2.2.5 Classification of Bridges by Project Type

Two project types, Group 1 and Group 2, were requested by the Government of the Republic of the Philippines. The description of the project types is as follows:

Group 1 Project: Steel girders to be procured by the Project, while design and construction of bridges to be undertaken by the Government of the Republic of the Philippines.

Group 2 Project: Design and construction of bridges to be undertaken by the Project, since design and construction are difficult and should be undertaken by Japanese consultants and constructors.

The criteria for classification of the project bridges by project type are as follows:

<u>Bridge Classification Criteria</u>

(1) Bridges for Group 1 (which fulfill the following conditions):

- H-beam girder or built-up beam girder is applicable.
- Sufficient data for designing superstructures are available.
- High engineering technology, special machines or materials are not required for design and construction. Generally, the following structure types and construction methods are applicable to these bridges:

  Foundation type : Spread or precast RC piles
  Substructure type : Concrete gravity or RC inverted-T
  Erection method : Truck crane
  Temporary work for pier excavation : River diversion or fill type (sand bag) cofferdam

(2) Bridges for Group 2 (other than Group 1 which require high engineering technology, special machines or materials for design and construction):

Bridges classified into Group 2 and the reasons are as follows:

- The piers of the bridges are planned at deep and fast rivers, so special machines and materials are required for temporary works for constructing piers.

  10-01-10 Rizal Bridge
  10-01-12 Guinabsan Bridge
  10-02-04 Maog Bridge
  10-05-09 Pagatpat-S.Simon Bridge
  11-02-05 Lower Silway Bridge
  11-04-03 Inambatan Bridge
  11-05-01 Culaman Bridge

- The bridge sites are located on deep soft ground, so special technology is required for driving long piles and filling the embankment of the approach roads on soft ground.

  10-01-08 Lingayao Bridge
  10-01-09 Magus Bridge

- The bridge site is located on boulder mixed ground, so special technology and machines are required for construction of foundations.

  11-05-03 Mintal Bridge

(3) Bridges for "Conditional Group 1" (among bridges classified into Group 2 which can be designed and constructed by the Philippine side if the necessary technology and/or materials are provided by the project):

Bridges classified into Conditional Group 1 and the reasons are as follows:

- The piers of the bridges are planned at deep rivers, so temporary works for pier construction is difficult. In this case, since the piers are located at estuaries and the current velocity is slow, provision of PC (Prestressed Concrete) piles to construct pile-bent type piers will enable difficult temporary works to be avoided.

  10-04-10 Katipunan Bridge
  11-01-01 Andanan Bridge
  11-03-06 Mahan-Ub Bridge

- The bridge sites are located on boulder mixed ground, so high engineering technology is required for geological survey, designing and construction of substructures. In this case, technical assistance provided by the project will ensure the quality of such works.

  10-03-03 Agusan Canyon Bridge
  11-05-02 Los Amigos Bridge
  11-05-06 Piedad Bridge

The bridges for Conditional Group 1 were grouped into the Group 1 project, and provision of the necessary technical assistance and materials by the project was planned.

<u>Peace and order condition related with the classification</u>

Related with the classification by Project Group, peace and order conditions of the candidate bridge sites were evaluated based on the following criteria:

Peace and order condition evaluation criteria

Peace & order level A:	Very good, so Group 1 and Group 2 project is applicable
Peace & order level B:	Good, so Group 1 project is applicable
Peace & order level C:	Uncertain, so neither project is applicable

Bridge sites evaluated at peace and order level C were excluded from the final request.

As a result of the classification, the list of project bridges by project type and their peace and order levels are shown in Table 2-4. The location of the project bridges is shown in the map presented at the beginning of this report.

2.2.6 Appropriateness of the Project

The bridges for the project were selected since they are in urgent need of reconstruction, they provide considerable socioeconomic effects and they are appropriate to the project. Therefore, the necessity, effects and appropriateness of this project as a whole are summarized as follows:

<u>Necessity of the Project</u>

- Most of the requested bridges are dilapidated and weak temporary bridges which limit traffic and are dangerous to cross; therefore, replacement by permanent bridges is urgent.

- Some of the requested bridge sites are ford crossings, where vehicles and pedestrians cannot cross in rainy seasons and which are remote from towns and cities; therefore, construction of bridges is urgent.

<u>Socioeconomic effects of the Project</u>

- The replacement of dilapidated and weak temporary bridges by permanent bridges allows machines and materials for development access to rural areas, and local products to be sold at markets; therefore, replacement will contribute directly to the socioeconomic development of the areas concerned.

- These bridges are located along secondary national roads and other major rural roads, which connect major agricultural areas with major city markets or trunk highways.

Table 2-4 LIST OF PROJECT BRIDGES BY PROJECT TYPE

No.	Bridge No.	Bridge Name	Region	Province	Peace & Order	Remarks
Bridges for Group 1						
1	10-01-01	Tag-Anabhao	X	Agusan Del Norte	A	
2	10-02-01	Mesli	X	Agusan Del Sur	B	
3	10-02-03	Anibongan	X	"	B	
4	10-03-03	Agusan Canyon	X	Bukidnon	A	Conditional
5	10-03-06	Aglayan	X	"	A	
6	10-03-09	Silae	X	"	B	
7	10-04-03	Tipalac	X	Misamis Occidental	B	
8	10-04-04	Tipan Diut	X	"	B	
9	10-04-10	Katipunan	X	"	B	Conditional
10	10-06-01	Hayangabon II	X	Surigao Del Norte	B	
11	10-06-02	Capandan	X	"	B	
12	10-06-06	Tigbao	X	"	B	
13	10-06-07	Balite	X	"	B	
14	11-01-01	Andanan	XI	Surigao Del Sur	B	Conditional
15	11-01-02	Pagtilaan	XI	"	B	
16	11-01-03	Quezon	XI	"	B	
17	11-01-04	Pagbakatan	XI	"	B	
18	11-01-05	Union	XI	"	B	
19	11-01-06	Tagasaka	XI	"	B	
20	11-03-01	Dao-An	XI	Davao Oriental	B	
21	11-03-02	Licop	XI	"	B	
22	11-03-03	Tawas	XI	"	B	
23	11-03-06	Mahan-Ub	XI	"	B	Conditional
24	11-05-02	Los Amigos	XI	Davao Del Sur	A	Conditional
25	11-05-06	Piedad	XI	"	A	Conditional
26	11-05-07	Lais	XI	"	B	
27	11-06-02	Baliton	XI	Sarangani	B	
28	11-06-03	Pangyan	XI	"	B	
Bridges for Group 2						
1	10-01-08	Lingayao	X	Agusan Del Norte	A	
2	10-01-09	Magus	X	"	A	
3	10-01-10	Rizal	X	"	A	
4	10-01-12	Guinabsan	X	"	A	
5	10-02-04	Maog	X	Agusan Del Sur	A	
6	10-05-09	Pagatpat-S. Simon	X	Misamis Oriental	A	
7	11-02-05	Lower Silway	XI	South Cotabato	A	
8	11-04-03	Inambatan	XI	Davao	A	
9	11-05-01	Culaman	XI	Davao Del Sur	A	
10	11-05-03	Mintal	XI	"	A	

Note: Conditional Group 1 is described in Section 2.2.5(3).

Overall, the appropriateness of the project is summarized as follows:

Appropriateness of the Project

- The urgency and necessity of the project is very high.
- The socioeconomic effects of the project are very great.
- The project benefits large numbers of the general population.
- No problems during implementation of the project are anticipated.
- Maintenance of the bridges is simple and possible by DPWH.

As described above, the necessity, effects and appropriateness of the project are confirmed; therefore, it is appropriate to implement this project under Japan's Grant Aid.

2.3 Project Description

2.3.1 Execution Agency and Implementation Organization

The Department of Public Works and Highways (DPWH) is the responsible execution agency of the project.

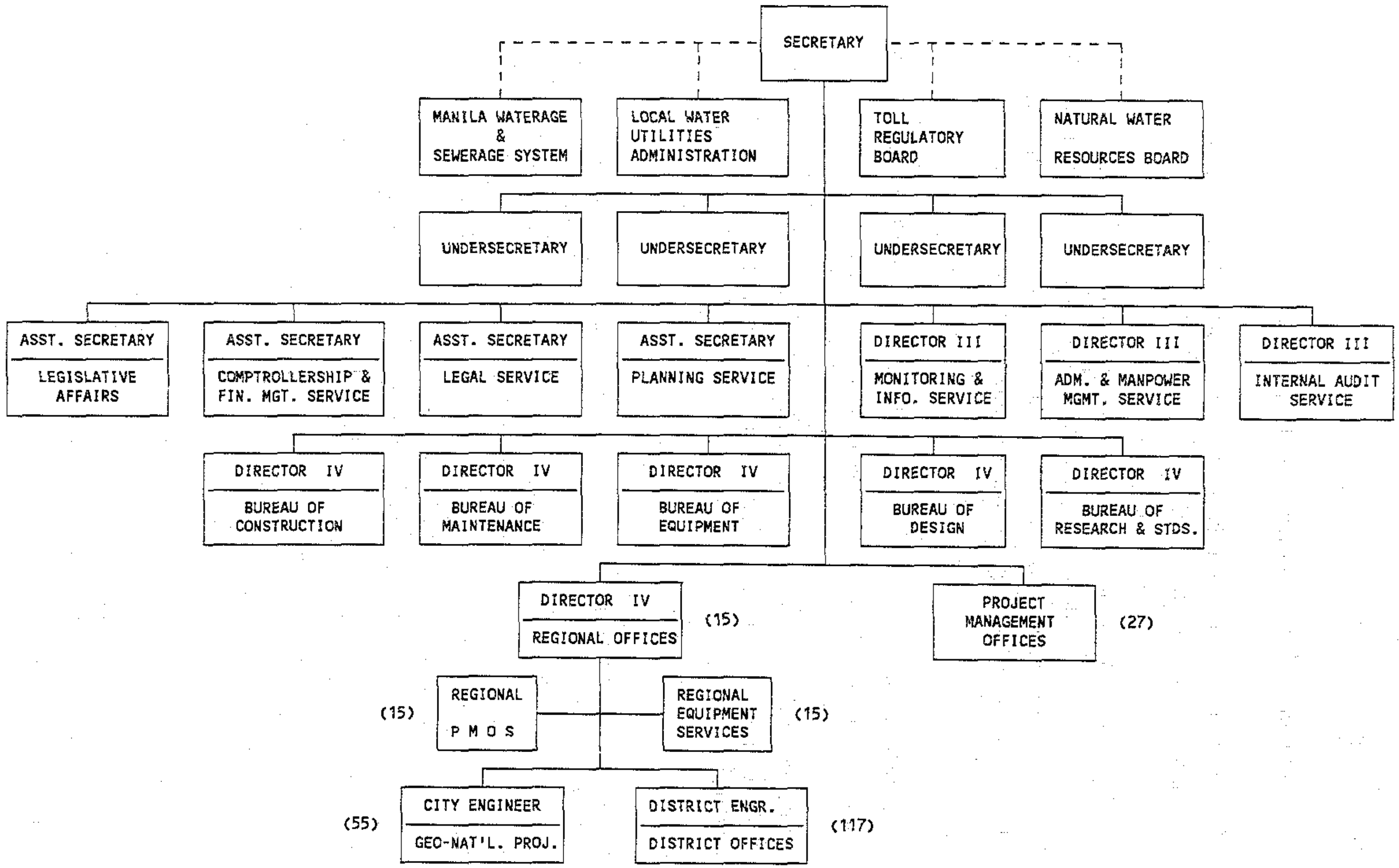
The DPWH is responsible for planning, designing, construction and maintenance of infrastructure, especially national highways, flood control and water resources development facilities. Provincial, city, municipal, and barangay roads are under the responsibility of local government units.

The organization chart of the DPWH is shown in Figure 2-2. The DPWH is headed by the secretary who is assisted by four undersecretaries, four assistant secretaries and directors. In the DPWH Central Office, there are 7 service offices, 5 bureaus and project management offices (PMO). At the regional level where the infrastructure projects are implemented, the DPWH has 15 Regional Offices. The organization chart of a regional office is shown in Figure 2-3.

The implementation organization for this project is shown in Figure 2-4. For the Group 1 project, the detailed design will be undertaken by the Planning and Design Division of the Regional Offices under the supervision of the Bureau of Design, and the construction will be undertaken by contractors. The construction will be supervised by the Construction Division of the Regional Offices at the site level. The Project Management Office for Special Bridge Project (PMO-SBP) will control construction of this project at the Central Office level.

For the Group 2 project, DPWH will implement the project by procuring a Japanese consultant firm for designing and construction supervision. Construction of the bridges will be undertaken by a Japanese constructor.

Annual budgets allocated for the DPWH for the last 3 years are shown in Table 2-5, and the DPWH investment program for infrastructure in 1994 is shown in Table 2-6.



Note : Number in ( ) shows the number of offices.

Figure 2-2 ORGANIZATION CHART OF DPWH

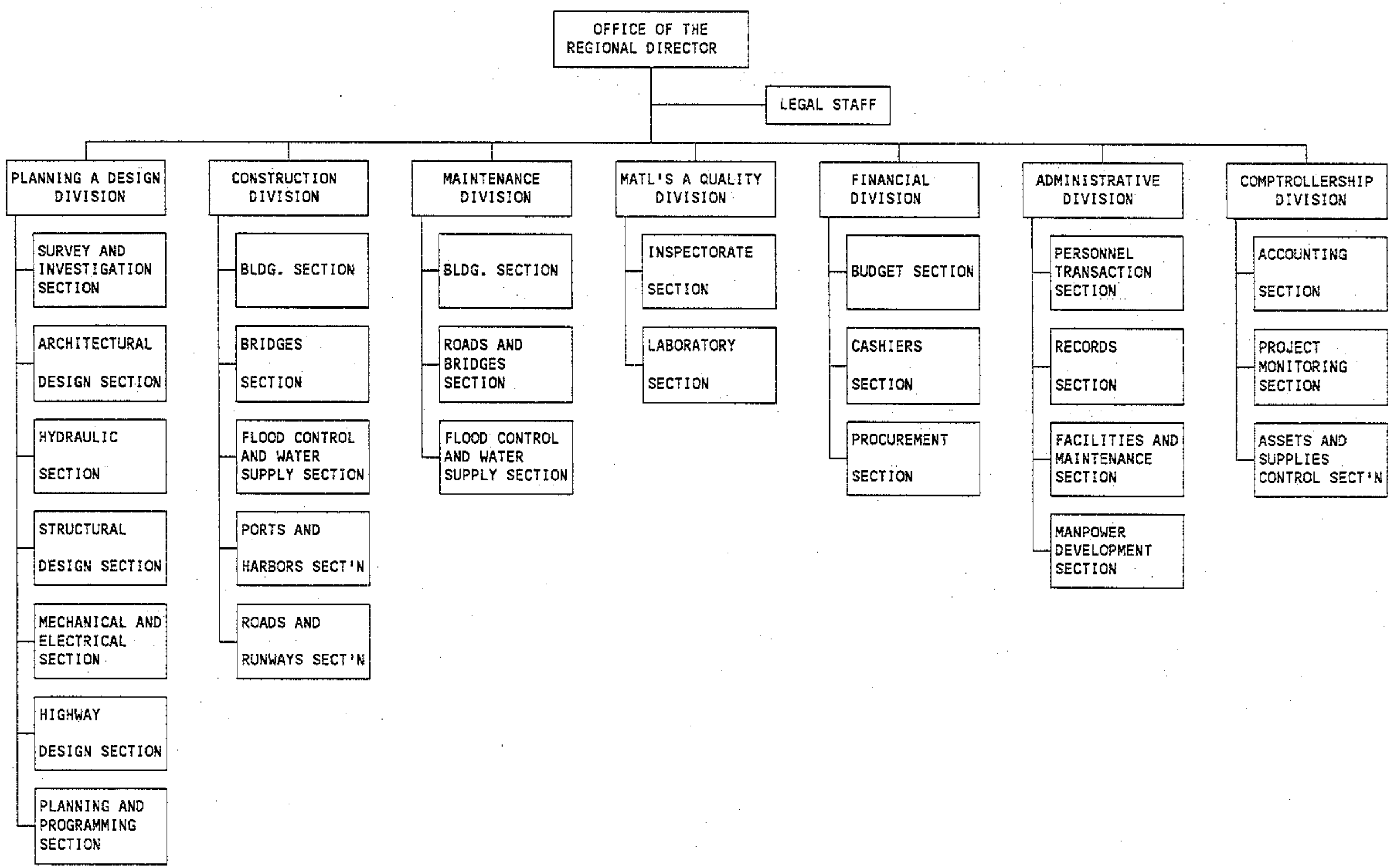


Figure 2-3 ORGANIZATION CHART OF DPWH REGIONAL OFFICE

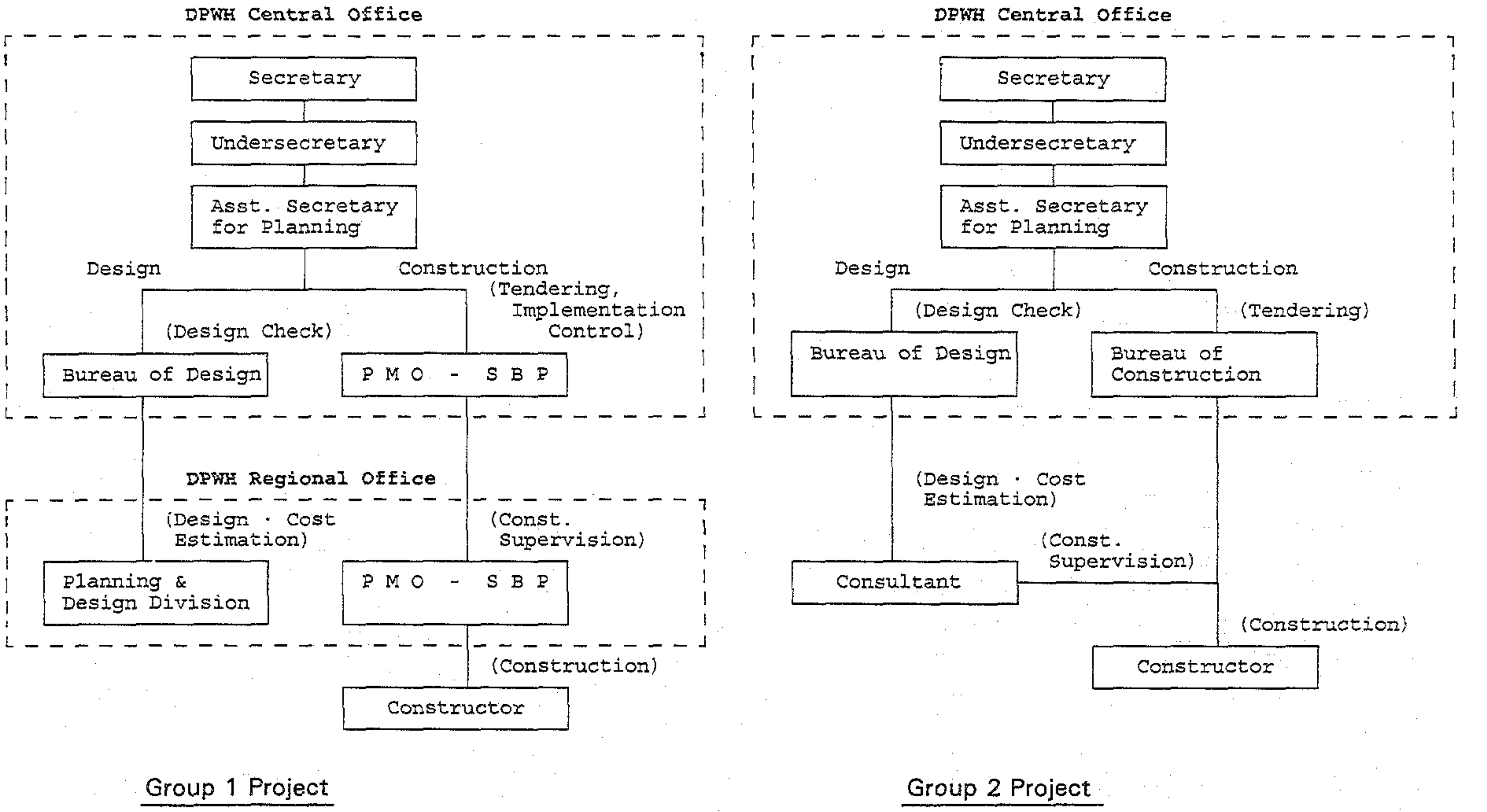


Figure 4-4 IMPLEMENTATION ORGANIZATION OF THE PROJECT

Table 2-5 ANNUAL BUDGET OF DPWH

(Unit : Billion Pesos)

	1992	1993	1994
A. Capital Outlays	16.73	16.53	20.54
A. 1 Infrastructure	16.65	16.42	20.45
Basic Program	16.65	12.85	13.85
Additional	0	3.57	6.60
A. 2 Non-infrastructure	0.8	0.11	0.09
B. Current Operating Expenditures	4.56	3.56	3.87
Total	21.29	20.18	24.41

Source: Highlights of 1994 Budget/Program, Aug. 25 1993 DPWH

Table 2-6 DPWH INVESTMENT PROGRAM FOR INFRASTRUCTURE (1994)

(Unit : Million Pesos)

Highways	10,617
Arterial Roads	7,378
Secondary Roads	3,239
Flood Control	1,907
Water Supply	660
Urban Community Infrastructure	519
Feeder Ports	47
Others	100
Total	13,850

Source: Highlights of 1994 Budget/Program, Aug. 25 1993 DPWH

2.3.2 Maintenance Plan

The Bureau of Maintenance of DPWH is responsible for the maintenance of national roads and their bridges, while the road maintenance divisions of local government units are responsible for the maintenance of local roads under the technical supervision of DPWH.

There are 4 types of maintenance programs:

- Routine Maintenance : Daily basis throughout the year
- Periodic Maintenance : Recurrent time cycle of more than one year
- Emergency Maintenance: Unprogrammed activities required in the aftermath of slides, floods, etc.
- Special Maintenance : Outside the scope of normal maintenance

The Philippines Highway Maintenance Management System (PHMMS) regulates 56 work activities, of which 8 activities are related to bridge maintenance, as shown in Table 2-7.

Table 2-7 MAINTENANCE ACTIVITIES FOR BRIDGES

Activity No.	Activity
151	Clearing
152	Patching of concrete decks
153	Repair of concrete bridges
154	Repair of steel bridges
155	Repair of Bailey bridges
157	Clearing drainages
402	Initial response to emergencies
65X	Repainting

It is important that the bridges constructed by the project be monitored in accordance with the maintenance activities indicated in Table 2-7.

