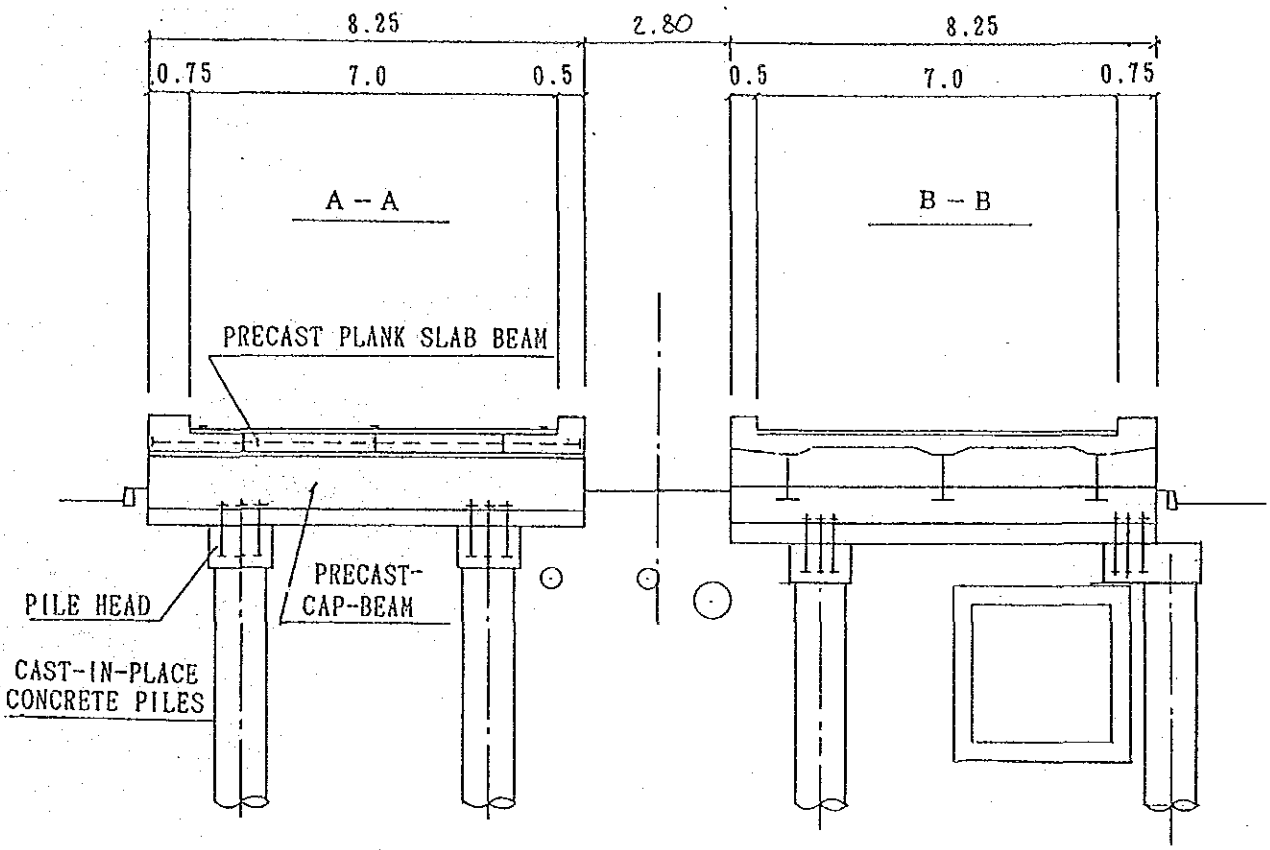


Fig. 4-3-11 Approach Slabs

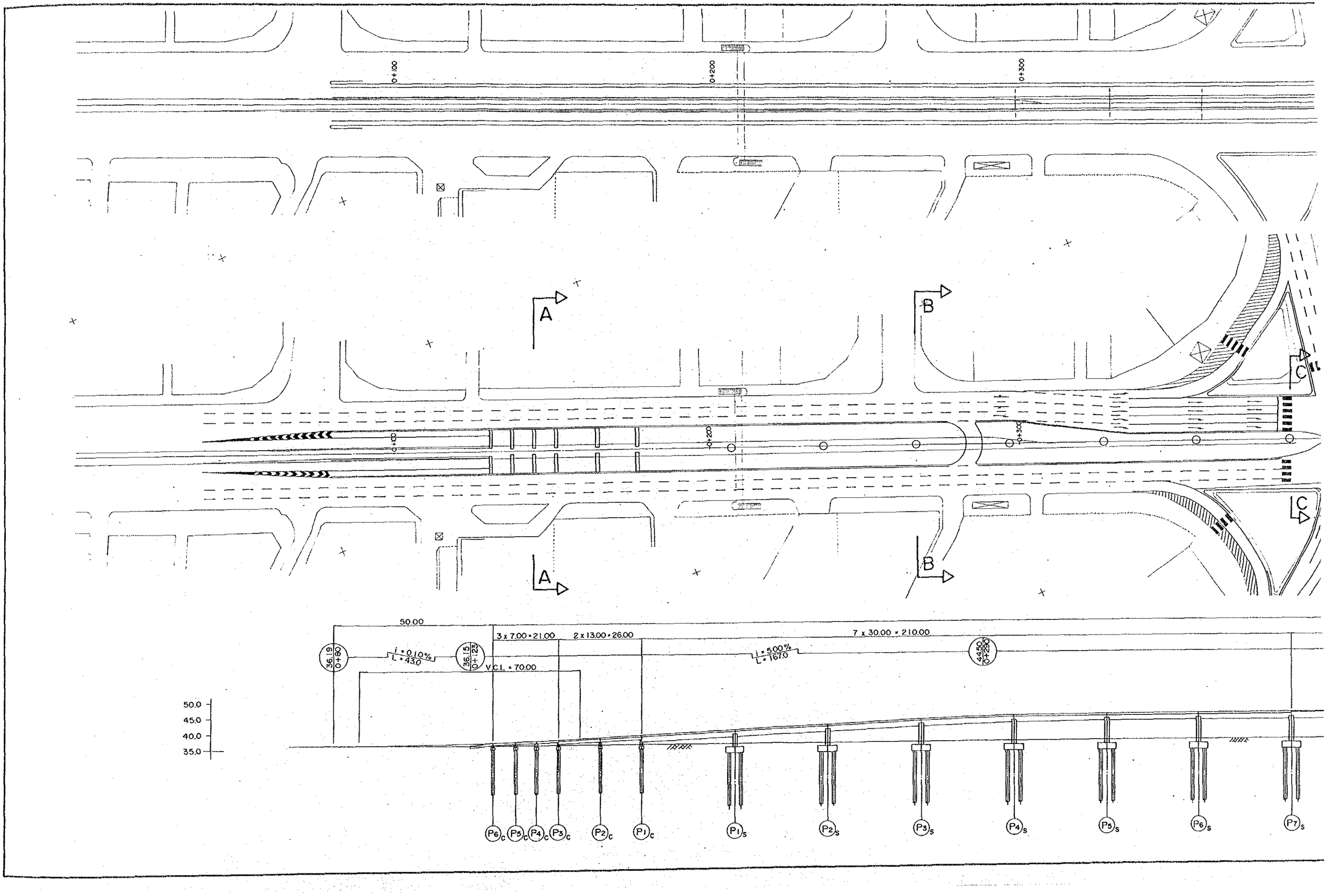
4-3-4 Basic Design Drawings

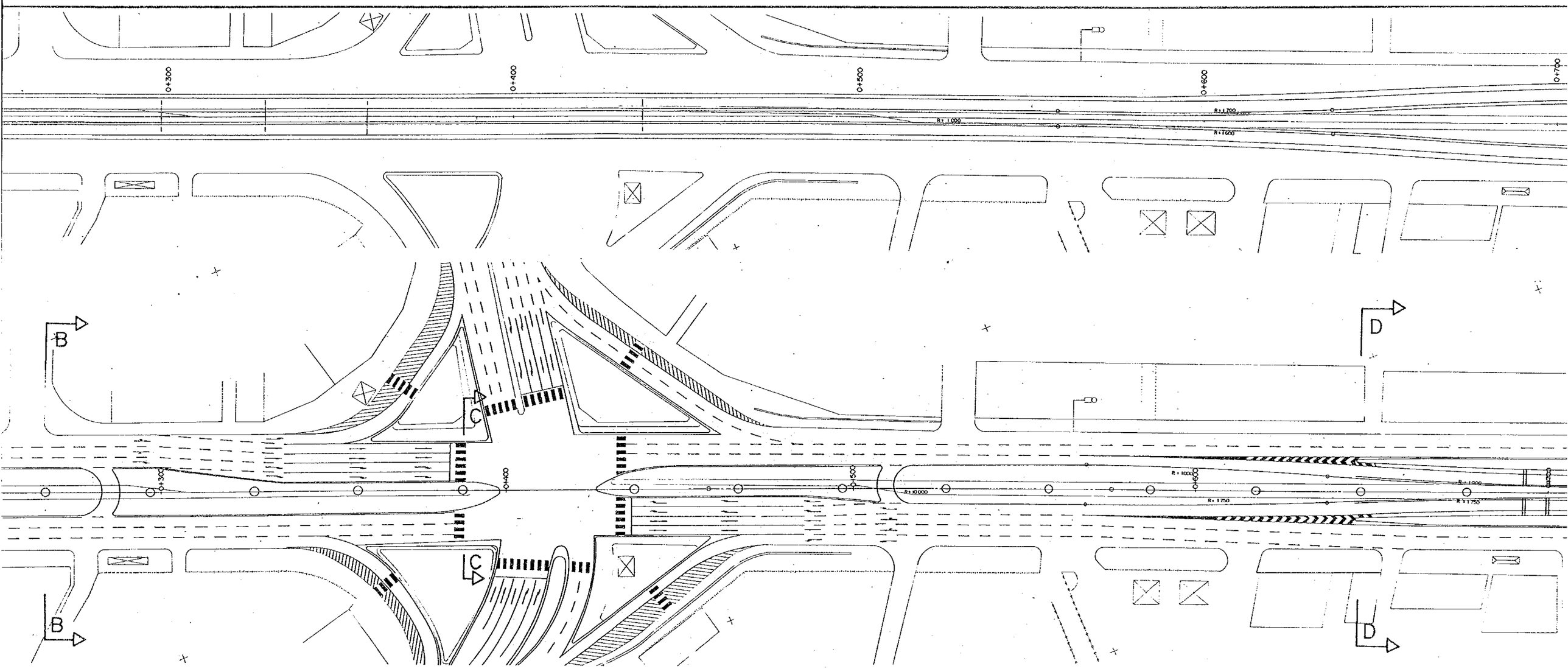
Basic Design Drawings for Rama IV Viaduct are presented as follows:

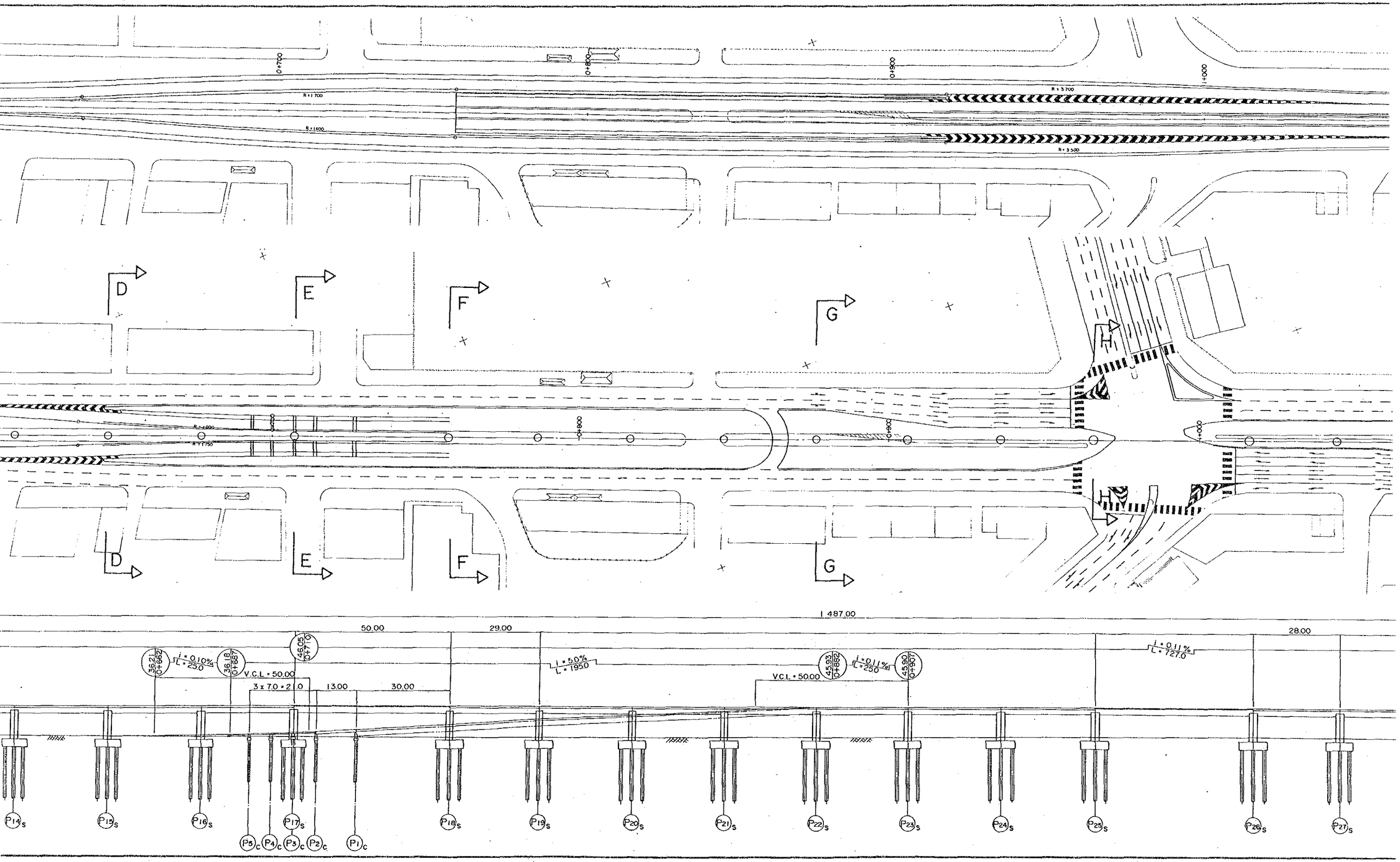
(1) Layout of Viaduct

(2) General Plans of Superstructures

(3) General Plan of Pier


0+100
0+200
0+300
A
B
C
50.00
3 x 7.00 = 21.00
2 x 13.00 = 26.00
7 x 30.00 = 210.00
36.19
0+80
i = 0.10%
L = 43.0
36.15
0+123
V.C.L. = 70.00
i = 5.00%
L = 167.0
44.50
0+290
50.0
45.0
40.0
35.0
P6C P5C P4C P3C P2C P1C P1S P2S P3S P4S P5S P6S P7S


0+300
0+400
0+500
0+600
0+700
R=1000
R=1200
R=1000
B
C
D
R=10000
R=1750
R=1750
00 = 210.00
50.00
9 x 30.00 = 270.00
44.50
0+250
i = 0.369%
L = 420.0
36.21
0+692
i = 0.10%
L = 250
36.18
0+687
V.C.L = 50.0
3 x 7.0 = 2
P3S
P4S
P5S
P6S
P7S
P8S
P9S
P10S
P11S
P12S
P13S
P14S
P15S
P16S
P5C
P4C


R = 1700
R = 1600
R = 3700
R = 3500
D
E
F
G
H
R = 1000
R = 1750
1 487.00
50.00
29.00
28.00
36.21
0+662
36.18
0+687
46.05
0+710
I = 0.10%
L = 250
V.C.L = 50.00
3 x 7.0 = 21.0
13.00
30.00
I = 5.0%
L = 1950
45.93
0+892
I = 0.11%
L = 250
45.90
0+907
I = 0.11%
L = 727.0
P14S
P15S
P16S
P17S
P18S
P19S
P20S
P21S
P22S
P23S
P24S
P25S
P26S
P27S
P5C
P4C
P3C
P2C
P1C

