Ministry of Ports and Highways
The Democratic Socialist Republic of Sri Lanka

PREPARATORY SURVEY REPORT
(OUTLINE DESIGN STUDY)
ON
THE PROJECT FOR CONSTRUCTION
OF MANMUNAI BRIDGE
IN
THE DEMOCRATIC SOCIALIST REPUBLIC
OF SRI LANKA

February 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

Japan International Cooperation Agency (JICA) conducted the Preparatory Survey (Outline Design Study) on the Project for Construction of Manmunai Bridge in the Democratic Socialist Republic of Sri Lanka, and organized a survey team consisting of CHODAI CO., LTD. and ORIENTAL CONSULTANTS CO. LTD. between July, 2010 to February, 2011.

The survey team held a series of discussions with the officials concerned of the Government of Sri Lanka, and conducted a field investigation. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our three countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the survey team.

February, 2011

Kiyofumi KONISHI
Director General,
Economic Infrastructure Department
Japan International Cooperation Agency

SUMMARY

(1) Overview of Recipient Country

The Democratic Socialist Republic of Sri Lanka is located approximately 30km off the southern coast of the Indian subcontinent, surrounded by the Indian Ocean, the Gulf of Mannar and the Palk Strait. Its land area is 65,510 km^2. In the northern part of the island lies the flat areas, in the southern part the mountainous areas. The climate is tropic. The population is 20.45 million (middle of 2009), and increasing by 1.0 ~ 1.4% per year for past 10 years.

GDP per person in 2009 is 2,063US$.

(2) Background of the Requested Japanese Assistance

The Government of the Democratic Socialist Republic of Sri Lanka (hereinafter "Sri Lanka") formulated the 10-Year National Development Plan (Mahinda Chintana: Vision for A New Sri Lanka in 2006.The development of the regional and provincial road network in the Eastern and Northern Regions and the road rehabilitation in the Tsunami-affected area were highlighted in the plan. The Ministry of Highways established the National Road Master Plan 2007-2017 (NRMP), to develop and to improve competitiveness of the Sri Lankan economy. There are several regional development plans for the Project area including the Three Years Eastern Development Plan 2007-2010 (Neganahira Navodaya or Eastern Revival). The regional development plans place the main target on the reconstruction of Eastern Province which was affected by the internal war and the Tsunami disaster.

The Batticaloa District, a center of Eastern Province in the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka"), is separated into western and eastern parts by Batticaloa Lagoon (the Lagoon) which extends north and south by approximately 50 km, and thorough development and maintenance of the infrastructure have not been implemented in this area for over 20 years. This causes the residents to have the limited access to the facilities of health care and education, and also the barrier to the carry out of agriculture products.

After the Tsunami disaster caused by the Sumatra Earthquake in 2004, the infrastructures on the eastern side of the Lagoon have been rehabilitated under the assistance by the donors including Japan. However, the western side remains without rehabilitation because the side was once a main area of the internal war.

The main transport facilities across the Lagoon are small ferries at the moment. However, these ferry services are not available at the time of flooding every year, causing the significant difficulties for the traffic and the living standard in the area. Major highways around the areas have been opening to traffic rehabilitated by Tsunami rehabilitation projects, and the traffics in the regional network are anticipated to increase. The lack of smooth traffic mode

across the Lagoon remains as the bottleneck of local economy and society.

Based on the consideration above, the Government of Sri Lanka made a request to the Government of Japan for a Grant Aid on the Construction of a Bridge across the Batticaloa Lagoon. In response to the request, Japan International Cooperation Agency (JICA) carried out the Preparatory Survey (Preliminary Study) on the Project for Construction of a Bridge across the Batticaloa Lagoon (hereinafter referred to as "the Project") from April 2009 to July 2009. In the Preliminary Study, Manmunai has the highest priority for bridge construction among the three candidate routes requested from the Sri Lankan Side.

(3) Summary of the Study Findings and Project Contents

Based on the result of the Preliminary Survey, the Japanese Government decided to conduct the Preparatory Survey (Outline Design Study) on the Project for Construction of Manmunai Bridge, and JICA dispatched the Preparatory Survey Team to Sri Lanka from August to October of 2010. Based on the field survey and the study in Japan, the Team prepared the Summary Report. JICA dispatched the Team to Sri Lanka for the explanation of the Summary Report. Based on the discussions, the Sri Lankan Side and the Japanese Side confirmed and agreed on the contents of outline design and on the obrigations of the recipient country for this Project, and the Minutes of Discussion was signed by both sides on 15 February 2011.

In the field survey, the various surveys were carried out on the issues regarding the construction of Manmunai Bridge, such as traffic, topography, geology, meteorology, hydrology, environment, social and economic issues, procurement and costs for construction etc. Based on the results of these survey, the main conditions of the facilities were determined, and the outline of the bridge and the causeways was determined as shown below.

Facility	Specifications
Bridge	
(1) Bridge length/spans	15m@14 = 210m
(2) Bridge Width	1.2m (walkway) + 3.7m@2 (carriageway) + 1.2m (walkway) = 9.8m
(3) Gradient/ Crossfall	Longitudinal slope: 3.2% , -3.2% Crossfall: 1/60
(4) High Water Level	M.S.L + 1.42m
(5) Design loads	
・Live load	HA load and HB-30 load (BS5400)
・Seismic load	Not considered
(6) Superstructure	
・Bridge Type	Concrete simple deck slabs with pretension girder.
・Construction method	Girder erected by crane
(7) Substructure	Pier: Pile bent; Abutment: Inverted T-type abutment
(8) Foundation	Pile foundation
(9) Others	Considered for future installation of additional structures

Causeway	
(1) Length	West approach: 195m; East approach: 293m
(2) Standard	Road standard: R4; Design speed: 50km/h
(3) Roadway Width	1.8m (shoulder) + 3.1m@2 (carriageway) + 1.8m (shoulder)
(4) Crossfall	2.5%

(4) Project Period and Estimated Project Cost

The planned overall project period is 33 months, consisting of 11.0 months for the detailed design work and 22.0 months for construction. The project cost reqired for fulfilling the undertakings to Sri Lanka is estimated to be 109 million yen.

(5) Evaluation of the Project

1) Relevance

The development of infrastructures is left behind at the western side of the Lagoon. The construction of Manmunai bridge will supplement this delay, and will contribute to the social and economic development of the area and to improvement of living standard of the residents.

The implementation of this Project will accelerate the rehabilitation from Tsunami disaster, and will provide the safe traffic available for 24 hours and also during flood. Also this Project will improve the access from the western shore to emergency medical services on the eastern shore, and will reduce the travel time between both sides of the Lagoon.

2) Effectiveness

a） Quantative Output

Index	Baseline Value	Target value (after construction)
Travel Distance between Western and Eastern Shore of the Lagoon	approx. 32 km	approx. 300 m
Travel Distance from Manmunai Western Shore to Batticaloa	approx. 27 km	approx. 15 km
Travel Time between Western and Eastern Shore	approx. 60 minutes (waiting time: 30 ~ 60 minutes + ferry: 10 minutes)	less than 1 minute
Transport Capacity	2 passenger cars / ferry at maximum, operation interval: 30 ~ 60 minutes	no limit
Operating Hours	12 hours (daytime, 6:00 ~ 18:00)	no limit (24 hours)
Interrupted Period during Flood	approx. 2 weeks	approx. 1 ~ 2 days

b） Qualitative Output

- Improvement of traffic for the residents including access to emergency health care and education etc.
- Stable transport of agricultural products. Improvement the local industries such as agricultures, and contribution to the economic development of Eastern Province

and Sri Lanka.

- Acceleration for establishment of peace by accelerating the transportation of people and goods between both sides of the Lagoon.

In addition to the positive outputs described above, the completion of the Project will lead to the improvement of traffic network in the area, and will contribute to the rehabilitation, social / economic development and establishment of peace. Hence the implementation of this Project is considered highly meaningful, relevant and effective.

PREPARATORY SURVEY REPORT (OUTLINE DESIGN STUDY)

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Abbreviations

AASHTO	: American Association of State Highways and Transportation Officials
ADB	: Asisn Development Bank
AFD	: Agence Française de Développement
BIQ	: Basic Information Questionnaire
CCD	: Coast Conservation Department
CEA	: Central Environmental Authority
DBST	: Double Bituminous Surface Treatment
EIA	: Environmental Impact Assessment
EMAP	: Environmental Management Action Plan
EMoP	: Environmental Monitoring Plan
ESD	: Enbironmental and Social Division
EU	: European Union
GDP	: Gross Domestic Product
GPS	: Global Positioning System
HWL	: High Water Level
IEE	: Initial Environmental Evaluation
IMF	: International Monetary Fund
JICA	: Japan International Cooperation Agency
JRA	: Japan Road Association
LLT	: Lateral Load Test
LTTE	: Liberation Tigers of Tamil Eelam
MoPH	: Ministry of Ports and Highways
MSL	: Mean Sea Level
NRMP	: Naional Road master Plan 2007-2017
PC	: Prestressed Concrete
PCU	: Passenger Car Unit
PMU	: Project Management Unit
RANDORA	: National Infrastructure Development Programme
RC	: Reinforced Concrete
RDA	: Road Development Authority
TOR	: Terms of Reference
UXO(s)	: Unexproded Ordnance(s)
WB	: World Bank

Chapter 1 Background of the Project

1.1 Current Situation

The Batticaloa District, a center of Eastern Province in the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka"), is separated into western and eastern parts by Batticaloa Lagoon (the Lagoon) which extends north and south by approximately 50 km, and thorough development and maintenance of the infrastructure has not been implemented in this area for over 20 years. This causes the residents to have the limited access to the facilities of health care and education, and also the barrier to the carry out of agriculture products.

After the Tsunami disaster caused by the Sumatra Earthquake in 2004, the infrastructures on the eastern side of the Lagoon have been rehabilitated under the assistance by the foreign funds including Japan. However, the western side remains without rehabilitation because the side was once a main area of the internal war.

The main transport facilities across the Lagoon are small ferries at the moment. However, these ferry services are not available at the time of flooding every year, causing the significant difficulties for the traffic and the living standard in the area. Major highways around the areas have been opening to traffic rehabilitated by Tsunami rehabilitation projects, and the traffics in the regional network are anticipated to increase. The lack of smooth traffic mode across the Lagoon remains as the bottleneck of local economy and society.

Based on the consideration above, the Government of Sri Lanka made a request to the Government of Japan for a Grant Aid on the Construction of a Bridge across the Batticaloa Lagoon. In response to the request, Japan International Cooperation Agency (JICA) carried out the Preparatory Survey (Preliminary Study) on the Project for Construction of a Bridge across the Batticaloa Lagoon (hereinafter referred to as "the Project") from April 2009 to July 2009. In the Preliminary Study, Manmunai has the highest priority for bridge construction among the three candidate routes requested from the Sri Lankan Side.

1.2 Condition Surrounding the Project Site

1.2.1 Natural Conditions

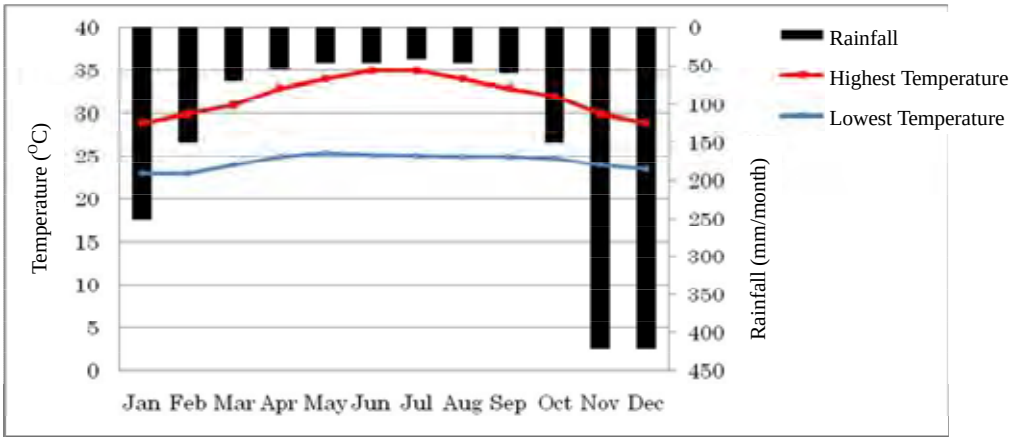
(1) Meteorological and Hydrological Conditions

1) Meteorology

① Meteorology

The rainfall is concentrated from October to February under the influence of the northeastern monsoon called “Maha”. Annual rainfall is approximately 1,500mm. The temperature variation through year is relatively small, 25 to 27.5 ^{O}C, and a little lower in the northeastern monsoon season.

The average monthly rainfalls and the highest / lowest temperatures at the period from 1993 to 2008are shown in Fig. 1.2-1.



Source: Batticaloa Observatory (Code: 434360, Puliyantivu), Meteorological Department

Fig. 1.2-1 Monthly Rainfalls and Temperatures (Highest and Lowest)

The northeastern monsoon brings strong northeast winds and rains. The southwestern wind called “Kachchan” blows for the season from May to September. As this wind loses humidity at the central highland in Sri Lanka and turns dry, the humidity on the east coast becomes relatively lower.

The average monthly relative humidity (2004 ~ 2008) and the wind velocity (1998 ~ 2007) are shown in Fig. 1.2-2.

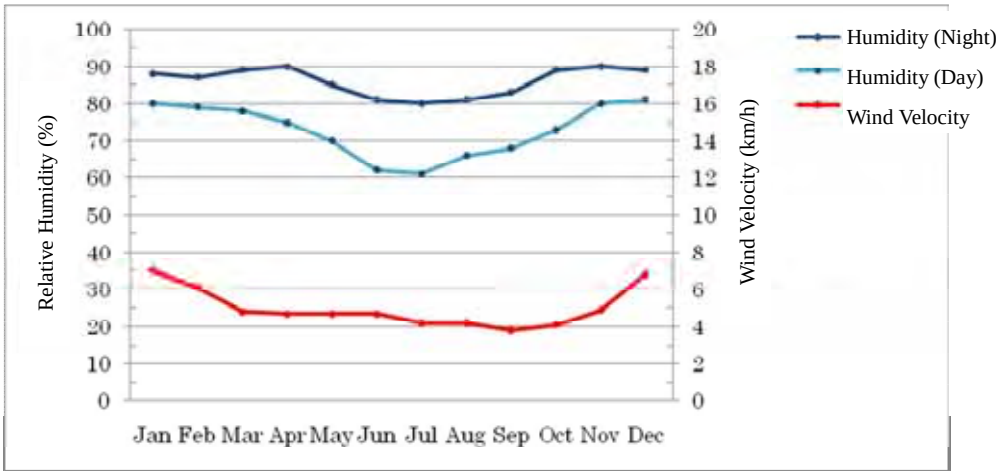


Fig. 1.2-2 Relative Humidity (Day/Night) and Wind Velocity

② Natural disasters

Although no earthquakes or landslides have been reported, this area suffers from cyclones, tsunamis, and flood disasters.

2) Hydrology

The Lagoon is divided into two parts by a narrow section (about 5km long and less than 200m wide) which lies in Kaluvanchikudiyiruppu village (at about 20km north of New Kallady Bridge).

The Lagoon runs out into the Indian Ocean at two estuaries, Palameenmadu in the north and Kallar in the south. These points are closed in seasons other than the northeastern monsoon season (from October to February). Their opening width are about 200m. The main opening is the north one at Palameenmadu. When the estuary is opened, fishes and shells enter from the sea into the Lagoon, supplying with marine resources.

① Situation of the Lagoon

The water level of the Lagoon is linked with the tide of the Indian Ocean for the period when the estuary is open and the water level difference (amplitude) is 10cm. According to the interview with fishers, there is no large debris such as driftwoods in the Lagoon.

The water depth (from the average water level to the lagoon bottom) at the Manmunai point on the ferry route is about 3.0m at maximum.

② Water level

The hydrological conditions for the new Kallady Bridge are shown in Table 1.2-1. The bridge is under construction at the point of Kallady about 5km south of Palameenmadu (about 9km north of Manmunai).

Table 1.2-1 Hydrological Conditions of New Kallady Bridge

Item		Value	Remarks
Hydrological Conditions	Discharge	2,160m^3/s	at H.W. L.
	Design High Water Level (H.W.L)	1.42m (M.S.L.)	100 years exceedance probability
	Niveau Flood level (N.F.L)	0.55m (M.S.L.)	2 years exceedance probability
	Mean Sea Level (M.S.L)	0.00m	
	Maximum Flow Velocity	2.5m/s	100 years Return Period
	Minimum Freeboard	1.2m (above H.W.L.)	2000< Flow < 5000m^3/s
	Local scouring	2.0m at Pier foundation	Calculated by HEC
	Driftwood	None	
Navigation Clearance	Minimum Navigational Height	3.93 m (M.S.L.)	Height under girder of the existing bridge
	Aperture Height	3.38 m (N.F.L.)	

Source: PPEIDP-Volume III, Part III, Appendix II : Contractor's Design, Table A11-2

(2) Topographic and Geological Conditions

1) Topographic conditions

The Project area is located in a coastal zone and surrounded by paddy fields and grasslands. Its terrain is flat which are approximately EL+0.0m to 1.0m high above sea level.

The topographic survey (planimetric survey) was carried out in this Survey (Total survey area: 148,323m^2 (on land: 52,692m^2, in water: 95,631m^2)). The result of the topographic survey is reflected in the design drawings.

2) Geological conditions

The Project area is considered to be located around the border of gneiss belt of inland plane and sedimentary stratum in coastal zone. The first stratum from surface to approx. 15 m deep is a sedimentary stratum composed of a soft sandy soil of about 10 m thick on top and a clayish layer of 1.5m~2.5m thick below. Below the sedimentary stratum there is a thin weathered rock and followed by a bedrock of gneiss layer.

In this Survey, boring (total: 8 locations (on land:3, in water: 5)), standard penetration test, and laboratory test were carried out for geological survey.

Location of the boreholes is shown in Fig. 1.2-3. The geological profile of the Project area are shown in Fig. 1.2-4 and Fig. 1.2-5.

