results of simulations suggest that the hydraulic design parameters for the preliminary designs are appropriate and adverse impacts due to the project construction will be minor in terms of hydrodynamics and river morphology for the design flood under 2003/04 conditions. The impacts, indicated as the differences in the 'without project' and 'with project' scenario conditions, are minor as a whole. For the design flood of the 100-year return period, the increment of the highest water level is almost negligible and only a +0.1m/sec increment would occur in the depth-averaged flow velocity.

Two-dimensional Modeling and Simulation (2003/04 Padma 2-D Long-term Model): The long-term simulation represents the indicative tendency for riverbed scour or deposition for locations for periods of 5 and 10 years respectively. The simulation results suggest that no large impact in terms of mid- and long-term morphological processes would be expected from the project construction.

(3) Estimate of Maximum Scour Depth

Types of Riverbed Scour: Natural and structure-induced scours were taken into account in the estimation of maximum scour depth. The natural scour was estimated as the sum of bend and confluence scours that could occur simultaneously under the worst case scenario, while structure-induced scours such as those around the bank protection works and bridge piers were calculated under natural scour flow conditions.

Design Maximum Scour Depth (DMSD): A total scour depth was calculated assuming the worst combination of the relevant types of scour. In order to account for extra scour, which may be induced by unforeseen and compounding structural influences, the total scour was multiplied by a factor of 1.20 to determine the design maximum scour depth (DMSD). Adopting the case of the closed Arialkhan River, the DMSD was defined for the 100-year flood as shown below:

1) In front of revetment: DMSD = 44.9 m below DHWL (Bed El. -37.6 m PWD)
2) In a mid-river section: DMSD = 31.0 m below DHWL (Bed El. -23.6 m PWD)

Historical Riverbed Scour: According to periodic river survey data available in the neighboring reaches of the crossing location for 35 years from 1968 onwards, the lowest recorded riverbed was -37.01 m PWD in 1970 followed by -31.73 m PWD in 1985, both at the foot of the left bank just upstream from the proposed bridge site. Most deep scour took place near the less erodible left bank, which resists erosion. Some deep scour occurred in the river center, which is deemed to be caused by flow turbulence due to the confluence of channels downstream from the char. In comparison with the historical lower beds around the crossing location, the proposed DMSD is judged to be reasonable.

5. PRELIMINARY FACILITY DESIGN

5.1 Preliminary Design of River Facilities

(1) Principles for Planning River Facilities

Objectives of River Works: The main objectives of the river works were:

1) To ensure the stability of the river section by maintaining existing river and flow conditions, and
2) To protect the bridge structures.

Strategies: In order to achieve the objectives, the following strategies were established:

1) The existing favorable river conditions at the bridge site shall be maintained and reinforced by river works, reducing the impact on the river and flow.
2) The existing perennial river width will not be constricted.
3) Conventional and state-of-the-art bank protection measures developed in Bangladesh should be employed with due consideration given to river characteristics

River Works for Padma Bridge: Reviews of previous studies and bridge works suggest the application of the latest bank protection measures developed for Bangladesh rivers. These would fix existing bank-lines in combination with super-quality bank protection measures conventionally used for bridges, thus firmly protecting the structures of Padma Bridge.

1) Hardinge Bridge, constructed in 1915 across the Lower Ganges River, provides guide bunds. The guide bund is a conventional bank protective measure developed for a meandering river, and its design standards are mostly related to the parameters of meandering rivers.
2) Jamuna Bridge, constructed in 1998 across the braided Jamuna River, is equipped with guide bunds and hard points. Since the design standards prepared for meandering rivers were not always applicable to braided rivers, these works were designed based on the results of intensive analyses using physical and mathematical models.
3) Recently, various efforts have been made to seek improved bank protective measures, e.g., Flood Action Plan Project (FAP-21/22:1991 to 2001), and the Jamuna-Meghna River Erosion Mitigation Project (JMREMP: 2001 to 2008), etc. The bank protective measures developed for these projects were constructed in the actual rivers and their performances were monitored and evaluated as satisfactory.

(2) Preliminary Design of River Facilities

Protection Line of Left Bank: The left bank was first discussed to be set 1 km away from the existing riverbank, to provide for potential future erosion of the less erodible bank. After further studies on the geomorphologic and geotechnical conditions of the left bank, however, it was finally proposed that the protection line be replaced in favor of existing bank-line strengthening with bank protection works. This latter scheme would have a lower total cost and provide the local communities with erosion-free land along the Padma River.

Layout of Bank Protection Works: The following continuous protection works were designed on both banks to repair existing banks and guide the Padma flow smoothly to the bridge opening:

1) Left Bank Work: A total length of 6 km to protect the bank around bridge structures (sites L1 and L2) and a protrusive bank (site L3) upstream from Mawa ghat strengthening the existing bank.
2) Right Bank Work: A total length of 4.0 km to secure the stability of the right bank, which is vulnerable to erosion, and to firmly protect the bridge structures (sites R1, R2 and R3).
3) South Channel Work: A total length of 6.3 km downstream from Charjanajat ghat to check the southward shifting of the riverbank and protect the right approach road.

Bank Protection Measures Applicable: Revetments are proposed for bank protection. The revetment mainly consists of slope protection with embankment and toe protection, which is, itself, composed of launching and falling aprons. Two types of revetments, A and B, with different toe protection construction methods were proposed. The toe

protection works for Type-A are constructed on land, as recommended by the FAP-21 Study, while those for Type-B are constructed underwater by placing the launching apron on the permanent slope formed beforehand by dredging, as in the Jamuna Bridge works. Type-A revetment enables dependable and easy construction, but excess materials are required to compensate the risk of slope-cover by natural forces. The Type-B revetment means definite functions can be achieved immediately upon construction but requires higher construction costs. Taking the site conditions and required functions into account, Type A revetment was applied to the Left Bank and South Channel Work, while Type B was applied to the erosion-susceptible right bank along the Padma River (Right Bank Work) giving conservative design consideration to the achievement of the required functions.

(3) Design Considerations

General: Revetments of Types A and B were mainly designed with reference to the river works designs for Jamuna Bridge and the FAP-21 Manual, based on the results of studies and pilot works over about 10 years.

Design of Embankment and Slope Protection: Embankments along the banks to be protected were designed to focus mainly on aligning the slope protection works and for use as a road for maintenance activities and stockpile yards for maintenance repairs. Embankments at the L1 and R1 sites located in front of the bridge structure were designed for year-round use with higher crest elevation +8.85 m PWD (DHWL+1.5m), whereas the other embankments were designed with crest elevation +6.00 m PWD, taking SHWL and the nearby ground elevation into account. The crest and side slopes shall be strong enough against overtopping flow. The toe elevation of the river-side slope was set at +2.00 m PWD.

Design of Toe Protection Works: Toe protection works are required to ensure the stability of the slope protection works from scouring and undermining due to river flow. The toe protection works recommended for standardized revetments by the FAP-21 Study were adopted for the Type-A revetment, while those of the Jamuna-Bridge type were adopted for Type-B revetment. The lower slope of Type-B revetment was designed at 1V:6H, referring to the experience of the Jamuna Bridge works, recent examples of other bridge projects and suggestions by the FAP-21 study; taking geo-technical site conditions into consideration. For Type-B revetment in front of the bridge structures (Site-R1), the dredging level was selected at -25 m PWD, taking into account the maximum dredging depth of the cutter suction dredger (assumed to be 30 m) and the estimated natural scour level. As for the other revetment sites for the Right Bank Work (sites R2 and R3), the dredging level was set at -15.0 m PWD; taking the capacity of dredgers and annual workable period into consideration.

Design Drawings: According to the results of design considerations, design drawings of revetment works were prepared for respective sites. The general plan of river works and standard designs for revetments of types A1 and B1 are shown in Figures 5.1 to 5.3.

