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FORESTRY PLANNING AND DEVELOPMENT PROJECT

CONSULTANCY REPORT

WOOD CONSUMPTION SURVEY OF THE RAILWAY INDUSTRY IN PAKISTAN

By

Envoforestry (Pvt) Limited

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PAKISTAN

WOOD CONSUMPTION SURVEY OF RAILWAY INDUSTRY

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PREFACE

Wood is virtually a universal material which is familiar to people world-wide. It is used for a great variety of purposes but principally for construction, furniture, packaging and other specialized uses such as transmission poles, matches, sportsgoods, household woodware, railway sleepers and carriages etc. Within the government system, Forest department has the responsibility for assisting the private and public sectors in the development of wood working industries through investment in projects, large and small.

2. In Pakistan, industrial utilization of wood began typically as an extractive industry with forests regarded as a resource to be "mined" rather than a renewable crop to be managed for sustained production. Until recently, forestry development activities have been largely focussed an commercial exploitation of natural coniferous forests and the establishment of hardwood plantations to meet the timber and fuel wood requirements of the urban sector. Onlya few years ago, the mode of forestry development has taken the form of fast growing mono-culture industrial plantations and tree farming on private lands as an adjunct to modern agriculture.

3. This kind of forest policy seems to have stemmed from the view that the productivity of existing state forests is far below their optimum productive potential and that it is not possible for the department to meet the increasing demand of raw material without resorting to social forestry on a national scale. Given the fact that the problems faced by the industry are less related to a lack of technology and more to a dwindling resource base, it is high time that the professionals undertake a fact finding survey about demand and supply of timber by major wood-using industries in the country so that an integrated approach could be adopted to solving the problems that are not merely environmental.

4. This report has been written in the context of a proposed plan for the development of country's social forestry sector. It emphasizes the present and future requirements of timber by the Pakistan Railways which have been traditionally a big consummer of wood ever since independence. It makes several recommendations, which if adopted, can help to regulate the supplies of wood to railways from indigenous resources, both private and public.

(A. S. BOKHARI)

FOR ENVOFORESTRY(PVT)LTD.

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ABBREVIATIONS

cm	Centimeter
cu.ft	Cu ic feet
km/Hr.	Kilometer per hour
m	meter
m^3	cubic meter
MAI	Mean Annual Increment
NWR	North Western Railway
PCV	Passenger Coaching Vehicle
PFI	Pakistan Forest Institute

CONVERSION FACTORS

1 cu.meter	=	35.3 cu ft.
1 kilometer	=	0.621 miles
1 Mile	=	1.609 kilometer
1 Ton-Mile	=	1.635 Ton-Milometer
Broad gauge 5'-6"	=	1.676 Meters
Metre-gauge 3'-3½"	=	1.000 Meters
Narrow gauge 2'-6"	=	0.762 Meters

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EXECUTIVE SUMMARY

Pakistan has about 12600 km. of railway track and 2598 number of Passenger Coaching Vehicles, which require careful maintenance, continued improvement as well as expansion to cater effectively to the growing demands of the country's expanding economy. Any deficiency allowed to develop therein can seriously jeopardize the efficacy of the whole network.

2. During the period 1978-83, there has been a decline in the railways freight traffic by 4.5 percent per annum resulting in heavy financial loss to the management. As a result of some peripheral policy changes in 1983, it achieved an annual growth rate of 0.8 percent during the Sixth Plan period. Although this trend has been arrested to some extent, yet there is an urgent need to improve the productivity of the whole system so as to make it more efficient and profitable.

3. The inability of the railways to achieve optimum utilization of the system's inherent capacity has been attributed partly to the backlog of track rehabilitation works and partly to the old and inadequate rolling stock which is not in a position to compete with the modern road transportation network in the private sector. The current policy aims at an alround improvement of railway operationsparticularly of the crucial elements in the railway infrastructure such as track rehabilitation and passenger Coaching vehicles.

4. Till recently, wood has been extensively used both in the fabrication of new coaches and in the replacement of sleepers to make the track fit for high speed diesel and electriclocomotives. It is during the last decade or so that the railways have started using pre-stressed concrete sleepers in place of wooden sleepers on

the track and metallic/fibrous components for the construction of passenger coaches. One of the reasons given for this change over is the non-availability of adequate timber of requisite specifications from the domestic market.

5. Based on the present comsumption of wood and the likely expansion of railway operations in the next decade, this report makes a realistic assessment of the future requirements of timber by the railway industry. It has been found that at present, the Pakistan Railways require nearly 18000 m^3 of deodar (Cedrus deodara) and 2000 m^3 of shisham (Dalbergia sissoo) timber in the round form annually to maintain over 12,600 km of track and run its two carriage factories at Lahore and Islamabad. The domestic production of deodar and shisham timbers from the state-owned forests, although prima facie sufficient to cover the demand, is not entirely available for the railway industry. Eucalypts can be efficiently used for all purposes where deodar is presently employed. The wood of these species can also serve as a substitute for shisham provided certain treatments are given to supplement its strength properties. Since sapwood of eucalypts is highly perishable when used in contact with ground, it is necessary that preservative impregnation treatment is applied under high pressure, before use.

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CHAPTER-I

BACKGROUND INFORMATION

Introduction

1.1 Pakistan Railways are the backbone of the national transportation and communication system. They play a pivotal role in the overall economy of the country. They not only cater to the needs of passenger traffic but also to the large scale in-land movement of freight which contributes significantly to economic growth and national integration. They provide year-round employment to a large number of professionals, sub-professionals, skilled and semi-skilled workers. Current estimates indicate that out of 5.25 percent labour force employed in the transport and communication sector, 2.06 percent is absorbed by the railways alone. Around 7.3 percent of the gross domestic product comes from the transportation of goods and passengers to which railways contribute nearly one percent per annum.

Pakistan Railways in 1947 and afterwards.

1.2 At the time of partition in 1947, Pakistan inherited 8045 kilometers of railway route which was equivalent to 12000.7 kilometers of railway track. In addition, it received 2585 coaching vehicles of which 1674 were meant for the conveyance of passengers and 911 for the transportation of luggage, parcels, mails, automobiles etc. The permanent way had a large percentage of wooden sleepers which were periodically renewed to maintain operational efficiency of the system.

1.3 After independence, Pakistan Railways have made considerable progress in achieving self-sufficiency in the manufacture of coaches and wagons badly needed to meet the ever-increasing demand of passenger/ freight traffic. Two carriage factories have been set up: one at Islamabad for the fabrication of new coaches and the second at Mughalpura (Lahore) for undertaking repairs. The old and obsolete rolling stock is being gradually phased out of service giving place to more powerful diesel and electric locos as well as the passenger coaches. With the completion

of locomotive factory at Risalpur in 1992, self-sufficiency in the manufacture of diesel and electric locomotives would also be acquired.

1.4 As the main carrier of passenger and freight traffic in the country, Pakistan Railways have increased the length of track which is the basic infrastructure of the system. It has provided rail links between the existing stations and new sites such as Kot Adu-Kashmore via D.G. Khan, Mangla and Kala-Bagh Dams, Kabul river bridge, Risalpur Locomotive Factory etc, etc. The position at the end of 1988-89 was that the track had increased from 12000.7 kilometers to 12621.93 kilometers and the rolling stock from 2585 to 3112 coaching vehicles of which 2598 were exclusively for the conveyance of passengers.

1.5 The number of route kilometers and coaching vehicles added to the passenger fleet together with the number of passengers and tons of freight carried from time to time are given in the following table:-

TABLE-I Route kilometers and Passenger Coaches from 1950 to 1989.

Year	Route Kilometers	Passenger Carriages	Other Coaching Vehicles	No.of Pasengers Carried (Million)	Freight Carried (Million Tons)
1950-55 (Average)	8,560.78	1,674	911	78	9.2
1955-60 (Average)	8,582.49	1,780	1,010	102	11.7
1960-65 (Average)	8,574.27	1,891	1,167	126	14.1
1965-70 (Average)	8,596.92	2,139	1,206	130	14.6
1970-75 (Average)	8,759.04	2,083	1,112	134	12.7
1975-80 (Average)	8,814,78	2,222	779	146	13.3
1980-85 (Average)	8,774.87	2,487	591	95	10.5
1985-86	8,774.87	2,772	506	83	11.8
1986-87	8,774.87	2,656	522	78	11.6
1987-88	8,774.87	2,663	494	81	11.6
1988-89	8,774.87	2,598	514	85	10.4

Source: Pakistan Railway Year Book 1988-89 pp 43,44,47,51,56.

