CHAPTER 6

CURRENT RAILWAY TRANSPORT PROFILE AND RAIL CARGO SURVEY

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The broad objective of the survey is to investigate whether the Rupsa Bridge is more effective when railway is added to the bridge. Accordingly, following items are studied.

6.1 A Brief Look at the Present State of Bangladesh Railways (BR)

Bangladesh Railway (BR) is operating approx. 2,700 route-km and 244 passenger trains and 47 freight trains run every day. The total railway revenue is Tk.2 billion a year with approx. 40 thousand employees. The railway route is shown in Fig. 6.1.1 and main statistics are presented in Table 6.1.1.

Table 6.1.1 Main Statistics of BR 1996/97

Item	**Broad Gauge**	Meter Gauge	Total	Notes
Route km	**883.6**	1,822.4	2,706.0	Km
Track km	**1527.9**	2,835.6	4,363.5	Km
Number of Passengers	**12,726 (35/day)**	24,876 (68/day)	37,602 (103/day)	1000 Pass.
Tons of Freight	**1,337 (3.7/day)**	1,631 (4.5/day)	2,968 (8.1/day)	1000 Tons
Passenger.km	**749,854 (2,054/day)**	3,003,755 (8229/day)	3,753,609 (10,283/day)	1000 Pass.km
Average traveled km	**59**	121	100	km
Ton.km	**221,496 (607/day)**	560,933 (1537/day)	782,429 (2,144/day)	1000 T. km
Freight average transported km	**164**	342	265	km
Passenger Earnings			1,003,634	1000 Tk.
Freight Earnings			1,042,622	1000 Tk.
Earnings/Passenger			26.7	Tk./Pass.
Earnings/Passenger .km			0.267	Tk./Pass.km
Earnings/Ton			351.3	Tk./Ton
Earnings/Ton.km			1.33	Tk./T.km
Number of loco.	**68**	216	284	
Number of P.C.	**266**	979	1,245	
Number of F.C.	**2,809**	10,139	12,948	

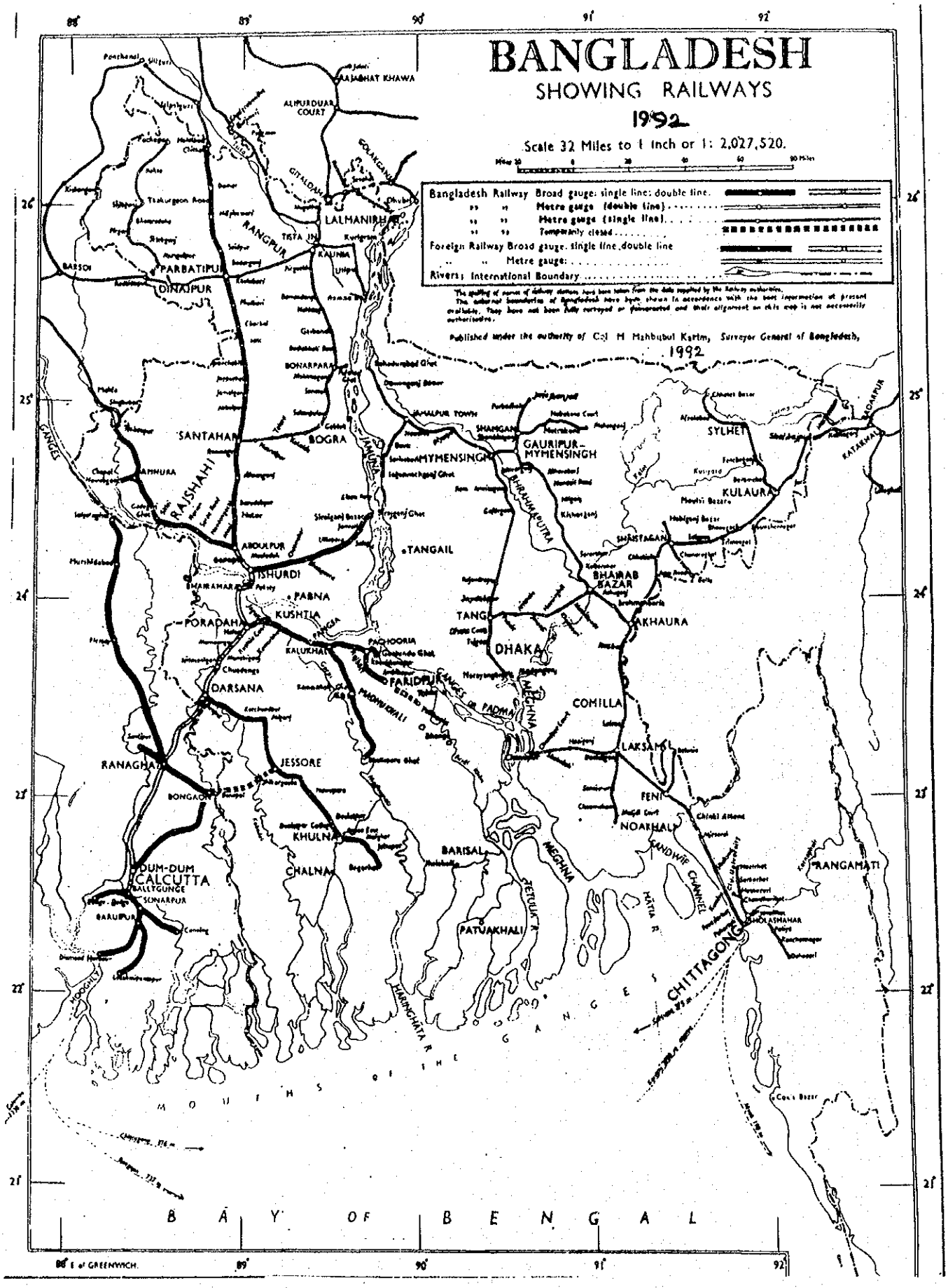


Fig. 6.1.1 Bangladesh Railway Network

Table 6.1.2 Earnings & Expenses of BR 1996-1997 (unit; thousand taka)

Earnings	Passenger Income	Other Coaching Income	Freight	Miscella neous	Land sell	Receivable	Total
	1,003,634	123,903	1,042,622	426,261	360,000	350,000	3,306,420

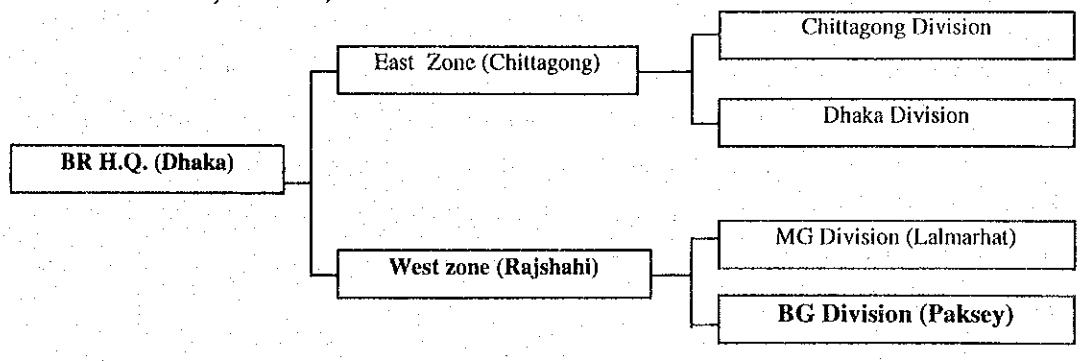
In the fiscal year 1996/97, the item of Land sell was first set in the BR earning items, and pushed up the income of BR Tk 360 Million.

Expenses	General Administr ation	Repairs & Maintena nce	Operation staff	Operation fuel	Operation other than staff and fuel	Miscella neous	Total
	7,32,114	1,406,028	619,331	544,905	293,108	546,200	4,141,686

BR had approx. **Tk. 0.8 billion in debt in 1996-1997 fiscal year**. The debt of the previous fiscal year **1996/97 was Tk. 1.2 billion**.

BR has two railway gauge systems. One is **Broad Gauge (1,676 mm)** and it serves **the western zone.** The other is Meter Gauge (1,000 mm) which serves the entire eastern zone and northern part of the western zone. The railway net work of BR has been divided into two zones, the eastern and the western by Jamuna River, Padma River and Meguna River. On the west, BG 833 km and MG 543 km are served, and on the east, MG 1279 km is served.

For administrative purposes, the BR is divided into two zones, viz., the East and the West. As stated above, the East is responsible for 1279 km of MG, and the West is responsible for 833 km of BG and 543 km of MG. The head office of the Eastern Zone is at Chittangong and that of the West is at Rajshahi. The Western zone is again subdivided into two divisions with the head office of BG division at Paksey, and that of MG division at Lalmanirhat (the northern end of the west zone). That is,



In Aug. 1998, the Jamuna Bridge is opened as a rail cum road bridge. The railway between the bridge and Joydebpur is now under construction and its service connecting East and West will begin in 2001.

As seen from the table 6.1.1, MG section is leading in most figures. MG is mainly in the East zone and this is partly because of the socio-economic geometry of the country. The population, GDP, etc., such economic indexes are relatively better in the Eastern zone.

Reference: Railway network density of Bangladesh

As one of basic infrastructures of land transportation, railway network has its importance when it is used. It is not justifiable only to compare the railway network density between countries, without discussing how it is used or whether alternative means are available, etc.,. However, the following table will suggest development measures.

Table 6.1.3 Railway net work density - Route-km/km^2 and route-km/person in several Asian countries

Country	Route-km (a)	Area (Thousand km^2) (b)	Railway density (in 10^{-3}) c= a/b	Population (million) (d)	Length /person (in 10^{-6}) (e = a/d)	Pop. Density (f= d/b)
Bangladesh	**2,706**	**148**	**18.2**	**124**	**21.8**	**838**
China	54,000	9,597	5.63	1,221	44.2	127
India	62,915	3,288	**19.1**	929	67.7	283
Indonesia (Java Is.)	4,967	127	39.1	115	43.2	**906**•
Japan	23,500	378	62.2	125	188	331
Korea	3,101	99	31.3	45	68.9	455
Malaysia (Peninsula)	1,798	132	**13.6**	18	99.9	136
Myanmar	3,955	677	5.8	45	87.9	66
Taiwan	1,108	36	30.8	21	52.8	583
Thailand	3,865	513	7.5	59	65.5	115
Vietnam	2,605	332	7.85	74	34.7	223

• Java Island's population density (906 persons/km^2 in 1995) is the nearest to that of Bangladesh (840/km^2 in this study).

From the above table, it can be found that the railway density of Bangladesh is 0.0182 km/km^2, and the density is the same level with India, and Malaysia peninsula, and there are countries that have smaller figures than Bangladesh. However, the route-km per person of Bangladesh is 21.8 x10^{-6} km/person, and this figure is the least among the countries mentioned above. This figure seems to be irrational to such densely populated countries as Bangladesh.

Nowadays, a way of thinking is prevailing that railway should be considered into two categories, i.e., upper part, which is railway operation including rolling stock and. the lower part which includes track, structures, right of ways and so on. In this thinking, the railway network belongs to the lower part. The upper part is the software of the railway, i.e., a

technology how to use effectively the hardware, railway, and the lower part is the hardware of the railway. As the hardware of the railway, Bangladesh is fully entitled to have more longer railway network as the other Asian countries, if the software works effectively and if people want to use the railway system more, because it has far more population density than other countries.

6.2 Study Area

(1) Broad Gauge

Rupsa river is in the western zone. In the railway network, Rupsa river is between the Khulna station and the Rupsa East station, which are in the Broad Gauge section. Then the study will be done in this BG section area.

As seen from Fig.6.1.1, there are BG sections as presented in Table 6.2.1.

Table 6.2.1 BG sections in the west area

Section		Distance (km)	Grade of importance	Note
Station	Station			
Khulna	**Jessore**	**56.00**	**1st class**	**Single track**
Jessore	**Darsana**	**71.99**	**1**	**Single**
Darsana	**Poradaha**	**41.90**	**1**	**Double track**
Poradaha	**Bhairamara**	**18.63**	**1**	**Double**
Bhairamara	**Ishurdi**	**16.27**	**1**	**Double**
Ishurdi	**Abdulpur**	**17.46**	**1**	**Double**
Abdulpur	**Santahar**	**60.99**	**1**	**Single track**
Santahar	**Parbatipur**	**95.95**	**1**	**Single**
Parbatipur	**Saidpur**	**15.10**	**1**	**Single**
Saidpur	**Chilhati**	**52.20**	**2nd class**	**Shingle**
Ishurdi	**Sirajganjghat**	**83.39**	**1**	**Single**
Poradaha	Kalukhali	50.83	2nd class	Single
Kalukhali	Rajbri	17.48	2nd class	Single
Rajbari	Goalundo	18.57	2nd class	Single
Arabunagar	Faridpur			Pachooria – Faridpur Jan./98 closed
Faridpur	Pukria			Closed
Kalukhali	Bhatiaparaghat			Temp. closed Aug./97
Modhukali	Kamarkhaighat			Closed
Jessore	Benapol	35		Closed. But in restoration work now*1.
Bhairamara	Raita			Closed
Abdulpur	Rajshahi	40.94	2nd, but 1st in future	Single track
Rajshahi	Amnura	37.80	2nd class	Single
Amnura	Rohanpur	25.16	2nd class	Single
Total		720.66		Single
Rupsa East	**Bagerhat**	**31.67**	**3rd class**	**Closed Aug./97**

*1 Jessore – Benapol is now in restoration. The total restoration budget is Tk. 20million. It is mainly for track (ballast and sleepers), but includes innovation of station buildings and signal systems. On sites, the restoration is on going. The completion was expected to complete in Dec./98, but is delaying.

Some of the above lines were closed following the BR's RRP (Railway Recovery Program).

