ALTERNATIVE TIMBER SPECIES FOR RAILWAY SLEEPERS

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Based on availability and strength properties, eight indigenous species were selected as alternatives to Garjan for use as railway sleepers. The sleepers were put to service test in the main track of the Bangladesh Railway. The performance of seven of them has been found satisfactory and, therefore, are recommended for use as railway sleepers.

INTRODUCTION

Garjan (*Dipterocarpus* spp.), by virtue of its availability and strength properties, happens to be the principal species for railway sleepers in Bangladesh. This species is used also for construction and many other purposes. The wide and extensive use of this species has created scarcity and its present supply position is not adequate to meet the requirement of sleepers. As a result, sleepers are being imported from foreign countries to overcome the supply shortage. It is, therefore, necessary that other suitable indigenous species be used as railway sleepers.

Although there are more than 500 hardwood species in the forests of Bangladesh only a few of them are available in quantities commensurate with the requirements of the timber industries. In order to find out a group of alternative timber species for sleepers a joint study was undertakenby Forest Research Institute, Bangladesh Railway and Forest utilization Division of the Forest Department. This report presents the findings of the investigation.

MATERIALS AND METHOD

Based on the availability and the relevant mechanical properties, five species from hill forests and one species from mangrove forest were initially selected for the investigation. Jam (*Syzygium grande*), Kanak (*Schima wallichii*), Batna (*Quercus* spp.), Pitraj (*Aphanamixis polystachya*) and Shil Bhadi (*Garuga pinnata*) were procured from the timber merchants of Chittagong and Chittagong Hill Tracts through the Forest Utilization Division. Sleepers of the individual species were inspected and passed by the concerning officer of the Bangladesh Railway in accordance with the specifications for hardwood railway sleepers (Anon. 1976). It was later found out that Kainjal Bhadi (*Bischofia javanica*) and Jial Bhadi (*Lannea coromandelica*) were mixed up with the Shil Bhadi sleepers. Because of difficulties in segregation of the different

species of Bhadi, it was thought practical to accept the three species of Bhadi as a group. Metre gauge sleepers, between 467 and 600 in number, of each species were procured. The sleepers, 183 cm x 21 cm x 12 cm, were taken to Kanchannagar treating plant of the Bangladesh Railway. These were stacked in the open yard for about two months for airdrying. Sleepers were also dried at the site of passing where these were lying for two to four weeks awaiting despatch. Prior to preservative treatments 20 sleepers were randomly selected from each species. The moisture content of outer 2.5 cm thick zone of these sleepers was determined with the help of an electric moisture meter. Sleepers were then treated in the treating cylinder of the Bangladesh Railway following the process currently practised with Garjan sleepers. The Full cell pressure treatment process was applied with a modification of heating the sleepers in the initial sequence. A mixture of creosote and furnace oil in the ratio of 40 : 60 was used as preservative. On completion of the treatment, the penetration and absorption of the preservative into sleepers and the moisture content of the 2.5 cm thick zone of treated sleepers were determined.

The sleepers were then placed in the main rail track during August–September, 1977 by the Bangladesh Railway for service test. Kanak sleepers were placed near Kadamtali Railway crossing and Jam, Batna, Bhadi and Pitraj sleepers were placed near Kaibalyadham Railway Station. Field inspections were made at the end of each wet and dry season and were continued till March, 1981. The performance of the sleepers could not be evaluated further due to removal of the sleepers from the track. One mangrove species, viz., Sundri (*Heritiera fomes*) was included for this study. The half round Sundri sleepers were airdried and treated following the same procedures as were done in case of other experimental sleepers. 375 Sundri sleepers were placed in the track near the Chittagong Railway Station during January, 1979. The performance evaluation of these sleepers was continued till March, 1984.

RESULTS

The relevant physical and mechanical properties of the alternative species under tests were compiled along with those of Garjan (Table 1). The moisture content of the experimental sleepers, penetration and absorption of the preservative into the sleepers are presented in Table 2. The performance of the sleepers after 4 to 5 years' service test is presented in Table 3.

DISCUSSION

Ideally, the timber for railway sleepers should be dense and hard. It should possess good compressive, bending and nail holding strength. It should also be resistant to mechanical wear and insect and fungal attack. Since Garjan is the proven and accepted species for railway sleepers in Bangladesh, its properties may be taken as standard for comparison. From Table 1, it is seen that Jam, Batna, Kanak, Bhadi and Sundri are, in most cases, heavier than Garjan. In respect of strength properties, these species are more or less similar to Garjan. Pitraj appears to be lighter and weaker than Garjan in all strength properties.

Table 1. Comparative physical and mechanical properties of Garjan and the species under tests for railway sleepers

Species	Physical properties		Strength properties (Airdry basis)								
	Sp. gr. (airdry volume)	Volumetric shrinkage from green to overdry condition (%)	Hardness		Compression perp. to grain	Static bending		Nail holding		Cleavage	Maximum crushing strength
			Side (kg)	End (kg)	(kg/cm²)	MR (kg/cm²)	ME (1000kg/cm²)	Side (kg)	End (kg)	(kg/cm²)	(kg/cm²)
Garjan* (*Dipterocarpus* spp.)	0.65	14.3	524	544	74	954	148	159	93	86	513
Jam (*Syzygium grande*)	0.72	13.0	705	823	105	805	81	223	155	70	458
Batna (*Quercus* spp.)	0.84	17.0	1168	1141	148	1340	169	284	236	68	592
Kanak (*Schima wallichii*)	0.61	12.0	525	577	71	898	110	141	93	70	468
Pitraj (*Alphanamixis polystachya*)	0.51	11.0	441	518	67	822	113	145	91	68	368
Bhadi											
(a) Shil bhadi (*Garuga pinnata*)	0.69	12.5	536	591	96	726	85	143	114	72	437
(b) Jial bhadi (*Lannea coromandelica*)	0.62	11.0	536	591	96	726	85	143	105	72	366
(c) Kainjal bhadi (*Bischofia javanica*)	0.63	12.0	500	510	76	810	79	140	95	70	405
Sundri (*Heritiera fomes*)	0.96	18.0	970	857	142	1203	142	311	259	116	650