1.6 Despite increase in the route length and number of coaching vehicles, there has been a continuous shift of goods traffic from railways to the roads in the past. This trend was arrested during the Sixth Plan period (1983-88) when the railways achieved an annual growth of 0.8 percent in freight traffic as against an annual decline of 4.5 percent during 1978-83. For the next decade, the productivity of the railways is proposed to be improved by carefully monitoring its performance and taking appropriate measures through policy initiatives outlined below:-

1.7 POLICY MEASURES PROPOSED FOR THE SEVENTH PLAN.

The following are the policy measures which will be taken during the Seventh Plan to ensure further utilization of railway capacity:-

- Losses on railway operations will be minimized by closing unremunerative lines where strategic and other considerations do not warrant continued operations. Trains will be cancelled where there is no potential for improvement and fare rationalization;

- A flexible policy for fares will be followed; freight rates will be varied according to type of commodity as well as route;

- The locomotive factory, the carriage factory at Islamabad and other large railway manufacturing units will be converted into autonomous organizations;

- Improvements in the overall efficiency of the railways will be sought through better managerial and operational techniques; suitable measures will be adopted to enable the railways to operate as a commercial enterprise by charging fares on commercial lines, opening or closing lines and rationalizing staff strength;

- Goods traffic will be accorded priority in locomotive power, particularly on branch lines;

- Railways and the National Logistics Cell (NLC) will complement each other to facilitate and optimize the intermodal movement of goods traffic;

- The railways and NLC will entrer into joint ventures on infrastructure projects.

1.8 The following strategy will be followed in the railways sub-sector during the Seventh Plan:

- the net benefit to the economy will be maximized by revitalising the role of the railways to achieve optimum capacity utilization;

- The existing infrastructure will be improved to realise the inherent capacity of the railways;

- the overall efficiency of the railways will be improved through better management information systems and managerial and operational techniques;

- allocation of traffic between rail and road will be made according to the suitability of traffic for the two modes;

- goods traffic which is more remunerative will be accorded priority in locomotive power over passenger services, particularly on branch lines; and

- on the main line between Karachi-Lalamusa, the speed of passenger trains will be increased to 120 kph and that of freight trains upto 80 kph with four wheeled stock and upto 90 kph for bogie stock.

1.9 To achieve the following targets, it will be necessary to provide additional motive power, improve line capacity works, replace major assets such as track renewal, coaches, wagons and introduce better management and operational techniques. This programme is outlined below.

MOTIVE POWER

Adequate allocation will be made for the rehabilitation of 101 DE locomotives, procurement and rehabilitation

of 375 traction motors and plant and machinery including structural works for DE locomotive shops and sheds.

ROLLING STOCK

Allocation will be made for the manufacture of 300 passenger carriages, 200 bogie wagons and modification of freight wagons with roller bearings and double link suspension.

TRACK REHABILITATION

By 1992-93 the backlog of over age rails and sleepers will be 6,233 km and 6,155 km respectively. Out of this 650 km of rails and 1,000 km of sleeper renewals will be carried out during the Seventh Plan period. Sufficient allocation will be made for track renewal.

ELECTRIFICATION

Electric traction will be intoduced on the Khanewal-Samasata section (via Chord) for optimal utilization of the existing fleet of 29 electric locomotives. Chord section which comprises of 91 km of single track and 27.4 km of double track will be completed.

TRANSFER OF TECHNOLOGY

Sufficient allocation will be made for the transfer of technology in respect of manufacture of long crossing sleepers and high capacity bogie wagons.

LOCOMOTIVE FACTORY

Adequate allocation will be made for the completion of the locomotive factory project.

Wood using departments of the Railways

1.10 The major consumers of wood in the Pakistan Railways are the track department and the carriage factories. The timber used in sleepers, bridges, points and crossing consists of Deodar (Cedrus deodara), Kail (Pinus excelsa), Fir (Abies Pindrow) and Spruce (Picea morinda) while in carriages and coaching vehicles it is partly

Deodar and partly Shisham (Dalbergia sissoo). The other departments consume negligible quantities of wood and wood products whose procurement has seldom posed any problem to the management. It is because of this reason that the present study has been confined to the assessment of timber requirements of the railway track and the carriage factories.

Survey Methodology

1.11 During 1989-90 only three units were based on wood works in the Pakistan Railways. The number being small, the requisite information has been collected from all the three units. During the course of survey, officers responsible for the management of this industry were interviewed at Lahore and Islamabad. Information collected from them is given in Annexure-I & II.

1.12 This survey, however, does not attempt a comprehensive examination of the economic and institutional features of the railway sector. Rather it focusses only on the wood consuming departments of the railway industry dealing extensively with the railway track and carriage factories which are the major consumers of wood at the present time.

CHAPTER - II

RAILWAY TRACK

Track Kilometers

2.1 Pakistan Railway is a multi-gauge system and operates on three different gauges. The broad gauge track is 5 ft. 6 inches (1.676 meters) wide while the meter gauge is 3 ft. $3\frac{3}{8}$ inches (1.00 meter) and the narrow gauge is 2 ft. 6 inches (0.762 meters) wide.

2.2 At the end of 1988-89, the total length of the track was 12621.93 kilometers including track on double lines, yards and sidings. This consisted of 11,340.72 kilometers of broad-gauge, 5551.10 kilometers of meter-gauge and 726.11 kilometers of narrow-gauge. The year-wise figures showing increase in the track length are given below:-

Table-2 Gauge-wise Track length(kilometers)

Year	Broad-Gauge	Metre-Gauge	Narrow-Gauge	Total
1950-55 (Average)	10,478.60	628.09	894.10	12,000.79
1955-60 (Average)	10,647.22	627.92	752.48	12,028.02
1960-65 (Average)	10,783.67	628.55	727.36	12,139.58
1965-70 (Average)	10,934.14	584.92	728.62	12,247.68
1970-75 (Average)	11,168.12	552.60	727.51	12,448.23
1975-80 (Average)	11,248.37	552.60	728.61	12,630.85
1980-81	11,349.64	552.60	728.61	12,630.85
1981-82	11,361.61	552.60	728.61	12,542.82
1982-83	11,302.29	555.10	726.11	12,582.50
1983-84	11,311.25	555.10	726.11	12,592.46
1984-85	11,311.97	555.10	726.11	12,593.18
1985-86	11,338.50	555.10	726.11	12,619.71
1986-87	11,338.50	555.10	726.11	12,619.71
1987-88	11,340.97	555.10	726.11	12,622.18
1988-89	11,340.72	555.10	726.11	12,621.93

Source: Pakistan Railways, Information Year Book 1988-89.

Track Rehabilitation

2.3 The broad gauge track on Pakistan Railways was renewed about 70 years ago with 90-lbs. and 87-lbs. rails on main line and with 75-lbs. and 60-lbs. rails on branch lines, with varying sleeper densities. The 87-lbs. rails were removed from the main line in early fifties, because of their old age and wear. During the first plan period (1955-60) the replacement work was restricted to the renewal of old rails and sleepers which were no longer fit for maximum speed and axle-load on various sections.

2.4 During the second five year plan (1960-65), it was realized that for a break-through in high speed technology and safe operation of Express trains, improvement of track was essential. Accordingly a study was undertaken for prescribing the optimum standards of track on various sections of the railways based on traffic forecasts projected over the next 20 years. As a result of this study, the following density of sleepers per kilometer of track was prescribed from 1967 onward:-

Sl.No	Route Classification	Speed (Km/Hr)	Sleeperdensity (Number per Km)
1.	Primary 'A'	120	1640
2.	Primary 'B'	100	1562
3.	Secondary lines	80	1410
4.	Meter gauge	80	1300
5.	Narrow gauge	50	1250

Source:- Sixth Five Year Plan of the Pakistan Railways.

2.5 Track rehabilitation has been a regular feature of railway operations since independence although the job has seldom been done according to actual requirements. During the last six five-year plans (1955-88) 6805 track kilometers of sleepers have been replaced but the fast rate at which sleepers were becoming overage could not be caught up by the renewals. By the end of the Sixth Five-Year Plan

i.e. June 1988 there were still 5816 track kilometres of overage sleepers on the system. Besides, most of the wooden sleepers replaced during the first and the second five-year plans when pre-stressed concrete sleepers had not come into use, had also become due for replacement because of their limited service life of 15-20 years.

Renewal of Track

2.6 Following table gives plan-wise renewals of overage rails and sleepers from the track:

Table.3 - Renewal of Track

Track length(km)

	Rail	Sleepers
Ist Plan (1955-60)	1091	1024(mostly wooden)
2nd Plan (1960-65)	1260	1452(-do-)
3rd Plan (1965-70)	566	966(Partly wooden & partly concrete)
4th Plan (1970-77)	869	1432(Mostly Concrete)
5th Plan (1977-83)	956	1191(-do-)
6th Plan (1983-88)	555	740(-do-)
Total:-		6805

In the Seventh Five-Year Plan (1988-93) 650 Kms of rails and 1000 kilometers of sleeper renewal has been programmed for rehabilitation and high speed operation.

Railway Sleepers.

2.7 Railway Sleepers are transverse beams set in a roadbed position to support railroad rails. They are generally made of wood but pre-stressed concrete sleepers are also being used in increasing number partly because of the non-availability of wooden sleepers and partly because of their relatively longer life. Table-4 gives the standard sizes of railway sleepers used in railway carriages, railway workshop and the railway track:-

Table-4

Sizes of sawn timber for different end uses.

