CHAPTER 10

CONSRTUCTION PLAN AND COST ESTIMATE

10. CONSTRUCTION PLAN AND COST ESTIMATE

10.1 Construction Plan

10.1.1 Construction Procedure

The construction procedure for the Project Bridges and access roads, based on the outline design in Chapter 9, is shown in Figure 10.1.1 through Figure 10.1.3. In the pre-construction stage, the compensation and resettlement works at the site, preparation works including mobilization may start prior to the bridge civil works.

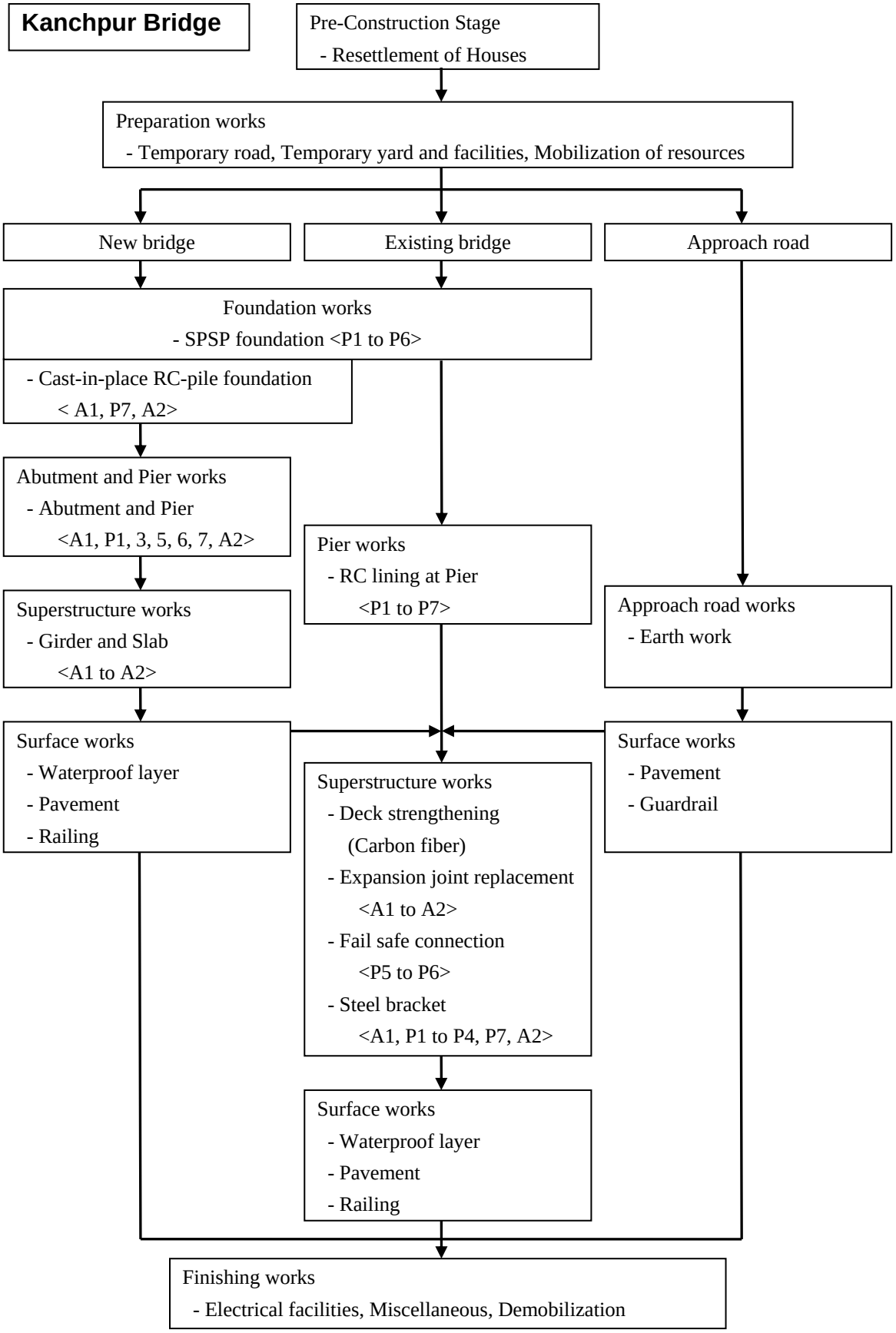


Figure 10.1.1 Construction Procedure for the Kanchpur Bridge

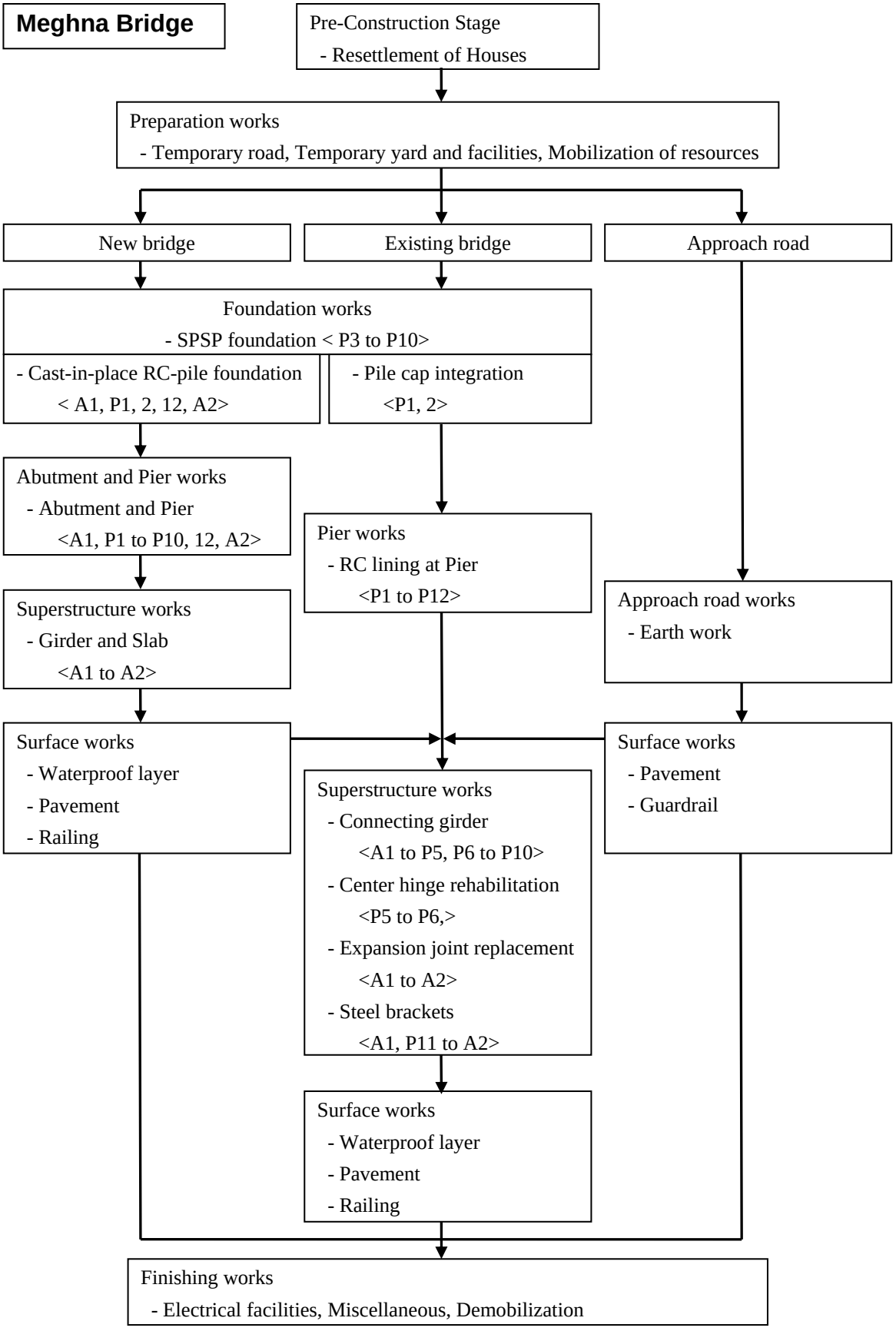


Figure 10.1.2 Construction Procedure for the Meghna Bridge

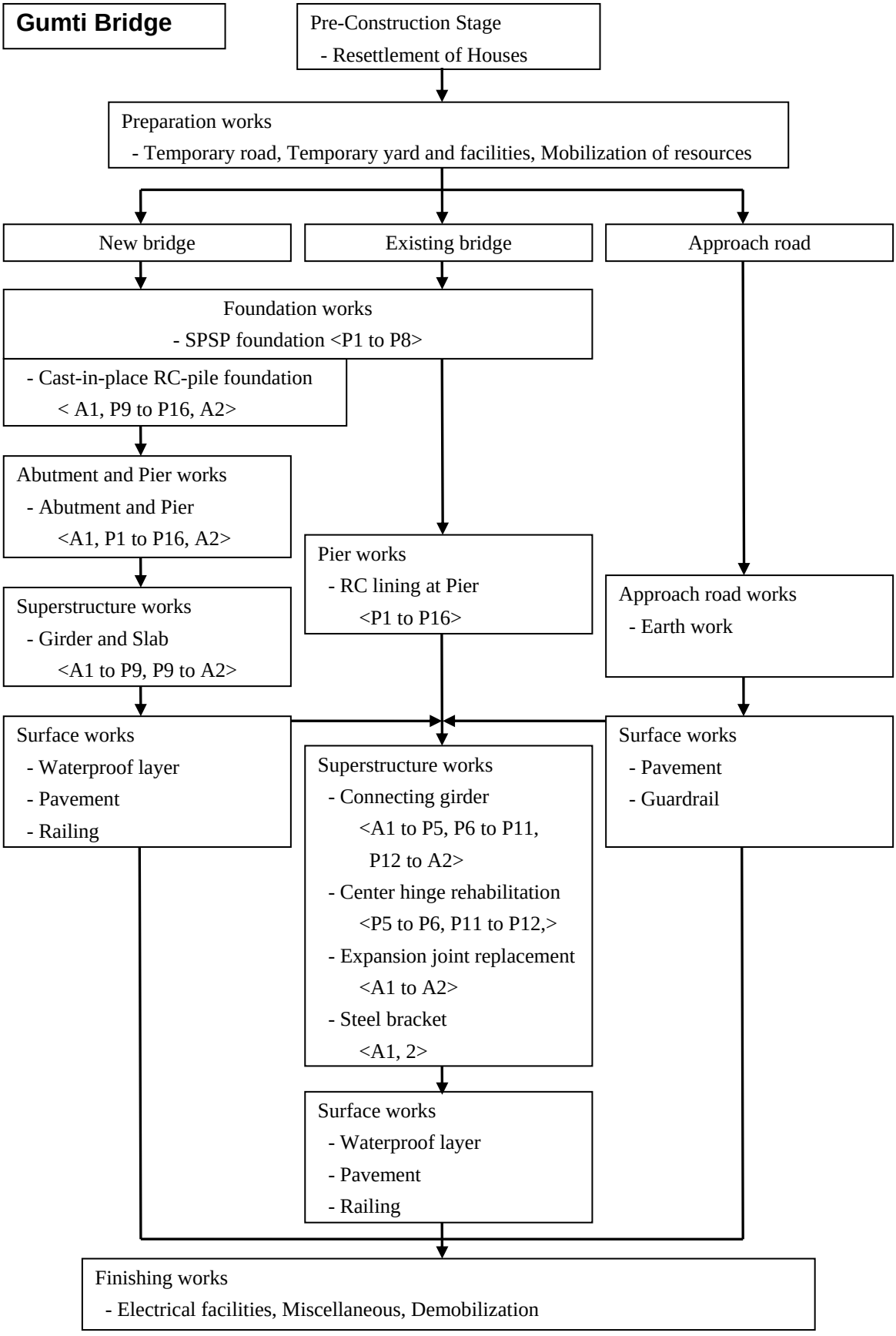


Figure 10.1.3 Construction Procedure for the Gumti Bridge

10.1.2 Preparation Works

(1) Temporary Road

Temporary roads should be 8 m to 15 m wide, which will be well compacted gravel road and durable enough to accommodate heavy loaded trucks and equipments.

(2) Construction Yard and Facilities

Construction yards will be flat and covered with gravel. Construction yards at the Kanchpur Bridge Dhaka side, Meghna Bridge Chittagong side and Gumti Bridge Dhaka side should be prepared and facilitated with contractor's office, engineer's office with quality control system installation, equipment workshop and parking space, concrete and asphalt plants, stockyard for various materials. The temporary yards and facilities should be demolished when the construction is completed. Figure 10.1.4 through Figure 10.1.6 show the locations of construction yards for the respective bridges.

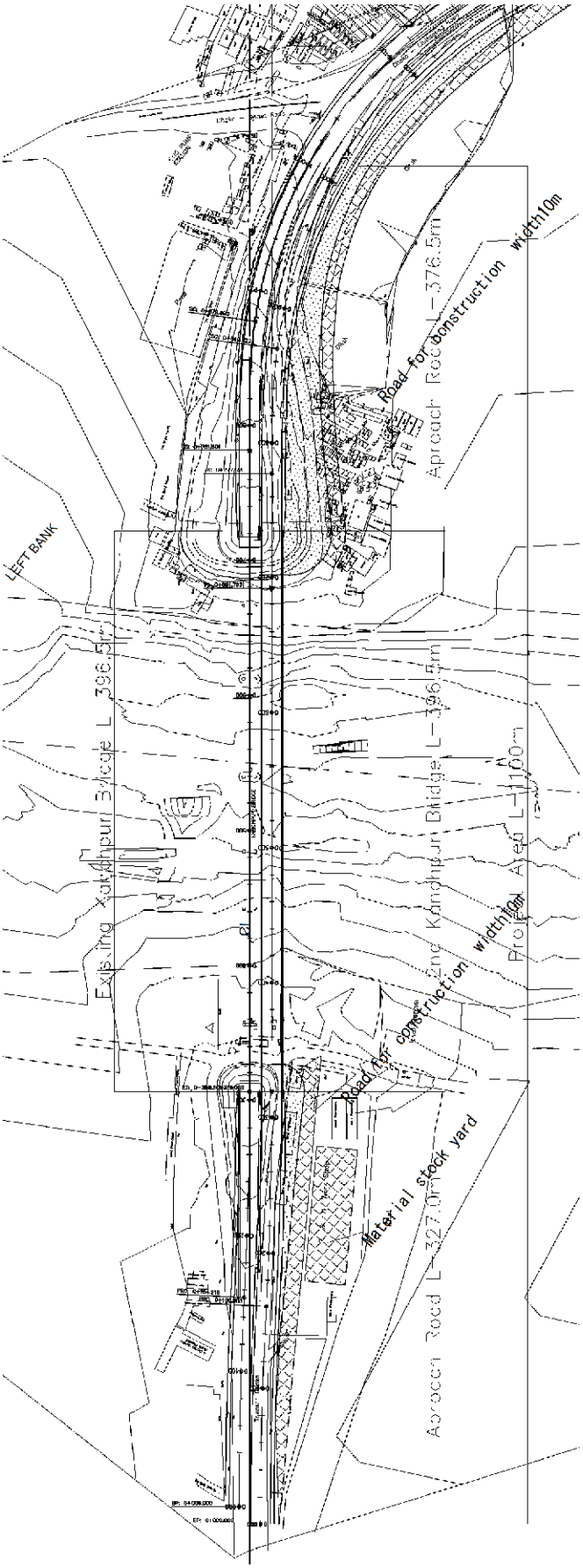


Figure 10.1.4 Construction Yard and Temporary Road at the Kanchpur Bridge Site

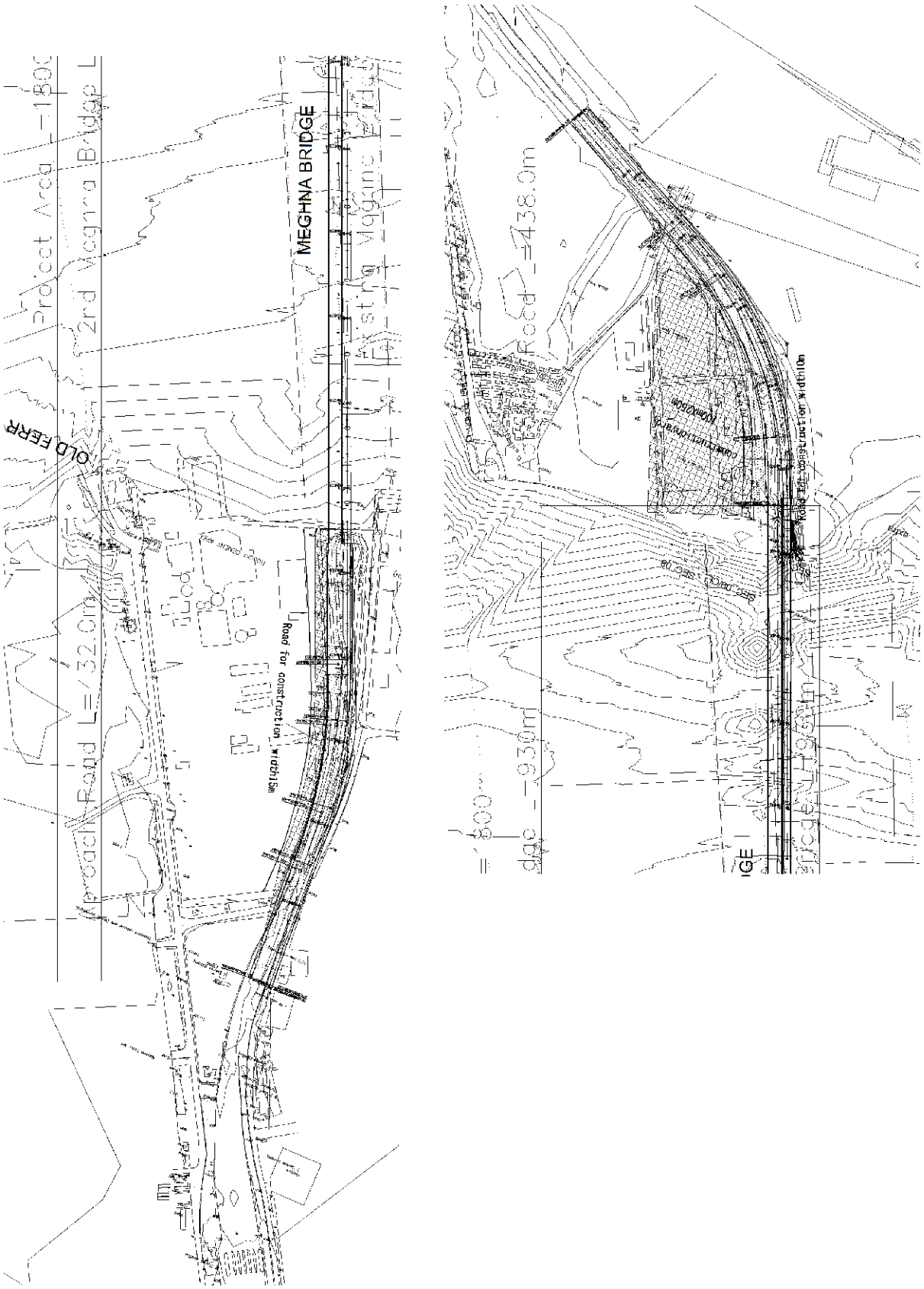


Figure 10.1.5 Construction Yard and Temporary Road at the Meghna Bridge Site

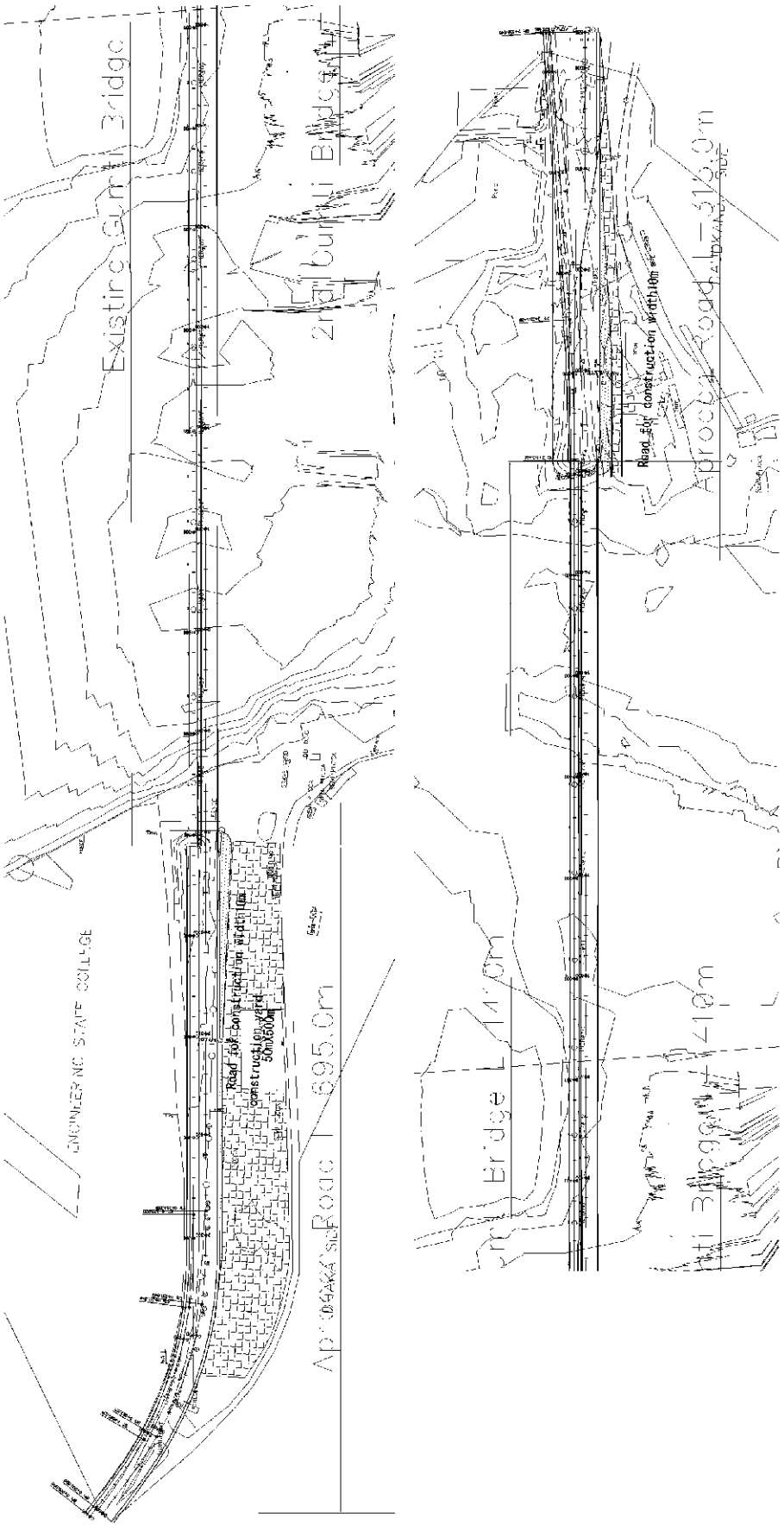


Figure 10.1.6 Construction Yard and Temporary Road at the Gumti Bridge Site

10.1.3 Bridge Civil Works

The procedures for the construction of the 2nd bridges and the rehabilitation of existing bridges are listed below sequentially.

① Foundation: As is planned the foundation of the 2nd bridge will unify with that of adjacent existing bridge, therefore the construction of the 2nd bridge-foundations along with the retrofitting of existing bridge-foundations will start simultaneously.

② Pier and abutment: Sequentially, the construction works for piers and abutments of the 2nd bridge is planning to complete. Prior to their construction completion, the retrofitting works for piers and abutments of existing bridges will start.

③ Superstructure of the 2nd bridge: Prior to the completion of bridge substructure works defined in ① through ②, the construction of 2nd bridge-superstructure (girder, slab and floor-slab system) will be start. Whenever the overall construction of the 2nd bridge will complete, the 2nd bridge will be opened and operative to road users.

④ Superstructure of existing bridge: Prior to the 2nd bridge becoming operative to road users, the rehabilitation works of existing bridge-superstructure will be started. The existing bridges will be operative to road users prior to completion of re-pavement and rehabilitation works.

(1) Foundation Works

1) Cast-in-place RC pile foundation

Cast-in-place RC pile foundation method will be adopted for the piers in shallow scouring zone as stated in Chapter 9. Excavation of the piles will be done by applying the "Reverse Circulating Method". Their pile cap construction will be followed prior to drying up the inside of cofferdam.

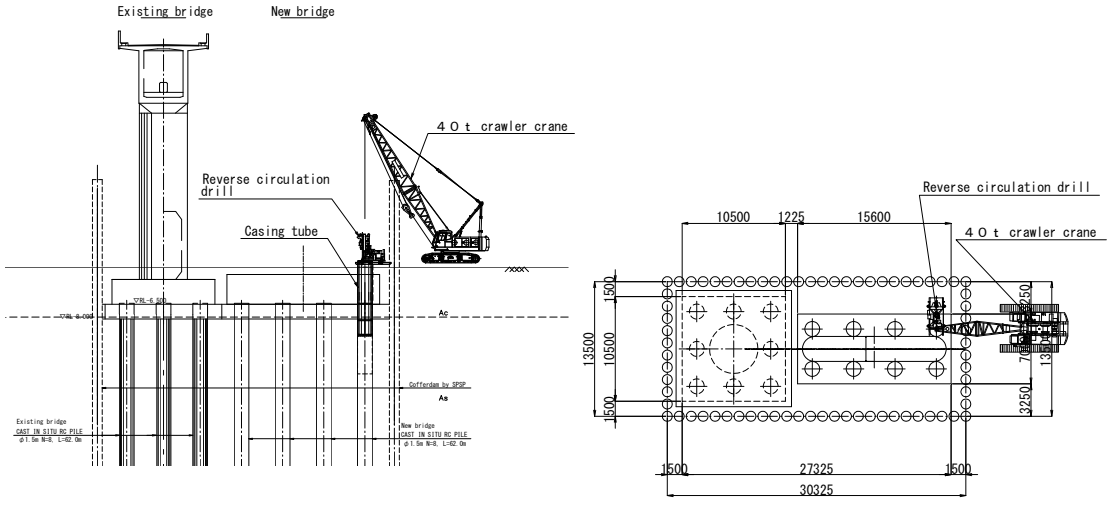


Figure 10.1.7 Reverse Circulating Method

The construction procedure of Cast-in-place RC pile foundation under shallow scouring zone is listed below and their sequence is schematically shown in Figure 10.1.8.

i) SP driving along the circumference

ii) Dewatering from the excavated area

iii) Setting bracing struts/H-beams

iv) Excavating soil

v) Cast-in-place RC pile foundation

vi) Sealing concrete

vii) Pile cap over the sealed concrete

viii) Pier construction

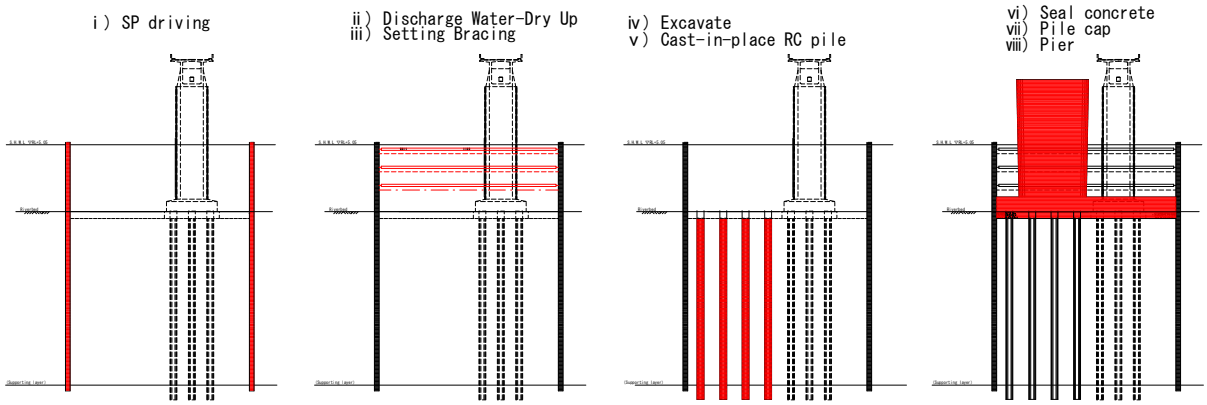


Figure 10.1.8 Construction Sequence in Shallow Scouring Zones

2) Steel Pipe Sheet Pile (SPSP) foundation

The SPSP method will be adopted for the construction of new foundations in severe scouring zone as stated in Chapter 9. This method is also adopted to retrofit the adjacent existing pile foundations. Moreover, the existing caisson foundations in shallow as well as severe scouring zones, which need rehabilitation, will be retrofitted by this method. Their pile cap construction will be followed prior to drying up the inside of cofferdam. The construction procedure of SPSP foundation under severe scouring zone is listed below and their sequence is schematically shown in Figure 10.1.9.

i) SPSP driving along the circumference

ii) Cleaning by Airlift pump

iii) Concrete placement under water by Tremie pipe

iv) Aggregate Placing

v) Dewatering

vi) Setting bracing struts/H-beams

vii) 1.5 m clear space above the aggregate base which covers existing foundation

viii) Drying the space above the aggregate base

ix) Sealing concrete

x) Pile cap over the sealed concrete

xi) Pier construction

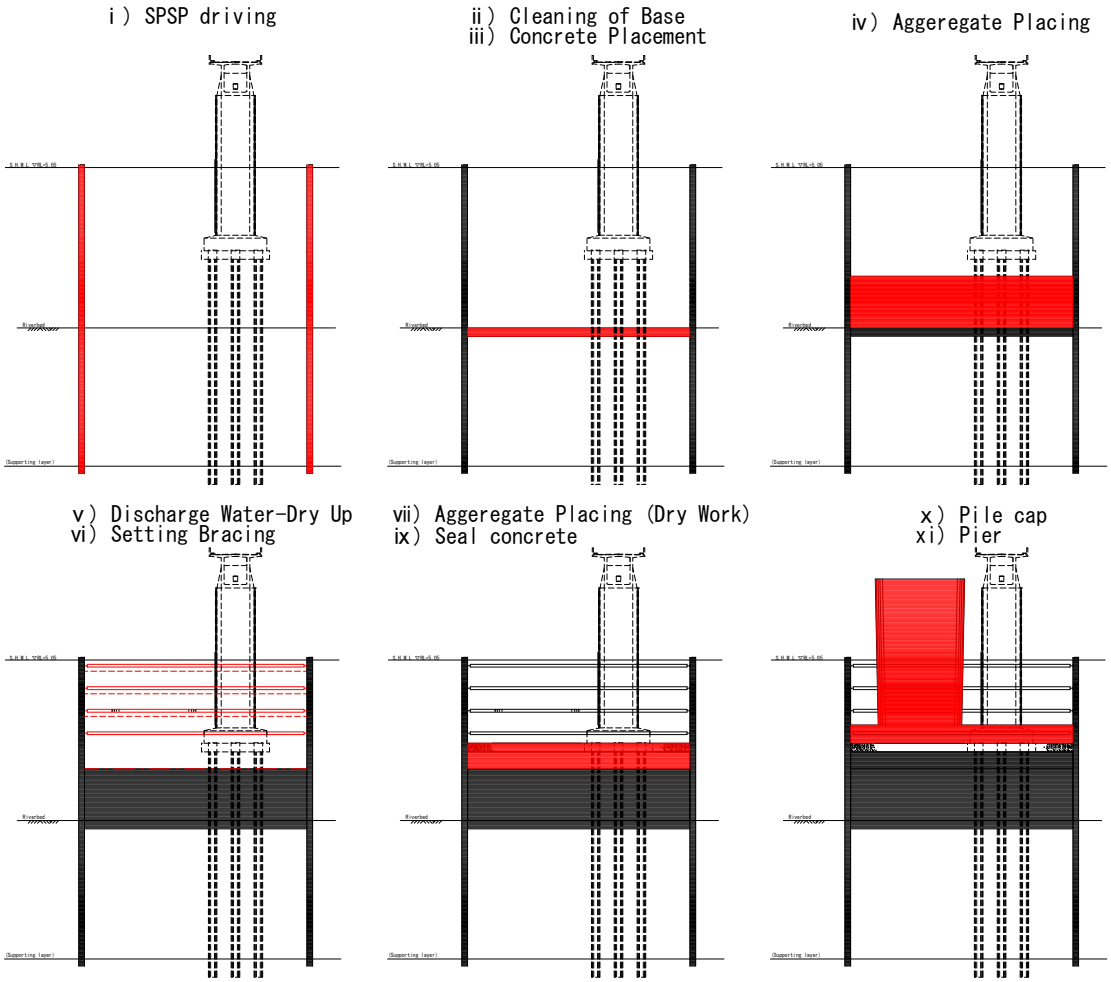


Figure 10.1.9 Construction Sequence in Severe Scouring Zones

(2) Pier and Abutment Works

At first the construction works for piers and abutments of the 2nd bridge will be done without any cofferdam protection. Thereafter, the RC-lining works as a seismic retrofitting of existing piers will be done. It should be noted that the height of one lift for concrete filling will be around 2 m for piers considering productivity.

(3) The 2nd Bridge-superstructure Works

1) Steel Girders

The preparation works for the superstructure will be started prior to constructing an earthwork slope to the abutment for an approach road. The girder launching for the 2nd Kanchpur Bridge will start from Dhaka side, while that for the 2nd Meghna and the 2nd Gumti Bridges will start from both of Dhaka side and Chittagong side. Three steel narrow box girders will be unified to launch easily. For assemblage the steel girder, the high tension bolts shall be used. The launching of one segment length of steel girder over the river portion will be 10 m approximately in the longitudinal direction, while that over land portion directly follows the erection support method. The launching of steel girder will be completed in four steps;

① Launching equipments and bridge girders will be assembled at the yard behind the abutment slope.

② Launching equipments and the steel girders will be pushed forward to the next pier.

③ When launching girder reached the next pier, the next girders will be assembled one by one.

④ The launching equipments and pushing equipments will be demobilized and the steel girders will be jacked down for fixing the bearing shoes.

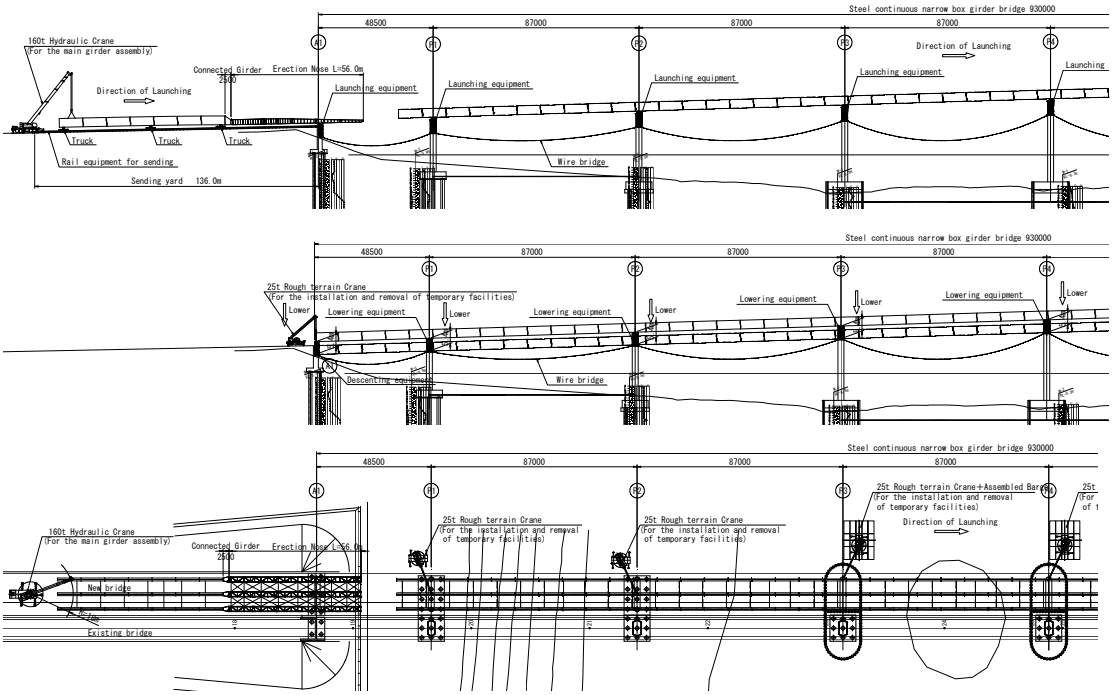


Figure 10.1.10 Steel Girder Erection Approach

2) Pre-cast floor slab

Prior to the completion of steel girder launching, the construction works of PC floor slab will start. It should be noted that the in-situ concrete will be used for casting the PC slab. After the completion of their construction works, the bridge pavement works along with installation of expansion joints as well as other ancillary works will be completed sequentially.

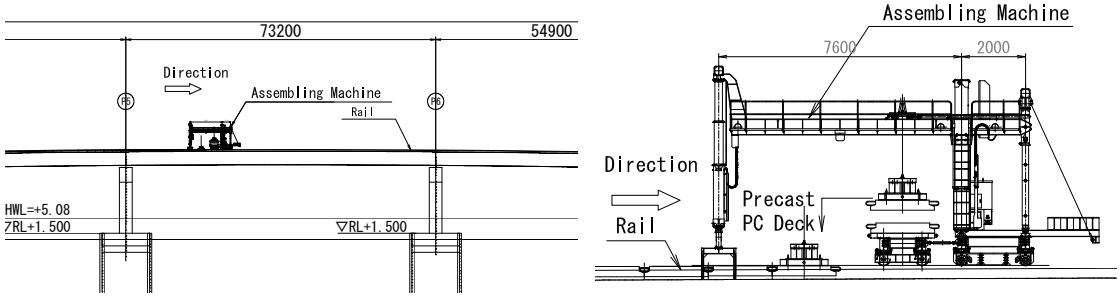


Figure 10.1.11 Slab Construction Approach

(4) Rehabilitation and retrofitting works of existing bridge-superstructure

The rehabilitation works of existing bridge-substructure comprises the rehabilitation of PC box girder of existing Meghna and Gumti Bridges. Specifically, this rehabilitation is mainly concerned with reducing the number of expansion joints and hinges, which can be achieved by connecting the segmented girder. The segmental girder should be connected by filling in-situ concrete and inserting PC bar in hinge part so to act as a monolithic joint. Moreover, the external cable tensioning along with carbon fiber sheet adhering on the bottom of the slab should be done so that they can restrain the excess bending moment to be generated from box girder continuity. The sequence of their construction works are shown in Figure 10.1.12.

On the other hand, the retrofitting of PC floor slab of existing Kanchpur Bridge will be done by increasing the floor slab thickness which shall be designed in accordance with JRA loading condition. All the existing damaged expansion joints should be replaced by finger type expansion joints.

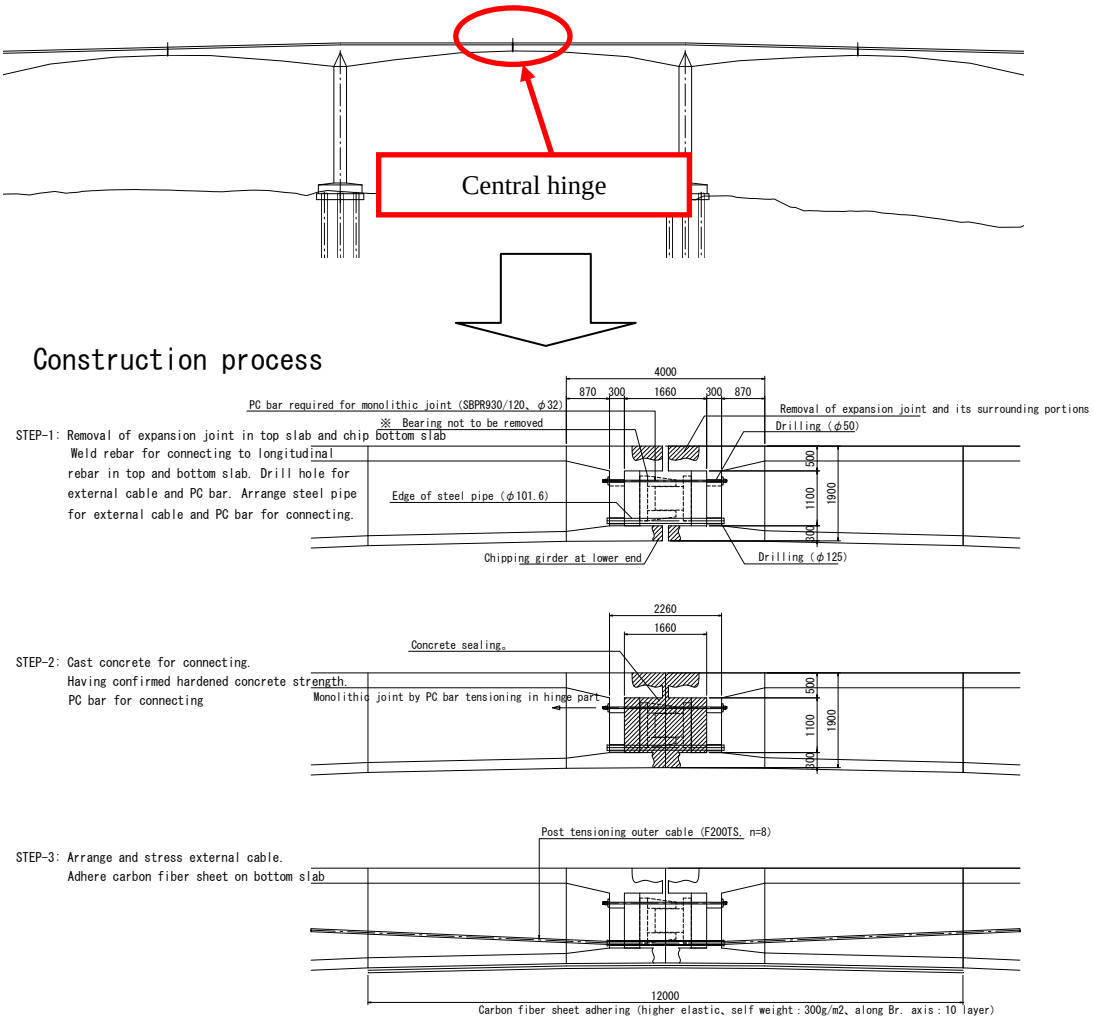


Figure 10.1.12 Continuity in Box Girder

10.1.4 Construction Works for the Approach Road

(1) Subbase

Subbase with 400 mm thick, excluding the shoulder, should be made of well graded crushed stone. They should be compacted by Vibrating Roller (7 - 8.5 ton).

(2) Base

Base course with 350 mm thick should also be made of well graded crushed stone (for the carriageway and shoulder). They should be compacted by Road Roller Macadam (12 ton) and Pneumatic Tire Roller (8 - 20 ton).

(3) Binder Course

The thickness of the binder course is designed as 200 mm wearing course, which should be compacted by Road Roller Macadam (12 ton) and Pneumatic Tire Roller (8 - 20 ton).

(4) Wearing Course

The thickness of the wearing course is designed as 50 mm wearing course, which should be compacted by Road Roller Macadam (12 ton) and Pneumatic Tire Roller (8 - 20 ton).

10.1.5 Finishing Works

(1) Electrical Facilities

Within last six months of the construction period, all the necessary electrical facilities will be installed. The facilities includes;

- Road lighting with poles
- Panels, pull boxes, cable and conduit for the lighting
- Power receiving system
- Obstacle lights and lighting protection system

(2) The Other Facilities

Following the foregoing works, the other minor works must be completed before the completion of the Project.

- Road Signs and Road Marking
- Kilometer Posts
- Fencing, if necessary
- Landscaping and Planting

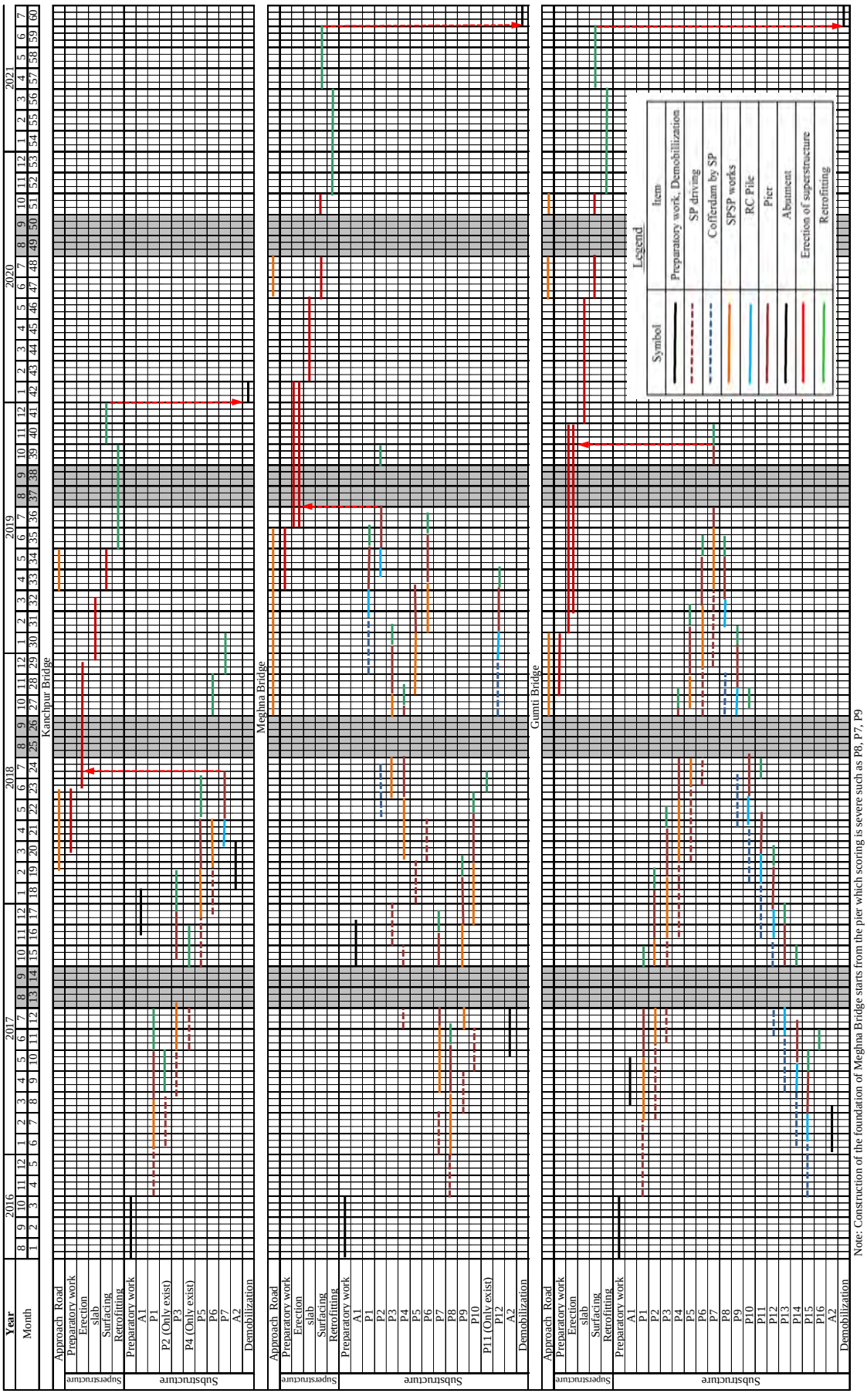
10.1.6 Construction Schedule

The overall completion of construction and rehabilitation works including mobilization and demobilization for three bridges are shown in Figure 10.1.13.

The construction of 2nd bridge-substructure along with the retrofitting of existing bridge-substructure will start simultaneously and is proposed to be completed by 2-years, while the construction of 2nd bridge-superstructure will take another 1-year for completion. Prior to overall completion of 2nd bridge, the rehabilitation works of existing bridge-superstructure will start. Accordingly, the overall construction of 2nd bridge including rehabilitation of existing bridge will take 3.5-years for completion.

In case of Meghna Bridge, the construction of 2nd bridge-substructure along with the retrofitting of existing bridge-substructure will initiate from P7-P10 located under severely scouring zone. Prior to completion of the substructure works, the 2nd bridge-superstructure work will start and take more than 1-year for completion. It is found that the overall construction works of 2nd bridge will take 4-years for completion. Afterwards another one year is allocated for the completion of rehabilitation works of existing bridge-superstructure. Therefore, the overall construction of 2nd bridge including rehabilitation of existing bridge will take 5.0-years for completion. Furthermore, if the construction equipments are shifted to Meghna Bridge construction, prior to completion of Kanchpur Bridge substructure, the Meghna Bridge construction will be speeded up reasonably and its total construction schedule can be shortened by six months accordingly.

The construction sequence of Gumti Bridge is same as that of Meghna Bridge but differs in way that the construction and the retrofitting works for substructure will initiate simultaneously from both ends. The construction period of Gumti Bridge is expected to be same as that of Meghna Bridge.



Note: Construction of the foundation of Meghna Bridge starts from the pier which scoring is severe such as P8, P7, P9

Figure 10.1.13 Construction Schedule

10.2 Cost Estimation

10.2.1 General Conditions of Cost Estimation

(1) Term of Cost estimation

The unit prices of resources (material, equipment and labor) adopted for this estimation are those prices in use at the time of July, 2012.

