The target year of the commission is said to be 1990, and the development of port facilities at B site depends on the realization of this project. Another ongoing project, Development of the Shampur Commercial Area, is related to the development of site A. The concept of this commercial area is not yet clear, so it is expected that the land use and facilities plan of this project will be coordinated with the development of site A. For example, port-related service industries and institutional facilities should be introduced.

The development of Buckland Bund is directly related to the development of Dhaka Port, that is, the future location of the passenger terminal and cargo handling facilities will affect the development scenario of this area. In addition, the transport network will be changed drastically by the construction of Bandantali Bridge and the underdraining scheme.

The extension of Bangabandhu Road in Narayanganj will play an important role in the development of site G.

The Dhaka-Chittagong Road By-pass is expected to be completed in 1986. This road will improve the transport of cargoes between Dhaka and Narayanganj.

The Ullon-Badda-Zoarshahara Road will contribute to alleviating the traffic congestion caused by trucks moving from the ports toward the northern part of the Dhaka Region.

8.2.2 Land Use Concepts around the Port Area

The future urbanized area in the Port-related Zone will extend almost all over the area, leaving some green areas in DND Triangle, Keraniganj and Bandar. Except for the river sides of Buriganga and Lakhya, the central part of DND Triangle and the hinterlands of Keraniganj and Bandar will all be transformed into residential areas.

New industrial areas will be formed as described below in addition to the existing areas along the sides of the two rivers.

a. An industrial estate will be developed just behind the port area in Keraniganj. The main factories which will be introduced into this estate are spare parts industries for various machinery and construction materials industries. Some factories which will locate in this estate will be new establishments and others will be existing factories relocating from Dhaka City.

   If some of the shipbuilding industries located upstream want to move or if other industries want to locate along the river banks, riverside industrial sites will be prepared.

b. The area around Kachpur Bridge in Bandar will be designated as an industrial zone for the textile and apparel industries including fabricators of textiles.

The commercial and business center in the Port-related Zone will continue to be at Narayanganj, but some sub-centers will be generated in accordance with the extension of residential areas.

Other special areas for service industries are as follows:

a. In Keraniganj, a new commercial center will be developed adjoining site B. The development of the long distance passenger terminal at site B will improve the commercial potential of this area.

b. The port functions of Old Dhaka Port shall be reorganized, and an integrated redevelopment plan including commercial facilities, warehouses, the passenger terminal, parking lots, roads, pedestrian ways and high rise apartment houses will be prepared.

8.2.3 Improvement of Transport Network

Future urbanization of the Port-related Zone and development of port facilities will require the following improvements of the transport network.

a. The Dhaka-Chittagong Road and the Postogola Bridge will be commissioned by 1986 and 1990, respectively.

b. Between the southern part of Narayanganj and the Dhaka-Chittagong Road, a new road will be constructed, at first with two lanes and finally with four lanes.

c. In Keraniganj, a new road from the Dhaka Mawa Road parallel to the Buriganga river will be constructed, keeping pace with the development of port facilities and of the hinterland.

d. In Bandar, the old railway tracks will be utilized as a local trunk road.

e. Construction of other roads will be conducted in accordance with the extension of urbanized areas.

f. The railway works will be limited to the maintenance and improvement of existing track, but for coping with the increased demand of passengers and freight, the improvement of stations and the increase of rolling stock should be pursued.

8.3 Project Sites

Five project sites are selected for the master plan based on the field survey by the Study Team and the discussion between the Study Team and BIWTA. Table 8.3.1 is on outline of the sites the natural conditions and the planning aspects.

Land around site E is currently used as a residential area, and the site is rather small. Thus, site E is not considered as a potential project site.

Table 8.3.1 Outline of Project Sites

Port, River		Dhaka Port (Buriganga River)			Narayanganj Port (Lakhya River)	
Site		A	A'	B	E	G
Location (distance from BIWTA Terminal)		Left side 5.5 km downstream	Right side 5.5 km downstream	Right side 3.5 km downstream	Right side 7.0 km upstream	Right side 3.5 km downstream
River Conditions	Width	250 m	250 m	550 m	300 m	250 m
	Shape of Stream	outside of curve	inside of curve	outside of curve	changing point	outside of curve
	Water level Difference	5 m	5 m	5 m	4.5 m	4.5 m
	Distance up to 12' depth (1000 DWT)	50 m	80 m	100 m	100 m	16 m
	Necessity of dredging	not necessary	necessary	necessary	necessary	not necessary
Soil Conditions	Alluvium Clay Layer	0 - 20 m	0 - 20 m (25 m)	0 - 25 m	0 - 35 m	0 - 30 m
	Dilluvium Sandy Layer	20 m -	(20 - 25 m) -	25 m -	35 m -	30 m -
	N-value (>30)	25	30	30	45	25
Elevation of Land	Waterfront	4 - 6 m	5 m	5 m	3 m	3 m
	Back area	0 m	2 m	2 m		
Scale of Open Area		small	wide	wide	small	wide
Actual land use		Brick field Brick selling center	Brick field	Brick field	Cultivation	Unused
Planning Aspects		(Advantages) 1 Possible to utilize the existing road and railway. 2 There is a plan to create a commercial zone near the site. (Disadvantages) 1 Traffic congestion on existing road. 2 Actual urbanization around the site. 3 High cost of land.	(Advantages) 1 Possible to develop the surrounding area. 2. Few limitations for land use. (Disadvantages) 1 High cost of construction of new roads. 2 Impossible to use the railway. 3. Dependent on the Bridge Project.	(Advantages) 1 Short distance to city center after construction of the bridge. 2 Few limitations for land use. 3 Possible to develop the surrounding area (Disadvantages) 1 Dependent on the Bridge Project. 2 Impossible to use the railway.	(Advantages) 1 Short distance to jute mill factory area. 2 Possible to use the existing road and railway. (Disadvantages) 1 Scale of open area near the site is small. 2 Residential area.	(Advantages) 1 Possible to function as a means of development for the Narayanganj area. 2 Few limitations for land use. (Disadvantages) 1 Necessary to construct a new access road. 2 Long distance from the city center.

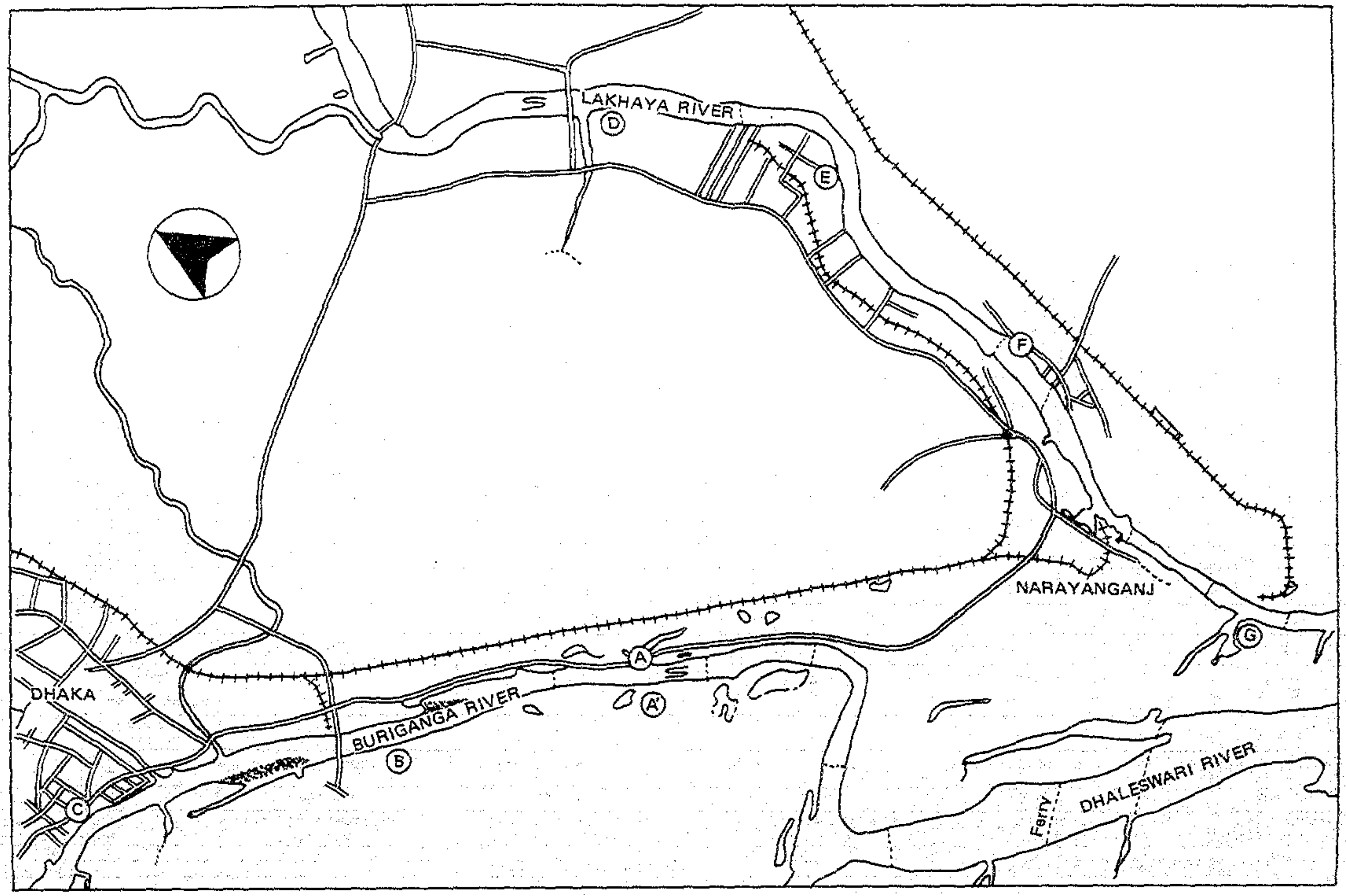


Fig. 8.3.1 The Sites Proposed for the Development Project of Dhaka and Narayanganj Ports

8.4 Scale of Port Facilities

8.4.1 Cargo Handling Volume for Port Facilities Planning

Based on the results of the traffic survey executed by the Study Team (hereinafter referred to as the "Traffic Survey"), the cargo handling volume forecast in Chapter 6 is divided into public cargoes and private cargoes, and these are shown in Tables 8.4.1. Here, "public cargoes" means those cargoes which are handled at the public port facilities operated by B.I.W.T.A. These tables do not include the cargoes handled by country boats and passenger launches as stated in Chapter 6.

In the following sections, the port facilities are designed to accommodate the public cargoes.

8.4.2 Cargo Handling Capacity of the Existing Public Facilities

(1) Based on the result of the Traffic Survey, the present cargo handling volume and the number of vessels by vessel type are summarized in Table 8.4.2.

As is clear from Table 8.4.2, the jetties used by coasters are limited, and the other jetties are mostily used by cargo launches and by barges.

(2) Cargo handling capacity of R.C.C. Jetty

(i) Based on the Traffic Survey, Badamtali Old & New R.C.C. Jetties are the most frequently used jetties. These two jetties are used exclusively by coasters. The actual operating situation at these two jetties is shown in Table 8.4.3 and Fig. 8.4.1.

The main data in Table 8.4.3 can be summarized as follows:

Table 8.4.1 Cargo Handling Volume in the Year 2005

(Unit: thousand tons)

	Public cargoes			Private cargoes			Total cargoes		
	In	Out	Total	In	Out	Total	In	Out	Total
(Bulk)									
Grain	116		116	1,485		1,485	1,601		1,601
Cement	905		905	91		91	946		996
Fertilizer		404	404					404	404
POL				681	136	817	681	136	817
Iron & Steel	228		228				228		228
Other	200	20	220				200	20	220
(Non-Bulk)									
Jute				6	75	81	6	75	81
Jute Goods					65	65		65	65
Other	177	18	195				177	18	195
(Container)									
Container	329	353	682				329	353	682
Total	1,955	795	2,750	2,263	276	2,539	4,218	1,071	5,289

Table 8.4.2 Cargo Handling Volume by Jetty

(Unit: tons)

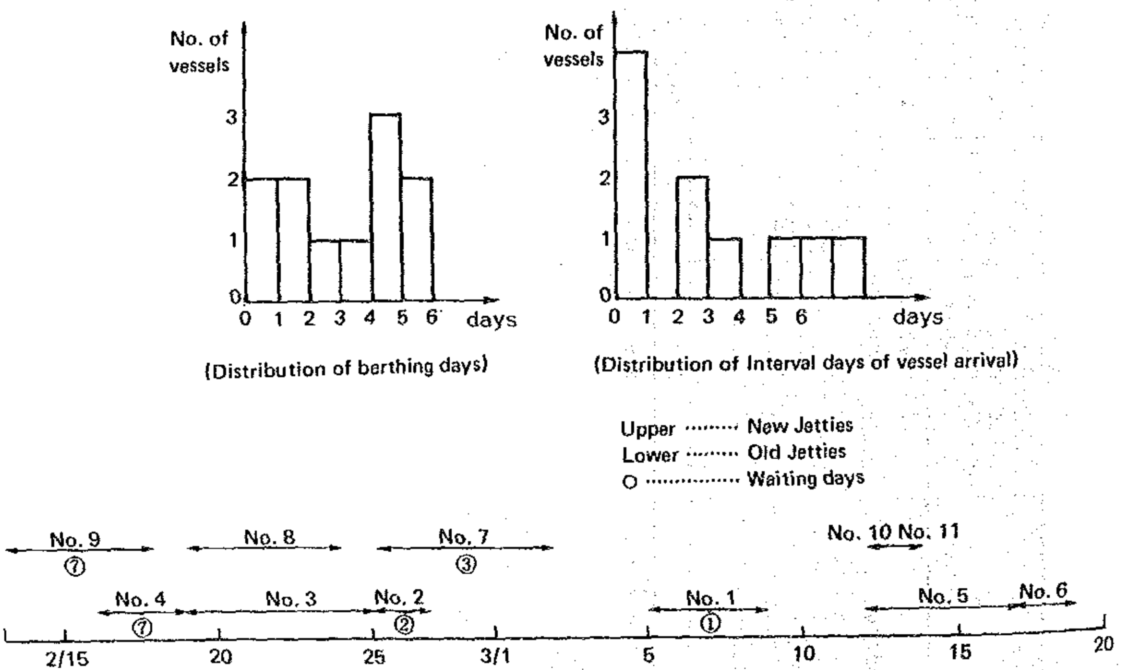
	Badamtali		Mill Barrack		M.M. Oil Mill		Khanpur		Ekranpur		Ghat No. 5 - 8	
	No. of vessels	Cargo handling volume	No. of vessels	Cargo handling volume	No. of vessels	Cargo handling volume	No. of vessels	Cargo handling volume	No. of vessels	Cargo handling volume	No. of vessels	Cargo handling volume
Coaster	22	13437.00	3	2475.00	7	4865.00	0	0	4	2011.65	10	2623.03
Cargo Launch	37	8988.90	2	975.00	23	7160.00	22	3895.00	0	0	81	23909.40
Passenger Launch	52	510.89	0	0	0	0	0	0	0	0	0	0
Flat Barge	13	3655.97	0	0	19	5517.00	12	3170.00	0	0	26	8969.65
Mechan. Country Boat	3	121.30	3	27.99	0	0	1	63.00	0	0	17	271.25
Manual Country Boat	6	248.26	66	527.07	0	0	11	305.94	226	3671.53	70	902.03
Other	0	0	0	0	0	0	0	0	0	0	0	0
Total	122	26962.32	74	4005.06	49	17542.00	46	7433.94	230	5683.18	204	36675.36

Source: Traffic Survey by the Study Team (Feb.18-Mar.19, 1986)

Table 8.4.3 Actual Operating Situation at Badamtali R.C.C. Jetties (1)

		D.W.T	Cargo handling volume	Waiting days	Berthing date	Berthing days
old	1	750	750	1	3 - 5	4
	2	650	400	2	2 - 25	2
	3	800	650	0	2 - 19	6
	4	750	750	7	2 - 16	3
	5	750	750	0	3 - 12	5
	6	970	750	0	3 - 17	2
new	7	700	600	3	2 - 25	6
	8	500	500	0	2 - 19	5
	9	750	800	7	2 - 13	5
	10	550	550	0	3 - 12	1
	11	750	1,000	0	3 - 13	1
Total		7,920	7,500	20		40

Source: Traffic Survey by the Study Team (Feb.-Mar., 1986)



Source: Traffic Survey by the Study Team (Feb.-Mar., 1986)

Fig. 8.4.1 Actual Operating Situation at Badamtali R.C.C. Jetties (2)

Average vessel size	750 DWT
Average cargo handling volume per vessels	680 tons
Average number of calling vessels	0.324 (vessels/day)
Average number of berthing days	3.64 (days/vessel)
Occupancy ratio	57%
Average cargo handling capacity per jetty.	187 tons/day

(ii) Based on the observation of cargo handling operations at Badamtali in Feb. 1986, the maximum cargo handling capacity of the R.C.C. jetty is estimated as 300 tons/day as outlined below.

(a) Operation of the ship crane

Cycle time	2 min
Cargo handling volume per cycle	1.0 tons
Cargo handling capacity	25 tons/hour

(b) Operation on the jetty

Number of laborers	1 gang (30 persons)
Number of mobile cranes	1 unit (out of order)

(c) Cargo handling capacity per jetty — 300 tons/day

As mentioned above, the actual average cargo handling volume per jetty is 187 tons/day, and the theoretical occupancy ratio is as follows:

187 - 300 = 62%

This value is almost coincident with the observed value.

(iii) Considering that the Buriganga River Bridge will open in the year 1990 and it will take at least three years to construct the new general cargo berths to replace those at Badamtali, the existing jetties lacated at Badamtali, Khampur and Ghat No 5 will have to accommodate the demand from coasters through the year 1989.

Accordingly, the cargo handling capacity of the R.C.C. Jetties is examined based on the following assumptions.

Forecast Cargo volume to be carried by coasters in 1989	351 thousand tons
Average loading/unloading cargo volume per vessel	750 tons
Cargo handling capacity per jetty	300 tons/day
Distribution of vessel calling	Poisson distribution
Distribution of loading/ unloading time	Poisson distribution
Working days per year	300 days
Number of R.C.C. Jetties	4 berths

The average number of waiting vessels, the average waiting time per vessel and the occupancy ratio are calculated using queuing theory.

berth occupancy ratio	78 %
average waiting vessels per day	1.83 vessels/day
average waiting time per vessel	1.17 days/vessel

In Dhaka Port, there are sufficient areas to serve as waiting areas, and the theoretical cargo handling capacity can be calculated as follows:

0.78 x 300 days x 300 tons/day = 71 thousand tons/year

(3) Cargo handling capacity of Pontoons and Wooden Jetties

The actual situation of pontoons and wooden jetties at Badamtali based on the Traffic Survey is presented in Fig. 8.4.2 and 8.4.3. In these figures, it can be observed that three vessels are worked simultaneously although each jetty is composed of only one berth. As these two jetties are actually being used beyond their theoretical capacity, the cargo handling capacity of these jetties is herein assumed to be equal to the actual cargo handling volume.

(4) Mill Barrack and Ekrampur Jetties

These jetties are owned by B.I.W.T.A. but the Central Storage Depot. (C.S.D.) of the Food Department operates the jetties on an exclusive basis for handling grain. These jetties will also be exclusively used for grain in the future, and the cargo handling capacity of the jetties are calculated as follows:

Mill Barrack C.S.D.

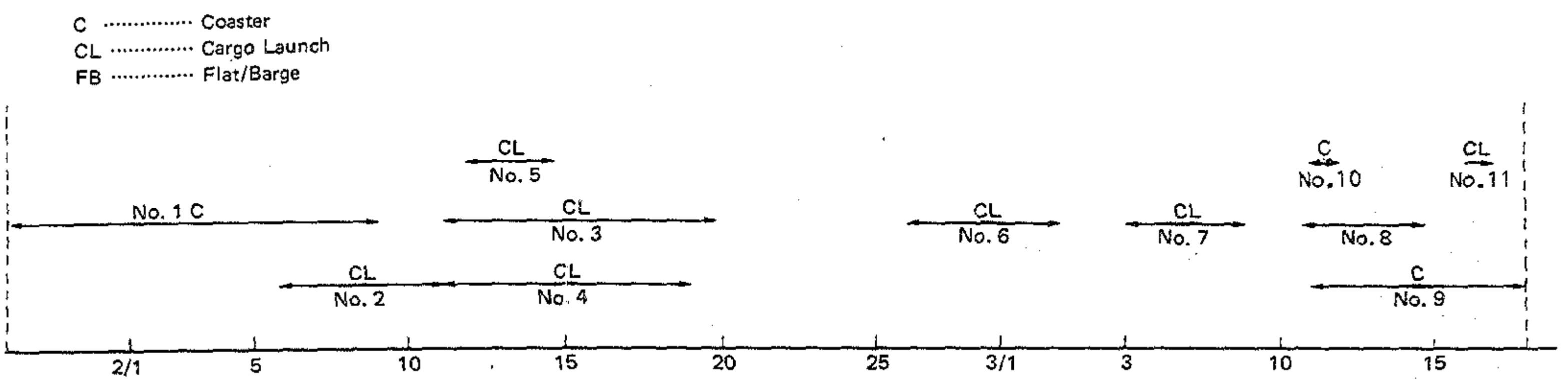
8,000(storage capacity) x 4(turnover)=32,000 tons

Ekrampur C.S.D.

21,000(storage capacity) x 4(turnover)=84,000 tons

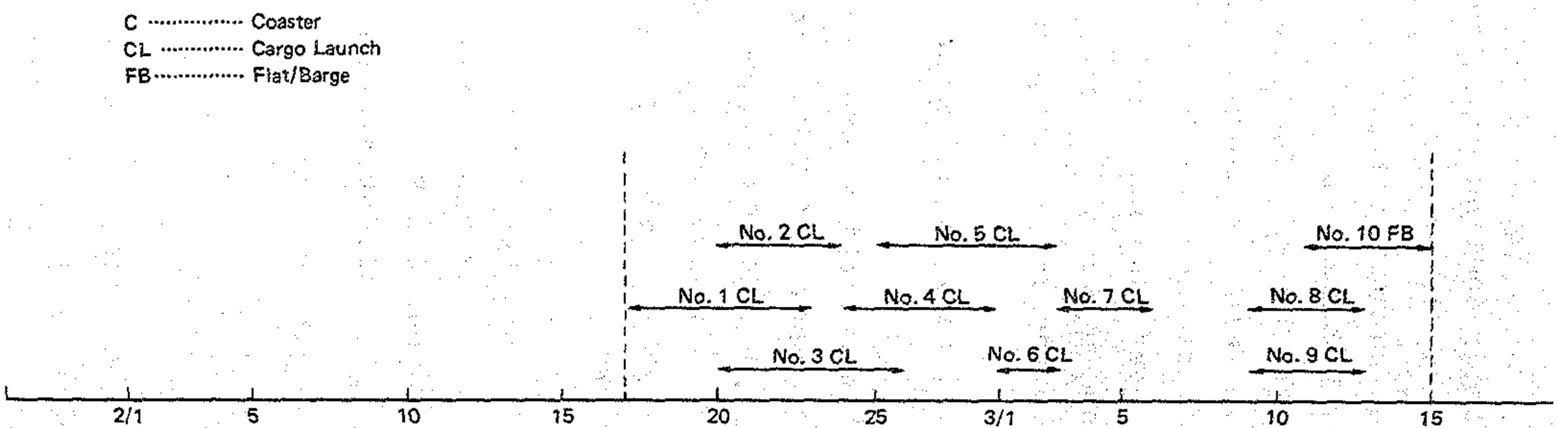
(Storage Capacity)

(Source: Food Department)



Source: Traffic Survey by the Study Team (Fev.-Mar., 1986)

Fig. 8.4.2 Actual Operating Situation at the East Pontoon at Badamtali



Source: Traffic Survey by the Study Team (Fev.-Mar., 1986)

Fig. 8.4.3 Actual Operating Situation at the Wooden Jetty at Badamtali

8.4.3 Cargo Handling Plan by Jetty

Based on the above analysis and the actual records of cargo handling volume by commodity/jetty, the cargo handling plan by jetty is given in Table 8.4.4.

The assumptions used for the cargo handling plan are as follows:

(1) As stated in 8.1.2, jetties in Badamtali are not used by coasters after 1990.

(2) In the year 2005, jetties in Badamtali are no longer used for port functions. Rather, this area will be used for urban functions, as there is a need to expand and rehabilitate the urban area close to Badamtali, and the Badamtali Area does not have sufficient cargo handling space and access transportation.

Table 8.4.4 Forecast Cargo Allocation in the Year 2005

(Unit: thousand tons)

	Dhaka Port			Narayanganj Port		
Existing Facilities	Mill Barracks	Grain	32	Khanpur	Fertilizer	142
	M.M. Oil Mill	Cement	152	Ekranpur	Grain	84
				Ghat No. 5-8	Cement	244
					Fertilizer	71
					Bulk	146
New Facilities	Container Terminal			Container	682	
	New General Cargo Berths			Non-Bulk	195	
				Cement	509	
				Fertilizer	191	
				Iron & Steel	228	
				Bulk	74	
				Sub-Total	1,197	

8.4.4 General Cargo Berth Planning

(1) In this section, the jetties and related facilities are planned for all cargoes except container cargoes, and the assumptions used for planning are as follows:

Standard vessel size	Coaster	1,000 DWT
Average loading/unloading cargo per vessel		750 tons
Working days per year		300 days

The cargo handling equipment comprises mobile cranes and ship cranes. Based on the observation results of the Study Team and assumed improvement of working productivity in the future, the working efficiency will be as follows:

Cargo handling capacity	2 tons x 2 hatches
Cycle time	5 min
Working time per day	8 hours
Maximum cargo handling capacity per day	384 tons ≒ 400 tons

According to the above assumptions, the loading/unloading time per vessel is 750 - 400 = 1.875 days/vessel

(2) Method of determining the number of berths

One method of determining the ideal number of berths is based on the concept of total port costs. Overall, the idea is to minimize the sum of the capital investment plus the costs incurred while vessels wait to berth and load and unloaded cargoes. Thus, the total costs are comprised of the construction costs of berths plus the costs of the vessels that stay in the port. The total cost is described by the following equation.

$$C = CbTS + CsTNs$$

Where C ... Total port cost during the calculation period when the number of berths is "S"

Cb ... Berth cost per day

Cs ... Vessel cost per day

T ... Calculation period (days)

Ns ... Average number of vessels that stay in port during the calculation period when the number of berths is "S" (vessels/day)

For any given cargo handling volume, the optimum number of berths is the one which results in the lowest value of C. Using the equation presented above, it is necessary to determine the value of Ns using queuing theory in order to determine the optimum C. For this calculation, it is assumed that the distributions of vessel calling and of berthing time are Poisson distribtions.