Track gauge	Railway Carriage			Specification for Railway Workshop			Railway Track			
	Length (m)	Width (cm)	Thickness (cm)	Length (m)	Width (cm)	Thickness (cm)	Length (m)	Width (cm)	Thickness (cm)	Volu (m3)
Broad	3.05	25.30	7.5-8.75	3.05	25	12.5	2.74	25.0	12.5 =	0.08
Meter	2.44	22.05	15.0	2.44	20	12.5	1.83	20.0	11.5 =	0.04
Narrow				2.13	10	10.0	1.52	17.5	11.25=	0.03

Source: Pakistan Journal of Forestry, April, 1989; p.92

Other specifications of soft wood and hardwood sleepers are given below:

2.8 SPECIFICATIONS OF RAILWAY SLEEPERS

(a) First class indigenous soft wood sleepers.

Sleepers must be well seasoned, sound, absolutely free from fungoid growth, insect attack, serious cracks and serious end shakes. Following are the points on which the classification of first class sleepers is based:-

Sl.No	-	Indigenous soft wood sleepers
1.	Minimum period required in a depot before presentation.	6 months after extraction from forests.
2.	Minimum period required in a depot after extraction from the river (in case sleepers are rafted by rivers).	One month.
3.	(a) Dimensions of broad-gauge sleepers at the time of presentation.	9'-0"x5". 30% of the supply may be accepted in sizes upto 8'-9"x9"x4¾".
	(b) Dimensions of metre-gauge sleepers at the time of presentation.	6'-0x8"x4½. 30% of the supply may be accepted in sizes up to 5'-9"x7"x4".
	(c) Dimensions of narrow-gauge sleepers at the time of presentation.	5'-0x7"x4½. 30% of the supply may be accepted in sizes up to 4'-9"x6"x4".

4. Position of heart.	Heart centre included in both ends of sleepers not permitted. When a sleeper does not contain the heart centre in one end or when the heart centre has been sawn longitudinally through the heart centre, the heart centre may be permitted to fall withir the cross-section of the sleepers at the other end provided it is not more than $1\frac{1}{4}$" from the nearest edge of the sleeper. When the heart centre is not included in the sleeper, the annual rings must not be perpendicular to the broad face.
5. Maximum spring allowed.	2" for broad-gauge sleepers, $1\frac{1}{4}$" for metre and narrow-gauge sleepers.
6. Maximum cup allowed.	½" for broad-gauge sleepers, $\frac{1}{4}$" for metre and narrow-gauge sleepers.
7. Winding allowed so that maximum adzing required to seat the bearing plates does not exceed in depth.	$\frac{1}{8}$".
8. Largest tight knot allowed within 6" from the centre of rails.	2" in diameter not more than 2 in number away from spike holes of rails.
9. Largest tight knot allowed away from rail seat. (A knot or group of knots must not materially affect the strength.)	3" in diameter for broad-gauge sleeper 2" in diameter for metre and narrow-ga sleepers.
10. Sapwood.	No limit for sapwood.
11. Wane.	1" wane permitted in standard section only i.e. 10"x5" section in case of broad-gauge and 8"x4½"and 7"x4½" in case of metre and narrow-gauge sleepers respectively.
12. Twisted fibre.	For Chir only.-Percentage of fibre tha must run through the whole of the sleepers:-

On either broad face	..	20%
On either depth face	..	20%

To be within the above limits on width face the fibres starting from the top at one end of the sleeper should finish at above 2" from the bottom corner at the other end.

To be within the above limit on depth face the fibres starting from the top corner on one end of the sleeper should finish at above 1" from the bottom corner at the other end.

13. End splits. — 3" permitted for B-G. only in case when sleepers are full 9' or over in length.

(b) Specification for Second and Third Class Sleepers.

(1) Second class sleepers must be serviceable for the main line but is one in which the defects mentioned in items 4 to 12 of the specificatio for First class sleepers, exceed the limits give therein, by not more than 25%

(2) Third class sleeper is one in which the defects mentioned in items 4 to 12 in the specification for First Class sleepers are so pronounced as to make it unfit for main line work but it must be fit for use in sidings, and in case of deodar only fit for building purpose.

(c) Specification for First Class Sleepers of Hard Wood.

Sleepers shall be sawn from sound logs. The timber shall be free from spongy or brittle wood. Except as otherwise permitted under the tolerances specified below the sleepers shall be straight, square-edged, decay or rot, heart defects, hollows, knots, scars, harmful insect attack, ruptured ends, excessive sapwood, shakes, excessive wane or any other harmful defect as will reduce appreciably (by more than 10%) the life strength. The dimensions shall be--

Broad-gauge sleepers	..	..	9'x10"x5"/9'x10"x6"
Metre-gauge sleepers	..	..	.. 6'x8"x4½"
Narrow-gauge sleepers	..	..	.. 5'x7"x4½"

TOLERANCES

(i) Centre Heart:- Provided the heart is small, sound and tight, sleepers with this defect will be accepted in the following circumstances:-

(a) When the heart appears at one or both ends in sleepers up to six inches depth, if the sleepers are not freshly sawn and are cut from a long capable of yielding at least two sleepers side by side and if the end or ends containing cnetre heart are clamped. The total number of sleepers so accepted must not exceed ten percent of the total quantity passed of each size at any inspection.

(b) When the heart appears at one end in sleepers up to sic inches depth provided it is not more than one and-a-half inches within that end. Measurements will be taken from the broad edge of the heart side to the centre of the core. [Ten percent of the total number of sleepers passed at any inspection may have centre heart at one end in any position as provided in rule 1(a) above].

(c) When the heart appears in one or both ends of sleepers over six inches in depth if the end or ends containing it are clamped and if the heart line is not visible on more than one broad face of a sleeper.

(ii) Crook,Cup, Twist and Warp:- (a) Crook or spring.- If a string is stretched from end to end along the side of a sleeper towards which the bend occurs the versine at the centre of the side should not exeed one-eighth of an inch for every foot of length for all classes fo sleepers.

(b) Cup.- If a straight edge is laid across the width of a sleeper the versine at the middle should not exceed one quarter of an inch for all classes of sleepers.

(c) Twist.- This defect may be permitted in any class of sleeper provided that one quarter of an inch of adzing can remove it.

(d) Warp.- If a string is stretched from end to end on the broad side of a sleeper (usually the sap side) towards which the bend occurs, the versine at the middle of the sleeper should not exceed

one-sixteenth of an inch for every foot of length in bridge, lead and crossing sleepers subject to a maximum of one and one-fourth inches in sleepers of a length of twenty feet and over and one-eighth of an inch for every foot of length in standard track sleepers.

(iii) Hollows, Knots and Scars:- (a) Hollows.- Hollows away from the rail seats may be permitted provided they do not exceed two inches in diameter and one inch in depth and provided two do not fall within the same cross-section of a sleeper.

(b) Knots.- Knots will be measured on the minor-axis of the exposed section.

Sound knots may be permitted as follows, unless the knot or group of knots is so situated as to make the sleeper liable to breakage:-

	At rail seats.	Elsewhere.	All positions.	
B.-G.standard and bridge sleepers	One inch	Three inches	..	At each rail seat there should not be more than three knots exceeding one inch in diameter.
B.-G.lead and crossing sleepers	..	..	Two inches	
M.-G.N.-G standard and bridge sleepers.	one inche	Two inches	..	
M.-G,N.-G and lead and crossing sleepers.	..	..	One and-a-half inch	

(iv) Sap wood:- Sap wood is measured along a surface in a direction at right angles to the length of sleeper and may be permitted as follows:-

Standard size and bridge sleepers (all guages)

(a) Rail seat.- For a distance of four inches on either side of the centre line of the rail, the amount of sap wood permissible must not exceed twenty-five percent(one quarter) of any surface dimension.

(b) Elsewhere.- At any other point, the amount of sap wood must not exceed fifty percent(half) of any surface dimension

(v) Size defects.- (a) Oversize.- The following excesses in measurement are permissible:-

	Length.	Width.	Depth.
Standard size sleeper, B.-G.	Eleven inches	One inch	Half an inch.
Standard size sleeper.M.-G.	Six inches	Do	Do.
Standard size sleeper,N.-G.	Three inches	Do	Do.
Special size sleepers(all gauges)	No dimension to exceed those shown in the sizes by more than five percent(one-twentie		

(b) Undersize.- Provided not more than five per cent. of the number of sleepers passed at any inspection are below dimension, the following deficiencies in measurement are permissible:-

Standard sleepers,B.-G.	Two inches	One quarter of an inch.	One-eighth of an inch.
Standard sleepers,M.-G.	One inch and-a-half	Do	Do
Standard sleepers,N.-G.	One inch	Do	Do
Special size sleepers.	No dimension to be less than those shown in the schedule by more than one and a quarter per cent.(one-eightieth) in length and two and-a-half per cent.(one-fortieth) in wdith or depth.		

(d) Specification for special size deodar sleepers.

