Chapter 2 Contents of the Project

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2-1 Basic Concept of the Project

The Asmara-Massawa road is serving as a unique lifeline road of greatest importance between the capital Asmara and Massawa, one of the two international seaports of the country. The road was built in the 1930's together with the objective bridges for the Project. After the independence in 1993 up to 1997, the road alignment and drainage system have been reestablished and asphalt pavement and safety facilities have been improved by a financial assistance of the European Union. However, the six objective bridges over 25 meters long were excluded from the EU funded improvement project and have been left unimproved so far. They still remain serving in such danger as having major elements destroyed with great possibility of losing structural soundness due to aging and collision by vehicles.

Under such background, the Government of the State of Eritrea requested the Government of Japan for Grant Aid for the rehabilitation of these six bridges to secure safe traffic on Asmara-Massawa road. The Government of Japan decided to implement the Basic Design Study for the request and dispatched the Study Team to Eritrea in May of 2003. The six bridges were investigated regarding their soundness and the results were compared with one another in order to attain the purpose. As the result, Gahtelay 2 Bridge, out of the six bridges, was excluded from the Project because it still remains sound, and the other five bridges are reconstructed or repaired according to the plan shown below under the Japan's Grant Aid Scheme.

Objective Bridges	Reconstruction / Repair Plan
Gindae Bridge	New bridge construction concurrently with the new by-pass construction
Gahtelay1 Bridge	Replacement of superstructure at the existing location
Dogali 1 Bridge	Repair of existing bridge
Dogali 2 Bridge	New bridge construction at an adjacent location
Emculu Bridge	Repair of existing bridge

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

Design concepts on Basic Design are mad in consideration of the following items.

- Results of field investigation such as visual inspection, neutralization of concrete, degree of penetration of chloride and structural analysis
- Function of bridge such as width and vertical clearance(height of portal)
- Social importance of bridge and project cost

Judging from various aspects of evaluation on the bridges, rehabilitation or repair of bridges along Asmara-Massawa road are determined. In the case of rehabilitation, design works are carried out with a consideration of the following factors;

- Selection of bridge type is made targeting to steel and prestressed-concrete bridge from the point of technology transfer, economical aspect and maintenance works
- Magnitude of live load is adopted by that of Eritrea, namely H(S)20-44 x 1.25 in which H(S)20-44 is stipulated in "Standard Specifications for Highway Bridge" adopted by the American Association of State Highway and Transportation Officials(AASHTO)

Based on above concepts, outline of this project is determined as follows;

1) Gindae Bridge

Although the superstructure of existing bridge was found necessary to be replaced after the soundness inspection, new Gindae Bridge on Gindae by-pass is adopted. This is because importance of the by-pass plan is recognized as the results of comparison with existing bridge and new bridge.

2) Gahtelay 1 Bridge

It is judged that two abutments (spread foundation) can be reused after field study, while it's upper structure needs rehabilitation.

3) Gahtelay 2 Bridge

As a result of the soundness inspection, both upper and sub structures are found to be sound. Therefore, this bridge is excluded from the targets for the Basic Design.

4) Dogalli 1 Bridge

Among three reinforced concrete arches , deteriorated members such as slab and hanger are to be repaired. In addition, extra supporting device is also installed to prevent the falling of girder from substructure in case of an earthquake.

5) Dogalli 2 Bridge

As the portal is completely collapsed ,and it is judged that slab and hanger do not function. Two abutments cannot be reused because there exists serious cracks along abutments due to earthquake. So that, a new bridge will be constructed at an adjacent location of the excising bridge.

6) Emculu bridge

The soundness inspection revealed that its superstructure is partly damaged and it needs to be repaired and that the substructure is sound. Thus, the rehabilitation will be done by repairing a part of the superstructure and also by installing extra supporting device to prevent the falling of girders in case of an earthquake.

2-2-1-2 Policy for Natural Condition

(1) Meteorological Condition

Metrological conditions of capital Asmara and those of Massawa are quite different because the capital is located in plateau with approximately above two thousand meter altitude, while Massawa, port town, faces the Red Sea. The following table shows meteorological observation records at Gindae and Massawa weather station.

Table 2.1 Observation Records of Temperature, Humidity and Rainfall in Gindae City

(Observation period：temperature and humidity 1947-1966/ rainfall 1947-66,1992-96)

	Month	1	2	3	4	5	6	7	8	9	10	11	12
Average temperature	℃	18.3	18.5	20.0	23.1	25.9	29.1	28.1	28.0	27.1	24.1	21.9	19.2
Temperature(max)	℃	24.0	24.1	26.5	29.9	34.0	37.8	36.4	36.1	35.8	32.4	28.9	25.6
Temperature(min.)	℃	12.7	12.8	13.6	16.4	17.8	20.4	19.9	19.9	18.5	15.8	14.8	12.8
Humidity	%	75	79	76	60	47	36	45	43	42	50	62	72
Rainfall	mm	109.7	102.8	70.4	51.9	30.9	10.8	66.0	55.9	20.3	44.4	61.8	99.0
Day of rainfall	Day	6	6	3	1	1	1	3	3	1	4	2	4
Day of rainfall (more than 10mm/ day)	Day	2	1	0	0	0	0	2	1	0	2	0	1

Table 2.2 Observation Records of Temperature, Humidity and Rainfall in Massawa City

(Observation period：temperature 1997,2001-2002/ humidity1949-1990rainfall 1963-1996)

	Month	1	2	3	4	5	6	7	8	9	10	11	12
Average temperature	℃	26.9	26.7	28.4	30.9	33.0	35.6	36.8	36.6	35.3	34.0	30.6	28.0
Temperature(max)	℃	29.9	29.3	31.6	34.7	37.4	39.8	40.8	40.6	39.5	38.3	34.2	30.0
Temperature(min.)	℃	24.0	24.1	25.2	27.0	28.5	31.3	32.8	32.7	31.2	29.7	27.0	26.0
Humidity	%	77	76	74	71	66	55	54	57	62	66	69	74
Rainfall	mm	30.2	26.1	13.8	11.3	6.3	0.1	6.7	7.6	3.3	16.8	21.0	39.9
Day of rainfall	Day	3	2	1	1	0	0	0	1	0	2	1	2
Day of rainfall (more than 10mm/ day)	Day	1	0	0	0	0	0	0	0	0	1	0	0

(2) Seismic Design

More than 500 Earthquakes over magnitude 4 in Rihiter scale have been recorded since 1973 in Eritrea, because Eritrea is located in the Great Rift Valley. However, no heavy damage has been reported, since severe damage was caused by an extremely strong earthquake in the 1890's. Accordingly it is considered that no massive earthquake triggering collapse of structures has arisen since the construction of the bridges along Asmara-Massawa road in the 1930's. Relation between expected period and horizontal acceleration compiled by University of Asmara is shown in Table2.3.

Table 2.3 Expected Period and Maximum Horizontal Acceleration

Expected Period	Asmara	Massawa
100	0.08	0.14
200	0.12	0.19
300	0.16	0.22

Table 2.4 Proposed Design Seismic Horizontal Coefficient

Route	Importance Classification	Acceleration Coefficient (Design value)
Asmara - Dongolo Tahtay	A	0.10
Dongolo Tahtay – Massawa	B	0.15
Nefasit - Dekemhare	A	0.10
Asmara - Zalambesa	A	0.10
Asmara – Hagaz	A	0.10

Although Gindae bridge is located 4km toward Asmra from Dongolo area, it is, in fact, on the border with other areas. Therefore the design value of acceleration coefficient of o.15 is also adopted for this Basic Design, referring above Table2.4.

(3) Hydrological Condition

After conducting collection of hydrological information regarding studied bridges such as records of water level, precipitation and river flow condition, the following results were obtained.

○Gindae Bridge（Gindae River）

*Water Level Record：not obtained

*Record of Precipitation; daily-based precipitation is available.

*River flow condition collected by resident：

a)Same discharge as study time(January and February in 2004) in general

b)Water level around planned Gindae bridge is sometimes close to crown height of embankment.

○Gahtelay 1 Bridge（Sabarguma River）

*Water Level Records：not obtained

*Record of Precipitation：not obtained

*River flow condition collected by resident：

a) Almost same discharge for whole year as study time(January and February in 2004) except rainy season in which discharge slightly increases.

b) Clearance under bridge is sufficient.

○Dogali 1 Bridge（Dogali River）

*Water Level Records：Record in 1999(4 months) and 2003(12 month)

*Record of Precipitation：not obtained

*River flow condition collected by resident：

Water flow cannot normally be found.

According to some resident, water level reaches to the bottom of slab about once a year.

In designing bridge repair, existing height under bridge was secured.

○Dogali 2 Bridge（Wadi Boo River）

*Water Level Records：not obtained

*Record of Precipitation：not obtained

*River flow condition collected by resident：

Water flow cannot normally be found.

According to some resident, water level reaches to the middle of the abutment about once a year.

○Emculu River（Obel River）

*Water Level Records：not obtained

*Record of Precipitation：daily precipitation record is available.

River flow condition collected by resident：not obtained.

Existing clearance under bridge will be secured.

2-2-1-3 Policy for Social Conditions

(1) Mines and unexploded bombs (UXB) survey

Survey and removal of mines/UXB were requested to RONCO by EDA at the time of the Basic Study. In case that further survey is necessary than those of the Basic Study, then removal of mines/UXB will be requested again in a similar manner.

(2) Environment

Construction of Gindae Bridge will be carried out together with that of the bypass. The bypass will be constructed totally at the expense of the Government of the State of Eritrea. It shall be monitored that the bypass construction is implemented properly in accordance with the environmental management plan resulted from the previously performed EIA.

Lands for the bypass and access roads shall be acquired by the Government of Eritrea, and in addition to it, yards for site office, stockpiles and girder fabrication shall be secured and leveled by the Government of the State of Eritrea.

2-2-1-4 Policy of Construction Conditions

(1) Labor Conditions

According to the Eritrean Labour Law, working hours are prescribed that they don't exceed 48-hour a week in 8 hours par day and working days are 6 days a week from Monday to Saturday. This project is based on this regulation.

(2) Construction Material Supply Conditions

As for the construction material supply conditions, the material which can be obtained locally, are concrete aggregate, crushed stone for roads, cement, timbers, plywood, and so on. The other materials depend on an import.

As for concrete aggregate and crushed stone, the state and private companies possess their owns crushing plant in the neighborhood of Asmara where quarries are available. Their quality and quantities are satisfactory. These aggregates and crushed stone can be transported to the project sites.

As for cement, there is only one state company that produces portland cement at a production rate of 45 to 50 tons par year. This production does not exceed even 10 % of the annual national demand (450 to 600 tons). Moreover, most of cement produced by the state company is at first supplied to the state companies and the national housing construction projects. Therefore, supply of cement in short depends on the import from the various neighboring countries, such as Egypt, Jordan, Indonesia and Kenya in order to meet the domestic demand. In such a circumstance, due to low productivity and limited supply of domestic product, the domestic procurement of cement will be difficult. In this project, cement will be procured from the third countries.

Although reinforcing bars are not domestically produced, they are supplied from various neighboring countries (Dubai, the Middle East, Asia) through local dealers. They have satisfactory quality as well. However, they can not be procured easily because their supply does not keep pace with the increase in demand. Therefore the bars should be procured from third countries. For PC steel materials, strain jacks, and pumps that are used for PC concrete bridge construction, since Eritrea has no experience in its construction, they can also be procured from other countries such as European, Asian (including Japan) counties and South Africa. However, many third countries refuse to give cost estimate to non-prospective buyers due to current price increase of steels, comparison of cost is virtually impossible. In consideration of this condition, these materials should be procured from Japan.

For asphalt and other related materials, they are not domestically manufactured but can be imported form the surrounding countries (Dubai, Middle East, Asia) through local dealers. Asphalt mixture should be purchased from local construction companies. As for construction machines, those machine that are locally available should be leased in the country as much as possible.

2-2-1-5 Policy of Procurement of Local Contractor

The total number of contractors registered in the Ministry of Public Works is 357; five state owned companies and 352 private companies. Most of them mainly undertake road and building construction works. There are 26 construction firms that are capable of contracting small and mid scale bridge construction projects as this one. However, none of them has

experience in the construction of PC concrete bridges. In Eritrea, there is a governmental service titled “National Service” that is institutionalized and requires obligatory social service work. The state companies receive those national service workers and send them to work in its public works projects such as road improvement. The workforce of these state companies, as explained above, is “for free” and the workers are not compensated. This type of workforce can not be used for tightly scheduled projects such as Japan’s grant-aid projects that require completion of construction within a limited time. Therefore it is reasonable that workforce should be procured from private companies. In addition, since Eritrea has no experience in PC concrete bridge construction, the engineers and technicians for PC bridge construction should be brought from Japan.

2-2-1-6 Policy of Management and Maintenance Control Ability of the Execution Agency

The executive body of this project is the Ministry of Public Works and it is the Department of Social Infrastructure that is directly engaged in this project. This is a new department established in 1999. Although the department needs more staff members (16 at present), its organization and work system are being established. Some of the staff members have experience of working in international aid organizations or those of other counties. Thus, it is judged that the department has sufficient ability to manage this project. The study team will strongly communicate the importance of post-completion maintenance work to the Eritrean side in the course of the project implementation.

2-2-1-7 Policy of Standard of Facilities

(1) Bridge Plan

Details of the rehabilitation works were determined based on the following policies;

- Replacement or repair was determined based on the field investigation during the basic design study in consideration of degree of deterioration of existing bridges
- Design of new bridge follows the current Eritrean bridge design such as relevant live load criteria.
- Repair works of bridge is carried out only to restore the damaged portions

(2) Condition of existing bridge

1) Gindae bridge

Bridge type of Gindae is categorized as reinforced concrete bridge with 3 hinges. Some damage around portal member and hanger provably caused by artillery shell is recognized. Dissolved lime is observed in the developing cracks in which reinforced bars are exposed at the lower portion of slabs. The foundation is not damaged seriously, though scours are

partially observed around foundation. As the bridge is located in a deep valley, there exists always a constant discharge in this river. When this bridge is replaced, a temporary bridge as detour will be required. Government of Eritrea has a by-pass plan including this bridge section.