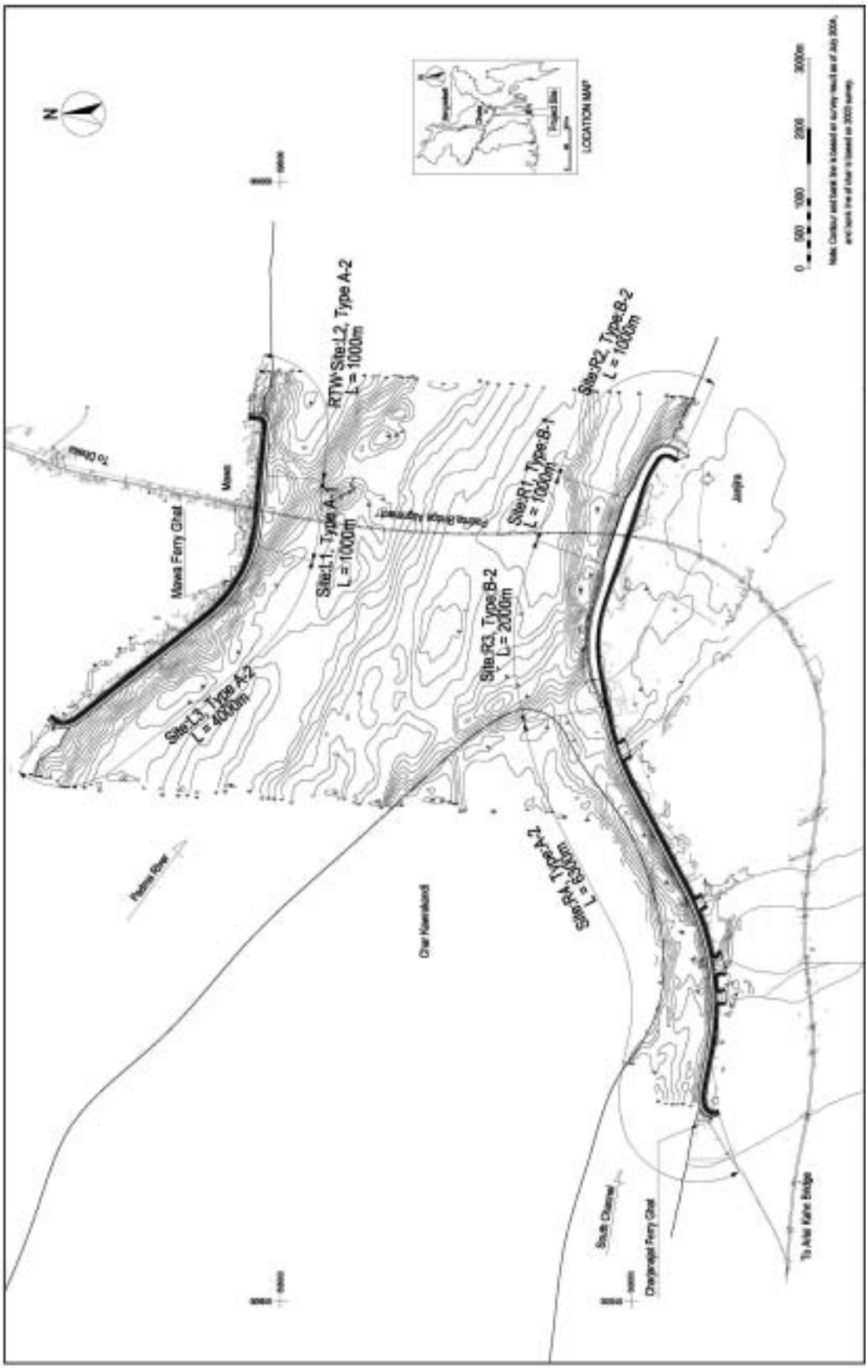


Figure 5.1 General Plan of River Works

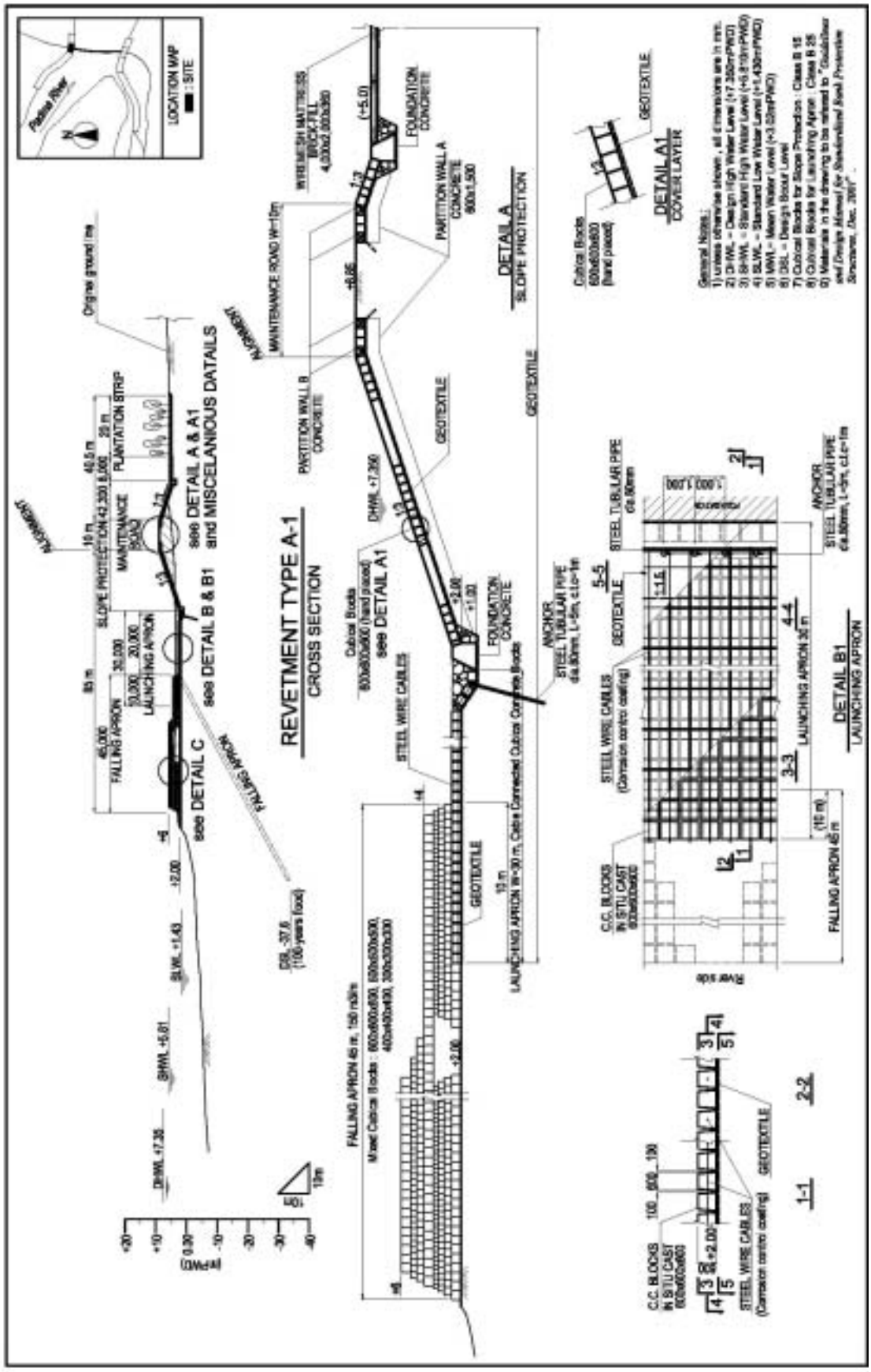


Figure 5.2 Standard Design of Revetment: Type A-1

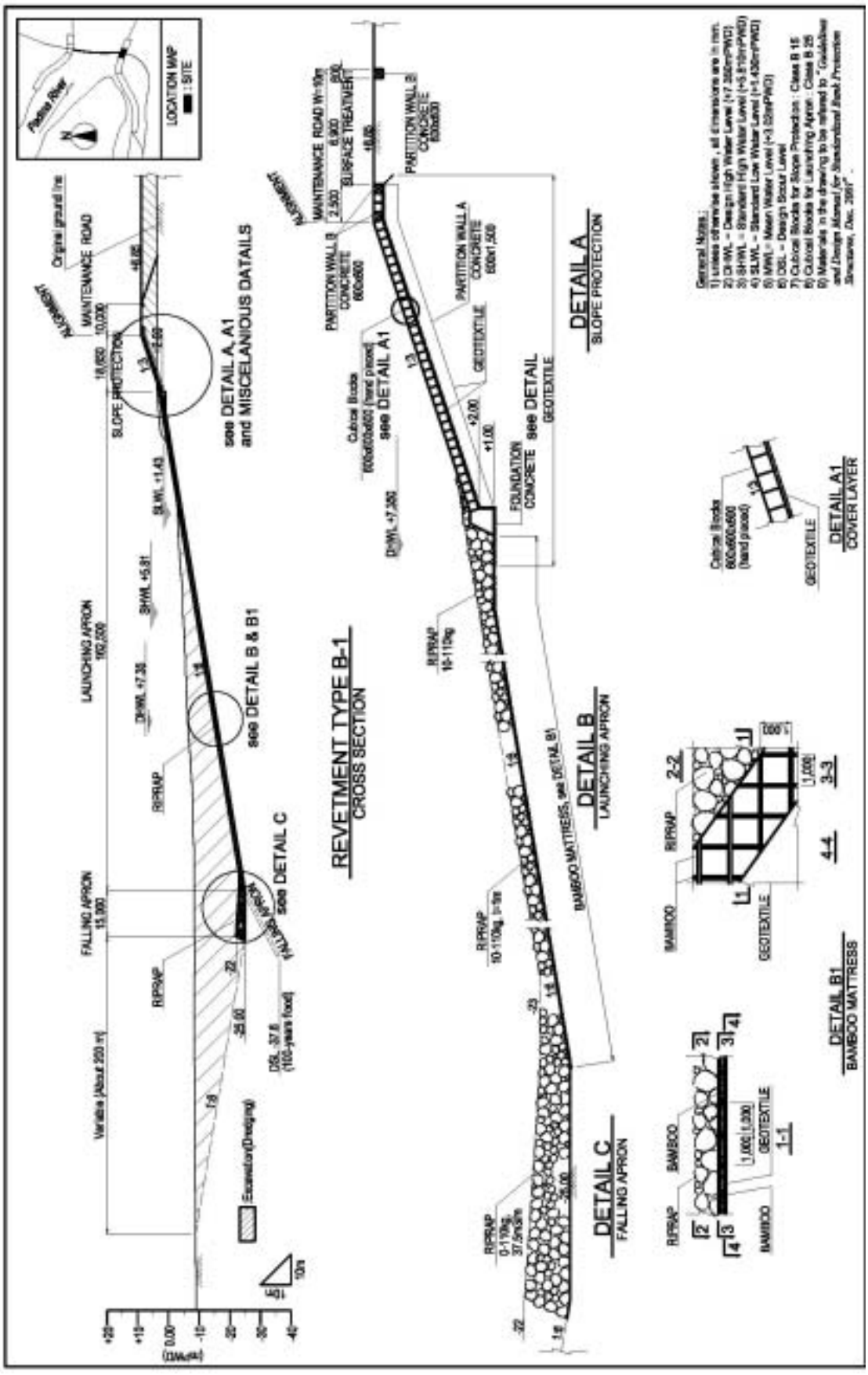


Figure 5.3 Standard Design of Revetment: Type B-1

5.2 Preliminary Design of Padma Bridge

(1) Bridge Width for Preliminary Design Alternatives

(a) Bridge Width based on the Asian Highway Standard

The Padma Bridge would be built on the Asian Highway (AH) Route No. A-1 that is planned under UN ESCAP. The Study Team has examined standard bridge widths with those stipulated in the AH standard by UN ESCAP and with the Bangladesh highway standard, stipulated by RHD. The following figure shows the standard section of a 2-lane dual carriageway without median strip, as stipulated in the AH standard.

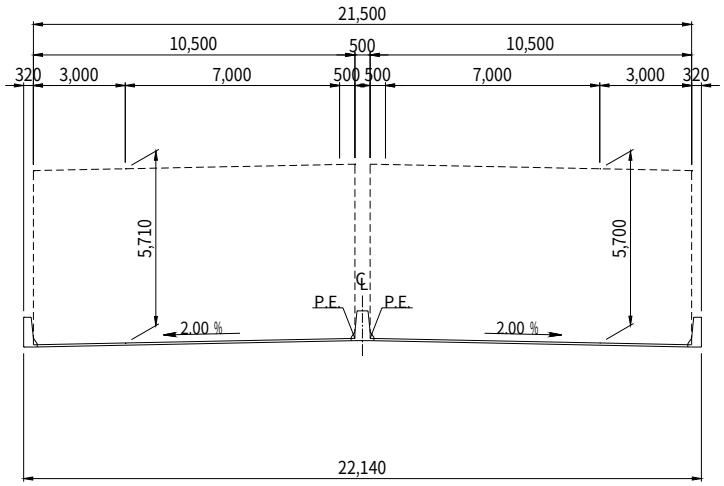


Figure 5.4 Bridge Cross-Section based on the AH Standard without Median Strip (Base Case)

The bridge cross-section above is considered as a "Base Case" for examining the standard bridge type and span length, which is discussed in Sections 5.2.2 and 5.2.3.

(b) Bridge Width based on RHD Substandard

In addition to the above bridge widths based on the AH standard, a further option was examined to implicate the minimum investment case, as shown in the following figure. This option has a 2-lane dual carriageway width of 7.3 m, as specified in the RHD Standard and a minimum side belt of 0.5 m on each edge and side.

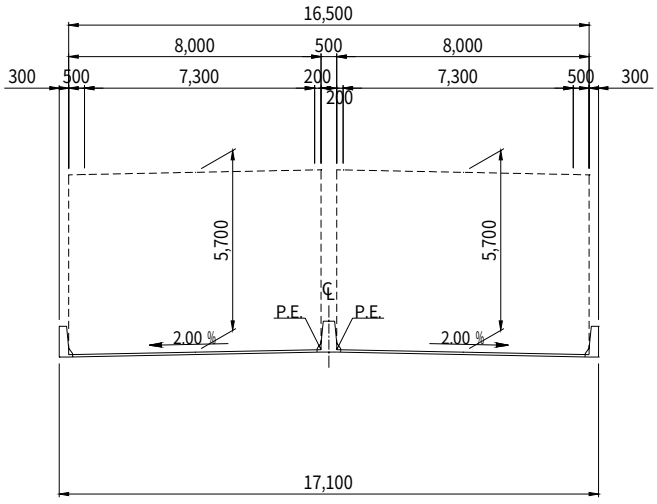


Figure 5.5 Bridge Cross-Section based on RHD Substandard

(2) Design Criteria and Standards

The preliminary design in the Study would be conducted on the basis of AH and RHD Substandards, the latter resembling AASHTO standards. The standards adopted by the Bangladesh Building Code (BBC), Japan Road Association (JRA), BSI and Indian Road Congress (IRC) would also be used as supplementary codes.

Dead Load	As specified in AASHTO
Live Load	HS 20-44, AASHTO
Impact	As specified in AASHTO
Thermal Effect	As specified in AASHTO
Seismic Effect	Horizontally equivalent force = 0.2 to 0.24 (0.125 g and soil type III specified in AASHTO)

Wind Force	Wind velocity = 55 m/sec As specified in the Bangladesh Building Code
Navigation Clearance	H = 250 ft, V = 60 ft at river center as concluded by BIWTA
Ship Impact	Ps = 23.7 MN (1,500 t, 10 knot), 4m above SHWL as concluded by BIWTA
Railway Load (in case of railway provision)	As specified in the Bangladesh Railway Standards
Public Utilities	400 kV power line, gas pipe line, telecom line

(3) Preferable Span Length

As a result of the cost-span relations examined during the course of the bridge location study by the Study Team, concrete-type bridges were judged as preferable to steel-type from the perspective of lower construction cost. Construction costs per meter of span length were estimated and compared for the following combinations of span and type to determine the optimum bridge type and span length:

PC continuous box girder for span lengths of 100m, 120m, 140m and 160m
PC extra-dosed girder for span lengths of 140m, 160m, 180m and 200m
PC cable stayed girder for span lengths of 180m, 200m, 220m and 240m

Cost – span relations by bridge type are shown in Figure 5.6:

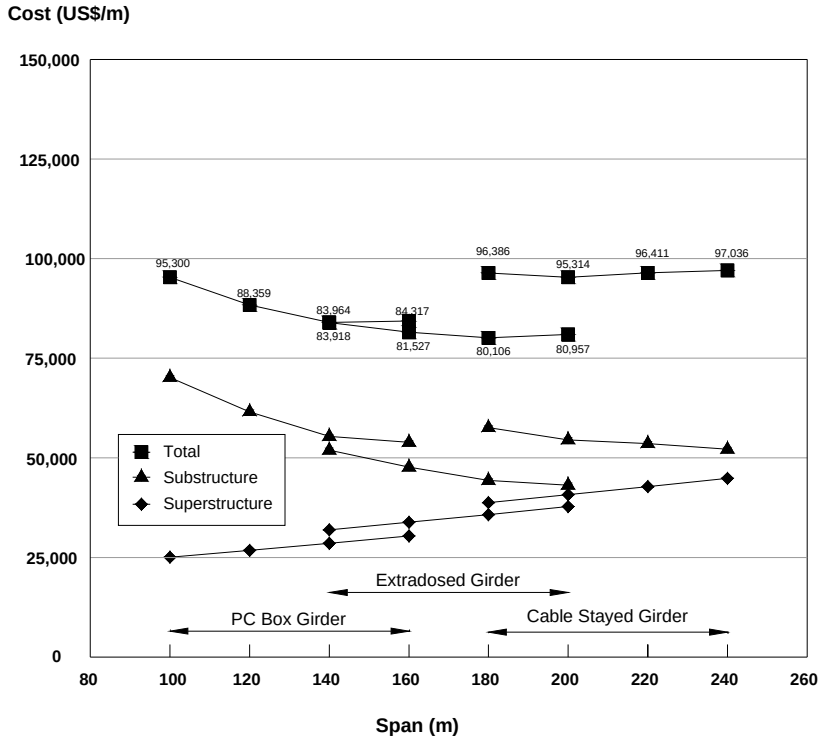


Figure 5.6 Cost-Span Relation

Based on the results to gauge the preferable span length and type, the preliminary designs of the extradosed bridge were made for the Base Case. The main reasons for selecting the extradosed girder as the standard structure for the Padma Bridge were as follows:

- The extradosed girder would be cheaper than other bridge types, as shown in the above figure.
- The concrete strength required for the extradosed girder would be the same as that for the PC box girder; a common type of bridge for long span bridges in Bangladesh. No issues would arise in terms of the concrete quality during the construction period.
- Exterior cables are used for the extradosed girder, meaning future maintenance would be relatively simpler than for the PC box girder. In the latter, cables are generally encased in cable conduits followed by cement mortar grouting, as is the case in the Jamuna Bridge and others of the PC box girder design in Bangladesh.

(4) Standard Bridge for Preliminary Design

The extradosed bridge for the Base Case is shown in the following figure. The preliminary substructure design is based on voided reinforced concrete piers, reinforced concrete pile caps and driven tubular steel piling 3150mm in diameter (3m in nominal diameter.)

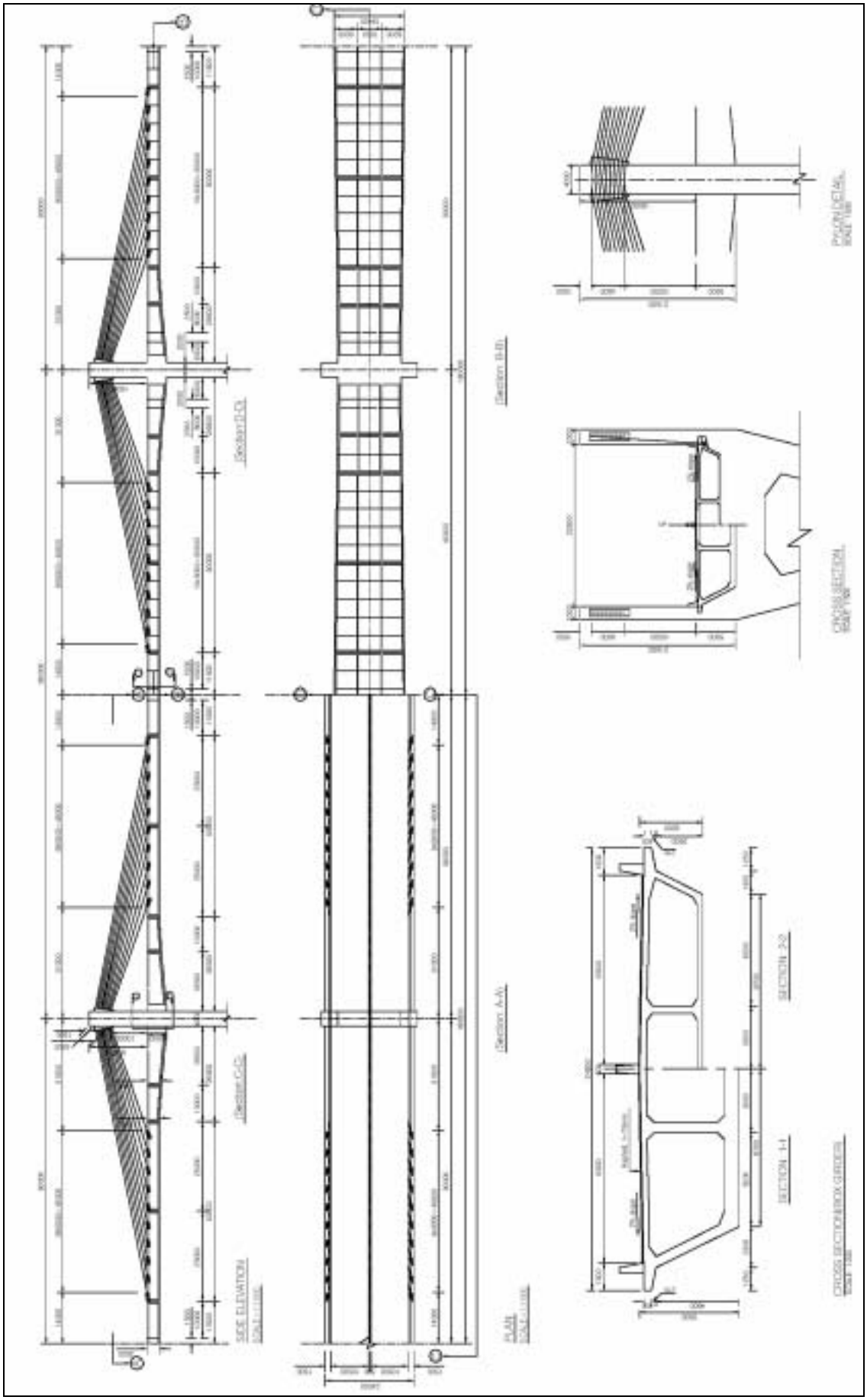


Figure 5.7 General View of the Extradosed Bridge for the Base Case based on the Asian Highway Standard

(5) Bridge Design Options

As stated in the river facility design, the main bridge portion is 5,400 m long. This means a multiplication of 180 m, which is the most preferable span length as recommended above.

Taking thermal expansion into account, the overall length of any continuous superstructure must not exceed approximately 750 meters. Thus (4x180m=720m) constitutes a standard superstructure module, and expansion joints must be placed at intervals of 720 meters or less between the neighboring structures.

In the case of adopting a cable stayed girder bridge in part of the main bridge, as requested by the Bangladesh side, a single module of 720 meters will be substituted by a composite cable stayed girder, with a span arrangement of (48+132+360+132+48=720m).

Regarding the requirements for vertical alignment, major portions of the bridge have to maintain a maximum incline of 3%. However, in cases where the slope is insufficient such as the approach viaduct, 4% is allowed for the roadway. At least one, and preferably three, navigational routes must have a vertical clearance of 60 feet, and at least 40 feet for the other routes throughout the whole navigational course of 4,800 meters width.

Consequently, the following three combinations were examined:

- Alternative-H1: PC Extradosed Girder Bridge based on the Bridge Width of the Asian Highway Standard
- Alternative-H2: PC Extradosed Girder and PC Cable Stayed Girder Bridges based on the Bridge Width of the Asian Highway Standard
- Alternative-H3: PC Extradosed Girder Bridge based on the Bridge Width of RHD Substandard

The configurations of these alternatives are shown in Figure 5.8, while table 5.1 shows a summary of major quantities for the three alternative designs.