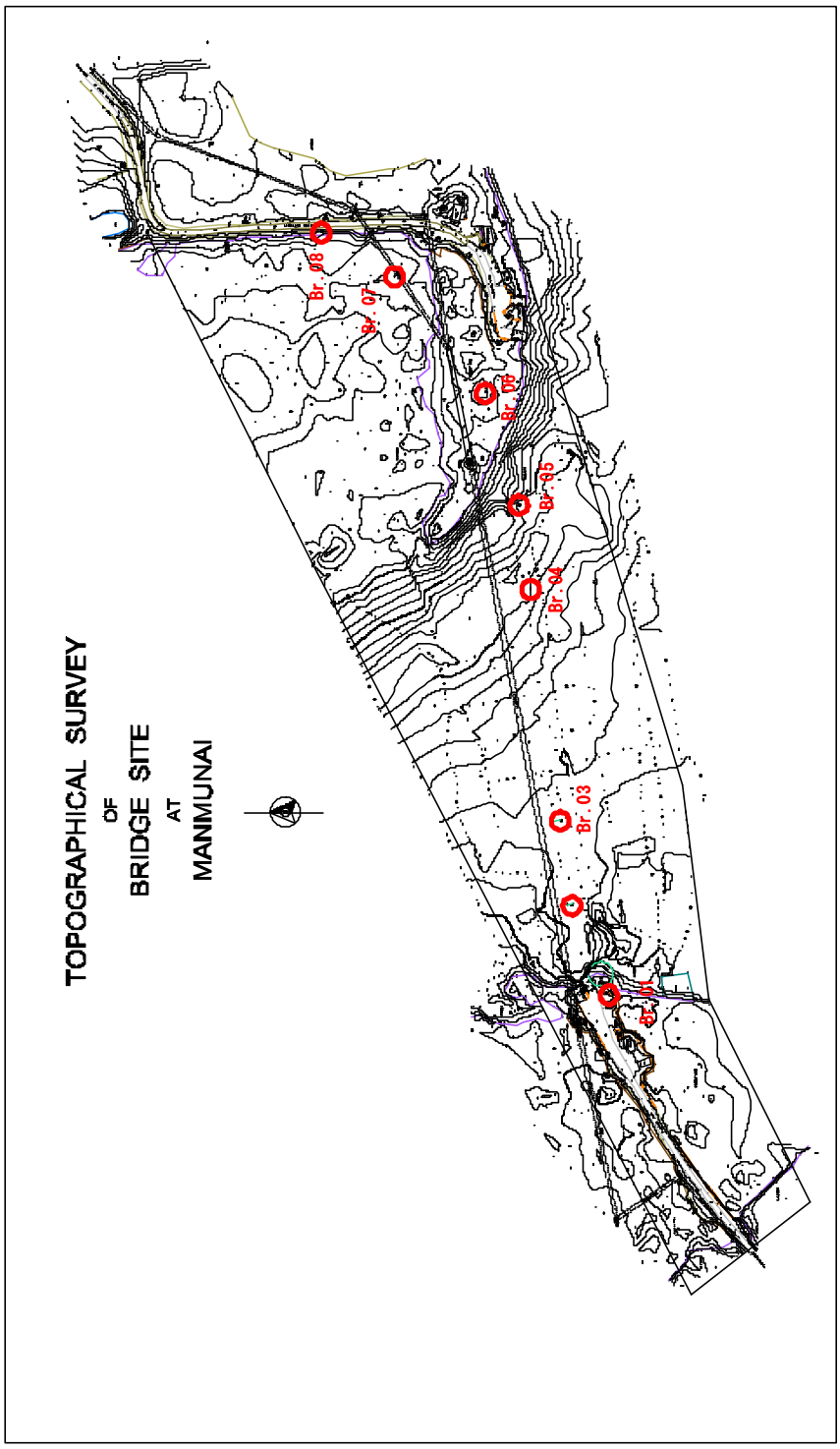


Fig. 1.2-3 Location of the Boreholes

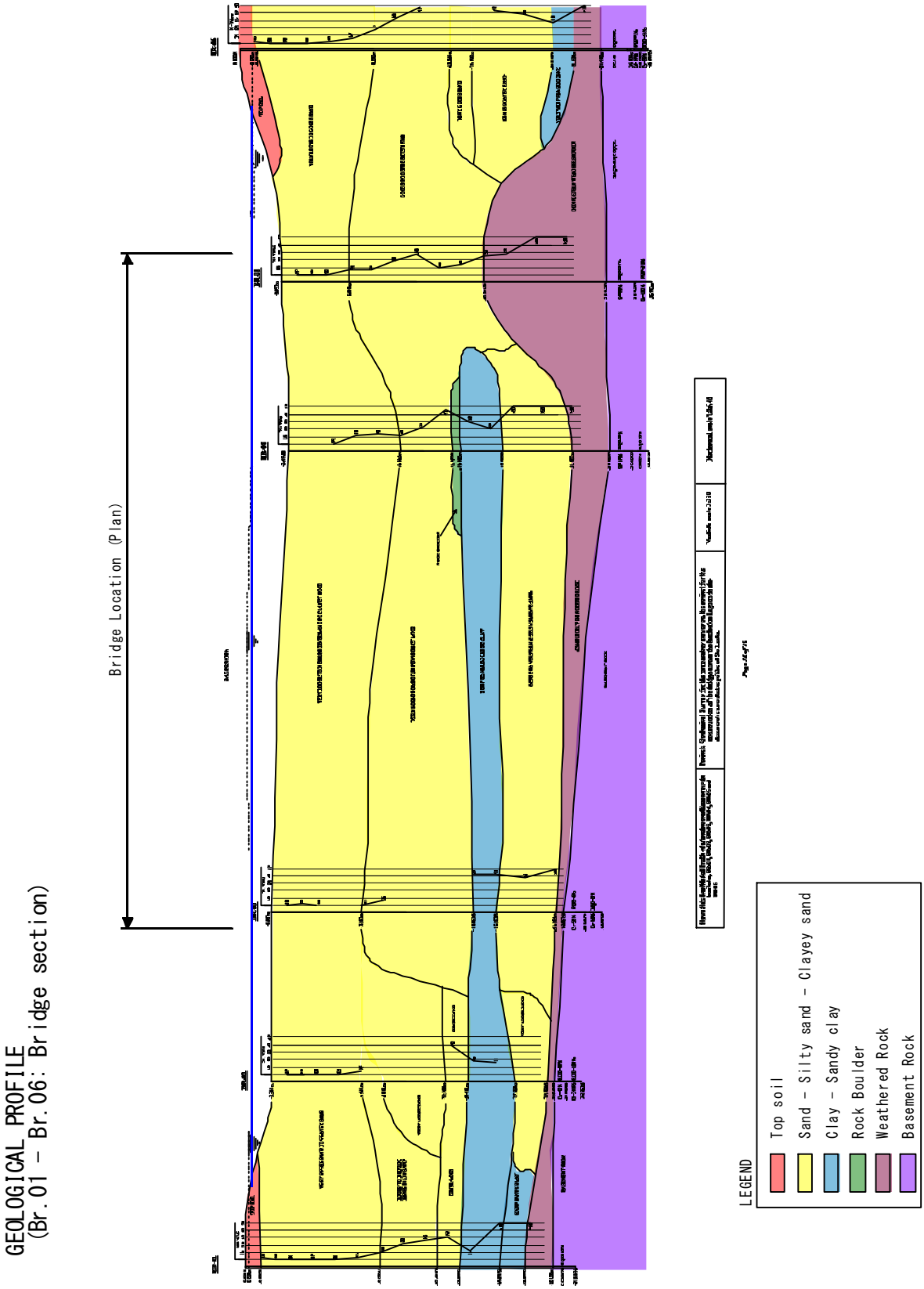


Fig. 1.2-4 Geological Profile (Br. 01~Br. 06: West side)

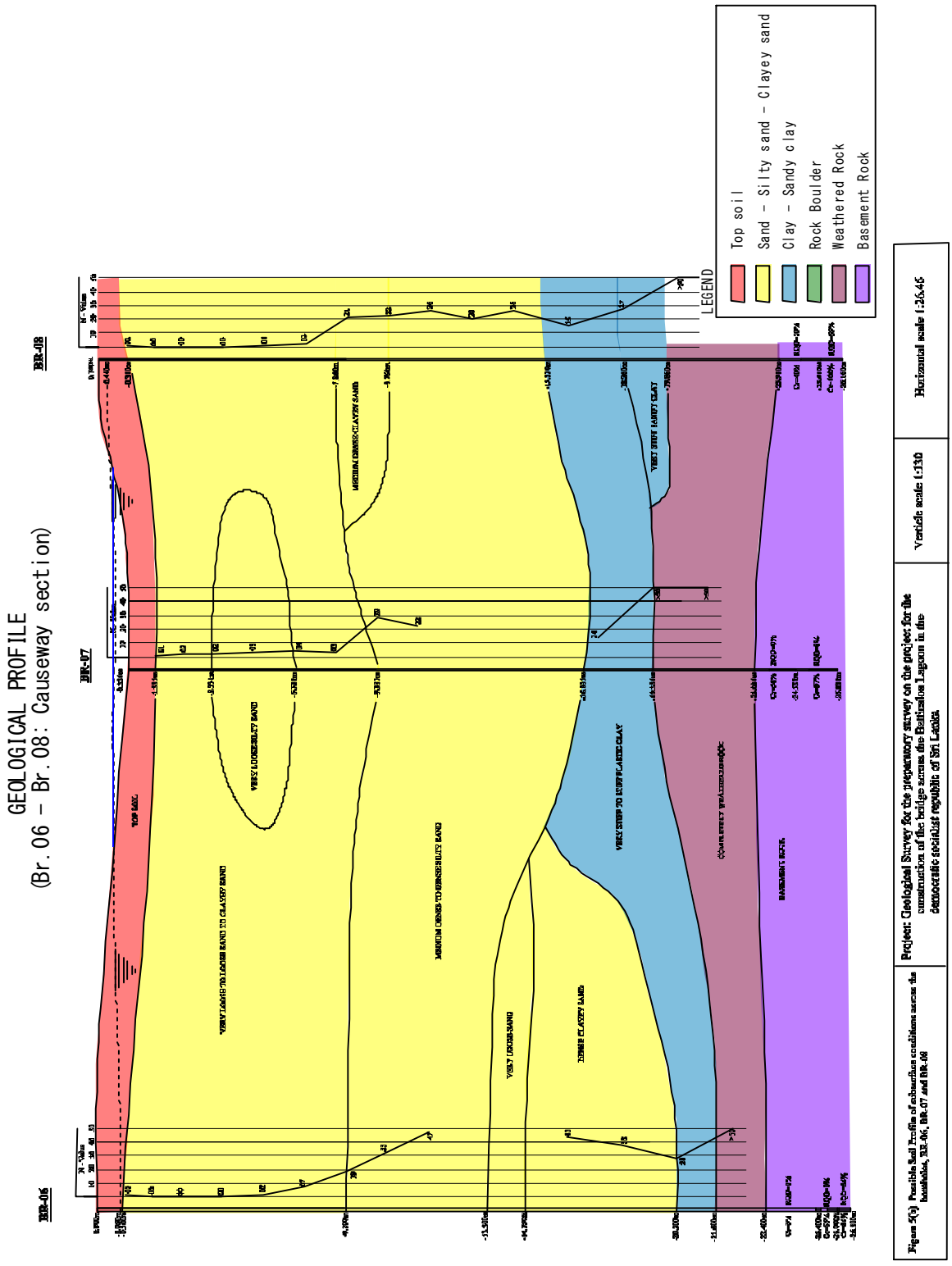


Fig. 1.2-5 Geological Profile (Br. 06~Br. 08: East side)

1.2.2 Environmental and Social Considerations

(1) Social consideration at the Project Site

One shop and a small Hindu shrine may be influenced by this Project (as shown in Fig. 1.2-6). The road alignment is planned not to affect to these facilities, to avoid any land acquisition or resettlement of private assets. Although the road alignment is planned not to influence to the ferry jetty at the eastern shore, the ferry jetty on the western shore (Fig. 1.2-7) shall be relocated during the construction. There is also a fishing weir near the ferry jetty (Fig. 1.2-8) at the western shore. RDA shall investigate the influence to the weir before the construction of bridge.

Fig. 1.2-6 A Shop at Roadside

Fig. 1.2-7 Ferry Jetty at Western Side

Fig. 1.2-8 Fishing Weir

This area have been under control of LTTE for many years as the Tamils are dominant. The engagement of Sinhalese contractors to the projects tends to raise conflicts with local residents, and troubles on the construction have occurred in the past. In the construction planning, therefore, it is necessary to consider the employment of Tamil workers for the construction .

At the stage when the routes are determined, Road Development Authority (RDA) is requested

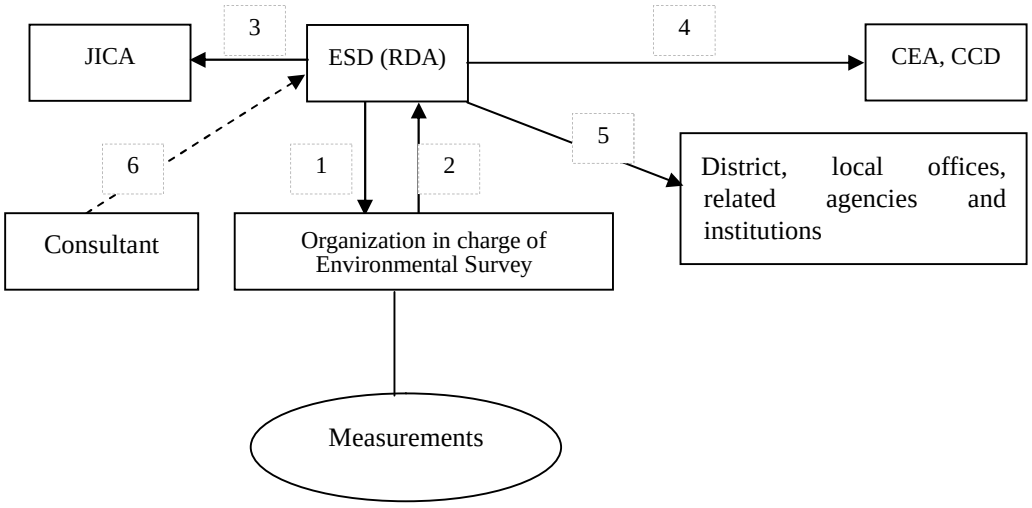
to submit the Basic Information Questionnaire (BIQ) to Central Environmental Agency (CEA) and acquire their approval for implementation of the Project. After the bidding for the Project, the contractor shall submit the method statement for environmental monitoring to RDA. In addition, the contractor shall obtain an Environmental Protection License (EPL) from CEA in accordance with NEA No. 47 of 1980 before the start of construction works. During construction, the environment monitoring will be carried out in accordance with Environmental Monitoring Plan (EMoP) based on Environmental Management Action Plan (EMAP) prepared by RDA.

(2) Environmental Monitoring

1) Environmental Monitoring Action Plan (EMAP) for Construction of Manmunai Bridge

The Initial Environmental Evaluation (IEE) Report submitted by RDA to JICA in June 2009 described that the environmental monitoring will be implemented by the Sri Lankan side when a bridge across the Batticaloa Lagoon is constructed. The EMAP will be implemented by a Project Management Unit (PMU) or a division of RDA in charge of the Project with the support of Environmental and Social Division (ESD) of RDA.

The Consultant will support the monitoring items of TOR (draft) delegated by RDA, estimate the cost for the environmental monitoring work, and confirm to RDA for the implementation of the monitoring. Procedure for the implementation of the monitoring is shown in Fig. 1.2-9. RDA will delegate the analysis of environmental information and data by a measurement company (the contractor or a third-party institution), and the report will be distributed to JICA and other related organizations.



1： Contract
2： Submission of survey results
3： Report to JICA
4： Reporting to related ministries and agencies
5： Reporting to other related agencies and organizations
6： Support of environmental management

Fig. 1.2-9 Implementation Structure of Environmental Monitoring

2) Environmental Monitoring Plan (EMoP)

The EMoP will be prepared in accordance with the construction schedule of the bridge. According to the EMoP, the program of the monitoring work (including monitoring method, monitoring points, data format etc.), the evaluation of monitoring results (including recording and checking of the site conditions, separation of seasonal factors and impacts by construction etc.), proposal of additional monitoring items, and proposal of additional mitigation measures of environmental impact in construction work, if necessary, will be implemented. Environmental baseline survey will be implemented around the construction site at the end of the detailed design or before starting construction, in order to figure out the change of environment before / after construction.

In construction supervision, an environmental specialist will be dispatched (twice/year for 0.5 month each) to manage the environmental assessment and recommend mitigation measures as needed. In addition, the environmental specialist will confirm the monitoring activities and reporting being implemented by RDA after the bridge is opened to traffic. The details of the environmental monitoring plan are shown in Table 1.2-2, and the items and period of monitoring are shown in Table 1.2-3.

Table 1.2-2 Environmental Monitoring Plan

Item		Description	Time of Work
1	Submission and confirmation of the implementation structure	Submission and confirmation of TOR	At the time of D/D
2	Checking of the capacity of measuring and analysis laboratory	Checking of equipment, tools and materials, personnel and achievements	
3	Preparation of the materials for budget request	Preparation of budget by monitoring item	At the end of D/D
4	Startup of monitoring	Checking of measuring methods and measuring points, data arrangement and recommendation of report form	At the start of construction
5	Evaluation of monitored data	Presentation of evaluation criteria and checking of abnormal data (including separation of seasonal changes and work factors)	During construction
6	Recommendation of additional environmental measures		During construction

Table 1.2-3 Items and Working Period for Environmental Monitoring

Items		Time of Work	Period of Work
1	Air quality	Before the start of construction	
		During construction	2 years
		After opening	2 years
2	Noise	Before the start of construction	
		During construction	2 years
		After opening	2 years

3	Water quality	Before the start of construction	
		During construction	2 years
		After opening	2 years
4	Waste water quality from construction site	During construction	2 years
5	Soil	During construction	2 years
6	Subsidence	During construction	2 years
		After opening	2 years
7	Verification of biota	During construction	2 years

1.3 Others

1.3.1 Traffic Survey

(1) Result of Traffic Survey

In the Preliminary Survey in 2009, a traffic survey was carried out at the 6 points (ferries and bridges) across the Batticaloa Lagoon on workdays and a holiday in May. A traffic survey was carried out again in this Preparatory Survey, as the traffic may be changed after the end of the war. The survey was carried out at the same 6 points as the previous survey in order to confirm the variation of traffic. Traffic count survey for 1 weekday and 1 holiday, and OD interview for the residents were carried out. The survey points and the survey result are shown in Fig. 1.3-1 and Table 1.3-1 respectively.