(2) Exchange Rate

The exchange rate adopted for this cost estimate is the prevailing average rate of exchange in December, 2012 (adopted by JICA as "General Guidelines of Appraisal for FY 2012), as shown hereunder;

US$ 1 = 79.0 Yen

US$ 1 = 81.7 BDT

BDT 1= 0.966 Yen

The exchange rate quoted above is used elsewhere in this report when Local Currency (LC) is converted into Foreign Currency (FC).

(3) Price Escalation

The price escalations are set at 4.9 % for LC and 2.1 % for FC.

(4) Physical Contingency

The physical contingencies are set at 10 % of the construction and 5 % of the consultant service.

(5) Administration Cost

The administration cost incurred for establishment of the organization in RHD is set at 10 % of construction cost and consultant service.

(6) Taxes and Duties

1) Import duty

An average import duty of 30 % is applied on product to be imported in Bangladesh. The import duty estimate is added to the operation and maintenance cost for the bridge structure and ancillary facilities for toll gates.

2) VAT

According to VAT law, Regulation, Order and SRO booklet (2011), a VAT rate of 15 % is applied on any engineering firm, and generally this rate is also applied for purchasing any product in the local market. Therefore, a VAT rate of 15 % is used to estimate construction cost as well as operation and maintenance cost shown elsewhere in this report.

10.2.2 Cost Estimation

(1) Construction Cost

Construction cost has two components: direct cost and indirect cost. Direct cost is mainly estimated based on the results obtained from the outline design, quantity take-off of each work item, and the studies on construction planning and methods as described in the previous sections.

Furthermore, certain indirect costs are needed to be considered for project implementation, which includes temporary and preparatory works & power /water supply system installation before construction along with quality control, safety measures and so forth during construction. These indirect cost items are also added to estimate the construction cost. In this regard, Japanese procurement rules proposed by Ministry of Land, Infrastructure, Transport and Tourism are followed. In accordance with the said rules, the indirect cost items are estimated as 25.05 % of direct cost, whereas the contractor's overhead are estimated as 7.22 % of direct plus indirect cost. The estimated total construction cost is shown in Table 10.2.1.

Table 10.2.1 Construction Cost

Bridge/Approach road		Foreign currency (million JPY)	Local currency (million BDT)	Total (million JPY)
Kanchpur	Approach road	80	393	460
	2nd bridge	2,256	1,340	3,550
	Existing bridge	1,974	343	2,305
	Sub total	4,310	2,076	6,315
Meghna	Approach road	80	650	708
	2nd bridge	6,449	4,163	10,471
	Existing bridge	4,105	1,410	5,468
	Sub total	10,635	6,224	16,647
Gumti	Approach road	80	516	579
	2nd bridge	9,198	5,608	14,615
	Existing bridge	4,959	1,543	6,450
	Sub total	14,237	7,667	21,644
Total		29,182	15,967	44,606

Source: JICA Study Team

(2) Consulting Services

The following costs are estimated for the consulting services;

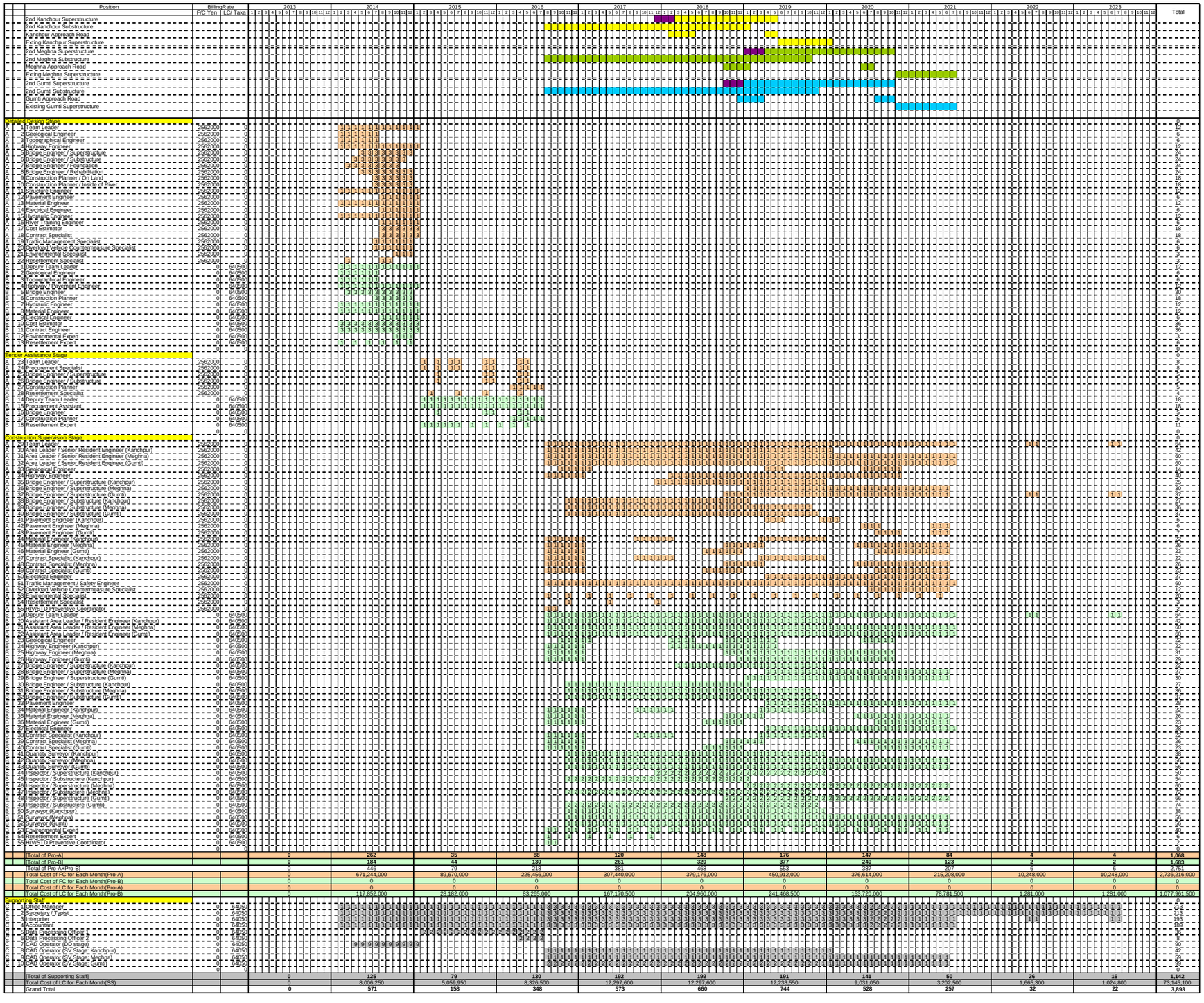
- Detailed Design Cost
- Preconstruction Process/Tender Assistance Cost
- Construction Supervision Cost

The above consulting services items are determined based on the total number of manpower hours (national and international level) required to implement the project. The total number of manpower hours is determined based on expected manpower required for project implementation (D/D, tendering and C/S). The estimated engineering cost is shown in Table 10.2.2.

Table 10.2.2 Engineering Cost

Position	Unit	Qty	Foreign (Thousand JPY)		Local (Thousand BDT)		Combined Total (Thousand JPY)
			Rate	Amount	Rate	Amount	
Remuneration							
1 Professional (A)	M/M	1068	2,562	2,736,216	0	0	2,736,216
2 Professional (B)	M/M	1683	0	0	640.500	1,077,962	1,041,311
3 Supporting Staff	M/M	1142	0	0	64.050	73,145	70,658
Sub Total				2,736,216		1,151,107	3,848,185
Direct Cost							
1 International Airfare	Round Trip	127	250	31,750		0	31,750
2 Accommodation Allowance	M/M	1068		0	383.023	409,068	395,160
3 Vehicle Rental	No./M	378		0	155.280	58,696	56,700
4 Office Rental	No./M	204		0	103.520	21,118	20,400
5 Office Supply	Set/M	204		0	103.520	21,118	20,400
6 Office Furniture and Equipment	Set/M	1020		0	207.039	211,180	204,000
7 Geographical Survey	LS	1		0	32,267.081	32,267	31,170
8 Topographical Survey	LS	1		0	1,262.940	1,263	1,220
9 Ground Water Monitoring	LS	1		0	774.327	774	748
10 Structure Measurements	LS	1		0	3,806.418	3,806	3,677
11 Others (EMP Implementation fee, etc)	LS	1		0	1,000.000	1,000	966
12 Implementing Agency (IA) sub-contract fee	LS	1		0	10,150.000	10,150	9,805
13 Training	person	30	2,000	60,000		0	60,000
Sub Total				91,750		770,441	835,996
Total				2,827,966		1,921,547	4,684,181

Table 10.2.3 Manning Schedule for the Consulting Service



	Position	Billing Rate F/C Yen	Billing Rate L/C Taka	Total
	2nd Kanchpur Superstructure			
	2nd Kanchpur Substructure			
	Kanchpur Approach Road			
	Exting.Kanchpur Superstructure			
	2nd Meghna Superstructure			
	2nd Meghna Substructure			
	Meghna Approach Road			
	Exting.Meghna Superstructure			
	2nd Gumti Superstructure			
	2nd Gumti Substructure			
	Gumti Approach Road			
	Existing Gumti Superstructure			
	Detailed Design Stage			
A	1 Team Leader	2562000	0	12
A	2 Geological Engineer	2562000	0	4
A	3 Topographical Engineer	2562000	0	4
A	4 Highway Engineer	2562000	0	12
A	5 Bridge Engineer / Superstructure	2562000	0	24
A	6 Bridge Engineer / Substructure	2562000	0	24
A	7 Bridge Engineer / Foundation	2562000	0	24
A	8 Bridge Engineer / Rehabilitation	2562000	0	24
A	9 Construction Planner / On Land	2562000	0	16
A	10 Construction Planner / Inside or River	2562000	0	16
A	11 Structure Engineer	2562000	0	24
A	12 Pavement Engineer	2562000	0	8
A	13 Material Engineer	2562000	0	12
A	14 Electrical Engineer	2562000	0	4
A	15 Hydraulic Engineer	2562000	0	12
A	16 River Training Engineer	2562000	0	12
A	17 Cost Estimator	2562000	0	16
A	18 Contract Specialist	2562000	0	16
A	19 Traffic Management Specialist	2562000	0	4
A	20 Overload Vehicle Countermeasure Specialist	2562000	0	4
A	21 Environmental Specialist	2562000	0	3
A	22 Resettlement Specialist	2562000	0	2
B	1 Deputy Team Leader	0	640500	12
B	2 Geological Engineer	0	640500	4
B	3 Topographical Engineer	0	640500	4
B	4 Highway / Pavement Engineer	0	640500	12
B	5 Bridge Engineer	0	640500	36
B	6 Construction Planner	0	640500	16
B	7 Hydraulic Engineer	0	640500	12
B	8 Material Engineer	0	640500	12
B	9 Electrical Engineer	0	640500	4
B	10 Cost Estimator	0	640500	16
B	11 Contract Engineer	0	640500	16
B	12 Environmental Expert	0	640500	3
B	13 Resettlement Expert	0	640500	2
		0	0	0
	Tender Assistance Stage			
A	23 Team Leader	2562000	0	3
A	24 Procurement Specialist	2562000	0	3
A	25 Bridge Engineer / Superstructure	2562000	0	3
A	26 Bridge Engineer / Substructure	2562000	0	3
A	27 Construction Planner	2562000	0	3
A	28 Resettlement Specialist	2562000	0	2
B	14 Deputy Team Leader	0	640500	18
B	15 Procurement Assistant	0	640500	18
B	16 Bridge Engineer	0	640500	9
B	17 Construction Planner	0	640500	9
B	18 Resettlement Expert	0	640500	11
		0	0	0
	Construction Supervision Stage			
A	29 Team Leader	2562000	0	60
A	30 Area Leader / Senior Resident Engineer (Kanchpur)	2562000	0	42
A	31 Area Leader / Senior Resident Engineer (Meghna)	2562000	0	60
A	32 Area Leader / Senior Resident Engineer (Gumti)	2562000	0	60
A	33 Geological Engineer	2562000	0	4
A	34 Highway Engineer	2562000	0	40
A	35 Bridge Engineer / Superstructure (Kanchpur)	2562000	0	60
A	36 Bridge Engineer / Superstructure (Meghna)	2562000	0	60
A	37 Bridge Engineer / Superstructure (Gumti)	2562000	0	37
A	38 Bridge Engineer / Substructure (Kanchpur)	2562000	0	37
A	39 Bridge Engineer / Substructure (Meghna)	2562000	0	36
A	40 Bridge Engineer / Substructure (Gumti)	2562000	0	37
A	41 Pavement Engineer (Kanchpur)	2562000	0	4
A	42 Pavement Engineer (Meghna)	2562000	0	4
A	43 Pavement Engineer (Gumti)	2562000	0	7
A	44 Material Engineer (Kanchpur)	2562000	0	27
A	45 Material Engineer (Meghna)	2562000	0	60
A	46 Material Engineer (Gumti)	2562000	0	23
A	47 Contract Specialist (Kanchpur)	2562000	0	60
A	48 Contract Specialist (Meghna)	2562000	0	60
A	49 Contract Specialist (Gumti)	2562000	0	37
A	50 Electrical Engineer	2562000	0	4
A	51 Traffic Management / Safety Engineer	2562000	0	60
A	52 Overload Vehicle Countermeasure Specialist	2562000	0	12
A	53 Environmental Specialist	2562000	0	30
A	54 Resettlement Specialist	2562000	0	30
A	55 HIV/STD Prevention Coordinator	2562000	0	24
B	19 Deputy Team Leader	0	640500	54
B	20 Assistant Area Leader / Resident Engineer (Kanchpur)	0	640500	42
B	21 Assistant Area Leader / Resident Engineer (Meghna)	0	640500	60
B	22 Assistant Area Leader / Resident Engineer (Gumti)	0	640500	60
B	23 Geological Engineer	0	640500	22
B	24 Highway Engineer (Kanchpur)	0	640500	40
B	25 Highway Engineer (Meghna)	0	640500	60
B	26 Highway Engineer (Gumti)	0	640500	23
B	27 Bridge Engineer / Superstructure (Kanchpur)	0	640500	60
B	28 Bridge Engineer / Superstructure (Meghna)	0	640500	60
B	29 Bridge Engineer / Superstructure (Gumti)	0	640500	30
B	30 Bridge Engineer / Substructure (Kanchpur)	0	640500	60
B	31 Bridge Engineer / Substructure (Meghna)	0	640500	60
B	32 Bridge Engineer / Substructure (Gumti)	0	640500	30
B	33 Pavement Engineer	0	640500	22
B	34 Material Engineer (Kanchpur)	0	640500	27
B	35 Material Engineer (Meghna)	0	640500	60
B	36 Material Engineer (Gumti)	0	640500	23
B	37 Electrical Engineer	0	640500	30
B	38 Contract Specialist (Kanchpur)	0	640500	60
B	39 Contract Specialist (Meghna)	0	640500	60
B	40 Contract Specialist (Gumti)	0	640500	30
B	41 Quantity Surveyor (Kanchpur)	0	640500	60
B	42 Quantity Surveyor (Meghna)	0	640500	60
B	43 Quantity Surveyor (Gumti)	0	640500	30
B	44 Inspector / Superstructure (Kanchpur)	0	640500	60
B	45 Inspector / Substructure (Kanchpur)	0	640500	60
B	46 Inspector / Superstructure (Meghna)	0	640500	60
B	47 Inspector / Substructure (Meghna)	0	640500	60
B	48 Inspector / Superstructure (Gumti)	0	640500	30
B	49 Inspector / Substructure (Gumti)	0	640500	30
B	50 Surveyor (Kanchpur)	0	640500	60
B	51 Surveyor (Meghna)	0	640500	60
B	52 Surveyor (Gumti)	0	640500	30
B	53 Environmental Expert	0	640500	4
B	54 Resettlement Expert	0	640500	4
B	55 HIV/STD Prevention Coordinator	0	640500	12
		0	0	0
	[Total of Pro-A]		0	1,068
	[Total of Pro-B]		0	1,683
	[Total of Pro-A+Pro-B]		0	2,751
	Total Cost of FC for Each Month(Pro-A)		0	2,736,216,000
	Total Cost of FC for Each Month(Pro-B)		0	0
	Total Cost of LC for Each Month(Pro-A)		0	0
	Total Cost of LC for Each Month(Pro-B)		0	1,077,961,500
	Supporting Staff			0
C	1 Office Manager	0	640500	216
C	2 Secretary / Typist	0	640500	216
C	3 Interpriter	0	640500	193
C	4 Accountant	0	640500	196
C	5 Data Processing Office 1	0	640500	90
C	6 Data Processing Office 2	0	640500	90
C	7 CAD Operator (DO stage)	0	640500	90
C	8 CAD Operator (SV Stage, Kanchpur)	0	640500	42
C	9 CAD Operator (SV Stage, Meghna)	0	640500	60
C	10 CAD Operator (SV Stage, Gumti)	0	640500	30
		0	0	0
	[Total of Supporting Staff]		0	1,142
	Total Cost of LC for Each Month(SS)		0	73,145,100
	Grand Total		0	3,893

(3) Operation and Maintenance Costs

The operation and maintenance cost includes the cost for the approach road and bridge maintenance (routine and periodic), facilities for toll gates and their operation. The details of Operation and maintenance costs are quoted in "Chapter 11: Operation and Maintenance Administration".

(4) Compensation Cost

The following costs are estimated at the Preconstruction Stage.

- Resettlement of Houses and Public/ Private Structures
- Relocation of Utilities

The detailing of compensation cost is shown elsewhere in RAP report.

(5) Project Cost Estimate

The project cost that includes construction cost, consulting services, environment monitoring, RAP implementation, physical contingencies, price escalation, VAT, custom duties is estimated at JPY 88,464 million.

Table 10.2.4 Project Cost

Item	Total			2013			2014			2015			2016			2017		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION																		
I) Procurement / Construction	36,999	24,120	60,299	0	0	0	0	0	0	0	0	0	5,970	3,633	9,479	6,081	3,793	9,744
Bridge Civil Work	29,182	15,966	44,606	0	0	0	0	0	0	0	0	0	4,985	2,728	7,620	4,961	2,714	7,583
Dispute Board	149	0	149	0	0	0	0	0	0	0	0	0	9	0	9	21	0	21
Base cost for JICA financing	29,331	15,966	44,755	0	0	0	0	0	0	0	0	0	4,994	2,728	7,629	4,982	2,714	7,604
Price escalation	4,304	5,961	10,062	0	0	0	0	0	0	0	0	0	433	575	989	546	733	1,254
Physical contingency	3,364	2,193	5,482	0	0	0	0	0	0	0	0	0	543	330	862	553	345	886
II) Consulting services	3,324	2,678	5,911	0	0	0	751	290	1,031	103	67	168	266	194	453	373	382	742
Base cost	2,828	1,922	4,684	0	0	0	686	251	928	92	55	146	233	153	380	320	286	597
Price escalation	337	629	945	0	0	0	29	25	53	6	9	14	20	32	51	35	77	110
Physical contingency	158	128	281	0	0	0	36	14	49	5	3	8	13	9	22	18	18	35
Total (I + II)	40,322	26,798	66,209	0	0	0	751	290	1,031	103	67	168	6,235	3,827	9,932	6,454	4,174	10,486
B. NON ELIGIBLE PORTION																		
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	97	94	0	0	0	0	22	21	0	25	24	0	26	25	0	25	24
Base cost	0	75	72	0	0	0	0	18	17	0	19	19	0	19	19	0	18	17
Price escalation	0	14	13	0	0	0	0	2	2	0	3	3	0	4	4	0	5	5
Physical contingency	0	9	9	0	0	0	0	2	2	0	2	2	0	2	2	0	2	2
c Administration cost	0	6,864	6,630	0	0	0	0	109	105	0	20	19	0	1,031	996	0	1,088	1,051
d VAT	0	4,550	4,396	0	0	0	0	163	158	0	30	29	0	619	598	0	688	664
e Import Tax	0	11,490	11,100	0	0	0	0	0	0	0	0	0	0	1,854	1,791	0	1,888	1,824
Total (a+b+c+d+e)	0	23,001	22,219	0	0	0	0	294	284	0	74	72	0	3,530	3,410	0	3,689	3,564
TOTAL (A+B)	40,322	49,800	88,429	0	0	0	751	584	1,315	103	141	240	6,235	7,357	13,342	6,454	7,863	14,049
C. Interest during Construction	36	0	36	0	0	0	0	0	0	0	0	0	1	0	1	2	0	2
Interest during Construction(Const.)	32	0	32	0	0	0	0	0	0	0	0	0	1	0	1	2	0	2
Interest during Construction (Consul.)	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Commitment Charge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL (A+B+C+D)	40,358	49,800	88,464	0	0	0	751	584	1,315	103	141	240	6,236	7,357	13,343	6,456	7,863	14,052

Item	2018			2019			2020			2021			2022			2023		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION																		
I) Procurement / Construction	6,208	3,978	10,051	6,339	4,173	10,370	6,472	4,378	10,701	3,866	2,679	6,454	29	0	29	2,034	1,486	3,470
Bridge Civil Work	4,961	2,714	7,583	4,961	2,714	7,583	4,961	2,714	7,583	2,894	1,583	4,423	0	0	0	1,459	798	2,230
Dispute Board	21	0	21	21	0	21	21	0	21	21	0	21	21	0	21	12	0	12
Base cost for JICA financing	4,982	2,714	7,604	4,982	2,714	7,604	4,982	2,714	7,604	2,915	1,583	4,445	21	0	21	1,472	798	2,243
Price escalation	662	902	1,533	780	1,080	1,823	901	1,266	2,124	600	852	1,423	5	0	5	378	553	912
Physical contingency	564	362	914	576	379	943	588	398	973	351	244	587	3	0	3	185	135	315
II) Consulting services	470	487	940	570	600	1,149	483	417	886	281	226	500	14	8	21	14	7	21
Base cost	395	348	731	469	409	864	390	271	651	222	140	357	10	5	15	10	4	14
Price escalation	52	116	164	73	163	230	70	126	193	46	75	118	2	3	5	3	3	5
Physical contingency	22	23	45	27	29	55	23	20	42	13	11	24	1	0	1	1	0	1
Total (I + II)	6,678	4,466	10,992	6,909	4,773	11,519	6,955	4,795	11,587	4,147	2,905	6,954	42	8	50	2,048	1,493	3,491
B. NON ELIGIBLE PORTION																		
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
c Administration cost	0	1,138	1,099	0	1,192	1,152	0	1,199	1,159	0	720	695	0	5	5	0	361	349
d VAT	0	743	718	0	804	777	0	794	767	0	479	463	0	3	3	0	226	218
e Import Tax	0	1,928	1,862	0	1,969	1,902	0	2,010	1,942	0	1,201	1,160	0	9	9	0	632	610
Total (a+b+c+d+e)	0	3,809	3,679	0	3,965	3,831	0	4,004	3,867	0	2,400	2,318	0	17	17	0	1,219	1,178
TOTAL (A+B)	6,678	8,274	14,671	6,909	8,738	15,350	6,955	8,799	15,454	4,147	5,305	9,272	42	25	67	2,048	2,713	4,669
C. Interest during Construction	3	0	3	4	0	4	6	0	6	6	0	6	6	0	6	7	0	7
Interest during Construction(Const.)	3	0	3	4	0	4	5	0	5	6	0	6	6	0	6	6	0	6
Interest during Construction (Consul.)	0	0	0	0	0	0	1	0	1	1	0	1	1	0	1	1	0	1
D. Commitment Charge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL (A+B+C+D)	6,681	8,274	14,674	6,913	8,738	15,354	6,960	8,799	15,460	4,154	5,305	9,278	49	25	73	2,055	2,713	4,675

10.2.3 General Terms of Reference for Project Implementation

(1) Scope of Works of General Consulting Services

The main feature of the general consulting services is to lead the Project to be successfully completed timely. This will be achieved through the following;

1) Engineering/Detailed Design

- Review of the Feasibility Studies and relevant existing reports;
- Preparation of the detailed design;
- Cost estimates based on the detailed design; and
- Financial analysis based on the revised cost estimation and toll policy.

2) Bid Assistance

- Preparation of bidding documents, assistance for RHD to select the Contractor: bid evaluation; award of the contract; contract negotiation; and finalizing the contract documents.

3) Construction Supervision

- Supervision of Works comprising aforementioned three components of bridge rehabilitation and construction;
- Guidance on Operation and Maintenance measures (Preparation of Manual, Training plan, and others) for RHD officials and outsourcing;
- Guidance on Weighbridge and its Control for outsourcing, and;
- Capacity building for Operation and Maintenance.

4) Safeguards Assistance

- Environmental and Social Considerations (updating, implementing, and facilitating the Resettlement Action Plan (RAP) , Environmental Management Plan (EMP), and the Environmental Monitoring Plan (EMoP), and other relevant considerations)

5) Safety Considerations (Complying with Safety policy based on JICA policy)

6) HIV/AIDS prevention

7) Dispute Board (DB) assistance

8) Transfer of Technology

9) Others

- Assistance in implementation of Information Campaign and Publicity (ICP) Program, and PR of the Project

CHAPTER 11

OPERATION AND MAINTENANCE ADMINISTRATION

11. OPERATION AND MAINTENANCE ADMINISTRATION

11.1 Overview of Roads and Bridges

11.1.1 Roads

The road network consists of six road categories, namely National Highways, Regional Highways, Zilla Roads, Upazila Roads, Union Roads and Village Roads (GoB, 2004). The Roads and Highways Department (RHD) under the Ministry of Communication (MoC) of Bangladesh manages about 21,571 km of the three upper categories that make up 8 % of the total road network as shown in Table 11.1.1. The density of National Roads is 15 km / 100 km^2 of land and 144km/million people. The road asset value, excluding land and bridges, is currently BDT 254.710 million. Although the asset value is increasing, the percentage of asset loss is also increasing because of under-investment in road maintenance and rehabilitation.

Table 11.1.1 Road Network in Bangladesh

Indicators	Value	Percentage	Descriptions
Main Roads (RHD)	21,571 km	8 %	Roads connecting cities and towns (e.g. national, regional, Zilla); under government of Bangladesh.
Classified Rural Roads	78,495 km	29 %	Roads connecting villages with local government centers and main roads; under national or local governments
Other Rural Roads	171,335 km	63 %	Village roads connecting villages with Union HQs, local markets, farms and Ghats or with other villages and roads within villages
Road-length Total	271,401 km	100 %	
National Road Density in terms of Population	144.2	unit Km/1 mill. people	As a result of 21,571/149,772,364 (Population:149,772,364)
National Road Density in terms of Land	14.62	km/100 sq. km total land area	As a result of 21,571/147,570 (Land area:147,570 km^2)

Source: WB Web site Transport in South Asia -Bangladesh-Highway data; Road Master Plan (2009), and Bangladesh Bureau of Statistics

11.1.2 Bridges

The number of bridges within the RHD road network (National highways, regional highways and Zilla roads) has also increased dramatically since 1991. Accordingly, the growth in the number of bridges in the last 20 years is shown in Table 11.1.2. In accordance with current data available at the RHD home page, the numbers of bridges monitored and maintained by RHD administration are 18,356 which is around six times that in 1991. Table 11.1.3 shows the breakdown of bridge structures by type.

In order to assess the need of repair, rehabilitation and reconstruction of bridges, RHD has adopted a simple but effective way of reporting the condition of bridges / structures. This method is set out in their Bridge Condition Survey (BCS) Manual. Accordingly, RHD has conducted Bridge Condition Surveys for classified culverts and bridges in all types of the roads to assess their damage condition. The existing condition of the classified structures are divided into four categories;

- Category A: Good
- Category B: Minor Element Damage
- Category C: Major Element Damage
- Category D: Major Structural Damage

Table 11.1.2 Growth in Number of Bridges under RHD

	1991		2006		2012 (Data from RHD home page)	
	No. of culverts &bridges	Total length (m)	No. of culverts & bridges	Total length (m)	No. of culverts & bridges	Total length (m)
National Highways	1,012	55,393	3,617	64,837	3,649	65,013
Regional Highways	302	9,896	3,535	43,828	3,612	44,370
Zilla Roads	1,843	26,383	7,560	75,933	11,095	109,920
Total	**3,144**	**91,672**	**14, 712**	**184,598**	**18,356**	**219,303**

Source: Road Master Plan (2009), and BMMS database, RHD, www.rhd.gov.bd

Table 11.1.3 Bridge Condition Category by Structure Type

Sl	Structure Type	Category A	Category B	Category C	Category D	No. of Structures
1	Box Culvert	7,554	1,016	794	131	9,495
2	Slab Culvert	2,554	494	755	207	4,010
3	RCC Girder Bridge	904	500	725	264	2,393
4	Baily with Steel Deck	570	132	213	59	974
5	PC Girder Bridge	282	61	52	11	406
6	Arch Masonry	149	61	87	36	333
7	RCC Bridge	127	34	68	16	245
8	Steel Beam & RCC Slab	76	35	89	30	230
9	Truss with Steel Deck	152	13	32	8	205
10	Truss with RCC Slab	17	4	8	1	30
11	Truss with Timber Deck	3	0	2	1	6
12	Baily with Timber Deck	11	2	6	4	23
13	PC Box	2	0	3	0	5
14	Pipe culvert	1	0	0	0	
Total		12,402	2,352	2,834	768	18,356

Source: BMMS database, RHD, www.rhd.gov.bd

RHD has recorded all observations of deterioration as major or minor in extent. The general criteria adopted for major deterioration are scouring, tilting, settlement, obstruction, cracks in concrete / any crack in work steel, concrete spalling, damaged or missing sections and missing bolts. Any other observations, which do not meet the above criteria and condition, are recorded as minor. The numbers of all types of structures according to condition category are given in Table 11.1.3.

In accordance with RHD classified structures, the type of existing Kanchpur Bridge is PC Girder Bridge, whereas the existing Meghna and Gumti Bridges are ‘PC Box’ type. Moreover, as per their survey data, the present condition of the existing three bridges falls under ‘Category C’, that means they are in major elemental damage and need urgent rehabilitation / replacement of major elements.

11.2 Ministry of Communication (Upper Level to RHD)

The Ministry of Communication (MoC) comprises two divisions, namely; Roads Division and Bridges Division. The Roads Division plays a vital role in the socio-economic development of Bangladesh since it governs the Departments / Organizations which are playing very important roles in infrastructure development, namely;

- Roads & Highways Department (RHD)
- Bangladesh Road Transport Authority (BRTA)
- Bangladesh Road Transport corporation (BRTC)
- Dhaka Transport Co-ordination Board (DTCB)

The principal motto of the Roads Division is to ensure the improvement of the socio-economic condition of the nation through formulating policies regarding roads and road transport in addition to the construction, development, expansion and maintenance of environmentally-friendly and user-friendly integrated road transportation.

11.2.1 Organization Chart of MoC

Organization Chart of MoC and respective officers under Roads Division are shown below. Total number of MoC officers is 157 as of May 2011.

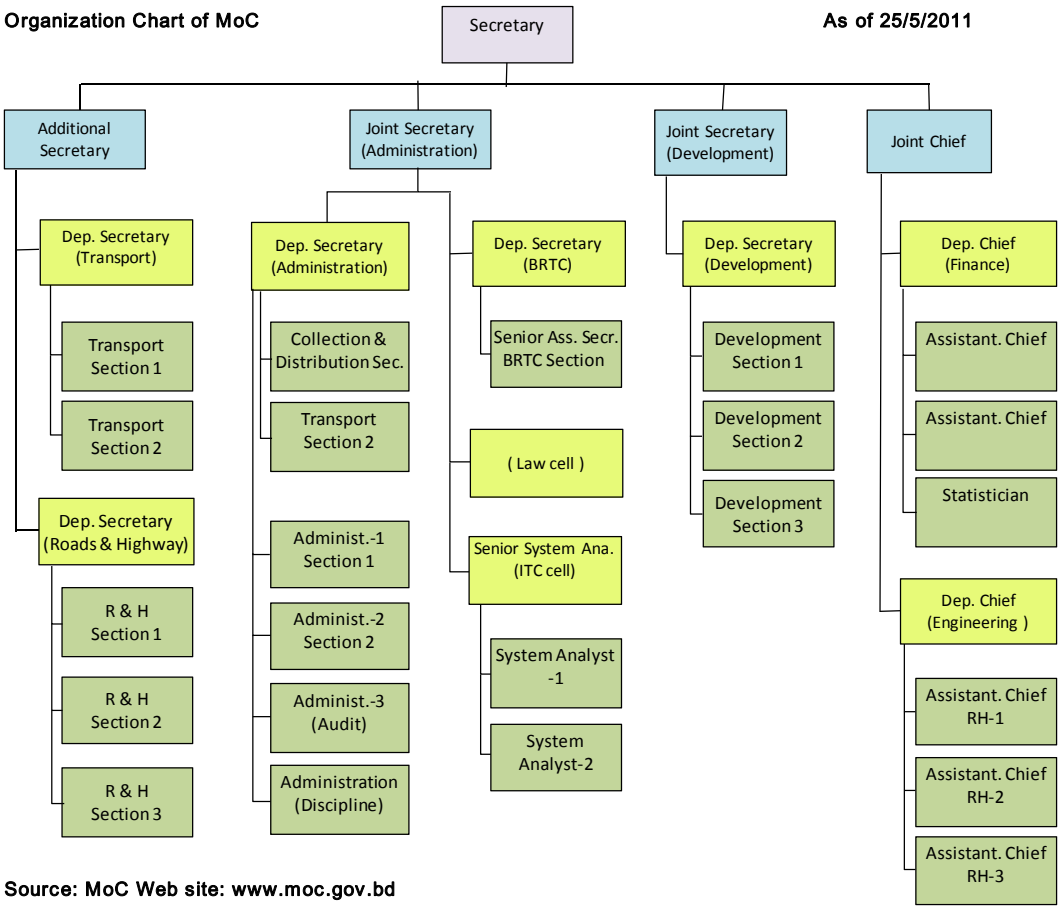


Figure 11.2.1 Organization Chart of Ministry of Communication (Roads Division)

Table 11.2.1 Ministry of Communication's Officers Class and Numbers (Road Division)

Name of the position	Number
Secretary	1
Additional Secretary	1
Joint Secretary/ Joint Chief	3
Deputy Secretary/ Deputy Chief/ Law Advisor	8
Senior System Analyst	1
Sr Asst. Secretary/ Asst. Secretary/ Law Officer	14
Sr. Asst. Chief/ Asst. Chief	6
Private Secretary of Secretary	1
System Analyst/ Programmer/ Maint. Engineer Engineer/ Asst. Programmer/ Asst. Maint. Engineer	12
Accounting Officer	1
Total 1st Class	**48**
Total 2nd Class	**29**
Total 3rd Class	**41**
Total 4th Class	**39**
Total Number (All Class)	**157**

Source: MoC Web site: www.moc.gov.bd

11.3 Roads and Highways Department (RHD)

The Roads and Highways Department (RHD) was founded in 1962 as an offshoot of the Construction and Building (C&B) organization. The Department is responsible for the construction and maintenance of the major road network of Bangladesh.

Since the Department was founded the size of the major road network in Bangladesh has grown from approximately 4,500 km to the present network of about 21,571 km (Table 11.1.1). The Department is headed by a Chief Engineer who is supported by a number of Additional Chief Engineers and personnel totaling 18,092 including temporary staff.

RHD annual budget from GoB amounts to approximately BDT 28,514 million. Of which, about BDT 19,899 million is from the annual development budget and BDT 8,615 million from the revenue budget in financial year 2005-06 (Source: RHD).

11.3.1 RHD: Responsible for National Roads

The legal basis of RHD is "The Highways Act 1925 (Bengal Act III of 1925)" whose mandate is to have effective administrative control over Government highways and bridges as well as land within the Right Of Way (ROW) and to facilitate efficient management at the time of maintenance/construction of highways and related structures.

- RHD Road Network

RHD is responsible for the administration of the following classes: National Highways, Regional Highways and Zilla Roads. The present situation of these roads is shown in Table 11.3.1.

Table 11.3.1 Condition of RHD Road Network

Road Class	Total Length (km)	Paved Length (km)	Unpaved Length (km)	Paved Road %
National Highways	3,570	3,485	85	98
Regional Highways	4,323	4,117	206	95
Zilla Roads	13,678	9,719	3,959	71
Total	21,571	17,321	4,250	80

Source: Road Master Plan (2009)

11.3.2 RHD's Organization

The Department is headed by a Chief Engineer who is supported by a number of Additional Chief Engineers (ACEs). The recent structure for RHD consists of five (5) Headquarter Wings / Zones and nine (9) Field Zones, each headed by an Additional Chief Engineer who reports directly to the Chief Engineer. In addition seven ACEs are also in place for the following Projects;

- Joydepro – Mymensing Road Improvement Project (World Bank)
- RNIMP (Road Network Maintenance and Improvement Project)-1 Project (ADB)
- RNIMP-2 project (ADB)
- EBBIP (East Bangladesh Bridges Improvement Project)- (JICA)
- Dhaka - Chittagong 4-laning Project (GoB & JDCF)
- The 3-Bridges (3rd Buriganga, Tista and 2nd Sitalakhya Bridge) Project (KFAED : Kuwait Fund for Arab Economic Development)
- The 3rd Sitalakhya Bridge Project (KFAED)

(1) Organization Chart of RHD

The organization structure of RHD is shown in Figure 11.3.1. This structure involves the formation of two new Head Quarter Wings, namely the "Bridge Management Wing" and the "Management Services Wing". In this structure, "Zonal Operation" means the head quarter of the field office of nine field zones. For instance, RHD local office, Narayanganj (Narayanganj division territory as shown in Figure 11.6.2), is assigned for maintenance of the three project bridges, which belong to the Dhaka Zone. The Training and Bridge Design functions are now located in the Management Services Wing and Bridge Management Wing respectively.

The Technical Service Wing acts as service providers within RHD into a single Wing to provide in-house services where possible, and manage outsourcing of such services when resources are inadequate to meet demand. This Wing ensures best practices in RHD by developing Design and Quality Standards (geometric, pavement, bridge, road safety and quality control) and contributes to environmental improvement, embankment protection, demolition and utilization of RHD land through the effective management of an arboriculture program.

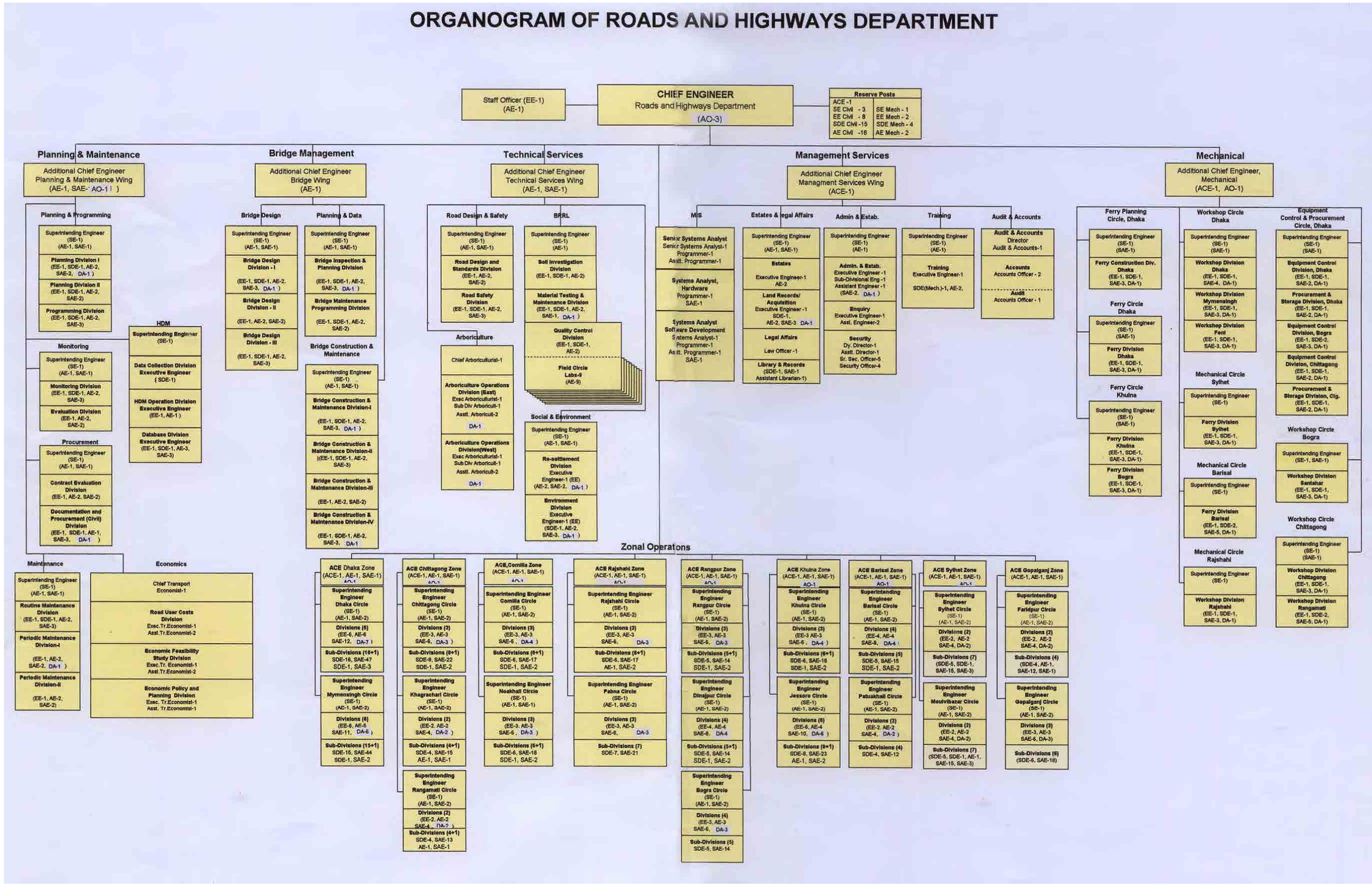


Figure 11.3.1 Organization Chart of RHD

(2) Personnel of RHD

The current sanctioned staff of the Department total 9,366 i.e. 649 Class I, 881 Class II, 4,535 Class III and 3,301 Class IV posts. In addition to this total figure there are currently about 6238 vacant posts all of which except for about 323 are from Class III and Class IV staff. However, these figures for sanctioned staff mask the fact that there are currently about 8,726 temporary (development & deputation, work charged, muster roll and casual staff) employed by the Department giving a total of about 18,092 posts.

Table 11.3.2 Summary of Existing Posts of RHD

(As of July 2011)

Name of the post	Number
Chief Engineer	1
Additional Chief Engineer (Civil)	13
Additional Chief Engineer(Reserved) (Civil)	1
Superintending Engineer Director(SE) (Civil	34
Superintending Engineer (Reserved) (Civil)	3
Executive Engineer (Civil)	99
Executive Engineer(Reserved) (Civil)	8
Sub-Divisional Engineer (Civil)	153
Sub-Divisional Engineer (Reserved) (Civil)	15
Assistant Engineer (Civil)	176
Assistant Engineer (Reserved) (Civil)	16
Class I Civil Engineers	519
Class I Mechanical Engineers	97
Other Class I Specialists	33
Total Class I Posts	649
Total Class II Posts	881
Total Class III Posts	4,535
Total Class IV Posts	3,301
Total Post (All Classes)	9,366

Source: RHD Web site www.rhd.gov.bd

Because of the Government restrictions on recruitment of Class III and Class IV staff as well as the total ban on recruitment of temporary staff, most staff members are now over 40 years of age. Moreover, the intended increase in retirement age from 57 years to 59 years should result in major changes in staff numbers in the next 5-10 years amid other pertinent changes to the existing organization.

(3) Assets of RHD

The RHD under the MoC is assigned for the development and maintenance of the network of the main roads and bridges of Bangladesh. The total value of these assets are conservatively estimated at BDT 460 billion[*]. The total asset value is the largest of any individual organization in Bangladesh. Clearly, maintaining the value of these assets is a fundamental requirement. But the value of these assets will rapidly decrease at a rate of some 8 % per year (Source: RHD Management Systems Users' Guide September 2007). This is based on assumption that the RHD asset value will depreciate at 8 % per year and is expected to be becoming zero after 30 years, if they are not properly maintained. This represents a loss to the Bangladesh economy of BDT 100 million per day (BDT 460000Million x 8 % / 365 = 100.8 million / day).

In reality, the economic loss, for instance, due to increased difficulty in access to health and education facilities, or lost access to local and global markets, is far greater. The performance of RHD in maintaining its assets is therefore vital to the economy and welfare of Bangladesh and hence should be treated as one of the highest priorities of the Government. This places a great responsibility on the MoC and the RHD.

The recent "Maintenance and Rehabilitation Needs Report of 2011–2012 for RHD Paved Roads" prepared by HDM Circle, RHD September, 2011, highlighted that the first year capital demand / km and the overall maintenance needs for National and Regional Highways as well as for Zilla roads increased from that of the previous year's analysis results, indicating some deterioration in overall network condition. According to the above mentioned report, immediate maintenance needs for the year 2011-2012 is BDT 38,511 million.

11.3.3 Overall Management System of RHD

To perform the above mentioned Assets Management effectively, RHD implemented the new "RHD Management System with the assistance of Information and Communication Technology (ICT)"[1], which was set up as part of technical assistance funded by the UK Department For International Development (DFID) from 1994 to 2006 through the Institutional Development Component (IDC) program. This RHD Management Systems consists of the two essential management systems that are in use at the RHD.

[*] These assets amounting to BDT 460 billion derived from RHD Home Page, Overview of RHD

[1] **Government's Policy on ICT**
RHD's management information systems are consistent with the policies of the Government of Bangladesh on Information and Communication Technology (the ICT Policy 2002). The Ministry of Communications has adopted its own internal ICT Policy.
With this policy, the Government of Bangladesh has committed itself to encourage the increasing application of e-governance, as a means to "empower the people and enhance democratic values". "E-governance" is about the use of information technology to raise the quality of the services that government delivers to citizens and businesses. E-governance is intended to strengthen the connection between public officials and civic society, leading to a stronger, more accountable and inclusive democracy.

- Asset management system, called RAMS
- Central monitoring and management system, called CMS

It also describes the process of Financial Management reform, which is centered on the establishment of the RHD Financial Management Unit (FMU). The aim of these management systems is to improve the efficiency and effectiveness with which RHD can deliver its responsibility in managing the network of roads and bridges.

(1) The RHD Road and Bridge Asset Management System (RAMS)

RAMS was designed as a comprehensive annual program of procedures essential for the effective maintenance management of the RHD network. RAMS brings together all of RHD's current databases and analytical procedures. The special feature about RAMS is the RAMS map: a single GIS-based map which combines all relevant information and tells the decision makers where to allocate funds for maintenance and development.

RAMS is based on the RHD GIS-map. It combines information from all RHD's databases and systems, including the Road Maintenance Management System, the Bridge Maintenance Management System and the HDM4 analytical software. The GIS-base map makes the link between the information in all the RHD databases and their geographical location or coordinates. Senior officers of RHD can see all information contained in RHD databases via a GIS-screen on their computer, through an inter-active GIS feature.

(2) The Central Management System CMS for RHD

CMS was designed and implemented starting in 2004, linking for the first time physical and financial reporting, based on "earned value analysis". It aims to improve the accountability and efficiency of all RHD field divisions, by reporting directly on all physical and financial progress. Reports from CMS are accessible to all senior managers of RHD, and are being submitted to the Ministry. Reports from the CMS are publicly accessible through the RHD website.

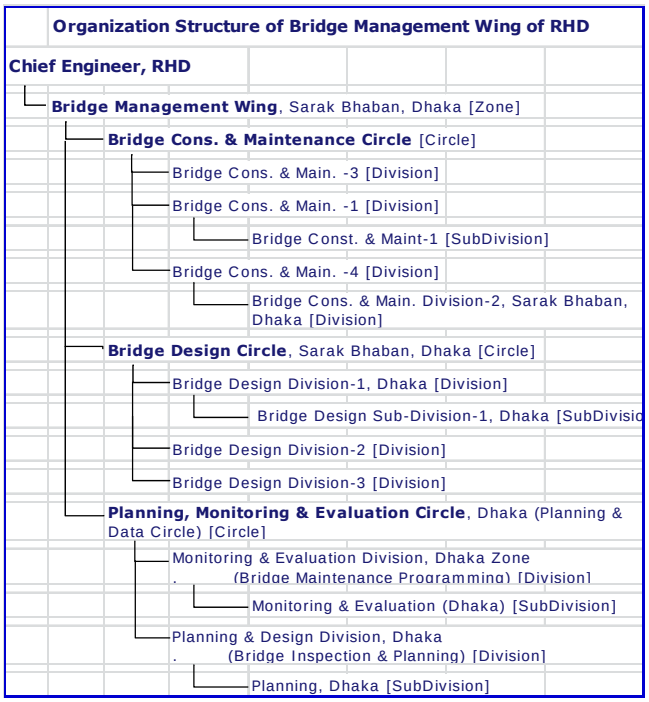
CMS is an advanced management information system being used at RHD headquarters and in all 64 field divisions. CMS is a tool that can assist in the day-to-day management, control and monitoring of the works contracts and projects which RHD is implementing. Using CMS will improve the transparency and accountability in relation to RHD activities and will encourage more discipline in the financial practices and performance of RHD.