In above table, the bold letters sections are the sections that have more direct influence on the Rupsa bridge, because of the following reasons.

① Khulna-Jessore-Darsana-Poradaha-Bhairamara-Ishurdi-Abdulpur-Santahar-Parbatipur- Saidpur-Chilihati, and Rupsa East-Bagerhat are the north-south corridor and its extension. Therefore, if Rupsa bridge is constructed, this corridor will be a trunk-line of the west area.

② Ishurdi-Sirajganjghat is the connecting line between the east and the west area by Jamuna bridge and will be a future trunk line which connects Mongla-Dhaka, via Khulna., if the Rupsa bridge is constructed.

③ Besides the transportation study, the technical principles and rules applied to the BG and the present state of the facilities, rolling stocks, locomotives, etc. will be studied. These are mainly for the technical study of the Rupsa bridge project.

(2) Khulna- Jessore area

In the above bold letter sections, Khulna-Jessore area is a section in BR where the Rupsa bridge is supposed. Then, the performance of the present transportation is a key to imagine some future projects. Therefore, railway transportation characteristics of Khulna-Jessore section will be studied station by station.

6.3 Present Status of the Western North-South Corridor

(1) Basic construction standards

BG has its several rules and regulations. As for facilities, the book "Schedule of dimensions" shows most of the dimensional rules. Other information, have been got through the meetings with BR personnel.

i. Formation width: Single track 20ft.(6m), Double track 34ft. (10.2m)

ii. Alignment: Curvature: a) horizontal 10 degree (R = 573ft. =172m)
Gradient: 1/100 (There is a description up to 1/50 in the Schedule book)

iii. Construction clearance (gauge)
a) horizontal; 14ft.(4.2m)
b) vertical; 17' 9'' (5.4m, in case of electrified)

(2) Present status of the alignment in the corridor

BR has so-called "Pocket book", which shows every adopted alignment of the sections. Some of the sections were checked on those books. The results are as shown in Table 6.3.1.

Table 6.3.1 Max. gradient and Min. curvature set on the selected sections

Section	Gradient	Curvature
Khulna – Jessore	Max. 1/1000	Min. 955'(286m) one, others more than2700'(810m)
Jessore – Darsana	Max.1/400, others more than 1/500	Min.1910'(573m) at several points.
Darsana – Ishurdi	Max. 1/200, others more than 1/400	Min. 955'(286m)
Ishurdi – Sirajganj	Max. 1/200, others more than 1/300	Min. 1146' (344m), there is one at Sirajganj

These sections have very good alignments, both horizontally and vertically. This is very desirable both for freight trains and passenger trains. Only two curves of R = 286m exist. However, as for freight trains the curvature influences hardly from the viewpoint of traction power.

Generally speaking, the alignment in Khulna – Jessore section is basically straight like and mostly flat. It is a rare occurrence that the curvatures are set continuously. Each curvature is independent and the straight part is long enough to recover the speed if there is a curve of speed limitation.

(3) Length of a train

In the BR's BG regulations, the passing line or siding line length is determined from the section's ruling gradient. Therefore, in a case of the ruling gradient is 1/500 to 1/300, the length is 2000 ft (600m), and in 1/300 to 1/100, it is 1800 ft. In Khulna – Jessore section 1800ft. (540m) is applied. This length is for 60 wagons + loco/locos length. Here, a wagon length is 28 ft.(8.4m). Then the wagons' length without a loco/locos is 504m (8.4m x 60).

The Nawapara station that is in the midst of Khulna – Jessore section has two loop (or passing) lines having more than 1,880ft.(564m) length. As this example shows, major stations have passing lines more than 500m mean that the freight trains of 500m can run on the corridor. Its loading capacity will be approx. 24tons • 60 = 1,440 tons/ train.

(4) Ability of the Locomotive

BR has 272 locomotives, with 68 in BG sections. In these locomotives, the type so-called

"BEB" is mainly for the freight locomotive. The specifications of the BEB are as follows:

BEB; Broad gauge, Electric, Bonvardier
Weight; 105 tons. Length; 58ft. (17.4m).
Power; 2,400 HP.
Max. speed; 60 mph (96 km/h).
This BEB has enough power for the present freight trains for a total of approx. 2000 tons or so (including tare weights).

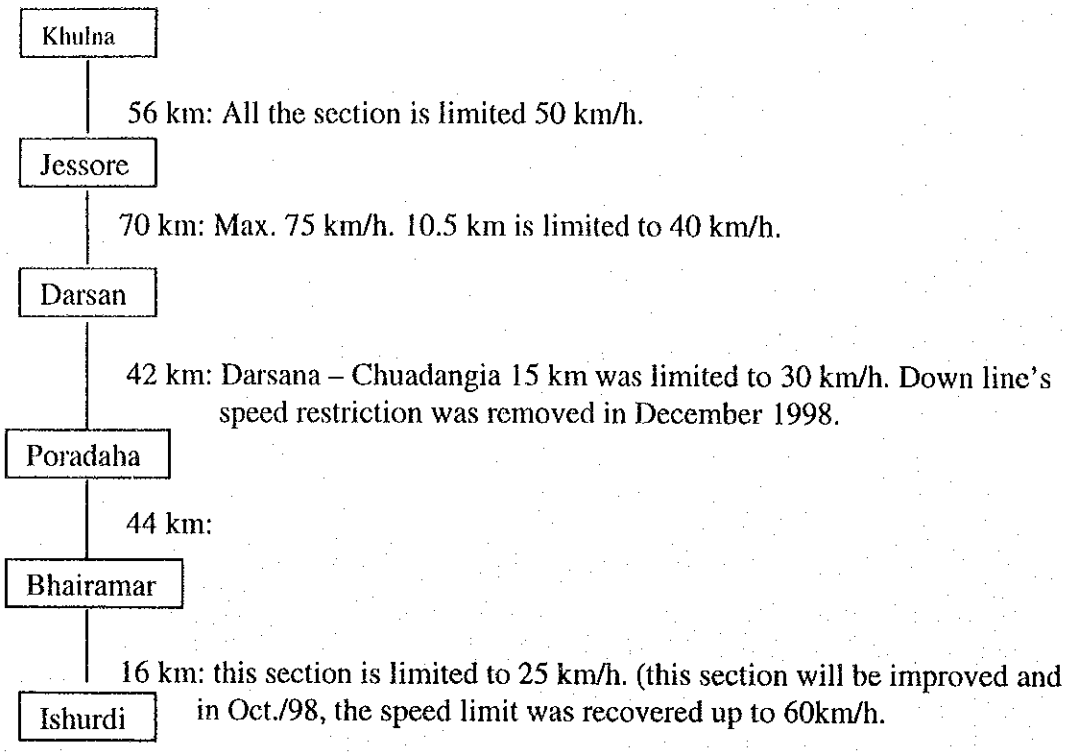
(5) Track

i. Kinds of rails and sleepers

In BG sections, at present three kinds of rails – 90 A, 90 R and 90 BS - are used. These are all 45 kg/m rail but of different shapes. However, there is not much difference in the strength. All the BG sections use these 45 kg/m rail. As for sleepers, there are two kinds, wood sleeper and steel sleeper. Combinations of both kinds are used in most sections of BG. The state of sleepers in use is not so good. Some of them are broken and not enough to support the train weight.

ii. Present state of the track

At present, train speed is limited due to inadequate state of track i.e. lack of ballast and sleepers. Besides the sections mentioned below, in most of the BG sections, **the shortage of ballast and sleepers in the track is totally clear in one sight.** The first thing to do in any renovation program is to fill ballast in the track.



Besides the track issue, the Hardinge Bridge is also in the speed limitation section. One of its girders was damaged by air-raids and train speed is now restricted to 25 km/h.

Now, in the West zone, a project titled "Rehabilitation of main line section of Bangladesh railway (West zone)" is in progress. Above speed limitations will be improved following this rehabilitation program. The salient features of the project are as follows:

Project budget; Total Tk.3.48 billion

Objective; After completion, the sectional speed will be increased (BG; to 90km/h, MG; to 70km/h)

Scope of work; Total 440.75km (BG; 342.5km, MG; 98.25km)

Detail; BG section; Khulna – Ishurdi 199km, Pordaha – Goalanda 87km, Parbatipur – Saidpur 15.5km, Rajshahi – Abdulpur 41km

MG section; Santahar – Bonarpara 82.5km, Kaonia – Lalmanirhat 15.75km

Progress of work; Track renewal 37km (with new steel sleeper) has been completed in Jessore – Ishurdi 150km in 97/98 fiscal year. Track renewal 10km (with new wooden sleeper and new 90A rail) will be done in 98/98 fiscal year.

Completion; In 99/2000 fiscal year. It may be delayed due to insufficient fund.

(6) Freight cars

Freight cars in BG section have no air brake systems. A freight train must stop only by the brakes of the locomotive. Then the speed of a freight train is limited to 15 mph (24 km/h).

Coupling system between freight cars is the chain and the damper type.
Design axle load of a freight car is 22.5 tons. (Tare weight is 10.4 tons)
No container is available in the BG section.

In the above items, only the axle load is acceptable. Other two items shall have to be changed as soon as possible. Apart from the Rupsa Bridge issue, if BR wants to survive in the competitive transportation world of freight, both air brake and automatic coupling system are essential. In this sense, there may be a way to introduce the containerization into the western zone too, in order to replace the freight cars in use. However, the containerization has difficulty to implement as discussed in a later section. Anyway, the modernization of the freight cars is indispensable.

(7) Present loading & unloading system, facility and equipment

- The loading/unloading: In the BG sections, this work depends on manpower. And there is no scene of the mechanical loading and unloading. In near future, the labor cost will rise and clients of freight will ask for quicker delivery and 24 hours delivery. In such case, the manpowered loading/unloading will be out of date and cannot remain in the competitive world.

- Loading/unloading lines: They are not so long enough in length, therefore, in order to make a train composition, more shunting operations are necessary. It causes a train's staying time in a freight station longer and ineffectiveness to go up. As for the more effective loading/unloading, longer loading/unloading lines are necessary and also, for shortening the time of loading/unloading, platforms with same elevation as that of freight cars floor are necessary beside the loading/unloading line. This high floor platform is usually equipped with the roof. Especially in Bangladesh, the roof is essential to protect goods. On this high floor platform, the freight is not set for long time as in warehouses. It is only for the temporary placing waiting for the another loading/unloading to trucks or barge in a day or so.

- Warehouse: Some warehouses are not so suitable to the freight system. Some of them are far from the loading/unloading lines or not parallel to the lines. And workers must

transport longer or between the different grades.

- Access road to the freight station: In Khulna, Nawapara, and Daulatpur stations, access roads to the freight station are in poor condition. The entrance from the road to the station, is always congested by general traffics including rickshaws. And the access road is narrow and unpaved or poorly paved. These two reasons increase the ineffectiveness of railway station space.

(8) Scheduled and open train diagram and room for new trains

There is no scheduled diagram of the freight trains in Khulna – Jessore section. To sell a scheduled diagram of freight trains, is one of the important services to the client. Even if there is no constant freight demand, only the freight train diagram shall be ready and set always. The accurate announcement of the arrival time is essential in the competitive world.

In the diagram of Khulna – Darsana section, there seems to be a room for new trains. The room for new trains depends on the track condition, affordability of locomotives, rolling stocks, etc.. However, if the conditions mentioned above are all satisfactory, the last obstacle is the diagram. At present, in the western north-south rail corridor, **the diagram is not a critical state for new train settings.**

(9) Containerization

Containerization is a worldwide tendency of freight transportation. Its merits are,

① door to door service,
② easy handling
③ quick and accurate at departure and at arrival,
④ safety of freight, etc.

BR has applied the containerization in the eastern zone, and it is in great success. Both client and BR welcome the system. However, the system needs big investment to containers' origin and destination. And more, if such huge investment is possible, but the container itself doesn't come, then such huge investment will come in vain. In that meaning, as for the containerization, a fully planned, fully examined and fully prepared plan will be necessary. This system is only available when the original side (normally port) and the arrival side (normally big consuming area) must be equipped with container base (so-called container depot or dry port). If there is an idea that the container train should run on the western north-south corridor by rail from Mongla port, an arrival side container base/bases is a must in the western inland area. And this might be a good chance to renew the freight system by rail in

the western zone, including the introduction of the airbrake and automatic coupling to the freight cars.

Several items that need improvement are discussed in this section. These items are not deadly critical for the freight in the western north-south transportation by rail. However, the present state of freight transportation by rail is not satisfactory, it would be a surprise that in such a difficult condition the railway freight transportation is performed. Therefore these items will need further specific studies in the next stage. Once again, these items are summarized below.

① Traction power of the locomotive
② Equipments for new freight cars or an improvement of the existing freight cars
③ Better layout, facilities, equipment, loading machines, etc. of freight stations
④ Introduction of containerization to the western north-south corridor
⑤ Immediate implementation of track improvement
⑥ To promote a policy of "To sell the diagram of freight trains"

These are the items covering both hard ware and soft ware of freight transportation management by rail.

6. 4 Rail Freight Survey

The present condition of the railway, especially the present state of Khulna – Jessore section shall have to be studied carefully for clear understanding on the implications of Rupsa Bridge. In this sense, the freight and the passengers survey has been carried out. And the results of the survey are shown in this section.

(1) Survey items

All the inward and outward freight are surveyed on the list of,

① Freight volume(Tons),
② Fares,
③ OD {from where (origin) and to where (destination)},
④ The contents of the goods (fertilizer, rice, etc.)
⑤ When (date). The data unit is fundamentally ton/year.
⑥ If possible, the influence area of station by hearing from clients of freight.

(2) The method of the survey

① At first, JICA member visited Khulna station, and had meetings with Khulna station staffs and understood the freight system of BR and the regional railway

transportation in the western zone. And it became clear that the data on above items are available.