2) Gahtelay 1 bridge

Gahtelay 1 bridge is reinforced concrete bridge with 3 hinges as well as Gindae bridge. Both portal on this bridge completely collapsed caused by collision of passing vehicles because of insufficient vertical clearance, namely 4.1m high. Hangers are also seriously damaged probably caused by collision of heavy vehicles at the connection point between hangers and slabs where induced cracks developed to structural cracks. No major damage or deteriorated portions were observed in either abutments. As this bridge is located at a flat area, detour will easily be secured.

3) Gahtelay 2 bridge

Gahtelay 2 bridge is reinforced concrete arch with 2 hinges. No damages are found in both superstructure and substructure after visual inspection or from the past investigation records.

4) Dogali 1 bridge

Dogali 1 bridge is reinforced concrete arch with 3 hinges composed of 3 set bridges. Though no major damage of the portal member is found, there exist some damages around upper lateral and hanger members probably caused by artillery shell. There are no structural cracks at the lower slab, in spite of exfoliation of surface concrete and exposure of reinforce bars. No major damage or scours are found around substructures. This bridge is constructed over a big river, but stream was not seen while field investigation. It is believed that detour is easily made as long as usage of this detour is limited to dry season.

5) Dogali 2 bridge

Dogali 2 bridge is reinforced concrete arch with 3 hinges. Portal members in both sides completely collapsed together with shortage of required section caused by collision of running vehicles. Besides above failures, there are considerable portions of exfoliation of concrete at surface and exposure of reinforce bars along with extensive cracks over lower portion of slabs, upper lateral and stringers. Though no major scour has occurred, intense cracks around abutments in both upper and down stream sides are found.

6) Emculu bridge

Emculu bridge is reinforced concrete arch with 3 hinges composed of 3 set bridges. Portal

member at middle bridge collapsed completely because its vertical clearance at middle bridge is less than 5.0m, that requires as vertical clearance over bridge in Eritrea comparing with other two bridges which satisfy Eritrean stipulation regarding vertical clearance. It is judged that no structural cracks at the bottom of slab is occurring though exfoliation of surface concrete and exposure of reinforce bar are found. No serious damage and scours in substructure are found. Three sets of concrete arch superstructure have respectively one movable bearing and fixed one. It is recognized that some of the movable bearings have titled, because some square shape bearings are inclined ten degrees to three degrees. Function of movable bearing of this bridge is to allow rotation at the point of bearing induced by elongation of superstructure due to temperature change or external force such as seismic force. Consequently, inclination of the movable bearing shows that they function properly.

(3) Policy on rehabilitation

Basic design will be proceeded under basic concepts described follows;

- Gahtelay 2 bridge is excluded from this study
- Dogali 1 and Emculu bridge is repaired for damaged members. While repair works is in progress, current traffic is diverted to the detour.
- Superstructure of Gahtelay 1 bridge will be constructed using existing substructure. While this works is carried out, current traffic will be detoured to temporary road constructed near the existing bridge.
- Gindae bridge will be constructed in accordance with bypass plan, while Dogali 2 bridge will be replaced by a new bridge near the existing bridge.

2-2-1-8 Policy of Construction Schedule

In the proposed construction schedule, the construction of bridge sub-structure in the rainy season is avoided. In principle, construction period is divided into two terms. The new bridge construction and reconstruction are allotted to the first term in consideration of emergency of the bridge improvement and the others to the second term.

The construction of Gindae bridge is carried out during the second term in consideration of environment issues and the Eritrean construction schedule and so on.

2-2-2 Basic Plan

2-2-2-1 Design Criteria

Bridge design to be conducted in Eritrea needs to refer to the following criteria, that is " National Bridge Condition Survey and Strength Analysis Report"(world bank March 2003) and the geometric design standard in accordance with design policy of Ministry of Public Works is shown in Table2.And also, standard cross section of the new bridge construction and replacement of superstructure is shown in Figure 2.1

Table 2.5 Geometric Standard Criteria

	Criteria	Remarks
Name of Route	Asmara-Massawa Road	
Design Speed	60km/hr	
Plan Curve	Minimum Radius 500m	
Number of Lane	2 lanes (1 lane each for both direction)	
Widths of Lane	3.50m/lane	(New Bridge)
Widths of Shoulder	0.25m/each lane	(〃)
Side Walk	Both side walk	(〃)
Width of Side Walk	Actual Width 1.50m	(〃)

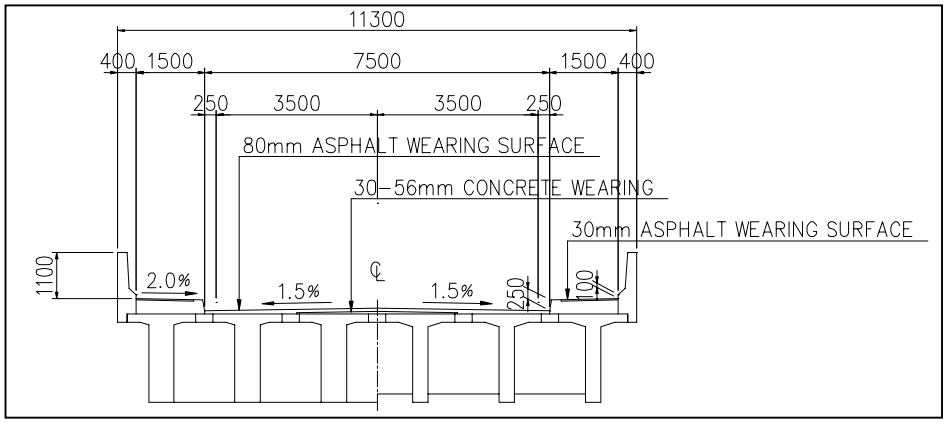


Figure 2.1 Standard Cross Section

2-2-2-2 Facility Design

(1) Summary of Facility

The details of the facilities determined based on design policy is shown in Table 2.6.

Table 2.6 Summary of Scale and Details Regarding Facility

Bridge Name	Gindae	Gahtelay 1	Dogali 1	Dogali 2	Emculu
Method	New bridge	Replacement of Superstructure	Repair of damaged member	New bridge	Repair of damaged member
Bridge Location	800m downstream from existing bridge	Existing bridge	———	Upstream 20m	———
Altitude	EL=908m	EL=314m	EL=103m	EL=95m	EL=37m
Present Traffic Volume	814vehicles/day	593vehicles/day	593vehicles/day	593vehicles/day	593vehicles/day
Crossing river	Gindae river	Sabarugum river	Dogali river	Wazipu river	Over river
Bridge Length	L= 39.000m	L= 29.900m	L=139.400m	L= 34.900m	L=132.300m
Width	Lane 7.50m Side walk 1.5m each both sides	Lane 7.50m Side walk 1.5m each both sides	Lane 6.20m Side walk 1.8m each both sides	Lane 7.50m Side walk 1.5m each both sides	Lane 6.20m Side walk 1.8m each both sides
River Protection	Wet masonry	Wet masonry	———	Wet masonry	———

(2) Bridge Length

Bridge length of newly constructed bridges and those for superstructure replacement is designed as follows;

Gindae Bridge：

Following the bypass plan in Gindae promoted by Government of the State of Eritrea, the location of new bridge is just same as that of by pass plan and the bridge length is decided to be 39 m long.

Gahtelay 1 bridge：

Bridge Length is 29.9 m, same as existing one, because the substructure is reused and only the superstructure is replaced.

Dogali 2 bridge：

Since the existing alignment of the bridge with the adjacent roads is not considered to be fair, being shifted downstream, new bridge location is planned so as to improve its alignment and its length is 34.9m.

(3) Bridge Type

If the type of superstructure for new three bridges is the same, total construction cost will be economized on an account of being able to divert the same construction equipment to each

construction site. The study team investigate selection of optimum type of superstructure suitable for this Project, taking into consideration following several premises;

-to select economically advantageous bridge that can be realized with reasonable total cost

- to select a bridge facilitating maintenance works after completion of the Project, and a bridge with high durability

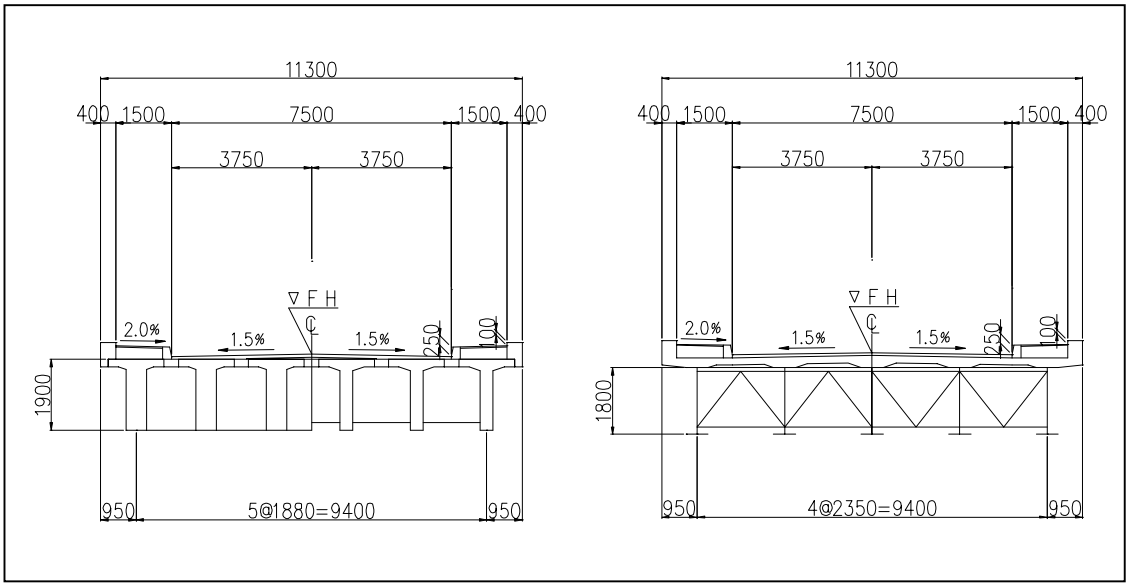
- to select type of bridge that is superior in workability for shortening the construction period.

- to adopt type of bridge giving high impacts on technology transfer, making it easy to procure local materials

Alternatives of bridge type are selected with a consideration of the following condition, namely commonly adopted bridge type suitable to a given bridge span. Two alternatives, one is prestressed concrete post tensioning T girder type and the other is steel simple I girder, were chosen, based on relation between standard span length and type of superstructure shown in Table2.7 and Figure 2.2.

Table 2.7 Relation between Span Length and Type of Superstructure

Type of Superstructure		Span Length: 10m 20m 30m 40m 50m 60m	Height of Girder/Span
Steel Bridge	H girder	Gindae	1/20
	I girder	Dogali 2	1/17
Concrete Bridge	RC slab		1/18
	PC T girder	Gahtelay 1	1/17



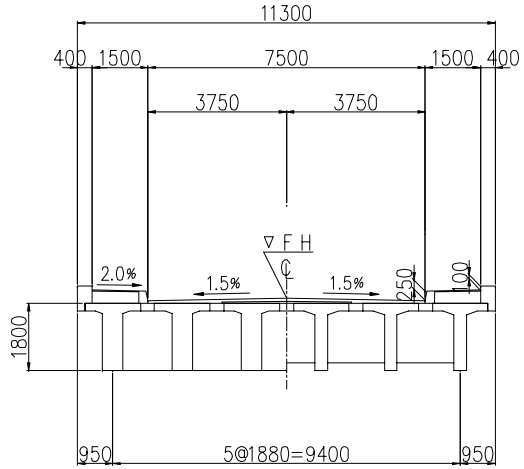
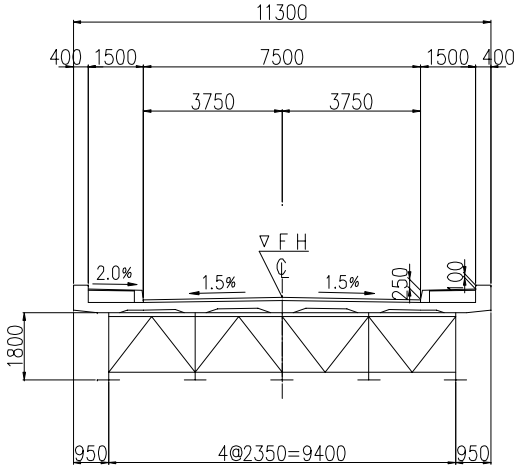
Alternative A (PC Simple Post-tensioning T girder Bridge)

Alternative B (Steel Simple I Girder Bridge)

Figure 2.2 Standard Cross Section of Two Alternatives

Summary of comparison regarding these two alternatives is shown in Table 2.8.

Table2.8 Comparison of Two Alternatives Brige Types

	Alternative A （ＰＣ post-tensioning simple T girder）		Alternative B（Steel simple I girder）	
Cross section				
Procurement	easy to procure local materials such as concrrete and aggregate so on to contribute to job opportunity	○	difficult to procure steel material from local marcket	△
Technology Transfer	Because most of major materials are obtainable in local marcket or neighboring countries, tranfered technology is sutainable.	○	Because most of materials is to import from foreign countries, it is difficult to expect sustainable growth.	×
Economical Aspect	**1.00**	○	**1.10**	△
Maintenance	almost free from maintenance works	○	As periodical paint is required, anti-corrosion steel is expected.	△
Workability	It is essential to facilitete construction yard for fablicating main girder. This type of bridge needs errection girder because of heavy girder.	△	Because all of steel members are fablicated at factory, tranported members are errected with truck crane in short period.	○
Structual Characteristic	As this type is frequently avaible in all of the world for 20～45m span length, there is no specific problem.	○	This type of bridge is fit for 20 ～ 55m span length. As weight of supperstructure is ligter than that of PC girder, induced force to substructure from superstructure in earthquick is less than that of PC girder.	○
Environment	As site work is relatively not so much, some impacts may occur.	△	No major imapacts	○
Overall Evaluation	Recommendable	◎	*****	△

※Legend ○ : Good, △ : Fair, × : Poor

Items such as capability of procurement for local materials, technology transfer, economically reasonable construction cost, maintenance works and workability are emphasized in evaluating these two alternatives. Considering structural characteristics and impacts on surrounding environment, final bridge plan was selected.