CHAPTER 3

BASIC DESIGN
OF
GROUP 1 PROJECT

CHAPTER 3

BASIC DESIGN OF GROUP 1 PROJECT

3.1 Basic Design Concepts

The basic design is carried out in accordance with the following basic concepts:

(1) Bridge location and bridge length

- The project bridge locations will be decided after technical examination of the Study Team based on the results of discussion and site investigation by the Study Team and DPWH staffs concerned.

- The project bridge locations will be decided by taking account of the topographic condition, river condition, existing houses, public facilities, existing road alignments and detours during construction.

- Bridge length is the distance between abutments. Abutment locations will be examined with flooding condition of the rivers. The bridge lengths should be long enough to discharge floods.

- The project bridge elevations will be decided based on the maximum flood level of the river ever obtained from hearing surveys of residents near the sites and on the results of hydrological analysis.

(2) Superstructure planning

The superstructure types should be simple supported steel girders which will be procured by Japan's Grant Aid. The steel girder types will be selected with consideration of construction costs, ease of construction and structural safety of the bridges.

(3) Substructure planning

Designing substructures of Group 1 bridges is the responsibility of DPWH. The Study Team will propose a standard design of substructures and other related structures for this project. The design concepts for planning substructures are as follows:

- Locally available materials are planned to be used for substructures as far as possible.

- Footings of abutments are planned to be embedded into existing ground.

- Footings of piers are planned to be embedded upto 2 m below the river bed, in principle.

- Scouring protection structures are planned where scouring around substructures is expected.

- Pile-bent type piers are planned where water is too deep to construct standard inverted-T type piers. For the pile-bent type piers, PC piles are planned to be used where the river is tidal.

(4) Design criteria

- The design specifications specified by DPWH are applied to this project, in principle.

- The standard designs of roads and bridges are used in this project as far as applicable.

(5) Construction method

- The structures are planned to be easy to construct for local constructors.

- The parts of the steel girders are planned to be not longer than 8.5 m for the convenience of transportation and erection.

(6) Earthquake proof design

Since the project area is earthquake prone, the project bridges are designed to be earthquake resistant in accordance with earthquake resistant specifications specified by DPWH and also by the Japan Road Association.

(7) Detours during construction

- Detour roads with temporary bridges are planned where existing bridges are need to be demolished for the project. The detour roads should maintain existing traffic service levels.

(8) Basic conditions of the project

- For the Group 1 project, the design of superstructures will be undertaken by a Japanese consultant, and the design and construction of substructures, approach roads and other related structures will be undertaken by DPWH. However, for 6 bridges evaluated as difficult in designing and construction, the technical assistance of a Japanese consultant is proposed.

- Locations, elevations and structures of the project bridges except for superstructures, will be decided finally in the detailed designs stage undertaken by DPWH based on detailed geological surveys, topographic surveys and hydrological analyses.

3.2 Project Site Survey and Analysis of the Collected Data

(1) Site discussion with DPWH staff and the Study Team

The following items necessary for the basic design of the project were confirmed through discussions with DPWH staff (engineers from the Planning Office of the Central Office and Regional Offices):

- Location of the proposed bridges
- Planning of detours during construction
- Planning of removal of obstacle objects (power posts, water pipes, etc.)
- Possibility of relocation of houses within proposed right-of-ways
- Possibility of land acquisition for proposed routes

(2) Project site investigation

The following items were investigated at the project sites:

- Condition of existing bridges
- Topography
- River condition
- Maximum flood levels
- Existing road conditions, especially for transportation of materials and equipment

(3) Topographic surveys

Topographic surveys to obtain topographic data for the basic design of the project bridges were carried out.

Topographic surveys were carried out on the 20 bridges of 28 Group 1 bridges whose topography is relatively complicated. Of the remaining 8 bridges of Group 1, the topographic maps prepared in the preliminary study of the project conducted by DPWH were checked at the sites by the Study Team and are used for the basic design.

The list of the surveyed bridges is shown in Table 3-1.

Table 3-1 TOPOGRAPHIC SURVEY SITES

Number	Bridge Number	Bridge Name
1	10-01-01	Tag-Anahao Bridge
2	10-01-08	Lingayao Bridge
3	10-01-09	Magus Bridge
4	10-02-01	Mesli Bridge
5	10-03-06	Aglayan Bridge
6	10-03-07	Zamboanguita Bridge
7	10-03-09	Silae Bridge
8	10-04-10	Katipunan Bridge
9	10-06-01	Hayangabon II Bridge
10	10-06-06	Tigbao I Bridge
11	10-06-07	Balite Bridge
12	11-01-01	Andanan Bridge
13	11-01-05	Union Bridge
14	11-03-01	Dao-An Bridge
15	11-03-02	Licop Bridge
16	11-03-06	Mahan-Ub Bridge
17	11-05-02	Los Amigo Bridge
18	11-05-07	Lais Bridge
19	11-06-02	Baliton Bridge
20	11-06-03	Pangyan Bridge

Contents of the surveys

- Area

Along the road centerline : extending 50 m back from the proposed abutments

Along the river center : extending 50 m up and downstream from the proposed bridges

- Survey Items

  Centerline survey
  Profile survey
  Cross section
  Plane survey

As a result of the topographic surveys, the following maps were de veloped:

Profiles	(Scale: 1/200)
Cross sections	(Scale: 1/200, at 20 m intervals)
Topographic maps	(Scale: 1/200)

(4) Results of the project site surveys

The results of the project site surveys are summarized in Table 3-2, and the outline of topographic and river conditions of the project sites is shown in Table 3-3.

Table 3-2 SUMMARY OF PROJECT SITE SURVEY RESULTS (GROUP 1)

(1/3)

No.	Bridge No. Bridge Name	Existing Condition	Proposed Bridge Location	Detour Plan	Existing Bridge Demolition Plan	Access Road Condition	Remarks
1	10-01-01 Tag-Anahao	• Timber (L=17.3m)	• New bridge center is the most downstream existing timber	• Detour bridge is constructed at upstream of new bridge	• Existing bridge is demolished prior to construction	• Nasipit to Butuan is paved. • Butuan to site is gravel in fair condition.	
2	10-02-01 Mesli	• Timber (L=41.0m)	• New bridge center connected both approach roads center	• Existing timber bridge is used during construction	• Existing bridge is demolished after construction	• Nasipit to Prosperidad is paved. • Prosperidad to site is gravel in fair condition.	
3	10-02-03 Anibongan	• Timber (L=23.1m)	• New bridge center is 4 to 5m upstream of existing bridge center	• Ford crossing	• Existing bridge is demolished prior to construction	• Nasipit to Prosperidad is paved. • Prosperidad to site is gravel in fair condition.	
4	10-03-03 Agusan Canyon	• Bailey (L=40.0m)	• New bridge center is 1 to 2m downstream of existing bridge center	• Detour bridge is constructed at downstream down-stream of new bridge	• Existing bridge is demolished prior to construction	• Cagayan De Oro to Prosperidad is paved. • Delmonte to site is gravel in fair condition.	• Temporary land is needed for detour bridge
5	10-03-06 Aglayan	• Bailey (L=27.4m)	• New bridge center is existing bridge center	• Detour bridge is constructed at downstream of new bridge	• Existing bridge is demolished prior to construction	• Cagayan De Oro to Malaybalay is paved. • Malaybalay to site is gravel in good condition.	
6	10-03-09 Silae	• Bailey (L=27.8m)	• New bridge center is existing bridge center	• Ford crossing	• Existing bridge is demolished prior to construction	• Cagayan De Oro to Malaybalay is paved. • Malaybalay to site is gravel in fair condition.	
7	10-04-03 Tipalac	• Bailey (L=19.5m)	• New bridge center is existing bridge center	• Detour road exists at 50m downstream	• Existing bridge is demolished prior to construction	• Ozamiz to Oroquieta is paved. • Oroquieta to site is partially gravel in good condition.	
8	10-04-04 Tipan Duit	• Bailey (L=19.3m)	• New bridge center is existing bridge center	• Detour road exists at 100m downstream	• Existing bridge is demolished prior to construction	• Ozamiz to Oroquieta is paved. • Oroquieta to site is partially gravel in good condition.	
9	10-04-10 Katipunan	• Bailey (L=67.3m)	• New bridge center is 2.6m downstream of existing bridge center	• Detour bridge is constructed at upstream of new bridge	• Existing bridge is demolished prior to construction	• Ozamiz to site is paved.	
10	10-06-01 Hayangabon II	• Timber (L=19.8m)	• New bridge center is existing bridge center	• Detour bridge is constructed at upstream of new bridge	• Existing bridge is demolished prior to construction	• Nasipit to Saison is paved. • Saison to site is gravel in good condition.	
11	10-06-02 Capandan	• Timber (L=14.6m)	• New bridge center is 0.25m downstream of existing bridge center	• Detour bridge is constructed at upstream of new bridge	• Existing bridge is demolished prior to construction	• Nasipit to Saison is paved. • Saison to site is gravel in good condition.	
12	10-06-06 Tigbao	• Timber (L=40.4m)	• New bridge center is existing bridge center	• Ford crossing	• Existing bridge is demolished prior to construction	• Nasipit to Agana An is paved. • Agana An to site is gravel in good condition.	

Table 3-2 SUMMARY OF PROJECT SITE SURVEY RESULTS (GROUP 1)

(2/3)

No.	Bridge No. Bridge Name	Existing Condition	Proposed Bridge Location	Detour Plan	Existing Bridge Demolition Plan	Access Road Condition	Remarks
13	10-06-07 Balite	' Ford crossing	' New bridge center is 2.6m downstream of existing approach roads center	' Ford crossing	' No bridge	' Nasipit to Agana An is paved. ' Agana An to site is gravel in good condition.	
14	11-01-01 Andanan	' Bailey (L=48.7m)	' New bridge center is 6.6m upstream of existing bridge center	' Existing bridge is used during construction	' Existing bridge is demolished after construction	' Nasipit to Prosperidad is paved. ' Prosperidad to site is gravel in fair condition.	
15	11-01-02 Pagtilaan	' Bailey (L=25.4m)	' New bridge center is 8m downstream of existing bridge center	' Ford crossing	' Existing bridge is demolished after construction	' Nasipit to Prosperidad is paved. ' Prosperidad to site is gravel in fair condition.	
16	11-01-03 Quezon	' Timber (L=19.2m)	' New bridge center is existing bridge center	' Ford crossing	' Existing bridge is demolished prior to construction	' Nasipit to Prosperidad is paved. ' Prosperidad to site is gravel in fair condition.	
17	11-01-04 Pagbakatan	' Timber (L=16.0m)	' New bridge center is existing bridge center	' Detour bridge is constructed at downstream of new bridge	' Existing bridge is demolished prior to construction	' Nasipit to Prosperidad is paved. ' Prosperidad to site is gravel in fair condition.	
18	11-01-05 Union	' Timber (L=24.6m)	' New bridge center is 20m downstream of existing bridge center	' Existing bridge is used during construction	' Existing bridge is demolished after construction	' Nasipit to Prosperidad is paved. ' Prosperidad to site is gravel in fair condition.	
19	11-01-06 Tagasaka	' Timber (L=26.9m)	' New bridge center is 2.1m upstream of existing bridge center	' Detour bridge is constructed at downstream of new bridge	' Existing bridge is demolished prior to construction	' Nasipit to Prosperidad is paved. ' Prosperidad to site is gravel in fair condition.	
20	11-03-01 Dao-An	' Ford crossing	' New bridge center is to connect approach roads center	' Ford crossing	' No bridge	' Davao to Mati is paved. ' Mati to site is gravel in fair condition except mountainous sections are steep and narrow.	
21	11-03-02 Licop	' Bailey (L=24.8m)	' New bridge center is existing bridge center	' Detour bridge is constructed at upstream of new bridge	' Existing bridge is demolished prior to construction	' Davao to Mati is paved. ' Mati to site is gravel in fair condition.	
22	11-03-03 Tawas	' Bailey (L=12.6m)	' New bridge center is existing bridge center	' Detour bridge is constructed at upstream of new bridge	' Existing bridge is demolished prior to construction	' Davao to Mati is paved. ' Mati to site is gravel in fair condition.	
23	11-03-06 Mahan-Ub	' No bridge	' New bridge center is to connect approach roads center	' Municipal road is used as is	' No bridge	' Davao to Mati is paved. ' Mati to site is gravel in fair condition except mountainous sections are steel and narrow.	
24	11-05-02 Los Amigos	' Bailey (L=30.5m)	' New bridge center is existing bridge center	' Detour bridge is constructed at upstream of new bridge	' Existing bridge is demolished prior to construction	' Davao to site is paved.	' 3 houses need relocation ' Power posts need relocation

Table 3-2 SUMMARY OF PROJECT SITE SURVEY RESULTS (GROUP 1)

(3/3)

No.	Bridge No. Bridge Name	Existing Condition	Proposed Bridge Location	Detour Plan	Existing Bridge Demolition Plan	Access Road Condition	Remarks
25	11-05-06 Piedad	' Bailey (L=40.1m)	' New bridge center is existing bridge center	' Detour bridge is constructed at downstream of new bridge	' Existing bridge is demolished prior to construction	' Davao to Mati is paved.	
26	11-05-07 Lais	' Ford crossing	' New bridge is about 300m upstream of existing route	' Ford crossing	' No bridge	' Davao to Sulop is paved. ' Sulop to site is gravel in fair condition.	' 2 small bridges are planned to cross branch rivers upstream instead of a long bridge
27	11-06-02 Baliton	' Bailey (L=27.4m)	' New bridge center is 9m upstream of existing bridge center	' Existing bridge is used during construction	' Existing bridge is demolished after construction	' Makar to Glan is paved. ' Glan to site is gravel in good condition.	' 2 to 5 houses need relocation
28	11-06-03 Pangyan	' Ford crossing	' New bridge center is to connect approach roads center	' Ford crossing	' No bridge	' Makar to Glan is paved. ' Glan to site is gravel in good condition.	

Table 3-3 OUTLINE OF TOPOGRAPHIC AND RIVER CONDITION OF THE PROJECT SITES (GROUP 1)

(1/4)

No.	Bridge No. Bridge Name	Topographic Condition	River Condition
1	10-01-01 Tag-Anahao	· Location is at foot of mountains · Site topography is hilly · Land is for cultivating coconuts, bananas	· River is very small, slow · Water is very little · Alignment is stable · River bed is clayey soil
2	10-02-01 Mesli	· Location is inland plain · Site topography is flat · Land is for cultivating coconuts, corn, bananas	· River is medium size, fast · Water depth is not shallow · Alignment is winding and being scoured · River bed is clayey soil with gravel
3	10-02-03 Anibongan	· Location is inland plain · Site topography is flat · Land is for cultivating coconuts, corn, bananas	· River is small, slow, shallow · Alignment is winding and being scoured · River bed is clayey soil with gravel
4	10-03-03 Agusan Canyon	· Location is at deep valley in inland plateau · Site topography is very steep on both sides of river · Houses are adjacent to bridge	· River is medium size, fast · Water depth is not shallow in dry season · Alignment is stable · Erosion is occurring · Large size boulders lie on riverbed
5	10-03-06 Aglayan	· Location is at hill in inland plain · Around site is not cultivated	· River is small · Water depth is shallow even in rainy season · Alignment is stable · Large size boulders lie on riverbed
6	10-03-09 Silae	· Location is in mountains · Site topography is mountainous · Around site is for cultivating corn, bananas	· River is small, shallow, medium fast · River bank is steep · Soft rock is appearing at river bank · Gravel is deposited at riverbed
7	10-04-03 Tipalac	· Location is halfway up mountains · Site topography is mountainous · Site is surrounded by coconut trees	· River is very small, steep · Water is very little except flooding · Alignment is stable · Boulders lie on clayey soil riverbed
8	10-04-04 Tipan Diut	· Location is at halfway up mountains · Site topography is mountainous · Site is surrounded by coconut trees	· River is very small, steep · Water is very little except flooding · Alignment is stable · Boulders lie on clayey soil riverbed

Table 3-3 OUTLINE OF TOPOGRAPHIC AND RIVER CONDITION OF THE PROJECT SITES (GROUP 1)

(2/4)

No.	Bridge No. Bridge Name	Topographic Condition	River Condition
9	10-04-10 Katipuman	· Location is at estuary of medium size river · Site topography is swampy on one side and hilly on the other · Nippa at swamp, coconuts at land are cultivated	· River is tidal · Clay is deposited on riverbed
10	10-06-01 Hayangabon II	· Location is at estuary of small river · Site is swampy scrub	· River is tidal · Gravel is deposited on clayey riverbed
11	10-06-02 Capandan	· Location is at small coastal plain · Site topography is flat · Rice is cultivated around site · 3 houses are adjacent to site	· River is small, fast · Alignment is winding and scouring is occurring · Gravel is deposited on riverbed
12	10-06-06 Tigbao	· Location is seaside (20m from sea) · One side is coast, the other is steep mountains · Coconuts are cultivated around site	· River is dry in dry seasons · Flash water comes down when it rains heavily · Gravel and cobble stones deposited deeply on riverbed
13	10-06-07 Balita	· Location is foot of steep mountains near sea · Site topography is hilly · Coconuts, bananas are cultivated around site	· River is dry in dry seasons · Flash water comes down when it rains heavily · Gravel and cobble stones deposited deeply on riverbed
14	11-01-01 Andanan	· Location is at estuary of medium size river · Site topography is mountainous · Coconuts are cultivated on the mountains around site	· River is tidal · River current is slow · Riverbed is clay deposit
15	11-01-02 Pagtilaan	· Location is at coastal plain · Site topography is flat · Site is residential area	· River is medium size, slow · River is not shallow always · Gravel is deposited on riverbed
16	11-01-03 Quezon	· Location is at coastal plain · Site topography is flat · Coconut trees are planted around site	· River is small, slow · Alignment is winding · Scouring is not occurring · Riverbed is hard clayey soil

Table 3-3 OUTLINE OF TOPOGRAPHIC AND RIVER CONDITION OF THE PROJECT SITES (GROUP 1)

(3/4)

No.	Bridge No. Bridge Name	Topographic Condition	River Condition
17	11-01-04 Pagbakatan	· Location is at deep mountain · Site topography is very mountainous · Site is tropical forest	· River is small mountainous river, fast · Alignment is winding and erosion is occurring · Gravel is deposited on riverbed
18	11-01-05 Union	· Location is foot of mountains · Topography is mountainous on both sides of river · Coconut trees are planted around site	· River is medium size, fast · Erosion is occurring · Gravel is deposited on riverbed
19	11-01-06 Tagasaka	· Location is in gentle mountains · Site topography is hilly · Bananas, coconuts are cultivated around site · Houses are located around site	· Irrigation dam is down-stream · Riverbed is coral
20	11-03-01 Dao-An	· Location is inland, foot of mountains · Topography is rolling · Coconut trees are planted around site	· River is medium size · Alignment is winding and changing · Erosion is occurring · Gravel is deposited on riverbed
21	11-03-02 Licop	· Location is in mountains · Site topography is very mountainous · Site is tropical forest	· River is small mountainous river · Water is very little in dry seasons · Erosion is occurring · Boulders and cobble stones are deposited on riverbed
22	11-03-03 Tawas	· Location is in mountains · Site topography is very mountainous · Site is tropical forest	· River is small mountainous river · Water is very little in dry seasons · Erosion is occurring · Boulders and cobble stones deposited on riverbed
23	11-03-06 Mahan-Ub	· Location is at coastal plain · Site topography is flat · Bus terminal, market are being constructed near site	· River is tidal · Gravel and cobble stones are deposited on riverbed
24	11-05-02 Los Amigos	· Location is on Davao plain · Site topography is flat · Corn, coconuts are cultivated around site · Houses are adjacent to site	· River is medium size, fast · Water is not shallow always · Erosion is occurring · Boulders lie on riverbed

Table 3-3 OUTLINE OF TOPOGRAPHIC AND RIVER CONDITION OF THE PROJECT SITES (GROUP 1)

(4/4)

No.	Bridge No. Bridge Name	Topographic Condition	River Condition
25	11-05-06 Piedad	· Location is on Davao plain · Site topography is flat · Site is residential area	· River is medium size, fast · Water is not shallow always · Boulders and cobble stones are deposited on riverbed · Bed rock is appearing
26	11-05-07 Lais	· Location is at small coastal plain · Site topography is flat · Cacao and coconut trees are planted around site	· River is medium size · Water is relatively fast · River is flat and wide · Gravel is deposited on riverbed · Sand with river branches off 200m upstream from sea
27	11-06-02 Balition	· Location is inland plain · Site topography is flat · Coconut trees are planted around site · Houses are located near site	· River is small, relatively fast · Clayey river bank is being eroded
28	11-06-03 Pangyan	· Location is inland, foot of mountains · Site topography is rolling · Coconut trees are planted around site	· River is medium size, shallow, relatively fast · River is flat and wide · Gravel is deposited on riverbed

3.3 Examination of Design Criteria

(1) Design specifications

The following specifications specified by DPWH are applied to this basic design. However, Japanese highway bridge design specifications are supplementary applied to the design where DPWH specifications do not specify.

- AASHTO Standard Specifications for Highway Bridge, 15th Ed., 1992
- Highway Design Guideline, DPWH
- AASHTO Guide for Design of Pavement Structures, 1986
- Standard Specifications for Highways, Bridges & Airports, DPWH, 1988
- Technical Guidelines, DPWH, August 1993

(2) Design load

- Dead load : Handrails, curbs, pavement, slabs, haunch and steel beam are considered in design

- Live load : HS 20-44 specified in ASSHTO (equivalent to trailer truck load)

  Concentrated load : for bending moment 18,000 lbs
  for shearing force 26,000 lbs

  Uniform load : 640 lbs/linear foot of load lane

- Impact : As specified in ASSHTO, Section 3.3.8

- Temperature change : ±10°C (base on the climate in Mindanao)

- Wind load : As specified in ASSHTO, Section 3.3.15

(3) Specified strength of materials

- Concrete
  - slab members Fc = 280 kgf/cm²
  - handrail members Fc = 210 kgf/cm²
  - substructure members Fc = 210 kgf/cm²

- Reinforcing bars (yield strength) Fy = 2100 kgf/cm²

(4) Specified material properties of steel girders

Specified material properties of steel girders for the project are shown in Table 3-4.

Table 3-4 MATERIAL PROPERTIES OF STEEL FOR GIRDERS

Japan Industrial Standards (JIS) Designation	Material Designation	Minimum Yield Point (kgf/mm²)			Tensile Strength (kgf/mm²)
		$t<16$	$16<t<40$	$40>t$	
JIS G 3101 Type-2	SS 400	25	24	22	41 to 52
JIS G 3106 Type-3	SM 490Y	37	36	34	50 to 62
JIS G 3114 Type-1	SMA 400	25	24	22	41 to 52
Type-2	SMA 490	37	36	34	50 to 62

t : Thickness of steel plate (in mm)

(5) Geometric standard of approach roads

The geometric standards to the secondary national roads are applied to designing all of the approach roads of the project bridges.

