MINISTRY 0F PUBLIC WORKS
THE PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

No.

THE BASIC DESIGN STUDY
ON
THE PROJECT FOR CONSTRUCTION OF WADI GAZA BRIDGE
ON
ROAD NO.4
IN
THE GAZA STRIP

October 2000

JAPAN INTERNATIONAL COOPERATION AGENCY
ORIENTAL CONSULTANTS CO., LTD.

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PREFACE

In response to a request from Palestinian Interim Self-Government, the Government of Japan decided to conduct a basic design study on the Project for Construction of Wadi Gaza Bridge on Road No.4 and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Palestine a study team from May 4 to June 8, 2000.

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

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

I wish to express my sincere appreciation to the officials concerned of the Palestinian Interim-Self Government for their close cooperation extended to the teams.

October, 2000

Kunihiko SAITO
President
Japan International Cooperation Agency

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Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Construction of the Wadi Gaza Bridge on Road No.4 in Palestinian Interim Self-Government.

This study was conducted by Oriental Consultants Company Limited, under a contract to JICA, during the period from April 28 to November 24, 2000. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Palestine and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

Very truly yours,

Masami FUKUDA
Project Manager,
Basic design study team on
the Project for Construction of the Wadi
Gaza Bridge on Road No.4
Oriental Consultants Company Limited

Perspective of the Wadi Gaza Bridge

Abbreviations

A Authorities and Agencies

JICA	Japan International Cooperation Agency
MOEA	Ministry of Environmental Affaires
MOF	Ministry of Finance
MOPIC	Ministry of Planning and International Cooperation
MOT	Ministry of Tourism
MPW	Ministry of Public Works
PA	The Palestinian Interim Self-Government Authority
PECDAR	Palestinian Economic Council for Development and Reconstruction

B Other Abbreviations

A	Area
AADT	Annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
@	At the rate
B	B
B/D	Basic Design
BS	British Standard
cm	Centimeter
cm^2	Square centimeter
D/F	Draft Final Report
°C	Degree
$	Dollar
Ec	Young's modules of concrete
Es	Young's modules of steel
Esp	Modules of elasticity
F/S	Feasibility Study
HWL	High water level
i	Coefficient of impact
Kgf/cm^2	Kilogram force per square centimeter
Kgf/cm^3	Kilogram force per cubic meter
Kgf/mm^2	Kilogram force per square millimeter
Kh	Horizontal Seismic Coefficient
Km	Kilometer
Km^2	Square kilometer
Km/h	Kilometer per hour
L	Length
LWL	Low water level
m	Meter
mm	Millimeter
M	Million
m^2	Square meter
m^3	Cubic meter
m^3/s	Cubic meter per Second
MSL	Mean sea level
N	N-value or Number of wheel load application

%	Percent
φ	Diameter
PC	Prestressed concrete
Q	Quantity
RC	Reinforced concrete
SD	Deformed Steel
Sec	Second
σck	Allowable stress of concrete
σsa	Allowable stress of steel bar
t	Ton or Thickness
W	Width

CHAPTER 1

Chapter 1 Background of the Project

Palestine consists of the West Bank and the Gaza Strip, which were divided as a result of the Middle East Peace Process. The Gaza Strip, where the project is located, is a rectangular flatland with an area of about 365 km^2. Facing the Mediterranean, it extends about 45 km from south to north and about 5 to 14 km east to west. From north to south principal cities in this Strip are Beit Hanun, Gaza, Deir Al-Balah, Khan Younis, and Rafah. Road No.4 (known also as the Salah El Deen Road) where the bridge covered by this project is located, connects these cities. It is a trunk road about 58 km in total length, running through the Gaza Strip from south to north, from Erez on the border with Israel to Rafah on the border with Egypt. This road is not a route for transportation of residents of the Gaza Strip, it is also an important road for shipments of goods to Israel and Egypt.

Since the occupation of the West Bank and Gaza Strip by Israel in 1967, only roads necessary for Israeli settlers and those essential for military transportation have been developed in the Gaza Strip. Even after establishment of the Palestinian Interim Self-Government Authority, development of roads in the Palestinian Autonomous Region and of inter-city roads has been lagging. At the same time, the number of vehicles in the Strip has doubled or tripled in the three years from 1992 to 1995. An international airport was opened in the southern part of the Strip in November 1998, and cargo terminal facility construction was also started. In addition, construction work on the commercial port of Gaza began in June 2000. It is expected therefore that transportation of people and goods through Road No. 4 will be further activated, resulting in an increase in traffic volume.

Therefore, a plan is being carried out to widen the existing Road No.4 into a four-lane road. For the section from Beit Hanoun, a town inside the Strip from Erez on the border with Israel, through Gaza City, up to the Gaza River on the northern end where the bridge concerned is located, improvement from a two-lane to a four-lane road with a median during a period from 1996 to 2000. This project was divided into a total of nine phases and implemented by local consultants and contractors in Palestine. Funding amounted to about $24 million, including Saudi Arabia and Arabic Fund (loans) were applied through the World Bank. Development of the Beit Lahia – Erez section is under way supported by the Japan-Palestine Fund of the UNDP as a project to create employment. The 12.5 km section from the south side of the bridge to a point before Khan Younis is a four-lane road, for which two lanes were constructed during British rule, and two during the Israel occupation. Improvement of the road into a four-lane road with a median has been planned. The basic design has been completed and the work will commence immediately when the funds from donors are obtained.

In consequence, Road No.4 will have four lanes from Erez to Khan Younis. Yet, only the bridge crossing the Wadi Gaza located approximately in the middle of this section remains a two-lane section as constructed 35 years ago, presenting a bottleneck against traffic flow. As a result, the four-lane sections before and after this bridge are not effectively utilized. The bridge is not only a congestion point during peak hours with large traffic volume, but also a point where traffic accidents occur frequently.

In this situation, expansion of the Wadi Gaza Bridge is urgently needed. The bridge should be a four-lane section similar to the earth work section before and after the bridge. As the Palestinian Interim Self-Government Authority is facing financial difficulties, funds required for infrastructure development are insufficient. The Authority therefore requested grant-aid from the Japanese Government for funds needed to construct a two-lane bridge over the Wadi Gaza.

CHAPTER 2

Chapter 2 Content of the Project

2-1 Objectives of the Project

The Palestinian Interim Self-Government Authority, whose territory is divided into the West Bank and Gaza Strip, strives toward autonomy free from any political and economic Israeli interference. It positions the Gaza Strip with coastline as a basis for foreign trade. Following the opening of the Gaza International Airport, Palestine's sole airport, in November, 1998, the port construction project began to be substantiated at the end of May 2000. As the possibility of direct trade with foreign countries increases, Palestine will undertake further development of infrastructure, such as roads, etc., while looking forward to a political settlement with Israel expected to bring about social and economic progress based mainly on foreign investment.

Road No.4 is a 58 km north-south trunk road running through the Gaza Strip from the border with Israel to the border with Egypt. A four-lane road with a median has been completed from the border with Israel in the north to Wadi Gaza where the bridge under study is to be constructed. A 12 km section of the road is the Salah El Deen Street described below. In addition, development of a four-lane road with a median is planned at present from Wadi Gaza to Quarara.
Salah El Deen Street is a part of Road No.4 located near the center of Gaza City, branching west from the Road toward Beit Lahia at the northern end of Gaza City. The Street was developed from a two-lane to a four-lane road during the period from 1996 to 2000. (Note the road branching east at Beit Lahia is also called Road No.4. This is a two-lane road, in which an intersection is being developed at a point where the road branches toward the industrial complex.)

The 12.5 km section from Wadi Gaza at the southern end of the bridge covered by this survey to Quararah before Khan Younis has four lanes. Two of these four lanes were constructed during the period when the territory was controlled by Britain (1940s) and improved during the occupation of Egypt. The remaining two lanes were constructed during the Israeli occupation (1968 – 1970). It is planned to improve the road to a four-lane road with a median. The basic design is already completed, and the construction work will be started upon securing of funds from the donor. For the Jamal Abd El Nasseer Road that branches at Quarara from Road No.4 to the urban area of Khan Younis, the Khan Younis Municipality is planning improvement to a complete four-lane road with a median as a top priority project.

In 1998, the Ministry of Planning and International Cooperation (MOPIC) established the Gaza Strip Development plan with cooperation from the Norwegian Government. This includes a prediction of the traffic volume of Road No.4. According to this prediction, within ten years, the daily traffic volume of the Gaza・Deir al-Balah section, where a bridge is to be constructed according to this project, is projected at about 60,000 vehicles.
The Wadi Gaza Bridge located approximately in the middle of Road No.4, an essential

trunk road of the Gaza Strip, has the largest traffic volume along this road. However, the bridge has only two lanes as constructed in 1965. This creates traffic bottlenecks, and traffic accidents frequently occur.

This project is positioned as one of the elements of a master plan, the Palestinian Development Plan for 1999 to 2003 (PDP). The Palestinian Interim Self-Government Authority requested grant aid from the Japanese Government for the construction project for a two-lane Wadi Gaza Bridge side by side with the existing bridge for the purpose of creating four lanes crossing the Gaza River. The objective of this project is to ensure safe and smooth traffic on Road No.4 by constructing a new bridge side by side with the existing Wadi Gaza Bridge that is currently a traffic bottleneck.

2-2 Basic Concept of the Project

2-2-1 Object of the Project

Object of the Project is including following items which become required along the construction of the new Wadi Gaza bridge.

(1) Construction of a bridge with 2 lane.

(2) Approach road to the bridge.

(3) Construction of facilities required due to construction of the above bridge and road

- ① Bridge facilities
- ② River slope protection and River bed protection.
- ③ Drainage facilities for road
- ④ Road lighting facilities
- ⑤ Safety facilities (Road traffic sign, Road marking, Guardrail)

The followings shall be executed by PA:

- ① to provide facilities for the distribution of electricity, water supply and other incidental facilities in and around the construction site.
- ② to extend median from the new median which will be constructed by the project to existing one, if necessary.
- ③ to extend road lighting from the new road lighting which will be constructed by the project to existing one, if necessary.
- ④ to install road lighting for existing lanes and bridge, if necessary.
- ⑤ to rehabilitate existing lanes and bridge, if necessary.

2-2-2 Basic Concept of the Project

In practice, the design standard including the road geometric design and the live load used in the bridge design has been applied individually to each project. It was decided to use BS and AASHTO as bases and to check them while referring to the local condition and Japanese standard, thereby ensuring selection of an appropriate standard for this plan. Concerning the road horizontal alignment, vertical alignment, bridge location, bridge length, clearance under girder, bridge construction type, foundation type, superstructure and substructure types, and revetment and bed protection types, the channel characteristics of the Gaza River and their relationship with the existing bridge, and the basic plan for the entire Road No.4, the most appropriate plan was selected. Such plan was established through comparative study in terms of structural properties, economy, maintainability, and workability.

As a result of review as above described, the basic concept of this project consists of assurance of safe and smooth traffic at the Wadi Gaza Bridge through construction of this bridge, guaranteeing the stable land transport in the area concerned, and promotion of the economic development between areas.

2-3 Basic Design

2-3-1 Design Concept

1) Basic design considerations

This basic design study is implemented according to the Japanese grant aid scheme to achieve the most appropriate content while taking into account the society and economy, natural conditions, environment, laws, and other conditions surrounding the project of Palestine. Basic consideration items are described below.

① Relationship with the existing bridge

The bridge construction of this project is to provide the road with four lanes by constructing a new bridge side by side with the existing one. Therefore, due consideration must be made on the relationship with the existing bridge. Namely, pier positioning for the new bridge must be aligned to that of the existing one relative to the river flow. Due attention must also be paid on the safety of the existing bridge and road during work and after completion. (Distance from the existing bridge, protection of the existing bridge foundation, bed protection work)

② Dry and rainy seasons

Dry and rainy seasons can be clearly identified in the area concerned, and the rainy season ranges from October to February. In the dry season, there is no rainfall at all and the Wadi Gaza River is completely dried up. The precipitation is small even in the rainy season in which there are days with and without rain, instead of continuation of heavy rain for consecutive days. As the catchment area of this river is wide covering also the Israeli territory, the heavy rail will cause turbid waters to the depth of about 1 to 3 m over the entire river width at the bridge location. Accordingly, the work within the river has to be executed during the dry season as much as possible. The appropriate structural type and construction method must be selected while taking into account the superstructure construction method. It is also essential to establish the protective work around the substructure while ensuring sufficient embedment to prevent erosion.

③ Establishing the road and bridge standards in consideration of the present and future road utilization condition

This road is not only a trunk road to connect the north with the south in the Gaza Strip, but will function as an important route to connect countries to the north and south beyond the border in the future. The current traffic volume runs up to more than 19,000 vehicles/day, and is expected to grow with associated increase in the passage of heavy traffic along with future development of Palestine. The width composition of the section concerned is determined to suit to the northern road that has already been improved to the four-lane type and the road plan scheduled for improvement of the southern road.

The road standard is in accordance with AASHTO, but the Japanese Road Structure Ordinance will also be referred to during the study. For the transition portion with the southern exiting road, existing road and improvement plans are not complying with these standards, so that measures such as regulation of the traffic speed, etc. will be proposed.

The Ministry of Public Works plans to regulate the maximum weight of passing vehicles to 50 ton in line with growth of the traffic volume and increase in vehicle weight. Actually, the passage of considerably over-weight vehicles is expected, so that the basic policy is to employ, as the bridge design standard, BS HB45 that offers the large live load, as described above. In this bridge design, however, the design is made basically in compliance with the Specification for Highway Bridge currently applied in Japan in order to improve the design efficiency. The HB 45 live load of BS is extremely larger than the B live load of the above Japanese specification, which may be due to difference in the design method between both standards. Accordingly, the Specification for Highway Bridge will be complied with through increase in the B live load of the Specification by the amount determined from comparison of the live load strength – member strength ratio between these standards.

④ Effective utilization of materials and equipment

In the Gaza Strip, there is no construction machinery lease market. But the constructors have the construction machinery and there is no problem in terms of procurement. The experience of bridge construction is few, however, and most of bridges are of a reinforced concrete (RC) construction on the spread foundation. Therefore, there is no large crane, jack for prestressing to steels for construction of a prestressed concrete (PC) bridge.

The foundation of bridge is mostly of a spread type. Though there are cases with a pile foundation, construction of foundation to the depth of about 20 m in the sandy ground with groundwater as planned in this project has never been made. The pile auger available in the Gaza Strip is not enough to execute such pilling work. Those materials and equipment not available in the Gaza Strip are to be brought into the site from Japan, Israel, or the third country. As equipment leasing from Israel is difficult because of national problem, all of equipment that has to be procured in Israel has to be purchased. Namely, equipment that has to be procured through lease must be brought into site from Japan or the third country.

In certain cases, the material and equipment that are normally imported without problem may be suddenly restricted in import depending on the relationship between Palestine and Israel. In consequence, the study will be proceeded in a direction toward maximum utilization of materials and equipment available in the Gaza Strip.

⑤ Consideration of the technical level of local engineers

In the Gaza Strip, construction of high-rise buildings and other buildings, roads, etc. is rapid in these days, but the design and field experience concerning bridge construction are limited. The technical level of constructors and field engineers is not enough for construction of the bridge. As the new bride construction technology is indispensable for the future development, it is intended to transfer and master the technology on the foundation and substructure construction, approach road, and superstructure by means of this project. It is necessary to dispatch Japanese engineers to Palestine for implementation of these works.