PC post-tensioning simple T girder (PC T girder) is recommendable compared with Steel Simple I Girder (Steel I girder) on an account of following reasons;

- economically advantageous with more reasonable construction cost
- easy to procure materials locally
- efficiency in technology transfer because of the first introduction of PC bridge construction in Eritrea

(4) Basic Structural Concepts

Gindae bridge/Gahtelay 1 bridge/Dogali 2 bridge :

Prestressed Concrete Simple Post-tensioning T girder is adopted for above three bridges based on evaluation of two alternatives. According to normal standard bridge applied to same size and type, number of girders is 6. Abutment type is determined as T reverse type adopted commonly in the same dimension. Foundation is determined as spread foundation because well compacted gravel layer is found around the position of foundation obtained from geological survey. Moreover, extension of both lateral sides of existing abutments is included for fitting to new girders width for Gahtelay 1Bridge.

Dogali 1 bridge :

After visual inspection, following reasons are thinkable for collapsed members (refer Figure2.3);

- damage caused by artillery shell(Asm S-1/CF-11/CF-12)
- damage caused by heavy vehicle's collision(Asm LV-5/RV-7/Mid RV-6/RC-10/MasLV-4/RC-10)
- deterioration by aging (S-xx)

Those members collapsed by artillery shell or collision of vehicles will be replaced with steel bars and be re-concreted. Those members exposing steel bars due to separation of concrete will be filled up with mortar after chipping. As for lower slab, exposed bar will be replaced depending on the degree of development of rusting.

Emculu bridge :

After visual inspection, following reasons are thinkable for collapsed members (refer

Figure2.4);

- damage caused by artillery shell(Asm UCB-6/Mid LC-7)
- damage caused by heavy vehicle's collision(Mid UCB-1/UCB-8/RV-4/CF-1)
- deterioration by aging (S-xx)

Tilting of the bearing is probably caused by seismic and overloading and so on. Those members collapsed by collision of vehicles will be replaced with steel bars and be re-concreted. Those members exposing steel bars due to separation of concrete will be filled up with mortar after chipping. As for lower slab, exposed bar will be replaced in the case of severe damage depending on the degree of development of rusting.

(4) River conditions

The Gindae river, over which the Gindae bridge is constructed, has a little flow except for the rainy season of July and August when the flow comes to fill the whole river course. The design high water level at the newly constructed Gindae bridge is studied and determined in the Gindae bypass road construction project. Therefore the study team adopt this value: Length between high water level and lower side of the girder (clearance under the deck: standard is more than 0.8 m) is set to be 1.37 m.

Other rivers than the Gindae are so called Wadis (dry river) and has no flows except for the time of flooding, when the flows are somehow recognizable. According to the interview survey , the clearance below the girder is maintained at about 2 m or more and is considered sufficient. In consideration of this fact, the bridge elevations for Dogali 2 and Gahtelay 1 were determined in such a way that the clearance under the deck of the existing bridges (1.7 – 2.0 m , design standard is 0.8 m) is maintained.

2-2-3 Basic Design Drawings

Based on Design Criteria , basic design drawings are prepared and presented in following pages.

Figure 2.3 Actual Bridge Condition of Dogali 1 Bridge

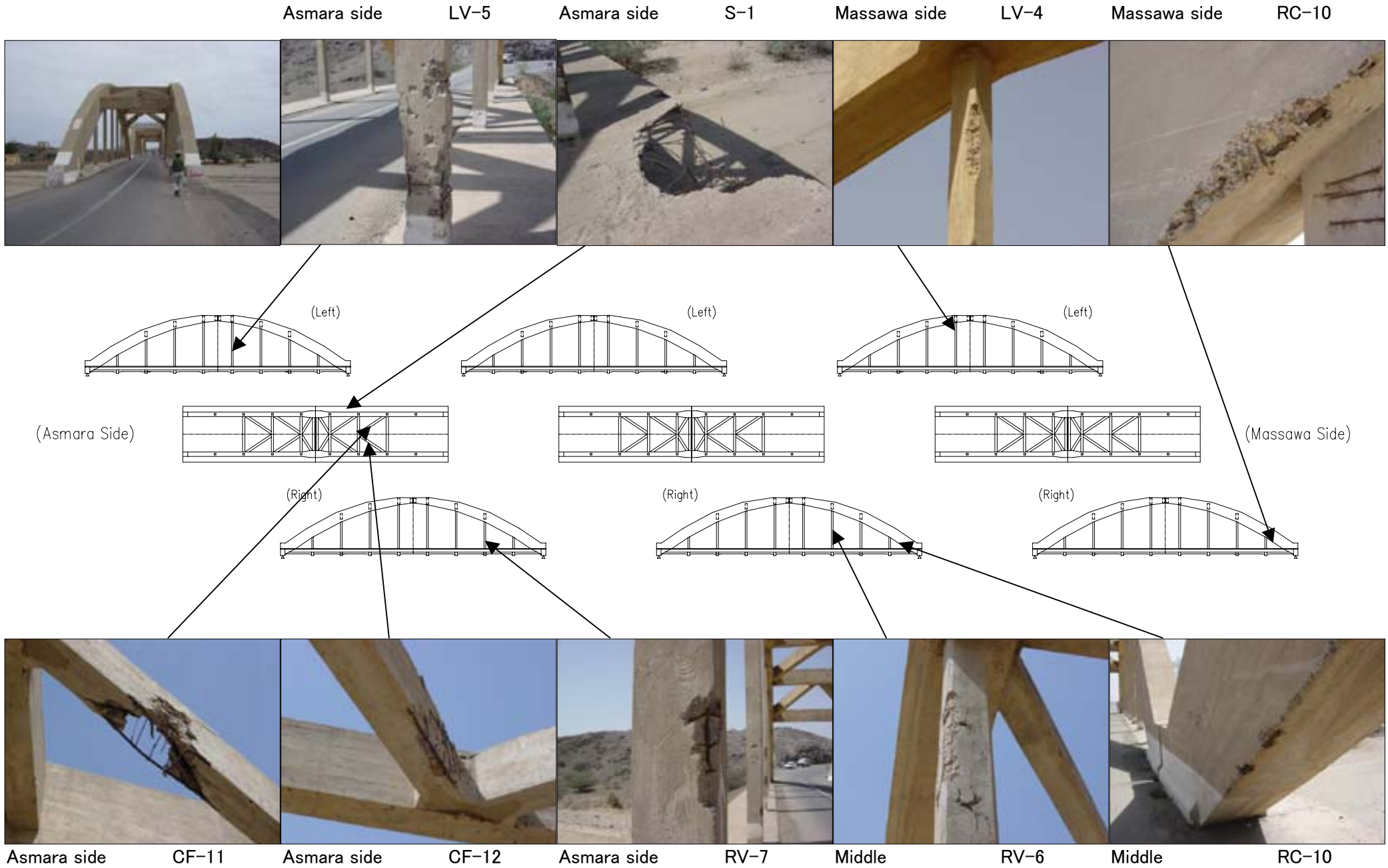
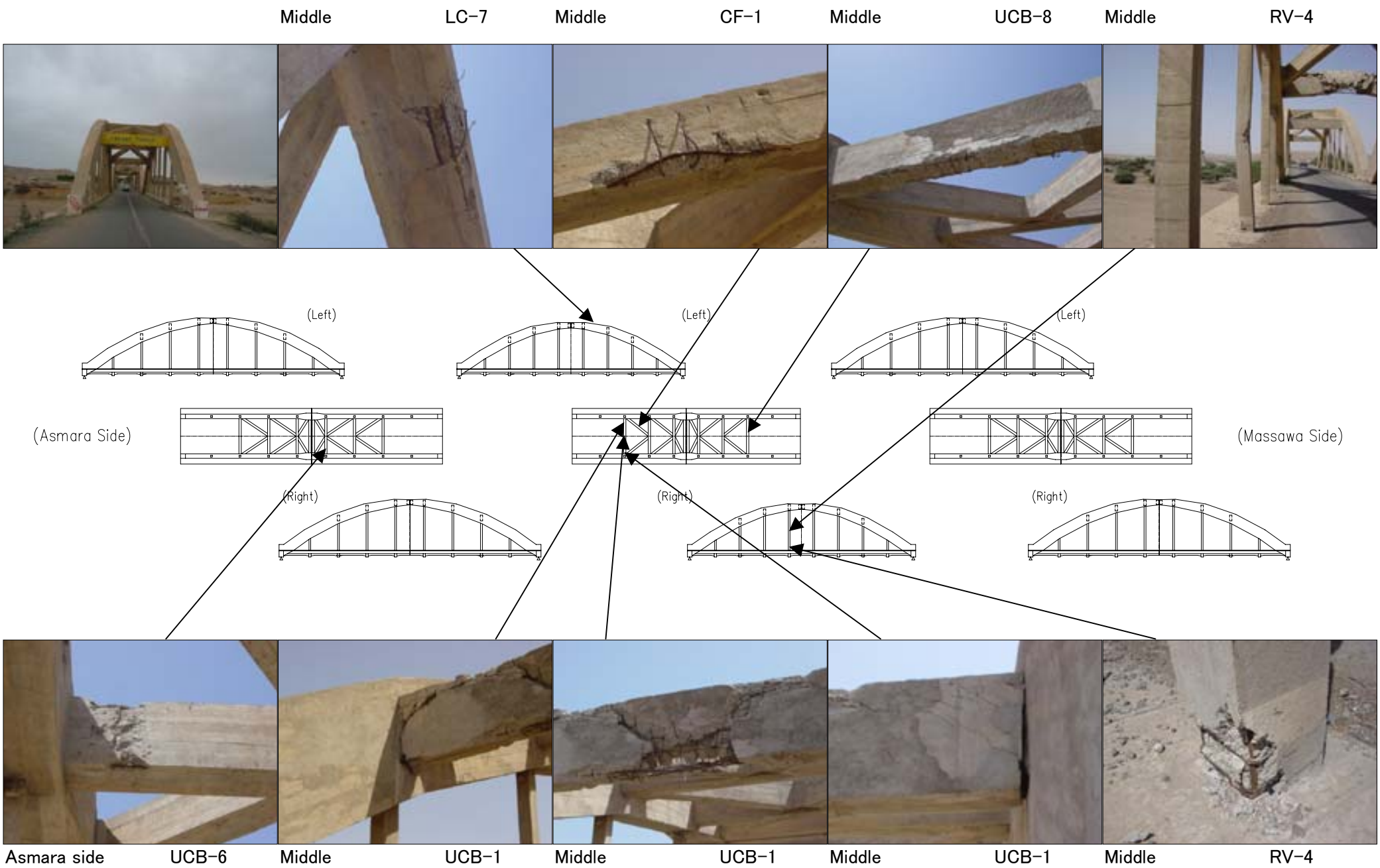
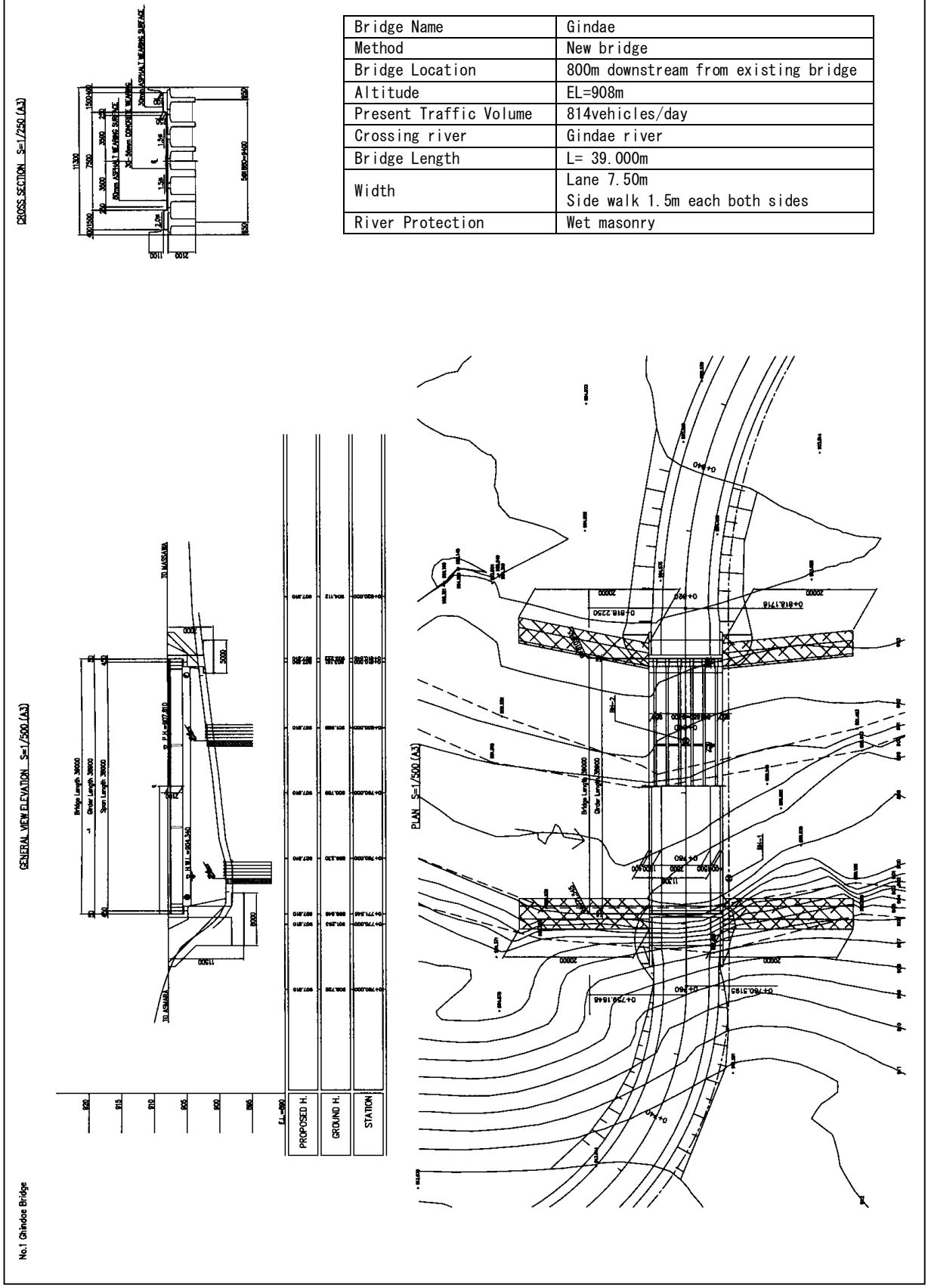