(3) Required number of berths

(i) Assumptions

Berth cost per day	42,200 T.K./day
Vessel cost per day	16,700 T.K./day
Average loading/unloading time	1.875 days/vessel
Average number of calling vessels	5.320 vessels/day

(ii) According to the these assumptions, the relation between the optimum number of berths and the total port cost is as shown in Fig. 8.4.4 (1). The required number of berths is 12 berths in 2005. When the Traffic Density "a" is defined as follows, the relation between the optiumum number of berths and the paramenter "a" is given as shown in Fig. 8.4.4 (2).

$$\text{Traffic Density} = \frac{\text{Average number of calling vessels}}{\text{Average loading/unloading time}}$$

The required number of berths corresponding to the demand forecst of general cargo volume can be calculated using Fig. 8.4.4 (2).

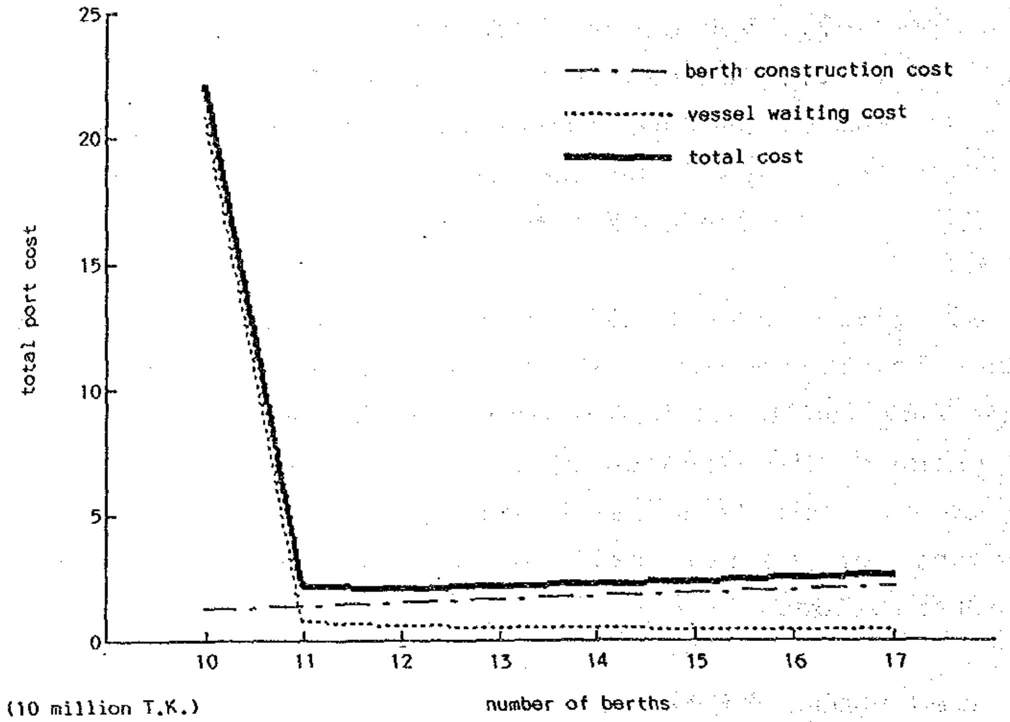


Fig. 8.4.4 (1) Required Number of General Cargo Berths

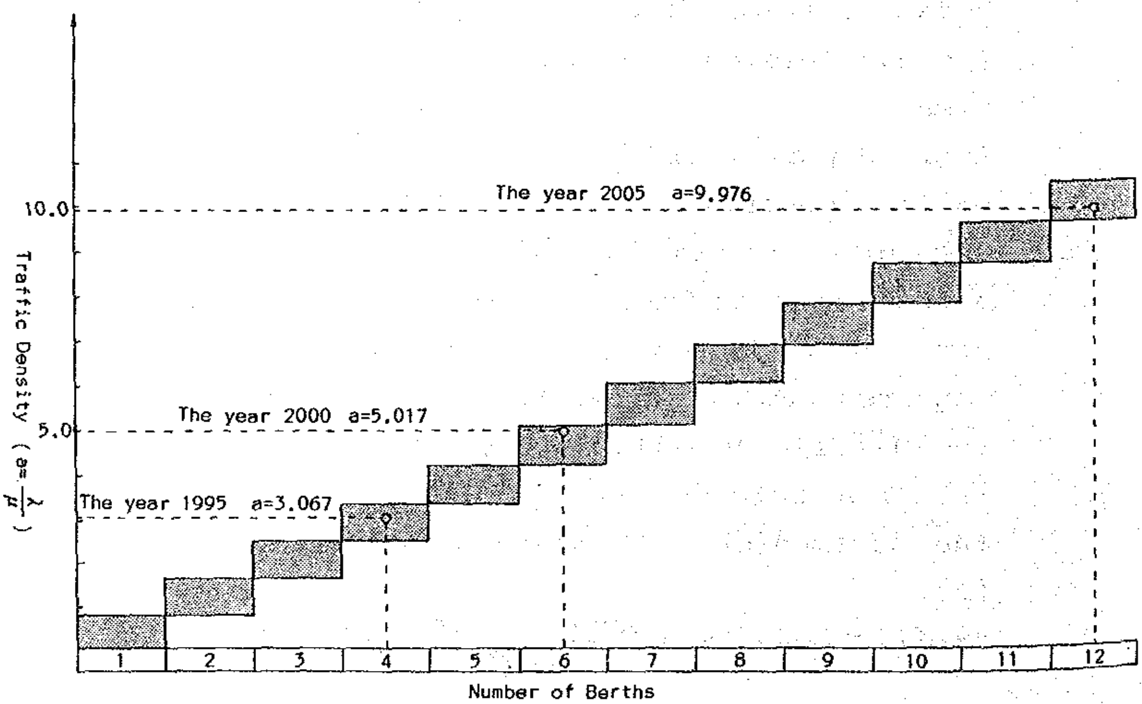


Fig. 8.4.4 (2) Required Number of General Cargo Berths

The average number of waiting vessels and the average waiting time per vessel are then calculated using queuing theory.

Table 8.4.5 Results of Queuing Theory Calculation

Year	Average waiting vessels per day	Average waiting time per vessel (days)	Average berth occupancy ratio
2005	2.189	0.441	83.1 %

Based on Table 8.4.5, there is always approximately one vessel waiting to berth in 2005. In Dhaka and Narayanganj Ports, there are sufficient areas to serve as waiting areas.

(4) Transit Sheds

The necessary area of transit sheds is generally determined by the following formula.

$$A = \frac{N}{R\ w}$$

where, A : Necessary area of transit sheds (m^2)
N : Annual volume of cargo handled (tons)
R : Turnover : 20 times/year
α : Utilization rate: 0.7
w : Volume of cargo per unit area; 3.0 tons/m^2

Assuming that 60% of the forecast cargo volume for general berths is handled through transit sheds, the required area of transit sheds is calculated as follows:

Table 8.4.6 Required Area of Transit Sheds

Year	2005
required number of berths	12
necessary area of transit sheds (m^2)	17,100
area per berth (m^2)	1,425

(5) Standard Layout of General Cargo Berths

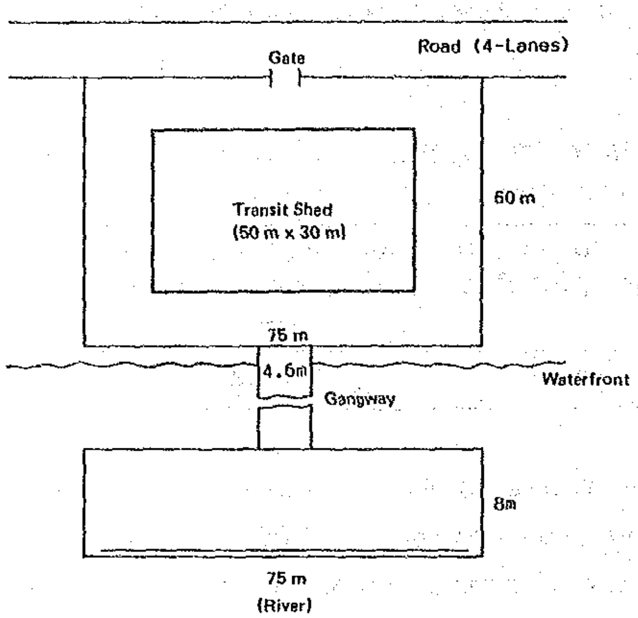


Fig. 8.4.5 Standard Layout of General Cargo Berths

8.4.5 Container Berth Planning

(1) Vessel calling

vessel size	1000 DWT container vessel
vessel capacity	60 TEU
per container cargo	11 tons

When calculating the number of calling vessels for container cargo, the larger one-way cargo volume, whether incoming or outgoing, is adopted. The estimated number of calling vessels per day in the target year are calculated as follows:

$$\frac{353000}{60 \times 11 \times 300} \fallingdotseq 1.78 \text{ vessels/day}$$

(2) Loading/unloading time

(i) Assumptions for container handling operations

cargo handling equipment	150 ton mobile crane
handling capacity	8 TEU/hour
working time per day	8 hours

Considering inevitable time loss, the container handling capacity per day is calculated as follows:

8 TEU/hour x 8 hours - loss time = 60 TEU/day/berth

So, the average loading/unloading days per vessel is calculated as follows:

number of containers per vessel	loading	60 TEU
	unloading	56 TEU
average loading/unloading days	1.93 days/vessel	

(3) Required number of berths

(i) The same method used in section 8.4.4. is applied here to determine the required number of container berths.

berth cost per day	84,400 T.K./day
vessel cost per day	25,000 T.K./day
average loading/unloading time	1.93 days/vessel
average number of calling vessels per day	1.78 vessels/day

(ii) Calculated results

Table 8.4.7 Calculation Results

Year	2005
required number of berths	5
average waiting vessels per day	0.785
average waiting time per vessel (days)	0.441
average occupancy ratio	68.7%

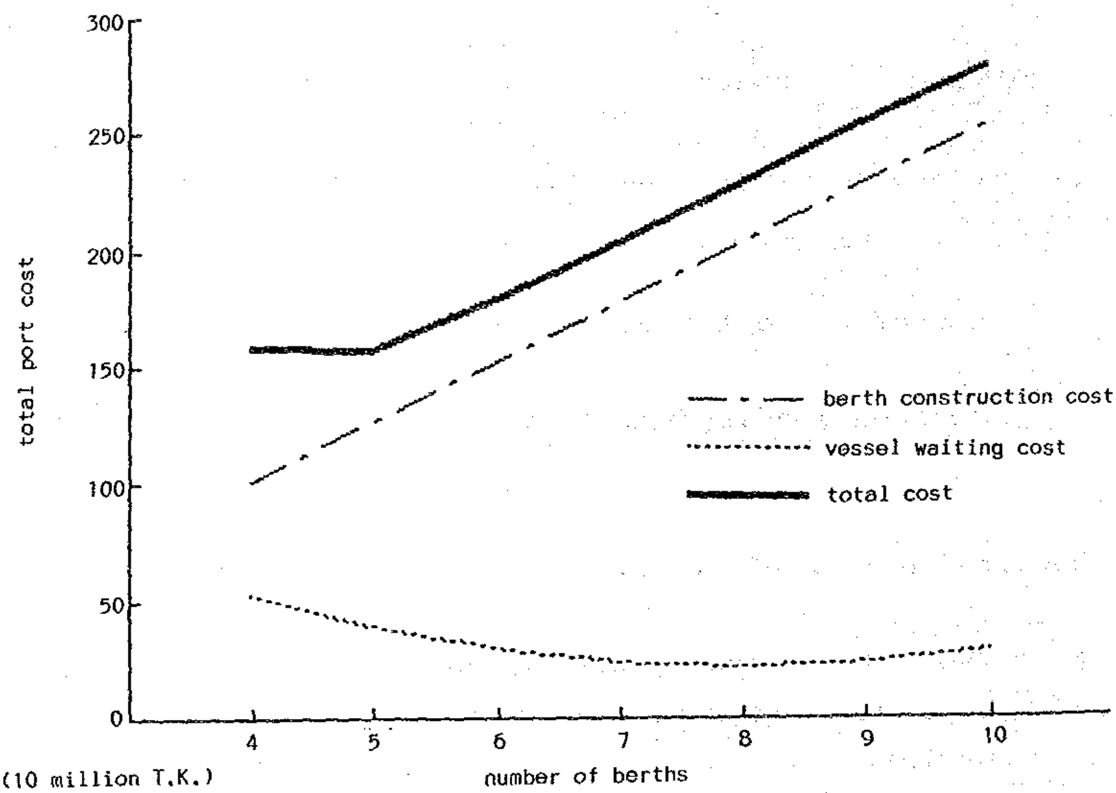


Fig. 8.4.6 Required Number of Container Berths

(4) Scale of container marshalling yard

(i) Generally, for each vessel arrival the flow of containers into and out of the container terminal can be summarized as shown in the following figure.

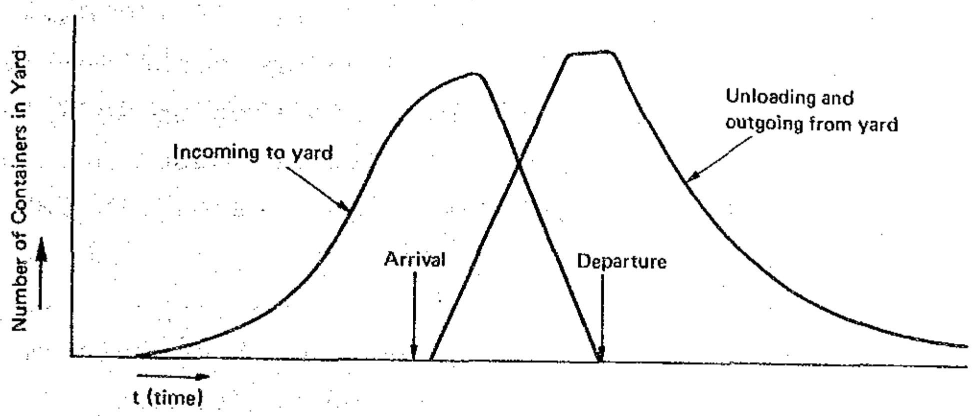


Fig. 8.4.7 Distribution of Incoming/Outgoing Containers

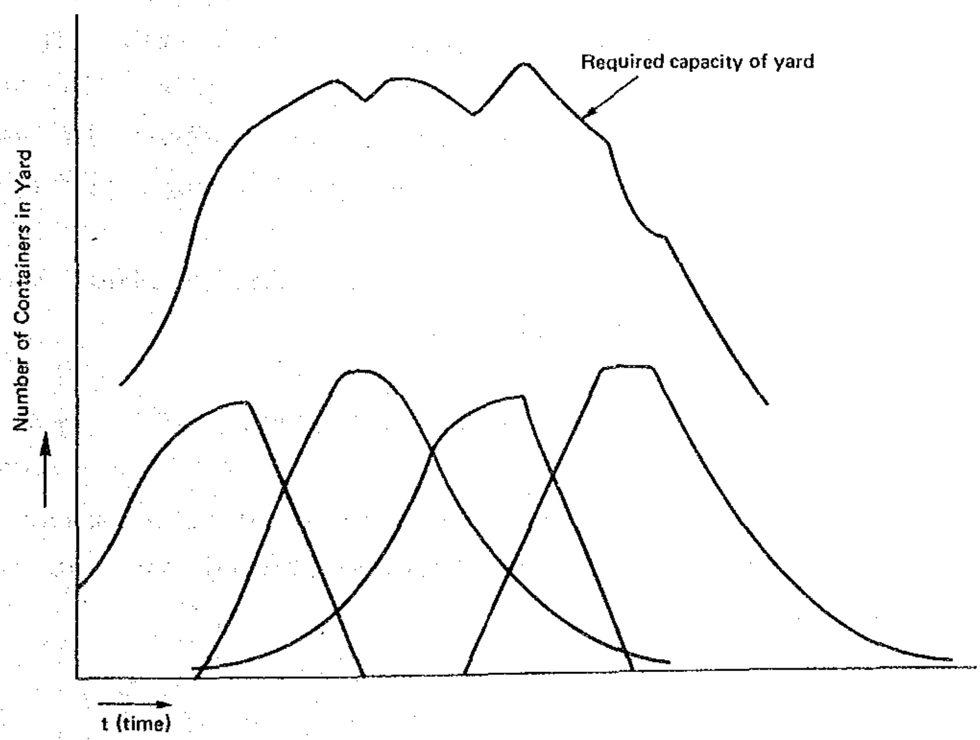


Fig. 8.4.8 Accumulated Distribution of Container Flow in the Yard

The maximum number of containers to be stored in the marshalling yard is thus estimated as equal to the maximum number of containers accumulated during each distribution curve for each vessel call. The calculation is made based on the following assumptions.

type of distribution	Poisson distribution
Flow of containers into the yard	starts from 7 days before vessel arrival
flow of containers out of yard	finishes up to 7 days after vessel arrival
number of loaded/unloaded containers	per vessel 60 TEU

Accordingly, the average number of containers in the marshalling yard is calculated as follows:

2005: 182 TEU

(ii) The container cargo in the marshalling yard is to be handled using a heavy forklift, and the storage area per container is calculated as 76 m^2 considering the required working area for the forklift. The heavy forklift can stack two containers per slot, but an average of 1.5 containers per slot is assumed considering working efficiency in actual operation.

The required area of the marshalling yard is calculated as follows:

$$186 \times 76 \div 1.5 = 9921 m^2/\text{berth}$$

Accordingly, the standard area of the marshalling yard is proposed as 10,000m^2/berth in the Master Plan.

(5) Container Freight Station (C.F.S.)

The C.F.S is generally used for L.C.L. (Less than Container Load) cargo. Based on the cargo forecast, there is a possibility that jute and jute goods will be transported as F.C.L. (Full Container Load) cargo, but it is very difficult to predict what portion of the entire general cargo will be transported as F.C.L. cargo. Based on the percentage in advanced countries, it is assumed that 30% of the general cargo will be transported as F.C.L. cargo.

Table 8.4.8 F.C.L. and L.C.L. Containers

(Unit: '000 tons)

Year	2005
F.C.L. container cargo	364
L.C.L. container cargo	318
Total	682

Thus, the width of the C.F.S. is calculated as follows:

number of containers handled per bay	3 TEU
width per bay	3.5m
maximum number of containers per day through the C.F.S	200 TEU

width of C.F.S. = 200 x 0.4 x 3.5 ÷ 3 = 93 m

The depth of C.F.S. is generally 40 m considering working efficiency. So the standard size of the C.F.S. for the ports is proposed as 100m x 40m per berth.

(6) Standard Layout of Container Berths

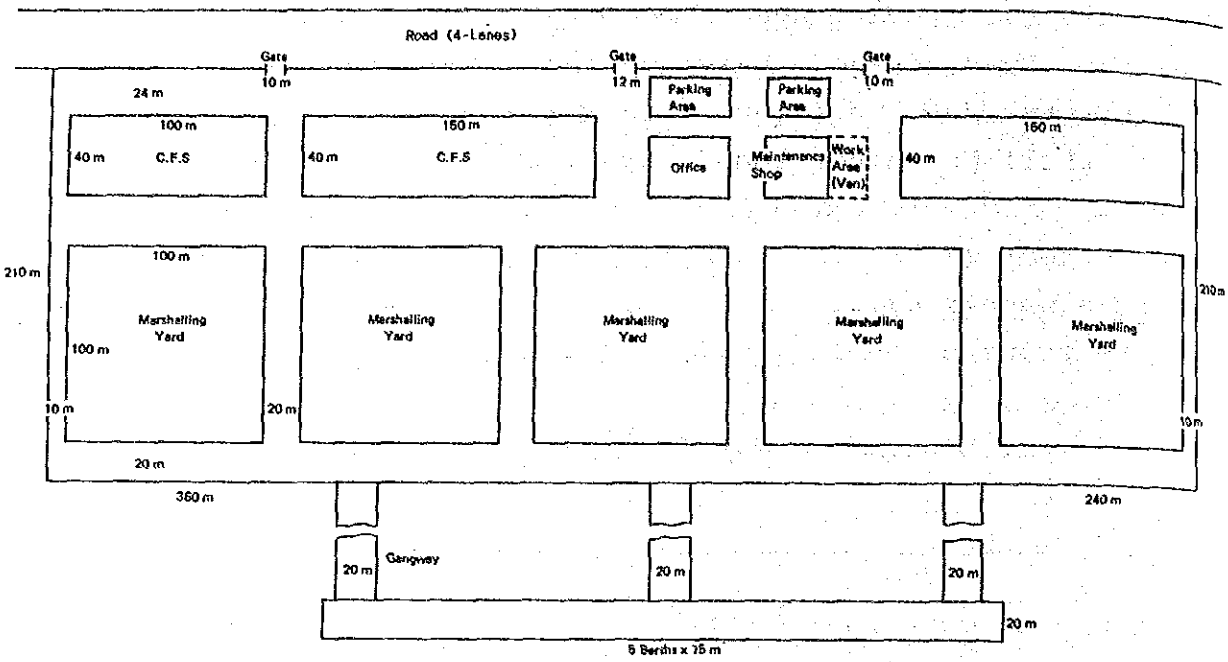


Fig. 8.4.9 Standard Layout of Container Berths

8.4.6 Passenger Terminal Planning

(1) As stated in 8.1.2, a passenger terminal is planned for middle/long distance service. According to the Traffic Survey, the present conditions of actual operations are summarized as shown in Table 8.4.9.

(2) The number of passengers and the number of calling vessels (In/Out) in the target years are estimated in Table 8.4.10 based on the following assumptions.

annual growth rate of passengers -----1984-1995 4.6%
1995-2005 3.2%
(refer to Chapter 6)

service level ----vessel size will slightly increase

Table 8.4.9 Operating Situation of Middle and Long Distance Services

Destination or Origin to/from Dhaka and Narayanganj	Number of vessels	Passenger capacity	Number of Passengers	Load Factor (%)	Average Number of Passengers per vessel
(Middle distance services)					
Fardipur	399	86,798	88,070	101.5	218
Madaripur	132	24,507	26,369	107.6	186
Sariatpur	148	29,618	33,645	113.6	200
(Long distance services)					
Barisal	193	78,738	68,773	87.3	408
Bhola	86	29,200	29,715	101.8	340
Patuakhali	83	40,764	34,170	83.4	491
Barguna	33	15,496	13,295	85.8	470
Khulna	21	12,980	10,155	78.2	618
Bagerhat	27	13,867	9,722	70.1	513

Source: Study Team Traffic Survey (Survey period: 16 days)

Table 8.4.10 Estimated Number of Passengers and Frequency of Services

	The Year 2005	Average daily performance in 1986
Middle distance services		
Number of Passengers per day	18,900	9,255
Frequency of services per day		
Type A	0	42
Type B	44	0
Long distance services		
Number of Passengers per day	21,300	10,364
Frequency of services per day		
Type A	0	0
Type B	50	28

(Remarks) Type A.... Capacity of vessel 200 persons

Type B.... Capacity of vessel 500 persons

(3) Required number of berths

berthing time	embarking	30 min
	disembarking	30 min
	total	1 hour
operating time per day		12 hours

Based on the above assumptions, the required number of berths is calculated as 8 berths in the both target years.

(4) Passenger Terminal Building

The method of determining the terminal building scale is the same as the method for determining the scale of the container marshalling yard. The required area is calculated based on the following assumptions.

type of distribution Poisson distribution
arrival of passengers to the terminal----starts one hour before vessel departure
leaving of passengers from the terminal----finishes up to one hour after vessel arrival

Based on the assumptions, the number of passengers which will pass through the terminal building is calculated as 1392 persons/hour.

required floor space per person	$1.2m^2$
hourly variation (peak/ordinary)	1.2
occupation ratio of office, shop	20%

The required area of the terminal building is:

$$1392 \times 1.2 \times 1.2 \times (1 + 0.2) = 2405\ m^2$$

(5) Parking Area

The passenger terminal should provide transportation to the city center. Almost all of the passengers will travel by bus.

$$\text{Bus traffic density} = \frac{\text{number of passengers}}{\text{capacity per bus}} \times \text{hourly variation}$$

$$= \frac{1392 \times 1.2}{80} = 21 \text{ buses/hour}$$

So, the parking area needs to provide space for 21 buses. Considering the actual situation of road traffic in Bangladesh, the parking area should also provide sufficient space for rickshaws and auto-rickshaws.

(6) Standard Layout of Passenger Terminal

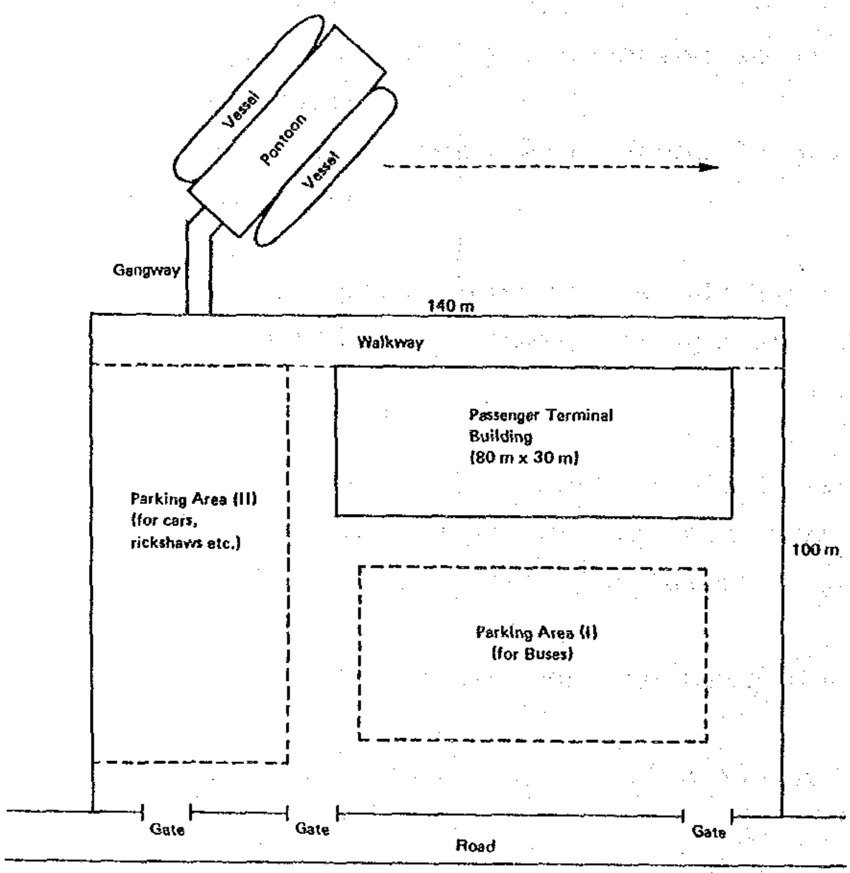


Fig. 8.4.10 Layout of Passenger Terminal

8.4.7 Planned Traffic Volume related to the Proposed Facilities

(1) The overland traffic volume which will be generated from the port facilities other than the passenger terminal is estimated using the following equation. This is an empirical formula that is used in drawing up master plans for Japanese port projects. This formula permits a simple forecast of the total traffic volume generated by port activities from a macroscopic view point.