⑥ Employment of the construction and type easy for maintenance

MPW accounts for the maintenance budget, but the maintenance is not thoroughly implemented and maintenance is not systematized. As existing bridges are all made from concrete and in order to establish the maintenance for the future, this project must be based on the method, construction, material, and type that can minimize the maintenance cost as much as possible.

⑦ Reduction of the project cost and work period

In order to meet the purpose of Japanese grant aid, the work content to be considered must be such as to minimize the work cost and work period as much as possible.

2) Design Standard

(1) Bridge

a) Applicable standard

As there is no standard applicable to bridge design in Palestine, the basic policy is to employ the British Standard (BS). Recent experience shows however that the actual design is made on the basis of the donor's standard. BS specifies HA and HB45 loads as live loads for bridge design, and the HB45 load is substantially large when compared with the Japanese live load. The weight of passing vehicles is restricted to as high as 50 t in Palestine, and the passing traffic volume will grow, with increased proportion of heavy vehicles, along with future economic growth. Considering these factors, the use of BS45 load for bridge design in Palestine is considered rational.

In view of above description, the live load to be used in this basic design study is HB45 of BS, but the Specification for Highway Bridge ("Specification for Highway Bridge, Explanation", December, 1996, published by Japan Road Association) of Japan will be used for the design standard. In this case, the B live load stipulated in this Specification is increased so that it becomes equivalent to the live load of BS. The design method using this Specification as a standard was explained to the Palestinian counterpart and obtained its understanding at a time of field survey.

b) Width composition

According to the Road Construction Decree, two lanes and sidewalk on out side will be provided. (See Fig.-2.3.1)

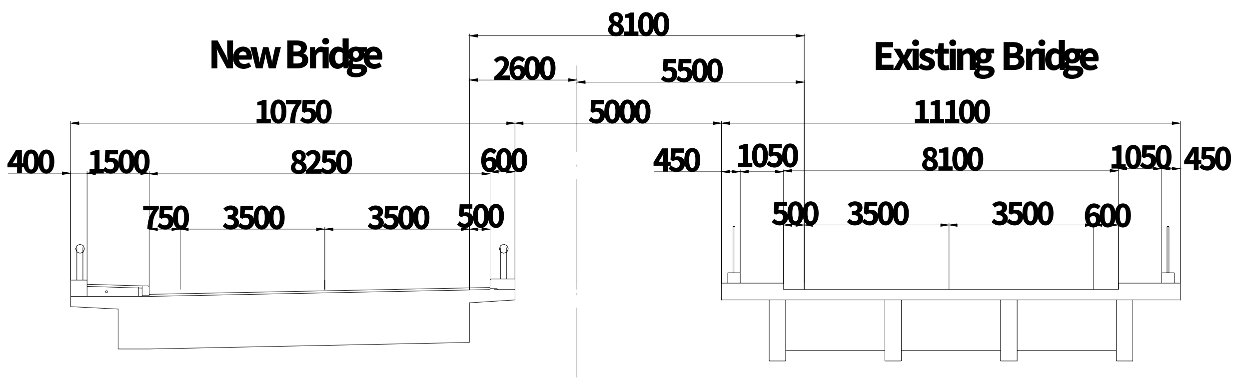


Fig. -2.3.1 Width composition of the bridge section

c) Load conditions

Loads used for bridge design are classified into the primary load, secondary load, and special load according to the loading method, loading frequency, and effects on the bridge. These loads are characterized as follows.

a. Primary load

① Dead load

The dead load is a sum of a bridge's self-weight and weight of attachments and calculated on the basis of the unit weight shown in Table -2.3.1.

Table -2.3.1 Material unit weight

Materials	Unit weight (kgf/m^3)	Materials	Unit weight (kgf/m^3)
Steel, cast steel	7,850	Plain concrete	2,350
Cast iron	7,250	Cement mortar	2,150
Aluminum	2,800	Asphalt concrete	2,300
Reinforced concrete	2,500	Woods	800

② Live load

The B live load of the Specification for Highway Bridge is increased so that it becomes equivalent to the HB live load 45 unit.

The increase rate was determined as follows:

- Calculate bending moments M_{BS} and M_{JS} in the middle of span of simple girder caused by live loads of BS and Specification for Highway Bridge.
- Calculate the ratio between the reinforcing bar stress limit σ_{BS} in the limit use condition of BS and the reinforcing bar allowable stress σ_{JS} according to the Specification for Highway Bridge
- M'_{BS} as converted from the bending moment under the BS live load by means of the allowable stress ratio
- The ratio k between the converted bending moment according to BS and the bending moment M_{JS} according to the Specification for Highway Bridge is used as an increase rate.

	Specification for Highway Bridge, B live load	BS HB 45 unit
Max bending moment under live load	M_{JS}	M_{BS}
Allowable stress	σ_{JS}	σ_{BS}
Comparative bending moment	M_{JS}	M'_{BS} $= M_{BS} \times (\sigma_{JS} / \sigma_{BS})$
Live load strength conversion ratio	1	$K = M'_{BS} / M_{JS}$

The maximum bending moment diagram due to live load in consideration of the difference in the design tolerance when the Carriageway width was 8.25 m is shown in Fig. -2.3.2, and its ratio is shown in Fig. -2.3.3.

In consequence, the increase rate K for the B live load is 1.3.

③ Impact

The impact factor i for the reinforced concrete bridge is determined as follows according to the Specification for Highway Bridge:

$i = 20 / (50 + L)$ ： When the T load is used
$i = 7 / (20 + L)$ ： When the L load is used

wherein, L is a span length (m).

④ Drying shrinkage of concrete

⑤ Soil pressure

⑥ Water pressure

⑦ Buoyancy or uplift

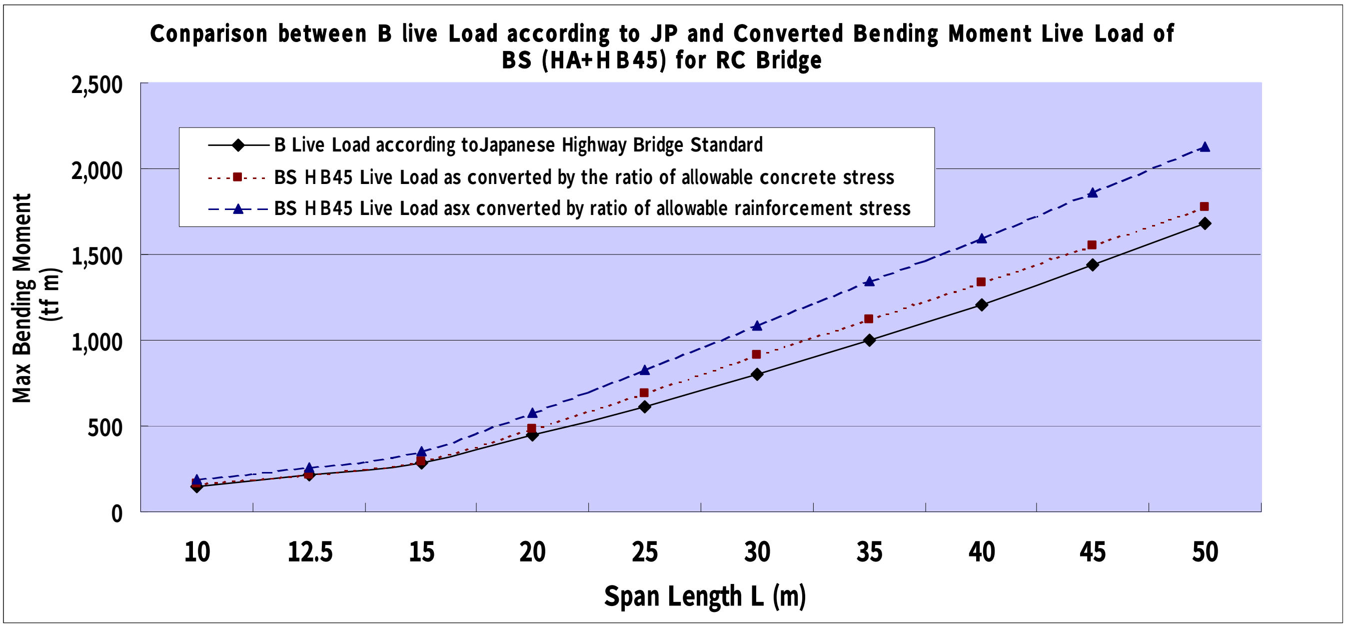


Fig.-2.3.2 Comparison of the max bending moment under live load

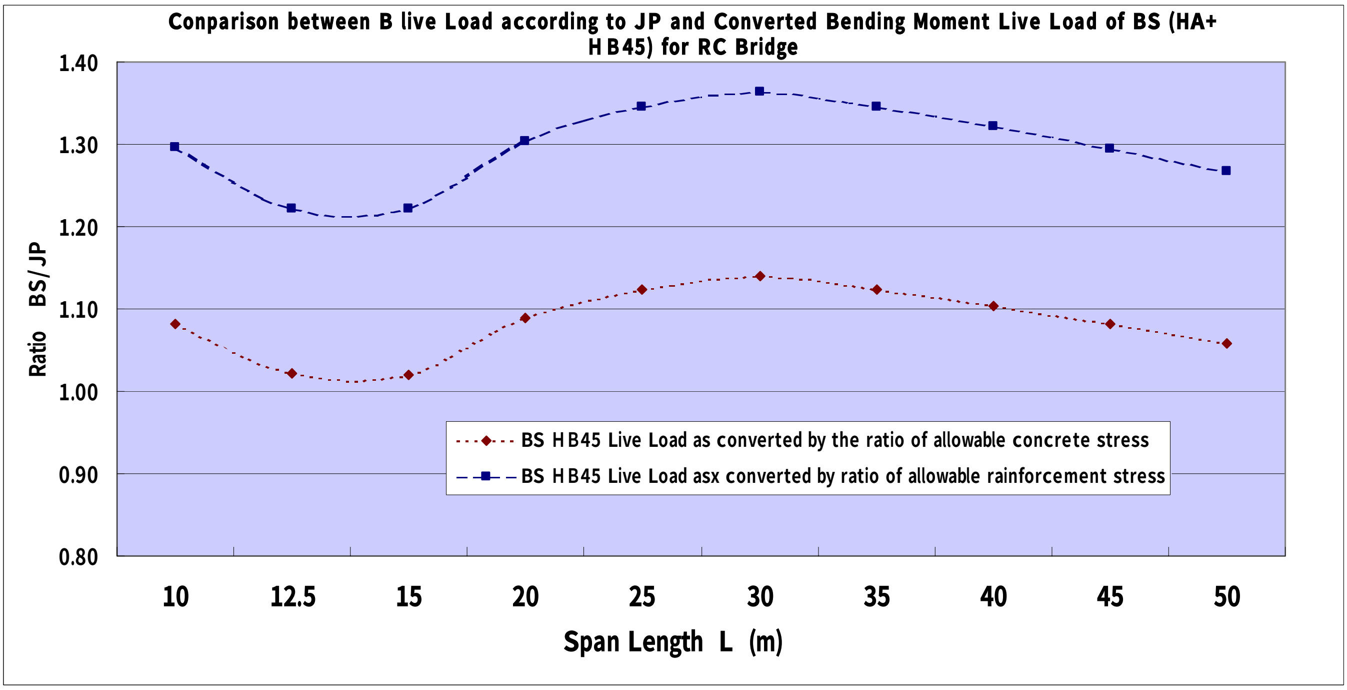


Fig. -2.3.3 Max bending moment ratio under live load

b. Secondary load

This is a load that must always be taken into account for combination of loads.

① Wind load

According to the topographical condition, the Japanese standard is applied to the superstructure.

② Effects of temperature change

The temperature change in Palestine is within ±12℃(average: 19℃、max:30℃、min: 7℃). Accordingly, the value shown below is considered for temperature change in the design.

Design temperature change for Concrete： ±15 ℃

③ Effects of earthquake

The Gaza Strip has no earthquake observation record and is classified as an area with the least earthquake occurrence in the Israeli Earthquake Resistant Design Standard. Since a weak earthquake was reported several a few decades ago, the effects of the earthquake are taken into account. The horizontal seismic coefficient relative to the self-weight is set at 5%.

c. Special loads

Special loads are those that must be taken specifically into account depending on such conditions as the bridge type, structural type, bridge location, etc. for this project, including loads during construction, etc. Since this bridge is a reinforced concrete bridge constructed according to the all-staging method, there is no special load acting on the section during the work.

d. Increase in the allowable stress due to load combination

Increase in the allowable stress due to load combination is shown in Table-1.3.2.

Table -2.3.2 Increase in the allowable stress due to load combination

Load combination	Increase coefficient
Primary load	1.00
Primary load ＋ Temperature loads	1.15
Primary load ＋ Braking loads	1.25
Primary load ＋ Effects of earthquake	1.50
During construction	1.50

d) Superstructure design conditions

e) Substructure design conditions

① Substructure type

Abutment : Inverted T-type abutment

Piers : Wall type

Embankment : As the foundation of new bridge piers is made in the neighborhood of existing piers, deep excavation of the new piers may affect adversely the stability of existing foundation. In particular, existing piers are considered to be on the spread foundation, the footing top is to be penetrated to the depth of 1.0 m from the river bed to minimize adverse effect as much as possible.

Design water level : Design high water-level is EL = +9.24 m which is the high water-level of 50-year probability.

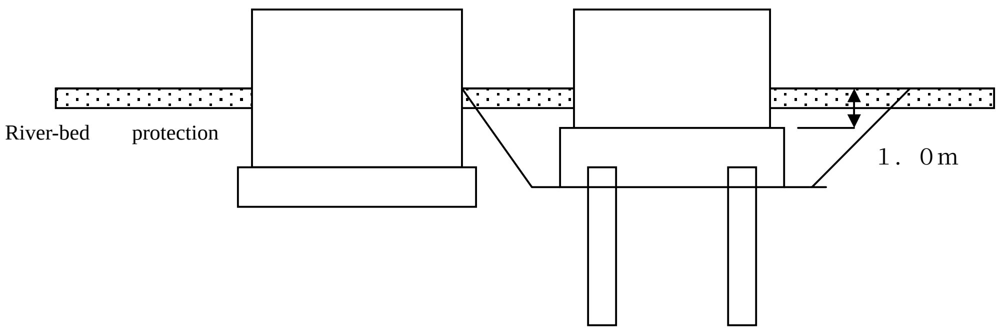


Fig. -2.3.4 Penetration of footing top

② Foundation type

Boring result shows that the sand stratum with the N value of less than 30 or the gravel stratum of river sediments exists to the depth of about 19 m from the river bed. The bearing layer is therefore the sandstone stratum below these strata.

Accordingly, the basic foundation is a pile foundation and the appropriate pile type and diameter are selected according to the ground condition, acting forces, and material/equipment procurement condition.

f) Revetment and bed protection works design conditions

The Wadi Gaza River has relatively gentle river banks near the bridge location, and the approach road to the bridge is protruding into the river bed. Therefore, there is no revetment work, except for the revetment brickwork provided to protect the embankment slop of the approach road.
The river bed of the existing bridge is provided with the concrete protection work of the width of about 40 m in the front and rear of the bridge.
On the basis of these conditions and by taking into account the availability of materials, economy, and workability, the structural type is determined.