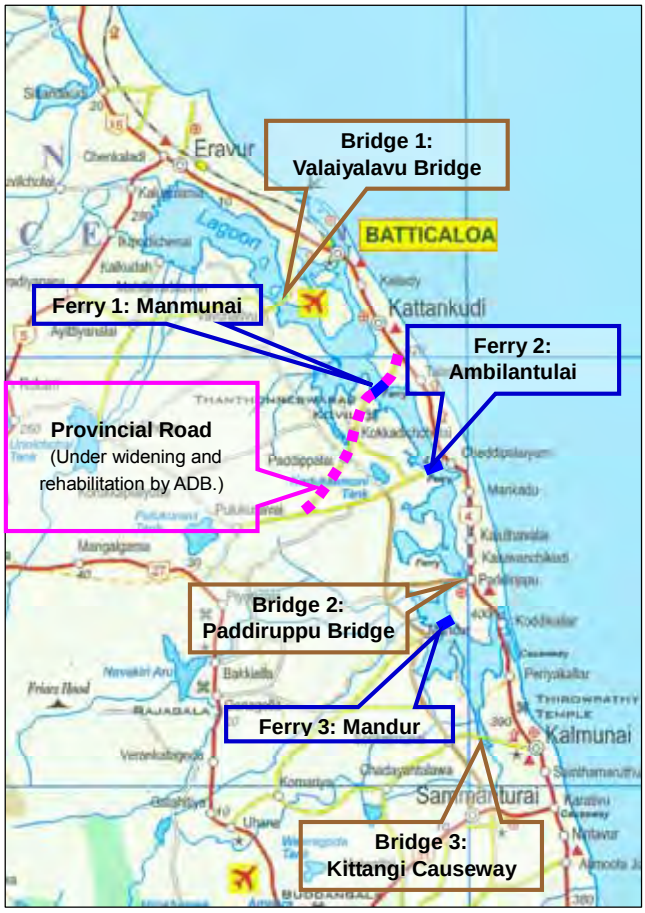


Fig. 1.3-1 Traffic Survey Points

Table 1.3-1 Traffic Survey Result

(Vehicles or Persons per 12h)

		Pedestrian	Bicycle	Motorbike / Car	PCU	Large Vehicle	User
Bridge 1:	Workday	11	646	1,444	1,065	90	—

Valaiyiravu Bridge	Holiday	16	746	1,975	1,369	76	—
Ferry 1: Manmunai	Workday	741	501	836	456	0	2,323
	Holiday	844	421	619	355	0	2,074
Ferry 2: Ambilanthurai	Workday	385	159	80	46	0	656
	Holiday	394	136	95	53	0	662
Brdige 2: Paddiruppu Bridge	Workday	4	887	2,602	1,873	36	—
	Holiday	4	856	2,809	1,978	25	—
Ferry 3: Mandur	Workday	797	214	238	119	0	1,311
	Holiday	982	331	208	104	0	1,590
Bridge 3: Kittangi Causeway	Workday	559	732	2,382	1,555	54	—
	Holiday	20	969	2,717	1,775	98	—

Survey Date: 3 (Fri.) and 5 (Sun.) in September 2010,

Survey Time: 12 hours from 6:00 to 18:00

(2) Traffic at Manmunai Ferry

Number of users on weekday in 2010 is approx. 30 percent smaller than that in 2009. According to the percentage of trips based on trip purpose in Sri Lanka (see Table 1.3-2), the trips for educational purpose are 30%, which agrees well with the reduction mentioned above. Also the number of users on holiday (5 / Sep. (Sun.)) is almost the same as that in 2009.

It can be thus concluded that there is no major change in the traffic at Manmunai Ferry in this survey compared to that of 2009.

Table 1.3-2 Percentage (%) of Trips Based on Trip Purpose in Sri Lanka

Purpose	% trips
Recreational	0.6
Shopping	4.7
Social	17.9
Educational	31.7
Work	45.1
Total	100.0

Source: Liyanage, T.U. “Use of Electricity Consumption for Traffic Modeling of a Suburban Area”, 2008

Chapter 2 Contents of the Project

2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Objective

The Government of Sri Lanka formulated the 10-Year National Development Plan (Mahinda Chintana: Vision for A New Sri Lanka in 2006. The development of the regional and provincial road network in the Eastern and Northern Regions and the road rehabilitation in the Tsunami-affected area were highlighted in the plan. The Ministry of Highways established the National Road Master Plan 2007-2017 (NRMP), to develop and to improve competitiveness of the Sri Lankan economy. There are several regional development plans for the Project area including the Three Years Eastern Development Plan 2007-2010 (Neganahira Navodaya or Eastern Revival). The regional development plans place the main target on the reconstruction of Eastern Province which was affected by the internal war and the Tsunami disaster.

The objective of this Project is to construct a bridge at Manmunai, to rehabilitate the area from disaster by both the Tsumami, to contribute as a countermeasure against damages caused by floods, to accelerate the social and economic development of Eastern Province, and also to symbolize the establishment of peace after postwar reconstruction.

2.1.2 Outline of the Project

This Project is planned to construct a new bridge at Manmunai in Batticaloa Lagoon for the safe traffic across the Lagoon available for 24 hours, reduction of interrupted period of traffic after flood, improvement of access to emergency medical services and educational institutions, and reduction of travel time and distance for the residents including farmers. Accommodation to increasing vehicles size and transportation will also be expected through the Project. The scope of this Project is the construction of a bridge and access roads crossing Batticaloa Lagoon at Manmunai..

2.2 Outline Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Policy

This Project is planned to construct Manmunai Bridge to secure safer and smooth traffic to cross the Batticaloa Lagoon, to rehabilitate the area from the disaster of Tsunami, and to provide a mitigation measure against flood damages. The social and economic development of Eastern Province are expected to be accelerated through this Project, and also the bridge will become a symbol of the establishment of peace after the internal war.

(2) Necessity of this Project

1) Necessity

The necessity of this Project was confirmed on the followings:

① Recover from Tsunami disaster

The Batticaloa District suffered from Tsunami by Sumatra Earthquake in December 2004. The rehabilitation in this District is left behind compared to other areas.

② Alleviation of damage from Flood

There is no bridge in the Project areas and ferries are the only means to cross the Lagoon at present. The Project area is suffered by flood several times every year, and transport by ferry is disrupted.

③ Capacity limit of ferries

As one ferry can carry only 2 passenger cars at maximum, the ferry do not accommodate to the large size vehicles and increasing demand of traffic volume.

④ Travel time

The detour routes are considerably long (approx. 32 km between both shores at Manmunai, approx. 27 km from the western shore to Batticaloa) and require long travel time. Therefore, emergency vehicles such as ambulances use ferries instead of the detours. In addition, they need to use detour routes during nighttime as the ferries are not operated.

⑤ Safety

The ferries are old and small with a small outboard motor, with poor safety facilities which cause a risk of accident.

2) Urgency

High grade hospitals are located only in Batticaloa City, and the residents on the western side are required to make their way to the eastern side when in need of urgent medical care. In the nighttime they need to take long detour because the ferries are not operated. In the daytime, even ambulances needs to wait for boarding onto the ferry because of its long operation intervals.

3) Relevance and Effects

The Eastern Province and Batticaloa District has high potential of development such as agricultural and fishing resources, but are behind in development due to the impacts of the internal war and the Tsunami disasters, and the separation between east and west by the Lagoon. Especially for the residents on the western side, the poor transport infrastructure is disturbing the improvement of their livelihood (the access to health care and educational institutions, and the development including agriculture).

This Project is planned to construct a bridge over the Lagoon and improve accessibility between both sides of the Lagoon. This Project is quite important to contribute to the reconstruction of the Eastern Province that suffered tremendous damage under the internal war and Tsunami disasters, and it is deemed that the implementation of this Project is fully relevant and will produce many beneficial effects.

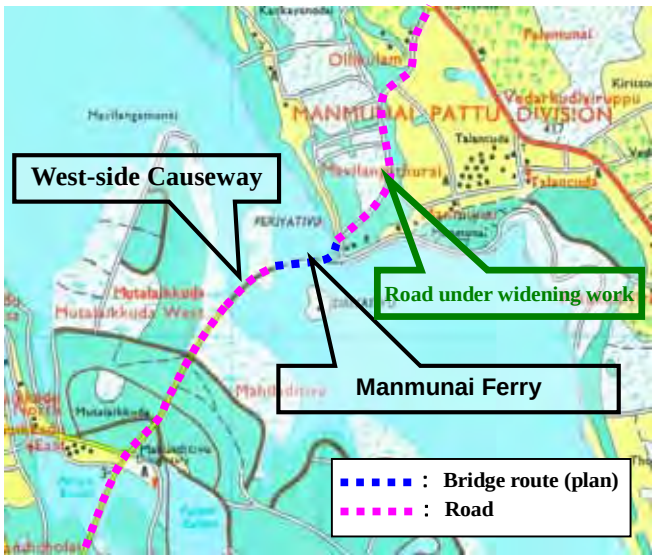
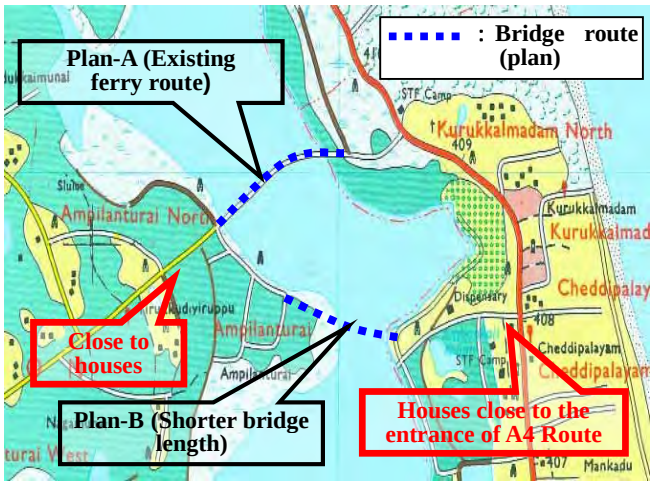
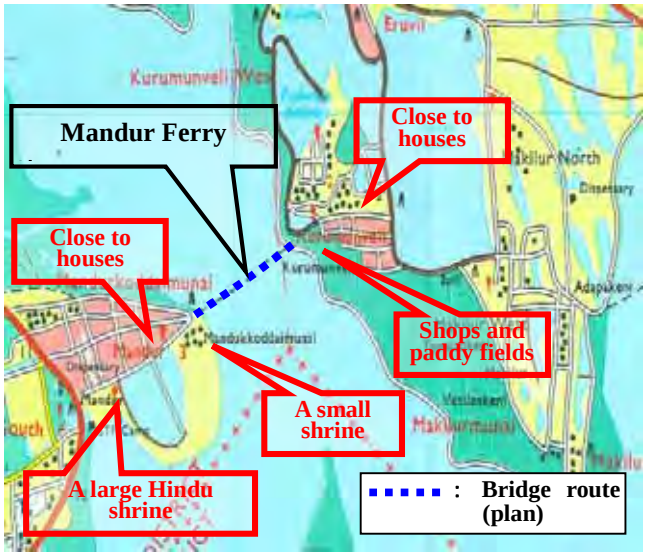
(3) Route Selection

In the Preliminary Survey, it was reported that the Manmunai route has the most high priority from the viewpoints of the future traffic demand, the road network plan, the development potential of the Eastern Province, and cost benefit.

In this Study, the results of the Preliminary Survey were reviewed and the candidate crossing routes were reconfirmed based on the results of the Site Survey. It was confirmed that the Manmunai route has highest priority among three alternative routes.

The comparisons of alternative crossing routes are shown in Table 2.2-1.

Table 2.2-1 Alternative Crossing Routes

Overview	Evaluation			
1. Manmunai  	Bridge size	400m (on water) → Shortest of 3 routes → Lowest cost	◎	◎
	Water depth	Approx. 3.0m max. (by survey)	○	
	Number of users	Highest number of users (2,323 persons and 836 vehicles per 12 hours)	◎	
	Restrictions	Western side: 1 shop and 1 shrine In parallel with route: High-tension power lines and towers → Necessary to consider for the road alignment No houses or paddy fields adjacent.	○	
	Relation to other projects	The roads (provincial highway) before and after the bridge are under rehabilitation by ADB fund. → No new access road required.	◎	
2. Ambilanturai  	Bridge size	Plan A (Ferry route):: 890m Plan B (Shorter route):: 440m → Higher cost than 1	△ ○	△
	Water depth	Similar to 1 (based on the Preliminary Study and information from RDA)	○	
	Number of users	Lower than 1. (656 persons and 80 vehicles per 12 hours)	○	
	Restrictions	Western side: Paddy fields, 2 shops and many houses Eastern side: 2 shops, houses (at the entrance from A4 in Plan B) → Land acquisition required, difficulties in resettlement	△	
	Relation to other projects	No rehabilitation plan for the roads before and after the bridge → Access roads required.	△	
3. Mandur  	Bridge size	740m → Hither cost than 1	△	×
	Water depth	Similar to 1 (based on the Preliminary Study and information from RDA)	○	
	Number of users	Lower than 1. (1,311 persons and 238 vehicles per 12 hours)	○	
	Restrictions	Western side: Close to temples and houses Eastern side: Shops and paddy fields → Problem with resettlement Access roads on both sides are close to houses → Many problems with the road widening	×	
	Relation to other projects	No rehabilitation plan for the roads before and after the bridge → Access roads required.	△	

(4) Natural Environment

1) Meteorology

① Meteorology

The rainfall in the area around the Project site is concentrated from October to February under the influence of the northeastern monsoon. The temperature variation through year is relatively small, 25 to 27.5 ^{O}C, and a little lower in the northeastern monsoon season. The humidity on the east coast becomes relatively lower from May to September.

The design of the bridge structure, the construction work plan and the quality control plan will be examined taking into consideration the above meteorological conditions.

② Earthquake

Seismic load is not taken into account in the design of this Project, as no damage due to earthquakes have been reported in the area.

2) Hydrology

In bridge planning, the conditions including water level and navigational height are determined taking into consideration the hydrological situations described in "1.2.1 Natural Conditions", referring also to the hydrological conditions of the new Kallady Bridge.

3) Geological conditions

The terrain of the Project areas is flat, which are approximately EL+0.0 to 1.0m high above the sea level. The first layer of the stratum is a soft sandy soil with a N-value of 0 to 3 at the depth of EL-7m below the surface, a middle layers approximately consisting of a clayish sand (of 4 to 7m thick, with an N-value of 5 to 15 or so), and a clay layer (of 1.5 to 3.0m thick, with an N-value of about 20) in the order of increasing depth, which are followed by a dense sandy soil layer (of about 5m thick, with an N-value of about 40). The bridge foundation will be supported by this layer. The bedrock layer at the bridge site consists of a hard rock layer which lies uniformly at the depth of EL-20m or more.

(5) Social and Economic Conditions

The traffic mode at the Project area have large varieties, such as pedestrians, bicycles, motorbikes, three-wheelers, cars, vans, buses (middle and large), goods vehicles (small to large), farm vehicles etc., and the traffic is heavy. Their driving is sometimes not very safe. Taking these situations into account, the bridge width shall be planned from viewpoint of safety.

(6) Construction Industry and Construction Material

In Sri Lanka, it is relatively easy to procure cement and aggregates, and pretensioned PC girders which accord to the RDA standards are manufactured by local fabricators. There is a plant in Mahiyangana in the Eastern region. It has been confirmed that the plant has the

capacity to supply the bridge to this Project.

(7) Utilization of Local Companies (Construction Companies and Consultant)

The Tamils are dominant in Batticaloa District and construction projects by Sinhalese constructor may raise conflicts with local residents. Therefore, Participation of Tamil worker to the Project shall be highly regarded.

(8) Operation and Maintenance

The agency responsible for the Project is Ministry of Ports and Highways (MoPH) and the implementing organization is RDA in MoPH.

The division in charge is Engineering Services under Asset Development of RDA in the design stage, and a Project Management Unit (PMU) in RDA in the construction stage. Maintenance after completion of the Project will be undertaken by Batticaloa District Office which is under the control of the RDA Office in Eastern Province.

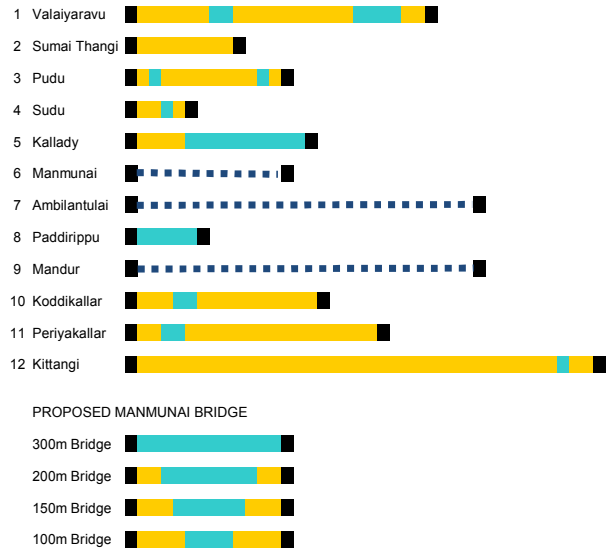
(9) Scale of Facility

1) Bridge length

Based on the discussion with local agencies and organizations related to environmental affairs such as CEA, Coast Conservation Department (CCD), Department of Fisheries and Aquatic Resources of Batticaloa and Eastern University, it is agreed that the bridge length shall be at least 200m, taking into consideration the influence on ecosystem and fishing activities at the Project site in the Lagoon.

The existing bridges and causeways in the Lagoon are shown in Fig. 2.2-1. The opening width at the Project site was determined as at least 200m, taking into considerations the opening width of bridges at upstream / downstream of Manmunai (upstream: ⑧Paddiruppu Bridge, approx. 160m, downstream: ⑤Kallady Bridge, approx. 250m).

No.	Structure		Length		Road		
	Name	Type	Total	Opening	No		
1	Valaiyaravu	Causeway	600	50+100=150	B433	Vavunativu ⇔Batticaloa	ADB
2	Sumai Thang	Causeway	200	non		⇔	
3	Pudu	Causeway	300	20+10=30		⇔	
4	Sudu	Causeway	100	25		⇔	
5	Kallady	Bridge	350	250	A4	Batticaloa⇔Kallady	JPN
6	Manmunai	Ferry	300				
7	Ambilantulai	Ferry	700				
8	Paddirippu	Bridge	160	160		⇔Paddirippu	
9	Mandur	Ferry	700			Mandur ⇔	
10	Koddikallar	Causeway	370	50	A4	⇔Koddikallar	JPN
11	Periyakallar	Causeway	500	50	A4	Koddikallar⇔Kalmunai	JPN
12	Kittangi	Causeway	770	6m@4=24	B187	Chadayantalawa⇔Kalmun	UK



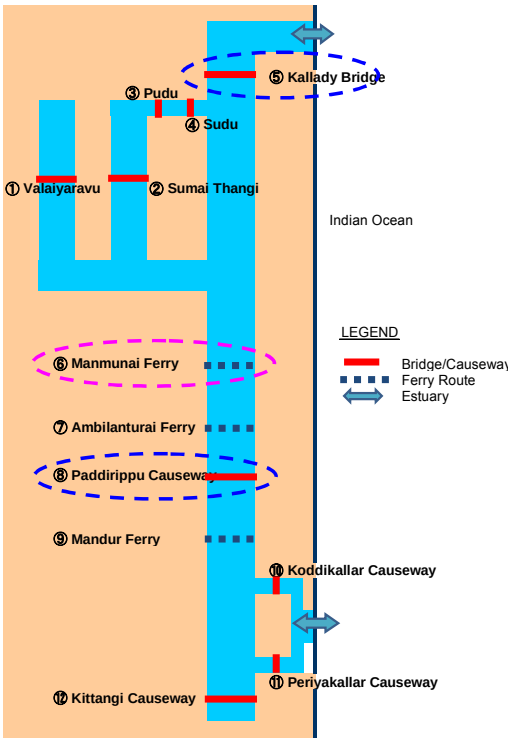


Fig. 2.2-1 Existing Bridges and Causeways in Batticaloa Lagoon

2) Bridge width

The bridge width was determined taking into account the safety of pedestrians and the situation of traffic. Based on the standard width of national highways in Sri Lanka and also referring to the causeway planned in the neighboring area, it is planned that the total bridge width will be 9.8m (including railings).