PLAN OF VIADUCT
SCALE 1:1000

PLAN OF AT-GRADE STREET
SCALE 1:1000

i = 0.11%
L = 727.0

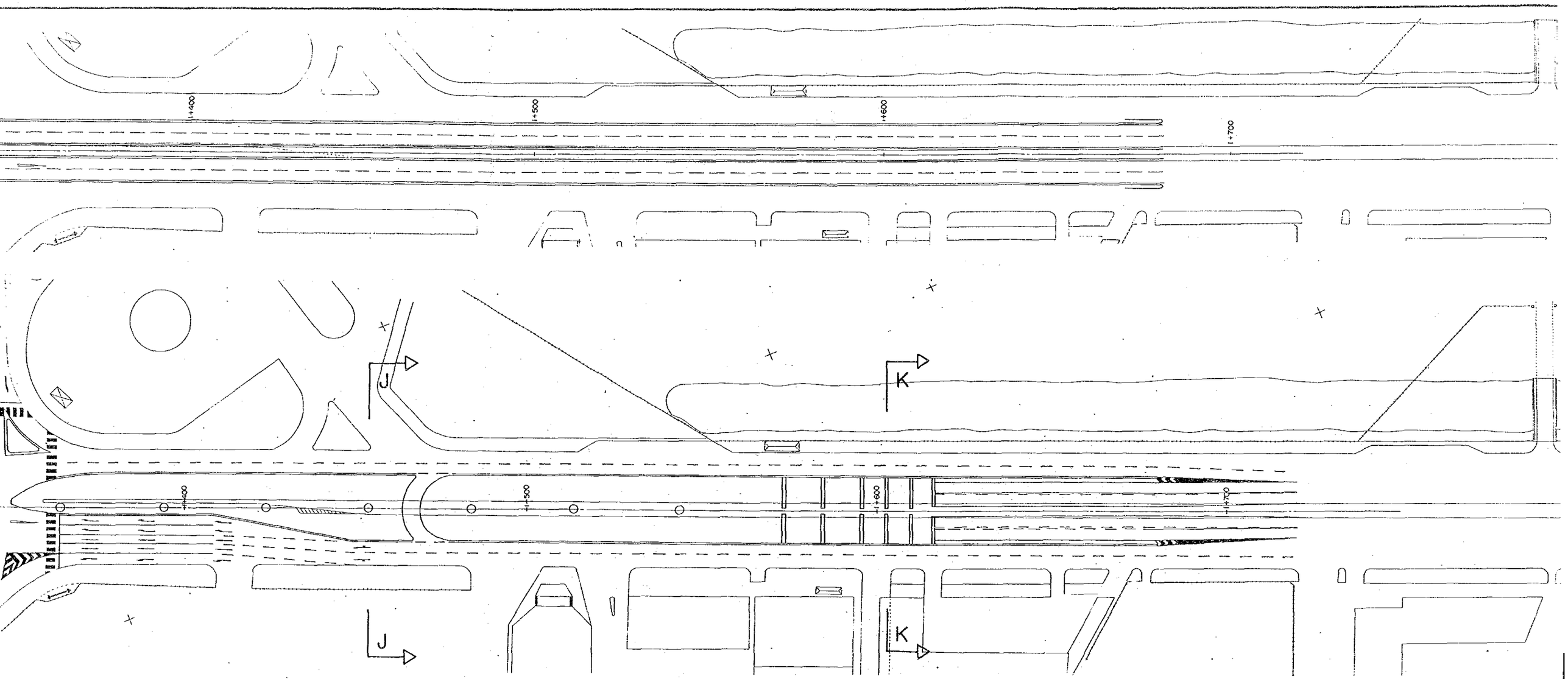
28.00

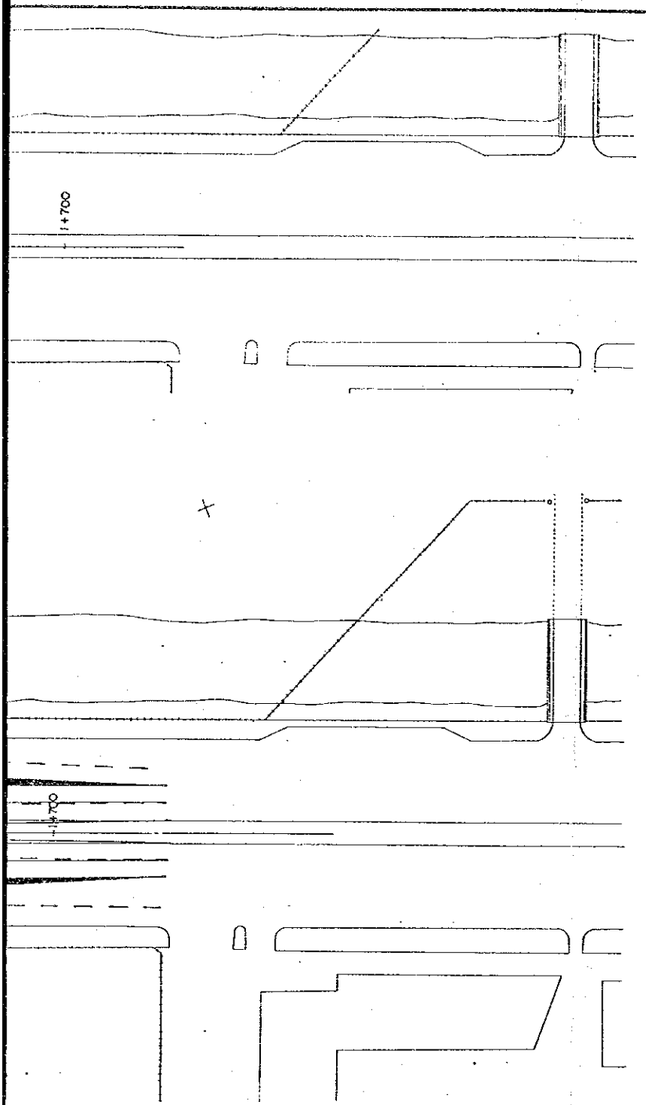
9 x 30.00 = 270.00

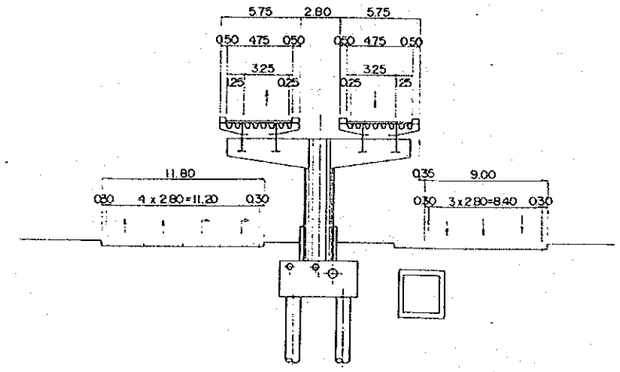
50.00

ELEVATION OF VIADULT
SCALE 1:1000

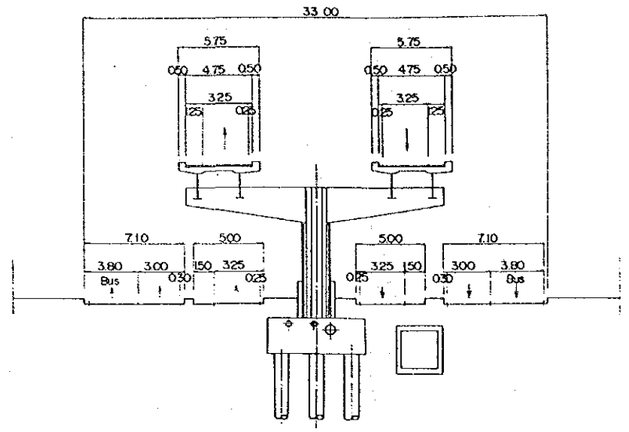
P26S P27S P28S P29S P30S P31S P32S P33S P34S P35S P36S P37S P38S P39


1+400
1+500
1+600
1+700
J
K
7 x 30.00 = 210.00
2 x 11.00 = 22.00
3 x 7.00 = 21.00
45.25 1+437
i = 5.0 %
L = 186.0
35.95 1+623
i = 0.1 %
L = 57.0
36.01 1+680
P37S
P38S
P39S
P40S
P41S
P42S
P43S
P1C
P2C
P3C
P4C
P5C
P6C

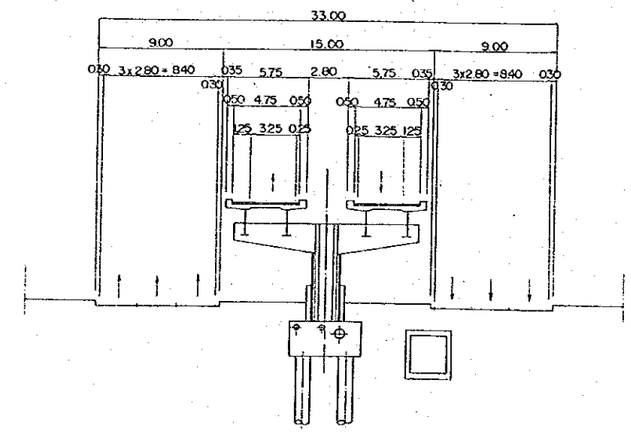




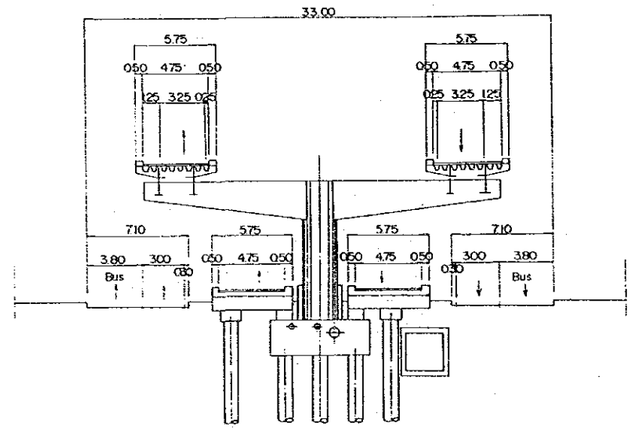
SECTION C - C



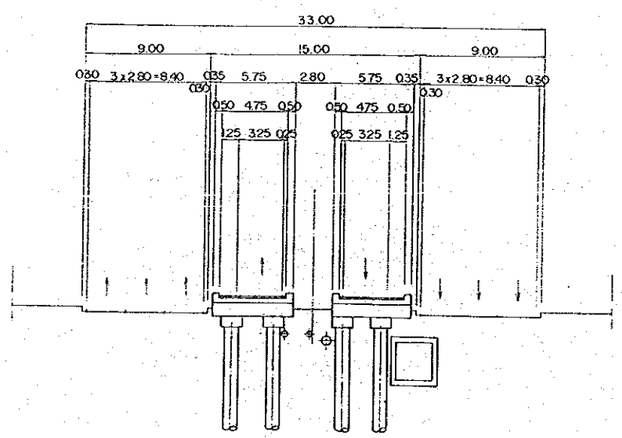
SECTION D - D



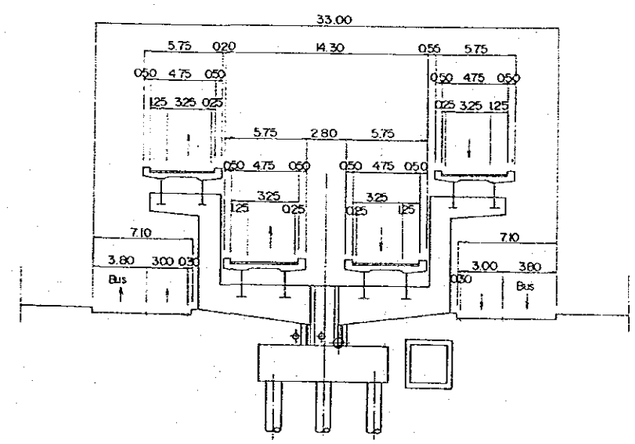
SECTION B - B



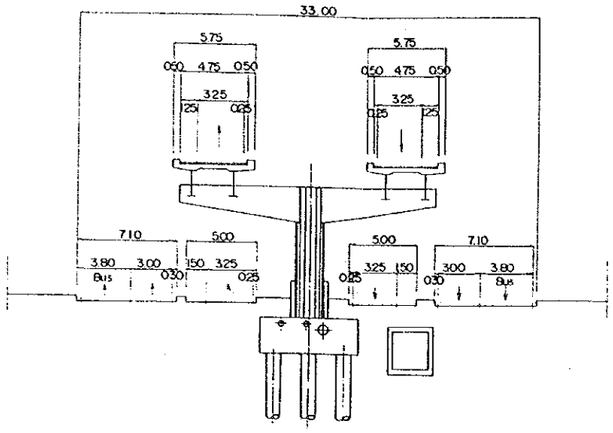
SECTION E - E



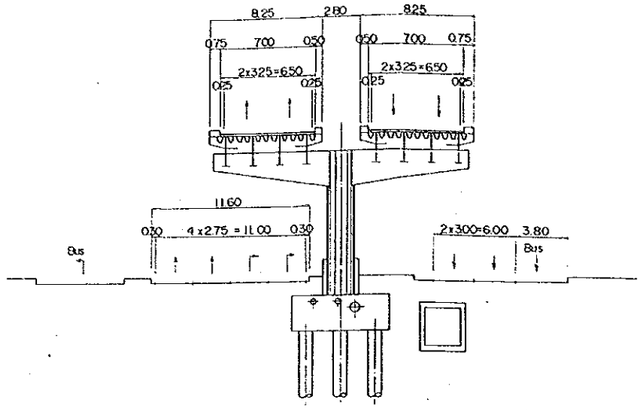
SECTION A - A



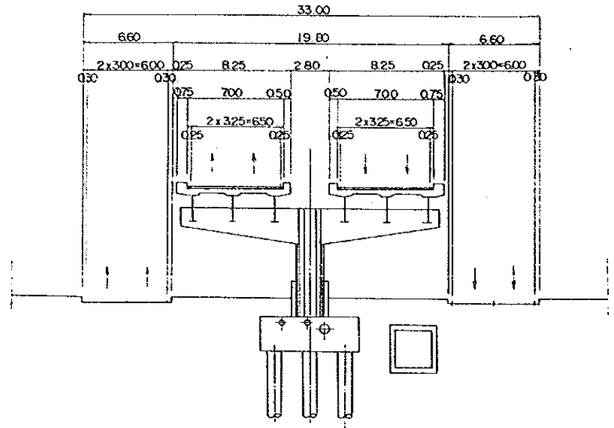
SECTION F - F



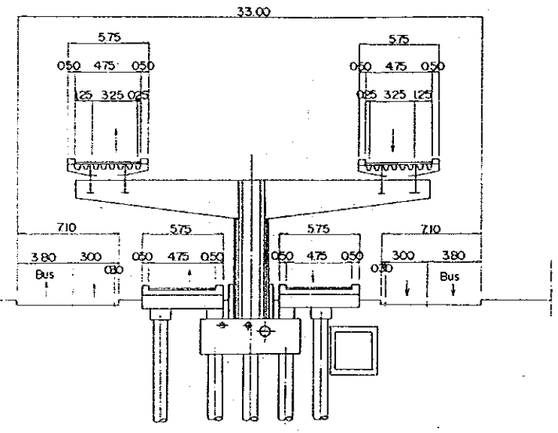
SECTION D - D



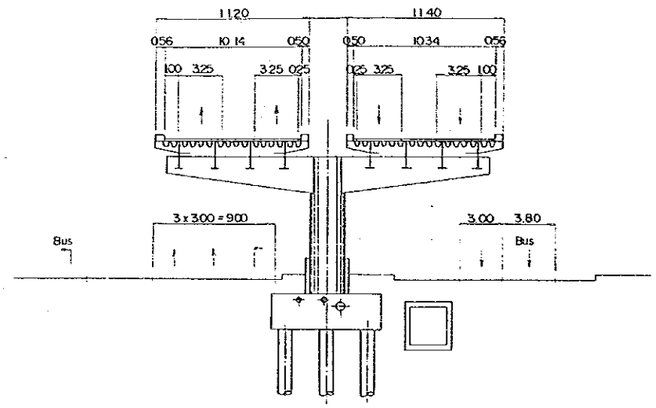
SECTION I - I



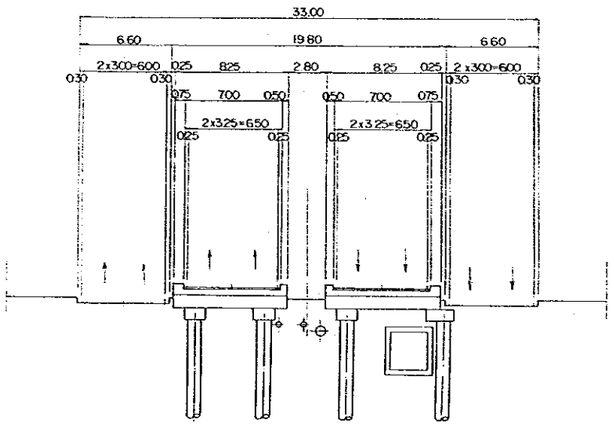
SECTION J - J



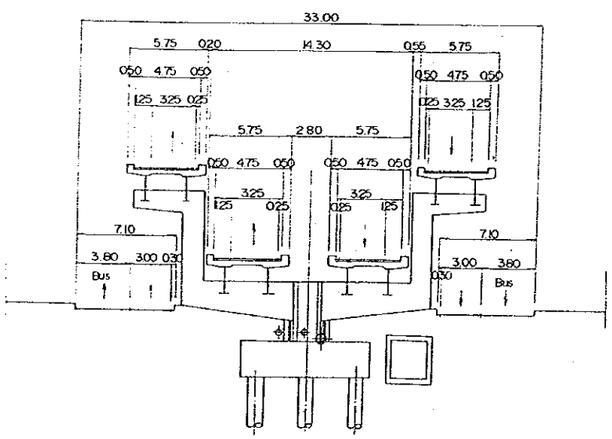
SECTION E - E



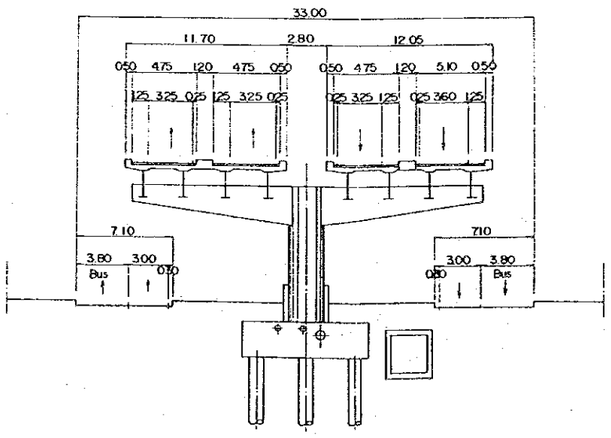
SECTION H - H



SECTION K - K



SECTION F - F



SECTION G - G

CROSS SECTIONS

SCALE 1 : 400

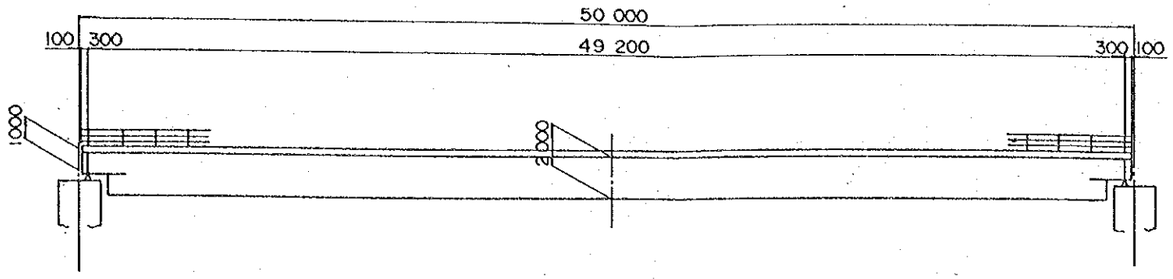
GOVERNMENT OF THE KINGDOM OF THAILAND

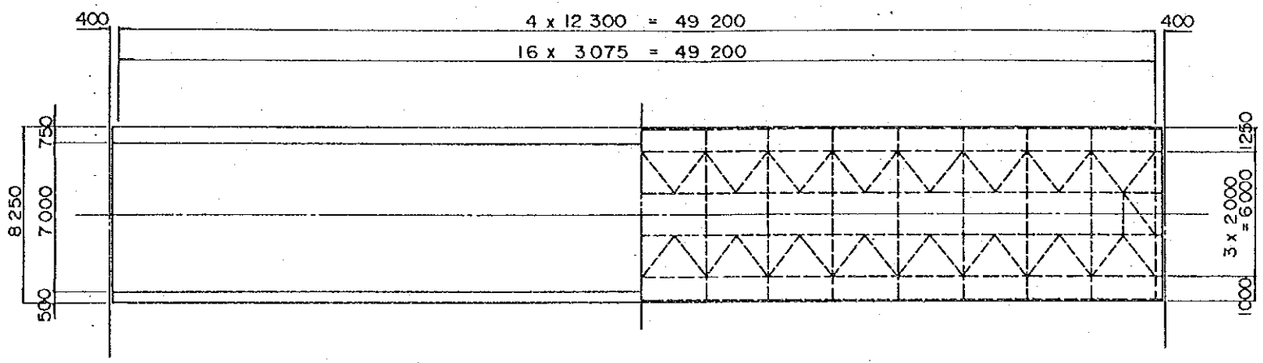
Fig. 4-3-12 BASIC DESIGN FOR RAMA IV VIADUCT

