EFFECTS OF MOISTURE CONTENT AND STEAMING PERIOD ON THE BENDING PROPERTIES OF TEAK WOOD

M. A. Sattar

Teak (*Tectona grandis*) wood in solid form was investigated on its steam bending properties. The effect of four levels of moisture content and also the effect of four steaming periods were evaluated. Both the moisture content and steaming period were found to influence the bending properties significantly. A 30-minute steaming has been found adequate for satisfactory bending of 1.27 cm thick wood. At 60-minute steaming the wood was sufficiently plasticized to enable it to be bent at a sharp angle.

INTRODUCTION

Bent solid wood is advantageously employed in fabricating a variety of products. Bending is an economical technique in the manufacture of sports goods, walking and umbrella sticks, chair parts, barrel staves, wood rings and covers. Some work has been done to evaluate the bending characteristics of woods in many countries. The level of moisture content of wood and the period of steaming in the process of bending are considered important criteria for bending wood (Anon. 1948, Anon. 1959, Anon. 1967, Martin and Wangaard 1950, Rehman et all 1956). However, no detailed study has been made on Teak wood in this regard. It is, therefore, considered necessary to make a thorough investigation on the bending of Teak wood efficiently.

MATERIAL AND METHOD

A Teak log was procured from the forests of Chittagong Hill Tracts and was converted into 1.9 cm x 20cm x 100cm planks. The planks were then resawn and dressed to prepare 1.27 cm x 3.81 cm x 91.4 cm specimens. 320 such specimens, free from defects, were selected and grouped into 16 sets, each comprising of 20 specimens. Four such sets were submerged into a water tank to keep them in green condition. The remaining 12 sets were stacked

inside a shed for air drying. Three extra identical strips were taken for each set to find out the moisture content of stock in the process of drying. Four levels of moisture content, viz., 12–14%, 25–30%, 40–45% and 65–75% were used to represent the air-drying, fibre saturation, semi green and green conditions respectively.

The wood needs softening prior to bending. This was done by steaming the specimens in a specially designed steam chest (Sattar 1981). The saturated steam at approximately 100°C temperature was applied to wood at atmospheric pressure. Four steaming periods, 0, 30, 60 and 120 minutes, were used for softening the specimens of each set.

The bending was carried out by the hand bending device developed by Rehman et al (1956) and remodelled at the Institute (Sattar 1981). One wooden form with varying radii of curvature from 10 cm to 25 cm was made. A flexible steel strap was used to counter the tensile forces on the convex face of the bent timber.

The specimens, on attaining the desired moisture content, were put in the steam chest for the period designed in the plan. Immediately after bending, the specimens were placed in the wooden form, clamped firmly and then subjected to hand bending with the bending apparatus. After getting the maximum acceptable bends in the form, the bent pieces were fastened by means of wires. These were. then removed from the form and kept in that position overnight for setting. At the end of the setting period, the binding wires were removed from the specimens and the bending operation was considered to be complete.

RESULTS

The minimum radius of curvature at which breakage during bending operation did not exceed 5 per cent of the total bent pieces was considered acceptable. The average values of the minimum radii of curvature for each set of specimens were found out (Table 1). The ease or difficulty of bending was recorded during tests. Analysis of variance was performed to note the effect of moisture content and steaming time on the minimum radius of curvature (Table 2). Duncan's multiple range test was also employed on the radii of curvature to evaluate the variation among the different categories of specimens (Table 3).

DISCUSSION AND CONCLUSION

Table 1 shows that there was an appreciable difference of bending properties in 1.27 cm thick Teak wood due to differences of moisture content and steaming period. The lowest radius of curvature of 10.0 cm was noted in green wood having 65 to 75 per cent moisture content after steaming the same for 120 minutes while the highest value of 20.8 cm was found in airdried wood of 12 to 14 per cent moisture concent without softening by steaming. Both the moisture content and the steaming period were found to affect the bending properties significantly (Table 2). It was further revealed by the Duncan's multiple range test that the bending properties did not vary much between the moisture content range of 25 to 75 per cent. The bending properties of this category of wood, however, differed significantly in all cases from those of airdried wood (Table 3).