Figure 2.4 Actual Bridge Condition of Emculu Bridge





Bridge Name	Gindae
Method	New bridge
Bridge Location	800m downstream from existing bridge
Altitude	EL=908m
Present Traffic Volume	814vehicles/day
Crossing river	Gindae river
Bridge Length	L= 39.000m
Width	Lane 7.50m Side walk 1.5m each both sides
River Protection	Wet masonry

Figure 2.5 Basic Design Drawing for Gindae Bridge

Bridge Name	Gahtelay 1
Method	Replacement of Superstructure
Bridge Location	Existing bridge
Altitude	EL=314m
Present Traffic Volume	593vehicles/day
Crossing river	Sabarugum river
Bridge Length	L= 29.900m
Width	Lane 7.50m Side walk 1.5m each both sides
River Protection	Wet masonry

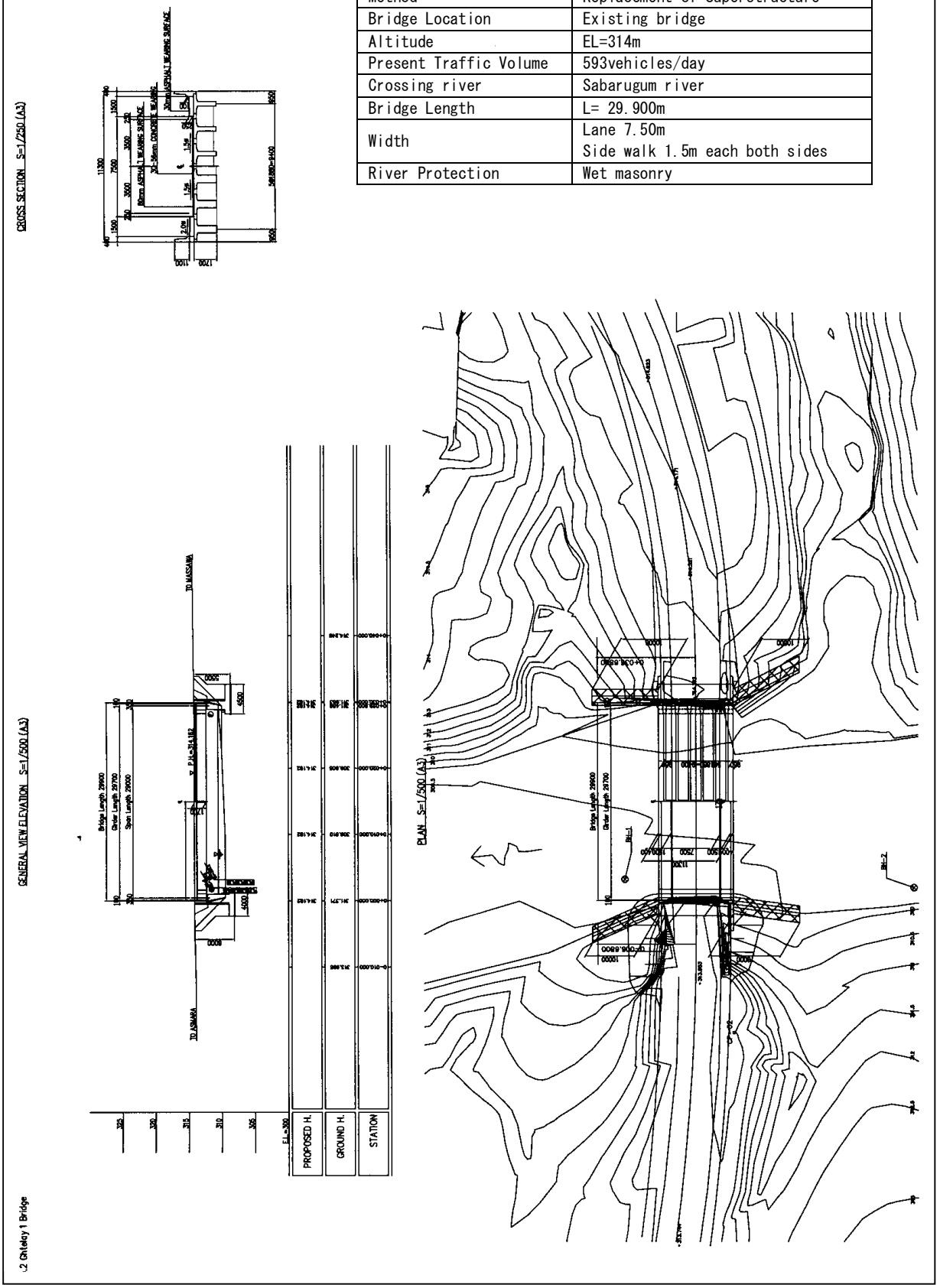


Figure 2.6 Basic Design Drawing for Gahtelay 1 Bridge

Bridge Name	Dogali 1
Method	Repair of damaged member
Bridge Location	―――
Altitude	EL=103m
Present Traffic Volume	593vehicles/day
Crossing river	Dogali river
Bridge Length	L=139.400m
Width	Lane 6.20m Side walk 1.8m each both sides
River Protection	―――

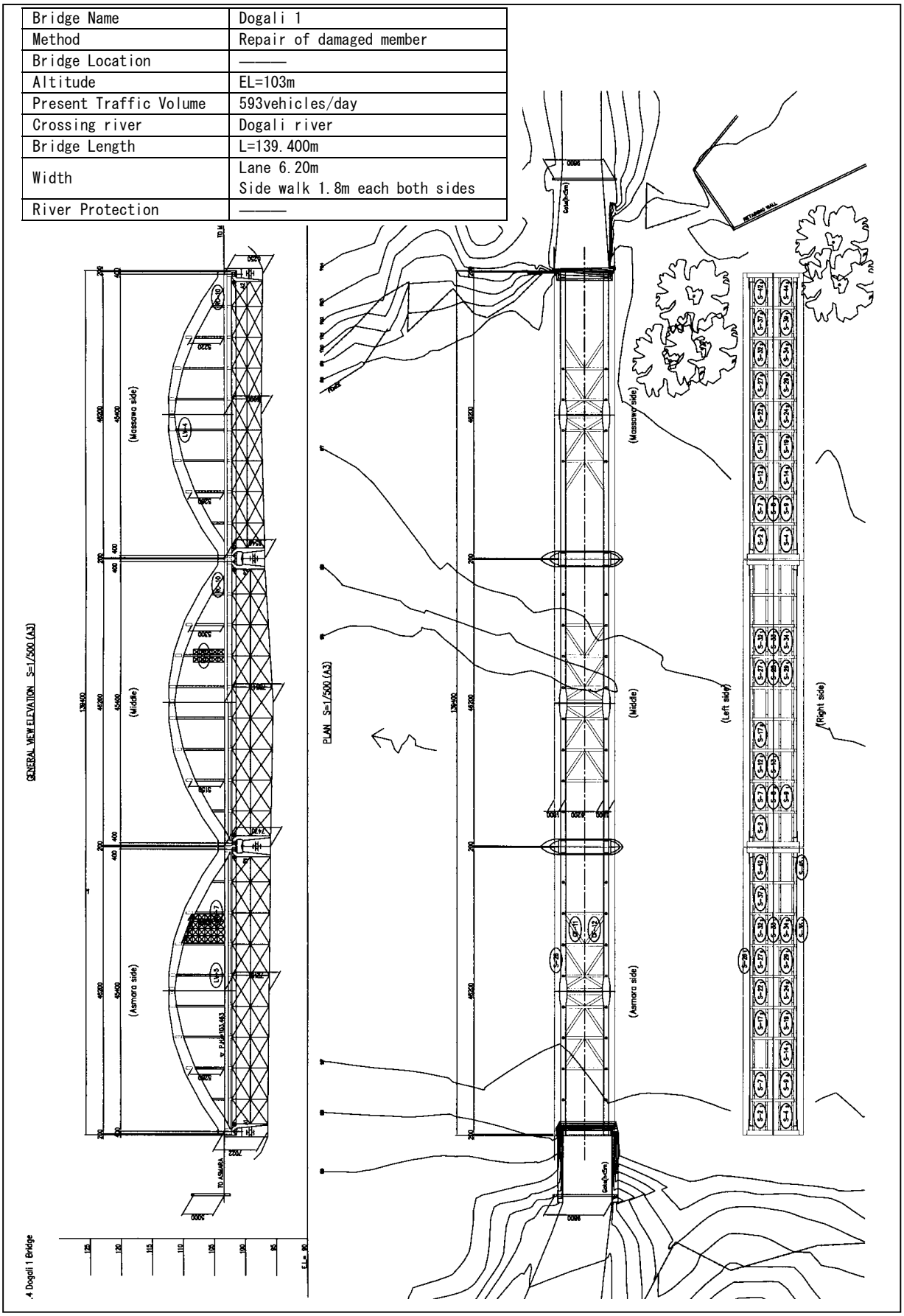


Figure 2.7 Basic Design Drawing for Dogali 1 Bridge

Bridge Name	Dogali 2
Method	New bridge
Bridge Location	Upstream 20m
Altitude	EL=95m
Present Traffic Volume	593vehicles/day
Crossing river	Wazipu river
Bridge Length	L= 34.900m
Width	Lane 7.50m Side walk 1.5m each both sides
River Protection	Wet masonry

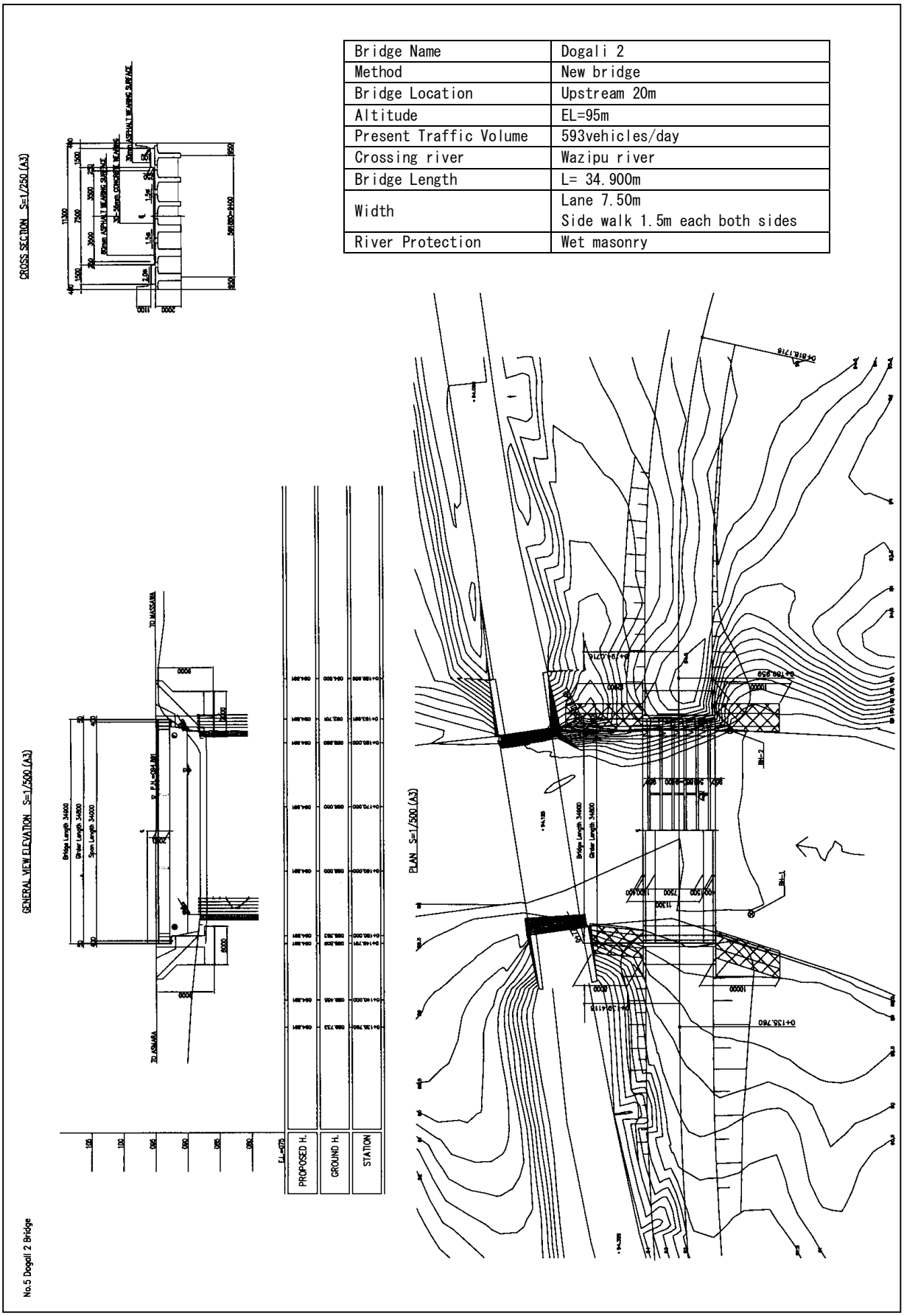


Figure 2.8 Basic Design Drawing for Dogali 2 Bridge

Bridge Name	Emculu
Method	Repair of damaged member
Bridge Location	―――
Altitude	EL=37m
Present Traffic Volume	593vehicles/day
Crossing river	Over river
Bridge Length	L=132.300m
Width	Lane 6.20m Side walk 1.8m each both sides
River Protection	―――

