- CBR
- Grain size analysis

3.7.3 Climate and Hydrological Conditions

(1) Site Survey

A site survey and hearings were carried out to investigate the hydrological conditions in the Project Site including river system and flood/high water conditions. Data of rainfall and water levels variation were collected from the concerned agencies as well as the inhabitants along the Route 6A. The data collected were analysed to prepare a sound basis for the basic design and the implementation plan of the Project.

(2) Climate

The seasons are influenced by the monsoons. During the southeast monsoon (from May to November), the average rainfall in Phnom Penh is around 170 mm per month and the average total yearly rainfall is approximately 1,270 mm. Table 3.14 shows the monthly average temperature, rainfall and number of rainy days based on the record at Phnom Penh - Bassac observation station between 1980 and 1990. The wind velocity data (1981 - 1984 at Phnom Penh - Bassac) showed that there is slight winds in February and March, and strong winds observed in July through October is 16 - 18 m/sec.

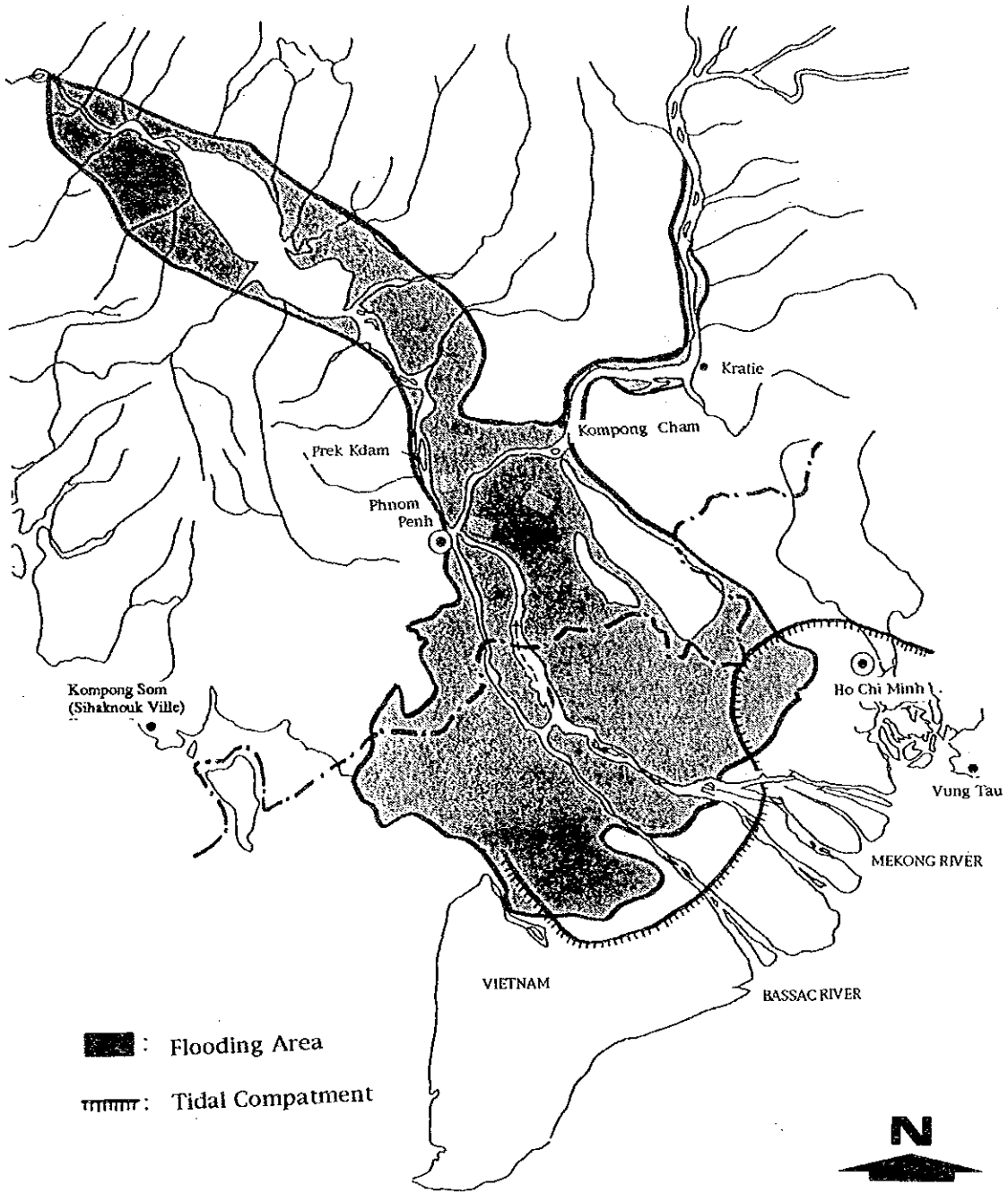
Table 3.14 Monthly Average Temperature, Rainfall and Number of Rainy Days

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temperature (°C)	26.1	27.5	28.9	29.4	28.8	28.1	27.6	27.7	27.3	27.2	26.7	25.4
Rainfall* (mm)	2	3	12	71	107	118	161	200	235	218	133	9
Rainy Days*	0.4	0.7	1.1	5.6	11.9	14.7	19.6	20.2	21.1	18.6	11.4	1.4

Note: * denotes rainfall data at Phnom Penh - Bassac (1980-1990).
Source: Road and Bridges Department

(3) Hydrology

Below Kompong Cham, the Mekong river enters its delta, overflooding the plain on both banks as water level rises over 7 m above mean sea level. The overbank flow on the west bank escapes toward the Tonle Sap river or the Tonle Sap lake. This reverse flow starts sometime before July every year and continues until the flood recession in October (see Appendix 6 for the stage hydrograph at Kompong Cham, Phnom Penh and Prek Kdam). The reverse flow in Tonle Sap river is governed mainly by the regulating effect of the Tonle Sap lake (the area of Tonle Sap lake in dry season becomes 7 times larger in high water season of the Mekong river). Figure 3.7 shows the flooding area in high water season of the Mekong river. Hearing with local people concerning the maximum water surface level along the Route 6A between Stas. 40 and 42 was conducted. This hearing aimed at the determination of the design high water elevation to restore the road embankment at the six locations of severe embankment which were washed away. The maximum water surface level obtained through the hearing was El. 12.0.



REHABILITATION OF NATIONAL ROAD ROUTE 6A

Figure 3.7 Flooding Area

Chapter 4: Basic Design

CHAPTER 4 BASIC DESIGN

4.1 Design Policy

Route 6A is a major trunk highway which is situated in an essential part connecting Phnom Penh with its northern hinterland. However, it passes through an area liable to troublesome flooding and this will offer many difficulties during the construction and in the road maintenance after the completion of the Project. Therefore, full attention was paid for the role of Route 6A and the natural conditions in the Project Site.

Contrary to many road rehabilitations ongoing in Cambodia, the following countermeasures are provided to overcome the inherent situation:

- Adoption of permanent design for the bridge replacement to attain the maintenance free structures;

- Adoption of asphalt concrete surface course to eliminate rapid damage or deterioration of pavement after the rehabilitation; and

- Introduction of a mechanised up-to-date construction technique to overcome the adverse natural conditions in the Project Site.

Taking such design policy in mind, the following basic guideline is exercised in proceeding with the Basic Design.

(1) The optimum rehabilitation scheme and construction plan is selected considering the following requirements:

- Shorter construction period;
- Lower construction cost; and
- Lower maintenance cost after the rehabilitation.

(2) Japanese design standard is applied for the bridge replacement and the rehabilitation of damaged bridge and culvert structures.

(3) Existing foundation piles are utilised for the reconstruction of substructures.

(4) Corrugated metal pipe is adopted for the replacement of damaged culverts considering the shortening of construction period and ease of quality control.

(5) Optimum construction method will be selected for the rehabilitation of major embankment damage between Stations 40 and 42 considering the variation of flood water surface levels.

(6) Bridge revetment (construction of stone masonry wall, stone masonry slope protection and wire cylinders) is provided for the repair of embankment of bridge approaches and the locations of embankment slope failures. However minor slope erosion is not be disturbed since these areas are covered by vegetation and fairly stabilised.

(7) Design life of 5-years is adopted for the pavement to reflect the object of rehabilitation and to avoid excessive initial investment.

(8) Asphaltic concrete surface course is adopted in the rehabilitation or reconstruction of pavement. Existing pavement layers are utilised as a subbase course or a base course.

(9) Adopted carriageway width and shoulder width are 7.0m and 1.5m respectively.

(10) Entire rehabilitation is divided into the following two phases:

- First Phase : Rehabilitation of bridges, culverts, embankment failures and subbase course which is aimed at the "passable road in the whole stretch of Route 6A"; and

- Second Phase : Completion of base and surface courses of the pavement aimed at the restoration of Route 6A as a regional trunk highway.

(11) Temporary bridge (4-locations) is adopted at the bridge replacement sections for the following purposes during the construction:

- By-pass of existing traffic;
- Removal of damaged bridge members;
- Erection of superstructure;
- Passage of construction equipment.

(12) Construction planning is carried out based on the following conditions to consider the meteorological and hydrological situations in the Project Site:

- Works which must be performed in the dry season
  - Substructure construction for the bridge replacement,
  - Embankment construction, and
  - Paving of asphalt surface course.

- Works which are preferable in the dry season
  - Site clearing,
  - Slope protection,
  - Repair of superstructure, and
  - Base course construction.

- Works which are possible in the dry and rainy seasons
  - Production of aggregates, and
  - Superstructure construction.

(13) The location of quarry, stone crushing plant and asphalt mixing plant is selected at Chi Lear.

(14) The location of a base camp with concrete mixing plant is selected near the middle point of Route 6A.

4.2 Study and Examination of Design Criteria

4.2.1 Bridges and Other Structures

(1) Loading Specifications

Japanese standard is applied in the Design. Loading consists of primary loads, secondary loads and certain circumstance loads.

1) Primary Loads

Primary loads consist of:

- Dead load;
- Live load;
- Impact load;
- Influence of the creep of concrete;
- Influence of the shrinkage of concrete;
- Earth and water pressure; and
- Uplift.

2) Secondary Loads

Secondary loads consist of wind loads and thermal forces.

3) Certain Circumstance Loads

Certain circumstance loads consist of:

- Brake and traction;
- Collision force; and
- Special loading during the construction operations.

(2) Applied Design Conditions for Superstructures

- Class of bridge	:	1st class in Japanese bridge standards		
- Type of superstructure	:	Reinforced concrete T-girder bridge		
- Span length	:	12 m		
- Live load	:	TL-20 (Gross weight of truck = 20 ton)		
- Traveledway width	:	9.0 m		
- Asphalt pavement	:	Asphalt concrete, 5 cm thickness		
- Temperature variation	:	15°C ~ 40°C		
- Allowable stress	:	Concrete	σ_{ck} = 240 kg/cm^2	
		Reinforcement	(SD295)	
			σ_{sa} = 1,400 kg/cm^2 -	Deck slab
			σ_{sa} = 1,800 kg/cm^2 -	Girders

(3) Applied Design Conditions for Substructures

- Type of substructure	:	Inverted T-type	- Abutment
		Pile bent	- Piers
- Allowable stress	:	Concrete	$\sigma_{ck} = 240$ kg/cm^2
		Reinforcement	(SD295 & SD345)
			$\sigma_{sa} = 1{,}800$ kg/cm^2
			$\sigma_{sa} = 1{,}600$ kg/cm^2
			(Structure in the earth)

4.2.2 Geometric Design Standard

There is no road section which necessitates the change of road alignment. The following geometric standard (Table 4.1) is envisaged in the rehabilitation.

Table 4.1 Geometric Design Standard (Abstract of Japanese Standard)

Item	Unit	Standard
Design speed	km/h	60
Horizontal curve		
Minimum radius	m	120
Maximum superelevation	%	6
Minimum curve length	m	50
Vertical curve		
Minimum radius of sag curve	m	1,000
Maximum radius of crest curve	m	1,400
Maximum gradient	%	5
Crossfall of carriageway	%	2.0
Lane width	m	3.5

4.2.3 Pavement Design Standard

The pavement design standard of Japan Road Association was applied in the design.

4.3 Basic Plan

4.3.1 Bridge Replacement (Superstructure)

(1) Selection of Superstructure Type

The minimum span length of a bridge is generally determined by the nature of the roads and rivers over which the bridge is required to pass; the soil conditions, and factors relating to the surroundings. For a bridge over an unimproved river, a careful study should be made of the river course and flow characteristics. The span length is one of the most important factors in determining the bridge type. Once the span length is fixed then the choice of bridge type is limited (Figure 4.1).

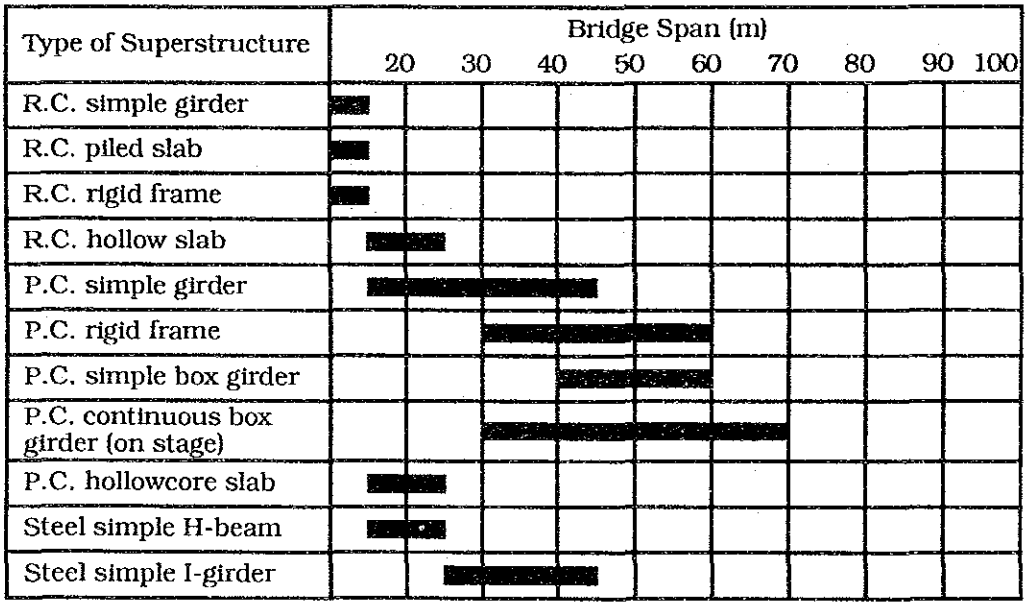


Figure 4.1 Standard Spans for Various Types of Bridges

The following six types of superstructures were selected for comparison considering existing foundations to remain, natural conditions in the Project Site (i.e., hydrological and soils conditions) and construction planning.

a. Alternative-1 : Reinforced concrete T-girder, simple (same as existing bridges)

b. Alternative-2 : Reinforced concrete hollow slab, simple

c. Alternative-3 : Prestressed concrete hollow core slab units, simple, pretensioned

d. Alternative-4 : Prestressed concrete I-girder, simple, post tensioned

e. Alternative-5 : Steel H-beams, simple

f. Alternative-6 : Reinforced concrete rigid frame for 24m span

All the possible alternatives have been duly examined by the Study Team. As a result of comparison of the alternatives, it was concluded that Alternative-1 is superior to the other alternatives in all aspects as listed below:

- Hydrological aspects in the Project Site and the Project implementation;
- Shorter construction period;
- Maintainability; and
- Aesthetic viewpoint.

(2) Design of Superstructure

1) Girders

Reinforced concrete T-girder is adopted in the design. T-girder is further compared in terms of the weight of girder unit and erection method (Figure 4.2) and has adopted the rectangular girder.

2) Deck Slab

The outline of design features of deck slab is as follows:

- Composite design is adopted for girders and deck slab;
- Adopted slab thickness is 18cm which considers the passage of large vehicles of 500/day/lane;
- Reinforcement is composed of bent-up steel bars in 16mm diameter and 125mm on center.

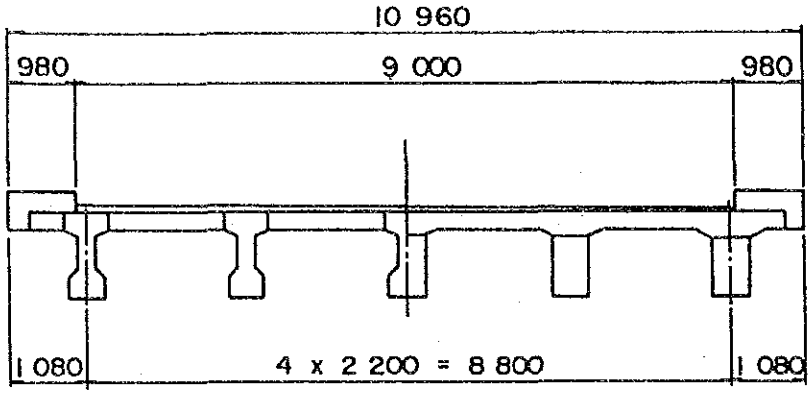
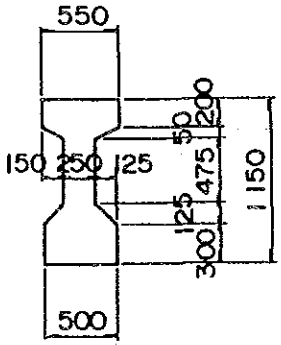
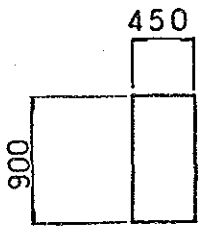
	I-Girder	Rectangular Girder
Dimensions		
		
Weight of Unit	14.8t	12.2t
Erection Equipment	Required capacity of crawler crane 80t	Required capacity of crawler crane 50t
Remarks	• Reinforcement: 8-D32 • Requires heavier crawler crane	• Reinforcement: 12-D32 • Easier fabrication and erection

Figure 4.2 Comparison of Girders

3) Bridge Appurtenances

i. Shoe

Synthetic rubber shoe (20mm thickness) is adopted. Anchor bolts are provided to resist the brake/traction forces.

ii. Expansion Joint

Simple type expansion is adopted. The expansion consists of ʊ -shaped copper plate and filler.

iii. Bridge Railing

Adopt the similar design as the existing, which consists of poured-in-place reinforced concrete posts and precast reinforced concrete railings.

4.3.2 Bridge Replacement (Substructure)

(1) Evaluation of Existing Foundation Piles

The bearing capacity of the existing foundation piles are examined based on:

- The bearing data concerning the construction procedures;
- Boring data near the existing substructures; and
- Japanese guidelines for substructure design.

As a result of calculations the bearing capacity of each foundation pile is estimated as shown in Table 4.2.

Table 4.2 Estimated Bearing Capacity of Existing Foundation Pile

Bridge Number	Bridge Name	Length of Pile (m)	Allowable Bearing Capacity (ton)
No. 14	Prek Kheng	24	74
No. 20	Prek Bak	18	70
No. 22	Prek Kra Poes	18	102
No. 24	Kompong Pras 1st	12	89

From the above data it is concluded that the existing piles can remain and utilised for the reconstruction of bridges, since the reaction of each pile is calculated to be approximately 60 tons which is smaller than the above estimated capacity.

(2) Selection of Pier Type

The basic assumption for the selection of pier type is to utilise existing foundation piles. Three alternative cases are compared and it has been decided to adopt Case-3 (Figure 4.3).

(3) Design of Substructure

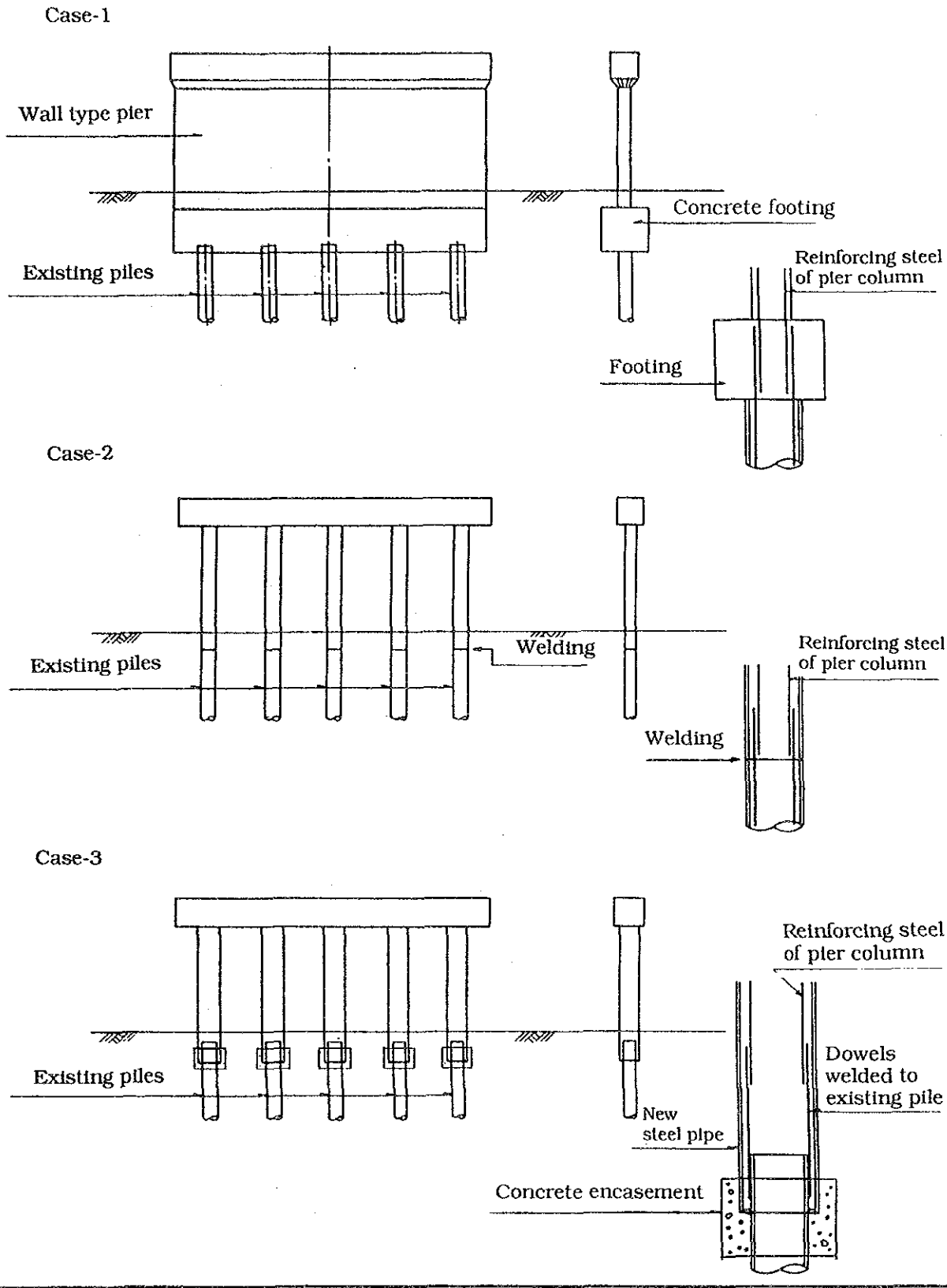
1) Pier

The steel pipe in the new pier column construction is not considered as a structural member but considered as cylindrical form for the placing of concrete. See Figure 4.3 for design features.

2) Abutment

New abutment is designed for No. 24 Kompong Pras 1st Bridge based on the following conditions:

- Earth pressure is calculated based on Coulomb's earth pressure theory;
- Stability analysis is carried out based on the assumption that the total earth pressure will be resisted by the entire abutment (7-piles);
- Approach slab is to be supported by the top of parapet wall at the abutment side.



REHABILITATION OF NATIONAL ROAD ROUTE 6A

Figure 4.3 Comparison of Pier Types

4.3.3 Repair of Other Damages of Bridges

(1) Concrete Girders and Deck Slabs

1) Girders

- Damage at the end : Replace with new concrete after jack-up. Epoxy resin will be applied on the contact surface of old and new concrete. Non-shrink agent will be added in the new concrete.
- Damages to the surface : Chip the affected areas and repair with cement mortar.

2) Deck Slabs

All blasted holes will be repaired with reinforced concrete by each slab unit which is encircled by girders and diaphragms. Epoxy resin will be applied at the contact surface and non-shrink agent will be added in the new concrete.

(2) Abutments

The same repair method for the girders will be applied. Repair is necessary for No. 4 Prek Ta Sun Bridge and No. 23 Kompong Prasath Bridge. The blasting of abutment has caused the damage to the end portion of girder(s). Therefore, the repair of the abutment will be done in parallel with the repair of girder(s) in accordance with the jack-up method.

(3) Bridge Railings

See subparagraph 4.3.1.(2).3).iii for railing design. Where a precast concrete railing unit is damaged, 2-concrete posts and 2-railing units will be reinstalled.

(4) Approach Slabs

Approach slabs will be newly provided for the following bridges:

No. 7 Prek Chik Bridge (Severe damage of bridge approach)
No. 24 Kompong Pras 1st (reconstruction of abutment)
No. 26 Kompong Pras 3rd (Severe damage of bridge approach)

The approach slabs will be constructed by dividing into 2 traffic lanes, Phnom Penh bound and Chun Chunok bound, considering the use of the bridge by local traffic during the construction.

(5) Bridge Revetment

Revetment will be provided in the following manner:

- New bridge revetment will be provided at the locations where no revetment is provided at present;

- Reconstruction of bridge revetment will take place where the existing slope protection is seriously damaged; and

- Bridge revetment will be constructed with stone masonry wall utilising undressed natural rocks. The slope of the wall is intended for 0.5 (horizontal) to 1.0 (vertical).

(6) Serious Scouring around Existing Abutments

Serious embankment damages in bridge approaches were found at No. 7 Prek Chik Bridge and No. 26 Kompong Pras 3rd Bridge. The backfill/embankment materials are completely washed away near the abutments of these bridges and the rehabilitation by ordinary revetment is impossible, the bottoms of waterway are badly scoured and the application of special remedial method is necessary.

Four alternative methods were selected and compared as shown Figure 4.4. The Study Team's conclusion is to select Alternative-3 as the optimum alternative.

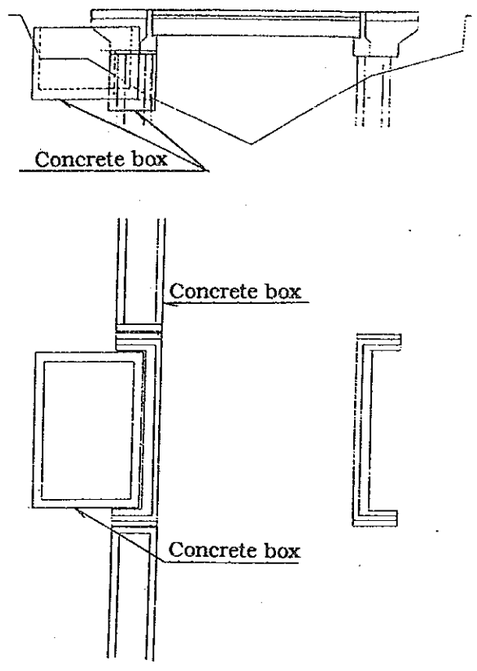
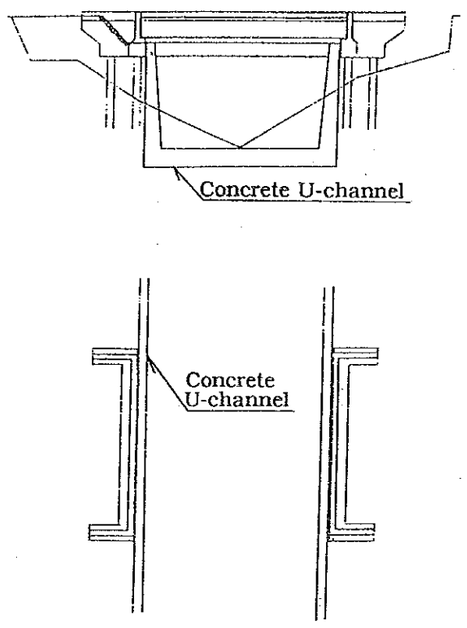
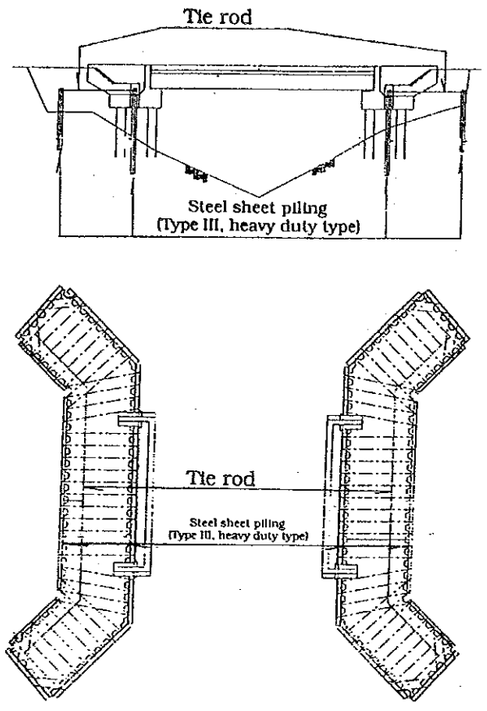
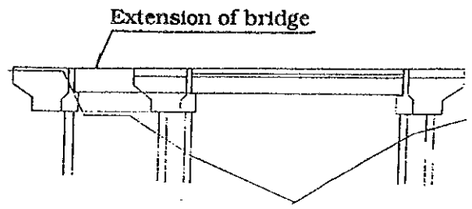
Alter-native	Alternative-1 Concrete Box	Alternative-2 Concrete U-Channel	Alternative-3 Steel Sheet Piling	Alternative-4 Extension of Bridge Span
Sketches				
Notes	• Concrete boxes are provided in lieu of retaining wall to eliminate the excessive lateral pressure to the existing piles. • Concrete boxes are not safe for further scouring. • Construction of boxes will necessitate longer construction period.	• U-channel will eliminate lateral pressure to the existing foundation piles. • Difficult in the determination of the length of U-channel. • Further scouring is anticipated near the ends of U-channel.	• Steel sheet piling will eliminate lateral pressure to the existing foundation piles. • Advantageous for further scouring and reliable in structural performance. • Steel sheet piles must be imported.	• Cannot solve the problem of souring. • Difficult to determine the additional span lengths. • Right-of-way problems for the widened waterway.

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Figure 4.4 Repair of Serious Scouring around Existing Abutments

4.3.4 Culvert Replacement

(1) Selection of Culvert Type

Culverts are generally divided into two categories, rigid and flexible.

Rigid culvert	:	Concrete pipe culvert
		Concrete box culvert
		Concrete bridge culvert
		Concrete arch culvert
Flexible culvert	:	Corrugated metal pipe culvert

It is foreseen that the construction period will be extremely short, the placement of culverts will be done in the dry season and Route 6A must always be open for local traffic during the construction. Considering such circumstances the adoption of corrugated metal pipe culvert is adopted in the design.

(2) Damaged Culverts

The following two culverts are damaged and necessitate reconstruction work:

1) No. 4 Culvert at Sta. 12 + 450

Existing culvert consists of 3 - 1.5m diameter concrete pipes.

2) No. 9 Culvert at Sta. 26 + 660

Existing culvert is 1 - 1.5m diameter concrete pipes.

(3) Adopted Design

1) No. 4 Culvert at Sta. 12 + 450

The surrounding area is now changed into a high productivity cultivated land and the width of existing waterway is very narrow and it seems difficult to widen. Therefore, 1 - 1.5m diameter corrugated metal culvert is adopted in the Design.

2) No. 9 Culvert at Sta. 26 + 660

Existing concrete pipe culvert has subsided and the entire pipe of the culvert is filled with silt. The drainage situation requires larger size of culvert opening. Considering this situation, an arch type corrugated metal culvert is adopted.

4.3.5 Repair of Major Damages of Road Embankment

(1) General

Existing Route 6A is severed at six locations due to the major damages of road embankment between Stas. 40 and 42. At these locations the sustained water would become major roadblocks for the rehabilitation schedule of the route. The following study is aimed at the selection of an optimum rehabilitation method and time schedule of the repair of major damages of road embankment.

(2) Variation of the Water Level in the Project Site

Statistical data concerning the variations of the water level at Phnom Penh, Compong Cham and Prek Kdam is attached in Appendix 3. The water levels near the above damaged locations are considered to be little higher than that at Phnom Penh, since the site is located at the upstream side of the city. The maximum water surface level at Phnom Penh had marked an elevation of 10.55m in 1991 flooding, but the maximum water levels obtained through the hearing at the Site was around an elevation of 12.00m.

(3) Outline of Damages of Road Embankment

Topographical survey was conducted at the Site to obtain the data for the repair of major damages of road embankment. Plans and plan – profiles were prepared for the design. Table 4.3 shows the outline of the above road embankment damages based on the said survey.

Table 4.3 Outline of Major Damages of Road Embankment

No.	Major Damages of Road Embankment (Sta. ~ Sta.)	Length (m)	Top Elevation of Existing Road	Bottom Elevation of Depressed Area (Pond)
1.	Sta. 40+364 ~ Sta. 40+394	30	12.3	7.5
2.	Sta. 40+444 ~ Sta. 40+515	71	12.3	6.0
3.	Sta. 41+269 ~ Sta. 41+343	74	12.2	6.1
4.	Sta. 41+530 ~ Sta. 41+570	40	11.9	6.1
5.	Sta. 41+944 ~ Sta. 41+982	38	11.8	7.0
6.	Sta. 42+010 ~ Sta. 42+046	36	11.8	7.1
	Total	289		

(4) Selection of the Optimum Scheme

1) Establishment of Alternatives

The following three alternatives were established and studied:

Alternative-1: To provide new bridges at the road sections where the road embankment is washed away by repeated floods (Bridge alternative).

Alternative-2: To restore the above damages providing new culverts and embankments (Culvert alternative).

Alternative-3: To restore the above damages providing new embankment.

2) Comparison and the Selection of the Optimum Scheme

Advantages and disadvantages of the three alternatives are compared. As a result of the comparison, it is found that Alternative-1 and Alternative-2 have the following inherent problems:

- A comprehensive hydrological study is required to prepare an integrated drainage master plan, covering all drainage needs, priority for bridge/culvert development, and river course development to connect with the new bridges/culverts as well as right-of-way acquisition;

- The aim of the Project is to repair and restore Route 6A in the shortest time possible to meet the Cambodian goals in the infrastructures rehabilitation programme; and

- Additional bridges and culvert construction should be proceeded in the framework of the long-term projects after the rehabilitation phase.

The restoration of Chroy Changwar Bridge is now ongoing with the completion scheduled in March 1994. To realise a passable road in the entire stretch of Route 6A in the 1st phase of the Project, the Study Team selected Alternative-3 as the optimum scheme for the repair works.

(5) Study of Embankment Construction

The embankment construction operation must be initiated as soon as possible to meet the requirements of the comprehensive construction schedule of the Rehabilitation. In the middle of November, the depressed areas have still retained water of approximately 1.5m depth. In such a case, the dry method or rubble-mound method is generally adopted for the early initiation of filling work:

i. Dry Method

Filling work will be initiated after the dry up of the foundation area of the embankment. Temporary coffering and dewatering are necessary before the dry up operation.

ii. Rubble-Mound Method

Rubbles (i.e. quarry-run rocks) will be directly cast into the pond and form a rubble-mound for the embankment base.

Rubble-mound method was adopted in the design, since the dry method has the following disadvantages:

- All embankment construction must be completed within one dry season; dry method requires lengthy preparatory work which comprises coffering and dewatering;

- Dry method is not economical compared with the rubble-mound method since the former will entail expensive temporary coffering and its maintenance and dewatering; and

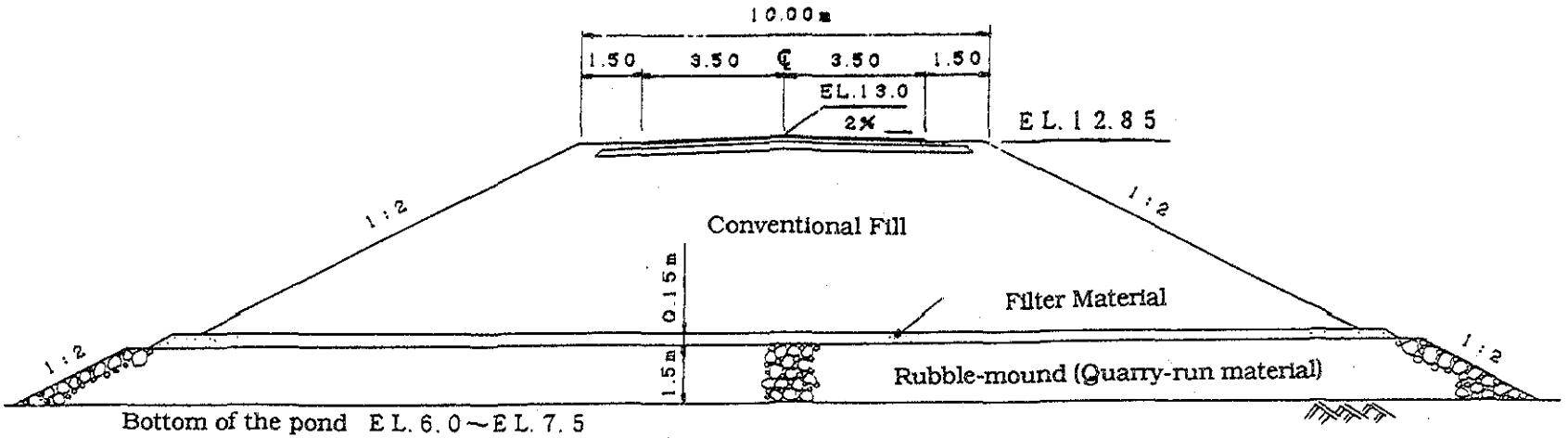
- It is difficult to estimate the quantity of leakage water of the temporary cofferdam and supply water through the pond bottom.

(6) Typical Cross Section of New Embankment

Typical cross section of new embankment is shown in Figure 4.5.

(7) Recommendations for the Filling Operation

Construction of rubble-mound will be started from No. 6 (Sta. 42+010 ~ Sta. 42+046) choosing the right time around the middle of November, the anticipated water surface level at that time will be approximately El. 8.5m and the pond bottom elevation at the lowest point will be approximately 7.1m.