GENERAL PLANS OF SUPERSTRUCTURES

S = 1/200

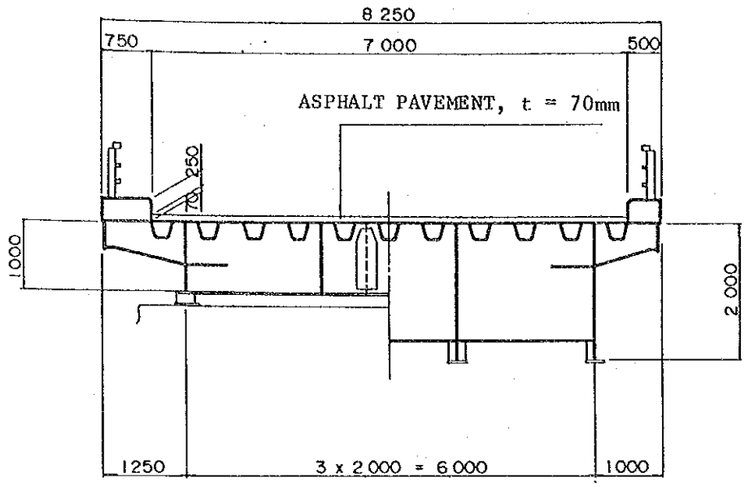
SIDE VIEW



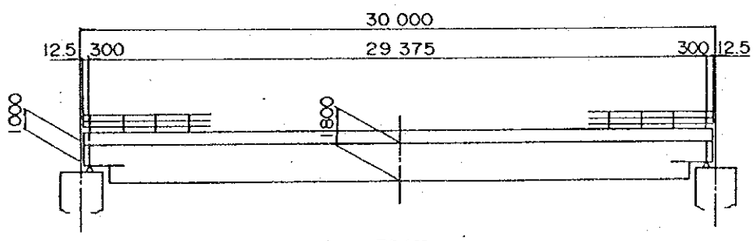


CROSS SECTION S = 1/60

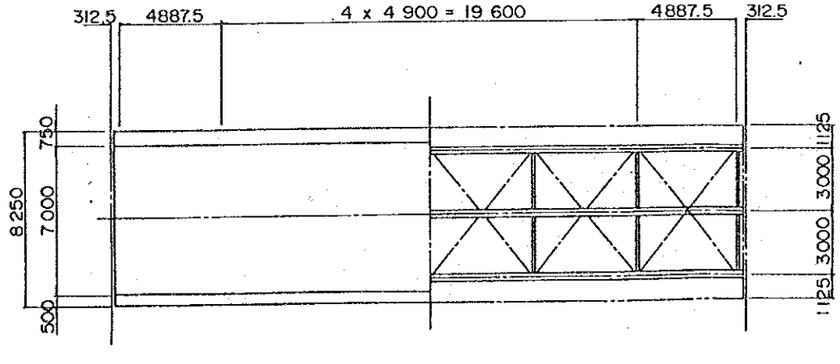
END INTERMEDIATE



SIDE VIEW



PLAN



CROSS SECTION S = 1/60

END INTERMEDIATE

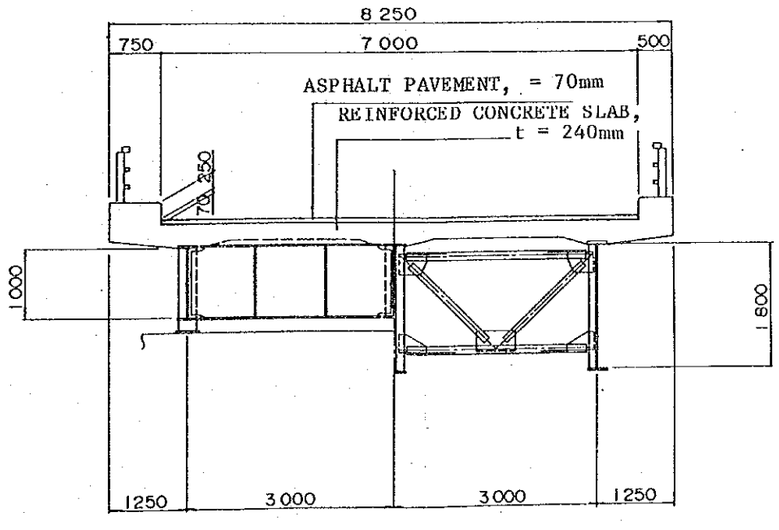


Fig. 4–3–13 GENERAL PLANS OF SUPERSTRUCTURE

GENERAL PLAN OF PIER

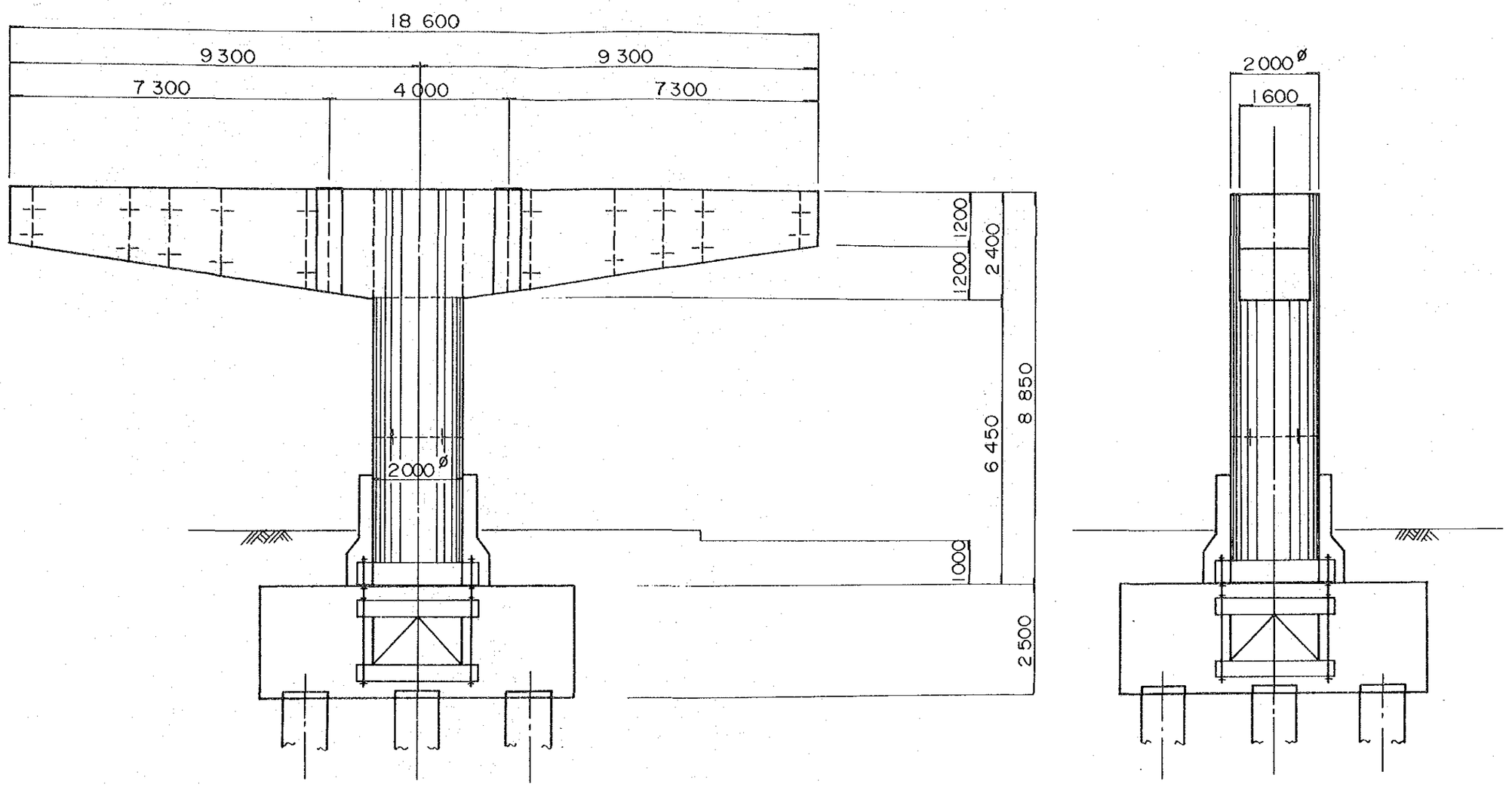


Fig. 4–3–14 GENERAL PLAN OF PIER

4-4 Implementation Plan

4-4-1 Construction Situation and Considerations

a. Construction Situation

In Thailand there are about 500 contractors who join the Thai Contractors Association (phone No. 251-0697) and out of them each of the following five contractors manages more than ₿1.0 billion construction business.

(1) Italian - Thai Development Corporation
(2) Chor Karn Clang Co., Ltd.
(3) Kreethai Co., Ltd.
(4) Benjamart Co., Ltd.
(5) Sino - Thai Engineering & Construction Co., Ltd.

More than 30 Japanese construction companies including Taisei, Nishimatsu, Ohbayashi, Takenaka, etc. have entered into joint-ventures with Thai construction companies. It is reported that Thai construction capabilities are in no way inferior to those of advanced countries, however, their quality control methods need much improvement.

b. Construction Considerations

Since the construction site has high traffic density, careful precautions will be required for the construction.

(1) For the traffic control and management especially at the time of girder erection, close liaison is essential between BMA and the Traffic Police Division of the Metropolitan Police Bureau.

(2) For the provision of detour roads, approval therefor must be obtained in advance from the parties concerned.

(3) Since the construction is conducted in the roadway which is crowded with heavy traffic, the contractor must have much experience in construction works in urban areas especially for foundation work and girder erection work. Beside, the structure

is of steel, and therefore the contractor must have experience and capability in obtaining steel material and fabricated steel members from foreign countries as well as in assembling and erection of steel structures in a short time.

4-4-2 Construction Policy

This Project is on Rama IV Road which has tremendous traffic volume in Bangkok and the traffic congestion on the road is very great in the morning and evening peak hours. The traffic lights at intersections are controlled manually by policemen who communicate with other policemen at adjacent intersections by radio. The cycle-time varies as much as 3 to 12 minutes in which they try to increase the traffic to be treated.

One of the greatest construction problems is how the traffic should be managed in these ultra-congestion periods. The present traffic on Rama IV Road in evening peak hours is as illustrated below.

	2,000		2,300-1,900		3,600-3,000		3,700	East
		Siphraya		Surawong		Silom		
West	2,400		2,400-2,200		3,100-2,700		2,700	

(Unit: PCU/hour)

It is assumed that during construction the lane changes would be unavoidable and to compensate the lane width should be reduced to the minimum. Assuming that the possible capacity of one lane is 800 -1,000 vehicles/hour per lane the number of required lanes is as below:

	3-2 lanes		3-2		5-4		5-4	East
		Siphraya		Surawong		Silom		
West	3-4		3		4-3		4-3 lanes	

Classifying the construction sections from the traffic management aspect, the carriageway widths are as follows: (See Fig. 4-4-1).

Section	Section Length	After Completion		Under Construction
		Width of viaduct	Width of At-grade road (one way)	Width of available At-grade road (one way)
(1) Approach ramp at start (Sta 80-270)	*190m	14.3m	9.0m (3 lanes)	8.6m (3 lanes)
(2) Normal viaduct section (span 30m)	340m	14.3m	9.0m (3 lanes)	10.1m (3 lanes)
(3) Intermediate Approach (Sta 660-830)	*170m	26.55m	7.1m (2 lanes)	7.1m (2 lanes)
(4) Normal viaduct section (span 30m)	550m	26.55m	7.1m (2 lanes)	10.1m (3 lanes)
(5) Intersection (span 50m)	3x50m	25.4m (max.)	-	-
(6) Approach ramp at end (Sta 1,480-1,660)	*180m	19.3m	6.6m (2 lanes)	6.1m (2 lanes)

* The vertical clearance status of those approach sections is Bridge longitudinal profile height - Ground height is less than (5.2m + 1.8m)

For the erection of girders over intersections cranes will be operated at night with the help of two temporary supports set in each intersection, considering the time and cost and the total weight of girders. In this way, however, the intersecting traffic may be interrupted for several nights. Traffic detour measures including re-routing bus routes which are shown in Fig. 4-4-4 should be worked out between BMA and the traffic police authority.

Underneath the normal viaduct sections in (2) and (4) above, where the traffic is passable, three lanes can be secured during night-time construction, and in day-time four lanes could be open to traffic if the work is suspended and if damaged pavement is covered with steel plates.