11.3.4 RHD's Bridge Management Wing

(1) Organization of Bridge Management Wing

The Bridge Management Wing consists of three sections, each headed by an officer of Superintending Engineer Level. The present total staffing for the Wing is 277 persons comprising 47 Class I officers, 20 Class II officers, 156 Class III and 54 Class IV staff.

Certain officers in the Wing are to be designated as specialists.



Source: RHD Web site: www.rhd.gov.bd

Figure 11.3.2 Organization Chart of Bridge Management Wing of RHD

(2) Bridge Maintenance Management System (BMMS)

The BMMS is an application-based database on the management of information regarding all bridges undertaken by RHD. The Bridge Maintenance Management System is an integral part of the RHD Management Information System as it establishes transparency for all bridge projects handled by RHD. The BMMS application has direct links to all major RHD databases, including the Contract Monitoring System database, Road Maintenance Management System database, and the project monitoring System database. In short, it seems to be a digital version of Bridge Ledger, which records all the data of each bridge and you can browse it easily. Sample data of Meghna Bridge is shown in the Appendix 12. The 2nd bridges and existing bridges of this project will be undertaken by the BMMS for maintenance and management prior to the completion of construction.

11.4 Budgetary Situation of Roads and Bridges Development and Maintenance

11.4.1 Trend of National Budget and Development Revenue

Trend on the National Revenue and Expenditure is shown in the following Table 11.4.1.

Table 11.4.1 Consolidated Receipts and Expenditures of the Government of Bangladesh

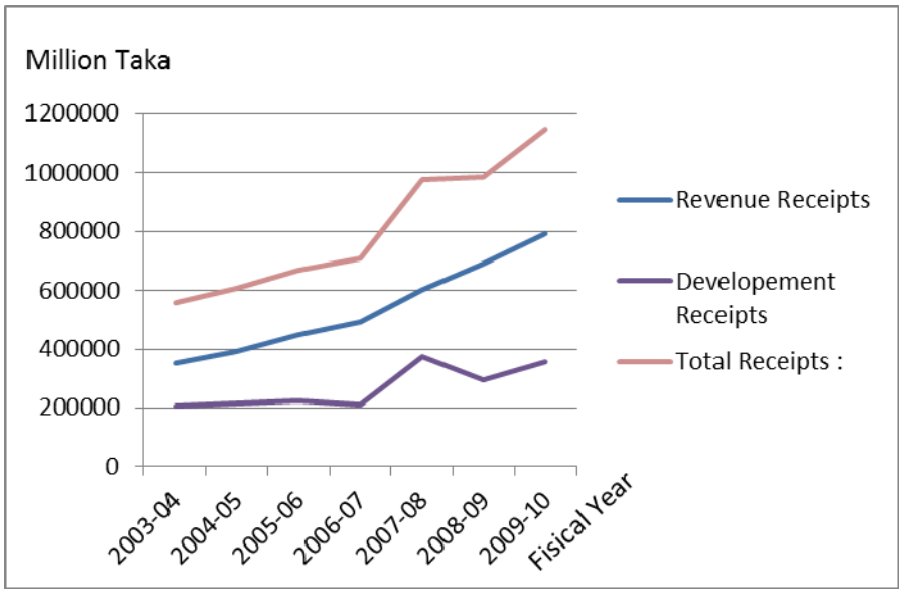
(Million Taka)

Heads	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Revenue Receipts	354000	392000	448680	494720	605390	691800	794840
(a) Tax	283000	319500	361750	392470	480120	555256	639560
(b) Non-Tax	71000	72500	86930	102250	125270	136544	155280
Developement Receipts	206740	216110	222320	212290	373350	293420	355590
(a) Project	74190	66200	74750	85290	94990	111900	124800
(b) Food and Commodities	36650	49210	39570	26690	79130	39540	57540
(c) Internal Resources	95900	100700	108000	100310	199230	141980	173250
Total Receipts :	560740	608110	671000	707010	978740	985220	1150430
Revenue expenditure (gross)	274322	327736	351544	413551	521923	626760	687110
(a) Wages and Salaries	87616	98077	109966	141186	155330	150160	170470
(b) Commodities and Services	41020	52614	51525	54183	82400	91640	96930
(c) Transfer	134211	162342	174369	201190	265686	258890	279320
(d) Other Services	11475	14703	15685	16992	18507	125170	140390
Development Expenditure :	168173	187260	194720	179280	185060	197000	259170
(a)Agriculture, Flood Control, water resources and Rural Institutions	36839	39411	40981	38022	39245	53174	63424
(b) Industry	4615	4812	5004	4579	4725	4125	4428
(c) Transport and Comuniacation	34086	41502	43157	39687	40963	21811	39073
(d) Other Services	92633	101535	105578	96992	100127	117890	152245
Total Expenditure:	442495	514996	546264	592831	706983	823760	946280

Source: Data obtained from RHD

The data from the table above is illustrated in Figure 11.4.1 where it can be seen that for the 6 years since 2003, the National Total Revenue has been increasing every year at an average growth ratio of 12.7 % with the rate of Developments Receipts to the Total Receipts accounting for around 1/3 of the amount.

And the ratio of Non-Tax Revenue to Total Revenue is around 20 % (For example; Year 2009-10, 155,280 / 794,840 = 19.54 % → 20 %), which includes toll fees.



Source: RHD

Figure 11.4.1 Trend of National Revenue Receipts and Developments Receipts

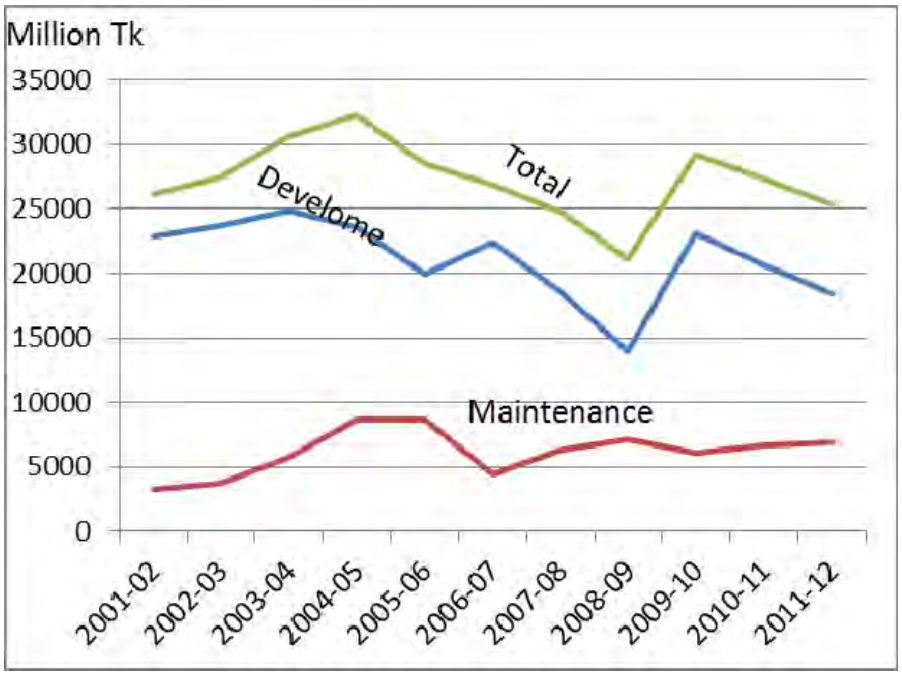
11.4.2 Trend of Development and Maintenance Allocation for RHD Roads and Bridges

The trend of Development and Maintenance Allocation for RHD Roads and bridges is shown in Table 11.4.2.

Table 11.4.2 Development and Maintenance Allocation for RHD Roads and Bridges

Financial Year	Allocation (in Million Taka)		
	Development	Maintenace	Total
2001-02	22828.4	3310.0	26138.4
2002-03	23699.5	3750.0	27449.5
2003-04	24876.8	5766.0	30642.8
2004-05	23613.1	8668.6	32281.7
2005-06	19898.7	8615.5	28514.2
2006-07	22454.4	4379.8	26834.2
2007-08	18522.9	6273.7	24796.6
2008-09	13992.8	7175.1	21167.9
2009-10	23082.1	6100.0	29182.1
2010-11	20636.1	6678.0	27314.1
2011-12	18403.6	6900.0	25303.6

Source : RHD



Source: RHD

Figure 11.4.2 Development and Maintenance Allocation for RHD Roads and Bridges

According to the recent "Maintenance and Rehabilitation Needs Report of 2011–2012 for RHD Paved Roads, prepared by HDM Circle, RHD September, 2011" report, immediate maintenance needs for the year 2011-2012 is BDT 38,511 million. However, the actual budget allocated for maintenance was only BDT 6,900 million, i.e. only 18 % of the necessary amount.

Table 11.4.3 Requested and Allocated Maintenance Budget

Financial Year	Amount (in Million Taka)		Allocated Percentage
	Requested	Allocated	
2009-2010	40,040	6,100	15.2%
2010-2011	47,450	6,678	14.1%
2011-2012	51,000	6,900	13.5%

Source: RHD

Table 11.4.3 shows that there still remain significant discrepancies between requested and actual allocated budgets year by year.

11.4.3 Toll collection Data on the Meghna and Gumti Bridges in NH-1

The record of "Toll collection Data from the Contractor on the Meghna and Gumti rivers in the Dhaka–Chittagong National Highway No.1" is shown in Table 11.4.4. And the yearly total of the collected amount is also shown in Figure 11.4.3.

Table 11.4.4 Toll Collection Data on the Meghna and Gumti Rivers

					Million Taka
Name of Months	2007	2008	2009	2010	2011
January	72.976	106.828	112.509	121.455	124.868
February	81.263	100.912	104.973	107.541	111.458
March	95.877	109.319	114.459	120.651	125.125
April	92.151	104.478	112.458	113.147	116.863
May	98.258	93.774	116.627	117.061	120.37
June	92.663	81.553	113.761	112.705	111.194
July	95.857	107.008	114.546	115.69	109.693
August	92.462	104.583	111.872	113.31	112.238
September	93.369	102.498	104.203	105.943	103.92
October	95.203	98.525	126.205	126.628	126.861
November	96.659	80.668	122.296	119.918	120.153
December	101.977	101.413	127.544	127.445	127.665
Total	1108.715	1191.559	1381.453	1401.494	1410.408

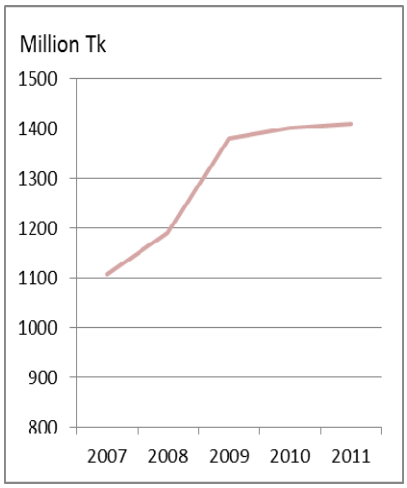


Figure 11.4.3 Yearly Total Amount

From the trend, it can be seen that from 2007 until 2009 the yearly total amount increased more than 10 % annually but from 2009 the trend decelerated and remained steady.

The toll amount of BDT1.4 billion generated annually from the Meghna and Gumti bridges in the Dhaka – Chittagong National Highway No.1 is according to the Constitution and General Financial rules, incorporated into the National treasury. The text of the relevant legislations respectively is shown below;

(1) The Constitution of the People's Republic of Bangladesh

PART V THE LEGISLATURE, CHAPTER II LEGISLATIVE AND FINANCIAL PROCEDURES

Consolidated Fund and the Public Account of the Republic;

84. (1) All revenues received by the Government, all loans raised by the Government, and all moneys received by it in repayment of any loan, shall form part of one fund to be known as the Consolidated Fund.

(2) All other public moneys received by or on behalf of the Government shall be credited to the Public Account of the Republic.

(2) General Finance rules

Chapter 3- Revenue and Receipts, I General,

26. Subject to any special arrangement that may be authorized by competent authority with respect to any particular class of receipts, it is the duty of the departmental Controlling officer to see that all sums due to Government are regularly and promptly assessed, realized and duly credited in the Public Account. They should accordingly arrange to obtain from their subordinates monthly accounts and returns in suitable form claiming credit for so much paid into the treasury or otherwise accounted for and compare them with the statements of treasury credits furnished by the Accountant General to see that the amounts reported as collected have been credited in the Public Account.

If wrong credits thus come to the notice of the Controlling officer, he should at once inform the Accountant General with a view to the correction of the accounts. If any credits are claimed but not found in the accounts, enquires should be made first of the responsible department officer concerned.

11.4.4 Conclusion of this Section

- Maintenance budgets are significantly insufficient.
- There is toll revenue of BDT1.4 billion/year.
- The toll revenue has been incorporated into the National Treasury, as the General Fund and not to be used as a Specific Fund for Bridges and Roads maintenance.
- If this toll revenue is particularized as a Specific Fund for Bridges and Road Maintenance, this revenue can substantially cover the necessary maintenance costs of bridges and roads as well as amortizing future rebuilding expenses.
- The JICA study team recommends that this toll revenue should be particularized as a special fund for road and bridges maintenance.

11.5 Operation and Maintenance Plan

11.5.1 Budget Allocation System

In order to understand the budget allocation system generally practiced by RHD, a flow diagram is schematically shown Figure 11.5.1. At first, RHD local offices send their budget demand to the Chief Engineer's office of the RHD Head Quarters. Their budget demand is determined based on their current road condition survey data. The need assessment of each fiscal year for maintenance work on roads & bridges is conducted by HDM circle under the Planning and Maintenance Wing, RHD Head Quarter.

After verification, the requirements are finalized and sent to the Ministry of Finance through the MoC. Then, the Ministry of Finance allocates the budget which seems to be insufficient compared to the requirements.

Consequently, the RHD Chief Engineer allocates the maintenance budget to the RHD local office through two categories, namely Routine and Periodic Maintenance budgets. The routine maintenance budget is allocated based on the amount requested by the local office. On the other hand, the periodic maintenance budget allocation is decided by the Chief Engineer in accordance with the priority decided by HDM circle. The RHD local offices also establish their maintenance program on the basis of the Chief Engineer's allocated amount.

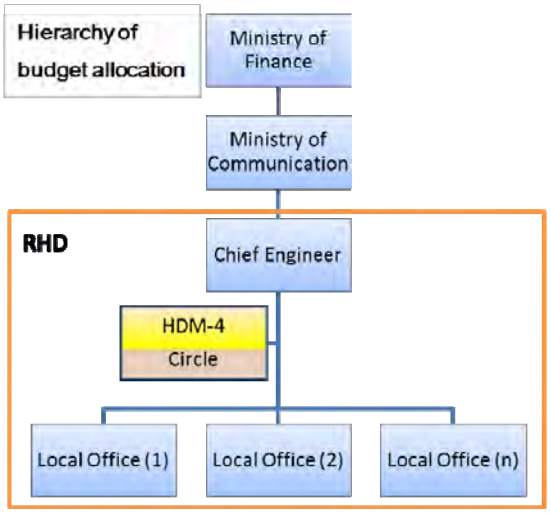


Figure 11.5.1 Budget Allocation System

11.5.2 Specific Sections of RHD and Other Relevant Organizations

The Narayanganj local office under RHD Dhaka Zone will be in charge of routine and periodic maintenance on Kanchpur Bridge, Meghna and Gumti Bridges of Dhaka-Chittagong Highway including toll plazas and river facilities.

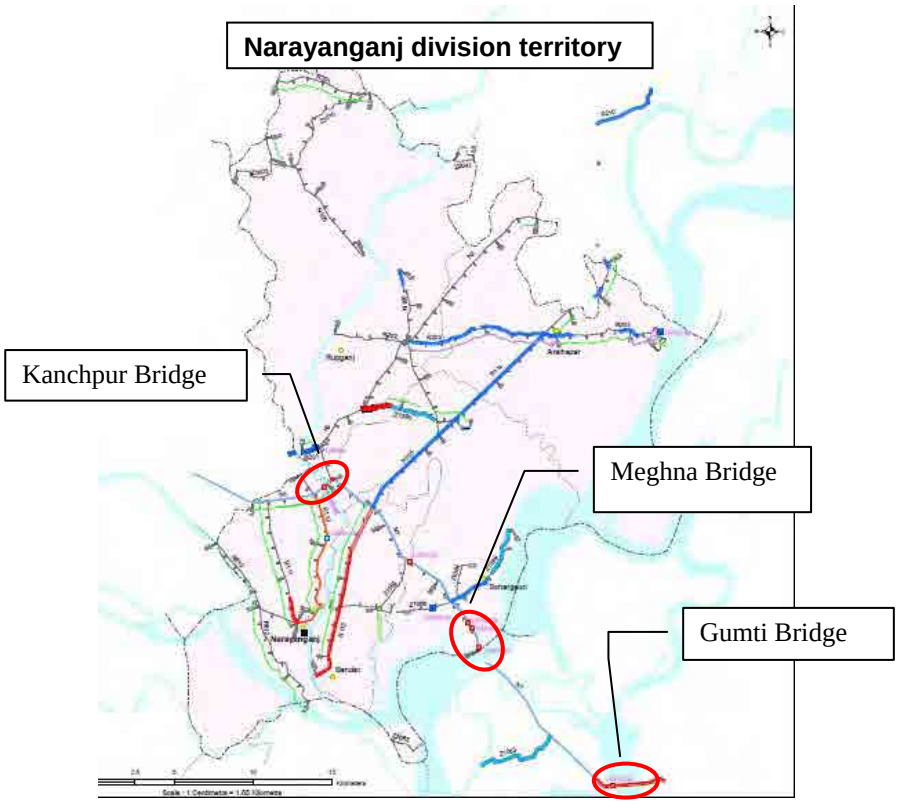


Figure 11.5.2 Narayanganj Division Territory

- RHD is currently responsible for the National Highway including, NH-1: Dhaka-Comilla- Chittagong Highway.
- RHD will be in charge of the roads branching from the Highway under Dhaka district.
- The Local Government Engineering Department (LGED) will be responsible for local roads mentioned as “classified rural roads” and “other rural roads” in Table 11.1.1, namely , all the rest except for RHD own roads.

The scope of operation and maintenance works for the 2nd bridges project on Dhaka-Chittagong Highway is broadly divided into the following three major components;

- Routine and periodic road maintenance
- Traffic Management
- Toll Collection of the Second Meghna and Gumti Bridges

11.5.3 Inspection and maintenance system

(1) Purpose of inspection and maintenance

1) Inspection

- To determine the damages in the bridge
- To identify the location of damages and their deterioration level, urgency for repairing

2) Maintenance

- To secure traffic safety and monitor the bridge health condition under current traffic loading.

(2) Type of inspection

- The type of bridge inspection shall be divided into follows:

Table 11.5.1 Types of Inspections

	Interval	Method	Equipment
Daily inspection	1/day	On board visual	Patrol vehicle and binoculars
Periodic inspection	1/year	distant visual inspection	Outside road or inspection way or boat and by bridge inspection car in case of need
Detailed inspection	1/ 5 year	Short distance visual or hammering	Bridge inspection car or temporary scaffoldings
Unscheduled inspection	As needed	Test sampling or attach equipment	Bridge inspection vehicle or temporary scaffolding

1) Daily inspection (once a day)

In order to get to know the current situation of the structures, the daily visual inspection should be conducted by the inspection vehicle. The structural components supposed to be inspected should be visible from the car.

Furthermore, in order to grasp the situation of any deformation of the structure, the daily visual inspection should be undertaken to verify the functional status of the structure. This can be conducted by simple diagnosis of the results obtained from field observation.

2) Periodic inspection (once a year)

In order to grasp the overall status of the structure, a distant visual inspection should be undertaken from the outside road or from the inspection way or from a boat. The purpose of such inspection is to check the status of aging. If damages are found, a short distant visual inspection will be conducted by means of Bridge Inspection Vehicle (BIV).

3) Detailed inspection (once in 5 years)

Generally a detailed diagnosis is necessary in order to grasp the damage on the structure. It can be conducted from a short distant visual inspection by means of BIV or preparing temporary scaffolding.

4) Special inspection (if necessary)

Beyond the daily inspection, sometimes an additional inspection is necessary if any structural damage is suspected to be caused by severe weathering action. In that case, the BIV or temporary scaffolding should be used, if it seems to be necessary.

(3) Inspection and maintenance plan

1) Road patrol

The party to be formed for road patrol consists of 3 members. The road patrol must be conducted 24 hours a day considering with the traffic issue.

Table 11.5.2 Shift of 5 Parties for 24 hr. Operation

Party	8-16	16-24	24-8	8-16	16-24	24-8	8-16	16-24	24-8
1	Patrol								
2		Patrol							
3			patrol						
4	Inspection								
5	absence								

Source: JICA study team

2) Periodic inspection

The periodic inspection should be conducted once a year. Accordingly, another team will be in charge of the periodic inspection and the detailed inspection as well.

Table 11.5.3 Periodic Inspection

Month/ methods	1		2	
Inspection access way				
Outside of road				
Bridge inspection vehicle				

Source: JICA study team

3) Detailed inspection

The detailed inspection should be conducted by means BIV. The interval of the inspection is set at every 5 years. If the inspection speed is set at 2 spans / day, it will take 30 days just for the actual inspection because there are altogether 60 spans of the existing and the 2nd bridges to be inspected. Furthermore, prior to initiating inspection works, several field works such as

traffic control, preparation and arrangement of transportation are needed. Therefore, almost two months are needed to conduct the entire detailed inspection.

Table 11.5.4 Detailed Inspection

Month	1		2
Inspection	Kanchpur	Meghna	Gumti
Bridge inspection vehicle			

Source: JICA study team

4) Maintenance work

The inspection party will be directly in charge for maintenance work to fix the potholes or sealing damages and others. In case of maintenance work under or on the side of the bridge, the bridge inspection vehicle can be used for setting scaffoldings for the repairing works.

Table 11.5.5 Annual Plan (in case of detailed inspection)

	1	2	3	4	5	6	7	8	9	10	11	12
Road patrol												
Periodic inspection												
Detailed inspection												
Maintenance work												
Bridge inspection vehicle												

Source: JICA study team

(4) Bridge Inspection Vehicle

The purpose of bridge inspection vehicle is listed as follows;

1) Safety

The bridge inspection vehicle is set on the stable and stiff bridge road surface. The stability is secured by using an outrigger.

2) Approach

The reach of the bridge inspection vehicle should be wide and also easily cover the space between the girders. The detailed inspection or the special inspection should be carried out by a short distance visual inspection or a touch treatment. Approach devices such as scaffoldings or bridge inspection vehicle will be necessary.

3) Usefulness

The bridge inspection vehicle should be used for detailed inspection or special inspections and also for the maintenance works to be conducted by preparing scaffoldings.

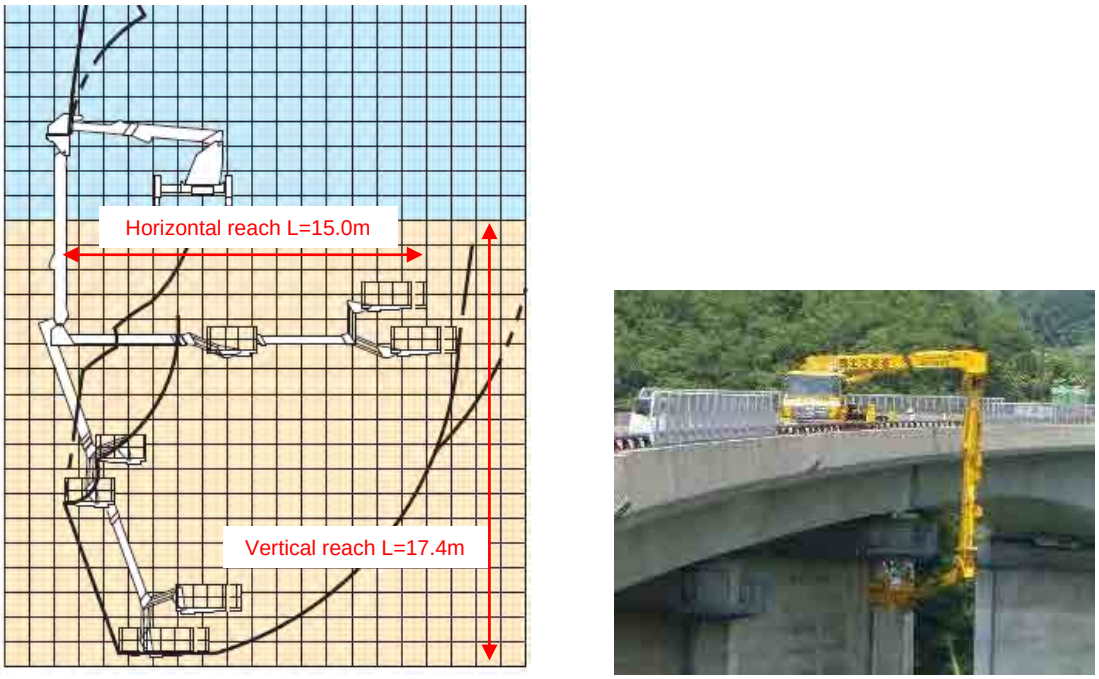


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Figure 11.5.3 Bridge Inspection Vehicle

(5) Need of bridge inspection vehicle

The maintenance works on the bridges are part of operation and management. The inspection works are also deviated from the daily patrol as it is special.

The bridge inspection vehicle is useful for inspections and the maintenance works, which should cover almost 100 % of the bridge surface. The bridge inspection vehicle helps to keep the inspection and the maintenance of the bridges safer, smoother and faster.

11.5.4 Incidental Maintenance

Incidental maintenance is basically the work to be carried out to restore the project road and the related facilities to their normal operating conditions after they are damaged by road accidents or natural causes.

11.5.5 Maintenance Operation by Outsourcing

Maintenance works except for inspections are usually executed by an O & M (Operation & Maintenance) Operator (Private Companies) under the supervision of the operation office, and include:

- Clearing of pavement
- Mowing and maintenance of plantations
- Clearing of ditches and culverts
- Pavement repairs e.g. patching and resurfacing
- Repair of sealant and expansion joints of bridges and viaducts
- Repair of damaged paint work on steel bridges and repainting as necessary
- Repair and maintenance of traffic control devices, including signs and traffic signals
- Repair and maintenance of lighting
- Repair of cut and fill slopes
- Repair of damage to road facilities caused by traffic accidents
- Improvement and maintenance works including pavement markings, pavement overlay, widening, etc.

11.5.6 Existing Sample of Maintenance Cost and Future Necessity

According to the information from the Narayanganj RHD office, the types of maintenance of the targeted three bridges are as follows;

- Routine maintenance

The Meghna and Gumti Bridges are operated by a private organization (O&M operator). This O&M operator is responsible for toll collection as well as for bridge cleaning and very minor repairs. However, Kanchpur Bridge is maintained by RHD's local office which visits the bridge site frequently and maintains the bridge approach road and other parts as necessary.

- Periodic maintenance

After construction, the expansion joints of Meghna and Gumti Bridges were firstly replaced in 2008 at a cost of BDT 30 million. A major maintenance exercise has already been undertaken to replace the expansion joints and repair the central hinges of Meghna and Gumti bridges.

There is also another evidence on-going major repairing works of Meghna and Gumti Bridges, which includes the replacement of the expansion joints and hinge bearings as well as scour protection of piers and the riverbed. The initial estimated cost of BDT 1.50 billion may change (Source: RHD and Financial Express 11th May 2012).

◆ The Budget for regional Narayanganj Office

The regional RHD office budget for Narayanganj is shown in the following table.

Table 11.5.6 Development and Maintenance Allocation for Narayanganj RHD

Fiscal year	Allocation (in hundred thousand Taka)		
	Development	Maintenance	Total
2001-02	3,068.33	405.00	3,473.33
2002-03	2,692.75	748.98	3,441.73
2003-04	6,320.00	991.20	7,311.20
2004-05	6,358.00	4,286.21	10,644.21
2005-06	4,628.00	3,902.98	8,530.98
2006-07	3,671.20	301.45	3,972.65
2007-08	2,434.40	1,398.22	3,832.62
2008-09	2,827.20	2,226.09	5,053.29
2009-10	3,915.90	3,651.67	7,567.57
2010-11	1,727.00	2,206.96	3,933.96
2011-12	2,461.11	1,797.53	4,258.64

Source: RHD, Narayanganj

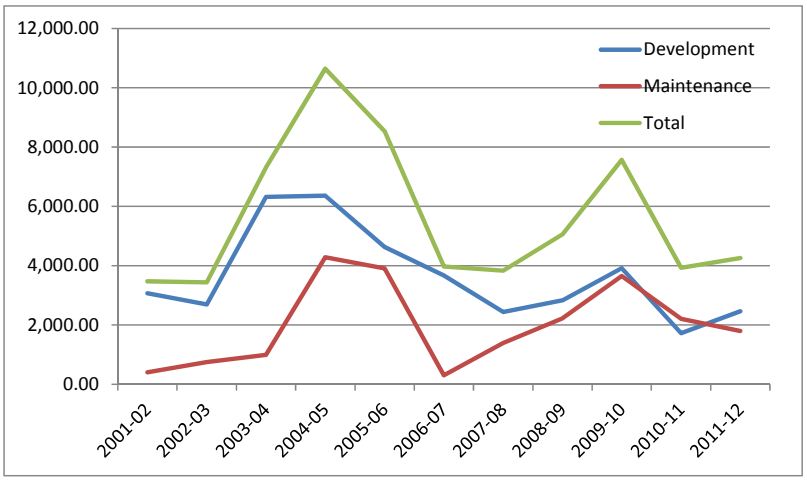


Figure 11.5.4 Development and Maintenance Allocation for Narayanganj RHD

According this table, the average allocated maintenance cost of these five years for maintenance is around BDT 202.56 million / year. Since the Narayanganj office's section covers 230 km the allocated maintenance budget per km translates to BDT 0.98 million / km.

Table 11.5.7 originating from the "Road Master Plan (2009)" Section 11.5.3 indicates unit rates which are used for cost estimation.

Table 11.5.7 Unit Rates for Cost Estimates

Works Required	Cost per km BDT Lakhs
Periodic Maintenance	35
Rehabilitation IRI 8-10	40
Rehabilitation IRI >10	60
New Construction – Hilly	120
New Construction – Plain	130
New Construction - Swampy	250

New Construction rates apply to the paving of unpaved roads
Lakhs = 100 thousands
Source: Road Master Plan (2009)

Using this unit cost per km, the Narayanganj office's required budget is estimated as follows;

Periodic Maintenance cost needs to be allocated for RHD, Narayanganj office:

BDT 35 Lakhs / km x 2 30 km = BDT 8,050 Lakhs ⇒BDT 805 million

Compared to the latter (BDT 805 million), the former allocation of BDT 179.7 million is only 22.4 % of the required amount. This proves an index of insufficiency of the maintenance budget allocation for Narayanganj office.

Table 11.5.8 List of Active Equipment Available at RHD, Narayanganj Office

List of active equipment available at RHD, Narayanganj office			
Sl. No.	Name of equipment	Model No.	Total No.
1	Vibro-Mex soil compactor	001	1
2	Vibro-Mex soil compactor	003	1
3	Vibro-Mex soil compactor	0055	1
4	Isuzu Raker machine	001	1
5	Komatsu bulldozer	001	1
6	Kurukawa pay loader	230	1
7	Mitsubishi Truck	0698	1
8	Spot bitumen mixture machine	-	1
9	J.M. road roller	141	1
10	J.M. road roller	114	1
11	J.M. road roller	013	1
12	J.M. road roller	01	1
13	J.M. road roller	02	1
14	J.M. road roller	677	1
Total			**14**

Source: RHD, Narayanganj office

The equipments listed in Table 11.5.8 are available at RHD, Narayanganj office, which are not sufficient for bridge maintenance. If the RHD office intends to maintain 2nd bridges by

itself, the RHD needs to procure appropriate equipments. However, the equipments available at RHD Narayanganj office can be used only for emergency works like disaster prevention.

- Existing Contract Sample for Operation & Maintenance

In accordance with the contract manual of "Toll Collection Operation and Maintenance of Meghna and Gumti Bridges and associated works in the Meghna and Gumti area", toll Collection Operation and Maintenance of Meghna and Gumti Bridges are estimated below for 5 years.

Table 11.5.9 Toll Collection Operation and Maintenance of Meghna and Gumti Bridges

Bill No.	Description	Amount (in Taka)
A	Toll Collection Operation and Maintenance of Meghna and Meghna-Gomti Bridges	
A1	Manpower Cost	54,000,000
A2	Operation and Maintenance Cost	38,140,000
	Sub-total: (A1+A2)	92,140,000

Source: RHD Narayanganj Office

This indicates the cost for Toll collection and Maintenance of Meghna and Gumti Bridges is around BDT 20 million / year.

◆ Rough estimate of maintenance cost for 2nd bridges and retrofitted bridges

The maintenance cost for 2nd bridges and retrofitted bridges will depend on the type of 2nd bridges and retrofit methods. Table 11.5.10 provides an estimate of the operation and maintenance cost for three 2nd bridges (Steel narrow box girder) and three existing bridges (PC box girder).

Table 11.5.10 Operations and Maintenance Cost Estimation (million BDT)

Items	Interval	Kanchpur Bridge	Meghna Bridge	Gumti Bridge	Total
Routine maintenance					
Routine inspection/ maintenance	Every day	2.8 / year	6.5 / year	9.8 / year	19.1 / year
Periodic maintenance (approach road)					
Pavement	20 years	214.2	214.2	316.2	744.6
Axle load scale	20 years	41.4	40.0	40.0	121.4
Weighbridge	20 years	20.7	20.0	20.0	60.7
2nd Bridge					
Periodic inspection	5 years	14.0	32.7	49.6	96.3
Repainting	20 years	109	264	414	787
Expansion joint	20 years	26.4	27.7	40.7	94.8
Pavement	10 years	64.0	134.5	204.0	402.5
Existing Bridge					
Periodic inspection	5 years	14.0	32.7	49.6	96.3
Carbonation	30 years	5.0	16.9	26.6	48.5
Expansion joint	20 years	41.3	16.9	22.3	80.5
Pavement repair	10 years	49.3	65.0	98.5	212.8
Toll booth operation cost					
Toll operation (cost increases gradually from first year)	Every year		23.0～28.0*	23.0～28.0*	46.0～56.0*
Traffic control cost					
Axle load scale / Weighbridge	Every day	10.6 / year	10.6 / year	10.6 / year	31.8 / year
Maintenance cost					
Bridge inspection vehicle	Every year	4.0			4.0

Source: JICA study team

Note: * Yearly toll operation cost gradually increases to maximum. The reason behind it is the increasing trend of traffic volume. The increase in traffic volume is directly interrelated with the toll gate management i.e. the number of staffs to be employed for traffic management at toll booths and also their administration.

- Necessity of import materials for bridge maintenance.

A few materials such as special expansion joints and axel load weighing equipment need to be procured from foreign countries. But, RHD could manage to procure those materials and undertake the maintenance of three bridges this time by itself. And for this, of course, RHD needs proper maintenance funding.

- Necessity of special training or method for the bridge maintenance.

In case of any special technical necessity in the bridge maintenance, a maintenance manual should be prepared for RHD to follow.

11.5.7 Traffic Management

Traffic management includes traffic control, removal of broken down and accident affected vehicles as well as furnishing users with expressway and traffic information.

Highway patrols will be conducted to identify damage to road facilities, traffic accidents, illegal parking, broken down vehicles and other extraordinary conditions which affect traffic safety. Information and reports will be relayed to the operation office through radio communication equipment in the patrol cars.

Services such as emergency rescue, emergency treatment of traffic accident victims and towing of broken down cars will be provided.

Traffic control includes general control for speed and overloading, and control of traffic and emergency lane use under unusual conditions such as traffic accidents, adverse weather and operation of maintenance works. Control of speed and prohibition of illegally overloaded trucks will be executed at entry weighing ramps.

11.5.8 Toll Collection

(1) Present toll system

- Number of toll gates: 58 in bridge sections and 3 in roads in the whole of RHD managed Roads. (Tolled roads: No. 302 Tongi-Asulia Bipal road, N2 Dhaka–Sylhet, N507 Hatikumrul-Bonpara link)

- Toll gate operation

The RHD is mainly responsible for toll collection. Basically, the RHD contracts with a private O &M operator to collect RHD’s Roads / Bridges tolls.

Table 11.5.11 Proposed Toll Rate of Meghna Bridge and Gumti Bridge

Unit: BDT

Division	Bridge	Bridge length (meter)	Types of vehicles												
			Trailer	Large Truck	Medium Truck	Large Bus	Light Truck	Minibus	Micro-bus	Utility	Jeep /Car	Tempo	Baby-taxi	Motor cycle	Rickshaw Van
Narayanganj	Meghna Bridge / Gumti Bridge	930 / 1410	1,000	400	400	400	400	150	70	50*	50	20	20	10	0

Source: RHD (dated: 20th July 2011)
Note: *Toll rate is proposed for utility cars. In accordance with RHD toll rate prescribed for Meghna / Gumti bridges, the present toll rate for each vehicle is adequate except utility cars. This is because the utility cars are generally used for Government officials or emergency repairing/rescue purpose and they need not to pay any toll fee. Moreover, the utility car needs to pay a certain toll fee of BDT 50 in future, which should be the same as that of Jeep / Car and a proposal by JICA study team.

(2) Toll Operation Plan

Toll collection system for the 2nd Meghna and 2nd Gumti Bridges will replace the existing toll plaza closed system with a barrier type toll collection. Totaling and auditing of collected tolls and recording of traffic data shall also be carried out. The necessity for extension of the toll plaza will be reviewed based on traffic data collection after the simultaneous operation with the replaced toll facilities. Data to be collected will be forwarded to RHD for coordination of the overall toll bridge system.

11.5.9 Issues Related to the Maintenance

In view of the foregoing, the following two main points concerning the maintenance are raised:

- Since the RHD is responsible to maintain the present road network of about 21,571 km, the RHD should secure sufficient budget for adequate maintenance works.
- The RHD should attain sufficient experience for proper maintenance of bridges & roads and also it should be well organized to manage them.

11.6 Recommendations for Effective Operation and Maintenances

An adequate and efficient transport system is a prerequisite condition for initiating and sustaining economic development. Transport efficiency is the key to the expansion and integration of markets – sub-national, national and international. It also helps the generation of economies of scale, increased competition, reduced cost, systematic urbanization, export-led faster growth and a larger share of international trade.

11.6.1 Stable Financing for Roads and Bridges Maintenance

As is discussed earlier, the national budget allocation is insufficient for road and bridges maintenance. Therefore, it is necessary to create a stable financing source. In accordance with the Road Master Plan (2009), the stable funding for Maintenance is accommodated as described below:

17.4.1. Road Fund
Funding for road and bridge maintenance should come from the Road Fund. Draft legislation for the Road Fund also provides powers for the fund to pay for road safety measures. Full funding for road and bridge maintenance should be provided by the Government of Bangladesh until the matter of the Road fund establishment is finalized.

The Consultant also strongly recommends establishing the Road Fund*. Vehicle Registration tax, additional earmarked tax on fuel and existing toll revenue can be considered as contributions to this Fund.

* The Cabinet of GoB approved, in principle, the draft of Road Fund Act in October, 2012. It is expected that the draft act will be sent to the Parliament for its consideration. Once it is turned into law, the Government needs to provide necessary administrative and financial support to put the Road Fund Board into operation.

*Japan has long experience with this funding system, which is included in the Appendix 12 as "Japanese Experience on road improvement". This can be taken as a reference for implementation.

11.6.2 Prohibition and Control of Overloaded Vehicles

- Overloaded vehicles inflict significant damage on roads and bridges. It is therefore imperative to prevent from damaging roads and bridges by strict control of overloading of trucks.

- In accordance with the Road Master Plan (2009), actions required to prevent from overloading vehicles are as follows;

Actions Required
The following actions are required to underpin axle-load control:
· A ban on the import of 2 axle trucks with gross weight over 6 tons
· Enhanced enforcement
· Placing the Highway Police under RHD
· Issuing penalty tickets for overloading
· Direct charging using toll mechanism
· Fines and tolls should be more than the benefit of overloading
· Allowing a small margin of overloading (say, 0.5 tons)

Enforcing the same actions proposed in the Road Master Plan for the National Road Network is also recommended.

Recently, RHD has installed two weighbridge stations at Meghna and Gumti Bridge sites in order to regulate heavy loaded truck movement over these existing bridges. Some records of vehicular axle load randomly measured by the weighbridge stations have been collected, which are attached in the Appendix 10. This record shows that some of the trucks were loaded with a heavy weight of 60 tf (axle load). Although those trucks are forced to go outbound from the toll gate, it is suspected that previously some of heavy loaded trucks/trailers passed over the existing bridges when the weighbridge station was not installed.

On the other hand, the government has sought the help of the armed forces for rehabilitation and supervision work on the vulnerable Meghna Bridge for continuation of traffic movement on the country's busiest highway. The Government also restricted the movement of vehicles on the bridge, diverting overloaded vehicles to cross the river on a ferry in February 2012. (Source: Financial Express, as of May 11, 2012)

- Proposal for the bridges specified in this project.

To protect a road network from being damaged by overloaded vehicles requires not only the overall actions mentioned in the “Road Master Plan”, but also establishing the essential monitoring or detecting facility network. As a part of the monitoring facility network, both ends of the bridge are effective points to detect and seize overloaded vehicles.

In order to avoid unexpected deterioration in the NH-1 by overloaded vehicles, it is highly recommended to install weight scale instruments at each bridge sites.

The recommended proposals are as follows;

(1) Bangladesh Road Transport Authority (BRTA) has a regulation on axle weight and vehicle weight. On the other hand, bridge is designed based on axle weight and vehicle weight. Accordingly, both of weights need to be controlled. Therefore, axle weight scale and weighbridge should be installed to regulate overloaded trucks.

(2) Establishment of 2 axle weight scales in each lanes* in front of toll gate to check the overloaded trucks before passing the bridges.

(3) Measurement of the weight of any suspicious large vehicles, induced to these lane with axle weight scale. The overloaded vehicles considering axle load shall be warned by alarm and signal.

(4) The axle load of overloaded vehicle shall be measured by weighbridge to be installed beside the toll gate and scaled the entire vehicle weight.

(5) Enforcement of overloaded vehicles not to pass over the bridge and re-directing through the exit lane.

(6) Since the cost of establishing one axle weight scale is around BDT 20.0 million and that of one weighbridge is around BDT 20.0 million, therefore our proposal of 6 axle weight scales and 3 weighbridges would cost BDT 180.0 million in total.

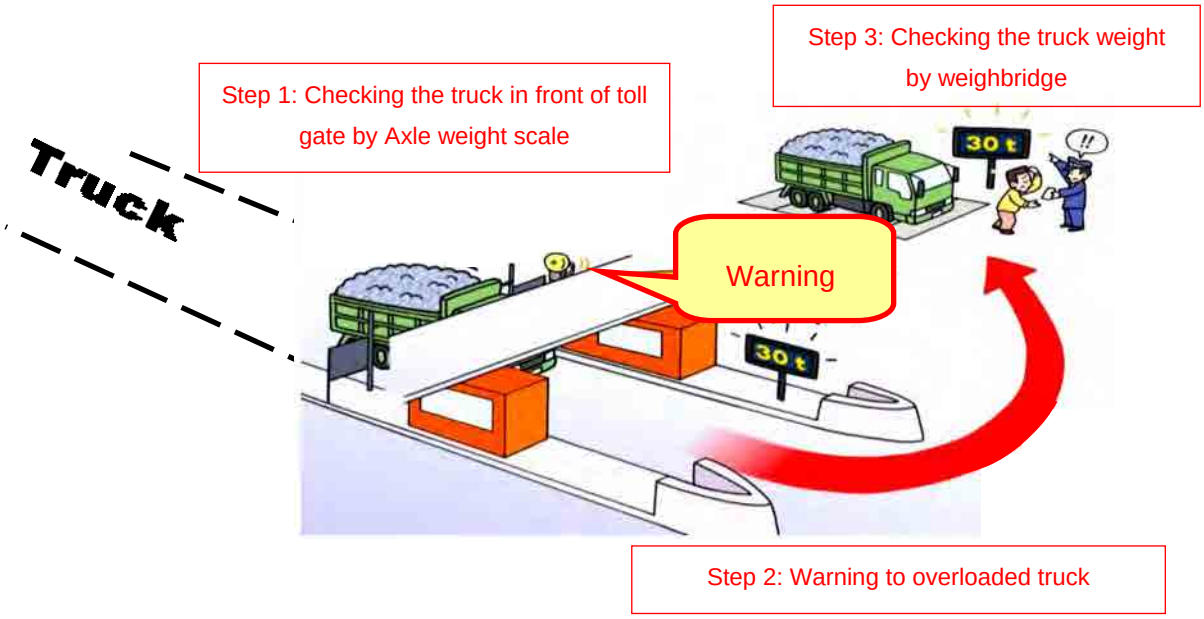


Figure 11.6.1 Image of Enforcement Step

* The basis for axle weight scale to be installed is as follows;

Traffic Volume		Large Truck	Total No
Saturation Traffic Volume (No./day)	Year 2024	6,904	53,071
Saturation Traffic Volume at Peak (No./hour)	Year 2024	469	3,604

Passing toll gate time (Weighing time)	sec/No	No / hour
One truck passing time	8	450

would

Necessary Lane Numbers		Necessary Lane Number	
Necessary No. to be checked in Year (2024)	469/450	=1. 04	⇒ **2** (per each direction)

Note: 8 seconds is allocated for passing toll gate, which is referred to Nippon Expressway Company standards in case of fixed toll fee.

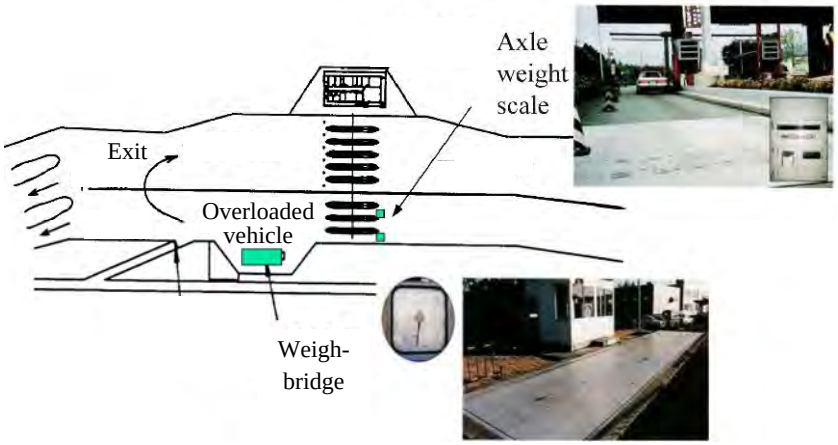


Figure 11.6.2 Location and Number of Installation

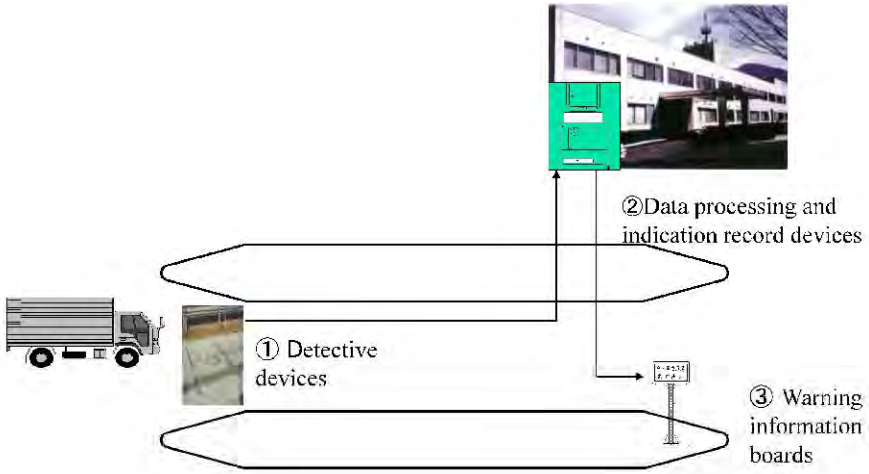


Figure 11.6.3 System Component of Axle Weight Scale

CHAPTER 12

PROJECT IMPLEMENTATION ARRANGEMENTS

12. PROJECT IMPLEMENTATION ARRANGEMENTS

12.1 Implementation Plan

12.1.1 Establishment of the Implementation Plan

The implementation plan is established indicating the months/years for the milestones of key events presuming the commencement of works in August 2016 upon conclusion of the Exchange of Notes (E/N) and the Loan Agreements (L/A) between the GoB and the GoJ early in 2013. Accordingly, the implementation plan shall be renewed if this assumption is changed. The key sequences of civil works are controlled taking the seasonal conditions into account including the timing for the commencement of foundation works in the river in October to make use of the low water level period for the each of the rivers. It is also taken into account that the rehabilitation of all existing bridges (except the foundations and substructures) should be started after the new bridges are completed in the construction sequence since the repair of bridge girders should be commenced after existing traffic is switched toward the new bridges to secure free loading condition for the works.

(1) Milestones for Key Events

The implementation plan includes the stages of detailed design, preconstruction and construction for three bridges together with rehabilitation of the existing bridges. The construction period is already analyzed in Chapter 10 with the ranges predicted from 4.5 to 5.0 years for each of the bridges.