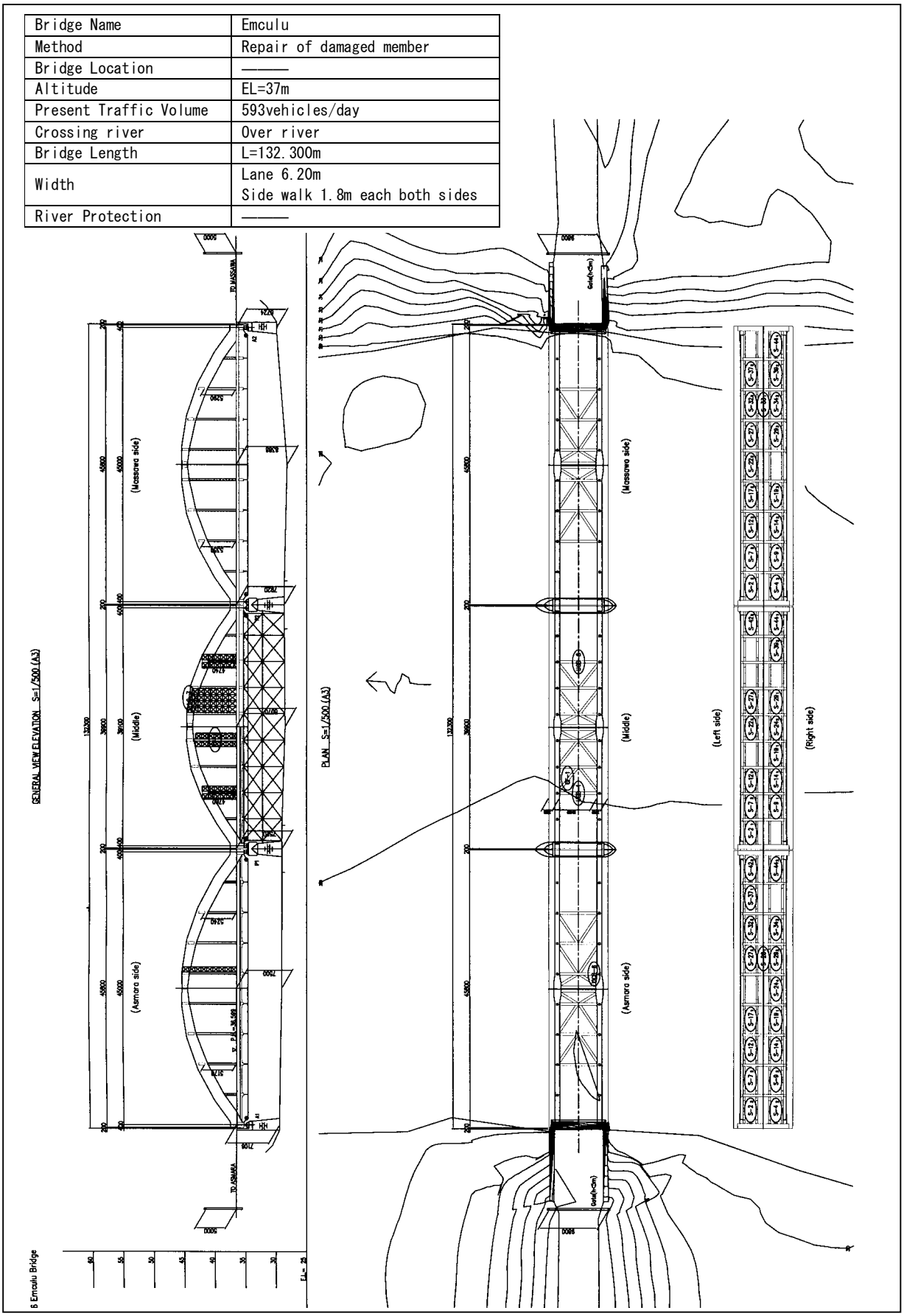


Figure 2.9 Basic Design Drawing for Emculu Bridge

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The following implementation policies are introduced, taking into account that the project has to be implemented under the Japan's Grant Aid Scheme.

- To maximize the use of local labour, materials and equipment in Eritrea so as to increase employment opportunities, to facilitate technology transfer and to provide positive impact to the local economy.
- To establish good communication between the Government of Eritrea, the consultant and the contractor for the project implementation to be as smooth as possible.
- To prepare a practical construction plan taking into account the local rainfall pattern, period required for materials and equipment procurement and application of appropriate construction methods.
- To keep constantly a close relationship with the organization engaged in demining in order to facilitate the communication with each other.

2-2-4-2 Implementation Condition

Special considerations for the project implementation are as follows.

(1) Labour Law

The contractor shall administer labour properly under adequate safety control and prevent conflict with local labour by observing the prevailing government laws in Eritrea.

(2) Environmental Sustainability

The construction works of the Project should minimize any adverse impact factors such as disposal of excavated soil, dust and water pollution during embankment and removal of existing bridge in order to maintain the present environmental condition. For the Gindae bridge especially, the environmental management plan described in the EIA report should be followed.

(3) Religious and Local Restriction

Besides national and public holidays, there are religious or local traditional holidays in Eritrea. These holidays have to be taken into account in the workable days.

(4) Customs Clearance of Import Items

The construction plan should be established taking into consideration of time needed for unloading, custom clearance, inland transportation, etc.

(5) Pubic Traffic Diversion during Construction

During construction, public traffic control such as direction of vehicles and pedestrians and notices for the awareness of possible detours have to be managed by the Government of the State of Eritrea for the security of the construction site.

(6) Land Acquisition

An advance agreement and compensation etc. related to the land acquisition should be cleared properly by Eritrean side.

(7) Adjustment of construction schedule

Work progress in Gindae bypass to be reported by Government of the State of Eritrea should be monitored.

2-2-4-3 Scope of Works

The scope of works to be undertaken by the Japanese and Government of the State of Eritrea respectively is as follows.

(1) Works and Facilities to be provided by the Japanese Government

1) Construction of Facilities

- Construction of facilities as per section "2-2-2 Basic Plan" of this report.
- Traffic safety facilities in connection with the above.
- Development of temporary construction yards (plant and material yards, site offices, etc.)

2) Procurement of Equipment and Materials

Equipment and materials required for building the bridges as per sub-section "2-2-4-6 Procurement Plan"

3) Safety Measure

Safety control and safety measures required for the execution of construction works.

4) Consulting Services

Detailed design, preparation of tender documents, assistance to the Government of the State of Eritrea for tender proceedings, and construction supervision as per sub-section "2-2-4-4 Consultant Services"

(2) Works and Facilities to be provided by Government of the State of Eritrea

1) Obtaining Construction Permit

Before distributing the tender documents to the prospective tenderers, a construction

permit has to be obtained from the Ministry of Public Works.

2) Demining survey and removal

When a contractor designates temporary construction yards outside the project area where the demining has been confirmed, the demining survey and removal should be executed before the commencement of construction works.

3) Construction of detours, connection roads and protection dike

Execution of works as per "2-3 Obligations of Recipient Country"

4) Others

- Issue visas, resident permits and other privileges to Japanese nationals and other personnel from any third countries necessary for the execution of the Project.
- Exempt taxes and other levies imposed by Government of the State of Eritrea for the consultant and contractor.
- Designate managing counterparts and allocate budget for their transport, and other expenses.

2-2-4-4 Consultant Supervision

(1) Schedule of Consulting Services

The project should commence with the signing of Exchange of Notes (E/N) between the two Governments (Japan and Eritrea) regarding the detailed design and preparation of tender documents of the Project. After the signing of E/N, JICA will issue a recommendation letter to the Ministry of Public Works, and then the contract for the said consulting service shall be concluded between the Ministry of Public Works and the Japanese consultant. After completion of the consulting services of the detailed design stage, E/N concerned with the construction shall be concluded and the contract for the services of the tender stage and construction supervision stage shall also be concluded between the Ministry of Public Works and the consultant. The consultant will provide the following consulting services within the limits of the Japan's Grant Aid:

1) Detailed Design and Preparation of Tender Documentation Stage

Detailed design, which includes the following outputs, should be conducted for the facilities based on the Basic Design Study Report. Finally, tender documents will be prepared for the approval of the department of infrastructure of the Ministry of Public Works.

- Design report
- Drawings

- Tender documents

2) Tender Stage

The department of infrastructure of the Ministry of Public Works will select a successful tenderer and conclude the construction contract with him through a competitive tender method among Japanese construction firms. Representatives from the Government of the State of Eritrea responsible for this procedure should consist of contractual officer and technical officer. The consultant should assist the department of infrastructure to conduct the following:

- Bid announcement
- Pre-qualification of contractors
-Tender and tender evaluation, and Contract negotiation

3) Construction Supervision Stage

After obtaining the verification of the construction contract from the Ministry of Foreign Affairs of the Government of Japan, the consultant will issue a Notice to Proceed to the contractor and then construction supervision shall begin.

The consultant within his capacity as the Engineer should directly report to the department of infrastructure of the Ministry of Public Works about the filed activities, and should issue field memoranda or letters to the contractor, if necessary, regarding the various matters including progress, quality, safety and payment for the Project. In addition, the consultant should report to the Embassy of Japan in Kenya and the JICA Kenya Office when required.

The defects liability period expires on the date one year after the completion of the Project. At the end of the defects liability period, defects liability inspection will be conducted as the final work of the consulting services.

(2) Staffing

The required staff and their responsibilities in the detailed design, tender and construction stages are described below:

1) Detailed Design and Tender Document Preparation

The consultant team headed by the Project Manager will conduct the design of the facilities. The services in this stage include the preparation of the tender documents. Taking into account of implementation under the Japan's Grant Aid System, the following items should be considered in the preparation of the tender documents.

- The forms of the instruction of tender and agreement should be followed by the

Guideline for the Japan's Grant Aid.

- The technique specification documents should be prepared in order to secure enough quality in due consideration of the Eritrean specification.

The preparation of tender document will be mainly conducted by the engineers who understand well the contents of the basic design study and detailed design.

2) Tender Stage

- Project Manager : Responsible for all the aspects of the tendering
- Tender Specialist : Responsible for the review of the tender document, bid announcement, tender and tender evaluation.
- Tender Assistant : Responsible for the review of the tender documents and drawings for assistance1 to the Tender Specialist.

3) Construction Stage

- Project Manager : Responsible for all the aspects of consulting services during the construction stages.
- Resident Engineer : Responsible for all the aspects of supervision at the sites.
- Bridge Engineer : Responsible for bridge building works.
- Environmental Expert : Responsible for confirmation of environmental issues.

(3) Construction Plan

1) Temporary Works

In consideration of scattered construction sites, construction yard should be in a place near Dogali 2 bridge site and Gindae bridge site. Plant and material yards, offices, storages and other facilities should be located in the construction yards. The approximate area of each construction yard will be about 7,500m2, which will be covered by the funds of the Eritrean side. The conceptual location (subject to change to site condition) plans of the respective construction yards are shown in Figure 2.10.

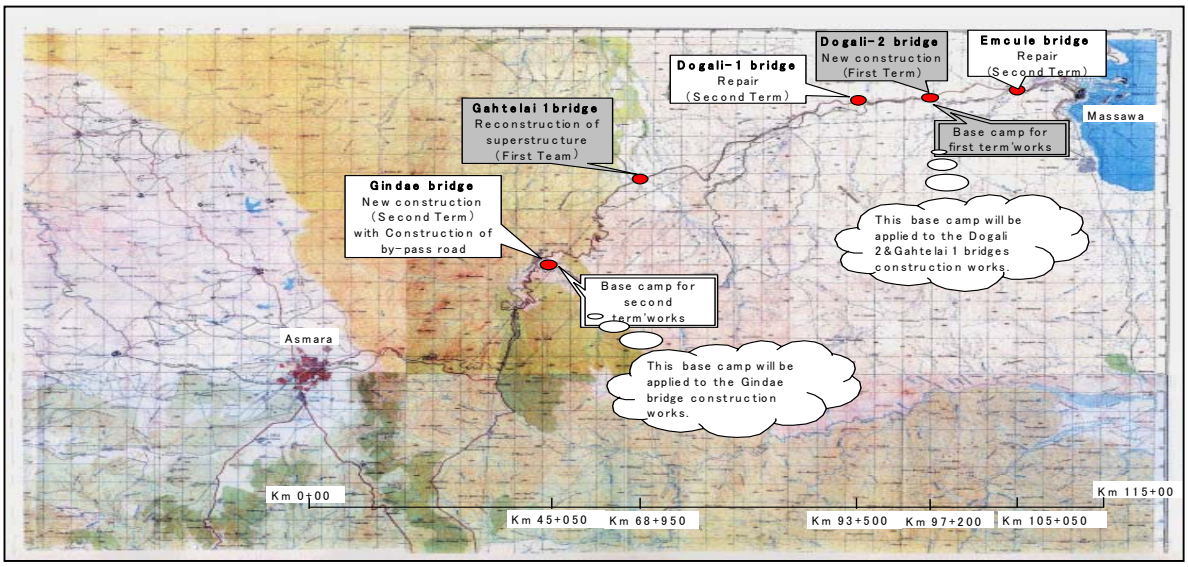


Figure.2.10 General Location Plan of Construction Base Camp

The detail layout plans of the respective construction yards are given as bellows.