(2) Road (Approach road)

In Palestine, the road design of existing improved section is based on AASHTO. As the design and construction is necessary for the approach road in the front and rear of the bridge in this project, understanding of the Palestinian counterpart was obtained concerning the method of design in which the Japanese Road Construction Decree (February, 1983, the Japan Road Association) , etc. will be applied while comparing them with ASSHTO.

a) Road classification

The design speed is set to 80 km/hr according to the existing improved section and plan. Therefore, this road is classified into Type 3, Class 1 according to the Road Construction Decree.

b) Road width composition

According to the existing improved section and the Road Construction Decree, the width composition is determined as follows.

① Transition section

The transition section is to be the same as for the standard cross section of the improved section. (See Fig.-2.3.5)

Median : 5.0 m, Carriageway : 2 @ 3.5m = 7.0m
Shoulder : 2.5 m, Soft shoulder : 1.0 m

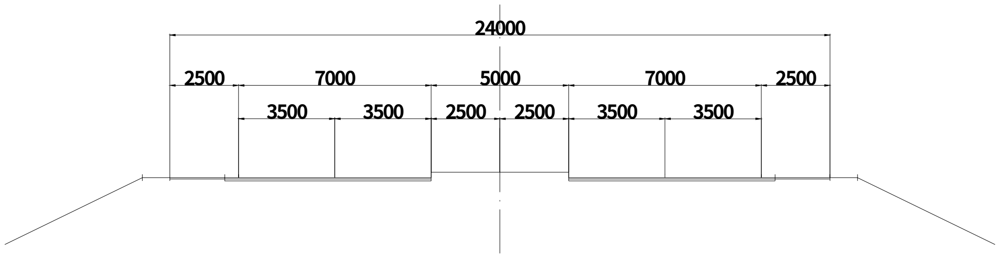


Fig. -2.3.5　Standard cross section of existing improved road section

② Approach road

Because of vertical alignment, the approach road is separated for up and down lanes.　The Road Construction Decree is therefore applied. (See Fig. -2.3.6)

Central soft shoulder : 1.0m,　　Carriageway　: 2 @ 3.5m = 7.0m

Shoulder　: 2.5m,　　Soft shoulder　: 1.0m

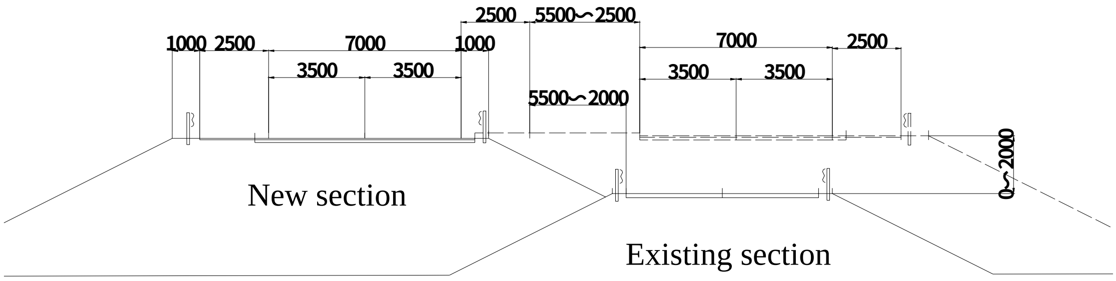


Fig. -2.3.6　Standard cross section of approach road

③ Bridge

As the bridge is constructed to separate up and down lanes, the Road Construction Decree is applied to provide a 1.5 m sidewalk on the outside. (See Fig. -2.3.1)

Central shoulder : 0.5 m,　　Carriageway　: 2 @ 3.5m = 7.0m

Shoulder　: 0.75m,　　Sidewalk　: 1.5m

c) Geometrical design of road

The road alignment is already designed during the improvement plan of Road No.4. As no improvement is attempted for the existing road and southern unimproved section of Road No.4 in this project, the alignment is temporary with transition provided to the existing road. Accordingly, modification to the existing design is made according to specifications of the Road Construction Decree on the basis of the field condition and temporary transition condition.

Table -2.3.3 Geometric design value of the road

Item		Design value
Horizontal alignment	Min radius of curve （without transition curve） （Without superelevation）	280 m （2,000 m） （3,500 m）
	Min curve length	140 m
Vertical alignment	Min radius of curve Crest Sag	 3,000 m 2,000 m
	Min curve length	70 m
	Steepest grade	4 %
Max. superelevation of the curve		10 %
Crossfall		2.5 %

d) Pavement design standard

Design of the pavement of improved northern road is based on AASHTO. Basically, this pavement composition is applied, but its adequacy is verified on the basis of this traffic volume survey with reference made to the Japanese design standard because of difference in the design time and in the set planned traffic volume. Fig. -2.3.7 shows the pavement composition of the northern road.

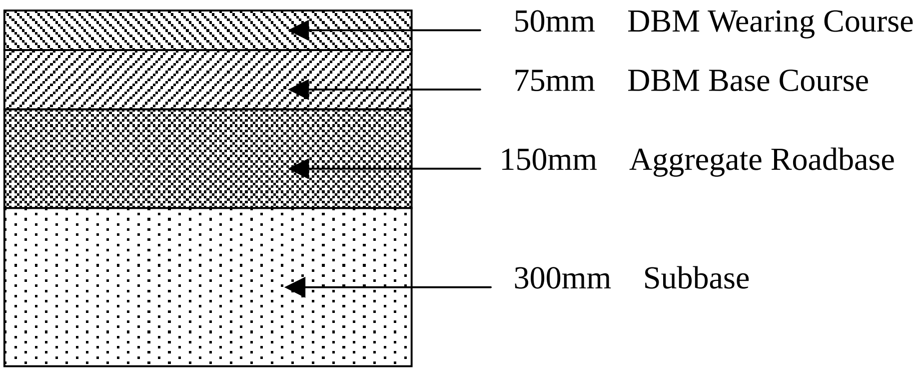


Fig-2.3.7 Pavement composition of the northern improved road

3) Material strength

(1) Concrete

Concrete to be used is the ready-mixed concrete from the local concrete plant. The specified concrete strength is represented as the strength test value with a cylindrical specimen as follows.
As the strength test is made with a cube specimen in the site, the obtained value is about 15% higher than the value with the cylindrical specimen. Therefore, it is necessary to state clearly the strength test method in the design drawing and specification.

① Specified concrete strength （Cylindrical specimen, 28-day strength）

RC slab, cross girder, vertical girder : σck=240 kgf/cm^2

RC sidewalk, handrail : σck=240 kgf/cm^2

Abutment body : σck=240 kgf/cm^2

RC piles : σck=300 kgf/cm^2

② Young's module

Specified concrete strength (kgf/cm^2)	240
Young's module (kgf/cm^2)	2.5x10^5

(2) Reinforcing bar

Though not manufacture in Palestine, Israel-made reinforcing bars are available in Palestine, which are to be used. The product design is based on BS.

Standard : BS 4449 Type II Grade 420

Yield strength : 420 N/mm^2

2-3-2 Basic Plan

1) Design plan

(1) Scope of implementation

The scope of implementation of this project is from the end point of the improved section on the north side up to the starting point of the existing unimproved four-lane section on the south side, as shown in Fig. -2.3.8. Fig. -2.3.9 shows a general view of the existing Wadi Gaza Bridge.

The road and new bridge are planned to enable run-off to existing and planned road alignment while minimizing effects on the existing bridge and approaches and eliminating the need for large-scale temporary facilities.

(2) Bridge plan

a) Bridge location

The width of the median in the ordinary road section of Road No.4 is 5 m. As a result of the study on the new bridge construction method, it was decided to increase the width of median and to shift the stream crossing point 3 m downstream side.

b) Design high water-level and clearance under girder

From the analytical result of hearings and collected data during the field survey, the probable high water level, flow rate, and flow velocity of the river at the bridge location are as shown in Table- 2.3.4.
This design uses 50 probability year and a design high water-level of EL + 9.3 m.

Table-2.3.4 Rate of Discharge and water level for each probability year

Probability	Rate of Discharge (m^3/s)	Water level (m)	Flow velocity (m/s)
1/100	880	9.43	3.35
1/50	780	9.24	3.16
1/20	640	8.96	2.86
1/10	530	8.72	2.60
1/2	300	8.13	1.95

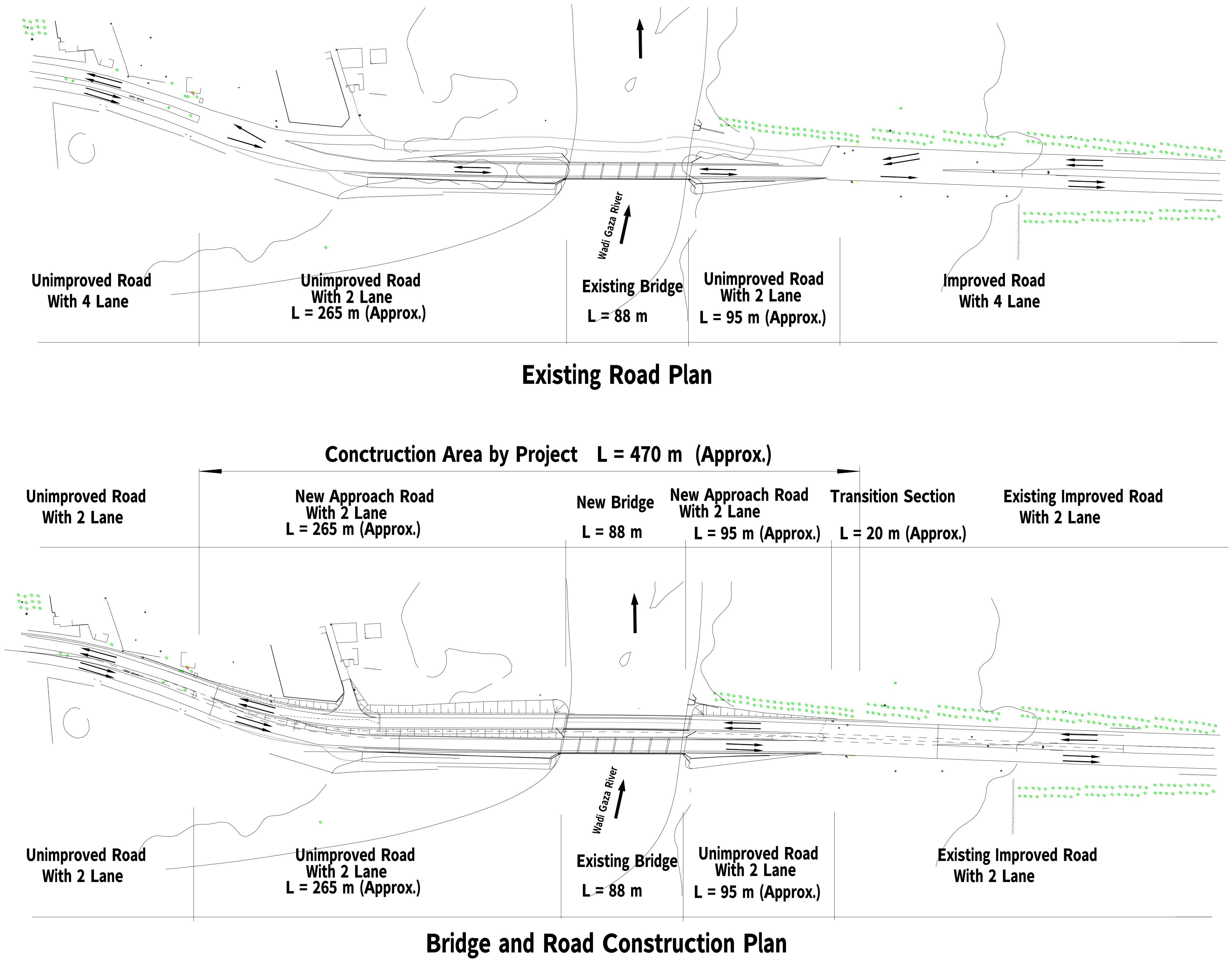


Fig. -2.3.8 Scope of the project

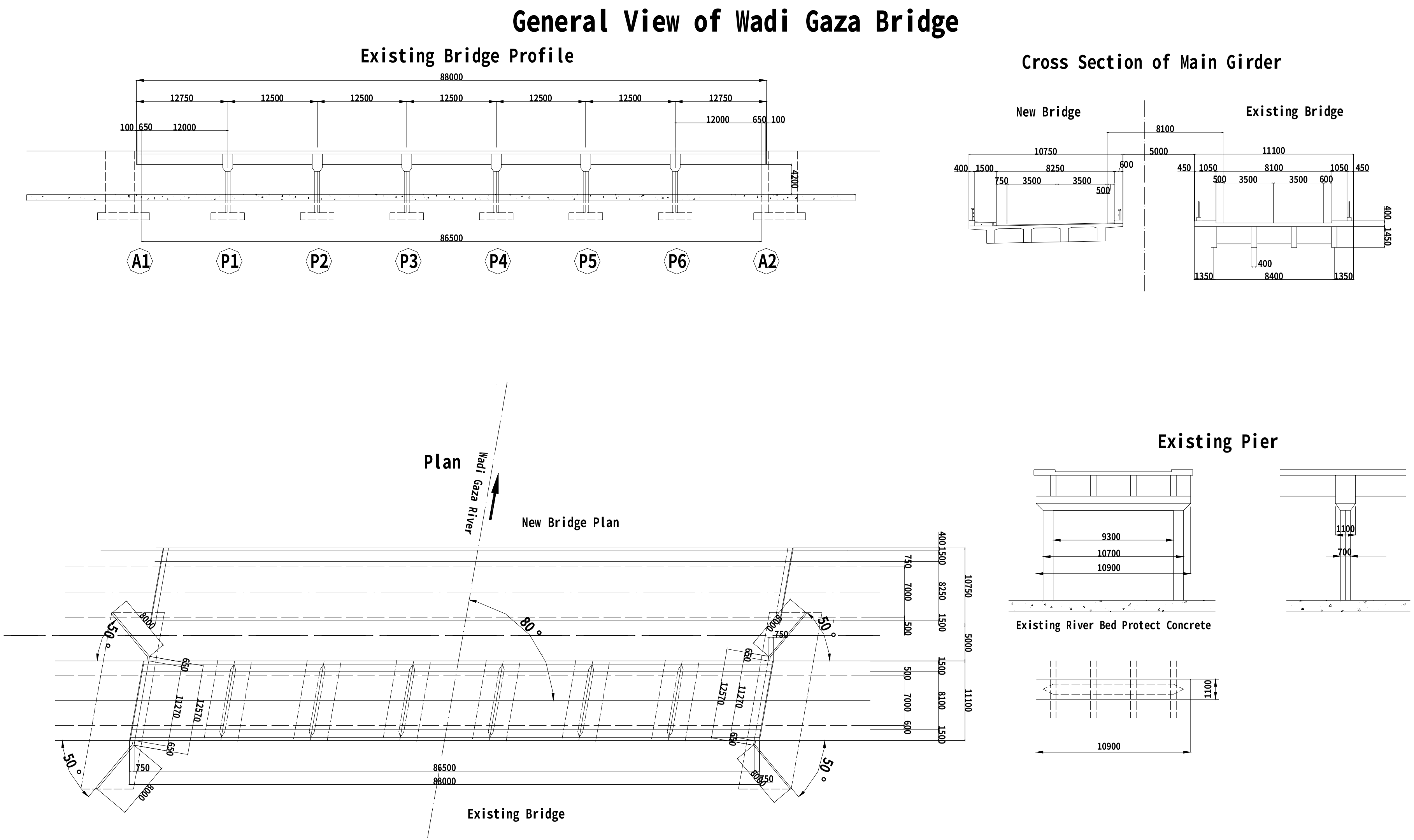


Fig.-2.3.9 General view of existing Wadi Gaza Bridge

The clearance under girder is determined while considering the record survey and in compliance with the Japanese River Structural Standard. Table-2.3.5 shows the relationship between the design flood discharge and clearance under girder.