Assuming that International Competitive Bidding (ICB) is applied to procurement of a contractor for the Project, the time required for procurement is based on the procedures for a financing scheme of Japanese ODA loan. The milestones for the implementation of the project undertaken by Japanese ODA are defined as follows;

- E/N for the implementation of the project is to be concluded by the end of January 2013 and L/A is to be concluded soon after E/N.
- Assumed 10 months for selection of D/D, Tender Assistance and Supervision consultant period.
- The period of Review of F/S and D/D works including topography, geological survey and preparation of tender documents is 12 months period.
- Assumed 18 months for procurement of contractor period.
- The construction of 3 bridges together with rehabilitation of 3 existing bridges is to be simultaneously commenced in August 2016 period.
- Overall construction and rehabilitation is to be completed by the end of July 2021.
- The defect liability period is 24 months after completion of each work component and final defect liability period is to be completed in July 2023.

To summarize, the total implementation schedule will begin with L/A in March 2013 and the construction will be completed in July 2021 as detailed in Figure 12.1.1.

In addition, as the detailed design of new bridges and the approach road shall be undertaken within the ROW defined in the JICA Study, therefore, RHD will be able to proceed with the compensation for affected households and obstacles soon after the Study.

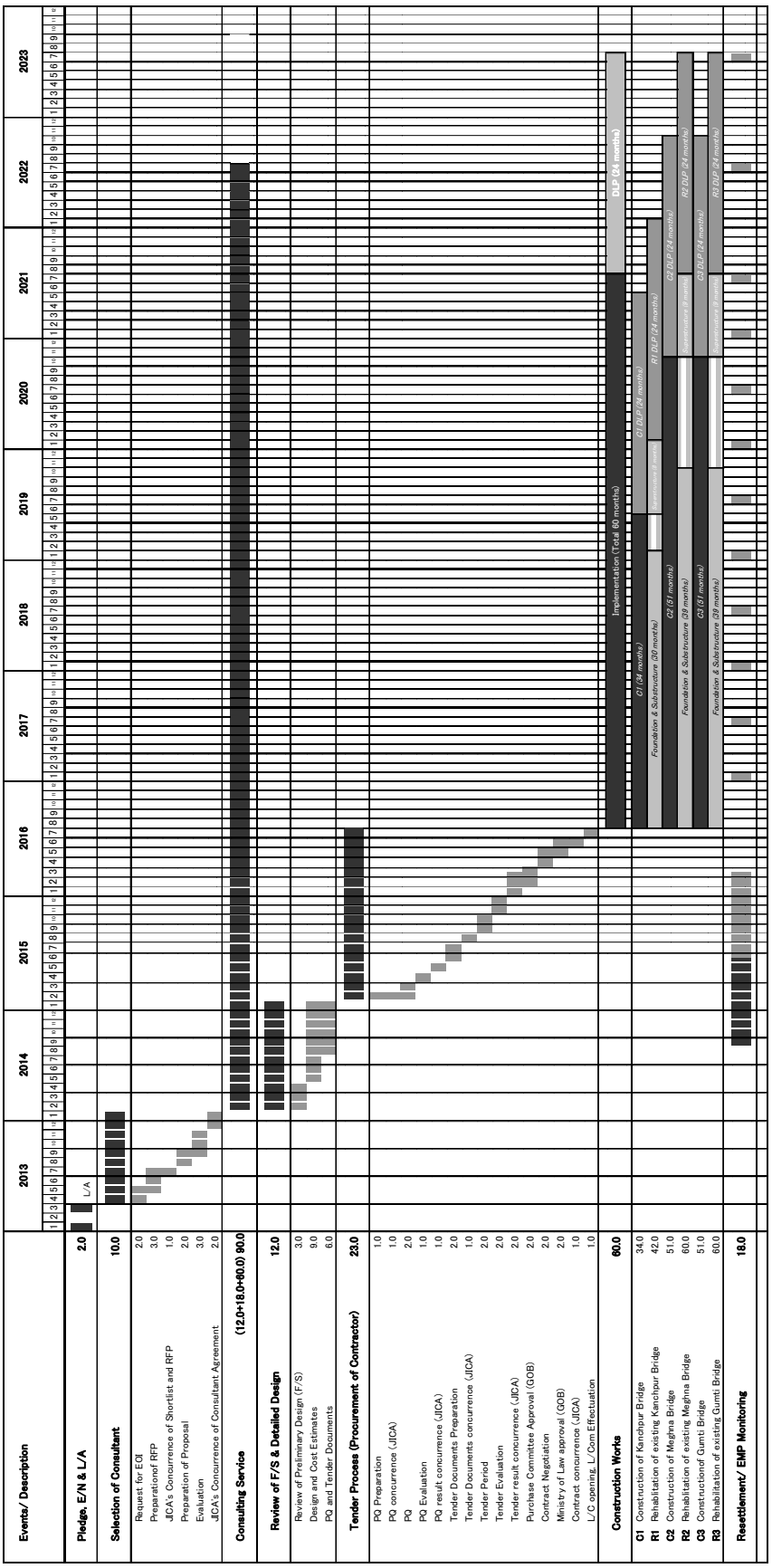
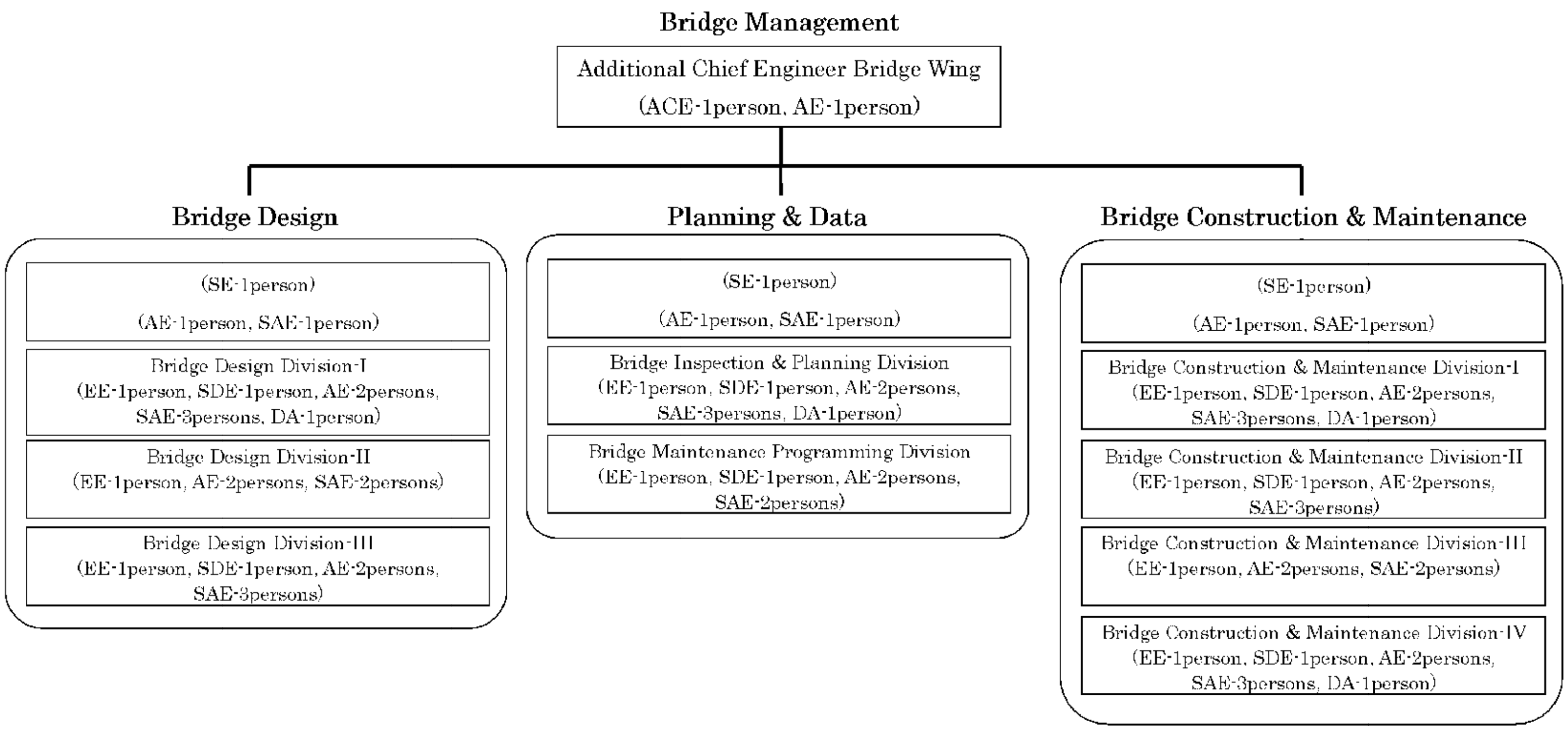


Figure 12.1.1 Implementation Schedule of Dhaka-Chittagong NH-1 Bridge Construction and Rehabilitation Project

12.2 Project Organization

12.2.1 Current Implementation Organization

The project organization will be organized so that the GoB may proceed to smoothly and effectively implement the project as well as to coordinate with project stakeholders. In this respect, RHD will organize a "Project Implementation Unit (PIU)" under Bridge Management using referred from other international projects as below.



	Class I (649 Persons in RHD)						Class II (881 Persons in RHD)		Total
	CE	ACE	SE	EE	SDE	AE	SAE	DA	
Bridge Management	-	1	-	-	-	1	-	-	2
Bridge Design	-	-	1	3	2	7	9	-	22
Bridge Construction & Maintenance	-	-	1	4	3	9	12	2	31
Planning & Data	-	-	1	2	2	5	6	1	17
Total	-	1	3	9	7	22	27	3	72

Figure 12.2.1 Current System of Bridge Management of RHD

12.2.2 Proposed Project Implementation Unit (PIU)

The project implementation unit (PIU) which will be set up in RHD is divided into two stages; 1st stage for Detailed Design and Tender stage and 2nd stage for Construction.

(1) Detailed Design and Tender stage (1st stage)

The detailed design and tender will be carried out by the PIU in the 1st stage. One (1) project coordinator, one (1) project director and one (1) additional project director are assigned for the entire project and one (1) project manager is to be assigned on the each project; Kanchipur bridge, Meghna bridge and Gumti bridge. As the same superstructure and substructure type is applied for all three bridges and the same methodology for maintenance and reinforcement is used for the existing bridges, the detailed design for the three bridges should be managed by one (1) responsible person. The tender also should be conducted by one (1) responsible person due to the construction work being implemented in one package. On the other hand, one (1) project manager should be assigned on each project as the compensation work including the relocation will be carried out on site in this stage. The communication with residents for compensation can be managed by the local staff on each project. The proposed PIU for the Detail Design and Tender stage is presented in Figure 12.2.2

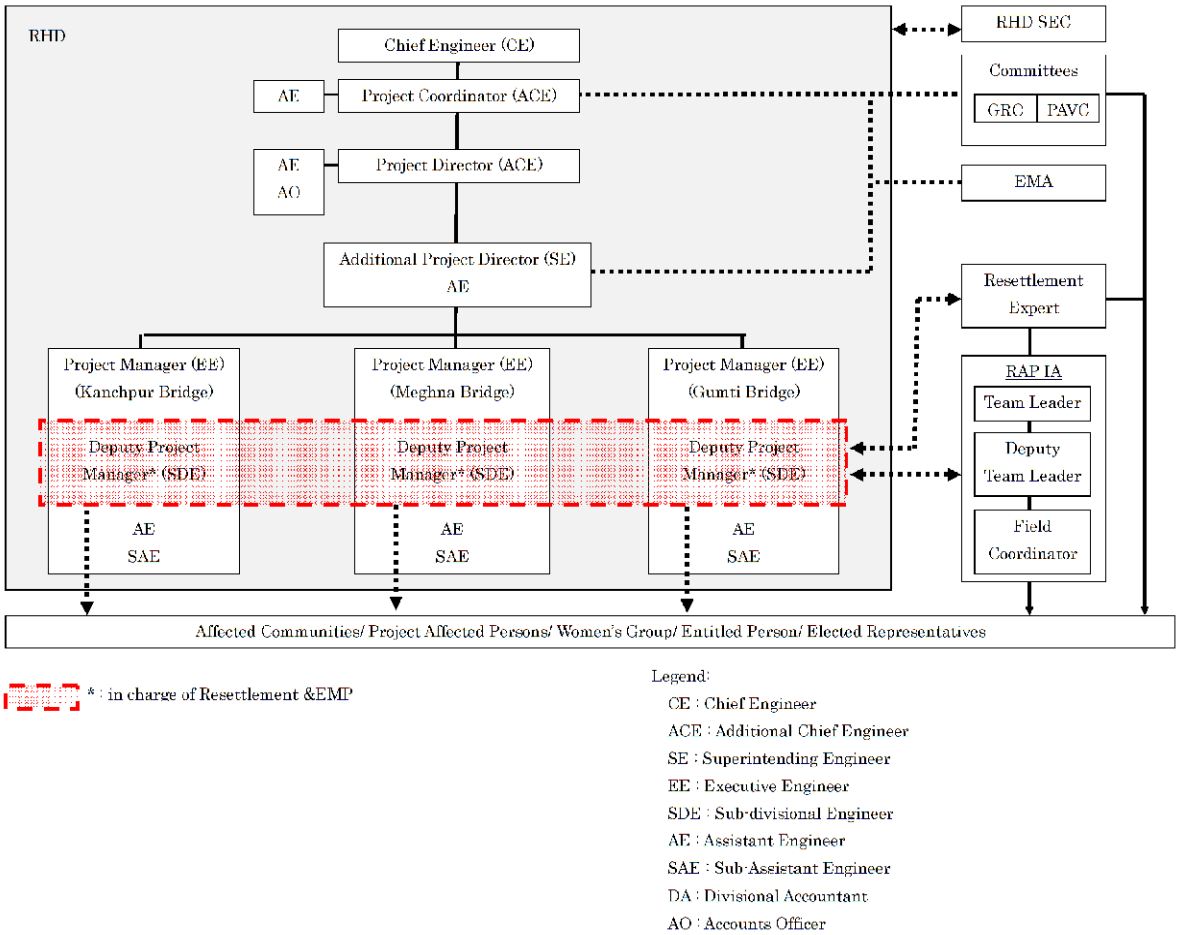


Figure 12.2.2 PIU of Design and Tender Stage

(2) Construction stage (2nd stage)

Due to the increase of work loads on site and the necessity of prompt action for construction activity, one (1) project director and one (1) additional project director should be deployed on each project. Additionally, the number of local staff should be increased. The communication with residents for compensation can be managed by the local staff on each project as well as in the 1st stage. The proposed PIU for the Construction stage is presented in Figure 12.2.3.

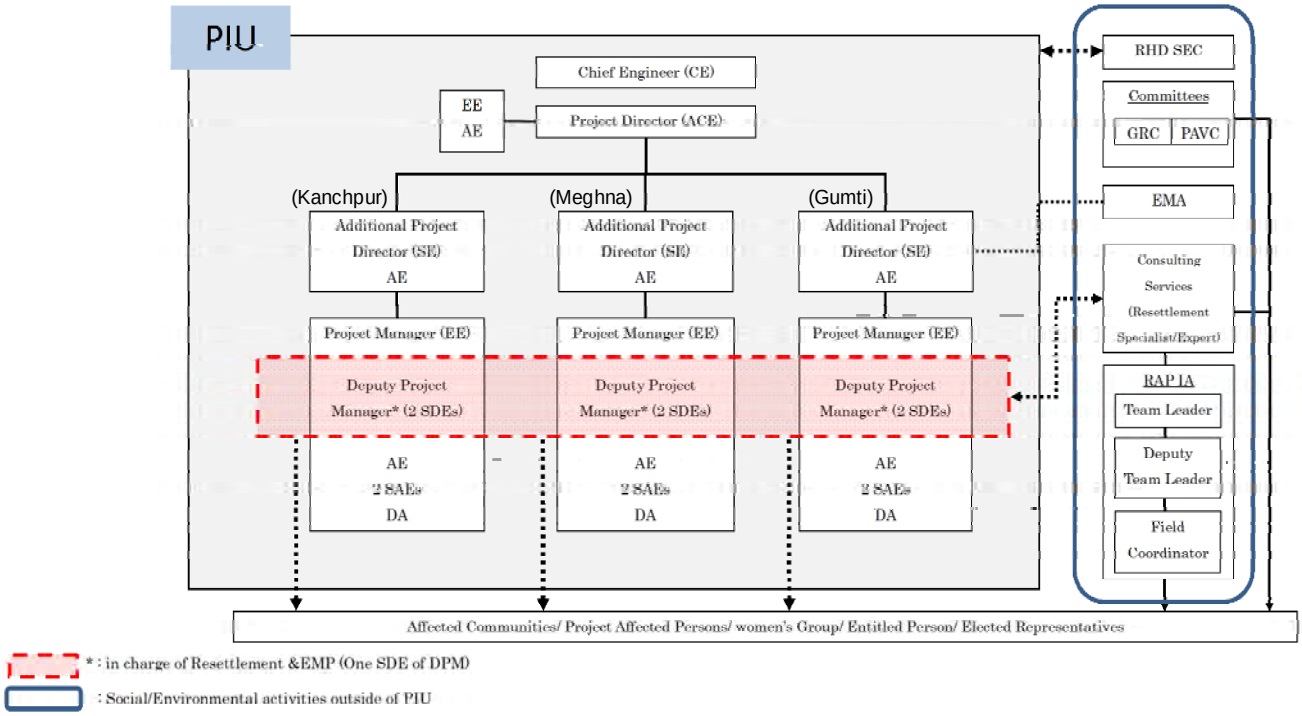


Figure 12.2.3 PIU of Construction Stage

Table 12.2.1 Number of Project Members

	Class I (649 Persons in RHD)						Class II (881 Persons in RHD)			Total
	CE	ACE	SE	EE	SDE	AE	SAE	DA	AO	
Design and Tender Stage										
RHD HQ	1	2	1	3	3	6	3	-	1	20
Total	1	2	1	3	3	6	3	-	1	20
Construction Stage										
RHD HQ	1	1	3	1	-	4	-	-	-	10
AREA	-	-	-	3	6	3	6	3	-	21
Total	1	1	3	4	6	7	6	3	-	31

12.3 Contract Package and Procurement Method

12.3.1 Contract Package

The Project consists of construction of three separate new bridges with the rehabilitation of three existing bridges. The packaging of the project components should be carefully considered according to the scope of works required for each work. The comparative analysis for packaging of the contract is to be conducted taking into account the benefits of overall project implementation, especially focused on procurement arrangements and control of works to ensure smooth implementation of the project (See Figure 12.1.1).

As a result of analysis for each optional packaging it is recommended that the Project should be implemented with a sole contract package in order to ensure smooth implementation under simple project management. The management of a sole contract has various advantageous, especially the merit of ease of coordination with the stakeholders and simple contract management in conformity with contact requirements.

12.3.2 Procurement Method

A two envelope system with prequalification is proposed by the JICA Study Team. The two envelope system is generally used in international projects to secure the quality of civil works and is recommended in the JICA guidelines.

The use of the two envelope bidding system ensures that any bidders with insufficient technical ability shall be disqualified from the bid and that no consideration be given to those with insufficient technical ability whatever bidder presents the lowest price. Due to the technical requirements of the unique construction together with rehabilitation of three bridges in this project, the bidder should demonstrate that they have adequate capability to fulfill the quality of works in accordance with the technical specifications provided in the contract. To select a bidder without assessment of technical ability may cause trouble during the construction that may consequently increase the cost of project.

The bidding procedure hereunder including the pre-qualification procedures are proposed within the total time frame of 18 Months as below

1) PQ preparation :1.0 M
2) PQ concurrence (JICA) : 1.0 M
3) PQ : 2.0 M
4) PQ evaluation: 1.0 M
5) PQ result concurrence (JICA): 1.0 M
6) Tender Documents Preparation :2.0 M
7) Tender Documents concurrence (JICA): 1.0 M

8) Tender Period : 2.0 M

9) Tender Evaluation: 2.0 M

10) Tender result concurrence (JICA): 2.0 M

11) Purchase Committee Approval (GOB): 2.0 M

12) Contract Negotiation : 2.0 M

13) Ministry of Law approval (GOB): 2.0 M

14) Contract concurrence (JICA): 1.0 M

15) L/C opening, L/Com Effectuation: 1.0 M

The bidding procedure will comply with the procedures stipulated in the Guidelines for Procurement under Japanese ODA Loan's April, 2012. For the preparation of bidding documents, Standard Bidding Documents under Japanese ODA Loans shall be applied in coordination with local regulations and rules for procurement by the GoB. The bid documents shall comprise technical specifications corresponding to the three separate bridge components set for bidding a contract package.

Table 12.3.1 Comparative Analysis for Alternative Project Packages

No.		One (1) Package	Two (2) Packages				Three (3) Packages		
			Option-1		Option-2				
i)	Combination of bridges	K+M+G	K	M+G	K+M	G	K	M	G
ii)	Cost scale (hundred million Yen) incl. new construction and rehabilitation	446 (154 | 292)	63 (20 | 43)	383 (134 | 249)	230 (81 | 149)	217 (75 | 142)	63 (20 | 43)	167 (61 | 106)	217 (75 | 142)
	Incl. procurement cost	448 (+0.5%)	451 (+1.0%)		451 (+1.0%)		454 (+1.5%)		
iii)	Characteristic of packaging	-Same superstructure girder types -Similar formation of foundation type (Steel pipe sheet pile well) -possible integrated control of works for all three bridges	-K bridge located in congest area - M and G bridges are located in rural and close each other - M and G bridges are similar components of existing bridge		- Optional combination only for considering financial scale.		- Individual packages of three bridges		
iv)	Merit for packaging	Ease control of works due to similar components of three bridges	- difficult work control of works in congested area - possible small contractor for contract of K bridge		- less requirement for the combination of K with M		- Individual contract may vary the liability capacity by scale of company		
v)	Procurement of contract	- shortest procurement period -simple management by sole contract	- relatively long procurement period -relatively complex management for two separate contracts				- longest procurement period -most complex management for three individual contracts		
vi)	Work management & supervision	- possible integrated control of quality, progress and payment for the works	- separate management required for individual contracts and complicated control of quality, progress and payment for the works. - difficult simultaneous completion of three bridge works						
vii)	Benefit for materil and equipment sharing	- possible sharing for material and equipment in sole contract	- impossible (difficult) sharing for materials and equipment in each individual contract						
viii)	Design components & documentation	- one set contract document - one supervision team for sole contract	- two sets of contract documents - two supervision teams responding to two different contracts				- three sets of contract documents -three supervision teams responding to three different contracts		
	Overall Evaluation	-minimum cost and time consuming for management of sole contract	- relatively higher cost and longer time consuming required for managing two individual contracts				-highest cost and longest time consuming required for managing three individual contracts		

Note: K: Kanchpur, M: Meghna, G: Gumti, Distances between K&M: App.15km, and between M&G: App.10km

12.3.3 Disbursement Plan

The forecast of disbursement for the engineering service and construction is estimated as shown in Table 12.3.2.

The loan facility should include the funds for the detailed design, preconstruction and construction stage (including construction supervision services), though a loan agreement will be made for a project package without separate components.

Loan facilities will be provided with the loan amount at a level of the feasibility study, hence, the actual loan application will be adjusted after the precise cost estimates are provided in the detailed design undertaken by the GoB.

Table 12.3.2 Disbursement Plan of Project Costs

(million: JPY)

Work Item	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Engineering cost	1,031	168	453	742	940	1,149	886	500	21	21	5,911
Construction cost	0	0	9,479	9,744	10,051	10,370	10,701	6,454	29	3,470	60,299

Source: JICA Study Team

Note: Price escalation and physical contingency are included in the above total amounts. But, VAT (including import duty: 30 %) is not included in the above total amounts.

12.4 Recommendations

12.4.1 Procurement of Consultant

It is recommended that a sole consultant should be employed to manage overall project implementation, Detailed Design and Tender stage through Construction stage, so as to maintain consistent quality for the complicated work components even though the contractor's contract is divided into individual separate packages, although it has been persistently recommended that the package should preferably be one. That a sole consultant is employed throughout all the project stages should also contribute to shorten the entire project period. The consultant should be a general consultant vested with tasks and duties for providing total engineering services with overseas projects.

It is also emphasized to maximize the interest in the project that the procurement of the consultant should be undertaken as soon as possible so as to facilitate the commencement of the preconstruction activities. It is essential to issue prequalification documents at the earliest possible date so that the contractor's procurement period can be shortened to finalize following bidding processes.

The completion of the Project on time is very important taking into account the current traffic condition on National Highway No.1 and the urgent rehabilitation for the vulnerable existing bridges damaged by scouring of their foundations.

12.4.2 Technical Transfer Program

As practical experience through implementation of past bridge projects, it is necessary (and indeed most desirable) to pursue technology transfer to the GoB's counterpart personnel during the implementation of the project. In order to ensure appropriate supervision activity and administration of the project, it is recommended to conduct the on-the job training at the phase of the implementation of the project. Also the maintenance management by RHD is essential for the operation of the major bridge project after the completion of the project.

It will be the Study team's intention to provide technology transfer during the design and preconstruction stage and to recommend that it further be implemented during the construction supervision stage of the Project through a trip to Japan or other countries of counterpart personnel to study advanced bridge technology and methods currently being applied to newly constructed bridges.

For the design stage of the study it is recommended that the following Technology Transfer Program should be implemented so that the design and management capability of the counterpart team and the provincial personnel can be strengthened.

12.4.3 On-The-Job-Training

The program will be aimed at "person to person" training by means of "co-working" with the consultant's experts in the respective fields. The "co-working" programs will be organized in the office and in the field (if appropriate and time permits) and will include the latest design techniques and computer software programs that are currently applicable to a bridge study of this magnitude. Also the use and applications of computer network and communication systems for the design will be explained to the counterpart personnel.

The Study team expects that using this type of on-the-job training, the counterpart and local Government personnel assigned to or involved with, the design, supervision of contract and maintenance will become acquainted with the day-to-day manner of handling the various activities.

12.4.4 Seminars/Lectures and Tour in Japan

Seminars and lectures organized by the Japanese experts could be held in those subjects in which the GOB and the technical personnel will be most interested. These seminars/lectures would be aimed at explaining not only the latest theories and criteria but also at using illustrative cases in which these theories and criteria would be applied to the ongoing Project. To improve the performance of the staff of RHD the following technical training is proposed to equip them with adequate technical abilities for a secure self-reliant operation and maintenance for the project as shown in Table 12.4.1. These are timed upon completion of major activities during the implementation of the project such that the seminars will also serve as venues for presentation by the Consultant of items completed during the preceding

period prior to the Seminar. The tour should also include job site inspections to different construction fields of ongoing projects in Japan.

Table 12.4.1 Proposed Program for Seminars/Lectures

Seminar Titles	Tentative Year	Subject for Lecture/ Discussions	Study Team Expert in Charge	Class of C/P
Design concept and analysis	2014	Collection and interpretation of available data Preliminary conclusions and computerization of design by Software Applications	Team Leader/ Senior Bridge Engineer	I
Procurement and construction technique	2015	Procurement of equipment, and materials. Fabrication & erection techniques of bridge girder, and quality control of bridge works	Bridge Engineer, Procurement Specialist/ Civil Engineer, etc	I & II
Supervision and Operation & Maintenance Ability	2016	Programs and plan for supervision of civil works especially focused on day to day administrative works during the construction. Advanced techniques for operation and maintenance of steel bridge.	Team Leader/ Administrative Officer/ Bridge Engineer	I & II

CHAPTER 13

ECONOMIC AND FINANCIAL EVALUATION

13. ECONOMIC AND FINANCIAL EVALUATION

13.1 Economic Analysis

13.1.1 Methodology

The economic analysis of the Project is principally made in comparison between benefits and costs which is derived from with and without construction and rehabilitation of the three bridges namely Kanchpur Bridge, Meghna Bridge and Gumti Bridge (the Project Bridges). The economic analysis procedure illustrated in Figure 13.1.1 is employed in this study.

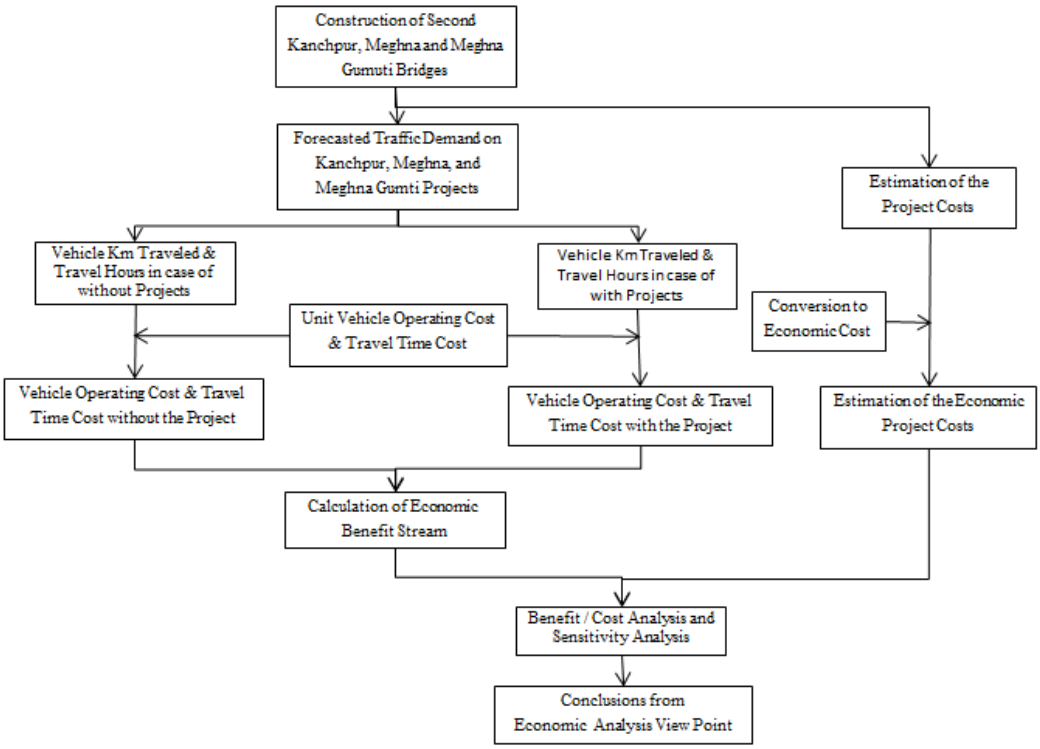


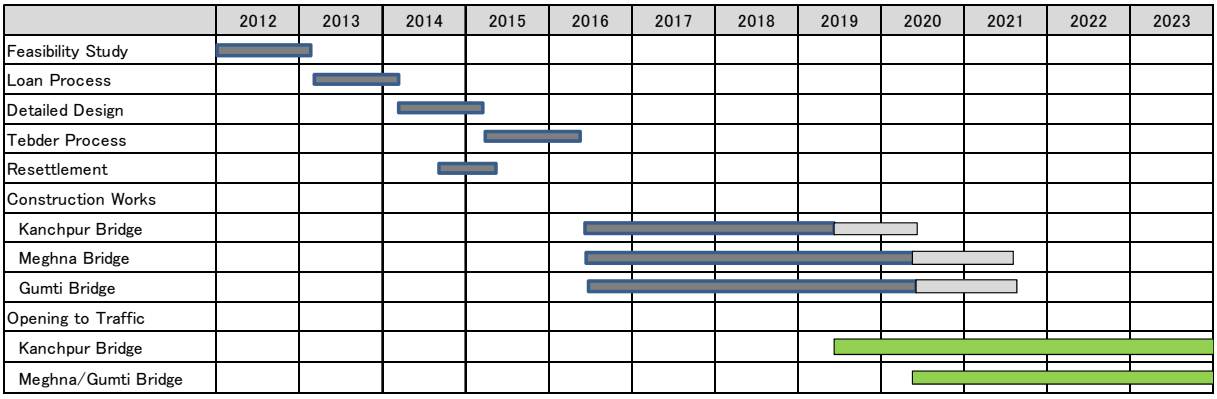
Figure 13.1.1 Procedure for Economic Analysis

13.1.2 Presumptions for Economic Evaluation

(1) Implementation Plan of the Project and Evaluation Period

Based on the Project implementation schedule proposed in Chapter 12, the Project implementation schedule for economic analysis is assumed as shown in Table 13.1.1.

Table 13.1.1 Project Implementation Schedule for Economic Analysis



(2) Evaluation Cases

The following Bridge and Road Plans are used in the economic analysis;

1) Bridge Plans in cases of "With Project" and "Without Project"

"With Project" is defined as the situation where the proposed three new bridge constructions and existing bridge rehabilitations are implemented, and "Without Project" is defined as the situation where no such investment takes place. The quantified economic benefits, which would be realized from the implementation of the project, are defined as savings in vehicle travel costs (vehicle operating costs and vehicle travel time costs) derived from the difference between "With Project" and "Without Project"

2) Road Plans

In the economic analysis, two (2) versions of the road plans are evaluated as follows;

(a) Plan 1: Road to be improved

Plan 1 means that the roads related to the Meghna and Gumti Bridges are widened into 6-lanes and those of Kanchpur Bridge are widened into 8-lanes in the target year. (See Table 13.1.2)

(b) Plan 2: Roads not improved

The plan committed to by the RHD, is that only the roads related to Kanchpur Bridge will be widened into 8-lanes in the target year, but those of Meghna and Gumti Bridges will not be widened into 6-lanes as shown in Table 13.1.2.

Table 13.1.2 Bridge and Road Plans in cases of With and Without Project

Unit: No. of Lanes

Case		Bridge Section	Road Section
Plan 1: Road to be Improved			
Kanchpur Bridge	W/ Case	8	8
	W/O Case	4	8
Meghna Bridge	W/ Case	6	6
	W/O Case	2	6
Gumti Bridge	W/ Case	6	6
	W/O Case	2	6
Kanchpur Bridge	W/ Case	8	8
	W/O Case	4	8
Meghna Bridge	W/ Case	6	4
	W/O Case	2	4
Gumti Bridge	W/ Case	6	4
	W/O Case	2	4

(3) Evaluation period and daily factor

Taking into consideration the functional lifetime of long span bridges in developing countries, the evaluation period is assumed to be 25 years after opening traffic to the public, which is from 2019 to 2043 for Kanchpur Bridge and from the 2nd half of 2019 to the 1st half of 2044 for Meghna and Gumti Bridges.

The annualized factor of the daily benefits is calculated to be 340 days per year taking into consideration the weekly variation in the volume of traffic on the roads based on the following formula;

$$AF = (TV_{wd} \times (365 - WD)) + (0.77 \times TV_{wd} \times 106) = 340 \times TV_{md} \quad \cdots \text{Formula13.1.1}$$

Where : AF : annualized factor, TV_{wd} : traffic volume on a weekday, $0.77TV_{wd}$: daily traffic volume on a weekend

(4) Discount rate

A discount rate of 12 % is assumed, taking into account the opportunity rate for capital in Bangladesh.

(5) Economic indicators

In order to evaluate the Bridge projects from an economic view point, the following economic indicators were estimated;

- Economic internal rate of return (EIRR)
- Cost - benefit ratio (B/C Ratio)
- Net Present Value (NPV)

(6) Salvage value

The salvage value of the Bridges is not taken into account.

(7) Forecast traffic demand on the Project

The traffic demand on the Bridges forecast in Chapter 3 is used for the economic analysis both in the cases of with and without the Project. It is assumed that the future traffic demand on the Project of Plan 1 and Plan 2 will reach its capacity in 2024 and 2031 respectively.

Table 13.1.3 Traffic Demand Forecast on the Bridges on Plan 1 and 2

Unit: AADT in terms of PCU

Bridge	Plan 1				Plan 2			
	2012	2020	2023	2025	2012	2020	2023	2025
Kanchpur Bridge	76,732	117,202	136,030	150,349	76,732	117,202	136,030	142,985
Meghna Bridge	65,147	96,813	112,001	123,415	65,147	96,813	112,001	117,552
Gumti Bridge	65,147	96,813	112,001	123,415	65,147	96,813	112,001	117,552

13.1.3 Road User Cost (RUC)

(1) Type of Benefits

By implementing the Project road, a variety of benefits such as reduction of traffic congestion, and delay, improvement of comfort and safety, reduction of commodity damage, promotion of international and inter-regional trade and promotion of regional development in the short and long terms are expected. Among these benefits, the following tangible benefits are considered in the Study;

- Reduction of travel time costs (TTC)
- Reduction of vehicle operating costs (VOC)
- Reduction of accident cost (ACC)
- Saving of riprap cost (RRC)

(2) Road Users Cost (RUC)

As mention above, some basic parameters are estimated such as a) TTC, b) VOC and c) ACC. The procedure and estimation results of these parameters are as follows;

1) TTC

TTC is estimated in terms of two kinds of RUC. The one is the cost per passenger, and the other is the cost per vehicle. The former value is applied to passenger transport such as cars, buses, and auto rickshaws, while the latter cost is for freight transport such as trucks. The procedure for estimation of the above two kinds of unit cost is given as follows;

a) Passenger based TTC

As for passenger based TTC, the outputs of the existing study in Bangladesh are available. The Road and Highway Department (RHD) opened the study report to the public in 2005, the title of which is "RHD Road User Cost Annual Report for 2004 - 2005", in 2005. The report estimates passenger based travel time unit costs by each transport mode and the passenger based travel time unit costs by passenger based vehicle type. However, the report was published in 2005. Therefore some calibration of the estimation is necessary in order to obtain the value available in the present year of 2012. In obtaining such unit cost in the year of 2012, Per Capita GDP growth rate is taken into account. Per Capita GDP growth rate is obtained from the World Economic Outlook of the International Monetary Fund (IMF) as of April 2012. Formula used to calculate the TTC in 2012 is as follows;

$$TTC_{12} = TTC_{05} \times (1 + \beta) \quad \cdots\cdots\cdots \text{Formula13.1.2}$$

Where: TTC_{12} : Travel time cost in 2012

TTC_{05} : Travel time cost in 2005

β: Growth rate of per capita GDP between 2005 and 2015

On the basis of the above-mentioned ideas and procedures, passenger based travel time unit cost in the present year 2012 is estimated as follows;

Table 13.1.4 Passenger based unit TTC (Unit: BDT/hr)

Vehicle Category	2005	2012
All Buses	17.6	24.2
Microbus	24.9	34.2
Car/Utility	30.9	42.5
Auto Rickshaw	16.4	22.6
Motor Cycle	22.9	31.5

Source: RHD Road User Cost Annual Report 2004/2005, June 2005
Note: All buses includes heavy bus, light bus and Mini-bus defined in RHD User Cost Report

b) Truck based TTC

As for vehicle based truck TTC, existing study's outputs in Bangladesh are also available in the "Project Appraisal Framework, Road Sector Manual [1]", in 2005. According to the report, truck based unit TTC were estimated by each truck type. However, the report was published in 2005. Therefore some calibration of the estimation is necessary in order to obtain the value for the present year of 2012. Truck based unit TTC is estimated through review of that report and calibration of the value in the report taking into account GDP growth rate, which was projected in the study. The formula used to calculate truck -based TTC is as follows;

$$TTC_{12} = TTC_{05} \times (1 + \alpha) \quad \cdots\cdots\cdots \text{Formula 13.1.3}$$

Where: TTC_{12} : Travel time cost in 2012

TTC05 : Travel time cost in 2005

α: Growth rate of GDP between 2005 and 2015

The travel time unit costs by each truck type are estimated as follows;

Table 13.1.5 Vehicle based Unit TTC for each Truck in 2012 (Unit: BDT/hr.)

Vehicle Category	2005	2012
Medium Truck	104.85	159.16
Light Truck	95.22	144.54

Source: JICA Study Team
Notes: Figures for 2005 were estimated by the Planning Commission

c) Vehicle based TTC

The above mentioned unit passenger based TTC is converted to the unique passenger vehicle cost averaged by share of volume of each type of vehicle, which is obtained from the traffic survey conducted in this study as mentioned in Chapter 3. Converted and calibrated unit TTC is shown as follows;

[1] Project Appraisal Framework - Road Sector Manual, Transport Sector Coordination Wing, Planning Commission, Government of Bangladesh, 2005

Table 13.1.6 Vehicle based unit TTC

Vehicle Category	TTC per passenger	Average Occupancy	TTC per Vehicle
	(BDT/hr)	(Person/Veh)	(BDT/hr)
All Buses	24.2	37	901.5
Microbus	34.2	6	205.2
Car/Utility	42.5	3	127.5
Auto Rickshaw	22.6	3	67.8
Motor Cycle	31.5	1	31.5
Medium Truck	-	-	159.2
Light Truck	-	-	144.5

Source: RHD Road User Cost Annual Report 2004/2005, June 2005

Table 13.1.7 Weighted Vehicle based unit TTC

Vehicle Category	TTC per Vehicle	PCU Conversion	Vehicle Composition	TTC per PCU
	(BDT/hr./Veh.)	PCU/Veh.	%	BDT/Hr
All Buses	901.5	3.00	34.1 %	102.3
Microbus	205.2	3.00	10.0 %	6.8
Car/Utility	127.5	1.00	7.7 %	9.8
Auto Rickshaw	67.8	0.75	5.3 %	4.8
Motor Cycle	31.5	0.75	1.0 %	0.4
Medium Truck	159.2	3.00	32.7 %	17.4
Light Truck	144.5	3.00	9.2 %	4.4
			Total	149.7

Source: RHD Road User Cost Annual Report 2004/2005, June 2005
Note: Vehicle composition rate is obtained from the traffic survey conducted in this study

2) Vehicle Operating Cost (VOC)

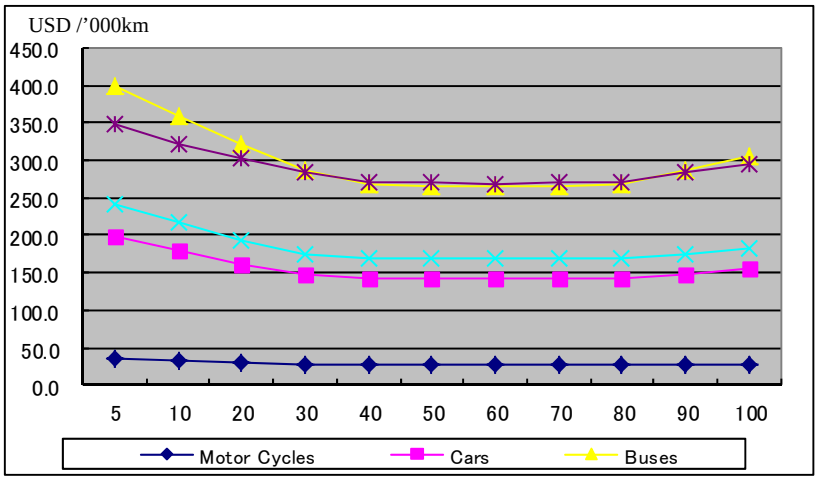
After careful examination of the VOC estimated by RHD, the Study Team judges that this VOC can be applicable for this study. It is therefore estimated on the basis of the RHD report. The values in the RHD report were for the year of 2005 therefore those values are calibrated taking into account the GDP growth rate to meet our study requirements. Also the unit VOC is converted to the value for unique passenger vehicles by use of the PCU and traffic volume which is obtained through the study. The estimated values in the RHD report, which are the base value for our study, are shown as follows;

Table 13.1.8 Comparison of Vehicle Operating Cost by Various Studies

Vehicle Category	VOC in 2004/05	VOC in 2012	PCU Conversion	Vehicle Composition	VOC in 2012
	BDT/km/Veh	BDT/km/Veh.	PCU/Veh	%	BDT/km/PCU
Medium Truck	12.9	22.79	3.00	32.7 %	2.49
Small Truck	9.56	16.89	3.00	10.0 %	0.56
Large Bus	13.72	24.24	3.00	19.4 %	1.56
Mini Bus	11.4	20.14	3.00	14.7 %	0.99
Microbus	11.36	20.07	3.00	10.0 %	0.67
Utility	9.26	16.36	1.00	3.5 %	0.57
Car	9.32	16.47	1.00	4.2 %	0.69
Auto Rickshaw	2.32	4.1	0.75	5.3 %	0.29
Motor Cycle	1.3	2.3	0.75	1.0 %	0.03
				Total	7.86

Source: RHD Road User Cost Annual Report 2004/2005, June 2005
Note: Vehicle composition rate is obtained from the traffic survey conducted in this study

There is a well known a relationship between VOC and travel speed. The VOC varies in proportion to the travel speed as shown in Figure 13.1.2.



Source: The Study on the National Road Network Development in Cambodia" JICA, 2006"

Figure 13.1.2 Relationship between VOC and Travel Speed

Based on the above-mentioned relationship, a formula for VOC and travel speed by vehicle type is calibrated as shown in below;

$$Y = 0.003 x2 - 0.3706 x + 18.799 \cdots\cdots\cdots \text{Formula 13.1.4}$$

Where: Y : VOC (BDT/km)

X: Passenger car based travel speed (km/h)

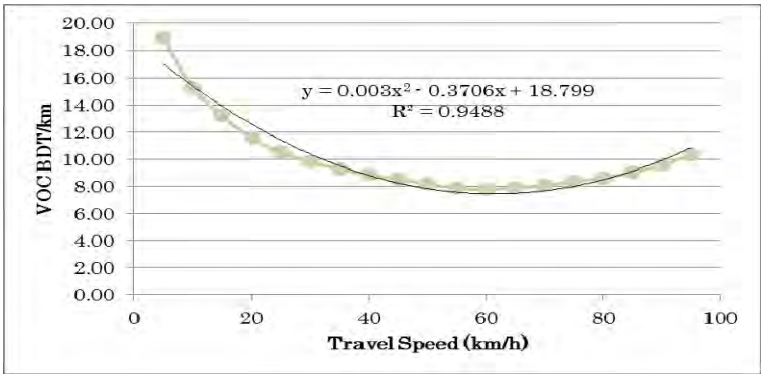


Figure 13.1.3 Relationship between VOC and Travel Speed Accident Cost (ACC)

After careful examination of the ACC estimated by RHD, the Study Team judges that this ACC can be applicable for this study. Therefore, the ACC is estimated on the basis of the RHD report. Since the unit ACC value in the RHD report was presented for the year of 2005 those values are calibrated taking into account the growth rate of GDP per capita to meet our study requirements. Also, the unit ACC is converted to the value for unique passenger vehicles by use of the PCU and traffic volume which is obtained through the study. The estimated values in the RHD report, which are the base values for our study, are shown as follows;

$$ACC_{12} = ACC_{05} \times (1 + \beta) \quad \cdots\cdots\cdots \text{Formula 13.1.5}$$

Where: ACC_{12} : Accident cost in 2012

ACC_{05} : Travel time cost in 2005

β : Growth rate of GDP per capita between 2005 and 2015

Table 13.1.9 Unit ACC

Unit: BDT/RTA

	BDT / RTA
Unit ACC in 2004	234,000
Unit ACC in 2012	355,200

Note: All costs are 2012 prices

Table 13.1.10 Road Traffic Accident (RTA) Rate on NH-1 between Dhaka and Chittagong

	2007	2012
No. of RTA	600	792
Road Length (km)	208	208
Rate of RTA (RTA/km)	2.89	3.81

Note: Data in 2007 is based on Dhaka -Chittagong Expressway PPP Design

13.1.4 Construction Cost, Land Acquisition Cost and Operation/Maintenance Cost

Based on the construction cost and operation/maintenance cost presented in Chapters 10 and 11, the economic construction and operation/maintenance costs are estimated for economic evaluation. Some basic presumptions are applied in conducting the economic evaluation as follows;

- Escalation factor: Price inflation was not taken into account for either construction cost or operation/maintenance cost.
- Administrative cost, VAT and import duty: Imposition of value added tax and import duty was excluded.
- Standard conversion factor: Standard conversion factor $(0.85)^2$ is applied to the price of non-tradable goods and services.
- Land acquisition cost and compensation cost: the Resettlement cost estimated in the Resettlement Action Plan (RAP) is used in the economic and financial analysis.
- The stream of construction and operation/maintenance costs are set up for each Bridge based on the Project implementation schedule.
- Operation and maintenance cost consists of three items: routine maintenance, periodic maintenance and toll levying cost.

Table 13.1.11 shows the estimation of the resettlement cost estimate and Table 13.1.12 shows the estimation of the economic cost. For more details, the calculation of economic cost is shown in Appendix 16.