Planned traffic volume (vehicles/hour)

$$= Z \times \frac{1}{w} \times \frac{\alpha}{12} \times \frac{\beta}{30} \times \frac{(1+\delta)}{\varepsilon} \times \gamma$$

where
- Z : Annual cargo volume (tons)
- w : Average tonnage/truck
- α : Monthly variation (peak/ordinary)
- β : Daily variation (peak/ordinary)
- δ : Rate of related vehicles (related vehicles/all vehicles)
- ε : Loading rate (loading trucks/all trucks)
- γ : Hourly variation (generated traffic volume of peak hour/generated traffic volume of peak day)

The following values for the parameters are employed to calculate the traffic volume in the year 2005.

w = trucks 7 tons, containers 11 tons,
bus 80 passengers

α = 1.0

β = 1.5

δ = General cargo berth 0.5, container berth 0.2
Passenger terminal 0.5

ε = 0.5

γ = 0.2

The traffic volume which will be generated by the proposed port facilities in the target years is calculated in Table 8.4.11.

Table 8.4.11 Estimated Volume of Port-related Traffic

Year	2005
General Berths	425
Container Berths	124
Passenger Terminal	458

(2) Based on the estimated traffic volume, the necessary number of lanes per side is estimated as one lane. But, considering the future development around the project site and the actual heavy traffic caused by rickshaws and auto-rickshaws, the new road is planned with two lanes per side.

8.4.8 Examination of the capacity of the river channel

(1) As Dhaka Port and Narayanganj Port are river ports, the river traffic capacity should be examined to ensure smooth vessel operation and to confirm that the port facilities can actually support the forecast demand. Table 8.4.12 and 8.4.13 show the actual records of river traffic at both ports. Dhaka Port has much heavier traffic than Narayanganj Port. So, it is sufficient to only evaluate the situation at Dhaka Port.

(2) Evaluation method

Vessels moving in the same direction keep a constant distance (stopping distance) to ensure safe navigation. This distance is generally called the "Blocking area". This concept of "stopping distance" is used in evaluating the capacity of the river channel.

The assumptions used for the examination are as follows:

Table 8.4.12 River Traffic (Feb. 28 - Mar. 19, 1986)
Dhaka: Fatulla (Upstream)

(Unit: number of vessels)

Hour	6	7	8	9	10	11	12	13	14	15	16	17	Total
Coaster	3	5	4	9	3	2	2	4	6	2	0	1	11
Cargo Launch	17	15	22	27	23	30	39	28	42	39	34	24	340
Flat/Barge	0	1	3	4	5	2	1	10	2	3	4	2	37
Passenger Launch	38	53	66	104	93	75	80	79	127	90	86	73	964
Mechanized Country Boat	35	48	53	51	56	65	63	82	98	82	95	84	812
Manual Country Boat (1)	55	48	70	49	58	45	119	101	101	86	58	53	843
Manual Country Boat(2+)	650	796	915	1317	1265	792	596	625	618	644	674	530	9422
Total	798	966	1133	1561	1503	1011	900	929	994	946	951	767	12459

Source: Study Team Survey

Table 8.4.13 River Traffic (Feb. 28-Mar. 19, 1986)
Narayanganj: Tolaram Premisses (Upstream)

(Unit: number of vessels)

Hour	6	7	8	9	10	11	12	13	14	15	16	17	Total
Coaster	1	2	10	6	5	5	3	11	4	3	3	2	55
Cargo Launch	5	10	27	19	17	25	32	25	35	29	35	28	287
Flat/Barge	0	0	8	16	8	16	15	9	4	3	3	4	86
Passenger Launch	31	44	45	69	95	91	95	116	89	58	96	89	918
Mechanized Country Boat	53	26	45	25	24	24	42	36	45	26	36	34	416
Manual Country Boat (1)	93	66	100	101	66	60	55	44	54	50	48	39	776
Manual Country Boat(2+)	143	256	418	390	323	258	297	308	297	359	352	268	3669
Total	326	404	653	626	538	479	539	549	528	528	573	464	6207

Source: Study Team Survey

(i) Each vessel can pass an imaginary base line at a certain point in the river only after the prior vessel has advanced the stopping distance from the base line.

(ii) Stopping distance: 300 m
(5 times the length of coasters)

(iii) Navigation speed in port area: 5 knots

(iv) Objective vessels: coasters, cargo launches, passenger launches, flats/barges

(v) Calculation model: Queuing theory
(average clearance time = 0.5 vessels/min)

(3) Analysis of the actual situation

The average vessel arrival to the base line is 0.09 vessels/min from Table 8.4.12. Assuming that the distribution of the vessel arrival is a Poisson distribution, the following values are calculated.

Average waiting vessels at base line	0.04 vessels/min
Average waiting time	0.44 min/vessel

Accordingly, it can be judged that the river channel of Dhaka Port has a sufficient capacity to accommodate the traffic volume at present.

(4) Traffic capacity in the year 2005

Table 8.4.14 Average number of vessel arrivals

Actual record of average vessel arrivals	0.09 vessels/min
Additional traffic by the Master Plan * container vessels * coasters * passenger launches	 0.003 0.007 0.140
Total	0.24 vessels/min

So, assuming the Master Plan is implemented, in the year 2005:

average waiting vessels at base line	0.04 vessels/min
average waiting time	1.8 min/vessel

These values mean that the 50% of the total vessels will theoretically wait two minutes to pass the base line. However, there is sufficient flexibility in actual vessel operations to adjust two minutes.

Accordingly, it can be stated that the channel capacity at Dhaka Port is sufficient to accommodate the forecast traffic volume in the target year.

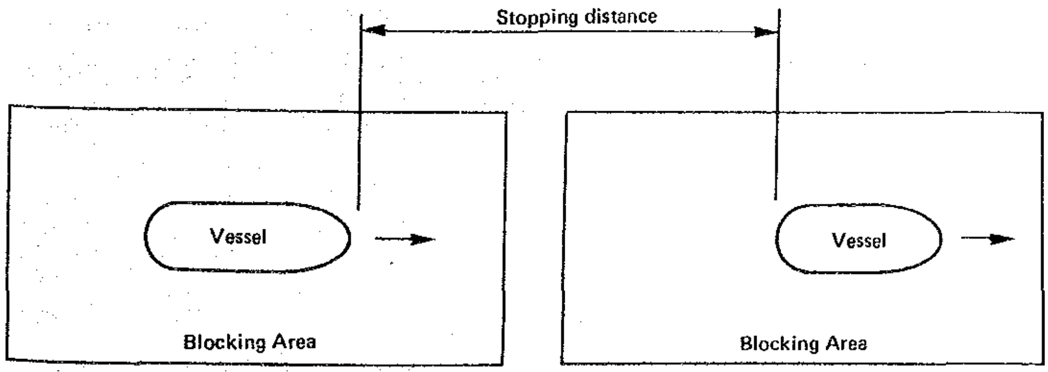


Fig. 8.4.11 Blocking Area

8.4.9 Land Use Plan

The Master Plan should include a land use plan for the land area nearby the ports which will be used for port activities and other urban activities. Specifically, the Master Plan should include sufficient land for port activities as estimated in Chapter 6, and land for the grain terminal which is calculated below.

Land requirement of the grain terminal

(i) The handling capacities of existing facilities as provided by the Food Department are:

Dhaka	Mill Barrack	8,000 tons
N'ganj	Ekrampur	21,000 tons
N'ganj	Silo	50,000 tons
Total		79,000 tons

Assuming the turnover is four times per year, the present grain handling capacity is 316 thousand tons per year. The forecast grain cargo volume of I.W.T. is 1,601 thousand tons as noted in chapter 6.

(ii) Required land scale

Turnover 10 times a year

Land unit value 0.3 m^2/ton

Required land area = (1,601-316) ÷ 10x0.3

= 38,550m^2

8.5 Alternative Master Plans

8.5.1 Analysis of the Project Sites to formulate the Alternative Master Plans

(1) In the minutes of meeting on the Progress Report on March 23, 1986, it was agreed that five project sites would be examined for the project. These five sites are analysed in light of natural conditions and planning aspects such as actual land utilization (refer to "8.3 Project Sites"). Based on these analyses, the Study Team selected four project sites to formulate teh alternative master plans.

(2) These four project sites are only slightly defferent in terms of natural conditions, and the construction costs of same scale facilities at each site are almost equal. The only difference is the construction cost of access roads to connect with the existing road around the site. Accordingly, it can be stated that the most advantageous site is "A", considering the shorter length of the required access road, followed by "B", "A" and "G".

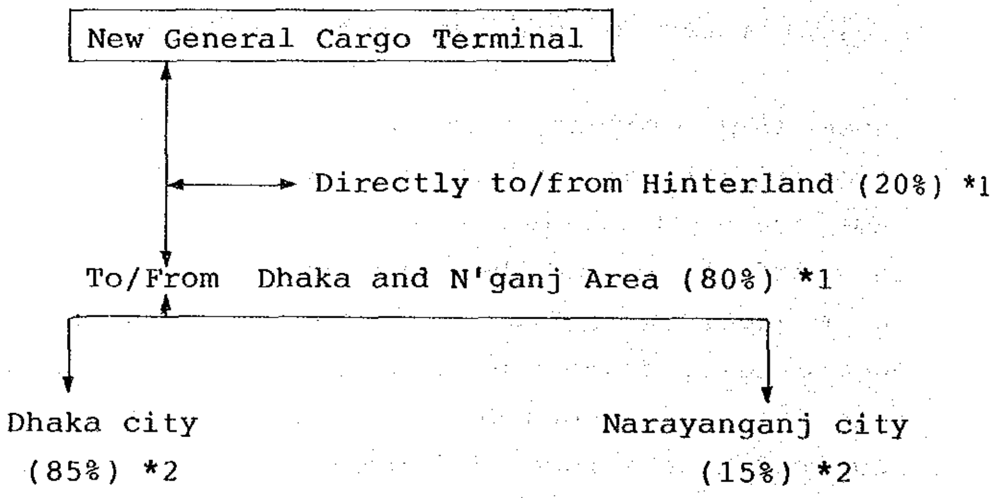
(3) As for the direct benefits derived from the development project, the benefits are savings in ship waiting cost, transportation cost, cargo handling cost, pilferage and damage of cargo. However, the savings except for the relative short distance feeder costs are almost the same for all the proposed sites. Therefore, the individual feeder cost from each proposed site to/from the cargo destinations is examined from the economic viewpoints. The feeder costs are analysed as follows.

(i) Road distance to/from the proposed sites

Proposed site	Dhaka	Narayanganj
" A "	10 km	12 km
" A'"	11	24 *
" B "	7	20 *
" G "	22	12

* Using the Dhaka-Narayanganj Road By-pass

(ii) Cargo flow



*1 OD Survey by the Study Team (18.2.1986-19.3.1986)

*2 Future Population Distribution in Dhaka and Narayanganj Metropolitan Area made by the Study Team (Table 6.6.3)

(iii) Feeder Transportation Cost by Truck

Fixed cost	53.5	Tk/hr
Variable cost	5.02	Tk/km
Non-steaming hours per trip	1.5	hours
Average speed	30	Km/hr
Overall Average load	4.7	tons

Proposed site	" A "		" A' "		" B "		" G "	
to/from	Dhaka	N'ganj	Dhaka	N'ganj	Dhaka	N'ganj	Dhaka	N'ganj
Distance (km)	10	12	11	24	7	20	22	12
Running hours	0.67	0.80	0.73	1.60	0.47	1.33	1.47	0.80
Trip hours	2.17	2.30	2.23	3.10	1.97	2.83	2.97	2.30
Fixed cost (Tk)	116.1	123.1	119.3	165.9	105.4	151.4	158.9	123.1
Viraiable cost (Tk)	100.4	120.5	100.4	241.0	70.3	200.8	220.9	120.5
Total cost (Tk)	216.5	243.6	229.7	406.9	175.7	352.2	379.8	243.6
Transport cost (Tk/t)	46.1	51.8	48.9	86.6	37.4	74.9	80.8	51.8
Average feeder transportation cost (Tk/t)	47.0		54.6		43.0		76.5	

As a result of the examination of feeder transportation cost, it can be summarized that the most advantageous site is "B" followed by "A", "A'" and "G".

8.5.2 Layout of the Alternative Master Plan

Based on the previous analysis, three alternative master plans, A, B and C, covering project site A, B, A' and G are designed as shown in Fig. 8.5.1-8.5.3. Special considerations have been made in preparing each alternative plan, as outlined below.

(Plan A)

General Cargo Berths ... Sites A' and B have a big potential for development around the sites because of the construction of the Buriganga River Bridge. The land cost is not so high compared with opposite side. The general cargo berth can function as nucleus of regional development supporting small/medium port-oriented industries.

Container berths... The container terminal functions as the link between sea and land transportation for container cargoes. Thus, good connections with overland transportation modes are essential for the smooth functioning of this facility. Considering the proposed expansion of the container terminal and the connection with the railways, the container terminal should be located at Site A.

Passenger terminal... The present terminals at Dhaka and Narayanganj Ports can not possibly be expanded to meet the future demand. In this Master Plan, a new passenger terminal is planned for middle and long distance service. Thus, as long as access is secured, it is not necessary that the passenger terminal be located close to the city center. As stated in the traffic forecast, passenger vessels will call frequently, and a large mooring basin is required. Accordingly, the passenger terminal is proposed to be located at site B.

(Plan B)

General cargo berths, Container berths...Container berths and general cargo berths are planned at site G to function efficiently as a one I.W.T. terminal and to avoid mixed land utilization with existing urban areas.

Passenger terminal ... Same as Plan A.

(Pla C)

General cargo berth... Most of the cargoes handled in general berths are bulk cargoes, so the general berths do not necessarily have to be located near the urban area. In an effort to develop both ports considering the urban development of Dhaka and Narayanganj cities, the general berths are proposed at site G.

Container berth, Passenger terminal... Same as Plan A.

8.5.3 Evaluation of the Alternative Master Plans

(1) Criteria for evaluation

The alternative plans are evaluated based on following criteria:

(i) Convenience

Maneuverability of vessels - Ease of entry/departure and berthing/deberthing of vessels.
Land use - ease with which cargo can be stored or transported, from the standpoint of users, considering the shape of the reclaimed land and the arrangement of facilities and roads.
Operation of facilities - effectiveness with which port facilities and loading equipment can be operated.

(ii) Safety

Emergency measures - effectiveness and adaptability of measures to deal with accidents occuring inside the port.

(iii) Economy

Total construction cost - minimization of the total construction budget, considering topography, soil conditions etc., Balance between dredging volume and reclamation volume.
Timing - minimization of investment and maximization of effect while conforming to the requirements of early construction and early start of service.

(iv) Flexibility of the Plan

Adaptability to changing conditions - whether it is possible to alter the plan to adopt to changing circumstances.
Potential for future development - availability of room for future expansion in order to meet future demands after 2005.

(v) Environmental Protection

Impact on the social environment - Harmful effects on the living standards of citizens in terms of noise and vibrations created by port activities.
Impact on the natural environment - minimization of deleterious effects on the river flow.

(2) Selection of the Optimum Plan

Alternative plans A, B and C are evaluated according to the above-mentioned criteria, as shown in Table 8.5.1.

As can be seen from the evaluation, the relative advantages of the plans do not differ greatly, but Plan A, by comparison, has following merits:

(i) Maximum utilization of the development efforts of the new Buriganga River Bridge.

(ii) Efficient port operation due to the concentrated layout of new port facilities.

(iii) Flexibility in terms of stage-by-stage construction.

(iv) Minimum feeder transportation cost to the hinterland

(v) Project site "G" can be reserved for future expansion of port activities after the year 2005.

Thus, Plan A may be recommended as the best alternative.

Table 8.5.1 Evaluation of Alternative Plans

Evaluation Items		Evaluation Plan A	Plan B	Plan C
Convenience	Maneuverability of vessels	○	○	○
	Land use	◎	○	○
	Operation of the facilities	○	○	○
Safety	Emergency measures	○	○	○
Economy	Total construction cost	◎	○	○
	Distribution of the Investment	◎	○	○
Flexibility of planning	Measures for anticipated future change	◎	○	○
	Future development	○	○	○
Environmental aspects	Effects on social environment	○	○	◎
	Effects on natural environment	○	△	○

Note: Ranking of evaluation ◎ Excellent
○ Ordinary
△ Some problems

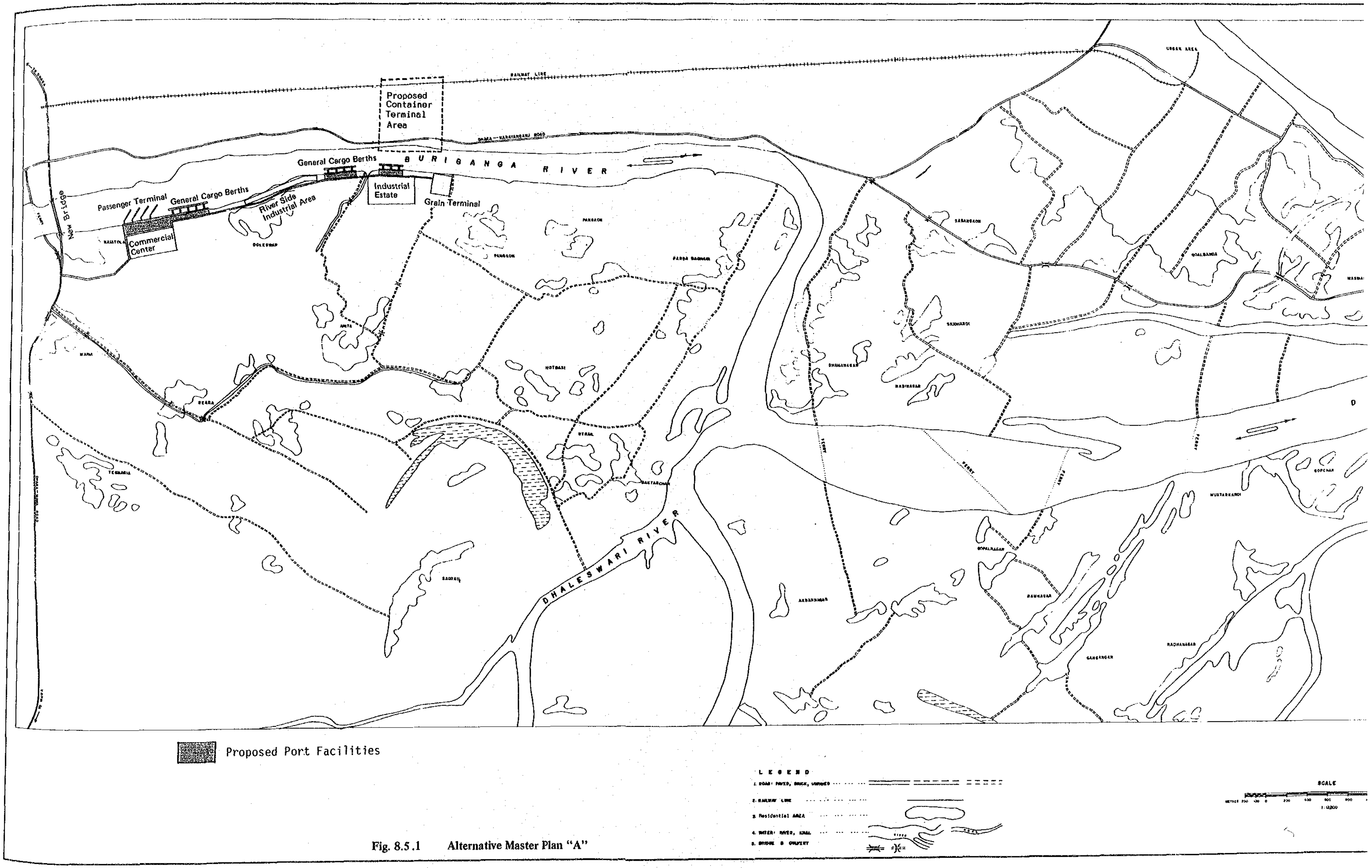
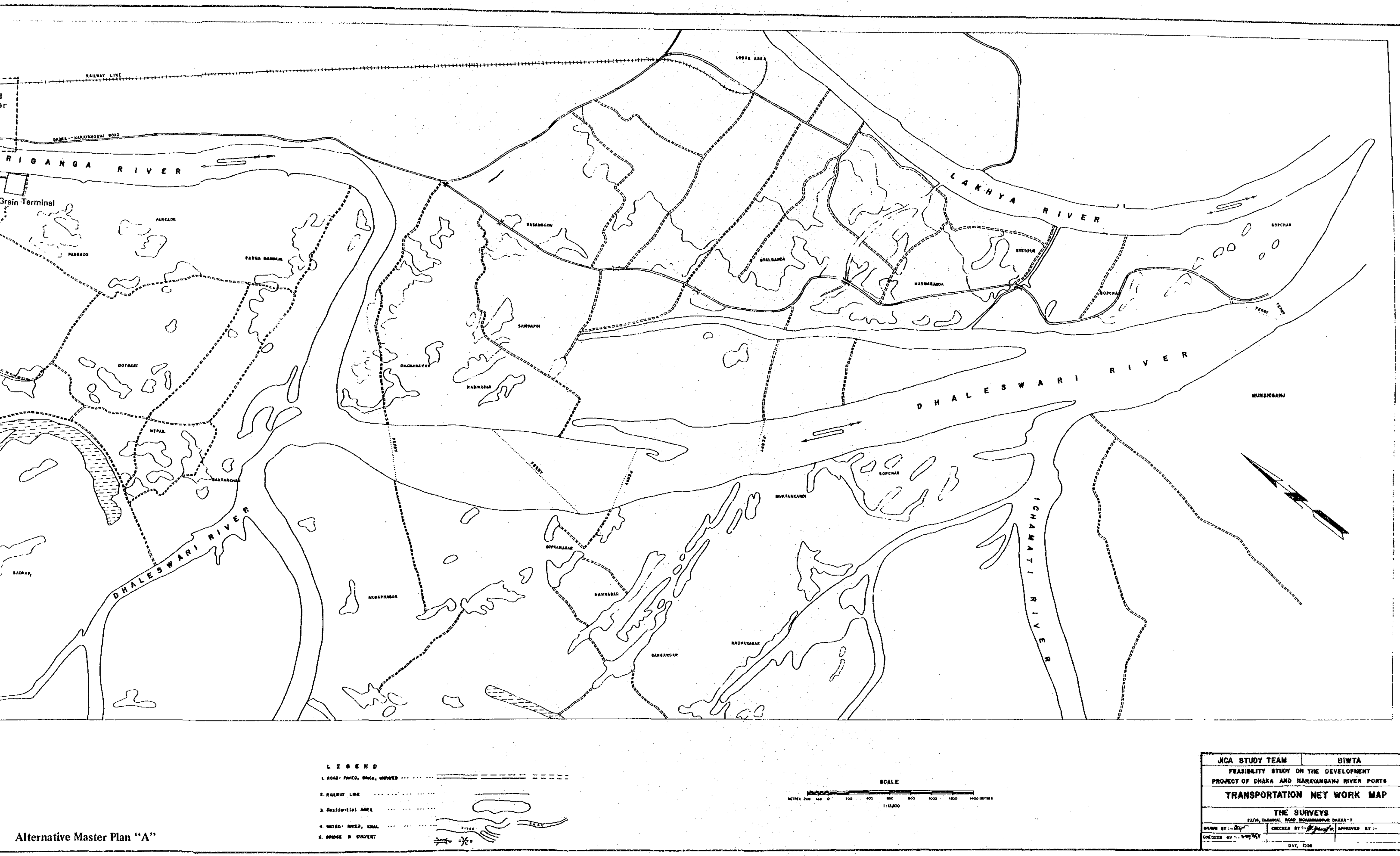


Fig. 8.5.1 Alternative Master Plan "A"



Alternative Master Plan "A"

