2. CONTENTS OF THE PROJECT

2.1 Objective of the Project

Referring to the plan of reconstruction of Cambodia presented at the Conference on National Programme to Rehabilitate and Develop Cambodia held in Tokyo in March 1994, and International Road Network Conference under the Economic Cooperation Programme for the Greater Mekong Subregion held in Chiang Mai in 1994, the objective of the Project could be identified as follows:

According to the Report on the Second National Reconstruction Conference published in March 1994, the Government of Cambodia sets forth the development target in the overall level-up of living standard of citizens to enjoy minimal level of equity, justice and security in the society by economic development which is crucial through agricultural redevelopment.

First of all to attain these objective, the integration of land is now separated by the Mekong river in the western half and the eastern areas, and developments of areas with high agricultural development potential are the most essential measure to be undertaken. With this regard the connection of lands through the construction of a bridge across the Mekong river and to provide road network centered around it is most effective and strategic measure.

The provision of transportation infrastructure would promote shipment of agricultural products of farmers to the nearby markets and as a result it would yield increase in agricultural income.

Second, a newly introduced bridge across the Mekong would contribute to the strengthening of the north-south corridor of the nation combined with such related road improvement projects as National Route 6 and 7, which enables the easy access to the Sihanoukville port, of which feasibility study is now undertaken by the Government of Japan. This would contribute to trade expansion of the nation in a long term.

Lastly, the introduction of a bridge across the Mekong river would enable realization of the long envisioned Asian Highway in Indochina. This idea, advocated and reconfirmed in conference of the Economic Cooperation Program in the Greater Mekong Subregion in Chiang Mai in 1994, aims at straightening internal consolidation among the nations in and around the Indochinese peninsula.

2.2 Basic Concept of the Project

At present there is no bridge across the Mekong river to connect the east and west sides of the Kingdom of Cambodia. The Government of Cambodia that intends to reconstruct the national economy, eagerly expects an early implementation of the Mekong bridge because of its impetus on the country's economic conditions. Cambodian, however, is being faced with a difficult situation for the realization of the bridge by herself, due to financial constraints of the public sector.

Under these circumstances, the Government of Cambodia requested the Government of Japan to implement a feasibility study on the Mekong bridge. In response to this request, the Japan International Cooperation Agency (JICA) conducted an investigation for selection of the optimum location and a feasibility study of the Mekong bridge from 1995 to 1996. As a result, it was concluded that the bridge route linking the existing Route 7 in nearby Kompong Cham city has an advantage over other comparative routes in economic and technical terms. The government of Cambodia then requested Japan's Grant Aid to implement the above-mentioned Kompong Cham route and JICA has conducted this basic design study.

The scope of the basic design study and such features as location, alignment and type of bridge and span division are the same as those proposed in the feasibility study. In this basic design study, however, the following have been studied in order to identify the viability of the Project under Japan's Grant Aid:

1) Recommendation of a more economical structure for connection between the superstructure and the substructure of the main bridge;

2) Reconsideration of the required bridge width to be conforming to the road width of the Asian Highway as proposed by the Government of Cambodia.

3) Examination of the life load applied in bridge design.

4) Reflection of actual vehicle load and crowd load in bridge design.

5) Comparison of multi column pile foundation and steel pipe sheet caisson for selecting the suitable type of substructure for the Project bridge.

6) Study of the substructure from the viewpoint of magnitude of score.

7) Study of the location of the pile cap (pier footing).

8) Validity of supplying countries, means of procurement and prices.

A bridge plan has been worked out following this basic design study with a view of contributing to the economic reconstruction of Cambodia and to realize an international trunk road linking the southern and northern areas of the Indochinese peninsula.

2.3 Basic Design

2.3.1 Design Concept

(1) Natural Condition

1) Planned Water Level

The high and low water level have been determined on the basis of observed records at gauge station, taking account of their return periods, and the bridge and related

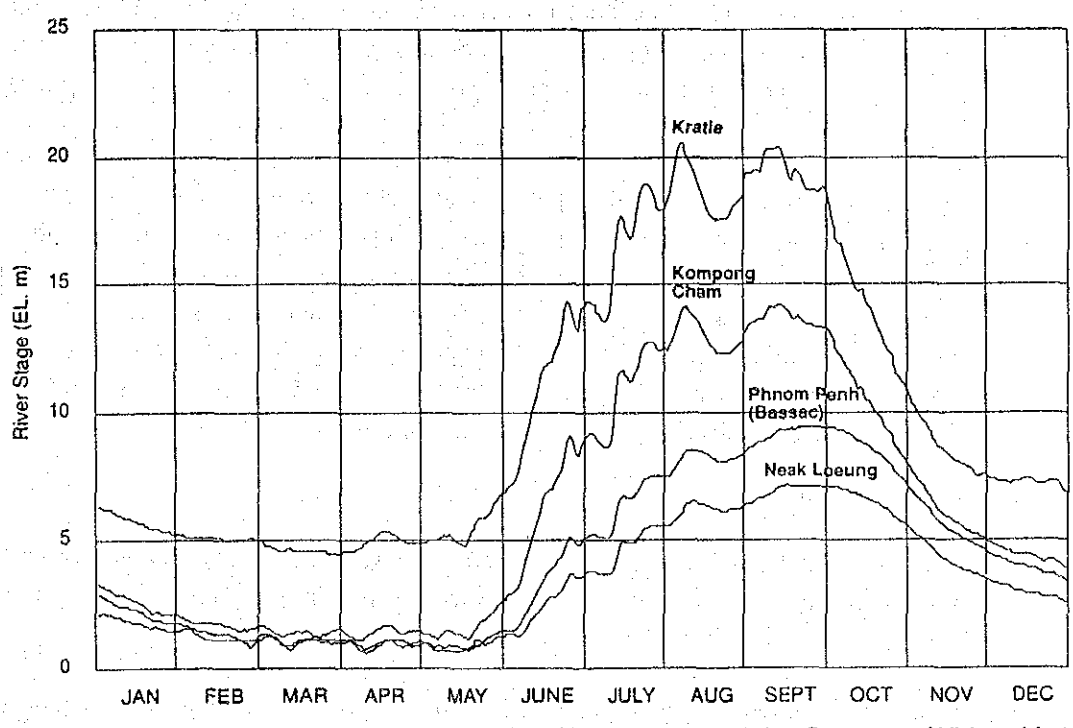
road plan together with the construction plan have been designed according to the said water levels.

There are five gauge stations in Cambodia: Karatie, Kompong Cham, Phnom Penh (one is on the Mekong River and the others are on the Bassac River) and Neak Loeung. The highest and lowest water level ever observed at four gauge stations are presented in Table 2.1, and maximum and minimum discharge are shown in Figure 2.1.

Table 2.1

Station	Maximum		Minimum	
	Gauge Height (m)	Elevation (EL. m)	Gauge Height (m)	Elevation (EL. M)
Kratie	23.02 (1984)	21.94	4.67 (1960)	3.59
Kompong Cham	16.11 (1996)	14.89	1.74 (1963)	0.81
Phnom Penh	11.08 (1961)	10.00	1.22 (1960)	0.14
Neak Loeung	7.93 (1966)	7.60	-	-

Source: National Mekong Committee, Meteorology and Hydrology Department of Ministry of Agriculture



Source : National Mekong Committee, Meteorology and Hydrology Department of Ministry of Agriculture

Figure 2.1 Water Level Hydrographs in 1994

Analytical results of high and low water levels at the proposed bridge route are presented in Table 2.2, in consideration of the return period, based on observed datum at Kompong Cham gauge station.

Table 2.2 Probable High and Low Wataer Levels at the Propsed Site

Water Level	Return Period (year)					
(MSL)	2	5	10	25	50	100
H.W.L.	13.76	14.44	14.77	15.10	15.30	15.47
L.W.L.	0.98	0.82	0.73	0.66	-	-

Referring above results, height of high water level is adopted as 15.47 m corresponding to 100 year return period with consideration of the life of bridge and that of low water level is set as 0.82m to 5 year return period in considering construction period. These water level is reflected to design works..

2) *Score*

A structure in river preventing from river flow is generally subjected to be excavated at a portion of its downstream direction. This phenomena is called as score. While several empirical formulas in which quantity of discharge, depth of river bed and velocity of river flow are proposed to estimate a depth of score, overall understanding of river and local comprehension around marked point are requested to grasp the magnitude of score. Accordingly overall understanding of Mekong River is followed to use flooding photograph map in flooding period photographed from earth satellite.

In addition in order to catch local situation on score, sedimentary condition on the river bed near the proposed bridge route is investigated together with the results of bathymetric survey conducted in the Feasibility Study. It is judged that the degree of sedimentation on the river bed at the proposed line tends to increase. Furthermore, old ferry piers at the Kompong Cham side on rote 7, which is located at about one kilometer downstream and was constructed approximately 40 years ago, is not in use due to the sedimented soil. Judging from this fact, river bed condition with respect to sedimentation is considered to have a tendency to develop alluvium.

(2) Social Condition

While major religion in Cambodia is Buddhism, Cham tribe who are minor people and believe Islam, are scattered around Kompong Cham. However, no dispute will not occur for this reason.

As for currency in Cambodia, country currency is riel but US$ is also available. Exchange ratio between riel and US$ come to settle down recent year.

Although a lot of mines and unexploded ordinances are lain under ground owing to unfortunate inner war, no information about existence of these dangerous materials is obtained so far. Research for these materials by Cambodian side, however, is requested before the commencement of construction works and it is necessary for Cambodian side to undertake removal of mines and ordinances if these materials are found after research works.

(3) Circumstances of Construction Conditions

The construction sector has been currently expanding steadily due to UNTAC, successive UN agencies and bilateral donors. Since the departure of UNTAC, aid programs continue to contribute to solid growth in construction sector. Based on these circumstances, many local contractors are established in Phnom Penh, but, the levels of construction practice as for large bridge construction are not relatively high. On the other hand, main local contractors have been positively jointing to the large aid project as a sub-contractor and improving their level of construction practice.

As for as the Mekong bridge construction is concerned, experienced bridge workers of the prestressed concrete bridge are necessary to recruit in the neighbor countries.

Local materials such as concrete and asphalt aggregate, sand, borrow bit (embankment material) and wood can be obtained in the vicinity of the project site. All the taxes of imported materials and equipment used in the aid project are excepted. However, materials procured in Cambodia include the taxes imposed by the Government.

(4) Applicability of Local Contractor

Local contractors, who has been improving capability to construct highways and building in aid project, should be participated in the project as sub-contractors of Japanese construction firm. It is important that technology of PC bridge construction transfer to Cambodian contractor through joint cooperation between both countries.

(5) Capability of Executing Agency for Maintenance and Operational Works

The Ministry of Public Works and Transport is responsible for maintenance and operational works on road and bridge facilities, but they could not execute these works periodically to their satisfaction due to the shortage of budge and engineers. Accordingly, it is necessary for MPWT to intend to increase its capability for these works in line with expansion of infrastructures.

Overloading vehicles run throughout Cambodia, and transporting timber and construction materials. It is judged that these vehicles are causing damage on bridge structures and pavement of roads. Though traffic control on overloaded vehicles are conducted by officials of Ministry of Interior at present, officials of Ministry of Public Works and Transport in which weight measure equipment are not available are not engaging this control simultaneously.

It is expected that new organization dealing with maintenance works on road and bridge periodically is established with sufficient budget and law on road traffic is developed to keep infrastructures of road traffic in good condition. At the same time it is important to educate young engineers with technical transfer of maintenance works during construction stage through on-the-job training.

(6) Construction Schedule

Construction schedule is planned to adopt the appropriate construction methods for coping with variation between the highest and lowest water level, taking into account the conditions of construction projects in Cambodia.

Construction works are devided into four (4) fiscal years. The first year is for preparatory and temporary works. The second and third year are for main works of main and approach bridges and apporach roads. The fourth year is for pavement and bridge accessories works. Works in each phase are as follows ;

The first year

Mobilization

Preparatory and temporary works

A part of substructue

The second year

Approach bridge (Kompong Cham side)

- Foundation, substructure

Main bridge

- Pier No.6 Foundation, substructure, superstructure
- Pier No.13 Foundation, substructure, superstructure

Approach bridge (Tonle Beth side)

- Foundation, substructure

Approach Road

- Embankment (Kompong Cham side)
- Embankment (Tonle Beth side)

The third year

Approach bridge (Kompong Cham side)

- Fablication, erection

Main bridge

- Pier No.7 Foundation, substructure, superstructure
- Pier No.8 Foundation, substructure, superstructure

- Pier No.9 Foundation, substructure, superstructure
- Pier No.10 Foundation, substructure
- Pier No.11 Foundation, substructure
- Pier No.12 Foundation, substructure

Approach bridge (Tonle Beth side)

- Fablication

Approach road

- Embankment (Kompong Cham side)
- Related structures

The fourth year

Main bridge

- Pier No.10 Superstructure
- Pier No.11 Superstructure
- Pier No.12 Superstructure

Approach bridge (Tonle Beth side)

- Erection

Approach road

- Embankment (Tonle Beth side)
- Pavement

Bridge accessaries

2.3.2 Basic Design

(1) Whole Plan

The scope of Project corresponds to that of the finally selected route at Kompong Cham which was studied in the Feasibility Study on Construction of Mekong Bridge in the Kingdom of Cambodia in 1995 and 1996 conducted by Japan International Cooperation Agency. This route originates at roundabout on route 7 in Kompong Cham city. After passing through bank portion with retaining wall and approach bridge in west side of Mekong River, the proposed route crosses over Mekong River nearly at right angles through main bridge to the east side of river and connects to existing route 7 through approach bridge and bank portion extended to approximate 2 km length.