3) Navigation Clearance

① Span Length

Equal or longer than those of the Paddiruppu Bridge

(Navigational Span: 14m, Side Spans: 7m)

② Navigational Height

MSL + 4.0m at Navigational Span

(Taking into account those of the Paddiruppu Bridge and the Kallady Bridge)

(10) Construction method/procurement of construction material and construction period

1) Bridge construction method

The PC pretensioned girders will be erected by a crawler crane installed on a temporary jetty. All concrete will be cast by concrete buckets because the concrete pump vehicles are inferior and the number of vehicle units is small in Sri Lanka.

2) Procurement of construction material

The main materials such as steel materials (including steel temporary works and reinforcing

bars) and PHC piles for the foundation will be imported from third countries such as Malaysia and India. Sufficient volumes of these materials have been imported continuously to Sri Lanka and used for various purposes of construction after the internal war. Therefore, these products required for this Project will be procured from a common market in Sri Lanka.

3) Construction period

The construction schedule for the Project will be influenced by the rainy season especially for the construction of causeway. Therefore, for the construction of causeway, temporary roads etc. shall be constructed in the dry season from March to September. The work period from the contract with contractor to the completion of the work will be expected as 22 months.

2.2.2 Basic Plan

(1) Overall Plan of the Project

The facilities planned in this Project are outlined in Table 2.2-2.

Table 2.2-2 Outline of Facilities

Facility	Specifications
Bridge	
(1) Bridge length/spans	15m@14 = 210m
(2) Bridge Width	1.2m (walkway) + 3.7m@2 (carriageway) + 1.2m (walkway) = 9.8m
(3) Gradient/ Crossfall	Longitudinal slope: 3.2% , -3.2% Crossfall: 1/60
(4) High Water Level	M.S.L + 1.42m
(5) Design loads	
・Live load	HA load and HB-30 load (BS5400)
・Seismic load	Not considered
(6) Superstructure	
・Bridge Type	Concrete simple deck slabs with pretension girder.
・Construction method	Girder erected by crane
(7) Substructure	Pier: Pile bent; Abutment: Inverted T-type abutment
(8) Foundation	Pile foundation
(9) Others	Considered for future installation of additional structures
Causeway	
(1) Length	West approach: 195m; East approach: 293m
(2) Standard	Road standard: R4; Design speed: 50km/h
(3) Roadway Width	1.8m (shoulder) + 3.1m@2 (carriageway) + 1.8m (shoulder)
(4) Crossfall	2.5%

(2) Road Plan

1) Design Policy

This Project is planed to improve the traffic crossing Batticaloa Lagoon by the construction of a bridge in place of the existing ferries. In planning this Project, to decrease the impacts from the construction of bridge and causeway, the existing approach road will be utilized as much as possible to minimize the length of the new approach road. Soft soil condition are fully examined for the design of the embankment.

2) Applicable Standards

- RDA Geometric Design Standards of Road (RDA, 1998)
- Guidelines for Road and Civil Works (Japan Road Association)
- Specifications for Highway Bridges I-V (Japan Road Association)

3) Design Standards

Although the access roads to the bridge is being improved as provincial roads, RDA plans to upgrade those roads into national roads until the completion of the bridge. In order to conform to the upgrade of road category, the following road standard and design speed are applied for the Project:

- Road standard: R4
- Design speed: 50km/h

4) Geometric Standard

The road alignment will be designed in accordance with the Geometric Design Standards of Roads of Sri Lanka. The design speed of the road is 50km/h and other values adopted in this Project are listed in Table 2.2-3.

Table 2.2-3 Geometric Standard

Item	Unit	Geometric Design Standards of Roads	Adopted Value
Design speed	km/h	50	50
Curve radius	m	≧105	120
Minimum curve length	m	≧80	110
Superelevation	%	2.5 (Recommended value)	2.5
Superelevation run-off rate	―	1/115	1/115
Widening on Horizontal Curve R=300 R=120	 m m	 0.6 1.1	 0.6 1.1
Curve width run-off rate	m	≧40	40
Transition curve length	m	≧40	40
Longitudinal slope length	m	≦330	140
Longitudinal gradient	%	≦6	3.2
Vertical curve radius	m	≧800	1,850
Vertical curve length	m	≧40	50

5) Roadway Width

① Width of Bridge Section

The bridge width is shown in Fig. 2.2-2. The bridge deck will be paved with asphalt.

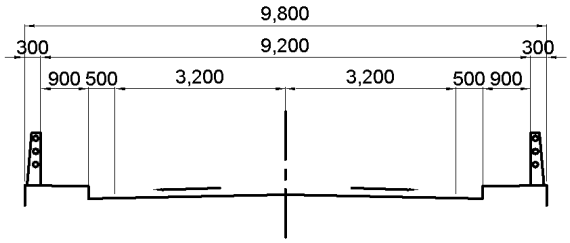


Fig. 2.2-2 Bridge Width

② Roadway Width at Causeway Section

The width of the causeway section is shown in Fig. 2.2-3. The shoulder will be 1.8m taking the integrity with the bridge section into consideration. The causeways will be paved with concrete, taking past experience in Sri Lanka into consideration.

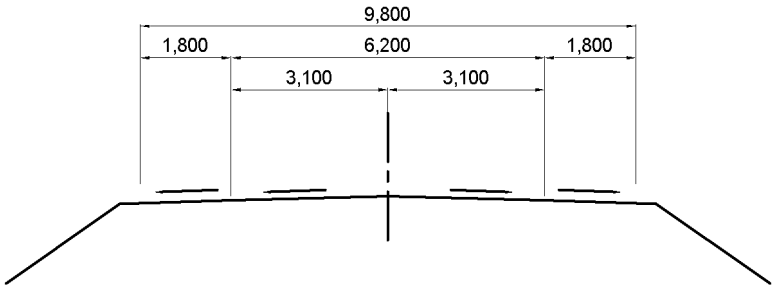


Fig. 2.2-3 Causeway Width

6) Road Alignment

The road alignment is planned based on the Geometric Road Standard of Sri Lanka and it shall be satisfy the restrictions from the existing structures and navigational clearance. In general, the bridge location will be selected to meet the requirements that "the length of the road section over the water shall be the shortest". In addition, road alignment does not overlap with the high-voltage cable crossing over the water parallel to the road alignment because the high-voltage cable are hanged over at Lagoon section. Road alignment (centerline) shall be 10m or more away from the cable for the safety during construction and after the bridge is opened to traffic.

① Plan of Road

The ferries should be operated until the bridge is completed, but the existing ferry jetty of at west-bank will be a obstacle for the construction work because it is located on the road alignment. Therefore, the ferry jetty shall be relocated before the start of the construction of approach road.

Relations between the existing facilities and the road alignment are shown in Fig. 2.2-4.

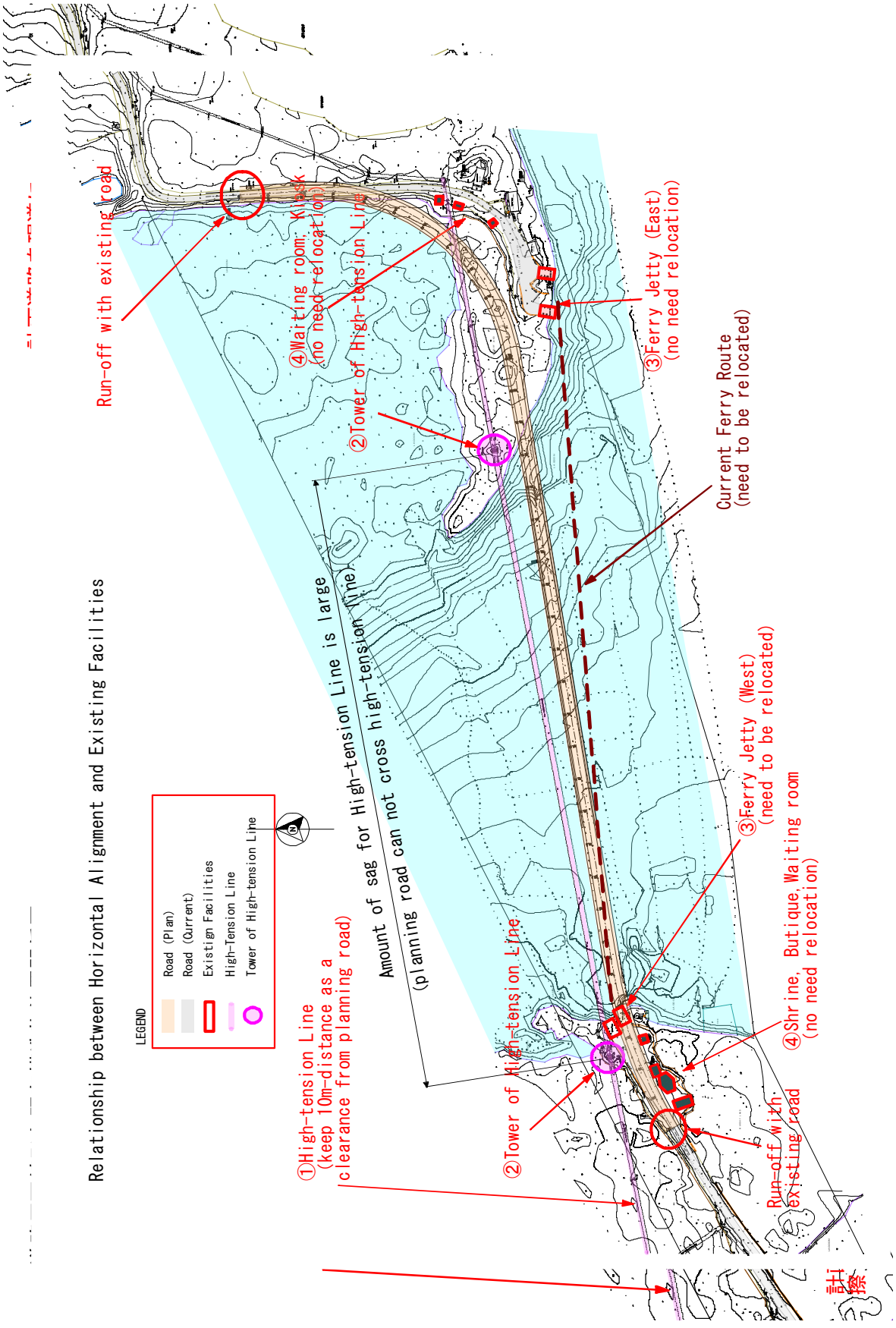


Fig. 2.2-4 Road Alignment and Existing Structures

② Vertical alignment

The vertical alignment is planned to keep the navigation clearance under the bridge and connection with the height of existing approach road.

7) Pavement

The causeway sections will be paved with concrete, and the asphalt concrete pavement will be adopted at the bridge deck.

8) Drainage

The drainage from the bridge is planned to directly discharged to the Lagoon. The surface water from the causeways is also planned to be discharged directly to the Lagoon. The slopes of embankment will be protected by vegetation (turf etc.) or stone-filled revetments to prevent them from erosion.

The road surfaces including shoulders are paved with asphalt or concrete.

9) Lighting

Road lighting will not be planned taking into consideration the surrounding road conditions on this route.

10) Causeway

The surface layer of soil at the causeway sections is relatively soft, consisting mainly of sand. An embankment of approximately 4.5m high will be constructed on this soil. As the bearing layer for the embankment is sandy soil, most portion of the settlement at the embankment during and after the construction is prospected to occur initially, and the long-time settlement in clayish soil is expected to be small.

(3) Bridge Design

1) Design Policy

The bridge shall be designed to satisfy the natural conditions, navigational clearance, and other requirements from site conditions, taking into full consideration on cost, construction planning, and social / environmental aspects around the Project Site.

2) Applicable Standards

The following standards will be applied to this Project:

- Bridge Design Manual (RDA, based on the British Standard (BS5400))
- RDA Geometric Design Standards of Road (RDA, 1998)
- British Standard 5400 (BS5400)
- Specifications for Highway Bridges I-V (Japan Road Association)

3) Design Load

The design loads will comply with Bridge Design Manual of Sri Lanka and BS5400, but in the case of items for which concrete values are not specified in these standards, the values specified in the Specifications for Highway Bridges by Japan Road Association will be applied.

① Dead Load

The dead load will be calculated on the basis of the unit weights of materials as shown in Table 2.2-4.

Table 2.2-4 Unit Weights of Materials

Material	Unit Weight (kN/m^3)
Iron, cast steel, forged steel	77.0
Cast iron	71.0
Aluminum	27.5
Reinforced concrete	24.5
Prestressed concrete	24.5
Concrete	23.0
Cement mortal	21.0
Wood	8.0
Bituminous material (for waterproofing)	11.0
Asphalt pavement	22.5
Filling material (earth and sand)	18.0

Source: - Specifications for Highway Bridges Vol. I General 2.2.1

The unit weight of the railings is assumed as 0.6kN/m.

② Live Load

i) Number of Notional Lanes

The number of notional lanes based on the carriageway width is shown in Table 2.2-5.

Table 2.2-5 Assumed Number of Lanes

Carriageway width, m	Number of notional lanes
5.00 ＜ Carriageway width ≦ 7.50	2
7.50 ＜ Carriageway width ≦ 10.95	3
10.95 ＜ Carriageway width ≦ 14.60	4
14.60 ＜ Carriageway width ≦ 18.25	5
18.25 ＜ Carriageway width ≦ 21.90	6

Source: BD 37/88[1] 3.2.9.3.1

Thus, the number of notional lanes is 2 (roadway width: 7.4m).

ii) HA Load

The HA load consists of Uniformly Distributed Load (UDL) and Knife Edge Load (KEL).

(a) Uniformly Distributed Load (UDL)

The relation between vertical load length and uniform load is shown in Table 2.2-6.

Table 2.2-6 Uniformly Distributed Load (UDL)

Vertical load length [m]	Uniform load (UDL) [kN/m per assumed lane]
L ≦ 50	$W = 336\ (1/L)^{0.67}$
50 < L ≦ 1600	$W = 36\ (1/L)^{0.1}$

Source: BD 37/88 6.2.1

Assuming that the span length of a simple girder is 14.5m and the loading length is L =14.5m,

$$W = 336 \times (1/14.5)^{0.67} = 56.0 \text{ kN/m (per 1 notional lane)}$$

(b) Line Load (KEL)

Based on BD 37/88 6.2.2, KEL = 120 kN (per 1 notional lane)

(c) Lane Factor

The lane factors for HA load is 1.0 for this bridge (Source: BD 37/88).

iii) HB Load

Based on Bridge Design Manual 2.2.3 (b) (i), the HB load always straddles 2 lanes. The bridge with 2 lanes will carry the single HB load. The HB load by the Sri Lankan Standard is composed of “30” units. The loading position of HB load is shown in Fig. 2.2-5.

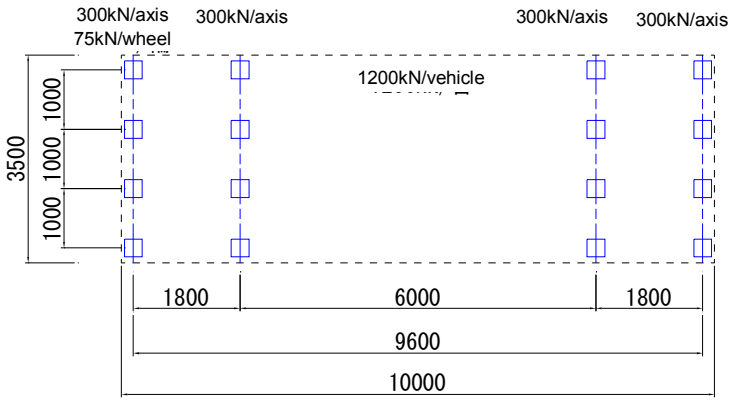


Fig. 2.2-5 HB Load

③ Other Loads to be Considered

The following loads will also be considered for bridge design when necessary:

- Impact load (including braking load)
- Prestressing force
- Creep of concrete
- Shrinkage of concrete
- Earth pressure
- Water pressure
- Buoyancy or uplifting force

4) Material strength（Superstructure, Substructure/Foundation）

The design strength of concrete will be determined taking into consider the available material in Sri Lanka. The Japanese Standards will be applied to the material strength for reinforcing bars. The strength of material used for the bridge design are shown in Table 2.2-7 and Table 2.2-8

Table 2.2-7 Strength of Concrete

Item	Design Standard Strength (N/mm^2)	Remarks
PC girders	45	Based on achievements in Sri Lanka
Cast-in-place slabs	40	Same as above
Abutment and pier	30	
Cast-in-place pile	30 (24)	

Table 2.2-8 Strength of Reinforcing Steels

Item	Yield Strength (N/mm^2)	Remarks
PC girder	345 ~ 440 (SD345)	

[1] BD 37/88: Loads for Highway Bridges, Department of Transport, UK (Supplemental Document for BS5400)

Cast-in-place floor slabs	Same as above	
Abutment and pier	Same as above	
Cast-in-place pile	Same as above	

5) Determination of high water level and navigational channel conditions

① High Water Level

The high water level was determined based on the water levels at Kallady Bridge.

The highest water level during the construction period is planned to be EL+1.00m taking into consideration an allowance to the water level in the rainy season. Water level at each conditions are shown in Table 2.2-9.