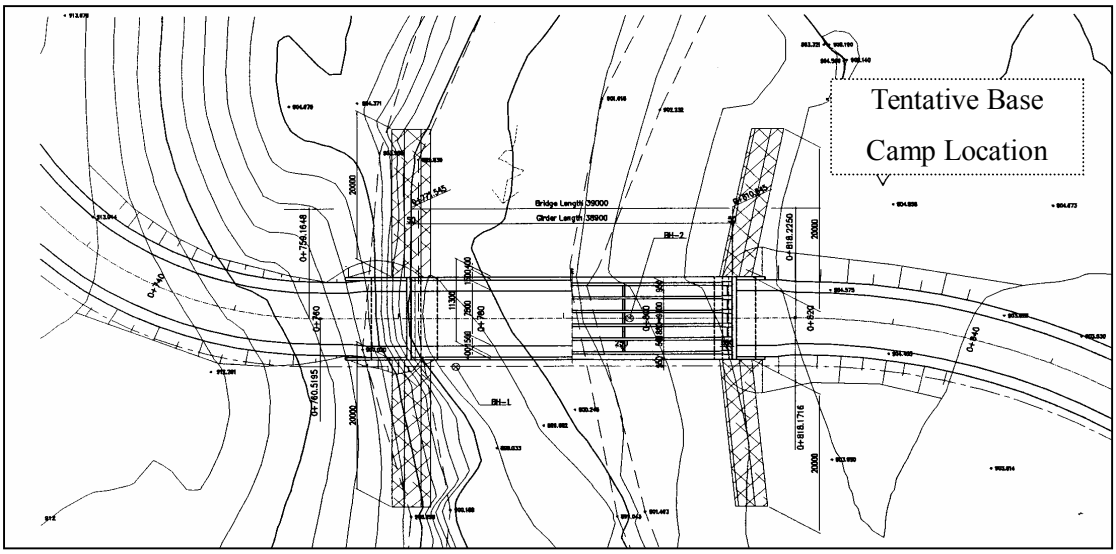


Figure 2.11 Location Plan of Base Camp in Gindae Bridge Construction Site

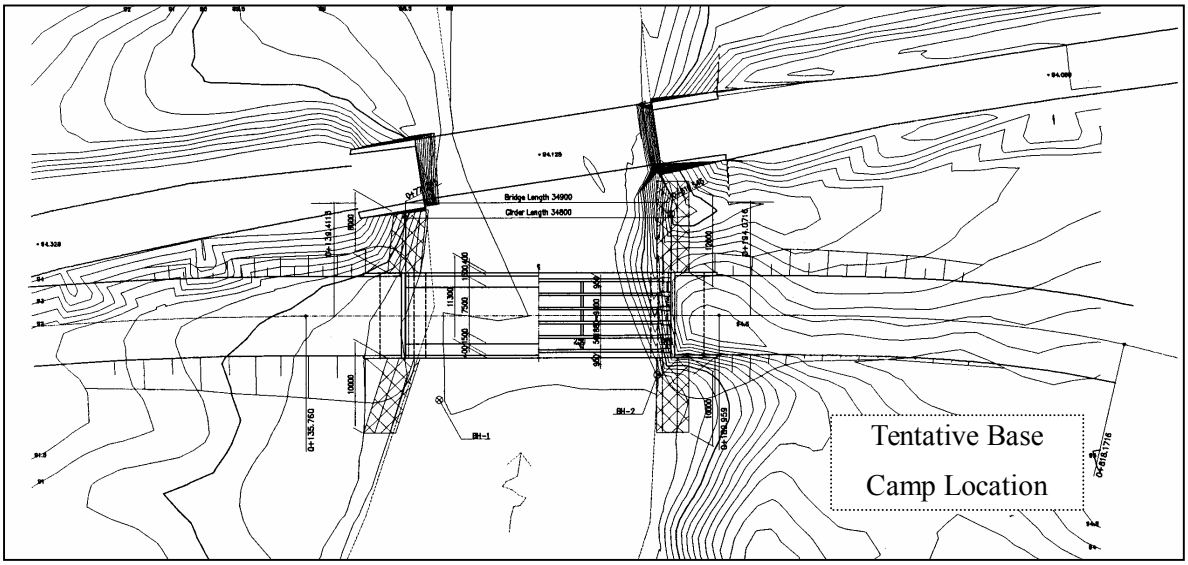


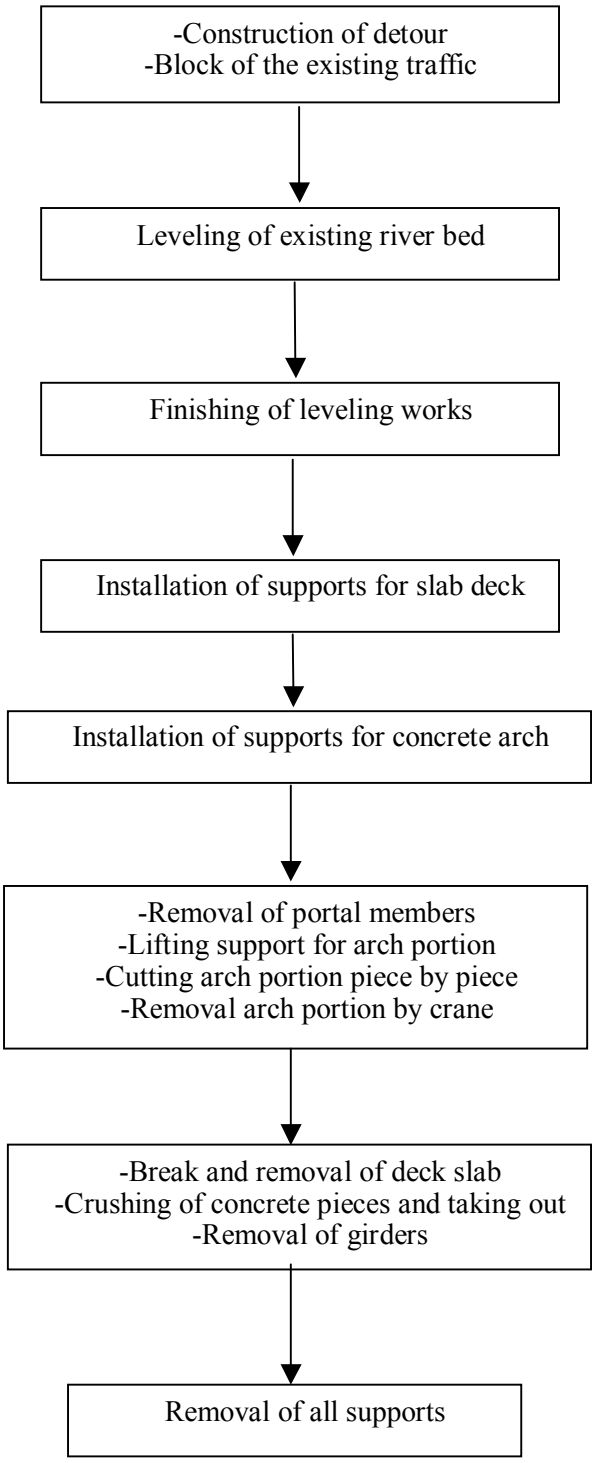
Figure 2.12 Location Plan of Base Camp in Dogali 2 Bridge Construction Site

2) Construction Works

① Construction Order

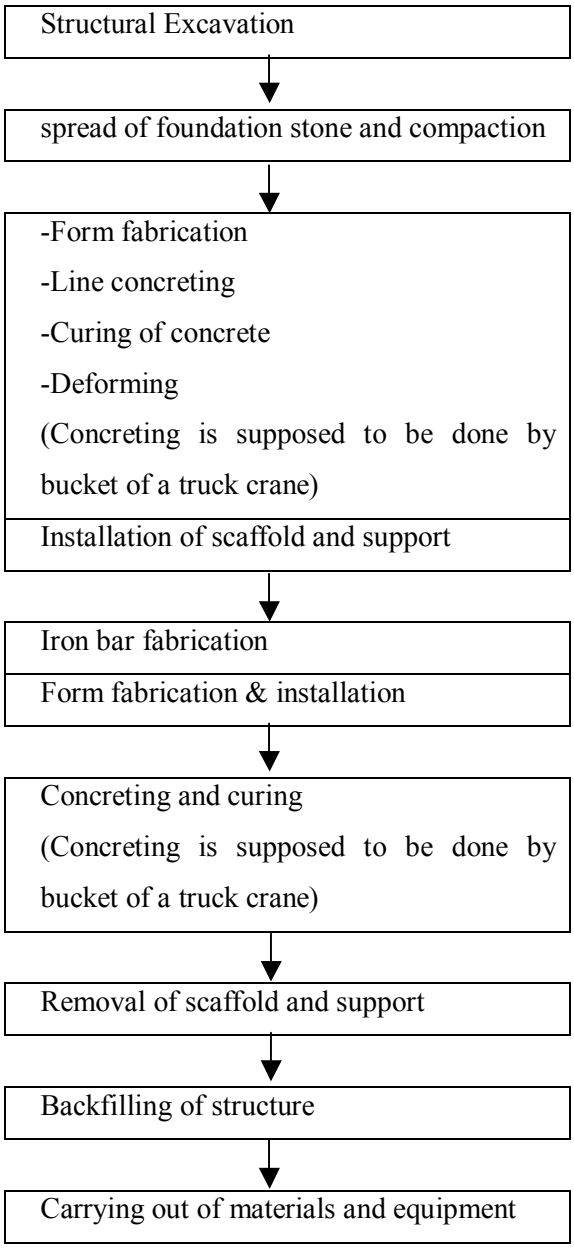
- Procedure of the demolition works

Procedure of the demolition works for the existing superstructure of Gahtelay 1 is shown as below.



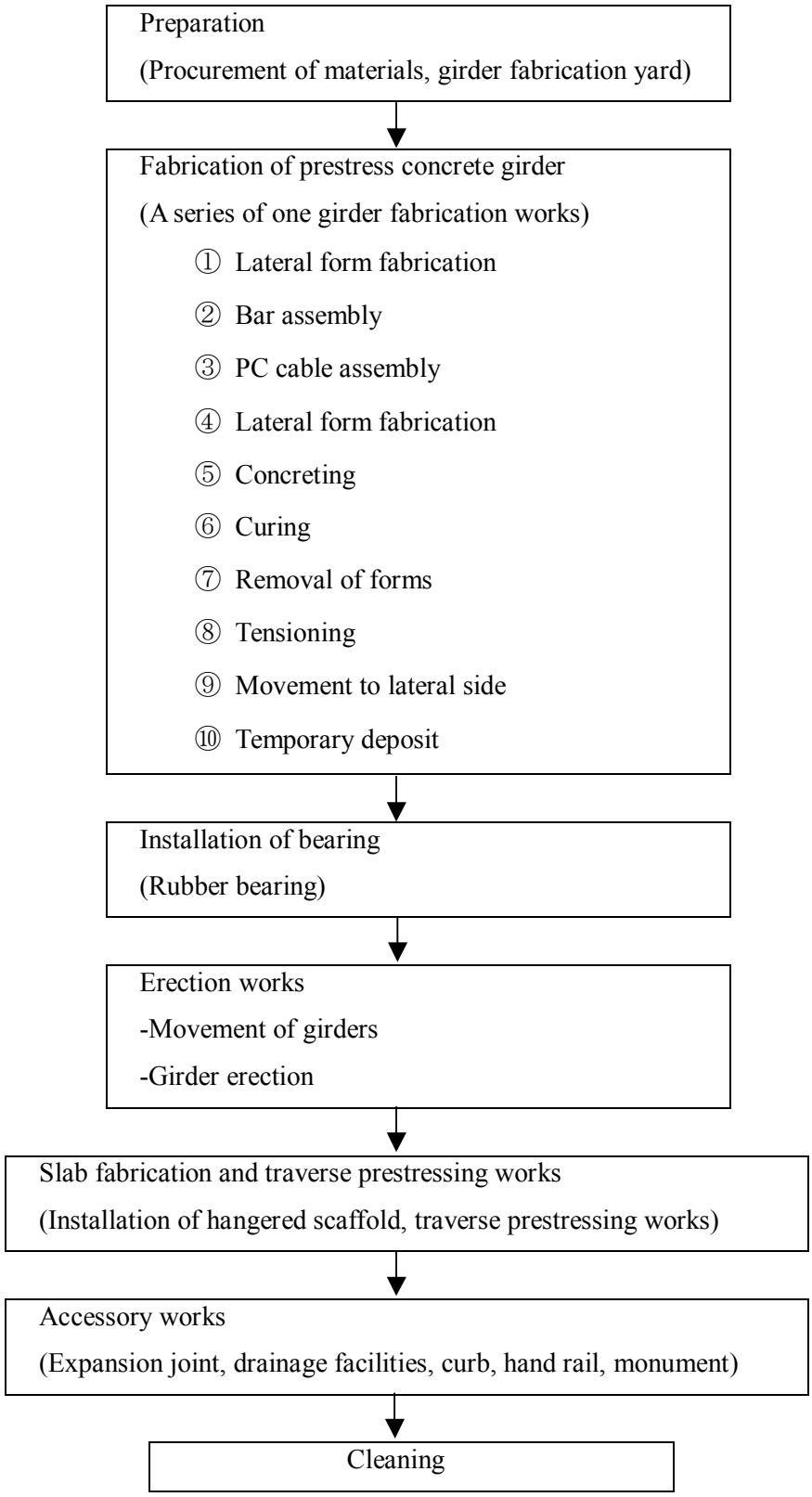
- Construction Procedure of substructure

Procedure of construction of substructure is shown in the following diagram.



