	13	
5.	V_2R_2D	90	81	11	
6.	V_2R_3D	153	139	10	
7.	V_3R_1D	240	214	12	
8.	V_3R_2D	50	43	16	
9.	V_3R_3D	170	147	15	

Energy consumption :

The bamboo sliver making machine is electrically operated by a 3- phase, A.C. induction motor. The reading was taken at no load condition and at load conditions for fresh as well as dry bamboo. The current and voltage measurements were taken with the help clamp on meter.

Energy consumption at no load condition :

The data revealed that energy requirement at no load condition was less than the load condition. The Table 3 shows that the power required at no load condition was 2.23 kW.

Table 3 : Energy consumption at no load condition

Sr. No.	Power required kW		Power required, kW	Average power required kW
	Voltage (V)	Current (A)		
1.	380.3	4.0	2.24	
2.	376.3	4.2	2.32	
3.	380.43	3.86	2.16	2.23
4.	388.2	3.9	2.22	
5.	390.4	3.7	2.12	
6.	392.2	3.6	2.32	

Energy consumption at load condition for fresh cut bamboo :

Table 4 and 5 shows the data on energy requirement at load condition for fresh cut and dry cut respectively. Data from

table revealed that at load condition for fresh cut bamboo power required was 3.10 kW and energy consumed was 0.091 kWh and for dry bamboo it was 2.43 kW and 0.057 kWh respectively.

Table 4 : Energy consumption of machine at fresh cut bamboo

Sr. No.	Sample no.	Power required, kW		Power required	Average power required kW	Energy consumed kWh
		Voltage(v)	Current(A)			
1.	V_1R_1F	386.67	5.66	3.22		
2.	V_1R_2F	388.06	5.53	3.16		
3.	V_1R_3F	387.2	5.40	3.08		
4.	V_2R_1F	388.3	5.6	3.20		
5.	V_2R_2F	390.8	5.33	3.07	3.10	0.091
6.	V_2R_3F	380.6	5.28	2.96		
7.	V_3R_1F	390.8	5.43	3.12		
8.	V_3R_2F	394.96	5.30	3.08		
9.	V_3R_3F	388.4	5.28	3.02		

Table 5 : Energy consumption of machine at dry cut bamboo

Sr. No.	Sample no.	Power required, kW		Power required	Average power required kW	Energy consumed kWh
		Voltage(V)	Current(A)			
1.	V_1R_1D	386.4	4.50	2.56		
2.	V_1R_2D	382.64	4.30	2.42		
3.	V_1R_3D	390.0	4.25	2.44		
4.	V_2R_1D	392.4	4.35	2.51		
5.	V_2R_2D	385.46	4.45	2.52	2.43	0.057
6.	V_2R_3D	380.24	4.20	2.35		
7.	V_3R_1D	370.68	4.32	2.36		
8.	V_3R_2D	386.98	4.26	2.43		
9.	V_3R_3D	380.0	4.17	2.33		

Capacity of machine :

Capacity of the bamboo sliver making machine is expressed as number of slivers per minute.

Capacity of machine for fresh cut bamboo :

Table 6 and 7 shows the capacity of machine of fresh and dry bamboo. The number of slivers produce during each respective replication for freshly cut bamboo was found to be 36, 37, and 35 slivers for respective time. The capacity of machine for fresh cut bamboo was found to be 36 slivers produce per minute.

Table 6 : Capacity of machine for fresh cut bamboo

Sample no.	Total no. of slivers	Time	Machine capacity	Average capacity with verities	Average
V_1R_1F	55	1.34	41		
V_1R_2F	55	2.02	27	36	
V_1R_3F	61	1.54	39		
V_2R_1F	57	2.01	28		
V_2R_2F	70	1.54	45	37	36
V_2R_3F	46	1.50	38		
V_3R_1F	59	2.01	30		
V_3R_2F	59	2.01	30	35	
V_3R_3F	64	1.49	43		