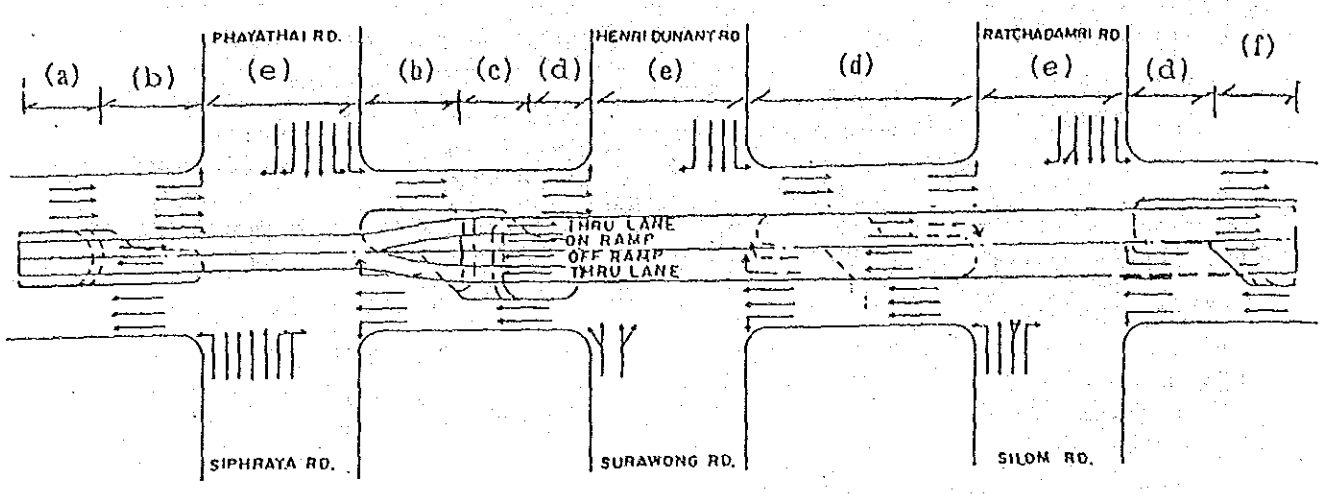


Fig. 4-4-1 Division of Construction Site

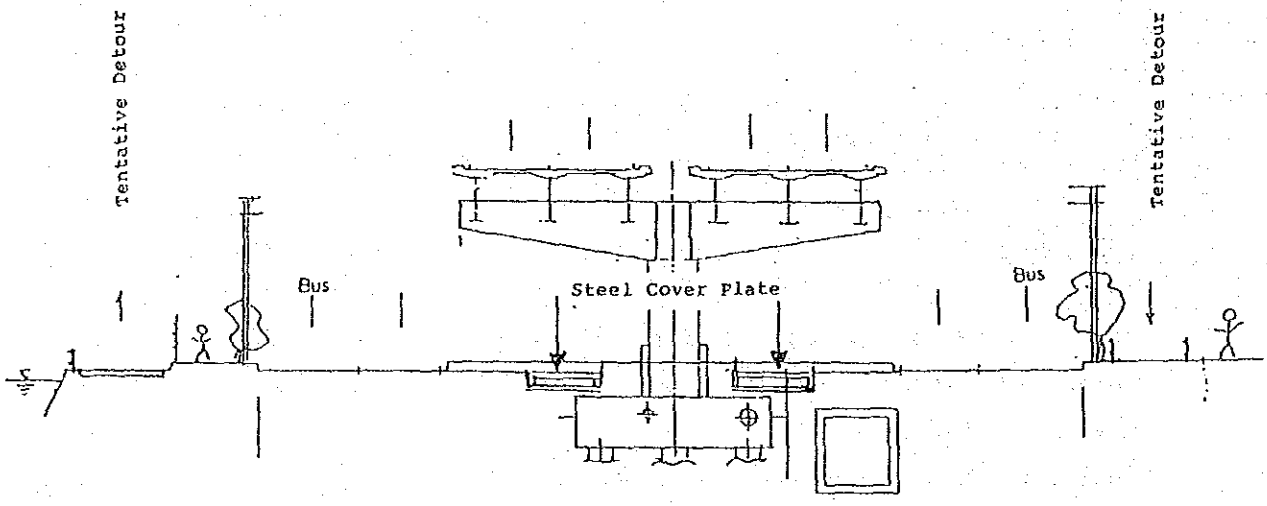


Fig. 4-4-2 Cross Section of Construction Site

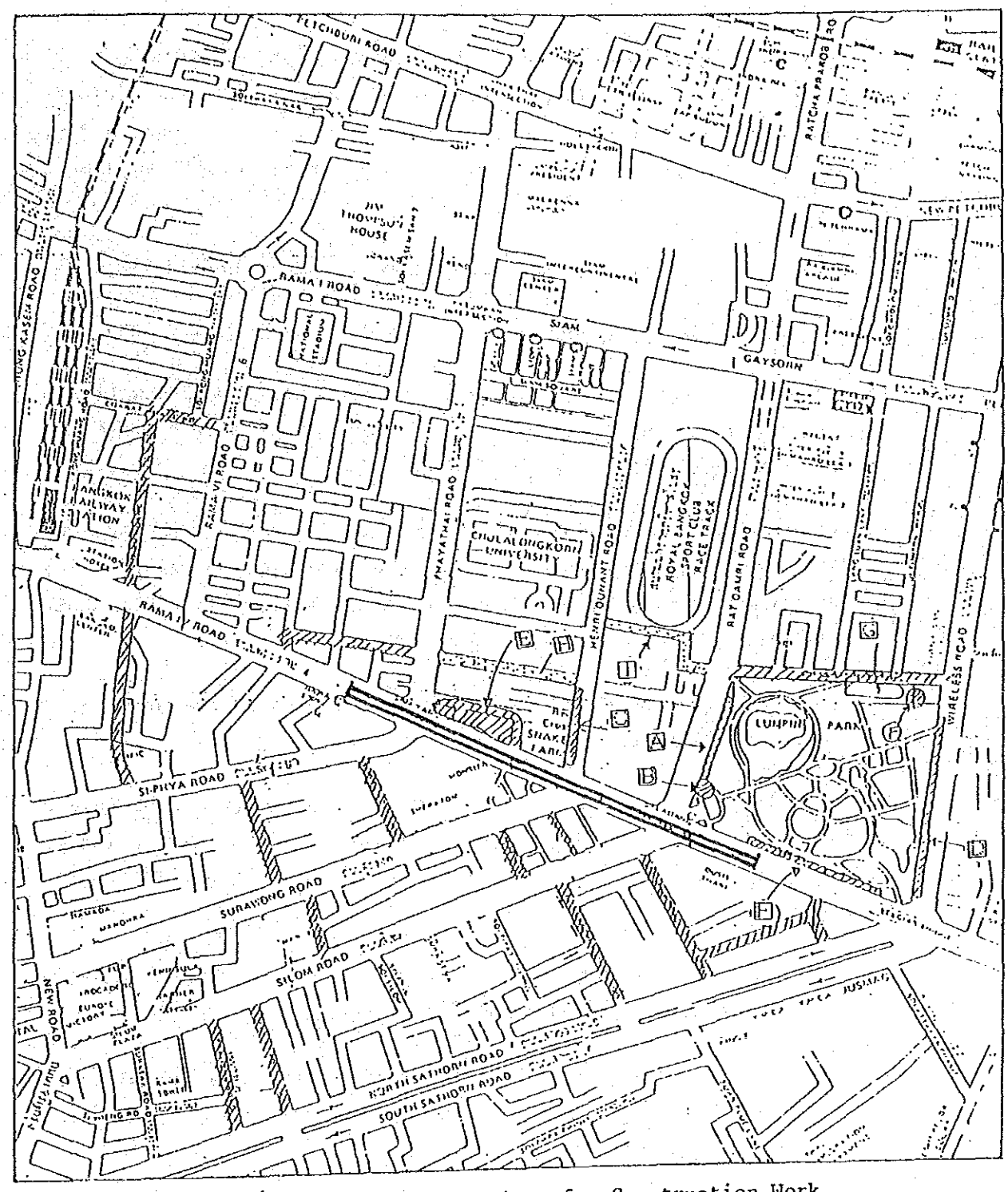


Fig. 4-4-3 Candidate Area for Construction Work

- A Fabrication/Stock Yard
- B Offices
- C-D Parking Area for Waiting Truck
- E 2nd Fabrication/Stock Yard
- F Dumping Area
- G Drying Area for Mud
- H Tentative Detour Road
- I Detour Road
- Available Detour

On the contrary, however, in the construction of the approach sections in (1), (3) and (6) above, the provision of pier columns and abutments will occupy the respective spaces for 24 hours a day. Accordingly the present 5 lanes in one way must be reduced to 3 or 2 lanes.

To solve this problem, the following measures can be considered:

(1) to provide detour roads (see the shaded areas in Fig. 4-4-3),

(2) to remove interlocking blocks on existing 3m-wide sidewalk and provide additional one lane by placing steel sheets over the uncovered sidewalk (See Fig. 4-4-2),

(3) to construct these approach sections at the very final step of the construction procedure in the shortest possible time continuously day and night so that afterwards the whole structure can be open to traffic; and

(4) to construct the structure in halves, permitting the other half to be available for the two-way traffic.

The measures discussed in (4) above would be unfavourable because a second pier column would be required by or near the existing 2.7m x 2.75m box culvert drain under Rama IV Road, which will entail a longer construction period.

The measures in (3) requires speedy construction of the approach section, which is thought to be almost impossible.

The measures in (2) above must be taken into consideration: although its merit seems small it is very practicable, but pedestrian protection will be required.

The measures in (1) above must be taken any way, because, as discussed above, the other measures are not too effective. In the vicinity of the construction site, however, there are few spaces for detour roads. In the north of the site access roads in Chulalongkorn University and Hospital and Royal Sports Club are available but there are no public roads to connect them to Rama I Road. Following proposals can be made:

(1) use of a road within the compound of Chulalongkorn University to connect Phaya Thai and Henri Dunant Roads, and,

(2) use of a road within the Royal Sports Club to connect Ratchadamri and Sarasin Roads.

For the provision of such detour roads, prior negotiation with the owners for approval is very important.

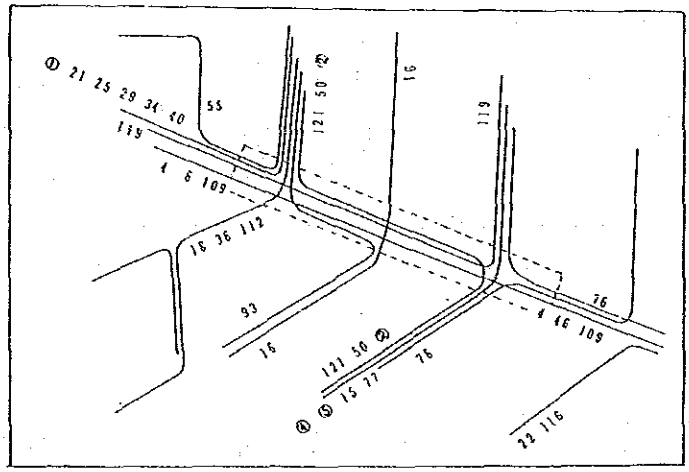


Fig. 4-4-4 Bus Routes around the Site

4-4-3 Construction and Supervisory Plan

a. Construction Plan

1. Preparatory Work

(1) In order to get the construction smoothly started, the main water pipes under the median should be displaced, street trees be removed and pedestrian bridges and curb stones and separator in the median also be cleared.

To confirm the exact position of the existing underground utilities, trial excavation to a depth of 1.5 - 2.0m should be made at appropriate intervals.

Public utilities on and over the ground should be confirmed and prompt contact with the authorities concerned should be made for relocation if they are obstacles to the construction.

(2) Base survey points should be confirmed from which control points can be established and the necessary survey should be conducted.

(3) Discussion for traffic management should be conducted with the Metropolitan Police Bureau and BMA.

The traffic control signs during construction should follow the standards of the National Safety Council of Thailand issued in 1984.

The transportation route of construction materials and equipment from the Bangkok port to the site is shown in Fig. 4-4-5. If approval is obtained from the police, goods having length: 20m, height: 3.5m, width: 4.0m and weight: 30 - 50 tons can be hauled. Confirmation therefor will be required from the police.

(4) The construction site requires electricity, water and telephone. Electricity for site illumination (total 1,000KVA), and office use (lighting and air-conditioning: 100KVA) will be taken from the nearby BMA sub-stations, and electricity for other purpose can be produced by generators.

Water is used for piling excavation, concrete curing, cleaning, office keeping, etc. ϕ50 pipe should be installed to obtain water from MWA pipes.

Telephones should be installed and one VHF frequency for tranceivers is required to be made available by BMA.

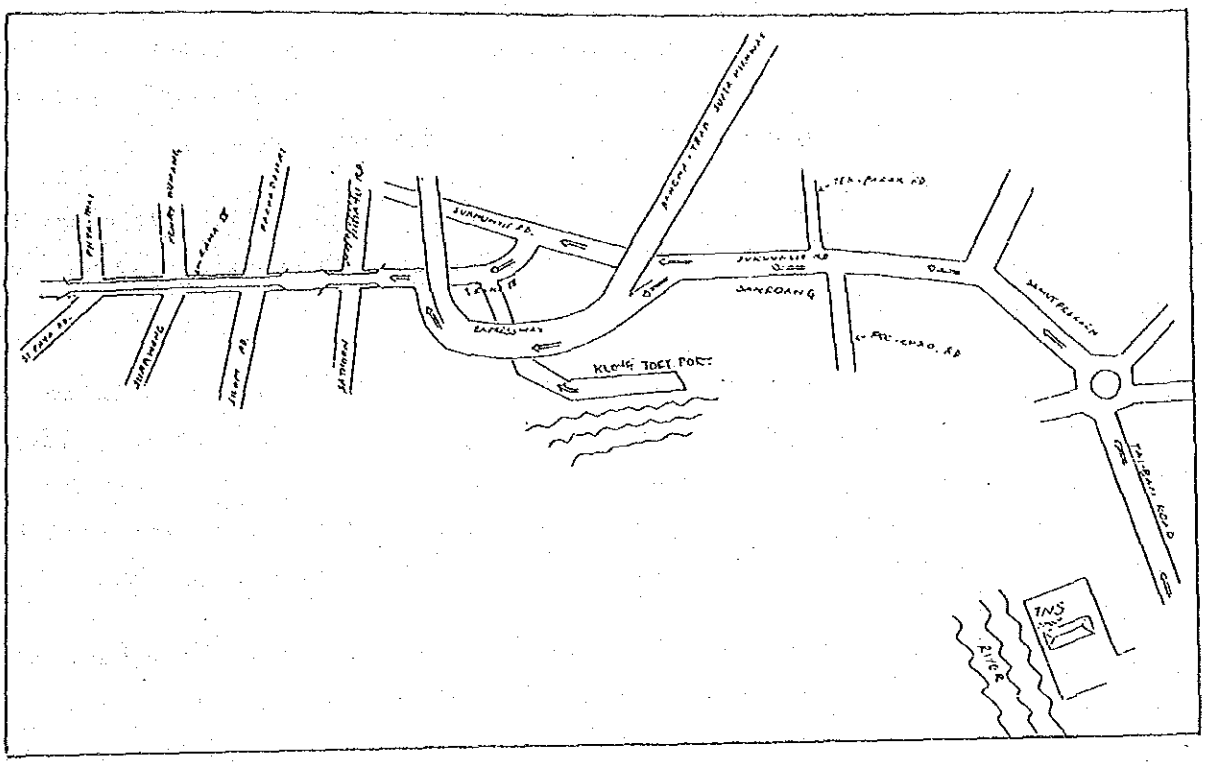


Fig. 4-4-5 Transportation Route to the Site

2. Temporary Works

(1) The space (25m wide, 400m long) which is situated by Lumpini Park and along Ratchadamri Road and at present used for parking is most suitable for material stockpiling and temporary assembly. The area on the rightside of the entrance of the park is appropriate for office site.

A roadside length (10 x 300m) of Henri Dunant Road and the roadside of Wittayu Road which was used at the time of Thia - Belgian Bridge construction can be used.

(2) The transportation of materials and equipment to the stockyards and from the yards to the site should be conducted generally at night. However, the transportation of temporarily assembled members should be made in daytime to keep their accuracy.

(3) BMA will provide fences surrounding these spaces. The Contractor should confirm their security and provide supplementary facilities if deemed necessary.

(4) At a field fabrication yard two gantry cranes of 30t capacity should be mobilized considering construction time and efficiency.

(5) A space should be secured in the vicinity of the site so as to keep excavated good quality soil of the ground surface which can be re-used in the approach ramps. The soft, unstable earth which is not suitable for earth fill will be dumped in a swampy area somewhere near Chao Phraya River.

(6) Between the pile excavation areas and the waste areas, the road surface usually becomes dirty and dusty. Every possible measures should be taken to prevent such a situation arising because the Project site is located in the central area of Bangkok.

3. Foundation Piling

(1) Cast-in-place piles of about 1.0m diameter will be provided. In principle, earth-auger or earth-drill machines should be operated without any trouble around which steel plates must be placed to protect the adjacent environment. Beyond the depth of 20m under the ground surface, artesian water will appear and appropriate treatment for muddy water is required. Mud tanks should be set in the median of the road.

(2) Pile drilling and casting at any one pier site will take place at only one location at any moment. A minimum of 24-hour curing is required after concreting. To avoid incurrence of any undesirable impact on the freshly cast pile, the site of pile excavation for the next day will be selected either at the same pier site from one which is not immediately next to it, or one at the site of any other piers. Reinforcement cages should be fabricated in the median.

(3) Considering the site conditions, there would occur a problem with bentonite slurry treatment. Checks should be made for the residual slurry and attention paid to the time reduction in pulling out and disconnecting the tremie pipe to secure good quality concrete in the pile.

4. Footing

(1) After providing all the piles for one footing, sheet piles having about 7m length are driven outside of the proposed footing and the inside of the sheet pile alignment is excavated to the proposed footing bottom line. H-shape steel wales are fixed to the innerside of the steel sheet pile wall. Cobble stones or sand and levelling concrete are placed. Near the excavation sufficient steel sheet plates should be stocked so as to be used for a temporary cover over the excavation so that one lane carriageway can be secured temporarily for traffic in day time.

(2) Pile heads should be treated as early as possible after the pile concrete is placed. This way is very effective and helpful in shortening the construction time.

(3) After rebars are assembled, forms are set and anchor bolts are fixed, the footing concrete is placed. To make accurate position of the anchor bolts, templates should be attached to the surface of the footing.

5. Preparation for Steel Structure

(1) The total weight of the steel used for this Project is estimated at about 6,800 tonnes of types SM58 and 50YB both of which are not available in Thailand, being imported from Japan.

(2) There are three steel fabrication companies in Thailand and among them Thai - Nippon Steel Engineering Construction Corp., Ltd. fabricated Ram IX Bridge which currently is the longest bridge span in the world. One of the objectives of

this Project is the technology transfer to local contractors. It has been verified, however, that the average monthly capacity of the above-cited fabrication company is judged to be 600 tons but has no experience in welding SM58 steel. In order to increase efficiency in the work, the cutting of all the steel materials should be done by means of computer in Japan.

(3) Estimated steel girders are classified by block as follows:

Bridge Width (m)	Span Length (m)	No. of spans	No. of Blocks	Maximum Weight/ Block (ton)
5.75	50	4	8	73
8.25	50	4	16	63
5.75	30	54	54	25
8.25	30	28	56	23
8.25 - 11.5	30	10	20	24
5.75	13	6	6	7
8.25	11	4	4	8
	Total:	110	164	

(4) Steel members consisting of 164 girder blocks and 43 piers will be fabricated both in Japan and Bangkok and at field fabrication yards near the construction site. Those steel members will be refabricated to 30m long members to be transported for erection.

It has been learned that Thailand has no experience in welding of high-strength steel material. Therefore, it is decided that 50m-orthotropic steel deck girders and cylinder-shape large diameter steel pier columns for which the above-mentioned welding technology is required, be manufactured in Japan. However, other steel members will be processed in Thailand.

(5) The decking for the 30m spans will be concrete prefabricated slabs. These are used to provide cost reduction, noise reduction, ease for maintenance of pavement and to increase the use of local materials.

6. Bridge Pier

The weight of one steel pier will range from about 30 to 110 tons. Steel piers will be dismembered in the factory and carried to the field fabrication yard. A small size pier will be refabricated into one complete pier in the yard and on the site it will be bolted onto the footing, which will afterwards be backfilled and the ground compacted. A large size pier will be refabricated in the yard into major components, column and brackets, and then the column will be bolted onto the footing and the brackets fixed to the column.

7. Approach Abutment and Retaining Wall

(1) After PC or RC piles are driven, the abutment is formed on them with prefabricated concrete members. For the abutment to be provided for the approach at the east end, part of the abutment structure might be shaped to avoid the existing box culvert drain (2.7 x 2.75m).

(2) For the approach, a volume of earth fill will be very small and retained by a precast concrete plate wall.

(3) The works of abutment, retaining wall and pier column of the approach ramps will be started all simultaneously and completed within one month. During this construction period, two lanes in each direction will be secured.

(4) The members of retaining wall, approach slab, abutment and bridge slab are all of prefabricated concrete, and necessary cast-insitu concrete will be designed for high early strength.

8. Erection of Standard 30m-span Girder

(1) 30m long girders assembled at the Lumpini Park yard will be transported for erection. The planned average in one day is for one 5.75m wide girder and one 8.25m wide girder to be erected. The field fabrication yard must have such space and facilities that 6 spans can be assembled.

(2) In the standard span sections, concrete decks, water-proofing, handrailing and pavement are provided after the erection of girders. Jet cement is grouted into the joint between the steel girder and the concrete precast decks.

9. Erection of 50m-span Girder over Intersection

At the intersection one half span of a 50m-span girder will be erected and then the remainder connected. Therefore two temporary supports are required to support these two half girders at an intersection. During lifting, crossing traffic will be interrupted. The ancillary work for the underside and painting work of the girder will be conducted on staging suspended from the girders, thus keeping the traffic flowing underneath.

10. Pavement

Asphalt concrete of normal kind is recommended for the bridge surface. The deck of 30m-span sections is of concrete plates, over which water-proof membrane is applied, and 7cm-thick asphalt concrete is placed thereon in two layers. This method is very favourable from the points of low cost, noise reduction and ease of maintenance.

For the 50m-span sections, to reduce the structure weight and construction cost and time, steel orthotropic deck is planned as the girder and decks over which sheet-formed water-proof agent is applied and 7cm thick asphalt concrete is placed thereon in two layers.

The reasons for the planning of asphalt concrete of normal kind are as follows:

(1) Usually 'goose asphalt', dense waterproof asphalt is suitable for the surface of steel orthotropic deck from the points of flexibility, water-proof, adhesiveness, etc. There is no experience in goose asphalting in Thailand, and suitable equipment necessary for preparation is not available in Thailand. Introduction of such equipment is very expensive because the application area is as small as 24,000 m^2.

(2) Epoxy resin (about 5 - 7cm thick) was applied to the pavement for Thai-Belgian Bridge. This type of application is difficult to maintain the necessary quality control, and a thin layer on the steel orthotropic deck might be easily damaged under the heavy traffic. The Thai-Belgian Bridge which was completed in April 25, 1988 has still such a trouble as to require continuous repair since part of its pavement has started to peel off about six months after its completion.