3.4 Basic Plan

3.4.1 Planning of Bridges

Based on the project site survey results and the basic design concepts, bridge location, bridge length, span length and bridge elevation of the project bridges were examined and planned as follows:

(1) Bridge location

The bridge locations were examined to plan the optimum location sagainst the site conditions. The following considerations were given to the examination:

- To shorten bridge length to economize construction cost
- To minimize removal of existing houses and other facilities within right-of-ways
- To minimize land acquisition for bridge and approach road construction
- To improve alignment of approach roads
- To economize construction cost in total including additional works and detour road construction
- To make bridges stable and easy to construct

(2) Bridge length and span length

Abutments and piers in the river should be located so as not to hinder flood discharge.

As a rule, the position of both abutments should be located behind the intersection points of the maximum flood level and the river dikes.

Planning of bridge length

Bridge length is determined as follows:
- Bridge lengths are long enough to provide sufficient river width between both abutments to discharge the maximum flood.
- Bridge lengths are not so long as to be unnecessary or uneconomical.
- Bridge locations are positioned to prevent scouring and the washing away of abutments.
- Floods flow smoothly and do not endanger abutments and approach embankments by scouring.

Planning of span length

The optimum span lengths were selected from the comparative combinations of numbers of spans and lengths which comprise the bridge length.

In comparing span length combinations, the following criteria were taken into consideration:

- Total construction costs
- Difficulty of construction of piers and their foundations in the river
- Degree of obstruction by piers against flood discharge
- Stability of piers against scouring

(3) Bridge elevation

The bridge elevations (elevation of top of deck slab at the center of carriageway of the bridge) were planned based on the maximum flood levels (MFL) plus freeboard and bridge structure depth.

The MFLs were obtained by hearing surveys and observation surveys in the site surveys. The maximum flood levels will be clarified with hydrological analyses during detailed design.

The freeboard (clearance between MFL and a bottom of girder) is planned to be 1.0 m high. Where bridges are needed to be low because of the conditions, the freeboard will be reduced to 0.5 m if there is no possibility of any flooding exceeding the MFLs.

Proposed bridge length, span length and bridge elevation of the project bridges are shown in the Table 3-5.

Table 3-5 BRIDGE LENGTH, SPAN LENGTH AND BRIDGE ELEVATION OF PROJECT BRIDGES

(1/2)

No.	Bridge No. Bridge Name	Bridge Length (m)	Span Length (m)	Girder Depth (m)	MFL (m)	Free Board (m)	Bridge Elev. (m)	Remarks
1	10-01-01 Tag-Anahao	21.0	1x21.0	0.90	48.0	2.9*	52.0 53.0	· Bridge is planned vertically sloped due to the mountainous topography.
2	10-02-01 Mesli	40.0	1x40.0	2.00	48.1	0.5**	51.0	· Simple span is planned since constructing a pier in the deep river is difficult.
3	10-02-03 Anibonga	24.0	1x24.0	0.912	50.7	1.0	53.0	
4	10-03-03 Agusan Canyon	42.0	24.0+18.0	0.912 0.890	46.5	1.0	48.8	· Use of 2 spans is planned longer to avoid constructing a pier at the center of the river where the water is deep and fast.
5	10-03-06 Aglayan	24.0	1x24.0	0.912	15.0	4.2*	20.5	
6	10-03-09 Silae	29.0	1x29.0	1.40	34.6	4.1*	40.5	· Simple span is planned since constructing a pier in the deep river is difficult.
7	10-04-03 Tipalac	20.0	1x20.0	0.90	47.5	2.2*	51.0	
8	10-04-04 Tipan Duit	21.0	1x21.0	0.90	46.4	3.1*	50.8	
9	10-04-10 Katipunan	54.0	3x18.0	0.89	45.1	1.0	47.4	· 3 span bridge with pile-bent type piers is planned since the river is a deep estuary.
10	10-06-01 Hayangabon II	23.0	1x23.0	0.912	50.5	0.5**	52.3	· River overflows when flooding.
11	10-06-02 Capandan	19.0	1x19.0	0.89	49.6	0.5**	51.4	· River overflows when flooding.
12	10-06-06 Tigbao	44.0	2x22.0	0.912	50.8	1.0	53.1	· Pier construction is easy.
13	10-06-07 Balite	24.0	1x24.0	0.912	49.7	1.0	52.0	
14	11-01-01 Andanan	60.0	3x20.0	0.90	14.7	1.0	17.0	· 3 span bridge with pile-bent type piers is planned since the river is a deep estuary.
15	11-01-02 Pagtilaan	32.0	1x32.0	1.60	14.8	1.0	17.8	· Simple span is planned since constructing a pier in the deep river is difficult.
16	11-01-03 Quezon	19.0	1x19.0	0.89	49.8	1.0	52.1	
17	11-01-04 Pagbakatan	24.0	1x24.0	0.912	40.7	3.2*	45.2	
18	11-01-05 Union	35.0	1x35.0	1.70	42.3	1.0	45.3	· Simple span is planned since constructing a pier in the deep river is difficult.
19	11-01-06 Tagasaka	28.0	1x28.0	1.40	42.0	1.0	44.8 45.3	· Simple span is planned since constructing a pier in the deep river is difficult. · Bridge with vertical slope is planned since the approach roads have a big elevation gap.

Table 3-5 BRIDGE LENGTH, SPAN LENGTH AND BRIDGE ELEVATION OF PROJECT BRIDGES

(2/2)

No.	Bridge No. Bridge Name	Bridge Length (m)	Span Length (m)	Girder Depth (m)	MFL (m)	Free Board (m)	Bridge Elev. (m)	Remarks
20	11-03-01 Dao-An	48.0	2x24.0	0.912	48.4	1.0	50.7	· Pier construction is easy.
21	11-03-02 Licop	25.0	1x25.0	1.20	42.4	1.5*	45.5	
22	11-03-03 Tawas	15.0	1x15.0	0.70	15.6	3.6*	20.3	
23	11-03-06 Mahan-Ub	60.0	3x20.0	0.90	47.5	2.7*	51.5	· 3 span bridge with pile-bent type piers is planned since the river is a deep estuary.
24	11-05-02 Los Amigos	38.0	1x38.0	1.90	17.5	1.0	20.8	· Simple span is planned since constructing a pier in the deep river is difficult.
25	11-05-06 Piedad	46.0	12.0+22.0 +12.0	0.70	50.8	0.5**	52.4	· The center span is planned longer to avoid constructing a pier in the water. · The bridge is planned vertically curved to lower the approach road to meet the existing road before the intersection.
26	11-05-07 Lais	30.0+24.0	1x30.0 1x24.0	1.50 0.912	21.6	0.5**	24.0 23.4	· 2 single span bridges are planned upstream of the junction of the 2 rivers, instead of planning a long bridge with difficult pier construction.
27	11-06-02 Baliton	30.0	1x30.0	1.50	46.7	1.0	50.0	· Single span bridge is planned since constructing a pier in the river is difficult.
28	11-06-03 Pangyan	32.0	1x32.0	1.60	48.2	1.0	51.2	· Single span bridge is planned since constructing a pier in the river is difficult.

Note:
- Free boards with * are higher than 1.0 m since the vertical alignment design of the approach roads governed the bridge elevations.
- Free boards with ** are planned at 0.5 m since the bridge elevations need to be low and there is no possibility of any flood exceeding the MFL.
- The bridge depth used in planning bridge elevations is comprised of a deck slab (20 cm), concrete pavement (5 cm) and a deck slab haunch (11 cm).
- The bridge lengths in this table do not include the lengths of girder ends and expansion clearances.

3.4.2 Examination of Superstructure Types

(1) Superstructure types

The criteria for selection of superstructures for Group 1 project bridges are as follows:

- The superstructure types are steel girder types.
- The superstructure types are applicable to a span length range of 15 m to 40 m.
- The superstructures can be erected easily by local constructors.
- Transportation of the steel girders to the construction site is possible.
- Maintenance of the superstructures is easy.
- The superstructure types are economical, safe and durable.

Based on the above selection criteria, the following superstructure types were proposed based on experience in Japan and the Philippines:

- H-beam girder (composite girder)
- Built-up beam girder (composite girder)

Of the proposed superstructure types, the composite girder was proposed considering the advantages of cost, applicable variations of span length and experience in the Philippines. However, to construct the composite girders, quality control of the deck slab concrete to follow the specifications is required.

Of the proposed superstructure types, the simple supported beam type is proposed based on the following considerations:

- A continuous supported beam type bridges is not applicable where unequal settlement of the substructures is expected. Therefore, the continuous supported beam type is not recommendable for the project since the geological conditions of the sites is not yet known.

- Construction of the simple supported beam type is easier than of the continuous supported beam type.

- In general, continuous supported beam type bridges cost less compared with simple supported type bridges where bridge spans are longer than around 30 m. Since 60 m is the longest bridge in the project, the continuous supported beam type is not advantageous for this project.

To know the most economical superstructure type at each span length, the approximate steel material costs of each superstructure type at each span length were estimated and are plotted in Figure 3-1.

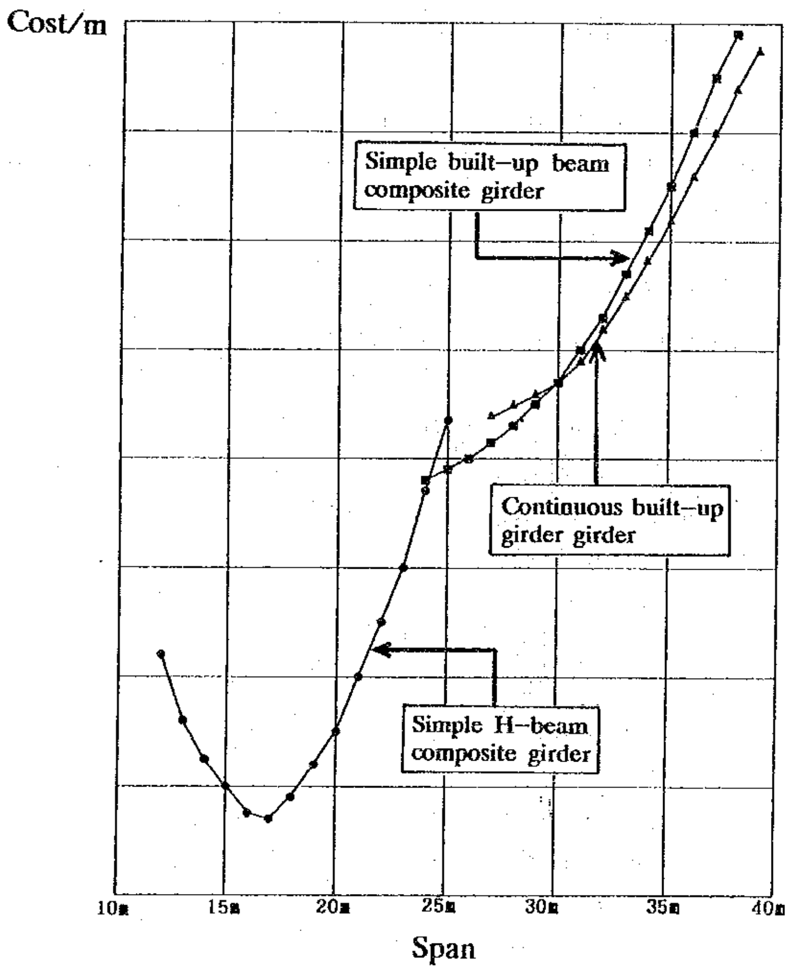


Figure 3-1 STEEL MATERIALS COSTS VERSUS SPAN LENGTHS

As a result, the superstructure types and their application span length are proposed as follows:

Span length 15 - 24m : Simple H-beam composite girder
Span length 25 - 40m : Simple built-up beam composite girder

(2) Bridge width

The standard bridge width for bridges along the secondary national roads specified in Highway Design Guideline, DPWH is applied to this project. The bridge width and its components are shown in Figure 3-2.

Sidewalks are not provided in the plan, because sidewalks are not separated from carriageways in rural areas in the Philippines in general. All of the project bridges are located in rural areas and their pedestrian traffic is not large. However, the pedestrian load on the curbs is considered in structural design.

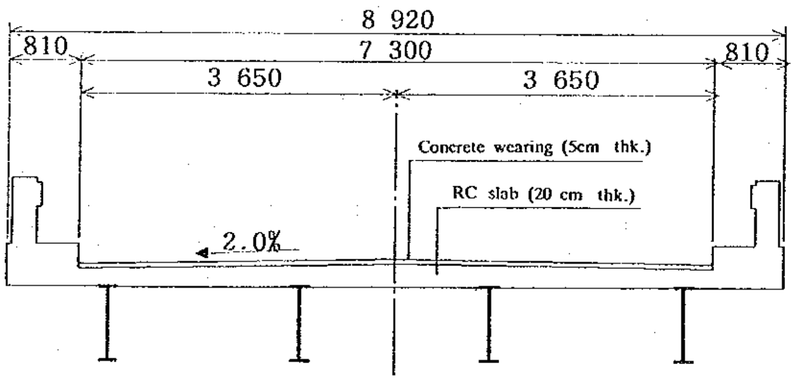


Figure 3-2 CROSS SECTION OF THE PROJECT BRIDGE

(3) Number of main girders and their intervals

The number of main girders and their intervals were examined by comparing 3 schemes as shown in Figure 3-3.

As a result, a scheme of 4 main girders at 2.2m intervals is proposed.

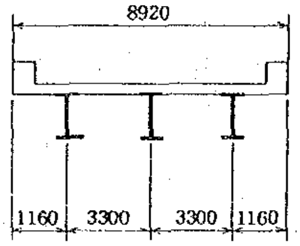
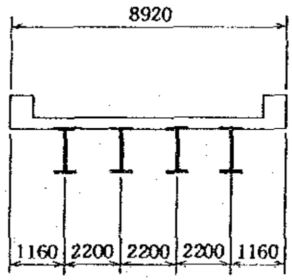
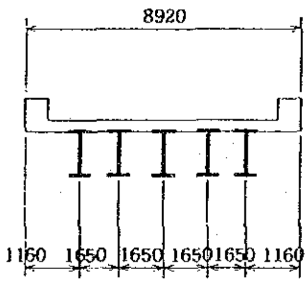
	Number of Girders	Girder Interval	Slab Thickness	Evaluation
	3	3.30 m	24 cm	· Applicable spans are less than 18m. · Girder depths are comparatively large.
	4	2.20 m	20 cm	· Applicable spans are less than 25m. · This is the most common main girder interval and slab thickness.
	5	1.65 m	18 cm	· Uneconomical for span lengths less than 25m.

Figure 3-3 COMPARISON OF NUMBER OF GIRDERS AND THEIR INTERVALS

(4) RC deck slab thickness

The thickness of the RC deck is planned in accordance with the formula specified in the Specification for Highway, Part II Steel Bridges, Japan Road Association. The thickness of the RC deck slab thickness (t in cm) of bridges having heavy trailer truck traffic has obtained by the following formula:

$$t = (3 \times \text{main girder interval} + 11) \times 1.15$$
$$t = (3 \times 2.2 + 11) \times 1.15 = 20.24 \text{ cm}$$

(5) Girder depth

The optimum girder depth is related to the span length when the bridge width and number of girders are constant. Figure 3-4 shows the relation between span lengths and girder depths in the case of simple H-beam composite girder type bridges with 4 main girders, as the result of a preliminary design of the Study Team.

The largest H-beam commonly available is H-912.

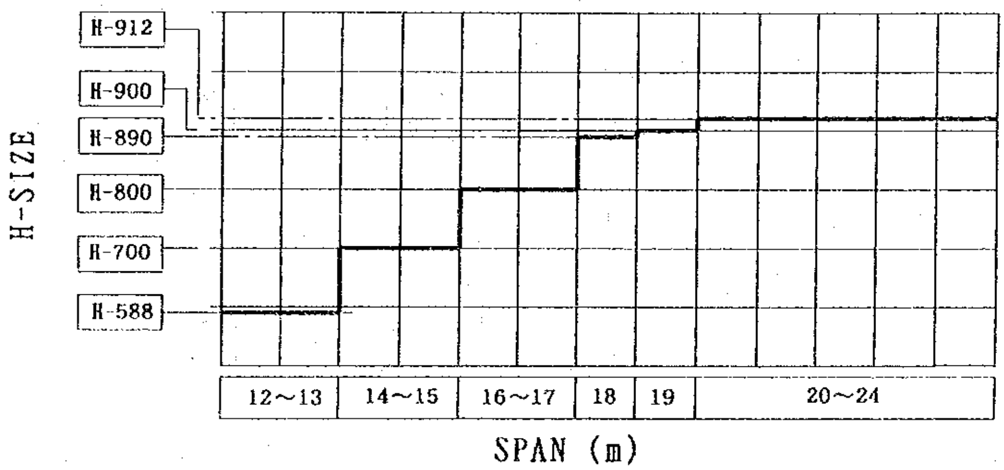


Figure 3-4 RELATION BETWEEN SPAN LENGTH AND GIRDER DEPTH (H-beam Composite Girder)

The application of H-beam sizes at each span length is shown in Table 3-6.

Table 3-6 APPLICATION OF H-BEAM SIZE

Span Length	H-beam Size
12m - 13m	H - 588
14m - 15m	H - 700
16m - 17m	H - 800
18m	H - 890
19m	H - 900
20m - 24m	H - 912

Simple built-up beam composite girder

The ratio of the optimum depth of simple built-up beam composite girder against span length is 1/20 in general, which is given in the Bridge Design Manual, Japan Highway Public Cooperation based on its experience. This ratio is adapted to planning of the girder depths.

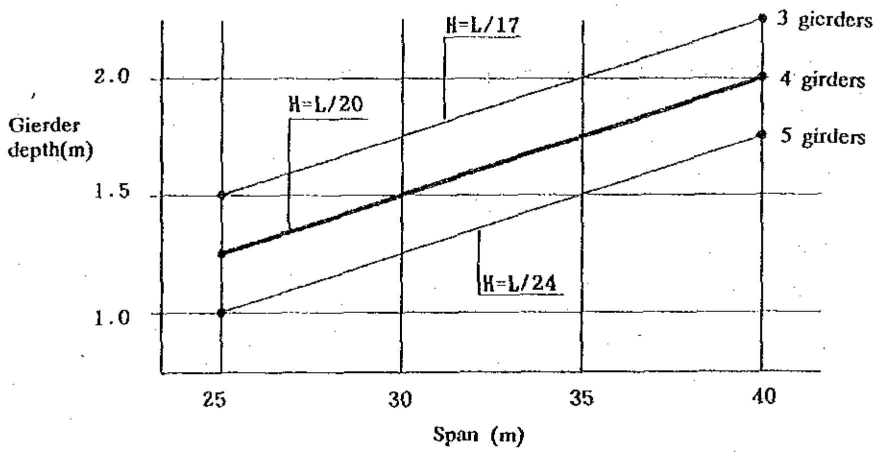


Figure 3-5 RELATION BETWEEN SPAN LENGTH AND GIRDER DEPTH (Simple Built-up Beam Composite Girder)

(6) Expansion joint

The required expansion space between girder ends or between abutments and girder ends is obtained by the following formula:

DL = the coefficient of liner expansion of steel x temperature change (20 degrees) x span length
= 12 x 10(-6) x 20 x 40 = 10 mm

In case of the longest span (40m) bridge of the project, the horizontal movement of the girder ends due to temperature change is 10 mm. Additionally, 20 mm for construction allowance is required.

As a result, 30 mm for the expansion space is planned for all the project bridges.

The following points were considered in selection of the expansion joint type:

- Building of mud and dust from the bridge deck, which will corrode steel girders, is prevented.
- Maintenance is easy.
- The type is common in the Philippines.
- The materials are available in the Philippines.
- A lack of maintenance will not cause structural failure.

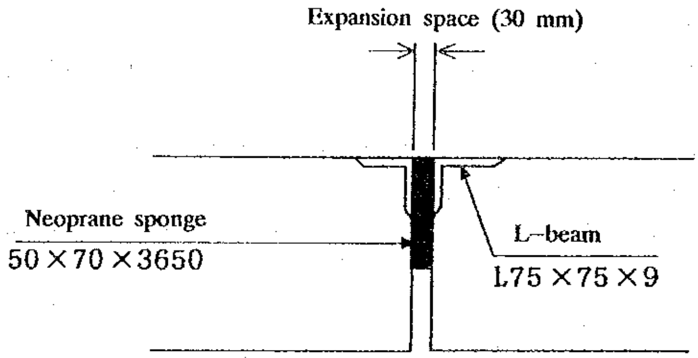


Figure 3-6 EXPANSION JOINT

(7) Earthquake-resistant structure

To prevent the collapse of superstructures, the following measures are planned to be furnished to the project bridges:

- To install steel plates connecting both girder ends at the top of piers.

- To install concrete stoppers in front of the cross beams of the superstructures at the top of abutments.

- To design bearings to be earthquake resistant.

- To secure the length of bearing anchor bolts embedded into substructure concrete. (The minimum to be 15 times the diameter of the bolts.)

- To secure the widths of the substructures top in accordance with the specification of Road Design Standard Part VI, Seismic Design, Japan Road Association.

(8) Bearings

Liner rocker bearings, which are economical and commonly used for short span steel girder bridges, are planned to be used for the project bridges, except for bridges longer than 38 m or skewed.

Bearing plate bearings (BP-A) are planned for long or skewed bridges.

(9) Maximum length of steel girder members, and method of splice

- The maximum length of steel girder members is planned to be 8.5 m as a result of a consideration on convenience of transportation of them.

- The high tension bolt (M22 F10T) splicing method is planned to connect the girder members on site.

(10) Painting

The steel materials are planned to be painted under coats in the factory, and then finish coats on site. Field painting materials will be procured by the project.

(11) Camber adjustment

The vertical alignments of the bridges are planned to be level or straight slope. Cambers will be given to the girders in the course of fabrication to compensate for sags caused by dead loads.

3.4.3 Examination of Substructure Types

Planning and detailed design of substructures of Group 1 bridges will be undertaken by DPWH, based on topographic and geological survey results and hydrological analyses to be executed by DPWH. Recommended substructure types are proposed in this study based on the following examination:

(1) Abutments

Inverted-T type abutments are proposed as the standard type. This type will be adopted for the project bridges except where site conditions are unsuitable. The following considerations are given to the planning of abutment structures:

- The width of abutment bearing seat is planned to be sufficiently wide to prevent the collapse of superstructures due to earthquakes. The necessary width is specified in Highway Bridge Design Part VI, Seismic Design, Japan Road Association.

- To prevent scouring around abutment footings and to maintain ground sound to support the stability of the abutment foundations.