Outline of planed facility is as follows:

Total length of bridge 1,360m

Main Bridge	80m+7@120m+80m=1,000m	
Approach Bridge	Kompong Cham side	5@40m=200m
	east side of Mekong River	4@40m=160m
Related Road	Kompong Cham side	256m
	east side of Mekong River	1,981m

Type of bridge for main bridge and approach bridge are presented bellow:

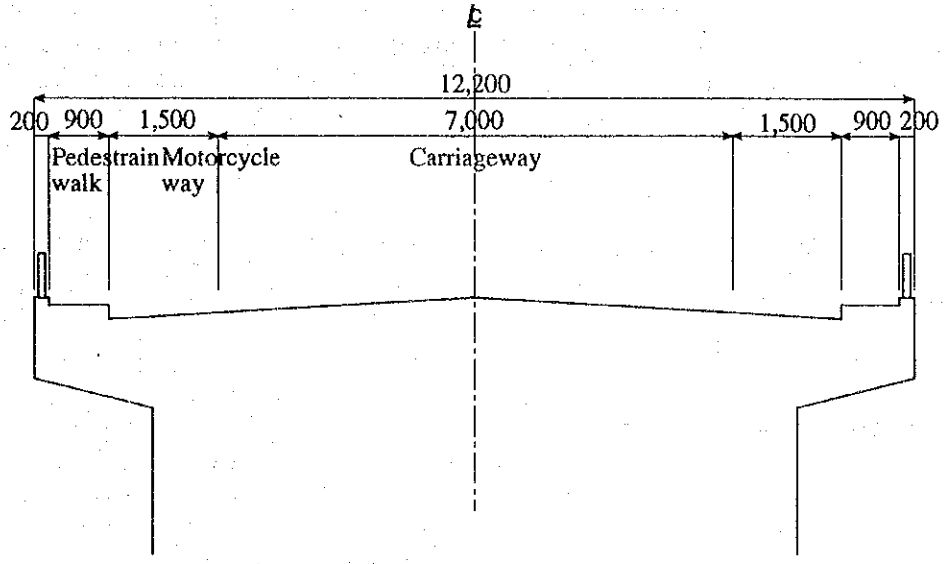
Superstructure	Main Bridge	prestressed concrete 9 span continuous box girder (3 span rigid frame in center) 80m+7@120m+80m-1,000m
	Approach Bridge Kompong Cham side	prestressed concrete 5 span continuous connecting girder 5@40m=200m
	east side of Mekong River	prestressed concrete 3 span continuous connecting girder 4@40m=160m
Substructure	Inverse Type abutment	2 set
	T type column pier	9 set
	Box type pier	8 set
Foundation	Main Bridge	Cast in place RC pile Ø 2.0m
	Approach Bridge	Cast in place RC pile Ø 1.0m
Applied Design Criteria	Bridge Design	Japan Road Association Design Criteria for Road Bridge
	Pavement Design	Japan Road Association Asphalt Concrete Design

(2) Plan of Facility

1) Width

a) Bridge

Total Width	12.2 m
Carriage Width (2 lane)	7.00 m
Motorcycle Width (both side)	1.50 m
Pedestrian Walk (both side)	0.90 m
Width of Curve	0.20 m



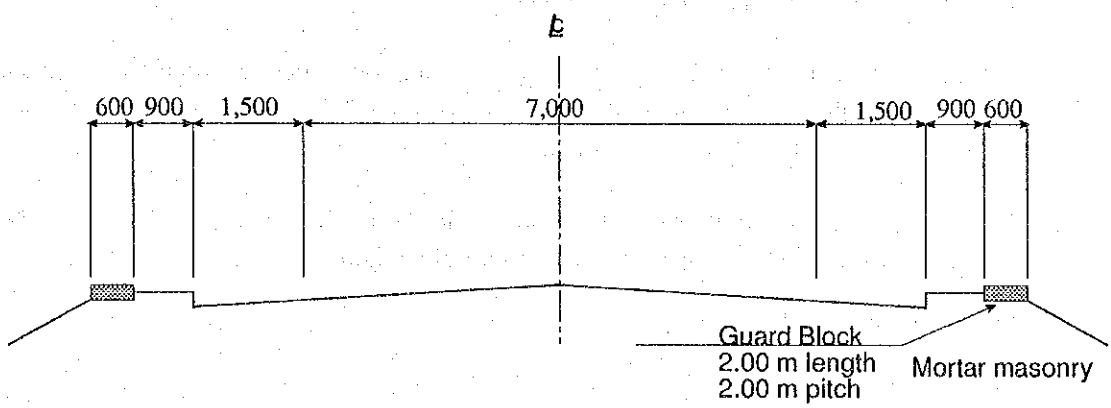
b) Road

b-1) West side of Mekong River

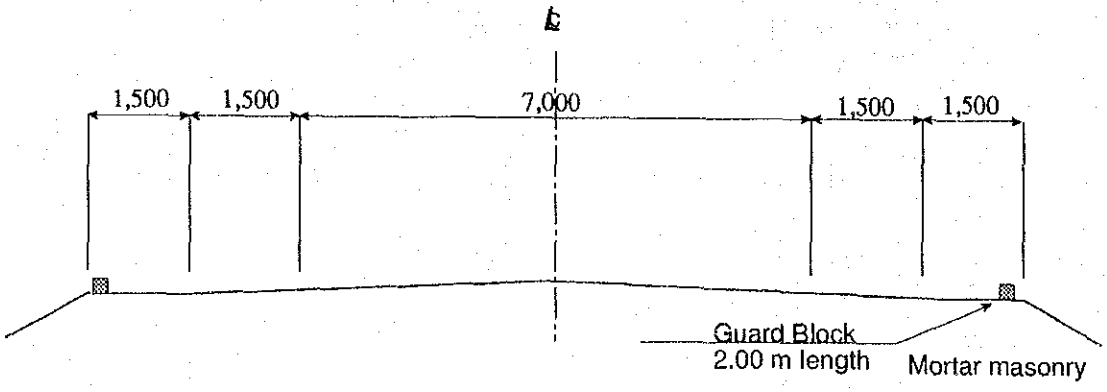
Width between origin and beginning of approach bridge at west side of Mekong River is same as that of bridge

b-2) East side of Mekong River

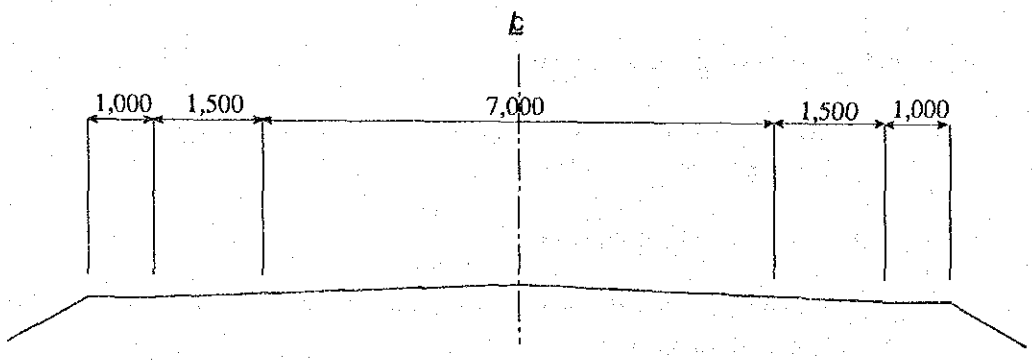
Width between end of approach bridge and step facility is same as that of bridge with pedestrian walk



b-3) Protection shoulder with gourd block is planned to the section between step facility and 5m height of bank from existing ground level without pedestrian walk.



b-4) Protection shoulder with reduced width(1m) is planned to the section where bank height from existing ground level is less than 5 m without guard block.



2) Horizontal and Longitudinal Alignment

Radius adopted to horizontal alignment is 300m at Kompong Cham side and same 300m at the section of road at east side of Mekong River, then proposed route links to existing route 7 with radius of 250m.

Longitudinal alignment is as follows: Starting origin with 0.504% of gradient, proposed route is ascending to the center of bridged.

(3) Design Condition

1) Applied Criteria

Bridge design criteria for road bridge of Japan Road Association is applied to bridge design in this Project after discussion with officials of Ministry of Public Works and Transport.

With regard to width, that of Asian Highway planned by Cambodian Government is incorporated in the Project for bridge and road section.

Width of road is same as that of basic design on route 6 and 7 being conducted by Japan International Cooperation Agency .

2) Geometrical Design

Design Speed		80 km/h
Maximum Longitudinal Gradient		4.00%
Minimum Radius of Curb		250 m
Minimum Length of Cube		119 m
Minimum Longitudinal Radius		60 m
Cross Slope	Bridge	1.5%
	Road	2.0%

3) Navigational Clearance

Height for horizontal navigational clearance is secured by 15.0 m from high water level at the center of river, that is the section between P9 and P10 pier, and width of horizontal navigation is kept by 90m after discussion with Cambodian side.

4) Determination of Water Level

High water level is deter mined by 15.10 m with consideration of 100 year return period and low water level is taken as 0.87m considering 5 year return period. According to observed records at Kompong Cham gauge station, maximum discharge shows 57,000 m^3/sec marked in 1966.

5) Application of Life Load

a) In designing floor and slab system, B load corresponded to a vehicle of 25 ton in weight stipulated above mentioned Japanese design criteria is applied

b) A load corresponded to a vehicle of 20 ton in weight is applied to design of main girder

c) Co-loading of life load and crowd load is not adopted.

6) Earthquake Load

Horizontal earthquake is considered by 0.05.

7) Other Loads

a) Principal Loads

Following loads are considered as permanent loads

dead load
impact
soil pressure
water pressure
buoyant
creep of concrete
shrinkage of concrete

influence of concrete by temperature

b) Secondary Loads

Following secondary loads are adopted to design bridge structure in combination with principal loads.

wind load
earthquake load

c) Special Loads

temporary load while construction

8) Depth of Score

Depth of score is considered to 5m in depth from existing river bed

9) Range of Temperature

Range of temperature is taken by ±10 C for design of it bridge

10) Unit Weight of Materials

Unit volume of materials adopted in following figure for dead load.

reinforced concrete	2,500 kg/m3
concrete	2,350 kg/m3
prestressed concrete	2,500 kg/m3
asphalt concrete	2,300 kg/m3
steel	7,850 kg/m3

11) Strength of Materials

Concrete standard design strength	PC continuous box girder main girder	400 kgf/cm3
	PC connecting girder main girder	400 kgf/cm3
	substructure	240 kgf/cm3
PC cable	12T12.7(SWPR 7B)	190 kgf/mm2
	1T21.8(SWPR19)	185 kgf/mm2
Reinforced steel bar	corresponded to SD295A	3,000 kgf/cm3

(3) Contents of Basic Design

1) Selection of Type of Superstructure

Selection of Type of Superstructure, Division of Span and others.

The type of superstructure has been determined based on the conditions related to the bridge site such as geographical and geological conditions, high water level and

required navigational clearance. It is judged that the type of superstructure selected at the stage of feasibility study is appropriate in general, according to the result of this basic design study. The superstructure examined in the feasibility study is summarized in following paragraph together with the results of this basic design study.

a) Selection of Type of Bridge

Among conceivable types of bridge, the concrete type has advantage over the steel type from following aspects: minimization of construction cost, reduction of maintenance cost, technical transfer to skilled worker, and efficient use of locally provided materials.

Among several kinds of concrete type bridge, two types are adoptable in view of the magnitude of this Project: one is prestressed concrete bridge with box girder and the other is prestressed concrete extra- dosed type. After examining some selection criteria shown below, the PC box girder type is considered superior to the other.

The main selection criteria applied are construction period, technical aspect, actual experience of construction, maintenance requirement, construction cost, foreign and local components in the construction cost, and technical transfer.

b) Determination of Span Division

A cost performance analysis based on the costs of superstructure, substructure, approach bridge and related road, and considering eventual technical constrains indicated that a 120 m span division anables to minimize the construction cost. Therefore, the PC 9 continuous box girder bridge type with a 120 m span length is considered most recommendable for the main bridge.

c) Basic Design Study

The basic design study has examined the following aspects with regard to the type of bridge and span division that were recommended in the feasibility study.

For the bridge recommended in the feasibility study, connection between the pier and superstructure is rigid at all intermediate piers. For comparison, another structural system in which movable shoes are installed at both two end piers has been studied. This type of structure allows bridge movement in its axis direction at installed movable shoe.

Another expectable effect of the above structure is the removal of displacement constrain at installed movable shoes in the direction of the bridge axis, which otherwise prevents movement due to shrinkage, creep and temperature. Due to this effect, the number of foundation piles can be reduced

because transmission of force induced in the superstructure is decreased. According to the structural calculation, the number of foundation piers for this newly proposed type is 106 nos. compared with 128 nos. for the type proposed in the feasibility study.

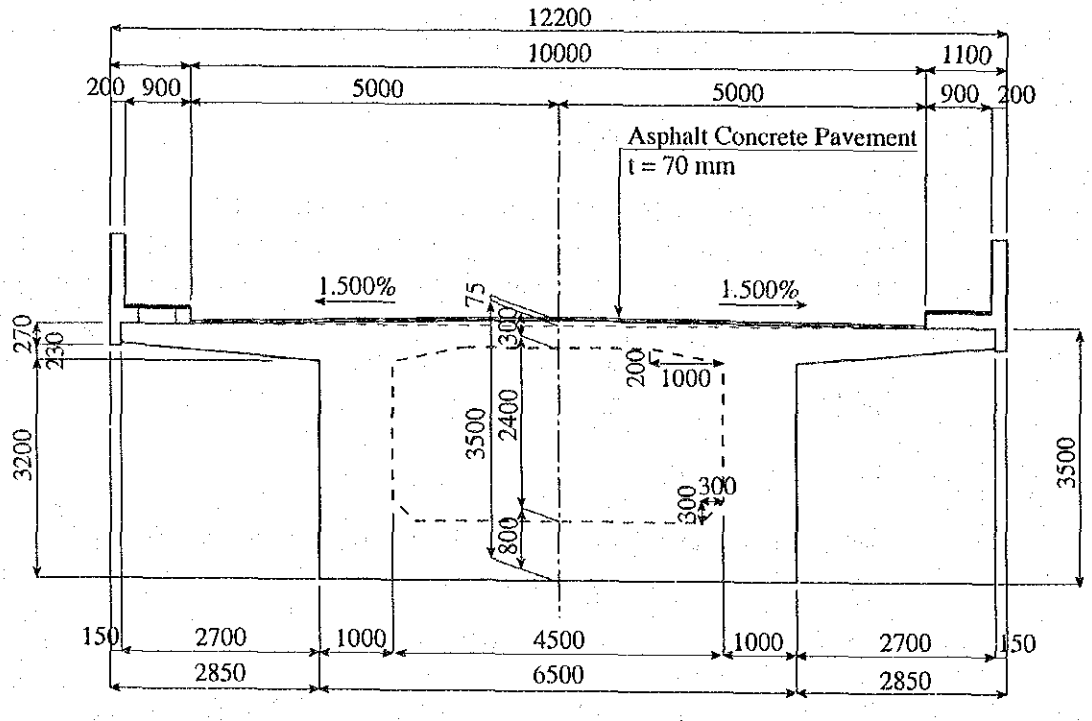
From the above analysis, following effects are expected:

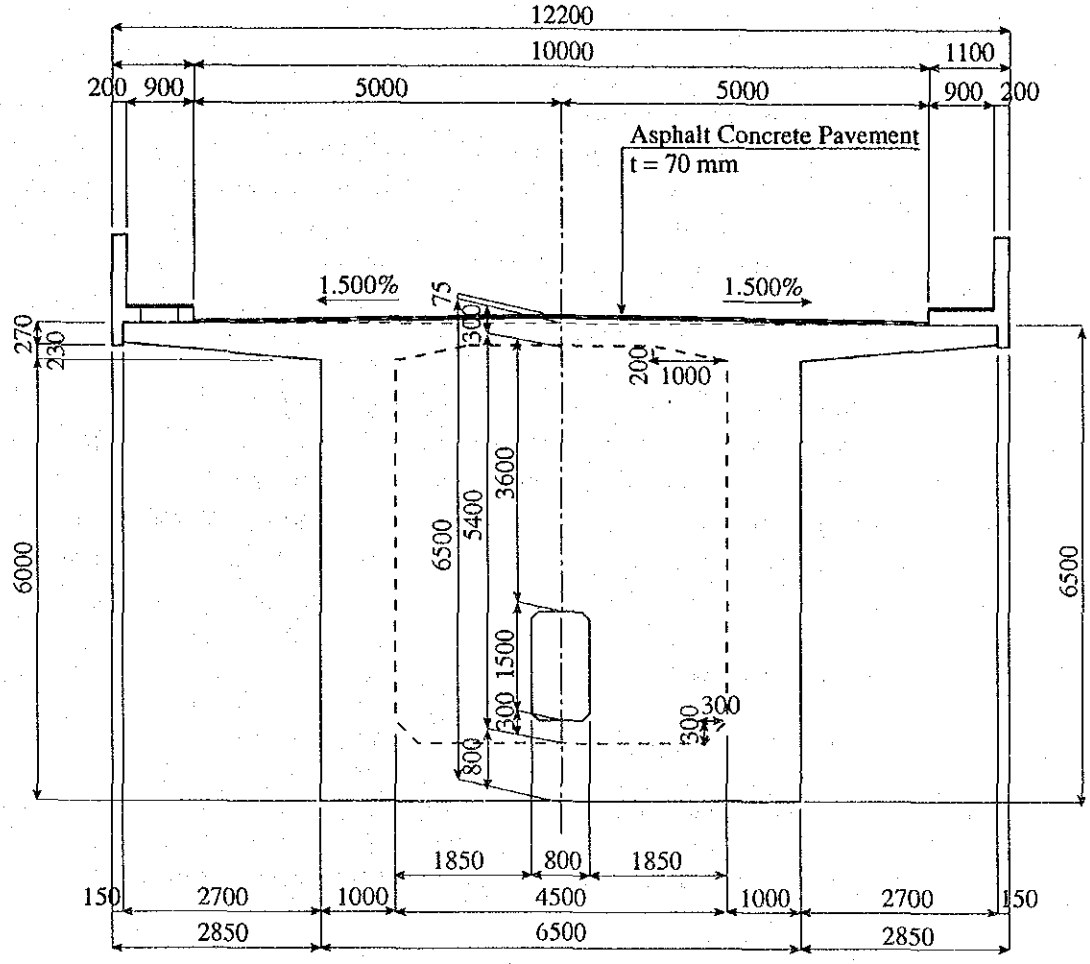
- reduction in construction cost
- easier construction of foundation piles which is scheduled to be carried out in the dry season.

For the above reasons, the bridge structure with movable shoes installed at both two end piers has been adopted in the basic design study without changing the span length recommended in the feasibility study.

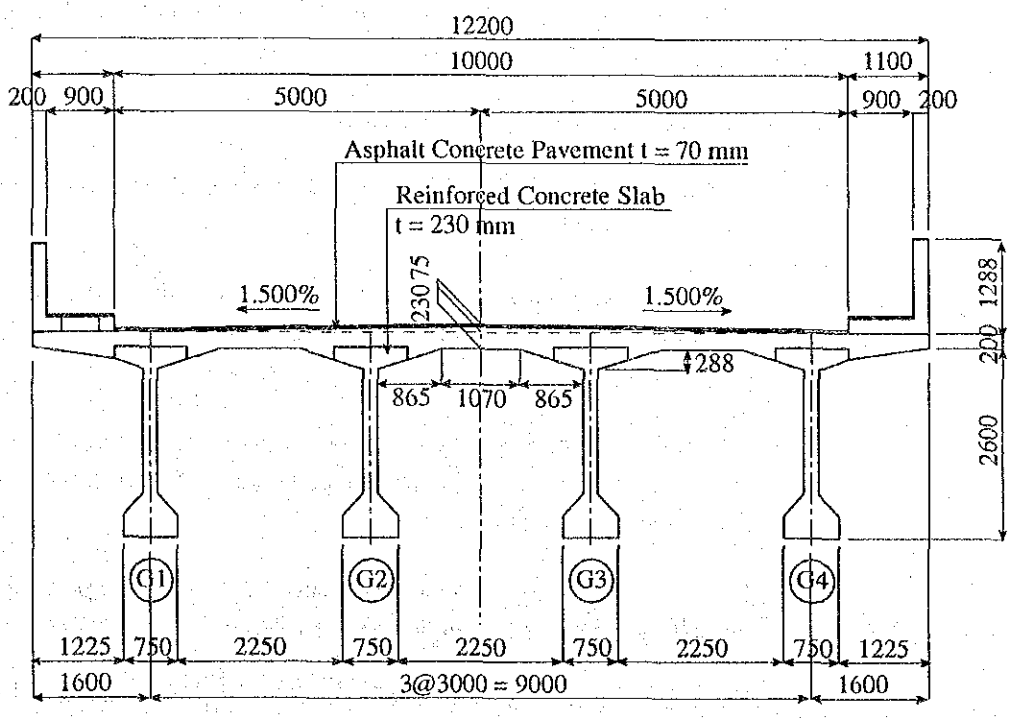
2) *Results of Superstructure Design*

a) Height of the main bridge girder has been increased from 3.00m to 6.00m. Typical cross sections are presented as below.





b) The approach bridge is designed as PC connecting girder bridge with 4 main girders (height of girder is 2.60 m)



3) Selection of Type for Substructure

Although the bridge substructure as selected in the feasibility study, if has been examined again in the basic design study to adopt the optimum type. Two types of substructure, multi-column pile foundation and steel pile sheet caisson, were compared. As a result, the former type was adopted as recommended in the feasibility study, for the following reasons:

a) Multi-column pile foundation

The Multi-column pile foundation construction method is as follows: The pile head portion is dug by excavation machine and concrete is placed after removing excavated soil and installing reinforcement bars for the pile. Depending on the way of soil excavation, this method is classified into reverse circulation method or benote method. The former that was adopted in the feasibility study is in general advantageous for construction in water.

This method has the following features:

- almost no coffering equipment is required;
- dynamic water pressure caused by current water is small due to multi-piling;
- construction period is longer than that of steel pipe sheet caisson.

b) Steel Pile Sheet Caisson

After the area to be excavated is coffered with steel sheets or steel pipes, excavation is executed in dry condition in the wake of removal of water within the coffer dam. After placing pile, this temporary coffering facility is connected to the pier structure.

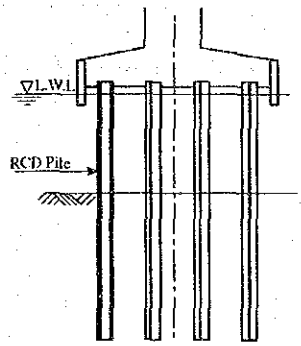
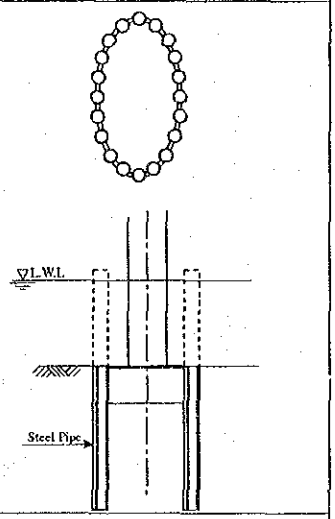
This method has the following features:

- Reliability of the substructure is high because excavation and construction of the pier is done in dry condition.
- As the substructure is constructed from the river bed in dry condition, connecting body between the pile and pier such as pile cap in multi column pile foundation is not required.
- In order to ensure construction works in dry condition, connection between the steel sheet or steel pipe is perfectly sealed. Consequently, accuracy of construction works is required to be high.
- If this method id applied in Mekong River site, the steel pipe sheet caisson should be completed within the dry season.
- To secure the coffer dam, a lot of temporary steel materials are required.

- After completing the pier, steel sheets or steel pipes should be cut out by very sophisticated technology.

- As the body of the substructure in water needs a considerable size, issue on score expands.

Judging from features of the multi-column pile foundation and the steel sheet caisson, former type has advantage over the other, considering the conditions of the Mekong River site.

Foundation Type		Multi Column Pile Foundation (Cast-in-place R.C. Pile)	Steel Pipe Sheet Caisson
Configuration of Foundation			
Principal Materials of Foundation		Concrete, Reinforcing Bar, and Steel Casing Pipe	Steel Pipe, Concrete, Reinforcing Bar
Procurement of Materials and Equipment and Transportation		Steel casing pipes are imported. Self-elevated platform (SEP) and large capacity crane are required.	Large capacity pile driver is required.
Construc-tion Aspect	Applicable span	80 ~ 250 m	up to 150 m
	Construction Method	Steel casing pipes are driven by vibro-hammer. Bore holes are made by using reverse-circulation drill. Concrete is placed up to top of a casing pipe. Pile cap is supported on the multi-column.	Driving steel pipe sheet pile with both functions of foundation and coffer dam. After dried up in the caisson, pile cap is connected to steel pipes with re-bar. Steel pipes are cut at top of the pile cap.
	Difficult points of Construction	Scouring depth is large. Protection work is necessary.	Connection method between steel pipe piles and pile cap is not reliable
	Construction Period	6 months/pier	5 ~ 6 months
	Construction Cost (Radio)	1.00	1.20

4) Application of geological survey to basic design

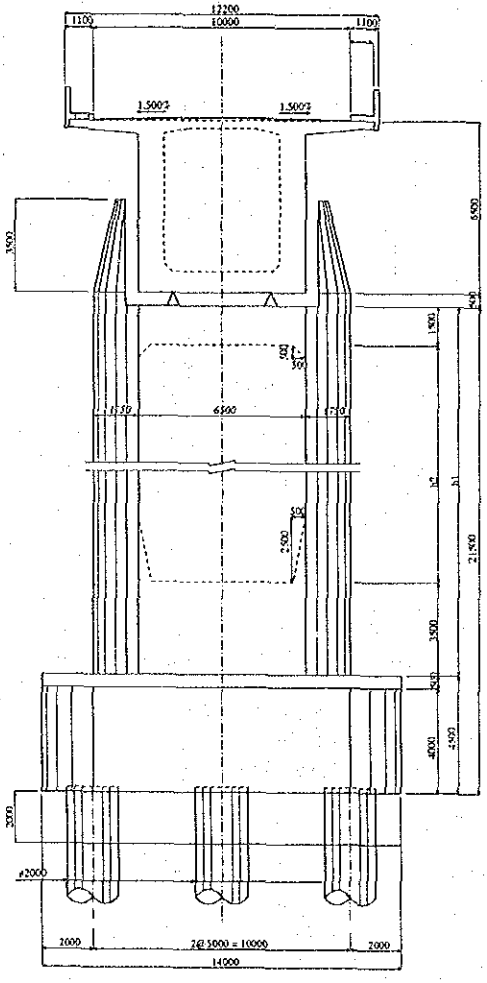
Geological survey on the proposed route was conducted at five locations in the feasibility study but the results of geological survey at three locations executed in May 1996 were not taken into consideration. In this basic design study, the results of these three geological survey are incorporated in designing the substructure.

5) Results of Substructure Design

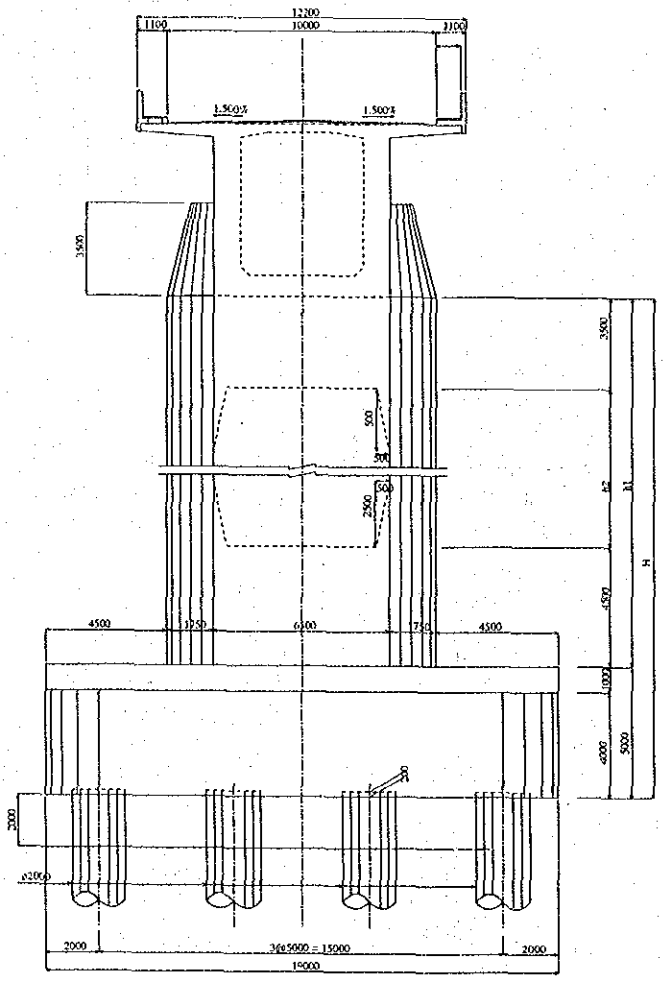
a) Main Bridge

Typical cross sections of the substructure are presented below for piers with movable shoes and piers connected rigidly to the superstructure.

