LIST OF TABLES AND FIGURES

ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
ADB	Asian Development Bank
CAR	Cordillera Administrative Region
DENR	Department of Environment and Natural Resources
DPWH	Department of Public Works and Highways
ECC	Environmental Compliance Certificate
EMK	Equivalent Maintenance Kilometer
GDP	Gross Domestic Product
ICC	Investment Coordination Committee
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
LWUA	Local Water Utilities Administration
MBA	Maintenance by Administration
MBC	Maintenance by Contract
MFWL	Maximum Flood Water Level
MWSS	Metropolitan Waterworks and Sewage System
NAMRIA	National Mapping and Resource Information Authority
NEDA	National Economic Development Authority
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PC	Prestressed Concrete
PCC	Portland Cement Concrete
PCDG	Prestressed Concrete Deck Girder
PHIVOLCS	Philippine Institute of Volcanology and Seismology
RC	Reinforced Concrete
RCDG	Reinforced Concrete Deck Girder
SCS	Soil Conservation Service
UK	United of Kingdom
VAT	Value Added Tax

SUMMARY

The Philippines is an archipelago of 7,109 islands with a total land area of 299,404 square kilometers, surrounded by the Pacific Ocean in the east, South China Sea in the west and north and Celebes Sea in the south. The topography is generally undulated with irregular coastlines and mountains of 2,000 meters or more in height. The climate is tropical oceanic with high temperature and high humidity throughout the year. The rainy season is from June to October. The rainfall varies depending on the area due to the effect of the topography.

The Government of the Philippines, in its economic development plan, attaches much importance to the development of infrastructure with the vision of achieving the sustainable development and growth with social equity. In this view, development of social infrastructure in the rural areas, especially improvement of roads and bridges shouldering much of the transportation demand of people and goods is of vital need. However, in the rural areas, there are many temporary bridges made with timber or pin type steel truss and some are in danger of washout when the river rises, causing a hindrance to daily life of inhabitants.

Under such situation, the Medium-term Philippine Development Plan 1999-2004 addresses the development of infrastructure in rural areas as one of the important strategies. In line with the policy, the Medium-term Infrastructure Development Plan 2001-2004 makes it one of the measurable targets in the road transportation sector that national bridges will be 95 percent permanent by 2004.

Northern Luzon where many ethnic groups reside is rather a depressed area with high incidence of poverty comparing with national average and therefore given priority of development. Under the necessity of constructing bridges along rural roads in the said area as a fundamental infrastructure for development of depressed areas and alleviation of poverty, the Government of the Philippines made a request to the Government of Japan for grant aid for construction of 108 bridges in Northern Luzon.

In response to the request, the Government of Japan decided to conduct a basic design study on the said project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Philippines a study team twice from February 11 to March 27, 2001 and from April 23 to June 6, 2001. The team held discussions with the

officials concerned of the Government of the Philippines and conducted field studies at the study area. After returning to Japan, the team evaluated the necessity of the project and its social and engineering viabilities and prepared a basic design and implementation plan of the most appropriate scheme. The contents of the study was compiled into a draft report. Then, JICA sent to the Philippines a draft report explanation team from August 22 to August 31, 2001.

Finally proposed plan is construction of 40 bridges consisting of 33 Group 1 bridges (procurement of steel materials for superstructure to be undertaken by Japan and construction by the Philippines) and 7 Group 2 bridges (construction by Japan). The outline of the plan is as follows:

GROUP 1 BRIDGES (Procurement of Steel Materials for Superstructure)

<table>
<tr><th colspan="2">Superstructure Type / Item</th><th>Rolled H Steel Girder Bridge</th><th>Welding Plate Girder Bridge</th><th>Total</th></tr>
<tr><td colspan="2">Number of Bridges</td><td>22 Bridges</td><td>11 Bridges</td><td>33 Bridges</td></tr>
<tr><td colspan="2">Aggregate Length of Bridges</td><td>837.2m</td><td>352.7m</td><td>1,189.9m</td></tr>
<tr><td colspan="2">Width</td><td colspan="3">Carriageway 7.32m, Sidewalk 0.76m (both sides), Total width 8.84m</td></tr>
<tr><td colspan="2">Superstructure Type
(Span Length/Average Span Length in case of Multi-span)</td><td>Simple girder:
12 bridges (15~22m)
2-span continuous girder:
4 bridges (15~18m)
3-span continuous girder:
6 bridges* (13~19m)</td><td>Simple girder:
10 bridges (24~40m)
2-span continuous girder:
1 bridge (28m)</td><td>Simple girder:
22 bridges
2-span continuous girder:
5 bridges
3-span continuous girder:
6 bridges</td></tr>
<tr><td rowspan="4">Materials to be Procured</td><td>Steel Materials</td><td>1,129 ton</td><td>622 ton</td><td>1,751 ton</td></tr>
<tr><td>Bearings</td><td>322</td><td>92</td><td>414</td></tr>
<tr><td>Expansion Joints</td><td>47</td><td>22</td><td>69</td></tr>
<tr><td>Materials/Tools for Erection</td><td colspan="3">6 wrenches for Torshear type bolt, 240 drift pins, and 2,000 spare bolts</td></tr>
</table>

* including one bride composed of 4 sets of 3-span continuous girders

GROUP 2 BRIDGES (Total Construction)

Item \ Superstructure Type		PC Girder Bridge	Welding Plate Girder Bridge	PC Girder + Welding Plate Girder Bridge	Total
Number of Bridges		5 Bridges	1 Bridge	1 Bridge	7 Bridges
Aggregate Length of Bridges		623.0m	87.1m	58.4m	768.5m
Width		Carriageway 7.32m, Sidewalk 0.76m (both sides), Total width 8.84m			
Superstructure Type (Span Length / Average Span Length in case of Multi-span)		3-span connected girder: 2 bridges (21.6~30.2m) 5-span connected girder: 1 bridge (24.1m) 6-span connected girder: 1 bridge (24.8m) 7-span connected girder: 1 bridge (27.8m)	2-span continuous girder: 1 bridge (43.1m)	3-span simple girders center span: Plate girder (33.0m) Side spans: PC girder (12.4m)	
Substructure	Abutment	Pile-bent type: 2 Gravity type: 1 Reversed-T wall type: 7	Reversed-T wall type: 2	Reversed-T wall type: 2	14
	Pier	Pile-bent type: 2 Reversed-T 2-column type: 17	Reversed-T 2-column type: 1	Reversed-T 2-column type: 2	22
	Foundation	Spread foundation: 13 Bored pile foundation: 4 (8 piles) H-pile foundation: 12 (417 piles)	Spread foundation: 3	Spread foundation: 4	Spread foundation: 20 Bored pile foundation: 4 H-pile foundation: 12
Approach Road		1,657.4m	179.0m	79.7m	1,916.2m
Revetment		1,715.0m^2	86.0m^2	1,135.1m^2	2,936.1m^2

If the project is implemented under the Japan's grant aid, the construction period is estimated as follows:

Group 1 bridges	:	detailed design	:	2.5 months
		procurement of steel materials	:	7.5 months
Group 2 bridges	:	detailed design	:	3.0 months
		construction	:	16.5 months

The system, personnel and budget of the Government of the Philippines for implementation of the project and its maintenance after completion are considered to be well arranged and no problem is expected.

The beneficiaries of the project are the population residing in Northern Luzon amounting to about 8.28 million. The major direct and indirect effects of the protect are as follows:

Direct Effect

- Provision of Safe and Smooth Transport Means

  Many of the project bridges are decrepit bailey, timber and suspension bridges with high possibility of collapse or washout. Some sites have no bridge where vehicles ford the river during dry season and cannot cross the river during rainy season. By constructing/reconstructing bridges, safe and smooth transport means will be secured in the relevant areas.

- Contribution to the Improvement of Inhabitants' Living
  The inhabitants utilize the project bridges in their daily lives. This project will provide safe means of access to social facilities such as markets, schools, clinics, etc., at all time and thus improve the daily life of inhabitants.
- Improvement of Efficiency of Transportation of People and Goods
  Since the bridges with high load carrying capacity will be constructed, large vehicles will be able to pass. Furthermore, the travel distance will be shortened because of elimination of making a detour. Thus, travel time and transport cost will be saved and efficiency of transportation of people and gods will be improved.
- Savings of Maintenance Work
  The existing decrepit bridges require a lot of time and cost for maintenance work. Since the bridges to be constructed are basically maintenance free, maintenance cost will be saved and efficiency of maintenance work will be improved.

Indirect Effect

- Development of Regional Economy
  By provision of safe and stable transport means, the movement of people and goods will be accelerated resulting in the expansion of agricultural market, increase of employment opportunities, etc. Thus, the project will contribute to the development of regional economy.
- Alleviation of Poverty
  The living standard of inhabitants will be improved by the provision of safe and smooth transport means, development of regional economy, etc. and consequently the project will contribute to poverty alleviation.
- Encouragement of Road Network Improvement
  Improvement of the related roads will be encouraged by the bridge construction. As a result, the project will contribute to the road network improvement of the country.

The project will contribute to the improvement of living condition of the inhabitants in Northern Luzon and have many effects as mentioned above. Therefore it is concluded to be appropriate to implement the project under the Japan's grant aid.

To realize, enlarge and sustain the effects of the project, the matters to be undertaken by the Government of the Philippines are proper construction of Group 1 bridges, improvement of the connecting roads and adequate maintenance and repair works of all the project bridges and their connecting roads.

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Appendices

CHAPTER 1 BACKGROUND OF THE PROJECT

Some of the bridges along rural roads in the Philippines are of temporary structure made with timber or pin type steel truss (bailey). Furthermore, there are river crossing points without bridge where vehicles ford the river, disrupting the traffic entirely during rainy season. Such situations of the bridge cause the constraint of the effective use of road assets and the difficulty of carrying machinery and materials for rural development and local products. Thus, the poor bridge condition not only causes a bottleneck for rural development but restricts the basic traffic demand of inhabitants. Construction of these bridges is of urgent need.

The Government of the Philippines, giving priority to the construction of bridges along rural roads, has been improving the bridges. The Government of Japan extended the grant aid to the procurement of steel materials for superstructure of 24 bridges in 1987 and construction of 10 bridges in 1988, both located nationwide. The Government of the Philippines, highly appreciating the effect of the said projects, formulated the Five Year Program for Construction of Bridges along Rural Roads in 1989. This program, under which the whole country is divided into five areas to be covered in turn, is composed of two types of projects: procurement of steel materials for superstructure (Group 1) and total construction of bridges (Group 2). According to the program, continuous requests for grant aid were made to the Government of Japan. The first year program (covering Regions III and IV), the second year program (Regions V to VIII) and the third year program (Regions X and XI) were implemented in 1989-1991, 1992-1994 and 1995-1996, respectively.

Northern Luzon is rather a depressed area with average household income of 98,000 pesos and incidence of poverty of 36.5% comparing with 123,000 pesos and 31.8% respectively in national average. Especially CAR is regarded as one of the regions that are the most depressed and therefore given priority of development. Under the necessity of constructing bridges along rural roads in the said area as a fundamental infrastructure for development of depressed areas, the Government of the Philippines made a request to the

Government of Japan for grant aid for the Project for Construction of Bridges along Rural Roads in Northern Luzon as the fourth year program in the said Five Year Program for Construction of Bridges along Rural Roads.

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 BASIC CONCEPT OF THE PROJECT

The Government of the Philippines, in its economic development plan, attaches much importance to the development of infrastructure with the vision of achieving the sustainable development and growth with social equity. In this view, development of social infrastructure in the rural areas, especially improvement of roads and bridges shouldering much of the transportation demand of people and goods is of vital need. However, in the rural areas, there are many temporary bridges made with timber or pin type steel truss and some are in danger of washout when the river rises, causing a hindrance to daily life of inhabitants.

Under such situation, the Medium-term Philippine Development Plan 1999-2004 addresses the development of infrastructure in rural areas as one of the important strategies. In line with the policy, the Medium-term Infrastructure Development Plan 2001-2004 makes it one of the measurable targets in the road transportation sector that national bridges will be 95 percent permanent by 2004.

This project aims to improve the transport infrastructure in rural areas in Northern Luzon (Region I, Region II and CAR) by constructing bridges therein, enhance the exchange of people and goods and save the cost of transportation and thus to contribute to the activation of economy in the Northern Luzon.

This project is to construct 40 bridges along rural roads to attain the above aim. By this project, safe and stable transport means will be secured and transport capacity will be increased. Under the project, the Japan's grant aid will cover the procurement of steel materials for superstructure of 33 bridges and the total construction of 7 bridges.

2.2 BASIC DESIGN OF THE REQUESTED JAPANESE ASSISTANCE

2.2.1 Design Policy

2.2.1.1 Selection and Categorization of Project Bridges

1) Selection of Project Bridges

The procedure for selection of the project bridges out of 94 final requested bridges is shown in Figure 2.2.1.1-1. At first, the bridges planned to be constructed in other projects were omitted and then the remaining bridges were evaluated on their engineering viability and socio-economic viability. The bridges which pass both engineering and socio-economic evaluation criteria were selected as the project bridges. Evaluation criteria for engineering and socio-economic viabilities are shown in Table 2.2.1.1-1.

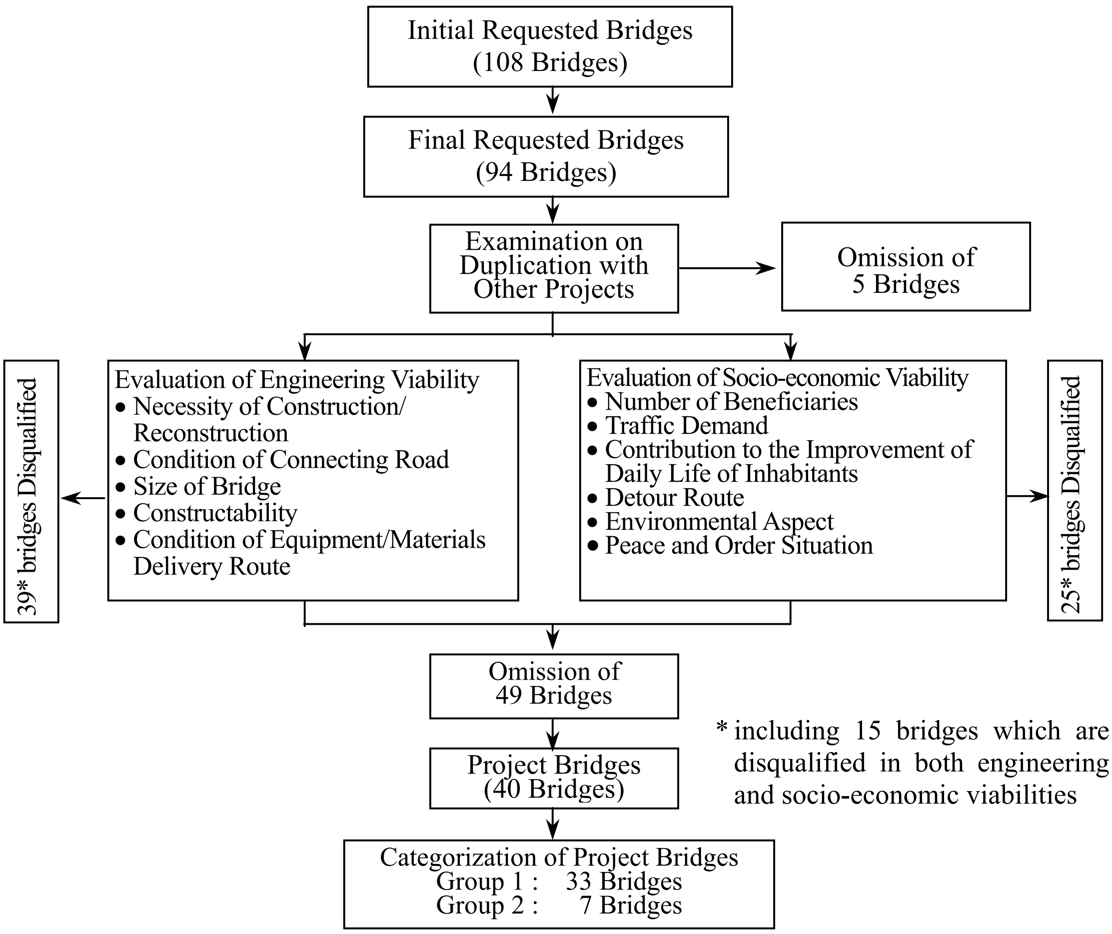


FIGURE 2.2.1.1-1 PROCEDURE FOR SELECTION OF PROJECT BRIDGES

TABLE 2.2.1.1-1 EVALUATION CRITERIA FOR ENGINEERING AND SOCIO-ECONOMIC VIABILITIES

Evaluation Criteria for Engineering Viability
All of the following conditions shall be met: Necessity of construction / reconstruction Construction or reconstruction of the bridge is justified conforming to any of the following: ① There exists no bridge passable for vehicles, ② Loading capacity/stability of the existing bridge is insufficient or the existing bridge is seriously damaged being structurally in danger, ③ The existing bridge is a weak temporary bridge or spillway, or ④ The existing bridge is one-lane bridge and traffic volume is so high (2,000 vehicles per day or more) that the bridge causes a significant bottleneck. Condition of connecting road ① The connecting road is passable for vehicles and has a two-lane width (6m or more), or ② There is the definite plan to improve the road to meet the above condition. Size of bridge The size of the bridge is reasonable (length within the range of 15 to 250m) for the project intending to distribute its benefit over as wide area as possible. Constructability The bridge can be constructed by common construction method. Condition of equipment/materials delivery route There is a route along which the delivery of equipment and materials to the bridge construction site is possible.
Evaluation Criteria for Socio-economic Viability
All of the following conditions shall be met: Number of beneficiaries Number of beneficiaries is 10,000 persons or more for 50m or less long bridge and 20,000 persons or more for more than 50m long bridge. Traffic demand ① Daily traffic volume is 50 or more, or ② In case vehicles cannot or can hardly pass the existing bridge, daily traffic volume of 50 or more is expected after construction of the bridge. Contribution to the improvement of daily life of inhabitants The bridge is used by the inhabitants for going to office, school, clinic, townhouse, church, market, or so on. Detour route ① No detour route exists, or ② The detour route, if exists, is longer by 20km or more. Environmental aspect No serious environmental problem such as right-of-way acquisition and resettlement of inhabitants with difficulty to be resolved is expected. Peace and order situation No peace and order problem is expected during the survey and construction.