Table -2.3.5 Clearance under Girder for Design flood discharge

Design flood discharge Q (m3/s)	Q＜200	200≦ Q ＜500	500≦ Q ＜2,000	2,000≦ Q ＜5,000	5,000≦ Q ＜10,000	10,000＜ Q
Clearance under girder (m)	0.6	0.8	1.0	1.2	1.5	2.0

c) Bridge length

Two alternatives are considered for the bridge length according to conditions described below: 88 m, that is the same as for the existing bridge length, and 100 m determined by adding the one-span of 12.5 m to the existing length. These alternatives have been compared and studied.

- The Wadi Gaza River meanders greatly in the front and rear of the existing bridge, and the river width is the narrowest at the bridge location.
- Hearing survey on past floods showed that a flood in December 1991 was the largest. The water level was estimated to have risen to a level 50 cm under the existing bridge girder.
- The existing bridge length is considered to be marginally sufficient to pass the river water.
- The existing bridge has a short span of 12.5 m, which is less than the standard span of 20 m as stipulated in the Japanese Government Ordinance for Structural Standards for River Administration Facilities.
- The existing bridge will be 35 years or more old after construction. If the bridge is to be replaced in the future, the bridge length and span arrangement of the new one will be the standard.

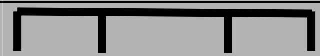
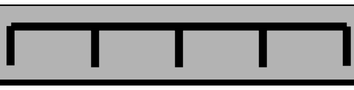
d) Span Arrangement

The existing bridge is a seven-span reinforced concrete bridge with 88 m long and 12.5 m spans. The crossing angle between the river and bridge axis is 80 degrees. Wall-type piers with 70 cm thick are installed in a direction similar to the river flow direction. The distance between abutment fronts is 86.5 m, and its entire width functions as a flow passing section. The ratio of pier thickness to river width is about 4.8%.
Fig. -2.3.9 shows a general view of the existing Wadi Gaza Bridge.

The new bridge is constructed on the downstream side of the existing one. Considering effects on the river water flow, it is necessary to position the new piers on an extension of existing piers in the flow direction. Accordingly, the span of the new bridge will be either the equivalent or a multiple of the existing one, and the combination shown in Table –2.3.6 may be considered as the span arrangement.

With fewer piers and spans, the span length increases naturally, and the cost of superstructure construction grows. On the other hand, the cost of substructure and foundation works decreases in correspondence to the decrement of piers. Accordingly, the overall construction cost may not differ substantially between seven to four spans. A symmetrical structure is advantageous in terms of stress balance, but the five-span type in Alternative 2 is not well balanced because a short span is inserted in the middle. The three-span type in Alternative 4 ensures a satisfactory balance between main and side spans, but is slightly higher in cost than other multi-span alternatives.
The bridge length shown in Alternative 7 is increased by one span of 12.5 m. Its cost is grater by the amount of increment when compared with Alternative 3. But this alternative can have the high embankment section reduced, ensuring satisfactory balance. Accordingly, alternatives 1 through 4 and 7 are chosen for comparison.

Table -2.3.6 Span Arrangement

Alternatives	No. of spans	Illustration	Max span (m)	Symmetry	Bridge type	Stress balance
Existing bridge	Seven spans		12.5	Symmetrical	RC	Good
1	Seven spans		12.5	Symmetrical	RC	Good
2	Five spans		25.0	Symmetrical	PC or Steel bridge	Bad
3	Four spans		25.0	Asymmetrical	PC or Steel bridge	Slightly bad
4	Three spans		37.5	Symmetrical	PC or Steel bridge	Good
5	Two spans		50.0	Asymmetrical	Steel bridge	Bad
6	Single span		88.0	Symmetrical	Steel bridge	Good
7	Four spans		25.0	Symmetrical	PC or Steel bridge	Good

e) Superstructure type

① Selection of the superstructure bridge type

The following points were taken into account to determine whether the superstructure bridge type is to be made from concrete or steel:

-Availability of construction materials and machinery

-Economy and contractibility including the cost of substructure and foundation

-Type which ensures easy maintenance with low cost

-Actual record of use in Palestine and technology transfer

There are only five bridges in the Gaza Strip and all of them are reinforced concrete bridges. Two bridges constructed after establishment of the Palestinian Interim Self-Government Authority are also reinforced concrete bridges. The steel bridge type, if selected, cannot be manufactured in the Gaza Strip, and must be manufactured outside Palestine, that is, in Israel or Japan.

The maximum span currently under study is 37.5 m, and the reinforced concrete or prestressed concrete structure is judged to be appropriate when expenses for manufacture and import are considered. In addition, a concrete bridge will be easier to maintain than a steel bridge.

② Study on superstructure type

As the pier positioning must be aligned to that of the existing bridge, the maximum span can be set to 12.5, 25.0, and 37.5 m for each span arrangement plan. Superstructure types corresponding to these spans are shown in Table-2.3.7.

When the clearance under girder is determined from the design high water level, the overhead clearance of the existing bridge is the approximate limit and the girder height of the new bridge must be limited to a maximum 1.7 m, the same as for the existing one. The structurally required girder height is determined from the superstructure type and span.

The plan comparison results for each span arrangement are shown in Table - 2.3.8. According to the overall judgment, the reinforced concrete T-girder bridge of Plan 1 is considered most appropriate.

Table-2.3.7 Span and superstructure type

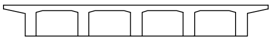
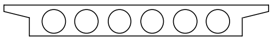
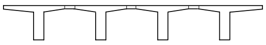
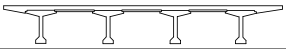
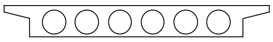
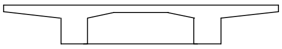
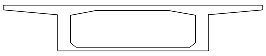
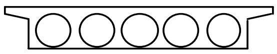
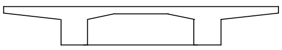
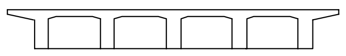
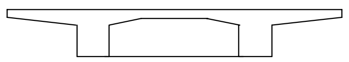
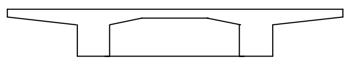
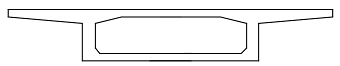
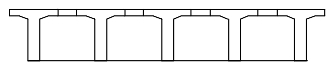
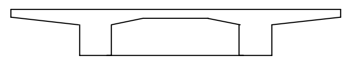
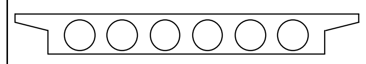
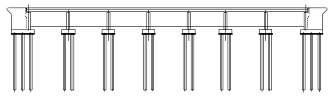
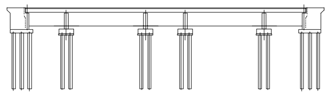
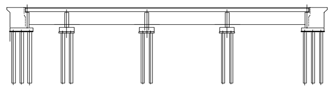
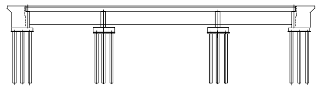
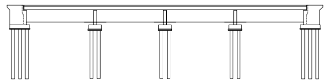
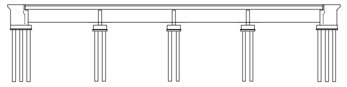
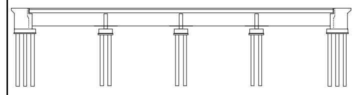
Max span (m)	Girder type	Main girder section	Applicable span	Girder height / Span	Girder height (m)
12.5	Reinforced concrete T-girder bridge		～15m	1/11	1.2
	Reinforced concrete hollow slab bridge		～20m	1/18	0.7
25.0	Prestressed concrete T-girder bridge		20～40m	1/16	1.6
	Prestressed concrete composite girder bridge		20～40m	1/15	1.7
	Prestressed concrete hollow slab bridge		20～40m	1/22	1.2
	Prestressed concrete main slab girder bridge		20～40m	1/17	1.5
37.5	Prestressed concrete box-girder bridge		30～60m	1/20	1.9
	Prestressed concrete hollow slab bridge		20～30m	1/22	1.7
	Prestressed concrete main slab girder bridge		20～35m	1./17	2.2

Table -2.3.8 Plan comparison for superstructure type

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5A	Alternative 5B	Alternative 5C
Bridge type	**RC T-Girder Bridge**	**PC Two-main Slab Girder Bridge**	**PC Two-main Slab Girder Bridge**	**PC Box Girder Bridge**	**PC Connecting T-Girder Bridge**	**PC Two-main Slab Girder Bridge**	**PC Hollow Slab Bridge**
Sectional shape	 H = 1.2m	 H = 1.5m	 H = 1.5m	 H = 1.7m	 H = 1.7m	 H = 1.5m	 H = 1.25m
Span arrangement (bridge length)	7 @ 12.5m (87.5 m)	12.5m+25.0m+12.5m +25.0m+12.5m (87.5m)	3 @ 25.0m + 12.5m (87.5m)	25.0m + 37.5m + 25.0m (87.5m)	4 @ 25.0m (100.0m)	4 @ 25.0m (100.0m)	4 @ 25.0m (100.0m)
Side view							
Symmetry	○	○	×	○	○	○	○
Design related features	△	△	△	○	△	○	○
Outline of structure	**○**	△	△	**○**	**○**	○	**○**
	Same pier arrangement as the existing bridge. Continuous girder type can reduce girder height and enhance rideability. Ordinary type for RC bridge. The girder height of 1.2 m is the Lowest among these alternatives.	Symmetrical structure. The girder height and quantity PC tendons are same as Alternative 3. No structural merit with this Alternative. There is a short span in middle of river, which is not favorable for the flow.	The span is twice that of existing bridge and one span at the end is same to the existing one. The 12.5 m end span rarely exerts adverse effect structurally.	Symmetrical structure with the largest span among alternatives. Girder height is limited to less than ordinary girder height, so prestressing steel is used in slightly larger quantity. Lateral prestressing steel necessary.	Symmetrical structure with equal spans Prestressing steel for lateral prestressing necessary. Connecting girder requires two rows of bearings on the pier crown, resulting in increase in pier crown width.	Symmetrical structure with equal spans. Lateral prestressing is not required in slab deck. The girder height can be reduced from that of Alternative 5A.	Symmetrical structure with equal spans. The span arrangement presents less problems similarly to Alternative 5B. The concrete quantity for superstructure is larger than that of Alternative 5B.
Aesthetics	○	△	△	**○**	**○**	○	**○**
	There are many piers, which may cause a complicated impression, but presents less massive feeling because the girder height is low.	Though symmetrical in the bridge axis direction, it has a short middle span to cause an unnatural feeling.	Less complicated in impression when compared with Alternatives 1 and 2. Asymmetrical structure, with a short span causing adverse effect in terms of aesthetics.	Well balanced central and side spans As the clearance under girder is narrow, a box girder 1.7 m high presents a massive feeling.	This Alternative offers a simple and clear span arrangement. As the girder height is 1.7 m and the pier width is 1.8 m, the bridge presents a massive feeling.	This Alternative offers a simple and clear span arrangement. Small clearance under girder gives less massive feeling than Alternative 5A.	Because of small number of piers and low girder height, the bridge offers a slender impression.
Pier thickness/River width Shortest Span	4.9% ＜ 5.0% **○** 12.5m ＜ 20m ×	4.2% ＜ 5.0% **○** 12.5m ＜ 20m ×	4.2% ＜ 5.0% **○** 12.5m ＜ 20m ×	3.5% ＜ 5.0% **○** 25.0m ＞ 20m **○**	4.2% ＜ 5.0% **○** 25.0m ＞ 20m **○**	3.7% ＜ 5.0% **○** 25.0m ＞ 20m **○**	4.6% ＜ 5.0% **○** 25.0m ＞ 20m **○**
Features related to construction	**○**	**○**	**○**	×	×	**○**	△
Construction	**○**	**○**	**○**	×	△	○	△
	Superstructure is cast in place according to the all-staging method.	Superstructure is cast in place according to the all-staging method. Prestressing steel arrangement and prestressing requires thorough control and guidance.	Same as Alternatives 1, 2.	Superstructure is cast in place according to the all-staging method. Internal falsework is assembled after concrete placement of lower slab and web lower portion, then the web upper portion and upper slab concrete are placed.	Main girder (girder weight: about 50 t) is erected with erection girder. It is necessary to prepare the girder fabrication yard (about 100m×40m). Post concrete of slab and cross girder is placed after erection of main girder.	Superstructure is cast in place according to the all-staging method.	Superstructure is cast in place according to all-staging method. Due care must be taken to prevent uplifting of void form during concrete placement.
Construction period	△	△	○	×	×	○	○
	Because of large number of piers and piles, the substructure work period of this Alternative is longer than others. The superstructure work period is the shortest.	Because of large number of piers and piles, the substructure work period of this Alternative is longer than Alternative 3 with the same bridge length.	The substructure work period is shortest of all Alternatives. The overall work period is the same as that of other Alternatives in which the falsework is to be constructed.	The overall work period becomes longer because of two placements of main girder concrete and installation/removal of internal falsework as well as prestressing required for lateral prestressing steel.	Girder erection can be completed earlier than other Alternatives. As removal of girder fabrication yard after erection, the overall work period is the longest among these Alternatives.	There is almost no difference in the work period from Alternative 3.	Corresponding to the number of piles that is larger than the case of Alternative 4B with the same bridge length, the substructure work period is longer.
Procurement of materials	◎	**○**	○	○	○	○	△
	All materials are available locally.	Prestressing steel and anchorage must be imported.	Prestressing steel and anchorage must be imported.	Prestressing steel and anchorage must be imported	Prestressing steel and anchorage must be imported.	Prestressing steel and anchorage must be imported.	Prestressing steel and anchorage .as well as void frame must be imported.
Procurement of equipment	**○**	**○**	**○**	○	△	○	**○**
	Import of pile driver necessary	Import of pile driver and prestressing jack pump necessary	Import of pile driver and prestressing jack pump necessary	Import of pile driver and prestressing jack pump necessary	In addition to import of pile driver and prestressing jack, import of main girder transverse system and heavy cart necessary.	Import of pile driver and prestressing jack pump necessary	Import of pile driver and prestressing jack pump necessary
Construction cost	○	△	○	×	△	△	×
Bridge direct work cost	**100**	**105**	**101**	**115**	**106**	**104**	**108**
Overall judgment	○	△	×	×	×	△	×

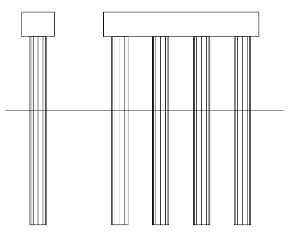
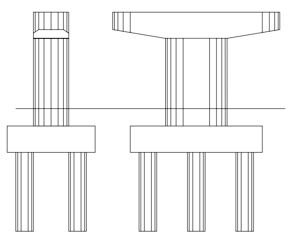
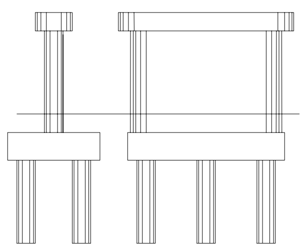
f) Substructure type

Selection of the substructure type must be made with due attention paid to the effects on the existing bridge, as follows:

- Piers of the existing bridge are of a wall type and at an oblique angle relative to the river flow direction. Accordingly, the pier positioning of the new bridge is set on an extension of existing piers.
- Existing piers are considered to be on a spread foundation constructed on the bearing layer of the relatively weak sand or gravel stratum. Accordingly, the substructure must be of a type not adversely affecting the safety of the existing bridge during construction of the new bridge.
- The river bed at the existing bridge is provided with the scour protection concrete work over the entire surface. It is considered that footing embedment is relatively shallow. As a rule, therefore, scour protection concrete work is to be provided to the river bed also for the new bridge, with the footing top set about 1.0 m from the river bed to minimize the effect on the existing bridge.
- Basically, a wall type pier is selected, which can reduce the sectional thickness.
- As the height is 10 m or less, the abutment is to be the most economical inverted-T type.