REHABILITATION OF NATIONAL ROAD ROUTE 6A

Figure 4.5 Typical Cross Section of the Repair of Major Damages of Road Embankment

4.3.6 Repair of Other Damages of Road Embankment

(1) Embankment Settlement and Blasted and Eroded Holes

1) Embankment Settlement

The minor pavement settlement will be remedied with the change of the thickness of new pavement layer, but the repair method mentioned in 4.3.6.(2).2) will be applied at the damaged locations where the settlement resulted in large depressed areas.

2) Blasted and Eroded Holes

Fill with crushed rocks and compact by layer until the top surface reaches the desired level.

(2) Damages Caused by Embankment Slope Failure or Erosion

1) Damages Caused by Embankment Slope Failure

The object of this repair is the restoration of the embankment slope failure at one side or both sides. Repair consists of the following works:

- Conventional fill; and
- Revetment work which comprises stone masonry wall or stone masonry slope protection. Wire cylinders will be provided as required.

2) Embankment Slope Damages Caused by Erosion

Repair consists of the following works:

- Conventional fill; and
- Conventional slope protection utilising sandbags containing sod seeds.

4.3.7 Pavement Design

(1) Background and Condition of Pavement Rehabilitation

1) Background

The following background was taken into account in the planning of the pavement rehabilitation.

i. Asphalt concrete surface course still remains in the 10.5km stretch in the Phnom Penh side of Route 6A.

ii. Asphalt treated surface and base course in variable widths exist in certain stretches of other road sections of Route 6A.

iii. The required aggregates (crushed rock) necessary for the pavement construction will be obtained from Chi Lear quarry.

iv. Expected future traffic growth in Route 6A will be rather high.

v. Heavy rainfall and flood situation must be considered in the design of the pavement structure.

vi. The end 3km stretch near Chun Chunok terminal has been submerged in the 1978 and 1991 flood.

2) Basic Conditions

- Abovementioned remaining asphalt concrete surface course and base course layers will be utilised in the rehabilitation without demolition (pavement design considers the said surface course and base as a part of the entire pavement structure);

- Existing base course mentioned in 4.3.7.(1).1).ii above will be utilised as the subbase course layer;

- Surface course will be asphalt concrete based on 4.3.7.(1).1).v in the above, and aimed at the minimisation of maintenance effort;

- Raising of road surface level will be performed in the road sections where submergence has been experienced; and

- Shoulders will be applied with bituminous surface treatment near the carriageway to resist erosion.

(2) Study of Pavement Design Factors

1) Design Factors

The thickness of each layer of pavement will be determined based on:

- Soil support strength of subgrade;
- Road traffic; and
- Available construction materials.

2) Evaluation of Subgrade Strength

Laboratory test data recommends a design with CBR of 6.

3) Traffic Condition and Design Traffic Volume

Existing traffic data near the Project Site is shown in Table 3.12 in Chapter 3. The following design traffic volume was obtained considering the future traffic growth rate, as well as, overloading of trucks.

Design life	:	5 years
Average daily traffic volume of heavy vehicles	:	127 vehicles/day/direction (growth rate of 5% p.a. was applied)

Composition of heavy vehicles	:	• Trailer trucks (full loading)	43t	7.0%
		• Trailer trucks (no loading of trailer trucks, and full loading of trucks)	25t	16.5%
		• Trucks (no loading)	15t	10.0%
		• Other heavy vehicles	less than 8t	66.5%

(3) Design of Pavement Structure

1) Required Equivalent Asphalt Concrete Thickness (TA)

TA is determined based on the following equation.

$$TA = 3.84 \times N^{0.16} / CBR^{0.3}$$

where: N = Total equivalent 5 ton wheel load applications in design period of n-year (wheel load/direction)

CBR = Design CBR of subgrade

N is calculated by the following equations.

$$N_5 = \sum_{j=1}^{13} \{(P_j/5)^4 \times N_{Lj}\}$$

where: N_5 = Total equivalent 5 ton wheel load applications per day

P_j = Representative conversion value (from Japanese standard)

N_{Lj} = Number of wheel load applications (from Japanese standard)

and $$N = \sum_{i=1}^{n} (N_5 \times 365 \times a_i)$$

where: a_i = Traffic growth rate after i-year to be applied to N_5

n = 5

From the above calculations N = 34,700 was obtained, and TA is calculated from the following:

$$TA = 3.84 \times (34,700)^{0.16} / 6^{0.3} = 11.97$$

2) TA and Layer Coefficients

Using the Japanese standard the following layer coefficients are obtained:

Pavement Component	Layer Coefficient
Surface and binder courses	1.00
Base course (stabilised aggregate)	0.35
Subbase course (crusher-run aggregate)	0.25

Adopted equivalent asphalt concrete thickness (T'A) is determined by the following equation.

$$T'A = a1 \times T1 + a2 \times T2 + a3 \times T3$$

where: a1, a2, a3 = Layer coefficients
T1, T2, T3 = Thickness of each layer in cm

3) Minimum Thickness of Surface, Binder, Base and Subbase Courses

From the Japanese standard the minimum thicknesses are as follows:

Pavement Component	Minimum Thickness
Total thickness of surface and binder courses	5 cm
Base course	3 times of maximum aggregate size
Subbase course	3 times of maximum aggregate size

4) Optimum Design of Pavement Structure

The optimum design is determined on the basis of the economical viewpoint while also considering the ease of construction and maintenance (Figure 4.6).

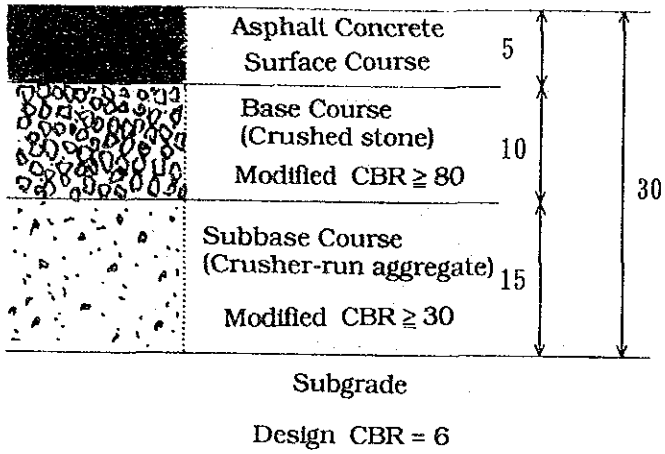


Figure 4.6 Optimum Design of Asphalt Pavement (New Construction)

5) Adopted Equivalent Asphalt Concrete Thickness (T'A)

T'A is calculated based on the beforementioned method in 4.3.7.(3).2).

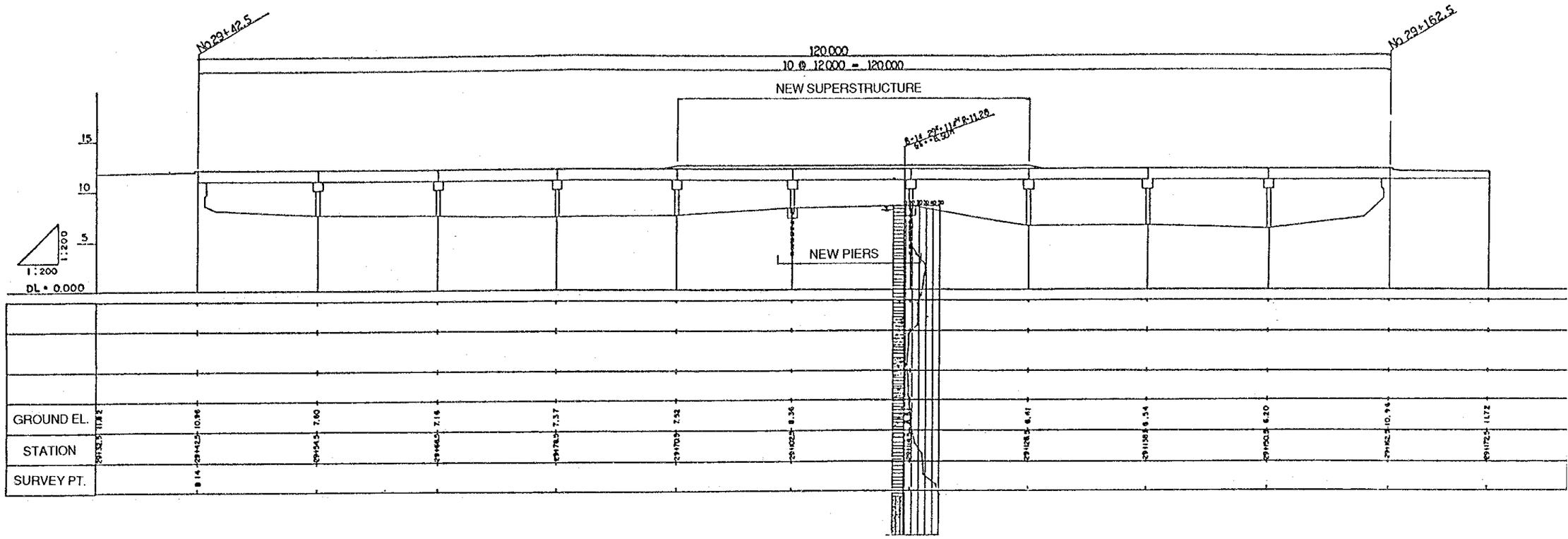
T'A = 12.25 > 11.97 (TA)

4.3.8 Basic Design Drawings

Basic design drawings for the rehabilitation of Route 6A are presented in the following pages.

Figure No.	Title
4.7	General Plan of No. 14 Prek Kheng Bridge (Replacement of Damaged 3-Spans)
4.8	General Plan of No. 20 Prek Bak Bridge (Replacement of Damaged 2-Spans)
4.9	General Plan of No. 22 Prek Kra Poes Bridge (Replacement of Damaged 2-Spans)
4.10	General Plan of No. 24 Kompong Pras 1st Bridge (Replacement of Damaged 1-Span)
4.11	Dimensions of New Superstructure (Pier to Pier)
4.12	Dimensions of New Superstructure (Pier to Abutment)
4.13	Dimensions of New Abutment
4.14	Dimensions of New Pier
4.15	General Plan of Scour Protection around Abutments
4.16	Revetment for Existing Abutment
4.17	Revetment for New Abutment
4.18	General Plan of No. 4 (Sta. 12+450) Culvert
4.19	General Plan of No. 9 (Sta. 26+660) Culvert
4.20	Typical Cross Sections of Pavement Rehabilitation
4.21	General Plan for the Repair of Embankment Slope Failure
4.22	Revetment Details

NO.14 Prek Kheng



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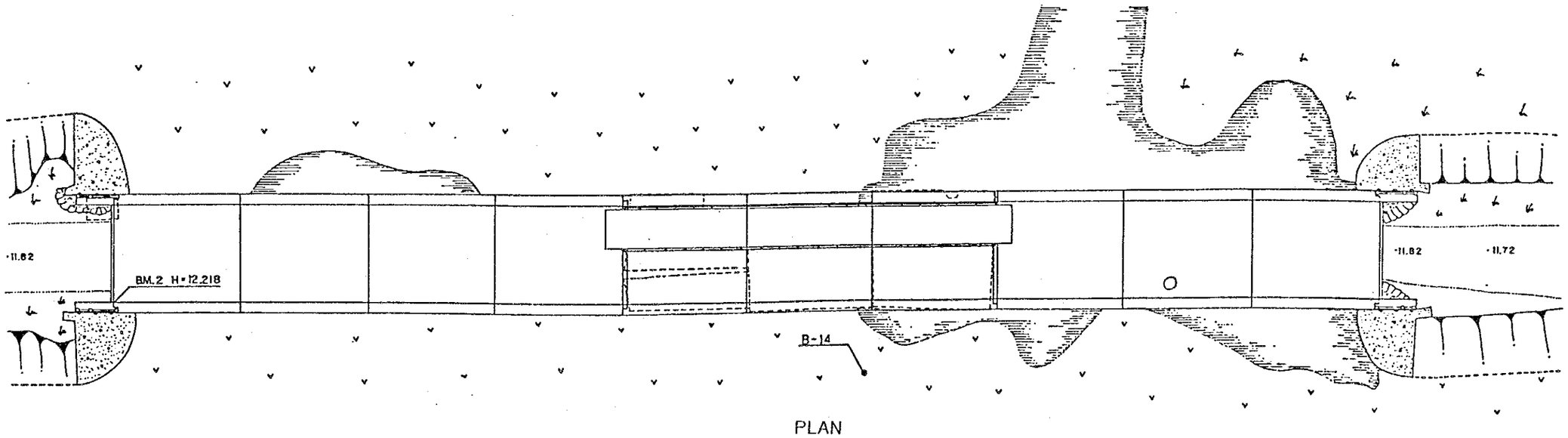
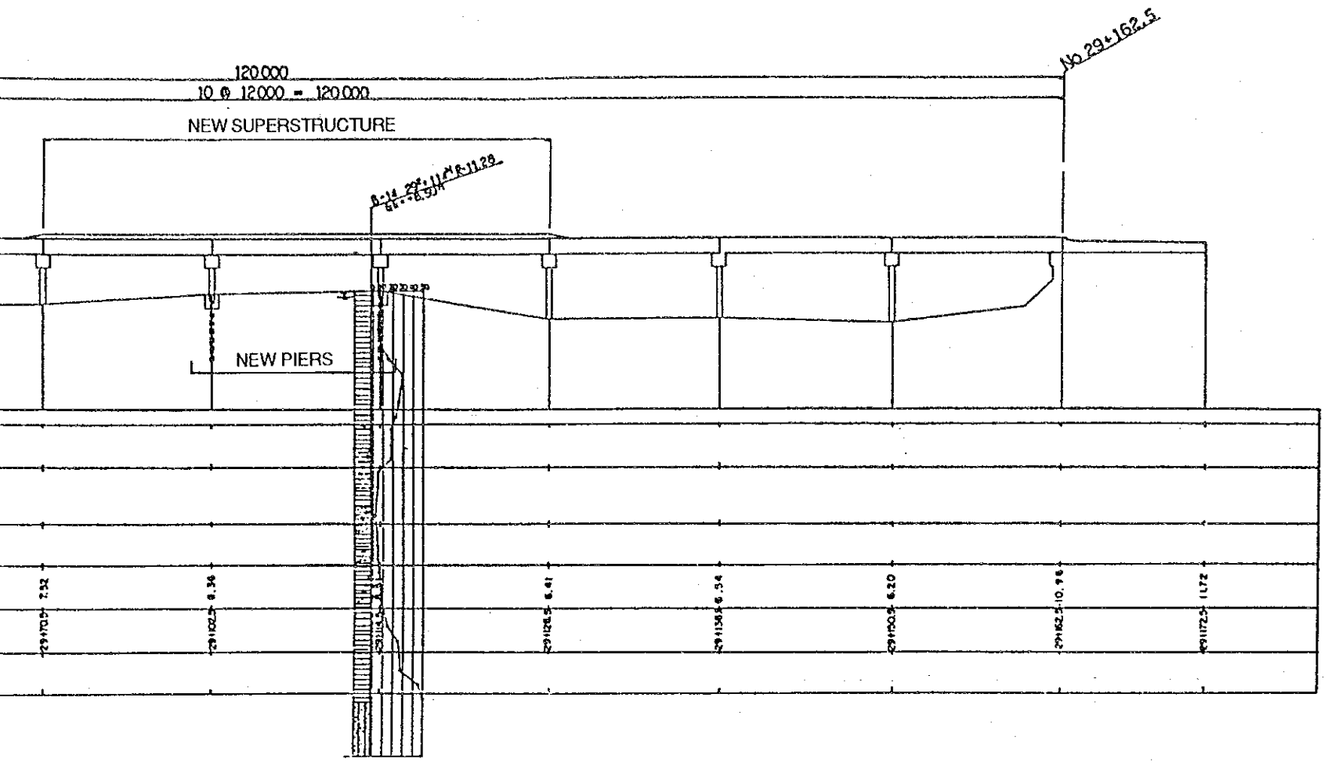


PLAN

NO.14 Prek Kheng



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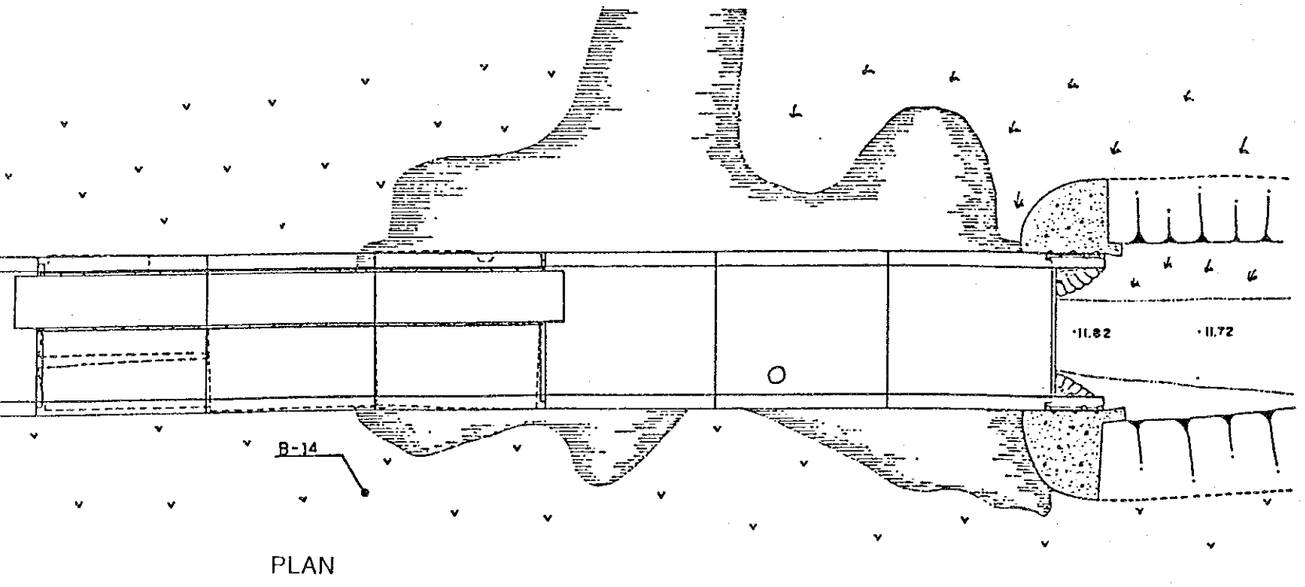
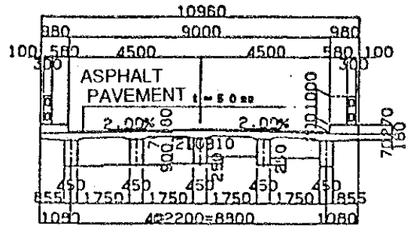


PLAN



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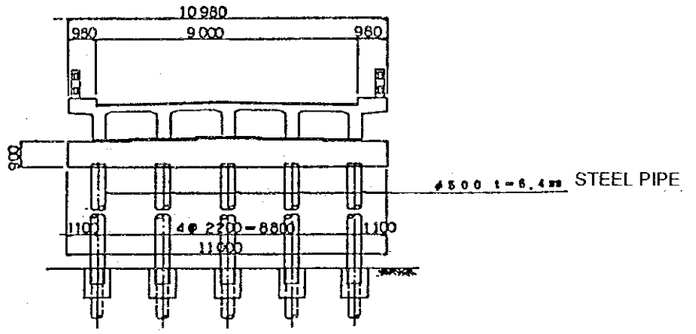
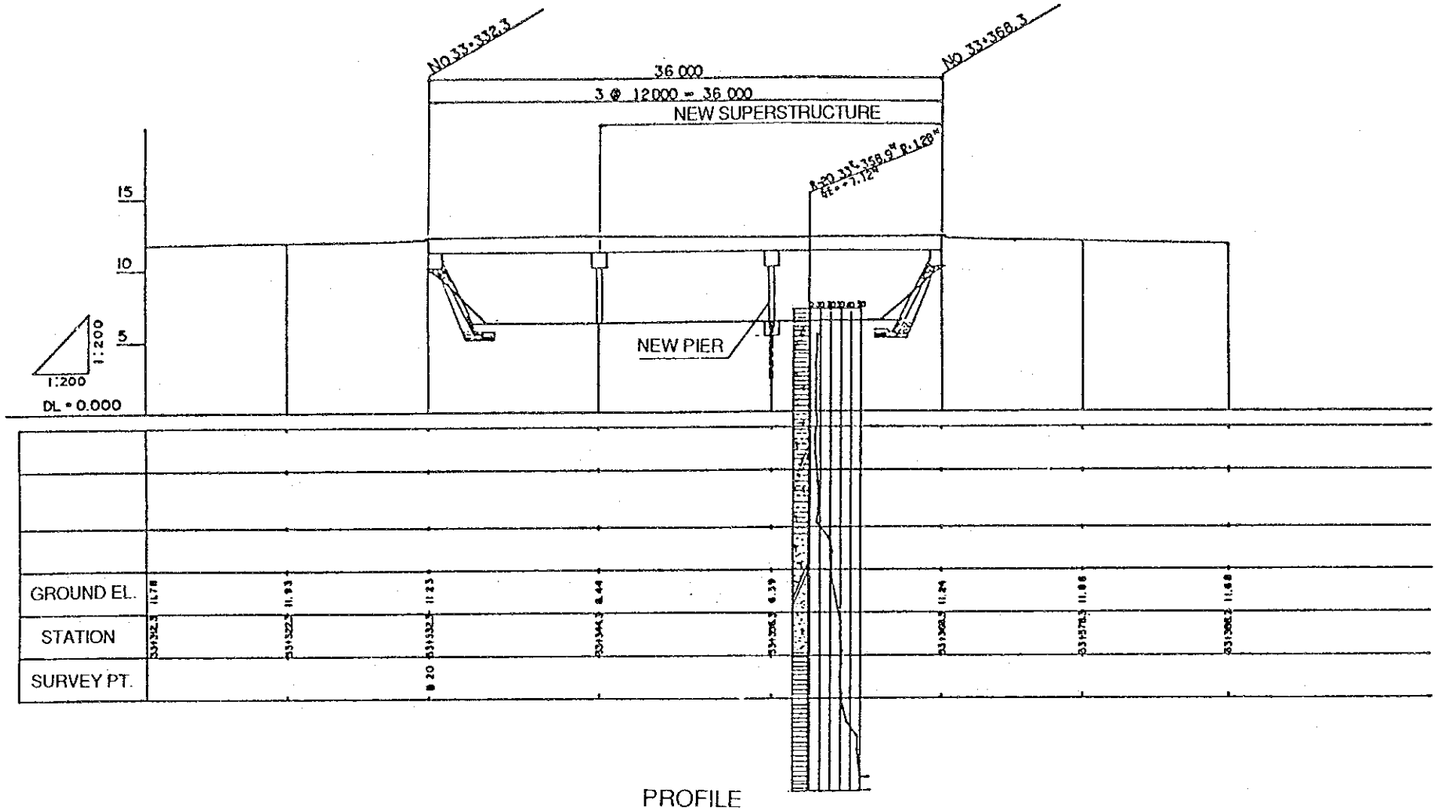


PIER DETAIL

Figure 4.7 General Plan of No. 14 Prek Kheng Bridge (Replacement of Damaged 3-Spans)

No.20 Prek Bak



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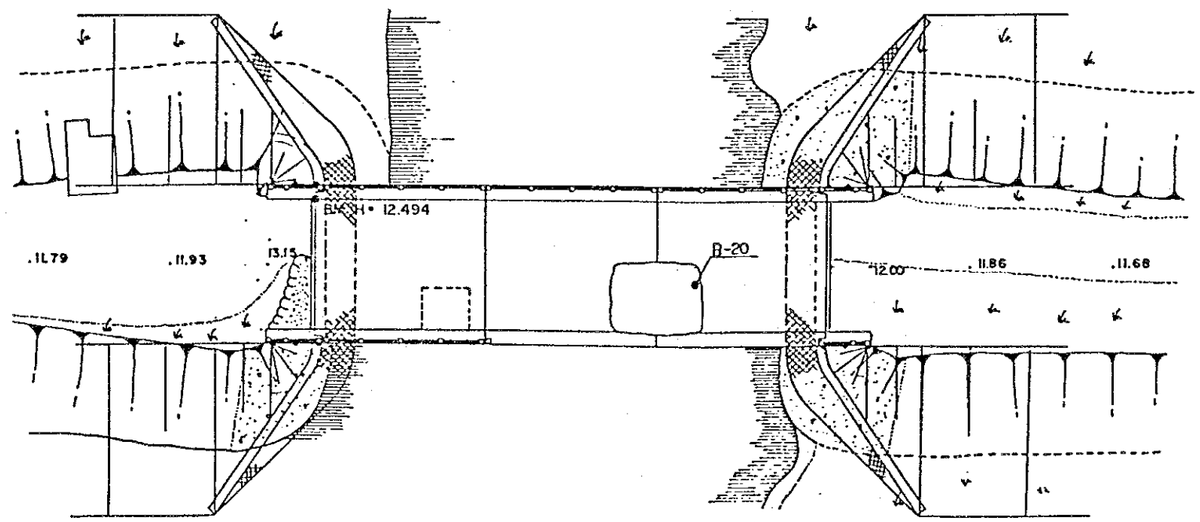
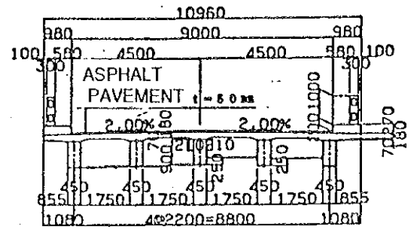


PLAN



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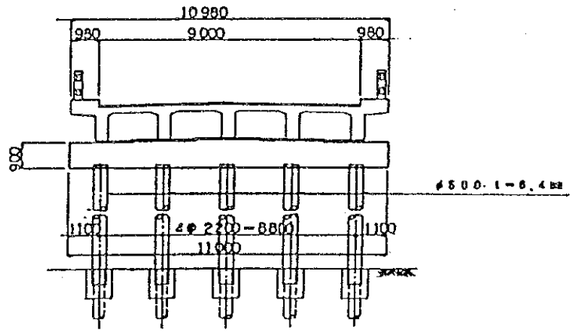
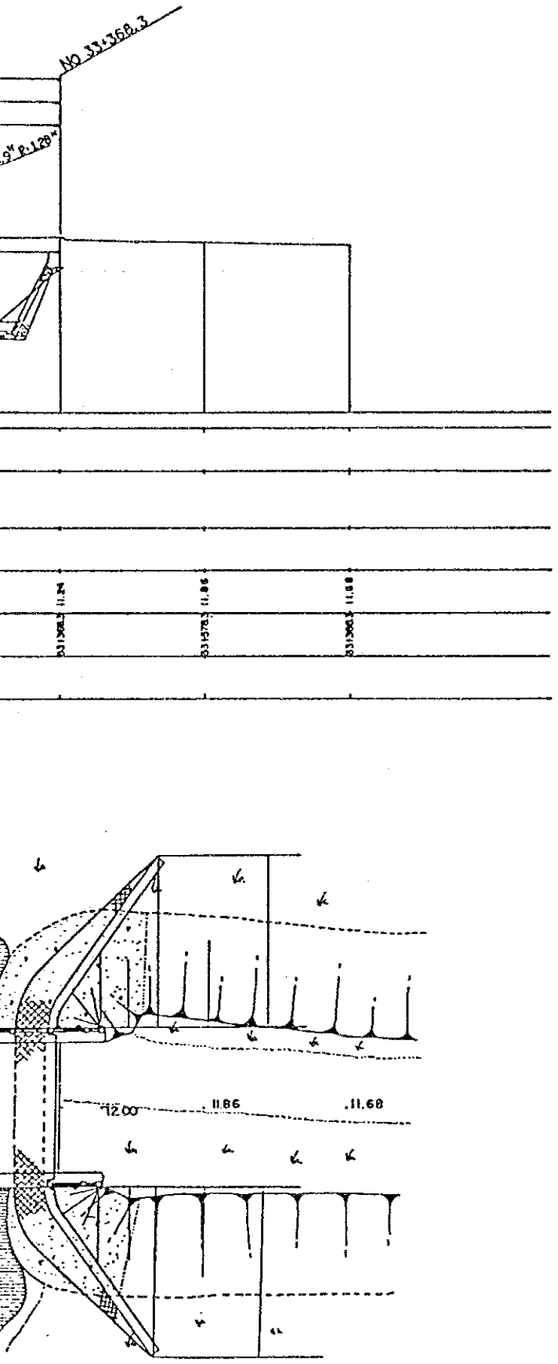
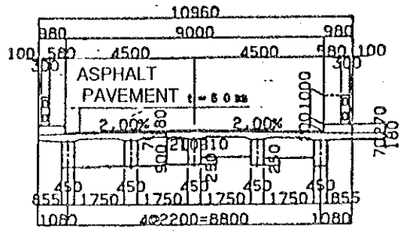


PIER DETAIL

No.20 Prek Bak





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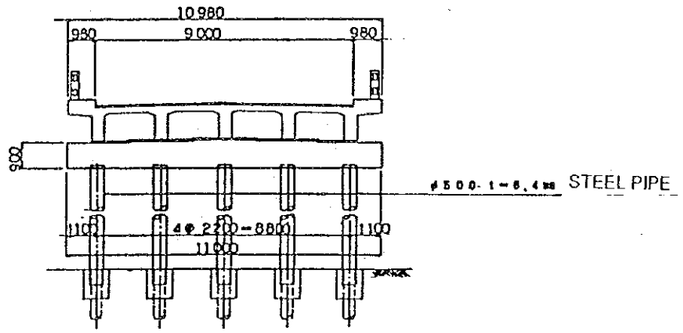
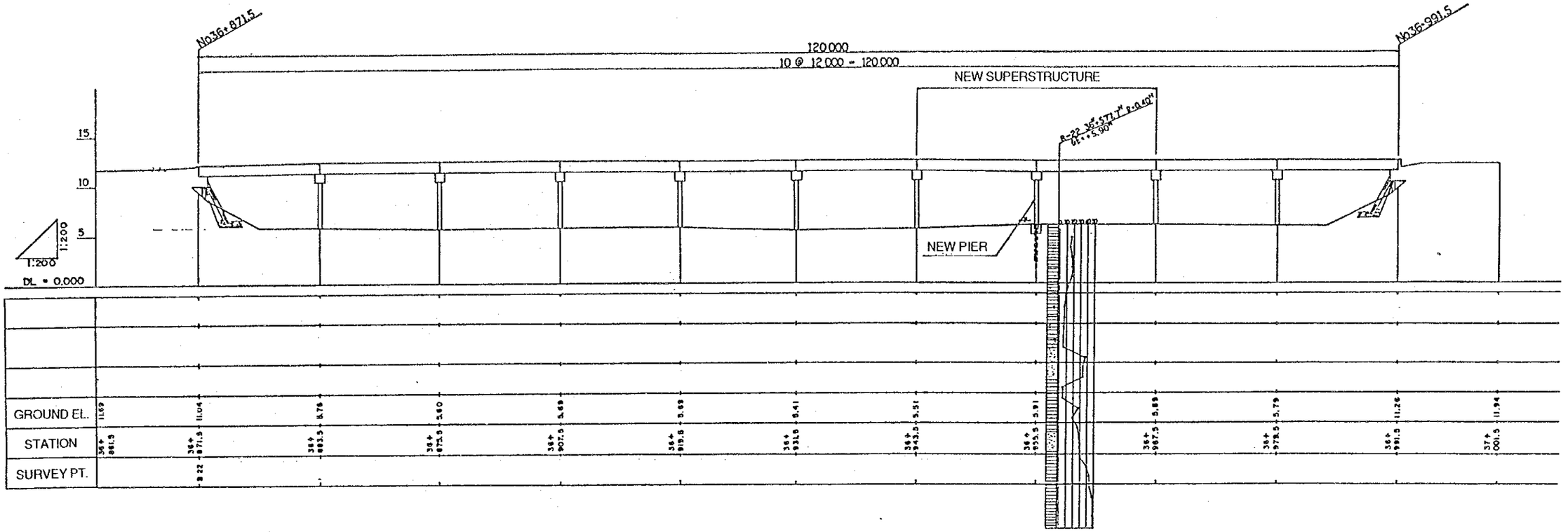


PIER DETAIL

Figure 4.8 General Plan of No. 20 Prek Ta Sun Bridge (Replacement of Damaged 2-Spans)

NO.22 Prek Kra Poes



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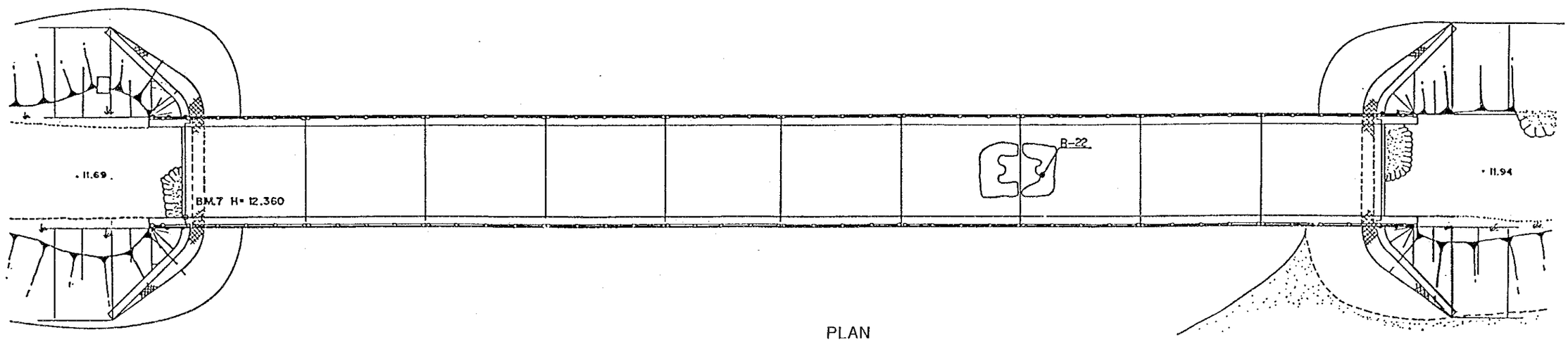
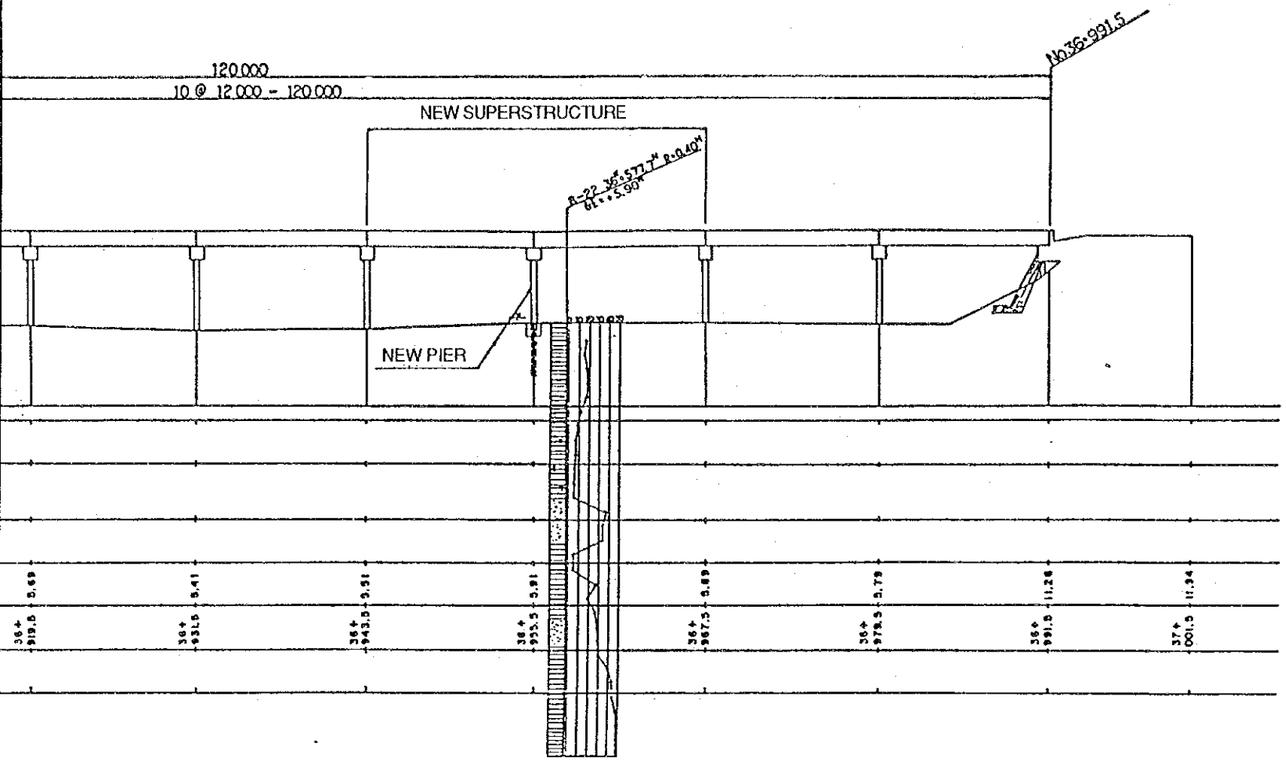


PLAN

NO.22 Prek Kra Poes



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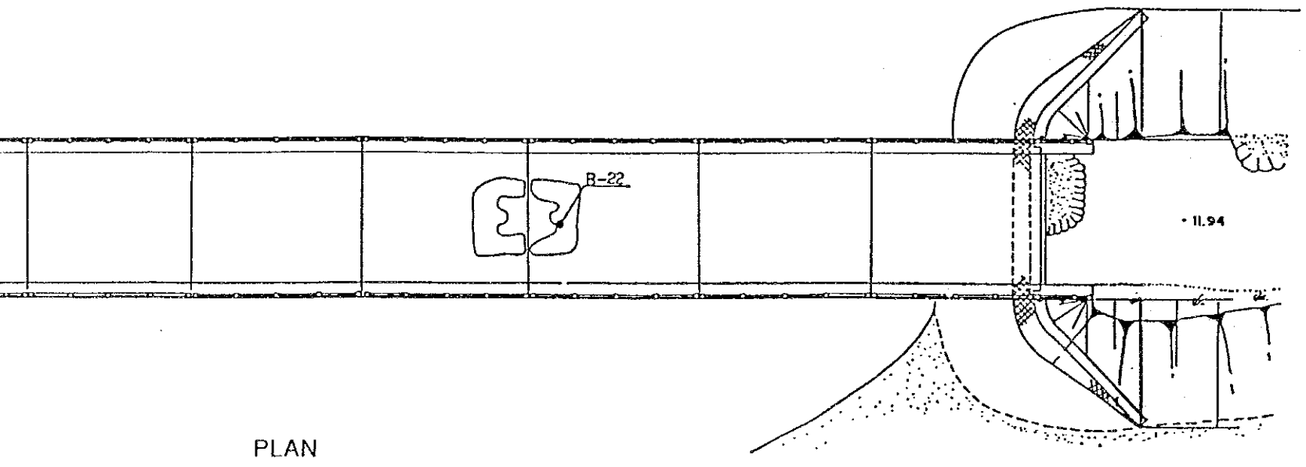