- Approach slabs behind the abutments are planned to be furnished to prevent settlement of road surface.

The design method of checking substructure stability and structural member strength is shown in the Technical Guideline for Constructing Bridges Along Rural Roads, DPWH.

(2) Piers

Inverted-T column type piers are proposed as the standard type. This type will be adopted for the project bridges except where site conditions are unsuitable. The following considerations are given to the planning of abutment structures:

- Column type piers can avoid disturbance to the stream lines when the rivers change their directions or angles against the bridges.

- Column type piers, which is less rigid than wall type piers, are earthquake resistant type, since the earthquake force works more strongly on more rigid structures.

- The width of pier bearing seat is planned to be sufficiently wide to prevent the collapse of superstructures due to earthquakes. The necessary width is specified in Highway Bridge Design Part VI, Seismic Design, Japan Road Association.

- Footings are planned to be embedded into the riverbeds deeply enough to prevent failure of stability of piers due to scouring or erosion of the rivers. Embedding footing 2 m beneath the river-bed is proposed as the standard. Installing Gabions and filter units are proposed where occurrence of scouring is anticipated.

(3) Foundations

Precast RC piles (400 mm x 400 mm), which are commonly used in the Philippines, are proposed as the standard pile type.

Pile-bent type piers with PC piles (700 mm dia.) are proposed for the following project bridges. Their sites are located at estuaries where the rivers are tidal and the water is too deep to construct standard inverted-T type piers. PC piles are proposed because they have the required strength and are free of corrosion in salt water.

10-04-10 Katipunan Bridge
11-01-01 Andanan Bridge
11-03-06 Mahan-Ub Bridge

3.4.4 Design of Superstructures

A basic design of the superstructures of the project was carried out based on the bridge plan and the proposed structures. The results of the basic design of the superstructures, which are shown in Appendix 9, are as follows:

- Basic design of simple H-beam composite girders (Figure A9-1)
- Basic design of simple built-up beam composite girders (Figure A9-2)
- Summary of design computation of superstructures (Table A9-1)
- Reaction force of superstructures (Table A9-2)
- Heights of girders, slabs and bearings (Table A9-3)

3.4.5 Design of Substructures

The standard substructures for the project, of which the following drawings are shown in Appendix 9, were proposed as a result of the study.

- Standard abutments (Figure A9-3)
- Standard pier and pile-bent pier (A9-4)

3.4.6 Design of Approach Roads

The design standards for secondary national roads specified in the Highway Design Guideline, DPWH is adopted for the design of the ap proach roads. Its geometric standard is shown in Table 3-7. The typical cross sections of the approach roads is shown in Figure A9-5 in Appendix 9. Guardrails are proposed to be installed along high embankment approach roads.

Table 3-7 GEOMETRIC STANDARD OF APPROACH ROADS

	Flat	Rolling	Mountainous
1. Design Speed (km/hr)	60	50	40
2. Pavement Width (m)	6.70	6.70	6.70
3. Shoulder Width (m)	1.00	1.00	1.00
4. Minimum Radius (m)	120	80	50
5. Maximum Superelevation (%)	8	8	8
6. Maximum Grade (%)	3	5	10
7. Minimum Length of Vertical Curve (m)	60	60	60
8. Minimum Radius for Crest Vertical Curve (m)	1500	1200	1000
9. Minimum Radius for Sag Vertical Curve (m)	1500	1000	800

3.4.7 Design of Pavement

The Portland Cement Concrete (PCC) pavement type is proposed for the approach roads of the project bridges. PCC pavement is easy to construct even in small amounts in rural areas, like this project, since construction PCC pavement does not require a large mixing plant.

The pavement structure is designed in accordance with the traffic volume of heavy vehicles and subgrade density. Since most of the project roads are secondary national roads and have very little traffic, a 20 cm thick PCC pavement over a 20 cm thick subbase course, which is the standard pavement structure for secondary national roads in the Philippines, is proposed as shown in the typical cross sections of the approach roads in Figure A9-5 in Appendix 9.

3.4.8 Design of Riverbank Protection

To prevent scouring at abutment foundations and erosion on riverbanks, construction of grouted riprap on riverbanks and approach road embankment slopes is proposed. The areas where grouted riprap is needed to be constructed is where scouring and erosion would endanger the stability of the abutments.

Since damage on the grouted riprap around the abutments is commonly observed, the following improved structure of grouted riprap riverbank protection is proposed for the project:

- 50 cm thick grouted riprap backfilled with 10 cm thick concrete and 20 cm thick gravel is proposed as shown in Figure 3-7.

- Scouring protection (gabions and filter units) is installed where scouring at grouted riprap footing is anticipated.

- Timber pile foundations for the grouted riprap are proposed.

- Where tidal water is too deep to construct grouted riprap footing, steel sheetpile foundations as shown in Figure 3-8 are proposed. Steel sheetpile foundation grouted riprap is proposed for the following bridges:
  - 10-04-10 Katipunan Bridge
  - 11-01-01 Andanan Bridge

The detailed structure of the riverbank protection is shown in Figure A9-6 in Appendix 9.

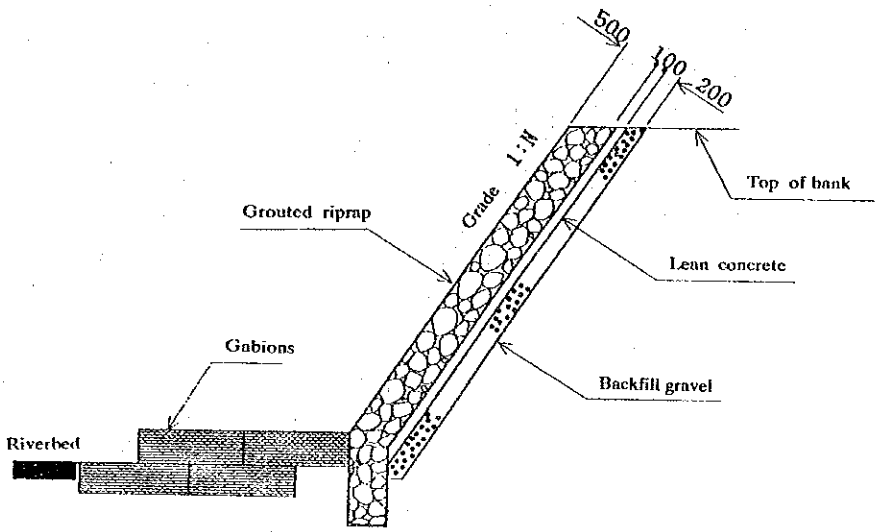


Figure 3-7 TYPICAL RIVERBANK PROTECTION

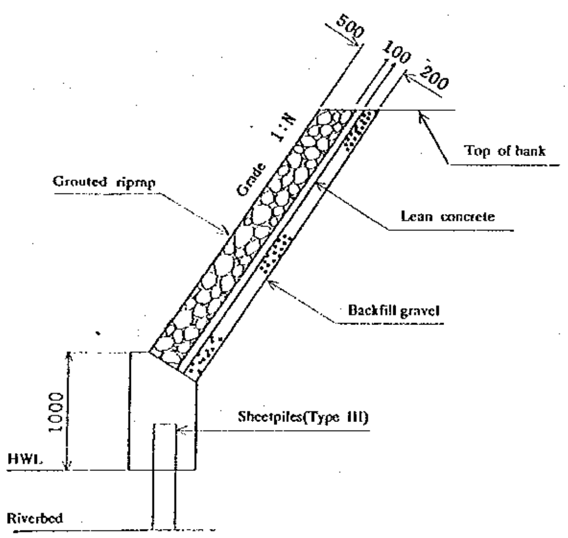


Figure 3-8 STEEL SHEETPILE FOUNDATION GROUTED RIPRAP

3.4.9 Scouring Protection

Installing scouring protection around piers and in front of riverbank protections is proposed where river currents are fast and scouring there is anticipated. Gabions, which are steel wire cages filled with cobbles, and filter units, which are nylon net bags filled with cobbles, are proposed for the scouring protection. Gabions are proposed where the water is shallow or dry, while filter units are proposed where the water is too deep to construct gabions, in general.

A typical installation method for scouring protection is shown in Figure 3-9, and the details are shown in Figure A9-7 in Appendix 9.

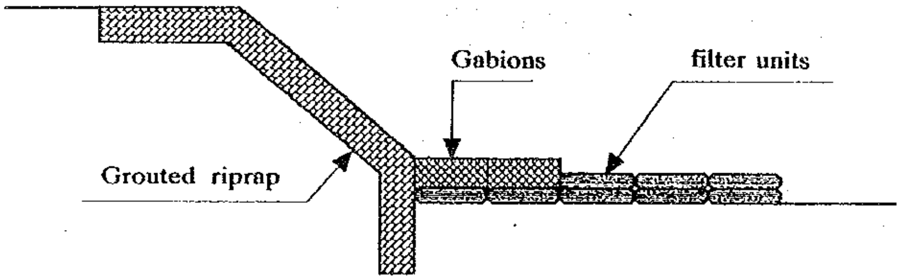


Figure 3-9 TYPICAL SCOURING PROTECTION

3.4.10 Summary of Basic Plan

As a result of the basic design, a Summary of the Basic Plan of Group 1 Bridges is shown in Table 3-8. The general plan of the project bridges and their structures is compiled in a separate volume of this report.

The materials which are proposed to be procured under Japan's Grant Aid are summarized in Table 3-9, and the contents of steel materials for the superstructures are shown in Table 3-10 and Table 3-11.

Table 3-8 SUMMARY OF BASIC PLAN OF GROUP 1 BRIDGES

(1/3)

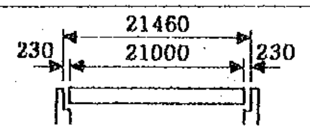
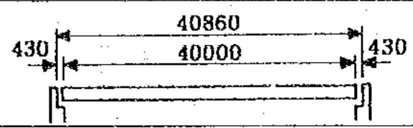
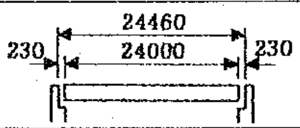
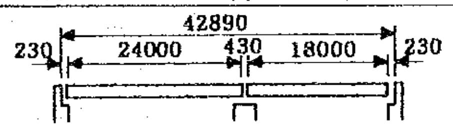
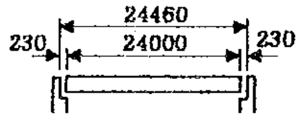
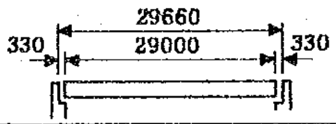
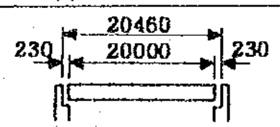
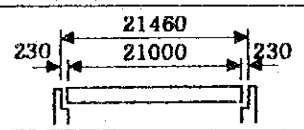
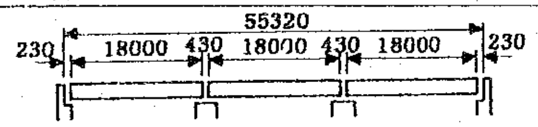
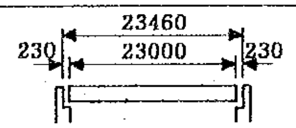
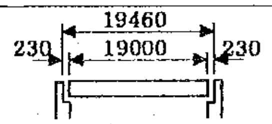
No.	Bridge No. Bridge Name	Bridge Layout	Superstructure Type Steel Girder Weight	Substructure AL/AR:Abutment P :Pier H :Height	Foundation RC Piles (400mm x 400mm)	Approach Road Length	Riverbank Protection	Remarks
1	10-01-01 Tag-Anahao		H-beam W = 32.031 t	AL : H = 4.0m AR : H = 4.0m	20m x 10 piles 20m x 10 piles	Left : 25m Right : 25m	Left : 240m² Right : 240m²	Vertically sloped (3.74%)
2	10-02-01 Mesli		Built-up beam W = 67.681 t	AL : H = 5.0m AR : H = 6.0m	7m x 20 piles 7m x 15 piles	Left : 50m Right : 45m	Left : 306m² Right : 280m²	Skewed (70°) Gabions(2mx1.2mx0.5m) 48 pcs. Gabions(2mx1.2mx0.5m) 168 pcs. Filter Units 1,548 bags
3	10-02-03 Anibongan		H-beam W = 32.029 t	AL : H = 4.0m AR : H = 4.0m	10m x 10 piles 10m x 10 piles	Left : 40m Right : 40m	Left : 340m² Right : 340m²	
4	10-03-03 Agusan Canyon		H-beam W = 57.948 t	AL : H = 5.0m P1 : H = 7.0m AR : H = 7.0m	Spread foundation Spread foundation Spread foundation	Left : 129m Right : 117m	Left : - Right : 147m²	Gabions(2mx1.2mx0.5m) 160 pcs. Gabions(2mx1.2mx0.5m) 38 pcs. Filter Units 1,649 bags
5	10-03-06 Aglayan		H-beam W = 36.029 t	AL : H = 6.0m AR : H = 5.0m	Spread foundation Spread foundation Spread foundation	Left : 20m Right : 20m	Left : 156m² Right : 156m²	
6	10-03-09 Silae		Built-up beam W = 39.192 t	AL : H = 5.0m AR : H = 5.0m	Spread foundation Spread foundation Spread foundation	Left : 10m Right : 10m	Left : 432m² Right : 414m²	
7	10-04-03 Tipalac		H-beam W = 30.863 t	AL : H = 4.0m AR : H = 4.0m	15m x 10 piles 15m x 10 piles	Left : 14m Right : 24m	Left : 230m² Right : 208m²	
8	10-04-04 Tipan Duit		H-beam W = 32.031 t	AL : H = 4.0m AR : H = 4.0m	15m x 10 piles 15m x 10 piles	Left : 18m Right : 25m	Left : 298m² Right : 298m²	
9	10-04-10 Katipunan		H-beam W = 65.825 t	AL : H = 3.0m P1 : Pile-bent P2 : Pile-bent AR : H = 3.0m	17m x 10 piles PC pile ϕ700x14mx4 PC pile ϕ700x14mx4 7m x 20 piles	Left : 30m Right : 20m	Left : 63m² Right : 63m²	Sheetpiles (Type III) L = 6m 73 sheets Sheetpiles (Type III) L = 6m 73 sheets
10	10-06-01 Hayangabon II		H-beam W = 34.861 t	AL : H = 4.0m AR : H = 4.0m	20m x 10 piles 20m x 10 piles	Left : 40m Right : 27m	Left : 235m² Right : 235m²	
11	10-06-02 Capandan		H-beam W = 25.661 t	AL : H = 5.0m AR : H = 5.0m	20m x 10 piles 20m x 10 piles	Left : 27m Right : 45m	Left : 224m² Right : 245m²	Filter Units 708 bags

Table 3-8 SUMMARY OF BASIC PLAN OF GROUP 1 BRIDGES

(2/3)

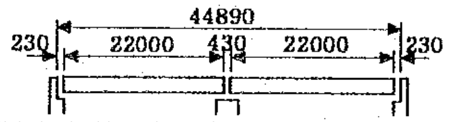
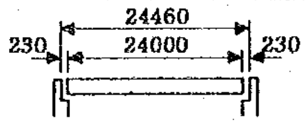
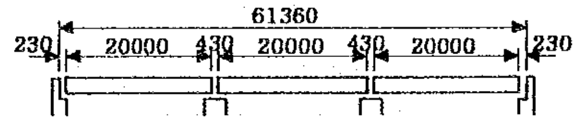
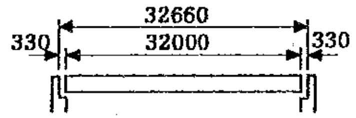
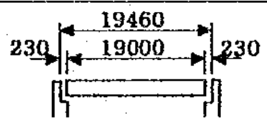
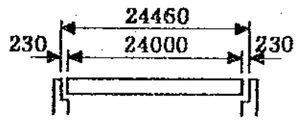
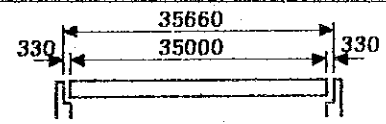
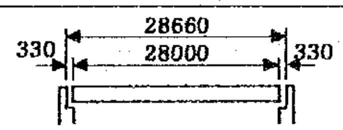
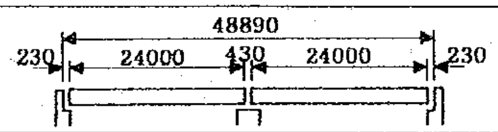
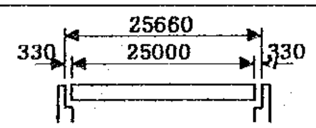
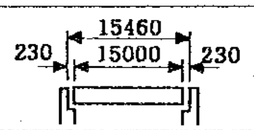
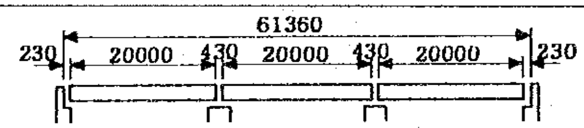
No.	Bridge No. Bridge Name	Bridge Layout	Superstructure Type Steel Girder Weight	Substructure AL/AR:Abutment P :Pier H :Height	Foundation RC Piles (400mm x 400mm)	Approach Road Length	Riverbank Protection	Remarks
12	10-06-06 Tigbao		H-beam W = 66.578 t	AL : H = 5.0m P1 : H = 6.0m AR : H = 5.0m	10m x 10 piles 10m x 12 piles 10m x 10 piles	Left : 35m Right : 20m	Left : 368m² Right : 368m²	
13	10-06-07 Balite		H-beam W = 36.029 t	AL : H = 6.0m AR : H = 6.0m	20m x 10 piles 20m x 10 piles	Left : 25m Right : 28m	Left : 259m² Right : 280m²	
14	11-01-01 Andanan		H-beam W = 92.441 t	AL : H = 3.5m P1 : Pile-bent P2 : Pile-bent AR : H = 4.0m	16m x 10 piles PC pile ϕ700x19mx4 PC pile ϕ700x19mx4 11m x 20 piles	Left : 40m Right : 40m	Left : 170m² Right : 195m²	Sheet piles (Type III) L = 4m 115 sheets Sheet piles (Type III) L = 4m 100 sheets
15	11-01-02 Pagtilaan		Built-up beam W = 45.107 t	AL : H = 5.0m AR : H = 5.0m	15m x 15 piles 15m x 10 piles	Left : 45m Right : 30m	Left : 322m² Right : 375m²	
16	11-01-03 Quezon		H-beam W = 25.661 t	AL : H = 4.0m AR : H = 4.0m	15m x 10 piles 15m x 10 piles	Left : 25m Right : 20m	Left : 221m² Right : 221m²	
17	11-01-04 Pagbakatan		H-beam W = 36.029 t	AL : H = 4.0m AR : H = 4.0m	15m x 10 piles 15m x 10 piles	Left : 10m Right : 20m	Left : 360m² Right : 360m²	
18	11-01-05 Union		Built-up beam W = 55.045 t	AL : H = 6.0m AR : H = 6.0m	15m x 15 piles 15m x 15 piles	Left : 15m Right : 28m	Left : 347m² Right : 358m²	Skewed (75°) Filter Units 779 bags
19	11-01-06 Tagasaka		Built-up beam W = 38.476 t	AL : H = 5.0m AR : H = 5.0m	15m x 10 piles 15m x 10 piles	Left : 15m Right : 15m	Left : 524m² Right : 517m²	Vertically sloped : i = 1.75%
20	11-03-01 Dao-An		H-beam W = 71.982 t	AL : H = 4.0m P1 : H = 5.0m AR : H = 4.0m	20m x 10 piles 20m x 12 piles 20m x 10 piles	Left : 27m Right : 25m	Left : 210m² Right : 210m²	Filter Units 897 bags
21	11-03-02 Licop		Built-up beam W = 32.782 t	AL : H = 5.0m AR : H = 5.0m	10m x 10 piles 10m x 10 piles	Left : 20m Right : 15m	Left : 589m² Right : 544m²	Filter Units 886 bags
22	11-03-03 Tawas		H-beam W = 16.739 t	AL : H = 5.5m AR : H = 5.5m	10m x 10 piles 10m x 10 piles	Left : 30m Right : 20m	Left : 240m² Right : 240m²	
23	11-03-06 Mahan-Ub		H-beam W = 92.441 t	AL : H = 4.5m P1 : Pile-bent P2 : Pile-bent AR : H = 4.0m	21m x 10 piles PC pile ϕ700x23mx4 PC pile ϕ700x23mx4 21m x 15 piles	Left : 20m Right : 30m	Left : 375m² Right : 384m²	Filter Units 792 bags

Table 3-8 SUMMARY OF BASIC PLAN OF GROUP 1 BRIDGES

(3/3)

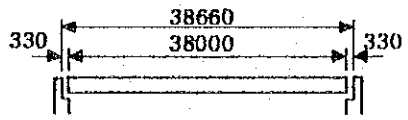
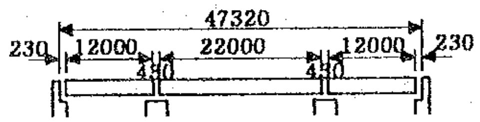
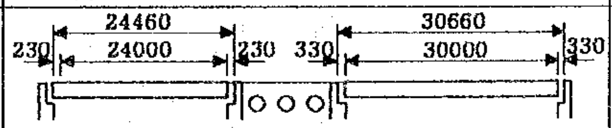
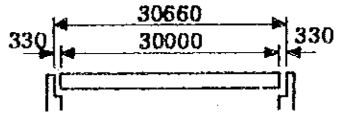
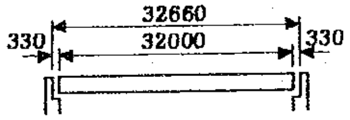
No.	Bridge No. / Bridge Name	Bridge Layout	Superstructure Type / Steel Girder Weight	Substructure AL/AR:Abutment P :Pier H :Height	Foundation RC Piles (400mm x 400mm)	Approach Road Length	Riverbank Protection	Remarks
24	11-05-02 Los Amigos		Built-up beam W = 63.135 t	AL : H = 6.0m AR : H = 6.0m AR : H = 4.0m	Spread foundation Spread foundation	Left : 20m Right : 20m	Left : - Right : 368m²	Gabions (2mx1.2mx0.5m) 41 pcs Gabions (2mx1.2mx0.5m) 42 pcs. Filter Units 1,326 bags
25	11-05-06 Piedad		H-beam W = 55.183 t	AL : H = 5.0m P1 : H = 8.0m P2 : H = 8.0m AR : H = 5.0m	Spread foundation Spread foundation Spread foundation Spread foundation	Left : 50m Right : 96m	Left : 310m² Right : 362m²	Vertically sloped (5%) Filter Units 1,254 bags
26	11-05-07 Lais		H-beam W = 36.029 t Built-up beam W = 42.277 t	AL : H = 4.5m AR : H = 4.5m AL : H = 4.5m AR : H = 4.5m	9m x 10 piles 9m x 10 piles 9m x 10 piles 9m x 10 piles	Left : 30m Right : 50m	Left : 140m² Right : 168m² Left : 140m² Right : 140m²	
27	11-06-02 Baliton		Built-up beam W = 42.277 t	AL : H = 5.0m AR : H = 7.0m	20m x 15 piles 20m x 10 piles	Left : 33m Right : 33m	Left : 446m² Right : 442m²	Filter Units 576 bags
28	11-06-03 Pangyan		Built-up beam W = 45.107 t	AL : H = 5.0m AR : H = 5.0m	20m x 15 piles 20m x 10 piles	Left : 40m Right : 26m	Left : 233m² Right : 223m²	

