AIR DRYING AND STEAM-VACUUM CONDITIONING OF JAM SLEEPERS

M. A. Sattar

Jam, *Syzygium grande* (Wt). Wald. railway sleepers were found to air-dry from green condition to a 30 percent moisture content level in 5 to 9 months. The fastest drying was observed in sleepers stacked in September when the climatic conditions are conducive to air drying. The moisture distribution pattern in the sleepers was found to be independent of air drying period and time of stacking. Drying degrades were found in the air dried sleepers which made 10-15 percent of the total sleepers liable to rejection. Anti-check iron clamps helped in retarding the drying degrade in sleepers considerably.

Steaming followed by vacuum conditioning could remove moisture rapidly from Jam sleepers. Three cycles of alternate steaming and vacuum treatment with a total of 9 hours' steaming and 3 hours' vacuum was found to be adequate to bring down moisture to a 30 percent level upto the depth of 1.27 cm (0.5 in) from the surface. If air drying becomes difficult, conditioning by steam-vacuum process may be adopted prior to preservative treatment by pressure methods.

INTRODUCTION

Garjan (*Dipterocarpus* spp.) is the principal species for railway sleepers in Bangladesh. Wide and extensive use of this species has already posed such a serious problem that its supply is not adequate to meet the requirement of the railway. As a result, sleepers are being imported to alleviate the supply shortage. It has, therefore, become essential to find out other suitable indigenous species. Considering its mechanical properties and

availability, Jam, *Syzygium grande.*, (Wt.), Wald., may serve as an alternative species for railway sleepers and was, therefore, taken up for the study.

The railway sleepers need to be pressure-treated to impart more durability in exterior use in the warm humid conditions prevalent in Bangladesh. It is essential that sleepers be dried beforehand to about 30 percent moisture content for satisfactory preservative treatment. The present practices of drying freshly sawn sleepers either by air-drying or by steam-vacuum drying cannot serve this purpose properly, because of their improper techniques. It was, therefore, considered necessary to investigate the air and steam-vacuum drying characteristics of Jam sleepers in order to formulate proper drying techniques.

MATERIALS AND METHODS

Five Jam trees were felled at Chunati Range Forest, Chittagong and 14 logs of about 2.13 m (7 ft) long and 1.22 to 1.52 m (4 to 5 ft) girth were procured. Twelve such logs were used for air drying and the ramaining two logs were used for steam-vacuum drying studies.

Air Drying : Twenty metre gauge sleepers, 11.43 cm x 20.32 cm x 182.88 cm (4.5 in x 8 in x 72 in), were made from green logs prior to erection of each stack. Twenty five percent of sleepers were found to contain centre-pith. Anti-check irons (Stewart clamps) were inserted only to the ends of the sleepers containing centre pith. Three stacking periods were followed employing the 2 x 7 piling method. Two tiers were constructed in each pile. The top of the pile was roofed with 2.54 cm (1 in) thick planks to protect it against direct sun. Sleepers were placed with the length in the east-west direction.

Five defect-free sleepers were selected from each pile for use as samples for the determination of moisture loss. Two- inch sections were cut from both the ends of each sleeper and their initial moisture content was determined. The moisture gradient specimens were also prepared and the moisture contents of four zones were estimated. The first three zones consisted of a 1.27 cm (0.5 in) thick strip each at distances of 1.27, 2.54 and 3.81 cm (0.5, 1.0 and 1.5 in) respectively from the surface. The fourth zone was the central one-inch portion.

Three stacks were erected in the open yard of the Forest Research Institute, Chittagong, in January 1975, April 1976 and September 1976 and were designated as the first, second and third stack respectively. The sample sleepers were weighed, to the nearest of 45.4g (0.1 lb), with a portable balance at one-month intervals. The collection of data was continued till the moisture content of the sleepers came down to about 30 percent level. At the end, two-inch thick sections were prepared from each sample sleeper and the final moisture content of the sleeper was determined. The moisture gradient specimens were also prepared and the final zone moisture contents were calculated. The stack was then dismantled and a qualitative assess-

ment of the degrade was made visually on the individual sleepers.