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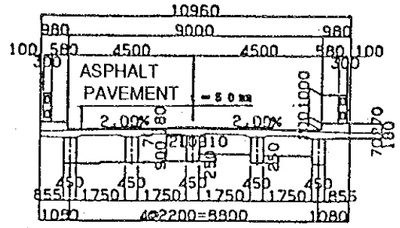

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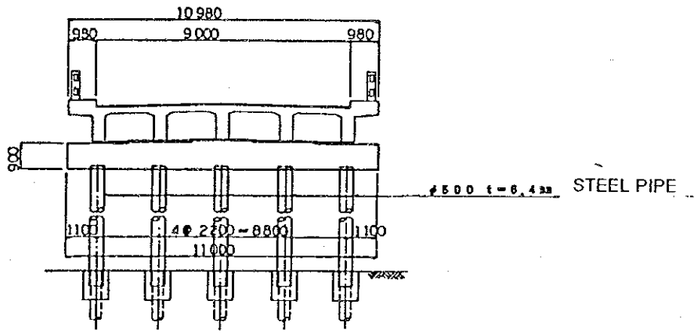
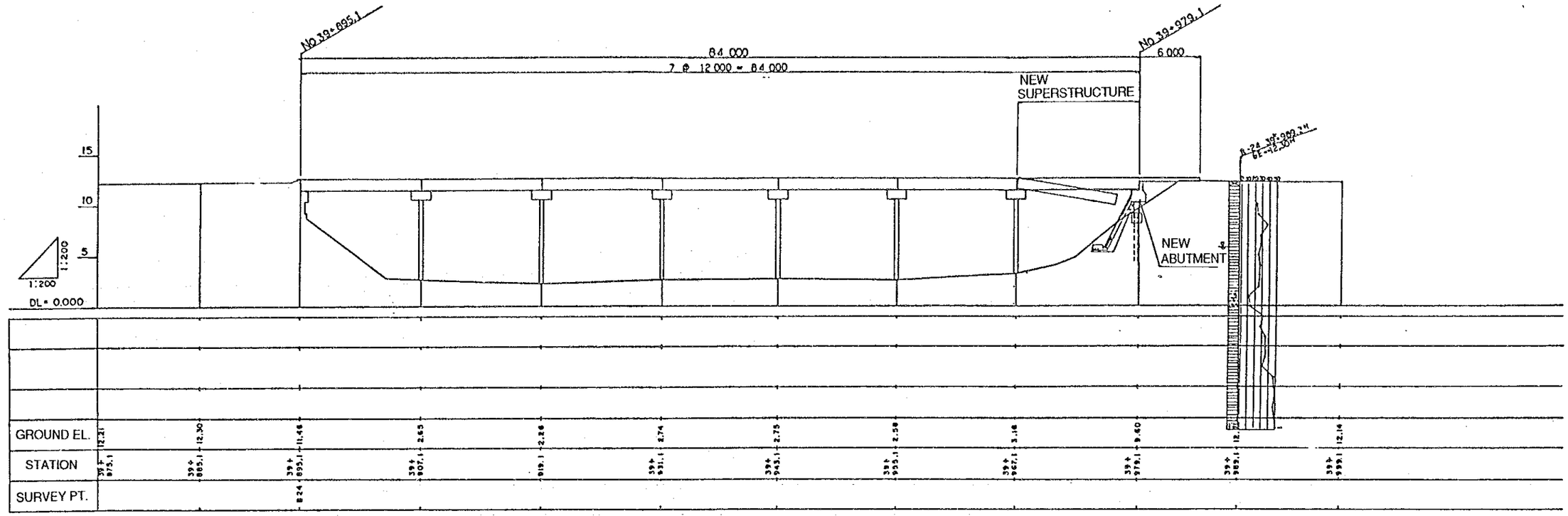


PIER DETAIL

Figure 4.9 **General Plan of No. 22 Prek Kra Poes Bridge (Replacement of Damaged 2-Spans)**

NO.24 Konpong Pras Ist



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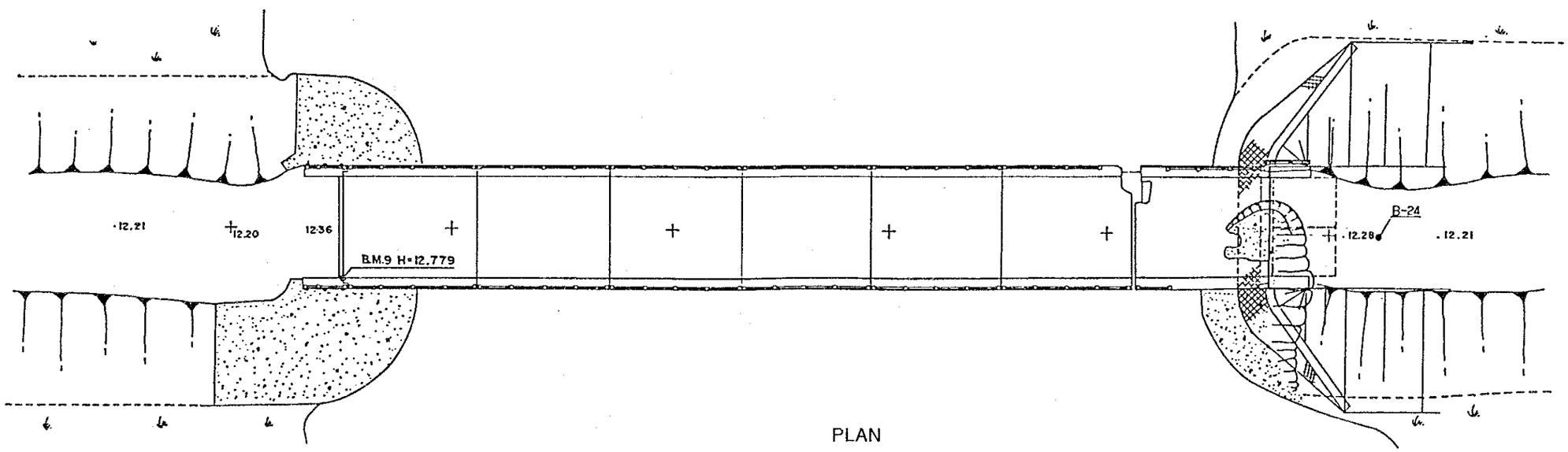
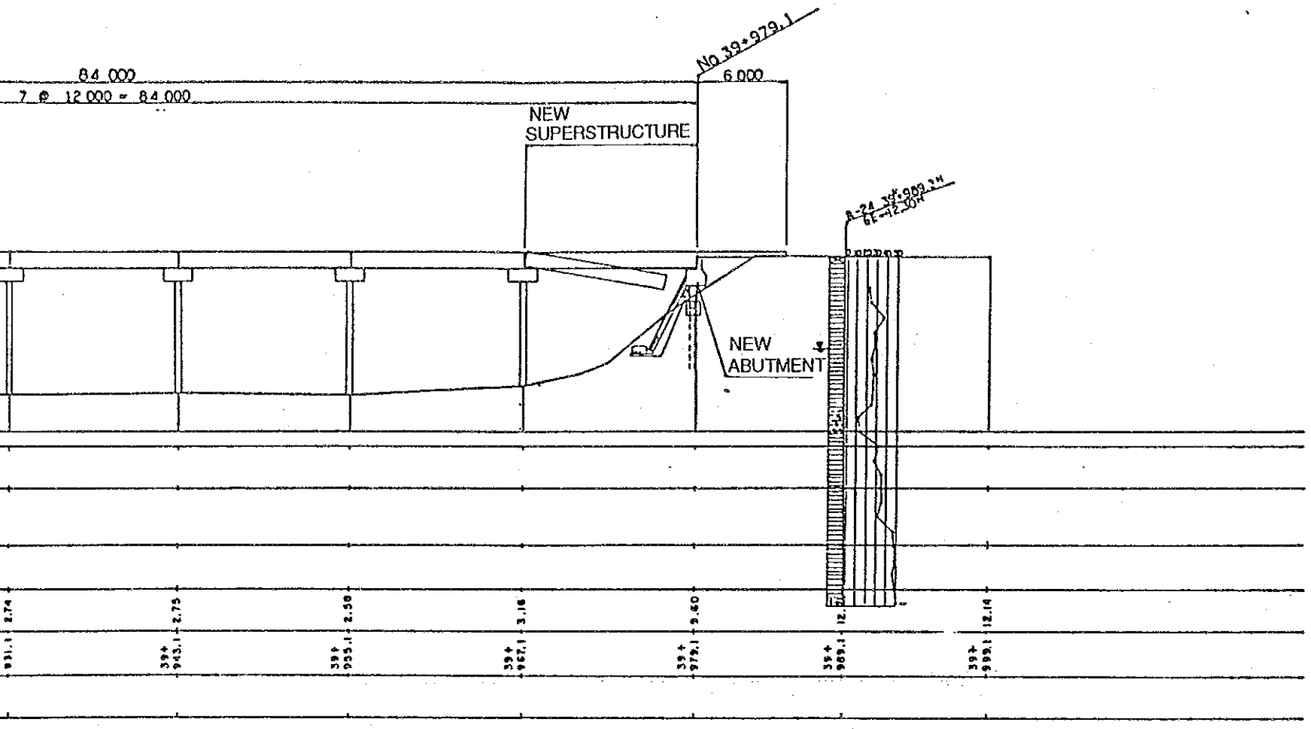


PLAN

NO.24 Konpong Pras Ist



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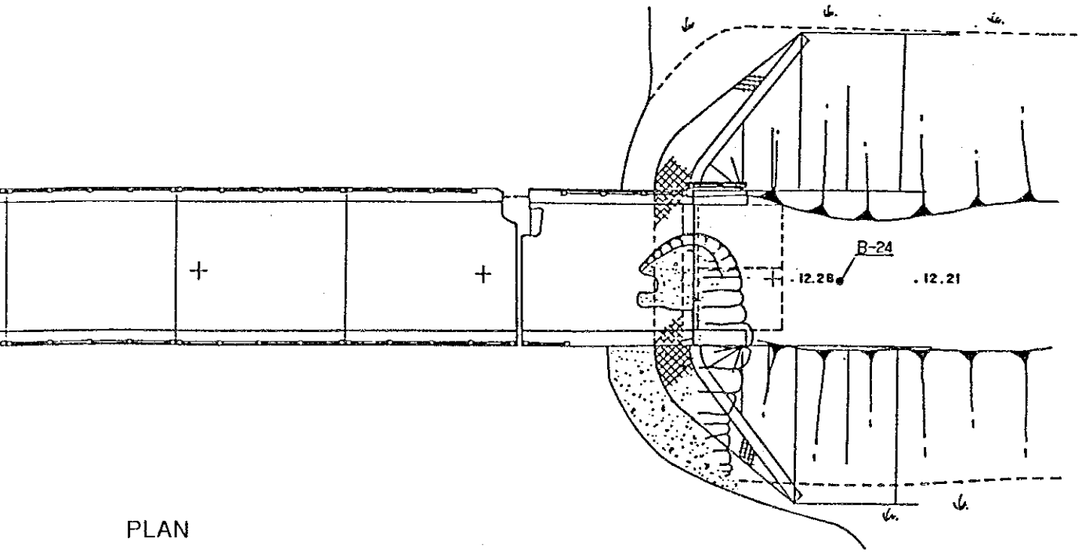

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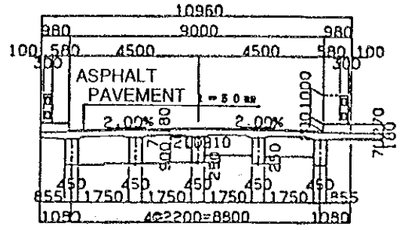

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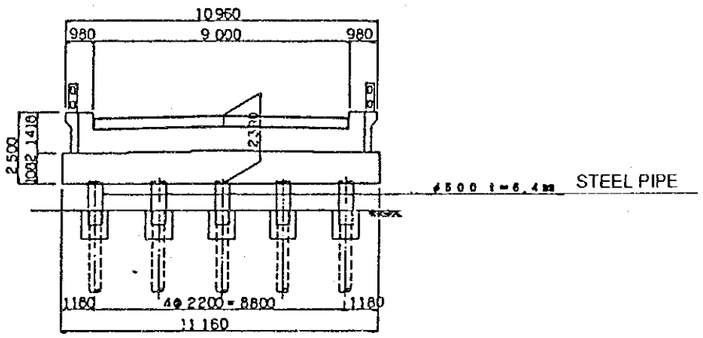
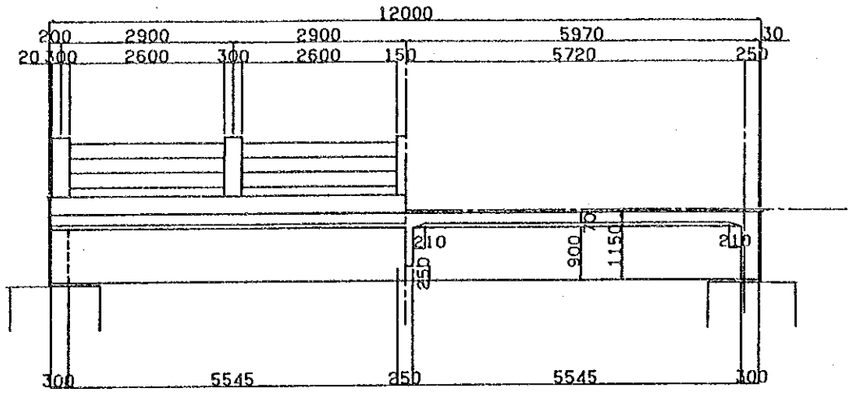
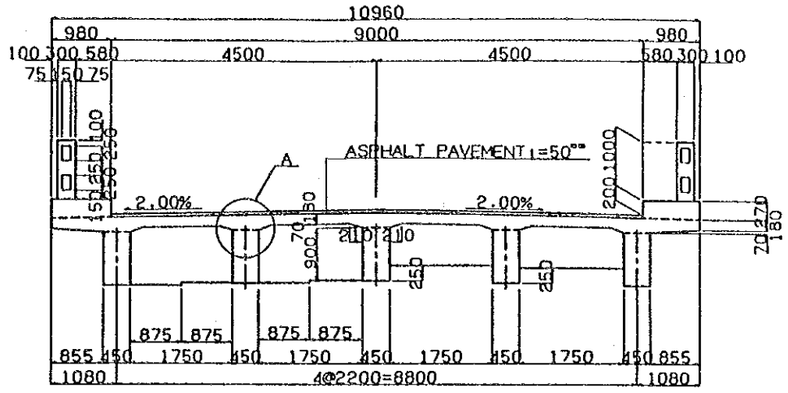


PIER DETAIL

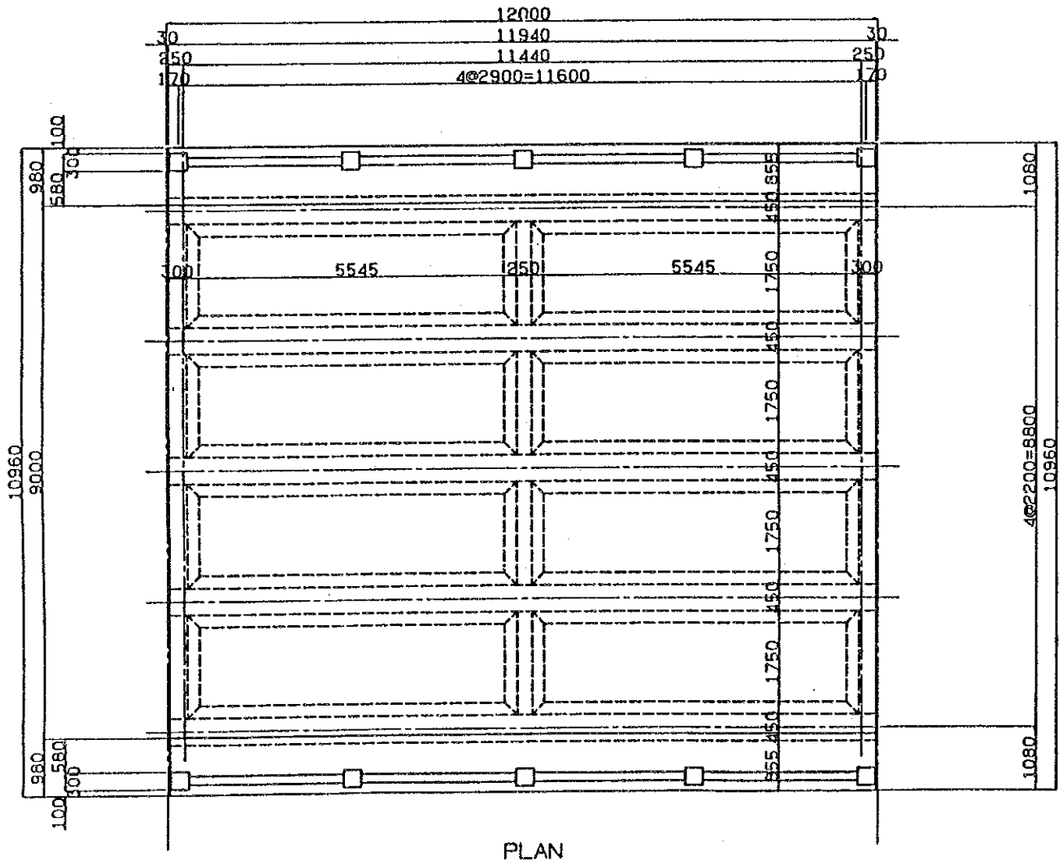
Figure 4.10 General Plan of No. 24 Kompong Pras 1st Bridge (Replacement of Damaged 1-Span)



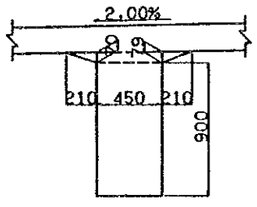
ELEVTION



CROSS SECTION

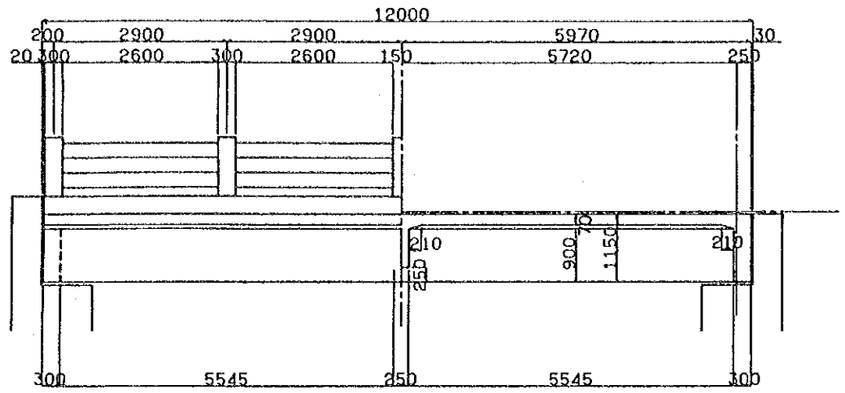


PLAN



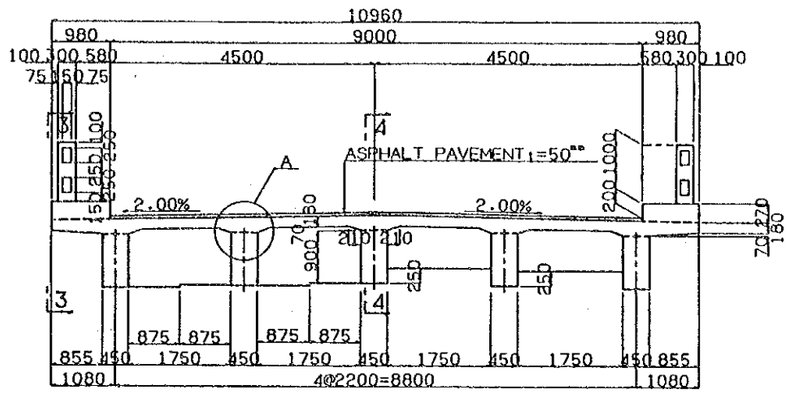
DETAIL of A

Figure 4.11 Dimensions of New Superstructure (Pier to Pier)



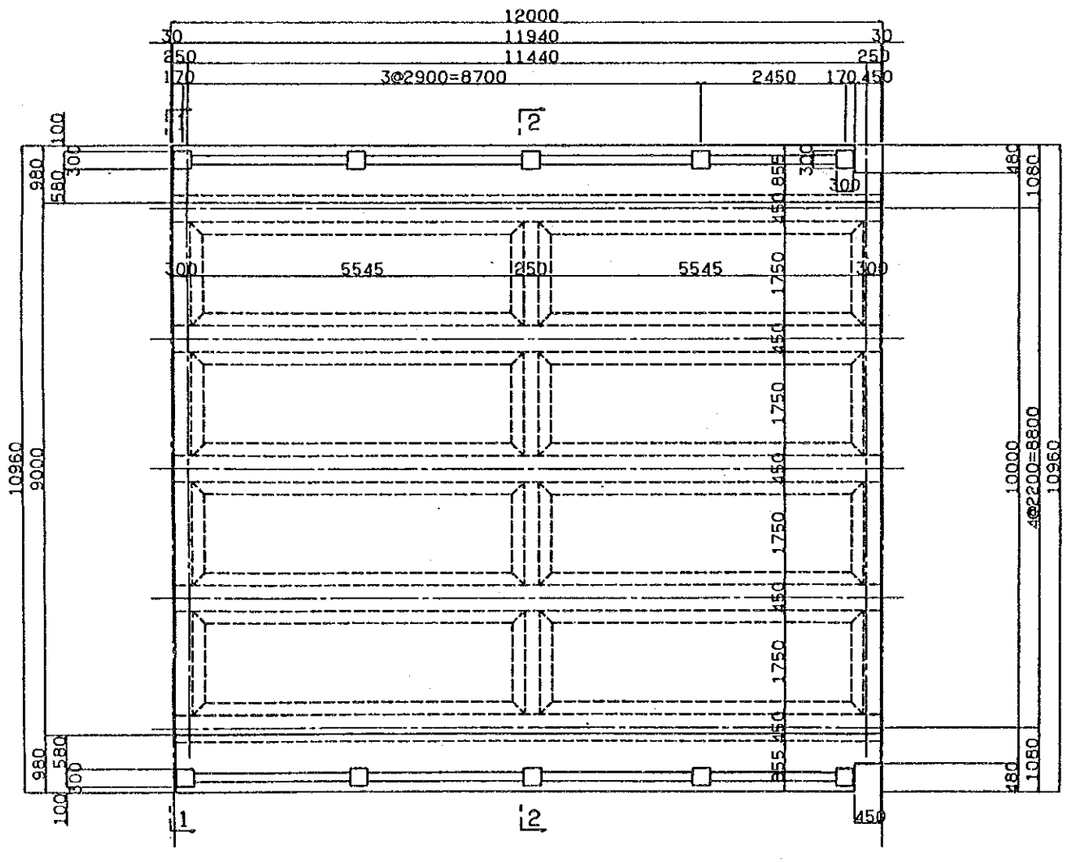
3-3 4-4

ELEVTION

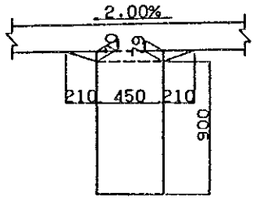


1-1 2-2

CROSS SECTION

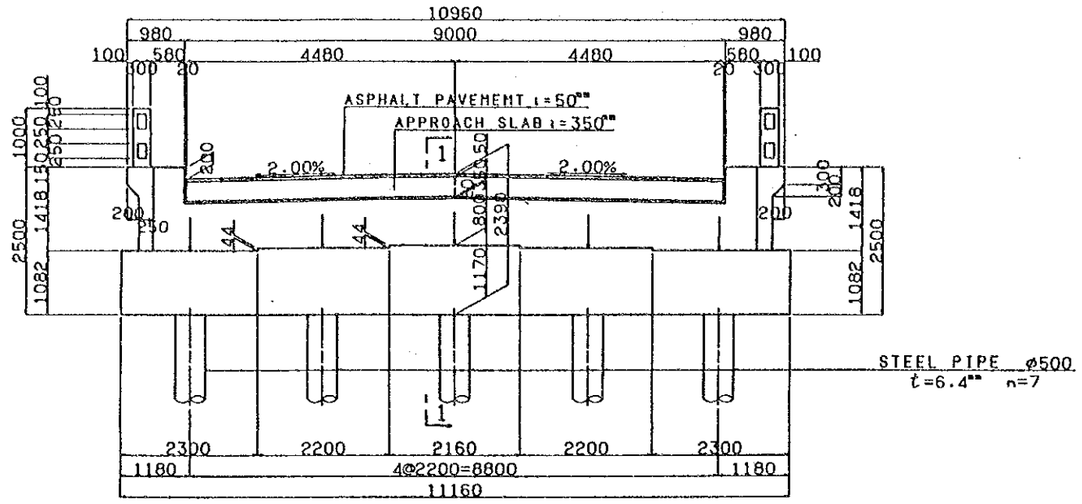


PLAN

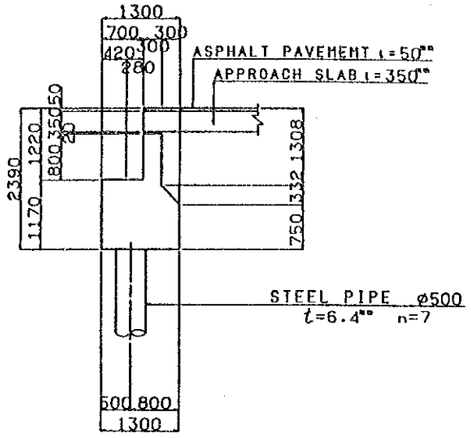


DETAIL of A

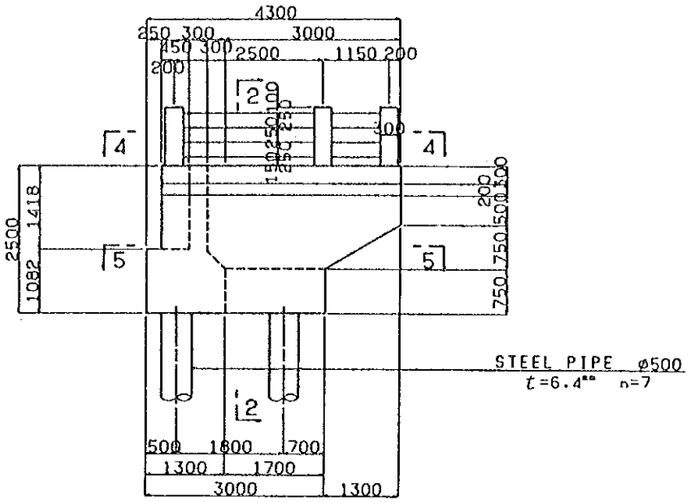
Figure 4.12 Dimensions of New Superstructure (Pier to Abutment)



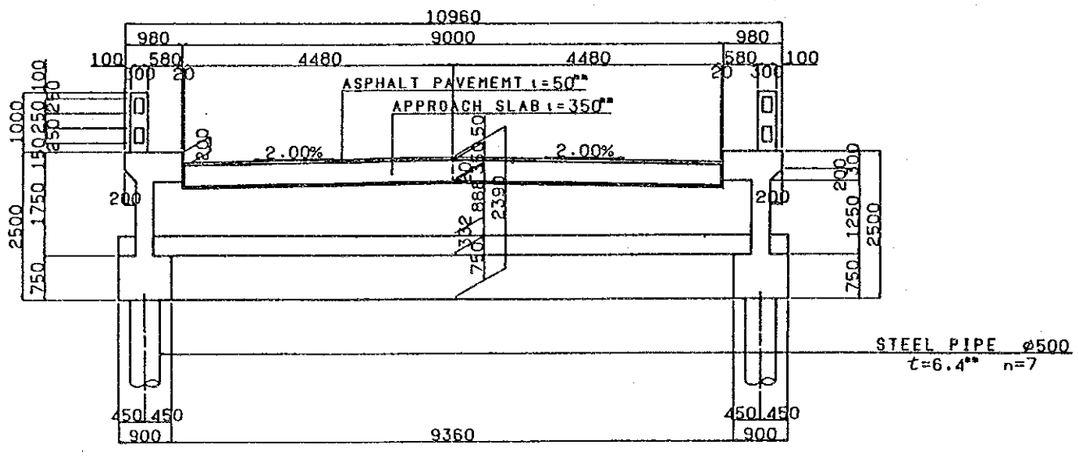
FRONT VIEW



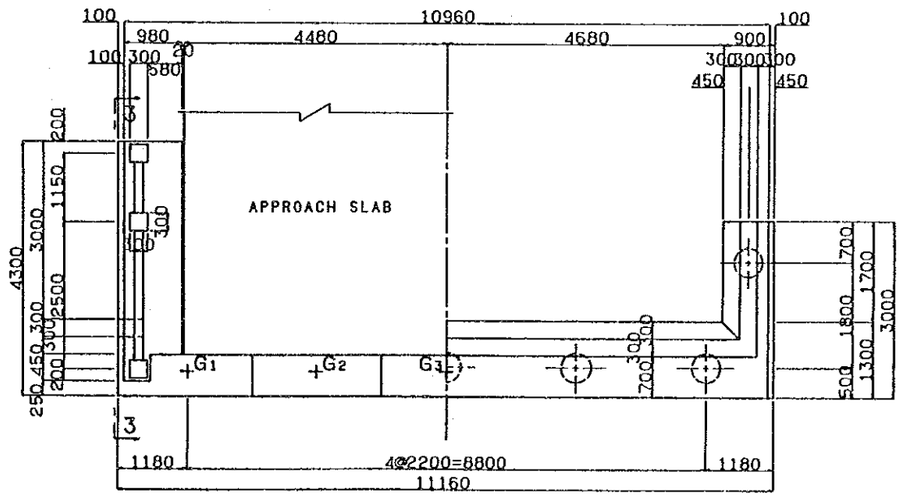
1-1



3-3



2-2

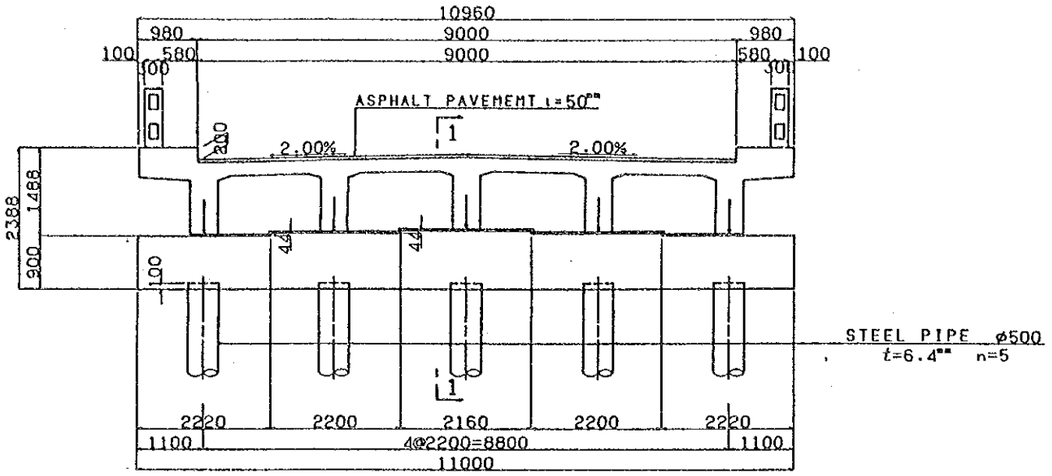


4-4 5-5

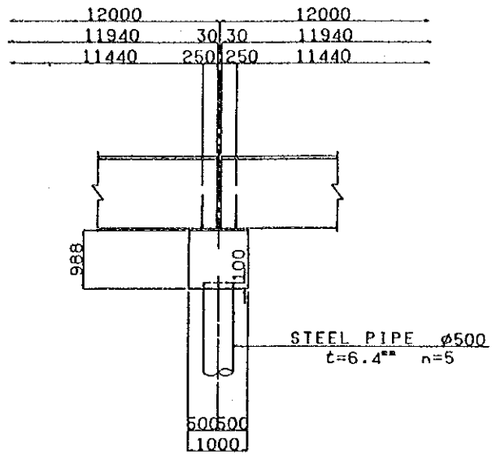
PLAN

Figure 4.13 Dimensions of New Abutment

BRIDGE PIER



FRONT VIEW



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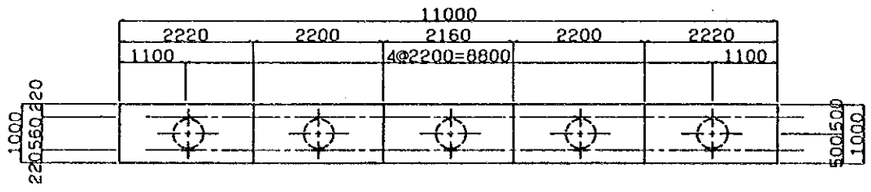
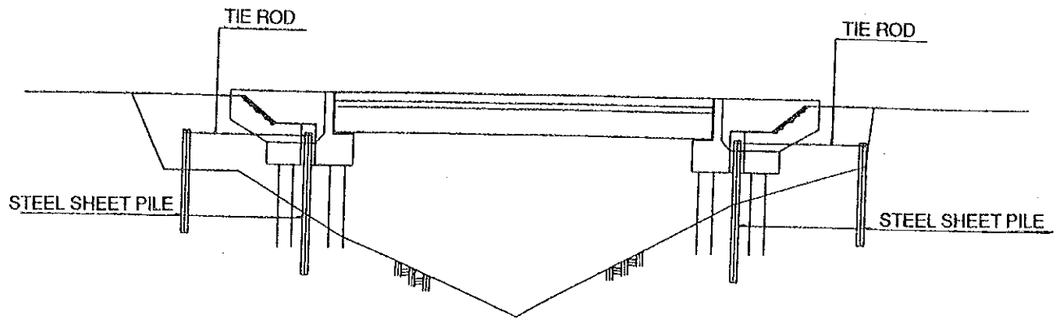
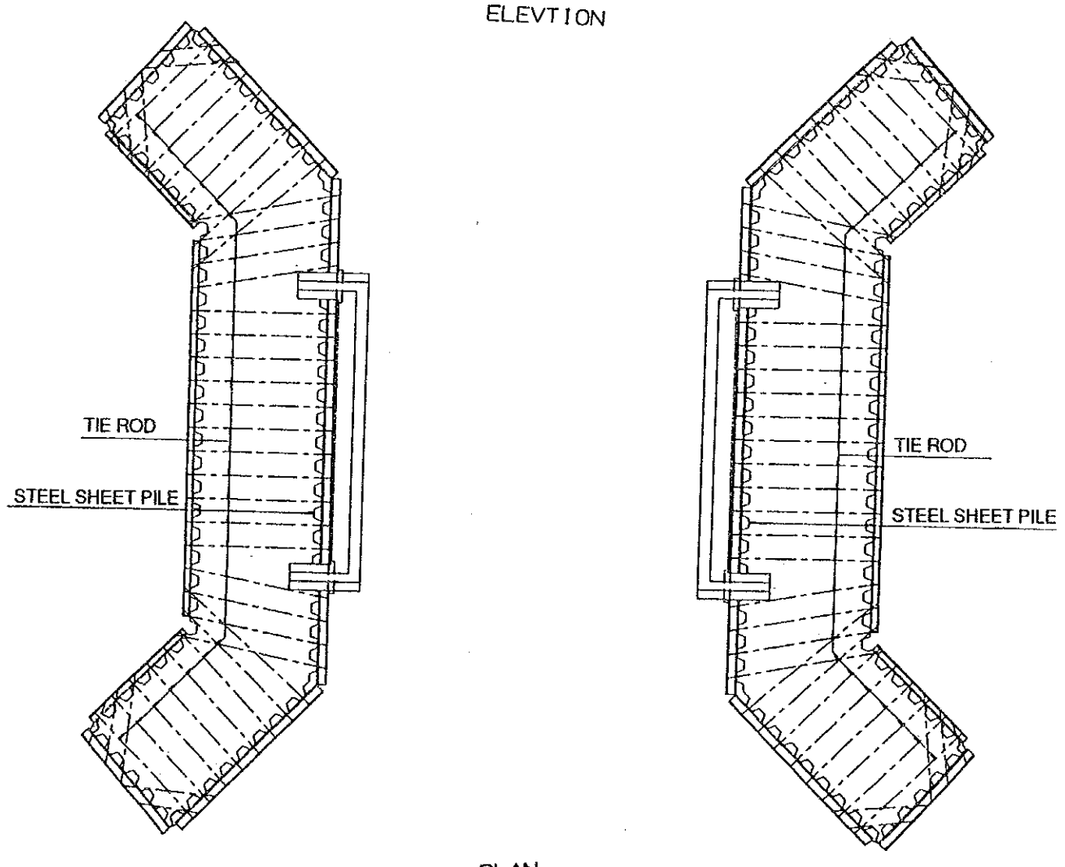