② Discussions with Khulna and Nawapara station masters & staffs were held and by their assistance the data were collected.

③ Remaining part of the survey was entrusted to a consultant by showing the examples.

(3) A part of the survey

Tables 6.4.1, and 6.4.2 are the examples of the surveyed results.

Table 6.4.1 Arriving freight; one year by every month, Nawapara station

Month	Origin station	Km	No. wagon	Rate /kg	Commodity	Freight Vol. (tons)	Again barged	Local	Taka
Jul./97	Darsana	110	942	.24/.26	Fertilizer	14,263		14,263	
					St. slab	222	222		
					Gypsum	4,718		4,718	
					Clinker	1832	1,832		
					Total	21,035			5,107,649
Aug.	Darsana	110	765	.24/.26	Cement	8103	6,077	2026	
					Gypsum	3,607.5		3,607.5	
					SSP-dust	3,552	2,664	888	
					St. chips	1,665	1,665		
					St. slab	55.5	55.5		
					Total	17,026			4,061,575
Sept.	-	-	944	-	Cement	16,261.5	1,2196	4,065.5	
					St. slab	1,720.5	1,720.5		
					SSP	2,220	1,665	555	
					Gypsum	499.5		499.5	
					Jute	126		126	5,176,036
					Total	20,835.7			
Oct.	-	-	1012	-	Cement	12,709.5	10,282	2,427.5	
					Gypsum	3,163.5		3,163.5	
					Clinker	1,442.5	1,442.5		
					Feldspar	1,609.5	1,609.5		
					SSP	2,386.5	1,790	593.5	
					Jute	336		336	
					Food	90		90	
					Total	22,042.3			5,324,686
Nov.			1427		Cement	27,028.5	20,271	6,757.5	
					St. slab	1,665	1,665		
					SSP	2,775.0	2,081	694	
					Jute	105.0		105	
					total	3,1573			6,182,970
Dec.			1122		Cement	20,313	15,235	5,078	
					SSP	4,051.5	3,039	1,012.5	
					Feldspar	333	333		
					Jute	147		147	
					Total	23,662			83,548
Jan./98			1625		SSP	9,768	7,326	2,442	
					Gypsum	6,660		6,660	
					Cement	19,647	14,735	4,912	
					Total	36,078			Paid
Feb.			1423		Cement	20,424	15,318	5,106	
					SSP	3,385.5	2,539	846.5	
					Gypsum	3,663		3,663	
					Jute	168		168	
					Rice	2,109	211	1,898	
					Pig Iron	1,665	1,665		
					Total	31,468			Paid

Mar.			1532		Cement	14,485.5	10,864	3,621.5	
					Gypsum	7,659		7,659	
					SSP	4,828.5	3,621	1,207.5	
					Rice	6937.5	694	6,243.5	
					Pig Iron	111	111		
					Total	34,022			Paid
Apr.			1390		Rice	11,322	1,132	10,190	
					Cement	15,817.5	11,863	3,954.5	
					S. b. d.	1,387.5	1,387.5		
					SSP	2,053.5	1,540		
					Gypsum	277.5		277.5	
					Total	3,0858			Paid
May			897		Cement	15,651	11,738	3,913	
					SSP	1,776	1,132	644	
					Rice	2,275.5	227	2,048.5	
					S. b. d.	166.5	166.5		
					St. slab	55.5	55.5		
					Total	19,924			Paid
Jun.			805		Cement	9,823.5	7,368	2,455.5	
					Rice	610.5	61	549.5	
					Gypsum	3,774		3,774	
					SSP	3,663	2,747	916	
					Total	17,871			Paid
Total						306,396	1,82,290.5	124,105.5	

There are several differences between the figures of the total of each month and the figures of the total of each month commodities. These differences are caused by the exchange rate of wagons.

SSP-dust = Single Super Phosphate dust, Again to barge 75 % and Local 25 %

Cement: Again to barge 75 %, Local 25 %

Rice: Again to barge 10 %, Local 90 %

Clinker: 100 % to Chittagong

St. chips = Stone chips: fine aggregate and 100 % to Dhaka

Gypsum: Local

St. slab = Stone slab: For building and 100 % to the barge again

Feldspar: 100 % to the barge again

Pig Iron: 100 % to Chittagong

S. b. d. = Soy bean dust and 100 % Dhaka

Table 6.4.2 Outward freight; One year by every month, Nawapara station

Month	Destination station	Km	No. of wagons	Freight Vol (tons)	Commodity	Total Taka
Jul./97	Nil					
Aug.	Jaipurhat Parbatipur	329 392	148	3,330	Urea	821,682
Sept.	Jaipurhat Parbatipur	329 392	94	2,225	Sleeper	819,277
Oct.	Jaipurhat Parbatipur	329 392	318	7,610	Urea	1,882,507
Nov.	Jaipurhat Parbatipur	329 392	183	4,620	Urea	1,266,486
Dec.	Jaipurhat Parbatipur	329 392	10	225	Urea	62,458
Jan./98	Jaipurhat Parbatipur	329 392	2	47	Urea	16,400
Feb.	Jaipurhat Parbatipur	329 392	44	990	Urea	241,616
Mar.	Rohanpur, Parbatipur	345 392	344	8,108	Urea	1,999,879
Apr.	Rohanpur, Parbatipur	345 392	180	4,062	Urea	1,139,408
May	Rohanpur, Parbatipur	345 392	292	6,570	Urea	2,275,232
Jun.	Rohanpur, Parbatipur	345 392	55	1,270	Urea	439,693
Total			1,670	39,057		10,964,638

Outward freight from Nawapara; 39057/12 = 3255 tons/ month, Average income 10,964,638/39,057 = 280.7 Tk/ton , Outward freight from Nawapara is all from Mongla and shipped to wagons again to the above destinations (i.e., Jaipurhat, Parbatipur and Rohanpur).

The above survey was done in Aug./98 with the cooperation and assistance of Nawapara station.

Similar surveys were carried out at Khulna junction, Daulatpur, Singia and Jessore Stations.

(4) Summary of Freight survey (6 freight stations)

Table 6.4.3 Inward commodities (one year Jul./97 to Jun./98)

Station	Freight Vol (thousand tons)	Commodity	From India (thousand tons)	To barge again (thousand tons)
Khulna	107	Cement, Rice, Jute, Stone, Food, Wheat	103 (96%)	NA
Nawapara	306	Fertilizer, Stone(slab), Stone(chip), Gypsum, Clinker, Single super phosphate dust, Cement, Jute, Feldspar, Rice, Pig iron, Soy bean dust	306 (100%)	182 (59%)
Khulna Jct.	52	Jute, Rice, Wheat	Nil	Nil
Daulatpur	41	Jute, Salt, Sand, Stone, Rice, Wheat,	14(34%)	NA
Singia	17	Clinker, Stone (chip)	17(100%)	NA
Jessore	1			
Inward Total	524		440(84%)	

Table 6.4.4 Outward commodities (Jul./97 to Jun./98)

Station	Total Freight Vol. (thousand tons)	Commodity	Destination(thousand tons)	
			Domestic	Foreign
Khulna	51	Wheat, Urea,	32(63%)*1	19(37%)*2
Nawapara	39	Urea, Sleeper*3	39(100%)*4	0
Khulna Jct.	122	Oil, Food grain,	122(100%)	0
Daulatpur	30	Wheat	29(97%)	1(3%)
Singia	Nil			
Jessore	Nil			
Outward Total	242		222(92%)	20(8%)

*1; Domestic destinations from Khulna station are further than 179 km (Jagoti station). The two exceptions are Darsana (126km, 46tons) and Nillphamari (25km,67tons). Freight volume to these two stations are so small. Therefore, it might be said that most commodities from Khulna station are transported more than 180 km.

*2; Here, Foreign means only Nepal. The commodity is urea. And this 19 thousand tons was transported during only 3 months, i.e., Dec./97, Jan./98, Feb./98. And in Jan./98 12 thousand tons (2/3 of the total volume) were transported.

*3; Sleeper is only one time and the volume was 2.2 thousand tons.

*4; Domestic destinations are only 3 destinations, i.e., Jaipurhat, Parbatipur and Rohanpur.

Table 6.4.5 Freight fluctuation by month

Station	Inward commodity/month (tons)		Outward commodity/month (tons)	
	Min.	Max.	Min.	Max.
Khulna	3312	18777	179	14201
Nawapara	17026	36078	47	8108
Khulna Jct.	293	11255	7035	19187
Daulatpur	193	8600	943	5109

(5) Known facts from the survey

① Inward freight volume exceeds the outward freight. The influence of the bridge might not be so effective. The reason is that **most freight is from India by rail** and that such freight would be influenced less by the bridge.

② Railway freight is under the strong influence of Inland barges. As for the Inward commodities, most of them are barged again to Dhaka, Chittagong. As for the Outward commodities, most of them are from the barge to the Inland area. These facts mean that barge transportation is very effective and indicate the fact that if the pier/wharf handling portion at Mongla port won't increase drastically, the freight from/to Mongla port will be mainly by barge and not by rail.

③ The commodities are very limited to some peculiar items. Especially as for the outward commodities, the items are only four. In these items, **there may be goods that are convertible to container transportation.**

④ There are very high monthly fluctuations in rail freight.

⑤ In the survey at Khulna, the cost of unloading from a barge to a railway wagon was Tk.100/ton (August 1996/97). Then, it can be said that if this transshipment work is abbreviated, the advantage of the railway freight will be **Tk.100/ton to (Tk.200 + *x*)/ton increased**. Here, Tk.100/ton is a case of direct transit freight (ship to freight wagon or vice versa) and (Tk. 200 + *x*)/ton is a case of the freight was once carried in a warehouse and then loaded to the freight wagon (x is the charge of a warehouse). From the above, if the transit expenditure is abbreviated, the advantage of the rail freight will be highly increased. It is said that the charge of Ocean freight ship to barges and that of Ocean freight ship to the pier is almost same at Mongla port. Then if barge transportation between Mongla and Khulna or Nawapara is replaced by the railway transportation, it can save the charge for transshipment at Mongla and Khulna or Nawapara and barge(but needs the railway charge between Mongla and Khulna or Nawapara). The freight charge by rail is from Tk.1.01/ton km (400km range) to Tk.1.56/ton km(180km range). Then, Tk.100/ton ~ Tk.1.56/ton km or Tk.1.01/ton km = 64km to 99 km. This concludes that if one transshipment from/to barge to/from rail wagon is abbreviated, the charge will equal to the 64 to 99 km length of enlarging the railway transportation area. **This length nearly equals to the twice of the length between Mongla and Khulna**. This calculation doesn't include the charge between Mongla and Khulna or Nawapara.

⑥ The conclusion of the above ‡D won't be applied to the inward freight of Nawapara and Khulna. Because the freight to Nawapara is again barged to Chittagong, Dhaka, so on. They won't be converted to the freight to Mongla port by rail, and the freight to Khulna is for the destination and there is no freight for the barge. The conclusion will have a strong persuasion if Mongla port will increase the wharf or pier ability so much and most of the ocean freight ship to the barge will be decreased. That is, **if the ratio between the wharf handling tons and the barge handling tons at Mongla port won't change drastically, the conclusion ‡D may not be applied.**

⑦ If the container system will be brought to Mongla port and if some inland container base is opened in the center of the western zone, the container transportation by rail can change the freight transportation in the western zone.

⑧ **There is a good successful example in BR. BR introduced the freight container by rail between Chittagong and Dhaka. The fare of the rail between the two points is cheaper than the road and it is approx. 2/3, in general.** Then the western north-south corridor will revive strongly. BR is the only transportation that has the bridge to cross the Padma river. Padma Railway bridge and BR's modern freight transportation will be the two strategic sales points of the Western freight zone.

⑨ From Khulna station, in a distance of 179 km (Jagoti) to 249 km (Naliagram), the following stations are located; Kustia (182km), Kumalkhali (197km), Pangsha (216km), Natore (235km), Rajbari (242km), Ishurdi (247km). In only 70 km difference there are 8 freight stations. As for the effectiveness, **some unification shall be considered**. For instance, Kustia, Kumalkhali, Pangsha and Rajbari are on the same line. Kustia is rather near to the trunk-line group, but other 3 stations shall be united to one destination (a freight station). Also, Jagoti and Kustia shall be united to one. Such new combination will increase the efficiency of the freight station. In the combination of the stations, many items such as, the nearest point to clients' gravity center, the best access for the feeder service (easier access from road), the affordability to the future accommodation, etc., shall be considered.

6. 5 Rail Passenger Survey

Along with the rail freight survey, rail passenger survey was carried out. In Khulna – Jessore section, there are 13 passenger stations. The survey method is almost similar to that of the freight survey.

(1) Survey items

① All the passengers from station are classified into what train he/she used (express, mail, or ordinal) and where he/she went (destination). The survey has been done using the result of sold tickets of July/98.

② The comparison between the railway and the bus is done.

(2) Method of Survey

This is similar to that of the freight survey. At first, JICA made an experimental survey at Khulna station. Then the consultant followed the example and made other stations' survey.

(3) A part of the survey and some known facts

The following tables are parts of the survey at Khulna station.

Table 6.5.1 Passengers and earnings at Khulna Station (July/1998)

Serial No.	Name of trains	Passengers	Taka	Tk/Pass.
1.	Simanto Express	7,029	919,645	130.8
2.	Rupsa Express	3,515	349,765	99.5
3.	Kapatakhaya Express	3,677	254,288	69.2
4.	Sundorebone Express	1,832	1,69,565	92.6
5.	Mail, Express & Local Train	1,101	27,177	24.68
Total		17,154	17,20,440	100.3

In this survey all the passengers are known their destination one by one.