[2] "Project Appraisal Framework" Transport Sector Coordination Wing, Planning Commission, 2005

Table 13.1.11 Summary of Resettlement Cost for the Project

	Category of Losses	Kanchpur (BDT)	Meghna (BDT)	Gumti (BDT)	Total Budget (BDT)
A	Compensation for structures	46,483,271	4,393,710	2,486,618	53,363,599
B	Compensation for Trees	838,333	4,533,750	0	5,372,083
C	Other Resettlement Benefits	5,452,993	575,722	517,880	6,546,595
D	Training on IGA for eligible members of affected households and wage laborers	560,000	8,000	72,000	640,000
E	Approximately 3 Trainers for 10 days each @BDT 3000/day/person	90,000	0	0	90,000
F	RHD Capacity Building Training	1,000,000	500,000	500,000	2,000,000
G	Operation cost for RAP Implementing Agency **	2,000,000	1,000,000	1,000,000	4,000,000
H	Operation cost for External Monitoring Agency (EMA)	500,000	300,000	200,000	1,000,000
I	Contingency @ 10 % of the Total A-H*	2,895,377	1,131,118	362,591	4,389,086
	Total	**59,819,974**	**12,442,300**	**5,139,089**	**77,401,363**
	Total (USD)	729,512	151,735	62,672	943,919

Note: USD 1 = BDT 82 as of July 2012 All costs are 2012 prices
*10 % of the total budget excluding RHD compensation
**including operation cost for GRC and PAVC

Table 13.1.12 Economic Project Cost Estimate

Unit: Million BDT

	Economic				Financial			
	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total
2012	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0
2014	139	366	481	986	182	477	627	1,286
2015	24	62	81	167	32	83	109	224
2016	1,222	3,208	4,215	8,645	1,725	4,526	5,947	12,198
2017	1,249	3,277	4,305	8,831	1,761	4,620	6,071	12,451
2018	1,266	3,321	4,364	8,951	1,783	4,679	6,148	12,610
2019	1,285	3,371	4,430	9,085	1,809	4,746	6,236	12,790
2020	1,255	3,294	4,328	8,876	1,768	4,639	6,095	12,502
2021	730	1,917	2,519	5,166	1,029	2,699	3,547	7,275
2022	6	15	19	39	8	20	26	53
2023	345	906	1,190	2,441	488	1,281	1,683	3,452
Total	7,521	19,735	25,932	53,188	10,582	27,770	36,489	74,842

Note: All costs are 2012 prices

As for the operation and maintenance (OM) cost, the following costs are estimated based on the OM cost estimation made in Chapter 11.

- Routine maintenance cost
- Periodic maintenance cost

- Toll collection cost
- Other (equipment) maintenance cost, such as the weigh station

Table 13.1.13 shows the operation and maintenance costs for 25 years. For more details, the calculation of economic cost is shown in Appendix 16.

Table 13.1.13 Operation and Maintenance Cost

Unit: Million BDT

	Kanchpur	Meghna	Gumti	Total
Routine Maintenance	58.9	137.1	207.8	403.8
Periodic Maintenance	692.7	1,095.9	1,631.9	3,420.5
Toll Collection	0.0	595.7	585.7	1,171.3
Others	225.0	310.0	225.0	759.9
Total	976.5	2,128.6	2,650.3	5,755.4

Notes: 1) All costs are 2012 prices
2) OM costs are estimated for the evaluation period of 25 years
3) SCF is also applied to estimate the operation and maintenance cost

13.1.5 Estimation of Benefits

(1) Road Section

In order to estimate the benefits, the following Project Road that is influenced by the three (3) Bridges is assumed as follows;

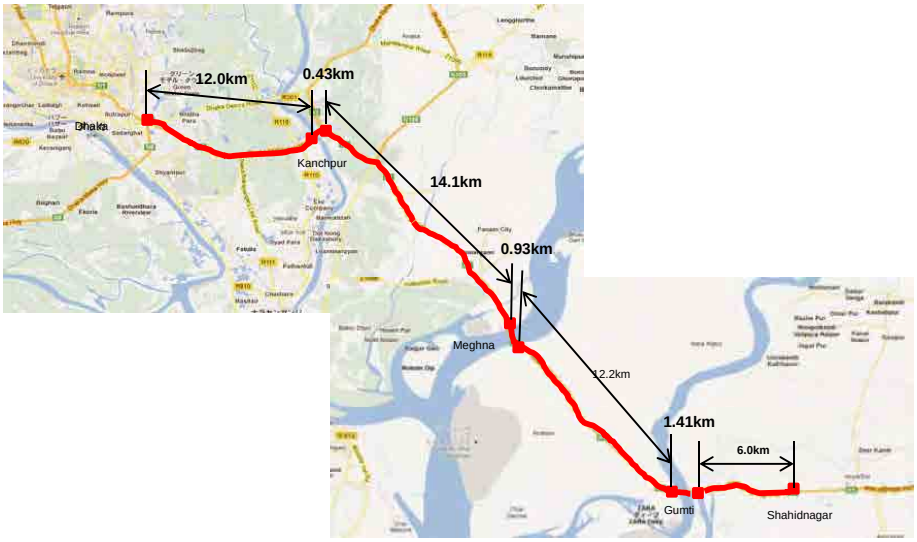


Figure 13.1.4 Target Road Section influenced by the Bridges

Table 13.1.14 Length of Target Road Section

Section		Distance (km)
1	Dhaka - Kanchpur Bridge(Dhaka Side)	12.0
2	Kanchpur Bridge	0.4
3-1	Kanchpur Bridge(Chittagong Side) - N2 Road	0.4
3-2	N 2 Road - Maghna Bridge (Toll Gate)	13.7
4	Meghna Bridge	0.9
5	Maghna Bridge (Chittagong Side) - Gumti Bridge (Dhaka Side)	12.1
6	Gumti Bridge	1.4
7	Gumti Bridge (Chittagong Side) - Shahidnagar	6.0
Total		47.0

(2) Steps of Benefit Estimation

The benefit estimation steps are shown below;

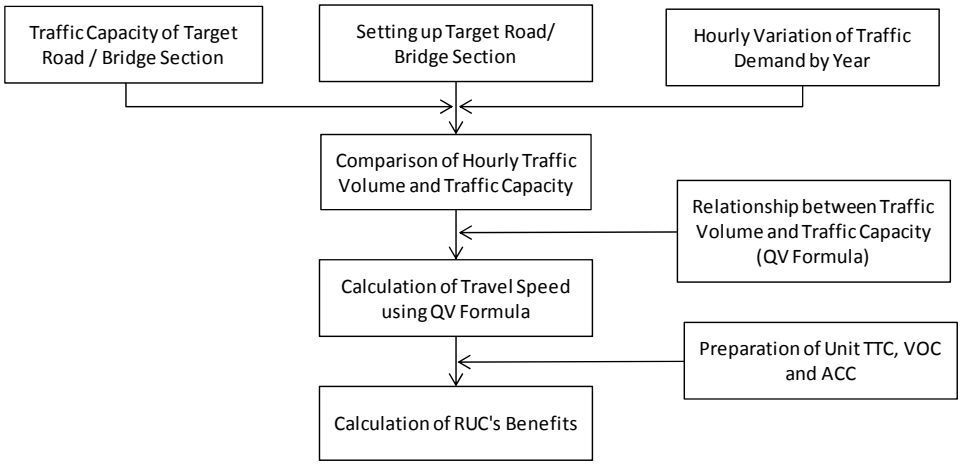


Figure 13.1.5 Procedure for RUC's Benefits Calculation

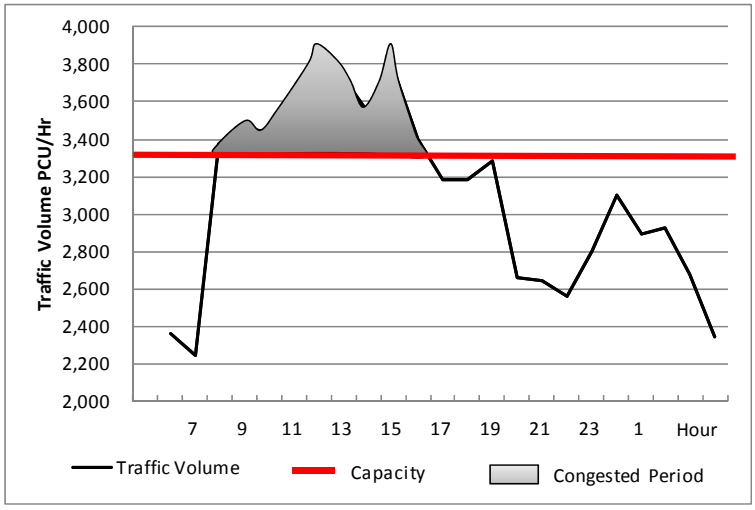


Figure 13.1.6 Hourly Variation of Traffic Volume and Road Traffic Capacity (Example)

It is anticipated that traffic congestion will be generated in the NH-1 traffic lane in the case of "Without Project" as illustrated in Figure 13.1.7 due to the bottleneck of the three Bridges. However, after passing the bottlenecked bridge point, traffic flow becomes free flow situation in the uncongested section.

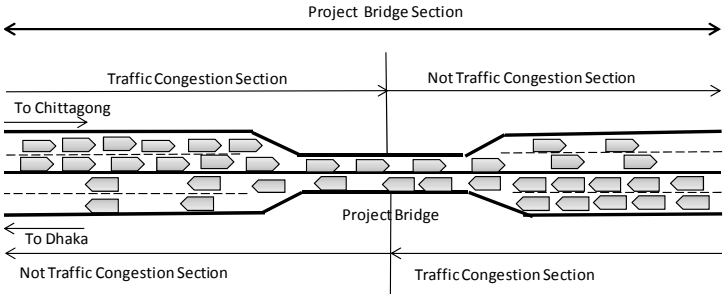


Figure 13.1.7 Traffic Flow Model adopted for the Target Road Section

Travel speed, which depends on the traffic congestion situation, can be calculated on the basis of the Q-V (quantity of traffic volume and velocity) relationship as shown in Figure 13.1.8.

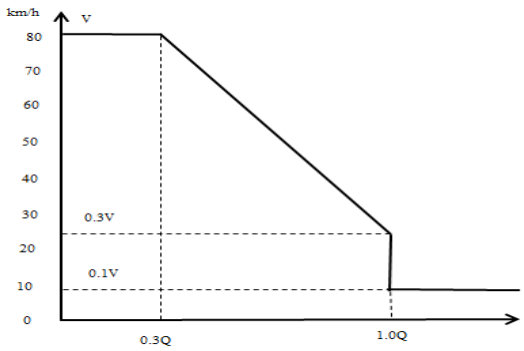


Figure 13.1.8 Q-V Relationship adopted for the Project Road Section

The saving in vehicle operating cost (VOC) and travel time cost are estimated on the basis of the estimated vehicle kilometers and vehicle hours in the traffic congestion sections using the following equations;

$$SVOC_b = TV^t_{b\,wo} \times L_i/2 \times UVOC_{wo} - TV^t_{b\,w} \times Li \times UVOC_w \quad \cdots\cdots\cdots \text{Formula 13.1.6}$$

Where:

$SVOC^t_b$: Saving in VOC at Bridge b in the year t
TV^t_b : Traffic volume at Bridge b in the year t
Li: Road Length of bridge b
$UVOC_{wo}$: Unit VOC in the case of "Without Project"
UVOCw : Unit VOC in the case of "With Project"

$$STTC^t_b = TV^t_{bwo} \times L_b/2 / TS_{wo} \times UTTC - TV^t_b \times L_i / TS_w \times UTTC \quad \cdots \text{Formula13.1.7}$$

Where:

STTC tb : Saving in TTC at Bridge b in the year t
TVtb : Traffic volume at Bridge b in the year t
Ltb : Traffic queue length at Bridge b
TSwo: Travel speed in the case of "Without Project"
TSwo: Travel speed in the case of "With Project"
UTTC : Unit TTC

In order to calculate the saving in VOC and TTC, input data are prepared as follows;

Travel speed by hour is calculated on the basis of the relationship between traffic volume and travel speed (Q-V formula) as follows;

- Less than 0.3 Q: TS = 80 km/h
- Between O.3 Q and 1.0Q TS = 104 - 80 CD

  Where: CD = congestion degree
- Over1.0 Q: TS = 8 km/h

} Formula 13.1.8

Traffic volume in the future was already projected in Tables 3.5.10 and 3.5.11. However, after traffic volume is saturated at over road traffic capacity, traffic volume is a constant value. The year of saturation is 2025.

(3) ACC Saving

Table 13.1.15 shows the ACC saving estimation based on unit ACC and rate of RTA on NH 1.

Table 13.1.15 Result of ACC Saving Calculation (Unit: BDT)

Section		Distance (km)	2020	2025
1	Kanchpur Bridge	0.4	444,174	569,795
2	Meghna Bridge	0.9	968,670	1,597,968
3	Gumti Bridge	1.4	1,458,213	1,874,123
Total		2.8	2,871,057	4,041,886

(4) RIPRAP Cost Saving

This benefit is not saving in RUC. However, one of the objectives in constructing the new bridges and to rehabilitate the existing bridges is to protect the foundations of the existing three bridges, namely Kanchpur, Meghna and Gumti Bridges. Due to the countermeasures, a riprap cost saving is expected every year. Table 13.1.16 shows the saving of the riprap cost.

Table 13.1.16 Saving in Riprap Cost

Bridge	Riprap Cost Saving		
	USD	JPY (million)	BDT (million)
Kanchpur	246,600	20	20.5
Meghna	3,425,000	270	276.9
Gumti	3,014,000	240	246.2
Total	6,685,600	530	543.6

Note: All costs are 2012 prices

(5) Results of Benefit Calculation

The results of benefit calculation are shown in Table 13.1.17.

Table 13.1.17 Results of Benefit Calculation (Plan 1 and 2)

Unit: million BDT

		Plan 1			Plan 2		
		2020	2025	2030	2020	2025	2030
Kanchpur Bridge	Saving in TTC	887.6	1,718.6	2,044.4	887.6	1,718.6	2,044.4
	Saving in VOC	777.7	4,810.0	8,102.3	777.7	4,810.0	8,102.3
	Saving in ACC	0.4	0.6	0.6	0.4	0.6	0.6
	Saving in RRC	20.5	20.5	20.5	20.5	20.5	20.5
	Total	1,686.2	6,549.7	10,167.8	1,686.2	6,549.7	10,167.8
Meghna Bridge	Saving in TTC	2,990.6	4,947.5	5,492.8	2,847.2	4,094.9	4,094.9
	Saving in VOC	1,046.6	1,698.7	1,878.2	974.7	1,252.7	1,252.7
	Saving in ACC	1.0	1.6	1.8	1.0	1.6	1.6
	Saving in RRC	276.9	276.9	276.9	276.9	276.9	276.9
	Total	4,315.1	6,924.7	7,649.7	6,096.7	5,626.0	5,626.0
Gumti Bridge	Saving in TTC	2,867.4	4,743.7	5,266.5	2,729.9	3,926.2	3,926.2
	Saving in VOC	1,003.5	1,628.8	1,800.9	934.6	1,201.1	1,201.1
	Saving in ACC	1.5	1.9	2.0	1.5	1.8	1.8
	Saving in RRC	246.2	246.2	246.2	246.2	246.2	246.2
	Total	4,118.6	6,620.6	7,315.5	3,912.2	5,826.4	5,826.4
All Bridges	Saving in TTC	6,745.6	11,409.8	12,803.6	6,464.7	9,739.8	10,065.5
	Saving in VOC	2,827.8	8,137.5	11,781.4	2,687.0	7,263.9	10,556.2
	Saving in ACC	2.9	4.1	4.4	2.9	3.9	3.9
	Saving in RRC	543.6	543.6	543.6	543.6	543.6	543.6
	Total	10,119.9	20,095.0	25,133.0	9,698.2	17,551.1	21,169.2

All benefits are as of 2012 prices

13.1.6 Economic Analysis

(1) Economic Analysis

Based on the results of the user benefits and cost estimates shown in the above section, construction of the Bridges is evaluated in terms of EIRR, BCR and NPV within the assumed operation period of 25 years. Evaluation of the economic viability was done through a comparative analysis between the EIRR and a social discount rate of 12.0 %. Comparing such a discount rate, it can be said that economic viability is secured at a highly feasibility level.

Table 13.1.18 Economic Indicators of Kanchpur, Meghna, Gumti Bridges and All bridges

Indicator	Plan 1: Road to be Improved				Plan 2: Road not to be Improved			
	Kanchpur Bridge	Meghna Bridge	Gumti Bridge	All Bridges	Kanchpur Bridge	Meghna Bridge	Gumti Bridge	All Bridges
EIRR (%)	38.5 %	24.1 %	19.1 %	24.9 %	38.5 %	21.4 %	16.5 %	23.2 %
BCR	6.22	1.96	1.72	2.59	6.22	1.59	1.40	2.27
NPV (Million BDT)	19,337	9,290	9,127	41,446	19,337	5,751	5,088	33,150

Notes: 1) Evaluation period is 25 years
2) Discount rate is 12 % for NPV and BCR

Table 13.1.19 Benefit and Cost Stream at Kanchpur Bridge (Plan1 & 2)

Unit : Million BDT

SQ	Year	Discounted Cost			Discounted Benefit					Net Benefit
		Construction Cost	O & M Cost	Cost Total	TTC	VOC	ACC	RRC	Benefit Total	
1	2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0
2	2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0
3	2014	111.2	0.0	111.2	0.0	0.0	0.0	0.0	0.0	-111.2
4	2015	16.8	0.0	16.8	0.0	0.0	0.0	0.0	0.0	-16.8
5	2016	776.8	0.0	776.8	0.0	0.0	0.0	0.0	0.0	-776.8
6	2017	708.5	0.0	708.5	0.0	0.0	0.0	0.0	0.0	-708.5
7	2018	641.2	0.0	641.2	0.0	0.0	0.0	0.0	0.0	-641.2
8	2019	581.1	5.1	586.3	351.8	244.3	0.2	9.3	605.6	19.3
9	2020	506.9	4.6	511.5	358.5	314.1	0.2	8.3	681.0	169.5
10	2021	263.4	4.1	267.5	365.3	403.7	0.2	7.4	776.6	509.1
11	2022	1.8	3.7	5.4	372.2	519.0	0.2	6.6	898.0	892.5
12	2023	0.0	6.7	6.7	379.3	667.1	0.1	5.9	1,052.5	1,045.8
13	2024	0.0	6.0	6.0	386.5	857.5	0.1	5.3	1,249.5	1,243.5
14	2025	0.0	2.6	2.6	393.9	1,102.3	0.1	4.7	1,501.0	1,498.4
15	2026	0.0	2.3	2.3	364.1	1,092.4	0.1	4.2	1,460.8	1,458.5
16	2027	0.0	2.1	2.1	336.6	1,082.6	0.1	3.7	1,423.0	1,420.9
17	2028	0.0	12.7	12.7	311.1	1,072.8	0.1	3.3	1,387.4	1,374.7
18	2029	0.0	9.5	9.5	287.6	1,063.2	0.1	3.0	1,353.9	1,344.4
19	2030	0.0	1.5	1.5	265.8	1,053.6	0.1	2.7	1,322.2	1,320.7
20	2031	0.0	1.3	1.3	245.7	1,044.1	0.1	2.4	1,292.3	1,291.0
21	2032	0.0	1.2	1.2	219.4	932.3	0.1	2.1	1,153.9	1,152.7
22	2033	0.0	2.1	2.1	195.9	832.4	0.1	1.9	1,030.2	1,028.1
23	2034	0.0	1.9	1.9	174.9	743.2	0.1	1.7	919.9	917.9
24	2035	0.0	0.8	0.8	156.2	663.6	0.0	1.5	821.3	820.5
25	2036	0.0	0.7	0.7	144.4	592.5	0.0	1.4	738.2	737.5
26	2037	0.0	0.7	0.7	128.9	529.0	0.0	1.2	659.1	658.5
27	2038	0.0	22.8	22.8	115.1	472.3	0.0	1.1	588.5	565.7
28	2039	0.0	4.8	4.8	102.8	421.7	0.0	1.0	525.5	520.7
29	2040	0.0	0.5	0.5	91.7	376.5	0.0	0.9	469.2	468.7
30	2041	0.0	0.4	0.4	84.8	336.2	0.0	0.8	421.8	421.4
31	2042	0.0	0.4	0.4	75.7	300.2	0.0	0.7	376.6	376.2
32	2043	0.0	0.7	0.7	67.6	268.0	0.0	0.6	336.2	335.6
Total		3,607.8	99.1	3,706.8	5,976.0	16,984.7	2.1	81.5	23,044.2	19,337.4

Note: Evaluation period is assumed to be 25 years after opening to public

Table 13.1.20 Cost and Benefit Stream at Meghna Bridge (Plan 1)

Unit : Million BDT

SQ	Year	Discounted Cost			Discounted Benefit					Net Benefit
		Construction Cost	O & M Cost	Cost Total	TTC	VOC	ACC	RRC	Benefit Total	
1	2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
2	2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
3	2014	291.8	0.0	291.8	0.0	0.0	0.0	0.0	0.0	−291.8
4	2015	44.1	0.0	44.1	0.0	0.0	0.0	0.0	0.0	−44.1
5	2016	2,038.6	0.0	2,038.6	0.0	0.0	0.0	0.0	0.0	−2,038.6
6	2017	1,859.2	0.0	1,859.2	0.0	0.0	0.0	0.0	0.0	−1,859.2
7	2018	1,682.6	0.0	1,682.6	0.0	0.0	0.0	0.0	0.0	−1,682.6
8	2019	1,525.0	0.0	1,525.0	0.0	0.0	0.0	0.0	0.0	−1,525.0
9	2020	1,330.2	15.1	1,345.4	1,207.9	422.7	0.4	111.8	534.9	−810.4
10	2021	691.2	14.1	705.3	1,192.7	415.8	0.4	99.9	1,708.7	1,003.4
11	2022	4.7	12.9	17.6	1,177.7	409.0	0.4	89.2	1,676.2	1,658.7
12	2023	0.0	11.7	11.7	1,162.9	402.3	0.4	79.6	1,645.2	1,633.5
13	2024	0.0	17.8	17.8	1,148.3	395.8	0.4	71.1	1,615.5	1,597.6
14	2025	0.0	15.9	15.9	1,133.8	389.3	0.4	63.5	453.1	437.2
15	2026	0.0	8.5	8.5	1,039.2	356.4	0.3	56.7	1,452.6	1,444.1
16	2027	0.0	7.6	7.6	952.4	326.3	0.3	50.6	1,329.6	1,322.0
17	2028	0.0	6.8	6.8	872.9	298.8	0.3	45.2	1,217.1	1,210.3
18	2029	0.0	26.8	26.8	800.0	273.6	0.3	40.3	1,114.1	1,087.4
19	2030	0.0	16.2	16.2	714.3	244.2	0.2	36.0	280.5	264.3
20	2031	0.0	4.8	4.8	637.7	218.1	0.2	32.1	888.2	883.3
21	2032	0.0	4.3	4.3	569.4	194.7	0.2	28.7	793.0	788.7
22	2033	0.0	3.9	3.9	508.4	173.8	0.2	25.6	708.1	704.2
23	2034	0.0	5.7	5.7	453.9	155.2	0.1	22.9	632.2	626.4
24	2035	0.0	5.1	5.1	405.3	138.6	0.1	20.4	159.2	154.0
25	2036	0.0	2.7	2.7	361.9	123.7	0.1	18.2	504.0	501.2
26	2037	0.0	2.5	2.5	323.1	110.5	0.1	16.3	450.0	447.5
27	2038	0.0	2.2	2.2	288.5	98.6	0.1	14.5	401.8	399.6
28	2039	0.0	31.6	31.6	257.6	88.1	0.1	13.0	358.7	327.1
29	2040	0.0	5.9	5.9	230.0	78.6	0.1	11.6	90.3	84.4
30	2041	0.0	1.6	1.6	205.3	70.2	0.1	10.4	286.0	284.4
31	2042	0.0	1.4	1.4	183.3	62.7	0.1	9.2	255.3	253.9
32	2043	0.0	1.2	1.2	163.7	56.0	0.1	8.3	228.0	226.7
33	2044	0.0	1.8	1.8	146.2	50.0	0.0	7.4	203.5	201.7
Total		9,467.4	228.4	9,695.8	16,136.3	5,553.1	5.2	982.4	18,985.8	9,290.1

Note: Evaluation period is assumed to be 25 years after opening to public

Table 13.1.21 Cost Benefit Stream at Meghna Bridge (Plan 2)

Unit : Million BDT

SQ	Year	Discounted Cost			Discounted Benefit					Net Benefit
		Construction Cost	O & M Cost	Cost Total	TTC	VOC	ACC	RRC	Benefit Total	
1	2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
2	2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
3	2014	291.8	0.0	291.8	0.0	0.0	0.0	0.0	0.0	−291.8
4	2015	44.1	0.0	44.1	0.0	0.0	0.0	0.0	0.0	−44.1
5	2016	2,038.6	0.0	2,038.6	0.0	0.0	0.0	0.0	0.0	−2,038.6
6	2017	1,859.2	0.0	1,859.2	0.0	0.0	0.0	0.0	0.0	−1,859.2
7	2018	1,682.6	0.0	1,682.6	0.0	0.0	0.0	0.0	0.0	−1,682.6
8	2019	1,525.0	0.0	1,525.0	0.0	0.0	0.0	0.0	0.0	−1,525.0
9	2020	1,330.2	15.1	1,345.4	1,150.0	393.7	0.4	111.8	505.9	−839.5
10	2021	691.2	14.1	705.3	1,124.4	374.2	0.4	99.9	1,598.9	893.6
11	2022	4.7	12.9	17.6	1,099.4	355.8	0.4	89.2	1,544.7	1,527.2
12	2023	0.0	11.7	11.7	1,075.0	338.2	0.4	79.6	1,493.2	1,481.4
13	2024	0.0	17.8	17.8	1,051.1	321.5	0.4	71.1	1,444.1	1,426.2
14	2025	0.0	15.9	15.9	1,027.7	305.7	0.4	63.5	369.5	353.6
15	2026	0.0	8.5	8.5	837.9	256.3	0.3	56.7	1,151.2	1,142.7
16	2027	0.0	7.6	7.6	748.1	228.9	0.3	50.6	1,027.8	1,020.2
17	2028	0.0	6.8	6.8	668.0	204.4	0.2	45.2	917.7	910.9
18	2029	0.0	26.8	26.8	596.4	182.5	0.2	40.3	819.4	792.6
19	2030	0.0	16.2	16.2	532.5	162.9	0.2	36.0	199.1	182.9
20	2031	0.0	4.8	4.8	475.4	145.5	0.2	32.1	653.2	648.4
21	2032	0.0	4.3	4.3	424.5	129.9	0.2	28.7	583.2	578.9
22	2033	0.0	3.9	3.9	379.0	116.0	0.1	25.6	520.7	516.9
23	2034	0.0	5.7	5.7	338.4	103.5	0.1	22.9	464.9	459.2
24	2035	0.0	5.1	5.1	302.2	92.4	0.1	20.4	113.0	107.8
25	2036	0.0	2.7	2.7	269.8	82.5	0.1	18.2	370.7	367.9
26	2037	0.0	2.5	2.5	240.9	73.7	0.1	16.3	330.9	328.5
27	2038	0.0	2.2	2.2	215.1	65.8	0.1	14.5	295.5	293.3
28	2039	0.0	31.6	31.6	192.0	58.7	0.1	13.0	263.8	232.2
29	2040	0.0	5.9	5.9	171.5	52.5	0.1	11.6	64.1	58.2
30	2041	0.0	1.6	1.6	153.1	46.8	0.1	10.4	210.3	208.8
31	2042	0.0	1.4	1.4	136.7	41.8	0.0	9.2	187.8	186.4
32	2043	0.0	1.2	1.2	122.0	37.3	0.0	8.3	167.7	166.4
33	2044	0.0	1.8	1.8	109.0	33.3	0.0	7.4	149.7	147.9
Total		9,467.4	228.4	9,695.8	13,439.8	4,203.9	4.8	982.4	15,447.1	5,751.4

Note: Evaluation period is assumed to be 25 years after opening to public

Table 13.1.22 Cost and Benefit Stream at Gumti Bridge (Plan1)

Unit : Million BDT

SQ	Year	Discounted Cost			Discounted Benefit					Net Benefit
		Construction Cost	O & M Cost	Cost Total	TTC	VOC	ACC	RRC	Benefit Total	
1	2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
2	2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
3	2014	383.4	0.0	383.4	0.0	0.0	0.0	0.0	0.0	−383.4
4	2015	57.9	0.0	57.9	0.0	0.0	0.0	0.0	0.0	−57.9
5	2016	2,678.6	0.0	2,678.6	0.0	0.0	0.0	0.0	0.0	−2,678.6
6	2017	2,443.0	0.0	2,443.0	0.0	0.0	0.0	0.0	0.0	−2,443.0
7	2018	2,210.9	0.0	2,210.9	0.0	0.0	0.0	0.0	0.0	−2,210.9
8	2019	2,003.7	0.0	2,003.7	0.0	0.0	0.0	0.0	0.0	−2,003.7
9	2020	1,747.9	14.9	1,762.8	1,158.1	405.3	0.6	99.4	1,663.4	−99.3
10	2021	908.2	13.9	922.1	1,143.6	398.7	0.6	88.8	1,631.6	709.5
11	2022	6.2	12.7	18.8	1,129.2	392.2	0.5	79.3	1,601.1	1,582.3
12	2023	0.0	11.6	11.6	1,115.0	385.8	0.5	70.8	1,572.0	1,560.4
13	2024	0.0	21.4	21.4	1,101.0	379.5	0.5	63.2	1,544.1	1,522.7
14	2025	0.0	19.1	19.1	1,087.1	373.3	0.4	56.4	1,517.3	1,498.2
15	2026	0.0	8.4	8.4	996.4	341.8	0.4	50.4	1,388.9	1,380.5
16	2027	0.0	7.5	7.5	913.2	312.9	0.4	45.0	1,271.4	1,263.9
17	2028	0.0	6.7	6.7	836.9	286.5	0.3	40.2	1,163.9	1,157.2
18	2029	0.0	37.4	37.4	767.0	262.3	0.3	35.9	1,065.5	1,028.1
19	2030	0.0	21.7	21.7	684.9	234.2	0.3	32.0	951.3	929.6
20	2031	0.0	4.8	4.8	627.7	214.4	0.2	28.6	870.9	866.1
21	2032	0.0	4.3	4.3	560.4	191.4	0.2	25.5	777.6	773.3
22	2033	0.0	3.8	3.8	500.4	170.9	0.2	22.8	694.3	690.5
23	2034	0.0	6.9	6.9	446.8	152.6	0.2	20.3	619.9	613.0
24	2035	0.0	6.1	6.1	398.9	136.3	0.2	18.2	553.5	547.3
25	2036	0.0	2.7	2.7	356.2	121.7	0.1	16.2	494.2	491.5
26	2037	0.0	2.4	2.4	318.0	108.6	0.1	14.5	441.2	438.8
27	2038	0.0	2.2	2.2	283.9	97.0	0.1	12.9	394.0	391.8
28	2039	0.0	45.7	45.7	253.5	86.6	0.1	11.5	351.7	306.1
29	2040	0.0	7.9	7.9	226.3	77.3	0.1	10.3	314.1	306.2
30	2041	0.0	1.5	1.5	202.1	69.0	0.1	9.2	280.4	278.9
31	2042	0.0	1.4	1.4	180.4	61.6	0.1	8.2	250.4	249.0
32	2043	0.0	1.2	1.2	161.1	55.0	0.1	7.3	223.5	222.3
33	2044	0.0	2.2	2.2	143.8	49.1	0.1	6.6	199.6	197.4
Total		12,439.8	268.3	12,708.1	15,591.8	5,363.9	6.5	873.5	21,835.6	9,127.5

Note: Evaluation period is assumed to be 25 years after opening to public

Table 13.1.23 Cost Benefit Stream at Gumti Bridge (Plan2)

Unit : Million BDT

SQ	Year	Discounted Cost			Discounted Benefit					Net Benefit
		Construction Cost	O & M Cost	Cost Total	TTC	VOC	ACC	RRC	Benefit Total	
1	2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
2	2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
3	2014	383.4	0.0	383.4	0.0	0.0	0.0	0.0	0.0	−383.4
4	2015	57.9	0.0	57.9	0.0	0.0	0.0	0.0	0.0	−57.9
5	2016	2,678.6	0.0	2,678.6	0.0	0.0	0.0	0.0	0.0	−2,678.6
6	2017	2,443.0	0.0	2,443.0	0.0	0.0	0.0	0.0	0.0	−2,443.0
7	2018	2,210.9	0.0	2,210.9	0.0	0.0	0.0	0.0	0.0	−2,210.9
8	2019	2,003.7	0.0	2,003.7	0.0	0.0	0.0	0.0	0.0	−2,003.7
9	2020	1,747.9	14.9	1,762.8	1,102.6	377.5	0.6	99.4	1,580.1	−182.7
10	2021	908.2	13.9	922.1	1,078.1	358.8	0.6	88.8	1,526.3	604.1
11	2022	6.2	12.7	18.8	1,054.1	341.1	0.5	79.3	1,475.0	1,456.2
12	2023	0.0	11.6	11.6	1,030.7	324.3	0.5	70.8	1,426.3	1,414.7
13	2024	0.0	21.4	21.4	1,007.8	308.3	0.5	63.2	1,379.7	1,358.3
14	2025	0.0	19.1	19.1	985.4	293.1	0.4	56.4	1,335.3	1,316.2
15	2026	0.0	8.4	8.4	803.4	245.8	0.4	50.4	1,099.9	1,091.5
16	2027	0.0	7.5	7.5	717.3	219.4	0.3	45.0	982.1	974.6
17	2028	0.0	6.7	6.7	640.5	195.9	0.3	40.2	876.8	870.1
18	2029	0.0	37.4	37.4	571.8	174.9	0.3	35.9	782.9	745.5
19	2030	0.0	21.7	21.7	510.6	156.2	0.2	32.0	699.0	677.3
20	2031	0.0	4.8	4.8	455.9	139.5	0.2	28.6	624.1	619.3
21	2032	0.0	4.3	4.3	407.0	124.5	0.2	25.5	557.2	553.0
22	2033	0.0	3.8	3.8	363.4	111.2	0.2	22.8	497.5	493.7
23	2034	0.0	6.9	6.9	324.5	99.3	0.1	20.3	444.2	437.4
24	2035	0.0	6.1	6.1	289.7	88.6	0.1	18.2	396.6	390.5
25	2036	0.0	2.7	2.7	258.7	79.1	0.1	16.2	354.1	351.4
26	2037	0.0	2.4	2.4	231.0	70.7	0.1	14.5	316.2	313.8
27	2038	0.0	2.2	2.2	206.2	63.1	0.1	12.9	282.3	280.2
28	2039	0.0	45.7	45.7	184.1	56.3	0.1	11.5	252.1	206.4
29	2040	0.0	7.9	7.9	164.4	50.3	0.1	10.3	225.1	217.2
30	2041	0.0	1.5	1.5	146.8	44.9	0.1	9.2	200.9	199.4
31	2042	0.0	1.4	1.4	131.0	40.1	0.1	8.2	179.4	178.0
32	2043	0.0	1.2	1.2	117.0	35.8	0.1	7.3	160.2	159.0
33	2044	0.0	2.2	2.2	104.5	32.0	0.0	6.6	143.0	140.8
Total		12,439.8	268.3	12,708.1	12,886.2	4,030.7	6.2	873.5	17,796.6	5,088.5

Note: Evaluation period is assumed to be 25 years after opening to public

Table 13.1.24 Cost and Benefit Stream at All Bridges (Plan 1)

Unit : Million BDT

SQ	Year	Discounted Cost			Discounted Benefit					Net Benefit
		Construction Cost	O & M Cost	Cost Total	TTC	VOC	ACC	RRC	Benefit Total	
1	2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
2	2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
3	2014	786.4	0.0	786.4	0.0	0.0	0.0	0.0	0.0	−786.4
4	2015	118.8	0.0	118.8	0.0	0.0	0.0	0.0	0.0	−118.8
5	2016	5,494.1	0.0	5,494.1	0.0	0.0	0.0	0.0	0.0	−5,494.1
6	2017	5,010.7	0.0	5,010.7	0.0	0.0	0.0	0.0	0.0	−5,010.7
7	2018	4,534.7	0.0	4,534.7	0.0	0.0	0.0	0.0	0.0	−4,534.7
8	2019	4,109.8	5.1	4,114.9	351.8	244.3	0.2	9	605.6	−3,509.4
9	2020	3,585.1	34.6	3,619.6	2,724.5	1,142.1	1.2	220	4,087.2	467.6
10	2021	1,862.8	32.1	1,894.9	2,701.5	1,218.2	1.1	196	4,116.9	2,222.0
11	2022	12.6	29.2	41.9	2,679.1	1,320.1	1.1	175	4,175.4	4,133.5
12	2023	0.0	30.0	30.0	2,657.2	1,455.2	1.0	156	4,269.7	4,239.7
13	2024	0.0	45.2	45.2	2,635.8	1,632.8	1.0	140	4,409.1	4,363.9
14	2025	0.0	37.6	37.6	2,614.8	1,864.9	0.9	125	4,605.3	4,567.6
15	2026	0.0	19.3	19.3	2,399.6	1,790.6	0.9	111	4,302.3	4,283.0
16	2027	0.0	17.2	17.2	2,202.1	1,721.8	0.8	99	4,024.0	4,006.8
17	2028	0.0	26.2	26.2	2,020.9	1,658.1	0.7	89	3,768.4	3,742.2
18	2029	0.0	73.6	73.6	1,854.6	1,599.0	0.6	79	3,533.5	3,459.8
19	2030	0.0	39.4	39.4	1,665.0	1,532.0	0.6	71	3,268.3	3,228.9
20	2031	0.0	10.9	10.9	1,511.2	1,476.6	0.5	63	3,051.4	3,040.5
21	2032	0.0	9.8	9.8	1,349.3	1,318.4	0.5	56	2,724.5	2,714.7
22	2033	0.0	9.8	9.8	1,204.7	1,177.2	0.4	50	2,432.6	2,422.8
23	2034	0.0	14.5	14.5	1,075.6	1,051.0	0.4	45	2,171.9	2,157.4
24	2035	0.0	12.1	12.1	960.4	938.4	0.3	40	1,939.2	1,927.1
25	2036	0.0	6.2	6.2	862.4	837.9	0.3	36	1,736.4	1,730.2
26	2037	0.0	5.5	5.5	770.0	748.1	0.3	32	1,550.3	1,544.8
27	2038	0.0	27.1	27.1	687.5	667.9	0.2	29	1,384.2	1,357.1
28	2039	0.0	82.1	82.1	613.8	596.4	0.2	25	1,235.9	1,153.9
29	2040	0.0	14.2	14.2	548.1	532.5	0.2	23	1,103.5	1,089.3
30	2041	0.0	3.5	3.5	492.2	475.4	0.2	20	988.2	984.6
31	2042	0.0	3.1	3.1	439.5	424.5	0.1	18	882.3	879.1
32	2043	0.0	3.2	3.2	392.4	379.0	0.1	16	787.8	784.6
33	2044	0.0	4.1	4.1	290.0	99.1	0.1	14	403.1	399.1
Total		25,514.9	595.8	26,110.7	37,704.1	27,901.7	13.9	1,937.3	67,556.9	41,446.2

Note: Evaluation period is assumed to be 25 years after opening to public

Table 13.1.25 Cost Benefit Stream at All Bridges (Plan 2)

Unit : Million BDT

SQ	Year	Discounted Cost			Discounted Benefit					Net Benefit
		Construction Cost	O & M Cost	Cost Total	TTC	VOC	ACC	ACC	Benefit Total	
1	2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
2	2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.0
3	2014	786.4	0.0	786.4	0.0	0.0	0.0	0.0	0.0	−786.4
4	2015	118.8	0.0	118.8	0.0	0.0	0.0	0.0	0.0	−118.8
5	2016	5,494.1	0.0	5,494.1	0.0	0.0	0.0	0.0	0.0	−5,494.1
6	2017	5,010.7	0.0	5,010.7	0.0	0.0	0.0	0.0	0.0	−5,010.7
7	2018	4,534.7	0.0	4,534.7	0.0	0.0	0.0	0.0	0.0	−4,534.7
8	2019	4,109.8	5.1	4,114.9	351.8	244.3	0.2	9.3	605.6	−3,509.4
9	2020	3,585.1	34.6	3,619.6	2,611.0	1,085.2	1.2	219.6	3,917.0	297.3
10	2021	1,862.8	32.1	1,894.9	2,567.8	1,136.8	1.1	196.0	3,901.7	2,006.8
11	2022	12.6	29.2	41.9	2,525.8	1,215.9	1.1	175.0	3,917.8	3,875.9
12	2023	0.0	30.0	30.0	2,485.0	1,329.7	1.0	156.3	3,971.9	3,941.9
13	2024	0.0	45.2	45.2	2,445.3	1,487.4	1.0	139.5	4,073.3	4,028.1
14	2025	0.0	37.6	37.6	2,232.1	1,664.7	0.9	124.6	4,022.3	3,984.6
15	2026	0.0	19.3	19.3	2,005.4	1,594.5	0.8	111.2	3,711.9	3,692.6
16	2027	0.0	17.2	17.2	1,802.0	1,530.9	0.7	99.3	3,432.9	3,415.7
17	2028	0.0	26.2	26.2	1,619.5	1,473.1	0.6	88.7	3,182.0	3,155.8
18	2029	0.0	73.6	73.6	1,455.8	1,420.6	0.6	79.2	2,956.1	2,882.5
19	2030	0.0	39.4	39.4	1,308.9	1,372.7	0.5	70.7	2,752.8	2,713.4
20	2031	0.0	10.9	10.9	1,177.1	1,329.1	0.5	63.1	2,569.7	2,558.7
21	2032	0.0	9.8	9.8	1,050.9	1,186.7	0.4	56.4	2,294.4	2,284.6
22	2033	0.0	9.8	9.8	938.3	1,059.5	0.4	50.3	2,048.5	2,038.7
23	2034	0.0	14.5	14.5	837.8	946.0	0.3	44.9	1,829.0	1,814.5
24	2035	0.0	12.1	12.1	748.0	844.6	0.3	40.1	1,633.1	1,621.0
25	2036	0.0	6.2	6.2	672.8	754.1	0.3	35.8	1,463.0	1,456.8
26	2037	0.0	5.5	5.5	600.7	673.3	0.2	32.0	1,306.3	1,300.7
27	2038	0.0	27.1	27.1	536.4	601.2	0.2	28.6	1,166.3	1,139.2
28	2039	0.0	82.1	82.1	478.9	536.8	0.2	25.5	1,041.4	959.3
29	2040	0.0	14.2	14.2	427.6	479.3	0.2	22.8	929.8	915.5
30	2041	0.0	3.5	3.5	384.7	427.9	0.1	20.3	833.1	829.5
31	2042	0.0	3.1	3.1	343.5	382.1	0.1	18.1	743.8	740.7
32	2043	0.0	3.2	3.2	306.7	341.1	0.1	16.2	664.1	660.9
33	2044	0.0	4.1	4.1	213.4	65.3	0.1	13.9	292.7	288.7
Total		25,514.9	595.8	26,110.7	32,127.2	25,182.9	13.0	1,937.3	59,260.4	33,149.7

Note: Evaluation period is assumed to be 25 years after opening to public

(2) Sensitivity Analysis

The sensitivity analysis of the economic analysis is conducted for a) Benefit fluctuation (±10 %), b) Project cost fluctuation (±10 %), c) Delay of completion of construction period and delay of opening and d) Inclusive riprap cost saving to the benefit. The results of the sensitivity analysis are shown in Table 13.1.26 to Table 13.1.29.

Table 13.1.26 Results of the Sensitivity Analysis of Kanchpur Bridge (Plan 1 & 2)

Unit EIRR (%)

Factor	Economic Indicator	Plan 1& 2
Benefit	Base Case	38.5
	10 % increase in every year	40.1
	10 % decrease in every year	36.7
Project cost	Base Case	38.5
	10 % increase in every year	36.5
	10 % decrease in every year	40.7
Time of completion of the construction	Base case	38.5
	1 year delay of opening	34.9

Source: JICA Study Team

Table 13.1.27 Results of the Sensitivity Analysis of Meghna Bridge (Unit: EIRR (%))

Factor	Economic Indicator	Plan 1	Plan 2
Benefit	Base Case	24.1	21.4
	10 % increase in every year	25.8	23.2
	10 % decrease in every year	22.3	19.8
Project cost	Base Case	24.1	21.4
	10 % increase in every year	22.5	19.9
	10 % decrease in every year	26.0	23.4
Time of completion of the construction	Base case	24.1	21.4
	1 year delay of opening	21.0	19.3

Source: JICA Study Team

Table 13.1.28 Results of the Sensitivity Analysis of Gumti Bridge (Unit: EIRR (%))

Factor	Economic Indicator	Plan1	Plan 2
Benefit	Base Case	19.1	16.5
	10 % increase in every year	20.5	17.9
	10 % decrease in every year	17.6	15.0
Project cost	Base Case	19.1	16.5
	10 % increase in every year	17.7	15.1
	10 % decrease in every year	20.7	18.1
Time of completion of the construction	Base case	19.1	16.5
	1 year delay of opening	17.5	15.0

Source: JICA Study Team

Table 13.1.29 Results of the Sensitivity Analysis of All Bridges (Unit: EIRR (%))

Factor	Economic Indicator	Plan1	Plan 2
Benefit	Base Case	24.9	23.2
	10 % increase in every year	26.5	24.8
	10 % decrease in every year	23.2	21.5
Project cost	Base Case	24.9	23.2
	10 % increase in every year	23.3	21.7
	10 % decrease in every year	26.7	25.6
Time of completion of the construction	Base case	24.9	23.2
	1 year delay of opening	22.1	20.3

Source: JICA Study Team

13.2 Financial Analysis

13.2.1 General

The financial performance of each bridge project is examined based on the financial cash flow for the Project implementation. The major works of the financial evaluation are to prepare the input data of the financial statements and necessary external variables such as construction costs, operation/maintenance costs, revenues and financial parameters. Usually

financial statements are composed of cash flow statements. The cash flow statement consists of cash-inflow and cash-outflow to estimate the annual surplus or deficit including the loan and application of funds.

Financial viability is examined from a variety of viewpoints such as financial feasibility, and profitability.

Among the three (3) bridges, Kanchpur, Meghna and Gumti Bridges, Meghna and Gumti Bridges are presently levied a toll, while Kanchpur Bridge is not levied a toll at present. (Figure 13.2.1 shows the location map of the Toll Gates) The RHD policy for Toll Levy of the bridges is as follows;

- A toll levy is principally applicable for a long bridge.
- When the traffic congestion is expected due to toll levy, a toll levy may not be applicable.

Although the RHD policy is mentioned above, whether or not a Toll Levy may be applicable for Kanchpur Bridge will be examined in this study.

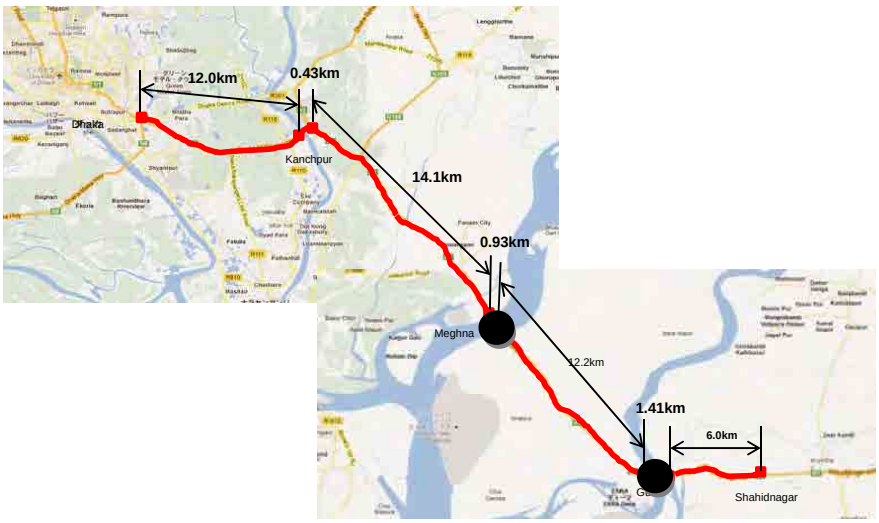


Figure 13.2.1 Location of Toll Gates for Meghna and Gumti Bridges

At present, the toll rate by vehicle type is adopted for Meghna and Gumti Bridges as follows;

Table 13.2.1 Toll Rate by Vehicle Type (as of August 2012) (Unit: BDT/Vehicle)

Class	Type of Vehicle	Toll Fee	Class	Type of Vehicle	Toll fee
Class 1	Motorcycle	10	Class 2	Auto Rickshaw	20
Class 3	Car, Jeep, Utility	50	Class 4	Micro Bus	70
Class 5	Mini Bus	150	Class 6	Large Bus	400
Class 7	Truck	400	Class 8	Trailer	1,000

Source: RHD

Although there are two (2) toll gates at Meghna and Gumti Bridges, the toll gate at Meghna Bridge levies a toll for vehicle traffic from Dhaka to Chittagong while that at Gumti Bridge levies a toll for the opposite direction from Chittagong to Dhaka. This means that when some vehicles travel from Dhaka to Chittagong, the toll fee is paid only one time at the toll gate of Meghna Bridge and returning vehicles from Chittagong to Dhaka also only pay one time at the toll gate of Gumti Bridge.

13.2.2 Cases for Financial Analysis

The following three (3) cases are considered for the financial analysis;

a) Case 1: Cost recovery analysis for the three (3) Bridges individually
b) Case 2: Cost recovery analysis of all three (3) Bridges using revenues from 2 bridges, namely Meghna and Gumti Bridges
c) Case 3: Cost recovery analysis of all three (3) Bridges using revenues of all 3 bridges

13.2.3 Assumptions Adopted

Basic assumptions adopted in the financial evaluation are as follows;

(1) Project Cost

Based on the construction costs and operation/maintenance costs in Chapters 10 and 11, the financial construction and operation/maintenance costs are estimated for the financial evaluation. Some basic assumptions in conducting the financial evaluation are as follows;

- Escalation factor: Price inflation is not taken into account for either construction costs or operation/maintenance cost.
- Tax and import duty: Those taxes are included.
- Resettlement cost: Resettlement cost estimated in the Resettlement Action Plan (RAP) is used in the economic and financial analysis.
- Operation and maintenance cost consists of three items: routine maintenance, periodic maintenance and toll levying cost.