PLAN

Figure 4.14 Dimensions of New Pier



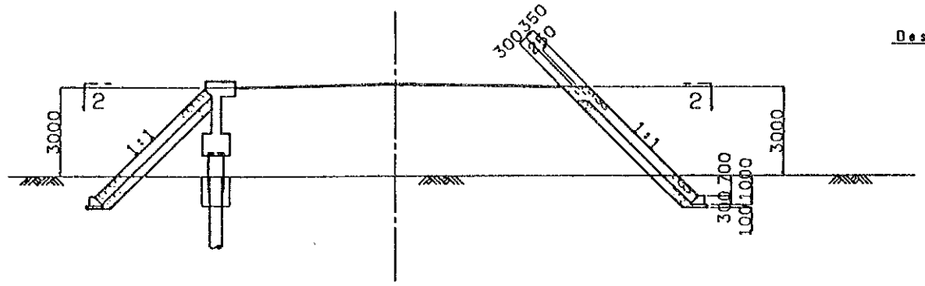
ELEVTION



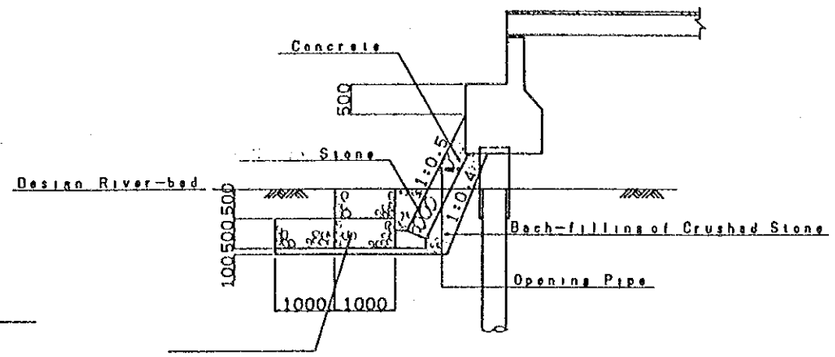
PLAN

REHABILITATION OF NATIONAL ROAD ROUTE 6A

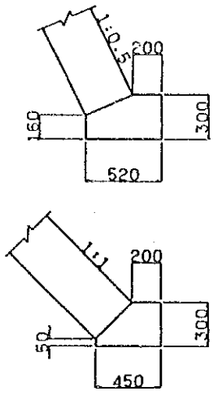
Figure 4.15 General Plan of Scour Protection around Abutments



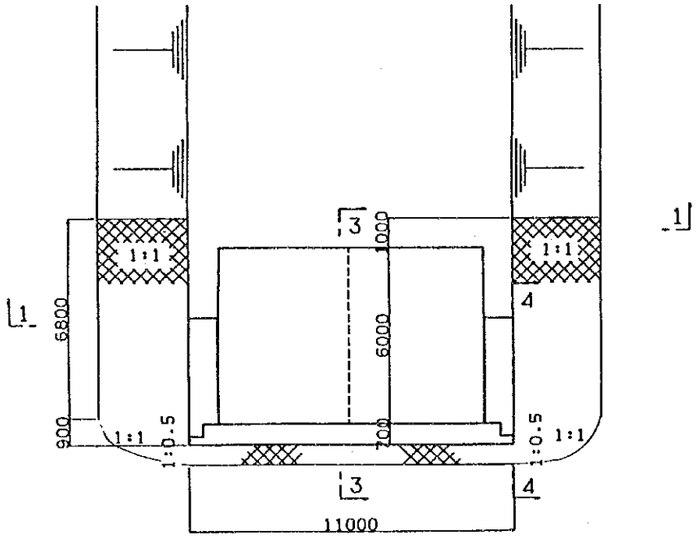
1-1



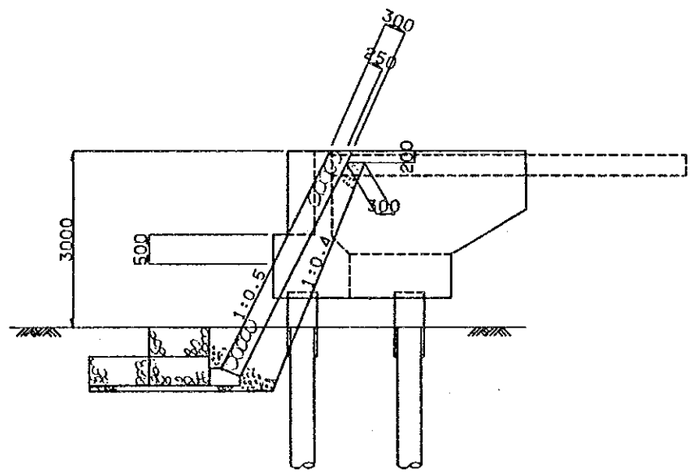
3-3



Foundation Scale 1:20

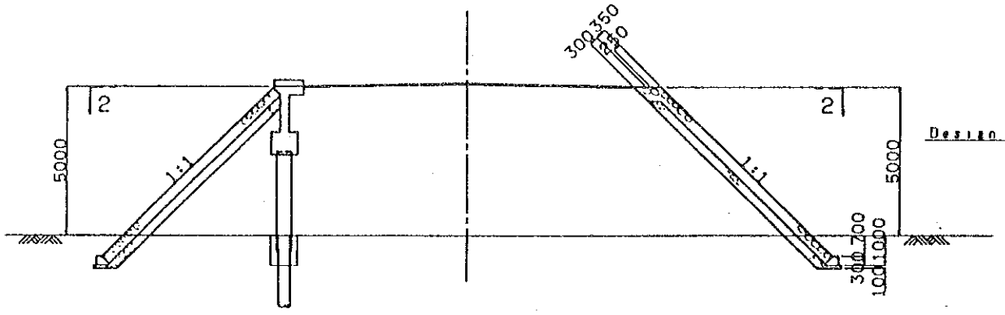


2-2



4-4

Figure 4.16 Revetment for Existing Abutment



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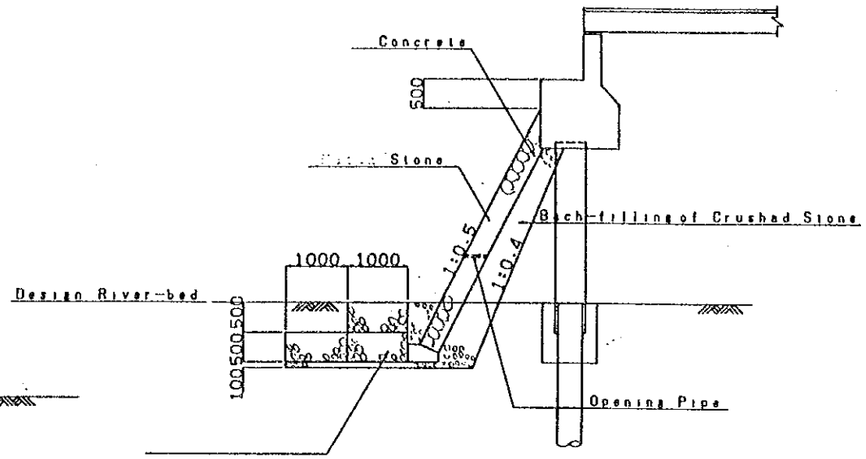

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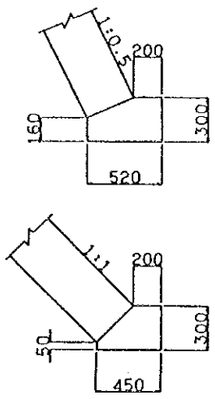
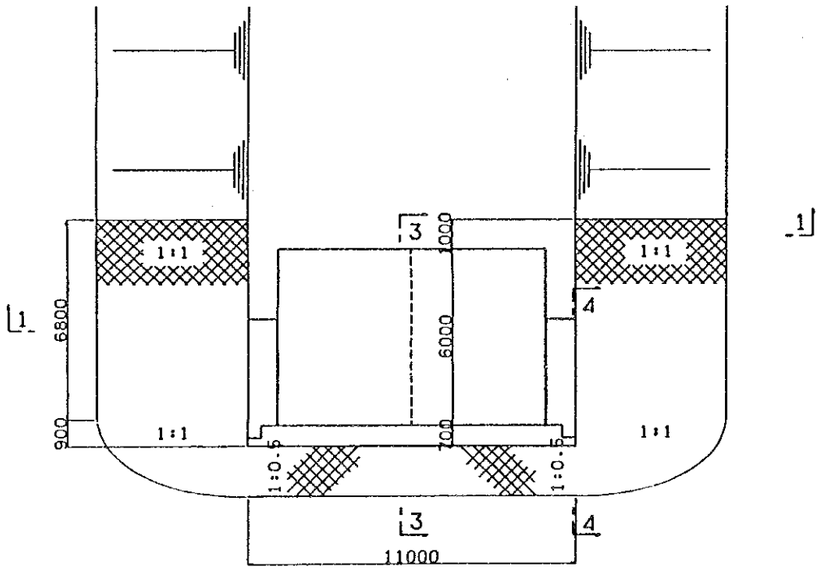


Foundation Scale 1:20



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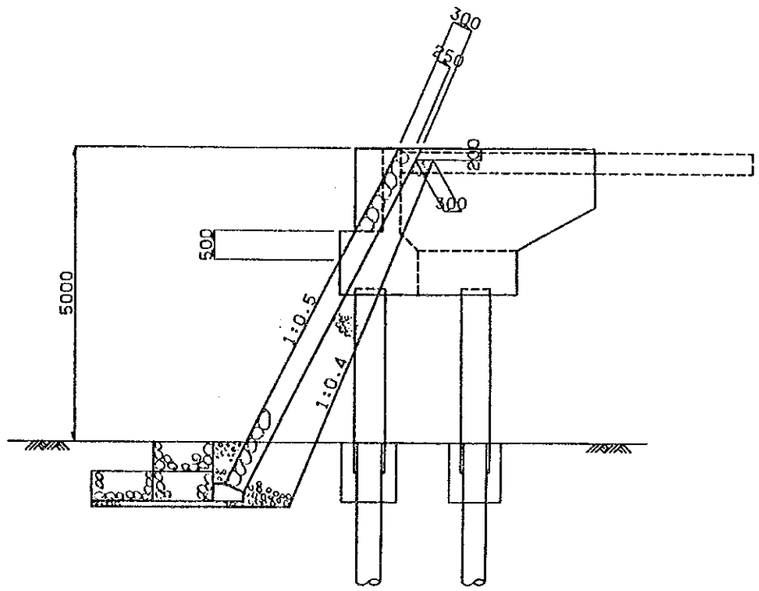
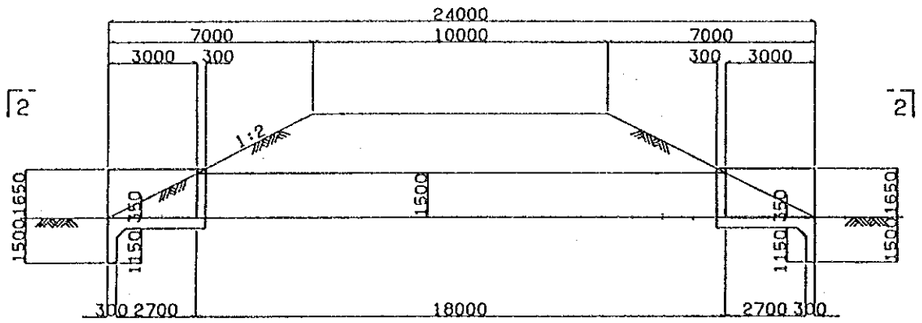


4-4

Figure 4.17 Revetment for New Abutment

Pipe Culvert



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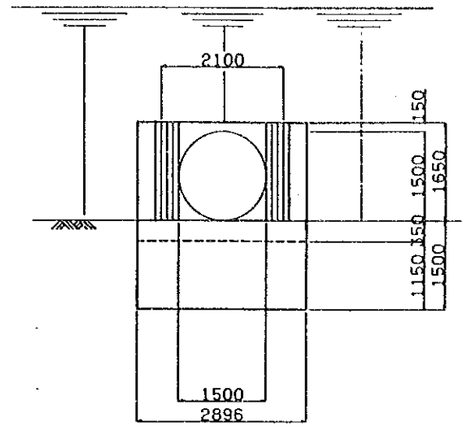

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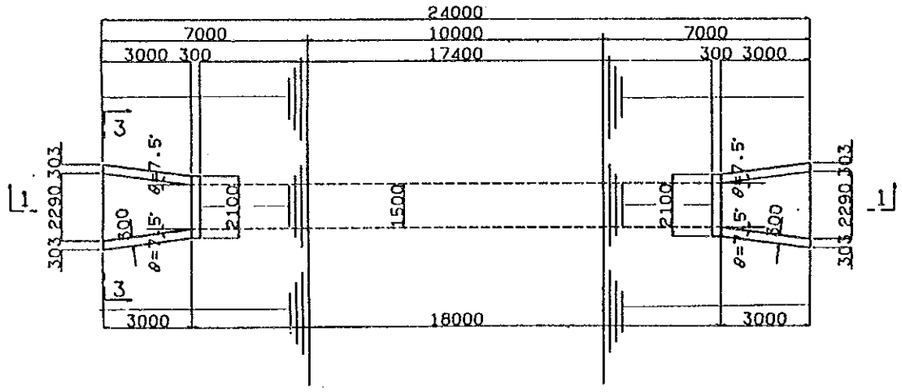
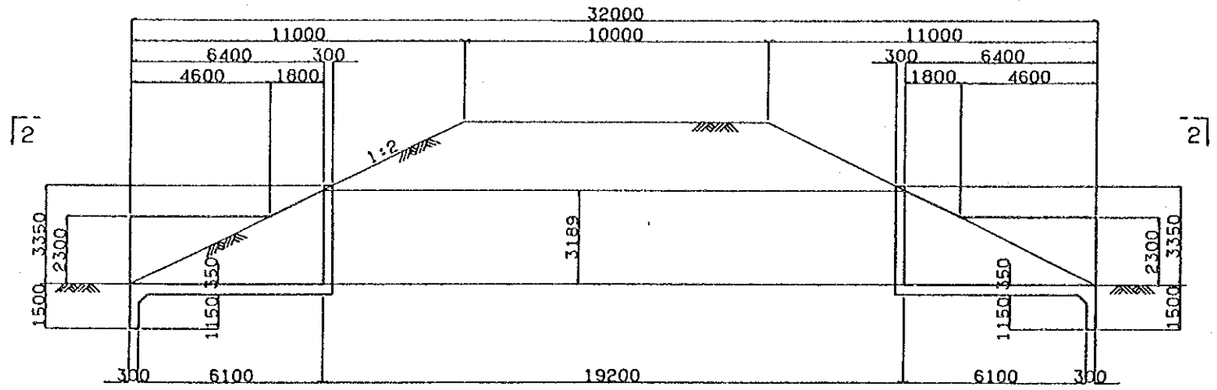


2-2

Figure 4.18 General Plan of No. 4 (Sta. 12+450) Culvert



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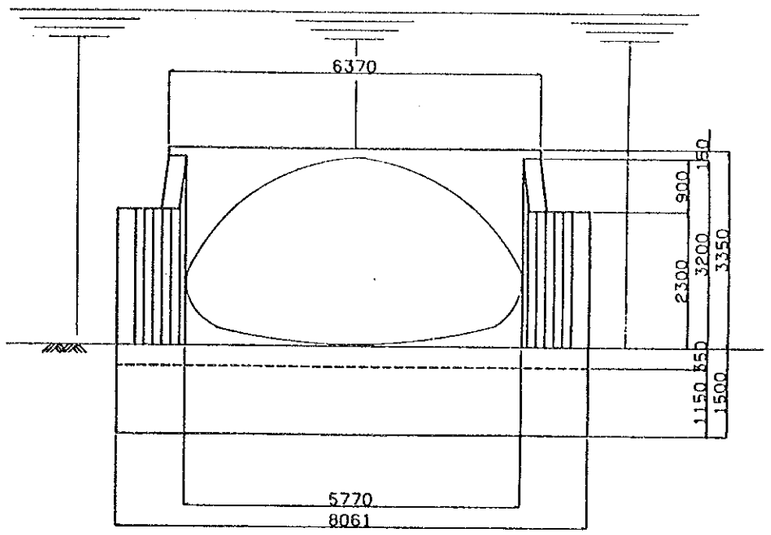

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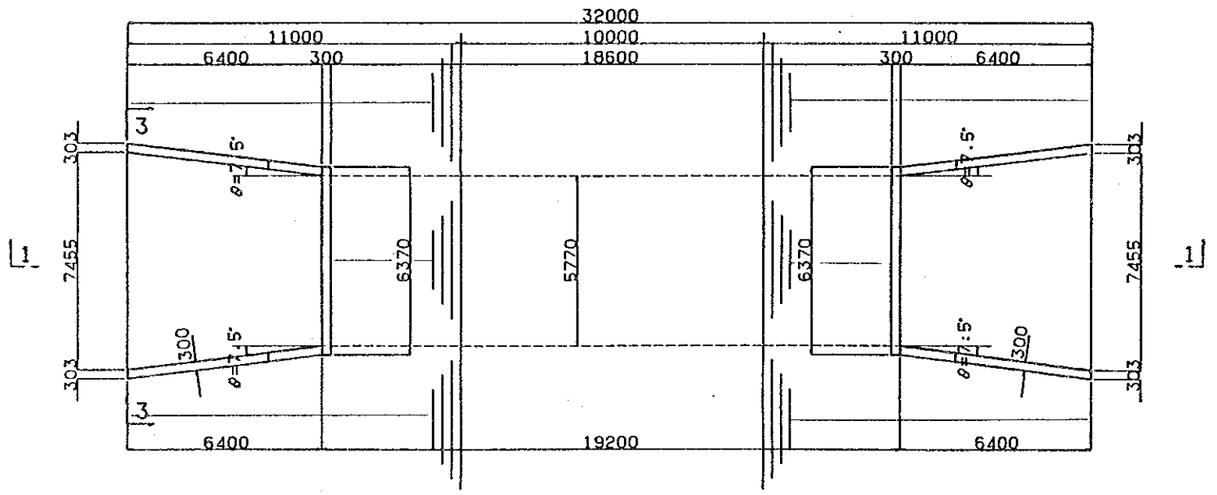

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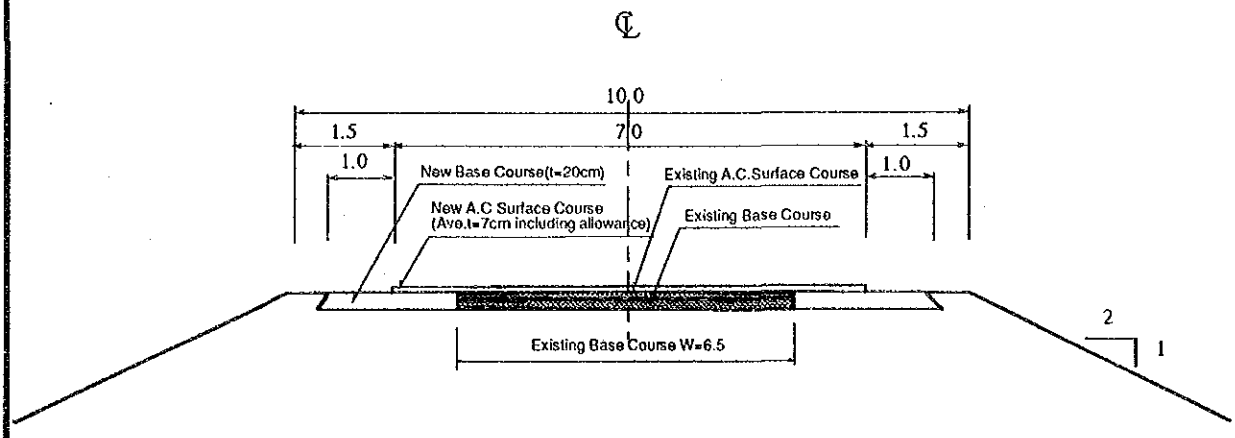
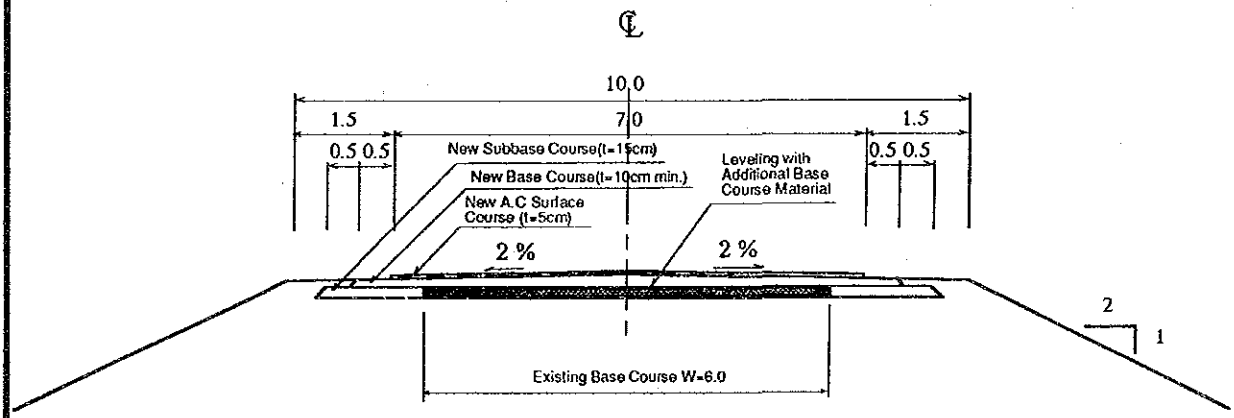
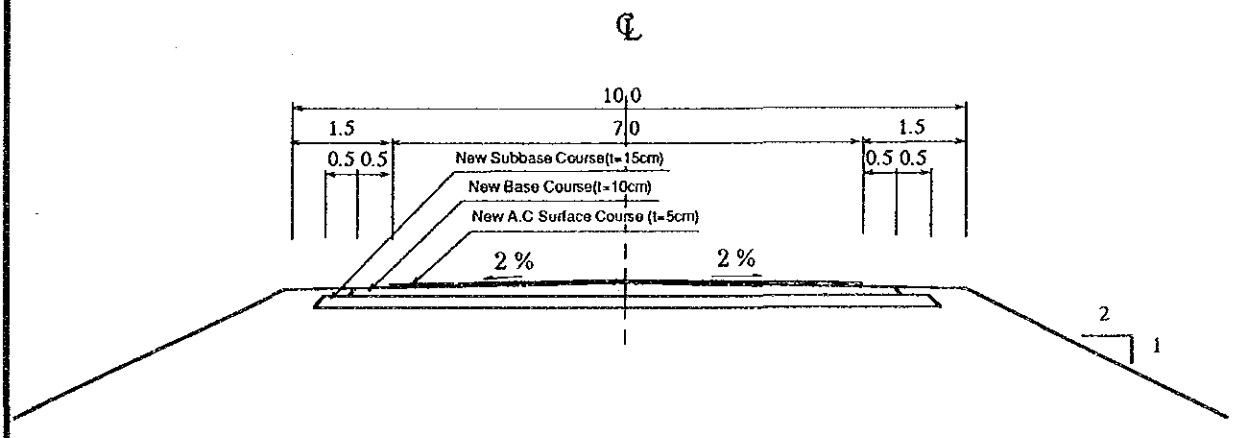
Figure 4.19 General Plan of No. 9 (Sta. 26+660) Culvert



Applicable for 10.5 km Phnom Penh Side Stretch where Asphalt Concrete Surface Course is Exist

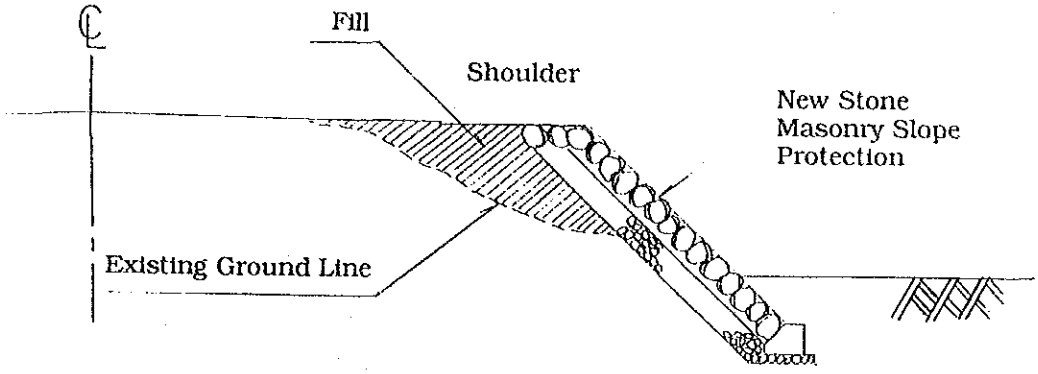


Applicable for Other Stretches Except New Construction Sections where Base Course Layer is Exist

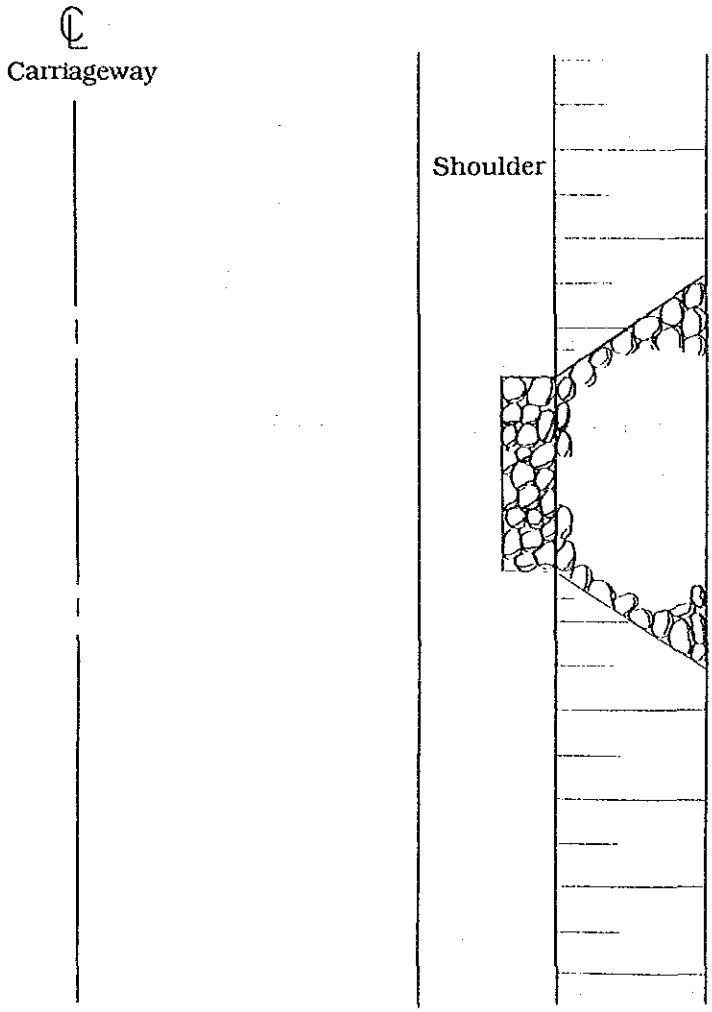


New Construction Section

REHABILITATION OF NATIONAL ROAD ROUTE 6A	**Figure 4.20** **Typical Cross Sections of Pavement Rehabilitation**

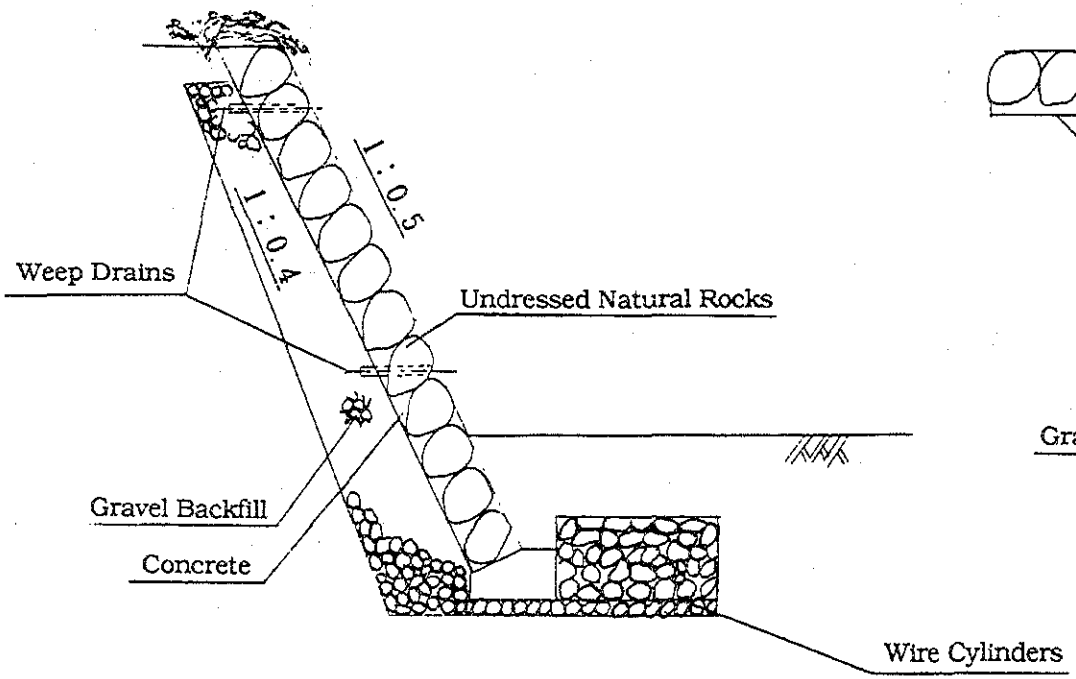


Cross Section

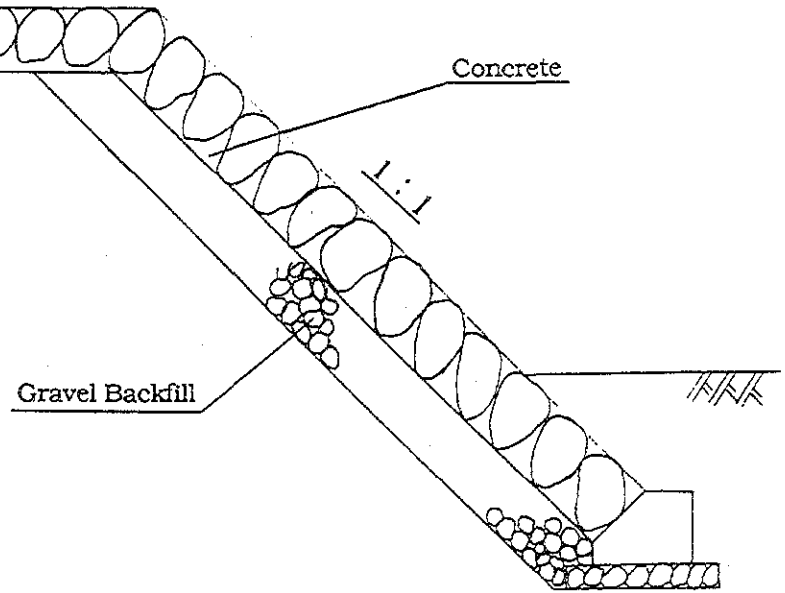


Plan

REHABILITATION OF NATIONAL ROAD ROUTE 6A	**Figure 4.21** **General Plan for the Repair of Embankment Slope Failure**



Scour Protection at Abutment



Repair of Embankment Failure

REHABILITATION OF NATIONAL ROAD ROUTE 6A

Figure 4.22 Revetment Details

4.4 Implementation Plan

4.4.1 Construction Conditions

(1) Approaches

Route 6A starts at the Chroy Changwar Bridge which is located at the northeast end of Phnom Penh city and terminates at Route 6 near Chun Chunok. The total length of Route 6A is approximately 44 kilometres.

However, the Chroy Changwar Bridge together with the several bridges of Route 6A were destroyed during the Cambodian conflict. Other road facilities such as road embankment and pavement were also affected by the conflict and the repetitive floods which occurred in the area lead to further damages. Thus, Route 6A at present is in an impassable condition and is not fulfilling the function of the trunk road in the region.

The objective of the Project is to rehabilitate Route 6A to provide uninterrupted road transport between Phnom Penh and its northern hinterland. The following background and approaches and methodology for construction planning are exercised based on the assumption that the Project will be implemented under Japan's Grant Aid:

1) Due to the importance and urgency of the Project to contribute toward the enhancement of the nation's economy, the elaborate implementation plan of the Project is examined based on the procedure of the Grant Aid System, construction plan and safety control under the natural and social conditions in Cambodia.

2) The Government of Japan has extended Grant Aid for the restoration of Chroy Changwar Bridge, and presently the said project is in the construction stage with completion scheduled in March 1994. It is now urgent to make Route 6A passable in parallel with the restoration of the Chroy Changwar Bridge, even if some temporary bridges are constructed.

3) Since considerable volume of traffic is estimated on Route 6A after the restoration of Chroy Changwar Bridge and there is no detour road in the project area, it is necessary to maintain traffic

so as not to interfere unnecessarily with the convenience of the public.

4) To secure quality and progress control of the Project which will require a large volume of aggregates, an exclusive quarry will be developed along or near Route 6A.

5) As a general principle, the local labour forces will be used to the maximum possible extent, nonetheless, consideration will also be paid to the use of heavy construction equipment in order to shorten the construction period. To meet this requirement, some Japanese heavy equipment operators will be assigned immediately upon the delivery of the equipment and some local technicians will be employed as the assistants to them.

(2) Situation of Construction Industry in Cambodia

1) Construction Equipment

Heavy construction equipment except concrete mixers, trucks and pickups will be supplied from Japan, which cannot be procured sufficiently from prevailing market in Cambodia.

Government Agencies, Road Construction Company and Bridge Construction Company are undertaking the construction works of roads and bridges and possess heavy construction equipment, while private contractors are undertaking building works and have some equipment.

Equipment for construction works is so obsolete that efficiency of operation may be low.

These government-owned equipment will not be utilized for the Project because on-going projects occupy them and require even more if they could be obtained.

2) Materials

Materials for construction works will be procured in Cambodia wherever they are available and in sufficient volumes.

The following materials are available in Cambodia:

- Portland cement (imported from Singapore, China and Indonesia);
- Coarse and fine aggregates for cement concrete;
- Reinforcing steel (imported from Singapore, China and Indonesia);
- Timber and plank;
- Asphalt cement and emulsion (imported from Singapore);
- Fuel and lubricants; and
- Galvanised iron sheet.

Materials other than above-mentioned are to be brought from Japan.

3) Labour

Generally, working hours of labour in Cambodia start at 7:00 a.m. and end at 5:30 p.m. with lunch break from 11:30 a.m. to 2:00 p.m., totaling 8 hours a day. Their working days are 6 days a week, from Monday to Saturday. No supplier of labourers can be found in Cambodia at present. Thus, it is necessary to add some overhead costs such as transport and housing allowances, insurance, tools, etc. to the prevailing market prices.

(3) Transport Plan

Materials procured from domestic markets are transported from Phnom Penh to a camp yard by river barges. Two slipways will be constructed at both Phnom Penh and at another point nearby camp yard to facilitate loading and unloading of materials and equipment.

The following three routes are deemed practical to transport materials and equipment brought from Japan:

1) Japan —> Kompong Som (Sihaknouk Ville) port by ship
Kompong Som (Sihaknouk Ville) port —> Phnom Penh by road (RN4 226 km)

2) Japan —> Kompong Som (Sihaknouk Ville) port by ship
Kompong Som (Sihaknouk Ville) port —> Phnom Penh by railway (264 km)

3) Japan —> Singapore by ship (ocean-going large ship)
Singapore —> Phnom Penh by ship (3,000t class ship)
(passing through Vietnam territory)

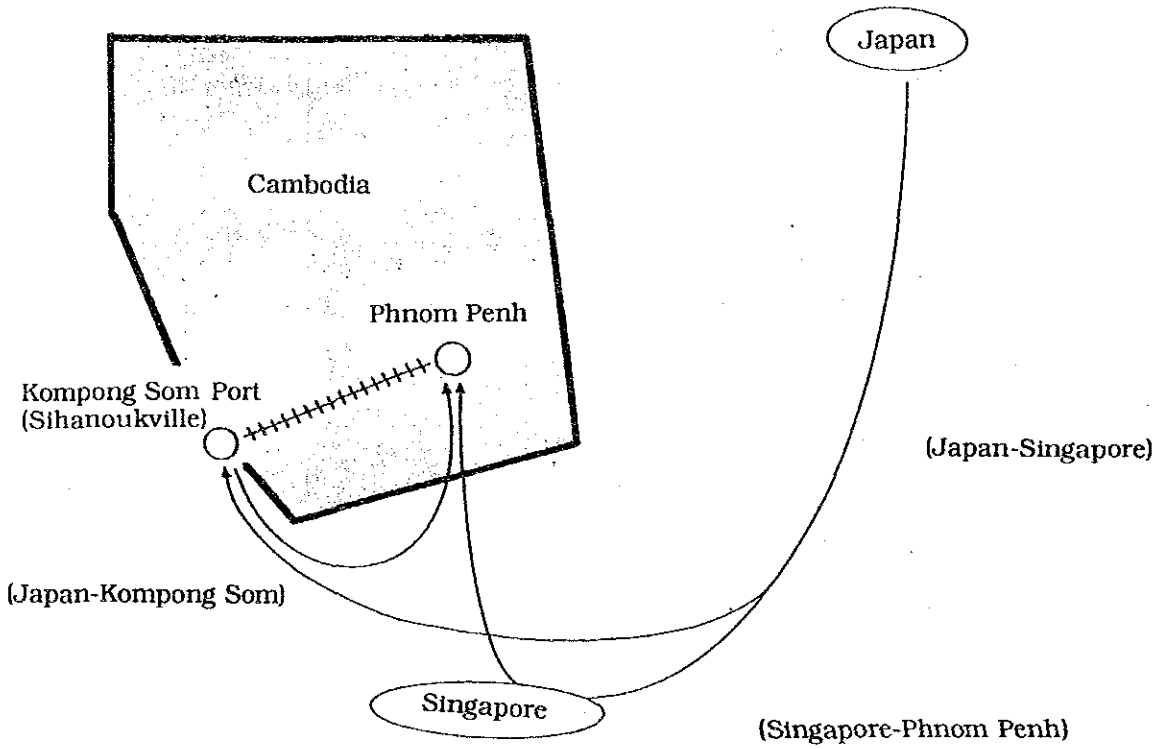
There are individual salient restraints on each transport route. Several temporary bridges on RN4 impose the maximum weight control of 30t therefore it will require to dismantle and assemble some heavy equipment.

The regulation of maximum longitudinal length of 12m and the no loading and unloading equipment at both stations will become critical on the railway route. It is unlikely and not practical, since excessive loads will be expected at the busy, full capacity Phnom Penh port which has only poor loading and unloading facilities.