In July/97, the number of passengers at Khulna were 21,719. Therefore, 17,154/21,719=0.79. This means that railway passengers have decreased approx. 20 % a year in Khulna station's influence area.

Table 6.5.2 Comparison of Rail and Bus (Between Khulna and Jessore; 57 km)

Item	Rail						Bus	Memo.
	1*1	2	3	4	5	6*2		
Fare	120	85	50	35	30	15	15	Taka
Frequency	5 or 6 times a day						Every 30 min.	
Travel time	1 hour				1.5 hour		1 hour	

*1; The number from 1 to 5 means each respective train in the Table 6.5.1. Every express train has different fares by service.

*2; 6=Mail and Local train

Table 6.5.3-a, b, c show the number of passenger numbers traveled during the survey period.

Table 6.5.3-a: Passengers nos. on15/8/1998

Train number	Train name	Passenger number
715 up	Kapatakhaye	182
727 up	Rupsa	233
725 up	Sundorebone	167
747 up	Simanto	241
25 up		111
23 up		97
15 up		102
Total		**1133**

Table 6.5.3-b: Passenger fluctuation in August 1998

Date	15/8	14/8	13/8	12/8	11/8	10/8	9/8	8/8	7/8	6/8	5/8	4/8
Pas.	**1133**	**1397**	**1253**	560	475	541	483	530	495	543	494	463

3/8	2/8	1/8
464	518	535

From 13/8 to 15/8, there were more number of local passengers due to the bus strike.

Table 6.5.3-c: Local trains service between Khulna and Jessore

Station name	Train number & departure time			
	25 up (Mail)	23 up (Mail)	15 up (Mail)	501up (Local)
	03:00	9:30	13:15	15:00
Khulna	○	○	○	○
Khulna Jct.	X	X	○	○
Daulatpur College	X	X	○	○
Daulatpur	○	○	○	○
Siramori (off st.)	X	X	○	○
Phultala	X	X	○	○
Bezerdangh	X	X	○	○
Taltala (off st.)	X	X	○	○
Nawapara	○	○	○	○
Chingutia	X	X	○	○
Singia	X	X	○	○
Rupdia	X	X	○	○
Jessore	○	○	○	○

Note: 501 up train is sometimes canceled because of no arrangement of the locomotive.

○: train; stops and available

X: train; doesn't stop and not available.

Known facts from the above tables

① The passengers have decreased rapidly (at Khulna).

② The service level between the rail and the bus in the section Khulna – Jessore is clear. The bus is far superior in term of frequency.

③ There is no convenient normal train service from Khulna to Jessore. To utilize trains in this section is not easy.

④ It is said that at Rupsa ferry ghat, there are approx. 60 thousand people crossing the river every day.

6. 6 Long Term Estimations of the BTSS and BITSS

Two previous studies namely, BTSS (Bangladesh Transport Sector Study), and BITSS (Bangladesh Integrated Transport System Study) estimated the rail traffic on five corridors of Bangladesh on long term basis as shown in the following tables

Table 6.6.1 Estimated Traffic on five corridors of Bangladesh: 1993

No.	Corridor	Freight (Million tons)				Passenger (Million)			
		Rail	Road	Water	Total	Rail	Road	Water	Total
1	Dhaka - Chittagong	1.1	6.5	2.8	10.4	4.2	7.2	11.8	23.2
2	Dhaka - N. West	0.7	3.8	2.6	7.1	2.0	4.6	4.1	10.7
3	Dhaka - Khulna	-	3.7	2.3	6.0	-	11.9	10.7	22.6
4	Dhaka - Sylhet	0.3	2.6	1.9	4.8	3.9	4.3	4.1	12.3
5	**Khulna - N. West**	**0.3**	**2.1**	**-**	**2.4**	**4.7**	**3.6**	**-**	**8.3**

BTSS, Dec. 1994

Table 6.6.2 Estimated Traffic on five corridors of Bangladesh: 1996

No.	Corridor	Freight (Million tons)				Passenger (Million)			
		Rail	Rail	Water	Total	Rail	Road	Water	Total
1	Dhaka – Chittagong	1.2	6.6	2.8	10.6	7.9	14.9	3.7	26.5
2	Dhaka – N. West	0.7	3.9	2.6	7.2	5.2	5.0	1.9	12.1
3	Dhaka – Khulna	-	3.8	2.3	6.1	-	13.2	12.5	25.7
4	Dhaka – Sylhet	0.2	2.6	2.0	4.8	5.4	4.8	4.0	14.2
5	**Khulna – N. West**	**0.2**	**2.1**	**-**	**2.3**	**5.5**	**4.0**	**-**	**9.5**

BITSS, Jun. 1998 (final report)

Table 6.6.3 Estimated Traffic on five corridors of Bangladesh: 2000

No.	Corridor	Freight				Passenger			
		Rail	Road	Water	Total	Rail	Road	Water	Total
1	Dhaka – Chittagong	1.7	13.2	3.5	18.4	10.0	30.7	25.1	65.8
2	Dhaka – N. West	0.6	15.3	2.2	18.1	2.9	16.0	7.2	26.1
3	Dhaka – Khulna	-	0.4	2.4	2.8	-	10.5	9.9	20.1
4	Dhaka – Sylhet	0.5	4.4	2.5	7.4	3.5	5.7	6.1	15.3
5	**Khulna – N. West**	**0.3**	**8.9**	**-**	**9.2**	**7.9**	**6.6**	**-**	**14.5**

BTSS, Dec. 1994

Table 6.6.4 Estimated Traffic on five corridors of Bangladesh: 2015

No.	Corridor	Freight				Passenger			
		Rail	Road	Water	Total	Rail	Road	Water	Total
1	Dhaka – Chittagong	4.0	29.9	8.3	42.2	52.6	60.7	20.8	134.1
2	Dhaka – N. West	1.6	34.6	5.4	41.6	15.2	31.6	6.2	53.0
3	Dhaka – Khulna	-	1.1	5.6	6.7	-	20.8	20.8	41.6
4	Dhaka – Sylhet	1.4	10.0	5.6	17.0	13.0	11.0	7.5	31.5
5	**Khulna – N. West**	**0.7**	**20.0**	**-**	**20.7**	**16.6**	**13.3**	**-**	**29.9**

BITSS, Jun. 1998 (final report)

Table 6.6.5 Estimated Traffic on five corridors of Bangladesh: 2017

No.	Corridor	Freight				Passenger			
		Rail	Road	Water	Total	Rail	Road	Water	Total
1	Dhaka – Chittagong	4.0	30.0	8.0	42.0	53.0	61.0	20.0	134.0
2	Dhaka – N. West	2.0	35.0	3.0	42.0	15.0	32.0	6.0	53.0
3	Dhaka – Khulna	0.4	1.0	6.0	7.4	0.1	21.0	21.0	42.1
4	Dhaka – Sylhet	1.0	10.0	6.0	17.0	17.0	13.0	8.0	32.0
5	**Khulna – N. West**	**1.0**	**20.0**	**-**	**21.0**	**17.0**	**13.0**	**-**	**30.0**

Estimated on the basis of BTSS & BITSS. (Specially made by BR. Aug. 1998)

These are the fundamental estimates by BTSS or BITSS or the combination of the two studies. These are the transportation volume between regions. Some breakdown in the region shall be necessary. Therefore, data from other sources are obtained and discussed in section 6.10

6. 7 Previous Experience of Rail Cum Road Bridge in Bangladesh

The Jamuna multipurpose bridge is commissioned in August, 1998 as a rail cum road bridge. A brief appraisal is done on certain technical aspects so that these experiences can be used for Rupsa Bridge too.

(1) Selection of number of tracks

The railway section of the Jamuna bridge is constructed with single track. The reason would have been that the rail transportation would remain within in the capacity of single track. As, this is the first track that connects the eastern and the western zones, it is expected that all the rail transportation demands will be concentrated to this point. Eventhough, present Bangladesh population is 120 million and the regional economy is not so large, if the railway link is made and appropriately operated to meet the demands, the railway transportation in future may exceed the capacity of single track. Hence, selection of appropriate number of tracks to meet the future demands is an important point.

(2) Compatibility of total axle load and number of rails

Number of rails on the bridge section is four while it is three on both sides of access sections. The fundamental idea behind this design is that both, the BG and the MG trains can run on the Jamuna bridge. However, the designed axle load on these rails is not enough for the BG freight cars. It should be taken care that the design axle load should match both MG and BG trains. However, it will not be a major problem for Rupsa bridge as it is exclusively under the BG zone.

(3) Provision of suitable railway formation width

The total length of Jamuna bridge is approx. 5km. But, there is no exclusive refuge space for railway staffs and workers, The designers might have though that the free space available between the electrical poles could be used for this purpose. However, it is always better to have the refuge space well outside of the railway construction gauge.

(4) Selection of appropriate train speed

The maximum train speed in the bridge section will be limited to 40 km/h. The track is non-ballast type and the alignment is of superior quality. Moreover, the transportation demand is expected to increase in future. If the train speed is increased further, travel time in the bridge section can be shortened and more trains can be operated in a day.

(5) Timely completion of related railway facilities

The rail tracks on the eastern side of the Jamuna Bridge are yet to be connected, thereby delaying the utilization of its full potential. Effective use of huge investment on such projects mainly depends on timely completion and integrated operation of all components of a multipurpose bridge.

For reference:

In Japan, there is a rail cum road bridge between Honshu and Shikoku that is similar to the Jamuna bridge. It was completed in 1987 and has been used more than 11 years. This bridge is over the Inland Sea called "Setonaikai". The bridge is approx. 10 km over the sea and the structure is two storied. The lower story is for the railway and the upper story is for the road. The designing section for the railway was a double-track for the Shinkansen and a double-track for the conventional railway. The Shinkansen (the bullet train) is 1435mm-gauge track and the conventional railway is 1067mm-gauge track. Therefore, the railway section (the lower deck) has a space for the 2 double tracks (the railway space is for 4 rail tracks). The

Shinkansen project has been indefinitely postponed. Now, the conventional railway uses the lower deck by a double-track.

The conventional railway transports many passengers everyday and it is a great success. It connects two medium scale cities in the distance of 70 km in one hour. Before the bridge's completion, Honshu and Shikoku were separated and the ship service took one hour only from the shore to the shore. And the travel time between the two central cities, their names are Okayama (population 620 thousand) and Takamatsu (330 thousand), took nearly 3 hours, i.e., train (roads) and ferry. But after the Seto-Ohashi (Ohashi is a big bridge in Japanese) completed, the travel time was shortened to only one hour. The facing two shores is connected only in 10 minutes. Therefore, nowadays people of both shores uses the railway as commuting transportation. Trains run in every 15 minutes interval in one direction.

In Shikoku Island, approx. 4 million people are living. On the Honshu side, in the range of 200 km both to east and west from the bridge, approx. 30 million people are living. As for the total population of the connected areas, the Jamuna's case is far larger than the Seto-Ohashi. The economic scale, way of life, financial background, etc., the Jamuna and the Seto-Ohashi are totally different. However, the demand for the rail will be higher, here, the Jamuna.

6.8 Previous BR Study and Implementation of Railway Connection to Mongla Port

In preceding years BR had studied the rail transportation to Mongla Port and Fig. 6.8.1 shows the routes. These routes are almost similar from Rupsa East to Mongla Port. However, their northwestern parts are completely different. The upper route (B) diverts to the east of Khulna City only in order to evade a high clearance bridge at the Rupsa river. On the other hand, the other route (A) goes in the western suburbs of Khulna City.

In the above routes, Rupsa East to Mongla Port is 40 km in length, and 17 km of it has been acquired already and owned by BR now.

From the point of view that Khulna City is the center of North-South Region of Bangladesh, the upper route (B) is not familiar.

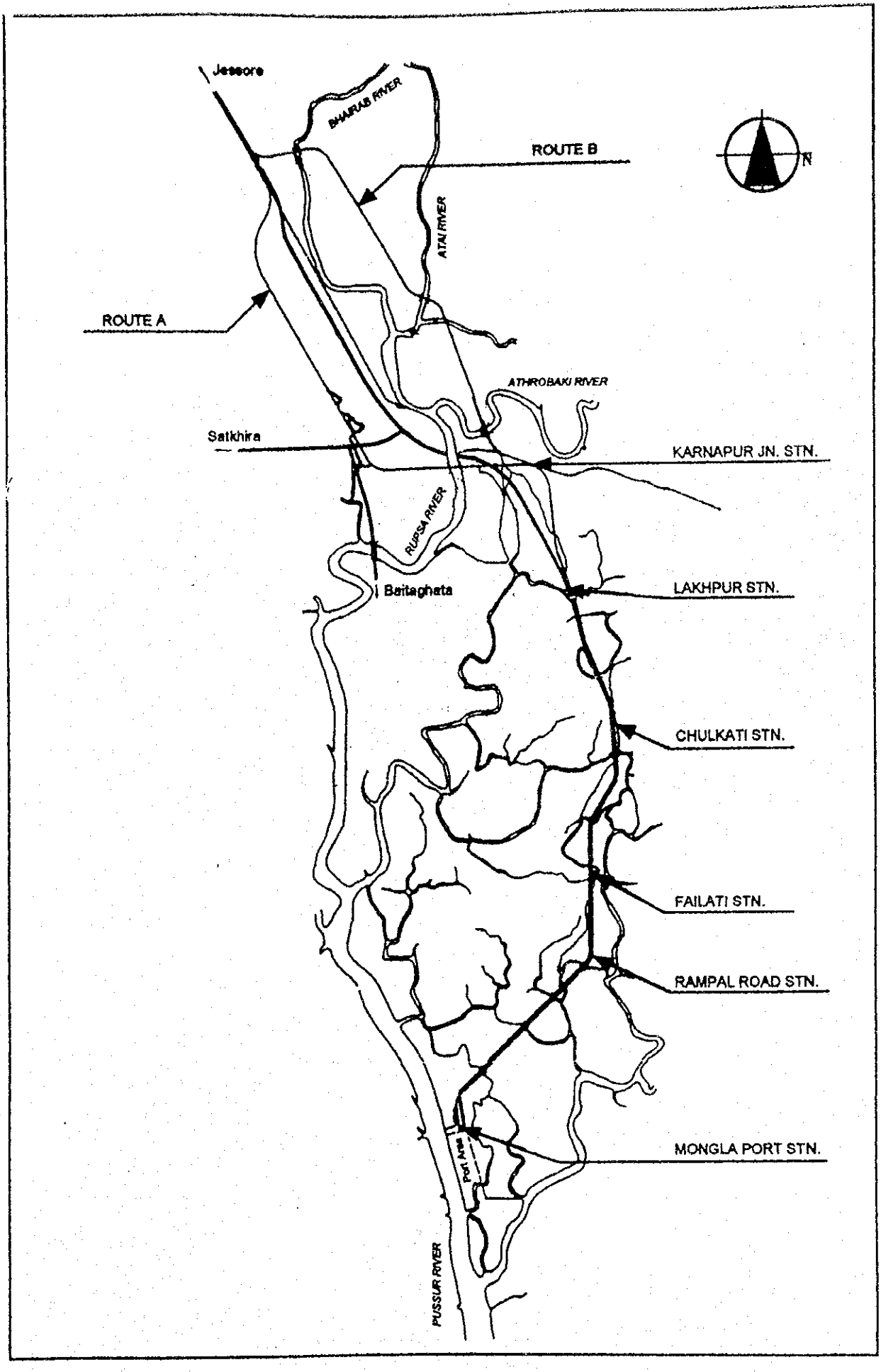


Fig. 6.8.1 Railway Routes to Mongla Port.