Steam - Vacuum Drying : Fifteen sleepers, 11.43 cm x 20.32 cm x 91.44 cm (4.5 in x 8 in x 36 in), were prepared from green logs. Three charges were run in the treating cylinder. Sleepers were first steamed at 121.11° C (250° F) for three hours. The steam pressure was then released and a vacuum of 55.88 cm (22 in) of Hg was applied for one hour. This process was repeated twice more. On completion of each steam-vacuum conditioning, the samples were weighed and their moisture contents were determined. The moisture gradients were also determined after each charge of conditioning.

RESULTS

Drying curves (Fig. 1) of Jam sleepers were drawn from the mean monthly moisture contents of the samples for each of the stacks. The total air drying times of sleepers from green condition to 30 percent moisture content were determined from these curves. The mean values are presented in Table 1. An analysis of variance was employed on the drying times and the result is presented in the same Table. The moisture contents of four zones of sleepers prior to and after air drying are given in Table 2. The analysis of variance was done also on these moisture gradients to note the effect of stacking period, the result of which is shown in the same Table. The sleepers were assessed visually in respect of their degrades. The number of acceptable sleepers as permissible under the specification of Bangladesh Railway (Annon.1976) was evaluated and is mentioned in Table 3. The effect of the use of anti-check iron clamps on retarding the drying defects was noted.

The reduction of moisture content after each charge of steam-vacuum drying was found out (Table 4). An analysis of variance was also done on the reduction of moisture content and the result is presented in Table 4. The moisture contents of four zones are also given in Table 5.

Table 1. Mean air drying times of Jam sleepers and the result of analysis of variance

Stack No. & month of erection	Specific gravity on green volume	Initial moisture content (%)	Time required to attain 30% moisture content (months)	Result of analysis of variance on drying times
First (January)	0.67	71.6	9.0	
Second (April)	0.68	63.2	7.0	F*
Third (September)	0.67	61.1	5.0	

* Significant at 5% level

Table 2. Moisture gradients of Jam sleepers prior to and after air drying and the result of analysis of variance

Stack No.	Moisture condition of sleepers	Average Moisture Content (%)					Result of analysis of variance on stacking period
		Zone 1	Zone 2	Zone 3	Zone 4	Average of zones	
First	Green	66.7	71.9	72.9	73.2	71.2	
	Dry	22.7	28.6	34.9	39.7	31.5	
Second	Green	56.1	62.9	65.2	67.4	62.9	N S
	Dry	22.8	29.8	34.6	38.1	31.2	
Third	Green	50.9	62.3	64.1	69.3	61.7	
	Dry	19.1	27.6	33.6	37.4	29.4	

N S = Not significant

Table 3. Visual assessment of degrades of Jam sleepers after air drying

Stack No.	Total sleepers		Rejected sleepers with clamps	Major reasons for rejection			
	Green tested	Airdry acceptable (%)		Deep check (surface/ edge)	Severe split (end/ edge)	Shake (cup/ring)	Distortion (twist/bow)
First	20	17 (85)	Nil	X	X		
Second	20	18 (90)	Nil		X	X	
Third	20	17 (85)	Nil		X		X

Table 4. Moisture reduction of Jam sleepers by steam-vacuum drying and the result of analysis of variance

Charge	Total time for		Average moisture content (%)	Reduction of moisture content percent[1]	Result of analysis of variance on moisture reduction
	Steaming (hour)	Vacuum (hour)			
Green			57.5		F**
After first (0 – 3 hrs)	3	1	50.2	7.3	
After second (first + 3 hrs)	6	2	44.2	13.3	
After third (second + 3 hrs)	9	3	40.3	17.2	