It is concluded that the transport route of Kompong Som (Sihaknouk Ville) and RN4 is more favourable, considering the nature and volume of cargo brought from Japan. The detailed route and time required are given as follows:

Description	Route	Time Required (month)
Loading	Factory to port in Japan	0.5
Shipping	Port in Japan to Kompong Som (Sihaknouk Ville)	0.5
Custom Clearance	at Kompong Som (Sihaknouk Ville) port	0.3
Inland Transport	Route No. 4	0.7
	Total	2.0

The schematic transport route map is shown in Figure 4.23.



REHABILITATION OF NATIONAL ROAD ROUTE 6A

Figure 4.23 **Transport Route of Equipment and Materials**

4.4.2 Construction Methods

The rehabilitation of Route 6A comprises the following works:

- Rehabilitation of damaged bridges and culverts;
- Rehabilitation of damaged road embankments; and
- Rehabilitation of damaged and/or deteriorated pavement.

The construction method is selected taking into consideration not only the construction conditions discussed in 4.4.1 but also the following technical requirements:

(1) Earth works related to the rehabilitation of damaged road embankments and embankment slopes should be performed in one season. In particular, the construction of rubble-mound at the major damages of embankments should be done at the beginning of the dry season.

(2) The large-scale failure of embankment slopes should be rehabilitated by stone masonry. However, the area to be rehabilitated should be minimised to avoid the disturbance of stabilised ground by vegetation.

(3) Damaged culverts should be replaced by corrugated metal pipe culverts. The installation of corrugated metal pipe culverts should be done by lane to secure the convenience of local traffic.

(4) Four temporary bridges are provided at four collapsed bridge sections where the bridge replacement is scheduled:

- to provide the by-pass for the existing traffic;
- to demolish and remove the girders and other large members of collapsed bridge utilising heavy equipment;
- to erect new girders for bridge replacement;
- to provide a temporary road for the passage of construction equipment.

The width of temporary bridges is designed with a 6m width due to the requirement of the proposed 50t crawler crane.

(5) Repair works of substructure of damaged bridges should be performed in the dry season because of the underground repair works and the necessity of staging/scaffolding. Repair works at bridge approaches which comprise the installation of approach slab and stone masonry with gabions should be also done in the dry season.

(6) Asphaltic concrete surface course (minimum thickness of 5cm) should be provided for the entire section of Route 6A considering the role of Route 6A and the minimisation of maintenance costs after the rehabilitation. The rehabilitation should be done maintaining technical transfer mainly for the Cambodian counterparts and the government officials engaged in the Project.

(7) The exclusive quarry will be developed at Chi Lear along National Road Route 6, 3.5km from Chun Chunok intersection to secure the quality control and the expeditious progress of the rehabilitation. A base camp yard will be also developed at about 22km from Chroy Changwar Bridge. For the purpose of transporting materials and equipment, a slipway is intended to be constructed on the right bank of the Mekong river.

4.4.3 Detailed Design and Construction Supervision Plan

(1) Outline of Detailed Design and Construction Supervision

1) Detailed Design

For the execution of the detailed design, it is favourable to select the same consultant which has carried out the basic design study to ensure the quality and to save time and cost.

2) Construction Supervision

Utilisation of the same consultant is recommended based on the similar reason stated in the above. Cambodian staff should participate for the greater extent for the supervisory works so that transfer of technical know-how can be attained.

(2) Staffing for Detailed Design

Following is the staffing and responsibilities of Japanese experts:

1) Project Manager

- Liaison and discussions with the SNC and JICA;
- Overall management of the design including liaison with RBD and other concerned agencies;
- Technical directions to the design works;
- Administration and coordination of the project;
- Review and preparation of detailed construction plans; and
- Study of maintenance plan

2) Structural Engineer

- Review and preparation of detailed design of bridge replacement/repair, stone masonry with gabion and false works; and
- Preparation of technical specifications (bridge, stone masonry and false works, etc.).

3) Soils and Materials Engineer

- Detailed investigation of aggregates;
- Examination of borrow materials for embankment; and
- Preparation of technical specifications (aggregates, borrow materials and quality control of embankment).

4) Highway Engineer

- Review and preparation of detailed design of road works;
- Review and preparation of detailed design of cross drainage; and
- Preparation of technical specifications (earthworks, drainage, etc.)

5) Pavement Engineer

- Review and preparation of detailed design of pavement; and
- Preparation of technical specifications (sub-base, base and surface courses, etc.).

6) Document Specialist

- Preparation of tender and contract documents.

7) Surveying Engineer

- Setting of control points; and
- Detailed cross-sectional survey.

8) Cost Estimator

- Review of cost estimates carried out in the basic design stage; and
- Comparison and study of changes of estimated quantities and costs between basic and detailed design.

9) Interpreter

- French interpretation during the field survey works in Cambodia.

(3) Staffing for Construction Supervision

Following is the staffing and responsibilities of Japanese experts:

1) Project Manager

- Liaison and discussions with the SNC and JICA;
- Overall management of the services including liaison with RBD and other concerned agencies; and
- Technical directions in the execution of the services.

2) Resident Engineer

- Quality control and inspection of daily progress; and
- Justification of change orders.

3) Structural Engineer

- Quality control of bridge replacement and repair works; and
- Quality control of slope protection (revetment).

4) Pavement Engineer

- Quality control of paving works; and
- Inspection of asphalt mixing plant

4.4.4 Construction Plan

(1) Preparatory Works

1) Mobilisation

Materials and equipment which are to be procured in the domestic markets will be ordered, while those imported from Japan are transported to Kompong Som (Sihaknouk Ville) by ship and then to Phnom Penh by truck and trailers. Major materials and equipment brought from Japan are listed below:

- Heavy construction equipment including crushers, mixing and batching plants;
- Equipment for laboratory tests and surveying;
- Materials for false works including staging and scaffolding;
- Materials for safety control during construction;
- Vehicles for transport; and
- Necessary items required for Contractor's and Consultant's offices.

2) Development of Crushing Plant

Crushing plant with a capacity of 200 t/hr and asphalt mixing plant with a capacity of 100 t/hr will be built at Chi Lear. The yard requires an area of 8,000m^2 and also the site offices for the Contractor and Consultant, housing for engineers and labourers, powder magazine, warehouse, fueling station, motor pool for dump trucks and so forth will be provided.

3) Development of Base Camp

A base camp with concrete batching plant is required in between Route 6A and the Mekong river at about 22km from Chroy Changwar Bridge. The yard requires an area of 15,000m^2 and main offices for Contractor and Consultant, housing for engineers and labourers, motor pool,

warehouse, fueling station and so forth. A wireless communication network covering Phnom Penh liaison office and Chi Lear stone crushing and asphalt mixing plants will be also established in the base camp.

4) Construction of Temporary Bridges

Four temporary bridges are to be constructed at collapsed bridges Nos. 14, 20, 22 and 24. Temporary bridges to facilitate new bridge construction as well as other works along Route 6A will be provided. The structure of temporary bridge will be designed strong enough to bear heavy equipment. Widenings will be required for the erection of new girders.

(2) Earth Works

1) Road Embankment

1.5m thick rubble-mound (quarry-run) will be spread and compacted on the existing ground as a lower road bed layer. 0.15m thick filter of sand and gravel will be installed between the upper and lower road bed layers. The slope protection of sodding will be made. The finished grade of road will be designed to be 13.0m high so that the elevation of the new pavement will become higher than the flood level.

2) Slope Protection

Failure of slope will be stabilized by either stone masonry or heaping of sand bags. Sand bags made of vinyl will contain soil, seed and fertilizer. The slope protection works will be done in many locations but the area of the works should be minimised to avoid the disturbance of stable slopes covered by vegetation.

3) Site Clearing

Weeding and cutting of shrubs will be done within the clearance limit of the roads. All stems and branches violating the clearance limit will be cut by labourers. After site clearing, the surface of the existing road will be cleaned to get rid of loose impediments.

4) Grading and Stabilizing of Existing Pavement

15cm thick sub-base course will be constructed making full use of the existing base course. The surface will be leveled and compacted by heavy equipment adding aggregates, then, stabilising of the aggregate mechanically. 10cm thick stabilised base course will be constructed on the leveled and stabilised sub-base course layer. The heavy equipment for the construction will comprise graders, tire rollers, macadam rollers and water tank trucks.

5) Surfacing

5cm thick asphalt concrete surface course will be constructed on the graded base course. The surfacing on the existing asphalt pavement will be done after damaged portions are repaired. An average thickness of 7cm of asphalt concrete surface course will be constructed in the 10.5km Phnom Penh side section where asphalt concrete layers exist.

Paving will be done lane by lane to maintain the convenience of the public use. The heavy equipment for construction will comprise finishers, macadam rollers and tire rollers.

6) Demolition of Collapsed Bridge

To prevent the damages of adjacent sound structures from the demolition operations, collapsed bridges will be split into individual girders and appropriate size of blocks utilising labour forces and concrete breakers. 50 ton crawler crane lifts them and haul to the place where no interruption of rehabilitation works can be expected. Finally, girders and concrete blocks will be broken into small sizes and they will be utilised for the rehabilitation of embankment slope failures, and so on.

7) Bridge Construction (Bridge Nos. 14, 20, 22 and 24)

Reinforced concrete (RC) rectangular girders will be fabricated in the nearby area of the construction site and erected utilising 50 ton crawler cranes on the temporary bridge. Reinforced concrete slab and diaphragms are constructed using suspension forms.

8) Repair of Piers and Abutments (Bridge Nos. 23 and 25)

Damaged portions of concrete structure will be removed after the superstructure is supported by staging. The staging will consist of H-piles, H-beams girders and jacks. Exposed steel bars will be cleaned, reinforced with new material and then filled up with non-shrinking concrete.

9) Approach Slab (Bridge Nos. 7, 24 and 26)

Reinforced concrete approach slabs with the dimensions of 35cm thickness and 6m length will be provided. The top portion of existing parapet wall will be cut to support the approach slab. Crushed stone layers (30cm thickness) will be provided for the base of approach slabs.

10) Repair of the Rear of Abutments (Bridge Nos. 7 and 26)

Sheet pile boxed structure will be needed where the rear of abutments is entirely washed away. The box will be filled with selected material. Above the box, reinforced concrete approach slab will be placed.

11) Revetments Surrounding Abutments

Stone masonry with gabion (wire cylinder) is constructed as a slope protection surrounding abutments where no slope protection is provided where the approach is damaged.

12) Rehabilitation of Culverts (Sta. 12 + 450 and Sta. 26 + 600)

Corrugated metal pipe culverts will be installed after the existing damaged pipe culverts are removed. The installation of culverts will be performed in halves to secure the space required for traffic. Reinforced concrete headwalls and grouted rip rap aprons will be also provided.

13) Repair of Holes of Bridge Deck Slabs and Bridge Railings

Holes of slabs caused by bombardments will be repaired using suspension forms after damaged portions of slab are removed and reinforcement is placed. Precast bridge railings will be installed after the damaged railings are demolished and removed.

4.4.5 Procurement Plan

(1) Material Procurement

1) Local Materials

The following materials will be procured from the local market:

- Portland cement;
- Coarse and fine aggregates for portland cement concrete;
- Timber and plank;
- Fuel and lubricants; and
- Galvanized iron sheet.

2) Materials from Japan

The following materials will be brought from Japan:

- Admixtures;
- Steel products (H-beam, sheet pile, pipe, etc.);
- Materials for false works (staging, scaffolding, etc.);
- Rubber shoe;
- Explosives;
- Materials for safety control; and
- Necessary items for Contractor's and Consultant's offices.

(2) Equipment Procurement

1) Local Equipment

The following equipment will be procured in Cambodia.

- Concrete mixer (0.3 cu.m);
- Trucks (4 ton);
- Pick-up trucks;
- Wagon type vehicles (4WD); and
- Microbus (29 passengers).

2) Equipment from Japan

The proposed major heavy construction equipment to be brought from Japan are as tabulated in Table 4.4.

Table 4.4 List of Proposed Major Heavy Construction Equipment to be Brought from Japan

Type of Equipment	Capacity/Specification
Bulldozer	11t, 15t, 32t
Backhoe	0.7 m3, 1.0 m^3
Motor grader	3.1 m
Wheel loader	2.1 m^3, 2.4 m^3
Rubber-tire roller	15t
Macadam roller	10 ~ 12t
Vibrating roller	0.8 ~ 1.1t
Asphalt distributor	4,000 litre
Asphalt plant	100 t/h
Asphalt spreader	2.4 ~ 4.5m
Truck with 2 ton crane	—
Truck	11t
Trailer truck	32t
Dump truck	4t, 11t
Water tank car	10,000 litre
Crawler crane	50t
Truck crane	20t, 25t
Vibro hammer	90 kw
Crawler drill	150 kg
Concrete batching plant	0.5 m^3
Concrete mixer truck	4.5 m^3
Stone crushing plant	200 t/h
Forklift	2.5t
Soil compactor	50 ~ 100 kg
Concrete vibrator	38 mm
Submersible pump	50 mm, 100 mm, 150 mm
Generator	10 kVA, 35 kVA, 60 kVA, 300 kVA, 350 kVA
Air compressor	5 m^3, 17 m^3
Fuel tanker	9,000 litre
Concrete breaker	20 kg
Welding machine	300 A
Melter	—
Breaker, hydraulic type	1,300 kg

4.4.6 Implementation Schedule

(1) General

The preparation of proposed implementation schedule for the Project follows the procedure described in the guidelines of JICA, but the formulation of time schedule requires the adoption of some assumptions. Therefore, major points other than that described in JICA Guideline are described as the following.

(2) Detailed Design (Phase I & II)

After the Exchange of Notes is concluded between both governments, the Consultant will enter into contract with the Executing Agency of Cambodia and commence the services. The services will comprise also the preparation of tender and contract documents.

(3) Tendering and Contract Process (Phase I & II)

After the tender documents are accepted by the Executing Agency and the qualified contractors are nominated through prequalification evaluation, the Consultant on behalf of the Executing Agency will invite short-listed qualified contractors and provide them with the approved tender documents at a pre-tender conference. The Consultant will prepare addendums if necessary during the tendering period and prepare a draft tender evaluation report after the opening of tender.

The successful tenderer will enter into contract with the Executing Agency after contract negotiations.

(4) Construction Work

The successful contractor will commence the work after the Contract is verified by the Government of Japan and the Notice to Proceed is issued by the Executing Agency.

Phase-I works intend to make Route 6A passable and consist of earthworks, repair of bridges and culverts, and the construction of sub-base course.

Phase-II works intend to recover the function of Route 6A as a trunk road and consists of the construction of base course, surface course and shoulders.

Earthworks, and the construction of substructure of bridges and asphalt concrete surface course should be performed in the dry season.

The Consultant will work as the Engineer to supervise the Contractor and prepare monthly progress reports and a final report to submit them to both governments.

(5) Implementation Time Schedule

Due to the magnitude of the work and natural conditions, the implementation of the Project is divided into two phases. The commencement of Phase-I works is assumed in the beginning of October, 1993 to make full use of advantages of the dry season.

The outline of proposed implementation schedule is as follows:

- Tendering and Contract : 1.5 months
- Phase-I works : 12 months
- Phase-II works : 12 months

Overall construction period is assumed as 23 months, including overlapping of one month as shown in Figure. 4.24.

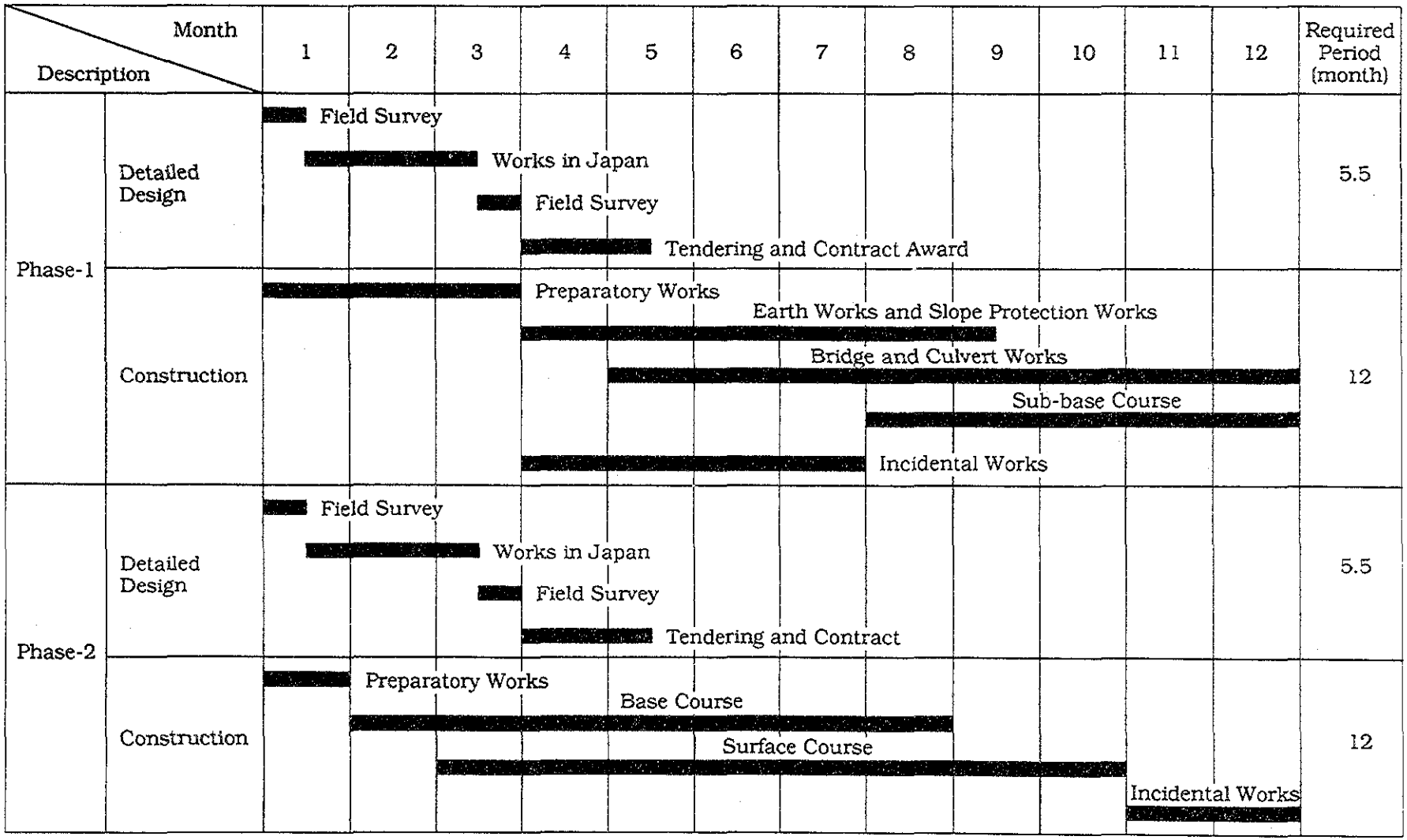


Figure 4.24 Implementation Schedule

4.4.7 Scope of Work

The scope of work of the Project and the undertakings to be taken by each side are as follows:

(1) Japanese Side

1) Bridge Repair Works

- Construction of eight bridge spans, totaling 96m long;
- Repair of two abutments at two bridges;
- Replacement of superstructure at four bridges;
- Repair of eleven holes in concrete slabs of bridges;
- Repair of bridge railings, totaling 300m long at fifteen bridges;
- Repair of five bridge approaches with steel sheet pile box and concrete approach slab at three bridges; and
- Construction of nineteen revetment surrounding abutments at ten bridges.

2) Pipe Culvert Repair Works

- Installation of corrugated metal pipe, 18m in length and 1.5m in diameter at Sta. 12 + 450;
- Installation of pipe-arch type corrugated metal pipe, 19.2m in length and 5.8m in diameter at Sta. 26 + 660; and
- Construction of reinforced concrete headwalls and grouted riprap aprons.

3) Road Embankment Repair Works

- Repair at six locations of embankment failure, totaling 35,300m^3 ; and
- Construction of slope protection by stone masonry or sand bags at more than three hundred locations of slope failure and slope erosion.

4) Pavement Repair Works

- Repair of existing asphalt pavement by 7m wide asphalt concrete surfacing, totaling 11,100m long;

- Repair of existing sub-base course by 8m wide stabilised aggregate base course and 7m wide asphalt concrete surfacing, totaling 33,200m length;
- Construction of new pavement on new embankment, totaling 283m length;
- Construction of 1.0m wide hard shoulders with surface treatment at both sides of carriageway in the first 10,360m long; and
- Construction of 0.5m wide hard shoulders with surface treatment at both sides of carriageway in the remaining stretches.

5) False Works

- Construction of four temporary bridges, totaling 210m long;
- Construction of two slipways at Phnom Penh and nearby camp yard;
- Development of crushing plant and asphalt concrete mixing plant including offices and housing at Chi Lear, totaling 8,000m^2
- Development of base camp including offices, housings, motor pool at around Sta. 22 + 000, totaling 15,000 m^2

6) Restoration of the damaged road facilities due to the implementation of the Project.

7) Provision of traffic management facilities for the concerned roads and rivers during the Project.

8) Consultancy services required for the implementation of the Project.

(2) Cambodian Side

1) Land acquisition and property compensation for the rehabilitation of Route 6A.

2) Provision of quarry site at Chi Lear.

3) Land lease or acquisition of the spaces for the base camps, aggregate processing and mixing plants, slipways, temporary bridges and other necessary temporary works.

4) Demolition and clearing of inhabitant's properties within the existing right-of-way area along Route 6A, as required.

5) Control of road traffic during the construction.

6) Security control of powder magazine for blasting.

7) Other undertakings described below:

i) To exempt taxes and to take necessary measures for customs clearance of the materials and equipment imported for the Project at the port of disembarkation;

ii) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Cambodia with respect to the supply of the products and services under the Verified Contracts;

iii) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts such facilities as may be necessary for their entry into Cambodia and stay therein for the performance of their work;

iv) To ensure that the Facilities constructed under the Grant Aid be maintained and used properly and effectively for the Project;

v) To bear all the expenses, other than those covered by the Grant, necessary for the execution of the Project; and

vi) To ensure prompt unloading and customs clearance at ports of disembarkation in Cambodia and internal transportation therein of the products purchased under the Grant.

Chapter 5: Project Evaluation and Conclusion

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

5.1 Project Evaluation

The National Road Route 6A (Route 6A) had served as the important connecting route from the metropolis of Phnom Penh to the northern hinterland. However, the Chroy Changwar Bridge and several bridges of Route 6A and road embankment were seriously damaged during the Cambodian conflict, thus Route 6A at present is in an impassable condition. For this reason, the other alternative routes which utilises Route 5, Prek Kdam ferry crossing and Route 6 has been in use of at present. However this route had been forced the inconvenience of the time-consuming ferry crossing.

Under such circumstances, it is urgent to realise the Project, since Route 6A is the main artery for the economic activities in Cambodia. If Route 6A was entirely rehabilitated, it is obvious that the Project can expect an economically high return which will be gained through the smooth movement of goods and passengers between Phnom Penh and its northern hinterland. The major effects of the Project are summarised as the following:

i. Remove the bottleneck created by the present ferry crossing at Prek Kdam, provide for uninterrupted road transport between Phnom Penh and its northern hinterland, and contribute towards the nation's economic restoration and enhancement.

ii. Route 6A will provide important access to the development area which is envisaged in Chroy and Changwar districts. Accordingly, the transport mobility and accessibility of the area will be greatly improved and bring about a striking reduction of traffic costs.

iii. The influence area of the Project will comprise Phnom Penh and nine provinces and shares 50% of the nation's population. In future, the population in the influence area could enjoy the benefits of Route 6A in various forms.

iv. Rehabilitation of Route 6A will support the immediate needs for quick-impact rehabilitation of nearby rural areas to absorb "returnees".

v Landuse potential along Route 6A will be greatly enhanced. In landuse allocation, inefficient concentrations in Phnom Penh can be decentralised and inefficient dispersions can be integrated.

vi. Project investment will produce the multiplier effect for the regional economy. Kompong Cham city is the second largest city of the nation. Also, Kompong Cham province has approximately 1.4 million of population and is the center of production of rice and rubber in Cambodia. If Route 6A was rehabilitated the accessibility to the City will be greatly improved and create considerable impact and would enhance employment opportunities.

5.2 Conclusion

In view of the above-mentioned effects, the implementation of the Project is indispensable not only for providing Route 6A for use as a traffic function, but also for promoting the stabilization of livelihood and improvement of the living standards.

Thus, it is concluded that the implementation of the Project by Japan's Grant Aid System is evaluated as appropriate.

Appendices

MEMBER LIST OF SURVEY TEAM

Team Leader

Name	:	Mr. Koichi Miyoshi
Present Post	:	Director, Second Basic Design Study Division, Grant Aid Study and Design Department, JICA

Road Construction System Planner

Name	:	Mr. Akira Fujimoto
Present Post	:	Coordinator for International Research Cooperation, Public Works Research Institute, Ministry of Construction

Bridge Construction System Planner

Name	:	Mr. Jiro Fukui
Present Post	:	Senior Research Engineer, Foundation Engineering Division, Structure and Bridge Department, Public Works Research Institute, Ministry of Construction

Project Coordinator

Name	:	Mr. Kenji Maekawa
Present Post	:	Second Basic Design Study Division Grant Aid Study and Design Department, JICA

Technical Experts

Name	Assignment
Mr. Akira Shikichi	Chief, Overall Design Manager
Mr. Kenji Maruoka	Highway Engineer
Mr. Nobuhiro Kuboya	Structure Engineer
Mr. Osamu Nogoshi	Geodetic Engineer
Mr. Masayuki Ikeda	Geodetic Engineer
Mr. Sakae Takada	Geo-Technical Engineer
Mr. Hiroyuki Endo	Construction Planning/Cost Estimates Specialist
Mr. Kazuhiro Ogawa	Translator/Interpreter

SURVEY SCHEDULE

For the 1st Field Survey (from November 11 to December 11, 1992)

Date	Day	Activities
November 11	(Wed.)	Departure from Tokyo
November 12	(Thu.)	Courtesy call to Ministry of Communication, Transport and Post (MCTP)
November 13	(Fri.)	Courtesy call to Ministry of Foreign Affairs (MFA)
November 14	(Sat.)	Explanation of Inception Report to the Vice Minister of MCTP
November 15	(Sun.)	Internal meeting
November 16	(Mon.)	Site reconnaissance
November 17	(Tue.)	Damages investigations and topo survey
November 18	(Wed.)	Damages investigations and topo survey
November 19	(Thu.)	Damages investigations and topo survey
November 20	(Fri.)	Damages investigations and topo survey
November 21	(Sat.)	Damages investigations and topo/soils surveys
November 22	(Sun.)	Internal meeting
November 23	(Mon.)	Damages investigations and topo/soils surveys
November 24	(Tue.)	Damages investigations and topo/soils surveys
November 25	(Wed.)	Damages investigations and topo/soils surveys
November 26	(Thu.)	Damages investigations and topo/soils surveys
November 27	(Fri.)	Damages investigations and topo/soils surveys
November 28	(Sat.)	Damages investigations and topo/soils surveys
November 29	(Sun.)	Internal meeting
November 30	(Mon.)	Study on bridge rehabilitation and topo/soils surveys
December 1	(Tue.)	Data collection at RBD and topo/soils surveys
December 2	(Wed.)	Collection of hydrological data and topo/soils surveys
December 3	(Thu.)	Hearings on bridge construction records (Route 6A) and topo/soils surveys
December 4	(Fri.)	Arrival of Team Leader in Phnom Penh. Courtesy call to MCTP and MFA

December 5	(Sat.)	Site inspection
December 6	(Sun.)	Internal meeting
December 7	(Mon.)	Discussion of Inception Report
December 8	(Tue.)	Signing of minutes of discussions
December 9	(Wed.)	Data collection of construction equipment and materials
December 10	(Thu.)	Departure from Phnom Penh
December 11	(Fri.)	Arrival to Tokyo

For the 2nd Field Survey (from March 20 to March 29, 1993)

Date	Day	Activities
March 20	(Sat.)	Departure from Tokyo
March 21	(Sun.)	Internal meeting
March 22	(Mon.)	Courtesy call to MCTP and explanation of Draft Report to Road and Bridge Department (RBD)
March 23	(Tue.)	Explanation of Draft Report to RBD
March 24	(Wed.)	Arrival of official team and courtesy call to MOF
March 25	(Thu.)	Discussion of Draft Report
March 26	(Fri.)	Signing of minutes of discussions
March 27	(Sat.)	Data collection
March 28	(Sun.)	Departure from Phnom Penh
March 29	(Mon.)	Arrival to Tokyo

MEMBER LIST OF CONCERNING PARTY IN THE RECIPIENT COUNTRY

Mr. So Khun	Minister, Ministry of Communication, Transport and Post
Mr. Tram Iv Tek	Vice Minister, Ministry of Communication, Transport and Post (MCTP)
Mr. Uk Chan	Director, Road and Bridge Department (RBD), MCTP
Mr. Tauch Chankosal	Deputy Director, Technical and Planning, RBD, MCTP
Mr. Yit Bunna	Director, Technical Department, MCTP
Mr. Koy Van	Deputy Director, RBD, MCTP
Mr. Mon Sambath	Chief, Technical and Planning, RBD, MCTP
Mr. Chum Sakun	Vice Director, Planning Department, MCTP
Mr. Kim Leang	Chief, Planning Office, RBD, MCTP
Mr. Iv Meng	Chief, Material Office, RBD, MCTP
Mr. Yean Seang	Engineer, Mechanical, RBD, MCTP
Mr. Uk Sota	Engineer, Mechanical, RBD, MCTP
Mr. Duong Moeun	Planning Department, MCTP
Mr. Sar Satya	Planning Department, MCTP
Mr. Vong Sam Ath	Personal Department, MCTP
Mrs. You Ay	Director, Ministry of Foreign Affairs
Mr. Kaing Leang Khan	Ministry of Foreign Affairs
Mr. Sok Savan	Council Minister

MINUTES OF DISCUSSIONS
BASIC DESIGN STUDY ON THE PROJECT FOR
REHABILITATION OF NATIONAL ROAD ROUTE 6A
IN CAMBODIA

In response to a request from Supreme National Council of Cambodia (SNC), the Government of Japan decided to conduct a Basic Design Study on the Project for Rehabilitation of National Road Route 6A (hereinafter referred to as the Project) and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as JICA).

JICA sent to Cambodia a study team, which is headed by Mr. Koichi Miyoshi, Director, Second Basic Design Study Division, Grant Aid Study and Design Department, JICA, and is scheduled to stay in the country from November 12 to December 9, 1992.

The team held discussions with the officials concerned of Cambodia and conducted a field survey at the study area.

In the course of discussions and field survey, both parties have confirmed the main items described on the attached sheets. The team will proceed to further works and consider about preparing the Basic Design Study report.

Phnom Penh, December 8, 1992

For H.E. HOR NAMHONG, member of
S.N.C., Coordinator for Economic
Cooperation with Japan

Koichi Miyoshi
Leader
Basic Design Study Team
JICA

So Khun
Minister
Ministry of Communication, Transport
and Post

ATTACHMENT

1. Objective

The objective of the Project is to rehabilitate the Route 6A to provide uninterrupted road transport between Phnom Penh and its northern hinterland and to contribute toward the enhancement of the nation's economy.

2. Project Site

The location of the Project site is shown in Annex I. The Route 6A starts at the Chroy Changwar Bridge which is located at the northeast end of Phnom Penh city and terminates at the Route 6 near Chun Chunok. The total length of the Route 6A is approximately 45 kilometres.

3. Executing Agency

Road and Bridge Department (RBD), Ministry of Communication, Transport and Post (MCTP) is responsible for the implementation of the Project.

4. Items requested by the Cambodian Side

After discussions with the Basic Design Study Team, the following items were finally requested by the Cambodian side.

(1) Rehabilitation of damaged bridges and culverts;
(2) Rehabilitation of damaged road embankment; and
(3) Rehabilitation of damaged and/or deteriorated pavement.

5. Design Criteria

Road and Bridge Department (RBD), MCTP has confirmed that the criteria for bridge design, highway geometric design, pavement design, embankment design, slope protection and other engineering designs will be carried out in accordance with the compatible Japanese standard.

6. Outline of the Project

(1) The outline of rehabilitation is shown in Annex II.

(2) Major damaged road embankment will be restored to the original condition

(3) Damaged and/or deteriorated pavement will be restored to the original conditions.

However, the final components of the Project may be differed from the above description, if it was judged from the result of the Study.

7. Japan's Grant Aid System

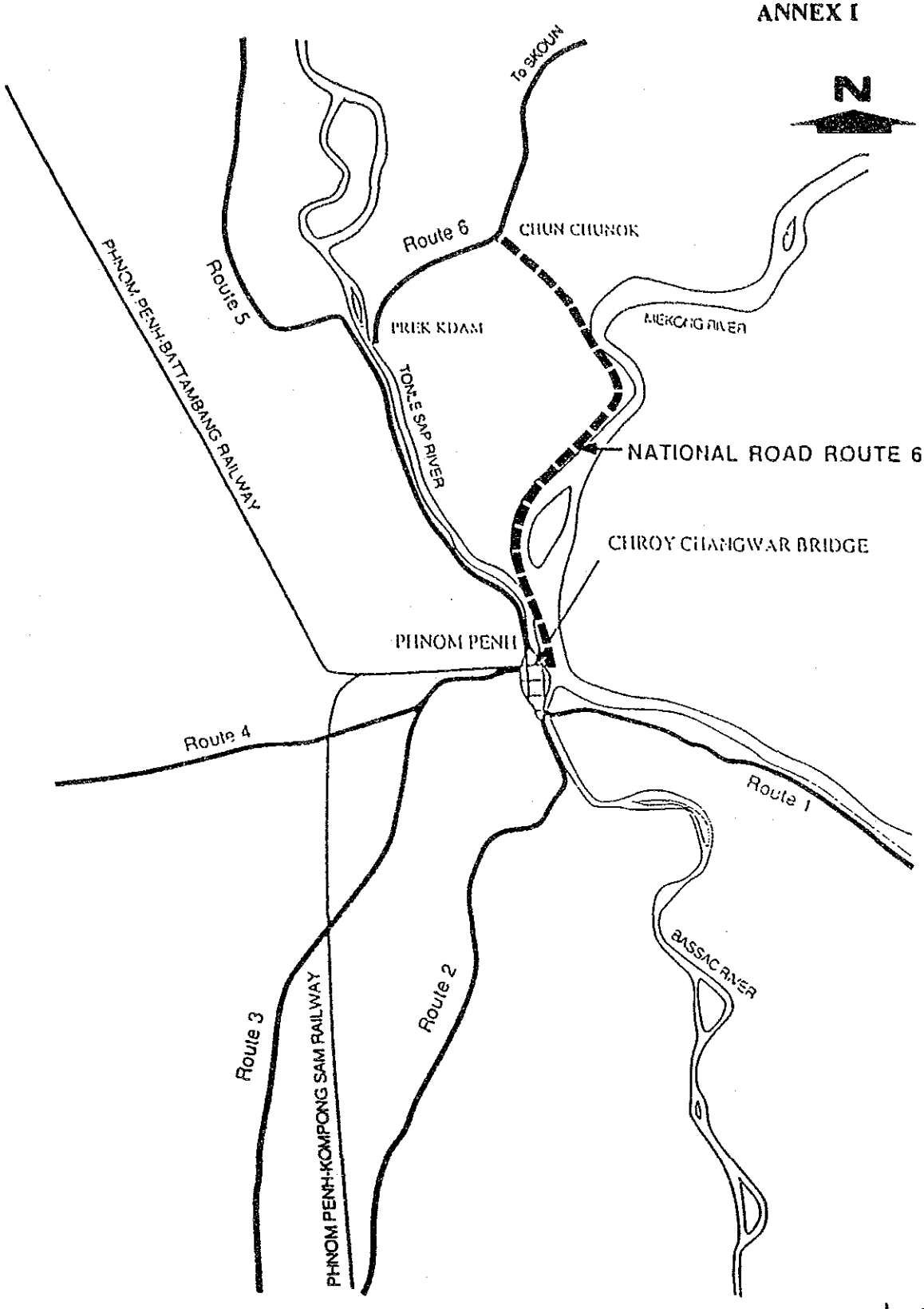
(1) The Cambodian side has understood the system of Japanese Grant Aid explained by the team.

(2) The Cambodian side will take necessary measures, described in Annex VI for smooth implementation of the Project, on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

8. Schedule of the Study

Based on the Minutes of Discussions and technical examination of the study results, JICA will complete the final report and send it to the Cambodian side by April, 1993.