-Construction Procedure of superstructure (Pre-stress concrete bridge)

Procedure of construction of superstructure (pre-stress concrete) is shown in following diagram.



②Supervision

Involvement of Eritrean firms in the Project should be considered as much as possible. In this regard the Japanese construction firm should be responsible for supervising the quality control and progress control of the works by Eritrean ones.

2-2-4-5 Quality Control Plan

The quality control plan is formulated on the basis of the design concept as shown in Table2.9.

Table 2.9 Quality Control Tests Plan

Item			Test Method	Frequency
Crushed Rock Base	Mixed Material		Liquid Limit, Liner Shrinkage	Every mixing
			Sieve Gradation	
			TFVsoaked & TFV dry	
			Aggregate Density	
			Maximum Dry Density	
	Paving		Field Density (Compaction)	Daily
Prim Coat & Tack Coat	Material	Bitumen	Quality Certificate	
			Storage and Spraying Temperature	Every Truck
Asphaltic Concrete	Material	Bitumen	Quality Certificate & Chemical Analysis	Every material
		Aggregate	Sieve Gradation	Every mixing
			Water Absorption	Every material
			TFVsoaked & TFV dry	
	Mix Requirements		Marshall Stability	Every mixing
			Marshall Flows	
			Air Voids	
			Voids in Mineral Aggregate : VMA	
			Indirect Tensile Strength	
			Immersion (Strength) Index	
			Bitumen Content	
	Paving		Max. Temperature of Asphalt at Mixing	If any
			Temperature for Compaction	Every truck

Item			Test Method	Frequency
Concrete	Material	Cement	Quality Guarantee, Chemical & Physical Analysis	Every material
		Water	Chemical Analysis	Every material
		Admixture	Quality Guarantee, Chemical Analysis	Every material
		Fine Aggregate	Bulk Specific Gravity Dry	Every material
			Sieve Gradation, Finesse Modulus	
			Clay and Friable Particles	
		Coarse Aggregates	Bulk Specific Gravity Dry	Every material
			Sieve Gradation	
	Mixing Test		Compressive Strength at 7 days & 28 days	Every mixing
	Casting		Slump (Concrete) Air Content Concrete Temperature before Casting	Daily Daily Daily
	Strength		Compressive Strength at 7 days & 28 days	Daily or >50m3
Re-bar	Material		Quality Certificate	Each lot
Bearing	Material		Quality Certificate, Mechanical Tests	Each lot
PC cable etc.	Material		Quality Certificate, Mechanical Tests	Each lot

2-2-4-6 Procurement Plan

(1) Procurement of Construction Materials

An indicative procurement schedule of major materials is shown in Table 2.10.

Table 2.10 Indicative Procurement Schedules of Materials

Item	Eritrea	Japan or Third Countries
Cement		O
Rebar		O
PC cable etc.		O
Bearing, Expansion joint		O
Asphalt, Fuel and Lubricant	O	

(2) Procurement of Construction Equipment

An indicative procurement schedule of major construction equipment is shown in Table 2.11.

Table 2.11 Indicative Procurement Schedule of Construction Equipment

Item	Capacity Spec.	Eritrea	Japan
Backhoe	0.6 m^3	○	
Giant Breaker	500~800kg	○	
Bulldozer	20t	○	
Dump Truck	10t	○	
Concrete Mixer	3.1 m^3		○
Tamper	100kg	○	
Vibration Roller	10t	○	
Truck Crane	16t		○
Crawler Crane	45t	○	
Tractor Shovel	0.3 m^3	○	
Concrete Plant	0.5 m^3		○
Concrete Mixer	0.2 m^3		○
Concrete Breaker	-	○	
Motor Grader	3.Im	○	
Tire Roller	8-20t	○	
Road Roller	10t	○	
Asphalt Finisher	2.5~5.0m	○	

The reason for procurement from Japan of the import supply machine (a concrete plant (0.5 m^3), concrete mixer truck (3.3 m^3 classes), truck crane (16 tons class)) is as below.

①As for a concrete plant and concrete mixer trucks, lease machine are not available and there is no fresh concrete supply company. That is the reason why these machines will be procured in the third country. In the case of western country's project, the contractors import the machinery by himself, otherwise procure it from local contractor directly. In such a condition, Japanese's machines have more advantages from the view point of the parts supply, the price and so on, comparing to the third country's products. Therefore, in consideration of bringing in the machine of the local contractor's possession, procurement from Japan is judged more suitable based on reliability of execution efficiency, safety and quality.

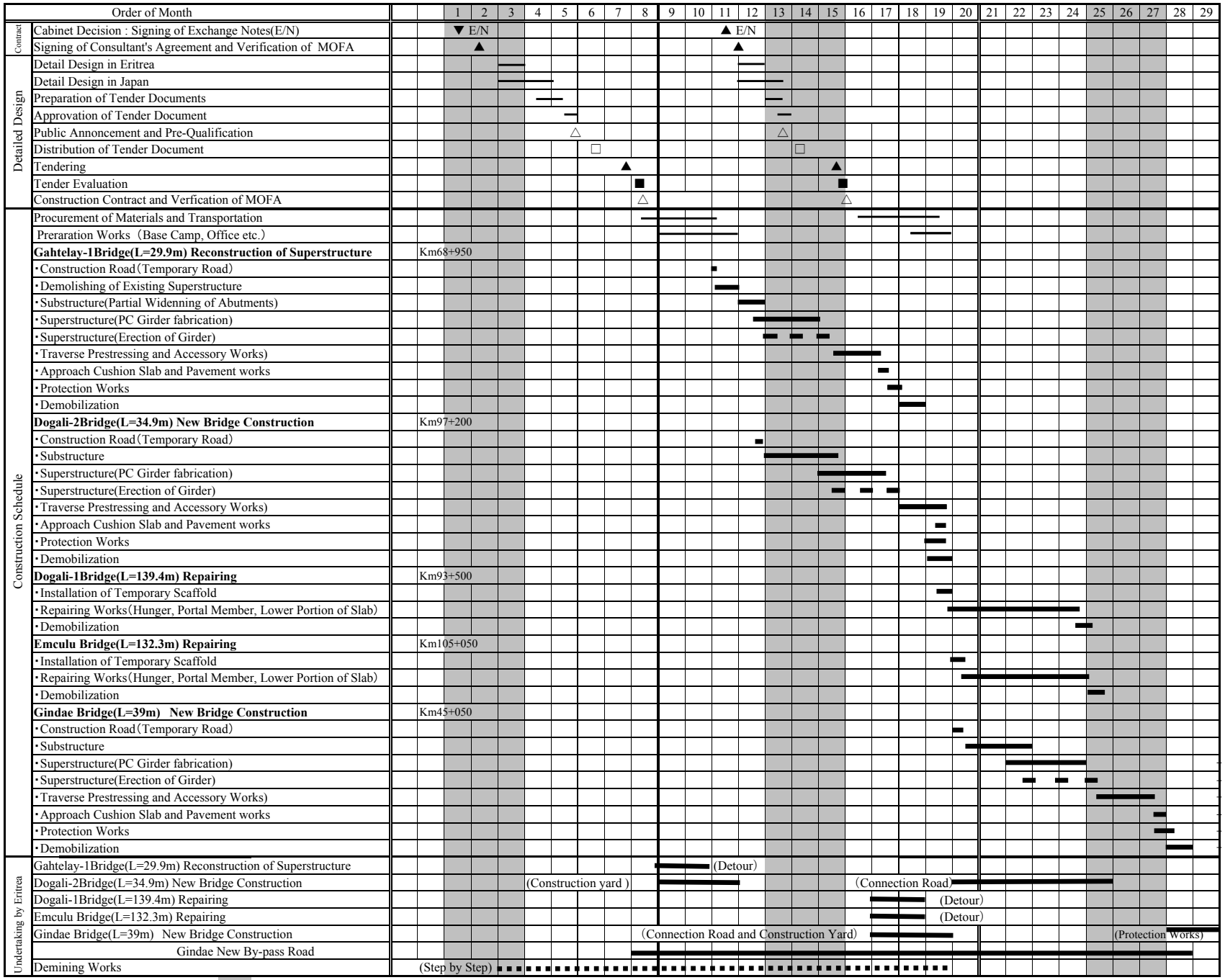
②As for truck crane (16 tons class), though it can be leased, it was reveled that leasing a truck crane (of 16 ton class) throughout the construction period of 21 months is difficult. Therefore the supply from the third country is examined. In the same way as the above, procurement from Japan is judged more suitable than from the third country on the basis of the reliability of execution efficiency, safety and quality.

2-2-4-7 Implementation Schedule

The tentative implementation schedule for the project is prepared as shown in Table 2.12 taking into account the procedure of the Japanese Grant Aid Scheme.

As the project is implemented in two terms, E/N, consultant agreement and construction contract will be proposed and concluded each term.

Table2.12 Implementation Schedule



Remark : Rainy Period in Gindae: August to Octobre

2-3 Obligations of Recipient Country

2-3-1 Common Items of Japan's Grant Aid Scheme

Common items of undertakings by Eritrea were already discussed and confirmed in the Minutes of Discussions. Nevertheless, general items are reproduced in the following for reference purposes:

- To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction.

- To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites.

- To ensure all the expense and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid.

- To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the verified contracts.

- To accord Japanese nationals, whose services may be required in connection with supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

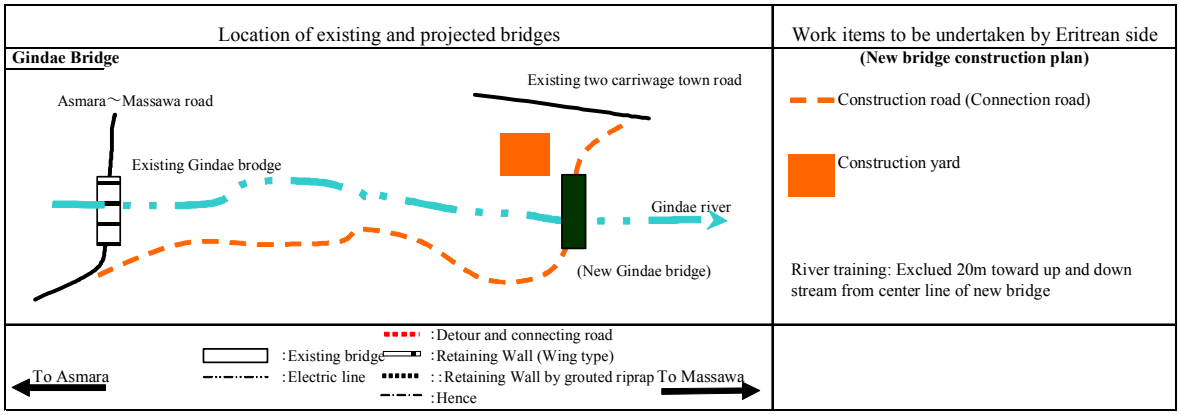
2-3-2 Special Items of the Project

2-3-2-1 Construction works to be undertaken by Eritrea

Construction works to be undertaken by Eritrea are shown in the following Table2.13~17.

(1) Gindae Bridge (Altitude:900m, 45km from Asmara, 65km from Massawa)

Table 2.13 Work Items to be Undertaken by Eritrean Side (Gindae Bridge)

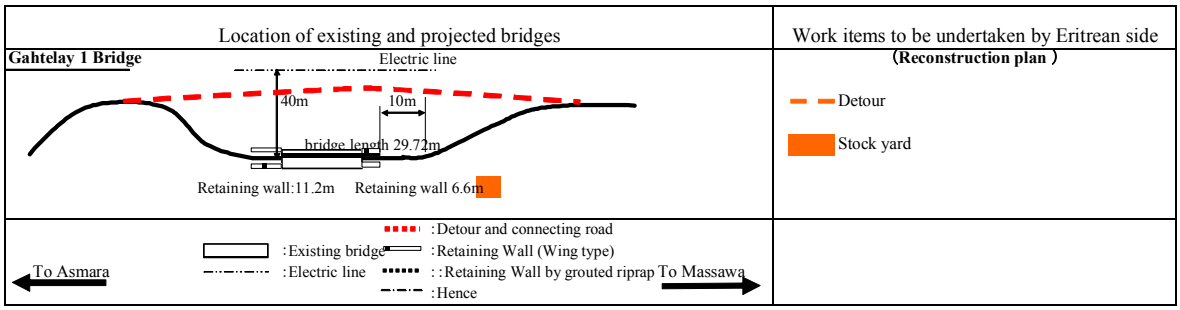


The construction road, river training work and construction yard development should be undertaken by Eritrean side. About 280 m of construction road is needed for new bridge construction works. As this construction road will be used as the connection road after the termination of bridge works, the height of the construction road should be raised up to the same height of the bridge surface. The river training works should be performed as soon as possible after the completion of bridge works upon the agreement of Government of the State of Eritrea. The quantities of major works quantities are approximately calculated as below.