11. Drainage

Drainage system will be provided to collect the rainwater on the bridge surface and lead it down to the foot of the pier column. The drain pipes should be arranged so as not to be seen from outside.

12. Illumination

Location of each lighting pole should be decided based on the MTS Skytrain structure design which is not available yet. It should be noted that relocation of lighting poles may be required on commencement of the MTS project.

13. Traffic Management

As discussed in Section 4-4-2, the traffic management for this Project can be divided into the following six sections.

Position	Section Length	Daily Construction Hours	Traffic lanes possible to open during construction	Traffic lanes possible to open in day time
a. Approach section at West end	190m	21:00-05:00	8.6m (3 lanes)	8.6m (3 lanes)
b. Normal viaduct section (span 30m)	340m	21:00-05:00	10.1m (3 lanes)	13.1m (4 lanes)
c. Intermediate approach section	170m	24 hours continuously	7.1m (2 lanes)	7.1m (2 lanes)
d. Normal viaduct section (span 30m)	550m	21:00-05:00	10.1m (3 lanes)	13.1m (4 lanes)
e. Intersection (span 50m)	150m	21:00-05:00	--	--
f. Approach section at East end	180m	24 hours continuously	6.1m (2 lanes)	6.1m (2 lanes)

The above table is assessed in terms of the number of lanes required for the peak hours traffic, and the capacities of respective direction-wise carriageways are as follows:

	East-bound	West-bound
Approach section at West end	OK. Possible to secure 3 lanes.	OK. But a little insufficient with 3 lanes.
Siphraya - Surawong: Normal viaduct section	OK. Possible to secure 3 lanes.	OK. Possible to secure 3 lanes.
Intermediate approach	2 lanes can be secured. A little insufficient.	Insufficient with 2 lanes secured.
Surawong - Silom: Normal viaduct	3 lanes are insufficient. Even 4 lanes are a little insufficient in day time.	A little insufficient with 3 lanes.
Silom - Sathon: Normal viaduct section	3 lanes are insufficient. Even 4 lanes are a little insufficient in day time.	A little insufficient with 3 lanes.
Approach section at East end	Absolutely insufficient with 2 lanes	Insufficient with 2 lanes

(1) The west-bound 2 lane width of the intermediate approach section seems insufficient. Since additional lane can not be provided on the sidewalk, the excess traffic about 1,000 PCU/hour must be detoured.

(2) Between Surawong and Silom, the west-bound 320m long carriageway along the normal viaduct section must be supplemented with additional lane by placing steel plate cover in daytime, and a detour road will be required between Chulalongkorn University and Royal Sports Club.

(3) For the east-bound approach section at the east end, a 2-lane wide carriageway is absolutely insufficient. Following measures will be required:

1) A temporary road is provided in the south of Lumpini Park.

2) Part of the traffic should be detoured to the existing northern road of the same park to supplement the capacity of the temporary road mentioned in 1) above.

(4) The west-bound 2-lane wide carriageway along the approach section at the ending point is insufficient. Following measures will be required:

1) Provision of a temporary road is considered on the existing sidewalk which has 7 - 8m width.

2) If the above measures is impossible, a detour road must be provided.

Note: At the subsequent detail design stage further study will be conducted in detail of the availability of detour roads discussed above to supplement the insufficient traffic lanes.

b. Construction Supervision Plan

1. Construction Control Plans

The three major controls in construction supervision are time control, cost control and quality control. Others are safety control, site environment control, site administration and reporting. In addition to these, labour control, equipment control and material procurement control are important in the case of contractors.

(1) Time Control

It is important in the time control to always find where the critical path exists. This can be solved by regular coordination between contractor, supervision team and owner on the condition that the three should have the same soft wear and data for CPM network analysis by computer and that each should monitor work process in their own ways.

(2) Cost Control

In the monthly report scheduled quantity, contract unit price, cumulative quantity, cumulative remunerable amount, cumulative total paid amount, quantity to be procured and amount due are filled up in terms of all work items. Usually there are many work items, some hundreds, and attention should be concentrated on the cost control for more important and large value work items.

(3) Quality Control

Quality control will prove its real worth if each of its procedures is strictly observed. If failures are continuously found, construction will not make progress.

An adequate screening system should be set up to avoid the occurrence of failures. Not only laboratory, testing apparatus, testing staff and test sheets should be provided, but also careful preparation and prior checking to detect errors and mistakes at each stage of the construction should be established. Once one failure has been found, the cause of it must be detected and the necessary measures taken to prevent re-occurrence.

(4) Safety Control

Safety control is a cost extra, but the cost for preventing damage or injury to third parties should be used for provision of facilities such as safety torches, barricades, etc.

(5) Site Environment Control

The construction site lies in the middle of the main street in Bangkok. Events to be avoided are such as soil being carried by truck tyres and spread over the surface of the street, which will make the environment dusty. Adequate protection should be provided, such as placing steel plates, provision of soil scraping pit, assignment of sweepers and water spraying.

Along the boundary between the construction area and the adjacent open carriageway, sufficient number of concrete blocks and barricades should be provided. At night flashing warning lights should be attached to them.

2. Supervision Staff and Office

The engineers assigned for the construction supervision are considered as below taking into consideration difficult site condition and day and night construction.

Japanese Staff

Superstructure Engineer	:	10 month x 2 men = 20man/month
Substructure Engineer	:	8 month x 2 men = 16man/month
Road Engineer	:	15 month x 2 men = 30man/month
Final Handover	:	2 month x 2 men = 34man/month
	Total:	70man/month

Thai Staff

Structure Engineer	:	16 month x 4 men = 24man/month
Road Engineer/Surveyor	:	16 month x 2 men = 32man/month
Material Engineer	:	16 month x 2 men = 32man/month
Pavement Engineer	:	8 month x 2 men = 16man/month
Clerical	:	16 month x 5 men = 48man/month
	Total:	152man/month

The space of the office is estimated to be about 200m^2.

c. **BMA (DPW) Task Force Organization**

On April 25, 1988 the Thai - Belgian Bridge was completed successfully, on the basis of which DPW would organize the same or similar task force for the construction of the Rama IV viaduct.

Fig. 4-4-6 shows the organization of the DPW task force at the time of construction of the Thai - Belgian Bridge. The Deputy Director of DPW was assigned as the project manager, and two assistant project managers assigned to cover the two shift operations, day and night.

For this Project, which is greater in length, longer in construction time and deemed to include more problems than the Thai - Belgian Bridge, sub-sections should be added to each section so as to cope with a wider variety of problems.

4-4-4 Procurement Plan

a. **Materials Procurement**

The materials that can be procured in Thailand shall, in principle, be procured in Thailand.

1. Materials Locally Available

The following materials have been found available in Bangkok and they are good in quality and sufficient in quantity.

(1) Concrete (ready mixed), cement and aggregates

(2) Concrete precast products

(3) Forms

(4) Reinforcing bar

(5) Asphalt material for pavement

(6) Traffic signal devices and traffic signs

(7) Bonded rubber bridge bearings

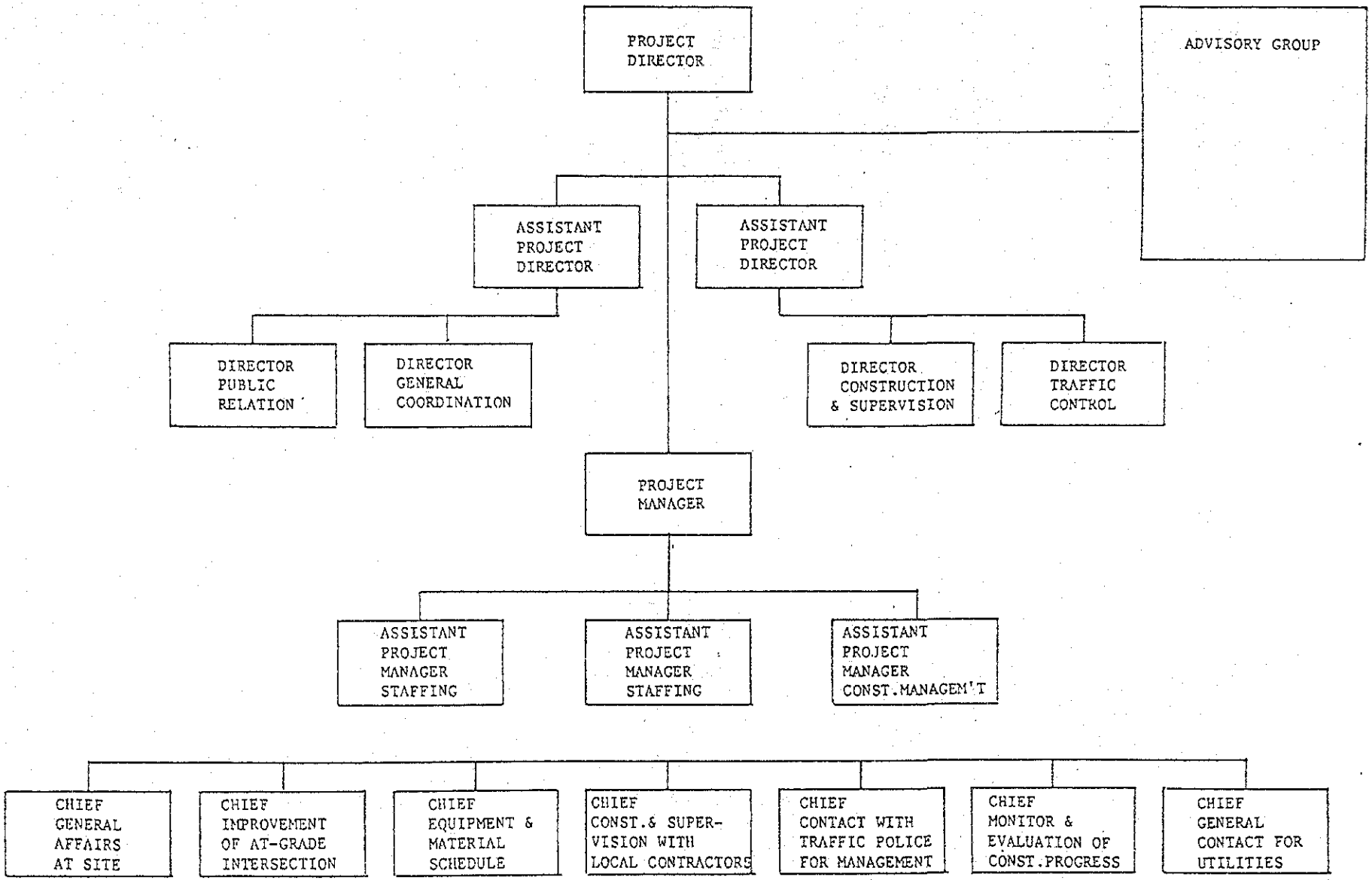


Fig. 4-4-6 Organization of Thai - Belgian Bridge Construction of BMA

2. Materials from Japan

The steel materials to be used for both superstructure and piers of the viaduct shall in principle, be brought from Japan for the following reasons:

(1) Steel materials noticed in Bangkok are all imported and no mill-sheets or quality tags are attached thereto.

(2) It has been estimated that procurement of steel materials in large quantity in short delivery period is not possible in Bangkok.

(3) High tensile strength steel which must be used for part of the superstructure is not available in Bangkok.

b. Procurement of Construction Equipment/Facilities

It has been found that in Bangkok almost all construction plant and equipment are available by purchase or on a lease basis. Major machineries/facilities available are as follows:

(1) Large-size crane	:	Maximum capacity 350t can be rented (owned by Naka Service, Trailer Transport Co., Ltd., etc.)
(2) Low-wide floor trailer	:	Due to speciality, manufactured in Thailand or procured from Japan.
(3) Earth-auger machine	:	Found many units worn out and having a high trouble rate.
(4) Vibratory-hammer	:	ditto
(5) Gantry crane	:	ditto
(6) Road sweeper	:	BMA does not own. Cleaning can be done manually.

(7) Others

1) Testing apparatus : Should be brought from Japan. (for quality control of concrete, pavement, cast-in-place concrete pile, etc.)

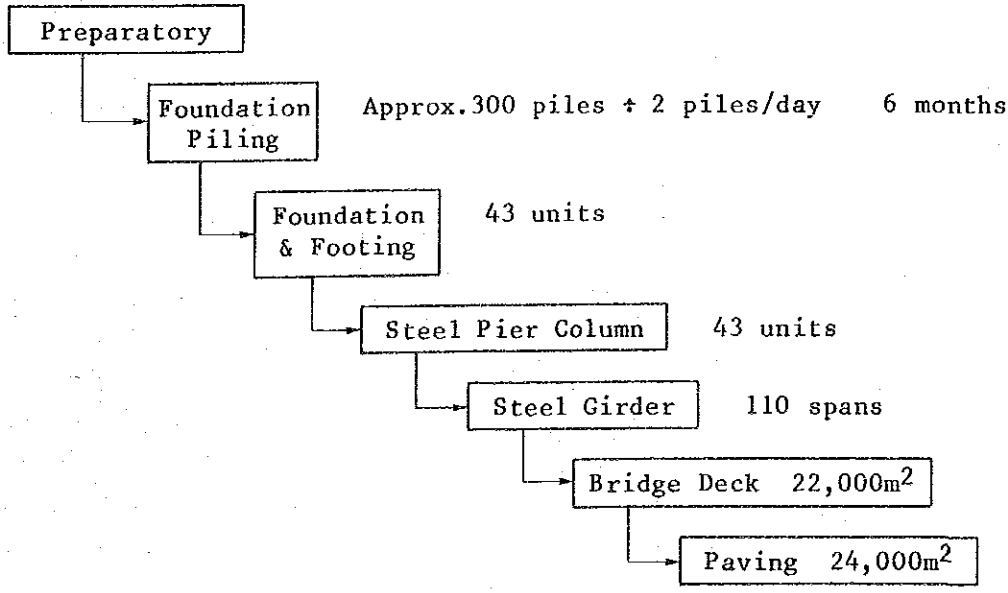
2) Steel cover plate : About 500 sheets that were used for the construction of Rama IX Bridge are available.

3) Safety facilities : Almost all available except flashing lights sheathed with vinyl tube.

4-4-5 Implementation Schedule

The implementation schedule for this Project will be subject to change as the final scope of work develops, relative to fiscal years, project implementation time, etc. Assuming that the Exchange of Notes for the Project occurs in May 1990 and that the construction is to be completed within two fiscal years, the implementation time schedule can be proposed as shown in Fig. 4-4-7.

It is certain, however, that the actual construction will consist of the process of major work items as illustrated below:



It is estimated that field fabrication, erection and deck placing of the steel girders will be greatest bottlenecks. The erection of one-span girders requires at least 4 days, and with two teams 7.5 months are needed with the completion of one span in two days. The number of teams that can be organized for one work item is limited in such a congested area as the project site.

Assuming that the above-illustrated work items, except preparatory work, require 7 months each and that the commencement of each work item is staggered by an average of 6 weeks, the total time to be taken will be: 6 weeks x 6 work items + 7 months + 2 months for restoration = 18 months, which covers two fiscal years.

In addition, it usually takes 4 to 6 months from the date of commencement to procure all the steel, and that another month is required for shipping or transportation. All considered, an overall construction time period of 22 to 26 months is required.

In this Project, however, taking into full account the adjacent environment of the Project site, a period of 18 months has been assumed as the shortest possible construction time. Besides it is desirable that the substructure work should be performed in the dry season (October - May), and therefore, the commencement of the construction has been assumed in August or September. Based on the above discussions the construction schedule for this Project is as shown in Fig. 4-4-8.

Fig. 4-4-7 Implementation Time Schedule for Rama IV Viaduct Project (Draft)