Basic data of the requested bridges are shown in Appendix 6 including their evaluation results.

2) Categorization of Project Bridges

The project bridges are divided into the following two categories:

Group 1 : The Government of Japan provides steel materials for superstructure under the Japan's grant aid, while the Government of the Philippines is responsible for the construction of bridges using the materials. The bridges falling in this category (Group 1 bridges) are those which can be designed and constructed by Philippine engineers/contractors requiring no special technology/machines.

Group 2 : The Government of Japan undertakes the total construction of bridges under the Japan's grant aid. The bridges falling in this category (Group 2 bridges) are those which are difficult in construction and considered appropriate to be designed/constructed by Japanese consultants/contractors.

The criteria for the categorization is shown in Table 2.2.1.1-2.

TABLE 2.2.1.1-2 CATEGORIZATION CRITERIA

Item	Group 1 (To satisfy all of the following conditions)	Group 2 (To conform to any of the following conditions)
Superstructure Type	Rolled H steel girder or welding plate girder (span length 40m or less)	Other than the left mentioned types
Substructure Type	Reversed T-shape wall type abutment and reversed T-shape 2-column type pier	-
Foundation Type	Spread foundation, precast reinforced concrete pile foundation, or H steel pile foundation	Cast-in-place concrete pile foundation or steel pipe pile foundation
Cofferdam Closure Method	Sand bag cofferdam (water depth 1.0m or less)	Sheet pile cofferdam (water depth 1.5m or more)
Pile Construction Method	Pile driving by diesel hammer	Cast-in-place concrete pile construction or steel pipe pile driving (requiring special equipment and technology)
Girder Erection Method	Truck crane erection	Draw erection, cable erection or other special erection method
Embankment Method of Approach Road	Ordinary embankment construction (embankment high 2m or less on common ground)	Embankment construction requiring high technology for quality control (Embankment on soft ground or on common ground with a height of 3m or more)

The seven bridges shown in Table 2.2.1.1-3 are categorized as Group 2 bridges and the remaining 33 bridges as Group 1 bridges.

TABLE 2.2.1.1-3 GROUP 2 BRIDGES

Bridge Number	Bridge Name	Bridge Length (m)	Main Reason for Being Categorized as Group 2
01-04-04	Macayug	65.4	①, ③
02-01-02	Capissayan	121.4	①, ③
02-02-01	Abuan	195.4	①, ③
CA-01-01	Abas	149.4	①, ③
CA-02-01	Amburayan I	87.1	②
CA-02-08	Mambolo	58.4	②
CA-05-03	Bananao	91.4	①, ③
Total		768.5	

① Since the river is wide and water is deep, the construction of substructure is difficult requiring sheet pile cofferdam. The erection of girder is also difficult requiring the construction of working stage for truck crane if the truck crane erection is applied, or application of other erection method such as draw erection with launching girder.

② Since the high capacity crane cannot be carried to the bridge construction site due to the condition of the access road, the ordinary track crane erection method is not applicable for girder erection. Co-lifting by two 50-ton cranes or other special erection method such as draw erection or cable erection is needed.

③ Adoption of prestressed concrete girder is envisaged for the economical reason.

3) List of Project Bridges

The selected project bridges are listed in Table 2.2.1.1-4 including their group categorization.

TABLE 2.2.1.1-4 LIST OF PROJECT BRIDGES

Region	Province	Bridge Number	Bridge Name	Bridge Length (m)	Road Name	Group
I	Ilocos Norte	01-01-01	Gasgas	230.5	Pob.Bagbao-Puttao-Baresbes Rd.	1
	Ilocos Sur	01-02-01	San Gaspar II	30.7	Sta.Lucia-Salcedo Rd.	1
		01-02-04	Victory	15.7	Candon-Salcedo Rd.	1
	La Union	01-03-03	Suyo	30.7	Bagulin-Naguilian Rd.	1
	Pangasinan	01-04-02	Baracbac	20.7	Pangasinan-Nueva Ecija Rd.	1
		01-04-04	Macayug	65.4	Mangaldan/San Jacinto-San FabianRd.	2
		01-04-05	Malanay-Tuliao	39.7	Sta.Barbara-Mangaldan Rd.	1
		01-04-06	Paitan	55.7	Pangasinan-Zambales Rd.	1
II	Cagayan	02-01-02	Capissayan	121.4	Jct.Gattaran-Currimao-Sta.Margarita-Bolos Point Rd.	2
		02-01-10	Pacapat	15.7	Luzon-Kalanasa-Dibalue Rd.	1
		02-01-11	Pena Weste	15.7	Gattaran-Capissayan-Bolos Rd.	1
		02-01-12	Sta. Isabel	15.7	Luzon-Kalanasa-Dibalue Rd.	1
	Isabela	02-02-01	Abuan	195.4	Ibogan-Bigao-Palalau Rd.	2
		02-02-03	Casili	55.7	Santiago-Tuguegarao Rd.	1
		02-02-04	Dalig	22.7	Brugos-Luna Rd.	1
		02-02-07	Sinippil	36.7	Calomagui Rd.	1
	Nueva Vizcaya	02-03-03	Gattac	15.7	Quirino-Salano-Nueva Vizcaya Rd.	1
		02-03-04	Inaban	25.7	Aritao-Dupax-Kasibu-Quirino Rd.	1
		02-03-06	Runruno	18.7	Quirino-Salano-Nueva Vizcaya Rd.	1
	Quirino	02-04-01	Angad	15.7	Jct.Victoria-Kasibu Rd.	1
		02-04-02	Balligui	30.7	Jct.Victoria-Kasibu-Nueva vizcaya Rd.	1
		02-04-06	Dumabato	47.7	Dumabato-Ballagai-Kasibu Rd.	1
		02-04-10	Nagtim-og	28.7	Jct.Victoria-Kasibu-Nueva vizcaya Rd.	1
CAR	Abra	CA-01-01	Abas	149.4	Abra-Sallapadan-Cervantes Rd.	2
		CA-01-03	Lublubnak	20.7	Abra-Sallapadan-Cervantes Rd.	1
		CA-01-05	Naguilian	30.7	Abra-Sallapadan-Cervantes Rd.	1
		CA-01-06	Palaquio	33.7	Abra-Sallapadan-Cervantes Rd.	1
	Benguet	CA-02-01	Amburayan I	87.1	Acop-Kapangan-Kebungan Rd.	2
		CA-02-07	Galap I	33.7	Gurel-Bokod-Kabayan-Buguias Rd.	1
		CA-02-08	Mambolo	58.4	Baguio-Bua-Itogon-Dulupirin Rd.	2
	Ifugao	CA-03-02	Habbang	56.7	Banaue-Mayoyao Rd.	1
	Kalinga	CA-04-01	Dao	20.7	Calanan-Lubuagan Rd.	1
		CA-04-02	Magabbangon	25.7	Bulanao-Paracelis Rd.	1
		CA-04-04	Manglig	50.7	Bulanao-Paracelis Rd.	1
		CA-04-08	Tuga	35.7	Calanan-Pinukpuk Rd.	1
	Apayao	CA-04-12	Salagunting	40.7	Calanasan-Claveria Rd.	1
	Mt. Province	CA-05-02	Amolong	24.7	Paracelis-Natonin Rd.	1
		CA-05-03	Bananao	91.4	Lita(Potia)-Paracelis Rd.	2
		CA-05-05	Lubo	22.7	Talubin-Barlig Rd.	1
		CA-05-06	Masablang II	24.7	Lita(Potia)-Paracelis Rd.	1
Total		40 bridges,	Total length	1,958.4m		
	Group 1	33 bridges,	Total length	1,189.9m		
	Group 2	7 bridges,	Total length	768.5m		

2.2.1.2 Design Policy

1) Scope of the Japan's Grant Aid

The scope of the Japan's grant aid is as follows:

- Procurement of steel materials for superstructure of 33 Group 1 bridges. The construction of the bridges including approach road and related works such as revetment and foot protection as necessary is the responsibility of the Government of the Philippines.
- Total construction of 7 Group 2 bridges including approach road and related works.

2) Grade of Bridge

All the project bridges are located on national roads except for six bridges on local roads. The local roads on which the project bridges are located are important roads complementing the national road network, such as the road abutting and continuing the national road and the road connecting two national roads, and will possibly be converted into national roads in the future. With this view, all the project bridges are designed as national bridge with the following width and design speed;

- Width : Carriageway 7.320 m, sidewalk 0.760 m on both sides, total width 8.840 m
- Design speed : 60 km/hr in flat terrain, 50 km/hr in rolling terrain and 40 km/hr in mountainous terrain (30 km/hr in special case due to topographic condition)

3) Consideration for Natural Conditions

- Hydrology

Hydrologically Northern Luzon is characterized by ① generally steep river slope due to mountainous terrain, ② poor vegetation and low water retention function due to deforestration, ③ concentration of precipitation in rainy season and occurrence of heavy rain due to typhoon, etc. Consequently, the river water level sometimes rises suddenly in a short time. In general, difference in the discharges in flood period and in normal time is remarkably big. In view of these characteristics, the bridge elevation is planned to be the maximum flood water level (MFWL) plus freeboard and bridge structure height. The MFWL is estimated based on the past highest water level obtained from hearing at site and verified by the hydrological analysis. The minimum freeboard is 1.5 m for streams carrying debris or 1.0 m for streams not carrying big debris in accordance with the DPWH design criteria.

- Seismcity

The Philippines, situated in the Circum-Pacific Seismic Zone, experienced many earthquakes and therefore the seismic safety is an important issue in the bridge design. In this regard, the DPWH Department Order No. 75, Series of 1992 shall be complied with. This is issued intending to mitigate, if not prevent damage(s) to bridges due to earthquakes and stipulates the design concept to be adopted as follows:

- Continuous bridges are the preferred type of bridge structure.
- Where multi-span simple bridges are justified, decks should be continuous.
- Restrainers (horizontal linkage device between adjacent spans) are required at all joints and generous seat-widths at piers and abutments should be provided to loss-of-span type failures.
- Transverse reinforcement in the zones of yielding is essential.
- Plastic hinging should be forced to occur in ductile column regions of the pier rather than in the foundation unit.
- The stiffness of the bridge as a whole should be considered in the analysis.

4) Design Specifications to be Applied

Since the responsible and implementing agency of the project is DPWH, the design specifications set up by DPWH are followed, which are:
AASHTO Standard Specifications for Highway Bridge, 1996, and
National Structural Code of the Philippines, 1997.

5) Participation of Local Construction Companies/Engineers

Group 1 bridges will be designed by DPWH Regional Offices under their direct management or engaging local consultants. The construction of Group 1 bridges will be undertaken by local contractors. To make it easy for the local consultants and construction companies to design and construct the bridges, the bridge type commonly used in DPWH as a standard type is selected.

The design and construction of Group 2 bridges will be undertaken by Japanese consultant and construction company respectively in accordance with contracts with DPWH. In construction, local construction companies will participate as subcontractors mainly in providing the personnel. To facilitate the participation of local construction companies/engineers, the design and construction plan as simple and easy in quality control as possible are prepared.

6) Considerations for Environmental Conservation

Although the project, consisting of new construction of 9 bridges (5 Group 1 bridges and 4 Group 2 bridges) and reconstruction of 31 bridges (28 Group 1 bridges and 3 Group 2 bridges), will not drastically change the social and natural environment but give a slight impact on the environment, enough attention should be paid to minimize the negative impact. Major considerations in planning, design and construction are as follows:

- Select the location of bridge minimizing the resettlement of inhabitants.
- Secure the traffic during construction.
- Minimize water pollution due to construction work.
- Dispose of excavated soil properly.

7) Selection of Superstructure Type

- Group 1 Bridges

The factors to be considered in the selection of superstructure type to be suitable for the project for procurement of steel materials for superstructure are as follows:

- Material : The material shall be steel.
- Span Length : Span length shall be within the range of 15 to 40 m.
- Constructability : Construction of the bridges including transportation and

erection of steel girders shall be able to be done easily by local contractors using locally available equipment.

- Economy : Construction cost of bridges including procurement cost of steel girders shall be as low as possible.
- Durability/Seismic Resistance : Bridges shall have enough durability and seismic resistance.
- Maintenability : Bridges shall be able to be easily maintained.

Based on the above considerations, rolled H steel girder and welding plate girder are selected. Maximum length of a member of steel girders is limited to 12 m for the convenience of transportation and erection.

- Group 2 Bridges

The most appropriate type of superstructure is selected comparing various types such as prestressed concrete girder, rolled H steel girder, welding plate girder, steel box girder, reinforced concrete rigid frame, etc. in consideration of economy, constructability, availability of local materials, maintenability, etc.

8) Selection of Substructure Type

The basic considerations in the selection of substructure type are as follows:

- The type is commonly used in DPWH as a standard type.
- All materials and equipment are locally available.

The basic plan of substructure is as follows:

- Abutment

  Reversed T-shape wall type is adopted. Footings are planned to be embedded enough into existing ground.
- Pier

  Considering the seismic resistance, reversed T-shape 2-column type is adopted in general, with footings embedded 2 m below the riverbed. 2-column pile bent type with cast-in-place concrete pile is selected under certain circumstances depending on geological condition.
- Foundation Pile

For Group 1 bridges, precast reinforced concrete pile or H steel pile is used. For Group 2 bridges, the most appropriate type among precast concrete pile, cast-in-place concrete pile, H steel pile, steel pipe pile, etc. is selected depending on geological condition.

9) Approach Road Design

- Geometric design of approach roads is prepared in accordance with the DPWH Design Standard in principle. However, in case the earthwork volume is too much and construction work is difficult due to the topographic condition if designed strictly following the standards, substandard design is applied to avoid the said problems.
- The Portland cement concrete (PCC) pavement is applied because if asphalt concrete (AC) pavement is applied, provision of asphalt plant is needed and considered to be costly.

10) Related Works Design

To prevent the erosion on riverbanks, revetment with grouted riprap is planned to be provided in principle in front of abutment and on the surface of riverbank on upstream and downstream sides of the abutment. Where water velocity is high and scouring of revetment foundations is anticipated, foot protection works with boulders are planned to be provided.

11) Construction Period and Implementation Phasing

- Construction period of undertakings of the Government of Japan is estimated as follows:

Group 1 bridges	:	detailed design	:	2.5 months
		procurement of steel materials	:	7.5 months
Group 2 bridges	:	detailed design	:	3.0 months
		construction	:	16.5 months

- For early realization of the effect of the project, construction of Group 1 bridges shall be completed by the Government of the Philippines within two years from the date of handing-over the steel materials for superstructure.
- The project is planned to be implemented in two phases as follows:

Phase 1 : Detailed design and procurement of steel materials for Group 1 bridges
Detailed design of Group 2 bridges
Phase 2 : Construction of Group 2 bridges

2.2.1.3 Design Conditions

Design conditions used for design of bridges will be adopted Design Specifications of the Philippines.

1) Design Specifications to be Adopted

- AASHTO Standard Specifications for Highway Bridge, 1996
- National Structural Code of the Philippines, 1997

2) Bridge Width

Carriageway 7.320 m, sidewalk 0.760 m, total width 8.840 m (Figure 2.2.1.3-1).