Comparison of pier types is shown in Table -2.3.9.

Table -2.3.9 Pier type comparison table

	Alternative 1 Pile bent type pier	Alternative 2 Columnar type pier	Alternative 3 Wall type pier
Illustration			
Structure	・ The simplest structure, with the pile foundation raised as it is and pile head capped. ・ Flexible structure ・ The river flow develops vortex flow readily, causing scour of river bed.	・ Ordinary structural type. ・ Effective when the river flow is not so much unidirectional. ・ Larger width of pier in a direction normal to the flow direction than case of wall pier. ・ Larger pier diameter, resulting in increased sectional-area impedance ratio.	・ Ordinary structural type ・ Effective when the river flow is unidirectional. ・ The width in a direction normal to the flow can be decreased, reducing the sectional-area impedance ratio.
Construction	・ Casing pipe used for underground and submerged portions ・ Temporary construction equipment may be relatively small in quantity.	・ Closure with sheet piles necessary when the footing is below the water level	• Closure with sheet piles necessary when the footing is below the water level
Economy	○	△	○
Evaluation	△	△	○

g) Foundation type

The bearing layer for the new bridge is located 19 m below the river bed. Basically, the pile foundation is selected for foundation. Piles can be classified roughly into driving and cast-in-place piles as shown in Table-2.3.10. Driving piles are further classified into reinforced concrete, prestressed concrete, H-shaped steel, and steel pipe piles. Considering the characteristics of the Gaza Strip and for the reasons described below, cast-in-place pile (all casing) has been selected.

① Neither pile drivers nor cast-in-place pile machine are available in the Gaza Strip, and they need to be brought in from outside. Since it is not practical to bring them in from Israel, they must be brought in from Japan or a third country.

② Fabrication on site is easy. All piles other than reinforced concrete and cast-in-place piles are imported from Israel or other countries.

③ Cast-in-place piles other than steel pipe piles cannot be used because of the gravel stratum located in the middle.

④ All casing piles are more economical than piles installed by reverse circulation drill method.

⑤ The soil quality can be checked during pile excavation, enabling ready measures against changes in the soil quality.

Concerning the cast-in-place piles applicable in this project, pile diameters of ϕ800、ϕ1000、and ϕ1200 were compared in terms of economy. As shown in Fig.-2.3.10, the pile diameter of ϕ1000 proved most economical.

Table -2.3.10 Features of applicable pile types

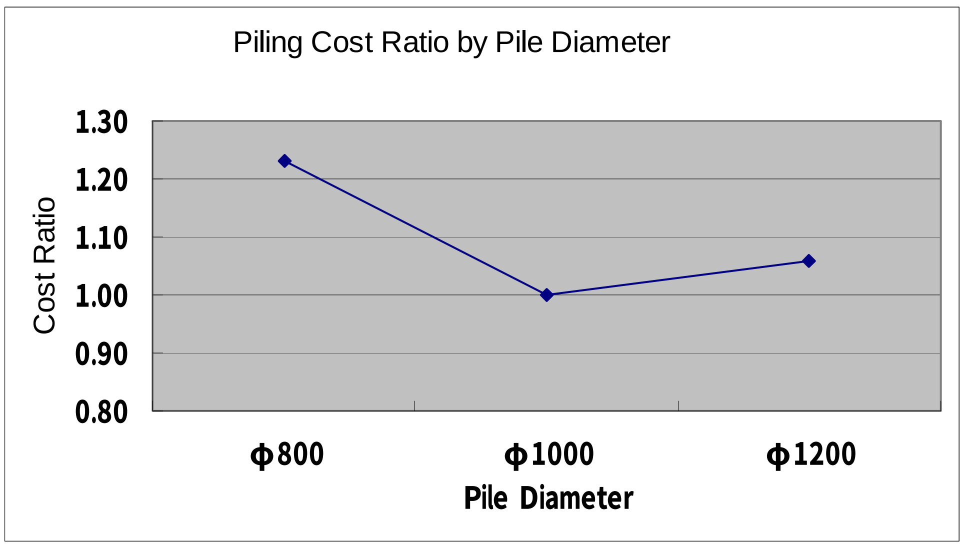
Pile type	Pile length application range	Pile supplier	Features
Reinforced concrete piles	5m to approx. 10m	Fabrication possible in the Gaza Strip	・As a driving method is expected, these piles are generally applied to cases with a soft upper stratum and a bearing layer to a depth of about 10 m. ・**Not applicable when the bearing layer is a rock mass.** ・Applicable when vertical and horizontal loads are small. ・Economically advantageous
Prestressed concrete piles	Up to approx. 30m	Import (Israel, Japan, other countries)	・As a driving method is expected, these piles are generally applied to cases with a soft upper stratum and a bearing layer to a depth of about 30 m. ・ Applicable when vertical and horizontal loads are small. ・Less crack and damage during driving because the concrete strength is higher than that of reinforced concrete piles. ・**Not applicable when the bearing stratum is a rock mass.** • Slightly economically advantageous
H shaped steel piles	Up to approx. 30m	Import (Israel, Japan, other countries)	・Applicable for long piles. ・There is few problems with welding joints. • **Applicable when vertical and horizontal loads are small**. • Slightly economically advantageous
Steel pipe piles	15m to about 60m	Import (Israel, Japan, and other countries)	・Applicable for long piles. ・There is few problems with welding joints. • **Applicable when vertical and horizontal loads are large**. • Slightly economically disadvantageous
Cast-in-place piles	15m to 60m	Fabrication possible in Gaza Strip	・Applicable for long piles. ・There is no problem with joints. ・Applicable when vertical and horizontal loads are large**.** ・**Applicable for rock excavation** • Economically advantageous

Table -2.3.11 Foundation type selection table

Conditions \ Type of Foudaton			Spread Foundation	Driving Pile Foundation: RC Pile	Driving Pile Foundation: PHC Pile	Driving Pile Foundation: Steel Pipe Pile	Pile Foundation by Inner Excavation, PHC Pile: Final Impact Method	Pile Foundation by Inner Excavation, PHC Pile: Jet String Method	Pile Foundation by Inner Excavation, PHC Pile: Concrete Placing Method	Pile Foundation by Inner Excavation, Steel Pipe Pile: Final Impact Method	Pile Foundation by Inner Excavation, Steel Pipe Pile: Jet String Method	Pile Foundation by Inner Excavation, Steel Pipe Pile: Concrete Placing Method	Cast-in-place Pile Foundation: All Casing	Cast-in-place Pile Foundation: Reverse Circulation Drill	Cast-in-place Pile Foundation: Earth Drill	Cast-in-place Pile Foundation: Caisson Type	Caisson Foundation: Pneumatic Caisson	Caisson Foundation: Open Caisson	Steel Pipe Sheet Pile Foundation	Diaphragm Foundation
Ground Conditions	Conditions above Bearing Layer	Extremely Soft Layer in Intermediate Stratum	△	○	○	○	○	○	○	○	○	○	○	○	×	×	○	○	○	○
		Extremely Hard Layer in Intermediate Stratum	○	×	△	○	○	○	○	○	○	○	△	○	△	○	○	△	△	○
		Gravel in the Intermediate Stratum: Gravel Size 5cm or less	○	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Gravel in the Intermediate Stratum: Gravel Size 5cm〜10cm	○	×	△	△	△	△	△	△	△	△	○	○	△	○	○	○	△	○
		Gravel in the Intermediate Stratum: Gravel Size 10cm〜50cm	○	×	×	△	×	×	×	×	×	×	△	×	×	○	○	△	×	△
		Ground that would Liquefy Exists	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Conditions of the Bearing Layer	Depth of Bearing Layer: Less than 5m	○	×	×	×	×	×	×	×	×	×	×	×	×	○	×	×	×	×
		Depth of Bearing Layer: 5〜15m	△	○	○	○	○	○	○	○	○	○	○	△	○	○	○	○	△	△
		Depth of Bearing Layer: 15〜25m	×	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Depth of Bearing Layer: 25〜40m	×	×	○	○	○	○	○	○	○	○	○	○	△	△	○	○	○	○
		Depth of Bearing Layer: 40〜60m	×	×	△	○	△	△	△	○	○	○	△	○	×	×	△	○	○	○
		Depth of Bearing Layer: More than 60m	×	×	×	△	×	×	×	×	×	×	×	△	×	×	×	△	△	△
		Nature of Bearing Layer Soil: Clayey Soil (20≦N)	○	○	○	○	○	×	△	○	×	△	○	○	○	○	○	○	○	○
		Nature of Bearing Layer Soil: Sand, Gravel (30≦N)	○	○	○	○	○	○	×	○	○	×	○	○	○	○	○	○	○	○
		Large Dip (More than 30 degree)	○	×	△	○	△	△	△	○	○	○	○	△	△	○	○	△	△	△
		Excessive Irregularities of Bearing Layer Surface	○	△	△	○	△	△	△	○	△	△	○	○	○	○	○	△	△	○
	Groundwater Condition	Groundwater Levels near surface	△	○	○	○	○	○	○	○	○	○	○	○	△	△	○	○	○	○
		Extremely Large Amount of Inflow Water	△	○	○	○	○	○	○	○	○	○	○	○	△	×	○	○	○	△
		Confined Groundwater at 2 m or more from surface	×	○	○	○	×	×	×	×	×	×	×	×	×	×	△	△	○	×
		Groundwater flow of 3m/min or more	×	○	○	○	○	×	×	○	×	×	×	×	×	×	○	△	○	×
Structural Characteristics	Load Size	Small Vertical Load (Span 20m or Less)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	×	△	×	×
		Normal Vertical Load (Span 20m〜50m)	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Large Vertical Load (Span 50m or more)	○	×	△	○	△	△	△	○	○	○	○	○	△	○	○	○	○	○
		Horizontal Load Comparatively Smaller than Vertical	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△
		Horizontal Load Comparatively Larger than Vertical	○	×	△	○	△	△	△	○	○	○	○	○	○	○	○	○	○	○
	Type of Support	Bearing Pile	/	○	○	○	○	○	○	○	○	○	○	○	○	○	/	/	/	/
		Friction Pile	/	○	○	○	/	/	/	/	/	/	○	○	○	/	/	/	/	/
Work Conditions	Work Above Water	Water Depth less than 5m	○	○	○	○	△	△	△	△	△	△	×	○	△	×	△	△	○	×
		Water Depth 5m or more	×	△	△	○	△	△	△	△	△	△	×	△	×	×	△	△	○	×
	Narrow Working Space		○	△	△	△	△	△	△	△	△	△	△	△	△	○	△	△	×	△
	Batter Pile		/	△	○	○	×	×	×	△	△	△	△	×	×	×	/	/	/	/
	Effects of Harmful Gas		△	○	○	○	○	○	○	○	○	○	○	○	○	×	×	○	○	○
	Environment	Anti-vibration / Anti-noise Measures	○	×	×	×	△	○	○	△	○	○	△	○	○	○	○	○	△	○
		Effects on Neighboring Structures	○	×	×	△	△	○	○	△	○	○	○	○	○	△	△	△	△	○

○：Highly Applicable △：Applicable ×：Less Applicable

Fig. -2.3.10 Work cost ratio by pile diameter



(3) Road plan

a) Horizontal alignment

The horizontal alignment that meets the following conditions was selected:

① Nearly parallel to the existing road and shifted about 3 m downstream at the bridge section

② Run-off to the straight section of northern improved section and a starting point at southern unimproved section

③ Compliance with Type 3, Class 1 road standard values

b) Vertical alignment

The vertical alignment was determined under the following conditions:

① Is in accordance with the alignment planned for the road improvement plan of Road No.4 as a whole

② Vertical alignment of bridge to be approximately the same as for the existing bridge

③ Since no improvement is made on the existing side, the new approach road section is higher than the existing section. It was planned to contain the slope within the width of median.

④ The manhole near the end point at the northern unimproved section is about 60 cm higher than the planned height of the road improvement plan. Since this height can be reduced by only about 30 cm structurally, it is necessary to change the vertical alignment including the existing improved section.

Fig. -2.3.11 shows an overall view of horizontal and vertical road alignments.

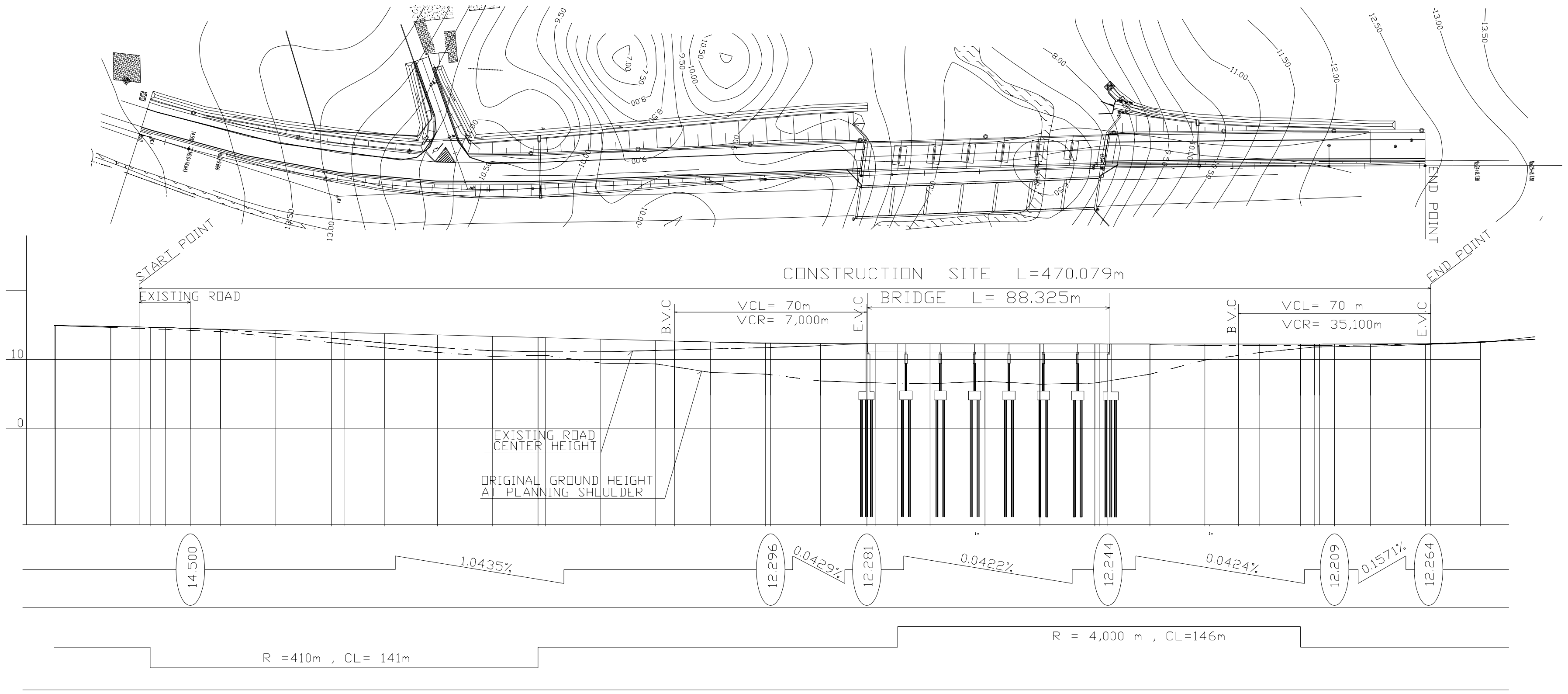


Fig.-2.3.11 Horizontal and vertical alignment of the Road

c) **Revetment and bed protection works**

The waterway varies greatly depending on revetment and bed protection works. In this project, these protection works are provided to ensure a stable channel and bridge safety, etc.