Table 7: Capacity of machine for dry cut bamboo

Sr. No.	Sample no.	Total no. of slivers	Time	Machine capacity	Average capacity with variety	Average
1.	V_1R_1D	60	1.38	50		
2.	V_1R_2D	63	1.46	43	47	
3.	V_1R_3D	53	1.26	46		
4.	V_2R_1D	56	1.37	41		43
5.	V_2R_2D	59	1.43	41	41	
6.	V_2R_3D	59	1.49	40		
7.	V_3R_1D	54	1.42	38		
8.	V_3R_2D	60	2.01	30	39	
9.	V_3R_3D	54	1.11	48		

Capacity of machine for dry cut bamboo :

Data from Table 7 revealed that the number of slivers produce for dry cut bamboo. The sliver produce were 47, 41and 39 slivers for respective time. Capacity of machine for dry cut bamboo was found to be 43 slivers produce per minute.

Cutting efficiency of machine :

Cutting efficiency of the bamboo sliver making machine is expressed as broken slivers over the total quantity of slivers produced.

Cutting efficiency for fresh cut bamboo :

Table 8 and 9 shows the cutting efficiency of fresh and dry bamboo. The cutting efficiency of machine for fresh cut bamboo was found to be 76.19 per cent. The cutting efficiency increases with decrease in moisture content

Table 8 : Cutting efficiency of machine for fresh cut bamboo

Sr. No.	Sample no.	Total No. slivers	Broken slivers	Cutting efficiency	Average cutting efficiency with varieties	Average efficiency
1.	$V1R_1F$	55	10	81.81		
2.	V_1R_2F	55	7	87.27	83.68	
3.	V_1R_3F	61	11	81.96		
4.	V_2R_1F	57	12	78.94		
5.	V_2R_2F	70	19	72.85	75.15	76.19
6.	V_2R_3F	46	15	73.68		
7.	V_3R_1F	59	19	67.79		
8.	V_3R_2F	59	17	71.18	69.76	
9.	V_3R_3F	64	19	70.13		

Table 9: Cutting efficiency of machine for dry cut bamboo

Sr. No.	Sample no.	Total no. slivers	Broken slivers	Cutting efficiency	Average cutting efficiency with varieties	Average efficiency %
1.	V_1R_1D	60	16	86.66		
2.	V_1R_2D	63	13	79.36	81.77	
3.	V_1R_3D	56	16	79.31		
4.	V_2R_1D	56	17	69.64		
5.	V_2R_2D	59	15	74.57	71.23	77.82
6.	V_2R_3D	59	18	69.49		
7.	V_3R_1D	54	7	87.03		
8.	V_3R_2D	60	14	76.66	80.48	
9.	V_3R_3D	54	12	77.77		

The cutting efficiency of machine for dry cut bamboo was found to be 77.82%. The cutting efficiency was found to be maximum for dry cut bamboo.

Percentages of damaged slivers :

The percentage damaged of sliver making machine is expressed as number of damaged slivers after cutting to total number of slivers produced.

Percentage of damaged slivers for fresh cut bamboo :

Table 10 and 11 shows the percentage of damaged slivers of machine of fresh and dry bamboo. The percentage of damaged slivers of machine for fresh cut bamboo was found to be 23.79 %. The percentage damaged of slivers was maximum for dry cut bamboo.

Table 10: Percentage damaged for fresh cut bamboo

Sr. No.	Sample no.	Total no. slivers	Broken slivers	% of damaged slivers	Average damaged slivers with varieties	Average
1.	$V1R_1F$	55	10	18.18		
2.	V_1R_2F	55	7	12.72	16.31	
3.	V_1R_3F	61	11	18.03		
4.	V_2R_1F	57	12	21.05		
5.	V_2R_2F	70	19	27.14	24.83	23.79
6.	V_2R_3F	46	15	26.31		
7.	V_3R_1F	59	19	32.20		
8.	V_3R_2F	59	17	28.81	30.23	
9.	V_3R_3F	64	9	29.68		