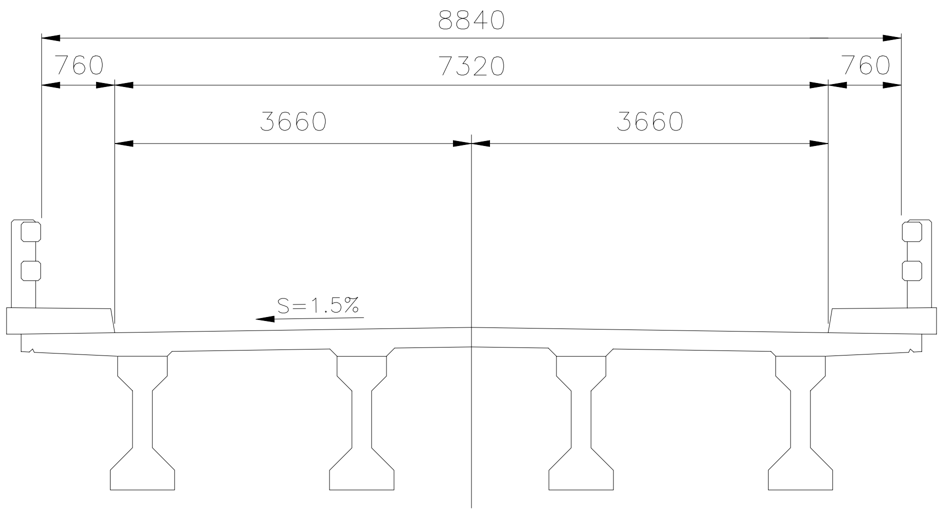


FIGURE 2.2.1.3-1 BRIDGE WIDTH

3) Design Loads

- Live load : AASHTO HS 20-44 is applied.
- Thermal load : Temperature range of 20 to 40℃ for concrete and 20 to 45℃ for steel are assumed.
- Earthquake load : Seismic acceleration coefficient of 0.40 at the ground surface is assumed.

4) Material Properties

- Design strength of concrete for substructure : Fc = 210 kgf/cm^2
  for deck slab : Fc = 240 kgf/cm^2
- Yield stress of reinforcing bars : Fy = 2,100 kgf/cm^2
- Mechanical property of steel material for superstructure

Standard	Category	Code	Yield Point Stress (N/mm^2)			Tensile Strength (N/mm^2)	Remarks
			t≦16	16<t<40	t≧40		
JISG3101	2	SS400	245 or more	235 or more	215 or more	400 – 510	Filler
JISG3106	3	SM400A SM400B	245 or more	235 or more	215 or more	400 – 510	Stiffener
JISG3106	3	SM490YA SM490YB	365 or more	355 or more	335 or more	490 – 610	Main Girder

t = thickness in mm

- Bolt for splice
  Torshear type high strength bolt M22 (S10T) in accordance with JSS II 09-1981.

5) Geometric Design Standards of Approach Road

Item \ Terrain	Flat	Rolling	Mountainous
Design Speed (km/hr)	60	50	40 (30)
Pavement Width (m)	6.70	6.70	6.70
Shoulder Width (m)	1.00	1.00	1.00
Minimum Radius (m)	115	80	50 (30)
Maximum Superelevation (%)	8	8	8
Maximum Gradient (%)	5	7	9 (10)
Minimum Vertical Curve length (m)	60	50	40 (30)

( ): Exceptional value to be applied in inevitable case due to topographic condition.

Substandard design is applied in special cases as stated in 2.2.1.2 9).

2.2.2 Basic Plan of Group 1 Bridges

2.2.2.1 Basic Plan

1) Location of Bridge

   Bridge locations should be decided taking into consideration the existing road alignment, topography, river condition, presence of obstacles such as houses, way of providing detours during construction, etc. The locations considered to be reasonable from the engineering point of view were decided as agreed between the DPWH and the Basic Design Study Team with confirmation at the sites.

2) Length of Bridge

   The length of bridge was decided to be the most economical on condition that abutments are placed behind the intersecting points of the design high water level and river cross section.

3) Elevation of Bridge

   The elevation of bridge was decided to be the maximum flood water level (MFWL) plus freeboard and bridge structure height. The MFWL was estimated based on the past highest water level obtained from hearing at the site and verified by the hydrological analysis. The procedure for determination of the elevation of girder bottom is shown in Figure 2.2.2.1-1.

   Analysis method and results are as follows:

   ① Catchment Area, Channel Length and Difference in Elevation

   They were measured based on the topographic map at a scale of 1/50,000 prepared by the National Mapping and Resource Information Authority (NAMRIA).

   ② Runoff Coefficient

   The project area is divided into steep mountainous area, rolling grassland, etc. The runoff coefficient varies from 0.4 to 0.7 according to the DPWH Design Criteria.

   ③ Design Flood Discharge

   Discharge of 50-year return period is taken as the design flood discharge and estimated by the following methods according to the catchment area (CA):

   - Rational formula for CA $\leqq$ 20 km^2
   - Expanded rational formula for 20 km^2 < CA $\leqq$ 500 km^2
   - SCS unit hydrograph for CA > 20 km^2

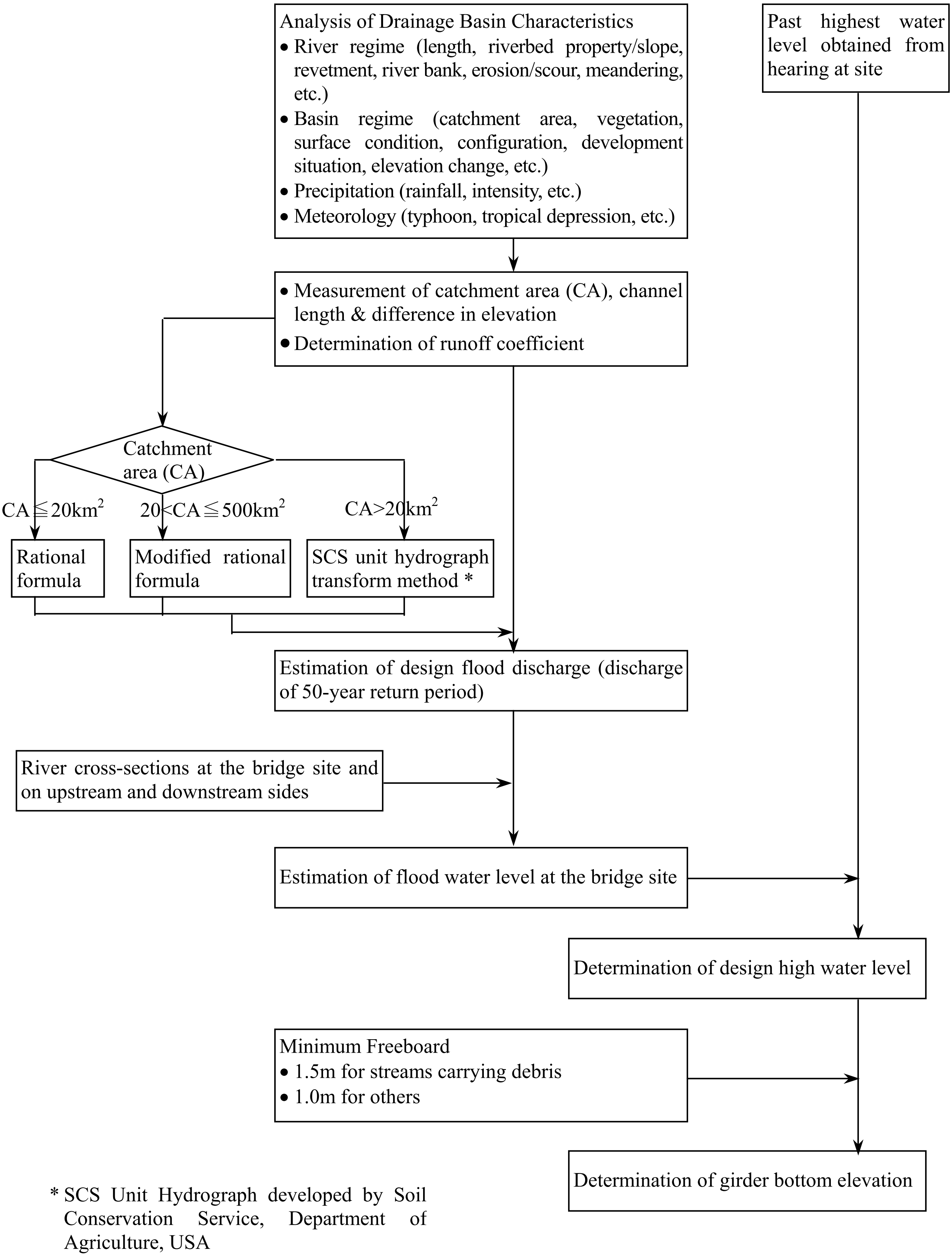


FIGURE 2.2.2.1-1 PROCEDURE FOR DETERMINATION OF ELEVATION OF GIRDER BOTTOM

Rational Formula

Flood discharge is obtained from the following formula:

$Qp = 0.278\ CIA$

where, Qp = flood peak discharge (m^3/sec), C = runoff coefficient, I = average rainfall intensity for duration equal to the time of concentration (mm/hr), A = catchment area (km^2)

The time of concentration is obtained by the Kirpich Formula:

$Tc = Ls^{1.15} / (51 + \triangle H^{0.385})$

where, Tc = time of concentration (min), Ls = channel length from the farthest point of catchment (m), △H = difference in elevation between the farthest point and bridge site (m)

Expanded Rational Formula

The rational formula is applicable only to the case in which the catchment area is 20 km^2 or less. By adjusting I (rainfall intensity), the applicability of the rational formula is expanded up to the catchment area of 500 km^2. The intensity adjustment coefficient is given in Figure 2.2.2.1-2.

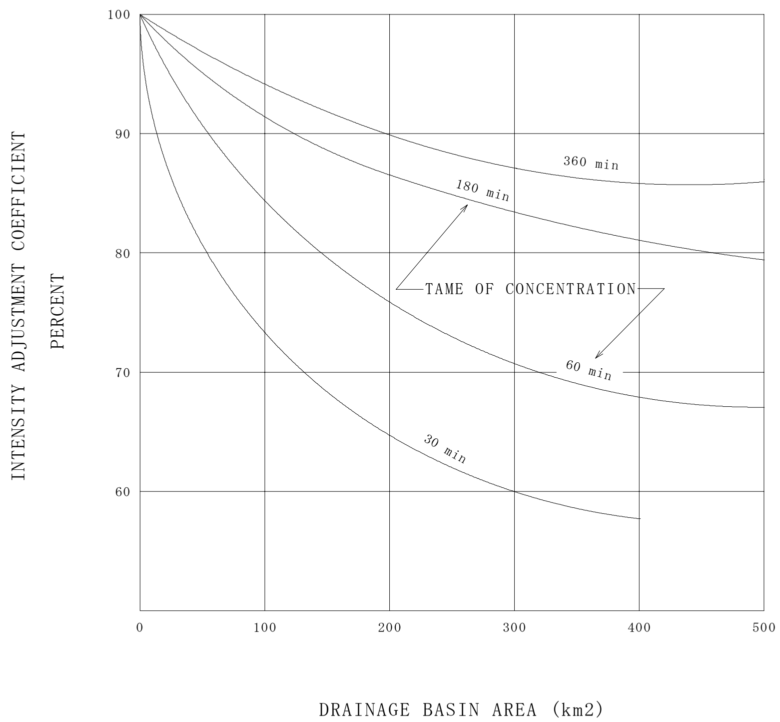


FIGURE 2.2.2.1-2 INTENSITY ADJUSTMENT COEFFICIENT

SCS Unit Hydrograph

The SCS Unit Hydrograph is shown in Figure 2.2.2.1-3.

Peak discharge is given by the following equation:

Up = CA/Tp

where, Up = peak discharge, C = conversion constant (2.08), A = catchment area, Tp = time of peak (also known as the time of rise)

The time of peak (Tp) is related to the unit excess precipitation duration as follows:

$Tp = \triangle t/2 + t_{lag}$

where, $\triangle t$ = excess precipitation duration (computation interval),

t_{lag} = basin lag

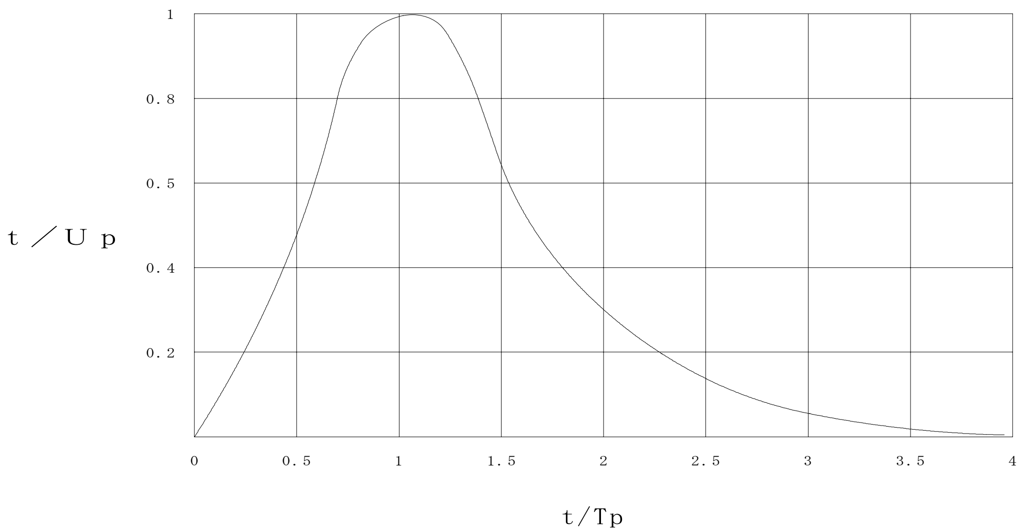


FIGURE 2.2.2.1-3 SCS UNIT HYDROGRAPH

④ Flood Water Level at the Bridge Site

The flood water level at the bridge site is estimated by the non-uniform flow analysis based on river cross-sections at the bridge site and on upstream and downstream sides.

⑤ Design High Water Level

The design high water level is determined based on the past highest water level obtained from hearing at site and the result of the hydrological analysis (④ above).

⑥ Elevation of Girder Bottom

The elevation of girder bottom is determined as the design high water level plus freeboard. The minimum freeboard is 1.5 m for streams carrying big debris like driftwood and 1.0 m for streams carrying no big debris.

Hydrological analysis results and girder bottom elevation determined based thereon are summarized in Table 2.2.2.1-1.

TABLE 2.2.2.1-1 RESULTS OF HYDROLOGICAL ANALYSIS

Bridge Number	Bridge Name	Catchment Area (km^2)	Runoff Co-efficient	Discharge of 50-year Return Period (m^3/s)			Flood Water Level of 50-year Return Period (El.m)	Past Highest Water Level obtained from Hearing (El.m)	Design High Water Level (El.m)	Freeboard (m)	Girder Bottom Elevation (El.m)
				Rational Formula	Modified Rational Formula	Unit Hydrograph					
01-01-01	Gasgas	78.65	0.60	–	1,282.82	1,296.80	19.340	20.680	20.680	1.0	21.680
01-02-01	San Gaspar II	3.77	0.45	68.38	–	–	16.490	17.590	17.590	1.0	18.590
01-02-04	Victory	1.25	0.45	99.48	–	–	11.280	11.450	11.450	2.5	13.950
01-03-03	Suyo	2.28	0.55	156.15	–	–	93.790	92.630	92.630	4.59	97.220
01-04-02	Baracbac	31.42	0.50	–	229.76	235.41	99.950	99.631	99.631	1.0	100.631
01-04-05	Malanay-Tuliao	450.46	0.40	–	1,309.88	1,400.01	8.410	8.220	8.220	1.0	9.220
01-04-06	Paitan	50.21	0.50	–	413.43	416.66	93.990	97.030	97.030	2.0	99.030
02-01-10	Pacapat	36.44	0.60	–	820.78	832.05	100.190	99.120	99.120	1.0	100.120
02-01-11	Pena Weste	1.28	0.45	33.74	–	–	97.740	99.750	99.750	1.0	100.750
02-01-12	Sta. Isabel	16.97	0.60	568.35	–	–	101.070	100.340	100.340	1.0	101.340
02-02-03	Casili	569.2	0.50	–	–	1,453.20	96.390	95.920	95.920	1.8	97.720
02-02-04	Dalig	41.2	0.45	–	313.47	313.44	99.340	98.500	98.500	1.0	99.500
02-02-07	Sinippil	8.58	0.50	95.59	–	–	33.760	34.330	34.330	1.0	35.330
02-03-03	Gattac	3.95	0.50	242.68	–	–	99.760	98.700	98.700	1.0	99.700
02-03-04	Inaban	10.61	0.50	279.99	–	–	99.110	97.850	97.850	1.0	98.850
02-03-06	Runruno	3.59	0.50	251.29	–	–	99.240	98.630	98.630	1.5	100.130
02-04-01	Angad	6.08	0.50	395.88	–	–	101.070	100.050	100.050	1.0	101.050
02-04-02	Balligui	21.11	0.50	–	446.22	461.01	100.820	100.940	100.940	1.0	101.940
02-04-06	Dumabato	31.52	0.60	–	655.59	647.70	100.690	99.390	99.390	1.0	100.390
02-04-10	Nagtim-Og	7.78	0.50	290.26	–	–	99.250	97.680	97.680	1.0	98.680
CA-01-03	Lublunak	3.54	0.55	78.00	–	–	21.200	20.700	20.700	1.0	21.700
CA-01-05	Naguilian	1.65	0.60	47.06	–	–	20.650	22.500	22.500	1.0	23.500
CA-01-06	Palaquio	2.35	0.60	68.49	–	–	17.140	17.000	17.000	1.0	18.000
CA-02-07	Galap I	21.96	0.60	–	933.85	1,103.30	9.140	7.150	7.150	1.0	8.150
CA-03-02	Habbang	136.42	0.65	–	1,980.66	1,978.64	93.360	91.750	91.750	2.6	94.350
CA-04-01	Dao	6.54	0.60	205.73	–	–	95.150	95.250	95.250	1.5	96.750
CA-04-02	Magabbangon	14.44	0.50	197.03	–	–	95.240	94.390	94.390	1.0	95.390
CA-04-04	Manglig	75.58	0.50	–	615.27	592.47	98.180	98.241	98.241	2.2	100.441
CA-04-08	Tuga	7.74	0.50	138.98	–	–	97.580	99.960	99.960	1.0	100.960
CA-04-12	Salagunting	12.5	0.60	–	509.29	520.83	96.280	94.340	94.340	6.0	100.340
CA-05-02	Amolong	15.7	0.60	377.06	–	–	97.300	97.600	97.600	1.0	98.600
CA-05-05	Lubo	6.68	0.60	160.00	–	–	96.800	95.330	95.330	2.3	97.630
CA-05-06	Masablang II	26.45	0.55	–	425.23	426.95	101.990	102.205	102.205	1.0	103.205

2.2.2.2 Superstructure Design

1) Superstructure Type

- Non-composite structure of steel girder and reinforced concrete slab is adopted. The adoption of the non-composite structure makes it possible for the slab to be easily reconstructed when necessary in the future.
- The continuous girder bridge is adopted for multi-span bridges taking advantage of aseismicity.
- The bridge structure height is required to be as low as possible to make the embankment height of the approach road low. For this purpose, the following considerations are given: adoption of rolled H steel girders as far as applicable, increase of number of girders, and adoption of continuous structure for multi-span bridges.
- The main girder type is selected according to the span length as follows:

Simple girder with a span length of 15 to 22 m	:	rolled H steel girder
Simple girder with a span length of 24 to 40 m	:	welding plate girder
Continuous girder with an average span length of 13 to 26 m	:	rolled H steel girder
Continuous girder with an average span length of 28 m	:	welding plate girder

2) Span Composition

The span composition is decided according to the following principles:

- The applicable range of span length of simple girder is 15 to 40 m.
- The span composition of 3-span continuous bridge is decided considering that the structurally best ratio of span lengths is 1:1.25:1.
- For 2-span continuous bridge, asymmetric composition of spans is adopted to avoid locating the pier in the center of the river flow. Otherwise the pier will be subject to scouring, whirlpool action, debris flow, etc.
- For long bridges, plural 3-span continuous bridges are combined to composite the bridge length.