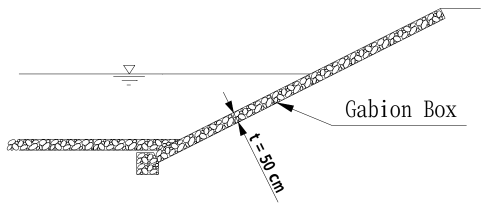
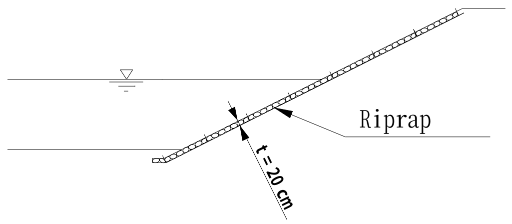
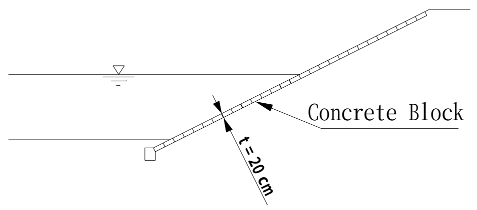
The river bed under the existing bridge is provided with a bed protection concrete work about 40 m wide in the front and rear of the existing bridge. Before the existing bridge was constructed, the river area was used as a road during the dry season. This concrete bed protection was used also as a road pavement. Measurement of the concrete thickness at the end showed about 70 cm

.

The entire slope of approach embankment in the front and rear of the bridge is protected with mortar masonry (Stone Riprap) because the river meanders substantially in the front and rear of the bridge, with the flow directly running into the embankment when the water flow increases in the rainy season.

Under the circumstances described above and considering the effects on the existing bridge foundation and embankment, it is appropriate to provide the new bridge with a bed protection of concrete and an embankment slope protection of mortar masonry. Table-2.3.12 shows a comparison of revetment work types.

Table -2.3.12 Comparison of revetment types

	Gabion Box	**Riprap**	**Concrete block**
Illustration			
Structure	• Gabions and wire mats are available. • Flexible structure, enabling application to any topographical condition • Tends to be sucked out readily in the case of sandy soil ×	• Stones must be arranged in a regular pattern. • Easy to match to the topographical condition • Structurally most stable ○	• Installation of prefabricated concrete blocks in a regular pattern. • Leveling stones needed under concrete blocks to ensure flatness. • Not applicable to the complicated topographical condition △
Construction	• Easy to work because it is sufficient to load stones into the wire mesh. • No experience in this kind of work locally ○	• Lay stones after leveling of the ground • Filling to be made with concrete or mortar • Same construction as the existing embankment ○	• Lay concrete blocks after leveling of the ground • Filling to be made with concrete or mortar • Curing of fillers necessary △
Maintenance	• Only loading of stones to points where stones are lost necessary • Maintenance necessary for broken wire mesh ×	• Easy to maintain and repair because only filling of points where stones are lost is necessary. ○	• Repair of lost portion is difficult. ×
Economy	1.10 ×	1.00 ○	1.30 ×
Evaluation	×	○	×

2) Construction method

The Construction method is described below.

a) Construction of foundation

Cast-in-place piles are selected according to the ground condition. This method allows excavation while checking the ground condition and soil quality, which means the bearing layer can be confirmed. Since the ground is sandy, with groundwater, it is necessary to perform the work with a benoto-boring machine while using a casing that can prevent collapse of the pile wall during excavation.

In the Gaza Strip, there is little record of construction of structures using pile foundations and there are no machines that can perform excavation under these ground conditions. Therefore it is necessary to procure the drilling machine in Japan or a third country and bring it to the Gaza Strip. Besides, there is only a small amount work with piles, and the knowledge and technology of local engineers are considered low. It is essential that Japanese engineers conduct thorough guidance and control of the work.

b) Construction of the substructure

An inverted-T abutment and wall pier are selected for the substructure. As the work is made in the river, construction of the foundation and substructure is basically to be made during the dry season when there is almost no water in the river. The work will be in the neighborhood of the bridge currently in service, which means the following construction methods are considered:

① The groundwater level is about 5 m under the river bed, so there is no water-related problem during the footing work. Since the existing river bed is provided with bed protection concrete work, open excavation will cause a wider breakage area of bed protection work and present problems in terms of safety of the existing abutment. To overcome this problem, earth retaining is made by means of the soldier piles and lagging method with H steel to protect the existing piers and abutments during excavation.

② Excavation is made with a backhoe, with due care not to damage the head of foundation piles.

③ After arrival at the specified excavation depth, the pile head is treated, the excavated bottom surface is leveled, cobblestones are laid, and levelling concrete is placed.

④ After footing reinforcing bar assembly, form installation, footing concrete placement, the structure is to be built in two or three separate blocks.

⑤ At the specified height, sufficient back-filling is made up to the surrounding ground level.

⑥ Broken bed protection concrete is recovered to the original condition.

c) Construction of the superstructure

For the superstructure, the all-staging method is economical because the river inside can be used. As the wet season begins in October, the water flows in the river during a period from November to February, with the water level expected to reach 1 to 3 m. Construction of the superstructure may extend into the wet season, so a special falsework using H steel that is safe even in flowing water should be used.

・Construction of the superstructure with special falsework

① After the substructure work, comes the bed protection work, followed by fixing of the special falsework with H steel to the substructure.

② The normal framed falsework is placed on the special falsework work and the form is set.

③ Main girder and slab reinforcing bars are arranged.

④ Concrete placement and curing is used for all spans or for several grouped spans.

⑤ After confirmation that the concrete has reached the specified strength, the form and falsework are removed.

⑥ Bridge surface works, such as curbs, expansion joints, and railings, are attached, followed by the pavement.

CHAPTER 3

Chapter 3 Implementation Plan

3-1 Implementation Plan

3-1-1 Implementation Concept

Considering the study results described in previous sections, the project implementation plan is proposed below.

1) Construction Period

The work content consists of preparatory, temporary road, bridge, access road, and revetment/bed protection works. The work period is 12.5 months, from mid-March 2001 until the end of March 2002. Five months of the period from October to February are the rainy season, although the amount of rainfall is small.

The substructure and the falsework for superstructure as well as revetment and bed protection works up to the high water level are to be completed before the beginning of the rainy season. During the rainy season, the superstructure and the base course work of the access road will be constructed.

2) Construction methods

The flow chart of work is shown in Fig.-3.1.1.

(1) Temporary construction road for the work

The temporary construction road is provided to transport materials and equipment into the construction yard near the bridge location and into the river area.

(2) Foundation work

Cast-in-place piles according to the all casing method have been selected due to the depth of the bearing layer at the bridge location and the soil condition. As the river bed is provided with bed protection concrete work, bed protection concrete within the excavation range shall be removed before the driving of foundation piles.
Excavation will be done to the bearing layer with a benoto-boring machine while preventing collapse of the boring wall with a casing. Upon completion of excavation, a prefabricated cage will be sunk and concrete will be placed using a tremie pipe.
The excavation machine and casing will be procured in Japan and brought into the site.

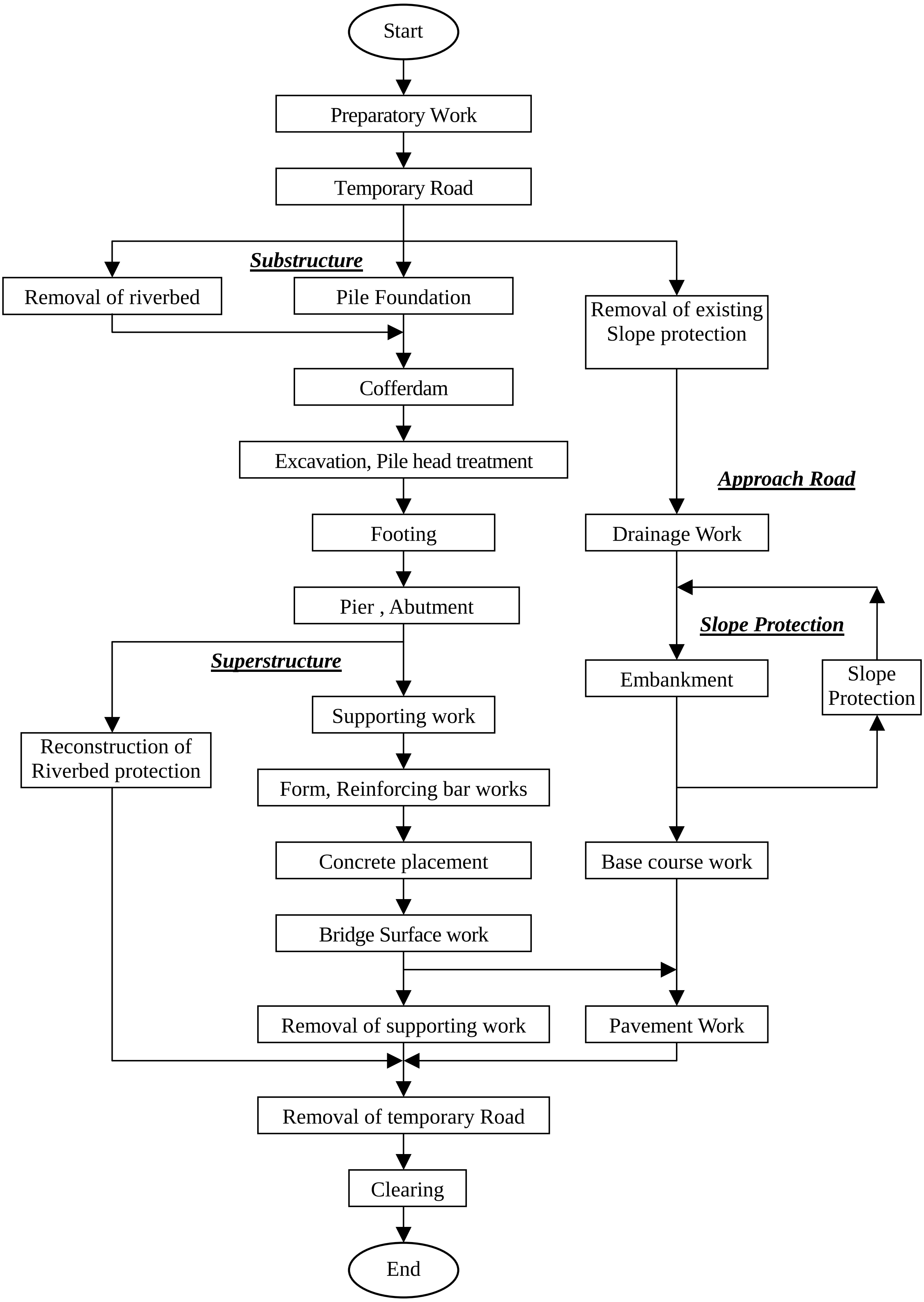


Fig.-3.1.1 Construction Flow Chart

(3) Substructure

The substructure which consists of two inverted-T abutments and six wall piers, shall be completed before the rainy season. For this purpose, a maximum of four parties of workers will be to take part in the construction work that should proceed sequentially from the substructures whose pile foundations are completed. In order to minimize effects on the neighboring existing bridge and break-up of bed protection concrete, excavation will be done according to the solder piles and lagging method using H steel.

① After driving of cast-in-place piles, excavation will be done according to the soldier piles and lagging method using H steel.

② Excavation is done by backhoe with care not to damage driven piles.

③ After arrival at the specified depth, the excavated bottom surface will be leveled, cobblestones are laid, and leveling concrete is placed.

④ After pile head treatment, comes footing reinforcing bar assembly, installation of the form, and concrete placement.

⑤ The structure is divided into two blocks and reinforcing bar arrangements. Installation of form, and concrete placement will be made sequentially for each block.

⑥ Upon completion of the substructure, lagging will be removed while performing back-filling.

⑦ After back-filling along with thorough compaction, the bed protection work with concrete will be made.

(4) Superstructure construction

The superstructure will be constructed according to the cast-in-place method through all-staging. As the work period may extend into the rainy season, the special falsework with H steel is used to cope with any flooding, and the work is to be completed before the rainy season. The construction procedure is described below:

① Upon completion of the substructure, the falsework is constructed over all spans by using H shaped steel, etc.

② Rubber shoes and anchor bolts are set to abutments and piers.

③ The form is installed on H steel while adjusting the height with the framed falsework.

④ Main girder and slab reinforcing bars are put in place, starting from a point where the form is completed.

⑤ Superstructure with seven spans is divided into two blocks. Then the main girder and slab concrete will be placed.

⑥ The expansion joint and curbstones are set and the bridge surface works such as curbs, railings are installed.

⑦ In line with the progress of earth works, asphalt pavement will be laid.

(5) Construction of the approach road

The approach road is the widened portion of existing road, which means the existing slope shall be bench-cut for integration in the embankment section. As the slope is provided with protection of mortar masonry, it shall be removed on the widening side. It is also necessary to build the embankment and revetment to a height of 3 m above the river bed before the rainy season.

① As soon as the preparatory work is completed, the embankment work will be started except for the backside of the abutment.

② The slope protection work with mortar masonry in the existing embankment section shall be broken up and removed according to the construction stage.

③ Soils appropriate for embankment are gathered in a nearby borrow pit and transported into the site for leveling and compaction.

④ When the embankment is built to a certain height, the slope protection work with mortar masonry will be done in parallel.

⑤ The base course work is made separately for the sub-base and base courses, and thorough compaction is made after leveling.

⑥ Pavement will be laid with asphalt concrete for both the binder and surface courses.

3) Utilization of local engineers and materials/equipment

Local engineers lack bridge construction experience, and the level of bridge construction technology is not high. The projects therefore, relied mostly on foreign technologies. In particular, most of the public works have been conducted with foreign assistance, and design services and preparation of a series of bid documents and specifications were entrusted to foreign consultants in many cases.

In this context, it is important to transfer technologies adequately for each part of the work to help local engineers acquire sufficient technology levels. Moreover, technology transfer should include specifications concerning the design of roads and bridges in Palestine. Such specifications do not exist here, and projects have been implemented on the basis of donors’ specifications.