The sleepers shall be sawn from sound logs. They shall be straight and out of winding and with faces square to one another. The wood in the sleepers shall be free from sapwood, heart-shakes, serious cracks, split ends and knots bigger than 3" and free from anything near the rail seat which might interfere with the driving or screwing of spikes. Tight boxed heart is permissibel in timbers under the following conditions:-

(1) For B.-G. timber up to (and including) 7" depth.- At one end only, provided the centre heart is not more than 1½" within that section.

(2) For B.-G.timbers above 7".-(a) At both ends (irrespective of the position of the centre-heart in the timber), provided the heart line is not visible on more than one broad face of a sleeper and if both ends are clamped.

(b) At one end only(irrespective of the position of the centre-heart in the timber), provided the end with the centre-heart is clamped.

(3) Sleepers with large, unsound or starred heart will not be accepted.

Consumption of Railway Sleepers

2.9 The annual requirement of sleepers have varied from year to year, depending upon the length of new track to be laid and the renewal of the existing one. During the period 1975-76 to 1979-80, about 542,000 sleepers were procured annually, about 500,000 for broad-gauge, 220000 for meter-gauge and 20,000 for narrow-gauge, track. Of these, about 150,000 were concrete and the rest wooden. In 1987, the wood consumption of the Pakistan Route and Track Department alone was 18684 $\overset{3}{m}$.

2.10 From 1975-76 to 1979-80 Pakistan Railways purchased 10,391 $\overset{3}{m}$ of wooden sleepers from the local market. The major sources of supply were Kashmir Logging and Saw milling Complex. Mirpur(Azad Kashmir), First Development Corporation (FDC) Havelian, Dargai(NWFP), Faisalabad and Bahawalpur(Punjab) timber markets. Decodar, Kail, Fir, Spruce and Shisham were the major species used for making railway sleepers. Eucalyptus, after presservative treatment, was also found to be a good substitute. The sleepers made from indigenous wood were treated in the Pakistan Railways own pressure impregnation plant at Wazirabad using creosote and fuel-oil mixture. The capacity of this plant on single shift basis was 250,000 sleepers per annum.

2.11 Owing to the shortage of wood in the country, the replacement work was initially restricted to the renewal of sleepers which were no longer fit for maximum speed and axle load. Later on, sleepers were imported from abroad in order to cope with the backlog of track rehabilition work.

Import of Wooden Sleepers

2.12 Prior to 1980-81, Pakistan Railways used to import wooden sleepers from Malaysia and Indonesia in order to supplement local purchases. Khattak and Amjad (1981) have reported that in 1978-79, Pakistan Railways purchased, 3439 $\overset{3}{m}$ of wooden sleepers from these countries. However, the volume of timber imported from abroad has fluctuated widely from year to year. Table.5 shows the import of railway sleepers from 1975-76 to 1979-80.

Table.5 - Import of railway sleepers

Year	Volume, m^3	Value in thousand rupees
1975-76	30,338	24,483
1976-77	4,914	5,473
1977-78	1,090	1,086
1978-79	3,439	3,912
1979-80	6,406	6,885

Source: Foreign Trade Statistics of Pakistan, 1976, 1977, 1978, 1979 and 1980.

During this period it was noticed that the supplies of sleepers by the overseas contractors were highly erratic and uncertain due to fluctuating prices of timber in the World market. Moreover it required considerable amount of foreign exchange which was seldom forthcoming. After 1980-81, when the concrete sleeper factories came into production the import of wooden sleepers was discontinued.

Back-log of Track Rehabilitation work and its Adverse effects.

2.13 As a consequence of the situation explained in para 2.6 above, 4816 track kilometers of sleepers are still overage after the execution of proposed renewals in the first year of the Seventh Five-Year Plan. On 30th June, 1989 the Division-wise length of worn-out sleepers was as under:-

Division	Length of worn out sleepers in kilometers
Karachi	628.32
Sukkur	908.41
Multan	602.39
Lahore	533.42
Rawalpindi	640.90
Quetta	987.83
Peshawar	514.73
Total:-	4816.00

2.14 The adverse effects of this back-log are:-

- restriction on the maximum permissible speed.
- greater wear and tear of the rolling stock.
- additional running time.
- traffic delays.
- diversion of railway traffic to road transport.
- increased operational costs.
- fall of revenue.

It has been estimated that on account of speed restrictions imposed due to overage rails and sleepers, 40,223 train-hours have been lost by the end of the Sixth 5-Year Plan.

Concrete Sleeper Factories

2.15 To overcome the problem of shortage of wooden sleepers, the Railway Board decided in 1965 to set up pre-stressed concrete sleeper factories to replace the out-lived wooden sleepers. Accordingly the following concrete sleeper factories have been commissioned from 1967 onward:-

Table-6 Capacity of Concrete Sleeper Factories

Factory	Location	Rated capacity per annum (No.)	Cumulative number of sleepers produced upto 30.6.87(No.)	Saving effect in foreign exchange (Rs.in million)	
1. Mono-Block Sleeper Factory.	Khanewal	150,000	359,286	152.91	(Notional figures)
2. Prestressed Concrete Factory.	Sukkur	70,000	1,581,754	673.19	(")
3. Twin-Block Sleeper Factory.	Kohat	100,000	285,984	136.34	(")
4. Twin-Block Sleeper Factory.	Kotri	100,000	324,468	141.22	(")
5. Twin-Block Sleeper Factory.	Shahinabad	100,000	278,507	152.80	(")
	TOTAL:-	5,20,000			

Source: Pakistan Railways Year Book of Information 1986-87 p.22.

Cost and Serviceable life of Wooden and Concrete Sleepers.

2.16 Although concrete sleepers are manufactured from locally available material, yet their per unit cost is higher than the wooden sleepers procured from the contractors within the country. The cost of wooden sleepers vis-a-vis concrete sleepers together with their serviceable life is shown in the following table:-

Sleepers	Cost per Sleeper	Serviceable life
- Wooden Sleepers	Rs. 490/- (Deodar)	15-20 years (When creosot
- Pre-stressed concrete sleepers	Rs. 622/- (Mono Block)	40-45 years
- Pre-stressed concrete sleepers	Rs. 722/- (Twin Block)	45-50 year

Proportion of Wooden Sleepers in the Track

2.17 As a result of the rehabilitation/maintenance work done during the previous few years, the proportion of wooden sleepers in the total number has gradually decreased. The following table would indicate the trend:-

Table.7 - Proportion of Wooden Sleepers

	1983-84	1986-87	1988-89
		(Percentage in the total number)	
- Wooden Sleepers	62.3	56.0	53.5
- Cast iron Sleepers	14.0	12.0	11.0
- Steel iron Sleepers	15.8	13.0	12.0
- Concrete Sleepers	7.9	19.0	23.5

Source: Pakistan Railways Information Year Books for 1983-84, 1986-87 and 1988-89.

2.18 The above description reveals that wooden sleepers which were once the mainstay of railway track, are being gradually phased out giving place to pre-stressed concrete sleepers. It is expected that in a couple of decades, they will be totally eliminated from the permanent way.

2.19 As may be seen from the calculations given below, there were 10.393 million wooden sleepers on the track at the end of 1989-90 (i.e. June, 1989):-

- Total Track length	=	12621.93 Km.
- Percentage of track with wooden sleepers	=	53.5%
- Track length with wooden sleepers	=	6750.7 Km.
- Average number of Sleepers per Km.	=	1540
- Total number of wooden sleepers	=	6750.7x1540=10.393 million

With a rated capacity of 5,20,000 sleepers per annum, the concrete sleeper factories are in a position to replace the entire lot of wooden sleepers in a period of 20 years.

$$10.393 \div 0.52=20 \text{ approximately}$$

Since adequate funds have not been forthcoming for track rehabilitation/ sleeper renewal work, the annual target in the Seventh Five-Year Plan has been fixed at 200 track kilometers per annum. At this rate, the replacement of wooden sleepers would take approximately 33 years.

$$\frac{12621.9 \times 53.5}{200} = 33 \text{ years approximately}$$

From the above arithmatics, it can be concluded that the wooden sleepers will remain an integral part of the system for another 20-33 years.

Wood Consumption in the Past

2.20 Inspite of the fact that steel and concrete are now being increasingly used in the railway industry, wood still continues to be used in sleepers, bridges, points and crossings

etc. by the Route and Track Department. The in-escapable requirements of timber by the Pakistan Railways can therefore be estimated with some degree of accuracy on the basis of timber consumed during the last few years. Table.8 gives the annual consumption of timber by the Route and Track Department for the period 1982-1987:-

Table.8 - Annual Wood Consumption

Year	Wood Consumed m^3	
1982	6,094	
1983	4,124	
1984	4,627	
1985	9,537	
1986	2,926	Average =
1987	18,944	7710 m^3

Source: Pakistan Journal of Forestry, April, 1989 p.92.