Table 3-9 SUMMARY OF PROCUREMENT MATERIALS

Item			Quantity
Superstructure	Steel Materials	H-beams Steel plates Other steel Total	772.6 t 475.7 t 105.0 t 1,353.3 t
	Erection tools Field paint		16.1 t 6.6 t
Substructure	PC piles (700 dia.)		64 piles
Riverbank Protections	Steel sheetpiles (Type III)		1,816 m (109t)
Scouring Protections	Gabions		1,046 m
	Filter units		12,095 pcs.
Approach Road	Guardrail (Gr-A-4E)		1,856 m (56t)

Table 3-10 CONTENTS OF STEEL MATERIALS FOR H-BEAM GIRDERS

Item		Designation	Weight (t)
Steel Beams	H-Beams for Main Girders	H - 912x302x18x34 (SM490YA) H - 900x300x16x18 (SM490YA) H - 890x299x15x23 (SM490YA) H - 700x300x13x24 (SM490YA) H - 588x300x12x20 (SM490YA)	539.280 37.712 62.720 11.400 14.976
	H-Beams for Cross Beams	H - 596x199x10x15 (SM490YA) H - 496x199x 9x14 (SM490YA) H - 596x199x10x15 (SS400) H - 446x199x 8x12 (SS400) H - 350x175x 7x11 (SS400)	16.362 1.521 32.724 2.538 17.808
	Total		737.041
Steel Plates	Splices	9 to 25 mm thick	62.112
	Stiffeners	9 to 22 mm thick	11.592
	Gussets	9 to 19 mm thick	4.149
	Total		77.853

Item		Designation	Weight (t)
Other Steel Mate-rials	Bars	13 & 16 dia.	0.940
	Studs	22 dia. x 150	17.320
	H.T. bolts	M 22	23.453
	Bearings	SC 450	13.400
	Drains	100 A	2.710
	Expansion joints	L-75 x 75 x 9	7.644
	Girder connectors		0.628
	Total		66.095
Erec-tion Tools	Erection bolts	M 22 (9,146 pcs)	5.294
	Drift pins	24.5 dia. x 150 (4,581 pcs)	2.559
	Torque wrenches	20 pcs.	0.180
	Calibrators	20 pcs.	0.855
	Total		8.888
Field Paint	Under coat	Red-Lead Paint	0.459
	1st Inter coat	Phenol MIO	0.405
	2nd Inter coat	Phtallic Acid Resin	1.150
	Finish coat	Phtallic Acid Resin	1.058
	Thinner		0.316
	Total		3.388

Table 3-11 CONTENTS OF STEEL MATERIALS FOR BUILT-UP BEAM GIRDERS

Item		Designation	Weight (t)
Steel Beams	Channel	[- 250 x 90 x 9 x 13	4.032
	CT beams	CT- 95 x 152 x 8 x 8	25.937
	"	CT-118 x 178 x 10 x 8	5.582
	Total		35.551
Steel Plates	Main girders	t = 9 to 32 mm thick	372.218
	Cross beams	t = 9 to 12 mm thick	21.510
	Total		393.728

Item		Designation	Weight (t)
Other Steel Mate-rials	Bars	36 & 16 dia.	0.178
	Stud	19 dia. x 150	6.854
	H.T. bolt	M 22	19.509
	Bearing	LB-107 & 108, BPA-503A & C	10.701
	Drain	100 A	1.871
	Expansion joints	L-75 x 75 x 6, D-16	3.112
	Total		39.113
Erec-tion Tools	Erection bolts	M 22 (7,468 pcs)	4.481
	Drift pin	24.5 dia. x 150 (3,734 pcs)	2.166
	Torque wrenches	10 pcs.	0.186
	Calibrators	9 pcs.	0.450
	Total		7.157
Field Paint	Under coat	Red-Lead Paint	0.444
	1st Inter coat	Phenol MIO	0.396
	2nd Inter coat	Phtallic Acid Resin	1.071
	Finish coat	Phtallic Acid Resin	0.982
	Thinner		0.289
	Total		3.182

3.5 Implementation Plan

3.5.1 Basic Conditions

The following are the basic conditions for implementing this project:

- This project, if approved, will be implemented in accordance with the provisions of Japan's Grant Aid Program after the signing of the Exchange of Notes between the Governments of Japan and the Philippines.

- Steel girders and the materials to be procured by this project with the assistance of Japan's Grant Aid will be used for construction of the Group 1 bridges selected in this study.

- The Department of Public Works and Highways (DPWH) is the responsible agency for implementing the project. In DPWH, the Bureau of Design is responsible for the detailed design of substructures and related works, and the PMO-SBP is responsible for construction of the bridges.

- The detailed design and procurement supervision of the materials will be undertaken by a Japanese consultant firm contracted by DPWH. Procurement of the materials will be undertaken by a qualified Japanese company contracted with DPWH.

3.5.2 Implementation Method

(1) Marine Transport

The materials procured under Japan's Grant Aid will be delivered by sea from Japan to the designated ports in the Philippines. DPWH has designated the following international ports:

- Cagayan de Oro

- Nasipit
- Ozamis
- Davao
- General Santos

Transporting the materials to these ports is planned by domestic freighter after clearing customs at Manila International Seaport, since no international freighters directly bound for the designated ports are scheduled.

(2) Land Transportation

The materials will be transported by truck from the landing ports to the sites. Based on investigation, it is required to reinforce temporary bridges along the transport routes to enable the trucks loaded with the materials to pass. The land transportation routes and the temporary bridge reinforcement plan are proposed in Table A9-1 in Appendix 9. The schemes for reinforcing wooden bridges and Bailey bridges are shown in Figures A9-1 and A9-2 in Appendix 9.

(3) Steel Girder Erection

The steel girders can be erected easily by truck crane or crawler crane with wooden bents. Conceptual figures of erection methods are shown in Figures A9-3 and A9-4 in Appendix 9. Where the water level is too deep for cranes to enter the river, timber bridges will be constructed above the river to provide working stages for cranes. The standard timber bridge plan is shown in Figure A9-5 in Appendix 9.

(4) Technical Assistance

As described in Section 2.2.5, technical assistance is required in detailed designing and construction planning for 6 of the Group 1 bridges since they require a high level of technology. Technical assistance by Japanese consultants is proposed as described in the following Section.

3.5.3 Implementation Supervisory Plan

The detailed design, assistance in tendering, supervision and technical assistance for materials procurement under Japan's Grant Aid will be undertaken by a Japanese consultant firm in accordance with the contract concluded between DPWH and the consultant. The outline of the works are as follows:

(1) Detailed Design

Major works in the detailed design of the materials to be carried out by the consultant are as follows:

- Preparation of drawings and specifications
- Cost estimation
- Preparation of tender documents

The necessary time for the detailed design is 2.5 months.

(2) Assistance in Tendering

The consultant will render the following services during the period from tender notice to procurement contract:

- Tender notice
- Pre-qualification
- Pre-bid conference and tendering
- Tender evaluation
- Contract facilitation

The necessary time for tendering is 2.5 months.

(3) Supervision of fabrication and delivery

The main work items to be executed by the consultant are as follows:

- Review and approval of fabrication plan and specifications prepared by the contractor
- Inspection of quantities and specifications prior to shipment
- Turnover

The estimated duration for fabrication of the materials and for marine transportation is 6 months and 1 month, respectively. Spot supervision is required for the turnover.

The consultant will oversee preparation of an erection manual and guidance on erection of steel girders provided by the materials supplier for DPWH engineers.

(4) Technical Assistance

The consultant will provide technical assistance on the detailed design and construction planning of the following 6 bridges:

- 10-03-03 Agusan Canyon Bridge
- 10-04-10 Katipunan Bridge
- 11-01-01 Andanan Bridge
- 11-03-06 Mahan-Ub Bridge
- 11-05-02 Los Amigos Bridge
- 11-05-06 Piedad Bridge

The major items of technical assistance are as follows:

- Geological survey
- Detailed design of the bridges and related structures
- Preparation of drawings and specifications
- Preparation of construction plan
- Preparation of a construction supervision manual

To expedite technology transfer, Filipino consult engineers are proposed to execute the above works jointly with Japanese engineers. The necessary time for the works is 2.5 months.

3.5.4 Procurement Plan

The materials to be procured under Japan's Grant Aid are not available in the Philippines. Considering the quality and the limited time for fabrication of the materials, all of the materials are planned to be procured in Japan.

3.5.5 Implementation Schedule

The implementation schedule for the detailed design, procurement of materials and technical assistance, which will be borne by Japan's Grant Aid, is shown in Table 3-12.

The Government of the Philippines is responsible for constructing bridges within a period of one year after delivery of the materials, as stated in the Exchange of Notes.

Table 3-12 IMPLEMENTATION SCHEDULE (Group 1 Project)

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Detailed Design	(Work in the Philippines) (Work in Japan) (Discussion in the Philippines) (Total 2.5 months)											
Procurement and Transportation	(Fabrication of the materials) (Marine transportation and turnover) (Total 10 months)											
Technical Assistance	(Work in the Philippines) (Total 2.5 months)											

3.5.6 Scope of Work

The undertakings of the Governments of Japan and the Philippines are listed in Table 3-13.

Table 3-13 UNDERTAKINGS OF THE GOVERNMENTS (Group 1 Project)

Item	Contents	Undertaken by		Remarks
		Japan	Philippines	
Procurement and Transportation of Materials	Procurement	o		Steel girders, PC piles, gabions
	Marine transportation	o		
	Customs clearance		o	At Manila Wharf
	Domestic marine transportation	o		
	Inland transportation		o	
	Erection guidance	o		At Manila Wharf
Design and Construction of Bridges	Detailed design of substructures and related structures		o	Technical assistance for 6 bridges is undertaking of the Government of Japan
	Construction of bridges		o	
	Maintenance of bridges		o	

The cost to be shouldered by the Government of the Philippines is roughly estimated as follows:

(1)	Custom clearance fee	:	₱1,353,633.00
(2)	Inland transportation cost	:	₱9,040,339.56
(3)	Bridge construction cost	:	₱175,109,260.00
(4)	Land acquisition cost	:	₱364,325.00
(5)	House & facility removal cost	:	₱2,426,250.00
(6)	Transportation route maintenance cost	:	₱1,311,350.00
(7)	Existing bridges demolition cost	:	₱715,360.00
	Total		₱190,320,517.00

CHAPTER 4

BASIC DESIGN
OF
GROUP 2 PROJECT

CHAPTER 4

BASIC DESIGN OF GROUP 2 PROJECT

4.1 Basic Design Concepts

The basic design is carried out in accordance with the following basic concepts:

(1) Bridge location and bridge length

- The project bridge locations will be decided after technical examination of the Study Team based on the results of discussion and site investigation by the Study Team and DPWH staffs concerned.

- The project bridge locations will be decided by taking account of topographic condition, river condition, existing houses, public facilities, existing road alignments and detours during construction.

- Bridge length is the distance between abutments. Abutment locations will be examined with flooding condition of the rivers. The bridge lengths should be long enough to discharge floods.

- The project bridge elevations will be decided based on the maximum flood level of the river obtained from hearing surveys of residents near the sites and on the results of hydrological analyses.

(2) Superstructure planning

Superstructure types are selected for the project from commonly used steel girder types and PC girder types based on an examination of their costs, construction and maintenance requirements and structural features.

The continuous supported girder type should be considered where site conditions are suitable. The PC girder type should be considered where procurement of high strength concrete and transportation of PC girders are available.

(3) Substructure planning

The design concepts for planned substructures are as follows:

- Locally available materials are to be used for substructures as far as possible.

- Footings of abutments are to be embedded into existing ground.

- Footings of piers are to be embedded upto 2 m below the river bed, in principle.

- Scouring protection structures are planned where scouring around substructures is expected.

(4) Design criteria

- The design specifications specified by DPWH are applied to this project, in principle.

- The standard designs of roads and bridges issued by DPWH are adapted to this project, as far as applicable.

(5) Construction method

- The parts of the steel girders should not be longer than 8.5 m for the convenience of transportation and erection.

- Steel pile cofferdams are planned for construction piers in rivers which are deep.

(6) Earthquake proof design

Since the project area is earthquake prone, the project bridges are designed to be earthquake resistant in accordance with earthquake resistant specifications specified both by DPWH and by the Japan Road Associations.

(7) Considerations on environment

The following considerations are given in planning bridge approaches and detour roads:

- The location of new bridges should result in minimal house relocation.

- The vertical alignment of the approach roads should not have high retaining walls in front of houses.

- Access roads connecting all the houses to the new roads should be provided.

- Detour roads with temporary bridges should be planned where existing bridges are needed to be demolished for the project. The detour roads should maintain the existing traffic service level.

(8) Basic conditions of the project

- For the Group 2 project, detailed design and construction supervision of the bridges will be undertaken by a Japanese consultant, and the design and construction of the bridges will be undertaken by a Japanese constructor.

4.2 Project Site Survey and Analysis of the Collected Data

(1) Site discussion with DPWH staff and the Study Team

The following items necessary for the basic design of the project are confirmed through discussions with DPWH staff (engineers from the Planning Office of the Central Office and Regional Offices):

- Location of the proposed bridges
- Planning of detours during construction

- Planning of removal of obstacle objects (power posts, water pipes, etc.)
- Possibility of relocation of houses within proposed right-of-ways
- Possibility of land acquisition for proposed routes

(2) Project site investigation

The following items were investigated at the project sites:

- Condition of existing bridges
- Topography
- River conditions
- Maximum flood levels
- Existing road conditions, specially to transport materials and equipment

(3) Topographic survey

Contents of the survey

- Area

Along the road center line	:	extending 100 m back from the proposed abutments
Along the river center	:	extending 50 m up and downstream from the proposed bridges

- Survey Items
  Centerline survey
  Profile survey
  Cross section
  Plane survey

As a result of the topographic surveys, the following maps were developed:

Profiles	(Scale: 1/200)

Cross sections (Scale: 1/200, at 20 m intervals)
Topographic maps (Scale: 1/200)

(4) Geological surveys

Geological surveys to obtain data necessary for the basic design of substructures and foundations of the bridges were carried out. (A geological survey was not executed at 10-01-08 Ligayao Bridge since it had been grouped into Group 1).

Contents of the surveys

- Standard penetration test
- Sampling
- Laboratory test
  - Natural water contents test
  - Specific gravity test

(5) Hydrological analyses

Hydrological analyses were conducted to estimate the magnitude of design discharge and maximum flood water level (MFL).

(6) Results of the project surveys

The results of the project site surveys are summarized in Table 4-1, and the outline of topographic, geological and river conditions of the project sites is shown in Table 4-2.

Table 4-1 SUMMARY OF PROJECT SITE SURVEY RESULTS (GRPUP 2)

No.	Bridge No. Bridge Name	Existing Condition	Proposed Bridge Location	Detour Plan	Existing Bridge Demolition Plan	Access Road Condition	Remarks
1	10-01-08 Lingayao	· Bailey Bridge	· New bridge center is existing bridge center	· Detour bridge is constructed at up-stream of new bridge	· Existing bridge is demolished prior to construction	· Nasipit to KM24.6 is paved. · KM24.6 to site is gravel in good condition.	
2	10-01-09 Magus	· Timber Bridge	· New bridge center is existing bridge center	· Detour bridge is construction at down-stream of new bridge	· Existing bridge is demolished prior to construction	· Nasipit to KM24.6 is paved. · KM24.6 to site is gravel in good condition.	
3	10-01-10 Rizal	· Ford Crossing	· New bridge center is to connect existing approach roads	· Ford crossing	None	· Nasipit to site is paved.	· Sabo dam exists approx. 200 m upstream
4	10-01-12 Guinabsan	· Ford Crossing	· New bridge center is to connect existing approach roads	· Ford crossing	None	· Nasipit to KM14.0 is paved. · KM14.0 to site is gravel in good condition.	· Relocation of 3 houses, power posts is needed
5	10-02-04 Maog	· Ford Crossing	· New bridge center is to connect existing approach roads	· Ford crossing	None	· Davao to KM220.6 is paved. · KM220.6 to site is gravel in good condition.	· Relocation of 2 houses is needed
6	10-05-09 Pagatpat-San Simon	· No bridge (rudder crossing)	· New bridge center is to connect existing approach roads	· No need	None	· Cagayan De Oro to KM8.5 is paved. · KM8.5 to site is gravel in good condition.	· Relocation of 3 houses, power posts is needed
7	11-02-05 Lower Silway	· Bailey Bridge	· New bridge center is 9m upstream of existing bridge center	· Existing bridge is used	· Existing bridge is demolished after construction	· Gen. Santos to site is paved.	
8	10-04-03 Inambatan	· Bailey Bridge	· New bridge center is 9m downstream of existing bridge center	· Existing bridge is used	· Existing bridge is demolished after construction	· Davao to site is paved.	· Existing bridge is used for girder erection · Relocation of a house is needed
9	10-05-01 Culaman	· Bailey Bridge	· New bridge location is up-stream of existing bridge	· Existing bridge is used	· Existing bridge is demolished after construction	· Malalag to site is gravel in fair condition.	· Relocation of 7 houses, power posts is needed
10	10-05-03 Mintal	· Bailey Bridge	· New bridge location is same as existing bridge	· Detour bridge is constructed at approx. 100m upstream from existing bridge	· Existing bridge is demolished prior to construction	· Davao to KM22.2 is paved. · KM22.2 to site is gravel in good condition.	· Relocation of 7 houses is needed

Table 4-2 OUTLINE OF TOPOGRAPHIC, GEOLOGICAL AND RIVER CONDITION OF THE PROJECT SITES (GROUP 2)

(1/4)

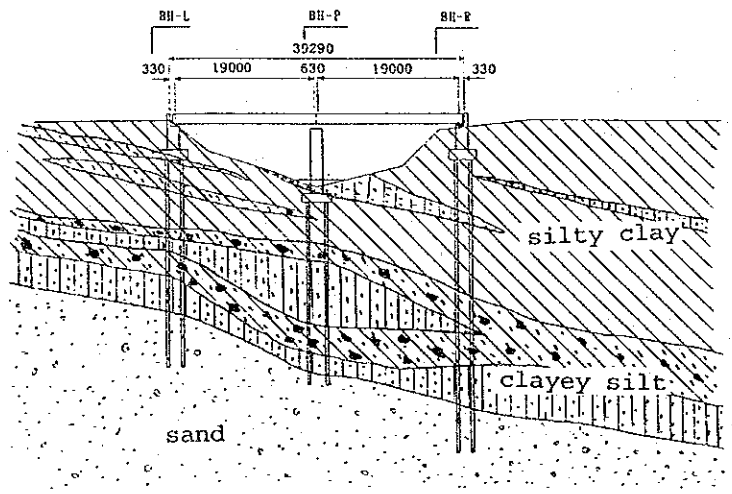
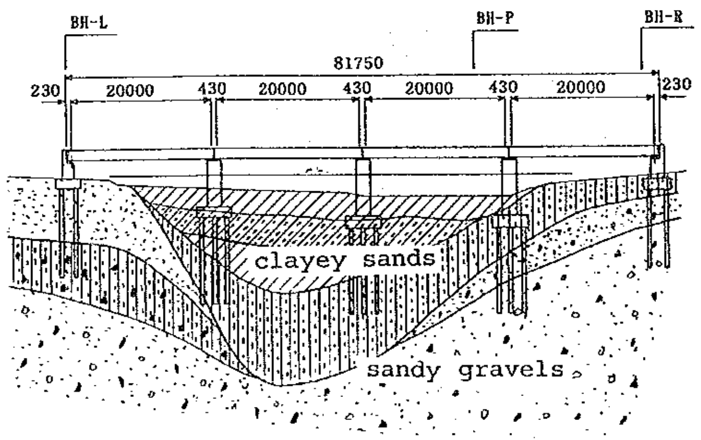
No.	Bridge No. Bridge Name	Geological Profile	Topographic Condition	Geological Condition	River Condition
1	10-01-08 Lingayao		· Site is located on a branch river of Agusan River which is the largest river in Mindanao. Site is approx. 25km from the Butuan Bay. · Narrow flood plain is developed along the river. · Site locates in the plain surrounded by gentle mountains. · River banks are steep slopes. · Rice field is adjacent to the site.	· Boring survey was not conducted at this site, since it had been classified Group 1. · The geological condition of the site is similar to Magus Bridge, since they are located near, and their topography is similar.	· The branch river meets Agusan River at around 300m downstream of the site. · River flows slowly ordinarily. · Flood water of Agusan River comes up and overflows the river when flooding. · River is not shallow always. · Alignment of the river is changing and erosion is progressing.
2	10-01-09 Magus		· Site is located on a branch river of Agusan River which is the largest river in Mindanao. Site is approx. 20km from the Butuan Bay. · Narrow flood plain is developed along the river. · Site locates in the plain surrounded by gentle mountains. · River banks are steep slopes. · Rice field is adjacent to the site.	· The subsurface is occupied by a thick layer of soft to medium stiff clayey silt or silty clay, overlaying a thick formation of medium dense to very dense clayey sand deposits. · The thickness of the overlaying soft clays and silts varies from about 15 to 30m. · Steel pile pile foundations are proposed since the bearing strata is around 20 to 35m deep.	· The branch river meets Agusan River at around 300m downstream of the site. · River crosses the road with skewed angle. · River flows slowly at ordinary. · Flood water of Agusan River comes up and overflows the river when flooding. · River is not shallow always. · River alignment is straight and erosion is not seen.
3	10-01-10 Rizal		· Site is approx. 15km from the Butuan Bay along Guihao-an River. · Site is surrounded by gentle mountains. · Right side river bank is being scoured and vertical, left side river bank is wide and gentle slope. · Coconuts and bananas are cultivated around the site. · A nippa house is located on the right side bank.	· Gravel consisting of silts and sands is deposited on riverbed surface. · Around 6m thick loose clayey sands and soft sandy clay occupy the shallow depths of the stream bed. · The deeper strata are occupied by stratified alluvial sediments of medium dense silty sands and very dense sandy gravels with cobbles. · Around 10m long RC precast pile foundations are proposed.	· Guihao-an River is medium size river, which flows medium fast. · A sabo dam is located approx. 100m upstream of the site. · River overflows when flooding and flood water reaches the floor of the house.