Building machinery in the Gaza Strip includes that possessed by the governmental agencies and private enterprises. In general, constructors possess their own machinery, and there is no machinery lease industry.
In the Gaza Strip, there is a shortage of heavy machinery necessary for bridge construction. In addition, there are not many experienced heavy machinery operators. It is therefore necessary to procure machinery and recruit experienced operators from neighboring countries. Procurement in Israel is difficult because of political problems.

This project is intended to achieve maximum utilization of locally-available materials and equipment. Principal equipment that must be imported from a third country includes the pile driver and vibro-machine.

4) Utilization of local constructors

Local constructors have reached a certain level of road construction technology, but it is difficult to say that they are sufficiently advanced technologically for bridge construction. Although this project does not include any work requiring high technology, local constructors are less experienced in pile foundation and not so conscious about the quality. Therefore, it is essential that the Japanese constructor provide supervisory and guidance services. By providing local constructors with an opportunity to participate as subcontractors, the construction technology of Palestine will be greatly enhanced.

5) Dispatch of Japanese engineers

Engineers are to be dispatched from Japan for the type of work that requires special technology or that greatly affects quality after completion. This includes foundation pile, bearing, embankment, base course, and pavement works.

3-1-2 Implementation Conditions

It is necessary to prepare a feasible implementation plan for the project while taking into account meteorological conditions (dry and rainy seasons) unique to the Gaza Strip. Particular attention should be given to the materials/equipment procurement situations.

1) Scheduling mainly during the dry season

The dry and rainy seasons are clearly identified. In the dry season, the Wadi Gaza River over which the bridge is to be constructed completely dries up. In the rainy season from October to February, rain does not necessarily fall consecutively every day. As the catchment area of this river is wide, rain will cause a water depth of about 1 to 3 m at the bridge location. With due consideration of the effects on the work during the rainy season and the countermeasures, the implementation plan must be established to complete the work for foundation, substructure and falsework for superstructure totally during the dry season.

As this project is for new construction and widening of the existing trunk highway bridge, there is no problem at all in terms of access to the site, and materials and equipment can be brought to the site even on rainy days. However, the access road to the site under the bridge and the material/equipment yard and construction yard near the site must be constructed with due consideration for the river water level.

As the superstructure construction period may extend into the rainy season, the falsework must ensure complete structural safety against the river flow. During concrete placement, it is necessary to always have a waterproof sheet. In certain cases, a roof will be needed to cover the placement location, to prevent mixing of rainwater into the concrete and thus causing qualitative damage of concrete. From the viewpoint of quality control, the storage yard and plant for materials, such as concrete, reinforcing bars, etc. must be provided with thorough drainage facilities and with a waterproof sheet to protect materials from rain water.

2) Land acquisition and leasing

Prior to the start of the work, it will be necessary to secure the land required for the work and to remove or transfer beforehand any obstacles that may hinder the work.

① Land acquisition and transfer of obstacles

Agencies concerned of the Palestinian Interim Self-Government Authority will undertake, in compliance with the basic design, land acquisition and removal and restoration of public utilities that may hinder the construction work. The Ministry of Public Works which will be informed of materials that may have to be moved, will coordinate handling this problem with agencies concerned.

Procedures of each agency concerned require time, which means it is necessary to request action beforehand.

At present, the river area at site is an illegal dumping site with heaps of concrete and other industrial waste. In addition to hindrance to the work, this presents critical problems in terms of flood control and safety of the river. The Ministry of Public Works, which has jurisdiction over the road site, will directly remove wastes dumped within this area. The river area outside the site is administered by the Ministry of Environmental Affairs. This Ministry will remove dumped waste. It is necessary to execute the procedure through MPW to complete removal of waste before the work starts.

Table-3.1.1 shows the obstacles that may have to be removed before construction work. As regards the sewage system, some of the drain pipes near the site are broken, and must be repaired beforehand. The crest of one existing manhole is above the design road height and thus its height must be adjusted during the work.

Table -3.1.1 Obstacles to be transferred

Obstacles to be transferred	Agencies concerned
Electric wires, poles （transfer）	Ministry of Public Works (MPW)、Palestinian Electric Authority（PEA）
Drain pipes （repair）	MPW、Gaza City Office
Fences of private houses (remove）	MPW

② Land for temporary facilities for work

It is necessary to secure the temporary facility land for installation of temporary site office buildings and temporary equipment and for storage of materials and equipment during construction. Table-3.1.2 shows the probable land and application.

Table -3.1.2　Temporary facility land for work

Candidate place	Application
① South side of the new bridge ② West side of the access road	Access road Construction materials and machinery storage, reinforcing bar and form yard

③ Bypass road (Diversion)

This project is for construction of a bridge to increase the number of traffic lanes. As the existing bridge will remain in service during the work period, there is no need to provide a bypass road.

④ Traffic regulation

Basically, ordinary traffic will not be closed and a detour route will not be provided. During transport of materials and equipment into the site or construction of run-off to the existing road, traffic regulation by means of traffic control or supervision is to will be done after obtaining approval from agencies concerned.
In such cases, necessary notice boards, safety equipment and traffic guides shall be arranged to ensure safety during the work.

3) Customs clearance and tax exemption

When materials / construction machinery, they are not procurable in Palestine, are imported, they will be first landed in Israel for tax exemption procedures from the Palestinian side to the Israeli side in addition to normal required procedures. It is necessary to obtain the advance understanding of the Palestinian Interim Self-Government Authority to ensure smooth customs clearance. For this purpose, the following procedures must be followed:

- ■To prepare a master list of materials and equipment to be imported and to submit the list to the owner for approval.
- ■After submission of a master list to Palestinian agencies concerned, the request document for exemption from import tax and others will be issued by the Palestinian side to the Israeli side.
- ■After entry of imported materials and equipment, Customs clearance of the Israeli side will be proceeded.

■ After customs clearance in Israel, materials and equipment will be transported with Palestinian trucks to the site in a convoy system

Concerning this project, we have received, at the time of the basic design study, a Ministry of Finance letter to the effect that the VAT tax exemption measure related to local services and materials transaction is applied. The Ministry of Public Works, which is the Palestinian implementing agency, explained that, with the following procedure, the tax exemption measure is fully executed. It is considered necessary to explain specific measures separately.

■ When the Japanese contractor makes an agreement with the local constructor as a subcontractor, measures to receive the tax exemption will be taken from the very beginning. Namely, a system in which the local constructor will not present a VAT request will be established.

■ When the Japanese contractor will purchase materials locally, a list of these materials shall be submitted beforehand to the Ministry of Public Works for approval. With presentation of the certificate issued by the MPW to the supplier, imposition of VAT will be prevented.

4) Safety measures

From approaches of four lanes the existing bridge road narrows to two lanes in each direction. Even in the present condition, traffic accidents occur frequently here. As the work is made in the vicinity of the existing road, it is essential to ensure the safety of ordinary vehicles.

The field office is planned near the bridge location, in which domestic and international telephone lines can be installed. The system must enable emergency communications.

3-1-3 Scope of Works

This project will be implemented while Japan will bear the total responsibility.

3-1-4 Consultant Supervision

During the construction period, the consultants will dispatch the Japanese resident engineer and the staff for supervisory and guidance of principal works. Job assignments among the principal staff are described below.

1) Project Manager

Project manager manages the detailed design, bidding and supervision of construction concerning the project.

2) Resident supervising engineer

The engineer resides at the site from the beginning to the end of the project, taking charge of technical jobs, such as quality control, process control, safety control, etc. and a series of clerical procedures. During construction period, this engineer is also in charge of supervision and witness inspection for the bridge, road, base course, pavement, and appurtenant works.

3-1-5 Procurement Plan

1) Labor conditions

(1) Construction engineer

Most construction laborers in Palestine are those who have been guest workers in Israel or those who fled to Yemen, Morocco, and Kuwait and other Gulf countries during the Israeli occupation. They are considered to present no problem except as special workers for bridge construction. In the Gaza Strip, about 60 enterprises, some of whose registered job are ranked as first class, are registered for public works, including local construction companies owned by Palestinian and joint ventures with Egypt, Italy, etc. Therefore, Palestinians will be employed for labor including work in the facilitator (foreman) class.
Employment of Israelis is impossible because of political issues.

(2) Laborers from third countries

Employment of laborers from a third country is practically impossible. Reasons are that matters related to entry into Palestine, such as obtaining a work visa in Palestine, etc. are under the control of Israel, and entry from surrounding Arab countries other than those friendly forward Israel (Jordan, Egypt) is strictly regulated to make entry into Israel practically impossible.

2) Construction materials

In this project, the quality and availability of the construction materials and equipment that can be produced or procured in Palestine and Israel were studied in order to utilize them. As of the study (May, 2000), principal construction materials, such as ready-mixed concrete and asphalt were produced in Palestine and procurable in sufficient quantity. Cement, coarse aggregate, and asphalt are procured in Israel and there is no shortage of these materials. However, a strike once occurred in the West Bank, causing a shortage of supply of coarse aggregate, resulting in the temporary shutdown of plants or temporary price rises.
The study result is described below for the present state of principal materials.

(1) Concrete

There are 11 ready-mixed concrete plants in the Gaza Strip (including five private plants in the suburb of Gaza city), and the production of each plant is more than $90m^3$/hour which is enough to meet the demand of this project. One of plants has received ISO9002 certification. There is no mixing machine in plants. They use the method of mixing by truck mixers. This means due consideration must be given to the mix design to ensure a stable supply of high-quality concrete for bridge construction.
There are three plants from which concrete can be transported to the site in 10 to 15 minutes. Procurement of concrete from these plants is considered appropriate.

Cement necessary for production of ready-mixed concrete is produced in Israel and cement transport is totally dependent on the transportation company. As regards aggregate, coarse aggregate is supplied from Israel while fine aggregate is available in the Gaza Strip. Similarly to the case of cement, coarse aggregate is transported from Israel by the transport company. Accordingly, procurement of concrete is not considered a significant problem.

(2) Fine and coarse aggregates

Coarse aggregate is supplied from the quarry in the West Bank and stocked at the El-Matar entry point from Israel, which is located to the north of the Gaza Airport. All aggregate used in the Gaza Strip is transported from here. Judging from the stock amount, there is no problem in terms of supply capacity.
A prolonged strike at the quarry in the West Bank could cause quarry production to be suspended and a shortage of crushed stone, resulting in a price rise. This in turn would

cause an increase in the concrete price in the Gaza Strip, which often leads to suspension of production itself.
Fine aggregates are produced by strip mining in the Gaza Strip, which is under the control of the Gaza Municipality. There is no problem in terms of quality and supply.

(3) Reinforcing bar

Reinforcing bar is either produced in Israel or imported via Israel, and is based on the British Standard. As reinforcing bar is expensive in Palestine, it is essential to take measures to reduce cutting loss.

(4) Forms

In Palestine, plywood for forms is extremely expensive. To reduce the work cost, it is necessary to consider efficient diversion of forms.

(5) Asphalt concrete

In the Gaza Strip, there are three private plants (two in the suburb of Gaza and one in Rafah), and the production of each plant is 150 t/hour, so there is no problem in supply capacity and quality. The raw material or asphalt emulsion is imported, and is one of the materials under control of the Israeli Government. Since it is to be procured via Israel, it is necessary to establish the implementation plan while coordinating the pavement time and plant supply rate.

Table -3.1.3 shows suppliers of principal construction materials.

Table -3.1.3 Suppliers of principal construction materials

Construction materials	Local procurement	Procurement in Japan	Procurement in third country	Remarks
Cement	○			Israeli product
Concrete admixture	○			Israeli product
Reinforcing bar	○			Israeli product
Structural steels	○			Israeli product
Bitumen	○			Israeli product
Sand	○			
Crushed stone	○			West Bank product
Ordinary wood	○			Israeli product
Form (plywood)	○			Israeli product
Falsework/ scaffold material	○			
Expansion joint (rubber)		○		Quality improvement
Bearing (rubber)		○		Quality improvement
Concrete pipe	○			

3) Construction machinery

Construction machinery includes those owned by Government agencies and those owned by private enterprise. Generally, construction companies have their own machinery, but the range of models is narrow and quantity is low. Accordingly, these are rented mutually among companies. Basically, it was confirmed that construction machines other than large cranes (50 t or more) and tower cranes are operating within the Gaza Strip. Special machines, such as pile drivers, prestressing jacks, etc. are not available in the Gaza Strip, and must be procured in Israel, the West Bank, or a third country. Rental from Israel is considered impossible due to political issues.

(1) Construction machines possessed by the government agencies

Table -3.1.4 shows construction machines supplied by the Japanese Government and possessed by the MPW. Since they are currently used for construction of the Palestinian Interim Self-Government Authority building and road maintenance it will be difficult to use them in the project.

Table -3.1.4 List of equipment supplied by the Japanese Government （Supplied in 1996）

No.	Machine	Q'ty	No.	Machine	Q'ty
1	Bulldozer	1	14	Asphalt finisher	1
2	Excavation machine	1	15	Asphalt distributor	1
3	Wheel loader	2	16	Plate compactor	3
4	Motor grader	2	17	Rammer	1
5	Dump truck	10	18	Air compressor	1
6	Cargo truck	1	19	Pick hammer	2
7	Water tank	1	20	Concrete mixer	3
8	Truck crane	1	21	Asphalt sprayer	3
9	Rubber tired roller	1	22	Equipment service tools	1 set
10	Truck trailer	1	23	Geological and asphalt testing equipment	1 set
11	Service car	2	24	Temporary equipment	1 set
12	Vibration roller	2	25	Auxiliary equipment for training	1 set
13	Hand guide roller	3			

(2) Construction machinery procurable in the Gaza Strip

Table 3.1.5 shows construction machines procurable in the Gaza Strip. Since these machines are limited in number and the operation factor is extremely low, the work without time allowance requires procurement of them a sufficient amount of replacement parts outside the Gaza Strip.

Table-3.1.5 Construction machinery procurable locally

Machine	Standard
Motor generator	150kva 、200kva
Concrete mixer	0.3m^3
Backhoe	0.35m^3、0.9m^3
Truck crane	5t ～25t
Crawler crane	35t、50t
Asphalt sprayer	200 litres
Asphalt finisher	2.4～5m
Tractor shovel	1.8 m^3
Dump truck	4t、10t
Air compressor	5 ～10 m^3/min
Concrete vibrator	1 kw
Vibration roller	8～20 t and manual
Tamper	600～800kg
Bulldozer	11t、 15t、 21t
Macadam roller	8～12t
Rubber tired roller	8～20t
Road sprinkler	5,500～6,500litres
Submerged pump	150mm
Concrete breaker	30kg
Motor grader	3.1m
Trailer	40t
Truck with crane	4t、2.9t capacity
Truck	4t
Asphalt cutter	
Backhoe ＋ breaker	0.6 m^3 1.0m^3

(3) Construction machinery to be procured outside the Gaza Strip

Special construction machinery is difficult to procure in the Gaza Strip. It is therefore necessary to procure it outside to ensure smooth implementation. Machines to be procured outside the Gaza Strip are shown in Table-3.1.6.

Table -3.1.6 Machines to be procured outside Palestine

Machine	Specification / Capacity
Vibro-hammer	46kw
Benoto boring machine	For φ1000

4) Local constructors

(1) Local constructors

There are many constructors in the Gaza Strip and they form a constructors' association for construction business registration. Constructors are ranked according to the scale of company, and the rankings are reviewed every three months by the public office on the basis of public works achievement.
Table -3.1.7 shows major constructors registered as Rank A.