The adopted span compositions are shown in Table 2.2.2.2-1.

TABLE 2.2.2.2-1 SPAN COMPOSITION

<table>
<tr><th colspan="2">Type</th><th>Span Length (m)</th><th>Number of Bridges</th></tr>
<tr><td rowspan="2">Simple Girder</td><td>Rolled H Steel Girder</td><td>15
18
20
22</td><td>6
1
3
2</td></tr>
<tr><td>Welding Plate Girder</td><td>24
25
28
30
33
40</td><td>2
2
1
3
1
1</td></tr>
<tr><td rowspan="2">2-span Continuous Girder</td><td>Rolled H Steel Girder</td><td>11 + 19
12 + 21
13 + 22
15 + 21</td><td>1
1
1
1</td></tr>
<tr><td>Welding Plate Girder</td><td>20 + 36</td><td>1</td></tr>
<tr><td>3-span Continuous Girder</td><td>Rolled H Steel Girder</td><td>12 + 15 + 12
14.5 + 18 + 14.5
15 + 20 + 15
17 + 21 + 17
(17.5 + 22 + 17.5) x 4</td><td>1
1
1
2
1</td></tr>
<tr><td colspan="3">Total</td><td>33</td></tr>
</table>

3) Structure Details

<u>Main Girder</u>

In accordance with the Guideline for Design of Steel Bridges for Highways, 1995, Ministry of Construction, Japan, the structure of the welding plate girder is simplified as follows to facilitate the fabrication and erection:

- Each member of main girder before splice shall be uniform.
- Number of horizontal stiffeners shall be zero or one.
- Slice plate shall be integrated into one, not separating moment plate and shear plate.
- Filler plate shall be put when the flanges with different thickness are spliced as shown in Figure 2.2.2.2-1.

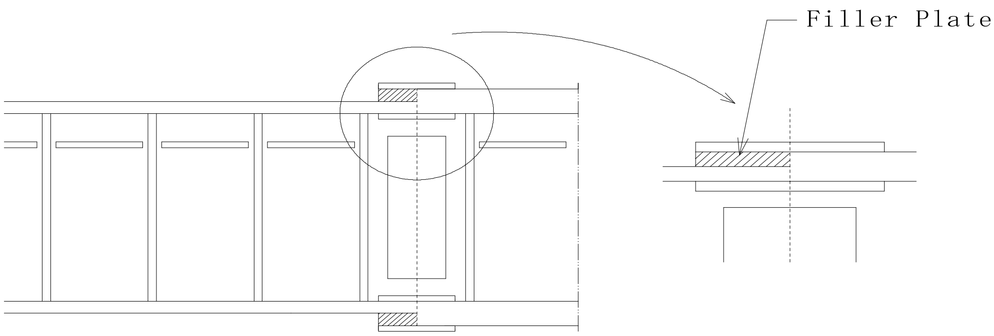


FIGURE 2.2.2.2-1 SPLICE OF FLANGES WITH DIFFERENT THICKNESS

<u>Bolt for Splice</u>

The Torshear type high strength bolts are used taking advantage of easy torque control and reliable bolting and thus resulting in the facilitation of girder erection.

<u>Camber</u>

Cambers are given to the girders in the course of fabrication to compensate for the deflection due to dead load. Steel plate is cut taking the camber into account when fabricating the welding plate girder. In case of rolled H steel girder, the camber is given by welding H steels in skew.

<u>Bearing</u>

Rubber bearings are used. Bearings shall meet the following criteria for aseismicity and maintenability:

- The rubber shoes shall have the functions of movement, rotation and load bearing.
- Bearings shall be composed of a few number of parts with simple structure to be easily assembled.
- Bearings shall be rust resistant and durable.
- Cost shall be reasonable.

<u>Painting</u>

The steel materials are painted for long-term protection from rust. The specifications for painting are shown in Table 2.2.2.2-2.

TABLE 2.2.2.2-2 SPECIFICATIONS FOR PAINTING

Painting System		Paint Grade	Paint	Quantity g/m²	Thickness μm	Interval of Painting
Shop Painting	Surface Cleaning	-	Blast Clearing SIS Sa 2.5 SPSS Sd2 Sh2	-	-	-
	Primer	JIS K5633 Class 2	Etching Primer	130 (spray)	15	～3 months
	Second Blast Clearing	-	Power Tool SIS St3 SPSS Pt3	-	-	2 days～
	Under Coat-1	JIS K5623～5 Class 1	Anti Corrosion Lead System Paint 1	170 (spray)	35	～10 days
	Under Coat-2	JIS K5623～5 Class 1	Anti Corrosion Lead System Paint 1	170 (spray)	35	～6 months
Site Painting	Intermediate Coat	JIS K5516 Class 2	Ftar-acid Resin Paint (Int Coat)	120 (brush)	30	2～10 days
	Top Coat	JIS K5516 Class 2	Ftar-acid Resin Paint (Top Coat)	110 (brush)	25	-

2.2.2.3 Substructure, Approach Road and Revetment Design

1) Abutment

Reversed T-shape wall type, which is commonly used in DPWH as a standard type, is adopted. The following considerations are given in the design:

- The width of bearing seat shall be wide enough to prevent the girder from falling down due to earthquake.
- Footings shall be embedded enough into the existing ground to secure the horizontal bearing capacity of the ground and to prevent the scouring.
- Approach slabs shall be provided behind the abutments to prevent the settlement of the approach road.

2) Pier

Reversed T-shape 2-column type, which is commonly used in DPWH as a standard type, is adopted. The following considerations are given in the design:

- The width of bearing seat shall be wide enough to prevent the girder from falling down due to earthquake.
- Footings shall be embedded enough below the riverbed to prevent the piers from loosing the stability when the riverbed is degraded or scoured in the future. 2-m embedment beneath the riverbed is proposed as standard.

- Piers shall not be located in the center of the river flow to prevent piers from suffering the scouring, whirlpool action, direct hit of debris flow, etc.

3) Approach Road

Approach roads are designed in accordance with the geometric design standards shown in 2.2.1.3 5). Where embankment is high, guardrails are provided on both sides of the road in 8-m section from the bridge end to prevent vehicles from falling down.

4) Revetment

To prevent the erosion on riverbanks, revetments with grouted riprap are provided in front of abutments and on the surfaces of riverbank on upstream and downstream sides of the abutments. The areas to be provided with revetments are those in which the stability of abutments is affected when scoured/eroded, being in principle the areas in front of abutments and 10 m each upstream and downstream therefrom.

The grouted riprap around the abutments is the most prone to be damaged. The following structure is proposed to prevent the damages:

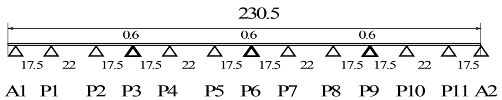
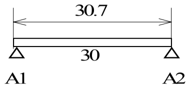
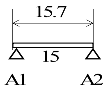
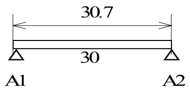
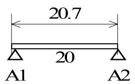
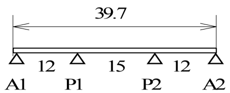
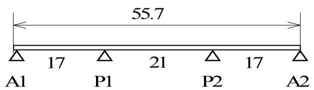
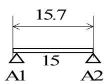
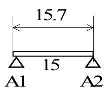
- Structural capacity is secured, thickness of grouted riprap being 50 cm with 10 cm thick lean concrete and 20 cm thick gravel beneath the riprap.
- The end of grouted riprap is embedded enough below the riverbed.
- Where scouring of the riverbed in front of the grouted riprap is anticipated, foot protection works are provided.

2.2.2.4 Basic Dimensions

The basic plans were prepared for the 33 group 1 bridges. The basic dimensions are shown in Table 2.2.2.4-1 including superstructure type, span composition, girder height, number of girders and outline of substructure, approach road and revetment.

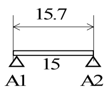
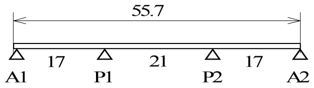
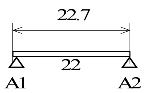
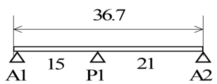
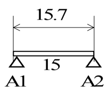
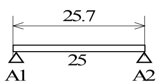
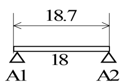
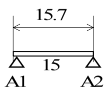
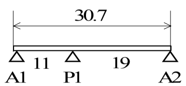
It should be noted that the type of foundation shall be decided based on geotechnical investigations to be undertaken by DPWH.

TABLE 2.2.2.4-1 BASIC DIMENSIONS OF THE PROJECT BRIDGES (1/4)

Number	Bridge No.	Name of Bridge	Side View	Superstructure Type	Superstructure Hw: Girder height(m) W : Girder weight(ton)	Number of Girders	Substructure Abutment/Pier H = height	Substructure Foundation*	Approach Road (m)	Revetment (m^2)
1	01-01-01	Gasgas		4 x 3 Span Continuous H Steel Girder	Hw = 0.912 W = 278.960	4	A1 : H = 7.5 m P1 : H = 5.0 m ↓ P11 : H = 5.0 m A2 : H = 7.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
2	01-02-01	San Gaspar II		Simple Welding Plate Girder	Hw = 1.6 W = 53.346	4	A1 : H = 7.5 m A2 : H = 7.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
3	01-02-04	Victory		Simple H Steel Girder	Hw = 0.90 W = 20.848	5	A1 : H = 6.5 m A2 : H = 6.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
4	01-03-03	Suyo		Simple Welding Plate Girder	Hw = 1.6 W = 53.346	4	A1 : H = 10.0 m A2 : H = 10.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
5	01-04-02	Baracbac		Simple H Steel Girder	Hw = 0.918 W = 43.263	6	A1 : H = 7.5 m A2 : H = 7.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
6	01-04-05	Malanay-Tuliao		3-Span Continuous H Steel Girder	Hw = 0.90 W = 47.288	4	A1 : H = 6.5 m P1 : H = 5.0 m P2 : H = 5.0 m A2 : H = 6.5 m	A1 : P1 : P2 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
7	01-04-06	Paitan		3-Span Continuous H Steel Girder	Hw = 0.90 W = 67.874	4	A1 : H = 6.0 m P1 : H = 7.0 m P2 : H = 7.0 m A2 : H = 6.0 m	A1 : P1 : P2 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
8	02-01-10	Pacapat		Simple H Steel Girder	Hw = 0.80 W = 20.848	5	A1 : H = 5.0 m A2 : H = 5.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
9	02-01-11	Pena Weste		Simple H Steel Girder	Hw = 0.80 W = 20.848	5	A1 : H = 5.0 m A2 : H = 5.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120

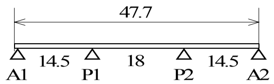
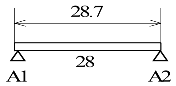
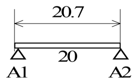
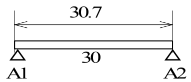
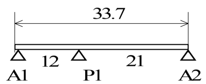
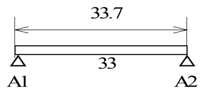
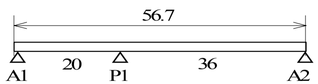
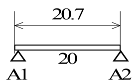
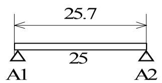
* to be decided based on geotechnical investigation

TABLE 2.2.2.4-1 BASIC DIMENSIONS OF THE PROJECT BRIDGES (2/4)

Number	Bridge No.	Name of Bridge	Side View	Superstructure Type	Superstructure Hw: Girder height(m) W : Girder weight(ton)	Number of Girders	Substructure Abutment/Pier H = height	Substructure Foundation*	Approach Road (m)	Revetment (m^2)
10	02-01-12	Sta. Isabel		Simple H Steel Girder	Hw = 0.80 W = 20.848	5	A1 : H = 5.0 m A2 : H = 5.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
11	02-02-03	Casili		3-Span Continuous H Steel Girder	Hw = 0.918 W = 67.874	4	A1 : H = 7.0 m P1 : H = 11.5 m P2 : H = 11.5 m A2 : H = 7.0 m A2 : H = 7.0 m	A1 : P1 : P2 : A2 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
12	02-02-04	Dalig		Simple H Steel Girder	Hw = 0.918 W = 46.709	6	A1 : H = 6.5 m A2 : H = 6.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
13	02-02-07	Sinippil		2-Span Continuous H Steel Girder	Hw = 0.918 W = 43.891	4	A1 : H = 6.0 m P1 : H = 4.5 m A2 : H = 6.0 m	A1 : P1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
14	02-03-03	Gattac		Simple H Steel Girder	Hw = 0.80 W = 20.848	5	A1 : H = 5.0 m A2 : H = 5.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
15	02-03-04	Inaban		Simple Welding Plate Girder	Hw = 1.3 W = 46.252	4	A1 : H = 6.0 m A2 : H = 6.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
16	02-03-06	Runruno		Simple H Steel Girder	Hw = 0.912 W = 27.756	5	A1 : H = 6.5 m A2 : H = 6.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
17	02-04-01	Angad		Simple H Steel Girder	Hw = 0.80 W = 20.848	5	A1 : H = 5.0 m A2 : H = 5.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
18	02-04-02	Balligui		2-Span Continuous H Steel Girder	Hw = 0.912 W = 36.669	4	A1 : H = 6.5 m P1 : H = 6.0 m A2 : H = 6.5 m	A1 : P1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120

* to be decided based on geotechnical investigation

TABLE 2.2.2.4-1 BASIC DIMENSIONS OF THE PROJECT BRIDGES (3/4)

Number	Bridge No.	Name of Bridge	Side View	Superstructure Type	Superstructure Hw: Girder height(m) W : Girder weight(ton)	Number of Girders	Substructure Abutment/Pier H = height	Substructure Foundation*	Approach Road (m)	Revetment (m^2)
19	02-04-06	Dumabato		3-Span Continuous H Steel Girder	Hw = 0.912 W = 58.382	4	A1 : H = 5.0 m P1 : H = 4.0 m P2 : H = 4.0 m A2 : H = 5.0 m	A1 : P1 : P2 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
20	02-04-10	Nagtim-Og		Simple Welding Plate Girder	Hw = 1.5 W = 47.444	4	A1 : H = 5.5 m A2 : H = 5.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
21	CA-01-03	Lublubnak		Simple H Steel Girder	L = 20.7 m Hw = 0.918 W = 43.263	6	A1 : H = 8.0 m A2 : H = 7.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
22	CA-01-05	Naguilian		Simple Welding Plate Girder	Hw = 1.6 W = 53.346	4	A1 : H = 6.5 m A2 : H = 6.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
23	CA-01-06	Palaquio		2-Span Continuous H Steel Girder	Hw = 0.918 W = 39.601	4	A1 : H = 5.5 m P1 : H = 5.0 m A2 : H = 5.5 m	A1 : P1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
24	CA-02-07	Galap I		Simple Welding Plate Girder	Hw = 1.7 W = 64.272	4	A1 : H = 7.5 m A2 : H = 7.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
25	CA-03-02	Habbang		2-Span Continuous Welding Plate Girder	Hw = 1.8 W = 87.715	4	A1 : H = 10.0 m P1 : H = 6.5 m A2 : H = 10.0 m	A1 : P1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
26	CA-04-01	Dao		Simple H Steel Girder	Hw = 0.918 W = 43.263	6	A1 : H = 7.5 m A2 : H = 7.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
27	CA-04-02	Magabbangon		Simple Welding Plate Girder	Hw = 1.3 W = 46.252	4	A1 : H = 7.5 m A2 : H = 7.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120

