Directorate General of Highways
Ministry of Public Workd
Republic of Indonesia

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF BRIDGES
IN SOUTH-EAST SULAWESI PROVINCE
IN
THE REPUBLIC OF INDONESIA

November 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

KATAHIRA & ENGINEERS INTERNATIONAL

PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the Project for Improvement of Bridges in South-East Sulawesi Province in the Republic of Indonesia.

JICA sent to Indonesia a survey team from April 14 to May 12, 2009.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Indonesia in order to discuss a draft outline design, and as this result, 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 two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the teams.

November, 2009

Toshiyuki Kuroyanagi
Director General, Economic Infrastructure Department
Japan International Cooperation Agency

November, 2009

Letter of Transmittal

We are pleased to submit to you the preparatory survey report on the Project for Improvement of Bridges in South-East Sulawesi Province in the Republic of Indonesia.

This Survey was conducted by Katahira & Engineers International, under a contract to JICA, during the period from February 2009 to November 2009. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Indonesia and formulated the most appropriate outline design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Soemu Oshita
Project manager,
Preparatory Survey team on the Project for
Improvement of Bridges in South-East Sulawesi
Province in the Republic of Indonesia
Katahira & Engineers International

Summary

1. Outline of the Country

Indonesia is composed of approximately 18,000 islands. It is the world's largest archipelagic country. With a population of 221,654,500 in 2006, it is the world's fourth most populous country. Indonesia is the world's 16th largest country in terms of country area with an area of about 1,940,000 square kilometers.
Sulawesi Island, the 11th largest island in the world with an area of 174,600 square kilometers, is surrounded by Kalimantan Island in the west, Maluku Island in the east, Mindanao Island in the North and West-Nusa Tenggara Islands in the south. Southeast Sulawesi Province, with an area of 38,110 square kilometers and a population of 2,002,000 in 2006, is surrounded by the sea, therefore, the temperature does not vary much throughout the years. May to September is relatively cool and the lowest temperature is about 20℃. While, October to April is relatively warm and the highest temperature is about 35℃. The annual rainfall in Southeast Sulawesi is about 1,600mm. The rainy season is from November to June, and the dry season is from July to October.
Indonesia has extensive natural resources, including crude oil, natural gas, tin, copper, and gold. Major agricultural products include rubber, rice and palm oil. The GDP per capita is US$ 2,191 in 2008. The GDP growth rate exceeded 5% in 2000s, however, it tended to decelerate the economic growth since the global economic crisis in 2008.

2. Background of the Project

Sulawesi Island comprises 6 provinces which are less developed in comparison with the central and western regions of Indonesia. The GDP per capita of the island is Rp 6.1M while the national average is Rp 10.7M. To mitigate the regional socio-economic imbalance, accelerating development activities in the eastern regions of Indonesia is a major issue in the national development. Southeast Sulawesi is the least developed province in Sulawesi Island. Furthermore, there are still many villages isolated from educational and medical services as well as experiencing difficulties in transporting their agricultural products to the markets due to the bad road condition, particularly in rainy season, and inadequate capacity of existing temporary bridges.

To overcome this adverse condition, the Government of Indonesia (GOI) with Southeast Sulawesi Provincial Government has been making efforts to improve the road condition. However, many roads still remain in poor condition since improvement of existing temporary bridges is difficult due to financial and technical constraints. The GOI and the Provincial Government of Southeast Sulawesi selected 47 temporary bridges (timber and bailey bridges longer than 20 m) along the roads which are important for regional development. The GOI then formulated the Project for the

Project") and requested to the Government of Japan (GOJ) for assistance to construct 22 bridges among the 47 bridges identified as above for the first phase of the Project.

In response to the request, a preliminary study on the project was conducted by a JICA study team from July to August 2008. In the study, the site conditions of the requested bridges were surveyed and their necessity, urgency and appropriateness of the project were evaluated. In the field survey, it was found that 6 of the requested bridges were under construction and other 3 bridges were then additionally requested to be included in the study. As a result of the preliminary study, the 11 bridges (4 bridges along Transmigration Area Road on Sulawesi Mainland and 7 bridges along Buton South-North Road on Buton Island) were selected for the further study.

Following the preliminary study, the GOJ decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") and JICA sent the Survey Team to reconfirm the necessity and appropriateness of the Project, finalize the bridge list for the Project, prepare outline design of the bridge facilities, prepare the implementation plan and estimate the project cost.

The Project roads in the Southeast Sulawesi mainland transmigration area are Raterate –Lapoa Road: 74km (Provincial Road) and Benua – Lapoa Road: 23km (Regency Road). Along these roads there are many towns and villages transmigrated from mostly Jawa and Bali. The major products in the area are cacao, paddy, orange and others. The population and agricultural production in the area have successfully expanded, however it is difficult to sell the products due to the transportation problem. The road connecting the areas with the national roads is difficult to pass for common vehicles due to existence of ford crossing, timber bridges, wooden deck bailey bridges and unpaved road sections. Such road condition is obstructing the economic activities in the area. Also the people in the area are limited to access to the social services due to the difficulty of the transportation to the facilities such as hospitals, high school and markets.

Buton Sout-North Road is Baubau – Labuan Road: 174km (national road) which runs from southern largest city Baubau to northern town Labuan along the west coast of the island. Along the road, many towns and villages are located and producing cashew, coconut, cacao, paddy and other agricultural products. Fishery is also the major industry in the area. The Project bridges are located in the northern section of the road where ford crossings, timber bridges and wooden deck bailey bridges exist and are impassable for common vehicles. Also the unpaved mountainous road sections are impassable for vehicle during raining. Such road condition is obstructing the economic activities in the area. Also the people in the area cannot receive social services due to the difficulty of the transportation to the social facilities.

Ferry terminal construction project which will connect Kendari (the provincial capital) and Baubau (the biggest city in Buton) with shorter distance and travel time comparing to the existing ferry route via Muna Island. To operate the ferry service, the improvement of the access roads to ferry route via Muna Island. To operate the ferry service, the improvement of the access roads to the ferry terminals is necessary. Buton South-North Road is the Buton side ferry terminal access road. Therefore, the construction of the Project bridges along Buton South-North Road is necessary for the ferry project.

3. Outlines of the Survey Results and Contents of the Project

This project aims to support the improvement of the road network in Southeast Sulawesi Province in order to promote the mitigation of regional development imbalance and the improvement of the living standard of the people in the Project area.

The scope of the Japanese assistance is to construct 11 bridges which are relatively large bridges along the Project roads. While, the Project road improvement including the construction of small bridges is being implemented by the Indonesian side is scheduled to be completed upon the completion of the Project bridges.

The Project will be implemented in two stages. Since the ferry project which will connect Amolengu in mainland and Labuan in Buton Island is scheduled to start the operation in 2013, the construction of 4 bridges in the mainland of Southeast Sulawesi Province will be implemented in the first stage and the construction of 7 bridges along Buton South-North Road will be implemented in the second stage to adjust the timing between the ferry project and this Project.

The design policy employed for the planning of the Project bridges is as follows:

(1) The natural site conditions such as topographical condition, geological condition, river condition and seismic condition are taken into consideration.
(2) The design specifications issued by the Directorate General of Highway, the Ministry of Public Works of Indonesia are basically adopted for the design of bridges and approach roads.
(3) The bridge widths are referred to the design standards of the Ministry of Public Works of Indonesia. However, their appropriateness against present and future traffic volume should be examined. Revision of the width should be proposed where the standard width deems inappropriate.
(4) In outline design of the superstructure, substructure, foundation and riverbank protections, comparative scheme study are carried out and the optimun schemes are proposed. The following are considered in the outline design:
  - Cost Efficiency: All materials are procured from local markets including the plate girders. Integral type structure is adopted since it can be made up with small members. Vertical curves are given to the bridges to reduce embankment volume and pavemet area for the approach roads. Multi-purpose construction equipments are employed to reduce equipment

and steep, safe and easy construction method are planned. Equipments and materials which are transportable to the sites without trailer-tuck are used.

- Environmental and Social Consideration: Avoiding land acquisition and resettlement are considered in selection of new bridge location.
- Maintenance Free: Integral type structure is proposed for all Project bridges since expansion joints and bearings which needs frequent maintenance are not necessary. Plate girders are galvanized. Countermeasures against salt water are taken to the bridges which locate in the seaside.

The project bridges are planned on the basis of the above policies. The components of the project bridge facilities are as summarized in the following table.

Components of the Project Bridge Facilities

Stage	Bridge No.	Bridge Name	Bridge Length (m)	Carriageway Width (m)	Superstructure Type	Foundation Type	Approach Road Length (m)
Stage-1	No.1	Roraya III	50.0	4.5	Plate Girder	Bored Pile	176.1
	No.3	Pinnango	22.0	6.0	RC Girder	Steel H-Pile	132.0
	No.4	Roraya II	64.0	6.0	Plate Girder	Bored Pile	273.8
	No.7	Lapoa	22.0	6.0	RC Girder	Steel H-Pile	124.6
	Subtotal		158.0	—	—	—	706.5
Stage-2	No.8	Wamorapa	22.0	6.0	RC Girder	Spread Footing	140.7
	No.9	Labuan Wolio III	22.0	6.0	RC Flat Slab	Spread Footing	108.3
	No.12	Maligano III	32.0	6.0	RC Girder	Steel Tubular Pile	146.1
	No.14	Wakaka II	24.0	6.0	RC Flat Slab	Steel Tubular Pile	157.9
	No.15	Labungka	22.0	6.0	RC Flat Slab	Steel Tubular Pile	106.6
	No.16	Tolie	22.0	6.0	RC Flat Slab	Steel Tubular Pile	148.0
	No.17	Wakorumba	36.0	6.0	RC Girder	Steel Tubular Pile	124.0
	Subtotal		180.0	—	—	—	931.6
Total			338.0	—	—	—	1,638.1

With regards to environmental certificate, Southeast Sulawesi Provincial Environmental Management Office (BLH) has required to submit Environmental Management Plan (UKL) and Environmental Monitoring Plan (UPL) for the Project. The UKL and UPL were submitted by the Directorate General of Highways and the environmental approval (Recommendation) has been issued. With regards to land acquisition necessary for the construction of Project bridges, agreement has been made between the land owners and the related parties. Neither resettlement/removal of house nor relocation of utilities is necessary for the Project.

Directorate General of Highways and the environmental approval (Recommendation) has been issued. With regards to land acquisition necessary for the construction of Project bridges, agreement has been made between the land owners and the related parties. Neither resettlement/removal of house nor relocation of utilities is necessary for the Project.

4. Project Period and Rough Cost Estimate

In case the project is implemented, the detailed design (including tendering) will take 7.0 months and the construction will take 14.0 months for Stage-1, and the detailed design will take 4.0 months and the construction will take 14.5 months for Stage-2. The Project will be implemented in accordance with the Japan's Grant Aid scheme and the cost will be determined before concluding the Exchange of Notes (E/N) for the Project.

5. Project Evaluation

The direct beneficiaries of the project are the residents in the transmigration area in Southeast Sulawesi Mainland and along Buton South-North Road with a population of approximately 100,000, whereas the indirect beneficiaries are the people of Southeast Province (Approximately 2,000,000).

(1) Direct Effects

- The people in the Project area become accessible to the towns/markets anytime to sell their agricultural products, buy goods and receive social services by construction of permanent bridges over the ford crossings which are impassable during raining.

- The transportation system becomes more efficient by replacement of timber bridges and temporary bridges which are only passable for pedestrians, motorbikes, and light vehicles (lighter than 0.5 ton) with permanent bridges which are passable for any vehicles even 20 ton trucks.

- Traffic safety will be secured by the construction of bridges under Project since accidents are commonly occurred when vehicles and motorbikes crossing deep fords and/or passing on broken wooden deck slabs.

(2) Indirect Effects

- As the Project bridges in transmigration area are constructed, the roads connected to the bridges will be improved by Indonesian side. The road and bridge improvement makes the road network more convenient and reliable to pass throughout the years for any vehicles. The improvement of the transportation condition will promote realization of the local industrial potentials. As the result, it is expected to mitigate the poverty in the area and to activate the socio-economic activities in the province.

- As the Project bridges in Buton Island are constructed, the ferry terminals and their access roads will be constructed/improved by Indonesian side. The new ferry route connects Kendari (the provincial capital) and Baubau (the biggest city in Buton Island) with shorter distance and travel time. The improvement of the transportation condition is expected to promote the economic development in the province.
- The Project improves the road network and provides detours to be used when a disaster close a road.

6. Recommendations

Since the project will make significant effects as mentioned above and contribute to the improvement of the residents' living condition, the project will be worth being implemented under the Japan's grant aid.

In order to realize, enlarge and sustain the effects of the Project, responsibilities to be undertaken by the Indonesian side are as follows:

- To replace the small timber/temporary bridges along the Project roads with permanent bridges and to improve their access roads before the completion of the Project bridges.
- To start the ferry service operation between Labuan and Amolengu as the completion of the Buton South-North Road improvement.
- To adequately carry out maintenance and repair works to keep the road and bridges in good condition and in order to maximize their serviceable lives.

Table of Contents

Preface
Letter of Transmittal
Summary
Table of Contents
Location Map / Perspective
List of Figures & Tables
Abbreviations

Page

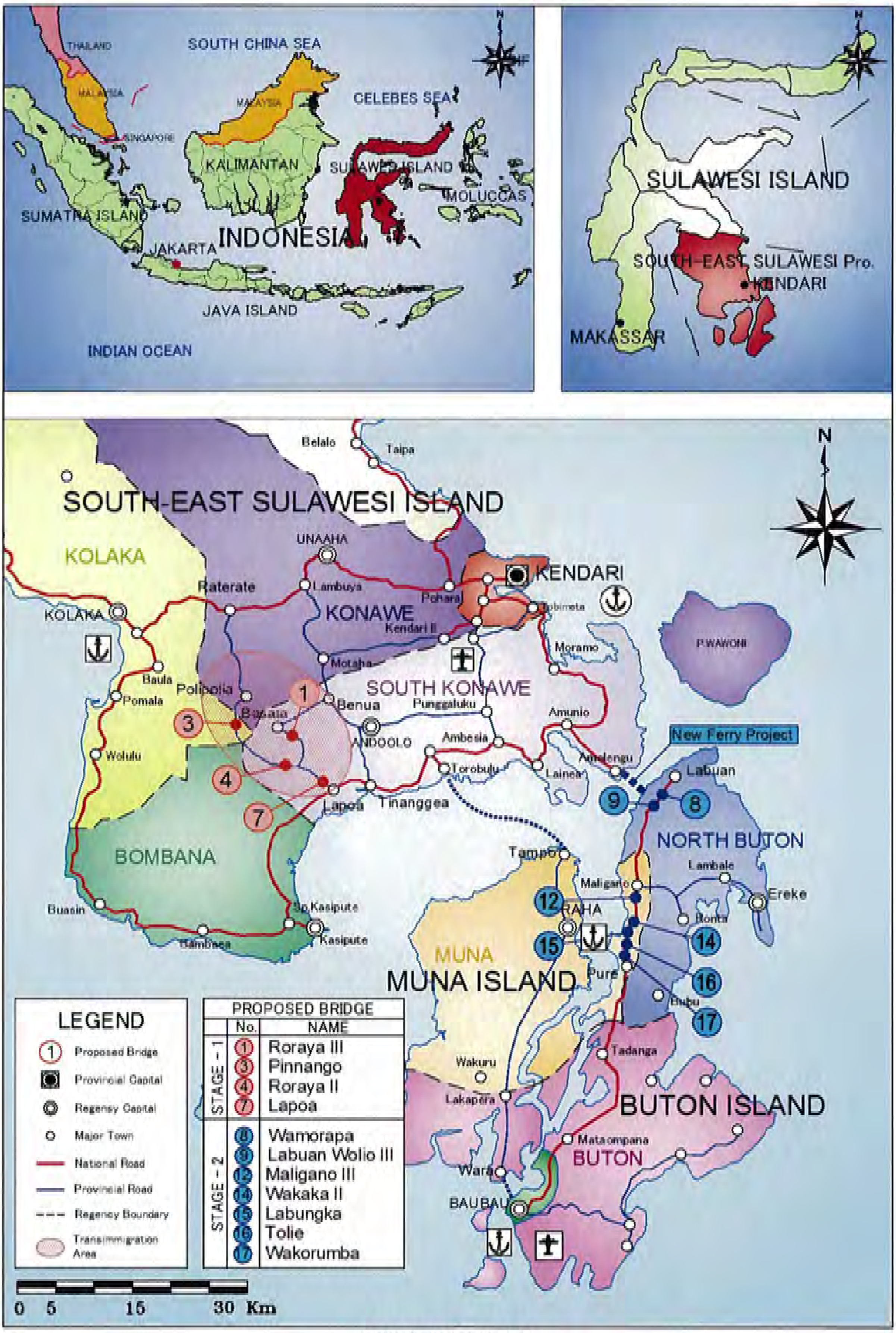
CHAPTER 1 BACKGROUND OF THE PROJECT 1-1
1.1 BACKGROUND, HISTORY AND OUTLINE OF THE PROJECT 1-1
1.2 NATURAL CONDITIONS 1-2
1.3 PROJECT ROAD CONDITIONS 1-6
1.4 TRAFFIC CONDITION 1-8
1.5 ENVIRONMETNAL AND SOCIAL CONSIDERATIONS 1-10

