CHAPTER 3 INTER-REGIONAL TRANSPORT SYSTEMS AND THE ROLE OF THE RAILWAY

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3-1 Outline of the Existing Transport Modes

3-1-1 Introduction

The Inter-regional transport services in the Socialist Republic of the Union of Burma (SRUB) consist of four modes, i.e., railway, road, water and air transport.

Among the four transport systems, water transport - especially inland-water transport along major rivers - has been playing the essential role for inter-regional passenger and freight transport since the ancient period. Coastal shipping is also an important transport means serving the area facing the Bay of Bengal and Andaman Sea.

The existing railway network had been almost completed by the 1930's and it covers the nation from north to south except some frontier state/divisions.

The trunk road network configuration was established in the 1940's and most of the trunk roads run through in north-south direction mainly due to the topographical condition.

Although the volume of transport is not so much compared with others, air transport has a certain importance for the regions along the national border where there is no convenient access by other modes.

Railway and air transport services are monopolized by state-owned transport organizations, Burma Railways Corporation and Burma Airways Corporation, respectively. On the other hand, road and water transport are served not only by state-owned transport organizations but by co-operative and private transport organizations. Moreover, some of the industrial corporations have their own transport means such as tankers, barges and haulage trucks for their commodities.

A brief description of each transportation system is given hereinafter.

3-1-2 Railway

(1) Network

The railway system with a total service length of 3,154 kms (1,960 miles) consists of 11 major lines and several branch lines. Major lines are as shown in Fig. 3.1.1.

The system is of metre gauge and most of the lines consist of single track except for the section between Rangoon and Pyinmana with 362 kms (225 miles) length and Rangoon circular line. There are 473 stations in total.

(2) Rolling stock

BRC owns 368 locomotives in 1985/86; out of which 141 are steam locomotives and the rest diesel, and the total number of passenger coaches is 1,333 and freight wagons 8,939.

The number of locomotives is almost constant since five years ago, while coaches and wagons are decreasing to 70 - 80 percent of that in 1981/82.

(3) Train operation

BRC operates passenger trains and freight trains, 291 trains for passenger and 64 for freight per day in 1985. Since passenger trains include 121 suburban trains which are mostly within Rangoon city, less than a hundred passenger trains are serving inter-regional movement. For example, Rangoon - Mandalay line (most major trunk line) has 3 round trips of express train, 2 of mail/ordinary and several local/mixed trains per day. It takes about 14 hours by express (Rangoon - Mandalay), and the scheduled speed is 44 kms/hr (27.5 miles/hr).

(4) Transport volume

BRC as a whole carried 62.3 million passengers and 2.3 million tons of freight in 1985/86 (provisional figures), and these figures indicate an increase from 1975/76 at an annual growth rate of 2.4 percent for passenger and 3.4 percent for freight. Since almost a half of the total passenger volume is the demand for suburban line (short trip), according to the data by BRC, 29 to 30 million passengers are for main lines. The average trip length of main line passengers is estimated as 115 kms.

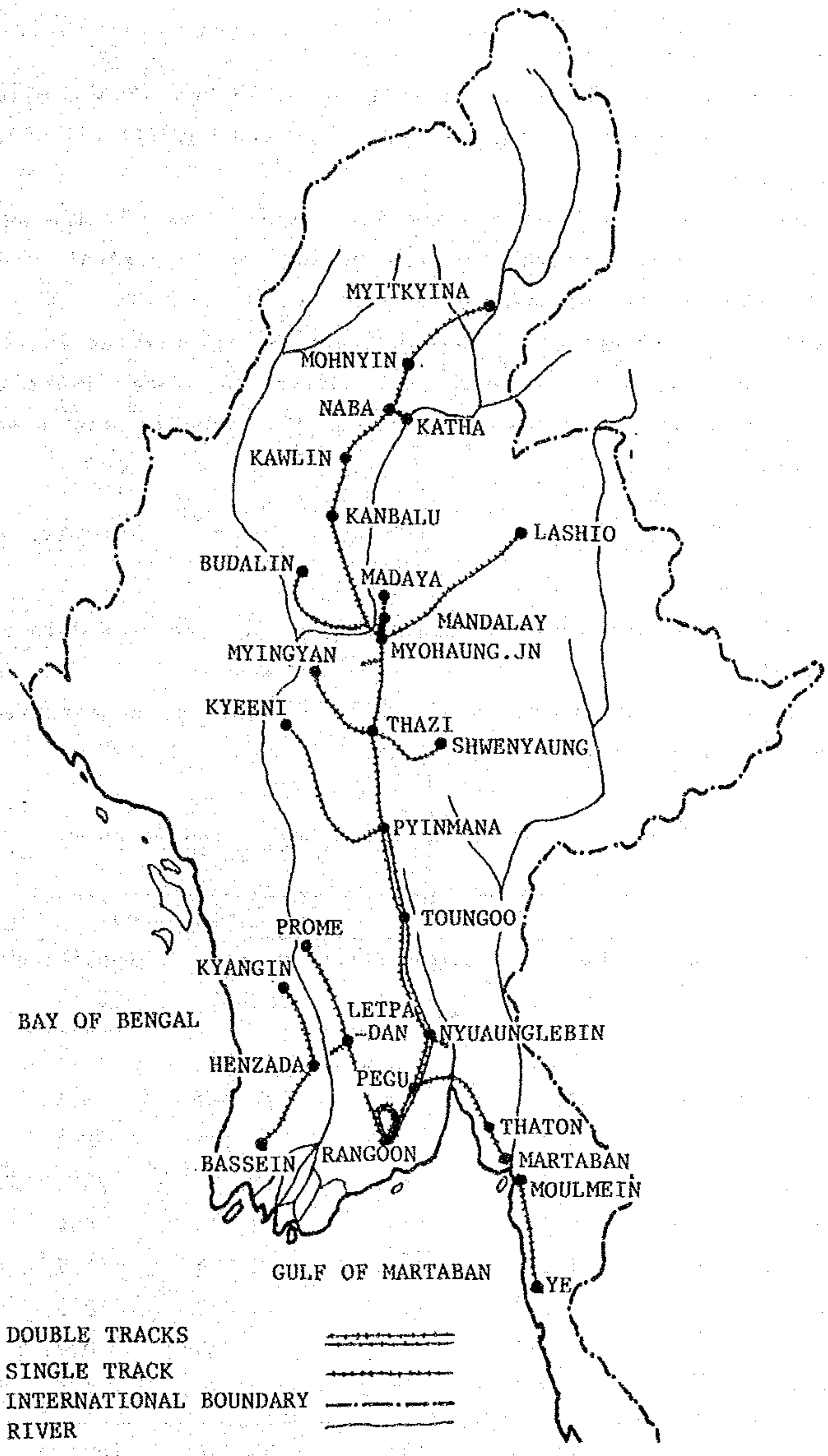


Fig. 3.1.1 Burma Railways Network

3-1-3 Road Transport

(1) Road network

Highway network in SRUB consists of 3,945 kms (2,452 miles) union highways and main roads with a length of 19,000 kms (11,811 miles) as of January, 1986.

Among these roads only 875 kms (544 miles) have bitumen surface and are of 18 to 22 feet width, this accounting for 23 percent of the total union highways (only four percent to the total highways).

The trunk road network configuration is as illustrated in Fig. 3.1.2; most of the roads run in north-south direction along rivers and these rivers are barriers to the connection of roads in the east - west direction.

(2) Number of vehicles

1) Total number of vehicles registered

In 1984/85 there are 131 thousands vehicles registered in SRUB. The composition by type of vehicles is tabulated in Table 3.1.1, and the annual growth of total vehicles indicates a comparatively high percentage of 6.6 from 1980/81 to 84/85.

Table 3.1.1 No. of Vehicles Registered in Burma

Type of Vehicle	1980/81		1984/85		Annual Growth Rate (%)
	No. of Vehicles	Composition (%)	No. of Vehicle	Composition (%)	
1. Small cars	33,254	32.8	35,845	27.4	1.9
2. Pick-up (Taxi)	8,349	8.2	18,063	13.8	21.3
3. Light truck	3,818	3.8	5,977	4.6	11.9
4. Truck	30,863	30.5	33,077	25.3	1.7
5. Bus	8,116	8.0	8,323	6.4	0.6
6. Three wheeler	2,207	2.2	2,259	1.7	0.6
7. Motor-cycle	12,159	12.0	24,253	18.5	18.8
8. Tractor	214	0.2	323	0.2	10.8
9. Others	2,305	2.3	2,876	2.2	5.7
Total	101,285	100	130,996	100	6.6

Source: Department of Road Transport Administration

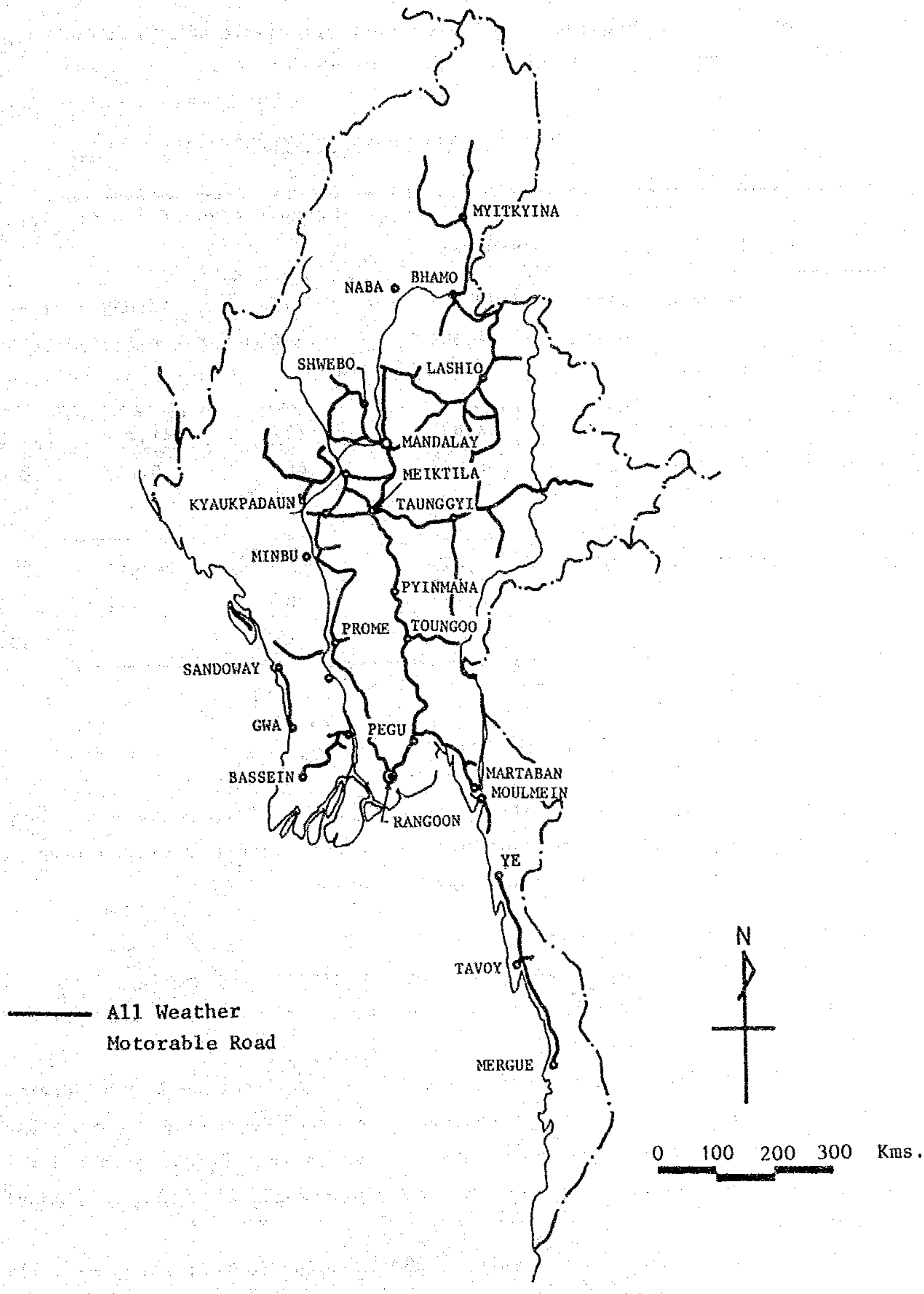


Fig. 3.1.2 Trunk Road Network

2) Number of vehicles by transport organization

The number of conveyances by transport organization is summarized as follows:

Table 3.1.2 No. of Conveyances by Organization

Year	Type	State transport organization	Co-operative	Private	Total
1976/77	Haulage trucks	2,693	516	18,657	21,866
	Passenger buses	1,506	114	6,135	7,755
	Taxis	1,008	-	-	1,008
1980/81	Haulage trucks	2,835	627	21,761	25,223
	Passenger buses	1,595	401	5,818	7,814
	Taxis	673	-	-	673
1985/86 1/	Haulage trucks	2,699	647	24,045	27,391
	Passenger buses	1,289	203	6,226	7,718
	Taxis	404	-	-	404

1/ Provisional

Source: Report to the Pyithu Hluttaw

State transport organization (Road Transport Corporation) has been reducing their own number of vehicles, while private sector increased their vehicles especially in haulage trucks.

(3) Bus and trucking services

The road transport services for regional movements, both of passengers and goods, are provided by RTC, co-operative and private organizations to the public.

In 1984/85 RTC operates nine routes of inter-regional bus service such as between Rangoon to Nyaunglebin, Toungoo, Magwe and so on. RTC transports 94,218 thousands passengers as a whole in 1984/85, of which 931 thousands (one percent) passengers are inter-regional (long distance) travellers.

Haulage division of RTC carries 1,280 thousand tons of cargo by 2,714 haulage trucks in 1984/85.

3-1-4 Water Transport

Water tranport in SRUB has been playing an important role of transport for passenger cum cargo taking advantage of topographical conditions, i.e., long navigable rivers and coastal ports.

(1) Network

Water transport consists of inland water transport and coastal shipping.

For inland water transport approximately 8,000 kms of river routes are navigable in highwater level season; along Irrawaddy, Chindwin, Salween rivers and so on.

On the other hand, coastal shipping is served between Rangoon port and other 8 outer ports; Sittwe, Bassein, Moulmein, Mergui, Kyaukpyu, Sandoway, Tavoy and Kawthaung.

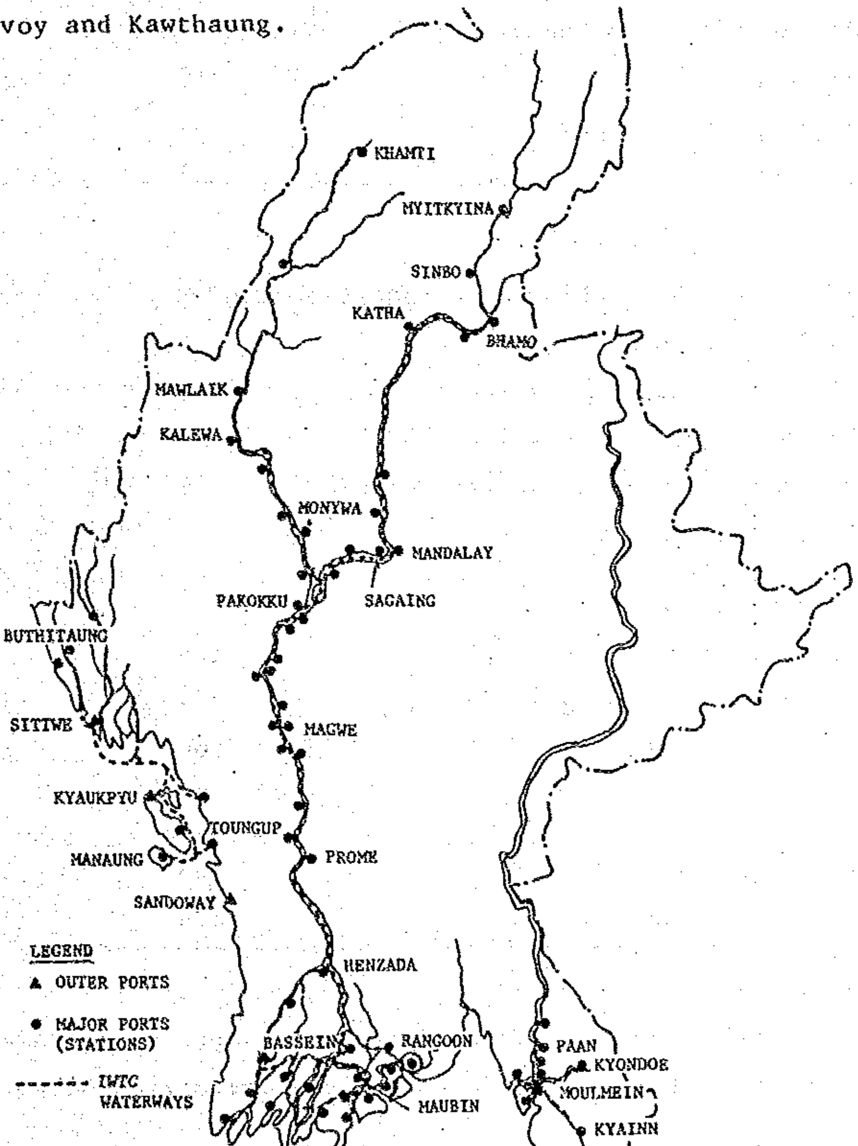


Fig. 3.1.3 Inland and Coastal Transport Network

(2) Size of fleet

Number of vessels for water transport is summarized by organization as follows:

A remarkable increase is indicated in the number of private powered vassels, at the rate of over 150 percent from 1980/81 to 1985/86.