Table 2.2-9 Design Water Levels

Type of Water Level	Water Level	Remarks
Water level in dry season (MSL)	EL+0.00m	MSL
Water level in rainy season	EL+0.60m	Highest tide level in rainy season
Planned high water level (HWL)	EL+1.42m	By reference to the planned value for Kallady Bridge
Water level during construction work	EL+1.00m	Confirmation required

② Navigation Clearance

The navigation of engine-driven vessels is restricted in the water area around the bridge site (as of 2010). In consideration for the integrity of other bridges over the Lagoon, the requirements for the navigational clearance are planned to maintain the navigational width equal to or longer than the center span length of the Paddiruppu Bridge, and the navigational height equal to or higher than that of the Kallady Bridge.

Table 2.2-10 Requirements for Navigation Clearance

Navigational Width	14.0m	(By reference to Paddiruppu Bridge)
Navigational Height	4.0m (EL+4.00m)	(By reference to Kallady Bridge)

6) Determination of Bridge Length and Spans

① Bridge Span Length

Span lengths of 10m, 15m, 20m and 25m have been studied to compare the costs for a bridge length of 200m. The optimum span length is 15m as shown in Fig. 2.2-6.

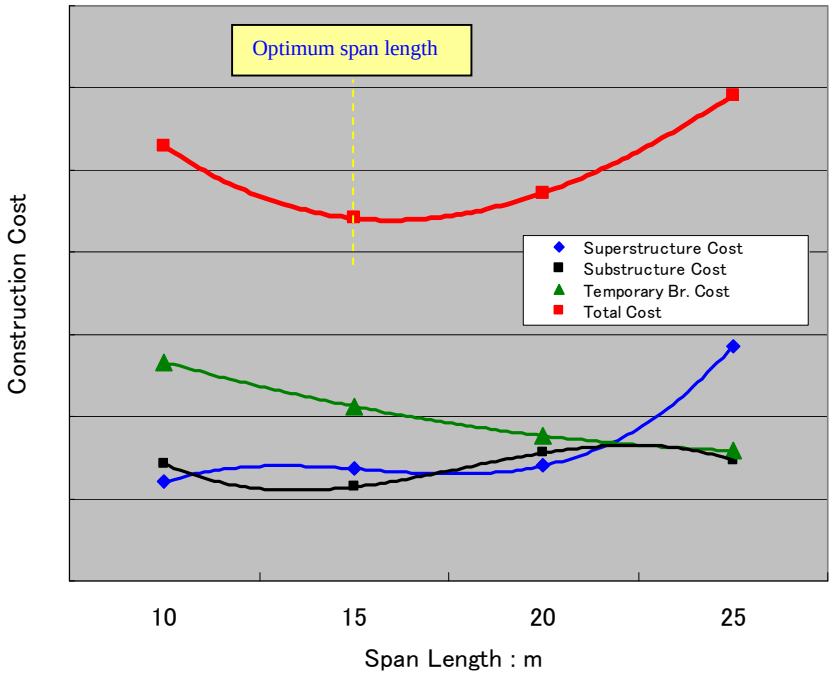


Fig. 2.2-6 Optimum Span Length

a) Span Arrangement

Taking into account the optimum span length, minimum bridge length and navigation clearance, the span arrangement for this Project is determined as shown in Fig. 2.2-7.

Span arrangement: 14 spans ×15m = 210m

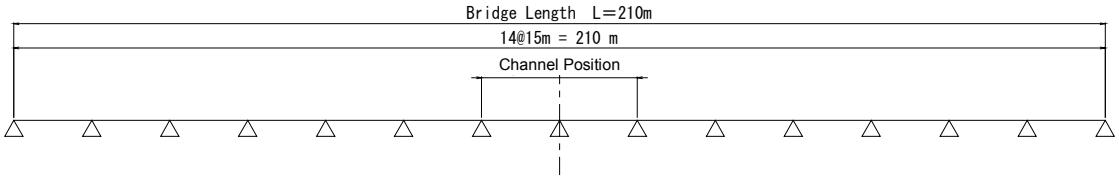


Fig. 2.2-7 Span Arrangement

② Location of abutment

The depth of the Lagoon along the road centerline varies in the range of about EL-3.0m to EL+0.0m. For the stability of embankment of the causeways, it is desirable to keep the embankment height as low as possible.

The abutment height is determined by the Lagoon depth and the surface height of road. The location of abutments are shown in Fig. 2.2-8

Abutment A1: No.9+15.0

Abutment A2: No.20+5.0

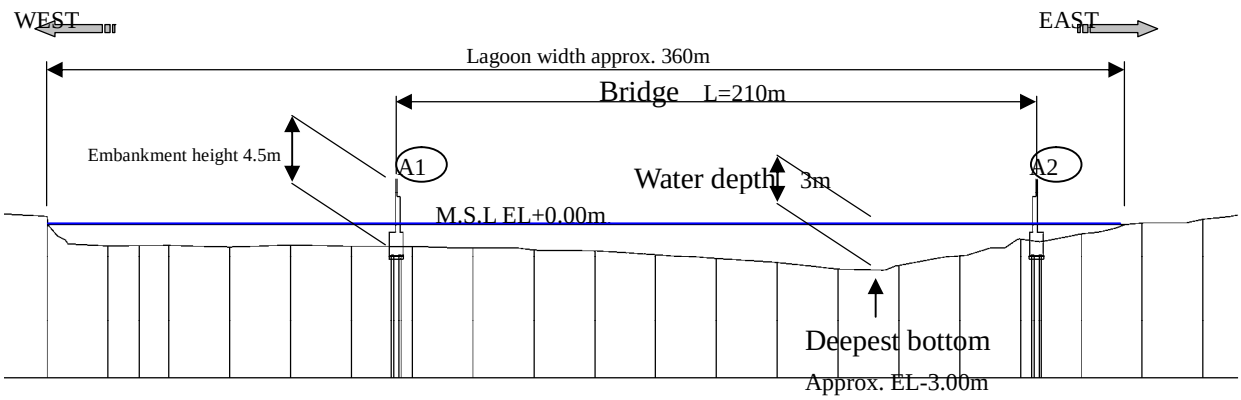


Fig. 2.2-8 Location of Abutments

7) Selection of Foundation Type

① Geological Conditions

The bearing layer for the bridge is the clayish sand layer distributed below the depth GL-16m ~ 18m. That layer has a depth of approx. 5m and has an average N-value of approx. 40 or more according to the standard penetration test.

However, the clayish sand layer disappears around the end of the bridge, and a weathered rock layer exists below the sand layer. Therefore, the heavily weathered rock layer will be the bridge bearing layer at this position.

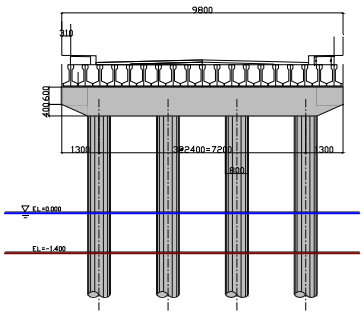
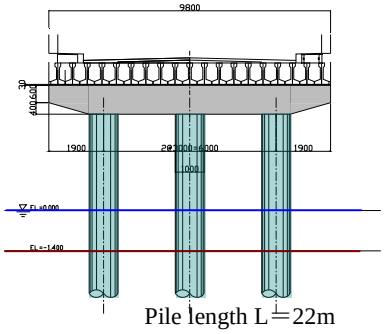
② Foundation type

The foundation type has been selected taking into consideration the construction experience and the materials procurement conditions in Sri Lanka. In selecting the foundation type, the following items have been reviewed:

- RC piles (driven piles) are relatively inappropriate for the bearing layer depth.
- Steel pipe piles (driven piles and bored piles) are procured at very high costs.
- PHC piles have abundant experience in Sri Lanka and well adopt to the geological condition at the bridge site.
- The reverse circulation drill method for cast-in-place piles has been used in Sri Lanka. For the construction in water, however, steel pipes with a diameter equal to or greater than the cast-in-place piles will be used as formwork. Therefore, The cost of the reverse circulation piles is comparatively high to be used for this Project.

As a result of the above review, PHC piles (driven piles) will be adopted for the foundation type for this bridge.

Table 2.2-11 Comparison of foundation and pile diameters

Pile Type	PHC Pile φ800 (Type A)	Cast-in-place Pile φ1000 + Steel Pipe Formwork
Structure Diagram	 Pile length L＝22m Number of piles: 4	 Pile length L＝22m Number of piles: 3
Features in Structure/ Construction	- Precast concrete piles are driven from a temporary platform. - PHC piles are secondary concrete products and allow simple work at the site and easy quality control. - Sri Lanka has much experience of construction using the method of driving precast concrete piles. - Diameters of driven piles are generally about 450mm in in the experiences in Sri Lanka. Piles with a diameter of 800mm is planned for this bridge. (Pile diameters generally applied are up to about 1,200mm in Japan.) - PHC piles are secondary concrete products and allow simple work at site and easy quality control.	- Piles are cast from a temporary platform. - Steel pipes are used for stability of the boreholes during boring (approx. 10m) and for formwork above the Lagoon bottom to the girder (approx 5m). As the steel pipes cannot be pulled out after concrete is hardened, they are left in concrete. (15m per pipe.) - The cast-in-place pile method is generally used in Sri Lanka, but the heavy construction ecquipments used in Sri Lanka are so and cause many troubles. This method thus has uncertainty in construction schedule. - As the capacity of site engineers has an influence on work quality, and quality control is difficult compared with precast piles.
Economy	1.00	1.20
Evaluation	**Adopted**	

8) Selection of substructure type

① Abutment type

With regard to the abutment type, the reversed-T type abutment is the optimum type taking into consideration the structure height and ground conditions.

② Piers

For piers, the pile bent type is structurally simple and lowest quantity of materials.

9) Selection of superstructure

① Selection of Superstructure

A superstructure type with the span length L=15m as described in the preceding paragraph will be selected.

For steel bridges, “simple composite H-shape steel bridge” is selected for an alternative which is the only type applicable for the span length of 15m.

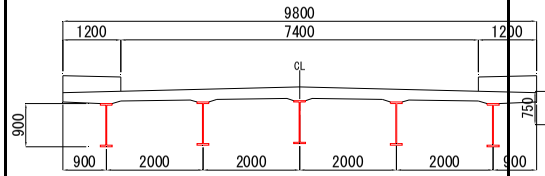
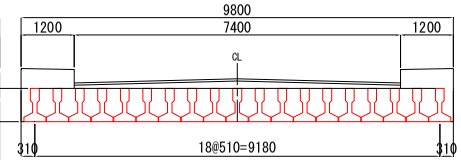
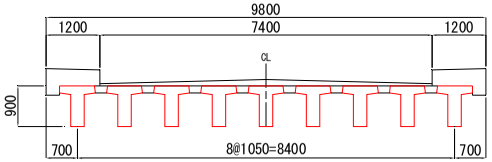
For concrete bridges, “pre-tensioned slab girder bridge” and “pre-tensioned T girder bridge” are selected for comparison. Although “RC slab girder bridge” is applicable for span length of 15m, this type is omitted from the alternatives because of much longer construction time.

② Summary for Selection

Category	Type	Description
Steel Bridge	Simple composite H-shape steel bridge	Applicable for span length 25m or shorter. The deck is RC structure. The main girder is composed of H-shape steel. Simple structure and easy to construct. – **Type-1**
Concrete Bridge	RC slab bridge	Cast-in-place RC bridge using short span lengths and its main girder has a bored cross section. This type requires much longer construction time (for setting scaffolding and formwork etc.) This type is thus omitted from alternatives.
	Pre-tensioned slab bridge	A pretensioned concrete girder is commonly used for bridges whose span is less than 20m. These girders are fabricated in the factory, then transported and erected. The construction time is shorter than the other type. Many experiences in Sri Lanka. – **Type-2**
	Pre-tensioned T girder bridge	A pre-tensioned T girder is also used for bridges of medium spans length or less. This type of bridge is constructed with the same method as above, and the number of the girders can be reduced due to the higher rigidity of the girder than that of a slab girder. – **Type-3**

The results of comparison of the alternatives, Type-1 to Type-3 are shown in Table 2.2-12.

Table 2.2-12 Comparison of Superstructure Types

	Type-1 **Simple Composite H Shape Steel Bridge**	**Type-2** **Pre-tensioned Slab Girder Bridge**	**Type-3** **Pre-tensioned T shape Girder Bridge**
Typical Cross Section			
Description	• Applied for a span length of less than 25m • Deck slab is constructed as RC structure • Simple structure due to H shape steel for main girder • Height of girder is higher than Type-2	• Applied for small span length • Construction period is shortened by applying factory product • This type is already applied in Sri Lanka • Hollow, solid and I-shape section are applied - Due to experiences in Sri Lanka, I-shape section is applied	• Applied for small and medium span length • Construction period is shortened by applying factory product • Number of girders is fewer than slab girder bridge
Economic Efficiency	Construction cost for superstructure (per $1m^2$) 160,000 JPY/m^2 ratio **1.103** - The above cost is estimated by Japanese experience	Construction cost for superstructure (per $1m^2$) 145,000 JPY/m^2 ratio **1.000** - The above cost is estimated by Japanese experience	Construction cost for superstructure (per $1m^2$) 155,000 JPY/m^2 ratio **1.069** - The above cost is estimated by Japanese experience
Structural Performance	• Much experience has been accumulated (in Japan) • Approach road must be elevated due to height of girde • Service ducts can be located easily	• Much experience has been accumulated in Sri Lanka • Approach road is not elevated due to low girder height • Transverse rebar is adopted instead of PC wire for deck slabs in Sri Lanka • Arrangement of the girders is adjusted for service duct	• Much experience has been accumulated when span length is more than 18m in Japan • Approach road must be elevated due to height of girde • Transverse PC wire for deck slab is needed • Service ducts can be located easily
Construction Efficiency	• Girders are erected by crane (weight: approx. 3.3 tf) • Formwork and scaffolding for deck slab are needed • Skillful workers for welding work and so on are needed • From the above, construction period is extended, compared with other types	• Girders are erected by crane (weight: approx. 6.2tf) • Formwork and scaffolding are needed for curb work only • Work on site is reduced, compared with other types • No skillful workers for pre-stressing is needed • From the above, construction period is shortened	• Girders are erected by crane (weight: approx. 13.3tf) • Formwork and scaffolding for deck slab are needed • Work on site is increased, compared with other types • Skillful workers for pre-stressing work are needed • From the above, construction period is longer than Type-2
Serviceability for Maintenance	• Re-painting on the girders is needed periodically • Deck slab is likely to deteriorate because of RC structure • Corrosion prevention of steel members is needed because bridge is located on coastal lagoon	• No maintenance cost is needed except accessories • PC girders fabricated with rich-mixed concrete have superior performance against chloride attack	• No maintenance cost is needed except accessories • PC girders fabricated with rich-mixed concrete have superior performance against chloride attack
Evaluation	• Since it is difficult to prepare materials and skillful workers, this type shall be designated as **Rank-3** △	• Considering the above, this type shall be recommended and designated as **Rank-1** ◎	• Although construction cost is superior to Type-1, this type shall be designated as **Rank-2** ○

③ Results of Comparison for Selection

As a result of the above review, the "pre-tensioned PC slab girder bridge" is selected because of its cost and fast construction. Other merits for the type are as follows:

- Temporary and horizontal structure works are easy (safe). → **Safety Control**
- Materials procurement in Sri Lanka. → **Quality Control**
- There is experience of this type of construction in Sri Lanka and no special skilled workers are needed. → **Work Process Control**
- The bridge has simple shape and easy for maintenance. → **Maintenance**

10) Handrail

The concrete handrails are generally used in Sri Lanka.

11) Bearings

Simple rubber bearings will be adopted in accordance with the Bridge Design Manual of Sri Lanka.

12) Expansion Joint

As the necessary clearance is small, ELASTITE will be used as joint material.

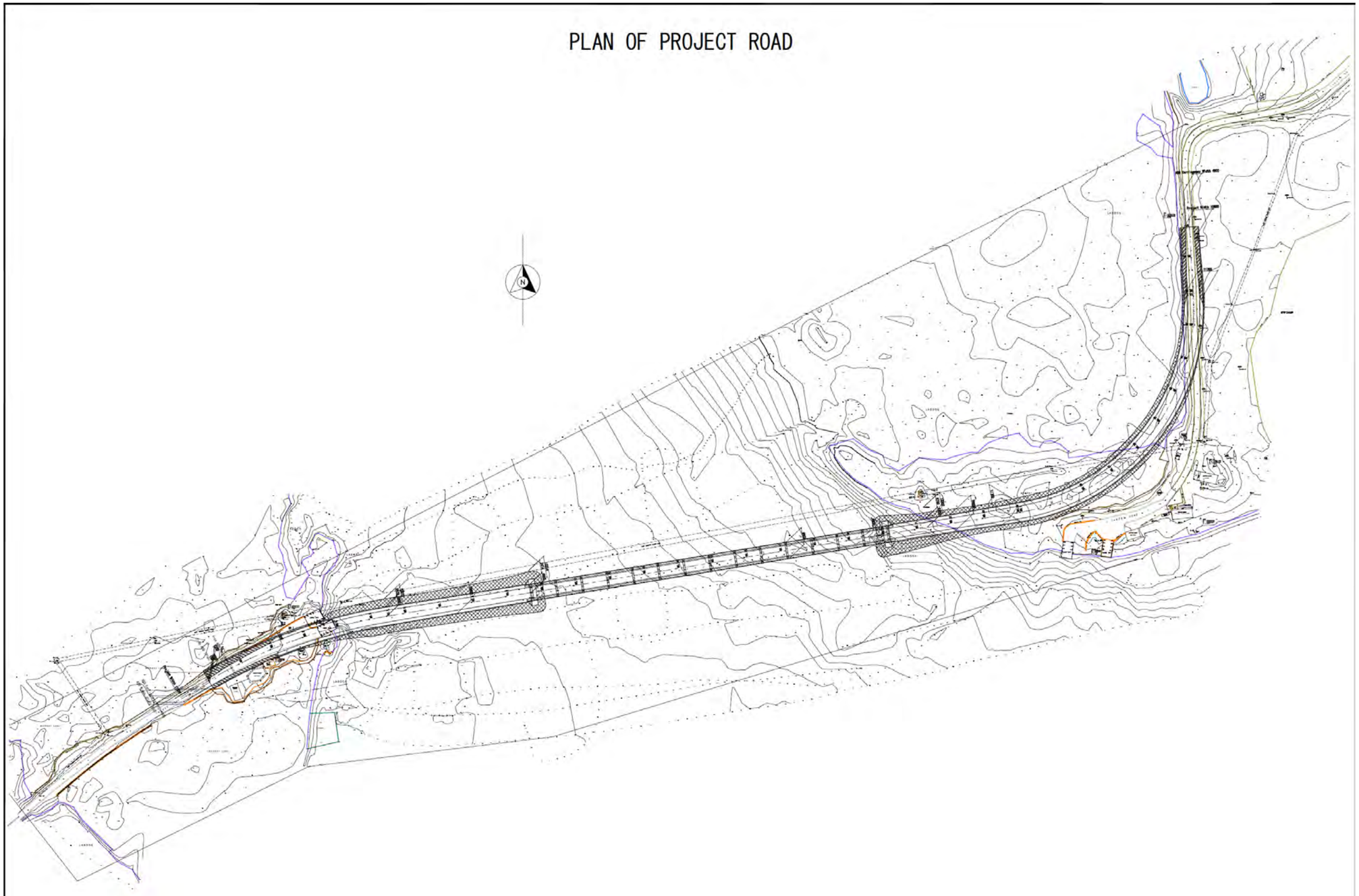
13) Drainage system

The drainage from the bridge is planned to directly discharged to the Lagoon.