CHAPTER 2 CONTENTS OF THE PROJECT 2-1
2.1 BASIC CONCEPT OF THE PROJECT 2-1
2.1.1 Overall Goal and Project Purpose 2-1
2.1.2 Outline of the Project 2-1
2.2 OUTLINE DESING OF THE JAPANESE ASSISTANCE 2-2
2.2.1 Design Concept of the Project 2-2
2.2.1.1 Scope of the Japanese Assistance 2-2
2.2.1.2 Design Concepts 2-2
2.2.1.3 Environmental and Social Consideration Policy 2-4
2.2.2 Outline Design 2-6
2.2.2.1 Design Standards and Criteria 2-6
2.2.2.2 Bridge Structures 2-9
2.2.2.3 Bridge Planning 2-15
2.2.3 Outline Design Drawings 2-33
2.2.4 Implementation Plan 2-182
2.2.4.1 Implementation Policy 2-182
2.2.4.2 Implementation Condition 2-185
2.2.4.3 Scope of Works 2-186
2.2.4.4 Consultant Supervision Plan 2-187
2.2.4.5 Quality Control Plan 2-188
2.2.4.6 Procurement Plan 2-189
2.2.4.7 Implementation Schedule 2-190

2.3 OBLIGATION OF THE GOVERNMENT OF INDONESIA 2-191
2.4 PROJECT OPERATION AND MAINTENANCE PLAN......................................2-192
2.5 PROJECT COST ESTIMATION 2-193
2.5.1 Initial Project Cost..2-193
2.5.2 Maintenance Cost 2-194
2.6 OTHER RELEVANT ISSUES...2-195

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS............................3-1
3.1 PROJECT EFFECTS...3-1
3.2 RECOMMENDATIONS 3-2

［Appendices］
1. Member List of the Survey Team
2. Survey Schedule
3. List of Parties Concerned in the Recipient Country
4. Minutes of Discussions
5. References
6. Environmental Approval (Recommendation) on UKL & UPL and English Translation
7. Land Acquisition Agreement
8. Traffic Survey Data
9. Road Condition Diagram of the Project Related Roads



LOCATION MAP

Perspective (No.17 Wakorumba Bridge)

List of Figure & Table

<Figure> *Page*

Figure 1.2-1 Average Monthly Rainfall in Kendari and Baubau 1-3
Figure 1.3-1 Major Road Network in Southeast Sulawesi Province and Road Condition 1-6
Figure 1.4-1 Location of Traffic Count Stations 1-8
Figure 1.5-1 UKL &UPL Procedure 1-11
Figure 2.2-1 A Scheme of Future Widening of Bridges along Buton South-North Road 2-7
Figure 2.2-2 Typical Cross Section of Bridge Approach Roads 2-9
Figure 2.2-3 Flowchart of Selection of Superstructure Type 2-11
Figure 2.2-4 Construction Equipment Transportation Plan (using 15-ton truck) 2-183
Figure 2.2-5 Portable Crushing Plant Layout 2-183
Figure 2.2-6 Portable Concrete Mixing Plant Layout 2-184
Figure 2.2-7 Pile Driving using Rafterrain Crane, Vibro-Hammer and Diesel Hammer 2-184
Figure 2.2-8 A Sample of Concrete Pouring Sequence of Integral Type Bridge 2-186

<Table>

Table 1.1-1 Bridge List 1-2
Table 1.2-1 Establishment of Design Flood Levels 1-4
Table 1.2-2 Calculation of Peak Discharge 1-4
Table 1.4-1 Summary of Present Traffic Volume 1-8
Table 1.4-2 Assumptions in Future Traffic Forecast 1-9
Table 1.4-3 Forecasted Future Traffic Volume 1-9
Table 2.1-1 Project Bridge List 2-2
Table 2.2-1 Land Acquisition for the Project 2-5
Table 2.2-2 Probable Negative Impacts and Mitigation Measures 2-5
Table 2.2-3 Proposed Bridge Widths 2-6
Table 2.2-4 Geometric Standard of Bridge Approach Road 2-8
Table 2.2-5 Feature of 3 Types of RC Bridges for Short Span Bridges 2-9
Table 2.2-6 Feature of 2 Types of Bridges for Long Span Bridges 2-10
Table 2.2-7 Feature of Common Pile Foundation Type 2-12
Table 2.2-8 Common Type of Abutment Protection/Riverbank Protection and Features 2-13
Table 2.2-9 Comparison of Countermeasures at End of Riverbank Protection at Upstream Side 2-14
Table 2.2-10 (1/4) Planning of Project Bridges 2-18
Table 2.2-10 (2/4) Planning of Project Bridges 2-19
Table 2.2-10 (3/4) Planning of Project Bridges 2-20
Table 2.2-10 (4/4) Planning of Project Bridges 2-21

Table 2.2-11(1/11)	Comparison of Superstructure Type and Span Arrangement (No.1 Roraya III Bridge)	2-22
Table 2.2-11(2/11)	Comparison of Superstructure Type and Span Arrangement (No.3 Pinnango Bridge)	2-23
Table 2.2-11(3/11)	Comparison of Superstructure Type and Span Arrangement (No.4 Roraya II Bridge)	2-24
Table 2.2-11(4/11)	Comparison of Superstructure Type and Span Arrangement (No.7 Lapoa Bridge)	2-25
Table 2.2-11(5/11)	Comparison of Superstructure Type and Span Arrangement (No.8 Wamorapa Bridge)	2-26
Table 2.2-11(6/11)	Comparison of Superstructure Type and Span Arrangement (No.9 Labuan Wolio Bridge)	2-27
Table 2.2-11(7/11)	Comparison of Superstructure Type and Span Arrangement (No.12 Maligano III Bridge)	2-28
Table 2.2-11(8/11)	Comparison of Superstructure Type and Span Arrangement (No.14 Wakaka II Bridge)	2-29
Table 2.2-11(9/11)	Comparison of Superstructure Type and Span Arrangement (No.15 Labungka Bridge)	2-30
Table 2.2-11(10/11)	Comparison of Superstructure Type and Span Arrangement (No.16 Tolie Bridge)	2-31
Table 2.2-11(11/11)	Comparison of Superstructure Type and Span Arrangement (No.17 Wakorumba Bridge)	2-32
Table 2.2-12	Major Components of the Project	2-33
Table 2.2-13	Responsibilities of Both Governments	2-186
Table 2.2-14	Quality Control Plan for Concrete Work	2-188
Table 2.2-15	Quality Control Plan for Earthwork and Pavement Work	2-188
Table 2.2-16	Quality Control Plan for Plate Girder Fabrication Work	2-188
Table 2.2-17	Material and Equipment Procurement Plan	2-189
Table 2.2-18	Implementation Schedule	2-190
Table 2.5-1	Maintenance Works and Annual Cost of 4 Project Bridges in Mainland of South-North Sulawesi (Provincial Road)	2-194
Table 2.5-2	Maintenance Works and Annual Cost of 7 Project Bridges along Buton South-North Road (National Road)	2-194

Abbreviations

AASHTO	: American Association of State Highway and Transport Officials
AC	: Asphalt Concrete
AMDAL	: Environmental Impact Assessment (Analisis Mengenai Dampak Lingkungan Hidup)
BAPEDAL	: Environmental Impact Management Agency (Badan Pengendalian Dampak Lingkungan)
BAPEDALDA	: Regional Environmental Impact Management Office (Badan Pengendalian Dampak Lingkungan Daerah)
BLT	: Regional Environmental Impact Management Office (Southeast Sulawesi Province (Bandan Lingkungan Hidup)
DGH	: Directorate General of Highways
EIA	: Environmental Impact Assessment
E/N	: Exchange of Note
G/A	: Grant Agreement
GDP	: Gross Domestic Products
GOI	: Government of Indonesia
GOJ	: Government of Japan
GRDP	: Gross Regional Domestic Products
JIS	: Japan Industrial Standards
M/D	: Minutes of Discussions
MFL	: Maximum Flood Level
Mpa	: Mega Pascal
MPW	: Ministry of Public Works
ODA	: Official Development Assistance
PAPs	: Project Affected Persons
PC	: Prestressed Concrete
RC	: Reinforced Concrete
ROW	: Right-of-Way
Rp	: Rupiah (Indonesian currency)
Sta.	: Station
UKL	: Environmental Management Plan (Upaya Pengelolaan Lingkungan Hidup)
UPL	: Environmental Monitoring Plan (Upaya Pemantauan Lingkungan Hidup)

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 BACKGROUND, HISTORY AND OUTLINE OF THE PROJECT

Sulawesi Island comprises 6 provinces which are less developed in comparison with the central and western regions of Indonesia. The GDP per capita of the island is Rp 6.1M while the national average is Rp 10.7M. To mitigate the regional socio-economic imbalance, accelerating development activities in the eastern regions of Indonesia is a major issue in the national development.

Southeast Sulawesi is the least developed province in Sulawesi Island. Furthermore, there are still many villages isolated from educational and medical services as well as experiencing difficulties in transporting their agricultural products to the markets due to the bad road condition, particularly in rainy season, and inadequate capacity of existing temporary bridges.

To overcome this adverse condition, the Government of Indonesia (GOI) with Southeast Sulawesi Provincial Government has been making efforts to improve the road condition. However, many roads still remain in poor condition since improvement of existing temporary bridges is difficult due to financial and technical constraints.

The GOI and the Provincial Government of Southeast Sulawesi selected 47 temporary bridges (timber and bailey bridges longer than 20 m) along the roads which are important for regional development. The GOI then formulated the Project for the Improvement of Bridges in South-East Sulawesi Province (hereinafter referred to as the Project) and requested to the Government of Japan (GOJ) for assistance to construct 22 bridges among the 47 bridges identified as above for the first phase of the Project.

In response to the request, a preliminary study on the project was conducted by a JICA study team from July to August 2008. In the study, the site conditions of the requested bridges were surveyed and their necessity, urgency and appropriateness of the project were evaluated. In the field survey, it was found that 6 of the requested bridges were under construction and consequently other 3 bridges were then additionally requested to be included in the study.

As a result of the preliminary study, the 11 bridges (4 bridges along Transmigration Area Road on Sulawesi Mainland and 7 bridges along Buton South-North Road on Buton Island) were selected for the further study. The bridge list is shown in Table 1.1-1.

Table 1.1-1 Bridge List

Location	Regency	Bridge No.	Bridge Name	Existing Bridge		Bridge Length Proposed in Preliminary Study(m)
				Bridge Type	Length(m)	
Transmigration Area Road on Sulawesi Mainland	South Konawe	1	Roraya III	Bailey	42.0	42.0
	Kolaka	3	Pinnango	Bamboo	21.5	22.0
	South Konawe	4	Roraya II	Bailey	62.0	62.0
	South Konawe	7	Lapoa	Timber (Collapsed)	20.5	22.0
Buton South-North Road on Buton Island	North Buton	8	Wamorapa	Timber	18.5	22.0
	North Buton	9	Labuan Wolio III	Timber	15.5	22.0
	Muna	12	Maligano III	Bailey	30.5	31.0
	Muna	14	Wakaka II	Timber	15.0	22.0
	Muna	15	Labungka	Timber	8.0	22.0
	Muna	16	Tolie	Timber	8.5	22.0
	Muna	17	Wakorumba	Bailey	27.0	30.0
				Total	269.0	319.0

Following the preliminary study, the GOJ decided to conduct a Preparatory Survey (hereinafter referred to as the Survey) and JICA sent the Survey Team to reconfirm the necessity and appropriateness of the Project, finalize the bridge list for the Project, prepare outline design of the bridge facilities, prepare the implementation plan and estimate the project cost.

1.2 NATURAL CONDITIONS

(1) Climate

Southeast Sulawesi Province is surrounded by sea, therefore, the temperature does not vary much throughout the years. May to September is relatively cool and the lowest temperature is about 20℃. While, October to April is relatively warm and the highest temperature is about 35℃.

The annual rainfall in Southeast Sulawesi is about 1,600mm. The rainy season is from November to June, and the dry season is from July to October. The average monthly rainfall in Kendari and Baubau is shown in Figure 1.2-1.

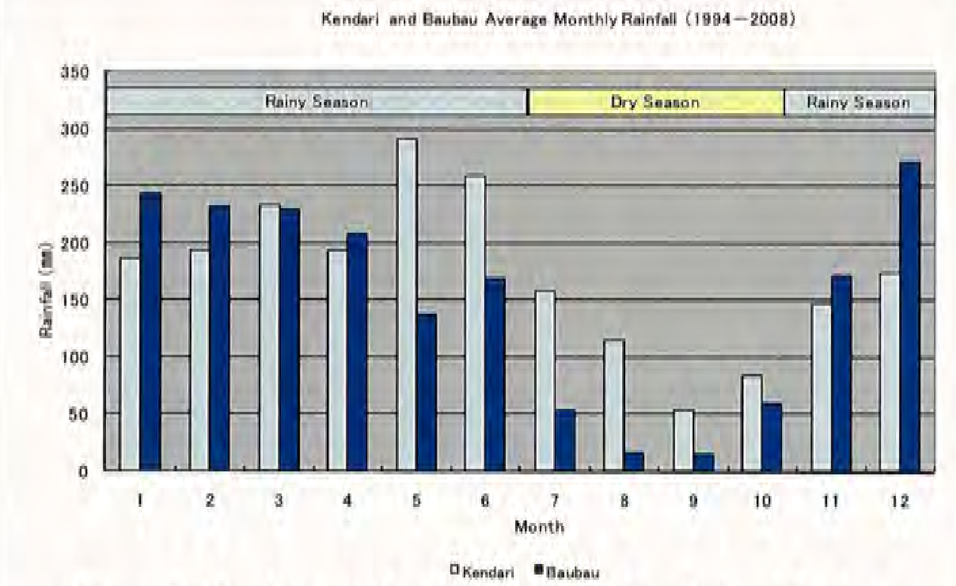


Figure 1.2-1 Average Monthly Rainfall in Kendari and Baubau

(2) Hydrology

Hearing survey on maximum flood levels

Hearing survey on the maximum flood levels at every project bridge sites was made by the Survey Team. The hearing was made to many people who reside around the sites. The maximum flood levels identified from the hearing survey are shown in Table 1.2-1. Since the rivers are winded severely, floods overflow from the rivers and inundate around the sites. Therefore, the design flood level was determined based on the maximum flood levels identified from the hearing survey. However, the hydrologic analysis was conducted to obtain the analyzed flood level (50-year return period) to clarify the accuracy of the design flood levels based on the hearing survey.

Hydrologic Analysis

The daily rainfall of 50-year return period of Southeast Sulawesi Mainland Transmigration Area and Buton Island South-north Road Area were analyzed based on the daily rainfall data from 1994 to 2008 surveyed at Kendari Airport and Baubau Airport. The peak discharges were calculated based on the rainfall and hydrologic and topographic conditions. The calculation of the peak discharges are shown in Table 1.2-2. The analyzed flood levels were derived from the hydrologic analysis based on the data of the peak discharges and the river conditions. The analyzed flood levels are shown in Table 1.2-1.

Table 1.2-1 Establishment of Design Flood Levels

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
						(d)+(e)	
	Hearing MFL (El.m)	Width of Waterway (m)	Bridge Length (m)	Riverbed Elevation (El.m)	Discharge Depth (m)	Analyzed MFL (El.m)	Design HWL (El.m)
1 Roraya III	28.970	68.20	50.00	23.400	5.40	28.800	28.970
3 Pinnango	47.850	26.60	22.00	44.700	3.10	47.800	47.850
4 Roraya II	24.800	56.40	64.00	18.000	6.60	24.600	24.800
7 Lapoa	11.450	20.00	22.00	7.500	2.50	10.000	11.450
8 Wamorapa	1.140	26.00	22.00	-1.400	2.50	1.100	1.140
9 Labuan Wolio II	3.500	22.80	22.00	1.100	2.30	3.400	3.500
12 Maligano III	5.300	35.60	32.00	1.200	3.90	5.100	5.300
14 Wakaka II	8.950	23.80	24.00	6.000	2.20	8.200	8.950
15 Labungka	11.310	21.00	20.00	9.700	1.50	11.200	11.310
16 Tolie	1.620	22.00	20.00	-2.100	3.00	0.900	1.620
17 Wakorumba	9.150	26.00	36.00	5.400	3.50	8.900	9.150

Table 1.2-2 Calculation of Peak Discharge

Bridge No.	Catch-ment Area (km2)	River Length (km)	Bridge Elevation (El.m)	Origin Elevation (El.m)	Elevation Gap (m)	Slope		Concentration Time (hour)	50 year Daily (Rainfall) (mm/day)	Rainfall Intensity (Mononobe) (mm/hr)	Runoff Coefficient	Peak Discharge (m3/sec)	Unit Discharge (m3/km2)
1	522.5	95	23.43	600	576.57	0.006069	1/165	28.22	151.85	5.68	0.7	577	1.10
3	64	35	44.613	560	515.387	0.014725	1/68	6.11	151.85	15.75	0.7	196	3.06
4	562.5	110	18.07	600	581.93	0.00529	1/189	35.48	151.85	4.88	0.7	534	0.95
7	32	15	7.196	30	22.804	0.00152	1/658	10.22	151.85	11.18	0.7	70	2.19
8	12.8	10	12	700	688	0.0688	1/15	0.69	188.04	83.32	0.7	207	16.17
9	6.6	6	12	500	488	0.081333	1/12	0.38	188.04	125.24	0.7	161	24.39
12	17.6	6.5	4	200	196	0.030154	1/33	0.74	188.04	79.84	0.7	273	15.51
14	5.7	4	6	300	294	0.0735	1/14	0.27	188.04	157.6	0.7	175	30.70
15	2.8	4	6	400	394	0.0985	1/10	0.22	188.04	177.18	0.7	96	34.29
16	4.7	2.5	6	50	44	0.0176	1/57	0.39	188.04	121.71	0.7	111	23.62
17	17.8	10	6	370	364	0.0364	1/27	1.01	188.04	64.59	0.7	224	12.58

(3) Topography and Geology

Transmigration Area Road on Sulawesi Mainland

The sites of bridges No.1, 4 and 7 locate on low land which is the on-land sediment formed by degressive and upheaval movements after rivers had carried fine-grained materials to the sea and deposited on the sea bottom for over several ten thousand years under gentle weather condition. The top portion of the deposit remains unconsolidated, while the deep portion of the deposit has become semi-consolidated silt rock by "diagnosis" (forming sedimentary rock by pressure and cementation). The top soft deposit has been eroded by water currents and formed rivers. The river alignments have been stable. The rivers have occasionally become deeper by downward erosion and filled up with river-bottom sediments, and this phenomena depends on the weather condition. The river alignments have changed when floods were strong, however, the present river alignments seem stable for several hundred years. The Bridge No.3 locates on relatively high land where the alluvial plain spreads widely and there is no marine-deposited silt bed because the area had become land earlier than the above. The Alluvial deposit consists of mostly silty materials which has been formed by repeated light floods. Under the alluvial deposit, there are older deposits composed of various materials such as gravel, sand, silt and clay which have been accumulated under unstable weather condition.