It is also apparent that Teak wood bends poorly and with difficulty without the softening treatment. A 30 minutes'

Table 1. Bending properties of Teak at various moisture content levels and steaming periods

Moisture content levels and steaming period (minute)	Average minimum radius of curvature (cm)	Bending status
(a) 12–14% m. c. (Airdry condition)		
0	20.8	Very difficult
30	17.6	Difficult
60	14.6	Difficult
120	12.8	Moderate
(b) 25–30% m. c. (Fibre saturation point)		
0	18.9	Very difficult
30	14.2	Difficult
60	11.8	Moderate
120	11.2	Moderate
(c) 40–45% m. c. (Semi-green condition)		
0	18.0	Very difficult
30	13.6	Moderate to difficult
60	11.4	Moderate
120	10.4	Easy
(d) 65–75% m. c. (Green condition)		
0	18.2	Very difficult
30	13.2	Moderate to difficult
60	11.1	Moderate
120	10.0	Easy

Table 2. Result of analysis of variance on minimum radius of curvature of Teak wood

Source of variation	DF	SS	MS	VR	Significance
Steaming time (S)	3	314.68	104.89	58.9	*
Moisture content (M)	3	221.06	73.69	41.4	*
M X S	9	27.91	3.10	1.74	NS
Residual	304	541.20	1.78		
Total	319	1104.85			

* Significant at the 0.1% level. NS=Not significant

Table 3. Result of Duncan's multiple range test on minimum radius of curvature of Teak wood

Moisture content levels (%)	STEAMING PERIODS			
	0 minute	30 minutes	60 minutes	120 minutes
12–14	20.8	17.6	14.6	12.8
25–30	18.9	14.2	11.8	11.2
40–45	18.0	13.6	11.4	10.4
65–75	18.2	13.2	11.1	10.0

Values bracketed by the same line are not significantly different

steaming period was found to be adequate for bending 1.27 cm thick Teak wood to a reasonable degree. A longer steaming period produced a higher degree of bending. This finding conforms to a similar investigation where woods of twenty different species yielded better bending for a steaming period of 60 minutes (Sattar 1981). In the entire range of moisture content, higher bending was obtained from higher periods of steaming in the present investigation. It is thus established that longer steaming period offers more plasticity to the wood to make it more amenable to bending. The bending properties were not found to change appreciably between 60 and 120 minutes. steaming period. This suggests that the steaming period of 60 minutes was sufficient to achieve maximum bending.

It is, therefore, inferred that solid wood like Teak does not require to be dried to

or below fibre saturation point prior to hand bending. Green or partially dried wood can conveniently be bent. A 30–minute steaming is adequate for satisfactory bending of 1.27 cm thick wood. If sharp bends are needed a 60 minute steaming should be applied for further softening the wood pieces prior to hand bending.

REFERENCES

Anon. 1948. Timber bending. Trade Circular No. 22, CSIRO, Melbourne. 15pp

Anon. 1959. The bending of solid timber. For. Res. Lab. Leaflet No. 33. H. M. Stationery Office, London. 14 pp

Anon. 1967. The steam bending properties of various timbers. For. Prod. Res. Lab. Leaflet No. 45, H. M. Stationery Office, London. 10pp

Martin, C. and Wangaard, F. F. 1950. The steam bending properties of certain tropical American woods. Tech. Report No. 6, Yale. 9pp

Rehman, M. A., Kishan, J. and Kukreti, D. P. 1956. The steam bending properties of Indian timbers. Ind. For. Rec. 1(1). 10pp

Sattar, M. A. 1981. The steam bending properties of twenty Bangladeshi Timbers. Bano Biggyan Patrika, 10(1 & 2) : 12–17 pp

M. A. Sattar, Divisional Officer, Forest Research Institute, Chittagong, Bangladesh