Table 5.1 Summary of Major Quantities by Alternatives

Structural Element		Items	Unit	Alternatives		
				H1	H2	H3
Superstructure	Girder and deck	Concrete	Cu. m	139,402	128,559	110,825
		Pre-stressing. tendon	Ton	5,822	5,392	4,628
		Rebar	Ton	22,178	20,458	17,632
	Pylon	Concrete	Cu. m	12,000	13,725	9,540
		Rebar	Ton	2,640	2,920	2,099
	Stay cable	Cable and fixture	Ton	4,695	4,871	2,733
	Steel girder	Structural steel	Ton	--	4,851	--
Substructure	Pier	Concrete	Cu. m	165,254	223,530	158,251
		Form	Sq. m	79,720	86,048	69,653
		Rebar	Ton	13,487	15,718	11,385
	Foundation	Vertical steel pile (3m nominal dia.)	m	--	1,280	--
		Raked steel pile (3m nominal dia.)	m	21,856	23,488	19,914
		Cast-in-place RC pile (1.2m dia.)		1,379	1,379	1,140

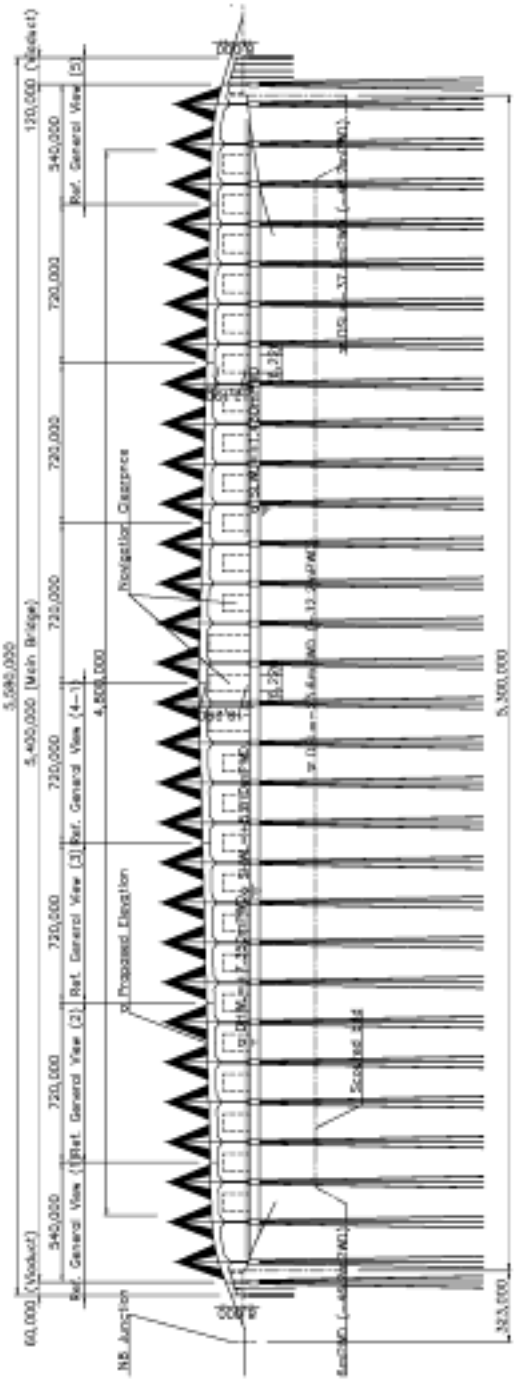


Figure 5.8 (a) General View of Alternatives-H1 and H3

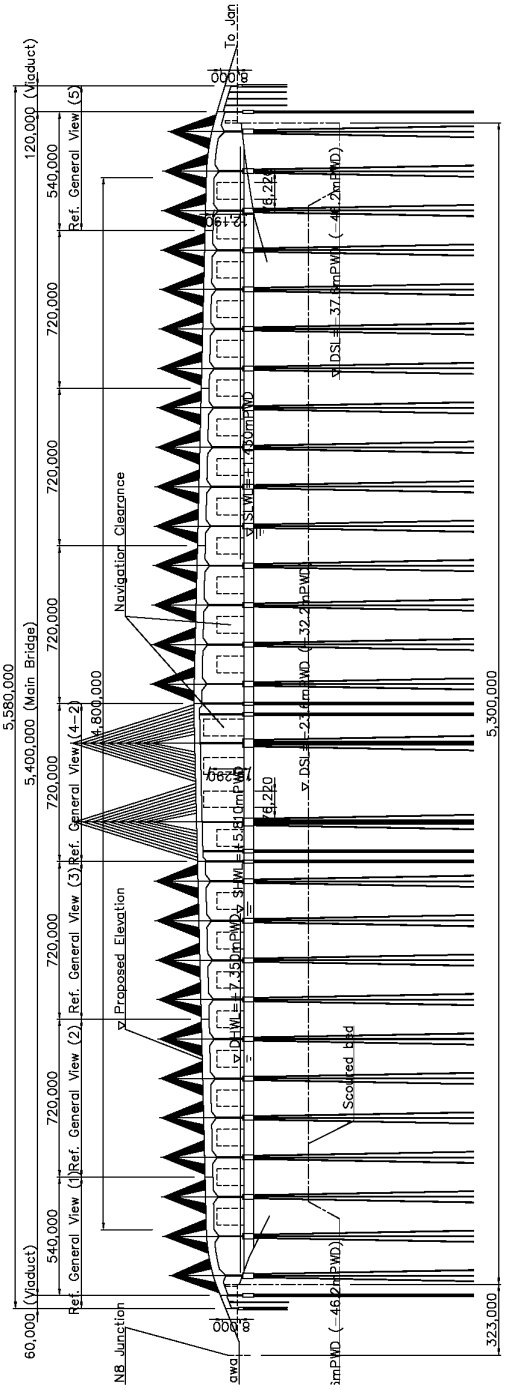


Figure 5.9 (b) General View of Alternative-H2

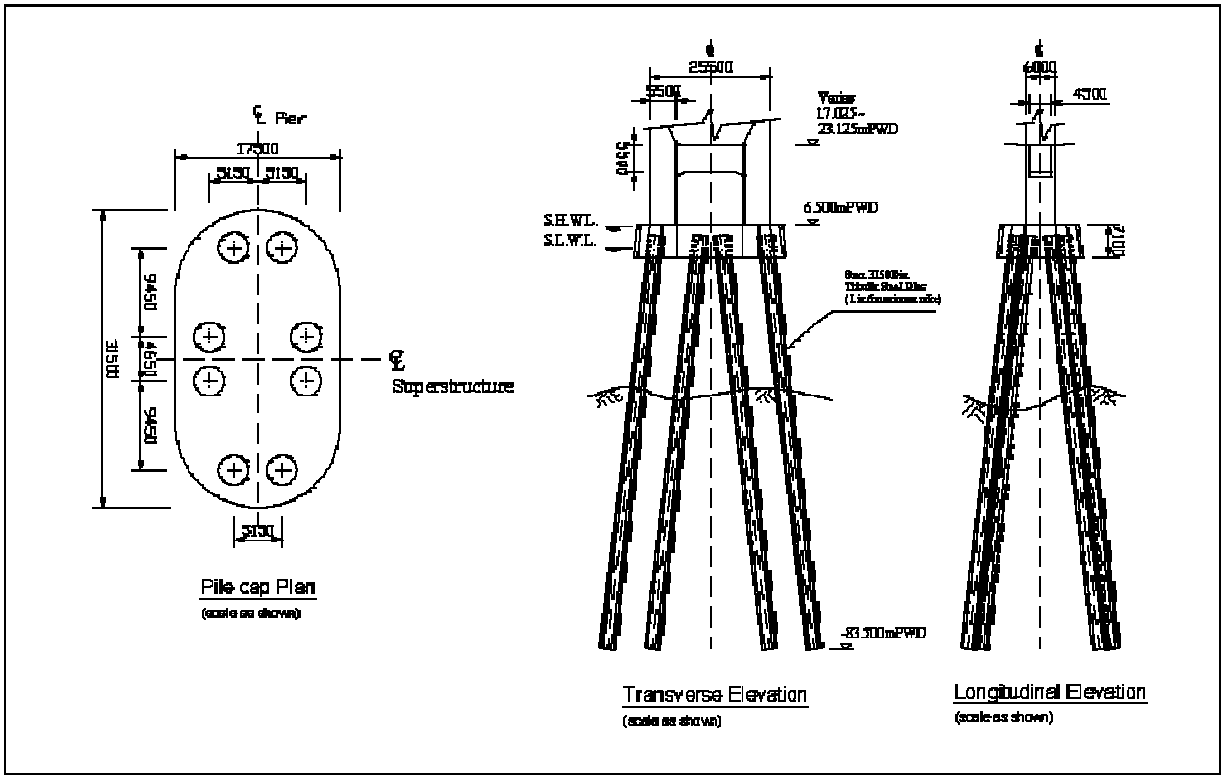


Figure 5.9 General Arrangement of River Substructure
(Alternatives-H1, H2 and H3 but the H3 includes less piles than the others)

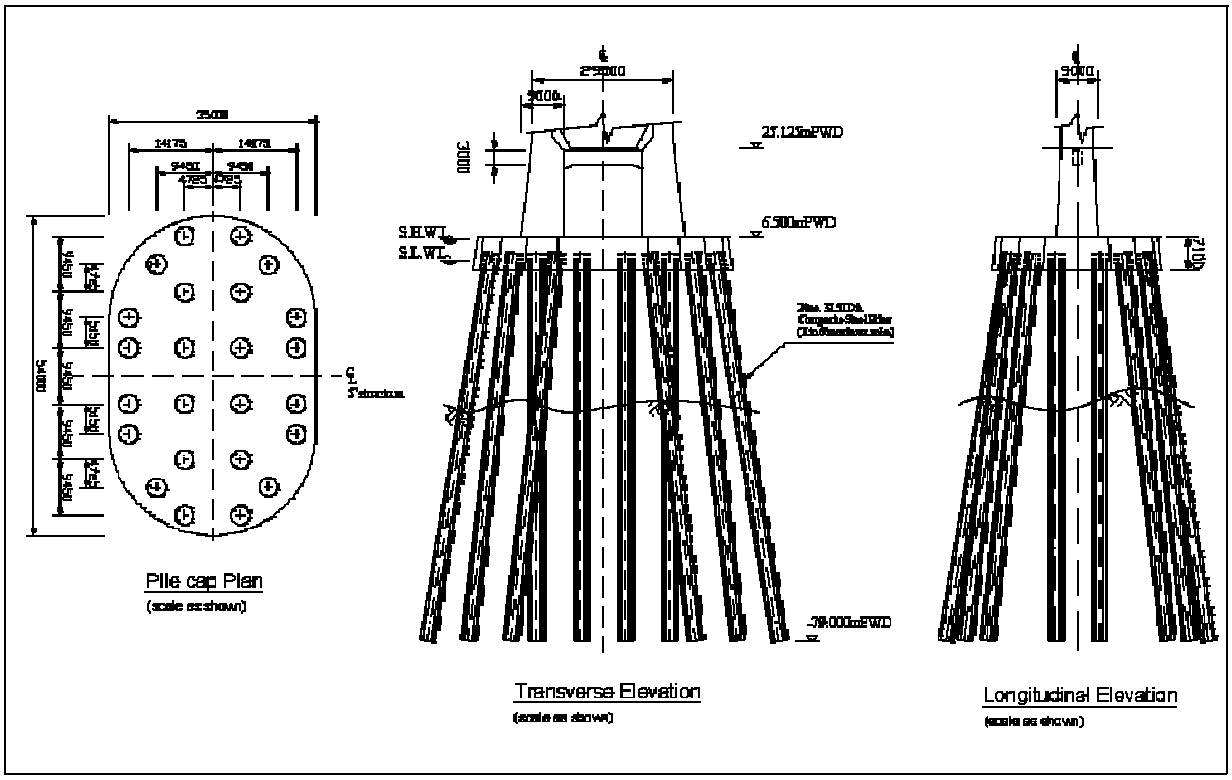


Figure 5.10 General Arrangement of River Substructure for Cable Stayed Tower
(Alternative-H2)

5.3 Preliminary Highway Design

(1) Design Standard and Criteria for the Preliminary Highway Design

The potential geometric standards to be applied to the preliminary highway design are the RHD Geometric Design Standards of Bangladesh and the Asian Highway Classification and Design Standards of UN ESCAP. The features of the Project highway are summarized as being a highway with full access control as the "road type", located in a rural "area", on level "terrain", and with average day traffic of 41,550 for 2025 as the "traffic level". This leads to the classification of "Type 2" (design speed: 80 km/h) and "Primary, Level Terrain" (120 km/h) of the RHD and Asian Highway standards, respectively, bi-directional and with four lanes.

Jointly applying these two standards tends to be favored rather than adopting the AH standard alone, which apparently includes a higher design speed than the RHD standard. However, there is actually relatively little difference in total bridge width between them in the case of future railway loading, minimizing any effect on the construction cost. Moreover, although the present condition of NH8 connecting to the project is lower than the AH standard, the road could be upgraded to the standard within 100 years, namely the design lifespan of Padma Bridge. It would be extremely difficult and costly to widen such a huge bridge after completion. In addition, the Study Team believes that, from the traffic safety perspective, provision of a continuous hard shoulder with insufficient width must be avoided, and that the shoulder width of 1.8 m, as specified by the RHD standard, is too narrow to be adopted for the Padma Bridge. However, the bridge width applying to the RHD standard is considered as an alternative design for minimum investment.

(2) Geometric Design of Project Highway

The Project highway at the Mawa-Janjira site has a distinct purpose, namely to supplement an important, but missing link on NH8. This is reflected in its routing over the Padma River and flood plain, together with the river conditions, topography, existing local road network, geology, social and environmental impacts, and public utilities.

The basic policy for the horizontal alignment is to have a combination of straight lines, and circular and transition curves with sufficiently mild and continuous geometry. This results in 3,000 m being the smallest radius on the entire Project highway.

For the vertical alignment, it is necessary to exceed the minimum navigational clearance over the Padma River and maintain the approach road at an adequate height over the inundated water level in the flood plain. This lead to minimum formation levels of 60 ft, 40 ft, and 3.04 m over SHWL for the central three spans, other spans of the main bridge, and approach road, respectively. These principal heights are inter-connected by slopes primarily less than or equal to 3%, but at a maximum of 4%, as well as adequate vertical curves.

The basic cross-sections of the Project highway have been set as:

AH standard with reduced median strip (w=21.5 m) for the main bridge, and

AH standard (w = 25.0 m) for the approach road..

(3) Preliminary Design of the Approach Road

The project highway has 12,163 m of approach road (213 m on the left bank and 11,950 m on the right bank). For the embankment with a crest width of 27.0m and average height

above ground of about 4 m, the earth dredged from the river training works of the Project on the right river bank will be utilized. The total pavement thickness of the approach road has been designated as 72 cm. The typical right-of-way width of the approach road is planned to be 100 meters in total.

For the convenience of local residents, the embankment of the approach road will include six bridges over minor waterways, ranging from 30 to 270m in length, 13 box culverts as underpasses for local road crossings, 16 transverse drainage culverts and 6m wide service roads on both sides. The formation levels will be 2.0 m lower than the approach road surface.

(4) Associated Facility Plan

As the Project highway is definitely to be operated as a toll road, using the simplest, stand-alone, single-section toll system, a single, barrier-type toll gate for each direction of traffic is desirable. Considering the requirements for toll plaza location and efficient toll operation, an intermediate point of the approach road on the right river bank has been selected as part of the basic plan for the joint-type toll gate with five traffic lanes in each direction. The O/M station for the Project highway, as well as the toll office, should be located at the road-side of the toll plaza. In response to a claim from the Bangladeshi side, however, a directionally-separated toll gate plan is presented as an alternative option to the basic plan.

The provision of a service area with parking spaces, a restaurant, shops, toilets, gas/repair stations, and landscaped areas is recommended near the right river bank line. This will be utilized as a tourism resource and effective use of the earth dredged from the river training works of the Project will be realized.

6. CONSTRUCTION PLAN AND COST ESTIMATE

Estimates of costs were prepared based on the construction plan and construction methods and taking the procurement circumstances of the labor, equipment and materials into consideration. As a precondition to construction planning, maximizing the use of available materials in Bangladesh has been taken into consideration to render the project more economically attractive.

The shortest construction schedule was planned to facilitate the potential commissioning of the project at the earliest opportunity. The construction method is expected to include the following:

- Bridge Foundation: A large sized piling barge with a large capacity lifting crane would be used to drive 268 nos. of 3.0 m diameter and 100m long steel tubular driven piles over a period of 16 months.
- Bridge Superstructure: 30 units of the Form Traveler would be operated at the same time for the main girder erection over a period of 30 months.
- River Facilities: The river training works would be constructed during the three seasons of low water levels over a period totaling 41 months. The construction would require 1.4 million tones of rip rap rocks, 840,000 square meters of Geotextile and 2.3 million cubic meters of cubic blocks.