* to be decided based on geotechnical investigation

TABLE 2.2.2.4-1 BASIC DIMENSIONS OF THE PROJECT BRIDGES (4/4)

Number	Bridge No.	Name of Bridge	Side View	Superstructure Type	Superstructure Hw: Girder height(m) W : Girder weight(ton)	Number of Girders	Substructure: Abutment/Pier H = height	Substructure: Foundation*	Approach Road (m)	Revetment (m^2)
28	CA-04-04	Manglig	50.7 A1 15 P1 20 P2 15 A2	3-Span Continuous H Steel Girder	Hw = 0.90 W = 61.648	4	A1 : H = 6.5 m P1 : H = 6.0 m P2 : H = 6.0 m A2 : H = 7.5 m	A1 : P1 : P2 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
29	CA-04-08	Tuga	35.7 A1 13 P1 22 A2	2-Span Continuous H Steel Girder	Hw = 0.918 W = 50.975	4	A1 : H = 7.5 m P1 : H = 8.0 m A2 : H = 7.5 m	A1 : P1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
30	CA-04-12	Salagunting	40.7 A1 40 A2	Simple Welding Plate Girder	Hw = 2.1 W = 91.052	4	A1 : H = 8.0 m A2 : H = 8.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
31	CA-05-02	Amolong	24.7 A1 24 A2	Simple Welding Plate Girder	Hw = 1.3 W = 39.579	4	A1 : H = 7.5 m A2 : H = 7.5 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
32	CA-05-05	Lubo	22.7 A1 22 A2	Simple H Steel Girder	Hw = 0.918 W = 46.709	6	A1 : H = 7.0 m A2 : H = 7.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120
33	CA-05-06	Masablang II	24.7 A1 24 A2	Simple Welding Plate Girder	Hw = 1.3 W = 39.579	4	A1 : H = 7.0 m A2 : H = 7.0 m	A1 : A2 :	Right side 25 Left side 25	Right side 120 Left side 120

* to be decided based on geotechnical investigation

		Total Length	Steel Weight
Simple H Steel Girder	12 Bridges	220.4m	376.051 ton
2-Span Continuous H Steel Girder	4 Bridges	136.8m	171.136 ton
3-Span Continuous H Steel Girder	6 Bridges	480.0m	582.026 ton
Simple Welding Plate Girder	10 Bridges	296.0m	534.468 ton
2-Span Continuous Welding Plate Girder	1 Bridge	56.7m	87.715 ton
Total	33 Bridges	1,189.9m	1,751.396 ton (1.472 ton/m)

* to be decided based on geotechnical investigation

2.2.2.5 Quantities of Materials to be Procured

1) Steel Materials

The quantities of steel materials for the 33 project bridges are shown in Table 2.2.2.5-1 and Table 2.2.2.5-2.

TABLE 2.2.2.5-1 QUANTITIES OF STEEL MATERIALS FOR ROLLED H STEEL GIRDER BRIDGES (22 BRIDGES)

Type	Material Standard	Dimension (mm)	Weight (kg)
Plate	SM400	6 ～ 22	10,210
	SM490Y	9 ～ 39	110,333
	Sub Total		120,543
H Steel	SM490Y	800 ～ 912	919,065
CH	SS400	300 x 90 x 9x 13	51,069
GP RB BN TC	SGP SS400 SS400 S10T	150A 9 ϕ ～16 ϕ M12 M22	2,778 1,682 59 34,017
Total			1,129,213

TABLE 2.2.2.5-2 QUANTITIES OF STEEL MATERIALS FOR WELDING PLATE GIRDER BRIDGES (11 BRIDGES)

Type	Material Standard	Dimension (mm)	Weight (kg)
Plate	SS400	3.2 ～ 15	2,050
	SM400	6 ～ 22	62,965
	SM490Y	9 ～ 39	500,150
	Sub Total		565,165
CH	SS400	250 x 90 x 9	4,446
CT	SS400	95 x 152 x 8 118 x 178 x 8	15,278
L	SS400	90 x 90 x 10 130 x 130 x 12	16,574
GP RB BN TC	SGP SS400 SS400 S10T	150A 9 ϕ ～16 ϕ M12 M22	3,462 1,696 70 15,492
Total			622,183

2) Bearing

The quantities of the bearings are shown in Table 2.2.2.5-3.

TABLE 2.2.2.5-3 QUANTITY OF BEARINGS (33 BRIDGES)

Span Length (m)	Number of Bearings per Bridge	Number of Bridges	Number of Bearings
15	10	6	60
18	10	1	10
20	12	3	36
22	12	2	24
24	8	2	16
25	8	2	16
28	8	1	8
30	8	3	24
33	8	1	8
40	8	1	8
11 + 19	12	1	12
12 + 21	12	1	12
13 + 22	12	1	12
15 + 21	12	1	12
20 + 36	12	1	12
12 + 15 + 12	16	1	16
14.5 + 18 + 14.5	16	1	16
15 + 20 + 15	16	1	16
17 + 21 + 17	16	2	32
(17.5 + 22 + 17.5) x 4	64	1	64
Total		33	414

3) Expansion Joint

The quantities of the expansion joints are shown in Table 2.2.2.5-4.

TABLE 2.2.2.5-4 QUANTITY OF EXPANSION JOINTS

Span Length (m)	Number of Expansion Joints per Bridge	Number of Bridges	Number of Expansion Joints
15	2	6	12
18	2	1	2
20	2	3	6
22	2	2	4
24	2	2	4
25	2	2	4
28	2	1	2
30	2	3	6
33	2	1	2
40	2	1	2
11 + 19	2	1	2
12 + 21	2	1	2
13 + 22	2	1	2
15 + 21	2	1	2
20 + 36	2	1	2
12 + 15 + 12	2	1	2
14.5 + 18 + 14.5	2	1	2
15 + 20 + 15	2	1	2
17 + 21 + 17	2	2	4
(17.5 + 22 + 17.5) x 4	5	1	5
Total		33	69

4) Materials/Tools for Erection

The quantities of materials/tools for erection are shown in Table 2.2.2.5-5.

TABLE 2.2.2.5-5 QUANTITIES OF MATERIALS/TOOLS FOR ERECTION

Item	Type	Size	Quantity
Wrench for Torshear Type Bolt	For M22 (manual type)	M22	6
Drift Pin	-	M22	240
Spare Bolt	-	M22	2,000

2.2.3 Basic Plan of Group 2 Bridges

2.2.3.1 Basic Plan

1) Location of Bridge

   Bridge locations should be decided taking into consideration the existing road alignment, topography, river condition, presence of obstacles such as houses, way of providing detours during construction, etc. The locations considered to be reasonable from the engineering point of view were decided as agreed between the DPWH and the Basic Design Study Team with confirmation at the sites.

2) Length of Bridge

   The length of bridge was decided so as to be the most economical on condition that abutments are placed behind the intersecting points of the design high water level and river cross section.

3) Elevation of Bridge

   The elevation of bridge was decided to be the maximum flood water level (MFWL) plus freeboard and bridge structure height. The method of determining the elevation of bridge is stated in 2.2.2.1 3). Hydrological analysis results and girder bottom elevation are summarized in Table 2.2.3.1-1. The elevations of Amburayan I and Mambolo Bridges were determined according to the road profile since they are located over the deep valleys and their MFWLs are far below the bridge elevation.

TABLE 2.2.3.1-1 RESULTS OF HYDROLOGICAL ANALYSIS

Bridge Number	Bridge Name	Catchment Area (km^2)	Runoff Co-efficient	Discharge of 50-year Return Period (m^3/s)		Flood Water Level of 50-year Return Period (El.m)	Past Highest Water Level obtained from Hearing (El.m)	Design High Water Level (El.m)	Freeboard (m)	Girder Bottom Elevation (El.m)
				Modifiled Rational Formula	Unit Hydrograph					
01−04−04	Macayug	752.01	0.40	1,898.11	2,000.00	50.27	49.80	49.80	1.00	50.80
02−01−02	Capissayan	233.61	0.40	1,362.73	1,225.90	94.11	95.00	95.00	1.50	96.50
02−02−01	Abuan	491.42	0.40	2,459.23	2,488.59	99.74	99.50	99.50	1.50	101.00
CA−01−01	Abas	37.62	0.60	634.13	623.57	20.86	21.70	21.70	1.50	23.20
CA−02−01	Amburayan I	192.5	0.60	3,059.90	3,200.00	12.72	12.00	12.00	6.83	18.83
CA−02−08	Mambolo	53.92	0.60	340.89	345.00	162.85	161.60	161.60	14.71	176.31
CA−05−03	Bananao	383.94	0.40	2,226.66	2,043.30	91.72	93.00	93.00	1.50	94.50

2.2.3.2 Bridge Design

1) Basic Structure

Basic structure of the bridges is as follows:

Seismic resistant structure

- Multi-span girders shall be continuous or connected.
- Superstructures and substructures shall be monolithic or connected with hinges. Where movable bearings are used, concrete blocks shall be installed on the girder seats to prevent girders falling off.
- Piers of two-column type shall be adopted taking advantage of their low stiffness.

Protection/Measures against scouring

- Design riverbed level shall be determined taking into consideration possibility of scouring, sedimentation and meandering in the future.
- Pier footings shall be embedded around 2 m below the riverbed to provide for the local scour caused by construction of piers.
- To prevent the erosion on riverbanks, revetment with ground riprap shall be provided in principle in front of abutment and on the surface of riverbank.
- Foot protection works with boulders shall be provided in front of the revetment foundations where local scouring is foreseen.

Adoption of commonly used structure

- AASHTO type precast prestressed concrete deck girders (PCDG) shall be used in case prestressed concrete girders are selected.
- Grouted riprap and stone masonry shall be used for slope protections, retaining walls and sideditches.
- Standard Drawings for Concrete Bridges prepared by DPWH shall be referred to in the design. However, modification shall be made where necessary to adjust to local conditions.
- For PCDG, rubber bearings shall be used and prestressing shall be installed along girder-end diaphragms, in accordance with the Japanese standard design.

2) 01-01-04 Macayug Bridge

Site location and topography

The site is located at the end of alluvial fan of Bued River. Bued River merges with Cayanga River about 500 m downstream from the site. The river mouth is about 5km downstream from the merging point. The surrounding terrain is sandy plain where corn is cultivated. There is a 100 m long bailey bridge but its center span has been washed out. A temporary pedestrian bridge is now serving for local traffic.

Bridge location and approach road plan

New bridge is located at upstream side of the existing bridge. To minimize the bridge length and decrease the disturbance to the flood discharge, the bridge at right angle to the river is proposed, while the existing bridge crosses the river at about 75 degree. Since the Mangaldan side approach road connecting with Mangaldan-San Jacinto Highway is narrow (4 m wide) and many houses are located on both sides of the road, re-alignment is proposed. Construction of the approach road section from the bridge to the existing road is included in this project while the re-aligned section thereafter (about 200 m) will be constructed by the Government of the Philippines. The approach road plan is shown in Figure 2.2.4.2-1.

Flood level and girder bottom level

During the strong floods, the farms around the site are inundated with a depth of about 0.3 m but the approach road is not submerged because it is higher by about 1m with embankment. Since no driftwood is foreseen to float, 1 m high freeboard is assumed in the design.

Geological condition and foundation plan

The soil to a depth of 12 to 20 m from the ground surface is very dense fine sand (N-value 20 to 30). The soil deeper than 20 m is stiff sand (N-value 50 or more) which is assumed as bearing stratum. Since the ordinary river width is wide (about 40 m) and high tide depth is deep (about 4 m), pile-bent type piers and abutments are adopted. Since the piles are long (22 m) and pre-cast concrete piles can hardly penetrate the stiff layer (N-value around 50) which lies in the fine sand layer at shallow depth, bored piles are adopted for all foundations.

Scouring and pier footing elevation

The pile-bent foundation can stand even if soured. The riverbed, composed of fine sand, is stable because the river current is very slow.

River meandering and revetment plan

Both sides of the riverbank are covered by deep grass and therefore no riverbank protection is needed. However, the river may possibly change its course during strong floods since the site is located at the end of alluvial fan. Therefore the bridge is designed to be extendable by converting abutments into piers.

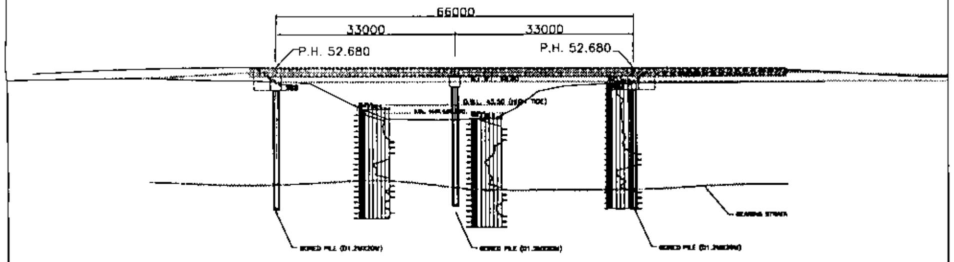
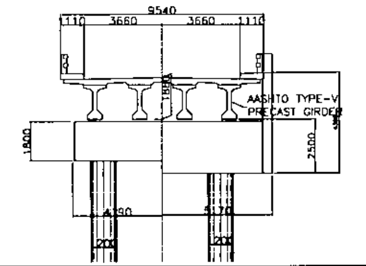
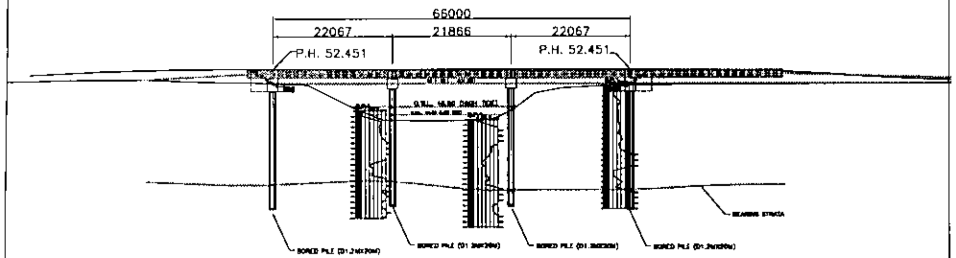
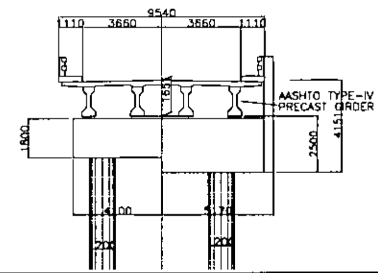
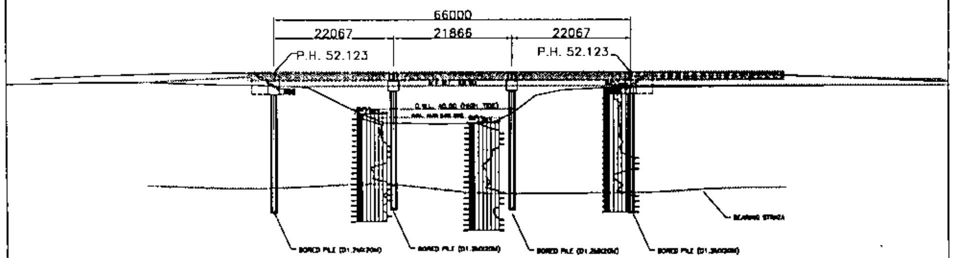
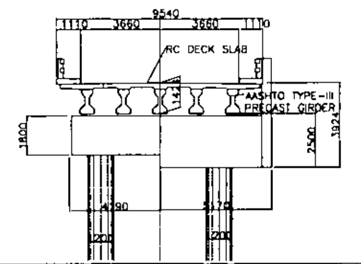
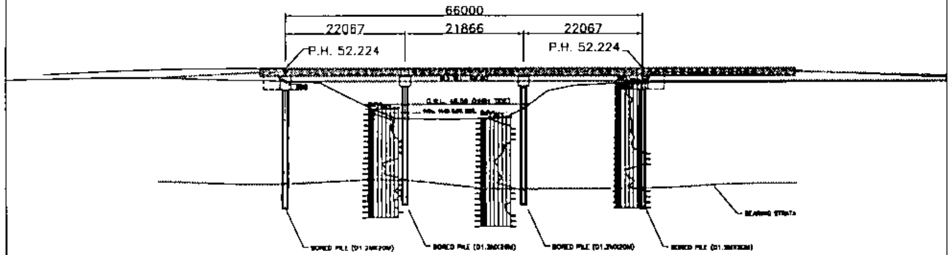
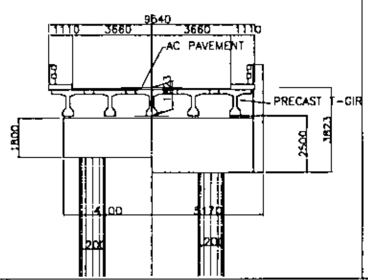
Abutment location and bridge length

Abutments are located somewhat behind the natural riverbank, the length of bridge being 65.4 m.