Buton South-North Road (Northwestern part of Buton Island)

The bridges No. 8 to 17 locate northwestern part of Buton Island. In Northern Buton, mountains exist near the coast of the island and a wide plain was formed in the center of Northern Buton. Narrow coastal plain runs along the northwestern coast of the island. The width of the coastal plain is several hundred meters. The rivers are originated in the western mountains and flowing into the sea. The rivers are mostly short, however, some of the rivers which flow northward or southward in the mountainous area then turn to westward to the sea are 7 to 10 km long. The river slopes are very steep in the mountains section while they are very gentle in the coastal section. The river alignments are winding in the coastal section. Large floods overflow from the rivers and spread over on the coastal plains.

The geological features are different between south and north of the bridge sites. The southern bridges No. 12 to 17 locate on the skirt of the mountains composed of mostly upheaved coral reef limestone. In the period of transgression, the coral reefs were piled up many times to form high cliffs of 60~100m. The gravels at those bridge sites contain both flood deposits and fragments of the coral reef limestone. The southern sites are also characterized by thick marine sediments mostly composed of fine grained materials such as silt and clay which exist beneath the riverbed deposits.

The rivers had carried only fine grained materials to the sea under gentle weather condition for several thousand years to pile up thick silty/clayey bed on the sea bottom. After the degression, flood deposits covered the above sediment under violent weather condition in the past hundreds years.

The bridges No. 8 and 9 locate in the northern area where coral reef limestone is not found. The mountains consist of mostly old sandstone and metamorphic rocks of chert, slate and others. Boulder, pebble and gravel in the riverbed are mostly metamorphic rocks. Since the upheaval of the northern area was greater than the southern area, the semi consolidated silt/gravel alternation and silt rock are exposed at the cut slope of the hills near the shore. Young and soft portions of the riverbed have been washed away and remained boulders only.

1.3 PROJECT ROAD CONDITIONS

(1) Project Road Conditions

Major road network in Southeast Sulawesi Province is shown in Figure 1.3-1. The outline condition of the major roads is also shown in the figure. The detailed conditions of the roads connecting the Project bridges are shown in Appendix-9.

Figure 1.3-1 Major Road Network in Southeast Sulawesi Province and Road Condition

<u>Transmigration Area Road on Mainland Southeast Sulawesi</u>

The Project bridges are located on Raterate –Lapoa Road: 74km (Provincial Road) and Benua – Lapoa Road: 23km (Regency Road). Along these roads there are many towns and villages transmigrated from mostly Jawa and Bali. The major products in the area are cacao, paddy, orange and others. The population and agricultural production in the area have successfully expanded, however it is difficult to sell the products due to the transportation problem. The road connecting the areas with the national roads is difficult to pass for common vehicles due to existence of ford crossings, timber bridges and wooden deck bailey bridges and unpaved road sections. Such road condition is obstructing the economic activities in the area. Also the people in the area are limited to access to the social services due to the difficulty of the transportation to the facilities such as hospitals, high school and markets.

Buton South-North Road

Baubau – Labuan Road: 174km (national road) runs from southern largest city Baubau to northern town Labuan along the west coast of the island. Along the road, many towns and villages are located and producing cashew, coconut, cacao, paddy and other agricultural products. Fishery is also the major industry in the area. The Project bridges are located in the northern section of the road where ford crossings, timber bridges and wooden deck bailey bridges exist and are impassable for common vehicles. Also the unpaved mountainous road sections are impassable for vehicle during raining. Such road condition is obstructing the economic activities in the area. Also the people in the area cannot receive social services due to the difficulty of the transportation to the social facilities.

(2) Project Roads Improvement Schedule

Transmigration Area Road on Mainland Southeast Sulawesi

The Public Work Office of Southeast Sulawesi Provincial Government has planned to improve the Raterate – Lapoa Road with the following schedule:

- -2009: Pavement with asphalt concrete (AC) (13.7km), installation of base course (24.5km) and replacement of timber bridges with concrete bridges/box culverts (10 bridges)
- -2010: Replacement of timber bridges with concrete bridges (10 bridges) and improvement of all timber bridges to be passable for heavy vehicles.
- -2011: Pavement with AC (20km)

Buton South-North Road

The Directorate General of Highways of the Ministry of Public Work has planned to improve the Baubau – Labuan Road with the following schedule:

- -2009: Pavement with AC for Pure – Maligano Section (30km)
- -2010 and 2011: Pavement with AC for Maligano – Labuan Section (35km), replacement of all timber bridges (20 bridges) with concrete bridges/box culverts and rehabilitation of damaged bituminous surface treatment by paving with AC for Baubau – Pure Section (105km)

The ferry terminal construction project which connects Labuan (Northern tip of Buton Island) and Amolengu in Mainland (opposite side of Labuan) is scheduled to be completed before the end of 2012. The Mainland side access road (Amolengu – Moramo Section: approx. 50km) is unpaved. The Directorate General of Highways of the Ministry of Public Work has planned to improve Amolengu – Moramo Section by paving with AC before the end of 2012.

(3) Ferry Terminal Construction Schedule

The ferry terminal construction project is being implemented by the Ministry of Transportation. The implementation schedule of the project is as follows:

-2008: Detailed design of the ferry terminal facilities
-2010: Land acquisition, work preparation and construction of approach roads
-2011: Start of construction of the terminals and office facilities
-2012: Completion of the ferry terminal and facilities
-2013: Start of operation of ferry service (by a public ferry operation company)

1.4 TRAFFIC CONDITION

(1) Present Traffic Volume

A traffic count survey at the Project bridge sites and related road sections were conducted during the site survey. The locations of the traffic count stations are shown in Figure 1.4-1. The Survey data is shown in Appendix 8. The summary of the result is shown in Table 1.4-1.

Figure 1.4-1 Location of Traffic Count Stations

Table 1.4-1 Summary of Present Traffic Volume

Traffic Count Station		ADT
Mainland	Bridge No.1	303
	Bridge No.3	396
	Bridge No.4	455
	Bridge No.7	395
	Terunate (Prov'l Rd)	1,608
	Lapoa (Nation'l Rd)	1,909
Buton Island	Bridge No.8	88
	Bridge No.12	504
	Bridge No.15	303
	Bridge No.17	186

(2) Future Traffic Volume Forecast

The future traffic volumes as of 2013 (scheduled completion date of the Project), 2023 (10 years after) and 2033 (20 years after) were forecasted. The future traffic volumes were forecasted based on the assumptions shown in Table 1.4-2. The forecasted future traffic volumes are shown in Table 1.4-3.

Table 1.4-2 Assumptions in Future Traffic Forecast

Road	Bridge	Assumption of Traffic Volume Change
Raterate – Lapoa Road	No.3 ~7	(1) Presently, travel time between Lapoa and Kolaka along the west coast route (230km) is about 8 hours. After this Project, travel time between Lapoa and Kolaka via Raterate (125 km) become about 4 hours. Therefore, the traffic between Kolaka and Lapoa, which is assumed to be 15% of traffic counted at Lapoa (national road) will shift the route to take through Raterate – Lapoa. (1909 x 0.15 = 286 veh./day) (2) The areas presently without passable roads become generate the traffic after the project. The traffic volumes per population of the area become same as the area where road is passable (e.g. Traffic volume at Raterate (1608) ÷ Population of Raterate and Polipolia (26933) = 0.06 (veh. / population) (3)Traffic volume will increase annually in accordance with the regional economic growth rate (5%).
Benua – Lapoa Road	No.1	Same as (2) and (3) above
Buton South-North Road	No.8 ~17	(1)When the completion of this Project, the ferry service between Labuan and Amolengu will start the operation. Presently travel time between Baubau and Kendari is about 12 hours, while, it will be shortened to 8 hours through the new ferry route. Therefore, about 50 % of ferry traffic between Bubau and Muna (295 veh./day) will shift to pass the new ferry route (about 150 veh./day)/ Same as (2) and (3) above

Table 1.4-3 Forecasted Future Traffic Volume

Location		Present Traffic (Veh./day)	Population in Affected Area	2013 (Veh./day)	2023 (Veh./day)	2033 (Veh./day)
Mainland	Bridge No.1	303	6,338	380	620	1,008
	Bridge No.3	396	7,778	735	1,199	1,950
	Bridge No.4	455	7,778	735	1,199	1,950
	Bridge No.7	395	7,778	735	1,199	1,950
Buton Island	Bridge No.8	88	3,946	237	386	627
	Bridge No.9	-	3,946	237	386	627
	Bridge No.12	504	7,000	570	929	1,511
	Bridge No.14	-	6,670	550	897	1,458
	Bridge No.15	303	6,340	530	865	1,406
	Bridge No.16	-	6,340	530	865	1,406
	Bridge No.17	186	6,340	530	865	1,406

1.5 ENVIRONMETNAL AND SOCIAL CONSIDERATIONS

(1) Environmental and Social Consideration Law and Regulations

Environmental Law

In Indonesia, Environmental Management Law which is the first general and comprehensive law to manage the environmental issues was legislated in 1982. Then it was revised as New Environmental Management Law (Law No.23) in 1997.

Ministry of Environment

Ministry of Environment is the responsible ministry to manage the environmental administration and coordination. The environmental aspect of natural resources management is also the responsibility of the Ministry.

Environmental Management Agency (BAPEDAL)

BAPEDAL was established in 1998 directory under the Environmental Minister to propose rules and regulations in the environmental administration and to recommend environmental impacts for preservation of the environment and prevention from pollutions and other general environmental issues. BAPEDAL has regional offices (BAPEDALDA) in each province. (In Southeast Sulawesi, it is called BLT instead of BAPEDALDA)

Environmental Impact Assessment (AMDAL)

Environmental impact assessment (AMDAL) is regulated under the Law No. 27 in 1999. BEPEDALDA decides whether detailed AMDAL is necessary or not for project implementations. In case the detailed AMDAL is not required, submission of Environmental Management Plan (UKL) and Environmental Monitoring Plan (UPL) to BAPEDALDA/BLT is required.

UKL & UPL Procedure

The procedure of preparation, evaluation and approval of UKL & UPL is shown in Figure 1.5-1.

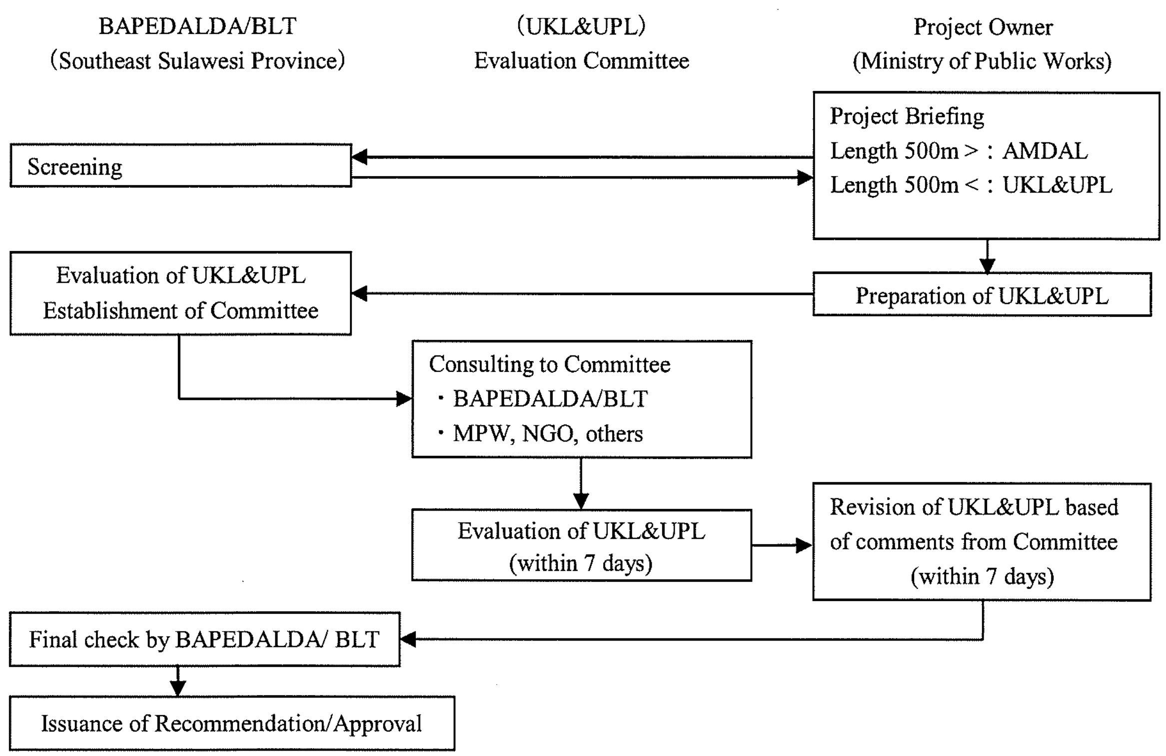


Figure 1.5-1 UKL &UPL Procedure

(2) Land Acquisition Law and Regulations

<u>Land Acquisition Law</u>

Land Acquisition Law in public works was regulated in No.36 in 2005. The law regulates the compensation procedures for land acquisitions in order to implement the public works.

<u>Land Acquisition Committee</u>

Mayor (bupati) is the chairman of the land acquisition committee in case the land area to be acquired is within a regency. In accordance with the law and regulation, the acquired land will be compensated with payment, provision of alternative land or other ways depends on the negotiation with the related parties.

<u>Land Acquisition Procedure</u>

Land acquisition procedure is regulated in Land and Asset Law No.3 in 2007. The land acquisition shall be coordinated among project owner, regency government, land acquisition committee, provincial land and asset office. In case the land is small (less than 1 ha), the land acquisition shall be negotiated between the project owner and the land owner.

<u>Environment Related Laws and Regulations</u>

Environmental laws and regulations related to sewage, water supply, air quality, noise, vibration and others are legislated in Indonesia. The works of the Project is deemed not to cause any considerable environmental impact.

(3) The Project Environment

Land use

The Project sites are surrounded by agricultural farms of paddy, cacao, cashew, banana and others or secondary forest. There are no remain, cultural heritage, religious facility and graveyard in the Project area.

Utilization of River Water

The river water is commonly used for washing clothes but not for drinking.

Resettlement and Land Acquisition

No resettlement will be necessary for the Project implementation. For the construction of new bridge approach roads, land acquisition will be necessary. (The detail is explained in Section 2.2.1.3.)

Sanctuary

There are 13 provincial sanctuaries and one national park (Rawa Aopa Watumohai) in Southeast Sulawesi Province, however, no Project bridge locates inside the sanctuary or the national park.

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 BASIC CONCEPT OF THE PROJECT

2.1.1 Overall Goal and Project Purpose

(1) Overall Goal

Major objectives of the National/Regional Development related to the Project are as follows:

- To develop infrastructures that boost up economic activities in underdeveloped regions to mitigate regional imbalances.
- To accelerate the development in eastern regions where socio-economic conditions are low.
- To develop road networks in eastern provinces of Sulawesi where the road network is less developed.

(2) Project Purpose

The major purposes of the Project are as follows:

- To construct safe and reliable roads and bridges in the areas where the socio-economic development is lagging due to lack of transportation means.
- To support the transmigration policy by providing effective transportation means in the transmigration areas
- To improve the regional road network which is the basic condition for the regional development

2.1.2 Outline of the Project

The Project aims to improve the following roads which are impassable or dangerous to pass for common vehicles because there are many temporary timber bridges and bailey bridges. The roads become impassable when it rains because the most sections of the roads are unpaved.