The tentative construction schedule for the construction of the bridge, river works and approach roads is estimated at 54 months, or a 4 and a half year period, as shown in Figure 6.1.

The basic information data were collected by the Study Team based on previous bridge

construction reports and an interview survey with local construction companies.

Regarding the estimating procedures, the project costs were calculated based on the total of the construction, engineering, administration, land acquisition/resettlement and EMP (Environmental Management Plan) costs, and contingencies. The project cost was prepared applicable to the following 3 configurations proposed in this feasibility study with the associated cost estimates shown in Table 6.1:

Alternative-H1 : PC extradosed girder bridge [Base case]
(Asian Highway standard effective width)
Alternative-H2 : PC extradosed and PC cable stayed girder bridges
(Asian Highway standard bridge effective width)
Alternative-H3 : PC extradosed girder bridge with minimum investment case
(RHD Substandard bridge effective width)

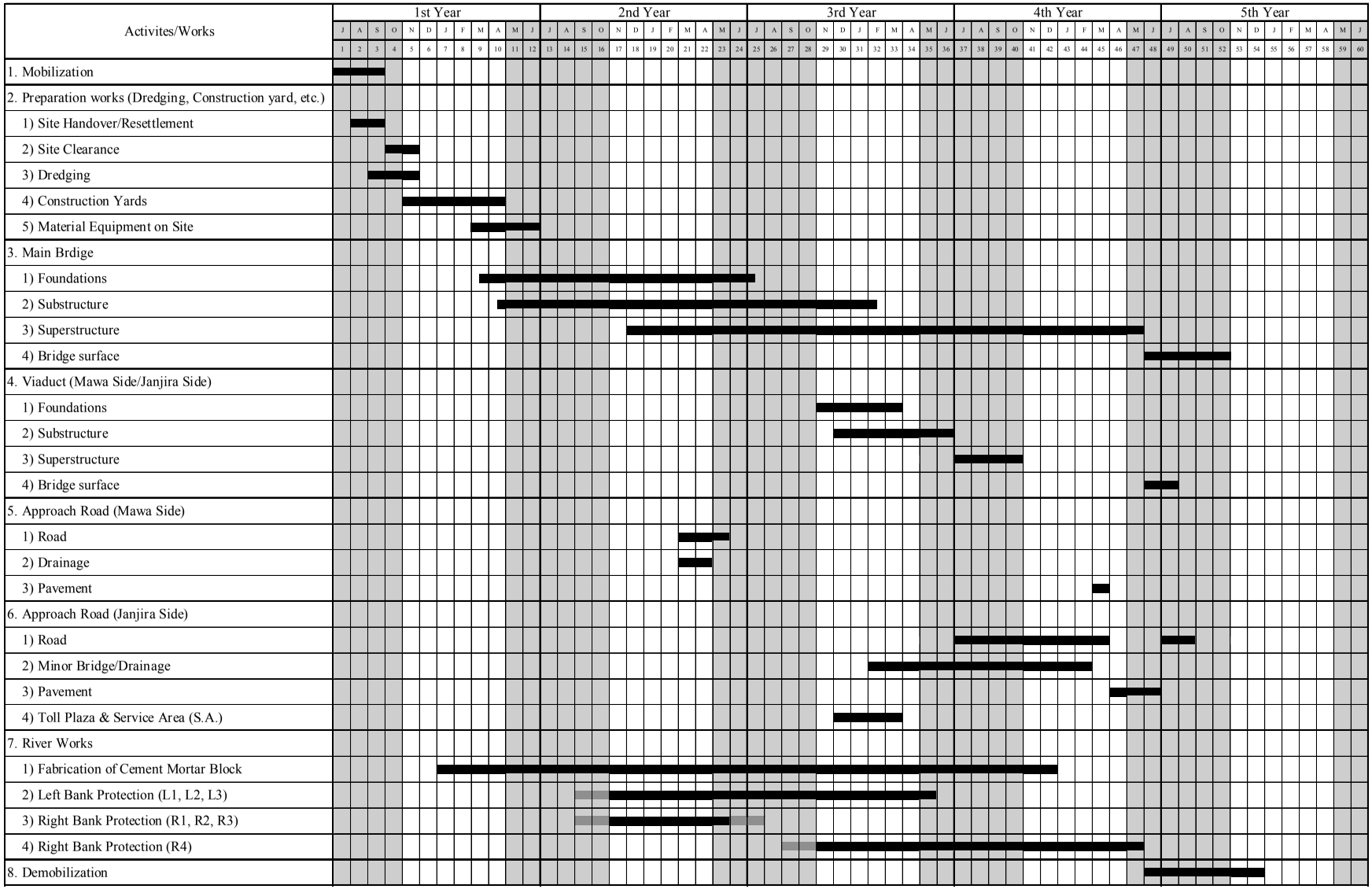


Figure 6.1 Tentative Construction Schedule

Table 6.1 Project Cost Comparison

Project Cost	Total amount (Unit : USD)		
Briidge alternatives	**Alternative-H1**	**Alternative-H2**	**Alternative-H3**
Bridge type	Extra-dosed girder	Extra-dosed plus Cable stay girder	Extra-dosed girder
Carriage purpose of bridge	Road	Road	Road
Bridge width	21.5m	21.5m	17.1m
Project cost items			
1. Construction cost	833,593,440	856,174,562	746,944,948
1) Bridge	423,396,040	445,977,162	336,747,548
2) Approach roads/Toll gate/S.A	49,193,790	49,193,790	49,193,790
3) River works	361,003,610	361,003,610	361,003,610
2. Engineering cost	50,015,590	59,932,210	50,015,590
1) Detailed design (2~3% of item-1)	16,671,860	25,685,230	16,671,860
2) Construction supervision (4% of item-1)	33,343,730	34,246,980	33,343,730
3. Administration cost	5,001,550	5,993,210	4,481,650
1) Details design stage (10% of item-2 1))	1,667,180	2,568,520	1,493,880
2) Construction supervision stage (10% of item-2 2))	3,334,370	3,424,690	2,987,770
4. Land acquisition and resettlement, and EMP cost	75,000,000	75,000,000	75,000,000
5. Physical contingency (15% of item-1)	125,039,010	128,426,180	112,041,740
6. Duty tax (VAT etc) (14.5% for importation of item-1+2)	89,686,310	92,984,830	80,891,490
Total project cost	**1,178,335,900**	**1,218,510,992**	**1,069,375,418**
(Project cost ratio)	(1.00)	(1.03)	(0.91)

7. ENVIRONMENTAL STUDIES

7.1 Introduction

The main objectives of the environmental study were to:

- identify the significant environmental impacts (positive and negative)
- propose potential mitigation measures
- meet the requirements of the environmental guidelines prepared by JICA, JBIC, GOB and other donor agencies, and
- prepare a preliminary EMP with indicative cost estimates.

The steps of the environmental study implemented for the Padma Bridge Feasibility Study were as follows:

- Environmental assessment of the Padma River eco-system in relation to the initial screening,
- Initial Environmental Examination (IEE),
- Environmental Impact Assessment (EIA), and
- Preliminary Environmental Management Plan (EMP) to counteract any negative impacts.

Initial environmental assessment for the four alternative sites and the Padma River ecosystem was carried out as part of the initial screening process during May to July, 2003. The IEE was conducted on the two preferred sites (Paturia – Goalundo and Mawa – Janjira)

during August to December, 2003. The EIA was executed from June to December, 2004 for the selected site (Mawa – Janjira). This also included a preliminary EMP.

7.2 Scope and Approach

The study approach can be summarized as follows:

- The Project components are described from an environmental aspect,
- A review of the EIAs of large bridges constructed in Bangladesh has been performed alongside a comparison of the present situation with those impacts anticipated in the EIAs,
- A detailed methodology has been established,
- The environmental base line has been described, based on both primary and secondary data,
- An environmental quality survey on air, noise, water (surface and ground) and riverbed material has been carried out,
- Input from an SIA study has been used,
- Input from a mathematical modeling study has been used;
- Questionnaire surveys have been conducted,
- There has been a meeting with stakeholders (FGD & PRA),
- There has been an analysis of the environmental impacts,
- There has been an impact assessment,
- Mitigation measures have been proposed,
- An impact evaluation considering the mitigation measures has been made,
- A preliminary EMP with approximate cost estimates has been proposed,
- Recommendations have been made for further studies required.

7.3 EIA Study Area and Project Component

An Environmental Impact Assessment (EIA) was carried out for the selected Mawa – Janjira site of the Padma Bridge. The impact area covered sections of the Padma River and its tributaries, associated channels and drains; and land in the vicinity of the approach road. The Work Area was in the districts of Munshiganj, Shariatpur and Madaripur. The project components studied for environmental assessments were as follows:

- Land Acquisition including Infrastructure;
- Main Bridge and Viaducts;
- River Training Works (RTW);
- Bridge Connecting Approach Roads;
- Service Area; and
- Toll Gate Area.

7.4 Environmental Investigation of Similar Projects

A number of large bridge projects have already been implemented in Bangladesh and EIAs were conducted in all cases. However, there has been no systematic study for environmental monitoring at the operational stage. To compare the anticipated impacts in the EIA stage with the present conditions, the JICA Study Team undertook an environmental investigation of the following bridges:

- Padma Bridge pre-feasibility study
- Jamuna Bridge
- Paksey Bridge

- Bhairab Bridge, and
- Rupsa Bridge

Reviews of environmental conditions following the completion of construction are very limited in Bangladesh. Investigations by the JICA Study Team, however, were an opportunity to review the environmental situation first hand. The significant conclusions that could be drawn were that the actual impact was much less than expected in all cases. This is because of the natural, topographic, hydraulic and biological settings of the bridges. It was also found that the normal impacts from a bridge project, such as increased flooding upstream and erosion downstream as seen elsewhere in the world are not observed in major Bangladeshi bridges, because of the scale of the rivers and flood plains. As a result, the actual environmental impact of the Padma Bridge construction is expected to be less than that found in this EIA, which was based on the following classical approach. On the other hand, the social impact of all major bridges was found to be critical. The JICA Study Team acknowledged the importance of this issue.

7.5 EIA Methodology

The Work comprised data collection for the natural environment and socio-economic context for the Work Area, questionnaire surveys, information from separate sector studies carried out within this JICA FS, Focus Group Discussions (FGD), Participatory Rapid Appraisals (PRA), field reconnaissance, baseline quality assessments for air, water, dredge material and noise, data analysis, identification of significantly affected environmental elements and EIA implementation for the proposed bridge site based on various guidelines. A preliminary Environmental Management Plan (EMP) is to be prepared based on the EIA findings to mitigate negative environmental impacts and enhance the positive impacts of the project.

7.6 Scoping and Bounding

Scoping and bounding of the EIA was carried out based on the result of the IEE conducted in an earlier phase of this Feasibility Study.

7.7 Information Disclosure and Public Participation

Disclosure of project information including the anticipated impacts and public participation such as stakeholder meetings were conducted continuously in this Study, in conformity with the new JICA guidelines.

In this study a total of seven FGD and PRA were conducted with the Project Affected Population (PAP), in which a total of 344 participants took part. The main objectives were to:

- adequately inform the PAPs about the various project components,
- assure the PAPs that a thorough EIA was underway;
- identify and prioritize various IECs based on local knowledge, and
- identify enhancement and mitigating measures.

7.8 Environmental Baseline

Extensive investigation was undertaken and compiled during the IEE and EIA stages to establish an environmental baseline.

7.9 Impact Assessment and Mitigation

The selection of Important Environmental Components (IEC) for the EIA is primarily based on the IEE study, also including consultation of the EIA Reports of other bridges. Finally, the selection of IECs was validated during FGD/PRAs in the study area. For the EIA study, 28 parameters were selected as IECs and impact assessments as well as mitigation measures were prepared in each case.

An attempt has been made to prioritize IECs, something which assists when formulating a detailed EMP. The prioritization was performed based on previous experiences with other bridges, FGD/PRAs carried out for the Padma Bridge and expert judgment. The major concern for the PAPs is social issues, with other concerns being the natural environment, ecological environment and environmental pollution, in that order.

7.10 Impact Evaluation

Impacts are evaluated on the basis of magnitude, immediacy, and sustainability/reversibility. The focus of each item is based on the following:

- Magnitude
  - Type of impact (direct, indirect, cumulative)
- Immediacy
  - Temporal extent (during / after construction)
  - Spatial extent (local, widespread)
- Sustainability and Reversibility
  - Scope for mitigation (full, partial)
  - Monitoring possibility (fully, partially)

A 21-point scale was adopted, for example: 1 to 10 for beneficial impacts, 0 for no impact, -1 to -10 for negative impacts. For the relative weighting, the magnitude was given a higher value (40%) ahead of immediacy and sustainability/reversibility (30% each) because of its more direct and visual influence.

For the impact evaluation, parameter-wise relative weighting factors have been taken from the IEE study. The graded values are calculated for the 'without mitigation measures' and 'with mitigation measures' scenarios respectively. The total graded values show that implementation of mitigation measures will considerably mitigate or enhance the impacts on IECs.

7.11 Preliminary Environmental Management Plan (EMP)

An Environmental Management Plan (EMP) should be prepared after the proponent JMBA obtains environmental clearance from the Department of Environment (DOE). There is a two-step procedure for obtaining this environmental clearance. Initially, the proponent applies using a prescribed site clearance form and attaching the IEE report. After obtaining DOE site clearance, the next step is to apply for environmental clearance, attaching the EIA report. The EMP should then be prepared during the detailed design stage. The JICA Study outlines a preliminary EMP as framework and guidance; consisting of the following sections:

- Objectives of EMP
- Environmental Mitigation Measures (EMM) (specified separately for pre-construction, construction and post construction stages)
- Environmental Enhancement (tree plantation, recreation facility, land use and landscape planning, income restoration / generation program and women empowerment)

- Institutional Arrangements to implement EMP
- Environmental Monitoring
- Implementation Schedule (which agencies are responsible for which stage of each item)

An indicative cost estimate was made for the preliminary EMP, of around 3 million US$. It should be noted that this is only indicative and the actual cost should be estimated during the EMP preparation stage.

7.12 Conclusions and Recommendations

The key conclusions of the EIA for the Padma River bridge project are as follows:

- The impact of the bridge on the regional hydrology and flooding patterns will be minimal as the increase in peak water level of the Padma River due to the bridge construction will be approximately 10cm.
- Adequate openings on the right bank approach road are planned to alleviate drainage congestion.
- Erosion and siltation will be limited.
- A total of 327,868 trees will need to be felled for the project. This loss may be compensated by planting 238,692 new trees.
- A total of 58 ponds (area=4.18ha) and 74 ditches (area=2.66ha) will be affected by the project. Fish production loss will be about 11 MT/year, which may be compensated for by fish culture in new borrow pit ponds.
- The project does not traverse any ecologically-protected and sensitive areas.
- There is no exclusive habitat of any endangered species near the Project site. However, the Padma River is a secondary habitat for two critically endangered species, namely, the Gangetic Gharial and Dolphin, although their main habitat is the Ganges River and they are seldom found in the project site area.
- The Padma River is an important migratory route for Hilsa fish.
- Due to land acquisition of 616ha, about 3,150 housing structures will be affected. An LA plan and RAP will be prepared to mitigate all such issues.
- Total income loss will be Tk 210 million, of which agricultural production loss will be about Tk. 45 million / year
- A total of 41 cultural establishments including schools, madrasha, mosques, eidgha, graveyards and Hindu burning-ghats will be directly affected.
- The proposed mitigation measures will limit overall impact.
- The indicative EMP cost is US$3 million.

Based on the findings of this study, various further studies are recommended. These include groundwater, surface water, air pollution, noise pollution, and dredge material analysis, and the analysis of future air and noise pollution within the EMP, hydrological and social investigation within the detailed design study and Hilsa Migration, Landuse and Landscape planning (regional development), a wildlife study and Charland Study, as independent investigations.