2.2.3 Design Drawings

This section shows the outline design drawings of the Project to which this assistance applies.

PLAN OF PROJECT ROAD



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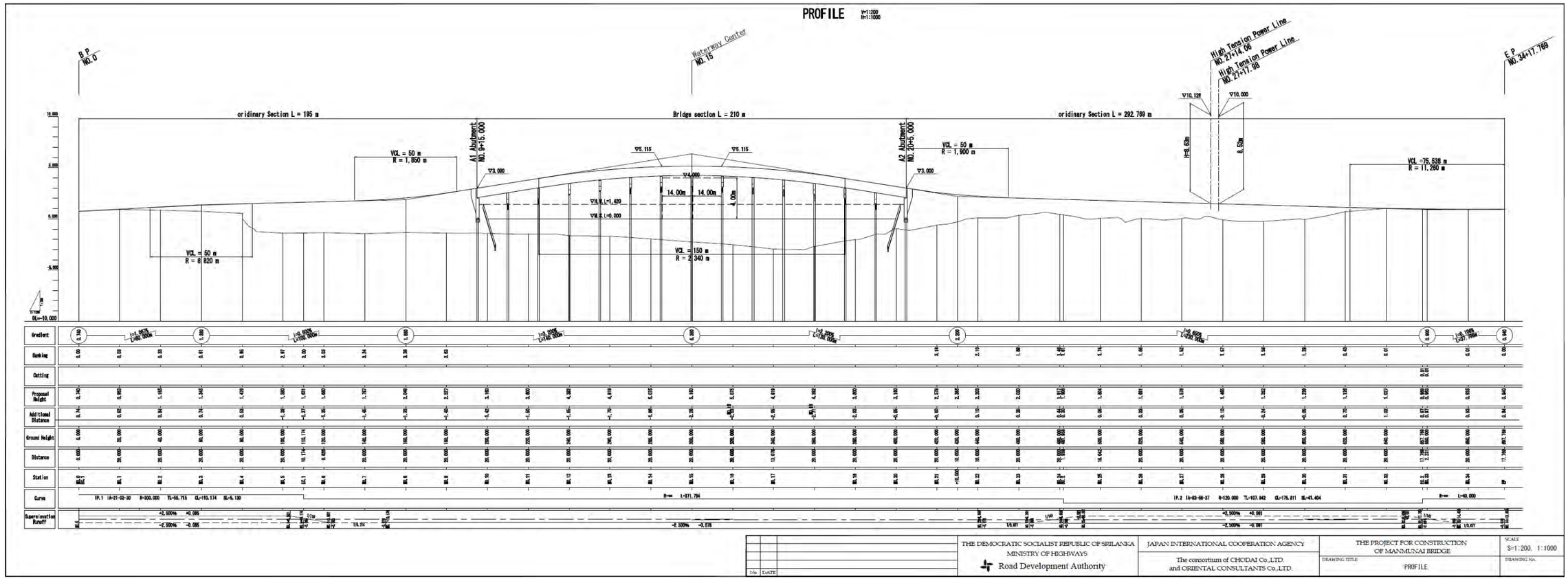
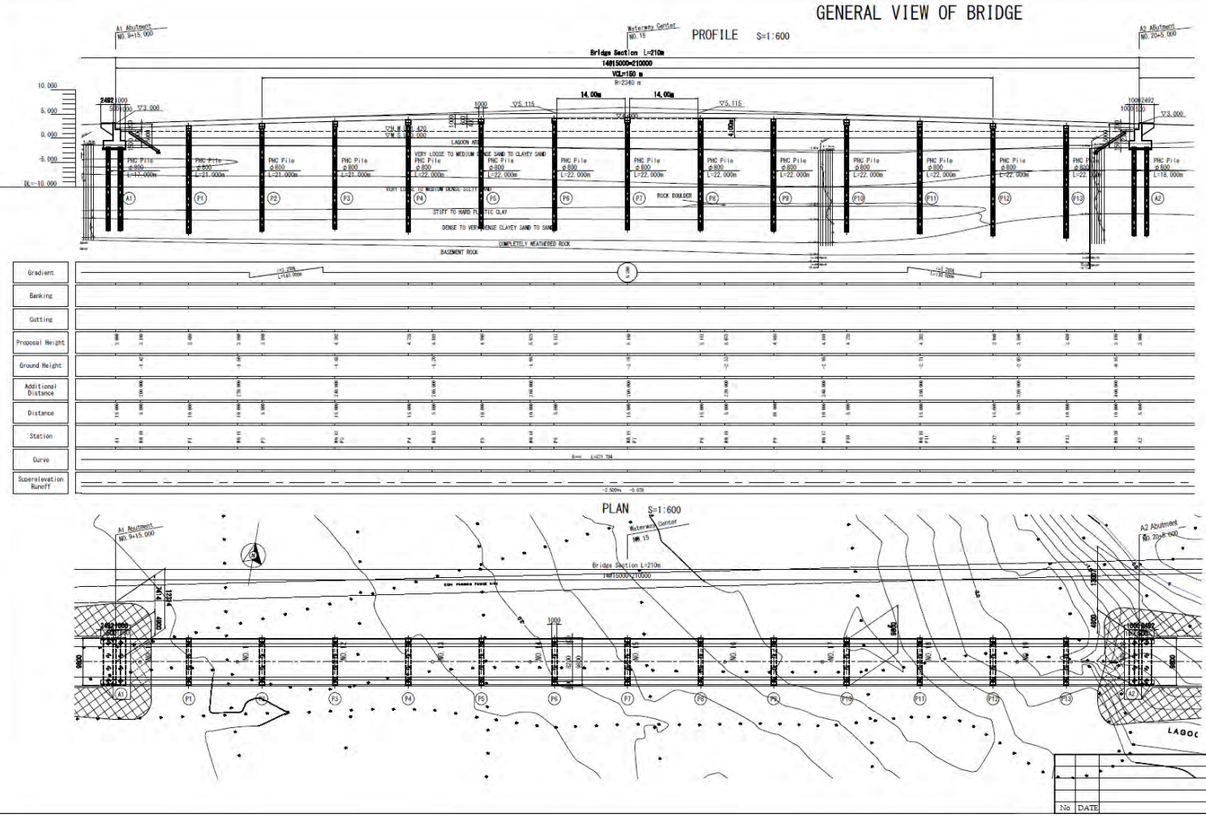
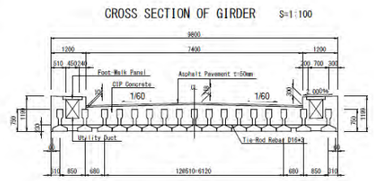
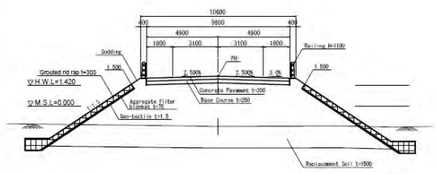
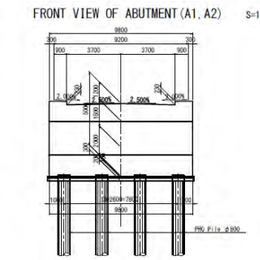

PROFILE
B P NO. 0
Waterway Center NO. 15
E P NO. 34+17.769
High Tension Power Line NO. 27+14.06
High Tension Power Line NO. 27+17.98
oridinary Section L = 195 m
Bridge section L = 210 m
oridinary Section L = 292.769 m
A1 Abutment NO. 9+15.000
A2 Abutment NO. 10+5.000
VCL = 50 m R = 1,850 m
VCL = 50 m R = 8,820 m
VCL = 150 m R = 2,340 m
VCL = 50 m R = 1,900 m
VCL =75.538 m R = 11,260 m
14.00m
14.00m
4.00m
H=6.63m
8.52m
Gradient
Ranking
Cutting
Proposal Height
Additional Distance
Ground Height
Distance
Station
Curve
Superelevation Runoff
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA
MINISTRY OF HIGHWAYS
Road Development Authority
JAPAN INTERNATIONAL COOPERATION AGENCY
The consortium of CHODAI Co.,LTD. and ORIENTAL CONSULTANTS Co.,LTD.
THE PROJECT FOR CONSTRUCTION OF MANMUNAI BRIDGE
DRAWING TITLE: PROFILE
SCALE S=1:200, 1:1000
DRAWING No.

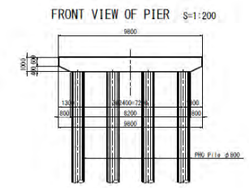
GENERAL VIEW OF BRIDGE











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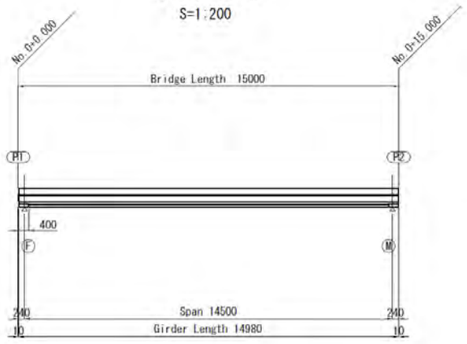
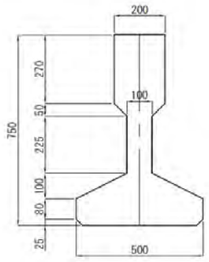
STRUCTURAL DRAWING OF GIRDER

Side View
S=1:200

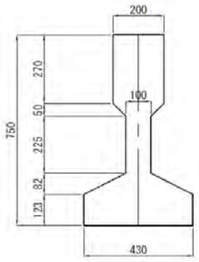


Cross Section of Beam
S=1:20

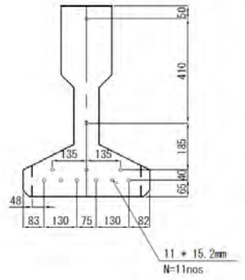
General Section



At Support



Tendon Arrangement
S=1:20



Design Condition

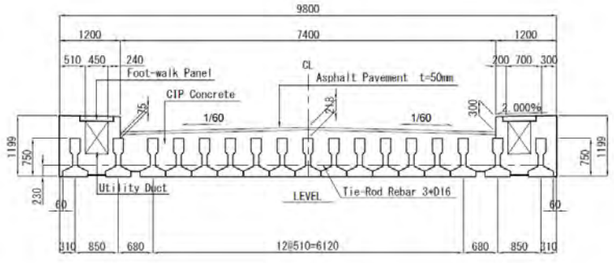
Category	Pre-stressed Concrete Road Bridge
Type	14 span Pre-cast PC Slab Simple Girder Bridge
Bridge Length	15.000m (on CL)
Girder Length	14.980m
Span Length	14.500m
Width	Total: 9.800m [1.200 + 7.400 + 1.200]
Angle	90° 00' 00"
Live-Load	HA Load and HB-30 Load (Bridge Design Manual)

Materials

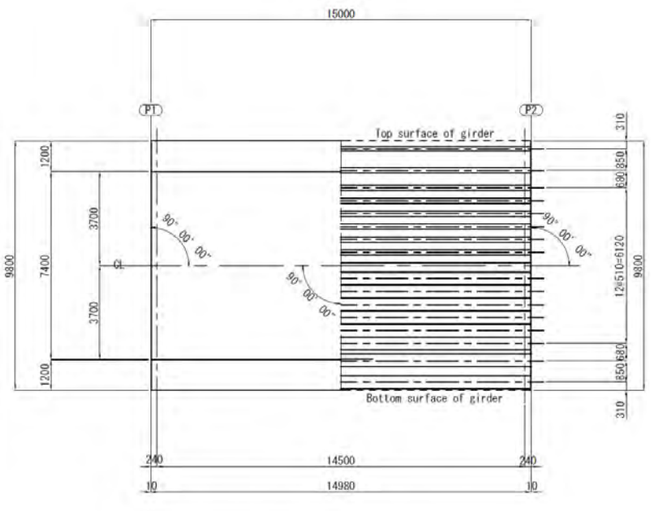
Concrete	Pre-cast Girder	f'ck = 45 N/mm2
	Cast-in-Place (Deck)	f'ck = 40 N/mm2
	Curb and Foot-walk	f'ck = 40 N/mm2
PC Steel	Pre-cast Girder	1S15.2 (SWPR7BN)
Deformed Bar	Pre-cast Girder	SD345
	Deck Slab	SD345
	Curb and Foot-walk	SD345

Cross Section of Girder
S=1:100

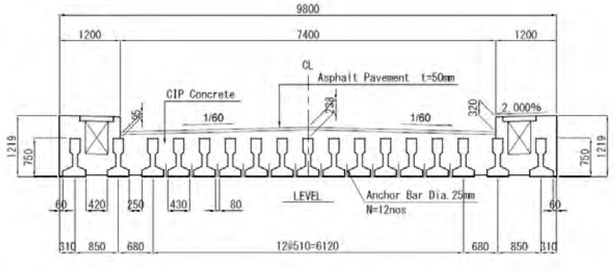
General Section



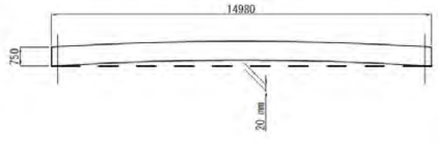
Plan View
S=1:200



At Support



Camber Diagram
S=1:20



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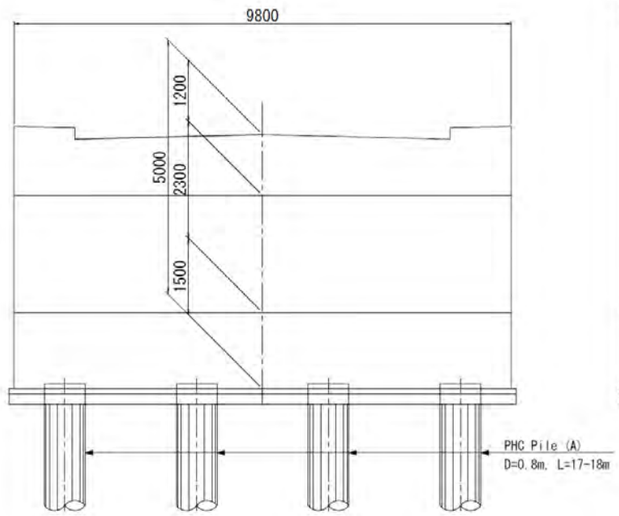
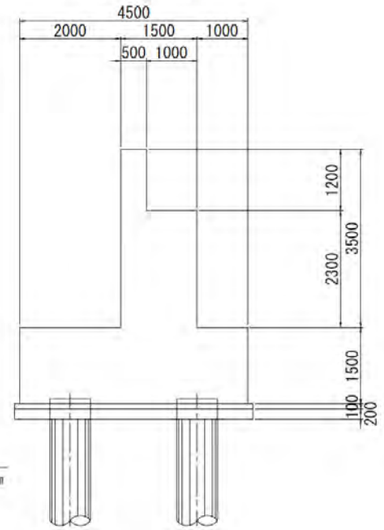
GENERAL VIEW OF SUBSTRUCTURE

Abutment (A1, A2)