<u>The Project Roads</u>

- Raterate – Lapoa Road (74 km) which runs through the transmigration area in the mainland of Southeast Sulawesi Province (Provincial Road)
- Benua – Lapoa Road (23 km) which branches out from Raterate Lapoa Road and connects with other provincial road (Regency Road)
- Buton South-North Road (174 km) which runs from Baubau to Labuan along the west coast of Buton Island (National Road)

There are many temporary timber and bailey bridges along the Project roads. The relatively long bridges (A total of 11 bridges which are longer than 22m) are proposed to be constructed under Japanese assistance since the construction of them are difficult for Indonesian side due to the constraints of fund and technology. While the other relatively small bridges are proposed to be constructed by Indonesian side. The Project bridge list for Japanese assistance is shown in Table 2.1-1.

Table 2.1-1 Project Bridge List

Location	Road Name	Bridge No.	Bridge Name
Southeast Sulawesi Mainland	Benua – Lapoa Road	1	Roraya III
	Raterate – Lapoa Road	3	Pinnango
		4	Roraya II
		7	Lapoa
Buton Island	Buton South-North Road (Baubau– Labuan Road)	8	Wamorapa
		9	Labuan Wolio III
		12	Maligano III
		14	Wakaka II
		15	Labungka
		16	Tolie
		17	Wakorumba

2.2 OUTLINE DESING OF THE JAPANESE ASSISTANCE

2.2.1 Design Concept of the Project

2.2.1.1 Scope of the Japanese Assistance

The scope of the Japanese assistance includes the construction of the following structures of the 11 Project bridges:

- Bridge structures
- Approach roads (Minimal length to connect the new bridge with the existing road)
- Abutment protections and riverbank protections (Minimal areas to protect the new bridges)
- Temporary detour road (if necessary for the new bridge construction)
- Removal of existing bridge (if necessary for the new bridge construction)

2.2.1.2 Design Concepts

(1) Consideration for Natural Conditions

In the bridge planning and designing, the natural site conditions such as topographical condition, geological condition, river condition and seismic condition are taken into consideration. The design flood levels are determined by comparison between the floods levels obtained from hearing / observation survey and from hydraulic analysis with 50-year return period probability. The seismic load is adopted from the seismic bridge design guideline issued by the Ministry of Public Works of Indonesia. The bridges close to the sea should be considered counter-measures for salt water.

(2) Consideration for Socio-economic Condition

The bridge widths are referred to the design standards of the Ministry of Public Works of Indonesia. However, their appropriateness against present and future traffic volume should be examined. Revision of the width should be proposed where the standard width deems inappropriate. The road width, the pavement structure and the geometric standards of the bridge approach roads are adopted from the design of the Project roads which have been improved by the Indonesian side. The appropriateness of them should be examined.

(3) Consideration for Construction and Procurement Conditions

Local materials and local products are utilized at optimum. Materials are selected by comparing their quality, cost and procurement possibility. Specifications and sizes of the materials and equipments to be procured are determined with consideration of transportability of them to the construction sites.

(4) Operation and Maintenance Policy

After the completion of the Project, the bridges will be maintained by the maintenance sections of the Directorate General of Highways of the Ministry of Public Works and the provincial government. Considering the possibility of inadequate maintenance, the bridge is designed to be maintenance-free as much as possible.

(5) Policy on Facilities Grading

The grading (standards) of the bridges and approach roads are determined referring to the design standards / criteria established by the Ministry of Public Works of Indonesia. However, the design standards proposed for the facilities are verified for their appropriateness by referring to the Japanese design standards and AASHTO.

(6) Policy on Construction Method Planning

Since the construction sites are remote and the access roads are narrow and steep, safe and easy construction method are planned. To secure the construction quality, the required specifications of the material quality tests and as-built measurement inspection are clearly written in the contract documents and technical specifications. The construction plan is prepared by taking safety of the surrounding residents and construction staff and environment into considerations. Detour roads are provided during the construction.

(7) Policy on Cost Efficiency

The bridge facilities will be designed with the top priority to secure the required functions and durability. However, cost efficiency will also be considered in the design. The major items to be considered are as follows:

- Materials are selected based on cost comparison including local materials.
- Construction methods are proposed based on cost comparison of schemes including utilizing local materials and equipments.
- The facility capacity is determined in anticipation to the present and future use.
- Materials for protections, retaining walls, and ditches should be locally available materials.
- Appropriate design standard is adopted.

2.2.1.3 Environmental and Social Consideration Policy

(1) Environmental and Social Consideration Policy

As this project is to construct bridges along the existing road, therefore, it will not change the natural environment conditions. However, the following are considered in the design and construction planning to minimize the effects on the environmental and social conditions.

- Complying with the environmental law and regulations to obtain the construction permit
- Work should be executed complying with Environmental Management Plan (UKL) and Environmental Monitoring Plan (UPL).
- Avoiding land acquisition and removal of houses in selection of new bridge location
- Minimizing relocation of utilities and obstacles in road alignment planning
- Minimizing the inconvenience for traffic by providing temporary detours

(2) Environmental Compliance Certificate

Southeast Sulawesi Provincial Environmental Management Office (BLH) has required to submit Environmental Management Plan (UKL) and Environmental Monitoring Plan (UPL) for the Project. The UKL and UPL were prepared by the Directorate General of Highways of the Ministry of Public Works and then submitted to BLH on August 2009. BLH evaluates the UKL & UPL and then issued the Recommendation for the implementation of the project in September 2009. The recommendation declares the permission to undertake the works, requirement to comply with Environmental Management System and periodic report on the implementation of UKL & UPL to BLH and others.

(3) Land Acquisition

In the site survey, inquiry to the local government staff and the resident representatives was conducted and confirmed their consent for the proposed locations of bridges and approach roads and availability of the land acquisition for the construction. In September 2009, the site plans which clearly show the construction areas and temporary work areas were explained to the land owners and availability of land acquisition and temporary land lease were confirmed. The list of land acquisition necessary for the Project is shown on Table 2.2-1.

Neither resettlement/removal of house nor relocation of utilities is necessary for the Project.

Table 2.2-1 Land Acquisition for the Project

Bridge No.	Bridge Name	Land Acquisition Area (m^2)
1	Roraya III	790
3	Pinnango	196
4	Roraya II	1,570
7	Lapoa	0
8	Wamorapa	0
9	Labuan Wolio III	0
12	Maligano III	550
14	Wakaka II	0
15	Labungka	0
16	Tolie	0
17	Wakorumba	0
Total		3,106

(4) Environmental and Social Considerations

Probable negative impacts due to the implementation of the Project and their mitigation measures are as shown in Table 2.2-2.

Table 2.2-2 Probable Negative Impacts and Mitigation Measures

Environ-mental Item (Affected Term)	Negative Impact	Counter measure / Mitigation measure	Monitoring		
			Before Construction	During Construction	After Construction
Land Acquisition (long-term)	Land acquisition and land lease is necessary for construction.	Execution of Public consultation, stake holder meeting complying with laws. Minimize land acquisition.	Check land acquisition procedure.	–	Check restoration condition of lease area
Water Pollution (short-term)	River becomes muddy due to excavation in the river.	Excavation area is closed with coffer dam.	Check temporary work plan	Check construction condition	–
Risk of Disease (short-term)	Incoming of construction staff. Installation of base camp.	Health education of laborers. Public consultation.	Check seminars	Check seminars	–
Accident (long/short term)	Construction equipment accident and traffic accident, after the completion due to high speed driving.	Installation of traffic sign boards, Implementation of traffic control. Implementation of traffic safety seminar.	Check facilities and seminar	Check facilities and seminar	–
Soil Erosion	Soil erosion during earthwork.	Installation of proper riverbank protection.	Check construction plan	Check construction condition	–
Ecosystem	Effect due to increase of population.	Minimize tree cutting. Control illegal tree cutting.	–	Check site condition	–
Waste (long/short term)	Waste from construction and base camp.	Proper treatment of waste	Check waste treatment plan	Check site condition	–
Noise and Vibration (short term)	Noise and vibration from construction equipment possibly affect residents.	Proper maintenance of equipments. Shortening of working hours.	Check construction plan	Check construction condition	–

2.2.2 Outline Design

2.2.2.1 Design Standards and Criteria

(1) Design Standard

The design specifications issued by the Directorate General of Highway, the Ministry of Public Works of Indonesia are basically adopted for the design of bridges and approach roads. These design specifications are similar to the specification of Australia, Japan and AASHTO. Supplementary, Japanese Specifications and AASHTO's are applied for the design.

(2) Bridge Width

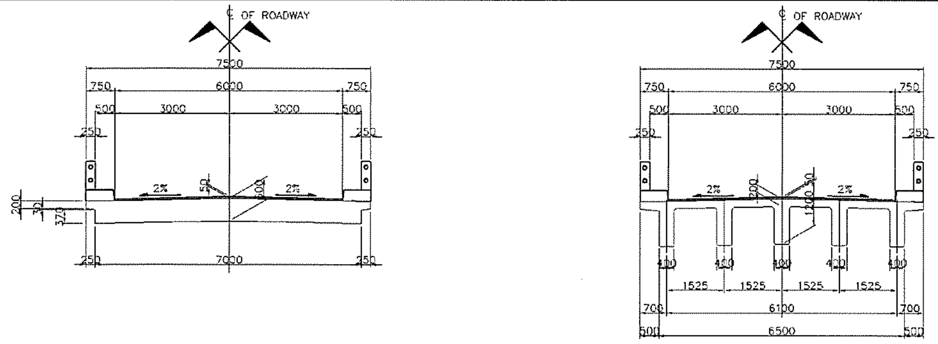
The design standards of the Directorate General of Highways specify the bridge width as follows:

- Regency road bridge: Carriageway = 4.5m, Curb = 0.25m
- Provincial road bridge: Carriageway = 6.0m, Curb/Sidewalk = 0.5m
- National road bridge: Carriageway = 7.0m, Curb/Sidewalk = 1.0m

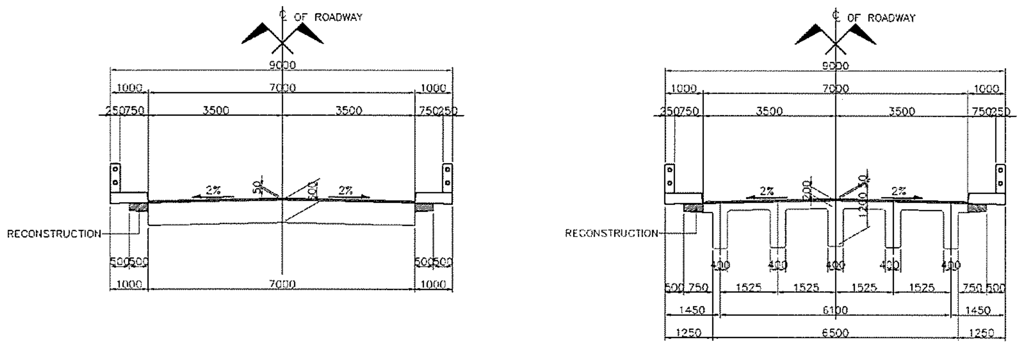
The above standards were issued on February 2008. Until then, national road bridges with small traffic volume used to be applied to the width standard of provincial road bridges. Therefore, the width of the existing bridges along Buton South – North Road, which is national road, are equivalent to provincial road bridge standard or less. To follow the above design policy, the Project bridge widths are examined based on the traffic volumes. The proposed bridge widths are shown in Table 2.2-3.

Table 2.2-3 Proposed Bridge Widths

Road Name	Bridge No.	Traffic Volume			Proposed Width and Reason
		Present	Opening	20yr. after	
Benua – Lapoa Road (Regency Road)	1	300	400	1000	Carriageway = 4.5m, Curb = 0.25m Regency road bridge standard is appropriate against the traffic volume.
Raterate – Lapo Road (Prov'l Road)	3 4 7	400 ~ 450	750	2000	Carriageway = 6.0m, Curb/Sidewalk = 0.5m Provincial road bridge standard is appropriate against the traffic volume.
Buton South – North Road (National Road)	8 9 12 14 15 16 17	100 ~ 500	250 ~ 550	600 ~ 1500	Carriageway = 6.0m, Curb/Sidewalk = 0.5m Provincial road bridge standard is appropriate because the traffic volume is small and the widths of the existing bridges along the road are equivalent to provincial road bridge standard or less. However, the bridges are designed to be expandable to be national road bridge standard when large vehicle traffic volume increased in the future. A future widening scheme is shown in Figure 2.2-1.



Provincial Road Bridge Standard to be Constructed by Japan's Grant Aid



Future Widening to be National Road Bridge Standard by Indonesian Side

Figure 2.2-1 A Scheme of Future Widening of Bridges along Buton South-North Road

(3) Design Criteria

- Live load: Design vehicle loads as specified in the specifications issued by the Ministry of Public Works, Indonesia
- Temperature change : ±15℃ (15 - 45℃)
- Seismic load: Base shear coefficient = 0.15 (Zone 4 in Indonesian earthquake zone map)

(4) Material Specification

Concrete (Design Strength)

- Deck slab, RC girder: 30 Mpa
- Substructure 30 Mpa
- Under water concrete 24 Mpa
- Lean concrete 18 Mpa

(5) Steel Plates

- For main member and splice: JIS G 3106-SM490Y
- For diaphragm and stiffener: JIS G 3101-SM400
- Other minor members: JIS G 3101-SS400

(6) Steel Materials

- Reinforcing steel bars: SD 40 (Min. yield point 390 N/mm2)
- High tensile bolt: JIS B 1186 F8T (Galvanized)
- Steel tubular pile: JIS A 525 STK400

(7) Railing

- Galvanized steel pipe with RC posts
- Rail elevation is 1.0 m from sidewalk (or 0.75 m from curb where no sidewalk)

(8) Bridge Freeboad

- Bridge over river without driftwoods : 1.0 m
- Bridge over river with driftwoods : 1.5m

(9) Geometric Standards of Bridge Approach Road

The geometric standard of the bridge approach road is shown on Table 2.2-4.

Table 2.2-4 Geometric Standard of Bridge Approach Road

	Benua – Lapoa Road Regency Road Flat Terrain	Raterate – Lapoa Road Provincial Road Flat Terrain	Buton South-North Road National Road Hilly Terrain
Carriageway Width (m)	4.5	4.5	4.5
Shoulder Width (m)	1.0 x 2	1.5 x 2	1.5 x 2
Design Speed (km/hr)	30	40	40
Horizontal Min. Curve Radius (m)	60	100	100
Maximum Grade (%)	7 (10)	5 (7)	5 (7)

Note: Figure in ( ) can be used where unavoidable case due to topographical reason.

(10) Typical Cross Section of Bridge Approach Road

The width components of the bridge approach roads are same as the road sections which are being improved by Indonesian side. However macadam pavement is planed instead of asphalt concrete pavement because the existing asphalt plant might be unavailable during the Project bridges construction. Asbuton which is the locally available asphalt contain sand rock is planned to be used as the filler for macadam pavement. Guide posts are installed at 2m interval at the both sides of embanked bridge approach roads. The typical cross section of the bridge approach roads are shown in Figure 2.2-2.

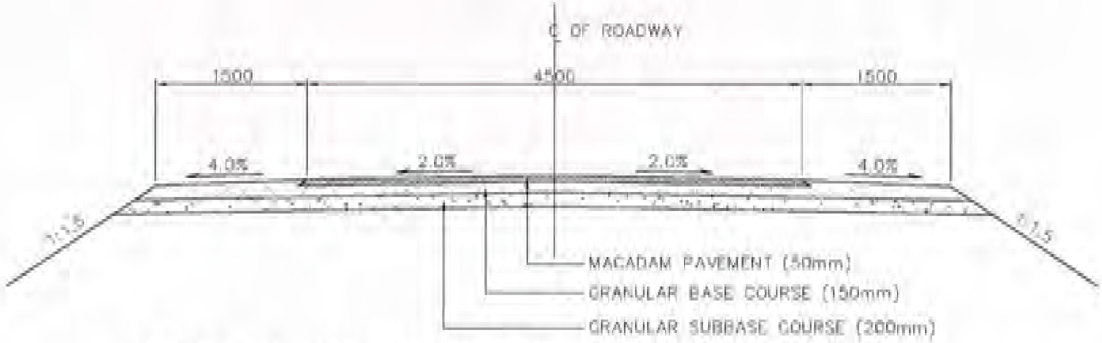


Figure 2.2-2 Typical Cross Section of Bridge Approach Roads

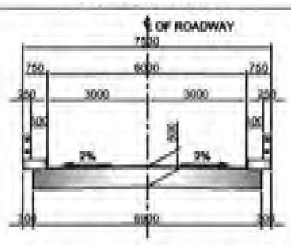
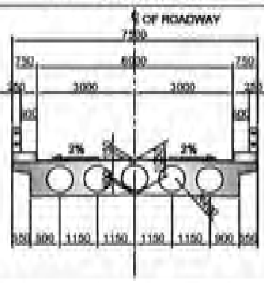
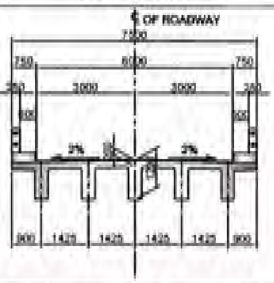
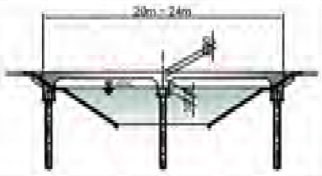
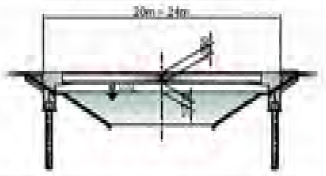
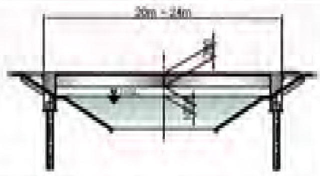
2.2.2.2 Bridge Structures

(1) Superstructure Type

Superstructure type for short span bridges

Reinforced concrete (RC) bridges are superior type for short span bridges less than around 25m since the cost is low and the construction is easy. However, it is not adoptable for the sites where the scaffolding is hard to install due to the reasons such as deep river, soft riverbed and prone to flooding. Common types of RC bridge are RC flat slab, RC hollow slab and RC girder. The features of the 3 types are shown in Table 2.2-5.