8. SOCIAL IMPACT/RESETTLEMENT STUDIES

The construction of the bridge and all associated infrastructures will require acquisition of 616.5 ha of land. In addition, 174 ha will be temporarily required during the construction period for facilities like the construction yard. Over 35 percent of the acquired land will be used for river protection work, followed by the approach road (25%) on the Janjira site. The impact of land acquisition will be felt more on the Janjira site than in Mawa. A census of all households/structures likely to be affected was carried out. In all, 3,150 households/businesses (Mawa – 1343 and Janjira – 1807) will lose their homestead

land/structures either partially or fully due to land acquisition by the project. In addition, an estimated 5,000 households are likely to be affected by land acquisition only (without being displaced); although the total number affected will be available only after the Land Acquisition Plan is prepared and notifications under section 3 (u/s3) are served on the titled owner(s) by the relevant Deputy Commissioner(s). Among those affected, about 1500 erosion-displaced households (*nadibashi*) live on land owned by others or on rental arrangements. The census identified thirteen different categories or types of losses to be incurred by those affected by the project. Based on the losses, an entitlement matrix has been prepared for compensation and replacement costs for all assets (land and structures) and resettlement of those affected. The resettlement framework provides multiple options or choices to the potential resettlers, which include: (i) self-managed resettlement; (ii) small group resettlement; and (iii) resettlement in project-sponsored resettlement sites. Finally, the entitlement matrix focuses especially on vulnerable groups, including provision for social development programs, for women and the very poor. The estimated cost for land acquisition and resettlement is Taka 4324 million (US$72 million).

The scope of work and TOR for the study was limited to social impact assessment and formulation of a resettlement framework, including a preliminary cost estimate and a review of issues relevant to the resettlement project implementation. In addition, the study concentrated on disclosure and community consultation and social analysis of the project-affected and benefit areas. Land acquisition and resettlement management in the Padma Bridge Project would be a very challenging task. Successful implementation would require: (i) a clear understanding of the tasks involved – their sequencing and linkages; (ii) a well conceived organizational set up, including the involvement of NGOs, with well-trained efficient staff to carry out various tasks; and (iii) a carefully prepared work plan or activity schedule synchronizing resettlement with the construction schedules. The report highlights a list of outstanding planning and implementation tasks to be completed by the project executory agency (EA) – the Jamuna Multipurpose Bridge Authority (JMBA) – during the detailed design and implementation periods. These include: (i) the preparation of a Land Acquisition Plan (LAP) and (ii) a Resettlement Action Plan (RAP). While the principles and resettlement entitlements have been stipulated in this framework document, the compensation and rehabilitation packages for the affected households and shops, including the indicative budget, should be revised based on further detailed planning. JMBA should use this report only as a planning tool, prepare a full inventory of land acquisition and affected households/businesses during the detailed project design, and prepare a RAP for the project. The RAP should benefit from the Jamuna Bridge resettlement experience and other "best practices" already established in various infrastructure projects in Bangladesh. Once prepared, the RAP should be reviewed further as a condition for project processing by the donor agencies.

9. ECONOMIC AND FINANCIAL EVALUATION

9.1 Economic Evaluation

(1) Methodology

In order to confirm the economic viability of highway development schemes and select the most favorable scheme, an economic evaluation was carried out. The magnitude of the potential project benefits was estimated and compared to the project cost as required when estimating the EIRR, B/C Ratio and NPV. The degree of project viability was evaluated and interpreted based on economic parameters such as the official discount rate of Bangladesh.

(2) Project Cost Disbursement Schedule

Project cost disbursement schedules were prepared for alternative highway bridge construction plans in accordance with the project implementation schedule as shown in Table 9.1:

Table 9.1 Economic Cost Disbursement Schedule

Unit: mil.TK

Year	Alt. -H1	Alt. -H2	Alt. -H3
2004	0.0	0.0	0.0
2005	0.0	0.0	0.0
2006	0.0	0.0	0.0
2007	1697.3	1928.5	1697.3
2008	1697.3	1928.5	1697.3
2009	1315.2	1315.2	1315.2
2010	7470.0	7679.0	6720.1
2011	20418.0	20989.2	18368.2
2012	11952.0	12286.3	10752.1
2013	7968.0	8190.9	7168.1
2014	5322.5	5378.2	5122.5
Total	57840.3	59695.8	52840.9

(3) Economic Costs resulting from the Closure of Ferry Operations

The existing ferry operations at Mawa – Charjanajat site will be stopped after the Padma Bridge at Mawa is opened. In that case, workers on existing ferry operations are usually compensated for the loss of their jobs or transferred to other ferry sites and such costs must be included in the project costs. However, existing ferries at Padma River are operated by the Bangladesh Inland Water Transport Corporation (BIWTC), a public sector body responsible for ferry operation under the Ministry of Shipping.

According to the BIWTC, there is no private company operating ferry services in the Mawa and Paturia ferry sectors. It also informed that there are many candidate ferry crossings in the country and that they would be able to continue their operations, meaning no compensations for the BIWTC would be necessary. In addition, launch boat operations and ferry terminals are managed by the Bangladesh Inland Water Transport Authority (BIWTA).

The only exceptions where compensation would be required in relation to the stopping of the ferry operation are the lost income of small shops along the approaches to the ferry ghats at Mawa – Charjanajat. The owners and workers of these shops will have to close their shops or move to other sites under operations. Therefore, compensation for them would be necessary and has already been included in the project costs as part of resettlement costs.

(4) Benefits from the Project

The following benefits were deemed to be direct Project benefits:

- Vehicle Operation Cost (VOC) Saving Benefit
- Travel Time Cost (TTC) Saving Benefit
- Ferry Waiting Time (FWT) Saving Benefit
- Freight Value Deterioration (FVD) Saving Benefit
- Ferry Operation Cost (FOC) Saving Benefit
- Benefit by installation of Power Transmission (UPT)

- Benefit by installation of telecommunication cables (UTC)
- Benefit by installation of gas pipelines (UGP)
- Land Enhancement Benefit (LE)

The results of estimated benefits for each item are summarized in Table 9.2.

Table 9.2 Summary of Estimated Benefits

Unit: mil. TK

Item of Benefit	2015	2025
Vehicle Operation Cost (VOC) Saving Benefit	2210.5	4381.5
Travel Time Cost Saving (TTC) Saving Benefit	966.4	2276.4
Ferry Waiting Time (FWT) Saving Benefit	3492.6	6797.9
Freight Value Deterioration (FVD) Saving Benefit	7.6	16.1
(a) FVD Saving due to Reduced Driving Time	2.9	6.1
(b) FVD Saving due to Reduced Waiting Time	4.7	10.3
Ferry Operation Cost (FOC) Saving Benefit	1706.2	3154.2
Benefit from Utility Installation (*Initial Year only)	1145.6	Initial Year Only
(a) Power Transmission Cable Installation (UPT)	91.3	do
(b) Telecommunication Cable Installation (UTC)	91.3	do
(c) Gas Pipeline Installation (UGP)	963.0	do
Land Enhancement (LE) Benefit (*Initial Year Only)	6374.3	Initial Year Only
Total	15903.2	16626.1

(5) Economic Evaluation

(a) Premise of Economic Evaluation

The premises for the economic evaluation were set out as follows:

a. The evaluation period was set for 30 years after the Project opening.
b. Annual cost flows were prepared for alternative development scenarios, in accordance with the project implementation schedule and cost disbursement schedule.
c. Annual benefit values for individual items were assigned throughout the evaluation period based on the estimated economic benefits in 2015 and 2025, excluding benefits from utility provision and enhanced land that are reckoned to occur only in the opening year of the Project to the public.
d. The benefit growth ceiling was set out in the year 2033, when the daily traffic volume on the bridge is expected to reach 75,000, corresponding to 1.5 times the daily highway capacity of 48,000 vehicles per 4 lane highway),
e. Economic residual values were assumed for the final year of evaluation (2044).
f. Annual maintenance costs were set out in the form of development alternatives.
g. The economic discount rate or opportunity cost of capital in Bangladesh necessary for the calculation of B/C and NPV and for the evaluation of EIRR, was set at 12% per annum.

(b) Results of Economic Evaluation

Estimates of evaluating indicators for the alternative bridge development plans are summarized in the following table. Based on this data, the project is concluded as being economically feasible for all alternatives of highway bridge, since all calculated EIRRs have discount rates exceeding 12%, B/C higher than 1.0, and positive NPV. The maximum EIRR was obtained in Alternative -H3, and the minimum in Alternative -H2. However, of the highway bridge development schemes, only Alt. -H3 is substandard in terms of the Asian Highway Standard with a bridge width of 16.5m. The Asian Highway

Sub-standard regulates that the bridge width must be more than a minimum of 21.5m to satisfy its conditions. Between the two alternatives that satisfy the Asian Highway Standard, Alt. -H1 is economically more viable than Alt. -H2, since the former has higher values for the various indicators. For these reasons, Alt. -H1 is concluded to be the most appropriate scheme of the three alternatives.

Table 9.3 Results of Evaluating Indicators

Alternative	IRR (%)	B/C	NPV (Mil. TK)	NPV (mil. $)
Alt. H1	15.35	1.46	12404.2	206.7
Alt. H2	15.01	1.41	11432.4	190.5
Alt. H3	16.18	1.61	14652.2	244.2

(c) Sensitivity Analysis

Sensitivity analysis was carried out for the case of Alt. H-1, which was concluded to be the most recommended development alternative. As a result, the economic viability was found to be robust, with all calculated values of EIRR higher than 12 % as shown in Table 9.4. A maximum return of 19.48% was expected with a combination of "costs 20% down and benefits 20% up" of those calculated.

Table 9.4 Results of Sensitivity Analysis-EIRR

Case:Alt.H-1 Unit: %

Cost \ Benefit	20% Down	10% Down	Original	10% Up	20% Up
20% down	15.35	16.48	17.54	18.54	19.48
10% down	14.26	15.35	16.36	17.31	18.21
0riginal	13.33	14.38	15.35	16.26	17.12
10% up	12.52	13.53	14.47	15.35	16.18
20% up	11.81	12.78	13.69	14.54	15.35

9.2 Financial Evaluation

(1) Methodology

In order to evaluate the financial viability of the Project and to provide base data for financial planning, a financial analysis was carried out. A financial cost disbursement schedule was prepared in real terms for the project cost. Project revenues were estimated and a cost-revenue flow prepared. The financial viability of the Project was evaluated in terms of the Financial Internal Rate of Return (FIRR) and Revenue Cost Ratio (R/C) assuming a discount rate of 12%.

(2) Estimate of Revenues

(a) Revenue from Toll Bridge

Revenue from the toll bridge was estimated under two different toll rates.

- Case 1: Toll rates at the present Jamuna Bridge: LV: 400TK: Bus; 800TK Truck: 1000TK
- Case 2: Toll rates to maximize toll revenue: LV: 415TK: Bus; 1040TK Truck: 1095TK

Toll revenues in 2015 were estimated to be 5952.4 mil TK for Case 1 and 6266.0 mil TK for Case 2, respectively.

(b) Revenue from Utility facilities

Revenues from utility facilities in 2015 were estimated as below:

- Power Transmission Cable: 42.0 mil TK/year
- Gas Pipeline: 52.5 mil TK/year
- Telecommunications: 52.5 mil TK/year

(3) Results of Evaluation Indicators and Sensitivity Test

The values of FIRR and R/C ratio obtained by the alternative to the bridge development scheme and by the toll rate case are shown in Table 9.6. All the FIRR are below the 12% Cost of Capital in Bangladesh and the R/C ration are less than the unity for all the development alternatives.

Sensitivity tests were carried out for Alt. -H1 under a toll rate intended to maximize toll revenue (Case 2) assuming a combination of probable variations of financial project cost and revenue, where costs and revenues were assumed to vary by +/- 20% of the original. Results are shown in Table 9.7. An FIRR exceeding 12 % was obtained in the case of a 20% increase in revenue over the original case.

(4) Investment Limit Based on Project Revenue and O&M Cost

In order to ascertain the investment limit linked to the Project revenue, the Investment Limit in terms of the relation between Project revenues and O&M costs was calculated for the cases of Alt -H1 under Case 2 of toll rate. The Investment Limit in this context is defined by the following formula:

Investment Limit= [Sum of the Present Value of Revenues] - [Sum of the Present Value of O&M Costs]

= 28969.7 mil TK – 1263.1 mil TK
= 27706.6 mil TK (=$461.8 mil)

When calculating the above, a discount rate of 12% was adopted. As the results, Investment Limit in this context was calculated at 27706.6 mil TK or $461.8 mil, which corresponds to 37.1% of the original project cost of 74600.2 mil TK (=$1243.3 mil).

The above result suggest that the portions of the project or subprojects less than 27706.6 mil TK or $461.8.mil are financially viable and manageable using the project revenue itself.

(5) Financial Evaluation under the Assumption that Utility Construction Costs are borne by Private Sector

To confirm the impact on financial indicators in the case of utility construction being borne by the private sector, financial evaluation excluding utility construction costs was carried out in the scenario of a maximum chargeable toll rate for the Alt. -H1 of the development scheme. The utility construction costs are estimated as 3900 mil TK or $64.9 mil in total as detailed below:

Power Transmission: 3666.0 mil TK ($61.0 mil)

Gas Pipeline: 225 mil TK ($3.75 mil)

Telecommunications Cable: 9 mil TK ($0.15 mil)

The results suggest no great changes in the indicators to enhance their levels beyond the criteria of financial viability, namely with FIRR of 12% and an R/C ration greater than unity. This is due to the very small portion of the utility facility construction cost as compared to the tremendous construction cost of the bridge itself. The results are shown in Table 9.5.

Table 9.6 FIRR and R/C Ratio in the Case of Utility Construction being done by the Private Sector

(LV: 415TK, Bus:1040TK, Truck: 1095TK)

Alternative	FIRR	R/C Ratio
Alt H1	11.04	0.88

(6) Conclusion

- It could be concluded that the Project is not financially viable overall, since all FIRRs are below the 12% Cost of Capital in Bangladesh, the R/C ration is less than unity for all the development alternatives,
- The sensitivity analysis results show that in the cases of increased revenue of 120% and more of the original case, FIRR exceeding 12 % and R/C higher than unity are obtainable. This fact suggests the potential for the project to be financially viable; assuming a proper tariff increase policy during the redemption period in a concerted effort to reduce Project costs,
- The Calculated Investment Limit in terms of the relation between revenues from the Project and O&M costs suggests that the portions of the project or subprojects with a scale of less than 27706.6 mil TK or $461.8 mil are financially viable and manageable based solely on the Project revenue itself.
- However, as far as the total project is concerned, the potential for project financing recommended by the Bangladesh Government itself, with the assistance of international organizations and/or by foreign governments, seems to be the most practical method of financing.

Table 9.6 FIRR and R/C Ratio Calculated

Case 1: Under Jamuna Bridge Toll Rate
(LV: 400TK, Bus: 800TK, Truck: 1000 TK

Alternative	FIRR	R/C Ratio
Alt. -H1	10.16	0.79
Alt. -H2	9.90	0.76
Alt. -H3	10.85	0.87

Case 2: Under Maximum Chargeable Toll Rate
(LV: 415TK, Bus:1040TK, Truck: 1095TK)

Alternative	FIRR	R/C Ratio
Alt. -H1	10.74	0.85
Alt. -H2	10.48	0.82
Alt. -H3	11.44	0.93

Table 9.7 Results of the FIRR Sensitivity Analysis

Case: Alt.-H1, max rate Unit: %

Revenue Cost	20% Down	10% Down	Original	10% Up	20% Up
20% down	10.74	11.66	12.50	13.30	14.05
10% down	9.86	10.74	11.56	12.32	13.04
0riginal	9.10	9.95	10.74	11.48	12.17
10% up	8.44	9.26	10.03	10.74	11.41
20% up	7.84	8.65	9.39	10.09	10.74

9.3 Qualitative Considerations for Private Sector Participation

In order to support and elaborate on the preliminary private financing consideration, the possibility of private sector participation and use of a private financing scheme for the Project were discussed here, with reference to the observed facts from the field survey and

literature review. First, the key success factors of the BOT (Build, Operate and Transfer) or PPP (Public Private Partnership) schemes applied to transport projects are extracted from literature, and then the relevancy of these extracted factors to the Project in the context of Bangladesh are discussed regarding the possibility of private sector participation.