Front View



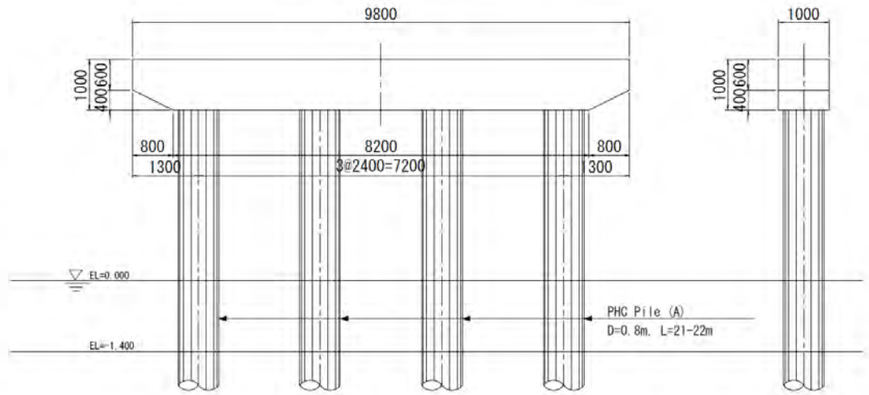
Side View



Pier

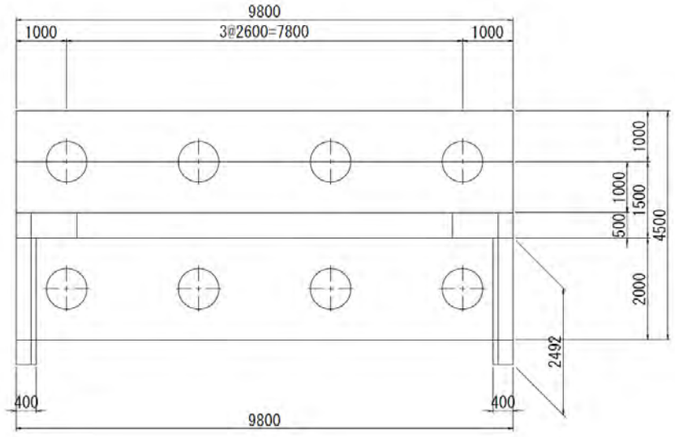
Front View

S=15m-15m, ϕ800

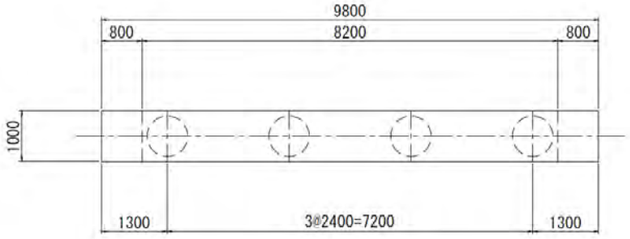


Side View

Plan



Plan



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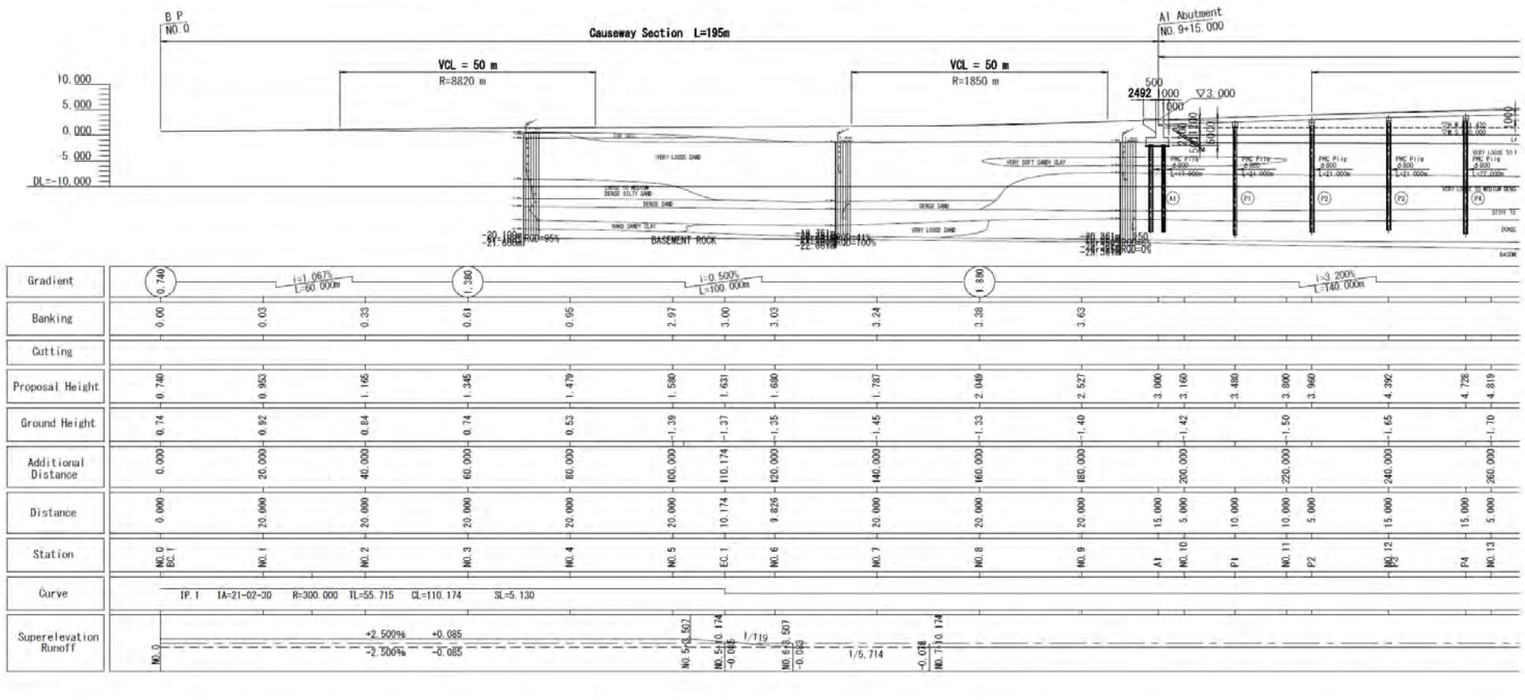
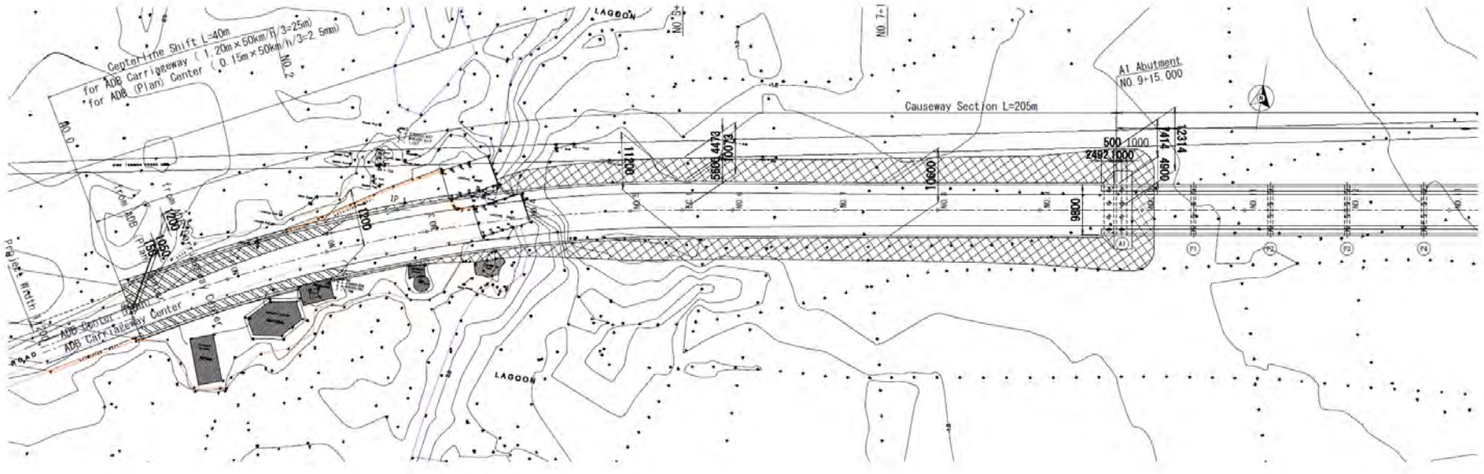
GENERAL VIEW OF CAUSEWAY(1)





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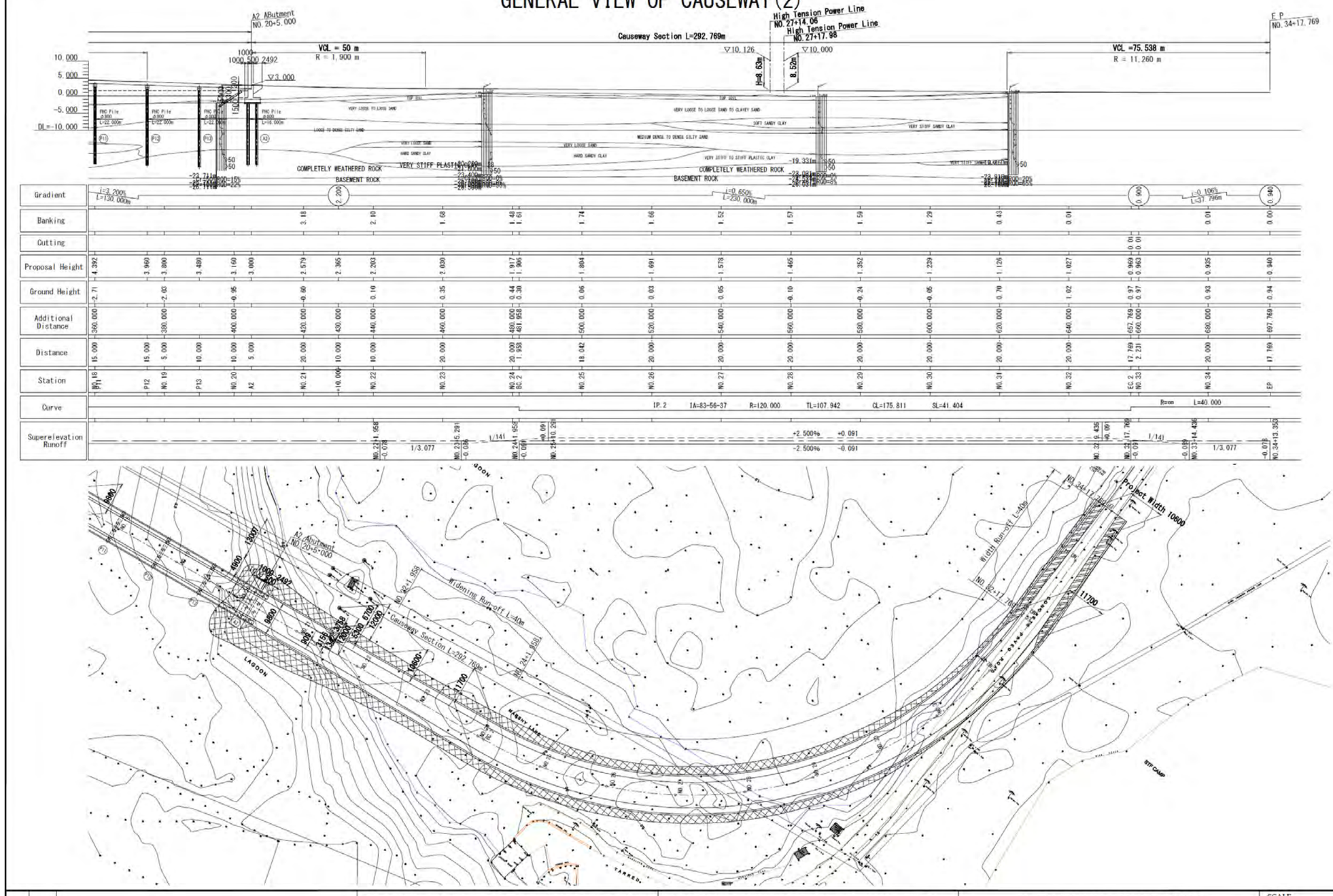
No	DATE					

GENERAL VIEW OF CAUSEWAY(2)



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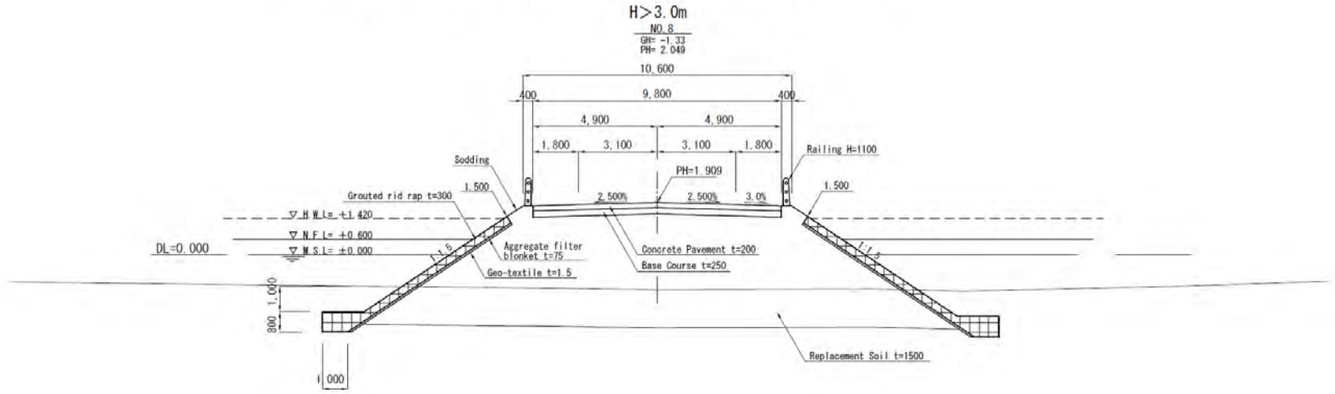
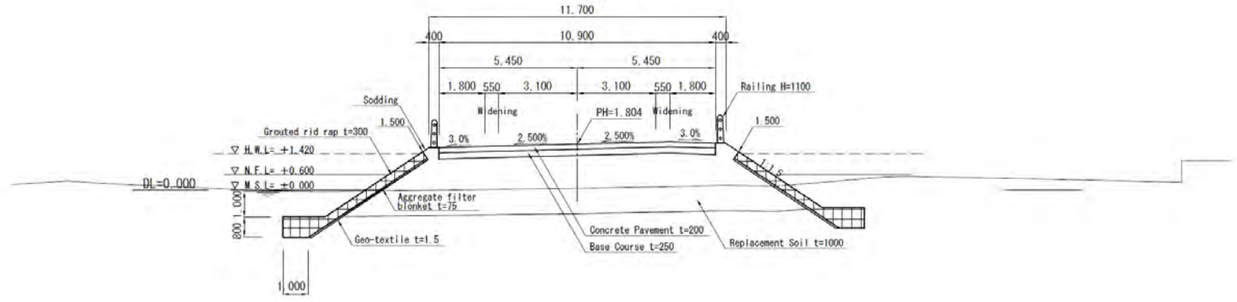
No	DATE				SCALE S=1:1000 DRAWING No.

TYPICAL CROSS SECTION OF CAUSEWAY S=1:200

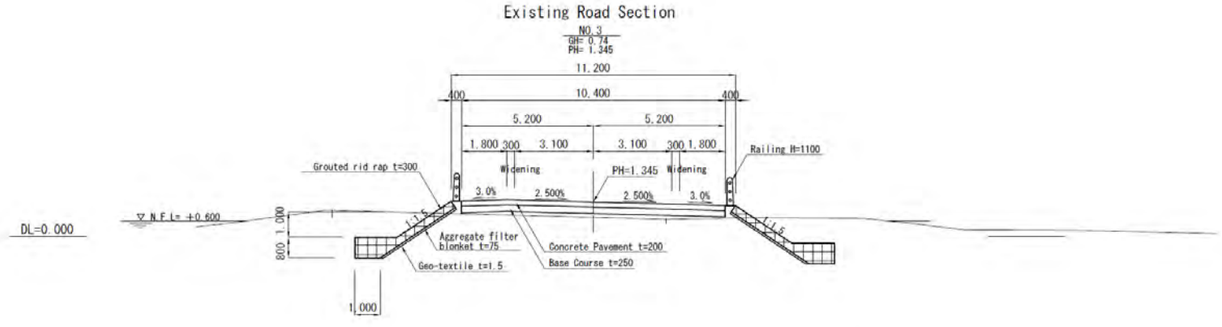
H>3.0m



H<3.0m



Existing Road Section



			THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF HIGHWAYS Road Development Authority	JAPAN INTERNATIONAL COOPERATION AGENCY The consortium of CHODAI Co.,LTD. and ORIENTAL CONSULTANTS Co.,LTD.	THE PROJECT FOR CONSTRUCTION OF MANMUNAI BRIDGE DRAWING TITLE: TYPICAL CROSS SECTION OF CAUSEWAY
No	DATE				SCALE S=1:200 DRAWING No.

2.2.4 Implementation Plan

(1) Construction Schedule/Procurement Policy

1) Flow of the Construction Works

The flow of the work is shown in Fig. 2.2-9.

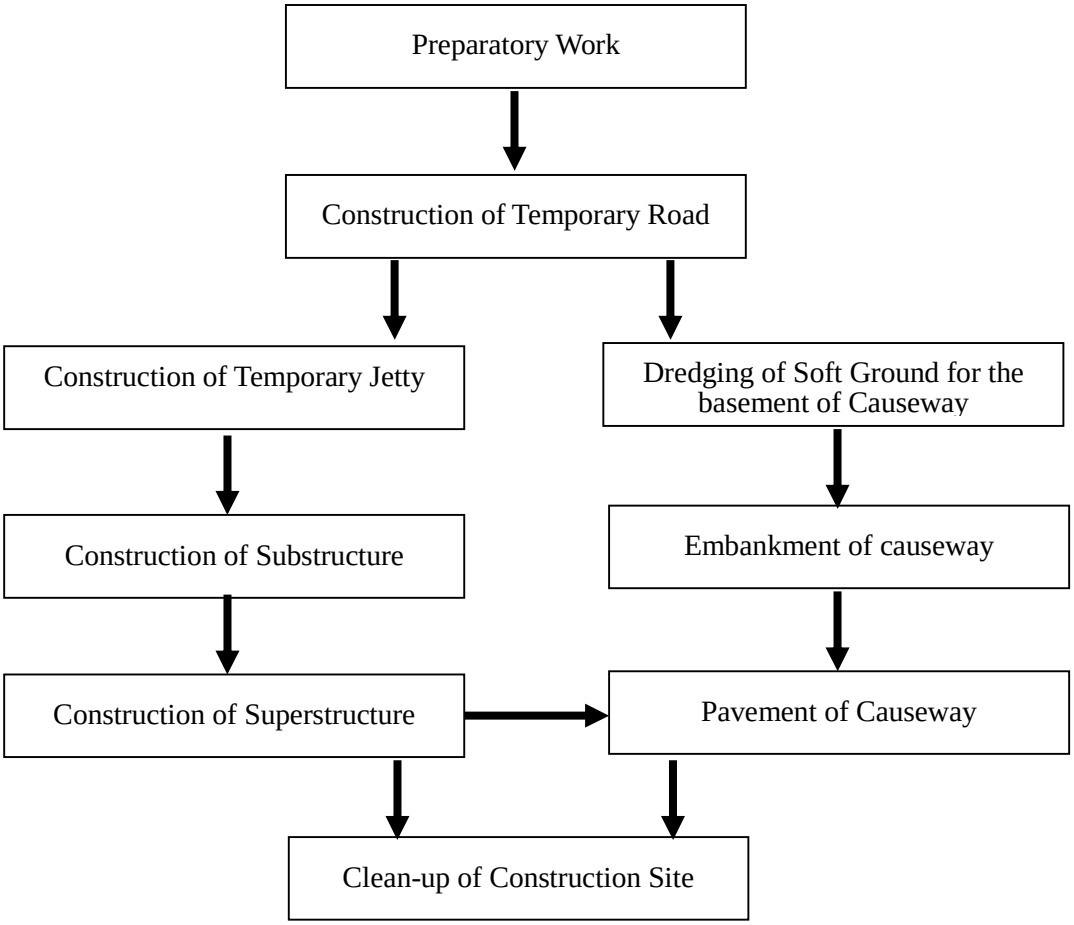


Fig. 2.2-9 Flowchart of the Construction

Rainy season of the construction site is from October to February. Earthworks including embankment of causeways etc. will be difficult in this period. Therefore, the work schedule for the construction of roads and causeway is planned to be completed during the dry season.

2) Temporary works

① Temporary Embankment for Causeway Construction

In construction of the causeways for the access roads, it is necessary to dry up the basement of embankment for soft ground replacement and causeway embankment. Therefore, it is necessary to construct temporary embankment at the both sides of the causeway.

② Causeway Construction Work

The causeway will be constructed at a water depth of 1.5m (max.) in the Lagoon. After drying up the basement of causeway, the soft surface layer (1.0m to 1.5m) will be removed and replaced with good sand and crushed stones and they will be compacted to maintain the stability of the causeway.

③ Construction of Temporary Ferry Jetty at the West Shore

The ferry jetty at the west shore overlaps on the causeway alignment. Therefore, a temporary ferry jetty and a temporary road to the ferry jetty shall be constructed before starting the construction. The temporary ferry jetty is planned to be located at the south of the bridge as shown in Fig. 2.2-10.