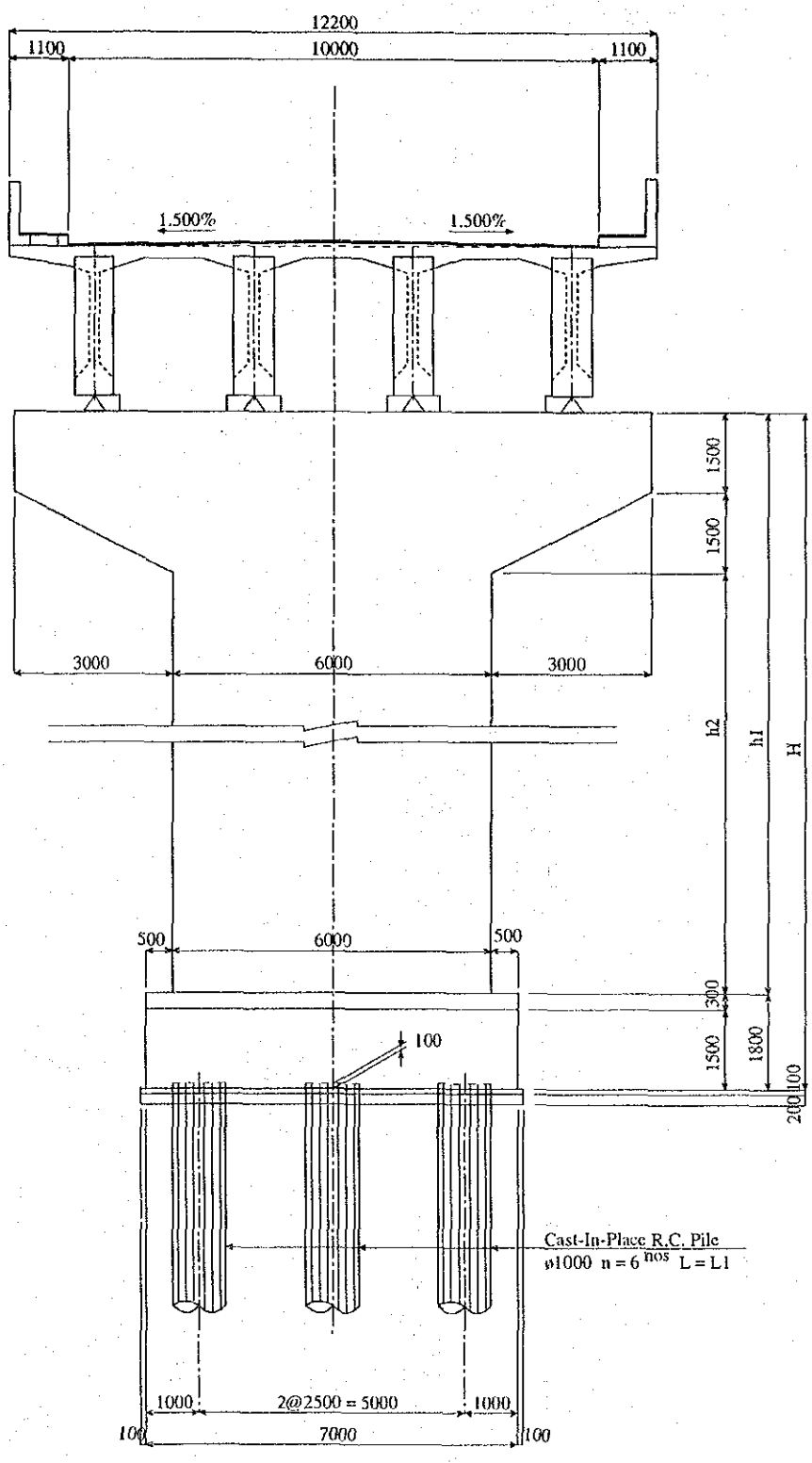
Pier with movable shoes



Pier rigidly connected to superstructure



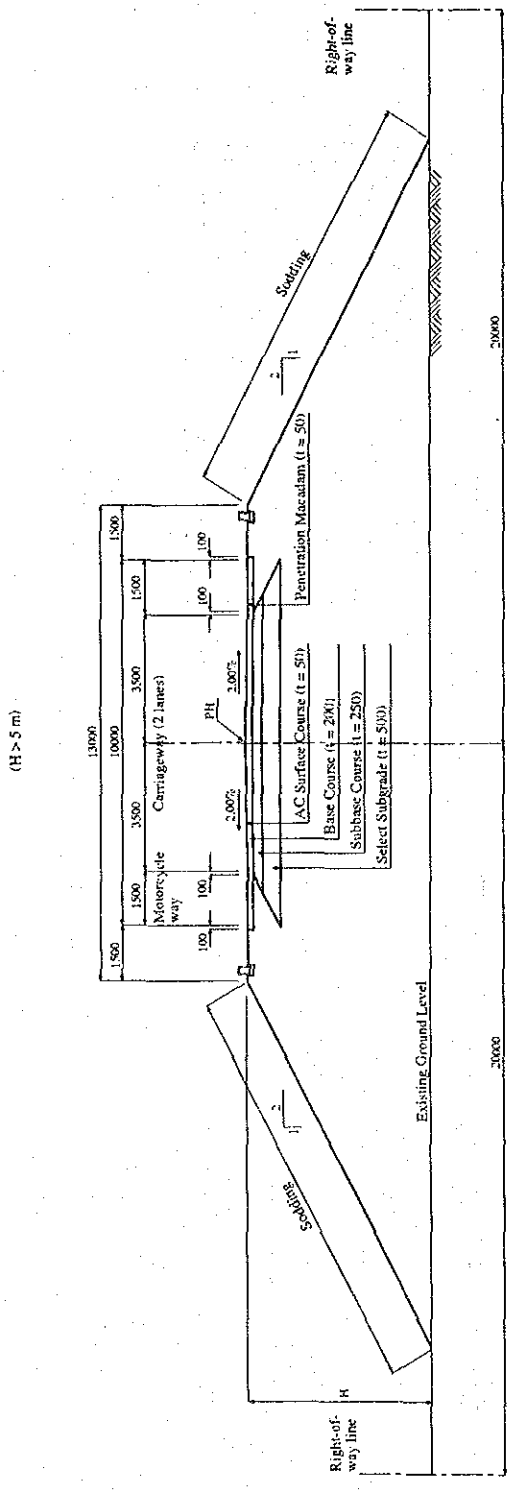
b) Substructure of Approach Bridge



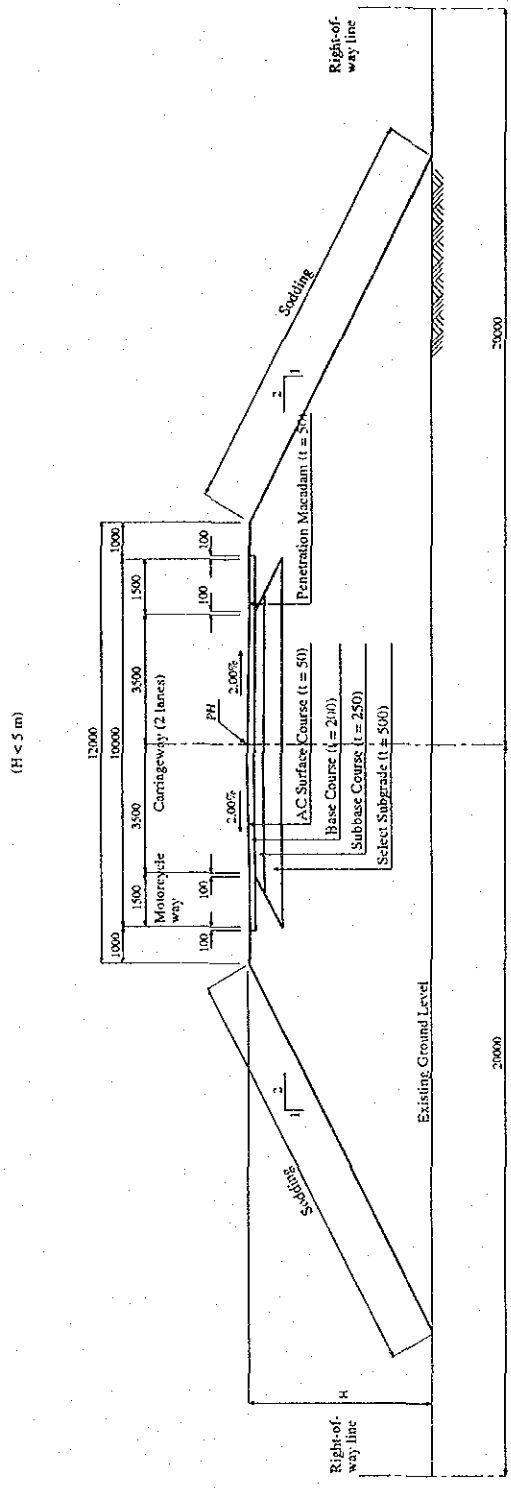
6) Design of Related Road

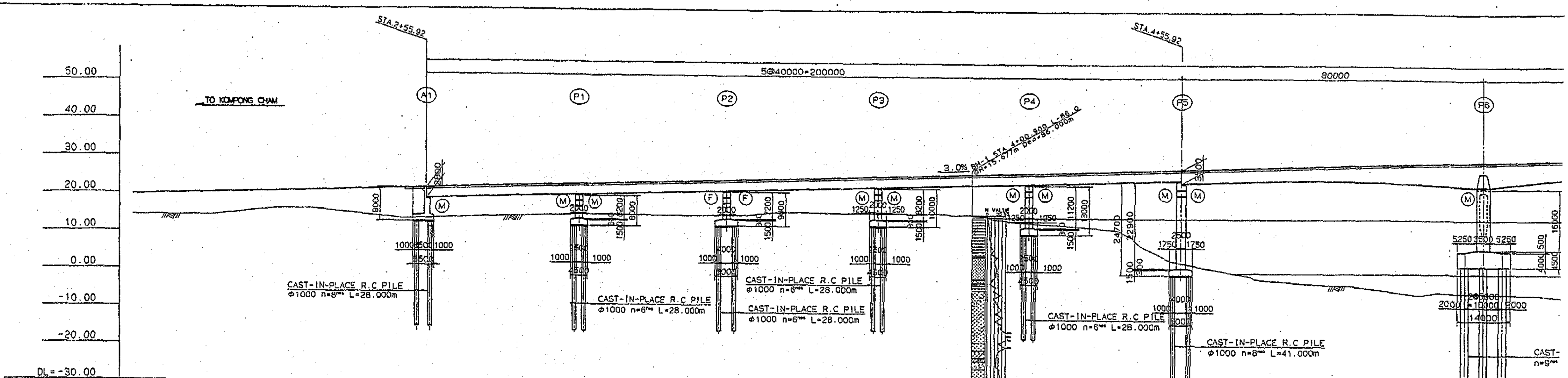
Tipical cross-section is shown below:

(H > 5 m))



(H < 5 m))


(H < 5 m)
Right-of-way line
Sodding
2
1
Penetration Macadam (t = 50)
1000
1500
3500
10000
12000
Carriageway (2 lanes)
Motorcycle way
100
2.00%
PH
A.C Surface Course (t = 50)
Base Course (t = 200)
Subbase Course (t = 250)
Select Subgrade (t = 500)
20000
Existing Ground Level
Sodding
H
Right-of-way line

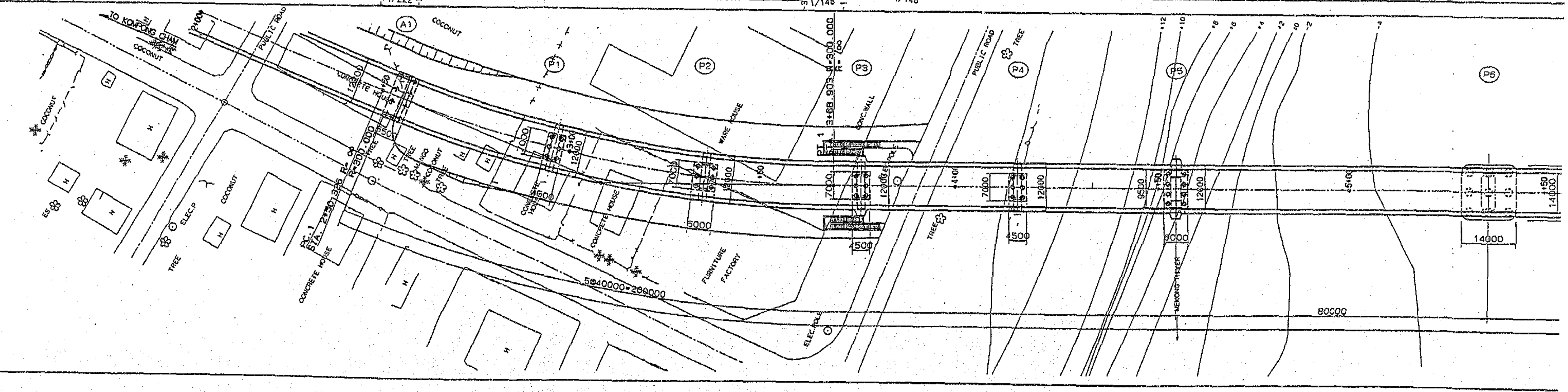


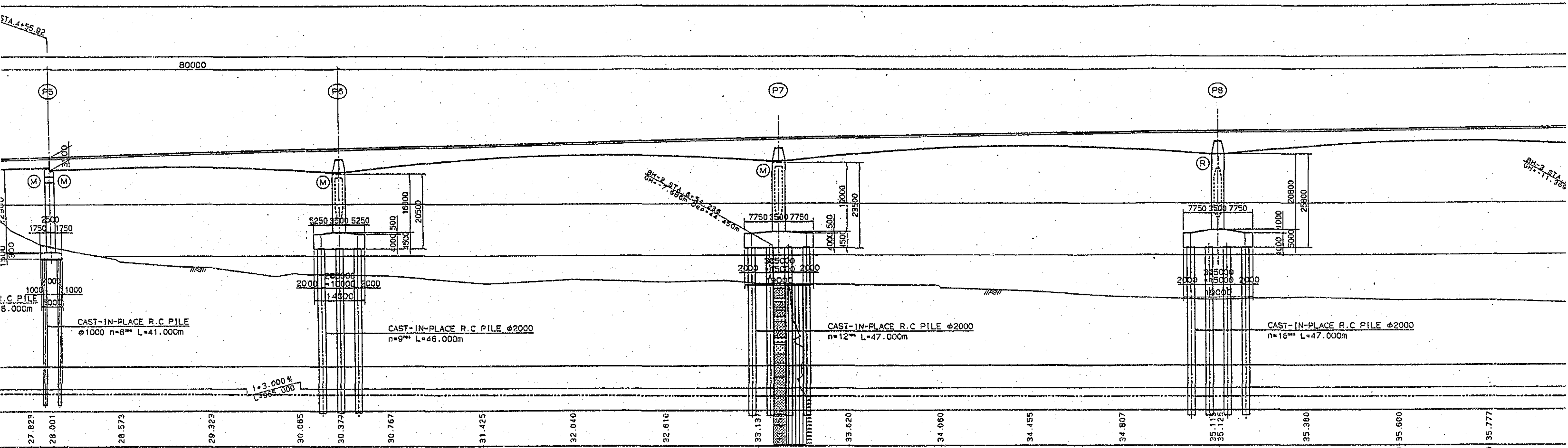
DESIGNHIGHT	20.323	21.073	21.823	22.001	22.573	23.201	23.323	24.073	24.401	24.823	25.573	25.601	26.323	26.801	27.073	27.823	28.001	28.573	29.323	30.065	30.377	30.767
EXISTINGLEVEL	14.34	16.27	13.75	13.93	14.53	15.12	15.24	15.01	15.09	16.03	16.31	16.28	15.69	13.76	13.20	7.00	3.42	-0.70	-2.30	-4.20	-4.42	-4.70
ACCUMULARTED DISTANCE	200.000	225.000	250.000	255.920	275.000	295.920	300.000	325.000	335.920	350.000	375.000	375.920	400.000	415.920	425.000	450.000	455.920	475.000	500.000	525.000	535.920	550.000
DISTANCE	25.000	25.000	25.000	5.920	19.080	20.920	4.080	25.000	10.920	14.080	25.000	920	24.080	15.001	9.080	25.000	5.920	19.080	25.000	25.000	10.920	14.080
STATION	2+ 0	+25	+50 PC.1	+55.92 (A1)	+75	(P1) +95.92	3+ 0	+25	(P2) +35.92	+50	PT.1 +75	+75.92 (P3)	4+ 0	(P4) +15.92	+25	+50	+55.92 (P5)	+75	5+ 0	+25	(P6) +35.92	+50