6.9 Desirable Conditions for the Bridge Study from the Viewpoint of Railway

If a rail cum road bridge study is done, the railway-side will have many requests for that, and each item will have to be studied in detail. In this section, such items will be discussed.

(1) Gradient

The gradient is one of the most critical conditions that the railway side asks for the Bridge. The Bridge must clear the limitation of clearance for ship transportation {height; 60ft. (18m) above SHWL (Standard High Water Level) and, width; 250ft. (75m)} at the River center. The under face of the bridge floor must clear the height. To the rail track height at the center of the Bridge, (SHWL + the bridge's structural depth + the track structure depth) must be considered. The structural depth of the Bridge varies with the type of bridge. Then roughly 25m or so will be the railway top on the Bridge. This means that if the gradient is 1/100, the approaching length is 2500m and if 1/200, 5000m, respectively. The milder gradient will result in higher cost. In the BG section, the "Schedule of Dimensions" allows the gradient up to 1/50 **The maximum gradient set in the west corridor is 1/200 between Darsana and Ishurdi** in Khulna – Ishurdi – Sirajganj section. This gradient 1/200 is almost the same with that of the Jamuna bridge. At Jamuna, the river width is approx. 5 km.

Therefore, the gradient was not so critical. In the case of Rupsa bridge, the gradient is very important and critical for the approaching section's construction cost. **The length of the passing lines or sidings are more than 1800 ft (840 m) as discussed previously. The corresponding gradient is 1/300 to 1/100.** Then from the rule and the existing examples it may be said that **1/100** would be the limit. One more explanation of 1/100 is the conventional locomotive (BEB) can go over 1/100 gradient pulling approx. 2000 tons. Here, **a steeper gradient will be suggested, if the road part will insist for the steeper gradient and it will have the reasonable answer**. In such case, the traction power will have to be checked. BR's gradient seems to be determined for the traction power of one locomotive. If the gradient will exceed the proportion to the effective length of a train, the traction power need to be added. **Concretely two locomotives or a stronger traction power locomotive shall be used to a train. Or the length of a freight train shall be shortened and the frequency will be increased.** The gradient study with such quantitative background shall be one of the main studies in the next stage.

(2) Axle load

In Jamuna Bridge case, the axle load and the dual track are a little bit in confusion. In the Rupsa bridge, it is far easy. The gauge is BG. Therefore, **axle load is 22.5 tons**. Here, in practice, Indian freight cars are running in the BG sections. This means that actually axle load of 28 tons are running in BG of BR. However, Schedule book admits the axle load 28 tons as only 115 lb (51kg) rail is used. Also, as mentioned earlier, the west zone uses only 90 lb. rail. Therefore, the axle load of 28 tons may be over the rule. And the second reason is that the Indian 28 tons wagons are only used for goods from India to Bangladesh. They are not used for goods from/to Mongla port, from/to domestic destinations or from/to Nepal. Therefore, there will be scarce chance to use the Indian wagons between Mongla and Khulna. The strict discussion shall be done in the next stage. Here, principally 22.5 tons will be enough.

(3) Other structural condition for the railway

The width of the railway section: In the Jamuna case, as discussed in the section 6.7, the section width was narrower than the normal. The track and the railway structure are always inspected, checked and maintained by the staff and workers on site. It is indispensable to have the refuge space for them. The construction gauge (clearance) shall be kept and **the refuge space shall be out of the clearance.** In the Jamuna case, it might be failed. In general, if the Bridge is two storied like Seto-Ohashi in Japan, or Tsing Ma Bridge in Hong Kong, the railway part can easily have its section space. Here, whether the railway will be single track or a double-track will be studied latter. Anyway, the railway section must have an enough width including refuge space, regardless of number of tracks.

(4) Route alignment

In the previous section, the formerly studied routes were shown, as follows:

- Route A; The route that goes around the city Khulna on the west, crosses the Rupsa river on the west of Khulna city, and down to Mongla port.
- Route B; The route that goes along the east of the Rupsa river with no relationship with the city Khulna and down to Mongla port.

And the third route shall be added from the view point of railway construction.

- Route C; The route that goes through the Khulna city and directly connects present Khulna station and Rupsa East station. This route is only 2 km from the Khulna station to the Rupsa bridge and the total length is shorter 16 km or more than other routes.

All these three routes, have both merits and demerits.

These merits and demerits shall be argued from many aspects. However, all the routes shall consider the condition of "Rail cum Road bridge". This is an essential proposition that this study cannot evade. Therefore, if a route is superior to any other routes from the viewpoint of railway alignment, the route must be superior too, from the viewpoint of road alignment, or the total evaluation (which is the sum of the railway-side merits and the road-side merits) shall exceed the merits of other two routes..

Several aspects in this regard are examined as described below.

① The route must have the greatest merit to Mongla port use

In the above evaluation, Rupsa bridge is considered to make the best use of the Mongla port. From this viewpoint, more than half of the freight which has been handled by the Mongla port is to/from Khulna city and its vicinity (Tables 5.2.2 & 5.2.3). This means that any route which does not pass Khulna city has less value than the route which pass Khulna city. In this point view Route B is inferior to the other two routes.

② Construction cost

If this route has another meaning, in the evaluation of the construction cost, management & operation cost, future development possibility, this route must have a superior stand than the other two. As for the evaluation of the road-side, this will be discussed in another chapter, here the railway-side evaluation shall be done. Construction cost of the B-route is 1.4 times of the A-route {from 6.12 (2)}.

③ Contribution to the Mass transportation in Khulna city and its suburbs

Then the point is whether the extension line has a futuristic prospect or not. If the extension to Mongla port is only for the freight, the East Route (Route B) will be allowed. However, BR is both for passengers and freight. Therefore, the extension shall be considered including futuristic passenger transportation. Route B (East route) has a less prospect in the future, the big reason is that it doesn't pass through the Khulna city. The railway network is most effective in large cities. Khulna city is the largest and most populated city in the South West region. It is a worldly well known fact that cities of more than 1 million population seek eagerly to have mass transportation systems, especially rail system as the ultimate means for the countermeasure of traffic congestion and the maintenance of their socio-economic activity. Now, the railway service ends at the center of Khulna city. It is only available to the northwest direction. However, if the route passes through or go by Khulna city, there will be great merits in the commuter service and inter-city service of passenger services by rail in two directions. In 2015, the GDP per capita of Bangladesh will be twice as much of the present GDP per capita, i. e., more than $500. (GDP will increase 2.4 times and the population will increase 1.2 times). This figure goes the same level with the present China and over the present India. In China and India the transportation problem in big cities are arising and mass transportation system has been discussed. The quickest way is to utilize the existing railway network. In this sense, to have an existing railway system or not, will make a tremendous difference in improving the transportation problems in big cities. In this meaning, the route which penetrate the city center is the best, and the route which goes around in the west is the second and the route which goes in the east is the third, from the view point of the mass transportation of Khulna area.

Table 6.9.1 GDP per capita in several Asian countries in 1996

Country	GDP per capita (US $)
Bangladesh	259
China	571
India	362
Indonesia	1147
Japan	36575
Korea	10645
Malaysia	4690
Myanmar	2633
Thailand	3024
Vietnam	270

Over $500 in 2015

The transportation problem will be a main problem of the country. Especially traffic jams in large cities will be much more serious like the present state of Bangkok, Jakarta, or large cities in Asia. The importance of the railway will be increased, both in freight and passenger. The importance of passenger transportation will be greatly increased because of the effectiveness of mass transportation. In this sense the two routes A and C, which goes through or go by the Khulna city, have a more positive prospects.

④ Other view points

Bangladesh is one of the most densely inhabited countries in the world and the cities are the typical examples. The surrounding conditions, such as **densely populated people, restriction of CO_2, lower air pollution, cheaper cost of transportation, smaller space occupation**, these view points clearly show the futuristic directivity for the railway. The more congested state is an alternative route of the extension, the more effective it is. Therefore, the East Route is not so clever choice. More over, if the East Route is chosen, another new Rupsa bridge must be necessary to connect the East Route and the Khulna city.

⑤ Effect on urban development developing along the railway

The only merit of the East Route is to give people living on the East Route the convenience of the railway, if new stations are set. However, at present the population along the route is lower than the other 2 routes.

Above merits and demerits can be summarized as shown in Table 6.9.2

Table 6.9.2 Merit and demerit of 3 routes

Items	Routes			Notes
	West	Center	East	
Connection between Khulna and Mongla	• ›	• ›	X	Most of the goods of Mongla port are from/for Khulna
Construction cost	• ›	• ›	X	East is 1.4 times of the West
Passenger demand	• ›	• ›	X	Passenger Income of BR is increasing.
Contribution to the commuer transportation	• ›	• ›	X	Khulna is the central city in the area.
Developing effect of the rail	X	X	• ›	In the East, there is no railway.
Urban development effects		• ›		The center of Khulna city will be developed by the railway construction.

• › yes or better, X no or worse

6.10 Shared Rail Transportation from the Jetty of the Mongla Port in 2015 and the Position of the Railway between Mongla and Khulna

(1) Total handling tons at the jetty of the Mongla port is estimated to be 2125 thousand tons in 2015. And in those tons, 763 thousand tons **can be transported by rail**, as estimated in the Chapter 7.

Table 6.10.1 Freight Handling of the Mongla port jetty

Freight Handling of the Mongla port (thousand tons)					
	(A)	**Transported by rail**			
Import	1,238	To Dhaka (0.15 X A=B)	To N.W.R. (0.1 X A=C)	To Nepal (0.15 X A=D)	E=B+C+D
		186	124	186	496
Export	887	From Dhaka (0.1 X A=B)	From N.W.R. (0.1 X A=C)	From Nepal (0.1 X A=D)	E=B+C+D
		89	89	89	267
Total	2,125	**275**	**203**	**275**	**763**

N.W.R.= North West Region (Central city is represented by Rajshahi)

(2) The importantce of the Mongla – Khulna in the BR freight sections

The above freight can be carried by the BR network if a railway is constructed to the Mongla port. In this section, the transportation density of main railway sections are studied and a comparison is done between the railway connected to the Mongla port and to the present state. The present state is represented by the 1996/97 freight data, and the case of the railway connected to the Mongla port is calculated adding the following figures to the present figures.

There is a discussion that Mongla-Dhaka freight by rail seems not realistic, comparing the advantage of Chittagong-Dhaka's rail transportation. Therefore, two cases are compared, i.e., Case-A with Mongla-Dhaka rail transportation, and Case-B without Mongla-Dhaka rail transportation.

Table 6.10.2 Freight Transportation Density by Sections (Case-A)

No.	Section	Ton/day (a)	Zone	Gauge	Increase by Mongla (b)	New total (c = a + b)
1	Chittagong-Feni	5248	E	M.G.		
2	Feni-Laksam	5241	E	M.G.		
3	Laksam-Akhaura	5048	E	M.G.		
4	Akhaura-Bhairb Bazar	3781	E	M.G.		
5	Tejgaon-Tongi	3527	E	M.G.	753	4280
6	Dhaka-Tejgaon	3214	E	M.G.	753	3967
7	Dewanganj B.-Bahadurabad	3128	E	M.G.		
8	Bhairab Bazar-Tongi	2681	E	M.G.		
9	Ishurdi-Abdurpur	2499	W	B.G.	1310	3809
10	Darsana-Poradaha	2344	W	B.G.	2090	4434
11	Jessore-Darsana	2209	W	B.G.	2090	4299
12	Bhairamara-Ishurdi	2145	W	B.G.	2090	4235
13	Poradaha-Bhairamara	2145	W	B.G	2090	4235
14	Bonarpara-Kaunia	2084	W	M.G.		
15	Khulna-Jessore	1907	W	B.G.	2090	3997
16	Abdulpur-Rajshahi	1595	W	B.G.	1121	2716
17	Rajshahi-Amnura	1563	W	B.G.	556	2119
18	Ishurdi-Sirajganjghat	1560	W	B.G.	753	2313
19	Akaura-Shaistaganj	1485	E	M.G.		
20	Parbatipur-Kanchan	1457	W	M.G.	188	1645
21	Gouripur M.-Mymensingh	1348	E	M.G.		
22	Shaistaganj-Kulaura	1174	E	M.G.		
23	Bhairab Bazar-Gouripur M.	1146	E	M.G.		
24	Tistamukhghat-Bonarpara	1136	W	M.G.		
25	Abdupur-Santahar	997	W	B.G.	188	1185
26	Narayanganj-Dhaka	952	E	M.G.		
27	Kaunia-Parbatipur	924	W	M.G.		
28	Kanchan-Biral	877	W	M.G.	188	1065
29	Santahar-Parbatipur	857	W	B.G.	188	1045
30	Kulaura-Sylhet	792	E	M.G.		