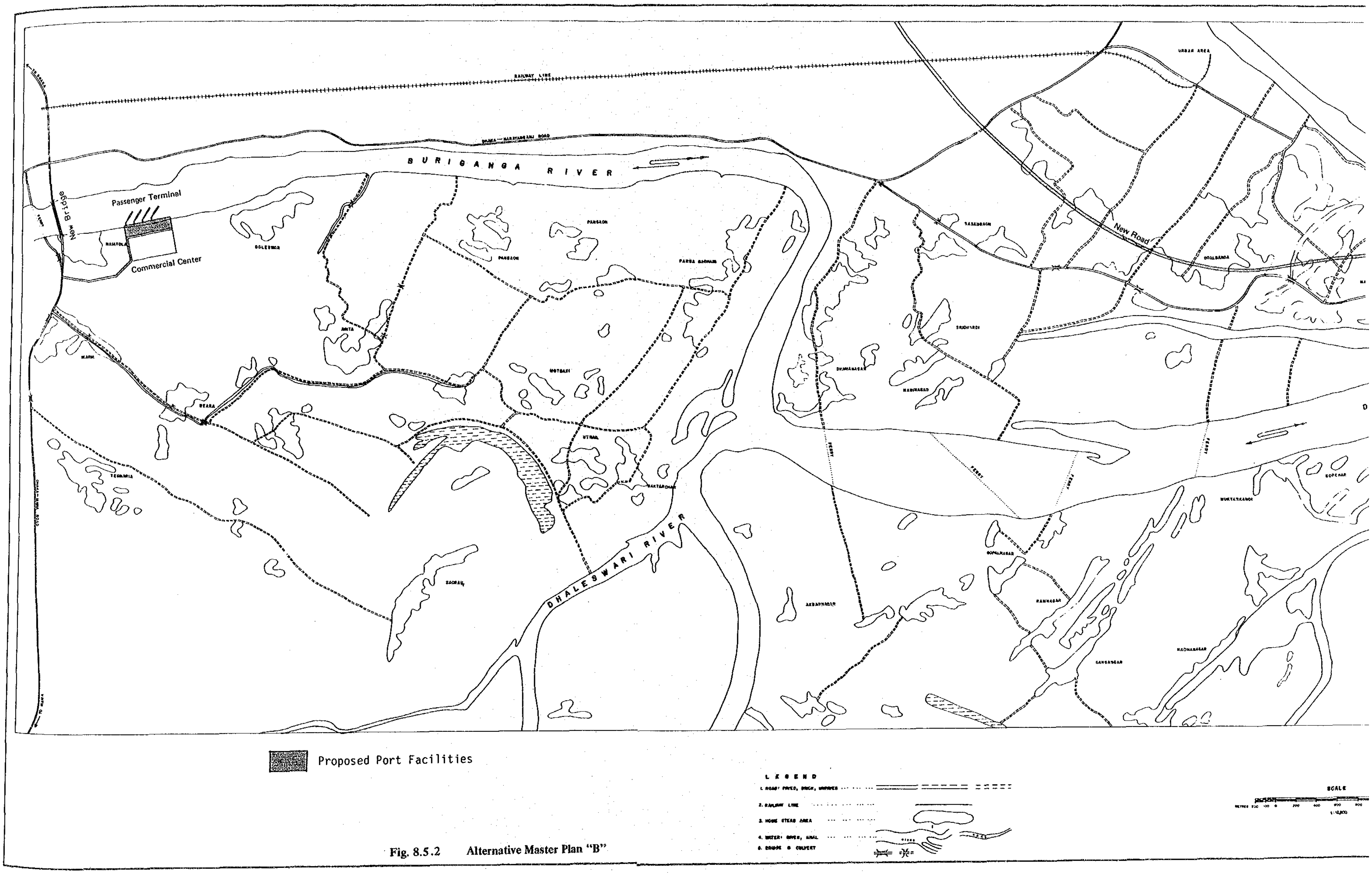
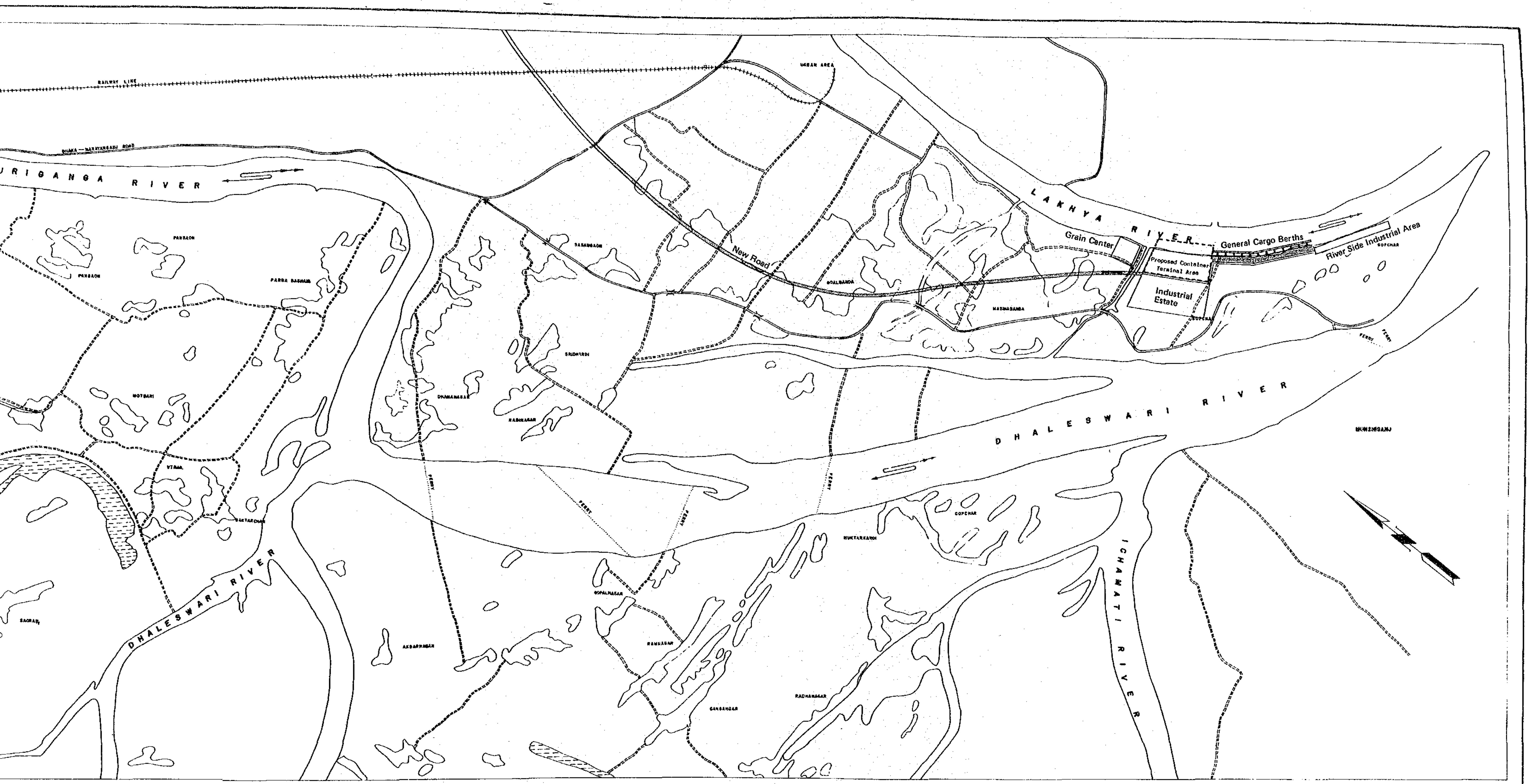


Fig. 8.5.2 Alternative Master Plan "B"

ilities



LEGEND

1. ROAD: PAVED, BRICK, UNPAVED
2. RAILWAY LINE
3. HOME STEAD AREA
4. WATER: RIVER, KHAL
5. BRIDGE & CULVERT

SCALE

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FEASIBILITY STUDY ON THE DEVELOPMENT PROJECT OF DHAKA AND NARAYANGANJ RIVER PORTS

TRANSPORTATION NET WORK MAP

THE SURVEYS

.2 Alternative Master Plan "B"

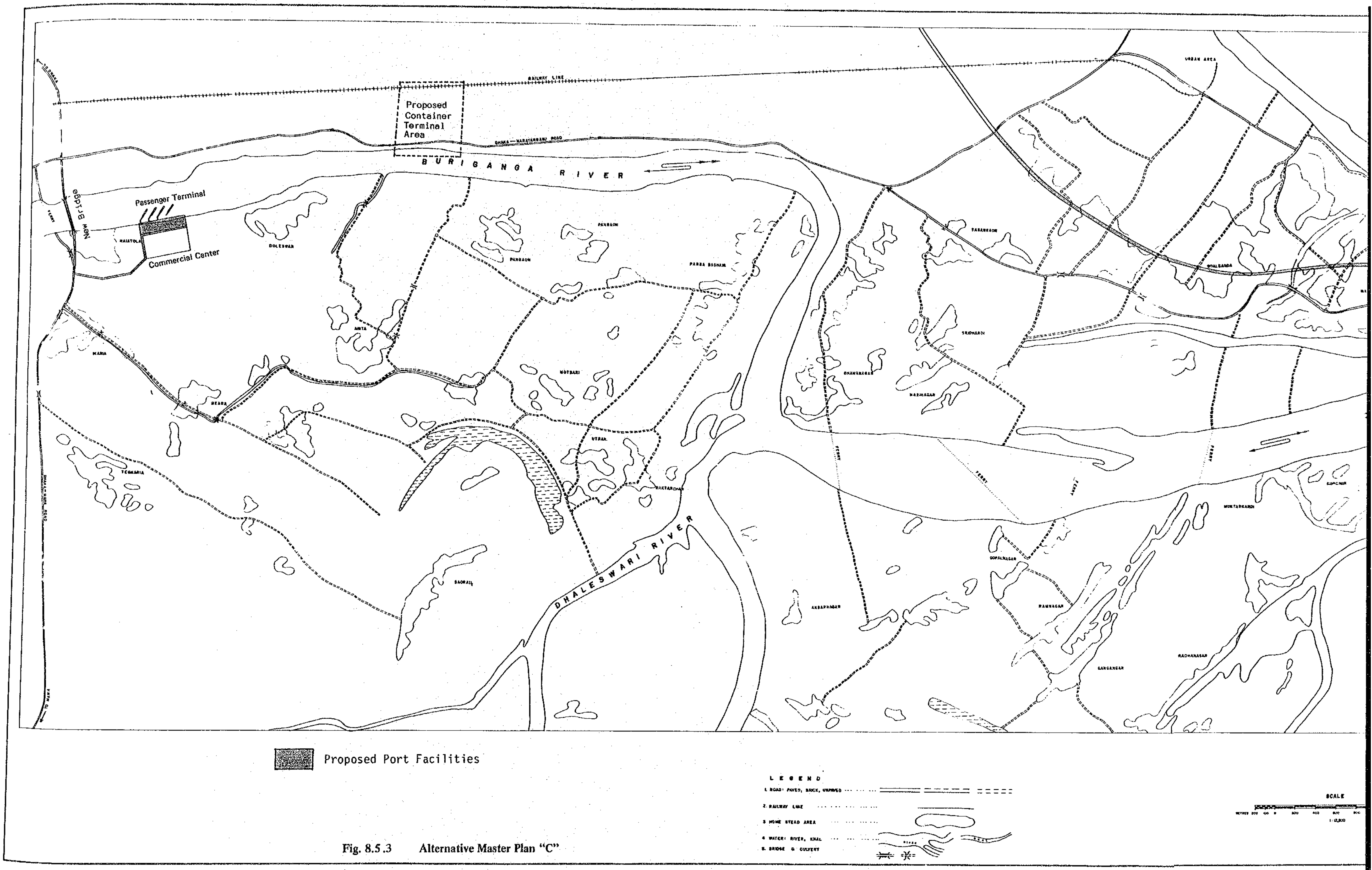
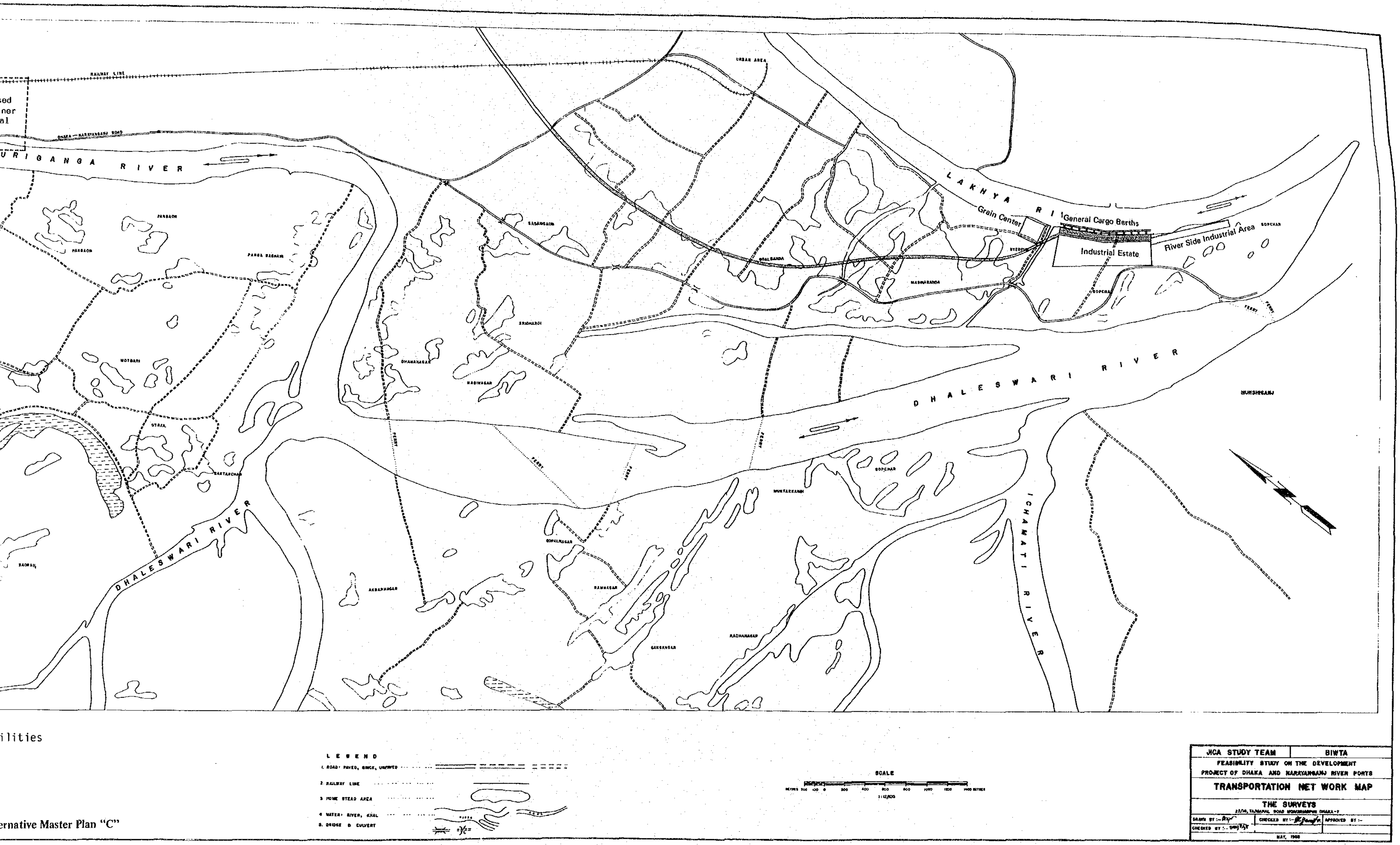


Fig. 8.5.3 Alternative Master Plan "C"



ilities

ernative Master Plan "C"

CHAPTER 9
SHORT-TERM DEVELOPMENT PLAN

CHAPTER 9 SHORT-TERM DEVELOPMENT PLAN

9.1 General

(1) The major short-term goals for the development of Dhaka and Narayanganj Ports by 1995 include supplementation of facilities and improvement of operations.

With regard to the facilities, the notable problems are the shortage of facilities to adequately handle the large volume of cargo and the obsolescence of the facilities that do exist. Of these two problems, the shortage of facilities is more acute. So, it is necessary to design the Short-term Plan efficiently using the existing facilities.

The present facilities must be maintained at their same level for the time being. Further improvements include the use of transit sheds and the introduction of measures to prevent cargo damage during loading, unloading and storage. Although changing over to these new systems is desirable in the long run, a short term policy aimed at expanding the actual number of certain key facilities will ensure smooth cargo handling in the near future, and will function as a step towards the implementation of the master plan.

(2) As mentioned in Chapter 8, the container transport by I.W.T. will be optimized if exclusive container vessels are utilized for Inland Water Transport, but the required investment for an inland container depot would be very costly as it would include container cranes, a container freight station and a marshalling yard. The cost of the general cargo berths would be comparatively low. Furthermore, before making a decision on the desirability of constructions an inland depot it would first be necessary to conduct a study on the modal split of container transportation considering the comprehensive transportation network. There are two ongoing studies

being conducted by IBRD an ADB concerning these factors. The comprehensive flow of inland container transportation is beyond of the scope of this JICA Study.

In this connection, it is not appropriate to examine the feasibility of a container terminal considering only the IWT sector. So, in this study, the short-term development of the container terminal is not considered.

9.2 General Cargo Berth Planning

9.2.1 Cargo Handling Volume for Port Facilities Planning

Based on the same method used in Chapter 8, the cargo handling volume and cargo allocation in the year 1995 is estimated as shown in Tables 9.2.1 and 9.2.2.

Table 9.2.1 Cargo Handling Volume in the Year 1995

(Unit: thousand tons)

	Public cargoes			Private cargoes			All cargoes		
	In	Out	Total	In	Out	Total	In	Out	Total
(Bulk)									
Grain	116		116	637		637	753		753
Cement	270		270	91		91	361		361
Fertilizer		465	465					465	465
POL				595	119	714	595	119	714
Iron & Steel	81		81				81		81
Other	200	20	220				200	20	200
(Non-Bulk)									
Jute				6	86	92	6	86	92
Jute Goods					88	88		88	88
Other	144	23	167				144	23	167
(Container)									
Container	162	223	385				162	223	385
Total	973	731	1,704	1,329	293	1,622	2,302	1,024	3,326

Table 9.2.2 Forecast Cargo Allocation in the Year 1995

(Unit: thousand tons)

	Dhaka Port		Narayanganj Port	
Existing Facilities	Badamtali	Cement 118 Bulk 54	Khanpur	Fertilizer 142
			Ekranpur	Grain 84
	Mill Barracks	Grain 32	Ghat No.5-8	Fertilizer 315 Bulk 146
	M.M. Oil Mill	Cement 152		
New Facilities	Container Terminal New General Cargo Berths			Container 385* Non-Bulk 167 Iron & Steel 81 Fertilizer 8 Bulk 20 Sub-Total 276

* Jute, Jute Goods 194
General Cargo 191

9.2.2 Required Number of Berths

The same method used in section 8.4.4 is applied here to determine the required number of general cargo berths for the Short-Term Development Plan.

(1) Assumptions

Forecast cargo volume	276 thousand tons
Average loading/unloading cargo volume per vessel	750 tons/vessel
Cargo handling capacity per jetty	300 tons/day
Distribution of vessel calls	Poisson distribution
Distribution of loading/unloading time	Poisson distribution
Working days per year	300 days
Berth cost per day	42,200 T.K./day
Vessel cost per day	16,700 T.K./day

(2) Calculation results

Required number of berths	4 berths
Average waiting vessels per day	1.767 vessels/day
Average waiting time per vessel	1.441 days/vessel
Occupancy ratio	76.7 %

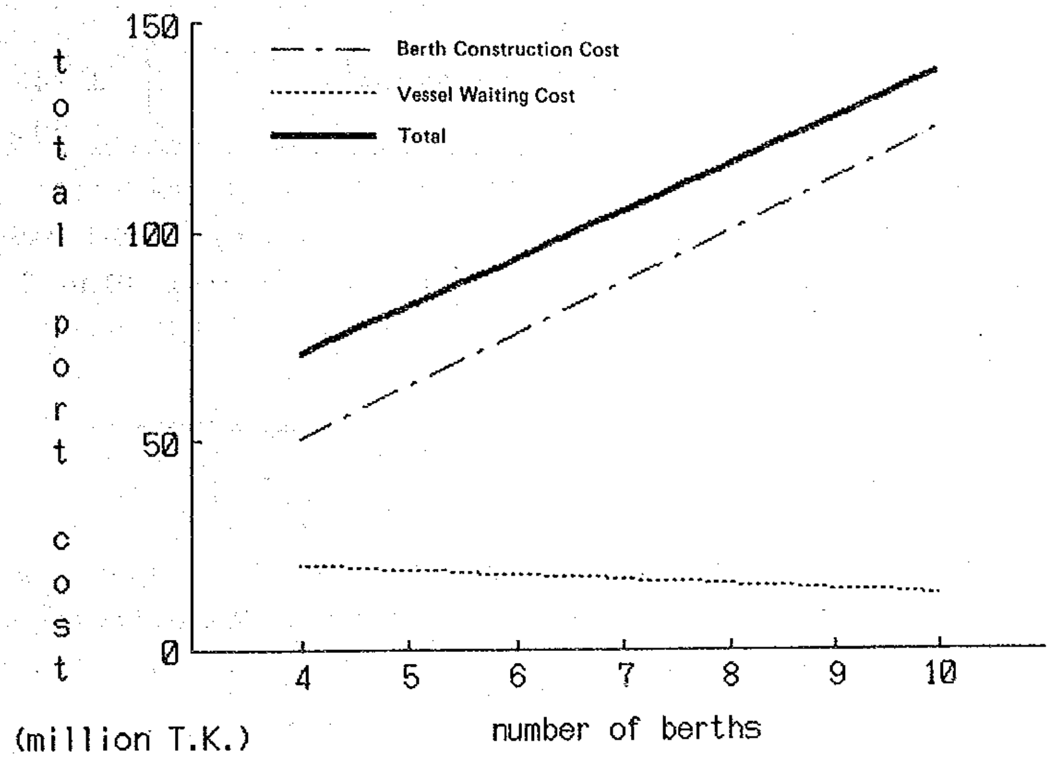


Fig. 9.2.1 Required Number of General Cargo Berths

9.2.3 Transit Sheds

The necessary area of transit sheds is generally determined by the following formula.

$$A = \frac{N}{R \alpha w}$$

where, A: Necessary area of transit sheds (m^2)

N: Annual volume of cargo handled (tons)

R: Turnover : 20 times/year

α: Utilization rate: 0.7

w: Volume of cargo per unit area: 3.0 tons/m^2

Assuming that 30% of the forecast cargo volume for general berths based on the existing circumstance is handled through transit sheds, the required area of transit sheds is calculated as follows:

Table 9.2.3 Required Area of Transit Sheds

Year	1995
required number of berths	2
necessary area of transit sheds (m^2)	3,943
area per berth (m^2)	990

Considering the continuity to the Master Plan, the same area of transit sheds proposed under the Master Plan is also proposed under the short-term plan.

9.2.4 Planned Traffic Volume Related to the Proposed Facilities

(1) The overland traffic volume which will be generated from the port facilities is estimated using the following equation.

Planned traffic volume (vehicles/hour)

$$= z \times \frac{1}{w} \times \frac{\alpha}{12} \times \frac{\beta}{30} + \frac{(1+\delta)}{\epsilon} \times \gamma$$

where Z : Annual cargo volume (tons)

w : Average tonnage/truck

α : Monthly variation (peak/ordinary)

β : Daily variation (peak/ordinary)

δ : Rate of related vehicles (related vehicles/all vehicles)

ϵ : Loading rate (loading trucks/all trucks)

γ : Hourly variation (generated traffic volume of peak hour/generated traffic volume of peak day)

The following values for the parameters are employed to calculate the traffic volume in the year 1995.

w = 7 tons

α = 1.0

β = 1.5

δ = General cargo berths 0.5

ϵ = 0.5

γ = 0.2

The traffic volume which will be generated by the proposed port facilities in the target year is thus calculated as shown in Table 9.2.4.

Table 9.2.4 Estimated Volume of Port-related Traffic

Year	1995
General Berths	98

(2) Based on the estimated traffic volume, the necessary number of lanes per side is estimated as one lane.

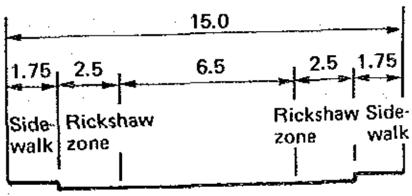


Fig. 9.2.2 Standard Section of Road

9.2.5 Construction Schedule of General Cargo Berths

The construction plan with the target year of 1995 must naturally be executed in stages. When planning the construction, attention must be paid to the following points: (a) availability of facilities to meet changing cargo volumes: (b), minimization of the disruptive effects of construction on daily port operations, and (c) even distribution of the construction investment so that it is not over-concentrated at any single development stage. The construction investment will continuously stimulate the regional economy, and will help the local economy achieve stability.

(1) The per berth cargo handling capacity of the existing facilities is 71 thousand tons as mentioned in Chapter 8.

Badamtali	R.C.C. jetties	2 berths	142 thousand tons
Khanpur	R.C.C. jetties	2 berths	142 thousand tons
Ghat No.5	R.C.C. jetties	1 berth	71 thousand tons

(2) The cargo handling capacity of the proposed new general cargo berth is 69 thousand tons calculated as follows:

76.7% x 300 days x 300 ton/day = 69 thousand tons

(3) Based on the above assumptions and Table 9.2.3, the construction schedule of the new general cargo berths is presented in Table 9.2.4.

Table 9.2.5 Construction Schedule of New General Cargo Berths

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
(A) Cargo handling volume by Coasters(thousand tons)	253	283	315	351	392	438	489	545	609	680
(B) Number of Existing Berths										
Badamtali	2	2	2	2	0	0	0	0	0	0
Khanpur	2	2	2	2	2	2	2	2	2	2
Ghat No. 5	1	1	1	1	1	1	1	1	1	1
Total	5	5	5	5	3	3	3	3	3	3
(C) Cargo handling capacity of the Existing Berths (71 thousand tons/berth)	355	355	355	355	213	213	213	213	213	213
(D) Overflow Cargo of the Existing Berths (A-C)	0	0	0	0	179	225	276	332	396	467
(E) Number of New General Cargo Berths	0	0	0	0	3(+3)	4(+1)	4	4	4	4
(F) Cargo handling Volume of the New General Cargo Berths (69 thousand tons/berth)	0	0	0	0	207	276	276	276	276	276
(G) Transfer Cargo to Container Terminal (D-F)	0	0	0	0	0	0	0	56	120	191

9.3 Passenger Terminal Planning

9.3.1 Number of Passengers in the year 1995

Table 9.3.1 Estimated Number of Passengers per day

	Average daily Perfomance in 1986	The Year 1995
Short distance services	25,693	44,500 *1
Middle/Long distance services	19,619	29,400 *2
Total	45,312	73,900

*1 Calculated using the growth rate of the forecast number of Dhaka IWT passengers (6.3% per year)

*2 Calculated using the growth rate of the forecast number of National IWT passengers (4.6% per year)

9.3.2 Capacity of the Existing Passenger Terminals

(1) There are two main passenger terminals in the Dhaka/ Narayanganj Area and the outlines of the passenger facilities are shown in Table 9.3.2.

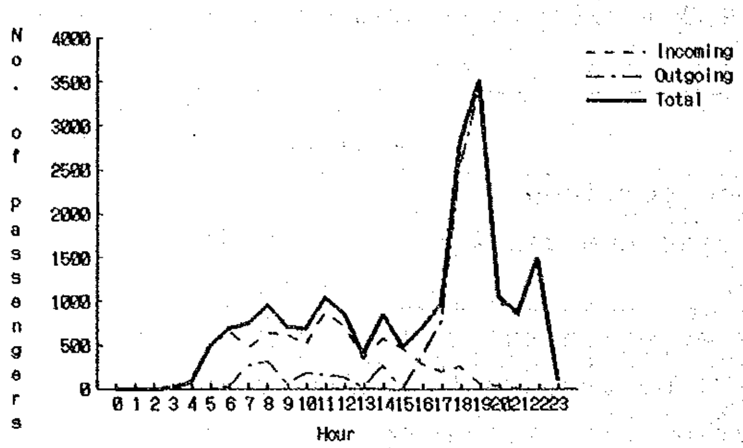
Table 9.3.2 Passenger Facilities

	Nature of Facilities	Year of Construction	Pontoon Size (feet)	Remarks
Dhaka Terminal	(a) 2 gangways & 6 pontoons (b) 2 gangways & 6 pontoons	1966/67 1983/84	6 x 100' x 25' 2 x 100' x 25'	Terminal Building
Narayanganj Terminal	2 gangways & 2 pontoons	1966/67	2 x 100' x 25'	Terminal Building

Source: BIWTA

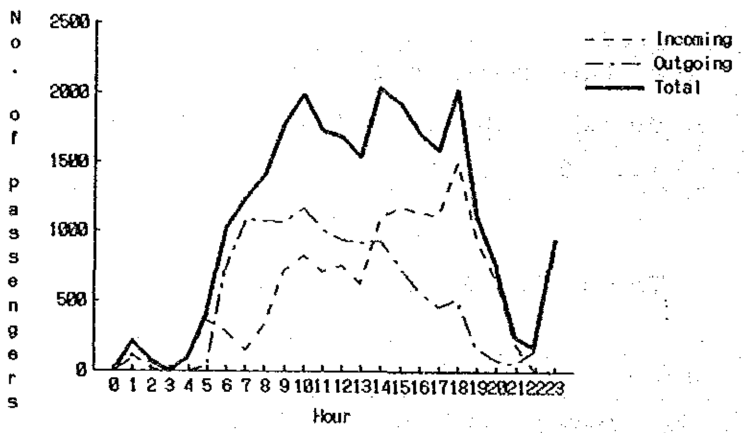
(2) The Study Team carried out a passenger movement survey at Dhaka and Narayanganj Port. The duration of the survey was 16 days, from 27 Feb. to 19 Mar. 1986, excluding 5 days due to a strike. An outline of the survey results is presented in Chapter 5 (Table 5.4.19 - 5.4.20).