Future Requirements of Wood

2.21 An attempt to forecast the future requirements of wood by the Route and Track Department of the Pakistan Railways has been made by M.I.Sheikh and others, using a linear regression model. Based on this model, the demand of wood for the year 1990, 1995 and 2000 has been projected at 18,012, 27,379 and 36,745 cubic meters respectively. The following table will indicate the estimated year-wise requirements of timber:

Table.9 - Future Requirements

Year	Estimated Wood consumption m^3
1988	14265.76
1989	16139.00
1990	18012.03
1991	19885.06

1992	21758.09
1993	23632.02
1994	25505.50
1995	27378.80
1996	29262.10
1997	31125.40
1998	32998.70
1999	34872.00
2000	36745.00

Source: Pakistan Journal of Forestry, April, 1989, p.93.

2.22 The auther of this report is of the opinion that the future requirements of wood projected in table 9 cannot be relied upon for future estimation because of the following reasons:-

(i) The linear regression is based on 18,944 m^3 of wood said to have been consumed in 1987. This figure is doubtful because it is totally out of proportion when we take into consideration the figures of annual wood consumption during 1982 to 1986.

(ii) The projections do not take into account the gradual replacement of wooden sleepers by pre-stressed concrete sleepers which has been a regular feature of track rehabilitation since 1967 onward.

2.23 In the present study, an attempt has been made to work out the inescapable requirements of wood by the Pakistan Railways Track Department on the basis of timber procured and issued during the last three years. An attempt has also been made to co-relate these estimates with those anticipated in the Seventh five-year plan (1988-93). The following table gives the average quantities of timber procured and issued during 1986-87, 1987-88 and 1988-89:-

Table.10 - Timber Procured and Issued
(Average of 1986-87, 1987-88 & 1988-89)

Size	Procured		Issued	
	Number	Volume (cu.ft)	Number	Volume (cu.ft)
I. Wooden Blocks (Deodar)				
3'x10"x5"	14209	14801	2631*	2740.5
II. Wooden Sleepers (Deodar)				
(a) 9'x10"x6"	10414	39052.5	8638	32392.5
(b) 9'x10"x5"	8766	27393.7	3151	3346.8
(c) 6'x8"x2½"	8910	13365.0	6409	9613.5
(d) 5'x7"x4½"	3657	3933.8	4338	4714.7
TOTAL:-		83,745.0		50,067.5
III. Timber for Points and Crossings (Deodar)				
Off size	-	1,43,597	-	31,462
IV. Timber for Bridges (Deodar)				
Off size		23,392	-	14,900
Grand Total:-		2,65,535.0		99,170.0 cu.ft
Or =		9835 cu.meters		3673 cu.meters

2.24 Based on the development programmes included in the Seventh five-year Plan (1988-93), the annual requirements of timber by the Route and Track Department have been anticipated as under:-

	Number	Volume (cu.ft.)	Total Cost (Million Rs.)	Foreign Exchange (Million Rs.)
- For Points and Crossings.	50,000	150,000	100	40
- For Bridges	25,000	75,000	25	12
TOTAL:	75,000	2,25,000	125.0	52.0
Or		= 8332 cu.meters.		

Employment

2.25 The Railways obtain their supply of sleepers through contractors. The employment generated in the manufacture of sleepers is, therefore, covered under sawmilling. The employment potential at track and sleeper renewal operations has been estimated by the Pakistan Forest Institute in a survey carried out in 1981 which is reproduced in Table 11 below:-

Table.11 - Estimated employment in track and sleeper renewal 1979-80.

Type of track	Length (km)	Man-days per km	Total man-days
		Track renewal	
Primary A	64.4	3,685	237,314
Primary B	11.3	3,376	38,148
Secondary	32.2	2,912	93,766
		Sleeper renewal	
Primary A	72.5	2,971	215,398
Primary B	11.3	2,661	30,069
Secondary	8.1	2,362	19,132
Others	24.2	2,463	59,605

Treatment of Sleepers

Treating of Sleepers	162 (number)	40,500

Source: A survey of socio-economic conditions of manpower engaged in forestry and wood based industries in Pakistan, Pakistan Forest Institute, 1981.

Assuming a worker supplies 150 man-days of labour a year, the employment in these jobs is about 4893. About 162 workers employed year-round at the Wazirabad treating plant: (20 skilled, 11 semi-skilled, 121 unskilled and 10 others) are included in this estimate. These estimates are valid for 1988-89 as well.

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CHAPER-III

RAILWAY CARRIAGES

General

3.1 Besides the track, passenger carriages and coaching vehicles constitute the basic infrastructure of the railway system. They have to bear the brunt of the transportation of ever-increasing traffic being moved on heavy density routes. With the introduction of powerful diesel and electric locomotives for hauling trains at higher speeds, the strain on the track as well as the carriages has increased manifold. The building up of a reliable track and carriage structure has, therefore, assumed greater importance in the running of the railways in the country.

Passenger Carriages/Coaching Vehicles

3.2 Pakistan Railways have been adding rolling stock to its fleet from time to time in replacement of the old and over-age coaches but the additions have never been commensurate with the growing needs of the traffic. Financial constraints have so far restricted the production capacity available in the country. The number of carriages and coaching vehicles added to the fleet since 1950-51 can be seen from table.12 given below:-

Table.12-Passanger Carriages and Coaching Vehicle since 1950-51.

Year	Broad-Gauge		Metre-Gauge		Narrow-Gauge		Total	
	Passenger carriages (No)	Other coaching vehicles (No)	Passenger Carriages (No)	Other Coaching vehicles (No)	Passenger carriages (No)	Other coaching Vehicles (No)	Passenger carriages (No)	Other coaching vehicles (No)
1950-51 Average	1,429	839	81	24	164	48	1,674	911
1955-60 Average	1,540	935	87	27	153	48	1,780	1,010

1960-65 Average	1,643	1,091	123	29	125	47	1,891	1,167
1965-70 Average	1,899	1,128	126	32	114	46	2,139	1,206
1970-75 Average	1,846	1,035	124	32	113	46	2,083	1,112
1975-76	1,882	927	114	30	112	46	2,108	1,003
1976-77	1,860	740	114	30	112	46	2,086	816
1977-78	1,991	730	110	30	112	46	2,133	806
1978-79	1,921	715	107	30	110	43	2,138	788
1979-80	2,011	706	101	30	110	43	2.222	779
1980-81	2,061	691	97	30	110	43	2,268	764
1981-82	2,116	655	97	30	110	47	2,323	732
1982-83	2,161	614	97	30	107	41	2,365	685
1983-84	2,201	538	97	30	107	41	2,405	609
1984-85	2,293	538	87	18	107	35	2,487	591
1985-86	2,515	457	87	18	120	31	2,722	506
1986-87	2,471	473	79	18	106	31	2,656	522
1987-88	2,500	450	71	18	92	26	2,663	494
1988-89	2,473	465	71	18	90	31	2,598	514

Source: Pakistan Railways, Information Year Book 1988-89.

Maintenance and Manufacture of Coaching Vehicles.

3.3 At the time of independence in 1947, Pakistan Railways inherited only one Carriage Workshop which was located at Moghalpura near Lahore. Established in 1907, this shop was designed to service and repair the carriages and wagons of the entire North Western Railway(N.W.R.). It did not have the capacity to manufacture new coaches to replace the old and the damaged ones. Consequently, coaches were imported from France and Germany to replenish the old stock which was no longer rail-worthy. The following table indicates the number of coaches imported annually during the period 1954-1969 in order to keep the system running:-

Table.13 - Import of Coaches from Abroad

Year	Number of Coaches Imported	Year	Number of Coaches Imported
1954	Nil	1963	45
1955	Nil	1964	60
1956	7	1965	158
1957	16	1966	196
1958	85	1967	41
1959	103	1968	46
1960	48	1969	43
1961	31		
1962	1		
		Total:-	880

3.4 The import of coaches involved lot of foreign exchange which was generally not forthcoming. Moreover the supplies from abroad were seldom in time which affected the efficiency of the system, as a whole. It was, therefore decided by the Government to set up a carriage factory in the public sector to fulfil the ever-increasing demand of coaching vehicles in the country. Consequently a carriage factory was established at Islamabad in 1970-71, to manufacture new coaches for domestic use.

Carriage Factories

3.5 Since 1970-71, Pakistan Railways have been operating two carriage factories: One known as the Carriage and Wagon workshop Moghulpura (Lahore) for the repairs of the rolling stock and the other Islamabad Carriage Factory for the manufacture of new coaches. Equipped with latest technology, the Islamabad carriage factory has the installed capacity of fabricating 144 coaches, per annum. During the period 1970-1989, the carriage factory, Islamabad has turned out 1395 Passenger Coaching Vehicles (PCVs) of all welded construction comprising Airconditioned sitter, First Class sleepers; Firt Calss sitter; Second Class, Postal Vans; Second Class with baggage;

Sleeper-cum-second class coaches, for domestic use as well as for export to Bangladesh. Most of the carriages were equipped with air-brakes and were of a very high standard. The year-wise production of P.C.Vs by this factory may be seen from table.14 given below:-

Table.14 - Year-wise Manufacture of Passenger Coaching Vehicles(PCVs) on 1st January 1990.