Works	Items	Unit	Quantity
Earth works and pavement works	Clearing	M^2	4,232
	Cut	M^2	494
	Fill	M^3	4,088
	Sub base course (20cm)	M^3	420
	Base course(15cm)	M^3	294
	Sub grade formation	M^2	2,800
River Training	Core compacted river deposit	M^2	43.3
	Gravel blanket (20cm)	M^3	154.7
	Loose boulder apron	M^3	229.6
	Grouted Riprap	M^3	584.7
Construction yard	Clearing	M^2	7,500
	Leveling	M^2	7,500

(2) Gahtelay 1 Bridge (Altitude:300m, 69km from Asmara, 41km from Massawa)

Table 2.14 Work Items to be Undertaken by Eritrean Side (Gahtelay 1 Bridge)

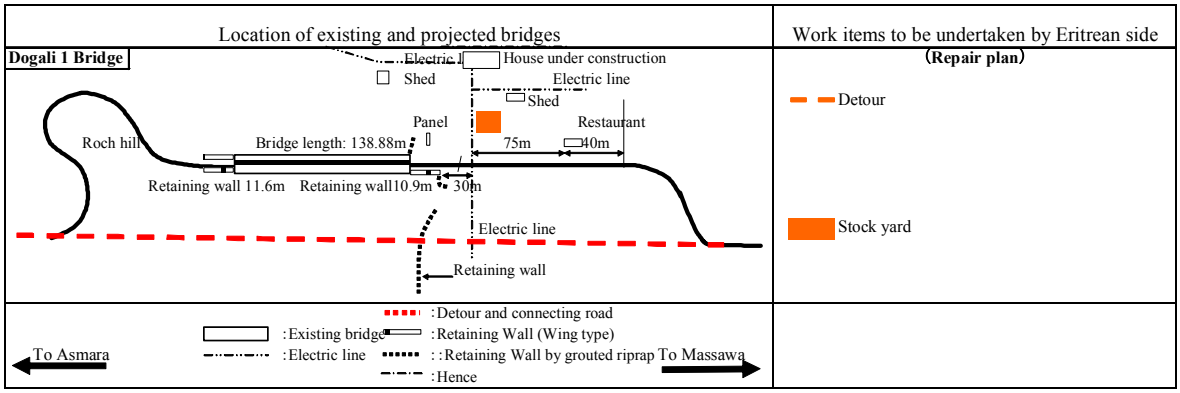


The actual traffic should be diverted during the construction works. Although a 500 meter one lane earth road at the upper stream side exists as a detour, it should be improved before the commencement of the bridge works in order to secure the safe passing of the low bed vehicles and heavily loaded trucks. Major works quantities are approximately calculated as below.

Works	Items	Unit	Quantity
Detour leveling	Fill by selected materials and compacting	M^3	2,500
Stock yard	Clearing	M^2	900
	Leveling	M^2	900

(3) Dogali 1 Bridge (Altitude:100m, 94km from Asmara, 16km from Massawa)

Table 2.15 Work Items to be Undertaken by Eritrean Side (Dogali 1 Bridge)

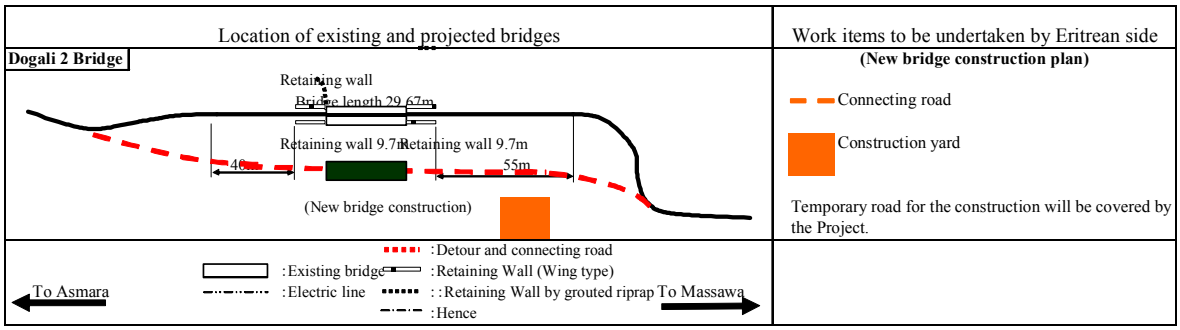


The actual traffic should be diverted during the repair works. But no existing road as a detour can be found in the vicinity of Dogali 1 bridge and the construction of a detour will be needed on the lower stream side for smooth construction. The earth works will be required for the detour development. Major works quantities are approximately calculated as below.

Works	Items	Unit	Quantity
Detour development	Cut	M^3	680
	Fill	M^3	6,390
	Fill by selected materials and compacting	M^3	2,000
Stock yard	Clearing	M^2	900
	Leveling	M^2	900

(4) Dogali 2Bridge (Altitude:95m, 97km from Asmara, 13km from Massawa)

Table 2.16 Work Items to be Undertaken by Eritrean Side (Dogali 2 Bridge)

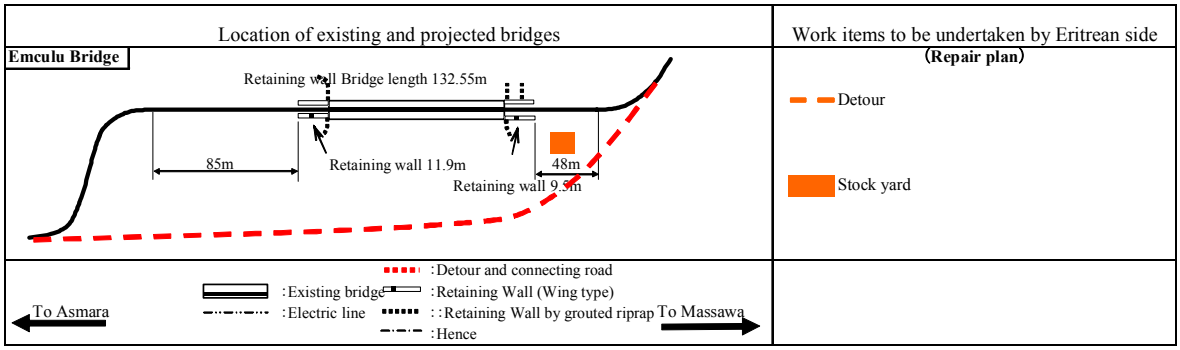


The new bridge will be constructed at 20m upper stream side from the existing bridge. The new bridge should be connected to the new connection road. That connection road's construction should be undertaken by Government of the State of Eritrea. The total length of the connecting road is 370m, excluding the bridge portion. Major works quantities are approximately calculated as below.

Works	Items	Unit	Quantity
Earth works	Cut	M^2	1,360
	Fill	M^3	2,830
	Fill by selected materials and compacting for sub grade	M^3	3,040
	Removal of cut soil	M^3	1,360
Pavement works	Sub base course (20cm)	M^3	2,950
	Base course(15cm)	M^3	2,790
	Binder course (5cm)	M^3	2,670
	Wearing course (3cm)	M^3	2,610
Protection works	Gravel blanket (20cm)	M^3	47
	Grouted Riprap	M^3	117
Construction yard	Clearing	M^2	7,500
	Leveling	M^2	7,500

(5) Emculu Bridge (Altitude:40m, 105km from Asmara, 5km from Massawa)

Table 2.17 Work Items to be Undertaken by Eritrean Side (Emculu Bridge)



The actual traffic should be diverted during the repair works. Existing one lane rough earth road on the upper stream side has about 800m in length as a detour, and it should be developed before the commencement of the bridge works in order to secure the safe passing of all the vehicles. Major works quantities are approximately calculated as below.

Works	Items	Unit	Quantity
Detour leveling	Fill by selected materials and compacting	M^3	4,000
Stock yard	Clearing	M^2	900
	Leveling	M^2	900

2-3-2-2 Other items to be undertaken by Eritrea

Apart from the construction works, the other works which should be undertaken by Eritrean side are given below

(1) Land Acquisition

Among objective bridges, land acquisition for the connecting road of Gindae and Dogali 2 bridges is needed. Land compensation should also be managed by Government of the State of Eritrea for the construction yard.

(2) Demining

Government of the State of Eritrea should make necessary arrangement of the demining works, if required.

(3) Assistance in necessary procedure for the Project

Necessary coordination will be needed to formulate the required procedures, such as construction permit etc.

2-4 Project Operation Plan

The Project features are mainly divided into two category of works: one is construction of new bridges and the other is repair of bridges. For each category, project operation plan is explained as follows.

(1) Project operation plan regarding newly constructed bridges

As the type of superstructure for newly constructed bridges (Gindae bridge, Gahtelay 1 bridge and Dogali 2 bridge) is prestressed concrete T girder, maintenance work on this type of bridge is described as follows;

1) Maintenance work required annually
   - removal of sand or rubbish at expansion joint and drainage including its work records
   - inspection of gabion around abutment, especially Gindae bridge, and immediate repair works for damaged gabion after rainy season
   - inspection and recording of gap between bridge deck and approach road on the abutment
2) Maintenance work required every three years
   - inspection and recording around rubber shoes
3) Inspection at emergency
   - inspection of shoes after earthquake including its record

(2) Project operation plan regarding bridges to be repaired

It is required for Dogali 1 and Emculu bridge to be well maintained and inspected.

1) Maintenance work required annually
   - removal of sand or rubbish at expansion joint and drainage
   - inspection of hanger including its record
   - visual inspection of the bottom of slab including its record
   - visual inspection of the member including its record
2) Maintenance work required every three years
   - repair work for the bottom of slab filling up with mortar
3) Inspection at emergency
   -inspection of shoes and anti-falling device after earthquake including its record
   -inspection of portal member when damaged by earthquake including its record

2-5 Cost Estimation

2-5-1 Project Cost

(1) Cost Estimate

The total cost of the Project by the Japanese Grant Aid is summarized in Table 2.18. This cost estimate is provisional and will be further examined by the Government of Japan for the approval of Grant.

Approximate Project Costs : Japanese Yen 647 million

Table 2.18 Approximate Project Costs

Item		Approximate Amount (million Japanese Yen)	
Facilities	Gindae Bridge	119	511
	Gahtelay 1 Bridge	75	
	Dogali 1 Bridge	109	
	Dogali 2 Bridge	124	
	Emculu Bridge	83	
Detailed design and Construction supervision			136

(2) Condition of Estimation

-Exchange rate : 1 us$＝J.Yen 108.21 (May, 2004)

-Project period : 29 months in total, executed in two term

-Others : *On condition that the Project is implemented under the Japan's Grant Aid Scheme

*The above-mentioned exchange rate is to be reviewed by Japanese Government

(3) Costs borne by Eritrean side

Approximate costs required for the undertaking of Eritrean side are shown in Table 2.19. This cost estimate is provisional.

Table 2.19 Approximate Costs to be borne by Eritrean side

Items	Cost (NKF)
Construction cost	5,040,000
Land acquisition cost	66,000
Cost for demining	12,000
Design and operation cost (5% of construction cost related to Dogali 2 connecting road)	137,000
Total	5,255,000

2-5-2 Project Maintenance Cost

Based on the maintenance work plan proposed in the previous section, the maintenance costs are approximately estimated as shown in Table 2.20.

Table 2.20 Approximate Maintenance Cost

Item	Works	Frequency	Approx. Costs(NKF)
Drain & joint	Check & cleaning	Every year	9,357
Slab and members	Check	Every year	6,238
Abutment	Check	Every year	6,238
Annual maintenance costs			21,833
Bearing	Check	Every 3 years	7,840
Slab	Check & repair	Every 3 years	209,951
Partial surface	Repair of pot hall	Every 3 years	35,315
Total maintenance cost in every 3 years			253,106
Total surface	Overlay	Every 8 years	695,010

On the basis of the above estimation, the annual costs to be required by Government of the State of Eritrea are estimated at about 21,833 NKF. The annual average cost for every 3 years' work is estimated at about 84,369 NKF and the 8 years' work is at about 86,876NKF. As a result, total required annual maintenance cost is approximately estimated at 193,078NKF for the Project, which is equivalent to 0.1% of the maintenance budget in 2004(220 million NKF) planned by the Ministry of Public Works. This maintenance cost for the Project is not a heavy burden for Government of the State of Eritrea. Therefore this maintenance work is doable.

Chapter 3 Project Evaluation and Recommendation

Chapter 3 Project Evaluation and Recommendation

3-1 Project Effect

The Table 3.1 below shows the results of this basic design study and the expected direct effects of the project implementation. The project is also expected to benefit the residents of the two regions of Maekel and S.K. Bahri and the total number of beneficiary is about 1.08 million.

Table 3.1 Effect of Project Implementation and Expected Improvement

Present condition and problems	Measures employed in this basic design study	Effect of the measures and degree of improvement
The five bridges selected for the basic design study lost their soundness due to aging and vehicle collision. Excessive passage of large vehicles cause breakage of structural parts and cracking of abutment. The bridges are used in such a dangerous state that the traffic can be interrupted any time.	Based on the evaluation of soundness of the targeted bridges, the rehabilitation work is planned in two types: reconstruction and repair.	The rehabilitated bridges are structurally reinforced. The repaired bridges will have prolonged lifespan unless over loaded trucks keep passing.
The effective width of the bridges is approximately 6m and are used as one-way lane to avoid collision. This condition causes traffic jam at the bridge.	For the newly reconstructed bridges and partly replaced bridges, 2-lanes road is planned.	The maximum retention time of 4 minutes will be reduced to 0.

In addition, the following are expected as indirect benefits:

- Increased reliability of transportation on Asmara-Massawa road contributes smooth delivery of commodities all over Eritrea leading to stabilization of the prices.
- PC reinforced concrete bridge is introduced for the first time in Eritrea by this project and its technology on bridge building and repair is transferred.
- The construction of Gindae bridge, since it is a part of regional development project, is expected to promote other development projects such as the bypass road construction.

3-2 Recommendations

This project aims at securing traffic safety on the Asmara-Massawa road by means of rehabilitating major bridges on the road. It directly contributes to the solution of traffic problems of the main trunk road that the Eritrea Government hopes to solve. Implementation of this project will require close coordination of the projects of both sides: the bridge rehabilitation project by grant-aid of Japan and related bypass road and civil works projects financed by Eritrea. In the course of the project implementation composed of detailed design and construction, it is recommended that the representatives from the two sides should remain in close contact with each other to better communicate and to exchange information on the details of their projects. Japan side should actively attempt the technical transfer to Eritrea side in the communication and information exchange. The technical transfer will be one step to progress this project favorably.