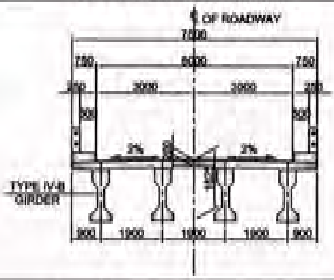
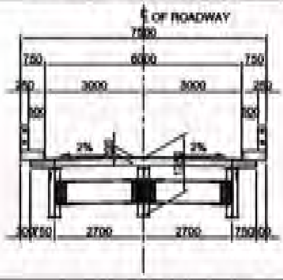
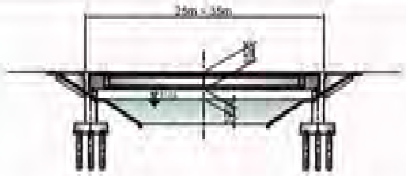
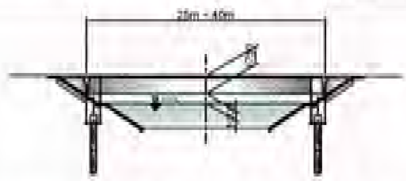
Table 2.2-5 Feature of 3 Types of RC Bridges for Short Span Bridges

	RC Flat Slab	RC Hollow Slab	RC Girder
Section			
Side View			
Adoptable Longest Span	12 m	18 m	22 m
Bridge Height	0.6 m (Span =12m)	1.05 m (Span =18m)	1.2 m (Span=22m)
Cost	Low	Relatively high	Low
Construct--ability	Easy	Relatively complicated	Easy
Adoptability	It is superior for the case the span is less than 12m.	It is superior for the case the span is between 12 and 18 m, and low bridge depth is needed.	It is superior for the case the span is between 12 and 22m.

Superstructure type for long span bridges

Pre-stress concrete (PC) girder bridge and plate girder bridge are common type for bridges of which span is between 20 and 40m. The features of PC girder bridge and plate girder bridge are shown in Table 2.2-6.

Table 2.2-6 Feature of 2 Types of Bridges for Long Span Bridges

	PC Girder Bridge	Plate Girder Bridge
Section		
Side View		
Cost	-Girder cost is less than plate girder, however, cost for substructure and temporary works is higher. Total cost is almost same as plate girder.	-Girder cost is higher than PC girder, however, cost for substructure and temporary works is less. Total cost is almost same as PC girder.
Transportability and Constructability	-Fabrication of PC girder is complicated and it requires high technique. -To produce high strength concrete, it is necessary to haul qualified aggregate from Remuno which is 100km away from the site. -Qualified concrete mixing plant is necessary to produce high strength concrete. -Large size crane or erection girder is necessary to erect large and heavy PC girder.	-Plate girder is fabricated in a factory in Jakarta. -Transportation of girders is easy since the plate girder can be cut into small pieces. -Quality of girder is high since it is fabricated in a factory -Erection of girder is easy. Pieces of plate girders are installed on temporary support using a small crane then connected by bolt tightening.
Required Maintenance	-Usually PC girder require no maintenance	-Usually Galvanized steel girder does not need repainting for 40 to 50 years.
Performance And Environment Impact	-Bridge height is almost same as plate girder. -Flat and wide (W=20m x Girder length +10m) area is necessary to fabricate PC girders behind an abutment. -Field work is many and long period.	-Bridge height is almost same as PC girder. -Wide working yard is not necessary around site. -Earthwork or excavation in river is less.
Overall Comparison	-Plate girder bridge is superior to PC girder bridge in constructability and environmental impact. -Cost and maintenance requirement is almost same.	

Selection of superstructure type

A flowchart for the selection of the most appropriate superstructure type is shown in Figure 2.2-3.

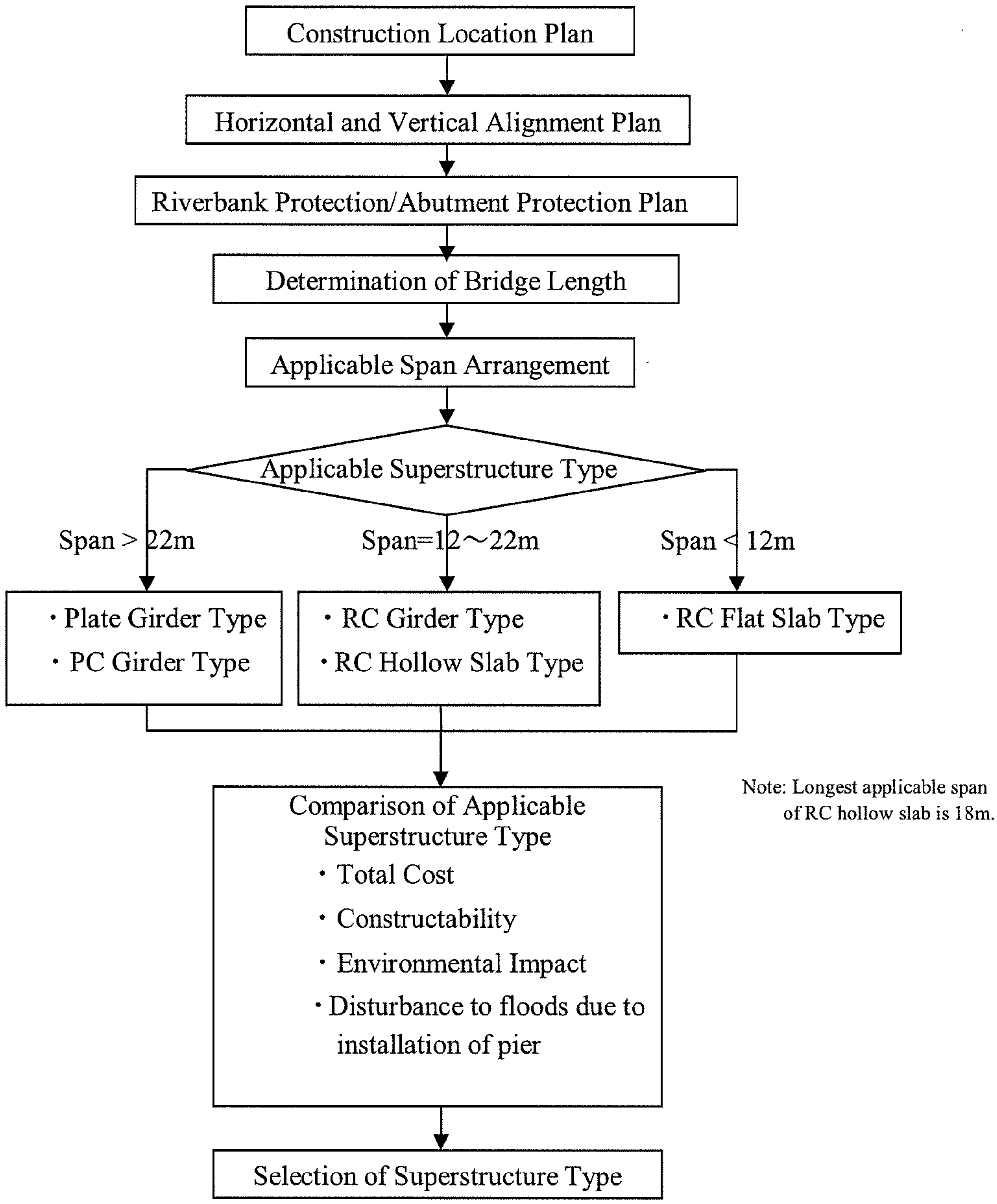


Figure 2.2-3 Flowchart of Selection of Superstructure Type

(2) Foundation Type

Spread footing foundation is planned for the bridges where hard strata exist at shallow. Pile foundation is planned where hard strata exist at deep. Features of the common pile foundation types are shown in Table 2.2-7.

Table 2.2-7 Feature of Common Pile Foundation Type

	Precast Pile	Bored Pile	Steel H-Pile	Steel Tubular Pile
Materials	• Reinforcing bars and Concrete	• Reinforcing bars and Concrete	• Steel H beam	• Steel tubu
Procurement of Pile	• Fabrication at site	• Constructing piles at final location	• Fabrication in Jakarta then transported to the site	• Fabrication in Jakarta then transported to the site
Construction Method / Constructability	• Driving pile using diesel hammer. • Large size crane and hammer are necessary since concrete pile is heavy and long.	• Drilling ground then placing reinforcing bars and concrete into the hole. • Large size drilling machine is necessary. • Construction of bored piles needs longer duration than driven piles.	• Driving pile using diesel hammer. • Crane and hammer size are smaller than concrete pile since the piles are small and light. • Construction duration is short. • Pile length can be adjusted easily since steel pile can be cut and welded easily.	• Same as Steel H-Pile.
Cost	• Least cost	• Almost same as steel piles	• Almost same as bored pile	• Same as Steel H-Pile
Applicability for soil containing boulders	• Inapplicable (concrete is not strong enough to penetrate boulder containing layers)	• Applicable (by using special drilling equipment)	• Applicable (steel H-pile can penetrate boulder layer)	• Applicable (Steel tubular pile can penetrate relatively thin boulder layer)
Applicability to this Project	• Inapplicable because large equipments are necessary.	• Appropriate for large bridges because bearing capacity and bending resistance is large.	• Appropriate for small bridges because bearing capacity and bending resistance is small. • Applicable for boulder contain ground.	• Appropriate for middle size bridges because bearing capacity and bending resistance is medium.

(3) Structure of Abutment Protection and Riverbank Protection

Abutment Protections are installed to protect abutment embankments from erosion and scouring. Riverbank protections are installed to protect riverbanks from scouring and meandering which might collapse abutments and bridge approach roads. Common structure types of abutment protection and riverbank protection are shown in Table 2.2-8.

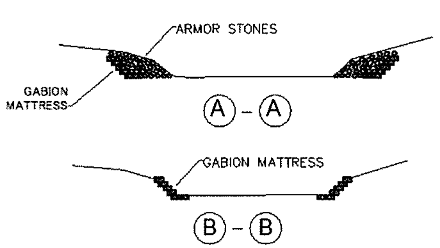
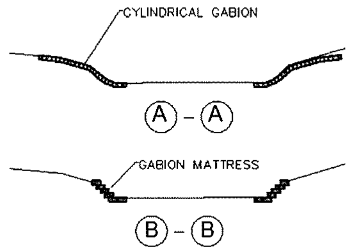
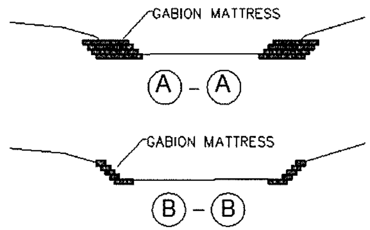
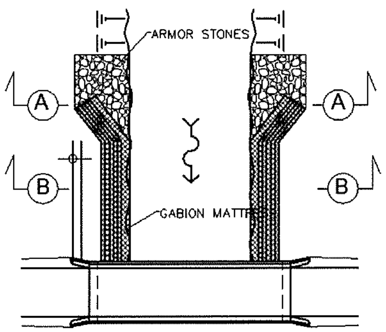
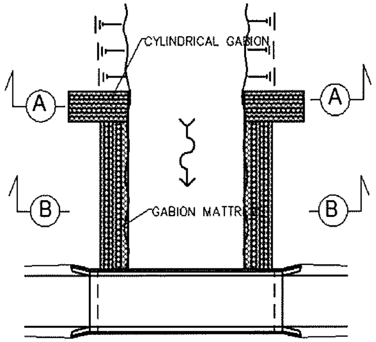
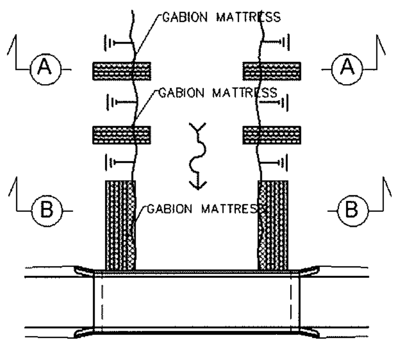
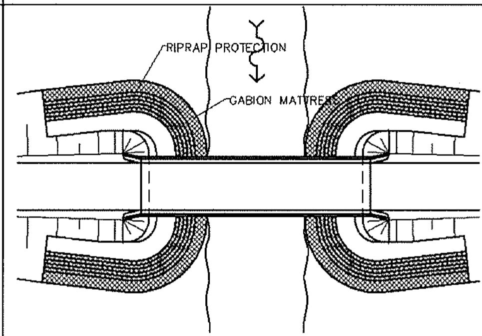
Table 2.2-8 Common Type of Abutment Protection/Riverbank Protection and Features

	Gabion Mattress	Cylindrical Gabion	Stonemasonry Wall	Grouted Riprap	Armor Stones
Section					
Material	· Gabion net · Boulders	· Gabion net · Boulders	· Concrete · Boulders	· Concrete · Boulders	· Armor stones
Slope	1:0.5 – 1:1	1:1.5 - 1:2	1:0.3 – 1:0.5	1:1.2 – 1:2	1:1.5 – 1:2
Cost	1.0	0.7	1.5	0.6	1.2
Durability	1.0	0.8	1.5	0.8	1.0
Inapplicable Site Condition	Near sea: Gabion corrodes. Soft ground: Gabion settles	Near sea: Gabion corrodes. Steep slope: Gabion is unstable on steel slope.	Underwater: Wall can not be constructed in water. Soft Ground: Wall is unstable on soft ground.	Steep slope: Riprap is unstable on steep slope. Soft ground: Riprap can not follow deformation.	Water current is fast: Large size stones are needed where current is fast.
Applicable Site Condition	Underwater: Gabion can be constructed in shallow water.	Gentle slope: Gabion is stable on gentle slope. Soft Ground: Gabion is flexible.	Steep slope: Wall can be constructed with steep slope.	Gentle slope above water.	Under sea water: Armor stone protection can be constructed under sea water.

(4) Countermeasures against River Meandering

Riverbank protections at upstream side of the bridges should be planned to avoid river meandering which might cause erosion at mountain side of the protection. Countermeasures at the end of riverbank protections at upstream side are compared as shown in Table 2.2-9.

Table 2.2-9 Comparison of Countermeasures at End of Riverbank Protection at Upstream Side

	Installation of Armor Stone	Installation of Cylindrical Gabion	Installation of River Controller	Installation of Protection All-around Abutment
Section				–
Plan				
Feature	• Excavation to install armor stone is a big work. • Procurement of large size armor stone is difficult.	• Cost is least. • Cylindrical gabions cannot be installed on steep riverbank.	• Cost for construction of river controllers which can withstand against floods is high.	• Excavation to install protections all-around the abutment is a big work. • River meandering cannot be controlled.
Evaluation	• Installation of cylindrical gabions is least cost and effective for small meanderings. • Installation of protection all-around abutment is only effective for big meanderings.			

(5) Maintenance-Free Structure

The following measures are introduced for the Project bridges to minimize maintenance.

- Integral type structure is proposed for all Project bridges since expansion joints and bearings which needs frequent maintenance are not necessary. Integral type is seismic resistant also.
- Plate girders are galvanized (Zink hot dip galvanized) which does not need repainting for around 50 years.
- No drain inlet is installed on the bridge deck since it used to be clogged with dirt. Instead, vertical slope is given to the bridge deck and it is drained along the vertical ditch on the abutment slopes.
- Gabion is not used near the sea.
- Durable type gabion is used. The size and galvanize thickness are clearly specified in the specifications.

(6) Cost Efficiency

The measures for cost efficiency are as follows:

- Integral type structure which does not need expansion joints, bearings and lessen the sizes of bridge members and number of piles is adopted.
- The bridges and the approach roads are vertically curved to reduce embankment and length of the approach roads.
- Plate girder is fabricated in Jakarta using Indonesian steels.
- Guide posts are used for the bridge approaches instead of guardrails which are costly.
- Railing is made of simple water pipes and RC post.
- Bridges along Buton South-North Road is constructed with 6m wide carriageway which is standard of provincial road bridge. However, it is designed to be expandable to be 7m wide when traffic becomes large in the future.

2.2.2.3 Bridge Planning

(1) Bridge Planning Concepts

The concepts for the bridge planning are as follows:

<u>New bridge location planning</u>

The new bridge locations are determined with the following considerations:

- Bridge locations are principally along the existing roads to minimize land acquisitions
- Locations of the bridges are structurally stable and construction costs are the most efficient
- Utilizing the existing temporary bridges to save costs for construction of temporary detours
- Bridge approach road alignments should satisfy the geometric standards

- Locations should be away from river meandering or protectable from river meandering

Vertical and horizontal road alignment planning

- Bridge deck elevations are equal to or higher than the elevations which are the results of design flood levels + freeboards + bridge heights. Bridges and existing approach roads are connected with smooth vertical alignments which satisfy the geometric standards.
- Bridges and existing approach roads are connected with smooth horizontal alignments which satisfy the geometric standards.