Three issues were identified as critical factors for the successful implementation of BOT or PPP schemes in the transport sector projects. They were namely i) whether consistent demand could be secured throughout the project period, (ii) whether the project would be planned or designed with a proper size (including financial aspects) and limited participatory scope, and (iii) whether the project would have full government support with potential risks appropriately shared among stakeholders; including government and private investors. According to the results of discussions, private financing could probably be introduced for a limited part of the Project and/or subproject with concerted effort to minimize risks among all stake holders. As with the Jamuna Bridge, where the operations and maintenance (O&M) have been implemented on a contractual basis with a private operator, the same scheme could also be applied to the Padma Bridge. This method would be endorsed by the fact that the JMBA, the governmental agency set to take charge of the O&M of the Padma Bridge, has already accumulated experiences in this field. Moreover, (i) construction and operation of the service area by a private company and (ii) installation of gas pipeline and telephone line with private sector participation would be possible, although with extremely limited scale and relatively little project cost saving expected.

Analysis of Private Sector Participation in Main Construction Work

Requirements for BOT （PPP） Project	Issues and Constraint
Consistent Demand and Appropriate Toll Level	Even if toll rates that could guarantee a certain level of demand were applied to the Project, overall profitability is predicted to be miserable compared to that expected by the private sector.
Adequate Size and Limited Scope of Participation	The financial scale of the Project may be too large for private companies. The total project cost will exceed US$ 1,200 million, and such a scale has never before been applied to a BOT or PPP project implemented in Bangladesh. The investment limit was calculated as 27706.6 mil TK or $461.8 mil, corresponding to 37.1% of the original project cost.
Substantial Public Support including Risk Sharing	It would be hard to expect to obtain substantial public support and appropriate risk sharing may not be realized when applying the PPP scheme to bridge construction works. However, there would be limited scope for maneuver for private sector participation and possible risk mitigation methods are summarized in the next table.

Risks of the Project and Methods of Risk Mitigation

Category of Risk	Description of Risk	Example of Risk Hedge
Market Risk	Traffic demand for roads or bridges fluctuates widely with socio-economic changes in the country. Toll rates may be decided based on socio-economic effects such as poverty alleviation and taxation issues, rather than financial profitability.	Guaranteeing a certain amount of revenue based on minimum traffic volume Giving a private company the authority to change toll rates
Credit Risk (Nonperformance or Contractual default risk)	A private sector partner may withdraw from the project.	Specifying punishment clause for such withdrawals on a concession contract
Financing Risk	A private sector participant may fail to acquire the necessary funds, forcing the enterprise to discontinue operations.	Obtaining a banker's guarantee for unpaid equity
Country (Political) Risk	Due to institutional change, including a change of economic policies or laws of the government, the project discontinuation may be abandoned.	Stipulating on the concession contract that the public sector will cover the additional cost caused by institutional changes. Utilizing insurance or a risk guarantee scheme developed by international financial agencies. Ideally, a parliamentary resolution for the project implementation is necessary.
Inflation and Foreign Exchange Risk	Due to sharp inflation, the profitability of the project may deteriorate. Restrictions on foreign exchange transactions may discourage interest from the private sector.	Applying a toll rate adjustment mechanism linked with inflation indexes Guaranteeing a private partner's discretion in foreign exchange

10. ALTERNATIVE WITH RAILWAY PROVISION

10.1 Objectives

The economic feasibility of Padma Bridge as a road bridge was confirmed in the previous chapter and Alternative-H1 (extra-dosed girder type) was selected as an optimum plan. Based on these results, the possibility of including the provision of a broad gauge railway link on the road bridge has been examined as an alternative design. The purpose of preparing an alternative with railway provision (Alternative-HR) is to maintain the possibility of railway installation on Padma Bridge as a future option when sound financial conditions of the government and BR and other relevant circumstances are realized.

10.2 Engineering Studies of Railway Provision

The Padma Bridge would be built on AH Route No. A-1 planned under UN ESCAP. The Study Team examined the standard bridge widths, comparing them with those stipulated in the AH standard by UN ESCAP and the Bangladesh highway standard by RHD. The Study Team proposes the width composition shown in Figure 10.1 for the initial stage before a railway is accommodated, meeting the AH standard for a 2 lane dual carriageway with median strip. When the railway is accommodated, the width composition will be changed as shown in Figure 10.2, to meet the AH substandard for a 2 lane dual carriageway and the Bangladesh Railway standard for a single broad gauge track.

Initial Stage

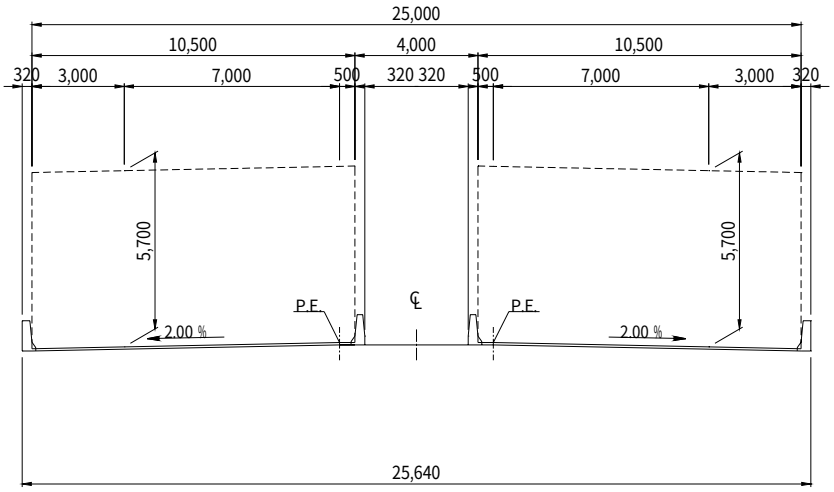


Figure 10.1 AH Standard (Initial Stage with Railway Provision)

Final Stage

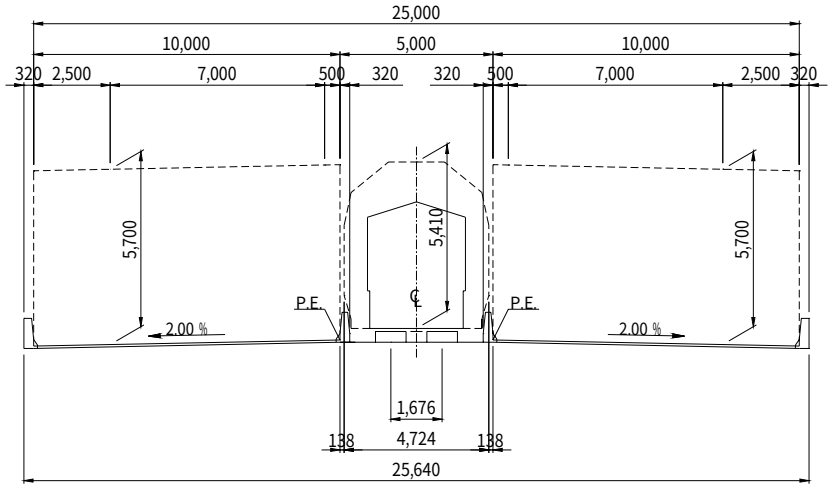


Figure 10.2 AH Substandard (Final Stage with Railway Provision)

The preliminary design (as shown in Figures 10.3 through 10.6) and cost estimates on an Alternative-HR (highway with railway provision) was conducted. The Alternative-HR would require an additional sum of around 80 million US$ compared with the project cost of the most favored highway, Alternative-H1. Table 10.1 shows the project cost summary for Alternative-HR.

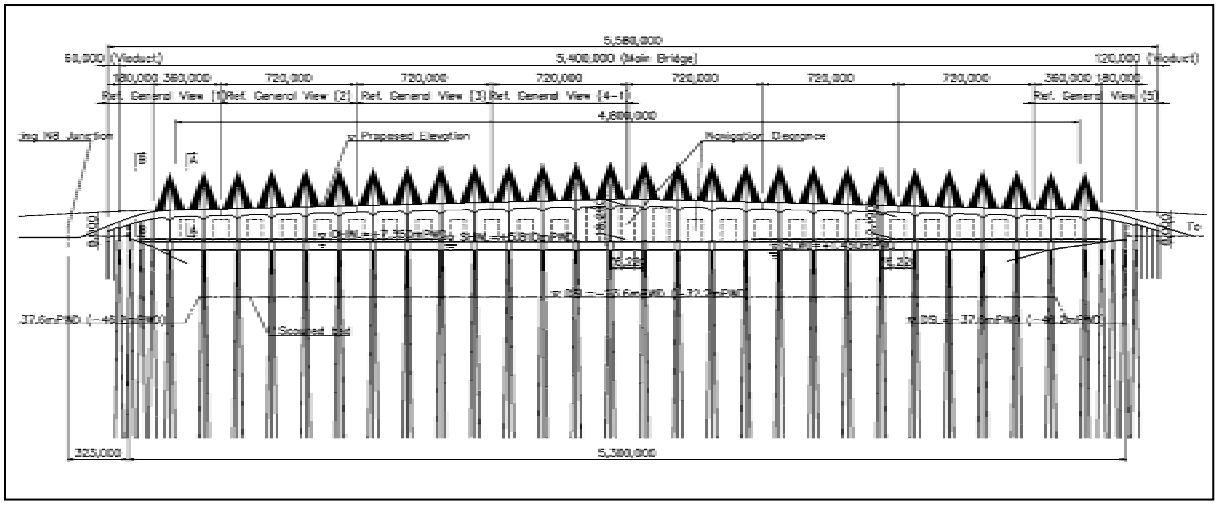


Figure 10.3 General View

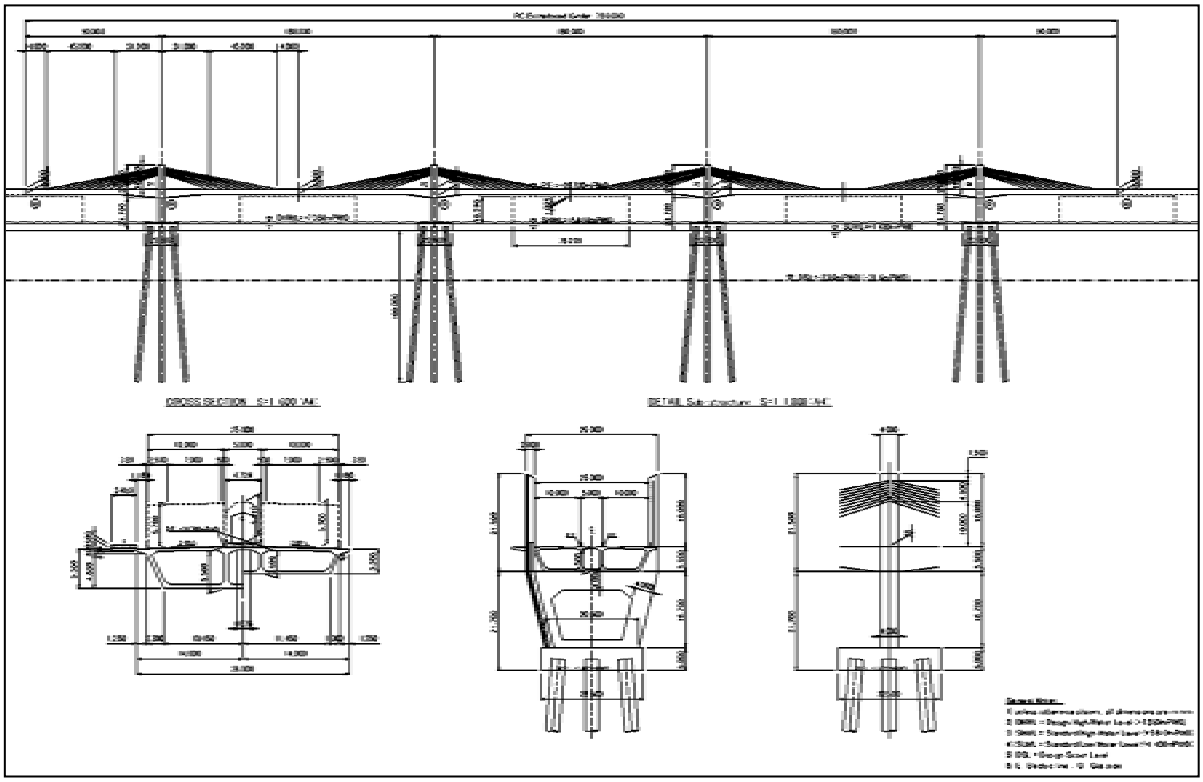


Figure 10.4 Main Bridge Portion

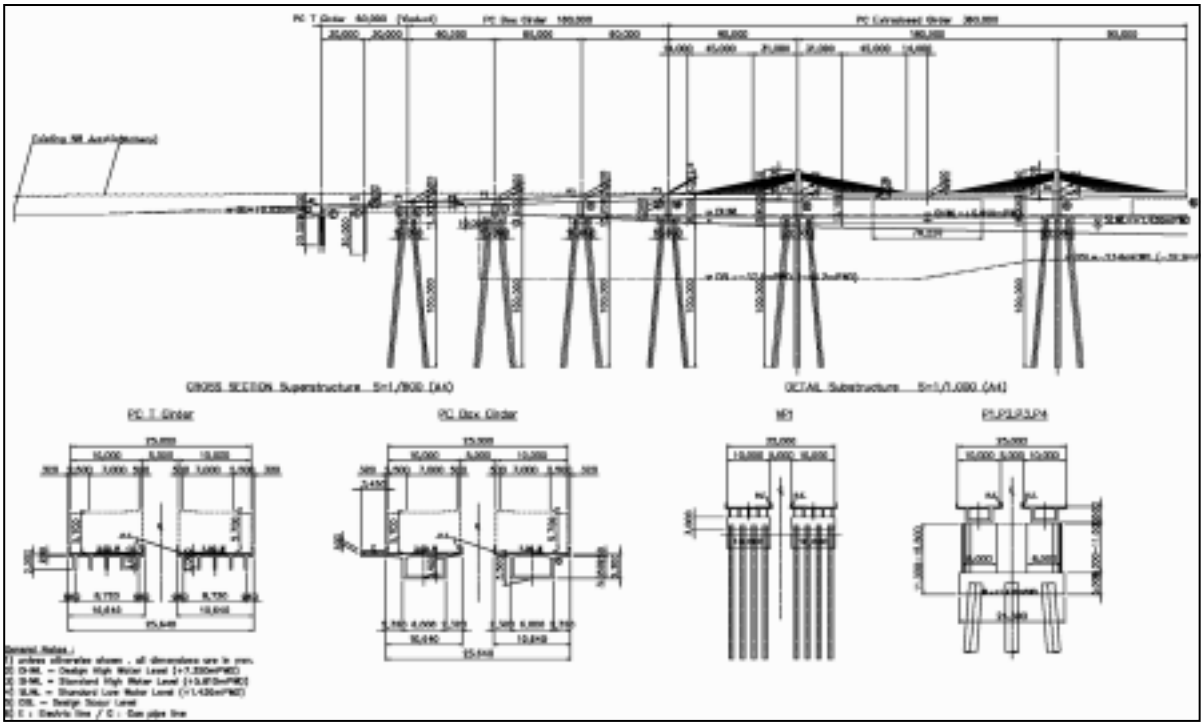


Figure 10.5 Viaduct Portion

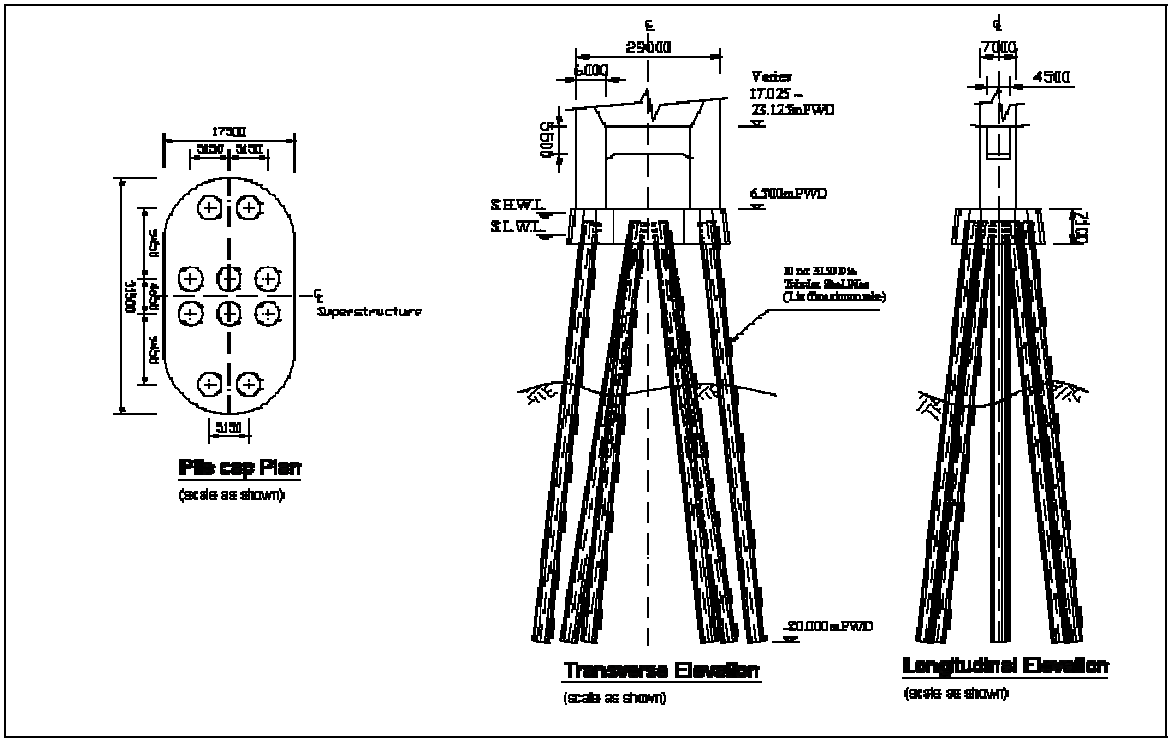


Figure 10.6 Mid-River Pier

Table 10.1 Project Cost Summary for Alternative-HR: Railway Provision

Name of Bridge Alternative	**Alternative-HR**
Bridge type	Extra-dosed girder
Carriage purpose of bridge	with Railway Provision
Bridge width	25.0m
Project cost items	Unit: USD
1. Construction cost	892,891,870
1) Bridge	482,694,470
2) Approach roads/Toll gate/S.A	49,193,790
3) River works	361,003,610
2. Engineering cost	53,573,500
1) Detailed design (2~3% of item-1)	17,857,830
2) Construction supervision (4% of item-1)	35,715,670
3. Administration cost	5,357,340
1) Details design stage (10% of item-2 1))	1,785,780
2) Construction supervision stage (10% of item-2 2))	3,571,560
4. Land acquisition and resettlement, and EMP cost	75,000,000
5. Physical contingency (15% of item-1)	133,933,780
6. Duty tax (VAT etc) (14.5% for importation of item-1+2)	96,066,230
Total project cost	**1,256,822,720**