- The same implementation schedule is adopted as for Table 13.2.1 and the project costs of all three bridges are estimated as shown in Table 13.2.2. For more details, the calculation of economic cost is shown in Appendix 16.

Table 13.2.2 Financial Project Cost Stream by Bridges

Unit: Million BDT

Year	Kanchpur Bridge	Meghna Bridge	Gumti Bridge	Total
2012	0	0	0	0
2013	0	0	0	0
2014	182	477	627	1,286
2015	32	83	109	224
2016	1,725	4,526	5,947	12,198
2017	1,761	4,620	6,071	12,451
2018	1,783	4,679	6,148	12,610
2019	1,809	4,746	6,236	12,790
2020	1,768	4,639	6,095	12,502
2021	1,029	2,699	3,547	7,275
2022	8	20	26	53
2023	488	1,281	1,683	3,452
Total	10,582	27,770	36,489	74,842

Notes: All costs are 2012 prices

Table 13.2.3 Financial Operation and Management Cost by Bridge

Unit: Million BDT

Type of Maintenance	Kanchpur No Toll	Kanchpur with Toll	Meghna	Gumti	All Bridges No Toll on Kanchpur	All Bridges with Toll on Kanchpur
Routine Maintenance	79.6	79.6	185.4	281.2	546.2	546.2
Periodic Maintenance	933.1	933.1	1,478.8	2,203.4	4,615.3	4,615.3
Toll operation cost	0.0	786.6	792.4	792.4	1,584.8	2,371.4
Other	304.3	419.3	419.5	304.3	1,028.1	1,143.1
Total	1,317.0	2,218.6	2,875.9	3,581.3	7,774.4	8,676.0

Notes: All costs are 2012 prices

(2) Revenue

The revenue estimation is based on the following assumptions;

- Revenue is set on the basis of the results of the traffic demand forecast mentioned in Chapter 3. However, the projected traffic volume is constant after 2025 due to traffic volume on these three (3) bridges exceeding their road traffic capacity.

- Toll rate is set based on the existing toll rates adopted for Meghna and Gumti Bridges.

- The escalation factor for the toll rate is not taken into account since the project cost does not include any price inflation.

The revenue obtained over the project implementation period is shown in Table 13.2.4.

Table 13.2.4 Forecast Annual Toll Revenues of Three (3) Bridges (Unit: Million BDT)

Plan/Case		2012 (Actual)	2020	2023	2025
Kanchpur Bridge w/o Toll Case		NA	0	0	0
Kanchpur Bridge w/ Toll Case		NA	2,899	3,408	3,797
Meghna / Gumti Bridge	Plan1	1,769	2,408	2,836	3,164
	Plan2	1,769	2,408	2,836	2,995
Meghna & Gumti Bridge only	Plan1	3,538	4,816	5,672	6,329
	Plan2	3,538	4,816	5,672	5,991
All Bridges (Toll on Kanchpur Bridge)	Plan1	3,538	7,714	9,080	10,126
	Plan2	3,538	7,714	9,080	9,788

Source: 1) Revenue data in 2011 by RHD
2) Other years by JICA Study Team

(3) Evaluation Period, Discount Rate, and Financial Application

- The evaluation period is assumed to be 25 years after opening of traffic to the public from 2019 to 2043 for Kanchpur Bridge and from the 2nd half of 2019 to the 1st half of 2044 for Meghna and Gumti Bridges, the same as the economic analysis.
- The annualized factor of the daily revenue is assumed to be 340 days per year as explained in Section 13.1.2.
- Discount rate for financial analysis is assumed to be 8 % per annum taking into consideration 10 year Treasury bonds in Bangladesh.
- The financial analysis does not consider application of a financial scheme.

(4) Indices for financial analysis

Each project stage was evaluated from the financial viewpoint. Indices adopted here are NPV and FIRR. Description of each index is given in Table 13.2.5.

Table 13.2.5 Indicators for Financial Viability Analysis

Typical Indicators	Descriptions
Net Present Value (NPV)	NPV is the summation of the difference between the present value of the future cash flows from an investment, and the amount of investment through the whole project period. Present value of the expected cash flows is computed by discounting them at the required rate of return. A zero NPV means the project is capable of repaying the original investment as well as the required rate of return. The rate of return at the zero NPV case is defined as the Financial Internal Rate of Return (FIRR). In addition, a positive NPV means a better return, and a negative NPV means a worse return compared to the return from zero NPV.

Financial Internal Rate of Return (FIRR)	The FIRR is an indicator to measure the financial return on an investment in an income generating project and FIRR is used to make the investment decision. FIRR is defined as a discount rate which produces zero NPV as explained above. The criterion for a financially viable FIRR is given by the weighted average capital cost (WACC). WACC is an average capital cost of loan interest rate and rate of return on equity weighted by the share of the amount of loan and equity respectively.
Cost Recovery Years	Cost recovery years that it takes to fully recover the project costs

13.2.4 Results of Financial Analysis

(1) Results of Financial Analysis

As mentioned in 13.2.2, three (3) cases of the financial schemes are considered in this study.

Indices showing financial performance are shown below;

a) Kanchpur Bridge is only financially viable if an interest rate of 8 % for 10 year Bangladesh Treasury bonds is assumed.

b) Meghna and Gumti Bridges are not financially viable if the same discount rate is applied.

c) If toll scheme will be adopted for only Meghna and Gumti Bridges (Case2), Case 2 will not be financially viable. If a toll scheme will be adopted for all three (3) Bridges (Case 3), Case 3 will be financially viable.

Table 13.2.6 Results of Financial Analysis for Kanchpur, Meghna and Gumti Bridge (Case 1)

Indicator	Case 1-1 Kanchpur Bridge		Case 1-2 Meghna Bridge		Case 1-3 Gumti Bridge	
	With Toll	W/O Toll	Plan 1	Plan 2	Plan 1	Plan 2
NPV (Million BDT)	21,978	NA	4,733	781.3	-1,297	-5,249
FIRR (%)	30.4 %	NA	10.2 %	8.1 %	7.4	5.4 %
Cost Recovery After Opening (Years)	4	NA	15	23	NO	NO

Notes: 1) Discount rate is assumed to be 8 % taking into consideration 10 year Treasury bonds in Bangladesh
2) Project life is assumed to be 25 years

Table 13.2.7 Results of Financial Analysis for Cases 2 and 3

Indicator	Case 2 w/o Toll Scheme for Kanchpur Bridge		Case 3 w/ Toll Scheme for Kanchpur Bridge	
	Plan 1	Plan 2	Plan 1	Plan 2
NPV (Million BDT)	-3,883	-11,787	23,628	15,517
FIRR (%)	7.2 %	5.1 %	12.4 %	11.3 %
Cost Recovery After Opening (Years)	No	No	12	12

Notes 1) Discount rate is assumed to be 8 % taking into consideration 10 year Treasury bonds in Bangladesh
2) Project life is assumed to be 25 years

Table 13.2.8 Cash Flow of Kanchpur Bridge (Case 1-1(W/ Toll Case)) (Unit: Million BDT)

SQ	Yaer	Cost			Toll Revenue	Net Revenue	Cummulative Net Revenue
		Construction	O & M	Total			
1	2012	0.00		0.0		-0.0	-0.0
2	2013	0.00		0.0		0.0	-0.0
3	2014	155.93		155.9		-155.9	-155.9
4	2015	25.14		25.1		-25.1	-181.1
5	2016	1267.76		1,267.8		-1,267.8	-1,448.8
6	2017	1198.21		1,198.2		-1,198.2	-2,647.0
7	2018	1123.58		1,123.6		-1,123.6	-3,770.6
8	2019	1055.25	27.1	1082.3	1575.31	493.0	-3,277.6
9	2020		25.1	25.1	1566.04	1,541.0	-1,736.7
10	2021		24.4	24.4	1532.21	1,507.8	-228.8
11	2022		23.1	23.1	1495.76	1,472.7	1,243.8
12	2023		28.8	28.8	1461.47	1,432.7	2,676.6
13	2024		27.1	27.1	1428.27	1,401.2	4,077.7
14	2025		19.2	19.2	1396.10	1,376.9	5,454.7
15	2026		17.8	17.8	1364.93	1,347.2	6,801.8
16	2027		16.4	16.4	1331.59	1,315.1	8,117.0
17	2028		41.4	41.4	1300.15	1,258.8	9,375.7
18	2029		33.7	33.7	1269.70	1,235.9	10,611.7
19	2030		13.1	13.1	1240.19	1,227.1	11,838.8
20	2031		12.1	12.1	1211.58	1,199.5	13,038.3
21	2032		11.2	11.2	1121.83	1,110.6	14,149.0
22	2033		13.6	13.6	1038.74	1,025.2	15,174.1
23	2034		12.5	12.5	961.79	949.2	16,123.4
24	2035		8.9	8.9	890.55	881.7	17,005.1
25	2036		8.2	8.2	824.58	816.4	17,821.4
26	2037		7.6	7.6	763.50	755.9	18,577.3
27	2038		83.9	83.9	706.95	623.0	19,200.3
28	2039		21.8	21.8	654.58	632.8	19,833.1
29	2040		6.0	6.0	606.09	600.0	20,433.2
30	2041		5.6	5.6	561.20	555.6	20,988.7
31	2042		5.2	5.2	519.63	514.4	21,503.2
32	2043		6.3	6.3	481.14	474.9	21,978.1
33	2044		0.0	0.0	0.00	0.0	21,978.1
Total		4,825.9	499.9	5,325.8	27,303.9	21,978.1	

Note: Evaluation period is assumed to be 25 years

Table 13.2.9 Cash Flow of Meghna Bridge (Plan 1)

(Unit: Million BDT)

SQ	Yaer	Cost			Toll Revenue	Net Revenue	Cummulative Net Revenue
		Construction	O & M	Total			
1	2012	0.00		0.0		-0.0	-0.0
2	2013	0		0.0		-0.0	-0.0
3	2014	409		409.2		-409.2	-409.2
4	2015	66		66.0		-66.0	-475.1
5	2016	3,327		3,326.8		-3,326.8	-3,801.9
6	2017	3,144		3,144.3		-3,144.3	-6,946.3
7	2018	2,948		2,948.5		-2,948.5	-9,894.7
8	2019	2,769	0.0	2769.2	0.00	-2,769.2	-12,663.9
9	2020	2,506	27.4	2533.6	1301.02	-1,232.5	-13,896.4
10	2021	1,350	26.5	1376.9	1273.61	-103.3	-13,999.7
11	2022	9	25.1	34.2	1244.02	1,209.8	-12,789.9
12	2023		23.7	23.7	1216.34	1,192.7	-11,597.3
13	2024		37.3	37.3	1189.52	1,152.2	-10,445.1
14	2025		34.6	34.6	1163.53	1,129.0	-9,316.1
15	2026		19.2	19.2	1138.32	1,119.1	-8,197.0
16	2027		17.8	17.8	1111.30	1,093.5	-7,103.5
17	2028		16.5	16.5	1085.96	1,069.5	-6,034.0
18	2029		67.2	67.2	1061.40	994.2	-5,039.8
19	2030		42.2	42.2	1037.54	995.3	-4,044.5
20	2031		13.1	13.1	1014.49	1,001.4	-3,043.1
21	2032		12.1	12.1	939.34	927.2	-2,115.8
22	2033		11.2	11.2	869.76	858.6	-1,257.3
23	2034		17.3	17.3	805.33	788.0	-469.2
24	2035		16.0	16.0	745.68	729.7	260.4
25	2036		8.9	8.9	690.44	681.6	942.0
26	2037		8.2	8.2	639.30	631.1	1,573.0
27	2038		7.6	7.6	591.94	584.3	2,157.4
28	2039		113.8	113.8	548.10	434.3	2,591.7
29	2040		22.0	22.0	507.50	485.5	3,077.2
30	2041		6.1	6.1	469.90	463.9	3,541.0
31	2042		5.6	5.6	435.10	429.5	3,970.5
32	2043		5.2	5.2	402.87	397.7	4,368.2
33	2044		8.0	8.0	373.03	365.0	4,733.2
Total		16,529.7	592.5	17,122.1	21,855.4	4,733.2	

Note: Evaluation period is assumed to be 25 years

Table 13.2.10 Cash Flow of Meghna Bridge (Plan 2)

(Unit: Million BDT)

SQ	Yaer	Cost			Toll Revenue	Net Revenue	Cummulative Net Revenue
		Construction	O & M	Total			
1	2012	0.00		0.0		-0.0	-0.0
2	2013	0		0.0		-0.0	-0.0
3	2014	409		409.2		-409.2	-409.2
4	2015	66		66.0		-66.0	-475.1
5	2016	3,327		3,326.8		-3,326.8	-3,801.9
6	2017	3,144		3,144.3		-3,144.3	-6,946.3
7	2018	2,948		2,948.5		-2,948.5	-9,894.7
8	2019	2,769	0.0	2769.2	0.00	-2,769.2	-12,663.9
9	2020	2,506	27.4	2533.6	1301.02	-1,232.5	-13,896.4
10	2021	1,350	26.5	1376.9	1273.61	-103.3	-13,999.7
11	2022	9	25.1	34.2	1244.02	1,209.8	-12,789.9
12	2023		23.7	23.7	1216.34	1,192.7	-11,597.3
13	2024		37.3	37.3	1189.52	1,152.2	-10,445.1
14	2025		34.6	34.6	1101.41	1,066.8	-9,378.3
15	2026		19.2	19.2	1019.82	1,000.6	-8,377.6
16	2027		17.8	17.8	944.28	926.5	-7,451.1
17	2028		16.5	16.5	874.34	857.9	-6,593.2
18	2029		67.2	67.2	809.57	742.3	-5,850.9
19	2030		42.2	42.2	749.60	707.4	-5,143.5
20	2031		13.1	13.1	694.08	681.0	-4,462.5
21	2032		12.1	12.1	642.66	630.6	-3,832.0
22	2033		11.2	11.2	595.06	583.9	-3,248.1
23	2034		17.3	17.3	550.98	533.7	-2,714.4
24	2035		16.0	16.0	510.17	494.2	-2,220.3
25	2036		8.9	8.9	472.38	463.5	-1,756.8
26	2037		8.2	8.2	437.39	429.2	-1,327.6
27	2038		7.6	7.6	404.99	397.4	-930.3
28	2039		113.8	113.8	374.99	261.2	-669.1
29	2040		22.0	22.0	347.21	325.2	-343.9
30	2041		6.1	6.1	321.49	315.4	-28.4
31	2042		5.6	5.6	297.68	292.1	263.7
32	2043		5.2	5.2	275.63	270.4	534.1
33	2044		8.0	8.0	255.21	247.2	781.3
Total		16,529.7	592.5	17,122.1	17,903.4	781.3	

Note: Evaluation period is assumed to be 25 years

Table 13.2.11 Cash Flow of Gumti Bridge (Plan 1)

(Unit: Million BDT)

SQ	Yaer	Cost			Toll Revenue	Net Revenue	Cummulative Net Revenue
		Construction	O & M	Total			
1	2012	0.0	0.0	0.0		-0.0	-0.0
2	2013	0.0	0.0	0.0		-0.0	-0.0
3	2014	537.6	0.0	537.6		-537.6	-537.6
4	2015	86.7	0.0	86.7		-86.7	-624.3
5	2016	4,371.3	0.0	4,371.3		-4,371.3	-4,995.6
6	2017	4,131.5	0.0	4,131.5		-4,131.5	-9,127.1
7	2018	3,874.2	0.0	3,874.2		-3,874.2	-13,001.3
8	2019	3,638.6	0.0	3,638.6	0.00	-3,638.6	-16,639.9
9	2020	3,293.1	26.9	3,320.0	1301.02	-2,019.0	-18,658.9
10	2021	1,774.4	26.1	1,800.5	1273.61	-526.9	-19,185.7
11	2022	12.1	24.7	36.8	1244.02	1,207.3	-17,978.5
12	2023	721.8	23.4	745.2	1216.34	471.2	-17,507.3
13	2024		44.8	44.8	1189.52	1,144.8	-16,362.5
14	2025		41.4	41.4	1163.53	1,122.1	-15,240.5
15	2026		18.9	18.9	1138.32	1,119.4	-14,121.1
16	2027		17.5	17.5	1111.30	1,093.8	-13,027.3
17	2028		16.2	16.2	1085.96	1,069.7	-11,957.6
18	2029		93.9	93.9	1061.40	967.5	-10,990.0
19	2030		56.5	56.5	1037.54	981.0	-10,009.1
20	2031		12.9	12.9	1014.49	1,001.6	-9,007.5
21	2032		11.9	11.9	939.34	927.4	-8,080.0
22	2033		11.0	11.0	869.76	858.7	-7,221.3
23	2034		20.7	20.7	805.33	784.6	-6,436.7
24	2035		19.2	19.2	745.68	726.5	-5,710.2
25	2036		8.8	8.8	690.44	681.7	-5,028.6
26	2037		8.1	8.1	639.30	631.2	-4,397.4
27	2038		7.5	7.5	591.94	584.4	-3,813.0
28	2039		164.5	164.5	548.10	383.6	-3,429.3
29	2040		29.4	29.4	507.50	478.1	-2,951.2
30	2041		6.0	6.0	469.90	463.9	-2,487.3
31	2042		5.5	5.5	435.10	429.6	-2,057.7
32	2043		5.1	5.1	402.87	397.7	-1,660.0
33	2044		9.6	9.6	373.03	363.4	-1,296.5
Total		22,441.2	710.7	23,151.9	21,855.4	-1,296.5	

Note: Evaluation period is assumed to be 25 years

Table 13.2.12 Cash Flow of Gumti Bridge (Plan 2)

(Unit: Million BDT)

SQ	Yaer	Cost			Toll Revenue	Net Revenue	Cummulative Net Revenue
		Construction	O & M	Total			
1	2012	0.0	0.0	0.0		-0.0	-0.0
2	2013	0.0	0.0	0.0		-0.0	-0.0
3	2014	537.6	0.0	537.6		-537.6	-537.6
4	2015	86.7	0.0	86.7		-86.7	-624.3
5	2016	4,371.3	0.0	4,371.3		-4,371.3	-4,995.6
6	2017	4,131.5	0.0	4,131.5		-4,131.5	-9,127.1
7	2018	3,874.2	0.0	3,874.2		-3,874.2	-13,001.3
8	2019	3,638.6	0.0	3,638.6	0.00	-3,638.6	-16,639.9
9	2020	3,293.1	26.9	3,320.0	1301.02	-2,019.0	-18,658.9
10	2021	1,774.4	26.1	1,800.5	1273.61	-526.9	-19,185.7
11	2022	12.1	24.7	36.8	1244.02	1,207.3	-17,978.5
12	2023	721.8	23.4	745.2	1216.34	471.2	-17,507.3
13	2024		44.8	44.8	1189.52	1,144.8	-16,362.5
14	2025		41.4	41.4	1101.41	1,060.0	-15,302.6
15	2026		18.9	18.9	1019.82	1,000.9	-14,301.7
16	2027		17.5	17.5	944.28	926.7	-13,374.9
17	2028		16.2	16.2	874.34	858.1	-12,516.8
18	2029		93.9	93.9	809.57	715.7	-11,801.1
19	2030		56.5	56.5	749.60	693.1	-11,108.1
20	2031		12.9	12.9	694.08	681.2	-10,426.9
21	2032		11.9	11.9	642.66	630.7	-9,796.2
22	2033		11.0	11.0	595.06	584.0	-9,212.2
23	2034		20.7	20.7	550.98	530.2	-8,681.9
24	2035		19.2	19.2	510.17	491.0	-8,190.9
25	2036		8.8	8.8	472.38	463.6	-7,727.3
26	2037		8.1	8.1	437.39	429.3	-7,298.1
27	2038		7.5	7.5	404.99	397.5	-6,900.6
28	2039		164.5	164.5	374.99	210.5	-6,690.1
29	2040		29.4	29.4	347.21	317.8	-6,372.2
30	2041		6.0	6.0	321.49	315.5	-6,056.7
31	2042		5.5	5.5	297.68	292.1	-5,764.6
32	2043		5.1	5.1	275.63	270.5	-5,494.1
33	2044		9.6	9.6	255.21	245.6	-5,248.5
Total		22,441.2	710.7	23,151.9	17,903.4	-5,248.5	

Note: Evaluation period is assumed to be 25 years

Table 13.2.13 Cash Flow for All Bridges (Plan 1)
(Case 2: No Toll Scheme is adopted for Kanchpur Bridge)

(Unit: Million BDT)

SQ	Year	Discounted Cost				Discounted Toll Revenue				Discounted Net Revenue				Cumulative Net Revenue			
		Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total
1	2012	0	0	0	0	0	0	0	0	-0	-0	-0	-0	0	0	0	0
2	2013	0	0	0	0	0	0	0	0	-0	-0	-0	-0	-0	-0	-0	-0
3	2014	156	409	538	565	0	0	0	0	-156	-409	-538	-1,103	-156	-409	-538	-1,103
4	2015	25	66	87	91	0	0	0	0	-25	-66	-87	-178	-181	-475	-624	-1,281
5	2016	1,268	3,327	4,371	4,595	0	0	0	0	-1,268	-3,327	-4,371	-8,966	-1,449	-3,802	-4,996	-10,246
6	2017	1,198	3,144	4,132	4,343	0	0	0	0	-1,198	-3,144	-4,132	-8,474	-2,647	-6,946	-9,127	-18,720
7	2018	1,124	2,948	3,874	4,072	0	0	0	0	-1,124	-2,948	-3,874	-7,946	-3,771	-9,895	-13,001	-26,667
8	2019	1,064	2,769	3,639	3,833	0	0	0	0	-1,064	-2,769	-3,639	-7,472	-4,835	-12,664	-16,640	-34,139
9	2020	963	2,534	3,320	3,497	0	1,301	1,301	2,602	-963	-1,233	-2,019	-4,215	-5,798	-13,896	-18,659	-38,353
10	2021	522	1,377	1,801	1,899	0	1,274	1,274	2,547	-522	-103	-527	-1,152	-6,320	-14,000	-19,186	-39,506
11	2022	11	34	37	45	0	1,244	1,244	2,488	-11	1,210	1,207	2,406	-6,331	-12,790	-17,978	-37,099
12	2023	223	573	745	796	0	1,216	1,216	2,433	-223	643	471	892	-6,554	-12,147	-17,507	-36,208
13	2024	12	37	45	50	0	1,190	1,190	2,379	-12	1,152	1,145	2,284	-6,566	-10,994	-16,363	-33,923
14	2025	6	35	41	40	0	1,164	1,164	2,327	-6	1,129	1,122	2,245	-6,572	-9,865	-15,240	-31,678
15	2026	5	19	19	24	0	1,138	1,138	2,277	-5	1,119	1,119	2,233	-6,577	-8,746	-14,121	-29,445
16	2027	5	18	18	23	0	1,111	1,111	2,223	-5	1,094	1,094	2,182	-6,582	-7,653	-13,027	-27,262
17	2028	31	16	16	47	0	1,086	1,086	2,172	-31	1,070	1,070	2,109	-6,613	-6,583	-11,958	-25,154
18	2029	24	67	94	91	0	1,061	1,061	2,123	-24	994	968	1,938	-6,637	-5,589	-10,990	-23,216
19	2030	4	42	57	46	0	1,038	1,038	2,075	-4	995	981	1,972	-6,640	-4,594	-10,009	-21,243
20	2031	4	13	13	17	0	1,014	1,014	2,029	-4	1,001	1,002	1,999	-6,644	-3,592	-9,007	-19,244
21	2032	3	12	12	15	0	939	939	1,879	-3	927	927	1,851	-6,647	-2,665	-8,080	-17,392
22	2033	6	11	11	17	0	870	870	1,740	-6	859	859	1,711	-6,653	-1,807	-7,221	-15,681
23	2034	6	17	21	23	0	805	805	1,611	-6	788	785	1,567	-6,659	-1,019	-6,437	-14,115
24	2035	3	16	19	19	0	746	746	1,491	-3	730	726	1,454	-6,662	-289	-5,710	-12,661
25	2036	2	9	9	11	0	690	690	1,381	-2	682	682	1,361	-6,664	393	-5,029	-11,300
26	2037	2	8	8	10	0	639	639	1,279	-2	631	631	1,260	-6,667	1,024	-4,397	-10,040
27	2038	79	8	8	87	0	592	592	1,184	-79	584	584	1,090	-6,745	1,608	-3,813	-8,950
28	2,039	17	114	164	131	0	548	548	1,096	-17	434	384	801	-6,763	2,042	-3,429	-8,150
29	2,040	2	22	29	24	0	507	507	1,015	-2	486	478	962	-6,764	2,528	-2,951	-7,188
30	2,041	2	6	6	8	0	470	470	940	-2	464	464	926	-6,766	2,992	-2,487	-6,262
31	2,042	2	6	6	7	0	435	435	870	-2	429	430	858	-6,768	3,421	-2,058	-5,404
32	2,043	3	5	5	8	0	403	403	806	-3	398	398	793	-6,770	3,819	-1,660	-4,612
33	2,044	0	8	10	8	0	373	373	746	0	365	363	728	-6,770	4,184	-1,297	-3,883
Total		6,770	17,671	23,152	24,442	0	21,855	21,855	43,711	-6,770	4,184	-1,297	-3,883	–	–	–	–

Note: Evaluation period is assumed to be 25 years

Table 13.2.14 Cash Flow for All Bridges (Plan 2)
(Case 2: No Toll Scheme is adopted for Kanchpur Bridge)

(Unit: Million BDT)

SQ	Year	Discounted Cost				Discounted Toll Revenue				Discounted Net Revenue				Cumulative Net Revenue			
		Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total
1	2012	0	0	0	0	0	0	0	0	-0	-0	-0	-0	0	0	0	0
2	2013	0	0	0	0	0	0	0	0	-0	-0	-0	-0	-0	-0	-0	-0
3	2014	156	409	538	565	0	0	0	0	-156	-409	-538	-1,103	-156	-409	-538	-1,103
4	2015	25	66	87	91	0	0	0	0	-25	-66	-87	-178	-181	-475	-624	-1,281
5	2016	1,268	3,327	4,371	4,595	0	0	0	0	-1,268	-3,327	-4,371	-8,966	-1,449	-3,802	-4,996	-10,246
6	2017	1,198	3,144	4,132	4,343	0	0	0	0	-1,198	-3,144	-4,132	-8,474	-2,647	-6,946	-9,127	-18,720
7	2018	1,124	2,948	3,874	4,072	0	0	0	0	-1,124	-2,948	-3,874	-7,946	-3,771	-9,895	-13,001	-26,667
8	2019	1,064	2,769	3,639	3,833	0	0	0	0	-1,064	-2,769	-3,639	-7,472	-4,835	-12,664	-16,640	-34,139
9	2020	963	2,534	3,320	3,497	0	1,301	1,301	2,602	-963	-1,233	-2,019	-4,215	-5,798	-13,896	-18,659	-38,353
10	2021	522	1,377	1,801	1,899	0	1,274	1,274	2,547	-522	-103	-527	-1,152	-6,320	-14,000	-19,186	-39,506
11	2022	11	34	37	45	0	1,244	1,244	2,488	-11	1,210	1,207	2,406	-6,331	-12,790	-17,978	-37,099
12	2023	223	573	745	796	0	1,216	1,216	2,433	-223	643	471	892	-6,554	-12,147	-17,507	-36,208
13	2024	12	37	45	50	0	1,190	1,190	2,379	-12	1,152	1,145	2,284	-6,566	-10,994	-16,363	-33,923
14	2025	6	35	41	40	0	1,164	1,164	2,327	-6	1,129	1,122	2,245	-6,572	-9,865	-15,240	-31,678
15	2026	5	19	19	24	0	1,138	1,138	2,277	-5	1,119	1,119	2,233	-6,577	-8,746	-14,121	-29,445
16	2027	5	18	18	23	0	1,111	1,111	2,223	-5	1,094	1,094	2,182	-6,582	-7,653	-13,027	-27,262
17	2028	31	16	16	47	0	1,086	1,086	2,172	-31	1,070	1,070	2,109	-6,613	-6,583	-11,958	-25,154
18	2029	24	67	94	91	0	1,061	1,061	2,123	-24	994	968	1,938	-6,637	-5,589	-10,990	-23,216
19	2030	4	42	57	46	0	1,038	1,038	2,075	-4	995	981	1,972	-6,640	-4,594	-10,009	-21,243
20	2031	4	13	13	17	0	1,014	1,014	2,029	-4	1,001	1,002	1,999	-6,644	-3,592	-9,007	-19,244
21	2032	3	12	12	15	0	939	939	1,879	-3	927	927	1,851	-6,647	-2,665	-8,080	-17,392
22	2033	6	11	11	17	0	870	870	1,740	-6	859	859	1,711	-6,653	-1,807	-7,221	-15,681
23	2034	6	17	21	23	0	805	805	1,611	-6	788	785	1,567	-6,659	-1,019	-6,437	-14,115
24	2035	3	16	19	19	0	746	746	1,491	-3	730	726	1,454	-6,662	-289	-5,710	-12,661
25	2036	2	9	9	11	0	690	690	1,381	-2	682	682	1,361	-6,664	393	-5,029	-11,300
26	2037	2	8	8	10	0	639	639	1,279	-2	631	631	1,260	-6,667	1,024	-4,397	-10,040
27	2038	79	8	8	87	0	592	592	1,184	-79	584	584	1,090	-6,745	1,608	-3,813	-8,950
28	2,039	17	114	164	131	0	548	548	1,096	-17	434	384	801	-6,763	2,042	-3,429	-8,150
29	2,040	2	22	29	24	0	507	507	1,015	-2	486	478	962	-6,764	2,528	-2,951	-7,188
30	2,041	2	6	6	8	0	470	470	940	-2	464	464	926	-6,766	2,992	-2,487	-6,262
31	2,042	2	6	6	7	0	435	435	870	-2	429	430	858	-6,768	3,421	-2,058	-5,404
32	2,043	3	5	5	8	0	403	403	806	-3	398	398	793	-6,770	3,819	-1,660	-4,612
33	2,044	0	8	10	8	0	373	373	746	0	365	363	728	-6,770	4,184	-1,297	-3,883
Total		6,770	17,671	23,152	24,442	0	21,855	21,855	43,711	-6,770	4,184	-1,297	-3,883	–	–	–	–

Note: Evaluation period is assumed to be 25 years

Table 13.2.15 Cash Flow for All Bridges (Plan 1)
(Case 3: Toll Scheme is adopted for Kanchpur Bridge)

(Unit: Million BDT)

SQ	Year	Discounted Cost				Discounted Toll Revenue				Discounted Net Revenue				Cumulative Net Revenue			
		Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total
1	2012	0	0	0	0	0	0	0	0	-0	-0	-0	-0	0	0	0	0
2	2013	0	0	0	0	0	0	0	0	0	-0	-0	-0	0	-0	-0	-0
3	2014	156	409	538	1,103	0	0	0	0	-156	-409	-538	-1,103	-156	-409	-538	-1,103
4	2015	25	66	87	178	0	0	0	0	-25	-66	-87	-178	-181	-475	-624	-1,281
5	2016	1,268	3,327	4,371	8,966	0	0	0	0	-1,268	-3,327	-4,371	-8,966	-1,449	-3,802	-4,996	-10,246
6	2017	1,198	3,144	4,132	8,474	0	0	0	0	-1,198	-3,144	-4,132	-8,474	-2,647	-6,946	-9,127	-18,720
7	2018	1,124	2,948	3,874	7,946	0	0	0	0	-1,124	-2,948	-3,874	-7,946	-3,771	-9,895	-13,001	-26,667
8	2019	1,082	2,769	3,639	7,490	1,575	0	0	1,575	493	-2,769	-3,639	-5,915	-3,278	-12,664	-16,640	-32,581
9	2020	1,006	2,534	3,320	6,859	1,566	1,301	1,301	4,168	560	-1,233	-2,019	-2,691	-2,717	-13,896	-18,659	-35,272
10	2021	563	1,377	1,801	3,741	1,532	1,274	1,274	4,079	969	-103	-527	339	-1,748	-14,000	-19,186	-34,934
11	2022	50	34	37	121	1,496	1,244	1,244	3,984	1,446	1,210	1,207	3,863	-302	-12,790	-17,978	-31,071
12	2023	254	573	745	1,572	1,461	1,216	1,216	3,894	1,208	643	471	2,322	905	-12,147	-17,507	-28,749
13	2024	49	37	45	131	1,428	1,190	1,190	3,807	1,380	1,152	1,145	3,677	2,285	-10,994	-16,363	-25,072
14	2025	45	35	41	121	1,396	1,164	1,164	3,723	1,351	1,129	1,122	3,602	3,636	-9,865	-15,240	-21,470
15	2026	37	19	19	75	1,365	1,138	1,138	3,642	1,328	1,119	1,119	3,567	4,964	-8,746	-14,121	-17,903
16	2027	34	18	18	69	1,332	1,111	1,111	3,554	1,298	1,094	1,094	3,485	6,262	-7,653	-13,027	-14,418
17	2028	31	16	16	64	1,300	1,086	1,086	3,472	1,269	1,070	1,070	3,408	7,531	-6,583	-11,958	-11,010
18	2029	52	67	94	213	1,270	1,061	1,061	3,392	1,218	994	968	3,180	8,749	-5,589	-10,990	-7,830
19	2030	44	42	57	143	1,240	1,038	1,038	3,315	1,196	995	981	3,173	9,945	-4,594	-10,009	-4,658
20	2031	25	13	13	51	1,212	1,014	1,014	3,241	1,187	1,001	1,002	3,190	11,132	-3,592	-9,007	-1,468
21	2032	23	12	12	47	1,122	939	939	3,001	1,099	927	927	2,953	12,231	-2,665	-8,080	1,485
22	2033	21	11	11	44	1,039	870	870	2,778	1,017	859	859	2,735	13,248	-1,807	-7,221	4,220
23	2034	23	17	21	61	962	805	805	2,572	939	788	785	2,512	14,187	-1,019	-6,437	6,732
24	2035	21	16	19	56	891	746	746	2,382	870	730	726	2,326	15,057	-289	-5,710	9,058
25	2036	17	9	9	35	825	690	690	2,205	808	682	682	2,171	15,865	393	-5,029	11,229
26	2037	16	8	8	32	764	639	639	2,042	748	631	631	2,010	16,613	1,024	-4,397	13,239
27	2038	15	8	8	30	707	592	592	1,891	692	584	584	1,861	17,305	1,608	-3,813	15,100
28	2,039	70	114	164	349	655	548	548	1,751	584	434	384	1,402	17,889	2,042	-3,429	16,502
29	2,040	26	22	29	77	606	507	507	1,621	580	486	478	1,544	18,469	2,528	-2,951	18,046
30	2,041	12	6	6	24	561	470	470	1,501	550	464	464	1,477	19,019	2,992	-2,487	19,523
31	2,042	11	6	6	22	520	435	435	1,390	509	429	430	1,368	19,528	3,421	-2,058	20,891
32	2,043	10	5	5	20	481	403	403	1,287	471	398	398	1,267	19,999	3,819	-1,660	22,158
33	2,044	0	8	10	18	445	373	373	1,192	445	365	363	1,174	20,445	4,184	-1,297	23,332
Total		7,305	17,671	23,152	48,128	27,749	21,855	21,855	71,460	20,445	4,184	-1,297	23,332	–	–	–	–

Note: Evaluation period is assumed to be 25 years

Table 13.2.16 Cash Flow for All Bridges (Plan 2)
(Case 3: Toll Scheme is adopted for Kanchpur Bridge)

(Unit: Million BDT)

SQ	Year	Discounted Cost				Discounted Toll Revenue				Discounted Net Revenue				Cumulative Net Revenue			
		Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total
1	2012	0	0	0	0	0	0	0	0	-0	-0	-0	-0	0	0	0	0
2	2013	0	0	0	0	0	0	0	0	-0	-0	-0	-0	-0	-0	-0	-0
3	2014	156	409	538	565	0	0	0	0	-156	-409	-538	-1,103	-156	-409	-538	-1,103
4	2015	25	66	87	91	0	0	0	0	-25	-66	-87	-178	-181	-475	-624	-1,281
5	2016	1,268	3,327	4,371	4,595	0	0	0	0	-1,268	-3,327	-4,371	-8,966	-1,449	-3,802	-4,996	-10,246
6	2017	1,198	3,144	4,132	4,343	0	0	0	0	-1,198	-3,144	-4,132	-8,474	-2,647	-6,946	-9,127	-18,720
7	2018	1,124	2,948	3,874	4,072	0	0	0	0	-1,124	-2,948	-3,874	-7,946	-3,771	-9,895	-13,001	-26,667
8	2019	1,064	2,769	3,639	3,833	1,575	0	0	1,575	511	-2,769	-3,639	-5,897	-3,260	-12,664	-16,640	-32,563
9	2020	963	2,534	3,320	3,497	1,566	1,301	1,301	4,168	603	-1,233	-2,019	-2,649	-2,657	-13,896	-18,659	-35,212
10	2021	522	1,377	1,801	1,899	1,532	1,274	1,274	4,079	1,010	-103	-527	380	-1,647	-14,000	-19,186	-34,832
11	2022	11	34	37	45	1,496	1,244	1,244	3,984	1,485	1,210	1,207	3,902	-162	-12,790	-17,978	-30,930
12	2023	223	573	745	796	1,461	1,216	1,216	3,894	1,239	643	471	2,353	1,077	-12,147	-17,507	-28,577
13	2024	12	37	45	50	1,428	1,190	1,190	3,807	1,416	1,152	1,145	3,713	2,493	-10,994	-16,363	-24,864
14	2025	6	35	41	40	1,396	1,101	1,101	3,599	1,390	1,067	1,060	3,517	3,883	-9,928	-15,303	-21,347
15	2026	5	19	19	24	1,365	1,020	1,020	3,405	1,360	1,001	1,001	3,361	5,243	-8,927	-14,302	-17,986
16	2027	5	18	18	23	1,332	944	944	3,220	1,327	927	927	3,180	6,570	-8,000	-13,375	-14,806
17	2028	31	16	16	47	1,300	874	874	3,049	1,270	858	858	2,985	7,839	-7,143	-12,517	-11,820
18	2029	24	67	94	91	1,270	810	810	2,889	1,246	742	716	2,704	9,085	-6,400	-11,801	-9,116
19	2030	4	42	57	46	1,240	750	750	2,739	1,236	707	693	2,637	10,321	-5,693	-11,108	-6,480
20	2031	4	13	13	17	1,212	694	694	2,600	1,208	681	681	2,570	11,529	-5,012	-10,427	-3,909
21	2032	3	12	12	15	1,122	643	643	2,407	1,119	631	631	2,380	12,648	-4,381	-9,796	-1,530
22	2033	6	11	11	17	1,039	595	595	2,229	1,032	584	584	2,200	13,680	-3,797	-9,212	671
23	2034	6	17	21	23	962	551	551	2,064	956	534	530	2,020	14,636	-3,264	-8,682	2,691
24	2035	3	16	19	19	891	510	510	1,911	888	494	491	1,873	15,524	-2,770	-8,191	4,564
25	2036	2	9	9	11	825	472	472	1,769	822	463	464	1,749	16,347	-2,306	-7,727	6,313
26	2037	2	8	8	10	764	437	437	1,638	761	429	429	1,620	17,108	-1,877	-7,298	7,933
27	2038	79	8	8	87	707	405	405	1,517	628	397	397	1,423	17,736	-1,480	-6,901	9,356
28	2,039	17	114	164	131	655	375	375	1,405	637	261	211	1,109	18,373	-1,218	-6,690	10,465
29	2,040	2	22	29	24	606	347	347	1,301	604	325	318	1,247	18,977	-893	-6,372	11,712
30	2,041	2	6	6	8	561	321	321	1,204	560	315	316	1,191	19,537	-578	-6,057	12,903
31	2,042	2	6	6	7	520	298	298	1,115	518	292	292	1,102	20,055	-286	-5,765	14,005
32	2,043	3	5	5	8	481	276	276	1,032	478	270	271	1,019	20,533	-15	-5,494	15,024
33	2,044	0	8	10	8	0	255	255	510	0	247	246	493	20,533	232	-5,248	15,517
Total		6,770	17,671	23,152	24,442	27,304	17,903	17,903	63,111	20,533	232	-5,248	15,517	–	–	–	–

Note: Evaluation period is assumed to be 25 years

(2) Sensitivity Analysis under Case 2

1) Toll Rate to cover all of the Project Costs

A sensitivity analysis is carried out in order to verify the viability of the project three (3) Bridges by setting a toll rate under Case 3, in which the Toll Scheme is not adopted for Kanchpur Bridge. The impact of the difference in toll rates which may affect the number of vehicles passing over the Meghna and Gumti Bridges is not considered in this study.

The result of the sensitivity analysis is shown in Table 13.2.17 and Figure 13.2.2. This sensitivity analysis suggested that if it is possible to increase the existing toll by about 33 %, which is financially feasible (namely FIRR being over the discount rate of 8 %), the Project Costs of all three Bridges can be covered by the toll revenues from Meghna and Gumti Bridges.

Table 13.2.17 Sensitivity Analysis of Toll Level and Financial Indicators (Case 2)

Increase Level	Toll Level (BDT/Veh.)	FIRR (%)	
		Plan 1	Plan 2
1.00	154	7.2	4.7
1.09	168	8.0	5.9
1.20	184	9.0	6.9
1.33	205	10.1	8.0
1.40	215	10.6	8.6
1.60	246	12.1	10.1
1.80	277	13.5	11.5
2.00	307	14.9	12.9

Source: JICA Study Team

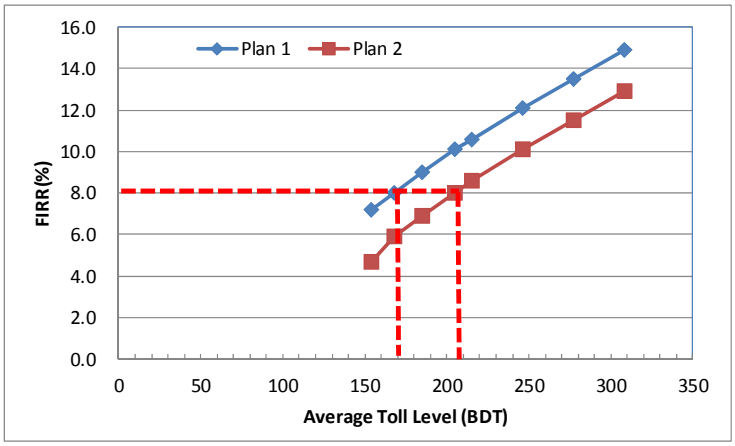


Figure 13.2.2 Relationship between Toll Level and FIRR (Case 2)

Table 13.2.18 Existing Toll Rate and Suggested Toll Rate Increase

Class	Type of Vehicle	Existing Toll Rate	40 % Increase of Toll Rate
Class 1	Motorcycle	10	14
Class 2	Auto Rickshaw	20	28
Class 3	Car, Jeep, Utility	50	70
Class 4	Micro Bus	70	97
Class 5	Mini Bus	150	209
Class 6	Large Bus	400	556
Class 7	Truck	400	556
Class 8	Trailer	1,000	1,380

Note: Based on the suggested toll rate increase of 39 % over the existing one.

2) Sensitivity Analysis of Case 2

The sensitivity analysis of the financial analysis is conducted for;

a) Toll revenue fluctu

ation (±10 %),

b) Project cost fluctuation (±10 %), and

c) Delay of completion of construction period and delay of opening.

The results of the sensitivity analysis are shown in Table 13.2.19.

Table 13.2.19 Results of the Sensitivity Analysis (Case 2)

Factor	Economic Indicator	FIRR (%)	
		Plan 1	Plan 2
Toll Revenue	Base Case	7.2	5.1
	10 % increase in every year	8.1	6.0
	10 % decrease in every year	6.2	4.1
Project cost	Base Case	7.2	5.1
	10 % increase in every year	6.3	4.2
	10 % decrease in every year	8.2	6.1
Time of completion of the construction	Base case	7.2	5.1
	1 year delay of opening	6.1	3.9

13.3 Operation and Effect Indicators

13.3.1 Project Objectives

The indicators to quantitatively monitor the operational condition of the project and effects are established based on the objectives of the Project.

As clearly mentioned in Chapter 1, the overall objective of this project is to mitigate the increasing traffic on NH-1 and the existing traffic congestion, which can be possible by construction of the 2nd Kanchpur, 2nd Meghna and 2nd Gumti Bridges as well as rehabilitation of existing Kanchpur, Meghna and Gumti Bridges on the NH-1, thereby, contributing to economic development of the Dhaka-Chittagong corridor.

Based on above mentioned objectives, performance indicators for operation and effect can be monitored that indicate in specific and measurable terms the performance to be achieved by each bridge in the project life. In addition, as long as the established indicators can be measured, they can also be used to manage better performance of the Project.

13.3.2 Operation and Effect Indicators

The operation and effect indicators to evaluate and monitor the project performance and its effectiveness are selected as shown in Table 13.3.1. The indicators are divided into two categories; direct effects which are directly influenced and indirect effects which are indirectly influenced to evaluate the impact of the project from the socio-economic view points.

Table 13.3.1 Indicators for Project Performance and Effectiveness

Impact Indicators	Definition	Purpose of Indicator
1. Direct Effects		
Traffic Volume	Average Annual Daily Traffic Volume (AADT)	To evaluate to what extent the movement of people and goods is encouraged.
Reduction of travel time and increase in travel speed	Average travel time required for the length of the road section including the Bridge	To evaluate the degree of improvement of the transport infrastructure services.
Reduction of travel cost	Saving in total travel time cost for all vehicles running on the road section including the Bridge	
Reduction of RTA	Reduction of road traffic accidents by improvement of bridge condition	To evaluate safety
2. Indirect Effects		
Promotion of regional development	Reduced transportation costs and travel time cost saving for economic activities will influence economic development.	To evaluate to what extent the economic and social development are enhanced
Promotion of Poverty Reduction	Poor people will also be given benefits from economic development.	
Product market expansion	Product market is expanded owing to transport cost and travel time reduction.	
Creation of employment opportunities with project construction	Employment opportunities will be increased during the construction period.	

However, among the above-mentioned indicators, reduction of RTA was already quantified as one of the benefits in the economic analysis so that it will not be mentioned in this section.

13.3.3 Targets of Operation and Effect Indicators

(1) Operation Indicators of Plans 1 and 2

The operation indicators of the Project and each Bridge under Plans 1 & 2 will be monitored by measuring the impact indicators. The targets of the indictors of the Project and each Bridge are estimated as of the planned monitoring timing as shown in Table 13.3.2 and Table 13.3.3.