Table 3.1.3 No. of Vessels by Organization

Particulars	1980/81	1985/86 1/
1. Inland Water Transport Corporation		
1) Passenger cum cargo	173	174
2) Cargo barges	48	50
3) Tug and cargo boats	45	58
4) Barges	218	258
5) Station pontoons	81	74
6) Tugs	37	39
7) Oil barges (Dumb)	16	19
2. Burma Five Star Shipping Corporation		
1) Ocean liner	8	11
2) Short seas trade vessels	4	5
3) Coastal cargo vessels	2	2
4) Coastal cargo/passenger vessels	4	4
5) Coastal Tanker	6	- 2/
3. Co-operatives		
1) Powered barges (Ferry)	245	301
2) Non-powered barges (Ferry)	804	898
3) Cargo vessels	309	213
4. Private		
1) Powered vessels	703	1,236
2) Coastal vessels	274	247

1/ Provisional

2/ One coastal tanker was transformed into short seas trade vessels and four were transferred to Petrochemical Industries Corporation

Source: Report to the Pyithu Hluttaw

(3) Transport volume

The total volume of transport by IWTC for these 10 years is summarized as follows:

Table 3.1.4 Transport of Passenger and Freight by IWTC

Year	Passenger			Freight		
	Pass. (1000)	Pass-kms. (1000)	Ave.kms.	Ton (1000)	Ton-kms. (1000)	Ave.kms.
1975/76	11,153	376,607	34	1,746	547,955	314
1980/81	14,209	425,828	30	1,414	309,037	219
1985/86 1/	20,088	690,461	34	2,000	445,107	223
Annual Growth Rate (%)	6.1	6.2	-	1.4	-2.1	-

1/ Provisional

Source: Report to the Pyithu Hluttaw

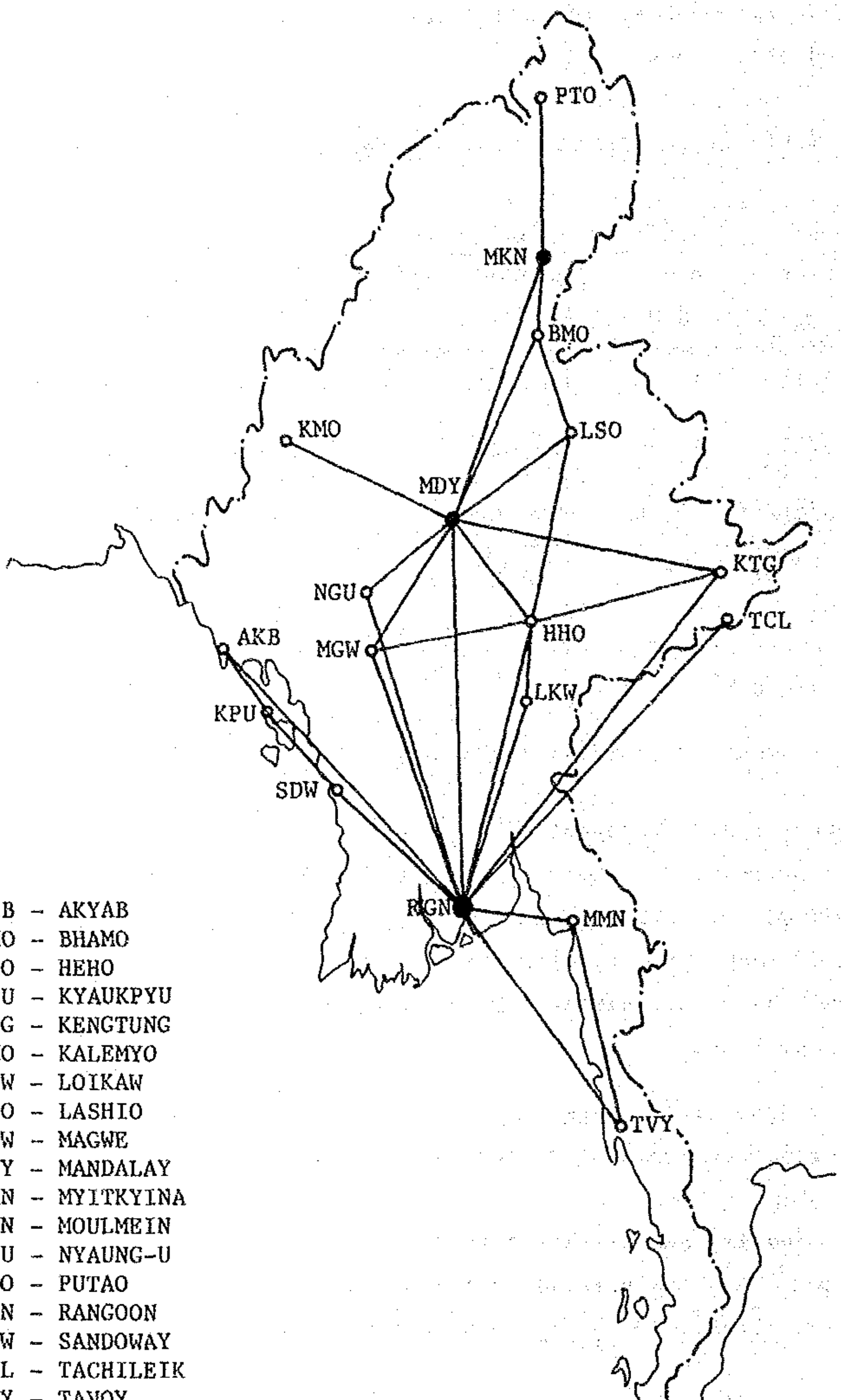
3-1-5 Domestic Air Transport

Air transport is under the administration of Department of Civil Aviation (DCA) in MOTC, and DCA maintains and manages Mingaladon Airport (in Rangoon) and other 36 airports in the country. Air transport service is operated by Burma Airways Corporation (BAC) for domestic as well as international lines.

(1) Major domestic airways

Domestic air transport routes connect major community centres as shown in Fig. 3.1.4. They consist of trunk routes and local routes with Rangoon, Mandalay and Myitkyina in the centre.

As present, the airline operates regular schedule services, charter and special flights to and between twenty-one towns within the country.



AKB - AKYAB
BMO - BHAMO
HHO - HEHO
KPU - KYAUKPYU
KTG - KENGTUNG
KMO - KALEMYO
LKW - LOIKAW
LSO - LASHIO
MGW - MAGWE
MDY - MANDALAY
MKN - MYITKYINA
MMN - MOULMEIN
NGU - NYAUNG-U
PTO - PUTAO
RGN - RANGOON
SDW - SANDOWAY
TCL - TACHILEIK
TVY - TAVOY

Fig. 3.1.4 Major Domestic Air Route

(2) Aircrafts

Number of aircrafts owned by BAC is as follows:

Table 3.1.5 Aircrafts by Type

Particulars	1975/76	1980/81	1985/86 1/
1. DAKOTA (28 seats)	6	-	-
2. TWIN OTTER (18/20 seats)	-	7	-
3. VISCOUNT (48 seats)	2	-	-
4. FOKKER F-27 (44 seats)	7	6	5
5. FOKKER F-28 (MK 1000) (65 seats)	-	2	2
6. FOKKER F-28 (MK 4000) (85 seats)	-	1	1
7. BOEING 727 (114 seats)	1	-	-
8. PUMA Helicopter (18/20 seats)	-	3	3

1/ Provisional

Source: BAC

(3) Transport volume

Passengers of domestic air transport indicate a declining trend with the peak in 1979/80, 543 thousand and 179,051 thousand passenger-kms. The volume of air cargo is stable in the range of 3 - 5 thousand tons for these ten years.

Table 3.1.6 Transport of Passenger and Freight by BAC

(1000)

Year	Passenger		Freight	
	Pass.	Pass.-kms.	Ton	Ton-kms.
1975/76	399	146,586	3.9	1,466
1980/81	536	178,300	4.4	1,717
1985/86 1/	412	161,978	3.2	1,537
Annual Growth Rate (%)	0.3	1.0	-2.0	0.5

1/ Provisional

Source: BAC

3-2 Modal Split and the Role of the Railway

Though various analyses were tried in order to make clear the role and function of the railway among all transport systems, the limitation of available data makes it very difficult, but some results are summarized hereinafter.

3-2-1 Modal Split in Freight Transport

For analysing the share of the railway in all internal freight transport, there are two available data: one is total freight volume in terms of tonnage by organization, and another is by organization and distance haul.

(1) Share of the railway to the total demand

The total internal freight demand has been increasing at the average annual rate of 6.4 percent in these 10 years as shown in Table 3.2.1. This table also shows the decreasing share of railway from 3.5 percent in 1977/78 to 2.5 percent in 1984/85 in spite of the stable demand for railway.

Table 3.2.1 Share of BRC and Total Internal Freight Volume

Year	Share of BRC (%)	Tonnage carried by BRC (1000 tons)	Total Internal Freight Volume (1000 tons)
1975/76	3.4	1,620	47,596
1976/77	3.4	1,675	49,542
1977/78	3.5	1,860	52,736
1978/79	3.4	1,914	56,369
1979/80	3.5	2,226	63,749
1980/81	3.3	2,294	68,580
1981/82	3.2	2,375	74,081
1982/83	3.0	2,293	77,416
1983/84	2.8	2,243	80,630
1984/85 1/	2.5	2,120	83,660
1985/86 2/	2.6	2,303	88,291

1/ Provisional actual

2/ Provisional

Source: Report to the Pyithu Hluttaw

(2) Share of railway in medium and long haul freight transport

According to the available data, internal freight transport is divided into three categories by distance; short (less 25 miles), medium (25 - 75) and long (75 miles and above). Since BRC freight transport mainly plays its role in the medium and long haulage as an inter-regional transport mode, the share in medium and long haul is tabulated as in Table 3.2.2 and 3.2.3.

Table 3.2.2 Railway Internal Freight by Distance 1/

(1000 tons)

		Short-haul	Medium-haul	Long-haul	Total
1974/75	Railway	-	204(13)	1,381(87)	1,585(100)
	All mode	28,267	9,370	9,454	47,091
	Share (%)	0	2.2	14.6	3.4
1984/85	Railway	-	329(15)	1,914(85)	2,243(100)
	All mode	51,734	18,771	16,771	87,276
	Share (%)	0	1.8	11.4	2.6

1/ Figures in parentheses indicate composiiotn percentage by distance.

Table 3.2.3 Internal Freight by Transport Mode, Medium and Long Haul 1/

(1000 tons)

Mode	1974/75	1981/82	1982/83	1983/84	1984/85 2/
Railway	1,585 (8.4)	2,375 (8.1)	2,293 (7.4)	2,243 (7.1)	2,243 (6.3)
Road 3/	10,878 (57.8)	17,722 (60.7)	18,629 (60.4)	18,526 (58.6)	21,821 (61.4)
Water 4/	6,361 (33.8)	9,116 (31.2)	9,933 (32.2)	10,869 (34.4)	11,478 (32.3)
Total	18,824(100.0)	29,213(100.0)	30,855(100.0)	31,638(100.0)	35,542(100.0)

1/ Medium haul: 25 - 75 miles, Long haul: 75 miles or more

2/ Provisional

3/ RTC, co-operative and private

4/ IWTC, co-operative and private

5/ Figures in parentheses indicate model split in percentage.

Source: Estimate based on the data by Ministry of Planning and Finance

The share of the railway also decreases in this analysis, while on the other hand road transport increases its share continuously.

3-2-2 Modal Split among Government Sectors

The internal freight demand mentioned before is carried by various transport sectors such as state owned transport organizations, other state owned organizations, co-operative and private transport organizations.

The share by state owned transport organizations (BRC, IWTC, RTC and BFSSC) is declining from 9.4 percent in 1975/76 to 6.4 percent (provisional) in 1985/86 as shown in Table 3.2.4.

Table 3.2.4 Composition of Share by Organization

(%)

Year	by state owned transport organizations	by other state owned organizations	by co-operative & private transport organizations	Total
1975/76	9.4	90.6		100
1976/77	7.3	92.7		100
1977/78	7.4	5.8	86.8	100
1978/79	6.9	6.8	86.3	100
1979/80	7.2	7.3	85.5	100
1980/81	7.2	6.8	86.1	100
1981/82	7.1	7.6	85.3	100
1982/83	7.2	7.4	85.4	100
1983/84	7.1	6.3	86.6	100
1984/85 1/	6.9	6.8	86.3	100
1985/86 2/	6.4	7.1	86.5	100

1/ Provisional actual

2/ Provisional

Source: Report to the Pyithu Hluttaw

(1) Internal freight volume

The internal freight volume by each state owned transport organization is summarized as follows:

Table 3.2.5 Internal Freight Volume by State Owned Transport Organizations

(1000 tons)

Year	BRC	IWTC	RTC	BFSSC 2/	TOTAL
1977/78	1,860 (47.5)	1,022 (26.1)	1,037 (26.5)	N.A	3,919 (100.0)
1978/79	1,914 (49.1)	966 (24.8)	1,016 (26.1)	N.A	3,896 (100.0)
1979/80	2,226 (48.7)	1,009 (22.1)	1,333 (29.2)	N.A	4,568 (100.0)
1980/81	2,294 (46.7)	1,414 (28.8)	1,066 (21.7)	141 (2.9)	4,915 (100.0)
1981/82	2,375 (45.1)	1,595 (30.3)	1,158 (22.0)	134 (2.5)	5,262 (100.0)
1982/83	2,293 (41.2)	1,870 (33.6)	1,268 (22.8)	129 (2.3)	5,560 (100.0)
1983/84	2,243 (39.0)	2,128 (37.0)	1,237 (21.5)	136 (2.4)	5,744 (100.0)
1984/85 3/	2,120 (36.7)	2,301 (39.9)	1,300 (22.5)	51 (0.9)	5,772 (100.0)
1985/86 4/	2,303 (40.9)	2,000 (35.5)	1,283 (22.8)	47 (0.8)	5,633 (100.0)

1/ Figures in parentheses indicate composition percentage by organizations

2/ Data by BFSSC are obtainable after 1980/81

3/ Provisional actual

4/ Provisional

Source: Report to the Pyithu Hluttaw

Except in 1978/79, total freight volume carried by state-owned transport organizations has increased since 1977/78. On the other hand there are no remarkable changes in the trend of freight volume by BRC, and 2,200 to 2,300 thousand tons per year are carried by railway. Therefore, the share of the railway has been decreasing sharply, 49 percent in 1978/79 to 37 percent in 1984/85.

(2) Passenger transport volume

Modal share by state-owned transport organization for passenger is analysed by other data as in Table 3.2.6.

Table 3.2.6 Internal Passenger Transport by State Owned Transport Organizations

Year	Mode	No. of pass. (1000)		Pass.-mile (1000)		Average trip length (mile)
1975/76	Railway	49,055	(22.8)	2,155,430	(71.8)	43.9
	Road	155,024	(71.9)	521,668	(17.4)	3.4
	Water 1/	11,153	(5.2)	234,063	(7.8)	21.0
	Air	339	(0.2)	91,104	(3.0)	268.7
	Total	215,571	(100.0)	3,002,265	(100.0)	13.9
1980/81	Railway	52,821	(24.6)	2,177,412	(64.6)	41.2
	Road	147,087	(68.5)	784,335	(23.9)	5.3
	Water 1/	14,209	(6.6)	264,654	(8.1)	18.6
	Air	536	(0.2)	110,814	(3.4)	206.7
	Total	214,653	(100.0)	3,277,215	(100.0)	15.3
1985/86 2/	Railway	62,306	(27.2)	2,339,291	(62.5)	37.5
	Road	145,871	(63.8)	873,856	(23.3)	6.0
	Water 1/	20,088	(8.8)	429,124	(11.5)	21.4
	Air	412	(0.2)	100,670	(2.7)	244.3
	Total	228,677	(100.0)	3,742,941	(100.0)	16.4

1/ Excluding coastal shipping

2/ Provisional

3/ Figures in parentheses indicate modal share in percentage

Source: Report to the Pyithu Hluttaw

This table shows that the average trip distance by passenger has increased as a whole and the share of the railway increased in number of passenger but decreased in passenger-mile.

3-2-3 The Role of the Railway

The characteristics and role of the railway among all transportation systems in Burma are summarized as a result of various analyses above.

o Railway has an important role in long-haul transport.

For instance about 90 percent of railway freight belongs to long-haul transport (120 kms above) and the share of the railway among total long-haul freight transport is 11.4 percent which is the highest of all public transport sectors.

o Railway is facing a difficult competition with other modes.

Although the demand by railway shows a slight increase for these years, other modes, especially road transport (private sector), indicate a remarkable growth. The share, therefore, of the railway has declined from 3.4 percent in 1975/76 to 2.6 percent in 1985/86 of total internal freight demand.

o Railway has an ability to increase its capacity.