10.3 Economic and Financial Evaluation

An economic evaluation of Alternative-HR was examined and it was consequently concluded to be economically viable, with an EIRR of 14.80%. When compared with the result of Alternative-H1, with an EIRR of 15.35%, no significant difference exists.

To clarify this difference in EIRR values, simple economic calculations in two cases were compared. One case would involve the construction of Alternative-HR while the other would involve constructing Alternative-H1 with a railway bridge constructed independently at a later stage, when the railway extension plan from Dhaka becomes more realistic. Under a discount rate of 12% per annum, construction of Alternative-HR is shown to be better than the construction of a railway bridge some 10 years after the opening of the road bridge, as suggested by simple economic analysis.

In terms of the timing for the construction of the "Trans-Padma Corridor", no one can forecast whether the construction of Alternative-HR will accelerate the realization of a railway crossing the Padma River.

Taking the importance of forming an international transport corridor into consideration, the construction of Alternative-HR is recommended.

A financial evaluation of Alternative-HR was also carried out and the result indicated that FIRR was at 10.28%.

It could be concluded that a highway bridge with railway provision is economically feasible.

Furthermore, simple economic analysis suggests that early provision of the railway function would be more economical than providing it well into the future. The additional project cost of the highway and railway would be priced at around 4,700 mil. TK ($78 mil.); less than 7% of the total project cost of just the highway bridge (Alternative-H1).

Although the bridge is not financially viable, as is also the case for all exclusive highway bridge alternatives (Alt.-H1, Alt.-H2, and Alt.-H3), the massive revenues from traffic tolls and utility and railway tariffs would guarantee that construction costs would be covered relatively early on.

It is also noted that, although the cost of capital (interest rate) is set at 12% in this study, this capital cost in terms of financial evaluation is variable, depending on the conditions of domestic and international financial markets. Therefore, the Alternative-HR still retains the potential to be financially viable with a FIRR value exceeding 10%. Under the situation, it would be incorrect to simply dismiss the Alternative-HR as not financially viable.

10.4 Benefits of Railway Provision (Alternative-HR)

The expected concrete benefits for Bangladesh from the Indian transit traffic explained above are summarized below:

1) Foreign exchange earnings (Transit Fee charges)
2) New business opportunities (Services such as the sale of fuel, water and food and rest house supply services, shopping, repair, maintenance work and others for trucks and buses, for example).
3) New job opportunities (depending on bilateral negotiations. Truck and bus drivers can be limited to Bangladeshi nationals)

However, the conditions required to realize the benefits listed above are as follows:

1) Services are not for domestic transport only. If the railway provision is limited to domestic use only, the traffic will be insufficient to justify its provision.
2) Commodities/cargos must be containerized (if general cargo or bulk) or tanked (if liquid) and securely locked up to their final destinations.
3) Containers or tanks may be opened only outside of Bangladeshi territory.
4) Trains should be operated by BR and railways/truck drivers may be Bangladeshis (depending on bilateral negotiations).
5) Expansion of broad gauge links in Bangladesh for the smooth transit of Indian Railway wagons.

11. SOCIO-ECONOMIC IMPACTS

11.1 Impacts on National Economy

Padma Bridge is expected to generate substantial impacts, not only in the transport sector but also the more extensive areas of national and regional economies. Increases in production, employment, income and ultimately poverty reduction should then be realized.

Quantitative estimation of induced/indirect economic impacts was attempted focusing mainly on the national level and applying the traditional Input – Output Model.

Estimated induced impacts in this context are induced output (demand), value added (factor income) and employment based upon the Multiplier Effects generated from investment in Padma Bridge and increased demand in the transport sector of the Southwest Region after

the opening of the Bridge. The adopted simulation scenario was set up as follows:

1) Investment costs for the construction of Padma Bridge were broken down into items of major material such as Cement, Steel pipe, PC stand, etc. Each cost was input in the form of a final demand to the corresponding industry sectors (Total cost = 22,576 million Taka).
2) Increases in demand in the transport sector of the Southwest Region due to Padma Bridge were set at a national level of 20%.

Simulations were carried out based on the following formulae and applying the "Input – Output Tables 2000 for Bangladesh":

<Balance Formula>
$X = AX + F(D) + F(E) – M(AX + F(D)$

<Model Formula>
$\boldsymbol{X} = [\boldsymbol{I} – (\boldsymbol{I} – \boldsymbol{M})\boldsymbol{A}]^{-1}[(\boldsymbol{I} – \boldsymbol{M})\boldsymbol{F}(\boldsymbol{D}) + \boldsymbol{F}(\mathbf{E})]$

Where,

X	:Output vector of sectors	F(E)	:Export vector
A	:Input-Output Coefficient	M	:Import Coefficient Matrix
F(D)	:Final Demand Matrix (except for Export)	$[\ ]^{-1}$	:Inverse Matrix

Simulation results are shown below:

- Induced Additional Output: 54,486 million Taka

(=Increase rate to National Level = 1.2 % in total)

- Induced Additional Value Added: 32,638 million Taka

(=Increase rate = 1.4 % in total)

- Induced Employment: 743,000 man-years in total

Therefore, if the assumed scenarios are realized, the construction of Padma Bridge will push up growth rate of national GDP by 1.2 %., raise value added factor income by 1.4 % and provide a total of 743,000 man-years of new employment opportunities. However, these impacts will require 4-5 years to be realized, considering the construction period of the Bridge and the time lag of investment and induced effects.

11.2 Impact on Regional Economic Development

Padma Bridge would have the biggest impact on the Southwest Region and its regional economic development would be accelerated through improved accessibility to/from Dhaka; the largest market in the country. Economic impacts in terms of the growth of GRP of the Southwest Region were estimated quantitatively. However, due to a lack of available data on the regional Input – Output table and in order to reflect the factor of improved accessibility explicitly in the model, a regression analysis was carried out for the alternative methodology to estimate the impacts on the GRP of the Southwest Region.

The data of GRP for districts in the Dhaka division and Southwest Region were explained by the travel time to/from Dhaka and the condition of the regional infrastructure such as the density of feeder roads by applying the following equation obtained through regression analysis.

$$Ln (G) = 3.0453 - 0.5482 Ln (T) + 0.4926 Ln (F) \qquad (R = 0.902)$$

where:

G	: GRDP/km^2
T	: Time to Dhaka from districts in Southwest region (hours)
F	: Density of feeder roads (km/km^2)
Ln	: Natural Logarithm

Based on the above equation and applying the travel time to/from Dhaka in "With Bridge Case" (with fixed feeder road density), the impact on the change of GRP was estimated. The results indicate that if the Padma Bridge were constructed, the GRP of the Southwest Region would increase by a total of 35% compared to the "Without Bridge Case". This rate of increase means the total impacts on GRP growth would be 2.3% per year if Padma Bridge were fully utilized within 15 years of opening.

11.3 Impact on International Transport between Surrounding Countries

(1) Subjects for Discussion

In addition to impacts on national and regional economies, Padma Bridge is also expected to promote international trade between neighboring countries such as India, Nepal, Bhutan and Myanmar, providing strong all-weather international road/rail links. Although, present trade volumes between Bangladesh and neighboring countries are relatively low and the share land-based imports is only about 4% of total imports (FY 2000), the roles of Padma Bridge and its role in contributing to international trade in the Eastern Regions of the Indian Subcontinent are also important topics.

It should be noted, firstly, that the geographical location of Bangladesh is strategically positioned to provide the following international links to neighboring countries:

- Linking India, Bhutan and Nepal
- Providing access to major ports from landlocked countries
- Transit routes for India to its eastern states of Tripura, Manipur and Mizoram

Discussions concentrated on whether or how Padma Bridge could contribute to boosting these international routes and the nature of the necessary conditions which would be required to realize such situations. In order to enhance international trade/international traffic, factors that influence/control international transport/trade are institutional frameworks including economic cooperation (such as SAARC, SASEC and BIMST-EC) and international transport infrastructure for cross-borders (such as Asian Highway and the Trans-Asian Railway).

(2) Institutional Framework for Cross-Border Traffic related to Padma Bridge

SAARC (South Asian Association for Regional Co-operation) unfortunately limits itself to broad policy declaration rather than program development and the charter precludes any discussions on bilateral issues. Therefore, the issue of cross-border transportation is not discussed at the table of SAARC, since cross-border issues are always bilateral by nature. The Asian Development Bank (ADB) has raised five types of potentials in the sub-region of ***SASEC*** (South Asia Sub-regional Economic Co-operation). They are: 1) Large workforce, 2) Fertile rice fields, 3) Energy potential, 4) Other natural resources (mineral, forest, livestock and marine resources) and 5) **Ports** ***(The network of ports in Chittagong, Mongla, Kolkata and Haldia). In this context, Padma Bridge will contribute toward formulating the Port Network connecting 4 ports including Chittagong and Mongla.*** It is also noted that the Transportation Working Group of SASEC has called for ***a review of existing***

bilateral transit agreements, simplification of cross-border inspections, and standardization of documentation. These movements will contribute to achieving smooth cross-border traffic and the necessary preconditions for the promotion of international trade. ***BIMST-EC*** (Bangladesh-India -Myanmar -Sri Lanka- Thailand -Economic Co-operation: recently changed its name to the "***Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation"***). Inter-group discussions have been held concerning the building of a "Trans-Asian Highway" linking the capitals of member countries and a study on major surface routes and border crossings is being undertaken by India in the field of Transportation and Communication.

(3) Impact of Padma Bridge on International Transport

1) The proposed Padma Bridge is situated at the optimum location to contribute to the formation of an international transport network by providing an all-weather road link on the Asian-Highway A-1. In addition, the location of the railway provision proposed by the Bangladesh Railway (BR) will also create an international railway network and increase international trade between surrounding countries through the ***"Trans-Padma Corridor"*** (refer to Figures 11.1 and 11.2).

2) Benefits from Railway Provision
Bangladesh Railway has proposed a future plan involving expansion of the railway network connecting Dhaka and the Southwest region via Padma Bridge, as shown in Figure 11.2.

The following benefits are expected from the Railway Provision for Padma Bridge from an international trade perspective:

- The proposed new railway links connecting Dhaka – Padma Bridge – Jessore – Benapole will shorten the distance between Dhaka – Kolkata via Benapole – Petorapole interchange route (distance from Darsana to Dhaka via Jamuna Bridge – 403 km, from Benapole to Dhaka via Jamuna Bridge – 518 km and from Benapole to Dhaka via Padma Bridge – 200 km).
- The movement of freight traffic from Benapole will be quicker and cheaper.
- It will reduce transportation costs by avoiding the extra haulage and transportation costs involved.
- Quick transportation will result in quick returns on investment and increased traffic.
- It will open up a new era in the surface communication sector between Dhaka and southern Bangladesh, including the Mongla Port.

3) Impacts on Transit Traffic through Bangladesh
The Indian transit traffic from West Bengal State and other areas of India to the eastern "Seven Sisters States" through Bangladesh will be able to save substantial travel distances when using the "Trans-Padma Corridor". When rail provision on the Padma Bridge is realized, it will contribute to the formation of multi-modal (road and rail) international transport and, simultaneously, also raise the revenue of Bangladesh Railway due to the transport of international cargo.

Figure 11.1 Trans-Padma Corridor

Figure 11.2 Future Railway Links via the Padma Bridge as Proposed by BR

(4) Distribution of Benefits and Poverty Impact Analysis

The main objective of this section was to analyze how the benefits accrued from the Project would be distributed among stakeholders such as road users and the government (Distribution analysis), and to estimate the Poverty Impact Ratio (PIR) that expresses the proportion of net economic benefits accruing to the poor (Poverty impact analysis). The results of these analyses can help clarify who are the major beneficiaries and losers in the project and can be used in answering the critical question of whether the project would contribute to the poor or not.

The results of the distribution analysis showed that Light vehicle passengers, bus passengers, truckers, utility companies and the locality would gain from the Project whereas the Government would be the significant net loser. The PIR for the Project was estimated as greater than unity (4.25), implying that the Project has an "ultra-pro-poor" nature and its benefits accruing to the poor are more than significantly greater than their income share in terms of GDP. A sensitivity analysis also shows the proportion of benefits to the poor will remain greater than unity, even when pessimistic assumptions are applied.

It should be noted, however, that the Government will also gain in the long-term through the successful indirect and induced impacts of Padma Bridge on the national economy.

(5) Fiscal Affordability of Government of Bangladesh

The Project will require more than US1,200 million and it is anticipated that the project will have a substantial impact on the government's budget. In this section, with an estimated statement of the direct Project impact on government expenditure flows, national

affordability for this Project will be discussed in the context of investment possibilities for the nation as a whole.

With regard to recurrent costs consisting of operation and maintenance costs, loan repayment and interest during construction, the simulation results clearly showed that the Project will generate sufficient financial surplus to cover the recurrent costs. With this in mind, it can be concluded that the affordability of the Project in this regard is no longer in question.

On the other hand, when the rest of the project cost is considered; namely a local portion of US400 million to be procured by the Government of Bangladesh, it would be urgently necessary for the latter to secure the initial investment amount through attempts to provide a variety of financing resources. Although the development budget could be the main resource for this, around 45 percent of this is remains supported by foreign aid and loans although the dependency ratio is tending to decrease these days. In this section, potential financing schemes will be recommended with reference to those in developed countries.

In the case of the Padma Bridge, issuing government bonds guaranteed against future toll revenue of the bridge is considered to be a practical financing method for the procurement of the local portion of US$400 million. The Project will generate a financial surplus sufficient to cover the recurrent costs (O&M, loan repayment and interest during construction) and the surplus can be utilized for financing. Of course bond issue for infrastructure projects in developing countries is quite difficult, but detailed consideration of this would be worthwhile.

12. IMPLEMENTATION PROGRAM

12.1 Comparison of Procurement Method

Two methods, viz. Conventional Contracting and Design-Build, were considered for the procurement method.

Conventional Contracting: The Owner, JMBA, shall employ a Design Consultant to design the facilities of the Project. This is ordinarily known as a Detailed Design Contract. Once the detailed design is complete or approaching completion, the Owner shall procure a contractor to construct the project facilities according to the detailed design; ordinarily known as a Construction Contract. In the course of construction, the Contractor's works are supervised by a Supervision Consultant.