GRADIENT: 15.673 — I=3.000 % L=905.000

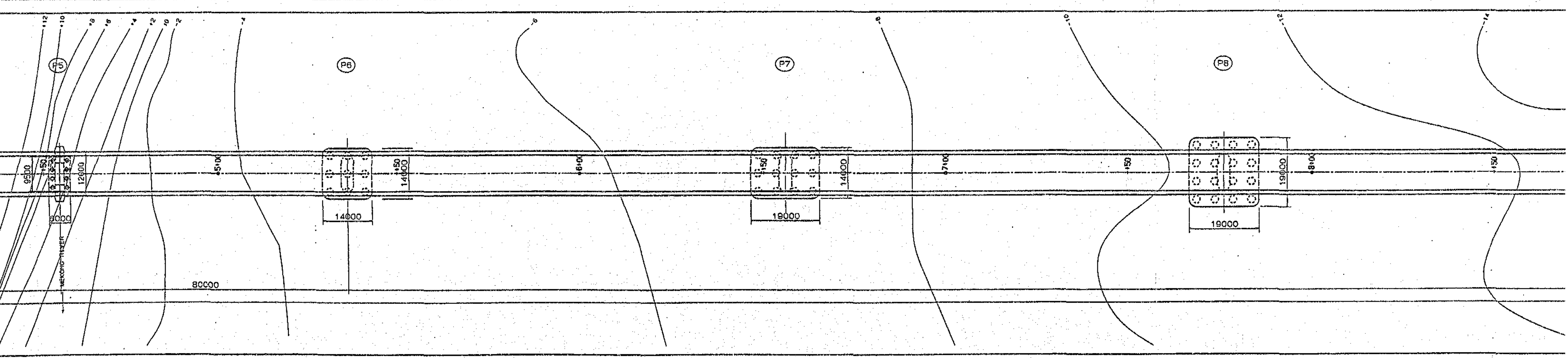
CURVEELEMENT: R=300.000 L=118.577

SUPERELEVATION: 1/139, 1/222, 2.0%, 3.0%, 1/148



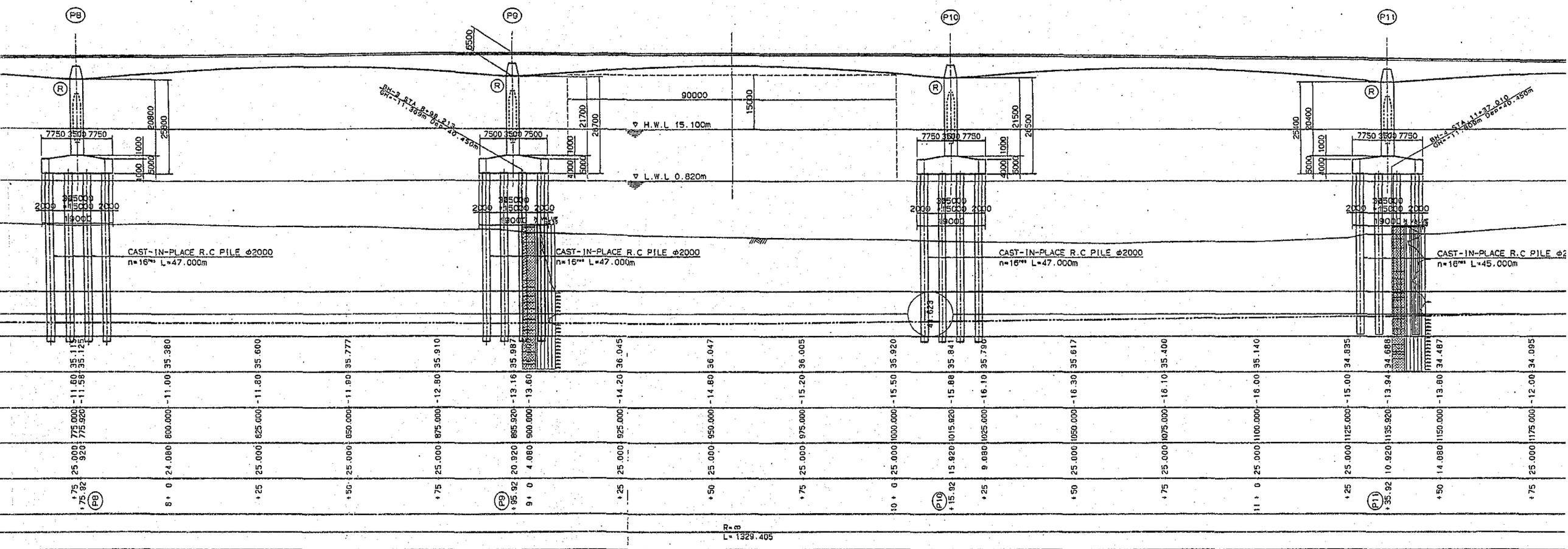


27.823	7.00	450.000	25.000	+50
28.001	3.42	455.920	5.920	+55.92 (P5)
28.573	-0.70	475.000	19.080	+75
29.323	-2.30	500.000	25.000	5+ 0
30.065	-4.20	525.000	25.000	+25
30.377	-4.42	535.920	10.920	+35.92 (P6)
30.767	-4.70	550.000	14.080	+50
31.425	-6.80	575.000	25.000	+75
32.040	-5.80	600.000	25.000	6+ 0
32.610	-6.50	625.000	25.000	+25
33.137	-7.00	650.000	25.000	+50
[illegible]	-7.08	655.920	5.920	+55.92 (P7)
33.620	-7.33	675.000	19.080	+75
34.060	-8.30	700.000	25.000	7+ 0
34.455	-9.20	725.000	25.000	+25
34.807	-10.80	750.000	25.000	+50
35.115	-11.60	775.000	25.000	+75
35.125	-11.58	775.920	920	+75.92 (P8)
35.380	-11.00	800.000	24.080	8+ 0
35.600	-11.80	825.000	25.000	+25
35.777	-11.90	850.000	25.000	+50