Based on the original data of this survey, the hourly variation of passenger movement and of road traffic in Dhaka are shown in Fig. 9.3.1 - 9.3.4.



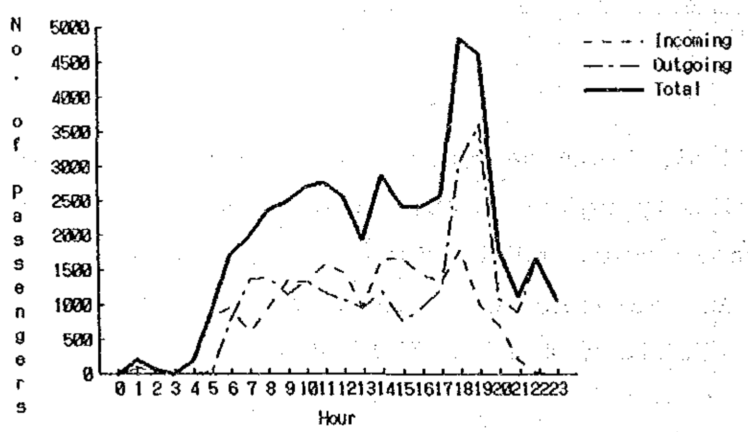
Number of Passengers: Dhaka + Narayanganj

Fig. 9.3.1 Hourly Variation of Passenger Movement (Middle/Long Distance)



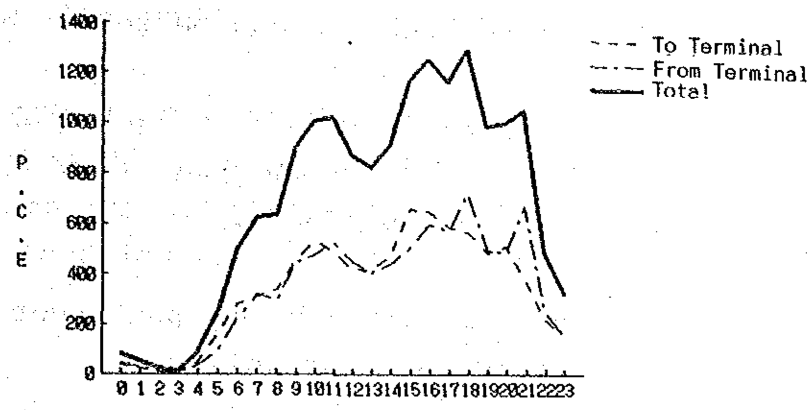
Number of Passengers: Dhaka + Narayanganj

Fig. 9.3.2 Hourly Variation of Passenger Movement (Short Distance)



Number of Passengers: Dhaka + Narayanganj

Fig. 9.3.3 Hourly Variation of Passenger Movement (All Routes)



P.C.E: Passenger Car Equivalent

Fig. 9.3.4 Hourly Variation of Road Traffic in Dhaka

(3) The main data in Fig. 9.3.1 - 9.3.4 can be summarized as follows:

(Passenger Movement)

Working time per day	19 hours	(04:00-23:00)
Number of passsengers at peak time	4843 passengers	(18:00-19:00)
Average number of passengers per hour	2359 passengers	
Hourly peak ratio	2.053	

(Road Traffic)

Working time per day	19 hours	(04:00-23:00)
Number of P.C.E. at peak time	1297 P.C.E.	(18:00-19:00)
Average P.C.E. per hour	860 P.C.E.	
Hourly peak ratio	1.508	

Note: P.C.E. means Passenger Car Equivalent

(4) As is clear from the above analysis, the hourly peak ratio of passenger movement shows a very high value and this means that the vessel operating schedule is not efficient in terms of the use of port facilities and roads. Generally speaking, the vessel operating schedule should be arranged so that the hourly peak ratio is 1.5. As the current ratio is high, the passenger terminal theoretically has a sufficient capacity to accommodate a larger number of passengers and

vessels, if the operating schedule can be rearranged.

On the other hand, BIWTA will develop 2 pontoons at the passenger terminal Dhaka Port by the year 1990 to accommodate more passenger vessels and passengers.

Accordingly, the capacity of the passenger terminal in the year 1995 can be calculated as follows:

(A) Number of passengers at peak time	4800 passengers
(B) Hourly peak ratio	1.5
(C) Working hours per day	19 hours
(D) Average number of passengers per hour ((A) ÷ (B))	3200 passengers
(E) Total length of the existing pontoons	1000 feet
(F) Additional (new) pontoons	200 feet

Thus, the capacity of the passenger terminal is

$$3,200 \times 19 \times \frac{1200}{1000} = 73,000 \text{ passengers}$$

So, it can be stated that the existing passenger terminal, including the two new pontoons which will be installed by BIWTA, can accommodate the forecast number of passengers in 1995 shown in Table 9.3.1, and it is not necessary to develop the new passenger terminal proposed in the master Plan before the year 1995.

9.4 Layout of the Short-term Development Plan

Within the framework of the selected Master Plan, the general cargo berths to be constructed during the short term development are planned as shown in Fig. 9.4.1 - 9.4.2 considering the use and location of facilities under the Master Plan.

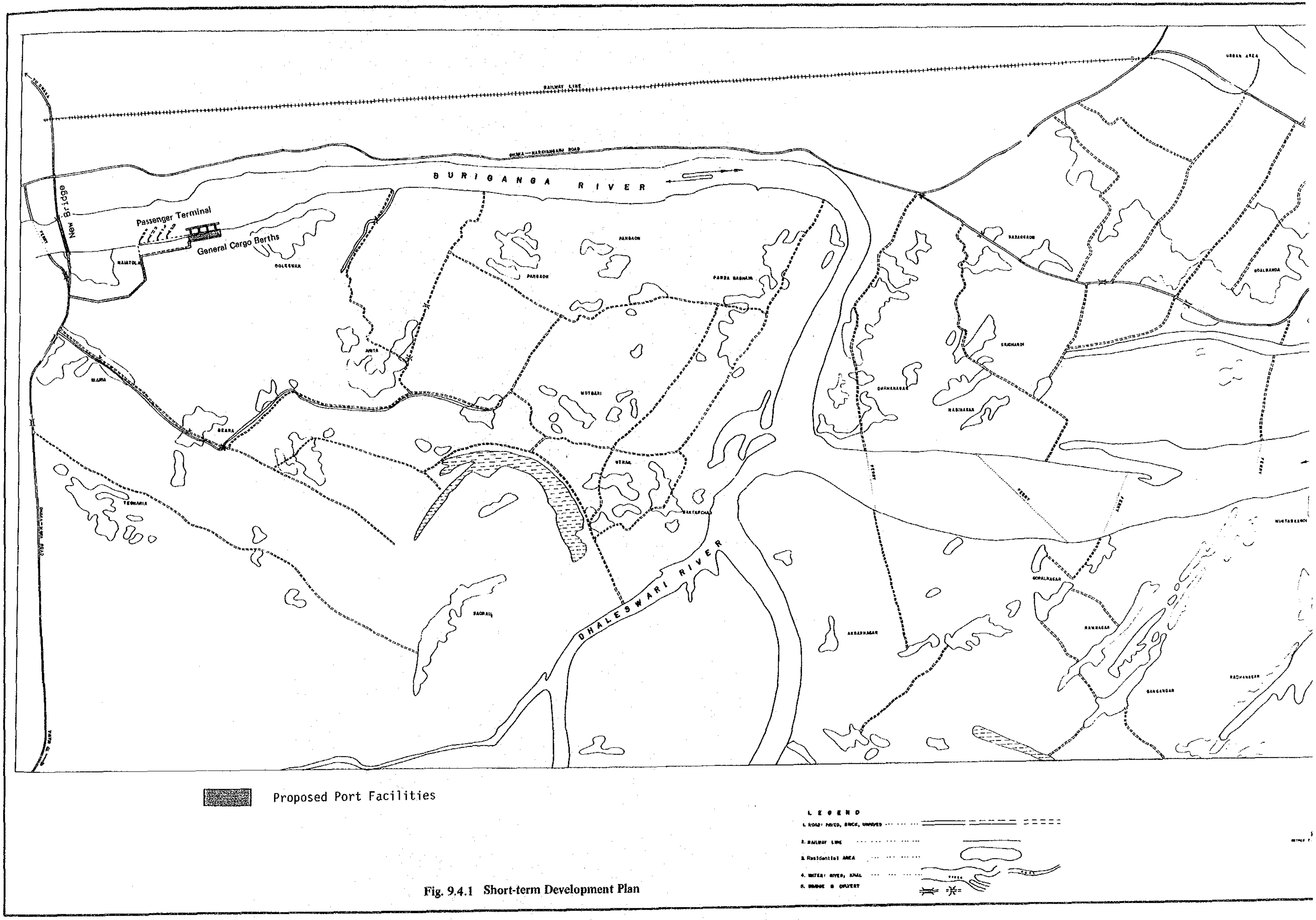
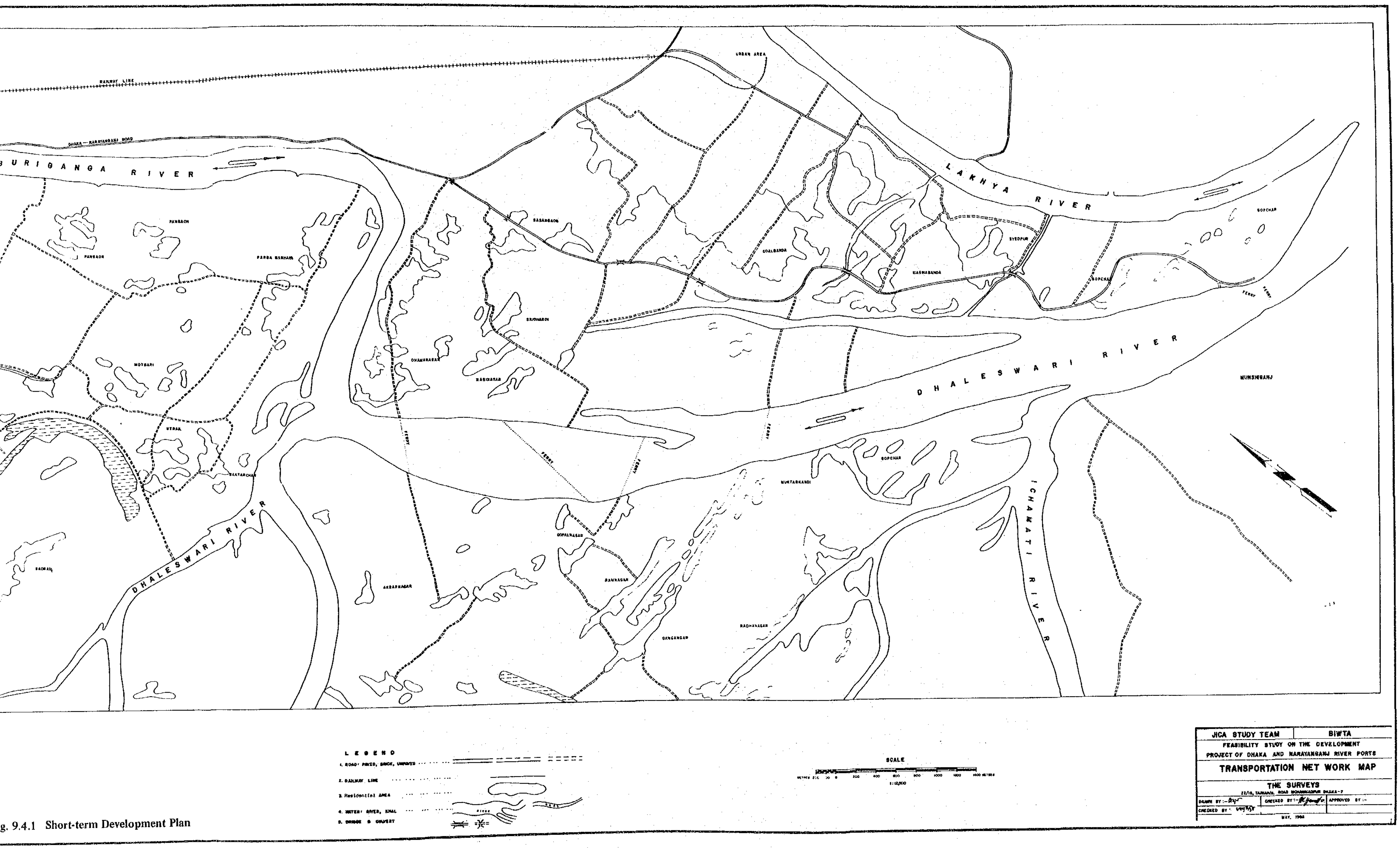


Fig. 9.4.1 Short-term Development Plan



g. 9.4.1 Short-term Development Plan

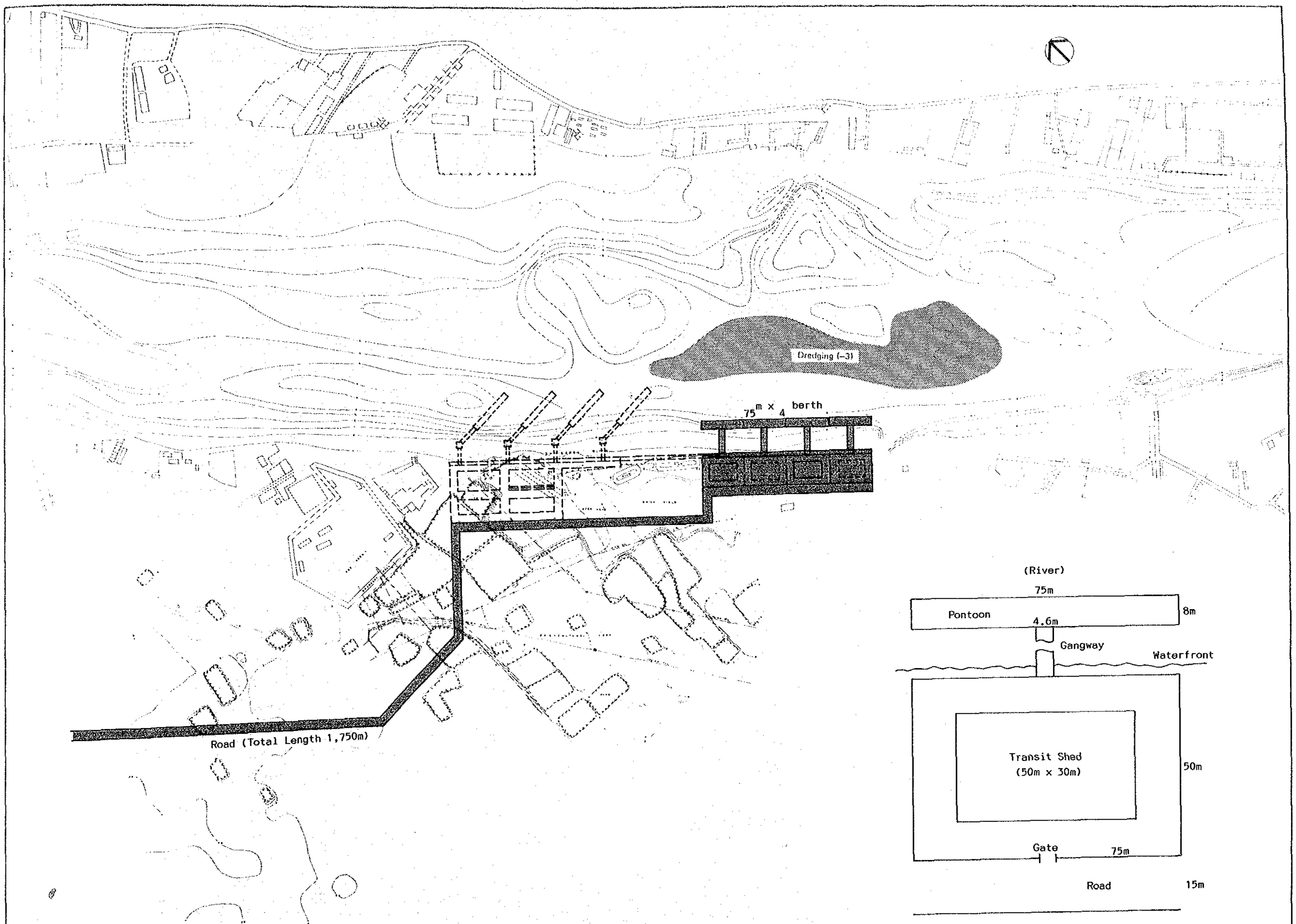


Fig. 9.4.2 Short-term Development Plan

9.5 Port Management and Operation

9.5.1 General

Port administration and operation systems vary greatly from country to country and from port to port. Furthermore, administrative and operating systems at individual ports change over time in response to changing circumstances. The main goal of port management and operation systems is to realize efficient port operations.

There are currently various problems which interfere with smooth port operations as mentioned in Chapters 5 and 8. These problems can be divided into two groups: planning aspects and operational aspects. The problems which can be resolved through proper facilities planning are considered in the Master Plan and the Short-term Development Plan.

Accordingly, this section considers operational aspects that should be improved to ensure improved productivity and smooth port operations in the future.

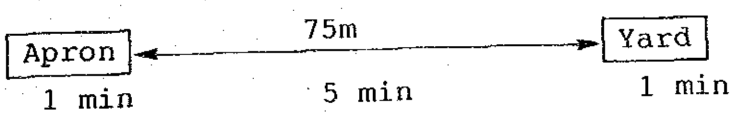
9.5.2 Cargo Handling System at the New General Cargo Berths

(1) Cargo handling cost analysis

(Conventional Cargo Handling)

(i) Performance of Head Loaders

Cargo handling volume	300 t/day
Cargo transfer distance	75 m
Velocity (Study team observation)	30 m/min
Working hours per day	8 hr
Loading ability	1 maund (37.2 kg)
Cycle time	7 min



Cargo handling ability of head loaders

8 x 60 / 7 x 0.0372 = 2.55 t/day

Assuming a loss time of 10%   2.55 / 1.1 = 2.3 t/day

(ii) Unit Cargo Handling Cost

Unit wage of head loaders   50 TK/day

Number of head loaders   300 / 2.3 = 131 persons

	Financial	Economic
Wage (Tk)	6550	4775
Unit cost (Tk/t)	21.8	15.9

(Improved Cargo Handling)

(i) Performance of Forklifts

Cargo handling volume   300 t/day

Cargo transfer distance   75 m

Velocity (loaded)   8 km/hr

(empty)   20 km/hr

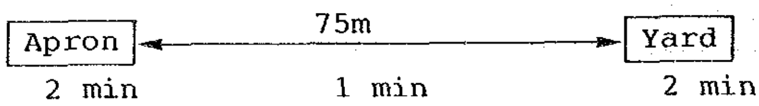
Average velocity

(75/8 + 75/20) x (60/1000)= 0.8→1.0 min

Working hours per day   8 hr

Loading capacity   2 tons

Cycle time   5 min



Cargo handling ability of forklifts

8 x 60 / 5 x 2 = 192 t/day

Assuming a loss time of 10%   192 / 1.1 = 175 t/day

(ii) Unit Cargo Handling Cost

Unit wage of helpers   50 TK/day

Number of helpers   15 persons

Number of forklift units   300 / 175 = 1.7 unit

	Financial	Economic
Wage of operators	80	80
Maintenance *1)	223	154
Insurance *2)	111	98
Fuel & Lubricants *3)	118	107
Overhead (5%)	47	34
Amortization *4)	480	320
Wage of helpers	750	547
Total (TK)	1809	1340
Unit cost (Tk/t)	10.3	7.6

*1) Maintenance cost

The maintenance cost is assumed as 10 % of the capital cost per year.

*2) Insurance cost

The insurance cost is assumed as 5 % of the capital cost per year.

*3) Fuel & Lubricant cost

The fuel and lubricant cost is computed based on the assumed unit fuel consumption 0.04 l/hr.Hp, and the power of the engine is 45 Hp.

Fuel cost = 7.4 x 0.04 x 45 x 8

= 107 Tk/day

The lubricant is assumed as 10% of the fuel cost.

*4) Amortization cost

The amortization cost is calculated for new imported forklifts using an interest rate of 15% per year over the life time of 8 years. The salvage value of the folklift is assumed to be 10% of the purchase cost.

New forklift cost 667500 Tk

	Financial		Economic
Forklift	667500		445000
(Taxes 50%)			
Annuity factor		0.2156	
Amortization	113913		95942
Amortization per day	480		320

(2) The cargo handling is performed by one handling contractor per port. A cargo handling contract for a period of one year is given to a contractor following public auctioning of the one year contract. The highest bidder is rewarded with the contract which is based on a unit price set by the local port authority. The same unit price is applied in all ports.

As examined in the previous section, the unit cargo handling cost using forklifts is lower than the unit cost using head loaders (manual laborers). This merit is enjoyed directly by the consignor and the appointed cargo handling contractor.

Accordingly, BIWTA should set the unit price based on the cargo handling cost using forklifts and should influence cargo handling contractors to introduce the more efficient cargo handling system.

9.5.3 Tariff Policy for the New Transit Sheds

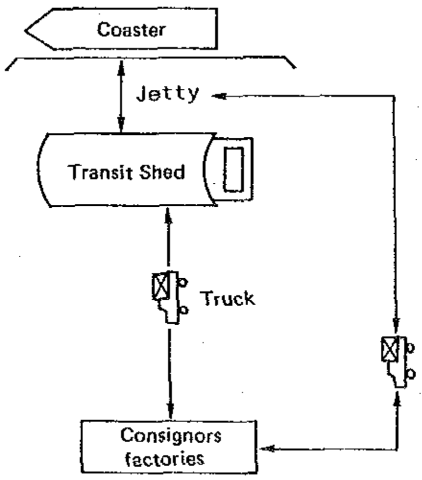


Fig. 9.5.1 Cargo Flow

The main function of the transit sheds is to sort cargoes by destination and type and to allow safe and smooth temporary storage of cargo during the sorting period. BIWTA must ensure that the proposed transit sheds are used only for their intended purposes and are not used as warehouses by consignors or by cargo handling contractors.

The functions of transit sheds and warehouses are entirely different.

Along these lines, the Study Team proposes a tariff policy as follows:

(1) High storage fees should be charged for cargoes that remain in the transit sheds beyond the normal storage period.

(2) The said period should be defined exactly for all types of cargoes.

(3) If the cargo is not loaded as scheduled due to the fault of the vessel or its owner/agent, the resulting fee should be paid by the vessel or its owner/agent.

9.5.4 Berth Assignment

(1) There are three main types of jetties in Bangladesh river ports: R.C.C. jetties, pontoons with gangways and wooden jetties. The scale arrangement, type and structure of the jetties at the subject ports should be specified or standardized in order to ensure smooth and consistent port operations. Then, accordingly, different size vessels should be allocated to appropriate berths. In actual operations, the objective vessel size for each berth is not clear, and several types of vessels carry out operations at each jetty.

(2) The local port and traffic officers should be notified upon vessels arrival in port whereupon berths will be allocated by the Traffic Inspector. Presently, no notification (ETA) is given prior to arrival and if berths are available, vessels will at times berth without giving any notification to port and traffic officers.

(3) Based on berth usage, there are two main types of berths as follows.

(i) General use berths

General use berths are berths which may be used by any vessel calling at port.

(ii) Prioirty use berths

Priority use berths are generally reserved for the preferential use of certain types of vessels on a priority basis. These berths may include certain equipment or facilities that permit the efficient handling of certain types of cargoes.

In the Short-term Development Plan, Forecast cargoes are allocated to each facility by vessel type, and the proposed general cargo berths are planned for use by coasters on a priority basis.

Thus, the proposed general cargo berths should be operated as priority berths for coasters. Berth assignment by BIWTA should be made accordingly to maximize the beneficial effects of the Short-term Development Plan.

CHAPTER 10

DESIGN, CONSTRUCTION PLAN, COST ESTIMATION

CHAPTER 10 DESIGN, CONSTRUCTION PLAN, COST ESTIMATION

10.1 Master Plan

10.1.1 Basic Design

(1) Types of basic structures

Facilities proposed in the Master Plan include a general cargo terminal and a passenger terminal. The main items for the construction of these facilities are as follows:

- o General Cargo Terminal
  Mooring Facilities, Sheds

- o Passenger Terminal
  Mooring Facilities, Passenger Terminal Building, Parking Lot

The basic designs of the individual construction items are presented below.

(2) General cargo terminal

(a) Mooring facilities

The main method used at present for loading and unloading cargo in Bangladesh is human power or ship derricks, and this is expected to continue for the time being. Nevertheless, it is also expected that, as time goes on, Bangladesh will follow the general world trend and gradually switch over to cranes positioned on shore.

With this in mind, the structural design for mooring facilies at the general cargo terminal include the following two plans.

Mechanized mooring facilities: Loading and unloading with shore cranes (20t lift), transporting with forklifts (5t) and trucks (T-20).

Improved mooring facilities: Loading and unloading with human power and ship derricks, transporting with forklifts (2t).

(i) Mechanized Mooring Facilities:

A. Design conditions:

- o Crown elevation at site reclamation: +7.00 m PWD
- o Planned water depth: -3.57 m PWD
- o Design vessel: 1,000 DWT

Length	Width	Depth	Full Load Draft	Light Draft
60.0m	9.1m	5.0m	3.66m	2.1m

- o Approaching velocity: 0.3 m/sec (1,000 DWT)
- o Wind speed: 20 m/sec (avg. over a 10 min. period)
- o Surcharge: Normal: 2.0 t/m^2, Earthquake: 1.0 /m^2

- o Live load:

  Truck crane (20t lift)

  Forklift (5t)

  Truck (T-20)

- o Water level, Current velocity, Wave height, Earthquake, Soil, Volume weight in unit, Allowable stress and Corrosion:

  See Chapter 7

B. Comparison of the alternatives:

Mechanized mooring facilities will make use of truck cranes (20 ton lift) for loading and unloading and forklifts (5 t) and trucks (T-20) for transporting cargo. As a result, the wharf apron must be 75m long and 15m wide. The approach bridge must be 10m wide.