Table 13.3.2 Operation Indicators for the Project under Plans 1 & 2

Bridge	Indicator	Base Year 2012	New Bridge Opening Year 2019	Rehabilitation Completion Year 2021	Monitoring Year 2023
Meghna/Gumti Bridge	Average Annual Traffic Volume (PCU)	65,008	94,106	105,374	116,342

Source: Estimated by the JICA Study Team

Table 13.3.3 Operation Indicators for the Project under Plan 1 & 2

Bridge	Indicator	Base Year 2012	New Bridge Opening Year 2019	Rehabilitation Completion Year 2021	Monitoring Year 2023
Kanchpur Bridge	Average Annual Traffic Volume (PCU)	76,732	110,388	123,301	136,030
Meghna Bridge	Average Annual Traffic Volume (PCU)	65,008	94,106	105,374	116,342
Gumti Bridge	Average Annual Traffic Volume (PCU)	65,008	94,104	105,374	116,342

(2) Effect Indicators of Plan 1

The effect of the Project will be monitored by measuring the impact indicators. The targets of the indictors of the Project are estimated as of the planned monitoring timing as shown in Table 13.3.4 and Table 13.3.5. Target roads for showing the effect indicators are assumed as follows;

- Road section between Dhaka and Gumti Bridge (Shahidinagar on NH-1) (Total length: 47.0 km)
- Total bridge and approach road (Total length:5.32 km)

Table 13.3.4 Effect Indicators of the Project in the Target Road under Plan 1

Effect Indicator	Base Year 2012	New Bridge Opening Year 2019	Rehabilitation Completion Year 2021	Monitoring Year 2023
Travel Time (min.)	74.4	42.5	44.4	46.5
Travel Speed (km/h)	37.9	66.3	63.5	60.7

Notes: 1) Travel time and travel speed on the target road of 47 km
2) Data in 2012 is obtained from Baseline survey

Table 13.3.5 Effect Indicators of the Project in the Target Bridge and Road Section (Plan 1)

Bridge	Effect Indictor	Base Year	New Bridge Opening Year	Rehabilitation Completion Year	Monitoring Year
		2012	2019	2021	2023
Kanchpur Bridge	Travel Speed (km/h)	25.0	63.9	61.6	59.3
Meghna Bridge	Travel Speed (km/h)	13.0	67.5	64.5	61.4
Gumti Bridge	Travel Speed (km/h)	12.0	67.5	64.5	61.3
All Bridges	Travel Speed (km/h)	14.0	66.8	63.9	60.9
Kanchpur Bridge (1.10 km)	Travel Time (min)	2.6	1.0	1.1	1.1
Meghna Bridge (1.80 km)	Travel Time (min)	8.3	1.6	1.7	1.8
Gumti Bridge (2.42 km)	Travel Time (min)	12.1	2.2	2.3	2.4
All Bridges (5.32 km)	Travel Time (min)	23.0	4.8	5.1	5.3

Notes: 1) Travel time and travel speed on the target bridges and approach road sections
2) Data in 2012 is obtained from Baseline survey

(3) Effect Indicators of Plan 2

The effect indicators of the Project will be monitored by measuring the impact indicators. The targets of the indictors of the Project are estimated as of the planned monitoring timing as shown in Table 13.3.6 and Table 13.3.7. Target roads for showing the effect indicators are assumed as follows;

- Road section between Dhaka and Gumti Bridge (Shahidinagar on NH-1) (Total length: 47.0 km)
- Total bridge and approach road (Total length: 5.32 km)

Table 13.3.6 Effect Indicators of the Project in the Target Roads under Plan 2

Effect Indicator	Base Year 2012	New Bridge Opening Year 2019	Rehabilitation Completion Year 2021	Monitoring Year 2023
Travel Time (min.)	74.4	55.7	60.4	66.0
Travel Speed (km/h)	37.9	50.6	46.7	42.7

Notes: 1) Travel time and travel speed on the target roads of 47 km
2) Data in 2012 is obtained from Baseline survey

Table 13.3.7 Effect Indicators of the Project in the Target Bridges and Road Sections (Plan 2) (Travel Speed and Travel Time)

Bridge	Effect Indictor	Base Year	New Bridge Opening Year	Rehabilitation Completion Year	Monitoring Year
		2012	2019	2021	2023
Kanchpur Bridge	Travel Speed (km/h)	25.0	63.9	61.6	59.3
Meghna Bridge	Travel Speed (km/h)	13.0	54.9	50.2	45.5
Gumti Bridge	Travel Speed (km/h)	12.0	54.9	50.2	45.5
All Bridges	Travel Speed (km/h)	14.0	56.8	52.6	48.4
Kanchpur Bridge (1.10 km)	Travel Time (min)	2.6	1.0	1.1	1.1
Meghna Bridge (1.80 km)	Travel Time (min)	8.3	2.0	2.2	2.4
Gumti Bridge (2.42 km)	Travel Time (min)	12.1	2.6	2.9	3.2
All Bridges (5.32 km)	Travel Time (min)	23.0	5.6	6.2	6.7

Notes: 1) Travel time and travel speed on the target bridges and approach road sections
2) Data in 2012 is obtained from Baseline survey

13.4 Qualitative Effect

13.4.1 Promotion of National / Regional Development and Market Expansion

The Kanchpur, Meghna and Gumti Bridge Projects contribute greatly to regional development of the Dhaka-Chittagong corridor. The Projects will be provided proper infrastructure to accommodate for huge cargo movement. As a result, the transport costs between Dhaka and Chittagong will be greatly reduced due to reduction of the traffic congestion. These phenomena will provide a favorable influence to industrial and export products in Dhaka Metropolitan Area, which is an engine of the economic development in Bangladesh.

13.4.2 Promotion of Poverty Reduction

Poor people's inability to access jobs and services is an important element of the social exclusion that defines poverty. Regional and transport development can reduce this poverty, by contributing to economic growth.

- During the construction period, poor people can work as unskilled construction workers.
- After construction, this Project road will promote development of the region along the Project road by enhancing promotion of agriculture, industry and commerce. It is expected that job opportunities will be increased in proportion with economic development.

Through such increases in employment opportunities, it is expected to promote poverty reduction.

CHAPTER 14

ENVIRONMENTAL AND SOCIAL CONSIDERATION

14. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

14.1 Summary of EIA

14.1.1 General

The EIA report was prepared on the basis of proposed engineering works, field investigations, stakeholder consultation, primary and secondary data collection, screening of all baseline environmental parameters, environmental quality baseline monitoring, and review of other similar project reports in Bangladesh. The study was taken up during March–August, 2012. The EIA covers the general environmental profile of the Project area including physical, ecological, environmental, social, cultural and economic resources. Baseline environmental monitoring was carried out on water (surface and ground), air, noise, soil, and sediment quality measurements. The EIA includes an overview of the potential environmental impacts and their severity, and proposes necessary mitigation measures and an environmental management plan for each of the identified impacts. Two rounds of public consultations were conducted as part of the EIA.

The EIA report in its present format as per the TOR and specified terms and conditions in the DoE letter no. DoE/Clearance/5150/2012/31 7/2002/900 dated 23/05/2012, has been prepared for obtaining the Environmental Clearance Certificate (ECC) from the Government of Bangladesh (GoB).

The methodology used for this study is based on the procedures described in Environmental Guidelines, (Volume 1) published by RHD and the other relevant regulations of Bangladesh as well as the "JICA Guidelines for Environmental and Social Considerations" (April 2010).

Methodology adopted for completion of the EIA study of bridges is as follows;

- Scoping workshop organization with various stake holders at the beginning of the Project preparation activities
- Reconnaissance survey was taken to collect baseline information in devised formats
- Analysis of collected data was carried out
- Documentation of baseline conditions was done by on site environmental monitoring
- Analysis and assessment of various alternatives was undertaken
- Identification and assessment of various impacts was done
- Formulation of mitigation, and avoidance measures was done for identified impacts
- Community consultations were carried out
- Preparation of standalone environmental management plans (EMPs), for both the bridges, has been done

The EIA report was submitted to DoE on October 11, 2012 and approved by DoE on 12 November, 2012.

14.1.2 Policy, Legal, and Administrative Framework

In accordance with Bangladesh laws, the project is classified as "red category" (equivalent to Category A in international donors' safeguard guidelines). This means that a full-scale Environmental Impact Assessment (EIA) is required in order to obtain an Environmental Clearance Certificate (ECC).

The EIA shall be implemented in accordance with not only the rules of Bangladesh Government but also with JICA Guidelines for Environmental and Social Considerations (April 2010). Information disclosure at the EIA shall be implemented in accordance with JICA Guidelines.

The Roads and Highway Department is the implementing agency of the project while the Social and Environmental Circle (SEC) under the RHD and the Department of Environment (DoE) under the Ministry of Environment and Forest (MoEF) are the supervising agencies for environmental protection.

14.1.3 Baseline Environmental Condition

From the natural environment viewpoint, an endangered species, the River Dolphin, is observed when it passes Meghna and Gumti Bridges. Noise generally exceeds the

environmental standards of World Health Organization (WHO) in day time in most of the areas surrounding the projects whereas it comes down to less than 70 dB in night time except for at the roadside. Meghna River is famous for changing its route very frequently; however, it seems that the stream line shows almost the same profile around Meghna and Gumti Bridges. Therefore, it is supposed that the river shore line around Meghna and Gumti Bridges is stable with respect to the morphological view point.

From the social environment viewpoint, while there are no fishermen in the Kanchpur Bridge site, there are approximately ten each in Meghna and Gumti Bridge sites. From the traffic volume of NH-1, the amount of CO_2 emission in 2010 was estimated as 1,000,000 ton per year in NH-1: about 35,000 vehicles / year, and about 3 % of total CO_2 emitted in Bangladesh.

14.1.4 Alternative Analysis

The project, construction of three 2nd bridges and rehabilitation of three existing bridges, is of key importance to secure the availability of NH-1 all year round without any delay of transportation service between Dhaka and Chittagong. The commerce carried on over that road is more important to the national income than any other transportation mode or route in the country.

Locations of the 2nd bridges were studied in the view of feasibility such as social impact, environmental impact and cost etc. and the following locations are found to be most feasible respectively:

Table 14.1.1 Bridge Locations

Bridges	The most feasible route
2nd Kanchpur Bridge	Downstream of the existing bridge
2nd Meghna Bridge	Upstream of the existing bridge
2nd Gumti Bridge	Downstream of the existing bridge

14.1.5 Initial Environmental Examination

(1) Screening

Screening is the step to categorize projects/activities based on degree of environmental impacts caused by the project.

The Project was classified as “Red” under regulation of Bangladesh and “A” according to the JICA Environmental Guidelines, and thus EIA is necessary to be conducted.

(2) Scoping

The aim of scoping is to find out possible ecological/environmental and social impact caused by the implementation of proposed project and to determine Terms of Reference (TOR) for EIA.

The results of screening are shown in Table 14.1.2 through Table 14.1.4. Impacts are rated in A, B, C and D. The definition of the rating is as follows;

Definition of the Rating:
A: Severe negative impact is predicted
B: Limited negative impacts can be predicted
C: Impact is unknown
D: Almost no negative impact is predicted

Table 14.1.2 Results of Scoping at Kanchpur Bridge Site

Sl. no.	Item	Rating			Potential impact description		Study methodology
		Overall	Before / During Const- ruction	During Operation	Before / During Construction	During Operation	
1	Involuntary resettlement	A	A	D	Loss of approximately 40 residential houses and small shops	-	Preparation of RAP Census Asset inventory
2	Local economics, such as employment, livelihood, etc.	A	A	D	Loss of approximately 20 small shops Some restrictions to sand carrying work	- (Local economy can be activated)	Socio-economical survey and group discussion
3	Land use and utilization of local resources	B	B	D	Impact on part of fishing place	-	Study of current land use
4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D	-	-	-
5	Existing social infrastructures and services	D	D	D	-	-	-
6	Poor, indigenous, or ethnic people	A	A	D	Relocation of approximately 40 poor and landless families and small shops	-	Group discussion
7	Misdistribution of benefits and damages	B	B	B	Relocated families may become poorer while the remaining families can have the project benefit		Socio-economical survey and group discussion
8	Local conflicts of interest	B	B	B	Local conflicts may take place by the misdistribution of benefits and damages		Socio-economical survey and group discussion
9	Cultural heritage	D	D	D	Appeared to be no cultural heritage around	-	-
10	Accident	B	B	B	Construction accident during construction	Traffic accident	Study and analysis of construction accident during construction and
11	Infectious diseases such as HIV/AIDS	B	B	C	Inflow of workers with HIV into camp	-	Study of present condition of HIV
12	Gender	B	B	C	Female laborers may be discriminated in wage at construction site	-	Study of present condition of gender gaps
13	Children's rights	B	B	C	Children's labor	-	Study of present condition of children's labor
14	Erosion and scouring	C	C	C	River bank erosion may be caused by installation of embankment road for construction and abutments		literature study and hearing study
15	River transportation	B	B	B	Construction vessels may obstacle passing vessels	New pier foundations may obstacle passing vessels	Study of the number of passing vessels and their passing direction Study of present condition of river traffic accident
16	Hydrology	B	B	B	Flood can be caused by installation of embankment road for construction and abutments		Hydrological analysis
17	Biota and Ecosystem	B	B	C	Impact on precious species	-	Hearing study
18	Global Warming	C	C	C	CO2 emission from construction equipment	An increase in CO2 emission from passing vehicles	Estimation of the amount of emission Prediction of the amount of emission
19	Air Pollution	B	B	C	Emission of air pollutant from construction equipment	An increase in emission of air pollutant from passing vehicles	Chemical analysis of air pollution Prediction of future density
20	Water Contamination	B	B	D	Release of construction turbid water without treatment into river Disturbance of river bottom by installation of pier foundation	-	Chemical analysis of present water quality Estimation and prediction of amount of suspended solid by installation of pier foundation
21	Soil Pollution	B	B	D	Leakage of asphalt and gasoline	-	Soil sampling and analysis for pollution Prediction of leakage in construction
22	Waste	B	B	D	Illegal dumping of construction solid waste	-	Prediction of amount of generated construction waste
23	Noise and Vibration	B	B	C	Noise and vibration of construction equipment	Noise and vibration of passing vehicles	Measurement of noise and vibration Prediction of future noise and vibration
24	Ground Subsidence	C	D	C		Ground subsidence of buildings and surrounding facilities	Study of current condition of soft ground distribution by boring
25	Offensive Odor	C	C	C	Odor from emitted gases by construction equipment and open burning of waste		Study of a cause and a resource of offensive odor
26	Bottom Sediment	C	C	D	-	-	Sampling and chemical analysis of bottom sediments
27	Landscape	C	C	C	View of bridges and embankments during construction	View of bridges and embankments during operation	Hearing from local residents

Table 14.1.3 Results of Scoping at Meghna Bridge Site

Sl. no.	Item	Rating			Potential impact description		Study methodology
		Overall	Before / During Const- ruction	During Operation	Before / During Construction	During Operation	
1	Involuntary resettlement	A	A	D	Loss of approximately 400 residential houses and small shops	-	Census Asset inventory -
2	Local economics, such as employment, livelihood, etc.	A	A	D	Loss of approximately 200 small shops Some restrictions to sand carrying work	- (Local economy can be activated)	Socio-economical survey and group discussion
3	Land use and utilization of local resources	B	B	D	Impact on part of fishing place and timber industry	-	Study of current land use
4	Social institutions such as social infrastructure and local decision-making institutions	B	B	D	Construction impact on school	-	Study of location, influence and so forth
5	Existing social infrastructures and services	B	B	D	Relocation of ferry terminal	-	Study of current condition of ferry use
6	Poor, indigenous, or ethnic people	A	A	D	Relocation of approximately 40 poor and landless families and small shops	-	Group discussion
7	Misdistribution of benefits and damages	B	B	B	Relocated families may become poorer while the remaining families can have the project benefit		Socio-economical survey and group discussion
8	Local conflicts of interest	B	B	B	Local conflicts may take place by the misdistribution of benefits and damages		Socio-economical survey and group discussion
9	Cultural heritage	D	D	D	Appeared to be no cultural heritage around	-	Appeared to be no cultural heritage around
10	Accident	B	B	B	Construction accident during construction	Traffic accident	Study and analysis of construction accident during construction and traffic accident
11	Infectious diseases such as HIV/AIDS	B	B	C	Inflow of workers with HIV into camp	-	Study of present condition of HIV
12	Gender	B	B	C	Female laborers may be discriminated in wage at construction site	-	Study of present condition of gender gaps
13	Children's rights	B	B	C	Children's labor	-	Study of present condition of children's labor
14	Erosion and scouring	A	C	A	Deep scour of river bottom around pier's foundations and river bank erosion may be caused by installation of embankment road for construction and abutments		Hydrological analysis
15	River transportation	B	B	B	Construction vessels may obstacle passing vessels	New pier foundations may obstacle passing vessels	Construction vessels may obstacle passing vessels
16	Hydrology	B	B	B	Flood can be caused by installation of embankment road for construction and abutments		Hydrological analysis, Analysis for erosion and scouring
17	Biota and Ecosystem	B	B	C	Impact on precious species	-	Hearing study
18	Global Warming	C	C	C	CO2 emission from construction equipment	An increase in CO2 emission from passing vehicles	Estimation of the amount of emission Prediction of the amount of emission
19	Air Pollution	B	B	C	Emission of air pollutant from construction equipment	An increase in emission of air pollutant from passing vehicles	Chemical analysis of air pollution Prediction of future density
20	Water Contamination	B	B	D	Release of construction turbid water without treatment into river Disturbance of river bottom by installation of pier foundation	-	Chemical analysis of present water quality Estimation and prediction of amount of suspended solid by installation of pier foundation
21	Soil Pollution	B	B	D	Leakage of asphalt and gasoline	-	Soil sampling and analysis for pollution Prediction of leakage in construction
22	Waste	B	B	D	Illegal dumping of construction solid waste	-	Prediction of amount of generated construction waste
23	Noise and Vibration	B	B	C	Noise and vibration of construction equipment	Noise and vibration of passing vehicles	Measurement of noise and vibration Prediction of future noise and vibration
24	Ground Subsidence	C	D	C		Ground subsidence of buildings and surrounding facilities	Study of current condition of soft ground distribution by boring
25	Offensive Odor	C	C	C	Odor from emitted gases by construction equipment and open burning of waste		Study of a cause and a resource of offensive odor
26	Bottom Sediment	C	C	D	-	-	Sampling and chemical analysis of bottom sediments
27	Landscape	C	C	C	View of bridges and embankments during construction	View of bridges and embankments during operation	Hearing from local residents

Table 14.1.4 Results of Scoping at Gumti Bridge Site

Sl. no.	Item	Rating			Potential impact description		Study methodology
		Overall	Before / During Const- ruction	During Operation	Before / During Construction	During Operation	
1	Involuntary resettlement	A	A	D	Loss of approximately 40 residential houses and small shops	-	Preparation of RAP Census Asset inventory
2	Local economics, such as employment, livelihood, etc.	A	A	D	Loss of approximately 20 small shops	-	Socio-economical survey and group discussion
					Some restrictions to sand carrying work	(Local economy can be activated)	
3	Land use and utilization of local resources	B	B	D	Impact on part of fishing place	-	Study of current land use
4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D	-	-	-
5	Existing social infrastructures and services	D	D	D	-	-	-
6	Poor, indigenous, or ethnic people	A	A	D	Relocation of approximately 40 poor and landless families and small shops	-	Group discussion
7	Misdistribution of benefits and damages	B	B	B	Relocated families may become poorer while the remaining families can have the project benefit		Socio-economical survey and group discussion
8	Local conflicts of interest	B	B	B	Local conflicts may take place by the misdistribution of benefits and damages		Socio-economical survey and group discussion
9	Cultural heritage	D	D	D	Appeared to be no cultural heritage around	-	-
10	Accident	B	B	B	Construction accident during construction	Traffic accident	Study and analysis of construction accident during construction and traffic accident
11	Infectious diseases such as HIV/AIDS	B	B	C	Inflow of workers with HIV into camp	-	Study of present condition of HIV
12	Gender	B	B	C	Female laborers may be discriminated in wage at construction site	-	Study of present condition of gender gaps
13	Children's rights	B	B	C	Children's labor	-	Study of present condition of children's labor
14	Erosion and scouring	C	C	C	River bank erosion may be caused by installation of embankment road for construction and abutments		literature study and hearing study
15	River transportation	B	B	B	Construction vessels may obstacle passing vessels	New pier foundations may obstacle passing vessels	Study of the number of passing vessels and their passing direction Study of present condition of river traffic accident
16	Hydrology	B	B	B	Flood can be caused by installation of embankment road for construction and abutments		Hydrological analysis
17	Biota and Ecosystem	B	B	C	Impact on precious species	-	Hearing study
18	Global Warming	C	C	C	CO2 emission from construction equipment	An increase in CO2 emission from passing vehicles	Estimation of the amount of emission Prediction of the amount of emission
19	Air Pollution	B	B	C	Emission of air pollutant from construction equipment	An increase in emission of air pollutant from passing vehicles	Chemical analysis of air pollution Prediction of future density
20	Water Contamination	B	B	D	Release of construction turbid water without treatment into river	-	Chemical analysis of present water quality
					Disturbance of river bottom by installation of pier foundation		Estimation and prediction of amount of suspended solid by installation of pier foundation
21	Soil Pollution	B	B	D	Leakage of asphalt and gasoline	-	Soil sampling and analysis for pollution Prediction of leakage in construction
22	Waste	B	B	D	Illegal dumping of construction solid waste	-	Prediction of amount of generated construction waste
23	Noise and Vibration	B	B	C	Noise and vibration of construction equipment	Noise and vibration of passing vehicles	Measurement of noise and vibration Prediction of future noise and vibration
24	Ground Subsidence	C	D	C		Ground subsidence of buildings and surrounding facilities	Study of current condition of soft ground distribution by boring
25	Offensive Odor	C	C	C	Odor from emitted gases by construction equipment and open burning of waste		Study of a cause and a resource of offensive odor
26	Bottom Sediment	C	C	D	-	-	Sampling and chemical analysis of bottom sediments
27	Landscape	C	C	C	View of bridges and embankments during construction	View of bridges and embankments during operation	Hearing from local residents

14.1.6 Environmental Impacts

On these 27 items, a baseline survey, project impact prediction and, if impact is considered either negligible or severe, environmental management planning including monitoring plan was established as below.

Table 14.1.5 Summary of EMP (Before Construction)

Environmental Impact/Issue	Severity of Adverse Impacts	Mitigation Measures
SOCIAL ENVIRONMENT		
1) Involuntary Resettlement	Severe: Households and people are influenced	• Proper resettlement action Plan (RAP) • Provide adequate compensation in time to PAPs
2) Local Economies such as employment, livelihood etc.	Severe: Shop owners, employees, cultivators, properties and plantation owners are influenced	• All direct income loss must be adequately compensated within the RAP • Income loss can be mitigated by providing alternative job opportunities for PAPs.
3) Land use and utilization of local resources	Moderate: Plantation area and an aqua culturing households are affected	• Plantation area which will be tentatively occupied during construction, will be restored to original state and returned to the land owner after construction
4) Social institutions such as social infrastructures and decision-making institutions	Moderate: Social institutions are affected by relocation	• Proper resettlement action Plan (RAP) • Provide adequate compensation in time to PAPs
5) Poor, indigenous people or ethnic minority	Severe: Livelihood of poor or female headed households are affected	• Prepare RAP involving the following measures Define the displaced persons and criteria for determining their eligibility for compensation Establish external monitoring committee consisting of a third party • For poor people, proponent activities improving surface water condition and making groundwater available shall be implemented
6) Maldistribution of benefits and damages	Severe: Displaced people may suffer at all bridge sites	• Prepare RAP involving the following measures Assessed compensation based on the market price Payment will be carried out before resettlement • Establish external monitoring committee consisting of a third party
7) Local conflicts of interest	Moderate: candidates for construction jobs may have some conflicts between communities	• Clear information about the labor needs (number and qualifications) should be provided to local people. • The job skills and the priority for the affected people shall be taken into account and the workers can be chosen.

Table 14.1.6 Summary of EMP (During Construction)

Environmental Impact/Issue	Severity of Adverse Impacts	Mitigation Measures
SOCIAL ENVIRONMENT		
1) Involuntary Resettlement	Severe: Households and people are influenced	• Proper resettlement action Plan (RAP) 1. Provide adequate compensation and assistance in time to PAPs
2) Local Economies such as employment, livelihood etc.	Severe: Shop owners, employees, cultivators, properties and plantation owners are influenced	• All direct income loss must be adequately compensated within the RAP • Income loss can be mitigated by providing alternative job opportunities for PAPs.
3) Land use and utilization of local resources	Moderate: Plantation area and an aqua culturing households are affected	• Plantation area and part of fish pond which will be tentatively occupied during construction, will be restored to original state and returned to the land owner after construction
4) Social institutions such as social infrastructures and decision-making institutions	Moderate: Social institutions are affected by relocation and noise	• Proper resettlement action Plan (RAP) • Provide adequate compensation in time to PAPs • Periodical maintenance of construction vehicles • Installation of sound insulation
5) Existing social infrastructures and Services	Moderate: Social service utilities are located underground in the affected area	• Proper detailed design is going to be done and the utilities lines will be diverted before starting the construction activity.
6) Poor, indigenous people or ethnic minority	Severe: Livelihood of poor or female headed households are affected	• Prepare RAP involving the following measures Define the displaced persons and criteria for determining their eligibility for compensation Establish external monitoring committee consisting of a third party • For poor people, proponent activities improving surface water condition, making groundwater available and enhancing their job skill shall be implemented
7) Maldistribution of benefits and damages	Severe: Displaced people may suffer at all bridge sites	• Prepare RAP involving the following measures Assessed compensation based on the market price Payment will be carried out before resettlement • Establish external monitoring committee consisting of a third party
8) Local conflicts of interest	Moderate: candidates for construction jobs may have some conflicts between communities	• Clear information about the labor needs (number and qualifications) should be provided to local people. • The job skills and the priority for the affected people shall be taken into account and the workers can be chosen.
9) Accidents	Moderate: Construction workers can have harmful and critical trouble	• Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors
10) HIV/AIDS-	Moderate: Transmission of disease by inflow of migrant workers	• An HIV-AIDS awareness campaign via approved service provider shall be implemented
11) Gender	Moderate: Salary gap between genders	• Monitoring of payment to workers by the contractor shall be implemented to prevent payment gaps between male and female.
12) Children's rights	Moderate: Children may come and work in the construction site	• Regular monitoring of sites to guide contactors and their related firms to discourage child labor. • If child labor is detected, necessary and decisive actions to the violating firms are implemented. • Some assistance for parents of working children

13) River Transportation	Moderate: Congestion of vessels could generate collisions	• Provision of illumination in the night time around anchorages
NATURAL AND ECOLOGICAL ENVIRONMENT		
17) Fauna and flora	Moderate: Wildlife including River Dolphin is affected by the construction using steel piles	• Any illegal discharge of waste water, leaked oil shall be prohibited • Construction development area shall be fixed, to prevent development or cutting of trees outside of project area • Monitoring both upstream and downstream will be conducted from the bridge surface • If dolphin are observed around the project site, piling works and vessels should be prohibited until the dolphin pass. • Night lightning in construction areas should be restricted to the construction site.
ENVIROMNTAL POLLUTION		
19) Air Pollution	Moderate: Dust rising from unpaved roads and others during construction	• Good maintenance and operation of equipment and vehicles • Use environmentally-friendly material • Spraying water to suppress the dust • Cover entire load with tarpaulin to prevent the load from being blown. • Good maintenance of material • Monitoring and regular meetings for air quality •
20) Water Pollution	Moderate: Pile driving, muddy water from earthwork, domestic waste liquid from worker's camp, and oil leaking from construction vessels	• Construction sludge generated by pile driving, concrete plant and asphalt plant is treated in a silt basin and remaining sludge is disposed of at designated dumping sites • Impermeable wall shall be used with cast-in-place piles • Turbid water from construction work area is treated in silt basins for satisfying water quality standards and drained away to the nearest drainage or river • Domestic waste water is treated in septic tanks for satisfying water quality standard and drained away to the nearest drainage or river. • Water quality including arsenic content will be checked before using groundwater as potable water for construction workers. • Waste oil shall be stored without leaking before legal disposal process. • Refilling of equipment/ vehicles shall be on a concreted floor • Fuel and oil shall be stored in concrete floored tanks surrounded with concrete wall • Equipment and vehicles are properly maintained so as not to cause leaking of fuel onto ground surface. Inspection sheet for the maintenance record shall be submitted regularly • Batteries containing liquid shall be kept on an impervious surface to prevent battery liquid that contains hazardous heavy metal from leaking and percolating into the ground • To be on the safe side, study on groundwater will be implemented by the consultant during detailed design stage in order to prevent adverse impacts on surrounding wells.
21) Soil pollution	Moderate: leakage of oil, and borrow can contaminate soil	• Disposal at designated dumping sites • Soil quality Testing • Disposal of waste oil without leakage • Refilling place having concreted floor • Potential pollutants to be stored in tanks surrounded by a concrete wall • Equipment and vehicles are properly maintained • Batteries containing liquid shall be kept on an impervious surface

22) Waste	Moderate: Generation of construction sludge and domestic waste	• Minimize volume going to the silt basin before disposing • Segregate waste to minimize waste material • Dispose in designated dumping sites as instructed by the section handling waste • Recycle as much as possible with consideration of the soil.
23) Noise and Vibrations	Moderate: Noise and vibration from construction machines and vehicles	• Periodical maintenance .of construction vehicles • Installation of sound insulation cover on boundary near residential areas
25) Offensive Odors	Moderate: open burning of construction waste, improper treatment of human liquid waste, exhaust smoke from heavy equipment etc	• Prohibition of open burning • Proper treatment of camp waste • Proper maintenance of heavy equipment
26) Bottom sediment	Moderate: Waste dumped into rivers can contaminate river bed	• Construction contractor will be obliged prevent dumping of waste into the river

Table 14.1.7 Summary of EMP (During Operation)

Environmental Impact/Issue	Severity of Adverse Impacts	Mitigation Measures
SOCIAL ENVIRONMENT		
10) Accidents	Moderate: Traffic accident can occur	• Provision of traffic signs, road marks, speed bumps, zebra marks, guard rails and poles, and curb stones etc
ENVIROMNTAL POLLUTION		
16) Hydrological condition	Severe: hydrological condition was affected by scouring	• Steel Pipe Sheet Pile (SPSP) foundation has been selected ; the size and depth of the SPSP foundation shall be designed so that the riverbed scouring will not create any threat to overall bridge stability.
23) Noise and vibration	Moderate: the forecast value exceeds the standard.	• Secure a buffer zone of around 100m as noise decay distance (land utilization guide by RHD and local authority)

RHD: Roads& Highways Department, NGO: Non Government Organization, DoE: Department of Environment, PAP: Project Affected Person

14.1.7 Environmental Management Plan

An environmental management plan was presented in the previous table. The monitoring plan proposed is:

Table 14.1.8 Costs for Environmental Management and Monitoring (Enhancement of Environment (A))

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Costs (BDT)
17) Fauna and flora and 27) Landscape	During Operation	Planting of native tree species including maintenance for three years	No	500	1,800	900,000
17) Fauna and flora and 27) Landscape	During Operation	Maintenance including monitoring of survival of plants	LS	100,000	1	100,000
Enhancement of environment (A)			TOTAL			1,000,000

Table 14.1.9 Costs for Environmental Management and Monitoring
(Environmental Management Cost (B))

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Costs (BDT)
1) Involuntary resettlement	Before Construction	Compensation for impact	-	(69,638,734)	-	-
	During Construction	Compensation for impact	-	ditto	-	-
2) Local Economies such as employment, livelihood etc.	Before Construction	Compensation for impact	-	ditto	-	-
	During Construction	Compensation for impact	-	ditto	-	-
3) Land use and utilization of local resources	Before Construction	Proper occupation	-	ditto	-	-
	During Construction	Proper occupation	-	ditto	-	-
4) Social institutions such as social infrastructures and decision-making institutions	Before Construction	Compensation for impact	-	ditto	-	-
	During Construction	Compensation for impact	-	ditto	-	-
5) Existing social infrastructures and services	During Construction	Construction for diversion	-	ditto	-	-
6) Poor, indigenous, or ethnic people-	Before Construction	Compensation for impact Activities improving surface water condition, making groundwater available and enhancing their job skill	-	ditto	-	-
	During Construction	Compensation for impact Activities improving surface water condition, making groundwater available and enhancing their job skill	-	ditto	-	-
7) Maldistribution of benefits and damages	Before Construction	Compensation for impact	-	ditto	-	-
	During Construction	Compensation for impact.	-	ditto	-	-
8) Local conflicts of interest	Before Construction	Compensation for impact	-	ditto	-	-
	During Construction	Compensation for impact	-	ditto	-	-
10) Accidents	During Construction	Ensuring that HSMP works right on the track	-	Included in construction cost	-	-

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Costs (BDT)
	During Operation	Installing traffic signs, road marks, speed bumps, zebra marks, guard rails and poles, and curb stones etc	-	Included in construction cost	-	-
11) HIV/AIDS	During Construction	HIV campaign	Times	30	100,000	3,000,000
12) Gender	During Construction	Monitoring of the gaps between male and female	-	Included in RAP cost	-	-
13) Children's Rights	During Construction	Prevention activities to inhibit child labor	-	ditto	-	-
15) River Transport	During Construction	Watch boats, watchman, sign boards etc	-	Included in construction cost	-	-
16) Hydrological condition	During Operation	Inspection of river bottom condition for scouring	-		-	-
17) Fauna and flora	During Construction	Restoration of construction development area	-	Included in construction cost	-	-
19) Air pollution	During Construction	Implement dust suppression plan and routine mitigation measure shall be taken to control emitting equipment.	-	Included in construction cost	-	-
	During Operation	Inspection of road side air condition	-	Included in Monitoring cost	-	-
20) Water pollution	During Construction	Installation of silt basins and septic tanks. Proper maintenance of equipment and vehicles. Removal of arsenic.	-	Included in construction cost	-	-
21) Soil pollution	During Construction	Disposal at designated dumping sites. Proper maintenance of equipment and vehicles.	-	Included in construction cost	-	-
	During Operation	Inspection of soil condition	-	Included in Monitoring cost	-	-
22) Waste	During Construction	Collection, transportation and dumping of waste at authorized dumping sites. Minimization of volume and recycling.	-	Included in construction cost	-	-

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Costs (BDT)
23) Noise and Vibration	During Construction	Periodical maintenance of construction vehicles and installation of sound insulation cover	-	Included in construction cost	-	-
	During Operation	Secure a buffer zone around 100m as noise decay distance	-	Included in Monitoring cost	-	-
25) Offensive odors	During Construction	Proper treatment of camp waste Proper maintenance of heavy equipment.	-	Included in construction cost	-	-
26) Bottom sediment	During Construction	Proper treatment in order to prevent waste from being dumped into the river.	-	Included in construction cost	-	-
27) Landscape	Before and During Construction	Inspection of landscape from vessel mooring station	-	Included in Monitoring cost	-	-
Environmental management cost (B)			TOTAL			3,000,000

Table 14.1.10 Costs for Environmental Management and Monitoring
(Monitoring Costs (C))

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Costs (BDT)
1) Involuntary Resettlement	Before Construction	Compensation for impact	-	Included in RAP cost	-	-
	During Construction	Compensation for impact	-	Included in RAP cost	-	-
2) Local Economies such as employment, livelihood etc.	Before Construction	Compensation for impact	-	Included in RAP cost	-	-
	During Construction	Compensation for impact	-	Included in RAP cost	-	-
3) Land use and utilization of local resources	Before Construction	Proper occupation	-	Included in RAP cost	-	-
	During Construction	Proper occupation	-	Included in RAP cost	-	-
4) Social institutions such as social infrastructures and decision-making institutions	Before Construction	Compensation for impact	-	Included in RAP cost	-	-
	During Construction	Compensation for impact	-	Included in RAP cost	-	-
5) Existing social infrastructures and Services	During Construction	Construction for diversion	-	Included in RAP cost	-	-
6) Poor, indigenous people or ethnic minority	Before Construction	Compensation for impact Direct survey in the field by interviews with the poor people in order to ensure that groundwater is available for them.	-	Included in RAP cost	-	-
	During Construction	Compensation for impact Direct survey in the field by interviews with the poor people in order to ensure that groundwater is available for them.	-	Included in RAP cost	-	-
7) Maldistribution of benefits and damages	Before Construction	Compensation for impact	-	Included in RAP cost	-	-
	During Construction	Compensation for impact	-	Included in RAP cost	-	-
8) Local conflicts of interest	Before Construction	Direct survey in the field by interviews with the locals in order to ensure that local people, especially PAPs, are satisfied with their jobs.	-	Included in RAP cost	-	-
	During Construction	Direct survey in the field by interviews with the locals in order to ensure that local people, especially PAPs, are satisfied with their jobs.	-	Included in RAP cost	-	-

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Costs (BDT)
10) Accidents	During Construction	Ensuring that HSMP works right on the track	-	Included in the construction cost	-	-
	During Operation	Installing traffic signs, road marks, speed bumps, zebra marks, guard rails and poles, and curb stones etc	-	Included in the construction cost	-	-
11) HIV/AIDS	During Construction	Ensuring that contractor's personnel and local community understand HIV-AIDS awareness campaign	-	Included in the EMP cost	-	-
12) Gender	During Construction	Direct survey in the field by interviews with the women in order to ensure that there are no any gaps between men and women.	-	Included in the construction cost	-	-
13) Children's rights	During Construction	Visual inspection of child laborers	-	Included in the construction cost	-	-
15) River Transport	During Construction	Giving adequate illumination	-	Included in the construction cost	-	-
16) Hydrological condition	During Operation	Inspection of river bottom condition for scouring	-	Included in the construction cost	-	-
17) Fauna and flora	During Construction	Restoration of construction development area and Counting the number of River Dolphin	-	Included in the construction cost	-	-
19) Air pollution	During Construction	Measurement of SPM, NOx, SO2, CO and inspection of brick, bitumen and cement facilities (spot checks)	Set	33	75,000	2,475,000
	During Operation	Measurement of SPM, NOx, SO2, CO	Set	3	750,000	2,250,000
20) Water pollution	During Construction	Measurement of pH, EC, Turbidity, DO, Coliform, BOD, NH4-N, Oil, Grease, fecal coliform, Fe, and As	Set	33	10,000	330,000
		Effluent Water Quality (from pile driving, concrete plant, and asphalt plant); pH and SS	Set	pH→500	9	18,000
				TSS→1500	9	
		Drinking Water Quality (Groundwater for construction workers); Measurement of pH, fecal coliforms, Fe and Arsenic	Set	pH→500	6	21,600
				FC→800	6	
				Fe→800	6	
				As→1500	6	

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Costs (BDT)
	During Operation	Measurement of pH, EC, Turbidity, DO, Coliform, BOD, NH4-N, Oil, Grease, fecal coliform, Fe, and As	Set	6	10,000	60,000
21) Soil pollution	During Construction	Visual inspection, or measurement of Cd, Pb, As, oil, grease and so forth	-	Included in the construction cost	-	-
	During Operation	Visual inspection, or measurement of Cd, Pb, As, oil, grease and so forth	Set	6	50,000	300,000
22) Waste	During Construction	Inspection of waste disposal sites and construction camps	-	Included in the construction cost	-	-
23) Noise	During Construction	Visual inspection to ensure that equipment of a good standard is in use and sound insulation cover is installed.	Set	15	20,000	300,000
	During Operation	Measurement of noise dB (A)	Set	3	20,000	60,000
25) Offensive odors	During Construction	Odor inspection to ensure harmful odors are not released from equipment and waste	-	Included in the construction cost	-	-
26) Bottom sediment	During Construction	Bottom sampling of Cd, Pb, As, oil, grease and so forth	-	Included in the construction cost	-	-
27) Landscape	Before and During Construction	Vessel mooring station for 2 times at 3 sites	Set	6	50,000	300,000
Monitoring Costs (C)			TOTAL			6,114,600

Table 14.1.11 Costs for Environmental Management and Monitoring (Environmental Training Costs (D))

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Costs (BDT)
Environmental Training	During Operation	Orientation Workshop and follow up training program for capacity building/ institutional development programme of SEC	LS	1	1,000,000	1,000,000
Environmental Training Costs (D)			TOTAL			1,000,000

Table 14.1.12 Costs for Environmental Management and Monitoring (Total Cost in BDT)

Total (A+B+C+D)	11,114,600
Contingency @ 10 %	1,111,460
Grand Total	12,226,060

14.1.8 Public Participation

Outlines of consultation meetings and discussions are shown in 14.2.5 Disclosure, Consultation and Participation. In the consultation meetings and discussions, the local people mostly did not have any comments, opinions, suggestions or questions relating to the environment.

14.1.9 Addendum of EIA Report Approved by DoE

In accordance with the EIA report (Appendx-13) prepared on 20th September 2012 and consequently submitted to Department of Environment (DoE) on behalf of RHD, DoE issued minutes of meeting on environmental clearance. The minutes clarify that the recommendation for approval of the EIA report along with an order of issuance of an Environmental Clearance Certificate (ECC) for the project is approved.

The EIA report approved by DoE is further revised. This revision consists of six major modifications which are enclosed in the subsequent tables and proposed to be the addendum of the EIA report.

Modification-1:

Table 2.2 (Material to be used and Waste to be Generated) shown in Page-9 of Chapter 2 (PROJECT DESCRIPTION) is revised by modification of sub item ‘Soil’ of ‘Construction material used’. The modifications are shown in Table 14.1.13. The estimated soil quantities are proposed to be re-examined while detailed design is carried out.

Table 2.2 Material to be used and Waste to be generated (as per EIA Report Approved)

		Unit	Kanchpur Bridge	Meghna Bridge	Gumti Bridge	Total
Construction material used	Soil	m^3	**47,000**	**39,200**	**32,800**	**119,000**

Table 14.1.13 Material to be used and Waste to be generated (to be included)

			Unit	Kanchpur Bridge	Meghna Bridge	Gumti Bridge	Total
Construction material used	Soil	Required amount (After correction)	m^3	**38,000**	**38,000**	**24,000**	**100,000**
		Excavated	m^3	1,000	4,000	9,000	14,000
		Borrow pit	m^3	37,000	34,000	15,000	86,000

Modification-2:

Paragraph-5 shown in Page-140, Section 7.2 (Project Impact to Key 27 Items) of Chapter 7 (ENVIRONMENTAL IMPACTS) is revised by adding the phrases, which are highlighted in Table 14.1.14by underlined text.

Table 14.1.14 Inclusion of Additional Phrases

Main text (as per EIA report approved): Page 140, Paragraph-5	Underlined text to be modified
7.2 Project Impact to Key 27 Items 2) Local economies such as employment, livelihood, etc. Before/During Construction Severe: There are generally 10 fishermen each in both Meghna and Gumti Bridge sites. They would experience some adverse impacts on fishing by changes of water quality and hydrological condition through construction.	**7.2 Project Impact to Key 27 Items** 2) Local economies such as employment, livelihood, etc. Before/During Construction Severe: There are generally 10 fishermen each in both Meghna and Gumti Bridge sites. They would experience some adverse impacts on fishing by changes of water quality and hydrological condition through construction. But the people do not largely fish using net and hook rigs around there. Furthermore, they do not necessarily fish just on the side of the bridges but rather fish in a wide range of spots having the vessels move. It can be said that there is almost no significant impact on fishermen by the project works. The reasons behind this are explained as follows: 1. Because of their broad range of fishing and small dependence on the points near the bridges, they are able to keep their fishing in places far from the construction sites during construction. 2. The construction of Steel Pipe Sheet Pile (SPSP) foundation mitigates the contamination of river water during construction. 3. The construction schedule is disclosed to the locals including the fishermen and they can make a plan to consider where they should fish.

Modification-3:

Table 7.3 (Depths of Scouring Made in the Past and Depths can be Caused in a 100 year Period in the Future) shown in Page-147 of Chapter 7 (ENVIRONMENTAL IMPACTS) is revised based on recalculating the values of two items. The recalculating values are shown in Table 14.1.15.

Table 7.3 Depths of Scouring Made in the Past and Depths can be Caused in a 100 year Period in the Future (as per EIA report approved)

	Kanchpur Bridge	Meghna Bridge	Gumti Bridge
Maximum scouring taken placed in the past, m	**0**	**18**	**6**
Maximum scouring that may take place in the future, m	**8**	**4**	**7**

Table 14.1.15 Scouring Depth in past and Scouring Depth expected in 100 Year Period

	Kanchpur Bridge	Meghna Bridge	Gumti Bridge
Maximum scouring taken placed in the past, m	**0**	**17**	**4**
Maximum scouring that may take place in the future, m	**9**	**4**	**8**

Modification-4:

Paragraph-4 shown in Page-159, Section 7.2 (Project Impact to Key 27 Items) of Chapter 7 (ENVIRONMENTAL IMPACTS) is revised by including the phrase "from the edge of the car lane" two times, which are highlighted in Table 14.1.16 by underlined text.

Table 14.1.16 Inclusion of Additional Phrase

Main text (as per EIA report approved): Page 159, Paragraph-4	Underlined text to be modified
7.2 Project Impact to Key 27 Items 23) Noise and Vibration During Operation Moderate: A result of quantitative noise forecast is shown in Tables 7.15, 7.16, and 7.17. Currently, (2012), the nearest house or shop from the road is 10m away and the values of noise are shown with bold text in the three tables. On the other hand, in the future (2022), the nearest house or shop from the road would be 20m away and the values of noise are shown with bold text in the three tables.	**7.2 Project Impact to Key 27 Items** 23) Noise and Vibration During Operation Moderate: The result of a quantitative noise forecast is shown in Tables 7.15, 7.16, and 7.17. Currently, (2012), the nearest house or shop from the road is 10m away from the edge of the car lane and the values of noise are shown with bold text in the three tables. On the other hand, in the future (2022), the nearest house or shop from the road would be 20m away from the edge of the car lane and the values of noise are shown with bold text in the three tables.

Modification-5:

Table 8.12 (Environmental Management Budget) under section 8.6 (EMP Cost Estimate) shown in Page 194 of Chapter 8 (ENVIRONMENTAL MANAGEMENT PLAN) is revised by including an additional two items in '20) Water pollution' component. The additional two items are enclosed in Table 14.1.17.

Table 14.1.17 Additional Two Items to be included in Table 8.12 of EIA Report (approved)

Component	Stage	Item	Unit	Unit Cost (BDT)	Quantity	Total Cost (BDT)
20) Water pollution	During Construction	Effluent Water Quality (from pile driving, concrete plant, and asphalt plant); pH and SS	Set	pH→500	9	18,000
				TSS→1500	9	
		Drinking Water Quality (Groundwater for construction workers); Measurement of pH, fecal coliforms, Fe and Arsenic	Set	pH→500	6	21,600
				FC→800	6	
				Fe→800	6	
				As→1500	6	
	Subtotal					39,600

Modification-6:

Total EMP cost estimate shown in Table 8.12 (Environmental Management Budget) section 8.6, Page 194 of Chapter 8 (ENVIRONMENTAL MANAGEMENT PLAN) is revised based on the additional cost of two items (Table 14.1.13). This additional cost results in an increase of total cost, contingency and grand total of EMP cost. The changes in cost estimates are shown in Table 14.1.18.

Table 8.12 Environmental Management Budget (as per EIA report approved)

Component	Total Cost (BDT)
Enhancement of Environment (A)	1,000,000
Environmental Management Cost (B)	3,000,000
Monitoring Cost (C)	**6,075,000**
Environmental Training (D)	1,000,000
Total (A+B+C+D)	**11,075,000**
Contigency@10 %	**1,107,500**
Grand Total	**12,182,500**

Table 14.1.18 Environmental Management Budget

Component	Total Cost (BDT)
Enhancement of Environment (A)	1,000,000
Environmental Management Cost (B)	3,000,000
Monitoring Cost (C)	**6,114,600** (=6,075,000+39,600)
Environmental Training (D)	1,000,000
Total (A+B+C+D)	**11,114,600**
Contigency@10 %	**1,111,460**
Grand Total	**12,226,060**

14.2 Brief Overview of RAP Report

The Resettlement Action Plan (RAP) Report (Appendix-18) has been submitted to RHD for obtaining approval from the GoB side and accordingly approved by MoC on November 28, 2012. In accordance with the RAP Report submitted, an executive summary is prepared, which is briefly explained hereinafter in the following sections;

14.2.1 Land Acquisition and Displacement

Construction of the 2nd bridges and rehabilitation of the existing bridges will require no land acquisition. All components of the project will be constructed on the RHD land. A total of 274 Project Affected Households (PAHs) or 972 peoples will be relocated due to the project interventions as shown in Table 14.2.1. Besides, two community properties will also be relocated from the project area. A total of 231 households and shop tenants will be displaced in Kanchpur Bridge, 19 in Meghna Bridge and 24 in Gumti Bridge. In addition to 274 households to be displaced, a total of 28 wage laborers will also lose their sources of livelihood due to the project of which 26 at Kanchpur Bridge and 2 at Gumti Bridge. These peoples and properties are located in RHD owned land and have not official land ownership. Bridge wise impacts are shown in theTable 14.2.1 below.

Table 14.2.1 Number of Affected Households

Type of loss		No of PAHs				No of people			
		Kanchpur	Meghna	Gumti	Total	Kanchpur	Meghna	Gumti	Total
Required for Displacement									
1	Residential house owners	100	1	6	107	412	3	19	434
2	Residential rentee	98	0	0	98	313	0	0	313
3	Shop owners	26	17	18	61	98	40	61	199
4	Shop tenants	4	1	0	5	12	4	0	16
5	Residential and shop owner	3	0	0	3	10	0	0	10
	Sub Total (1-5)	231	19	24	274	845	47	80	972
Not required for Displacement									
6	Pond/fish cultivator	1	0	0	1	5	0	0	5
7	Tree owners	0	1	0	1	0	6	0	6
8	Wage earners (Employees)	26	0	2	28	26	0	2	28
9	Community owned structures	1	1	0	2	1	1	0	2
	Sub Total (6-9)	28	2	2	32	32	7	2	41
Grand Total (1-9)		259	21	26	306	877	54	82	1,013

Source: RAP Report

Beside the results shown in Table 14.2.1, an additional census on asset inventory was conducted along the 'Meghna old ferry route' in order to optimize the route alignment of the 2nd Meghna Bridge. It is found that a total of 329 PAHs (housing and commercial entities, common properties including tenants and squatters, wage laborers) need relocation from 'Meghna old ferry route', whereas only 21 PAHs need relocation and affected by the alignment at upstream next and parallel to the existing bridge. Therefore, the latter one is selected and considered as project affected households due to the construction of 2nd Meghna Bridge.

14.2.2 Significance of Impacts

All physically displaced project affected households (PAHs) will experience significant impacts as a result of displacement. Mitigation of all impacts, including the significant resettlement impacts, will be undertaken through implementation of this Resettlement Action Plan (RAP). The RAP identified, and proposed a number of remedial measures for addressing the gaps between national legislation and the requirements of a Development Partner such as JICA's Policy on Involuntary Resettlement.

14.2.3 Indigenous People

There are no indigenous people (tribal or ethnic minority) within the affected population.

14.2.4 Compensation and Entitlements

The affected persons (APs) will be compensated for their affected structure, trees, cropping fields, ponds, businesses, both squatters and tenants staying on the government land. Compensation is to be paid by the RHD through an NGO/consulting firm to be engaged by the Design and Construction Supervision Consultant (DCSC) to assist RHD in the RAP implementation process. Compensation is based on entitlements including: (i) replacement value for structures, trees, etc. and (ii) other resettlement assistance as required such as transfer grants, re-installation grants (except replacement value) and compensation for loss of business/wages due to dislocation etc. Vulnerable households will be eligible for further cash assistance for relocation and resettlement to improve their living condition. The RAP Implementing Agency (IA) will assist the APs in searching for alternative relocation sites and in the relocation process. The entitlements as per loss category are presented in Table 14.2.2 through Table 14.2.7 below.