Since the railway had achieved about 1.5 to 2.0 times of freight transport in the 1960's compared with the present volume, the present transport capacity will be able to increase by an adequate improvement and maintenance of facilities.

3-3 Present Characteristic of Railway Transport

3-3-1 General

(1) Historical trend

The long-term trends of BRC transport both in passenger and freight are illustrated in the following figures.

The trend of passenger miles is upward in the postwar period. But in 1976 passenger-miles decreased keenly and it took 6 years to resume the figure in 1975.

Fig. 3.3.2 shows the change of total ton-miles. According to the figure, the achievement in postwar years has not exceeded the prewar level. In the postwar period, the peak was in 1965, and the trend has been downward.

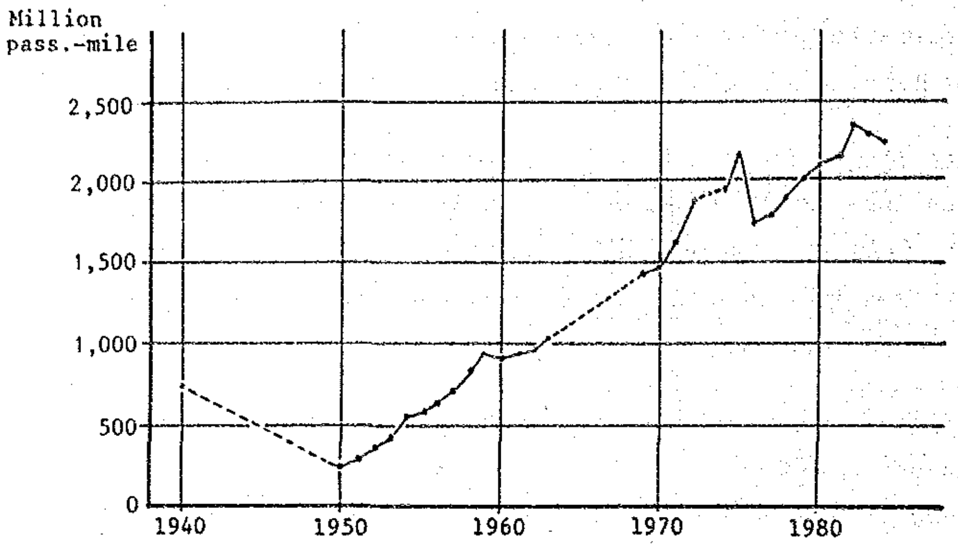


Fig. 3.3.1 Passenger-Miles (Whole BRC)

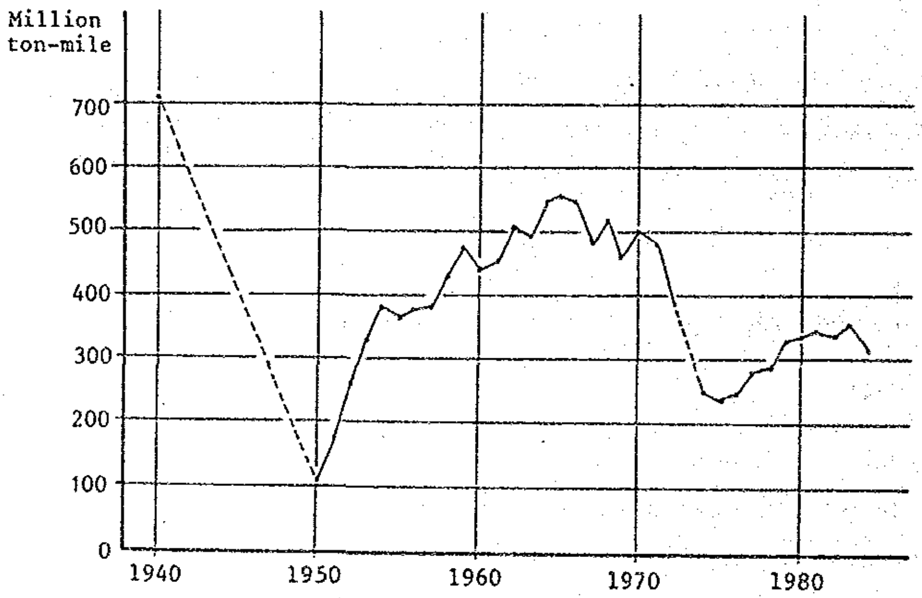


Fig. 3.3.2 Ton-Miles (Whole BRC)

Source: Year Book of Information

The trend of train operation is shown as in Table 3.3.1.

Although total train miles are constant since 1960/61, passenger train miles became over double but freight and mixed train miles remarkably decreased.

Table 3.3.1 Train Miles

(1000 kms)

Year	Passenger	Freight	Mixed	Departmental	Total
1940/41	2,319	3,402	6,418	-	12,139
1960/61	2,605	2,140	4,952	-	9,697
1984/85	5,666	1,551	1,957	529	9,703

Source: Burma Railways Corporation Book of Information 1985
A Year Book of Information 1962

(2) Train service frequency and scheduled time

In 1985 the scheduled services for main lines are summarized as follows:

Table 3.3.2 Current Passenger Train Service on Main Lines

Line	from/to	Distance kms (mile)	Type of train	No. of round trip (per day)	Travel time
Rangoon-Mandalay	. Rangoon-Mandalay	620 (385-1/2)	Express	3	14 hrs. - 14 hrs. 25 min.
	. Rangoon-Mandalay	620 (385-1/2)	Mail/ ordinary	1	18 hrs. 55 min.
	. Rangoon-Thazi	492 (306)	Mail/ ordinary	1	12 hrs. 55 min.
	. Rangoon-Pegu	75 (46-1/2)	Mixed/ local	1	2 hrs. 30 min.
	. Rangoon-Pyinmana	362 (225)	Mail/ local	1	11 hrs. 40 min.
	. Pyinmana-Thazi	130 (81)	Mail/ local	1	3 hrs. 35 min.
	. Thazi-Mandalay	128 (79-1/2)	Mail/ local	1	5 hrs. 55 min.
Rangoon-Martaban	. Rangoon-Martaban	278 (172-3/4)	Express	3	7 hrs. - 8 hrs. 35 min. 0.5 min
	. Rangoon-Martaban	278 (172-3/4)	Mail/ ordinary	1	12 hrs. 15 min.
Rangoon-Prome	. Rangoon-Prome	259 (161)	Express	1	7 hrs. 00 min.
	. Kemmendine-Prome	253 (157-1/2)	Mail/ ordinary	1	11 hrs. 15 min,
	. Kemmendine-Tharrawaw	153 (95-1/4)	Mail/ ordinary	1	5 hrs. 25 min.
Mandalay-Myitkyina	. Mandalay-Myitkyina	543 (337-1/4)	Mail/ ordinary	2	24 hrs. - 25hrs. 25 min.
	. Mandalay-Naba	329 (204-1/2)		1	17 hrs. 20 min.

Source: BRC

In addition to these services, one or two round trips per day are scheduled for each branch line.

Goods trains are also operated in accordance with train diagram and service frequency is summarized as follows:

Table 3.3.3 Current Goods Train Services on Main Lines

Train No.	from/to	Distance kms (mile)	Departure Time	Arrival Time
901	Mahlwagon /Thazi	488 (302-1/2)	2300	2230
903	Mahlwagon /Myohaung	547 (380-1/4)	0850	2200
905	Thazi /Myohaung	123 (76-3/4)	1000	1600
907	Mahlwagon /Pegu	71 (44)	2000	2230
803	Mahlwagon /Thainzayet	52 (32-1/4)	2030	0100
501	Mahlwagon /Pyinmana	358 (222-1/2)	0100	2030
509	Myohaung /Wuntho	243 (151)	2000	1330
511	Myohaung /Wuntho	243 (151)	0500	2230
505	Kemmendine/Paungde	203 (126)	1000	1800
507	Kemmendine/Paungde	203 (126)	1600	0400
227	Myohaung /Kawlin	230 (143)	2130	1330
229	Kawlin /Mohnyin	157 (97-3/4)	0245	1450
281	Kawlin /Mohnyin	157 (97-3/4)	1830	1240
231	Mohnyin /Myitkyina	144 (89-1/4)	0430	1245
233	Pegu /Martaban	203 (126-1/4)	0445	2100
235	Pegu /Dalangyun	314 (195)	2200	0740

1/ As example only up trains along major 4 lines are tabulated.

Source: BRC

(3) Capacity

Train formation of passenger trains is scheduled depending upon type of train, and seating capacity is limited to 62 seats for ordinary and 30 for upper class coach. Therefore, the seating capacity is obtained by train formation as follows:

Table 3.3.4 Train Formation and Capacity of Passenger Trains

Train No.	No. of coaches Upper	Ordn.	Mail	L/V	B/V	Total	Seating Capacity	Remarks
3 up	2	11	-	-	1	14	764	RN-MDY day exp.
5 up	3	12	-	-	1	16	858 1/	RN-MDY night exp.
7 up	3	10	-	-	1	14	730	RN-MDY night exp.
9 up	3	9	-	3	-	15	666	RN-(TZI)-MYI night local
1 up	3	8	1	3	1	16	602	RN-MDY ordn.
13 up	-	4	-	4	1	9	256	PN-PEGU local.
81 up	2	10	-	-	1	13	700	RN-MTBN day exp.
83 up	1	12	-	-	1	14	798	RN-MTBN day exp.
85 up	1	8	-	2	1	12	542	RN-MTBN ordn.
89 up	2	10	-	1	-	13	700	RN-MTBN day local
63 up	1	6	-	4	1	12	414	KMDN-PRM day local
69 up	2	9	-	1	1	13	636	KMDN-TRW ordn.
71 up	1	12	-	-	1	14	798	RN-PRM exp.
41 up	3	7	-	1	1	12	538	MDY-MTY ordn.
43 up	1	6	1	3	1	12	414	MDY-MTY ordn.

1/ Sleeping car is not considered.

Source: BRC

On the other hand, train formation of goods trains is ordinarily as follows:

27 Wagons + Brake Van + Rest Van

Since the loading capacity per wagon is usually 18 tons for 2-axle covered wagon, total capacity of one train is approximately 500 tons.

(4) Fare and tariff

For passenger there are two fare systems in BRC: one for suburban service and another for main line service. The unit fare for main line is as follows:

Table 3.3.5 Passenger Fare Structure

(pyas per mile)

Mileage	Ordinary Class	Upper Class	Special Class
1 - 300 miles	6.8	19.8	39.7
301 miles and above	5.9	13.9	27.9

Source: BRC

While, the rate for freight depends on commodity type as summarized in the table below.

Table 3.3.6 Goods Tariff Structure
(pyas per 100 viss 1/ per 10 miles or parts of 10 miles)

Mileage	Class I	Class II	Class III	Class IV	Class V
1 - 20	43	54	62	78	100
21 - 80	32	42	50	66	84
81 - 200	23	31	38	51	67
201 and above	18	25	28	35	50

I Salt, cement, fertilizer of all kinds empties N.O.C., firewoods, coal and coke, etc.

II Tiles, charcoal, machinery other than electrical, earthenware, flour, etc.

III Chillies, enamelled ware, brass ware, salted fish, leather, etc.

IV Biscuits, books, cotton, drugs manufactured, electric appliances, household effects, etc.

V Petroleum dangerous, firearms, dangerous goods N.O.C., ammunition, piece goods, etc.

1/ 1 viss = 3.6 lb. ≑ 1.6 kg.

Source: BRC

3-3-2 Passenger Transport

(1) Total demand

BRC carried 60 million passengers or 2,229 million passenger-miles in 1984/85 on both main lines and suburban line. Main lines have a share of 48 percent in number of passengers and 92 percent in passenger-miles.

Tabel 3.3.7 Traffic Record for These Ten Years, Passenger

Year	Main lines		Suburban line		Total	
	Pass.1/	Pass.-mile2/	Pass.1/	Pass.-mile2/	Pass.1/	Pass.-mile2/
1974/75	28,258	1,866	22,778	115	51,036	1,981
1975/76	27,314	2,043	21,741	113	49,055	2,155
1976/77	21,208	1,671	10,845	57	32,053	1,728
1977/78	22,647	1,718	11,522	61	34,169	1,779
1978/79	25,065	1,796	20,479	107	45,544	1,903
1979/80	26,326	1,885	23,288	123	49,614	2,007
1980/81	27,070	1,931	27,945	147	55,015	2,078
1981/82	27,387	1,954	30,358	167	57,745	2,121
1982/83	30,323	2,167	31,738	175	62,061	2,342
1983/84	29,563	2,106	31,635	174	61,198	2,280
1984/85	28,800	2,055	31,636	174	60,436	2,229

1/ in thousand

2/ in million

Source: BRC

These 10-year trend fluctuations of main lines' passenger show widely-ranged decrease and increase as in the figure below. It seems that the reason of sharp decrease in 1976/77 is mainly because of rolling stock shortage and damage by flood.

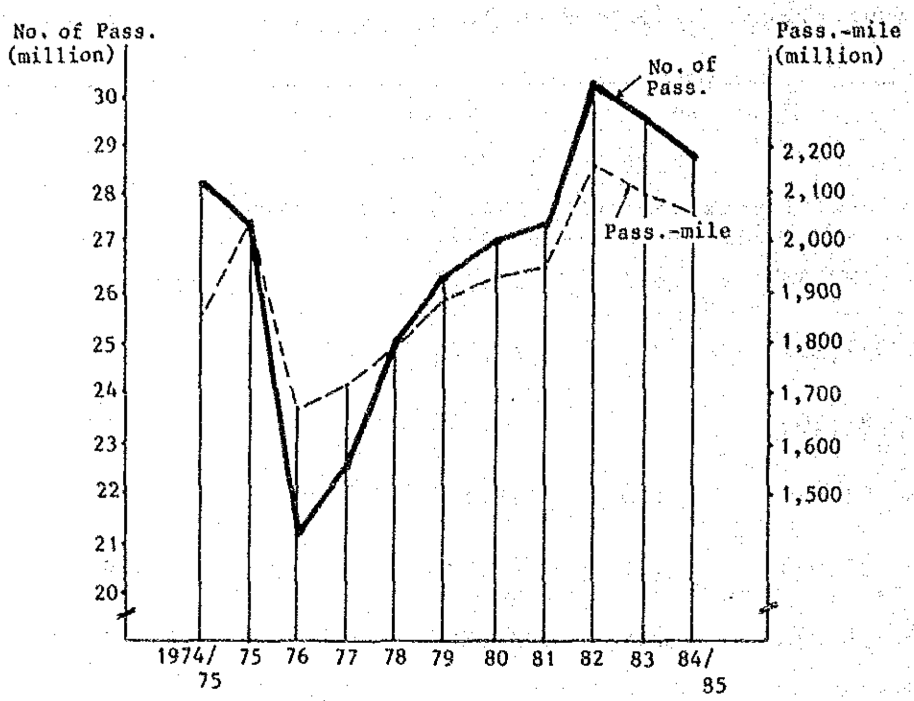


Fig. 3.3.3 Yearly Trend of Passenger Carried, Main Lines

(2) Monthly fluctuation

Since passenger demand generally depends on peoples' activity by season, it may show a remarkable peak in festival/vacation season. In Burma, however, such tendency is not noticeable.

Table 3.3.8 Monthly Fluctuation

(Quantum Index to Average)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1983/84	1.16	1.25	1.07	1.02	1.02	0.96	1.02	0.87	0.83	0.87	0.88	1.05
1984/85	1.03	1.15	0.99	0.92	0.98	0.95	1.09	0.95	0.96	1.02	0.91	1.05

Source: BRC

(3) Average mileage

According to the data by BRC, the average mileage travelled is almost 110 to 120 kms (70 to 75 miles) by main line passenger for these 10 years.

(4) Demand by division

As mentioned before, BRC's administration is divided into 8 divisions, and the demand by division is as follows:

Table 3.3.9 No. of Passengers by Division, Main Lines

(1000)

Division	1977/78	1981/82	1984/85	Annual Growth 77/78 - 84/85 (%)
1. (Mohnyin)	1,376	1,577	1,891	4.6
2. (Ywataung)	2,643	2,722	3,168	2.6
3. (Mandalay)	3,300	4,294	5,018	6.2
4. (Toungoo)	2,646	3,445	3,866	5.6
5. (Pegu)	3,861	4,337	4,723	2.9
6. (Rangoon)	2,476	3,450	3,315	4.3
7. (Thaton)	3,099	3,471	3,194	0.4
8. (Henzada)	3,246	4,091	3,624	1.6
Total	22,647	27,387	28,800	3.5

Source: BRC

Division 3 and 4 (Mandalay and Toungoo) shows higher rate of increase compared with other divisions, especially in lower Burma.

(5) Demand by line

The volume by four main lines are estimated based on BRC's data.