Design-Build: The Owner, JMBA, shall employ a Contractor to conduct the detailed design and construction of the project facilities through the bidding process. In the bidding process, the bidders produce detailed designs based on the design parameters and concept design prepared by a Concept Design Consultant.

The advantages and disadvantages between the two methods are summarized in the following table:

	Conventional Contracting	Design-Build
Time required before construction commencement after F/S completion (March, 2005)	- 54 months after JICA F/S (Commencement: October 2009, but still around 3 years later than GOB's expectation) ***Advantages for the Owner***	- At least 57 months after JICA F/S (Commencing: January 2010, but prolonged negotiation with a successful bidder may delay the commencement due to a number of conditions to be stipulated by bidders)
Likelihood of cost increase	- Claims for cost increase during construction due to adjustment in site conditions are probable, but the total increase would be relatively small.	- The bidding price may increase due to unforeseen physical, geotechnical and hydrological conditions.
Owner's control of design process and construction process	- Claims due to unforeseeable physical condition will be decreased. - Relatively easy to control design and construction process. ***Advantages for the Owner***	- Control of the design process is more difficult, because the extent to which detailed studies on geotechnical and hydrological conditions/behavior are undertaken is judged by the bidders. - Construction expertise is available during the design. - A variety of detailed design outputs may be produced from the alternative designs by the bidders. - Problematic control of the construction process due to varied requirements from the Contractor.
Fairness in the bidding process for Construction	- Easy to evaluate the successful bidder with a prescribed scope of work. ***Advantageous for the Owner***	- Difficult to evaluate various designs among the bidders fairly even if a two-envelope method is applied. - Competition is provisional without complete contract documents. - Difficult to decide the successful bidder based on the bid prices alone (absence of benchmark standard).
Overall Evaluation	**Although Conventional Contracting is more advantageous, special arrangements may be required to shorten the time to the commencement of construction.**	

Although based on the above table, Conventional Contracting is advantageous for the Owner, construction would nevertheless start about three years later than GOB's expectation (Bangladesh fiscal year 2006/2007). In this regard, special arrangements should be considered when preparing the implementation schedule.

12.2 Conventional Contracting with Overlapping

The Study Team concluded the following method "Conventional Contracting with Overlapping" for preparing the implementation schedule of the Project.

- The procurement method shall be Conventional Contracting based on its relatively lower cost increases, easy control of the design and construction processes by the Owner (JMBA), and fairness during the contractual bidding process.
- Special arrangements should be considered to commence construction as early as possible since GOB was expecting construction to begin in the Bangladesh fiscal year 2006/2007. Overlapping activities in proceedings before the commencement of construction would have to be studied.
- If overlapping of ADB TA and detailed design is possible, the probable commencement of construction would be in October 2008, with completion in March 2013 as shown in the following figure "Implementation Schedule of Padma Bridge Construction Project (Draft)".

12.3 Required Undertaking by GOB

(1) GOB's Approval of the Project

i) Preparation of Project Concept Paper (PCP) by JMBA and Submission to the Planning Commission under Ministry of Planning (MOP) for PCP Approval
ii) Environmental Clearance consisting of Site and Environmental Clearances
iii) Preparation of PP (Project Pro forma) and Submission to Executive Committee for National Economic Council under MOP for PP Approval

(2) Financial Arrangement

i) Request to International Funding, Donor Agencies
ii) Arrangement of Local Currency Funds

(3) Procurement of Detailed Design Consultant

i) Notice for EOI (Expression of Interest) for Detailed Design Consultancy Services
ii) Receiving EOI from Consulting Firms and Conclusion of Shortlist
iii) Distribution of TOR for Detailed Design Consultancy Services to Shortlisted Firms
iv) Receiving of Proposals from Shortlisted Consultants and Evaluation
v) Negotiation and Signing of Detailed Design Consultancy Services

(4) LA Plan, RAP and EMP

i) Preparation of LA Plan, RAP and EMP
ii) Submission of LAP, RAP and EMP
iii) Updating and finalization of LAP, RAP and EMP by DD consultants
iv) Submission of Revised LAP, RAP and EMP
v) Establishment of Separate Resettlement and Environmental Unit in JMBA
vi) Notification under Section 3 of LA Act by DC(s)
vii) Joint Verification of Acquired Assets
viii) Submission of LA cost estimate
ix) Payment of compensation
x) Announcement for Bid for Construction of Relocation and Residential Sites
xi) Relocation of Affected Persons
xii) Supervision and monitoring of LAP, RAP and EMP

(5) Procurement of CS Consultant and Construction Contractor

i) Invitation for CS Consultant for Short List and Evaluation
ii) Distribution of TOR for CS (Construction Supervision)
iii) Selection of CS Consultant
iv) Public Notice for Pre-qualification (PQ) of Construction Contracts by Packages
v) Distribution of PQ Documents
vi) Receipt of PQ Documents and PQ Evaluation
vii) Distribution of Bid Documents
viii) Holding of a Pre-Bid Meeting
ix) Bid Open, Evaluation
x) Selection of Successful Bidders
xi) Signing of Contracts by Contract Packages

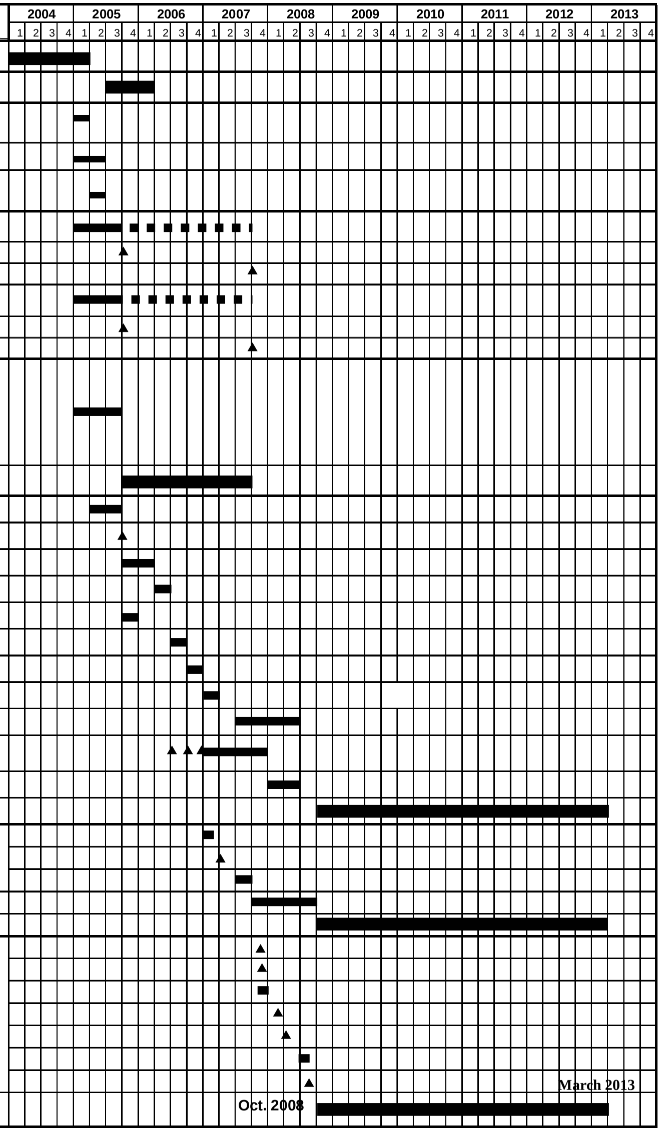
The overall implementation schedule is presented in Figure 12.1, which shows the required actions for GOB after this Study and up to Project completion. In this schedule, the installation works of the electric power transmission line, gas pipeline and telecom line are

excluded and would have to be considered by the related entities.

The schedule was prepared referring to the consultants' and contractors' procurement guidelines, as publicized by donor agencies such as ADB, WB, and JBIC as well in order to propose, as far as possible, the shortest and most reasonable timetable for the implementation. However, in the actual situation, delays in schedule may occur in the process of procurement due to, for example, complex procedures and the time required for negotiations and approvals.

Figure 12.1 Implementation Schedule under Conventional Contract with Overlapping Activities

Activities / Required Months		Year / Quarter
JICA Feasibility Study		Underway
ADB Supplementary TA		9 months
(1) GOB's Approval on the Project	i) Preparation of PCP by JMBA and Submission of Planning Commission Under MOP for PCP Approval	3 months
	ii) Environmental Clearance consisting of Site Clearance and Environmental Clearance	6 months
	iii) Preparation of PP (Project Pro forma) and Submission to ECNEC (Executive Committee for National Economic Council) under MOP for PP Approval	3 months
(2) Financial Arrangement	i) Request to International Funding Agencies, Donor Agencies	9months
	-Approval by international funding agencies and international donor agencies for Detailed design	
	-Approval by international funding agencies and international donor agencies for Construction	
	ii) Arrangement of Local Currency Funds	9 months
	- Approval by GOB for Land acquisition and RAP	
	- Approval by GOB for Construction	
(3) Procurement of Detailed Design Consultant	i) Notice for Expression of Interest for Detailed Design Consultancy Services ii) Receiving Expression of Interest from Consulting Firms and Conclusion of Short List iii) Distribution of TOR for Detailed Design Consultants iv) Receiving of Proposals from short-listed Consultants and Evaluation v) Negotiation and Signing of Design Consultancy Services	12months
	vi) Detailed Design by DD Consultants	24 months
(4) LA Plan, RAP and EMP	i) Preparation of LA plan, RAP and EMP	6 months
	ii) Submission of LAP, RAP and EMP to MOC/MOL for review and comments	
	iii) Updating and finalization of LAP, RAP and EMP by DD consultants	6 months
	iv) Submission of Revised LA Plan, RAP and EMP for Approval by MOC/MOL	3 months
	v) Establishment of Separate Resettlement & Environmental Unit in JMBA	3 months
	vi) Notification under Section 3 of LA Act by DC(s) to land owners for acquisition	3 months
	vii) Joint Verification of Acquired Assets	3 months
	viii) Submission of LA cost estimate to JMBA/MOC by DC(s)	3 months
	ix) Payment of compensation	12 months
	x) Announcement for Bid for Construction of Relocation and Residential Sites and Bid open for Construction of Relocation and Residential Sites, Evaluation, Contraction	12 months
	xi) Relocation of Affected Persons	6 months
	xii) Supervision and monitoring of LAP, RAP and EMP	54 months
(5) Procurement of CS Consultant	i) Invitation for Short List for CS Consultant and Evaluation ii) Distribution of TOR for CS Consultant iii) Selection of CS Consultant	9 months
	iv) Pre-construction by CS Consultant	12 months
	iv) Construction Supervision by CS Consultant	54 months
(6) Construction Contract	i) Public Notice for PQ Construction ii) Distribution of pre-qualification (PQ) Documents iii) Receipt of PQ Documents and PQ Evaluation iv) Distribution of Bid Documents for Construction v) Holding of a Pre-Bid Meeting for Construction x) Bid Open Evaluation for Construction vi) Selection of Successful Bidders for Construction	12 months
	vii) Construction by Contractor	54 months



13. OPERATION AND MAINTENANCE PLANNING FOR PADMA BRIDGE

For planning a operation and maintenance (O&M) program for the Padma Bridge as a toll road, which covers the technical O&M procedures, organization and staffing plans, and cost estimates, the actual O&M implementation for existing major bridges and operation of toll roads in Bangladesh, including the Jamuna, Bhairab, and Paksey Bridges, is initially examined and the features are briefly described.

Generally, highway operation includes more traffic-oriented activities conducted by a highway operator, while highway maintenance consists of more engineering-oriented tasks, which, broadly speaking, cover routine maintenance, repair work, and rehabilitation / improvement. Among them, generally speaking, the routine maintenance and operation of the highway is implemented directly by the highway operator, while the repair works are contracted out to specialized contractors on a long-term (e.g. annual) basis. However, the rehabilitation and improvement works are conducted by contractors selected by a competitive bidding. Accordingly in this chapter, the rehabilitation / improvement works are excluded from the scope of O&M for the Project highway.

In terms of highway operation, the operator's responsibility covers activities such as asset management, traffic surveillance and control, information and emergency management, patrols, breakdown assistance services, over-large vehicle regulation, toll collection, disaster management, and equipment operation.

The highway operator's tasks included in the routine maintenance of the Project highway are inspection (routine, periodic and special), cleaning (road surface, associated facilities and road accessories), vegetation (tree/forest control, lawn control and slope vegetation), some traffic accident recovery works, traffic regulation, the monitoring program on bridge deck levels, riverbed scour, etc., and the maintenance of utilities and equipment.

The repair works to be conducted by specialized full-time contractors on a long-term contract basis usually include pavement renovation and the repair of bridge components.

Specific to the Padma Bridge highway, the maintenance of river facilities, which includes monitoring the riverbank conditions and bank protection works, data analysis, diagnosis, program and execution of maintenance works, is a significant operator responsibility.

Subsequently, an organizational structure and staffing of about 160-member for the O&M of the Project highway is suggested, mainly taking into account the Jamuna Bridge practice.

As for the O&M cost estimate, based on the life-cycle span consideration, it is proposed that the annual costs are expressed in terms of varying percentages of the construction cost in the years following commissioning.

Finally, the general financial situation for the maintenance of roads and bridges in Bangladesh, as well as the issue of insurance application, shall be reviewed and mentioned.

14. CONCLUSION AND RECOMMENDATION

(1) Construction of the Padma Bridge is viable from a macro-economic perspective. It will contribute to the development of the regional economy and the reduction of poverty. At the same time, the contribution of the bridge has great significance in terms of developing an international transport corridor, rendering this an urgent project which should be implemented at the earliest opportunity.

(2) Taking the importance of the international transport corridor into consideration, the Padma Bridge shall have four lanes in both directions to satisfy the Asian Highway Standard and a necessary space for future railway provision in the medium term. An increase of about US$80 million will be required for the provision of the railway, but the EIRR for this project remains 14.80%, making this economically feasible. A further study on the railway provision is urgently required.

(3) Concerning the arrangement for the project cost of US$1257 million, the foreign currency portion of US$895 million shall be co-financed by international lending agencies or foreign governments, and the local currency portion of US$362 million shall be borne by the Government of Bangladesh. This arrangement will be considered the most practical and standard procedure.

(4) Prior to undertaking the next step for more detailed study, JMBA has to receive approval for the Project Concept Paper, Project Pro forma from the Government and Environmental Clearance from the DOE. JMBA should then request that the Government apply to international lending agencies for foreign currency funding. JMBA should simultaneously arrange the local currency portion.

(5) Based on the comparison between the two contracting methods; Conventional Contracting, and Design-Build, a Conventional Contracting with Overlapping Activities, to maximize the merit of the project owner is recommended. Concerning the operation and maintenance of the Padma Bridge, the selection of an O&M contractor under international competitive bidding is recommended, as was the case for the Jamuna Bridge.

(6) The success of the Project depends entirely on whether smooth and timely land acquisition and relocation of the affected people will be implemented. In order to attain this goal, the project execution agency should refer to Chapter 8 of this report and Appendix-12 together with resettlement experience of Jamuna Bridge and other infrastructure projects in Bangladesh to take appropriate measures during the detailed study and implementation periods. For example, a resettlement action plan (RAP) is critical to safeguard the rights of affected people such as the replacement value of their assets, resettlement, livelihood restoration, and additional assistance to marginal and vulnerable groups.

(7) The Government shall take the following actions to ensure the maximum contribution of the Padma Bridge in promoting the regional economy:
- To expand the capacity of the existing NH-8 (connecting to the Padma Bridge) to four lanes before the traffic volume exceeds its capacity.
- To intensify the local road network in the Padma Bridge area of influence.
- To invite enterprises and factories to set up in the Padma Bridge area of influence.
- To utilize the service area for the promotion of local working opportunities and small industries.
- To improve proper entrance and exit routes to and from Dhaka.

(8) The Government shall take the following actions to contribute further to the boosting of the Sub-Regional Economy encompassing both national borders and the international transport corridor of the Padma Bridge:
- To conclude an international treaty to promote smooth cross-border transport.
- To enact the necessary regulations and laws related to international treaties and to train officials regarding such regulations and laws.
- To complete the necessary facilities of land ports, such as Benapole.
- To introduce plans to promote domestic forwarders.