[1]Based on the green moisture content

** Significant at 0.1 % level

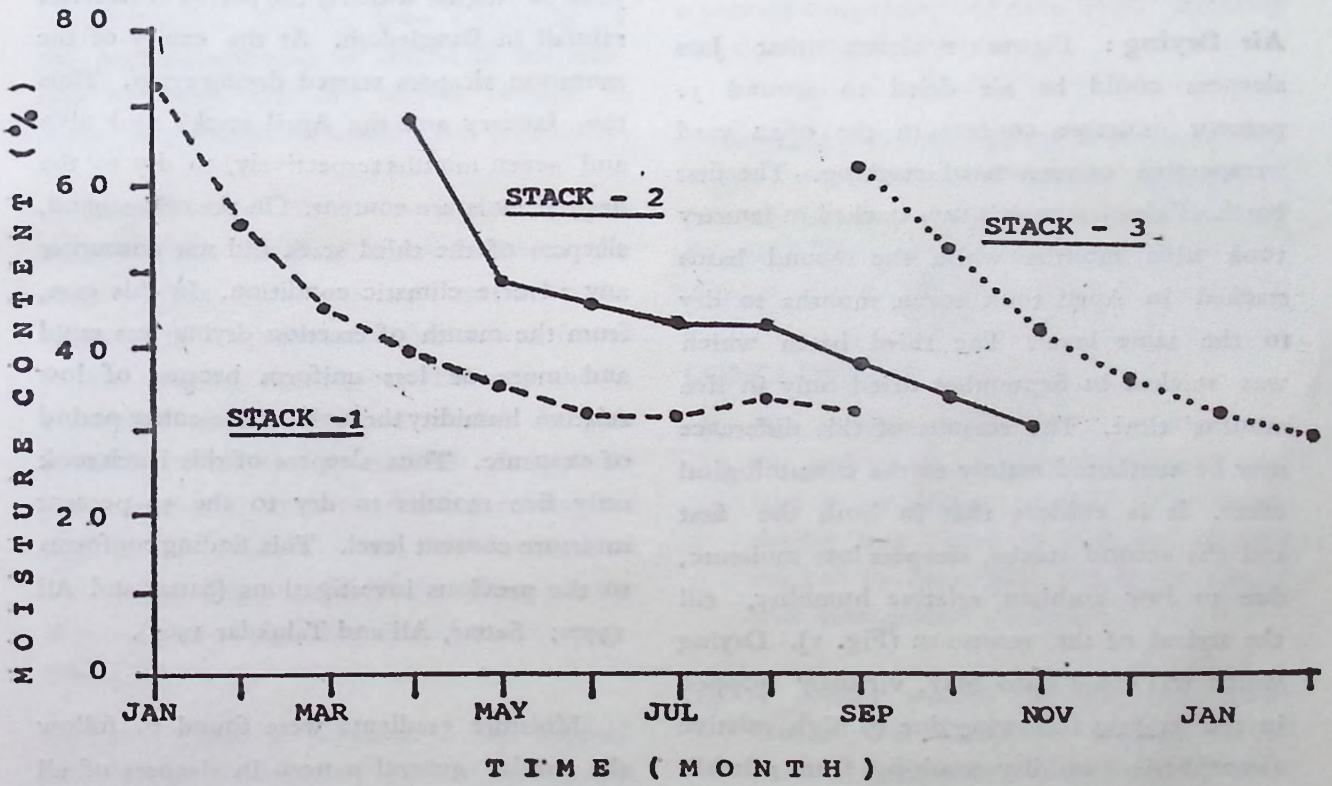

Figure 1. Drying Curves of Jam (*Syzygium* spp) Sleepers

Table 5. Moisture gradient of Jam sleepers prior to and after steam-vacuum drying

Charge	Average moisture content (%)				Average of Zones
	Zone 1	Zone 2	Zone 3	Zone 4	
Green	48.1	56.8	59.4	62.6	56.7
After first (0-3 hrs)	40.1	48.6	52.1	56.4	49.3
After second (first + 3 hrs)	33.9	41.7	47.3	51.2	43.5
After third (second + 3 hrs)	29.8	38.6	44.1	48.4	40.2