ANNEX I



PROJECT LOCATION MAP

ANNEX II

OUTLINE OF REHABILITATION ON NATIONAL ROAD 6A

Items	Damages	Intended Rehabilitation	Remarks
Bridge	Collapse of Span	Reconstruction	Details are shown in ANNEX III
	Destruction of Pier	Repair	
	Destruction of Abutment	Repair	
	Destruction of Girder	Repair	
	Destruction of Slab	Repair	
	Destruction of Bridge Railing	Repair	
	Failure of Approach Fill	Refill & Slope Protection	
Pipe Culvert	Destruction of Pipe	Reconstruction	Details are shown in ANNEX IV
	Destruction of Headwall	Reconstruction	
	Failure of Backfill	Refill	
Road Embankment	Failure of Embankment	Reconstruction & Slope Protection	Typical cross sections are shown in ANNEX V
	Settlement	Filling	
	Excavation	Filling	
	Failure of Slope	Refill & Slope Protection	
	Erosion of Slope	Refill	
Pavement	Deterioration of Carriageway	Repavement	
	Failure of Shoulder	Repair	

Outline of Bridge Rehabilitation

No.	Bridge Name	Bridge Length (m)	Carriageway Width (m)	Station	Intended Rehabilitation					
					Girder	Deck Slab	Railing	Pier	Abutment	Approaches
1	Prek Leab	1 x 12 = 12	9	6 + 570	○	○	○	—	○	●
2	Khtor 1st	2 x 12 = 24	9	7 + 710	●	○	●	○	○	●
3	Khtor 2nd	1 x 12 = 12	9	8 + 590	○	●	●	—	○	●
4	Prek Ta Sun	2 x 12 = 24	9	9 + 190	●	●	●	○	●	●
5	Bac Kheang	1 x 12 = 12	9	9 + 840	○	○	○	..	○	●
6	Prek Vongsar	5 x 12 = 60	9	10 + 360	○	●	●	○	○	●
7	Prek Chik	1 x 12 = 12	9	11 +380	○	○	○	—	○	●
8	Prek Suon Choeum	3 x 12 = 36	9	11 + 820	○	●	●	○	○	●
9	Prek Tamin	2 x 12 = 24	9	13 + 040	○	○	●	○	○	●
10	Prek Ta Soam	1 x 12 = 12	9	15 + 460	○	○	●	—	○	●
11	Prek Ta Pich	1 x 12 = 12	9	16 + 520	○	○	●	—	○	●
12	Prek Tabek	2 x 12 = 24	9	17 + 470	○	○	●	○	○	●
13	Prek Thmei	2 x 12 = 24	9	18 + 560	○	○	●	○	○	●
14	Prek Kheng	10 x 12 = 120	9	29 + 040	●	●	●	●	○	●
15	Prek Tambang 1st	2 x 12 = 24	9	29 + 630	○	○	○	○	○	●
16	Prek Tambang 2nd	3 x 12 = 36	9	29 + 810	○	○	○	○	○	●
17	Prek Hok Leng	3 x 12 = 36	9	31 + 790	○	○	○	○	○	●
18	Prek Ta Oun	3 x 12 = 36	9	31 + 940	○	○	○	○	○	●
19	Deum Chrey	2 x 12 = 24	9	32 + 400	○	○	●	○	○	●
20	Prek Bak	3 x 12 = 36	9	33 + 330	●	●	●	●	○	●
21	Chung Prek	2 x 12 = 24	9	35 + 210	○	○	○	○	○	●
22	Prek Kra Poes	10 x 12 = 120	9	36 + 880	○	●	○	●	○	●
23	Kompong Prasath	3 x 20 = 60	9	37 + 600	●	○	○	○	●	●
24	Kompong Pras 1st	7 x 12 = 84	9	39 + 890	●	●	●	○	●	●
25	Kompong Pras 2nd	1 x 12 = 12	9	40 + 520	●	●	●	—	○	●
26	Kompong Pras 3rd	3 x 12 = 36	9	41 + 210	○	○	○	○	○	●
	Total	936 m								

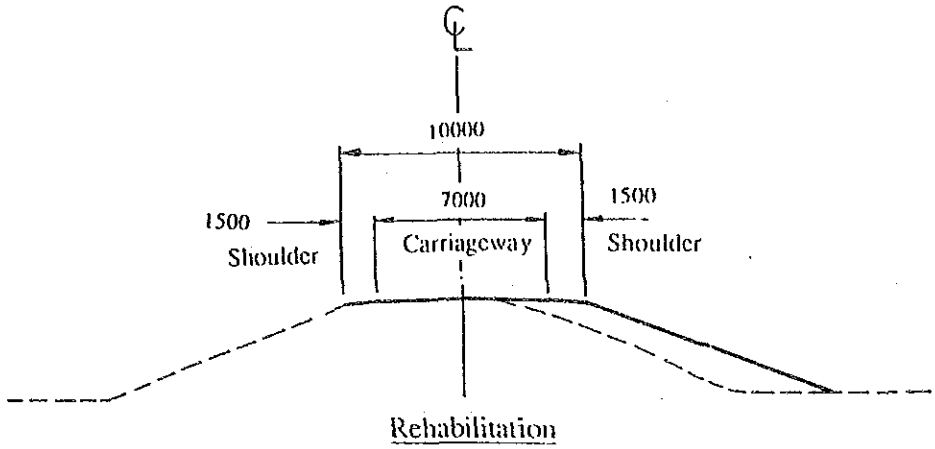
Note: ○ : No rehabilitation ● : To be rehabilitated — : Not exist 1 span is about 12 meters and 1 segment is about 3 meters.

Outline of Pipe Culvert Rehabilitation

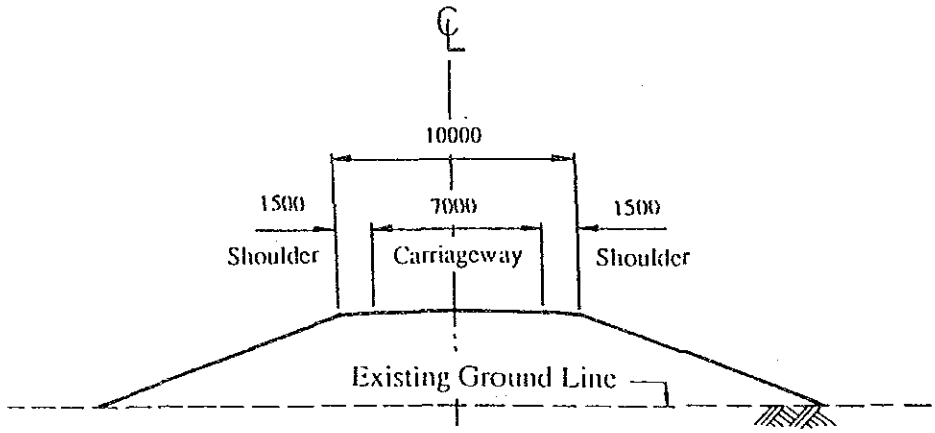
No.	Name of District	Station	Size of Pipe (m)	No. of Cell	Intended Rehabilitation				Embankment Height (m)	Flood Level from RoadSurface (m)
					Pipe	Headwall Mechong	Headwall Tonle Sap	Filling		
1	Russey Keo	7+270	1.5	2	○	○	○	●	3.0	-1.5
2	Russey Keo	8+140	1.5	1	○	○	○	○	1.5	-1.3
3	Muk Kompoul	10+770	1.5	1	○	○	○	●	3.0	-1.2
4	Muk Kompoul	12+450	1.5	3	●	●	●	●	1.7	-1.6
5	Muk Kompoul	12+740	1.5	2	○	○	○	○	1.5	-1.5
6	Muk Kompoul	14+300	1.5	1	○	○	○	○	1.5	-1.2
7	Muk Kompoul	14+800	1.5	1	○	○	○	○	2.0	-1.5
8	Muk Kompoul	16+880	1.5	1	○	○	○	○	1.5	-1.2
9	Muk Kompoul	26+660	1.5	1	●	●	●	●	3.0	-0.0

Legend : ○ : No rehabilitation

● : To be rehabilitated



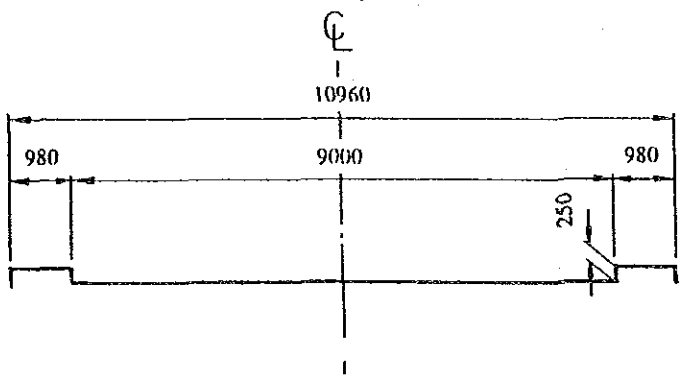
Rehabilitation



Reconstruction at
Damaged Section

Typical Cross Section of Roadway

Scal:1/300



Typical Cross Section of Bridge

Not to Scale

REHABILITATION OF NATIONAL ROAD ROUTE 6A	Fig. Typical Cross Sections (Roadway and Bridge)

ANNEX VI

MAJOR UNDERTAKINGS TO BE TAKEN BY EACH SIDE AND NECESSARY MEASURES TO BE TAKEN BY THE CAMBODIAN SIDE

1. Major Undertakings to be Taken by Each Side

No.	Items	To be Covered by Grant Aid	To be Covered by Recipient Side
(1)	Land acquisition and property compensation for the rehabilitation of Route 6A		o
(2)	Provision of quarry site		o
(3)	Land lease/acquisition of the spaces for the base camps (office, quarters, stock yard and motor pool), aggregates processing and mixing plant and other necessary temporary works		o
(4)	Demolition and clearing of the inhabitant's properties within the existing right-of-way area along Route 6A, as required		o
(5)	Rehabilitation of damaged bridges and culverts	o	
(6)	Rehabilitation of damaged road embankment	o	
(7)	Rehabilitation of damaged and/or deteriorated pavement	o	
(8)	Control of road traffic during the Rehabilitation		o
(9)	Security control of powder magazine for blasting		o
(10)	Restoration of damaged road facilities due to the implementation of the Rehabilitation	o	
(11)	Traffic management facilities for road and river during the Rehabilitation: cones, barricades, ropes, twinkler sign board, and pre-warning signs and lights	o	

2. Necessary Measures to be Taken by the Cambodian Side

(1) To exempt taxes and to take necessary measures for customs clearance of the materials and equipment brought for the Project at the port of disembarkation.

(2) To exempt study members from income taxes and other fiscal charges payable under the legislation of Cambodia in respect of any emoluments or allowances remitted to them from overseas.

(3) To accord Japanese Nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into Cambodia and stay therein for the performance of their work.

(4) To maintain and use properly and effectively that the facilities rehabilitated under the Grant.

(5) To bear all the expenses other than those to be borne by the Grant, necessary for the rehabilitation of the facilities.

(6) To ensure prompt processing of required internal formalities to secure the implementation time schedule of the Project.

(7) To ensure the safety of the Study Team members when and as it is required in the course of the Study.

Minutes of Discussion
Basic Design Study on
The Project for Rehabilitation of National Road Route 6A in Cambodia

In December, 1992, the Japan International Cooperation Agency (JICA) dispatched a Basic Design Study team on the Project for Rehabilitation of National Road Route 6A (hereinafter referred to as "the Project") to Cambodia, through discussions, field survey, and technical examination of the results in Japan, JICA has prepared the Draft Final Report of the Study.

In order to explain and to consult the Cambodian side on the components of the Draft Final Report, JICA sent to Cambodia a study team headed by Mr. Akira Fujimoto, Coordinator for International Research Cooperation, Public Works Research Institute, Ministry of Construction, and is scheduled to stay in the country from March 21 to 28, 1993.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Phonm Penh March 26, 1993

藤本昭

AKIRA FUJIMOTO

Leader
Basic Design Study Team
JICA

For H.E. HOR NAMHONG,
Member of S.N.C., Coordinator for
Economic Cooperation with Japan

SO KHUN

Minister
Ministry of Communication, Transport
and Post (MCTP) of Cambodia

ATTACHMENT

1. Components of Draft Final Report

Road and Bridge Department (RBD), MCTP has agreed and accepted in principle the components of the Draft Final Report proposed by the team.

2. Japan's Grant Aid System

(1) RBD/MCTP has understood the system of Japanese Grant Aid explained by the team.

(2) RBD/MCTP will take the necessary measures, described in Annex I, for smooth implementation of the Project on condition that the Grant Aid assistance by the Government of Japan is extended to the Project.

3. Further Schedule

The team will make the Final Report in accordance with the confirmed items, and send it to Cambodia by the end of May, 1993.

Annex I: Necessary Measures to be taken by the Cambodian Side in Case Japan's Grant Aid is executed

1. To secure the space for the Site and other necessary temporary works, and to clear the site;

2. To ensure prompt unloading and customs clearance of the materials and equipment brought for the Project at ports of disembarkation in Cambodia;

3. To control road traffic during construction

4. To exempt taxes of the materials and equipment brought for the Project at the port of disembarkation;

5. To exempt study members from income taxes and other fiscal charges payable under the legislation of Cambodian respect of any emoluments or allowances remitted to them from overseas;

6. To accord Japanese Nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into Cambodia and stay therein for the performance of their work;

7. To maintain and use properly and effectively that the facilities repaired under the Grant;

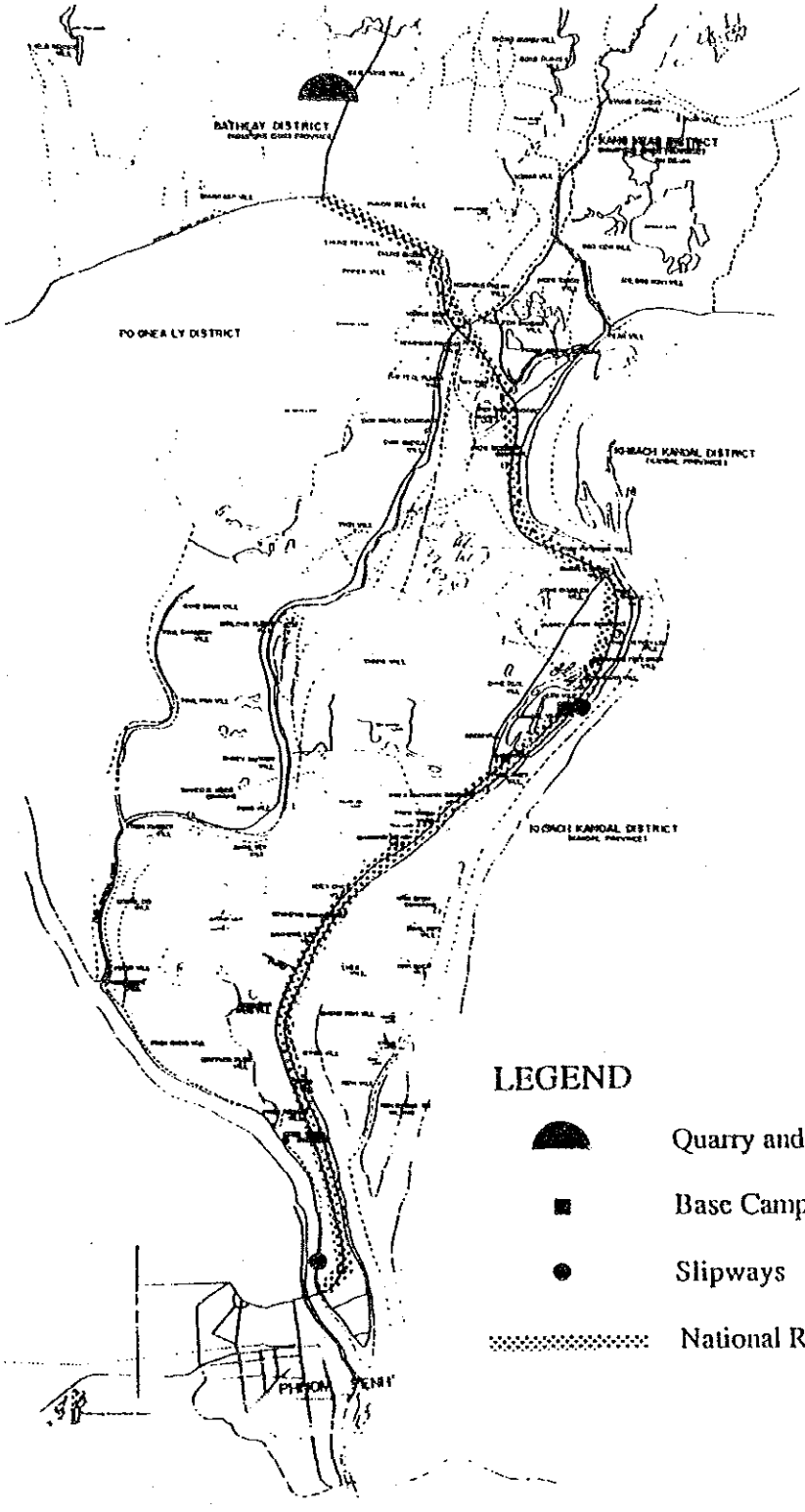
8. To bear all the expenses, other than those covered by the Grant, necessary for the execution of the Project;

9. To ensure prompt processing of required internal formalities to secure the implementation time schedule of the Project; and

10. To ensure the safety of study members when and as it is required in the course of the study.

Note: The Site means construction site, project office, housing for labour, motor pool, stone crushing and material stockyard asphalt concrete mixing yard and cement concrete batching yard as shown in Annex II.

ANNEX-II



MAP OF THE SITE

BORING LOGS

BORING LOG

PROJECT : REHABILITATION OF NATINAL ROAD ROUTE 6A GROUND ELEVATION + 8.70 m DATE 29TH NOV 1992 ~ 1TH DEC 1992

HOLE NO. E - NO.1 41K + 945 R16.4M GROUND WATER LEVEL GL - 3.65 m SURVEYED BY S. TAKADA DANG THO

SCALE	SOIL: ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	SYMBOL	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
1							
2						BROWN TO YELLOWISH BROWN	SILTY CLAY TO SILT Wn : LOW COHESION : MEDIUM
3							
4	4.20	4.50	4.50		CLAY		
5						LIGHT BROWN	FINE SILTY SAND WITH MICA FRAGMENT
6	2.20	6.50	2.00		SAND		
7	1.70	7.00	0.50		SILT	BROWN	SANDY SILT
8						YELLOWISH TO REDDISH BROWN	
9						BROWNISH GREY	
10						LIGHT BROWN	
11							
12							
13							
14							
15						BROWN	
16							SILTY CLAY TO CLAY NATURAL WATER CONTENT : LOW COHESION : MEDIUM TO HIGH
17						WHITISH TO LIGHT BROWN	
18							
19	-10.30	19.00	12.00		CLAY		
20							FINE TO NEDIUM GRAINED SILTY SAND
21	-12.30	21.00	2.00		SAND	BROWN	
22							
23							
24							WEATHERED GRANO DIORITE GRAVEL CONDITION
25							
26	-17.30	26.00	5.00		WEATHERED ROCK	DARK GREY	5~ 6cm
27							
28							
29							
30							

STANDARD PENETRATION TESTS

DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	NO OF BLOWS AT EACH 10cm 15 cm	30 cm	45 cm
1.50	28/30	8	14	14
1.95				
2.50	29/30	8	12	17
2.95				
3.00	28/30	8	12	16
3.50				
3.95				
4.50	20/30	7	9	11
4.95				
5.50	22/30	7	10	12
5.95				
6.50	19/30	8	9	10
6.95				
7.50	20/30	8	9	11
7.95				
8.50	18/30	5	8	10
8.95				
9.50	17/30	5	7	10
9.95				
10.50	19/30	6	8	11
10.95				
11.00	30/30	7	14	16
11.95				
12.50	33/30	7	15	18
12.95				
13.50	36/30	8	16	20
13.95				
14.50	34/30	10	16	18
14.95				
15.00	29/30	10	14	15
15.95				
16.50	29/30	9	13	16
16.95				
17.50	30/30	9	14	16
17.95				
18.50	31/30	8	14	17
18.95				
19.00	23/30	7	10	13
19.95				
20.50	37/30	5	11	26
20.95				

N VALUE: 0 10 20 30 40 50 60

SOIL SAMPLES

NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
S - 1	1.50 / 1.95	○
S - 2	2.50 / 2.95	○
U - 1	3.00 / 3.50	●
S - 3	3.95	○
S - 4	4.50 / 4.95	○
S - 5	5.50 / 5.90	○
S - 6	6.50 / 6.95	○
U - 2	7.00 / 7.50	●
S - 7	7.95	○
S - 8	8.50 / 8.95	○
S - 9	9.50 / 9.95	○
S-10	10.50 / 10.95	○
U - 3	11.00 / 11.50	●
S-11	11.95	○
S-12	12.50 / 12.95	○
S-13	13.50 / 13.95	○
S-14	14.50 / 14.95	○
U - 4	15.00 / 15.50	●
S-15	15.95	○
S-16	16.50 / 16.95	○
S-17	17.50 / 17.95	○
S-18	18.50 / 18.95	○
U - 5	19.00 / 19.50	●
S-19	19.95	○
S-20	20.50 / 20.95	○

REMARKS :

SYMBOLS OF SAMPLER
- ● THINWALL SAMPLER
- ○ SPLIT - SPOON SAMPLER
- ● DENISON-TYPE SAMPLER
- ⊖ FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

PROJECT : REHABILITATION OF NATIONAL ROAD ROUTE 6A GROUND ELEVATION + 8.40 m DATE 29 Th NOV.1992 ~ 1 st DEC. 1992

HOLE NO E-NO.2 40 K + 444 M R 14.9 M GROUNDWATER LEVEL GL - 5.44 m. SURVEYED BY S. TAKADA TRAN NHU HUY

SCALE	ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	SOIL: SYMBOL	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
1							
2						DARK GREY	
3						TO	HARD CLAY
4						BROWN	NATURAL WATER
5	3.40	5.00	5.00		CLAY		COTENT : LOW COHESION:MEDIUM
6							
7							FINE TO MEDIUM
8							GRAIN SAND
9	-0.85	9.25	4.25		SAND	BROWN	WITH MICA FRAG~ MENT
10							HARD CLAY
	-2.10	10.50	1.25		CLAY	BROWN	Wn: MEDIUM TO LOW COHESION:MEDIUM
11							FINE GRAIN SAND
12							WITH MICA FRAG~
	-4.10	12.50	2.00		SAND	BROWN	MENT AND LAMINA OF CLAY
13							SANDY CLAY
14							WITH LAMINA OF
	-6.10	14.50	2.00		CLAY	BROWN	WHITE CLAY
15							SILTY FINE GRAIN
16							SAND
17							WITH LAMINA OF SILT
18	-9.60	18.00	3.50		SAND	BROWN	
19	-10.60	19.00	1.00		SILT	BROWN	SANDY SILT Wn : LOW COHESION: LOW
20							SILTY FINE GRAIN
21							SAND WITH MICA
						LIGHT	FRAGMENT AND
22	-13.40	22.00	3.00		SAND	BROWN	LAMINA OF SILT
	-14.10	22.50	0.50		SILT	LIGHT BROWN	WITH LAMINA OF SAND
23							
24							SILTY FINE GRAIN
							SAND WITH MICA
25	-16.60	25.00	2.50		SAND	LIGHT BROWN	FRAGMENT
	-17.40	25.80	0.80		SILT	BROWNISH WHITE	SANDY SILT Wn : LOW COHESION:MEDIUM
26				+ + +			
27				+ + +		BROWN	WEATHERED
				+ + +		TO	GRANO - DIORITE
28	-19.80	28.20	2.40		WEATHERED ROCK	GREY	WITH BROWN CLAY
29							
30							

STANDARD PENETRATION TESTS

DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	NO OF BLOWS AT EACH 10cm 15 cm	30 cm	45 cm
1.00	41 /			
1.45	30	18	23	18
2.00	45 /			
2.45	30	9	21	24
3.00	52 /			
3.45	30	13	23	29
4.00	41 /			
4.45	30	9	18	23
5.10	27 /			
5.55	30	5	12	15
6.00	26 /			
6.45	30	5	11	15
7.00	31 /			
7.45	30	5	13	18
8.00	19 /			
8.45	30	3	7	12
9.00	22 /			
9.45	30	6	9	13
10.00	43 /			
10.45	30	9	16	27
11.00	42 /			
11.45	30	7	16	26
12.00	32 /			
12.45	30	8	14	18
13.00	29 /			
13.45	30	7	11	18
14.00	29 /			
14.45	30	5	10	19
15.00	28 /			
15.45	30	5	10	18
16.00	62 /			
16.45	30	10	27	35
17.00	48 /			
17.45	30	16	18	30
18.00	38 /			
18.45	30	9	16	22
19.00	35 /			
19.45	30	7	14	21
20.00	18 /			
20.45	30	6	7	11
21.00	17 /			
21.45	30	4	7	10
22.00	50 /			
22.45	30	8	20	30
23.00	50 /			
23.45	30	5	20	30
24.00	81 /			
24.45	30	16	30	31
25.00	60 /			
25.45	30	14	25	35

N VALUE: 0 10 20 30 40 50 60

SOIL SAMPLES

NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
	1.00	
S-1	1.45	○
	2.00	
S-2	2.45	○
	3.00	
S-3	3.45	○
	4.00	
S-4	4.45	○
	5.10	
S-5	5.55	○
	6.00	
S-6	6.45	○
	7.00	
S-7	7.45	○
	8.00	
S-8	8.45	○
	9.00	
S-9	9.45	○
	0.00	
S-10	10.45	○
	11.00	
S-11	11.45	○
	12.00	
S-12	12.45	○
	13.00	
S-13	13.45	○
	14.00	
S-14	14.45	○
	15.00	
S-15	15.45	○
	16.00	
S-16	16.45	○
	17.00	
S-17	17.45	○
	18.00	
S-18	18.45	○
	19.00	
S-19	19.45	○
	20.00	
S-20	20.45	○
	21.00	
S-21	21.45	○
	22.00	
S-22	22.45	○
	23.00	
S-23	23.45	○
	24.00	
S-24	24.45	○
	25.00	
S-25	25.45	○

REMARKS :

SYMBOLS OF SAMPLER

- ● THINWALL SAMPLER
- ○ SPLIT - SPOON SAMPLER
- ◉ DENISON-TYPE SAMPLER
- ⊕ FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

PROJECT : REHABILITATION OF NATIONAL ROAD ROUTE 6A GROUND ELEVATION + 8.50 m. DATE 2nd DEC. 1992 ~ 4Th DEC. 1992

HOLE NO. B-14 PREK KHENG 29K + 114M RII. 28M GROUNDWATER LEVEL GL - 0.45 m. SURVEYED BY S. TAKADA, DANG THO

SCALE	ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	SOIL: SYMBOL	VISUAL CLASSIFICATION	COLOR	DESCRIPTION	STANDARD PENETRATION TESTS: DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	NO OF BLOWS AT EACH 10cm: 15 cm	30 cm	45 cm	SOIL SAMPLES: NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
1							SILTY CLAY TO CLAY	1.50	5 / 30	1	2	3	S-1	1.50	○
2								1.95						1.95	
3						BROWN TO DARK BROWN	NATURAL WATER CONTENT: HIGH TO MEDIUM COHESION: HIGH TO MEDIUM	2.00					U-1	2.00	●
								2.00	5 / 30	1	2	3	S-2	2.95	○
4								3.50	9 / 30	3	4	5	S-3	3.00	○
								3.95						3.95	
5	3.50	5.00	5.00		CLAY			4.50	16 / 30	3	7	8	S-4	4.00	○
								4.95						4.95	
6								5.50	29 / 30	7	13	16	S-5	5.50	○
								5.95						5.95	
7							STIFF CLAY WITH ORGANIC SOIL NATURAL WATER CONTENT: LOW TO MEDIUM COHESION: MEDIUM	6.00					U-2	6.00	●
								6.00	28 / 30	7	13	15	S-6	6.95	○
8						WHITISH BROWN TO BROWN		7.50	26 / 30	6	11	15	S-7	7.50	○
								7.95						7.95	
9								8.50	23 / 30	6	10	13	S-8	8.50	○
								8.95						8.95	
10								9.50	19 / 30	6	9	10	S-9	9.50	○
								9.95						9.95	
11	-2.50	11.00	6.00		CLAY			10.50	19 / 30	6	9	10	S-10	10.50	○
								10.95						10.95	
12							SANDY SILT WITH MICA FRAGMENT NATURAL WATER CONTENT: MEDIUM TO HIGH COHESION: MEDIUM TO	11.00					U-3	11.00	●
								11.50	19 / 30	7	9	10	S-11	11.95	○
13						DARK GREY		12.50	5 / 30	2	2	3	S-12	12.50	○
								12.95						12.95	
14	-5.50	14.00	3.00		SILT			13.50	5 / 30	2	2	3	S-13	13.50	○
								13.95						13.95	
15	-6.50	15.00	1.00		CLAY	DARK GREY	SOFT CLAY HIGH Wn: HIGH COHESION: HIGH	14.50	4 / 30	1	1	3	S-14	14.00	○
								14.95						14.95	
16						DARK GREY	SILTY FINE GRAINED SAND WITH MICA FRAGMET	15.00					U-4	15.00	●
								15.50	3 / 30	1	1	2	S-15	15.95	○
17	-8.50	17.00	2.00		SAND			16.50	4 / 30	1	1	3	S-16	16.50	○
								16.95						16.95	
18	-9.50	18.00	1.00		CLAY	DARK GREY	SOFT CLAY Wn: HIGH COHESION: HIGH	17.50	5 / 30	1	2	3	S-17	17.50	○
								17.95						17.95	
19	-10.50	19.00	1.00		SAND	DARK GREY	SILTY FINE GRAINED SAND WITH MICA FRAGMENT	18.50	5 / 30	1	2	3	S-18	18.50	○
								18.95						18.95	
20								19.50	7 / 30	2	3	4	S-19	19.50	○
								19.95						19.95	
21							SANDY CLAY TO SILTY CLAY NATURAL WATER CONTENT: HIGH COHESION: MEDIUM TO HIGH	20.00					U-5	20.00	●
								20.50	8 / 30	2	3	5	S-20	20.95	○
22								21.50	9 / 30	3	4	5	S-21	21.50	○
								21.95						21.95	
23						DARK GREY		22.50	11 / 30	4	5	6	S-22	22.50	○
								22.95						22.95	
24	-15.50	24.00	5.00		CLAY			23.50	15 / 30	5	7	8	S-23	23.50	○
								23.95						23.95	
25							STIFF CLAY NATURAL WATER CONTENT: LOW COHESION: MEDIUM	24.50	25 / 30	8	10	15	S-24	24.50	○
								24.95						24.95	
26								25.50	27 / 30	9	11	16	S-25	25.50	○
								25.95						25.95	
27	-18.50	27.00	3.00		CLAY	BROWN		26.50	28 / 30	10	12	16	S-26	26.50	○
								26.95						26.95	
28							WEATHERED CLAY OF FINE SANDSTONE AND SILTSTONE	27.50	45 / 30	12	17	28	S-27	27.50	○
								27.95						27.95	
29	-20.50	29.00	2.00		CLAY	BROWN		28.50	50 / 30	13	19	31	S-28	28.50	○
								28.95						28.95	
30															
31							WEATHERED FINE SANDSTONE AND SILTSTONE WITH BROWN CLAY								
32						YELLOWISH BROWN									
33	-24.50	33.00	4.00		ROCK										

N VALUE: 0 10 20 30 40 50 60

BORING LOG

PROJECT : REHABILITATION OF NATIONAL ROAD ROUTE 6A GROUND ELEVATION + 7.12 m DATE 5TH DEC 1992 ~ 7TH DEC. 1992

HOLE NO. B - 20 PREK BAK 33K + 358.9M R 0.40M GROUND WATER LEVEL GL + 1.50 m. SURVEYED BY S. TAKADA DANG THO

SCALE	ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	SOIL: SYMBOL	SOIL: VISUAL CLASSIFICATION	SOIL: COLOR	SOIL: DESCRIPTION	STANDARD PENETRATION TESTS: DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	NO OF BLOWS AT EACH 10 cm: 15 cm	30 cm	45 cm	N VALUE	SOIL SAMPLES: NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
1								1.50							1.50	
2							SILTY CLAY NATURAL WATER CONTENT: HIGH COHESION: HIGH	1.95	7 / 30	1	3	4		S-1	1.95	○
3								2.50							2.50	
4	3.12	4.00	4.00		CLAY	BROWN		2.95	7 / 30	1	3	4		S-2	2.95	○
								3.00						U-1	3.00	●
								3.50							3.50	
								3.95	6 / 30	1	2	4		S-3	3.95	○
5								4.50							4.50	
							MEDIUM CLAY WITH LAMINA OF BLACK HUMUS SOIL	4.95	6 / 30	1	2	4		S-4	4.95	○
6						GREY TO BLACK		5.50							5.50	
								5.95	6 / 30	1	2	4		S-5	5.95	○
7	0.12	7.00	3.00		CLAY			6.50							6.50	
								6.95	6 / 30	1	2	4		S-6	6.95	○
								7.00							7.00	
								7.50						U-2	7.50	●
8								7.95	7 / 30	1	3	4		S-7	7.95	○
								8.50							8.50	
9								8.95	5 / 30	1	2	3		S-8	8.95	○
								9.50							9.50	
10								9.95	5 / 30	1	2	3		S-9	9.95	○
								10.50							10.50	
11								10.95	6 / 30	1	2	4		S-10	10.95	○
								11.50							11.50	
12								11.95	7 / 30	1	3	4		S-11	11.95	○
							CLAYEY SILT	12.50							12.50	
13							WITH BLACK	12.95	8 / 30	1	3	5		S-12	12.95	○
							ORGANIC SOIL	13.50							13.50	
14						GREENISH	AND BROWN	13.95	8 / 30	2	3	5		S-13	13.95	○
						GREY	CLAY	14.50							14.50	
15	-8.38	15.50	8.50		SILT			14.95	7 / 30	2	3	4		S-14	14.95	○
								15.50							15.50	
16								15.95	19 / 30	5	6	13		S-15	15.95	○
								16.50							16.50	
17								16.95	22 / 30	7	8	14		S-16	16.95	○
								17.50							17.50	
18								17.95	21 / 30	7	8	13		S-17	17.95	○
								18.00							18.00	
19								18.95	22 / 30	7	8	14		S-18	18.95	○
								19.50							19.50	
20								19.95	25 / 30	7	9	16		S-19	19.95	○
								20.50							20.50	
21								20.95	27 / 30	7	10	17		S-20	20.95	○
								21.00						U-3	21.00	●
							CLAYEY SAND WITH LAMINA	21.50	30 /						21.50	
22								21.95	30	7	11	19		S-21	21.95	○
						BROWN	OF ORGANIC	22.50	30 /						22.50	
23						TO	CLAY	22.95	30	8	11	19		S-22	22.95	○
						GREY		23.50	32 /						23.50	
24	-16.88	24.00	8.50		SAND			23.95	30	8	12	20		S-23	23.95	○
								24.50	31 /						24.50	
25								24.95	30	9	12	19		S-24	24.95	○
								25.50	30 /						25.50	
26								25.95	30	9	13	17		S-25	25.95	○
								26.50	31 /						26.50	
27								26.95	30	9	13	18		S-26	26.95	○
								27.50	33 /						27.50	
28							HARD CLAY NATURAL WATER CONTENT : LOW	27.95	30	10	15	18		S-27	27.95	○
								28.50	38 /						28.50	
29	-22.38	29.50	5.50		CLAY	BROWN	COHESION: MEDIUM	28.95	30	12	17	19		S-28	28.95	○
								29.50	47 /						29.50	
30								29.95	30	13	18	29		S-29	29.95	○
								30.50	47 /						30.50	
31								30.95	30	14	18	29		S-30	30.95	○
								31.50	48 /						31.50	
32							HARD CLAY AND WATHERED CLAY OF SAND-STONE TO SILT-STONE	31.95	30	15	18	30		S-31	31.95	○
								30.50	51 /						32.50	
33								30.95	30	15	19	32		S-32	32.95	○
								33.50	61 /						33.50	
34	-26.88	33.95	4.45		CLAY	BROWN		33.95	30	15	19	32		S-33	33.95	○

BORING LOG

PROJECT : REHABILITATION OF NATIONAL ROAD ROUTE 6A GROUND ELEVATION + 5.90 m DATE 4TH DEC. 1992 ~ 6TH DEC. 1992

HOLE NO B - 22 PREK KRA POES 36 K 957.7 M RI. 28 M GROUNDWATER LEVEL GL + 0.40 m. SURVEYED BY S. TAKADA TRAN NHU HUY

SCALE	ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	SOIL: SYMBOL	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
1						LIGHT BROWN	STIFF CLAY NATURAL WATER CONTENT : MEDIUM COHESION : MEDIUM TO HIGH
2							
3							
4						BROWN	
5						DARK GREY	
6							MEDIUM CLAY WITH HUMUS SOIL NATURAL WATER CONTET : HIGH COHESION : HIGH
7						BLACKISH GREY	
8							
9							
10							
11							
12	-6.40	12.30	12.30		CLAY	DARK GREY	
13						DARK GREY	FINE TO MEDIUM GRAIN SAND WITH MICA FRAGMENT
14						GREENISH GREY	
15	-9.60	15.50	3.20		SAND		
16						DARK GREY	MEDIUM CLAY NATURAL WATER CONTENT : HIGH COHESION : HIGH
17	-11.60	17.50	2.00		CLAY		
18						GREENISH GREY	VERY STIFF CLAY NATURAL WATER CONTENT : LOW COHESION : MEDIUM
19							
20	-14.70	20.60	3.10		CLAY		
21							FINE TO MEDIUM GRAIN SAND
22	-16.70	22.60	2.00		SAND	GREY	
23							
24							
25							
26							
27							
28						YELLOW TO DARKE YELLOW	HARD CLAY NATURAL WATER CONTENT : LOW COHESION : MEDIUM TO LOW
29							
30	-24.50	30.45	7.85		CLAY		

STANDARD PENETRATION TESTS

DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	NO OF BLOWS AT EACH 10cm 15 cm	30 cm	45 cm
1.00	17/			
1.45	30	4	7	10
2.00	15/			
2.45	30	4	7	8
3.00	17/			
3.45	30	5	7	10
3.60				
4.00	18/			
4.45	30	4	7	11
5.00	17/			
5.45	30	5	8	9
6.00	11/			
6.45	30	3	5	6
7.00	9/			
7.45	30	2	4	5
8.00	7/			
8.45	30	2	3	4
8.60				
9.00	7/			
9.45	30	2	3	4
10.00	6/			
10.45	30	2	3	3
11.00	5/			
11.45	30	1	2	3
12.00	5/			
12.45	30	1	2	3
13.00	37/			
13.45	30	5	18	19
14.00	34/			
14.45	30	7	16	18
15.00	33/			
15.45	30	6	15	18
16.00	5/			
16.45	30	3	2	3
17.00	5/			
17.45	30	2	2	3
17.70				
18.00	27/			
18.45	30	6	10	17
19.00	20/			
19.45	30	6	9	11
20.00	26/			
20.45	30	6	10	16
21.00	29/			
21.45	30	4	13	16
22.00	28/			
22.45	30	5	14	15
23.00	30/			
23.45	30	7	12	18
24.00	40/			
24.45	30	12	18	22
25.00	43/			
25.45	30	14	15	28
26.00	44/			
26.45	30	13	19	25
27.00	48/			
27.45	30	18	22	26
28.00	48/			
28.45	30	16	23	26
29.00	48/			
29.45	30	16	20	28
30.00	49/			
30.45	30	17	22	27

N VALUE: 0 10 20 30 40 50 60

SOIL SAMPLES

NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
S - 1	1.00 1.45	○
S - 2	2.00 2.45	○
S - 3	3.00 3.45	○
U - 1	3.60 4.00	●
S - 4	4.45	○
S - 5	5.00 5.45	○
S - 6	6.00 6.45	○
S - 7	7.00 7.45	○
S - 8	8.00 8.45	○
U - 2	8.60 9.00	●
S - 9	9.45	○
S -10	10.00 10.45	○
S -11	11.00 11.45	○
S - 12	12.00 12.45	○
S - 13	13.00 13.45	○
S -14	14.00 14.45	○
S -15	15.00 15.45	○
S -16	16.00 16.45	○
S -17	17.00 17.45	○
U - 3	17.70 18.00	●
S -18	18.45	○
S -19	19.00 19.45	○
S -20	20.00 20.45	○
S -21	21.00 21.45	○
S -22	22.00 22.45	○
S -23	23.00 23.45	○
S -24	24.00 24.45	○
S -25	25.00 25.45	○
S -26	26.00 26.45	○
S -27	27.00 27.45	○
S -28	28.00 28.45	○
S -29	29.00 29.45	○
S -30	30.00 30.45	○