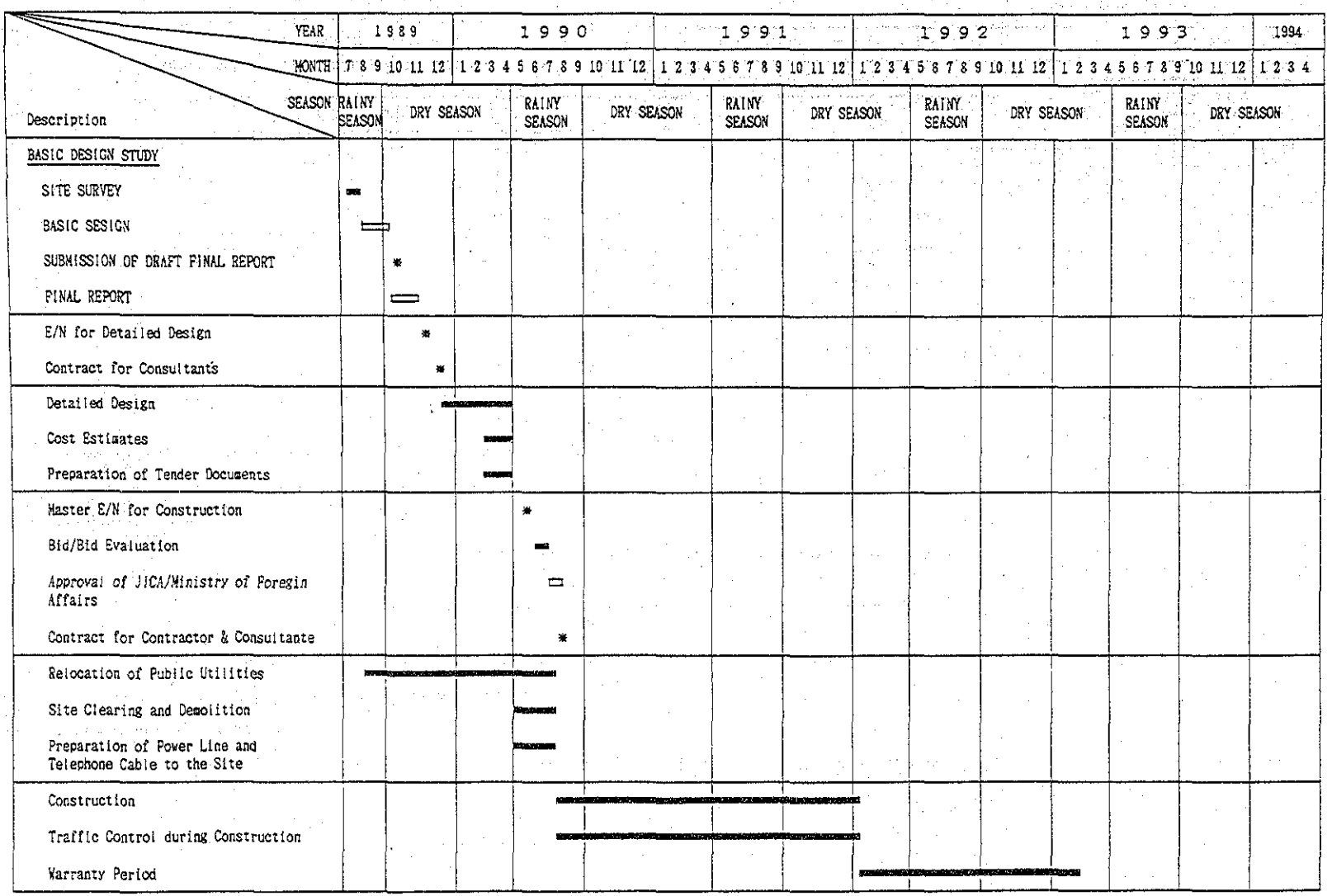
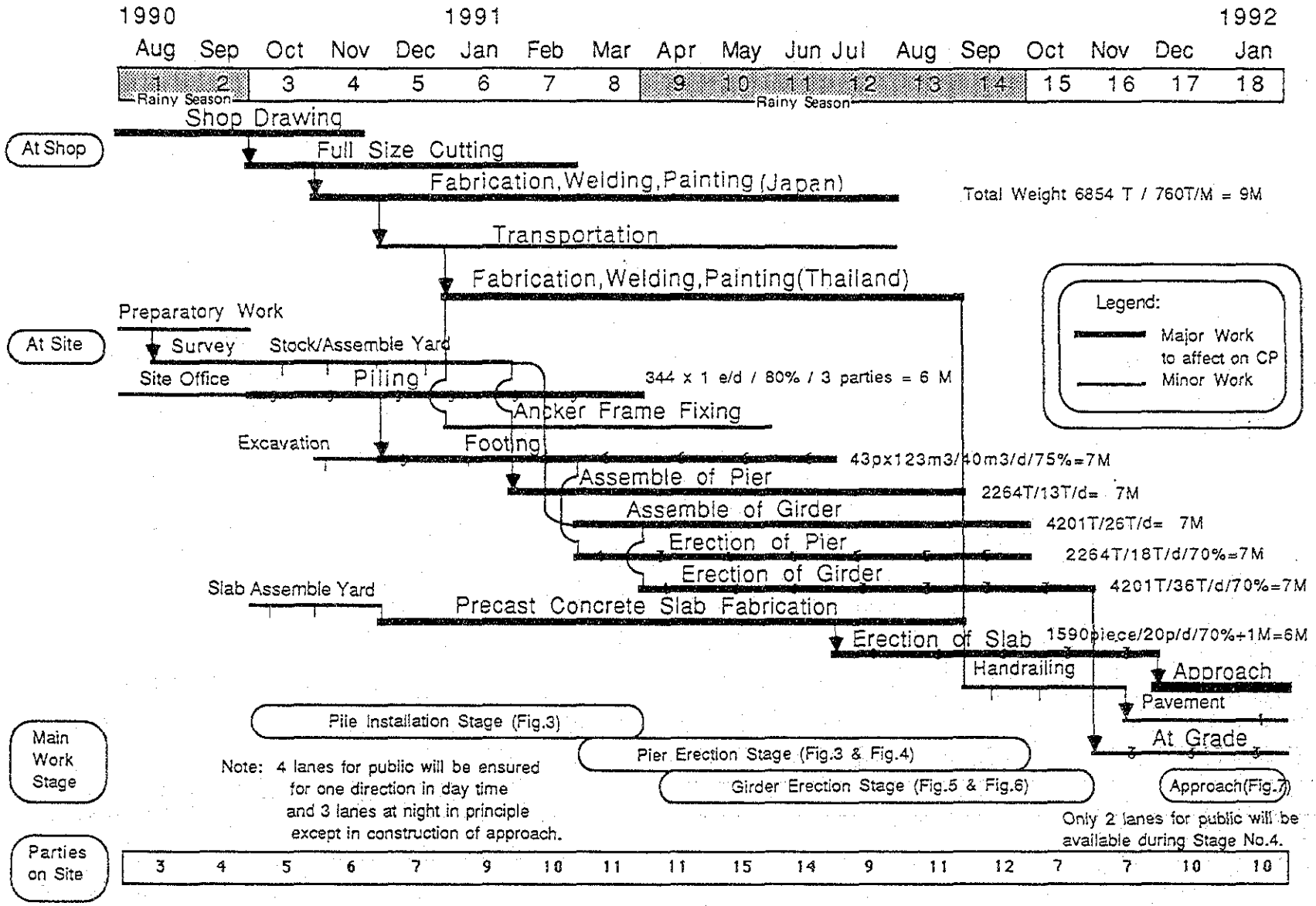


Fig. 4-4-8 Construction Schedule for Rama IV Viaduct



4-4-6 Scope of Work

a. Work Divisions

Work divisions which are to be carried out by the both governments are as follows:

1. Japanese Part of the Construction

(1) Construction of the foundation of the viaduct;

(2) Construction of pier columns and abutments;

(3) Construction of the retaining wall for approach and earth embankment;

(4) Construction of superstructure, deck, bearing; bridge surface pavement, expansion joints and handrailing, and provision of lane marking on the viaduct surfaces;

(5) Installation of drainage for bridge surface;

(6) Illumination over the viaduct surface and approaches and bridge underside lighting;

(7) Paving of the damaged surface of Rama IV Road due to the construction mentioned above;

(8) Provision of facilities to be used for traffic management during construction;

(9) Payment for the charges for installation and use of water, power and telephone of the site for the construction; and

(10) Consultancy services required for the implementation of the Project.

2. Thai Part of the Construction

(1) Displacement of existing public utilities which are deemed to hamper the construction (including water pipes, median strip fencing, bus stops, traffic signals and signs, guardrail, street lighting, trees, etc.);

(2) Removal of median and channel island;

(3) Expansion of water supply pipe, power line and telephone cable to be used for the construction to field fabrication yard and office site;

(4) Provision of spaces for the field fabrication yard enclosed with fence;

(5) Supply of power line for illumination to the viaduct and approaches;

(6) Repair of damaged pavement of at-grade road due to other causes than mentioned in a. 1. (7) above;

(7) Reinstatement of median, channel islands, traffic signals, re-programming of traffic signal sequence, traffic signs, guard rail, fence, separator, plantation, right-of-way stakes or monuments, lighting, etc. which have been displaced or removed due to the construction;

(8) End treatment of drained water from the bridge surface;

(9) Traffic control during construction; and

(10) Other undertakings shown below:

1) Ensuring prompt unloading, tax exemption, customs clearance at ports of unloading in Thailand and prompt internal transportation, to be paid under the Grant, therein of the products purchased under the Grant;

2) Exemption of Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Thailand with respect to the supply of the products and services under the verified contracts;

3) Accordance to Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contract, of such facilities as may be necessary for their entry into Thailand and stay therein for the performance of their works;

4) Proper and effective maintenance and use of the facilities constructed and equipment provided under the Grant; and

5) Bearing of all expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment.

b. Construction Plan of Works Undertaken by Thai Side

1. Work Items for the Thai Side

Displacement/removal of public utilities	- Main water pipes 400, 400 & 700mm dia. - Telephone cable - Power line - Trees - Median - Median strip fencing - Channel island - Bus stop - Pedestrian crossing bridge - Traffic signal - Traffic sign

Provision of spaces for site office and steel material to be fabricated and/or material stockpile with fences thereof.

Installation to site office, construction site and fabrication yard and stockpile	- Water pipe 50mm dia. - Power line 200KVA - Telephone line, 10 lines

Installation of drainage between the foot of pier column and the existing drainage system under the road.

Provision of power line to the panels for bridge illumination.

Additional traffic lights, as required.

Reinstatement of displaced public utilities	- Median - Median fencing - Channel island - Bus stop - Traffic signal - Traffic sign - Trees
Intersection improvement	- Pavement

2. Traffic Control and Management

Traffic control and management is required. Assuming that 4 policemen are on duty at one intersection by 3 shifts per day during the 15 month construction period, with additional about 8 policemen for the construction of the approach section in 2 months and additional 5 policemen for the guidance of heavy goods transportation for 10 months, a total of about 250 man-months of additional traffic police activity is required. Prior negotiation with traffic police is necessary.

3. Work Schedule of Thai Participation

	(Before Construction)			(During Construction)			
month	-10	-5	0	5	10	15	18
(Before Construction)							
Displacement of main water pipes	==========						
Removal of pedestrian crossing bridge			===				
Removal of other public utilities			===				
Security of spaces for fabrication yard and stockpile			=				
Provision of fence of the above spaces				=			
Installation of water pipe 50ϕ				=			
Installation of power line 200KVA				=			
Installation of telephone line, 10 lines				=			
(During Construction)							
Installation of drainage to existing system					=		=====
Provision of power line for illumination							======
Additional traffic lights							======
Reinstatement of public utilities							======
Pavement of Intersection							======
Traffic management			==========	==========	==========		

4-4-7 Project Cost Estimate

The Government of Thailand will be responsible only for the work items listed in Sub-section 4-4-6, b. of this Report. The cost of these works is estimated at ₿54.2 million.

CHAPTER 5: PROJECT EVALUATION AND CONCLUSION

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

5.1 Effects of the Project

Rama IV Road which involves the construction site of this Project directly links from the Bangkok Port to the centre of Bangkok in the east-west direction and is one of the most important major streets in the road network of the city. Great traffic concentrates on Rama IV Road with 10 lanes, forming the worst traffic congestion in Bangkok and hindering the development of vehicular transportation of Bangkok. The Report of the "Study on Road Improvement, Rehabilitation and Traffic Safety in Bangkok" was issued by JICA in March 1987. Its study result in a 10 year analysis period shows such high returns as with cost-benefit ratio: 2.64 and internal rate of return: 23.3%, and the study concluded that among the 11 intersection improvements selected the grade separation of Rama IV Road gives the largest effects of all in terms of both engineering and economic aspects. In the two years since then, the economic validity is considered not to have changed.

As mentioned in Section 3-2-4, by the implementation of this Project the following effects can be expected:

(1) For the stretch of 2.5km including the location of the Thai-Belgian Bridge (structure length: 330m), the traffic on Rama IV Road will form a smooth flow, divided into the through traffic on the viaduct and the (right and left) turning traffic on the at-grate road thus the traffic congestion will be mitigated with the increase in traffic capacity by about 20% although the number of lanes of Rama IV Road decreases from 10 to 8.

(2) Under the Rama IV Road viaduct, the traffic on Silom, Surawong and Siphraya intersections will be divided into the through traffic and the (right and left) turning traffic. Hence the present waiting time for signals 3 to 12 minutes at peek hours could be reduced to as short as one minute, thus the traffic congestion of the three intersections will be greatly reduced.

(3) From the matters mentioned in (1) and (2) above, the number of accidents of these intersections with Rama IV Road will be reduced, with a proportional reduction in delays.

(4) From the matters mentioned in (1), (2) and (3) above, the national cost for vehicular transportation, fuel consumption and users' travelling time will be greatly reduced.

(5) Due to the smooth traffic flow mentioned above traffic pollution such as exhaust gas and vehicular noise will be reduced and the living environments will be much better than the present.

(6) Up to now it is dangerous for pedestrians to walk across Rama IV Road due to the heavy traffic. After the completion of the Project, however, the through traffic can run on the viaduct which will make crossing the road by pedestrians much easier.

(7) After the implementation of the Project Rama IV Road will have more room for the traffic and the emergency transportation of patients to the Chulalongkorn Hospital will be made more easily.

5-2 Conclusion

In view of the above mentioned effects, the implementation of this Project is indispensable not only for alleviating the traffic congestion on Rama IV Road, providing non-stop, smooth traffic flow, improvement to the adjacent living environments by reducing exhaust gas and vehicular noise and development of transportation in Bangkok but also enhancing the urban transport industry and economic situation.

In conclusion, it can be judged that early implementation of the Project with grant aid assistance from the Japanese Government is appropriate and worthwhile.

A P P E N D I C E S

A P P E N D I C E S

			Page
Appendix 1.2.1	:	Members of the JICA Teams	A-1
Appendix 1.2.2	:	Schedule of Study Team	A-3
Appendix 1.2.3	:	Minutes of Discussions, April 3, 1989	A-7
Appendix 1.2.4	:	Minutes of Discussions, July 27, 1989	A-11
Appendix 1.2.5	:	Minutes of Discussions, October 19, 1989 ...	A-18
Appendix 1.3.1	:	List of Persons Met	A-22
Appendix 2.1.1	:	Country Data	A-25
Appendix 3.2.1	:	Major Works of Topographic Survey	A-34

Appendix 1.2.1: Members of the JICA Teams

	Name	Title	Present Position
(1)	The Project Formulation Survey Team (March 26 - April 4, 1989)		
1.	Mr. Takuo KIDOKORO	Team Leader	Deputy Director, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs
2.	Mr. Kazuya OHSHIMA	Road Planning	Advisory Office, Engineering Department, Hanshin Expressway Public Corporation
3.	Mr. Fumio HAKAMADA	Bridge Structure	Chief Engineer, Osaka Dai-ichi Design Department, Hanshin Expressway Public Corporation
4.	Mr. Hiroaki NAKAGAWA	Implemention Plan	Staff, Grant Aid Planning Division, Grant Aid Planning Survey Department, JICA
(2)	The Basic Design Study Team for Field Survey (July 19 - August 17, 1989)		
1.	Mr. Kazuya OHSHIMA	Team Leader	Advisory Officer, Engineering Department, Hanshin Expressway Public Corporation
2.	Mr. Minoru KISHIRO	Road Planning	Engineer, Design Section, Osaka 2nd Construction Bureau, Hanshin Expressway Public Corporation
3.	Mr. Akihiro MATSUMOTO	Planning Control	Staff, 2nd Basic Design Study Division, Grant Aid Planning and Survey Department, JICA
4.	Mr. Kunio TESHIMA	Chief Expert, Overall Design Management	Transportation & Development Department, Pacific Consultants International
5.	Mr. Kooki KANEDA	Expert, Construction Management	Transportation & Development Department, Pacific Consultants International

	Name	Title	Present Position
6.	Mr. Kunio SHIBATA	Expert, Structural Engineer (Super-structure)	Bridge & Structure Design Section, Transportation & Development Department, Pacific Consultants International
7.	Mr. Takashi CHUJO	Expert, Structural Engineer (Sub-structure)	Bridge & Structure Design Section, Transportation & Development Department, Pacific Consultants International
8.	Mr. Kenji MARUOKA	Expert, Urban Road Engineer	Transportation & Development Department, Pacific Consultants International
9.	Mr. Hiroyuki ENDO	Expert, Cost Estimator	Transportation & Development Department, Pacific Consultants International

(3) The Basic Design study Team for Explanation of the Draft Report (October 15 - October 22, 1989)

1.	Mr. Kazuya OHSHIMA	Team Leader	Advisory Officer, Engineering Department, Hanshin Expressway Public Corporation
2.	Mr. Tetsumi MURATA	Planning Control	Grant Aid Cooperation Division Economic Cooperation Bureau Ministry of Foreign Affairs
3.	Mr. Kunio TESHIMA	Chief Expert, Overall Design Management	Transportation & Development Department, Pacific Consultants International
4.	Mr. Kooki KANEDA	Expert, Construction Management	Transportation & Development Department, Pacific Consultants International
5.	Mr. Kunio SHIBATA	Expert, Structural Engineer	Bridge & Structure Design Section, Transportation & Development Department, Pacific Consultants International

Appendix 1.2.2: Schedule of Study Team

Data (1989)	Activities
For the Basic Design Study Team (from July 19 to August 17, 1989)	
July 19 (Wednesday)	Mr. Ohshima and Mr. Kishiro departed from Osaka and remaining members from Narita. Arrived in Bangkok.
July 20 (Thursday)	Paid a courtesy call to JICA Bangkok and Japanese Embassy in Thailand. Paid a courtesy call to the Department of Technical and Economic Cooperation.
July 21 (Friday)	Made a visit to Asian Engineering Consultants Corp., Ltd. to entrust the topographic survey. Held a meeting with BMA to explain Japanese grant aid, study purpose and Inception Report. Had an internal meeting.
July 22 (Saturday)	Inspected the project site. Made a visit to Padeco, Thailand (consultant) to entrust the traffic count survey.
July 23 (Sunday)	Had an internal meeting.
July 24 (Monday)	Held a meeting with BMA counterparts. Had an internal meeting. Held a meeting with BMA side about the displacement of existing water pipes.
July 25 (Tuesday)	Paid a courtesy call to Deputy Governor of BMA. Paid a courtesy call to Governor of ETA. Had an internal meeting about the Minutes of Discussions. Attended BMA's dinner party.
July 26 (Wednesday)	Held a meeting with BMA about the Minutes of Discussions. Paid a courtesy call to MWA to explain necessary displacement of existing water pipes. Had an internal meeting.

Data (1989)	Activities
July 27 (Thursday)	Mr. Ohshima, Mr. Kishiro and Mr. Matsumoto visited JICA Office and Japanese Embassy to say good-bye. Confirmed the Minutes of Discussion with BMA. Minutes of Discussions was signed. Attended JICA's dinner party.
July 28 (Friday)	Mr. Ohshima, Team Leader, Mr. Kishiro, Chief Engineer and Mr. Matsumoto, Project Coordinator left Bangkok for Japan. Visited by SEAFCO (cast-in-place piling contractor) to explain their performance. Attended the meeting by BMA, ETA and MWA.
July 29 (Saturday)	Site Inspection to supervise the topographic survey.
July 30 (Sunday)	(Rest)
July 31 (Monday)	Prepared data for a meeting (about design criteria). Collected data. Had an internal meeting.
August 1 (Tuesday)	Interviewed ETA personnel about Rama IX Bridge: Fabrication and erection of steel bridge. Interviewed BMA personnel about the general specifications for improvement of intersections.
August 2 (Wednesday)	Interviewed BMA Traffic Engineering Division. Prepared data for a meeting. Collected data.
August 3 (Thursday)	Visited Thai - Nippon Steel Engineering & Construction Corp., Ltd. to get information on their material supply and fabricating capacity.
August 4 (Friday)	Had a meeting with BMA about standard cross section of roads. Collected data. Watched a video of Thai - Belgian Bridge Construction.