Column (a) is from the information book96/97, and figures in column (b) are explained in the next page.

The above table can be rearranged into table 6.10.3 i.e., the figures on the right in boxes represent the respective freight volume listed on the Table 6.10.1 by daily transportation density. Each respective figure is explained below.

Table 6.10.3 Transportation density of the main sections when the railway service can be available between Khulna and Mongla port. Unit; ton/day (Case-A)

No.	Section	Ton/day	Zone	Gauge
1	Chittagong-Feni	5248	E	M.G.
2	Feni-Laksam	5241	E	M.G.
3	Laksam-Akhaura	5048	E	M.G.
4	**Darsana-Poradaha**	**4434**	**W**	**B.G.**
5	**Jessore-Darsana**	**4299**	**W**	**B.G.**
6	**Tejgaon-Tongi**	**4280**	**E**	**M.G.**
7	**Bhairamara-Ishurdi**	**4235**	**W**	**B.G.**
8	**Poradaha-Bhairamara**	**4235**	**W**	**B.G.**
9	**Khulna-Jessore**	**3997**	**W**	**B.G.**
10	**Dhaka-Tejgaon**	**3967**	**E**	**M.G.**
11	**Ishurdi-Abdurpur**	**3809**	**W**	**B.G.**
12	*Akhaura-Bhairb Bazar*	*3781*	*E*	*M.G.*
13	*Dewanganj B.-Bahadurabad*	*3128*	*E*	*M.G.*
14	**Abdulpur-Rajshahi**	**2716**	**W**	**B.G.**
15	*Bhairab Bazar-Tongi*	*2681*	*E*	*M.G.*
16	**Ishurdi-Sirajganjghat**	**2313**	**W**	**B.G.**
17	**Rajshahi-Amnura**	**2119**	**W**	**B.G.**
18	**Mongla-Khulna**	**2090**	**W**	**B.G**
19	*Bonarpara-Kaunia*	*2084*	*W*	*M.G.*
20	**Parbatipur-Kanchan**	**1645**	**W**	**M.G.**
21	*Akaura-Shaistaganj*	*1485*	*E*	*M.G.*
22	*Gouripur M.-Mymensingh*	*1348*	*E*	*M.G.*
23	**Abdulpur-Santahar**	**1185**	**W**	**B.G.**
24	*Shaistaganj-Kulaura*	*1174*	*E*	*M.G.*
25	*Bhairab Bazar-Gouripur M.*	*1146*	*E*	*M.G.*
26	*Tistamukhghat-Bonarpara*	*1136*	*W*	*M.G.*
27	**Kanchan-Biral**	**1065**	**W**	**M.G.**
28	**Santahar-Parbatipur**	**1045**	**W**	**B.G.**
29	*Narayanganj-Dhaka*	*952*	*E*	*M.G.*
30	*Kaunia-Parbatipur*	*924*	*W*	*M.G.*
31	*Kulaura-Sylhet*	*792*	*E*	*M.G.*

In the above table, **the bold sections increase their transportation density by railway extension to the Mongla port.** *The italic sections have no influence from the Mongla port.*

① Sections Tejgaon-Tongi and Dhaka-Tejgaon increase their transportation density via the Jamuna Bridge. 753 tons/day is derived from $275 \times 10^{3} \sim 365 = 753$ tons/day. Mongla-Khulna-Jessore-Darsana-Poradaha-Dhairamara-Ishurdi-Siranganj-Jamuna-Tangail-Joydebpur-Tongi-Tejgaon-Dhaka sections are added in this volume.

The transportation between Nepal and Mongla has two routes, i.e., via Rohanpur and Biral. The railway charge is approx. Tk. 314/ton and the transportation distance assumed from the

charge is approx. 250 to 300 km. The real distance of Rohanpur from Khulna is approx. 326 km and that of Birol from Khulna is approx. 428 km. The charge seems to have applied the case via Rohanpur. On the other hand, the actual transportation ratio of the two routes in 1997/98 is as follows:

6.10.4 Transportation volume of the two railway routes to/from

Nepal (1997/1998) unit: ton

	From Khulna to Nepal	From Nepal to Bangladesh	Total
Via Rohanpur	**15,152 (76%)**	7,881 (31%)	23,033
Via Birol	**4,800 (24%)**	17,671 (69%)	22,471
Total	**19,952 (100%)**	25,552 (100%)	45,504

In the above table, the cargo from Nepal is to entire Bangladesh and not particularly to Khulna. Then, as for the ratio of the two routes between the Mongla port and Nepal, **the ratio of "From Khulna to Nepal is used, namely, Via Rohanpur is 3/4 and Via Birol 1/4.** Then, Nepal- Mongla cargo via Biral is 275 x10^3~365 x 1/4 = 188 tons/day, and that via Rohanpur is 275 x10^3~365 x 3/4 = 565 tons/day.

③ 1310 tons/day is derived from the freight between the Mongla port and North West region and Nepal. (275 + 203) x 10^3~365 = 1310 tons/day. This volume shall be added to the section Ishurdi-Abdulpur.

④ 2090 tons/day is the volume between Mongla to Ishurdi. All the railway freight between the three regions (Dhaka, N.W.R. and Nepal) and Mongla goes through the sections between Mongla and Ishurdi. 763 x 10^3~365 = 2090 tons/day.

⑤ 1121 tons/day is derived as follows:
The central city in the N.W. Region is assumed as Rajshahi. The freight between Mongla and N.W. Region is 203 x 10^3 tons. 3/4 of the freight between Mongla port and Nepal goes through via Rohanpur. Then, (203 +275 x 3/4) x 10^3~365 = 1121 tons/day.

⑥ 556 tons/day is derived from 275 x 10^3~365 x 3/4 = 556 tons/day. This freight is applied to the Rajshahi-Amnura section.

⑦ 188 tons/day is applied to the sections, Abdupur-Santahar-Parbatipur-Kanchan-Birol. This route shares 1/4 of the freight between Nepal and Mongla port.

Freight without Mongla-Dhaka rail transportation is calculated as follows:

Table 6.10.5 (Case-B)

No.	Section	(a) Ton/day	Zone	Gauge	Increase by Mongla (b)	New total (c = a + b)
1	Chittagong-Feni	5248	E	M.G.		
2	Feni-Laksam	5241	E	M.G.		
3	Laksam-Akhaura	5048	E	M.G.		
4	Akhaura-Bhairb Bazar	3781	E	M.G.		
5	Tejgaon-Tongi	3527	E	M.G.		
6	Dhaka-Tejgaon	3214	E	M.G.		
7	Dewanganj B.-Bahadurabad	3128	E	M.G.		
8	Bhairab Bazar-Tongi	2681	E	M.G.		
9	Ishurdi-Abdurpur	2499	W	B.G.	1310	3809
10	Darsana-Poradaha	2344	W	B.G.	1310	3654
11	Jessore-Darsana	2209	W	B.G.	1310	3519
12	Bhairamara-Ishurdi	2145	W	B.G.	1310	3455
13	Poradaha-Bhairamara	2145	W	B.G	1310	3455
14	Bonarpara-Kaunia	2084	W	M.G.		
15	Khulna-Jessore	1907	W	B.G.	1310	3217
16	Abdulpur-Rajshahi	1595	W	B.G.	1121	2716
17	Rajshahi-Amnura	1563	W	B.G.	556	2119
18	Ishurdi-Sirajganjghat	1560	W	B.G.		
19	Akaura-Shaistaganj	1485	E	M.G.		
20	Parbatipur-Kanchan	1457	W	M.G.	188	1645
21	Gouripur M.-Mymensingh	1348	E	M.G.		
22	Shaistaganj-Kulaura	1174	E	M.G.		
23	Bhairab Bazar-Gouripur M.	1146	E	M.G.		
24	Tistamukhghat-Bonarpara	1136	W	M.G.		
25	Abdupur-Santahar	997	W	B.G.	188	1185
26	Narayanganj-Dhaka	952	E	M.G.		
27	Kaunia-Parbatipur	924	W	M.G.		
28	Kanchan-Biral	877	W	M.G.	188	1065
29	Santahar-Parbatipur	857	W	B.G.	188	1045
30	Kulaura-Sylhet	792	E	M.G.		

The above table can be rearranged Table 6.10.6, respectively.

Table 6.10.6 Transportation density of the main sections when the railway service can be available between Khulna and Mongla port. Unit; ton/day (Case-B)

No.	Section	Ton/day	Zone	Gauge
1	*Chittagong-Feni*	*5248*	*E*	*M.G.*
2	*Feni-Laksam*	*5241*	*E*	*M.G.*
3	*Laksam-Akhaura*	*5048*	*E*	*M.G.*
4	**Ishurdi-Abdurpur**	**3809**	**W**	**B.G.**
5	*Akhaura-Bhairab Bazar*	*3781*	*E*	*M.G.*
6	**Darsana-Poradaha**	**3654**	**W**	**B.G.**
7	*Tejgaon-Tongi*	*3527*	*E*	*M.G.*
8	**Jessore-Darsana**	**3519**	**W**	**B.G.**
9	**Bhairamara-Ishurdi**	**3455**	**W**	**B.G.**
10	**Poradaha-Bhairamara**	**3455**	**W**	**B.G.**
11	**Khulna-Jessore**	**3217**	**W**	**B.G.**
12	*Dhaka-Tejgaon*	*3214*	*E*	*M.G.*
13	*Dewanganj B.-Bahadurabad*	*3128*	*E*	*M.G.*
14	**Abdulpur-Rajshahi**	**2716**	**W**	**B.G.**
15	*Bhairab Bazar-Tongi*	*2681*	*E*	*M.G.*
16	**Rajshahi-Amnura**	**2119**	**W**	**B.G.**
17	*Bonarpara-Kaunia*	*2084*	*E*	*M.G.*
18	**Parbatipur-Kanchan**	**1645**	**W**	**M.G.**
19	*Ishurdi-Sirajganjghat*	*1560*	*W*	*B.G.*
20	*Akaura-Shaistaganj*	*1485*	*E*	*M.G.*
21	*Gouripur M.-Mymensingh*	*1348*	*E*	*M.G.*
22	**Mongla-Khulna**	**1310**	**W**	**B.G.**
23	**Abdulpur-Santahar**	**1185**	**W**	**B.G.**
24	*Shaistaganj-Kulaura*	*1174*	*E*	*M.G.*
25	*Bhairab Bazar-Gouripur M.*	*1146*	*E*	*M.G.*
26	*Tistamukhghat-Bonarpara*	*1136*	*W*	*M.G.*
27	**Kanchan-Biral**	**1065**	**W**	**M.G.**
28	**Santahar-Parbatipur**	**1045**	**W**	**B.G.**
29	*Narayanganj-Dhaka*	*952*	*E*	*M.G.*
30	*Kaunia-Parbatipur*	*924*	*W*	*M.G.*
31	*Kulaura-Sylhet*	*792*	*E*	*M.G.*

When the freight between Mongla port and Dhaka i.e., 275 thousand tons/year, is removed, the western rail transportation will loose its importance.

From the above tables, it is clear that if the railway is connected to the Mongla port, **there is a clear bottom up to the main western railway network.** However, tThe above tables only refer to the influence of the Mongla port. Summing up the data of 1996/97 and 2015 is a little bit too bold. Therefore only the order of the figures have been compared.

6.11 Income Increase by the Extension of Railway to Mongla Port

The estimated increase in freight due to the extension of the railway to Mongla port is shown in Table 6.10.1. The freight transportation by rail in respective railway lines is also shown in Tables 6.10.3 and 6.10.6.

A rough calculation of the income shall be done based on the following assumptions.

① Distances between Mongla port and respective region are assumed as the distance between Mongla and its central city. That is, Dhaka region is Dhaka, N.W. region is Rajshahi and Nepal is to the border.

② The distance between Khulna and Mongla is assumed as 31 miles (• à50 km).

③ The distance Tangail (Ibrahimabad)– Joydebpur is assumed to be 70km.