Year	Number of PCVs manufactured in Islamabad Carriage Factory	Year	Number of PCVs manufactured in Islamabad Carriage Factory
1970	34	1981	90
1971	73	1982	107
1972	4	1983	119
1973	4	1984	126
1974	3	1985	84
1975	30	1986	69
1976	137	1987	79
1977	81	1988	21
1978	51	1989	38
1979	95	Total:-	1395
1980	150	Average per annum	70

3.6 The Moghulpura Carriage and Wagon Workshop has the capacity to repair about 1400 coaches per annum. At present this target is being achieved to the extent of 90 percent.

Wood Requirements of the Carriage Factories.

3.7 (a) Carriage and Wagon(C&W)Workshop Moghulpura

Based on last ten years average, Khattak and Amjad (1981) estimated that the C&W Workshop, Moghulpura was utilizing 3240 $\overset{3}{m}$

of sawn deodar wood and 1610 $\overset{3}{m}$ of Shisham planks annually. In the round form, this represented an annual consumption of 5410 $\overset{3}{m}$.

3.8 After 1981, the wood has been gradually replaced by alternate metallic and non-metallic fibrous materials. In the present study, an attempt has been made to work out the requirements of timber on the basis of actual consumption during the last three years. The following table gives the quantity of wood actually purchased for Moghulpura repair shop during 1986-87 to 1988-89.

Table.15 - Quantity of wood used Moghulpura Repair shop during 1986-87 to 1988-89.

	Requirements($\overset{3}{m}$)			Actual purchase $\overset{3}{m}$		
	1986-87	1987-88	1988-89	1986-87	1987-88	1988-89
- Soft wood (Deodar)	2500	2500	2500	700	950	2500
- Hardwood (Shisham)	850	850	850	1400	1000	1000
TOTAL:-	3350	3350	3350	2100	1950	3500

Based on this table, the average consumption of soft and hardwood comes to 2520 $\overset{3}{m}$ in the sawn form and 4280 $\overset{3}{m}$ in the round form. The survey questionnaire duly completed is given at Annexure-I.

(b) Carriage Factory, Islamabad

Islamabad Carriage Factory has an installed capacity of 144 coaches per annum. Khattak and Amjad (1981) have estimated that about 7 cubic meters of deodar timber are used in the manufacture of each coach. On this basis, they have calculated the requirements of timber for the factory as 1008 $\overset{3}{m}$ sawn or 1783 $\overset{3}{m}$ round.

3.10 Ever since this factory has been commissioned into operation, it has not worked to its full capacity partly because of the paucity

of funds and partly because supply orders could not be collected for export. Against the installed capacity of 144 coaches, it has produced 70 coaches per annum on the average; which means that the factory has remained under-utilized to the extent of 50 percent. The requirements of timber worked out by Khattak and Amjad (1981) on the basis of 100 percent capacity cannot, therefore, be taken as valid.

3.11 Like Moghulpura Workshop, there has been a gradual decline in the use of wood in this factory as well. Keeping this in view future requirements of timber have been assessed on the basis of actual consumption during the last four years. The following table gives year-wise production of coaches alongwith the quantity of timber purchased/consumed for their manufacture:-

Table 16. - Quantity of timber consumed in Islamabad Carriage Factory during 1985-86 to 1988-89.

Year	Number of Coaches fabricated	Soft wood (deodar) (cf t)	Hardwood (Shisham) (cf t)
FY 1985-86	69	33,300	6000
FY 1986-87	79	-	-
FY 1987-88	21	-	-
FY 1988-89	38	4,540	-
Total:	207	37,840 cf t	6000 cf t
Average Annual consumption	52	9,460 cf t	1500 cf t
	Or	350 $\overset{3}{m}$	55 $\overset{3}{m}$
	=	405 $\overset{3}{m}$ sawn	
	Or	700 $\overset{3}{m}$ round	

The survey questionnaire duly completed is placed at Annexure-II.

3.12 At present the total requirements of the two factories are as under:-

Table.17 - Total requirements of timber by carriage Factories according to species and form.

Factory	Soft wood(Deodar) ($\frac{3}{m}$)		Hardwood(Shisham) ($\frac{3}{m}$)	
	sawn	round	sawn	round
- C&W repair workshop Moghulpura (Lahore).	1400	2380	1120	1900
- Islamabad Carriage Factory.	350	600	55	100
TOTAL:	1750	2980	1175	2000

Employment

3.13 The carriage factories employ about 2,027 workers in carpentry trade, as given in Table.18 below:-

Table.18 - Employment in carriage factories.

Factory	Number of workers employed in carpentry trade				
	Skilled	Semi-skilled	Unskilled	Others	Total
	(Number of workers)				
Islamabad	102	220	-	10	332
Lahore	1,232	297	144	22	1,695
TOTAL:	1,334	517	144	32	2,027

CHAPTER - IV

DEMAND AND SUPPLY SCENARIO

Timber Requirements of the Railway Industry

4.1 The current requirements of timber by the railway industry as discussed in the preceding chapters can be quantitively summed up as under:-

Sl.No.	Department/Industry	Species	Annual requirement of timbe ($\overset{3}{m}$)	
			sawn	round
1.	Route and Track department (Para 2.2)	Deodar	8332	14,164
2.	Moghulpura carriage and wagon workshop(Para 3.8).	(a) Deodar	1400	2380
		(b) Shisham	1120	1900
3.	Islamabad Carriage Factory(Para 3.10).	(a) Deodar	350	600
		(b) Shisham	55	100
	TOTAL:-	(a) Deodar	10,082	17,140
		(b) Shisham	1,175	2,000
	Grand Total:		11,257	19,140
	Or Say		20,000 cu.meters round	

Since wood is being continuously replaced by alternate metallic and fibrous materials, the authors presume that despite modest expansion of the railway industry, the requirements of timber till year 2000 would remain 20,000 $\overset{3}{m}$ in the round form.

Forest Resources

4.2 Government-owned forests covering 4.6 million hactares constitute 5.2 percent of the total land area of the country. Of

this, the production forests cover only 1.27 million hectares which form 27.6 percent of the total forest area. Keeping in view the present trends of wood consumption in agricultural and industrial sectors, the existing forest resources are highly inadequate for country's over 100 million population which is growing at the rate of 3.1 percent per annum. This situation is further aggravated by low productivity per unit area especially from scrub and coastal forests which are ecologically highly degraded. A comparison of the current yield with the optimum potential of various types of forests may be illustrated as under:-

	Current Yield and Optimum potential	
Forest Type	Current (m^3/ha/year)	Potential (m^3/ha/year)
- Coniferous forest	0.7	1.5
- Irrigated plantations	4.0	15.2
- Riverain forests	1.0	2.0
- Scrub forest	0.6	1.0
- Coastal forest	0.1	0.5

Source: Forest Management in Himalayan, Karakorum, and Hindukush regions of Pakistan - Abeedullah Jan (1990).

4.3 Based on these figures, the current yield of timber from state forests has been estimated at 0.544 million m^3. The trees grown by the people on farmlands outside state and community forests contribute nearly 1.236 million m^3 of wood annually and supplement to a large extent the supply of wood and wood products in the country. However the management practices and the species grown both in the state forests and the properietary lands have kept the productivity so low that on an average, the Mean Annual Increment (MAI) per hectare is not more than 1.3 m^3.

4.4 In the north of the country, which is primarily a hilly tract (altitude varying from 3,000 ft. to 12,000 ft., there are coniferous

forests comprising soft-wood species such as Chir pine(Pinus-roxburghii) Blu Pine(Pinus excelsa),Deodar (Cedrus deodara), Spruce(Picea morinda) and Fir (Abies pindrow). These forests although interspersed with habitations and cultivations, can still be classified as "more or less" compact from the stand-point of future planning for intensive utilization. They, in fact, are the only potential source of commercial timber for our housing industry, match-wood factories, railway sleepers & carriages, packages and containers industry, etc. Total area under these forests is about 2 million hectares which is declining partly, because of defective forest management practices, heavy reliance on natural regneration, excessive grazing and inadequate funds for artificial planting. Conifers generally grow in longer rotations (varying from 120 to 160 years) but the development needs of the country for lumber and other wood products are so urgent and immediate that one cannot afford to wait for that long a period. Maintaining timber supplies without causing serious ecological damage is therefore one of the most critical problems facing country's forestry sector in the northern regions.

4.5 In the plains, there are about three dozen artificially raised irrigated plantations of forest trees which are not only easily approachable by rail and road, but are also uniformly scattered all over the country. In many cases, they are close to the main marketing centres. Area under each of these plantations various approximately from 400 Ha. to 8000 Ha. which means that a sizeable compact block of forest is available for planning an integrated scheme for better and fuller utilization of the material that is produced. At present, these plantations are being managed on a 20 years rotation for the purpose of fuelwood and on a 60 years rotation for the purpose of timber. The species of trees grown here are cent per cent hardwoods, out of which most important are listed below:

1) Shisham (Delbergia sissoo)
2) Mulberry (Morus alba)
3. Bakain (Melia azedarach)

4) Babul (Acacia nilotica)

5) Farash (Tamarix aphylla)

6) New introductions are poplars and eucalypts.