Table 4-2 OUTLINE OF TOPOGRAPHIC, GEOLOGICAL AND RIVER CONDITION OF THE PROJECT SITES (GROUP 2)

(2/4)

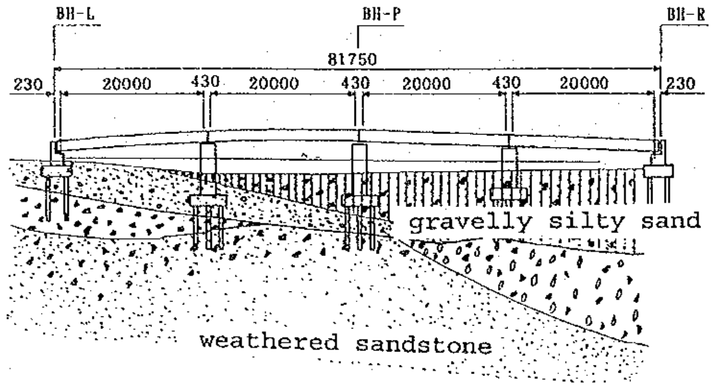
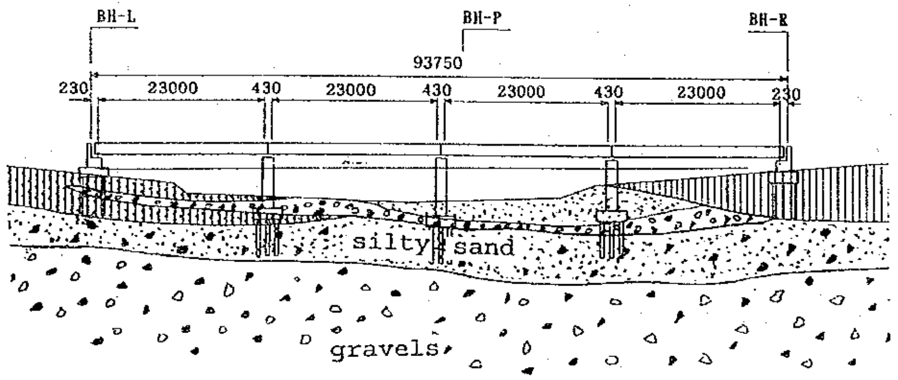
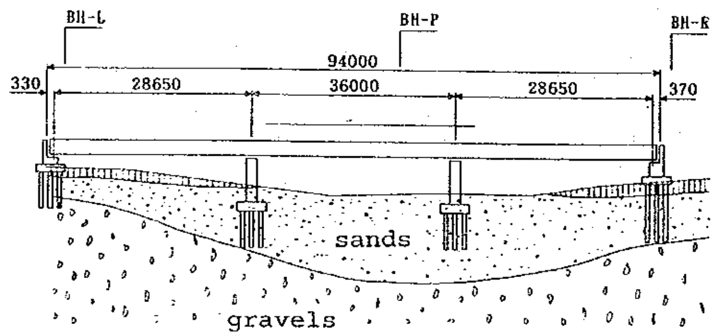
No.	Bridge No. Bridge Name	Geological Profile	Topographic Condition	Geological Condition	River Condition
4	10-01-12 Guinabsan		· Site is approx. 3km up-stream of Rizal Bridge along Guihao-an River. · Site is surrounded by gentle mountains. · Left side river bank is being scoured and vertical, right side river bank is wide and gentle. · Coconuts and bananas are cultivated around the site. · A crowd of houses of Guinabsan Barangay is located adjacent to the site on the left side of the river.	· Gravel consisting of silts and sands is deposited on riverbed surface. · Underlying the site is a 4 to 7m thick mantle of recent alluvium, consisting of medium dense to very dense deposits of coarse gravelly silty sand. · The deeper strata comprise soft weathered sandstone is the bearing strata. · Around 5m long RC precast pile foundations are proposed.	· Guihao-an River is medium size river, which flows medium fast. · River overflows when flooding and flood water reaches the floor of the house.
5	10-02-04 Maog		· Site is located on Maog River which joins Agusan River at approx. 40km down-stream from the site. · River banks are mildly to moderately sloped and covered with grass. · Flood plain is developed left side of the river and gentle mountains are of the right side. · Houses are existing along the right side approach road.	· Gravel and cobbles are exposed at riverbed. · A 2 to 3m thick layer of loose to medium dense silty sand occupied the surface. · A thick formation of very dense gravels and cobbles underlaid. · Pile foundations are pro-posed to ensure stabilities against future river erosion. · 5m long RC precast piles are planned to gain required stability of piles.	· River flows fast and erosion is progressing. · Alignment is straight and stable at the site.
6	10-05-09 Pagatapat-San Simon		· Site is located approx. 15km from the Macajalar Bay along Iponon River. · Site is located on a fan formed with sedimented soils which have eroded from the weathered hilly mountains in the upstream vicinity. · Narrow flood plain is de-veloped from the site to the downstream. · Around 10 houses are located near to the site.	· The stream bed is alluvial deposits. A relatively thin layer of fine silts and sands makes up the upper 2m layer of the stream bed. · Presence of gravels and coarser sediments become more distinct at deeper strata up to a depth of about 6m, where cobble size materials begin to pre-dominate. · RC precast piles (5 to 10m long) foundations are proposed.	· River is about 2.5m deep by 90m wide. · Current is fast and ero-sion and sedimentation is occurring alternatively. · Alignment is stable. · Flood water reaches the floor level of the houses.

Table 4-2 OUTLINE OF TOPOGRAPHIC, GEOLOGICAL AND RIVER CONDITION OF THE PROJECT SITES (GROUP 2)

(3/4)

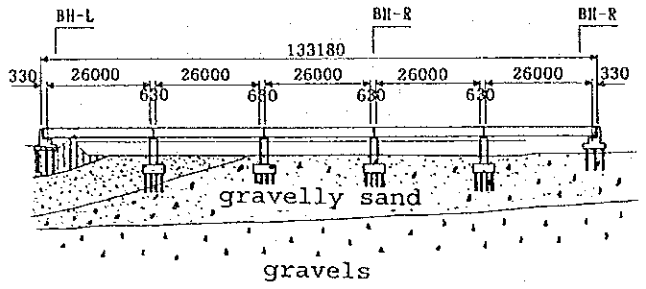
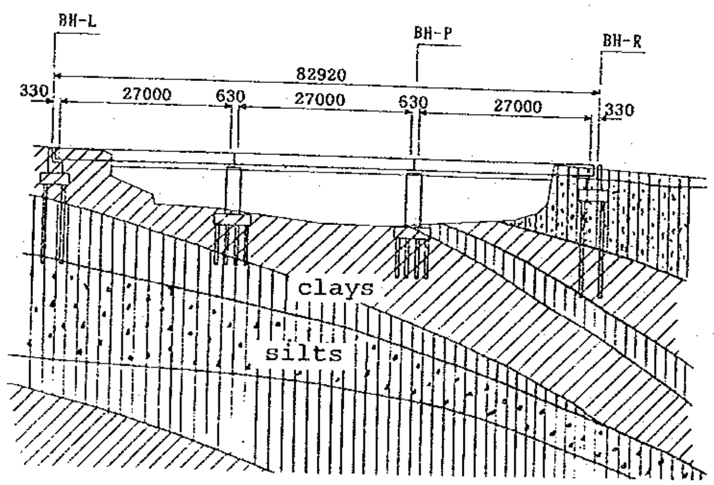
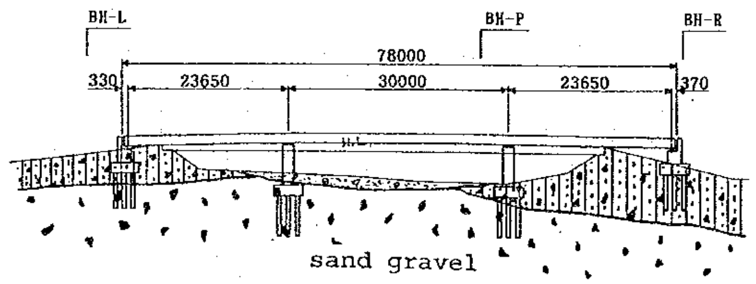
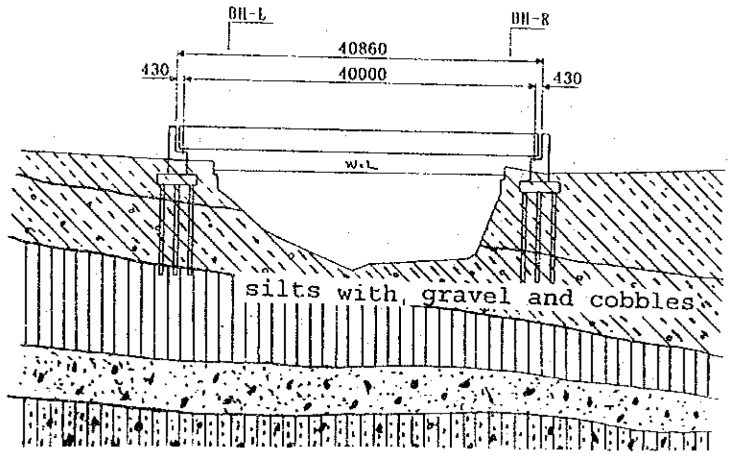
No.	Bridge No. Bridge Name	Geological Profile	Topographic Condition	Geological Condition	River Condition
7	11-02-05 Lower Silway		· Site is located in a populated area in General Santos City. · Many houses are crowded at the left side of the river. · Site is approx. 500m from the Sarangani Bay along Silway River. · Topography is flat broad flood plain. · Left side river bank is a concreted dike to protect the residential area.	· The site is alluvial deposits consisting of a thick formation of sandy gravels and gravelly sand sediments having increasing relatively density with depth from dense to very dense. · Pile foundations are proposed to be stable against future river erosion. · 6m long RC precast piles are planned to gain requisred stability of piers.	· River is about 1m deep and 100m wide. · High tide which comes from the bay reaches until about 50m downstream from the site. · River flows fast, and erosion and sedimentation is occurring alternatively.
8	11-04-03 Inambatan		· Site is located in inland mountainous terrain, which is approx. 100km from Davao City along the Pan Philippine Highway. Site is close to the highway. · Site location is upstream of Agusan River. Approx. 150km from the Butuan bay. · A narrow flood plain is developed along the river at the site.	· Subsurface consists of thick formation of fine gained deposits of clays and silts, having medium stiff consistency near the ground surface and stiff to hard at greater depths. · RC precast piles (7m for piers, 15m for abutments) embeded into stiff clays are proposed.	· River channel is about 6m deep and 60m wide. · Erosion activity is occurring and alignment is changing.
9	11-05-01 Culaman		· Site is located in populated area of Malita Municipality. · Site is in small coastal plain and close to steep mountains behind. · Many houses are existing beside of the concrete dike at the left side of the river. · Earth dike is constructed at downstream of the right side of the river.	· The stream bed deposits of coarse sand-gravel mixture are exposed. · The substructure is occupied by a thick homogenous formation of very dense sand gravel. · Pile foundations are proposed to be stable against future river erosion. · 6m long RC precast piles are planned to gain requisred stability of piers.	· A wide shallow stream channel which is about 50m wide and 2m deep. · Stream is fast, and erosion and sedimentation are occurring alternatively.

Table 4-2 OUTLINE OF TOPOGRAPHIC, GEOLOGICAL AND RIVER CONDITION OF THE PROJECT SITES (GROUP 2)

(4/4)

No.	Bridge No. Bridge Name	Geological Profile	Topographic Condition	Geological Condition	River Condition
10	11-05-03 Mintal		· Site is about 20km from Davao City. · Site vicinity is characterized by moderate to steeply sloping terrain. · River banks have relatively steep side slopes with exposure of cobbles and boulders. · Houses are located close to the site on both sides of the river.	· Large size of boulders are lied on the river. · Riverbed comprises medium stiff to stiff fine graded sediments of clays and silts with coarse sands, gravel and cobbles. · Shallower depth are more fine graded and the percentage of sands and gravels increases at deeper strata. · Very dense subsoil formation occurs starting at a depth of about 3 to 7m from the ground surface. · Around 10m long RC precast pile foundations are proposed. · Pre-boring using a rock auger prior to driving piles are proposed since cobbles are mixed in the ground.	· River channel has increasing width and depth towards the downstream. It is about 40m wide and 4m deep at the site. · Water depth is very shallow since the water detours to a mini hydraulic power plant at the upstream.

4.3 Examination of Design Criteria

(1) Design specifications

The following specifications specified by DPWH are applied to this basic design. However, Japanese highway bridge design specifications are supplementarily applied to the design, where DPWH specifications are not specified.

- AASHTO Standard Specifications for Highway Bridge, 15th Ed., 1992
- Highway Design Guideline, DPWH
- AASHTO Guide for Design of Pavement Structures, 1986
- Standard Specifications for Highways, Bridges & Airports, DPWH, 1988
- Technical Guidelines, DPWH, August 1993

(2) Design load

- Dead load : Handrails, curbs, pavement, slabs, haunches and steel beams are considered in design

- Live load : HS 20-44 specified in AASHTO (equivalent to trailer truck load)
  Concentrated load : for bending moment 18,000 lbs
  for shearing force 26,000 lbs
  Uniform load : 640 lbs/liner foot of load lane

- Impact : As specified in AASHTO, Section 3.3.8

- Temperature change : ±10°C (base on the climate in Mindanao)

- Wind load : As specified in AASHTO, Section 3.3.15

(3) Specified strength of materials

- Concrete PC girders Fc = 350 kgf/cm²
  Slab members Fc = 280 kgf/cm²
  Hand rail members Fc = 210 kgf/cm²
  Substructure members Fc = 210 kgf/cm²

- Reinforcing bars (yield strength) Fy = 2100 kgf/cm²

(4) Specified material properties of steel girders

The specified material properties of steel girders for the project are shown in Table 4-3.

Table 4-3 MATERIAL PROPERTIES OF STEEL FOR GIRDERS

Japan Industrial Standards (JIS) Designation	Material Designation	Minimum Yield Point (kgf/mm²)			Tensile Strength (kgf/mm²)
		t<16	16<t<40	40>t	
JIS G 3101 Type-2	SS 400	25	24	22	41 to 52
JIS G 3106 Type-3	SM 490Y	37	36	34	50 to 62
JIS G 3114 Type-1 Type-2	SMA 400 SMA 490	25 37	24 36	22 34	41 to 52 50 to 62

t : Thickness of steel plate (in mm)

PC steel : 12T-12.4

(5) Geometric standard of approach roads

The geometric standards of secondary national roads specified in the Highway Design Guideline, DPWH are applied to designing all the approach roads of the project bridges.

4.4 Basic Plan

4.4.1 Planning of Bridge

Based on the project site survey results and the basic design concepts, bridge location, bridge length, span length and bridge elevation of the project bridges were examined and are planned as follows:

(1) Bridge location

The bridge locations were examined to plan the optimum locations against the site conditions. The following considerations were given to the examination:

- To shorten bridge length to economize construction cost
- To minimize removal of existing houses and other facilities within right-of-ways
- To minimize land acquisition for bridge and approach road construction
- To improve alignment of approach roads
- To economize construction cost in total including additional works and detour road construction
- To make bridges stable and easy to construct

(2) Bridge length and span length

Abutments and piers in the river should be located so as not to hinder flood discharge.

As a rule, the position of both abutments should be located behind the intersection points of the maximum flood level and the river dikes.

<u>Planning of bridge length</u>

Bridge length is determined as follows:

- Bridge lengths are long enough to provide sufficient river width between both abutments to discharge the maximum flood.

- Bridge lengths are not so long as to be unnecessary or uneconomical.
- Bridge locations are positioned to prevent scouring and the washing away of abutments.
- Floods flow smoothly and do not endanger abutments and approach embankments by scouring.

Planning of span length

The optimum span lengths were selected from the comparative combinations of numbers of spans and lengths which comprise the bridge length.

In comparing span length combinations, the followings criteria were taken into consideration:

- Total construction costs
- Difficulty of construction of piers and their foundations in the river
- Degree of obstruction by piers against flood discharge
- Stability of piers against scouring

(3) Bridge elevation

The bridge elevations (elevation of top of deck slab at the center of carriageway of the bridge) were planned based on the maximum flood levels (MFL) plus freeboard and bridge structure depth.

The MFLs were obtained by hearing surveys and observation surveys in the site surveys. The MFLs were clarified with the values obtained by the hydrological analysis.

The freeboard (clearance between MFL and a bottom of girder) is planned to be 1.0 m high. Where bridges are needed to be low because of the conditions, the freeboard will be reduced to 0.5 m if there is no possibility of any flooding exceeding the MFLs.

Proposed bridge length, span length and bridge elevation of the project bridges are shown in the Table 4-4.

4.4.2 Examination of Superstructure Types

(1) Superstructure types

The following superstructure types are selected for the project bridges based on experience in Japan and the Philippines.

- Simple H-Beam composite girders
- Simple built-up beam composite girders
- Continuous built-up beam girders (non-composite)
- Simple PC composite girders

<u>Selection of Composite Type</u>
Of the selected superstructure types, the composite girder type is proposed based on the advantages of cost, applicable variations of span lengths and experience in the Philippines. However, to construct the composite girders, quality control of the deck slab concrete to adhere to the specifications is required.

<u>Selection of H-beam or Built-up Beam Type</u>
The estimated steel material costs of the above superstructure types at variations of span length are shown in Figure 4-1. From the figure, it is understood that the simple H-beam composite girder is economical for spans less than 25 m. As a result, adoption of H-beams or built-up beams for simple supported steel girder type bridges is as follows:

Simple H-Beam composite girders : for spans shorter than 25 m.
Simple built-up beam composite girder : for spans longer than or equal to 25m.

<u>Selection of Continuous Type</u>
In general, the continuous supported beam type is economical type for long multispan bridges. A comparison of cost between continuous built-up beams and simple supported beams at variations of

Table 4-4 BRIDGE LENGTH, SPAN LENGTH AND BRIDGE ELEVATION OF THE PROJECT BRIDGES

No.	Bridge No. Bridge Name	Bridge Length (m)	Span Length (m)	Girder Depth (mm)	MFL (m)	Free Board (m)	Bridge Elevation (m)	Remarks
1	10-01-08 Lingayao	40.89	2 x 20	912	50.90	0.5*	52.70	· Left side abutment is planned 6m behind existing abutment since scouring there is foreseen.
2	10-01-09 Magus	39.29	2 x 19	900	51.00	0.5*	52.80	· Bridge length is planned based on width of existing river banks at MFL level.
3	10-01-10 Rizal	81.75	4 x 20	912	51.50	1.0	53.80	· Bridge length is planned based on width of the Sabo dam just upstream of the site.
4	10-01-12 Guinabsan	81.75	4 x 20	912	51.50	0.5*	52.80	· Bridge length is planned the same as Rizal Bridge.
5	10-02-04 Maog	93.75	4 x 23	912	48.50	1.0	50.80	· Bridge length is planned based on width of existing river banks at MFL level.
6	10-05-09 Pagatapat San Simon	94.00	28.65+36+28.65	1,700	17.00	1.0	21.10	· ditto · Continuous type is planned since bridge is long and subsurface condition can be adopted.
7	11-02-05 Lower Silway	133.18	5 x 26	1,372	50.50	1.0	53.20	· Bridge length is planned based on width of existing river banks at MFL level.
8	11-04-03 Inambatan	83.00	3 x 27	1,372	47.50	1.0	50.14	· ditto
9	11-05-01 Culaman	78.00	23.65+30+23.65	1,500	50.00	0.5*	52.30	· ditto · Continuous type is planned since bridge is long and subsurface condition can be adopted.
10	11-05-03 Mintal	40.86	40	2,000	49.20	1.0	52.60	· ditto · Single span bridge is planned because construction of a pier is difficult.

Note: · Free boards with * are planned at 0.5m since the bridge elevations need to be low and there is no possibility of any flood exceeding the MFL.
· The bridge depth used in planning bridge elevations is comprised of a deck slab (20 cm), concrete pavement (5 cm) and a deck slab haunch (11 cm).

span length is shown in Figure 4-1. The continuous supported beam type is not suitable where excessive settlement of substructures is anticipated because unequal settlement causes additional stress on the beam which may result in bridge collapse.

The continuous built-up beam girder type is proposed for Pagatpat Sansimon Bridge and Culaman Bridge, since they are long multi-spans and it is judged that their planned substructure foundations will not settle much based on the geological survey results.

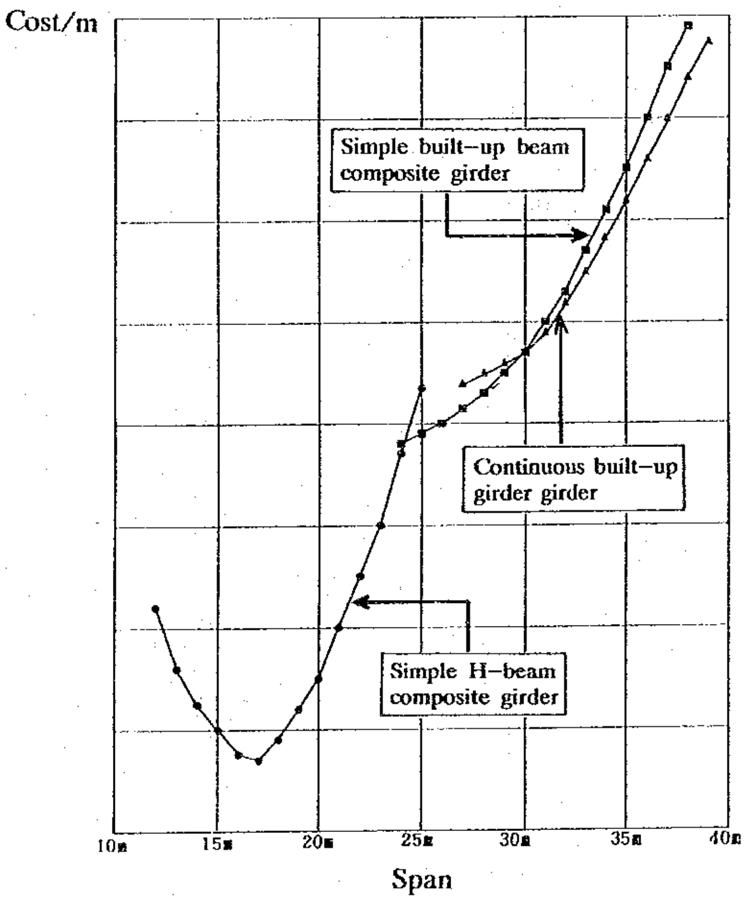


Figure 4-1 STEEL MATERIALS COSTS VERSUS SPAN LENGTHS

Selection of Simple PC Composite Girders

In general, since conditions for procurement of high strength concrete and transportation of PC girders are good, the simple PC composite girder type is most economical for medium long multi-span bridges in the Philippines among superstructure types. It is the recommended type since many local materials and labor can be utilized for the construction of the girders.