Data (1989)	Activities
August 5 (Saturday)	Inspected the site to discuss the method of traffic survey.
August 6 (Sunday)	(Rest)
August 7 (Monday)	Prepared data for a meeting with ETA about the position of MTS structures. Had an interval meeting. Collected data.
August 8 (Tuesday)	Had a meeting with Asian Engineering Consultants Corp., Ltd. to discuss the adoption of BMA's bridge design loading.
August 9 (Wednesday)	Inspected the traffic survey. Checked the collected data.
August 10 (Thursday)	Participated in the meeting held in the office of BMA Deputy Governor between BMA and ETA. Confirmed BMA's bridge design loading. Had a meeting with BMA side about BMA's general specifications for improvement of intersections.
August 11 (Friday)	Checked the collected data.
August 12 (Saturday)	Discussed with the Surveyor about the results of topographic survey.
August 13 (Sunday)	Inspected the site.
August 14 (Monday)	Held a meeting with BMA about the data collected.
August 15 (Tuesday)	Held a meeting with DPW Director about the data collection. Had a meeting with Mr. Matsuda, Secretary of Japanese Embassy, Mr. Kato, Deputy Director of JICA Office and Mr. Miyamoto, JICA Coordinator about the progress of the Basic Design Study survey.

Data (1989)	Activities
August 16 (Wednesday)	Signed the Minutes of Discussions about the data collection.
August 17 (Thursday)	Departed from Bangkok and arrived at Narita.
For the explanation of the draft report (from October 15 to October 22, 1989)	
October 15 (Sunday)	Mr. Ohshima departed from Osaka and remaining Members from Narita. Arrived in Bangkok.
October 16 (Monday)	Paid a courtesy call to JICA Bangkok and Japanese Embassy in Thailand. Visited BMA and held a meeting there to explain the draft report. Had an internal meeting about the result of the meeting
October 17 (Tuesday)	Paid a courtesy call to Deputy Governor of BMA. At BMA, had a meeting with ETA, MWA, MEA, CAT, TOT and DTEC to confirm the centre clearance of the viaduct for the sky train scheme and the relocation of respective existing utilities. Had an internal meeting about the result of the meeting.
October 18 (Wednesday)	Had an internal meeting to prepare Minutes of Discussions. Had a meeting with BMA about Minutes of Discussions.
October 19 (Tuesday)	Had a meeting with BMA about Minutes of Discussions. Confirmed Minutes of Discussions with BMA.
October 20 (Friday)	Visited BMA to say good-bye. Visited JICA Office and Jpanese Embassy to say good-bye. Visited DTEC to report of future procedure for the Project.
October 21 (Saturday)	Made a comparative study of structure BMA had requested.
October 22 (Sunday)	Departed from Bangkok and arrived at Narita.

Appendix 1.2.3: Minutes of Discussions, April 3, 1989

MINUTES OF DISCUSSIONS

ON

THE PROJECT FOR RAMA IV VIADUCT CONSTRUCTION

IN

BANGKOK, KINGDOM OF THAILAND

In response to the request made by the Kingdom of Thailand for the Project of Rama IV Road Viaduct Construction (hereinafter referred to as "the Project"), the Government of Japan has sent, through Japan International Cooperation Agency, a Project Formulation Team for grant aid programme headed by Mr. Takuo Kidokoro, Assistant Director of Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, from March 26th to April 4th, 1989.

The team had a series of discussions on the Project with the authorities concerned of the Kingdom of Thailand, and conducted a field survey at the site.

As a result of the discussions and the survey, both parties have agreed to recommend to their respective Governments that the major points of understandings reached between them as attached herewith should be executed towards the realization of the Project.

Bangkok , April 3, 1989

Takuo Kidokoro

Mr.Takuo Kidokoro

Leader
Project Formulation Team
Japan International Cooperation Agency

Wicha Jiwalai

Dr.Wicha Jiwalai

Deputy Governor
Bangkok Metropolitan Administration

wicha

A T T A C H M E N T

1. Objective of the Project

The objective of the Project is to construct viaduct in order to smoothen and improve the traffic flow along Rama IV Road.

2. Executing Agency of the Project

The executing agency for the implementation of the Project is the Department of Public Works, Bangkok Metropolitan Administration (BMA).

3. Site of the Project

The location of the Project is from the intersection of Si Phraya road to that of Silom road along Rama IV road as shown in Annex 1.

4. Outline of the Project

4.1	Super structure and column	:	Steel structure and not to be connected with any structure of other projects.
4.2	Foundation	:	Cast-in-place concrete pile and not to be connected with any structure of other projects.
4.3	Design standards	:	Follows JICA Feasibility Study Report submitted to BMA in March 1987.
4.4	Number of lanes	:	4 lanes, partly 2 lanes.
4.5	Total length	:	Approximately 1.5 kms.

5. Japan's Grant Aid System

The Thai side has understood Japan's grant aid system explained by the team including a principle that a Japanese consultant firm and a Japanese general contractor should be used for the implementation of the Project.

6. Measures to be taken by the Government of the Kingdom of Thailand

The Government of the Kingdom of Thailand will take necessary measures as listed in Annex 2 on condition that the grant aid by the Government of Japan is extended to the Project.

ANNEX 1

Location Map

A N N E X 2

Necessary measures to be taken by the Government of the Kingdom of Thailand

Basic Design Stage

To make available sufficient information for basic design such as:

- MTS information
- Underground utility investigation
- etc.

Implementation Stage

<1> To make a construction site clear from any obstacles prior to the commencement of the construction.

<2> To provide enough space for construction management such as temporary offices, working area, stockyard and other utilities.

<3> To ensure prompt unloading, tax exemption and customs clearance of materials and equipments under the grant aid at the port of disembarkation in Thailand and also to facilitate the internal transportation of them.

<4> To exempt Japanese nationals engaged in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Thailand with respect to the supply of the products and the services under the verified contracts.

<5> To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into Thailand and stay herein for the performance of their work.

<6> To bear all the expenses other than those borne by the grant.

Maintenance

To maintain the viaduct properly, once constructed under the grant aid.

Appendix 1.2.4: Minutes of Discussions, July 27, 1989

THE MINUTES OF DISCUSSIONS ON
THE BASIC DESIGN STUDY ON
THE PROJECT FOR RAMA IV VIADUCT CONSTRUCTION
IN BANGKOK
THE KINGDOM OF THAILAND

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a basic design study on the Project for Rama IV Viaduct Construction (hereinafter referred to as "the Project"), and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA"). JICA sent the Basic Design Study Team headed by Mr. Kazuya Ohshima, Advisory Officer, Engineering Department, Hanshin Expressway Public Corporation, to carry out the study from July 19 to August 17, 1989.

The Japanese Team had a series of discussions on the Project with the officials concerned of Thailand and conducted the field survey at the Project Site.

As a result of the study, both parties agreed to recommend to their respective Government authorities that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Bangkok July 27, 1989

Kazuya Ohshima
Leader
Basic Design Study Team, JICA

Dr. Wicha Jiwalai
Deputy Governor
Bangkok Metropolitan Administration

ATTACHMENT

1. Objective of the Project

The objective of the Project is to construct the Viaduct along Rama IV Road across the intersections at Si Phraya Road, Surawong Road and Silom Road in order to smoothen and improve the traffic flow on Rama IV Road.

2. Implementing Body

Bangkok Metropolitan Administration (BMA) is responsible for the implementation of the Project.

3. Construction Site of the Project

The Construction Site of the Project is located along Rama IV Road covering three intersections with Si Phraya Road, Surawong Road and Silom Road, as shown in Annex I.

4. Implementation

BMA has confirmed that when the implementation of Rama IV Viaduct started, no major disruption to the construction schedule should occur e.g. by the MTS Implementation of ETA and water pipes relocation of MWA, etc.

5. Outline of the Project is as follows:

Rama IV Viaduct

-	Total project length:	Approximately 1.5 kms
-	Superstructure:	Steel structure and not to be connected with any structure of other projects
-	Column pier:	Steel structure and not to be connected with any structure of other projects
-	Foundation:	Cast-in-place concrete pile, or, large-scale PC pile, and not to be connected with any structure of other projects

- Number of lanes: 4 lanes (2 lanes in one direction) for the stretch between the intersections with Silom Road and Surawong Road, and 2 lanes (one lane in one direction) for the intersection with Si Phraya Road. A 1.5 m wide space shall be kept between the both carriageways through the whole stretch.

6. Budget for Thai Side Undertakings

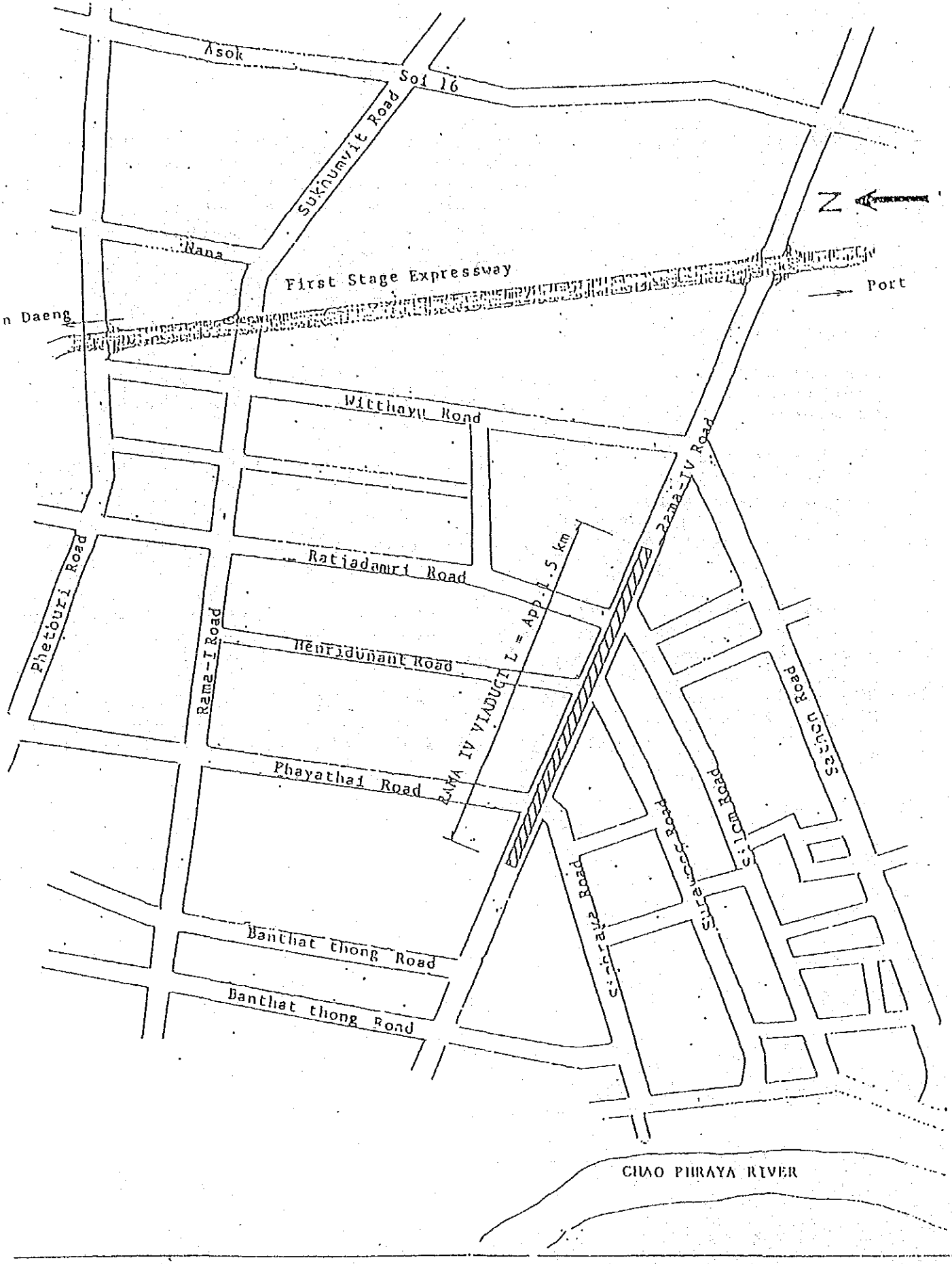
BMA has agreed to secure the budget for fulfilling the undertakings to be covered by Thai side before the Project has commenced.

7. BMA has agreed to take the necessary measures listed in Annex II on the condition that the Grant Aid by the Government of Japan is extended to the Project.

8. Both sides confirmed that the Japanese Study Team explained the Japanese Grant Aid Programme and the Thai side understood it.

9. The Government of the Kingdom of Thailand desired to be provided with training course for maintenance of the Viaduct in Japan under the Japanese Technical Cooperation Programme.

10. BMA shall forward the signed Minutes of Discussions to ETA and MWA for acknowledgement, confirmation and support in due course and submit them to the Japanese side during the stay of the Study Team.



K. Akashi
Wicha

ANNEX I PROJECT LOCATION MAP

ANNEX II

Necessary measures to be taken by the Government of the Kingdom of Thailand.

1. To execute the construction of the works specified in the undertakings to be covered by the Thai Side as shown in Annex III.

2. To ensure prompt unloading, tax exemption, customs clearance at ports of disembarkation in Thailand and prompt internal transportation, to be paid under the Grant, therein of the products purchased under the Grant.

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

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

5. To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant.

6. To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment.

ANNEX III: MAJOR UNDERTAKINGS TO BE TAKEN BY EACH GOVERNMENT

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1.	Displacement/demolition of public utilities		0
2.	Demolition of median and channel island, and clearing the site		0
3.	Girders, slab, bearings, surface pavement, expansion joints, handrailing, lane marking, etc.	0	
4.	Abutment, retaining wall, earth fill for approach	0	
5.	Deck drainage down to the foot of pier column	0	
6.	Deck water treatment from the foot of pier column		0
7.	Supply of power line for illumination to the viaduct and approaches		0
8.	Illumination above viaduct and approaches, and bridge underside lighting	0	
9.	Pier column, anchorframe, foundation piling	0	
10.	Reinstatement of median, channel islands, traffic signals, traffic signs, guard rail, fence, separator, plantation, right-of-way stakes or monuments, lighting, etc.		0
11.	(1) Pavement of damaged part by the Japanese bridge works of existing Rama IV Road surface	0	
11.	(2) Other part of damaged pavement		0

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
12.	Provision of spaces for the site enclosed with fence		0
13.	Traffic controlling during the construction		0
14.	Traffic management facilities during construction: cones, barricades, rope, twinklers, sign boards, and pre-warning signs.	0	
15.	Water Supply, Power line and telephone cable to the site for construction		0
16.	Charge for installation and use of water supply, power and telephone of the site during construction	0	

Note: Site means construction site, project office and material stockyard.

Appendix 1.2.5: Minutes of Discussions, October 19, 1989

MINUTES OF DISCUSSIONS

ON

THE PROJECT FOR RAMA IV VIADUCT CONSTRUCTION

IN

BANGKOK

In response to the request of the Government of the Kingdom of Thailand for Grant Assistance for the Project for Rama IV Viaduct Construction (hereinafter referred to as "the Project"), the Government of Japan decided to conduct a basic design study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Thailand the team headed by Mr. Kazuya Ohshima, Advisory Officer, Engineering Department, Hanshin Expressway Public Corporation from July 19 to August 17, 1989.

As a result of the study, JICA prepared a Draft Final Report of the Study and dispatched a Mission to explain and discuss it starting from October 15 to October 22, 1989.

Both parties had a series of discussions on the Report and agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Bangkok, October 19, 1989

Kazuya Ohshima
Leader
Basic Design Study Team, JICA

Dr. Wicha Jiwalai
Deputy Governor
Bangkok Metropolitan
Administration

ATTACHMENT

1. The Bangkok Metropolitan Administration (BMA), the executive agency of this Project on behalf of the Government of the Kingdom of Thailand, agreed in principle on the basic design proposed in the Draft Final Report.

2. BMA reconfirmed the Minutes of Discussions signed on 19th October, 1989 (Summary of Discussions is attached as Annex).

3. BMA requested 2.8m width of the center clearance as the final decision based on the coordination with the relevant authorities.

4. Both sides reconfirmed their respective responsibilities as indicated by Annex III of the Minutes of Discussions signed on July 27, 1989.

5. BMA agreed to be responsible for the budget allocation of works itemized in Paragraph 4 above and the undertaking thereof.

   5.1 In particular it is expected to take an immediate action on budget allocation, tendering process for the relocation of the water pipes.

   5.2 The relocation of the existing underground public utilities must be completed by August 1990.

6. BMA requested the Japanese Team to carry out the comparative studies of different types of bridge deck application i.e. steel deck, PC precast deck and, RC precast deck in order to reduce the overall weight of structure which may reduce both cost and construction time of the Project before the type of structure is selected.

   The Japanese Team agreed to carry out the study mentioned above, and revise the type of the structure instead of RC precast deck contained in Draft Final Report, in case the cost of the Project with steel or PC precast deck is less than that with RC precast deck.

   Both sides realized that the consensus of this matter should be reached before November 1989.

7. BMA desired to be provided with training course with regard to this Project under the Japanese Technical Cooperation Programme.

8. The Final Report (10 copies in English) will be submitted to the Government of the Kingdom of Thailand in November 1989.

K. Okuma Ueda

A N N E X

Summary of Discussions

1. The Japanese Team strongly requested the immediate action on the execution of removal/relocation of existing underground utilities, in particular, water pipes in order to ensure the start of the Viaduct construction.

   (Under normal conditions, it will take 10 months for the relocation of the water pipes under the median that is 2 months for preparation of tender documents, 2 months for tendering process and minimum 6 months for the execution.)

2. BMA expressed his anxiety for the aggravation of traffic flow during the construction of the viaduct, and desired to shorten the construction period.

   The Japanese Team agreed to recheck the time schedule of the construction at the detailed design stage. The Japanese Team also agreed to provide BMA with a perspective of the Project and a diagram showing a sequence of construction process, aiming to help increase the public understanding and obtain good cooperation from police, by the 2nd week of November 1989.

3. BMA requested 2.8m width of the center clearance as the final decision based on the coordination with the relevant authorities.

   The Japanese Team agreed on BMA's request but pointed out that the widening of the center clearance by 1.3 meters will affect the traffic lane width of adjacent at-grade road.

   The Japanese Team agreed that the modification of the center clearance from 1.5 meters to 2.8 meters will be incorporated in Final Report.

4. BMA requested the Japanese Team to carry out the comparative studies of different types of bridge deck application i.e. steel deck, PC precast deck and, RC precast deck in order to reduce the overall weight of structure which may reduce both cost and construction time of the Project before the type of structure is selected.