DISCUSSIONS

Air Drying : Figure 1 shows that Jam sleepers could be air dried to around 30 percent moisture content in the open yard irrespective of seasons of stacking. The first batch of sleepers which was stacked in January took nine months while the second batch stacked in April took seven months to dry to the same level. The third batch which was stacked in September dried only in five months' time. The reasons of this difference may be attributed mainly to the climatological effect. It is evident that in both the first and the second stacks, sleepers lost moisture, due to low ambient relative humidity, till the arrival of the monsoon (Fig. 1). Drying which was rapid upto May, virtually stopped in the months following due to high relative atmospheric humidity resulting from rainfall. Sleepers, rather, absorbed moisture during June to August which is the period of heaviest rainfall in Bangladesh. At the expiry of the monsoon sleepers started drying again. Thus the January and the April stacks took nine and seven months respectively, to dry to the desired moisture content. On the other hand, sleepers of the third stack did not encounter any adverse climatic condition. In this case, from the month of erection drying was rapid and more or less uniform because of low relative humidity throughout the entire period of exposure. Thus sleepers of this batch took only five months to dry to the 30 percent moisture content level. This finding conforms to the previous investigations (Sattar and Ali 1977 ; Sattar, Ali and Talukdar 1969).

Moisture gradients were found to follow the similar general pattern in sleepers of all the three batches (Table 2). There was

noticeable difference in the distribution of moisture content from the surface to the interior zones. The difference of stacking period could not affect the distribution pattern appreciably and this is why the stacking period was found to be non-significant (Table 2). It is also found that sleepers could be dried below 30 percent moisture content upto the second zone which extends to 2.54 cm (1.0 in) deep.

Table 3 shows that out of 20, two to three sleepers were found unacceptable as per specification of Bangladesh Railway (Anon. 1976). The major reasons for rejection were found to be deep check, severe split, shake and distortion. Checks were noticeable in the surfaces and ends of almost all the sleepers but they were not serious enough to render any sleeper unsuitable for acceptance.

Sleepers containing centre-pith and clamped with S-shape anticheck irons followed the same drying behaviour as that of other sleepers. No objectionable defect was found in this category of sleepers. The end checks and splits which developed around the pith before the insertion of anticheck clamps did not increase appreciably druring subsequent drying. The clamps were found to retard the drying degrade effectively. Thus all the sleepers with clamps were found to be acceptable (Table 3).

Steam Vacuum Drying : An appreciable amount of moisture was lost from green Jam sleepers by the steaming and vacuum process (Table 4). The moisture content was reduced by 7.3 percent in the first charge and in the second and the third charges it was reduced by 13.3 and 17.2 percents respectively, making the reduction statistically significant (Table 4).

It is evident that even after intermittent steaming of nine hours followed by vacuum of three hours Jam sleepers did not dry to the 30 percent moisture content level (Table 4). However, the results show that the first zone of the third charge dried to below 30 percent moisture content. Thus sleepers upto the depth of 1.27 cm (0.5 in) could be dried to around 30 percent moisture content by a process comprising of nine hours' steaming and three hours' vacuum.

Stacking by 2 x 7 piling method in September is recommended for air drying Jam sleepers. If air drying is not possible, conditioning by steam-vacuum treatment may be adopted prior to preservative treatment.

CONCLUSIONS

(i) Jam sleepers took five to nine months for drying to 30 percent moisture content in air drying process. The fastest drying was found in cases of sleepers stacked in September owing to favourable atmospheric condition.

(ii) A similar pattern of moisture distribution was found in sleepers of all batches irrespective of periods of stacking. Sleepers could be air dried to

below 30 percent moisture content upto the depth of 2.54 cm (1.0 in) in all cases.

(iii) Drying degrades, like deep check, severe split, shake and distortion, were responsible for rejection of 10 to 15 percent of total sleepers air dried.

(iv) Anti-check iron clamps retarded the drying degrades effectively.

(v) An intermittent steaming of 9 hours and vacuum of 3 hours could dry Jam sleepers to 30 percent moisture content upto a depth of 1.27 cm (0.5 in). The steam-vacuum conditioning is, therefore, recommended for drying Jam sleepers prior to pressure treatment where air drying becomes inconvenient.

REFERENCES

Anon. 1976. Specification for hardwood railway sleepers. Approved draft for Specification for Bangladesh Railway Pamphlet No. 4.

Sattar, M.A. and Ali, M.O. 1977. Studies on air drying characteristics of Garjan sleepers. Bano Biggyan Patrika, 6(1) : 27-32.

Sattar, M.A.; Ali, M.O. and Talukdar, Y.A. 1969. Air drying studies on 1" and 2" Garjan lumber. Forestdale News, 2(1) : 29-42.

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

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