A simple PC composite girder type is proposed for Lower Silway Bridge and Inambatan Bridge, since they are medium long multi-spans, and it is judged that it is easy to obtain high strength concrete for fabrication of PC girders in Davao City and to transport the PC girders from Davao City to the sites.

Proposed Superstructure Types

As a result of the study, the proposed superstructure types for the project bridges are shown in Table 4-5. The features of each superstructure type are summarized in Table 4-6.

Table 4-5 PROPOSED SUPERSTRUCTURE TYPE

No.	Bridge No. Bridge Name	Bridge Length (m)	Component Spans (m)	Superstructure Type
1	10-01-08 Lingayao	40.89	2 x 20	Simple H-beam components girder
2	10-01-09 Magus	39.29	2 x 19	Simple H-beam components girder
3	10-01-10 Rizal	81.75	4 x 20	Simple H-beam components girder
4	10-01-12 Guinabsan	81.75	4 x 20	Simple H-beam components girder
5	10-02-04 Maog	93.75	4 x 23	Simple H-beam components girder
6	10-05-09 Pagatapat San Simon	94.00	28.65 + 36 + 28.64	Continuous built-up beam girder
7	11-02-05 Lower Silway	133.18	5 x 26	Simple PC composite girder
8	11-04-03 Inambatan	83.00	3 x 27	Simple PC composite girder
9	11-05-01 Culaman	78.00	23.65 + 30 + 23.65	Continuous built-up beam girder
10	11-05-03 Mintal	40.86	40	Continuous built-up beam girder

Table 4-6 COMPARISON OF SUPERSTRUCTURE TYPES

Type	Structural Feature	Cost	Construction Requirement	Maintenance Requirement	Elevation
Simple H-Beam Composite Girder	· Its deflection and vibration are smaller than non-composite type girder's.	· It is comparatively economical type for 12 to 24m span bridges.	· Fabrication of girders is easy and fast. · Transportation of girders is easy. · Erection of girders is easy and fast.	· Repainting is required.	· It is suitable type for short span (12 to 24m) simple supported bridges.
Simple Built-up Beam Composite Girder	· Its deflection and vibration are smaller than non-composite type girder's. · Its applicable spans are longer than non-composite type girder's. · Girder size and shape are free.	· It is comparatively economical type for 24 to 45m span bridges.	· Fabrication of girders is comparatively complicated. · Transportation of girders is not so easy as H-beam since the girder size is larger than H-beam.	· Repainting is required.	· It is suitable type for medium long span (25 to 45m) simple supported bridges.
Continuous Built-up Beam Girder	· It is highly resistant type against earthquake. · It need less expansion joint which makes roadway smoother. · Its applicable spans are longer than simple type girder's. · Continuous girders are not suitable where substructure settlement is foreseen.	· It is comparatively economical type for 30m or longer multi span bridges.	· Erection needs comparatively high technology for chamber adjustment.	· Repainting is required.	· It is suitable type for long multi span (30m or longer) bridges where considerable substructure settlement is not foreseen.
Simple PC Composite Girder	· Its deflection, vibration and traffic noise are smaller than other type's. · Girder depth is smaller than other type's.	· It is comparatively economical type for multi span long bridges.	· It is required that PC girders can be transported to the site from a girder construction yard which is close to a ready-mixed concrete plant. · Engineering technology for concrete quality control is needed. · Construction period is comparatively long.	· Repainting is not required.	· It is suitable type for bridges close to sea. · It is the more economical the more spans of bridge. · It is suitable for medium multi span bridges where procurement of PC girders is available.

(2) Bridge width

A 7.3 m wide 2 lane carriageway is proposed for the project bridges, as the Highway Design Guideline, DPWH specifies for rural secondary national roads. The components of the bridge width are shown in Figure 4-2.

A 2.5 m wide sidewalk is proposed for Lower Silway Bridge since its pedestrian traffic is large. The components of the bridge width of Lower Silway are shown in Figure 4-3.

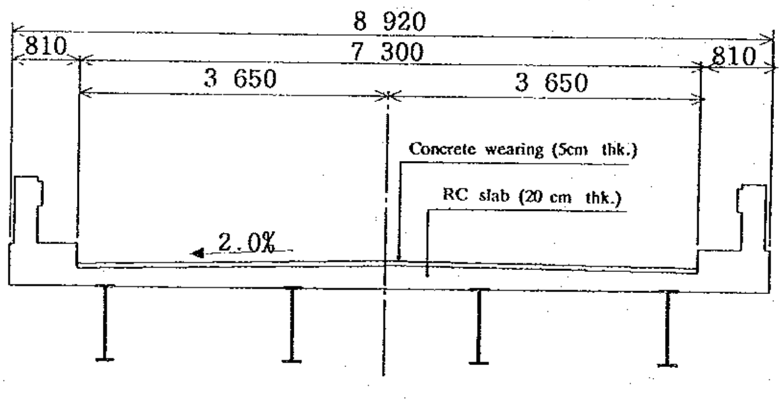


Figure 4-2 COMPONENTS OF BRIDGE WIDTH

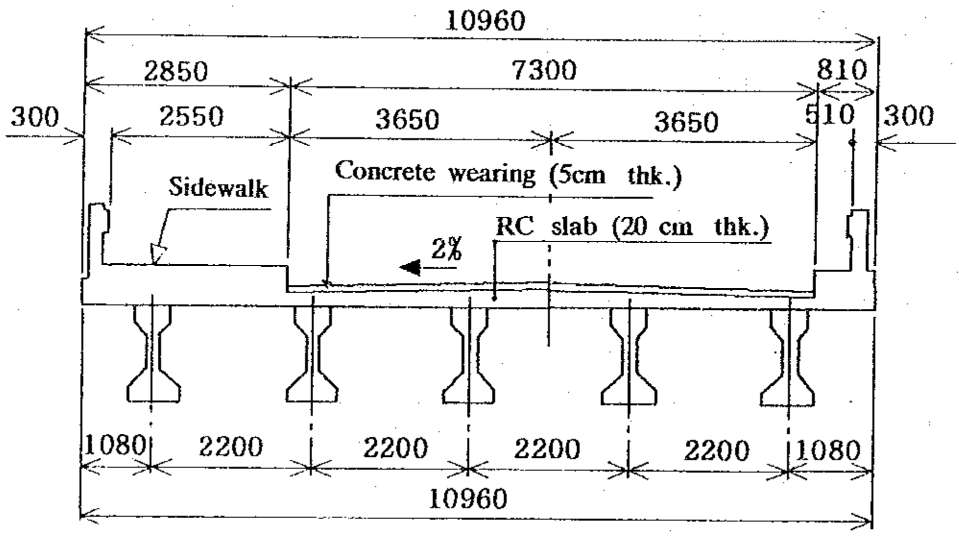


Figure 4-3 COMPONENTS OF BRIDGE WIDTH (LOWER SILWAY BRIDGE)

(3) Number of main girders and their intervals

The number of main girders and their intervals were examined by comparing 3 schemes as shown in Figure 4-4.

As a result, a scheme of 4 main girders at 2.2 m interval is proposed.

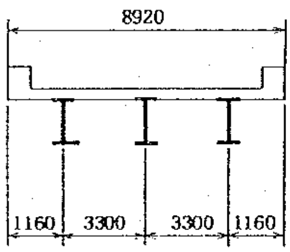
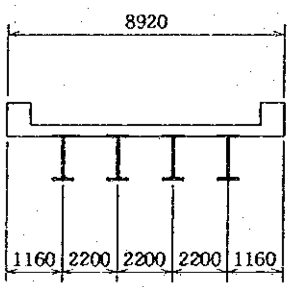
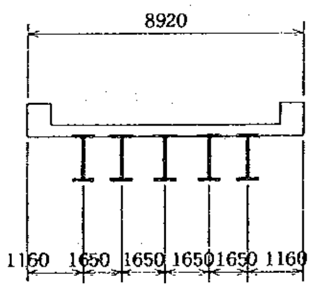
Scheme	Number of Girders	Girder Interval	Slab Thickness	Evaluation
	3	3.30 m	24 cm	· Applicable spans are less than 18m. · Girder depths are comparatively large.
	4	2.20 m	20 cm	· Applicable spans are less than 25m. · This is the most common main girder interval and slab thickness.
	5	1.65 m	18 cm	· Uneconomical for span lengths less than 25m.

Figure 4-4 COMPARISON OF NUMBER OF GIRDERS AND THEIR INTERVALS

Five girders at 2.2 m intervals are proposed for Lower Silway Bridge since it has a 2.5 m wide sidewalk.

(4) RC deck slab thickness

The thickness of the RC deck is planned in accordance with the formula specified in the Specification for Highway, Part II Steel Bridges, Japan Road Association. The thickness of the RC deck slab thickness (t in cm) of bridges having heavy trailer truck traffic has obtained by the following formula:

$$t = (3 \times \text{main girder interval} + 11) \times 1.15$$
$$t = (3 \times 2.2 + 11) \times 1.15 = 20.24 \text{ cm}$$

(5) Girder depth

Simple H-Beam Composite Girders

The optimum girder depth is related to the span length when the bridge width and number of girders are constant. Figure 4-4 shows the relation between span lengths and girder depths in the case of the simple H-beam composite girder type bridges with 4 main girders, as a result of a preliminary design of the Study Team.

The largest H-beam commonly available is H-912.

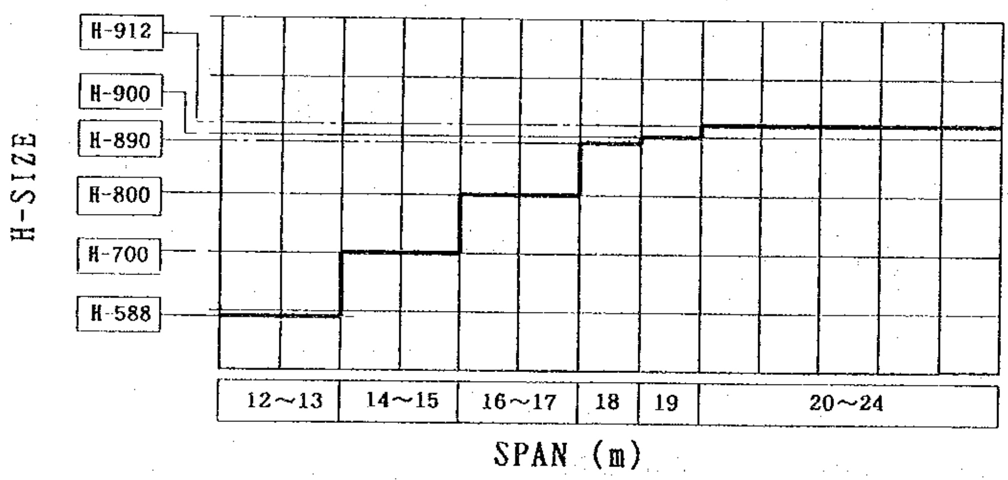


Figure 4-5 RELATION BETWEEN SPAN LENGTH AND GIRDER DEPTH (H-beam Composite Girder)

Built-up Beam Girders

The ratio of the optimum depth of simple built-up beam composite girder against span length is 1/20, while that of continuous built-up beam girder is 1/18, in general, which are given in the Bridge Design Data Bank, Japan Steel Bridge Construction Committee based on its experiences. These ratios are taken into the planning of the girder depths.

Simple PC Composite Girders

Precast PC girders used for the simple PC composite girders are planned to be AASHTO standard type PC girders. Type IV AASHTO girders (girder depth is 1.372m) are adopted for the spans between 25 to 30 m.

(6) Expansion joints

The required expansion space between girder ends or between abutments and girder ends are obtained by the following formula:

DL = coefficient of liner expansion of steel x temperature change (20 degrees) x span length

$= 12 \times 10^{-6} \times 20 \times 40 = 10$ mm

In the case of the longest span (40m) steel beam bridge of the project, the horizontal movement of the girder ends due to temperature change is 10 mm. Additionally, 20 mm for construction allowance is required.

As a result, 30 mm as expansion space is planned for all the simple supported beam type project bridges including PC girders.

The following points were considered in selection of the expansion joint type:

- Build-up of mud and dust from the bridge deck, which will corrode steel girders, is preventable.
- Maintenance is easy.
- Type is common in the Philippines.
- The materials are available in the Philippines.
- A lacking of maintenance will not cause structural failure.

As a result, the expansion joint shown in Figure 4-6 is proposed for the project.

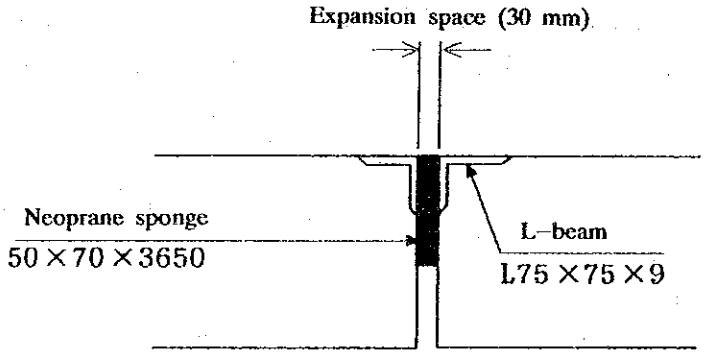


Figure 4-6 EXPANSION JOINT

Expansion Joints for Continuous Built-up Beam Girder

The continuous built-up beam bridges are 94 m and 78 m long. In their case the expansion space varies a maximum of 22 mm. A 70 mm wide expansion space for continuous built-up girders is planned to provide an additional allowance space. The steel finger type joint is proposed for the bridges.

(7) Earthquake-resistant structures

To prevent the collapse of superstructures, the following measures are were planned to be furnished to the project bridges:

- To install steel plates connecting both steel girder ends at the top of piers. To install PC bars instead of steel plates for simple PC composite girders

- To install concrete stoppers in front of the cross beams of the superstructures at the top of abutments.

- To design bearings to be earthquake resistant.

- To secure the length of bearing anchor bolts embedded into substructure concrete. (the minimum to be 15 times the diameter of the bolts.)

- To secure the widths of the substructures top in accordance with specification of Road Design Standard Part VI, Seismic Design, Japan Road Association.

(8) Bearings

Liner rocker bearings, which are economical and commonly used for short span steel girder bridges, are planned to be used for the project bridges, except for bridges longer than 38m or skewed.

Bearing plate bearings (BP-A) are planned for long or skewed bridges.

(9) Maximum length of steel girder members, and method of splice

- The maximum length of steel girder members is planned to be 8.5 m give convenience of transportation of them.

- The high tension bolt (22mm F10T) splicing method is planned to connect the girder members on site.

(10) Painting

The steel materials are planned to be painted under coats in the factory, and then finish coats on site.

(11) Camber adjustment

Camber adjustment is bending up girders to compensate the sags caused by the dead loads or to follow the curved vertical alignment given to the road surface. Cambers will be given to the girders in the course of fabrication girders in a factory.

4.4.3 Examination of Substructure Type

(1) Abutments

Inverted-T type abutments are proposed for the project bridges. The following considerations are given to the planning of abutment structures:

- The width of abutment bearing seat is planned to be sufficient enough wide to prevent the collapse to superstructures due to earthquakes. The necessary width is specified in Highway Bridge Design Part VI, Seismic Design, Japan Road Association.

- To prevent scouring around abutment footings and to maintain ground sound to support the stability of the abutment foundations.

- Approach slabs behind the abutments are planned to be furnished to prevent settlement of road surface.

The design method of checking substructure stability and structural member strength is shown in the Technical Guideline for Constructing Bridges Along Rural Roads, DPWH.

(2) Piers

Inverted-T column type piers are proposed for the project bridges. The following considerations are given to the planning of pier structure:

- Column type piers can avoid disturbance to the stream lines when the rivers change their directions or angles against the bridges.

- Column type piers, which are less rigid than wall type piers, are eearthquake resistant type, since the earthquake force works more strongly on the more rigid structures.

- The width of pier bearing seat is planned to be sufficiently wide to prevent collapse of superstructures due to earthquakes. The necessary width is specified in Highway Bridge Design Part VI, Seismic Design, Japan Road Association.

- Footings are planned to be embedded into the riverbeds deeply enough to prevent failure of stability of piers due to scouring or erosion of the rivers. Embedding footing 2 m beneath the riverbed is proposed as the standard. Installing gabions and filter units are proposed where occurrence of scouring is anticipated.

(3) Foundations

Precast RC piles (400 mm x 400 mm), which are commonly used in the Philippines, are proposed as the standard pile type.

Steel pipe piles are proposed for the foundations of the following bridges because they are located on around 30m deep soft ground, where RC piles are not adoptable.

10-01-08 Lingayao Bridge
10-01-09 Magus Bridge

4.4.4 Design of Superstructures

A basic design of the superstructures of the project was carried out based on the bridge plan and the proposed structures. The results of the basic design of the superstructures, which are shown in Appendix 9, are as follows:

- Basic design of simple H-beam composite girders (Figure A9-1)
- Basic design of simple built-up beam composite girders (Figure A9-2)
- Basic design of continuous built-up beam girders (Figure A9-7)
- Basic design of simple PC composite girders (Figure A9-8)
- Detailes of expansion joints (Figure A9-9)
- Summary of design computation of superstructures (Table A9-4)
- Reaction force of superstructures (Table A9-5)
- Heights of girders, slabs and bearings (Table A9-6)

4.4.5 Design of Substructures

The standard substructures for the project, of which the following drawings are shown in Appendix 9, are proposed as a result of the study.

- Standard abutments (Figure A9-3)
- Standard piers (Figure A9-4)

4.4.6 Design of Approach Roads

The design standard for secondary national roads specified in the Highway Design Guideline, DPWH is adopted for the design of the approach roads. Its geometric standard is shown in Table 4-7. Typical cross sections of the approach roads are shown in Figure A9-5 in Appendix 9. Guardrails are proposed to be installed along high embankment approach roads.

Table 4-7 GEOMETRIC STANDARD OF APPROACH ROADS

	Flat	Rolling	Mountainous
1. Design Speed (km/hr)	60	50	40
2. Pavement Width (m)	6.70	6.70	6.70
3. Shoulder Width (m)	1.00	1.00	1.00
4. Minimum Radius (m)	120	80	50
5. Maximum Superelevation (%)	8	8	8
6. Maximum Grade (%)	3	5	10
7. Minimum Length of Vertical Curve (m)	60	60	60
8. Minimum Radius for Crest Vertical Curve (m)	1500	1200	1000
9. Minimum Radius for Sag Vertical Curve (m)	1500	1000	800

4.4.7 Design of Pavement

The Portland Cement Concrete (PCC) pavement type is proposed for the approach roads of the project bridges. PCC pavement is easy to construct even in small amounts in rural areas, like this project, since construction PCC pavement does not require a large mixing plant.

The pavement structure is designed in accordance with the traffic volume of heavy vehicles and subgrade density. Since most of the project roads are secondary national roads and have very small traffic, a 20 cm thick PCC pavement over a 20 cm thick subbase course, which is the standard pavement structure for secondary national roads in the Philippines, is proposed as shown in the typical cross sections of the approach roads in Figure A9-5 in Appendix 9.

4.4.8 Design of Riverbank Protection

To prevent scouring at abutment foundations and erosion on riverbanks, construction of grouted riprap on riverbanks and approach road embankment slopes is proposed. The area where grouted riprap is needed to be constructed is where scouring and erosion would endanger the stability of the abutments.

Since damage on the grouted riprap around the abutments is commonly observed, the following improved structure of the grouted riprap river-bank protection is proposed for the project:

- 50 cm thick grouted riprap backfilled with 10 cm thick concrete and 20 cm thick gravel is proposed as shown in Figure 4-7.

- Scouring protection (gabions and filter units) is installed where scouring at grouted riprap footing is anticipated.

- Timber pile foundations for the grouted riprap is proposed.

The detailed structure of the riverbank protection is shown in Figure A9-5 in Appendix 9.

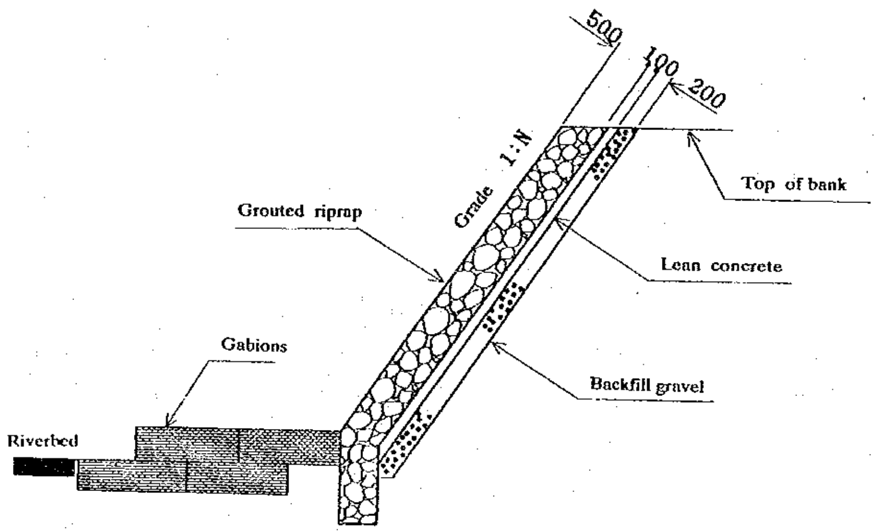


Figure 4-7 TYPICAL RIVERBANK PROTECTION

4.4.9 Scouring Protection

Installing scouring protection at around piers and in front of riverbank protections is proposed where river current are fast and scouring there is anticipated. Gabions, which are steel wire cages filled with cobbles, and filter units, which are nylon net bags filled with cobbles are proposed for the scouring protection. Gabions are proposed where the water is shallow or dry, while filter units are proposed where the water is too deep to construct gabions, in general.

A typical installation method for scouring protection is shown in Figure 4-8, and the details are shown in Figure A9-7 in Appendix 9.