4.6 Besides the irrigated plantations there are some areas under riverain forests also, where the predominant species are Acacia nilotica, Populus euphratica and Tamarix dioca. Both the irrigated plantations and the riverain forests yield something like 15 million cubic feet of stacked wood (mostly heavy and hard to work with) which supplements to some extent the supply of soft wood lumber for the construction of houses, manufacture of sports goods and the furniture stock. By far the greatest part of this produce (about 80%) is used as fuelwood for cooking food and for burning in brick kilns etc.

4.7 The specie-wise annual out-put of commercial woods from state forests in Pakistan (including Azad State of Jammu and Kashmir) for the year 1987-88 is given below:-

Softwoods	1.	Deodar	160,000	cu.meter
	2.	Blue Pine(Kail)	50,000	"
	3.	Chir Pine(Chil)	94,000	"
	4.	Fir and Spruce (Partal)	60,000	"
		Total (1):	3,64,000	"
Hardwood	5.	Shisham	64,000	"
	6.	Mulberry	6,000	"
	7.	Babul	36,000	"
	8.	Miscellaneous Species	70,000	"
		Total (2):	1,80,000	"
		Grand Total:-	5,44,000	"

Source: Annual Progress Reports of the Provincial Forest Departments for the Year 1987-88.

Eucalyptus as a substitute

4.8 Like other developing countries having similar problems of chronic shortage of wood, Pakistan has also been trying to

find a solution, in some of the fast growing species being raised outside their natural habitat. Eucalyptus due to its manifold qualities such as fast rate of growth as compared to that of indigenous species, ability to coppice, adaptability to a variety of edaphic and climatic conditions and various uses to which its wood can be put has become one of the most popular trees not only among the foresters but also the farmers and industrialists. A number of species have been tested in different climatic zones over a period of time. The trials have indicated that quite a few of them could be successfully raised in irrigated plantations, riverain belts and even in water logged and saline areas. There are still others which have shown promise in the average annual rainfall zone of 300 mm indicating that the marginal lands could also be planted up with this tree.

4.9 In its native country Australia, (as well as in Brazil and Argentina), Euc. camaldulensis is considered to be good for many purposes. The wood is specially used for structural purposes where durability is required. It is used extensively in wharf and bridge structures as piling material. It is the most favoured sleeper timber specially in Victoria and is also used for paving blocks and fence posts. Since the timber is hard and resistant to abrasion, it makes excellent feature flooring. The timber is not difficult to saw. Apart from the tendency of the grain to rise in dressing, it works well with machine and hand tools and has good turning properties. The timber takes good finish and can be glued readily with adhesives in common use. If reasonable care is taken planks from mature trees with thickness upto 2.5cm can be air or kiln dried from green condition free of checks.

4.10 The strength properties of the plantation grown eucalytus wood as determined according to the British Standard Specifications are as follows:-

(1)	Density: kg/m^3	705
(2)	Modulus of rupture: kg/cm^2	1,009
(3)	Modulus of elasticity: kg/cm^2	77,788
(4)	Tensile strength perpendicular to grain: kg/cm^2	33

(5)	Cleavage: kg/cm	32
(6)	Max. shearing strength parallel to grain: kg/cm^2	191
(7)	Max.compressive strength parallel to grain: kg/cm^2	397
(8)	Max.compressive strength parallel to grain at elastic limit: kcm^2	270
(9)	Impact bending strength per specimen of 2 cmx 2 cm:kg	2.5
(10)	Hardness: kg	
	End	688
	Side	599
(11)	Resistance to nail withdrawal:kg	128
(12)	Resistance to screw withdrawl:kg	262

4.11 In Pakistan, of all the species tried so far, Eucalyptus camaldulensis has given an outstanding performance. Its large scale planting has, therefore, been advocated to boost up production of raw material for related wood based industries. It has been found that E.camaldulensis wood can be efficiently used for all the purposes where Deodar (Cedrus deodara) is presently employed. The wood can also serve as a substitute for Shisham (Dalbergia sissoo) in furniture manufacture provided slight modifications are made in its design to adjust the strength properties.

4.12 Data collected from well maintained eucalyptus plantations indicates that the trees when grown at a spacing of 2mx2m can give a mean annual increment of 15 m^3 per hectare and can attain an average diameter of 40 cm over a period of 15 years. If the future requirements of railway sleepers were to be diverted entirely to eucalyptus wood, about 20,000 ha. of

land shall have to be put under E. camaldulensis to be worked on a rotation of 15 years.

4.13 Eucalypt wood when used indoors is fairly resistant to insects and fungi but it is not durable outside unless treated with preservatives especially when in contact with the soil as is the case with railway sleepers. Experiments carried out by PFI Peshawar to determine the life of treated and untreated fence posts of E. camaldulensis indicate that untreated posts were highly perishable when used in contact with ground but sawn heartwood poles with preservative treatment were quite sound even after 12 years of ground contact. Two kinds of preservatives are normally used viz. pentachlorophenol and Tanaltith-C, the latter giving cent/cent resistance against termite attack. The cost of each chemical comes to Rs.2.00 and paisas 50 per post respectively.

4.14 Beside E. camaldulensis, there are other eucalypt species which are reported to be equally suitable for railway industry provided they are given high pressure preservative treatment. They are as follows:

(i) Euc. maculata

(ii) Euc. citriodora

(iii) Euc. botryoides

(iv) Euc. tereticornis

(v) Euc. marginata

Source: M.I. Shiekh: Eucalptus in Pakistan, PFI (1982).

CHAPTER-V

CONCLUSION AND RECOMMENDATIONS

Conclusions

5.1 Pakistan Railways at present, require nearly 18000 m^3 of deodar (Cedrus deodara) and 2000 m^3 of shisham (Dalbergia sissoo) timber in the round form annually to maintain over 12,600 km of track and run its two carriage factories at Lahore and Islamabad. Keeping in view the present trend in the replacement of wooden components by metallic and fibrous materials, the likely expansion of railway industry in future is not going to increase the demand of wood for another decade i.e. the end of year 2000.

5.2 The domestic production of deodar and shisham timbers from the state-owned forests, although prima facie sufficient to cover the demand, is not entirely available for the railway industry. The existing supplies are under very heavy pressure from the construction and the furniture industries respectively. Consequently, there is a need to look for alternate species of wood which can suitably meet the requirements of track and carriage factories without affecting quality and durability of the end product.

Recommendations

5.3 According to studies conducted by PFI eucalypts can be efficiently used for all purposes where deodar is presently employed. The wood can also serve as a substitute for shisham provided certain treatments such as conversion at proper time into proper sizes followed by seasoning are given to supplement its strength properties and prolonging its serviceable life. Since sapwood of Eucalyptus is highly perishable when used in contact with ground, it is necessary that preservative impregnation treatment is applied under high pressure, before use.

5.4 A number of Eucalyptus species have been identified for their suitability for railway sleepers. They are:

(i) Euc. citriodora

(ii) Euc. camaldulensis

(iii) Euc. botryoides

(iv) Euc. maculata

(v) Euc. tereticornis

It is recommended that they may be subjected to further laboratory and field tests before multiplication in suitable ecological zones for end use by the railway industry.

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WOOD USING INDUSTRIES OF PAKISTAN
WOOD CONSUMPTION SURVEY QUESTIONNAIRE
RAILWAY INDUSTRY

Dated 28-29 May, 1990.

Persons Interviewed

1) Mr. Habib ur Rehman
Works Manager

2) Mr. Ishtiaq Haider
Assistant Works Manager(Furnishing)

1. Name and Address of the firm. — Pakistan Railways Carriage Factory Khayaban-i-Sir Syed, Islamabad.

2. Year the firm was established. — 1970-71.

3. Indicate which stages of wood processing are done by your firm.

Stage of Processing	By This Firm
- Harvesting trees	No
- Transporting logs	No
- Debarking logs	No
- Sawing or slicing logs	No
- Fabricating wood products	Yes
- Finishing wood products	Yes
- Wholesale distribution	The entire produc
- Retail distribution.	i.e.Carriages and Coaching vehicles are supplied to Pakistan Railways

4. Please list what you consider to be the four main pieces of equipment that you use in this enterprise, its size and the number that you have.

Equipment Type	Equipment Size	Number Used
#1.Seats	6.5ft.long,2ft wide	4-20
#2.Flooring	Strips 24" long 2" wide	Many
#3.Packing in	about 3' long 2" wide	"
#4.Support for electrical fittings.	8" long 6" wide	6-12

5. What was the Annual Production of your four Primary Products.

Product Type	No.Produced per year 1987	1988	1989(Units)
#1.Airconditioned Sitter	-	1	8
#2.First Class Sleepers	30	7	15
#3.First Class Sitters	30	7	15
#4.Second Class	19	6	-
Total:	79	21	38

6. What Per Cent of Capacity are you operating at?

The factory has the installed capacity of 144 coaches per annum. The annual production varies considerably from year to year. The average of the last 3 years is 32 percent.