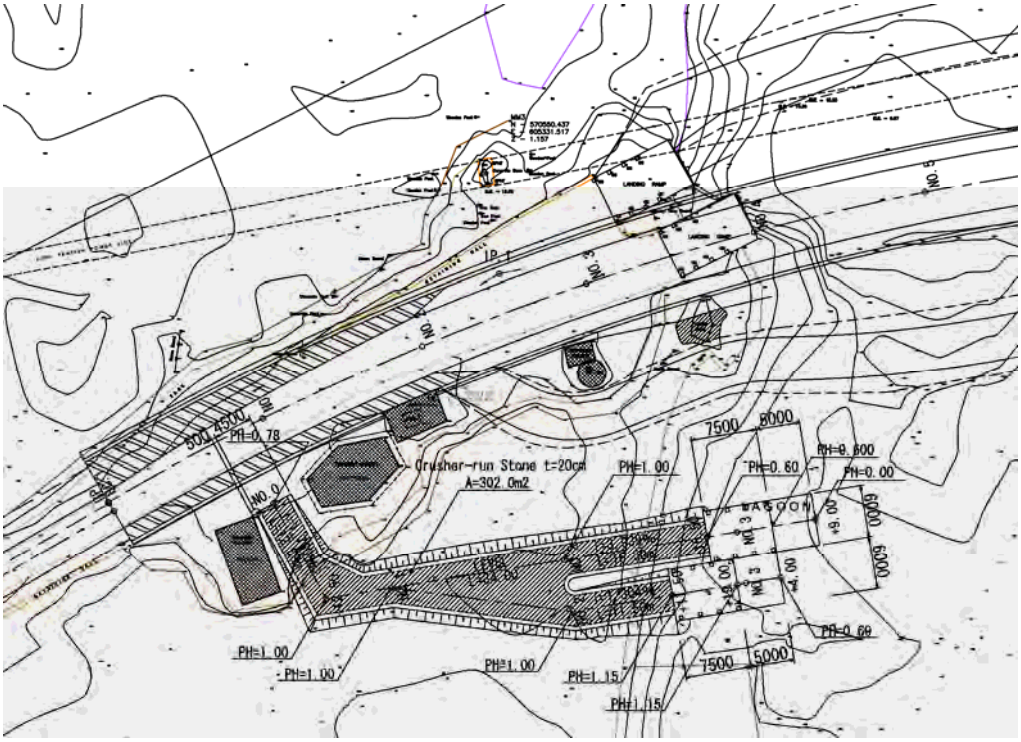


Fig. 2.2-10 Temporary Ferry Jetty

④ Temporary Jetty for construction of bridge

The jetty for bridge construction will be installed beside the alignment of the bridge. The jetty will be built by driving H-350 piles with a vibro-hammer.

3) Construction Yards

The construction yards necessary for these works are listed below.

Table 2.2-13 Construction yards

Construction Yard	Size	Location
Main office	Approx. 48m×60m	1 office at the east of the bridge
Sub office	Approx. 13m×20m	1 office at the west of the bridge
Stock yards for sands and aggregates	Approx. 30m×25m	2 yards (1 yard per each side of the bridge)
Stock yard for PC girders and PHC piles	Approx. 65m×30m	1 yard at the east of the bridge
Stock yard for construction materials	Approx. 20m×42m	1 yard at the east of the bridge
Concrete plant yard	Approx. 28m×36m	1 yard at the east of the bridge
Yard for bar bending and formwork	Approx. 23m×13m	1 yard at the east of the bridge

(2) Considerations for Construction and Procurement

1) Safety of Construction Work

Each of the construction yards will be protected by fences. Safety ropes shall be installed around the ferry jetty adjacent to the temporary embankment used for construction road. The safety ropes shall also be installed at the both side of the detours to prevent the accident of vehicles.

A guard booth will be installed at the entrance of each office for the required period. To protect the workers and residents, a total of 4 traffic watchmen shall be assigned at each of the east-shore and west-shore site offices, the ferry port and the intersection points of temporary roads. The signboards for construction, and detour guidance will be installed at the necessary points.

(3) Detailed Design and Construction Supervision

1) Basic Policy for Detailed Design

The field surveys will be carried out before starting the detailed design to confirm the new conditions including revisions of laws and regulations and design standards to be reflected on the detailed design. Total of 6 engineers will be assigned for the survey.

The detailed design work will be carried out by the engineers including superstructure engineer, substructure engineers, road engineer and quantity surveyor as well as engineer for tender documentation. The design report, design drawings, material quantity, project cost estimation and tender documents will be prepared in the detailed design.

2) Basic Policy for Construction Supervision

One Japanese resident engineer will be assigned for the construction supervision.. The causeway construction and the bridge construction work will be done simultaneously during the entire work period. Therefore, one local engineer will be employed depending upon the

operating conditions at the sites. The standard pre-stressed concrete PC girders will be manufactured by a local manufacturer in Sri Lanka so that one superstructure engineer will be employed for this bridge for the quality control during the period of PC girder manufacture and the girder installation. One road engineer will be assigned to supervise the foundation work and causeway construction. In addition, an engineer in charge of environmental management will be dispatched at a certain intervals to supervise an environmental assessment activities.

3) Construction Supervision

The supervisors dispatched to the sites will perform the following construction supervision works while leading the local engineer to be employed in Sri Lanka:

- Approval of the construction plan, construction schedule and temporary works drawings

  The supervisors will inspect whether the work schedule plans, construction schedule charts, temporary works drawings are accord with the contract documents, and approve them.
- Schedule control

  The supervisors will receive the monthly progress reports from the contractor and give necessary instructions for the completion of the Project as scheduled.
- Quality control

  The supervisors will inspect and approve the quality of construction materials and construction methods, according to the contract documents.
- Inspection of completed construction works

  The supervisors will inspect whether the shapes, locations and dimensions of the completed construction works are conforming to the control criteria, and certify the quantities.
- Issueing of certificates

  The supervisors will issue the necessary certificates for payment to the contractor, the completion of the work, expiration of the warranty period, etc.
- Submission of reports

  The supervisors will assess the monthly reports, as build drawings, photos, etc., prepared by the contractor, and submit them to the Sri Lankan authorities and JICA. After completion of the work, the supervisors will prepare the work completion reports and submit them to JICA.

(4) Quality Control Program

The Sri Lankan standards for design of roads and bridges have been established as their own design manuals with reference to the British Standards. However, the standards for quality control are not well developed in Sri Lanka. The quality control in this Project will thus be carried out in accordance with the British Standards or the Japanese standards and testing methods.

The quality control plan for this Project is shown in Table 2.2-13.

Table 2.2-13 Quality Control Plan (draft)

Type of Work	Control Item	Inspection, Testing etc.	Frequency and timing of Inspection / Testing
1) Earthwork, Asphalt Pavement	Material Control	Geotechnical Test (Specific gravity, Grain size, Moisture content, Liquid & Plastic limit, Density), Aggregate Test (Specific gravity, Grain size, Strength, Coefficient of water absorption), Bituminous material (Quality certificate, Componential analysis result)	Before implementation
	Routine Management	Soil Compaction Test, Bituminous material (Stability, Flow value, Void ratio, Marshall test, Temperature)	At implementation and mixing
2) Concrete Structure, Concrete Pavement	Batching Plant calibration	Weighing equipment, Mixing efficiency	Before implementation and once a month
	Material Control	Cement, Admixture (Quality certificate, Result of componential analysis), Aggregate test (Specific gravity, Grain size, Strength, Coefficient of water absorption, Alkali-aggregate reaction)	Before implementation, the timing of changing material
	Concrete Trial Mix	Slump, Air content, Temperature, Sample Strength	Before implementation
	Routine Management	Fresh concrete (Air content, Slump, Temperature)	Witness inspection at placement
		Inspection (Consolidation, Curing method, Removal of laitance)	Witness inspection at placement
		Concrete Sample (Sample compressive strength test, Preparation of the concrete control chart)	7 and 28 days after placement
3) Reinforcing Bar, Prestressing Steel	Material Control	Quality certificate (Mill sheet), Tensile strength test	Before placement
	Routine Management	Inspection (Cover, Arrangement, lap length)	At placement

(5) Procurement Plan of Construction Equipments and Materials

1) Procurement of main materials

The main materials will be procured as shown in Table 2.4-2. All the materials including foundation piles and rubber bearings can be procured within Sri Lanka. The stones and sand required as concrete materials can be supplied from the quarries in Mahiyangana and Amparai areas.

Table 2.2-14 Procurement plan for main materials

Construction Material	Local Procurement	Procurement form Third Countries	Remarks
Cement	○		
Concrete admixtures	○		
Asphalt admixtures	○		
Reinforcing bars	○		Imported
Steel materials for temporary structure	○		Imported
Aggregates, sand and earth	○		

Formwork materials	○		
Scaffolding materials	○		
Secondary concrete products	○		
PHC piles	○		Imported
Expansion joints, bearings	○		Imported

2) Construction Equipment

All the construction equipment and materials can be procured in Sri Lanka. However, there are few heavy machines in stock in the Eastern Province and all heavy machines for this Project will be required to be transported from Colombo.

Table 2.2-15 Procurement plan for main machines

Type	Item	Procured from	Reason for Selection
Machines	Road-use heavy machinery	Colombo, Sri Lanka	Necessary quantity procurable
	Excavation-use heavy machinery	Colombo, Sri Lanka	Stable quality and supply
	Cranes	Colombo, Sri Lanka	Necessary quantity procurable
	Pile drivers	Colombo, Sri Lanka	Necessary quantity procurable
Vehicles for supervision	Jeeps and pick-up trucks	Colombo, Sri Lanka	Imported vehicles purchasable in market

(6) Construction schedule

The construction schedule is shown in Table 2.4-4. The earthworks including road and causeway in water will be scheduled to be completed in the dry season.

Table 2.2-16 Construction Schedule (Draft)

Month			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.
Item \ Cumulative Months						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Work Schedule	Preparation Work																										
	Approach Road & Causeway																										
	Foundation / Substructure																										
	Superstructure (Manufacturing)																										
	Superstructure (Site Work)																										
	Pavement																										
	Cleanup																										

2.3 Obligations of the Recipient Country

2.3.1 General Conditions for Japan's Grant Aid

- To award the contract and implementation of the Project;
- To Secure the lands necessary for implementation of the Project;
- To manage resettlement of the residents necessary to implement the Project and compensation for those residents;
- To open bank account in the name of the Government of the recipient Country in Japan (B/A) and issue the Authorization to Pay (A/P) and bearing of the costs thereof;
- To ensure all expenses and prompt execution for unloading , custom clearance.
- To exempt Japanese Nationals from customs duties, domestic taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of goods and services under the project.
- To providing support to Japanese personnel necessary for them to carry into Sri Lanka the products and services procured within the scope of the Project Agreement; and
- To ensure proper maintenance, management and preservation of the facilities constructed by Japan's Grant Aid Project.

2.3.2 Special Conditions for the Project

- To relocate and dismantling of existing utilities including electricity and water supply at project sites;
- To supply electricity, water supply and drainage and other incidental facilities at the vicinity of project site;
- To take necessary measures for the safety of traffic and ship navigation;
- To secure and dismantling of temporary yards;
- To secure a land for disposal of waste from the works in this Project;
- To secure environmental licenses and approvals; and
- To secure the security of the project sites including detection and removal of unexploded ordnances and mines.

2.4 Project Maintenance Plan

The maintenance work necessary to operate and maintain the facilities constructed in this Project are recommended as shown in Table 2.4-1.

Table 2.4-1 Maintenance Work for the Facilities

Item	Check Point	Description of Work	Frequency
Maintenance and repair of bridge and roads	All facilities	Maintenance in accordance with the RDA Bridge Maintenance Manual	2 days per month
Bridge maintenance	Elastite in expandable sections	Cleaning of expansion joints. Any damage shall be photographed and recorded.	4 times per year
	Drainage system	Cleaning of drainage clogged with earth and sand. Any damage shall be photographed and recorded.	4 times per year
	Bearings	Cleaning of bearings. Checking on any displacement and rubber deterioration.	Twice per year
	Handrail and guard rail	Checking on whether any railing is damaged due to a vehicle crash.	4 times per year
	Main girders	Check on any damage. If any, such damage shall be photographed and recorded.	Once per year
	Bridge deck (pavement and curbs)	Check on deck surface. If any pothole or damage, repair the damage.	Once per year
	Abutments/and piers	Check on any local scours and settlement.	Once per year
Maintenance of causeways and access roads	Road surface	Check on road surface if any pothole or damage, repair the damage.	12 times per year
	Shoulders	Check on any deformations and cracks. Weeding and grading of damaged sections.	12 times per year
	Slopes	Check on any deformations and cracks. Weeding and grading of damaged sections and removal of earth and sand sediments.	12 times per year
	Guard rail	Check on any damage due to a vehicle crash.	4 times per year
	Revetments	Check on any scouring, deformation or cracking.	Once per year

2.5 Project Cost Estimate

2.5.1 Initial Cost Estimation

(1) Expense to be borne by Sri Lanka

① Exemption of VAT : 129.0 Million LKR
② Cost for the B/A and AP : 1.0 Million LKR
③ Electrical power and water supply to the construction site : 7.5 Million LKR
Total : 137.5 Million LKR

2.5.2 Operation and Maintenance Cost

Annual operation and Maintenance cost after the completion of the Project are estimated as shown in Table 2.5-1.

Table 2.5-1 Annual Operation and Maintenance Cost

Personal Cost	Engineer	LKR 165,750 x 2/30 x 12Months	LKR 132,600
	Inspector	LKR 1,989 x 2 x 2 x 12months	LKR 95,472
Material			LKR 342,108
Equipment		LKR. 10,000 x 2day/Month/ x 12Months	LKR 240,000
			Total LKR 810,000

Chapter 3 Evaluation of the Project

3.1 Preconditions for the Project

3.1.1 Preconditions for Project Implementation

The preconditions for the implementation of the Project is described below.

1) Land Acquisition

Acquisition of private lands or resettlement are not required in this Project. However, lease of private land is required for construction yards.

2) Obtainment of Construction Permits and Environmental Permits

When the routes are determined, RDA is requested to submit the Basic Information Questionnaire (BIQ) to CEA and obtain their approval for the implementation of the Project. Prior to construction, the contractor shall submit the method statement for environmental monitoring to RDA. In addition, the contractor shall obtain an Environmental Protection License (EPL) from CEA. During construction, the environment monitoring shall be carried out in accordance with Environmental Monitoring Plan (EMoP) based on Environmental Management Action Plan (EMAP) prepared by RDA.

3) Traffic Control on Land and on Water during Construction

As the construction of the Project will be carried out keeping the existing ferry traffic, the traffic shall be properly controlled by the Sri Lankan side on the roads at both sides of ferry and on the water surface (fishing boats etc.).

4) Landmines and UXOs

Smooth and proper removal of the landmines and UXOs are required under the responsibility of the Sri Lankan Side, if any are found in the Project-related area during the Project.

3.1.2 Preconditions and Important Assumptions

The tasks to be effectively performed by the Sri Lankan side are described below as preconditions to ensure the achievement and sustainment of the project outputs. Important assumptions to achieve the project outputs and their subsequent sustainment are described in 3-1-2-2.

(1) Tasks to be Performed by the Sri Lankan SIde

1) Proper Operation and Maintenance of the Newly Constructed Facilities

Appropriate maintenance will be required for the newly constructed bridge and causeways after opening to traffic. The connection zone of the bridge and the causeways shall be checked for damages at the time of flood etc. and shall be repaired promptly and properly if necessary.

(2) Important Assumptions for the Project

1) Improvement of Provincial and Local Roads on the West Side of the Lagoon

When the provincial and local road networks are improved on the west side of the Lagoon, the implementation of this Project will be highly effective.

Especially the improvement of two provincial roads (One from Paddipalai to A27, and the other from Vallaveli on B18 to Rajagalatenna South on A27. Both are earth roads at the moment) will significantly develop the road network on the west side of the Lagoon and the access between both sides of the Lagoon.

2) Development of Management Structure for Bridges

Although maintenance for highways and roads are being developed in Sri Lanka, maintenance for bridges are not sufficiently carried out at the moment. Development of adequate structure for bridge management is required.

3.2 Project Evaluation

3.2.1 Relevance

1) Beneficiaries of the Project

The development of infrastructures is left behind at the western side of the Lagoon. The construction of Manmunai bridge will supplement this delay, and will contribute to the social and economic development of the area and to improvement of living standard of the residents.

2) Necessity

The implementation of this Project will accelerate the rehabilitation from Tsunami disaster, and will provide the safe traffic available for 24 hours, and reduce interrupted period of traffic after flood.

3) Urgency

This Project will improve the access from the western shore to emergency medical services on the eastern shore, and will reduce the travel time and distance between both sides of the Lagoon.

4) Relations with Superior Plans

The objective of this Project agrees well with Mahinda Chintana and various regional development plans, as Manmunai bridge is located will contribute to the rehabilitation of roads in the Tsunami-affected areas, and also to the development of agricultural and fishing potentials.

5) Maintenance

The structures applied in this Projects have many experiences in Sri Lanka, and has no special difficulties for maintenance.

6) Social and Environmental Considerations

Acquisition of private lands or resettlement are not required in this Project, as the road alignment is determined not to effect the private assets.

3.2.2 Effectiveness

(1) Quantitative Outputs

Quantitative Outputs expected from this Project are shown in Table 3.2-2.

Table 3.2-2 Expected Quantitative Outputs of the Project

Index	Baseline Value	Target value (after construction)
Travel Distance between Western and Eastern Shore of the Lagoon	approx. 32 km	approx. 300 m
Travel Distance from Manmunai Western Shore to Batticaloa	approx. 27 km	approx. 15 km
Travel Time between Western and Eastern Shore	approx. 60 minutes (waiting time: 30 ~ 60 minutes + ferry: 10 minutes)	less than 1 minute
Transport Capacity	2 passenger cars / ferry at maximum, operation interval: 30 ~ 60 minutes	no limit
Operating Hours	12 hours (daytime, 6:00 ~ 18:00)	no limit (24 hours)
Interrupted Period during Flood	approx. 2 weeks	approx. 1 ~ 2 days

(2) Qualitative Outputs

- Improvement of traffic for the residents including access to emergency health care and education etc.
- Stable transport of agricultural products. Improvement the local industries such as agricultures, and contribution to the economic development of Eastern Province and Sri Lanka.
- Acceleration for establishment of peace by accelerating the transportation of people and goods between both sides of the Lagoon.

In addition to the positive outputs described above, the completion of the Project will lead to the improvement of traffic network in the area, and will contribute to the rehabilitation, social / economic development and establishment of peace. Hence the implementation of this Project is considered highly meaningful, relevant and effective.