Table 3.3.10 BRC Passenger Volume by Main Line, 1984/85

Line	Passenger (1000)		Composition (%)	
	Passenger	Pass.-kms	Passenger	Pass.-kms
Mandalay	6,252	1,659,835	21.7	46.3
Martaban	3,026	340,801	10.5	9.5
Prome	3,208	258,111	11.1	7.2
Myitkyina	5,351	516,576	18.6	14.4
4 lines total	17,837	2,775,323	61.9	77.4
Whole main lines (excluding suburban line)	28,800	3,586,210	100	100

Source: BRC

3-3-3 Freight Transport

(1) Total tonnage and ton-mile

Total volume of goods transported by BRC had favourably increased up to 1979/80 and it is stable these 5 years. In 1984/85 BRC carried 2 million tons of commodities and 313 million ton-miles.

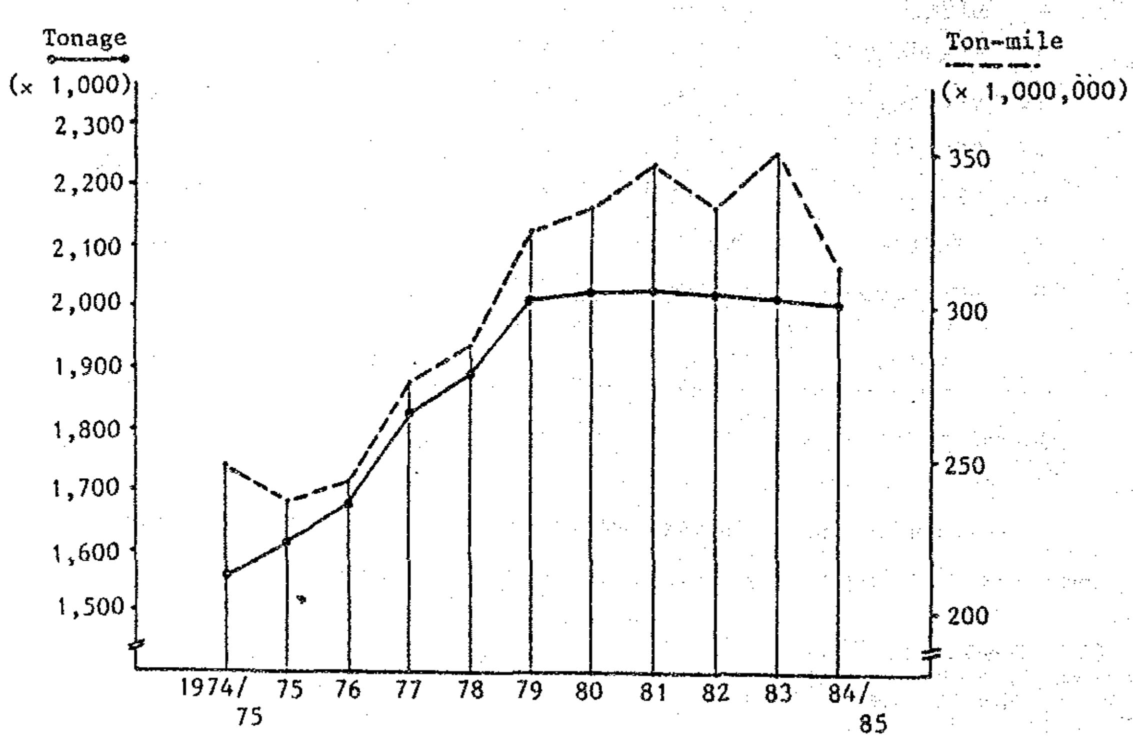


Fig. 3.3.4 Freight Volume Carried by BRC

(2) Commodity type

Major commodities of railway goods are rice, sugar cane, forest products, mining products and so on. They are summarized in Table 3.3.11.

Table 3.3.11 Goods Transport by Major Commodities

(1,000)

Commodities	1975/76		1980/81		1984/85	
	Ton	Ton-mile	Ton	Ton-mile	Ton	Ton-mile
1. Rice and rice products	543	76,692	684	105,000	572	82,940
2. Sugar cane	207	5,785	309	11,445	323	9,690
3. Forest products	217	40,504	343	65,685	299	59,600
4. Beans and pulses	16	4,610	17	4,305	2	500
5. Other agricultural products	76	14,491	30	5,946	37	6,660
6. Coal and coke	11	5,727	12	6,251	44	11,000
7. Petroleum and oil products	71	15,499	93	16,795	101	20,200
8. Base metal and ores	32	6,351	88	20,521	151	38,680
9. Stone	66	11,479	131	15,738	126	16,380
10. Salt	52	8,286	26	7,373	27	6,750
11. All other industrial	132	25,704	222	40,486	204	40,800
12. Military	33	8,545	62	15,215	31	7,750
13. BRC freight	184	13,578	241	18,566	170	11,900
Total	1,620	237,251	2,258	333,326	2,087	313,050

Source: BRC

(3) Demand by line

The existing freight volume for four main lines is tabulated in Table 3.3.12.

Table 3.3.12 BRC Freight Volume by Line, 1984/85

Line	Freight (1000)		Composition (%)	
	Tonnage	Ton-kms	Tonnage	Ton-kms
Mandalay	926	259,757	44.4	51.6
Martaban	112	9,731	5.4	1.9
Prome	195	45,808	9.3	9.1
Myitkyina	301	57,148	14.4	11.3
4 lines total	1,534	372,444	73.5	73.9
Whole BRC	2,087	503,697	100	100

Source: BRC

CHAPTER 4 RAILWAY TRANSPORT DEMAND FORECAST ON THE MAIN LINES

CHAPTER 4 RAILWAY TRANSPORT DEMAND FORECAST ON THE MAIN LINES

4-1 Introduction

For the long-term modernization programme (up to 2005), traffic demands both in passenger and freight were forecasted in accordance with the following procedure.

4-1-1 General Procedure

Since this traffic demand covers nearly whole inter-regional transport demand by railway in conjunction with other transportation modes, the nationwide comprehensive transportation study on all modes could provide the principal information for the purpose. In Burma, however, there were no such studies and very few data on that topic, and the detailed analysis on modal split among various transport modes could not be carried out in this stage of the study.

The outline of the procedure on demand forecasting is summarized in the following.

First of all, total railway traffic demands both in passenger and freight on four major lines are forecasted based on the analysis of the correlationship between traffic demand and economic activities in the past.

And the future economic growth estimated in the previous part of the report is applied to that correlation to forecast the demand in future (without project case).

On the other hand the implementation of railway facility improvement is likely to provide an advantageous competition with other modes. Therefore, the probability of demand diverted from other modes to railway is considered in the case of with project.

Regarding the inter-regional flow, the assumed patterns based on the limited existing data are applied both in 'without' and 'with' cases.

4-1-2 Major Premises

(1) Target years

1984/85 as the basis year and 1993/94, 1997/98 and 2005/06 are target years in accordance with stage planning of the modernization programme.

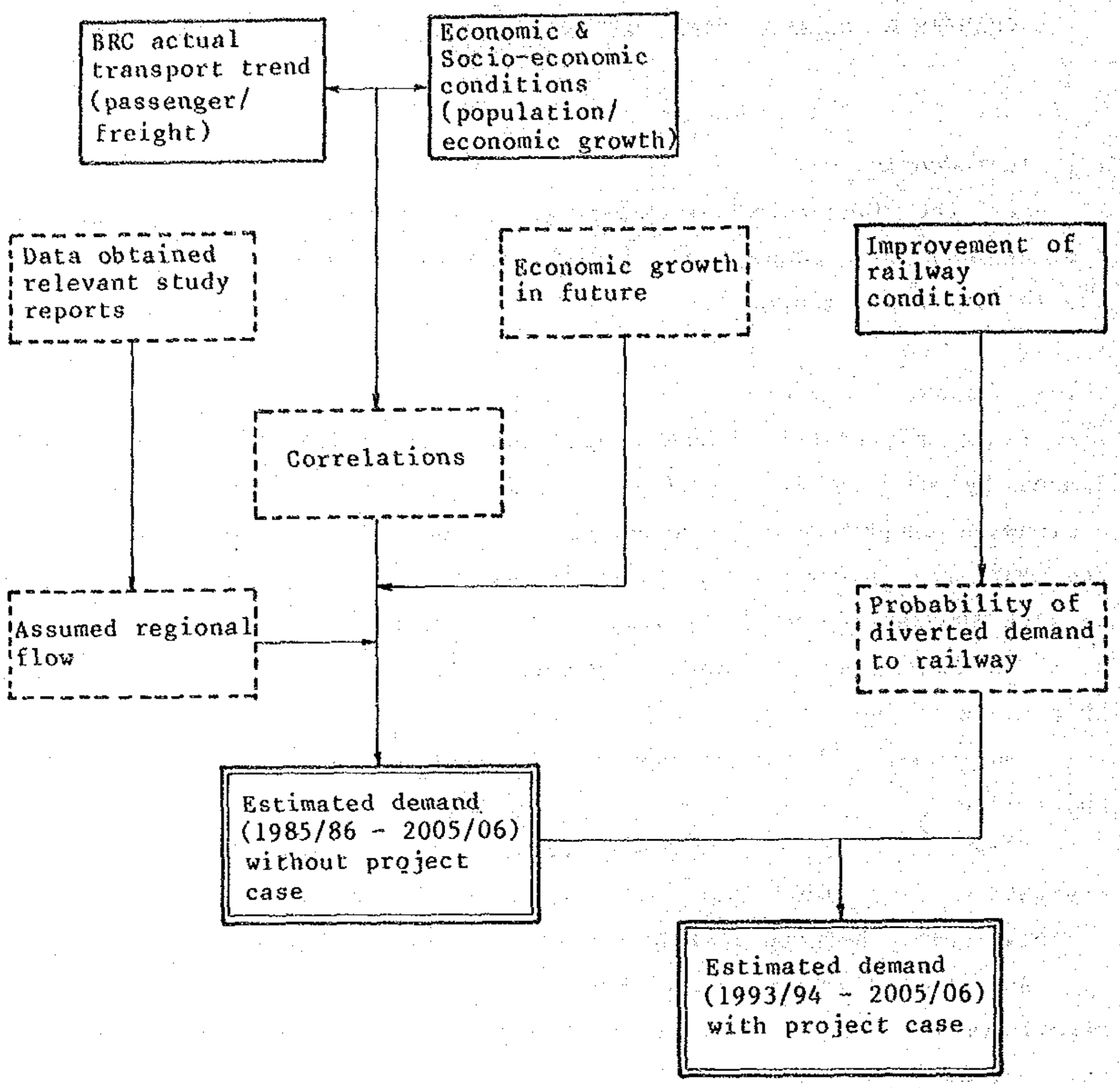


Fig. 4.1.1 Outline of Demand Forecast

(2) Limitation of scope of study

Demand limited to four main lines only, excluding the suburban line and branch lines.

(3) Transport conditions of other modes

Without consideration of future development of other transport conditions but of authorized programmes such as Rangoon-Prome road improvement project.

(4) Assumed inter-regional flow

The following 12 zoning system is applied to estimate the inter-regional flow.

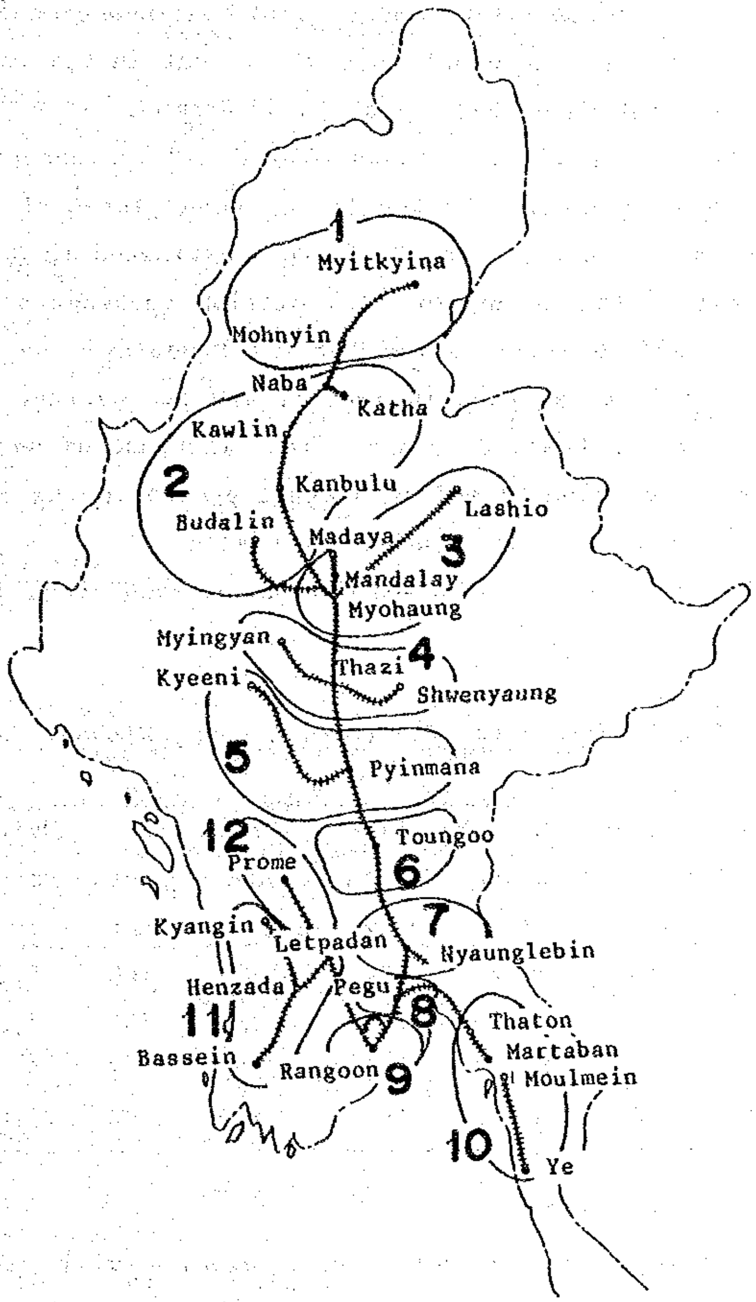


Fig. 4.1.2 Zoning Map

4-2 Passenger Traffic Demand

4-2-1 'Without Project' Case

This forecast is done upon the assumption that the existing railway condition among all transportation modes would continue even in the future, and this means to invest the usual cost at present in railway maintenance without the implementation of modernization programme.

The correlation analysed between growth of passenger demand and economic indicators is applied to the total demand forecast on four lines in accordance with the future economic factors estimated in Chapter 2-6.

As the results, the demand of 12.6 million passengers/3,351 million passenger-kms in 2005/06 is estimated for the Mandalay line. This demand is equivalent to 2.02 times that in 1984/85 and its average annual growth rate is 3.4 percent for these 20 years. This increase of passenger demand reflects the expected economic and population growth in the area along the Mandalay line; Rangoon, Pegu and Mandalay divisions.

The results of demand forecast at the end of each stage are summarized by line as follows.

Table 4.2.1 Forecasted Passenger Demand, Without Case

(1000)

Year	Mandalay line		Martaban line		Prome line		Myitkyina line	
	Passengers	Quantum Index	Passengers	Quantum Index	Passengers	Quantum Index	Passengers	Quantum Index
1984/85	6,252	100	3,026	100	3,208	100	5,351	100
1993/94	7,709	123	3,970	131	4,283	134	7,352	137
1997/98	9,015	144	4,572	151	4,895	153	8,567	160
2005/06	12,623	202	6,306	208	6,599	206	11,815	221

4-2-2 'With Project' Case

The implementation of modernization programme will provide various beneficial effects to railway transport against other modes, and the reduction in travel time is considerable as an effective factor for the probability of demand transfer from other modes to railway, when the fare structure of each mode is unchanged.

Since the travel time with the project is estimated as in Table 4.2.2, the demand of 'with project' case is forecasted taking into consideration the effect of travel time reduction by lines.

Table 4.2.2 Travel Time, With/Without Project

Section (distance)	Without Project (existing)		With Project		Comparison
	Travel time	Scheduled speed	Travel time	Scheduled speed	
(kms)	min.	kms/hr	min.	kms/hr	
Rangoon - Mandalay (620.4)	825	45.1	600(540) 1/	62.0(68.9) 1/	0.73(0.65) 1/
Pegu - Martaban (203.4)	341	35.8	311	39.2	0.91
Rangoon - Prome (259.1)	420	37.0	380	40.9	0.90
Myohaung - Myitkyina (547.1)	1,428	23.0	1,368	24.0	0.96

1/ after stage 2.

The logistic curve is assumed in order to represent the modal split in terms of travel time ratio between railway and other modes (mainly bus transport), and differences are estimated between 'with' and 'without' case. The results derived from the analysis above are tabulated as in Table 4.2.3.

Table 4.2.3 Forecasted Passenger Demand, with Case

(1000)

Year	Mandalay line		Martaban line		Prome line		Myitkyina line	
	Passengers	Quantum Index	Passengers	Quantum Index	Passengers	Quantum Index	Passengers	Quantum Index
1984/85	6,252	100	3,026	100	3,208	100	5,351	100
1993/94	8,790	141	4,085	135	4,408	137	7,481	140
1997/98	10,891	174	4,814	159	5,178	161	8,888	166
2005/06	17,099	274	6,951	230	7,308	228	12,639	236

The demand on Mandalay line in 2005/06 is nearly three times of that in 1984/85, because of very effective travel time reduction by project implementation. Table 4.2.4 shows the summary of comparison by line in terms of demand annual growth rate.