Riverbank protection/abutment protection planning

- Riverbank protections / abutment protections are laid out so as to discharge floods smoothly and to minimize bridge length.
- Wherever there are natural riverbanks, they should be maintained and protected by installing protections from erosion. The protection areas are 20 to 30m from abutments to both upstream and downstream sides.
- Wherever there is no riverbank, locations of abutment protections are placed along with natural river alignments securing necessary river width which is estimated on the basis of site observations and hydrological analysis. The abutment protections should be laid out not to cause bottleneck of floods. Embankments around abutments are protected by installing riprap slope protections. Gabion mattresses are installed at toes of abutment protections to prevent protections from scouring.
- River openings (distances between riverbanks) should not be smaller than existing openings where floods overflow around the bridges.
- Armor stones instead of gabions are used where sea water comes to the sites.

Bridge length/superstructure type/span arrangement planning

- Abutments are laid out just behind the riverbank protections or abutment protections. The bridge length is the distance between both abutments' back faces.
- Comparative schemes of superstructure types and span arrangements are identified and the best schemes are selected based on comparisons in terms of cost, constructability, environmental impact, disturbance against flood discharge and others.

Foundation planning

- Referring to the features of the foundation types in Table 2.2-5, applicable foundation type is planned. In the case the plural types are applicable, the most economical one is selected.
- The pile size should be drivable by small size equipments since the sites are remote. The standard size of bored pile is 1.2m, steel tubular pile is 0.8m and Steel H-pile is 0.4m.

Temporary detour planning

- Temporary detour roads are planned for the bridges which are demolished for the construction.

- Temporary pipes are used to discharge river water crossing the detours.

Ancillary work planning

- For the bridge approach roads, macadam pavement is applied.
- Guide posts are installed at the shoulders of the bridge approach roads where embankments are high or alignments are curved.
- Stone masonry ditches are installed at mountain side of the approach roads.

(2) Planning of the Project Bridges

The Project bridges are planned referring to the above concepts. The summary of the planning of the bridges are shown in Table 2.2-10.

The comparison of superstructure type and span arrangement is shown in Table 2.2-11.

Table 2.2-10 (1/4) Planning of Project Bridges

Bridge No. Bridge Name	No.1 Roraya III Bridge	No. 3 Pinnango Bridge	No.4 Roraya II Bridge
Bridge Location	The new bridge location is planned at upstream side of the existing bailey bridge.	The old bridge has been collapsed. The new bridge location is same as old bridge (along the existing road).	The new bridge location is planned at upstream side of the existing bailey bridge.
Vertical and Horizontal Alignment	The new bridge deck elevation (about 2.5m higher than existing bridge) is obtained from flood level + freeboard (1.5m) + bridge height. The vertical alignment is planned to connect the bridge with the both side existing approach roads with 5% slope. Vertical curve is provided for the bridge. The bridge is connected with the existing roads with 100m horizontal curves.	The new bridge deck elevation (about 1.5m higher than existing road) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 3 % vertical alignment. Vertical curve is provided for the bridge. It is gentle since the bridge is located in the straight and flat road section.	The new bridge deck elevation (about 2m higher than existing bridge) is obtained from flood level + freeboard (1.5m) + bridge height. The bridge is connected with the existing approach road with 5 % (right bank) and 3% (left bank) vertical alignment. The bridge is connected with the existing roads with 300m (right bank) and 250m (left bank) horizontal curves.
Riverbank Protection / Abutment Protection	Layers of gabion mattress riverbank protections are installed along the existing riverbank to protect the natural riverbank from erosion. The installation area is about 30m to upstream and 20m to downstream from the new bridge. Riprap protections are installed around the abutment and approach road embankment slopes under the flood level. Gabion mattress scouring protection is installed at the toe of embankment slopes. Approach road shoulders under the flood level are coated with asphalt to protect the road from erosion.	Floods overflow from the river and spread over on the cacao firms around the bridge. Layers of gabion mattress protections are installed all-around the abutments to protect abutments from floods and from erosion by meandering river. The left bank approach road of which slope has slid due to floods is planned to be restored with layers of gabion mattress.	The river is streaming down along the left riverbank. Layers of gabion mattress riverbank protection are installed along the left riverbank to protect riverbank from erosion. The installation area is about 30m to upstream and 20m to downstream from the new bridge. Riprap protections are installed around the abutment and approach road embankment slopes under the flood level. Gabion mattress scouring protection is installed at the toe of embankment slopes. Approach road shoulders under the flood level are coated with asphalt to protect the road from erosion. Gabion mattress scouring protection is installed around the pier.
Bridge Length / Superstructure Type / Span Arrangement	New abutments location are planned to align with the existing abutments. Consequently, the bridge length becomes 50m. The superstructure comparative schemes are 2-span plate girder and 2-span PC girder.	New abutments are planned to be located same as old abutments. Consequently, the bridge length becomes 22m. The superstructure comparative schemes are single-span RC girder and 2-span RC flat slab.	New abutments location are planned to align with the existing abutments. Consequently, the bridge length becomes 64m. The superstructure comparative schemes are 2-span plate girder and 2-span PC girder.
Foundation	The ground surface is soft silt. With deeper the depth, the silt becomes stiffer. The stiff silt at 4 to 8m depth is the bearing strata. Bored pile foundation is planned since the bridge is large and boring the silt using grab hammer is necessary to drive the pile into the stiff silt.	The ground is composed of alternative gravel and sandy layers. Hard strata are located at about 13m depth. Steel H-pile foundation is planned since the pile driving is necessary to penetrate the medium hard gravel layers.	The ground surface is soft silt. With deeper the depth, the silt becomes stiffer. The stiff silt at 4 to 8m depth is the bearing strata. Bored pile foundation is planned since the bridge is large and boring the silt using grab hammer is necessary to drive the pile into the stiff silt.
Temporary Work	Construction of a temporary staging in the river is necessary to construct the pier and erection of girders.	Existing detour can be used during construction.	Detour is not necessary since the existing bailey bridge can be used during the construction.

Table 2.2-10 (2/4) Planning of Project Bridges

Bridge No. Bridge Name	No.7 Lapoa Bridge	No.8 Wamorapa Bridge	No.9 Labuan Wolio Bridge
Bridge Location	The old bridge has been collapsed. The new bridge location is same as old bridge (along the existing road).	The existing bridge is dilapidated timber bridge, therefore, the new bridge location is planned to be same location of existing bridge.	The existing bridge is dilapidated timber bridge, therefore, the new bridge location is planned to be same location of existing bridge.
Vertical and Horizontal Alignment	The new bridge deck elevation (about 1.5m higher than existing road) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 3 % (left bank is higher) and 7% (right bank is lower) vertical alignment. Vertical curve is provided for the bridge. The bridge is located in a straight road section.	The new bridge deck elevation (about 2m higher than existing bridge) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 5 % vertical alignment. Vertical curve is provided for the bridge. The bridge is located in a 1000m radius horizontal curve.	The new bridge deck elevation (about 2m higher than existing bridge) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 5 % vertical alignment. Vertical curve is provided for the bridge. The bridge is located in a 200m radius horizontal curve.
Riverbank Protection / Abutment Protection	Floods overflow from the river and spread over on the paddy fields around the bridge. Layers of gabion mattress protections are installed all-around the abutments to protect abutments from floods and from erosion by meandering river. The approach road embankment slope under the flood level is protected with riprap protection. Road shoulders under the flood level are protected with asphalt coating.	The river curved to left side at the bridge, therefore, right bank is being eroded. Riverbank protection is installed along the right bank. The installation area is about 30m to upstream and 15m to downstream from the new bridge. Since the river is tidal, the riverbank protection is made of armor stone (under ordinary water level) and stonemasonry wall (above ordinary water level). Riprap protection is planned for the left side abutment since it is located at inside of curb of the river and above the ordinary water level. Armor stone scouring protection is installed at the toe of the riprap protection slope.	Riverbank protection is installed at the both riverbank since the river is meandering at the site. Since the river is tidal, the riverbank protection is made of armor stone (under ordinary water level) and stonemasonry wall (above ordinary water level). The bridge approach road slope is planned with stonemasonry wall instead of embankment because the fences of private lots are very close to the road. Stonemasonry ditches are provided along the approach wall.
Bridge Length / Superstructure Type / Span Arrangement	New abutments are planned to be located same as old abutments. Consequently, the bridge length becomes 22m. The superstructure comparative schemes are single-span RC girder and 2-span RC flat slab.	Floods overflow from the river and spread over around the bridge. To increase the capacity of flood discharge, the bridge length is planned 22m which is the applicable longest span of RC girder bridge. The superstructure comparative schemes are single-span RC girder and 2-span RC flat slab. The bridge is skewed with 80 degree to follow the crossing angle of the road and the river.	Floods overflow from the river and spread over around the bridge. To increase the capacity of flood discharge, the bridge length is planned 22m which is the applicable longest span of RC girder bridge. The superstructure comparative schemes are single-span RC girder and 2-span RC flat slab. The bridge is skewed with 75 degree to follow the crossing angle of the road and the river.
Foundation	Hard gravel layer exists under sandy silt layer. Bearing strata locate at the depth of 5 to 6m. Steel H-pile foundation is planned since the bridge is small and the bearing layer is shallow.	Riverbed is made of boulders. Spread footing foundation is planned. Since the site is tidal river and the boulder layer is very permeable, plain concrete base is installed under the ordinary water level and the RC footings of the bridge is placed on the concrete base is planned.	Riverbed is made of boulders. Spread footing foundation is planned. Since the site is tidal river and the boulder layer is very permeable, plain concrete base is installed under the ordinary water level and the RC footings of the bridge is placed on the concrete base is planned.
Temporary Work	Existing detour can be used during construction.	Temporary detour is constructed at upstream side of the bridge.	Temporary detour is constructed at upstream side of the bridge.

Table 2.2-10 (3/4) Planning of Project Bridges

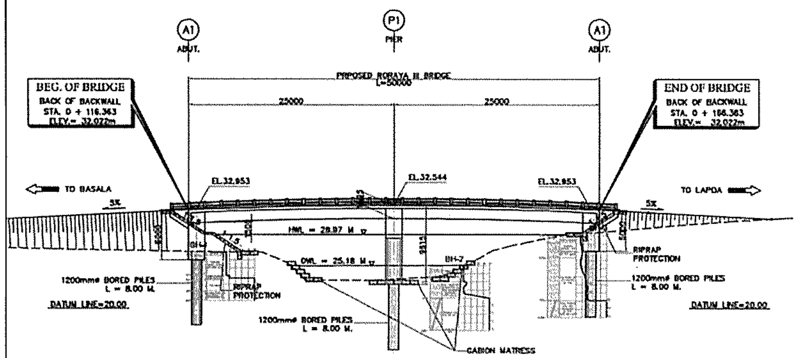
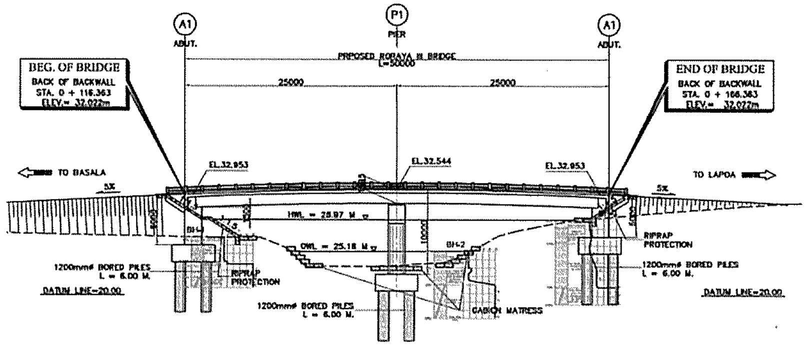
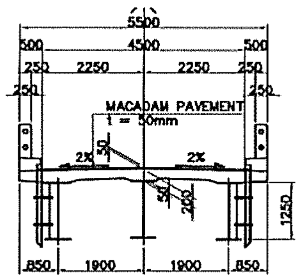
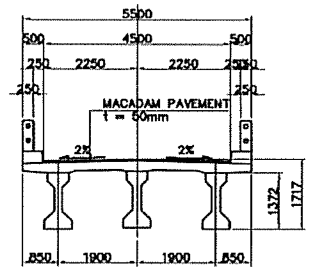
Bridge No. Bridge Name	No.12 Maligano III Bridge	No.14 Wakaka II Bridge	No.15 Labungka Bridge
Bridge Location	New bridge is planned at same location of existing bailey bridge since the river is shallow and construction of a detour is easy.	The existing bridge is dilapidated timber bridge, therefore, the new bridge location is planned to be same location of existing bridge.	The existing bridge is dilapidated timber bridge, therefore, the new bridge location is planned to be same location of existing bridge.
Vertical and Horizontal Alignment	The new bridge deck elevation (about 1.5m higher than existing bridge) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 5 % vertical alignment. Vertical curve is provided for the bridge. The bridge is located in a 1000m radius horizontal curve.	The new bridge deck elevation (about 2m higher than existing bridge) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 5 % vertical alignment. Vertical curve (R=500m) is provided for the bridge. The bridge is located in a 150m radius horizontal curve.	The new bridge deck elevation (about 2m higher than existing bridge) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 5 % vertical alignment. Vertical curve (R=500m) is provided for the bridge. The bridge is located in a straight section which adjacent to 150m radius horizontal curve.
Riverbank Protection / Abutment Protection	The river curved to left side at the bridge, therefore, right bank is being eroded. Layers of gabion mattress riverbank protection are installed along the right bank. The installation area is about 100m to the upstream from the bridge. Layers of gabion mattress riverbank protection are installed at the left bank. The installation area is about 15m for both upstream and downstream from the bridge. Riprap protection is installed around the abutments. A layer of gabion mattress scouring protection is installed around the pier.	Floods overflow from the river and spread over around the bridge. Layers of gabion mattress protections are installed all-around the abutments to protect abutments from floods and from erosion by meandering river. A layer of gabion mattress scouring protection is installed around the pier. The approach road embankment slope under the flood level is protected with riprap protection. Road shoulders under the flood level are protected with asphalt coating.	River is meandering through residential area. The river alignment is maintained by providing layers of gabion mattress riverbank protection at the both sides of the river. The bridge approach road slope is planned with stonemasonry wall instead of embankment because the private lots are very close to the road. Stonemasonry ditches are provided along the approach wall.
Bridge Length / Superstructure Type / Span Arrangement	Floods overflow from the river and crossing over the approach road. Therefore, a 36m bridge length which is 5m longer than the existing bridge is planned. The superstructure comparative schemes are single-span plate girder and 2-span RC girder.	Floods overflow from the river and spread over around the bridge. To increase the capacity of flood discharge, the bridge length is planned 22m which is the longest applicable span of RC girder bridge. The superstructure comparative schemes are single-span RC girder and 2-span RC flat slab.	Floods overflow from the river and spread over around the bridge. To increase the capacity of flood discharge, the bridge length is planned 22m which is the longest applicable span of RC girder bridge. The superstructure comparative schemes are single-span RC girder and 2-span RC flat slab.
Foundation	A thick soft silt layer deposit on the hard gravel layer which is about 20m deep. Steel tubular pile foundation is planned because the soft layer is thick so the strong bending resistance is required	A thick soft silt layer deposit on the hard gravel layer which is about 14m deep. Steel tubular pile foundation is planned because the soft layer is thick so the strong bending resistance is required	A thick silt layer deposit on the hard silt layer which is about 15m deep. Steel tubular pile foundation is planned because the soft layer is thick so the strong bending resistance is required
Temporary Work	Temporary detour is constructed at upstream side of the bridge.	Temporary detour is constructed at upstream side of the bridge.	Temporary detour is constructed at downstream side of the bridge.

Table 2.2-10 (4/4) Planning of Project Bridges

Bridge No. Bridge Name	No.16 Tolie Bridge	No.17 Wakorumba Bridge	
Bridge Location	The existing bridge is dilapidated timber bridge, therefore, the new bridge location is planned to be same location of existing bridge.	Many houses are located closed to the road at both sides of roads, therefore, the new bridge location is planned to be same as the existing bridge.	
Vertical and Horizontal Alignment	The new bridge deck elevation (about 2m higher than existing bridge) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 5 % vertical alignment. Vertical curve (R=500m) is provided for the bridge. The bridge is located in a straight section which adjacent to 200m and 150m radius horizontal curves.	The new bridge deck elevation (about 1.5m higher than existing bridge) is obtained from flood level + freeboard (1m) + bridge height. The bridge is connected with the existing approach road with 7 % vertical alignment. The steep slope is necessary to lower the approach road in front of houses. Vertical curve (R=450m) is provided for the bridge. The bridge is located in a 200m horizontal curve.	
Riverbank Protection / Abutment Protection	River is meandering through the forest near residential area. The river alignment is maintained by providing riverbank protection at the both sides of the river. Armor stone riverbank protection is planned because the site is tidal river. The river is scouring at roadside at the upstream of the river. Armor stone riverbank protection is installed along the road section to protect the road.	Layers of gabion mattress riverbank protection have been installed for the long section along the river. The existing riverbank protections in the construction affected area (about 10m for upstream and downstream side and temporary detour location) is once demolished and restored after the construction with smooth alignment to connect the existing riverbank protections at upstream and downstream side of the bridge.	
Bridge Length / Superstructure Type / Span Arrangement	Floods overflow from the river and spread over around the bridge. To increase the capacity of flood discharge, the bridge length is planned 22m which is the longest applicable span of RC girder bridge. The superstructure comparative schemes are single-span RC girder and 2-span RC flat slab.	The bridge crosses with the river with 30 degree. The bridge is planned with 75 degree skew due to the structural reason. Consequently, the bridge length becomes 36m. The superstructure comparative schemes are single-span plate girder and 2-span RC girder. A single column pier is planned because the wall pier direction does not meet the flood direction.	
Foundation	A thick silt layer deposit on the hard silt layer which is about 15m deep. Steel tubular pile foundation is planned because the soft layer is thick so the strong bending resistance is required	A thick soft silt layer deposit on the hard gravel layer which is about 22m deep. Steel tubular pile foundation is planned because the soft layer is thick so the strong bending resistance is required	
Temporary Work	Temporary detour is constructed at downstream side of the bridge.	Temporary detour is constructed at upstream side of the bridge.	