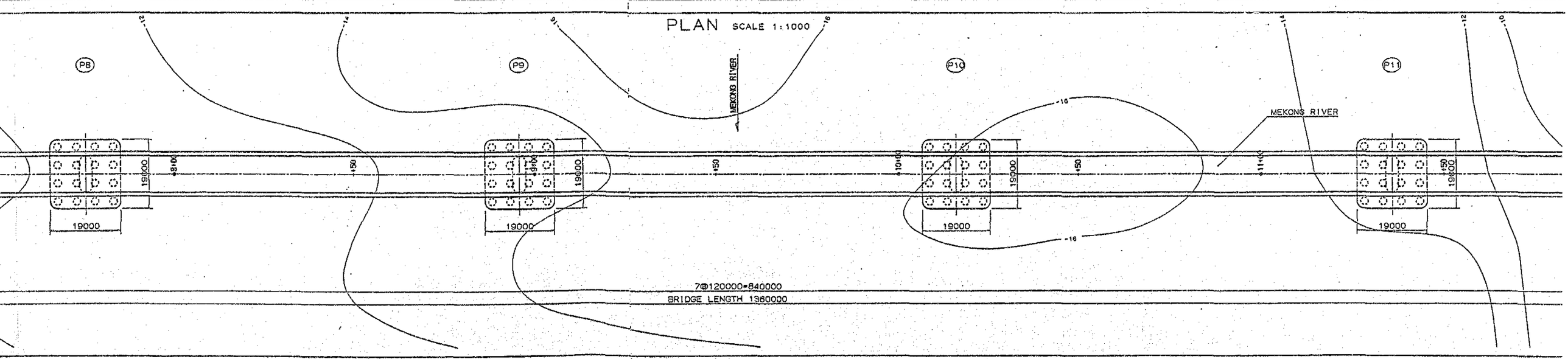


SIDE ELEVATION SCALE 1:1000

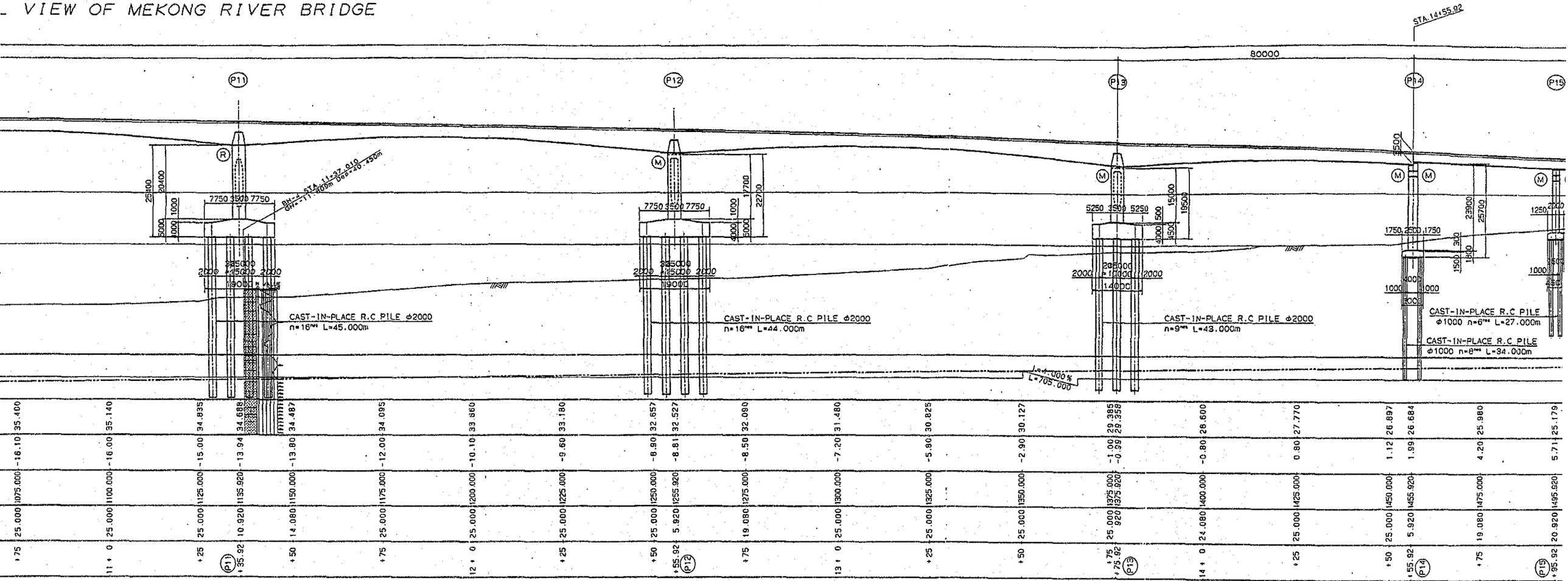
GENERAL VIEW OF MEKONG RIVER BRIDGE

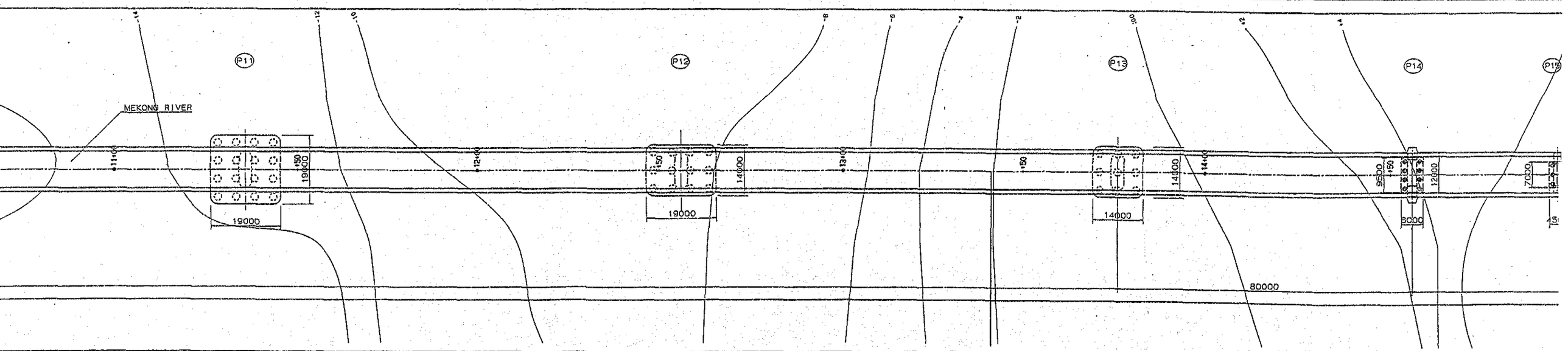


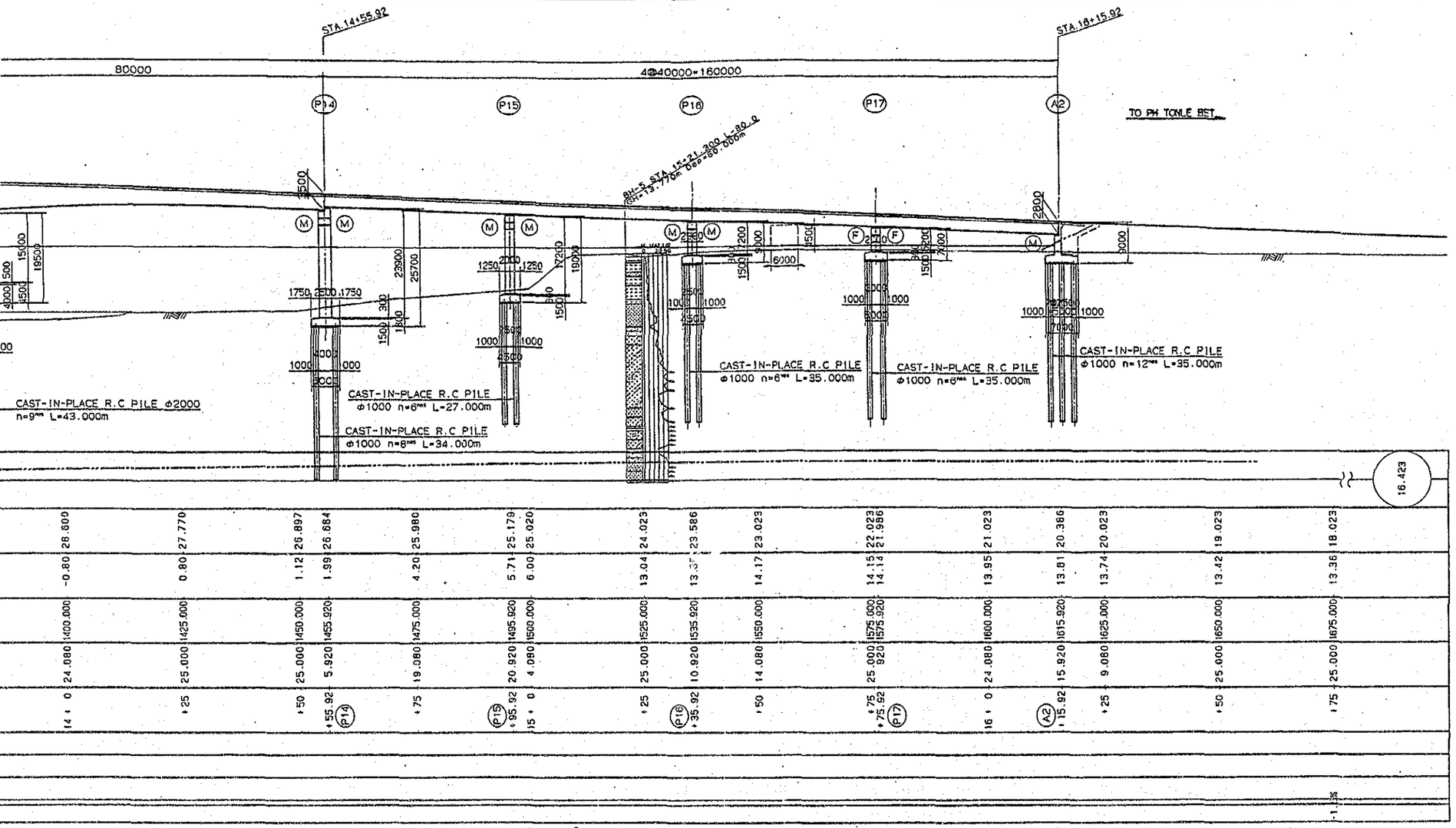
PLAN SCALE 1:1000

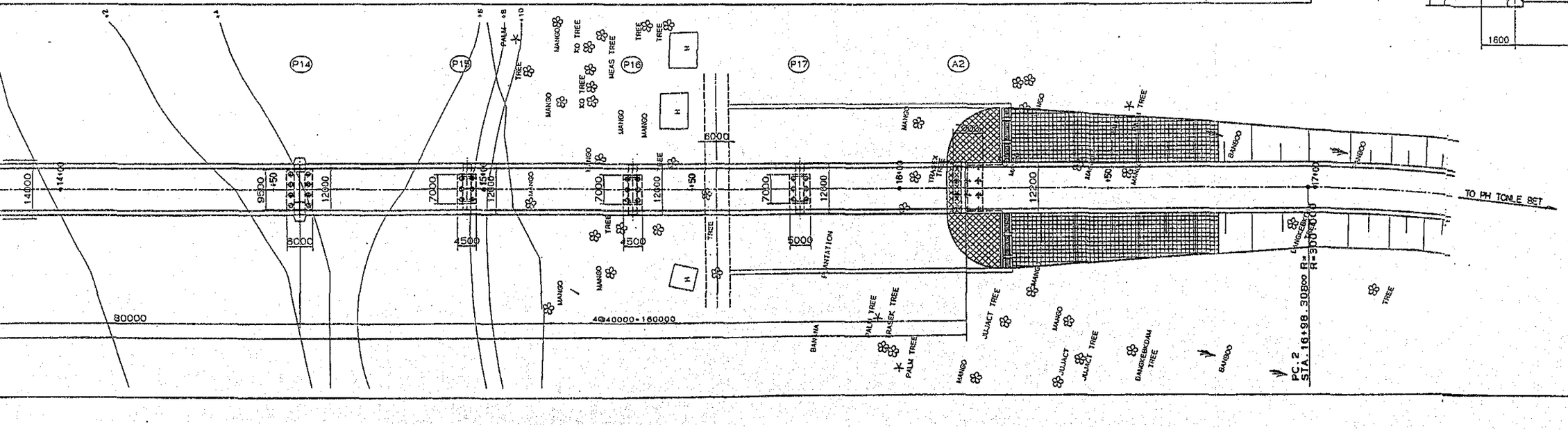


_ VIEW OF MEKONG RIVER BRIDGE



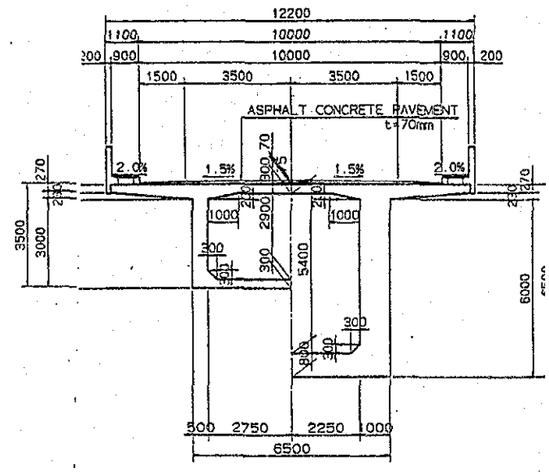






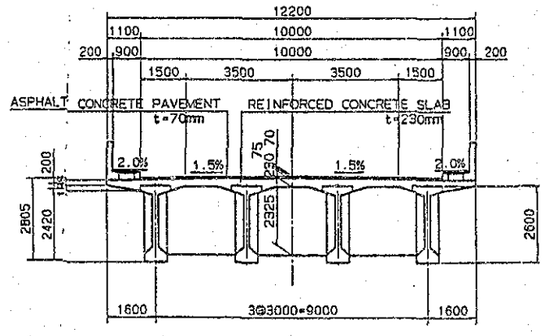
SECTION SCALE 1:200

(P5) ~ (P14)



(A1) ~ (P5)

(P14) ~ (A2)



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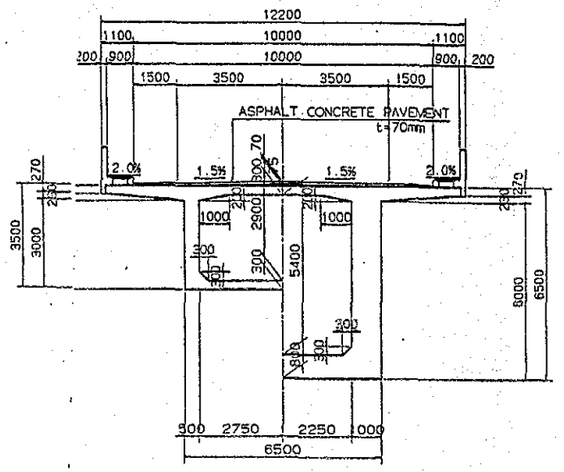

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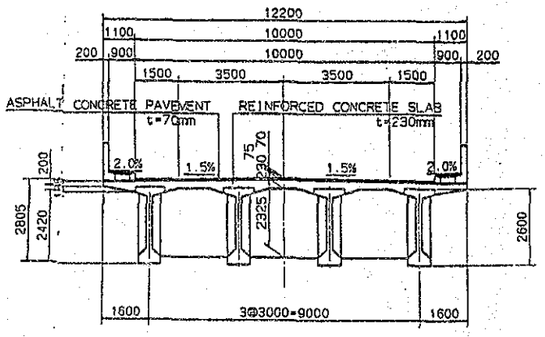
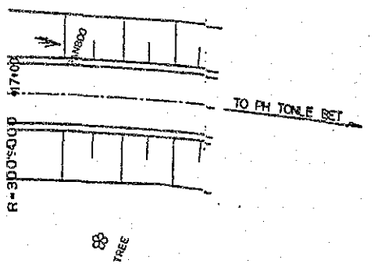
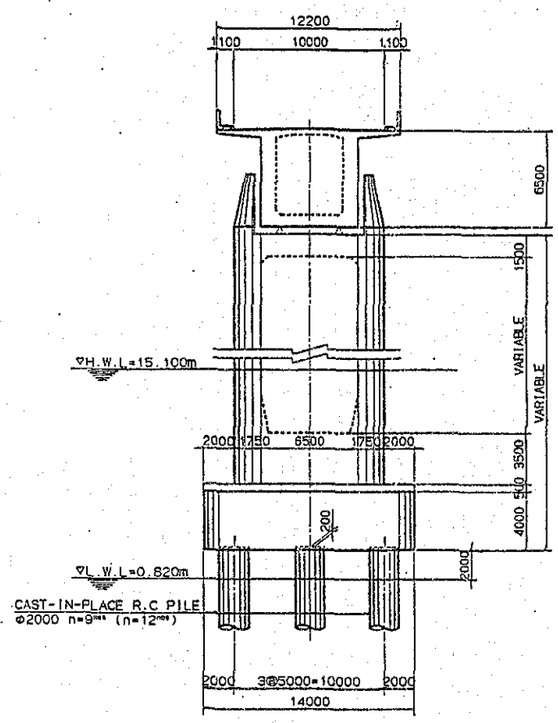




CROSS SECTION SCALE 1:400

(P6) · (P13)
(P7) · (P12)



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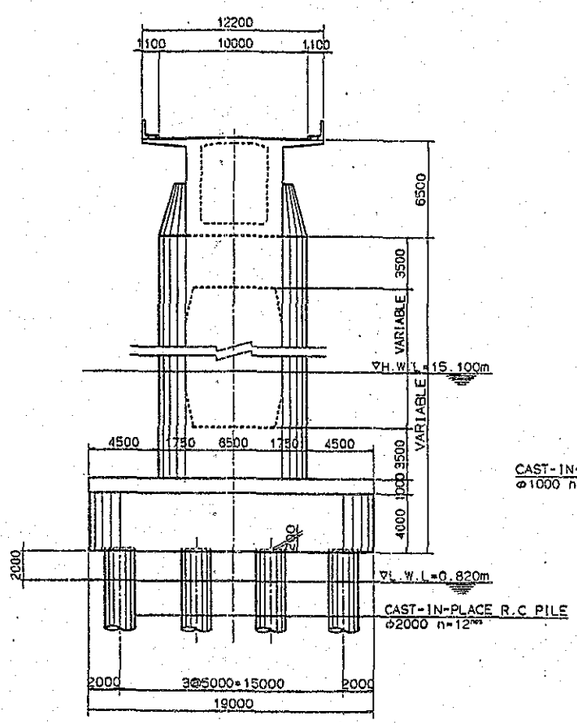
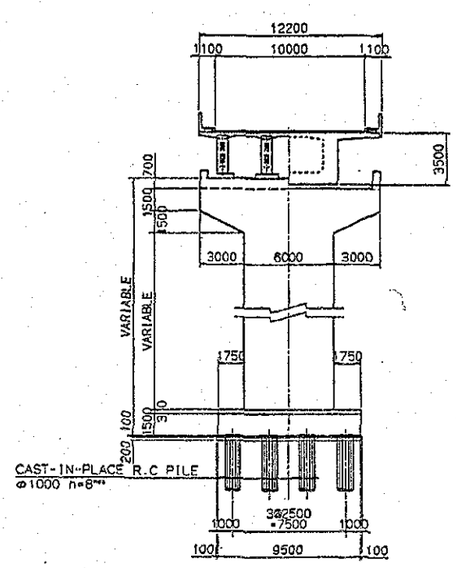
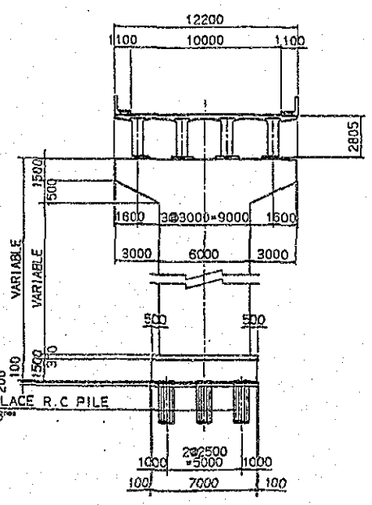


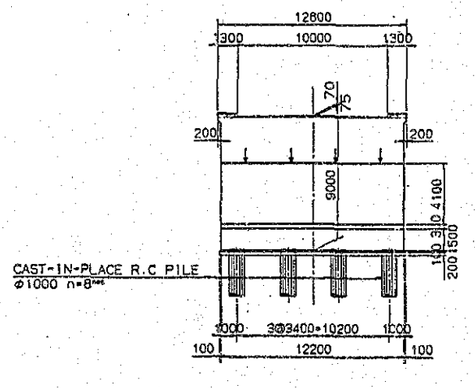
(P5) . (P14)



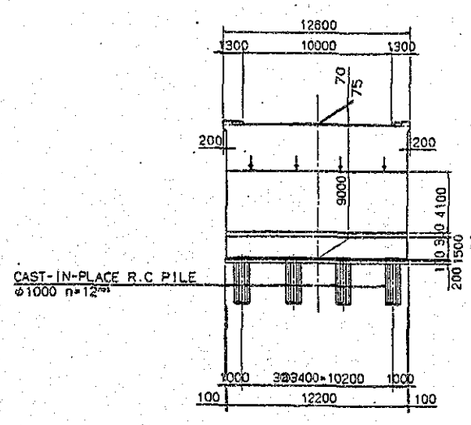
(P1) ~ (P4) . (P15) ~ (P17)



(A1)



(A2)



JAPAN INTERNATIONAL COOPERATION AGENCY	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MEKONG RIVER BRIDGE IN THE KINGDOM OF CAMBODIA	GENERAL VIEW	SCALE AS SHOWN	DWG.No.

3. IMPLEMENTATON PLAN

3.1 Implementaton Plan

The agency that executes this project on behalf of the Kingdom of Cambodia is the Ministry of Public Works and Transport (MPWT) whose responsibility is to manage, supervise and maintain the project. The MPWT will also engage in the coordination, adjustment, preparation, etc. of the matters on grant aid and technical cooperations agreed between two countries, Cambodia and Japanese Governments.

The Consultant will involve in the following services as the Engineer on behalf of the Kingdom of Cambodia ;

- Detailed Engineering Design
- Preparation of Bids and Tender Documents
- Construction Supervision

Japanese contractor selected by open tender according to the grant aid system of the Japanese Government must undertake the construction works effectively and appropriately in accordance with the program and schedule of works, identifying materials and equipment to be procured.

The contractor shall maintain the works during construction and until the project is accepted. This maintenance shall constitute effective and continuous works prosecuted day by day, with required equipment and force to the end that structures and roadway are kept in satisfactory condition at all time. The contractor must fully understand the grant aid system and pay attention to complete the works within the prescribed construction period.

3.1.1 Implementation Concept

The following planning conditions have been considered due to the fact that the project will be executed under severe river conditions: River width of 1.0 km, water depth of 16 m in dry season and water level difference of 14.3 m between the dry and rainy seasons.

1) Construction shall be commenced in October of the first dry season considering that at least two piers will be constructed in the river.

2) The piers in the river and approach roads will be constructed in the dry season, and the bridge superstructure of bridge throughout the year.

3) Construction works in the river will be carried out by floating construction plant or ships (self-elevating platform, concrete mixing plant on barge, barges and tug boat)

4) Construction equipment will be procured from neighboring countries except special bridge erection equipment which will be imported from Japan.

5) Construction materials will be procured in Cambodia and from neighboring countries except special bridge materials which will be imported from Japan

6) Operators of large cranes, drilling equipment of cast-in-place RC piles and prestressing equipment of PC cable will be recruited from neighboring countries.

7) The project works will be carried out with due attention to the environment and ecology near the site.

3.1.2 Implementation Conditions

Considerations for construction are as follows ;

(1) The labor laws and traditional customs

In Cambodia, no such codes as Japan's Labor Lows exists. However, the contractor shall effect adequate labor and safety conditions and controls of employment practices, and prevent conflicts with local laborers by respecting the governing labor laws and traditional customs in Cambodia.

Typical working hours in Cambodia are 8:00 to 17:00 with 2 hours for lunch time. Consequently, the actual working day consists of 7 hours. They have special holidays on their own traditional customs.