Table 4.2.4 Estimated Growth Rate and Demand on Major Lines (Passenger)

Duration	Mandalay line with	Mandalay line without	Martaban line with	Martaban line without	Prome line with	Prome line without	Myitkyina line with	Myitkyina line without
1984/85 ~ 1987/88	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
1987/88 ~ 1993/94	4.8%	3.3%	4.1%	3.6%	4.4%	3.9%	4.7%	4.4%
1993/94 ~ 1997/98	5.5%	4.0%	4.2%	3.6%	4.1%	3.4%	4.4%	3.9%
1997/98 ~ 2005/06	5.8%	4.3%	4.7%	4.1%	4.4%	3.8%	4.5%	4.1%
Demand in 2005/06 (million Pass.-kms)	4,540	3,351	783	710	588	531	1,220	1,141
Quantum Index against 1984/85	2.74	2.02	2.30	2.08	2.30	2.07	2.36	2.21

4-3 Freight Traffic Demand

Almost the same procedure as for passenger is applied to freight traffic forecasting. However, the effect of the project in travel time reduction seems to be very slight for freight trains as shown in Table 4.3.1, and the discrepancy between 'with' and 'without' case is negligible for Martaban, Prome and Myitkyina line.

Table 4.3.1 Travel Time of Freight Train, With/Without Project

Section (distance)	Without Project: Travel time	Without Project: Scheduled speed	With Project: Travel time	With Project: Scheduled speed	Comparison
(kms)	min	kms/hr	min	kms/hr	
Mahlwagon - Myohaung (612.2)	2,230	16.5	1,500	24.5	0.67
Pegu - Martaban (203.4)	975	12.5	960	12.7	0.98
Kemmendine- Paungde (202.8)	480	25.4	460	26.5	0.97
Myohaung - Myitkyina (547.1)	3,230	10.2	3,200	10.3	0.94

The results of the forecast are summarized as follows.

Table 4.3.2 Forecasted Freight Demand, With/Without Case

(1000 tons)

Year	Mandalay line with	Mandalay line without	Martaban line with/without	Prome line with/without	Myitkyina line with/without
1984/85	926		112	195	301
1993/94	1,318	1,244	152	270	431
1997/98	1,565	1,421	176	314	510
2005/06	2,259	1,901	250	437	725

Table 4.3.3 Estimated Growth Rate and Demand on Major Lines (Freight)

Duration	Mandalay line with	Mandalay line without	Martaban line with/without	Prome line with/without	Myitkyina line with/without
1984/85 ~ 1987/88	3.0%	3.0%	3.0%	3.0%	3.0%
1987/88 ~ 1993/94	4.5%	3.5%	3.7%	4.0%	4.6%
1993/94 ~ 1997/98	4.4%	3.4%	3.7%	3.9%	4.3%
1997/98 ~ 2005/06	4.7%	3.7%	4.5%	4.2%	4.5%
Demand in 2005/06 (million Ton-kms)	634	533	22	103	138
Quantum Index against 1984/85	2.44	2.05	2.24	2.24	2.41

CHAPTER 5 PRESENT SITUATION AND ITS PROBLEMS OF RAILWAY TRANSPORT

CHAPTER 5 PRESENT SITUATION AND ITS PROBLEMS OF RAILWAY TRANSPORT

5-1 General Profile and Its Problems

A preliminary study was carried out mainly on the following items, centering around the four lines now under study.

(1) Present condition of train operation service and transport.

(2) Actual situation of railway facilities and their operating conditions.

(3) Train operation control system and operation handling.

(4) Railway field organizations and their operating conditions.

(5) Related railway projects and their progress.

(6) Various requirements necessary for establishing a facility improvement plan.

The study revealed that BRC, with a history of over 100 years of operation, does not make full use of its inherent advantages as a railway transport system, although it has served as a basic means of transport for supporting the social and economic activities of the country.

In particular, poor operating conditions such as train delays, and frequent accidents and troubles in its train operation, have been observed on the four main lines, indicating that BRC has not sufficiently provided such railway advantages as high speed, safety, riding comfort, and mass transport capacity.

As a result, both passenger and freight transport have shown a tendency to stagnate, even though BRC's share of gross passenger transport has slightly increased in the last few years. This suggests that BRC might lose business to other competing modes of transport, as well as public confidence, if the system is left as it is.

A primary factor responsible for the present situation is that there has not been sufficient investment for the improvement and modernization of important facilities of railway transport, including rolling stock, tracks, telecommunication and signalling.

As a result, most of the ground facilities, as well as rolling stock, have deteriorated to such an extent that BRC cannot smoothly carry on its train operation. Also, train operation control does not fully work due to troubles with the telecommunication equipment.

The present situation of BRC is summarized in the following along with their problems.

5-1-1 Problems on Train Operation

(1) Train speed reduction

Fig. 5.1.1 shows the changes in scheduled time and maximum train speed on the main line between Rangoon and Mandalay for the past 20 years. The shortest scheduled time achieved was 11 hours, at the maximum train speed of 72 km/h (45 mph) from 1973 to 1975, but only one express day-train was operated on the line at that time.

The conditions of track, signalling and rolling stock at that time can be assumed to have been fairly better than their present condition, because the express train could run through most of the stations at the speed of 64 km/h (40 mph).

Since then, the number of express trains has been increased, and travel time has also increased to 13 hours and 45 minutes, along with decrease in the maximum train speed to 64 km/h (40 mph) since 1983.

Furthermore, points and key interlocking devices have deteriorated, resulting in speed restriction at stations. Speed restriction distribution at stations on the Mandalay line is shown in Fig. 5.1.2, indicating the permissible speed restrictions over 64 Km/h (40 mph) have reduced sharply at present.

The present maximum permissible speeds on the Mandalay line are as follows:

Rangoon - Toungoo section	59 km/h	(37 mph)
Toungoo - Yamethin section	64	(40)
Yamethin - Myohaung section	69	(43)
Myohaung - Mandalay section	48	(30)

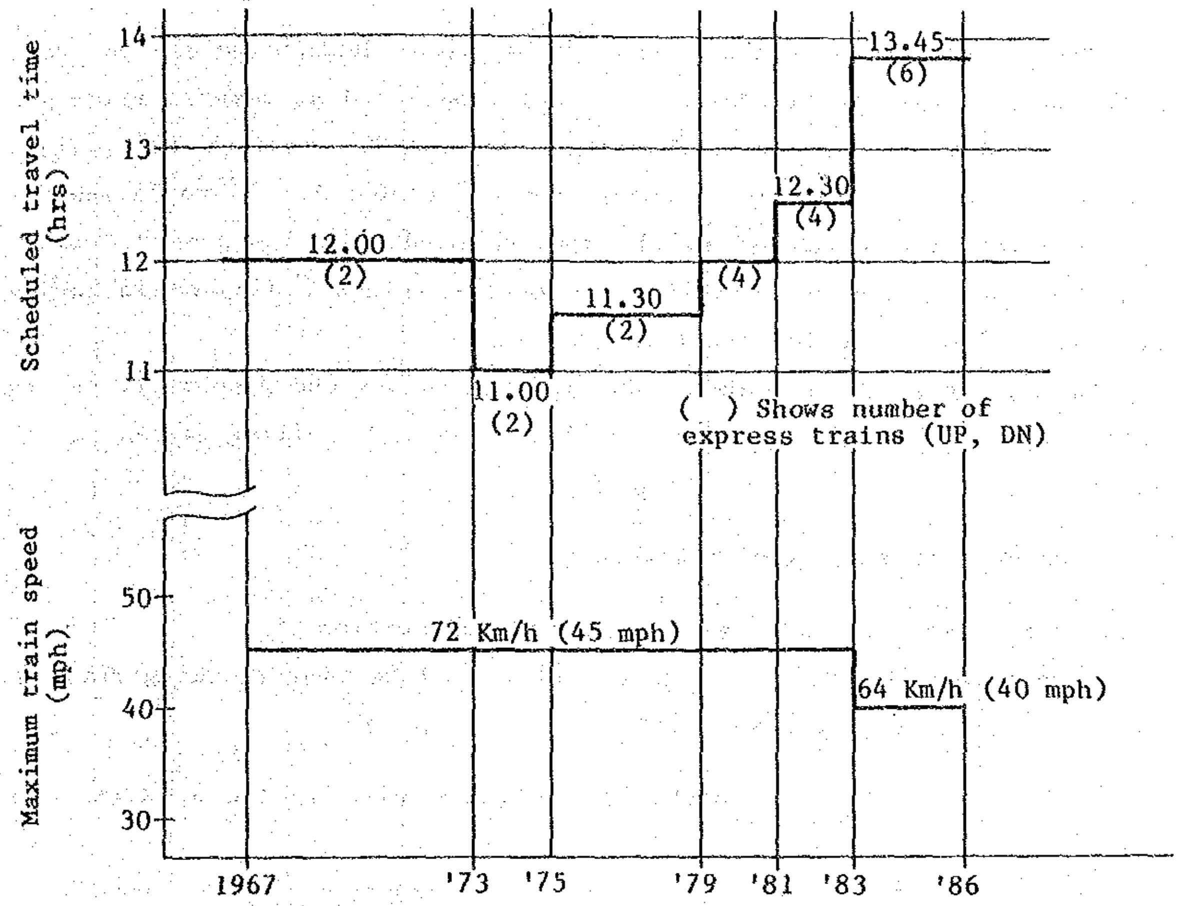


Fig. 5.1.1 Changes in Scheduled Time and Maximum Train Speed on the Mandalay Line for the Past 20 Years

Source: BRC

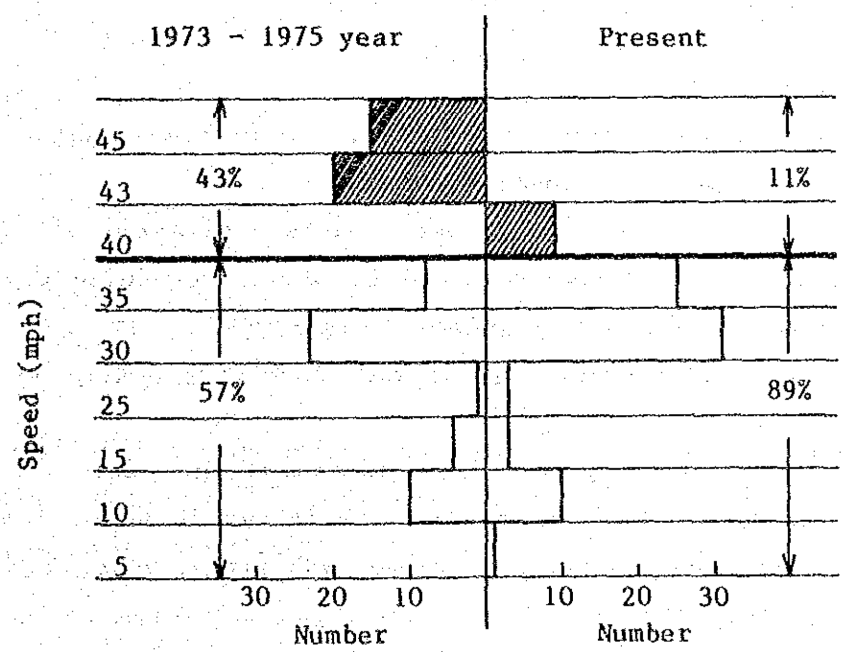


Fig. 5.1.2 Speed Restriction Distribution at Stations on the Mandalay Line

Source: BRC

The difference in speed between the sections depends mainly on track conditions. Also express trains are usually operated at several miles per hour less than the maximum permissible speed. The maximum permissible speed on the other three lines ranges from 48 to 56 km/h (30 to 35 mph).

Freight trains run at fairly slower speeds than passenger trains. Both kinds of trains on each line run at the speeds indicated in Tables 5.2.3 and 5.2.4 in section 5-2-1 (3).

The main reason for such a reduction in train speed appears to be the worsening condition of the ground facilities and the rolling stock. It is due to:

a) Deteriorated and aged track condition

b) Repair work for bridges located between stations
Deteriorated facing points at points and key interlocking devices, and lack of isolating trap points

c) Poor visibility of mechanical signals with reflector from long distances

d) Long braking distance because of troubles with the brake systems of rolling stock

e) Free access of people and animals to station yards and other railway facilities

(2) Train delay

Train delays are prevalent among all the main lines, which is one of the main problems with BRC's operation management.

In short, deterioration of tracks, telecommunication and signalling facilities, due to aging, have resulted in slower scheduled train speed, train delays and yearly declines in on-time arrival.

In addition, the occurrence of engine troubles can also be listed as a cause.

The train operation punctuality is shown in Fig. 5.1.3. The percentage of express and mixed trains, with delays of 30 minutes to three hours, reached more than 40 percent in the 1984 fiscal year.

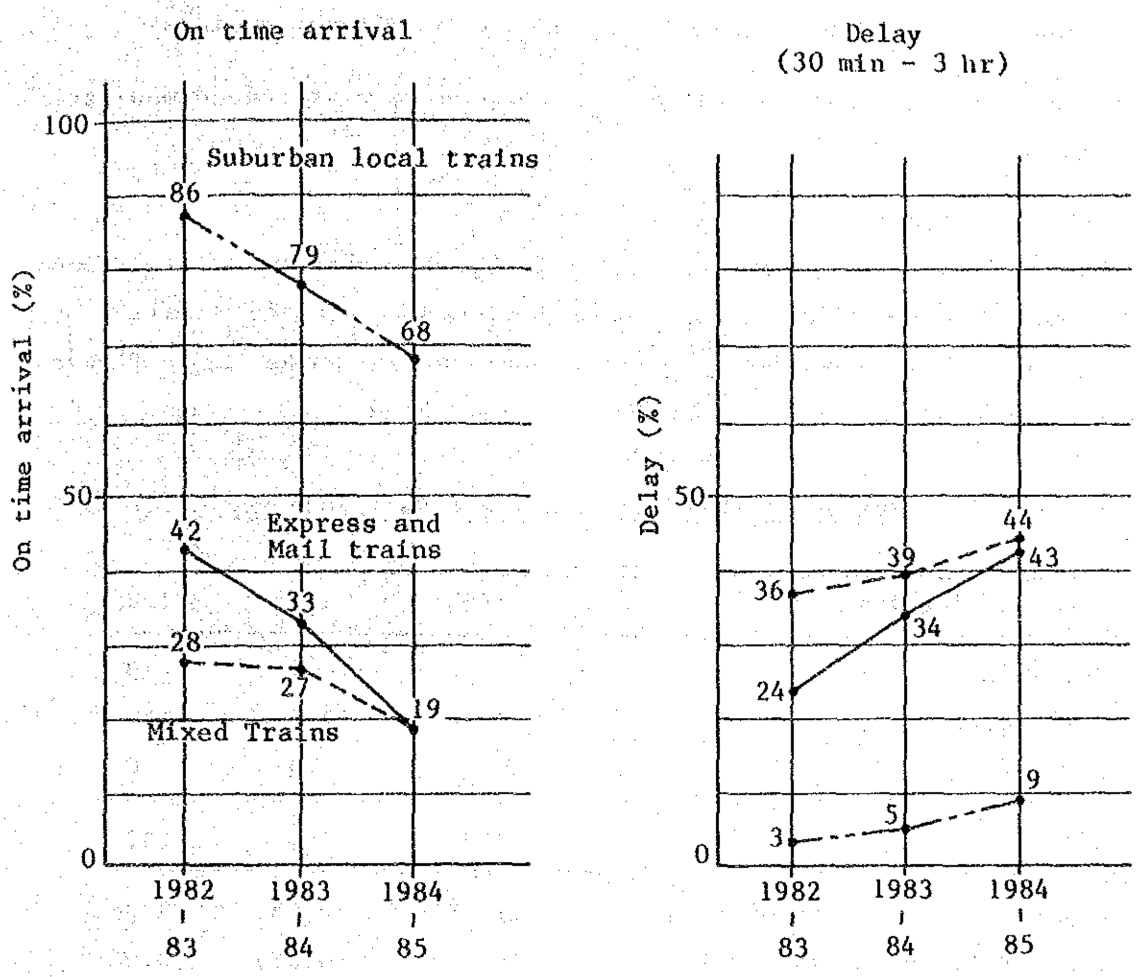


Fig. 5.1.3 <u>*Punctuality of Train Operation*</u>

Source: BRC

The possible causes for the increases in train delays are considered to be mainly as follows:

a) Decline in the ability to make up lost time due to poor track conditions and speed restrictions between and at stations.

b) Unavailability of quick and smooth communication with concerned authorities when train disorders occur due to poor condition of telecommunication networks.

c) Poor condition of signalling facilities, in particular, frequent failure of mechanical signals and handling time required for the paper line-clear ticket system.

d) Engine trouble and a decline in the operability of engines.

e) Insufficient train operation control due to poor telecommunication equipment.

(3) Train accidents

The train accidents as shown in Table 5.1.1 amount to a large number every year: train collisions and train derailments already totaling over 100 a year. This shows how grave the accident situation is. Physical injuries by these accidents might be also quite high.