14.2.5 Disclosure, Consultation and Participation

The Displaced Persons (DPs) and their community have been consulted for their perception of the compensation payment process, scope and importance of participation in the project process, relocation requirements, etc. While conducting the survey and the group discussions, personal contact and community based stakeholder consultation meetings were held at

different stages of the project formation to seek opinions of the various stakeholders on the project. At least 3 formal stakeholder consultation meetings were held at Kanchpur, Meghna and Gumti with different occupational groups near the three bridges. Among 3 formal stakeholder meetings, 2 RAP disclosure meetings were held in three bridge locations on 15th March 2012, 1st August 2012 and 1st September 2012..

For the first stage and second stage (consultation and disclosure) meetings, the people were informed through notices published in the national Daily newspapers and verbal notices through community leaders. During the implementation of the RAP more stakeholder's consultation and focused group meetings will be held to seek cooperation from various stakeholders in the decision-making and implementation of the RAP. The RAP will be summarized in an information booklet in Bangla (local language) and disclosed to the affected people during the implementation period. The APs will participate in the RAP implementation process through representation in the Grievance Redress Committees (GRCs).

14.2.6 Eligibility of Cut-off Date

All of the APs are identified on the RHD land and no new land acquisition is required for the project. This is why the commencement date of census survey is declared as the cut-off date for eligibility of resettlement benefits for the properties standing on the GoB land. In this project the date of commencement of the census i.e. 8th March 2012 in Kanchpur Bridge, and 15th March 2012, in Meghna and Gumti Bridge are declared as the cut-off dates.

Table 14.2.2 Entitlement Matrix, Loss Item-1

Loss Item 1: LOSS OF PHYSICAL STRUCTURES RESIDENTIAL AND COMMERCIAL (WITHOUT TITLE TO LAND)			
Entitled Persons	Entitlements	Application Guidelines	Additional Services
1. Socially recognized owners (Squatters) of structures built in the ROW as identified by the Census	1. Replacement Value[1] (RV) for structures 2. Transfer Grant @ BDT 7 (seven) per ft[2] of affected structure. 3. Utility reconnection assistance @BDT2,000/household 4. Removal grant for billboards as lump sum @ BDT 200,000/ number 5. Special Assistance of a one-time payment as recommended by PAVC for each vulnerable household (VHH) i.e. female-headed, disabled-headed, elderly-headed and hardcore poor household with an amount of BDT 10,000/VHH. 6. BDT 12,000/- as one time grant in addition to other compensation for female headed including disabled/handicapped/widow member family. 7. Skill Training for vulnerable households is provided by IA. 8. Owner will be allowed to take all salvageable materials free of cost.	1. Applicable to all structures located in ROW at cut-off dates. 2. PAVC will record structures and recommend the RV of structures. 3. Compensation will be paid for the structures built by the RHD and employees of RHD. 4. Transfer grant would be paid only for primary structures such as residential houses (measured in sq ft). 5. Hardcore poor is defined as the households in which the income level is lower than BDT 60,000/year[3]	1. RAP Implementing Agency (IA) will assist the APs in finding alternative sites for relocation.
Implementation Issues			
2. Entitled persons will be identified through the Census survey to be conducted by IA and RHD at the detailed design stage. 3. RV of structure will be determined by PAVC 4. Compensation must be paid before EP dismantles and removes the structures as per civil works requirements by RHD through IA.			

[1] As determined based on the result of replacement cost survey conducted by study team and to be recommended by PAVC
[2] Based on Padma Bridge Project (2010) financed by WB, ADB, JICA and IDB because of the proximity of the area and year the survey was conducted, the value used for this project is considered to be applicable in due consideration of recent price levels.
[3] Based on the Southwest Area Integrated Water Resources Planning Management Project (2011) financed by ADB

Table 14.2.3 Entitlement Matrix, Loss Item-2

Loss Item 2: LOSS OF STANDING CROPS/FISH STOCK/ TREES BY HOSE WHO HAVE A CONTRACT WITH THE LAND OWNER			
Entitled Persons	Entitlements	Application Guidelines	Additional Services
1. Socially recognized owners, that have contract documents with the land owner, for trees and crops grown on public or other land, as identified by IA and verified by PAVC.	1. The crop owners will be issued 60 days prior notice by the RHD to harvest the crops. If it is not near harvesting period, the expected yield will be compensated at RV. 2. In addition, grants for loss of access (right of cultivating) to cultivable land equivalent to the crop harvested in one harvesting season, to be verified by PAVC, RV of fish stock and trees as determined by PAVC 3. Owners will be allowed to harvest crops and fish stock and fell the trees. 4. Dislocation allowance for fish pond @ BDT300/dec. 5. 5. Provisions of lease agreement will supersede above entitlements unless there are otherwise no conflicts with guidelines stated in this matrix.	1. Applicable for all crops/fish stock on land/ponds within ROW at the time of dispossession. 2. If the tree is planted on the RHD land by taking lease, compensation for trees will be paid following the clause of the lease agreement signed between the parties[4] 3. 3. RV of trees/crops/fish stock will be recommended by PAVC based on data obtained from forest department/ district agriculture extension office/ district marketing office/fishery department respectively/market survey, etc. for those identified through joint on-site verification by PAVC	Nil
Implementation Issues:			
Loss of agricultural products (standing crops) will be assessed by PAVC and compensation will be paid by RHD through IA			

[4] Usually, the lease contract is made to pay half of the total sales (market price) to the land owner. Therefore, half the price of planted trees is paid to the tree owners. The other half is not required to be paid since the land owner is RHD

Table 14.2.4 Entitlement Matrix, Loss Item-3

Loss Item 3: LOSS OF STANDING CROPS/FISH STOCK/ TREES FOR THOSE WITHOUT TITLE TO LAND OR CONTRACT WITH LAND OWNER			
Entitled Persons	Entitlements	Application Guidelines	Additional Services
1. Actual cultivators, without consent from land owner, as identified in census by IA and verified by PAVC during implementation of RAP.	1. The crop owners will be issued 60 days prior notice by the RHD to harvest the crops. If it is not near the harvesting period, the expected yield will be compensated at RV. 2. In addition, grants for loss of access (right of cultivating) to cultivable land equivalent to the crop harvested in one harvesting season, to be verified by PAVC. 3. RV of fish stock, and trees as determined by PAVC 4. Owners will be allowed to harvest crops and fish stock and fell the trees.	1. Applicable for all crops/fish stock on land/ponds within ROW at the time of dispossession. 2. RV of trees/crops/fish stock will be recommended by PAVC based on data obtained from forest department/ district agriculture extension office/ district marketing office/fishery department respectively/market survey, etc. for those identified through joint on-site verification by PAVC	
Implementation Issues: None			

Table 14.2.5 Entitlement Matrix, Loss Item-4

Loss Item 4: LOSS OF INCOME (BUSINESS OWNER, WAGE EARNERS AND RENTED-OUT HOUSE OWNER)			
Entitled Persons	Entitlements	Application Guidelines	Additional Services
1. Small shop owner affected by displacement 2. Wage earners affected at business enterprises 3. Owner of rented house/rooms affected by the Project	1. Grants for business loss and/or for loss of rental income with an amount equivalent to three months net income not exceeding BDT. 24,000[5]. or 2. Grant to cover temporary loss of regular wage income @ BDT 250[6] for 90 days 3. and 4. Special Assistance of a one-time payment as recommended by PAVC for each vulnerable household (VHH) i.e. female-headed, disabled-headed, elderly-headed and hardcore poor household with an amount of BDT 10,000/VHH. 5. BDT. 12,000/- as one time grant in addition to other compensation for only female headed without elderly support disabled/ handicapped/widow member family. 6. Skill training for vulnerable households is provided by trainer NGO	1. The needs of vulnerable groups will be assessed by IA through the needs assessment survey[7] in the detailed design stage 2. The owners of rented out premises will be entitled to a business loss allowance for each unit of premises rented out to separate families or persons.	1. EPs will be brought under income generation program based on needs assessment survey result. 2. EPs will be preferentially employed in civil construction work. 3. EPs who lose structure will also be entitled to loss Item 1. 4. EPs who rent premises will also be entitled to loss Item 5.
Implementation Issues: 1. IA identifies EPs at census, PVAC verifies the compensation amount, and RHD, thorough IA, pays the compensation. 2. Business losses have been assessed during inventory of losses. All categories of business will be paid equal amount as grant			

[5] As were estimated based on the maximum average daily income of BDT 250/days x 30 days x 3 months and is a little less than BDT 24,000.

[6] BDT 250 is likely the average of payment per day according to the socio-economic survey implemented.

[7] Socio-economic survey made to meet demand and supply. To survey the demands of skills (what skill is wanted) from enterprise owner and skills the affected people want to attain.

Table 14.2.6 Entitlement Matrix, Loss Item-5

Loss Item 5: LOSS FOR RENTING RESIDENTIAL AND COMMERCIAL HOUSE/ ROOM			
Entitled Persons	Entitlements	Application Guidelines	Additional Services
1. Rentee (who borrows residential structure) as identified by Census and verified by PAVC 2. Rentee (who borrows structures) for his business identified by Census and verified by PAVC	1. Rental assistance for both residential and commercial rentee as per the prevalent rate in the form of grant to cover maximum of 3 months rental but not exceeding BDT. 7,500[8] 2. Actual shifting assistance to be determined by PAVC, or BDT 500 per member up to BDT 5,000 per rentee residential household 3. If advance rental payment was already made by rentee to renter, and renter would not reimburse the advanced payment to rentee, then payment of allowance to renter will be deducted from owners' resettlement assistance package and paid back to the rentee up to the ceiling (3 months' allowance) of owners entitlements with GRC approval 4. Right to salvage materials from demolished structures erected by tenant. 5. Special Assistance of a one-time payment as recommended by PAVC for each vulnerable household (VHH) i.e. female-headed, disabled-headed, elderly-headed and hardcore poor household with an amount of BDT 10,000/VHH. 6. BDT. 12,000/- as one time grant in addition to other compensation for only female headed without elderly support disabled/ handicapped/widow member family. 7. Skill training for vulnerable households is provided by trainer NGO	1. Each rentee of affected premises will be entitled to shifting assistance 2. RHD employees that erected structures by themselves will be compensated for the RV and allowed to take away salvageable materials.	1. EPs will be brought under income generation program. 2. IA assists finding new rent-out house.
Implementation Issues:			
1. IA identifies EPs at census, PVAC verifies the compensation amount, and RHD, thorough IA, pays the compensation. 2. Payment shall be done before physical relocation of EPs.			

[8] Average rental fee per month is less than BDT 2,500 per month according to socio-economic survey

Table 14.2.7 Entitlement Matrix, Loss Item-6

Loss Item 6: UNFORESEEN ADVERSE IMPACTS (IF APPLICABLE)			
Entitled Persons	Entitlements	Application Guidelines	Additional Services
Households or persons affected by any unforeseen impact identified during implementation of the RAP	Entitlements will be recommended as necessary by GRC.	The unforeseen impacts will be identified through a special survey by the PAVC as per request from impacted population. The entitlements will be approved by the Ministry of Communication (MoC)	As appropriate
Implementation Issues:			
The unforeseen impacts and affected persons will be identified with due care as per policy of RAP and proposed to the MoC for approval including quantity of losses, their owners and the entitlements.			

14.2.7 Grievance Redress Mechanism

Through public consultations and distribution of the public information booklet, APs will be informed that they have a right to resolve any grievance/ complaints they may have regarding resettlement issues. Grievances will be settled with full representation in GRCs constituted of the Ministry of Communications with representatives from the Executing Agency (EA)- here RHD, the RAP IA to be engaged to assist RHD in RP implementation, local government institutions (LGI) representatives and the APs representatives to be selected by RHD in consultation with IA, LGI representative and Resettlement Specialist/Expert from the Design and Construction Supervision Consultant. The APs will call upon the support of the IA to assist them in presenting their grievances to the GRCs. The GRCs will review grievances involving all resettlement benefits, relocation and other assistance. Grievances will be redressed within 21 days from the date of lodging the complaints.

14.2.8 Income Restoration Strategy

Vulnerable Project Affected Households (PAHs) (including hardcore poor and female headed, elderly headed, etc.) will be given additional support for livelihood and income restoration.

14.2.9 Institutional Arrangements

A Project Implementation Unit (PIU) will be established by RHD headed by the Project Director at the rank of Additional Chief Engineer. Superintending Engineer and Executive Engineers will be also in place to handle the project activities. The PIU will be responsible for coordinating and overall execution of the project including payment of compensation/resettlement benefits to the entitled persons (EPs) before relocation. The DCSC will appoint an IA for implementation of the RAP for proper resettlement and rehabilitation of the project affected people before and after relocation.

14.2.10 Cost Estimate and Budget

The total indicative cost estimate for implementation of the RAP is BDT 84,768,648 (Eighty four million seven hundred sixty eight thousand six hundred forty eight) equivalent to USD 1,033,763 (1 USD=82 BDT as of July 2012.) This includes payment of compensation for structure & resettlement benefits with other allowances, training on income generating activities, operation cost of the RAP IA and external monitoring agency (EMA) of the RAP implementation. The total estimated budget is shown in the Table 14.2.8 below.

Additionally, the RAP has kept provision of the budget for structures made by RHD at Kanchpur Bridge and Gumti Bridge which are required to be demolished due to the approach road or construction yard. The unit rates of the RHD structures are the same as for other affected structures. The total budget for the RHD structures stands at **BDT 29,121,415** (USD 355,139). RHD will pay this amount to the local road division as per RHD rules.

Table 14.2.8 Summary of Resettlement Costs for the Project

	Category of Losses	Kanchpur (BDT)	Meghna (BDT)	Gumti (BDT)	Total Budget (BDT)
A	Compensation for structures	47,088,661	4,452,370	2,540,550	54,081,581
B	Compensation for Trees	838,333	4,533,750	0	5,372,083
C	Other Resettlement Benefits	5,249,603	519,062	607,480	6,376,145
D	Training on IGA for eligible members of affected households and wage laborers	560,000	8,000	72,000	640,000
E	Approximately 3 Trainers for 10 days each @BDT 3000/day/person	90,000	0	0	90,000
F	RHD Capacity Building Training	1,000,000	500,000	500,000	2,000,000
G	Operation cost for RAP Implementing Agency **	5,000,000	2,575,000	2,575,000	10,150,000
H	Operation cost for External Monitoring Agency (EMA)	500,000	300,000	200,000	1,000,000
I	Contingency @ 10 % of the Total A-H*	3,235,577	1,288,818	534,444	5,058,839
	Total	63,562,174	14,177,000	7,029,474	84,768,648
	Total (USD)	775,148	172,890	85,725	1,033,763

Note: USD 1 = BDT 82 as of July 2012

*10 % of the total budget excluding RHD compensation

**including operation cost for GRC and PAVC

14.2.11 Implementation and Monitoring

Internal monitoring of RAP implementation will be the overall responsibility of the PIU and the DCSC/RAP-IA. The EA along with Resettlement Specialist/Expert of the DCSC will independently be monitoring implementation of RAP as per the guideline as well as assessing the ability of project affected households (PAHs) to restore their living standards and

livelihoods to pre-project levels. An external monitoring agency will be engaged by RHD during RAP implementation for ongoing verification.

14.2.12 Glossary of Terms

(1) Affected Person (AP)

Includes any person, affected household (AH), firm or private institution that, on account of changes that result from the project will have their (i) standard of living adversely affected; (ii) right, title, or interest in any house, land (including residential, commercial, agricultural, forest, and/or grazing land), water resources, or any other moveable or fixed assets acquired, possessed, restricted, or otherwise adversely affected, in full or in part, permanently or temporarily; and/or (iii) business, occupation, place of work or residence, or habitat adversely affected, with or without displacement.

(2) Assistance

Means support, rehabilitation and restoration measures extended in cash and/or kind over and above the compensation for lost assets.

(3) Compensation

Means payment in cash or kind for an asset to be acquired or affected by a project at replacement cost at current market value.

(4) Cut-off date

Means the date after which eligibility for compensation or resettlement assistance will not be considered. Date of service of notice under Section 3 of Land Acquisition Ordinance is considered to be the cut-off date for recognition of legal compensation and the starting date of carrying out the census/inventory of losses or any designated date declared by the RHD will be considered as the cut of date for eligibility of resettlement benefit for the properties standing on the GoB land and not covered by Deputy Commissioner (DC). In this Project the dates of commencement of the census i.e. 8th March 2012 in Kanchpur and Meghna and 15th March 2012 in Gumti Bridge are declared as cut-off dates.

(5) Encroachers

Means those people who move into the project area after the cut-off date and are therefore not eligible for compensation or other rehabilitation measures provided by the project. The term also refers to those extending attached private land into public land.

(6) Entitlement

Means the range of measures comprising cash or kind compensation, relocation cost, income restoration assistance, transfer assistance, income substitution, and business restoration which

are due to AHs, depending on the type and degree /nature of their losses, to restore their social and economic base.

(7) Eminent Domain

Means the regulatory authority of the Government to obtain land for public purpose/interest or use as described in the 1982 Ordinance and Land Acquisition Law.

(8) Household

A household includes all persons living and eating together (sharing the same kitchen and cooking food together as a single-family unit).

(9) Inventory of losses

Means the pre-appraisal inventory of assets as a preliminary record of affected or lost assets.

(10) Non-titled

Means those who have no recognizable rights or claims to the land that they are occupying and includes people using private or public land without permission, permit or grant i.e. those people without legal title to land and/or structures occupied or used by them. WB's policy explicitly states that such people cannot be denied resettlement assistance.

(11) Project

Means Dhaka-Chittagong National Highway (NH-1) Bridge Construction and Rehabilitation Project

(12) Project Affected Household

Combines residential households (HHs), Commercial and Business Enterprises (CBEs), Common Property Resources (CPRs) and other affected entities as a whole.

(13) Relocation

Means displacement or physical moving of the APs from the affected area to a new area/site and rebuilding homes, infrastructure, provision of assets, including productive land/employment and re-establishing income, livelihoods, living and social systems

(14) Replacement value

Means the value of assets to replace the loss at current market price, or its nearest equivalent, and is the amount of cash or kind needed to replace an asset in its existing condition, without deduction of transaction costs or for any material salvaged.

(15) Resettlement

Means mitigation of all the impacts associated with land acquisition including restriction of access to, or use of land, acquisition of assets, or impacts on income generation as a result of displacement due to the Project.

(16) Significant impact

Means where 200 or more APs suffer a loss of 10 % or more of productive assets (income generating) or physical displacement.

(17) Squatters

Means the same as non-titled and includes households, business and common establishments on land owned by the State. Under the project this includes RHD land, the slope of the existing road and right of way of the proposed bridge alignments.

(18) Structures

Mean all buildings including primary and secondary structures of houses and ancillary buildings, commercial enterprises, living quarters, community facilities and infrastructures, shops, businesses, fences, and walls.

(19) Vulnerable Households

Means households that are (i) headed by a single woman or a woman with dependents and low incomes; (ii) headed by elderly/ disabled people without means of support; (iii) households that fall on or below the poverty line; (iv) households of indigenous population or ethnic minority; and (v) households of low social group or caste.

CHAPTER 15

CONSIDERATIONS FOR CLIMATE CHANGE

15. CONSIDERATIONS FOR CLIMATE CHANGE

15.1 Vulnerability due to Climate Change

The vulnerability of Bangladesh to climate change has been discussed in the UN IPCC and Bangladesh. IPCC described the south Asian area as vulnerable to the greenhouse gas effect.

(1) UN IPCC 2000 to 2007

The Intergovernmental Panel on Climate Change (IPCC), in its Second Assessment Report, defines vulnerability as "the extent to which climate change may damage or harm a system." It adds that vulnerability "depends not only on a system's sensitivity, but also on its ability to adapt to new climatic conditions" (Watson et al., 1996). In a presentation made at the Sixth Conference of the Parties to the UNFCCC (COP-6), Robert T. Watson, Chair of the IPCC, defines vulnerability as the extent to which a natural or social system is susceptible to sustaining damage from climate change, and is a function of the magnitude of climate change, the sensitivity of the system to changes in climate and the ability to adapt the system to changes in climate.

Hence, a highly vulnerable system is one that is highly sensitive to modest changes in climate and one for which the ability to adapt is severely constrained. In the case of these project Bridges, vulnerability has two exposures;

- Vulnerability of the structure itself
- Additional perturbation to the natural system due to change in the environment caused by the proposed bridges

(2) BD NAPA 2005 and 2007

The Government of Bangladesh adopted the National Adaptation Program of Action (NAPA; MoEF, 2005) and recently developed the Bangladesh Climate Change Strategy and Action Plan (BCCSAP; MoEF, 2008) for building a climate resilient development framework through adaptation and mitigation.

15.1.1 Scenario of Climate Change

Many scenarios have been indicated.

(1) Variety of scenarios

The mainly used scenarios are indicated in Table 15.1.1.

Table 15.1.1 Scenarios of Global Warming postulated by IPCC

Scenarios	Assumptions	Temperature Change (degrees Celsius)		Sea Level Rise (cm)
		Most likely value	Most likely Range	Most likely Range
Scenario A1B (A balanced emphasis on all energy sources)	General Considerations: * Rapid economic growth. * A global population that reaches 9 billion in 2050 and then gradually declines. * The quick spread of new and efficient technologies. * A convergent world - income and way of life converge between regions. Extensive social and cultural interactions worldwide.	2.8 °C	1.7 to 4.4 °C	21 to 48 cm
Scenario A1F1 (An emphasis on fossil-fuels)		4.0 °C	2.4 to 6.4 °C	26 to 59 cm
Scenario A1T (Emphasis on non-fossil energy sources)		2.4 °C	1.4 to 3.8 °C	20 to 45 cm
Scenario A2	General Considerations: * A world of independently operating, self-reliant nations. * Continuously increasing population. * Regionally oriented economic development. * Slower and more fragmented technological changes and improvements to per capita income.	3.4 °C	2.0 to 5.4 °C	23 to 51 cm
Scenario B1	General Considerations: * Rapid economic growth as in A1, but with rapid changes towards a service and information economy. * Population rising to 9 billion in 2050 and then declining as in A1. * Reductions in material intensity and the introduction of clean and resource efficient technologies. * An emphasis on global solutions to economic, social and environmental stability	1.8 °C	1.1 to 2.9 °C	18 to 38 cm
Scenario B2	General Considerations: * Continuously increasing population, but at a slower rate than in A2. * Emphasis on local rather than global solutions to economic, social and environmental stability. * Intermediate levels of economic development. * Less rapid and more fragmented technological change than in A1 and B1.	2.4 °C	1.4 to 3.8 °C	20 to 43 cm

15.2 Basic Concept

15.2.1 Need for Adaptation Options

This project is the planning of construction of 3 2nd bridges and repair of 3 bridges on NH-1 in Bangladesh. The bridge project is necessary to consider the safety of the bridges themselves and to protect traffic safety from the effects of climate change.

There are various types of climate change in the global climate system. This project site is located in Bangladesh so that the most significant influence of global climate change is global warming and its related changes. The temperature rise is our concern and its related sea level rise, rainfall rise, drought and tropical storm magnitude are not independent climate phenomenon.

The temperature rise and related phenomenon are the main factors for Bangladesh and this bridge project may be affected by the climate change.

The influences of temperature change are as flows;

(1) The air temperature rises at the bridge site, which will raise the bridge temperature.

(2) The global temperature causes de-icing of the polar area. This leads a rise of sea level.

(3) The air temperature rise leads to an increase in rain fall due to the rise in humidity from the sea water temperature rise.

(4) The air temperature rise leads to a decrease of rainfall.

(5) The rain fall affects river levels.

(6) The temperature rise leads to an increase in tropical storm magnitudes. This leads to a rise in wind speed.

(7) River level rise is caused by sea level rise and an increase in rain fall.

(8) The intrusion of sea water into the rivers is caused by a sea level rise and light rain fall.

The reasons for the consideration of the effects of climate change as they impact this bridge project are as follows;

(1) The bridge shape can easily be deformed by temperature change.

(2) The clearance under the bridge must be secured for vessel passage.

(3) The bridge materials are mainly concrete and steel.

(4) The bridge must bear the natural forces. A wind speed rise could be generated by climate change.

(5) The bridge must drain the deck surface for traffic.

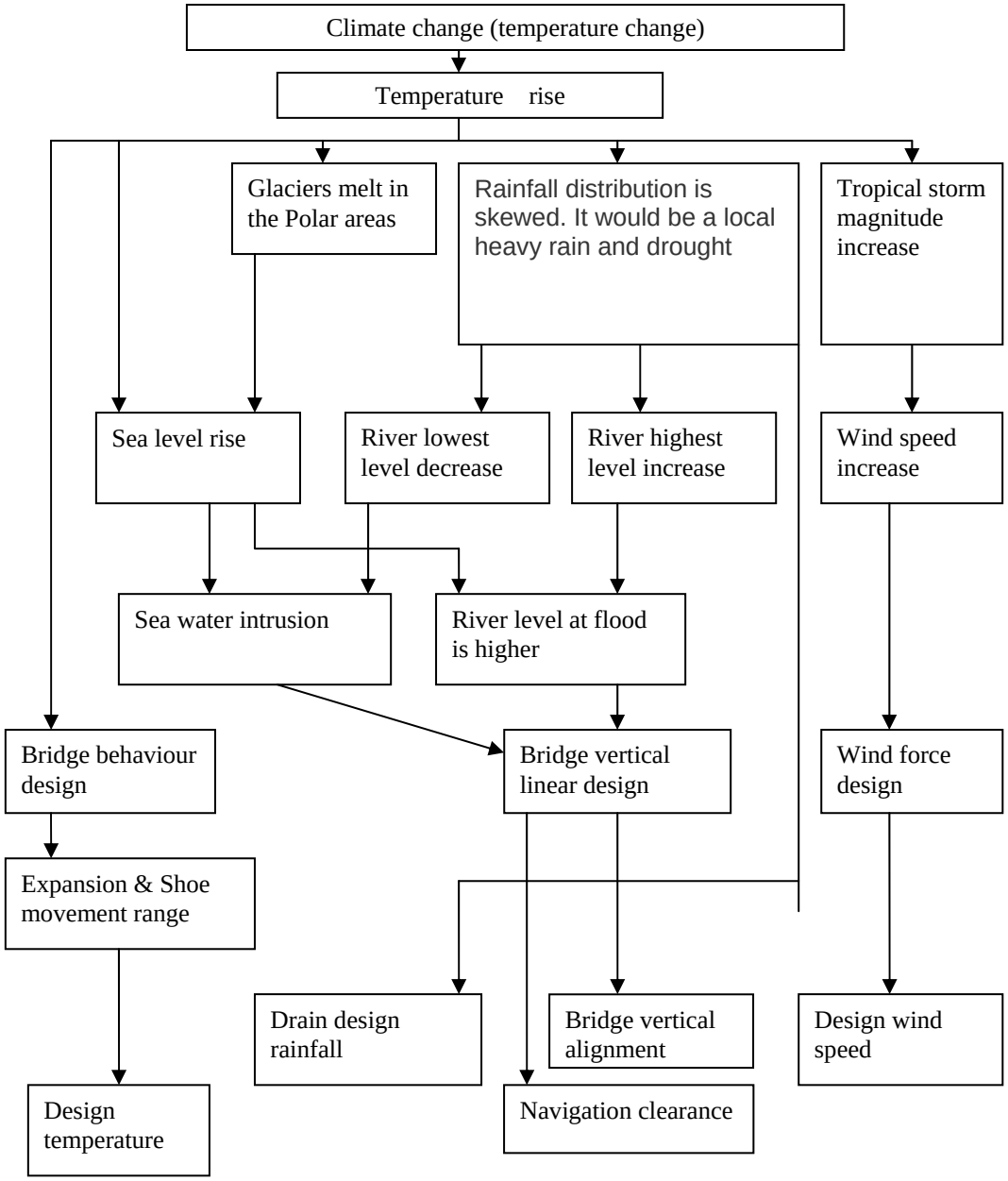


Figure 15.2.1 Scope of Consideration.

15.2.2 Adaptation Options

The options are divided into two categories. One is design considerations and the other is operation considerations. The adaptation options for climate change in Bangladesh due to the above mentioned causes are selected as follows;

(1) Temperature change

(2) Sea level rise due to temperature change

(3) Rain fall due to temperature change

(4) River height rise due to rain fall in the basin

(5) River height decrease due to drought

(6) Seawater intrusion into the river because the river water decreases and the sea level rises.

(7) Wind speed increase due to the rise in cyclone magnitude due to the temperature rise

15.2.3 Target Year of Climate Change

This time, the target year of the project is based on the service life of the bridges. Here, the service life of the bridges is 75 years in the design criteria so that the project target year will be within a range of 2090 to 2100 because it depends on the completion date of the bridge.

15.3 Climate Change Data for this Project

Data are collected from existing reports and nearby weather and river stations. And the predicted data are also collected from other existing reports.

15.3.1 Temperature

There are various kinds of predictions for temperature. The IPCC has predicted temperature change at the Madaripur observation point, which is in close proximity to this project, for 6 scenarios Those scenarios range from no need for taking countermeasures to taking countermeasures.

Table 15.3.1 Projected Global Average Surface Warming under Different Scenarios in Southern Asia

Item	Scenarios					
	B1	A1T	B2	A1B	A2	A1FI
Temperature	1.1 – 2.9	1.4 – 3.8	1.4 – 3.8	1.7 – 4.4	2.0 – 5.4	2.4 – 6.4

From IPCC 2007

BD NAPA adopted the most severe scenario. The results are shown in Table 15.3.2.

Table 15.3.2 Future Climate Scenarios used for Preparation of NAPA for Bangladesh

Year	Temperature change (°C)		
	Annual	DJF	JJA
2030	1	1.1	0.8
2050	1.4	1.6	1.1
2100	2.4	2.7	1.9

Note: DJF= December, January & February; JJA= June, July & August;

This study adapted the results of BD NAPA 2007 then assumed the prediction.

Prediction of temperature is calculated for Madaripur in the Padma study[1].

Table 15.3.3 Probability Analysis of observed Maximum and Minimum Temperatures and corresponding projected Temperature Statistics according to the PRECIS Model

Return Period	Observed Minimum Temperature	Observed Maximum Temperature	Projected Maximum Temperature		Projected Minimum Temperature	
			Yr 2050	Yr 2100	Yr 2050	Yr 2100
RP-2	12.5	37.9	39.4	41.9	13.6	14.5
RP-10	12.4	40.8	42.5	45.1	13.4	14.3
RP-25	12.2	41.6	43.2	45.9	13.1	14
RP-50	11.7	41.9	43.6	46.3	12.6	13.5
RP-75	10.9	42.1	43.8	46.5	11.8	12.6
RP-100	8.6	42.2	43.9	46.6	9.3	9.9

15.3.2 Sea Level Rise

Sea level rise is also described by IPCC and BDNAPA, and the scenario has 6 cases, the highest sea level rise is 0.88 m in BD NAPA. Table 15.3.4 to Table 15.3.5 show the result. Projected global average surface warming and sea level rise at the end of the year 2100 based on AOGCMs was presented in the following Table 15.3.4.

Table 15.3.4 Projected Global Average Sea Level Rise under Different Scenarios in Southern Asia

Item	Scenarios					
	B1	A1T	B2	A1B	A2	A1FI
Sea Level Rise	0.18 – 0.38	0.20 – 0.45	0.20 – 0.43	0.21 – 0.48	0.23 – 0.51	0.26 – 0.59

[1] Padma Multipurpose Bridge Design Project Final Report (Environment Action Plan) 32 Factoring Climate Change Consideration-Draft April 30, 2010

Table 15.3.5 Future Climate Scenarios used for Preparation of NAPA for Bangladesh

Year	Sea Level Rise (m)	
2030	0.14	
2050	0.12	
2100	0.88	

A study titled "Impact Assessment of Climate Changes on the Coastal Zone of Bangladesh" that was carried out by WARPO in 2005 assessed a Sea Level Rise of 32 cm and 88 cm in the river and estuary region. It has shown that at Daulatkhan in Shahabazpur channel (Figure 15.3.1), high tide is found to increase by 0.30 m for a 0.32 m sea level rise and 0.80 m for a 0.88 m sea level rise. More sea water will enter at Chandpur and the water level will rise by 0.50 m for a 0.88 m rise in sea level and 0.15 m for 0.32 m rise of sea level.

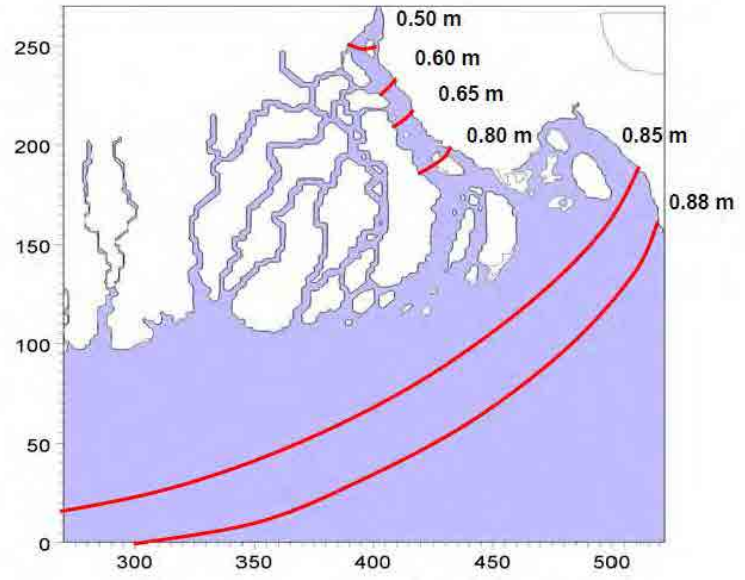


Figure 15.3.1 Increase in Water Level in Meghna Estuary due to 88 cm Sea Level Rise Compared to Base Condition

The influence of sea level rise towards river level is indicated and calculated as in Figure 15.3.1 and Table 15.3.6. The river level change will be less than 50 cm.

Table 15.3.6 Effect of Sea Level in the River and Estuary Region including the Change in Water Level at Other Locations.

Distance from theouter most boundary of SLR in	Sea Level Rise (SLR in m)		
	0.88	0.6	0.26
26 km(Doulat khan)	0.85	0.55	0.19
105km	0.8	0.52	0.18
131km	0.65	0.42	0.15
149km	0.6	0.39	0.14
168 km(Chandpur)	0.5	0.33	0.11

This data comes from the Padma bridge study.

15.3.3 Rainfall

Rainfall is also studied by the ICPP and BDNAPA at Madaripur weather station.

Table 15.3.7 Projected Change in Rainfall derived from PRECIS Model for Base and Future Scenarios at Madaripur Station Rainfall (in mm)

Month Statistics	Base	2010	2050	2090
December	1.24	1.86	63.86	0.31
January	44.64	0	38.44	12.4
February	16.66	39.2	10.36	9.8
DJF Average	62.54	41.06	112.66	22.51
% change from base		-34%	80%	-64%
March	45.105	116.25	30.38	189.41
April	78.3	280.2	249	28.5
May	117.34	303.49	1374.23	225.06
MAM Average	240.74	699.94	1653.61	442.97
% change from base		191%	587%	84%
June	296.1	435	247.8	192.9
July	236.69	229.71	169.26	345.96
August	203.05	139.5	256.37	321.78
JJA Average	735.84	804.21	673.43	860.64
% change from base		9%	-8%	17%
September	174.45	171.6	311.1	226.2
October	142.45	116.25	60.76	230.02
November	4.65	0.6	0 1	1.4
SON Average	321.55	288.45	371.86	467.62
% change from base		-10%	16%	45%

Source: Padma bridge projection

As shown above, the RCM model PRECIS model showed a 17 % increase in precipitation during peak monsoon. But the PRECIS outputs were found inconsistent10 over the years and thus IPCC-IV recommendations derived from the GCM models were adopted for projecting rainfall (26 % increase in monsoon seasonal rainfall). For design event estimation, the Generalized Extreme Value distribution method for 1-day and 2-day consecutive maximum rainfall of different recurrence intervals was used. It was found that for a 100-year return period event the rainfall may increase due to climate change from 295 mm to 372 mm and from 408 mm to 514 mm respectively for 1-day and 2-day consecutive maximum rainfall (Table 15.3.8) events.

Table 15.3.8 Probability Analysis of observed 1-Day and 2-Day Consecutive Maximum Rainfall and corresponding projected Statistics according to the IPCC Fourth Assessment Report

	Observed Rainfall		Projected Rainfall (26% increase)	
Return Period	1-day	2-day	1-day	2-day
2	124	170	156	214
10	200	276	252	347
25	238	329	300	415
50	267	368	336	464
75	283	391	357	493
90	291	402	366	506
100	295	408	372	514

15.3.4 River Water Level

The water level records for 3 bridges crossing points have been recorded for almost 40 years for each point. The calculated 100 year return period high water levels are shown below.

Table 15.3.9 Recorded High and Low Flows

Bridge	Kanchpur	Meghna	Gumti
HHWL (100 yr return Period)	7.469 m	6.984 m	7.355
Record high	7.11 m	6.76 m	6.77 m
Record low	0.48 m	0.00 m	0.22 m

Data: JICA study team (ITR) and records

Locations: Kanchpur (Demra) Meghna Ferry station Gumti Bridge (Daudkandi)

The water level rise projection from sea level rise and rainfall is calculated for Mawa point in the Padma bridge study. The water system of Meghna River is different from Padma River, therefore the water level rise due to the combination of rainfall and sea level rise is projected in Table 15.3.10.

Table 15.3.10 Probability Analysis of observed Water Level at Mawa Station and corresponding projected Statistics according to IWM generated Model Output

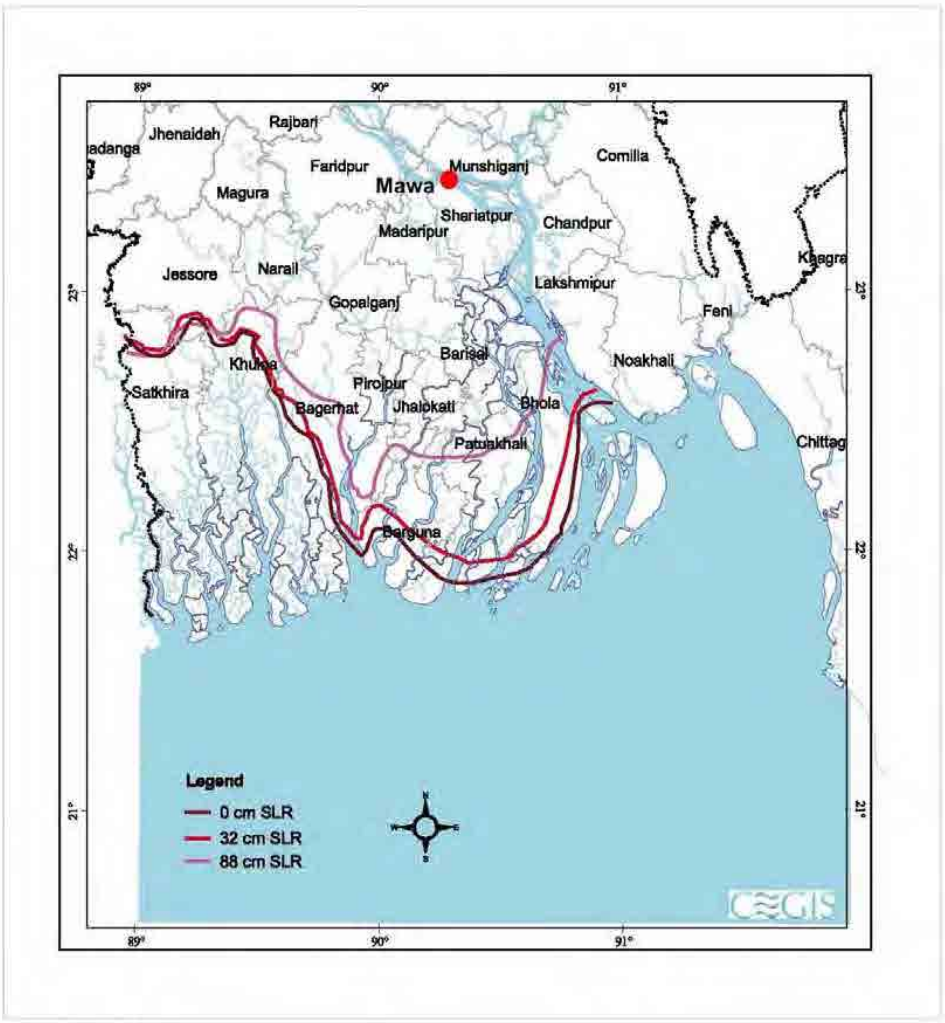
Recurrence interval	Observed Water Level (mPWD)	Predicted Water Level (mPWD)
RP-2	6.27	6.9
RP-10	6.76	7.39
RP-25	6.8	7.43
RP-50	6.81	7.44
RP-75	6.81	7.44
RP-90	6.81	7.44

The result is 63 cm rise due to sea level rise and additional rain fall.

15.3.5 Sea Water intrusion

The area affected by sea level rise is indicated based on the above mentioned lowest river height study. This time the study is based on Mawa point, which is located downstream of Meghna river. The highest river rise affected by sea level at Mawa point is 50 cm. Figure 15.3.2 shows the sea level rise.

The salinity intrusion is limited and far from the bridge locations. The salinity reaches 5 ppt approximately 110 km below the bridge locations.



Source: CEGIS, Dhaka.

Figure 15.3.2 Project Site Relative to 5 ppt Salinity Isolines for Various Sea Level Rise Scenarios (adapted from MoEF, 2008, Map 4)

15.3.6 Wind Speed

Table 15.3.11 shows the variety of results of studies.

Table 15.3.11 Results of Study for Wind Speed

Study name	Increase of wind speed
A BCAS-RA-Approtech (1994)	10 %
IPCC, 2001.	20 % to 30 %
Knutson and Tuleya (2004)	18 % within 100 km of storm centers
research cited by AR4 (IPCC, 2007a)	10 to 20 %

The maximum 10 minute average recorded wind speed at Daudkandi, which is the nearest weather station to this project, is less than 20 m/s. Therefore the forecast value is adapted from the records for Madaripur point, which is the Padma Bridge forecast point and also is nearer than Daudkandi to the sea.

15.3.7 The Result of Climate Change

This time the value adopted for consideration is the maximum.

(1) Temperature

For a once in 100 year event (Generalized Extreme Value Distribution, see Table 15.3.12), it was found that the projected maximum temperatures for year 2050 and year 2100 may be around 43.9 ^{0}C and 46.6 ^{0}C respectively. On the other hand, for the same event, minimum temperatures were anticipated to increase to 9.3 ^{0}C and 9.9 ^{0}C respectively

(2) Sea level rise

Sea level rise is also described by IPCC and BDNAPA, and the scenario has 6 cases, the highest sea level rise is 0.88 m in BD NAPA. Table 15.3.12 shows the result. The effect of sea level rise on the bridge sites where the distance from the sea is approximately 240 km is studied based on the Padma bridge study which is also located 240 km from the sea.

The sea level rise at the bridge points is 47 cm.

(3) Rainfall

Rainfall is also studied by IPCC and BDNAPA at Madaripur weather station. The results are 1-day and 2-day consecutive maximum rainfalls of 372 mm and 514 mm, respectively, for once in 100 yr return period event.

(4) River water level

The values for the rise in the high water level due to floods come from the Meghna river system study. The records of 3 bridge crossing points have been recorded for almost 40 years for each point. Combining the effect of sea level rise and increase in basin rainfall, a 0.63 m rise in water level or maximum water level of 7.74 m (Kanchpur) 7.39 m (Meghna Ferry) 7.40 m (Daudogangi) PWD can be considered. And the lowest levels were also recorded, this

time the lowest record is selected from the records as 0.48 m (Kanchpur) 0.00 m (Meghna) and 0.22 m (Gumti) PWD at the bridge crossings.

(5) Wind speed

The maximum recorded 10 minutes average wind speed at Daudogandi, which is the nearest weather station in this project, is less than 20 m/s. Therefore, this time the forecast value is adapted from the records for Madaripur point, which is the Padma Bridge forecast point and also is nearer than Daudkandi to the sea. However, the forecast wind speed at Madaripur is 126 km/h for a 233 year recurrent non-exceedance probability.

Table 15.3.12 shows the summery of the study results.

Table 15.3.12 Effect of Climate Change on Bridges

Item	Influence
Temperature rise	9.3 ℃ increase to 43.9 ℃ 2100 9.9 ℃ increase to 46.6 ℃
Sea level rise	2100 Maximum height of water level will be raised 0.47m
Rainfall	2100 rainfall forecast will be increased. The prediction for short period rainfall is 378 mm in one day or 512 mm in 2 days
Highest water level	Maximum water level calculated for a 100 year recurrent cycle is 63 cm including sea level rise and additional rainfall due to climate change
Minimum water level	Meghna bridge recorded lowest water level is 0.00 m in most recent 40 years.
Salinity effect	In the worst case scenario for 2100, 5 ppt (5000 ppm) salt content Sea water will penetrate 110 km up stream.
Wind speed	Wind speed forecast is 126 km/h.(233 year return period)

The data comes from the IPCC BDNAPA Padma bridge study and JICA study team collected.

15.4 Study of Adaptation Options

15.4.1 Study of Countermeasures for CC

The countermeasures for climate change are divided into two categories. One is considerations for design or construction and the other is considerations for operations.

Table 15.4.1 and Table 15.4.2 show the countermeasures for each stage.

Table 15.4.1 Countermeasures in Design for Climate Change.

Item	Influence	Design consideration	Countermeasure
Temperature rise	Temperature rise in maximum and minimum is changed and difference between max and min is larger than existing record. Minimum temperature +1 degree and maximum temperature +6 degrees.	Design temperature range for steel structures is 10 degrees Celsius to 50 degrees Celsius. So it almost covers the temperature change range. So that the expansion joints or shoes will not be changed.	No
Sea level rise	Maximum height of water level will be plus 0.47 m（ in the extreme case）	Vertical linear design is not changed because it is governed by the existing bridges. And clearance under the bridge is also the same as the existing bridges.	No
Rainfall	Yearly, seasonally and daily rainfall forecasts will be increased. The prediction of 1and 2 day rainfalls is 378 mm and 512 mm	Drainage of bridge is based on the hourly rainfall and it is designed based on the design rain fall forecast for a recurrent 50 year cycle so that it will be adequate for 120 mm / h	No
Highest water level	Maximum water level rise is calculated for a 100 year recurrent cycle to be 63 cm, which includes sea level rise and additional rainfall due to climate change	Vertical linear bridge design is not changed because it is governed by the existing bridges. At the time of flooding there is no passing vessel because it is difficult to control the vessel..	No
Minimum water level	Meghna bridge recorded a lowest water level of 0 m in the most recent 40 years.	There is no effect for design change for substructure or superstructure due to the minimum water level.	No
Wind speed	Wind speed forecast is 126 km/h.	Design wind speed is 195 km/h, therefore, there is no influence to the superstructure.	No

Data comes from the IPCC BDNAPA Padma bridge study and JICA study team collected.

Table 15.4.2 Countermeasures for Operation

Item	Notes
Temperature rise	The expansion joint movement must be observed in maintenance.
Sea level rise	This factor does not directly affect the bridge design.
Rain fall	Design rain fall is 120 mm/h but the rain gage should be monitored. And also secure the drainage capacity by constant cleaning the drain facilities.
High water level	Secure the clearance under bridge.
Low water level	It is necessary to maintain the navigation sign for passing ships. And river bed measurement should be done at least once every 10 years for not only the navigation safety but also scouring.
Wind speed	Must be monitored.

Data from JICA study team

15.5 Items for Considering Adaptation Option Study

Table 15.5.1 shows the monitoring items at the time of operation. The countermeasures would have been taken in the construction stage but there is a remaining uncertainty. The countermeasures or observation points cannot be addressed during the construction, they are the suggestions for operation stage.

Table 15.5.1 Monitoring Items during Operation

Item	Method	Notes
Temperature rise	Weather data of maximum, minimum and average temperatures at Daudkandi weather station must be observed after opening to traffic.	The design bridge movement is due to average temperature and difference between high and low temperatures. The expansion joint movement must be observed in maintenance.
Sea level rise	The data of sea level at tidal stations must be observed.	This factor does not directly affect the bridge design
Rain fall	The data of rainfall at Daudkandi weather station must be observed. A rain gage is recommended to be installed at the toll station or maintenance office and its data recorded.	Design rain fall is 120 mm/h and the rain gage should be monitored. And also secure the drainage capacity by constant cleaning the drain facilities.
High water level	The data of the river level station must be observed and recorded for determining the change. The water level meter should be placed at a pier.	Secure the clearance under the bridge. And also observe the height of passing vessels. To prevent the ship collision it is necessary to advertise the clearance under the bridge.
Low water level	Same as high water level	It is necessary to maintain the navigation sign for passing ships. And river bed measurement should be done at least once every 10 years for not only the navigation safety but also scouring.
Wind speed	An anemometer is recommended for monitoring wind speed.	There is a possibility of girder oscillation occurrence at high wind speed and direction according to the girder type. If it occurs, it is necessary to implement a countermeasure for vibration based on the measuring of vibration at the girder.

Data from study team.

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