Mooring facilities on the Buriganga River must be in the form of structures jutting out into the river so as to obtain sufficient water depth. Sheet pile walls and gravity quaywalls are generally popular mooring facilities, but are not good in Dhaka and Narayanganj Ports, because they will disturb the current and their feet may be scoured by the river. The following discussion will be limited to an open-type jetty, a floating wharf having an approach bridge of a single span and another floating wharf having an approach bridge cnbined with a steel girder and a reinforced concrete trestle.
The following is a comparison of these different types.

1. Open-type jetty:

The open-type jetty is one popular structure for mooring facilities at general cargo terminals. Steel pipe piles driven deeply into the river bottom form a few rows at the same interval and support a reinforced concrete slab. The surface of the slab serves as an apron to enable cargo handling of trucks and forklifts. The approach bridge is of the same structure as the open-type jetty itself. Pile-driving barges capable of driving long pipe piles with a large diameter have to be brought in from a foreign country for the construction works. The other construction equipment can be obtained locally. The operation of loading and unloading cargoes on this jetty requires a crane with good lifting performance, and has a tendency toward slightly reduced efficiency during the dry season due to the large height difference between the apron and the board. The transporting of cargoes between jetty and shed presents no problem because the approach bridge is level and stable. The construction costs are relatively low.

2. Floating wharf with a single span approach bridge:

The floating wharf consists of a pontoon large enough to allow operation of truck-cranes and forklifts for loading and unloading cargoes, a movable bridge with a span of approx. 35 meters, and an abutment on the land side of the movable bridge. This structure presents no problem in loading and unloading operations, but has some slight difficulty in transport operations. The vertical motion characteristics of the wharf following the water level fluctuation solve the problem of handling cargoes as the apron moves up and down along with the vessels. However, there may be some difficulty moving cargoes laterally between wharf and shed, because the slope of the approach bridge becomes approximately 10° during the dry season, a little steep for ordinary operations. The pontoon and approach bridge are fabricated at a factory and then installed at the site. The installation of a movable bridge requires a floating crane capable of lifting, heavy cargo. Construction operations such as driving mooring piles also require a floating crane. Construction costs are somewhat high.

3. Floating wharf with a combined approach bridge

Since the long span of the approach bridge is a draw back in such a facility, the bridge is divided into two structures of a short span girder and a reinforced concrete trestle, and has three passages of different slopes to serve respectively in dry, intermediate and flood seasons. One of the favorable points of this structure is that it is possible to shorten the steel part. Some drawbacks are that the concrete trestle requires a complicated structure and an extremly wide width (three times the width of the steel girder), and that the steel girder must be replaced four times annually depending on the water level. The construction cost is higher and the maintainance cost will also increase since it is necessary to replace the steel girder frequently using a floating crane.

A technical evaluation of the three alternatives is presented in Table 10.1.1 and the plan sketches of these three types are shown in Fig. 10.1.1, 10.1.2 and 10.1.3. The evaluation shows that the Floating Wharf having a combined approach bridge is difficult for adoption and that there is no great differences in the relative merits of the other two plans, but that the open-type jetty is preferable as it is less expensive.

(ii) Improved Mooring Facilites:

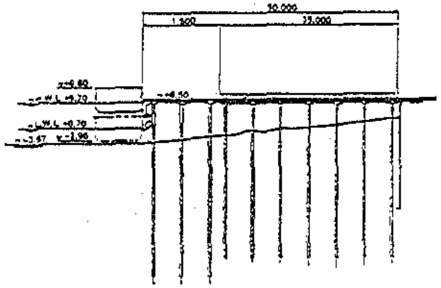
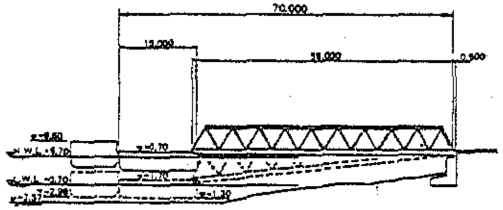
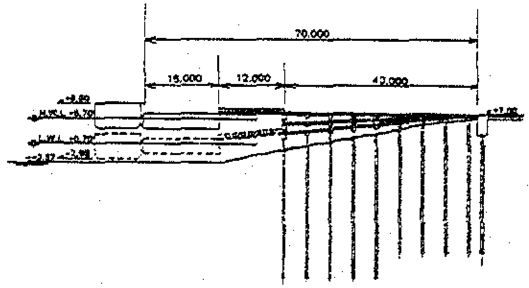
A. Design conditions:

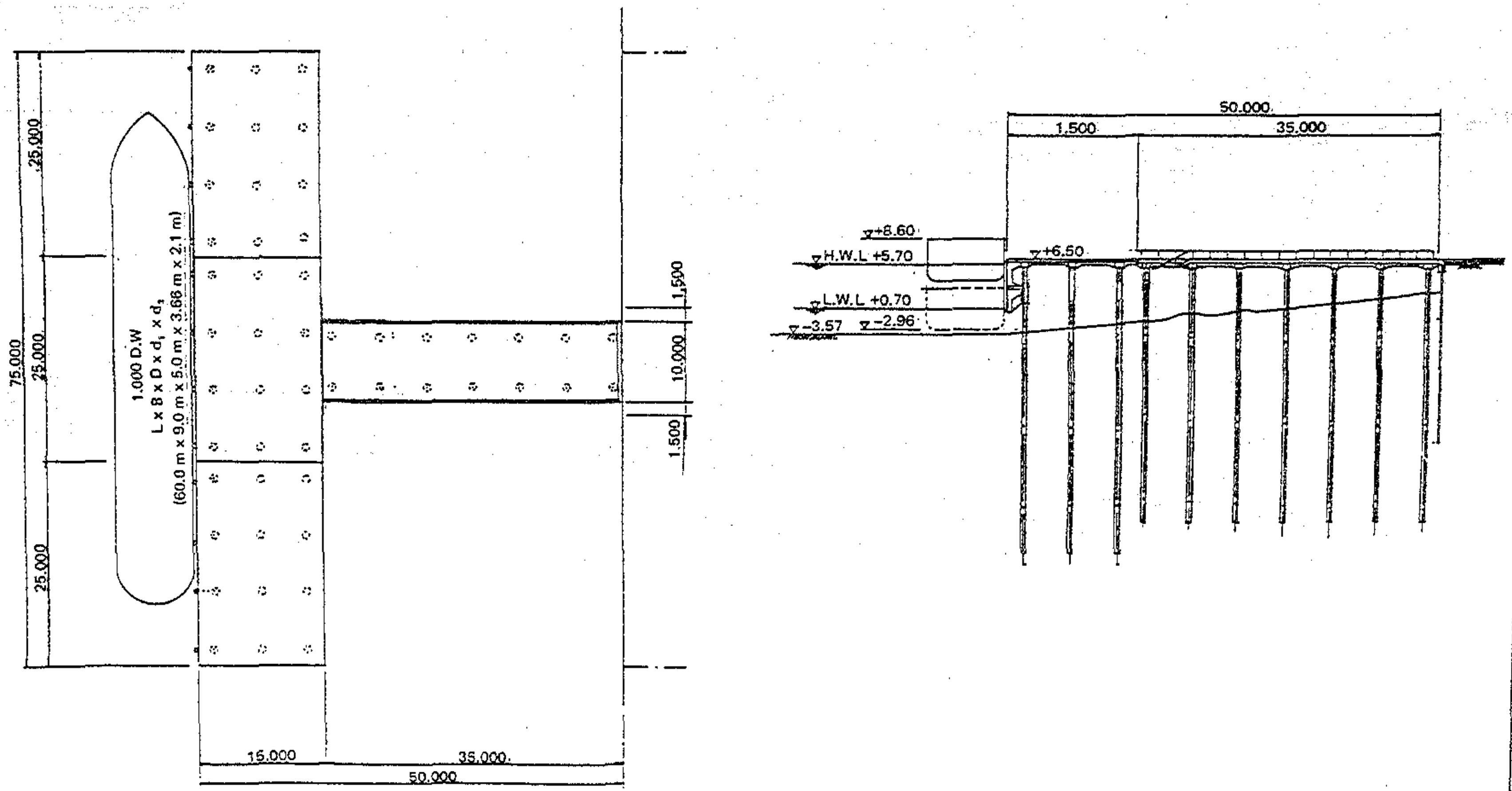
. Live load: Forklift (2t)
. Other conditions: The Other design conditions are the same as those found in the section on "Mechanized Mooring Facilities".

B. Comparison of the Alternatives:

The mooring facilities must jut out into the river to maintain the proper depth. As a result, the approach bridge becomes long 42m making it more difficult to carry freight with human power only. If transporting operations on the present facilities are carried out with forklifts (2t), the size of the wharf will have to be 75 m long and 8 m wide and the approach bridge will have to be 4.6 m wide. As a substitute for the present facilities, the following three types can be considered:

Table 10.1.1 Comparison of Proposed Mechanized Mooring Facilities for General Cargo

Item	Open-type jetty	Floating Wharf with a single span approach bridge	Floating Wharf with a combined approach bridge
Rough overall form			
Location in the river	To obtain the planned water depth for the berth.	To keep a water depth of at least -3m in front of and under the pontoon.	To keep a water depth of at least - 3m in front of and under the pontoon.
Operational workability	Cargo handling operations are somewhat difficult before and after the flood season	A little difficulty in transport operation.	A little difficulty in transport operation.
Construction workability	Necessity of bringing pile-drivers from overseas.	Necessity of introducing a floating crane with a high lifting capability for installation of the approach bridge.	Necessity of bringing pile-drivers and a floating crane from overseas.
Period of construction	Total construction period relatively short.	Field work at site is short but fabrication work at factory is long.	Medium
Care after construction	Only repairs	Only repairs	It is necessary to move the pontoon with the change of water depth in addition to repair works.
Rough cost estimate	57,000,000 Tk per berth	61,000,000 Tk per berth	78,000,000 Tk per berth
General appraisal	◎	○	×



(Unit: m)

Fig. 10.1.1 Open-Type Jetty for Cargo Terminal of Mechanized Mooring Facilities

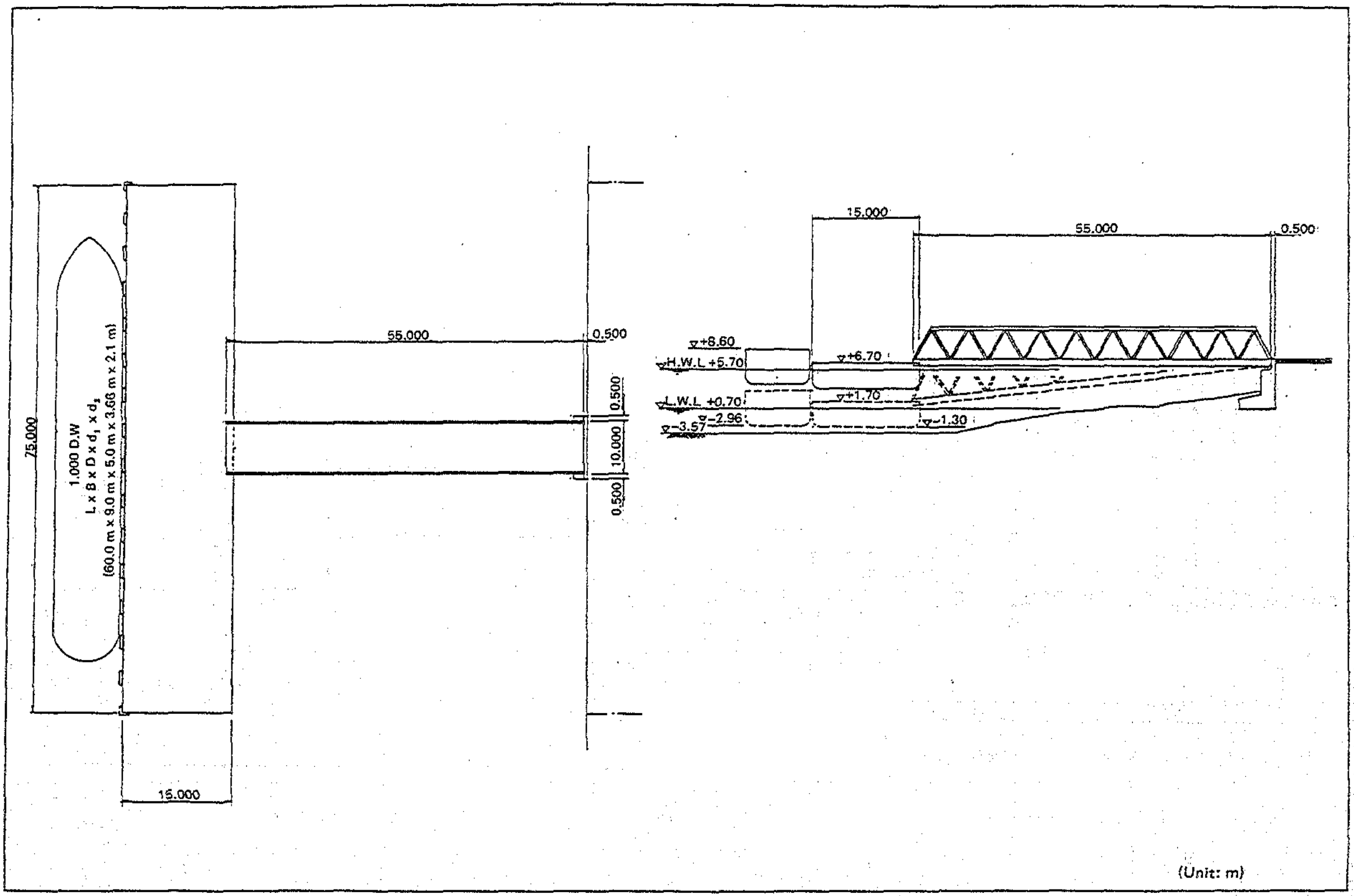


Fig. 10.1.2 Floating Wharf (single span approach bridge) for Cargo Terminal of Mechanized Mooring Facilities

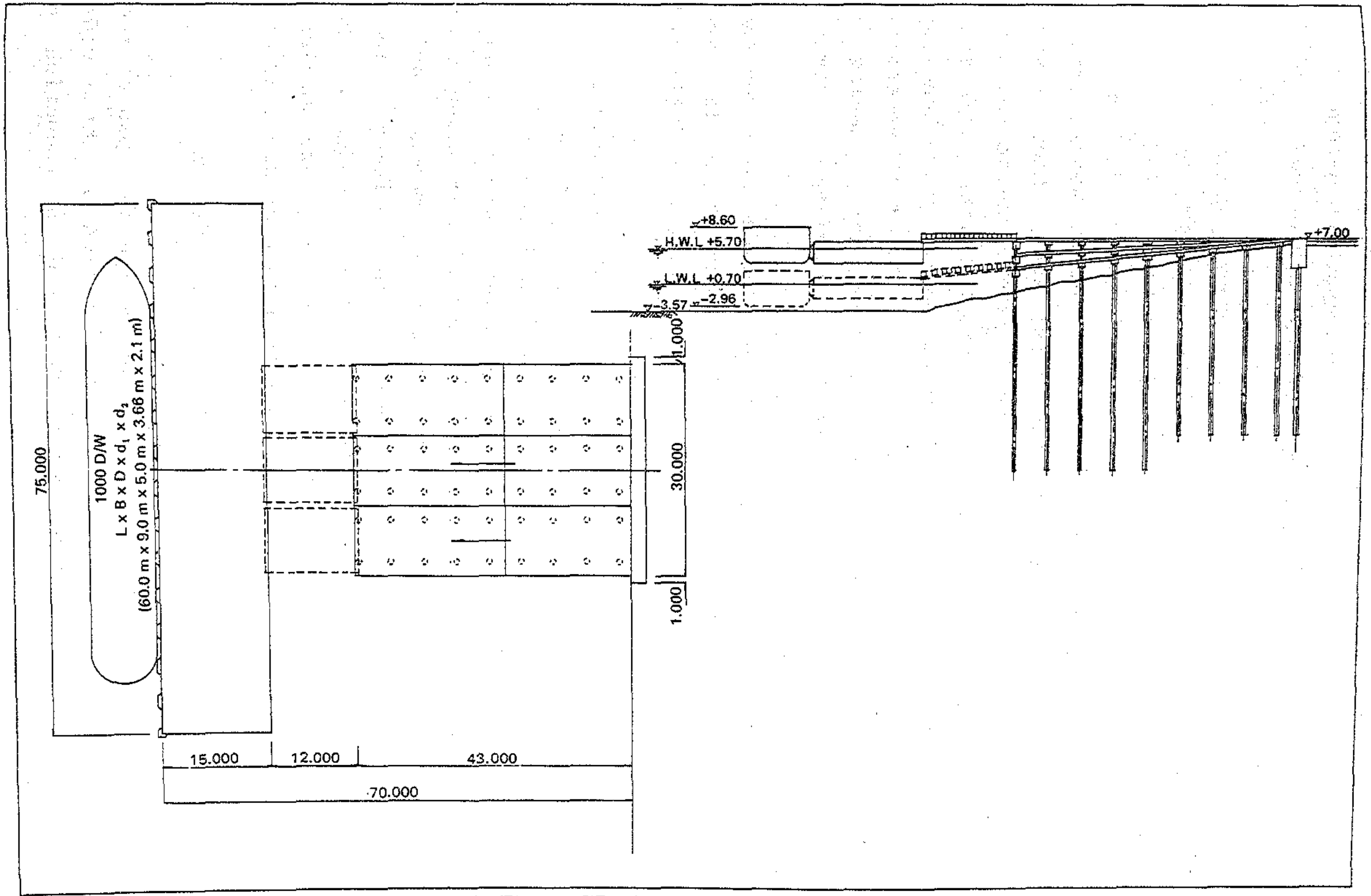


Fig. 10.1.3 Floating Wharf (combined approach bridge) for Cargo Terminal of Mechanized Mooring Facilities

- Open type jetty
- Floating wharf with a single span approach bridge
- Floating wharf with a combined approach bridge

The following is a discussion of each type.

1. Open type jetty

   Cargo handling operations carried out by manual labour only on an ordinary open-type jetty face severe difficulty during the dry season, since the decrease in the water level results in a great height difference between apron and deck. In providing for cargo handling by manual labour during the dry season, it is necessary to build a double-deck open-type jetty having a relieving platform just under a main platform forming the apron.
   Since loading and unloading equipment does not go on the structure, the wharf and the approach bridge are smaller. However operations are somewhat more difficult compared with the floating wharf.

2. Floating wharf with a single span approach bridge

   Since loading and unloading operations take place on a pontoon which goes up and down according to changes in the water level, such operations are somewhat easier than with an open-type jetty. In addition, since loading and unloading equipment does not go on the structure the wharf and the approach bridge are smaller. Nevertheless, the bridge requires a span of about 40 m.

3. Floating wharf with a combined approach bridge

   This style makes it possible to shorten the span of the steel girders but requires construction of three wide passages of different slopes which means no reduction in cost. In addition, it is necessary to replace the steel girders four times annually in relation to the water level which raises post-construction cost.

Table 10.1.2 shows the above comparison in graphic form and the plan sketches of these three types are shown in Fig. 10.1.4, 10.1.5 and 10.1.6. Since shore cranes are not presently used at mooring facilities for general cargo, the overall operability is important to consider along with the construction costs. As a result, the floating wharf with a single span approach bridge is recommendable.

(b) Shed:

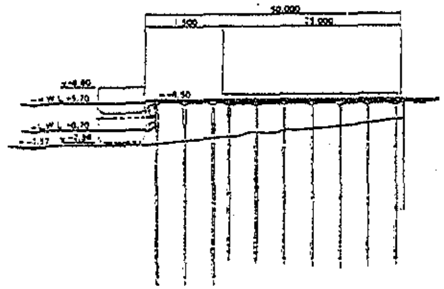
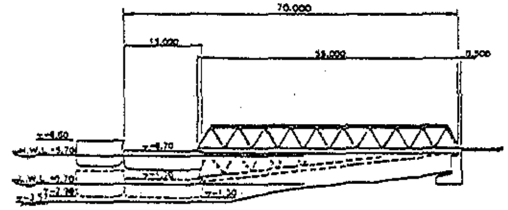
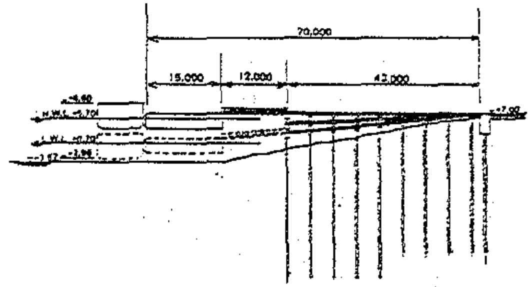
(i) Design conditions

- Crown elevation at site reclamation: +7.00 m PWD
- Wind velocity: 50 m/sec (max. instantaneous wind velocity)
- Earthquake, soil: See Chapter 7

(ii) Design of the shed

The shed shall be 30m x 50m. The roofing frame is steel truss supported with intermediated pillars at the center, and pillars and girders in the wall are reinforced concrete. The walls will be made of brick and the roof will be covered with corrugated steel sheets. Fig. 10.1.7 shows an outline drawing of the shed.

Table 10.1.2 Comparison of Improved Mooring Facilities for General Cargo

Item	Open-type jetty	Floating Wharf with a single span approach bridge	Floating Wharf with a combined approach bridge
Rough overall form			
Location in the river	To obtain the planned water depth for the berth.	To keep a water depth of at least -3m in front of and under the pontoon.	To keep a water depth of at least - 3m in front of and under the pontoon.
Operational workability	Cargo handling operations are somewhat difficult before and after the flood season	A little difficulty in transport operation.	A little difficulty in transport operation.
Construction workability	Necessity of bringing pile-drivers from overseas.	Necessity of introducing a floating crane with a high lifting capability for installation of the approach bridge.	Necessity of bringing pile-drivers and a floating crane from overseas.
Period of construction	Total construction period relatively short.	Field work at site is short but fabrication work at factory is long.	Medium
Care after construction	Only repairs	Only repairs	It is necessary to move the pontoon with the change of water depth in addition to repair works.
Rough cost estimate	41,000,000 Tk per berth	35,000,000 Tk per berth	55,000,000 Tk per berth
General appraisal	○	◎	×

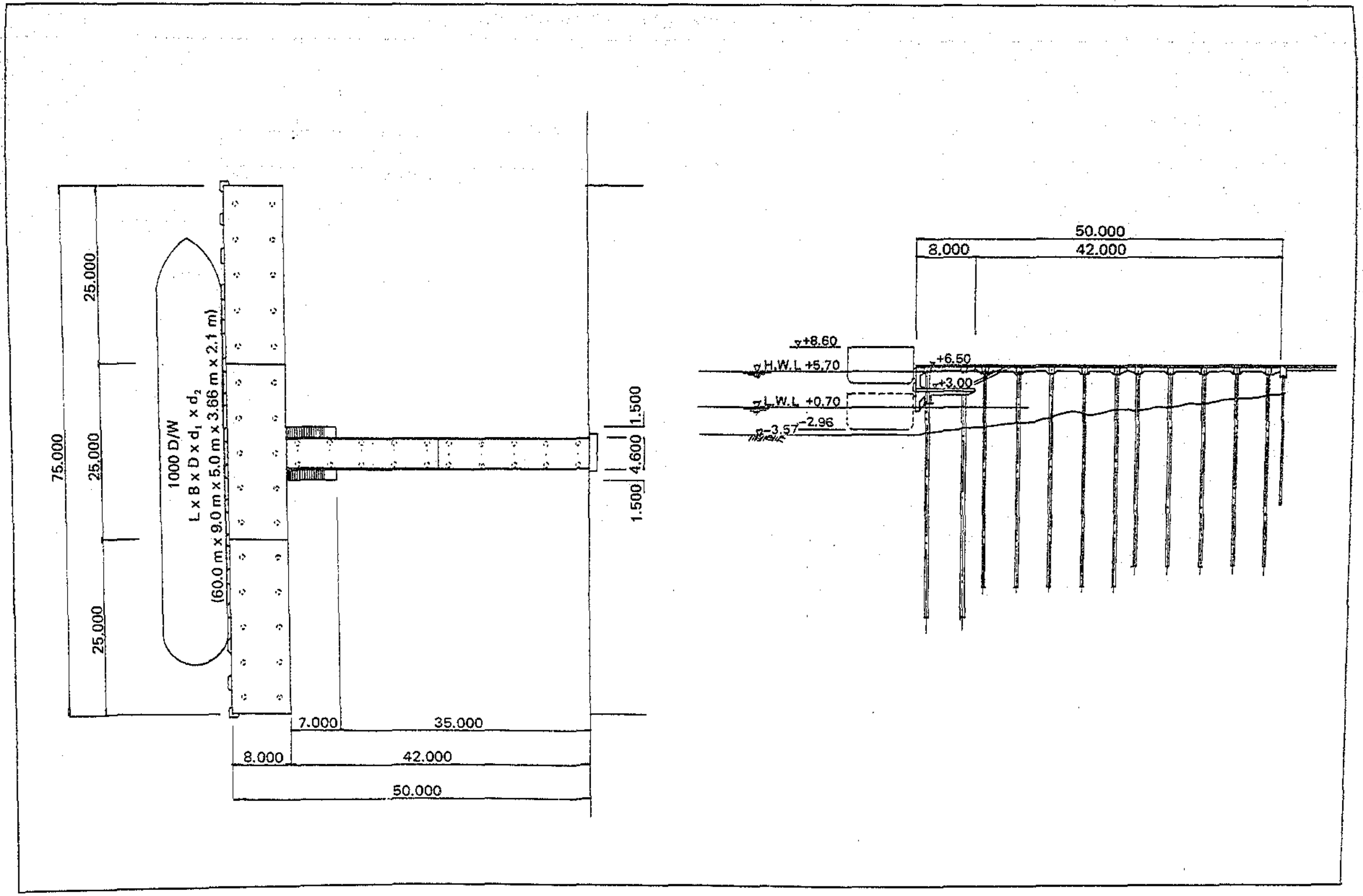


Fig. 10.1.4 Open-Type Jetty for Cargo Terminal Improved Mooring Facilities

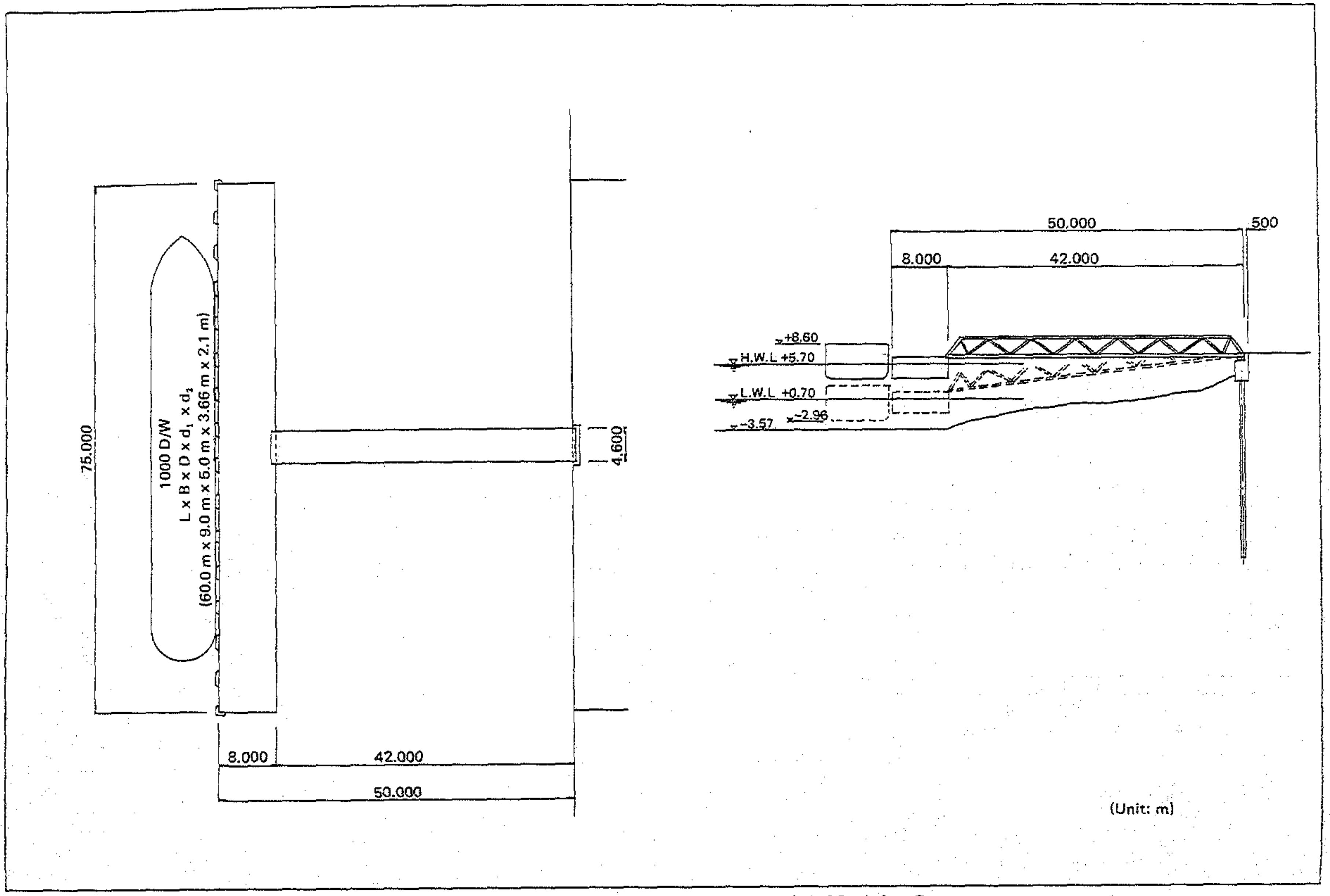


Fig. 10.1.5 Floating Wharf (single span approach bridge) for Cargo Terminal of Improved Mooring Facilities