Span composition and superstructure type

Schemes of span composition and superstructure type are prepared and comparatively evaluated as shown in Table 2.2.3.2-1. As a result of comparison, 3-span connected PCDG (5-girders) is selected. The bridge general view is shown in Figure 2.2.4.2-2.

TABEL 2.2.3.2-1 01-04-04 MACAYUG BRIGDE : STRUCTURE TYPE SCHEMES

Side View	Cross-Section	Cost	Constructability	Maintenance Requirement	Overall Evaluation	Selection
 Scheme-A : 2-Span Connected PCDG		1.01 △	Works in the river is minimal, however, girders are the heaviest. △	Minimal maintenance is required since the structure is made of concrete. ○	The constructability is infevior to Scheme-C. The road alignment is less smooth than others since the ridge elevation is high. △	
 Scheme-B : 3-Span Connected PCDG (4-Girder)		1.00 ○	The girders are heavier than Scheme-C. △	Same as Scheme-A. ○	The cost is the lowest, however, the girder is heavier and the road elevation is higher than Scheme-C. △	
 Scheme-C : 3-Span Connected PCDG (5-Girder)		1.02 △	The girders are the lightest. ○	Same as Scheme-A. ○	The construction is the easiest and the brigde elevation is lower than Scheme-A & Scheme-B. ○	Adopted
 Scheme-D : 3-Span Connected PCDG (T-Girder)		1.08 ×	Asphalt concrete (AC) pavement is required on the deck slab surface. AC is difficult to be procured at the site. To assemble the precast gireders, traverse prestressing at about 50cm interval is required at the site. ×	Same as Scheme-A. ○	The cost is the highest. Materials are difficult to be procured. ×	

3) 02-01-02: Capissayan Bridge

Site location and topography

The site is located at the middle course of the river in the plain. The river curves leftward at the upstream side of the site. A wide sandbank was formed at the center of upstream side. The current is medium slow. No bridge exists but the mark showing the presence of an old bridge is seen.

Bridge location and approach road plan

New bridge is located along the alignment connecting the existing roads on both sides of the river. The approach roads up to the ends of the existing paved roads are included in the project. The approach road plan is shown in Figure 2.2.4.2-3.

Flood level and girder bottom level

Flood depth is about 6 m. Because of possibility of driftwood floating, 1.5 m high freeboard is assumed in the design.

Geological condition and foundation plan

At “A1” and “P1”, the soil to a depth of 3 to 4 m from the ground surface is weathered rock which is classified as sandy silt. Thereunder is bedrock. At “P2” to “A2”, the soil to a depth of about 10 m from the ground surface is sandy gravel. Thereunder is bedrock. At around 5 m in depth, the sandy gravel is very stiff (N-value 30 to 50), which is assumed as bearing stratum. Since precast concrete piles are hard to be driven, H-pile foundation and spread foundation with 2 to 3 m thick concrete base underneath are applicable. As a result of comparison, H-pile foundation is selected. The H-piles are driven into the bearing strata with a depth of 3 to 4 times the pile diameter.

Scouring and pier footing elevation

Since the river current is medium slow, the riverbed is stable. At the upstream side of the site, sand and gravel of the riverbed is being quarried, but it’s effect on the riverbed level at the site is minimal since the quarry scale is small. Pier footing elevations are 2 m beneath the lowest level of the riverbed for the footings not to be exposed if local scours occur around the piers.

River meandering and revetment plan

The river curves leftward at the upstream side of the site and the river current hits the right riverbank. It has been scoured and soft rock is exposed. After the site, the river runs straight. The river alignment is stable. For the right riverbank, a grouted riprap revetment aligning with the natural riverbank is provided. For the left side, since it locates inside of the curve and the scouring action is weak, a grouted riprap revetment is limited to the fringe of the abutment. Boulders are placed in front of the revetment to protect from scouring.

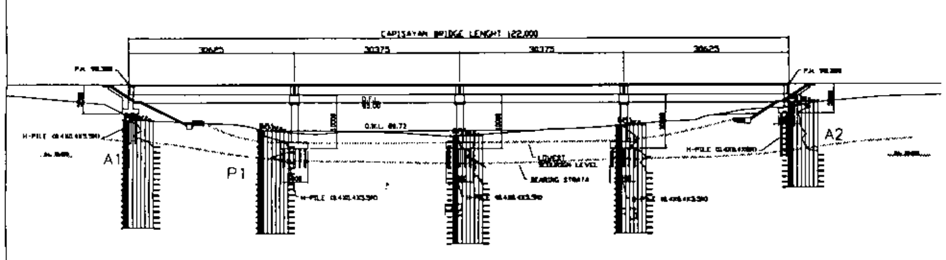
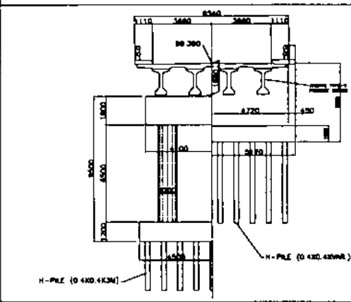
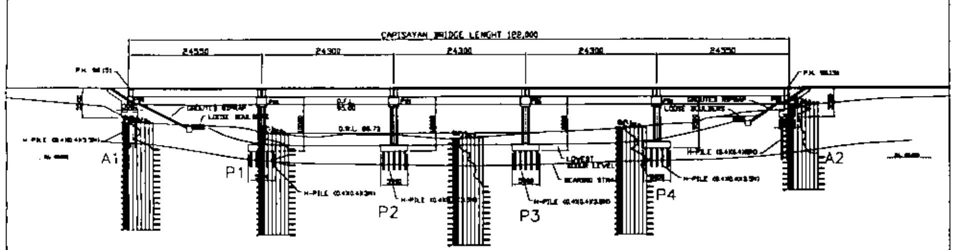
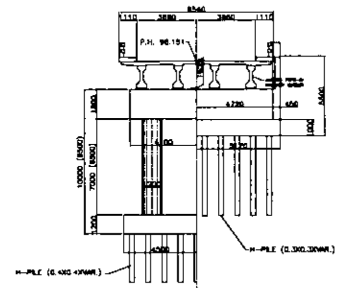
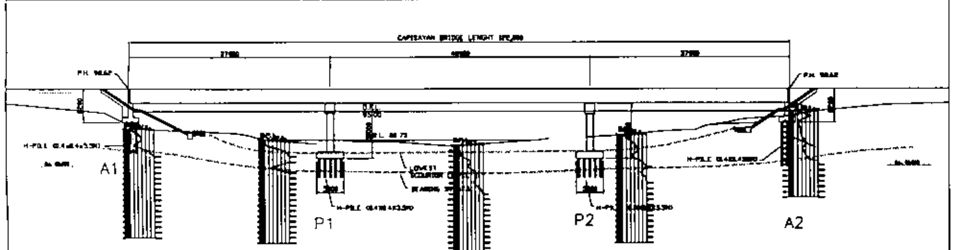
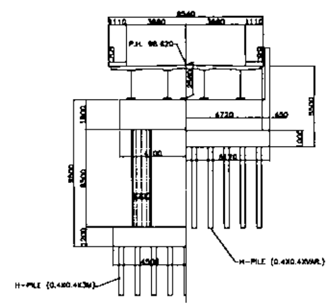
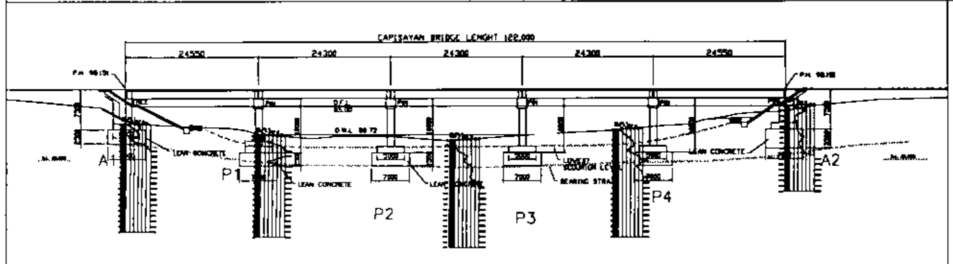
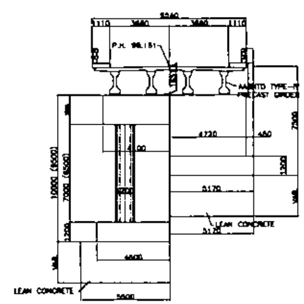
Abutment location and bridge length

Abutments are located behind the riverbanks, the length of bridge being 121.4 m.

Span composition and superstructure type

Schemes of span composition and superstructure type are prepared and comparatively evaluated as shown in Table 2.2.3.2-2. As a result of comparison, 5-span connected PCDG is selected. The bridge general view is shown in Figure 2.2.4.2-4.

TABEL 2.2.3.2-2 02-01-02 CAPISSAYAN BRIGDE : STRUCTURE TYPE SCHEMES

Side View	Cross-Section	Cost	Constructability	Maintenance Requirement	Overall Evaluation	Selection
 Scheme-A : 4-Span Connected PCDG (H-pile foundation)		1.1 △	Works in the river is less, however, girder is heavier than Scheme-B. △	Minimal maintenance is required since the bridge is made of concrete. ○	The cost is higher than Scheme-B. △	
 Scheme-B : 5-Span Connected PCDG (H-pile foundation)		1.0 ○	Works in thr river is more, however, girder is lighter than Scheme-A. △	Same as Scheme-A. ○	The cost is the lowest and construction is easy. ○	Adopted
 Scheme-C : 3-Span Continous Welding Plate Girder		1.5 ×	Works in the river is minimal and girders are the lightest. ○	Periodic repainting of steel girders is required. △	The cost is the highest and more maintenance works than other schemes are required. ×	
 Scheme-D : 5-Span Connected PCDG (Spread Foundation with concrete base)		1.1 △	It requires large scale cofferdam works to excavate until the bedrock. ×	Same as Scheme-A. ○	The cost is higher than Scheme-B.The construction is difficult. ×	

4) 02-02-01: Abuan Bridge

Site location and topography

The site is located at the top of alluvial fan. The upstream side of the site is valley, the downstream right side is terrace and the downstream left side is gentle hill. The river current is medium fast. The right riverbank has been scoured and rocks are exposed. Since no bridge exists, small boats are used by travelers for crossing the river.

Bridge location and approach road plan

New bridge is located along the alignment connecting the existing roads on both sides of the river. The approach road plan is shown in Figure 2.2.4.2-5.

Flood level and girder bottom level

Flood depth at the site is about 7 m. Because of possibility of driftwood floating, 1.5 m high freeboard is assumed in the design.

Geological condition and foundation plan

At "A1" and "P1", the bed rock is exposed and spread foundation is proposed. At "P2" to "A2", the soil to a depth of about 10 m from the ground surface is dense gravel. Thereunder is bedrock. At 6 to 7 m in depth, the gravel is very dense (N-value 30 to 50), which is assumed as the bearing stratum. Since precast concrete piles can hardly be driven, H-piles are used for the foundation.

Scouring and pier footing elevation

The riverbed is being scoured at the center of flow. However, the riverbed at the site will not change much as quantities of supplied and scoured materials are balanced. Pier footing elevations are 2 m beneath the lowest level of the riverbed for the footings not to be exposed if local scours occur around the piers.

River meandering and revetment plan

The river curves leftward at the upstream side of the site and the river current hits the right riverbank. It has been scoured and rocks are exposed. The river alignment is stable. Since the right side abutment is located directly on the bedrock, no revetment is needed. For the left side, since it locates inside of the curve and the scouring action is weak, a grouted riprap revetment is limited to the fringe of the abutment.

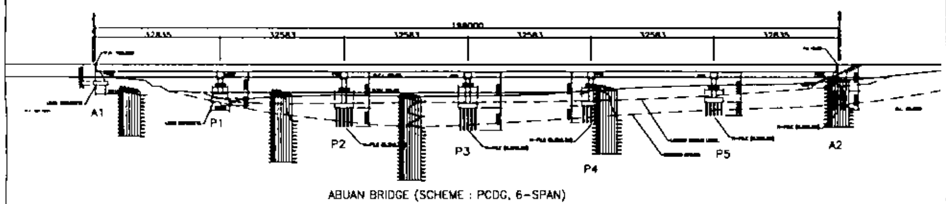
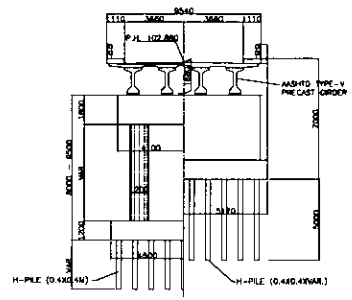
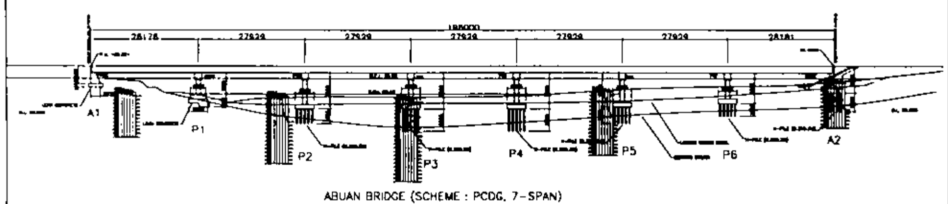
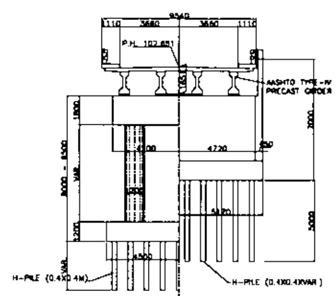
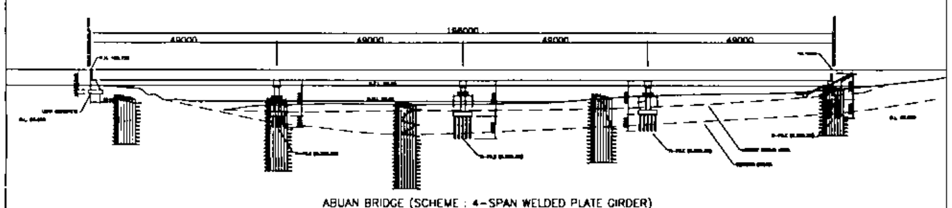
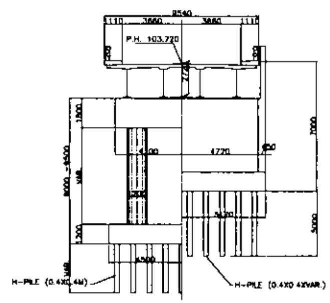
Abutment location and bridge length

The right side abutment is located a little setting back from the tip of salient rock, preparing for the strong scouring action. The left side abutment is located in front of the natural riverbank since the scouring action is weak. The length of bridge is 195.4 m.

Span composition and superstructure type

Schemes of span composition and superstructure type are prepared and comparatively evaluated as shown in Table 2.2.3.2-3. As a result of comparison, 7-span connected PCDG is selected. The bridge general view is shown in Figure 2.2.4.2-6.

TABEL 2.2.3.2-3 02-02-01 ABUAN BRIGDE : STRUCTURE TYPE SCHEMES

Side View	Cross-Section	Cost	Constructability	Maintenance Requirement	Overall Evaluation	Selection
 Scheme-A : 6-Span Connected PCDG		1.01 △	Works in the river is less than Scheme-B. The girders are heavier than Scheme-B. △	Minimal maintenance is required since the bridge is made of concrete. ○	The cost is higher than Scheme-B. △	
 Scheme-B : 7-Span Connected PCDG		1.00 ○	Works in the river is more, however, girders are lighter than Scheme-A. △	Same as Scheme-A. ○	The cost is the lowest and construction is easy. ○	Adopted
 Scheme-C : 4-Span Continous Welding Plate Girder		1.30 ×	Works in the river is minimal and girders are the lightest. ○	Periodic repainting of steel girders is required. △	The cost is the highest and more maintenance works than other schemes are required. ×	

5) CA-01-01: Abas Bridge

Site location and topography

The original route is located on the alluvial fan in the mountains where flood plain is vast and a long bridge is required. Therefore, a new bridge is planned to be along the barangay road which is located at the upstream side of the alluvial fan. There are ford crossings along the original route, while there is a hanging bridge for pedestrian (150 m long) along the barangay road. The flow velocity is medium.(Approx.0.5m/sec)

Bridge location and approach road plan

New bridge is located along the alignment connecting the existing barangay roads on both sides of the river. The left side approach road is constructed up to the end of the existing road. For the right side approach road, in addition to construction of the road up to the end of the existing road, improvement of about 450 m long existing road section is included in the project since the section is narrow and steep. The approach road plan is shown in Figure 2.2.4.2-7.