   The Japanese Team agreed to carry out the study mentioned above, and revise the type of the structure instead of RC precast deck contained in Draft Final Report, in case the cost of the Project with steel or PC precast deck is less than that with RC precast deck.

   Both sides realized that the consensus of this matter should be reached before November 1989.

K. Ohshima Wicha

5. BMA requested the Japanese Team to take a precaution measure on the expansion and dummy joints as proposed in the basic design on the ground that they may easily be damaged as BMA experienced from the past project. Moreover, the expansion joints at the main span (50.0 m) should be carefully designed as damage may occur due to the different type of decks and vibration.

The Japanese Team agreed to take into consideration the matter mentioned above at the detailed design stage.

****

Appendix 1.3.1: List of Persons Met

Japanese Side

Japanese Embassy in Thailand

Mr. Tomoyuki Abe	Counsellor
Mr. Hideo Matsuda	Fist Secretary
Mr. Yoshihiro Chiba	Second Secretary

JICA Office in Thailand

Mr. Tsutomu Saito	Director of Thailand Office
Mr. Keiichi Kato	Deputy Director
Mr. Hideo Miyamoto	Assistant Resident Representative

Thai Side

Department of Technical and Economic Cooperation (DTEC)

Mr. Piehet Sonntornpipit	Deputy Director-General
Mr. Aehari Yuktanandana	Chief, Japan Sub-division
Mr. Gecha Chaeehai	Programme Officer, Japan Sub-division
Mr. Hidetaka Kouzuki	Expert, DTEC

Bangkok Metropolitan Administration (BMA)

Dr. Wicha Jiwalai	Deputy Governor
Mr. Bampen Jatoorapreuk	Director of Department of Public Works (DPW)
Mr. Thanit Srichu	Senior Engineer, DPW
Mr. Nikom Prachnakorn	Director of Construction & Maintenance Division, DPW
Mr. Vitoon	Director of Planning Division, DPW
Mr. Worawit Rothong	Director of Construction Control and Supervision Division, DPW
Mr. Suphot Phongkidakarn	Head of Public Works Planning Sub-division, DPW
Dr. Prapon Vongvichien	Chief of Traffic Management Sub-division, Traffic Engineering Division

Mr. Jumpol	Chief of Maintenance Section
Mr. Yonchoke Sukwarg	Chief of Engineering Design Section 2, Design Division, DPW
Mr. Chirasak Ninchaikowit	Civil Engineer, Design Division, DPW
Mr. Chailurt Panjatewakupt	Civil Engineer, Public Works Sub-division, DPW
Mr. Supote Raweesangsoon	Civil Engineer, Public Works Sub-division, DPW
Mr. Somchai Takasiyaman	Civil Engineer, Design Division, DPW
Mr. Nipon Noeimuangpak	Civil Engineer, Public Works Sub-division, DPW
Mr. Mongkon Jesadanon	Civil Engineer, Public Works Sub-division, DPW

Expressway and Rapid Transit Authority of Thailand (ETA)

Mr. Charan Burapharat	Governor of ETA
Mr. Pisuth Na Nakorn	Deputy Governor for Engineering
Dr. Teeraphong Attajarusit	Director of Technical Department
Mr. Yutharusak Srihiran	Chief of Railway Design
Mr. Vichitr Vatcharindr	Chief of Railway Design
Dr. Toshihiko Naganuma	Expert, ETA
Mr. Nantachai Yuktanon	Civil Engineer
Mr. Chitisak Visatsuranan	Civil Engineer
Mr. Chaisit Kururatana	Civil Engineer
Mr. Sonchai Takasiyanan	Civil Engineer
Mr. Jirasak Nilchaikovitaya	Civil Engineer
Mr. Banchai	Civil Engineer
Mr. Piboonsak	Civil Engineer

Metropolitan Waterworks Authority (MWA)

Mr. Swit	Governor of MWA
Mr. Prasan Vantanakon	Senior Engineer
Mr. Santi Sonboonviboon	Senior Engineer

Metropolitan Electricity Authority (MEA)

Mr. Montree	MEA Senior Staff
Mr. Prapon	MEA Senior Staff
Mr. Manns	MEA Senior Staff

Communication Authority of Thailand (CAT)

Mr. Prayuth	CAT Senior Staff
Mr. Sompoh	CAT Senior Staff

Telephone Organization of Thailand (TOT)

Mr. Savong	TOT Senior Staff

Asian Engineering Consultants, Corp., Ltd.

Mr. Somchai Achavanuntakul	Managing Director
Mr. Boonchai Chittikuladilok	Director
Mr. Krai Tungsanga	Senior Geodetic Engineer

Padeco, Thailand

Mr. Yuichiro Motomura	President
Mr. Surapong Laona-Unya	Senior Traffic Analyst

Appendix 2.1.1: Country Data

1. Population (in 1988)

   54,960,917 : Male 27,574,256, Female 27,386,661

2. Land Area : 513,115km^2

3. Religion

   Buddhists : 95% of the total population
   Muslims : 4%
   Christians : 0.6%

4. People : Mostly Thai followed by Laotian, Chinese, Malaya, Khmer, Meo, Karen, etc.

5. Language : Thai language

6. Overseas Chinese : About 5 million Chinese are estimated to reside in Thailand.

7. Education and Students

   Education System:

   Kindergarten
   Elementary school (6 years: compulsory education)
   First-term middle school (3 years)
   Last-term middle school (3 years)
   University (4 - 6 years)
   Vocational school (2 - 4 years)
   Military, police schools (5 years)
   Teacher training college (2 - 4 years)

   School year begins in May or June.

   Number of universities

   16 national universities and 25 private universities

Number of students/pupils in 1986 school year

Elementary school children: 7,160,949 persons (66.79% of total children school age)
First-term middle school pupils: 1,277,619 persons (11.92%)
Last-term middle school pupils: 907,231 persons (8.46%)
University/high education students: 348,487 persons (3.25%)
Others: Post-graduate school students: 17,818 persons
Pre-school (kindergarten) children: 1,009,131 persons

Number of illiterate registered in 1983 - 84: 672,759 persons was reduced to 148,157 persons in September 1987.

8. Transportation

(1) Land Transport

a. Railway is owned and operated by the State Railway of Thailand, having total 3,728 route kilometres as of September 1987.

b. Road network consists of special national roads (251km long), normal national roads (15,820km), provincial roads (31,991km), feeder roads (107,867km) and expressways (27km). The length of paved national roads in 1987 is 14,833km.

(2) Water Transport

The Chao Phraya River and its tributaries and those of the Mekong River are linked by means of canal network which plays an important role in the transportation of agricultural and live stock products. At present the Bangkok Port is a main commercial port, and deep-sea port projects are going on at Sattahip, Laem Chabang, Songkhla and Phuket.

(3) Aviation

State-owned Thai Airways International operates the whole aviation services which is the second largest after Japan Airlines in Asia. Thailand has international airports in Bangkok, Chiang Mai, Hat Yai and Phuket, and 30 domestic airports.

9. Economy

(1) Finance

a. National Budget

Fiscal year from October to September

1986 : ₱215.7 billion
1987 : 227.5 billion
1988 : 243.5 billion
1989 : 285.5 billion

Breakdown of 1989 expenditure budget:

Agriculture	:	₱21,327.60 million
Mining and Manufacturing	:	913.90 million
Transportation and Telecommunication	:	14,810.00 million
Commerce and Tourism	:	1,392.70 million
Science, Technology, Energy and Environment	:	1,264.40 million
Education	:	48,843.40 million
Public Health	:	12,447.90 million
Social Welfare	:	12,447.60 million
National Defence	:	50,605.50 million
Domestic Security	:	10,610.50 million
General Administration	:	44,335.70 million

b. Currency and Prices

The Baht is the unit of currency, and one baht equivalent to 100 Satang. The currency in circulation is as follows:

(Unit: Million Baht)

Year	Supply	Issue
December 1986	103,426.8	82,817
December 1987	132,395.7	98,681
December 1988	148,492.6	113,709.2

Rates of price increase against previous years:

1984	0.9%
1985	2.4%
1986	1.9%
1987	2.5%
1988	3.8%

(2) *Gross National Product (GNP), National Income, International Reserves.*

Gross Domestic Product (1972 prices)

	Amount (Million Baht)			Growth Rate (%)		
	1986	1987	1988	1986	1984	1988
Gross Domestic Product (GDP)	411,814	446,361	495,375	4.5	8.4	11.0
Net income from Overseas	-6,554	-6,449	-6,719	-	-	-
Gross National Product (GNP)	405,260	439,912	388,655	4.1	8.6	11.1
GNP per capita	7,697	8,207	8,960			

International reserves at the end of December 1988: US$12 million (equivalent to 4.3 month import amount)

(3) Industry and Raw Materials

a. Agriculture, Forestry and Marine Products Industries

The weight of these industries has dropped as the manufacturing sector and the retail sector have made a rapid progress (with rates of 21.44% and 15.95% to the GDP nominal production in 1981).

The area of cultivated land is 20,570 thousand ha, equivalent to about 40.1% of the total land area. It consists of paddy field (60%), dry field (23%), plantation (10%) and others. The farming population accounts for about 64% of the total population but it is on the decrease. The main products are as follows:

Main Agricultural Products

(Unit: 1,000 tons)

Item	1985	1986	1987	1988*
Paddy	20,599	19,026	17,072	20,060
Rubber	722	790	910	970
Maize	5,030	4,300	2,310	5,200
Topioca (root)	19,263	15,255	19,550	22,300
Sugarcane	24,000	24,441	27,200	30,000
Mung beans	323	301	267	280
Peanuts	166	169	158	165
Soybeans	308	350	312	440
Coconut	981	1,024	850	860
Cotton	102	57	74	81
Jute	266	240	212	169

* Estimated

Forest lands are decreasing in area: 221,707km^2 (43.21% of the total land area) in 1973 and 149,053km^2 (22.05%) in 1985. The timber cutting has been prohibited since 1981 and Thailand has been an importer of wood in the 1980s.

The marine products industry in Thailand consists of breeding for domestic consumption and sea fishing in the Gulf of Thailand and the Andaman Sea, with the quantities of about 2.0 - 2.5 million tons annually. Shrimp/prawn, cuttlefish, tuna, sardine, short-necked clam are canned and exported to various countries.

Water buffalos and cattle are raised for livestock farming as well as agricultural use. 80 million broilers were exported in 1986. Hogs and ducks are also raised. The production of dairy products amounted to about 62,000 tons in 1986 which is equivalent to 3.5 times that of 1980.

b. Manufacturing Industry

Export-oriented manufacturing has made a great progress. The main industrial products are as follows:

Production of Main Industrial Products

Item (Unit) \ Year	1986	1987	1988*
Sugar (1,000t)	2,607,186	2,432,214	2,864,741
Beer (1 million liters)	86,329	97,293	130,261
Cigarette (1,000t)	29,538	31,403	33,992
Textiles (1,000sq.yards)	1,054,262	n.a.	n.a.
Jute product (1,000t)	198,514	195,567	n.a.
Cement (1,000t)	7,913,662	9,850,367	11,514,410
Galvanized sheet iron (1,000t)	140,908	171,666	189,996
Tinplate sheet (1,000t)	104,433	119,319	147,337
Commercial vehicle (unit)	53,102	68,815	99,724
Passenger car (unit)	21,053	29,333	54,459

Note: n.a. not available

c. Electric Power

The total capacity in 1986 was 6,805 megawatts and the total production of electric power was 24.7 billion KWH in the same year. The generation plants installed are hydropower, thermal, gas turbine and diesel.

d. Mining Industry

About 40 kinds of mineral resources are produced; tin, gypsum, zinc ore, lead ore, fluorite ore, tungsten, antimony ore, barite, etc. Thailand has prospective oil and natural gas deposits in its inland area and the Gulf of Thailand, reducing the reliance of supply of energy on importation.

In 1986 the production of indigenous petroleum increased to about 20% of the total national oil consumption. Oil deposits exist in Kamphaeng Phet and Chiang Mai, and oil shell deposits in the north part of the country.

Natural gas is produced mainly in the Gulf of Thailand and its production in 1986 amounted to 127.8 billion cubic feet.

(4) Economic Development Plan

The Thai Government has put into force the following national 5-year plans:

The First Six Year National Economic and Social Development Plan (January 1961 - September 1966 with total development funds: ฿28.18 billion)

The Second Five Year National Economic and Social Development Plan (1966 - 1971 with total development funds: ฿57.52 billion)

The Third Five Year National Economic and Social Development Plan (1971 - 1976 with total development funds: ฿100.075 billion)

The Fourth Five Year National Economic and Social Development Plan (1976 - 1981 with total development funds: ฿252.45 billion)

The Fifth Five Year National Economic and Social Development Plan (1981 - 1986 with total development funds: ฿799.34 billion)

Thailand is currently under the Sixth Five Year National Economic and Social Development Plan (1986 - 1991). The main objectives are to achieve higher rates of economic growth (at least five percent per annum) than during the Fifth Plan, and also to improve the quality of life. There are three main priority areas of the development strategy designed to achieve these objectives:

a. Increasing efficiency by improving human resources, promoting science and technology, conserving natural resources, and optimizing management and administrative systems. The role of the private sector in development is to be limited while the role of the private sector will increase.

b. Improving manufacturing systems, marketing systems and infrastructural support in order to boost industrial productivity and diversification.

c. Increasing social equity by distributing income and progress through programmes to develop low income areas in an effort to reduce the economic and social disparities between urban and rural regions.

The Sixth Plan has placed more emphasis on export production than did previous plans. The private sector has been given a more active role which the government acts as a supporter, coordinator, and advisor to the private sector. Private sector investment has been targeted to grow at 8.1 percent per year and to account for 70 percent of Thailand's total investment during the current plan.

(5) Trade

Thailand exports agricultural products and manufacturing products. Main export items are as follows:

(Unit: ₱100 million)

Item \ Year	1986	1987	1988*
Rice	203.15	227.03	346.36
Rubber	151.16	205.39	259.84
Maize	92.61	39.28	36.62
Topioca products	190.86	206.61	216.85
Prawn/shrimp	43.91	57.49	95.53
Tin	30.96	23.44	22.42
Sugar	72.71	85.73	93.94
Integrate circuits	128.18	151.79	86.68
Textile and garments	312.68	485.55	583.79
Jewelry and ornaments	81.50	115.50	137.72
Total	1,307.72	1,597.81	1,879.75

* Estimated

Since 1985 the manufactured exports outranked the primary products exports. With the progress of the manufacturing in Thailand the import of raw materials, capital goods, crude oil, etc. has increased, which causes the trade loss of the country.

Since 1984 Thailand's major export markets were the U.S.A., Japan, Singapore, the Netherlands, West Germany, Hong Kong, etc., and major import markets Japan, the U.S.A., Singapore, West Germany, Malaysia, Taiwan, etc.

For Thailand Japan is the greatest exporter and the second greatest importer in the world. The balance between exports and imports shows that imports are always greater than exports.

Trade Balance

(Unit: ¥1 million)

Year	World-wide Trade			Trade against Japan		
	Export	Import	Balance	Export	Import	Balance
1985	193,366	251,169	-57,803	25,828	66,587	-40,759
1986	233,383	241,358	-7,975	33,134	63,656	-30,522
1987	299,853	334,209	-34,356	44,590	86,864	-42,274
1988*	402,838	487,871	-85,033	62,731	143,172	-80,441

* Estimated

(6) Assistance of Foreign Countries

Since the first 5-year economic development plan in 1961, Thailand has accepted regular overseas assistance: member countries of OECD, DAC and OPEC and international institutions such as World Bank, IDA, IMF, ADB, IFAD, EEC, UNPP, UNICEF, UNHCR, etc.

(7) Regulations for Alien Enterprise Activities and Employment of Foreigners

In August 1986 the existing law for employment of foreigners was in part simplified and the policy for induction of foreign capital was strengthened. In 1987 the regulation for alien enterprise activities was relaxed, the limit of business permit was postponed by 5 years, and the total capital brought for ordinary enterprise other than manufacturing was raised to five million Baht.

Appendix 3.2.1: Major Works of Topographic Survey

1. Centreline Survey

A tentative centreline for Rama IV Viaduct was set at the curb stone of the median for the purpose of profile and cross section survey. The beginning of base line was located about 300m west of Siphraya-Phaya Thai road intersection and the ending at about 400m east of Silom-Ratchadamri Road intersection.

The conventional method of second order accuracy traverse was used in the establishment of the horizontal control positions. The positioning stemmed from Station "J-0" with the coordinates as follows:

Northing (X coordinate)	1,518,573.129m
Easting (Y coordinate)	665,991.000m

The coordinates of this station are based on the Everest Spheroid, Indian Datum, Universal Transverse Mercator Grid Projection (UTM) Zone 47 with its central meridian at 99° East of Greenwich and was taken by scaling from RTSD map. Station "J-0" was adopted as the beginning of the plan coordinate system used in all the following survey controls of the Project.

Eighteen permanent marks were established utilizing the steel bolts embedded in concrete curb along both sides of the sidewalks of Rama IV Road. The total length of the traverse is 3,418.689 meters.

The closure error of traverse was of 1 to 183,790.

2. Levelling, Profile and Cross Section Surveys

The levelling originated from BMA's Benchmark "BM-124" located in front of Youth Center Building in the Compound of Lumpini Park with the elevation = +36.222m. This benchmark was established by the Department of Survey, Faculty of Engineering, Chulalongkorn University in 1986. The elevation equation between BMA Datum and the Mean Sea Level (Kolak Datum) is minus (-) 35.03 metres. As in this respect, the elevation of BM-124 shall be = +1.192 metres above mean sea level.

Third order criteria were used for the whole length of the Levelling observation. Elevations were brought to all of survey stations. Hence all survey stations can be utilized as horizontal and vertical control stations.

Profile and cross section were taken at each 20-metre chainage station, at all change information of the road and as frequently as necessary.

Cross sections at 20-metre interval were also taken along the cross roads of the major intersections. The cross sections were extended not less than 100 metres to the left and 100 metres to the right of the centreline of the Rama IV Road.

3. Topographic Map

The topographic map was prepared with the coordinate method by SAMMAGRAPHIC MICRO GRID II PLOTTER on the scale 1:200 with spots elevation at 20m intervals.

Houses, buildings, roads, traffic markings, traffic signs, road lightings, traffic signals, curbs, median, and all exposed utilities were shown on the topographic map.