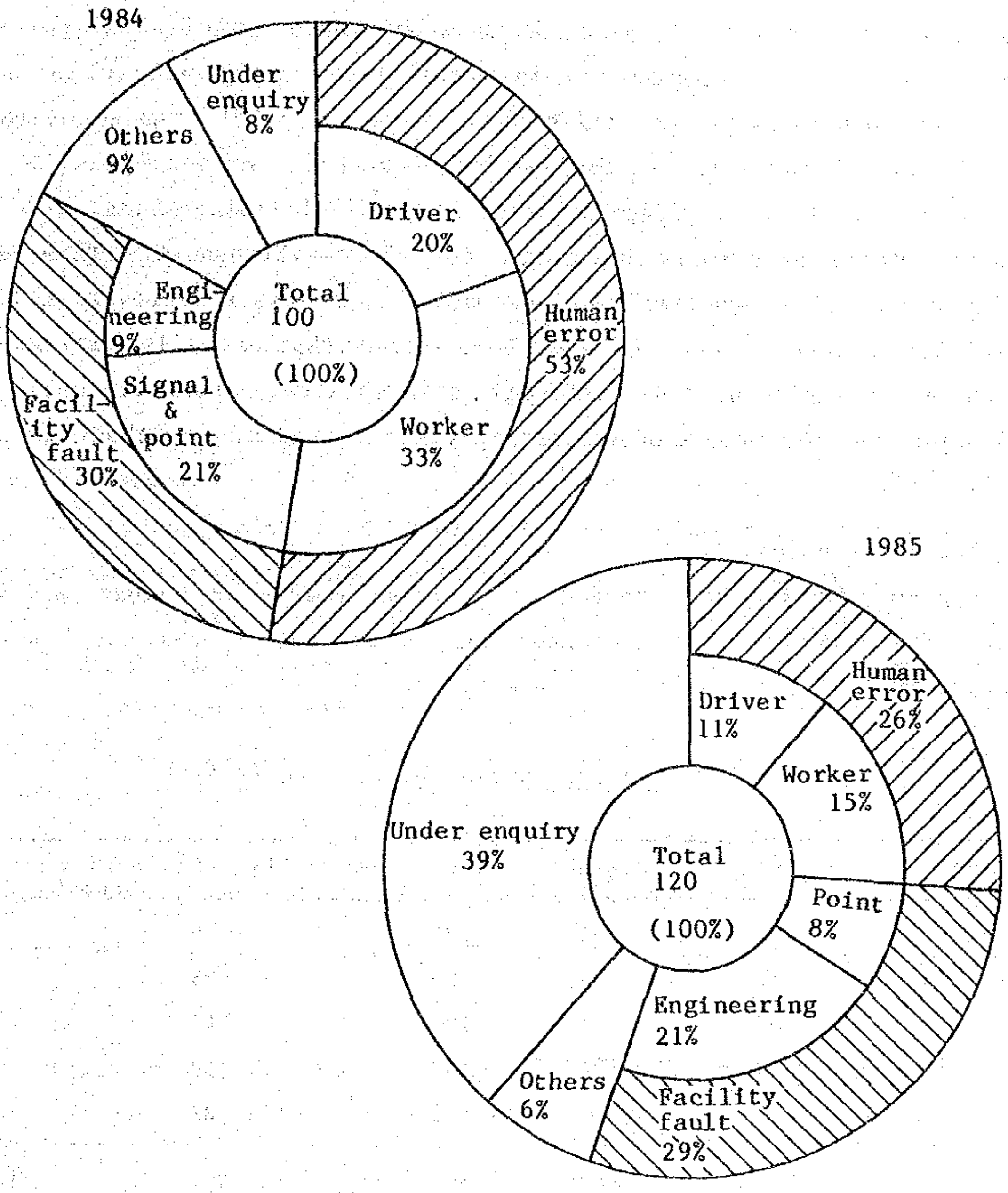
Table 5.1.1 Number of Train Accidents and Rail/Road Accidents

Classification	1983	1984	1985
Collision	2	2	13
Derailment	123	100	120
Fire	0	2	0
Total	125	104	133
No. of accidents per million Train-Km (Case of JNR, Unit: F.Year, for ref.)	11.75 (0.05)	10.28 (0.08)	13.96 (0.06)
Rolling stock collision and derailment at shunting	79	64	77
Rail/Road crossing accident	6	11	12

Source: BRC

An analysis of these accidents shows that collisions are caused mainly by the fault of drivers and workers, while derailment is due to the faults of system, materials and equipment, and poor condition of tracks and wagons. The causes of train derailment for the past two years are shown in Fig. 5.1.4.

According to the train derailment figure, faults in facilities and errors by drivers and workers caused an overwhelming 83 percent of the total derailments that occured in 1984. In 1985, these same problems were responsible for 55 percent of train derailments, and 90 percent if the category "under enquiry" is excluded.



Note 1: Engineering includes faults in track, coach and wagon.

2: Others mean the causes belonging to the public or other government departments.

Fig. 5.1.4 Causes of Train Derailments

Source: BRC

It will be difficult, even with improved facilities, to reduce such an amount of accidents close to nil, unless workers' concern about their prevention is improved. So the earliest possible replacement of devices relying on human control by those relying on modern system should be made along with facility improvement, in particular, on every busy and main line. The paper line-clear ticket system is a typical example of those that should be improved. In conjunction with this, personnel training is also quite important for upgrading skills and disciplining minds.

Safety is of primary importance for railway transport. Therefore, such particulars on problems mentioned above in sections 5.1.1 (1) and (2) should be improved. But it should be noted that a railway transport system cannot implement truly safe and efficient train operation until the facilities and the people who operate, maintain and manage them are well coordinated.

(4) Engine troubles

Engine troubles have tended to increase yearly in number on every line. The Mandalay line accounted for 58 percent of the total engine troubles in 1984/85 as shown in Table 5.1.2.

Table 5.1.2 Engine Troubles by Line in 1984/85

Line	Passenger	Freight	Total	Per million train-miles	%
Mandalay	128	654	782	435	58
Martaban	29	24	53	93	4
Prome	87	52	139	315	10
Myitkyina	80	100	180	229	13
Other	113	82	195	83	15
Total	437	912	1,349	227	100

Source: BRC

The possible cause of these troubles might be insufficient inspection and repair work due to a shortage of spare parts and materials.

The availability of rolling stock is not so good: 57 percent for locomotives; 70 percent for coaches; 77 percent for wagons in 1984/85. (Refer to Table 5.2.6 in section 5-2-2)

(5) Decline of train operation control system

Train operation control has two problems: first, in smooth communication with various related locations whenever required; and second, in its system of conducting control.

Due to the inadequate development of a traffic control system, the frequent failures in communication equipment, and shortages of equipment such as wayside telephones, or a sort of train radio between controllers, station masters, and train crews, the existing controls covering the lines by division are insufficient for their intended function. As a result, smooth restoration of train operation in disorder is delayed, contributing to train delays.

The train operation control system has two functions. One is to enhance the efficiency of traffic control, and the other is to quickly rectify any train disorders. Therefore, the train operation control should cover the entire line or network in the future for transport planning, arrangement planning of rolling stock, and forming of trains. It will need organization and enough manpower to deal with any traffic situation.

5-1-2 Ground Facilities and Their Maintenance Control

(1) Deterioration of ground facilities and decline of their operability

1) Track

Track on the Mandalay line is in considerably poor condition and is responsible for reduction in train speed. The main reasons are as follows:

a) About 90 percent of the rails have been used for over 40 years, resulting in deterioration due to aging.

b) Because concrete sleepers are unavailable, a large number of wooden sleepers have been installed.

In addition, only four percent of wooden sleepers are replaced annually, which means that they are renewed in every 25 years. During this time they deteriorate because the long period of use exceeds the durable life.

c) Shortage of ballast is found in some sections and at rail joint spots due to insufficient supplies against maintenance requirements, and also to insufficient wagon arrangement. Thus, there are irregularities on the tracks and depressions at the rail joints.

d) Railway bridges are generally well maintained, but the repair works of five bridges on the Mandalay line has resulted in speed restrictions.

e) All large stations have drains, but they do not function properly. It will be necessary to have properly functioning drainage system for tracks and safety facilities at station yards, especially at stations installed with track circuits.

2) Telecommunication and Signalling

a) Local telecommunication lines, for blocks, train operation control, and telephones, leased from PTC, frequently fail due to insufficient maintenance. This disturbs smooth train operations, and often takes time for restoring normal train operation after trouble happens.

30 percent of the 5,500 Km bare lines leased from PTC are in poor condition, and there are about 770 Km lines missing for block, control and telephones, on the Mandalay line, and about 120 Km on the Prome line.

b) Telephones, STC equipment, SSB wireless and UHF radio sets, and telephone exchanges are used as a means of communication mainly for train operation and related work. Many of these have deteriorated considerably due to aging. It often makes smooth operation and control difficult. The condition of the BRC communication network is poor.

Table 5.1.3 shows the operability of signals and block system at the time when the field survey was carried out. Block system on the Mandalay line beyond Pegu, and on the Myitkyina line are always using the paper line-clear ticket, as shown in the Table, due to the shortage and failure of bare lines for blocking.

On some sections of the other two lines, train operation blocking is frequently carried out by the paper line-clear ticket system. This system relies on human control, suggesting that serious accidents might occur.

Table 5.1.3 Operability of Signal and Block System (Token or Tokenless) at Field Survey

Line	Signal	Block
Mandalay (Down forward)	Distance: Almost nil Outer and Home: 92%	Mandalay-Pegu: Nil (Paper line-clear ticket) Pegu-Rangoon: 100% (Tokenless)
Martaban (Up forward from Pegu)	100%	Token: 24% (76% of Paper line-clear ticket)
Prome (Up forward from Danygon)	100%	Token: 50% (The rest: Paper line-clear)
Myitkyina (Up forward)	Almost nil	Mandalay-Kawlin: Almost nil (Paper line-clear ticket)

Source: BRC and Study Team

c) Most signalling facilities have deteriorated, with relay interlocking devices being over 20 years old, and electric and mechanical ones being over 40 years old. This has resulted in frequent failures in such equipment as signals, track circuits and blocks. The number of failures reaches several hundreds a year. Accordingly, maintenance costs might have been rising every year.

d) Most of the stations on the three lines, excluding the Myitkyina line, are equipped with key interlocking devices, which have deteriorated due to aging. This causes restrictions in speed at stations.

In addition, the Martaban, Prome, and Myitkyina lines, are not provided with isolation trap points at station yards. This results in speed restrictions at the facing points as well. The installation of key interlocking devices and isolation trap points on the four lines is shown in Table 5.1.4.

Table 5.1.4 Installation of Key Interlocking Devices and Isolation Trap Points

Line	No. of stations	No. of stations with key interlocking	No. of stations without isolation trap points
Mandalay	82	70	12 (only at large station)
Martaban	19	19	19
Prome	26	25	25
Myitkyina	51	0	51

Source: BRC

(2) Problems with the maintenance system

Although periodic maintenance is carried out on tracks, it is not sufficient because of supply shortage of sleepers, ballasts and rail fittings. Therefore, the track condition seems to become yearly deteriorated. On the other hand, concerning the telecommunication and signalling, inspection and repair after failures (so called "corrective-maintenance") are done, but these do not meet full repair requirements since there are frequent failures of equipment due to aging and a lack of transport to get to the troubled areas.

Due to shortage of a sort of Rail Gang car for inspectors to go to the spot of failure, there is inconvenience or some troubles for conducting quick repair. This problem will be studied to improve the maintenance system.

Furthermore, another maintenance problem is that local bare communication lines maintained by PTC are often left unrepaired for a long time. BRC inspectors sometimes do the repair work by themselves.

And also, spare parts and materials required for maintaining telecommunication and signalling equipment are in short supply. This is one of the main problems preventing the satisfactory functioning of this equipment.

(3) Shortage of spare parts and materials

A supply of spare parts and materials is one of the key factors to keeping facilities in good working condition. At present, they are manufactured or repaired at BRC's workshops and repair shops.

Because of import limitations to encourage local products, foreign spare parts and materials are actually in short supply. This shortage is extensively common to almost every section and department of the railway.

Table 5.1.5 shows the supply of spare parts. There are some differences in classification, but generally the supply is insufficient for the demand. The short supply of spare parts for rail fittings, steam locomotives, carriages and wagons is especially keen. The supply rate of materials for rolling stock is also extremely inadequate: supplying less than 40 percent of that required. (Not shown in the Table.)

This is one of the problems that should be solved for effective maintenance, and should be taken into consideration in the planning and implementation stages.

Table 5.1.5 Supply of Spare Parts and Raw Materials in 1984/85

Classification		Percentage of Demand met (Quantity) %	Remarks
Track	Sleeper	76	
	Ballast	56	
	Rail fittings	45	
Rolling Stock	Steam Loco	*18	*: including stores of foreign spare parts and materials
	Diesel Loco	*44	
	Carriage & Wagon	*33	
	Electrical stores	43	

Source: BRC

(4) *Insufficiency of standards, manuals, etc. for maintenance.*

Since the existing track, telecommunication, and signalling facilities were constructed or installed a long time ago, most of the manuals containing information on maintenance are not kept at hand at the inspection offices. Maintenance standards, manuals for facility maintenance information, and tolerance regulations for construction and safety should be fully available to carry out maintenance work for improving the railway system.

5-1-3 Other Conditions

(1) Training

There are two institutes for educating and training personnel of railways. One is the Central Institute of Transport and Communications (CITC) in Meiktila under the Ministry of Transport and Telecommunications. It has motor vehicle and communication courses, besides the railway course in which more than 300 trainees are trained. There are about 1,000 trainees in the three courses every year.

The other institute is the Railway Technical Training Center in Ywataung, under BRC. The center trains more than 100 trainees a year, with the main courses dealing with the maintenance and repair of diesel locomotives.

The accommodations of these two institutes are not enough, and are inadequate for providing effective training on new technologies and technical skills. These problems will become progressively more serious as diversification and specialization of technology advances in railways. Therefore, a study on education and training along with the facility improvement should be taken up from a long-term point.

(2) Condition of power supply

The condition of power supply in Burma is not so good. The percentage of stations with power supply is about 60 percent on the average for the four lines. Table 5.1.6 shows the condition of station power supply. The Prome line receives 81 percent of the power supply, while the Myitkyina line receives 35 percent. This condition will have an influence on the facility improvement of telecommunication and signalling unless it is improved in the future. Thus, power supply is one of the items to be considered for the facility improvement.

(3) Free access to railway facilities

People and animals are free to enter tracks in most station yards and level crossing areas, often disturbing the smooth train running and railway facilities.

This is a sort of social problem that is difficult to resolve, but some measures are necessary to ensure smooth train operation.

Table 5.1.6 Condition of Power Supply for Stations

Line	Number of stations	Percentage of power supply for stations	Remarks
Mandalay	82	70%	Supply whole day through
Martaban (Pegu-MTBN)	19	53%	Most of stations: Supply at night only
Prome (DNGN-PRM)	26	81%	Supply whole day through
Myitkyina	51	35%	Most of stations: Supply for whole day through

Source: BRC

5-2 Transport

At present, BRC consists of 4 long-distance main lines, Rangoon-Mandalay, Rangoon-Martaban, Rangoon-Prome and Mandalay-Myitkyina, and a Rangoon circular line. The four main lines are all single track, except the double track on the Mandalay line, between Rangoon and Pyinmana and between Mandalay and Myohaung. The Rangoon circular line, which is not included in the long-term modernization programme, is a double track line, and the track between Rangoon and Danyinan is commonly used with the Prome line.

The Mandalay and Martaban lines form a mainstay of BRC, on which there are more express passenger trains than the other two lines. The length of the Prome line is 295 km, starting from Rangoon, and it is a comparatively short section. It is in the same position as the Martaban line but the number of express passenger trains is only two. The Myitkyina line starts from Mandalay, and has a long section of 543 km to the terminal station Myitkyina. The feature of this line is that express passenger trains has not been put into service, but the number of freight trains is the same as that of the Mandalay line.

As for the motive power, diesel locomotives are widely used. Some time ago, diesel cars were introduced on Rangoon circular line, but are not in use now due to maintenance problems. At present, electrification is being planned for the Rangoon circular line and Rangoon suburban line and a feasibility study has already been completed.

Generally speaking, the number of trains, both passenger and freight trains, is very small. The main causes of this conditions are the deterioration of ground facilities such as tracks, telecommunications and signalling, and rolling stock, and the lowering of transport capacity due to the shortage of spare parts.

5-2-1 Present Situation of Train Operation

(1) Train diagram

Passenger trains are classified into express, ordinary and local trains, while freight trains, at present, are not divided into classes though there used to be four classes.

On the four main lines, 14 express passenger trains, 14 ordinary passenger trains, 10 local passenger trains and 28 freight trains are set up in the diagram (refer to Table 5.2.1).

On the Mandalay line, which has more express passenger trains than the other lines, 18 passenger trains and 10 freight trains are set up. Thus this line exceeds the other lines in number of trains in operation.

Between Rangoon and Pegu on the Mandalay line is the most dense traffic section commonly used with the Rangoon suburban trains (between Rangoon and Ywathagyi) and the Martaban line trains: 68 trains a day, passenger and freight trains altogether, are concentrated in this section (refer to Fig. 5.2.1). The track capacity of this high density section will be checked to meet the future demand.