(2) Condition of transport and customs clearance

The assistance of Cambodia Port Authority is particularly indispensable for cargo discharge and customs clearance, which influences the commencement of the project.

Construction materials and equipment to be imported, procured and transported from Thailand are loaded and unloaded at the Kampong Soam Port in Sihanoukville. Access roads from the port to the site are available for National Highway No.4, No.6 and No.7 on the inland transportation of 350km in total distance.

On the other hand, construction materials and equipment to be imported and procured from Japan are transported to Phnom Penh Port as the international port of Cambodia on Mekong River transversing Viet Nam. Access roads from the port to the site are available for National Highway No.6 and No.7 on an inland transportation of 120km in total distance. Further, an inland water transportation of Mekong River is also available on the construction site in case temporary quays is constructed for loading and unloading directly at the site. This distance of inland water transport is 85km long by using boats and barges.

Concerning materials and equipment supplied from Japan, a minimum of three weeks will be necessary to have them packed, transported. cleared through customs and brought to the site.

(3) Environmental constraints during construction

most major construction projects impose quite significant temporary hazards to the environment. The typical impacts caused by construction projects during the construction stage are described below. A particular consideration of these impacts is required.

1) Noise and vibration

During the construction stage, the operation of construction equipment causes noise and vibration. Noise and vibration affect facilities requiring particular tranquillity, such as hospitals and schools.

Construction equipment such as diesel pile hammer and compressor cause noise nuisance at level of 80 - 100 dB within a 10 m radius and 70 dB within a 30 m radius. Vibro-hammers and bulldozers demolition of existing road structures cause vibration nuisance at levels of 60 - 70 dB in the surrounding area.

Such noise and vibration nuisance cause environmental impacts during foundation construction works. In this Project, however, the foundation type consisting of built up cast-in-place concrete piles installed by means of reverse circulation drilling method is adopted which does not cause noise and vibration nuisance. The most suitable construction methods in implementation of the Project are adopted so as not to affect residences in and around the proposed bridge site.

2) Water pollution and soil contamination

During construction, water pollution and soil contamination caused by rainwater running off road surfaces, effluent generated from roadside areas and soil erosion resulting from banking and ground are to be considered.

It should be noted that the contractors shall make efforts to construct the slope protection for banking and to clear the construction sites, so as not cause water pollution, erosion and siltation in the Mekong River.

3) Resettlement issue

Resettlement and land acquisition issues are the obligation of the Government of Cambodia. Resettlement is a very important issue that shall be settled properly and *timely for smooth and successful execution and completion of the Project.*

People living in the project site should be relocated due to land acquisition for execution of the Project. Loss of livelihood of inhabitants, difficulty in social and cultural adaption to the resettlement area may occur. The Government of Cambodia is expected to take necessary measures to achieve adequate resettlement.

4) Clearance of unexploded ordnance

The approach bridges and roads on the east bank of the River might have been former battle fields for thirty years. It is unlikely that all the unexploded ordnance have ever been totally cleared, so clearing is one of the first tasks of the Project. The executing agency of Cambodia shall request CMAC, etc. to carryout an investigation of unexploded ordnance as a preparatory work on the proposed route.

If there is a significant problem, this poses a more significant problem for this Project. The Government of Cambodia shall carry out field investigations and clearance of unexploded ordnance in the area before the signing of the Exchange of Notes on the construction works.

3.1.3 Scope of Works

The responsibilities of works for which the Japanese Government and the Cambodia Government will be allocated are as follows ;

(1) Works and facilities to be provided by Japanese Government

1. Construction of the bridge and approach roads

2. Bridge and approach road accessories

   - Lighting
   - Drainage system
   - Guard rails, expansion joints, bearing
   - Farm crossing such as box culvert

3. Facilities to be used during the work

   - Roads to be used during the work
   - Provisional landing stage to be used during the work

4. Others

   - Transportation of construction materials and equipment from Japan and the third country to Cambodia
   - Consulting and engineering services

(2) Works and facilities to be provided by Cambodia Government

1. Acquisition and reclamation of land

2. *Field investigations and clearnce of unexploded ordnance*

3. *Power distribution lines for the work*

4. Main water pipe leading to the site

5. Rewiring of telephone lines

6. Traffic safety signs, marks, etc.

3.1.4 Consultant Supervision

(1) *Consulting Services Schedule*

The project will commence after signing an Exchange of Notes pertaining to engineering services between the Governments of Japan and Cambodia. The detailed design and construction supervision contracts will be concluded between the Ministry of Public Works and Transport and the Japanese Consultant who will provide the following services within the limits of the grant aid.

1) Detailed Design Phase

The Consultant shall carry out the detailed engineering designs of bridge and approach roads in compliance with specifications and concepts of the basic designs.

- Criteria and standards
- Design reports
- Drawings
- Quantity and cost estimates
- Proposal of construction execution
- Tender and relevant documents

2) Pre-Construction Phase

The MPWT shall select Japanese contractor to implement the project through an open tender. The Consultant shall assist the MPWT on the following tasks ;

- Bid announcement
- Prequalification of contractors
- Pre-bid conference and site inspection
- Bids and award of contract
- Contract negotiation

3) Construction Supervision Phase

The engineering services for construction supervision will begin after issuance of the Notice to Proceed to the Consultant by the MPWT.

The Consultant shall perform his duties in accordance with acceptable criteria and standards applicable to construction works and shall exercise the powers vested in him as the Engineer under the Government's contract with the contractors awarded.

The Consultant in his capacity as the Engineer shall report directly to the MPWT concerned which will coordinate all works in connection with JICA financed highway projects and will issue from time to time guidelines for the purpose of establishing uniformity in the administrative as well as the technical working procedures.

(2) Organization of Implementation

1) Organization for detailed design

In the preparation of the detailed design including the tender documents, Japanese staff of the following expertises are needed ;

- Team Leader
- Bridge Superstructure Engineer
- Bridge Substructure Engineer
- Foundation Engineer
- Road Enginner
- Construction Planner/Cost Estimator

2) Organization for construction supervision

With reference to the construction organization during the construction period, Japanese supervisory engineers for main portion of construction works are as follows;

- Team Leader
- Bridge Superstructure Engineer
- Bridge Substructure Engineer
- Road Engineer

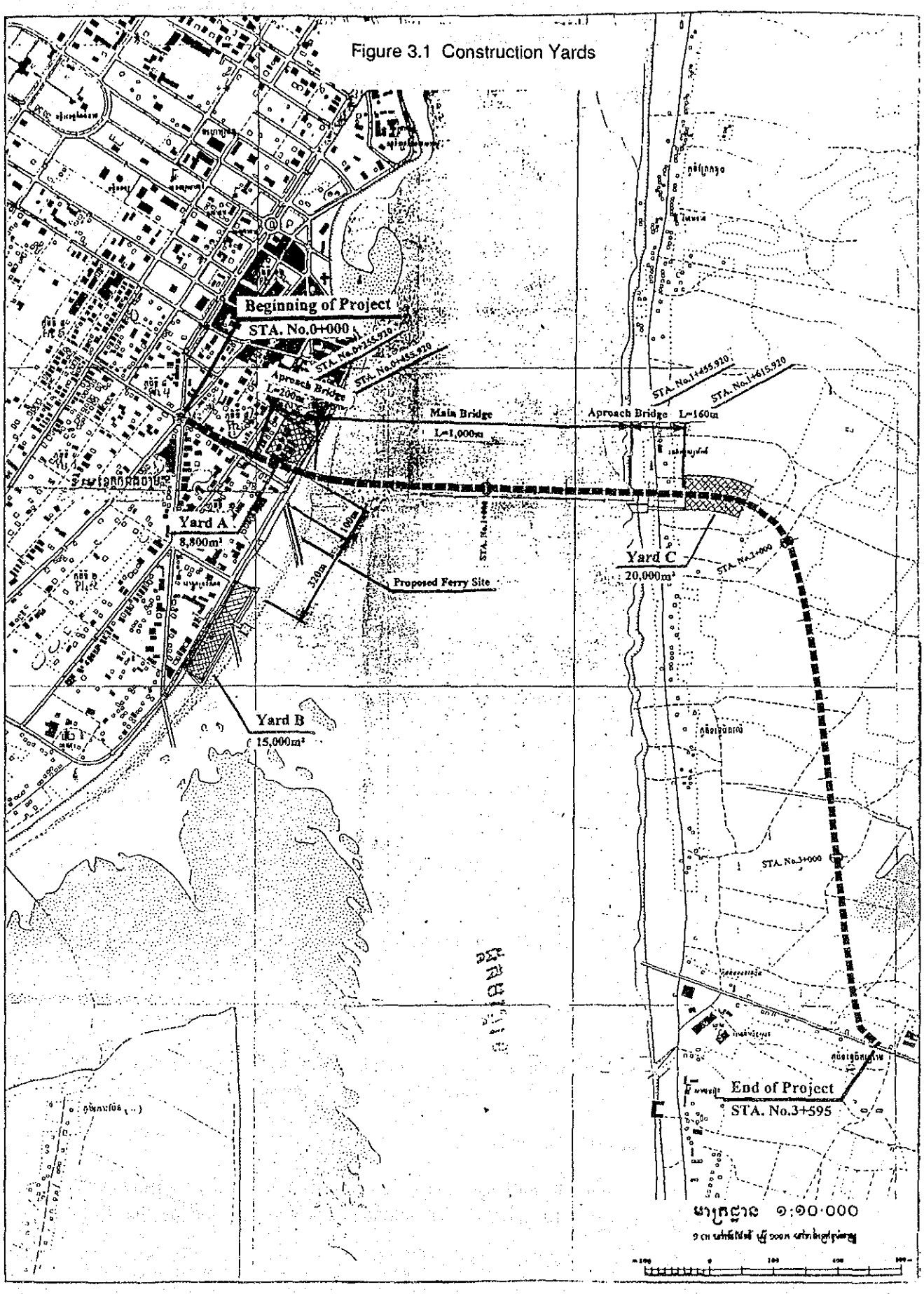
(3) Construction Implementation Plan

1) Temporary work

(a) Construction yards

Construction yards of 43,800m^2 will be reclaimed and composed of three yards (Refer to Figure 3.1) along/adjacent to the proposed route as follows;

Figure 3.1 Construction Yards



Yard A : 8,800m^2 (in a land of warehouses on the proposed route of Kompong Cham side)

Yard B : 15,000m^2 (in a riverside of a right dike facing Kompong Cham)

Yard C : 20,000m^2 (in a landside of left dike adjacent to the route)

It is planned to reclaim Yard B and C by filling-up to the top elevation of 15.5 m more than H.W.L. during flood period and to connect a site with a yard by an access road.

A site office, warehouses, materials and equipment storage houses, crushing and asphalt plants, etc. will be built in the yards to serve as work bases.

The slope of the embanked and filled-up yards will be protected from erosion and scour in a rainy season with a concrete slope protection work, and the yards will be surrounded by a barbed wire fence to prevent thefts of the materials and equipment transported to the yards.

(b) Power distribution to the work sites

Electric power used in the work is provided with generator due to stable supply.

(c) Water distribution to the work sites

Drinking water is obtained from new well and is distributed through installed water tabs of 50 mm in diameter to where necessary. For mixing and curing concrete to be used in construction work, water from the river will be used.

2) Construction of substructure

The construction plan of substructures for the Mekong Bridge is based on the following conditions ;

- The foundations be constructed in the 6 months (January to June) during the dry season.
- The variation between the highest (+15.10m) and lowest (+0.82m) water level is 14.3m at the site.
- The scouring depth from the river bed is estimated at 5m.
- The foundation works should be completed within 2 dry seasons. However, some parts of pier is to be constructed in the third dry season.

(a) Substructure of main bridge

Self Elevating Platform (SEP) is installed at downstream side of piers such as P7, P8, P9, P10 and P11. Foundations are constructed by this SEP is

dismantled immediately after completion of foundation. Construction procedure as follows:

- Self-Elevating Platform is set at the exact position.
- Steel pipe piles are driven by vibro hammer through guide frame attached to SEP.

Two (2) self-elevating platforms are installed to build up substructures for the main bridge.

For constructing foundation of P6 and P7, scaffold made of H shape steel is erected at each pier of downstream side and then are constructed fro this scaffold.

Crawler cranes and vibro hammers are used to erect the landing stages. H-shaped steel used for the landing stages is brought from the third country such as Thailand and sent back immediately after completion of the work.

The third country's workers such from neighboring countries assign to the key jobs (crawler crane drivers, scaffolding men and other operator) for such works as piling by means of vibro hammers. Local workers are assigned to the auxiliary works.

(b) *Coffering for the approach bridges*

A single coffering is built at P5 and P14 using steel sheet piles when cutting-off water due to the river's water level and retaining due to the depth of excavation floor. At A1, P1, P2, P3, P4, P15, P16, P17 and A2, coffering works are not necessary for constructing each foundations.

Steel sheet piles are placed using crawler cranes and vibro hammers. Steel sheer piles are procured from the third country, basically such as Thailand, and sent back immediately after completion of the work. The third country's workers are assigned the above operators.

(c) Piling of cast-in-place concrete piles

Cast-in-place concrete piles are piled by means of the reverse circulation drilling method, which proves to be very economical.

In the main bridge, boreholes having the 2.0m diameters are made in the steel pipe piles and drilled down to weathered rock to form a socket length up to 2.5 times the pile diameter. After slime at the borehole tip is removed, the required concrete volume for one pile is placed with tremie pipes by the large capacity of concrete batching plant. Sedimentation tank barge is installed on the barge.

The concrete piling works are carried out from concrete mixer ship with pump. Since the ground subject to drilling is formed by sand layers, collapse of the holed walls must be prevented by using soil agents.

Crane operators, reverse operators and workers play the main roles in this work, and it is the personnel dispatched from the third country, basically from Thailand, who undertake these assignments. Local workers are hired for the reinforcement work and concrete placement.

In the approach bridges, boreholes having the 1.0m diameter are drilled down to the bearing stratum without landing stages.

(d) Footing and body of pier and abutment

Cast-in-place concrete piles are jointed with a pile cap.

Local wooden forms are procured for the structural members. Reinforcing bar conforms to Class 30 of JIS G3112 or equivalent. Concrete for the main bridge and approach bridge is procured at concrete mixer barge and concrete is placed by pump through distribution pipe.

Formworks, reinforcing arrangement works, and concrete works for footings and bodies of piers and abutments are performed by local labors.

3) Construction of superstructure

(a) Superstructure construction method of the main bridge

Girders of the main bridge are constructed by means of the cantilever construction method with Vorbau Wagen. The cantilever spans are prestressed using the Freyssinet Method. The construction procedure of the main bridge are as follows ;

Top portions of the pier, called the pier top, are concreted on blacket staging which are anchored to pier. It can be used as the starting platform for the traveling wagons. Two traveling wagons are placed side by side on the top of pier, then forming, reinforcing bar installation, and concreting are performed on the first block of the box girder. After the girder is prestressed, this wagon travels to the end of the girder and the other wagon is set up on the other side to repeat the same procedure.