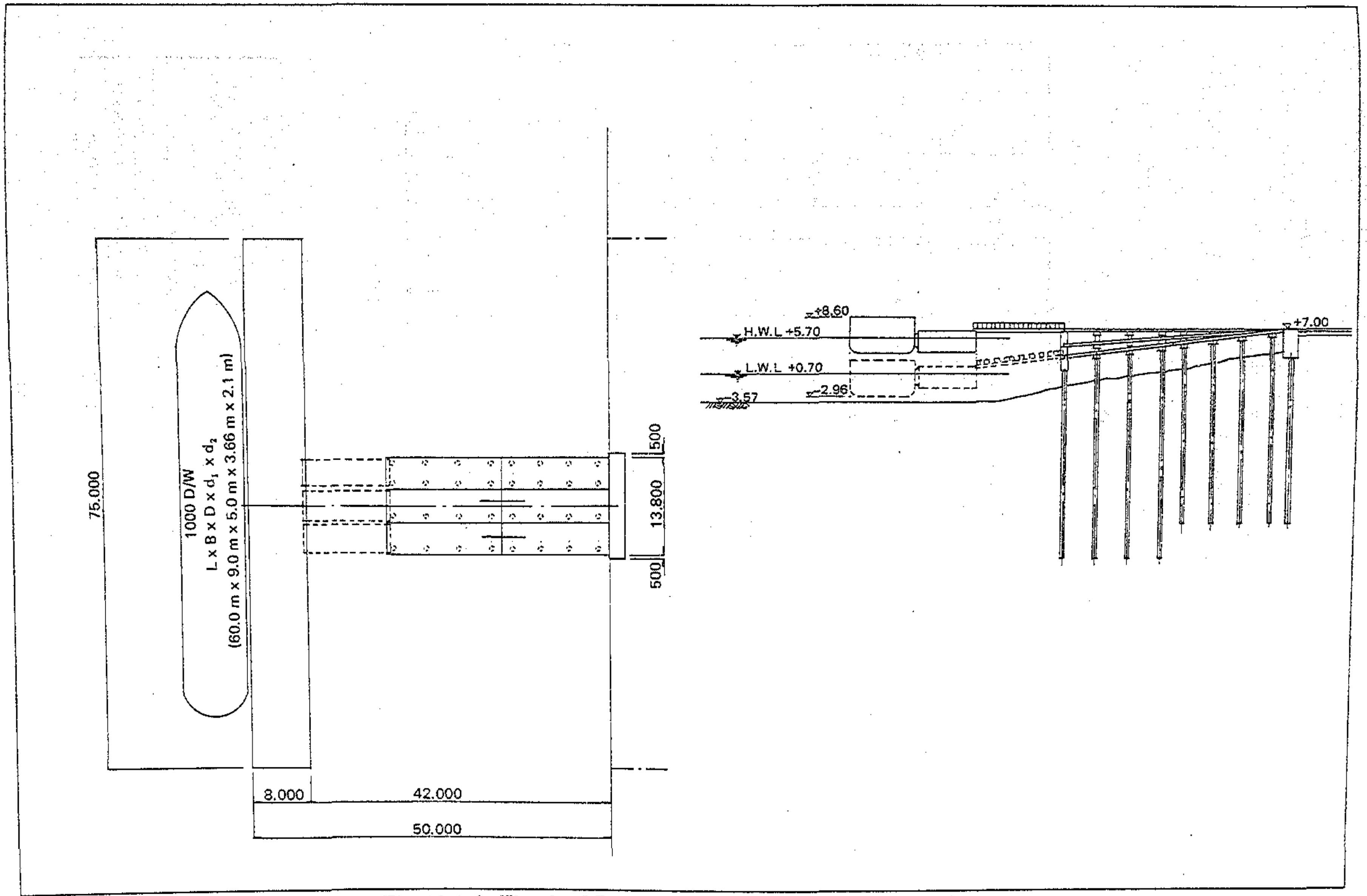
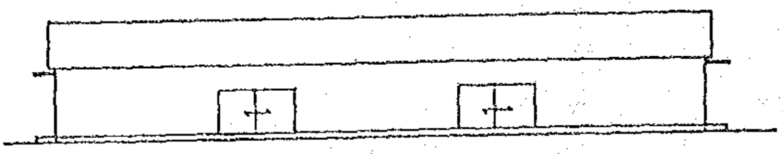
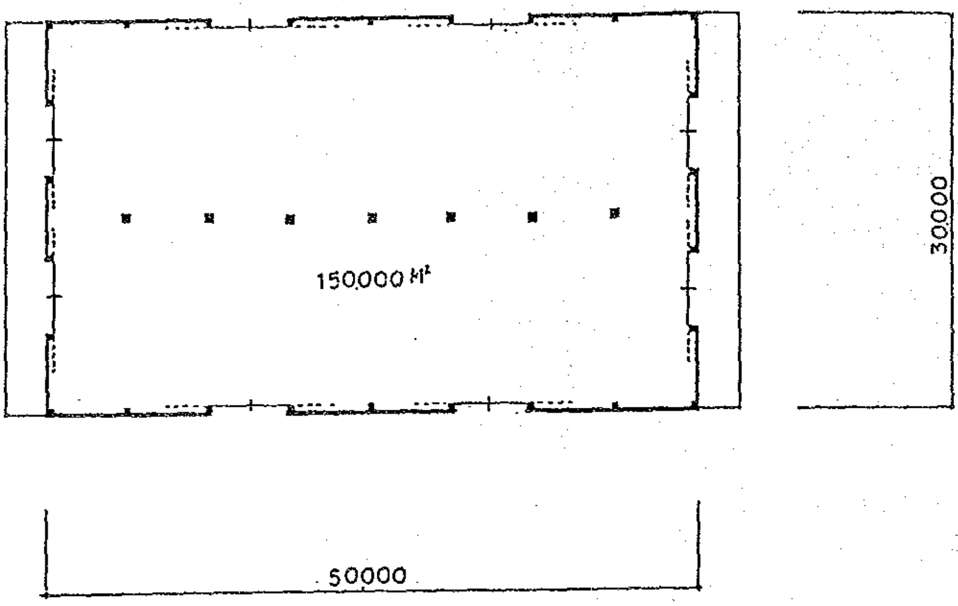
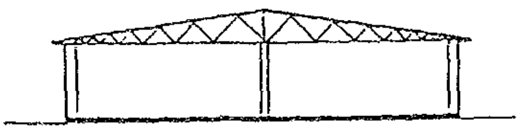


Fig. 10.1.6 Floating Wharf (combined approach bridge) for Cargo Terminal of Improved Mooring Facilities

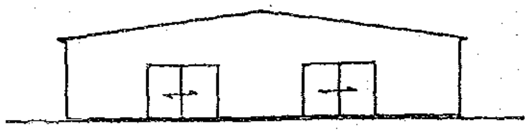


ELEVATION (1)





SECTION



ELEVATION (2)

FINISH	
ROOF	CORRUGATED STEEL SHEET CORRUGATED TRANSLUCENT SHEET
WALL	MORTAR PLASTERING
FLOOR	STEEL TROWEL FINISHED SLAB ON GRADE CONCRETE
DOOR	STEEL HANGER DOOR

Fig. 10.1.7 Shed

(3) Passenger terminal:

(a) Mooring facilities

(i) Design conditions

°Crown elevation at site reclamation: +7.00 m PWD
°Planned water depth: -1.30 m PWD
°Design vessel: 500 G/T

Length	Width	Depth	Full Load Draft	Light Draft
73.2M	9.1M	3.0M	1.8M	1.2M

°Approaching velocity: 0.3 m/sec (1,000 DWT)
°Wind speed: 20 m/sec (avg. over a 10 min. period)
°Live load: sidewalk live load (0.5 t/m^2)
°Water level, Current speed, Wave height, Earthquake, Soil, volume weight in unit, allowable stress corrosion:

See Chapter 7

(ii) Selection of construction style

It is important that the mooring facilities for the passenger terminal enable passengers to board and disembark safely and smoothly. The floating wharf type is obviously best suited for this purpose. In addition, the load conditions applied to the mooring facilities are considerably light in comparison with container and cargo terminals, and thus the construction costs are lower.

Thus, floating wharf type mooring facilities are highly recommended for the passenger terminal.

The plan sketch of this type is shown in Fig 10.1.9.

(b) Passenger terminal

(i) Design conditions:

°Crown elevation at site reclamation: +7.00 m PWD

°Wind speed: 20 m/sec (avg. over a 10 min. period)

°Earthquake, Soil: See Chapter 7

(ii) Shape of the terminal building

The terminal building will be 80m x 30m and consist of a two-storey reinforced concrete structure.
Fig. 10.1.10 and 10.1.11 show the general shape of the terminal building.

(c) Parking lot

(i) Design load

Truck (T-20)

(ii) Section of pavement

Pavement in the parking lot will probably be asphalt. The section is as follows.

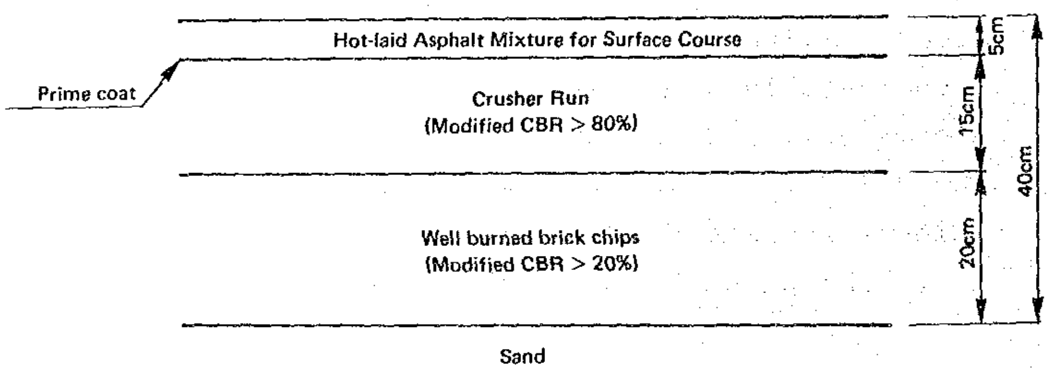


Fig. 10.1.8 Paving Sectional Construction of Parking Lot

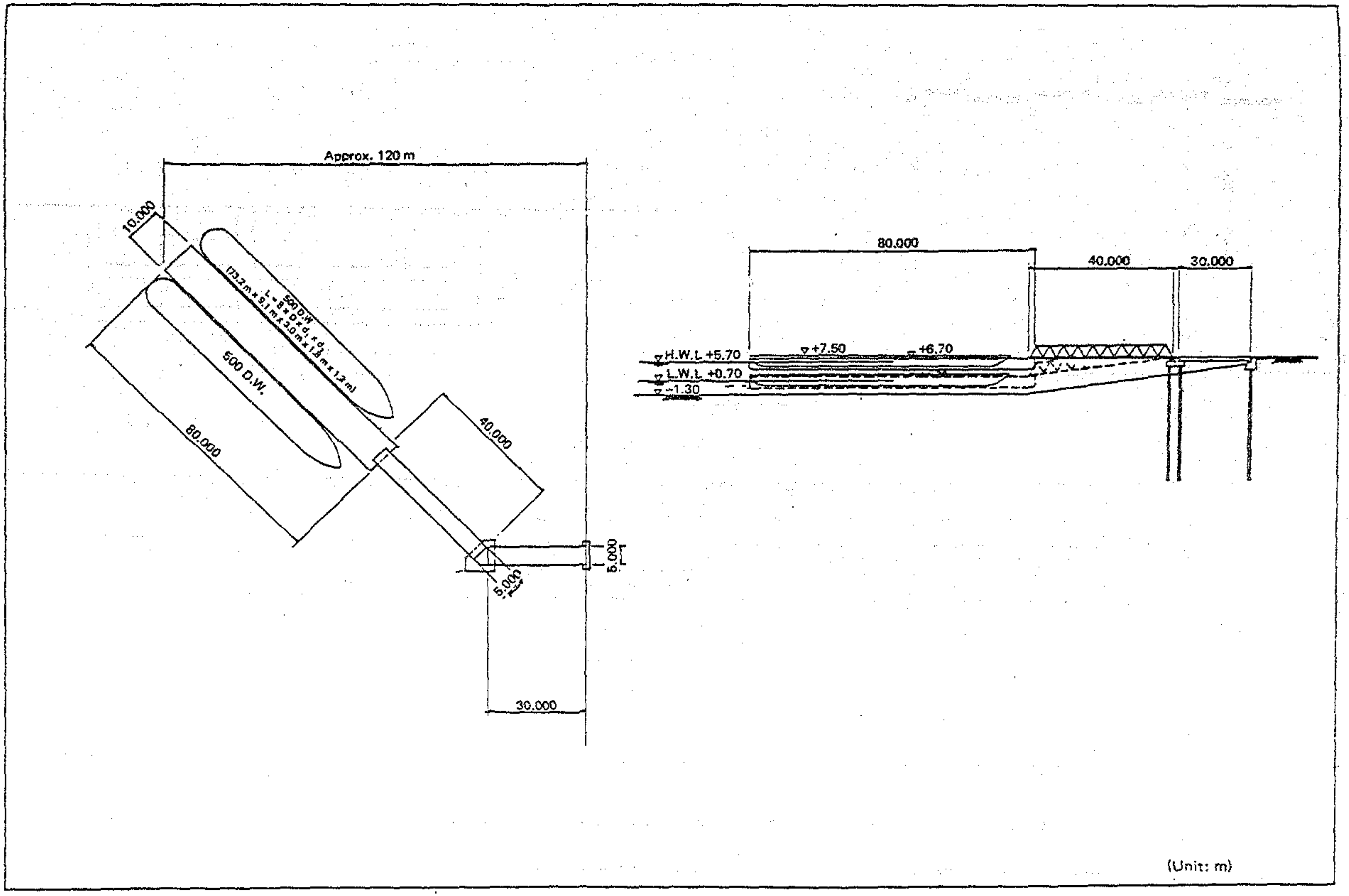


Fig. 10.1.9 Floating Wharf for Passenger Terminal

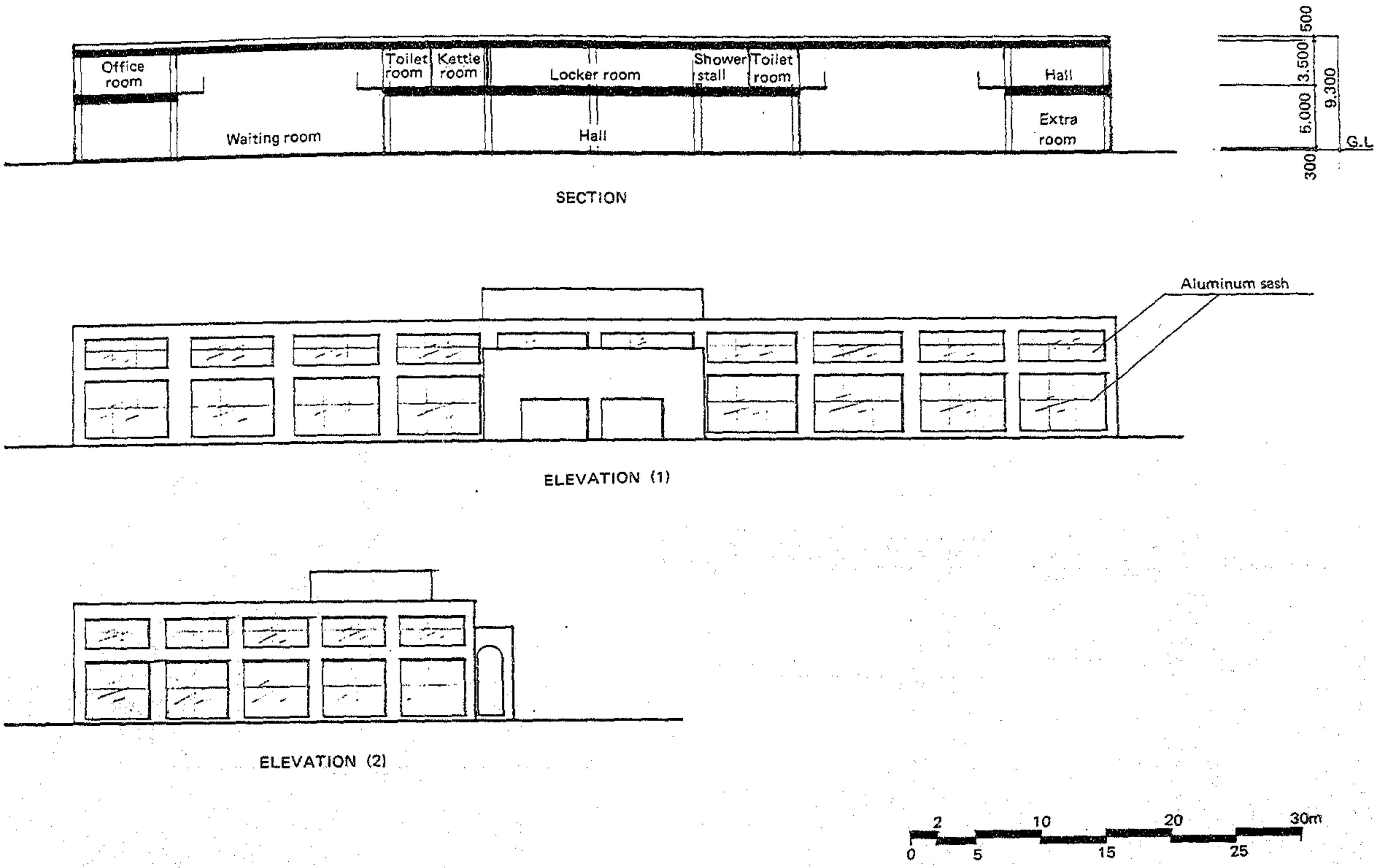


Fig. 10.1.10 Passenger Terminal Building (1)

FINISH		
INSIDE	FLOOR	TERAZZO TILE
	WALL	MORTAR PLASTERING
	CEILING	GYPSUM BOARD
OUTSIDE	WALL	MORTAR PLASTERING
	ROOF	CONCRETE SLAB LIME CONCRETE MORTAR SKIM COATING

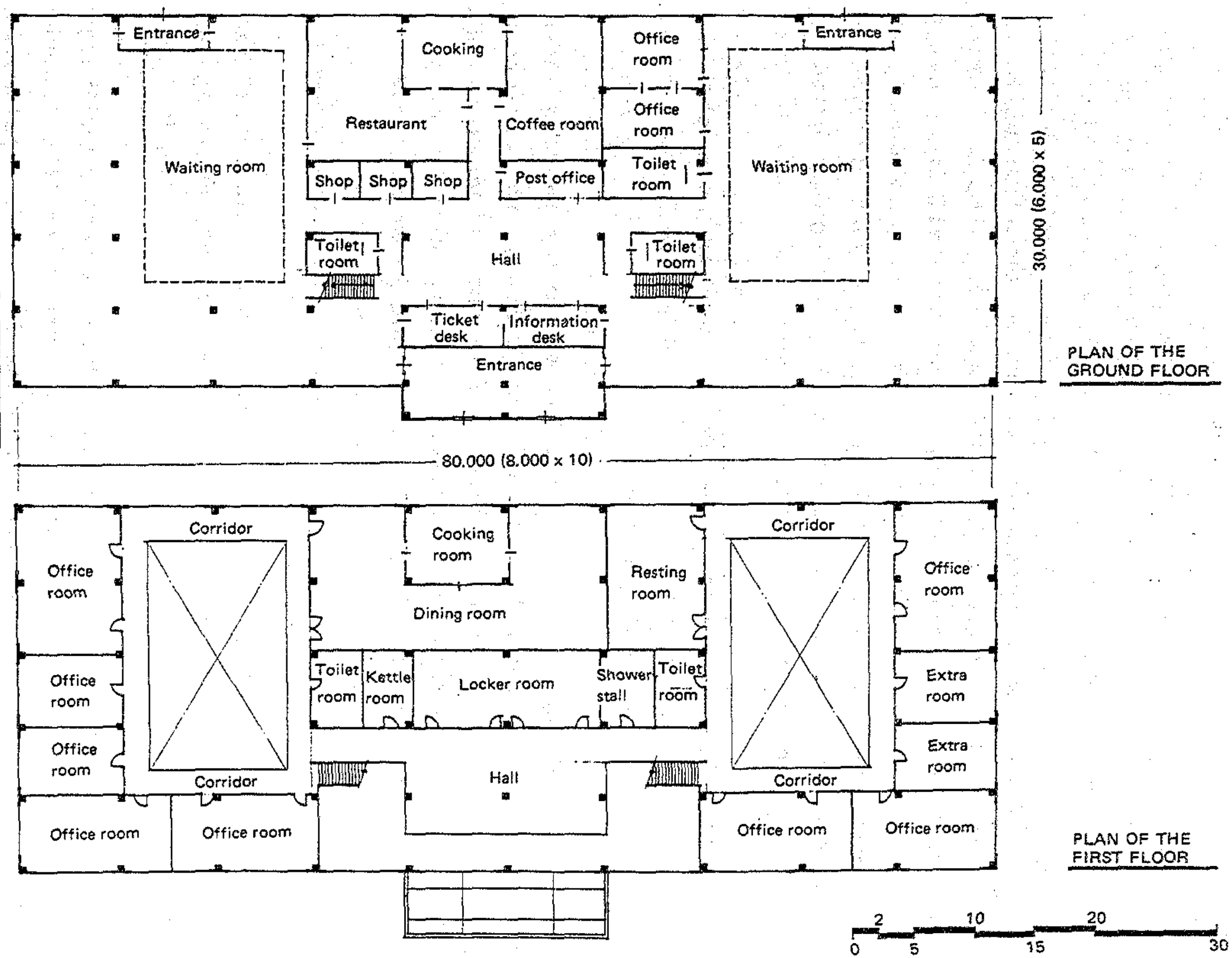


Fig. 10.1.11 Passenger Terminal Building (2)

10.1.2 Construction work

(1) Condition for construction work

Since Dhaka and Narayanganj Ports are inland river ports the wave height is low a mere 0.40m. Although precipitation between November and March is small (100 mm/month), rainfall from June to August exceeds 300mm/month. Thus the workable days during the rainy season are limited and it is difficult to work efficiently. In addition, there is considerable gusting during April and May and in some years wind speeds reach 40 m/sec.

The riverbed water depth in Dhaka port is more than 10m below S.L.W. in particular areas but 3 to 4 meters in most areas. The riverbed soil is mostly sandy.

As for the supply of materials and machinery in Bangladesh, locally available materials include rock, cement, and reinforcing bars. Common construction machinery such as bulldozers, dump trucks, motor graders, and concrete mixers, can be procured locally but special equipment must be brought in from abroad.

(2) Method of construction

Main construction work in this project includes site reclamation and construction of mooring facilities, buildings and roads.

Site reclamation shall be executed using a sand pump dredger to obtain soil from the riverbed in front of the planned construction sites and to carry it directly to the reclamation sites through discharge pipes. It is important to reclaim a wide enough land area not only for the project facilities but also for a temporary construction work yard and for storage of construction materials and equipment.

The mooring facilities will be of two types, the open type jetty and the floating wharf. Pile-driving is a major operation for the jetty type facilities, and pile-driving equipment will have to be brought in from abroad as it is not available locally. As for the floating type, the pontoons and approach bridges will be fabricated at a local factory. Following fabrication at the factory these will be hauled by tug and installed at the site. A floating crane is necessary to install the approach bridges on the pontoon and the river bank.