Table -3.1.7 Major constructors list

Name of company	Representative	Phone No.
Assel Trade & Construction Co., Ltd	Osman Al Khuzundar	07-286-3077
Middle East Development Association	Wael Al Shurafa	07-284-5828
Saqqa & Khoudary Company	Suheil Al Saqa	07-282-3164
Amer Mohanna & Partners Company	Amer Mohanna	07-286-6546
Palestine Development Company	Bashar Isa Helal	07-282-0282
Mushtaha & Hassouna	Safwat H. Mushtaha	07-284-7801
Arab Contractor Palestine	Nabil Todary Mankarios	07-282-3415
El Farra Contracting & Trading Company	Ahmed G. Al Masri	07-205-1364
Arab Structural Bureau Co., Ltd	Nnabil Mausa Seyam	07-286-3140
Bonyan International Group	Walid Kh. Abou Shaaban	07-282-7564
Al Zafer General Contracting & Trading Co., Ltd.	Mohd Abu Mazkour	07-282-1049
Mohanna & Partner Company	Omar Mohanna	07-282-1453

(2) Foreign constructors entering in Palestine

Constructors entering Palestine establish joint ventures with local constructors. In Table-3.1.7, Arab Contractor Palestine is a joint venture with an Egyptian enterprise and Palestine Development Company is a joint venture with an Italian enterprise.

3-1-6 Implementation Schedule

This project is implemented according to the following process after conclusion of the Exchange of Notes.

1) Consultant agreement and implementation

After the consultant agreement, the detailed design will be established and the design documents and tender-related documents will be prepared.

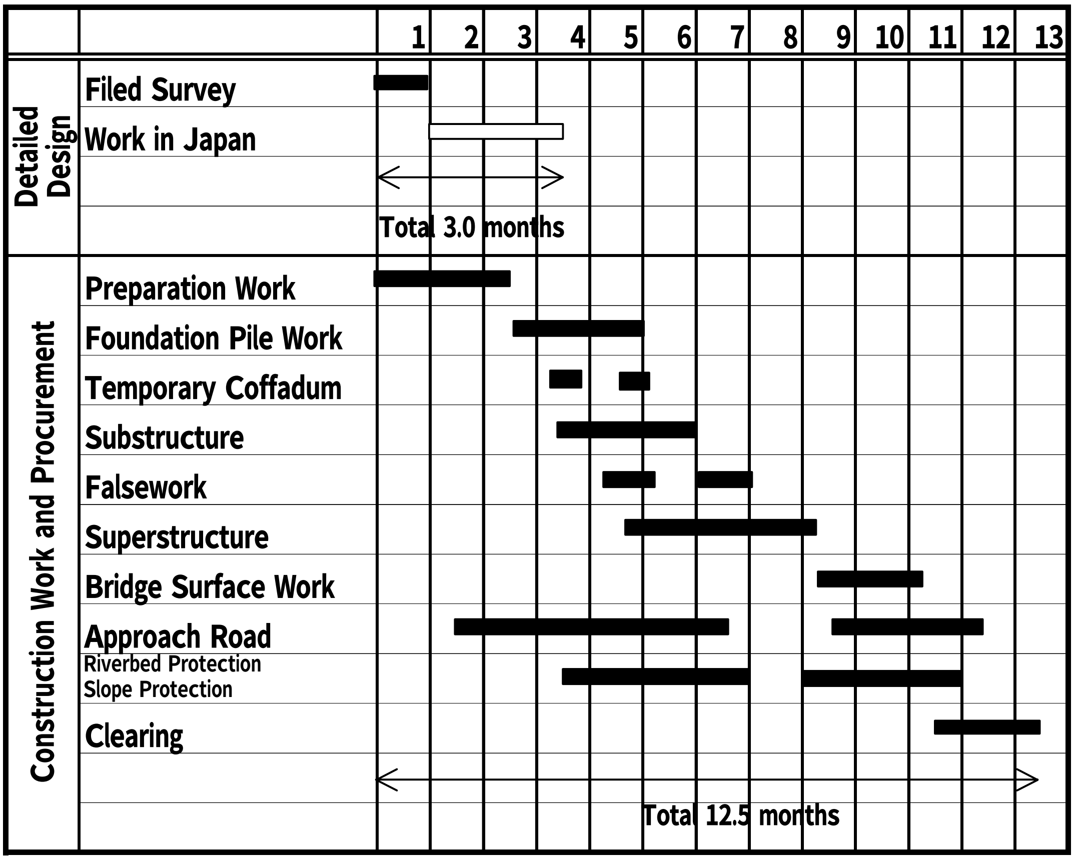
2) Scheduling

The project agreement will be concluded between the Palestinian Interim Self-Government Authority and the Japanese contractor. As a rule, the Japanese contractor shall be selected through open tendering among Japanese contractors.
Prequalification of the approved constructor will be examined on the basis of examination items determined beforehand through coordination with JICA. For the prequalification, the consultant acts on behalf of the implementing agency of the Palestinian Interim Self-Government Authority.
Bid evaluation and determination of the successful bidder will be made in the presence of the Palestinian Interim Self-Government Authority, consultant, and bidders and witnessed by the JICA staff in charge. Subsequently, the project agreement is concluded.
In parallel with conclusion of the project agreement, the Palestinian Interim Self-Government Authority accepts the assistance fund from the Japanese Government and concludes the banking arrangement as soon as possible with the Japanese bank to open and operate the special account to make payment to the Japanese contractor. This banking arrangement is the basis on which the Palestinian Interim Self-Government Authority issues an authorization to pay (A/P). This A/P is necessary when the Japanese contractor submits the application to receive advance payment according to the payment term of the agreement or for receiving the export authorization from the Ministry of International Trade and Industry. This A/P is essential to start implementation concurrently with conclusion of the agreement.
Next, the contract must be verified. Verification of the contract means that the Japanese Government acknowledges that the contract thus established is appropriate as an object of grant aid. Verification of the contract is a requirement for coming into force of the contract. Specifically, the Ministry of Foreign Affairs sends away for the contract from the Palestinian Interim Self-Government Authority via the Japanese Overseas Establishment, determining appropriateness of such approval. Upon receiving the verified contract and the A/P, the Japanese contractor implements the contract.

3) Construction work

Preparatory work is followed by the main work, such as construction of temporary roads, substructure, superstructure (girders, bridge surface), and access road, and appurtenant works such as the revetment work. Finally, materials and equipment related to the work are cleared from the site. As the period from October to February is the wet season around the site, the bridge substructure must be completed before October.
The implementation schedule of the project is shown in Table -3.1.8. Implementation requires about 12.5 months for completion.

Table -3.1.8 Service implementation process chart



3-1-7 Obligations of Palestinian Interim Self-Government Authority

1) Removal of obstacles, etc.

The obligations of the Palestinian Interim Self-Government Authority includes land acquisition, demolition of buildings in the site, removal of illegally dumped industrial waste in the river area and at the construction site, securing of the construction yard, and transfer of power transmission lines.

Table -3.1.9 Obstacles to be removed and transferred

Obstacles	Measure	Agencies concerned	Remarks
Electric wire and poles	Transfer	MPW, PEA	About three to six months required after application for transfer
Drain pipeline	Repair	MPW, Gaza Municipality	
Industrial waste dumped illegally in river, etc.	Remove	MPW, MOEA	
Fences of private houses	Remove	MPW	Within the road site

The area of the land to be expropriated for the project is estimated as follows:

① Bridge and road construction site related to the project
(Inside of the right-of-way with 26.5 m width on both sides of road center line) :

Approx. 8,500 m^2

② Temporary site （Candidate site to be on either left or right bank of the existing bridge）:

Approx. 4,175 m^2

Temporary yard	30m	×100m	=	3,000 m^2
Temporary road	5m	×235m	=	1,175 m^2
				4,175 m^2

Power transmission line and telephone line to be transferred for this project is estimated as follows:

③ Transmission line to be transferred for this project : Approx. 400 m (including three poles)

2) Construction of facilities

In this project, construction of the following facilities is included in the scope of responsibility of the Palestinian counterpart:

① Extension of electricity and water supply equipment necessary for the construction work into or to a point around the construction site

3-2 Project Costs Estimation

1) Expenses by Palestinian Interim Self-Government Authority

Table -3.2.2 Estimated project cost (US $=JPY 107)

Classification of project cost	Cost (¥ million)	Remarks
(1) Transfer cost	5.4	
Electric wire and pole transfer cost	5.4	Implemented by MPW、PEA 400 m×50 $/m＋3 No.×10,000 $/No.＝ 50,000 $ 50,000 $ ×107 ¥/$ ¥5,355 thousand
(2) Land acquisition cost	0	No compensation necessary because the land is within the right-of-way
Total	5.4	

2) Estimate conditions

① Time of estimate : August 2000

② Exchange rate : 1US $＝JPY 107

③ Implementation period : Detailed design and work periods are as shown in the implementation schedule.

④ Others : This project is implemented according to the grant aid system of the Japanese Government.

3-3 Operation and Maintenance Cost

Upon completion of the project, the Palestinian Interim Self-Government Authority will undertake maintenance of the constructed bridge.

1) Maintenance method

In order to effectively utilize the limited budget of the Palestinian Interim Self-Government Authority, a maintenance method based mainly on daily and periodical inspections will be employed. The method will enable early damage detection and early countermeasures, thereby preventing major damages, such as scour of the abutment by river water, collapse of revetment, collapse of slope, etc.

① Daily inspection

Patrols with inspection vehicles is made on the route concerned about once a month, with check made on the road surface, shoulder, and slope from inside the vehicle. The condition is to be recorded on recording paper and reported to the engineer. The personnel assignment consists of a three-person system, including an inspector, recorder, and a driver.

② Periodical inspection (after the wet season)

In-depth inspection is made for adequate appreciation of the situation mainly at locations where no abnormality requiring emergency countermeasures has been reported and on the shoulder of the route immediately after completion. As regards the bridge, a survey must be made not only of the bridge main body, but also of the revetment condition, river scour condition, sand sedimentation in river bed, etc. after lowering of the water level. On the basis of survey reports, the engineer judges the necessity of repair and arranges for immediate repair if necessary.

2) Maintenance system

In order to establish the maintenance system as described above, the plan must be prepared within the maintenance system of Palestine.

① Establishment of the daily inspection group in the Gaza Strip. The group composition is as follows:

- Engineer : 1
- Inspector, recorder, driver : 2
- Record storage : 1

② The system must be developed for rapid action on the basis of daily inspection results when minor repairs become necessary.

③ A maintenance manual must be developed, and personnel training of inspector and recorder must be made according to the plan through dispatch of an expert.

④ The record of daily inspections must be data-based for use to achieve accurate estimates of required maintenance costs.

⑤ A system must be established for storage of drawings (as-built drawings, property register) of this project for use in future repairs.

3) Operation and maintenance costs

The content and costs of maintenance services expected for the ten years after completion of this project are shown in Table-3.2.3.

Table -3.2.3 Maintenance services and costs

Interval	Description	Cost
Every year	①River bed repair ②Revetment repair ③Pavement repair (patching)	1,800m2 x 4 $ x 15% = 1,080 1,600m2 x 4 $ x 10% = 640 4,200m2 x 3 $ x 10% = 1,260
	Sub total	2,980
Every five years	①Bridge surface repair ②Medium scale repair of river bed ③Medium scale repair of revetment ④Overlay of pavement	1,000m2 x 4 $ x 20% = 800 1,800m2 x 5 $ x 20% = 1,800 1,600m2 x 5 $ x 20% = 1,600 4,200m2 x 6 $ x 10% = 2,520
	Sub total	6,720
Cost for ten years		2,980 x 10 + 6,720 x 2 = 43,240

The required maintenance cost is estimated as follows:

43,240 $／10 years 4,400 $／year

The ratio of the above maintenance cost（4,400 $／year） to the existing maintenance cost （1,600,000 $／year）is approx. 0.3%. Its ratio to the existing MPW budget （6,800,000 $／year）is approx. 0.1%.

Accordingly, it is judged that the Palestinian counterpart can bear the maintenance cost through priority allocation of maintenance costs to the management of the bridge concerned.

CHAPTER 4

Chapter 4 Project Evaluation and Recommendation

4-1 Project Effect

Road No.4 on which the bridge covered by the project exists is a principal trunk road running north to south through the Gaza Strip from Erez on the border to Israel with Rafah on the border with Egypt. This is not only a regional road in the Gaza Strip, but also an important road for transport of materials to Israel and Egypt. The road development plan is a top priority item in the infrastructure development plan of the Palestinian Interim Self-Government Authority. Improvement mainly of trunk roads and local roads is planned, and development of Road No.4 is the top priority project in the Gaza Strip. Improvement into a four-lane road is currently under way for the section north of the bridge planned point with support from the World Bank and Japan-Palestine Fund of UNDP.

Accordingly, Road No.4 will becomes a four-lane road from Erez to Khan Younis. Yet,only the bridge crossing the Wadi Gaza located approximately in the middle of this section is left as a two-lane section constructed 35 years ago. As a result, four-lane sections before and after the bridge are not effectively utilized, resurting in a bottleneck impeding traffic flow. This is not only a congestion point during peak hours with large traffic volume, but also a point where traffic accidents occur frequently.
This project will eliminate this bottleneck on Road No.4, ensuring smooth traffic flow on a continuous four-lane road while providing the road with sufficient traffic capacity to cope with increasing cargo transport. This in turn facilitates future introduction of industries, which will contribute to economic development in the Gaza Strip.

Effects of this project are listed below.

Present condition and problems	Measures of this project	Effect of the project and degree of improvement
①Only the bridge located approximately in the middle of Road No.4 with four lanes remains with only two lanes, presenting bottlenecks against traffic flows and causing congestion and accidents.	① New construction of a two-lane bridge and approach road parallel to the existing one to turn this section into a four-lane bridge.	① Smooth and safe traffic flow can be ensured for about 19,000 vehicles/day and pedestrians currently passing through the existing bridge. A continuous four-lane section is secured for about 30 km from the border with Israel to Khan Younis in Road No.4, contributing to increase in the transport capacity of major sections in the Gaza Strip.
②At present, Palestinian contractors are relatively inexperienced in construction of bridges and technically incapable of constructing large bridges and pile foundations.	②In the course of implementation of this project, seminars and inspection tours can be held to study actual repair and reinforcement operations.	②Technology transfer to Palestinian bridge engineers and bridge construction promotion effects are expected.

The population to benefit is up to about one million over the entire Gaza Strip, including the approximately 500,000 people of Gaza City and Deir Al-Balah City where the bridge exists.
As result of the review of the budget for maintenance by the MPW of the Palestinian Interim Self-Government Authority for the bridge concerned, and technical and managerial capacity of divisions in charge, it is determined that implementation with grant-aid is appropriate.

4-2 Recommendation

Since implementation of the project is expected to present considerable beneficial effects, as described above, and the project contributes to enhancement of Basic Human Needs of residents widely, it can be confirmed that implementation of the project with grant-aid is appropriate. Moreover, the counterpart governmental agencies are well qualified for maintenance and operation in terms of personnel and financial resources.

From the establishment of the Palestinian Interim Self-Government Authority up to now, all materials necessary for bridge construction, excluding the sand, have been brought in from Israel. Even imported materials and equipment from countries other than Israel, are imported via Israel. Therefore, should the cooperative relationship with Israel deteriorate, procurement of materials will become difficult. In such a case, smooth operation of the project will become difficult.