Table 2.2-11(1/11) Comparison of Superstructure Type and Span Arrangement

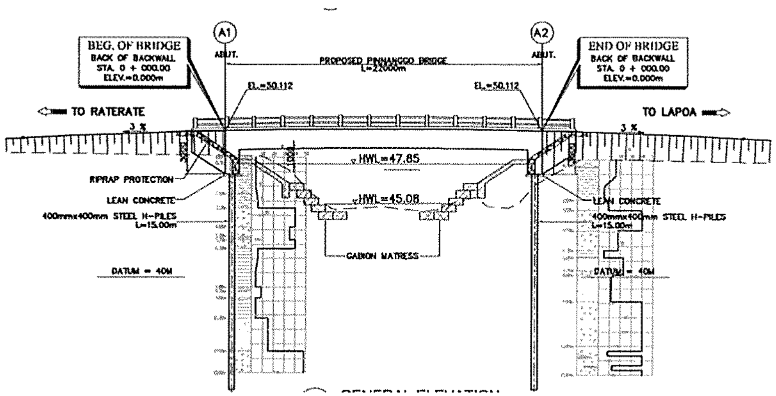
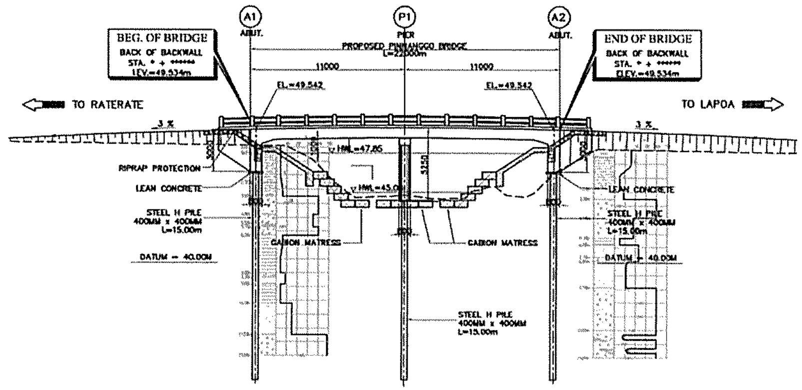
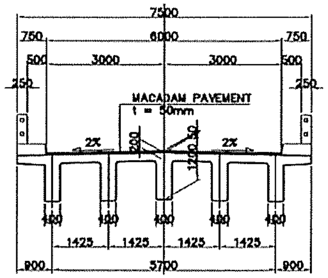
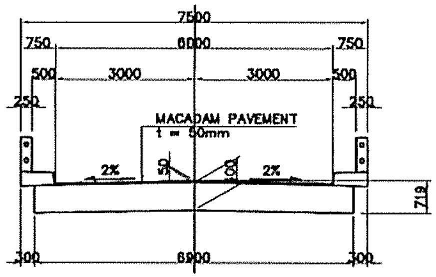
No.1 Roraya III Bridge

Scheme	2-Span Plate Girder	2-Span PC Girder
Bridge Side View		
Superstructure Section		
Cost	Almost same as PC girder (△)	Almost same as plate girder (△)
Constructability	Easy construction (○)	Large equipment and high technology is necessary (×)
Environmental Impact	Temporary yard is very small (○)	Wide temporary yard is necessary (×)
Other Features	Substructure is small (○)	Substructure is large (△)
Selection	○	△
	Plate girder is superior to PC girder since construction is easier and environmental impact is less.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (2/11) Comparison of Superstructure Type and Span Arrangement

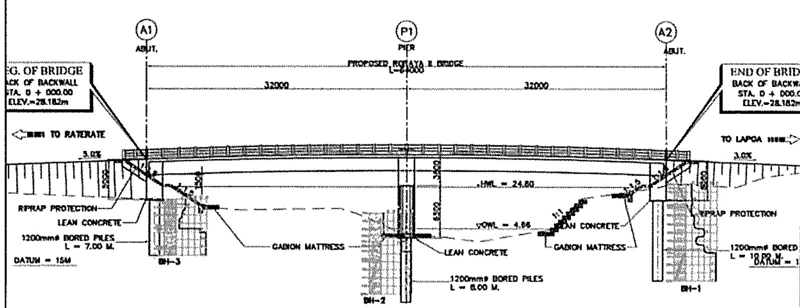
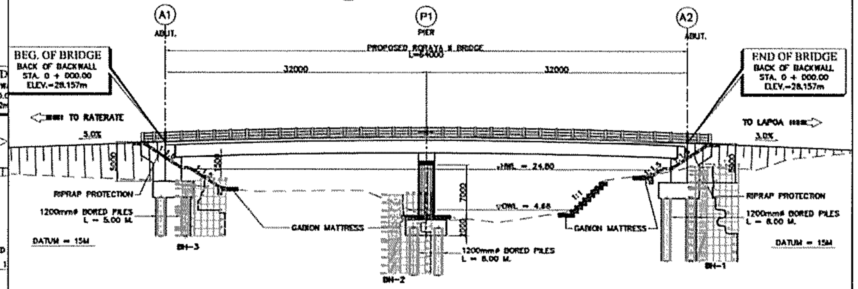
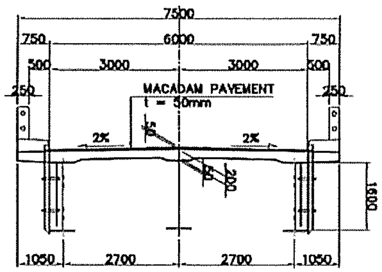
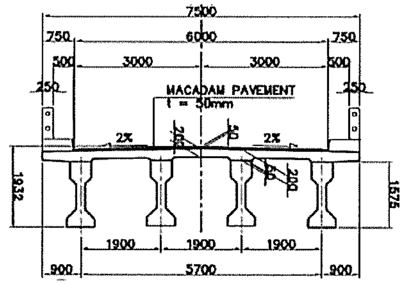
No.3 Pinnango Bridge

Scheme	Single-Span RC Girder	2-Span RC Flat Slab
Bridge Side View		
Superstructure Section		
Cost	Economical (○)	Economical (○)
Constructability	Easy (○)	Easy (○)
Environmental Impact	Bridge height is higher (1.25m), Land acquisition is larger (△)	Bridge height is lower (0.65m), Land acquisition is smaller (○)
Other Features	Disturbance to flood discharge is less (○)	Disturbance to flood discharge is bigger (△)
Selection	○	△
	Single-Span RC girder is superior since disturbance to flood discharge is less. Land acquisition (of farm) is not problem.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (3/11) Comparison of Superstructure Type and Span Arrangement

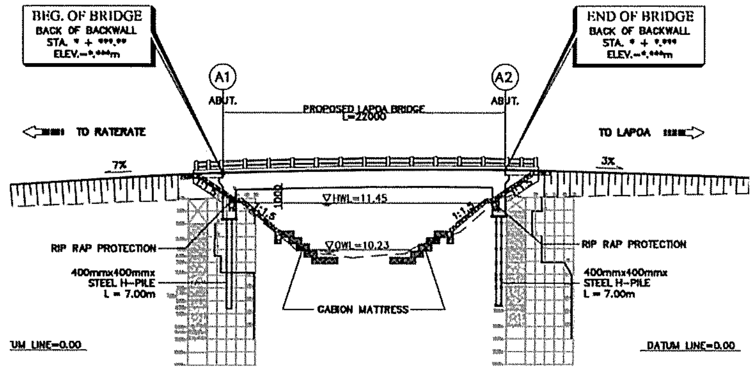
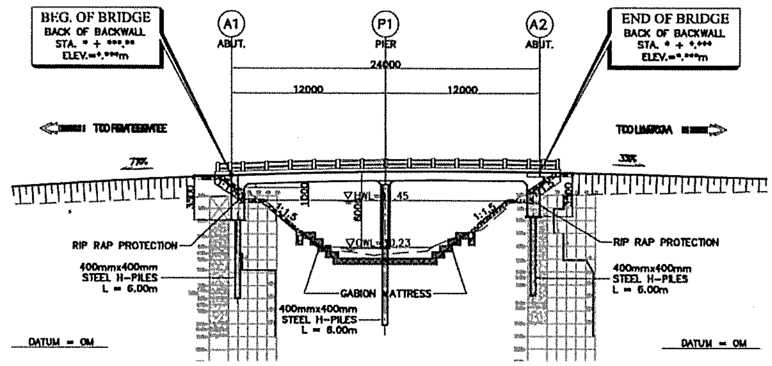
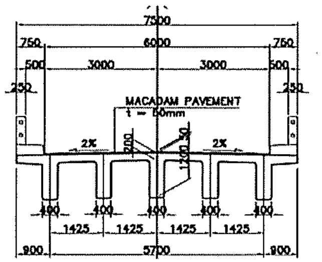
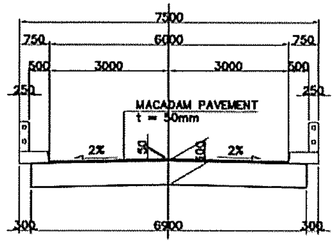
No.4 Roraya II Bridge

Scheme	2-Span Plate Girder	2-Span PC Girder
Bridge Side View		
Superstructure Section		
Cost	Almost same as PC girder (△)	Almost same as plate girder (△)
Constructability	Easy construction (○)	Large equipment and high technology is necessary (×)
Environmental Impact	Temporary yard is very small (○)	Wide temporary yard is necessary (×)
Other Features	Substructure is small (○)	Substructure is large (△)
Selection	○	△
	Plate girder is superior to PC girder since construction is easier and environmental impact is less.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (4/11)　Comparison of Superstructure Type and Span Arrangement

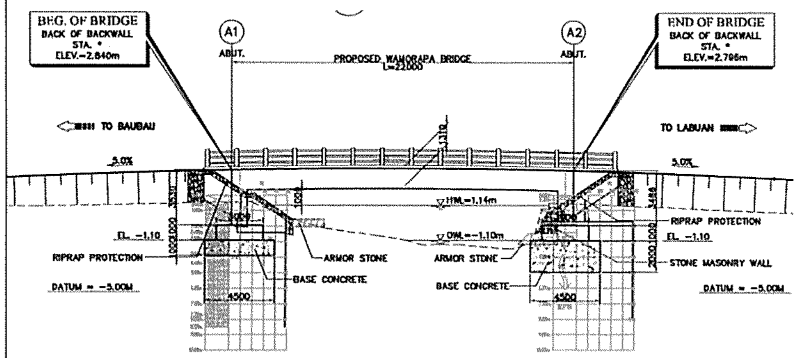
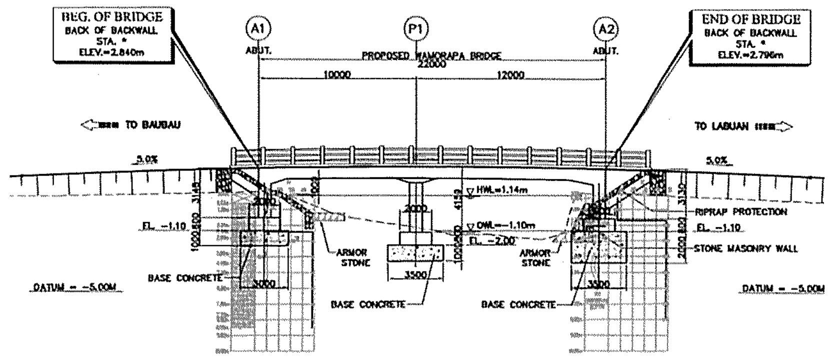
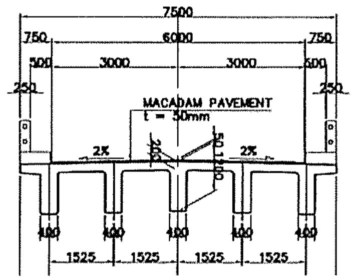
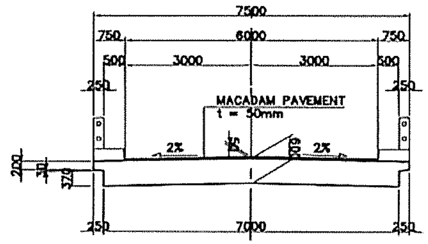
No.7 Lapoa Bridge

Scheme	Single-Span RC Girder	2-Span RC Flat Slab
Bridge Side View		
Superstructure Section		
Cost	Economical (○)	Economical (○)
Constructability	Easy (○)	Easy (○)
Environmental Impact	Bridge height is higher (1.25m), Land acquisition is larger (△)	Bridge height is lower (0.65m), Land acquisition is smaller (○)
Other Features	Disturbance to flood discharge is less (○)	Disturbance to flood discharge is bigger (△)
Selection	○	△
	Single-Span RC girder is superior since disturbance to flood discharge is less. Land acquisition (of farm) is not problem.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (5/11) Comparison of Superstructure Type and Span Arrangement

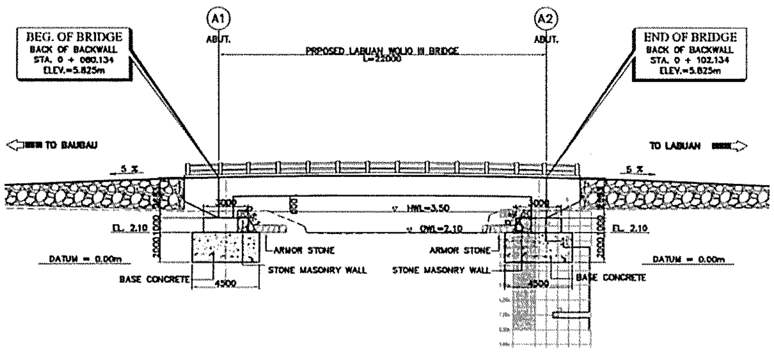
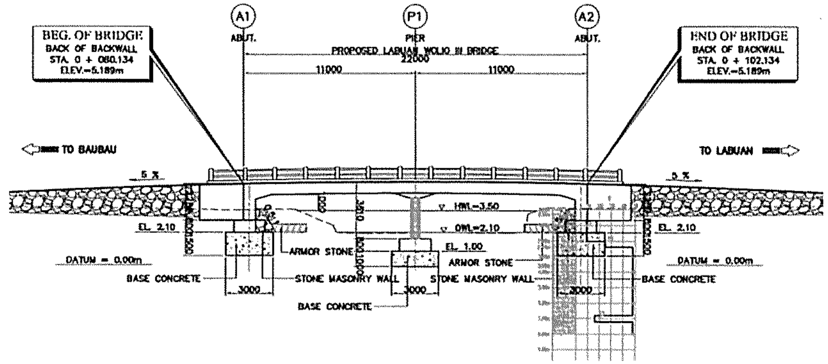
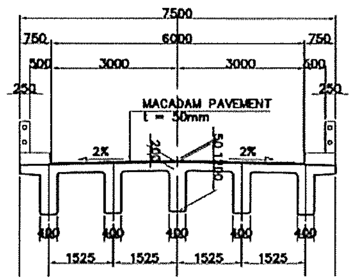
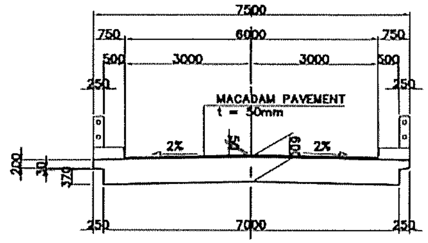
No.8 Wamorapa Bridge

Scheme	Single-Span RC Girder	2-Span RC Flat Slab
Bridge Side View		
Superstructure Section		
Cost	Economical (○)	Economical (○)
Constructability	Easy (○)	Construction of pier footing under sea level is needed (△)
Environmental Impact	Bridge height is higher (1.25m), Land acquisition is larger (△)	Bridge height is lower (0.65m), Land acquisition is smaller (○)
Other Features	Disturbance to flood discharge is less (○)	Disturbance to flood discharge is bigger (△)
Selection	○	△
	Single-Span RC girder is superior since pier is not necessary to construct. Land acquisition (of farm) is not problem.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (6/11) Comparison of Superstructure Type and Span Arrangement