Flood level and girder bottom level

Flood depth at the site is about 3 m. Because of possibility of driftwood floating, 1.5m high freeboard is assumed in the design.

Geological condition and foundation plan

The soil to a depth of 2 to 3 m from the ground surface is gravel layer. Thereunder is bedrock. Spread foundation to be placed directly on the bedrock is adopted for all substructures.

Scouring and pier footing elevation

The riverbed level will not change much since the quantities of supplied and scoured materials are almost balanced. Many boulders of 10 to 15 cm in diameter lie on the riverbed.

River meandering and revetment plan

The river curves leftward at the upstream side of the site and the river current hits the right riverbank. It has been scoured and rocks are exposed. The river alignment is stable. For the right riverbank, a stone masonry wall revetment aligning with the natural riverbank is provided. For the left side, since it locates inside of the curve and the scouring action is weak, a grouted riprap revetment is provided only surrounding the abutment. The revetment foundations are rested on the bedrock and no foot protection is required.

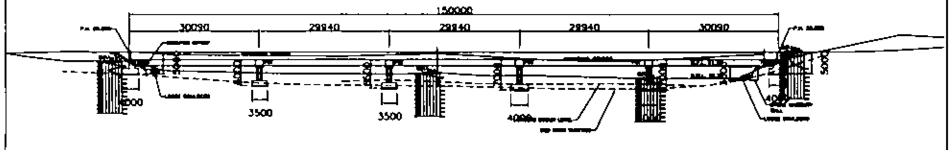
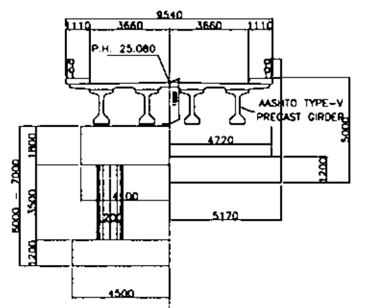
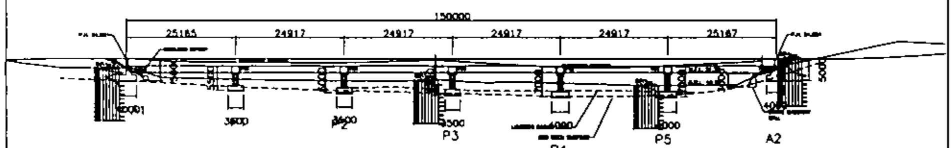
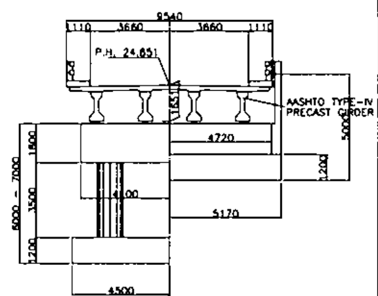
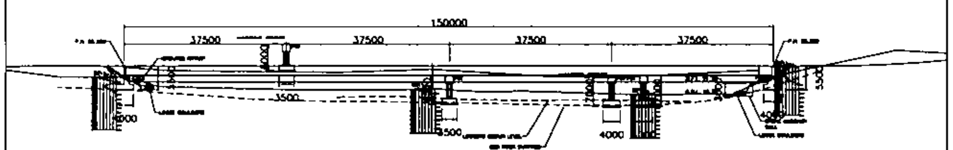
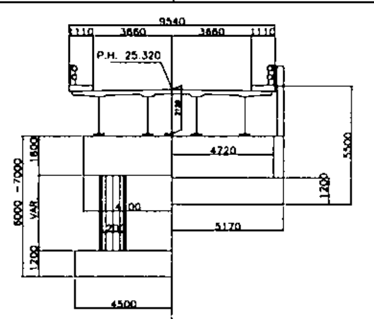
Abutment location and bridge length

Abutments are located behind the riverbanks, the length of bridge being 149.4 m.

Span composition and superstructure type

Schemes of span composition and superstructure type are prepared and comparatively evaluated as shown in Table 2.2.3.2-4. As a result of comparison, 6-span connected PCDG is selected. The bridge general view is shown in Figure 2.2.4.2-8.

TABEL 2.2.3.2-4 CA-01-01 ABAS BRIGDE : STRUCTURE TYPE SCHEMES

Side View	Cross-Section	Cost	Constructability	Maintenance Requirement	Overall Evaluation	Selection
 Scheme-A : 5-Span Connected PCDG		1. 1 △	Works of substrcture are less than Scheme-B. The girders are heavier than Scheme-B. △	Minimal maintenance is required since the bridge is made of concrete. ○	The cost is higher than Scheme-B. △	
 Scheme-B : 6-Span Connected PCDG		1. 0 ○	Works of substructure are more, however, girders are lighter than Scheme-A. △	Same as Scheme-A. ○	The cost is the lowest and construction is easy. ○	Adopted
 Scheme-C : 3-Span Continous Welding Plate Girder		1. 7 ×	Works of substructure are minimal and girders are the lightest. ○	Periodic repainting of steel girders is required. △	The cost is the highest and more maintenance works than other schemes are required. ×	

6) CA-02-01: Amburayan I Bridgeis

Site location and topography

The site is located in a deep valley in steep mountainous area. A 10-ton load limited single-lane suspension bridge exists. The river current is very fast. Many large sized boulders lie on the riverbed. The height from the riverbed to the bridge is about 20 m.

Bridge location and approach road plan

New bridge is located at the same location as the existing bridge. The extension of the approach roads to meet the existing road alignments is included in the project. The approach road plan is shown in Figure 2.2.4.2-9. Due to the very steep topography, existing road alignment does not satisfy the geometric design standard of national roads and vehicles run at a speed of 10 to 20 km/hr. Considering such present situation and the fact that a huge volume of earthwork is required if designed strictly complying with the geometric design standard as specified in 2.2.1.3 5), the approach roads are designed substandard (maximum gradient:12%, pavement width:6 m, mountain side shoulder width: 0.5 m, minimum radius: 20 m, maximum widening:1 m). Additionally, no superelevation is applied for curves of shorter than 30 m in length and more than 100 m in radius, and 3% superelevation is applied for the curved section with a radius of 20 m.

Flood level and girder bottom level

Flood depth at the site is about 7 m. The bridge elevation is determined according to the road profile, not from the hydrological requirements.

Geological condition and foundation plan

At “A1” and the location 15 m distant from “P1” to the left, the soil to a depth of about 3 m from the ground surface is weathered rock/gravel, and thereunder is stiff bedrock. At “A2” and the location 15 m distant from “P1” to the right, the soil to a depth of about 8 m from the ground surface is weathered rock/gravel, and thereunder is stiff bedrock. Since the gravel layer contains large size boulders (0.5 to 1 m in diameter) and therefore pile foundations are not applicable, spread foundations are adopted. 2 to 3 m thick gravel layer underneath the foundations is replaced with concrete.

Scouring and pier footing elevation

Since flood discharge is big and velocity is very fast, the pier foundation is rested directly on the bedrock. The pier is located on the lefter side of the river since the levels of both riverbed and bedrock on the righter side of the river is deeper than those on the lefter side.

River meandering and revetment protection plan

At the upstream side of the site, the river curves leftward. The right side riverbank has been scoured and perpendicular cliffs are formed. The right side abutment is located higher than the MFWL. Therefore, no revetment is required for the right side riverbank. The left side riverbank is gently sloped and formed with weathered rock. On the left side of the river, there is a dry riverbed bounded from the main channel by a stone masonry wall. There are residences on the dry riverbed. To protect the slope in front of the left side abutment from floods and rainwater, the stone masonry wall is extended up to the downstream side of the abutment (about 20 m long). To protect the pier columns from debris flow containing boulders, the columns are covered by concrete lining.

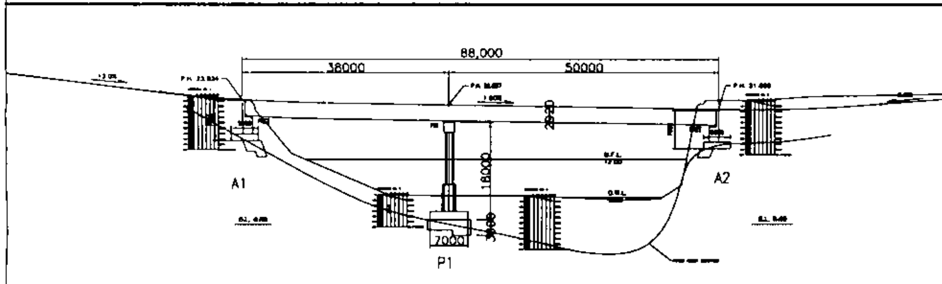
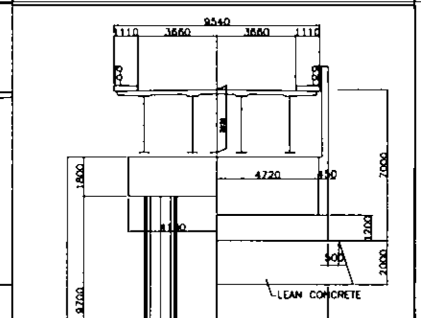
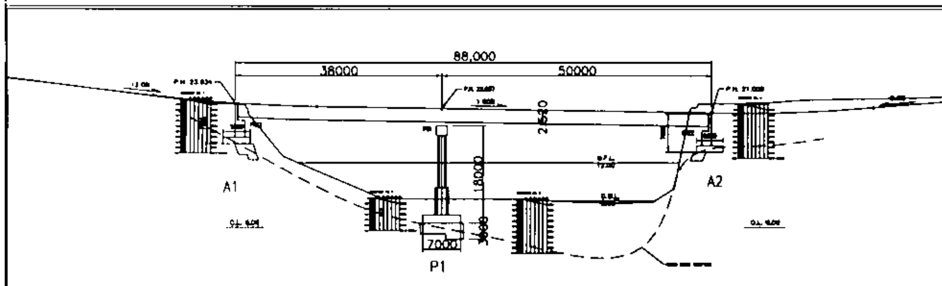
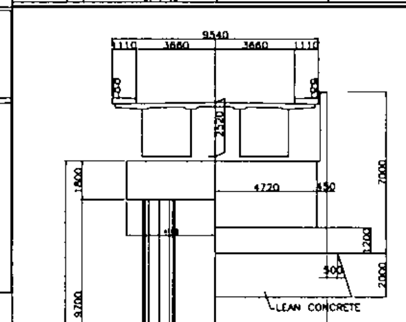
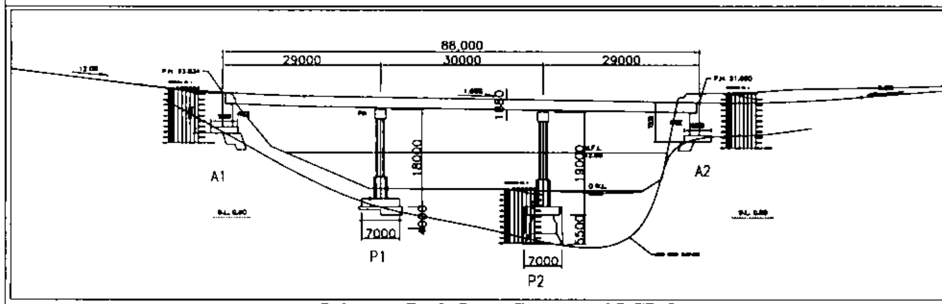
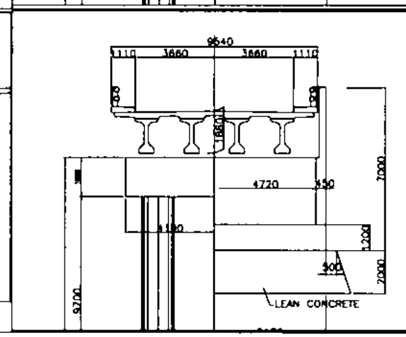
Abutment location and bridge length

The towers of the existing suspension bridge are rested on sound rocks. The abutments of the new bridge are located at the same locations as the towers. The bridge length is 87.1 m.

Span composition and superstructure type

Schemes of span composition and superstructure type are prepared and comparatively evaluated as shown in Table 2.2.3.2-5. As a result of comparison, 2-span continuous welding plate girder is selected. The bridge general view is shown in Figure 2.2.4.2-10.

TABEL 2.2.3.2-5 CA-02-01 AMBURAYAN I BRIGDE : STRUCTURE TYPE SCHEMES

Side View	Cross-Section	Cost	Constructability	Maintenance Requirement	Overall Evaluation	Selection
 Scheme-A : 2-Span Continous Welding Plate Girder		1.08 △	Hauling and erection of the girders are easier than Scheme-B since the plate girder members are smaller than box girders. ○	Periodic repainting of steel girders is required. △	Construction is the easiest and the cost is less than Schem-B. ○	Adopted
 Scheme-B : 2-Span Continous Steel Box Girder		1.26 ×	Hauling and erection of girders are more difficult than Scheme-A. △	Same as Scheme-A. △	The cost is higher and construction is more difficult than Scheme-A. ×	
 Scheme-C : 3-Span Connected PCDG		1.00 ○	Erection of heavy PC girders is difficult because the approach road is steep and the pier is very high. Construction of the open caisson into the cobble stones layer is difficult. ×	Minimal maintenance is required since the bridge is made of concrete. ○	The cost is the lowest, however, construction is difficult and dangerous. P2 has structural problem because it will be hit by very rapid floods containing cobble stones. ×	

7) CA-02-08: Mambolo Bridge

Site location and topography

The site is located in a deep valley in steep mountainous area. A 43 m long bailey bridge exists. The river current is very fast. Only boulders are seen on the riverbed. The height from the riverbed to the bridge is about 13 m.

Bridge location and approach road plan

New bridge is located at the downstream side of the existing bridge. The extension of the approach roads to meet the existing road alignments is included in the project. The approach road plan is shown in Figure 2.2.4.2-11. Due to the very steep topography, the connecting road alignment, even improved section, does not satisfy the geometric design standard of national roads and vehicles run at a speed of 10 to 20 km/hr. Considering such present situation and the fact that a huge volume of earthwork is required if designed strictly complying with the geometric design standard as specified in 2.2.1.3 5), the approach roads are designed substandard (maximum gradient: 12%, pavement width: 6 m, minimum radius: 15 m, maximum widening: 1 m). 3% superelevation is applied for curved section with a radius of 15 m and for the bridge section.

Flood level and girder bottom level

Flood depth at the site is about 3 m. The bridge elevation is determined according to the road profile, not from the hydrological requirements.

Geological condition and foundation plan

Stiff bedrock is exposed at the left side riverbank. Boulders are deposited on the right side riverbank. Bedrock is not seen on the right side riverbank due to presence of a stone masonry abutment which has been constructed in the past, but stiff bedrock is exposed on just upstream side of the abutment. Since the river current is very fast and debris flow is foreseen, substructures are located not in the riverbed but on the slopes of the valley. Piers and abutments with spread foundation are to be constructed on the slopes by digging rocks.

Scouring and pier footing elevation

Footings are not located in the riverbed nor affected by scouring.

River meandering and revetment plan

River alignment at the site is straight but the current runs down along the left side riverbank after curving leftward and bounding to the left. Since both sides of riverbank are scoured and bedrocks are exposed, the river alignment is stable. RC crib works filled with grouted riprap are provided to protect the slopes backfilled after constructing the pier footings and concrete wall is provided to protect the RC crib foundations and bedrocks beneath the pier footings.