REMARKS :

SYMBOLS OF SAMPLER

- ● THINWALL SAMPLER
- ○ SPLIT - SPOON SAMPLER
- ◉ DENISON - TYPE SAMPLER
- ⊕ FOIL SAMPLER
- × OTHER SAMPLER

BORING LOG

PROJECT : REHABILITATION OF NATIONAL ROAD ROUTE 6A GROUND ELEVATION 11.80 m DATE 2nd DEC. 1992 3rd DEC. 1992

HOLE NO. B-24 KOMPONG PRAS (St 39K + 989.3M) GROUNDWATER LEVEL GL - 6.50 m. SURVEYED BY S. TAKADA TRAN NHU HUY

SCALE	SOIL: ELEVATION m	DEPTH m	THICKNESS OF STRATUM m	SYMBOL	VISUAL CLASSIFICATION	COLOR	DESCRIPTION
	11.80	0.50	0.50		AGREGGATE	GREY	GRAVEL AND CLAY
	1.80	10.50	10.00		CLAY	BROWN	STIFF TO HARD CLAY; NATURAL WATER COTET : LOW; COHESION : MEDIUM; DEPTH 6 ~ 7M WITH SMALL ORGANIC SOIL; DEPTH 10M, WITH FINE ROUNDED GRAVEL
	0.20	12.50	2.00		SILT	BROWN	SANDY TO CLAYEY SILT WITH MICA FRAGMENT
	11.20	23.50	11.00		CLAY	BROWNISH YELLOW / BROWN / YELLOWISH BROWN	HARD CLAY; NATURAL WATER CONTENT : LOW; COHESION : MEDIUM
	12.15	24.45	0.95		ROCK	BROWN	WETHERED FINE SAND STONE

STANDARD PENETRATION TESTS: DEPTH	NO OF BLOWS / LENGTH OF PENETRATION cm	NO OF BLOWS AT EACH 10cm: 15 cm	30 cm	45 cm
2.00	22 / 30	6	10	12
3.00	24 / 30	6	10	14
4.00	36 / 30	11	13	23
5.00	28 / 30	7	11	17
6.00	28 / 30	7	11	17
7.00	25 / 30	6	10	15
8.00	26 / 30	8	12	14
9.00	26 / 30	7	12	14
10.00	25 / 30	6	11	14
11.00	11 / 30	3	4	7
12.00	14 / 30	2	6	8
13.00	32 / 30	6	13	19
14.00	29 / 30	7	11	18
15.00	35 / 30	9	15	20
16.00	35 / 30	8	16	19
17.00	35 / 30	7	15	20
18.00	31 / 30	6	14	17
19.00	47 / 30	11	20	27
20.00	49 / 30	12	22	27
21.00	49 / 30	14	21	28
22.00	47 / 30	14	20	27
23.00	49 / 30	12	23	26
24.00	65 / 30	16	22	43

N VALUE: 0 10 20 30 40 50 60

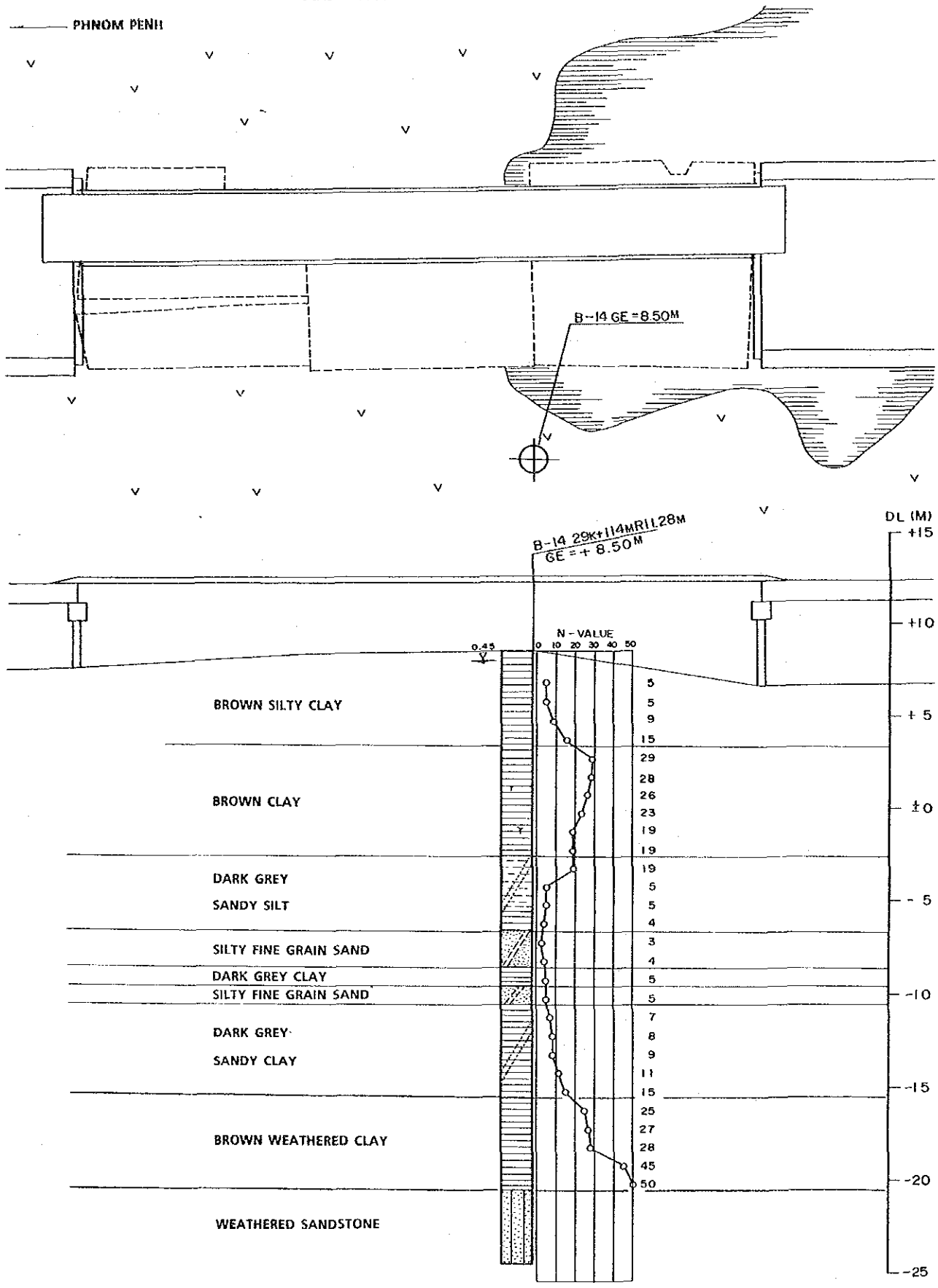
SOIL SAMPLES: NO OF SAMPLE	DEPTH m	SYMBOL OF SAMPLER
S-1	2.00 / 2.45	○
S-2	3.00 / 3.45	○
U-1	3.70 / 4.00	●
S-3	4.00 / 4.45	○
S-4	6.00 / 6.45	○
S-5	6.00 / 6.45	○
S-6	7.00 / 7.45	○
S-7	8.00 / 8.45	○
U-2	8.50 / 9.00	●
S-8	9.00 / 9.45	○
S-9	10.00 / 10.45	○
S-10	11.00 / 11.45	○
S-11	12.00 / 12.45	○
S-12	13.00 / 13.45	○
U-3	13.80 / 14.00	●
S-13	14.00 / 14.45	○
S-14	15.00 / 15.45	○
S-15	16.00 / 16.45	○
U-4	16.80 / 17.00	●
S-16	17.00 / 17.45	○
S-17	18.00 / 18.45	○
S-18	19.00 / 19.45	○
S-19	20.00 / 20.45	○
S-S	20.80 / 21.00	●
S-20	21.00 / 21.45	○
S-21	22.00 / 22.45	○
S-22	23.00 / 23.45	○
S-23	24.00 / 24.45	○

REMARKS :

SYMBOLS OF SAMPLER
- ● THINWALL SAMPLER
- ○ SPLIT - SPOON SAMPLER
- ● DENISON-TYPE SAMPLER
- ⊕ FOIL SAMPLER
- × OTHER SAMPLER