On the other hand, the total number of trains on the other three lines amounts to only 20 passenger and 18 freight trains, and there is no express passenger train on the Myitkyina line, as shown in Table 5.2.1.

As for traffic volume per day, as shown in Table 5.2.2, the Mandalay line occupies 35 percent to 60 percent of the four main lines in passengers carried train-kilometers and freight carried train-kilometers. On the Myitkyina line, the number of passenger trains is only six, but the passengers carried occupy 30 percent of the total of four lines. It shows that the congestion on the line is larger than that on the Mandalay line.

Table 5.2.1 Route Length and Current Number of Trains

Line	Route length (km)	Number of trains: Passenger trains: Express	Ordinary	Local	Freight trains
Mandalay	620 (385.5 miles)	6	4	8	10
Martaban	278 (172.75 miles)	6	2	-	4
Prome	259 (161.00 miles)	2	4	-	4
Myitkyina	543 (337.25 miles)	-	4	2	10
Total	1,700 (1,056.5 miles)	14	14	10	28

Note: Not including the Rangoon suburban trains (between Rangoon and Ywathagyi)

Source: BRC

Table 5.2.2 Traffic Volume per Day on Four Railway Lines

(1984/85)

Line	Passenger: No. of Passengers Carried (passengers/day)	Rate (%)	Train-Kilometers (Km/day)	Rate (%)	Freight: Volume of Freight Carried (tons/day)	Rate (%)	Train-Kilometers (Km/day)	Rate (%)
Mandalay	17129	35	5948	48	2737	60	1986	57
Martaban	8290	17	2224	18	331	7	275	8
Prome	8790	18	1339	11	577	13	608	18
Myitkyina	14660	30	2882	23	891	20	578	17
Total	48869	100	12393	100	4536	100	3447	100

Source: BRC

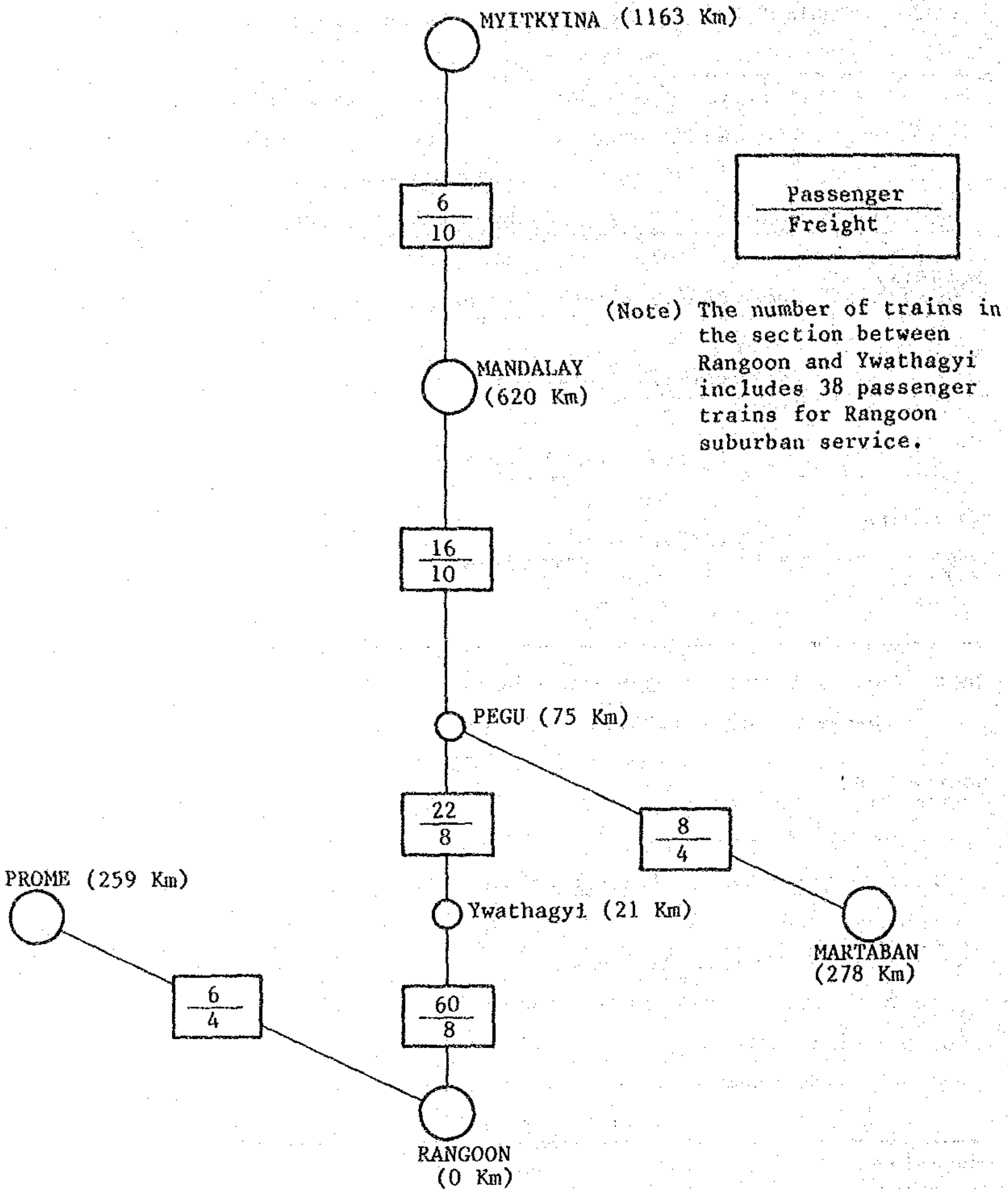


Fig. 5.2.1 Current Number of Trains in Operation per Day

Source: BRC

(2) Train make-up

Representative train make-ups are as follows:

Passenger train (the longest)

- Express train = 1 diesel locomotive + 3 upper class cars + 12 ordinary class cars + 1 brake van

- Ordinary train = 1 diesel locomotive + 3 upper class cars + 9 ordinary class cars + 3 luggage vans + 1 brake van

- Local train = 1 diesel locomotive + 4 ordinary class cars + 4 luggage vans + 1 brake van

Freight trains (the maximum hauling tons)

- 1 Diesel locomotive + wagons totaling 850 tons

From the point of view of the tractive power of the diesel locomotive the number of cars and tons of load hauled are excessive both in passenger and freight trains. But actually, due to the shortage of passenger cars and wagons, the train make-up is less than those shown above. When future increase in speed is considered, it is necessary to decrease both the number of cars and the total load hauled.

(3) Train speed

The maximum speed, the scheduled speed and scheduled time of the representative passenger and freight trains on the four lines are shown in Tables 5.2.3 and 5.2.4. The maximum speed of express passenger trains is 48 km/h to 64 km/h and that of freight trains is 32 km/h; they are so low that it can be said that the inherent characteristic of railway transport is beginning to be lost. The scheduled time for the section between Rangoon and Mandalay on the Mandalay line is currently 13 h and 45 min but, before the revision of the timetable in 1983, the train was operated in 12 h and 30 min. The maximum speed was also decreased from 72 km/h to 64 km/h. This is caused by many speed restriction points at turnouts, between stations, and deterioration of track condition and rolling stock.

Table 5.2.3 Actual Operation of Typical Passenger Trains

Line	Section	Express passenger train			
		Maximum speed (km/h)	Scheduled speed (km/h)	Scheduled time	Stopping time
Mandalay	Rangoon-Mandalay	64 (40 mph)	45 (28 mph)	13°45'	3' - 8'
Martaban	Rangoon-Martaban	48 (30 mph)	37 (23 mph)	7°35'	2' - 5'
Prome	Rangoon-Prome	48 (30 mph)	37 (23 mph)	7°00'	3' - 5'
Myitkyina	Mandalay -Myitkyina	48 (30 mph)	23 (14 mph)	24°00'	2' - 55'

Note: Ordinary passenger trains between Mandalay and Myitkyina

Source : BRC

Table 5.2.4 Actual Operation of Typical Freight Trains

Line	Section	Freight train				
		Length (km)	Maximum speed (km/h)	Scheduled speed (km/h)	Scheduled time	Stopping time
Mandalay	Malagon Goods Yard - Myohaung	612 (380.25 miles)	32 (20 mph)	16 (10 mph)	37°10'	25'-2°
Martaban	Pegu - Martaban	203 (126.00 miles)	32 (20 mph)	12 (8 mph)	16°15'	25'-2°
Prome	Kemmen-dine - Paungde	203 (126.00 miles)	32 (20 mph)	25 (16 mph)	8°00'	25'-2°
Myitkyina	Kawlin - Mohnyin	230 (143.00 miles)	32 (20 mph)	14 (9 mph)	16°00'	25'-2°

Source: BRC

(4) Block system

The types of block system and their sections in use are shown in Table 5.2.5. There are four types of block system: automatic, tokenless, token and paper line-clear ticket system. 64 percent of the four lines have the paper line-clear ticket system, in which a block is confirmed by telegraph or telephone communications. Safety is dependent only on the human power of attention.

Table 5.2.5 Types of Block System and Sections Employed

Type	Mandalay line (km)	Martaban line (km)	Prome line (km)	Myitkyina line (km)	Rate (%)
Automatic block system	4 (2.50 miles)	4 (2.50 miles)	21 (12.75 miles)	-	2
Tokenless block system	71 (44.00 miles)	71 (44.00 miles)	-	-	8
Token block system	-	203 (126.25 miles)	238 (148.25 miles)	-	26
Paper line-clear ticket system	545 (339.00 miles)	-	-	543 (337.25 miles)	64
Total	620 (385.50 miles)	278 (172.75 miles)	259 (161.00 miles)	543 (337.25 miles)	100

Source : BRC

5-2-2 Situation of Rolling Stock

(1) Rolling stock

The working-efficiency of locomotives, carriages and wagons is shown in Table 5.2.6. This table shows the low working efficiency of locomotives. The deterioration of rolling stock is in an advanced stage: 33 percent of diesel locomotives and 64 percent of carriages have been used for more than 20 years, and 52 percent of wagons have seen 30 years in use. All steam locomotives have already passed 30 years in service.

Inspection and repair of locomotives are performed, in principle, at the periods of daily, 22 day, 1.5 month, 3 month, yearly, 2 year and 3 year. Inspection is carried out on carriages and wagons at the periods of daily, yearly, 2 year and 4 year. But there are many difficulties due to the deterioration of rolling stock or the shortage of spare part supply, which are affecting train operations. Especially conspicuous are the engine troubles of locomotives (refer to Table 5.2.7). On the four main lines, three engine troubles are occurring a day.

A vacuum brake system is used, but due to the shortage of spare part supply for rolling stock, even express passenger trains are not equipped with brake linings for a part of their rolling stock. Most of the wagons

Table 5.2.6 The Present Situation of Rolling Stock

Line	Locomotives						Passenger Coaches			Freight Wagons		
	D.L			S.L								
	No.	Using	Working Efficiency (%)	No.	Using	Working Efficiency (%)	No.	Using	Working Efficiency (%)	No.	Using	Working Efficiency (%)
Mandalay		51			31			178				
Martaban	207	10	57	113	17	55	1333	64	70	8939	6340	77
Prome		9			3			50				
Myitkyina		28			6			120				
Other		20			7			523			515	
Shunting	20	12		28	14		-	-		-	-	
(Total)	(227)	(130)		(141)	(78)		(1333)	(935)		(8939)	(6855)	

Source: BRC

Table 5.2.7 Number of Engine Troubles (1984/85)

Year-Month	Mandalay Line		Martaban Line		Prome Line		Myitkyina Line		Other Line		Total	
	Passenger Train	Freight Train	Passenger Train	Freight Train	Passenger Train	Freight Train	Passenger Train	Freight Train	Passenger Train	Freight Train	Passenger Train	Freight Train
1984 - 4	16	36	2	-	6	3	19	10	8	5	51	54
5	9	36	-	1	6	4	1	9	8	3	24	53
6	24	34	1	-	5	3	2	6	5	10	37	53
7	9	31	3	5	5	-	5	14	5	3	27	53
8	12	31	1	2	5	6	8	14	8	12	34	65
9	7	54	4	4	9	3	4	5	6	6	30	72
10	12	42	4	2	5	4	4	11	13	9	38	68
11	10	54	3	2	6	4	10	5	8	10	37	75
12	3	88	3	3	12	5	6	6	6	4	30	106
1985 - 1	6	61	3	-	9	7	7	10	16	6	41	84
2	4	91	4	4	4	4	8	6	11	4	31	109
3	16	96	1	1	15	9	6	4	19	10	57	120
(Total)	128	654	29	24	87	52	80	100	113	82	437	912

Source: BRC

are not equipped with brake linings, and the braking force of freight trains depends totally on that of the locomotive. This results in the limitation of the train speed.

(2) Rolling stock sheds and driver depots

The allocation of each rolling stock shed and workshop is shown in Table 5.2.8. The number of drivers by main lines and by driver depots is shown in Table 5.2.9. The number of drivers on a locomotive for a passenger train is 2 (a driver and a co-driver), and 4 (2 teams of drivers) to relieve the other team on the way for a freight train.

Table 5.2.8 Rolling Stock Shed and Workshop for the Four Main Lines

Line	Rolling Stock Shed		Workshop
	Loco Shed	Coach & Wagon Shed	
Mandalay	Mahlwagon	Rangoon	
	Pegu	Mahlwagon	
	Pyuntaza	Pegu	Myitnge
	Toungoo	Pyuntaza	Carriage and
	Pyinmana	Toungoo	Wagon
	Thazi	Pyinmana	
	Mandalay	Thazi	
		Myohaung	
		Mandalay	
Martaban	Martaban	Martaban	
	Mokpalin	Mokpalin	
Prome	Insein	Kyimedine	
	Letpadan	Letpadan	Insein
	Prome	Prome	Locomotive
Myitkyina	Kawlin	Kawlin	Ywataung
	Mohnyin	Ywataung	Locomotive
		Naba	
		Mohnyin	

Source: BRC

Table 5.2.9 Drivers Office the Four Main Lines

Line	Drivers Office (Shed or Workshop)	Number of Crews
Mandalay	Mahlwagon	107
	Pegu	22
	Toungoo	151
	Pyinmana	17
	Thazi	44
Martaban	Mahlwagon	10
	Pegu	24
	Mokpalin	19
	Martaban	38
Prome	Insein Diesel Shed	82
	Letpadan	26
	Mahlwagon	10
Myitkyina	Mandalay	154
	Kawlin	68
	Mohnyin	55

Note: 1) 1 Crew = 1 Driver + 1 Co-Driver

2) 1 Crew for a passenger train and 2 crews for a freight train

Source: BRC

5-3 Train Operation Control

5-3-1 Train Control System

Control offices are located at eight places, and their respective control territory of the four main lines is shown in Table 5.3.1.

The organization of a control office is shown in Fig. 5.3.1. Control duties are divided into the train control, centering on a chief controller, and the locomotive control covered by a power controller.

Table 5.3.1 Control Range of Control Office in the Four Lines under the Study

Traffic Control Office	Line	Control Territory
Pegu	Mandalay	Rangoon - Pyuntaza
	Martaban	Pegu - Martaban
Prome	Prome	Rangoon - Prome
Suburban	Rangoon and Suburban Line	Rangoon Suburban
Toungoo	Mandalay	Pyuntaza - Pyinmana
Thazi	Mandalay	Pyinmana - Thazi
Mandalay	Mandalay	Thazi - Mandalay
	Myitkyina	Mandalay - Kanbalu
Kawlin	Myitkyina	Kanbalu - Naba
Mohnyin	Myitkyina	Naba - Myitkyina

Source: BRC

Divisional Traffic Manager

Chief Controller

Controllers (3 persons)

Recorders (3 persons)

Divisional Mechanical Engineer

Power Controllers (3 persons)

Fig. 5.3.1 Organization of Control Office

Source: BRC

Train controllers perform the issuing instructions and receiving information to and from main stations as shown below:

- Delay time
- Train crossing
- Loading freight train
- Detaching and attaching of coaches
- Load position at various stations

Power controllers perform the issuing instructions and receiving information to and from rolling stock sheds as shown:

- Engine failure
- Engine location
- Fuel (diesel, engine and axle oil)

The control offices are equipped with communication facilities such as controller telephones, automatic subscriber telephones, direct telephones, to issue and receive information to and from stations, rolling stock sheds and other control offices. But frequent telephone troubles caused daily due to the deterioration of equipment or maintenance problems interfare train operation management. When train operation is out of order, issuing and receiving information at the control office is very important, so the improvement of the information network is an urgent necessity.

At present, when train operation is out of order, it is a rare case that the controller judges independently, and in most cases he asks for advice from the main office. The examination of the improvement of control system, such as the provision of a new system which makes comprehensive judgment between the main office and control offices, is necessary.

5-3-2 Control Facilities

Facilities for train and locomotive control, using selective calling control telephones, automatic telephones, magneto telephones and radio telephones are equipped, but they are not working satisfactory because most of them are becoming worn out and the PTC bare wires are not reliable due to their frequent failures and insufficient maintenance.