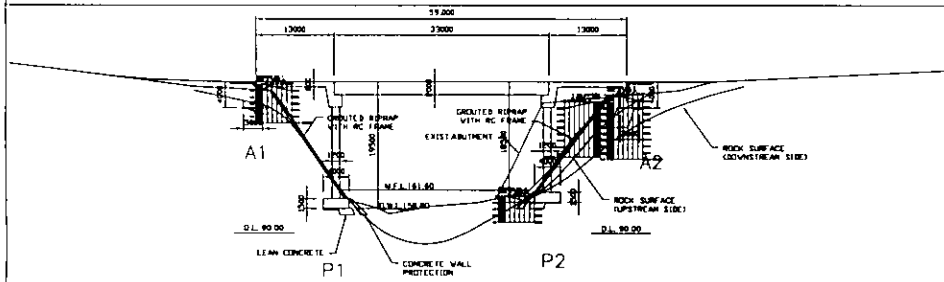
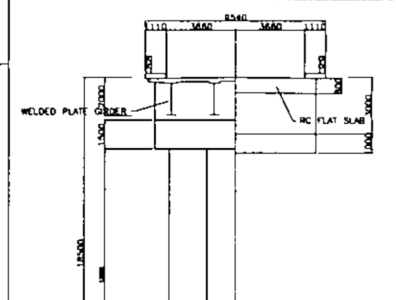
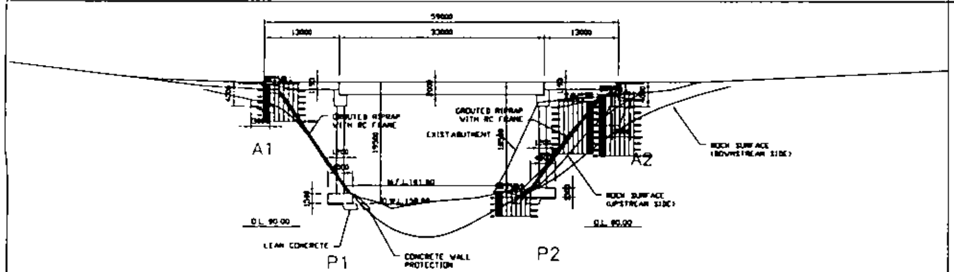
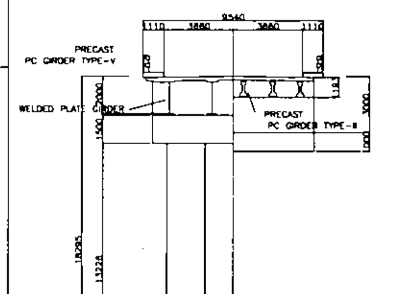
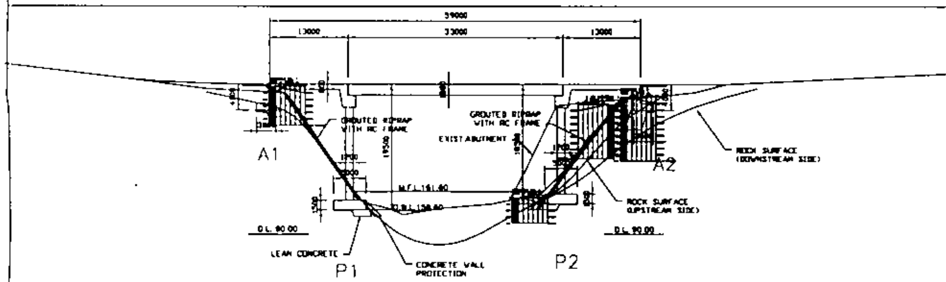
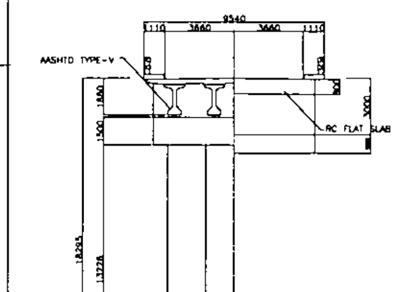
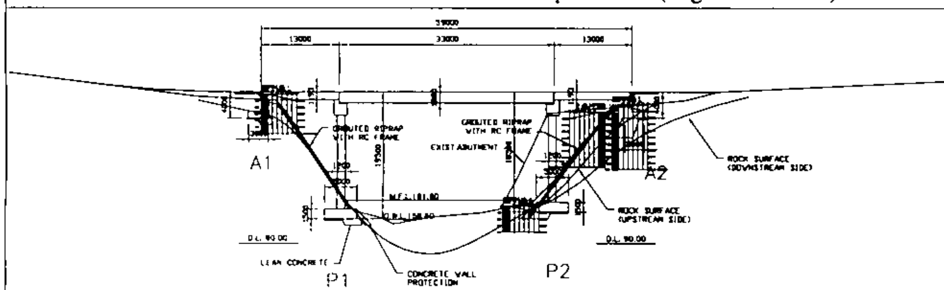
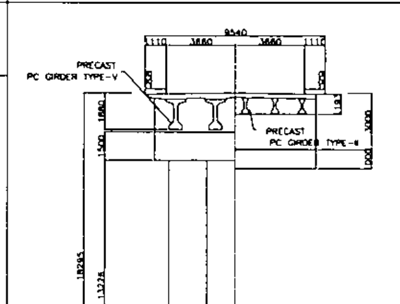
Abutment location and bridge length

The location of the abutments are determined to satisfy two requirements: the stability of the abutments and the stability of the superstructure. The bridge length is 58.4 m.

Span composition and superstructure

Schemes of span composition and superstructure type are prepared and comparatively evaluated as shown in Table 2.2.3.2-6. As a result of comparison, 3-span bridge, composed of welding plate girder for the center span and PCDGs for the side spans, is selected. The bridge general view is shown in Figure 2.2.4.2-12.

TABEL 2.2.3.2-6 CA-02-08 MAMBOLO BRIGDE : STRUCTURE TYPE SCHEMES

Side View	Cross-Section	Cost	Constructability	Maintenance Requirement	Overall Evaluation	Selection
 Scheme-A : Frame Abutment + Simple Welding Plate Girder		1.00 ○	Erection of steel girders is easy. Installing supports on steep slope to construct abutment slabs is difficult. △	Periodic repainting of steel girders is required. △	The cost is the lowest, however, construction is less easy than Scheme-B. Seismic resistance is high. △	
 Scheme-B : Simple Welding Plate Girder (center span) + Simple PCDG (side spans)		1.00 ○	Erection of steel girders is easy. Erection of side span PCDGs is easy. ○	Same as Scheme-A. △	The cost is the lowest and construction is easy. ○	Adopted
 Scheme-C : Frame Abutment + Simple PCDG (Segment Method)		1.01 △	Since heavy capacity crane can not be carried to the site, PCDGs are segmented and assembled on temporary supports. The temporary work is costly and difficult. ×	Minimal maintenance is required since the bridge is made of concrete. ○	Construction is difficult. ×	
 Scheme-D : 3-Span Simple Supported PCDG (Segment Method)		1.01 △	Since heavy capacity crane can not be carried to the site, PCDGs are segmented and assembled on temporary supports. The temporary work is costly and difficult. ×	Same as Scheme-C. ○	Construction is difficult. ×	

8) CA-05-03 : Bananao Bridge

Site location and topography

The site is located at the top/mid of alluvial fan in gentle mountainous area. Upstream side is mountainous terrain while downstream side is rolling terrain. A wide sandbank spreads over on the downstream side of the site. An 87 m long bailey bridge exists. Left side approach of the bridge is mountain with trees while right side is gentle hills with residences and farms.

Bridge location and approach road plan

Since a depression was formed by scouring due to whirlpools on the downstream side of the existing bridge, new bridge is located on the upstream side of the existing bridge. The approach roads up to the connection with the existing road are included in the project. The approach road plan is shown in Figure 2.2.4.2-13.

Flood level and girder bottom level

Flood depth at the site is about 12 m. Because of possibility of driftwood floating, 1.5m high freeboard is assumed in the design.

Geological condition and foundation plan

At “A1” and “P1”, the soil to a depth of 5 m from the ground surface is dense gravel (N-value 30 to 40). Thereunder is bedrock. At “P2”, the soil to a depth of 4 m from the ground surface is heavily weathered rock then thereunder is the bedrock. At “A2”, a 2 m thick surface soil covers over 3 m thick weathered rock. Thereunder is bedrock. Since piles are hard to be driven, spread foundation with 1 to 2.5 m thick concrete base underneath is adopted.

Scouring and pier footing elevation

The site is located at top/mid of alluvial fan and the river current is medium fast. It seems scouring and sand/gavel supply from the upstream are balanced and riverbed level will not change much. The deep portion of the riverbed with a water depth of 4.5 m at maximum was caused by the scouring but no further scouring is anticipated since the hard rock is exposed. The level of pier footings is deeper than the lowest point of the riverbed not to be exposed even if the deep portion of the riverbed expands.

River Meandering and revetment plan

The river curves rightward at the upstream side of the site and the river current hits the left side river bank. It has been scoured and rocks are exposed. Since the left side riverbank is heavily weathered soft rock, concrete wall is provided to protect the abutment. The right side abutment is located inside of the curve and the scouring action is weak. A stone masonry wall dike exists at the upstream side of the new abutment. The stone masonry wall is extended to the downstream side of the new abutment. Boulders are placed in front of the stone masonry wall to protect from scouring.

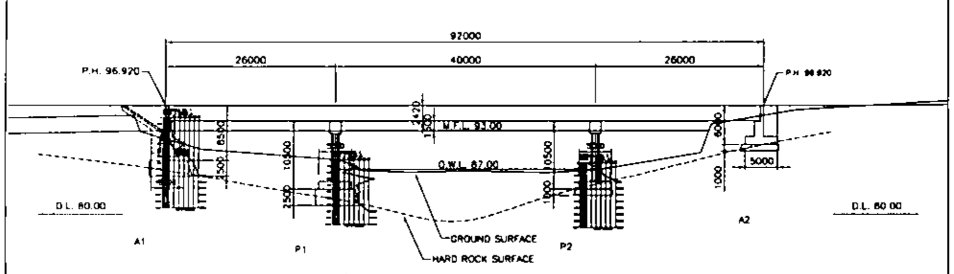
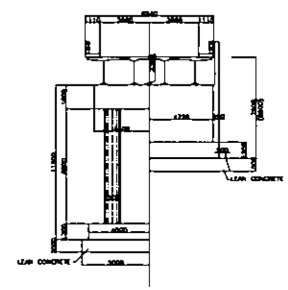
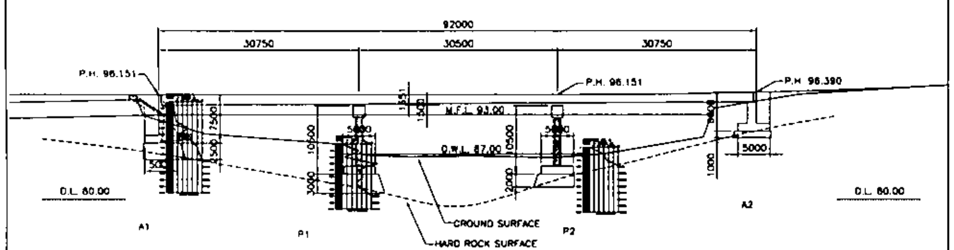
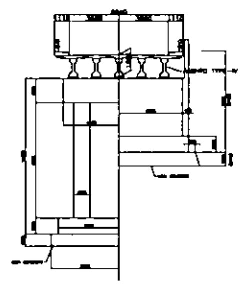
Abutment location and bridge length

Abutments are located behind the riverbanks, the length of bridge being 91.4 m.

Span Composition and superstructure type

Schemes of span composition and superstructure type are prepared and comparatively evaluated as shown in Table 2.2.3.2-7. As a result of comparison, 3-span connected PCDG is selected. PCDG of 5 AASHTO Type-IV girders is proposed since the heavy capacity crane cannot be carried to the site due to the access road condition. The bridge general view is shown in Figure 2.2.4.2-14.

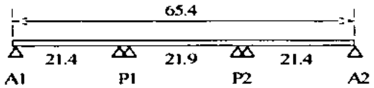
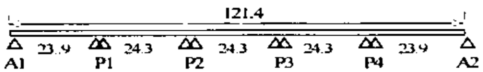
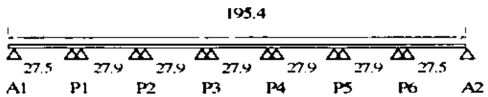
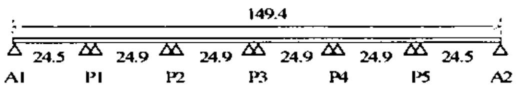
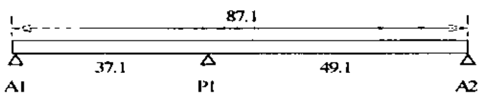
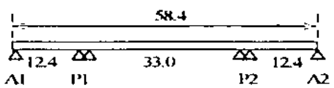
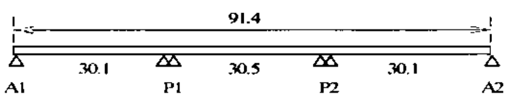
TABEL 2.2.3.2-7 CA-05-03 BANANAO BRIGDE : STRUCTURE TYPE SCHEMES

Side View	Cross-Section	Cost	Constructability	Maintenance Requirement	Overall Evaluation	Selection
 Scheme-A : 3-Span Continous Welding Plate Girder		1.5 ╳	Erection of steel girders is easy. Construction of piers is easier than Scheme-B since the piers locate nearer to the riverbanks. ○	Periodic repainting of steel girders is required. △	Construction is easier but the cost is higher than Scheme-B. △	
 Scheme-B : 3-Span Connected PCDG		1.0 ○	Erection of PCDG is more difficult than steel girders. Construction of piers is more difficult than Scheme-A since they locate nearer to the river center. △	Minimal maintenance is required since the bridge is made of concrete. ○	Cost is lower and maintenance is easier than Scheme-A. ○	Adopted

2.2.3.3 Basic Dimensions

The basic plans were prepared for the 7 group 2 bridges. The basic dimensions are shown in Table 2.2.3.3-1 including superstructure type, span composition, girder height, number of girders and outline of substructure and approach road.

TABLE 2.2.3.3-1 BASIC DIMENSIONS OF THE PROJECT BRIDGES

No.	Bridge No. Bridge Name	Superstructure Type Side View	Girder Height (m)	Number of Girders	Substructure: Abutment / Pier	Substructure: Foundation	Approach Road: Length (m)	Approach Road: Side Ditch (m)	Approach Road: Retaining Wall (m)	Revetment (m^2)
1	01-04-04 Macayug	3-span Connected PC Girder 	1.144	5	A1: Pile-bent H=4.0m P1: Pile-bent H=1.8m P2: Pile-bent H=1.8m A2: Pile-bent H=4.0m	A1: Bored pile (φ 1,200mm, L=20m, 2piles) P1: Bored pile (φ 1,200mm, L=20m, 2piles) P2: Bored pile (φ 1,200mm, L=20m, 2piles) A2: Bored pile (φ 1,200mm, L=20m, 2piles)	Left Side: 110.1* Right Side: 183.9	0 0	0 0	50.9 50.9
2	02-01-02 Capissayan	5-span Connected PC Girder 	1.371	4	A1: Reversed-T Wall H= 5.5m P1: Reversed-T 2-Column H=10.5m P2: Reversed-T 2-Column H=10.5m P3: Reversed-T 2-Column H=10.5m P4: Reversed-T 2-Column H= 9.0m A2: Reversed-T Wall H= 5.5m	A1: H-pile (H-414×405×18×28, L=5.5m, 21piles) P1: H-pile (H-414×405×18×28, L=3.0m, 30piles) P2: H-pile (H-414×405×18×28, L=3.0m, 30piles) P3: H-pile (H-414×405×18×28, L=3.0m, 30piles) P4: H-pile (H-414×405×18×28, L=3.0m, 30piles) A2: H-pile (H-414×405×18×28, L=8.0m, 21piles)	Left Side: 85.6 Right Side: 133.2	0 255	0 0	313.7 433.8
3	02-02-01 Abuan	7-span Connected PC Girder 	1.371	4	A1: Gravity H= 4.5m P1: Reversed-T 2-Column H= 7.0m P2: Reversed-T 2-Column H=10.5m P3: Reversed-T 2-Column H=10.5m P4: Reversed-T 2-Column H=10.5m P5: Reversed-T 2-Column H= 9.0m P6: Reversed-T 2-Column H= 7.0m A2: Reversed-T Wall H= 7.0m	A1: Spread P1: Spread P2: H-pile (H-414×405×18×28, L=3.5m, 45piles) P3: H-pile (H-414×405×18×28, L=5.0m, 45piles) P4: H-pile (H-414×405×18×28, L=5.0m, 45piles) P5: H-pile (H-414×405×18×28, L=4.5m, 45piles) P6: H-pile (H-414×405×18×28, L=4.5m, 45piles) A2: H-pile (H-414×405×18×28, L=5.0m, 30piles)	Left Side: 199.7 Right Side: 157.0	270 235	0 190	272.5 0
4	CA-01-01 Abas	6-span Connected PC Girder 	1.371	4	A1: Reversed-T Wall H= 5.0m P1: Reversed-T 2-Column H= 5.5m P2: Reversed-T 2-Column H= 6.0m P3: Reversed-T 2-Column H= 6.5m P4: Reversed-T 2-Column H= 7.0m P5: Reversed-T 2-Column H= 7.0m A2: Reversed-T Wall H= 5.0m	Spread	Left Side: 70.4 Right Side: 459.6	75 717	33 357	106.7 326.5
5	CA-02-01 Amburayan I	2-span Continuous Welding Plate Girder 	2.50	4	A1: Reversed-T Wall H= 7.0m P1: Reversed-T 2-Column H=18.0m A2: Reversed-T Wall H= 7.0m	Spread	Left Side: 116.4 Right Side: 62.6	95 90	95 90	43.0 43.0
6	CA-02-08 Mambolo	Simple Welding Plate Girder (Center Span) + Simple PC Girders (Side Spans) 	1.60	4	A1: Reversed-T Wall H= 4.0m P1: Reversed-T 2-Column H=17.0m P2: Reversed-T 2-Column H=16.0m A2: Reversed-T Wall H= 4.0m	Spread	Left Side: 37.8 Right Side: 41.9	70 91	0 0	567.5 567.6
7	CA-05-03 Bananao	3-span Connected PC Girder 	1.37	5	A1: Reversed-T Wall H= 7.5m P1: Reversed-T 2-Column H=10.5m P2: Reversed-T 2-Column H=10.5m A2: Reversed-T Wall H= 6.0m	Spread	Left Side: 81.4 Right Side: 176.5	160 80	0 0	120 40

* Excluding the section to be constructed by the Government of the Philippines