Table 11: Percentage damaged for dry cut bamboo

Sr. No.	Sample no.	Total no. slivers	Broken slivers	% of damaged slivers	Average damaged slivers with varieties	Average
1.	V_1R_1D	60	16	23.52		
2.	V_1R_2D	63	13	20.63	23.91	
3.	V_1R_3D	58	16	57.58		
4.	$V_2 R_1D$	56	17	30.35		
5.	$V_2 R_2D$	59	15	25.42	28.75	24.05
6.	$V_2 R_3D$	59	18	30.50		
7.	$V_3 R_1D$	54	7	12.96		
8.	$V_3 R_2D$	60	14	23.33	19.50	
9.	$V_3 R_3D$	54	12	22.22		

Percentage of damaged slivers for dry cut bamboo :

Data from table 11 revealed that the percentage of damaged for dry cut bamboo.The percentage of damaged slivers for dry cut bamboo was found to be 24.05%

Conclusion :

- The power required at no load condition is 2.2 kW. Energy consumption at load condition for fresh cut bamboo is 0.091 kWh and for dry cut bamboo is 0.057 kWh.
- The capacity of machine is more at dry condition.
- The cutting efficiency of machine is more at dry condition.
- The percentage damaged is more at dry condition.

REFERENCES

Abd, Mohd. Llif and Khoo, K.C. (1992). Fibre morphology and chemical properties of Gigantochloa Scortechini. *J. Forest Sci.*, **6**(4): 397-407.

Bali, M. (2003). Vertical soak diffusion for bamboopreservation. *Environmental Bamboo Conservation*. Linda Garland. : 28-30.

Banik R. L. (1980). Propagation of bamboos by clonal methods and by seed. Proceedings of the Workshop on Bamboo Research in Asia, Singapore, IDRC, pp. 139-150.

Behera, B.K. (1996). Development and testing of power operated wheat thresher. *Agric. Mechanization in Asia, Africa & Latin America.* **21**(4): 15.

Bining, M. (1985). Laboratory studies of design parameters for wood cutting mechanism. *J. Agric. Engg.*, ISAE, **23**(2): 132.

Chancellor, W.J. (1993). Basic concept of cutting operation. *Thesis*. Cornell University. : 63.

Drigo, R., Shaheduzzaman, M. and Chowdhury, J.A. (1988). Inventory of Forest Resources of Southern Sylhet Forest Division. Assistance to the Forestry Sector. Phase-11. Bangladesh, FAO/UNDP Project BGD/85/085. Field Document No. 3.

Hasnin, S.M.M., Biswas, D., Sheikh, M.W. and Ali, M. (1997). Particleboard making characteristics of three bamboo species. *Bangladesh J. Forest Sci.,* **26**(2): 12-20.

Huan-Ming, H. (2005). Bamboo-based Boards in China: an Introduction. Proceedings of the 5th International Bamboo Workshop and 4th International Bamboo Congress on Bamboo, People and the Environment, 19-22 June, 1996, Bali, Indonesia, pp. 70-80.

Lopez, O. H. (2003). Bamboo-The gift of the Gods. (Oscar Hildalgo-Lopez, Columbia). pp. 553.

Sattar, M.A., Kabir, M.F. and Bhattacharjee, D.K. (1990). Effect of age and height position of Muli (*Melocanna baccifera*) and Borak (*Bambusa balcooa*) bamboos on their physical and mechanical properties. *Bangladesh J. Forest Sci.,* **19**(1&2): 29-35.

Yuming, Y. and Jian, Z.H. (1994). Prospects for bamboo based products as replacement for wood in Yunnan. Proceedings of the 4th International Bamboo Workshop on Bamboo in Asia and the Pacific, 27-30 November, 1991, Chiangmai, Thailand, pp. 273-277.

MEMBERS OF RESEARCH FORUM

AUTHOR FOR CORRESPONDENCE :

S.P. Kurhekar
Department of Farm Structures,
College of Agricultural Engineering and Technology,
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth,
Dapoli, RATNAGIRI (M.S.) INDIA

CO-OPTED AUTHORS :

N.S. Shinde, College of Agricultural Engineering and Technology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, RATNAGIRI (M.S.) INDIA