Table 5.3.2 Equipment for Train Operation Control

Equipment	Usage	Situation
Selective Calling Control Telephone	Communication with stations under control	Line resistance is high, lines are not uniform and line to line or line to earth resistance is very low during the rainy season. Therefore, this kind of equipment using high voltage impulse is not workable or can be used at only a few stations.
Automatic Subscriber Telephone (PTC)	Communication with Head Office and some major stations	Underground cable and distribution boxes are defective, so troubles occur especially during the rainy season.
Magneto Telephone	Communication with Head Office and different departments of BRC and major points	Exchange switchboards are old. Jack and socket are so worn out that speech fades out or sometimes becomes totally cut off. Since no spare parts are available and there is no spare switchboard, heavy repair works cannot be carried out on the existing switchboard.
H.F (SSB) Radio Telephone	Communication with other controls and some key-stations in remote areas	There is a certain period at night when none of the channel is operative due to a lot of noise.

5-4 Track

5-4-1 Outline of Permanent Way

The distance of the section between Rangoon and Mandalay is 620 km (385 1/2 mile) of which 362.2 km (225 mile) section between Rangoon and Pyinmana, and 4.4 km (2 3/4 mile) section between Myohaung and Mandalay are double tracks. The ratio of double tracks is 59 percent.

The permanent way is generally flat and has less curves.

(1) Gradient of permanent way

The gradient of permanent way is 5/1000 or less. Therefore the train operation is not affected by gradient.

(2) Curve of permanent way

The minimum curve radius is 291 m (6°). The whole length of curved tracks is 99.6 km (62 mile) for the main track, of which the length of curves with radius of 873 m (2°) or more accounts for 69 percent of curved tracks.

At 10 curves, train speed restriction is required under the present maximum speed.

The length of curve classified by curve radius is shown in Table 5.4.1.

(3) Standard track structure

1) Track materials

- Rail 75 lb/y (37 kg/m)
- Sleeper Wooden sleeper and PC sleeper
- Ballast Crushed stone
- Fastenings Dog, screw, and elastic spike

2) Ballast section

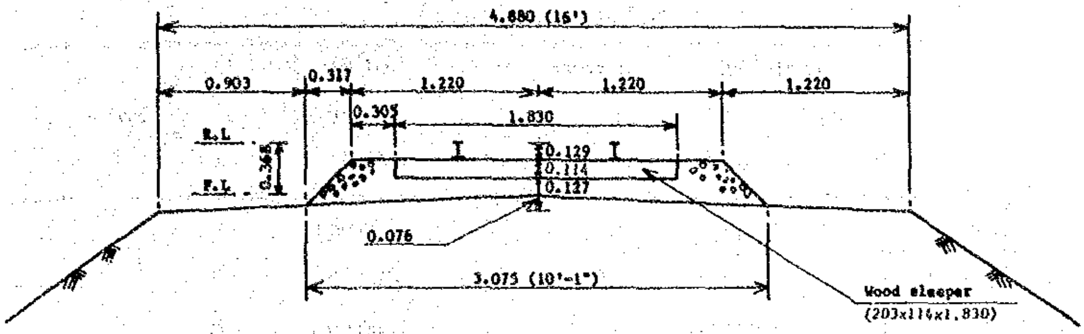
Standard cross section of ballast is shown in Fig. 5.4.1.

Table 5.4.1 Classification of Curve

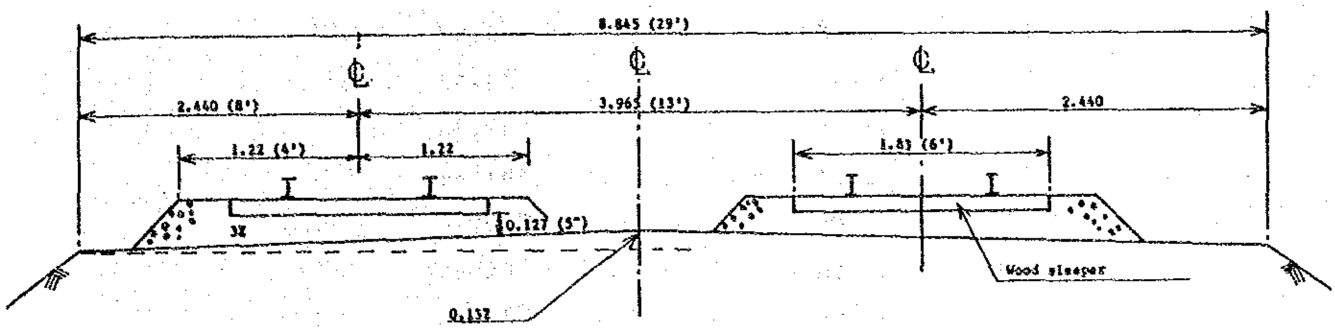
Radius (°)	Radius (m)	Rangoon - Pyinmana UP	Rangoon - Pyinmana DN	Pyinmana - Myohaung	Myohaung - Mandalay UP	Myohaung - Mandalay DN	Total
0 1/4	6,985	(1) 137	(1) 274	-	-	-	(2) 411
0 1/2	3,493	(12) 1,291	(9) 1,054	-	-	-	(21) 2,345
0 3/4	2,328	(4) 639	(2) 389	-	-	-	(6) 1,028
0 7/8	1,996	(1) 152	-	-	-	-	(1) 152
1	1,746	(50) 6,322	(52) 6,008	(11) 5,357	-	-	(113) 17,687
1 1/4	1,397	(7) 1,440	(6) 1,303	-	-	-	(13) 2,743
1 1/2	1,164	(13) 3,132	(13) 3,071	-	-	-	(26) 6,203
2	873	(50) 11,409	(48) 11,638	(42) 14,077	(1) 254	(2) 553	(143) 37,911
2 1/2	699	(2) 686	-	-	-	-	(2) 686
3	582	(13) 3,809	(15) 4,431	(15) 4,846	(1) 175	-	(44) 13,261
3 1/2	499	-	(1) 343	(1) 375	-	-	(2) 718
4	437	(11) 3,685	(12) 3,858	(14) 4,745	(2) 356	(2) 356	(41) 13,000
5	349	(1) 322	(2) 416	(1) 274	-	-	(4) 1,012
5 1/2	318	(1) 297	(1) 297	-	-	-	(2) 594
6	291	(2) 901	(2) 901	-	-	-	(4) 1,802
G. Total		(168) 34,222	(164) 33,983	(84) 29,674	(4) 785	(4) 889	(424) 99,553

Note: ( ) shows number of curves

Source: BRC



Single track



Double track

Fig. 5.4.1 Standard Cross Section of Ballast

(4) Railway bridge

There are 834 bridges of various length between Rangoon and Mandalay. However, there are no tunnels on this section.

The total length of bridges is about 13 km (8 mile). The number of bridges whose length is 10 m or less is 54 percent.

The number of railway bridges and their length is shown in Tables 5.4.2 and 5.4.3.

Table 5.4.2 Number and Length of Railway Bridges
(Double Track)

Length of bridge (ft)	Length of bridge (m)	Number of bridges	Total length (m)	Note
2	0.61	1	0.61	
10	3.05	45	137.25	
12	3.66	3	10.98	
20	6.10	89	542.90	
30	9.14	15	137.10	
40	12.19	64	780.16	
50	15.24	2	30.48	
60	18.29	23	420.67	
80	24.38	22	536.36	
100	30.48	5	152.40	
110	33.53	1	33.53	
120	36.58	12	438.96	
160	48.77	2	97.54	
180	54.86	6	329.16	
200	60.96	5	304.80	
220	67.06	1	67.06	
250	76.20	1	76.20	
280	85.34	1	85.34	
300	91.44	2	182.88	
320	97.54	1	97.54	
380	115.82	1	115.82	
680	209.26	2	418.52	
700	213.36	1	213.36	
Total		305	5,209.63	305 x 2 = 610 5,209.63 x 2 = 10,419.26 m

Source: BRC

Table 5.4.3 Number and Length of Railway Bridges
(Single Track)

Length of bridge (ft)	(m)	Number of bridges	Total length (m)	Note
3	0.91	2	1.82	
6	1.83	18	32.94	
10	3.05	68	207.40	
20	6.10	57	347.70	
30	9.14	3	27.42	
40	12.19	26	316.94	
50	15.24	-	-	
60	18.29	9	164.61	
80	24.38	18	438.84	
100	30.48	5	152.40	
112	34.14	1	34.14	
120	36.58	2	73.16	
160	48.77	4	195.08	
200	60.96	2	121.92	
230	70.10	2	140.20	
240	73.15	1	73.15	
280	85.34	1	85.34	
300	91.44	1	91.44	
320	97.54	1	97.54	
380	115.82	1	115.82	
400	121.92	1	121.92	
680	207.26	1	207.26	
Total		224	3,047.04	

Source: BRC

(5) Level-crossing

There are 413 level-crossings, of which gate men are stationed at 180 crossings. These crossings have barriers which are operated manually.

Each level-crossing has the guard rails.

Asphalt concrete or pile of soil is used to pave level-crossings.

5-4-2 Present Condition of Track

Rail and sleeper are in poor condition due to wear and corrosion, and ballast is insufficient. Therefore, on some section, tracks have large irregularities of joint and alignment which cause vibration of trains.

(1) Rail

The standard rail length is 39 ft (11,887 m). As the rail is comparatively short, it has many joints which are the weak points of rails, causing many irregularities of joints in most sections.

On the other hand, welded rails of three or six pieces of 39 ft length (35.7-71.3 m) are used in some sections, where the occurrence of track irregularities is small. In general, the condition of track with welded rails is better than that using standard rails.

The length of rail classified by age is shown in Table 5.4.4.

Table 5.4.4 Length of Rail by Age

(Unit: km)

Line	Year					Total
	20 or less	21-40	41-60	61-80	81 or over	
Rangoon - Mandalay	-	192	1,784	-	-	1,976

Source: BRC

(2) Sleeper

18 sleepers are placed per 39 ft. Most sleepers are of soft wood and are in poor condition because of corrosion or breakage.

Annual replacement rate of sleepers between Rangoon and Mandalay is 4.1 percent for the past five years, while the average deterioration rate is estimated at 30 to 40 percent.

Approximately 9,000 PC sleepers are adopted on trial in 6.7 km section.

The method to fasten PC sleepers is to use screw spikes, however, wooden plug imposes a problem in service life.

(3) Ballast

The quantity of ballast is generally insufficient. As a result, the thickness of ballast does not meet the requirement and the ends of sleepers are exposed because of thin shoulders.

Particularly, the back of abutments, both sides of level-crossings and turnouts are insufficient. Therefore, there are large irregularities in alignment in many sections.

The average addition of ballast is 11,400 m^3/year for the past five years between Rangoon and Mandalay. It is only 12 m^3/km.

The addition of ballast is shown in Table 5.4.5.

Table 5.4.5 Addition of Ballast

(Unit: m^3)

Year / Line	79/80	80/81	81/82	82/83	83/84	Average
Mandalay	5,538	16,472	13,177	8,795	12,978	11,392
Myitkyina	7,669	10,626	13,552	6,804	5,390	8,808
Martaban	2,027	7,655	6,925	4,026	3,819	4,890
Prome	6,073	3,024	4,665	4,883	8,112	5,351
Total (A)	21,307	37,777	38,319	24,508	30,299	30,442
Other (B)	16,638	10,710	11,847	17,550	21,635	15,676
Grand total (A+B)	37,945	48,487	50,166	42,058	51,934	46,118

Source: BRC

(4) Fastenings

The rail is mainly fastened by dog spikes and due to the insufficiency of supporting, there are many floatings of dog spikes which may cause rail tilting or gauge enlargement.

At sharp curves, it seems difficult to maintain the gauge as base plates are not used.

5-4-3 Station Facilities

The platforms are relatively low and are made of brick. But as passenger cars have two steps, it is not difficult to get on and off.

Most of the tracks are straight in station yards, but tracks in some stations have sharp curves. Therefore, the improvement of these curves will be required to increase train speed.

Turnouts of 1 in 12 are used for main tracks and most of the turnouts are of the built-up type. Turnouts are considerably deteriorated due to aging at some stations.

5-4-4 Roadbed

The geology of roadbed is mainly sandy clay, and is relatively stable.

As the embankment is relatively low between Rangoon and Pegu, tracks are submerged in heavy rains, which causes delay of trains. The occurrence of track submergence is shown in Table 5.4.6.

Table 5.4.6 Track Submergence
(Mandalay Line)

No.	Date of occurrence	Mile from	Mile to	Length (mile)	Train delay	H.W.L.
1	25.5.1982	263/10	264/1	$\frac{1}{8}$	8 h	1 ft 8 in.
2	24.8.1982	71/4	74/12	$3\frac{1}{3}$	10 h	2 ft
3	24.8.1982	40/4	40/24	$\frac{5}{6}$	4 h	7 in.
4	24.8.1982	47/3	49/9	$\frac{1}{4}$	4 h	7 in.
5	24.8.1982	49/22	50/21	1	4 h	7 in.

Note: H.W.L. above rail head

Source: BRC

5-4-5 Railway Bridge

The superstructure of railway bridges is I-beams, deck steel girders, PC girders, and steel trusses, and substructure is made of brick.

Most of the bridges are relatively well maintained. But at present, the speed restriction is in effect at five bridges. The repair works will be completed within one year, except No. 678A.

Besides this, problems of track on the bridges are as follows:

- The number of decayed sleeper is large.
- Holding power of hook bolts is not enough.
- The spacing of sleepers is irregular.

Speed restriction at bridges is shown in Table 5.4.7.

Table 5.4.7 Speed Restriction at Bridges

No.	Bridge No.	Location (Mile)	Cause	Restricted speed
1	13	6 (9.9 km)	Abutment, Cracked	(km/h) 16
2	166	111 (181.2)	Abutment, Cracked	8
3	179	120 (192.9)	Abutment, broken and tilted	(UP) 24 (DN)Dead slow
4	678A	327 (526.8)	Approach roadbed, loosened	24
5	699	338 (544.3)	Pier, tilted by undermining	Dead slow

Source: BRC

5-4-6 Track Maintenance System

The permanent way between Rangoon and Mandalay is maintained by four divisions. Two or three permanent way depots are placed in each division. There are some branch depots under these depots.

Track maintenance gangs are stationed about 4 miles (6.4 km) apart and each gang is taking charge of both track inspection and maintenance work.

The gang consists of one head trackman, one patrolman, and 10 workers. Personnel in permanent way depots is shown in Table 5.4.8.

Table 5.4.8 Personnel in Permanent Way Depot
(Mandalay Line)

Division	P.W. Depot	Mile from	Mile to	Length	Personnel Leader	Personnel Patrol	Personnel Worker	Personnel Total
	Rangoon	0	6/5	6/5	9	9	90	108
Rangoon	Malagon	6/5	26/12	20/7	11	11	110	132
	Total			26/12	20	20	200	240
	Pegu	26/12	67/0	40/12	21	21	210	252
Pegu	Myaunglebin	67/0	112/6	45/6	23	23	230	276
	Pyu	112/6	164/0	51/18	26	26	260	312
	Total			137/12	69	69	690	840
	Yedashe	164/0	206/20	42/20	20	20	200	240
Tounggoo	Pyinmana	206/20	236/19	29/23	9	9	90	108
	Yameithin	236/19	295/14	58/19	16	16	160	192
	Total			131/14	45	45	450	540
	Thazi	295/14	359/16	64/2	16	16	160	192
Mandalay	Mandalay	359/16	385/12	25/20	6	6	60	72
	Total			89/22	22	22	220	264
	G. Total			385/12	157	157	1,570	1,884

Source: BRC

(1) Inspection of tracks

Tracks are inspected by train, track motor car, trolley, or on foot. The period of inspection is shown in Table 5.4.9.

Table 5.4.9 Period of Inspection

No.	Personnel	Period
1	Patrolman	Daily
2	Assistant Inspector	Twice a week
3	Inspector	Once a week
4	Assistant Engineer	Once a month
5	Divisional Engineer	Once in two months

Source: BRC

(2) Track maintenance works

Maintenance works are mainly done manually by workers in track maintenance gangs. Besides, mechanical maintenance gangs are at Rangoon, Pyinmana and Mandalay, each consisting of about 60 workers.

The renewal of sleepers is done by a sleeper renewal machine, a power wrench, a track jack, and a four-tool tamper. A large multiple tie tamper is not provided for each gang.

Major track maintenance machines are shown in Table 5.4.10.

Table 5.4.10 Track Maintenance Machines

No.	Description	Number of machine			
		Rangoon	Pyinmana	Mandalay	Total
1	Track motor car	1	1	1	3
2	Hydraulic tamping machine	2	1	2	5
3	Hydraulic lifting and sighting unit	2	1	2	5
4	Rail grinding machine	4	0	1	5
5	Rail profile grinding machine	1	1	0	2
6	Friction rail saw	2	2	2	6
7	Thermit weld shear	1	0	1	2
8	Power wrench (bolt fastening)	1	0	1	2
9	Tie renewer	1	1	0	2
10	Hydraulic rail threader	1	1	0	2
11	Electric light plant	1	0	1	2
12	Rail loader	6	0	0	6

Source: BRC