7. Since 1986, what are the actual wood requirement of the four main wood raw materials that you use.

Species	Initial Form of Wood Used*	Source of Raw Material (Private,Govt.Import)	Wood Volume Used 86	87	88	89 units (cu.ft)
#1.	Deodar	Private Contractors	33,000	-	-	4,540
#2.	Shisham	"	6,000 (Sheets 8'x4' size)	-	-	-
#3.	Formica	"	-	6400	3520	5040
#4.	Phywood	"	(a) -	2400	1320	1890 marine
			(b) -	3600	1980	2835 commercial

*(Scants,log wood,branch wood, lumber, etc.)

8. How is wood delivered to your factory? (Please check all tht apply)

-/	Railways	X	Waterway
X	Truck	X	Push cart
X	Animal cart	X	Hand carried
X	Other(		

9. How much do you pay for wood raw material per unit delivered at the factory gate for the four primary species and grades used. For up to two other species, if

Species Current Use	Grade	Local Rs/Unit Farm lands	Importe Rs/Unit State land
#1.Deodar	Sleepers Grade	Rs.282.72 per cft.	Not applicable
#2.Shisham	Planks, seasoned	Rs.150.00	

these woods were available, how much could you use and what price would you be willing to pay for it.

#3.Formica (a) 6 m.m thick Rs.346.00 per sq.meter
(b) 4.5m.m thick Rs.1345.00 per sheet 8'x4'

#4.Phywood (a) Marine Rs.706.00 per sheet 8'x4'
(b) Commercial Rs.411.50 per sheet 8'x4'

Potential Use

#1.
#2. Eucalyptus properly treated.

10. Are Your average per unit wood costs the same at last year?

Choose One:

Up	+15-20%
THE SAME	00 %
DOWN	-No %

11. From whom is wood purchase?

Contractors through open tenders

(Tree grower, forest auction, middle man, own lands, et

12. If your Primary supplier is an individual please list his name and address here.

(a) Timber:- M/S Ahmed & Co Satellite Town, Rawalpindi.

(b) Farmima:- M/S Balochistan Laminates, Karachi.

(c) Phywood:- -do-

13. Please describe any wood availablity problems that you now have or expect to have next year.

The use of wood is being gradually replaced by metallic and non-metallic fibrous components. Since the requirements are relatively small, there is no problem in their acquisition.

14. Current and Future consumption of

Species	Grade	Expected Wood Volume 1990	1991	1992	Units
#1.Deodar	IClass (Sawn)	1400 m^3	1500 m^3	1500 m^3	
#2.Shisham	Seasoned (Sawn)	1120 m^3	1200 m^3	1200 m^3	

#3.

#4.

15. What significant other materials are used in connection with your wood based product? (e.g.if wood is your fuel are there other fuels used, if it is a part in fabrication what are the other parts?)

Material	Quantity	Tonnes/Year
#1. Electricity		Estimates not available
#2. Gas		-do-

16. Annual Volume of Wood Waste (Units?) — Ten percent of the total volume.

-Principal Form of Wood Waste. — (i) Saw dust (ii) Edgings and trimings

-Uses of Wood Watste — -Sold to factory workers for fuel.

-Sale price/Unit of waste — -Rs.1/- per bag.

17. What is the distribution of your costs of production?

-Metallic raw material	70%
-Wood raw material	5%
-Labor costs	15%
-Other operating costs	10%
Total:-	100%

18. What is your gross annual value of sale in Rs?

-A normal II Class coach costs		Rs.3.24	million
-A normal I Class sitter costs		Rs.3.89	"
-A.C.C.lower	"	Rs.5.00	"
-A.C.C.Sleeper	"	Rs.5.50	"

If 50 coaches are produced annually, the gross value of the product is Rs.200 million. Since the entire product is supplied to Pakistan Railways the transaction is made by book transfer.

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ANNEXURE-II

WOOD USING INDUSTRIES OF PAKISTAN,
WOOD CONSUMPTION SURVEY QUESTIONNAIRE,
RAILWAY INDUSTRY

Date - 27 June, 1990.

Persons Interviewed

(1) Mr. Mushtaq Ahmed Khan,
Deputy Chief Engineer (Mech.)
Carriages & Wagons, Lahore.

(2) Mr. Ghulam Sarwar,
Junior Mechanical Engineer.

1. Name and Address of the firm. — Carriage and Wagon Workshop, Moghulpura, Lahore.

2. Year the firm was established. — 1907

3. Indicate which stages of wood processing are done by your firm.

State of Processing	By This Firm
- Harvesting trees	Nil
- Transporting logs	Nil
- Debarking logs	Nil
- Sawing or slicing of logs is done in the workshops.	Nil
- Fabrication of seats for coaches and carriages is done in the shop.	
- Repair and manufacturing is done for local consumption.	

4. Please list what your consider to be the four main pieces of equipment that you use in this enterprise, its size and the number that you have.

Equipment Type	Equipment size	Number Used
(a) Seats	6½ long 2ft.wide	4-20
(b) Supports for electric fittings.	6"x8"	6-12
(c) Packings in side walls.	3'x2"	-
(d) Flooring	Strips 24"x2"	-

5. What was the Annual Production of your four Primary products.

It is primarily a repair shop. Production of new items is not done in this factory.

6. What Per Cent of Capacity are you operating at?

The shop has the capacity to repair and service nearly 1400 Coaches per annum. At present, the target is being achieved to the extent of 90%.

7. Since 1986, what are the actual wood requirement of the four main wood raw materials that your use.

	1987	1988	1989
1. Deodar Contractors Sleepers.	700 m^3	950 m^3	2500 m^3
2. Shisham Contractors planks.	1400 m^3	1000 m^3	1000 m^3

Note. Some quantities of Farmica and phywood were also used but the figures were not readily available.

8. How is wood delivered to your factory? (Please check all that apply).

-/	Railways	X	Waterway
X	Truck	X	Push cart
X	Animal cart	X	Hand carried
X	Other(_____)		

9. How much do you pay for wood raw material per unit delivered at the factory gate for the four primary species and grades used. For up to two other species, if these woods were available, how much could you use and what price would you be willing to pay for it.

Species	Grade	Local Rs/Unit (Farm lands state land)	Imported Rs/Uni
Current Use			
#1.Deodar	Sleepers 1 grade	Rs.282.72 per cp	Not applicab
#2.Shisham	Planks, seasoned.	Rs.150.00 "	"
#3.Farmica	(a) 6 m.m" thick	Rs.346.00 per sq.meter	"
	(b)4.5m.m"	Rs.1345.00 per sheet 8'x4'	"
#4.Plywood	(a)Marine	Rs.706.00 per sheet 8'x4'	"
	(b)Commerial	Rs.411.50 "	"

Potential Use

#1. _____

#2. Eucalyptus Properly treated.

10. Are your average per unit wood costs the same as last year?

Choose One:

UP	+ 15-20%
THE SME	00
DOWN	- No%

11. From whom is wood purchased? — Contractors through open tenders.

(Tree grower, forest auction, middle, man, own lands, etc.)

12. If your primary supplier is an individual please list his name now have or expect to have next and address here.

(1) M/S M. Ahmed & Co. Satellite Town, Rawalpindi.

(2) Mutwakkal, Traders, Wazirabad.

(3) Fazal Elahi & Co. Lahore.

13. Please describe any wood availability problems that you now have or expect to have next year. — There is no problem so far as the availability of wood is concerned.

14. Current and Future Consumption of your four most used woods. (Use actual this year and best estimates thereafter).

Species	Grade	Expected Wood Volume 1990	1991	1992
(a) Deodar Sleepers	I Class	1400	1300	1300
(b) Shisham	Planks Seasoned	1120	1200	1200

15. What significant other materials are used in connection with your wood based product? (e.g. if wood is your fuel are there other fuels used, if it is a part in fabrication what are the other parts?)

Material	Quantity	Tonnes/Year
#1. Electricity	Estimates not available	
#2. Gas		-do-

16. Annual Volume of Wood Waste Units? — Ten percent of the total volume.

-Principal Form of Wood Waste — (i) Saw dust (ii) Edgings and trimings

-Uses of Wood Waste — - Sold to factory workers for fuel.

-Sale price/Unit of waste — - Rs.1/- bag.

17. What is the distribution of your costs of production?

-metallic raw material	70%
-Wood raw material	5%
-Labor costs	15%
-Other operating costs	10%
Total:-	100%

18. What is your gross annual value of sales in Rs? — It is a repair shop. The gross value of the product has never been assessed.

19. Howmany man-years of employees does your establishment employ in an average year? (Include all managers, professionals, staff, and laborers). — 1695-man-years out of which 400 man years in the carpentary trade.

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