Main steel structual members in the building will be imported and fabricated at the project site by means of truck cranes.

The sub base course of the road, being placed directly on reclamation fill, is made of crushed bricks which are obtained in the vicinity. This will then be covered by asphalt made at an asphalt plant on the site.

10.1.3 Rough Estimate of the Construction Costs

A rough estimate of the construction costs for each of the facilities in the Master Plan is presented in Table 10.1.3. The following assumptions are made for the estimate.

(1) Date of reckoning: July, 1986

(2) Exchange rate

1 US Dollar = 31.5 TK = 162 Yen
1 TK = 5.14 Yen

(2) Imported equipment

The cost of imported equipment is based on CIF prices without import duties.

(3) Imported materials

The cost of imported materials comprises CIF prices plus customs duties.

(4) Acquisition costs and compensation costs:

Land acquisition costs and compensation costs for removal of homes, etc. are not included in the estimate.

(5) Physical contingency

Five percent of the total is calculated as a physical reserve.

(6) Price Contingency:

No price contingency to compensate for increased costs is considered.

Table 10.1.3 Construction Cost for the Master Plan

(Unit: million Tk)

Item	Cargo Terminal (12 berths)	Passenger Terminal (8 berths)	Total
Mooring Facilities	770	280	1,050
Reclamation	50	20	70
Buildings	350	90	440
Roads & yards	100	20	120
Bank protection, etc.	50	10	60
Others	40	10	50
Total	1,360	430	1,790

A comparision of the alternative master plan investment values is shown in Table 10.1.4, comparing alternatives A, B, and C which are presented in Fig. 8.5.1 to 8.5.3. Rough cost estimates for alternatives A, B and C and 1,790 million TK, 2,050 million TK, and 2,130 million TK respectively, and alternaive A is the least expensive of the three alternatives. The cost difference mostly depends on the different length of the access road and the tendency of scouring the river bank.

The general cargo terminal with two berths and the passenger terminal with eight berths will begin service during the 5 years after 1995/96. A general cargo terminal with another six berths will be operated during the following 5 years. The construction schedule and each 5 year investment cost for the river port facilities are shown in Table 10.1.5 and Table 10.1.6. The construction cost for the Short-term Development Plan is divided into 2 parts of the third and fourth five year plan periods.

Table 10.1.4 Comparison of Construction Costs for the Master Plan

Unit: Million Tk

		Mooring Facilities	Reclamation	Building	Roads & Yards	Bank Protection etc.	Others	Total
Plan A	Cargo Terminal (12 berths)	770	50	350	100	50	40	1,360
	Passenger Terminal (8 berths)	280	20	90	20	10	10	430
	Total	1,050	70	440	120	60	50	1,790
Plan B	Cargo Terminal (12 berths)	770	100	350	150	200	50	1,620
	Passenger Terminal (8 berths)	280	20	90	20	10	10	430
	Total	1,050	120	440	170	210	60	2,050
Plan C	Cargo Terminal (12 berths)	770	140	350	190	200	50	1,700
	Passenger Terminal (8 berths)	280	20	90	20	10	10	430
	Total	1,050	160	440	210	210	60	2,130

Table 10.1.5 Construction Schedule of the Master Plan

	Item	Volume	Unit	III Five Year				IV Five Year					V Five Year					VI Five Year				
				1986 /87	87 /88	88 /89	89 /90	90 /91	91 /92	92 /93	93 /94	94 /95	95 /96	96 /97	97 /98	98 /99	99 /00	2000 /01	01 /02	02 /03	03 /04	04 /5
Cargo Terminal	Mooring Facilities	12	berth			3 berths		1 berth					2 berths							6 berths		
	Sheds	10	set			2 set							2 set							6 set		
	Others	1	set																			
Passenger Terminal	Mooring Facilities	8	berth												8 berths							
	Building	1	set												1 set							
	Others	1	set																			

Table 10.1.6 Constructin Costs of the Master Plan under Each Five Year Plan of Bangladesh

Facilities	General Cargo Terminal				Passenger Terminal				T o t a l				Graund Total
	III	IV	V	VI	III	IV	V	VI	III	IV	V	VI	
Mooring Facilities	120	30	150	470	0	0	280	0	120	30	430	470	1,050
Land Reclamation	30	-	10	10	0	0	20	0	30	-	30	10	70
Buildings	40	-	80	230	0	0	90	0	40	-	170	230	440
Road & Yards	40	-	40	20	0	0	20	0	40	-	60	20	120
Bank Protectin etc.	10	-	10	30	0	0	10	0	10	-	20	30	60
Others	10	-	10	20	0	0	10	0	10	-	20	20	50
T o t a l	250	30	300	780	0	0	430	0	250	30	730	780	1,790

10.2 Short-term Development Plan

Four berths are planned as a general cargo terminal under the Short-term Development Plan which is included in the Master Plan. The single span approach floating wharf is the structural type of the mooring facilities under the Short-term Development Plan. This type of facility is recommended for cargo handling operation by means of human labour and ship gear as mentioned in 10.1.1 (3) (a) (ii) "Improved mooring facilities".

10.2.1 Basic Design

(1) Facilities in the short-term development plan

The main facilities in the short-development plan are as follows:

- °Mooring facilities: Floating wharf with a single span approach bridge: 4 berths
- °Sheds: 2
- °Roads:
  - Access Road 1750^m
  - Roads within port 1000^m
- °Bank protection

(2) Design of mooring facilities

The mooring facilities consist of a pontoon and a approach bridge. The design of these items is outlined below.

(a) Pontoon:

The major dimensions of the pontoon are set as follows considering the length of the design vessel (1,000 DWT), the minimum rotary radius of transportation equipment (forklifts: 2 tons) and bouyancy against the freight weight.

Length	75,000mm
Breadth	8,000mm
Depth	3,000mm

The dimensions of the sections of the pontoon are as follows: upper deck: 11 mm, side wall: 10 mm and bottom plate: 8mm. The pontoon is to be constructed by dividing the entire pontoon into 9 compartments with bulk heads, and then inserting water ballast in the opposite side of the support of the approach bridge to maintain overall balance. Fig. 10.2.6 shows the structure of the pontoon.

(b) Approach bridge

The overall design requires the following span and width due to the topograhical feature of the river bank, the required water depth for design vessels, as well as, the passage width and the maximum possible slope which transport machinery can climb smoothly:

Bridge span:	42,000 mm
Width of passageway:	4,600 mm

The design shown in Fig. 10.2.7 is being considered.

(3) Design of the shed

The major dimensions of the shed are as follows: width: 30m, length: 50m. The roof structure will be a steel truss supported at both the sides and the center by reinforced concrete pillars. There will be two entrances on each side for a total of four and a steel hanger door will be included. In addition, there will be a roof ventilator for internal ventilation and a roof window to supply light.
Fig. 10.2.8 shows the design of the shed.

(4) Road design

Roads can be divided into the access road which connects the terminal with the main road (the road connecting with the Buriganga Bridge) and the roads within the port.

(a) Access road

The road connecting the terminal with the main road will include a 2-lane motor vehicle road, a 2-lane rickshaw road, dividers and pedestrain ways. A cross section of the acces road is shown in Fig. 10.2.1.

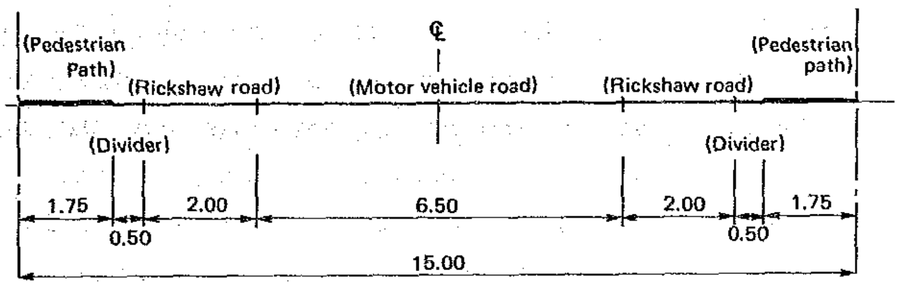


Fig. 10.2.1 Cross Section of the Access Road

The access road will be paved with asphalt. The cross section of the pavement will be designed in accordance with "The Essentials of Asphalt Paving", edited by the Japan Road Society, as well as the design condition that the rate of traffic for large-scale vehicles is not expected to exceed 250 vehicles per day each way and that the design value of CBR is 3 for the subsoil. The sectional paving structure for the access road is shown in Fig. 10.2.2.

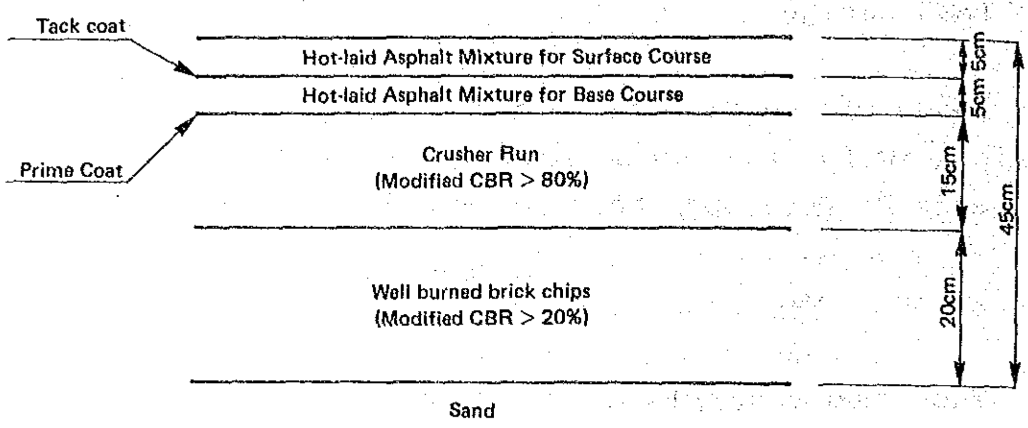


Fig. 10.2.2 Sectional Paving Structure of the Access Road

(b) Roads within the Port

The roads within the port will include a two-way road for vehicle traffic, a pedestrian path and a dividing line. The cross-section of the roads appears in Fig. 10.2.3.

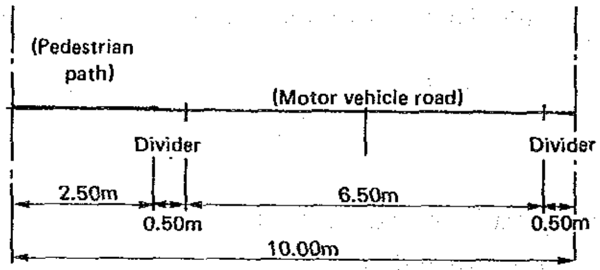


Fig. 10.2.3 Cross Section of the Roads Within the Port

Paving of the roads will be the same as that for the access road. Fig. 10.2.4 shows the sectional structure of the paving.

°Rate of traffic for large motor vehicles: 250 vehicles each way.

°Grading of the road bed: Plan CBR-3

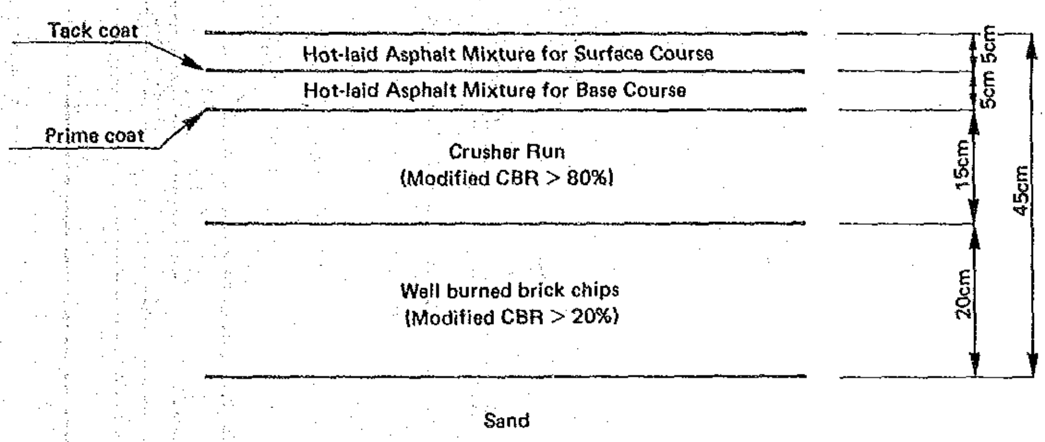


Fig. 10.2.4 Sectional Paving Structure of Roads Within the Port Area

(5) Bank protection design

The slope of the bank protection will be 1:2. Brick will be laid on the face to prevent corrosion due to washing away. In order to prevent the bricks from falling down to the toe of the river bank, a ditch will be excavated and filled with brick chips as foot protection.

To further prevent the falling down of the end of the face line, the roads on the premises will be built a meter away from the protection work. Fig. 10.2.5 shows the design of the levee protection work.

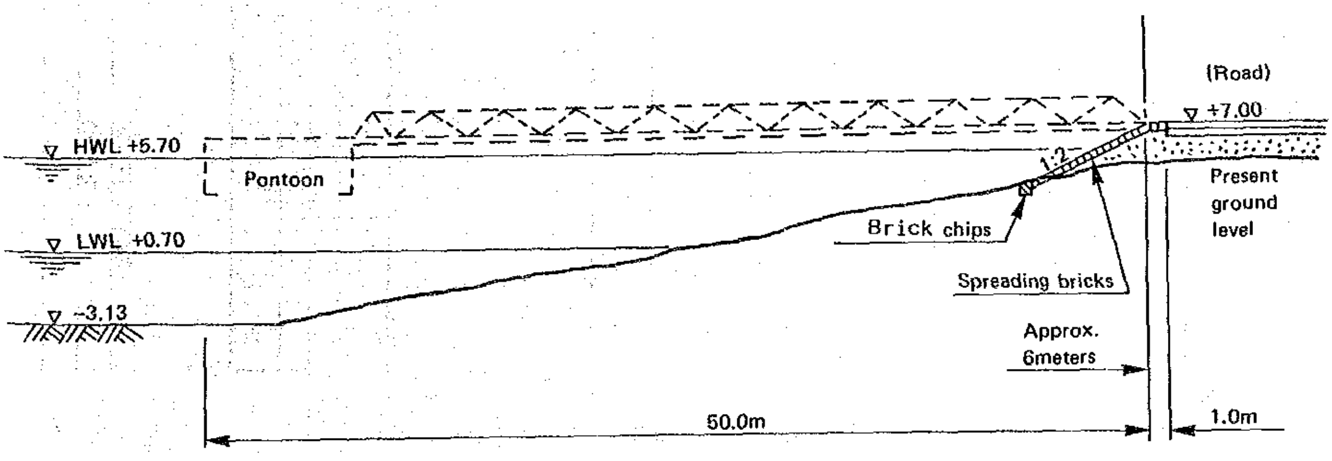


Fig. 10.2.5 Level Protection Work Design

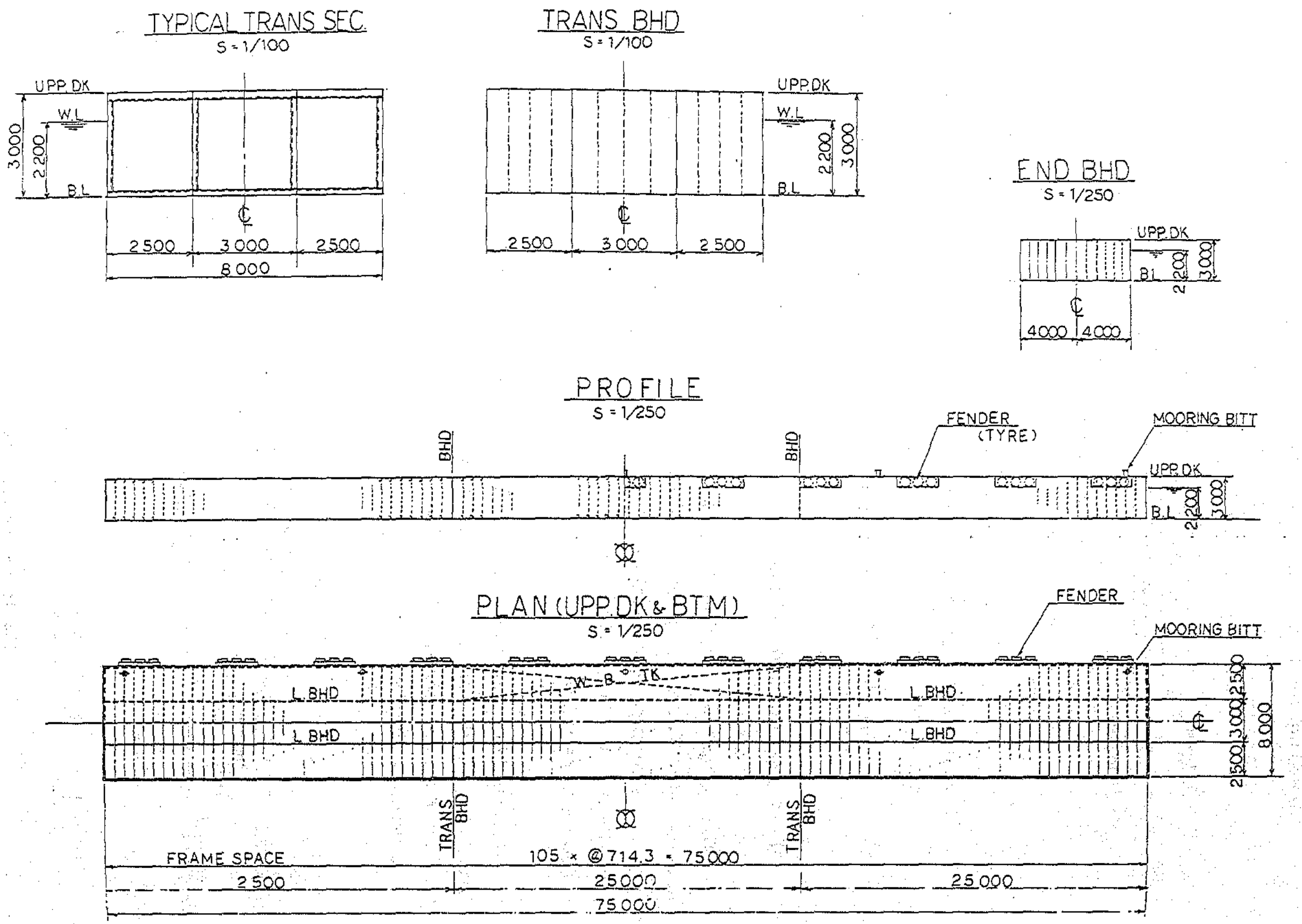


Fig. 10.2.6 Plan of the Pontoon

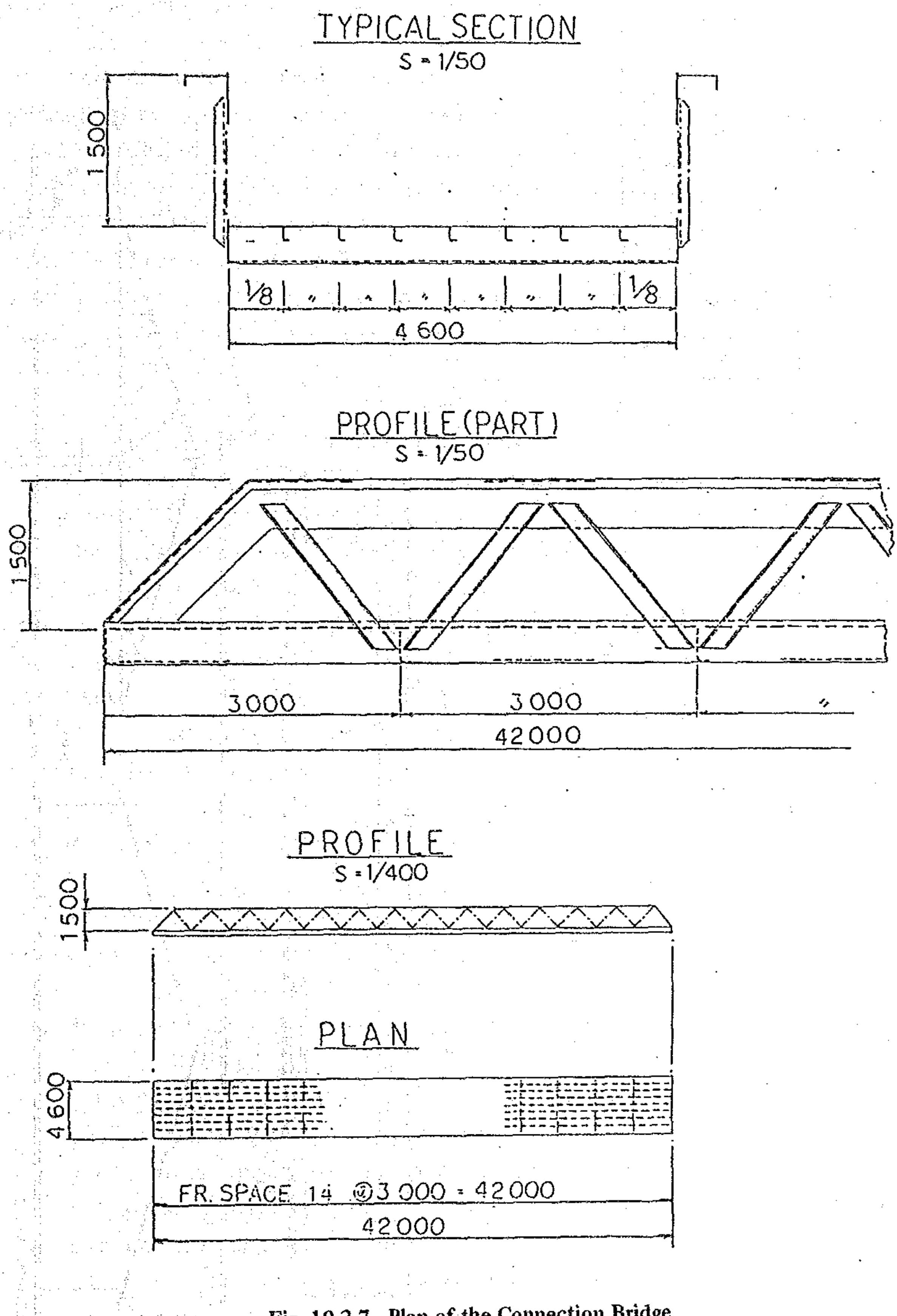
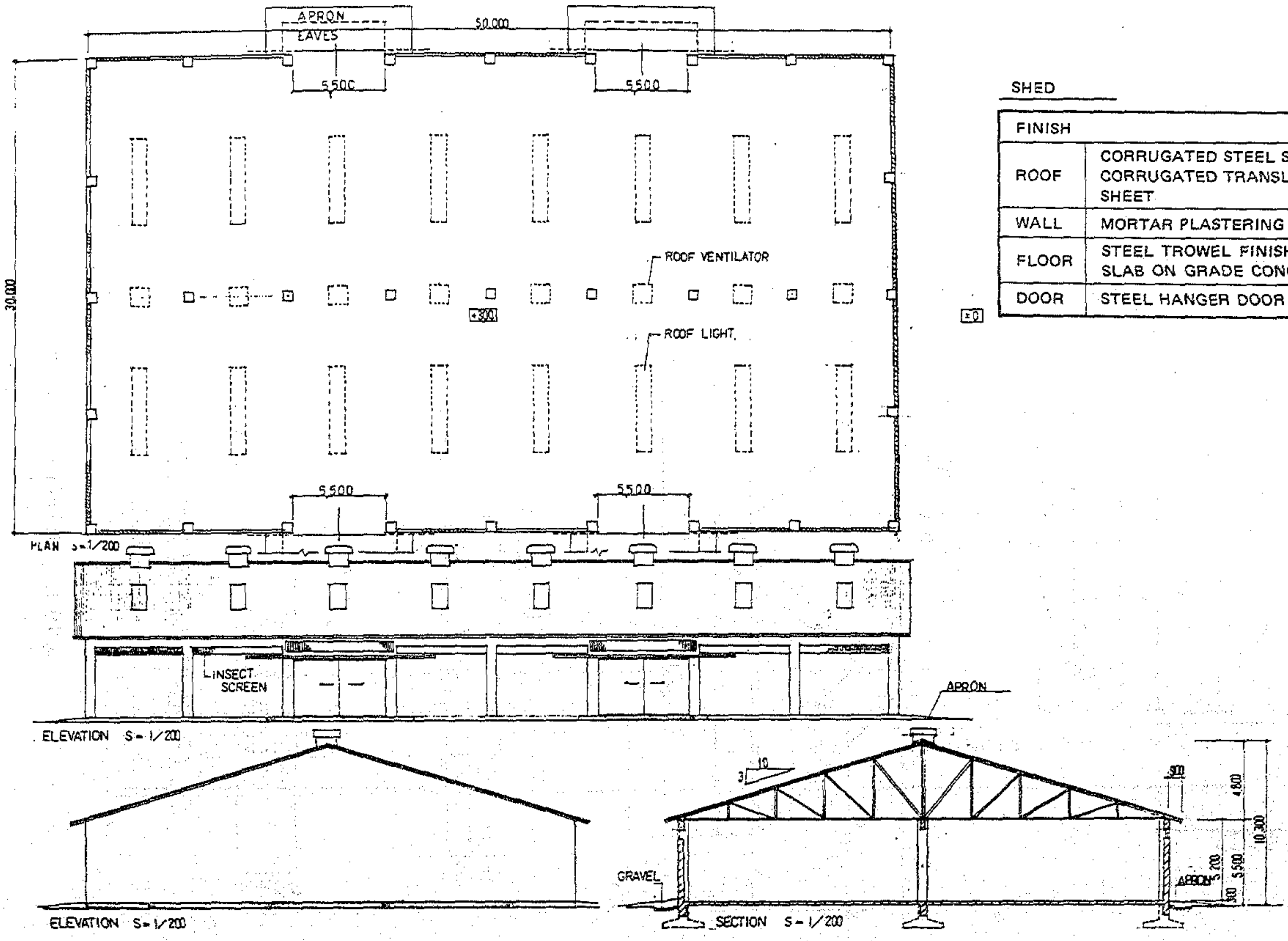


Fig. 10.2.7 Plan of the Connection Bridge



SHED

FINISH	
ROOF	CORRUGATED STEEL SHEET CORRUGATED TRANSLUCENT SHEET
WALL	MORTAR PLASTERING
FLOOR	STEEL TROWEL FINISHED SLAB ON GRADE CONCRETE
DOOR	STEEL HANGER DOOR

Fig. 10.2.8 Plan of the Transit Shed