(1) Distance between Mongla port and each region

○ Mongla – Dhaka

Mongla – Khulna 50 km,
Khulna – Ishurdi – Jointola - (Sirajganj) 287 km (Jointola-Monsorabard is not clear, so Ishurdi-Monsorabard is supposed as the same length with Ishurdi-Sirajganj.)
Jamuna Bridge
Tangail(Ibrahimabad) – Joydebpur 70 km,
Joydebpur – Dhaka 40 km,
Total 447• à 450 km

○ N.W. Region (Rajshahi)

Mongla – Khulna 50 km,
Khulna – Rajshahi 263 km
Total 313 km

○ To Nepal

To Nepal, the transportation distance is to the border.
Mongla – Khulna 50 km,
Khulna – Abdulpur – Parbatipur – Birol 428 km (1/4 of the total freight) or
Khulna – Abdulpur – Rohanpur 326 km (3/4 of the total freight)

Then the average km to the border;
50 + 428 • 1/4 + 326• 3/4 = 401.5 km • à 400 km

(2) Present Freight charges (1997/98 charge; from site investigation)

Table 6.11.1 Typical freight charges

Origin	Destination	Charged distance (km)	Rate (Tk./kg)	Commodity
Khulna	Rajshahi	310	0.35	Wheat
	Santahar	326	0.38	Wheat
	Hili	380	0.41	Wheat
	Birampur	394	0.41	Wheat
	Phulbari	405	0.41	Wheat
	Parbatipur	423	0.43	Urea
	Saidpur	437	0.43	Wheat
	Chilatti	497	0.47	Wheat
Panchagarh	Khulna	555	0.56	Stone

From the above table, the charged distance is a little longer than the actual rail distance, as detailed in Table 6.11.2

Table 6.11.2 Difference between the charged km and the actual rail km

Section	Rail distance (km)	Charged distance (km)	Difference (km)
Khulna-Rajshahi	263	310	47
Khulna-Santahar	283	326	43
Khulna-Parbatipur	379	423	44
Khulna-Chilatti	447	497	50
Khulna-Panchagarh	512	555	43
Khulna- Nepal Border	400	300	-100
Khulna-Darsana	126	126	0
Khulna-Kustia	182	182	0

There is a clear difference between the upper table and the lower table, except the case to Nepal. The upper table destinations cross Padma river (Hardinge Railway Bridge). This crossing charge deserves approx. 50 km.

Following this charging system, the newly constructed route Mongla-Khulna has a long bridge of Rupsa, then approx. 50 km charge shall be added only for the passing.

And the Jamuna Bridge shall be the other charging, 50 km respectively for Dhaka.

Table 6.11.3 Assumption of new freight charges (mainly Mongla – Khulna)

Section	Mongla-Khulna (km)	Rupsa Bridge (km)	Present Charged Distance (km)	Other Elements (km)	Assumed Total Distance (km)	Supposed Rate (Tk./ton)
Mongla-Dhaka	50	50	*11 287+40	*12 50 + 70	550	560
Mongla-Rajshahi	50	50	310		410	430
Mongla-Border	50	50	300*13		400	430

*11 287+40 is not a presently charged distance and figures mean (287;Khulna-Sirajganj and 40; Joydebpur-Dhaka).

*12 50+70 means that 50km is for the Jamuna bridge and 70km is for the distance between Tangail(Ibrahimabaad) and Joydebpur.

*13 This 300 km is derived from the fact in 1997/98. The income of 19,093 tons from Khulna to Nepal was Tk.5,991,054, namely, Tk.314/ton. This corresponds to the charge of approx. 300 km.

(3) Income freight by the extension of the railway to Mongla

From the above tables, the expected income by opening the extension line to Mongla shall be calculated as follows:

Table 6.11.4 Income by the extension of the railway to Mongla (Case-A)

Transportation	Charge rate Tk./ton	Freight (1000 tons)	Income (Million Taka)
Mongla-Dhaka	560	275	154
Mongla-N.W.R.	430	203	87
Mongla-Border	430	275	118
Total			**359**

Table 6.11.5 Income by the extension of the railway to Mongla (Case-B)

Transportation	Charge rate Tk./ton	Freight (1000 tons)	Income (Million Taka)
Mongla-N.W.R.	430	203	87
Mongla-Border	430	275	118
Total			**205**

Above are very rough estimations. The applied freight rate is based on the cereal, such as rice or wheat. And the goods from/to Mongla port by rail are supposed to be converted to the container transportation. Then, the affordable cost might be higher. In that case (containerized),the estimated income can be multiplied by 1.2 to 1.5.

The total income of the BR from freight transportation was Tk.1.04 billion in 1996/97. The above figure Tk. 0.3 billion ($7.5 million) corresponds nearly 35% of the freight income in1996/97, and Tk. 0.205 billion ($4.3 million), 20%, respectively. The total income of the BR was Tk.3.31 billion in 1996/97 year. Therefore, the extension to Mongla port will push up total transportation income approx.10.9% or 6.2%.

6.12 Costs for the Railway Extension to Mongla

The railway extension to Mongla port comprises the construction cost, cost of the rolling stock and the transportation cost (operation and maintenance).

These costs are discussed in this section.

(1) Rolling stock cost

The rolling stock, locomotives and wagons, shall be calculated according to the following assumption.

- The ability of the traction in the B.G. section is 1440 tons/train. (It is decided from the available length of the siding or passing tracks.)
- Load capacity 24 tons/wagon, tare weight 10.4 tons/wagon.
- A = (1 – E)X(G + T.S) +E.X.G,

N = (1 – E)X(T.S)

Here, A; Traction power and it is**1440 tons**.

N; Transportation volume of a train
Yearly transportation is 763 thousand tons/year (Case-A) or 478 thousand tons/ year (Case-B), i.e., 2090 tons/day (divided by 365 days) or 1290 tons/day. But, it is too severe for the average transportation planning to use 365 days. And in the process, 300 transportation days a year is common including contingency. Then 763,000/300 = **2,540tons/day** or 478,000/300 = **1,590 tons/day** is used.

E; Ratio of vacant wagons; it is supposed 30 %.

X; Total nos. of a train; it is supposed 60 wagons.

G; Tare weight; it is 10.4 tons.

T; Load capacity of a wagon; it is 24 tons.

S; Effective loading ratio of a wagon; it is assumed 85 %.

A = (1 - 0.3) x 60x(10.4 + 24x0.85) + 0.3x60x10.4 = 1480.8 · à 1440.

N = (1 – 0.3)x60x(24x0.85) = **856.8 tons/train**

Trains needed are, 2540/856.8 = **2.65** trains/ day (both directions) or 1590/856.8 = **1.86** trains/a day.

@ Wagons needed; 2.65(both directions) x 60 x 6 (1cycle 6 days) = 954.

Reserve ratio is 5%. Then 954x1.05 = 1001.7 · à **1000**
Or, (1.86x60 · 6 = 669.6)x1.05 = 703 · à **700.**
The respective figures in the B.G sections of BR are shown in Table 6.12.1.

In the following table, one cycle is 9.25 days for a wagon. And under or awaiting repair wagons are 17.9%, at 1996/97 year. In the above calculation, **one cycle in six days and reserve ratio of 5 % are used.** In the past 10 years, BR B.G. sections achieved 8.5 days/ cycle and 6.1% (in 1969/70 year). 6 days are shorter than 8.5 days, but the new transportation to/from Mongla port is a totally new and a modernized freight system and new wagons will be introduced. Therefore, 6 days and 5% are not so high figures.

Table 6.12.1 A wagon's efficiency in B.G of BR in recent years

	Present (1996/97)	Best year	Worst year
Average turn around of a wagon	9.25 days	8.5 days (69/70)	31 days (87/88)
Wagons under or awaiting repairs	17.9%	6.1% (69/70)	24.7% (89/90)

(From Information Book1997)

A Locomotives needed;

Table 6.12.2 Ton.km of the freight from/to Mongla port

	Mongla-Dhaka	Mongla-N.W.	Mongla-Nepal Border	Total (Case-A)	Total (Case-B)
Distance (km)	450	360	400		
Freight (thousand tons)	275	203	275	753	478
Million Ton. km	124	73.1	110	307	183

Locomotives:

- Case-A; 307 x10^{6}~856.8~300~181 = 6.6 engines (locomotives or trains).
- Case-B; 183 x10^{6}~856.8~300~181 = 3.9 engines.

Here, 181 is engine-km/day/engine on line (of freight trains) in the BR 1996/97 figure. Percentage of average number of engine under or awaiting repairs daily to average total

number on line is19.1% (· à 20%), it is also in the BR 1996/97 figure. Then locomotives needed is 6.6 x 1.2 = 7.9 locomotives or 3.9 x 1.2 = 4.8, respectively. This number **8 (or 5)** includes the locomotives for reserve and those for inspection and repair. The figure 181km/day is a little bit lower figure than usual. There may be an opinion that the freight locomotive engine-km is 116 km/day. 181km/day is an overestimation. However, MG sections' average freight engine.km in 1996/97 is 173 km/day, and the B.G. sections' best freight engine.km is 175 km/day. Therefore, 181km/day is not difficult to be achieved. Therefore, **the needed locomotives, 8 (or 5) will be enough**. Here, the more strict calculation shall be necessary to make a precise planning, based on new train diagrams. In such case, the necessary number 8 will be decreased.

Table 6.12.3 Locomotive efficiency in B.G of BR in recent years

	Present (1996/97)	Best year	Worst year
Engine.km/day on line	181km/day	210km/day (87/88)	130km/day (69/70)
Engine.km/day in use	261km/day	304km/day (90/91)	230km/day (69/70)
Goods engine.km/day	116km/day	175km/day (88/89)	116km/day (96/97)
Engines under or awaiting repair	19.1%	8.3% (69/70)	30.0%(90/91)

(From Information Book 1997)

Initial cost for the rolling stocks (locomotives and wagons)

Rough unit costs of them are assumed as follows:

① Wagon; $0.12 million/wagon
② Locomotive; $2.5 million/loco.

Table 6.12.4 Rolling stocks; Purchase costs

	Wagons ($0.12 million/wagon)		Locomotives ($2.5 million/loco.)		Total
Case-A	1000 wagons	$120 million	8 locos	$20million	$140million
Case-B	700 wagons	84million	5 locos	$12.5 million	$96.5 million

(2) Construction cost (Right of way, railway structures and track) of the extension

Here, the construction costs of A(West route) and B(East route) are calculated using the routes shown in Fig. 6.8.1.

Table 6.12.5 Construction costs of the two routes

Route	Construction cost
East route	Tk. 7,083 million ($148 million)
West route	Tk.4,960million ($103 million)

(3) Transportation cost by rail (Operation and Maintenance)

Increased freight volume of 307 million or 183 million ton. km needs additional transportation cost.

This calculation has much difficulty to have correct figure. And two ways of assumption are made for cost estimation.

ú@. Assumption that management cost is proportional to the train.km

Passenger train.km & Freight train.km of BR and Expense of BR are as follows:

Table 6.12.6 Passenger train. km and Freight train.km of BR

Year	Passenger train. km (1000km)			Freight train. km (1000km)			Total
	B.G.	M.G.	Total(a)	B.G.	M.G.	Total (b)	c = a + b
1996/97	3,766	9,004	12,770	322	1,033	1,355	14,125

Table 6.12.7 Expenses of BR in 1996/97

	General Administration	Repairs & Maintenance	Operation staff	Operation fuel	Operation other than staff and fuel	Miscellaneous.	Total
Expenses (d) (thousand Tk.)	732,114	1,406,028	619,331	544,905	293,108	546,200	4,141,686
E = d/c	51.8	99.5	43.8	38.6	20.8	38.7	293.2

The above table shows the cost of a train.km, i.e., when a train runs 1 km, it costs 293.2 taka.

- Total ton.km from/to Mongla port is 307 million ton.km or 183 million ton. km.

  A train carries 856.8 tons, then 307 x 10^6~856.8 = 358 x 10^3 train.km, or 183 x 10^6 ~856.8 = 214 thousand train.km.

- Total expenses of the freight transportation of Mongla freight

  293.2 x 358 x 10^3 = Tk.105 x 10^6 = Tk.10.5 crore, or 293.2 x 214 x10^3 = Tk.62.7x 10^6 =Tk.6.3 crore.

This cost will push up the BR expenses to Tk.10.5 crore or Tk.6.3 crore. They increase by 10.5/414.2 =2.5%, or 6.3/414.5 = 1.5% up the management cost, respectively.

- The above estimation is based on the following assumptions:

① A train-km will show the proportional expense of BR in every item, from General Administration cost, Repair & Maintenance cost, Operation Staff cost, Operation Fuel cost, Operation other than staff & fuel cost and Miscellaneous cost. This assumption is too bold and there are items that are not so proportional to the train-km, e.g., Administration cost, Operation other than staff & fuel cost and Miscellaneous cost. But, any more appropriate variable that can explain better relation with expense items than **train.km** hasn't been found in the data of BR.

② The cost of a passenger train.km is equal to that of a freight train.km. This assumption is too bold, too. But, there is no item that can explain only the freight cost reasonably. All the expenses are shown by total expenses of the passenger and freight. Then the above estimation has been done.

③ One of the reasons of adopting train.km as the explicable variable is that BR uses the train.km as the explicable index of the number of employees. The train.km is used as a kind of work volume. And the employee number is most influential to the total expense. The personnel cost of BR in the total expense is 49.7% in 1996/97 year.

ii. Assumption that a passenger.km cost and a ton.km cost are proportional to each other

In the BR data, the JICA team hasn't found neither passenger.km cost nor ton.km cost, nor their ratio. Therefore, in this estimation, the team uses the value of a ratio 3:1 (passenger.km cost: ton.km cost), which is the ratio used in Japan for the fiscal 1996.

This figure 3:1 is the average of the figures between JR Hokkaido (3.46), JR Shikoku (3.09), JR Kyushu (2.36), and JR Freight (1). JR East, JR Central and JR West are omitted, because in their passenger transportation figures, the commuter service (short distance passenger ratio) is rather high and bullet train service is also included. Then following tables are calculated.

Table 6.12.8 Passenger.km and ton.km of BR

Year	Passenger.km (in thousands)	Ton.km (in thousands)	Total (a) (in thousands)
1996/97	3,753,609	1,162,495	4,916,104
Passenger.km is converted to the proportional freight ton.km	3 x 3,753,609 = 11,260,827	1,162,495	12,423,322 (a)

Table 6.12.9 Expense of BR in 1996/97 (unit; thousand taka)

	General Administration	Repairs & Maintenance	Operation staff	Operation fuel	Operation other than staff and fuel	Miscellaneous	Total
(b)	732,114	1,406,028	619,331	544,905	293,108	546,200	4,141,686
c =b/a							0.333

The above result shows that a ton.km costs Tk.0.333. This means that 1 ton.km costs approx. **0.333Taka** (1 passenger.km costs approx. 3 x 0.333 = Tk.1).