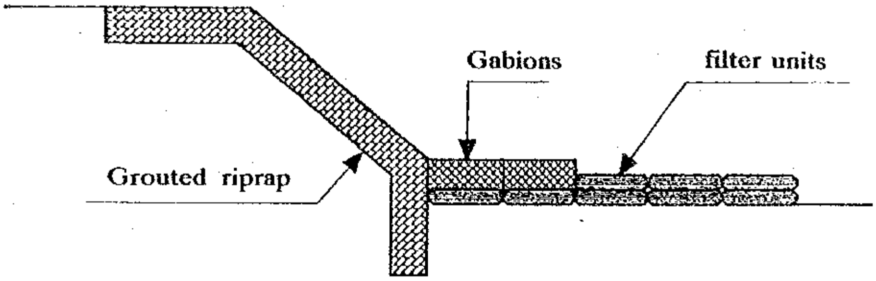


Figure 4-8 TYPICAL SCOURING PROTECTION

4.4.10 Summary of Basic Plan

As a result of the basic design, a Summary of the Basic Plan of Group 2 Bridges is shown in Table 4-8. The general plan of project bridges and their structures are compiled in a separate volume of this report.

Table 4-8 SUMMARY OF BASIC PLAN OF GROUP 2 BRIDGES

(1/3)

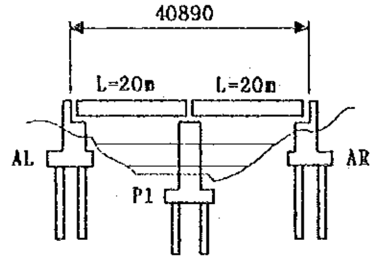
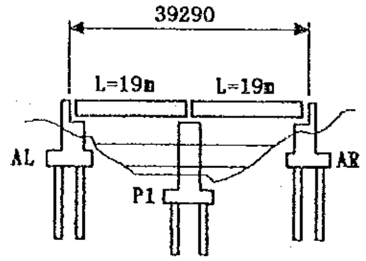
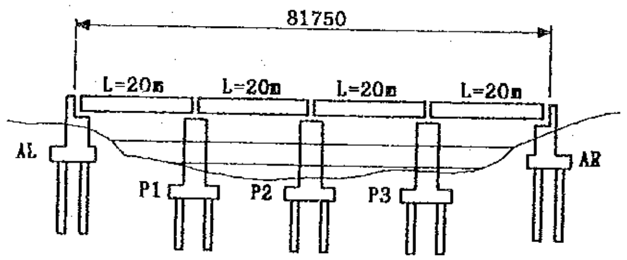
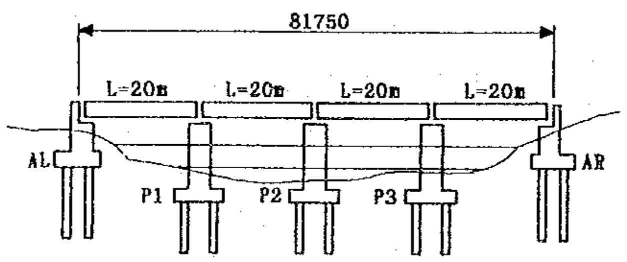
No.	Bridge No. Bridge Name	Bridge Layout	Superstructure Type Steel Girder Weight	Substructure/Riverbank Protection/Approach Road	Remarks
1	10-01-08 Lingayao		Simple H-beam W = 61.646 t	<u>Substructure (Foundation)</u> AL : H = 3.0m (Steel pipe ϕ 600 x 34m x 8 piles) P1 : H = 9.5m (Steel pipe ϕ 600 x 34m x 8 piles) AR : H = 4.0m (Steel pipe ϕ 600 x 34m x 8 piles) <u>Riverbank Protection</u> Left : Grouted Riprap A = 396m^2 Right : Grouted Riprap A = 340m^2 <u>Approach Road</u> Left : Cut = 0m^3 Fill = 1,390m^3 Right : Cut = 0m^3 Fill = 3,771m^3	Filter Units Left : 419 bags Right : 407 bags
2	10-01-09 Magus		Simple H-beam W = 53.055 t	<u>Substructure (Foundation)</u> AL : H = 4.0m (Steel pipe ϕ 600 x 28m x 10 piles) P1 : H =10.5m (Steel pipe ϕ 600 x 34m x 6 piles) AR : H = 4.0m (Steel pipe ϕ 600 x 34m x 10 piles) <u>Riverbank Protection</u> Left : Grouted Riprap A = 513m^2 Right : Grouted Riprap A = 594m^2 <u>Approach Road</u> Left : Cut = 32m^3 Fill = 2,490m^3 Right : Cut = 0m^3 Fill = 2,586m^3	Skewed (60°)
3	10-01-10 Rizal		Simple H-beam W = 123.224 t	<u>Substructure (Foundation)</u> AL : H = 5.0m (RC pile 400m x 400m x 12.0m x 10 piles) P1 : H = 7.0m (RC pile 400m x 400m x 12.0m x 12 piles) P2 : H = 8.5m (RC pile 400m x 400m x 13.0m x 12 piles) P3 : H = 8.5m (RC pile 400m x 400m x 13.0m x 12 piles) AR : H = 5.0m (RC pile 400m x 400m x 11.0m x 10 piles) <u>Riverbank Protection</u> Left : Grouted Riprap A = 295m^2 Right : Grouted Riprap A = 280m^2 <u>Approach Road</u> Left : Cut = 274m^3 Fill = 2,912m^3 Right : Cut = 0m^3 Fill = 1,588m^3	Filter Units P1, P2, P3 : 891 bags
4	10-01-12 Guinabsan		Simple H-beam W = 123.224 t	<u>Substructure (Foundation)</u> AL : H = 4.5m (RC pile 400m x 400m x 6.0m x 10 piles) P1 : H = 8.0m (RC pile 400m x 400m x 6.0m x 12 piles) P2 : H = 8.0m (RC pile 400m x 400m x 6.0m x 12 piles) P3 : H = 6.5m (RC pile 400m x 400m x 6.0m x 12 piles) AR : H = 4.5m (RC pile 400m x 400m x 6.0m x 10 piles) <u>Riverbank Protection</u> Left : Stone Masonry Gravity Wall V = 180m^3 Gabion (2 x 1.2 x 0.5) 64 pcs. Right : Grouted Riprap A = 185m^2 Gabion (2 x 1.2 x 0.5) 47 pcs. <u>Approach Road</u> Left : Cut = 0m^3 Fill = 1,744m^3 Right : Cut = 0m^3 Fill = 242m^3	Vertically curved Filter Units Left : 1,022 pcs. Right : 47 pcs.

Table 4-8 SUMMARY OF BASIC PLAN OF GROUP 2 BRIDGES

(2/3)

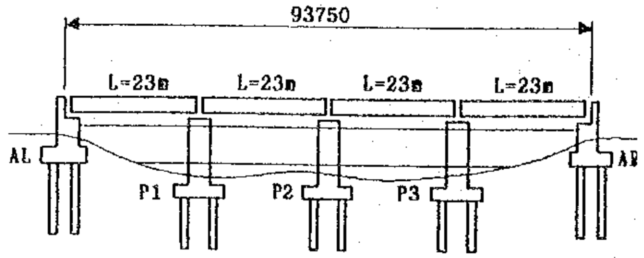
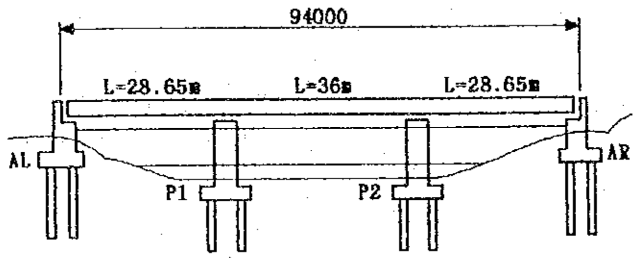
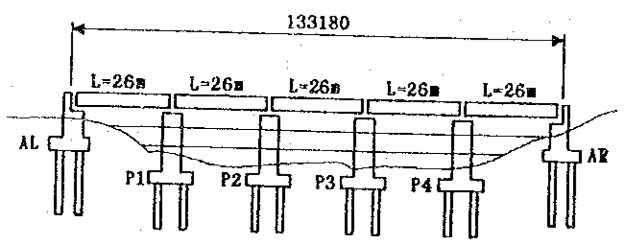
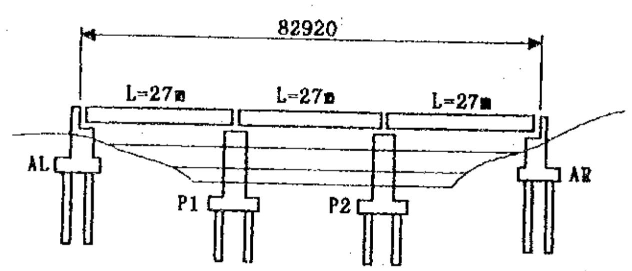
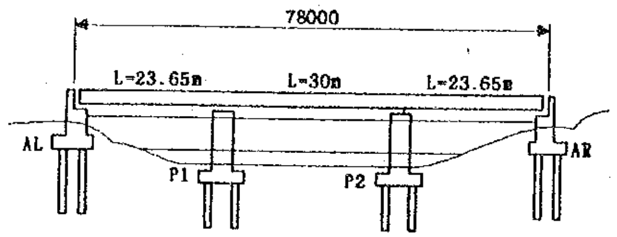
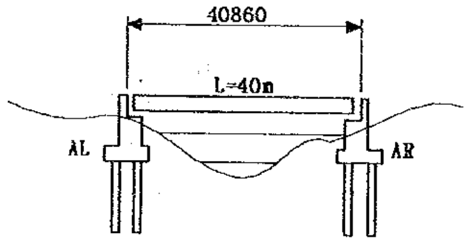
No.	Bridge No. Bridge Name	Bridge Layout	Superstructure Type Steel Girder Weight	Substructure/Riverbank Protection/Approach Road	Remarks
5	10-02-04 Maog		Simple H-beam W = 139.216 t	Substructure (Foundation) AL : H = 4.5m (RC pile 400m x 400m x 5.0m x 10 piles) P1 : H = 8.0m (RC pile 400m x 400m x 5.0m x 12 piles) P2 : H = 8.0m (RC pile 400m x 400m x 5.0m x 12 piles) P3 : H = 6.5m (RC pile 400m x 400m x 5.0m x 12 piles) AR : H = 4.5m (RC pile 400m x 400m x 5.0m x 10 piles) Riverbank Protection Left : Grouted Riprap A = 276m² Right : Grouted Riprap A = 276m² Approach Road Left : Cut = 208m³ Fill = 504m³ Right : Cut = 329m³ Fill = 619m³	Vertically curved Filter Units Left : 336 pcs. Right : 300 pcs. P1, P2, P3 : 891 bags
6	10-05-09 Pagatapat San Simon		Continuous built-up girder W = 128.168 t	Substructure (Foundation) AL : H = 4.5m (RC pile 400m x 400m x 6.0m x 18 piles) P1 : H = 8.0m (RC pile 400m x 400m x 6.0m x 12 piles) P2 : H = 8.0m (RC pile 400m x 400m x 6.0m x 12 piles) AR : H = 6.0m (RC pile 400m x 400m x 10.0m x 15 piles) Riverbank Protection Left : Grouted Riprap A = 455m² Right : Grouted Riprap A = 350m² Approach Road Left : Cut = 18m³ Fill = 588m³ Right : Cut = 28m³ Fill = 2,148m³	Vertically curved Filter Units Left : 407 pcs. Right : 455 pcs. P1, P2 : 594 bags
7	11-02-05 Lower Silway		Simple PC girder	Substructure (Foundation) AL : H = 5.5m (RC pile 400m x 400m x 7.0m x 18 piles) P1 : H = 7.5m (RC pile 400m x 400m x 6.0m x 20 piles) P2 : H = 7.5m (RC pile 400m x 400m x 6.0m x 20 piles) P3 : H = 7.5m (RC pile 400m x 400m x 6.0m x 20 piles) P4 : H = 7.5m (RC pile 400m x 400m x 6.0m x 20 piles) AR : H = 5.5m (RC pile 400m x 400m x 7.0m x 18 piles) Riverbank Protection Left : Concrete dike is existing Right : Grouted Riprap A = 347m² Approach Road Left : Cut = 149m³ Fill = 1,223m³ Right : Cut = 71m³ Fill = 1,947m³	Vertically curved Filter Units Right : 336 pcs. P1, P2, P3, P4 : 1,188 bags
8	11-04-03 Inambatan		Simple PC girder	Substructure (Foundation) AL : H = 4.5m (RC pile 400m x 400m x 13.0m x 10 piles) P1 : H = 9.3m (RC pile 400m x 400m x 7.0m x 20 piles) P2 : H =10.3m (RC pile 400m x 400m x 7.0m x 20 piles) AR : H = 4.5m (RC pile 400m x 400m x 16.0m x 10 piles) Riverbank Protection Left : Grouted Riprap A = 760m² Right : Grouted Riprap A = 560m² Approach Road Left : Cut = 82m³ Fill = 36m³ Right : Cut = 0m³ Fill = 2,822m³	Vertically curved Filter Units Left : 372 pcs. Right : 372 pcs. P1, P2 : 594 bags

Table 4-8 SUMMARY OF BASIC PLAN OF GROUP 2 BRIDGES

(3/3)

No.	Bridge No. Bridge Name	Bridge Layout	Superstructure Type Steel Girder Weight	Substructure/Riverbank Protection/Approach Road	Remarks
9	11-05-01 Culaman		Continuous built-up beam W = 93.716 t	Substructure (Foundation) AL : H = 4.5m (RC pile 400m x 400m x 5.0m x 15 piles) P1 : H = 7.5m (RC pile 400m x 400m x 6.0m x 12 piles) P2 : H = 7.5m (RC pile 400m x 400m x 6.0m x 12 piles) AR : H = 5.0m (RC pile 400m x 400m x 6.0m x 10 piles) Riverbank Protection Left : Concrete dike V = $154m^3$ Right : Grouted Riprap A = $60m^2$ + $30m^2$ Approach Road Left : Cut = $188m^3$ Fill = $600m^3$ Right : Cut = $130m^3$ Fill = $2,444m^3$	Vertically curved Filter Units Right : 300 pcs. P1, P2 : 594 bags
10	11-05-03 Mintal		Simple built-up beam W = 66.438 t	Substructure (Foundation) AL : H = 4.5m (RC pile 400m x 400m x 10.0m x 18 piles) AR : H = 6.0m (RC pile 400m x 400m x 10.0m x 18 piles) Riverbank Protection Left : Gabion (2 x 1.2 x 0.5) 156 pcs. Right : Gabion (2 x 1.2 x 0.5) 168 pcs. Approach Road Left : Cut = $738m^3$ Fill = $4,094m^3$ Right : Cut = $0m^3$ Fill = $1,741m^3$	Skewed (70°) Vertically curved Left : 727 pcs. Right : 783 pcs.

4.5 Implementation Plan

4.5.1 Basic Conditions

The following are the basic conditions for implementing this project:

- This project, if approved, will be implemented in accordance with the provisions of Japan's Grant Aid Program after the signing of the Exchange of Notes between the Governments of Japan and the Philippines.

- This project is to construct the bridges selected for Group 2 project in this study with the assistance of Japan's Grant Aid.

- The Department of Public Works and Highways (DPWH) is the responsible agency for implementing the project. In DPWH, the Bureau of Design is responsible for the detailed design, and the Bureau of Construction is responsible for construction of the bridges.

- The detailed design and construction supervision of the bridges will be undertaken by a Japanese consultant firm in accordance with a contract between DPWH and the consultant. Construction of the bridges including procurement of materials will be contracted by a Japanese constructor.

4.5.2 Implementation Method

(1) Transportation Plan

The materials procured from Japan will be transported by domestic freighter to the landing ports near the project sites after clearing customs at Manila International Seaport.

The materials will be transported by truck from the landing ports to the project sites. Based on an investigation, it is required to reinforce temporary bridges along the transport routes to enable the trucks loaded with the materials to pass. The land transportation routes and the temporary bridge reinforcement plan are proposed in Table A9-2 in Appendix 9. The schemes for reinforcing wooden bridges and Bailey bridges are shown in Figures A9-1 and A9-2 in Appendix 9.

(2) Girder Erection

The steel girders can be erected easily by truck crane or crawler crane with wooden bent. Conceptual figures of erection methods are shown in Figures A9-3 and A9-4 in Appendix 9. For erection of PC girders, which are heavy and long, 2 cranes are required to hang each side of the girders.

Where the water level is too deep for cranes to enter the river, timber bridges will be constructed above the river to provide a working stage for cranes. The standard timber bridge plan is shown in Figure A9-5 in Appendix 9.

(3) Construction of Cofferdams

Construction of substructures and river protections should be executed in the dry season so as not only to reduce the construction costs but also to assure the safety and quality of construction. Where river water exists around the excavation sites, excavation of the riverbed for construction of structures can be executed by damming the water by constructing of temporary cofferdams.

The fill type cofferdam is proposed where the water is shallow, while the sheetpile cofferdam is proposed where the water is relatively deep. The schematic figures of the fill type and sheetpile type cofferdams are shown in Figure A9-6 in Appendix 9. The cofferdam construction plan proposed for the project bridges is shown in Table A9-4 in Appendix 9.

(4) Traffic Control During Construction

Detour roads are required during construction where the existing bridges will be demolished for the construction. The detour roads should maintain the present traffic service level.

The detour road construction plan proposed for the project is shown in Table A9-5 in Appendix 9.

4.5.3 Implementation Supervisory Plan

A Japanese consultant firm will supervise the implementation of the project on behalf of the Government of the Philippines. The consultant will carry out the detailed design, assistance in tendering and construction supervision in accordance with the consultant contract concluded between the Government of the Philippines and the consultant.

(1) Detailed Design

The major works in the detailed design to be carried out by the con sultant are as follows:

- Supplemental geological surveys
- Detailed design of the bridges and the related structures
- Preparation of drawings and specifications
- Construction planning and cost estimation
- Preparation of tender documents

The necessary time for the detailed design is 3 months.

(2) Assistance in Tendering

The consultant will render the following services during the period from tender notice to procurement contract:

- Tender notice
- Pre-qualification
- Pre-bid conference and tendering
- Tender evaluation
- Contract facilitation

The necessary time for tendering is 2.5 months.

(3) Construction Supervision

The main work items to be executed by the consultant are as follows:

- Inspection and approval of site surveys
- Inspection and approval of construction planning
- Quality control
- Progress control
- Measurement of work
- Inspection of safety aspects
- Final inspection and turnover

The construction period is 12 months. To successfully carry out supervision involving the various works listed above, consultant personnel are required to be stationed during the whole period of construction.

4.5.4 Procurement Plan

Procurement planning of materials and equipment necessary for the project is as follows:

- Materials are to be procured locally as far as available.
- Equipment is to be procured from local lease companies.
- Special materials unavailable locally are to be procured from Japan considering the quality and limited time for construction.

The procurement plan of major materials and equipment is shown in Table 4-9.

Table 4-9 PROCUREMENT PLAN OF MAJOR MATERIALS AND EQUIPMENT (1/2)

Item	Procured from		Remarks
	Philippines	Japan	
1. Construction Materials			
· Crashed stone	o		Local
· Cement	o		ditto
· Gravel	o		ditto
· Sand	o		ditto
· Reinforce bars	o		Local & imported
· H-beams		o	Unavailable locally
· Built-up plate girders		o	ditto
· PC sheaths		o	ditto
· PC anchors		o	ditto
· PC grout mixture		o	ditto
· Bearings		o	ditto
· Guardrails		o	ditto
· Unit filters		o	ditto
2. Temporary Work Materials			
· Wooden forms	o		Local
· Scaffolding & platforms	o		ditto
· Sand bags	o		ditto
· Oil & fuel	o		Local & imported
· Erection tools		o	Unavailable locally
· PC girder erection tools		o	ditto
· Sheetpiles		o	ditto
· H-beams		o	ditto

Table 4-9 PROCUREMENT PLAN OF MAJOR MATERIALS AND EQUIPMENT (2/2)

Item	Procured from		Remarks
	Philippines	Japan	
3. Equipment			
· Bulldozer (15 t)	o		Imported
· Backhoe (0.6 m^3)	o		ditto
· Diesel hammer (2.5 t)	o		ditto
· Diesel hammer (3.5 t)	o		ditto
· Vibro hammer (40 KW)	o		ditto
· Dump truck (8 t)	o		ditto
· Trailer truck (15 ~ 40 t)	o		ditto
· Truck crane (15 ~ 30 t)	o		ditto
· Truck crane (120 t)	o		ditto
· Tire roller (9 t)	o		ditto
· Tamper (60 kg)	o		ditto
· Concrete mixer (0.2 m^3)	o		ditto
· Agitator truck (3 m^3)	o		ditto
· Electric welder (300A)	o		ditto
· Water pump (150 mm)	o		ditto
· Water pump (200 mm)	o		ditto
· Generator (35 KVA)	o		ditto
· Generator (45 KVA)	o		ditto
· Generator (125 KVA)	o		ditto
· Rock auger		o	Unavailable locally

4.5.5 Implementation Schedule

The implementation schedule for detailed design and construction, which will be borne by Japan's Grant Aid, is shown in Table 4-10.

Table 4-10 IMPLEMENTATION SCHEDULE (Group 2 Project)

		Month										
		1	2	3	4	5	6	7	8	9	10	11	12
Detailed Design	(Work in the Philippines)	═											
	(Work in Japan)	═	═	═									
	(Discussion in the Philippines)			═									
	(Total 3.0 months)												
Construction	(Preparatory work)	═											
	(Substructure)		═	═	═	═	═						
	(Procurement of materials)	═	═	═	═	═	═						
	(Superstructures)						═	═	═	═			
	(River bank protection)								═	═			
	(Approach roads)										═	═	
	(Removal of office)												═
	(Total 12.0 months)												

4.5.6 Scope of Work

The undertakings of the Governments of Japan and the Philippines are listed in Table 4-11.

Table 4-11 UNDERTAKINGS OF THE GOVERNMENTS (Group 2 Project)

Item	Contents	Undertaken by		Remarks
		Japan	Philippines	
Design	Detailed design	o		Bridges & related structures
Procurement of Materials Equipment	Procurement & delivery	o		Marine & land transportation
	Customs clearance	o		
	Reinforcement of trans. route		o	Reinforcement of temporary bridges
Preparatory Works	Land acquisition		o	Land for new roads, offices, storage
	Removing facilities		o	Houses, power posts, water pipes
	Demolition of former bridges prior to construction	o		
Construction	Construction	o		Bridges, related structures
	Demolition of former bridges after completion of new bridges		o	
	Construction supervision	o		
	Maintenance of bridges		o	

The cost to be shouldered by the Government of the Philippines is roughly estimated as follows:

(1)	Land acquisition cost	:	₱451,880.00
(2)	Temporary land acquisition cost	:	₱330,405.00
(3)	House removal cost	:	₱1,260,000.00
(4)	Facility relocation cost	:	₱716,600.00
(5)	Transportation route maintenance cost	:	₱158,200.00
(6)	Existing bridges demolition cost (after completion of new bridge)	:	₱602,651.00
	Total		₱3,519,736.00