*Average of *Dipterocarpus turbinatus*, *D. pilosus* and *D. alatus*

Table 2. Moisture content, penetration and absorption of preservative treated sleepers

Species	Average moisture content (%)		Range of penetration (mm)	Approximate absorption (kg/sleeper)
	Bbefore treatment	After treatment		
Jam	41	43	3.2 – 6.4	
Batna	39	42	1.6 – 3.2	
Kanak	46	48	6.4 – 12.7	3.63
Pitraj	42	46	6.4 – 12.7	
Bhadi	40	43	3.2 – 12.7	
Sundri	39	40	3.4 – 8.5	

Table 3. Performance of alternative species under tests for railway sleepers

Species	Total number of sleepers	Rejected sleepers		Causes of rejection		
		Number	Percentage	Drying defect	Mechanical wear	Biological deterioration
After 4 years' service test						
Jam	564	24	4.3	ES, SC, ED	–	–
Batna	467	22	4.7	ES, SC, ED	–	–
Kanak	586	28	4.8	ES, SC, ED, DT	–	–
Pitraj	504	30	5.9	ES, SC, ED, DT	–	–
Bhadi	556	26	4.7	ES, SC, ED, DT	–	–
After 5 years' service test						
Sundri	375	5	1.3	ES, SC	–	–

ES–Severe end split/crack, SC–Severe surface crack, ED–Severe edge split and DT–Severe distortion

Table 2 shows that an absorption of preservative of 3.63 kg/sleeper was found in the sleepers of alternative species. This is within the minimum level of retention for metre gauge sleepers (Anon. 1975). The penetration of preservative in the sleepers ranged from 1.6 to 12.7 mm which is well below the recommended minimum level of 25 to 40 mm as specified for railway sleepers in Bangladesh Standard (Anon. 1975). It is interesting to note that no alternative sleeper was found to deteriorate

due to fungal or insect attack (Table 3) although the sleepers were in direct contact with the ground in hot and humid conditions for a period of 4 to 5 years. This indicates that the preservative was concentrated in the outer region of the sleepers and as such it could excellently protect the sleepers from fungal and insect attack inspite of inadequate penetration.

No sleeper was rejected due to mechanical wear (Table 3). This implies that the alternative timber species were sufficiently dense and hard to withstand the wear due to regular movement of the loaded trains.

The only cause of rejection was drying defect which included severe end split, end crack, surface crack, edge split and distortion. The main reason for development of these defects may be due to the use of partially dried sleepers containing high proportion of pith without adequate protection by anti-check iron clamps. It was observed that the alternative sleepers contained 39 to 46 percent moisture content prior to treatment (Table 2). For better service, sleepers should be dried to below the fibre saturation point i. e. about 25 percent moisture content. A good number of alternative sleepers was found to contain pith which accelerated drying degrade in service consequent upon drying. In a separate study it was found that no objectionable defect was noticed in airdrying Jam sleepers containing pith which was properly clamped with S-shaped anticheck irons (Sattar 1979).

It is evident from the performance data that the rejection of the alternative sleepers was 4.3 to 5.9 percent in case of sleepers procured from hill forests. Only 1.3 percent was rejected from sleepers of mangrove species. The highest rejection was recorded in Pitraj after subjecting to 4 years of exposure in the rail track, whereas the lowest rejection was observed in sleepers of Sundri even after 5 years of exposure. The rejection upto 5 percent is considered reasonable for sleepers placed in the main track for a period of 4 years. From this rejection figure it may be expected that an average service life of 15 years may be obtained from the sleepers of the alternative hill forest species except Pitraj. An average life exceeding 20 years may be expected from the half round sleepers of Sundri. The average service life of Garjan sleepers is taken to be about 15 years. So the sleepers of alternative species are acceptable in respect of service life. The sleepers made from Pitraj appear to be inferior to other species in all respects and as such this species cannot be recommended for use as railway sleepers.

It may be mentioned that Garjan was found not to be properly treated as was observed in the case of alternative sleepers resulting in inadequate penetration and poor retention of preservative. The sleepers were not also dried to the recommended level of moisture which caused pronounced drying degrades and ultimate rejection. If the sleepers are seasoned, clamped where necessary and treated properly, both Garjan and alternative sleepers are likely to last for more than 30 years even in the most hazardous tropical climatic conditions of Bangladesh.

CONCLUSIONS

From this study, the following conclusions may be drawn :

(i) The physical and mechanical properties of seven alternative timber species, viz., Jam, Batna, Kanak, Shil Bhadi, Jial Bhadi, Kainjal Bhadi and Sundri compare favourably with those of Garjan. These species are acceptable as alternative species for railway sleepers.

(ii) The sleepers should be properly dried to about 25 percent moisture content prior to preservative treatment. Proper anti-check iron clamps should also be fixed to the ends of the sleepers containing permissible pith to reduce the drying degrade and thereby avoiding undue rejection of sleepers in service.

(iii) The performance of the sleepers made from the alternative species was found satisfactory in the main metre gauge track of the Bangladesh Railway.

(iv) All the seven species are recommended for use as railway sleepers in order to reduce the dependency on Garjan and imported sleepers.

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