- Total ton.km from/to Mongla port

  The increased freight from/to Mongla port by the extension is 307 million tonkm or 183 million ton-km.

- The BR cost for the increased freight

  0.333 x 307 · 10^6 = Tk.102 x 10^6 = Tk.10.2 crore. Or, 0.333 x 183 · 10^6 = Tk.60.9 x10^6 = Tk.6.1 crore. They will push up the expense of BR by 2.5%, or 1.5%

iii. Summing up of the two assumptions

Table 6.12.10 Expenses of transportation by rail

Assumption	Case-A	Case-B
ú@	**Tk.10.5 crore ($2.2mil.)**	**Tk.6.3 crore ($1.3mil)**
úA	Tk.10.2 crore ($2.1mil.)	Tk.6.1 crore ($1.3mil)

$1 = Tk.48.0

From Table 6.12.10, expense calculationú@andúAbecome nearly equal when the ratio between passenger.km and freight.km is assumed 3:1. **Therefore, bold figures (i) are used here.**

(4) Total Expense; Investment and Management

Investment and management costs are estimated using the above figures and presented in the following tables. The West route selected for the estimation of the investment cost.

Table 6.12.11 Investment Cost of Extension (million $)

Case	Rolling Stock (a)	Infrastructure (b) & (b')	Total (c = a + b)
Case-A	140	b = 103 b' =97	243
Case-B	96.5		199.5

$1 = Tk.48.0, b includes land cost, b' excludes land cost.

Table 6.12.12 Management Cost of Extension (unit; million $)

Case	Interest (d)		Depreciation e=0.9a/30	Depreciation f = b'/60	Transportation Cost (g)	Total (h = d + e + f + g)	
	7%	1%				7%	1%
Case-A	17.0	2.4 (1.4)*1	4.2	1.6	2.2	25.0	10.4
Case-B	14.0	2.0 (1.0)*1	2.9		1.3	19.8	7.8

$1 = Tk.48.0 ( )*1 figures in the parenthesis exclude infrastructures cost.

(5) Comparison of total income and expenses

The following table shows the total income and expense of extended railway.

Table 6.12.13 Comparison of Income and Expense (unit; million $)

Case	Income (a)	Expense (b)		c = a – b	
		7%	1%	7%	1%
Case-A	7.5	25.0	10.4	-17.5	-2.9
Case-B	4.3	19.8	7.8	-15.5	-3.5

Income does not compensate the expenses. Only in a case, when the interest is neglected and either of the depreciation is omitted, the income will be approximately the same level with the expense. **It means that if the infrastructure is neglected in the calculation, the railway extension to Mongla port would be on the verge of plus or minus. That is, as follows:**

Table 6.12.14 Income and Expenses (excluding infrastructure and interest 1%)

(unit; million $)

Case	Income (a)	Expense (b)	Total (c=a+b)
Case-A	7.5	7.8	-0.3
Case-B	4.3	5.2	-0.9

Increase in the due to the railway extension is Tk.36 crore ($7.5 million) or Tk.20 crore ($4.3 million).

And it raises BR's income approx. 11% or 6% respectively. On the other hand, the expenses of Tk.10 crore ($2.1 million) raises only 2.5% (Case-A), or Tk.6 crore ($1.2million) raises only 1.5% (Case-B) respectively.

The reasons are as follows:

① Difference of transportation unit by a freight train

At present, B.G. sections' average wagons per train are 43.7 wagons and 550 tons freight is loaded. In the extension, there will be 60 wagons and 856.8 tons of freight.

② Increased productivity is considered in the engine.km of locomotive and wagon cycle.

③ Present freight transportation consists of gathering freight from many freight stations. On the contrary, in this extension, freight transportation is assumed drastic between the four destinations (Mongla, Rajshahi, Border and Dhaka).

④ Difference of Income and Expenses of BR.

⑤ BR's income is less than its expenses. Then, if the same figure is added to both the income and expenses, part of income will show the higher percentage figure and that of expense vice versa.

(6) Reference

As for the passenger trains on the extended railway from Khulna to Mongla, it is out of the study scope. And in fact, the railway service between Rupsa East and Bagerhat was ended in 1997. And the passengers between Khulna and Jessore are not increasing. However, the section has 14 passenger and dual purpose trains and 2 freight trains. From the train numbers, the passenger service is predominant. Therefore, if the extension to Mongla port is open, there will be a high probability that the passenger trains will be also extended to Mongla port. Based on this assumption a very rough projection of the passenger study is attempted as described below.

① Ridership projection

(a) The Mongla port is the terminal and stations in the extension are not decided. Therefore, an imaginary new stations are assumed on the extension line which will be a central station of Bagerhat zila, like Khulna station in Khulna zila. Khulna zila has 2.5 million population and Khulna station has 500 to 1,000 passengers/day in August 1998 or 17,000 passengers in July 1998. Then imaginary station's ridership is supposed as follows:

Khulna station's 17,000/month is adopted. The ridership ratio of the Khulna zila is 17,000x12/2,500,000 = 0.08 passenger/inhabitant/a year. Then, 0.08 x1,630,000 = **130,400 passengers/year** (**357** passengers daily). In this case, passengers are one way (passenger who buy tickets at the imaginary station).

(b) In the past, Rupsa East – Khulna transported 1,388 passengers/day (1992/93) or 546 passengers/day (199/1997), respectively. These figures were the figures in the railway ferry era, Rail – Ferry – Rail. The abbreviation of ferry will raise passengers more than twice. Then 1000 to 3000 passengers/day by order would be possible. In this case, passengers is both ways, so **one way is 500 to 1500**.

(c) On the BITSS estimation in 2015, the passenger transportation in 5 corridors of Bangladesh is suggested. In which, Khulna-N.W. Region accounts for 16.6 million passengers by rail. Khulna stands for S.W. Region, i.e., 10 zilas. Population of 10 zilas are 14.6 million (1996/97) and that of Bagerhat zila is 1.6 million. If the railway using ratio is the same in every zila, railway passengers from Bagerhat zila is supposed as follows;

16.6 million x 1.6/14.6 = 1.89 million/year (4984 passengers/day). Then, BITSS supposes approx. **5000** passengers between Bagerhat zila and N.W. Region. In this case, 5000 passengers are both ways, then **2500 are passengers who buy ticket at the station.**

(d) Summary:

Passengers in the extended railway will highly depend on its service level including fare, frequency, etc. There are no such assumptions now, and only the service is assumed as that available now at Khulna station, i.e, 7 trains/ day, including a condition that railway is connected. Then, **from 1000 to 1500** passengers/day (both ways) would be possible. Therefore, a train will transport approx. 1000/14 ≒ 70 to 1500/14 ≒ 110 passengers, **approx. 100 passengers/ a train**.

Conclusion; 700 passengers going out from the new station and 700 passengers come down to the new station, everyday.

② Passengers income

From the above, income will be calculated as follows:

A revenue/passenger is Tk.16.73 (Information book 96/97).
Then, Tk.16.73 x100×14 x 365 = **Tk.8.5 million**.

③ Passenger trains' expenses or Passenger transportation cost

The assumption made for this item is totally different from freight assumption.

In freight transportation, its cost is for total transportation distance from Mongla to destination or vice versa. In this passenger case, the income is from/to destination to/from the imaginary station, but the cost is only between Khulna and the imaginary station. The reason is that all 7 trains will be extended to the imaginary new terminal.

The train frequency of 7 trains for 357 passengers is too much. But here, only train extension is assumed. If a total new transportation is considered, the train numbers will be different.

Train.km of the extended section; 14 trainsx50km = 700 train.km.
Tk.293.2 x 700 = **Tk.205,240 ($4.3 thousand)**

④ New Locomotives and passenger cars

- ○ Strictly speaking, locomotives and passenger cars for the extended line should have been already calculated in a train.km cost. Because Tk.293.2/train.km includes all the costs which BR spent in fiscal 1996/97. Therefore necessary new purchase for passenger cars and locomotives should have been included. However, in fiscal 1996/97 there was no purchase of passenger car and no description about the locomotive in the Information Book.
- ○ If the productivity of train.km is increased 700/14,125 = 4.9%×5%, there will be no additional cost for passenger trains extension. Here, 14,125 is BR's train. km of 1996/97.
- ○ In case new rolling stocks shall be purchased, the necessary number will be calculated as follows:

Locomotives; Total engine.km of the extended 700.

Engine.km/day = 300 (In this case, assumed engine.km/day in B.G. sections).
Then, 700/300x1.2=2.8≒**3**

Passenger cars; passengers are supposed 70 to 110/train. Fluctuations of passengers are considered. Then, 3 cars will be enough at most. In this case, connection/disconnection of cars at Khulna station is accompanied. It is not desirable for such a short distance of 50km, but this is estimated to be moderate. In this section 50 km, the locomotive and passenger cars are so-called fixed train set. Then, number of cars necessary are 3x3 = 9 (including reserve cars). 1 loco pulls only 3 passenger cars, this is not highly economical. However, to make easier understanding, locomotive system is used.

Table 6.12.15 Rolling stock cost

Rolling stock	Unit price (in millon) (a)	Number (b)	Purchase cost (in Million) (c = axb)
Locomotive	$2.5	3	$7.5
Passenger car	$0.33	9	$2.97
Total			**$10.5**

Depreciation of rolling stocks is $0.9x10.5×$10^6$/30 = $0.315 million every year.

Interest of the rolling stocks is,

0.07 (or 0.01)x$10.5x$10^6$ = $0.7 million (or 0.1 million), respectively.

⑤ Passenger Income and Passenger Expense

Table 6.12.16 Passenger Income and Expense (unit; $ million)

Income (a)	Expenses						Total (f = a-e)	
	Interest (b)		Depreciation (c)	Trans. cost (d)	Total (e=b+c+d)			
	7%	1%			7%	1%	7%	1%
0.177	0.735	0.105	0.315	0.004	1.054	0.424	-0.877	-0.247

In the above, a loss of $0.9million/year or $0.25million/year will occur by passenger transportation.

⑥ Total Freight and Passengers Income

○ Income

Table 6.12.17 Income (in million) of the Extension

Case	Freight	Passenger	Total
Case-A + Passenger	Tk.360	Tk.8.5	Tk.369 ($7.7)
Case-B + Passenger	Tk.200		Tk.209 ($4.4)

○ Expenses

Table 6.12.18 Expense of the Extension (unit; $ million)

Case	Interest (7% or 1%)			Depreciation			Trans. Cost		Total
	Infr.	Rolling stock		Infr.	Rolling stock		(Fr.)	(Pass.)	
		(Fr.)	(Pass.)		(Fr.)	(Pass.)			
Case-A + Pass.	7.4 [1.1]	9.8 [1.4]	0.7 [0.1]	1.6	4.2	Max. 0.32	2.2	0.0043	26.22 or 10.92
Case-B + Pass.		6.8 [1.0]			2.8		1.3	0.0043	20.92 or 8.22

Figures in [ ] show the interest rate of 1%.

Table 6.12.19 Comparison of Income and Expense (Freight and Passenger)

(unit; million $)

1 Case	Income (a)	Expense (b)		Total (c = a + b)	
2	3	7%	1%	7%	1%
Case-A+Pass.	7.7	26.22	10.92	-18.52	**-3.22**
Case-B+Pass.	4.4	20.92	8.22	-16.52	**-3.82**

4. In the above 2 tables, if the interest is 1% and the infrastructure is neglected, the total column of Table 6.12.18 will be improved to 1.1+1.6= **$2.7 million**.

5. **This means that Case-A will make $0.52million losses and Case-B will make $1.12 million losses. Therefore the extension is coming to a feasible range, only if the underpart of the railway (infrastructure) is seperated from the management of the railway and if the interest is 1%.**

From the above discussions, it can be concluded that in the extension, both the railway income and expenses are mainly decided by freight. In this sense, revenue derived passengers has more influences on income (2.4% to 4.3%) and less influence less on the

expenses in transportation cost (less than 0.2% or 0.3%). Therefore, **if the rail is extended to Mongla port, it is far better to do both passenger and freight service at the same time.**

6. 13 The Necessity of the Basic Studies for the Future Railway

In the study of the Rupsa bridge, the railway freight transportation in the western zone has been studied. In the process, many problems have been encountered. At present, the BR lacks investment, and it never can be said that BR is providing an adequate transportation service to the people. In such a troublesome situation, still BR is providing the daily railway service, thanks to the effort of railway staffs and employees who endeavor to keep the railway service.

However, fundamentally, the lack of the investment shall be overcome as soon as possible. And all future investments can be made most effective and timely. To do so, a master plan for the total investments that suggest what, when and how BR should do is necessary, considering the management and present problems encountered by BR.

Measures such as track improvement and rolling stock renewal, are now being carried out slowly. In that process, many basic problems are encountered, for instance, BG and MG, transportation shares of railway in the total transportation, the critical state of railway finance. However, they lack an adequate adjustment or consensus, because of different appreciation of different proceeding groups. Railway projects should be scheduled timely and executed properly. Even a renewal project should be done considering the availability of resources in future.

Bangladesh is densely inhabited and hence has much possibility for development. There are so many projects that are coming after the projects that are now being executed and are deeply related to each other. They are, modernization of freight & passenger transportation systems, double tracking, railway network extension, modernization of signaling & communication, electrification, introduction of multiple unit engines, separation of long distance service from commuter service (or transportation in big cities), level separation against the road traffic, improvement of stations and their plazas, etc.. Formulation of a master plan will help, all such projects go effectively and smoothly without or less waste. And one more great effect of the master plan is to raise the morale of the BR staffs and employees. It can show people clearly what is BR's future and what BR is aiming at. In these contexts, a master plan needs to be studied.