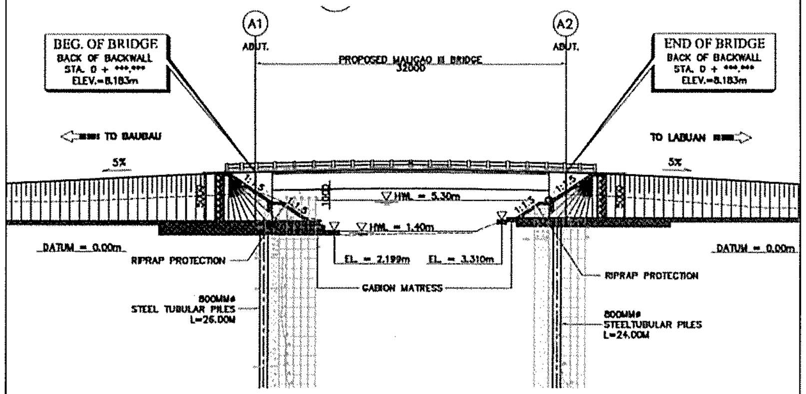
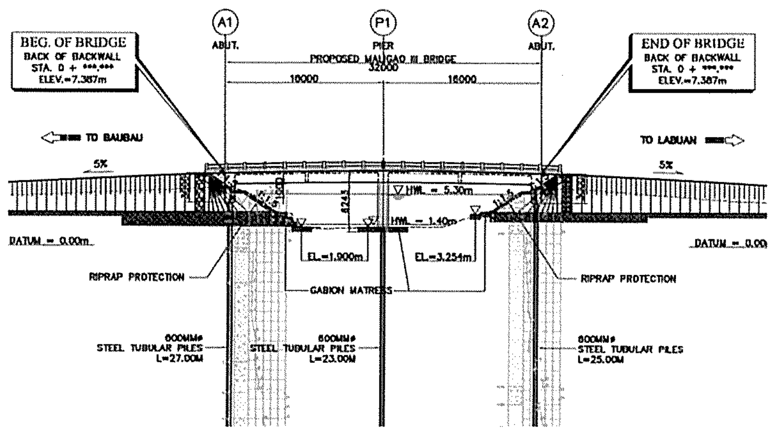
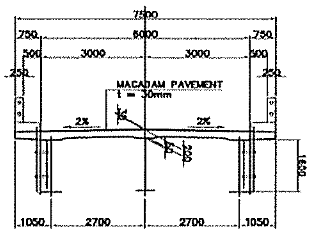
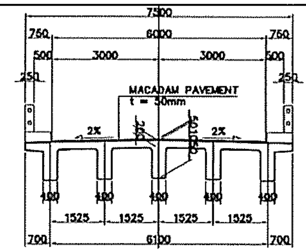
No.9 Labuan Wolio Bridge

Scheme	Single-Span RC Girder	2-Span RC Flat Slab
Bridge Side View		
Superstructure Section		
Cost	Economical (○)	Economical (○)
Constructability	Easy (○)	Construction of pier footing under sea level is needed (△)
Environmental Impact	Bridge height is higher (1.25m), Land acquisition is larger (×)	Bridge height is lower (0.65m), Land acquisition is smaller (◎)
Other Features	Disturbance to flood discharge is less (○)	Installation of pier under curve bridge is structurally good (○)
Selection	△	○
	2-span RC flat slab of which height is lower and embankment area is smaller is superior since houses exist near the bridge.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (7/11) Comparison of Superstructure Type and Span Arrangement

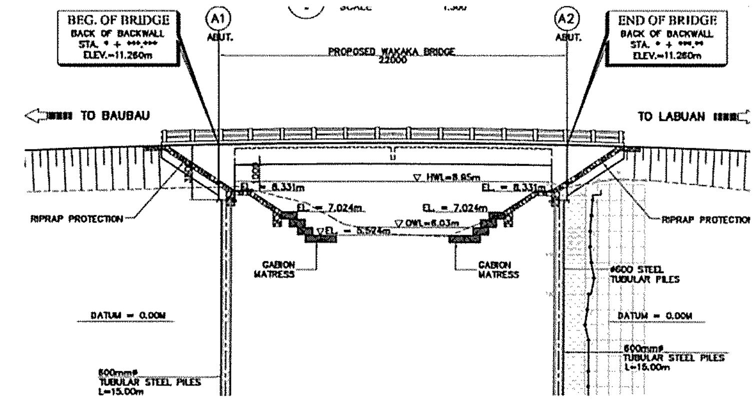
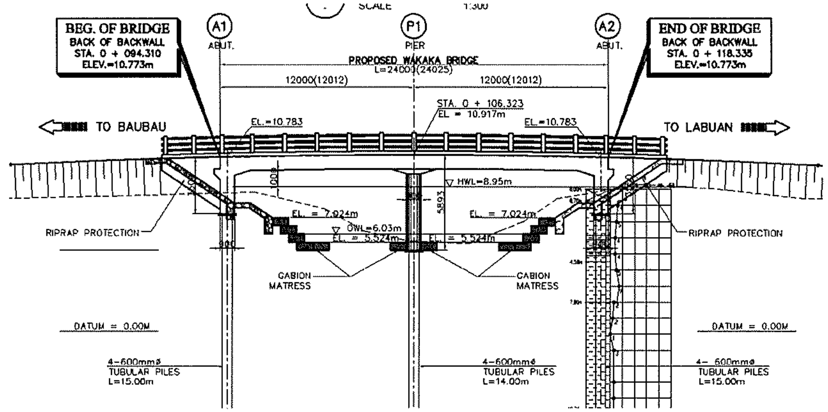
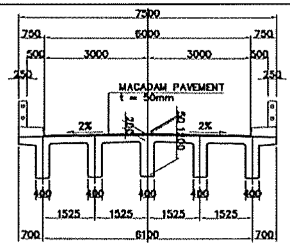
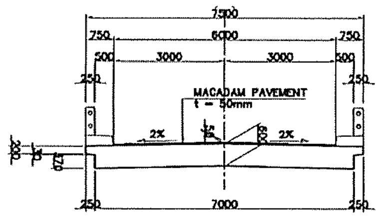
No.12 Maligano III Bridge

Scheme	Single-Span Plate Girder	2-Span RC Flat Slab
Bridge Side View		
Superstructure Section		
Cost	Steel girder is more expensive (×)	RC bridge is less expensive (◎)
Constructability	Construction is easy (○)	Construction is easy (○)
Environmental Impact	Bridge height is higher (1.85m), Land acquisition is larger (△)	Bridge height is lower (1.25m), Land acquisition is smaller (○)
Other Features	Disturbance to flood discharge is less (○)	Disturbance to flood discharge is bigger (△)
Selection	×	○
	2-span RC girder is superior since cost is less.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (8/11) Comparison of Superstructure Type and Span Arrangement

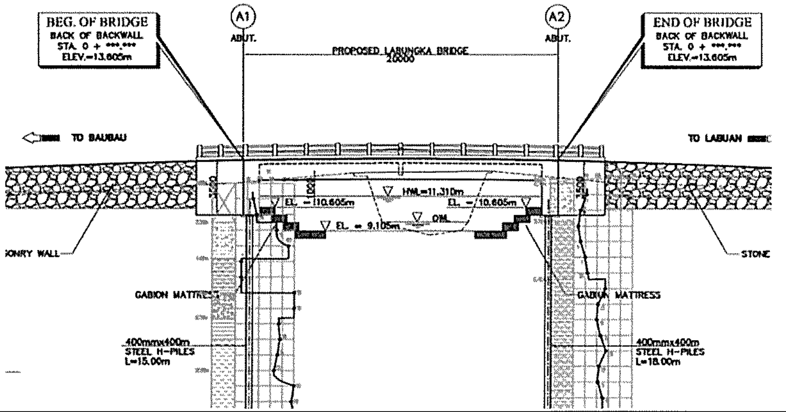
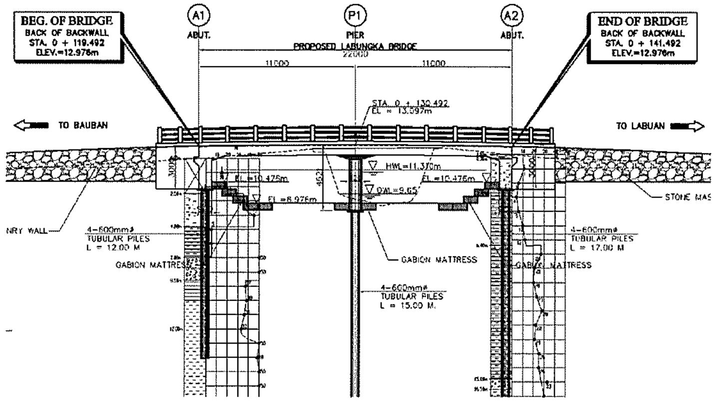
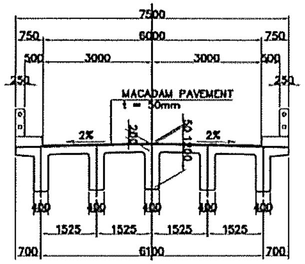
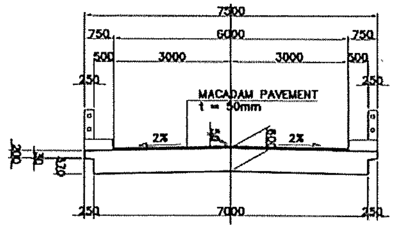
No.14 Wakaka II Bridge

Scheme	Single-Span RC Girder	2-Span RC Flat Slab
Bridge Side View		
Superstructure Section		
Cost	Economical (○)	Economical (○)
Constructability	Easy (○)	Easy (○)
Environmental Impact	Bridge height is higher (1.25m), Embankment area is larger (△)	Bridge height is lower (0.65m), Embankment area is smaller (○)
Other Features	Disturbance to flood discharge is less (○)	A pier under curve (R=150m) bridge is structurally necessary (◎)
Selection	△	○
	2-span RC flat slab is superior since installation of a pier in the curb bridge is necessary structurally.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (9/11) Comparison of Superstructure Type and Span Arrangement

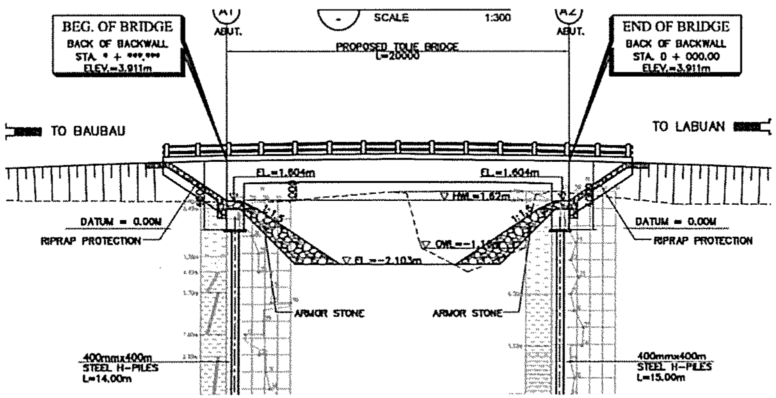
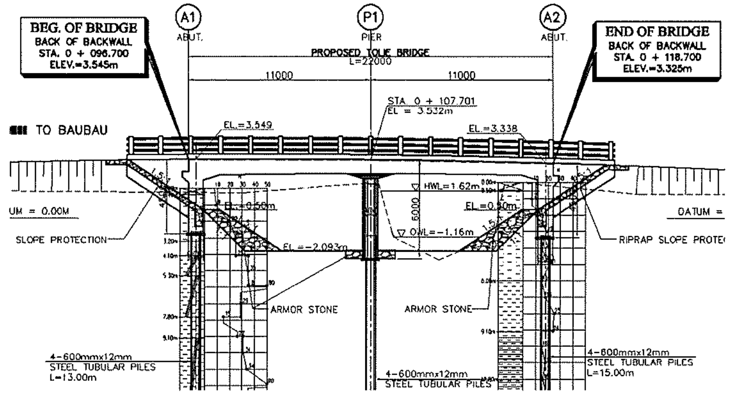
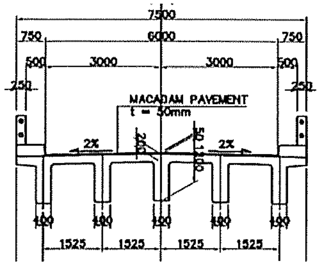
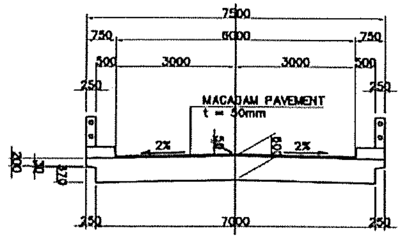
No.15 Labungka Bridge

Scheme	Single-Span RC Girder	2-Span RC Flat Slab
Bridge Side View		
Superstructure Section		
Cost	Economical (○)	Economical (○)
Constructability	Easy (○)	Easy (○)
Environmental Impact	Bridge height is higher (1.25m), Embankment area is larger (×)	Bridge height is lower (0.65m), Embankment area is smaller (○)
Other Features	Disturbance to flood discharge is less (○)	Disturbance to flood discharge is bigger (△)
Selection	△	○
	2-span RC flat slab of which height is lower and embankment area is smaller is superior since houses exist near the bridge.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (10/11) Comparison of Superstructure Type and Span Arrangement

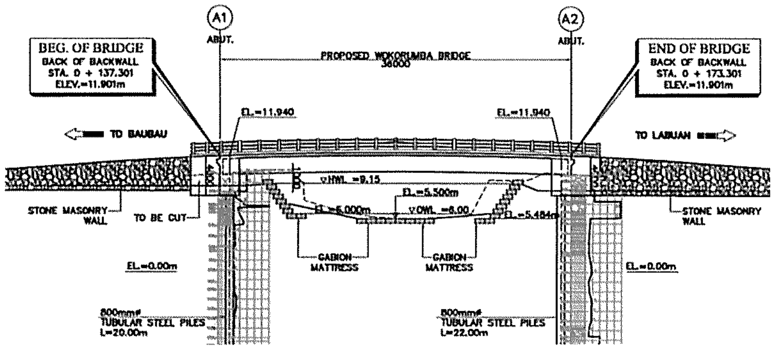
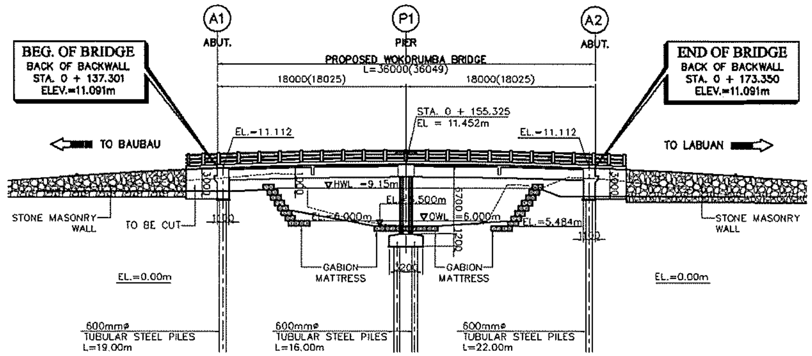
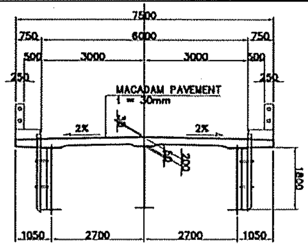
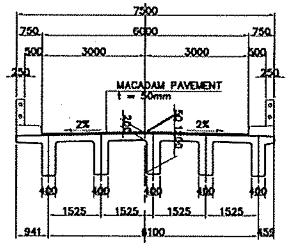
No.16 Tolie Bridge

Scheme	Single-Span RC Girder	2-Span RC Flat Slab
Bridge Side View		
Superstructure Section		
Cost	Economical (○)	Economical (○)
Constructability	Easy (○)	Easy (○)
Environmental Impact	Bridge height is higher (1.25m), Embankment area is larger (×)	Bridge height is lower (0.65m), Embankment area is smaller (○)
Other Features	Disturbance to flood discharge is less (○)	A pier under curve (R=150m) bridge is structurally necessary (△)
Selection	△	○
	2-span RC flat slab of which height is lower and embankment area is smaller is superior since houses exist near the bridge.	

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior

Table 2.2-11 (11/11)　Comparison of Superstructure Type and Span Arrangement

No.17 Wakorumba Bridge

<table>
<tr><th>Scheme</th><th>Single-Span Plate Girder</th><th>2-Span RC Girder</th></tr>
<tr><td>Bridge Side View</td><td>
</td><td>
</td></tr>
<tr><td>Superstructure Section</td><td>
</td><td>
</td></tr>
<tr><td>Cost</td><td>Steel girder is more expensive (×)</td><td>RC bridge is less expensive (◎)</td></tr>
<tr><td>Constructability</td><td>Construction is easy (○)</td><td>Construction is easy (○)</td></tr>
<tr><td>Environmental Impact</td><td>Bridge height is higher (1.85m), Land acquisition is larger (×)</td><td>Bridge height is lower (1.25m), Land acquisition is smaller (○)</td></tr>
<tr><td>Other Features</td><td>Disturbance to flood discharge is less (○)</td><td>Disturbance to flood discharge is bigger (△)</td></tr>
<tr><td rowspan="2">Selection</td><td>×</td><td>○</td></tr>
<tr><td colspan="2">2-span RC girder is superior since cost is less.</td></tr>
</table>

Note: ○:Superior, △:Medium/Relatively inferior, ×: Inferior