After finishing one block of the box girder on each side of a pier, subsequent blocks are alternately constructed on each side using the Cantilever Method with the traveling wagons. Technical control is taken so that loads do not create an excessive unbalanced moment on the pier. The end of the cantilever girders at abutments are constructed using post shoring, staging and scaffolding, and is connected with the cantilever girder by prestressing. The end of the cantilever girders at the center of each span are connected with a key segment using a suspended shoring system.

Deflection of the cantilever bridge is controlled during the construction period taking into consideration both elastic and plastic deformation.

Girder is to be constructed of 2x19 blocks ranging from 2.0m to 3.45m and 3.0m block at the bridge center.

(b) Formwork

Steel form is used for outer face and waterproof plywood form for inner face of the PC box girders for the main bridge. Steel form is prepared 3 sets as well as a number of sets of a traveling wagon. 3 times of re-use are expected for wooden form.

Skilled carpenters from the neighboring country are employed to give special training to the local labor.

(c) Reinforcing bar work

Reinforcing bars fabricated in the construction yard are transported to the site and positioned in place using truck crane.

The work is done by local labor under the supervision of skilled workmen from the neighboring country such as Thailand.

(d) Arrangement of prestressing cables

Pre-fabricated prestressing cables are placed by crane. Sheaths and anchorages for the post-tensioning method are arranged so as to satisfy the construction accuracy and fixed so tightly as not to move during placement of concrete. High experience is required for placing, tensioning, grouting of the prestressing steel and Vorbau Wagen for erection of the main bridge girders.

(e) Concrete placement

Concrete is mixed by concrete mixer barge and transported by concrete pump. Water-reducing agent / plasticizer is used to low water-cement ratio together with air entraining agent to maintain workability of concrete respectively.

(f) Introducing of tensioning and grouting

Compressive strength of concrete at stage of the prestressing shall be more than 1.7 times the maximum compressive stress generated immediately after prestressing. Concrete around anchorage zones shall have enough compressive strength to resist bearing stress coused by anchorage.

Before the injection of the grout, the inside of theaths generally is flushed to ensure that theaths are thoroughly wetted.

The grout shall slowly be injected by a grouting pump immediately after mixing. The grouting pump have capability to inject the grout without intermixing the air.

(g) Girder construction method of the approach bridge

The girder type is a prestressed concrete composite I-section connecting girder with spans up to 40m as the most appropriate and economical girder length. The PC I-girder is hoisted and positioned in place with 2 crawler cranes.

Construction reason for adopting continuity with connecting girders is the reduction of the maintenance costs associated with bridge deck joints and deck drainage onto the substructure. Continuity also improves the appearance and driving quality for users.

4) Approach roads

The embankment is left for considerable duration as a surcharge for accelerating settlement due to consolidation of the existing ground layers.

70cm thick of sand mat is placed on the road area of the proposed west and east approach roads before starting fill works in order to improve existing ground and obtain higher trafficability for construction machinery and equipment.

5) Replacement of ferry ghat

Ferry ghat at the side of Kompong Cham is located directly under the centerline of the proposed bridge. Accordingly, it is necessary to replace it to the downstream side for keeping safety of construction works and ferry operations.

It was agreed between MPWT and the study team that new ferry site is located to the downstream side of about 100m far from the centerline of the proposed route.

3.1.5 Procurement Plan

(1) Construction Materials

Concrete aggregate and sand, crushed stone for pavement and wood are available in Cambodia. However, other construction materials except PC anchorage, labor shoes expansion joints, which are imported from Japan, are recommend to be procured in the neighboring countries. Ready mixed concrete and asphalt compound are not procured near construction site, these materials are produced in the site.

a)	Concrete aggregate	:	River gravel excavated near Kratie in dry season and transported by barges
b)	Sand	:	River sand excavated from sand bar downstream of the construction site.
c)	Asphalt aggregate	:	Crushed stone produced in local crushing plants along Route 7
d)	Wood	:	Timber

The procurement countries of construction materials is shown in Table 3.1

Table 3.1 Procurement for Major Construction Material

Item	Procured in Cambodia	Procured in Third Country	Procured in Japan
Cement		○	
Reinforcing bar		○	
Shaped Steel		○	
PC Strand		○	
PC Bar			○
PC Anchorage			○
PC Sheath		○	
Straight Asphalt		○	
Concrete Admixture		○	
Expansion Joint			○
Rubber Shoes			○
Waterproof plywood			
Lighting Poles		○	
Handrail		○	
Crushed Stone	○		
Sand and Gravel	○		
Wood	○		
Materials for Scaffolding		○	
Oil	○		

(2) Construction Equipment

Rental company for construction equipment is not now founded in Cambodia. However, some of equipment, which belong to the local contractors, are recommend to be procured. The heavy equipment to be used for bridge construction are mostly procured in Thailand and Singapore and Japan. As for construction equipment, the procurement is shown in Table 3.2.

Table 3.2 Procurement for Major Construction Equipment

Item	Specification	Procured in Cambodia	Procured in Third Country	Procured in Japan
Bulldozer	21 t		○	
Bulldozer	15 t	○		
Wheel Loader	1.4 m3	○		
Dump Truck	11 t		○	
Back Hoe	0.6 m3		○	
Vibrating Roller	3 - 4 t		○	
Road Roller	10 t	○		
Tire Roller	10 t		○	
Motor Grader	3.1 m		○	
Asphalt Finisher	3.5 m		○	
Asphalt Distributor	4,000 lit		○	
Crawler Crane	50 t		○	
Crawler Crane	100 t		○	
Crawler Crane	150 t		○	
Truck Crane	25 t		○	
Truck Mixer	5 m3		○	
Trailer	32 t		○	
Generator	75 kVA	○		
Generator	100 kVA	○		
Generator	200 kVA		○	
Generator	300 kVA		○	
Generator	600 kVA			○
Air Compressor	7 m3/min		○	
Air Compressor	3.7 m3/min		○	
Welder	300A		○	
Hydro-breaker	200 kg		○	
Tampa	60 - 100 kg	○		
Water Pump	4" dia., 30 m	○		
Water Pump	6" dia., 30 m	○		
Vibrator	45 mm	○		
Line Marker	2 lit/min		○	
Vibro-Hammer	60 kW		○	
Vibro-Hammer	200 kW			○
Reverse Drill	110 kW			○
Barge	1,000 t		○	
Barge	400 t		○	
Barge	200 t	○		
Tug Boat	500 ps		○	
Tug Boat	200 ps		○	
Concrete Mixer on Barge	1 m3 batch			○
Wagon				○
Self-elevating platform	MINISEP			○

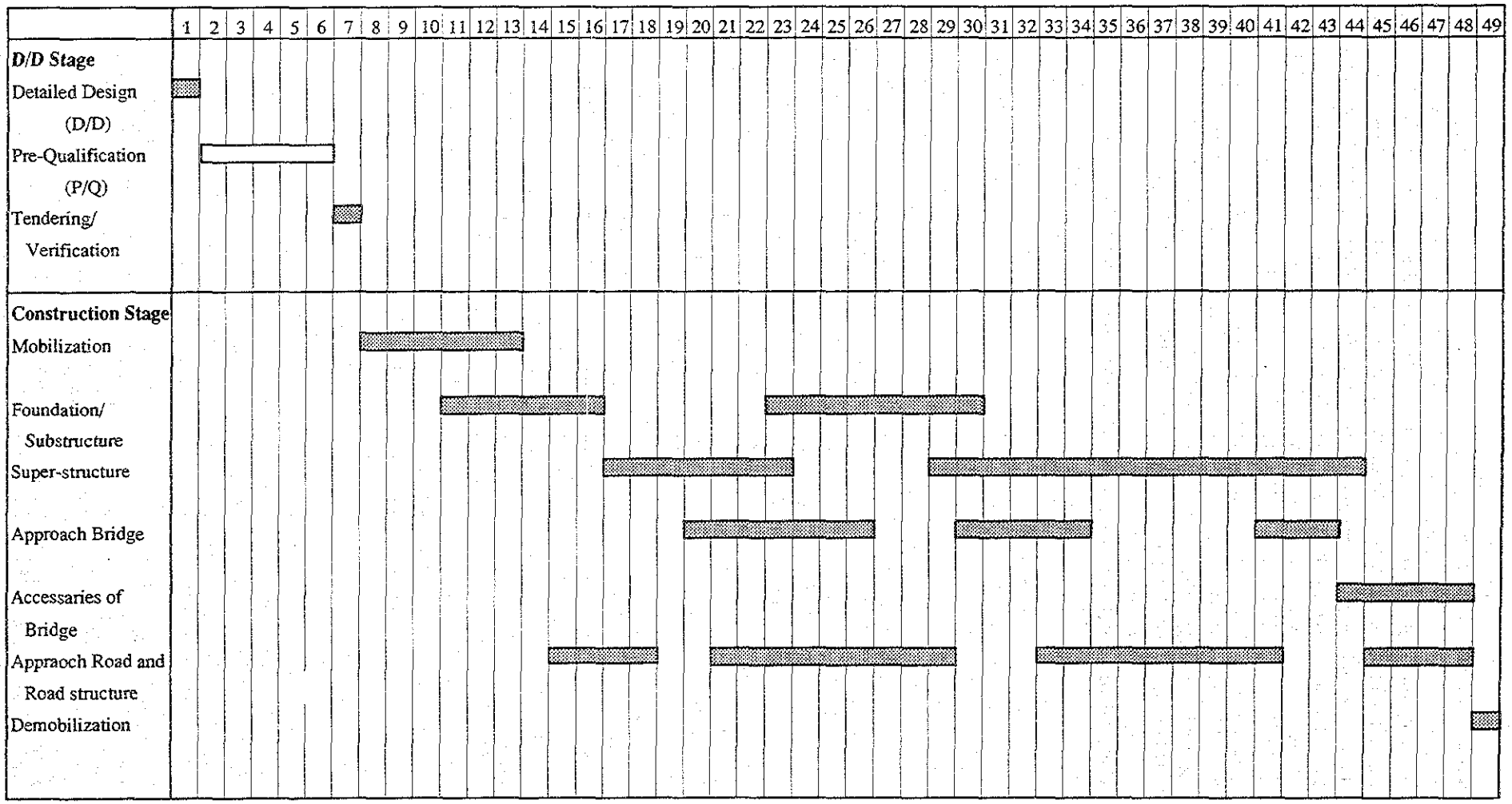
3.1.6 Implementation Schedule

MPWT will sign a contract with a selected consultant after the Exchange of Note for detailed design. The, the project implementation will be commenced. The detailed design is carried out for 6 months including 1 month in site survey. The pre-qualification of contractor will be made under the JICA guideline in parallel with the detailed design. The following one month will be provided for tendering, evaluation and contract signing.

During construction stage for 42 months (3.5 years), mobilization, construction of foundations, substructures, and superstructure for main bridge and approach bridge, approach road, protection of scoring and demobilization.

Total implementation period is estimated at 49 months as shown in Table 3.3.

Table 3.3 Implementation Schedule



3.1.7 Obligation of the Recipient Country

Following necessary measures should be taken by the Cambodian side on condition that the Grant Aid by the Government of Japan is extended to the Project:

- To provide data and information necessary for the Project.
- To secure the land for the excursion of the Project, such as land for road alignment, bridge construction, working areas, storage yard, etc.
- To clear the sites prior to the commencement of the construction.
- To bear commissions to the Japanese foreign exchange bank for its banking services based upon the Banking Arrangement, namely the advising commission of the "Authorization to Pay" and payment commission.
- To ensure prompt unloading, tax exemption, customs clearance at the port of disembarkation in the Kingdom of Cambodia and prompt international transportation therein of the materials and equipment for the Project purchased under the Grant Aid.
- To exempt Japanese juridical and physical nationals engaged in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in the Kingdom of Cambodia with respect to the supply of the Products and services under the verified contracts.
- To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the Kingdom of Cambodia and stay therein for the performance of their work.
- To provide necessary permissions, licenses and other authorizations for implementing the Project, if necessary.
- To maintain and use properly and effectively the facilities constructed under the Project.
- To bear all the expenses other than those to be borne by the Japan's Grant Aid within the scope of the Project.
- To coordinate and solve any issues related to the project which may be raised from third parties or inhabitants in the Project area during implementation of the Project.

3.2 Operation and Maintenance Plan

3.2.1 Training of Maintenance Personnel

The Ministry of Public Works and Transport (MPWT) will be responsible for maintenance and operation of the bridge structure including the related road section after completion of the

Mekong River Bridge at Kompong Cham. MPWT is scheduled to establish a new executing body to deal with these maintenance and operation works immediately after completion of this Project.

It is recommended to set up a plan for training of maintenance personnel to be assigned to this new body from the construction stage of this Project in order to secure a sufficient number of engineers required and to adequately improve their expertise. Because bridge engineers are in serious shortage at present. The following items are expected to be adopted in the progress of the Project to facilitate the training for the maintenance works.

(1) When the Project is implemented, MPWT will organize a new section to handle bridge construction matters. It is expected the assigned engineers will acquire technical knowledge, experience and thorough understanding of drawings, through on-the-job training. These engineers will later participate in the operation and maintenance works to further develop there technical expertise. The engineers so trained under the Project will form the backbone of bridge engineers of Cambodia and will transfer their acquired knowledge and experience to younger generations of Cambodian engineers.

(2) Trainees who took part in training course on bridge engineering in foreign countries will be involved in the above mentioned on-the-job training in the construction stage.

(3) Maintenance Manual of Mekong Bridge shall be compiled by supervising consultant.

3.2.2 Maintenance and Operation Plan for the Mekong Bridge and Related Road

Contents of maintenance works and there frequency are considered as follows.

	Frequency	Items to be checked	Contents of Works
Maintenance works on bridge structure	one a year	Expansion Joint	Cleaning expansion joint, degree of damage and photograph
		Handrail	Recording of damaged portion and photograph
		Lighting	Replacement of bulb and checking distribution lines
		Shoe	Recording show rubber and cleaning around shoe
		Pavement	Recording degree of deterioration and quick repair works
		Scoring around piers	Recording depth of score
Maintenance works on related road	twice a year	Pavement	quick repair works if damaged
		Slope protection	Cleaning slope, repair of sodding and collapsed slope
		Drain system	Cleaning ditch
		Culvert box	Removal of sedimentation soil and flown timber
Others	ten years interval	Overlay of asphalt concrete	Damaged asphalt concrete is to be removed

3.2.3 Organization of Maintenance Works

The Maintenance Section to be established after completion of this Project will deal not only with the Mekong bridge but also with other small bridges in Cambodia. It is estimated that about 30 staffers will be required for engineering works and 20 staffers for office works.

3.2.4 Required budget for Maintenance Works

According to maintenance work data obtained so far, the annually required road maintenance cost is 600 US$ per kilometer which are almost occupied with labor cost and the cost of overlay of asphalt concrete of the bridge and road section for every ten years is 6.50 US$ per square meter comprising 60% of materials cost, 35% of machine one and 5% of labor one. Consequently, some 1,900 US$ will be required every year and some 206,000 US$ for every ten year.