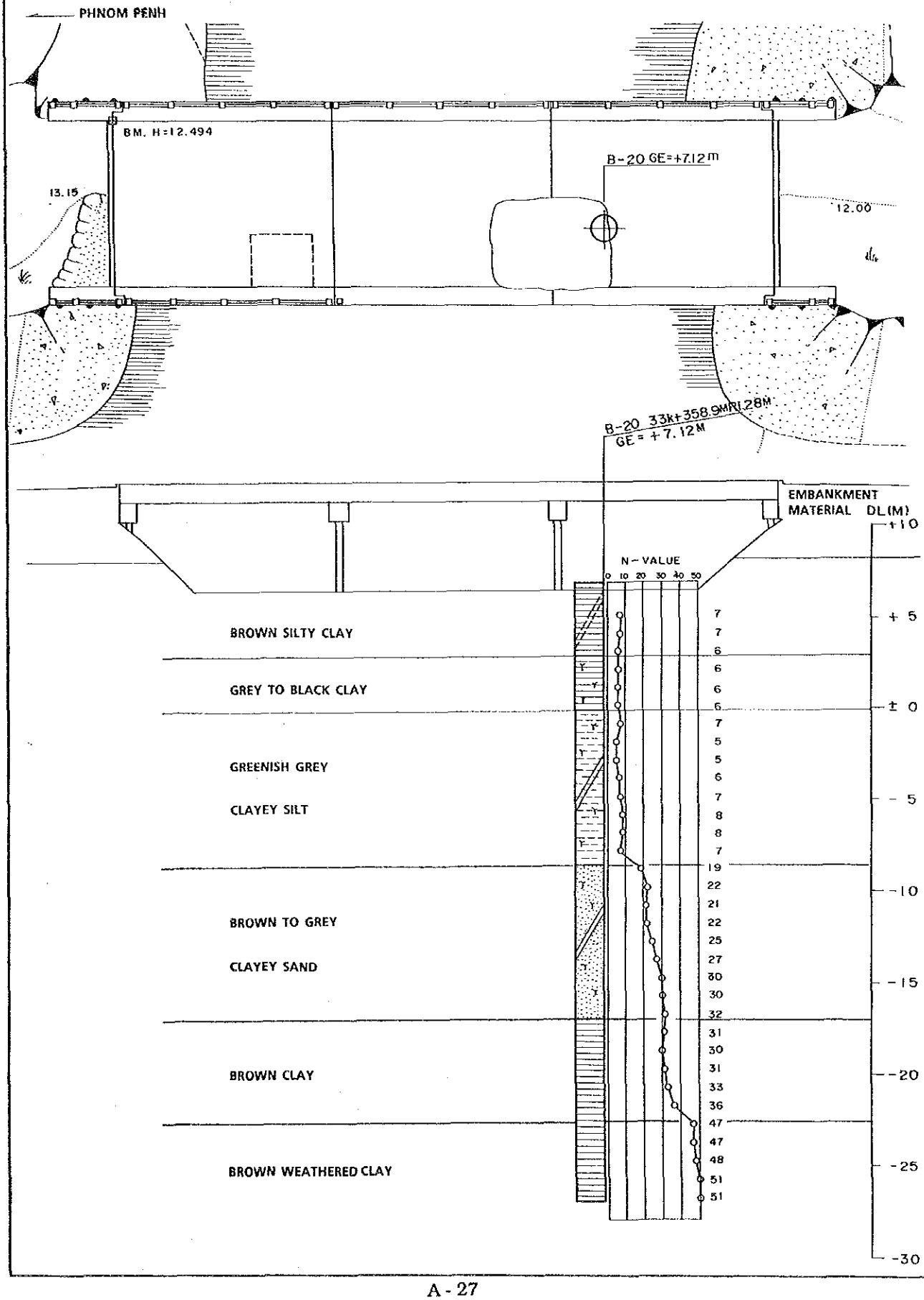
SOIL PROFILE OF NO. 14 PREK KHENG BRIDGE

SCALE 1 : 200 Reduced to 70% of scale



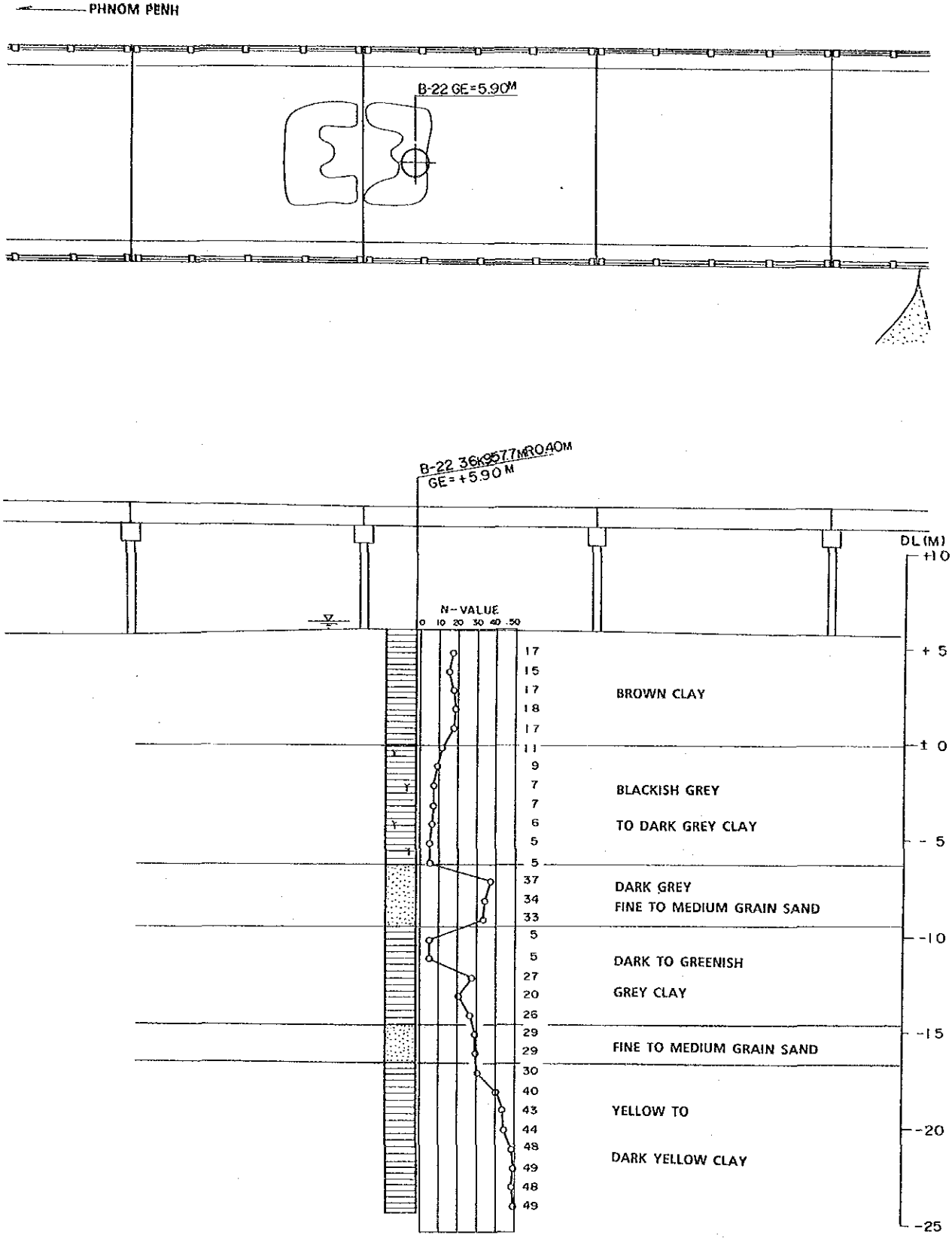
SOIL PROFILE OF NO. 20 PREK TA SUM BRIDGE

SCALE 1 : 200 Reduced to 70% of scale



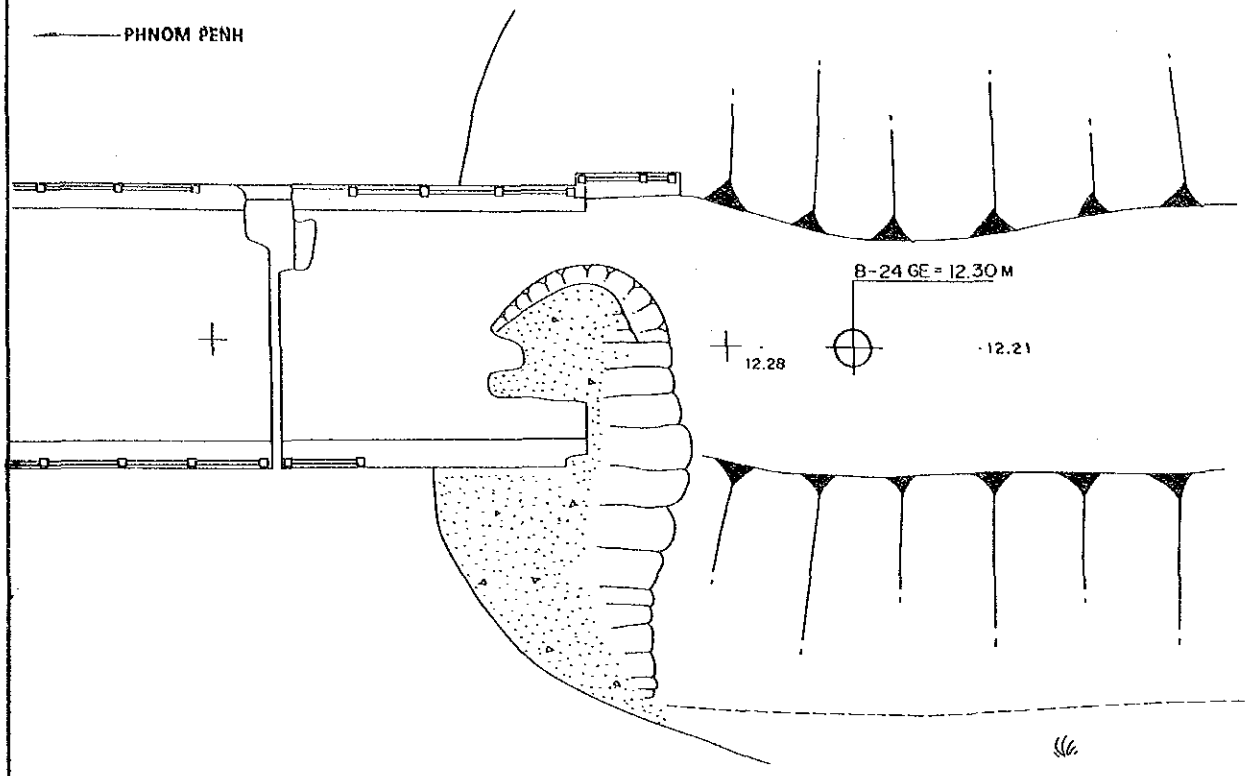
SOIL PROFILE OF NO. 22 PREK KRA POES BRIDGE

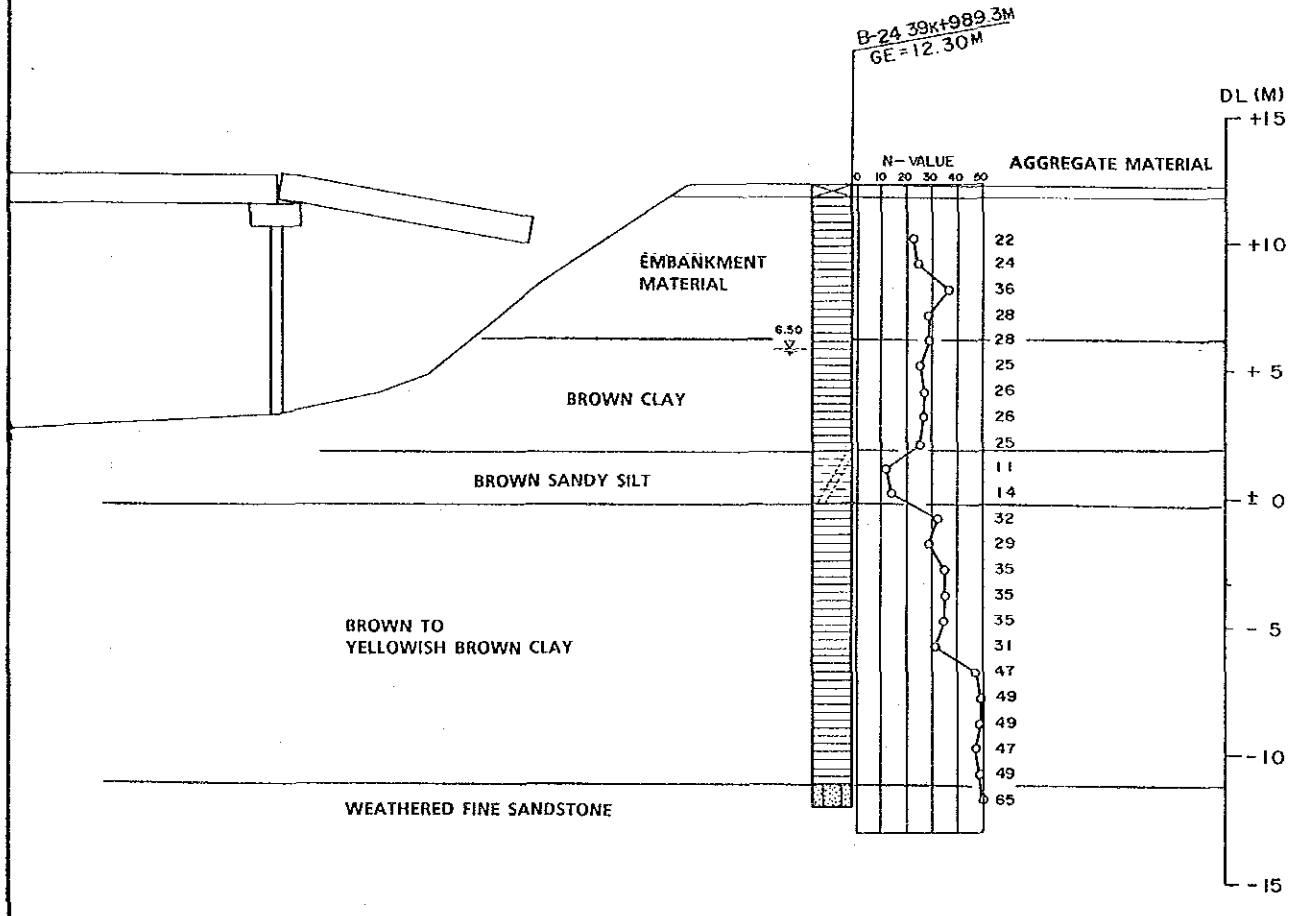
SCALE 1 : 200 Reduced to 70% of scale



SOIL PROFILE OF NO. 24 KOMPONG PRAS 1st BRIDGE

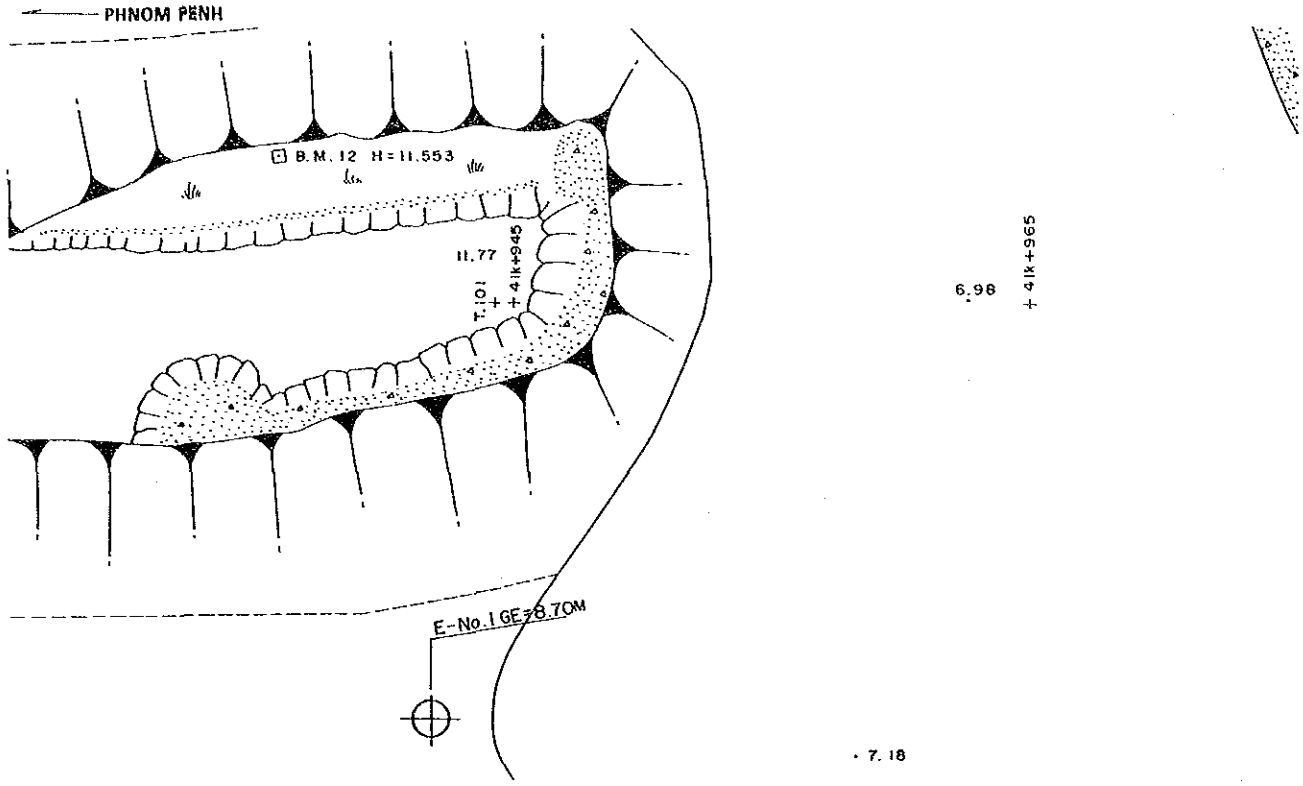
SCALE 1 : 200 Reduced to 70% of scale

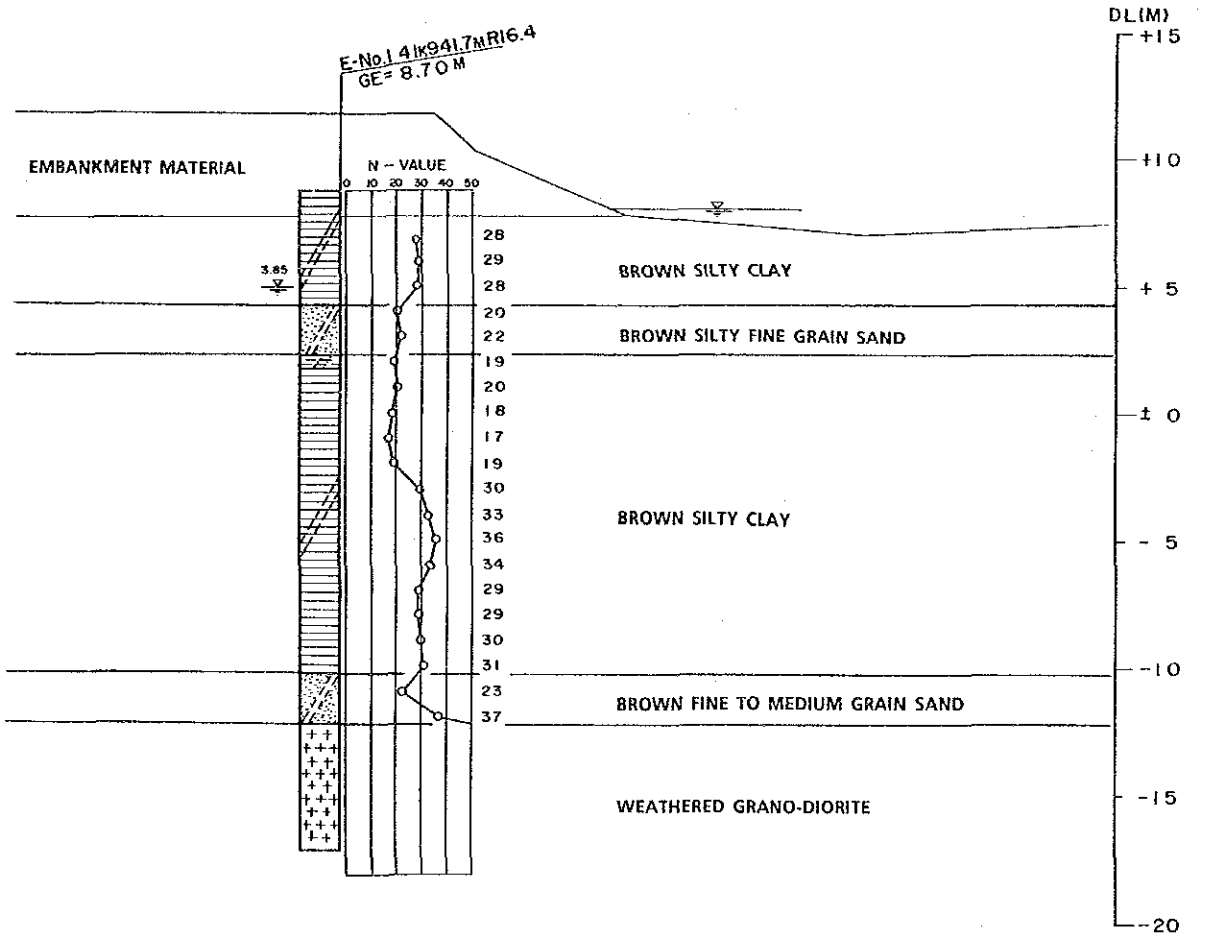




SOIL PROFILE OF EMBANKMENT SECTION

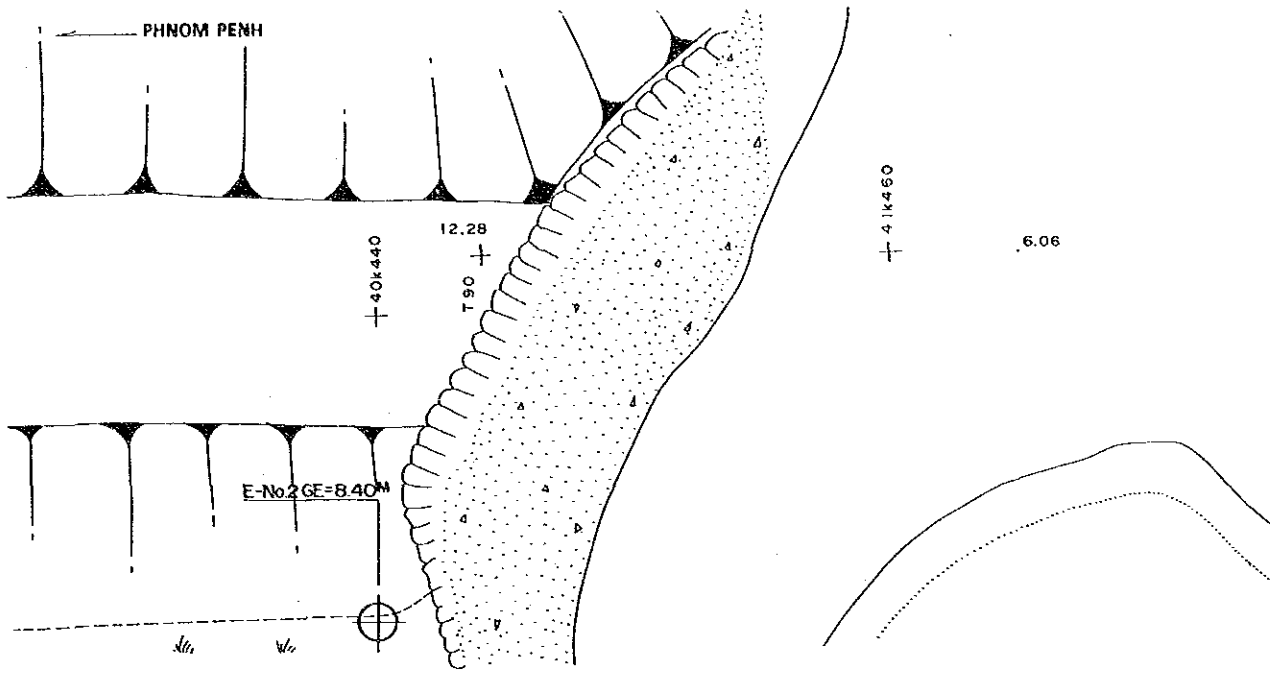
SCALE 1 : 200 Reduced to 70% of scale

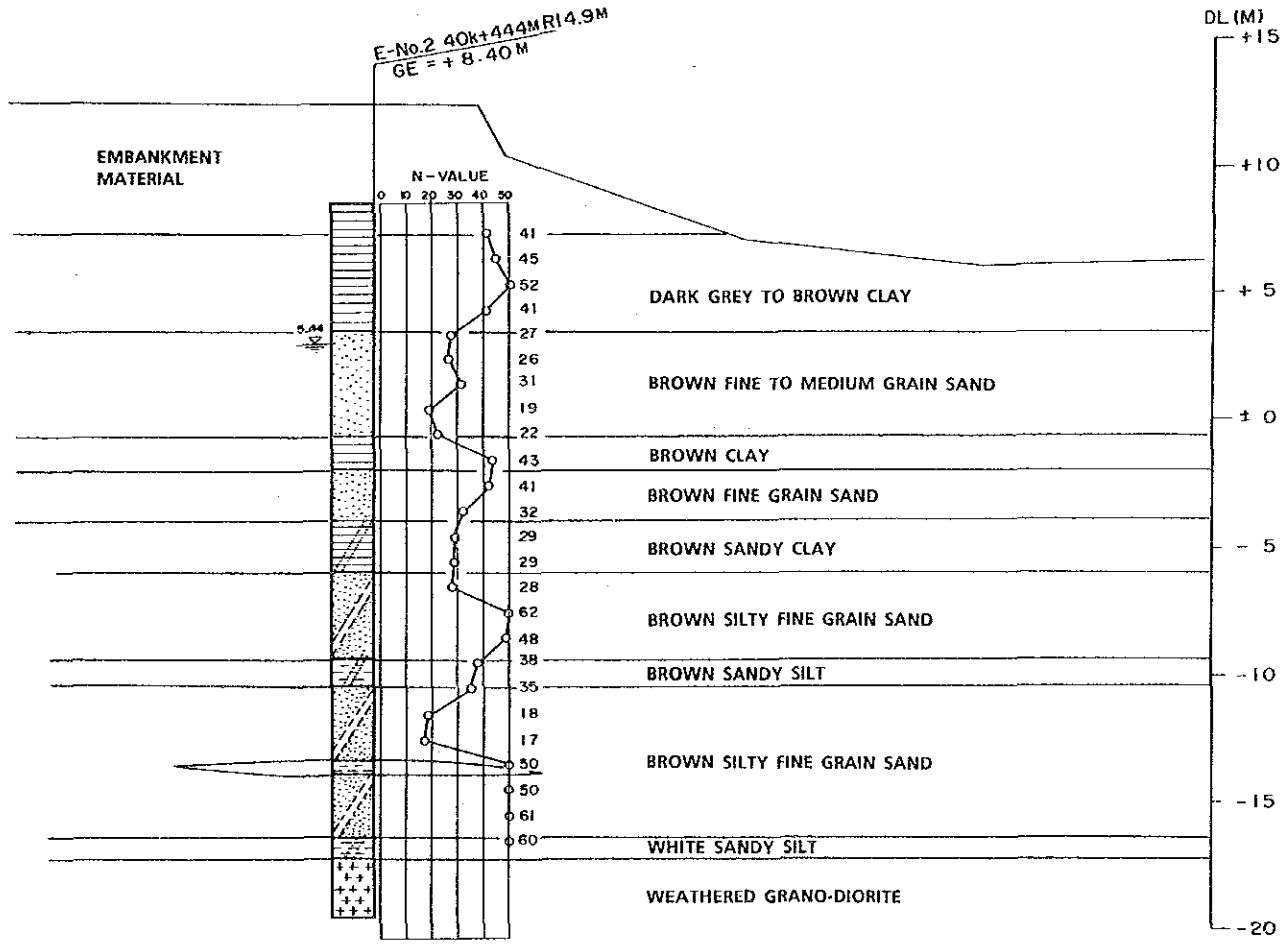




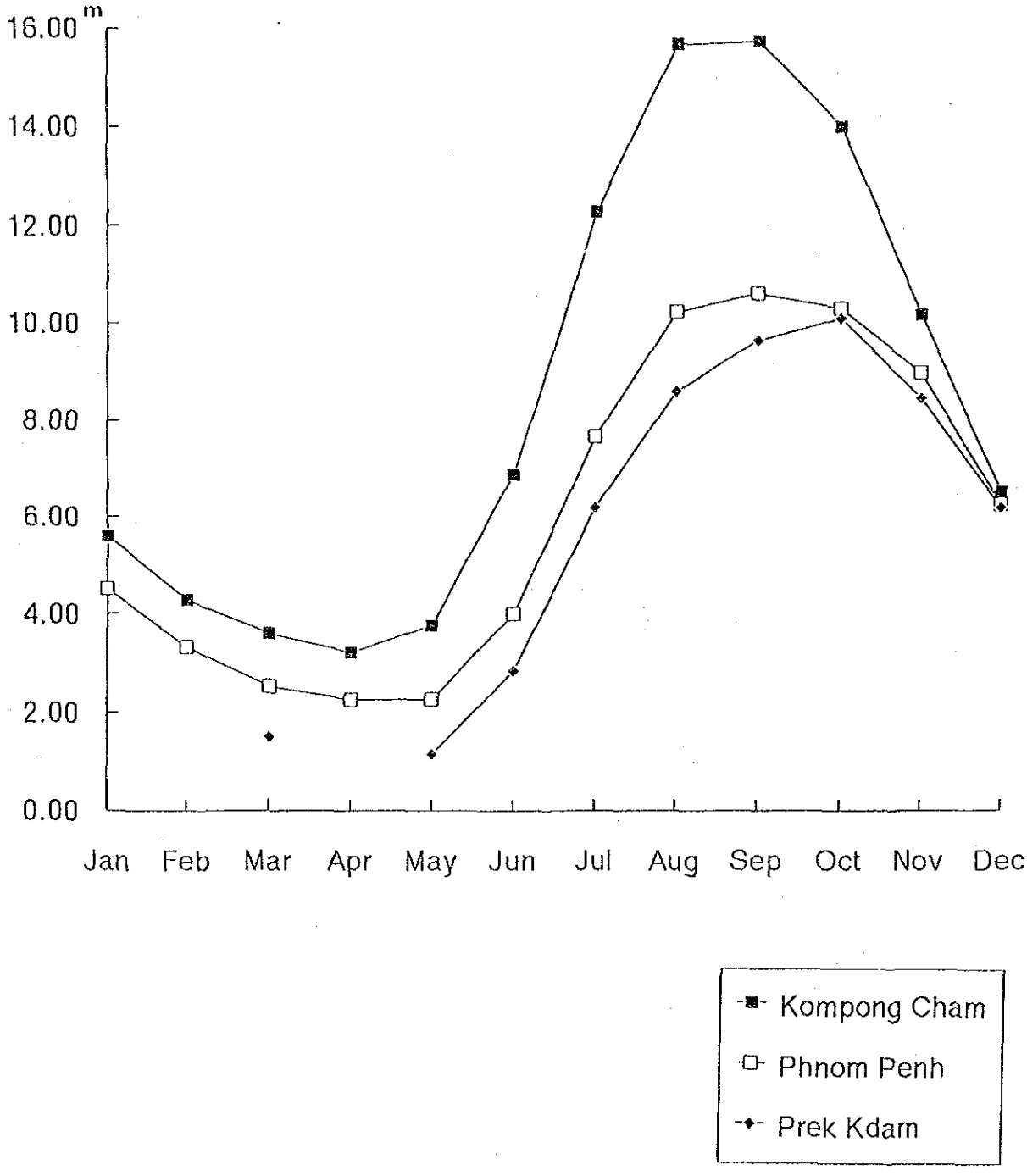
SOIL PROFILE OF EMBANKMENT SECTION

SCALE 1 : 200 Reduced to 70% of scale



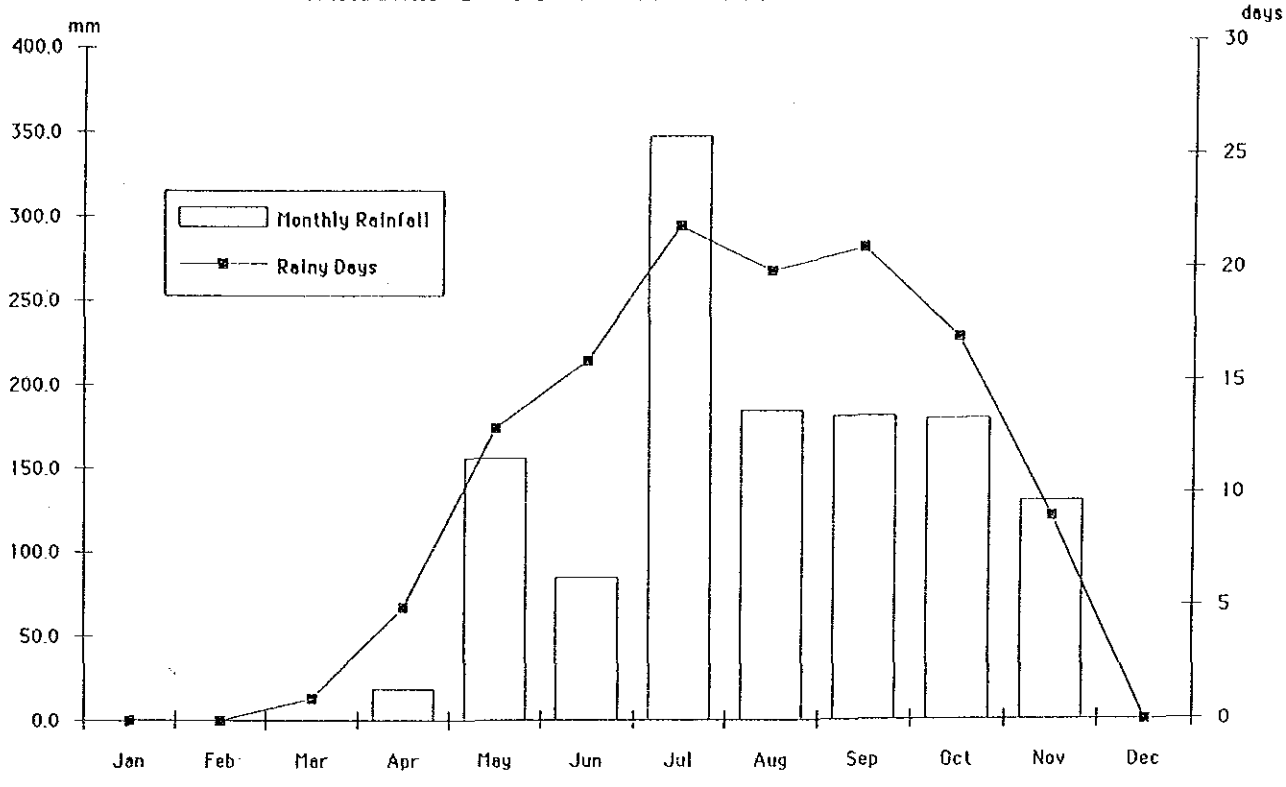


STAGE HYDROGRAPH AT PHNOM PENH, KOMPONG CHAM AND PREK KDAM (1991)

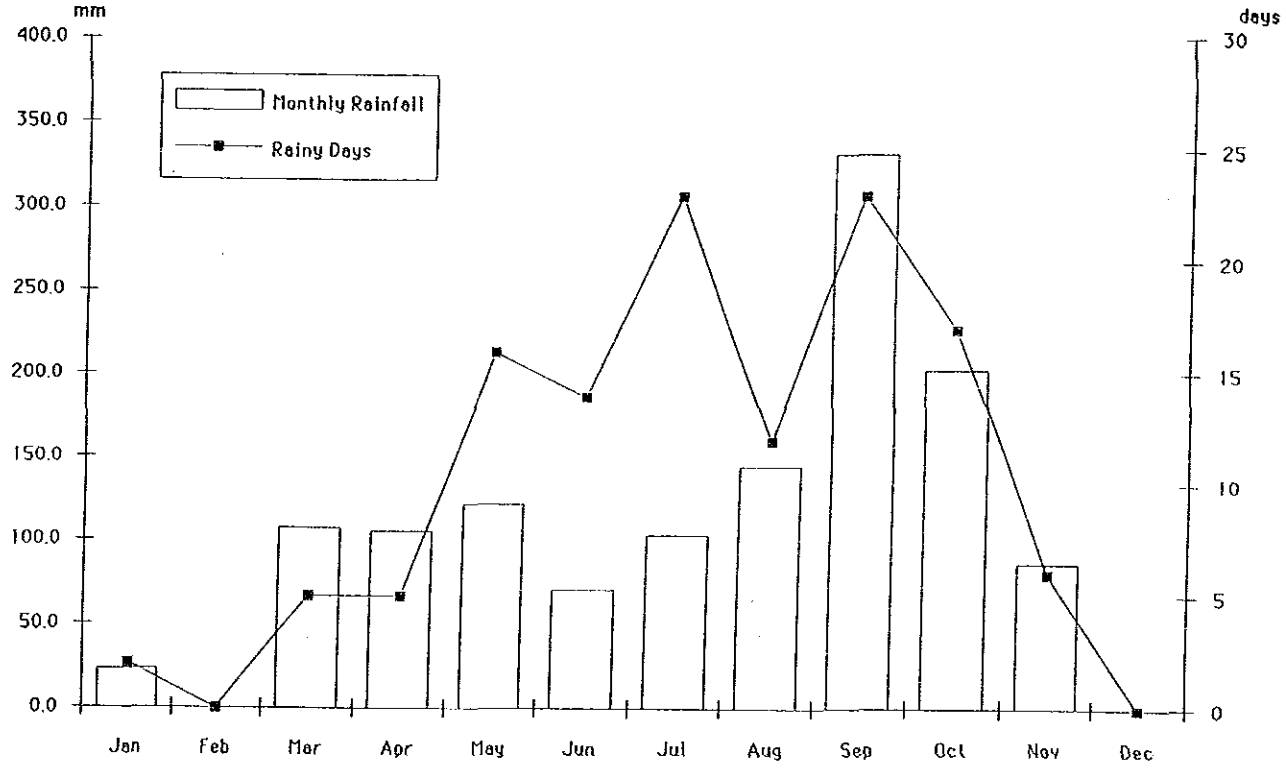


RAINFALL RECORD IN PHNOM PENH

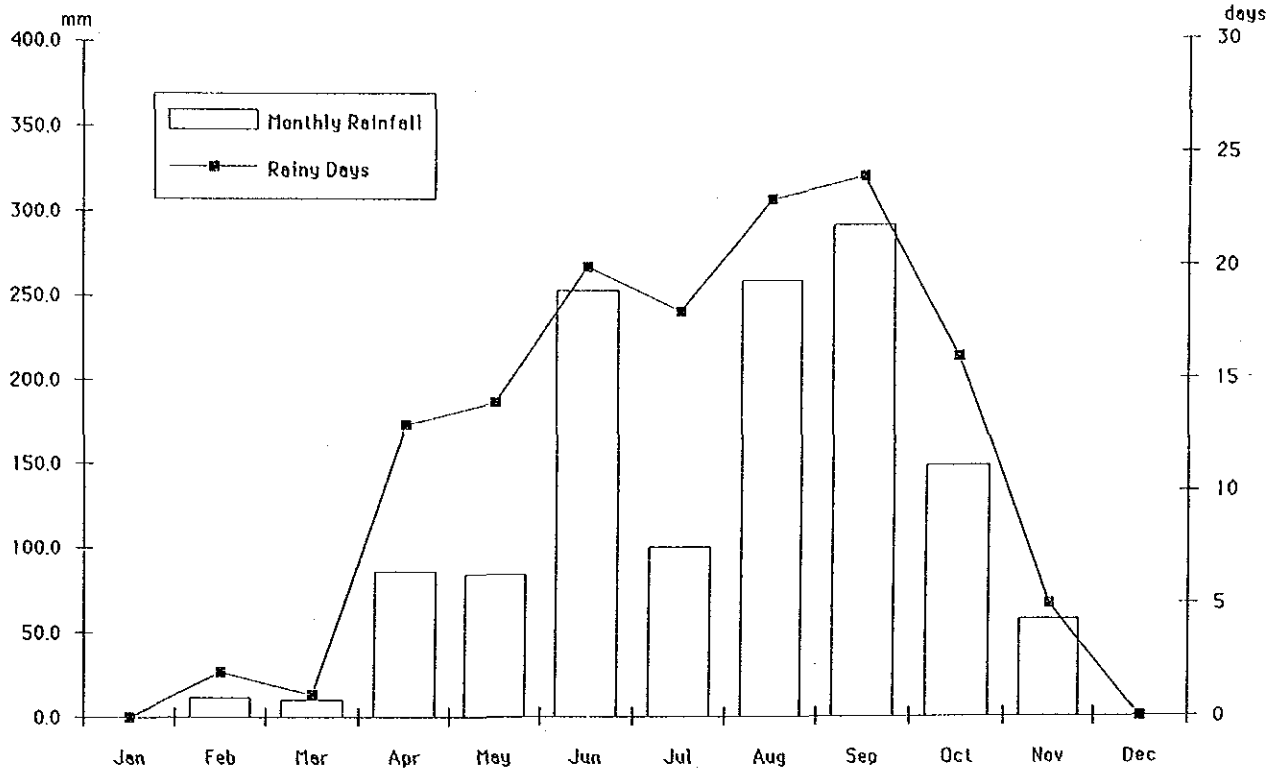
APPENDIX-7



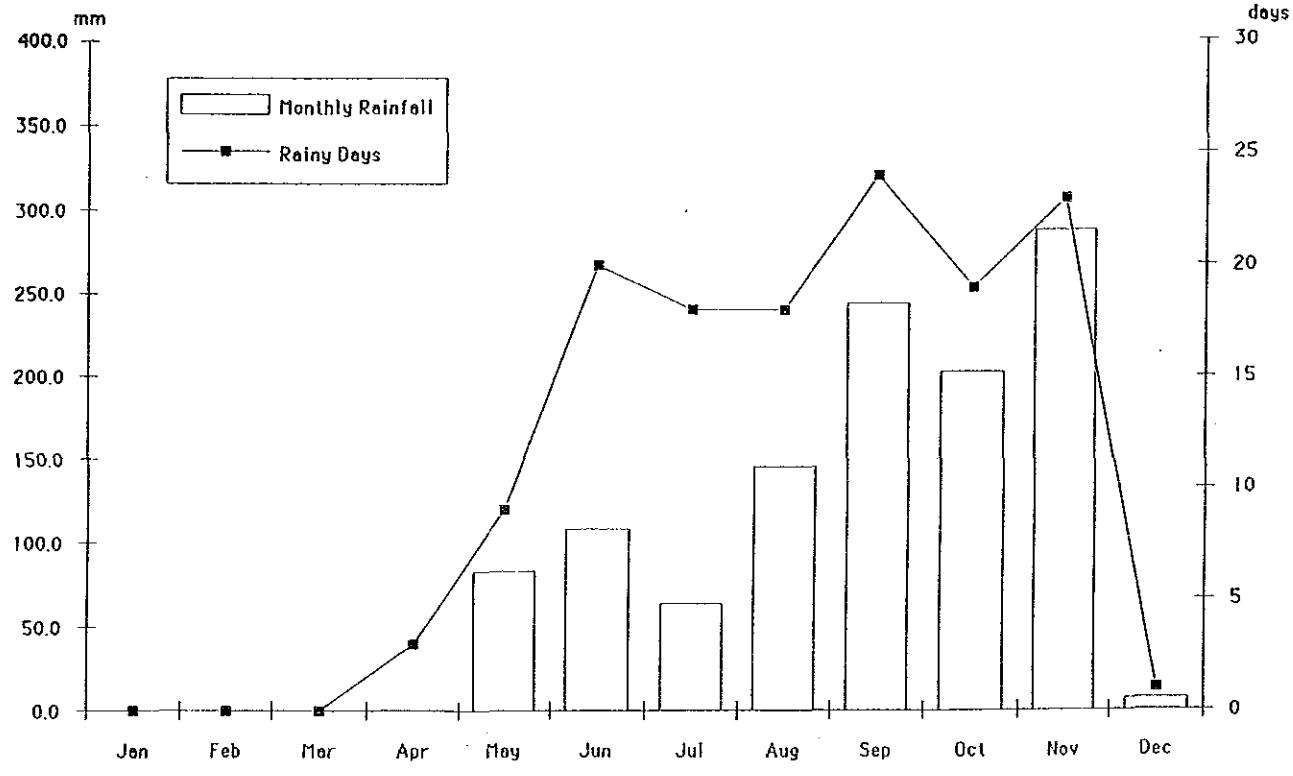
Rainfall Record at Bassac Station in Phnom Penh (1990)



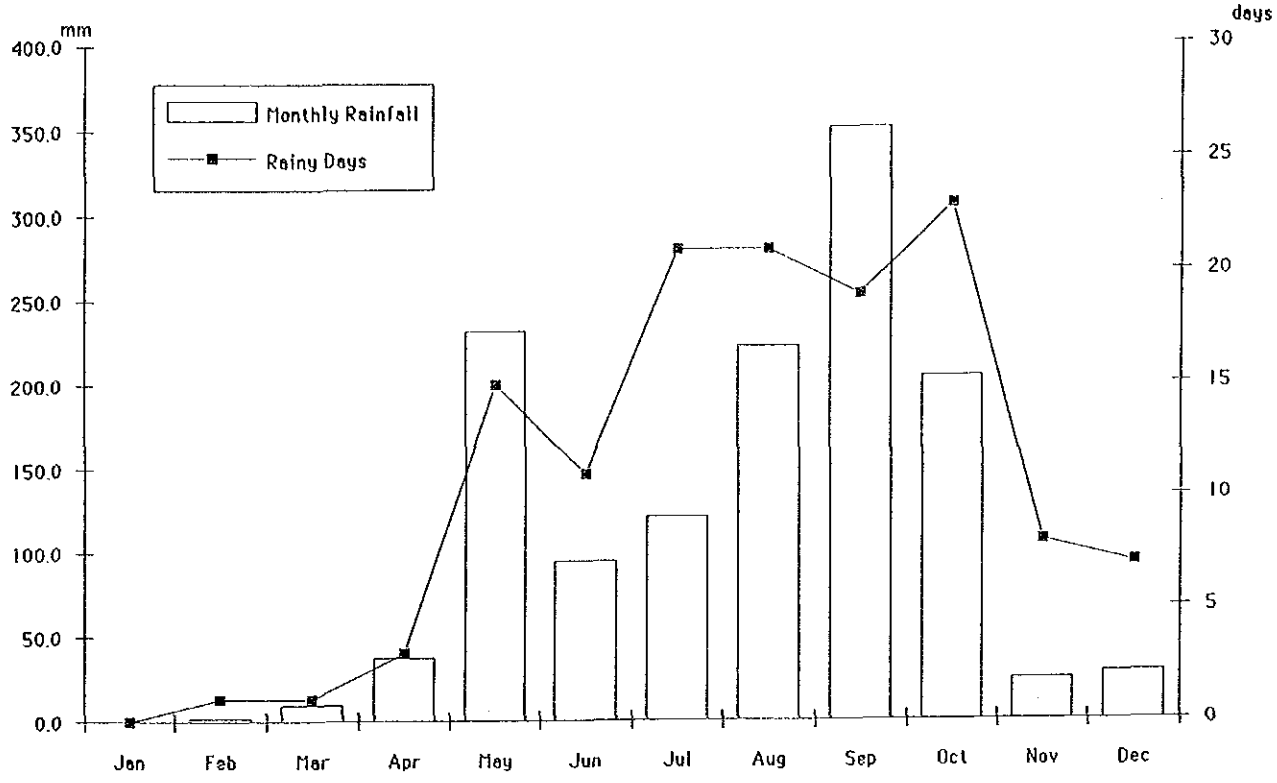
Rainfall Record at Bassac Station in Phnom Penh (1989)



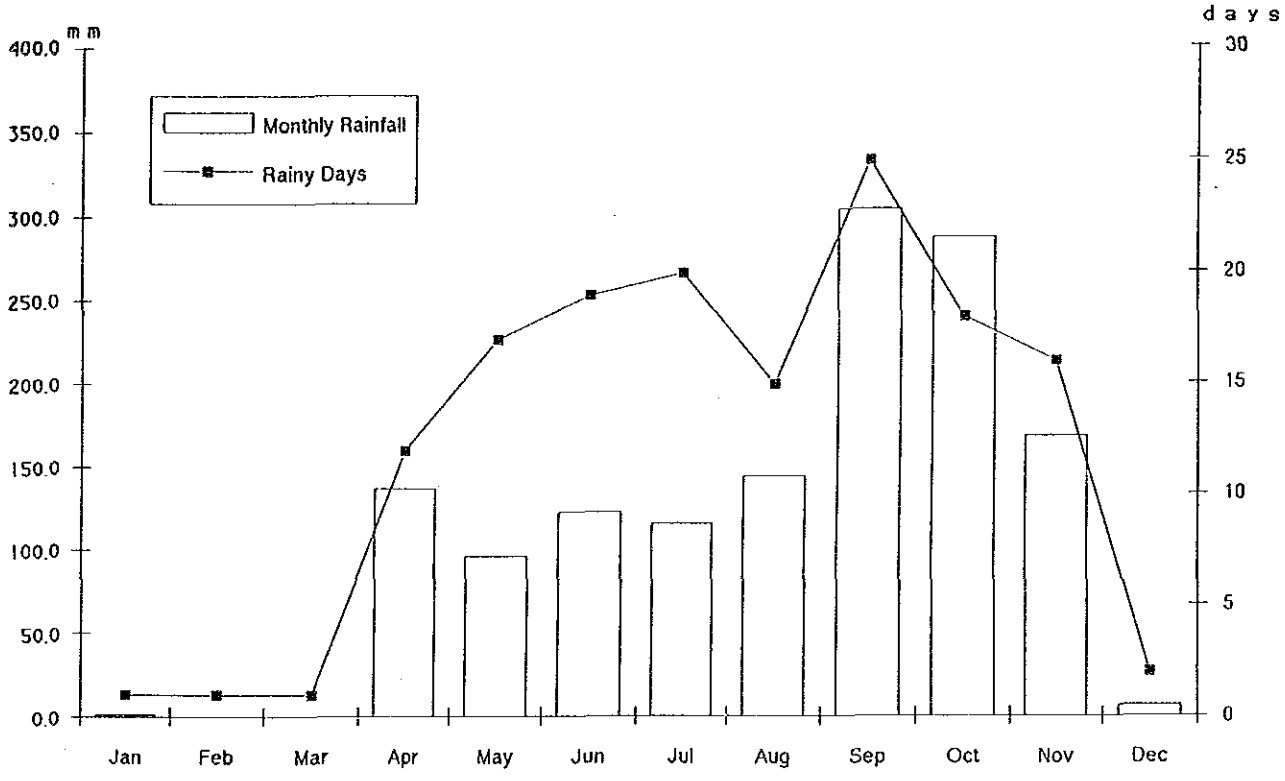
Rainfall Record at Bassac Station in Phnom Penh (1988)



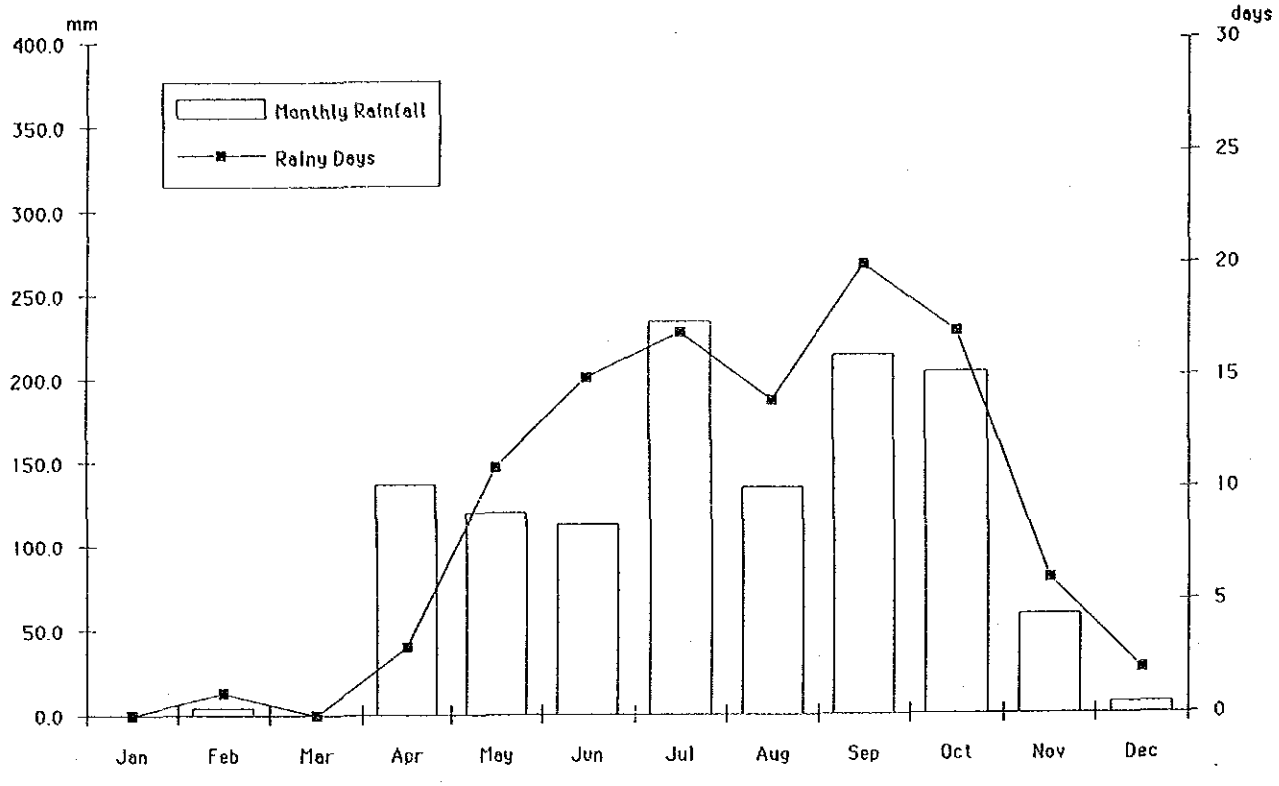
Rainfall Record at Bassac Station in Phnom Penh (1987)



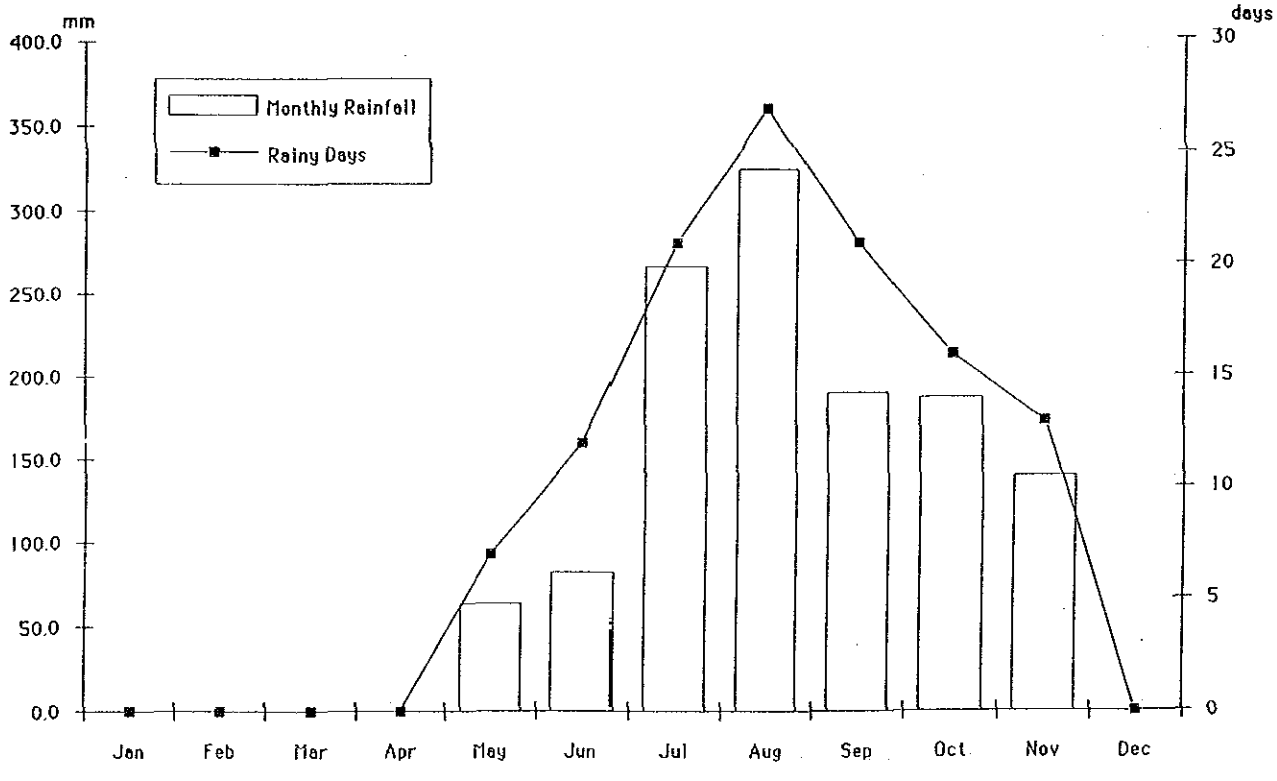
Rainfall Record at Bassac Station in Phnom Penh (1986)



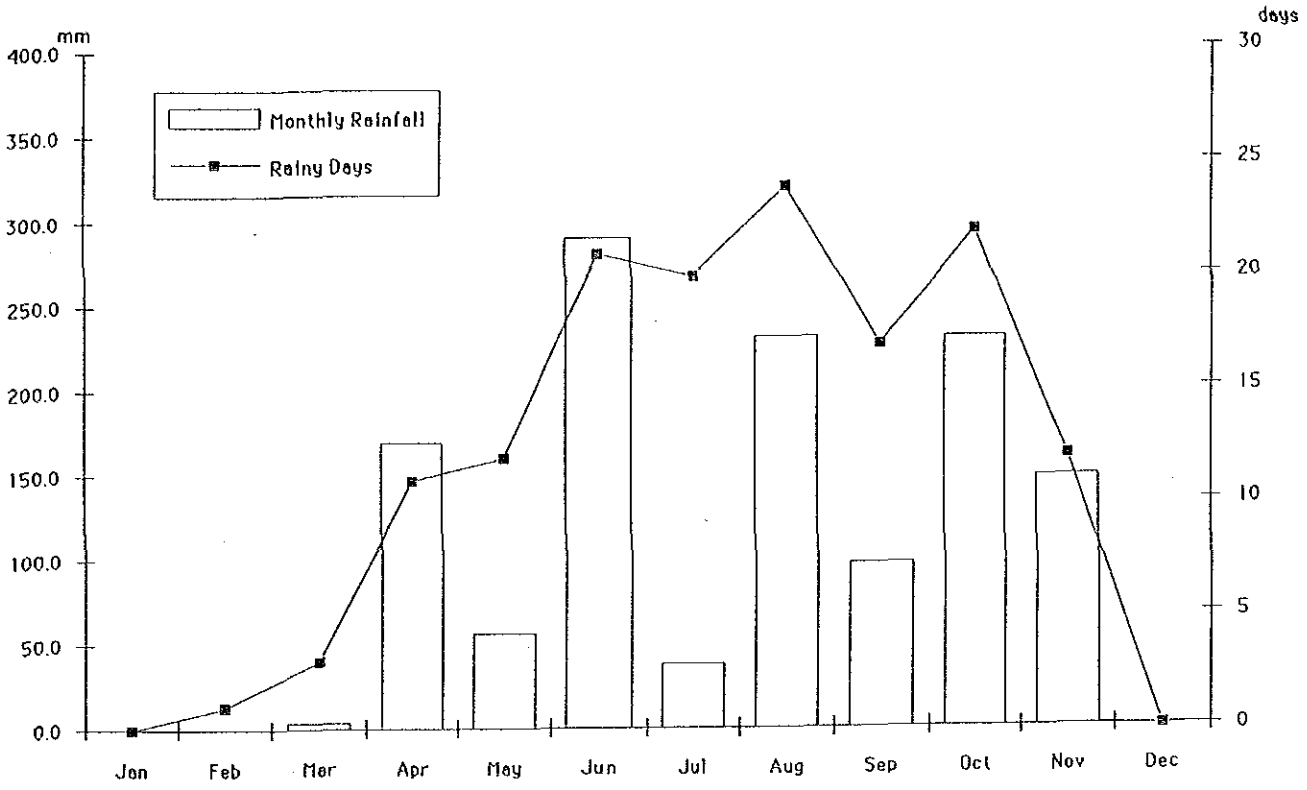
Rainfall Record at Bassac Station in Phnom Penh (1985)



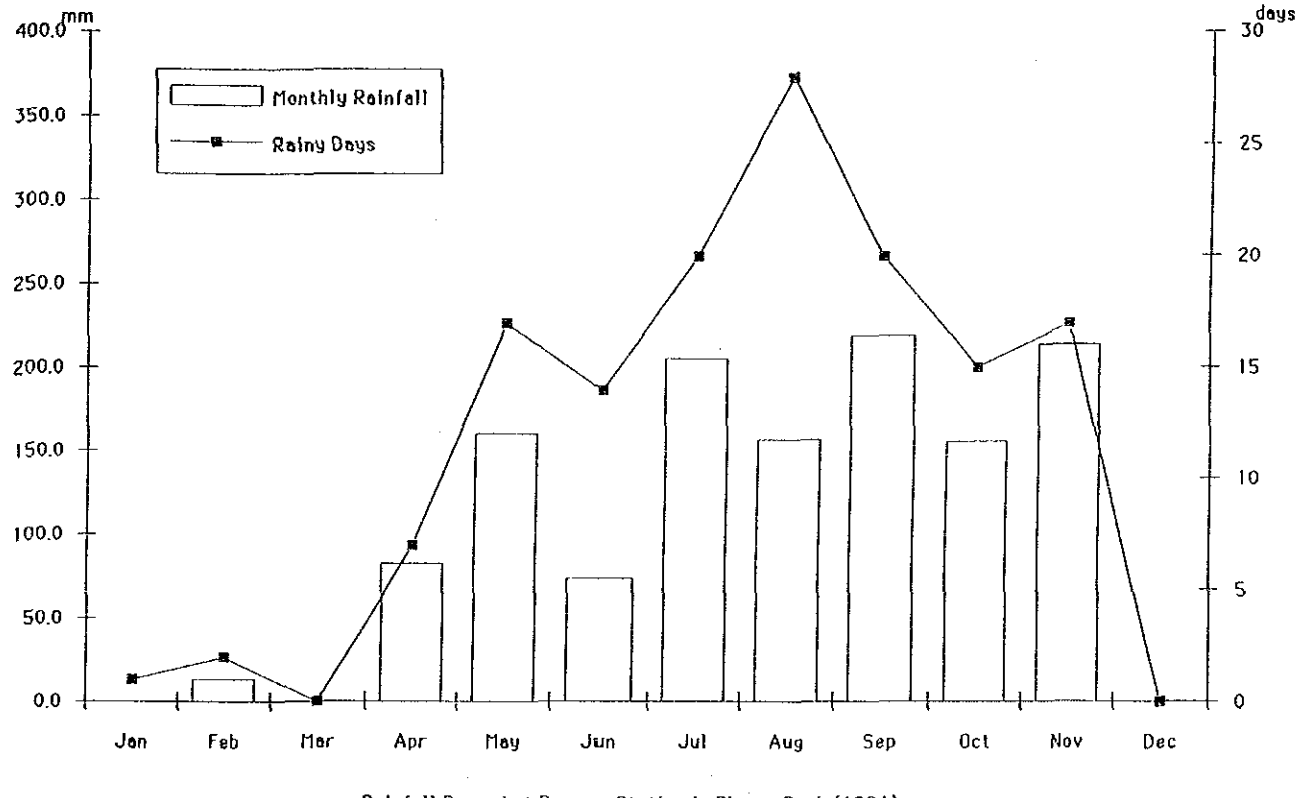
Rainfall Record at Bassac Station in Phnom Penh (1984)



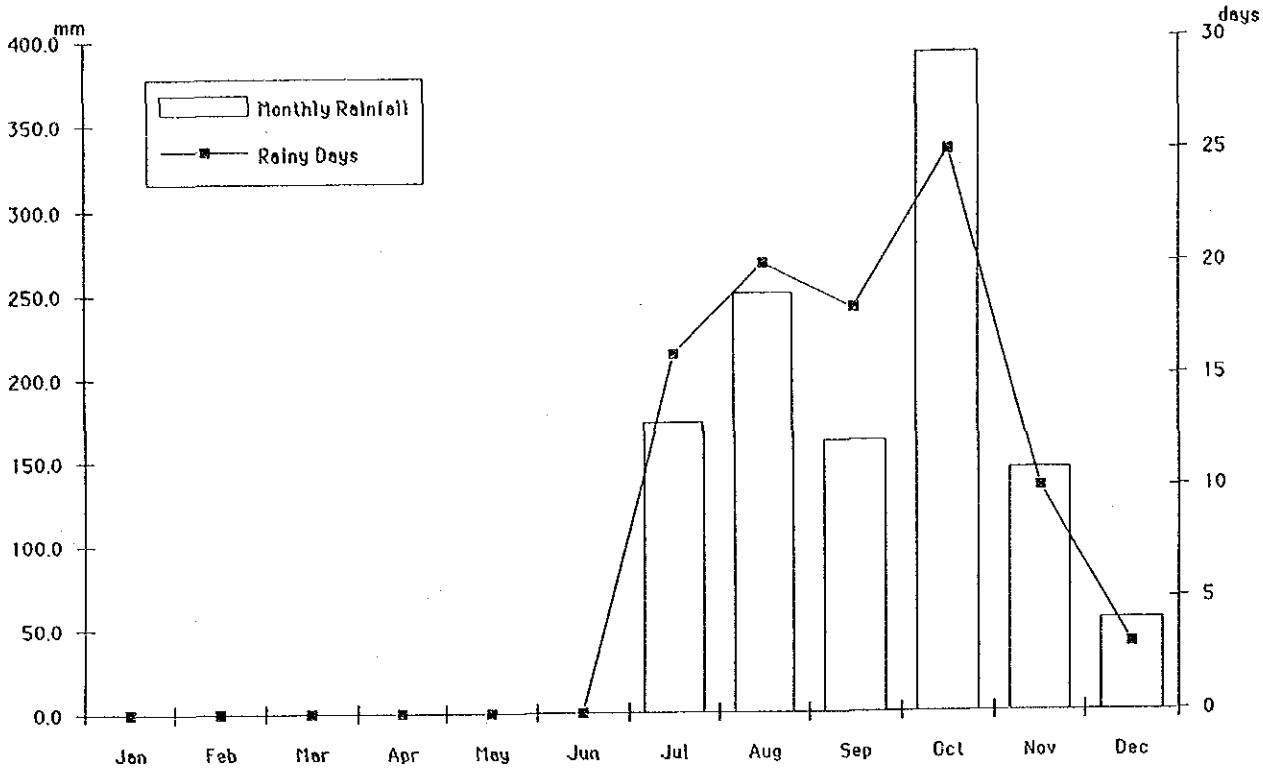
Rainfall record at Bassac Station in Phnom Penh (1983)



Rainfall Record at Bassac Station in Phnom Penh (1982)



Rainfall Record at Bassac Station in Phnom Penh (1981)



Rainfall Record at Bassac Station in Phnom Penh (1980)